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Penrith City Council

Penrith Riverlink Precinct

Traffic, Transport and Access Impact Assessment

June 2009

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Executive Summary

Penrith City Council has engaged GHD Pty Ltd (GHD) to carry out a Traffic, Transport and Access Study for the Riverlink Precinct, as part of local environmental studies towards the preparation of Local Environmental Plan and Development Control Plan, to guide the future development of the Precinct.

The Penrith Riverlink Precinct is the development area bounded by the eastern bank of the Nepean River to the west, the M4 Motorway to the south, Mulgoa Road to the east, and the Western Railway line / Great Western Highway to the north. It has an area of approximately 370 hectares. The Precinct contains the major bulky goods retail/warehousing concentration in the Penrith Local Government Area, at the south west corner of Mulgoa Road and Wolseley Road, the Panthers Penrith Entertainment Precinct off Panther Place, rural residential development along Blaikie Road, public open space and private recreational developments. The Precinct also contains vacant and significant landholdings, which have the potential to be developed further.

Following representations by the major landholders for rezoning to permit additional development, in May 2008 Council adopted a precinct plan and a concept plan, as a preliminary guide for rezoning and additional development.

This assessment study has been carried out to investigate potential impacts on traffic, transport and access, resulting from the proposed development of the Riverlink precinct. The proposed land uses assumed for modelling purposes include additional development in the Panthers Penrith Entertainment Precinct and cultural and civic developments in the Carpenter and Woodriff Gardens Site along the Great Western Highway (west of its intersection with Mulgoa Road/Castlereagh Road).

The Riverlink Precinct is surrounded by three state classified roads, i.e. the M4 Motorway to the south, Mulgoa Road to the east and the Great Western Highway to the north. The other classified roads close to the Precinct are Jane Street and Castlereagh Road. These classified roads, in addition to Jamison Road, a regional road, provide the existing key north-south and east-west road links to the Precinct.

The proposed land uses would be expected to generate approximately 1547 veh/hr and 2477 veh/hr movements during the weekday AM and PM peak hours. Regional traffic modelling has been carried out as part of this study to assess the impact of the proposed uses on the existing road network and to identify required infrastructure upgrades to accommodate or mitigate impacts of the proposed development in the Precinct.

The regional traffic modelling has identified that due to the layout of the existing road network, the noticeable impact from development in the Precinct will be on Mulgoa Road, and at key intersections providing access to the Precinct.

The modelling suggests that till Year 2026, deemed ‘End State’, Mulgoa Road, with localised intersection improvements, will be capable of sustaining the development growth within the Penrith LGA, including the generation from the proposed Riverlink

Precinct development. The model identifies no spare capacity along the Mulgoa Road corridor, between High Street and the M4 Motorway, and highlights the need for intersection improvements at the following intersections:

- Mulgoa Road/Jamison Road – optimised traffic signal settings (currently under roundabout control but proposed to be converted to a signalised intersection);
- Mulgoa Road/ Blaikie Road – dual right turn from Blaikie Road and;
- Mulgoa Road/Glenbrook Street – left turn slip lane from Mulgoa SB.

The proposed treatments afford increased green time to the through movements along Mulgoa Road while improving the throughput of highlighted critical movements, to and from the side streets.

In addition, two (2) new access points are proposed for the Riverlink Precinct site:

- A proposed traffic signal controlled intersection on Great Western Highway at the Riverlink Access Road, some 300m, west of Mulgoa Road, directly east of Peach Tree Creek; and
- A proposed left-in/left-out arrangement on Mulgoa Road at Union Street.

Beyond 2026, sensitivity modelling for an increase of 10% in through traffic volumes along the Mulgoa Road corridor indicates significant potential degradation of a number of intersections on Mulgoa Road.

A 10% modal shift to public and active transport target use (from private car) has been agreed with Council. To achieve this modal split and moderate traffic growth in the local area as a result of the proposed additional development or other land use options that may be adopted by Council, a number of transport measures would have to be implemented. These measures include:

- Provision of improved pedestrian and cycle facilities as identified in the Study;
- Restricted car parking provision to the levels adopted for the Penrith City Centre; and
- Liaison with the Ministry of transport for high bus frequency to service the Precinct,

Within the Precinct, street vistas to the Blue Mountains exist along the east-west public streets such as Jamison Road, Blaikie Road and the Great Western Highway while views to the Nepean River exist from the southern end of the Tench Reserve. It is recommended that view corridors along the routes in the Riverlink Precinct be improved through a proper mix of building height restrictions, setbacks, and landscaping. These vistas should not only focus on views from the road carriageways, but also consider views from foothapths and cycleways.

Given the nature of the development assumed for modelling purposes of this study, it can be concluded that subject to the implementation of the recommendations of this Study, the traffic impact of possible additional development in the Riverlink Precinct can be mitigated.

1. Introduction

1.1 Study Context

Penrith City Council has engaged GHD Pty Ltd (GHD) to carry out a Traffic, Transport and Access Study of the Riverlink Precinct, as part of the local environmental studies undertaken towards the preparation of a Local Environmental Plan and Development Control Plan, to guide the future development of the Precinct.

This Traffic and Transport Study is one of three background studies being carried out to provide Council with background information on land use, traffic and transport planning and urban design for the preparation of a Local Environmental Plan and Development Control Plan for the Riverlink Precinct.

1.2 Purpose of the Study

The Penrith Riverlink Precinct is the development area bounded by the eastern bank of the Nepean River to the west, the M4 Motorway to the south, Mulgoa Road to the east, and the Western Railway line to the north, as shown in Figure 1.

The Precinct is currently subject to a number of Planning Instruments and zonings including industrial, rural residential, residential, recreation and special uses.

The Precinct contains the major bulky goods retail/warehousing concentration in the Penrith Local Government Area (at the south west corner of Mulgoa Road and Wolseley Road), the Panthers Penrith Entertainment Precinct off Panther Place, Jamison Retirement Village off Jamison Road, residential development on the south west corner of Mulgoa Road and Jamison Road and along Nepean Avenue, rural residential development along Blaikie Road, public open space and private recreational developments.

Council has reviewed the prospects for additional future land uses in the precinct regularly over several decades. However, the risk of flooding and the need to achieve safe evacuation have proved to be the primary constraint on redevelopment of the Precinct.

Major land owners in the Precinct, particularly Panthers Penrith as well as the Blaikie Road landowners group have been examining future development options and have made representations to Council for rezoning and development of their land holdings. Council as a major landowner of the site known as the Carpenter Site on the south-western corner of the Mulgoa Road/Great Western Highway intersection has also considered land use options for its site.

As a preliminary guide for rezoning and additional development, Council in May 2008 adopted the Riverlink Precinct Plan as an interim concept plan pending completion of more detailed background studies. A copy of the adopted Concept Plan for the Precinct is shown in Figure 2.

To provide Council with a sound basis for the preparation of a Local Environmental Plan (LEP) for the Precinct, studies are being undertake to examine Traffic, Transport

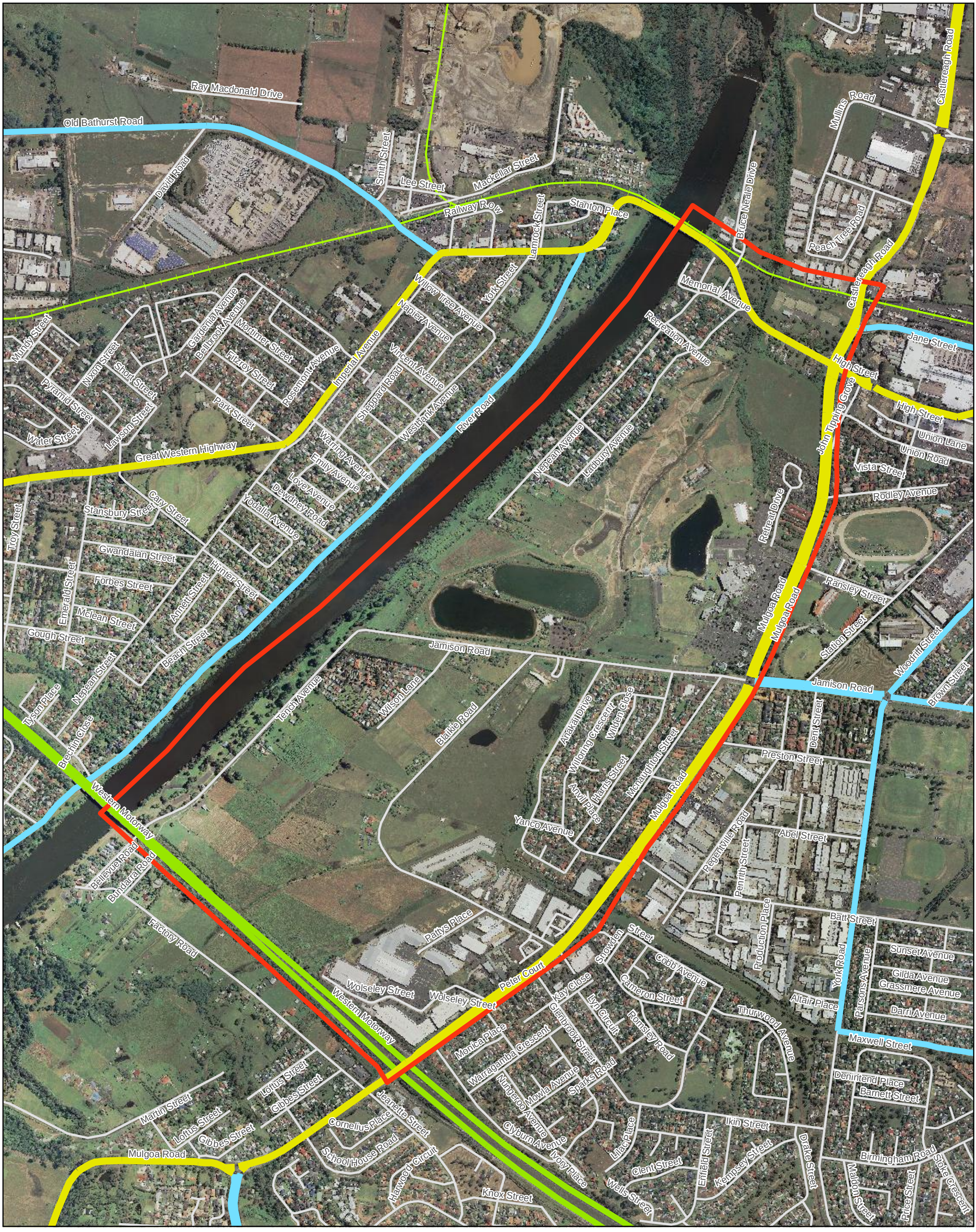
and Access; Visual Character & Urban Design; and Economic Impact & Land Use Analysis.

This report deals with the traffic, transport and access impact of possible additional redevelopment options and should be considered in the context of the findings of the land use and economic assessment, visual character and urban design reports.

1.3 Traffic, Transport and Access Assessment Process

The framework for this Traffic, Transport and Access Assessment Report is outlined in the following sections:

- Project Context – regional and local planning context, previous land use and transport planning studies, the assessment objectives and performance target ***(Sections 2 and 3);***
- Existing Land Use - location of the Riverlink Precinct and existing land use ***(Section 4)***;
- Assessment of Existing Traffic and Transport Conditions – identification of the existing traffic and transport network, services and facilities ***(Section 5);***
- Development Assumptions – proposed land use development options which will be used for modelling purposes ***(Section 6);***
- Traffic and Transport Assessment – estimation of the traffic generation potential of the land use development, regional transport modelling, road network capacity implications, assessment of public and active transport improvement options to encourage public transport use and increased active transport **(*Section 7 and 8);***
- Summary and Conclusions - outlines the findings and conclusions of the traffic and transport assessment ***(Section 9);*** and
- Recommendations – outlines the recommendations for regional traffic and transport improvements including integrated pedestrian and cycle improvements, to minimise the impacts of proposed additional developments ***(Section 10).***



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Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Legend

- Riverlink Boundary
- Highways
- Arterial Roads
- Collector Roads
- Local Roads
- Railways

Penrith City Council
Riverlink Study

Job Number	21-18430
Revision	A
Date	30 MAY 2009

Riverlink Precinct Locality Plan

Figure 1

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Data source: GHD Pty Ltd. Created by: nbuchanan

10 Bond Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

2. Project Context

2.1 Regional Context

The metropolitan planning strategy for the greater Sydney area is provided for in the City of Cities: A Plan for Sydney's Future. Released in December 2005, it outlines the vision for Sydney for the next 25 years, and provides the blueprint to enable the Sydney metropolitan area to accommodate a projected 1.1 million population increase in that period, as well as 500,000 more jobs.

The Metropolitan Strategy sets out the aims and principles that would support economic growth while balancing social and environmental impacts, and is based on anticipated population, economic and demographic trends. It has been developed with five aims: enhance liveability, strengthen economic competitiveness, ensure fairness, protect the environment, and improve governance.

The City of Cities concept evolves around Global Sydney, comprised of the Sydney CBD and North Sydney, which works together with a network of strategic centres comprised of regional cities, specialised centres, major centres, and planned major centres. These will all be linked through a network of corridors. The Regional Cities identified in the strategy include Parramatta, Liverpool, and Penrith. Other regional cities outside the Sydney Metropolitan Area are Gosford in the Central Coast, Wollongong in the Illawarra, and Newcastle in the Lower Hunter.

The regional cities, of which Penrith is one, will provide a focus for innovative business environments, jobs and more lifestyle and work opportunities closer to growing parts of Sydney. These centres will attract new shopping, health, education, business and cultural facilities.

2.2 Sub-regional Planning Context

Ten subregions within the Sydney metropolitan area have been identified. The planning for each of these sub-regions will translate the objectives of the Metropolitan Strategy's long-term objectives to the local level. The subregional strategies provide for a venue for local councils to undertake coordinated planning, to eventually incorporate the metropolitan housing and employment objectives into the local environmental plans.

The North West Subregional Strategy indicates that the Penrith local government area, with a population of around 180,000 people (ABS 2006) and covering an area of around 400 km², would need to cater to the significant growth target of 10,000 new jobs and 10,000 additional residents within the centre. Part of the Western Sydney Employment Hub is located within Penrith local government area and these areas will also be a focus for employment growth in the future.

2.2.1 Key Directions for the North West subregion

The North West Subregional Strategy states that:

A key direction in the Metropolitan Strategy is the location of more jobs in Western Sydney. The North West Subregion has experienced rapid population growth that has not been matched by comparable growth in employment, resulting in relatively low levels of employment self–containment for the subregion. The subregion has an employment capacity target of 130,000 new jobs, which is 24 per cent of the employment target for Sydney. Significant employment growth is expected to occur in Strategic Centres of the North West Subregion as well as within some larger local centres. The clustering of industries around the new M7 Motorway and development of the Western Sydney Employment Hub will be also integral to achieving these targets and will provide opportunities for spin–off developments in nearby centres. Further opportunities for employment growth will also be explored within the Western Sydney Employment Lands Investigation Area.

The North West Subregion will accommodate 140,000 new dwellings by 2031. This represents 23 per cent of the overall housing target for Sydney. 60,000 dwellings will be located in the North West Growth Centre, with the remaining 80,000 dwellings located in other areas. Over the life of the strategy the majority of new dwellings will be located within close proximity to centres to ensure accessibility to jobs and services.

2.2.2 Penrith as a Regional City

One of the key elements in the Metropolitan Strategy is the designation of Penrith as a Regional City.

As a river city, the Metropolitan Strategy looks to Penrith to "*provide a focus for innovative business environments, jobs, and more lifestyle and work opportunities for a growing part of Sydney. It will attract new and improved shopping, health, education, business, recreational and cultural facilities.*"

The Strategy further states, "*Penrith offers several advantages such as a large regional catchment area, proximity to natural assets such as the Nepean River, and the Blue Mountains and important infrastructure including the Nepean Hospital. It is also a focus for regional public transport infrastructure. Future planning will look at how to better connect and consolidate assets such as the University of Western Sydney, North Penrith Defence Lands, Penrith Lakes and the Penrith Panthers precinct with the Penrith City Centre. The Cities Taskforce is looking at employment, housing and lifestyle opportunities, and in partnership with Penrith City Council has developed a draft Penrith City Centre Plan.*"

2.3 Local Planning Context

Council has been considering land use development options for the northern portion of the Riverlink Precinct for over ten years. Other major landowners in the central part of the Precinct including Panthers and its development partner ING Real Estate, as well

as the Blaikie Road landowners group, have also been examining their future development options.

In 2006, Landcom (on behalf of Council) and Panthers undertook a study of the 'Carpenter site' and Woodriff Gardens (both owned by Council on the opposite sides of the intersection of High St/Mulgoa Road) and Panthers Penrith site, between the Main Western Railway and Jamison Road. The study considered and recommended a range of appropriate land uses to build on the status of Penrith as a Regional City, and to enhance links between the City Centre and the Nepean River.

Landowners and developers on the southern part of the Precinct have over the last fifteen years also applied for rezoning of their land holdings.

2.4 Previous Land Use and Transport Planning Studies

Penrith Council and Panthers Penrith, as major landowners within the precinct, have both carried out a number of land use planning studies to identify possible development options for the above mentioned development sites. In addition, Council has carried out a number of land use and traffic/transport planning studies and adopted planning strategies in the local area. The relevant strategies and studies include the following:

2.4.1 Riverlink Precinct Plan

As indicated above, Council adopted the Penrith Riverlink Concept Plan on 5 May 2008. A copy of the Plan is shown in Figure 2. The Plan's objective is to develop a living entertainment and working hub and improve links from the Penrith City Centre to the Nepean River.

The urban design principles set out in the Precinct Plan includes the following:

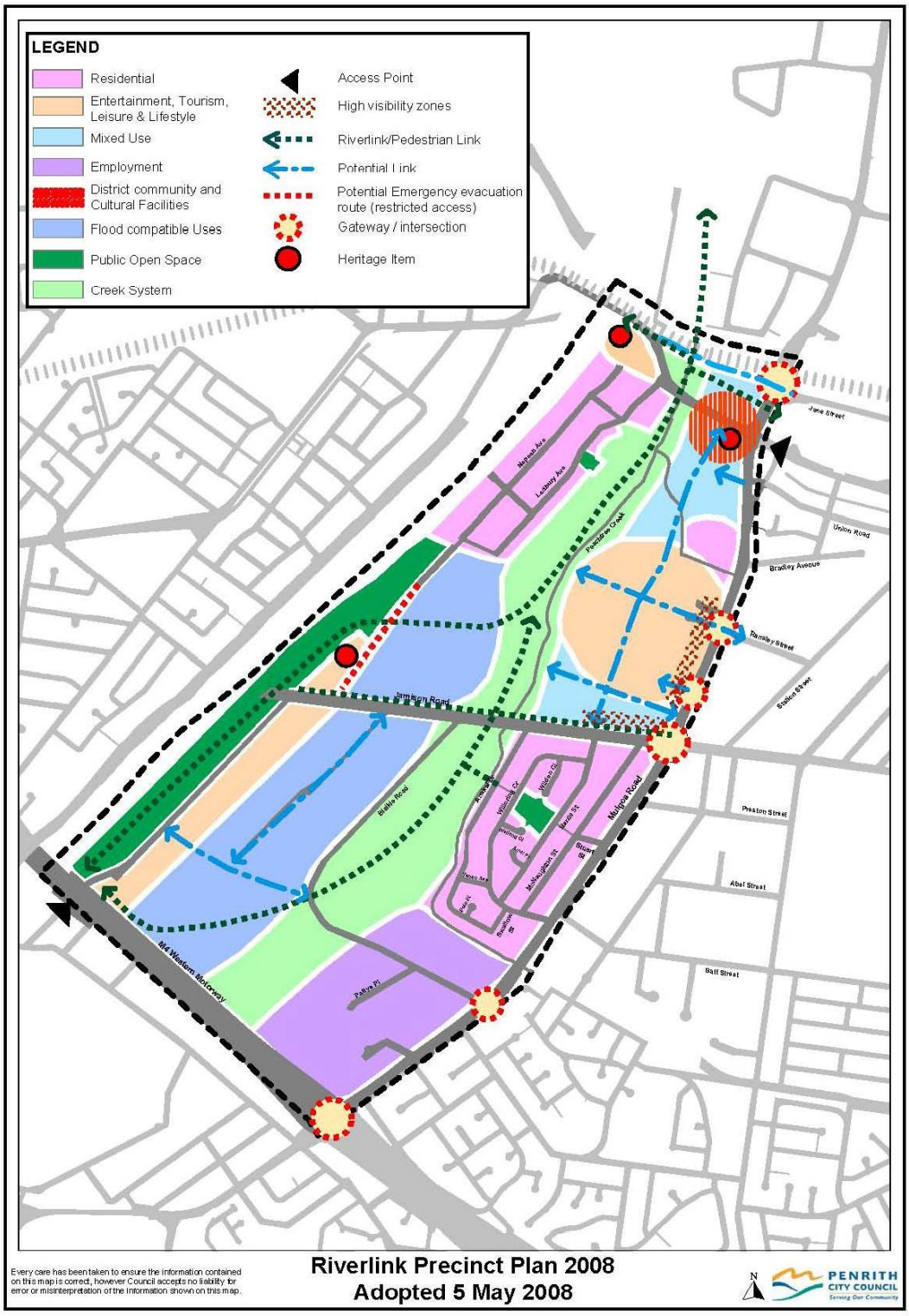
- Creating a cohesive and well connected precinct;
- Enhancing and activating Mulgoa Road as a significant approach to Penrith City Centre;
- Reinforcing key intersections as gateways to the precinct and the Penrith City Centre;
- Creating a clear and legible public domain framework of streets and open space;
- Creating a new north-south access link between Jamison Road and the Great Western Highway;
- Extending Ransley Street west through the Panthers site to allow access to Peach Tree Creek;
- Creating an exciting core of entertainment, leisure and lifestyle uses around the existing club;
- Incorporating sustainability best practice;
- Connecting Riverlink pathways with the Great River Walk;
- Encouraging views of the Blue Mountains from the public domain;

- Encouraging design excellence;
- Improving connectivity through the Precinct; and,
- Enhancing Peach Tree Creek.

The Riverlink Precinct Plan is intended to guide the preparation of more detailed plans for individual properties or landholdings within the area, within the context of a significant precinct that links the Penrith City Centre and the Nepean River.

The above urban principles have been considered in this traffic and transport impact assessment. Options recommended for achieving these design principles are addressed in Sections 8 and 9.

Figure 2 Penrith Riverlink Precinct Plan, 2008



2.4.2 Panthers Penrith Concept Plan

The major private landholding within the Riverlink precinct is Panthers Penrith. Panthers Penrith have prepared and submitted a concept Plan to Council for consideration.

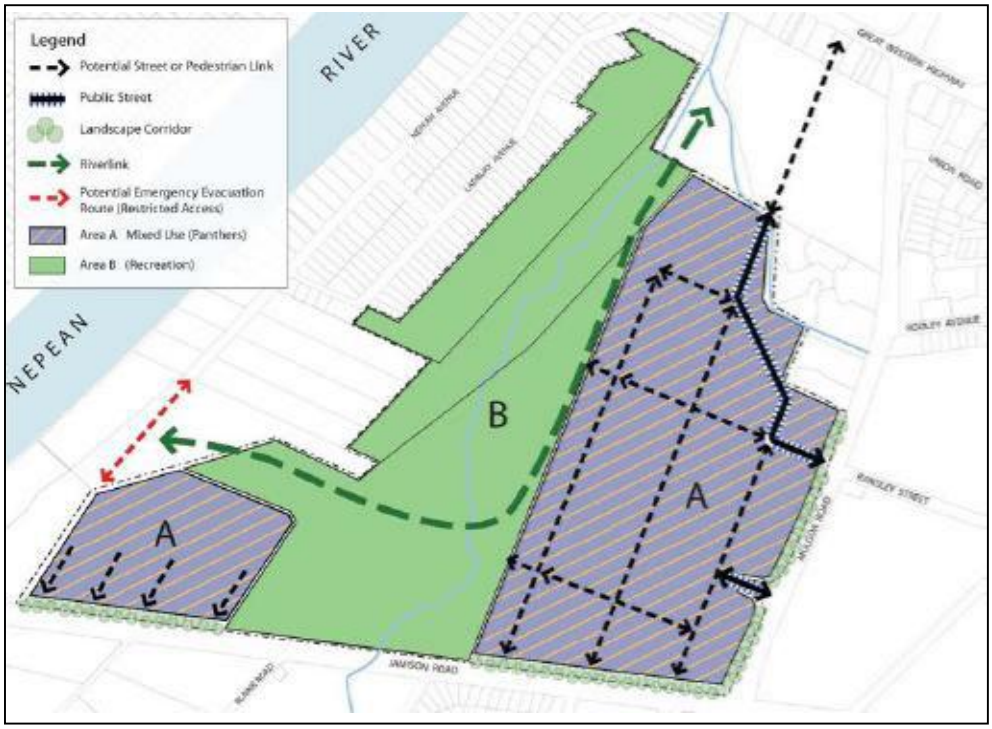
The concept plan outlines a proposal for redevelopment of the Panthers Penrith land holdings that seeks to redevelop the existing entertainment facilities with possible uses such as short term accommodation, conferencing and exhibition facilities, cinemas, bowling, restaurants, cafes, retail, health wellness and aquatic facilities, and a multi use arena, surrounded by a mix of residential development, campus style office accommodation with recreational opportunities such as green parks and open spaces, as well as walking and cycling tracks.

The recreational use will include the recently developed 18-hole golf course on either side of Peachtree Creek.

The Concept Plan proposes an extension of Ransley Street further west and north through to the Carpenter Site (corner High Street and Mulgoa Road), additional access points off Jamison Road, as well as additional pedestrian and bicycle paths to the existing network.

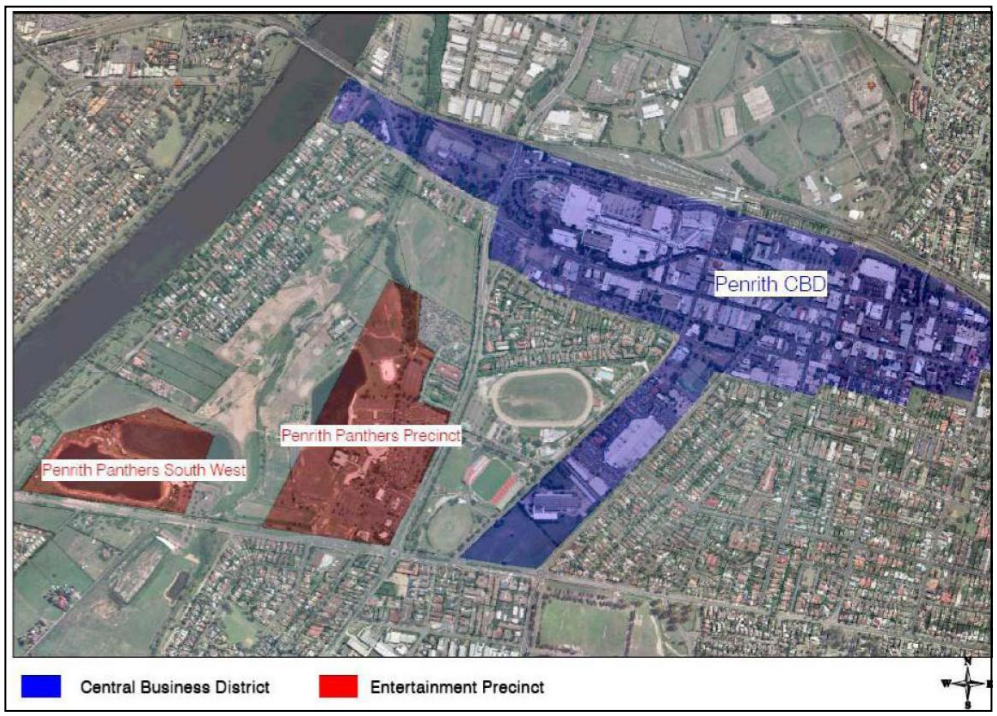
The internal road and pedestrian links proposed in the Concept Plan are as shown in **Figure 3**. The relationship of the Panthers Penrith development site and the Penrith City Centre is as shown in **Figure 4**.

Figure 3 Panther Penrith Concept Plan – Proposed Road and Pedestrian Network



Source: Concept Plan V6-2, ING-Panthers

Figure 4 Proposed Panthers Penrith Development



Source: ING (2008), MacroPlan Australia (2008)

2.4.3 Penrith Arterial Roads Study, Oct 2007 (focusing on the Penrith Lakes Development)

Penrith City Council carried out this study to assess the traffic impact of major additional land use developments including the Penrith Lakes Development Scheme, St Mary's Release Area, Werrington Living and Learning (WELL) Precinct, Glenmore Park Stage 2, Penrith Lakes Environs, and North Penrith Army Land, on the arterial road network in the Penrith Local Government Area.

The study was carried out using regional traffic modeling and assessed future traffic conditions by 2036.

2.4.4 Access and Transport Analysis of Penrith City Centre and St Marys Town Centre, Nov 2004

Penrith City Council undertook a study to identify and analyse the vehicular, pedestrian and public transport issues around the Penrith City Centre. The study also prepared recommendations for improving access around Penrith City Centre.

The key findings of the Study are as follows:

Traffic

- The majority of intersections in Penrith City Centre are operating at a satisfactory level of service, except the Mulgoa Road/Great Western Highway intersection;
- The majority of the roads in Penrith City Centre are carrying significant traffic volumes during peak hours; and,
- Vehicles are currently experiencing significant delay at the following locations:
  - Mulgoa Road, between Jane Street and the Great Western Highway
  - High Street (westbound) between Woodriff and Station Streets
  - The Great Western Highway (westbound) on the approach to Parker Street during the PM peak hours.

Public Transport

- The frequency of bus services in Penrith City Centre is very limited, with bus services departing every 30 minutes;
- The maximum waiting time for passengers to catch eastbound trains during AM and PM peak hours are approximately 11 and 19 minutes;
- The maximum waiting times for westbound trains in the AM and PM peak hours are approximately 32 and 35 minutes; and
- Public transport constraints identified include delay for buses while accessing Penrith City Centre from Macquarie Bridge and the length of Bus Zone on the southern side of Henry Street, adjacent to the Coach Parking area.

Walking and Cycling

Pedestrian facilities have been provided around the Penrith City Centre; however, cycle facilities are very limited, with various areas in the Penrith City Centre providing cycle paths and facilities.

2.4.5 Penrith Integrated Transport Land Use Strategy 2008

The Penrith Integrated Transport and Land Use Strategy (PITLUS) was prepared with the aim to provide integrated, accessible land use and environmentally friendly transport, which supports environmental, social and economic policies.

Implementation of the strategy would improve the transport system to existing and potential major activity centres in Penrith LGA. The key features of the Strategy are as follows:

Public Transport

Bus

- Frequency of services and bus routes is an issue for passengers and potential users;

- There are missing links in the bus network;
- Only 28% of the total LGA falls within the 400m walking catchments of bus stops; and
- Review of bus routes is currently being carried out by the Ministry of Transport.

Trains

- Significant gaps in the rail catchment areas;
- Under utilisation of land around rail stations; and
- Poor provision of pedestrian and cycle facilities around stations.

Walking and Cycling

- Lack of cycle facilities;
- Implementation of the proposed footpath network is required; and
- Patchy footpath network with little connectivity between residential areas and key attractors in some areas.

2.4.6 Penrith New Urban Release Areas, Feb 2009

Penrith City Council has identified and assessed a number of release areas in the Penrith LGA including the WELL Precinct (which incorporates Caddens, Werrington Mixed Use Area, Claremont Meadows Stage 2, South Werrington Urban Village and Werrington Enterprise Park), Penrith Lakes and the Riverlink Precinct, for proposed urban developments.

3. Traffic and Transport Impact Assessment Process

3.1 Impact Objectives

Penrith City Council's Sustainability Blueprint for urban release areas requires the submission of an Infrastructure Delivery Plan for all release areas. The Delivery Plan is required to identify and provide for infrastructure and services including:

- A safe, efficient and effective road network and pedestrian/cycleway network which links with existing and new infrastructure, public transport services, shopping centres, community facilities and recreational areas;
- Public transport networks and systems, which deliver effective access to major destinations and other mode connections; and
- A Transport Management Accessibility Plan is required to identify public transport system improvements generated by new release areas.

While the Riverlink Precinct is not a release area, the traffic impact of additional development in the Precinct will have a significant impact on the existing road network and road based public transport services and facilities in the local area.

Council's sustainability blueprint requirements and principles have therefore been considered in the traffic and transport impact assessment and will involve the following:

- Identification of current status of traffic, transport and accessibility environment in and around the Riverlink Precinct;
- Trends in traffic, transport and accessibility that should be considered in achieving best practice futures for the Riverlink precinct;
- Traffic and transport impacts of land use options that are permissible within Riverlink under existing zonings and recommended in the land use, economic and urban design studies by Hill PDA and HBO + EMTB;
- Traffic impact assessment of additional development of the Riverlink Precinct on existing pedestrian and bicycle facilities and options to improve these facilities to accommodate the impact of additional development; and
- Assess the impact of public transport services and options to address any deficiencies.

The assessment will also provide principles for integrated land use and transport planning

- Identify local road network to accommodate road based public transport services;
- Identify ways of encouraging public transport use including walking, bicycles;
- Identify ways to achieve a safe, efficient and effective vehicular traffic system, which does not adversely affect traffic flows on existing roads; and

- Provide vistas to identified landmarks and public transport to assist legibility, based on open space, shops, schools, community facilities, recreational facilities and other local landmarks.

3.2 Targets / Performance Criteria

The transport target proposed and agreed to with Council is the aim to achieve a 10% modal shift from private car use to public and active transport over the current levels for the journey to work. Modal split for the journey to work is able to be monitored through the five yearly census data and provides a very good measure of the use of sustainable transport measures.

This target is considered a realistic yet ambitious objective and will require transport demand management measures including restricted car parking policy, improved bus services to the precinct and improvements to the existing pedestrian and bicycle facilities.

Other performance targets include - bus services delivery, local accessibility and road network performance targets. The associated recommended targets are as follows:

- Improving bus service delivery provides potential for allowing demand responsive services to be in place. The current Service Planning Guidelines for bus services focuses on delivering an integrated network whilst providing greater flexibility for operators to allow more flexible routing and servicing;
- Local accessibility refers to the proximity of residents to a bus service - An appropriate target is for 85% of residents to live within 400m of a public transport stop; and
- Road network performance target – The capacity of an urban road is dependent on the traffic conditions and performance at the intersection within the local road network. A simple index to assessing network performance is based on level of service provision. A level of service “D” is acceptable to the RTA as minimum design criteria as it relates to traffic levels at 85% of theoretical maximum capacity. Improving intersection performance entails providing capacity enhancements. However, the RTA also uses capacity constraint as a demand management technique. It is proposed that the target for intersections which have the main influence on the Riverlink precinct development be ameliorated to a level of service D or better. A summary of performance indicators, i.e. RTA’s Level of Service Index, is shown in Appendix A.

4. Existing Conditions

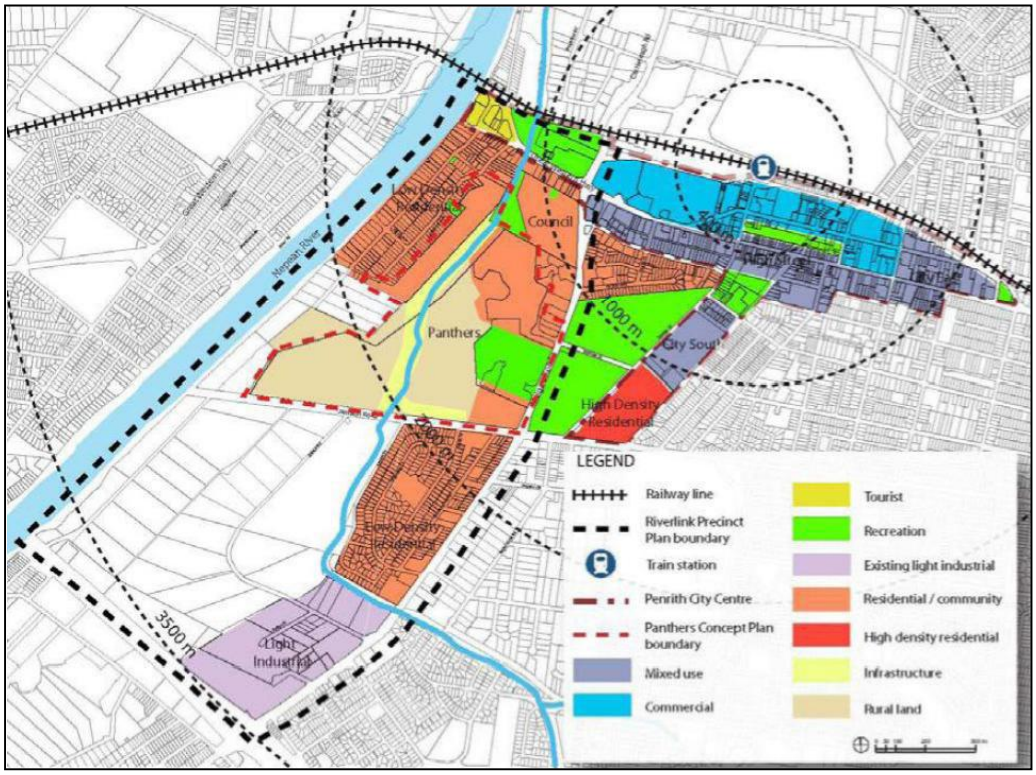
4.1 Existing Land Uses

The Riverlink Precinct is a 370 Ha development precinct and contains a number of existing land uses including the following:

- the Panthers Penrith Entertainment Precinct off Panther Place;
- The major bulky goods retail/warehousing precinct including Harvey Norman and Bunnings, at the south west corner of Mulgoa Road and Wolseley Road;
- Jamison Retirement Village off Jamison Road; and,
- Residential development on the south west corner of Mulgoa Road and Jamison Road and along Nepean Avenue and Ladbury Avenue;
    - Nepean Shores Riverside Resort and Conference Centre at the corner of Jamison Road and Tench Avenue; and
    - Rural residential development along Blaikie Road.

The current zoning system that applies to the Riverlink Concept Plan area is shown in Figure 5.

Figure 5 Existing Zoning



4.2 Details of Existing Developments

4.2.1 Penrith Panthers Entertainment Precinct

The Panthers Penrith Entertainment Precinct is off Mulgoa Road via Panthers Place and Retreat Drive, on the northwestern corner of the Mulgoa Road/Jamison Road intersection.

The Precinct contains a number of mixed-use developments, including the following:

- Registered Club, Entertainment facilities, Restaurants, Cafés, Micro Brewery, Health and Well-being Centre, Gymnasium, Sporting Complex/uses, Aquatic facilities;
- Exhibition facilities; and
- Hotel.

The areas and number of rooms in the existing development is as follows:

Table 1 Existing Land Uses within Panthers Penrith Precinct

Building	Area (sqm)
Club – Existing	27,200
Club – Conference	6,000
Hotel – Existing (216 rooms)	11,500

Source: ING (2008), MacroPlan Australia (2008)

4.2.2 Bulky Goods Precinct

The bulky goods and distribution precinct is at the north-western corner of the M4 Motorway and Mulgoa Road. Vehicular access is off Mulgoa Road at its intersection with Wolseley Street and Blaikie Road

The precinct contains large branches of Harvey Norman and Domayne, automotive parts retailer Supercheap Auto, furniture retailers such as Knotts Pine, Forty Winks, Living, Oz Design and Sleep City, as well as electrical and whitegoods distributors, such as Bing Lee and Betta Electrical.

4.2.3 Residential developments

The existing residential precinct is in Jamisontown (south western corner of the Mulgoa Road/Jamison Road intersection) as well as south of the Great Western Highway along Nepean Avenue and Ladbury Avenue. There is also large rural residential development along Blaikie Road and Tench Avenue.

4.2.4 Council Landholdings

There are several large Council landholdings within the Riverlink Precinct, which include:

- the Carpenter Site (at the south west corner of the Great Western Highway and Mulgoa Road) which is currently vacant and undeveloped;
- Woodriff Garden (opposite the Carpenter Site) which comprises tennis courts and open space; and
- Tench Reserve (a public recreation area) adjoining the Nepean River.

5. Existing Transport Context

5.1 Travel Demand

5.1.1 Journey to Work in Penrith LGA

The Transport Data Centre provides information on the characteristics of work trips made by NSW residents gathered from the national census. Among the tables that the TDC provides is a breakdown by LGA of work trip origins (place of usual residence) and destinations (work place).

For Penrith LGA, the 2006 census[1] indicates that approximately 37% of work trips made by residents of Penrith LGA (30,760 out of 83,028) are destined to work places within Penrith. A further 12% (10,967) are to Blacktown, and 7% (5,895) are to Parramatta. Only 6% are trips to Sydney City.

Other journey-to-work information from the TDC indicates the following:

- 59% of Penrith LGA jobs are held by local residents;
- A further 12% are held by residents of Blue Mountains and 9% by Blacktown residents, representing half of work trips coming into Penrith;
- Car is the main mode of travel for work: close to 90% of Penrith workers get to work by private modes (car as driver, car as passenger, truck or motorcycle); and,
- 85% of Penrith residents get to work by car.

5.1.2 Journey to Work Destinations in Riverlink Precinct

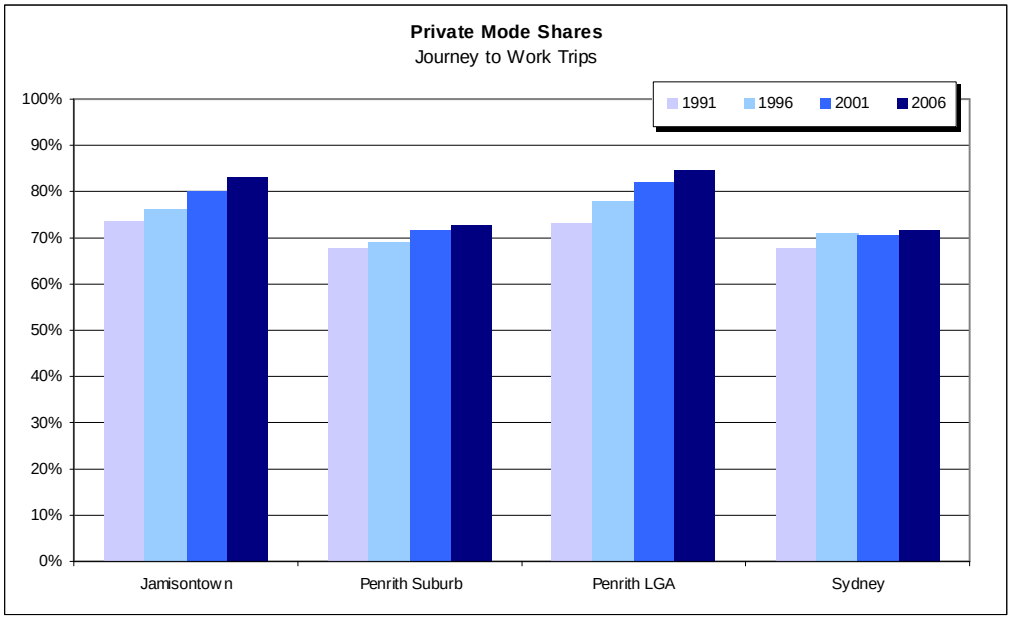
The Riverlink Precinct is located within the suburbs of Jamisontown and Penrith. Census information relating to travel modes of journey to work trips for these two suburbs have been compiled and shown in Figure 6 and Figure 7. Figure 6 shows the combined private vehicle mode shares for journey to work trips compiled from census data for 1991, 1996, 2001 and 2006, while Figure 7 shows the combined public transport, walking and cycling mode shares for journey to work trips for the same census years.

As can be seen from the two figures, trends indicate a steady increase in private vehicle mode shares and a decrease for public transport, walking and cycling mode shares over the 15-year period. The rise in private vehicle mode shares and the decline in public transport, walking and cycling mode shares for these journey to work trips are sharper in the case of Penrith LGA compared with Sydney statistical sub-division as a whole. The trends for Penrith suburb show a gentler decline in public

[1] *2006 Census Counts of Workers in the Sydney Greater Metropolitan Area; Place of Usual Residence (LGA) by Workplace LGA. Source: 2006 TDC Journey to Work Dataset, Table 17*

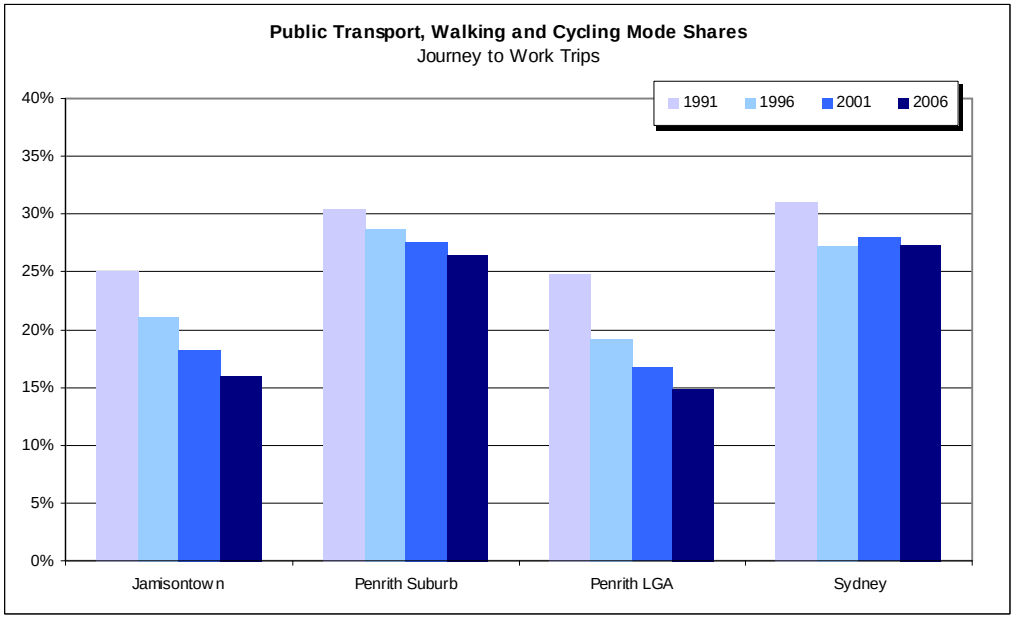
transport, walking and cycling mode share, which may be attributed to the role Penrith train station plays in transport mode choice.

Figure 6 Private Vehicle Mode Shares for Journey to Work Trips



Data Source: Australian Bureau of Statistics; www.id.com.au

Figure 7 Public Transport, Walking and Cycling Combined Mode Shares for Journey to Work Trips



Data Source: Australian Bureau of Statistics; www.id.com.au

5.1.3 Car Ownership

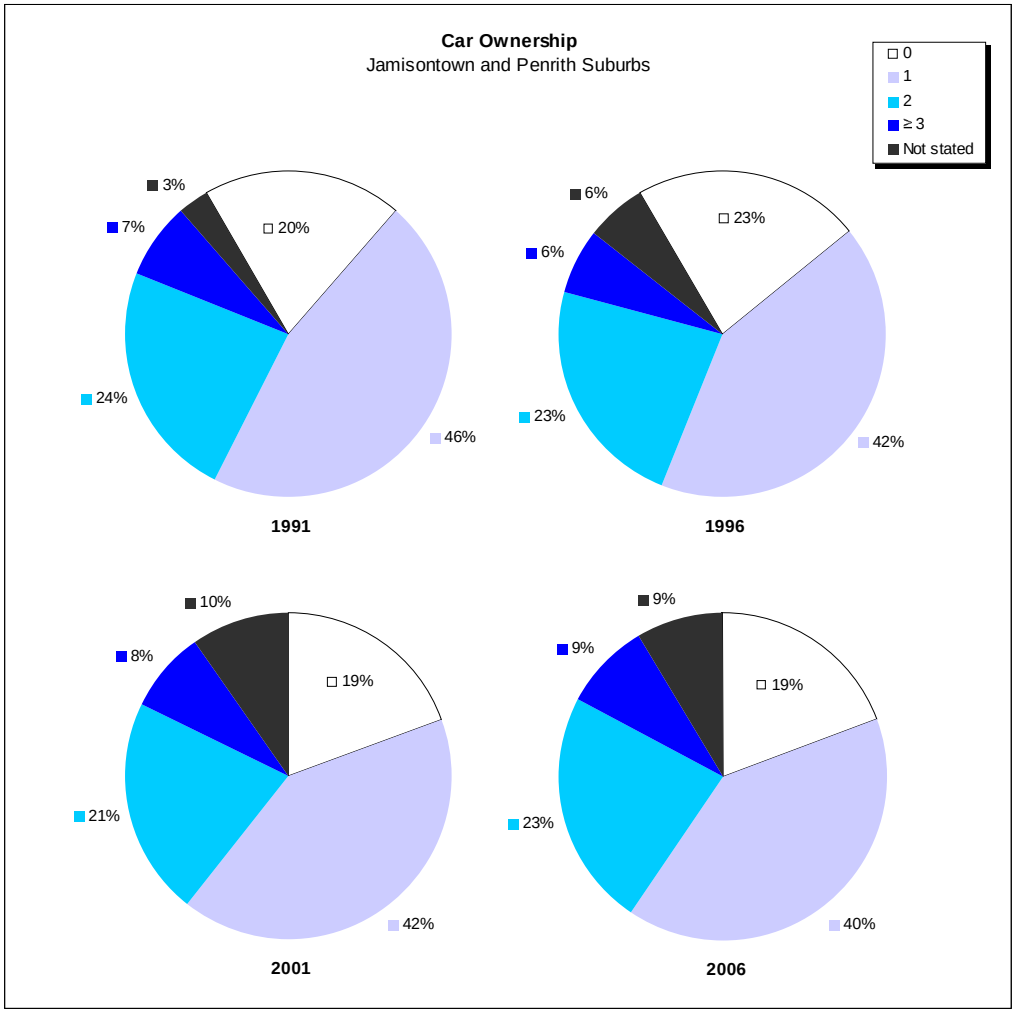
Data from the 2006 Census indicate that in 2006, 53% of the 59,000 households within Penrith LGA owned two or more cars. This is significantly higher than the average figure for the entire Sydney statistical sub-division, at 42%.

The suburbs of Jamisontown and Penrith have a lower proportion of households owning two or more vehicles, at 45% and 27% respectively, compared with the Penrith LGA average.

Across the two suburbs, 32% of households own two or more vehicles. This has slightly increased from previous census years, but is still lower compared with the figure for the Sydney SSD. This may be attributable to the higher rate of public transport use among Jamisontown and Penrith suburb residents. The proportion of households not owning any cars is 19% for these two suburbs, compared with 9% in Penrith LGA and 13% in Sydney SSD.

Figure 8 shows the trend of car ownership for the Jamisontown and Penrith suburbs, as gathered from census information. Although relatively lower compared to Sydney SSD, the proportion of households owning two or more vehicles is slightly increasing.

Figure 8 Car Ownership – Jamisontown and Penrith Suburbs



Data source: Australian Bureau of Statistics

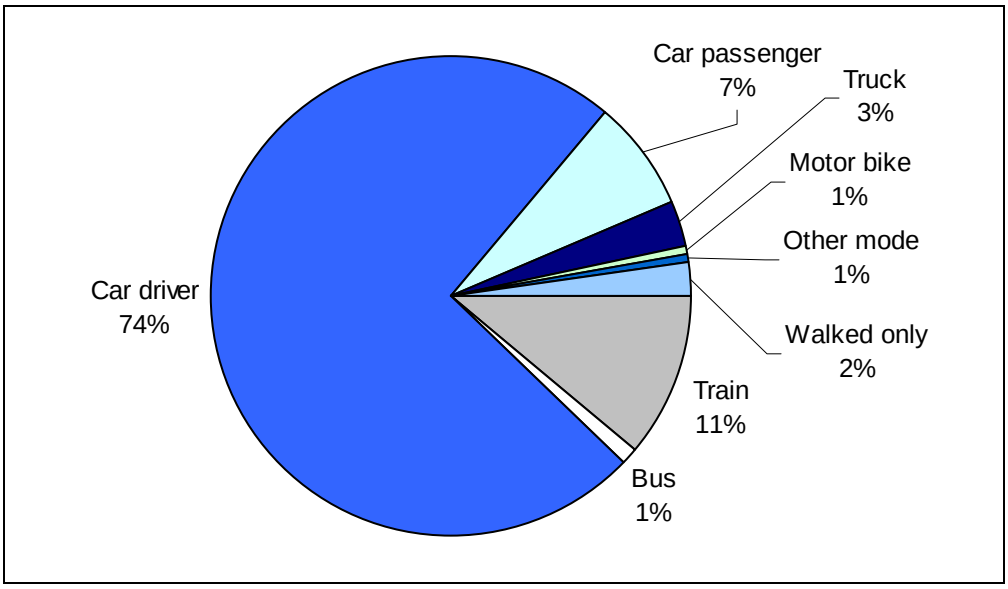
5.2 Modal Split

A modal split of 10% shift from car (as driver) to non-car modes from the existing mode split base has been used in a number of Transport Management and Accessibility Plans (TMAP) for Western Sydney and a similar target has been adopted for the Riverlink Precinct. A 10% mode shift for the Precinct will result in similar travel characteristics to the Sydney average mode split, which is considered a desirable outcome.

Based on the 2006 Census, the Penrith LGA workforce numbered 83,028 workers. An overwhelming majority of the Penrith LGA workforce took a car to work (74 percent as a car driver and 7 percent as a car passenger). This is however, an area wide average and may not apply to all the local precincts.

The second highest mode was the train mode at 11 percent. Other modes (bus, truck and motorcycle) had a combined share of only 6 percent. Walk only mode had a 2 percent share.

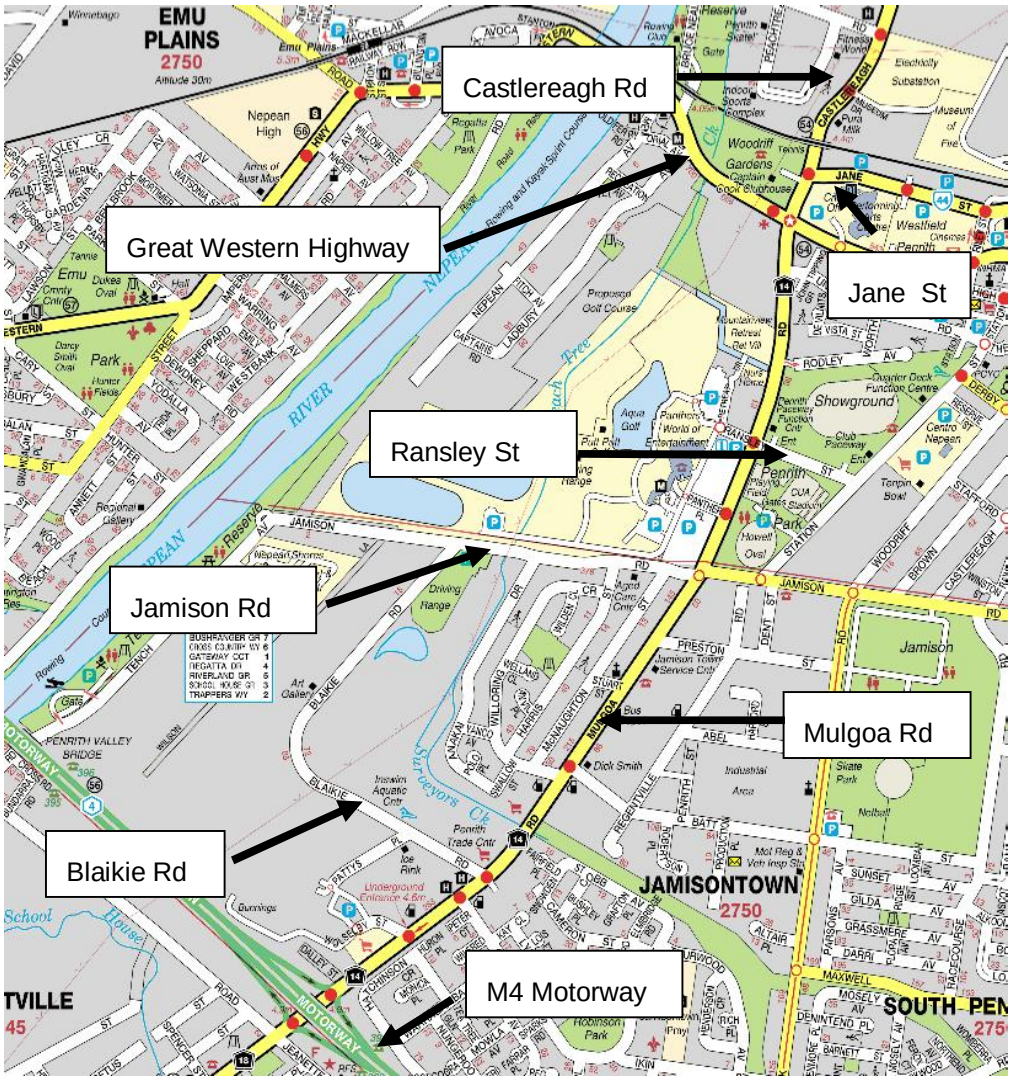
Figure 9 Mode Share of Journey to Work



5.3 Existing Road Network

The Penrith Riverlink Precinct is surrounded by three state classified roads, i.e. the M4 Motorway to the south, Mulgoa Road to the east, and the Great Western Highway to the north. The other classified roads close to the Precinct are Jane Street and Castlereagh Road. These classified roads, in addition to Jamison Road, a regional road, provide the key north-south and east-west road links to the Precinct. The surrounding road network is shown in Figure 10.

Figure 10 Local Road Network



Map Source: UBD

5.3.1 Motorways, and Highways

M4 Motorway

The M4 Motorway connects Strathfield and Penrith, and is an important east-west link between Sydney's eastern suburbs including the Sydney CBD and the western suburbs. The M4 is a classified State Road. In the Penrith LGA it is a six lane divided road east of Mulgoa Road and a four lane divided road west of Mulgoa Road. In 2005, it carried an annual average daily traffic volume of approximately 56,000 vehicles just west of Mulgoa Road.

It has a signposted speed limit of 90 km/hr west of Russell Street and 110 km/hr east of Russell Street. It has spare capacity to accommodate additional traffic growth.

However as identified in the Penrith Arterial Road Study, the existing M4 on and off ramps in the Penrith LGA including the ramps at Mamre Road, The Northern Road,

Mulgoa Road and Russell Street all experience significant delays during the morning and afternoon peak periods. The RTA has recently improved the capacity of the Mamre Road ramps and the Authority is preparing designs for upgrading of the ramps at The Northern Road.

Mulgoa Road

Mulgoa Road is a classified road linking the Penrith City Centre and Mulgoa Village. It is generally a four lane divided road north of Glenmore Park. South of Glenmore Park it is a two lane undivided road.

It has a signposted speed limit of 60km/hr north of Glenmore Park and is currently carrying an annual average daily traffic volume of approximately 38,000 vehicles at the section south of Preston Street, Jamisontown.

Mulgoa Road forms the eastern boundary to the Riverlink Precinct and provides the key traffic route to and from the precinct. It has a number of intersections providing access to the industrial, retail and residential developments along the road.

Mulgoa Road, in addition to The Northern Road provides the main north–south arterial roads to the Penrith City Centre and provides the main traffic distributor function to the Penrith City Centre and its surrounding areas including the Penrith Entertainment Centre and CUA Sport Stadium.

Due to its location and function, Mulgoa Road will be the key thoroughfare affected by additional development in the Riverlink Precinct, as well as number of other release areas to north of the Penrith City Centre, including Penrith Lakes and the Penrith North Army Land.

Castlereagh Road

Castlereagh Road is an extension of Mulgoa Road north of the Great Western Highway. It is a four lane divided road between the Great Western Highway and Andrews Road, North Penrith. It has a signposted speed limit of 60 km/hr.

With a similar function to Mulgoa Road, Castlereagh Road provides access to the Penrith City Centre from the north and to the industrial, bulky goods retail development and motor show rooms along the road.

The section between the Great Western Highway and Andrews Road has two signalised intersection and two roundabouts. All the intersections are operating with an acceptable level of service. However, previous land use and transport studies (including the Penrith Lakes Regional Traffic Modelling) have identified that depending on the level of development at the Penrith Lakes Site, the existing mid-block road capacity may be exceeded.

Great Western Highway

The Great Western Highway is one of key east-west road links between the Sydney CBD and Sydney western suburbs and beyond. It is a classified state road. In the local area, it has a signposted speed limit of 60km/hr and is currently carrying a daily traffic volume of over 30,000 vehicles.

West of Mulgoa Road, it is an undivided two lane road. East of Mulgoa Road, the Highway bypasses the Penrith City Centre along Jane Street.

The local section of the Highway intersects with Mulgoa Road, Castlereagh Road, and Jamison Road. It is the key east-west arterial through the Riverlink Precinct and provides the northern link road between the Precinct and the Penrith City Centre.

Due to its location and function, the Great Western Highway and its intersection with Mulgoa Road will be affected by additional development of the Riverlink Precinct. The impact of additional development is discussed in Section 7.

Jane Street

Jane Street is a classified state road. It forms the continuation of the Great Western Highway, between Castlereagh Road and Station Street and hence it forms part of the key east-west road linking the Sydney CBD and Sydney western suburbs including the Penrith LGA. It provides alternate access to Penrith Plaza and Penrith Station.

Jane Street is a divided, four lane road with a signposted speed limit of 60km/hr. East of Station Street, it links Belmore Street and North Street to the Great Western Highway.

Jane Street is currently carrying an average annual traffic volume of approximately 23,000 vehicles (AADT 2005) and has spare capacity to accommodate additional traffic in the local area. However its intersection with the Castlereagh Road and the Great Western Highway/Mulgoa Road intersection, which is approximately 100m south, are both operating at capacity during the AM and PM peak periods. The RTA has proposed a 4-way signalised intersection at the Castlereagh Road/Jane Street intersection with an extension of Jane Street to connect to the Great Western Highway just before the Victoria Bridge.

The Castlereagh Road/Jane Street and Great Western Highway/Mulgoa Road intersections are gateways between the Riverlink Precinct and the City Centre. The traffic impact of additional development is discussed in Section 8.

5.3.2 Local Roads

The key local roads in the Riverlink Precinct include Jamison Road, Blaikie Road, Ransley Street and Wolseley Street. The features of these roads are as follows:

Jamison Road

Jamison Road is an east-west road providing access to the Nepean River from The Northern Road. It is a four lane divided road between The Northern Road and Mulgoa Road and a two lane undivided road, west of Mulgoa Road.

It has a signposted speed limit of 60km/h east of Mulgoa Road and 50km/h west of Mulgoa Road. East of Mulgoa Road, it is currently carrying a traffic volume of 16,456 vehicles per day (AADT 2005).

Jamison Road has a major intersection with Mulgoa Road, a two-lane roundabout, which is proposed to be replaced with a signalised intersection in the 2009/2010 financial year to improve traffic efficiency.

Blaikie Road

Blaikie Road is a two lane road providing access to the industrial and bulky retail area and large lot rural residential properties between Jamison Road and Mulgoa Road.

The north-south section of Blaikie Road through the currently rural residential area, is a two lane rural road carrying a very low traffic volume. Its location and connectivity indicates that it can provide relief to traffic flow on the section of Mulgoa Road between Blaikie Road and Jamison Road.

Wolseley Street

Wolseley Street is a local street off Mulgoa Road providing access to the bulky goods retail development just north of the M4 Motorway.

It has a signalised intersection with an underpass for the right turn movements (from Mulgoa Road) into Wolseley Street. At the intersection, it has two inbound lanes (including the underpass) and three outbound lanes. It has a signposted speed limit of 50 km/hr.

Panthers Place

Panthers Place is a two-lane local street, providing access to the Panthers Penrith Entertainment Precinct off Mulgoa Road via a signalised “Tee” intersection. It also provides the main pedestrian access to the CUA Stadium and is the link between the Panthers Penrith Entertainment Precinct and Stadium. It is a private road under the care and control of Panthers Club. It has speed limit of 20 km/h within the Entertainment Precinct and car park and 50km/h close to Mulgoa Road.

Ransley Street

Ransley Street is another two lane local street, providing alternate access to the CUA Stadium and the Nepean Square Shopping Centre from Mulgoa Road. It has a signposted speed limit of 50km/hr.

It has a 4-Way signalised intersection at its junction with Mulgoa Road and Retreat Drive.

Retreat Drive

Retreat Drive is a local street, and a continuation of Ransley Street west of Mulgoa Road. It provides alternate access to the Penrith Panthers Entertainment Precinct and the Mountain View Retirement Village. It is signalised at its intersection with Mulgoa Road.

5.3.3 Key Intersections

The key intersections within the Penrith Riverlink Precinct and its surrounding area are:

Signalised Intersections

- Castlereagh Road/Jane Street;
- Great Western Highway/Mulgoa Road;
- Mulgoa Road/Ransley Street;
- Mulgoa Road/Batt Street;
- Mulgoa Road/Blaikie Road;
- Mulgoa Road/Wolseley Road; and
- M4 Motorway/Mulgoa Road.

The Castlereagh Road/Jane Street and Great Western Highway/Mulgoa Road intersections were reported to be operating at capacity during the AM and PM peak periods. Council have on a number of occasions requested that the RTA upgrade these intersections. The suggested upgrading is an extension of Jane Street as described in Section 5.3.4.

The 2009 base year intersection performance of the key intersections along Mulgoa Road is summarised in Table 2.

Table 2 Base Year 2009 Intersection Performance

Intersection	AM Peak			PM Peak		
	DS[1]	AVD[2]	LOS[3]	DS[1]	AVD[2]	LOS[3]
Mulgoa Road / Union Road	0.14	0	A	0.12	0	A
Mulgoa Road / Ransley Street	0.21	0	A	0.54	1	A
Mulgoa Road / Panthers	0.43	21	B	0.62	34	C
Mulgoa Road / Jamison Road	0.81	40	D	0.78	36	C
Mulgoa Road / Blaikie Road	0.58	20	B	0.56	31	C
Mulgoa Road / Glenbrook Street	0.62	26	B	0.65	23	B
Mulgoa Road / Wolseley Street	0.64	25	B	0.69	31	C

1 Degree of Saturation;

2 Average Vehicle Delay

3 Level of Service

However, exiting movements from the Mulgoa Road/Wolseley Road intersection experience delays and could be improved by re-line marking the inner lane to permit right turn instead of the current left turn.

Roundabout

- Mulgoa Road and Jamison Road

The existing roundabout is a two-lane circulating roundabout. It is understood that following concerns by the local community about road safety and traffic efficiency at the existing roundabout, the RTA is currently preparing a design to upgrade the intersection. The proposed intersection upgrade is described in Section 5.3.4.

5.3.4 Proposed Road Network Improvements

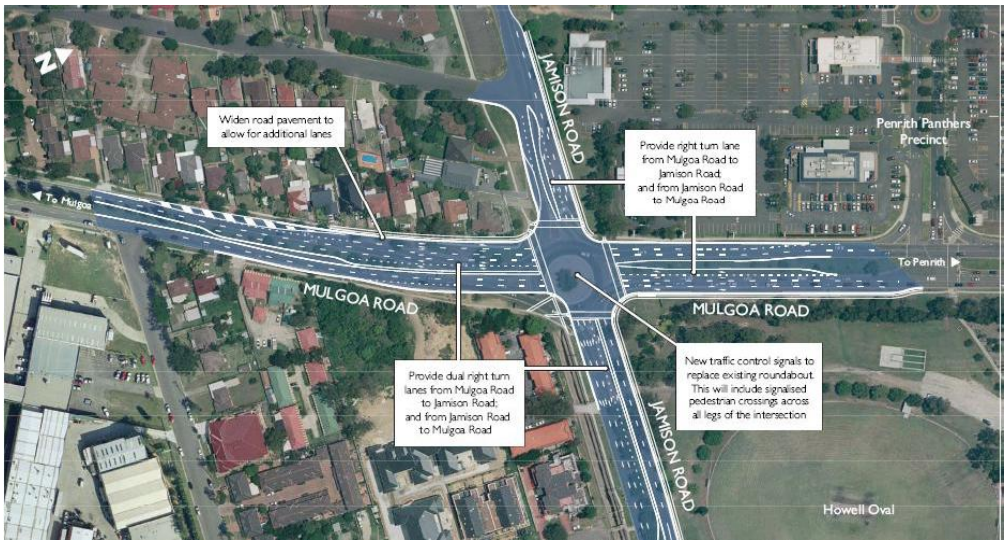
Mulgoa Road – Jamison Road intersection upgrade

The NSW Government has a proposal to replace the existing roundabout at the Mulgoa Road/Jamison Road intersection with traffic signals and to increase the capacity of the intersection by road widening along Mulgoa Road to provide three lane approaches in each direction.

The upgrade will include pedestrian crossing facilities and improve road safety for motorists and pedestrians. Traffic efficiency is also expected to be improved.

The RTA has advised that design and environmental assessment of the project is being finalised with utility relocation scheduled to start in mid 2009 with project completion in 2010. The concept layout of the proposed intersection upgrade is shown in Figure 11.

Figure 11 Jamison Road Intersection Upgrade



Source: RTA

Jane Street Extension

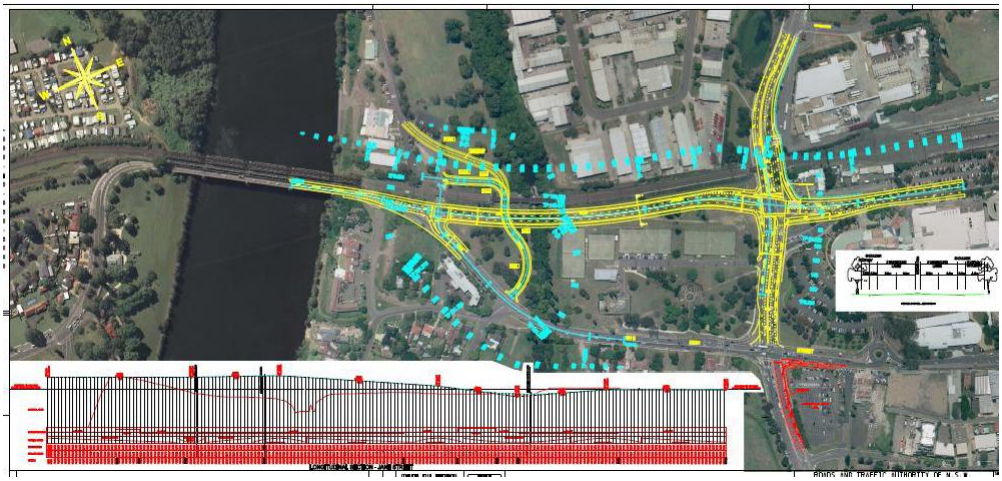
Following a number of representations from Penrith City Council, the RTA has prepared a strategic concept design to address the localised congestion and delays at the Jane Street/Castlereagh Road and Great Western Highway/Mulgoa Road

intersections by extension of Jane Street westbound from Castlereagh Road, to connect the Great Western Highway east of the Nepean River at Bruce Neale Drive.

The extension would improve the capacity of the two intersections and permit an additional access point off the Highway to service the Carpenter Site (at the southeast corner of High Street/Mulgoa Road). The layout of the proposed extension could also improve pedestrian access to the Woodriff and Carpenter Sites. The strategic layout of the proposed Jane Street extension is shown in Figure 12.

Timing for the project is unknown at this stage. As part of the preparation of future Development Control Plans for the Riverlink Precinct and in particular the Carpenter and Woodriff Gardens Sites, it is recommended that Council make representations to the RTA for a program for the proposed extension to be adopted by the State Government. Council should also be involved in the design of the project to ensure that it takes into consideration any proposed redevelopment of the Carpenter and Woodriff Garden Sites (and the Riverlink Precinct generally).

Figure 12 Proposed Jane Street Extension



Source: RTA

5.4 Bus Services

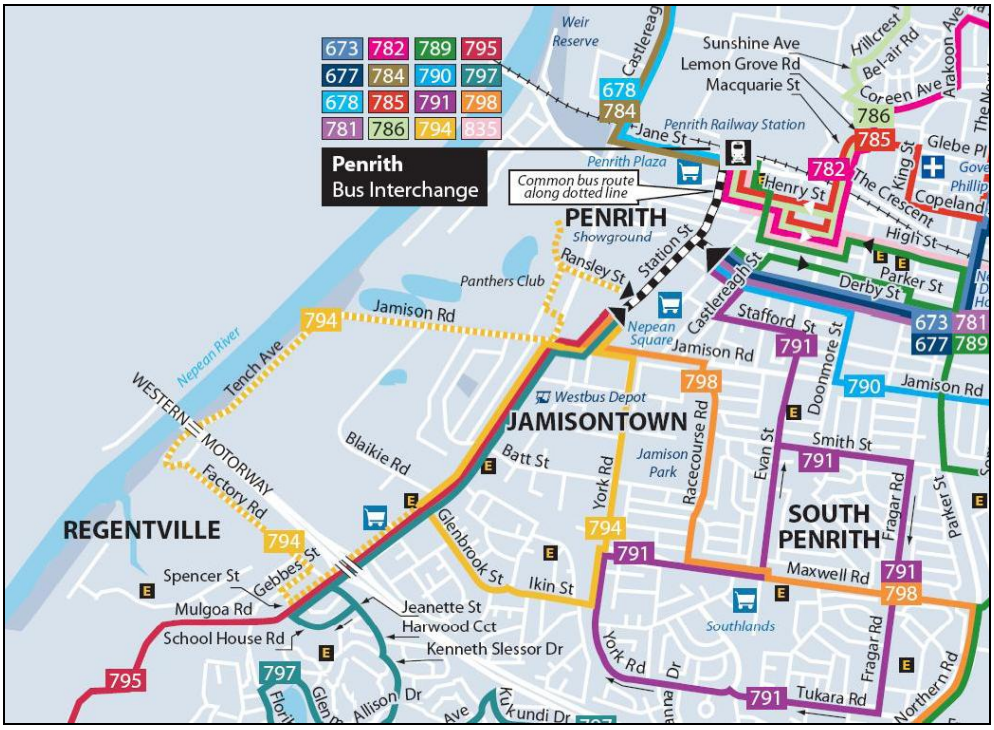
5.4.1 Bus Routes

The majority of bus services in the Penrith LGA are provided by Westbus, with the Blue Mountains Bus Company (Pearce Mountain Link) operating services to and from Penrith and Emu Plains to several towns in the Blue Mountains

Bus routes 794, 795 and 797 are operated by Westbus and service the Riverlink Precinct. These routes depart from Penrith Station and run along Mulgoa Road. Bus service 794 is the only service that operates directly to Penrith Panthers, with an alternate off-peak service to the Riverlink Precinct. Route 795 and Route 797 travel along Mulgoa Road to Warragamba and Glendale Park respectively.

The existing bus routes in and around the Riverlink Precinct are as shown Figure 13.

Figure 13 Existing Bus Routes



Source: Westbus website.

5.4.2 Service Frequencies

Table 3 provides a summary of the bus service frequency for bus routes 794, 795 and 797, including route peak and off peak frequencies. The bus services terminate at Penrith Station / Interchange to meet train services.

Table 3 Bus Service Frequencies (in minutes)

		Weekday				Saturday		Sunday	
Route Number	Route Description	AM Peak	Off peak	PM Peak	Eve-ning	AM	PM	AM	PM
794	Penrith - Jamisontown via Nepean Shores	30	60	30	ns	ns	ns	ns	ns
795	Penrith - Warragamba via Mulgoa Road	45-60	120	50	ns	3 trips	ns	2 trips	ns
797	Penrith - Glenmore Park via Mulgoa Road	15-30	30	20-30	ns	(f)	(f)	(f)	(f)

Notes: ns – No Service, (f) - Route N1 evening/weekend loop service, (e) - Route N2 evening/weekend loop service

5.4.3 Bus Stops

Information provided in the Penrith Integrated Transport and Land Use Study (PITLUS) covering Penrith SLA indicates that for the area surrounding the Riverlink Precinct 98% of Penrith SLA is adequately covered by bus services following the accepted planning standard of 400 metre maximum walking distance to a bus stop. However, from the figure provided in the PITLUS report (and in Figure 14), the main portion of the PITLUS study area that is not covered by bus services is the Riverlink Precinct. This may be attributed to the current development level of the precinct, with a relatively lower population and thus lower demand for transport in general, including public transport.

Figure 14 Bus Coverage in Penrith SLA

Source: Penrith Integrated Transport and Land Use Study

The 400-m catchment area of the existing bus stop locations in the Riverlink Precinct indicate that the current coverage does not extend to areas along Blaikie Road towards Jamison Road. This is shown in Figure 15.

1:12,000

220 110 0 220 Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

Legend

1 Bus_Stops

Bus Routes

400m Buffer

Railways

Penrith City Council
Riverlink Study

Job Number	21-18430
Revision	A
Date	14 MAY 2009

Bus Service Coverage

Figure 15

G:\21\18430\CADD\GIS\MapDocuments\Z008_Penrith_Existing_Bus_Routes.mxd

Data source: GHD Pty Ltd. Created by: nbuchanan

10 Bond Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

5.4.4 Level of Service

The Ministry of Transport Service Planning Guidelines identifies targets for bus service provision but does not specify guidelines for the assessment of levels of service. This assessment makes reference to the Transport Research Board's *Transit Capacity and Quality of Service Manual* (2003)[2] which outlines a means of determining the Level of Service of bus routes. Based on an assessment of service frequency, service hours, and coverage an indicative Level of Service for a given area can be determined.

The criterion for Level of Service based on service frequency is shown in Table 4, while Level of Service criteria for service hours is shown in Table 5. Level of Service C and above is considered acceptable and would be attractive to users.

Table 4 Level of Service Criteria for Bus Route Frequency

Level of Service	Average Headway (minutes)	Buses per Hour	Comments
A	<10	>6	Passengers do not need schedules
B	10-14	5-6	Frequent service, passengers consult schedules
C	15-20	3-4	Maximum desirable time to wait if bus/train missed
D	21-30	2	Service unattractive to choice riders
E	31-60	1	Service available during the hour
F	>60	<1	Service unattractive to all riders

Table 5 Level of Service Criteria for Bus Route Operating Hours

Level of Service	Hours of Service	Comments
A	19-24	Night or "owl" service provided
B	17-18	Late evening service provided
C	14-16	Early evening service provided
D	12-13	Daytime service provided
E	4-11	Peak hour service only or limited midday service
F	0-3	Very limited or no service

[2] Transit Capacity and Bus Planning Manual, Transport Research Board, Washington DC, USA.

The level of service results for the existing three bus routes servicing Mulgoa Road and the Penrith Riverlink precinct are summarised in Table 6.

Table 6 Level of Service Assessment

Bus Route	AM Peak hour		Interpeak hours		PM peak hour		Hours of Operation	Level of Service (based on Hours of Operation)
	Frequency	LOS	Frequency	LOS	Frequency	LOS		
794	2	D	1	E	2	D	13	D
745	1	E	<1	F	1	E	14	C
797	2	D	2	D	2	D	24	A

It is evident from the table above that in terms of service frequency, the existing routes are operating at levels of service below the acceptable standard of LOS C. The Manual (2003) notes that a housing density of 4.5 dwellings/hectare or a job density of 4 jobs/hectare is the minimum required for an hourly bus service to be feasible.

Moreover, the level of service criteria for service coverage is based on area served for major origins and destinations. This is outlined in Table 7.

Table 7 Level of Service Criteria for Service Coverage

Level of Service	% Area Covered	Comments
A	90.0-100.0%	Virtually all major origins and destinations served
B	80.1-89.9%	Most major origins and destinations served
C	70.0-79.9%	About 3/4 of higher density areas served
D	60.0-69.9%	About 2/3 of higher density areas served
E	50.0-59.9%	At least half of the higher density areas served
F	<50%	Less than half of the higher density areas served

From Figure 16, it can be seen that there are approximately 13 bus stops within the Study Area. Assuming a 400-metre catchment area for each stop, it is estimated that 70% of the Riverlink Precinct is served by public transport buses. This equates to a Level of Service C, however, the level of service can be expected to vary from stop to stop as a result of the frequency of the bus routes which utilise a given stop. In particular, the bus stops along Tench Parade where only five buses a day use the stop would be rated with a lower Level of Service.

5.5 Rail Services

There are two train stations located relatively close to the northern end of the Riverlink Precinct. These are Penrith and Emu Plains Stations, on the Western line (Emu Plains to Central). The northern boundary of the precinct is the Main Western Rail Line linking central Sydney with the Blue Mountains and areas further to the west. The northern end of the Riverlink Precinct is located approximately 800 to 1000 metres from Penrith train station.

Penrith Station is located east of the Riverlink Precinct near Jane and Station Street intersection. Emu Plains Station is located approximately 2 kilometres west of the Precinct, along Old Bathurst Road, off the Great Western Highway.

Most CityRail Western Line services terminate at either Penrith or Emu Plains stations. They are also served by the Blue Mountains intercity rail line, which links the Blue Mountains with Sydney CBD and the North Shore line.

In 2007, Penrith Station ranked the 38th busiest station within the CityRail network, with an average of more than 7,000 weekday station entries and exits. More than 3,000 rail passengers (2,870 entering and 1,290 exiting) use Penrith Station during the 3.5-hour weekday morning peak between 6:00 and 9:30. In the afternoon / evening, an average of 1,890 entering and 3,050 exiting passengers have been recorded for Penrith Station between 15:00 and 18:30.

Household Travel Survey data indicate that in 2004, rail passengers access Penrith Station during the morning hour mostly by private car (68%), 23% walked to Penrith Station, while 5% took the bus[3].

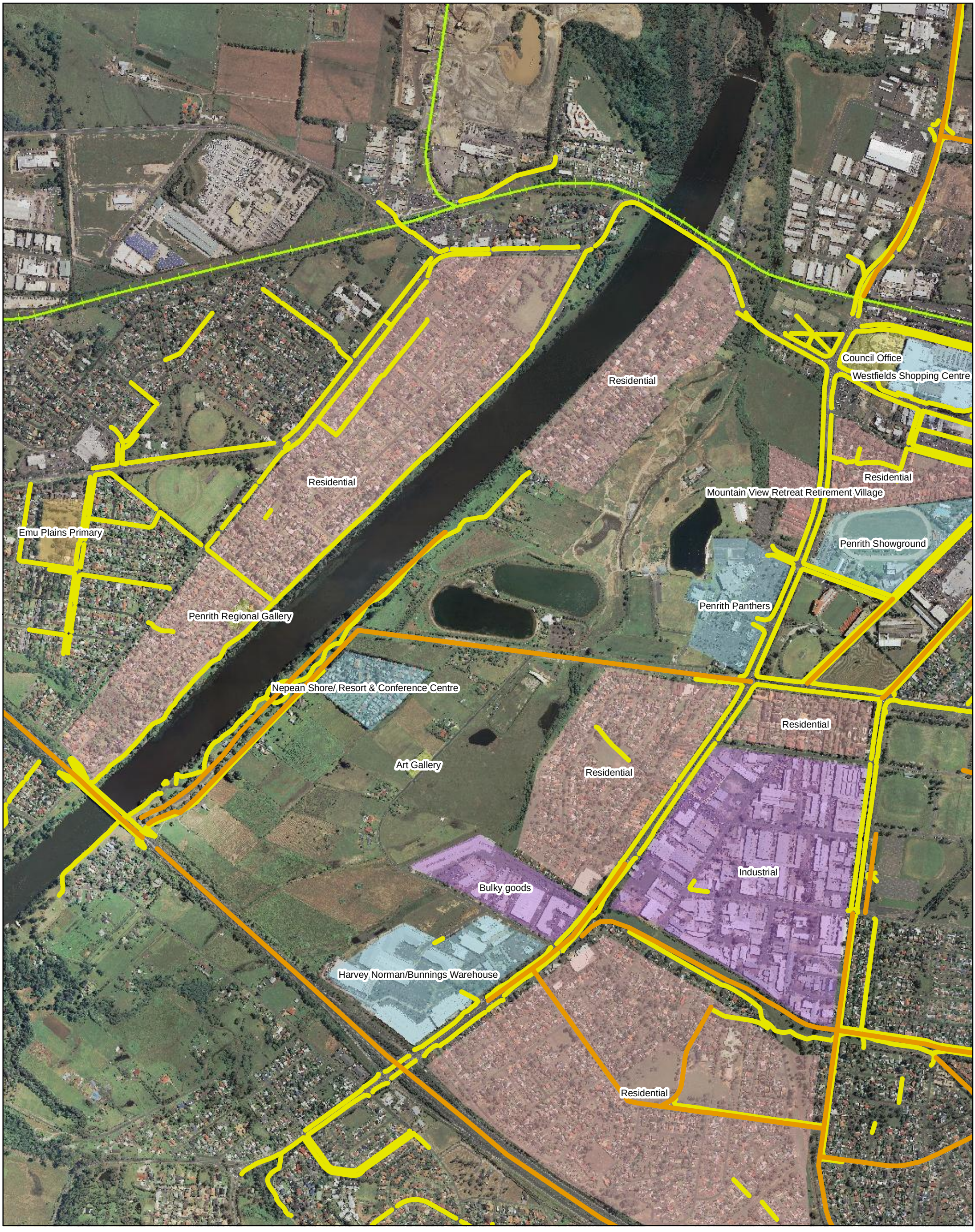
5.6 Pedestrian Network and Facilities

Walking is the simplest form of transportation. It is available to most people (inclusive of those who use mobility aids), is free and has insignificant environmental cost. Furthermore, all trips involve some walking component, if only from the car park to the shop. Pedestrians use every part of the public domain, including roads, footpaths, nature strips, shopping centres and other public spaces. Planning for pedestrians is therefore of primary importance to transportation planning.

While footpaths are located along major roads (such as Mulgoa Road) bounding the Riverlink study area, few footpaths and other pedestrian facilities are present. This provision of footpaths is typical of car-dominated areas, where road priority has been assigned to the longer distance movements of private vehicles. Other locations, such as Jamison Road, near the corner with Tench Avenue, have had short sections of paving implemented; these however lack a connection to the wider network. This has resulted in a lack of suitable footpaths in the Riverlink precinct.

Figure 16 shows the existing pedestrian facilities in the Riverlink Precinct.

[3] A Compendium of CityRail Travel Statistics – Sixth Edition. Rail Corporation of NSW, 2008.



1:12,000

240 120 0 240 Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

0

Legend

- Bikeways
- Footpaths
- Railways

Land Use

- Industrial
- Educational
- Residential
- Shopping/Commercial
- Civic

Penrith City Council
Riverlink Study

Job Number	21-18430
Revision	A
Date	14 MAY 2009

Existing Walking and Cycling Routes
Figure 16

G:\21\18430\CADD\GIS\MapDocuments\Z009_Penrith_Existing_Walking&Cycling.mxd

Data source: GHD Pty Ltd. Created by: nbuchanan

10 Bond Street Sydney NSW 2000 Australia **T** 61 2 9239 7000 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

The quality of the pedestrian environment varies, with some streets (such as Nepean and Ladbury Avenues) tree lined, quiet and attractive while others (such as Mulgoa Road) are noisy and provide little shade or visual interest for walkers.

Car Dominated Environment on Mulgoa Road

Aside from footpaths along either side of Mulgoa Road, a recreational trail runs parallel on the eastern bank of the Nepean River, with a partial section of footpath along Tench Avenue. As mentioned previously, Mulgoa Road has high traffic volumes and has been designed for car use, at the expense of pedestrians. Footpaths typically only meet minimum width requirements (1.2m) rather than providing a width sufficient for encouraging more pedestrian activity.

In addition to the street network, the Great River Walk offers exclusively pedestrian and cyclist access along the River's edge. The walk extends from the Cassola Place (north of Victoria bridge) to Memorial Avenue. The walk will be extended on the eastern side of the bridge through Tench Reserve and ultimately provide a complete circuit on both sides of the Nepean. It is currently a popular and attractive recreational walking route.

In areas where there should be footpaths, such as the Harvey Norman Centre in the south of the precinct and especially the residential areas located next to Mulgoa Road (McNaughton Street and Harris Street) and the Nepean River (Nepean Avenue and Ladbury Avenue), none have been provided to assist pedestrians in walking to their

destinations. Residents in these areas currently walk on the road as no footpaths have been provided.

Pedestrians Walking on Ladbury Avenue

The distances involved between key locations such as the light industrial area, the Penrith Panthers development and residences across the precinct and external destinations such as the Penrith CBD are also counter-productive, which make walking a difficult proposition for residents and visitors alike.

Pedestrian crossings are typically at signalised intersections. However, signalised intersections are typically located on busy arterial and sub-arterial roads, thus presenting difficulties for pedestrians to cross, unless at signalised intersections.

External pedestrian links to other destinations outside the precinct are also not pedestrian friendly, with major intersections to be traversed, or narrow bridges to be crossed, such as next to the M4 Motorway or the Victoria Bridge.

No formal surveys of pedestrian activity were undertaken for this study. However, anecdotal reports from Council staff suggest that significant pedestrian movement occurs along the Tench Reserve footpaths and along Nepean Avenue and Jamison Road, especially in the morning and evening and at weekends. Walking trips to schools, bus stops and employment have been noted along Mulgoa Road in the morning and evening peaks.

It is also noted that the flat topography of Riverlink and its wider Penrith City setting make both pedestrian and cycle access within and beyond the Precinct practical and attractive.

5.7 Cycle Network and Facilities

Cycling is a highly efficient, environmentally friendly form of transport. As with walking, cyclists are improving their health and contributing to an active environment at a human scale.

Cyclists move around the public domain in various ways, largely depending on the trip purpose and rider characteristics. For example, children will tend to use the footpath and cycle at low speeds, while an adult on the way to work will ride along the fastest and most direct route available (on or off-road).

Overall, few cycle paths are provided in the Riverlink precinct. Those routes that have been designated as cycle routes (such as sections of Mulgoa Road and Jamison Road) do not have adequate cycling facilities provided. As for pedestrians, the scale of development and the design of roads in the precinct have been designed to prioritise car travel. This has marginalised space for cyclists. Additionally, there is limited directional signage for cyclists and limited line marking present at major intersections.

There is little room on Mulgoa Road for cyclists, with certain sections of Mulgoa Road signposted as 'no parking' in order to provide some space for bicycle use. Jamison Road has also been designated as a cycle route; however, few line markings exist, and combined with Jamison Road being relatively narrow, result in a less than conducive cycling environment.

Figure 16 also shows the existing cycle facilities in the Riverlink precinct.

Partial Cycleway on Jamison Road

Cyclists also use the path along the Nepean River, with access provided via ramps from the M4 Motorway, at the southern end of the precinct. This link along the river provides for recreational uses. However, to the north, once the path reaches Nepean Avenue and Captains Road, the path stops and there is no line marking to designate a cycle route.

A cycleway running through South Penrith and Jamisontown (along the reserve/floodway) terminates where it intersects with Mulgoa Road at Surveyors Creek. This would otherwise act as a natural cyclist/pedestrian feeder into Riverlink.

No formal survey of cyclists trips has been undertaken for this study. However, council staff advise that journeys to work and school by bikes have been noted along Mulgoa Road during AM and PM peaks. Significant recreational cycling occurs through/along Tench Reserve, Jamison Road and around Nepean Avenue on weekends. This recreational cycling attracts riders across all age ranges.

5.8 Summary of Trends in Transport, Traffic and Accessibility

Penrith, as with Western Sydney, has been experiencing significant economic growth, which has impacted on the transport, traffic and accessibility levels within the city. These trends are described further below:

5.8.1 Car ownership

Car ownership levels in Penrith have slightly increased between 1996 and 2006, with the proportion of households within the Jamisontown and Penrith suburbs not owning any cars decreasing from 23% to 19%. For Penrith LGA, there has been a steady increase in the proportion of households owning more than 1 car from 44% in 1991 to 53% in 2006.

5.8.2 Journey to work travel modes

Penrith exhibits a relatively higher proportion of work trips using private modes compared with the average for the Sydney region. Moreover, the share of private modes being used for work trips is increasing, which would impact on traffic congestion levels. The share of people travelling to work using public transport decreased from 12% in 2001 to 10% in 2006. This highlights an issue that needs to be addressed through the planning of developments, so that this trend can be shifted to encourage more use of public and active transport modes for travel.

5.8.3 Access Trends

Portions of the Riverlink Precinct have, in recent years, become more accessible for private transport modes, in particular with the introduction of the grade separated access from Mulgoa Road into the bulky goods precinct at the southern end of the precinct. No new major pedestrian or cycle facilities have been constructed to improve on previous accessibility levels of the precinct from external areas. Among the issues highlighted in the Penrith Integrated Transport and Land Use Study (Cardno, 2008) is the need to have stronger pedestrian links between the river and Penrith City Centre.

5.8.4 Traffic Trends

Vehicular traffic data from the Roads and Traffic Authority indicate that, along Mulgoa Road at Jamisontown, vehicular traffic is increasing steadily at an average growth rate of about 2% per year between 1993 and 2005, while traffic along the Great Western Highway has decreased by an average of 1.5% per year between 1989 and 2005.

5.8.5 Car parking demand

Previous studies, including the *Penrith City Centre Vision 2006*, highlight the continuing growth in demand for car parking, particularly in Penrith City Centre. This has the potential to create significant traffic congestion problems as well as a deterioration in pedestrian amenity and less viable public transport operations. Parking policy invariably will have to be reviewed for the Riverlink Precinct if sustainable transport objectives are to be met. Practices in other areas consider a maximum amount of parking, supported by the provision of public transport, in order to influence mode choice.

6. Proposed Riverlink Precinct Development

A Riverlink Precinct Economic Impact and Land Use Assessment Study has been undertaken by Hill PDA in parallel with the Urban Design Study by HBO+EMTB and this study. Hill PDA carried out economic opportunities constraints mapping and viability assessment of possible land uses for the Precinct. The Hill PDA study schedule of potential land uses along with a potential Brand Outlet Centre and associated scales of development provides the indicative basis for this report's traffic and transport analysis of the impact of the additional development in the Riverlink Precinct.

Examination of the combination of Hill PDA's land use schedule and the potential Brand Outlet Centre is considered appropriate to ensure all potential development outcomes have been assessed.

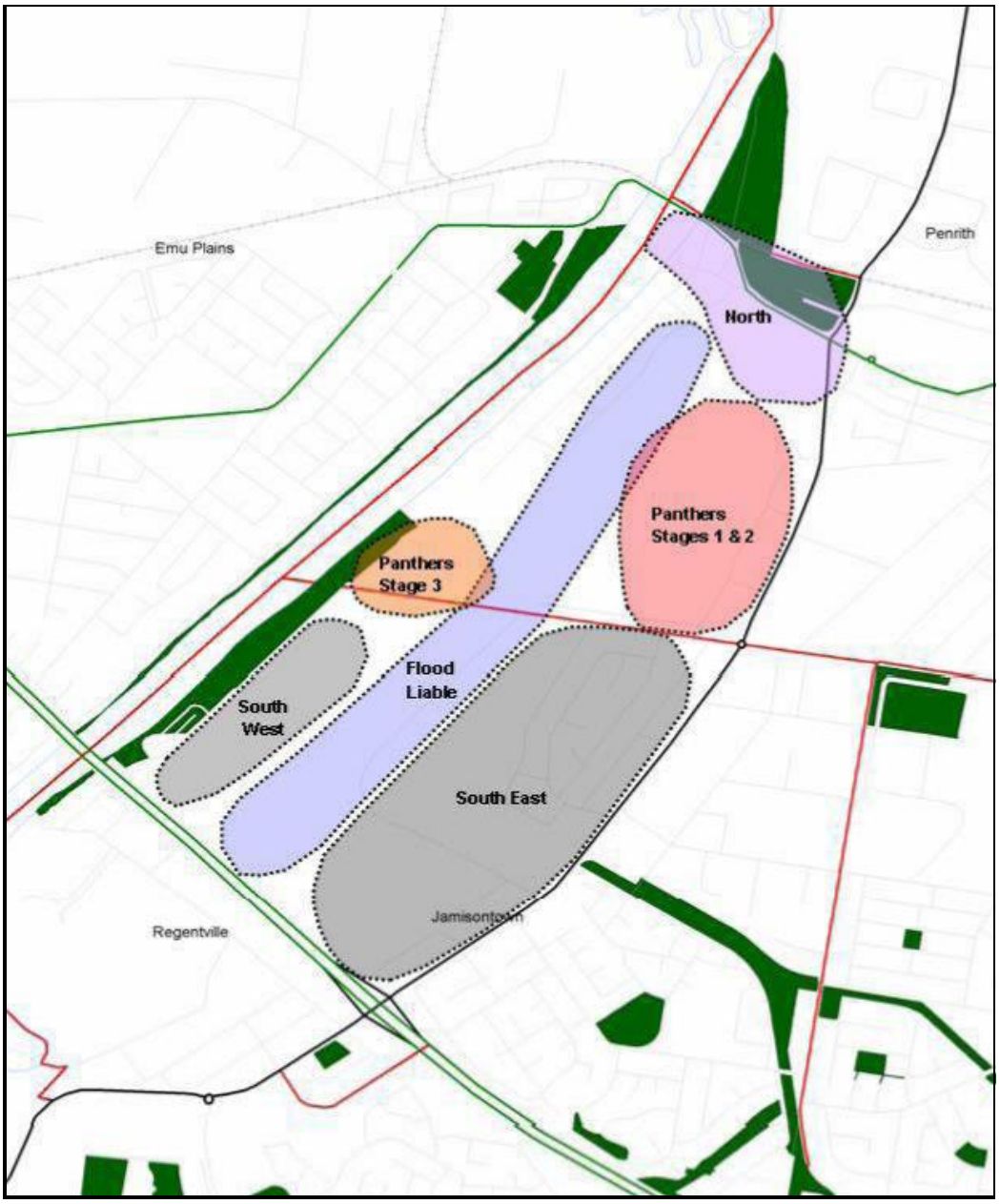
Table 8 Proposed Developments

Precinct	Uses	Site (ha)	GFA Existing	GFA Proposed	Comments
North					
	Sports Stadium	2.0		2,000	
	Indoor / Outdoor Sports Centre	1.5		5,000	
	Integrated Visitor Centre / museum / gallery			2,000	
	Sports Academy / Management School	2.0		4,000	
	Art / Cultural / Business Incubator			3,000	
	Retail ground floor			2,000	
	GPS School	6.0		10,000	700 students
	TOTAL	**11.5**		**28,000**	
Penrith Panthers Stage 1					
	Club		27,200	27,200	
	Conferences / Conventions		21,000	48,200	
	Hotel		11,500	31,300	466 rooms
	Cinemas & bowling			8,500	
	General Retail			15,000	
	Restaurants			3,000	
	Commercial Suites			6,000	
	Brand Outlet Retail (Panthers Proposal)			25,000	
	Multi-use Arena			30,000	
	Seniors Living			50,000	250 units
	Residential				
	Car Parking multi-deck (not GFA)			108,000	
	TOTAL	**45.6**		**244,200**	

Precinct	Uses	Site (ha)	GFA Existing	GFA Proposed	Comments
Panthers Stage 2					
	Hotel			10,400	
	Serviced Apartments			9,000	
	Aquatic health wellness centre			4,000	
	Retail			1,500	
	Commercial Suites			6,000	
	Business Park			25,000	
	Bulky Goods / Homeware retail (Panthers proposal)			18,000	
	Residential			84,000	
	Car Parking (incl. residential) (not GFA)			52,000	
	TOTAL	**29.5**		**157,900**	
Southwest					
	Restaurants			1,200	4 to 6 restaurants
	Tavern	1.2		1,500	
	Functions / receptions			1,500	
	TOTAL	**1.2**		**4,200**	
Southeast					
	Bulky Goods	3.0		12,500	Extension to existing cluster
	Industrial	10.0		6,000	
	Convenience Retail	1.0		3,000	
	TOTAL	**14.0**		**21,500**	
Flood Liable Land					
	Water Theme Park	7.5		20,000	Entertainment/Attractions 7,000sqm. Retail/Dining 3,000sqm, Hotel/Spa 10,000sqm.
	Golf Course (18 Holes)	20.0		3,000	
	Camping Grounds				
	Eco tourism resort	4.0			150 huts
	TOTAL	**31.5**		**23,000**	
TOTAL		**133.2**		**478,800**	

The proposed development footprint is shown in Figure 17.

Figure 17 Proposed Development Layout



Source: Hill PDA

The proposed land uses would be expected to generate significant traffic volumes during the weekday AM and PM peak hours as well as during major events at the proposed Sport stadium, Convention Centre, Golf Course, Eco Tourism resorts and water theme parks.

The traffic impact of the proposed land uses has been assessed using Regional Traffic modelling. The methodology, assumptions and results of the impact assessment are outlined in Sections 7 and 8 of this Assessment.

7. Future Transport Demand

7.1 Traffic Modelling

Regional transport modelling was undertaken in order to determine the future transport and access requirements of the Riverlink Precinct. Through this regional modelling, a detailed transport management framework is identified to achieve a safe, efficient and controlled public and private transport system for Riverlink Precinct and its surrounding area.

7.1.1 Objectives of the Regional Model

The objectives of the regional model are to:

- Assess the existing traffic conditions within the study area and the surrounding road network and highlight any constraints and/or deficiencies;
- Recommend any necessary mitigation measures;
- Consider the role of transportation within the study area as it interfaces with the broader planning and transport objectives planned throughout the region;
- Identify the private and public infrastructure requirements of the study area and a timeframe for the implementation of these requirements; and
- Recommend a suitable road hierarchy within the study area to facilitate future development in connection with other development expected within the surrounding precinct lands.

7.1.2 The NETANAL Network

A regional network model was developed using NETANAL to assess the impact of the proposed development on the surrounding road network.

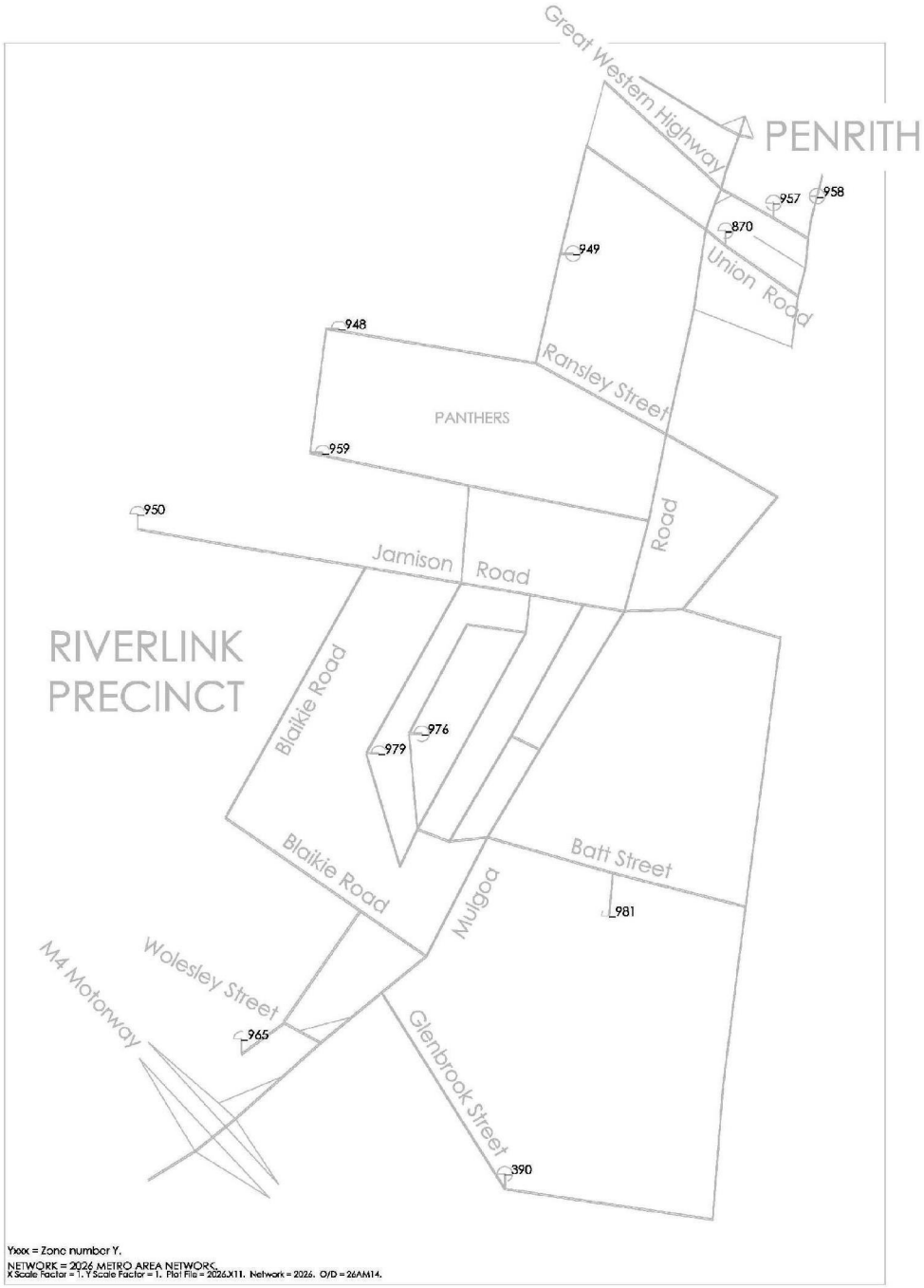
NETANAL is an acronym for the NETwork ANALysis Assignment Modelling Program. The NETANAL model utilises defined travel demand between zonal (represented by centroids) pairs, represented as assimilated traffic movements, throughout the Sydney Metropolitan Area. These centroids are connected to the road network, and a trip matrix represents the number of trips travelling between each origin-destination pair for a particular time period, e.g. AM, PM or Business Peak. The program incrementally assigns vehicular traffic onto the (computer-based) road network, developing link-demand forecasts for each modelled section of road. The road network consists of a series of nodes (intersections) and links (roads) that connect nodes to each other. Links and nodes are then coded with various assumptions regarding their capabilities, free-flow speed and number of lanes.

7.1.3 Trip Matrices

The trip matrix details the individual travel demands between origin and destination pairs. Each distinct area representing a trip origin or end is called a ‘zone’. The Sydney Netanal model contains some 960 zones. The boundaries of these zones

were defined by TPDC, and have been generic across all traffic and transport modelling activities undertaken in Sydney. For the Riverlink precinct, the zone structure from the TPDC was further disaggregated to better reflect demand zones within the precinct. The zone locations within the Penrith Local Government Area (LGA) are shown in Figure 18.

Figure 18 Riverlink Precinct Zone Locations



The base year 2008/2009 trip matrix was developed by TPDC in 2001. As changes to the generation and distribution of trip demand between zonal pairs has occurred over the years, the trip tables for the 1hr morning and evening peak travel periods have been modified to accurately reflect and assimilate the operation of the Sydney Metropolitan road network.

The future year trip tables, produced by TPDC, have been developed from a 4 step travel model based on forecast population, employment and the transport network. These trip tables form the basis for the Netanal future year trip demands.

7.1.4 Modelling Assumptions

The modelling methodology makes the following assumptions:

- Base year model reflects 2009 traffic conditions;
- Year 2026 represent 'end-state' conditions;
- No trip containment is assumed;
- The network scenario requires all intersections and links to perform at Level of Service D or better;
- Modelling has not compared a "with" or "without" scenario; and
- Year 2031 assumes 9% additional growth in Riverlink Precinct.

7.2 Base Year Model Development

The NETANAL base model developed for the traffic impact assessment of the Penrith Lakes Development Scheme (2006) has been modified and used as the base model. It is noted that previous studies and proposals have identified required road network improvements to year 2009 and to Year 2011. These are summarised in Table 9 and Table 10.

Table 9 Formerly identified Road Network Intersection Improvements to Year 2009

	Location	Network Intersection Improvement
A	Great Western Highway / Parker Street	Installation of dual RT bays will increase the intersection capacity and operation
B	Leonay Parade / M4 WB Off Ramp	Construction of traffic signals and the introduction of a dual RT from the M4 offload ramp, WB at Leonay
C	Great Western Highway and Bennett Road	Provision of a 60 m dual RT bay is recommended
D	Mamre Road and M4 WB Offload Ramp	Provision of an exclusive LT lane from the offload ramp onto Mamre Road
E	Great Western Highway and Old Bathurst Road	Provision of dual LT lanes from Bathurst Street; Introduction of a dual 120 metre long RT bays

	Location	Network Intersection Improvement
		from Great Western Highway, WB, into Bathurst Street
F	Mulgoa Road and M4 Offload Ramp	Construction of a LT slip lane from M4 EB ramp onto Mulgoa Road, northbound to Wolseley Street
G	Mulgoa Road and Glenmore Park	Reconstruction of the existing roundabout to facilitate a northbound slip lane in Mulgoa Road for through traffic
H	Palmyra Avenue and A.D.I. Eastern Village Northern Access	Construction of traffic signals at the St Marys Eastern Village, northern access
I	Forrester Road and Palmyra Road	Removal of existing roundabout and installation of traffic signals
J	Forrester Road and Links Road	Removal of existing roundabout and installation of traffic signals with dual right and left turn bays with the exception of three LT lanes from Forrester
K	Forrester Road and Christie Street	Removal of the existing roundabout and installation of traffic signals with RT bays
L	Castlereagh Road and Jane Street	Jane Street extension from Castlereagh Road, WB to Great Western Highway at Neale Drive with RT turn from Castlereagh Road, southbound, to Jane Street Extension, WB.
M	Castlereagh Road, Mulgoa Road and High Street	Banning of RT from Castlereagh Road, SB to Great Western Highway, WB in conjunction with the construction of the Jane Street Extension
N	Great Western Highway and Mamre Road	Reconstruction of traffic signals at the intersection of Mamre Road and the Great Western Highway
O	Werrington Road and Dunheved Road	Removal of roundabout and installation of traffic signals. 130m dual RT lanes from Dunheved Rd, EB, to Werrington Road, SB – 150m dual LT lanes from Werrington Road, NB, to Dunheved Road, WB – 150m LT bay from Christie St, WB
P	Werrington Road and Parkes Avenue	Removal of roundabout and installation of traffic signals. Traffic signals – two lanes in each direction on Werrington Road between Dunheved Road and Parkes Avenue
Q	The Northern Road and Glenmore Parkway	Removal of existing roundabout and installation of traffic signals
R	Cranebrook Road, Andrews Road and Castlereagh Road	Removal of existing roundabout, civil reconstruction and installation of traffic signals

The above infrastructure improvements have not been incorporated in the base year 2009, with the exception of Item F, Mulgoa Road and M4 Offload Ramp, to assess if any further congestion issues are present.

Table 10 Formerly Identified Road Network Intersection Improvements to Year 2009

Location	Network Link Improvement
Cranebrook Road	Cranebrook Road deviation to Andrews Road widen to 6 lanes including transitway
Castlereagh Road	Andrews Road to Jane Street widen to 6 lanes
Mamre Road	Luddenham Road to M4 Motorway widen to 4 lanes including duplication of the Mamre Road overbridge at the M4 Motorway
Mamre Road	Erskine Park Catchment C Access to Luddenham Road widen to 4 lanes
Werrington Arterial (Stage 1)	Construction of a four lane arterial road between M4 Motorway and Great Western Highway
Andrews Road	Castlereagh Road to The Northern Road widen to 4 lanes
Christie Street	Forrester Road to South Creek widen to 4 lanes
The Northern Road	Borrowdale Way to Andrews Road widen to 4 lanes
The Northern Road	Andrews Road to Dunheved Road widen to 6 lanes
The Northern Road	Glenmore Parkway to Bradley Street widen to 4 lanes

It should be noted that the above infrastructure improvements have not been incorporated in the base year 2009 but are noted to highlight improvement measures that have been verified and ratified by the Department of Planning, Penrith City Council and the Roads and Traffic Authority, as measures to address existing deficiencies.

7.3 Future Year Model Development

7.3.1 Future Internal Road Network

The future year internal road network assumed:

- Left-in/left-out at Union Street connection with Mulgoa Road; and

- A proposed traffic signal controlled intersection on Great Western Highway at the Riverlink Access Road, some 300m, west of Mulgoa Road, directly east of Peach Tree Creek; and

7.3.2 Future External Road Network

The future year external road network incorporates future year proposed and committed improvements to 'End State'. These infrastructure improvements are summarised in Table 11.

Table 11 Former Identified Intersection Improvements – Year 2012 to 'End State'

Location	Network Intersection Improvement
Great Western Highway and Parker Street	By End State: Duplication of the bridge over the railway is required to facilitate the necessary turn movements. Construction of a further 3 lane bridge to facilitate a 6 lane approach SB in The Northern Road; Land acquisition required between Great Western Highway and Cox Avenue to enable lane transition to Copeland Street including intersection improvements at Cox Avenue and Copeland Street; 140m dual RT and LT lanes are required from The Northern Road, SB to Great Western Highway while, three RT lanes from Great Western Highway, WB to Parker Street, NB are required.
Mulgoa Road and Jamison Road	Removal of existing roundabout and installation of signals
Northern Road and Dunheved Road	80m dual RT lanes from The Northern Rd, NB, to Dunheved Rd, EB – 60m dual LT lanes from The Northern Road, SB, to Dunheved Road, EB – dual RT lanes from Dunheved Road, WB, to The Northern Road, NB – 150m dual RT lanes
Great Western Highway and UWS Access	Double diamond overlap phasing - three lanes each way on the Great Western Highway – exclusive dual LT and RT bays on each
Werrington Arterial Stage 2 and UWS Access	Roundabout recommended. Access conditions to be determined by Council in consultation with developer
Caddens Road, UWS Access and Hermitage Circuit	Roundabout recommended. Access conditions to be determined by Council in consultation with developer
O'Connell Street and Caddens Bypass	Roundabout

Location	Network Intersection Improvement
Caddens Bypass and UWS Access	Roundabout
Caddens Street, Kingswood Road and Caddens Bypass	Roundabout
O'Connell Street and TAFE Access	Roundabout
O'Connell Street and Second Avenue	Traffic Signals
Second Avenue and UWS Eastern Access	Roundabout – Access conditions to be determined by Council in consultation with developer
Second Avenue and UWS Eastern Access	Roundabout – Access conditions to be determined by Council in consultation with developer

Table 12 Former Identified Link Improvements – Year 2012 to 'End State'

Location	Network Link Improvement
Coreen Avenue	Castlereagh Road to Richmond Road widen to 4 lanes
Dunheved Road	Widening and reclassification of Dunheved Road to Sub Arterial, 4 lanes and 80 km/h
Werrington Arterial (Stage 2)	Widening of Werrington Road between Great Western Highway and Parkes Street – 4 lanes at 80 km/h
Lenore Lane	Construction of a four lane wide arterial link between Erskine Park Road and Old Wallgrove Road

All infrastructure improvements to 'End State' listed in Table 11 and Table 12 have been incorporated in the future year road networks and models.

7.3.3 Future Land Use

The future land uses modelled include the following proposed developments in the local area:

- Full Development of the Riverlink Precinct by 2026;
- Eastern Creek Precinct;
- St Marys Urban Release area;
- Penrith Lakes;
- Well Precinct (Caddens Release and Claremont Meadows);

- North Penrith Army land;
- Glenmore Park Extension;
- Development of the Industrial development of the Western Sydney Employment Hub; and
- Northwest Growth Sector (Riverstone, Marsden and Alex Avenue).

Traffic modelling has been carried out for 2026 and 2031 traffic conditions. For the purposes of the traffic modelling, it has been assumed that 100% of the proposed development listed in Table 14 will be completed by 2026 and a 9% increase in the development is expected to occur by 2031.

Table 13 Penrith LGA Development Growth

Development	Land Use	No. of dwellings / Area (hectares) or No. of Employees						
		2009	2011	2016	2021	2026	2031	2036
St Marys Western Precinct	Residential (dwellings)			1,250	2,000	2,000	2,000	2,000
	Commercial (hectares)			23.8	23.8	23.8	23.8	23.8
	Retail (hectares)			3.4	3.4	3.4	3.4	3.4
	Industrial (hectares)							
	Educational (hectares)			7.7	7.7	7.7	7.7	7.7
St Marys Eastern Precinct	Residential (dwellings)	2,000	2,000	2,000	2,000	2,000	2,000	2,000
	Commercial / Industrial (hectares)	5.9	5.9	5.9	5.9	5.9	5.9	5.9
	Retail (hectares)	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Educational (hectares)	7.7	7.7	7.7	7.7	7.7	7.7	7.7
St Marys Central Precinct and Dunheved	Residential (dwellings)			100	1,068	1,068	1,068	1,068
	Commercial (hectares)			2.9	2.9	2.9	2.9	2.9
	Retail (hectares)			0.9	0.9	0.9	0.9	0.9
	Industrial (hectares)			25.8	25.8	25.8	25.8	25.8
	Educational (hectares)			2.6	2.6	2.6	2.6	2.6
Penrith Lakes Scheme	Residential (dwellings) excl. Employment Component		500	1,000	2,000	2,800	2,800	2,800
	Employment/Recreational within Residential (10.75ha) - On-site employee numbers					2,451	2,451	2,451
	Employment/Recreation employees within Business Park (47ha) - On-site employee numbers					546	546	546
WELL Precinct	Residential (dwellings)			1,583	1,583	1,583	1,583	1,583
	High Tech (GLFA)			982,500	982,500	982,500	982,500	982,500
	Commercial (GLFA)			1,089,300	1,089,300	1,089,300	1,089,300	1,089,300
	Retail (GFA)			11,666	11,666	11,666	11,666	11,666
	TAFE (Enrollments)			5,124	5,124	5,124	5,124	5,124
Nortwest Growth Sector (Riverstone, Marsden Park, Alex Avenue	Residential (dwellings)					31,459		67,000
	Employment (employees on-site)					32,639		39,000
Waterside (Penrith Lakes Scheme)	Residential (dwellings)		399	701	701	701	701	701
	Commercial (hectares)		4	7	7	7	7	7
WELL - Caddens Release Area	Residential (dwellings)			1,060	1,060	1,060	1,060	1,060
North Penrith Urban Area	Residential (dwellings)	300	600	800	800	800	800	800
	Commercial (hectares)	2.5	5	7	7	7	7	7
Erskine Park Catchment A	Residential (dwellings)							
	Commercial / Industrial (hectares)			17.1	17.1	17.1	17.1	17.1
Erskine Park Catchment B	Residential (dwellings)							
	Commercial / Industrial (hectares)			164.7	164.7	164.7	164.7	164.7
Erskine Park - Lyssaght B	Residential (dwellings)							
	Commercial / Industrial (hectares)			7.9	7.9	7.9	7.9	7.9
Erskine Park - Bluescope B	Residential (dwellings)							
	Commercial / Industrial (hectares)			10.3	10.3	10.3	10.3	10.3
Erskine Park - Catchment C	Residential (dwellings)							
	Commercial / Industrial (hectares)		20.6	72.7	72.7	72.7	72.7	72.7
WELL - Claremont Meadow	Residential (dwellings)			479	479	479	479	479
Glenmore Park Extension	Residential (dwellings)		450	1,200	1,699	1,699	1,699	1,699
Infill Development	Residential (dwellings)	791	2,082	3,965	3,965	3,965	3,965	3,965
Riverlink Precinct	*As per following table...*							

7.4 Traffic Generation Potential for the Riverlink Precinct

The traffic generation potential of the proposed development has been estimated and distributed onto the local road network using regional traffic modelling.

The traffic generation potential during the weekday morning and afternoon peak periods has been estimated for the proposed land uses based on traffic generation rates specified in the RTA's *Guide to Traffic Generating Developments, 2002.* Where the Guide does not specify a traffic generation rate, the traffic generation potential has been estimated from first principles by comparison with similar developments elsewhere.

The traffic generation potential of the proposed land use is as shown in Table 14 below. The table indicates that the proposed land use is expected to generate approximately 1,579 trips during the morning peak hour and 2,480 trips during the afternoon peak hour.

The major traffic generators are the proposed retail developments including the general retail, brand retail and the bulky goods, the conference facilities, and the GPS School.

Traffic generation of a sport stadium and multi use arena will be higher during major events at the facilities and additional assessment should be carried out when the proposed uses are well defined.

Year 2031 projected Riverlink Precinct vehicle generations assume a nominal 9% growth over the 5 year period from 2026. The model also includes background growth during this period.

Table 14 Estimated Riverlink Precinct Traffic Generation

Precinct	Land Use	Site (ha)	GFA Existing	GFA Proposed	Net Area		Assumed Generation Rates	Traffic Generation AM Peak	Traffic Generation PM Peak	Netanal Zone	2026 AM Outbound	2026 AM Inbound	2026 PM Outbound	2026 PM Inbound	2031 AM Outbound	2031 AM Inbound	2031 PM Outbound	2031 PM Inbound
North																		
	Sports Stadium	2		2,000			0.75/100	15	15		3	11	11	3	3	11	11	3
	Indoor/Outdoor Sports Centre	1.5		5,000			0.2/100	10	10		2	7	7	2	2	8	8	2
	Integrated Visitor Centre / Museum / gallery			2,000			0.5/100	10	10		2	7	7	2	2	8	8	2
	Sports Academy / Management School	2		4,000			0.2/100	8	8		1	6	6	1	2	6	6	2
	Art / Cultural / Business Incubator			3,000			0.2/100	6	6		1	4	4	1	1	5	5	1
	Retail ground floor			2,000	1,500		2/100	10	30		2	7	21	5	2	8	23	6
	GPS School	6		10,000		700 students	1/100	100			18	70			19	76		
	TOTAL	11.5		28,000						949	28	111	55	14	30	121	60	15
Penrith Panthers Stage 1																		
	Club		27,200	27,200			1/100	75	75		13	53	53	13	14	57	57	14
	Conferences / Conventions		21,000	48,200				150	150		26	105	105	26	29	114	114	29
	Hotel		11,500	31,300		466 rooms	0.5 per room	125	125		22	88	88	22	24	95	95	24
	Cinemas & bowling			8,500			0.6/100	20	50		4	14	35	9	4	15	38	10
	General Retail			15,000	11,250		2/100	100	225		18	70	158	39	19	76	172	43
	Restaurants			3,000				100	100		18	70	70	18	19	76	76	19
	Commercial Suites			6,000				90	90		16	63	63	16	17	69	69	17
	Brand Outlet Retail			25,000	18,750			125	500		22	88	350	88	24	95	382	95
	Multi-use Arena			30,000				15	15		3	11	11	3	3	11	11	3
	Seniors Living Residential			50,000		250 units		45	45		32	8	32	8	34	9	34	9
	Car Parking multi-deck (not GFA)			108,000														
	TOTAL	45.6		244,200						948	172	568	963	241	187	619	1049	262
Panthers Stage 2																		
	Hotel			10,400				75	75		13	53	53	13	14	57	57	14
	Serviced Apartments			9,000				50	50		35	9	35	9	38	10	38	10
	Aquatic health wellness centre			4,000				10	10		2	7	7	2	2	8	8	2
	Retail			1,500	1,125		2/100	10	23		2	7	16	4	2	8	18	4
	Commercial Suites			6,000			15/ha	9	9		2	6	6	2	2	7	7	2
	Business Park			25,000			15/ha	38	38		7	27	27	7	7	29	29	7
	Bulky Goods / Homeware retail			18,000	13,500		2/100	100	270		18	70	189	47	19	76	206	52
	Residential			84,000	63,000	210 lots	0.4/lot	84	84		59	15	59	15	64	16	64	16
	Car Parking (incl. residential) (not GFA)			52,000														
	TOTAL	29.5		157,900	118,425					950	136	193	391	98	148	210	427	107
Southwest																		
	Restaurants			1,200			employees	20	45		4	14	32	8	4	15	34	9
	Tavern	1.2		1,500			na										0	0
	Functions / receptions			1,500			employees	5	5		1	4	4	1	1	4	4	1
	TOTAL	1.2		4,200														
Southeast																		
	Bulky Goods	3		12,500			2.5/100	100	315		18	70	221	55	19	76	240	60
	Industrial	10		6,000			15/ha	9	9		2	6	6	2	2	7	7	2
	Convenience Retail	1		3,000	2,250		2/100	20	45		4	14	32	8	4	15	34	9
	TOTAL	14		21,500														
Flood Liable Land																		
	Water Theme Park	7.5		20,000			employees	15	15		3	11	11	3	3	11	11	3
	Golf Course (18 Holes)	20		3,000			employees	20	20		4	14	14	4	4	15	15	4
	Camping Grounds						na											
	Eco tourism resort	4		150			employees	10	10		2	7	7	2	2	8	8	2
	TOTAL	31.5		23,000														
TOTAL		133.2		478,800	359,100		Sub Total	1,579	2,477	959	35	139	325	81	38	152	354	89
							Reduction in private vehicle usage	-197	-310									
							Total vehicle generation after modal shift	1,382	2,167									

Note...
i) 0% Self Containment
ii) 10% modal shift from private vehicle use (12.5% actual)

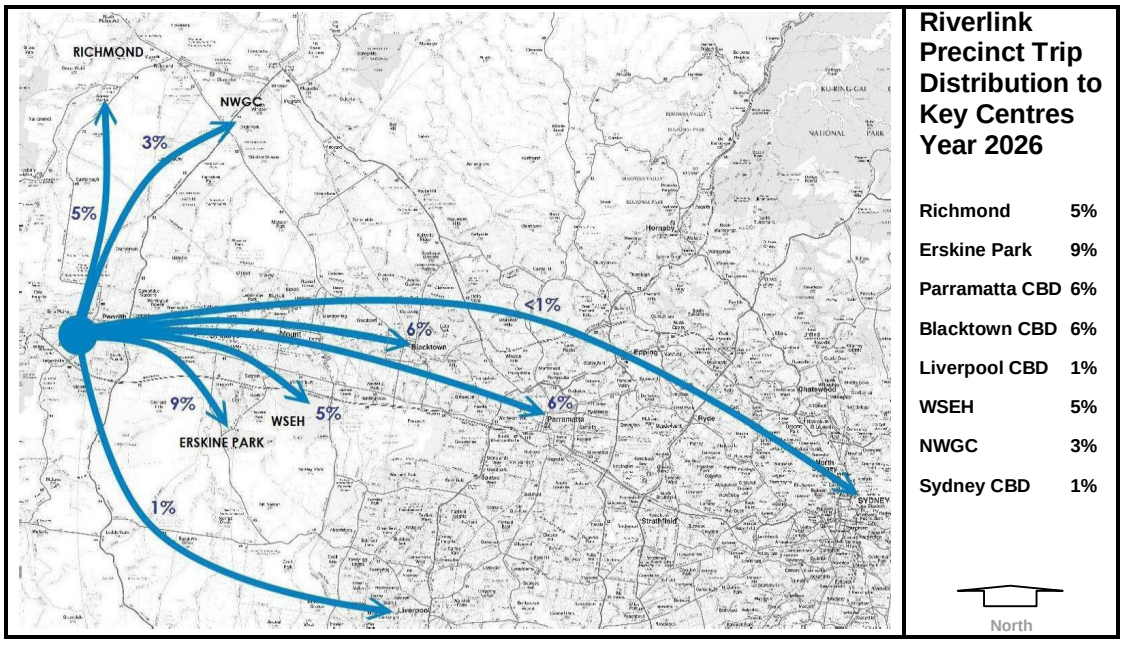
7.5 Trip Containment

No containment has been applied in the determination of vehicle generation levels for the Riverlink precinct since the development structure is considered incapable of satisfying the necessary community needs to facilitate a significant level of containment.

7.6 Traffic Distribution

Figure 19 presents the reported trip distribution to key regional centres, for the future year morning peak trip matrix utilised in the modelling of the 'End State' conditions for the Riverlink Precinct project

Figure 19 Riverlink Precinct Morning Peak Hour Trip Distribution



7.7 Key Findings of the Regional Traffic Modelling

The results of the modelling indicate that the traffic to and from the Riverlink Precinct will concentrate on the Mulgoa Road and Jamison Road. These findings are explored in further detail below and in Section 8 of this study report.

7.7.1 Link Volumes

The model plots for the Base Year 2009, Future year 2026 and Future year 2031 are attached in Appendix B, Appendix C and Appendix D, respectively. A summary for each model is provided in Table 15, Table 16 and Table 17.

Table 15 Modelled year 2009 Link Volumes

Location	Lane Capacity Threshold	2009 Link Volumes (veh)		V/C Ratio	
		AM	PM	AM	PM
GWH EB W Mulgoa Rd	1350	1001	712	0.4	0.3
GWH WB W Mulgoa Road		446	1280	0.2	0.5
Union Rd WB E Mulgoa Rd	896	342	553	0.2	0.3
Union Rd EB E Mulgoa Rd		330	30	0.2	0.0
Ransley St EB W Mulgoa Rd	630	103	148	0.1	0.1
Ransley St WB W Mulgoa Rd		98	83	0.1	0.1
Panthers EB W Mulgoa Rd	630	67	200	0.1	0.2
Panthers WB W Mulgoa Rd		173	163	0.1	0.1
Jamison Rd EB W Mulgoa Rd	898	802	263	0.4	0.1
Jamison Rd WB W Mulgoa Rd		306	598	0.2	0.3
Blaikie Rd EB W Mulgoa Rd	630	95	27	0.2	0.0
Blaikie Rd WB W Mulgoa Rd		55	19	0.1	0.0
Mulgoa Rd NB S Union Rd	1350	983	615	0.4	0.2
Mulgoa Rd SB S Union Rd		859	1402	0.3	0.5
Mulgoa Rd NB N Panthers	1350	942	573	0.3	0.2
Mulgoa Rd SB N Panthers		850	1335	0.3	0.5
Mulgoa Rd NB S Jamison Rd	1350	1696	678	0.6	0.3
Mulgoa Rd SB S Jamison Rd		917	1497	0.3	0.6
Mulgoa Rd NB N Blaikie Rd	1350	2017	1134	0.7	0.4
Mulgoa Rd SB N Blaikie Rd		1434	1853	0.5	0.7
Mulgoa Rd NB N Wolseley St	1350	2237	1520	0.8	0.6
Mulgoa Rd SB N Wolseley St		1849	2110	0.7	0.8
Jamison Rd EB E Mulgoa Rd	896	1508	197	1.7	0.2
Jamison Rd WB E Mulgoa Rd		431	554	0.5	0.6

Table 15 shows Mulgoa Road has some spare capacity to accommodate additional traffic and Jamison Road eastbound lane from Mulgoa Road has exceeded its capacity.

Table 16 Future Year 2026 Link Volumes

Location	Lane Capacity Threshold	2026 Link Volumes (veh)		V/C Ratio		2026 Recom-mended Lanes
		AM	PM	AM	PM	
GWH EB W Mulgoa Rd	1350	769	360	0.3	0.1	2
GWH WB W Mulgoa Road		585	812	0.2	0.3	
Union Rd WB E Mulgoa Rd	896	452	1415	0.3	0.8	2
Union Rd EB E Mulgoa Rd		1560	895	0.9	0.5	
Ransley St EB W Mulgoa Rd	630	109	484	0.2	0.8	1
Ransley St WB W Mulgoa Rd		283	99	0.4	0.2	
Panthers EB W Mulgoa Rd	630	560	355	0.4	0.3	2
Panthers WB W Mulgoa Rd		239	437	0.2	0.3	
Jamison Rd EB W Mulgoa Rd	898	914	709	0.5	0.4	2
Jamison Rd WB W Mulgoa Rd		430	728	0.2	0.4	
Blaikie Rd EB W Mulgoa Rd	630	106	85	0.2	0.1	1
Blaikie Rd WB W Mulgoa Rd		68	84	0.1	0.1	
Mulgoa Rd NB S Union Rd	1350	2827	1199	1.0	0.4	2
Mulgoa Rd SB S Union Rd		1135	2034	0.4	0.8	
Mulgoa Rd NB N Panthers	1350	2830	1062	1.0	0.4	2
Mulgoa Rd SB N Panthers		1019	2113	0.4	0.8	
Mulgoa Rd NB S Jamison Rd	1350	1853	613	0.7	0.2	2
Mulgoa Rd SB S Jamison Rd		787	1655	0.3	0.6	
Mulgoa Rd NB N Blaikie Rd	1350	2304	946	0.9	0.4	2
Mulgoa Rd SB N Blaikie Rd		1320	2002	0.5	0.7	
Mulgoa Rd NB N Wolseley St	1350	2510	1321	0.9	0.5	2
Mulgoa Rd SB N Wolseley St		1989	2313	0.7	0.9	
Jamison Rd EB E Mulgoa Rd	896	406	511	0.5	0.6	1
Jamison Rd WB E Mulgoa Rd		346	603	0.4	0.7	

The modelling results show that in Year 2026, at 'End State', Mulgoa Road will have the capacity to sustain the development growth from the proposed Riverlink Precinct, with the localised intersection improvements.

Table 17 Future Year 2031 Link Volumes (+9% Dev + Background Growth)

Location	Lane Capacity Threshold	2031 Link Volumes (veh)		V/C Ratio	
		AM	PM	AM	PM
GWH EB W Mulgoa Rd	1350	834	424	0.3	0.2
GWH WB W Mulgoa Road		633	863	0.2	0.3
Union Rd WB E Mulgoa Rd	896	482	1569	0.3	0.9
Union Rd EB E Mulgoa Rd		1634	1070	0.9	0.6
Ransley St EB W Mulgoa Rd	630	113	512	0.2	0.8
Ransley St WB W Mulgoa Rd		284	109	0.5	0.2
Panthers EB W Mulgoa Rd	630	624	380	0.5	0.3
Panthers WB W Mulgoa Rd		243	557	0.2	0.4
Jamison Rd EB W Mulgoa Rd	898	933	772	1.0	0.9
Jamison Rd WB W Mulgoa Rd		446	775	0.5	0.9
Blaikie Rd EB W Mulgoa Rd	630	105	74	0.2	0.1
Blaikie Rd WB W Mulgoa Rd		67	86	0.1	0.1
Mulgoa Rd NB S Union Rd	1350	2956	1223	1.1	0.5
Mulgoa Rd SB S Union Rd		1198	2122	0.4	0.8
Mulgoa Rd NB N Panthers	1350	2973	1081	1.1	0.4
Mulgoa Rd SB N Panthers		1087	2207	0.4	0.8
Mulgoa Rd NB S Jamison Rd	1350	1955	605	0.7	0.2
Mulgoa Rd SB S Jamison Rd		862	1646	0.3	0.6
Mulgoa Rd NB N Blaikie Rd	1350	2495	1053	0.9	0.4
Mulgoa Rd SB N Blaikie Rd		1630	2090	0.6	0.8
Mulgoa Rd NB N Wolseley St	1350	2634	1367	1.0	0.5
Mulgoa Rd SB N Wolseley St		2092	2323	0.8	0.9
Jamison Rd EB E Mulgoa Rd	896	443	564	0.5	0.6
Jamison Rd WB E Mulgoa Rd		367	661	0.4	0.7

7.7.2 Future Intersection Performance without Mitigation

Future year intersection performance are summarised in Table 18 and Table 19. These results indicate intersections requiring capacity enhancements.

Table 18 Future Year 2026 Intersection Performance, without Mitigation

Intersection	AM Peak			PM Peak		
	DS[1]	AVD[2]	LOS[3]	DS[1]	AVD[2]	LOS[3]
GWH / Riverlink	0.24	12	A	0.25	20	B
Mulgoa Rd / Union Rd	0.60	32	C	0.71	42	C
Mulgoa Rd / Ransley St	0.69	41	C	0.63	34	C
Mulgoa Rd / Panthers	0.89	36	C	0.68	35	C
Mulgoa Rd / Jamison Rd	0.83	109	F	0.71	85	F
Mulgoa Rd / Blaikie Rd	0.70	56	D	0.89	52	D
Mulgoa Rd / Glenbrook St	0.95	43	D	0.82	46	D
Mulgoa Rd / Wolseley St	0.97	36	C	0.90	40	C

1 Degree of Saturation
2 Average Vehicle Delay
3 Level of Service

From the above, it is evident that the intersection of Mulgoa Road/Jamison Road will be operating at capacity and the intersections of Mulgoa Road/Blaikie Road and Mulgoa Road/Glenbrook Street will be operating near capacity.

Table 19 Future Year 2031 Intersection Performance, without Mitigation

Intersection	AM Peak			PM Peak		
	DS[1]	AVD[2]	LOS[3]	DS[1]	AVD[2]	LOS[3]
GWH / Riverlink	0.26	13	A	0.28	23	B
Mulgoa Rd / Union Rd	0.71	34	C	0.74	44	D
Mulgoa Rd / Ransley St	0.71	43	C	0.62	325	D
Mulgoa Rd / Panthers	0.86	32	C	0.69	37	C
Mulgoa Rd / Jamison Rd	0.81	108	F	0.74	87	F
Mulgoa Rd / Blaikie Rd	0.76	57	E	0.93	55	E
Mulgoa Rd / Glenbrook St	0.95	49	D	0.90	47	D
Mulgoa Rd / Wolseley St	0.90	34	C	0.93	44	D

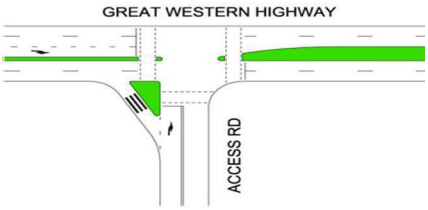
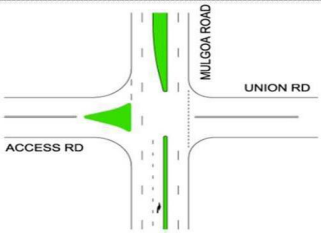
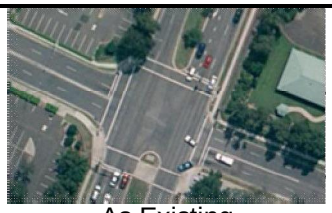
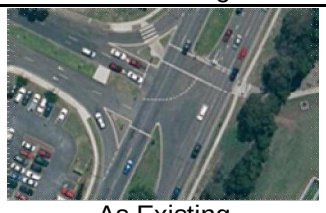
1 Degree of Saturation
2 Average Vehicle Delay
3 Level of Service

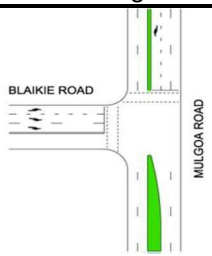
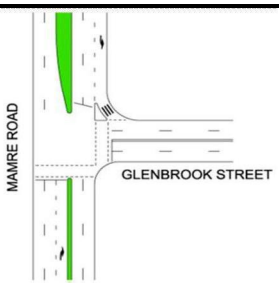
The modelling results for modelled year 2031 show an additional three intersections will be operating near capacity. These intersections are: Mulgoa Road/Union Road, Mulgoa Road/Ransley Street and Mulgoa Road/Wolseley Street.

7.7.3 Future Intersection Performance with Mitigation

Improvement measures have been tested to mitigate capacity deficiencies at the key intersections. Future year intersection performance with the recommended improvements are summarised in Table 20.

Table 20 Future Year 2026 Intersection Performance, with Mitigation

Access Location	AM Peak			PM Peak			Mitigated Condition
	DS	AVD	LoS	DS	AVD	LoS	
Great Western Highway / Riverlink Access	0.3	13	A	0.52	17	B	 New Riverlink Access on GWH
Mulgoa Road/Union Road	0.14	0	A	0.12	0	A	 Left In/Left Out from Riverlink
Mulgoa Road / Ransley Street	0.85	21	B	0.78	20	B	 As Existing
Mulgoa Road / Panthers	0.86	19	B	0.5	11	A	 As Existing

Access Location	AM Peak			PM Peak			Mitigated Condition
	DS	AVD	LoS	DS	AVD	LoS	
Mulgoa Road / Jamison Road	0.87	36	C	0.8	31	C	 Traffic Signals
Mulgoa Road/Blaikie Road	0.82	12	A	0.72	10	A	 Dual RT from Blaikie
Mulgoa Road / Glenbrook Street	0.9	29	C	0.93	38	C	 LT Slip Lane SB in Mulgoa
Mulgoa Road / Wolseley Street	0.78	27	C	0.88	35	C	 As Existing

8. Impacts of the Proposed Development

8.1 Introduction

This section describes the traffic generation potential of the proposed land uses and the assessment of its impact on the local road network, and identifies strategies to minimise or accommodate the anticipated increases in the future traffic demand

Assuming the proposed land use as outlined in Table 14 is considered further for the rezoning of the Riverlink Precinct, the traffic generation potential of the proposed development is estimated at approximately 1,580 veh/hr during the morning peak and 2,480 veh/hr during the afternoon peak.

The regional traffic modelling has identified that due to the local road network and function of Mulgoa Road and Jamison Road, the noticeable traffic impact of the development will be expected on Mulgoa Road and Jamison Road. In addition, increased traffic flow will be expected on a number of local streets in and around the Penrith City Centre and the Riverlink Precinct.

The traffic impact of this traffic generation has been assessed by the regional traffic modelling carried out for the redevelopment of the Riverlink Precinct.

In addition, the impact on the existing pedestrian and bicycle network has been assessed and discussed with Council representatives, Hill PDA and HBO + EMTB consultants engaged in the local environmental planning studies.

8.2 Traffic Impacts on the Local Road Network

RTA Traffic Forecast

Table 21 shows the traffic forecast on Mulgoa Road in 2007 and 2016 during the AM peak period.

Table 21 Traffic Forecast on Mulgoa Road[1]

Location	2007		2016	
	Northbound	Southbound	Northbound	Southbound
Mulgoa Road north of the M4 Motorway	2,076	935	2,170	1,064
Mulgoa Road south of Jamison Road	1,471	601	1,577	800
Mulgoa Road north of Ransley Street	991	835	1,038	1,097
Castlereagh Road north of Jane Road	1,635	1,021	1,662	1,348

1 RTA EMME2 Modelling Output

The traffic forecast indicates that traffic on Mulgoa Road will increase with additional development in the Penrith City Centre, the Riverlink Precinct and the other release areas to the north of the Centres i.e. the Penrith Lakes, Penrith North Army land and the Penrith Lakes Environs.

Austroads Guide – Part 2 & 5 specify that as a four lane divided road with interrupted traffic flow, Mulgoa Road could have a road capacity of 1900 veh/h. (See Table 22 below).

Table 22 Typical maximum Service Volumes on the Major Leg of an Intersection

Type of Road	OMC[1] (veh/h)
Median or inner lane	
■ Divided road	1,000
■ Undivided road	900
Outer or kerb lane	
■ Adjacent parking lane	900
■ Clearway conditions	900
■ Occasional parked vehicles	600
4 lane undivided	1,500
4 lane undivided – clearway conditions	1,800
4 lane divided – clearway conditions	1,900
6 lane undivided	2,400
6 lane divided – clearway conditions	2,900

[1] OMC – One-way mid-block capacity

Source: Table 5.6, Austroads Guide to Traffic Engineering Practice, Part 5, p.54, 2005.

Although higher road capacities have been used in a number of land use transport studies, Council has advised that a road capacity of 1350 veh/h/lane is to be used in this study for Mulgoa Road. This translates to a maximum daily traffic volume of 54,000 vehicles.

The section of the Mulgoa Road (south of Preston Street) fronting the development site is currently carrying a traffic volume of approximately 38,000 vehicles. This indicates that Mulgoa Road has the potential to accommodate an additional 16,000 vehicles per day.

The proposed Riverlink Precinct is expected to generate an additional 1,400 vehicles per hour in the morning peak and 2,200 vehicles per hour in the evening peak. The modelling results suggests that till Year 2026, Mulgoa Road, with localised intersection improvements will have the capacity to sustain the anticipated growth with the Penrith

LGA but will not have the spare capacity to accommodate expected traffic volumes for Year 2031.

8.3 Pedestrian Impacts and Improvement Opportunities

A wide range of potential development futures are outlined for the Riverlink Precinct under Council's Riverlink Precinct Plan (adopted 5 May 2008) and recently under the Panthers Partnership Concept Plan. Whatever the final development outcome in Riverlink, considerable additional pedestrian movements both within the Riverlink Precinct and to/from Penrith CBD, are expected.

Key pedestrian destinations are likely to include:

- Penrith CBD (including Penrith Train Station and Westfield's shopping centre);
- Penrith Panthers development;
- Residential areas;
- Tench Reserve (and any associated restaurants opposite) next to the Nepean River;
- Any future GPS school; and
- Development on the Carpenter and Woodriff Gardens sites.

With residential development proposed under the Panthers plan, this would locate residential areas in close proximity to a wide range of services and facilities. The final layout of the development will need to ensure that pedestrian desire lines are catered for. Due to the location of the Panthers development, it is unlikely that there will be high pedestrian demand between the Panthers development and the Penrith CBD, train station and Westfield's shopping centre at over 1 kilometre away.

Based upon the *Well Precinct TMAP* (Maunsell, 2006), it was identified that at a nominal 1-2 per cent of journey to work trips, this would equate to between 75 and 100 pedestrians moving during the peak hour in and around the precinct.

Major pedestrian flows will therefore be along Tench Reserve next to the Nepean River, Jamison Road (to access the Nepean River), northern sections of Mulgoa Road (to access the Penrith CBD) and within the Panthers developments. It will be important that pedestrian facilities are provided to access these destinations.

Council has also identified the need to improve pedestrian links to the Carpenter and Woodriff Gardens sites (from the Civic Centre). The community has raised concerns about the safety of the existing footpath across the Nepean River (along the Great Western Highway) at Victoria Bridge.

To provide more direct pedestrian and cycle access between Riverlink and Emu Plains and to link Riverlink to the activity centre of the Lewers Gallery, a footbridge across the Nepean River as a continuation of the existing and proposed shared path along Jamison Road would be desirable.

8.4 Cycle Impacts and Improvement Opportunities

It is expected that the percentage of cyclists will remain relatively low as it has been shown earlier that the mode share for cyclists has remained very low (approximately 1%) in the Penrith LGA over the last 15 years.

Nevertheless, an increased provision of cycle facilities (such as cycle lanes and bicycle storage at destinations) would increase the potential for people to cycle within the precinct (to access services and for recreational purposes) and outside the precinct (travelling to Penrith CBD/train station).

Land use development with a greater emphasis on walking and cycling for short trips could potentially increase the mode share of cycling from 1%. Encouraging cycling trips between the residential areas, employment areas, precinct areas and external destinations will require appropriate cycle parking/storage provision to be made at these locations.

More specific locations and opportunities for cycle facility improvement include:

- Mulgoa Road;
- Jamison Road;
- Along Peachtree Creek;
- Tench Reserve next to the Nepean River;
- Blaikie Road; and
- Nepean Avenue.

8.5 Bus Impacts and Improvement Opportunities

8.5.1 Impacts of Increased Public Transport Service Frequencies

Increases in vehicle operating charges (fuel, parking, tolls, etc.) often result in a reduction of vehicle use. Some of this travel disappears, due to fewer and shorter trips, and more use of alternatives such as working from home. A portion of reduced car use consists of shifts to other travel modes.

Which changes occur depends on specific conditions, such as the type of trip, the travel route, the quality of travel alternatives and the type of traveller. Overall, it has been found that a larger share of shorter distance, non-work trips shift to walking and cycling, while a larger share of longer distance trips shift to public transport (particularly for urban destinations) and car-sharing (particularly with suburban trip origins).

A disincentive to driving (for example, higher parking charges) typically causes 20-60% of car trips to shift to public transport, while other trips will shift to non-motorised modes, or be avoided altogether. Conversely, when public transport services are improved, typically 20-80% of the added trips will occur instead of car trips, with higher shifts for longer-distance commuting trips.

A previous study has found that as the frequency of bus and rail services increase, additional patronage is generated by these additional services.

Table 23 indicates that the largest increases occur with a shift from prior car users once public transport service frequencies are improved.

Table 23 Mode Shifts by New Public Transport Users

Additional Patronage Attracted By Increased Bus Frequency		Additional Patronage Attracted By Increased Commuter Rail Frequency	
Prior Mode	Percentage	Prior Mode	Percentage
Own Car	18-67%	Own Car	64%
Carpool	11-29%	Carpool	17%
Train	0-11%	Bus	19%
Taxi	0-7%		
Walking	0-11%		

Source: Transit Cooperative Research Program (TCRP), 2004. *Traveler Response to Transportation System Changes: Chapter 9—Transit Scheduling and Frequency*.

The TravelSmart program in Perth, WA (a travel demand management program) used a variety of incentives to encourage residents to use alternative travel modes. The goal of the program was (and is) to encourage residents to increase the proportion of total trips made by environmentally friendly modes (walking, cycling and public transport) from 10% to 25% of trips by 2029.

Before-and-after surveys of pilot projects found the following results, as shown in Table 24:

Table 24 TravelSmart Results

Trips By	Change
Car Driver	Down 14%
Public Transport	Up 17%
Cycling	Up 61%
Walking	Up 35%
Car Distance Travelled	Down 17%

Source: http://www.dpi.wa.gov.au/travelsmart/14974.asp.

8.5.2 MOT- Proposed Bus Service Changes

The Ministry of Transport, in its recent review of the bus contract for Region 1 (which covers Penrith), proposed changes to bus services. Future routes were developed through the adoption of the following principles[4]:

- More direct routes, which in turn, will assist in decreasing travel times;
- Maximise service frequency and Level of Service;
- Improved connectivity between major towns and centres;
- Improved access to services for residents; and
- Improved legibility of the wider network.

It is anticipated that through the implementation of these measures, patronage numbers will increase.

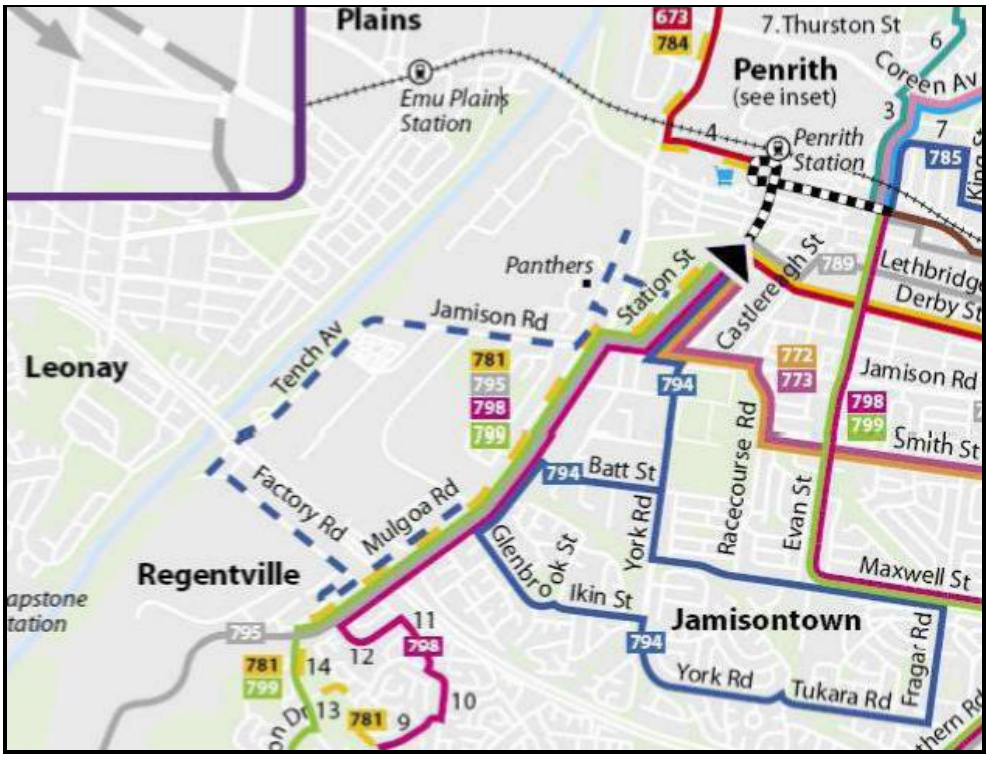
The proposed changes relating to the Riverlink precinct are as follows:

- Existing routes 791, 797, N1 and N2 would be discontinued, replaced by new 772, 773, 786, 798 and 799 loop services and modified route 794;
- New routes 772 and 773 would be modified to operate between Penrith and St. Marys via Racecourse Rd and Smith St, replacing routes 791 and 798 in this area;
- Existing route 794 would be modified to operate as a two-way loop service between Penrith, Jamisontown and South Penrith, via York Rd, Batt St, Mulgoa Rd, Glenbrook St and Ikin St. Services to Nepean Shores and Mountainview Retirement Villages would be maintained. This would replace part of route 791 in the York Rd (south), Tukara Rd and Fragar Rd area;
- Existing route 798 and new route 799 would also replace route 791 along Maxwell Rd and Evan St;
- New route 799 would operate a two-way loop service between Penrith, Jamisontown, Glenmore Park, The Northern Rd and Penrith, operating in conjunction with modified route 798;
- Existing route 797 to Jamisontown and Glenmore Park would be replaced by modified route 798 and new route 799; and
- Existing night / weekend route N1 would be replaced by routes 798 and 799.

The Ministry of Transport (Bus Contract Unit) has advised that it is currently reviewing the comments from the community about possible changes to the bus routes and services to its Region 1 Contract Area (which covers the Penrith LGA). The proposed bus routes are as shown in Figure 20.

[4] From Ministry of Transport (2006) *Service Planning Guidelines – Sydney Metropolitan Regions*

Figure 20 Proposed Bus Network



Source: Ministry of Transport, 2008

The land use options proposed for the Riverlink Precinct including the residential, retail, commercial, school and the cultural development would create additional demand for travel by public transport.

The adopted mode shift target of 10% will require higher public and active transport use. An additional demand of between 160 and 250 bus trips is expected. The proposed GPS School in the development area would also create demand for increased bus trips.

The Ministry of Transport has advised it would be willing to consider changes to the bus services to the proposed development after Council has adopted a preferred land use for the Riverlink Precinct.

The level of the development in the Panthers site, in particular, will require a frequent bus service or a Penrith City Centre Shuttle bus service, as has recently been implemented in the Parramatta City Centre. Service frequency will need to be determined from more detailed demand studies. Council should discuss the cost implications with the Ministry of Transport and the cost could be shared with the developers.

8.6 Impacts on Passenger Rail and Opportunities for Improvement

The northeastern portion of the Riverlink Precinct lies just at the edge of the nominal 800-metre walk up catchment of Penrith rail station. While this poses as a constraint for rail transport to be used as an access mode for the development, it also presents at the same time opportunities to combine rail with other modes such as a regular bus, shuttle bus services and cycle links between the Riverlink Precinct and Penrith station.

Provision of a rail-bus link will enhance the accessibility of the Riverlink Precinct, strengthen its linkages with Penrith CBD, and assist in achieving targets to minimise climate change impacts brought about by vehicle emissions. This can also be achieved through the provision of a safe and convenient cycle facility that links an internal Riverlink Precinct cycle network with Penrith train station.

In essence, the impact of the development of the Riverlink Precinct on rail transport would relate to required improvements to ensure adequate linkages with the existing station, including the provision of more pedestrian and cycle friendly crossing facilities at the intersection of Mulgoa Road and Jane Street, and Mulgoa Road and Henry Street.

9. Summary and Conclusions

9.1 Achieving Mode Shift

With an increase in the visibility of buses through the precinct, behaviour change programs, good pedestrian connection, comfortable shelters and high levels of service offered by routes on the major roads, it is anticipated that an existing public transport mode share increase target of 25% over the proposed 10% could be achieved, resulting in a public transport/non car mode share of 12.5%.

Achieving reduced car travel by improving public transport, pedestrian and cycling facilities is increased when their introduction coincides with a marketing campaign informing potential users of the benefits of using these modes. A number of community and government based initiatives have been put in place over recent years endeavouring to alter people's behaviour and decrease the number of people travelling by private car. The most common behaviour change strategy is TravelSmart, an Australian government based program that promotes the use of public transport for routine travel by encouraging individuals to reconsider their need for the use of a private car.

9.2 Future Network Capacity

The results of the traffic modelling suggests that till Year 2026, deemed "End State", Mulgoa Road, with localised intersection improvements, will be capable of sustaining the development growth within the Penrith LGA, including the generation of some 1,400 vehicle per hour in the morning peak and 2,200 vehicles per hour in the evening peak, from the planned Riverlink Precinct development. Event-based land use and recreational land use do not usually generate traffic during the regular network peak. Often times, traffic attributed to these land use types are expected to be spread out and occurring outside the usual AM and PM peak.

The model exhibits no spare capacity along the Mulgoa Road corridor, between High Street and the M4 Motorway, and highlights the need for intersection improvements at the following intersections:

- Mulgoa Road and Jamison Road, currently under roundabout control;
- Mulgoa Road and Blaikie Road; and
- Mulgoa Road and Glenbrook Road.

In addition, two (2) new access points are proposed for the Riverlink Precinct site being:

- A proposed traffic signal controlled intersection on Great Western Highway at the Riverlink Access Road, some 300m west of Mulgoa Road directly east of Peach Tree Creek, and
- A proposed left-in/left-out arrangement on Mulgoa Road at Union Street.

The proposed treatments, outlined in Table 18 afford increased green time to the through movements along Mulgoa Road while improving the throughput of highlighted critical movements to and from the side streets.

Sensitivity models were tested, at a micro level, utilising the Intanal program, and reported significant degradation of a number of intersections on Mulgoa Road when run with a modelled increase of 10% in through traffic volumes along the corridor.

The Year 2031 model, with a 9% increase in the development vehicle generation from the Riverlink Precinct, suggests widening of Mulgoa Road to six (6) lanes will be necessary.

9.3 Intersection Upgrades

The results of the modelling process revealed that intersection upgrades are necessary to provide additional capacity for the future traffic levels regardless of planned density of the future development of the Riverlink precinct. Proposed intersection treatments to improve operational performance for the intersections are given as follows:

- Mulgoa Road/Jamison Road – optimised traffic signal settings;
- Mulgoa Road/ Blaikie Road – dual right turn from Blaikie Road; and
- Mulgoa Road/Glenbrook Street – left turn slip lane in Mulgoa.

The proposed intersection treatments were modelled for 2026 traffic conditions and the results are shown in Table 25.

Table 25 Future Year 2026 Intersection Performance, with Mitigation

Intersection	AM Peak			PM Peak		
	DS	AVD	LOS	DS	AVD	LOS
Great Western Highway/Riverlink Access	0.3	13	A	0.52	17	B
Mulgoa Road / Union Road	0.14	0	A	0.12	0	A
Mulgoa Road / Ransley Street	0.85	21	B	0.78	20	B
Mulgoa Road / Panthers	0.86	19	B	0.5	11	A
Mulgoa Road / Jamison Road	0.87	36	C	0.8	31	C
Mulgoa Road / Blaikie Road	0.82	12	A	0.72	10	A
Mulgoa Road / Glenbrook Street	0.9	29	C	0.93	38	C
Mulgoa Road / Wolseley Street	0.78	27	C	0.88	35	C

10. Recommendations

10.1 Integrating Land Use with Public Transport

The development of the Riverlink Precinct will invariably have to adhere to sound and accepted planning principles that would promote sustainability objectives. The NSW Government, through the Roads and Traffic Authority (RTA), the Ministry of Transport, and the Department of Planning, have jointly developed guidelines that can be used in planning for the development of the Riverlink Precinct. These are discussed in detail in the document *Integrating Land Use and Transport: Improving Transport Choice – Guidelines for planning and development*.

Ten principles are outlined in the document on how transport choice can be improved. These principles are as follows:

- **Concentrate in centres –** develop centres with highest possible densities of housing, employment and services and public facilities within an acceptable walking distance to major public transport nodes. Also known as "transit-oriented developments", locating these concentrated centres near public transport interchanges would encourage less reliance on private vehicle modes. In the case of the Riverlink Precinct development, the concentration of activity centres will make public transport more viable to operate;
- **Mix uses in centres** – Planned centres within the Riverlink Precinct should host a variety of uses, such as housing, employment, services, public facilities and other compatible uses in accessible centres;
- **Align centres with corridors** – Identified corridors through the development should cater for public transport routes, preferably with bus priority measures in place. Aligning centres along the public transport corridors will encourage more origins and destinations within the corridor and support high frequency public transport services. The corridor through the Riverlink Precinct can link with Penrith City Centre;
- **Link public transport with land use strategies –** Planning for public transport infrastructure will need to be aligned with the planning for the precinct. Public transport planning also needs to consider linkages with active transport modes such as walking and cycling;
- **Connect streets –** The street network for the Riverlink Precinct will need to cater to direct connections with public transport routes. A number of the different components of the precinct are currently inaccessible from other parts. The precinct street network would need to be legible and easily understood, to allow for a choice of routes;
- **Improve pedestrian access –** The network of footpaths through the precinct would have to consider all requirements of pedestrians, whether to access public transport, to access other parts of the precinct, or to access the leisure component of the system. The network should be designed to standards that would

encourage more walking, by careful consideration of gradients, widths, surface treatments, and in particular, pedestrian crossings;

- **Improve cycle access** – The Riverlink Precinct offers the opportunity to be a showcase for developing an accessible and efficient cycle network in Penrith, conveniently and safely linked to major activity centres such as Penrith City Centre and Penrith Station. The current link with the M4 motorway can further be improved by addressing the steep gradient the current ramp provides;
- **Manage parking supply** – The location, supply, availability and affordability of car parking can be designed in a way to discourage car use. A balance between public transport accessibility and parking supply can be integrated in the planning process, such that those centres more accessible to public transport need not provide as much parking supply as others not as accessible. Parking supply control is one element that can address the reduction in public transport attractiveness;
- **Improve road management** – Road traffic flow can be managed by setting the proper priorities in traffic control. Access to road space, including at intersections, needs to address the requirements of pedestrians, cyclists and public transport users as well as motorists; and
- **Implement good urban design** – Urban design undertaken with an emphasis on the needs of pedestrians, cyclists and public transport users will enable the Riverlink Development to improve transport choice. Buildings and structures need to take human scale into account. Urban design also considers passive surveillance of footpaths, public transport stops and ranks, accompanied by legible and attractive street furniture. Bus stops need to be provided with standard information plinths, the guidelines for which have been prepared by the Ministry of Transport.

Sound planning and design practices following these ten principles would assist in achieving the sustainable development objectives for the Riverlink Precinct.

10.2 Road Classification and Hierarchy for the Riverlink Precinct

The Roads and Traffic Authority (RTA) has developed guidelines for classification of the roads. The RTA's classifications reflect traffic volume limits for all road types and defines functions and connections. This is shown in Table 26.

Table 26 Functional Classification of Roads (NSW RTA)

Road Type	Traffic Volume (AADT)	Through Traffic	Inter-Connections	Speed Limit (km/h)
Arterial/Freeway	No limit	Yes	Sub-Arterial	70-110
Sub-Arterial	<20,000	Some	Arterial/ Collector	60-80

Road Type	Traffic Volume (AADT)	Through Traffic	Inter-Connections	Speed Limit (km/h)
Collector	<5,000	Little	Sub-Arterial/Local	40-60
Local	<5,000	No	Collector	40

The road classifications for the Riverlink Precinct can be determined based on the AADT, as shown in Table 27.

Table 27 2026 AADT for Riverlink Precinct Road Network

Location	AM Peak (veh/hr)	PM Peak (veh/hr)	AADT[1] (veh/day)	Proposed Cross Section
Great Western Highway west of Mulgoa Road	1354	1172	12630	2 lanes
Ransley Street, west of Mulgoa Road	392	583	4875	1 lane
Panthers, west of Mulgoa Road	799	792	7955	2 lanes
Jamison Road, west of Mulgoa Road	1344	1437	13906	2 lanes
Blaikie Road, west of Mulgoa Road	174	169	1715	1 lanes
Mulgoa Road at Wolseley Street	4499	3634	40667	2 lane

[1] Based on the assumption that average peak hr traffic consists of 10% of AADT.

From the RTA's guidelines, a proposed road hierarchy for the Precinct is summarised in Table 28 and shown in **Figure 21**.

Table 28 Proposed Riverlink Precinct Road Hierarchy

Location	AADT (veh/day)	Classification	Functions and Connections	Speed Limit
Great Western Highway west of Mulgoa Road	12630	Sub-Arterial	Arterial roads to town centres. Carries major bus routes,	Up to 70 km/h
Ransley Street, west of Mulgoa Road	4875	Collector	Connects neighbourhoods Can	Up to 60 km/h

Location	AADT (veh/day)	Classification	Functions and Connections	Speed Limit
			accommodate public transport	
Panthers, west of Mulgoa Road	7955	Collector	Connects neighbourhoods . Can accommodate public transport	Up to 60 km/h
Jamison Road, west of Mulgoa Road	13906	Sub-Arterial	Arterial roads to town centres. Carries major bus routes,	Up to 70 km/h
Blaikie Road, west of Mulgoa Road	1715	Local	Priority to pedestrians and cyclists, Designed to slow residential traffic	Up to 50 km/h
Mulgoa Road at Wolseley Street	40667	Arterial	Connects large urban areas	Up to 80 km/h

Proposed new links for the Riverlink Precinct street network are shown in Figure 22.

1:10,000

140 70 0 140 Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

Legend

- Highways
- Arterial Roads
- Sub Arterial Roads
- Collector Roads
- Local Roads

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Proposed Riverlink Precinct Road Network Hierarchy

Figure 21

G:\21\18430\CADD\GIS\MapDocuments\28052009\22NewZ010_Penrith_Street Map.mxd

Data source: GHD Pty Ltd. Created by: nbuchanan

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1:10,000

150 75 0 150 Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

Legend

- Riverlink/ Pedestrian Link
- Potential Link
- Railways

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Proposed Links for Riverlink Precinct Street Network

Figure 22

G:\21\18430\CADD\GIS\MapDocuments\28052009\22NewZ010_Penrith_ Proposed links.mxd

Data source: GHD Pty Ltd. Created by: nbuchanan

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10.3 Intersection Enhancements

Capacity enhancements may be necessary for the intersections with an unacceptable Level of Service. These intersections and the associated treatments have been identified in Section 9.3.

10.4 Pedestrian and Cycle Facilities

New Links

New pedestrian and bicycle facilities have been proposed along the Great Western Highway, Jamison Road, Blaikie Road and Peachtree Creek to increase connectivity between the Nepean River and Penrith CBD and the Riverlink Precinct. These include improvements to the existing facilities along the Great Western Highway, Mulgoa Road, and Blaikie Rd, Jamison Road along Peachtree Creek and an upgrade or a new pedestrian/cycle bridge over the Nepean River. Moreover, extending footpaths through all streets and creating shaded walking environments (I.e. tree-lined streets) is also recommended.

Link along Nepean River

A new shared path is proposed along the Nepean River. While existing facilities connect from Jamison Road to Nepean Avenue, there is potential to create a link along the riverbank, rather than along Nepean Avenue. This would provide connectivity along the entire length of the river precinct and would provide views towards the Blue Mountains.

However, it is recognised that this link may be difficult to implement due to private land ownership and a steep riverbank.

Northern Link over Nepean River

The existing shared pedestrian/cycle path along the Great Western Highway across the Nepean River (Victoria Bridge) is narrow and would not meet current RTA and AUSTROADS standards.

It may be possible that the existing path can be improved to share the area between the Western Railway Line and the Great Western Highway or develop a new cantilever bridge on the southern side of the existing Nepean River Bridge.

This would strengthen the east- west pedestrian/bicycle link at the northern end of the study area.

Pedestrian Connectivity at Mulgoa Road/Great Western Highway Intersection

Further investigation at a later stage is warranted at the Mulgoa Road/Great Western Highway intersection for pedestrian access and connectivity. As this is a large intersection, in conjunction with potential land development of the Woodriff Garden and Carpenter sites, it is recommended that pedestrian links to the Civic Centre and Penrith Plaza be further investigated. It may be necessary to grade separate pedestrian movements as development progresses.

A concept for the improvements could be considered as part of development of the Woodriff Garden and Carpenter sites and/or the Jane Street extension.

Riverlink

The Riverlink has been proposed in a north-south direction along Peach Tree Creek by the Panthers Partnership. This would be a shared path and link to the Nepean River. The Riverlink proposal is supported in this report, although the exact alignment is still to be determined. It would also be beneficial to connect the Riverlink to Jamison Road, potentially at the intersection with Blaikie Road.

Jamison Road

An existing cycleway has been designated on Jamison Road; however, Jamison Road is relatively narrow, with narrow shoulders. Jamison Road also has a partially constructed cycleway. It is recognised that Jamison Road forms the critical east-west alignment through the Riverlink Precinct, and as such it is recommended that an off-street shared path for pedestrians and cyclists be provided.

Pedestrian/Cycle Link over Nepean River

A potential long-term option is to provide a pedestrian and bicycle 'green' bridge over the Nepean River at the western end of Jamison Road. This would help connect the two sides of the river together and provide access to the Penrith Regional Gallery on the western side of the river and proposed new developments within the Riverlink Precinct and beyond to the CBD.

Pedestrian Link to Panthers Stadium

While bordering the study area, it is recognised that there are substantial pedestrian movements between the Panthers complex and the CUA stadium on game days.

With the proposed additional development on the Panthers site, pedestrian access across to the stadium and the other services in the Penrith Town Centre should be improved. A pedestrian bridge (over Mulgoa Road) could be further investigated.

Blaikie Road

To provide pedestrian and cycle connectivity throughout the southern half of the Precinct, it is recommended to provide an off-street shared path for pedestrians and cyclists along the length of Blaikie Road in the medium term as additional development proceeds in the Panthers south west and central areas. An east-west connection through to Tench Avenue is also recommended to provide a shared path to the Nepean River eastern bank.

Mulgoa Road

Cycle facilities are currently lacking on the majority of Mulgoa Road. The current bicycle facility along Mulgoa Road along the Riverlink Precinct consists of limited line markings on a relatively narrow road shoulder.

It is recommended that off-road bicycle facility along Mulgoa Road be improved. This cycleway within the verge, as part of widened footpaths (into shared paths) is

understood to be already under negotiation with the RTA and involves a 2.5m wide shared path set back 0.5m from the kerb.

Exceed Minimum Standards

It is recommended that for the development of new footpaths and cycleways, that minimum width requirements are exceeded, rather than adhered to. This will provide pedestrians and cyclists with more room to walk and cycle in relation to vehicular traffic.

The proposed pedestrian and cycle facilities for the Riverlink precinct are shown in Figure 23. Design Standards for new facilities are summarised in Appendix F

1:10,000

190 95 0 190 Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

Legend

Proposed Links

- Panthers Riverlink
- Proposed Pedestrian/Bicycle Bridge
- Proposed Shared Path
- Proposed Cycle path
- Proposed Road

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Proposed Walking and Cycling Routes

Figure 23

G:\21\18430\CADD\GIS\MapDocuments\Z010_Penrith_Proposed_Walking&Cycling.mxd

Data source: GHD Pty Ltd. Created by: nbuchanan

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10.5 Bus Service Changes

Bus Routes and Frequency

As shown earlier in Table 6, the majority of bus services operating in and around the Riverlink Precinct run at low frequency levels. In order to provide viable alternatives to the motor vehicle, it is recommended that following adoption of an LEP and DCP which specify permissible land uses (and their scale), the Ministry of Transport be requested to review bus service frequency to Penrith CBD and the Penrith Station, to/from the Riverlink Precinct.

An overall increase in bus service frequencies and hours of operation will help encourage the use of more sustainable transport in the area and enable people to leave their car at home for short trips to the Penrith CBD and for connecting with longer-distance services at the train station.

More specifically, the loop weekend service along Tench Avenue and Jamison Road for bus route number 794 should be further investigated as part of a future full-time route. This would support the east-west demand through the Precinct.

There is also some potential to deviate certain services via Blaikie Road. Bus stop locations will need to be reassessed to ensure maximum coverage and accessibility to and from residences and other key destinations throughout the Precinct.

Free Shuttle Bus Service

It is also recommended that Council investigate the potential for a free community shuttle bus. This could run in the Penrith City Centre and the Riverlink Precinct. This would potentially link with the Riverlink Precinct, Penrith CBD and the train station.

This type of service is currently operating in and around the Parramatta CBD, with support from Council, Ministry of Transport and the private sector.

10.6 Plan for Street Vistas

Within the Precinct, street vistas to the Blue Mountains exist along the east-west public streets such as Jamison Road, Blaikie Road and the Great Western Highway while views to the Nepean River exist from the southern end of the Tench Reserve.

The design and function of public transport facilities can be improved by following principles given in the /Guidelines for the Development of Public Transport Interchange Facilities /(NSW Ministry of Transport, 2008). In particular, the priority for providing access to public transport facilities should favour pedestrians and cyclists over car users. The legibility of these facilities, which is an important issue to consider particularly for new ones, can be improved following common design features such as way-finding and information signage.

View corridors along the routes in the Riverlink Precinct can be improved through a proper mix of building height restrictions, setbacks, and landscaping. These vistas should not only focus on views from the road carriageways, but also consider views from foothapths and cycleways. Vistas can also be achieved from static structures through proper building massing and careful attention to achieving such view corridors, potentially reflected in building height restrictions.

Along Jamison Road, proper landscaping on both sides of the road, supplemented by well-designed footpaths and cycleways, can provide improved vistas towards the Blue Mountains to the west. At the junction with Tench Avenue, a properly designed public transport facility, such as a landmark bus shelter, can further enhance vistas.

Figure 24 shows the location of street vistas.

1:10,000

150 75 0 150 Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

Legend

Vistas

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Proposed Plan for Riverlink Vistas

Figure 22

G:\21\18430\CADD\GIS\MapDocuments\28052009\22NewZ010_Penrith_ Vistas.mxd

Data source: GHD Pty Ltd. Created by: nbuchanan

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Appendix A

Performance Indicators

Performance Indicators

Performance is best described by the indicators of Level of Service (LoS), Average Vehicle Delay (AVD) and the Degree of Saturation (DS) during peak hours. The intersection performance indicators adopted in this assessment, are presented below.

The Level of Service criteria set by the RTA[5] is outlined in Table 29**.** In analysing intersection performance, a Level of Service "D" or better is generally acceptable to the RTA.

Table 29 Level of Service Criteria

Level of Service	Average Delay (seconds/veh)	Traffic Signals, Roundabout	Give Way and Stop Signs
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause excessive delays	At capacity, requires other control mode
F	More than 70	Roundabouts require other control mode	

Average Vehicle Delay (AVD)

AVD is a measure of the operational performance of a road network or an intersection. AVD is determined globally over a road network or within a cordon during an assignment model run. The AVD exhibited on comparable network models, for analogous peak periods, forms the basis of comparing the operational performance of the road network.

AVD is used in the determination of an intersection's Level of Service. Generally, the total delay incurred by vehicles through an intersection, is averaged to give an

[5] Guide to Traffic Generating Developments, NSW-RTA, 2002

indicative delay on any specific approach. Longer delays do occur but only the average over the peak hour period is reported.

Degree of Saturation (DS)

The Degree of Saturation (DS) of an intersection is usually taken as the highest ratio of traffic volume on an approach to the intersection, compared with its theoretical capacity and is a measure of the utilisation of available green time. The DS reported is generally of a critical movement through the intersection, rather than the DS of the intersection, unless equal saturation occurs on all approaches.

For intersections controlled by traffic signals, generally both queue length and delay increase rapidly as DS approaches 1.0. An intersection operates satisfactorily when its DS is kept below 0.875. When the DS exceeds 0.9, extensive queues can be expected.

Mid Block Road Capacities and Thresholds

This project assumes a range of road types and capacities based on published sources and traffic volumes experienced on the Sydney Metropolitan Area Road Network, in particular, in built-up areas consisting primarily of concentrated commercial and industrial land use. From these volumes, are derived the thresholds for road links.

The thresholds are based on the particular road links or intersections to ensure a satisfactory LoS of D, or better.

These thresholds represent the 'Capacity' of specific road types. Traffic volumes observed on the road that are higher than the prescribed thresholds will be perceived by the community and road users as being over saturated.

While generally a single trafficable lane may carry up to 1900 vehicles per hour, the capacity of each particular road type has been determined by considering a number of key factors noted in Austroads 'Roadway Capacity' manual including, but not limited to:

- Vehicle speed;
- Volume of vehicles demanding to use the carriageway (linked to road classification);
- Potential for lane changing (higher vehicle volumes reduce the incidence of lane changing);
- Available lane widths and lateral clearances;
- Surrounding land use characteristics (industrial, residential, retail, commercial, etc);
- Vertical carriageway alignment;
- Horizontal carriageway alignment;
- Carriageway condition; and,
- Carriageway access (driveways, side street intersections, etc).

Subsequently, varying lane capacities apply to each classification and road type, adopted during the course of this assessment, as shown in Table 30.

As a consequence, road links reporting a volume in excess of the adopted thresholds, should be considered for remedial treatment and reclassification in order to achieve their specific volume threshold.

The use of traffic management measures and intersection controls, were modelled to achieve optimum performance of road-based movements within the study area.

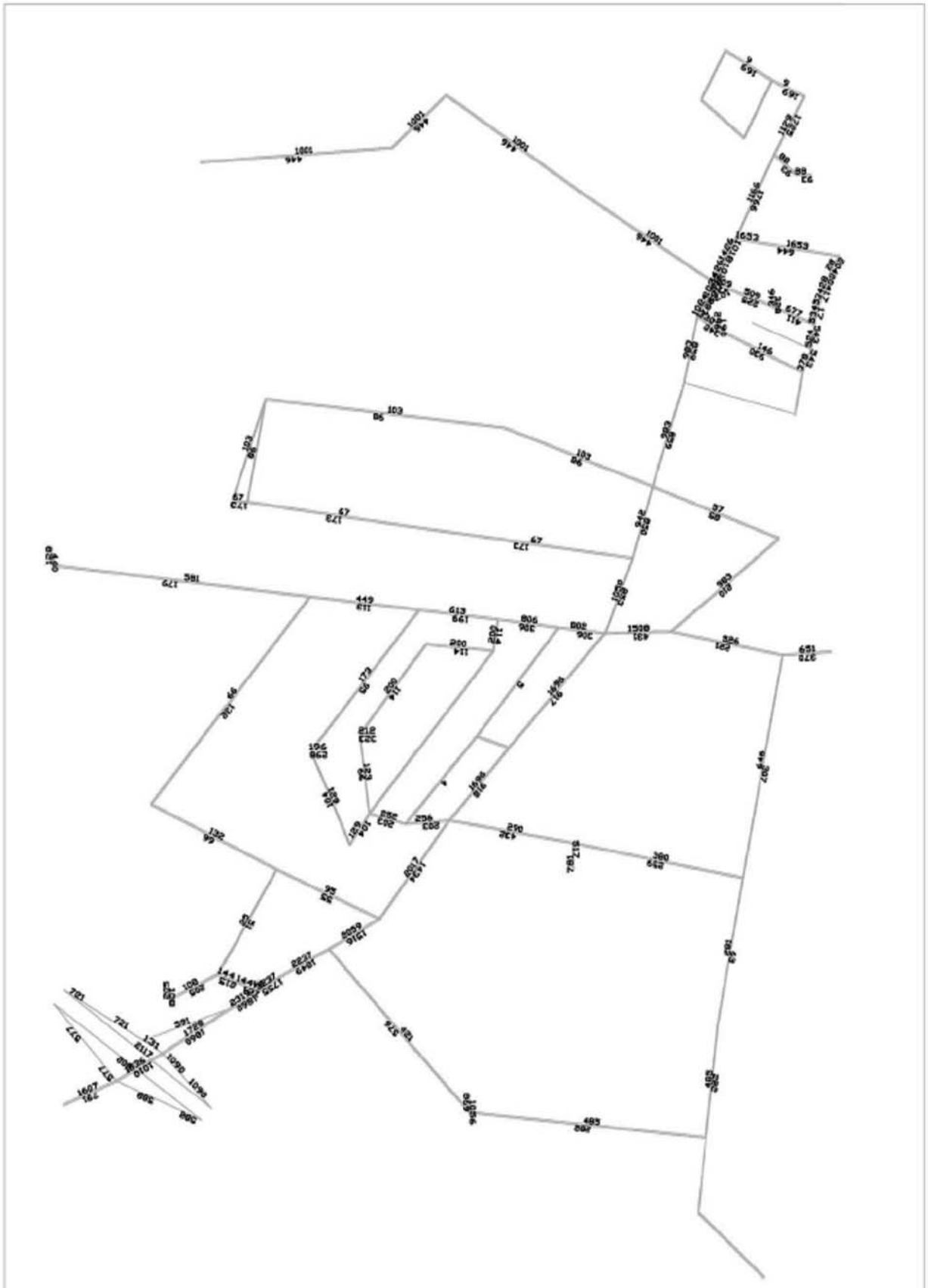
Table 30 Mid Block Link Capacity Thresholds

Road Type Conditions	Lane Capacity at Level of Service F (vehicle per hour)	Assumed Maximum Satisfactory Lane Flow in Vehicles/ hour (Level of Service D)
Urban Divided / Undivided Highways with Clearways and signal coordination	1,500	1,350
Urban Divided / Undivided Highway conditions with interruptions	1,200	1,080
Rural Two-Way Two-Lane	1,400	896
2 Lane Residential Street with on street parking	700	630

Appendix B

Base Year 2009 Model Outputs

AM and PM Peak



PLOT SHOWS VEHICLE VOLUMES/HOUR
MODEL = 2009 AM PEAK RIVERSIDE CALIBRATED MODEL
NETWORK = 2007 SYDNEY METRO NETWORK

CORDON FILE = RIVLINK.COR

Model Run Date = 5/09 22:26 Model = 09AMRIV Ver = 2000
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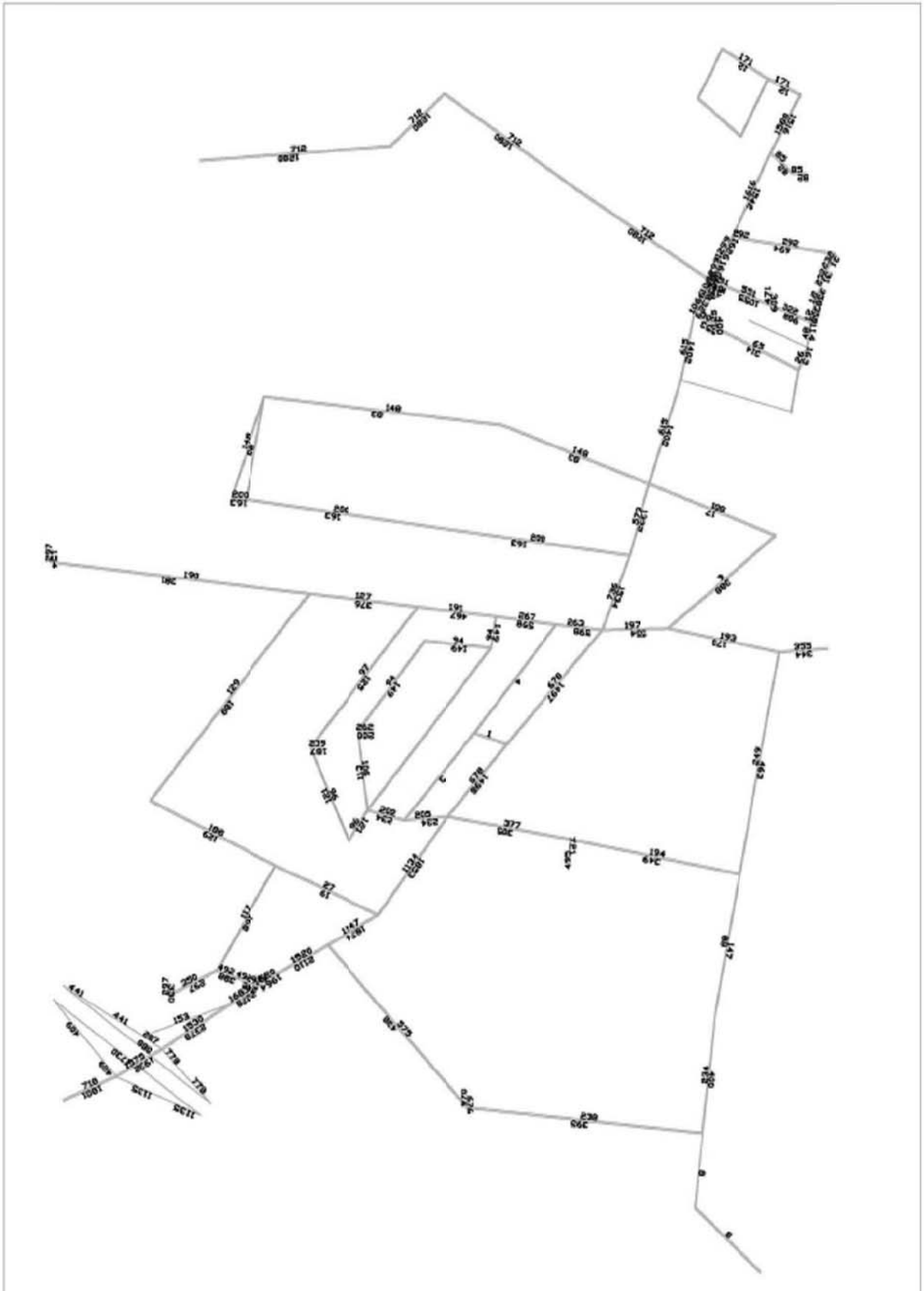

PLOT SHOWS VEHICLE VOLUMES/HOUR
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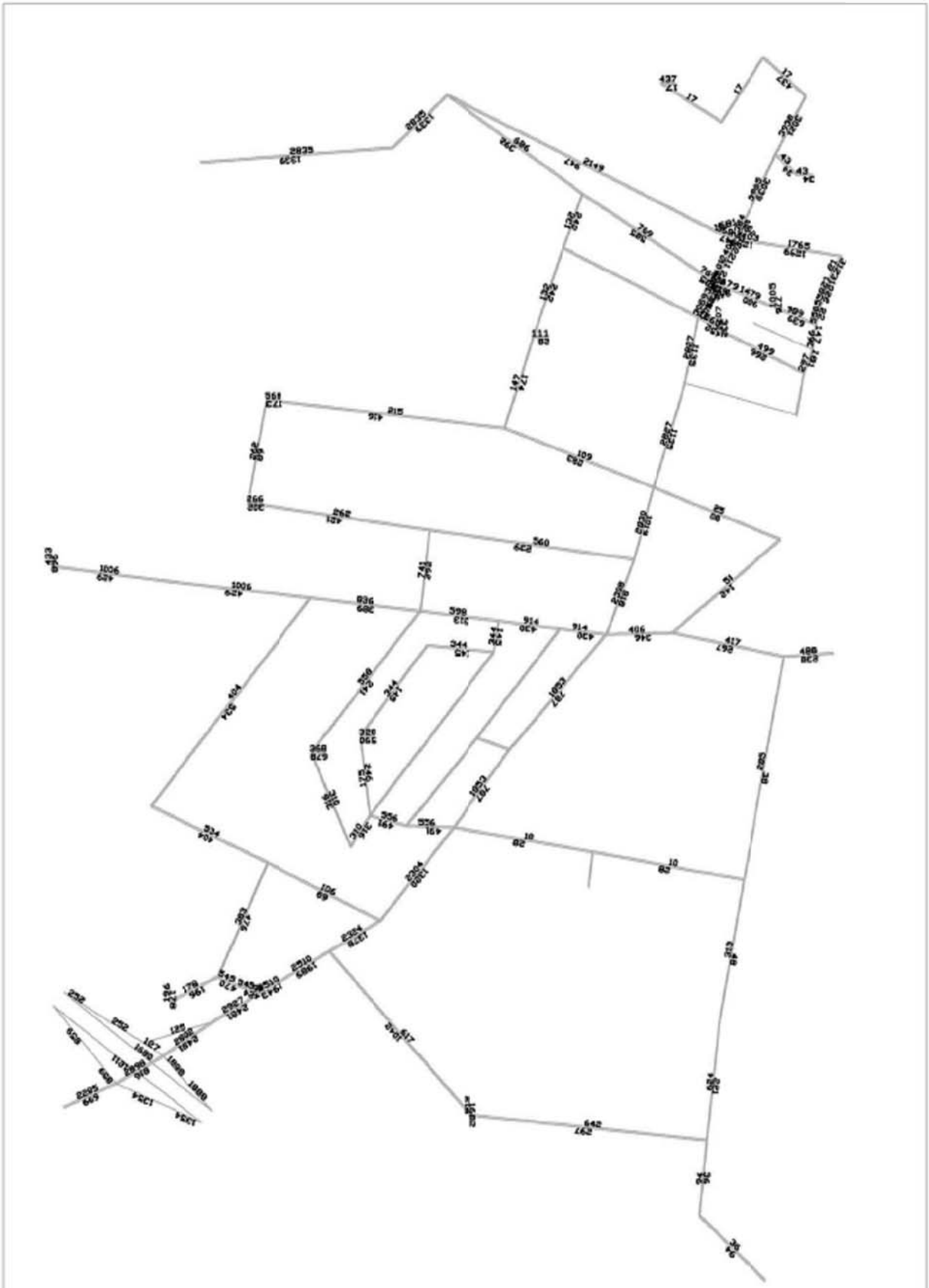
Appendix C

Future Year 2026 Model Outputs

AM and PM Peak



PLOT SHOWS VEHICLE VOLUMES/HOUR
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NETWORK = 2026 METRO AREA NETWORK

CORDON FILE = RIVLINK.COR

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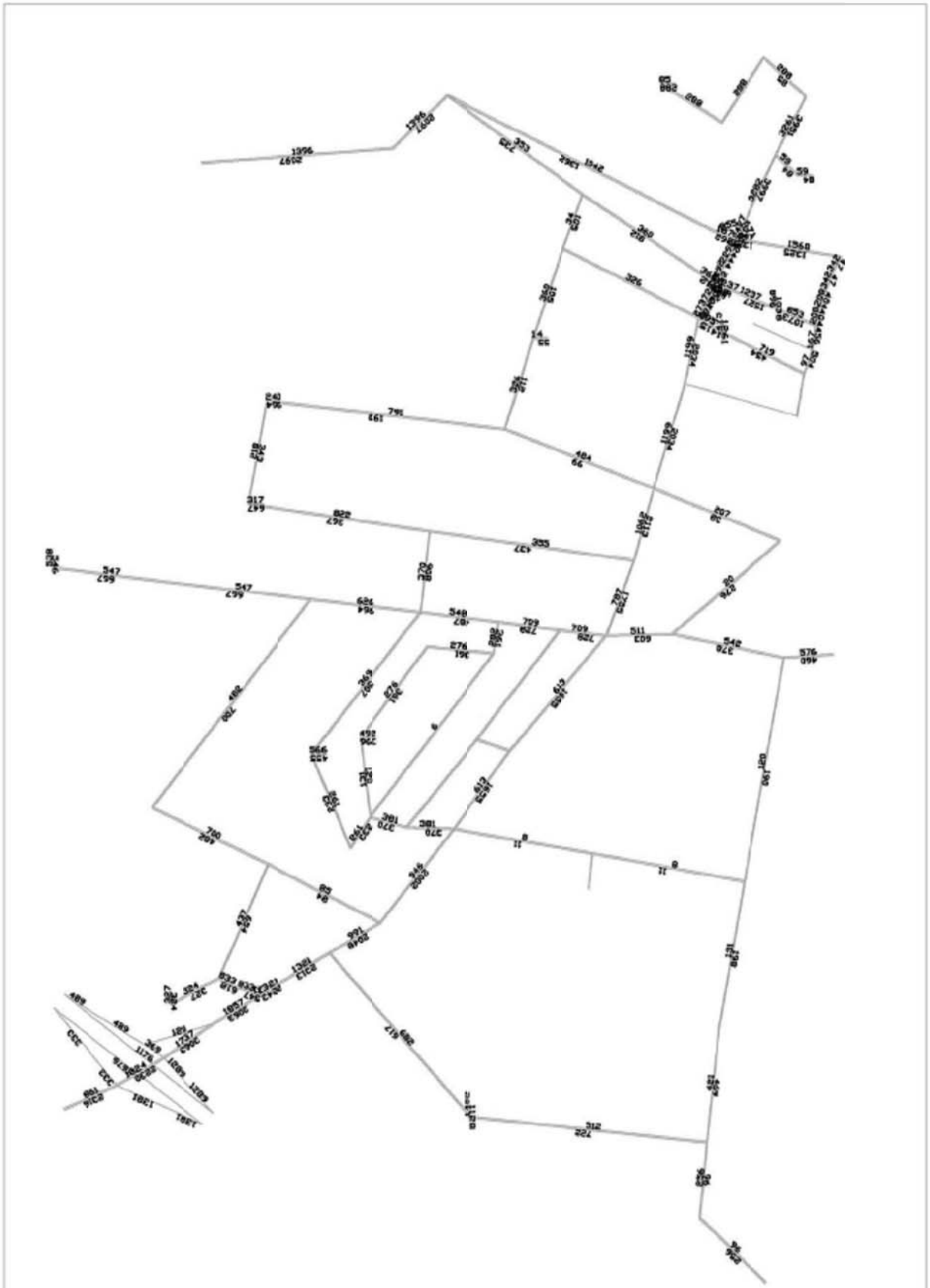

PLOT SHOWS VEHICLE VOLUMES/HOUR
MODEL = 2026 PM PEAK RIVERLINK MODEL
NETWORK = 2026 METRO AREA NETWORK

CORDON FILE = RIVLINK.COR

Model Run Date = 5/09 2303, Model = 26PM, Ver = 2008
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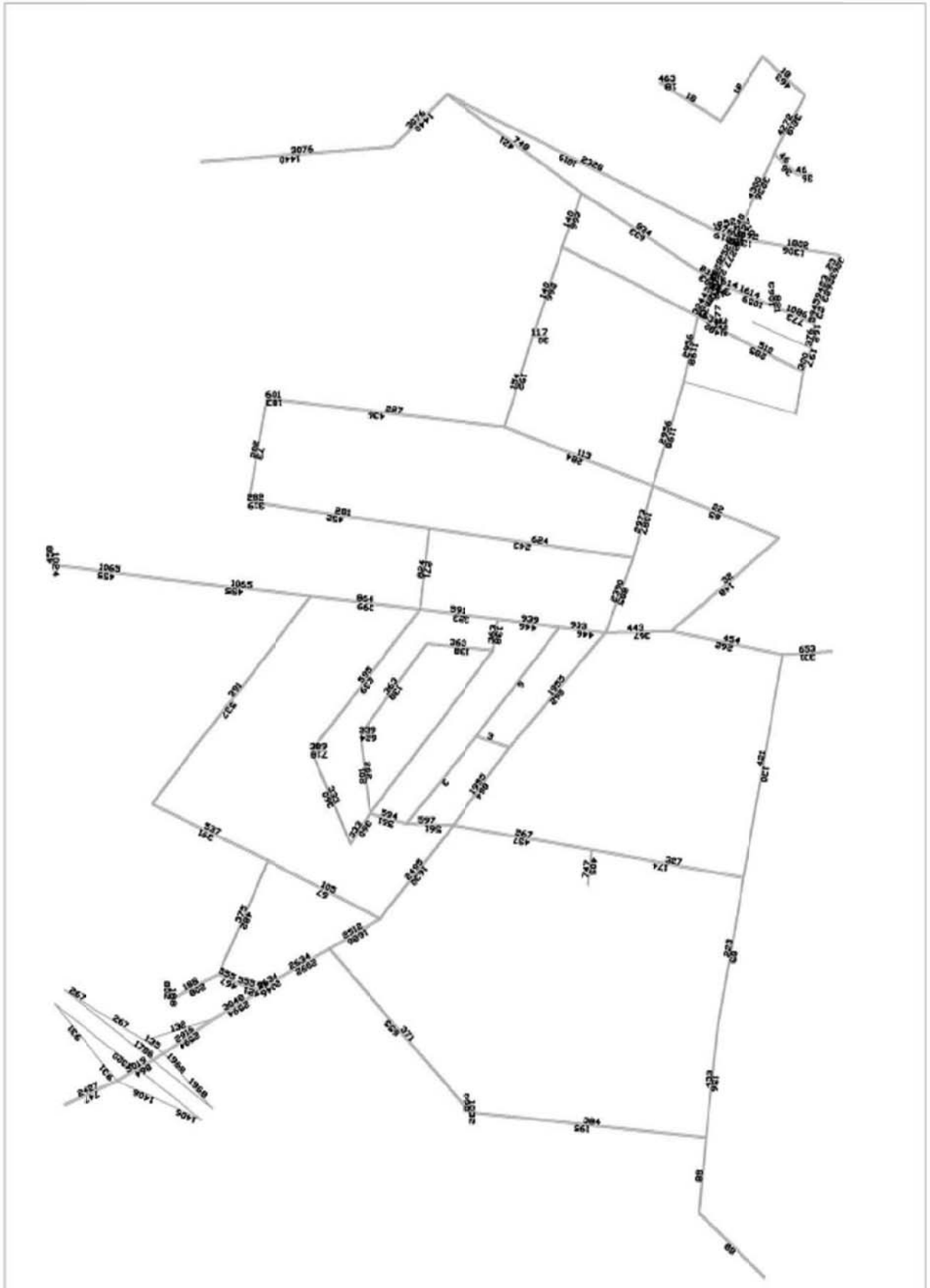
Appendix D

Future Year 2031 Model Outputs

AM and PM Peak



PLOT SHOWS VEHICLE VOLUMES/HOUR
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NETWORK = 2031 METRO AREA NETWORK

CORDON FILE = RIVLINK.COR

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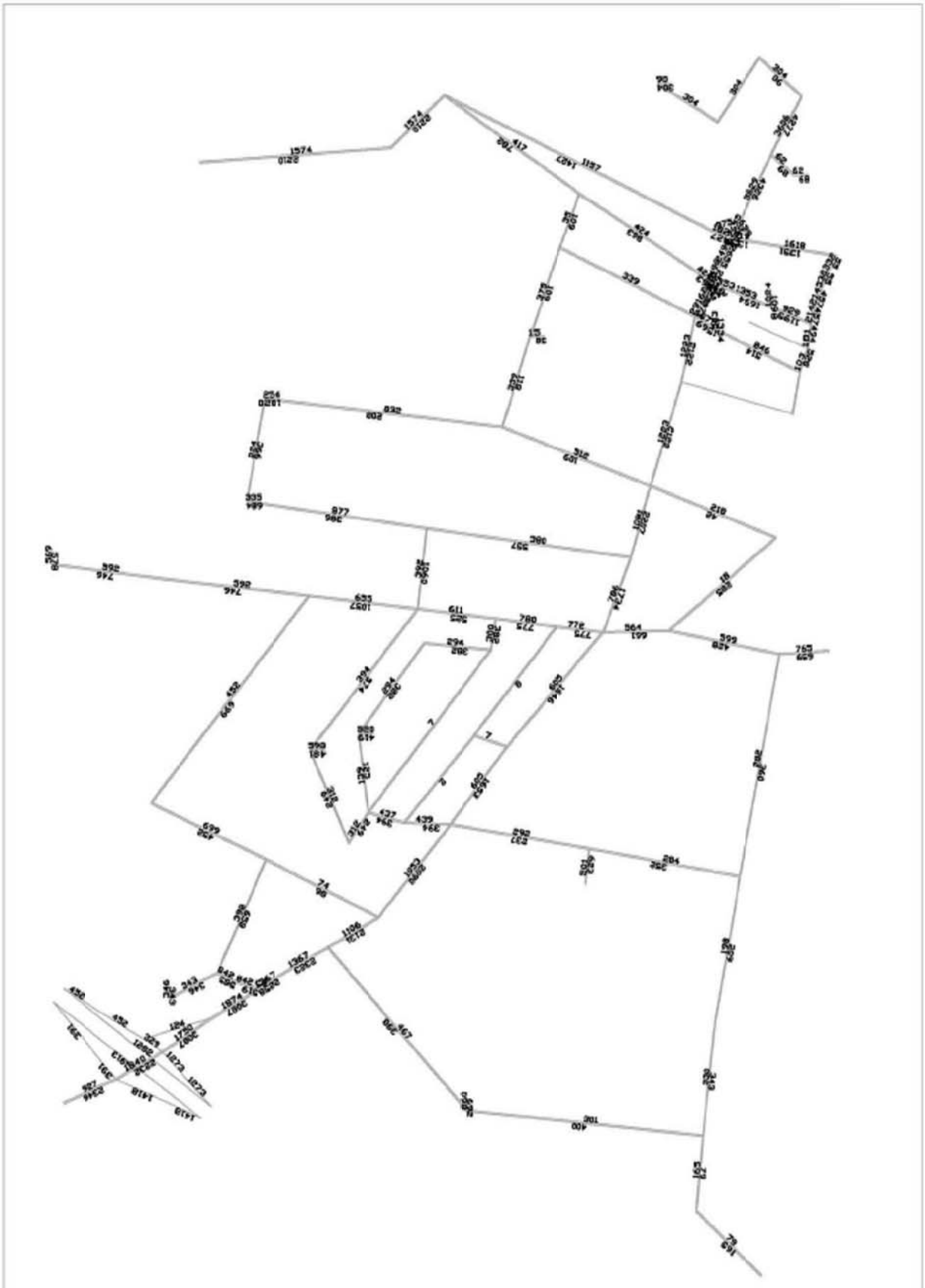

PLOT SHOWS VEHICLE VOLUMES/HOUR
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NETWORK = 2031 METRO AREA NETWORK

CORDON FILE = RIVLINK.COR

Model Run Date = 5/09 8:41. Model = 31PM. Ver = 2008
X Scale Factor = 1. Y Scale Factor = 1. Plot File = 31PM.X10. Network = 2031. O/D = 31PM20.

Appendix E

Supplementary Modelling Report

Road Delay Solutions

Riverlink Precinct
Penrith

Transport and Access Model

Years 2009 2026 2031

Prepared in association with...

Reference: 20090058
May 2009
(This is an A3 document)

Date: 4/07/2008

Every care has been taken to ensure the information contained on this map is correct, however Council accepts no liability for error or misinterpretation of the information shown on this map.

RIVERLINK

N

PENRITH CITY COUNCIL
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DOCUMENT STATUS

D:\Documents and Drawings\Riverlink\Riverlink Infrastructure Model.docx

		Date...	*Prepared...*	*Passed...*
		Date...	*Prepared...*	*Passed...*
A	Final Draft	*Date...* May 2009	*Prepared...*	*Passed...* GHD Pty Ltd
i	Preliminary Draft	*Date...* May, 2009	*Prepared...*	*Passed...* GHD Pty Ltd

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ABSTRACT

Road Delay Solutions has been engaged by GHD Pty Ltd, to undertake strategic modelling of the Riverlink Precinct, for the staged development occupation years 2026 and 2031.

This is document is intended as a supplement to the GHD Report, May 2009, providing the critical inputs for determination of the required infrastructure to sustain the Riverlink Precinct Development..

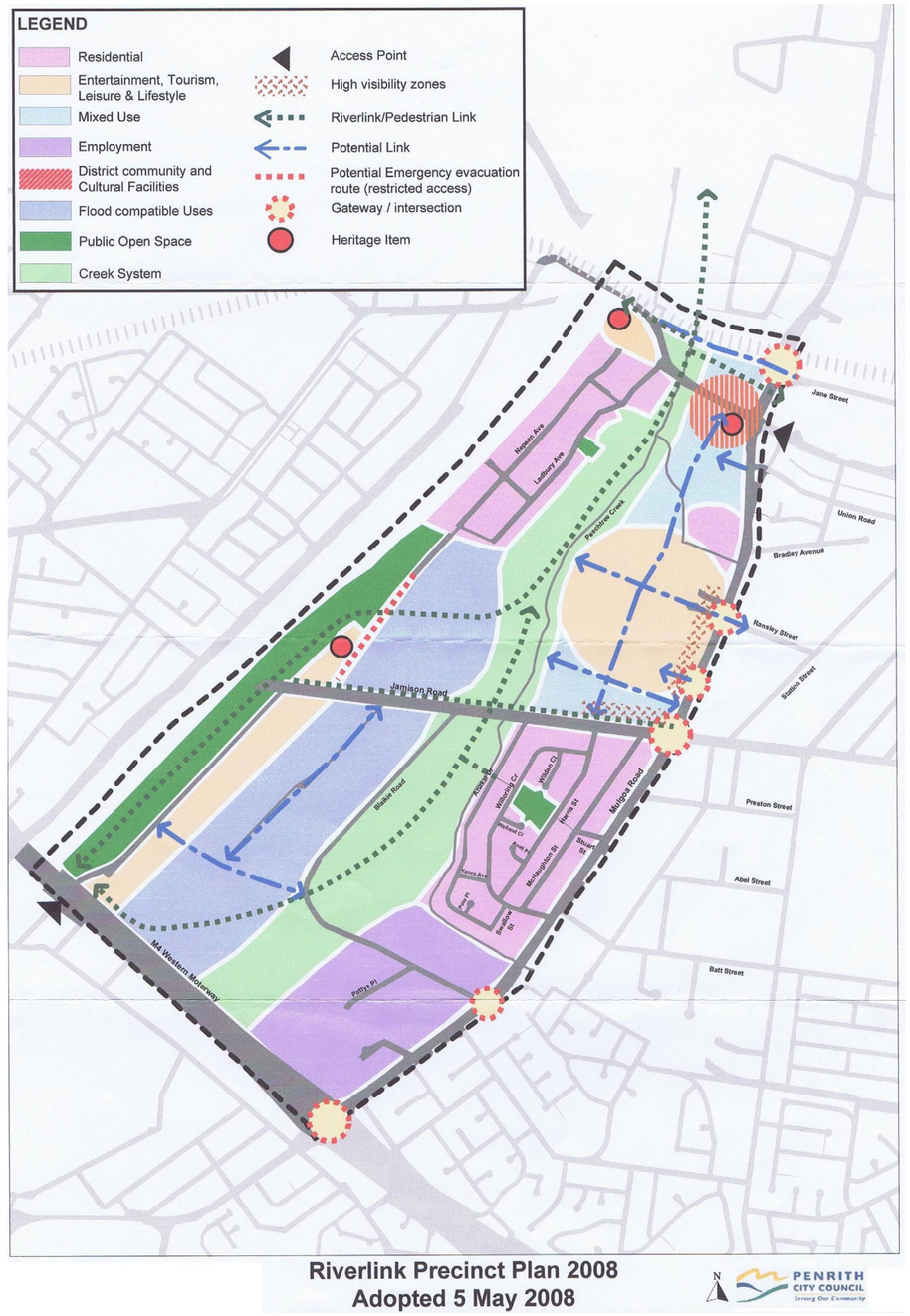
1 STRATEGIC OBJECTIVES AND TASKS

GENERAL

The purpose of the strategic model is to provide a framework of infrastructure measures to ensure the satisfactory management of traffic and transport demands imposed by the planned Riverlink Precinct, local and regional development growth, up to and including the anticipated 'End State' year 2031.

Based on agreed data and model parameters, the principle task will be to identify any highlighted road network deficiencies in Year 2026, know here as the 'End State'..

Figure 1 : Study Area - Riverlink Precinct, Penrith



PLANNING POLICIES AND GUIDELINES

Planning Provisions - SEPP No. 59 – Central Western Sydney Economic and Employment Areas

State Environmental Planning Policy No.59 (SEPP 59) presents guiding principles for sustaining efficient transport with future developments and the requirements to be met in the preparation of a long-term transport plan. The aims of the policy include...

- *"promote economic development and the creation of employment in Western Sydney by providing for the development of major warehousing, industrial, high technology, research or ancillary facilities with good access to the existing and proposed road freight network, including the M4 motorway and the Westlink M7".*
- *"provide for the optimal environmental and planning outcomes for the land to which the policy applies by helping to achieve the goals set out in Action for Air, to contain the per capita growth in VKT (vehicle kilometres travelled) by achieving higher than normal public transport usage."*

The policy states that in developing Precinct plans, attention must be given to the following relevant issues that expand on the foregoing general provisions...

"A transport plan should be prepared that addresses the following...

i) roads, transit ways, and provision for walking and cycling, both within the Precinct and off site linkages,

ii) freight transport provisions, including initiatives for integrating freight handling within the precinct, and maximising opportunities for synergies between industries with regard to materials handling,

iii) the relationship between the staging of development and the provision of transport infrastructure,

iv) ways, including the design and layout of the proposal, in which the mode split to public transport, cycling and walking is to be increased above levels typical of areas surrounding the development. It is expected as a minimum that the proposal demonstrates that...

iv) the mode split of "cars as driver" for the journey to work can be reduced by at least 10% (eg from 75% down to 65%) compared to existing surrounding areas, and

- *the total VKT (vehicle kilometres travelled) to be generated by the proposed development should be reduced by at least 5% below that which would be generated by a 'conventional' approach to development, and*

v) funding proposals for the development of transport infrastructure."

Metropolitan Planning Strategies - Employment Lands for Sydney Action Plan, 2007

The strategic framework in *'City of Cities Metropolitan Strategy, a Plan for Sydney's Future'*, dictates transport systems and urban structures with equitable access to jobs, services and leisure.

It also identifies the priority outcomes and presents the key policies and actions to achieve them. The regional strategy bridges the gap between local area needs and opportunities and the broader goals of the City of Cities strategy.

The purpose of the Employment Lands Action Plan is to create more job oportunities and stimulate economic growth, providing a cleaner environment, an improved transport network, safe community neighbourhoods and affordable housing. Further, it aims to reduce the growth of private vehicle use and curb urban sprawl.

DRAFT SEPP No.66 – Integration of Land Use and Transport

This policy provides guiding provisions that aim to ensure the urban structure, building forms, land use locations, development design, subdivision and street layouts help achieve the following planning objectives...

- Improving accessibility to housing, employment and services by walking, bicycling and public transport,
- Improving the choice of transport and reducing the dependancy on private vehicle usage,
- Moderating growth in the demand for travel and the distances travelled, especially by car,
- Supporting the efficient and viable operation of public transport services, and
- Providing for the efficient movement of freight.

2 THE STRATEGIC MODEL

The Netanal model utilises defined travel demand between zonal pairs, represented as assimilated traffic movements, throughout the Sydney Metropolitan Area. The program incrementally assigns vehicular traffic onto a, computer based, road network developing link demand forecasts on each modelled section of road.

ROUTE SELECTION

Route selection between zonal pairs is determined on the basis of the shortest travel time or cost, considering the inherent route delays incurred along possible link(s). Parameters such as link capacity, speed and distance are coded into the model, by the user, from which the program determines the relative vehicular delays on each route, selecting, after undertaking a prescribed number of iterations, the route with the shortest travel time. Costs and travel time are relative within the Netanal model. Time penalties are applied to turn movements, stops and delays, etc... which in turn have a corresponding cost.

In the most general form, this 'cost' represents a combination of factors that drivers take into account when choosing routes through the road network; the most important of these factors are time and distance. Also where tolls are charged for the use of a specific section of road, these costs are included in the driver's route choice and are based on a driver's willingness to pay the toll.

The process that Netanal uses to determine the 'cost' of travel on competing paths, is based on travel time only. The toll value on a specific link is included indirectly by converting the monetary toll value to time (in minutes) based on the driver's perceived value of time. This 'time value of the toll' is applied as a 'penalty' to the link and is known as the Toll Diversion Penalty (TDP).

The premise on which the future year modelling has been based, specifically the route selection process, is the current value of time. Toll values, toll diversion penalties and socio economic decision making defaults, have not been increased with CPI or standard of living projections.

INCREMENTAL ASSIGNMENT

In order to reflect the impact of congestion on route selection, Netanal assigns the traffic from the trip table as a series of equal increments. This process is outlined below:

- The process commences by identifying the routes with the shortest travel times, for each origin-destination pair, with no traffic using the roads (ie based on sign-posted speed limits, green lights, etc). Known colloquially as increment 0 (zero), the link and intersection delays, accumulated over the modelled 0ne hour, are tabulated for later reference.
- The first incremental run of the model imposes the time delays recorded during Increment 0 and adds the delays to the travel time of each link. During the increment, routes yielding the lowest travel time between zonal pairs are chosen. Again the resultant delays on each link, inclusiv intersection, are recorded by the program.
- Each subsequent increment performs ongoing route selection based on recorded delay and the resultant link travel times. As delays stabilise, so too does the route selection within the model, until the optimum number of increments are run.
- At the completion of the incremental run, the optimum routes and vehicle demands on each link are reported.

Incremental convergence is employed to determine the projective stability and optimum number of increments. The process of incremental convergence involves the running of sensitivity models reflecting a differing number of increments, with the projected volumes on a select number of key links, reported. Once the differential change between the projected volumes, on each reported link, minimises, the model is considered stable and the resultant number of increments are utilised in the project model runs.

For this project, 20 increments were found to provide stability in link demand.

ASSIGNMENT CALCULATIONS

Netanal calculates travel time on the basis of the capacity related, geometric and operational characteristics of roads and intersections defining the road network. The following are specifically incorporated in the calculations for the mid-block section of each link...

- Speed-flow relationships. As traffic volume increases, speeds on roads decrease and the relationships within Netanal take this into account. The speed is based on the ratio of the traffic flow to the nominated road capacity. Netanal assumes free flow conditions on links up to a set value of degree of saturation (DS). This value is set to equal 90%. When traffic flows on a particular link exceeds the DS set value, the speed drops according to a speed flow relationship, to the power of four.
- Transit lanes. The proportion of traffic using the transit and non-transit lanes on a section of road is based on RTA surveys of Epping Road, Military Road and Victoria Road. This survey reported that the transit lanes operated to a maximum of 50% of the adjacent trafficable lane. Illegal use was reported as 25% while the DS of the adjacent lane was below 0.75.

  With an increase above 0.75 in the adjacent lane, a proportionate increase in the illegal use of the transit lane results. Netanal applies this principle on all transit lanes, within the model.

The program assumes a 40% maximum usage of T3 transit lanes while the DS of the adjacent lane remains below 0.75. The program assumes the illegal usage of a T3 lane is the same as that of a T2.

- Bus lanes, and bus stops can be included as part of the network. Netanal can report on travel time changes on these routes.
- On-street parking.
- Speed limits.
- LATM devices (eg speed humps, raised thresholds, road narrowings, etc...).
- Pedestrian crossings.
- Toll plazas A delay of seven seconds per vehicle is applied at toll plazas that have manual payment collection. This delay is reduced as some manual collection is retained and the proportion of electronic tolling increases. Electonic tolling invokes no toll plaza delay.
- Toll fees Tolls are collected in dollars but have the effect of making a route less attractive. Therefore the toll has to be converted to a time value that can be attributed to the relevant link in Netanal to reflect additional travel time in the route selection process. This conversion factor is the TDP, and is expressed in minutes per dollar.

Those network characteristics which may vary across a 24hr time of day operation, such as transit lanes, bus lanes, parking restrictions, toll fees, turn prohibitions, etc,,, are included in the network definition and further impact on the assignment route selection.

Intersection delay, calculated within the model, employs the *Austroad's* and *AARB* established formulae for the control of intersections operating as Give Way or Stop Sign, roundabout or traffic signals. For the latter the benefits of Sydney's coordinated signal control system, SCATS, on improved traffic flow is incorporated. A turn penalty is added to the travel time to represent the delay that is associated with pedestrian conflict with left turns and opposing traffic for right turns.

Netanal specifically calculates both road mid-block and intersection performance. The model is therefore able to calculate queues when traffic demand exceeds capacity and incorporate the queuing delay in the calculation of travel time for each route.

If the travel time remains lower on a particular route with queues, Netanal will continue to assign traffic to that route until such time as the queue results in a time delay that makes an alternative route more attractive.

3 EXISTING CONDITIONS

CALIBRATION

This section provides a concise framework for the verification, validation and calibration of the base year 2008/09 traffic model, assimilating the current study area road network and it's operational conditions.

STUDY AREA

The study area, known as the Riverlink Precinct, is generally bounded by Great Western Highway, to the north, Nepean River to west, the M4 Motorway to the south and Mulgoa Road to east, as shown in *Figure 1*.

DATA COLLATION

Intersection traffic count data has been utilised in the calibration procedure to align the model volumes with the current traffic flow and distribution, within the study corridor.

Count data, specifically tube counted link volumes, were supplied by Penrith City Council for...

- Panthers Place,
- Ransley Street,
- Patty's Place, and
- Wolseley Street.

A detailed audit and catalogue of the study corridor road network, and surrounds, has been undertaken ensuring the accuracy of the platform onto which the developed morning and evening peak trip matrices have been assigned.

Generally, the network characteristics catalogued were...

- Road hierarchy,
- Road alignment,
- Number of lanes by peak period,
- Transit corridors,
- Regulated link speeds,
- Intersection control modes, and
- Toll collection locations on motorways.

Table 1: Year 2009 Peak Hour Traffic Flows

Penrith Traffic Count Results 2009			
Count Conducted From: 01 May 2009 to 08 May 2009			
Panthers Place, West of Mulgoa Rd - b/w Panthers Complex & Mulgoa Road			
	5-Day Morning Peak Time	5-Day Afternoon Peak Time	2-Day Weekend Midday
East-bound	112 vph	226 vph	15 vph
West-bound	177 vph	175 vph	23 vph
Ransley Street, East of Mulgoa Rd - b/w Panthers Complex & Station Street			
	5-Day Morning Peak Time	5-Day Afternoon Peak Time	2-Day Weekend Midday
East-bound	115 vph	158 vph	9 vph
West-bound	87 vph	230 vph	15 vph
Pattys Place, South of Blaikie Rd - b/w Blaikie Road & The End of Road			
	5-Day Morning Peak Time	5-Day Afternoon Peak Time	2-Day Weekend Midday
North-bound	19 vph	95 vph	52 vph
South-bound	44 vph	110 vph	26 vph
Wolseley Street, West of Mulgoa Rd - b/w Gibbes Street & Mulgoa Road			
	5-Day Morning Peak Time	5-Day Afternoon Peak Time	2-Day Weekend Midday
East-bound	113 vph	469 vph	72 vph
West-bound	222 vph	363 vph	116 vph

All major infrastructure projects, to date, have been employed in the base year model road networks.

In collating and applying the collected field data, it is necessary to understand the function of Mulgoa Road, within the context of the Penrith arterial road network and as an access point for the planned Riverlink Precinct.

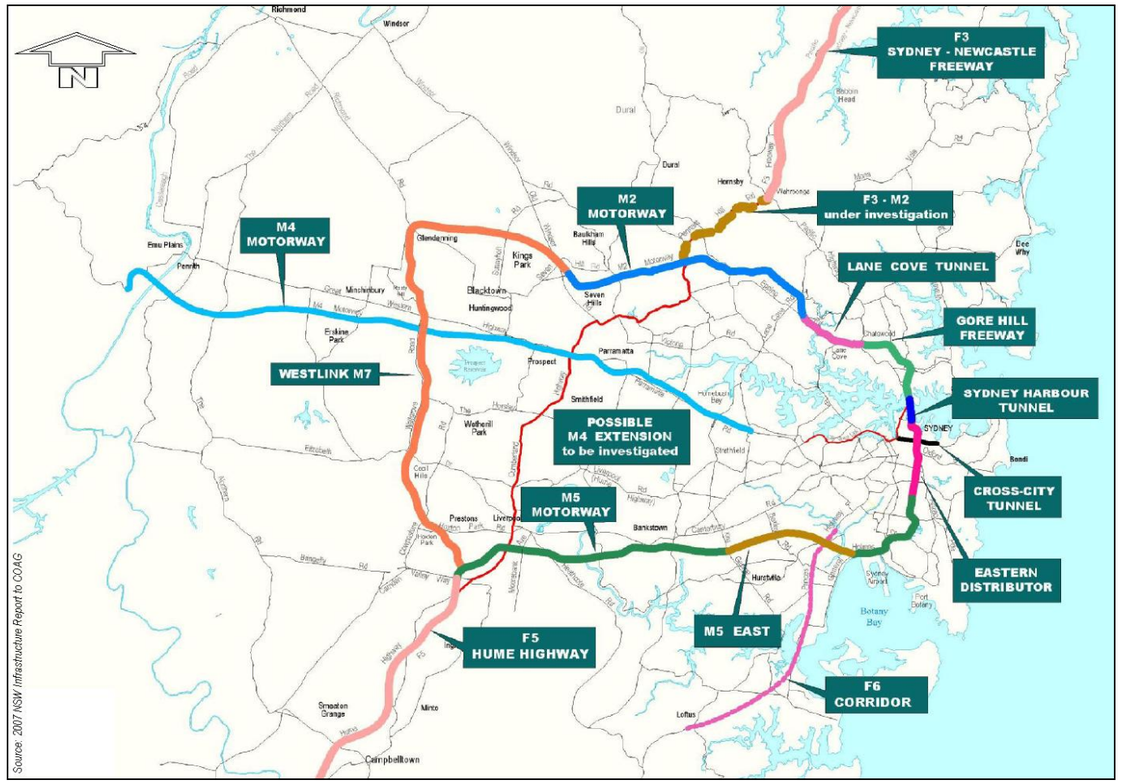
Mulgoa Road, serves as a principal north south link between The M4 Motorway and the City of Penrith.

A state road, under the auspices of the Roads and Traffic Authority, N.S.W., Mulgoa Road, along with The Northern Road, to the east, constitute two major, road based, public transport and freight corridors.

Mulgoa Road is currently a four lane road accommodating a diversity of land use, including...

- Light industrial,
- Retail, and
- Residential.

Figure 2: Principle Road Infrastructure Projects



This project will assess and determine if a warrant is justified for the widening of Mulgoa Road, with the planned development growth and subsequent vehicle generations.

VERIFICATION

Verification is the process of determining if the computer code, that implements the modelling logic, produces the desired output for a given set of input data and/or parameters.

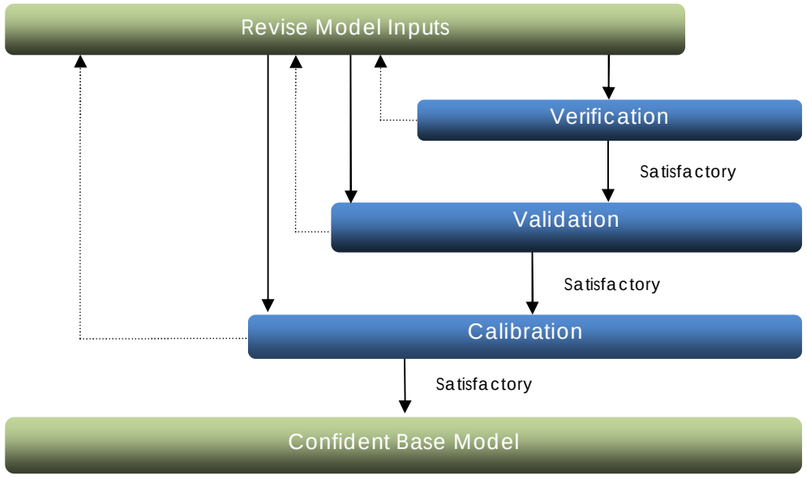
A model is considered successful if the outputs are consistent, in terms of both magnitude and direction, with results from the direct application of the logic on which the code within the Netanal software is based.

The Netanal software package produces traffic forecasts generally based upon travel time rather than distance or gravity principles. Netanal determines the invoked link and intersection delays, during a model assignment run, to effectively produce travel times between origin and destination.

Based on these times, route selection within the model is influenced by the determined travel times on each modelled or alternate route. Preferred travel routes will be those yielding the lowest travel times, with a direct correlation to the vehicle operating costs.

The Netanal model has been verified by the RTA, with reference found in *Part 2* of the '*Economic Analysis Manual*'[1].

Figure 3: The Correctness Procedure



VALIDATION

The term applied to the fundamental method of assessing the effectiveness of the calibration procedure and its underlying principles in achieving an acceptable level of calibration.

To assess the model calibration, a formula known as the 'GEH Statistic'[2] has beenemployed to rationalise the differential between the modelled and actual counted traffic volumes, on selected links.

---

[1] '*Economic Assessment Manual*' Roads and Traffic Authority, N.S.W., 1999 – Revised May 2006.

[2] The GEH Statistic named after Geoffrey E. Havers, who invented it in the 1970s while working as a transport planner in London, England. In a mathematical form it is similar to a chi-squared test, but is not considered a true statistical test. Rather, it is an empirical formula that proves useful for a variety of traffic analysis purposes.

Links with low volumes and a higher differential between the modelled and counted volumes, while possibly exhibiting a high percentage of inaccuracy, are considered less critical than links accommodating higher volumes. The GEH Statistic balances the relative priority of each link based on the counted volume, during the model calibration process. The GEH statistic is computed as depicted below.

Figure 4: The GEH Statistic

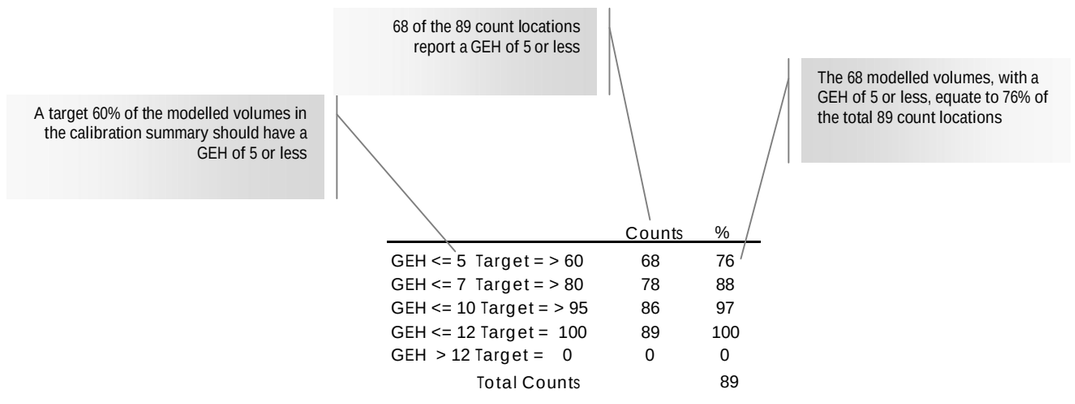
$$GEH = \sqrt{\frac{(E-V)^2}{(E+V)/2}}$$

where... E = Predicted model volume V = Actual field counted volume

A range of GEH targets have been realistically set to achieve the prescribed LoA, noted in the following section, '*Calibration*'. The targets highlight the percentage and degree of difference between modelled volumes and the collected field data.

The following figure depicts the components of the GEH Statistic and the targets employed in the calibration of the base year models.

Figure 5: Typical GEH Targets



CALIBRATION

Defined as the process of model parameter and input manipulation to achieve a prescribed differential between actual local traffic volumes and those modelled.

Calibration is, fundamentally, the transparent production of output, controlled by the value of input parameters on the basis of available field data. The success or failure of the calibration process, is determined by the accurate and logical evaluation of the collected and available field data employed in the selected input parameters.

From the collected intersection counts, all turn movements have been calibrated, individually, to ensure the integrity of the trip distribution and volume flows within the study area and surrounds.

The calibration report of traffic flows, on key routes, was used as output for the base Year 2008.

The trip matrices, currently employed in the base Netanal models, were developed by TPDC, based upon the Year 2001 Census Data published as LGA Community Profiles by the Australian Bureau of Statistics.

The zonal information, contained within the matrices, has been disaggregated in accordance with data collated during studies conducted by Sims Varley Traffic Systems Pty Ltd and Road Delay Solutions Pty Ltd, generally yielding a mean absolute screen line calibration LoA of some 15-20%.

The traffic volume calibration process for this project has adopted a standard deviation of 15% of the absolute mean, constituting an accepted LoA within the study area, while a deviation of 25% defines the LoA through the greater Metropolitan area.

It should be noted that the Netanal program is in fact a demand model, which reflects the total volume of traffic on a link, including queued traffic at the end of the modelled one-hour time period. This is in contrast to the counted volume, collected in the field data, which only records those vehicles passing a given point during the same period. Therefore, it is safe to assume, that a count location will report a lower traffic volume than those reported in the Netanal model, significant vehicle queues exist at the site.

CALIBRATION SYNOPSIS

Table 2: Morning Peak Calibration Report

2009 AM PEAK RIVERLINK CALIBRATED MODEL

Location.....	Node	Node	Count	Model	Diff	Diff%	GEH
GWH EB W CASTLEREAGH	2876	1079	1017	1001	-16	-2	1
GWH WB W CASTLEREAGH	2877	1079	461	446	-15	-3	1
CASTLEREAGH SB N GWH	1070	2877	1006	1018	12	1	0
CASTLEREAGH NB N GWH	2877	1070	1458	1426	-32	-2	1
GWH WB E CASTLEREAGH	9366	1071	272	225	-47	-17	3
GWH EB E CASTLEREAGH	1071	9366	608	509	-99	-16	4
MULGOA NB S GWH	10362	1073	1167	1024	-143	-12	4
MULGOA SB S GWH	1073	10362	997	887	-110	-11	4
RANSLEY EB W MULGOA	1077	12667	115	103	-12	-10	1
RANSLEY WB W MULGOA	12667	1077	87	98	11	13	1
PANTHERS EB W MULGOA	1075	12688	112	67	-45	-40	5
PANTHERS WB W MULGOA	12688	1075	177	173	-4	-2	0
PATTYS NB S BLAIKIE	12686	1013	19	25	6	32	1
PATTYS SB S BLAIKIE	1013	12686	44	51	7	16	1
WOLSELEY EB E PATTYS	12686	1014	113	144	31	27	3
WOLSELEY WB E PATTYS	1014	12686	222	215	-7	-3	0

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	16	100
GEH <= 7 Target = > 80%	16	100
GEH <= 10 Target = > 95%	16	100
GEH <= 12 Target = 100%	16	100
GEH > 12 Target = 0%	0	0
Total Counts	16	

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts
0001 to 0500	4.62	11.41	1.41	10
0501 to 1000	13.02	13.02	3.02	2
1001 to 1500	3.85	4.37	0.00	4
1501 to 2000	0.00	0.00	0.00	0
2001 to 2500	0.00	0.00	0.00	0
2501 to 3000	0.00	0.00	0.00	0
3001 to 3500	0.00	0.00	0.00	0
3501 to 4000	0.00	0.00	0.00	0
4001 to 5000	0.00	0.00	0.00	0
5001 to Maximum	0.00	0.00	0.00	0
Total of Counts 0001 to Maximum Range	5.88	7.58	0.00	16
Total of Counts 0501 to Maximum Range	6.21	6.59	0.00	6

Table 3: Evening Peak Calibration Report

2009 PM PEAK RIVERSIDE CALIBRATED MODEL

Location.....	Node	Node	Count	Model	Diff	Diff%	GEH
GWH EB W CASTLEREAGH	2876	1079	749	712	-37	-5	1
GWH WB W CASTLEREAGH	1079	2876	1291	1280	-11	-1	0
CASTLEREAGH SB N GWH	1070	2877	1587	1626	39	2	1
CASTLEREAGH NB N GWH	2877	1070	1284	1299	15	1	0
GWH WB E CASTLEREAGH	9366	1071	1168	1055	-113	-10	3
GWH EB E CASTLEREAGH	1071	9366	556	551	-5	-1	0
MULGOA NB S GWH	10362	1073	1096	1066	-30	-3	1
MULGOA SB S GWH	1073	10362	1182	1329	147	12	4
RANSLEY EB W MULGOA	1077	12667	158	148	-10	-6	1
RANSLEY WB W MULGOA	12667	1077	87	83	-4	-5	0
PANTHERS EB W MULGOA	1075	12688	226	200	-26	-12	2
PANTHERS WB W MULGOA	12688	1075	175	163	-12	-7	1
PATTYS NB S BLAIKIE	12686	1013	95	117	22	23	2
PATTYS SB S BLAIKIE	1013	12686	110	168	58	53	5
WOLSELEY EB S PATTYS	12686	1014	469	492	23	5	1
WOLSELEY WB S PATTYS	1014	12686	363	388	25	7	1

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	16	100
GEH <= 7 Target = > 80%	16	100
GEH <= 10 Target = > 95%	16	100
GEH <= 12 Target = 100%	16	100
GEH > 12 Target = 0%	0	0
Total Counts	16	

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts
0001 to 0500	-4.52	10.70	0.70	8
0501 to 1000	3.22	3.22	0.00	2
1001 to 1500	-0.13	5.25	0.00	5
1501 to 2000	0.00	2.46	0.00	1
2001 to 2500	0.00	0.00	0.00	0
2501 to 3000	0.00	0.00	0.00	0
3001 to 3500	0.00	0.00	0.00	0
3501 to 4000	0.00	0.00	0.00	0
4001 to 5000	0.00	0.00	0.00	0
5001 to Maximum	0.00	0.00	0.00	0
Total of Counts 0001 to Maximum Range	-0.76	5.45	0.00	16
Total of Counts 0501 to Maximum Range	-0.06	4.45	0.00	8

SITE ACCESS

Table 4: Existing Access Conditions

Access Location	AM Peak			PM Peak			Current Conditions
	DS	AVD	LoS	DS	AVD	LoS	
Great Western Highway / Riverlink Access	-	-	-	-	-	-	
Mulgoa Road/Union Road	0.14	0	A	0.12	0	A	
Mulgoa Road / Ransley Street	0.21	10	A	0.54	12	A	
Mulgoa Road / Panthers	0,43	21	B	0,62	34	C	
Mulgo Road / Jamison Road	0.81	40	D	0.78	36	C	
Mulgoa Road/Blaikie Road	0.58	20	B	0.56	31	C	
Mulgoa Road / Glenbrook Street	0,62	26	B	0.65	23	B	
Mulgoa Road / Wolseley Street	0.64	25	B	0.69	31	C	

Table 5: Formerly Identified Road Network Intersection Improvements to Year 2009

	Location	Network Intersection Improvement
A	Great Western Highway / Parker Street	Installation of dual right turn bays will increase the intersection capacity and improve operation.
B	Leonay Parade / M4 WB Off Ramp	Construction of traffic signals and the introduction of a dual right turn from the M4 offload ramp, WB, at Leonay Parade.
C	Great Western Highway and Bennett Road	Provision of a 60 m dual right turn bay is recommended.
D	Mamre Road and M4 WB Offload Ramp	Provision of an exclusive left turn lane from the offload ramp onto Mamre Road.
E	Great Western Highway and Old Bathurst Road	Provision of dual left turn lanes from Bathurst Street. Introduction of a dual 120 metre long right turn bays from Great Western Highway, WB, into Bathurst Street.
F	Mulgoa Road and M4 Offload Ramp	Construction of a left turn slip lane from M4 EB ramp onto Mulgoa Road , northbound to Wolseley Street
G	Mulgoa Road and Glenmore Parkway	Reconstruction of the existing roundabout to facilitate a northbound slip lane in Mulgoa Road for through traffic.
H	Palmyra Avenue and A.D.I. Eastern Village Northern Access	Construction of traffic signals at the St Marys Eastern Village, northern access.
I	Forrester Road and Palmyra Avenue	Removal of existing roundabout and installation of traffic signals.
J	Forrester Road and Links Road	Removal of existing roundabout and installation of traffic signals with dual right and left turn bays with the exception of three LT lanes from Forrester, WB, to Links Road, SB.
K	Forrester Road and Christie Street	Removal of existing roundabout and installation of traffic signals with right turn bays.
L	Castlereagh Road and Jane Street	Jane Street extension from Castlereagh Road, westbound, to Great Western Highway at Neale Drive with right turn from Castlereagh Road, southbound, to Jane Street extension, westbound.
M	Castlereagh Road, Mulgoa Road and High Street	Banning of right turn from Castlereagh Road, southbound, to Great Western Highway, westbound, in conjunction with the construction of the Jane Street extension.
N	Great Western Highway and Mamre Road	Reconstruction of traffic signals at the intersection of Mamre Road and Great Western Highway.
O	Werrington Road and Dunheved Road	Removal of roundabout and installation of traffic signals. 130m dual RT lanes from Dunheved Rd, EB, to Werrington Rd, SB – 150m dual LT lanes from Werrington Rd, NB, to Dunheved Rd, WB – 150m LT bay from Christie St, WB, to
P	Werrington Road and Parkes Avenue	Removal of roundabout and installation of traffic signals. Traffic signals – Two lanes in each direction on Werrington Road between Dunheved Road and Parkes Avenue.
Q	The Northern Road and Glenmore Parkway	Removal of existing roundabout and installation of traffic signals.
R	Cranebrook Road, Andrews Road and Castlereagh Road	Removal of existing roundabout, civil reconstruction and installation of traffic signals.

NB. The above infrastructure improvements have not been incorporated in the base year 2009, with the exception of Item F, Mulgoa Road and M4 Offload Ramp, to assess if any further congestion issues are present at the site.

Table 6: Formerly Identified Road Network Link Improvements to Year 2011

	Location	Network Link Improvement
1.	Cranebrook Road	Cranebrook Road Deviation to Andrews Road widen to 6 lanes including Transitway (Currently
2.	Castlereagh Road	Andrews Road to Jane Street widen to 6 lanes.
3.	Mamre Road	Luddenham Road to M4 Motorway widen to 4 lanes including duplication of the Mamre Road overbridge at the M4 Motorway.
4.	Mamre Road	Erskine Park Catchment C Access to Luddenham Road widen to 4 lanes.
5.	Werrington Arterial (Stage 1)	Construction of a four lane arterial road between M4 Motorway and Great Western Highway.
6.	Andrews Road	Castlereagh Road to The Northern Road widen to 4 lanes.
7.	Christie Street	Forrester Road to South Creek widen to 4 lanes.
8.	The Northern Road	Borrowdale Way to Andrews Road widen to 4 lanes.
9.	The Northern Road	Andrews Road to Dunheved Road widen to 6 lanes.
10.	The Northern Road	Glenmore Parkway to Bradley Street widen to 4 lanes.

CURRENT YEAR TRIP MATRIX

The geographic region to be modelled is represented by a trip matrix (trip table), that details the individual travel demands between origin and destination pairs. Each distinct area representing a trip origin or end is called a '*Zone*'. The Sydney Netanal model contains some 960 zones, following disaggregation. These elements define areas of homogenous land use (eg. residential, industrial, retail, education, airports, hospitals) enclosed and linked by physical features such as major roads, railways and rivers. The trip table specifies the number of car trips travelling from each zone to every other zone in the modelled area.

The zone locations, within the Penrith Local Government Area (LGA), are presented in *Figure 7*.

The boundaries of these zones for the Sydney Metropolitan Area were defined, in 1996, by the NSW Department of Transport's TPDC, and have been generic across all traffic and transport modelling activities undertaken in Sydney. New boundaries were defined by TPDC at the end of 2008, but have yet to be employed.

The assignment process described above essentially determines the anticipated route selection made by motorist between the 'origin' and 'destination' zone during a designated time period. The total number of trips between all the zonal pairs produces the projected traffic volumes reported by the model. Netanal models the road network assignment over a 1hr period.

The base year 2008/2009 trip matrix was generally developed by TPDC in 2001. As changes to the generation and distribution of trip demand between zonal pairs has occurred over the years, the trip tables for the 1hr morning and evening peak travel periods has been modified to accurately reflect and assimilate the operation of the Sydney Metropolitan road network.

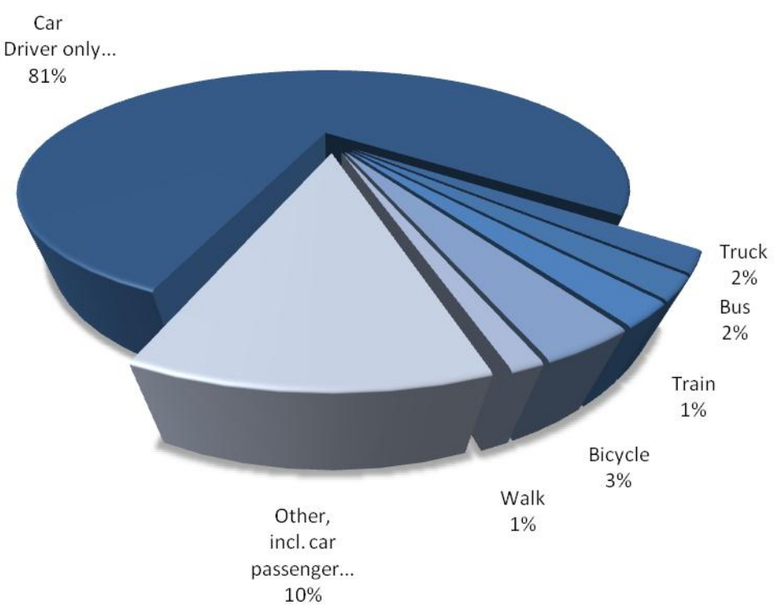
MODE SHARE

There is a much higher car usage for Journey to Work (JTW) in Western Sydney than compared with the Sydney Metropolitan Area average. The 2006 census data indicates that the overall mode split for the Penrith LGA is 81% car driver, in the context of a single mode journey. This is, however, an area wide average and must not be taken to apply equally to all local precincts.

Cityrail have identified the population within the Penrith LGA as growing at some 2% per annum, while rail patronage is growing at less than 1% p.a.

Figure 6 presents a comparison of transport modes for JTW trips within the Penrith LGA, as adopted in the project trip matrices.

Figure 6: Penrith LGA JTW Mode Share – Journey by Single Mode



Source: 2006 ABS Census data – '*Basic Community Profile- Penrith*'

The high percentage of car drivers is likely a result of one or a combination of any or all the following reasons...

- Inability or perception that public transport fails to meet community needs,
- Lack of direct public transport services to employment centres,
- Inadequate frequency of public transport,
- Inadequate inter regional services,
- Congestion on major roads accommodating bus services,
- Poor modal interchange,
- Peception private vehicle travel is more convenient,
- Access by motor vehicles to regional employment centres, is comparatively more convenient, and/or
- A significantly high proportion of self employed and/or tradesmen are car dependent for business.

The future traffic generation rates for the Penrith LGA are based on a minimum 10% modal shift away from private motor vehicle usage through the introduction of strategic public transport initiatives, improved pedestrian amenity, revitalised urban cohesion between transport modes and increased focus on the differing community priorities. Given that 10% is of a whole 100%, a percentage correction must be applied to achieve the modal reduction associated with only 81% of JTW trips made by private motor vehicle. The percentage of modal shift, in this instance, is calculated by applying the following formula...

$$\frac{10\%\ Modal\ Shift}{81\%\ Journey\ by\ Car} = \frac{x}{100}$$

Where x = the percentage shift applied to JTW trips made by private vehicle (In this instance – 12.1%)

FUTURE TRIP MATRIX

The future Year trip tables, produced by TPDC, have been developed from a 4 step travel model based on forecast population, employment and the transport network. These trip tables form the basis for the Netanal future year trip demands.

Generally, the Netanal distribution for the future year trip tables of the Sydney Metropolitan Region has been retained from the TPDC trip matrices. However, irregularities have been found between the land use assumptions within the TPDC matrices and available data, making it necessary to disaggregate the course zone structure to better reflect the furture year demand generations.

Following the zonal disaggregation process, the sensitivity of the trip end distribution, for the Penrith LGA, has been reported between select zones within the Riverlink Precinct and regional catchments, as shown in *Table 7*.

Figure 8 presents a cross section of the reported trip distribution to key regional centres, for the year 2031 morning peak trip matrix utilised in the modelling of the 'End State' conditions for the Riverlink Precinct project.

The land use, growth level and vehicle generation assumptions, adopted for the Riverlink Precinct, are presented in *Table 3*.

The local and regional development growth adopted from recent studies throughout the Western Sydney region, undertaken by Road Delay Solutions and Sims Varley, include, but are not limited to...

- Eastern Creek Precinct,
- Huntingwood Stage1 and Stage 2,
- Erskine Park,
- Penrith LGA Arterial Road Study, and
- St Marys ADI Transport Study.

Table 7: Modelled Trip Distribution from the Riverlink Precinct to Select Regional Centres

	% Netanal Trip Distribution from...
Trip Destination	Riverlink Precinct
Penrith Lakes/Windsor / Richmond	5%
Erskine Park	9%
Noth West Growth Centre	3%
Parramatta CBD	6%
Blacktown CBD	6%
Liverpool CBD	1%
WSEH	5%
Sydney CBD	<1%

TRIP CONTAINMENT

Trip containment is a valuable tool, providing state and local government with a strong foundation on which to plan for services and infrastructure in support of higher density development within both Greenfields and established areas to sustain the burgeoning population growth.

Clearly defined urban precinct boundaries must be supported by the potential for balanced and efficient public transport, job opportunity, recreational tracts, education, retail, etc... to achieve a desired level of containment.

While the Riverlink Precinct exhibits clearly defined topographic and man made boundaries, the planned development structure is considered incapable of satisfying the necessary community needs to facilitate a significant level of containment.

Therefore, no containment has been applied in the determination of vehicle generation levels for the Riverlink Precinct.

Table 8: Incorporated Penrith LGA Development Growth

Development	Land Use	No. of dwellings / Area (hectares) or No. of Employees						
		2009	2011	2016	2021	2026	2031	2036
St Marys Western Precinct	Residential (dwellings)			1,250	2,000	2,000	2,000	2,000
	Commercial (hectares)			23.8	23.8	23.8	23.8	23.8
	Retail (hectares)			3.4	3.4	3.4	3.4	3.4
	Industrial (hectares)							
	Educational (hectares)			7.7	7.7	7.7	7.7	7.7
St Marys Eastern Precinct	Residential (dwellings)	2,000	2,000	2,000	2,000	2,000	2,000	2,000
	Commercial / Industrial (hectares)	5.9	5.9	5.9	5.9	5.9	5.9	5.9
	Retail (hectares)	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Educational (hectares)	7.7	7.7	7.7	7.7	7.7	7.7	7.7
St Marys Central Precinct and Dunheved	Residential (dwellings)			100	1,068	1,068	1,068	1,068
	Commercial (hectares)			2.9	2.9	2.9	2.9	2.9
	Retail (hectares)			0.9	0.9	0.9	0.9	0.9
	Industrial (hectares)			25.8	25.8	25.8	25.8	25.8
	Educational (hectares)			2.6	2.6	2.6	2.6	2.6
Penrith Lakes Scheme	Residential (dwellings) excl. Employment Component		500	1,000	2,000	2,800	2,800	2,800
	Employment/Recreational within Residential (10.75ha) - On-site employee numbers					2,451	2,451	2,451
	Employment/Recreation employees within Business Park (47ha) - On-site employee numbers					546	546	546
WELL Precinct	Residential (dwellings)			1,583	1,583	1,583	1,583	1,583
	High Tech (GLFA)			982,500	982,500	982,500	982,500	982,500
	Commercial (GLFA)			1,089,300	1,089,300	1,089,300	1,089,300	1,089,300
	Retail (GFA)			11,666	11,666	11,666	11,666	11,666
	TAFE (Enrollments)			5,124	5,124	5,124	5,124	5,124
Nortwest Growth Sector (Riverstone, Marsden Park, Alex Avenue	Residential (dwellings)					31,459		67,000
	Employment (employees on-site)					32,639		39,000
Waterside (Penrith Lakes Scheme)	Residential (dwellings)		399	701	701	701	701	701
	Commercial (hectares)		4	7	7	7	7	7
WELL - Caddens Release Area	Residential (dwellings)			1,060	1,060	1,060	1,060	1,060
North Penrith Urban Area	Residential (dwellings)	300	600	800	800	800	800	800
	Commercial (hectares)	2.5	5	7	7	7	7	7
Erskine Park Catchment A	Residential (dwellings)							
	Commercial / Industrial (hectares)			17.1	17.1	17.1	17.1	17.1
Erskine Park Catchment B	Residential (dwellings)							
	Commercial / Industrial (hectares)			164.7	164.7	164.7	164.7	164.7
Erskine Park - Lyssaght B	Residential (dwellings)							
	Commercial / Industrial (hectares)			7.9	7.9	7.9	7.9	7.9
Erskine Park - Bluescope B	Residential (dwellings)							
	Commercial / Industrial (hectares)			10.3	10.3	10.3	10.3	10.3
Erskine Park - Catchment C	Residential (dwellings)							
	Commercial / Industrial (hectares)		20.6	72.7	72.7	72.7	72.7	72.7
WELL - Claremont Meadow	Residential (dwellings)			479	479	479	479	479
Glenmore Park Extension	Residential (dwellings)		450	1,200	1,699	1,699	1,699	1,699
Infill Development	Residential (dwellings)	791	2,082	3,965	3,965	3,965	3,965	3,965
Riverlink Precinct	*As per following table...*							

Table 9: Riverlink Precinct Development Footprint and Generation Rates

Precinct / Land Use	Site (ha)	GFA Existing	GFA Proposed	Net Area		Assumed Generation Rates	Traffic Generation AM Peak	Traffic Generation PM Peak	Netanal Zone	2026 AM Outbound	2026 AM Inbound	2026 PM Outbound	2026 PM Inbound	2031 AM Outbound	2031 AM Inbound	2031 PM Outbound	2031 PM Inbound
North																	
Sports Stadium	2		2,000			0.75/100	15	15		3	11	11	3	3	11	11	3
Indoor/Outdoor Sports Centre	1.5		5,000			0.2/100	10	10		2	7	7	2	2	8	8	2
Integrated Visitor Centre / Museum / gallery			2,000			0.5/100	10	10		2	7	7	2	2	8	8	2
Sports Academy / Management School	2		4,000			0.2/100	8	8		1	6	6	1	2	6	6	2
Art / Cultural / Business Incubator			3,000			0.2/100	6	6		1	4	4	1	1	5	5	1
Retail ground floor			2,000	1,500		2/100	10	30		2	7	21	5	2	8	23	6
GPS School	6		10,000		700 students	1/100	100			18	70			19	76		
TOTAL	11.5		28,000						949	28	111	55	14	30	121	60	15
Penrith Panthers Stage 1																	
Club		27,200	27,200			1/100	75	75		13	53	53	13	14	57	57	14
Conferences / Conventions		21,000	48,200				150	150		26	105	105	26	29	114	114	29
Hotel		11,500	31,300		466 rooms	0.5 per room	125	125		22	88	88	22	24	95	95	24
Cinemas & bowling			8,500			0.6/100	20	50		4	14	35	9	4	15	38	10
General Retail			15,000	11,250		2/100	100	225		18	70	158	39	19	76	172	43
Restaurants			3,000				100	100		18	70	70	18	19	76	76	19
Commercial Suites			6,000				90	90		16	63	63	16	17	69	69	17
Brand Outlet Retail			25,000	18,750			125	500		22	88	350	88	24	95	382	95
Multi-use Arena			30,000				15	15		3	11	11	3	3	11	11	3
Seniors Living Residential			50,000		250 units		45	45		32	8	32	8	34	9	34	9
Car Parking multi-deck (not GFA)			108,000														
TOTAL	45.6		244,200						948	172	568	963	241	187	619	1049	262
Panthers Stage 2																	
Hotel			10,400				75	75		13	53	53	13	14	57	57	14
Serviced Apartments			9,000				50	50		35	9	35	9	38	10	38	10
Aquatic health wellness centre			4,000				10	10		2	7	7	2	2	8	8	2
Retail			1,500	1,125		2/100	10	23		2	7	16	4	2	8	18	4
Commercial Suites			6,000			15/ha	9	9		2	6	6	2	2	7	7	2
Business Park			25,000			15/ha	38	38		7	27	27	7	7	29	29	7
Bulky Goods / Homeware retail			18,000	13,500		2/100	100	270		18	70	189	47	19	76	206	52
Residential			84,000	63,000	210 lots	0.4/lot	84	84		59	15	59	15	64	16	64	16
Car Parking (incl. residential) (not GFA)			52,000														
TOTAL	29.5		157,900	118,425					950	136	193	391	98	148	210	427	107
Southwest																	
Restaurants			1,200			employees	20	45		4	14	32	8	4	15	34	9
Tavern	1.2		1,500			na										0	0
Functions / receptions			1,500			employees	5	5		1	4	4	1	1	4	4	1
TOTAL	1.2		4,200														
Southeast																	
Bulky Goods	3		12,500			2.5/100	100	315		18	70	221	55	19	76	240	60
Industrial	10		6,000			15/ha	9	9		2	6	6	2	2	7	7	2
Convenience Retail	1		3,000	2,250		2/100	20	45		4	14	32	8	4	15	34	9
TOTAL	14		21,500														
Flood Liable Land																	
Water Theme Park	7.5		20,000			employees	15	15		3	11	11	3	3	11	11	3
Golf Course (18 Holes)	20		3,000			employees	20	20		4	14	14	4	4	15	15	4
Camping Grounds						na											
Eco tourism resort	4		150			employees	10	10		2	7	7	2	2	8	8	2
TOTAL	31.5		23,000														
TOTAL	133.2		478,800	359,100		Sub Total	1,579	2,477	959	35	139	325	81	38	152	354	89
						Modal Shift (Corrected 12.1%)	-191	-300									
						Total vehicle generation after modal shift	1,388	2,177									

Note... i) 0% Self Containment
ii) 10% modal shift from private vehicle use (12.1% corrected)

Note: Year 2031 projected Riverlink Precinct vehicle generations assume a nominal 9% growth over the 5 year period from 2026. The model also includes background growth during this period.

Figure 7: Year 2026 Netanal Zone Disagregation

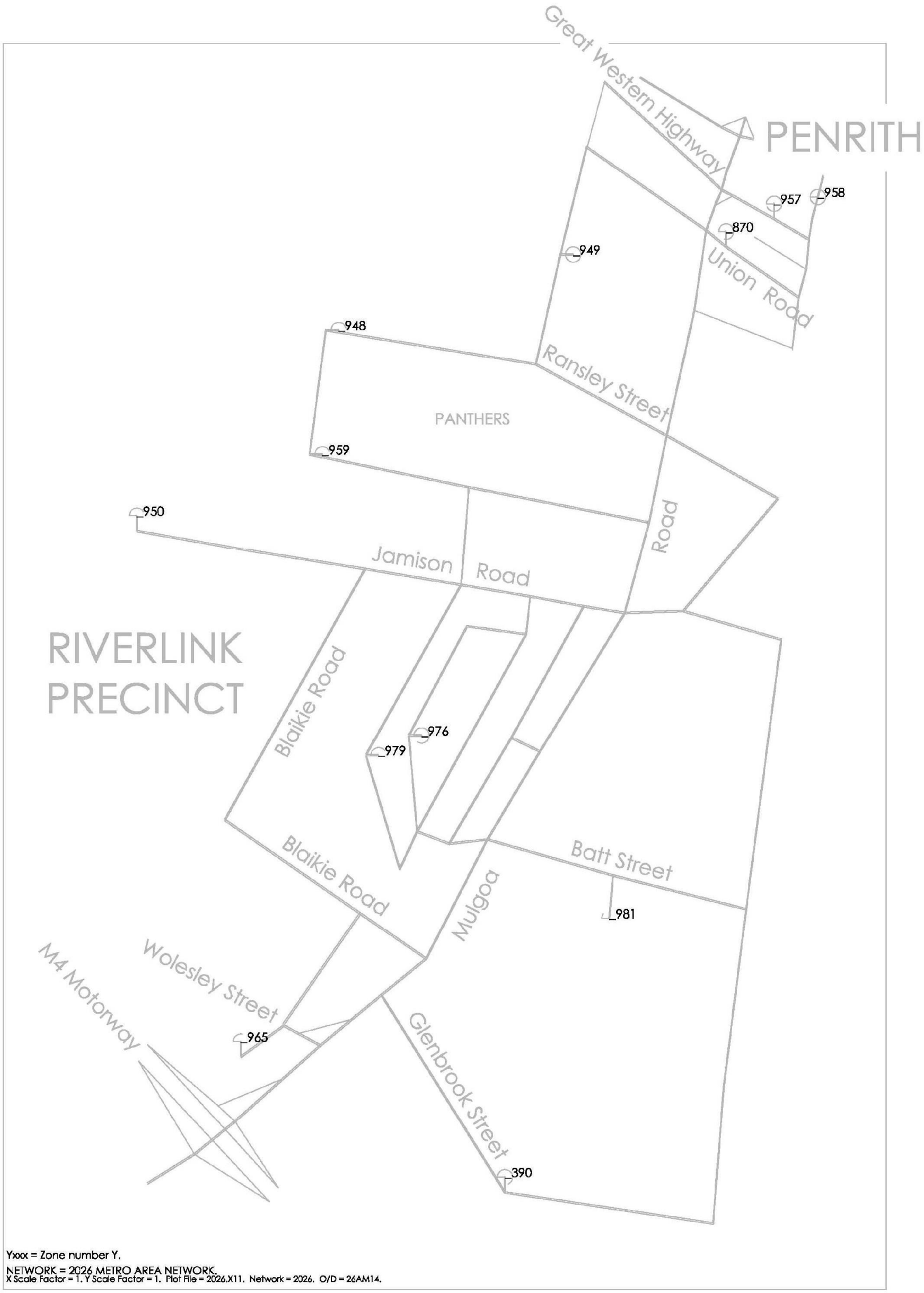
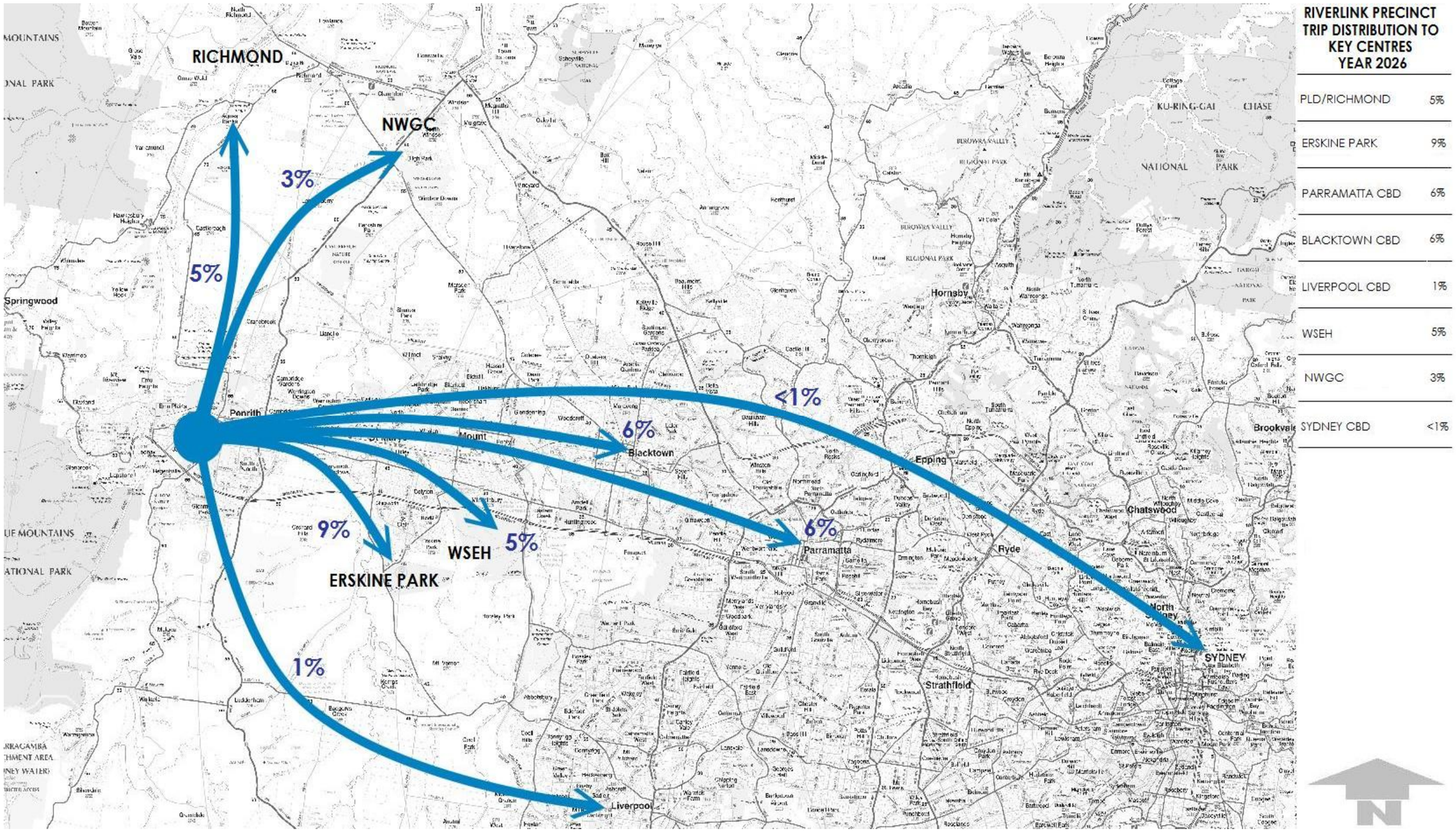


Figure 8: 2036 Morning Peak Hour Riverlink Precinct Zone 610 – Cross Section of Trip Distribution to Select Regions



4 FUTURE CONDITIONS

YEAR 2026 'END STATE' TRAFFIC PROJECTIONS

Traffic modelling was undertaken for the planned Riverlink Precinct development. This model forms the basis for the 'End State' infrastructure requiremernts to adequately sustain the Riverlink Precinct.

The AM and PM peak periods were modelled and incorporate all planned development within the Metro area. Particular focus was placed on the Penrith LGA and the adopted development growth, as presented in *Tables 8 and 9*.

The projected link volumes for the Years 2026 and 2031 peak periods are presented in *Figures 9 through 14, inclusive* They present the modelled volumes for typical mid block cross section of Mulgoa Road with the planned Riverlink Precinct development growth.

The Mulgoa Road corridor, and surrounds, consists of a range of road types and capacities derived from the RTA road hierarchy, exhibited traffic volumes and road function.

The thresholds utilised in the determination of the mid block lane configurations and published by Austroads, are based on the particular road function to ensure an acceptable LoS of 'D', or better.

These thresholds represent the 'Capacity' of specific road types. Volumes higher than the prescribed thresholds will be perceived by the community and road users as being over saturated.

While generally accepted a single, trafficable, lane may carry up to 1950 vehicles per hour at an operational LoS 'F' and significantly long vehicle queues, the capacity of each particular road type has been determined by considering a number of key factors, noted in Austroads *'Roadway Capacity'* manual, including, but not limited to…

- Vehicle speed,
- Volume of vehicles demanding to use the carriageway (linked to road classification),
- Potential for lane changing (higher vehicle volumes reduce the incidence of lane changing),
- Available lane widths and lateral clearances,
- Surrounding land use characteristics (industrial, residential, retail, commercial, etc...)
- Vertical carriageway alignment,
- Horizontal carriageway alignment,
- Carriageway condition, and
- Carriageway access (driveways, side street intersections, etc...)

As a consequence, road links reporting a volume in excess of the adopted thresholds, should be considered for remedial treatment and reclassification for achievement of the specificified volume threshold.

The use of traffic management devices and intersection controls, are to be modelled and recommended to determine the impact and achieve optimum performance of road-based movements, in particular, along the Mulgoa Road for the development years 2026 and 2031.

Table 10: Mid Block Link Capacity Thresholds

Road Type Conditions	Lane Capacity at LoS 'F' (veh/hour)	Assumed Maximum Satisfactory Lane Flow in Vehicles/hour (LoS 'D')
Urban Divided / Undivided Highways with Clearways and signal coordination	1,500	1,350
Urban Divided / Undivided Highway conditions with interruptions	1,200	1,080
Rural Two-Way Two-Lane	1,400	896
2 Lane Residential Street with on street parking	700	630

PERFORMANCE INDICATORS

Intersection performance is best measured by the indicators of Level of Service (LoS), Average Vehicle Delay (AVD) and the Degree of Saturation (DS) during peak hours.

This is defined as the assessment of a qualitative effect of factors influencing vehicle movement through the intersection. Factors such as speed, traffic volume, geometric layout, delay and capacity are qualified and applied to the specific intersection control mode, as shown in *Table 1*.

The measure of average delay assessed for traffic signal operation is over all movements. For roundabouts and priority controlled intersections, the critical criterion for assessment is the movement with the highest delay per vehicle.

Table 11: Performance Indicators by Control Method

Intersection Control	Performance Measure [Unit]
Sign or Priority Control	Delay of critical movement(s) [seconds/vehicle] Average Vehicle Delay [seconds/vehicle] Queue length of critical movement(s) [metres]
Traffic Signal Control	Delay of critical movement(s) [seconds/vehicle] Degree of Saturation [ratio of vehicles to capacity] Average Vehicle Delay [seconds/vehicle] Cycle Length [seconds] Queue length of critical movement(s) [metres]
Roundabout Control	Delay of critical movement(s) [seconds/vehicle] Degree of Saturation[ratio of vehicles to capacity] Average Vehicle Delay [seconds/vehicle] Queue length of critical movement(s) [metres]

AVERAGE VEHICLE DELAY (AVD)

The AVD is a measure of the operational performance of a road network or an intersection.

AVD is determined globally over a road network or within a cordon during an assignment model run. The AVD exhibited on comparable network models, for analogous peak periods, forms the basis of comparing the operational performance of the road network.

AVD is used in the determination of intersection Level of Service. Generally, the total delay incurred by vehicles through an intersection is averaged to give an indicative delay on any specific approach. Longer delays do occur but only the average over the peak hour period is reported.

DEGREE OF SATURATION (DS)

The DS of an intersection is usually taken as the highest ratio of traffic volume on an approach to the intersection compared with its theoretical capacity, and is a measure of the utilisation of available green time. The DS reported is generally of a critical movement through the intersection rather than the DS of the intersection unless equal saturation occurs on all approaches.

For intersections controlled by traffic signals, generally both queue length and delay increase rapidly as DS approaches 1.0. An intersection operates satisfactorily when its DS is kept below 0.875. When the DS exceeds 0.9, extensive queues can be expected.

Table 12: Qualified Level of Service by Control Method

LOS	AVD secs	Traffic Signals and Roundabout	Give Way and Stop Sign Priority Control
A	1 to 14	Good operation.	Good operation
B	14 to 28	Good operation with acceptable delays and spare capacity.	Good operation with acceptable delays and spare capacity.
C	28 to 42	Satisfactory.	Satisfactory but accident study and operational analysis required.
D	42 to 56	Operating near capacity.	Near capacity. Accident study and operational analysis required.
E	56 to 70	Unsatisfactory. Traffic signals incidence will cause excessive delays. Requires additional capacity. Roundabouts require alternative control mode.	At capacity. Requires alternative control mode.
F	>70	Unsatisfactory. Over capacity and unstable operation.	Over capacity. Unstable and unsafe operation.

FUTURE YEAR MODEL SUMMARY

The modelling suggests that till Year 2026, deemed 'End State', Mulgoa Road, with localised intersection improvements, will be capable of sustaining the development growth within the Penrith LGA, including the generation of some 1,400vph in the morning peak and 2,200vph in the evening peak, from the planned Riverlink Precinct development.

The model exhibits no spare capacity along the Mulgoa Road corridor, between High Street and the M4 Motorway, and highlights the need for intersection improvements at the following intersections...

- Mulgoa Road and Jamison Road, currently under roundabout control,
- Mulgoa Road and Blaikie Road, and
- Mulgo Road and Glenbrook Road.

In addition, two (2) new access points are proposed for the Riverlink Precinct site, being...

- A proposed traffic signal controlled intersection on Great Western Highway at the Riverlink Access Road, some 300m, west of Mulgoa Road, directly east of Peach Tree Creek, and
- A proposed left in/left out arrangement on Mulgoa Road at Union Street.

The proposed treatments, as shown in *Table 16*, afford increased green time to the through movements along Mulgoa Road while improving the throughput of highlighted critical movements, to and from the side streets.

Sensitivity models were undertaken, at a micro level utilising the Intanal program, and reported significant degradation of a number of intersections on Mulgoa Road when run with a modelled increase of 10% in through traffic volumes along the corridor.

The Year 2031 model, with a 9% increase in the development vehicle generation from the Riverlink Precinct, suggests widening of Mulgoa Road to six (6) lanes will be necessary.

Table 13: Years 2009 – 2031 Link Volumes

Location	2009		AM	PM	2026		AM	PM	2031 (10% Dev Loading + Background Growth)		AM	PM	Lane Capacity Threshold	2026 Recommended Lanes
	AM	PM	V/C Ratio	V/C Ratio	AM	PM	V/C Ratio	V/C Ratio	AM	PM	V/C Ratio	V/C Ratio		
HIGHWAY EB W MULGOA	1001	712	0.4	0.3	769	360	0.3	0.1	834	424	0.3	0.2	1350	2
HIGHWAY WB W MULGOA	446	1280	0.2	0.5	585	812	0.2	0.3	633	863	0.2	0.3		
UNION WB E MULGOA	342	553	0.2	0.3	452	1415	0.3	0.8	482	1569	0.3	0.9	896	2
UNION EB E MULGOA	330	30	0.2	0.0	1560	895	0.9	0.5	1634	1070	0.9	0.6		
RAINSLEY EB W MULGOA	103	148	0.1	0.1	109	484	0.2	0.8	113	512	0.2	0.8	630	1
RAINSLEY WB W MULGOA	98	83	0.1	0.1	283	99	0.4	0.2	284	109	0.5	0.2		
PANTHERS EB W MULGOA	67	200	0.1	0.2	560	355	0.4	0.3	624	380	0.5	0.3	630	2
PANTHERS WB W MULGOA	173	163	0.1	0.1	239	437	0.2	0.3	243	557	0.2	0.4		
JAMISON EB W MULGOA	802	263	0.4	0.1	914	709	0.5	0.4	933	772	1.0	0.9	896	2
JAMISON WB W MULGOA	306	598	0.2	0.3	430	728	0.2	0.4	446	775	0.5	0.9		
BLAIKIE EB W MULGOA	95	27	0.2	0.0	106	85	0.2	0.1	105	74	0.2	0.1	630	1
BLAIKIE WB W MULGOA	55	19	0.1	0.0	68	84	0.1	0.1	67	86	0.1	0.1		
MULGOA NB S UNION	983	615	0.4	0.2	2827	1199	1.0	0.4	2956	1223	1.1	0.5	1350	2
MULGOA SB S UNION	859	1402	0.3	0.5	1135	2034	0.4	0.8	1198	2122	0.4	0.8		
MULGO NB N PANTHERS	942	573	0.3	0.2	2830	1062	1.0	0.4	2973	1081	1.1	0.4	1350	2
MULGOA SB N PANTHERS	850	1335	0.3	0.5	1019	2113	0.4	0.8	1087	2207	0.4	0.8		
MULGO NB S JAMISON	1696	678	0.6	0.3	1853	613	0.7	0.2	1955	605	0.7	0.2	1350	2
MULGOA SB S JAMISON	917	1497	0.3	0.6	787	1655	0.3	0.6	862	1646	0.3	0.6		
MULGOA NB N BLAIKIE	2017	1134	0.7	0.4	2304	946	0.9	0.4	2495	1053	0.9	0.4	1350	2
MULGOA SB N BLAIKIE	1434	1853	0.5	0.7	1320	2002	0.5	0.7	1630	2090	0.6	0.8		
MULGOA NB N WOLSLEY	2237	1520	0.8	0.6	2510	1321	0.9	0.5	2634	1367	1.0	0.5	1350	2
MULGOA SB N WOLSLEY	1849	2110	0.7	0.8	1989	2313	0.7	0.9	2092	2323	0.8	0.9		
JAMISON EB E MULGOA	1508	197	1.7	0.2	406	511	0.5	0.6	443	564	0.5	0.6	896	1
JAMISON WB E MULGOA	431	554	0.5	0.6	346	603	0.4	0.7	367	661	0.4	0.7		

Table 14: Former Identified Intersection Improvements - Year 2012 to 'End State'

	Location	Network Intersection Improvement
Z	Great Western Highway and Parker Street	By End State: Duplication of the bridge over the railway is required to facilitate the necessary turn movements. Construction of a further 3 lane bridge to facilitate a 6 lane approach SB in The Northern Road.
		Land acquisition required between Great Western Highway and Cox Avenue to enable lane transition to Copeland Street including intersection improvements at Cox Avenue and Copeland Street.
		140 metre dual right and left turn lanes are required from The Northern Rd, SB to Great Western Highway. While, three RT lanes from Great Western Highway, WB, to Parker Street, NB are required.
AA	Mulgoa Road and Jamison Road	Removal of existing roundabout and installation of traffic signals.
AB	Northern Road and Dunheved Road	80m dual RT lanes from The Northern Rd, NB, to Dunheved Rd, EB – 60m dual LT lanes from The Northern Road, SB, to Dunheved Rd, EB – Dual RT lanes from Dunheved Rd, WB, to The Northern Rd, NB – 150m dual LT lanes from
AC	Great Western Highway and UWS Access	Double diamond overlap phasing – Three lanes each way on GWH – Exclusive dual LT and RT bays on each approach
AD	* Werrington Arterial Stage 2 and UWS Access	Recommended Traffic Signals - Access conditions to be determined by Council in consultation with developer
AE	* Caddens Road, UWS Access and Hermitage Circuit	Roundabout recommended. Access conditions to be determined by Council in consultation with developer.
AF	O'Connell Street and Caddens By Pass	Roundabout
AG	* Caddens By Pass and UWS Access	Roundabout
AH	Caddens Street, Kingswood Road and Caddens By Pass	Roundabout
AI	* O'Çonnell Street and TAFE Access	Roundabout
AJ	O'Çonnell Street and Second Avenue	Traffic Signals
AK	* Second Avenue and UWS Eastern Access	Roundabout - Access conditions to be determined by Council in consultation with developer
AL	* Second Avenue and UWS Western Access	Roundabout - Access conditions to be determined by Council in consultation with developer

@ Denotes infrastructure required to facilitate access to the North Penrith Army Lands.

** Denotes infrastructure required to facilitate acces to the University of Western Sydney Campus as part of the WELL Precinct development.*

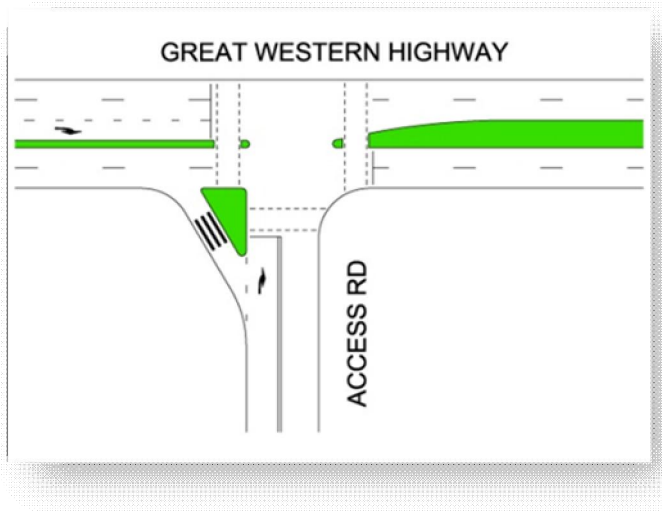
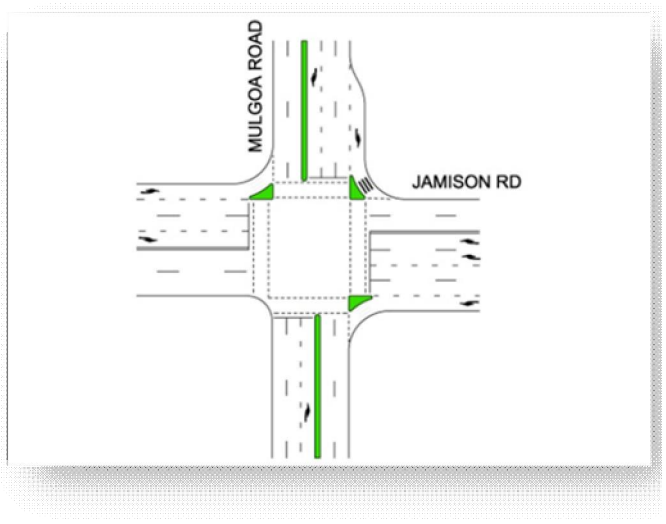
NB. All infrastructure improvements to 'End State' have been incorporated in the future year road networks and models.

Table 15: Former Identified Link Improvements - Year 2012 to 'End State'

	Location	Network Link Improvement
11.	Coreen Avenue	Castlereagh Road to Richmond Road widen to 4 lanes.
12.	Dunheved Road	Widening and reclassification of Dunheved Road to Sub Arterial, 4 lane and 80kmh.
13.	Werrington Arterial (Stage 2)	Widening of Werrington Road between Great Western Highway and Parkes Street – 4 lanes at 80kmh.
14.	Lenore Lane	Construction of a four lane wide arterial link between Erskine Park Road and Old Wallgrove Road.

NB. All infrastructure improvements to 'End State' have been incorporated in the future year road networks and models.

Table 16: Year 2026 Proposed Riverlink Intersection Treatments

Access Location	AM Peak DS	AM Peak AVD	AM Peak LoS	PM Peak DS	PM Peak AVD	PM Peak LoS	Mitigated Condition
Great Western Highway / Riverlink Access	0.3	13	A	0.52	17	B	 New Riverlink Access on GWH
Mulgoa Road/Union Road	0.14	0	A	0.12	0	A	 Left In/Left Out from Riverlink
Mulgoa Road / Ransley Street	0.85	21	B	0.78	20	B	 As Existing
Mulgoa Road / Panthers	0.86	19	B	0.5	11	A	 As Existing
Mulgo Road / Jamison Road	0.87	36	C	0.8	31	C	 Traffic Signals

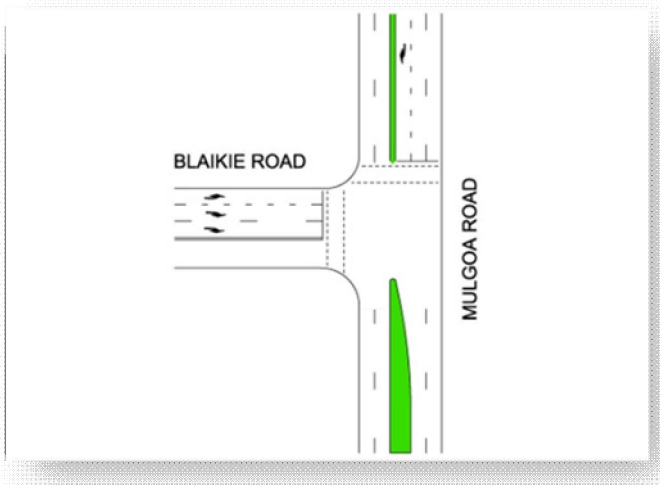
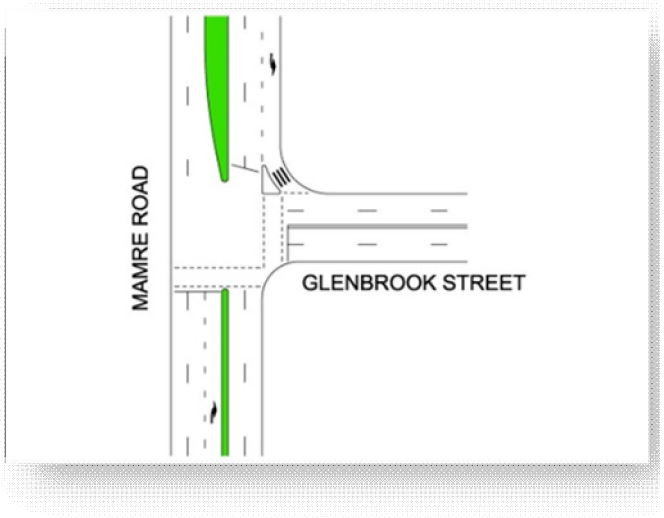
Mulgoa Road/Blaikie Road	0.82	12	A	0.72	10	A	 Dual RT from Blaikie
Mulgoa Road / Glenbrook Street	0.9	29	C	0.93	38	C	 LT Slip Lane SB in Mulgoa
Mulgoa Road / Wolseley Street	0.78	27	C	0.88	35	C	 As Existing

Figure 9: 2009 Morning Peak Traffic Volumes

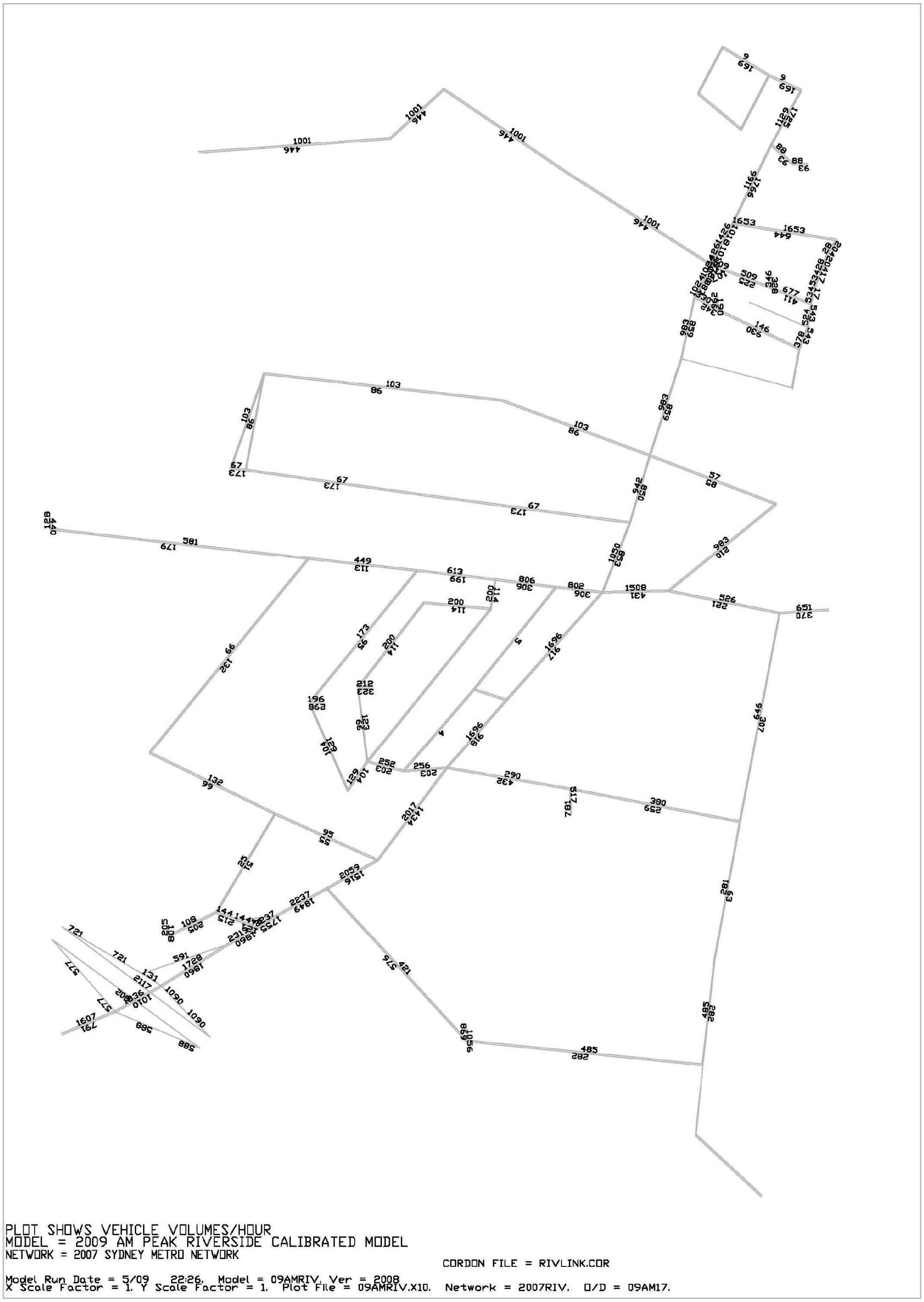


Figure 10: 2009 Evening Peak Traffic Volumes

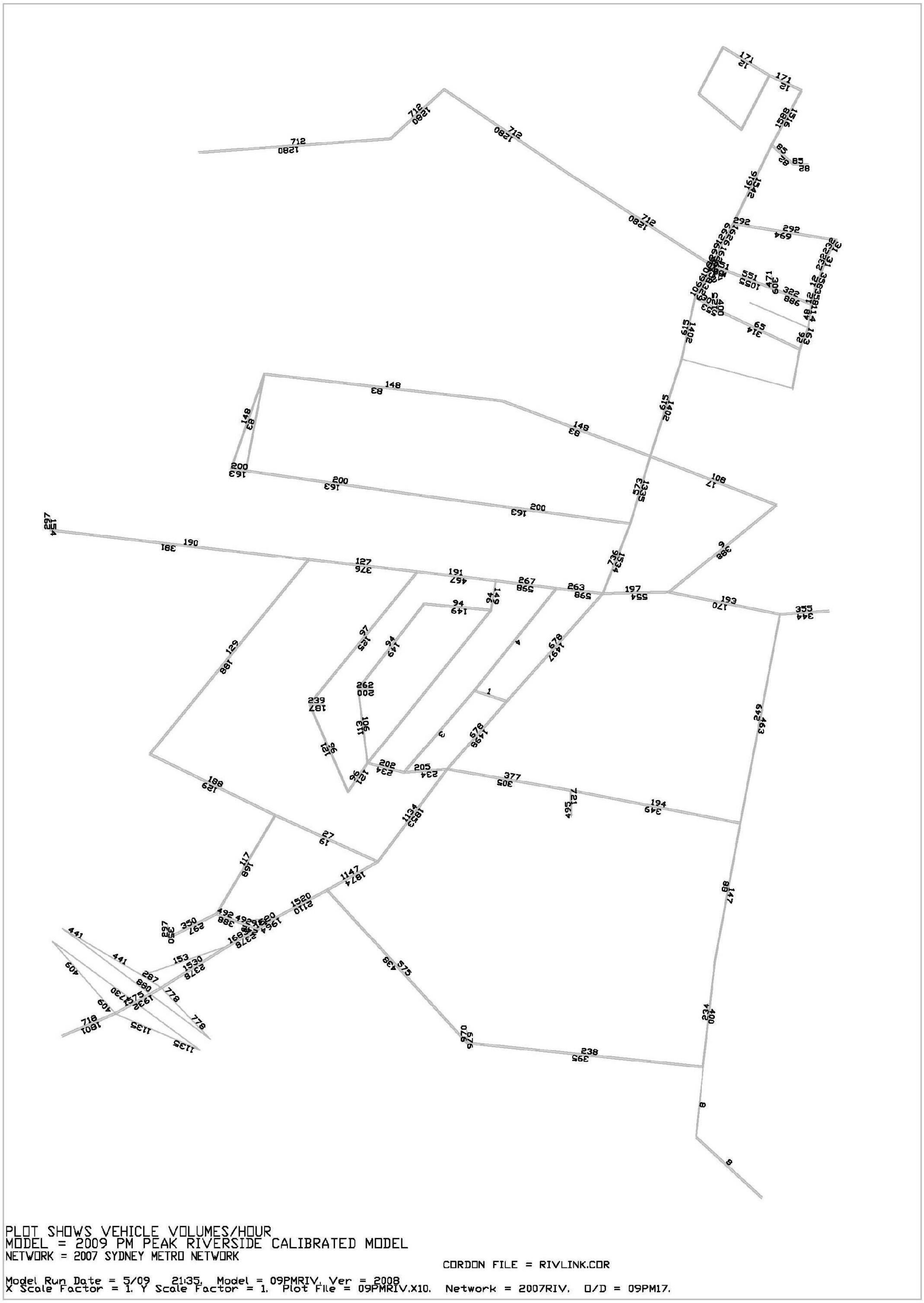


Figure 11: 2026 Morning Peak Traffic Projections

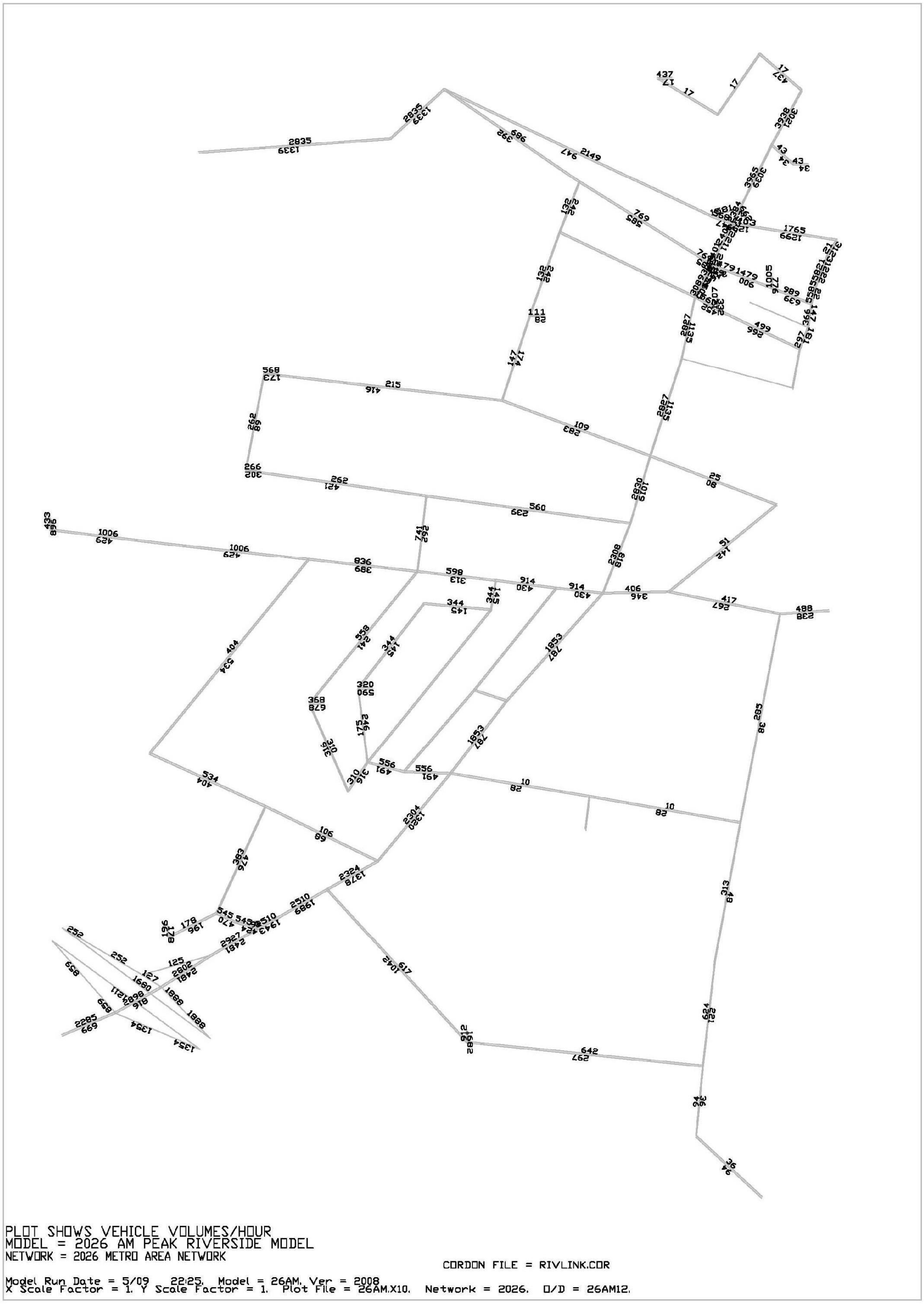


Figure 12: 2026 Evening Peak Traffic Projections

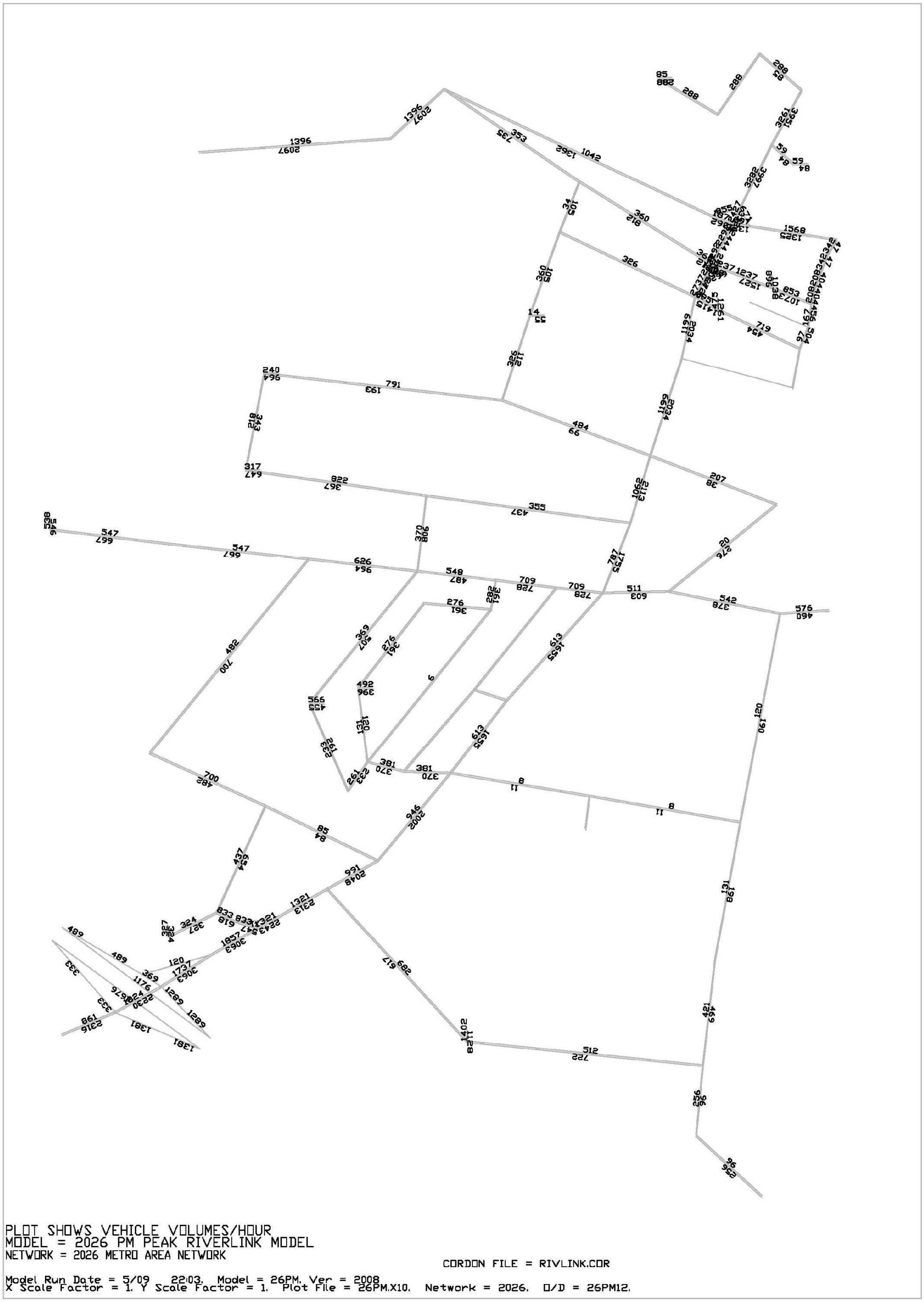


Figure 13: 2031 Morning Peak Traffic Projections

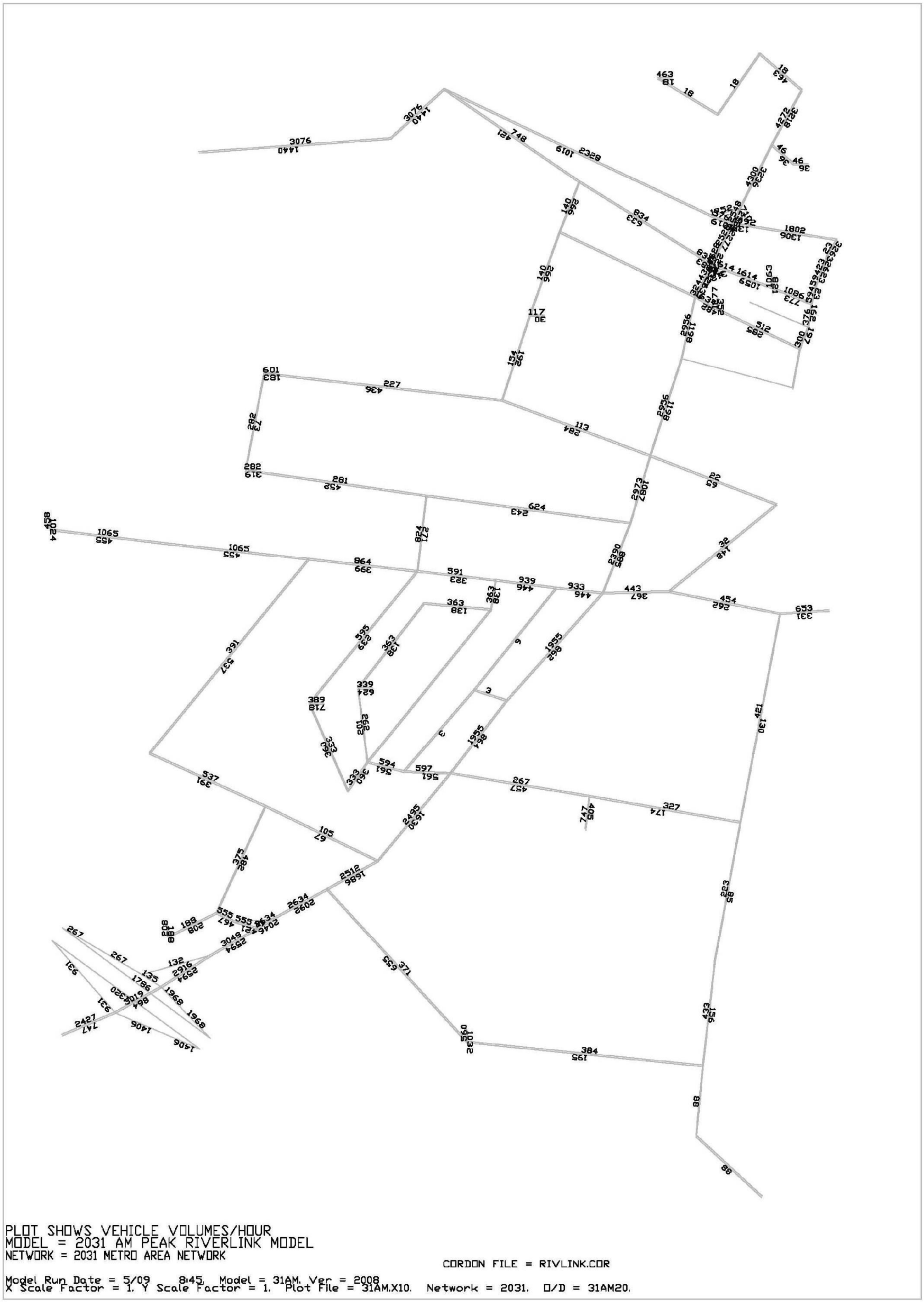
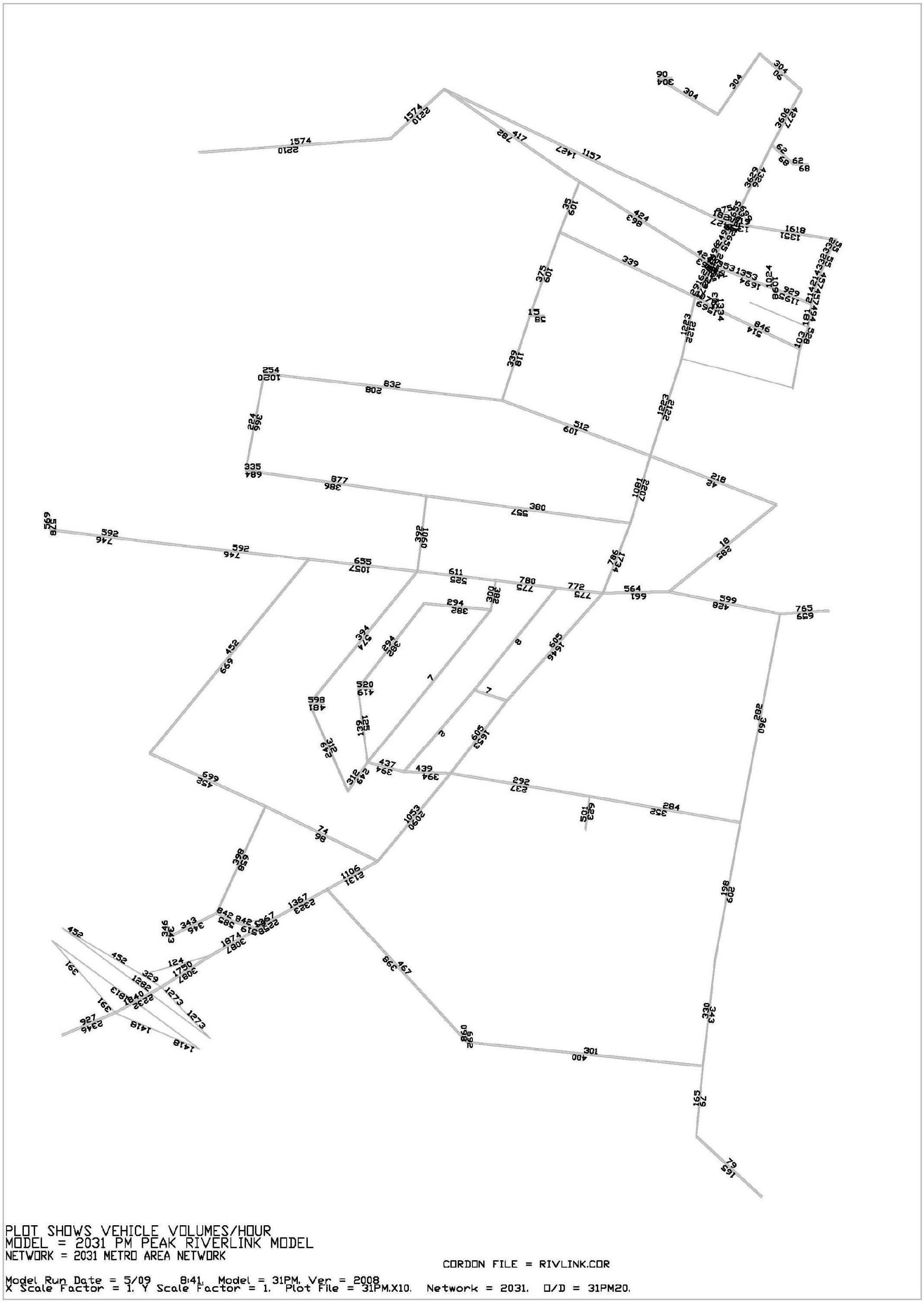


Figure 14: 2031 Evening Peak Traffic Projections



Appendix F

Design Standards for Pedestrian and Cycle Facilities

Austroads Guide to Traffic Engineering Practice

Minimum Footpath Widths

Table 31 shows the minimum widths for various types of footpath users.

Table 31 Minimum Footpath Widths

Footpath Type	Width
General minimum width	1.2m
Absolute minimum	0.9m
High pedestrian volumes or greater depending on demand	2.4m
For wheelchairs to pass	1.8m
Absolute minimum	1.5m
For people with disabilities	1.0m to 1.8m

Source: *Austroads Guide to Traffic Engineering Practice Part 13 – Pedestrians.*

The *Austroads Guide to Traffic Engineering Practice Part 13 – Pedestrians* states that:

"*The general minimum footpath width of 1.2m is adequate for most road and street situations except in commercial and shopping environments… A footpath wider than the minimum may also be necessary at locations where pedestrians gather such as at the entrance to schools and associated crossings, at recreation facilities and at important bus stops etc. In these cases a width of up to 5m may be appropriate*."

Bicycle Lane Widths

The width for bicycle lanes will vary depending on the number of cyclists, the speed of motor vehicles, the volume of large vehicles and the space available given the needs of other road user groups, physical constraints and budgetary constraints (Austroads, *Part 14 – Bicycles*, 1999). Recommended widths are summarised below and shown in Table 32.

Overall, the following widths are recommended:

- 3.0 metres is the absolute maximum width and is desirable where the motor traffic is moving at high speeds (100 km/h);
- At least 2.0 metres is desirable where the motor traffic is moving at high speeds (100 km/h) or where speeds are moderate (80 km/h);
- 1.5 metres is the desirable width to be used in 60 km/h speed zones; and
- 1.2 metres is the absolute minimum width to be used along the length of the lane and should only be used where the provision of a wider lane is impractical.

Table 32 Recommended Bicycle Lane Widths

	Lane Width (m)		
Road Speed (km/h)	60	80	100
Desirable	1.5 m	2.0 m	2.5 m
Accepted Range	1.2 – 2.5 m	1.8 – 2.7 m	2.0 – 3.0 m

Source: Austroads: *Guide to Traffic Engineering Practice*, *Part 14 – Bicycles* (1999)

Minimum Provision of Footpaths

This report has shown that there is an overall lack of footpaths in the Riverlink Precinct. One method to overcome this lack of pedestrian infrastructure is to set a goal of at least one footpath along one side of each road. This could be progressively implemented based on the prioritisation of certain roads and be linked to different types of pedestrian generators.

Line Marking at Intersections

There is very limited line marking for cyclists at intersections. It is recommended that line marking be implemented at major intersections, as intersections are typically where cyclists and car drivers need to be most aware of exactly where to travel through the intersection.

Increased Signage

There is currently little signage for pedestrians and cyclists away from Tench Reserve and the Nepean River. More directional signage should be progressively implemented across the Precinct as development occurs.

10 Bond Street Sydney NSW 2000
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T: 2 9239 7100 F: 2 9239 7199 E: sydmail@ghd.com.au

Document Status

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1	S Manahan	A Horton	On file	A Horton		10 May 2009
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