
Mint Interchange Pre-Feasibility Study Review Technical Note

9 December 2013

To : **Land Development Agency (LDA)**
Attention : **Justin McEvoy**

1. Introduction

SMEC was commissioned by Land Development Agency (LDA) to review the *Mint Interchange Pre-Feasibility Study Report (2012)* prepared by AECOM, with particular focus on the cost estimate of the preferred interchange layout option.

The pre-feasibility study assessed the following four interchange layout options:

- Option 1: Elevated Roundabout Interchange (with the Adelaide Avenue median bus stop under the Kent Street/Novar Street overpass)
- Option 2: Single Point Diamond Interchange
- Option 3: Elevated Roundabout Interchange (with the Adelaide Avenue median bus stop halfway between the Kent Street/Novar Street overpass and the Mint Interchange)
- Option 4: Diverging Diamond Interchange

From discussions with LDA prior to conducting the review, SMEC was under the impression that the roundabout interchange was the preferred/recommended option. However, there is no definitive statement in the report that clearly identifies a preferred layout option. The main body of the pre-feasibility study report discussed design features and 'probable construction costs' of each option, but there was no 'Conclusions' or 'Recommendations' section at the end of the report that discusses which layout option is best.

As the scope of this review only allowed for re-estimating the costs associated with the roundabout interchange, the costs of the other proposed interchange layouts were not checked or re-estimated.

Other relevant sections of the report were also briefly reviewed to provide high-level comments and recommendations (i.e. qualitative assessment of the AECOM design based on engineering/professional judgment).

2. Cost Estimate of Roundabout Interchange

The quantities used for estimating the cost of the proposed roundabout interchange was based on the following information provided to SMEC (by AECOM via LDA):

- CAD files of the proposed roundabout interchange
- 12D model file (control lines only)

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The resulting cost estimate is higher than what was initially anticipated, but still around \$15 million lower than the estimate by AECOM. There appears to be a lot of service road on Denison Street and Cotter Road included as part of the interchange.

A summary of the resulting cost estimate, broken down into the different pay items, is shown in **Table 1**.

Table 1: Cost Estimate Summary – Roundabout interchange

Section No.	Description	Cost
0	Preliminaries	\$1,000,000
1	Provision for Traffic	\$2,500,000
2	Earthworks	\$5,163,832
2a	Demolish Cotter	\$1,125,000
3	Underground Services	\$4,472,402
4	Flexible Pavement Construction	\$9,706,936
6	Concrete Kerbs Footpaths and Minor Works	\$745,241
7	Road Furniture	\$2,561,941
8	Incidental Works	\$813,181
9	Landscape	\$838,188
10	Road Signs	\$407,224
11	Pavement marking	\$152,059
13	Traffic Signals	\$505,188
14	Street Lighting	\$2,912,100
15	Bridges and Retaining Walls	\$19,532,175
Sub Total		\$52,435,467.00
Contingency (40%)		\$20,974,187.22
Consultancy Fees (3%)		\$1,573,064.04
Construction Superintendence (3%)		\$1,573,064.04
Contract Administration (SSP) (4%)		\$2,097,418.72
Insurance (1%)		\$524,354.68
CONSTRUCTION AND DESIGN COST ESTIMATE		\$79,177,556.77

The estimation of costs undertaken by SMEC did not provide for design improvements but it is expected that additional significant cost savings can be made if further investigations are conducted to improve the design. The following are some examples of design refinements that could potentially provide cost savings:

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- Use of as much of the existing Adelaide Avenue westbound off ramp as possible, increasing the spacing between Adelaide Avenue and the ramp, therefore eliminating the need for a retaining wall.
- The retaining wall on the verge of the Adelaide Avenue eastbound on ramp could be rationalised and reduced or changed to a batter if adjacent development allows, which appears possible based on the road layout.
- Allow the batter slope of the Adelaide Avenue eastbound off ramp to spill into the adjacent property (currently unleased territory land with an agistment)
- Convert the retaining wall within the roundabout annulus into a batter

Table 2 of AECOM’s report was also reviewed, with the following comments:

- The costs for the bridge on Option 1 is significantly underestimated. The estimated volume of 1,400 m² assumes a straight bridge, but the bridge will be curved to suit the roundabout option. This will increase the deck area by an estimated 30%.
- The \$3500/m² cost of deck would suit a simple bridge, i.e. Super-T. However, based on the proposed arrangement, it is expected that this structural system will cost 70% extra.
- Retaining wall quantities were underestimated, which were about 30% less than SMEC’s estimate.
- Cost per m² of pavement seems excessive. SMEC used the Majura Parkway unit rate for Adelaide Avenue (70% less) and Molonglo John Gorton Drive (JGD) unit rate for granular pavement on Cotter Road/local roads (a third of the cost per m²).

A summary of the comparison of quantities and cost between AECOM Report’s Table 2 and SMEC’s own quantity and cost estimates are shown in

Table 2: Comparison of AECOM and SMEC Quantity and Cost Estimates

Item	AECOM			SMEC		
	Rate/m ²	Quantity	Cost	Rate/m ²	Quantity	Cost
Pavement Area	\$300	62,700	\$18,810,000.00	\$175	37,917	\$6,635,475.00
				\$98	31,341	\$3,071,418.00
Bridge – Elevated Roundabout	\$3,500	1,400	\$4,900,000.00	\$6,000	1,850	\$11,100,000.00
Retaining Walls	\$700	6,900	\$4,830,000.00	\$889	9,143	\$8,128,127.00

3. Comments on Other Sections of the AECOM Report

3.1. Traffic Analysis

No micro-simulation modelling was conducted, as stated in the report, however given it is a pre-feasibility study of the interchange intersection this could be considered reasonable. The report’s recommendation for micro-simulation at a later stage of the project, including the impact of the brickworks development, is sound.

Table 1 of the report implies that the RTA NSW delay method was used for calculating intersection Level of Service (LoS). The numbers are not quite the same, but they are within one second in most cases. The LoS method to use should be clarified and agreed with the client.

The SIDRA models of Mint Interchange (Single Point Diamond option) show all the ramps with two continuous lanes (e.g. Figure 2). This may have been intended, but if not and the ramps are shorter than 500 metres they should show short lanes. Assuming the quoted queue lengths are 95th percentile back of queue distances, the effect this aspect of the SIDRA intersection models has on performance of the approaches is likely to be minimal, however its effect on exiting movements may be affected by the length of the continuous lane before the downstream merge. Merge/diverge analysis between the interchange ramps and Adelaide Avenue/Yarra Glen should also be included, while weaving analysis should be considered for the east facing ramps (eastbound onramp and westbound offramp).

The Cotter Road – Brickworks Access intersection is shown with three approaches in Figure 1 of the report but has been modelled in SIDRA with four approaches (e.g. Figure 10 of the report). It is not clear what the extra approach is for, and this could be unnecessary.

The pre-feasibility study expresses reservations with the roundabout interchange option. While its traffic performance is better than the other options, it does not support pedestrians/cyclists, and a separate pedestrian/cyclist bridge will be required for access between CB+E and West Deakin.

3.2. General Engineering Design Comments

Cycle lanes will not work safely through a two lane roundabout. The report states support for cycling and pedestrian movements but the designs do not support the statement. If Option 1 (Roundabout) is selected, additional structures for pedestrians and cyclists will probably be required, as earlier mentioned.

The report indicates that a bus stop is proposed on the verge of Adelaide Avenue for buses using Cotter Road. In SMEC's report for *Adelaide Avenue Bus Stops Feasibility Study* (2013), the potential safety and operational issues related to bus stops in those locations were identified. That report found that there are substantial safety risks for stopping buses adjacent to high speed traffic lanes. In addition, the topography in the area will make pedestrian and cycle access challenging.

The report suggests that safety barriers be used to shield large trees along Cotter Road. A preferred option would be to use clear zones where possible.

The report indicates that a large diameter high pressure gas main may be impacted. It appears that the report does not recognise the potential seriousness of that impact, and that this is potentially a fatal flaw in the design.

4. Recommendations

Based on the review of the pre-feasibility study report, it is recommended that a more detailed assessment of the potential options be undertaken before a single option is selected. This assessment should include:

- Cost estimates, based on current costs for similar projects in the ACT
- Concept design, including:
 - Minimisation of cost
 - Urban design considerations

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- Impact on existing services, especially the high pressure gas main
- Allowance for pedestrian and cyclist access and operation
- Traffic analysis based on latest forecasts, including analysis of the operation of Adelaide Avenue ramps
- Cost-Benefit Analysis of the proposed interchange to determine its economic feasibility

Given the location of the proposed interchange on one of Canberra's busiest transport corridors, and potentially significant project cost, it is recommended that more details of all potential options be considered and investigated before any are removed from further consideration.

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Final Report – Options and Evaluation

Canberra Brickworks and Environs Planning Strategy: Traffic, Transport + Infrastructure

24 November 2011

Ref. 3002209

Project Name:	Canberra Brickworks and Environs Planning Strategy
Project Number:	3002209
Report for:	Land Development Agency

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3	11-11-2010	Lindsay Jacobsen	Jerome Catbagan Mal Dunning	
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Options and Evaluation Report (Final)

For: Land Development Agency

NOVEMBER 24, 2011

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EXECUTIVE SUMMARY

This report details the intersection and local level network impacts of the proposed development of the Canberra Brickworks in Yarralumla, ACT. The development involves extensive modifications to the existing road network which includes Adelaide Avenue/Yarra Glen, Cotter Road, Denison Street, Denman Street, Dudley Street, Kent Street and Novar Street. These changes include the addition of a new service interchange connecting Cotter Road to Adelaide Avenue/Yarra Glen, and the extension of Cotter Road to intersect with Denison Street (also referred to as the “Deakin Link”). Land use increases expected in the development are an additional population of 1,950 and 60,000 m² GFA of additional floor space for retail and other uses.

Strategic transport modelling was conducted for the 2031 weekday AM peak period using SMEC’s strategic model of Canberra, maintained in TransCAD 5.0. The strategic modelling identified increases in traffic on Cotter Road and Yarra Glen due to both the land use changes and improvement in network connectivity. These results are discussed in detail in Chapter 3 while a summary of the outputs is shown below.



Strategic Model Midblock Count Locations

2031 AM Strategic Model Midblock Counts

Location	Road	Do Nothing	Preferred Option
1	Cotter Rd (EB/WB)	1,730/720	2,005/1,090
2	Brickworks Rd (NB/SB)	N/A	630/270
3	E-W Main Street (EB/WB)	N/A	400/50
4	Abbott St (NB/SB)	0/0*	200/2
5	Kintore Cres (EB/WB)	0/0*	210/0
6	Dudley St (EB/WB)	750/230	250/50
7	Novar St (NB/SB)	265/200	320/110
8	Deakin Link (EB/WB)	N/A	1,030/510
9	Denison St (EB/WB)	230/560	520/440
10	Kent St (NB/SB)	440/830	510/660
11	Yarra Glen (NB/SB)	2,900/960	3,380/1,200
12	Adelaide Ave (EB/WB)	4,060/1,860	4,010/1,790

Note: Traffic counts are rounded to the nearest 10 vehicles.

* Due to the placement of TAZ centroid connectors to load traffic into a strategic model, this part of Yarralumla does not receive any traffic. This implies that where zero volume is shown for the preferred option, additional traffic flows due to the development can be expected to be minimal.

Micro-simulation modelling was conducted for the 2031 weekday AM, 2031 weekday PM and 2031 weekend daytime peak periods to test localised traffic impacts and proposed network and intersection treatments. The modelling results suggest that traffic travelling through the study area will in most cases experience a moderate increase in delay, mainly due to the introduction of new intersections in the network. The modelling also identified issues with the current roundabout intersection of Cotter Road – Lady Denman Drive; conversion of this intersection to signal control dramatically improved the performance of Cotter Road in the 2031 weekday PM peak period. These results are also discussed in detail in Chapter 3.

Intersection analysis was conducted in SIDRA Intersection 5.0 to test the impacts of the network changes and proposed intersection treatments for mitigation of those impacts. A number of alternative configurations were tested for each intersection in the study area to obtain an ideal case for each that optimises pedestrian accessibility and traffic performance. It was established that three of the existing intersections, Cotter Road – Lady Denman Drive, Kent Street – Denison Street and Kent Street – Adelaide Avenue Offramp, should be converted to signal control to maintain acceptable performance in 2031. In most cases it was not possible to provide a realistic configuration that provides an acceptable Level of Service (LoS) for vehicular traffic while completely catering to pedestrian accessibility through the use of signal controlled left turns. The details of these results are discussed in Chapter 3. A summary of the intersection analysis is given below.

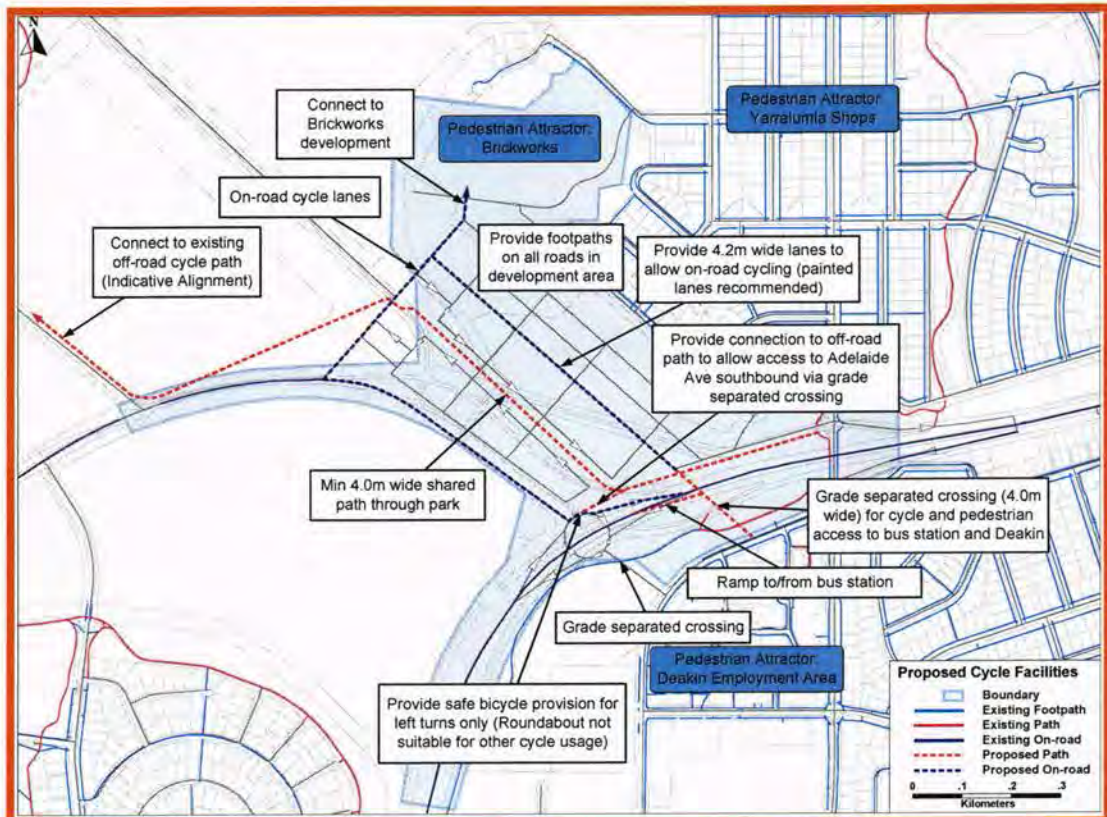
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Intersection Analysis Results Summary

Intersection	Analysis Notes
Cotter Road – Lady Denman Drive	The existing roundabout configuration exhibits poor performance (LoS F) in both the AM and PM peaks. The recommended treatment involves signal control and three lanes eastbound on Cotter Road, which improves performance significantly to LoS C in both periods.
Cotter Road – Brickworks Road	The recommended configuration provides two right turn lanes from Brickworks Road to Cotter Road and slip lanes for both left turns, yielding performance of LoS B in the AM peak and C in the PM peak. Removing the slip lanes results in a substantial drop in performance in the 2031 AM peak to LoS F.
Cotter Road – Adelaide Avenue/Yarra Glen	The roundabout interchange design concept from AECOM provides good performance in all periods (LoS A).
Cotter Road – Denison Street	The recommended treatment requires two lanes for the Denison Street through movements, which the modelling indicates will perform acceptably without left turning slip lanes; on the threshold of LoS C and D in the AM peak and LoS C in the PM peak.
Kent Street – Denison Street	Due to the connection of Cotter Road to Denison Street in the preferred option the traffic volumes and turning movement pattern at this intersection changed substantially, resulting in poor performance (nominally LoS F) in the 2031 AM peak. The recommended treatment involves installing signals and providing left turn slip lanes, which restores performance to LoS D in the AM peak and LoS B in the PM peak.
Kent Street – Adelaide Avenue Offramp	In isolation, the performance of this intersection improves to LoS A in both the 2031 AM and PM peak periods in the Preferred Option due to the change in traffic patterns, however the recommended treatment is to install signals and coordinate with Kent Street – Denison Street to better control the traffic flow.
Novar Street – Dudley Street/ Adelaide Avenue Onramp	This intersection operates well in all scenarios and periods and no intervention is required.

Chapter 4 includes an assessment of public transport, cyclist and pedestrian access to the development. The current Strategic Public Transport Network Plan (SPTNP) does not provide for bus services stopping close to the study area, although there are current services along Cotter Road and Adelaide Avenue/Yarra Glen and with extra stops these could provide bus access to the area. The development is expected to be medium-high density and mixed-use, which is favourable for increasing public transport mode share in line with the targets set out by the Sustainable Transport Plan. Connection of the major north-south and east-west roads within the study area to the existing trunk cycleway network will provide sufficient cyclist accessibility for the area. Recommendations for provision of pedestrian and both on-road and off-road bicycle facilities is shown below.

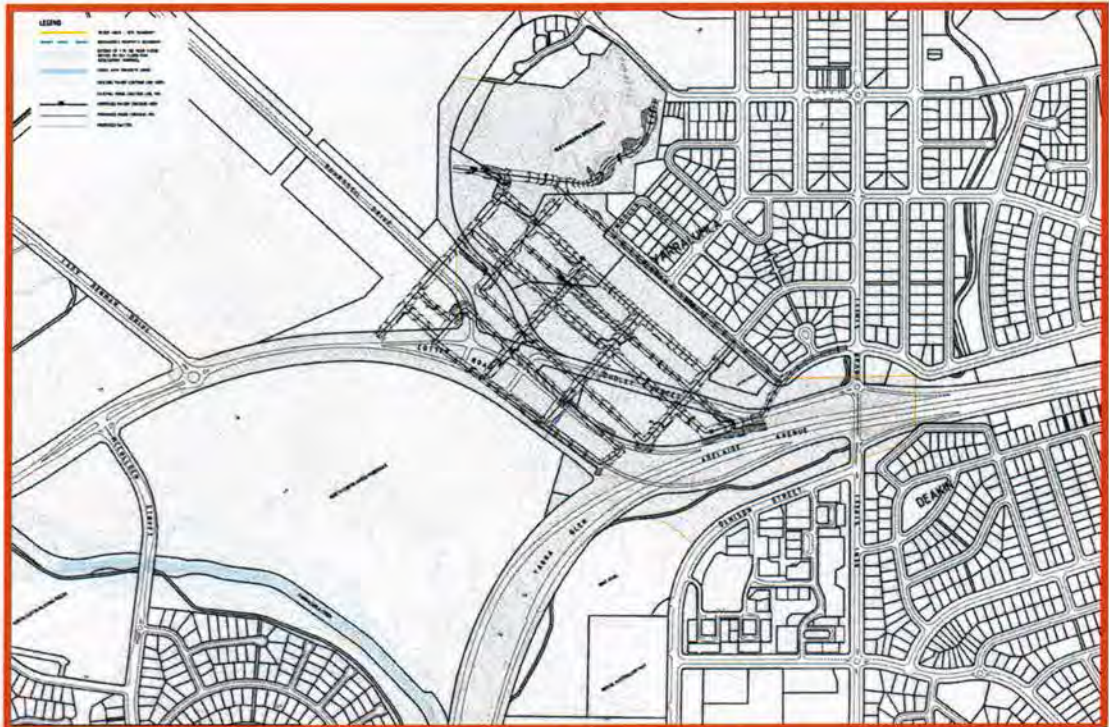
The bus station proposed for construction in the median of Adelaide Avenue to the east of the Cotter Road – Adelaide Avenue interchange is within 750m (required by the *Future Urban Areas Residential Subdivision Development Code 2008*) of all of the residential zones within the CB+E development and also large parts of Yarralumla and Deakin, including the Deakin employment area, as shown below.



Potential Pedestrian and Cycle Facilities and Attractors (Bus Station Catchment Shown)

An assessment of civil engineering issues is included in Chapter 5 along with indicative cost estimates for roadways including service alignment and realignment. The estimated earthworks requirements entail 24,000 m² of cut and 22,000 m² of fill for the roads, while 25,000 m² of cut to fill are required for block development. The design calls for 5,975 m of additional roads with reserve widths between 9 m and 30.5 m. This does not include the realignment of Cotter Road which will be required to accommodate the new roads, as well as the modification of the Cotter Road – Adelaide Avenue Interchange for which concept designs are currently being developed by another engineering consultant. Water detention requirements for the approximately 37.5 ha catchment would be approximately 2,800 m³ for a 50 year storm, however this could be reduced by the use of water sensitive urban design (WSUD) principles. The extent of earthworks and a summary of the cost estimates for each parcel of work (excluding earthworks) are included below.

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Earthworks Requirements

Preferred Design Cost Estimates

Work Parcel	Cost
Road including services/utilities (water, electricity, telecoms, gas etc.)	\$9,907,756
Road Drainage	\$1,676,946
Sewer	\$1,831,843
Relocation of High Voltage Electricity (HV-OH) and Icon Services	\$3,000,000
Signalisation of intersection between the collector road and Cotter road	\$200,000
Total Cost	\$16,616,545

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ABBREVIATIONS

ABS	: Australian Bureau of Statistics
ACTION	: Australian Capital Territory Internal Omnibus Network
CB	: Canberra Brickworks
CB+E	: Canberra Brickworks and Environs
HCM	: Highway Capacity Manual
LDS	: Lady Denman (Drive) Signals
LILO	: Left-In Left-Out
LoS	: Level of Service
OD	: Origin-Destination
SIDRA	: Signalised and unsignalised Intersection Design and Research Aid
TAZ	: Traffic Analysis Zone
WSUD	: Water Sensitive Urban Design

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1 ROAD NETWORK LAYOUT

A single road network layout option, consistent with the urban design alternatives proposed by Hill Thalys, was used in the traffic and transport analysis. The design assumes major changes to the existing arterial road network, including the addition of a roundabout interchange between Cotter Road and Adelaide Avenue/Yarra Glen and extension of Cotter Road to Denison Street (referred to as the Deakin Link). The preferred option assumes full development of the Canberra Brickworks (CB) area; all undeveloped land in Yarralumla sections 94, 106, 107, 113 and 123 and Deakin section 75.

A summary of the major elements of each option is shown in Table 1. A notable element is the introduction of a new road at the western side of the development that intersects Cotter Road and is expected to serve as the main access road to the CB site. For reference purposes, this road will be called Brickworks Road in this report, and is shown in Figure 1.

Table 1: Major Elements of Preferred Road Network Option

Elements	Preferred Option
1. Yarra Glen – Cotter Rd Intersection	Roundabout Interchange*
2. On/off ramps between Cotter Rd and Adelaide Ave	Remove
3. Re-alignment of Cotter Rd from Adelaide Ave to Lady Denman Dr	Yes
4. Cotter Rd Extension to Denison St (Deakin Link)	Yes
5. New road at western side of the development that will intersect Cotter Rd (Brickworks Rd).	Yes
6. Dunrossil Dr Extension	No
7. Dudley St	Remove but retain existing connection to Novar Street
8. Kintore Cr Extension	Yes
9. Novar St - Dudley St Roundabout	Retain
10. Duplication of Cotter Rd**	Yes

*Proposed interchange configuration from the concept design study by AECOM.

**Planned upgrade by 2016 (TAMS).



Figure 1: Preferred Option Road Network Layout

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2 TRAFFIC MODELLING AND ANALYSIS

SMEC was provided with the final layout of the preferred design option by Hill Thalys on 14 December 2010 which was used as the basis of the traffic modelling and analysis. In addition to the preferred option identified earlier a “Do Nothing” scenario was modelled to allow comparison and illustration of the differences in network flow and operations between the existing configuration and the preferred option.

2.1 Existing Traffic Volumes

Manual, classified traffic counts were performed for all major intersections in the study area for the weekday AM and PM peak periods on Thursday 11/02/2010 and the weekend mid-day peak period on Saturday 13/02/2010. The total count volumes are shown in Figure 2.

2.2 Strategic Transport Modelling

Initial strategic modelling runs were undertaken to provide preliminary indications of the network flow changes the options will bring about. The long term planning horizon (2031) was used to assess the network’s operational performance under the heaviest demand forecast available.

SMEC’s strategic transport model of the ACT was used to estimate traffic projections along the links within the designated study area. The model includes all planned land use changes and road infrastructure upgrades that are expected to be in place by 2031, based on information obtained from TAMS.

2.2.1 Land Use Inputs

The strategic transport model is divided into traffic analysis zones (TAZs), which contain the following land use information:

- Population
- Employment
- Retail Space
- School Enrolment
- Tertiary Enrolment

ACT land use projections for 2031 were provided by TAMS. An illustration of the TAZs within and around the study area is shown in Figure 3, while Table 2 details the corresponding land use data for some of these TAZs. The table also includes the estimated additions to the land use figures due to the CB development under the preferred option proposed by Hill Thalys. These figures were developed from average occupancy rates for various dwelling types obtained for the ACT from the ABS Census 2006.



Figure 2: Manual Traffic Count Movement Totals

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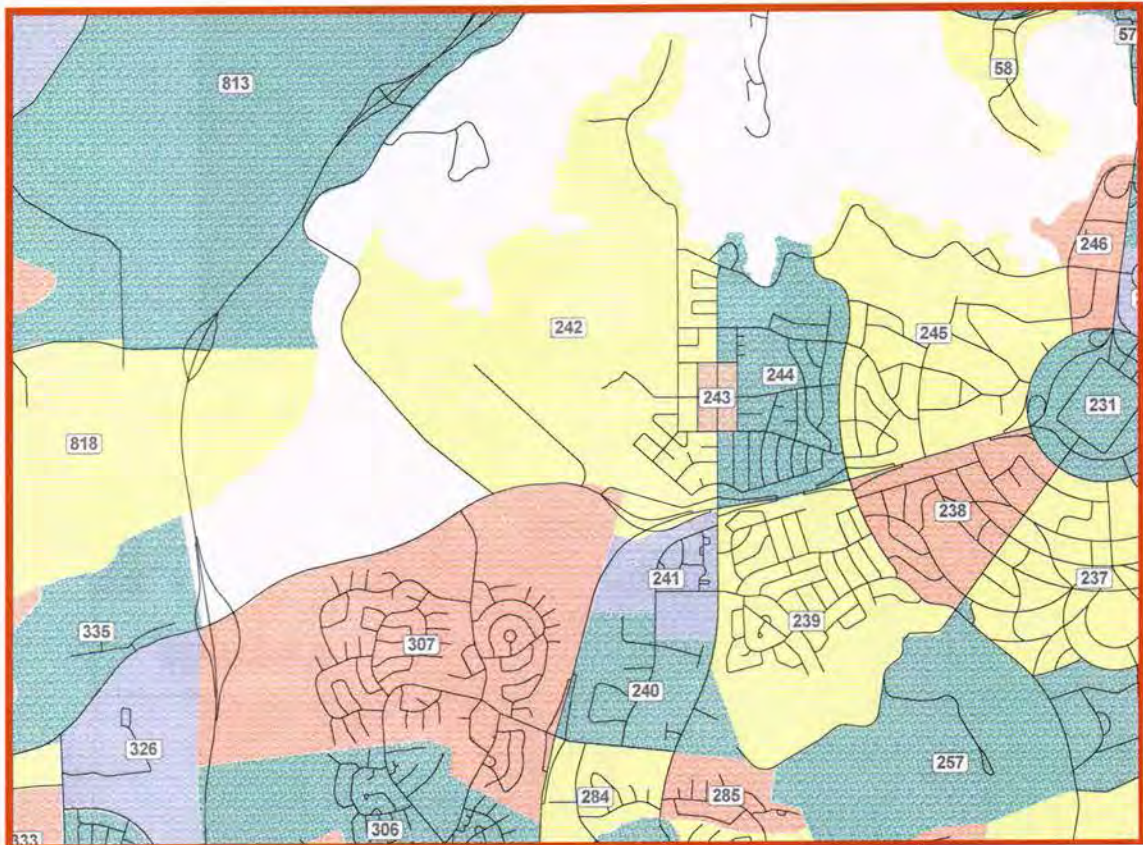


Figure 3: Traffic Analysis Zone (TAZ) Layout in the Study Area

Table 2: Land Use Information for TAZs Within and Around the Study Area (2031)

Zone	Description	Population	Employment	Retail Space [m ² GLFA]	School Enrolments	Tertiary Enrolments
239	Deakin (Shops & Stonehaven Cr)	2,040	549	8,000	0	0
240	Deakin West (south of Strickland Cr)	0	1,373	150	0	0
241	Deakin West (north of Strickland Cr)	50	2,648	0	525	0
242	Yarralumla	568	270	0	0	0
243	Yarralumla	878	355	5,300	0	0
244	Yarralumla	827	200	0	225	0
307	Curtin (north)	3,238	855	6,000	375	0
Canberra Brickworks Development						
CB+E	Preferred Option	1,962	0	60,300	0	0

2.3 Micro-Simulation Modelling

Traffic micro-simulation was conducted to estimate finer operational parameters that cannot be determined to a reasonable level of detail using a strategic transport model.

Micro-simulation allows the further investigation and assessment of traffic impacts caused by potential land use changes in a given study area. Outputs produced by strategic modelling packages are macroscopic and are generally not considered to provide sufficient microscopic detail for analysing operational issues like vehicle queues, weaving sections and intersection performance. Detailed information on the impacts of small changes in the network can also be obtained, providing analysts and decision-makers with insight in to the effectiveness of proposed intervention measures and network system improvements. It is thus a useful tool for comparing traffic operations between design alternatives that don't have large-scale differences.

Quadstone Paramics is the traffic micro-simulation software of choice within SMEC and the ACT Government. It is a suite of software tools that are used to model vehicle behaviour on an individual level, providing visualisation of road network and traffic demands using a graphical user interface. Paramics has already been used in a number of previous and ongoing SMEC projects.

Illustrations of the Paramics models used for the two scenarios are shown in Figure 4 (do nothing) and Figure 5 (preferred option).

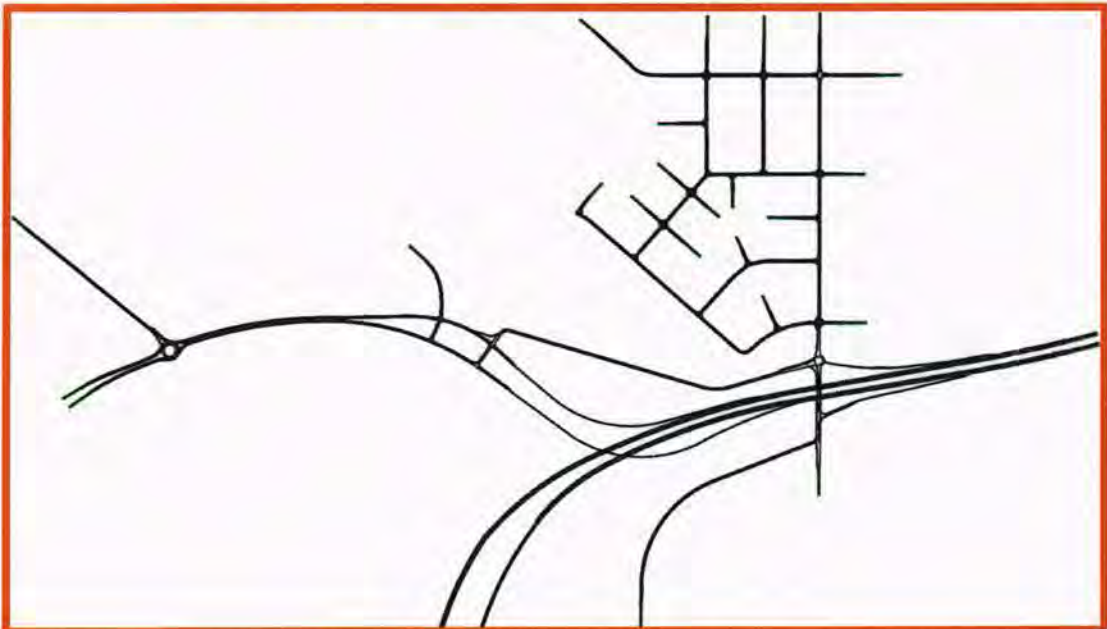


Figure 4: Do Nothing Paramics Model

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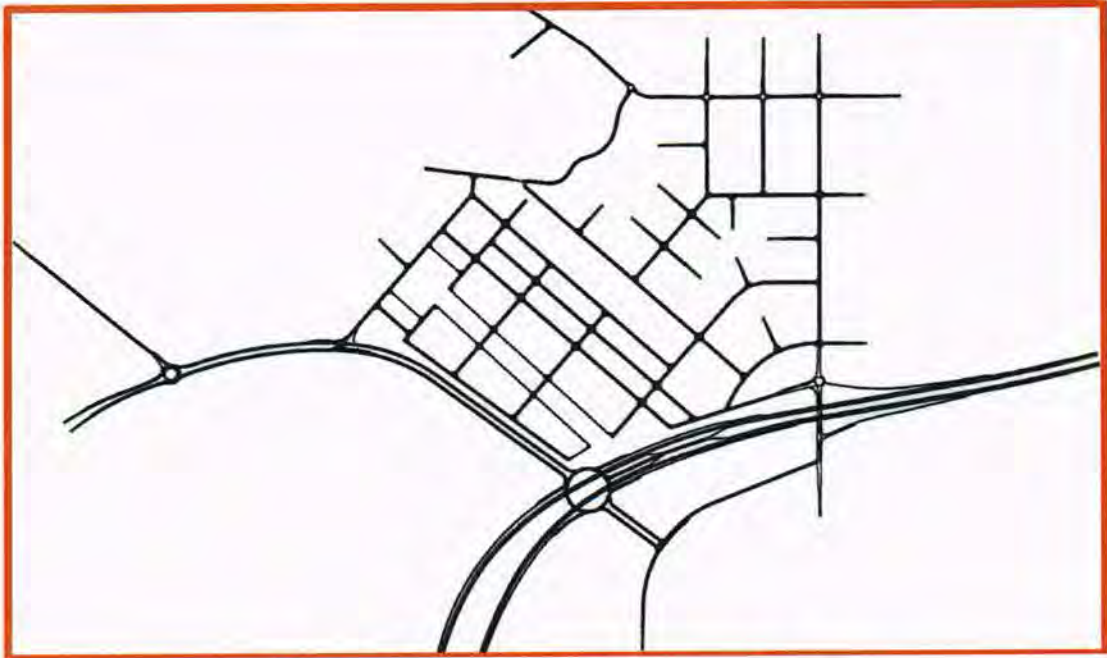


Figure 5: Roundabout Interchange Paramics Model

2.3.1 OD Matrix Estimation and Calibration

Origin – Destination (OD) matrix estimation was performed using Paramics Estimator V6, with input from intersection turn counts conducted as part of this study. Estimator generates an OD matrix by iteratively adjusting an existing OD matrix to provide a trip pattern that more closely matches the supplied count data.

The accuracy of an OD matrix estimation in matching the input survey data is gauged by the GEH statistic (named after the transport planner who devised it), which compares the modelled (M) volumes to the counted (C) volumes. The GEH statistic is given by the following equation:

$$GEH = \sqrt{\frac{2(M - C)^2}{M + C}}$$

where

- M : Traffic volume estimated by the model
- C : Actual (real-world) traffic volume

The function displays a direct relationship between the value of C and the sensitivity of the function to a proportional difference between C and M. For example, for C=20 and M=40, GEH=3.7 (acceptable), while for C=100 and M=200, GEH=11.5 (unacceptable) even though in both cases M=2C. Where possible, the GEH for 85% of the estimated volumes should be less than 5, and ideally no volumes should have a GEH greater than 10. In the micro-simulation modelling tasks done for this study, the estimated matrices were optimised in terms of its GEH as far as practical.

Manual classified traffic counts were conducted for all major intersections in the study area for the weekday AM, weekday PM and weekend daytime peak periods in February 2010, forming the basis for the estimation process and against which the estimation output was evaluated. The resulting GEH values from the calibration of the base network model are given in Table 3. The average GEH was very favourable for all three peak periods modelled. This indicates that the OD matrix developed during the estimation

process produces traffic volumes that very closely match the observed volumes at each count location.

Table 3: GEH Statistics of the Base Micro-Simulation Model Calibration

Period	Average GEH	GEH < 5	GEH > 10
AM Peak	0.5	100%	0%
PM Peak	0.5	100%	0%
Weekend Peak	0.4	100%	0%

During estimation, the base network was validated visually in an attempt to reflect the real performance and queuing behaviour of the traffic in the study area. It is worth noting that network performance and congestion patterns vary from day to day, while the calibrated network necessarily performs identically each time a simulation is run.

2.3.2 Future Demand

2031 OD matrices for each design option and model period were developed using the estimated 2010 OD matrices as a baseline, and growth rates extracted from the TransCAD strategic modelling results. The process involves a number of steps:

2031 AM Peak Period

1. Productions and attractions (trip ends) at each zone are extracted for the study area in 2011 and 2031 using TransCAD strategic transport modelling software.
2. Annual growth rates for the trip ends at each zone of this sub-area OD matrix are calculated, and applied to the estimated 2010 OD matrix trip ends.
3. The grown trip ends are balanced so that the total productions and attractions are equal (the next step would otherwise not converge on a single result).
4. The grown trip ends are then used to *fratar* the estimated matrix, a process that alternately and iteratively applies the calculated growth to the rows (productions) and columns (attractions) of the OD matrix. This results in an OD matrix containing the total number of trips expected from the calculated growth rates and a trip pattern resembling the estimated OD matrix.

2031 PM Peak Period

1. The TransCAD model is an AM only model, so the OD matrices from the TransCAD model were transposed to reverse the direction of each trip and factored down by 10%, giving a PM trip pattern.
2. The procedure detailed above for 2031 AM is performed.

2031 Weekend Daytime Peak Period

1. The AM and PM sub-area OD matrices were averaged to give an approximate weekend trip pattern. The result is an OD matrix with about twice as many trips as would be expected in the weekend peak, however since it is used to determine growth between two similarly generated matrices the discrepancy cancels out.
2. The procedure detailed above for 2031 AM is performed.

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2.4 Intersection Analysis

A number of major intersections within the study area have been identified for analysis and these are the following (some of these intersections are not in all scenarios):

1. Cotter Road – Lady Denman Drive
2. Cotter Road – Brickworks Road
3. Cotter Road – Adelaide Avenue Interchange
4. Cotter Road – Denison Street
5. Kent Street – Denison Street
6. Kent Street – Adelaide Avenue Offramp
7. Novar Street – Adelaide Avenue Onramp

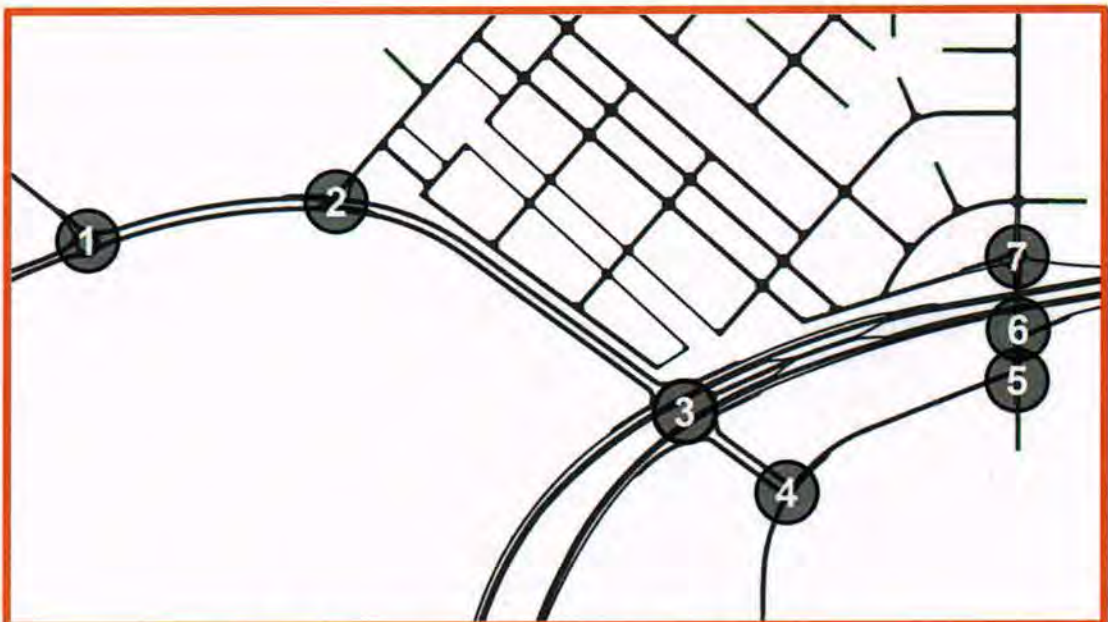


Figure 6: Intersections for analysis in SIDRA Intersection

Intersection analysis was conducted using SIDRA Intersection 5.0. Level of Service (from delay) and queue length at the specified key intersections within and surrounding Yarralumla and the brickworks will provide information on how the planned developments across the three planning horizons can affect the performance of major junctions. Table 4 details the HCM criteria for the evaluation of LoS at signalised intersections, while the HCM LoS criteria for unsignalised intersections are given in Table 5.

Table 4: HCM LoS Criteria for Signalised Intersections

Level of Service	Average Control Delay [seconds]
A	≤ 10
B	> 10-20
C	> 20-35
D	> 35-55
E	> 55-80
F	> 80

Source: Exhibit 16-2, HCM2000

Table 5: HCM LoS Criteria for Unsignalised Intersections

Level of Service	Average Control Delay [seconds]
A	0 - 10
B	> 10-15
C	> 15-25
D	> 25-35
E	> 35-50
F	> 50

Source: Exhibit 17-2, HCM2000

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3 TRAFFIC OPERATIONS ASSESSMENT

The modelling outputs were used in the operations assessment process, which essentially established traffic operational conditions in the future years, assuming only the planned road networks will be implemented (“base” cases). The performance measures that were evaluated are the following:

- Peak Volume
- Volume to Capacity Ratio (V/C)
- Route Travel Time
- Average Travel Speed
- Intersection Delay (Level of Service)

The succeeding sections discuss the results obtained from the operations assessments, as well as some professional and industry standards that were used for evaluation.

3.1 Peak Volume and V/C Assessment

The traffic flow diagrams from strategic modelling of the two scenarios are shown in Figure 7 (do nothing) and Figure 8 (preferred option). These results indicate that the preferred option results in some significant changes in the traffic flow patterns.

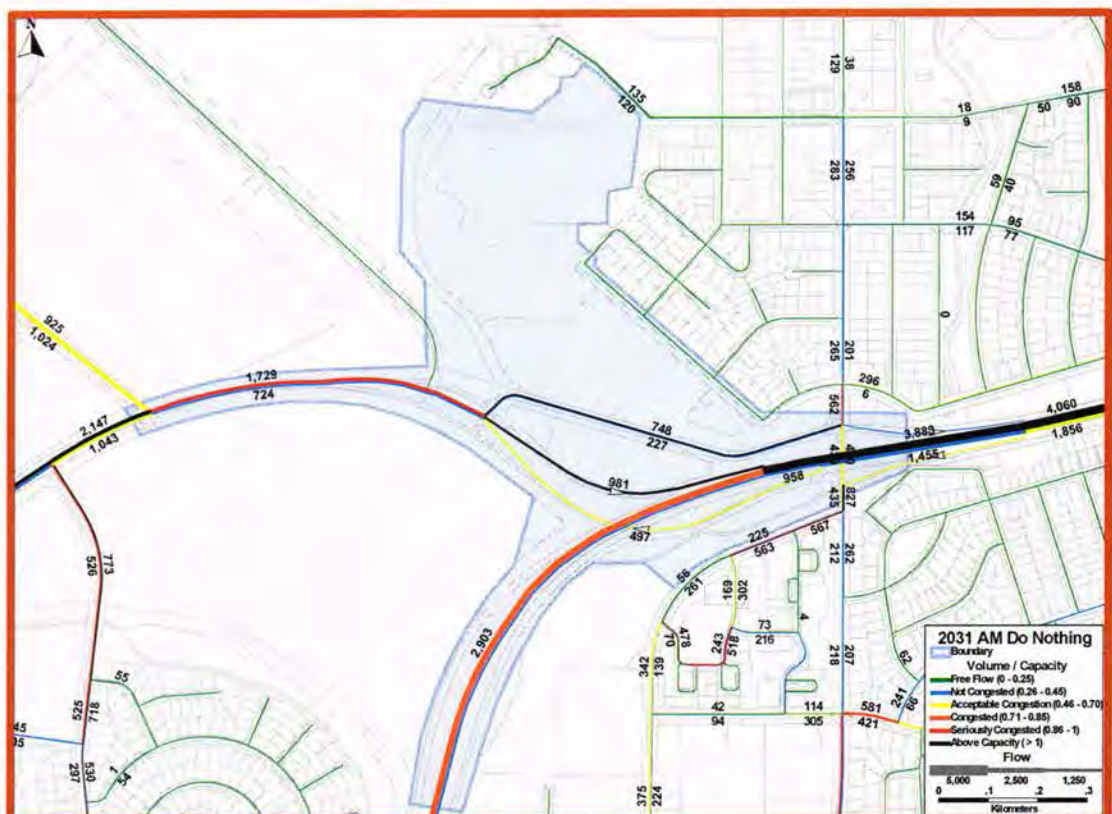


Figure 7: Do Nothing 2031 AM

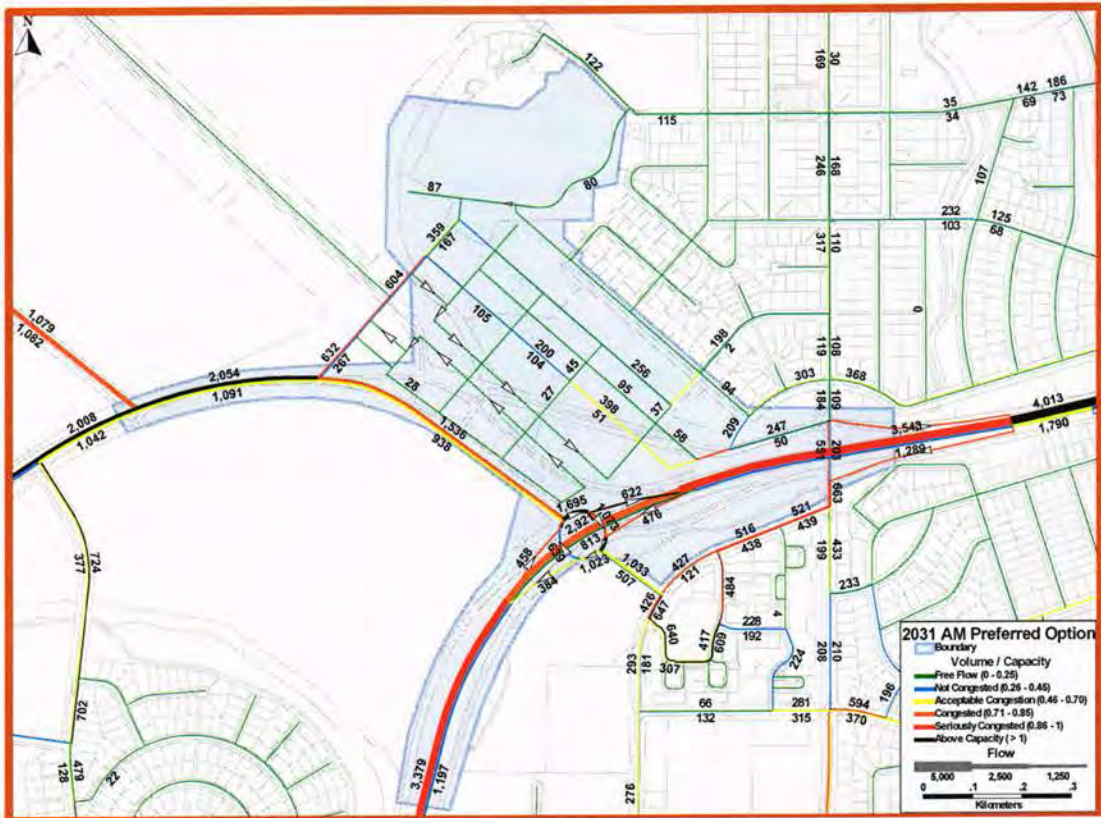


Figure 8: Preferred Option 2031 AM



Figure 9: Strategic Model Midblock Count Locations

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Table 6: 2031 AM Strategic Model Midblock Counts

Location	Road	Do Nothing	Preferred Option
1	Cotter Rd (EB/WB)	1,730/720	2,005/1,090
2	Brickworks Rd (NB/SB)	N/A	630/270
3	E-W Main Street (EB/WB)	N/A	400/50
4	Abbott St (NB/SB)	0/0*	200/2
5	Kintore Cres (EB/WB)	0/0*	210/0
6	Dudley St (EB/WB)	750/230	250/50
7	Novar St (NB/SB)	265/200	320/110
8	Deakin Link (EB/WB)	N/A	1,030/510
9	Denison St (EB/WB)	230/560	520/440
10	Kent St (NB/SB)	440/830	510/660
11	Yarra Glen (NB/SB)	2,900/960	3,380/1,200
12	Adelaide Ave (EB/WB)	4,060/1,860	4,010/1,790

Note: Traffic counts are rounded to the nearest 10 vehicles.

* Due to the placement of TAZ centroid connectors to load traffic into a strategic model, this part of Yarralumla does not receive any traffic. This implies that where zero volume is shown for the preferred option, additional traffic flows due to the development can be expected to be minimal.

The changes to the road network result in increased traffic on Cotter Road and Yarra Glen, indicating that a trip between these two points is made viable by the new interchange.

3.2 Route Travel Time and Average Travel Speed

The Paramics Do Nothing models were used in the analysis of route travel times and average speeds, as these typically provide a more accurate depiction of operations than strategic transport models. Specific routes within the study area were selected and analysed to give an indication of traffic operational changes from the base year to the future planning horizons.

It is important to note that, while this is considered as the Do Nothing case for CB+E, the planned road network upgrades across the greater Canberra network for 2031 have been included in the modelling.

Major routes within the study area were chosen to determine vehicular flow parameters, particularly average speed and average route travel time. The following routes in the study area network were selected, shown in Figure 10:

1. Between Adelaide Avenue and Deakin Employment Area
2. Between Cotter Road and Adelaide Avenue
3. Between Cotter Road and Deakin Employment Area
4. Between Yarra Glen and Adelaide Avenue



Figure 10: Paramics Performance Testing Routes

For the 2031 weekday AM and PM peak periods an additional scenario was tested using micro-simulation, identified in the relevant results tables as *Preferred Option ES*. To investigate the potential of further intersection improvements this alternative includes signalisation of the following intersections:

- Cotter Road – Lady Denman Drive
- Kent Street – Adelaide Avenue Offramp, coordinated with;
- Kent Street – Denison Street

It can be seen from the results that this proposed treatment can considerably improve traffic performance along some routes in the 2031 weekday PM peak period, and would form an important part of future improvements to this major route.

The preferred option contains numerous road network changes, additional intersections, more than 1,150 additional dwellings housing a population of 1,950 and more than 60,000 m² GFA of additional floor space for retail and other uses. Overall the micro-simulation modelling results indicate that a decrease in average speed can be expected for most of the routes surveyed.

The micro-simulation modelling results are outlined in Table 7 for the 2031 weekday AM peak period, Table 8 for the 2031 weekday PM peak period and Table 9 for the 2031 weekend daytime peak period.

The average vehicle count statistics indicate that there is a large increase in demand on roads along the considered routes in the *Preferred Option* scenario compared to *Do Nothing*. Where there is a difference between the average vehicle count statistics for the two *Preferred Option* scenarios, this indicates that one with the lower vehicle count had more difficulty loading vehicles in to the network due to greater congestion, and differences in travel time should be viewed in this context (for instance if one scenario shows better performance, it may be because fewer vehicles made it into the route due to this congestion preventing those vehicles from even entering the network, and congestion within that route then appears lower). When comparing the two *Preferred Option* scenarios the vehicle count statistic is essentially a measure of whether congestion was

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propagating outside the study area network and preventing vehicles from being released in to the model.

In some cases both the average speed and average travel time for route 3 decrease. This is due to the route being shortened by ~800 m by the direct link from Cotter Road to Denison Street. The increase in traffic due to the additional land use and improved connectivity in the area is evident in the Average Vehicle Count Difference line at the bottom of each table.

Table 7 illustrates the performance impacts of the preferred option in the 2031 weekday AM peak period. All of the routes experience a significant reduction in average speed in the *Preferred Option*, which in most cases is comprehensively outperformed by the *Preferred Option ES* configuration.

Even so, the *Preferred Option ES* configuration still results in lower average speeds and longer travel times than *Do Nothing* along routes 1 and 3, with the effective shortening of route 3 making up for the decrease in average speeds, while routes 2 and 4 are affected slightly. While showing a decrease in speed and increase in time the statistics for the two *Preferred Option* scenarios should not be interpreted as the network performing poorly relative to the *Do Nothing* scenario. It should be noted that the *Preferred Option* scenario networks are able to accommodate considerably more vehicles, as illustrated by the Average Vehicle Count statistics which contribute to the speed reductions.

Table 7: Comparison of 2031 Weekday AM Peak Average Speed and Travel Time on Selected Routes

Route		1		2		3		4	
Direction of Travel		EB	WB	EB	WB	EB	WB	EB	WB
Average Speed [km/hr]	Do Nothing	59	66	65	81	58	56	85	86
	Preferred Option	12	43	22	66	13	24	35	85
	Preferred Option ES	24	22	56	69	39	37	68	84
Average Speed Difference	Preferred Option	-80%	-35%	-66%	-19%	-78%	-57%	-59%	-1%
	Preferred Option ES	-59%	-67%	-14%	-15%	-33%	-34%	-20%	-2%
Average Travel Time [min:sec]	Do Nothing	1:15	1:05	1:55	1:40	2:30	2:35	1:20	1:15
	Preferred Option	6:15	1:40	6:15	2:05	7:25	4:00	3:05	1:15
	Preferred Option ES	3:00	3:10	2:25	2:00	2:30	2:35	1:35	1:15
Average Travel Time Difference	Preferred Option	+5:00	+0:35	+4:20	+0:25	+4:55	+1:25	+1:45	0:00
	Preferred Option ES	+1:45	+2:05	+0:30	+0:20	0:00	0:00	+0:15	0:00
Average Vehicle Count [VKT/route length]	Do Nothing	440	420	1,700	430	950	180	2,060	690
	Preferred Option	980	780	2,330	640	1,690	350	3,290	1,600
	Preferred Option ES	1,150	800	2,850	650	2,190	380	3,680	1,600
Average Vehicle Count Difference	Preferred Option	+123%	+86%	+37%	+49%	+78%	+94%	+60%	+132%
	Preferred Option ES	+161%	+90%	+68%	+51%	+131%	+111%	+79%	+132%

Note: Travel times are rounded to the nearest five seconds, traffic counts are rounded to the nearest 10 vehicles.

As above, the modelling results shown in Table 8 indicate that a general decrease in average speeds can be expected in the 2031 weekday PM peak period. It is in this period that the advantages gained by signalling the Cotter Road – Lady Denman Drive intersection become clear. Compared to *Do Nothing*, there are additional multiple-minute delays westbound along routes 2 and 3 in the preferred option, due largely to the bottleneck of the roundabout intersection at Cotter Road and Lady Denman Drive.

Due to the changes in road network connectivity, particularly the connection of Cotter Road to Denison Street, there is an increase in local congestion on Denison Street.

Table 8: Comparison of 2031 Weekday PM Peak Average Speed and Travel Time on Selected Routes

Route		1		2		3		4	
Direction of Travel		EB	WB	EB	WB	EB	WB	EB	WB
Average Speed [km/hr]	Do Nothing	58	65	67	72	60	42	86	81
	Preferred Option	40	4	47	31	28	24	82	62
	Preferred Option ES	24	24	43	45	27	32	83	79
Average Speed Difference	Preferred Option	-31%	-94%	-30%	-57%	-53%	-43%	-5%	-23%
	Preferred Option ES	-59%	-63%	-36%	-38%	-55%	-24%	-3%	-2%
Average Travel Time [min:sec]	Do Nothing	1:15	1:05	1:50	1:55	2:25	3:30	1:15	1:20
	Preferred Option	1:50	16:30	2:50	4:25	3:30	4:00	1:20	1:45
	Preferred Option ES	3:00	2:55	3:05	3:05	3:35	3:00	1:20	1:20
Average Travel Time Difference	Preferred Option	+0:35	+15:25	+1:00	+2:30	+1:05	+0:30	+0:05	+0:25
	Preferred Option ES	+1:45	+1:50	+1:15	+1:10	+1:10	-0:30	+0:05	0:00
Average Vehicle Count [VKT/route length]	Do Nothing	590	690	700	1,990	250	1,150	1,260	2,190
	Preferred Option	730	550	1,010	1,410	500	1,730	1,910	1,140
	Preferred Option ES	720	1,310	1,000	2,380	520	2,040	1,900	3,260
Average Vehicle Count Difference	Preferred Option	+24%	-20%	+44%	-29%	+100%	+50%	+52%	-48%
	Preferred Option ES	+22%	+90%	+43%	+20%	+108%	+77%	+51%	+49%

Note: Travel times are rounded to the nearest five seconds, traffic counts are rounded to the nearest 10 vehicles

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Due to the low traffic demand in the 2031 weekend daytime peak period, the results shown in Table 9 are a good indicator of the impact on performance that results from the changes to the road network. The intersection analysis that follows in Section 3.3 indicates that the weekend peak period traffic operates at low density and that most of the delays can be attributed to the network changes rather than to congestion.

The *Preferred Option ES* variant was not tested for the 2031 weekend midday peak period but could be expected to increase delay slightly for routes 1, 2 and 3 due to the expected free-flow operation of the existing unsignalised intersections in this period.

With the exception of route 2 westbound, any increase in delay experienced by vehicles travelling through the study area is no greater than 30 seconds.

Table 9: Comparison of 2031 Weekend Daytime Peak Average Speed and Travel Time on Selected Routes

Route Number		1		2		3		4	
Direction of Travel		EB	WB	EB	WB	EB	WB	EB	WB
Average Speed [km/hr]	Do Nothing	61	68	71	81	61	56	87	86
	Preferred Option	50	60	59	63	44	50	85	86
Average Speed Difference	Preferred Option	-18%	-12%	-17%	-22%	-28%	-11%	-2%	+0%
Average Travel Time [min:sec]	Do Nothing	1:10	1:05	1:45	1:40	2:25	2:35	1:15	1:15
	Preferred Option	1:25	1:10	2:00	2:10	2:10	1:55	1:20	1:15
Average Travel Time Difference	Preferred Option	+0:15	+0:05	+0:15	+0:30	-0:15	-0:40	+0:05	0:00
Average Vehicle Count [VKT/route length]	Do Nothing	260	280	670	570	370	340	930	770
	Preferred Option	460	430	810	730	520	460	1,260	1,110
Average Vehicle Count Difference	Preferred Option	+77%	+54%	+21%	+28%	+41%	+35%	+35%	+44%

Note: Travel times are rounded to the nearest five seconds, traffic counts are rounded to the nearest 10 vehicles

3.3 Intersection Analysis

The turning flows at each of the analysed intersections were taken from the micro-simulation modelling outputs and used as input to SIDRA Intersection for the assessment of service levels.

A number of variations of each intersection model were tested where necessary to evaluate the performance without slip lanes (for reasons of pedestrian safety) and with configurations required to reach a minimum performance of LoS C, if possible.

Intersection layouts as modelled in SIDRA Intersection 5 are included in Figure 11 through Figure 27.

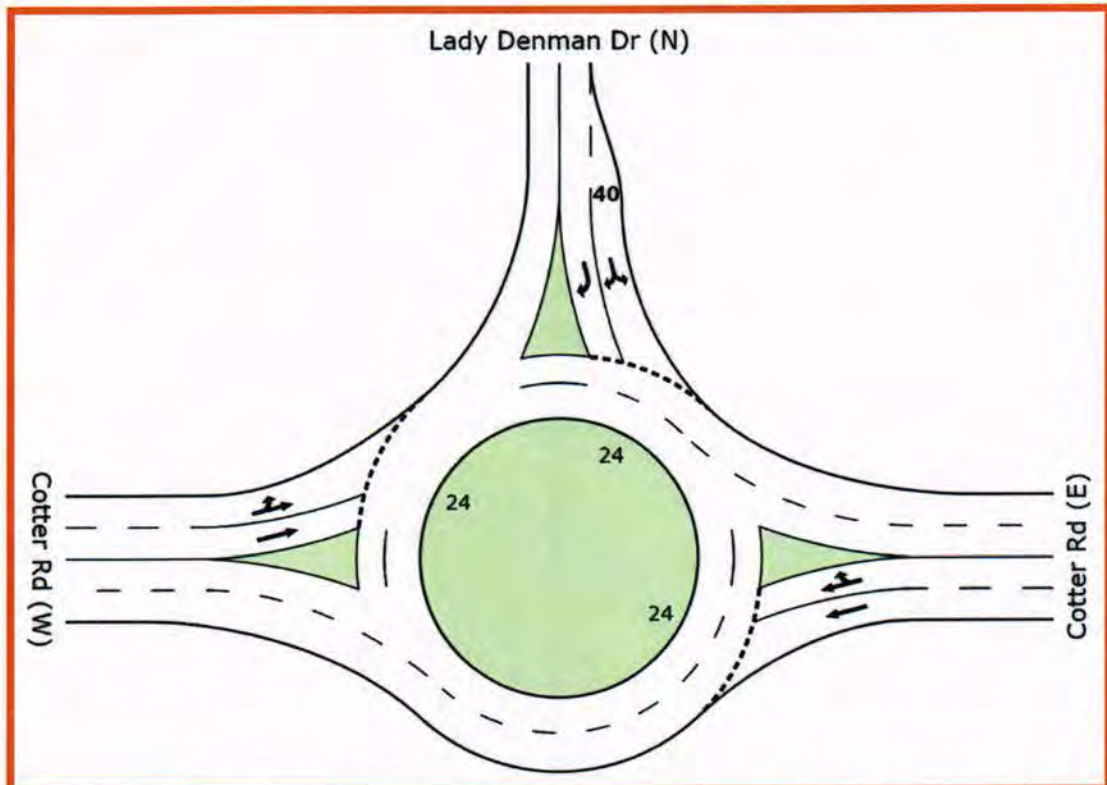


Figure 11: Cotter Rd – Lady Denman Dr (Do Nothing and Preferred Option)

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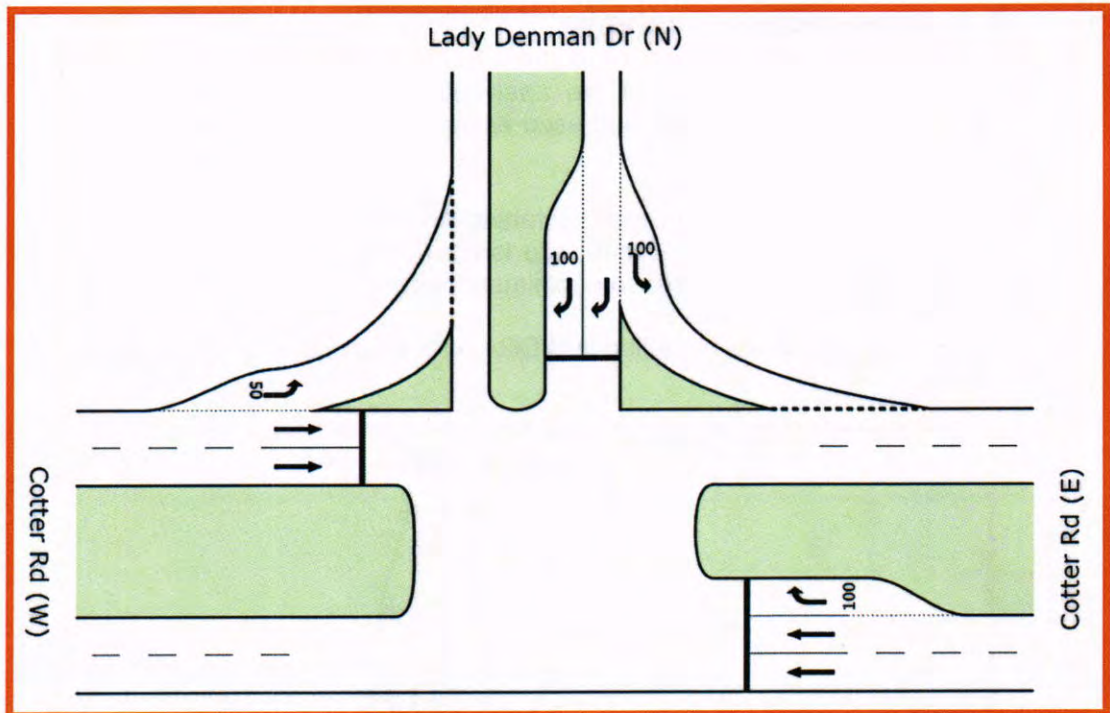


Figure 12: Cotter Rd – Lady Denman Dr Signalised (Preferred Option)

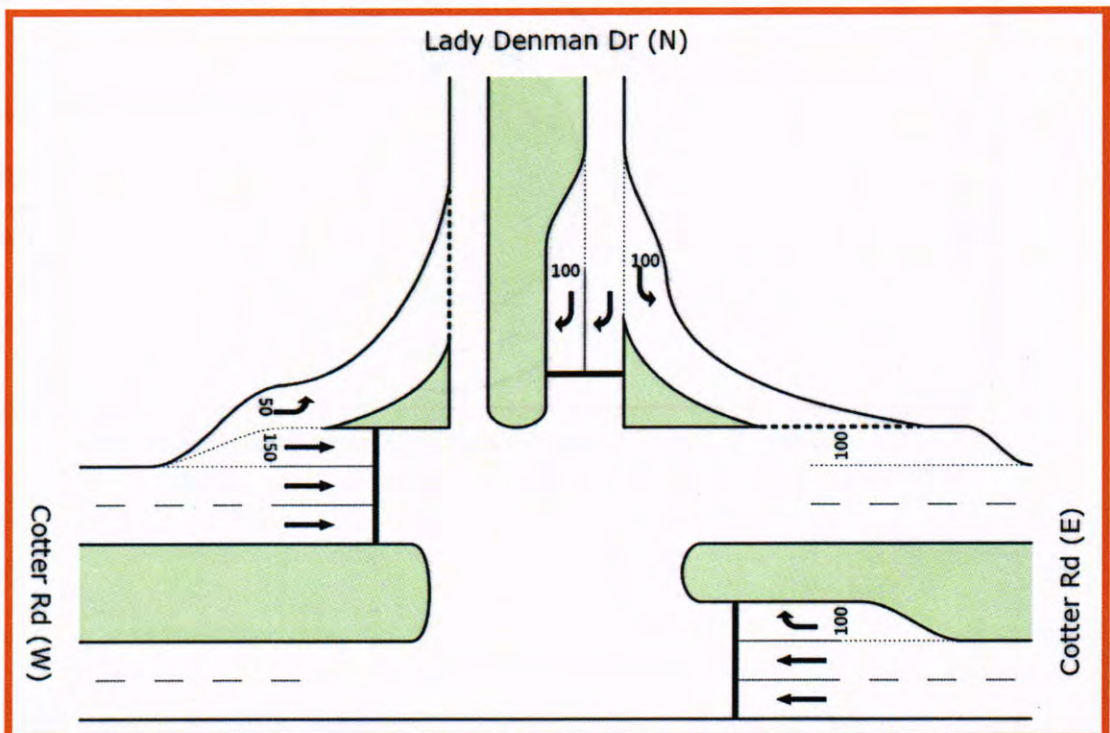


Figure 13: Cotter Rd – Lady Denman Dr Signalised, 3LT (Preferred Option)

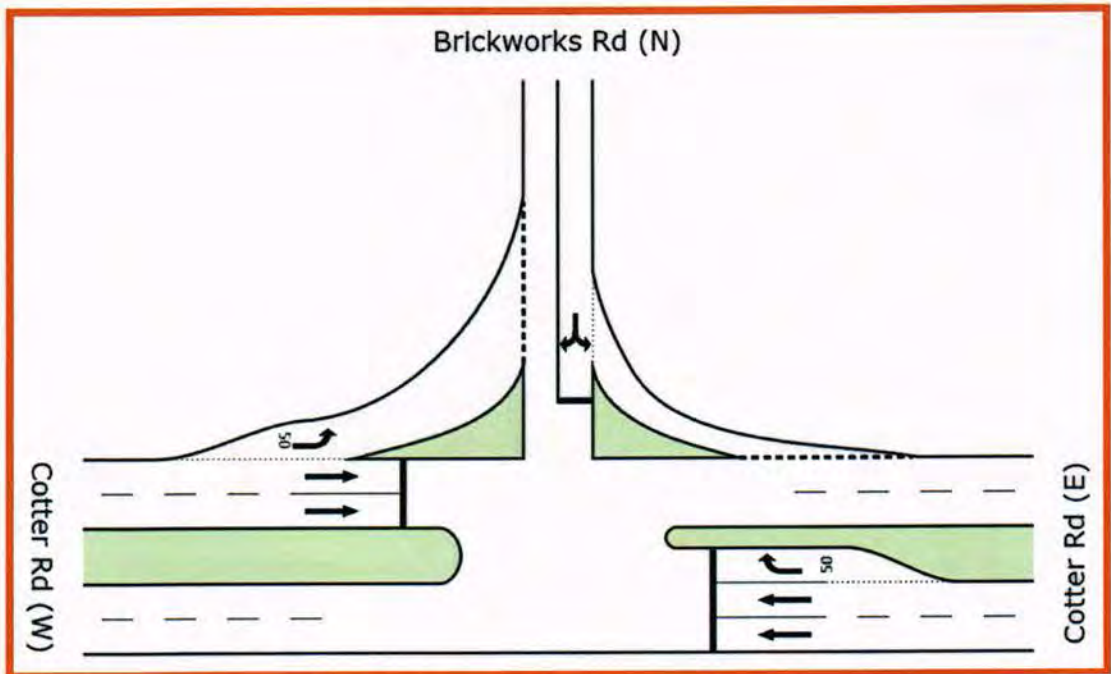


Figure 14: Cotter Rd – Brickworks Rd (Preferred Option)

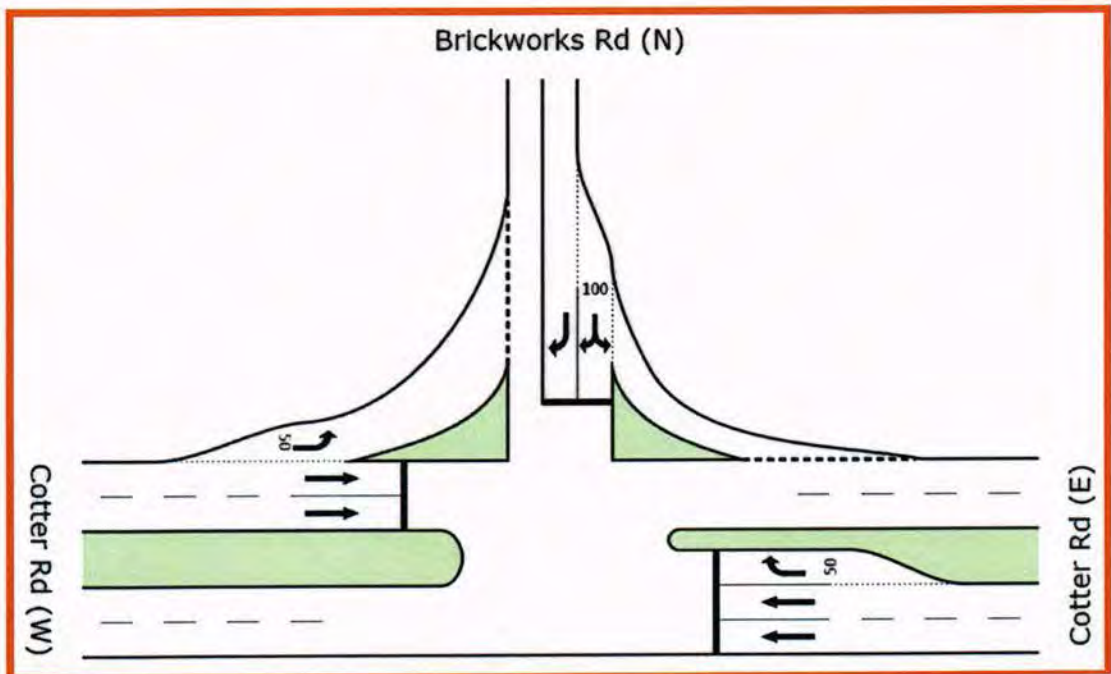


Figure 15: Cotter Rd – Brickworks Rd Double Right Turn (Preferred Option)

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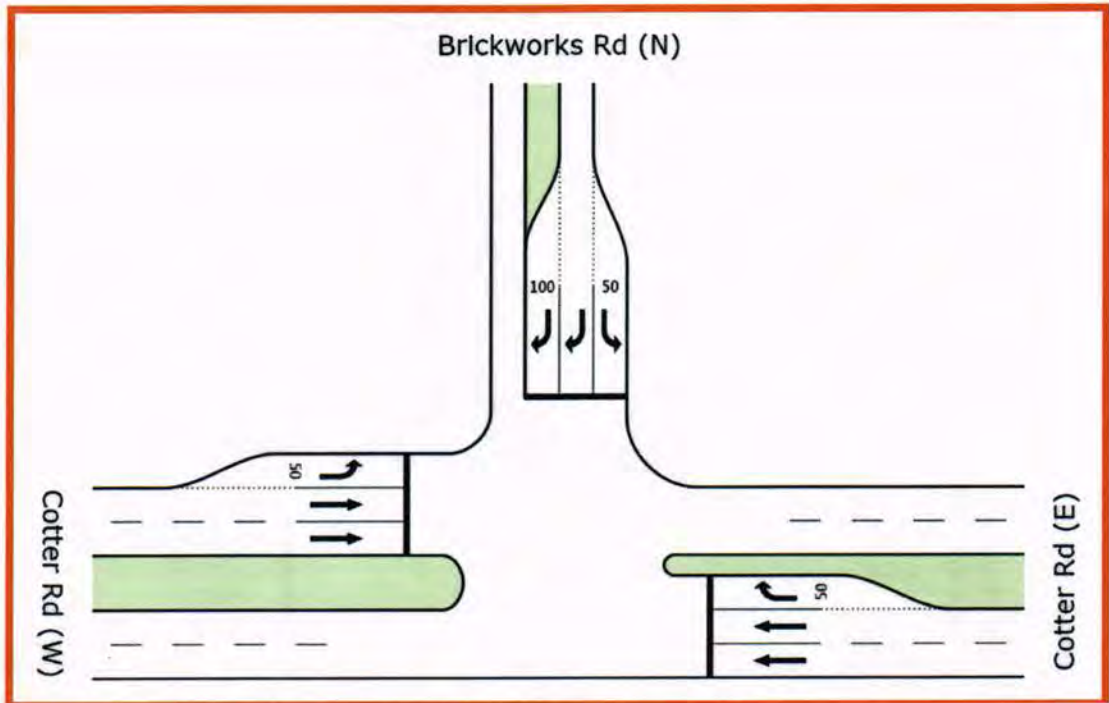


Figure 16: Cotter Rd – Brickworks Rd Double Right Turn with no Slip Lanes (Preferred Option)

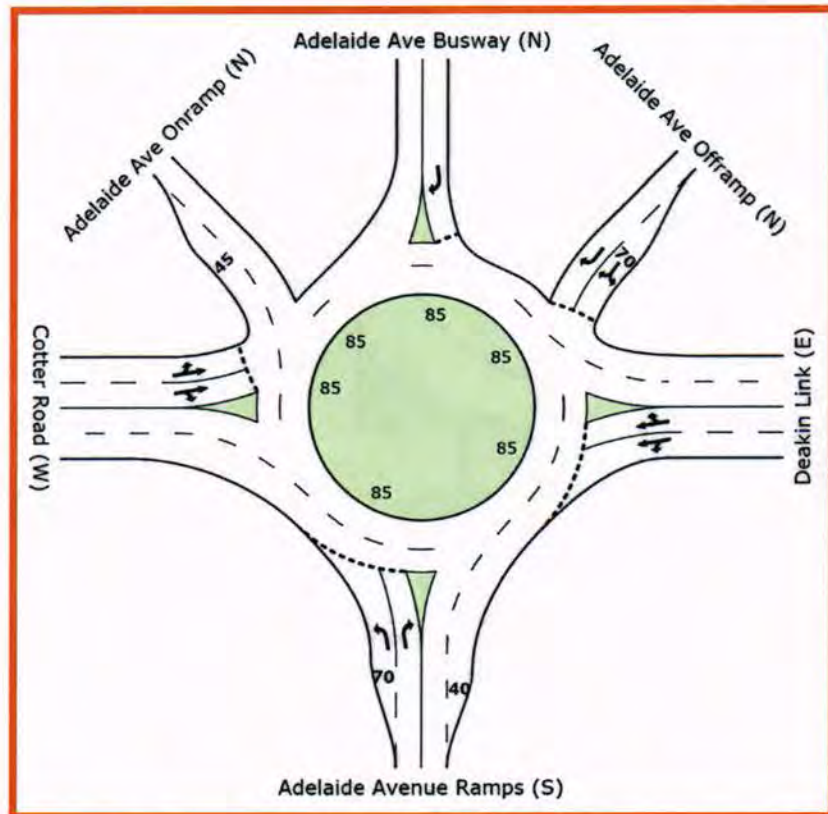


Figure 17: Cotter Rd – Adelaide Avenue Interchange (Preferred Option)

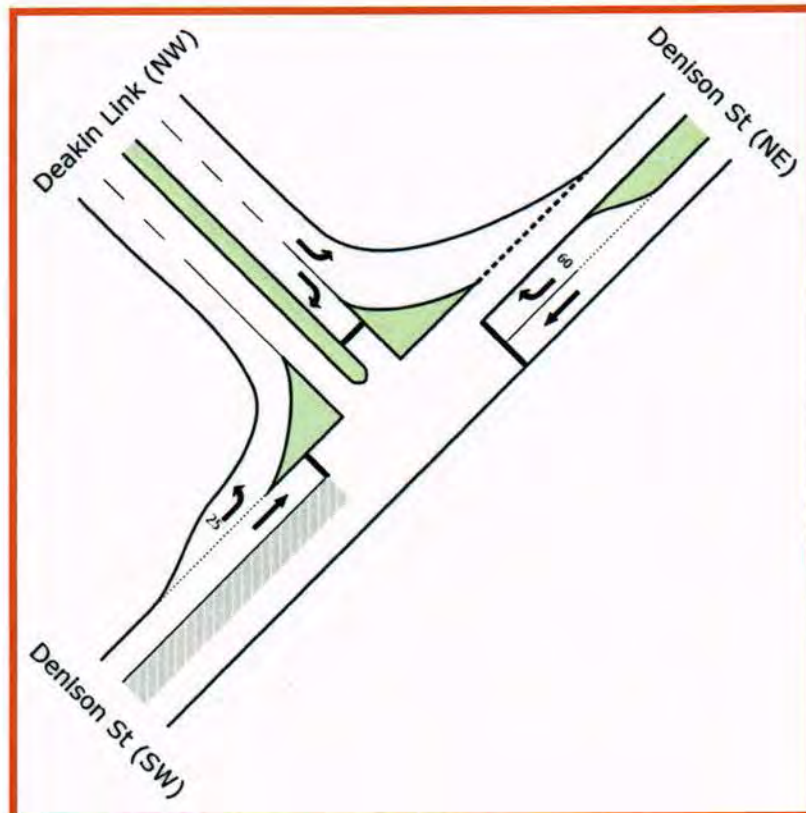


Figure 18: Cotter Rd – Denison St (Preferred Option)

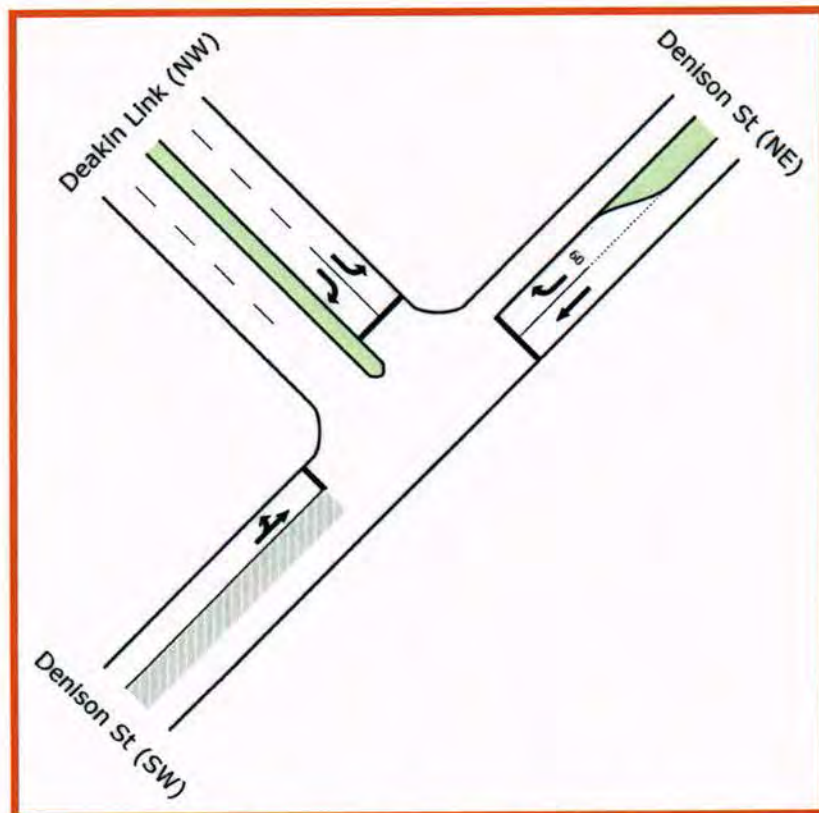


Figure 19: Cotter Rd – Denison St no Slip Lanes (Preferred Option)

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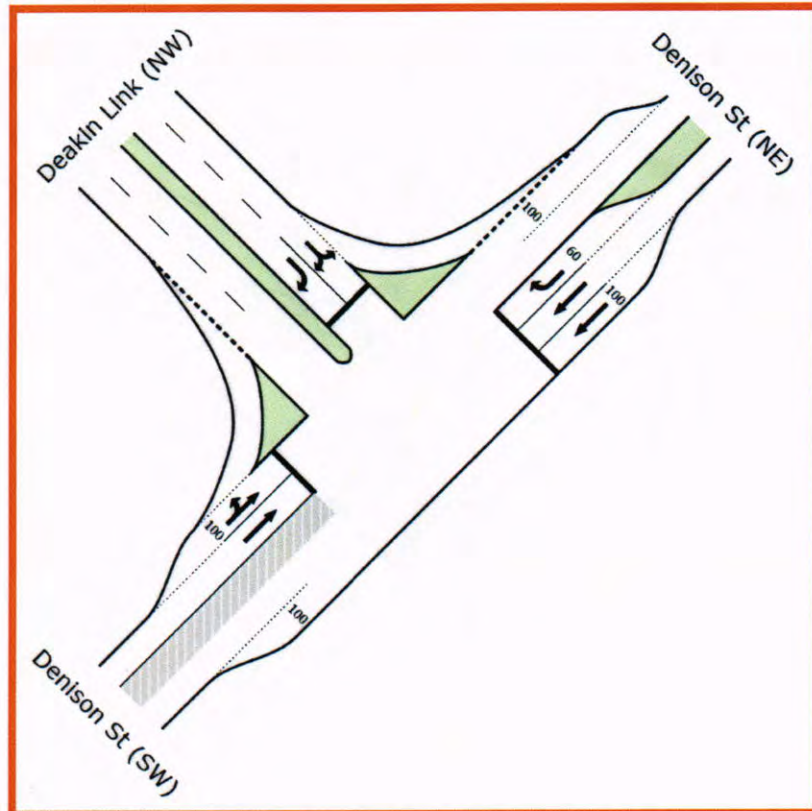


Figure 20: Cotter Rd – Denison St 2LT (Preferred Option)

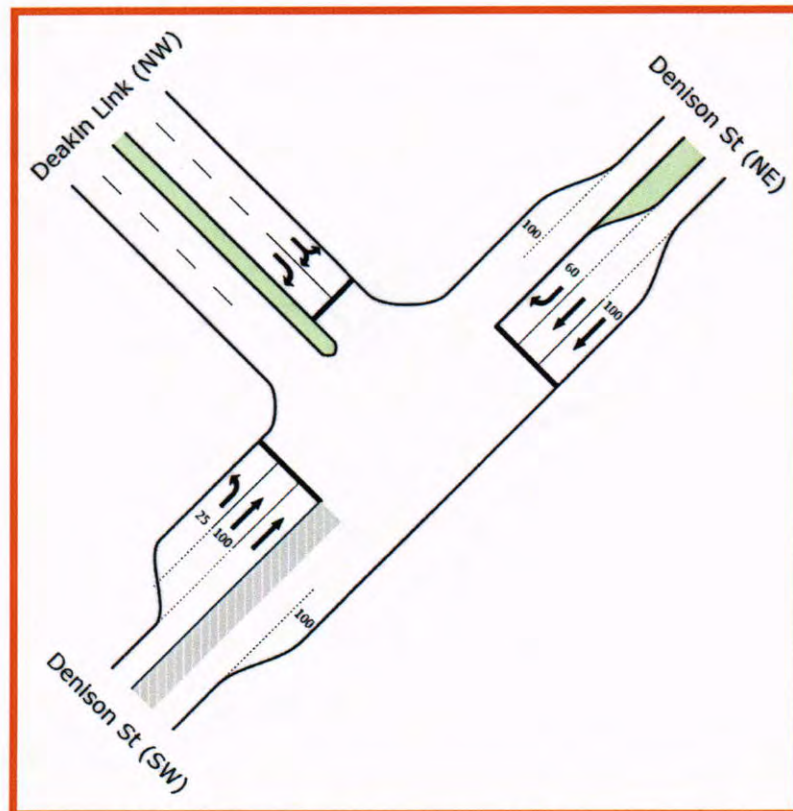


Figure 21: Cotter Rd – Denison St 2LT, no Slip Lanes (Preferred Option)

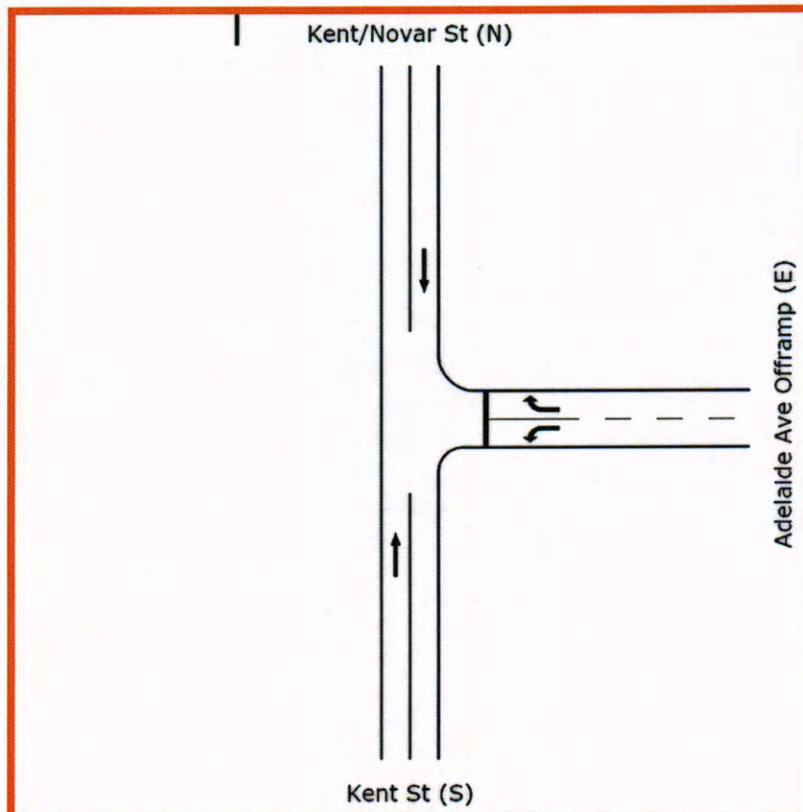


Figure 22: Kent St/Novar St – Adelaide Ave WB Offramp (Do Nothing and Preferred Option)

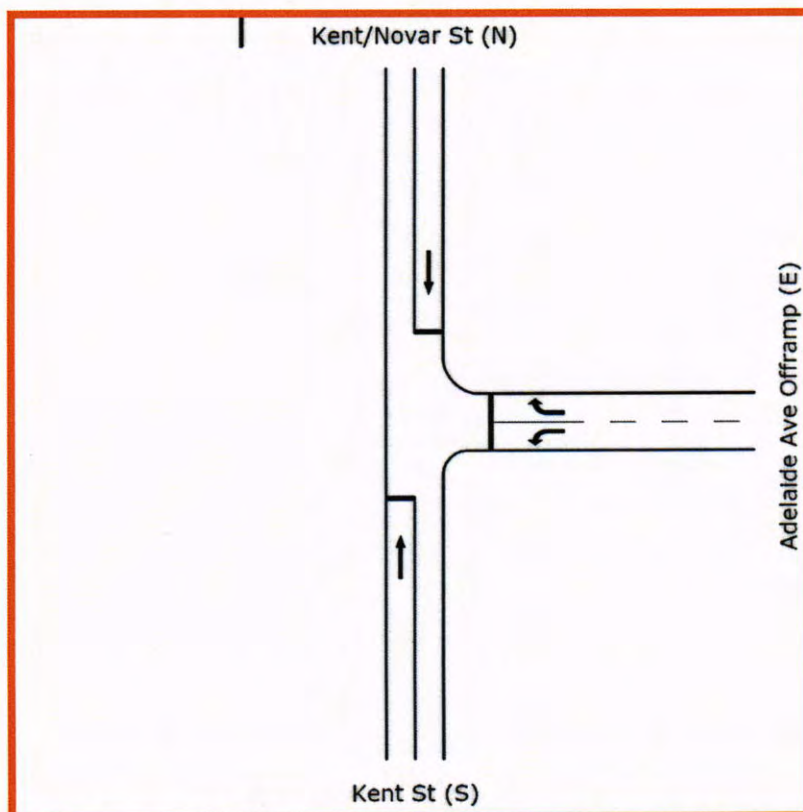


Figure 23: Kent St/Novar St – Adelaide Ave WB Offramp Signalised (Preferred Option)

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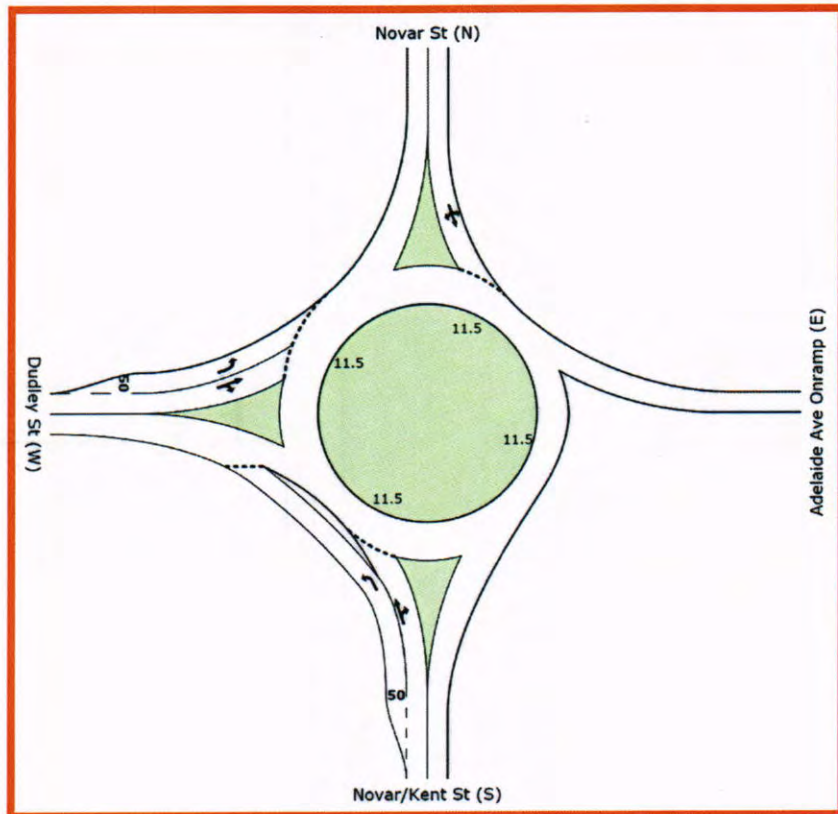


Figure 24: Kent St/Novar St – Dudley St/Adelaide Ave EB Onramp (Do Nothing and Preferred Option)

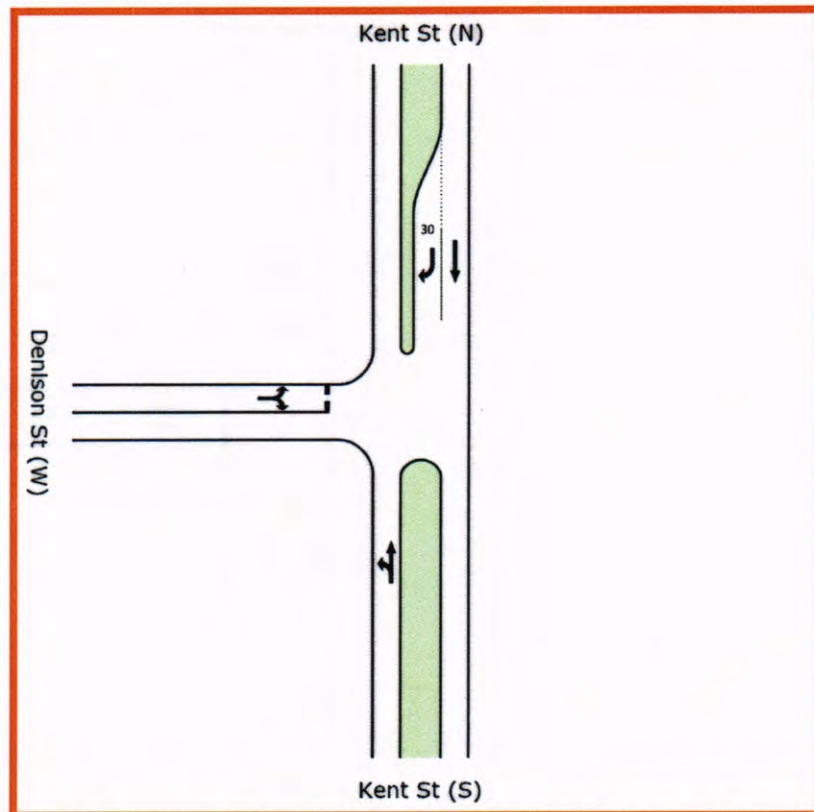


Figure 25: Kent St – Denison St (Do Nothing and Preferred Option)

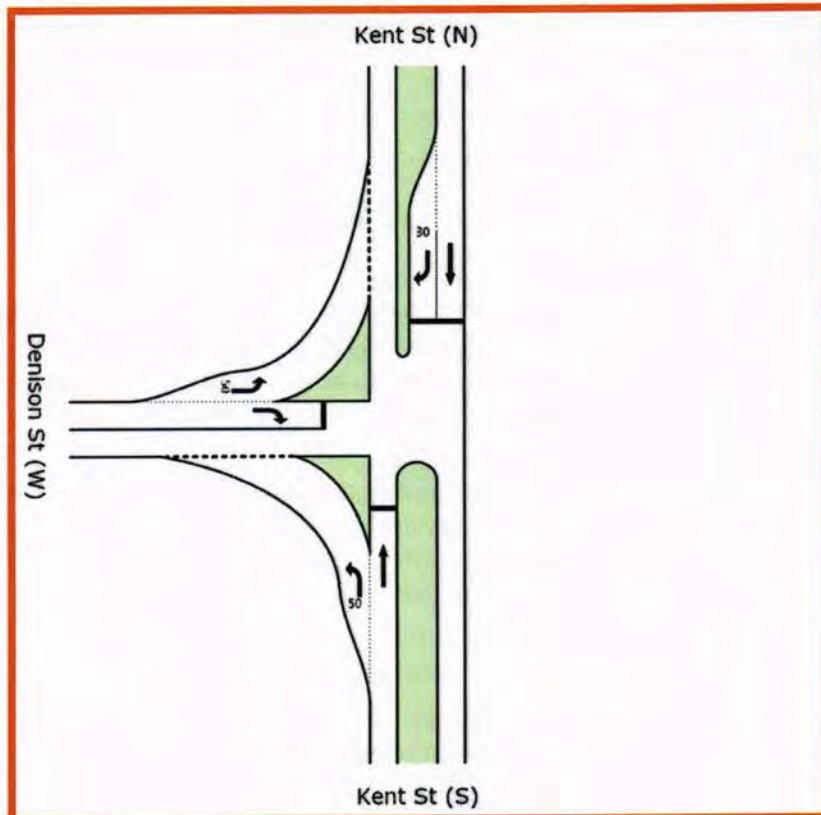


Figure 26: Kent St – Denison St Signalised (Preferred Option)

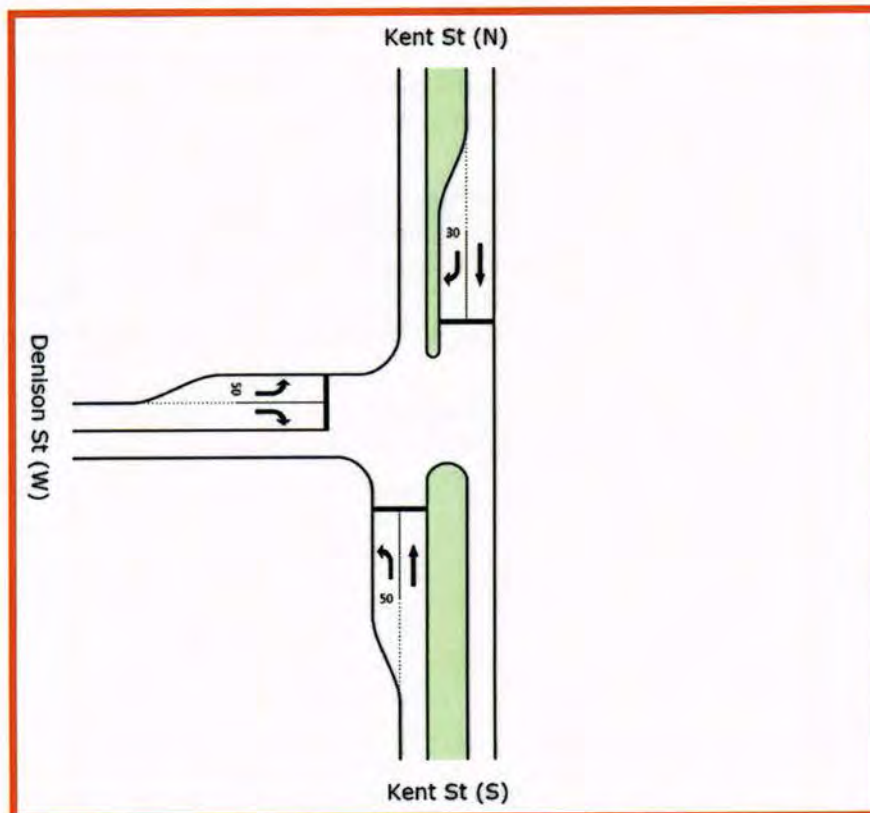


Figure 27: Kent St – Denison St Signalised no Slips (Preferred Option)

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The 2031 AM, PM and weekend peak intersection assessment results are outlined in Table 10, Table 11 and Table 12 respectively. The analysis shows that the roundabout at Cotter Road and Lady Denman Drive is well over capacity in the weekday peak periods by 2031. The configuration of the Cotter Road – Adelaide Avenue interchange operates at a good level of service in all tested periods.

Summarised intersection analysis results:

1. Cotter Road – Lady Denman Drive
Poor performance (LoS F) in its existing roundabout configuration (Figure 11) in both AM and PM peak periods, signalisation (Figure 12) improves this LoS C in the 2031 PM peak period, however an additional eastbound through lane is required to achieve LoS C in the 2031 AM peak period (Figure 13).
2. Cotter Road – Brickworks Road
Good performance in both weekday peak periods (2031 PM is borderline LoS C/D) with two right turn lanes provided from Brickworks Road to Cotter Road westbound and slip lanes for both left turns (Figure 15). Removing the slip lanes (Figure 16) results in a slight drop in performance in the 2031 AM peak period.
3. Cotter Road – Adelaide Avenue
Good performance in all periods (LoS A).
4. Cotter Road – Denison Street
Performs acceptably at LoS C in the 2031 PM peak period, but requires upgrades to Denison Street (Figure 20) for LoS C performance in the 2031 AM peak period. Without these Denison Street upgrades the removal of slip lanes results in poor performance (LoS E/F).
5. Kent Street – Denison Street
Due to the connection of Cotter Road to Denison Street in the preferred option the traffic volumes and pattern at this intersection have changed substantially. Signalisation (Figure 26 and Figure 27) improves the performance somewhat; LoS D and E respectively without and with slip lanes in 2031 AM, and LoS B and C in 2031 PM.
6. Kent Street – Adelaide Avenue Offramp
With no changes to its configuration, the performance of this intersection improves to LoS A in both the 2031 AM and PM peak periods in the preferred option due to the change in traffic patterns. This intersection can be effectively signalised and coordinated with *Kent Street – Denison Street* to improve performance along Kent Street.
7. Novar Street – Dudley Street/Adelaide Avenue Onramp
This intersection operates well in all periods.

Table 10: Comparison of 2031 Weekday AM Peak Intersection Analysis Results

ID	Intersection	Average Delay [s]		Level of Service	
		Do Nothing	Preferred Option	Do Nothing	Preferred Option
1	Cotter Road – Lady Denman Drive	128.7	253.8	F	F
	Cotter Road – Lady Denman Drive (signalised)	N/A	112.7	N/A	F
	Cotter Road – Lady Denman Drive (signalised, 3LT)	N/A	31.0	N/A	C
2	Cotter Road – Brickworks Road	N/A	58.5	N/A	E
	Cotter Road – Brickworks Road (2LRT)	N/A	32.9	N/A	C
	Cotter Road – Brickworks Road (2LRT, no slip lanes)	N/A	102.4	N/A	F
3	Cotter Road – Adelaide Avenue	N/A	5.4	N/A	A
4	Cotter Road – Denison Street	N/A	48.2	N/A	D
	Cotter Road – Denison Street (no slip lanes)	N/A	72.0	N/A	E
	Cotter Road – Denison Street (2LT)	N/A	34.7	N/A	C
	Cotter Road – Denison Street (2LT, no slip lanes)	N/A	37.4	N/A	D
5	Kent Street – Denison Street	6.1	1839.2	(A)*	(F)*
	Kent Street – Denison Street (signalised)	N/A	48.5	N/A	D
	Kent Street – Denison Street (signalised, no slip lanes)	N/A	61.4	N/A	E
6	Kent Street – Adelaide Avenue Offramp	35.8	9.6	(D)*	(A)*
	Kent Street – Adelaide Avenue Offramp (signalised, coordinated with Kent – Denison)	N/A	15.2	N/A	B
7	Novar Street – Dudley Street/Adelaide Avenue Onramp	14.8	9.4	B	A

* SIDRA Intersection does not report overall intersection delays for give way or stop intersections because of the effectively zero delay typically experienced by major road movements; the Level of Service shown has been determined manually using Table 5.

0407

Table 11: Comparison of 2031 Weekday PM Peak Intersection Analysis Results

ID	Intersection	Average Delay [s]		Level of Service	
		Do Nothing	Preferred Option	Do Nothing	Preferred Option
1	Cotter Road – Lady Denman Drive	280.3	184.2	F	F
	Cotter Road – Lady Denman Drive (signalised)	N/A	24.9	N/A	C
	Cotter Road – Lady Denman Drive (signalised, 3LT)	N/A	24.7	N/A	C
2	Cotter Road – Brickworks Road	N/A	131.5	N/A	F
	Cotter Road – Brickworks Road (2LRT)	N/A	36.0	N/A	D
	Cotter Road – Brickworks Road (2LRT, no slip lanes)	N/A	30.6	N/A	C
3	Cotter Road – Adelaide Avenue	N/A	8.8	N/A	A
4	Cotter Road – Denison Street	N/A	17.7	N/A	B
	Cotter Road – Denison Street (no slip lanes)	N/A	95.1	N/A	F
	Cotter Road – Denison Street (2LT)	N/A	24.1	N/A	C
	Cotter Road – Denison Street (2LT, no slip lanes)	N/A	25.9	N/A	C
5	Kent Street – Denison Street	71.8	62.0	(F)*	(F)*
	Kent Street – Denison Street (signalised)	N/A	16.0	N/A	B
	Kent Street – Denison Street (signalised, no slip lanes)	N/A	28.3	N/A	C
6	Kent Street – Adelaide Avenue Offramp	92.6	6.0	(F)*	(A)*
	Kent Street – Adelaide Avenue Offramp (signalised, coordinated with Kent – Denison)	N/A	13.9	N/A	B
7	Novar Street – Dudley Street/Adelaide Avenue Onramp	18.7	8.6	B	A

* SIDRA Intersection does not report overall intersection delays for give way or stop intersections because of the effectively zero delay typically experienced by major road movements; the Level of Service shown has been determined manually using Table 5.

Table 12: Comparison of 2031 Weekend Daytime Peak Intersection Analysis Results

ID	Intersection	Average Delay [sec]		Level of Service	
		Do Nothing	Preferred Option	Do Nothing	Preferred Option
1	Cotter Road – Lady Denman Drive	6.9	10.5	A	A
2	Cotter Road – Brickworks Road	N/A	21.2	N/A	B
	Cotter Road – Brickworks Road (2LRT)	N/A	16.8	N/A	B
	Cotter Road – Brickworks Road (2LRT, no slip lanes)	N/A	19.3	N/A	B
3	Cotter Road – Adelaide Avenue	N/A	6.4	N/A	A
4	Cotter Road – Denison Street	N/A	13.8	N/A	B
	Cotter Road – Denison Street (no slip lanes)	N/A	17.2	N/A	B
5	Kent Street – Denison Street	3.3	8.5	(A)*	(A)*
6	Kent Street – Adelaide Avenue Offramp	6.0	3.6	(A)*	(A)*
7	Novar Street – Adelaide Avenue Onramp	10.4	7.9	B	A

* SIDRA Intersection does not report overall intersection delays for give way or stop intersections because of the effectively zero delay typically experienced by major road movements; the Level of Service shown has been determined manually using Table 5.

A summary of the recommended intersection treatments is shown in Table 13.

Table 13: Summary of Recommended Intersection Treatments

ID	Intersection	Recommended Treatment
1	Cotter Road – Lady Denman Drive	Signals, three lanes for the eastbound through movement (Figure 13).
2	Cotter Road – Brickworks Road	Signals, two lane right turn from Brickworks Road to Cotter Road westbound, slip lanes for left turns (Figure 15.)
3	Cotter Road – Adelaide Avenue	Preferred design operates well in all periods.
4	Cotter Road – Denison Street	Signals, two lanes for the Denison Street through movements, left turn slip lanes provide only a small benefit and can be omitted (Figure 21).
5	Kent Street – Denison Street	Signals, slip lanes for left turns (Figure 18).
6	Kent Street – Adelaide Avenue Offramp	While the SIDRA results suggest that the existing intersection will still perform well in 2031, signalling the existing layout is recommended as it can then be coordinated with signals at Kent Street – Denison Street, providing a wider network benefit.
7	Novar Street – Dudley Street/ Adelaide Avenue Onramp	No intervention required.

0406

3.4 Summary of Operational Assessment Findings

The micro-simulation and intersection modelling results suggest that in the weekday peak periods parts of the network are well over capacity, particularly the westbound movement. Lower operating speeds can be expected in the area due directly to the configuration of the network changes, and to a certain extent to the lower level capacity of the new network elements. The weekend peak period also experiences a reduction in average speeds, however this is in part due directly to the configuration of the preferred option road network.

The weekend modelling is useful as it provides a "baseline" network performance, i.e. traffic is low enough during this period to demonstrate how the network works at or close to free flow conditions. It indicates that the new roads and intersections will slow down traffic within this area, with the additional indication that the difference in performance between the do nothing and preferred option configurations is not only due to congestion effects.

The modelling suggests that the intersection of Cotter Road and Lady Denman Drive and the intersections on Kent Street south of Adelaide Avenue will be important factors in the performance of the network in the weekday peak periods.

3.4.1 Impacts

It is noteworthy with respect to the modelling that the increased land use necessarily results in a localised increase in traffic demand, which manifests as an overall increase in traffic movements to and from the area. Due to the network modifications individual roads may experience a reduction in traffic independent of the overall traffic increase.

It is clear from the analysis results that the road network modifications, which were proposed as part of the Canberra Brickworks development, will affect the future road network performance within the study area with reduced speeds and increased delays/travel times. The challenge then would be to conceptualise possible counter-measures to mitigate the negative effects of network changes in the overall traffic operational performance.

3.4.2 Proposed Solutions (Preliminary)

A variation of the preferred option, identified as *Preferred Option ES*, was tested to evaluate the conversion of the existing roundabout intersection at Cotter Road and Lady Denman Drive to signal control. This was shown to generally improve average vehicle delay and Level of Service compared to the plain *Preferred Option*. Additionally the intersection modelling suggests that signalisation of Kent Street – Denison Street and Kent Street – Adelaide Avenue Offramp is necessary to maintain acceptable levels of service at that intersection.

4 OTHER TRANSPORT MODES

While private car is the primary transport mode in Canberra, the ACT Government has made a commitment to increasing sustainable transport with the *Sustainable Transport Plan* (ACTPLA, 2004). The plan hopes to increase the share of sustainable modes, including public transport, cycling and walking, from 13.1% in 2001 to 30% in 2026. Consideration has therefore been given in this report as to how to contribute to meeting these goals.

4.1 Mode Split (Existing + Target)

Census data for Yarralumla, 2006, indicates the mode split for journey to work trips shown in Table 14. Journey to work trips data have been examined since this information is readily available from the Australian Bureau of Statistics. The table indicates that the current sustainable transport share (walking, cycling and public transport) for Curtin, Yarralumla and Deakin ranges from 12% (Deakin) to 19% (Curtin) with Yarralumla currently at 16%.

Table 14: Current Journey to Work Mode Split for Suburbs Surrounding the Study Area

Mode	Curtin		Yarralumla		Deakin	
	Trips	Mode Share	Trips	Mode Share	Trips	Mode Share
Car/Motorcycle	1,706	80.8%	957	84.0%	886	87.9%
Public Transport	214	10.1%	54	4.7%	61	6.1%
Cycling	83	3.9%	63	5.5%	41	4.1%
Walking	108	5.1%	65	5.7%	20	2.0%
Total	2,111		1,139		1,008	

Source: ABS Census, 2006

The Sustainable Transport Plan produced by the ACT Government lists the targets outlined in Table 15.

Table 15: Sustainable Transport Plan Targets

Mode	2001	2011	2026
Public Transport	6.7%	9%	16%
Cycling	2.3%	5%	7%
Walking	4.1%	6%	7%
Total	13.1%	20%	30%

Source: Sustainable Transport Plan, ACT Government

The suburbs around the study area are close to meeting the sustainable transport plan targets and any new developments in the study area should encourage sustainable transport in line with the targets specified by the ACT Government.

The higher-density, mixed-use developments that are proposed are expected to encourage more sustainable transport options. However, the development must be supported by good access to public transport and pedestrian/cycle facilities as well.

4.2 Public Transport

Figure 28 shows the proposed strategic bus network for 2031 (*ACT Strategic Public Transport Network Plan*, MRC). This network proposed increased coverage for the study area by introducing a bus route along Cotter Road.



Figure 28: Strategic Bus Network for 2031 (based on ACT Strategic Public Transport Network Plan, MRC)

The Strategic Public Transport Network Plan does not currently include any provision for bus stops close to the study area. Possible options include a stop on Cotter Road or a bus station in the median of Adelaide Avenue that would service not only the new development but the Deakin employment area as well.

The AECOM roundabout interchange design proposal includes a median bus station on Adelaide Avenue east of, and connecting directly to, the roundabout interchange, which will service the peak express and rapid routes using Adelaide Avenue and Cotter Road. Due to the choice of a roundabout for the Cotter Road – Adelaide Avenue interchange, a pedestrian/cyclist overpass crossing Adelaide Avenue will be required to connect this facility to both Yarralumla and Deakin.

Current planning for ACTION indicates that the maximum walking distance to a bus stop should be 500 metres. However, the *Future Urban Areas Residential Subdivision Development Code 2008* states that a walk distance of up to 750 metres is acceptable for high frequency services. The proposed location of a median bus station on Adelaide Avenue, as per AECOM's concept design, provides coverage of the new development as well as the Deakin employment area and is expected to increase public transport usage for these areas. The coverage area is shown in Figure 29.

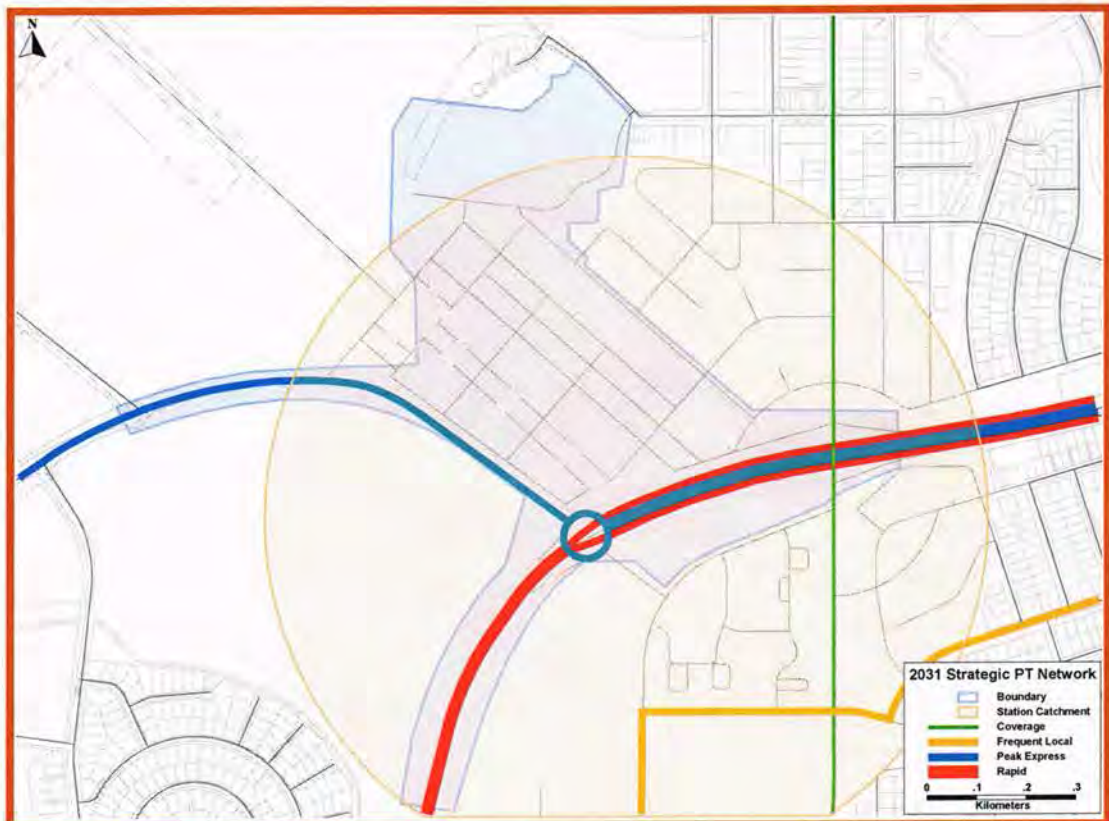


Figure 29: Coverage of Proposed Adelaide Avenue Median Bus Station

4.3 Cycling

The current coverage of facilities for use by cyclists in the study area is shown in Figure 30. This figure shows that while there are a number of existing facilities, these facilities tend to be outside of the study area. However, the existing facilities offer opportunities for connections into and through the study area.

Of particular note is the fact that the existing off-road cycle path is grade separated at its crossings of Lady Denman Drive, Cotter Road, Dunstan Street, Adelaide Avenue and McCulloch Street, making it easier and safer for cyclists to pass through the area.

The ACT *Design Standards for Urban Infrastructure Part 13 – Pedestrian and Cycle Facilities* (DS13) (TAMS, 2007) present the requirements for the provision of pedestrian and cycle facilities. Of particular note is the requirement for provision of facilities for different types of cyclists from school children to commuters and athletes. School children and recreational cyclists typically prefer off-road paths while commuters and athletes prefer higher speed, direct routes on-road.



Figure 30: Existing Cycling Facilities (Information Obtained from TAMS)

4.3.1 On-Road Cycling

The main on-road network, as shown in Figure 30, provides high-speed, continuous access for cyclists along the main arterial roads in the area. Appropriate connections to this network from the proposed development need to be made.

With the exception of Brickworks Road, the roads in the new development are not considered appropriate for formal bicycle lane marking as traffic speeds and volumes are expected to be low enough to allow safe cycling. Provision of on-road bicycle lanes along Brickworks Road is recommended to allow cyclist access between Cotter Road and the new development. The major east-west road through the development, connecting Brickworks Road to Dudley Street, should provide wider than normal traffic lanes to allow safe on-road cycling.

The proposed roundabout interchange between Cotter Road and Adelaide Avenue does not provide any pedestrian or cyclist access across Adelaide Avenue. An overbridge is proposed to the east of Cotter Road to enable access from both sides of Adelaide Avenue to access the proposed bus station within the Adelaide Avenue median. Access to the median bus station should provide for cyclist as well as pedestrian movements. The eastbound on-road cycle path on Cotter Road should connect to the northbound lane on Adelaide Avenue. However, the high speed, multi-lane roundabout interchange does not allow for safe connections to Deakin or the southbound on-road lane on Adelaide Avenue. Connection and signage should be made to the off-road path so these movements can be made via the grade separated crossing.

The proposed interchange between Cotter Road and Adelaide Avenue provides no pedestrian and minimal cyclist connectivity with the employment area in Deakin. A grade separated pedestrian and cyclist crossing is proposed to provide this connection, which should encourage walking and cycling trips to work. In particular, the Deakin employment

area is approximately one kilometre from the new development. The Sustainable Transport Plan suggests that the maximum cycle trip to work is ten kilometres. The provision of good cycling links between the development and Deakin employment area is expected to encourage cycling to work. Also, the connection of the development to the on-road network will allow access to Civic, Russell, Woden and the Parliamentary Zone, all of which are less than approximately six kilometres from the development and are the major employment areas in Canberra. Figure 31 shows potential facilities and connections that will encourage use of the cycling mode.

4.3.2 Off-Road Cycling

Off-road cycling is appropriate for slower riders and riders who do not feel confident riding adjacent to traffic. The linear park through the proposed development provides a good opportunity for an off-road shared path. The Cycling and Pedestrian Network report (Cardno Eppell Olsen, 2010) recommends an off-road cycle path from Dunrossil Drive along Dudley Street to Novar Street and then south along Kent Street. This alignment is not feasible with the proposed development but the off-road path shown in Figure 31 provides the same connectivity.

The grade separated crossing over Adelaide Avenue should be connected to the off-road paths at either end to allow travel in either direction along Adelaide Avenue. Also, the off-road path on the southern side of Adelaide Avenue is part of the trunk cycling network and should be grade separated at the crossing of the Deakin link road.

The recommended cycle facilities for the development are shown in Figure 31.

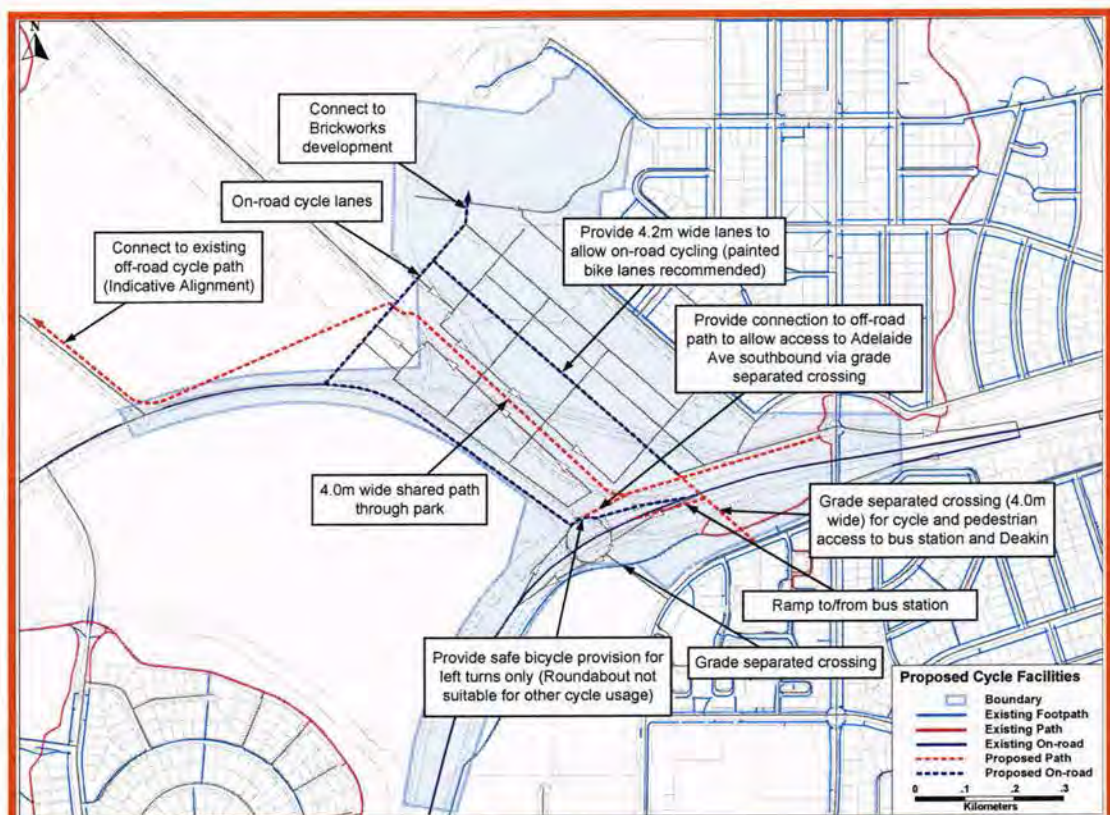


Figure 31: Proposed Cycle Facilities

4.4 Pedestrians

There are currently no pedestrian facilities in the development area. However, the off-road path on the south side of Adelaide Avenue is part of the trunk cycling and pedestrian network and is expected to be heavily utilised. Figure 32 shows the existing pedestrian facilities.



Figure 32: Existing Pedestrian Facilities (Information obtained from TAMS)

The ACT *Design Standards for Urban Infrastructure Part 13 – Pedestrian and Cycle Facilities* (DS13) (TAMS, 2007) state that paths are required on streets where traffic volumes exceed 200 vehicles per day, which is the majority of streets in the proposed development. DS13 also states that paths should generally be provided on all streets in new developments. Paths should be provided on both sides of the street in areas of higher density, higher pedestrian traffic or near commercial centres.

Based on these requirements, it is recommended that paths be provided on both sides of the street on all streets in the development except the south side of the southern boundary road and the park side of the one way streets adjacent to the park.

The proposed interchange between Cotter Road and Adelaide Avenue provides no pedestrian connectivity with the employment area in Deakin or the proposed bus interchange in the median of Adelaide Avenue. A grade separated pedestrian and cyclist crossing is proposed to provide this connection, which should encourage walking trips to work and promote usage of the proposed bus station. In particular, the Deakin employment area is approximately one kilometre from the new development. The Sustainable Transport Plan suggests that the maximum walk trip to work is two kilometres. The provision of good walking links between the development and Deakin employment area is expected to encourage walking to work.

Similarly, the Deakin Link requires grade separation of the shared path adjacent to Adelaide Avenue. This path is an important link in the pedestrian and cycling trunk network and should not be obstructed.

Figure 33 shows the main pedestrian attractors in the area along with the proposed pedestrian facilities. It is expected that any retail or commercial areas in the new development will also attract pedestrians and should have adequate footpath connectivity.

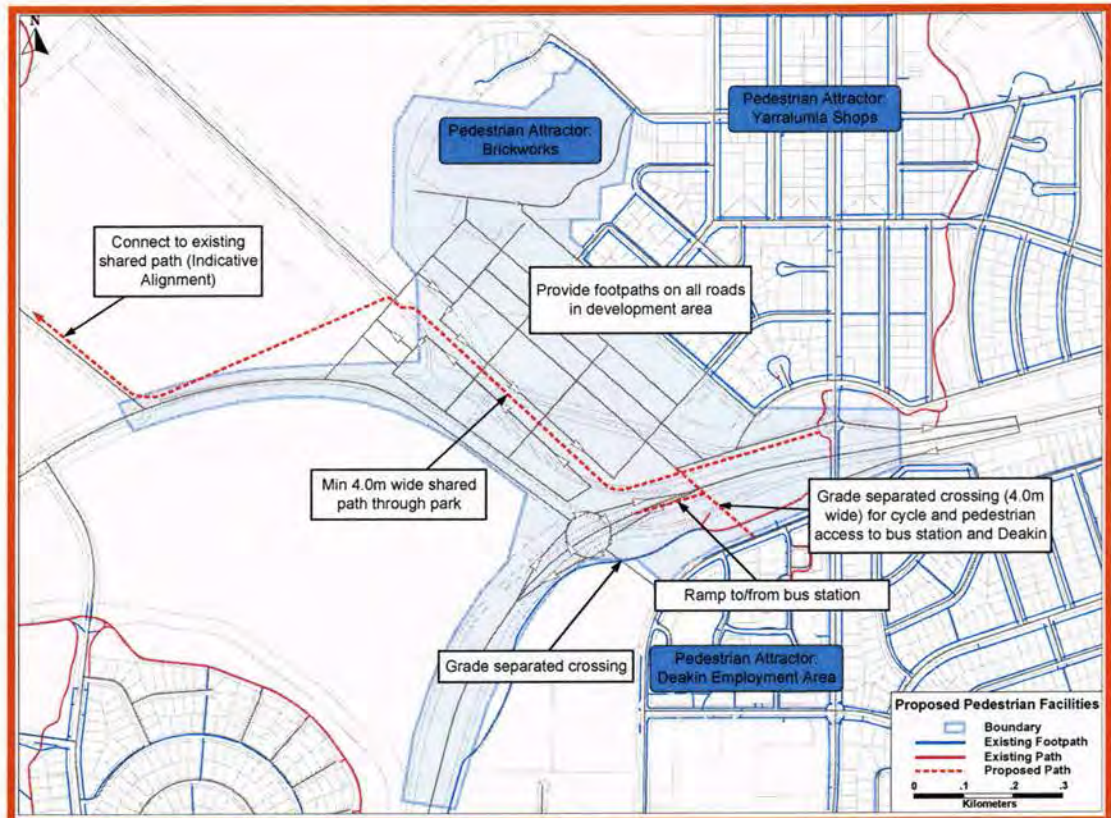


Figure 33: Proposed Pedestrian Facilities

5 ROADWAYS AND CIVIL INFRASTRUCTURE

SMEC engineers have completed a preliminary assessment of the site area as relating to civil infrastructure, including road construction and the provision of utility services. The construction costs anticipated for the preferred option are based on recent ACT infrastructure data compiled from a number of local construction projects with certain similarities.

5.1 Site Assessment for Road Layout and Stormwater Runoff

An analysis of the “Preferred Option” road layout has been completed in regard to the required earthworks and stormwater management facilities. The earthwork required for the proposed road layout was assessed for what is perceived to be the most critical; the southern section of the site. The stormwater management requirements were considered for the entire site area.

5.1.1 Road Layout

The layout provided by Hill Thalys was superimposed onto topographic data to verify the feasibility of the grid-system alignment proposed. The study area is shown on the earthworks plan in Figure 34. The vertical alignment of the major roads was considered in relation to a typical cross section of an urban street. The various road hierarchy typical sections proposed by Hill Thalys have been included in the model, giving a conceptual design which has yielded a reasonable understanding of the earthworks required and final design issues to be considered. Preliminary longitudinal sections have been prepared with consideration to necessary stopping sight distance (SSD) and at all crests and low points in the roads. Safe intersection sight distance (SISD) has also been considered, and the design will achieve appropriate sight lines to all intersections once detailed design makes allowance for batter slopes and possible retaining walls at road verges.

The earthworks required for the roads are estimated to be in the order of 24,000 m³ of cut and 22,000 m³ of fill inclusive of pavement boxing requirements. This is exclusive of the earthworks required for the site development of each individual block, which is in the order of a further 25,000 m³ cut to fill. The plan in Figure 34 shows the minimum areas of cut and fill required.

Road design concerns:

- The grid-system layout is generally at odds with the existing landform and subsequently the earthworks required are higher than would be the case with a more sympathetic layout. The grid system also provides little scope for directing stormwater into appropriate flow paths away from potential building pad areas. However, the design does accommodate adequate road sight distance requirements and can be considered acceptable provided that good solar access principles and energy efficient designs can be incorporated into the buildings within the blocks.
- The proximity of the roads at the southern extremity of the site to the existing alignment of Cotter Road and Adelaide Avenue. Further attention will need to be given to minimising earthworks in these areas to avoid impinging on these existing roads.

5.1.2 Stormwater Detention

The development of the study area will require post-development stormwater discharges to be less than or equal to the pre-development conditions. Best practices associated with water-sensitive urban design (WSUD) and stormwater harvesting can reduce the required stormwater detention volumes to a significant degree.

Because the site is situated at the lower end of the total Yarralumla Creek catchment area, there may be some argument for reducing or eliminating throttling effect of detention basins so that in a critical storm event, the flow from this development will have drained to Yarralumla Creek and the Molonglo River before being joined by flows from the upper catchment.

It should be noted, however, that detention ponds provide more than the effective calming of peak stormwater flows. They can be designed to enhance the aesthetic appeal of the neighbourhood and provide wildlife habitat and ongoing pollution controls once the development is complete.

Given the catchments location, flooding from upstream catchments will not occur. Some site regrading may be required to ensure that overland flows are directed along roads and/or dedicated stormwater easements rather than existing gullies within the site.

The site is located on high ground with no runoff or watercourses draining toward the site. Figure 35 illustrates the five small catchments comprising the entire site area.

Opportunity exists for the provision of stormwater detention basins within green spaces proposed for the development. Basins could be located on either side of the extensions of Dunrossil Drive at the intersection of the Maxwell Street extension. Detention could be provided as a surface pond or alternately as an underground storage in the form of Atlantis cells or other underground storage method. Given catchment sizes, the basin would preferentially be provided to the west of the Maxwell Street extension. Additional basins may be required along Dunrossil Drive should site topography make this option unviable. In addition, Dunrossil Drive could also support infiltration zones, bioretention zones, filtration zones and swales.

The commercial area proposed for the Deakin side of Adelaide Avenue could accommodate a precinct wide WSUD strategy. Site topography indicates that water would be able to be collected and stored in underground tanks, similar to the option suggested for Dunrossil Drive, and used as irrigation for surrounding sporting fields. If this option proves unviable, collected stormwater could be used to irrigate green spaces within the precinct.

5.1.2.1 Catchment No. 1

This catchment located in the southern section of the site is approximately 14 ha, with stormwater flowing in generally a south-westerly direction gathering at the existing 675 mm diameter pipe culvert under Dudley Street, and then to the existing 900 mm diameter pipe under Cotter Road.

For a design storm with a 2% probability of occurring in any given year (i.e. a 50 year recurrence interval storm) the peak runoff discharge leading to the new alignment of Cotter Road would be expected to be in the order of 1.0 m³/s with the existing undeveloped conditions. If we conservatively assume no rainwater harvesting and no detention effects of WSUD facilities the post-development runoff would be expected to increase to approximately 1.8 m³/s for the same 50 year return period. The required detention volume would then be estimated to be approximately 2800 m³. This could be accommodated by a basin of about 35 m × 75 m assuming an average design depth of 1.0 m. This basin could be sited in a green buffer near Cotter Road or in a number of basins located near the downstream end of the development. Again the size of the ponding required can be significantly reduced by the use of WSUD principles during final design.

5.1.2.2 Catchment No. 2

This is a 5 ha catchment at the western end of the site draining to catch drains beside Dunrossil Drive in the existing conditions. It is considered that the post-development conditions would result in this catchment draining into and becoming a part of Catchment No. 3

5.1.2.3 Catchment No. 3

This catchment is mainly contained within the existing Brickworks site and was measured at approximately 13 ha. The ultimate discharge point for this catchment is toward the Royal Canberra Golf Club, as indicated by the contours in Figure 35. The heritage buildings comprising the old Brickworks operations have an old underground drainage system that is anticipated to be renovated and perhaps augmented in regard to its hydraulic capacity. Final design proceedings will most likely result in the need for additional detention basin volume in a green belt area to be located in the northern extremity of the site. It is also noted that the old clay excavation areas in this catchment are earmarked for parkland with presumably some significant ponding of the rainfall runoff. The pre-development runoff discharge is estimated at 0.7 m³/s for the design 50 year storm, and the post-development runoff and downstream detention pond volume will be very much contingent on the amount of ponding and WSUD facilities incorporated into the final design. The downstream basin would be expected to be less than 1000 m³.

5.1.2.4 Catchment No. 4

This is a small (0.5 ha) catchment at the south-western end of the site draining to catch drains beside Adelaide Avenue in the existing conditions. It is considered that the post-development conditions would result in this catchment continuing to drain to this area.

5.1.2.5 Catchment No. 5

This catchment of approximately 4 ha is located at the eastern end of the site and currently drains to catch drains along the edge of the existing Cotter Road entry ramp to Adelaide Avenue. It is considered that the post-development conditions would result in this catchment draining southwest beside Adelaide Avenue and then under the proposed new alignment of Cotter Road at the intersection with Adelaide Avenue.

5.2 Road Facilities

The road facilities will vary from narrow one-way one lane access alleyways with 7.5 m wide road reserves to major four-lane collector roads with 30.0 m wide road reserves. Pavements are assumed to be flexible (i.e. asphalt overlaying granular base material) ranging from 300 mm depth for the 7.5 m road reserves to 500 mm depth for the 30.0 m road reserves.

The preliminary construction costs are tabulated for each road type based on calculations for all salient road features resulting in overall construction cost per linear metre of each road type in each of the two design options. The following tables summarise these road costs taking into account intersection costs, kerbing, footpaths, signage, and services including electricity transmission, water distribution, gas distribution, and telecommunications. Separate items for sanitary sewerage, stormwater drainage, electrical transmission line relocation, high security fibre optic (ICON) relocation, and traffic signalisation at the collector road intersection with Cotter Road have also been included, as shown below.

Table 16: Preferred Option Cost Estimates

OPTION "Preferred Option"					
1	Road including services/utilities (water, electricity, telecoms, gas etc.)				
	Road Hierarchy	Reserve Width (m)	Length (m)	Rate per metre	Total Cost
	1	7.5	566	\$999.00	\$565,434
	2	12	1353	\$1,262.00	\$1,707,486
	3	15	493	\$1,221.00	\$601,953
	4	18	851	\$1,430.00	\$1,216,930
	5	20	1559	\$1,477.00	\$2,302,643
	6	30	1718	\$2,045.00	\$3,513,310
	Total		6540		\$9,907,756
2	Road Drainage				\$1,676,946
3	Sewer				\$1,831,843
4	Relocation of High Voltage Electricity (HV-OH) and Icon Services				\$3,000,000
5	Signalisation of intersection between "Brickworks "Road and Cotter road				\$200,000
Total Cost Option "Preferred Option"					\$16,616,545

These civil infrastructure costs relate only to the subject development. Associated reconstruction of regional highway facilities such as Adelaide Avenue, Cotter Road and Yarra Glen has not been sufficiently conceptualised to give a cost estimate at this time. As requested by the client, however, a separate allowance has been itemised for the reconstruction of the portion of Cotter Road that is directly adjacent to the development.

5.3 Utility Services

5.3.1.1 Existing Utility Services

The study area is located in a very developable topography, mostly free of obstructions with the exception of some existing utility services that will require relocation. The owners

and agents of the various services have been cooperative in providing responses to an initial "Dial-Before-You-Dig" request and in subsequent telephone conversations. Refer to the accompanying Existing Conditions Plan for a graphic representation of the existing utility services in the area.

In the Old Canberra Brickworks site, there are existing tie-ins to water distribution, sewer reticulation, power distribution and telecommunications. It is expected that the adaptive reuse development in this area will make use of these facilities or require the relocation and/or augmentation of these essential facilities. The remainder of the study area comprises undeveloped land and road reserves areas. The undeveloped land has some significant ICON (high security telecommunications) fibre optic cabling crossing the site. These cables are in shared trenching with some telecommunications lines and these are estimated to be only about a metre in depth. Therefore, the ultimate development is expected to require the relocation of much of these services to the perimeter of the study area. Additionally, there are high voltage overhead lines crossing through the undeveloped area which will similarly require some relocation.

The road reserves within the study area (Cotter Road, Yarra Glen, Adelaide Avenue, McCulloch Street and Dudley Street) have street lighting and other miscellaneous service facilities leading to the nearby residential areas, these services will require relocation accordingly.

The initial account of the services is summarised in Table 17. Existing services are shown in Figure 36.

Table 17: Summary of Existing Services

Utility Service	Old Canberra Brickworks	Remainder of the Study Area
ICON	No facilities in area.	<ul style="list-style-type: none"> ▪ 1,078 m of fibre optic cabling runs from Yarralumla Creek to Denman St. ▪ Another 1,301 m of fibre optic cabling is located in a shared trench with AAPT (as stated again in the AAPT row and TransACT row of this table).
ActewAGL Sewer	<ul style="list-style-type: none"> ▪ An 87 m long sewer connection line crosses the brickworks property boundary in its northwest corner. 	No facilities in area.

Utility Service	Old Canberra Brickworks	Remainder of the Study Area
ActewAGL Electricity	<ul style="list-style-type: none"> ▪ Approximately 200 m of high voltage overhead powerlines feed electricity to the brickworks (southern most buildings only) originating from the corner of Woolls St and Denman St. ▪ 13 m of abandoned underground high voltage power cabling runs between two of the southern-most buildings in the brickworks. 	<ul style="list-style-type: none"> ▪ Approximately 3,161 m of high voltage overhead powerlines are located within the undeveloped project area. Most of this is found along road edges, however there is a 560 m length which runs from north to south through the horse paddocks, and there is a 289 m section which runs between Dudley St and Denman St. ▪ Approximately 270 m of underground low voltage cabling is located in Cotter Rd, between Lady Denman Dr and McCulloch St. ▪ There is over 8 km of underground streetlight power supply cabling which is located along road edges only. There is an additional 850 m of abandoned streetlight power cabling located along various road edges.
ActewAGL Water	<ul style="list-style-type: none"> ▪ 651 m of reticulation line with a diameter of 100 mm delivers water to the brickworks buildings originating from the corner of Woolls St and Denman St. 	<ul style="list-style-type: none"> ▪ 1,749 m of reticulation lines with diameters of 100-225 mm are located in the project area. 1,135 m of this piping is located along road edges. The remaining 614 m is located in open areas. ▪ A bulk distribution line (450 mm) follows the bridge over Adelaide Av, along Kent St and Novar St.
Telstra	<ul style="list-style-type: none"> ▪ 317 m of Telstra cabling is located within the brickworks property, although it is not in close proximity to any buildings. ▪ 229 m of this cabling is located just within the property boundary (less than 10 m). ▪ The remaining 88 m extends into the brickworks block. 	<ul style="list-style-type: none"> ▪ 3,011 m of Telstra cabling is located within the project area (not including brickworks). Most of this cabling is located along road edges (Cotter Rd, Dunrossil Dr, Dudley St, Novar St). ▪ There is approximately 600 m of cabling just below the southeast corner of the Uniting Church. This cabling is not along a road edge.
Optus	No facilities in area.	<ul style="list-style-type: none"> ▪ Optus has one length of cabling which is within the project area. This is a 230 m length of cabling which runs across the bridge over Adelaide Av and continues north and south along Novar St and Kent St respectively.
TransACT	No facilities in area.	<ul style="list-style-type: none"> ▪ A 230 m length of cabling runs across the bridge over Adelaide Av and continues north and south along Novar St (where it becomes underground cabling) and Kent St respectively. ▪ TransACT also shares a trench with ICON and AAPT for 1,301 m (as stated again in the ICON row and AAPT row of this table).

Utility Service	Old Canberra Brickworks	Remainder of the Study Area
AAPT	No facilities in area.	<ul style="list-style-type: none"> Approximately 1,301 m of cabling is located within the project area, primarily running along the southern edge of the project. All of this cabling is shared with ICON and TransACT (as stated again in the ICON row and TransACT row of this table).
Jemena Gas	No facilities in area.	<ul style="list-style-type: none"> 849 m of 63 mm gas lines and 256 m of 110 mm gas lines are located within the project area. All of this piping is located along road edges, running along Novar St, Dudley St, and Lady Denman Dr.

5.3.1.2 Proposed Utility Services

Gas utilities currently service surrounding areas, and gas supply should be relatively simple to provide. However, some upgrades may be required subject to Jemena requirements and availability. Gas reticulation services would be provided from within street verges as per ACT standard practice.

Water mains currently cross the development site, and would need to be relocated as part of the works. Water connections to the wider network are possible at Dunrossil Drive, Cotter Road, Dudley Street and from within existing streets in Yarralumla. The existing water distribution network is expected to be adequate to accommodate the proposed development. The limits of the development are very close to the water zone boundary of the Scan655 (South Canberra) Zone and the Wodlow640 (Woden/Lowe) Zone. The zone valve along Dunrossil Drive will need to be relocated to enable connection to the 150 mm diameter line located in the Dudley Street reserve. Additional connection will be possible at the 150 mm diameter line just north of the Brickworks site and other connections to the 100 mm diameter line in the adjacent residential subdivision of Yarralumla. There is approximately 60 m of static head available at the site's highest elevation.

The existing sewerage facilities in the surrounding area are also understood to be adequate to accommodate the development, with infrastructure existing to the north-east within Yarralumla and to the south on the southern side of Yarralumla Creek. Sewer reticulation would be provided within street verges as per ACT standard practice.

Telecommunications utilities will be provided by TransACT, with the National Broadband Network (NBN) possibly also provided subject to timeframes of the development and the NBN. Telecommunications utilities would be provided from within street verges as per ACT standard practice.

Electricity would be provided by ActewAGL. Further investigations will be required to ascertain the energy requirements of the development and if network upgrades are required. The transmission of electricity for the development would also be accommodated by the nearby existing transmission lines. An overhead high voltage line is currently crossing the site area from the north end of Dudley Street to the Yarralumla residential areas. This line will require relocation to an underground trench within one of the proposed road reserves.

Major reticulation routes and possible connection locations for services are shown in Figure 37.

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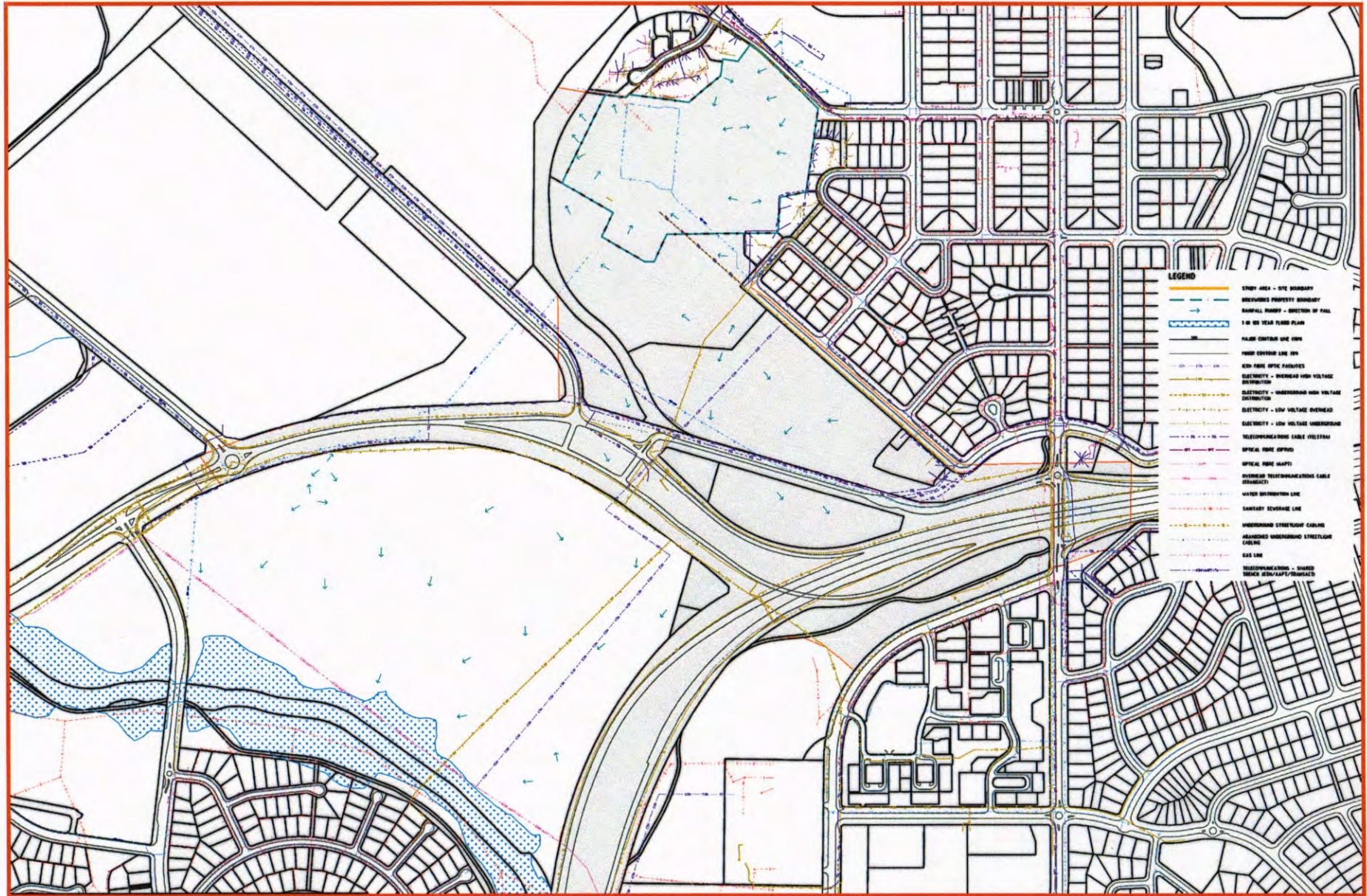


Figure 36: Existing Services Conditions

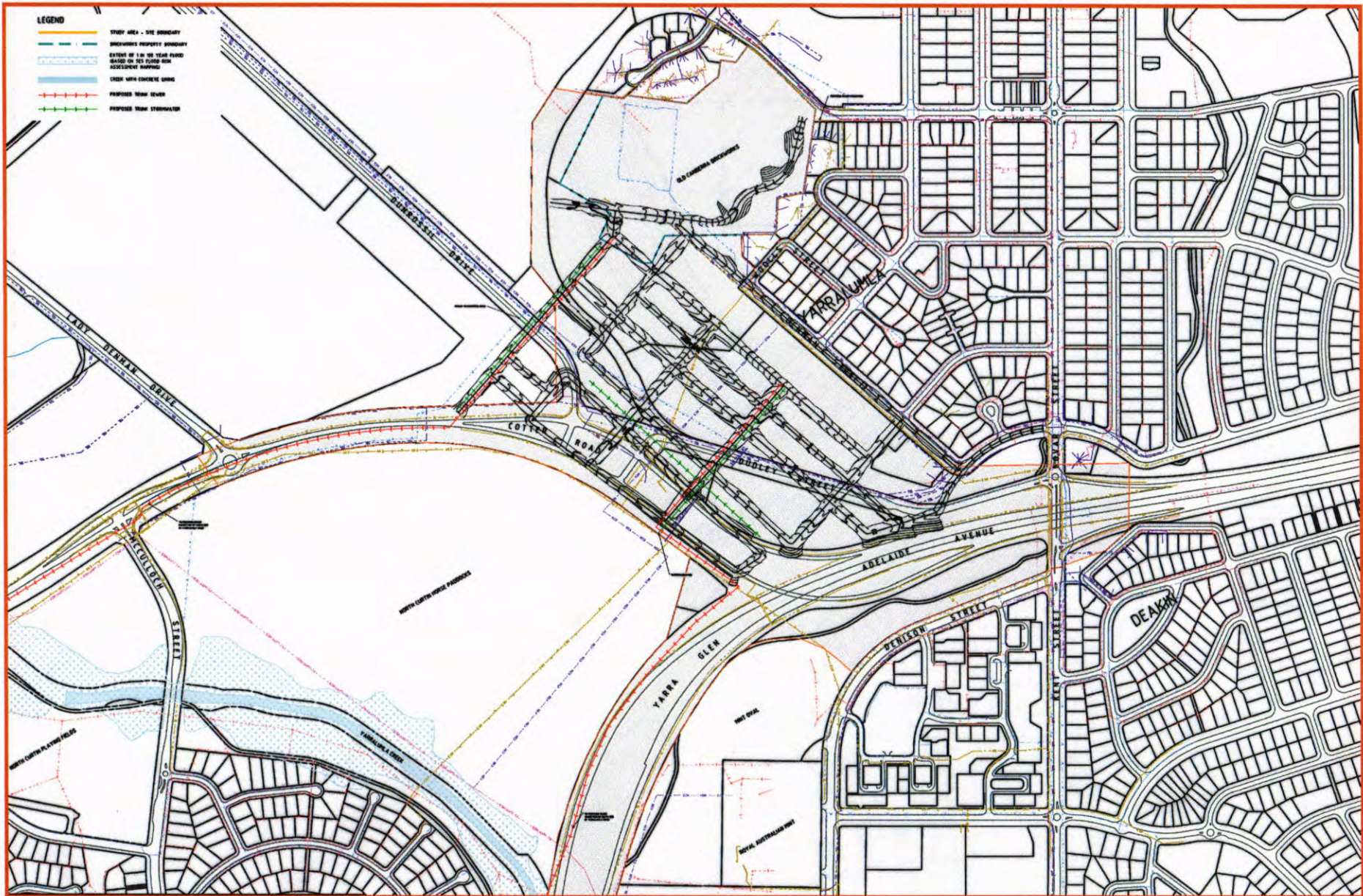


Figure 37: Proposed Service Connections

6 CONCLUSIONS

6.1 Traffic Operation

A number of key findings were made during the traffic analysis:

- The proposed roundabout interchange between Cotter Road and Adelaide Avenue/Yarra Glen operates well in all periods.
- The performance of the intersection of Cotter Road and Lady Denman Drive has a large impact on the rest of the network, and in the existing roundabout configuration its performance is expected to be poor during the 2031 weekday peak periods. Signalisation of this intersection can be expected to substantially improve 2031 weekday peak performance.
- The road network changes associated with the CB+E development, particularly the addition of signalised intersections, will result in an overall calming of traffic within the area. A general localised increase in travel time can be expected for vehicles travelling through the area, but this is minimal in the context of a vehicle's overall trip.

6.2 Other Transport Modes

The provision for public transport, bicycle and pedestrian traffic must consider the goals of the *Sustainable Transport Plan*. Within this context recommendations have been made to accommodate these alternative transport modes within and around the development area.

- Lower hierarchy streets will operate at speeds that accommodate on-road bicycle use without dedicated bicycle lanes.
- Dedicated on-road bicycle lanes have been recommended for the major streets through the development, with connection to the existing on-road bicycle lanes and off-road bicycle paths.
- The proposed roundabout interchange connecting Cotter Road to Adelaide Avenue/Yarra Glen provides no opportunities for improved pedestrian accessibility between Deakin and Yarralumla at this point. A grade separated connection for pedestrians and cyclists will be required to achieve this goal.
- The *Strategic Public Transport Network Plan* recommends a number of bus routes of various hierarchies near the area, which can be modified to directly service the area.

6.3 Roadways and Civil Infrastructure

A preliminary engineering assessment of the development site has concluded the following:

- The existing water distribution network is expected to be adequate, with some minor relocation of water services to accommodate the required connections.
- The existing sewerage facilities are understood to be adequate.
- The nearby electrical transmission lines can be used to supply the site. The existing overhead high voltage line should be relocated underground.
- The high security ICON cable will require relocation.

- Existing natural gas lines are expected to be available for connection to the site.
- Earthworks to accommodate stopping and safe intersection site distances were considered. An total of 24,000 m³ of cut and 22,000 m³ of fill is required for the roadways and a further 25,000 m³ of cut to fill is required for levelling blocks.
- The alignment of the grid layout is considered acceptable for solar access but limits scope for directing stormwater around or away from building pad areas.
- The site is on high ground and is not expected to collect runoff. Peak 50 year stormwater flows are expected to be able to be accommodated by no more than 2,800 m³ worth of detention pond volume.



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