MEADOWBANK EMPLOYMENT AREA
TRAFFIC NEEDS ASSESSMENT




BITZIOS consulting

Gold Coast
Suite 26, 58 Riverwalk Avenue
Robina QLD 4226
P: (07) 5562 5377
W: www.bitziosconsulting.com.au

Brisbane
Level 2, 428 Upper Edward Street
Spring Hill QLD 4000
P: (07) 3831 4442
E: admin@bitziosconsulting.com.au

Sydney
Studio 203, 3 Gladstone Street
Newtown NSW 2042
P: (02) 9557 6202

FOR

CITY OF RYDE

Project No: P0989 Version No: 003 Issue date: 15 August 2012

DOCUMENT CONTROL SHEET

Issue History

Report File Name	Prepared by	Reviewed by	Issued by	Date	Issued to
P0989.001R Meadowbank Employment Area Traffic Needs Assessment	P. Bollavaram	D. Bitzios	D. Bitzios	10 July 2012	Harry Muker City of Ryde
P0989.002R Meadowbank Employment Area Traffic Needs Assessment	P. Bollavaram	D. Bitzios	D. Bitzios	24 July 2012	Harry Muker City of Ryde
P0989.003R Meadowbank Employment Area Traffic Needs Assessment	D.Yu	D. Bitzios	D. Bitzios	15 August 2012	Harry Muker City of Ryde

Certified System
Quality
ISO 9001
SAI GLOBAL

CONTENTS

PAGE

Tables

Figures

Appendices

EXECUTIVE SUMMARY

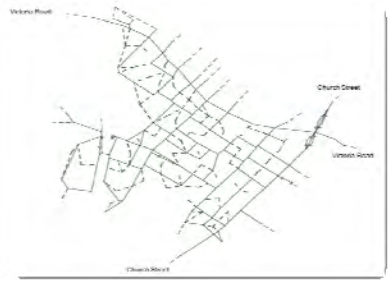
Meadowbank is located at the southern end of the City of Ryde (CoR). Part of this suburb has been identified as the Meadowbank Employment Area (MEA) in Council's Local Environment Plan (LEP2011). The intent of the MEA is to convert an ageing industrial area into a modern population and employment hub in close proximity to the Meadowbank Railway Station, the Parramatta River the Meadowbank Ferry Terminal.

The MEA Planning Study and Master Plan provided input into the Development Control Plan for the area. Since that time, a number of developments have occurred in the MEA whilst development applications have been received for a number of other sites. Some of these applications have been lodged with the Department of Planning as "Part 3A" applications seeking to increase the scale of development in the area proposed in LEP2011.

Meadowbank already experiences traffic congestion in peak periods, primarily as a consequence of "rat running" traffic avoiding the RMS-controlled Victoria Road and Church Street-Devlin Street (M3). The CoR has raised concerns that the level of development proposed under the Part 3A applications will further affect traffic conditions in the area and has commissioned Bitzios Consulting to prepare a traffic model and conduct a traffic study to identify what traffic works would be required under:

- A scenario where only the LEP2011 development levels were achieved in the MEA; and
- A scenario where the "Holdmark" Part 3A development levels were achieved for those sites and LEP2011 development levels elsewhere in the MEA.

The study has a timeframe of 2031 (as a notional "full development" year) and considers background traffic growth, local development traffic growth and increasing pedestrian/traffic conflicts. The traffic model for the broader Meadowbank Study area was developed using the SATURN package, which is a "mesoscopic" modelling package. The Meadowbank SATURN model was estimated/calibrated based on twenty intersection counts in the area and was validated to travel time and back of queue data; achieving RMS validation criteria as per its Paramics Micro Simulation Modelling Guidelines.



The base year 2012 modelling reinforced the "causes and effects" of existing traffic congestion experienced in Meadowbank in peak periods as:

- In the morning peak, traffic travelling eastbound via Bank Street, Railway Road and Constitution Road being constrained by pedestrian crossings and geometrical limitations in the Meadowbank Station area, which effectively preserves the function of intersections further east; and
- In the evening peak, traffic travelling westbound being constrained at the crossings and tight alignment near Meadowbank Railway Station generating queues along Constitution Road all the way back to Belmore Street, also affecting Bowden Street traffic and generating some overflow "rat running" into residential streets. Some delays are also being generated at The Loop Road/Parsonage Road roundabout.

These existing issues are likely to be exacerbated by 2031 as background traffic grows and local development occurs. Under LEP2011, 3,210 additional dwellings and 13,799 m^2 of addition commercial floor space (compared to 2012) is expected to be constructed. The Part 3A applications, if realised, would add a further 768 dwellings and 5,084 m^2 of commercial floor space. In traffic terms, this means that traffic demands under each scenario will be as per Table ES1.

Table ES1: Network Traffic Demands

Network Traffic Demand by Scenario	AM Peak Hour	PM Peak Hour
2012 Base	17,581	16,437
2031 LEP2011 (Scenario 1)	18,909	17,924
2031 Part 3A Development and LEP2011 elsewhere (Scenario 2)	19,307	18,323

A 2031 Reference Case was established for comparing network upgrade options to. The reference case included a number of upgrades identified by the CoR in 2005 for the MEA network. The Reference Case also included the proposed Holdmark Part 3A developments. Public transport mode share assumptions were assumed to be 10% (on average) as per the current conditions as a conservative assessment of traffic upgrade requirements. Five options were then assessed against this Reference Case. The five options are shown in Table ES2.

Table ES2: Option Development Levels

Option	Development Levels Included	Traffic Network
1	LEP2011 + Part 3A Developments	CoR proposed traffic improvements (from 2005)
2	LEP2011 + Part 3A Developments	CoR proposed traffic improvements (from 2005), LATM + new roundabouts to restrict "rat-runs" in local streets
3	LEP2011 + Part 3A Developments	CoR proposed traffic improvements (from 2005), new signalised intersections at a number of intersections to manage traffic/pedestrian conflicts through MEA
4	LEP2011 + Part 3A Developments	Option 2 + Option 3 network changes together
5	LEP2011	Option 2 + Option 3 network changes together

Notes:

1. *Part 3A developments are as per the applications submitted*
2. *LEP2011 is the development levels under the LEP as interpreted and provided by CoR.*
3. *Part 3A development assumptions "overwrite" LEP2031 development assumptions in the locations where Part 3A applications exist.*

The modelling of these options revealed that regardless of which land use scenario was used, the "rat running" conditions in Meadowbank are likely to worsen and spread to more streets. This is primarily a consequence of the fact that most traffic in the area in peaks is actually through traffic. The option testing revealed that introducing a number of signalised intersections into Constitution Road would exacerbate this as traffic diverted off this street to avoid signal-related delays. These diversions (due to signals) could not be satisfactorily managed by traffic calming measures alone.

The other key finding from the option testing was the emergence of alternative through traffic routes such as See Street and McPherson Street that could be managed appropriately through targeted upgrades so as to reduce the pressure on Bowden Street.

In addition, emerging capacity constraints at the eastern end of the network (i.e. near The Loop Road/Parsonage Street) are likely to also limit traffic the traffic capacity of the MEA in a similar way that the rail station areas currently does; unless some improvements are made. The challenge therefore becomes how best to manage the competing demands for limited road space whilst minimising impacts on adjacent residential areas and minimising pedestrian and traffic conflicts.

The option testing lead to the definition of a set of key objectives to manage the growing pedestrian and traffic issues in the MEA in the future. The objectives that led to the formulation of the preferred network were:

- Objective 1 - Managing intersection capacity to limit the effect of rat running/through movements blocking the ability to undertake local traffic movements;
- Objective 2 - Limiting the effects of through traffic on residential amenity in traditional residential streets and new lane ways;
- Objective 3 - Actively encouraging the ease of pedestrian movements towards the Bay Street retail area, the Ferry Terminal, the Parramatta River bank, the Meadowbank Rail Station and the Meadowbank TAFE (and between these areas) by appropriately managing pedestrian and traffic conflict points;
- Objective 4 - Facilitating appropriate alternative traffic routes in Meadowbank through intersection and other upgrades on these routes; and
- Objective 5 – Fixing existing traffic and pedestrian safety issues that will be exacerbated with increasing traffic.

A draft preferred network was designed based on the findings of the options testing to achieve intersection volume-capacity ratios within Meadowbank of less than 1.0 for all intersections with the exception of those around the Meadowbank Rail Station and those on RMS-roads. The development of the preferred network also considered the need to facilitate safe and efficient pedestrian movements between the MEA and key destinations.

Items included in the Preferred Meadowbank Traffic Network for 2031 are described in Table ES3 and shown in Figure ES1. These works will cost in the order of $3M to implement.

Table ES3: Traffic Improvement Items

Improvement Item	Rationale
Pedestrian signals replacing the zebra crossing on Railway Road at the Station.	Identified in 2005 by CoR. Already a traffic capacity and safety issue. Increasing development in MEA will increase pedestrian demand along this desire line and further exacerbate this issue. Preliminary signal warrants assessment suggests that this crossing will meet RMS warrants in the future.
Roundabout at See Street/Constitution Road	Identified in 2005 by CoR. Facilitates better access to the TAFE and the use of See Street-McPherson Street to access Victoria Road as an alternative to Bowden Street.
Widening the Angus Street bridge	Identified in 2005 by CoR. Provides a more efficient alternative outlet for MEA local traffic travelling via See Street to reduce impacts on Bowden Street/Constitution Road intersection.
Signalising Bowden Street/Constitution Road	Identified in 2005 by CoR. Congestion and uneven approach volumes leads to some movements being adversely affected with excessive delays. Also, this area is expected to accept far more pedestrian movements in the future due to MEA development. There are limitations to the size of the signalised intersection able to be provided and hence the proposal is more about capacity balancing and conflict management rather than purely providing additional throughout capacity.
See Street/Angus Street roundabout	Identified in 2005 by CoR. Facilitates Angus Street traffic accessing See Street, consistent with the intent of widening the Angus Street bridge for use by locally-generated traffic.
Completion of the Rothesay Avenue Link, connections to it plus the roundabouts at Rothesay/Bowden and Rothesay/Belmore	Identified in 2005 by CoR. This link provides access to the Shepherds Bay Development area from the east and west. The modelling of this link in the draft preferred option has assumed that it is not connected in the middle due to the string desire to use it as a "rat run" if it were connected through and the limited effects that traffic calming measures would have on diminishing these effects.
Roundabout at McPherson/Rhodes/Mellor	This route is increasing in its usage in the future and non-priority movements are expected to be impacted by significant delays. The roundabout provides an opportunity for these local movements to pass through the intersection with reduced delay.
Roundabout at McPherson/See	This route is increasing in its usage in the future and non-priority movements are expected to be impacted by significant delays. The roundabout provides an opportunity for these local movements to pass through the intersection with reduced delay.
McPherson/Bowden left in/out	The right turns out of McPherson into Bowden in particular are potentially hazardous due to the limited separation distance at this intersection and gaps for right turns into McPherson can be difficult to judge due to roundabout departures immediately to the south. These issues are exacerbated in the future with increasing volumes and the left in/out configuration better manages these movements.
Yerong/Belmont left in/out	The right turns into Yerong from Belmont are potentially hazardous due to the limited separation distance from the roundabout. Similarly, right turns out can be difficult as opposing vehicles exit the roundabout nearby. These issues are exacerbated in the future with increasing volumes and the left in/out configuration better manages these movements.
LATM scheme in Squire Street	The intent of this scheme is to reduce the propensity to "rat run" through this street by reinforcing its residential character. An important part of this scheme will be speed management for safety and for reducing its attractiveness as a through route.
Hamilton "Lane" and Nancarrow "Lane" LATM and two-way construction between Belmore and Bowden	With Hamilton Crescent connected through the Nancarrow Avenue there will be a strong desire to use this route as a "bypass" of Constitution Road in peak times. This route will need to be heavily constrained (almost to a "shared zone" level) to discourage through and promote its use as a pedestrian link. A "tight" roundabout at Nancarrow/Hamilton is also proposed
Underdale Lane/Bowden Street signalised intersection	With the proposed development in the MEA, Nancarrow Avenue and Underdale Lane will become a key pedestrian route through to Bay Street and the rail station. Traffic signals are proposed at this location on the basis of future pedestrian and traffic volumes at this location and also as a mechanism for discouraging through traffic passing from Nancarrow to Underdale, which is clearly shown as a desirable rat run in the future.
Underdale Lane LATM	Underdale Lane is intended to function as a local access link and a key pedestrian route. Modelling however has shown that without this street being constrained, it will be an attractive through traffic rat run. The proposal is to severely constrain this street west of Argus Street such that it functions as a "shared zone" or equivalent.
Roundabout at See Street/Stone Street	Needed to address a capacity issue identified when modelling the draft preferred option.
Hamilton Lane/Belmore Street left in/left out	Needed to address a capacity issue identified when modelling the draft preferred option.
Well Street LATM	Needed to address "rat running" issues identified when modelling the draft preferred option.
Belmore Street/Parsonage Street roundabout – remove u-turn potential and modify alignment	Needed to remove u-turn potential and modify the alignment to increasing capacity through the roundabout as identified when modelling the draft preferred option.

The staging as responsibility apportionment assessment followed the definition of the preferred network. This process used the following principles for identifying the responsibilities for upgrade works associated with the Holdmark Part 3A development:

- apportioning 100% of the responsibility for construction of works identified as being a direct impact of the development; and
- apportionment of a percentage of the works required where Holdmark Part 3A development traffic and/or pedestrians are expected to use a new/upgraded infrastructure item.

This assessment resulted in the recommended infrastructure upgrade schedule, funding apportionment and timing triggers as shown in Table ES4.

Table ES4: Upgrades, Reasoning and Timing

ID	Upgrade Description	Holdmark %	Reasoning	Timing/Trigger
1	Pedestrian signals replacing the zebra crossing on Railway Road at the Station.	50%	Moderate contribution associated with additional pedestrian movements generated at this crossing.	During construction of Stage 1 of the Shepherds Bay Development
2	Roundabout at See Street/Constitution Road	None	Not needed for, or used by, Holdmark (<5%)	When signals at Bowden/Constitution are constructed
3	Widening the Angus Street bridge	None	Need for this upgrade not generated by Holdmark	As determined by Council, before 2031
4	Signalising Bowden Street/Constitution Road	100%	Major contribution associated with development-related traffic and increasing pedestrian demands through this intersection	During construction of Stage 1 of the Shepherds Bay Development
5	See Street/Angus Street roundabout	None	Not needed for, or used by, Holdmark (<5%)	When Angus Street bridge widened
6	Completion of the Rothesay Avenue Link, connections to it plus the roundabouts at Rothesay/Bowden and Rothesay/Belmore	100%	Local connection primarily for development access	During construction of Stage 1 of the Shepherds Bay Development
7	Roundabout at McPherson/Rhodes/Mellor	None	Not needed for, or used by, Holdmark (<5%)	As determined by Council, before 2031
8	Roundabout at McPherson/See	None	Not needed for, or used by, Holdmark (<5%)	As determined by Council, before 2031
9	McPherson/Bowden left in/out	None	Not needed for, or used by, Holdmark (<5%)	As determined by Council, suggested by 2017
10	Yerong/Belmont left in/out	50%	Reasonable increase in Belmont due to Holdmark; exacerbating existing safety issue	During construction of Stage 1 of the Shepherds Bay Development
11	LATM scheme in Squire Street	None	Need for this work not generated by Holdmark	As determined by Council, suggested by 2017
12	Hamilton “Lane” and Nancarrow “Lane” LATM and two-way construction between Belmore and Bowden	100%	Within the site and related to connections made	During construction of Stage 1 of the Shepherds Bay Development
13	Underdale Lane/Bowden Street signalised intersection	100%	Directly linked to traffic and pedestrian management associated with Shepherds Bay development	When Nancarrow Avenue is realigned to Underdale Lane, suggested as during construction of Stage 1 of the Shepherds Bay Development
14	Underdale Lane LATM	100%	Directly linked to reducing traffic from Shepherds Bay development through this area and facilitating pedestrian movements between the site and the retail/station area.	When Nancarrow Avenue is realigned to Underdale Lane, suggested as during construction of Stage 1 of the Shepherds Bay Development
15	Roundabout at See Street/Stone Street	None	Not needed for, or used by, Holdmark (<5%)	As determined by Council, before 2031
16	Hamilton Lane/Belmore Street left in/left out	100%	As part of the connection of Hamilton Crescent/Lane to Belmore Street	When Hamilton Crescent is connected through to Belmore Street suggested as during construction of Stage 1 of the Shepherds Bay Development
17	Well Street LATM	50%	Partly as a consequence of local Holdmark traffic.	When 1,000 dwellings have been constructed at Shepherds Bay
18	Belmore Street/Parsonage Street roundabout – remove u-turn potential and modify alignment	50%	Partly as a consequence of local Holdmark traffic	When 1,000 dwellings have been constructed at Shepherds Bay

Overall, the network modelling has identified that any additional traffic in Meadowbank will exacerbate existing congestion issues that will need to be managed through intersection upgrades and LATM schemes. However, the scale of difference in traffic generation of the Holdmark Part 3A proposal, compared to what would have otherwise been in place with just LEP2011-consistent development is not significant enough to generate noticeably different traffic upgrades across the network; although the modelling has identified some locally significant effects immediately surrounding the Holdmark development.

Notwithstanding this, there are a number of upgrade works that could be directly attributable to the Holdmark Part 3A development for satisfactory traffic and pedestrian management in Meadowbank.

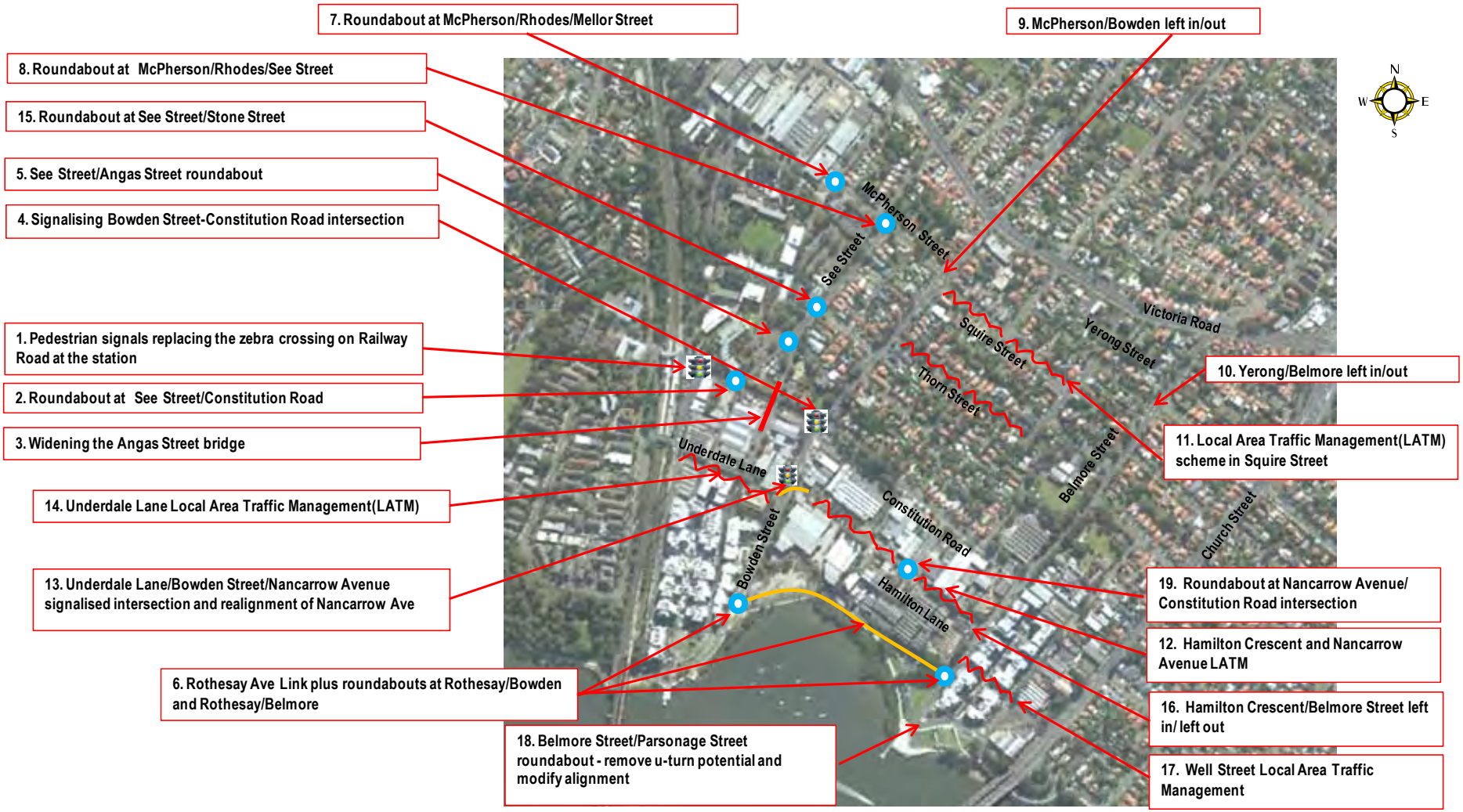


Figure ES1: Meadowbank 2031 Preferred Network

1. INTRODUCTION

1.1 BACKGROUND

Meadowbank is located at the southern extent of the City of Ryde (CoR) and part of this suburb is identified as the Meadowbank Employment Area (MEA) in Councils Local Environment Plan (LEP2011).

The LEP identified expected development types, building types and Floor Area to Site Area (FSR) ratios for development within the MEA. The LEP also includes a list of proposed traffic facilities in the area to be provided by Council. Items relevant to traffic capacity considerations include:

- Railway Road:
  - construct a roundabout at the railway bridge (completed); and
  - construct pedestrian signals (RMS approval required) at the intersection of Constitution Road.
- Constitution Road:
  - construct a roundabout at See Street;
  - widen the See Street over-bridge to two lanes; and
  - construct traffic signals (RMS approval required) at Bowden Street.
- Angus Street:
  - construct roundabout at See Street.
- Rothesay Avenue:
  - roundabout at Belmore Street; and
  - roundabout at Bowden Street.

A number of "Park 3A" development applications have also been submitted to the Department of Planning. These applicants generally seek to increase the level of development over what was initially envisaged in the LEP. The largest of these developments, the Shepherds Bay Urban Renewal Concept Proposal fronts the Parramatta River.

Figures 1.1 shows the broader Meadowbank area, the MEA boundary and the Shepherds Bay project concept. The Shepherds Bay concept includes the Rothesay Avenue link between Belmore and Bowden Street and also extends Nancarrow Avenue through to Belmore Street.

Figure 1.1: Study Area

1.2 SCOPE/BRIEF

The CoR has raised concerns regarding the ability for the local traffic network to accommodate the additional traffic introduced by the "Part 3A" developments. Furthermore, Council also was interested in identifying what traffic and pedestrian-related upgrade works are attributable to the Part 3A developments and what works are required due to the growth in through traffic or traffic generated by other developments in the area under the LEP provisions.

Bitzios Consulting was commissioned to develop a mesoscopic traffic model for Meadowbank to allow a number of network scenarios to be tested against "LEP – only" and "LEP + Part 3A" traffic demand scenarios.

Year 2031 was nominated as the horizon year for traffic facilities needs assessment (i.e. notional full development year).

The study process is shown in Figure 1.2.

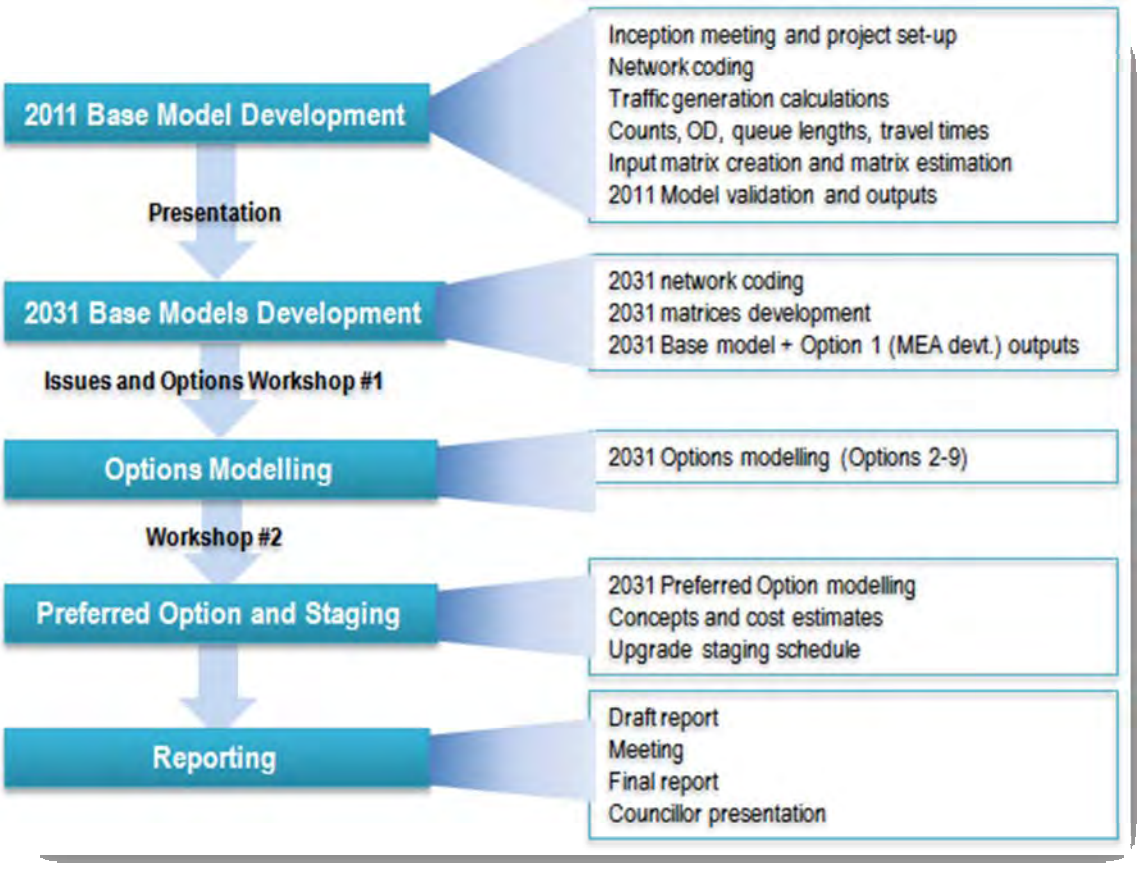


Figure 1.2: Study Process

2. MODEL DEVELOPMENT

2.1 OVERVIEW

This section outlines the development, calibration and validation process undertaken to develop the Saturn model for the Meadowbank Enterprise Area (MEA). The network coding has been based on aerial photography and verified through site investigations. Traffic demands were generated through firstly establishing a comprehensive property by property development database and applying traffic generation rates to these developments. Traffic surveys have also been undertaken to establish key through movement patterns in the area and to estimate the AM and PM peak traffic matrices through calibration of these models. The models were then validated to travel times on four key routes in the study area and a reasonableness check was also undertaken on back of queue lengths at critical intersections.

A full description of the model development, calibration and validation is contained in the Bitzios Consulting report titled *Meadowbank Traffic Assessment Model Calibration/Validation*, 25 July 2012 (*ref: P0989.003R Meadowbank Traffic Assessment_Model Calibration Validation.pdf*).

2.2 TRAFFIC SURVEYS

Traffic counts were collected at most of the key intersections in the study area on 3rd April 2012 and the 4th April, 2012. A total of twenty intersections were surveyed in the study area and the locations for the counts are shown in Figure 2.1.

Details regarding the traffic surveys are:

- turning movement counts were collected and recorded in 15 minute intervals;
- morning period surveys ran from 7:00 AM to 9:00 AM;
- afternoon period surveys ran from 4:00 PM to 6:00 PM;
- vehicle classification was only based on car, rigid trucks and semi-trailers;
- back of queue length data was collected at four intersections in the study area;
- travel time surveys were also undertaken on four key routes during peak periods to understand travel time variability on these routes; and
- origin-destination surveys were also undertaken at seven locations in the study area.

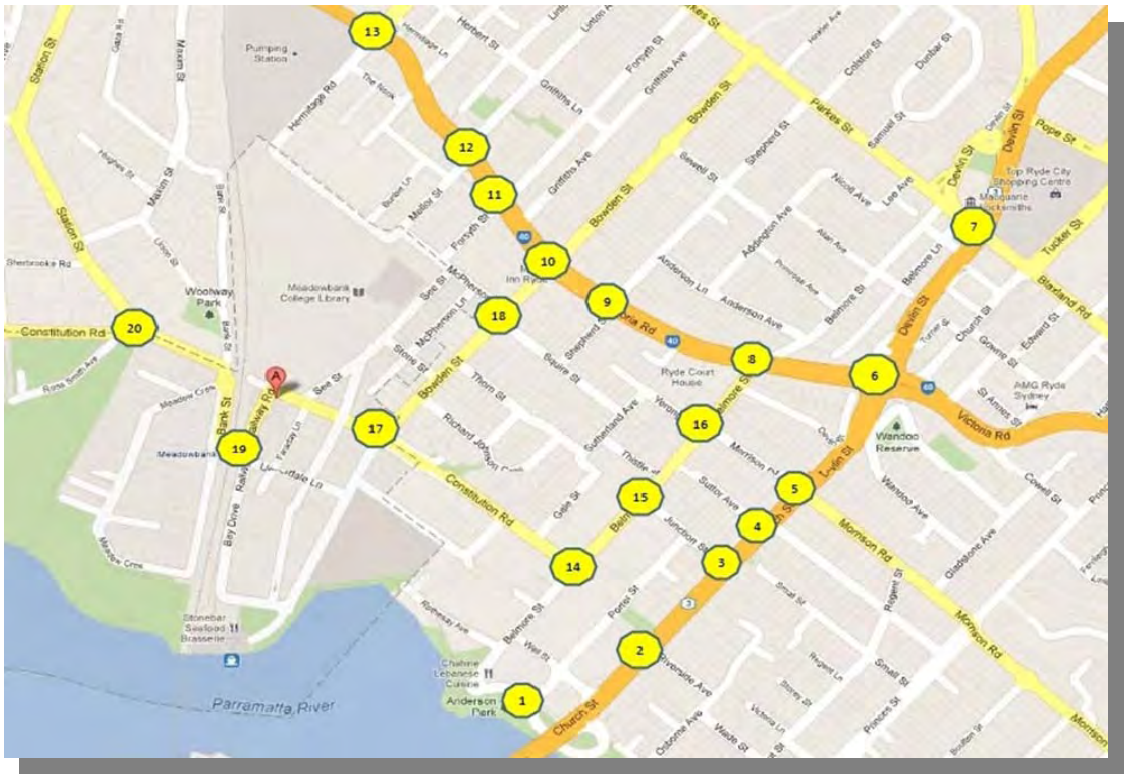


Figure 2.1: Intersection Counts Survey Locations

2.3 NETWORK CODING

The boundary of the study area extends to Church Street/Blaxland Road intersection to the north, Hermitage Road/Victoria Road intersection to the west and ends at the bridge (on Parramatta River) to the south. Figure 2.2 shows the full extent of the base model.

Simulation nodes were provided at every intersection in the modelled area and "dummy" nodes were used where zone connectors were fed into the network. The model included 21 "external" zones and 50 "internal" zones.

In general Austroads-based turn capacity values were incorporated into the model at all the intersections in the study area. In some locations the capacity values were reduced to reflect the observed site conditions. Typically this was done in constrained locations such as local/small roundabouts where turning speed and hence circulating capacities were restricted by geometrical constraints. All of the residential streets in the study area were coded with reduced capacities and link speeds of 40 Kph to reflect the speed environment in these streets and to account for their short length in general.

"Left turn on red" turn movements are currently permitted at three intersections in the study area and this was modelled by allowing the side street left turn to also run in the major road green phase but as a give-way movement.

Pedestrian signal phases were also included into the signal plan which involved adding dummy phases to the model's signal phases. This information was based on the IDM data (provided by RMS) for the movements which showed pedestrian calls for more than half of the signal cycles in each peak period.

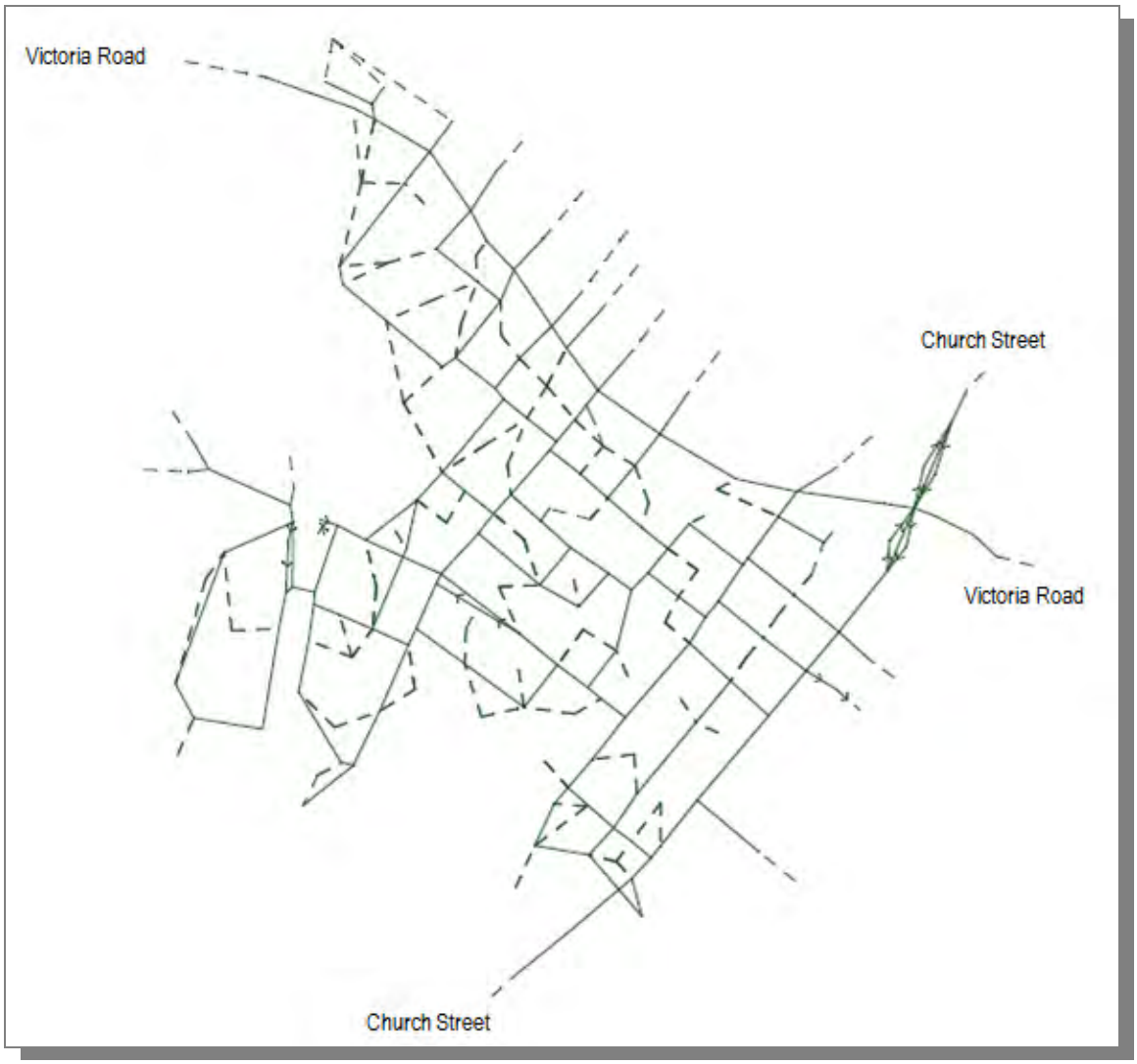


Figure 2.2: Base Model Network

2.4 MATRICES DEVELOPMENT

The first step in this process was to determine the peak hours for both the AM and PM peaks which involved calculating the approach volumes across all of the intersections counts and summating to determine the "aggregate" peak hours across the modelled area.

Peak hours for the MEA were identified, as follows:

- AM Peak: 7:15 AM – 8:15 AM, and;
- PM Peak: 4:45 PM –5:45 PM.

A database was developed containing the existing development details for each land parcel within the model boundary (data provided by City of Ryde). This data was used to calculated the internal zone traffic generation by applying RMS traffic generation rates to floor areas, unit numbers etc. for each land parcel. Assumptions were then made regarding the split of in/out splits in the peaks for trips for each land parcel and these assumptions were based on the development type within the lot. This database in contained in Appendix A.

The traffic generated by the external zones on the edges of the model boundary was determined from traffic count data for the area's peak hours. SATURN assigns traffic on the basis of passenger car units (PCUs) and hence the classified traffic counts at the externals of the model needed to be converted to PCUs. This was achieved by the following formula:

PCUs = Cars x 1.0 + Rigid Trucks x 2.0 + Semi-Trailers x 4.0

The methodology to develop the pattern matrix was quite complex due to size of the matrix with 71 zones in the SATURN model. The development of the prior matrix required use of all available data sources as well as local knowledge to ensure that the scale relativity between major O-D movements was appropriate. The O-D data was used to fix specific cells in the matrix which were "locked" prior to the two dimensional balancing process to create the prior matrix. This matrix was reviewed in detail to ensure that trip patterns and relativities were logical and in accordance with local knowledge and site observations. This was done recognising how important a good pattern matrix is for effective matrix estimation.

The matrix estimation process in SATURN used its inbuilt "ME2" and "SATPIJA" processes. This requires the input "prior" matrix and a set of counts to constrain the matrix to, through multiple iterations of traffic assignment and matrix factoring.

The criteria for model calibration were set in accordance with the RMS Paramics Micro simulation Modelling Manual, as follows:

- AM and PM Peak periods:
  - 85% of turn counts achieved a GEH of 5.0 or better; and
  - 100% of turn counts achieved a GEH of 10.0 or better.

GEH is an effective tool for comparing actual and modelled flows as it implicitly accounts for the size of the volume placing greater relative emphasis on high volume movements compared to low volume movements. GEH statistics less than 5 shows a very good match between modelled and actual volumes whilst a GEH less than 10 shows a fairly good match.

The key turn count/matrix calibration statistics achieved for the base 2012 AM and PM peak models were:

- AM Peak:
  - 85% of turn counts achieved a GEH of 5.0 or better; and
  - 100% of turn counts achieved a GEH of 10.0 or better.
- PM Peak:
  - 85% of turn counts achieved a GEH of 5.0 or better; and
  - 100% of turn counts achieved a GEH of 10.0 or better.

2.5 2012 MODEL VALIDATION

The validation process for the base models involved comparing the modelled travel time data and back of queue data with the surveyed data. Travel time surveys were conducted on four key routes in the area and compared to the model results for validation purposes.

In SATURN the determination of travel times required the manual extraction on "nodal" delays and "link" travel times and the addition of these to create "route" travel times. The models have been validated to travel time surveys and all model-output travel times are within 25% (most within 20%) of average surveyed travel times whilst all values sit within the minimum and maximum travel times recorded.

Back of queue outputs from the models also lie between the maximum and minimum surveyed values tending towards the average of these values.

2.6 2012 MODEL RESULTS

In the Base Case Scenario during the AM peak 28 of the 120 intersections in the study area are operating at capacity and the majority of these intersections are located along Church Street and Victoria Road. The number of through lanes on Victoria Road in the eastbound direction reduces from three lanes to two lanes approaching the Bowden Street/Victoria Road intersection and this in turn has a major effect on queue propagation back to the east along Victoria Road during peak periods

The pedestrian crossings east and west of the railway line along Railway Road and Bank Street has a significant number of pedestrians crossing during the peak periods interrupting the traffic flow on Bank Street and limiting the capacity to an observed approximate rate of 600-900 PCUs per hour.

Figure 2.3: Intersection Performance – 2012

Total trips in the network in 2012 in each peak hour are as follows:

- AM Peak = 17,581 PCU-trips
- PM Peak = 16,437 PCU-trips

The SATURN modelling showed that the percentage of the vehicle-time spent in the network that was in congested conditions was approximately:

- 79% in the AM Peak; and
- 73% in the PM peak.

Existing traffic issues are discussed further in Section 3.1.

2.7 2031 TRAFFIC DEMANDS DEVELOPMENT

2.7.1 Year 2031 "Internal" Traffic Generation

As was done for the 2012 traffic demands development, the creation of 2031 traffic matrices was undertake initially at the "Lot" or "Development Site" level. The process commenced with extracting the final traffic generation (AM/PM and IN/OUT) volumes from 2012 by Lot. The CoR provided the development levels to assume in key sites under the LEP2011 provisions (Land Use Scenario 1) and also under the scenario where the Part 3A sites were included (Land Use Scenario 2).

Table 2.1 shows the development levels proposed under each scenario for key sites within the MEA. All lots outside of these key sites were assumed to have the same development/traffic generation as in 2012.

Table 2.1: Assumed 2031 Development Levels – Key Sites

Site/Address	LEP2011 (Scen. 1)		Part 3A Developments (Scen. 2)	
	#Dwellings	Comm. Area (m2)	#Dwellings	Comm. Area (m2)
37 Nancarrow	163	457	254	0
21 Nancarrow, 2-18 Constitution, 7 Hamilton	252	367	424	0
20 Nancarrow, 116-118 Bowden	297	1,505	484	0
6-18 Nancarrow, 9-12 Rothesay	163	950	194	0
39 and 41 Belmore	261	637	500	0
155-161 Church, 8-12 Porter	99	1,000	146	10,000
1-18 Railway, 50&54 Constitution	138	3,850	138	3,850
1-13 Angus	143	0	143	0
2&2a Angus & 117-127 Bowden	112	623	112	623
21 Railway	53	0	53	0
1 Constitution	170	942	170	942
133-139 Bowden	52	0	52	0
101-123 Church, 2-8 Junction St, 3-19 Porter	272	1,510	272	1,510
20-28 Constitution & 25-33 Nancarrow	109	270	109	270
102-112 Bowden	94	523	94	523
146 Bowden	61	0	61	0
4-8 Angus	46	0	46	0
125 - 135 Church	256	1,165	256	1,165
74-78 Belmore (Crowle)	470	0	470	0
TOTAL	3,210	13,799	3,978	18,883

2.7.2 Year 2031 "External" Traffic Generation

"External" zone traffic growth has been estimated based on historic count data on Church Street and Victoria Road. Given the capacity constraints on these roads traffic growth has been suppressed over the last 5-10 years with an effective average growth rate of approximately 0.3% per annum. It is expected that this growth rate will be suppressed even further over time as phases times for through movements consistently achieve their maximum values. On this basis, the assumption for through traffic growth (i.e. generated by external zones) is:

- 0.3% p.a. for 10 years from 2012 then no growth until 2031.

It is important to highlight than this is an "actual" growth rate not a "demand" growth rate reflecting what traffic could actually enter the model area over time.

2.7.3 Matrix Furnessing (Balancing)

The lot-based traffic generation for each land use scenario was aggregated up to the SATURN zone level for the internal zones. The external zone traffic generation was factored up using the external traffic growth rates discussed above. This then resulted in new (target) 2031 zonal trip end totals for each land use scenario.

Using the 2012 final traffic matrices as a starting point (prior matrix) and the 2031 zonal trip end targets, a two-dimensional matrix balancing process was undertaken to create the 2031 matrices for each land use scenario. Table 2.2 shows the resultant matrix totals for the MEA network, along with the 2012 totals for comparison.

Table 2.2: MEA Traffic Matrix Totals

Scenario	AM Peak Hour	PM Peak Hour
2012 Base	17,581	16,437
2031 LEP2011 (Scenario 1)	18,909	17,924
2031 Part 3A Development and LEP2011 elsewhere (Scenario 2)	19,307	18,323

By also assuming the RMS traffic generation rates for development in the MEA in 2031, this implies a case where mode splits will be the same as in 2012 for the MEA; representing an expected worst case scenario for traffic impacts as some gradual shift to public transport and walking is expected.

It is important to highlight that because the Part 3A developments simply replace what would have otherwise been LEP2011 development levels on those sites, and the fact that the vast majority of traffic in the model is through traffic (i.e. >70%) the differences between Scenario 1 and Scenario 2 traffic demands in 2031 are relatively small (in the order of 400 vph).

2.8 2031 LEP BASE MODEL

The 2031 LEP Base Model included the additional traffic generated by the development expected under the LEP (as advised by City of Ryde) as well as background traffic growth. No additional transport infrastructure has been included in this modelling so as to determine what the impacts of this development and through traffic growth will be on the existing network. Figure 2.4 highlights the areas within the MEA where the majority of localised traffic generation is likely to occur.

Note: traffic densities shows are at the SATURN zone level and may therefore vary between individual land parcels within each zone

Figure 2.4: Traffic Growth – 2011 to 2031 Under LEP Growth Only

Figure 2.5 highlights the intersection performance under the 2031 LEP base case represented as volume-capacity ratios.

The PM peak is generally the worst case as observed on site with the key constraint in Meadowbank being congestion associated with the rail-bridge and adjacent pedestrian crossings. The Bowden Street/Constitution Road roundabout is also over capacity and queuing from these areas has secondary effects on adjacent intersections. The Loop Road also begins to become a key pinch point by 2031 with the mix of local traffic and increasing through traffic being affected by the capacity of the roundabouts in this area (partly geometrical effects and partly opposing movement effects).

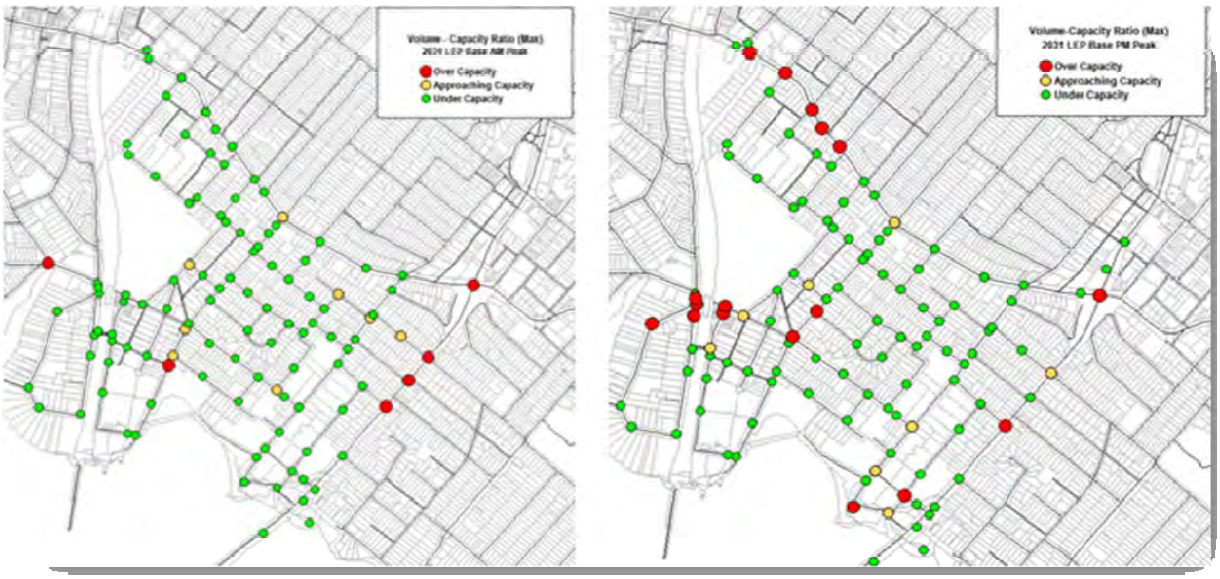


Figure 2.5: Intersection Performance - 2031 Under LEP Growth Only

In the AM peak, the roundabout at Constitution Road/Station Street reaches capacity (the pinch point is actually further east in 2012) and constrains the downstream flow to the rail bridge area, thereby "protecting" this area from further congestion issues. In the AM peak, some localised congestion issues begin to emerge in the development areas around Bowden Street south of Constitution Road.

Figure 2.6 shows the relative traffic volumes on key links in Meadowbank under 2031 LEP2011 traffic demands. This figure shows the continuation of relatively heavy traffic volumes on Constitution Road, Belmore Street and Bowden Street (particularly PM Peak). This figure however also shows the emergence of rat running through residential streets such as Squire Street and Thorn Street as well as increasing reliance on See Street and Angus Street as local traffic seeks alternative routes to access/egress the MEA.

Figure 2.6: Actual Traffic Volumes - 2031 Under LEP Growth Only

2.9 2031 HOLDMARK PART 3A BASE MODEL

The 2031 Holdmark Part 3A Base Model included the additional traffic generated by the Part 3A developments proposed in the MEA and development under the LEP for sites outside of the Part 3A applications (as advised by City of Ryde). Background traffic growth or through traffic was also included. No additional transport infrastructure has been included in this modelling so as to determine what the impacts of this development and through traffic growth will be on the existing network. Figure 2.7 highlights the areas within the MEA where the majority of localised traffic generation is likely to occur.

Note: traffic densities shows are at the SATURN zone level and may therefore vary between individual land parcels within each zone

Figure 2.7: Traffic Growth–2011 to 2031 Part 3A Developments and LEP Outside These Areas

Figure 2.7, when compared to Figure 2.4 shows significantly more traffic between The Loop Road and Church Street and increased traffic in the MEA generally, albeit with a similar patters to that shown for the LEP2011 scenario.

Figure 2.8 shows the intersection performance under this scenario. The results are similar to the LEP2011 scenario with similar congestion issues in similar locations.

Figure 2.8: Intersection Performance – 2031 Part 3A Development and LEP Outside These Areas

Figure 2.9 shows the relative traffic volumes on the network again highlighting the emergence of "rat running" routes, increased use of See Street and the emergence of the use of Underdale Lane and Bay Street as alternative route to access the rail bridge crossing (as the Constitution Road route queues continue to extend).

Figure 2.9: Actual Traffic Volumes – 2031 Part 3A Development and LEP Outside These Areas

3. KEY ISSUES AND NEEDS

3.1 EXISTING ISSUES

A summary of the existing observed traffic issues in Meadowbank are summarised in Figure 3.1

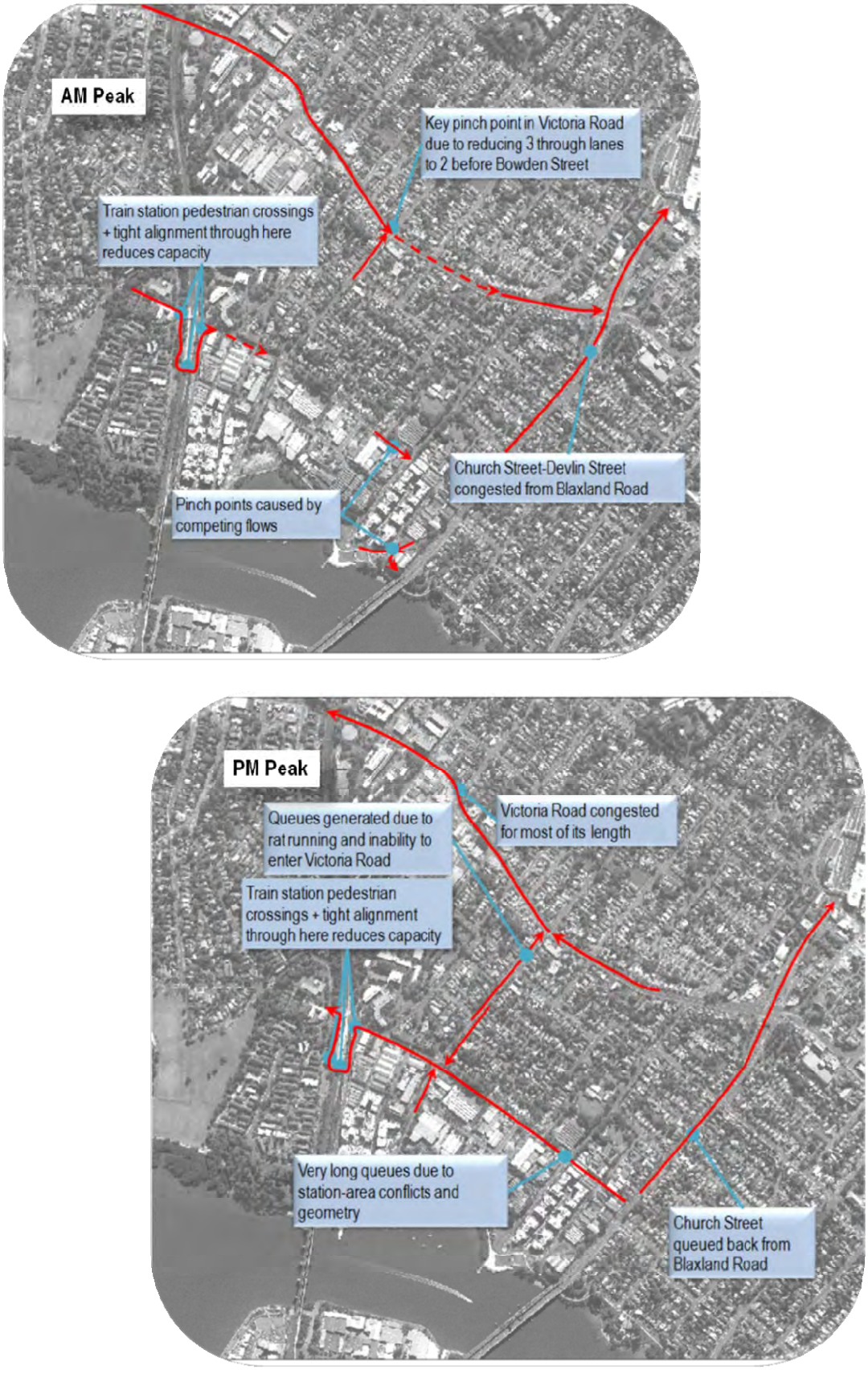


Figure 3.1: Existing Issues

In essence, most of the congestion issues in Meadowbank are associated with through traffic demands exceeding the capacity of the available infrastructure.

In the morning peak, predominant flows are eastbound. Congestion on Victoria Road encourages traffic to filter through Meadowbank to access Morrison Road and Church Street. As this traffic approaches the MEA and Constitution Road it is delayed at the Meadowbank Rail Station pedestrian crossing on the western side of the rail line. A relatively constant flow of pedestrians at this crossing limits traffic throughput to the rail overbridge. The zebra crossing on the eastern side of the rail line has similar effects on interrupting (and constraining) traffic flow moving towards the east.

When these crossings are not being used, the narrow geometry of the rail bridge and the "tightness" of the new roundabout at the Station Road intersection limit throughput capacity. These combined effects appear to limit capacity in this constrained area to between 700 and 900 vehicles per hour eastbound. This pinch point effectively limits arrival flow to intersections on Constitution Road further to the east (such as Bowden Street and Belmont Street) and as a consequence these intersections generally show only minor queuing in the AM peak.

In the PM peak, predominant flows are westbound. Extremely heavy traffic congestion in Victoria Road and in Church Street – Devlin Street sees multiple "rat-runs" forming through Meadowbank.

As with the morning peak, the rail station area is the primary capacity pinch point (combination of pedestrian crossings and rail bridge geometry) and queues spill back on Constitution Road through the Bowden Street roundabout and all the way back to Belmore Street. This level of queuing is seeing other "rat-run" routes beginning to emerge in the residential streets north of Constitution Road whilst there is heavy demand on Bowden Street for traffic filtering through to access Victoria Road.

In additional to these primary issues, other existing issues include:

- the priority given to the right turns from Parsonage Street into The Loop Road over traffic arriving from the Church Street left turn into The Loop Road;
- the geometry and proximity of the Morrison/Belmore roundabout to the Morrison/Yerong T intersection and, similarly, the proximity of the Bowden/Squire roundabout to the Bowden/McPherson T intersection;
- congestion on Church Street making it difficult for traffic to exit from Meadowbank via Morrison Road and Junction Street intersections; and
- congestion on Victoria Road making it difficult for traffic to exit Meadowbank, particularly from Bowden Street to the west in the afternoon peak.

3.2 THROUGH TRAFFIC CONSIDERATIONS

Peak period traffic volumes through Meadowbank are significantly higher than off peak volumes and there are no "internal" congestion issues in off peak periods. This is primarily related to through traffic staying on Victoria Road and Church Street when there is significant capacity on these roads in off peak times.

During peak periods however, both Victoria Road and Church Street - Devlin Street are at capacity with long delays and long queues. Unless these capacity constraints are relieved, any growth in through traffic is most likely to be absorbed through Meadowbank to the extent that existing capacity constraints permit.

These constraints are primarily in the west of the study area surrounding the rail station and rail overpass. Emerging constraints in the east are near The Loop Road/Parsonage Street intersection due to conflicting movements of traffic entering and leaving the MEA at the same time.

It is expected that any improvements in these edge constraints will inevitably release more through traffic into Meadowbank and further affect the capacity and amenity of roads and streets in this area. Maintaining these constraints effectively shields the performance of intersections within Meadowbank but makes it increasingly difficult (over time) for both local and through traffic to enter and leave the area in peak periods.

Accepting that this correlation is an inevitable consequence of external constraints then shifts the focus from capacity provision to appropriate traffic management, access management and pedestrian and public transport provisions within the MEA.

3.3 PEDESTRIAN NEEDS AND PUBLIC TRANSPORT ACCESS

The primary focal point for public transport is the Meadowbank Rail Station and to a lesser extent, the Ferry Terminal. Furthermore, local convenience shopping is located in Bay Drive suggesting that there is strong east-west pedestrian demand to access these facilities. The safety and convenience of these pedestrian desire lines is a key consideration in developing options to manage the traffic/pedestrian conflict in the MEA.

4. YEAR 2031 OPTIONS ASSESSMENT

4.1 REFERENCE CASE

4.1.1 Description

The reference case for all other options to be compared to has been defined as the implementation of the development envisage under the LEP2011 (as advised by the City of Ryde) and construction of "proposed Traffic Facilities" as defined by CoR for the MEA in 2005. These facilities of relevance to traffic capacity assessments are:

- Railway Road:
  - construct a roundabout at the railway bridge (completed); and
  - construct pedestrian signals (RMS approval required) at the intersection of Constitution Road.
- Constitution Road:
  - construct a roundabout at See Street;
  - widen the See Street over-bridge to two lanes; and
  - construct traffic signals (RMS approval required) at Bowden Street.
- Angus Street:
  - construct roundabout at See Street.
- Rothesay Avenue (with Part 3A developments in place):
  - roundabout at Belmore Street; and
  - roundabout at Bowden Street.

Figure 4.1 shows the reference case projects added to the 2012 base case network.

Figure 4.1: Reference Case Additional Traffic Upgrades

As with all of the options assessed for 2031, the public transport modal split has been assumed to remain constant at 10% (i.e. the same as in 2011) to reflect a conservative approach in terms of additional traffic generation to/from the MEA for sizing potential infrastructure upgrade requirements.

4.1.2 Key Network Performance Results

Figure 4.2 shows the intersection performance under the Reference Case whilst Figure 4.3 shows relative link volumes under this option. Whilst there are still some issues surrounding the rail bridge, a key difference between 2012 and the 2031 Reference Case is that increasing local development traffic creates congestion "pinch points" at the eastern (AM peak) and western (PM peak) extents of the study area. This effectively reduces the ability for traffic to pass through to Constitution Road and reduces the arrival flow or pattern of arrivals on Constitution Road.

Notwithstanding these effects, See Street emerges as a key alternative route to Bowden Street with the Bowden Street/Constitution Road signalised intersection operating with long delays in both peaks. It should be highlighted that the configuration assumed at the Bowden/Constitution intersection was generally limited to existing/available land are for widening of the intersection footprint.

East-west streets through residential areas also start to take on more traffic as the rat-running spreads affecting local traffic intersections. For example, Constitution Road has long delays in the PM peak leading to use of Nancarrow and Underdale.

Figure 4.2: Reference Case Intersection LOS

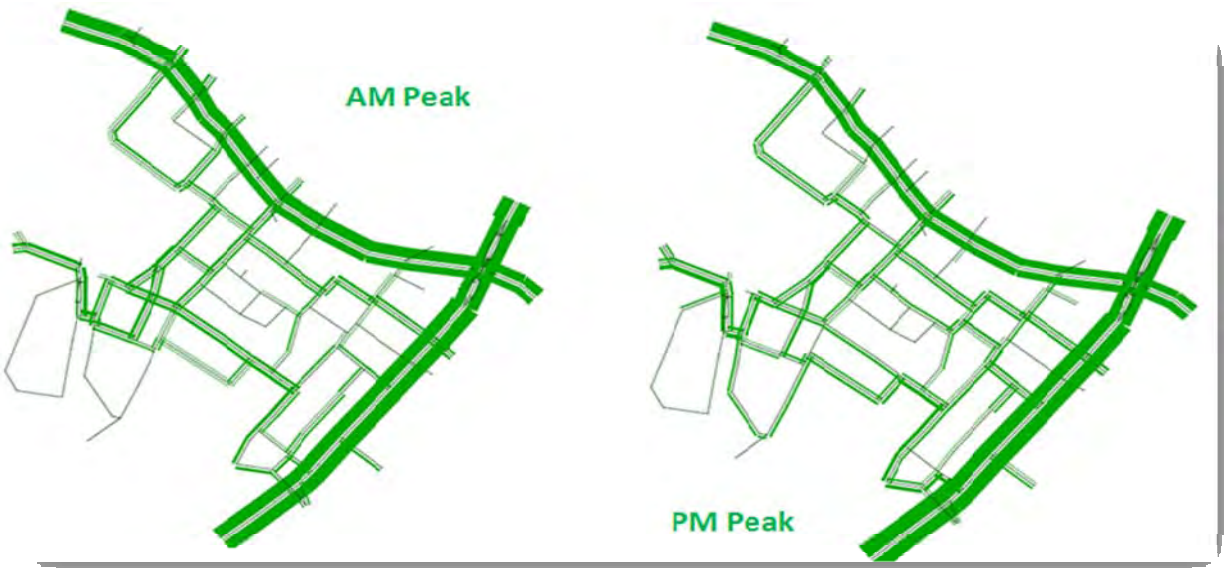


Figure 4.3: Reference Case Peak Hour Volumes

Figure 4.3 reinforces the LOS issues identified in Figure 4.2 by showing heavy volumes moving towards alternative rat run routes of See Street, McPherson Street, Squire Street, Yerong Street that out through Morrison Road. This route is also popular in the afternoon peak with greater pressure also placed on Belmore Street, Nancarrow Road, Underdale Lane and Bay Drive as an alternative access route to the rail bridge.

4.2 OPTIONS

A number of options were subsequently developed to identify what impacts the "Part 3A" developments would have on the Reference Case conditions. These options are briefly described as follows:

Option	Development Levels Included	Traffic Network
1	LEP2011 + Part 3A Developments	CoR proposed traffic improvements (from 2005)
2	LEP2011 + Part 3A Developments	CoR proposed traffic improvements (from 2005), LATM + new roundabouts to restrict "rat-runs" in local streets
3	LEP2011 + Part 3A Developments	CoR proposed traffic improvements (from 2005), new signalised intersections at a number of intersections to manage traffic/pedestrian conflicts through MEA
4	LEP2011 + Part 3A Developments	Option 2 + Option 3 network changes together
5	LEP2011	Option 2 + Option 3 network changes together

Notes:

1. *Part 3A developments are as per the applications submitted*
2. *LEP2011 is the development levels under the LEP as interpreted and provided by CoR.*
3. *Part 3A development assumptions "overwrite" LEP2031 development assumptions in the locations where Part 3A applications exist.*

The options are shown pictorially and described in more detail below.

4.3 OPTION 1

4.3.1 Option Description

Figure 4.4 shows Option 1. This option contains all of the Part 3A applications as well as the additional road links proposed as part of the Shepherds Bay development. The upgrade works proposed by the CoR as per the reference case are also included in this option. These new road links have been coded with a 40 kph speed limit to reflect the highly constrained and pedestrianised environment that they are located in.

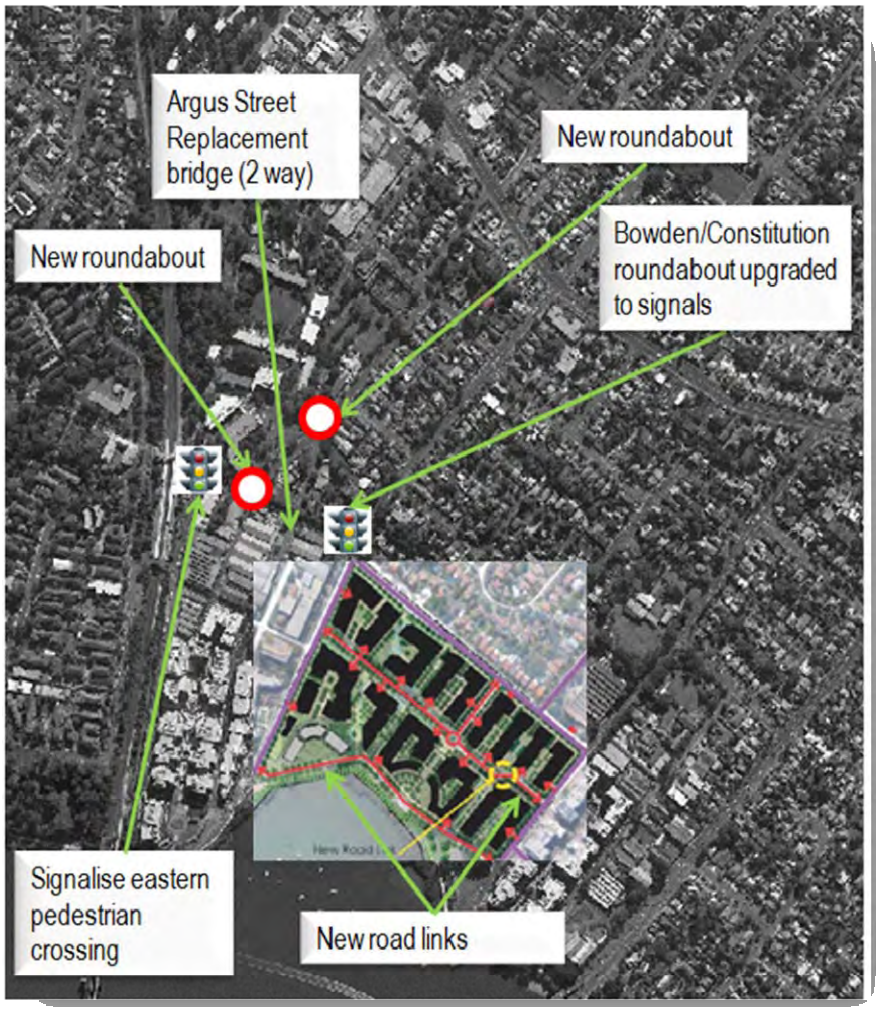


Figure 4.4: Option 1

4.3.2 Option Modelling Results

The intersection delays (LOS) in this Option are similar to the reference case model results with key intersections still over capacity, as shown in Figure 4.5. This congestion leads to some diversion of traffic away from the primary Constitution Road corridor and onto parallel routes through residential areas, partially as a consequence of the signals at Bowden/Constitution and new signals at the eastern side of the Rail Station.

Figure 4.5: Option 1 Intersection LOS

Figure 4.6 shows the relative traffic volumes in the area under Option 1. It is important to note that the new Rothesay Avenue link appears to be a very attractive alternative to Constitution Road for moving through Meadowbank, with an associated impact on Underdale Lane a consequence. The "edge constraints" at the rail bridge area in the west and at the M3/The Loop Road area in the east tend to self-mange the rate at which traffic can enter the MEA.

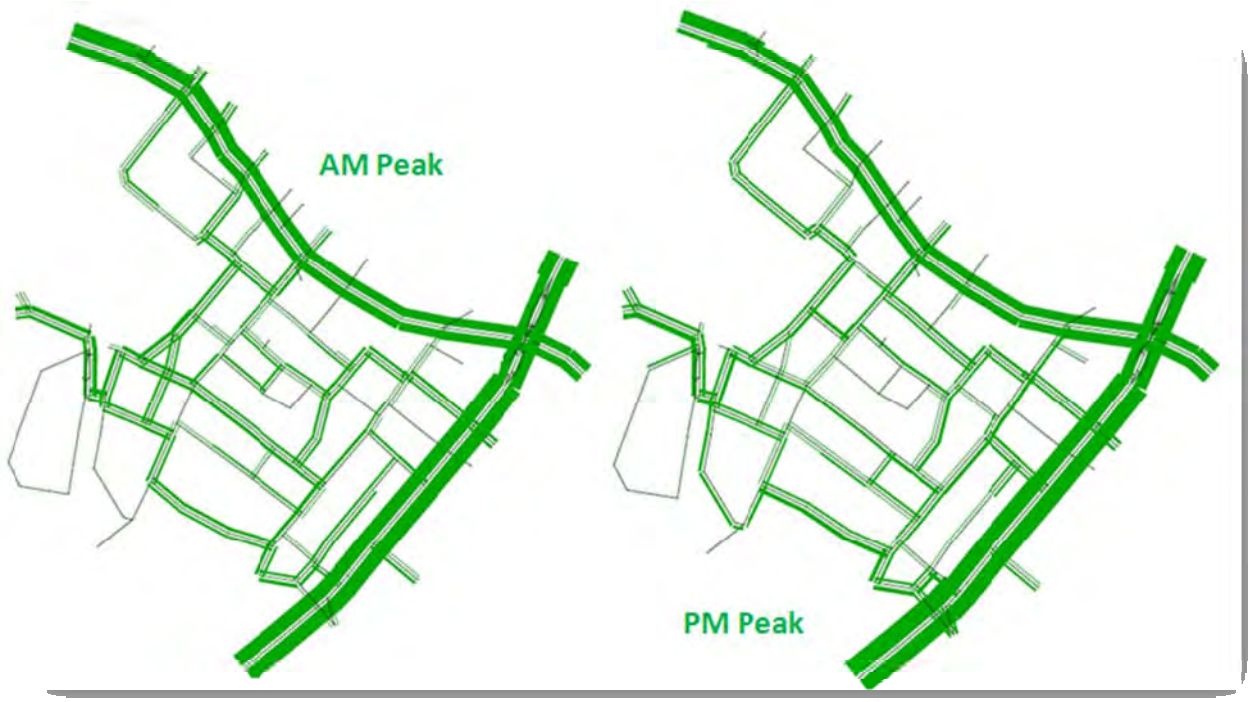


Figure 4.6: Option 1 Peak Hour Volumes

4.4 OPTION 2

4.4.1 Option Description

Figure 4.7 shows Option 2. This option contains all of the Part 3A applications as well as the additional road links proposed as part of the Shepherds Bay development. The upgrade works proposed by the CoR as per the reference case are also included in this option. This option also includes roundabouts at either end of Rothesay Avenue and LATM devices in five east-west streets.

The purpose of the LATM scheme is to discourage the use of these streets as rat runs (as identified in Option 1) which appears to be a consequence of more local traffic using Constitution Road and some "through traffic" being pushed into these local streets due to further delays on Constitution Road.

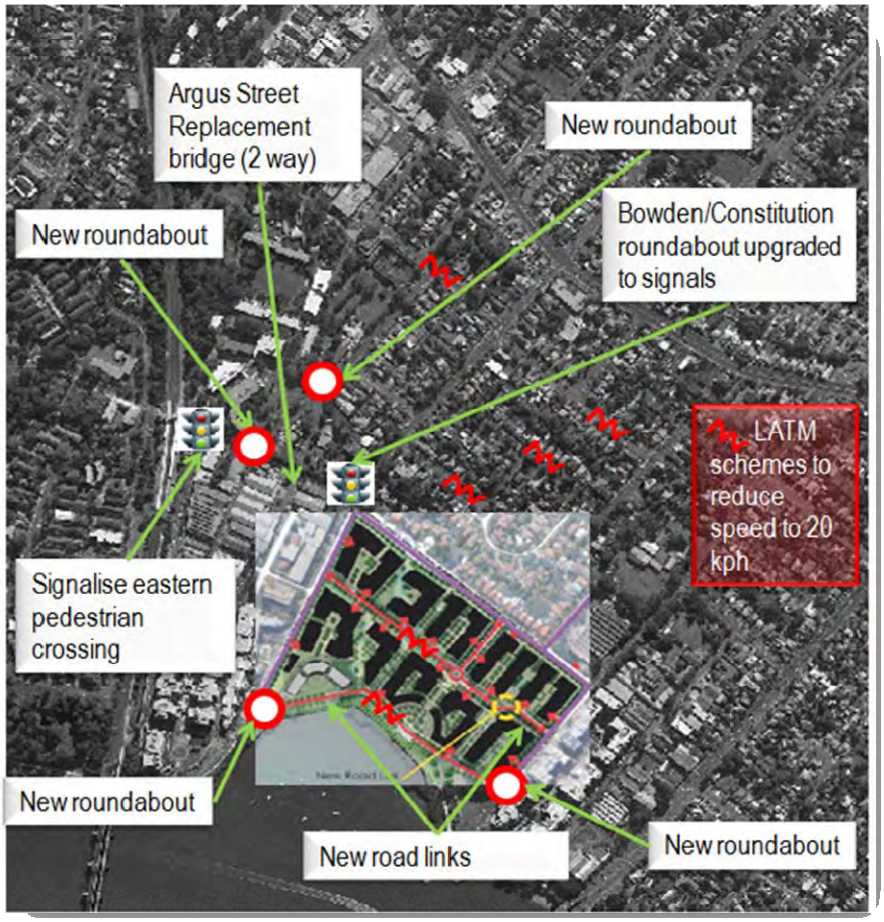


Figure 4.7: Option 2

4.4.2 Option Modelling Results

Figure 4.8 shows the intersection LOS under Option 2. The implementation of the LATM schemes on key east-west streets made very little difference to intersection performance on the network. This is because the LATM schemes were modelled as 20kph roads however the alternative routes are travelling at much slower speeds than this, particularly in the PM peak where link speeds of 5kph-10kph are experienced on Constitution Road.

Similarly as shown in Figure 4.9, Option 2 shows very little difference in the distribution of network traffic volumes when compared to Option 1, which is also a consequence of the limited effects that the LATM schemes are expected to have in peak times. They will however provide some deterrence in the peak shoulders for "rat running" traffic to remain on Constitution Road.

Figure 4.8: Option 2 Intersection LOS

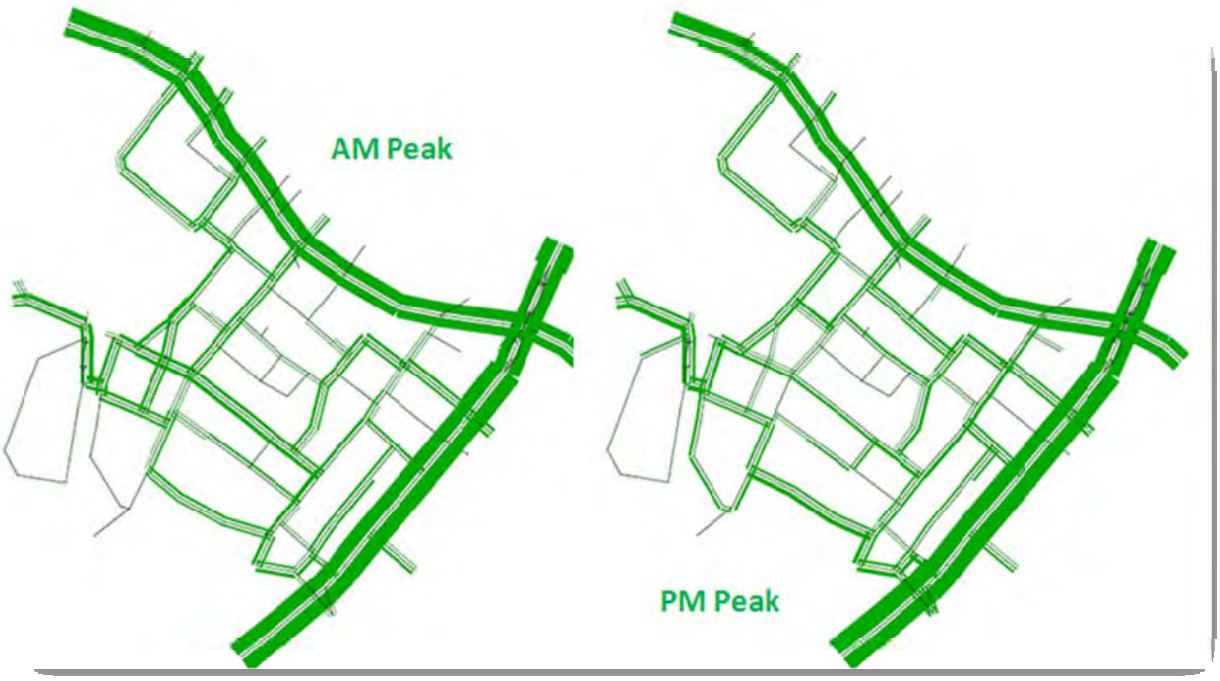


Figure 4.9: Option 2 Peak Hour Volumes

4.5 OPTION 3

4.5.1 Option Description

Figure 4.10 shows Option 3. This option contains all of the Part 3A applications as well as the additional road links proposed as part of the Shepherds Bay development. The upgrade works proposed by the CoR as per the reference case are also included in this option.

This option also includes new traffic signals at:

- the pedestrian crossing on the western side of the rail station;
- the intersection of Nancarrow Avenue and Constitution Road; and
- the intersection of Parsonage Street and The Loop Road.

The intent of the traffic signals is to discourage the ease of passage of "rat running" traffic through Meadowbank whilst at the same time manage the conflict between through movements and local traffic and pedestrian movements. The signalisation of Parsonage Street and the Loop Road aims to manage queues in the northern approach to the intersection which are likely to extend back into the M3 if the existing roundabout configuration is maintained.

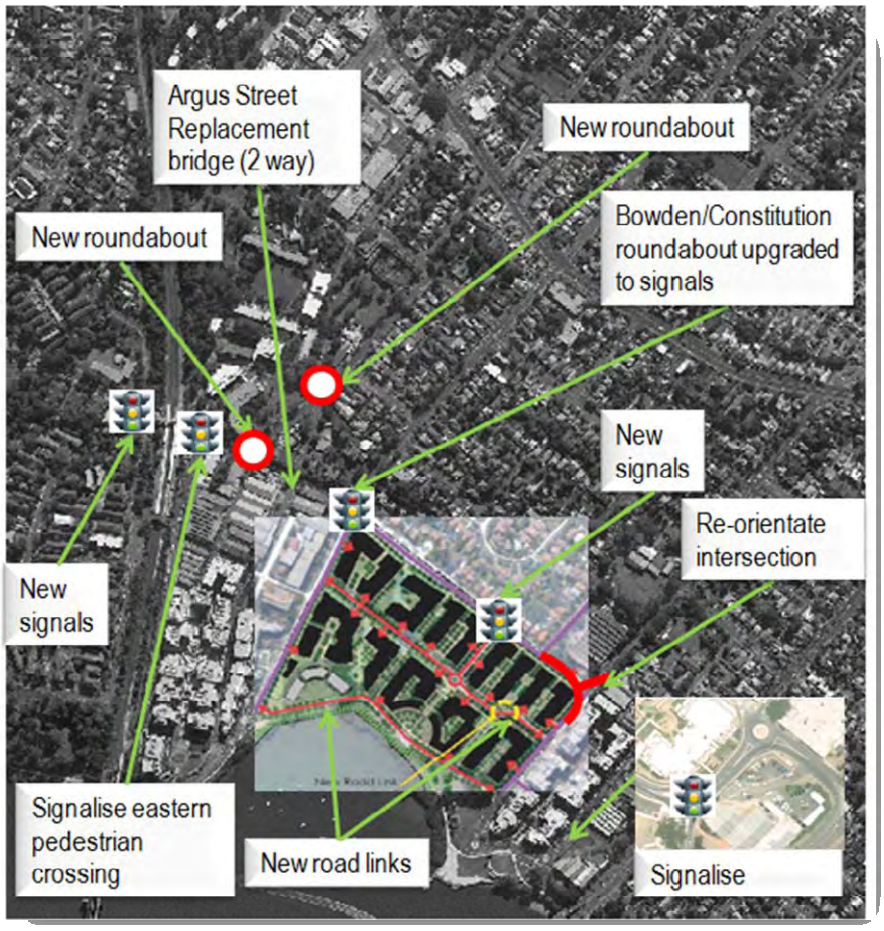


Figure 4.10: Option 3

Option 3 also includes the re-orientation of the Belmore/Constitution intersection to better align its geometry with the predominant traffic flows.

4.5.2 Option Modelling Results

As shown in Figure 4.11, longer delays (primarily due to the signals under this option) create a poorer level of service at intersections on Constitution Road but achieve the objective of reducing traffic volumes and managing pedestrian conflicts. A consequence however is worsening conditions on connecting and parallel routes such as See Street, McPherson Street, Belmore Street and Underdale Lane which would all require intersection upgrades.

Figure 4.12 shows that volumes on the new Rothesay Avenue connection would be as high as those on Constitution Road unless specific and very restrictive management measures were put in place. This Figure also highlights the traffic increase impacts on Underdale Lane and Squire Street.

In effect, the signals at either end of Constitution Road "block" traffic from entering but also divert some more through traffic to parallel streets and these effects result in some traffic being pushed through the Holdmark site which is undesirable.

Overall this option's multiple signals reduce through traffic on Constitution but queues and delays will still exist and worsen with undesirable rat runs emerging.

Figure 4.11: Option 3 Intersection LOS

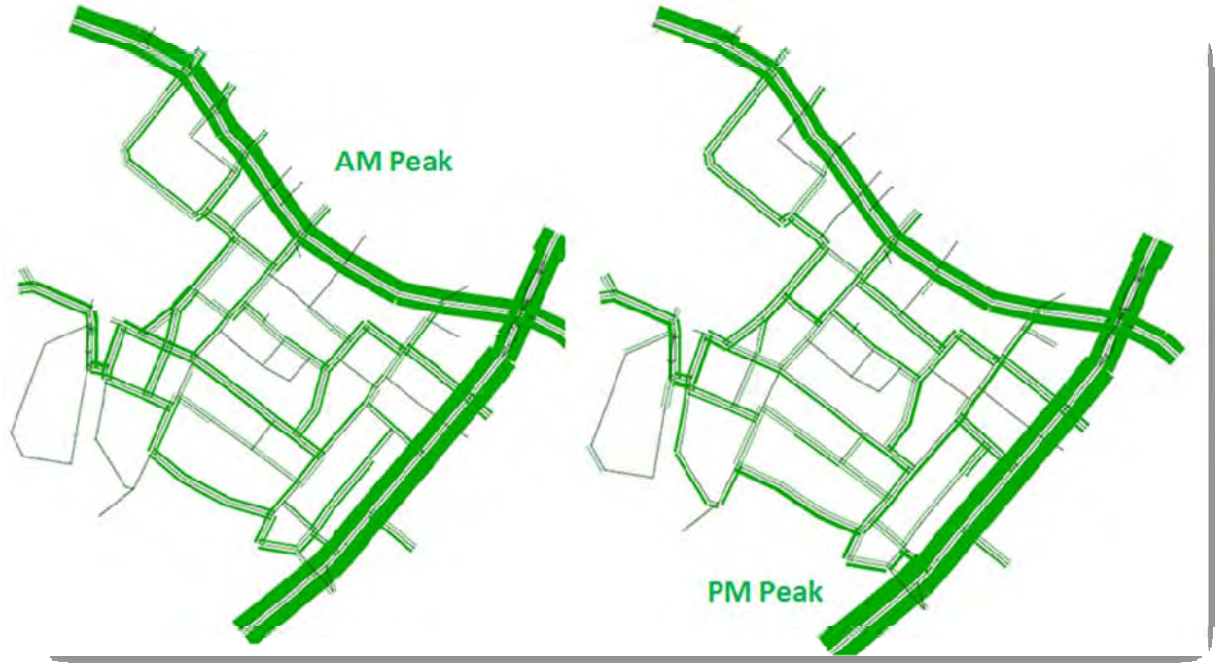


Figure 4.12: Option 3 Peak Hour Volumes

4.6 OPTION 4

4.6.1 Option Description

Figure 4.13 shows Option 4. This option contains all of the Part 3A applications as well as the additional road links proposed as part of the Shepherds Bay development. The upgrade works proposed by the CoR as per the reference case are also included in this option as are the LATM devices and roundabout proposed as part of Option 2.

This option also includes the new traffic signals as per Option 3 at:

- the pedestrian crossing on the western side of the rail station;
- the intersection of Nancarrow Avenue and Constitution Road; and
- the intersection of Parsonage Street and The Loop Road.

The intent of this option is to better manage through traffic conflicts on Constitution Road (i.e. as per Option 3) whilst trying to discourage associated traffic diversions to local streets (as per Option 2).

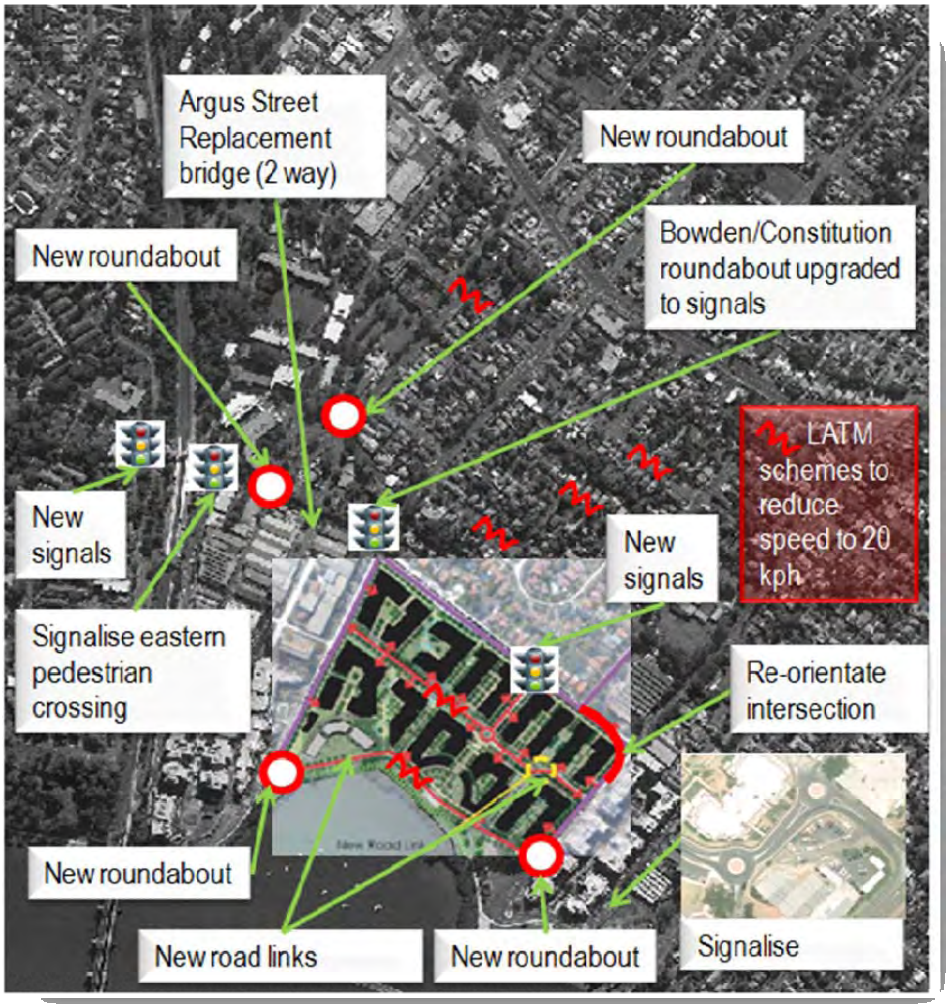


Figure 4.13: Option 4

4.6.2 Option Modelling Results

The results shown in Figure 4.14, when compared to other options results, really highlight that the traffic signals on Constitution Road have a far greater influence on Meadowbank traffic patterns than any LATM schemes would do, particularly in peak hours.

As with Option 3, Option 4 showed:

- long delays to through traffic due to congestion and the signals on Constitution Road;
- delays and traffic volume increases on some laneways due to rat running traffic; and
- Belmore and McPherson Street showing increased volumes with traffic moving between these routes using residential streets.

Figure 4.15 also highlights much more pressure on local residential roads and the clear desirability for Rothesay Avenue to be used as a rat run. This link may need to be closed or very carefully managed to achieve Council's intent for this area.

Figure 4.14: Option 4 Intersection LOS

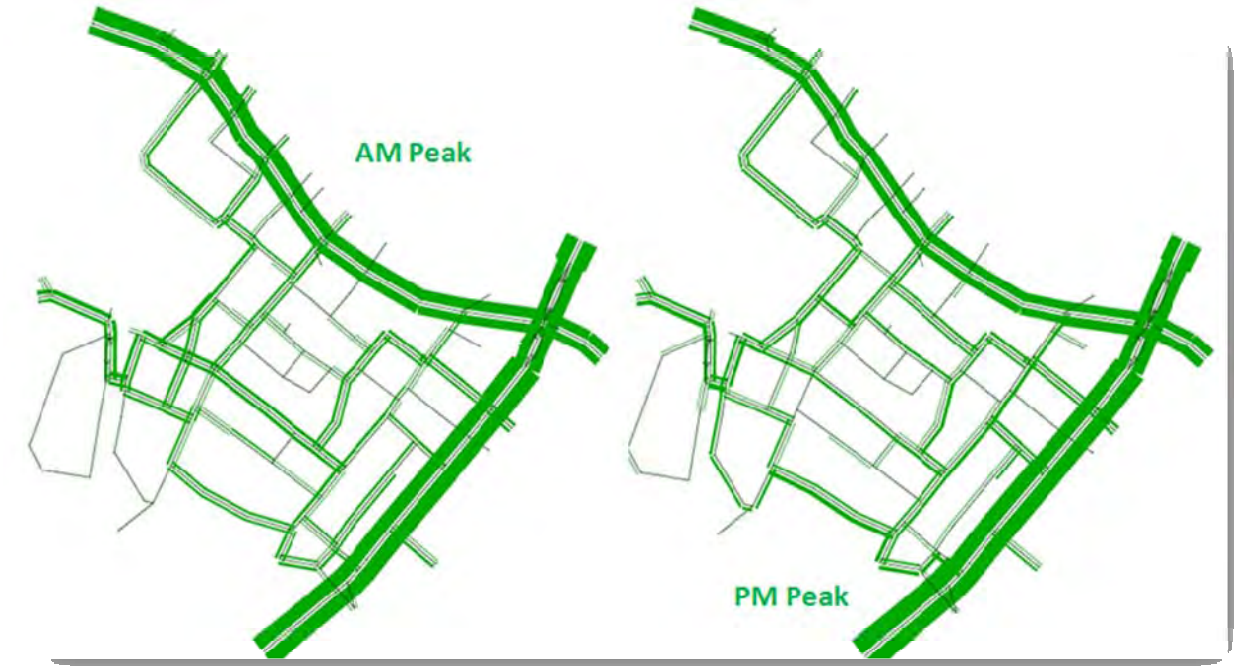


Figure 4.15: Option 4 Peak Hour Volumes

4.7 OPTION 5

4.7.1 Option Description

Figure 4.16 shows Option 5. This network is exactly the same as Option 4. The key difference is that the Part 3A developments are not included so that the development levels revert back to those under the LEP. The local road connections that are proposed as part of the Shepherds Bay Development are still included in this option to determine the level of usage of these links without the Part 3A developments in place.

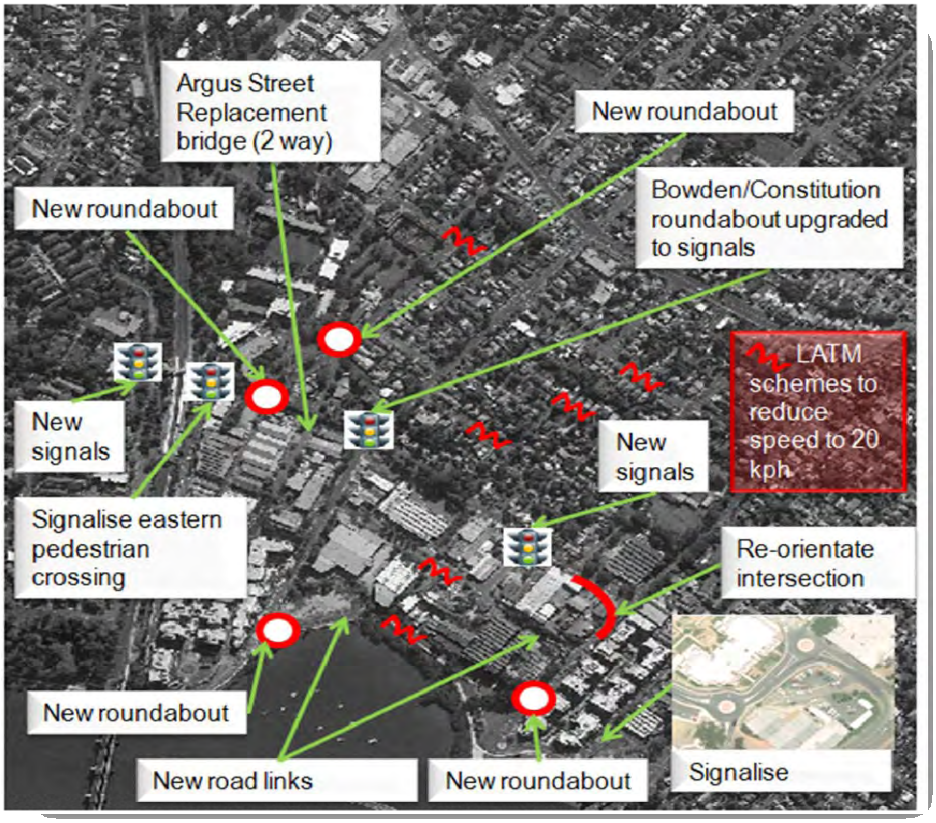


Figure 4.16: Option 5

4.7.2 Option Modelling Results

It is important to re-state that the traffic volumes in the network are only 400 vehicles per hour less under this option than under the Part 3A scenario (Scenario 1) which means that traffic conditions are generally similar with a few localised exceptions.

These effects are shown in Figure 4.17 when compared to Figure 4.14 with similar congestion/delay points observed (with slightly lower consequences). When comparing Figure 4.18 with 4.15 there is also a similar attraction for through traffic to use Rothesay Avenue if it is connected through.

Figure 4.17: Option 5 Intersection LOS

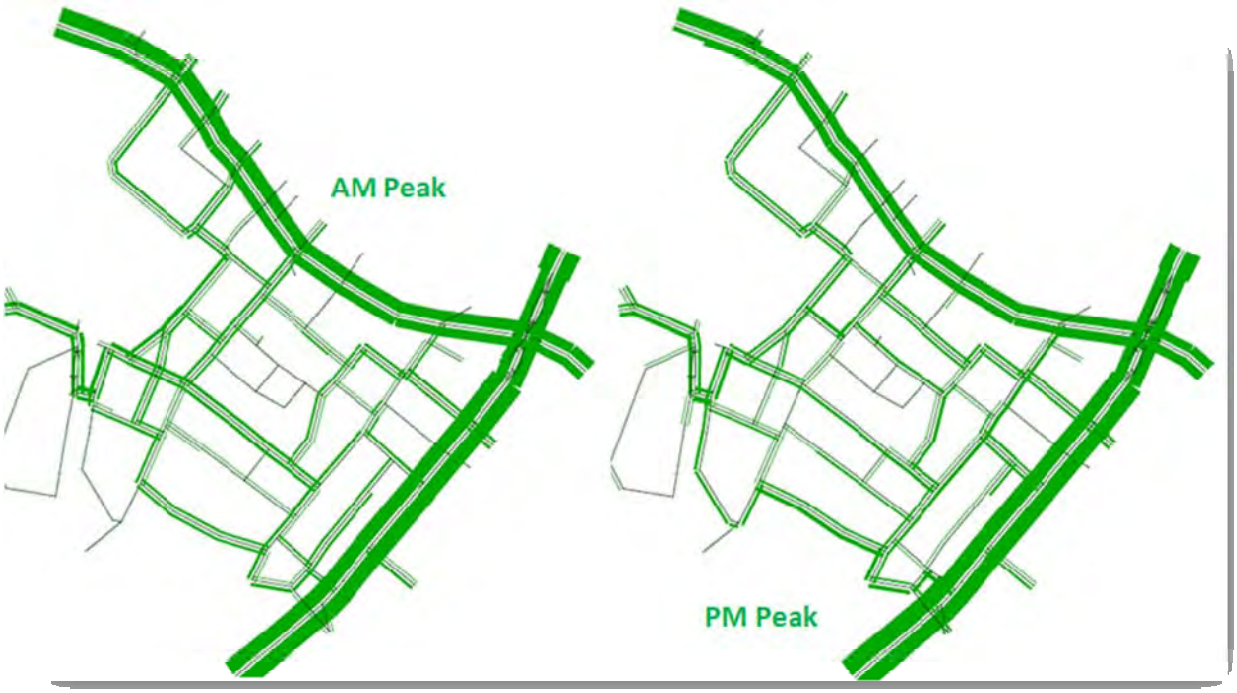


Figure 4.18: Option 5 Peak Hour Volumes

5. PREFERRED OPTION DEVELOPMENT

5.1 RATIONALE

5.1.1 Key Issues

It was clear from the option modelling that the peak period rat running issues in Meadowbank are practically impossible to remove without capacity relief in Victoria Road and Church Street. There are no plans for these improvements and the prospect of any upgrades to intersections on these roads appears remote at this stage.

Moreover, as external traffic grows there will be increasing demand for this rat running to occur whilst local re-development traffic will be competing for the same road space. To some extent the volume of traffic able to move through Meadowbank (typically west to east in the morning and east to west in the afternoon) will be limited by the capacity constraints at the edges of the network. There would be little point in releasing these capacity constraints (e.g. upgrading the rail bridge) as this would simply encourage greater use of through traffic paths through the area. Some increases in volumes (in the order of 2,000 vehicles per hour in the network by 2031) will however be inevitable with local development proposed to occur.

In effect, the consequence of this will be a greater number of routes through Meadowbank being used by more vehicles. The challenge will be to manage these volume increases as best as possible to achieve key transport and land use objectives for the area.

5.1.2 Key Objectives

Given the likely traffic issues facing the MEA in the future, and the inability to simply cater for desired traffic demands through the study area, the focus turns to traffic and pedestrian conflict management. Associated objectives that were considered in preparing the preferred network option for the study area are:

- Objective 1 - Managing intersection capacity to limit the effect of rat running/through movements blocking the ability to undertake local traffic movements;
- Objective 2 - Limiting the effects of through traffic on residential amenity in traditional residential streets and new lane ways;
- Objective 3 - Actively encouraging the ease of pedestrian movements towards the Bay Street retail area, the Ferry Terminal, the Parramatta River bank, the Meadowbank Rail Station and the Meadowbank TAFE (and between these areas) by appropriately managing pedestrian and traffic conflict points;
- Objective 4 - Facilitating appropriate alternative traffic routes in Meadowbank through intersection and other upgrades on these routes; and
- Objective 5 – Fixing existing traffic and pedestrian safety issues that will be exacerbated with increasing traffic.

5.2 DRAFT PREFERRED NETWORK, MODELLING AND OPTIMISATION

5.2.1 Draft Network Upgrades

Based on the objectives defined above a number of network upgrades were coded into the base model to create the Draft Preferred Option (Option 6).

These improvements and the rationale for including them are provided in Table 5.1.

Table 5.1: Rationale for Meadowbank Traffic and Transport Improvements

Improvement Item	Rationale	Objectives[1]
Pedestrian signals replacing the zebra crossing on Railway Road at the Station.	Identified in 2005 by CoR. Already a traffic capacity and safety issue. Increasing development in MEA will increase pedestrian demand along this desire line and further exacerbate this issue. Preliminary signal warrants assessment suggests that this crossing will meet RMS warrants in the future.	3,5
Roundabout at See Street/Constitution Road	Identified in 2005 by CoR. Facilitates better access to the TAFE and the use of See Street-McPherson Street to access Victoria Road as an alternative to Bowden Street.	1,4
Widening the Angus Street bridge	Identified in 2005 by CoR. Provides a more efficient alternative outlet for MEA local traffic travelling via See Street to reduce impacts on Bowden Street/Constitution Road intersection.	1,4
Signalising Bowden Street/Constitution Road	Identified in 2005 by CoR. Congestion and uneven approach volumes leads to some movements being adversely affected with excessive delays. Also, this area is expected to accept far more pedestrian movements in the future due to MEA development. There are limitations to the size of the signalised intersection able to be provided and hence the proposal is more about capacity balancing and conflict management rather than purely providing additional throughout capacity.	1,3,5
See Street/Angus Street roundabout	Identified in 2005 by CoR. Facilitates Angus Street traffic accessing See Street, consistent with the intent of widening the Angus Street bridge for use by locally-generated traffic.	1,4
Completion of the Rothesay Avenue Link, connections to it plus the roundabouts at Rothesay/Bowden and Rothesay/Belmore	Identified in 2005 by CoR. This link provides access to the Shepherds Bay Development area from the east and west. The modelling of this link in the draft preferred option has assumed that it is not connected in the middle due to the string desire to use it as a "rat run" if it were connected through and the limited effects that traffic calming measures would have on diminishing these effects.	2,4
Roundabout at McPherson/Rhodes/Mellor	This route is increasing in its usage in the future and non-priority movements are expected to be impacted by significant delays. The roundabout provides an opportunity for these local movements to pass through the intersection with reduced delay.	1,4
Roundabout at McPherson/See	This route is increasing in its usage in the future and non-priority movements are expected to be impacted by significant delays. The roundabout provides an opportunity for these local movements to pass through the intersection with reduced delay.	1,4
McPherson/Bowden left in/out	The right turns out of McPherson into Bowden in particular are potentially hazardous due to the limited separation distance at this intersection and gaps for right turns into McPherson can be difficult to judge due to roundabout departures immediately to the south. These issues are exacerbated in the future with increasing volumes and the left in/out configuration better manages these movements.	5
Yerong/Belmont left in/out	The right turns into Yerong from Belmont are potentially hazardous due to the limited separation distance from the roundabout. Similarly, right turns out can be difficult as opposing vehicles exit the roundabout nearby. These issues are exacerbated in the future with increasing volumes and the left in/out configuration better manages these movements.	5
LATM scheme in Squire Street	The intent of this scheme is to reduce the propensity to "rat run" through this street by reinforcing its residential character. An important part of this scheme will be speed management for safety and for reducing its attractiveness as a through route.	2
Hamilton "Lane" and Nancarrow "Lane" LATM and two-way construction between Belmore and Bowden	With Hamilton Crescent connected through the Nancarrow Avenue there will be a strong desire to use this route as a "bypass" of Constitution Road in peak times. This route will need to be heavily constrained (almost to a "shared zone" level) to discourage through and promote its use as a pedestrian link. A "tight" roundabout at Nancarrow/Hamilton is also proposed	2,3
Underdale Lane/Bowden Street signalised intersection	With the proposed development in the MEA, Nancarrow Avenue and Underdale Lane will become a key pedestrian route through to Bay Street and the rail station. Traffic signals are proposed at this location on the basis of future pedestrian and traffic volumes at this location and also as a mechanism for discouraging through traffic passing from Nancarrow to Underdale, which is clearly shown as a desirable rat run in the future.	1,3
Underdale Lane LATM	Underdale Lane is intended to function as a local access link and a key pedestrian route. Modelling however has shown that without this street being constrained, it will be an attractive through traffic rat run. The proposal is to severely constrain this street west of Argus Street such that it functions as a "shared zone" or equivalent.	2,3

[1] Refer to the Key Objectives in section 5.1.2

A preliminary assessment has been undertaken for the intersections proposed to be signalised in the draft preferred network. Whilst none of the intersections currently meet RMS warrants for signalisation, it is very likely that with the additional pedestrian movements generated by the MEA developments that these will "tip" these intersections into meeting the RMS warrants.

One exception is the proposed signalisation of the four-way intersection of Nancarrow Avenue, Bowden Street and Underdale Lane. Rather than requiring signals there based on retrospective warrants, this intersection is intended to be signalised as a proactive means of reducing "rat running" whilst promoting the safety and efficiency of what will evolve into the primary east-west pedestrian route through Meadowbank.

5.2.2 Modelling Results

Figure 5.1 shows the Volume-Capacity conditions at intersections for the draft preferred network. In general, the proposed network upgrades shown in Table 5.1 overcome some of the capacity and residential amenity issues identified during option testing. However, as shown in Figure 5.1, a number of intersections in the area are shown to operate over capacity under this network.

Figure 5.1: Intersection Volume-Capacity Conditions (Draft Preferred Network)

It is clear through the option testing and consideration of constraints in the area that the intersections surrounding the Meadowbank Railway Station (i.e. between the bridge over the railway line and Constitution Road each side of the rail station) are not able to be designed to accommodate expected traffic volumes within current geometrical constraints and there is little willingness by Council to expend significant funds on potential solutions in this area which would simply increase the attractiveness and speed of "rat running" traffic. The finalisation of the preferred network has therefore considered that there are no practical solutions to over-capacity operations in this area.

Similarly, this report does not consider potential options to overcome capacity issues on the RMS roads of Victoria Road and Church Street and the scale of the upgrades required and their downstream effects are on other intersections are beyond the scope of this study.

The remaining over-capacity intersections are mostly in the south-east corner of the MEA reflecting an increase in locally-generated and through traffic to/from the M3 using the southern end of Belmore Street. The connections of Hamilton Lane through to the Belmore Street and the recent completion of Well Street through to Belmore Street see both of these intersections with Belmore Street reaching capacity as turns into/out of these streets are opposed by heavy through movements. The geometry of the two-leg roundabout at Belmore Street and Parsonage Street also reaches its geometrical capacity (as there are no competing flows).

Beyond this area, the intersection of See Street and Stone Street also reaches capacity due to the increasing use of this route as an alternative to the increasingly congested Bowden Street and to avoid the Bowden Street/Constitution Road signalised intersection.

Figure 5.2 shows the relative traffic volumes under this option. This figure highlights that the LATM schemes introduced along with the closure of Rothesay Avenue mid-block has severely reduced through traffic on local east-west streets and lane-ways and encouraged greater use of Constitution Road (compared to the options tested). The plots in Figure 5.2 also show increasing use of Belmore and Bowden Streets and hence the importance of the changes proposed at their intersections with McPherson Street and Yerong Street respectively.

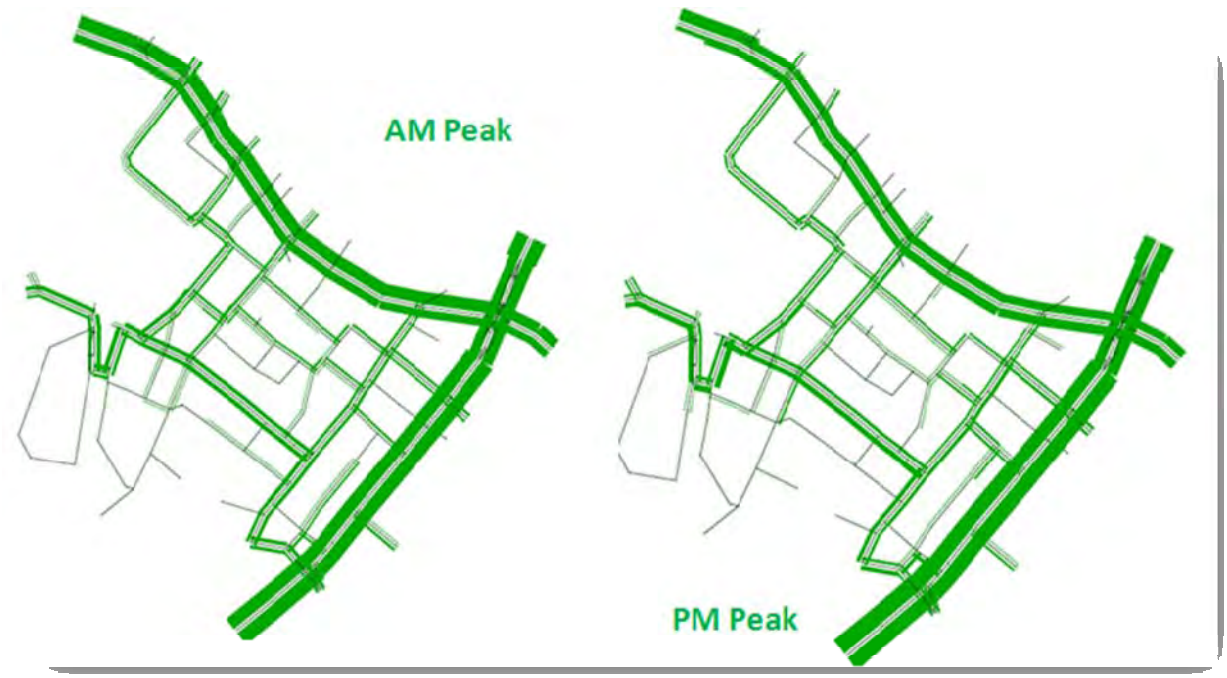


Figure 5.2: Relative Network Volumes (Draft Preferred Network)

Based on the results of the options testing, a number of refinements were made to the draft preferred option and re-modelled. These additional network modifications included:

- introduction of a roundabout at See Street/Stone Street;
- limiting the intersection of Hamilton Lane and Belmore Street to left in/left out;
- introduction of a LATM scheme in Well Street to reduce its speed to 10kph; and
- slight modifications to the roundabout where Belmore Street connects to Parsonage Street to reduce the curvature of the intersection and reduce the need to "prop" for potential U-turners, hence improving its geometrical capacity.

5.3 PREFERRED NETWORK

5.3.1 Description

The preferred network is shown in Figure 5.3 with the recommended upgrades from what is currently in the network (as at July 2012) are documented in Table 5.2.

Table 5.2: Recommended Upgrades

ID	Upgrade Description
1	Pedestrian signals replacing the zebra crossing on Railway Road at the Station.
2	Roundabout at See Street/Constitution Road
3	Widening the Angus Street bridge
4	Signalising Bowden Street/Constitution Road
5	See Street/Angus Street roundabout
6	Completion of the Rothesay Avenue Link, connections to it plus the roundabouts at Rothesay/Bowden and Rothesay/Belmore
7	Roundabout at McPherson/Rhodes/Mellor
8	Roundabout at McPherson/See
9	McPherson/Bowden left in/out
10	Yerong/Belmont left in/out
11	LATM scheme in Squire Street
12	Hamilton “Lane” and Nancarrow “Lane” LATM and two-way construction between Belmore and Bowden
13	Underdale Lane/Bowden Street signalised intersection
14	Underdale Lane LATM
15	Roundabout at See Street/Stone Street
16	Hamilton Lane/Belmore Street left in/left out
17	Well Street LATM
18	Belmore Street/Parsonage Street roundabout – remove u-turn potential and modify alignment

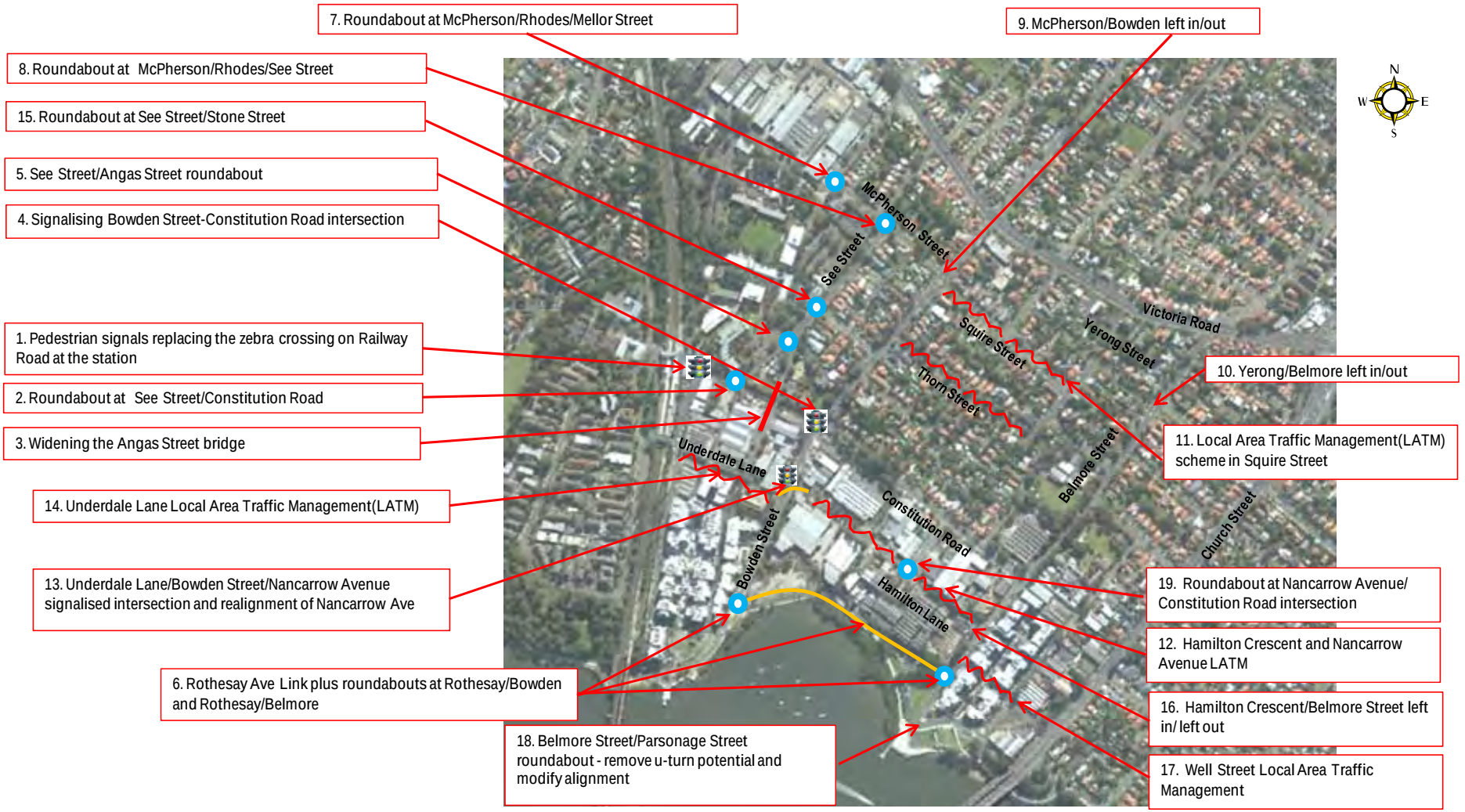


Figure 5.3: Meadowbank 2031 Preferred Network

5.3.2 Modelling of the Preferred Network

The volume-capacity performance of each intersection in the network is shown in Figure 5.4 for the preferred network. This figure shows the network identified as being needed to support background traffic growth, development under LEP2011 and development associated with the Part 3A applications in the MEA.

Figure 5.4: Intersection Volume-Capacity Conditions (Preferred Network)

Figure 5.4 shows that, apart from the intersections on Victoria Road, on Church Street and the intersections/pedestrian crossings around the Meadowbank Rail Station, all other intersections operate under capacity in 2031 under this scenario.

The final traffic volumes under this scenario are shown in Figures 5.5 and 5.6.

A check has also been undertaken on key east-west residential streets to determine if any of these would exceed their daily "environmental" capacity. It is recognised that rat running through Meadowbank's residential areas is only likely to be a significant issue in peak periods. Notwithstanding this, daily volumes have been estimated by multiplying the AM and PM peak two-way volumes by 5.0. The estimated daily volumes for selected local streets are shown in Table 5.3.

Table 5.3: Estimated Daily Volumes on Selected Residential Streets

Street	2031 Daily Volume Estimate
Squire Street - between Shepherd Street and Sutherland Avenue	2,600
Thorn Street - between Bowden Street and Robert Street	3,600
Hamilton Crescent – between Belmore Street and Nancarrow Avenue	1,500
Nancarrow Avenue - between Bowden Street and Belmore Street	1,700
Underdale Lane - between Bowden Street and Angus Street	900

Table 5.3 highlights that all of the residential streets show daily volumes less than 5,000 vpd which would ordinarily be considered the limit of environmental capacity in a local street that is not designed to cater for through traffic.

SATURN

Atkins Ltd /
DVV / ITS

ANK_2031_AM_
OPTION6A.UFS

Scale 9477

Link Annot:

Actual flow

Figure 5.5: Link Volumes for the Preferred Network - 2031 AM Peak

SATURN

Atkins Ltd /
DVV / ITS

ANK_2031_PM_
OPTION6A.UFS

Scale 9477

Link Annot:

Actual flow

Figure 5.6: Link Volumes for the Preferred Network - 2031 PM peak

5.3.3 Differences with No Part 3A development

The preferred network was subsequently run with the Part 3A development traffic demands removed leaving the LEP2011 traffic demands for 2031.

In general there was very little difference in the link volumes under each option given that the only 400 additional trips per peak hour (approx.) are generated when Part 3A developments are included in place of what would have otherwise been development consistent with LEP2011.

Figures 5.7 and Figure 5.8 show the absolute volume differences between the two scenarios.

These figures demonstrate that the Part 3A development traffic has its greatest influence locally around Nancarrow Avenue and Belmore Street (primarily) with some broader traffic re-assignment noticed in other streets in Meadowbank as a consequence of Part 3A traffic "pushing" traffic to other routes.

5.4 CONCEPTS AND COST ESTIMATES

Concept diagrams have been prepared for each proposed improvement item as a basis for determining the order estimated construction costs for each item.

The cost estimates have relied on limited utilities information and have been based on rates used for construction projects within the City if Ryde in recent years. Accordingly, these estimates should only be considered as indicative construction costs.

The proposed upgrade items and associated construction costs (in 2012 dollars) are provided in Table 5.4. Further details are provided in Appendix D.

Table 5.4: Improvement Items and Indicative Construction Costs

ID	Upgrade Description	Indicative Construction Cost Estimate
1	Pedestrian signals replacing the zebra crossing on Railway Road at the Station.	$304,300
2	Roundabout at See Street/Constitution Road	$102,000
3	Widening the Angus Street bridge	$300,800
4	Signalising Bowden Street/Constitution Road	$603,500
5	See Street/Angus Street roundabout	$100,700
6	Completion of Rothesay Avenue Link + roundabouts at Rothesay/Bowden and Rothesay/Belmore[1]	$475,800
7	Roundabout at McPherson/Rhodes/Mellor	$108,700
8	Roundabout at McPherson/See	$108,100
9	McPherson/Bowden left in/out	$51,700
10	Yerong/Belmont left in/out	$47,400
11	LATM scheme in Squire Street	$97,300
12	Hamilton "Lane" and Nancarrow "Lane" LATM and two-way construction between Belmore and Bowden	$119,200
13	Underdale Lane/Bowden Street signalised intersection	$404,600
14	Underdale Lane LATM	$70,700
15	Roundabout at See Street/Stone Street	$93,500
16	Hamilton Lane/Belmore Street left in/left out	$157,600
17	Well Street LATM	$58,000
18	Belmore Street/Parsonage Street roundabout – remove u-turn potential and modify alignment	$96,200
	TOTAL	$3,107,200

[1] *Represents the total construction for these works assuming no parts completed by others*

SATURN

Atkins Ltd /
DVV / ITS

ANK_2031_AM_
OPTION7A.UFS
_AM_OPTION6A

Scale 9477

Link Annot:

+ Actual flo
- Actual flo

Differ: 2-1

Figure 5.7: Trafifc Volume Differences (Land Use Scenario 2-Land Use Scenario 1) - AM Peak

SATURN

Atkins Ltd /
DVV / ITS

ANK_2031_PM_
OPTION7A.UFS
_PM_OPTION6A

Scale 9477

Link Annot:

+ Actual flo
- Actual flo

Differ: 2-1

Figure 5.8: Traffic Volume Differences (Land Use Scenario 2-Land Use Scenario 1): PM Peak

6. STAGING AND APPORTIONMENT

6.1 STAGING AND APPORTIONMENT METHODOLOGY

Additional traffic infrastructure works within the MEA and broader Meadowbank area are a consequence of traffic growth from a range of travel "markets", including:

- background through traffic (essentially "rat running" traffic);
- LEP2011 development traffic and pedestrian needs; and
- additional Part 3A development traffic and pedestrian needs (i.e. in excess of what the LEP traffic effects are).

In addition, some works associated with Part 3A developments could be considered as "frontage works" or "internal access works" associated with the needs and/or impacts of specific developments.

The principles used for identifying the responsibilities for upgrade works associated with the Holdmark Part 3A development are:

- apportioning 100% of the responsibility for construction of works identified as being a direct impact of the development; and
- apportionment of a percentage of the works required where Holdmark Part 3A development traffic and/or pedestrians are expected to use a new/upgraded infrastructure item.

6.2 APPORTIONMENT, JUSTIFICATION AND TIMING

Table 6.1 outlines the proposed works, the suggested apportionment justification and timing or "trigger points" for these works.

Table 6.1: MEA Traffic Infrastructure, Apportionment and Timing

ID	Upgrade Description	Holdmark Proportion	Reasoning	Timing/Trigger
1	Pedestrian signals replacing the zebra crossing on Railway Road at the Station.	10%	Minor contribution associated with additional pedestrian movements generated at this crossing.	As soon as RMS warrants are met
2	Roundabout at See Street/Constitution Road	None	Not needed for, or used by, Holdmark (<5%)	When signals at Bowden/Constitution are constructed
3	Widening the Angus Street bridge	None	Need for this upgrade not generated by Holdmark	As determined by Council, before 2031
4	Signalising Bowden Street/Constitution Road	20%	Minor contribution associated with development-related traffic and increasing pedestrian demands through this intersection	At the same time as the early stages of the Shepherds Bay Development
5	See Street/Angus Street roundabout	None	Not needed for, or used by, Holdmark (<5%)	When Angus Street bridge widened
6	Completion of the Rothesay Avenue Link, connections to it plus the roundabouts at Rothesay/Bowden and Rothesay/Belmore	100%	Local connection primarily for development access	As part of the Shepherds Bay Development
7	Roundabout at McPherson/Rhodes/Mellor	None	Not needed for, or used by, Holdmark (<5%)	As determined by Council, before 2031
8	Roundabout at McPherson/See	None	Not needed for, or used by, Holdmark (<5%)	As determined by Council, before 2031
9	McPherson/Bowden left in/out	None	Not needed for, or used by, Holdmark (<5%)	As determined by Council, suggested by 2017
10	Yerong/Belmont left in/out	50%	Reasonable increase in Belmont due to Holdmark; exacerbating existing safety issue	At the same time as the early stages of the Shepherds Bay Development
11	LATM scheme in Squire Street	None	Need for this work not generated by Holdmark	As determined by Council, suggested by 2017
12	Hamilton “Lane” and Nancarrow “Lane” LATM and two-way construction between Belmore and Bowden	100%	Within the site and related to connections made	At the same time as the early stages of the Shepherds Bay Development
13	Underdale Lane/Bowden Street signalised intersection	100%	Directly linked to traffic and pedestrian management associated with Shepherds Bay development	When Nancarrow Avenue is realigned to Underdale Lane, suggested as part of the early stages of the development
14	Underdale Lane LATM	100%	Directly linked to reducing traffic from Shepherds Bay development through this area and facilitating pedestrian movements between the site and the retail/station area.	When Nancarrow Avenue is realigned to Underdale Lane, suggested as part of the early stages of the development
15	Roundabout at See Street/Stone Street	None	Not needed for, or used by, Holdmark (<5%)	As determined by Council, before 2031
16	Hamilton Lane/Belmore Street left in/left out	100%	As part of the connection of Hamilton Crescent/Lane to Belmore Street	When Hamilton Crescent is connected through to Belmore Street
17	Well Street LATM	50%	Partly as a consequence of local Holdmark traffic.	As part of 157 Church Street Part 3A
18	Belmore Street/Parsonage Street roundabout – remove u-turn potential and modify alignment	50%	Partly as a consequence of local Holdmark traffic	50% completion of 157 Church or 50% of Shepherds Bay

7. CONCLUSIONS

Meadowbank's "internal" road network is currently heavily used in peak times by through traffic primarily related to congestion and long delays on adjoining major roads such as Victoria Road and Church Street. Constitution Road, Bowden Street, Railway Road, Bank Street and Belmore Street are some of the most heavily used streets forming various through routes in the area. In fact, over 70% of the traffic in Meadowbank in peak times is through traffic.

The Meadowbank Employment Area (MEA) is proposed by City of Ryde under its LEP2011 to convert an ageing industrial area into a modern employment and residential precinct. A number of Part 3A applications have been received within the MEA in recent years by the Department of Planning and these proposals generally foreshadowed higher development densities than expected under LEP2011. The development levels assumed in each land use scenario are summarised in Table 7.1.

Table 7.1: Development Levels Under Each Scenario

Scenario	Additional Units	Additional Commercial Area(m^2)
1. LEP2011 in the MEA	3,210	13,799
2. Part 3A applications + LEP2011 elsewhere in the MEA	3,978	18,883

The above land use scenarios have been modelled in a SATURN Model created for Meadowbank considering a range of future network options. This process has led to a series of traffic and pedestrian infrastructure upgrades to be proposed with associated timeframes and responsibilities for construction.

Key conclusions from this analysis are as follows:

- peak hours in Meadowbank are 7:15 AM-8:15 AM and 4:45 PM-5:45 PM;
- a SATURN model has been created and validated to RMS Paramics Modelling guidelines (given that no mesoscopic modelling guidelines currently exist in NSW);
- key existing issues primarily relate to rat running traffic through Meadowbank. In the morning peak, the issues are typically focussed eastbound however the Bank Street-Railway Road area constrains the volume of traffic that can move further east. Constraints in this area include pedestrian crossings and the tight alignment at the rail bridge and adjacent roundabout. In the afternoon peak this constraint area blocks traffic back along Constitution Road to Belmore Street with increasing use of residential streets to bypass this congestion to access Bowden Street and Victoria Road westbound;
- the traffic generated under LEP2011 as well as background traffic is expected to introduce an additional 1,300-1,500 peak hour trips into Meadowbank (an increase of 8%-9% over 2012 values);
- the traffic generated under the Part 3A applications will introduce approximately 400-500 more peak hour trips into the study area compared to the LEP2011 (only) scenario. In terms of additional, locally generated traffic between 2012 and 2031, this represents am increase of about 60%;
- the MEA development will introduce an increasing need for improved pedestrian access between this area, the rail station and the retail/commercial area on Bay Street and the quality and safety of thee pedestrian connections will become increasingly important;
- the SATURN modelling suggests that the works proposed by CoR (in 2005 as part of the MEA Master Plan) will be insufficient to cater for 2031 traffic demands and additional traffic upgrades will be required;
- the SATURN modelling of options to overcome future traffic issues identified the need to cater for additional through traffic routes whilst minimise the impacts on local traffic movements and residential amenity. This is best achieved through a combination of targeted intersection upgrades and the introduction of Local Area Traffic Management Schemes;
- there is little desire to "unconstrain" the area around the Meadowbank Railway station as this would simply allow/encourage more rat running traffic to pass into Meadowbank, generating traffic and pedestrian-conflict issues for more parts of the network;
- Rothesay Avenue should not be connected as a through traffic due to the string demand for this route to be used by rat running traffic. This road may need to be closed mid-block as the modelling has

demonstrated that even with sever traffic calming measures, the direct nature of this link to the rail bridge introduces strong traffic demand onto this road with consequences for Bay Drive and Underdale Lane as well; and

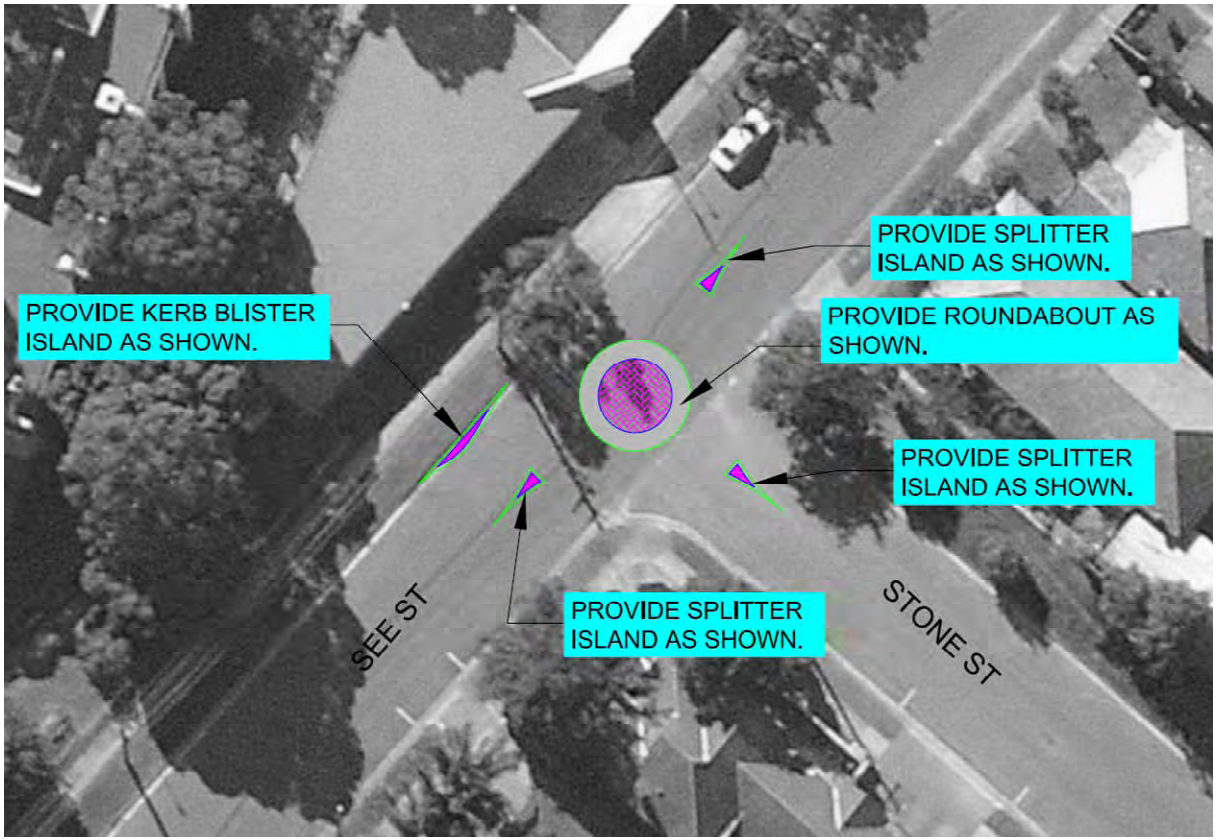
- a number of network upgrades have been identified in Table 6.4. These upgrades are expected to provide sufficient network capacity under the land use scenario with the Part 3A applications' development levels in place.

Overall, some roads in Meadowbank are at capacity now, primarily due to rat running traffic. The development levels proposed under LEP2011 would displace some of this traffic onto alternative routes within Meadowbank and a series of LATM schemes and intersection upgrades will be required for traffic accessibility to be maintained and pedestrian conflicts to be appropriately managed. Any reduction in development levels proposed within the MEA will, of course, reduce these issues and hence reduce the need for works in the area. The traffic upgrades identified in this report for Meadowbank will cost in the order of $3M to implement.

Any major increase in development in the MEA (e.g. doubling) would be expected to have much more significant traffic impacts in the residential streets which may not be able to be managed through LATM schemes and localised intersection upgrades. Furthermore, such a change in development levels may not be able to be absorbed by the network given the edge constraints that currently exist, resulting in further queuing accessing the area from Victoria Road, Church Street and Constitution Road west.

The higher levels of development proposed in the Holdmark Part 3A proposals will exacerbate these issues generally bringing forward the need and increasing the size of the traffic and pedestrian facility upgrades required although this development does not introduce a number of other major upgrade items not contemplated before.

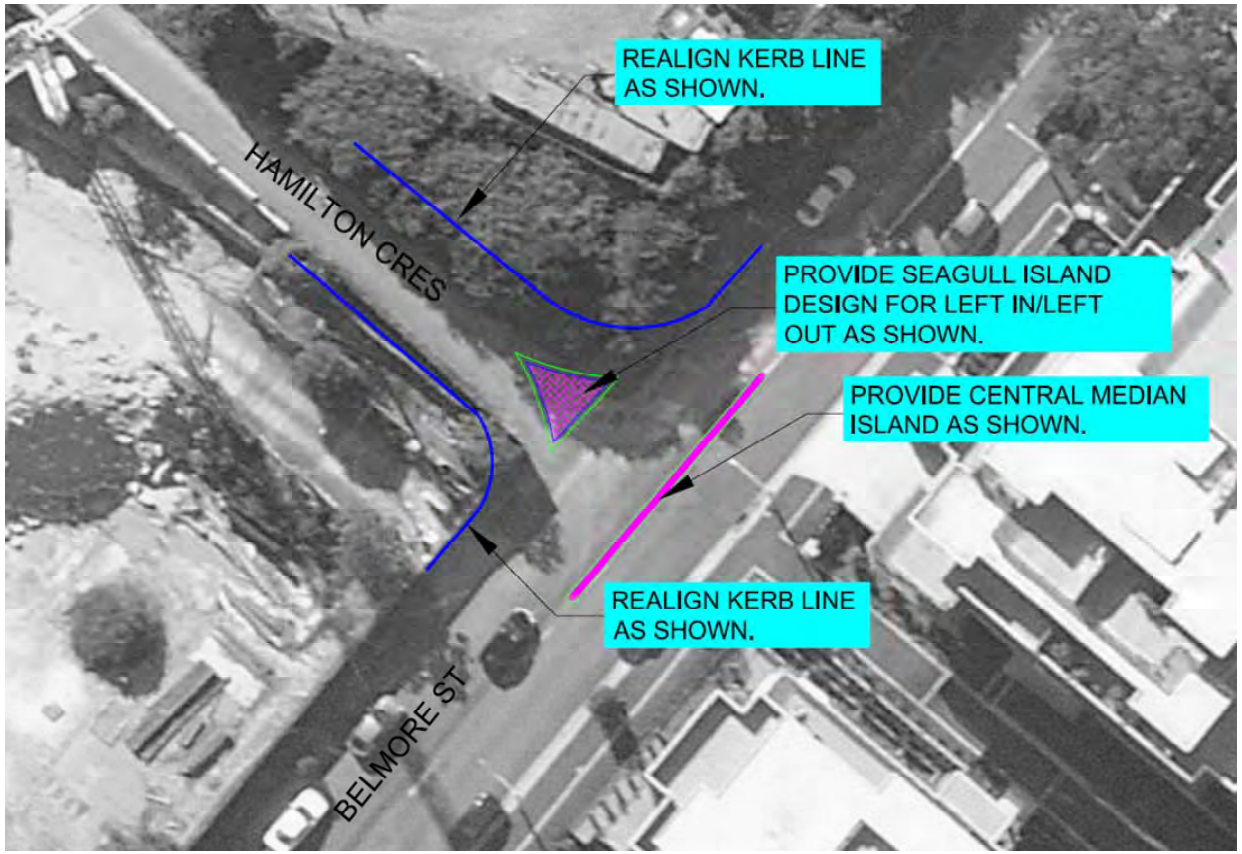
15. Roundabout at See/Stone



Cost Estimate Summary

Item	TOTAL	
Civil Works	$	60,100
Traffic Control	$	11,700
Project Management	$	6,100
Contingency @ 20%	$	15,600
Total	**$**	**93,500**

16. Left in/out at Hamilton/Belmore



Cost Estimate Summary

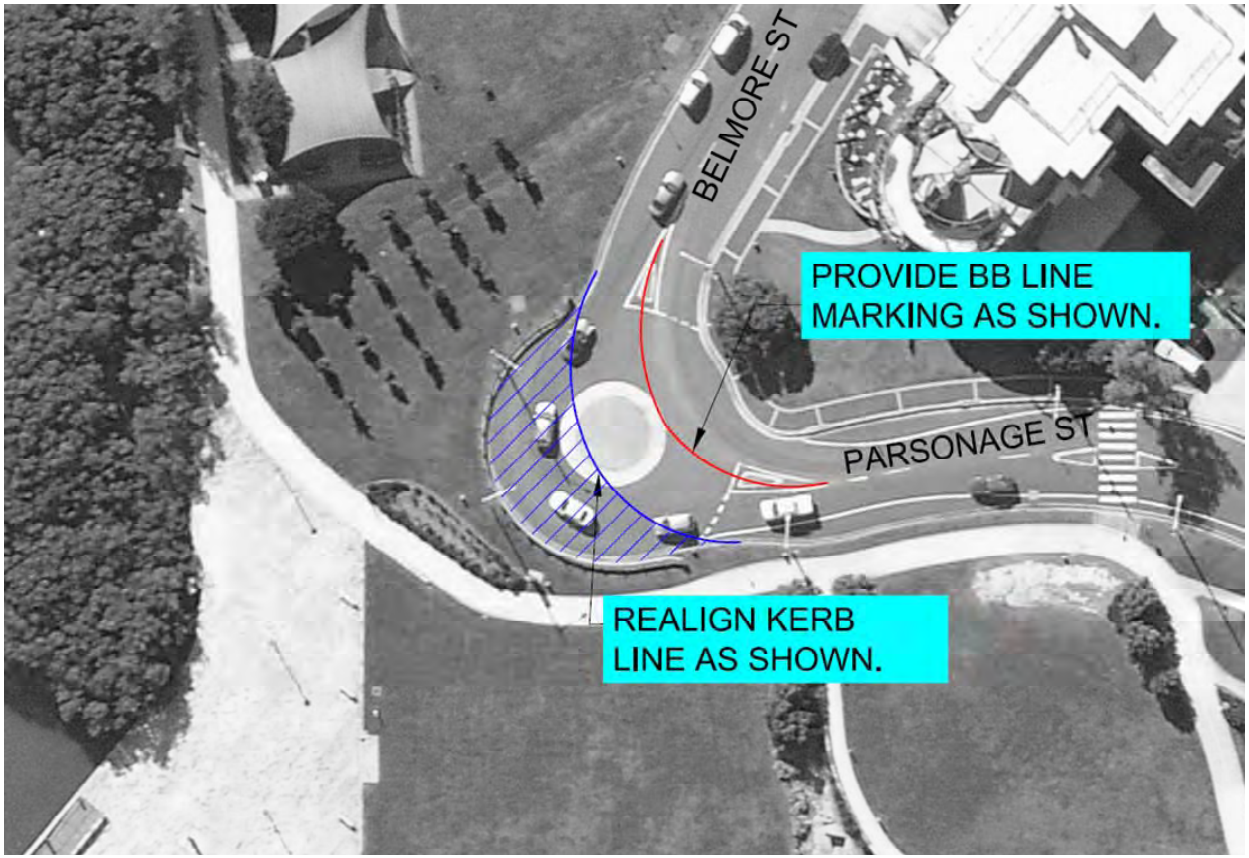
Item	TOTAL	
Civil Works	$	116,000
Traffic Control	$	8,800
Project Management	$	10,700
Contingency @ 20%	$	27,100
Total	**$**	**162,600**

17. LATM Scheme in Well Street

Cost Estimate Summary

Item	TOTAL	
Civil Works	$	35,700
Traffic Control	$	8,800
Project Management	$	3,800
Contingency @ 20%	$	9,700
Total	**$**	**58,000**

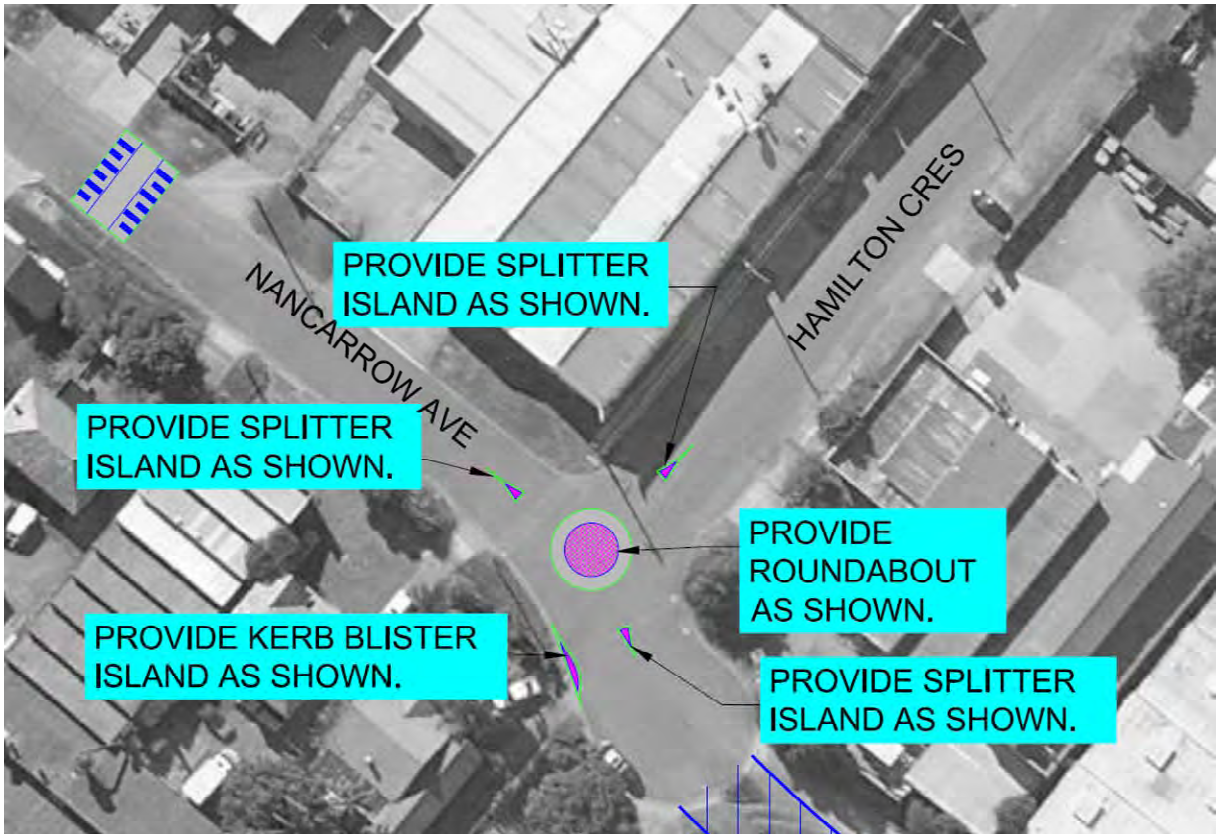
18. Removal of U-turn potential & modifying alignment at Belmore/Parsonage



Cost Estimate Summary

Item	TOTAL	
Civil Works	$	62,200
Traffic Control	$	11,700
Project Management	$	6,300
Contingency @ 20%	$	16,000
Total	**$**	**96,200**

19. Roundabout at Nancarrow/Hamilton Intersection



Cost Estimate Summary

Item	TOTAL	
Civil Works	$	65,400
Traffic Control	$	11,700
Project Management	$	6,600
Contingency @ 20%	$	16,700
Total	**$**	**100,400**