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Services
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Hawkesbury District: Richmond - Windsor
Traffic Issues Paper

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SENSITIVE: NSW GOVERNMENT

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1.2	Final draft issue	July 22nd 2015	Kam Tara (URaP) John Hart (RMS)
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APPENDIX – MAPS & TRAFFIC MODEL VOLUME PLOTS

1. BACKGROUND & OBJECTIVES

Roads and Maritime Services has carried out a desktop assessment of traffic conditions in the Richmond and Windsor district to assess whether there are noticeable areas of under-performance or traffic capacity constraint, either evident now or likely to emerge in the future as population growth occurs.

The purpose of the investigations is to update the Minister on broad traffic issues within the Richmond and Windsor areas, particularly cross-river connections and implications of neighbouring land development.

The issues are presented under two strands of investigation:

- River crossings and their capacity.
- Traffic conditions on arterial roads between Richmond and Windsor.

The assessment has made use of the RMS EMME strategic traffic model which provides peak 2 hour traffic assignments of forecast traffic on the network. In this instance the current RMS trip demand matrix is based on the August 2012 BTS population and employment forecasts (LU12) which does not yet factor in all of the forecast land use on the north of the Richmond River.

An updated trip matrix (Version STM3) is only likely to be available to RMS towards the end of 2015. When available, it will take into account the regional mode shift implications of the North West Rail Link project and other significant projects, as well as include updated September 2014 BTS population and employment forecasts (LU14). STM3 may re-inform the EMME outputs, but until then, modelling is predicated on land use assumptions from the LU12 BTS population and employment, and road-based transport only. However, for the purposes of this exercise, these inputs to traffic forecasts should be adequate.

Specific tasks carried out have been:

- Collate traffic planning material from previous reports, briefings and available RMS data;
- Summarise traffic investigations for the Windsor Bridge and Richmond Bridge projects
- Determine traffic forecasts and associated land use assumptions for 2015, 2026 and 2036 networks for a variety of bridge infrastructure options;
- Summarise existing performance of the road corridor through Richmond and Windsor.
- Consider the implications of current projects such as the Outer Sydney Orbital and flood evacuation planning being carried out.
- Consider the ramifications of the development of the Redbank and Glossodia residential releases in North Richmond.
- Summarise infrastructure commitments and identify potential projects to fill gaps in network performance.

A map of the study area for these investigations is given in Exhibits 1.1 and 1.2 below.

To carry out the required tasks, reference material has been sourced from:

- The 2012 Environmental Impact Statement Environmental Impact Statement for Windsor Bridge Replacement Project (TfNSW, Nov. 2012).
- The 2011 investigations into the short and long term future of Richmond Bridge investigations.
- RMS Briefing Notes and files relating to development proposals for land releases in North Richmond and Glossodia.
- The final 2013 "Redbank" North Richmond Transport Management and Accessibility Plan.

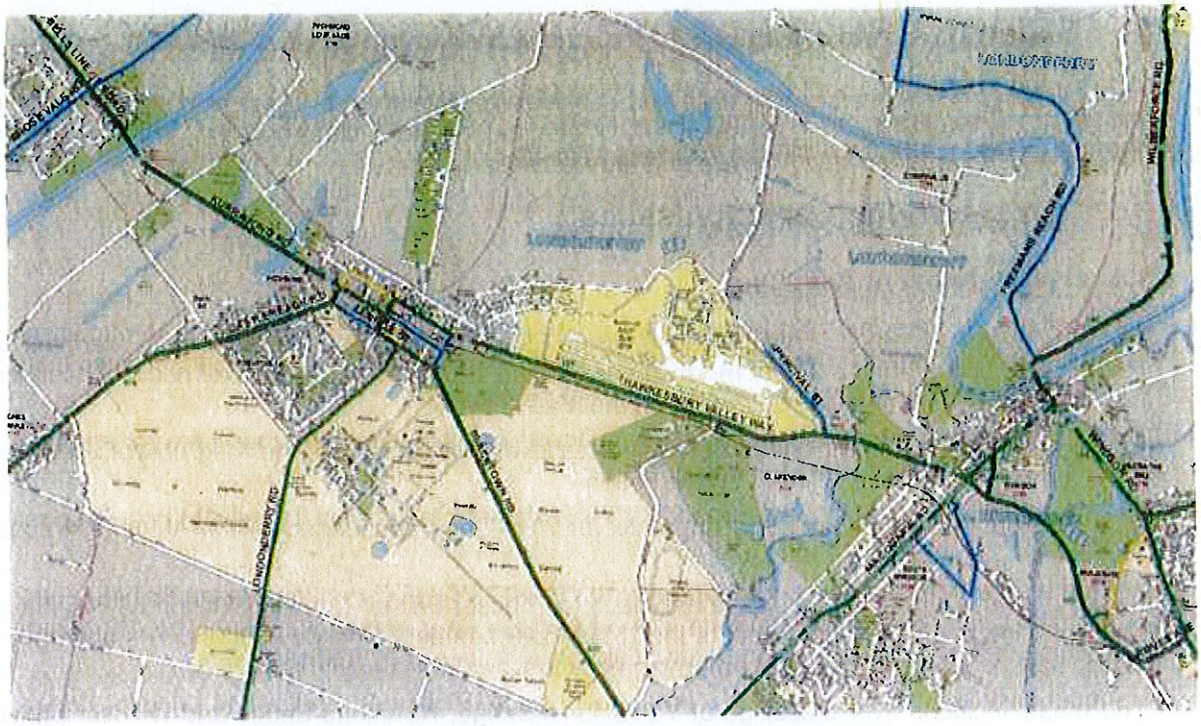

Exhibit 1.1 – Road Network of Richmond-Windsor District

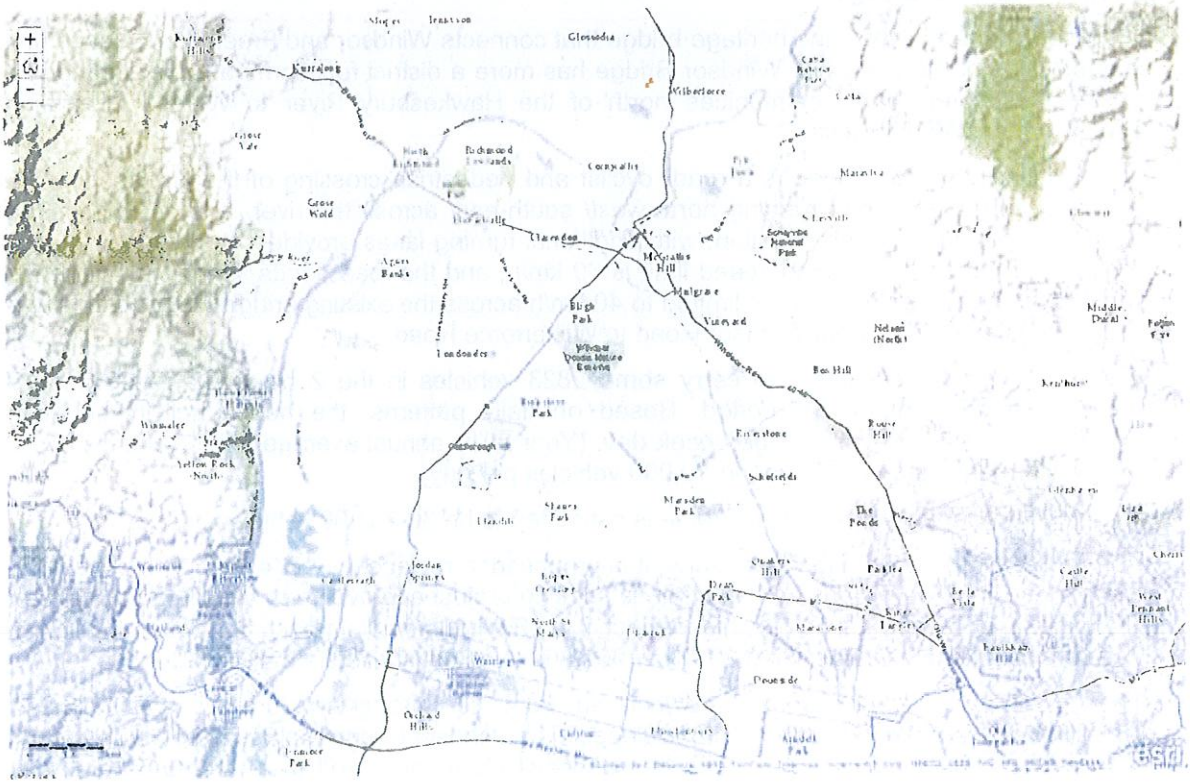

Exhibit 1.2 –Richmond-Windsor Region

2. BRIDGE CROSSINGS OVER HAWKESBURY RIVER

The following is a summary of issues and considerations relating to usage and capacity of river crossings in the vicinity of Windsor and Richmond. Current crossings are Windsor Bridge, Richmond Bridge, Yarramundi Bridge and ferry services.

2.1 Current Bridge Capacity Issues

2.1.1 Overall Network Activity

RMS maintains a Strategic Traffic Model (utilising EMME software) across the Sydney Metropolitan Region. It is built around a 2 hour morning peak period and 2 hour evening peak period when there is a high component of journeys to work on the road network.

This has been used as a basis to determine the level of traffic across the road network and then later, the ramifications of different bridge options.

Modelling outputs are given in the Appendix for 2014 Base Case traffic for the AM and PM peak periods.

Based on a daily traffic count on the approach to Windsor Bridge (Counting Station 88.046), the 2 hour morning peak typically accounts for 15% of average daily weekday activity. The appropriate extrapolation factors for the 2 hour morning peak to typical week day traffic is 6.6.

The model includes river crossings of Yarramundi Bridge, Richmond Bridge and Windsor Bridge, but does not include car ferries.

2.1.2 Windsor Bridge

Windsor Bridge is a two lane heritage bridge that connects Windsor and Freemans's Reach on the eastern side of the township. Windsor Bridge has more a district function than a regional one and connects several small communities north of the Hawkesbury River to Windsor, Parramatta, Blacktown and M7 Motorway.

The existing Windsor Bridge is a road, cyclist and pedestrian crossing of the Hawkesbury River and is a sub-arterial road running north-west/ south-east across the river. It is on Bridge Street, primarily one lane in each direction, with additional turning lanes provided at the intersection with Macquarie Street. The posted speed limit is 60 km/h, and the road bends sharply at both ends of the bridge. Trucks and buses are limited to 40 km/h across the existing bridge. Bridge Street is part of the B-Double Route from Windsor Road to Wilberforce Road.

Windsor Bridge is estimated to carry some 2823 vehicles in the 2 hour AM period and 2990 vehicles in the 2 hour PM period. Based on daily patterns, the hourly activity equates to approximately 18,630 vehicles per week day. (Year 2011 annual average traffic volumes over the bridge were estimated to be around 19,000 vehicles per day).

The effective capacity of Windsor Bridge is estimated to be 30-36,000 vehicles per day.

For structural and maintenance reasons, it is proposed to replace the 1874 vintage Windsor Bridge with a new structure. Roads and Maritime is seeking project approval from the NSW Department of Planning and Infrastructure for this project. An Environmental Impact Statement for Windsor Bridge Replacement Project (TfNSW, Nov. 2012) is at an advanced state of assessment.

The new bridge will be 35 metres downstream from the existing structure. It is not proposed to substantially increase the capacity of the bridge. The Windsor Bridge replacement will be two lanes but has been designed so that it can be subsequently reconfigured to a three lane bridge (two southbound and one northbound lane) to meet future traffic demands without additional construction work. The current proposal also includes new approach roads and intersections and removal of existing approach roads.

Analysis carried out for the bridge replacement project shows that the intersections on the approaches to the bridge are operating near their maximum capacity with long delays and queues during peak periods. As a consequence, the following intersections are to be upgraded as part of the bridge replacement project:

- Bridge Street / George Street.
- Wilberforce Road (Bridge Street) / Freemans Reach Road.

2.1.3 Richmond Bridge

Richmond Bridge is a two lane heritage bridge that connects North Richmond and a variety of settlements on Bells Line of Road to Richmond and the road network of north-west Sydney. Richmond Bridge has more a regional function than many bridges and predominantly connects communities in North Richmond/ Kurrajong Heights to Richmond, Windsor, Penrith and M7 Motorway.

Richmond Bridge is estimated to carry some 4463 vehicles in the 2 hour AM period and 4706 vehicles in the 2 hour PM period. Based on daily patterns, the hourly activity equates to approximately 29,450 vehicles per week day.

The effective capacity of Richmond Bridge is estimated to be 30-36,000 vehicles per day.

Origins and destinations of traffic that is served by Richmond Bridge are given in Exhibit 2.1.

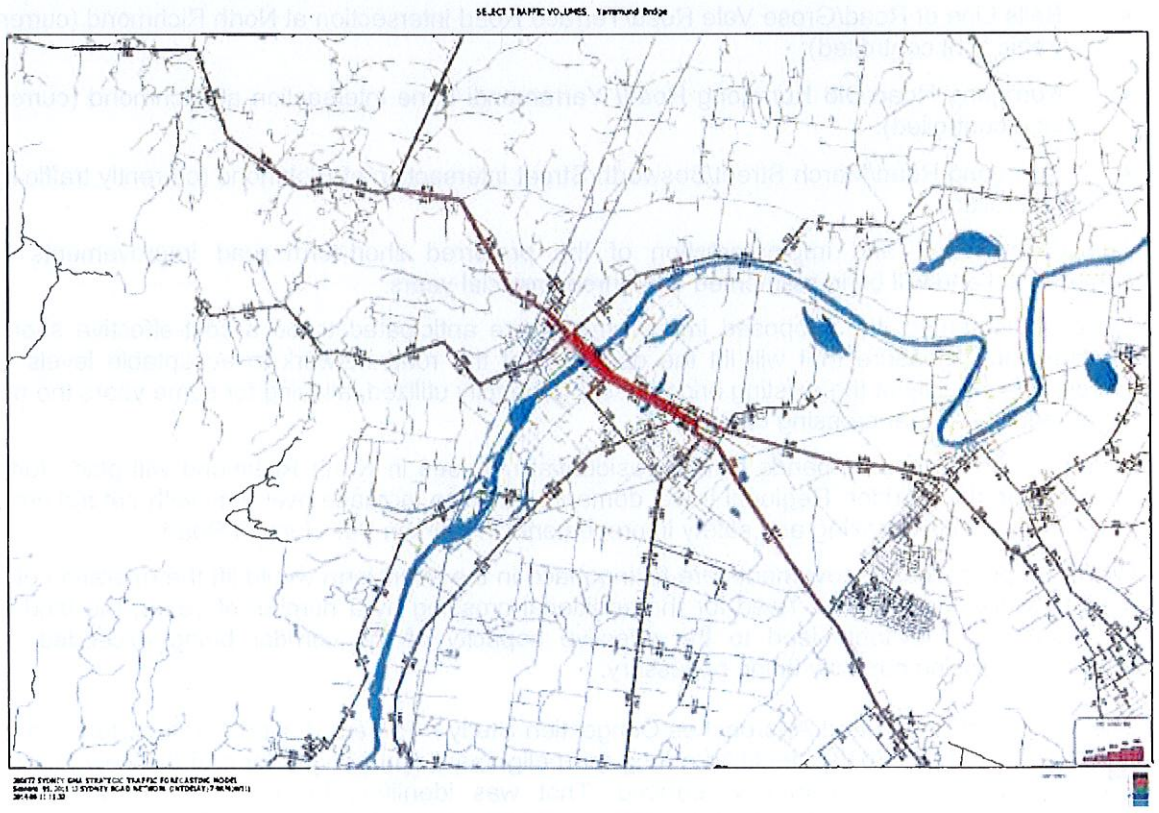

Exhibit 2.1 – Origins and Destinations of Richmond Bridge Traffic

At a broad level, Bells Line of Road (BLoR) is a regionally important connection between Sydney and the Central West, and an alternative route to the Great Western Highway running through the Blue Mountains. The Richmond Bridge corridor is the eastern urban gateway to BLoR and comprises March Street and Kurrajong Roads which run through Richmond town centre, and BLoR through North Richmond town centre, with Richmond Bridge in between.

Richmond Bridge is the only Hawkesbury River crossing connecting the south with the northern residential district catchment of North Richmond, Kurrajong, Bell, Bilpin and beyond. The proper functioning of the Richmond Bridge and its approaches is therefore of importance at local, district and regional levels.

Investigations carried out for Richmond Bridge and Approaches Congestion Study in 2012 have determined that the intersections on its approaches are constraining the full capacity of the bridge being achieved. Investigations have also found that travel speeds along the approximate two km section of road on either side of the bridge are below acceptable levels. Westbound traffic is particularly slow throughout afternoon peak periods.

Even though the corridor is tightly managed through access and turning restrictions and signal coordination, slow travel speeds are experienced. These are caused by a combination of turning movements mixed with through movements; general intersection delay; and capacity constraints caused by on-street parking. With natural fluctuations in demand, bottlenecks regularly occur, and performance of the corridor and use of capacity is often compromised.

In its current form, the Richmond Bridge corridor is near effective capacity due to the limitations of its approaches which require attention to unlock and defer for as long as possible, the eventual need for expensive duplication. Improvements at three intersections are currently in train either side of Richmond Bridge to enable the maximum capacity of Richmond Bridge to be fully utilized.

The locations are:

- Bells Line of Road/Grose Vale Road/Terrace Road intersection at North Richmond (currently traffic light controlled).
- Kurrajong Road/Old Kurrajong Road/ Yarramundi Lane intersection at Richmond (currently sign controlled).
- Kurrajong Road/March Street/Bosworth Street intersection at Richmond (currently traffic light controlled).

The development and implementation of the preferred short-term road improvements has commenced and will be implemented over three financial years.

Once implemented, the proposed improvements are anticipated to be a cost-effective short to medium term measure that will lift the operation of the road network to acceptable levels and enable the capacity of the existing bridge asset to be fully utilized, allaying for some years the need for an additional river crossing capacity.

In future, the access demands of new residential releases in North Richmond will place further pressure on the corridor. Regional travel demand may also increase over time with natural growth and the planned overtaking and safety improvements in train on Bells Line of Road.

While the proposed improvements are taking place in the short term would lift the operation of the road network and allay the need for the additional crossing by a number of years, the land use influences will inevitably lead to the effective capacity of the corridor being exceeded, and additional crossing capacity being necessary.

The Richmond Bridge and Approaches Congestion Study – Preferred short and long term options report (TfNSW, Feb 2013) identified a long term alignment and general form of the new four lane bridge that would be ultimately required. That was identified to be a new structure 50m downstream from the existing bridge which would be retained. Additional capacity to approach roads was also proposed. The strategic cost of the structure was $154M (P90, 2012).

2.1.4 Yarramundi Bridge

Yarramundi Bridge is a two lane modern but low level bridge that connects the eastern side of the river at Agnes Banks to Yellow Rock on the western side. Yarramundi Bridge predominantly connects communities in Springwood and Winmalee to Richmond and Windsor.

Yarramundi Bridge is estimated to carry some 1849 vehicles in the 2 hour AM period and 2067 vehicles in the 2 hour PM period. Based on daily patterns, the hourly activity equates to approximately 12,200 vehicles per week day.

The effective capacity of the bridge is estimated to be 30-36,000 vehicles per day.

2.1.5 Ferry Services

A number of car ferry services ply across the upper reaches of the Hawkesbury River to meet the needs of small-scale remote settlements east of Windsor. Car ferry crossings operate limited hours. Anecdotally, car ferries only carry 200-300 vehicles per day. Locations are:

- The Lower Portland ferry cross the Hawkesbury River just upstream of the Colo River junction at Lower Portland, linking West Portland Rd with River Rd.
- The Webbs Creek ferry at Wisemans Ferry crosses the Hawkesbury River just south of the junction of the Macdonald River.
- The Wisemans ferry crosses the Hawkesbury River just east of the junction of the Macdonald River at the village of Wisemans Ferry.
- The Sackville ferry crosses the Hawkesbury River, north of Sackville on the Sackville Road and connects the roads linking Windsor and Wisemans Ferry.

No changes to services are envisaged for the foreseeable future.

2.2 Future Bridge Capacity Issues

2.2.1 Future Land Use Drivers

Two large residential releases have been approved for the North Richmond area:

- Redbank, by the North Richmond Joint Venture involves the rezoning of 180 hectares of land located off Grose Vale Road and Arthur Phillip Drive. The land, named is to be developed to accommodate 1,399 dwellings and a neighbourhood centre.
- Another proposed development in Glossodia called Jacaranda Ponds is a proposed rezoning for 580 residential lots.

During assessment of the Redbank projects, consideration of a new alternative bridge crossing at Yarramundi and the approach intersections at Grose Vale Road and Springwood Road showed it would provide relief to current traffic congestion on the Richmond Bridge corridor and spread the load of peak hour traffic. The alternate crossing would also provide adequate capacity across the district to service the proposed development, and provide a link to Penrith and Springwood.

All works required to accommodate this new alternative crossing and key intersection upgrades on the existing transport corridor are proposed to be fully funded by the Redbank developer through a Voluntary Planning Agreement.

Further information on the land release projects and infrastructure agreements are currently being prepared under ML15/01551. No other substantial land releases have been identified in the area to date.

2.2.2 River Crossing Options

As covered in the previous section, each of the Windsor, Richmond and Yarramundi bridges has an effective capacity[1] of 30-36,000 vehicles per day. As is evidenced by the works proceeding or proposed on the approaches to both Richmond Bridge and Windsor Bridge (covered in preceding sections), the capacity of roads either side of the bridge structures can play a significant role in achieving those capacities.

There are basically two futures for road crossings of the Hawkesbury River – ones either with or without the proposed developer-funded crossing of the Grose River and consequent increase use of Yarramundi Bridge, rather than the Richmond Bridge only.

Indicative volumes of traffic on the bridges for various scenarios under consideration are given in Exhibit 2.2. These have been sourced from the RMS Strategic Traffic Model which is based on certain assumptions of population and employment that are less than those used on the 2013 "Redbank" North Richmond TMAP investigations. Resultant traffic volumes are likely to be slightly below those suggested by the TMAP modeling.

	Forecast Daily Traffic Using Bridge at:			
Scenario	**Windsor**	**Richmond**	**Yarramundi**	**Grose River**
2014 Current Bridges	18632	29456	12203	
2026 Current Bridges	23925	34980	15319	
2026 + Grose River Bridge	23021	28010	19061	8019
2036 Current Bridges	27482	37686	17549	
2036 + Grose River Bridge	26539	30155	21344	8785

Exhibit 2.2 – Forecast Daily Traffic on Hawkesbury-Nepean River Bridges

Based on the assumptions used, the modeling indicates the following:

- The levels of activity on Windsor Bridge are relatively independent from Richmond Bridge, whereas the activity between Richmond Bridge and Yarramundi Bridge are more inter-twinned;
- The capacity of the new Windsor Bridge should suffice for the next 20-30 years;
- The spare capacity of Richmond Bridge (assuming committed works on approaches are effective and considering residential growth in North Richmond) would be exceeded in about 5-10 years should there be no augmentation of capacity elsewhere;
- Should the Grose River Bridge proceed, there would be a shift of activity away from Richmond Bridge towards Yarramundi Bridge in the order of 6500 vehicles per day in 2026 and 7500 vehicles per day in 2036;
- Should the Grose River Bridge proceed, the shift of activity away from Richmond Bridge should extend its life by some 15-20 years, possibly more.
- Yarramundi Bridge would have sufficient capacity to deal with the extra activity. It is noted that Yarramundi Bridge is a low level structure that experiences periodic closure due to flooding. On these occasions, detoured traffic may cause highly congested conditions on Richmond Bridge in its current format.

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[1] The effective capacity reflects the absolute capacity during peak periods in the peak direction and the pattern of demand throughout the rest of the day and in the opposite non-peak direction. The contraflow traffic volume is assumed to be two-thirds of the peak direction during peak periods. Effective capacity can increase over time as community tolerance to delay increases and peak spreading occurs. It is appropriate to express effective capacity as a range due to these variables.

2.3 Future Bells Line of Road Castlereagh Connection

Transport for NSW is currently investigating suitable corridors for the Outer Sydney Orbital (OSO) and the Bells Line of Road Castlereagh Connection.

The Outer Sydney Orbital is a multimodal transport corridor to provide a broad north-south connection for a future motorway, freight rail and where practical a passenger rail line shaped loosely as an arc around Western Sydney. This road would run on the Western edge of the Sydney Basin, connecting the South-West and North West Growth Centres via the Penrith area and could potentially be part of a new long term route to the central coast. Earlier planning suggests the corridor could broadly run parallel to the Hawkesbury River, well to the south of it and therefore may have limited impact on river crossing issues.

More relevant is the Bells Line of Road Castlereagh Connection which is also under investigation. TfNSW are seeking to identify a suitable corridor that would eventually connect the Bells Line of Road east of Kurrajong Heights with the OSO and M7 Motorway to provide an alternative route across the Blue Mountains and also serve the future development of far north-western Sydney.

No detailed alignment of either corridor has been settled on however. The study areas for the respective corridors are very wide (refer Figure 2 in the Appendix). TfNSW are only setting out to identify and preserve a corridor for the OSO rather than progress its construction which is more likely in the 20 year plus time horizon. As part of the initial planning process, constraints to eventual alignments and opportunities for the alignment with the broader road network are now being examined.

The Bells Line of Road Castlereagh Connection offers the opportunity for an additional long term connection over the Hawkesbury River. While too early to set a definitive direction, there is potential to align the river crossing elements of that connection with the intended long term Richmond Bridge crossing of the Hawkesbury River.

The developer funded bridge over Grose River offers the opportunity to buy substantial capacity and time for the network to operate without constraint by diverting traffic activity onto Yarramundi Bridge and away from Richmond Bridge. At a future point in time, a new river crossing near Richmond could be provided to suit all purposes.

3. RICHMOND-WINDSOR TRAFFIC ISSUES

3.1 Current Traffic Conditions

In urban areas, capacity analysis is a useful tool to guide the planning, design and operation of roads. It provides a means of determining the traffic carrying performance of a road under prevailing roadway, traffic demand and traffic control device conditions.

An assessment of mid-block through-traffic operation may assist to determining the general locations of through-traffic capacity constraint, and where potential intervention or enhancement may be needed.

However, in highly built up areas, the operation of intersections and their interaction is likely to influence the roadway capacity to a much greater degree as intersections are more often the major source of delays and interruptions to through traffic flow caused by turning vehicles and occasional crashes and breakdowns.

A range of traffic management measures are applied to regulate and optimise the efficiency of traffic flow across a road network (principally measured by overall corridor travel speed), and balance competing mobility needs with safety. Key amongst these are:

- The Sydney Coordinated Adaptive Transport System (SCATS) network which regulates signalised intersections and optimises traffic flow across the network;
- Signage, line-marking, access control and parking management supplement the traffic signal system; and
- Amplification of storage lane capacity to improve turning or through capacity.

The following analysis describes the travel speed and capacity analysis of individual segments of the corridor with a view to determining general performance and locations or issues requiring further consideration.

A detailed analysis of intersection performance and identification of potential treatments was not possible within the timeframe available. Such an analysis would also require intersection traffic data to be collected to reflect "typical day" traffic activity, but due to lower than average levels of traffic as a result of school holidays, such an approach was not feasible.

3.1.1 Travel Speed Performance

Typical travel speeds on the corridor were derived from GPS multi-vehicle fleet speed data collected from January to December 2014.

Exhibits 3.1 and 3.2 show the indicative average travel speeds during weekday peak commuter periods between Mulgrave and the Hawkesbury River and the level of service offered relative to the posted travel speed.

These show that the travel speeds experienced are reasonable being in the range of 40-50 km/hr for both directions for the morning and evening peaks, with the relative exception of westbound travel speed which drops to 33 km/hr in the PM peak (still reasonable relative to similarly classed roads in Western Sydney).

Direction	Length of Section (km)	Travel Time (minutes)	Average Speed over Length (km/hr)
Inbound (Eastbound)	13.3	16.7	47.8
Outbound (Westbound)	13.3	15.9	50.2

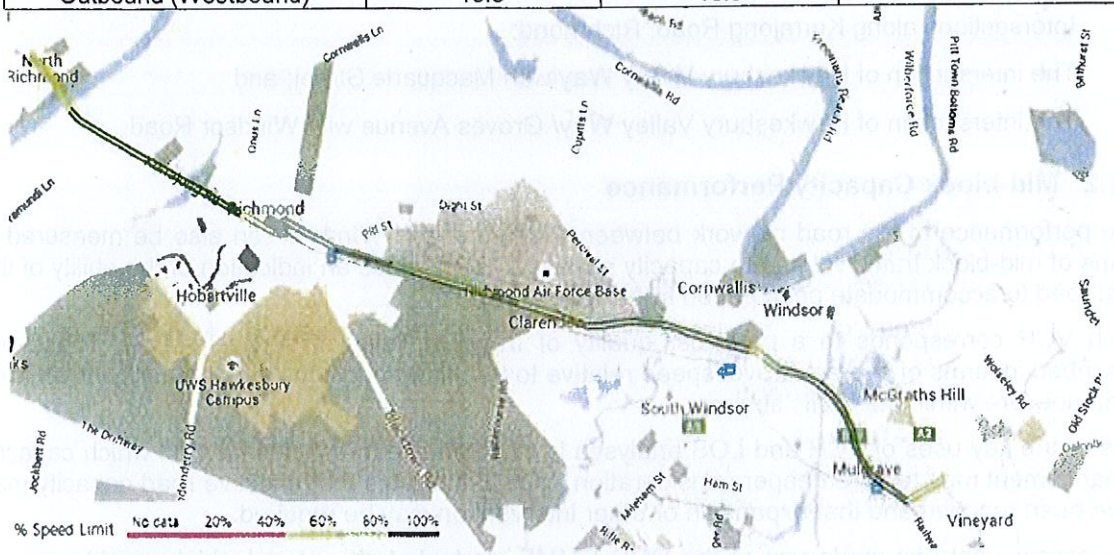


Exhibit 3.1 - Travel speed performance: Mulgrave–Nth Richmond 2 Hr AM Peak (7-9am)

Direction	Length of Section (km)	Travel Time (minutes)	Average Speed over Length (km/hr)
Inbound (Eastbound)	13.3	17.2	46.4
Outbound (Westbound)	13.3	24.4	32.7

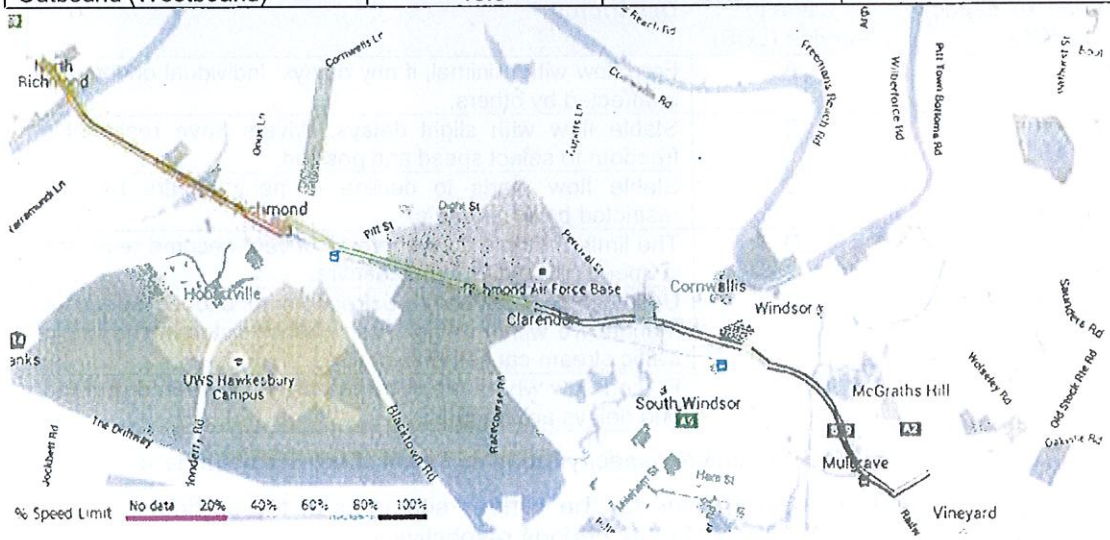


Exhibit 3.2 - Travel speed performance: Mulgrave–Nth Richmond 2 Hr PM Peak (4-6pm)

Accepted benchmarks for speed-based Level of Service analysis are given below:

Travel speed as a percentage of Posted Speed Limit (%)	Level of service
>80	A – Unimpeded
>70 – 80	B – Minor Impedance
>60 – 70	C – Moderate Impedance
>40 – 60	D – High Impedance
>20 – 40	E – Congested
<= 20	F – Highly Congested

Source: Adapted from US Highway Capacity Manual, Transportation Research Board (2010, p.16-8)

In terms of individual congested segments, the analysis accords with findings of the North Richmond Bridge congestion investigations of slower speeds on the approaches to and from Richmond Bridge and elsewhere. The analysis points to localised congestion points around:

- Intersections along Kurrajong Road, Richmond;
- The intersection of Hawkesbury Valley Way with Macquarie Street; and
- The intersection of Hawkesbury Valley Way/ Groves Avenue with Windsor Road.

3.1.2 Mid-block Capacity Performance

The performance of the road network between Richmond and Windsor can also be measured in terms of mid-block traffic volume to capacity ratios (VCR) provides an indication of the ability of the host road to accommodate peak period traffic loads.

Each VCR corresponds to a particular quality of travel or 'level of service' (LOS). These are described in terms of average travel speed relative to free flow conditions and the ability of vehicles to manoeuvre within the traffic stream.

One of the key uses of VCR and LOS analyses is to determine thresholds beyond which capacity enhancement may require deeper consideration. LOS E indicates that effective road capacity may have been reached and that expansion or other intervention may be required.

The assessment has made use of the RMS EMME strategic traffic model which provide peak 2 hour traffic assignments of forecast traffic on the network. A caveat that needs to be applied is that intersection capacity may be a constraint to full achievement of mid-block capacity. Intensive intersection queuing may be a reason why mid-block demand on a particular link may be high, particularly on the approach to major intersections.

The relationship between VCRs and their corresponding LOS definitions are shown in Exhibit 3.3.

Volume to capacity ratio (VCR)	Level of service (LOS)	Descriptor
<0.35	A	Free flow with minimal, if any delays. Individual drivers are unaffected by others.
0.35 – 0.6	B	Stable flow with slight delays, drivers have reasonable freedom to select speed and position.
0.61 – 0.75	C	Stable flow starts to decline – many drivers become restricted by other traffic.
0.76 – 1.00	D	The limit of stable flow where all drivers become restricted in speed and ability to manoeuvre.
1.01 -1.20	E	Unstable flow, virtually no freedom to choose speed or manoeuvre within traffic stream. Minor disturbances within traffic stream cause break down.
> 1.2	F	Forced flow where break-down easily occurs and queuing and delays are frequent.

Exhibit 3.3 – Link volume to capacity ratios and level of service definitions

The average VCR and LOS calculations for the various segments of the corridor are shown in Exhibits 3.4 and 3.5 for the AM and PM peak periods respectively.

This analysis shows that on average the Richmond-Windsor corridor operates well within available mid-block capacity that would better the performance of similarly classed urban roads.

This analysis points to the only segments of the corridor having elevated levels of congestion being the Richmond Bridge and approaches.

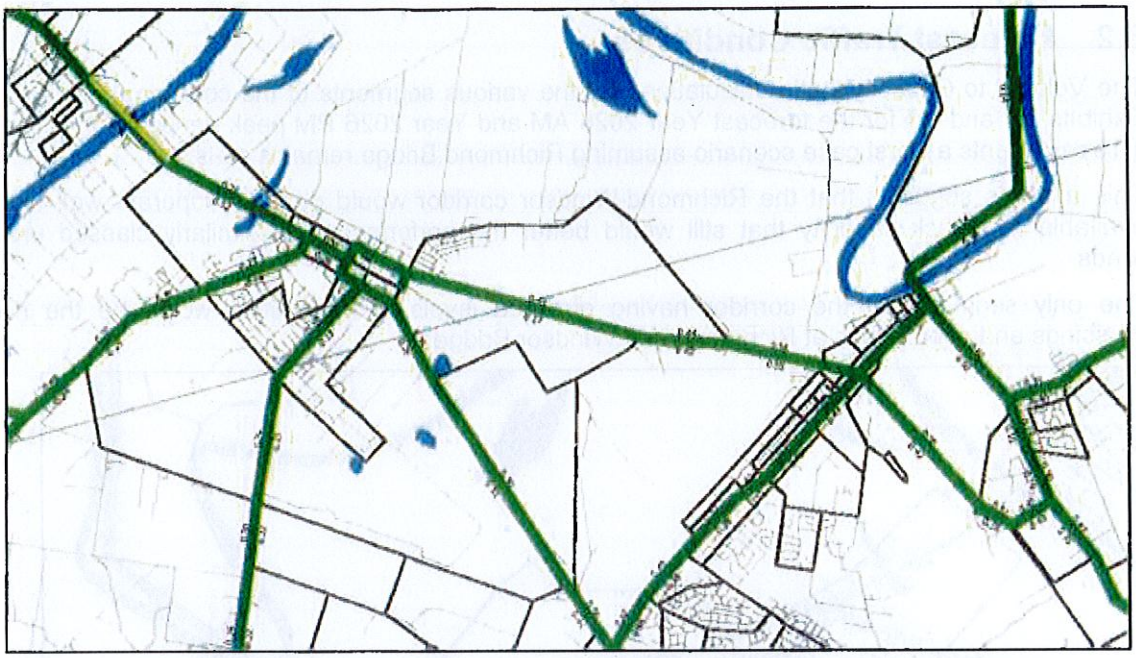


Exhibit 3.4 – Volume to Capacity Ratio: Mulgrave–Nth Richmond 2014 2Hr AM Peak

Exhibit 3.5 – Volume to Capacity Ratio: Mulgrave–Nth Richmond 2014 2Hr PM Peak

3.2 Forecast Traffic Conditions

The Volume to Capacity Ratio calculations for the various segments of the corridor are shown in Exhibits 3.6 and 3.7 for the forecast Year 2026 AM and Year 2026 PM peak periods respectively. This represents a worst case scenario assuming Richmond Bridge remains as-is.

This analysis suggests that the Richmond-Windsor corridor would generally operate well within available mid-block capacity that still would better the performance of similarly classed urban roads.

The only segments of the corridor having elevated levels of congestion would be the river crossings and approaches at Richmond and Windsor Bridges.

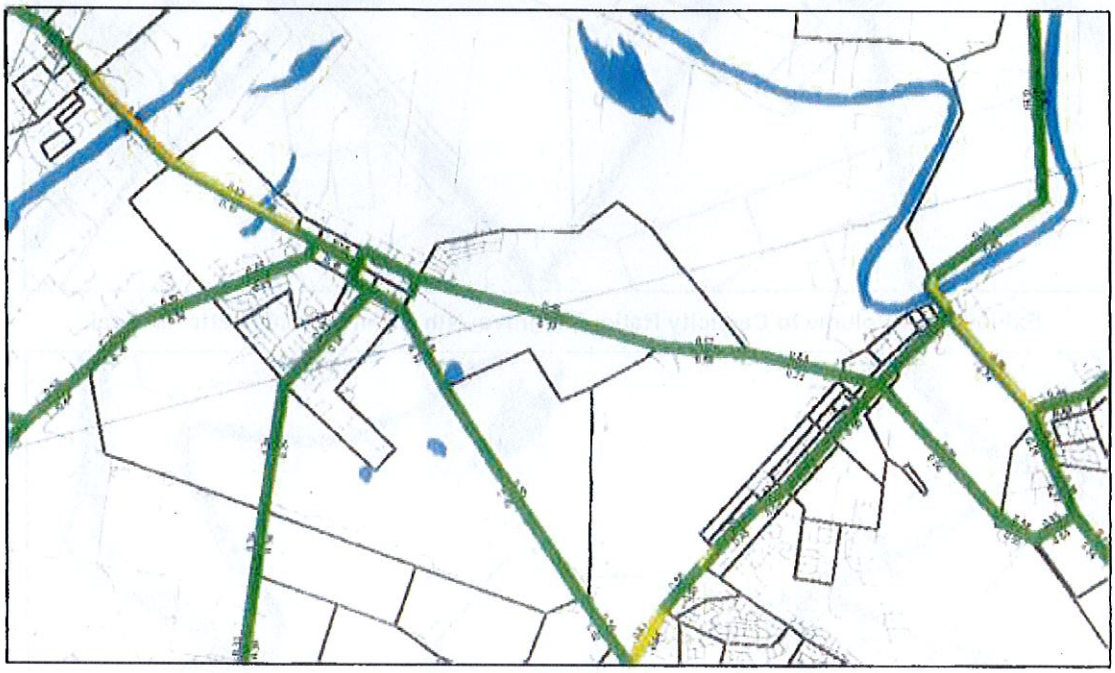


Exhibit 3.6 – Volume to Capacity Ratio: Mulgrave–Nth Richmond 2026 2Hr AM Peak

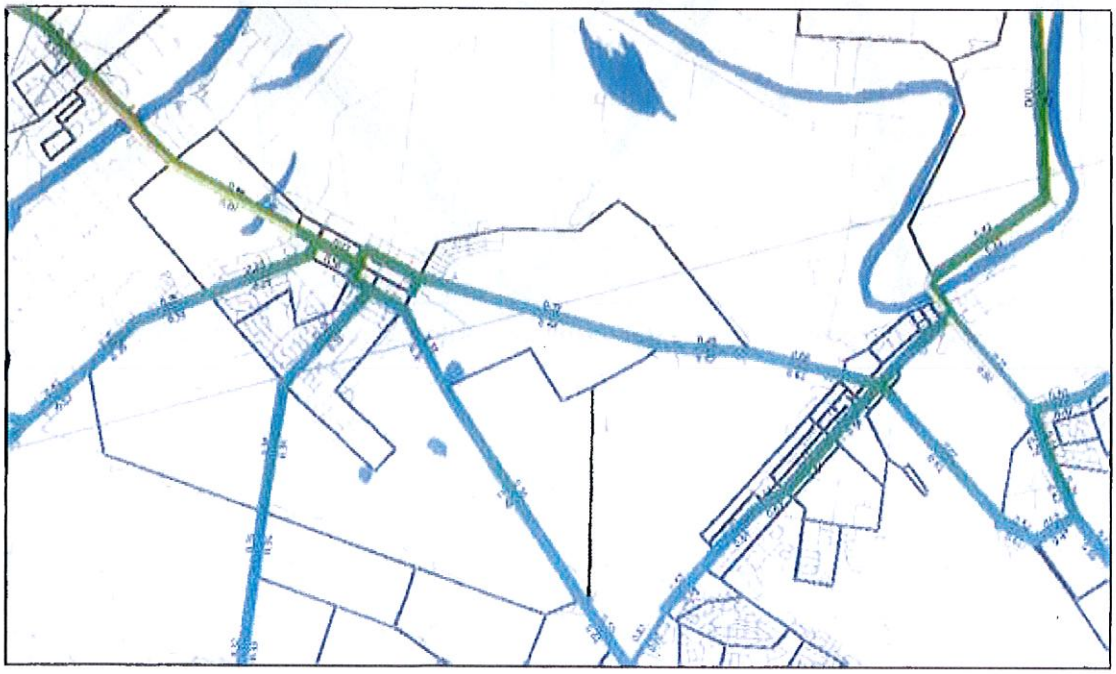


Exhibit 3.7 – Volume to Capacity Ratio: Mulgrave–Nth Richmond 2026 2Hr PM Peak

3.3 Flood Evacuation Planning

RMS is currently investigating flood evacuation route planning in conjunction with Infrastructure NSW and State Emergency Services on behalf of the Hawkesbury - Nepean Valley (HNV) Flood Management Taskforce. The Taskforce has been established by the NSW Government to develop an integrated flood risk management strategy for the HNV by the end of 2015. The aim of the Strategy is to reduce the current and future risk to life and impact of flooding in the floodplain on the economy.

The work is being reported in two overall stages. The first stage was reported to Cabinet in October 2014, includes interim findings regarding potential improvements to local evacuation roads (those connecting residential catchments to higher order regional evacuation routes) so that these roads might be less susceptible to closures from flash flood events.

The second stage is to cover regional evacuation improvements and consideration of demands from future population and employment in and surrounding the North West Growth Centre during major river-rising flood events. The second stage is utilising project-specific flood evacuation and traffic modelling to determine locations where roads get cut by rising flood waters and/or where additional evacuation traffic capacity would be desirable.

While investigations are still underway and are yet to be finalised and reported, preliminary modelling points to the following issues in the vicinity of Richmond and Windsor:

- Such are the differences between non-flood and higher order or peak flood levels (up to 7m height difference), it would be space and cost-prohibitive to reconstruct any of the bridges to heights that would allow flood free conditions;
- Bridges are closed to traffic when flood level is within 0.5m of the soffit (underside of the structure) level - this is in accordance with RTA Bridge Waterway Manual (2000) which suggests 0.3m for low velocity water, 0.5m generally, and 1.0m when trees or large debris are present, or when the structural integrity of the bridge warrants.
- During evacuation events, once a bridge is closed, evacuees are forced or directed to stay on the side of the river they are on. The heights of the river crossings and cut-off times are not critical to successful evacuation outcomes (although it might be an inconvenience for evacuees).
- The evacuation routes out of Richmond and Windsor are:
  - Castlereagh Road towards Penrith;
  - Blacktown Road/ Richmond Road towards Blacktown; and
  - Hawkesbury Valley Way/ Windsor Road towards Parramatta.
- The locations that preliminary modelling is suggesting may have inadequate capacity for free-flowing evacuation (subject to a host of working assumptions) are:
  - Hawkesbury Valley Way at Windsor as evacuating traffic merges together;
  - Hawkesbury Valley Way at Mulgrave as it joins Windsor Road;
  - Richmond Road south of Windsor Downs.

  Note that these conclusions are yet to be thoroughly tested and verified. Work is on-going and potential solutions including spare capacity and viability of alternative evacuation routes have yet to be fully determined.
- Short-lived blockages to evacuation routes due to local flash flooding are most problematic in riverside environs. Desirably, a variety of local evacuation improvements and way-finding signage systems would be implemented to improve overall flood resilience of the Hawkesbury Valley. Recommendations for potential works are being reported to Cabinet through the Taskforce.

4. CONCLUSIONS

A desktop assessment of traffic conditions has been undertaken of the river crossings and arterial roads in the Richmond to Windsor district, to assess whether there are noticeable areas of under-performance or traffic capacity constraint, either now or likely to emerge in the future as population growth occurs. The assessment has principally considered bridge capacity at river crossings and general congestion between the two townships of Richmond and Windsor.

The investigations have utilised RMS strategic transport modelling of the morning and evening peak weekday periods, supplemented by documentation of the Windsor Bridge replacement project and short and long term options for Richmond Bridge and its approaches. Traffic modelling is predicated on population and employment forecasts from the Bureau of Transport Statistics (2012 release) which has only considered a portion of the nearly 2000 future new dwellings proposed in North Richmond and Glossodia.

Two possible bridge structure options exist, depending on whether a new $23 million bridge across the Grose River feeding onto the Yarramundi Bridge is pursued. This would be potentially funded by proponents of the North Richmond residential development.

Currently the daily use of the Windsor, Richmond and Yarramundi Bridges is 18632, 29456 and 12203 vehicles per weekday respectively, within the effective capacity of these two lane bridges of 30,000 – 36,000 vehicles per day.

In the cases of Windsor and Richmond Bridges, capacity constraints of intersections on the approaches to the bridges are the limiting factor to full utilisation of capacity of these structures. There are current funding commitments to improving these bridge approaches. At Richmond Bridge, implementation of three intersection improvements at a cost of $25M is currently progressing, while at Windsor Bridge, the subject of a planning application to replace it for maintenance and structural reasons, new or upgraded approach intersections are proposed.

Should the developer funded bridge at Grose River NOT PROCEED, traffic forecasts indicate that the remaining effective capacity of Richmond Bridge would be exceeded in approximately 5-10 years requiring an additional major structure at a cost of $154M (P90, $2012).

However, should the developer funded bridge at Grose River PROCEED, traffic forecasts indicate that the remaining effective capacity of Richmond Bridge would be sufficient for approximately another 15-20 years, if not more, as the new bridge would result in a shift of activity away from Richmond Bridge towards Yarramundi Bridge in the order of 6500 vehicles per day in 2026 and 7500 vehicles per day in 2036. There are no traffic capacity constraints on Yarramundi Bridge.

The latter outcome would present an opportunity to align the future crossing of the Hawkesbury River with the corridor of the Bells Line of Road Castlereagh Connection currently under examination by TfNSW. A new crossing could then potentially be an early stage of the ultimate alignment of that corridor.

It is conjectured that the alignment of the Outer Sydney Orbital, similarly under investigation would broadly run parallel to Hawkesbury River to the south and would not be a significant influence on bridge capacity issues.

The assessment also indicates the level of traffic activity on Windsor Bridge is relatively independent of Richmond Bridge. The capacity of the proposed Windsor Bridge should suffice for the next 20-30 years.

In terms of traffic capacity generally between Richmond and Windsor (separate to the bridge issues), emerging locations of congestion over the next 10 years likely to be:

- Hawkesbury Valley Way at Windsor as evacuating traffic merges together;
- Hawkesbury Valley Way/ Grove Street at Mulgrave as it joins Windsor Road;

These locations are also possible locations of traffic capacity constraint for flood evacuation and may need a degree of amplification for that purpose. The infrastructure requirements at these locations are currently under examination as part of Hawkesbury Nepean Valley Flood Management Taskforce flood evacuation investigations.

While details of infrastructure requirements are as yet unknown, an indication of the expense of potential improvements can be based on cost estimates of Richmond Bridge intersection upgrades. On that basis, the cost of two intersections may be in the order of $20M including moderate levels of acquisition and could be designed and delivered over a period of 2-3 years.

Potential Way Forward

- The favoured position regarding additional bridge capacity over the Hawkesbury River at Richmond is to proceed with the developer-funded bridge over the Grose River connecting to Yarramundi Bridge, and that the long term position of a new crossing be considered in conjunction with the corridor being investigated by TfNSW for the Bells Line of Road Castlereagh connection between Kurrajong and the M7 Motorway.
- That strategic designs and costs for works at the intersections of Hawkesbury Valley Way with Macquarie Street and Windsor Road need to be investigated in detail at the conclusion of the Hawkesbury Nepean Valley Flood Management Taskforce flood evacuation investigations, with the aim of integrating everyday traffic and flood evacuation capacity.

APPENDIX – TRAFFIC MODELLING PLOTS

1. Hawkesbury District: Richmond-Windsor Traffic Issues – Study Area
2. Bells Line of Road–Castlereagh Connection – Study Area

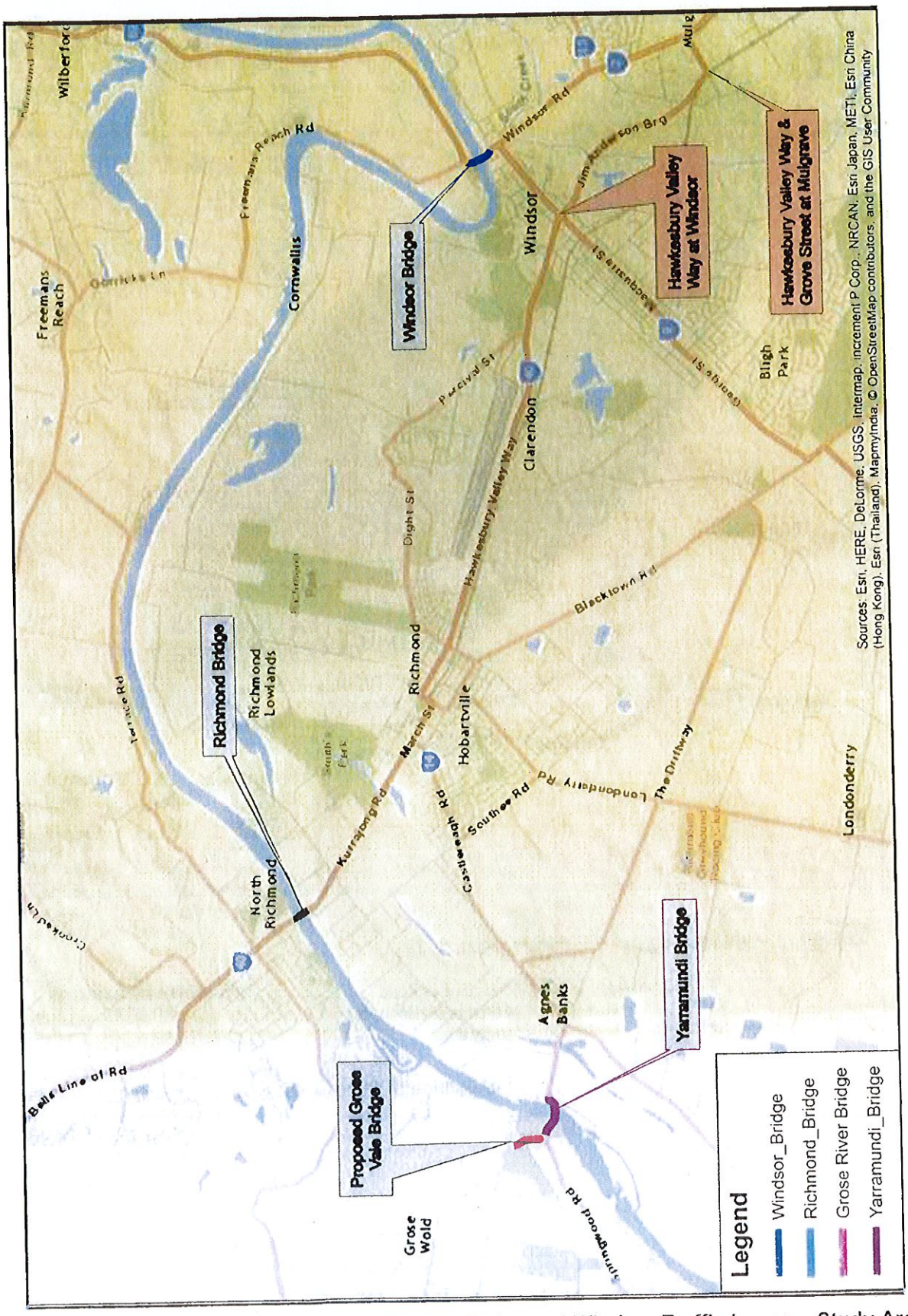
3. Existing Network – Year 2014 AM Peak Period (7-9am)
4. Existing Network – Year 2014 PM Peak Period (4-6pm)

5. Existing Network – Year 2026 AM Peak Period (7-9am)
6. Existing Network – Year 2026 PM Peak Period (4-6pm)

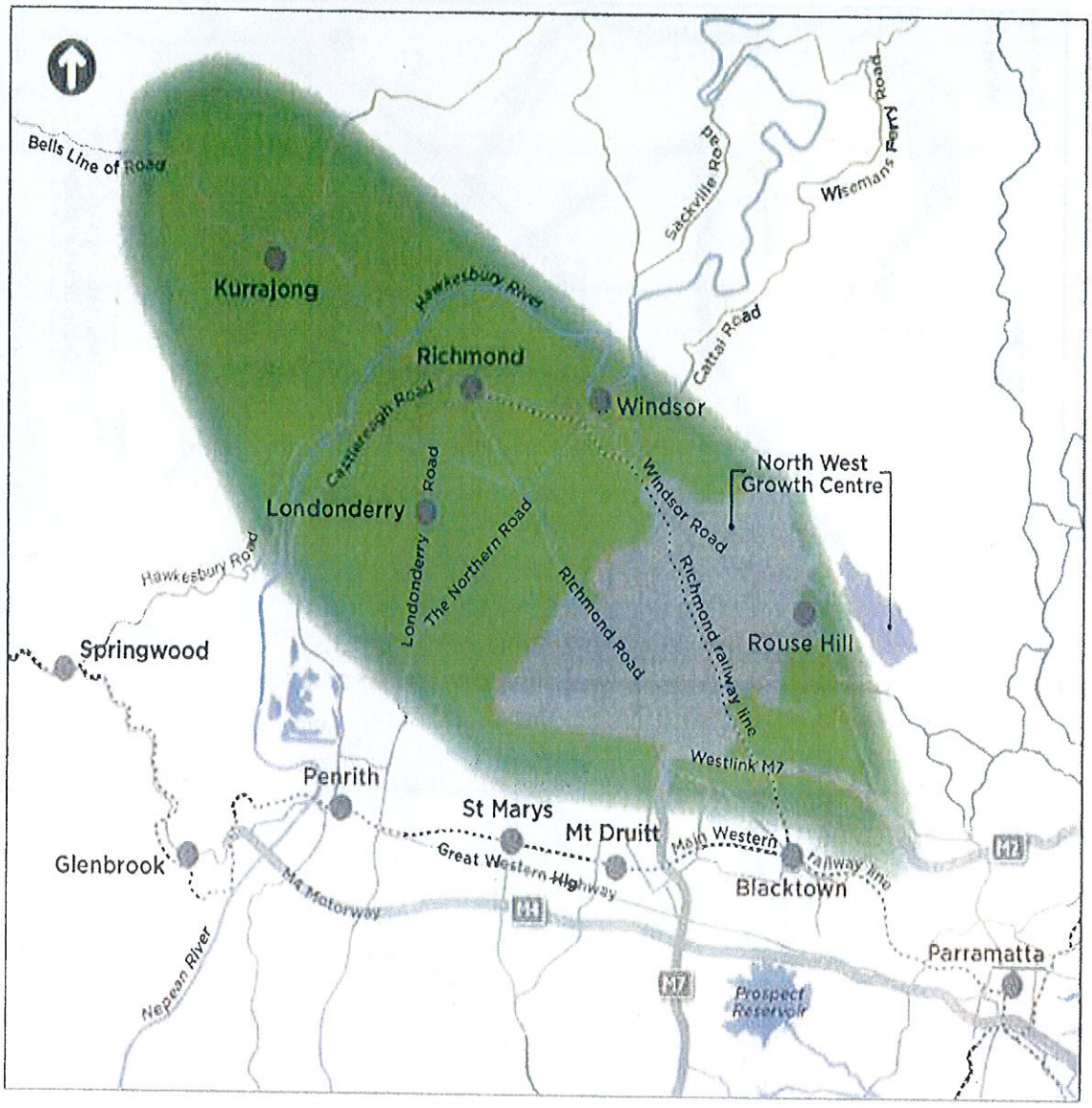
7. Existing Network – Year 2036 AM Peak Period (7-9am)
8. Existing Network – Year 2036 PM Peak Period (4-6pm)

9. Existing Network + Grose River Crossing - Year 2026 AM Peak Period (7-9am)
10. Existing Network + Grose River Crossing - Year 2026 PM Peak Period (4-6pm)

11. Existing Network + Grose River Crossing - Year 2036 AM Peak Period (7-9am)
12. Existing Network + Grose River Crossing - Year 2036 PM Peak Period (4-6pm)



1. Hawkesbury District: Richmond-Windsor Traffic Issues – Study Area

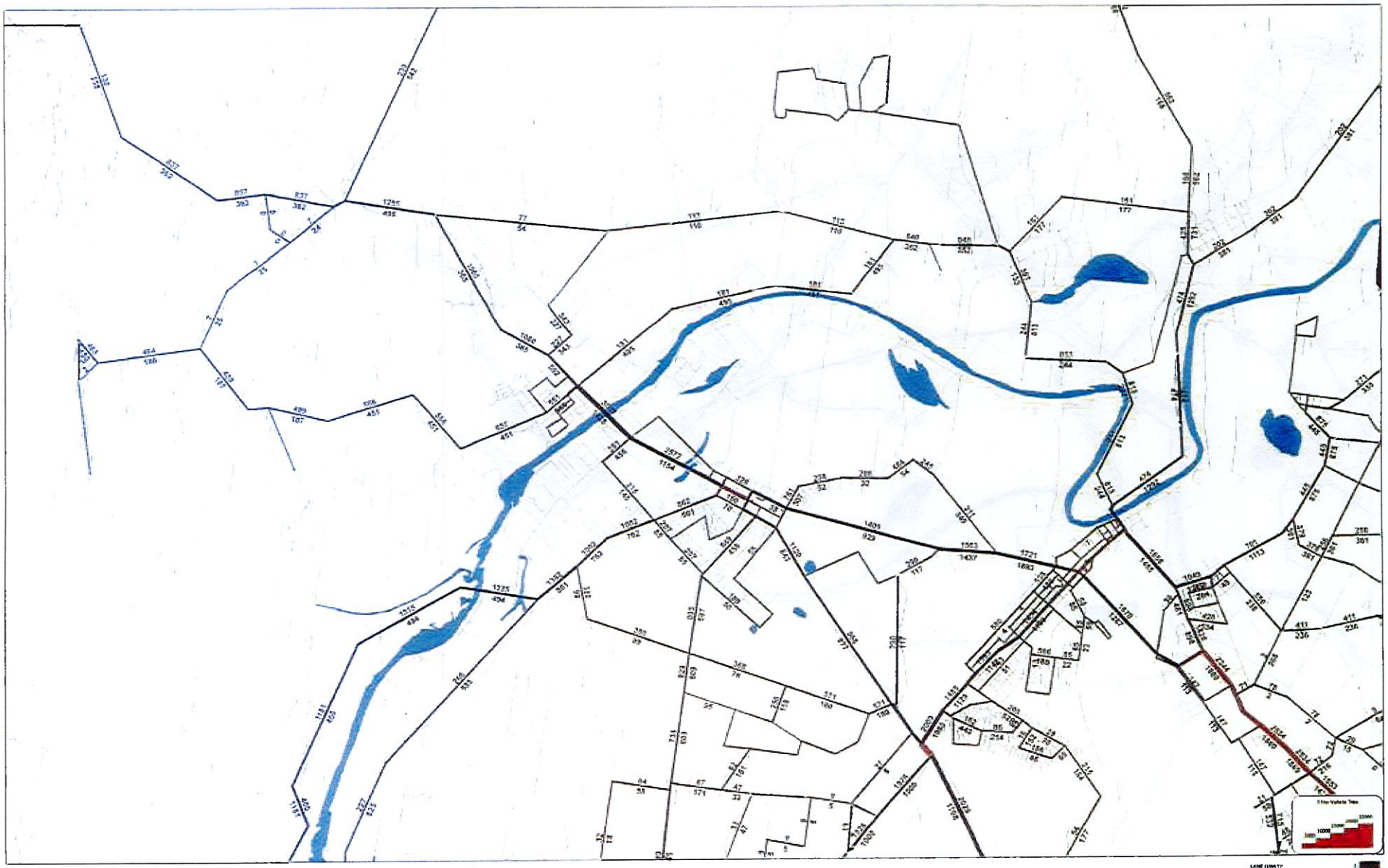


Bells Line of Road - Castlereagh Connection study area

2.

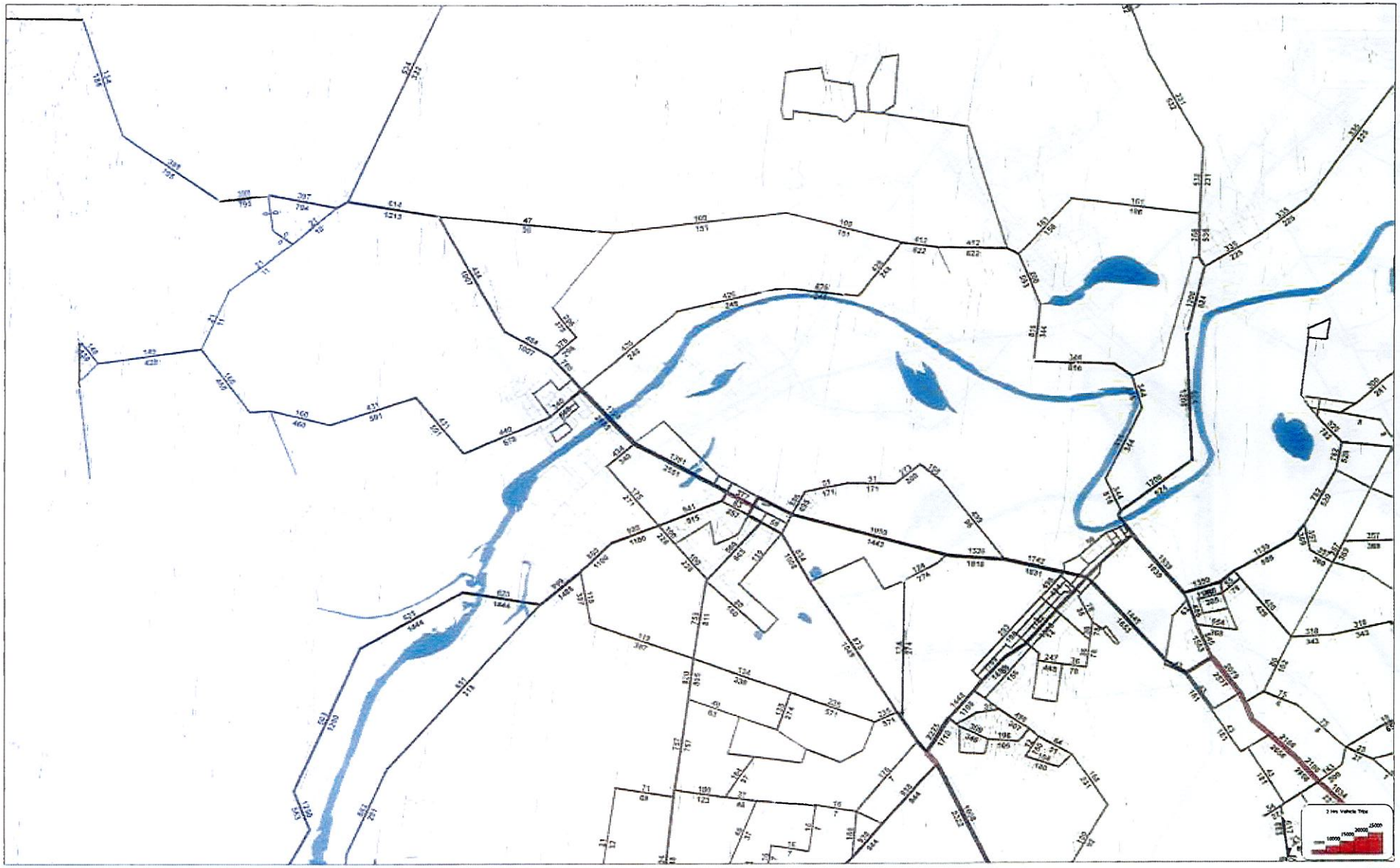
Source: TfNSW

TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 8: 2011-13 SYDNEY ROAD NETWORK (INTDELAY)-7-9AM(mf11)
2015-07-17 10:45

TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 1114: 2011-13 SYDNEY ROAD NETWORK (INTDELAY)-4-6PM(mf16)
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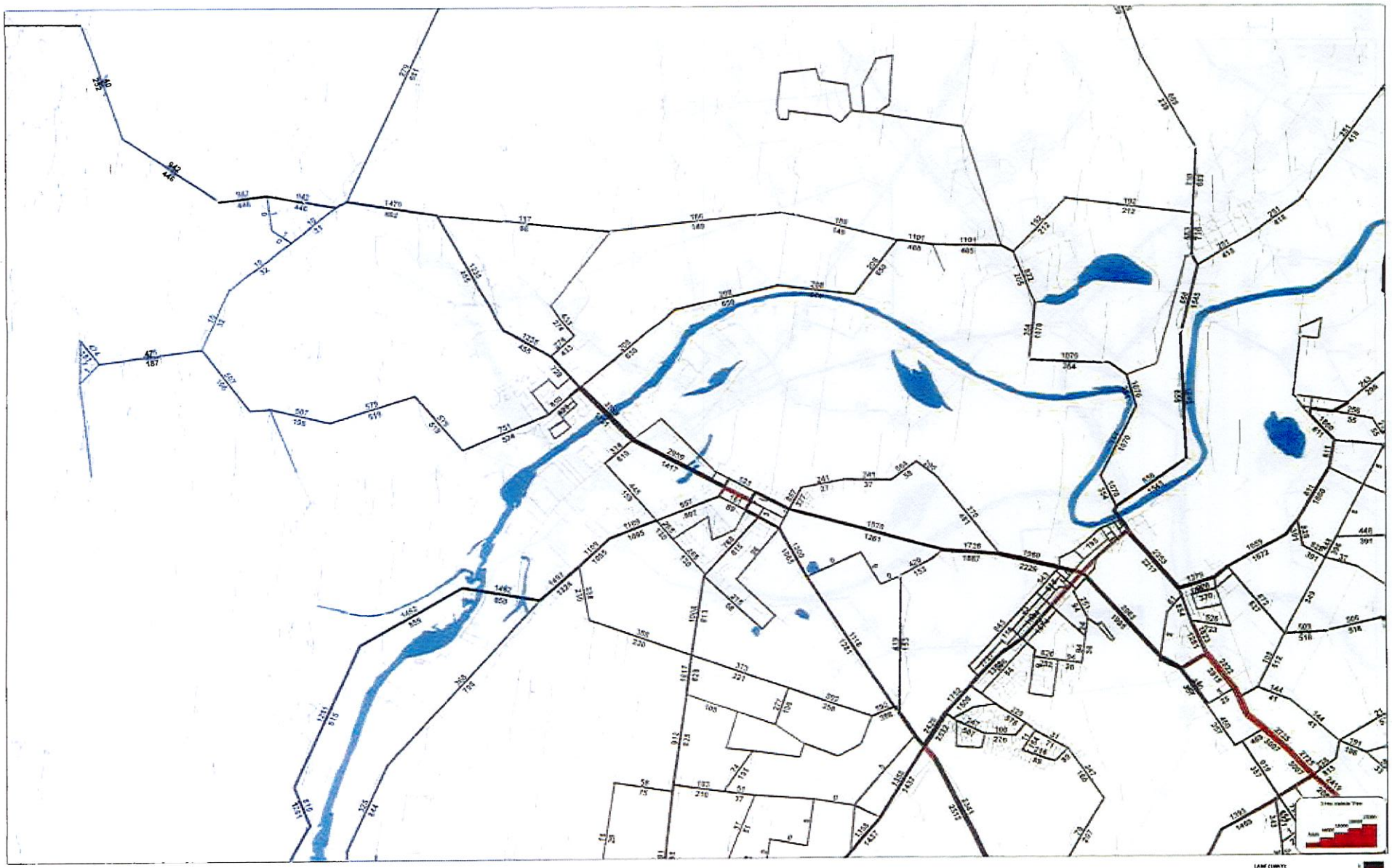
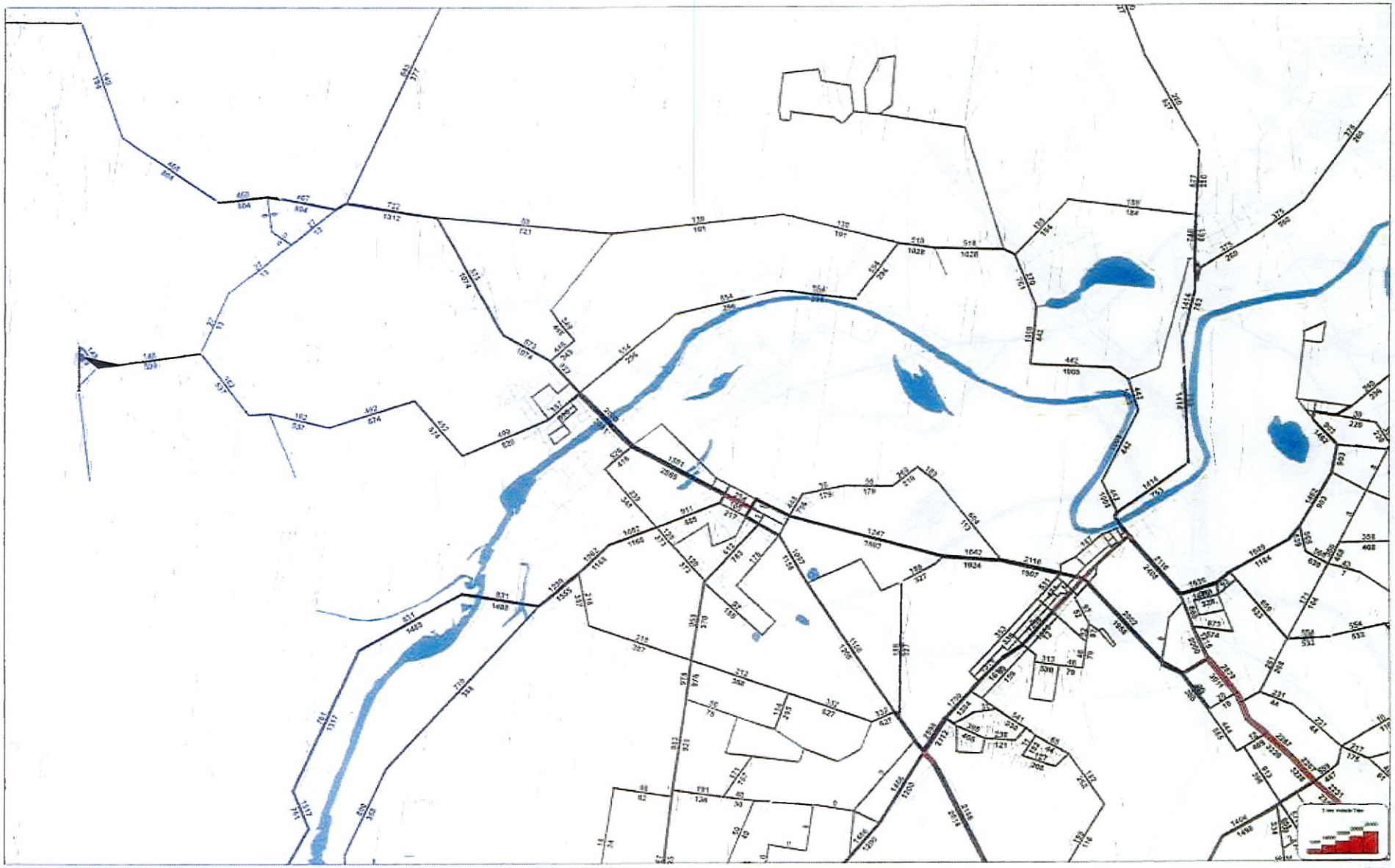
TRAFFIC VOLUMES__



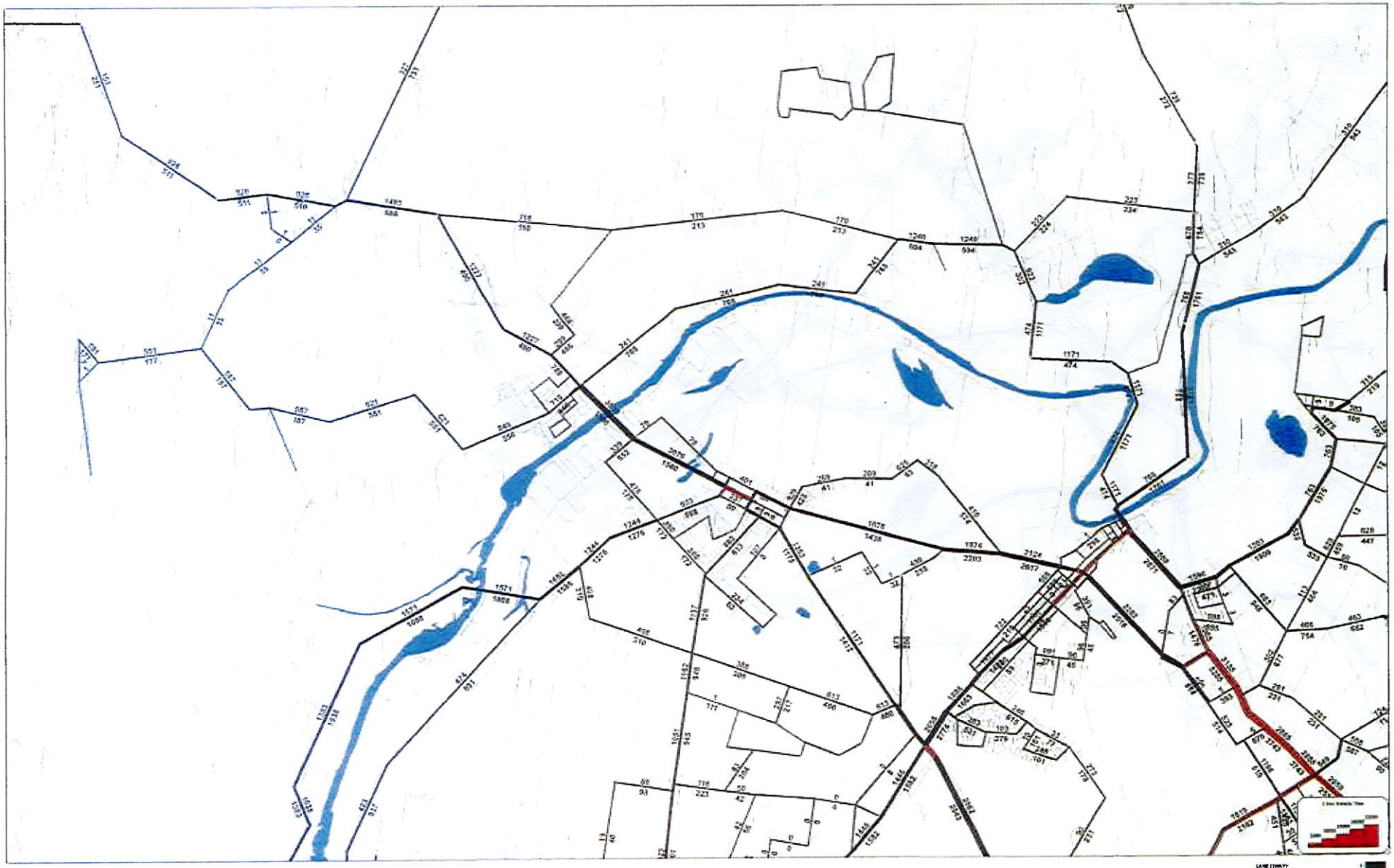
2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 1112: 2026 SYDNEY ROAD NETWORK (INTDELAY)-7-9AM(mf13)
2015-07-17 10:49

TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 1116: 2026 SYDNEY ROAD NETWORK (INTDELAY)-4-6PM(mf18)
2015-07-17 10:49

TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 31127: 2036 SYDNEY ROAD NETWORK ([NTDELAY)-7-9AM(mf15)
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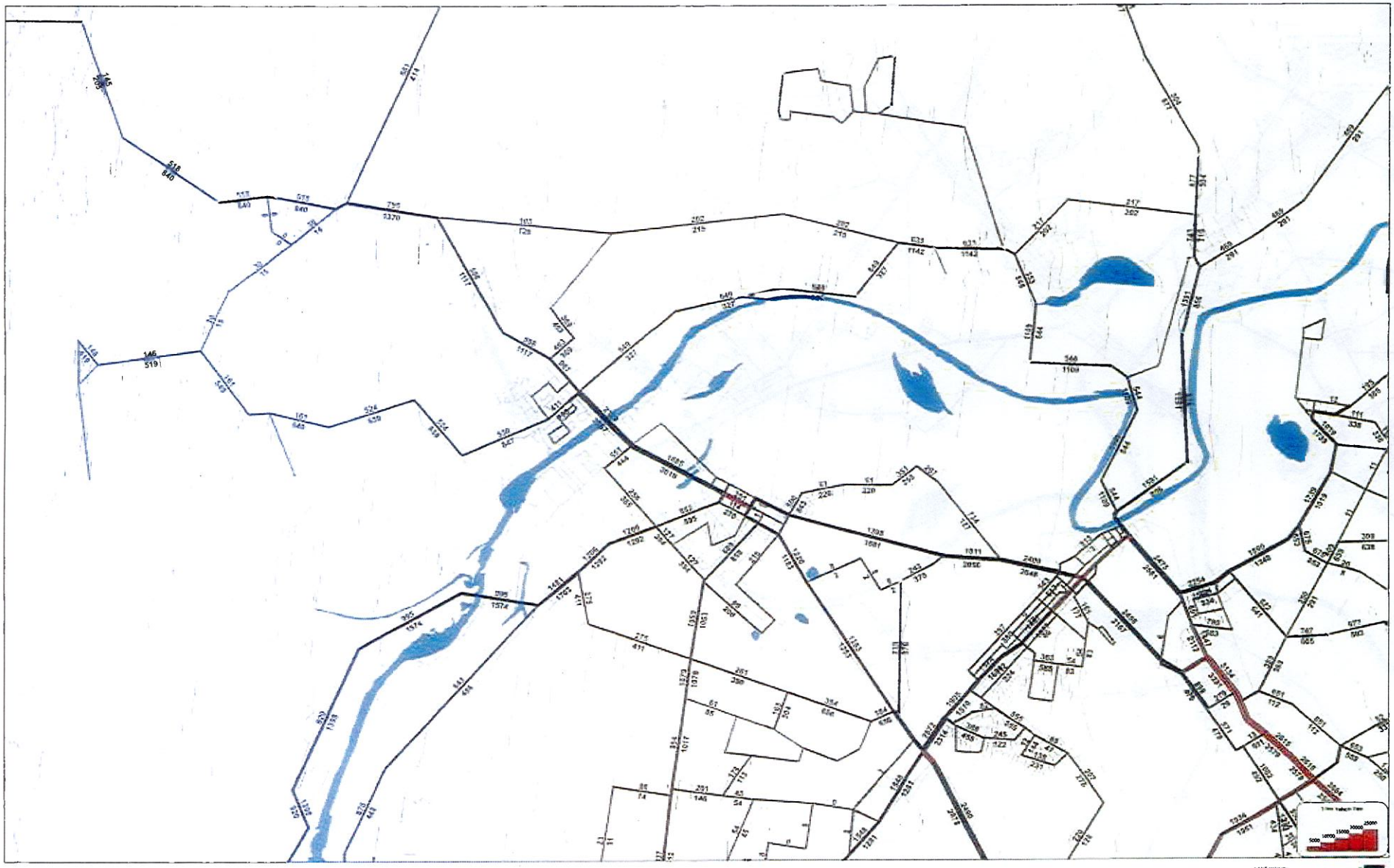
TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 1118: 2036 SYDNEY ROAD NETWORK (INTDELAY)-4-6PM(mf20)
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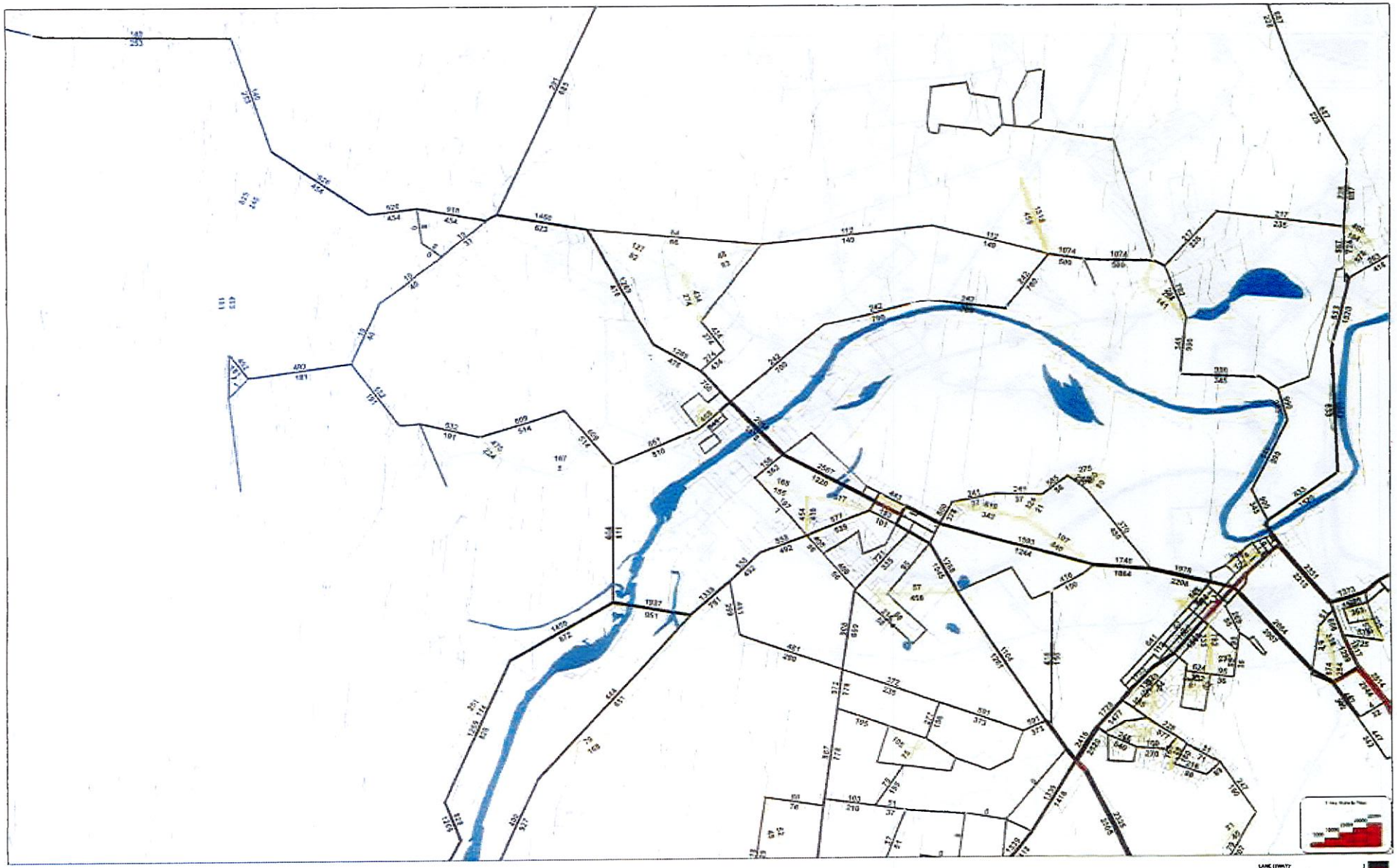
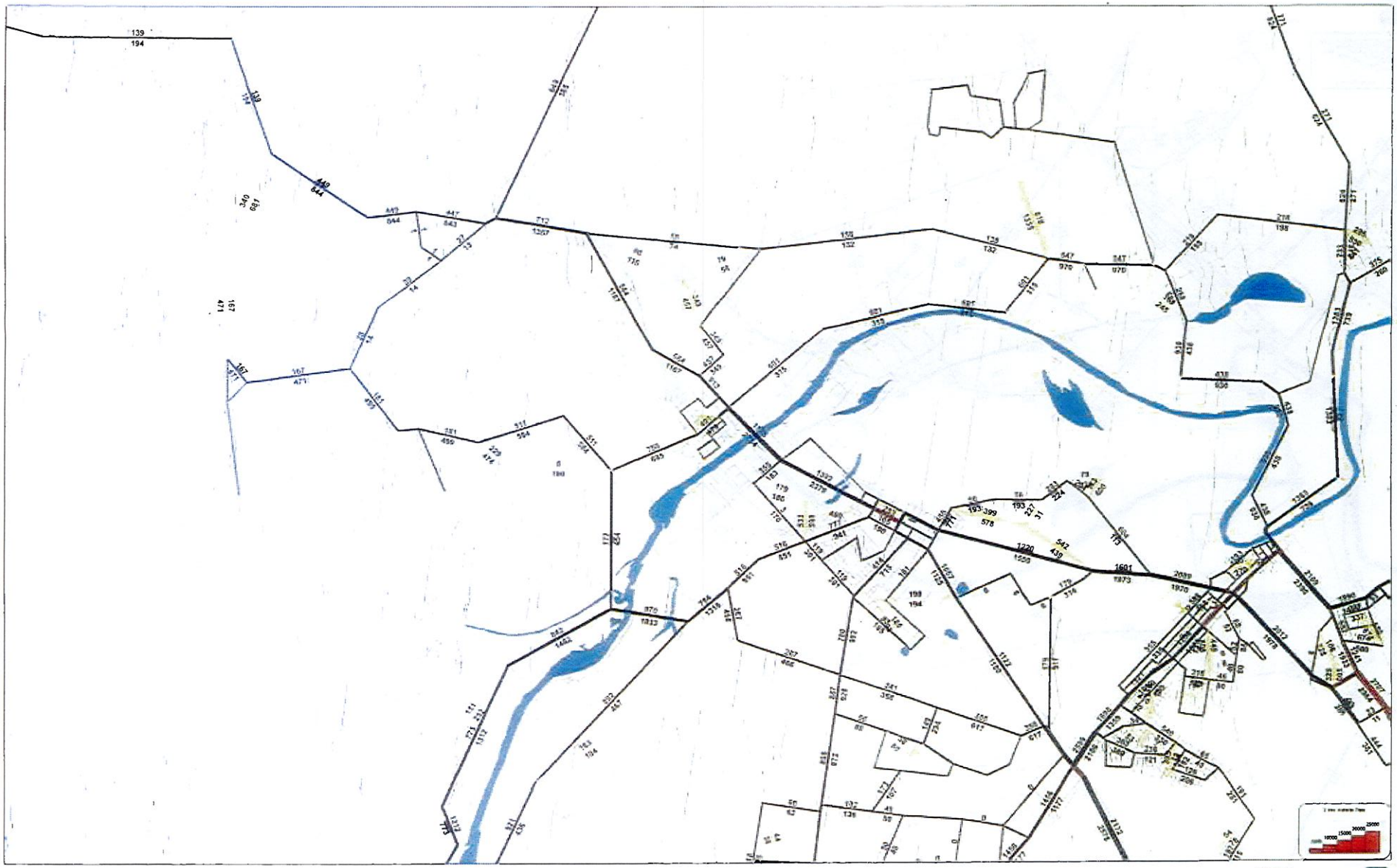
TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 5002: 2026 SYDNEY ROAD NETWORK (INTDELAY)-7-9AM(mf13)Bridgetest
2015-07-17 16:04

TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 5003: 2026 SYDNEY ROAD NETWORK (INTDELAY)+1-6PM(mf18)Bridgetest
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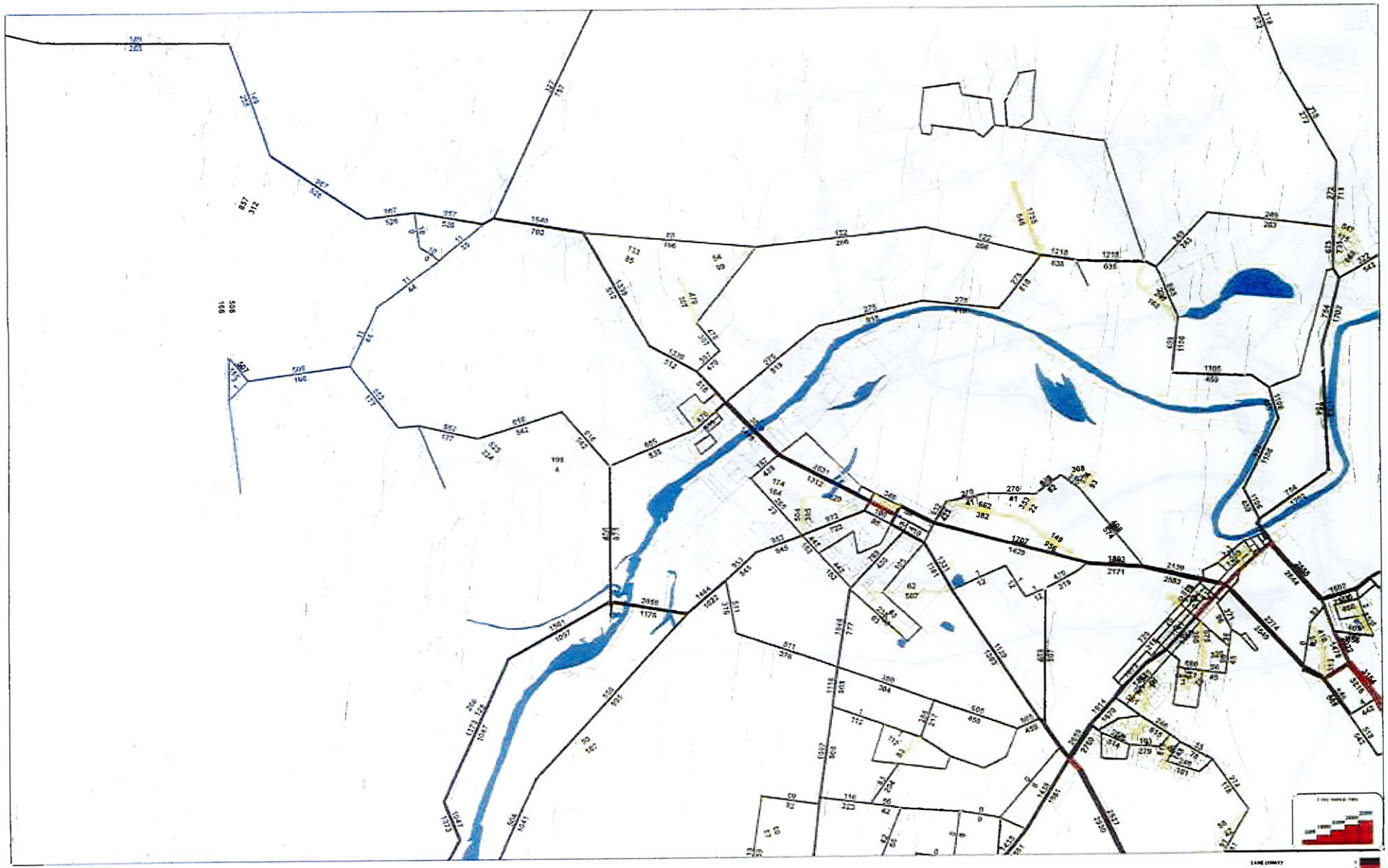
TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 5004: 2036 SYDNEY ROAD NETWORK (INTDELAY)-7-9AM(mf15)Bridgelest
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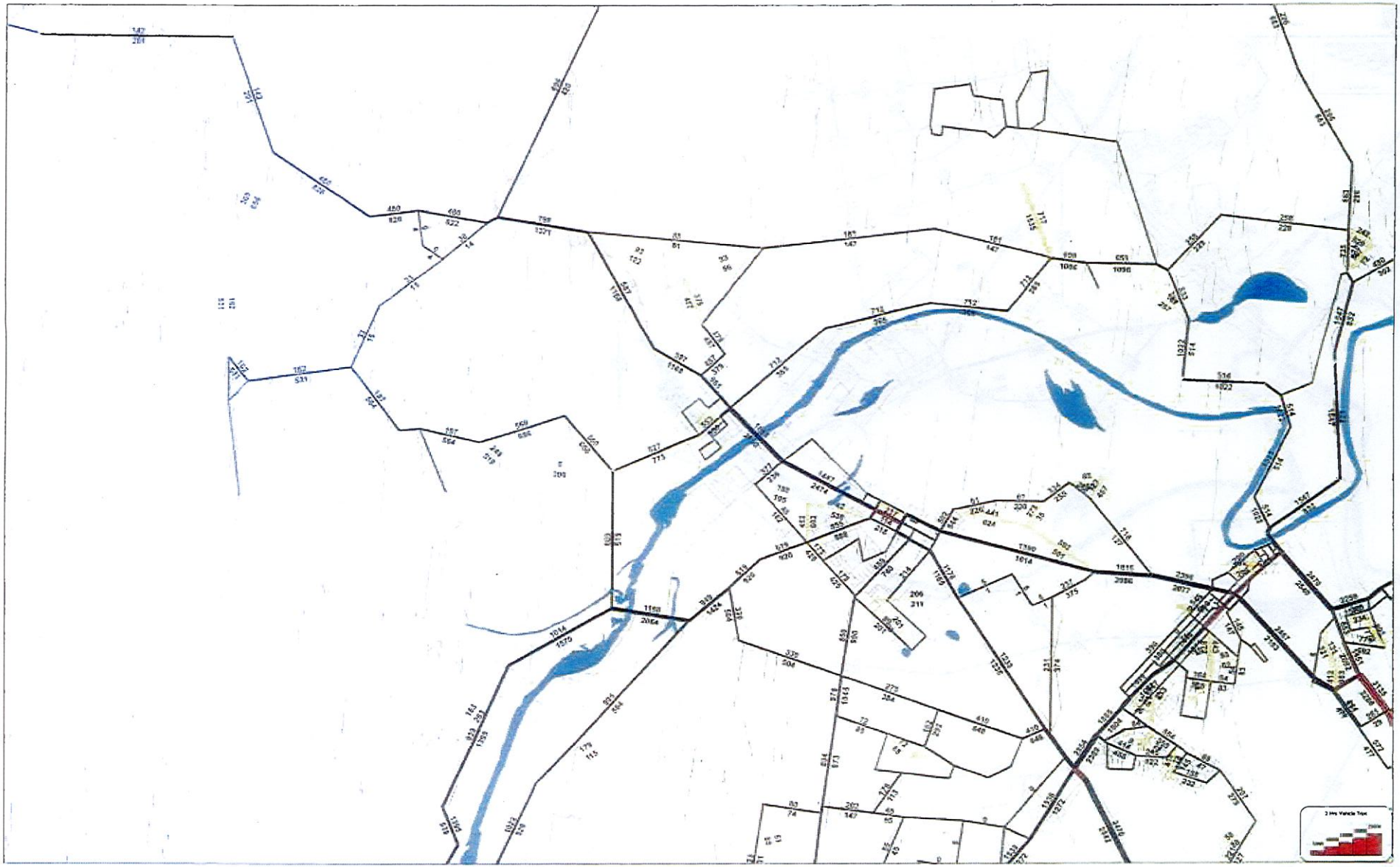
TRAFFIC VOLUMES__



2006TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 5005: 2036 SYDNEY ROAD NETWORK (INTDELAY)-4-6PM(mf20)Bridgetest
2015-07-17 16:06