FINAL REPORT

Project: Eastern Broadacre Traffic and Transport Modelling

Reference: 3002154

Date: 09/09/2008

AUSTRALASIA | ASIA | MIDDLE EAST | AFRICA | PACIFIC

Document / Report Control Form

Project Name: **Eastern Broadacre Traffic and Transport Modelling**

Project number: **3002154**

Report for: **Macroplan/ACTPLA**

PREPARATION, REVIEW AND AUTHORISATION

Revision #	Date	Prepared by	Reviewed by	Approved for Issue by
0	01/08/2008	Ahmed Al-Sergany Josh Everett		
1	06/08/2008	Ahmed Al-Sergany Josh Everett	Khaled Abbas	
2	03/09/2008	Josh Everett	Mal Dunning	Craig Sutton
Final	15/09/2008	Josh Everett	Mal Dunning	Craig Sutton

ISSUE REGISTER

Distribution List	Date Issued	Number of Copies
ACTPLA	15/09/2008	Electronic
SMEC Canberra	15/09/2008	1

SMEC Australia Pty. Ltd.

2/14 Wormald Street
SYMONSTON ACT 2609

PO Box 1654 FYSHWICK ACT 2609

Tel: **(02) 6126 1900**
Fax: **(02) 6126 1966**
Email: **josh.everett@smec.com.au**
WWW: **http://www.smec.com.au**

This document is intended to be printed double-sided. Please think of the environment when printing.

Contents

Tables

Figures

1 Background

The Canberra Spatial Plan identified the eastern edge of the ACT (from Majura through to Hume) for future residential and employment generating development. In October 2007, the ACT Planning and Land Authority (ACTPLA) engaged Macroplan, assisted by specialist sub-consultants, to undertake the Eastern Broadacre Planning Study. The study is investigating the suitability and feasibility of the area as a future ‘employment corridor’.

SMEC has been engaged to test the transport infrastructure required to support the potential development opportunities.

2 Objectives

The purpose of this sub-consultancy is to undertake traffic and transport modelling and provide advice on the likely traffic generation and the transport infrastructure requirements. This advice will assist Macroplan in its investigations into the potential of the Eastern Broadacre area for employment generating development.

The specific objectives of this study are:

- To conceptualise main road network connections to link the expected eastern developments to the main Canberra road network.
- Update SMEC strategic transport model to account for road network scenarios and land use changes within the study area.
- Model road network performance in 2031 and 2051 with expected Eastern Broadacre developments as well as other developments
- Assess the Level of Service (LOS) of road network links in light of generated traffic
- To identify potential road network deficiencies
- To identify public transport opportunities
- Present conclusions and recommendations on road network infrastructure
- Present recommendations on public transport
- Provide comment on how the Very High Speed Train (VHST) may be included in the area

3 Geographical Scope

In accordance with the brief, the key focus is the Eastern Broadacre area as shown in the following Figure 3-1 with red boundaries. However, the SMEC strategic model includes the entire Canberra and Queanbeyan urban area. Traffic across this area will be modelled but findings and recommendations will focus on the study area.

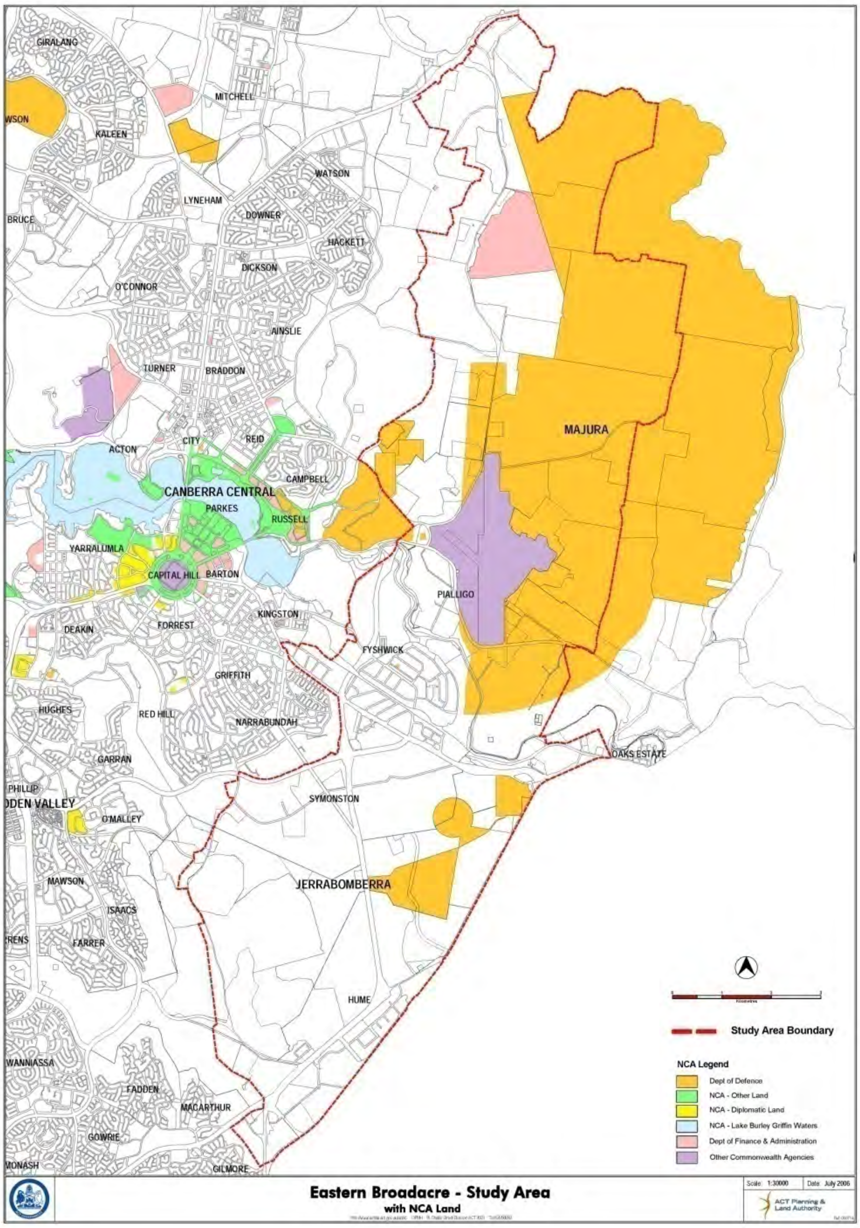

Figure 3-1: Key Study Area Focus

4 Study Methodology

The methodology for this study is presented in Figure 4-1. The stages and tasks are discussed in more detail below.

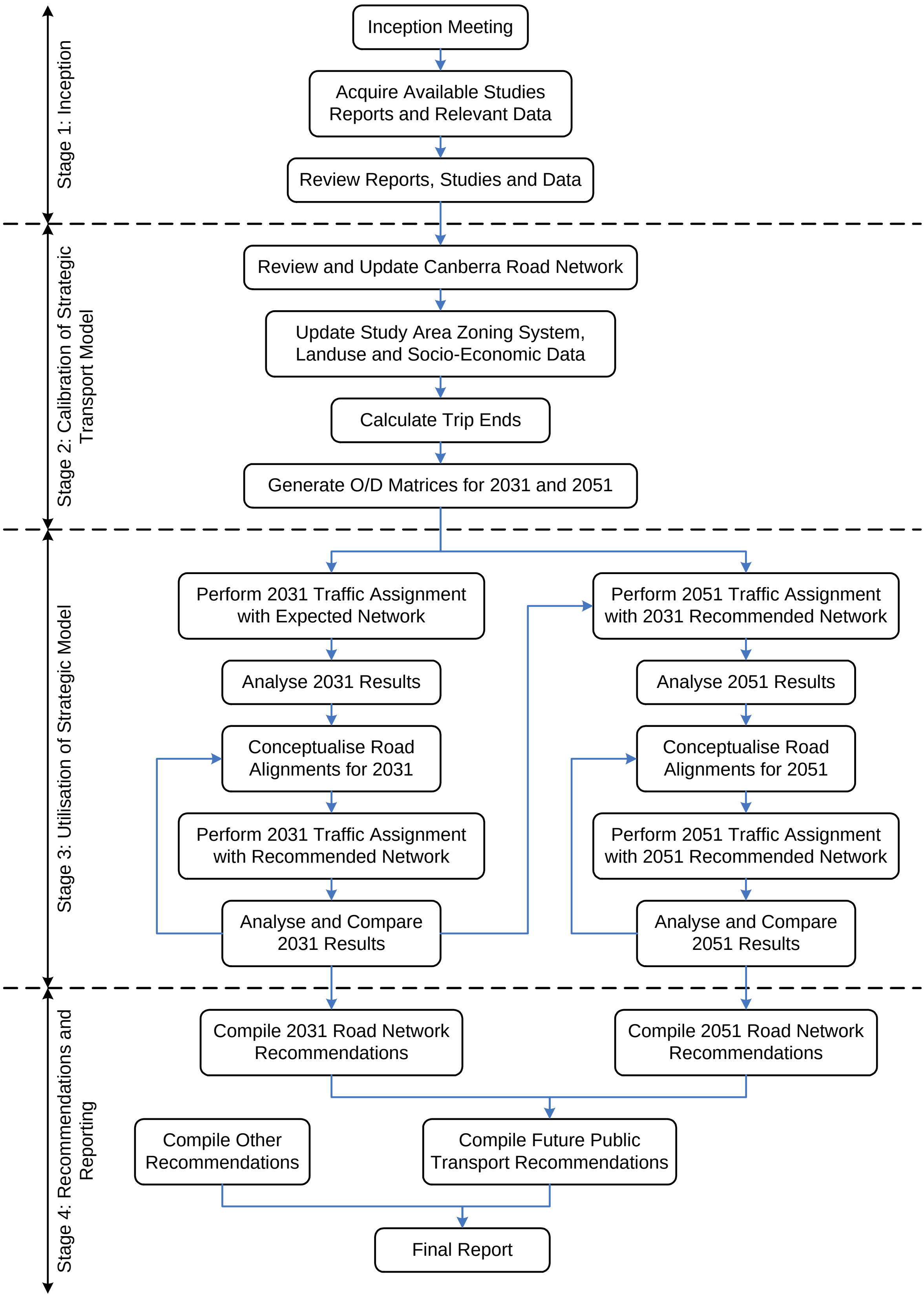

Figure 4-1: Study Methodology

The first stage was the inception stage where two meetings were held, relevant studies, reports, data and information were obtained, reviewed and utilised.

The second stage involved updating and calibrating SMEC's strategic transport model to allow future traffic predictions in light of the proposed employment precincts, future land use and socio economic planning data provided by Macroplan and ACTPLA to be obtained.

The third stage estimated future traffic volumes and then conceptualised road alignments for new roads required to provide necessary connectivity and crossings to link the expected eastern developments to the ACT road network. An iterative process was used to conceptualise and test potential road upgrade options to identify the best options.

Finally, the fourth stage provided an assessment of the transport implications and recommendations for the considered future development options.

A detailed discussion of the main tasks involved in SMEC methodology is presented in the following sections

5 Stage 1: Meetings & Communication

In the course of this study SMEC was involved in a number of meetings and communications with Macroplan, ACTPLA and other ACT government organisations. These included two inception meetings as well as one intermediate meeting. These meetings provided a forum for interaction among SMEC, Macroplan and ACTPLA. They also enabled a better understanding of the requirements of ACTPLA.

5.1 Acquire Available Studies, Reports & Relevant Data

On several occasions, SMEC obtained relevant available and updated data, reports and maps from ACTPLA and Macroplan.

5.2 Review Reports, Studies & Data

SMEC reviewed studies and plans to provide background to the current study. SMEC interpreted and synthesised this information to provide land use and socioeconomic data on expected developments in accordance with SMEC zoning system. These were used to provide the required database for the intended traffic modelling.

6 Stage 2: Update and calibrate Strategic Transport Model

SMEC maintains an in house developed transport model for Canberra that uses TransCAD transport planning software. TransCAD is used to store, display, manage, and analyse transportation data. TransCAD combines Geographic Information Systems (GIS) and transportation modelling capabilities in a single integrated platform. SMEC's TransCAD model was used to obtain the impact of land use and road network changes on the traffic circulation in the study area as well as on neighbouring roads. SMEC has used its TransCAD model in several studies in Canberra including the Molonglo Roads Feasibility Study, Parliamentary Zone Traffic Study, Griffin Legacy Future Transport Modelling, and Pialligo Network Modelling. Throughout these studies, SMEC was able to refine, update and maintain its TransCAD model.

SMEC's model is based on the ACTPLA land use and population data as well as an AM seed matrix provided by ACTPLA. The seed matrix contains a general travel pattern for all of Canberra and Queanbeyan. The landuse data includes population, employment, retail space, school enrolments and tertiary enrolments for each of the ACTPLA zones in Canberra. This data is then converted to match the SMEC zoning system for Canberra. The model also includes a current Canberra and Queanbeyan road network representation and information including expected and potential future road network changes.

Figure 6-1 shows the extent of SMEC's strategic model of Canberra. It can be seen that the model includes all of the Canberra and Queanbeyan urban areas. The model has 854 zones distributed as shown. Table 6-1 shows a sample of the landuse data used as input to the strategic model. These five landuses are used to calculate the number of trips attracted to and produced by each zone.

Table 6-1: Example Landuse Data (Source: ACTPLA Landuse Data)

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m^2)	School Enrolment (Students)	Tertiary Enrolment (Students)
233	350	6,000	200	0	0
234	1,100	2,550	250	850	0

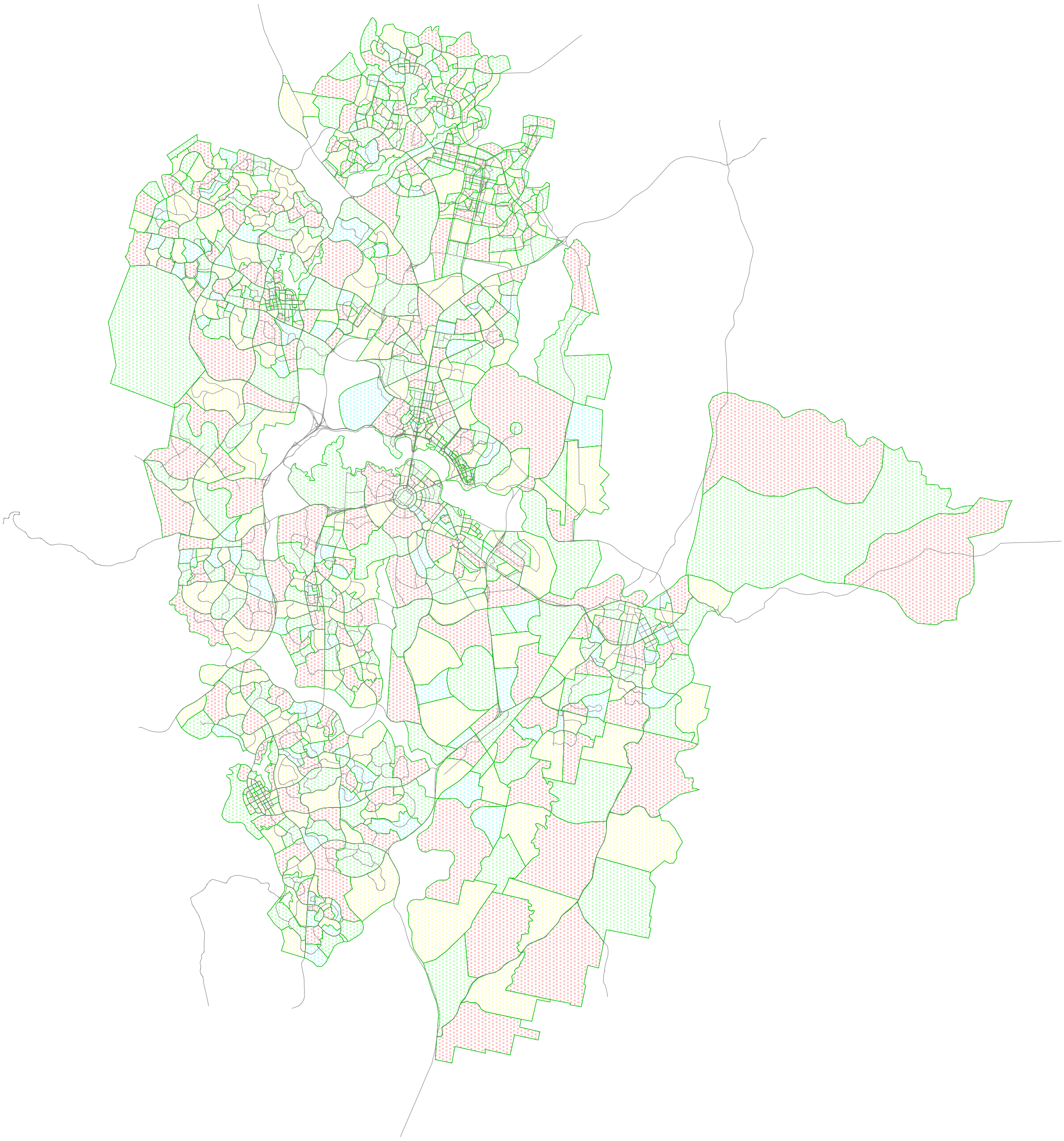

Figure 6-1: Extent of SMEC's TransCAD Model of Canberra with Landuse Zones

6.1 Calibration of Strategic Transport Model

For this project, SMEC updated its strategic model of Canberra and produced a 2031 and a 2051 Origin/Destination (O/D) matrices and respective expected road networks to simulate the traffic flows in and around the study area. The O/D matrices show how many vehicles are expected to travel from each zone to each other zone. This means the matrices are 854 rows by 854 columns and include 729,316 cells or possible trips.

Calibration is the process whereby a strategic model is developed or updated to simulate real conditions as closely as possible. The calibration process undertaken by SMEC was as follows:

1. Review and update the road network for Canberra including expected, planned and newly conceptualised road network projects to 2031.
2. Obtain the most up to date land use and socio economic data for the expected developments from ACTPLA and Macroplan for 2031 and 2051.
3. In light of provided data and information, review and refine zoning system in the study area. This includes Eastern Broadacre employment precincts, Canberra Airport, Fyshwick, Hume and an expanded security (Defence and AFP) presence at Majura.

4. In light of provided data and information, review and refine zoning system outside the study area. This includes Eastlake, Canberra Central, Tralee, Googong, Kowen and the expanded Defence HQ at Bungendore.
5. Compute produced and attracted trips using appropriate trip production and attraction rates.
6. Generate 2031 and 2051 Origin/Destination matrices for Canberra including the study area using TransCAD.
7. Run appropriate assignment algorithm and obtain loaded road network for the considered future scenarios.

Each of these tasks is explained further in the following sections.

6.2 Review & Update Canberra Road Network

The Canberra modelled road network consists of nodes and links. Each link has properties such as length, capacity, free-flow speed and travel time. Operating speeds were set to the current speed limits. Capacities and free flow speeds were calculated using Austroads and HCM manuals, see Table 6-2. Travel time is calculated from the length of the link and the free flow speed.

Table 6-2: Road Network Capacities

Type of Network Facility	Peak Hour Capacity	Source
Freeway Basic Section	2300 veh/hr/lane at FFS 100 km/hr	HCM 2000
Freeway One lane Ramp	1800 veh/hr/lane	HCM 2000
Two Lane Highway	1600 veh/hr/lane	HCM 2000
Multilane Highway	2000 veh/hr/lane at FFS of 80 km/hr	HCM 2000
2 lane divided interrupted urban arterial	1000 veh/hr/lane	Austroads 1999
2 lane undivided interrupted urban arterial	900 veh/hr/lane	Austroads 1999
4 lane undivided urban arterial with interrupted flow (non-clearway conditions)	750 veh/hr/lane	Austroads 1999
4 lane undivided urban arterial with interrupted flow (clearway conditions)	900 veh/hr/lane	Austroads 1999
4 lane divided urban arterial with interrupted flow (clearway conditions)	950 veh/hr/lane	Austroads 1999
6 lane undivided urban arterial with interrupted flow (non-clearway conditions)	800 veh/hr/lane	Austroads 1999
6 lane undivided urban arterial with interrupted flow (clearway conditions)	967 veh/hr/lane	Austroads 1999

The Canberra road network was then updated to include all planned and expected road network changes expected to be complete by 2031. The development of the future road networks will provide a representation of expected capacities and levels of service that the future road networks can accommodate. The future road network used includes the additions shown in Table 6-3. For a diagram showing these changes, see Figure 6-2.

Table 6-3: Canberra Future Road Network Additions Expected by 2031

Road/Location (Type of Change)	Change
Clarrie Hermes Dr (Extension)	Extension through to intersection of Barton Highway and Kuringa Dr
Glenloch Interchange (Modification)	Upgraded to include GDE (Stage 2)
Gungahlin Dr Extension (Modification)	Completed through to Glenloch Interchange (2 lanes each way)
Horse Park Dr (Extension)	Completion of route through Moncrieff, Jacka, Casey and Taylor
Majura Parkway (Addition)	Completed (2 lanes each way)
Molonglo (Addition)	Molonglo network modelled to reflect latest development plan
Queanbeyan Bypass (Addition)	From Canberra Avenue (West of Queanbeyan) to Kings Highway (East of Queanbeyan)
Sandford St (Extension)	Extension through to intersection of Federal Highway and Antill St
Wells Station Dr (Extension)	Extension from Gungahlin Drive across Flemington Rd to Horse Park Dr
Kowen Link (Addition)	Completed (2 lanes each way) from Kowen to Fairbairn Avenue
Airport Northern Access Road (Addition)	Completed
Googong/Tralee Network (Addition)	Completed
Edwin Land Parkway (Addition)	Completed
Newcastle St (Extension)	Completed to allow better access to Eastlake development
Isabella Dr (Extension)	Extended across Monaro Hwy to provide access to Googong/Tralee

In addition to the network changes shown in Table 6-3, there were a number of upgrades made to existing roads in the network as shown in Table 6-4. These changes are based on upgrades to existing network elements that are expected to take place before 2031.

Table 6-4: Canberra Future Road Network Modifications Expected by 2031

Road	Location	Change
Gundaroo Dr	Barton Hwy to Mirrabei Dr	Upgraded to 4 lanes
Gungahlin Dr	Wanganeen Ave to Barton Hwy	Upgraded to 4 lanes
Hindmarsh Dr	Jerrabomberra Ave to Monaro Hwy	Upgraded to 6 lanes
Horse Park Dr	Gundaroo Dr to Federal Hwy	Upgraded to 4 lanes
Monaro Hwy	Newcastle St to Pialligo Ave	Upgraded to 6 lanes
Monaro Hwy	Isabella Dr to Hindmarsh Dr	Upgraded to 6 lanes

Road	Location	Change
Barton Highway	Victoria Street to North	Upgraded to 4 lanes
College Street	Haydon Drive to Eastern Valley Way	Upgraded to 4 lanes
Constitution Avenue	Anzac Parade to Northcott Drive	Upgraded to 4 lanes
Coulter Drive	Belconnen Way to Southern Cross Drive	Upgraded to 6 lanes
Flemington Road	Sandford Street to Hibberson St	Upgraded to 4 lanes
Gungahlin Drive	Gundaroo Drive to Anne Clark Avenue	Upgraded to 4 lanes
Gungahlin Drive Extension	Parkes Way to Barton Highway	Upgraded to 4 lanes
Hindmarsh Drive	Monaro Highway to Jerrabomberra Avenue (Westbound)	Upgraded to 3 lanes
Lanyon Drive	Monaro Highway to Tompsitt Drive	Upgraded to 4 lanes
Monaro Highway	Isabella Drive to Hindmarsh Drive	Upgraded to 6 lanes
Monaro Highway	South to Johnson Drive (Northbound)	Upgraded to 4 lanes
Parkes Way	Glenloch Interchange to Coranderrk Street	Upgraded to 6 lanes
Pialligo Avenue	Oaks Estate Road to Ulinga Place	Upgraded to 4 lanes

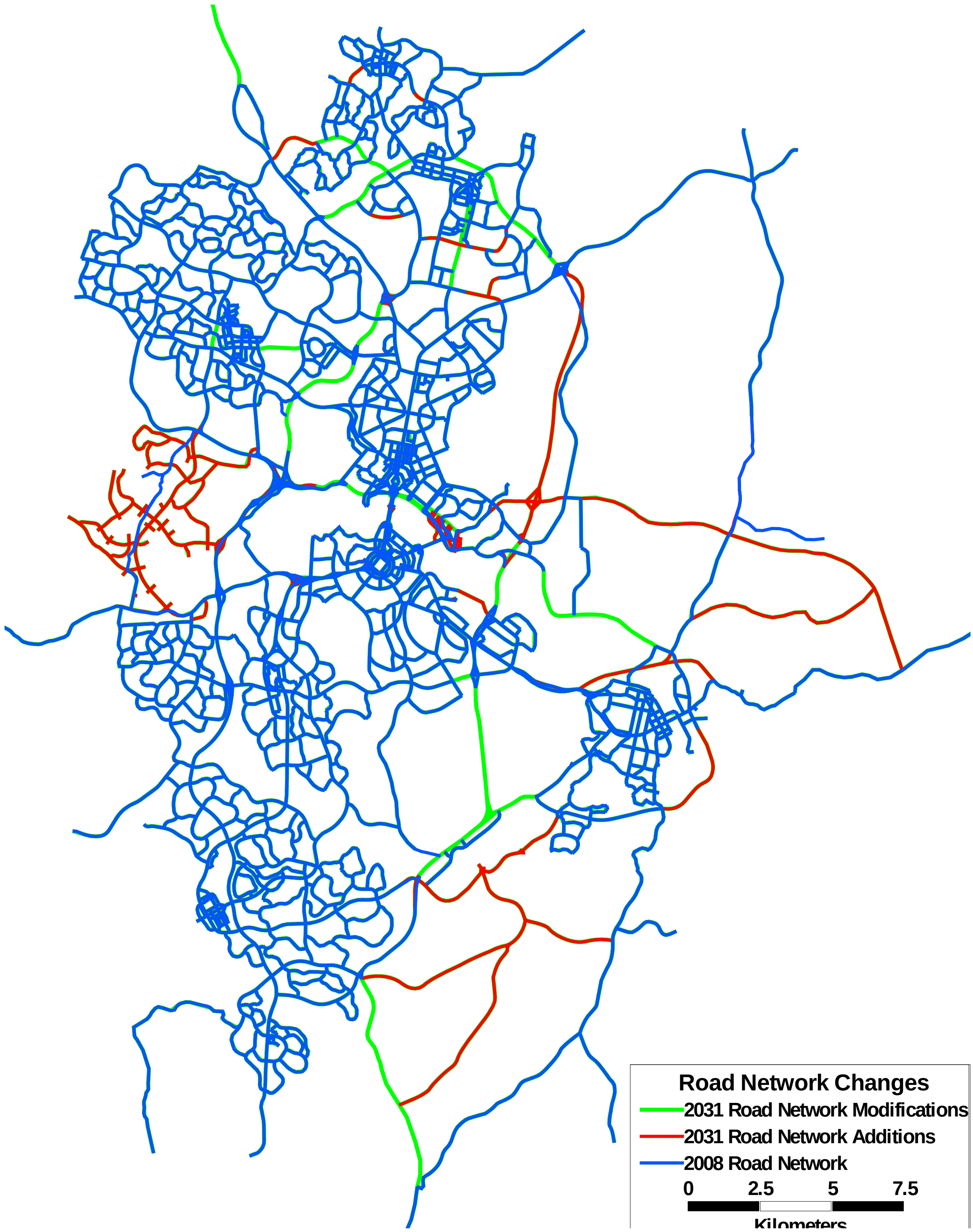

Figure 6-2: Expected Road Network Changes in 2031

SMEC notes the advice to ACTPLA from Territory and Municipal Service (TAMS) (02/06/2008) that the initial connections from Tralee in particular are to be via Tompsitt Drive and Lanyon Drive, and these will suffice for most, if not all, of the first ten years of development of Tralee. Thus the initial linkages will be via Lanyon Drive, not a conceptual link between Sheppard Street and the ACT Border. However, by 2031, it is assumed that the Isabella Dr connection will be complete.

The Kowen link has been aligned to travel around the defence firing areas at Majura.

6.3 Update Study Area Zoning System, Land Use & Socio Economic Data

The zoning system for the study area and the immediate area surrounding it was reviewed to determine if any changes are needed to cater for the expected land use, population and socio-economic changes. For many zones, there was assumed to be no growth between 2031 and 2051. The tables presented for 2031 and 2051 show the total landuse for each zone. If there is no change in the landuse in a zone between 2031 and 2051, the data in the tables for 2031 and 2051 will be the same.

The following two future scenarios are taken into account:

- 2031 to include:
  - Molonglo (Full Development)
  - Canberra Central development in accordance with NCA (West Basin development excluded)
  - Eastern Broadacre (2031 Expected Development)
  - East Lake (Full Development)
  - Tralee and Googong (2031 Expected Development)
  - Kowen (2031 Expected Development)
  - Canberra airport according to the draft 2008 master plan (2031 Expected Development)
- 2051 to include all of the above as well as:
  - Eastern Broadacre (2051 Expected Development)
  - Kowen (2051 Expected Development)

The details of these developments are presented in the following sections.

6.4 Land Use and Zoning System for Eastern Broadacre

The following diagram shows a summary of the initial land use assumptions within the study area. This was provided by Macroplan in its brief. This diagram does not show the expected land use assumptions for the Eastern Broadacre.

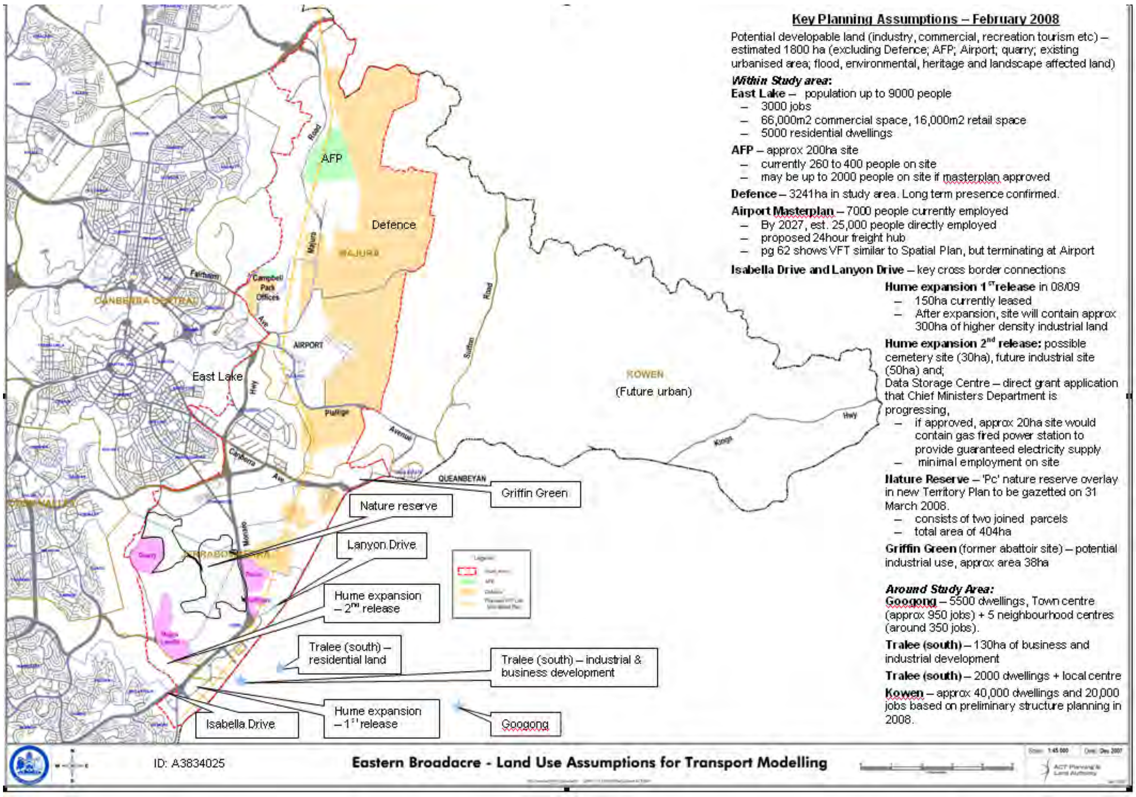

Figure 6-3: Initial Land Use Assumptions for Transport Modelling (Source: Macroplan)

SMEC examined, interpreted and synthesised planning data provided at different times from different sources (ACTPLA, Macroplan, Queanbeyan City Council via ACTPLA, Canberra Airport Draft Master Plan, etc) in the course of the study. In this context, SMEC took into consideration:

- Macroplan employment scenarios for Eastern Broadacre;
- Proposed land releases in Queanbeyan City Council (Googong and Tralee);
- Expected office developments in the Central of Canberra (e.g.: consistent with Canberra Central implementation without West Basin);
- East Molonglo expected Development by 2031;
- Proposals under the Canberra International Airport Master Plan 2008;
- Future urban development at Kowen;
- Residential intensification projects in Canberra, namely Eastlake; and
- Expansion of security presence in the Majura area (Defence, AFP) and new headquarters at Bungendore.

In the following sub-sections, SMEC will show for each of the development areas the distribution of socio economic data among SMEC's adopted zoning system.

Eastern Broadacre

The Eastern Broadacre area is expected to be primarily an employment corridor. Figure 6-4 shows the employment precincts identified by Macroplan. The developable land was assumed to be developed by 2071. This allows time for population in the region to grow in line with the employment. It was assumed that the development would happen linearly over time. This leads to 37% of the employment land being developed by 2031 and 68% by 2051. Table 6-5 shows the developable land areas and the associated employment for each precinct in the Eastern Broadacre study area.

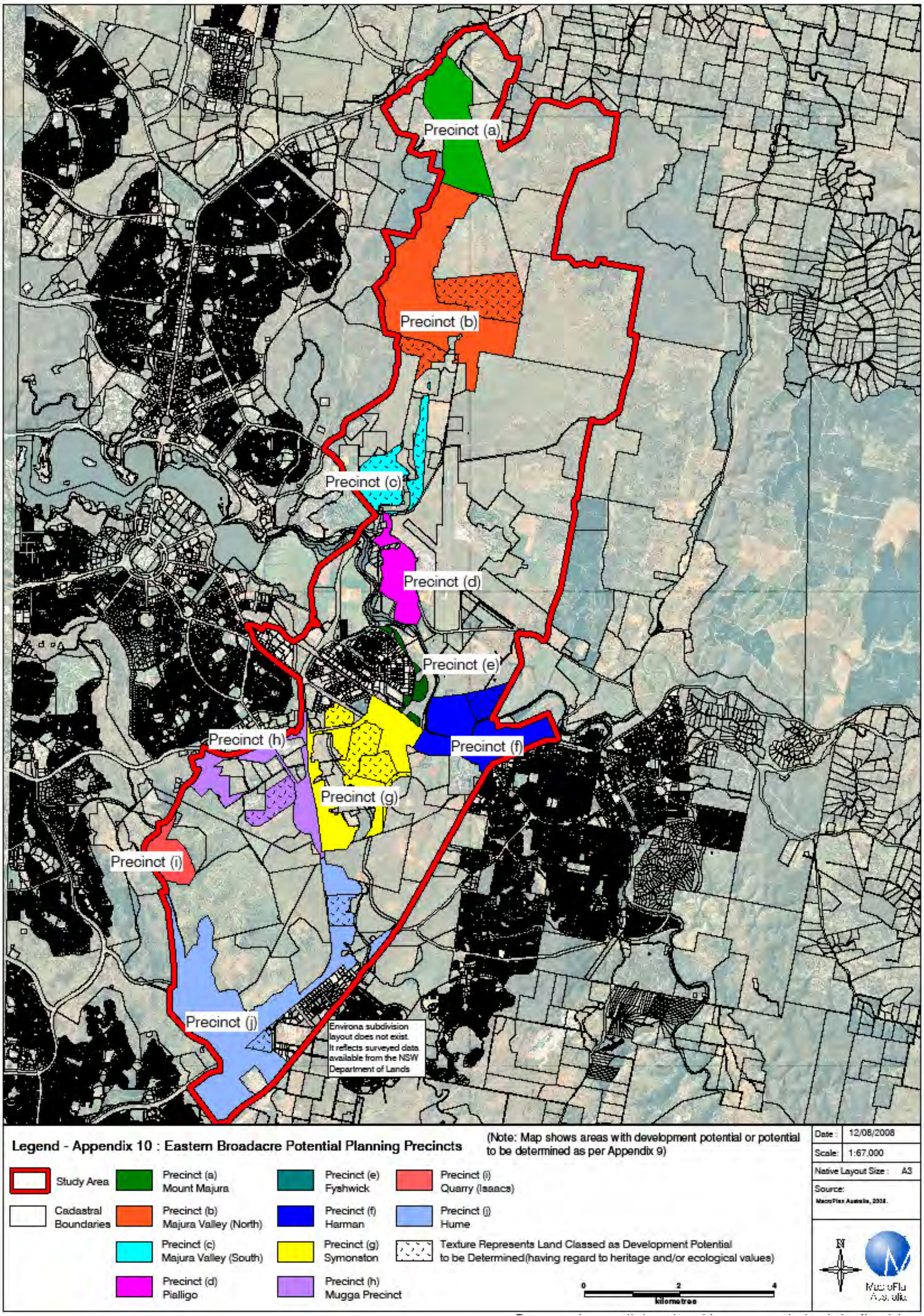

Figure 6-4: Eastern Broadacre Employment Precincts

Table 6-5: Medium Scenario (Developable land) (Source Macroplan)

Precinct	Developable Land Area (ha)	Precinct role	Expected employment per hectare	Total emp (2031)	Total emp (2051)	Total emp (2071)
(a)	239	Tourism, Recreation	50	4,355	8,141	11,929
(b)	479	Transport, Warehouse, Storage, Security	20	3,499	6,540	9,583
(c)	0	Storage, freight, logistics, airport related, transport	30	0	0	0
(d)	121	Tourism, innovative emerging industries, light industrial, trade park	50	2,309	4,317	6,325
(e)	30	Bulky goods, retail, light industrial, trade park, warehouse, emerging innovative industries	50	1,286	2,404	3,522
(f)	250	Transport, warehouse, office, bulky goods	50	5,394	10,083	14,775
(g)	260	Office and business park	100	9,516	17,789	26,067
(h)	177	Office, pharmaceuticals, warehouse, office	80	4,702	8,790	12,880
(i)	88	Broadacre	20	645	1,206	1,767
(j)	620	Manufacturing, component assembly, transport warehouse/storage, light industrial	30	6,787	12,687	18,590
Employment in all precincts (BASED ON DEVELOPABLE LAND ONLY)				38,493	71,957	105,438

This employment data was transferred to SMEC's TransCAD model zoning system. Figure 6-5 shows the SMEC zones that have been modified to include the Eastern Broadacre employment data. Table 6-6 and Table 6-7 show the landuse information for 2031 and 2051 respectively. Most of these zones already included data from ACTPLA and the Eastern Broadacre employment information has been added to these zones. A notable zone is Zone 416. This zone includes part of Fyshwick so it has considerable amounts of retail space as well as the Eastern Broadacre employment data. Zones have been altered in the SMEC model to align as closely as possible with the Macroplan zones. For some zones, the SMEC zone does not match the Macroplan zone exactly. However, the zone is used to generate traffic based on the landuse inside it so as long as the landuse data is correct for the zone, the traffic generation will be consistent with other forecasts.

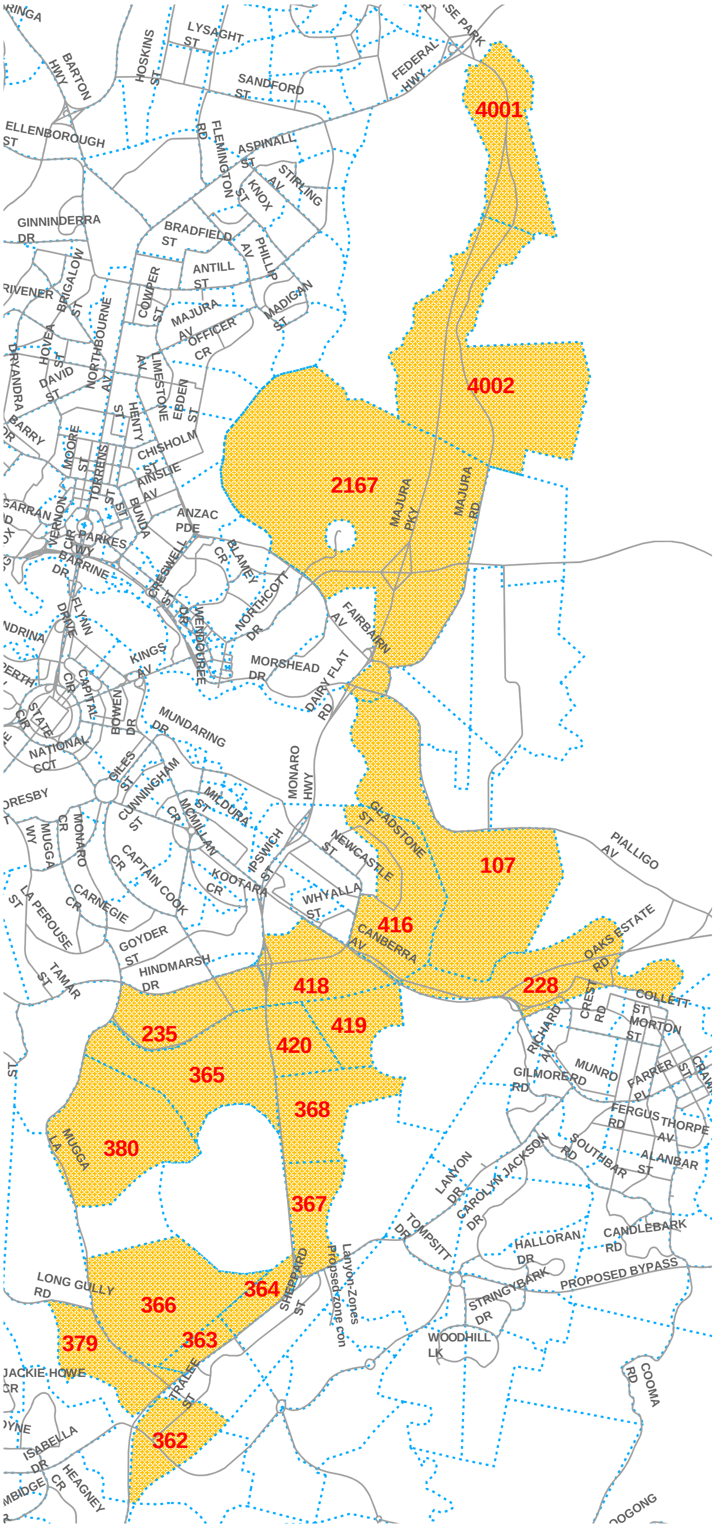

Figure 6-5: Eastern Broadacre SMEC Zoning System (Source: SMEC)

Table 6-6: Eastern Broadacre Land Use 2031

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
4001	0	4,355	0	0	0
4002	0	3,499	0	0	0
2167	67	411	1,348	0	0
107	33	2,309	652	0	0
228	350	5,434	700	0	0
416	0	6,165	87,500	0	0
418	300	2,203	9,375	0	0
419	300	2,379	0	0	0
420	200	1,190	0	0	0
235	73	2,586	0	0	0
362	0	1,616	5,000	0	0
363	0	646	0	0	0
364	0	323	1,000	0	0
365	123	2,746	0	0	0
366	0	1,616	0	0	0
367	0	970	0	0	0
368	0	2,379	0	0	0
379	0	1,616	0	0	0
380	0	645	0	0	0
Total	1446	43,088	105,575	0	0

Table 6-7: Eastern Broadacre Land Use 2051

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
4001	0	8,141	0	0	0
4002	0	6,540	0	0	0
2167	67	411	1,348	0	0
107	33	4,317	652	0	0
228	350	10,083	700	0	0
416	0	9,352	87,500	0	0
418	300	3,237	9,375	0	0
419	400	4,447	0	0	0
420	300	2,224	0	0	0
235	73	4,630	0	0	0
362	0	3,021	5,000	0	0
363	0	1,208	0	0	0
364	0	604	1,000	0	0
365	123	4,790	0	0	0

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m^2)	School Enrolment (Students)	Tertiary Enrolment (Students)
366	0	3,021	0	0	0
367	0	1,812	0	0	0
368	0	4,447	0	0	0
379	0	3,021	0	0	0
380	0	1,206	0	0	0
Total	1646	76,512	105,575	0	0

Canberra Central

Traditionally TAMS has used ACTPLA's Canberra Central estimates for its transport modelling purposes. However, TAMS is currently establishing other "rationalised" scenarios. These are in preparation and are not available to SMEC for this project.

TAMS originally did not provide SMEC with Canberra Central estimates for its existing model. Rather, Maunsell's report on the Griffin Legacy implementation, commissioned by the National Capital Authority, was provided by the NCA as input into the SMEC model.

SMEC is utilising the following diagram provided in the past to SMEC by NCA as the basis for modelling the expectations for Canberra Central.

Note that the details for West Basin (391,800m2) were not used for the Eastern Broadacre modelling because the NCA advised in early 2008 that it is unlikely that this development will proceed.

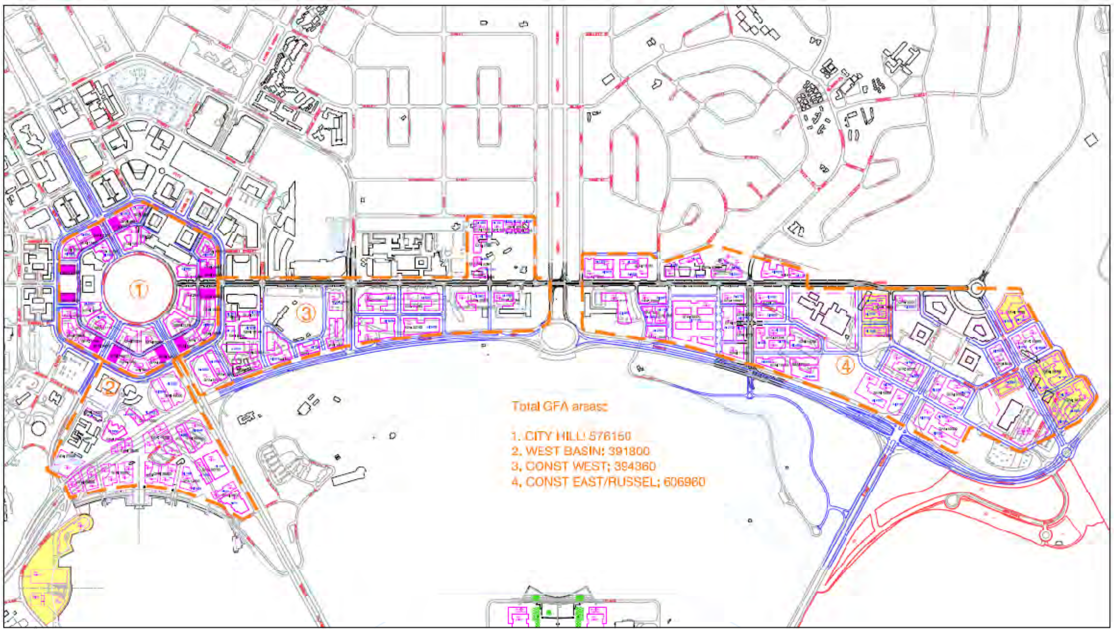

Figure 6-6: Canberra Central Developments (Source: NCA)

SMEC zoning system and land use input data for Canberra Central are shown in Figure 6-7, Table 6-8 and Table 6-9.

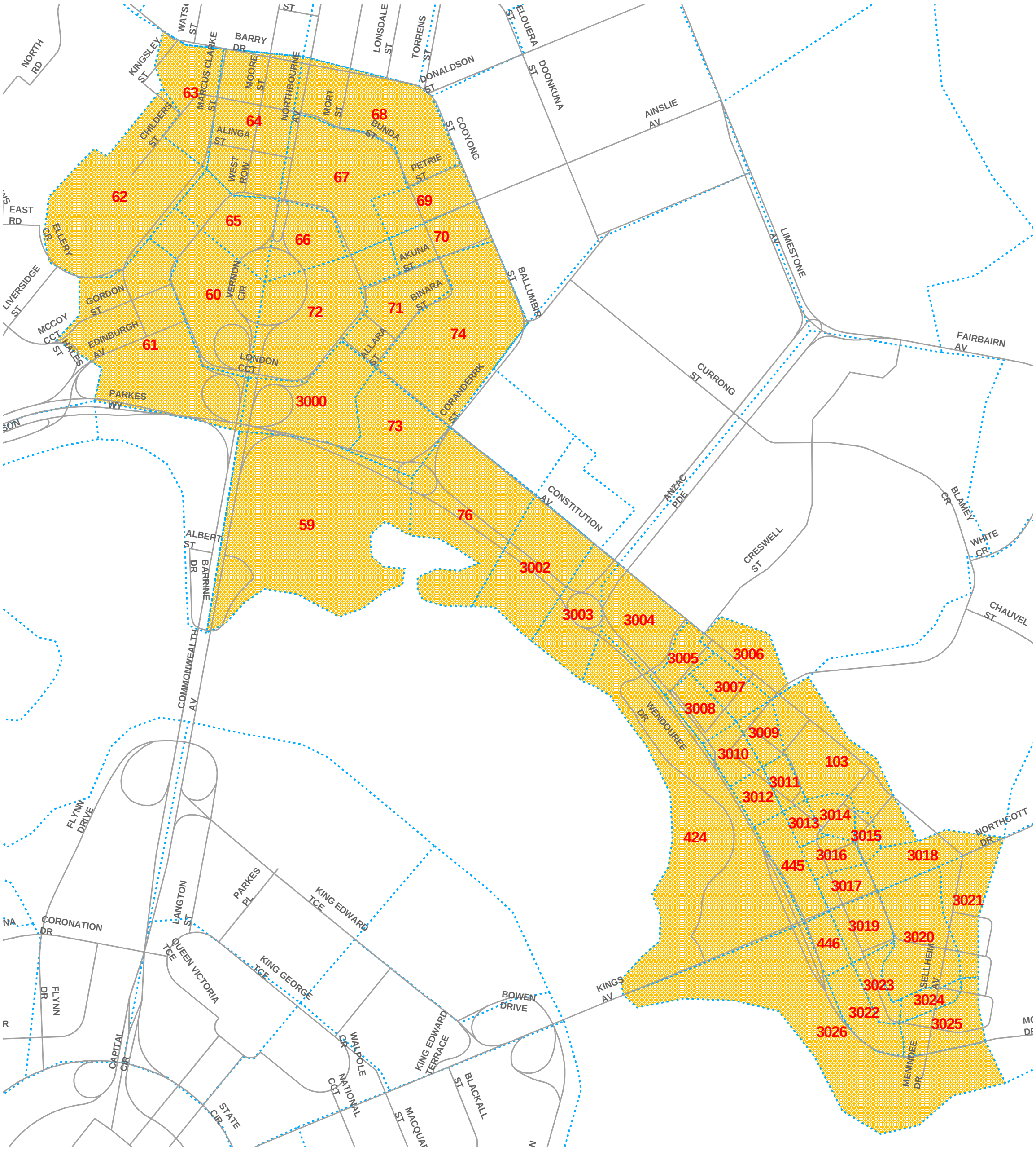

Figure 6-7: Canberra Central SMEC Zoning System (Source: SMEC)

Table 6-8: Canberra Central Land Use 2031

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
3000	150	625	0	0	0
60	1,200	10,863	0	0	0
61	1,050	3,863	500	0	0
62	486	1,174	7,000	0	0
63	714	1,277	1,200	0	0
64	100	4,276	9,000	0	0
65	250	1,213	10,500	0	0
66	0	1,063	3,450	0	0
67	200	1,313	3,000	0	0

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m^2)	School Enrolment (Students)	Tertiary Enrolment (Students)
68	1,000	5,688	37,500	0	0
69	0	2,000	28,000	0	0
70	0	2,125	23,500	0	0
71	100	1,463	4,000	0	0
72	0	7,063	0	0	0
73	400	1,500	350	0	0
74	150	4,288	2,000	0	0
59	0	63	0	0	0
76	0	1,063	0	0	0
3002	0	1,000	0	0	0
3003	0	0	0	0	0
3004	0	250	0	0	0
3005	600	188	200	0	0
3007	0	2,500	0	0	0
3008	800	188	0	0	0
424	0	0	0	0	0
103	0	875	0	0	0
445	0	625	0	0	0
3009	0	0	0	0	0
3010	0	0	0	0	0
3011	0	0	0	0	0
3012	0	0	0	0	0
3013	0	90	0	0	0
3014	0	1,250	0	0	0
3015	0	375	0	0	0
3016	0	0	0	0	0
3017	0	0	0	0	0
3018	0	250	0	0	0
3006	0	1,300	0	0	0
446	0	1,375	0	0	0
3019	0	0	0	0	0
3020	0	1,375	0	0	0
3021	0	0	0	0	0
3022	0	0	0	0	0
3023	0	0	0	0	0
3024	0	1,250	0	0	0
3025	0	0	0	0	0
Total	7,200	63,811	130,200	0	0

Table 6-9: Canberra Central Land Use 2051

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m^2)	School Enrolment (Students)	Tertiary Enrolment (Students)
3000	150	625	0	0	0
60	1,200	10,863	0	0	0
61	1,050	3,863	500	0	0
62	486	1,174	7,000	0	0
63	714	1,277	1,200	0	0
64	100	4,276	9,000	0	0
65	250	1,213	10,500	0	0
66	0	1,063	3,450	0	0
67	200	1,313	3,000	0	0
68	1,000	5,688	37,500	0	0
69	0	2,000	28,000	0	0
70	0	2,125	23,500	0	0
71	100	1,463	4,000	0	0
72	0	7,063	0	0	0
73	400	1,500	350	0	0
74	150	4,288	2,000	0	0
59	0	63	0	0	0
76	0	1,063	0	0	0
3002	0	1,000	0	0	0
3003	0	0	0	0	0
3004	0	250	0	0	0
3005	600	188	200	0	0
3007	0	2,500	0	0	0
3008	800	188	0	0	0
424	0	0	0	0	0
103	0	875	0	0	0
445	0	625	0	0	0
3009	0	0	0	0	0
3010	0	0	0	0	0
3011	0	0	0	0	0
3012	0	0	0	0	0
3013	0	90	0	0	0
3014	0	1,250	0	0	0
3015	0	375	0	0	0
3016	0	0	0	0	0
3017	0	0	0	0	0

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
3018	0	250	0	0	0
3006	0	1,300	0	0	0
446	0	1,375	0	0	0
3019	0	0	0	0	0
3020	0	1,375	0	0	0
3021	0	0	0	0	0
3022	0	0	0	0	0
3023	0	0	0	0	0
3024	0	1,250	0	0	0
3025	0	0	0	0	0
Total	7,200	63,811	130,200	0	0

East Lake

The following diagram, see Figure 6-8, shows the adopted zoning system for the East Lake study area. This zoning system was adapted from information provide by ACTPLA. In addition Table 6-10 and Table 6-11 show the Population, Employment and Retail Expectations for 2031 and 2051 in East Lake. It was assumed that there would be no further development of Eastlake after 2031. This means that the landuse will be the same in 2031 and 2051. ACTPLA advised SMEC to break down a previously provided total of 82,000m² retail space to 66,000m² for commercial space and 16,000m² for retail.

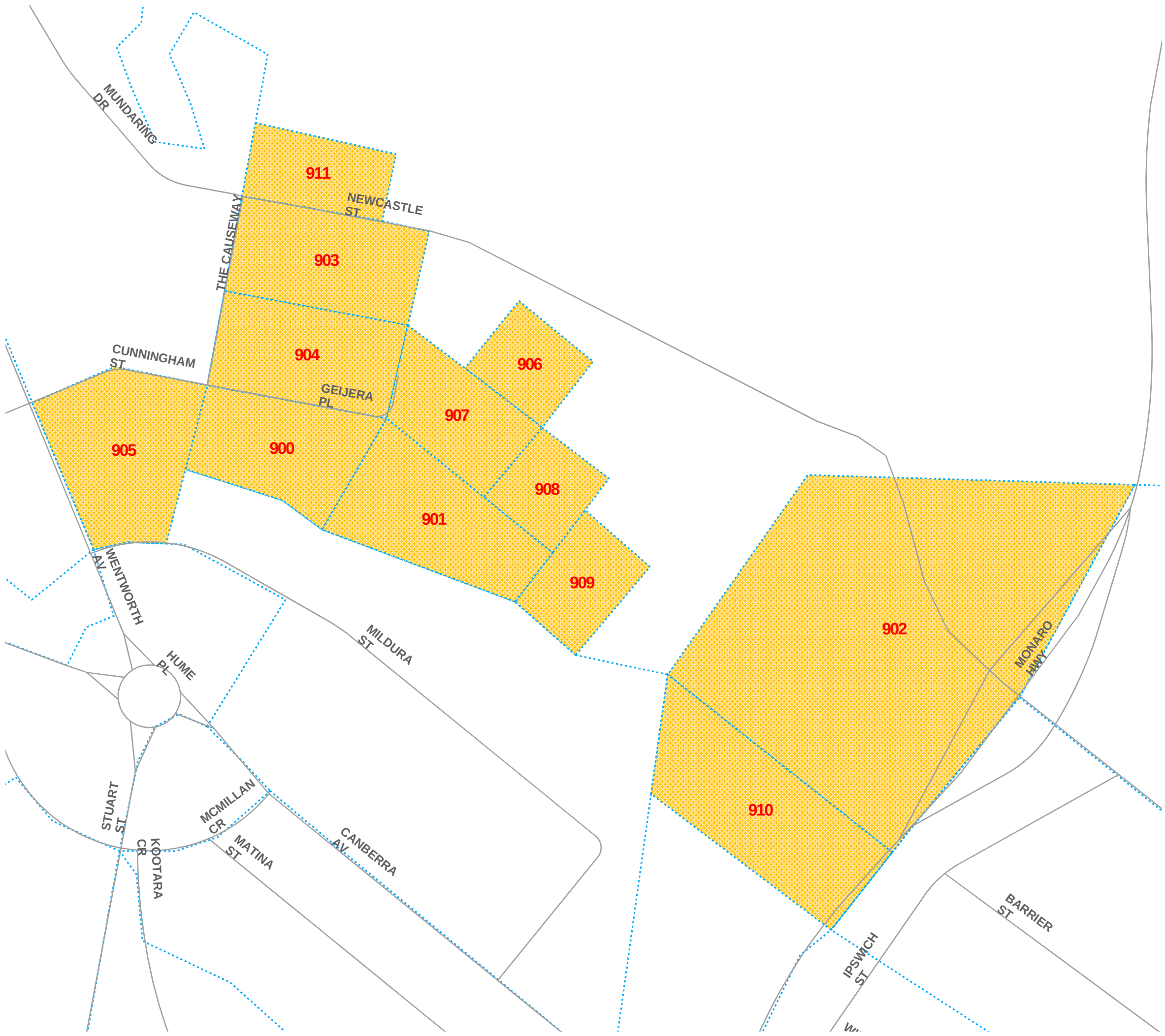

Figure 6-8: East Lake SMEC Zoning System (Adapted from ACTPLA)

Table 6-10: East Lake Land Use 2031

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
900	1,400	114	780	0	0
901	517	86	585	0	0
902	0	1,000	6,829	0	0
903	992	0	0	0	0
904	1,456	314	0	0	0
905	791	236	585	0	0
906	422	0	0	0	0
907	401	0	0	0	0
908	791	0	0	0	0
909	443	157	390	0	0
910	0	1,000	6,829	0	0
911	744	0	0	0	0
Total	7,957	2,907	15,998	0	0

Table 6-11: East Lake Land Use 2051

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m^2)	School Enrolment (Students)	Tertiary Enrolment (Students)
900	1,400	114	780	0	0
901	517	86	585	0	0
902	0	1,000	6,829	0	0
903	992	0	0	0	0
904	1,456	314	0	0	0
905	791	236	585	0	0
906	422	0	0	0	0
907	401	0	0	0	0
908	791	0	0	0	0
909	443	157	390	0	0
910	0	1,000	6,829	0	0
911	744	0	0	0	0
Total	7,957	2,907	15,998	0	0

Security (Australian Federal Police, Defence)

The AFP site is assumed to have 2000 employment in 2031 (Source: Macroplan). The AFP site is accessed from Majura Road. The AFP site is assumed to have the same amount of employment in 2051.

The Defence presence at Majura and the Defence HQ expansion at Bungendore have been modelled.

Airport

Macroplan states that, according to the 2008 Airport Draft Master Plan, the airport is expected to have approx 25,000 employment at the airport in 2027. This has been assumed to be the case in 2031 as well. The Airport is assumed to have the same level of employment in 2051. The airport is broken into 4 zones. Figure 6-9 shows the zoning adopted by SMEC. Table 6-12 and Table 6-13 show the landuse for 2031 and 2051 respectively.

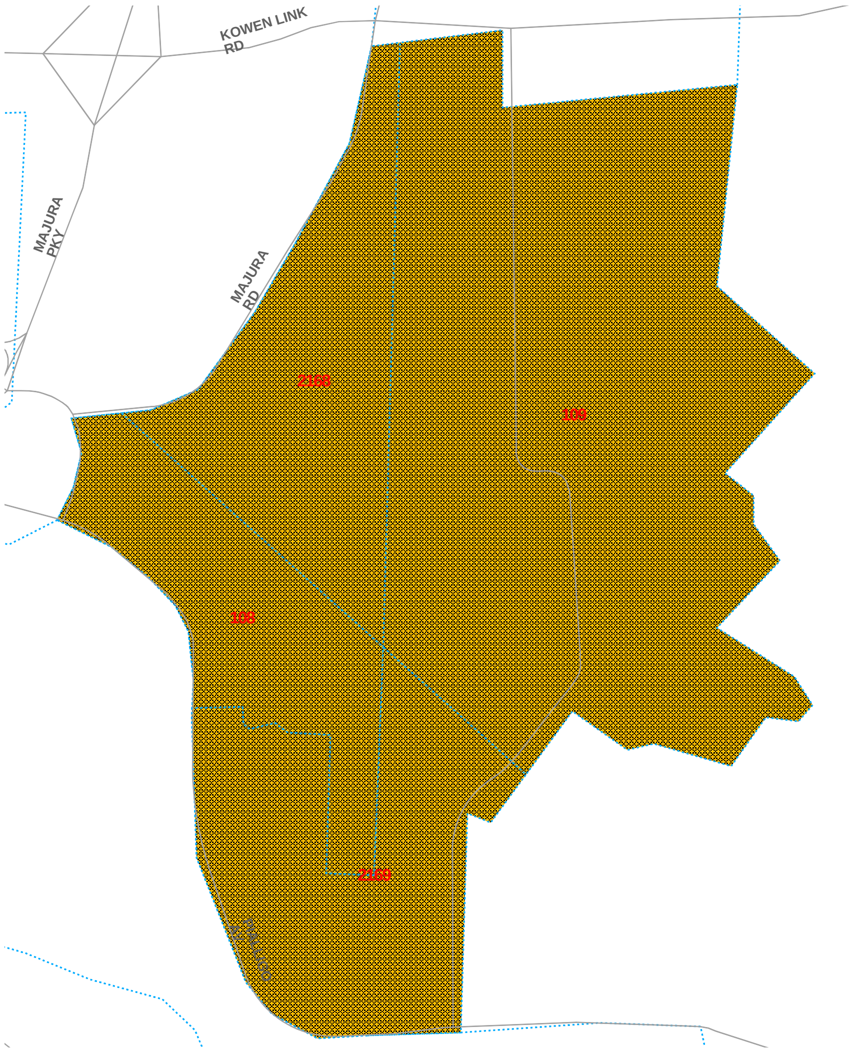

Figure 6-9: Airport Zoning System Adopted by SMEC

Table 6-12: Airport Land Use 2031

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
108	0	7,000	0	0	0
109	0	500	4,000	0	0
2168	0	8,750	2,000	0	0
2169	0	8,750	80,000	120	0
Total	0	25,000	86,000	120	0

Table 6-13: Airport Land Use 2051

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
108	0	7,000	0	0	0
109	0	2,100	4,000	0	0
2168	0	8,750	2,000	0	0
2169	0	8,750	80,000	120	0
Total	0	26,600	86,000	120	0

Queanbeyan New Release Areas (Googong, Tralee)

The zones in this area have been updated to match the gazetted suburbs from Queanbeyan City Council shown in Figure 6-10. Landuse for these zones is based on QCC Forecast ID data supplied to SMEC by ACTPLA. The zoning system adopted by SMEC is shown in Figure 6-11. Table 6-14 and Table 6-15 show the 2031 and 2051 landuse respectively.

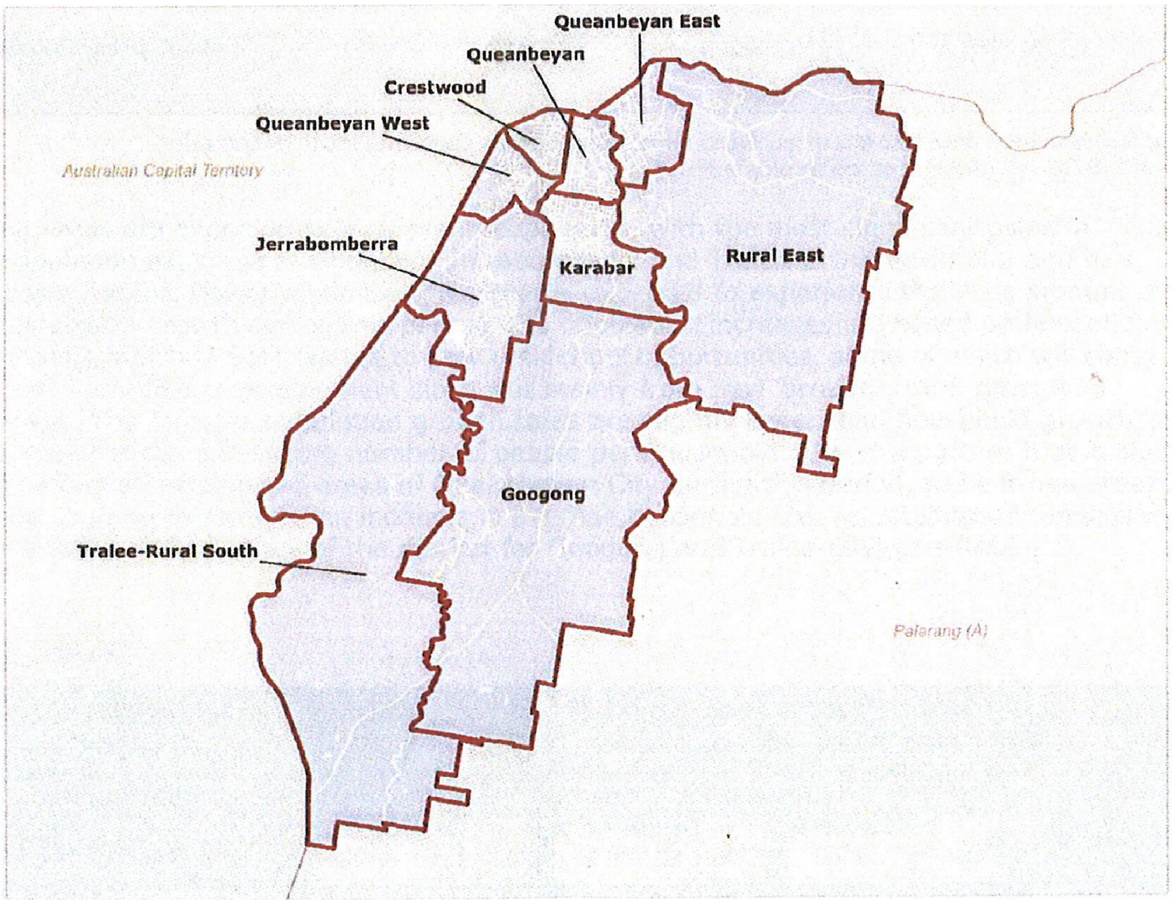

Figure 6-10: Boundaries for Tralee and Googong (Source: Queanbeyan City Council)

In terms of release areas in Queanbeyan City Council (QCC) population and employment estimates are difficult to determine at this stage as both Googong and South Jerrabomberra proposed release areas are subject to ongoing studies and review. The Queanbeyan City Council Residential and Economic Strategy 2031 proposed 10,000 new dwellings which included approximately:

- 500 infill within Queanbeyan,
- 5550 at Googong and
- the balance (3950) at South Jerrabomberra

South Jerrabomberra

The approved strategy did not include any residential at the Poplars and deferred land at North Tralee (1625 dwellings). As such, the balance of 3950 dwellings was reduced to a possible 2000 dwellings at South Tralee, Environa and Robin, pending a decision on North Tralee/Environa.

According to ACTPLA instructions: as far as South Tralee is concerned, although only 2000 dwellings are 'approved' under QCC endorsed Strategy, an estimate of 3625 dwellings for North and South Tralee total should be used to indicate the potential scenario with land release in QCC. This is appropriate as QCC has had a sustained period of rapid population growth and it is possible that corresponding pressure for further land release beyond South Tralee, will occur in the period to 2031.

In terms of employment, the endorsed strategy outlined 130 ha at South Jerrabomberra, near the existing industrial area of Hume. Of the proposed 130 ha of employment land, the split of industrial as opposed to higher employment oriented land uses has not been confirmed. Council will seek to retain a certain amount of traditional industrial land within the proposed 130 ha, and that will affect employment estimates. This 130ha development has been included in the modelling. Further work is required by QCC on the split of industrial/ commercial. In addition, employment estimates need to take into account the need for a neighbourhood centre (the size of which is also unable to be determined at this stage, due to the deferral of North Tralee/Environa).

Should developments within South Jerrabomberra be approved, the centre would need to cater for between 2000 and 3625 dwellings, without adversely impacting upon existing centres.

Googong

QCC Strategy proposes 5550 dwellings at Googong. QCC preliminary estimates (June 2008) are that Googong would include a town centre (approx 950 jobs), together with a total of 350 additional jobs in non-town centre employment (i.e.: across 5 neighbourhood centres, schools etc).

The draft LEP includes a B2 zone for the town centre of around 16.5ha. The floor space and size of neighbourhood centres is currently being determined and subject to additional studies.

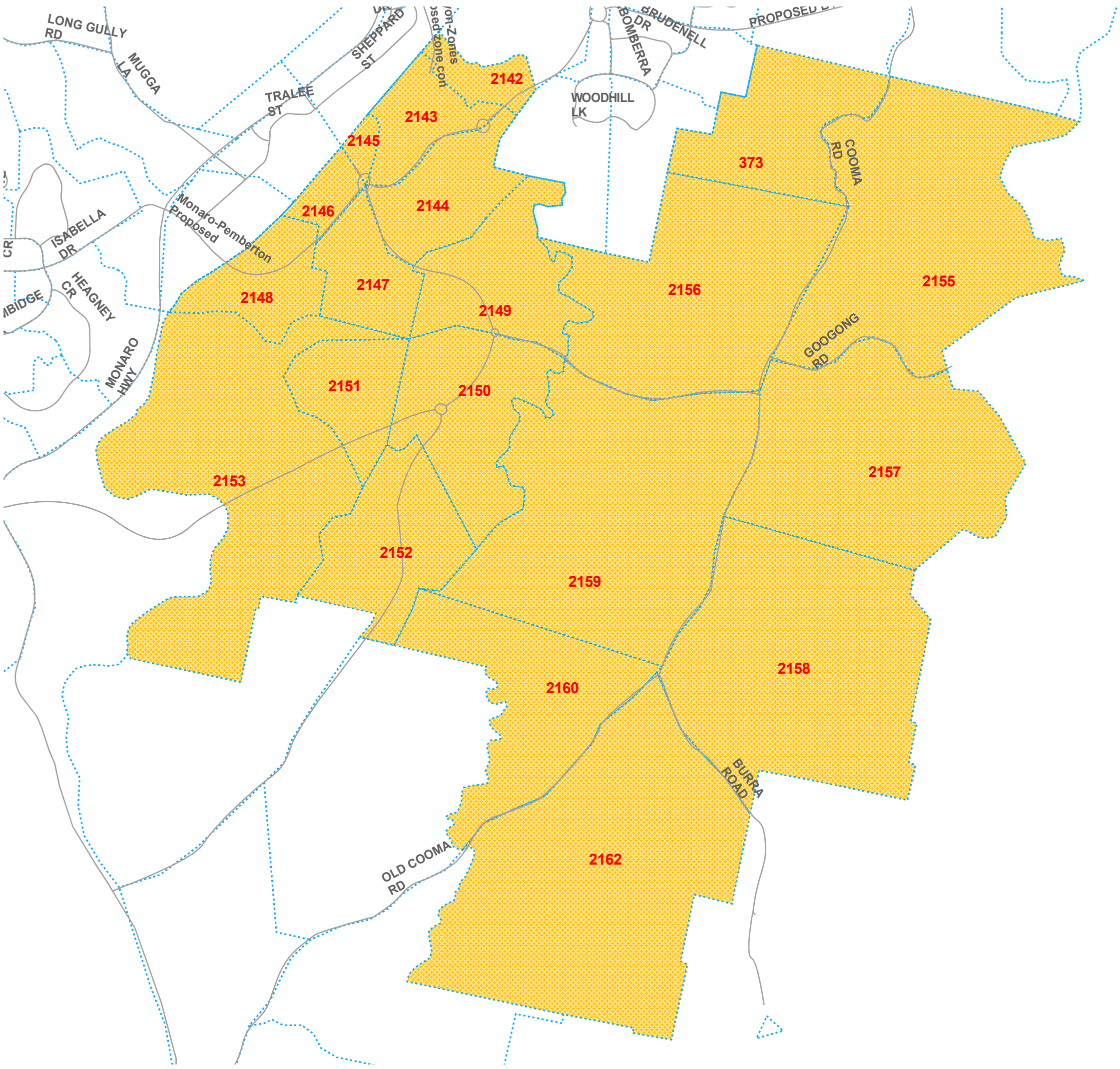

Figure 6-11: Tralee and Googong Zoning System Adopted by SMEC

Table 6-14: Queanbeyan New Release Areas Land Use 2031

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
373	641	50	840	0	0
2142	242	0	0	2,014	0
2143	454	0	0	0	0
2144	683	0	0	0	0
2145	81	127	0	0	0
2146	188	127	3,680	0	0
2147	535	127	0	0	0
2148	577	118	0	0	0
2149	972	0	421	235	0
2150	1,184	0	0	0	0
2151	595	118	0	0	0
2152	1,052	118	1,030	720	0
2153	2,990	118	0	0	0
2155	1,778	50	577	240	0
2156	1,413	450	2,540	960	0
2157	1,536	50	412	240	0
2158	1,853	50	330	0	0
2159	1,951	500	384	0	0
2160	890	50	0	0	0
2162	2259	0	0	0	0
Total	21,874	2053	10,214	4,409	0

Table 6-15: Queanbeyan New Release Areas Land Use 2051

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
373	641	50	840	0	0
2142	242	0	0	2,014	0
2143	454	0	0	0	0
2144	683	0	0	0	0
2145	81	127	0	0	0
2146	188	127	3,680	0	0
2147	535	127	0	0	0
2148	577	118	0	0	0
2149	972	0	421	235	0
2150	1,184	0	0	0	0
2151	595	118	0	0	0

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
2152	1,052	118	1,030	720	0
2153	2,990	118	0	2,014	0
2155	1,778	50	577	240	0
2156	1,413	450	2,540	960	0
2157	1,536	50	412	240	0
2158	1,853	50	330	0	0
2159	1,951	500	384	0	0
2160	890	50	0	0	0
2162	2,259	0	0	0	0
Total	21,874	2053	10,214	6,423	0

Molonglo

Molonglo was based on SMEC's Molonglo Road Feasibility Study (2008). The landuse, road network and zoning system for Molonglo were developed by SMEC and ACTPLA as part of the Road Feasibility Study. Figure 6-12 shows the adopted zoning system while Table 6-16 and Table 6-17 show the 2031 and 2051 landuse.

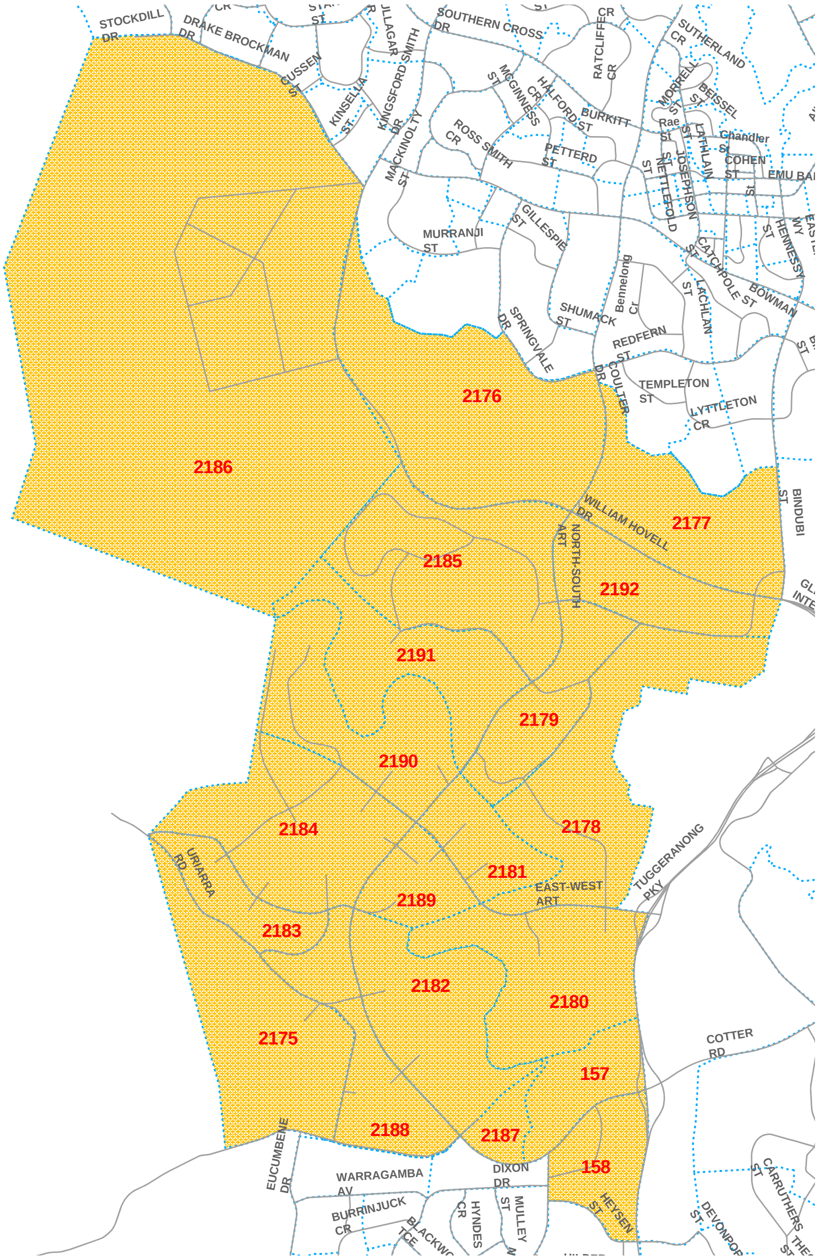

Figure 6-12: Molonglo Zoning System Adopted by SMEC

Table 6-16: Molonglo Land Use 2031

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
157	740	0	0	0	0
158	1,400	0	0	325	550
2175	0	20	500	0	0
2176	0	0	0	0	0
2177	0	0	0	0	0
2178	1,550	0	0	0	0
2179	4,910	135	3,000	0	0
2180	0	0	0	0	0

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
2181	3,010	0	0	0	0
2182	5,180	30	700	0	0
2183	2,520	21	490	0	0
2184	7,800	71	490	550	0
2185	2,350	0	0	0	0
2186	0	0	0	0	0
2187	1,040	21	490	0	0
2188	4,140	0	0	0	0
2189	3,700	800	15,000	550	0
2190	3,790	150	0	1600	0
2191	520	0	0	0	0
2192	620	0	0	0	0
Total	43,270	1,248	20670	3,025	550

Table 6-17 Molonglo Land Use 2051

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
157	740	0	0	0	0
158	1,400	0	0	325	550
2175	0	20	500	0	0
2176	0	0	0	0	0
2177	0	0	0	0	0
2178	1,550	0	0	0	0
2179	4,910	135	3,000	0	0
2180	0	0	0	0	0
2181	3,010	0	0	0	0
2182	5,180	30	700	0	0
2183	2,520	21	490	0	0
2184	7,800	71	490	550	0
2185	2,350	0	0	0	0
2186	0	0	0	0	0
2187	1,040	21	490	0	0
2188	4,140	0	0	0	0
2189	3,700	800	15,000	550	0
2190	3,790	150	0	1600	0
2191	520	0	0	0	0
2192	620	0	0	0	0
Total	43,270	1,248	20,670	3,025	550

Kowen

ACTPLA advised that for the purpose of this initial transport modelling, that Kowen may have 40,000 dwellings at 2051. One third of these can be assumed to be delivered by 2031 and the rest by 2051.

ACTPLA rationale for this input is as follows:

The Canberra Spatial Plan (2004) estimated total of 26,000 dwellings, with approx 8,000 (one third) by 2032. Hence the initial suggestion of 1/3 by 2031, as above.

ACTPLA has undertaken some 'desk top' urban capability work, and structure planning on Kowen. This preliminary work indicates that Kowen may have urban capability of around 3,000ha (30km²).

This work factors in, that, under today's sustainability and affordability considerations it is likely that we would achieve far greater population than envisaged in the Spatial Plan for Kowen.

ACTPLA's preliminary population scenarios for Kowen include:

- Low- 33,000 dwellings total (78,300 pop)
- Med- 39,000 dwellings total (84,600 pop)
- High - 46,500 dwellings total (100,350 pop)

Therefore, ACTPLA has rounded-up the medium scenario and assumed 40,000 dwellings.

At a preliminary estimate, based on the need for a level of self-containment, given the separation of this future urban area from metropolitan Canberra, approximately 20,000 jobs could be provided which includes 10,000 in the Town Centre and 4,000 in local centres.

Kowen employment by 2051 will be 20,000 jobs.

Kowen employment by 2031, assuming one third of 2051 employment, will be 6,667 jobs.

Kowen would also be serviced for employment purposes by the Airport and the Eastern Broadacre employment Area.

The zoning system adopted by SMEC is shown in Figure 6-13. This zoning is indicative only as there is currently no committed layout for Kowen. Table 6-18 and Table 6-19 show the 2031 and 2051 landuse for Kowen.

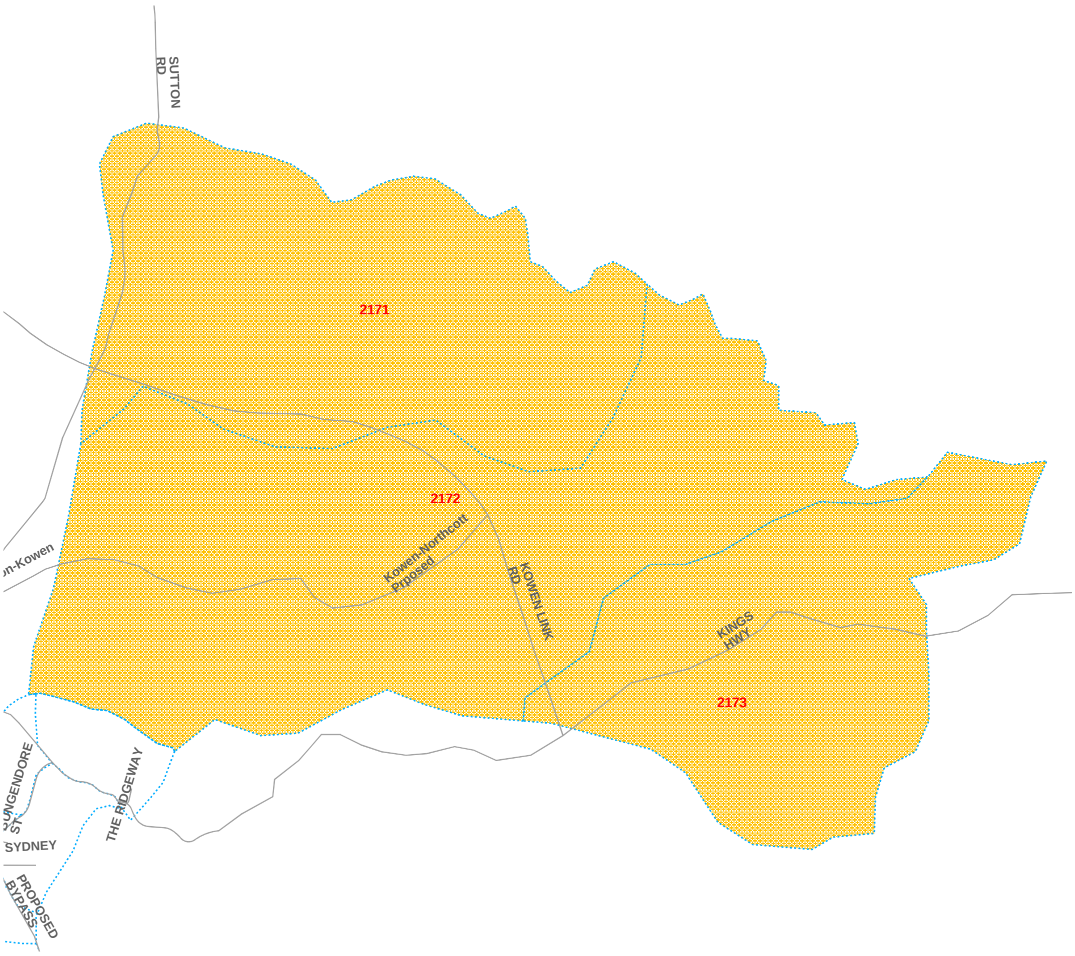

Figure 6-13: Kowen Zoning System Adopted by SMEC

Table 6-18: Kowen Land Use 2031

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
2171	9,867	1,667	0	0	0
2172	9,867	3,333	0	0	0
2173	9,867	1,667	0	0	0
Total	29,601	6,667	0	0	0

Table 6-19: Kowen Land Use 2051

Zone	Population (Capita)	Employment (Total Jobs)	Retail Space (m²)	School Enrolment (Students)	Tertiary Enrolment (Students)
2171	29,600	5,000	0	0	0
2172	29,600	10,000	0	0	0
2173	29,600	5,000	0	0	0
Total	88,800	20,000	0	0	0

6.5 Calculate Trip Ends

In this step, the 2031 AM peak trip ends are calculated for each of the traffic zones. Trip ends are estimated as a function of population trip making patterns as well as on the trip attraction factors attributed to land use patterns. Land use information for each zone is multiplied by appropriate trip generation and trip attraction factors and summed into in/out trip ends for each zone.

The trip generation rates adopted for the 2031 AM peak are shown in Table 6-20. These were checked against the RTA Guide to Trip Generating Developments (2002) and also compared to the trip generation rates of the ACTPLA EMME/2 model and were found to be consistent.

Table 6-20: AM Trip Generation Rates

	Unit	Production (per Unit)	Attraction (per Unit)
Population	Capita	0.2100	0.0400
Employment	Job	0.0520	0.4200
Retail Space	m^2	0.0035	0.0065
School Enrolments	Student	0.1700	0.2400
Tertiary Enrolments	Student	0.0175	0.0680

In addition to these calculations, there are special zones such as external links where trip ends are taken from actual traffic counts. An example of this is the Federal Highway which has no actual land use data but the number of trips produced and attracted can be taken from counts at the Roads ACT count station.

6.6 Generate O/D Matrix

The pattern O/D matrix was developed initially from 1996 Australian Bureau of Statistics census Journey-to-Work (JTW) data and has been refined by SMEC in past projects. This was converted to a future matrix by frataring the matrix to match zone productions and attractions as calculated earlier. The fratar method is a form of doubly constrained growth factor method. This method iteratively adjusts the values to match the total number of trip ends calculated from the land use data. By this method individual trips from one zone to another will be scaled so that the total productions and attractions balance, and the totals are matched to the trips ends.

For new zones, or zones that have had significant changes to their landuse, and no current trip patterns exist, origins and destinations were generated based on landuse across the model. For example, a zone in Kowen that is primarily residential, has traffic destinations applied to it based on employment opportunities across the model. This is because the primary trip purpose in the AM peak is traffic travelling to employment locations.

6.7 Further Comments about the Strategic Model

6.7.1 Population and Employment

Table 6-21 shows the total number of residents and working population from the ABS census in 2006. It can be seen that there are 0.55 workers per resident.

Table 6-21: Population and Workers in the ACT in 2006 (Source: ABS)

Canberra	Total
Population	323,054
Workers	178,152
Ratio	0.55

Table 6-22 shows a summary of the main landuse categories for the strategic model. It can be seen that the workers/population ratio has risen to 0.63 in 2031 and 0.62 in 2051. This indicates that the levels of employment modelled may be slightly higher than will realistically occur.

Table 6-22: Summary of SMEC Landuse for 2031 and 2051

Year	Population	Employment	Retail Space (m^2)	School Enrolments	Tertiary Enrolments
2031	502,956	317,016	1,785,665	65,269	39,450
2051	568,656	351,493	1,825,931	70,819	39,450

ACTPLA provided some draft preliminary work prepared by Access Economics for the Chief Minister's Department (CMD) showing the expected population of the ACT in the future. These are presented in Table 6-23. However, CMD caution that Access Economics data are still draft, subject to review and are not supported by Government until finalised. It can be seen that the population figures modelled by SMEC appear to be higher than the predicted figures. However, the SMEC strategic model also includes Queanbeyan so the Access Economics High Scenario appears to be close to the data that SMEC has modelled.

Table 6-23: Access Economics Preliminary Population Forecasts

Draft Indicative figures for ACT Region	Jun-2031	Jun-2047	2051*
Medium scenario ACT Total	416,105	466,782	480,387
High scenario ACT Total	440,696	501,333	517,753

* Extrapolated 2051 based on 2031-2047 Growth

Table 6-24 shows the calculated "Trip Ends" from the SMEC strategic model. It can be seen that there are significantly more trips attracted than produced. This reinforces the statement before that the levels of employment modelled may be higher than can be realistically expected. For the transport modelling, SMEC balanced the produced and attracted trips and used the average.

Table 6-24: SMEC Strategic Model Trip End Summary

Year	Produced	Attracted	Attracted/Produced
2031	142,304	173,494	1.22
2051	158,978	192,196	1.21

It is believed that this imbalance has come from the following increases in employment:

- Canberra Central
  - 576,150m^2 GFA increase by 2031
- Constitution Avenue West
  - 394,360m^2 GFA increase by 2031
- Constitution Avenue East and Russell
  - 606,960m^2 GFA increase by 2031
- Canberra Airport
  - Approximately 18,000 employment increase by 2031
- Eastern Broadacre
  - 38,493 employment in 2031 and 71,957 employment in 2051
- Kowen
  - 6,667 employment in 2031 and 20,000 employment in 2051

This growth in employment is partially offset by potential population increases in Kowen, Molonglo and QCC new release areas. However, the population growth modelled is not sufficient to keep the same employment to population ratio as 2006.

7 Stage 3: Utilise Strategic Transport Model

The strategic transport model was then used to predict the expected 2031 and 2051 congestion levels. Using traffic assignment techniques, the future 2031 and 2051 O/D matrices were assigned onto the future road networks. In order to model the effects of possible congestion that will develop during the later forecast years, the stochastic equilibrium assignment technique was used. It was assumed that route choice is based on travel time. The assignment is iterative and uses the Bureau of Public Roads congestion function to determine the effect of congestion on travel speed. After each assignment iteration, route travel times are recalculated based on the congested travel speeds and route assignment is then performed again. When the system reaches a stable state, known as convergence, the assignment is complete.

The results from this traffic assignment include a loaded road network for Canberra and the surrounding areas.

7.1 Analyse Traffic Assignment Results in 2031 with Expected Network

Congestion is defined as, “The level at which transportation system performance is no longer acceptable due to traffic interference.” Levels of acceptable service vary according to factors, which include geographic location, population of area and classification of roadway.

Worldwide acceptable congestion ratings follow the guidelines in the Highway Capacity Manual. The Volume to Capacity ratio (V/C) is a performance measure that provides a good indication to the congestion of a road by identifying whether “excess” capacity, or whether saturated conditions exist. A V/C ratio greater than 1.0 indicates that the demand volume exceeds the available capacity of the roadway and forced flow conditions will inevitably result, or operation under Level of Service F. In general, the following LOS criteria shown in Table 7-1 were used to define road link congestion

Table 7-1: V/C and LoS Classification

Volume to Capacity Ratio (V/C)	LOS	Congestion Level
0 – 0.25	A	Free Flow
0.26 – 0.45	B	Not Congested
0.46 – 0.65	C	Acceptable Congestion
0.66 – 0.85	D	Congested
0.86 – 1	E	Seriously Congested
> 1	F	Seriously Congested (Over Capacity)

The results from the traffic assignment in the 2031 AM peak period with the expected network are presented in Figure 7-1.

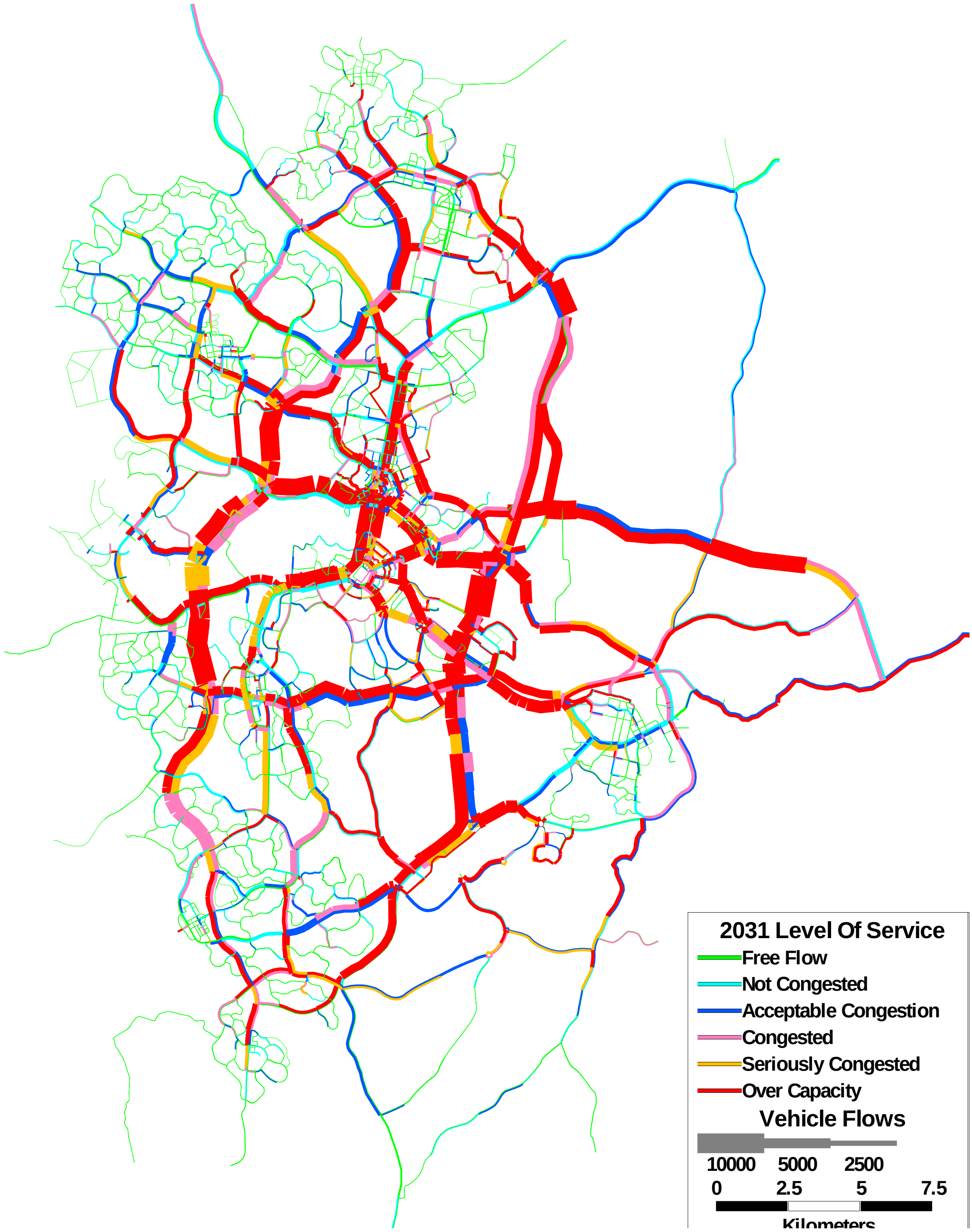

Figure 7-1: Traffic Operation with Expected Network (2031 AM Peak)

7.2 Conceptualise 2031 Road Network Upgrades

SMEC team reviewed previous road network suggestions within the study area. A number of connections and road alignments are proposed as vital connections including:

- Connections between Kowen/Majura Road and onto the city taking into consideration that Defence have advised that access will not be permitted through their training area at Majura. (According to Macroplan theoretical alignments should still be explored). SMEC have endeavoured to avoid heavy artillery training areas and to conceptualise a connection that passes at the periphery of an area that is thought to be dedicated for rifle training.
- Road connections between Fyshwick/ Pialligo/ Eastlake/ Airport (across the Molonglo River).

- cross border road connections from the study area to NSW (e.g.: Lanyon Drive, Isabella Drive) and from Kowen, particularly having regard to future proposed development at Googong and Tralee;

For the Kowen link and other route alignments, route options are presented with key characteristics including how many lanes, intersection location and possible intersection type.

Also please note that the Canberra Avenue upgrade is to be contemplated in the 2051 network.

Areas that had high levels of congestion were identified and ways of decreasing this congestion were conceptualised. In some cases, this involved increasing the capacity of the congestion road. In other cases, alternative routes were added or strengthened to take traffic from the congested area. Table 7-2 shows the interventions and improvements that have been identified to assist with congestion for 2031. These proposed changes are in addition to the expected changes that were presented in Table 6-3. If the Kowen Link (expected by 2031) is not constructed, the Southern Kowen Connection, presented below, may not provide a useful role.

Table 7-2: 2031 SMEC Proposed Road Network Upgrades

Road	Location (From – to)	Expected Cross-section	Rationale
Southern Kowen Connection (Addition)	Connection from Kowen Link east of the Airport to Monaro Highway north of the Prison. (includes connections to Pialligo Avenue and Canberra Avenue)	1 Lane each way	Increased arterial capacity to cater for development in Kowen and Googong/Tralee
Jerrabomberra Avenue (Extension)	Extended to meet Southern Kowen Connection at Monaro Highway	2 Lanes each way	Increased arterial capacity to cater for development in Kowen and Googong/Tralee
Monaro Highway (Modification)	Split Diamond Interchange at Isabella Dr/Mugga Lane	Split Diamond	Provide better access across Monaro Highway
New Googong/Tralee Link (Addition)	Googong/Tralee to Southern Kowen Connection (Across Lanyon Dr parallel to Monaro Highway)	1 Lane each way	Increased arterial capacity to cater for development in Kowen and Googong/Tralee

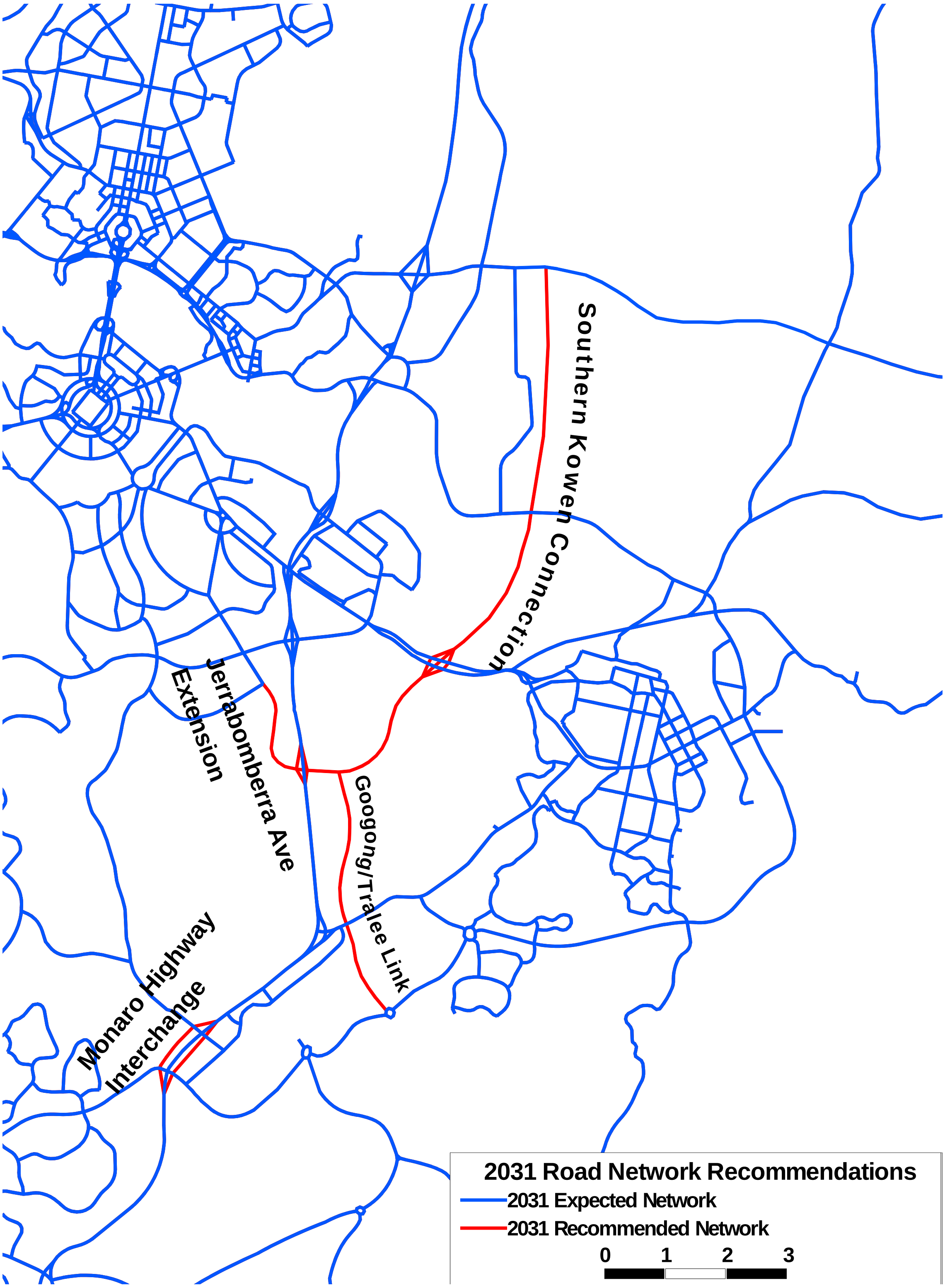

Figure 7-2: Recommended Network Changes for 2031

7.3 Model 2031 Recommended Road Network

The interventions presented above were tested for the 2031 AM peak period. This led to the results presented in Figure 7-3.

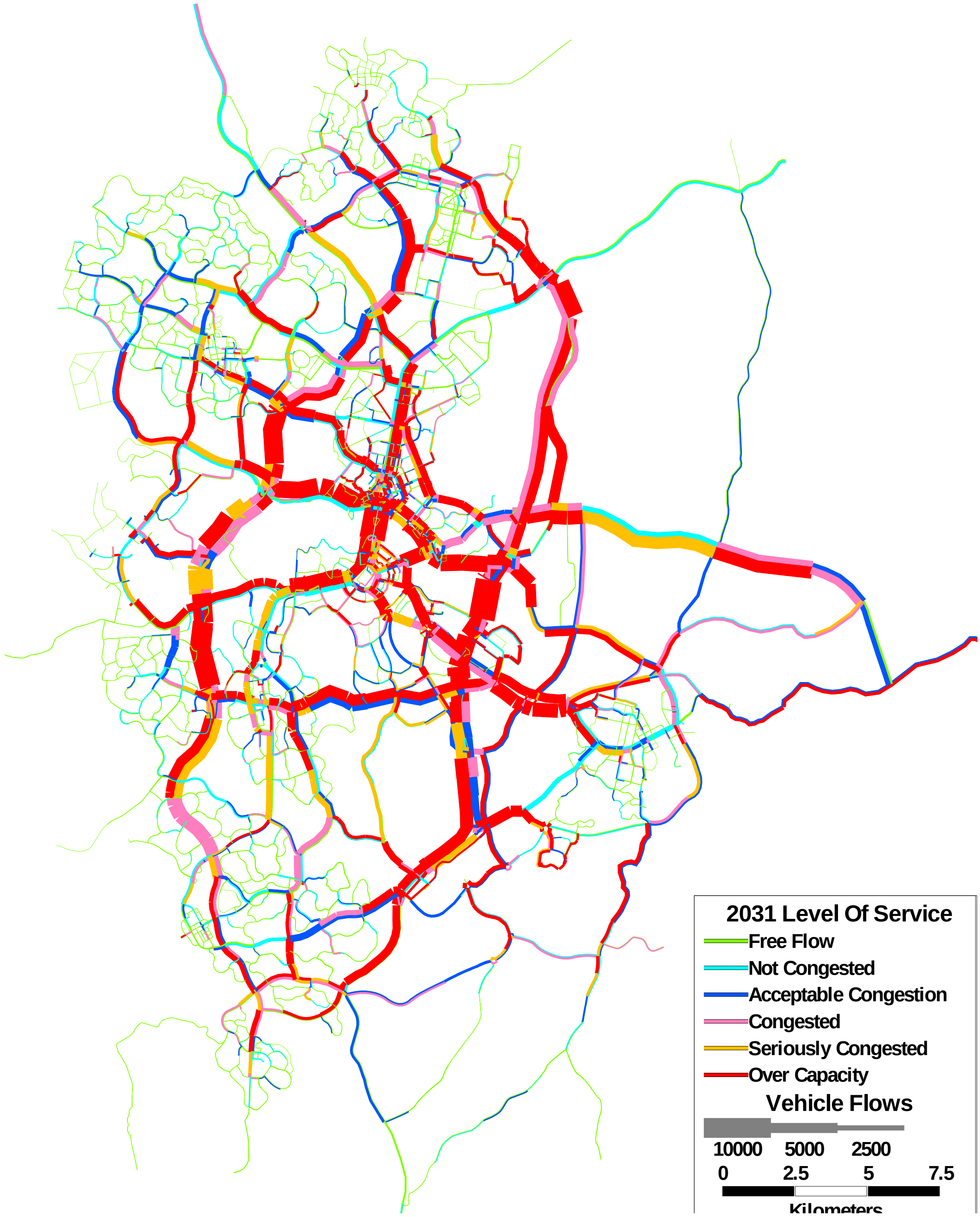

Figure 7-3: Traffic Operation with Recommended Network (2031 AM Peak)

7.4 2031 AM Peak Period Comparison

The travel time distribution for the 2031 AM peak period is presented in Figure 7-4. This figure shows the number of vehicles making trips of different durations. It can be seen from the figure that the network modifications proposed by SMEC have slightly increased the number of shorter trips and decreased the number of longer trips. Table 7-3 shows a comparison of the total travel time over the network and the average trip durations.

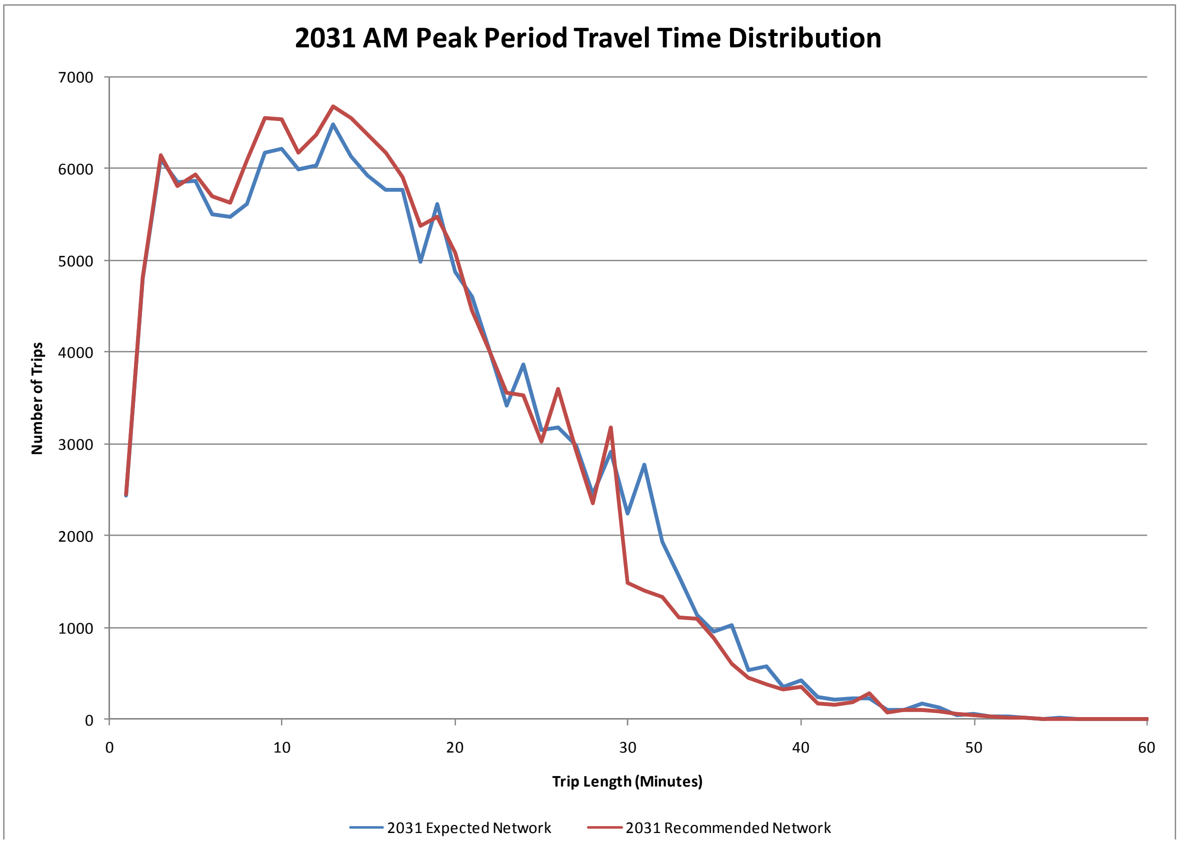

Figure 7-4: 2031 AM Peak Period Travel Time Distribution

Table 7-3: Comparison of Network Travel Times

	2031 Expected Network	2031 Recommended Network
Trips	157,798	157,798
Total Travel Time (Minutes)	2,465,040	2,376,472
Saving (Minutes)	-	88,568
Average Trip Length (Minutes/Vehicle)	15.65	15.09
Average Trip Length Saving (Minutes/Vehicle)	-	0.56
Average Trip Length Saving (%)	-	3.58

7.5 Analyse Traffic Assignment Results in 2051 with Expected Network

The network used as the basis for comparison in 2051 is the 2031 SMEC recommended road network. The results from the traffic assignment are presented in

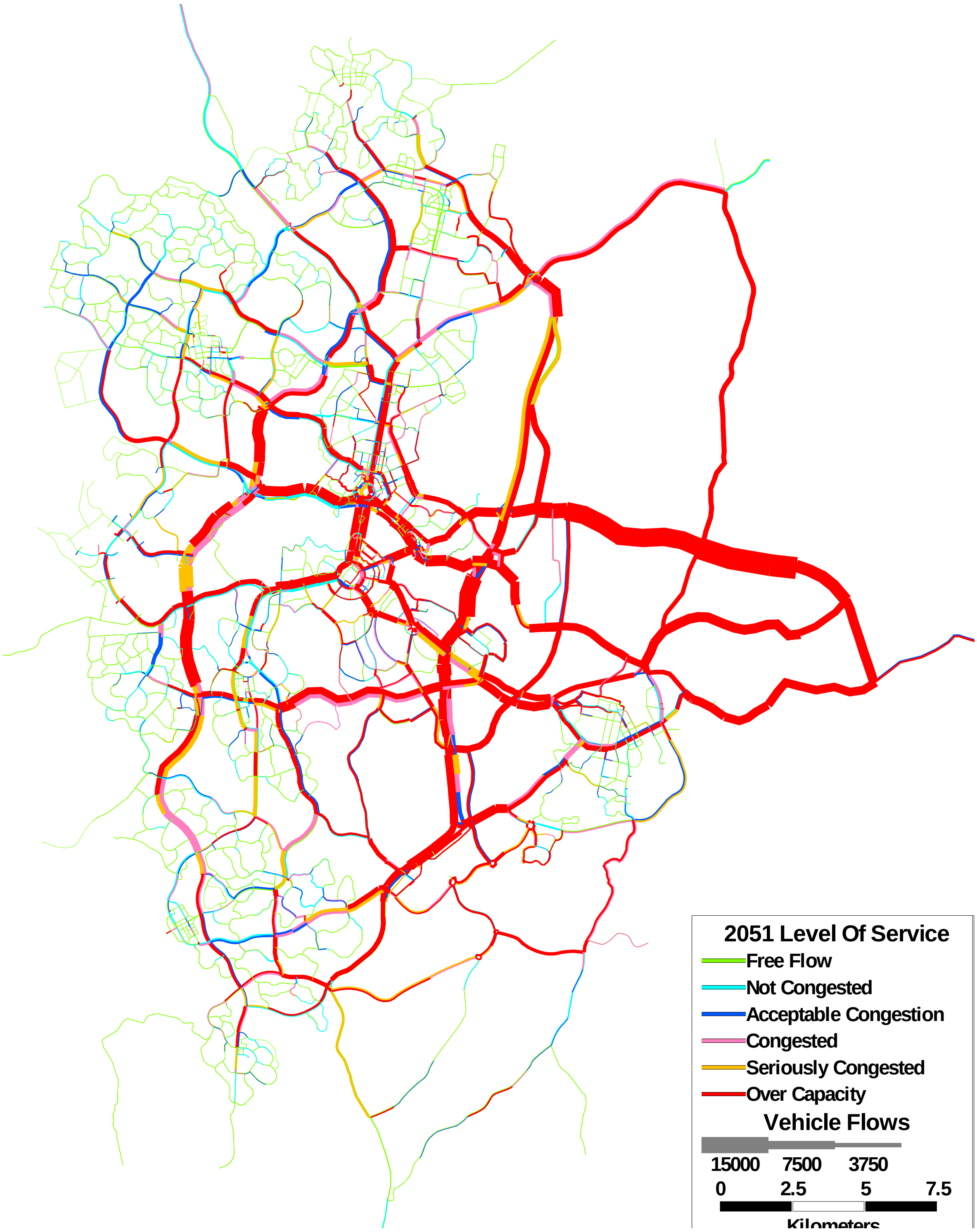

Figure 7-5: Traffic Operation with Expected Network (2051 AM Peak)

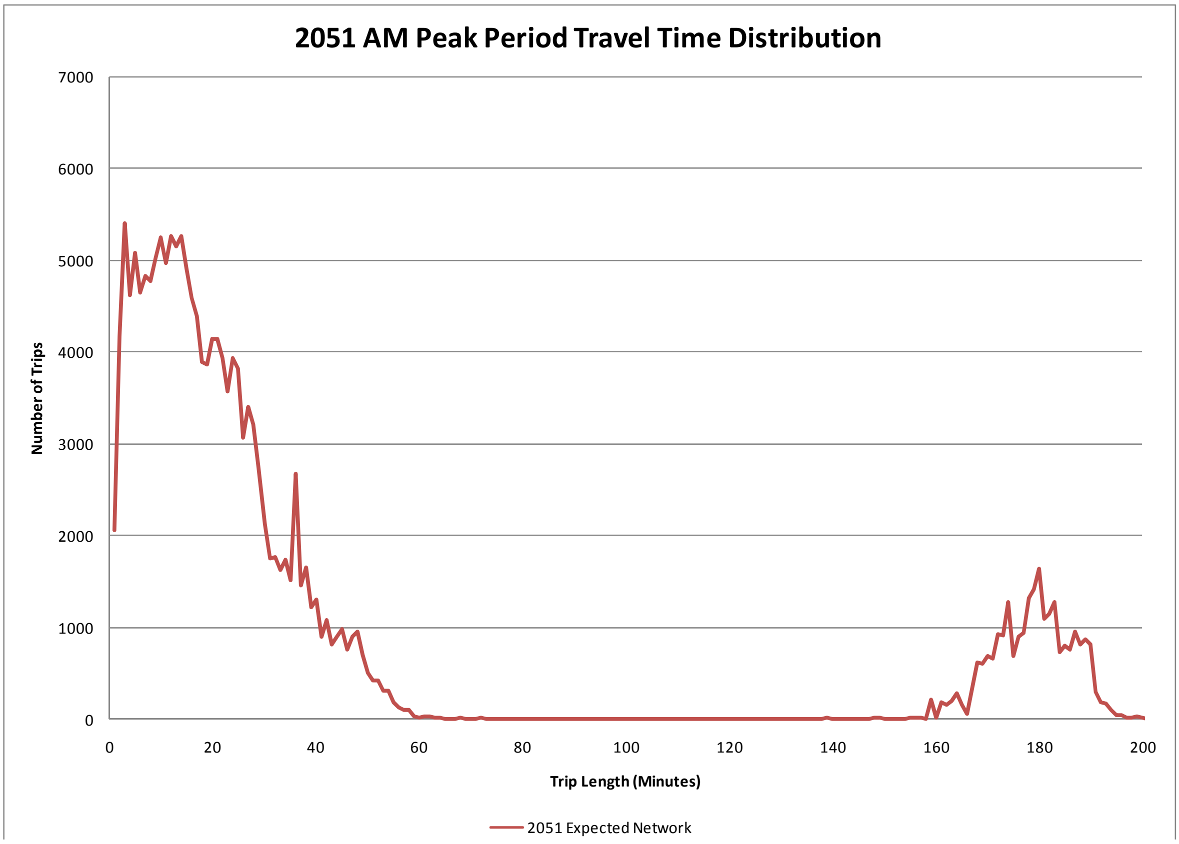

Figure 7-6: 2051 AM Peak Period Travel Time Distribution

7.6 Conceptualise Road Alignments for 2051

While the network changes presented above provide reasonable network performance in 2031, it was found that the performance of the network was very poor in 2051. The primary causes of this poor performance are Kowen and Eastern Broadacre and the large number of trips generated by their development. In particular, the spike in trips around the 180 minute length can be attributed to the development in Kowen and the lack of access points to it. To help deal with this increase in traffic, especially in the Kowen area, the network modifications shown in Table 7-4 are proposed.

Table 7-4: 2051 Proposed Road Links and Alignments

Road	Location (From – to)	Expected Cross-section	Rationale
Kowen Link (Modification)	Kowen – Kings Highway (East of Queanbeyan)	3 Lanes each way	Provide additional access to Kowen
Southern Kowen Connection (Modification)	Connection from Kowen Link east of the Airport to Monaro Highway north of the Prison. (includes connections to Pialligo Avenue and Canberra Avenue)	2 Lanes each way	Increased arterial capacity to cater for development in Kowen and Eastern Broadacre
Northern Kowen Link (Addition)	Kowen to Wakefield Avenue	3 Lanes each way	Increased arterial capacity to help cater for development in Kowen

Road	Location (From – to)	Expected Cross-section	Rationale
Southern Kowen Connection (Extension)	Extend to intersect Northern Kowen Link	2 Lanes each way	Increased arterial capacity to cater for development in Eastern Broadacre, Kowen and Googong/Tralee
Canberra Ave (Modification)	Hindmarsh Dr to Queanbeyan	3 Lanes each way	Increased East-West capacity
Parkes Way (Modification)	Coranderrk St to Kings Ave	3 Lanes each way	Increased East-West capacity
Morshead Dr (Modification)	Kings Ave to Monaro Highway	3 Lanes each way	Increased East-West capacity
Pialligo Ave (Modification)	Monaro Highway to Queanbeyan	3 Lanes each way	Increased East-West capacity
New Googong/Tralee Link (Modification)	Googong/Tralee to Southern Kowen Connection (Intersecting Lanyon Dr between Tompsitt Dr and Monaro Hwy)	2 Lanes each way	Increased arterial capacity to cater for development in Kowen and Googong/Tralee
Fyshwick to Pialligo Link	Canberra Ave to Beltana Rd via Tennant St	1 Lane each way	Better access to Fyshwick and across Molonglo River

The changes presented above are shown in Figure 7-7.

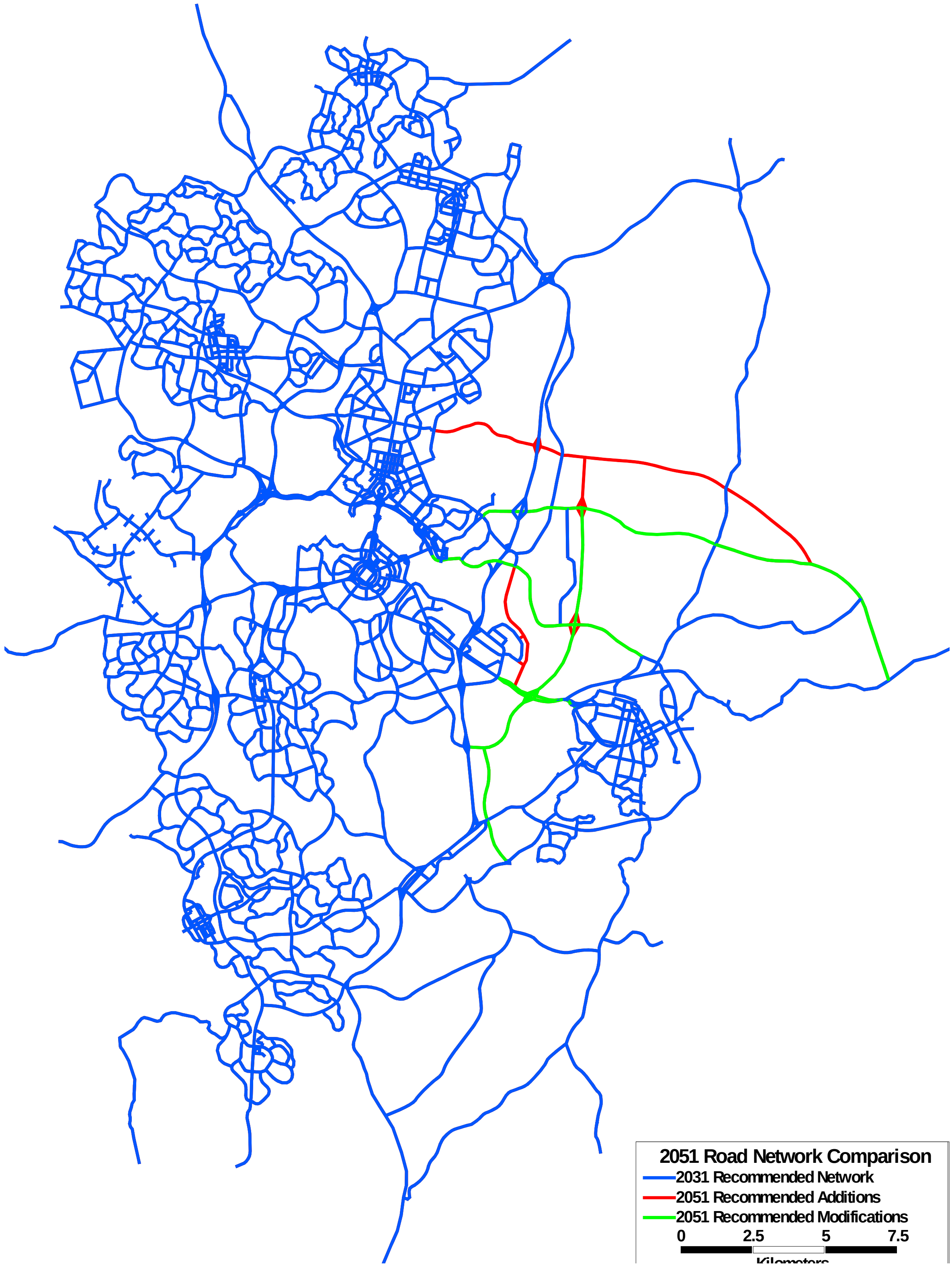

Figure 7-7: Proposed Network Changes for 2051

7.7 Model 2051 Recommend Road Network

The interventions presented above were tested. This led to the results presented in Figure 7-3.

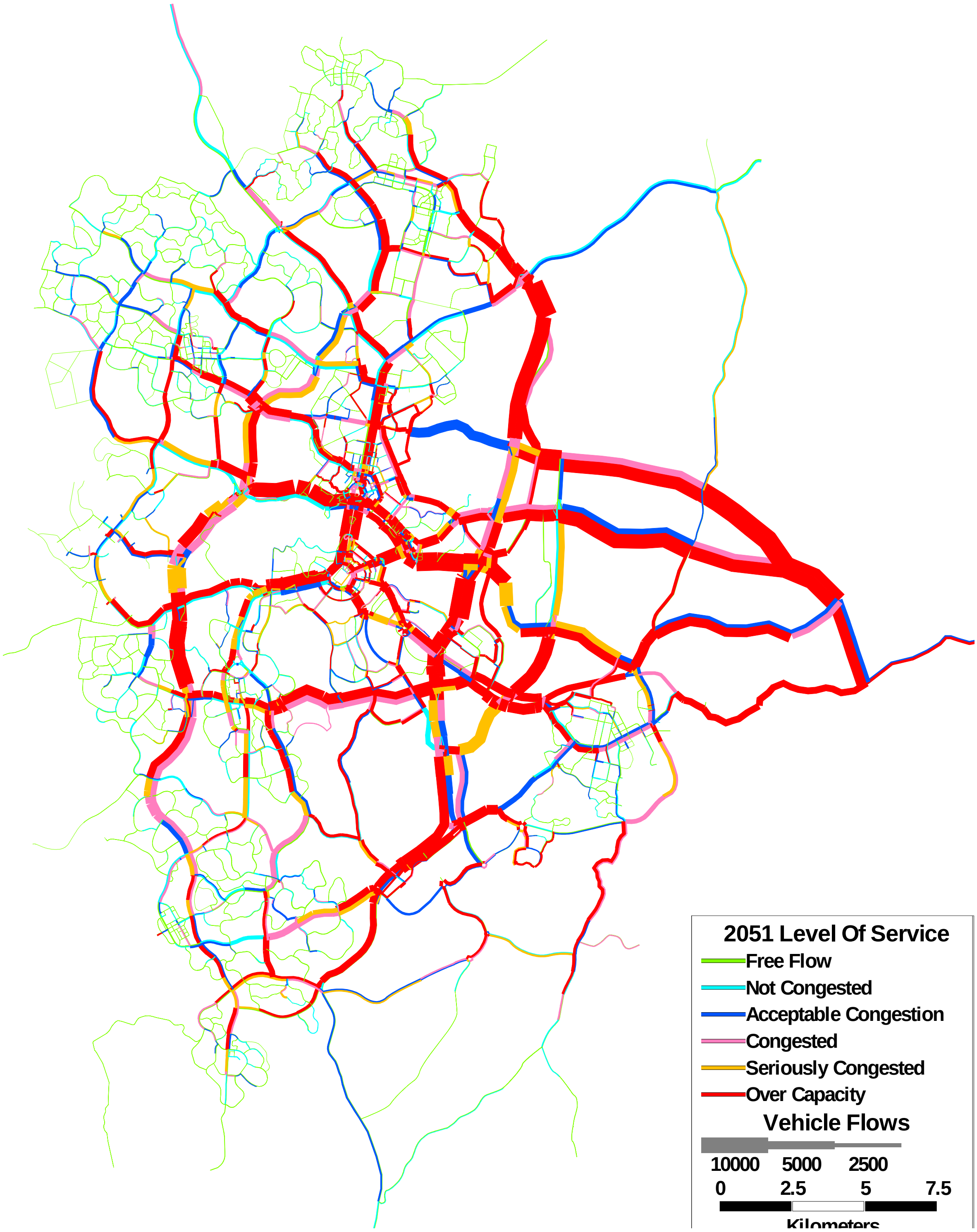

Figure 7-8: Traffic Operation with Recommended Network (2051 AM Peak)

7.8 2051 AM Peak Period Comparison

The travel time distribution for the 2051 AM peak period is presented in Figure 7-9. It can be seen from the figure that there are significant delays without the recommended upgrades. Table 7-5 shows a comparison of the total travel time over the network and the average trip lengths.

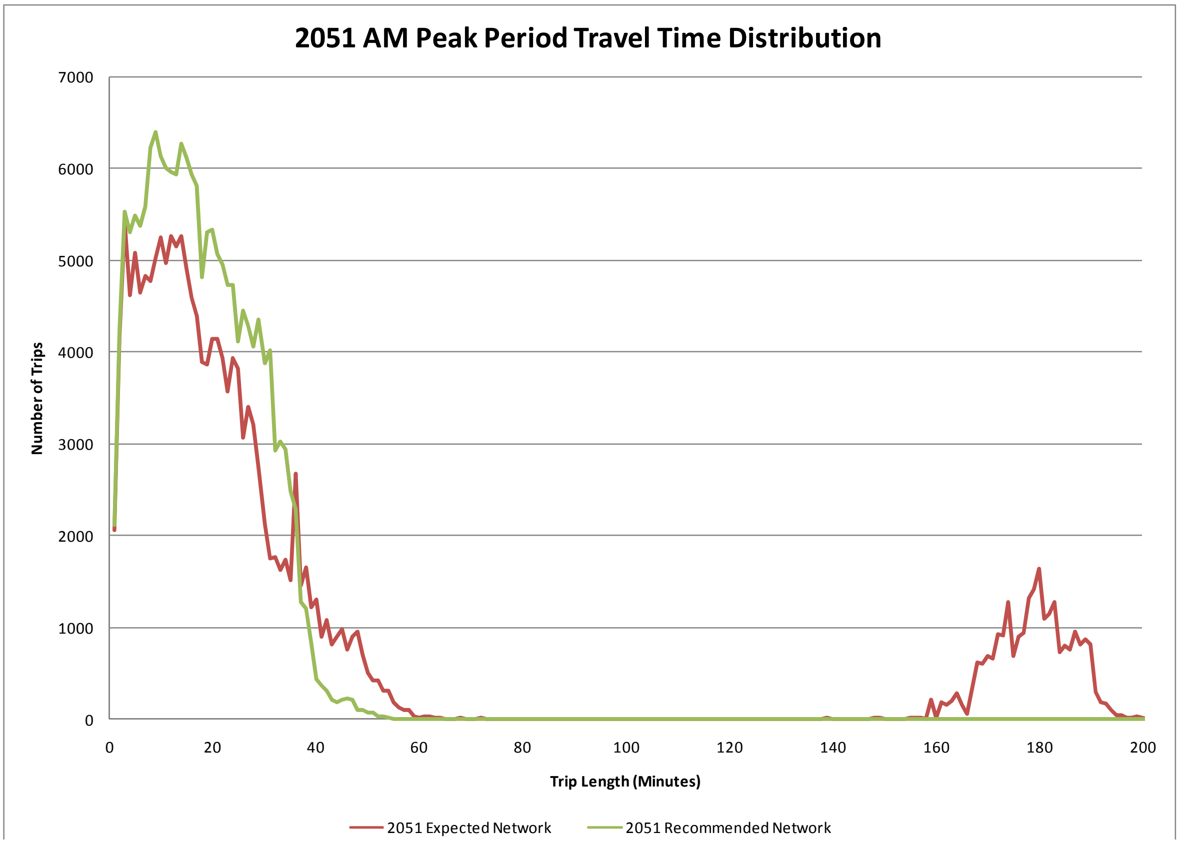

Figure 7-9: 2051 AM Peak Period Travel Time Distribution

Table 7-5: Comparison of Network Travel Times

	2051 Expected Network	2051 Recommended Network
Trips	178,912	178,912
Total Travel Time (Minutes)	7,266,719	3,149,002
Saving (Minutes)	-	4,117,717
Average Trip Length (Minutes/Vehicle)	40.69	17.63
Average Trip Length Saving (Minutes/Vehicle)	-	23.06
Average Trip Length Saving (%)	-	56.65

It can be seen that increases in network capacity in and around the Eastern Broadacre area are necessary to deal with the traffic generated in 2051. The changes recommended by SMEC, while still conceptual, allow the Canberra road network to operate at a reasonable level of service in 2031 and 2051.

7.9 2051 with IPT Travel time comparison

As it was felt that the main causes of traffic congestion were in the Eastern Broadacre and Kowen area, a simulation run with the number of trips from Kowen reduced was conducted. This run was supposed to model the effects of a well utilised public transport link to and form Kowen. To simulate this, the traffic volumes to and from Kowen were reduced by 25%. The travel time distribution for this simulation run is shown in Figure 7-10. It can be seen that not only is there a significant reduction in long trips (as would be expected when Kowen trips are reduced) but there is an increase in shorter trips due to the reduction in congestion.

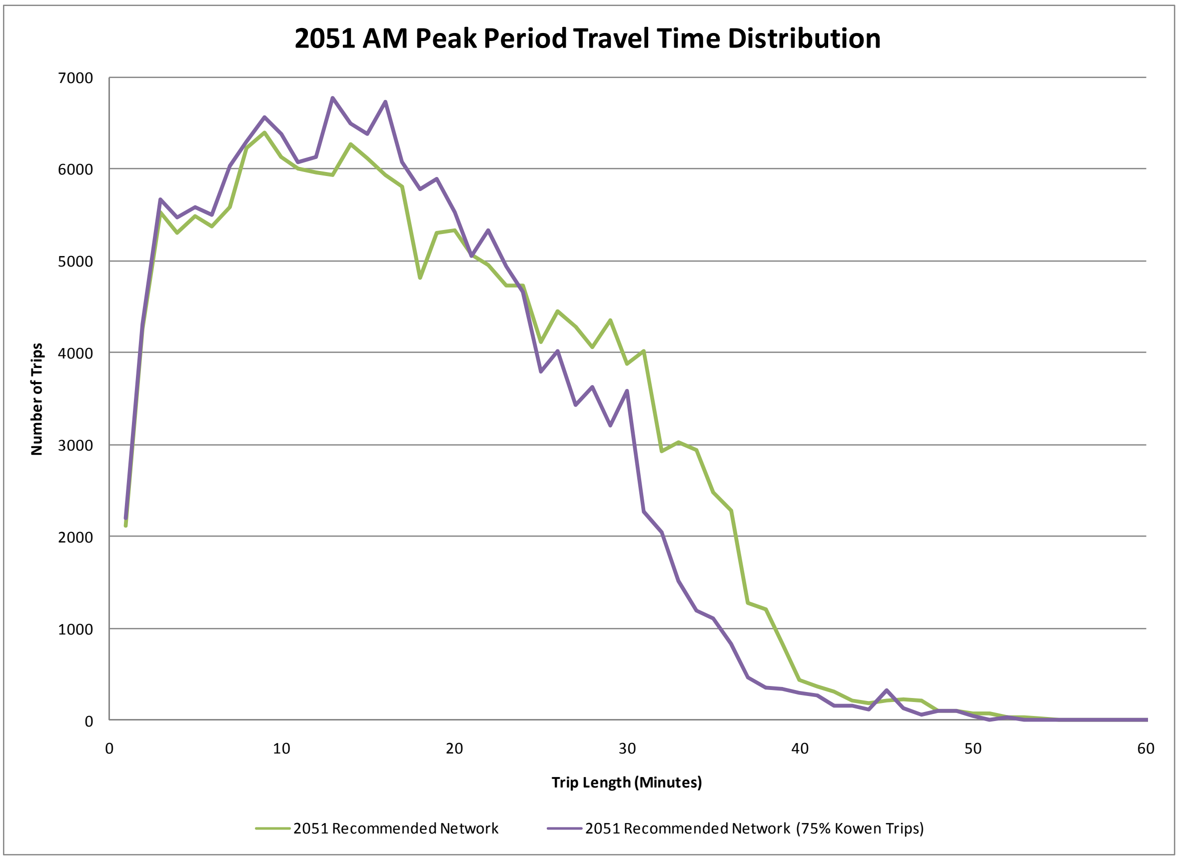

Figure 7-10: Comparison of 2051 Travel Time distribution (Reduced Kowen Trips)

7.10 Comparison of Trip Lengths

The trip length distributions for 2031 and 2051 on the recommended networks were compared to determine the effect of the previously discussed developments. The trip length distributions are shown in Figure 7-11. As can be seen from the figure, the number of short trips has decreased slightly while the number of longer trips has increased significantly. Table 7-6 shows the increase in trip length that can be expected in 2051.

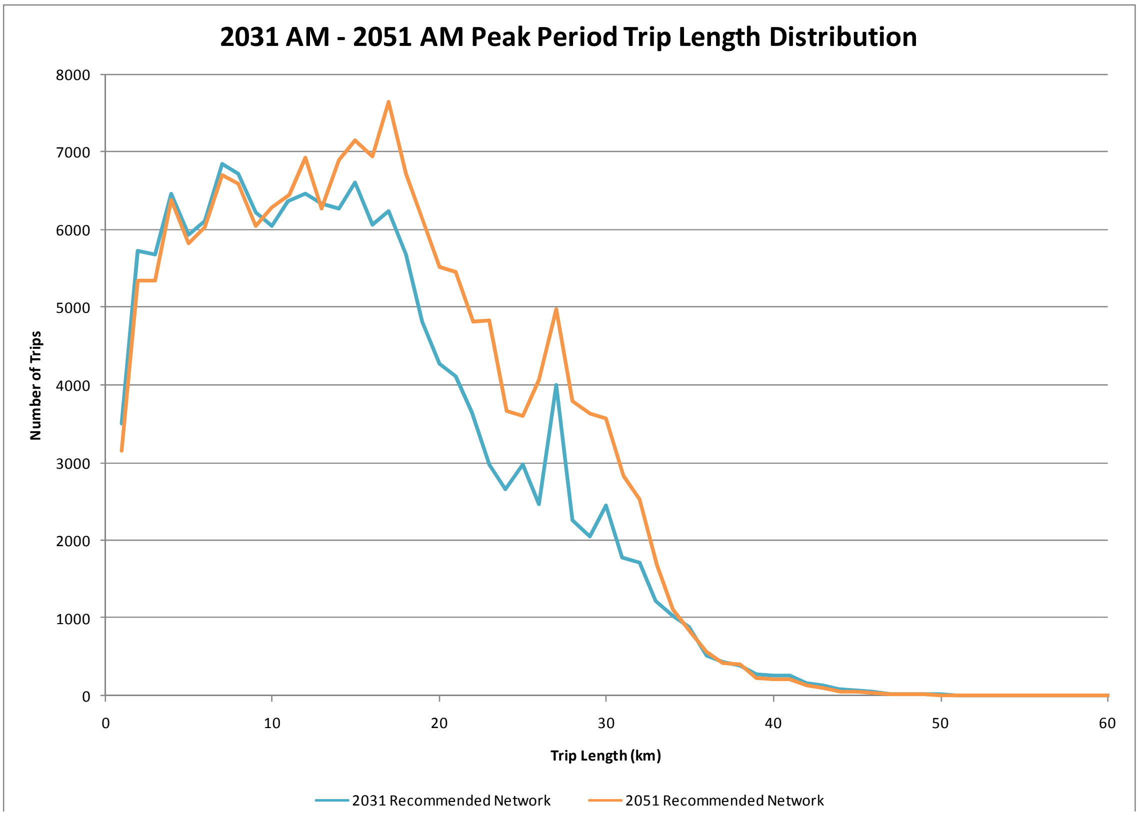

Figure 7-11: Trip Length Distribution Comparison 2031-2051

Table 7-6: Comparison of Network Travel Distances

	2031 Recommended Network	2051 Recommended Network
Trips	157,494	178,607
Total Travel Distance (km)	2,299,048	2,816,060
Increase (km)	-	517,012
Average Trip Length (km/Vehicle)	14.60	15.77
Average Trip Length increase (km/Vehicle)	-	1.17
Average Trip Length increase (%)	-	8.01%

8 Stage 4: Main findings

The key findings contained in this report are:

1. The development in and around Eastern Broadacre, including Kowen and QCC new release areas (along with Molonglo), is expected to induce a cross (+) urban development pattern for Canberra rather than the existing Y shaped pattern
2. The development (and other future metropolitan growth) are expected to increase travel demand on the existing Parkways and Arterial roads leading to peak period traffic congestion (despite road upgrades)
3. Upgrading of east-west parkways (Adelaide Avenue, Parkes Way and conceptual Kowen Links) and major roads will be warranted as east-west traffic will substantially increase due to the Eastern Broadacre and Kowen developments
4. The east-west parkways are constrained in their ultimate capacity and this reinforces the need for public transport to cater for east-west travel both to the Eastern Broadacre and to/from Kowen.
5. Good public transport will be essential as achievable road capacity will be below current expectations for level of service and duration of peak flows
6. The adverse consequences of the development can be reduced by developing an attractive public transport network to reduce the traffic volumes generated by the development.
7. The planned development in Kowen will require at least two high-capacity road access points.
8. The Kowen links will require careful planning to minimise environmental impacts
9. The Kowen link alignments are constrained by the topography of the area (Kowen escarpment) and the firing ranges in the defence area at Majura.
10. The proposed Kowen Links could use tunnels to overcome the topography and connect into the Canberra road network (especially where the Northern Kowen Link connects into Ainslie)

9 Recommendations

An integrated package of recommendations is made in this report. The recommendations are classified as follows:

1. Road capacity
2. Non-motorised transport
3. Arterial road alignment
4. Traffic management
5. Public transport
6. Land use

9.1 Road Capacity Recommendations

9.1.1 Sustainable Transport

An integrated environmentally sustainable transport strategy composed of travel demand management (TDM) and land use management (LUM) policies, measures and actions is recommended. The main ingredients for the strategy should be directed towards:

1. increasing vehicle occupancy through ridesharing
2. encouraging shift to transit modes
3. encouraging shift to non-motorized transport modes
4. exercising preferential treatment for ridesharing, transit and non-motorised transport
5. discouraging traffic in general and single occupant vehicles (SOV) in particular
6. introducing more parking management policies including physical, regulatory and pricing restraints on parking
7. shifting trips to times and places with spare network capacity
8. reducing need to travel
9. reducing average trip lengths
10. adopting LUM encouraging of transit modes
11. adopting LUM encouraging non-motorised transport modes

9.1.2 Road Network Capacity Increases Adjacent to the Development

The road capacity increases recommended here will provide reasonable network operability in the future assuming that trip generation rates remain at current levels. However, trip generation rates may change so these forecasts are indicative.

The following road network capacity increases in the areas around the development appear to be warranted for development by 2031:

Road	Location (From – to)	Rationale
Southern Kowen Connection (Addition)	Connection from Kowen Link east of the Airport to Monaro Highway north of the Prison. (includes connections to Pialligo Avenue and Canberra Avenue)	Increased arterial capacity to cater for development in Kowen and Googong/Tralee
Jerrabomberra Avenue (Extension)	Extended to meet Southern Kowen Connection at Monaro Highway	Increased arterial capacity to cater for development in Kowen and Googong/Tralee

Road	Location (From – to)	Rationale
Monaro Highway (Modification)	Split Diamond Interchange at Isabella Dr/Mugga Lane	Provide better access across Monaro Highway
New Googong/Tralee Link (Addition)	Googong/Tralee to Southern Kowen Connection (Across Lanyon Dr parallel to Monaro Highway)	Increased arterial capacity to cater for development in Kowen and Googong/Tralee

The following road network capacity increases in the areas around the development appear to be warranted for development by 2051:

Road	Location (From – to)	Rationale
Kowen Link (Modification)	Kowen – Kings Highway (East of Queanbeyan)	Provide additional access to Kowen
Southern Kowen Connection (Modification)	Connection from Kowen Link east of the Airport to Monaro Highway north of the Prison. (includes connections to Pialligo Avenue and Canberra Avenue)	Increased arterial capacity to cater for development in Kowen and Eastern Broadacre
Northern Kowen Link (Addition)	Kowen to Wakefield Avenue	Increased arterial capacity to help cater for development in Kowen
Southern Kowen Connection (Extension)	Extend to intersect Northern Kowen Link	Increased arterial capacity to cater for development in Eastern Broadacre, Kowen and Googong/Tralee
Canberra Ave (Modification)	Hindmarsh Dr to Queanbeyan	Increased East-West capacity
Parkes Way (Modification)	Coranderrk St to Kings Ave	Increased East-West capacity
Morshead Dr (Modification)	Kings Ave to Monaro Highway	Increased East-West capacity
Pialligo Ave (Modification)	Monaro Highway to Queanbeyan	Increased East-West capacity
New Googong/Tralee Link (Modification)	Googong/Tralee to Southern Kowen Connection (Across Lanyon Dr parallel to Monaro Highway)	Increased arterial capacity to cater for development in Kowen and Googong/Tralee
Fyshwick to Pialligo Link (Addition)	Canberra Ave to Beltana Rd via Tennant St	Better access to Fyshwick and across Molonglo River

9.2 Non-motorised Transport Recommendations

The dependence on motorised transport should be minimised by encouraging cycling and walking by incorporating the following:

1. Cycleways (both on and off road)
2. Footpaths
3. Permeable[1] neighbourhood design

[1] Permeable neighbourhood design provides numerous routes for non-motorised transport by adding shared pathway links where the road pattern does not provide direct routes for pedestrian and cyclist traffic to bus stops, schools, shops etc.

4. Off road cycleways to complement on road cycle lanes are recommended[2]

The sustainable transport plan states that trips longer than two kilometres are not suitable for walking and trips longer than ten kilometres are not suitable for cycling. This would indicate that non-motorised trips between Kowen and the city are unlikely. However, provision should be made for cycling in the Eastern Broadacre development area.

9.3 Arterial Road Alignment Recommendations

The indicative alignments for the new arterial roads recommended by SMEC are shown in Figure 9-1. These arterial roads will provide access through the Eastern Broadacre area. However, they will not service developments directly. Lower hierarchy roads must be used for this purpose. The arterial road alignments in Kowen are subject to modification following outline planning. Most new roads in the Majura and Jerrabomberra Valley will have environmental impacts on sensitive areas and detailed alignment work needs to consider how these impacts can be minimised.

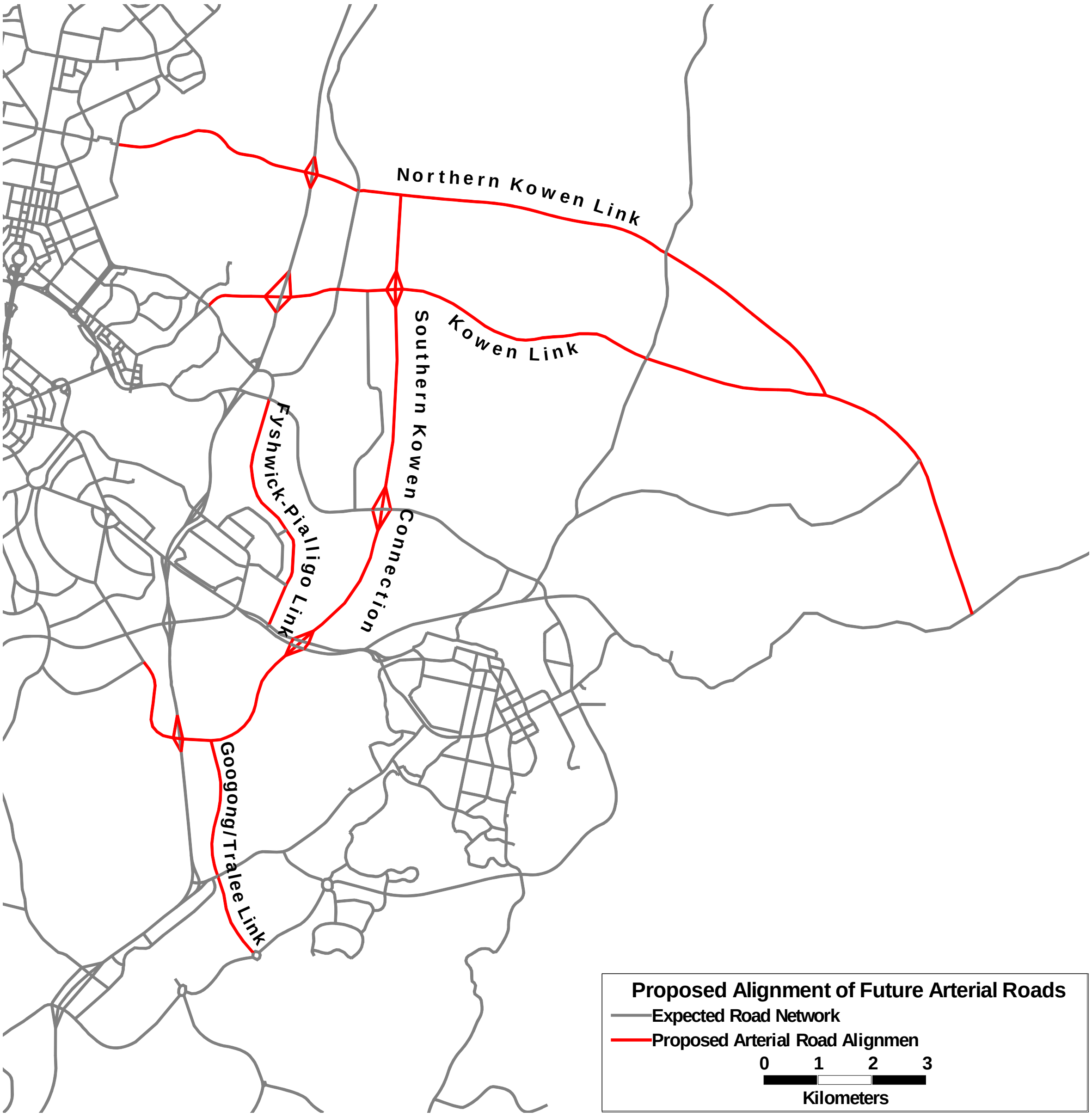

Figure 9-1: Conceptual Arterial Road Alignments

[2] This is normal ACT practice.

Figure 9-2 shows possible alignments for the future roads and some of the constraints. Note that the Kowen Link avoids the defence firing areas at Majura but the Northern Kowen Link does not. Note also the Kowen escarpment which will be a significant obstacle to the construction of major arterial roads in the area.

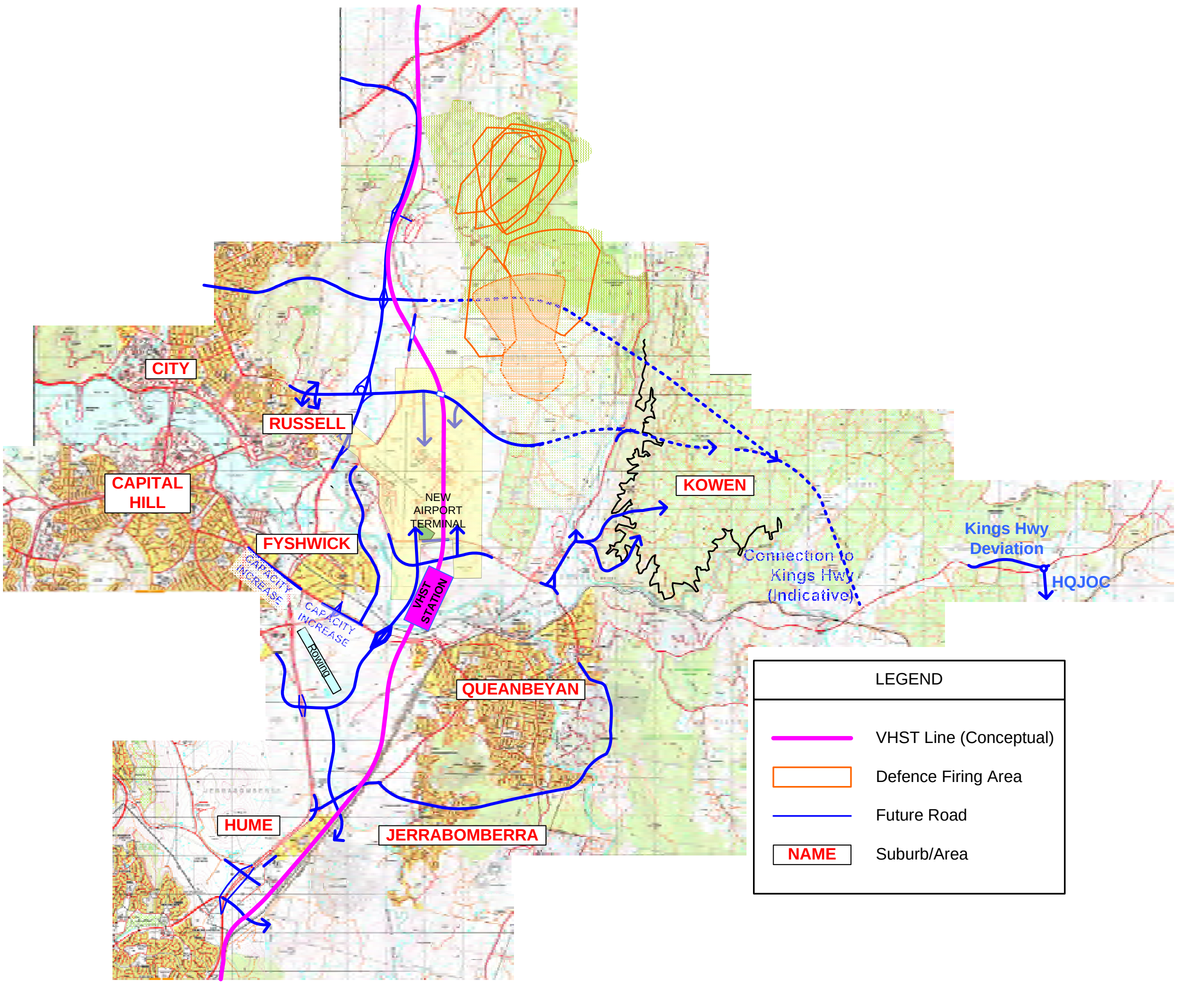

Figure 9-2: Future Road and VHST Alignments and Constraints

9.4 Traffic Management Recommendations

1. More widespread and costlier long stay pay parking at employment nodes to reduce demand and increase average car occupancy
2. Bus priority measures, particularly in the PZ/City/Russell/Airport area integrated with the IPT routes

9.4.1 Intersections

The arterial road network proposed and presented here should preferably have a grade separated interchange where they intersect other roads. The volumes on the arterial roads are expected to be high and at-grade intersections will not be sufficient.

9.5 Public Transport Recommendations

The need for sustainable transport serving the Eastern Broadacre development is particularly acute as the development of new arterial road connections in the area may be difficult. Defence and the airport provide an obstacle to East-West arterial road construction and crossing the river in the North-South direction may be difficult and costly. The lack of suitable east–west transport corridors will increase the importance of a good quality public transport service and enhance the potential for Transit Oriented Development (TOD). Provision for an IPT corridor connecting the Eastern Broadacre and Kowen developments to the wider Canberra IPT network is therefore recommended as a key element in the transport plan for Eastern Broadacre. We recommend that the IPT be initially established for Bus Rapid Transit (BRT).

If ever converted to light rail (tram), the rail should be installed embedded in the busway pavement so that the Xpresso services can continue to benefit from the segregated IPT facility.

Any stops on the bus/tram IPT route should include provision for non-stopping buses to overtake stopped trams and buses.

The IPT should be complemented by bus priority facilities on the new and connecting arterial road system for Eastern Broadacre. Roads where bus priority measures may be appropriate are shown in Figure 9-3. Bus priority on these routes will allow fast and reasonably direct access to Belconnen, Woden, Tuggeranong, the Parliamentary Zone and the Canberra Central area.

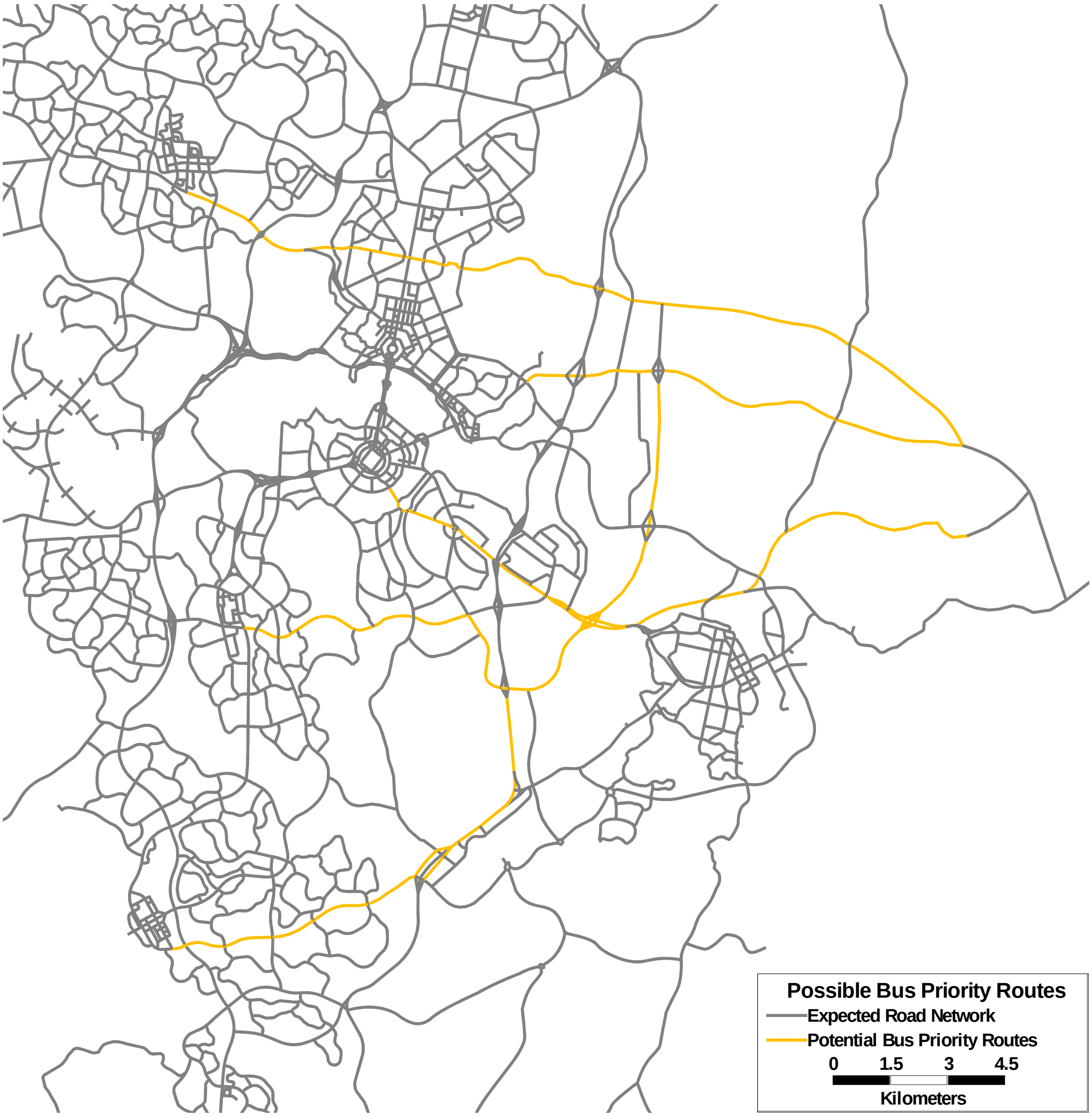

Figure 9-3: Potential Bus Priority Routes

The public transport system should be a bus network with:

1. Buses running at high frequencies
2. Extensive bus priority measures

3. Park and ride facilities for cars and bikes
4. Kiss and ride facilities
5. Shared paths linking bus stops to surrounding development
6. Cycle storage at important bus stops

The bus network should be supported and integrated with an IPT route.

The IPT route should be fully grade separated and segregated from other traffic, with park and ride opportunities and geometric standards allowing for 100km/h operation of Rapid Light Transit (RLT) vehicles (which could be BRT, LRT or future technology). Please refer to APPENDIX for more information about Rapid Light Transit technologies.

The IPT network in the Eastern Broadacre area should take the form shown in Figure 9-4

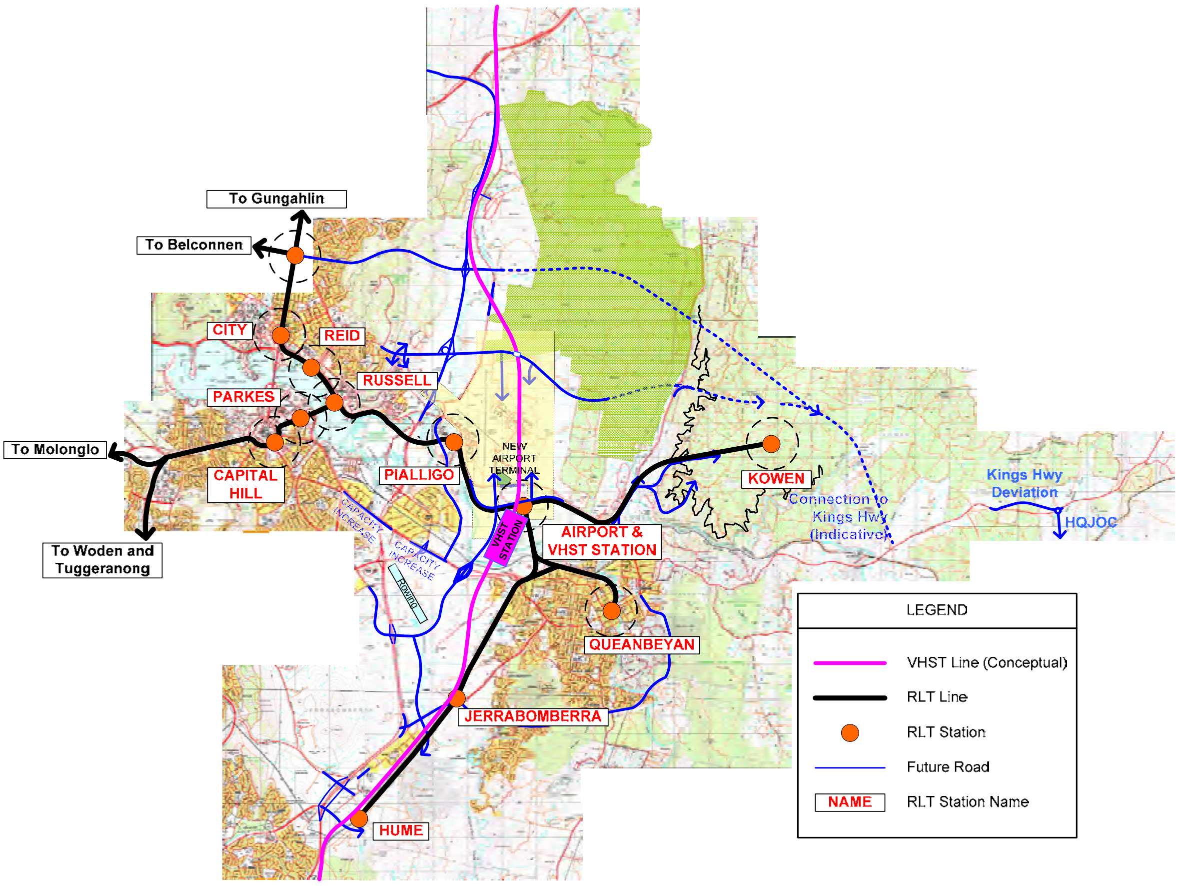

Figure 9-4: Indicative IPT Network for Eastern Broadacre with Conceptual VHST

Note the location of the VHST station and the relocation of the airport terminal. This would provide a transport hub accessed by road, bus, rail, IPT and air.

9.6 Land Use Recommendations (General)

9.6.1 Sustainable Transport

To increase the effectiveness of the sustainable transport plan, land use planning should provide for:

1. Providing residential blocks that can accommodate high population densities within the catchment area of premium public transport services in terms of frequency, reliability, punctuality, etc. This is expected to attract such population to use buses instead of private cars.
2. Locating employment along bus routes

3. Mixed use development surrounding IPT stations (Transit Oriented Development)

9.7 Road Network Development Conclusions

As regards the overall road network development, the following indicative road network development is envisaged:

9.7.1 Road Network Staging by 2031:

Table 9-1: Expected Road Network Additions by 2031

Road/Location (Type of Change)	Change
Clarrie Hermes Dr (Extension)	Extension through to intersection of Barton Highway and Kuringa Dr
Glenloch Interchange (Modification)	Upgraded to include GDE (Stage 2)
Gungahlin Dr Extension (Modification)	Completed through to Glenloch Interchange (2 lanes each way)
Horse Park Dr (Extension)	Completion of route through Moncrieff, Jacka, Casey and Taylor
Majura Parkway (Addition)	Completed (2 lanes each way)
Molonglo (Addition)	Molonglo network modelled to reflect latest development plan
Queanbeyan Bypass (Addition)	From Canberra Avenue (West of Queanbeyan) to Kings Highway (East of Queanbeyan)
Sandford St (Extension)	Extension through to intersection of Federal Highway and Antill St
Wells Station Dr (Extension)	Extension from Gungahlin Drive across Flemington Rd to Horse Park Dr
Kowen Link (Addition)	Completed (2 lanes each way) from Kowen to Fairbairn Avenue
Airport Northern Access Road (Addition)	Completed
Googong/Tralee Network (Addition)	Completed
Edwin Land Parkway (Addition)	Completed
Newcastle St (Extension)	Completed to allow better access to Eastlake development
Isabella Dr (Extension)	Extended across Monaro Hwy to provide access to Googong/Tralee

Table 9-2: Expected Road Network Modifications by 2031

Road	Location (From – to)	Expected Cross-section
Gundaroo Dr	Barton Hwy to Mirrabei Dr	Upgraded to 4 lanes
Gungahlin Dr	Wanganeen Ave to Barton Hwy	Upgraded to 4 lanes
Hindmarsh Dr	Jerrabomberra Ave to Monaro Hwy	Upgraded to 6 lanes
Horse Park Dr	Gundaroo Dr to Federal Hwy	Upgraded to 4 lanes
Monaro Hwy	Newcastle St to Pialligo Ave	Upgraded to 6 lanes
Monaro Hwy	Isabella Dr to Hindmarsh Dr	Upgraded to 6 lanes
Barton Highway	Victoria Street to North	Upgraded to 4 lanes
College Street	Haydon Drive to Eastern Valley Way	Upgraded to 4 lanes
Constitution Avenue	Anzac Parade to Northcott Drive	Upgraded to 4 lanes
Coulter Drive	Belconnen Way to Southern Cross Drive	Upgraded to 6 lanes
Flemington Road	Sandford Street to Hibberson St	Upgraded to 4 lanes
Gungahlin Drive	Gundaroo Drive to Anne Clark Avenue	Upgraded to 4 lanes
Gungahlin Drive Extension	Parkes Way to Barton Highway	Upgraded to 4 lanes
Hindmarsh Drive	Monaro Highway to Jerrabomberra Avenue (Westbound)	Upgraded to 3 lanes
Lanyon Drive	Monaro Highway to Tompsitt Drive	Upgraded to 4 lanes
Monaro Highway	Isabella Drive to Hindmarsh Drive	Upgraded to 6 lanes
Monaro Highway	South to Johnson Drive (Northbound)	Upgraded to 4 lanes
Parkes Way	Glenloch Interchange to Coranderrk Street	Upgraded to 6 lanes
Pialligo Avenue	Oaks Estate Road to Ulinga Place	Upgraded to 4 lanes

Table 9-3: Recommended Road Network Additions and Modifications by 2031

Road	Location (From – to)	Expected Cross-section	Rationale
Southern Kowen Connection (Addition)	Connection from Kowen Link east of the Airport to Monaro Highway north of the Prison. (includes connections to Pialligo Avenue and Canberra Avenue)	1 Lane each way	Increased arterial capacity to cater for development in Kowen and Googong/Tralee
Jerrabomberra Avenue (Extension)	Extended to meet Southern Kowen Connection at Monaro Highway	2 Lanes each way	Increased arterial capacity to cater for development in Kowen and Googong/Tralee
Monaro Highway (Modification)	Split Diamond Interchange at Isabella Dr/Mugga Lane		Provide better access across Monaro Highway
New Googong/Tralee Link (Addition)	Googong/Tralee to Southern Kowen Connection (Across Lanyon Dr parallel to Monaro Highway)	1 Lane each way	Increased arterial capacity to cater for development in Kowen and Googong/Tralee

9.7.2 Road Network Staging by 2051:

Table 9-4: Recommended Road Network Additions and Modifications by 2051

Road	Location (From – to)	Rationale
Kowen Link (Modification)	Kowen – Kings Highway (East of Queanbeyan)	Provide additional access to Kowen
Southern Kowen Connection (Modification)	Connection from Kowen Link east of the Airport to Monaro Highway north of the Prison. (includes connections to Pialligo Avenue and Canberra Avenue)	Increased arterial capacity to cater for development in Kowen and Eastern Broadacre
Northern Kowen Link (Addition)	Kowen to Wakefield Avenue	Increased arterial capacity to help cater for development in Kowen
Southern Kowen Connection (Extension)	Extend to intersect Northern Kowen Link	Increased arterial capacity to cater for development in Eastern Broadacre, Kowen and Googong/Tralee
Canberra Ave (Modification)	Hindmarsh Dr to Queanbeyan	Increased East-West capacity
Parkes Way (Modification)	Coranderrk St to Kings Ave	Increased East-West capacity
Morshead Dr (Modification)	Kings Ave to Monaro Highway	Increased East-West capacity
Pialligo Ave (Modification)	Monaro Highway to Queanbeyan	Increased East-West capacity

Road	Location (From – to)	Rationale
New Googong/Tralee Link (Modification)	Googong/Tralee to Southern Kowen Connection (Across Lanyon Dr parallel to Monaro Highway)	Increased arterial capacity to cater for development in Kowen and Googong/Tralee
Fyshwick to Pialligo Link (Addition)	Canberra Ave to Beltana Rd via Tennant St	Better access to Fyshwick and across Molonglo River

10 References

Canberra International Airport 2008 Master Plan (Preliminary Draft)

QCC Website Forecast ID Data (Accessed 22/06/08, Supplied by ACTPLA)

Kowen Preliminary Draft Structure Planning Investigations, 21/04/08

Molonglo Roads Feasibility Study, SMEC, June 2008.

Southern Broadacre Planning Study, SMEC, February 2005.

Eastern Broadacre Precincts, Macroplan, August 2008

Griffin Legacy, NCA, 2007/08

Appendix A Future IPT

A.1 Client Requirements

The ACT Government requires the bus way system to be designed to facilitate possible future technologies, including light rail and personal rapid transit systems. An 8m wide envelope for the IPT has been previously selected for the Flemington Road cross section. (Check basis for this. New European light rail 2.65m wide. Melbourne use 8.42m minimum between kerbs with central power supply column).

A.2 Light Rail

Figure 10-1 Light Rail with Grass

Figure 10-2 Modern Styling of Light Rail - Strasbourg

Bus ways are normally planned to facilitate future conversion to light rail, and design guides are available. The geometric requirements for light rail and buses are not greatly different. Issues to note (at detailed design stage) include:

- conventional (steel wheel steel rail) light rail must avoid negative cant
- if reinforced concrete structures are required that may carry light rail in the future, then the bridge design loading needs to consider the axle loading for rail vehicles
- the need to provide earthing of structures to ensure stray currents associated with the light rail power supply do not cause corrosion

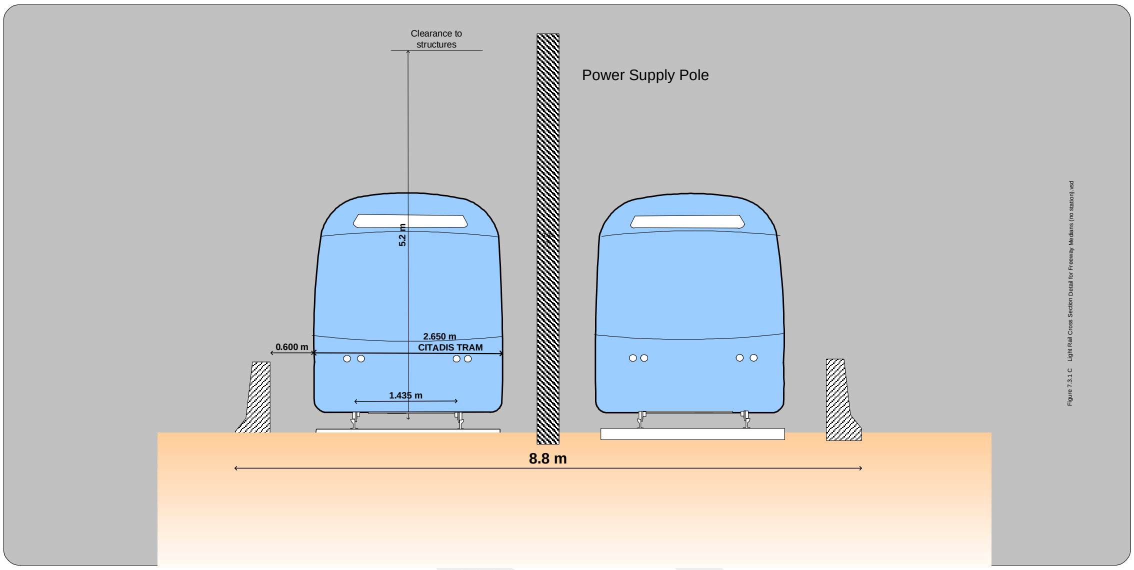

Figure 10-3 Light Rail with central power supply and barriers (or pedestrian control fences)

If the future light rail track is to be shared with buses, the power supply may need to be supported from poles at the sides of the facility. If only light rail is to use the facility, centrally located power supply may be preferred to avoid the need for tree lopping and minimise the number of supporting columns to reduce visual impact. In this case, the centreline of the light rail would need to avoid longitudinal services in the median. **Table 10-1** shows the widths required for light rail in medians.

Table 10-1 Arterial Road Median Widths to Accommodate Light Rail

Case	Width
Away from intersections for light rail* no stops, no trees	8.5
Away from intersections for light rail* with stops and shelter**, shrubs, trees < 150mm diameter.	13.0
Near intersections one 3.0m right turn lane and light rail* with stops and shelter** shrubs, trees < 150mm diameter.	15.7
Near intersections two 3.0m right turn lanes and light rail* with stops and shelter** (large tree planting)	21.7
Flemington Road Median (large tree planting)	19.0
Recommended Minimum (4m clear zone to large trees)	20.0
Width to accommodate light rail, twin cycle paths and one right turn lane (large trees)	24.0

* Power supply from one centrally located power pole.

** Shelter is within the clear zone.

A.3 Light Rail – A Mature Technology

According to *Urban Transit News* of 11 February 2005, published by the Light Rail Transit Association, the small French city of Angers (with an urbanized area population of just 226,900) "has decided in favour of a steel wheel tramway for a 12-km [7.4-mile] north/south line to be built by 2009...." LRT tramway technology was selected over an alternative "rubber-tired tramway" (using guided "bus rapid transit", or "BRT", technology) for a variety of reasons (see below).

According to the official announcement, well-proven, standard-rail tramway technology was selected rather than a guided-bus "BRT" system for reasons of safety as well as because of technical issues and financial advantages. A steel-wheel tramway offered the advantage of a large variety of vendors, and the hardware had "proven reliable for a very long time...."

Angers planners apparently were extremely impressed with the performance and durability of light rail transit (LRT) tram rolling stock on other systems. For example, they note the "very good condition" of the first vehicles of the original trams in Nantes, despite their now being 20 years old. At the same time, they also appear impressed by advances in tram (light rail vehicle) technology, noting the "improvement of the quality (comfort, silence, flexibility, accessibility) of new vehicles recently put in service."

Metro district officials recount that the only "tramway sur pneu" (rubber-tired "tramway", or guided-bus technology) which met the capacity requirements of the Angers project was the proprietary "new generation" system developed by Translohr. While this technology has been selected for deployment in the small city of Clermont Ferrand (headquarters of Michelin), notes the Métropole, it has not yet operated in actual service.

Another advantage of LRT recognized by Angers was that it opened rolling-stock selection to a wider spectrum of competitive bidders, "thus attracting the best possible prices...." Apparently, the availability of a well-proven, widely standardized technology (steel-wheel on rail) was particularly attractive. The Métropole announcement cites again the example of Nantes, where "the oldest vehicles that run today were manufactured by Alstom and the most recent by Bombardier."

Angers apparently was also not impressed by claims of significantly quieter operation made on behalf of guided "BRT" or "tram on rubber tires". The announcement cites a study demonstrating that, at lower operating speeds, typical in most populated areas, "where the noise issue is thus most important," the difference between the two systems (steel-wheel vs. rubber tire) was only one decibel.

Now that the choice of mode has been made, Angers is moving swiftly to get the tramway project under way. Besides soliciting bids (tenders) for rolling stock, officials also expect to launch competitive bidding for construction of the system's maintenance centre, to be located next to the city's old airport. Groundbreaking is expected by the autumn of 2006.

A.3.1 Tram-Train

Figure 10-4 Dutch experiment with 'Tram Train'.

A light rail system could be integrated with existing lightly used railway line between Canberra, Queanbeyan and Jerrabomberra/Hume.

Figure 10-5 Light Rail becomes Tram

Figure 10-6 Shared Bus and Light Rail (Tram) Facilities

A.4 Accommodating Future Technologies

A.4.1 Vehicle Automation

General

Vehicle-automation systems are being developed that include low-speed automation, autonomous driving, and close-headway platooning (which provides increased roadway throughput), and electronic vehicle guidance in segregated areas such as bus ways.

Automation for operating snow ploughs (magnetic nails) and agricultural equipment (GPS) is showing promise. These developments have the potential to offer people-carrying capacity approaching that of a light-rail system, without the capital costs required with rail. Because of space restrictions in urban areas, bus-only lanes are often very narrow. Electronic guidance potentially lets a bus precisely track within its designated lane at full speed. Electronically guided bus systems are now being considered in the Netherlands, France, England, and Japan. In the US, several transit agencies are considering electronic-guidance systems, with support from the federal Bus Rapid Transit program. Guided bus systems are also under consideration in Sao Paulo, Brazil, and other South American cities. Optically guided systems are also under development. (These could be disrupted by snow, hail, pavement graffiti, large patches and resurfacing operations, leaves, etc). Single steel rail guidance has also been developed in Europe for rubber tyred bus/tram/trolley bus hybrid vehicles.

BRT Lane Assist & Precision Docking Technology

According to the Federal Transit Administration, "BRT combines the quality of rail transit and the flexibility of buses. It can operate on exclusive transit ways, HOV lanes, expressways, or ordinary streets. One of the more likely candidate IVI applications to be initially implemented on BRT systems will be lane assist technology. The premise behind lane assist technology is to increase the safety of BRT vehicles as they operate in the more unique environments, such as narrow lanes. Lane assist technology will allow BRT vehicles to operate at the desired higher operating speeds while maintaining the safety of the passengers, BRT vehicle and the motoring public."

Bus Rapid Transit Lane Assist Technology Systems Vol. 1 Tech. Assessment (Federal Transit Administration 2003) investigated:

- the results of a study to determine US requirements for lane assist and precision docking systems
- a review of available lane assist and precision docking system technologies
- a comparison of lane assist and precision docking technologies based on system functionality
- an assessment of these technologies with respect to national requirements

The report concluded that lane assist and precision docking systems are still in the early stages of system development. Insufficient operational experience disallows any statistically valid claim to system performance, system reliability, maintenance requirements, failure modes, etc. Too few of these systems have been deployed worldwide. Systems, which have been deployed have suffered from a lack of development and testing. This premature deployment has reduced public and driver acceptance of these systems.

A.5 Bombardier GLT

Figure 10-7 GLT operating in Nancy

The “Guided Light Transit” (GLT) is being developed by Bombardier Transport. While this vehicle may be guided by a steel wheel beneath the vehicle which runs on a steel rail in a groove in pavement, it may also be driven conventionally.

The technology has been designed to fill the gap between at-grade LRT and conventional bus technology. It provides many of the fundamental features of LRT but at a possibly lower cost (Bombardier suggests 30 percent savings from LRT). The vehicle is Bombardier’s lightweight, low-floor Light Rail Vehicle (LRV) supported on pneumatic tires rather than on steel wheels on rail.

The GLT can, on a limited basis, be driven and steered on ordinary roads by the operator as if it were a long bus. The same vehicle could serve a collection/distribution function as well as a line haul function.

This ability to run on roads reduces the cost and complexity of the maintenance facility since a switchyard of tracks is not necessary. However, the vehicle can also be guided as if on rails when the centre guide wheels are lowered into a guide rail installed flush in the centre of the road line.

The guide rail is lightly loaded compared with an LRT rail, and is thus less expensive to buy and install. Each of the four rubber-tired bogies that support the vehicle has a guide wheel to steer it.

Thus, the entire double-articulated vehicle is guided as precisely as if it were an LRV on rails.

In guided mode, the vehicle can negotiate turns in a shared street without encroachment into adjacent lanes, and can stop closely along a station platform for level passenger loading without supplemental ramps to close the gap.

The low-floor GLT is Bombardier’s third generation of this class. Twenty second-generation vehicles (called the Transport sur Voie Reserve or TVR) are operating on a 15-Kilometer (9.3 miles) route in Caen, France. The City of Nancy, France, contracted for 25 GLTs in February 1999. Revenue service is scheduled to begin in early 2001.

The overhead electric catenary is needed; however, this vehicle can also run on a diesel motor for up to 4 hours of off-wire service. Paris’s RATP is testing a similar Translohr Tram from Lohr of Strasbourg.

The GLT vehicle is 24.5 meters (80.4 feet) long and 2.5 meters (8.2 feet) wide. Its length is about 10 feet shorter than the 90-foot Bombardier LRV. There are four doors on each side. The vehicle capacity is 200 passengers, with 51 seated and 149 standing at the design standee space of 4 passengers per square meter (11 square feet).

If the vehicle could operate at the traffic signal cycle length downtown (say 60 seconds), the theoretical line capacity would be 12,000 passengers per hour per direction. Maximum speed is 70 kilometres per hour (44 mph), possibly a limiting factor for operation on other than arterial streets.

The vehicle is electrically propelled. Four sources of power for the drive motors are offered – overhead pantograph, overhead trolley wires, batteries, or a motor/alternator set.

The vehicles could draw power from overhead wires for much of the route but on a limited basis use battery power in visually sensitive areas of the Urban Core.

The motor/alternator option would eliminate overhead wires completely, but would not eliminate the problems associated with diesel-powered vehicle.

Figure 10-8 GLT operating in Nancy

Figure 10-9 GLT (Rubber tyred bus/tram with single rail steering)

The flexibility of these new buses (or trolley buses) further allows them to adapt to complex urban environments. The Bombardier-built vehicle (Figure 5.1) in use in Nancy, France, is capable of operating as a bus (self-powered on pavement), as a streetcar (powered by overhead cables on pavement) or as a guided “rail” vehicle (using either power source on a guided pathway). This dexterity allows BRT vehicles to use existing transit infrastructure, operating alongside existing modes when appropriate and operating on surface streets or dedicated bus ways when necessary.

All the signs in technical documents and engineering reports on this new type of tramway point to a sceptical attitude by planners and academics because experiments so far conducted do not appear to have met with the success that those involved had hoped for. This could change if Nancy eventually resolves its current difficulties in keeping the vehicle "captive". (There have been some accidents involving instability of the trailer section).

A.6 Translohr

Figure 10-10 Translohr Rubber Tyred Single Rail Tram

This is a similar concept to the GLT.

The Translohr is a range of modular bi-directional low floor (25cms) vehicles designed for passenger flows between 2,000 and 5,000 per hour/direction. To achieve this the vehicles come in several variants:

- STE2 - two passenger modules totalling 18 metres in length.
- STE3 - three passenger modules totalling 25 metres in length.
- STE4 - four passenger modules totalling 32 metres in length.
- STE5 - five passenger modules totalling 39 metres in length.

With multiple-unit operation longer trains are also possible although in many countries there are laws restricting the maximum length of vehicles which operate within the street environment. Translohr vehicles can be between 2.2m and 2.65m wide (as per local requirements) and be either bi-directional (with driving cabs at both ends of the vehicle) or uni-directional (which means that they would have a definite front and back).

Figure 10-11 Rubber Tyres Guided by Single Steel Rail

Passenger seating can be varied according to requirements too, although there are four pre-designed seating 'formats' - sit/stand, wide or extra wide - other options include installing the seats at right angles to the bays to improve passengers' visibility of the town (transverse seating) or longitudinally to increase (standing) passenger capacity. Another design possibility is for special fittings for bicycles. Total passenger capacity of the vehicles depends on length, width and seating configurations but is claimed to be between 80 and 250. Translohr publicity material suggests that as ridership increases it would be relatively easy to increase passenger capacity on STE2 / STE3 / STE4 vehicles by adding extra modules - up to a maximum length of 5 modules, which equates to the STE5 variant.

Translohr vehicles are supported on a series of single-axle bogies that each have sets of two guidance rollers at both the forward and aft ends of the bogies. These rollers (which are centrally located between the road wheels) form a 'V' as they lock on to a guiderail which is located flush with the road surface. They are mounted at 45 degrees to the road surface and at 90 degrees to each other. Linkages from the roller assembly provide the steering function by connecting to the road wheels. Translohr vehicles have a turning circle of 10.5 metres.

Because the rail profiles are different the GLT and Translohr tracks are not compatible.

The Translohr is marketed as a tramway and it is intended / expected that at all times the vehicles will remain in guided mode with power coming from an overhead wire via a roof-mounted pantograph and the electric return being via the guide rail. However a design possibility allows for tractive effort without the overhead wire. How this would be achieved depends on local circumstances / requirements. (e.g., short distances to be travelled could be powered by flywheels and batteries whilst longer distances might require fossil fuel engines). There are two traction motors providing a total output of 400 kW.

So far (May 2005) four European cities have chosen to install Translohr rubber-tyred tramway systems. Clermont-Ferrand (France) and Mestre-Venice (Italy) will use STE4 vehicles whilst L'Aquila (Italy) and Padua (Italy) will use STE3 vehicles. The first two of these systems are expected to open in the autumn / winter of 2005.

The Translohr is also being actively marketed in Asia and there is a test / demonstration track (0.5km in length) in Osaka, Japan.

A 30km Translohr line is also planned in the Chinese city of Tianjin, which is East of Beijing. This will be built in several stages with construction of the first section due to commence in 2005. According to various press reports (which say slightly different things) this first phase will be between 8km - 10km in length and use type STE4 tramsets.

A.7 CiViS

The Irisbus Civis is a joint venture of Renault and Fiat's industrial vehicle company, Iveco. The Civis buses are propelled by electric motors mounted on the wheels. A diesel engine runs an alternator that produces the needed electricity. Because there is no drive shaft or transmission, the cabin floors are flat from the front door to the back window, with no steps that passengers need to negotiate. Instead, the doors open at the level of the curb so that people can enter or exit in groups, as they would on a subway car. Those in wheelchairs can roll onto the bus.

It is understood that current versions of these vehicles have a high capital cost and a high running cost.

The great potential advantage of this optically guided bus is its precision. Buses can dock within 2 inches of the curb so that all the doors line up with the platform. This precision eliminates the need for wheelchair ramps, a major time delay. The other advantage of optically guided steering is that buses with the technology require a narrower roadway—typically 5 feet narrower—than buses that rely on humans to guide them. The smaller paths the buses use make them particularly suited to tight spots like median strips, road shoulders, and tunnels.

The optical 'self-steering' guidance system is called 'Visée', and this is claimed to be the first technology to use Artificial Vision in passenger transport. It works by a forward looking video camera detecting the correct path by 'seeing' the contrast between twin white dashed lines and the darker road surface on which they are painted. Initially Visée was developed to enable accurate docking at bus stops but it is claimed to be equally competent for full-time vehicle guidance. However, when using the optical guidance (in France) the buses are limited to 30km/h (about 20mph) with the bus drivers being required to keep their hands on the steering wheel at all times. There are two options for this guidance system with the 'virtual rail' either being located down the centre of the vehicle or offset to the left.

The Visée Optical guidance can actually be fitted to almost any bus - not just the Civis - initially most trials used otherwise 'standard' Renault (Irisbus) Agora diesel buses.

The optical guidance system was selected over a system using embedded tracks, because the vehicle track (path) may be modified, which reduces or distributes roadway wear and rutting.

Civis buses may have global positioning satellite (GPS) equipment that tracks their location. This information is transmitted to displays at the stops so that riders will know when the next bus is coming. The French vehicles also have controls that let the drivers change traffic lights ahead to avoid slowing down.

More than 200 of the CIVIS units, which come in a variety of electric and hybrid versions, are on order or option by Lyon. Grenoble, Clermont-Ferrand, and Rouen.

The Lyon and Grenoble systems will not employ the optical guidance system.

The optical scanning system has potential applicability in the United States in select operating environments where space is at a premium and where precise positioning of buses is essential.

Having trialled their hybrid Civis buses for several years the two cities have come to opposite conclusions. Clermont-Ferrand has decided that once the leasing period is over it will neither be purchasing the 6 Civis buses which have already been delivered nor will it be proceeding with purchasing a fleet of Civis buses. It has been suggested that the main reasons for this change of plans are financial - compared to the diesel mechanical Agora buses the diesel-electric Civis consumes 30% to 35% more fuel plus the Agoras are only half as expensive to purchase. According to media reports Irisbus suggest that the higher fuel consumption is because of the lack of dedicated bus way / bus right of way - although experience in Seattle (USA) with diesel-electric hybrid buses has also shown them to be thirstier than expected. As a contrast, early in 2005 Rouen ordered another 28 of these high-tech buses (albeit of the Cristalis and not Civis design) for its TEOR *Bus Rapid Transit* line and is now proceeding with its plans for expansion.

Examples include the existing bus tunnel in Seattle and the proposed Silver Line Tunnel in Boston. It is reported that Las Vegas is considering this system for its planned BRT line. The major constraints of snow and ice preclude application in northern parts of the United States and all of Canada. **Further testing of the system is desirable before any large-scale application.**

Figure 10-12 Fuel Cell Powered Civis

In 2005, a fuel cell bus manufactured by the French company IRISBUS is expected to operate in the streets of Paris.

Table 10-2 Comparison of Light Rail Cost and BRT Cost

Table 1: Comparative At-Grade LRT vs. Civis Transit

(10 Mile, 20 Station, 15 Vehicle System)

		$ Millions Per Mile or Per Unit			
		LRT		CIVIS	
SYSTEM					
Vehicle	Per unit	3	45	1.1	16
Guidance	Per unit	-	0	0.1	2
Signaling and Controls	Per mile	5	50	1	10
Communications and Signaling	Per mile	0.7	7	0.3	3
Power Supply & Distribution	Per mile	6	60	-	0
Pre-Revenue Testing	One project	3	3	2	2
Fare Collection	Per station	0.25	5	0.25	5
SUBTOTAL		***170***		***38***	
CIVIL WORKS					
Guideway/Track Bed or Roadwork	Per mile	10	100	3	30
Stations	Per unit	1.5	30	0.2	4
Maintenance Facility & Tracks	One unit	10	10	2	2
Infrastructure (3 rail and PDS)	Per mile	4	40	-	0
Utilities Relocation	Per mile	1	10	0.3	3
Traffic Maintenance	Per mile	2	20	0.5	5
Land Acquisition and Landscaping	Per mile	1.5	15	1.5	15
SUBTOTAL		***225***		***59***	
SOFT COST (25% OF SYSTEM/CIVIL)					
Project Management	10%	40		10	
Construction Management	5%	20		5	
Design	5%	20		5	
Planning & Prelim Engineering	5%	20		5	
SUBTOTAL		***100***		***25***	
TOTAL (10 MILE, 20 STATION, 15 VEHICLE SYSTEM)		***$495 Million***		***$122 Million***	

Note: Many factors can effect per mile calculations; certainly longer length and larger fleet size systems cost less per mile than smaller ones.

(16km system with 20 Stations and 15 Vehicles)

A.8 Volvo de Brasil Articulated Bus

This service proven technology can carry a high capacity of passengers. Issues inhibiting their use in some areas may include the length of the vehicle (see **Figure 10-13**), the diesel powered motor, and the high floors. Vehicles are 26.8 meters long, double articulated, manually driven, diesel-powered Volvo buses (built in Curitiba) with a "crush loading" capacity of 270 – 300 passengers per bus. Dwell times (time at a stop) are low because of a unique station design which features fully-enclosed, weather-protected stations with platforms that are level with the floor of the bus as shown in **Figure 10-14.**

Figure 10-13 Double Articulated Bus

Figure 10-14 Boarding System in Curitiba

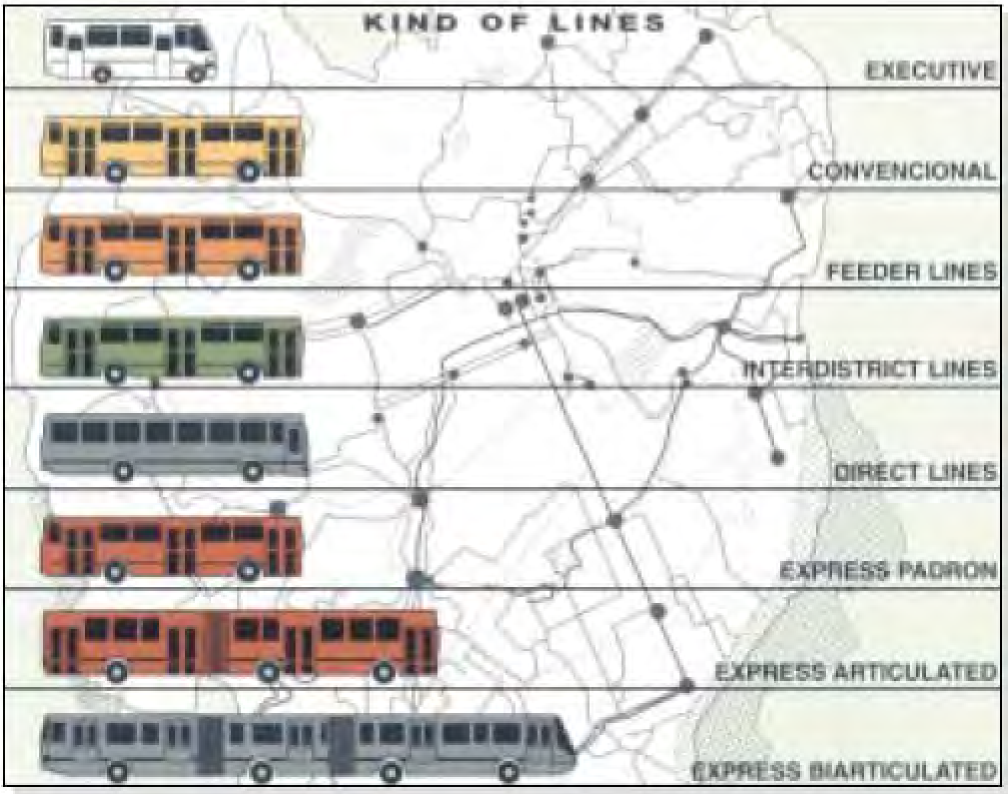

Figure 10-15 Bus Types in Curitiba

Figure 10-16 High Density residential Development Adjacent to Busway in Curitiba

A.9 Monorail

Monorail technology tends to be highly site-specific and thus is usually found in theme parks, in other tourist attractions, as short connectors to parking, as relatively short urban transit lines and connectors to larger, faster systems. In Japan, where space is limited and densities extremely high, heavy-duty monorail systems for six public transit lines with relatively high ridership

Figure 10-17 Osaka Monorail

Figure 10-18 Kuala Lumpur Monorail

In the U.S.A., monorail technology is being promoted by monorail enthusiasts as an alternative to light rail transit (LRT). However, most of the claims that monorail is cheaper to build, is cheaper to operate (will "make a profit"), is better suited to the urban environment, etc., are unsubstantiated or not supported by the actual data available from existing monorail operations when compared to LRT systems currently in operation. For example, the actual total cost to install a mile of monorail in Las Vegas right now (based on actual project costs) is approximately $141 million a mile – more than four times the price per mile that it has cost so far to build the existing (and rapidly expanding) 45-mile Dallas light rail system, and *more* than three times what light rail is projected to cost per mile for new-start LRT projects such as the one now underway in Charlotte, NC.

Table 10-3 Urban Monorail System Installation Costs (Cost per Mile (US$ Millions, 2002))

Chiba (Japan): Monorail (extension)	128.2
Jacksonville: Skyway (new)	81.1
Kitakyushu (Japan): Monorail (new)	205.9
Kuala Lumpur (Malaysia) (new)	58.2
Las Vegas (LVMC Project, new)	166.7
Newark: Monorail AGT (new)	223.1
Okinawa (Japan): Monorail (new)	103.9
Average	**138.2**
[Sources: Capital Metro, Rapid Transit Project, ADraft B Milestone 2 Executive Summary: Urban Transit Vehicles@, 1 October 2001; Steve Arrington, Jacksonville Transportation Authority, 12 October 2001; Leroy Demery, Jr., May 2002; Monorail Malaysia, news release, 23 April 2001; Jacob Snow, AThe Las Vegas Monorail@, Monorail Society website, 2002/11/02. Calculations by LRP]	

Table 10-4 Light Rail Transit System Installation Costs (Cost per Mile (US$ Millions, 2002))

Surface - Minimum Civil Works	
Baltimore: Central Line Phase 1 (new)	20.0
Baltimore: Central Line/3 (ext.)	17.4
Denver: RTD Central (new)	25.9
Denver: RTD Southwest (ext.)	21.5
Portland: MAX Eastside line (new)	28.3
Sacramento: RTD starter line (new)	13.1
Sacramento: RTD Mather (ext.)	16.4
Saint Louis MetroLink SW Illinois (ext.)	19.4
Salt Lake City: UTA starter line (new)	22.8
San Diego: Trolley Blue Line (ext.)	33.2
San Diego: Trolley Orange Line (ext.)	24.9
San Jose: VTA Guadalupe corridor (new)	27.8
San Jose: VTA Tasman corridor (ext.)	46.5
Average	24.4
Extensive Civil Works	
Dallas: DART S & W Oak Cliff	33.2
Dallas: DART - North to Park Ln	62.2
Los Angeles: MTA Blue Line	46.1
Los Angeles: MTA Green Line	52.1
Portland: MAX Westside line	60.2
St. Louis: Metrolink (new start)	37.2
Average	48.5
[Sources: Capital Metro Rapid Transit Project, Draft Milestone 2 Executive Summary: Urban Transit Vehicles, 1 October 2001; converted to 2002 dollars by LRP]	

From **Table 10-3** and Table 10-4, some broad conclusions can be drawn. In regard to monorail systems, it can be seen that, with an average capital cost of nearly US$140 million per mile, and with some individual systems exceeding US$200 million per mile, these examples of monorail systems do not seem to corroborate the low-cost claims of many monorail promoters. Furthermore, these costs hardly bear out assertions that monorails are roughly equivalent in cost to LRT.

A.10 Philias

In Holland a fleet of 13 distinctively-styled buses are being trialled on the 15km *Phileas* system which links Eindhoven Central Station with its airport and Veldhoven, serving the Westcorridor development zone. Most of the fleet are 18m in length with a single articulation although there is one 24m double-articulated variant. The concept also allows for even longer 25.5m double articulated variants - for use where local laws permit vehicles of this length.

Phileas has been partially funded by the Dutch government, local governments in Eindhoven & surrounding areas and the private sector.

Most of the buses feature a gas powered hybrid-electric drive system whereby (when the vehicle is in motion) the LPG engine runs at a constant speed providing power for both the electric motors and the storage batteries. All wheels except the front wheels are motored. The vehicles also regenerate their braking energy into the batteries which have been designed to allow up to 3km of inner-city operation with the LPG engine switched off. This is also claimed to reduce fuel consumption by up to 30% compared to an LPG powered bus of comparable size.

By way of a further refinement (and experimentation) one vehicle has also been fitted with a flywheel which provides the energy required to start from rest, with the LPG engine then taking over. To further boost fuel efficiency the flywheel is recharged by regenerative braking whilst decelerating.

To increase fuel efficiency and reduce weight the construction of Phileas buses includes extensive use of lightweight materials such as aluminium and plastic. Modular construction means that some aspects of vehicle configuration can be adjusted to suit a transport operators perceived requirements (e.g.: door positioning). Internally all seats and stanchions are mounted in the buses' inside walls - this is claimed to make extra space for shopping bags to be stored under the seats as well as simplify internal cleaning. They are fully air-conditioned.

A unique feature is the all-wheel steering. This allows the Phileas buses to move sideways (crab-like) and at bus stops helps ensure very precise docking with a gap between vehicle and platform of just 5cms. Because bus stop platforms are of the same height as the buses' floor these features should improve access for special needs people and thereby speed the service by helping to reduce dwell time when calling at bus stops. Passenger capacities are around 120 in the 18m version and 180 in the 24m version.

Next to the dedicated vehicles the core of the Phileas system however, is its pioneering guidance technology based on magnetic beacons, which is known as *Frog*.

Frog features magnets which are embedded (at 4m intervals) in the road surface. These are read by the on-board computer system which has also been programmed with details of the route to be followed. The computers also monitor wheel revolutions, this provides precise location information and helps the computer guide the buses both along the correct route and into bus stops. The promoters of Phileas claim that in adverse weather conditions - such as snow and ice - Frog will provide a more secure system than the Visée Optical guidance system used by the French Civis (etc) buses. (Note the similarity to North American snow plough automated steering systems).

Frog also provides vehicle location data for electronic "real time" information systems - not just for passengers waiting at bus stops but also for in-vehicle passenger information announcements & displays and for "off-system" users - such as mobile phone and Internet based information services.

Phileas and Frog combined offer three driving options:-

In *automatic* mode the computers control acceleration, braking and steering / guidance. However at bus stops the human driver controls the doors.

In *semi-automatic* mode the computers control steering and the human driver does everything else.

In *manual* mode the human driver does everything, just like a regular road going bus.

So far Phileas remains "under development". Initial trials have been dogged with challenges which are still being worked on. Apparently the Frog guidance system has suffered from electrical interference - including from traffic signals. There have also been some issues with driver alertness - especially when the vehicles are operating in automatic mode. Part of the issue here is that it is intended that automatic mode will be used even when Phileas vehicles are operating on the normal highway (which is shared with other traffic) and subject to pedestrians who do not want to be told that to cross the road they must wait for the "cross now" symbol at specified crossing points which may be "out of the way" for where they are going.

Figure 10-19 Phileas

A.11 STREAM

"STREAM" technology (the acronym for "magnetic pick-up electric transportation system" in Italian) is a traction power delivery system being developed by Ansaldo Breda, and represents an alternative to overhead contact systems. Electric power is provided to the vehicle from a power strip embedded at surface level in the street pavement which is only energized under stationary or moving vehicles. At all other points the power strip is not energized, and therefore poses no hazards to pedestrians or other surface traffic crossing the alignment.

This form of providing traction power from the wayside eliminates the need for overhead contact systems, and because no structures protrude from the pavement, the right-of-way can be shared with pedestrians and other vehicles. While early applications have employed rubber-tired vehicles (buses), the traction power delivery system could be employed with light rail vehicles as well. This technology has been under research and development in a test mode for several years in Naples, Italy.

The first commercial installation is under construction in Trieste, Italy. Testing of a first vehicle has begun in Trieste on the first 300 meters of STREAM track. After the completion of the three month testing program, some modifications and improvements may occur before the track is extended to 3.3 kilometres, the length of the first phase.

A.12 FTR

In the autumn of 2004 one of the major British transport operators (FirstGroup) and a major British Isles-based bus builder (The Wright Group) announced plans for a new concept in bus travel.

It is expected that the first prototype vehicle(s) will be trialled in the spring of 2005. Three cities have been short-listed, these being Leeds, Sheffield and York. Trials in Leeds will probably include operation on the kerb-guided bus way.

Figure 10-20 FTR Bus

A.13 Automated People Movers & Personal Rapid Transit

Personal rapid transit is a subset of a class of transit systems known as Automated People Movers (APMs). Typical APM (i.e., non-PRT) systems generally consist of vehicles having capacities between 12 to 100 people which run along dedicated guide ways in a line-haul, fixed-schedule configuration. Examples of this type of system can be found in airport people-movers. Although fairly successful in these applications, APM systems have not been widely accepted as realistic modes of urban transport for many reasons, particularly with respect to PRT-type APMs. For PRT systems, some of these reasons include inertia within traditional transit sectors to consider new modes of transportation and inadequate testing of early prototype systems which led to highly publicized failures.

Figure 10-21 Automated People Mover Concept

A PRT system should have:

- Fully automated vehicles capable of operation without human drivers.
- Vehicles captive to a reserved guide way.
- Small vehicles available for exclusive use by an individual or a small group, typically 1 to 6 passengers, travelling together by choice and available 24 hours a day.
- Small guide ways that can be located aboveground, at ground level or underground.
- Vehicles able to use all guide ways and stations on a fully coupled PRT network.

▪ Direct origin to destination service, without a necessity to transfer or stop at intervening stations.
▪ Service available on demand rather than on fixed schedules.

Figure 10-22 Lille VAL (automatic, rubber-tired mini-metro)

Figure 10-23 Bishop Austrans

VAL (**Figure 10-22**) has been operating in Lille since the 1980's. It has been installed in a few other French cities. Latest versions do not require a crew. It requires a completely segregated track. It uses rubber tyred vehicles with the same bogies as the rubber tyred Paris Metro. It appears to be an expensive version of light rail, but with automatic control. It needs a control centre and therefore the apparent reduction in labour costs may not be as great as may be expected. The labour force would include trained technicians and these may be in shorter supply than bus or light rail drivers.

One of the experimental devices (once mooted for trial in Canberra) is Austrans. Slightly larger than a car people mover, Austrans (**Figure 10-23**) potentially provides high frequencies that make timetables and long waiting periods a thing of the past. Development of the Austrans **concept** is claimed to be complete. Any further work has to relate to a specific application to be useful and efficient. If there is an application, the process of engineering design, prototyping and durability testing, followed by production and commissioning, will be required.

There are numerous other prototype and experimental systems, including the ULTra system which is intended to be trialled at Heathrow Airport. The planned route for the pilot is from the N3 passenger car park to the new Heathrow Terminal 5. The route requires 4.2 km of track including station loops, and 18 vehicles. The guideway will connect into the Multi Story Car Park at T5 to provide a station at the entrance to the Terminal. The system is scheduled to be carrying passengers in Summer 2008 following the opening of T5 in March 2008.

Figure 10-24 ULTra PRT

A.14 Summary

There is a wide range of emerging technologies being developed for public transport. Judging by the reaction of markets, it must be concluded that most new devices, if not all, are not yet competitive with conventional buses or proven light rail technologies.

If a new high capacity system were required to replace buses, light rail currently offers one of the most proven solutions. Even in Curitiba, where bus based transit has been enormously successful, light rail is being considered. (A monorail project has been cancelled owing to lack of financing). The city has announced that it will study replacement of buses with "electric tramcars" – that is, surface light rail transit (LRT) – on the two busiest bus ways.

While monorails are also well proven, the urban design issues associated with their supporting structures make them an unlikely choice for Canberra, although a recent proposal for their introduction has received front page coverage in the *Canberra Times*. Monorail systems are generally high cost, and may be appropriate in densely developed cities, but are unlikely to be economic for a low density city where right of way for the IPT is generally readily available at low cost.

As it will be many years before Canberra BRT requires supplementing by a higher capacity system, the future technology that would be appropriate is uncertain. However, judging by current trends, it is expected that advances in rubber tyred public transport vehicles will make them increasingly competitive with light rail, particularly in low density cities such as Canberra.

While light rail can provide a higher capacity service than BRT, very high capacity vehicles for services in Canberra may not be a high priority, **as frequency of service is likely to remain of greater importance than a high capacity service**. Larger vehicles would often be running lightly loaded if a high frequency service is provided compared with smaller vehicles running at the same frequency. Running vehicles partly loaded will increase energy consumption, and capital costs for larger vehicles are higher.

The principal advantage of rubber tyre based systems is that a vehicle can "trawl" the suburbs for passengers and use the BRT facilities on the intertown routes without the passengers needing to transfer. Light rail systems with steel wheels will never be able to provide this type of service.

Consequently a rubber tyre based system is expected to remain the appropriate public transport system for Canberra.

PRT and People Mover systems that would be attractive for Canberra are not yet commercially available. Those that do operate are similar to elevators, except that they move laterally. They are suitable for airports where large volumes of people are moved relatively short distances.

The advances being made on new rubber tyre based systems have potential application in Canberra, and will no doubt be considered for introduction in the future. Many of these new technologies rely on automated steering. The Federal Transport Administration (USA) reported (in 2003) that lane assist and precision docking systems are still in the early stages of system development. Insufficient operational experience disallows any statistically valid claim to system performance, system reliability, maintenance requirements, failure modes, etc. Too few of these systems have been deployed worldwide. **Systems which have been deployed have suffered from a lack of development and testing.** This premature deployment has reduced public and driver acceptance of these systems. Further testing of these systems is desirable before any large-scale application is contemplated in Canberra.