



87 BAY STREET, GLEBE TRAFFIC IMPACT ASSESSMENT

FOR

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Issue History

Report File Name	Prepared by	Reviewed by	Issued by	Date	Issued to
P1082.001R 87 Bay Street TIA.doc	S.Read	A Finlay	A Finlay	14/09/2012	Anthony Elias Chase Property Investments
P1082.002R 87 Bay Street TIA.doc	S.Read	A Finlay	A Finlay	19/09/2012	Anthony Elias Chase Property Investments



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1. INTRODUCTION

Bitzios Consulting has been commissioned by MT Management Pty Ltd to undertake a traffic impact assessment of the proposed mixed use development at 87 Bay Street, Glebe. This report presents findings of the study into traffic effects of the proposed development, including the results of the Paramics micro-simulation modelling of the local streets.

The proposal is for a mixed commercial office, residential and retail development. The residential dwelling units comprise a mix of studio, 1 bedroom, 2 bedroom and 3 bedroom apartments. Included in the residential development is 'affordable housing' which provides low cost housing for people on lower incomes. A small convenience type store is proposed to service the residential and commercial elements.

The report covers:

- Existing traffic conditions including, access, traffic volumes and parking;
- Proposed development including parking and access arrangements, and predicted traffic generation; and
- Traffic effects of the proposal as assessed by the Paramics micro-simulation traffic model.

1.1 PREVIOUS STUDIES

The site was the subject of a previous traffic impact assessment report by Arup in October 2011. That report was a preliminary assessment of the site and did not include any traffic analysis. Since that report was completed, the proposed development has changed somewhat in mix of use.

1.2 ADJACENT DEVELOPMENTS

The site is adjacent to a proposed Housing NSW development to the south. This Housing NSW development is proposed as a mix of market units, seniors living social housing and 'affordable' dwellings. The predicted traffic generation of the Housing NSW site has been taken into account in the preparation of this study.

2. EXISTING CONDITIONS

2.1 SITE LOCATION

The site is located at 87 Bay Street, Glebe and is bounded by Bay Street, Wentworth Park Road, Cowper Street and Wentworth St. (see Figure 2.1) The study area encompasses Wattle Street, Bay Street and Cowper Street.

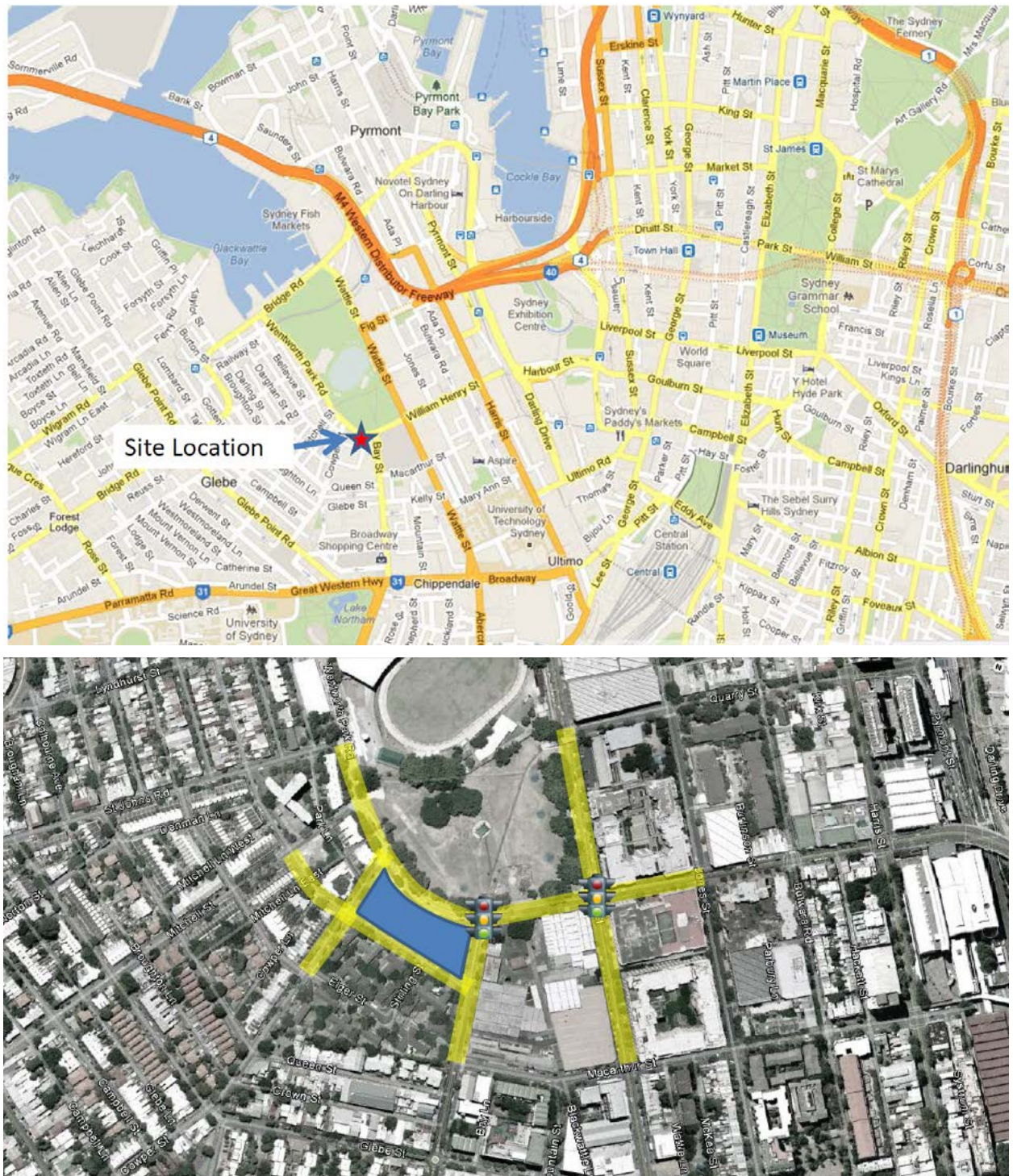


Figure 2.1 Site Location and Study Area

2.2 LOCAL ROAD NETWORK

The local road network has a 50km/h area speed zone. Wattle Street is the main northbound route through the area. Local traffic generators in the area include the Broadway Shopping Centre, Sydney CBD and the Fish Markets.

Wattle Street is a one-way street that functions as an arterial connector linking Broadway to the Sydney Harbour Bridge, Anzac Bridge and the city north. It operates effectively as a one-way pair with Harris Street southbound. Traffic can access the Sydney Harbour Bridge via Fig Street, and the Anzac Bridge via Pyrmont Bridge Road. Wattle Street is four lanes wide although on-street parking is permitted on some sections.

Wentworth Park Road / William Henry Street is a collector road that connects Pyrmont Bridge Road to the southern CBD via Pier Street and Goulburn Street. Within the study area it is generally 4 lanes wide with parking in the kerb side lanes.

Bay Street is a local collector street that runs north-south. It connects Broadway to William Henry Street. In general it is a typical 12.8m road with parking in the kerb side lanes and allows a single lane in each direction. At its southern end (outside the study area) there is a vehicular access to the Broadway Shopping Centre which is a major traffic generator in this area.

Wentworth Street is a local street that is some 8m wide and has parking on either side. The eastern end of Wentworth Street is one-way eastbound.

Cowper Street is a local street connecting Glebe Point Road to Wentworth Park Road. It is some 10m wide and allows for traffic in both directions.

2.3 EXISTING TRAFFIC VOLUMES

Traffic surveys were undertaken on 30 August by Traffic Data & Control at key intersections:

- Cowper Street / Wentworth Park Road
- Cowper Street / Wentworth Street
- William Henry Street / Wattle Street
- Bay Street / William Henry Street
- Bay Street / Wentworth Street

These traffic counts are presented in Appendix A of this Report.

The key mid-block volumes are shown in Tables 2.1 and 2.2. They show that there is tidal traffic flow behaviour along William Henry Street and Bay Street toward the city in the morning and away from the city in the afternoon. Wattle Street traffic volumes remain consistent in both peaks.

Table 2.1 AM Peak Mid-Block Traffic Volumes (8:00am – 9:00am)

Mid - Block	Northbound or Eastbound	Southbound or Westbound
William Henry Street (Bay Street – Wattle Street)	612	396
William Henry Street (Cowper Street – Bay Street)	817	397
Cowper Street (Wentworth Street – Wentworth Park Road)	31	118
Bay Street (Wentworth Street – William Henry Street)	289	493
Wattle Street (before William Henry Street)	1922	-

Table 2.2 PM Peak Mid-Block Traffic Volumes (5:00pm – 6:00pm)

Mid - Block	Northbound or Eastbound	Southbound or Westbound
William Henry Street (Bay Street – Wattle Street)	495	697
William Henry Street (Cowper Street – Bay Street)	574	932
Cowper Street (Wentworth Street – Wentworth Park Road)	27	101
Bay Street (Wentworth Street – William Henry Street)	619	463
Wattle Street (before William Henry Street)	2006	-

2.4 PUBLIC TRANSPORT

A trunk bus route is located on Parramatta Road some 500m walk to the south of the site. Buses from here connect to the CBD and to the inner-west. Bus stops are also located on Harris Street near Quarry Street, also about 500m from the proposed development.

A tram stop is located 1km from the site at the Fish Markets light rail station, with access available via walking.

2.5 CYCLING

The site is located adjacent to a bicycle route with access to the greater City of Sydney bicycle network. A shared path traverses Wentworth Park with connections to the CBD and to Anzac Bridge shared path.

2.6 WALKING

The area has excellent pedestrian connections with signalised crossings and footpaths. A grade separated crossing of Wattle Street near Quarry Street exists which has good connections to the Sydney CBD via Darling Harbour. Sydney Town Hall is within 1.6km (15 minute) walk from the site.

2.7 EXISTING DEVELOPMENTS

The site is currently used by a variety of commercial offices and a tertiary college of which the major tenant is the Australasian College. Other tenants on the site include a construction and project management company and an equipment hire shop. These existing developments have off-street parking with access from various driveways distributed around the block. The main driveways are located on Wentworth Park Road and Cowper Street.

2.8 EXISTING PARKING

On-street parking on Wentworth Park Road and Cowper Street is 2 hours (8am-6pm) while in Bay Street, and Wentworth Street there are no parking restrictions.

There are 67 designated off-street car spaces in the existing developments across five separate car-parking areas. Many of the spaces in the lower basement of Building 5 are tandem parking bays. Table 2.3 presents the allocation of the existing parking spaces.

Table 2.3 Existing Off-Street Car Parking

Building	1	6	5 (Upper Basement)	5 (Lower Basement)	4a	Total
Car Spaces	3	20	11	32	1	67

2.9 EXISTING TRAFFIC GENERATION

The existing site is assumed to generate 64 trips per hour in the peak hour based on the RTA Guide to Traffic Generating Development rates for commercial offices.

The majority of the site is used by a private college. The RTA Guide to Traffic Generating Developments provides no guidelines for traffic generation for similar developments. However a significant proportion of the college is the administration and office. Similarly the majority of the other businesses are commercial offices. The construction company have a high turnover of vehicles as project managers travel to and from sites. Therefore the traffic generation for the site is based on the RTA Guide to Traffic Generating Developments recommendation for offices of 2 trips per 100m².

At this rate for a total leasable floor area of 3200m² the traffic generation would be 64 trips per hour. These trips are assumed to be split 80% in and 20% out in the morning peak and vice versa in the afternoon peak. That is, 51 trips to the site and 13 trips from the site in the morning peak, and 13 trips to the site and 51 trips from the site in the afternoon peak.

2.10 ADJACENT DEVELOPMENTS

At the time of this study the Housing NSW site to the south of the proposed development (see Figure 2.2) had been cleared and was not generating any traffic. However this study has taken into account that the site will become developed with a mix of market based apartments, seniors living social housing apartments and 'affordable' housing.



Figure 2.2 Housing NSW Site Location

3. THE PROPOSAL

3.1 PROPOSAL

The proposal is for a mixed use development with residential, commercial and retail components. The site is to be divided into two separate structures with separated car parks and access arrangements.

The two sections are called Bay Street (East) Block and Cowper Street (West) Block. The mix of residential units is indicated in Table 3.1 below.

Table 3.1 Residential Unit Mix

	Studio	1 Bed	2 Bed	3 Bed	Total
Bay Street (East) Block	6	22	44	8	80
Cowper Street (West) Block	9	33	67	11	120
Total	15	55	111	19	200

A commercial office component will be included on the lower levels. The floor areas (GFA) for each block are:

- Bay Street Block 780m²
- Cowper Street Block 1220m²
- Total 2000m²

A small retail area (100m²) will be provided on the ground floor of the Bay Street Block suitable for a café or small convenience store to service the development.

3.2 VEHICULAR ACCESS

The proposed access locations are on Cowper Street and Wentworth Street (see Figure 3.1). Separate service vehicle access will be provided.



Figure 3.1 Access locations

3.3 TRAFFIC GENERATION

Based on the RTA Guide to Traffic Generating Developments the following generation rates were assumed:

- 0.29 Trips per apartment (high density residential)
- 2 Trips per 100m² of commercial office

The residential traffic generation of 0.29 was more conservative than the 0.24 rate applicable for CBD areas. We have assumed that the retail area would only serve the building and would not attract any additional vehicle trips to the site. In the AM Peak it is assumed that the residential trips are split 10% - 90% to and from the site, while the commercial trips are 80% - 20%. In the afternoon peak, the splits would be reversed. The estimated traffic generation for the site is shown in Tables 3.2 and 3.3.

Table 3.2 AM Peak Traffic Generation (8:00am – 9:00am)

	Apartments	Commercial GFA (m ²)	Vehicle Trips Generated		
			To Site	From Site	Total
Bay Street (East) Block	80	880	16	24	41
Cowper Street (West) Block	120	1220	23	36	59
Total	200	2100	39	61	100

Table 3.3 PM Peak Traffic Generation (5:00pm – 6:00pm)

	Apartments	Commercial GFA (m ²)	Vehicle Trips Generated		
			To Site	From Site	Total
Bay Street (East) Block	80	880	24	16	41
Cowper Street (West) Block	120	1220	36	23	59
Total	200	2100	61	39	100

For the purpose of modelling the traffic effects, the existing traffic generation was subtracted from the proposed traffic generation. The net traffic generation is shown in Table 3.4. The negative trips to the site were subtracted from the base traffic flows in the model. The PM peak would be the same, except in the reverse direction.

Table 3.4 AM Peak Net Traffic Generation

	Existing	Proposed	Net Traffic Generation
To Site	51	39	-12
From Site	13	61	48
Total	64	100	36

To assess the combination of this development and proposed Housing NSW development adjacent to the site, traffic generation was developed for that site. The 0.29 per dwelling rate for traffic generation was adopted here and it was assumed that the 'social housing' generates no vehicular traffic. The AM and PM peak traffic generation for the Housing NSW Site are shown in Tables 3.5 and 3.6.

Table 3.5 AM Peak Traffic Generation Housing NSW Site (8:00am – 9:00am)

	Units	Vehicle Trips Generated		
		Into Site	Out of Site	Total
Market Units	250	7	65	73
Affordable Housing	90	3	23	26
Social Aged Housing	153	-	-	-
Total	493	10	89	99

Table 3.6 PM Peak Traffic Generation Housing NSW Site (5:00pm – 6:00pm)

	Units	Vehicle Trips Generated		
		Into Site	Out of Site	Total
Market Units	250	65	7	73
Affordable Housing	90	23	3	26
Social Aged Housing	153	-	-	-
Total	493	89	10	99

3.4 TRAFFIC DISTRIBUTION

Traffic was assumed to be distributed from the site relatively evenly to the major streets. The traffic distribution assumptions are shown in Table 3.7 below.

Table 3.7 Traffic Distribution

	To Site	From Site
Wentworth Park Road	30%	30%
Wattle Street (south)	20%	-
William Henry Street	30%	20%
Bay Street	20%	20%
Wattle Street (north)	-	30%

The traffic routes to and from the site are indicated in Figures 3.2 and 3.3. It can be seen that some of the traffic routes for the Housing NSW site are beyond the scope of the model. For example, trips from the north would access via Bay Street and Edgar Street.



Figure 3.2 Traffic Assignment to the Site



Figure 3.3 Traffic Assignment from the Site

3.5 PARKING

A total of 162 car parking spaces are to be provided. This is equal to the maximum number of car spaces allowable under the City of Sydney Draft LEP (2011) for land in Category B, which would be 162 car spaces (see Table 3.8). The car-park will be designed in accordance with the Australian Standard AS2890.1 for off-street parking.

The consolidation of driveways on the site may also increase the potential number of on-street parking spaces along Wentworth Park Road frontage.

Table 3.8 Parking Provision

	Provided	Maximum
Residential	135	135
Visitor Residential	16	16
Commercial Office	11	11
Total	162	162

The following describes how the maximum number of car spaces was derived from the City of Sydney Draft LEP (2011). The maximum residential parking is calculated in Table 3.9.

Table 3.9 Maximum Residential Parking

	Studio	1 Bed	2 Bed	3 Bed	Total
Units	15	55	111	19	200
Rate	0.2	0.4	0.8	1.1	-
Maximum Parking Provision	3	22	89	21	135

A further 16 car spaces may be allocated to visitor parking based on the equation:

$$\begin{aligned}
 \text{Visitor spaces} &= (\text{first 30 units} \times 0.167) + (\text{next 40} \times 0.1) + (\text{any additional} \times 0.05) \\
 &= (30 \times 0.167) + (40 \times 0.1) + (130 \times 0.05) \\
 &= 16
 \end{aligned}$$

The commercial office maximum parking is calculated below:

$$\begin{aligned}
 M &= (G \times A) / (50 \times T) \\
 &= (2100 \times 5427) / (50 \times 20,892) \\
 &= 11
 \end{aligned}$$

Where:

- M is the maximum number of parking spaces;
- G is the gross floor area of all office premises and business premises in square metres;
- A is the site area in square metres; and
- T is the total gross floor area of all buildings on the site in square metres.

3.6 BICYCLE PROVISION

Proposed provision is storage of 239 bicycles within the site, which is equal to the 239 stipulated in the City of Sydney 2010 Draft DCP.

The amount of bicycle storage stipulated in the 2010 Draft DCP is shown in Table 3.10.

Table 3.10 Bicycle Storage

	rate	Unit	Bicycle Storage
Residential	1 per dwelling	200 units	200
Residential visitors	1 per 10 dwellings	200 units	20
Commercial	1 per 150sqm GFA	2100sqm	14
Commercial visitors	1 per 400sqm GFA	2100sqm	5
Total			239

Showers will be provided for the commercial offices in order to encourage the use of cycling to work.

3.7 PEDESTRIAN ACCESS

The site will be able to be accessed from the footpath by pedestrians and further the layout of the buildings is such that pedestrians will be able to walk through the site (see Figure 3.4)



Figure 3.4 Pedestrian Access

4. TRAFFIC EFFECTS

4.1 PARAMICS MODEL BACKGROUND

A Paramics micro-simulation traffic model was developed to test the traffic effects of the proposed development, taking into account the adjacent developments. Micro-simulation models model the behaviour of individual vehicles as they travel through a network using a complex set of acceleration, vehicle following and gap acceptance rules. The models are graphical in nature and can be used to illustrate traffic congestion in a way that is readily understandable for both the traffic engineer and lay person. The models can also be used to collect a number of statistics about the network performance including intersection delay and travel times.



Figure 4.1 Paramics Model Screen Shot

The models cover the weekday AM Peak hour from 8am-9am and the PM Peak hour from 5pm-6pm and have been calibrated based on traffic counts undertaken in late August 2012. The calibration of the models has been undertaken to meet the requirements of the Roads and Maritime Service (RMS) in terms of traffic volumes and travel times. Further, the unusual queuing behaviour and lane utilisation on Wattle Street has been simulated. Detailed discussion and presentation of the calibration criteria is presented a Technical Note in Appendix B of this report.

The models have made use of the Ceejazz plug-ins for recording intersection delay and travel times as well as adding additional functionality to the models in terms of lane discipline.

4.2 METHODOLOGY

The following steps were followed in the modelling methodology:

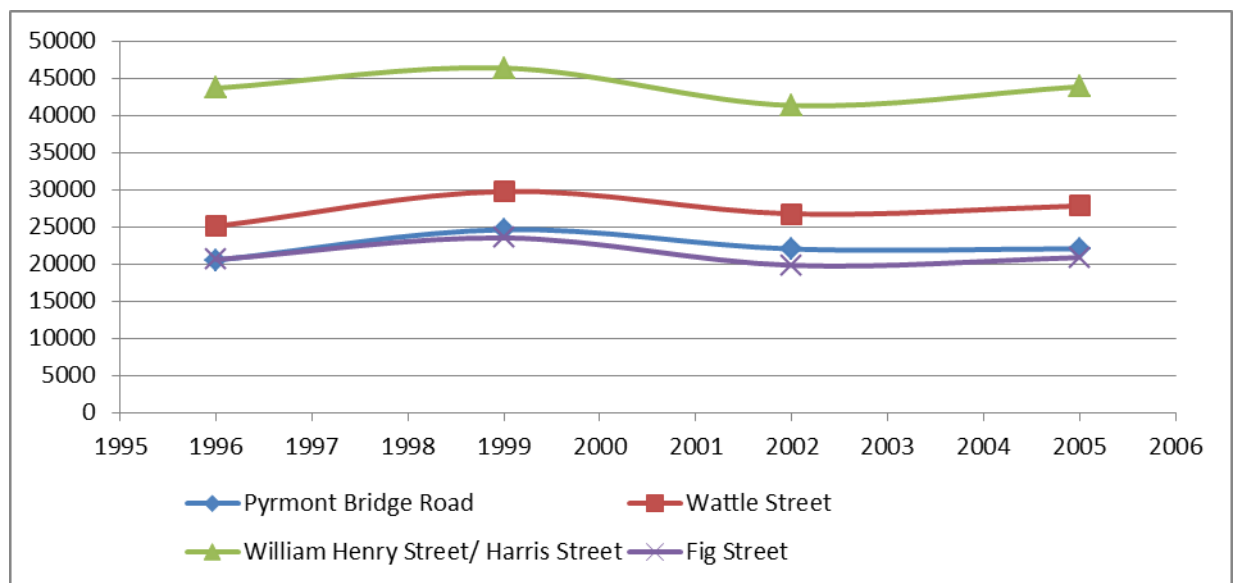
- Base Model calibration;
- Testing of traffic generation;
- Adding a 2022 design year growth in background traffic; and
- Reporting of the model results.

The base models were setup for the purpose of comparing the effects of the development on the road network. From this base model the additional traffic generated by the site is added to the network and in this case additional traffic from the Housing NSW site was also added to the network so that the combined effects could be analysed.

Background traffic growth was established based on historical data and applied to the network. The models were again tested for the effects with and without the developments.

4.3 BACKGROUND TRAFFIC GROWTH

From published traffic data the historical traffic volumes have been plotted (see Figure 4.2). Average daily traffic volumes appear to spike in 1999 but when comparing the 10 year difference it can be seen that volumes on Fig Street have remained relatively flat. The William Henry Street / Harris Street intersection has also been flat between 1996 and 2005. Wattle Street, however, has grown by some 10% in this time period.



Source: RMS Traffic Volume Data

Figure 4.2 Historical Traffic (AADT) Volumes

Based on this data, a linear growth rate of 1% per year has been applied to Wattle Street to obtain the 2022 traffic volumes. It is assumed that background growth on William Henry Street would be negligible. In many ways the traffic volumes in this are capacity-constrained by the Fish Markets intersection, Broadway / Wattle Street intersection and the ability of traffic to leave the CBD. Increases in AADT may in part be due to 'peak spreading' – the tendency for the duration of the peak period to increase.

4.4 MODELLING RESULTS

4.4.1 Intersection Level of Service

Intersection performance in terms of average delay per vehicle was recorded using the Ceejazz Level of Service Plugin. Level of service (LoS) is ranked from “A” to “F” with “A” indicating free flow conditions while “F” is slow congested conditions, where vehicles typically take more than one cycle to pass through a set of traffic signals (see Table 4.1). The models have random variation which is why they are run for five (5) different seed values. The results presented below are based on the median of five random seed runs.

Table 4.1 Average Delay Level of Service Criteria

Level of Service	Average Delay per vehicle (sec)	
	From	To
A	0	14
B	14.	28
C	28	42
D	42	56
E	56	70
F	70	>

Source: RTA Guide to Traffic Generating Developments

It should be noted that Paramics is a network model with random variability and will produce results that are different from single intersection analytical models such as SIDRA. A Paramics model therefore may produce results with better levels of service downstream of congestion due to starving effects and likewise record higher congestion downstream due to increased capacity. As queues can propagate beyond the previous intersection an increase in average delay may only appear at intersections ahead of the congestion point rather than at the intersection itself.

The Level of Service results for the AM Peak are shown in Table 4.2. The model results indicate that in the AM Peak there is little change in the intersection performance at Bay Street and Cowper Street. The average delay increases by some 7 seconds at Wattle Street but in the 2022 scenario there was no increase.

Table 4.2 AM Peak Level of Service

Intersection	AM Base		AM 2012 with Development		AM 2022 Do Nothing		AM 2022 with Development	
	Ave. Delay	LoS	Ave. Delay	LoS	Ave. Delay	LoS	Ave. Delay	LoS
Wattle Street – William Henry Street	34	C	41	C	48	D	48	D
Bay Street – William Henry Street	25	B	26	B	25	B	26	B
William Henry Street - Cowper Street*	9	A	7	A	8	A	8	A

*Delay of the worst movement is reported only

The PM Peak results are shown in Table 4.3. The model predicts that there would be very little change in average delay at intersections, with all results within the model variability.

Table 4.3 PM Peak Level of Service

Intersection	PM Base		PM 2012 with Development		PM 2022 Do Nothing		PM 2022 with Development	
	Ave. Delay	LoS	Ave. Delay	LoS	Ave. Delay	LoS	Ave. Delay	LoS
Wattle Street – William Henry Street	45	D	47	D	49	D	49	D
Bay Street – William Henry Street	30	C	27	B	29	C	27	B
William Henry Street - Cowper Street*	7	A	8	A	9	A	9	A

4.4.2 Travel Times

The average travel times recorded in the model along William Henry Street and Wentworth Park Road from Cowper Street to Wattle Street are presented in Tables 4.4 and 4.5.

Table 4.4 AM Peak Travel Time – Cowper Street to Wattle Street

Scenario	Eastbound	Westbound
AM 2012 Base	1:15	0:34
AM 2012 with Development	1:23	0:35
AM 2022 Do Nothing	1:14	0:35
AM 2022 with Development	1:14	0:34

In the AM Peak the model indicates that the increase in travel times would be within model variation. The 2012 with development scenario indicates an increase of 8 seconds eastbound but this is considered an outlier in terms of the general trends of the model.

Table 4.5 PM Peak Travel Time – Cowper Street to Wattle Street

Scenario	Eastbound	Westbound
AM 2012 Base	1:20	0:35
AM 2012 with Development	1:20	0:40
AM 2022 Do Nothing	1:19	0:39
AM 2022 with Development	1:16	0:39

In the PM Peak the model predicts no significant increases in travel times.

4.5 MODEL SCREEN SHOTS

The following Figures 4.3 to 4.6 are screenshots comparing the models at the middle of the peak hour. In each case the screenshot was taken immediately after the traffic signal for William Henry Street at Wattle Street turned green in order to illustrate the maximum queue length in William Henry Street. The background traffic is coloured red, 87 Bay Street traffic is light green and the Housing NSW site traffic is light blue.



2012 Without Development Traffic (8:30am)



2012 With Development Traffic (8:30am)

Figure 4.3 2012 AM Peak



2022 Without Development Traffic (8:30am)



2022 With Development Traffic (8:30am)

Figure 4.4 2022 AM Peak



2012 Without Development Traffic (5:30pm)



2012 With Development Traffic (5:30pm)

Figure 4.5 2012 PM Peak



2022 Without Development Traffic (5:30pm)



2022 With Development Traffic (5:30pm)

Figure 4.6 2022 PM Peak

4.6 CONCLUSION

Bitzios Consulting has undertaken a traffic impact assessment for the proposed development of 87 Bay Street, Glebe. The proposed development is a mixed use of residential, commercial office and a small retail space to service the building. The study has taken into consideration the total traffic effects of this development and the adjacent Housing NSW site.

The study has included the development of Paramics Traffic models to assess the effects of the proposed development on the road network operation and found:

- The proposed development is estimated to generate in the order of 100 vehicle trips spread between the two car park access driveways;
- After discounting existing generated traffic, the net traffic generated was estimated to be 36 trips;
- The models indicate that the average delay at Cowper Street / Wentworth Park Road, Bay Street / William Henry Street and Wattle Street / William Henry Street will have minimal changes as a result of the development traffic;
- The models predict that travel times will remain consistent along William Henry Street with the existing situation.
- Screen shots of the models with development traffic show that queues remain relatively similar compared to the 'no development' traffic scenarios;
- The number of car parking spaces provided will meet the maximum allowable.

It should be noted that the development traffic model scenarios include trips generated by the proposed Housing NSW site. The base models were developed during a period when that site was vacant and not generating any traffic.

The modelling indicates that the traffic effects of the combined developments would not cause undue congestion on the immediate road network.

APPENDIX A

INTERSECTION TRAFFIC COUNTS

INFO

Location Glebe, Sydney NSW
Date Thursday, 30th August 2012
Weather Fine
Survey Periods 7:00am - 9:00am & 2:00pm - 6:00pm

SITES

PEAK

AM

PM

1	Wentworth Park Rd & Cowper St	9:00	18:00
2	Wentworth St & Cowper St	9:00	17:45
3	William Henry St & Bay St	9:00	18:00
4	Wentworth St & Bay St	9:00	18:00
5	William Henry St & Wattle St	8:45	17:45

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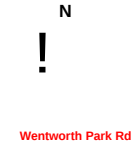


Certified System

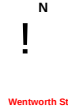


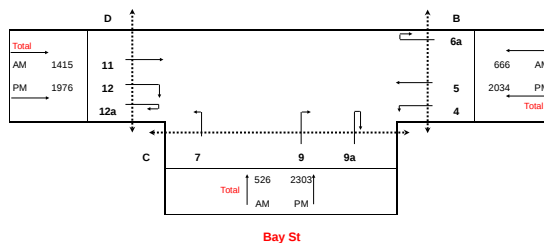
Quality
 ISO 9001

SAI GLOBAL



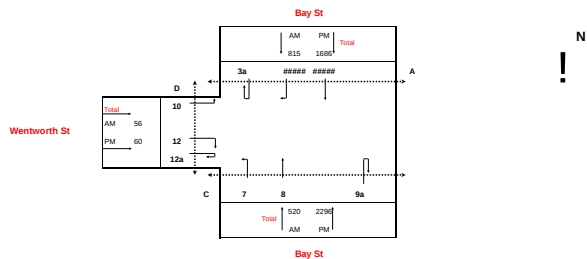
TIME	Wentworth Park Rd (Westbound)												Cowper St (Northbound)												Wentworth Park Rd (Eastbound)												Pedestrians						
	Movement 4 (Left Turn)				Movement 5 (Through)				Movement 6a (U Turn)				Movement 7 (Left Turn)				Movement 9 (U Turn)				Movement 9a (U Turn)				Movement 11 (Through)				Movement 12 (Right Turn)				Movement 12a (U Turn)				B	C	D				
15 MINUTE PERIOD ENDING	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	East	North	West								
1 2:15 PM	15	0	0	0	115	2	0	0	0	0	0	0	3	0	0	0	0	6	0	0	0	0	0	0	0	99	1	0	2	4	0	0	0	0	0	5	1						
2 2:30 PM	10	0	0	0	101	3	0	0	1	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	84	1	0	5	6	0	0	0	0	0	15	7						
3 2:45 PM	14	0	0	0	126	2	1	0	1	0	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0	118	3	0	4	14	0	0	0	0	0	0	11	4					
4 3:00 PM	20	0	0	1	107	2	0	0	0	0	0	0	2	0	0	0	0	5	1	0	0	0	0	0	0	133	0	0	2	4	0	0	0	0	0	0	1	11	8				
5 3:15 PM	20	0	0	0	130	1	1	5	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	123	2	1	1	8	0	0	2	0	0	0	0	11	10				
6 3:30 PM	13	0	0	0	142	2	2	6	0	0	0	0	3	0	0	0	0	5	0	0	1	0	0	0	0	87	1	0	3	5	0	0	0	0	0	0	0	12	7				
7 3:45 PM	14	0	0	1	145	3	0	0	1	0	0	0	2	0	0	0	0	5	0	0	0	0	0	0	0	107	1	1	3	5	0	0	0	0	0	0	0	10	6				
8 4:00 PM	20	0	0	0	117	1	1	4	1	0	0	0	6	0	0	0	0	5	0	0	0	0	0	0	0	104	1	1	3	7	0	0	0	0	0	0	0	7	2				
9 4:15 PM	17	0	0	0	157	4	0	5	0	0	0	0	4	0	0	0	0	4	0	0	0	0	0	0	0	109	3	0	3	7	0	0	1	1	0	0	0	12	2				
10 4:30 PM	10	1	0	0	144	2	0	4	3	0	0	0	1	0	0	0	0	4	1	0	1	0	0	0	0	114	2	2	1	11	1	0	1	0	0	0	0	9	2				
11 4:45 PM	18	0	0	1	168	2	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	121	0	1	2	13	0	0	0	0	0	0	0	1	5				
12 5:00 PM	27	1	0	1	168	1	0	6	2	0	0	0	2	0	0	0	0	5	0	0	0	0	0	0	0	107	0	0	3	8	0	0	0	0	0	0	0	0	10	4			
13 5:15 PM	17	1	0	0	198	0	0	8	0	0	0	0	4	0	0	0	0	2	0	0	1	0	0	0	0	134	0	0	4	7	0	0	0	0	0	0	0	12	3				
14 5:30 PM	14	0	0	0	212	0	0	10	0	0	0	0	4	0	0	0	0	4	0	0	0	0	0	0	0	139	1	1	5	6	0	0	0	0	0	0	0	0	3	3			
15 5:45 PM	27	0	0	1	216	0	2	13	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	159	2	1	6	4	0	0	2	0	0	0	0	0	6	3			
16 6:00 PM	22	0	0	0	216	1	0	6	0	0	0	0	3	0	0	0	0	7	0	0	0	0	0	0	0	113	2	2	3	3	0	0	1	0	0	0	0	0	6	5			
4HR Total	275	3	0	5	2462	28	7	81	9	0	0	0	40	0	0	0	1	65	3	0	0	3	0	0	0	185	18	10	50	112	1	0	6	1	0	0	0	0	1	140	72		
Peak Hour Total	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####

[illegible]



TIME		William Henry St (Westbound)												Bay St (Northbound)												William Henry St (Eastbound)												Pedestrians																			
		Movement 4 (Left Turn)					Movement 5 (Through)									Movement 6a (U Turn)								Movement 7 (Left Turn)								Movement 9 (Right Turn)				Movement 9a (U Turn)								Movement 11 (Through)				Movement 12 (Right Turn)				Movement 12a (U Turn)					B
15 MINUTE PERIOD ENDING		Cars, Trucks & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Articulated	Cyclists					Cars, Trucks & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Articulated	Cyclists							East	South	West															
1	7:15 AM	11	1	0	0	24	0	0	1					0	0	0	0	21	1	0	0					18	1	0	2	0	0	0	0							62	2	0	2	20	3	2	0	0	0	0	0	0	2	3	2		
2	7:30 AM	26	3	0	0	41	2	0	1					0	0	0	0	19	3	0	0					25	1	0	0	0	0	0	0							86	2	0	4	27	2	1	3	0	0	0	0	0	0	4	3	6	
3	7:45 AM	18	1	0	1	40	1	0	1					0	0	0	0	33	4	0	1					32	4	0	0	0	0	0	0							92	1	0	3	54	1	2	3	0	0	0	0	0	0	9	5	3	
4	8:00 AM	32	3	0	1	44	3	0	1					0	0	0	0	20	3	0	1					41	2	0	0	0	0	0	0							111	1	0	4	53	1	3	2	0	0	0	0	0	8	3	12		
5	8:15 AM	36	2	0	1	44	3	0	2					0	0	0	0	31	2	0	0					33	4	1	1	0	0	0	0							103	1	0	2	70	3	2	1	0	0	0	0	0	10	6	12		
6	8:30 AM	34	3	0	1	60	0	0	0					0	0	0	0	38	1	0	0					27	1	0	1	0	0	0	0							120	2	0	8	84	4	3	0	0	0	0	0	0	14	3	15		
7	8:45 AM	42	0	0	0	64	0	0	1					0	0	0	0	56	0	0	0					35	2	0	1	0	0	0	0							124	4	0	3	75	4	0	3	0	0	0	0	0	31	12	26		
8	9:00 AM	43	1	0	0	62	4	0	2					0	0	0	0	30	5	0	0					22	2	0	2	0	0	0	0							136	0	1	6	79	5	2	3	0	0	0	0	0	25	18	24		
2HR Total		242	6	14	0	379	7	13	9					0	0	0	0	248	8	19	0	2				223	8	16	1	1	0	0	0							854	7	13	1	32	482	23	15	7	15	0	0	0	0	0	103	43	100
Peak Hour Total		155	6	0	7	230	7	0	5					0	0	0	0	155	8	0	0	0				117	8	1	1	5	0	0	0							483	7	1	1	19	308	16	7	7	0	0	0	0	0	80	29	77	

TIME		William Henry St (Westbound)												Bay St (Northbound)												William Henry St (Eastbound)												Pedestrians																																																																																																																																																																																																																																																																																																				
		Movement 4 (Left Turn)				Movement 5 (Through)								Movement 6a (U Turn)				Movement 7 (Left Turn)								Movement 9 (Right Turn)				Movement 9a (U Turn)								Movement 11 (Through)				Movement 12 (Right Turn)				Movement 12a (U Turn)					B	C	D																																																																																																																																																																																																																																																																																					
15 MINUTE PERIOD ENDING		Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists					Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists					Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Articulated	Cyclists					East	North	West																																																																																																																																																																																																																																																																																														
1	2:15 PM	34	3	0	0	48	2	0	2					0	0	0	0	65	2	0	0					47	0	0	0	55	1	0	1	0	0	0	0					13	3	13																																																																																																																																																																																																																																																																																														
2	2:30 PM	29	2	0	0	66	2	0	2					0	0	0	0	57	2	0	1					40	2	1	1	50	0	0	3	0	0	0	0					7	2	24																																																																																																																																																																																																																																																																																														
3	2:45 PM	35	5	0	0	56	2	0	0					0	0	0	0	77	1	0	0					50	2	0	0	66	0	0	2	0	0	0	0					4	2	19																																																																																																																																																																																																																																																																																														
4	3:00 PM	25	2	0	2	57	3	0	3					0	0	0	0	76	0	0	1					58	1	0	0	80	1	0	1	0	0	0	0					7	8	24																																																																																																																																																																																																																																																																																														
5	3:15 PM	31	1	0	0	61	1	0	1					0	0	0	0	81	0	1	2					50	1	1	1	66	0	0	0	0	0	0	0					109	6	25																																																																																																																																																																																																																																																																																														
6	3:30 PM	28	1	0	0	60	0	1	3					0	0	0	0	92	1	0	1					48	0	1	1	54	1	0	2	0	0	0	0					19	7	23																																																																																																																																																																																																																																																																																														
7	3:45 PM	33	0	0	1	68	3	0	4					0	0	0	0	93	0	0	2					48	1	0	1	67	0	1	1	0	0	0	0					7	3	19																																																																																																																																																																																																																																																																																														
8	4:00 PM	35	1	0	1	74	3	0	2					0	0	0	0	75	1	0	2					55	0	0	4	65	1	1	2	0	0	0	0					12	3	19																																																																																																																																																																																																																																																																																														
9	4:15 PM	29	0	0	1	82	3	0	3					0	0	0	0	88	1	0	1					68	1	0	0	0	0	0	0	0	0	0	0	0					6	2	27																																																																																																																																																																																																																																																																																													
10	4:30 PM	37	0	0	1	76	2	0	1					0	0	0	0	77	1	0	4					52	0	3	0	68	2	0	2	0	0	0	0					11	10	19																																																																																																																																																																																																																																																																																														
11	4:45 PM	38	1	0	0	82	1	0	4					0	0	0	0	90	0	0	2					63	0	0	2	0	0	0	0	0	0	0	0					24	5	22																																																																																																																																																																																																																																																																																														
12	5:00 PM	36	0	0	2	109	3	0	3					0	0	0	0	85	0	0	1					62	0	0	1	0	0	0	0	0	0	0	0					17	7	23																																																																																																																																																																																																																																																																																														
13	5:15 PM	27	0	0	1	102	0	0	6					0	0	0	0	97	0	0	4					64	0	0	1	0	0	0	0	0	0	0	0					12	11	22																																																																																																																																																																																																																																																																																														
14	5:30 PM	48	0	0	2	135	1	0	7					0	0	0	0	96	0	0	2					67	0	1	1	65	0	0	4	0	0	0	0					19	9	23																																																																																																																																																																																																																																																																																														
15	5:45 PM	49	0	0	2	150	1	0	12					0	0	0	0	106	1	0	1					40	0	0	0	0	0	0	0	0	0	0	0	0					8	11	23																																																																																																																																																																																																																																																																																													
16	6:00 PM	43	1	0	4	130	1	0	5					0	0	0	0	103	0	0	2					62	0	1	0	75	0	0	1	0	0	0	0					28	6	31																																																																																																																																																																																																																																																																																														
4HR Total		557	17	0	0	1560	28	1	58					0	0	0	0	1580	10	1	26					880	11	2	9	0	0	0	0	0	0	0					859	7	10	15	1042	9	3	31	0	0	0	0	0	0	0	0	0	0	0	303	95	356																																																																																																																																																																																																																																																																												
Peak Hour Total		#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####	



TIME	Bay St (Southbound)												Bay St (Northbound)												Wentworth St (Eastbound)												Pedestrians					
	Movement 2 (Through)				Movement 3 (Right Turn)				Movement 3a (U Turn)				Movement 7 (Left Turn)				Movement 8 (Through)					Movement 9a Turn				(U	Movement 10 (Left Turn)					Movement 12 (Right Turn)				Movement 12a Turn				(U	A	C
15 MINUTE PERIOD ENDING	Cars, Trucks & Motorcycles	Trucks & Buses	Motorcycles	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Motorcycles	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Motorcycles	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Motorcycles	Cyclists	Cars, Trucks & Motorcycles	Trucks & Buses	Motorcycles	Cyclists		Cars, Trucks & Motorcycles	Trucks & Buses	Motorcycles	Cyclists		Cars, Trucks & Motorcycles	Trucks & Buses	Motorcycles	Cyclists		Cars, Trucks & Motorcycles	Trucks & Buses	Motorcycles	Cyclists	North	South	West				
1 7:15 AM	36	4	2	0	0	0	0	0	0	0	0	0	1	0	0	0	36	3	0	3	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	3	6					
2 7:30 AM	67	4	1	6	0	0	0	0	0	0	0	0	0	0	0	0	48	5	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	6					
3 7:45 AM	73	1	2	4	0	0	0	0	0	0	0	0	1	0	0	0	56	7	0	2	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	2	10					
4 8:00 AM	88	4	4	5	0	0	0	0	0	0	0	0	1	0	0	0	54	3	0	4	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	14					
5 8:15 AM	106	5	1	2	0	0	0	0	0	0	0	0	0	0	0	0	59	6	1	3	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	7						
6 8:30 AM	113	9	1	1	1	0	0	0	0	0	0	0	0	0	0	0	66	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	24						
7 8:45 AM	122	4	0	9	0	0	0	0	0	0	0	0	0	0	0	0	83	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4						
8 9:00 AM	124	6	2	8	1	0	0	0	0	0	0	0	0	0	0	0	55	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	39					
2HR Total	729	37	13	30	2	0	0	0	0	0	0	0	2	0	0	1	460	33	1	10						21	1	1	1	1	0	0	0	2	3	16	123					
Peak Hour Total	465	24	4	20	2	0	0	0	0	0	0	0	0	0	0	0	263	15	1	9						9	1	0	0	0	0	0	0	2	6	123						

TIME	Bay St (Southbound)												Bay St (Northbound)												Wentworth St (Eastbound)												Pedestrians			
	Movement 2 (Through)				Movement 3 (Right Turn)				Movement 3a (U Turn)				Movement 7 (Left Turn)				Movement 8 (Through)				Movement 9a (U Turn)				Movement 10 (Left Turn)				Movement 12 (Right Turn)				Movement 12a (U Turn)				(U)	A	C	D
	Cars, Utilities & Motorcycles	Trucks & Buses	Incidents	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Incidents	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Incidents	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Incidents	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Incidents	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Incidents	Cyclists	Cars, Utilities & Motorcycles	Trucks & Buses	Incidents	Cyclists	Booth	North	West									
1	2:15 PM	56	4	0	1	0	0	0	0	0	0	0	0	0	0	0	123	2	1	0	0	0	0	0	1	0	0	0	0	0	3	0	19							
2	2:30 PM	79	2	0	3	0	0	0	0	0	0	0	0	0	0	0	107	8	0	0	0	0	0	0	0	0	0	0	0	0	1	0	31							
3	2:45 PM	100	4	0	4	0	0	0	0	0	0	0	0	0	0	0	122	2	2	0	0	0	0	0	3	0	0	0	0	0	0	2	32							
4	3:00 PM	108	4	0	4	0	0	0	0	0	0	0	0	0	0	0	132	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3							
5	3:15 PM	93	1	0	0	0	0	0	0	0	0	0	0	0	0	0	134	1	0	2	0	0	0	0	0	0	1	0	0	0	0	5	39							
6	3:30 PM	78	2	0	2	0	0	0	0	1	0	0	0	0	0	0	150	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4	31						
7	3:45 PM	106	0	1	2	0	0	0	0	0	0	0	0	0	0	0	138	1	1	2	0	0	0	0	3	0	0	0	0	0	0	0	3							
8	4:00 PM	100	2	1	3	0	0	0	0	0	0	0	0	0	0	0	129	2	0	7	0	0	0	0	0	0	1	0	0	0	0	1	2	35						
9	4:15 PM	83	1	0	3	0	0	0	0	1	0	0	0	0	0	0	154	2	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	43						
10	4:30 PM	107	2	0	4	0	0	0	0	0	0	0	0	0	0	0	149	1	0	8	0	0	0	0	1	0	0	0	0	0	0	0	0	42						
11	4:45 PM	111	1	0	1	0	0	0	0	0	0	0	0	0	0	0	157	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	41					
12	5:00 PM	83	0	0	2	0	0	0	0	0	0	0	0	0	0	0	127	0	0	2	0	0	0	0	3	0	0	0	0	0	0	0	0	3	41					
13	5:15 PM	86	0	0	4	0	0	0	0	1	0	0	0	0	0	0	159	0	0	6	0	0	0	0	2	0	0	0	0	0	0	0	0	4	34					
14	5:30 PM	119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	158	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	45						
15	5:45 PM	132	3	0	8	0	0	0	0	0	0	0	0	0	0	0	162	1	0	3	0	0	0	0	2	0	0	0	0	0	0	0	1	3	35					
16	6:00 PM	110	1	0	5	0	0	0	0	0	0	0	0	0	0	0	146	1	0	3	0	0	0	0	2	0	0	0	0	0	0	0	0	1	51					
4HR Total		1600	20	3	30	1	0	0	0	4	0	0	0	6	0	0	2216	25	2	40					26	2	0	0	2	0	0	11	20	97						
Peak Hour Total																																								



TIME	(Southbound)																William Henry St (Westbound)												Wattle St (Northbound)												William Henry St (Eastbound)												Pedestrians									
																	Movement 5 (Through)				Movement 6 (Right Turn)				Movement 6a (U Turn)				Movement 7 (Left Turn)				Movement 8 (Through)				Movement 9 (Turn)				(Right)	Movement 8a (Turn)				(U)	Movement 10 (Left Turn)				Movement 11 (Through)				Movement 12a (Turn)				(U)	A	B	C
15 MINUTE PERIOD ENDING																	Km, Ullman & Waverley	Trucks & Buses	Influenced	Cyclists	Km, Ullman & Waverley	Trucks & Buses	Influenced	Cyclists	Km, Ullman & Waverley	Trucks & Buses	Influenced	Cyclists	Km, Ullman & Waverley	Trucks & Buses	Influenced	Cyclists	Km, Ullman & Waverley	Trucks & Buses	Influenced	Cyclists	Km, Ullman & Waverley	Trucks & Buses	Influenced	Cyclists	Km, Ullman & Waverley	Trucks & Buses	Influenced	Cyclists	South	East	North	West														
1 2:15 PM																	68	0	0	0	36	1	0	0	14	0	0	0	361	23	4	6	0	0	0	44	0	1	0	0	2	0	0	0	17	3	7	17														
2 2:30 PM																	74	3	0	0	58	3	0	1	20	1	0	2	300	16	1	4	0	0	0	59	4	0	0	0	0	1	0	0	0	19	2	9	8													
3 2:45 PM																	76	6	0	0	61	0	0	0	0	0	0	0	246	5	1	0	0	0	51	1	0	0	0	0	0	0	18	3	4	4																
4 3:00 PM																	62	4	0	0	62	4	2	2	0	0	0	0	349	13	1	5	0	0	0	55	0	0	0	0	0	0	0	12	2	14	20															
5 3:15 PM																	69	3	0	1	48	0	0	0	0	0	0	0	406	11	3	13	0	0	1	0	0	0	57	1	1	1	0	0	0	13	4	4	13													
6 3:30 PM																	63	2	0	1	38	1	0	0	0	0	1	1	429	10	2	11	61	2	0	0	0	65	0	0	0	0	0	1	0	0	13	6	15	18												
7 3:45 PM																	63	4	0	1	41	2	0	0	0	0	0	0	392	9	4	4	55	0	0	0	54	9	2	0	0	0	0	12	11	4	12															
8 4:00 PM																	72	2	0	2	32	0	0	0	0	0	0	0	414	13	2	11	53	3	0	0	0	47	0	0	2	54	1	0	3	22	7	3	20													
9 4:15 PM																	83	1	0	2	51	3	0	2	0	0	0	0	392	8	2	14	53	0	0	0	70	1	0	1	51	0	0	0	14	10	12	19														
10 4:30 PM																	77	2	0	2	50	2	0	1	0	0	0	0	400	8	1	10	65	1	0	0	42	1	1	0	65	0	0	0	17	4	20	28														
11 4:45 PM																	96	1	0	3	59	1	0	0	0	0	0	0	367	9	0	12	67	0	0	0	62	9	0	0	30	4	24	20																		
12 5:00 PM																	119	3	0	7	56	3	0	0	0	0	0	0	393	4	0	12	67	0	0	0	67	0	0	0	75	0	0	0	24	4	15	19														
13 5:15 PM																	108	1	0	4	39	1	0	2	0	0	0	0	427	5	1	14	72	1	0	0	58	0	1	1	62	0	0	0	28	4	18	27														
14 5:30 PM																	154	0	0	46	46	0	0	0	0	0	0	0	359	4	0	10	73	0	0	0	54	1	0	1	78	0	0	0	30	7	18	32														
15 5:45 PM																	154	1	0	10	54	0	0	1	0	0	0	0	433	1	1	10	83	0	0	0	42	0	0	1	79	0	0	0	23	8	15	27														
16 6:00 PM																	156	4	0	5	52	0	0	0	0	0	0	0	427	4	0	13	67	0	0	0	45	0	1	1	70	1	0	1	24	5	16	24														
4HR Total																	2514	38	0	50	783	27	2	11	0	0	0	861	140	24	137	67	0	0	865	12	8	8	120	12	16	0	324	84	158	313																
Peak Hour Total																	2514	38	0	50	783	27	2	11	0	0	0	861	140	24	137	67	0	0	865	12	8	8	120	12	16	0	324	84	158	313																

APPENDIX B

MODEL CALIBRATION AND VALIDATION

Issue History

File Name	Prepared by	Reviewed by	Issued by	Date	Issued to
P1082.001T 87 Bay St Paramics Modelling – Calibration and Validation.doc	S.Read	A.Finlay	A.Finlay	14/09/2012	Anthony Elias Chase Property Investments

87 Bay Street, Glebe Paramics Modelling – Validation and Calibration

1. INTRODUCTION

1.1 BACKGROUND

Bitzios Consulting was commissioned by Chase Property Investments to develop a Paramics microsimulation model to assist in the assessment of traffic impacts as a result of the proposed re-development of 87 Bay Street, Glebe. The model will also be used to identify potential improvements that could be implemented in the corridor to mitigate the effects of future development in the area.

The purpose of this Model Calibration and Validation Technical Note is to demonstrate the base model validity in accordance with RMS guidelines. Many of the roads in the network surrounding the development are under state control.

1.2 METHODOLOGY

The Paramics modelling was undertaken in accordance with the RMS's Paramics Microsimulation Modelling Manual. The processes involved in validating and calibrating the 87 Bay Street Paramics model included:

- data collection and analysis for the AM and PM peak period;
- model traffic network coding;
- estimation of traffic demands; and
- model calibration and validation.

This technical note describes the processes used and results achieved in developing the base model.

1.3 STUDY AREA

The study area shown in Figure 1.1 shows the location of the 87 Bay Street development site and the extent of the Paramics model for assessment of potential traffic impacts and needs. The model boundary has been defined by the City of Sydney and includes two signalised intersections at Wattle Street / William Henry Street and Bay Street / William Henry Street.



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2. DATA COLLECTION AND ANALYSIS

A variety of data sets have been collected on site including:

- Intersection turning volume counts;
- Travel times;
- Queue length estimations; and
- Intersection signal timings.

Intersection counts were undertaken on 30 August 2012 at five locations:

- Wattle Street / William Henry Street;
- Bay Street / William Henry Street;
- Cowper Street / Wentworth Park Road;
- Cowper Street / Wentworth Street;
- Bay Street / Wentworth Street;

The intersection counts used in the traffic demands estimation and turning counts validation processes are provided in Attachment A.

3. NETWORK CODING

3.1 LINK CATEGORIES AND SPEEDS

The link categories used in the base model coding are taken from RMS's standard category file. Link categories have been created for links with a higher number of lanes than those included in RMS's standard file.

All roads within the study area are in a 50km/h speed zone.

3.2 ZONE SYSTEM

The zone system used for the base model is detailed in Figure 3.2 below. Zone 10 was added to control the queuing behaviour observed as vehicles approach Fig Street to access the Sydney CBD and Sydney Harbour Bridge.

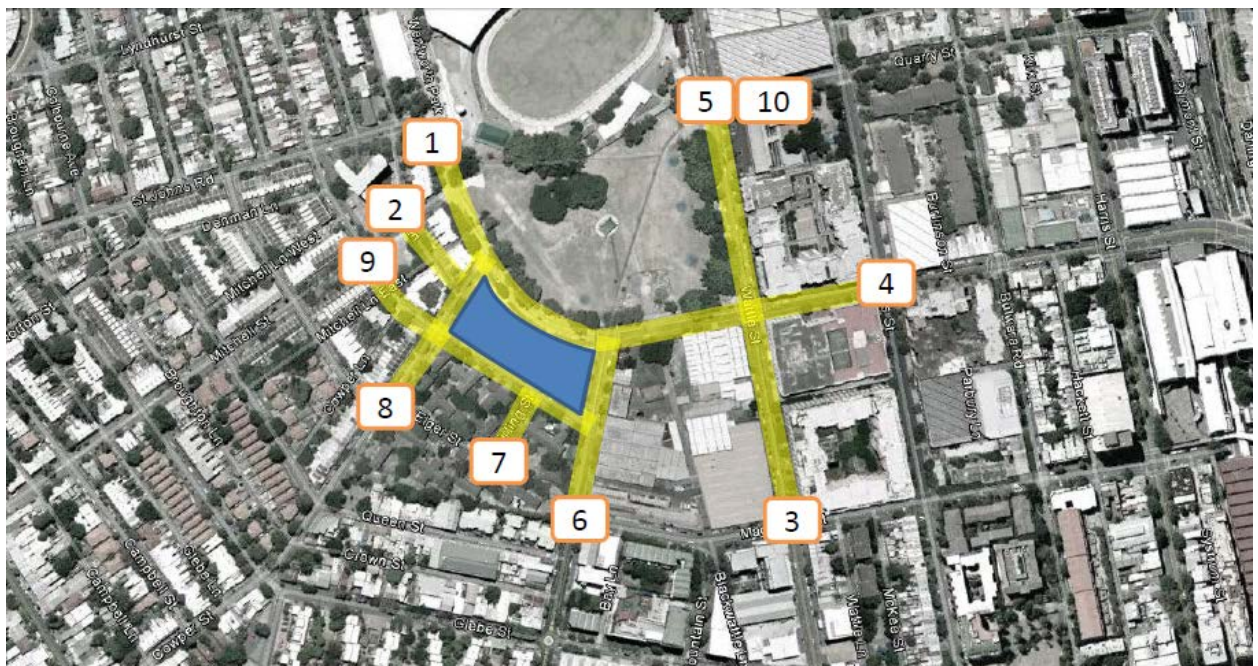


Figure 3.1: Zone System

3.3 TRAFFIC SIGNALS AND KEY ASSUMPTIONS

Traffic signal timing was based on on-site observation on 30 August 2012. The two traffic signals in the model were found to be in co-ordination east-west along William Henry Street with the A phase at Bay Street ending some 8 seconds before the A Phase on Wattle Street begins.

Due to the high pedestrian activity it was assumed that pedestrians would delay turning vehicles at all crossings and that the full pedestrian protection would be called every cycle on applicable phases. The delay caused by pedestrian crossings was coded as a 'dummy' phase that represents the start of a phase. At the T-intersection at Bay Street an all red phase was coded to represent the pedestrian protection of the crossings parallel to Bay Street.

3.4 BUS ROUTES AND STOPS

There were no bus routes within the study area.

4. TRAFFIC DEMANDS AND ASSIGNMENT METHODOLOGIES

4.1 PATTERN MATRIX AND DEVELOPMENT

As the model is relatively small with minimal route choice, Paramics Estimator was not required to be used in the development of the demand matrix. The demand matrix was developed using the count data and assumptions for the expected distribution of vehicles within the network, considering the relative volume of entering and exiting traffic at each location. An iterative process was used to check that the demands, when assigned to the network and represented as turning volumes at intersections, were appropriately validated to the intersection count volumes.

4.2 “WARM-UP” AND “COOL-DOWN” PERIODS

The model has been developed for an 8-9am and 5-6pm peak hour period including a 1 hour warm up and 1 hour cool down period before and after the peak hour. The warm up and cool down demands are 90% of the peak hour demands.

4.3 DEMAND PROFILES AND VEHICLE CATEGORIES

The intersection count data was used to derive a profile in the morning and afternoon peaks based on the 15minute counts. Individual profiles were applied to Bay Street, Wattle Street, Wentworth Park Road and William Henry Street.

The classified traffic counts were also used to refine the standard vehicles files. The counts showed very few articulated vehicles and lower number of heavy vehicles than in the standard file. The vehicle mix was therefore adjusted to match the data collected on site.

4.4 TRAFFIC ASSIGNMENT METHOD

As the model is simplistic with minimal route choice available, an “all-or-nothing” traffic assignment methodology has been used.

5. MODEL CALIBRATION AND VALIDATION

5.1 CALIBRATION AND VALIDATION PROCESSES

The base model validation process involved comparisons between the following observed and modelled attributes:

- traffic volume turning movement data;
- queue lengths; and
- travel time.

The comparison between the modelled and observed traffic count data was undertaken using the commonly used GEH statistic, which measures the degree of divergence of the modelled value from the observed value whilst accounting for the relative scale of each movement volume (i.e. the higher volume movements are more important to match than the lower volume movements). GEH results less than 5 indicated acceptable comparisons between observed and modelled counts. GEH statistics were used to assist in validating traffic volumes for each of the RMS seed value model runs.

The models were then validated to queue lengths and travel times. Comparing the modelled travel times to the travel time surveys and the queuing behaviour to the observed queuing behaviour.

5.2 MODEL ROBUSTNESS

In accordance with RMS modelling guidelines, the base models were run with five different seed values to demonstrate the robustness of the model under slight variations of vehicle release rates. More specifically, the seed values used were:

- Seed = 560;
- Seed = 28;
- Seed = 7771;
- Seed = 86524; and
- Seed = 2849.

5.3 TRAFFIC VOLUMES AND GEH STATISTIC

To compare the modelled traffic volumes to observed volumes the GEH statistic is typically used. The formula for GEH is shown below where M is the modelled traffic volume and C is the observed traffic volume. As the modelled value approaches the observed volume the GEH becomes smaller.

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

The advantage of GEH is that it can deal with a range of traffic volumes typically observed on a road network that a simple percentage may skew. For example an observed count of 100 vehicles could be different by 50% increasing the total by 50 vehicles. This may not be as critical as a difference of 50% on an observed count of 1000 vehicles which would be an increase of 500 vehicles.

RMS has adopted the UK's Design Manual for Roads and Bridges (DMRB) Volume 12 method; which specifies that 85% of the modelled counts should have a GEH of less than 5 and no counts should be greater than 10.

The comparison of the modelled to the observed traffic counts for the AM and PM peak models is indicated in Tables 5.1 and 5.2. This is based on 35 observations. More detailed GEH tables are attached in Attachment B.

Table 5.1 AM Peak (8-9am) GEH Statistic

Seed	<2		<5		<10		>10	
560	32	91%	35	100%	35	100%	0	0%
28	29	83%	35	100%	35	100%	0	0%
2849	29	83%	35	100%	35	100%	0	0%
86524	30	86%	35	100%	35	100%	0	0%
7771	32	91%	35	100%	35	100%	0	0%

In the AM Peak (see Table 5.1) the all turn counts modelled had a GEH of less than 5 indicating an excellent correlation between modelled and observed traffic counts.

Table 5.2 PM Peak (5-6pm) GEH Statistic

Seed	<2		<5		<10		>10	
560	32	91%	35	100%	35	100%	0	0%
28	32	91%	35	100%	35	100%	0	0%
2849	28	80%	35	100%	35	100%	0	0%
86524	29	83%	35	100%	35	100%	0	0%
7771	34	97%	35	100%	35	100%	0	0%

In the PM Peak (see Table 5.1) the all turn counts modelled had a GEH of less than 5 as well indicating an excellent correlation between modelled and observed traffic counts in the PM Peak.

5.4 QUEUE LENGTHS

5.4.1 AM Peak

Queue lengths were observed on site and the patterns were replicated in the model (see Figure 5.1)

William Henry Street - eastbound the maximum queue often extended back from Wattle Street nearly to Bay Street. This pattern was replicated in the model.

Wattle Street – northbound the queue mainly forms in the third lane which was replicated by adding zone 10 to represent traffic going to Fig Street and the queuing behaviour this causes.

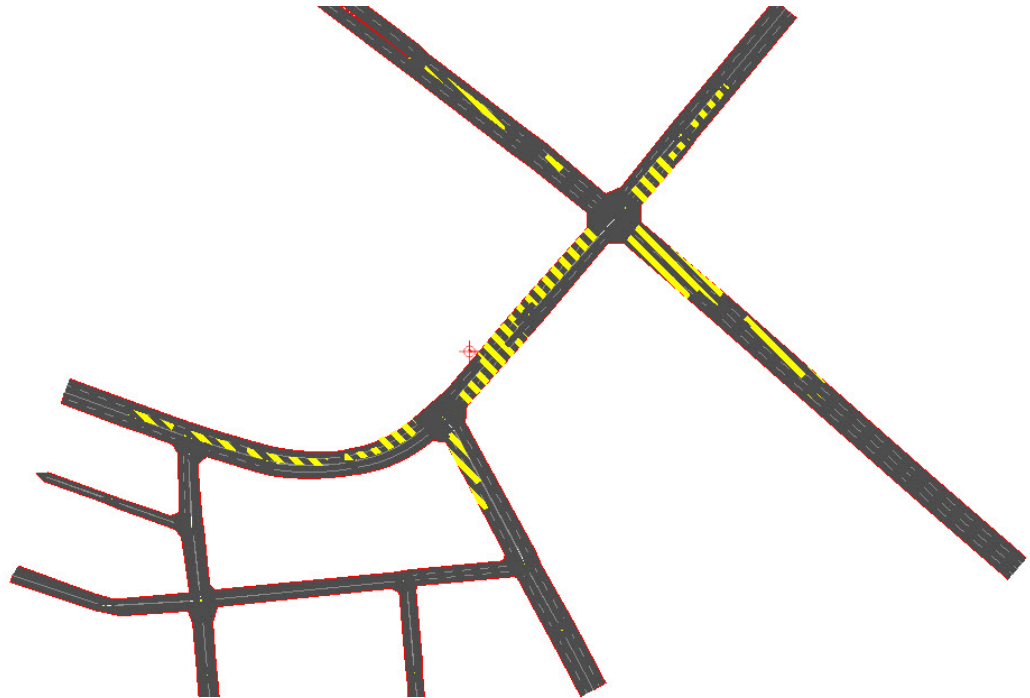


Figure 5.1 AM Peak 95th Percentile Queues Modelled

5.4.2 PM Peak

In the PM peak the queues are similar to the morning peak (see Figure 5.2). The eastbound queues on William Henry Street are generally less, while the queues northbound on Wattle Street are generally longer. The models generally show a good correlation to the queues observed. On Bay Street the observed queues were longer than in the AM Peak, extending past Wentworth Street.

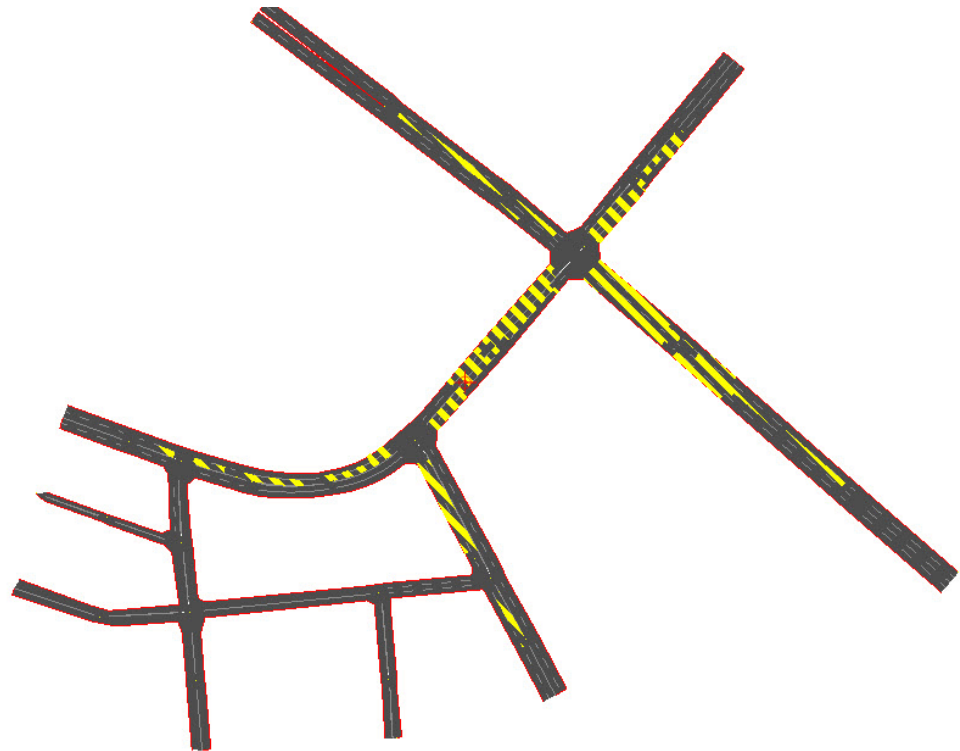


Figure 5.2 PM Peak 95th Percentile Queues Modelled

5.5 TRAVEL TIMES

Travel time surveys were undertaken at the same time as the traffic counts. The survey route was along William Henry Street and Wentworth Park Road between Cowper Street and Wattle Street.

The results of the traffic surveys have been compared to the modelled travel times (see Table 5.3 and Table 5.4). In both peaks the model showed a strong correlation between the observed travel times with differences of less than 5 seconds for all observations.

Table 5.3 AM Peak Travel Time Comparison

Direction		Average	Lower Quartile	Upper Quartile
Eastbound	Observed	1:19	0:28	2:07
	Modelled	1:15	0:43	1:45
Westbound	Observed	0:38	0:25	0:31
	Modelled	0:34	0:19	0:53

Table 5.4 PM Peak Travel Time Comparison

Direction		Average	Lower Quartile	Upper Quartile
Eastbound	Observed	1:18	0:40	1:50
	Modelled	1:20	0:56	1:40
Westbound	Observed	0:33	0:26	0:35
	Modelled	0:35	0:20	0:54

5.6 MODEL CALIBRATION DECLARATION

The Paramics model for the AM and PM peak hour period has been validated and calibrated to meet the requirements as per the RMS's Microsimulation Modelling Manual.

ATTACHMENT A

INTERSECTION VOLUMES

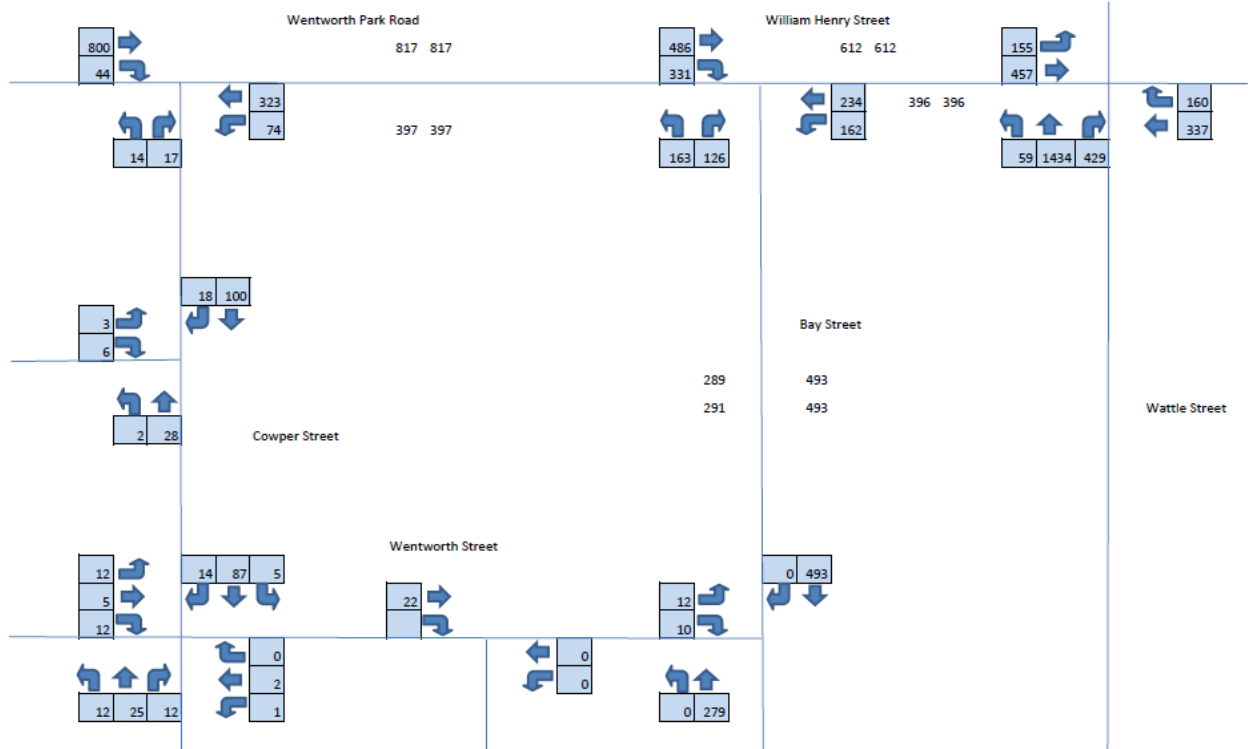


Figure A.1 AM PEAK - 8:00am - 9:00am

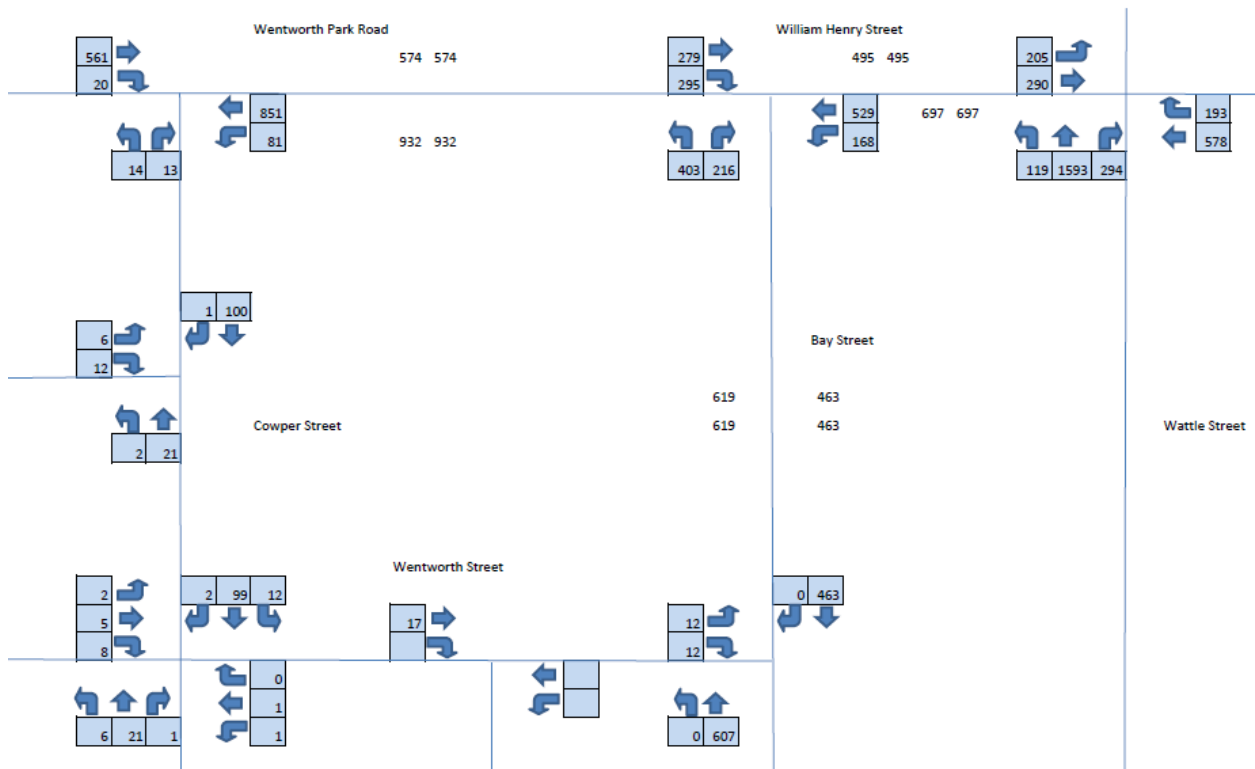


Figure A.2 PM PEAK 5:00pm - 6:00pm

ATTACHMENT B

GEH CALIBRATION TABLE

TABLE B.1 AM Peak GEH Table

Intersection	Approach	Turn	Observed Volume	Modelled 560		
				Volume	Difference	GEH
Wattle St / William Henry St	South	Left	59	45	14	1.94
Wattle St / William Henry St	South	Through	1434	1421	13	0.34
Wattle St / William Henry St	South	Right	429	425	4	0.19
Wattle St / William Henry St	East	Through	337	363	-26	1.39
Wattle St / William Henry St	East	Right	160	181	-21	1.61
Wattle St / William Henry St	West	Left	155	151	4	0.32
Wattle St / William Henry St	West	Through	457	484	-27	1.24
William Henry St / Bay St	East	Left	162	188	-26	1.97
William Henry St / Bay St	East	Through	234	222	12	0.79
William Henry St / Bay St	South	Left	163	163	0	0
William Henry St / Bay St	South	Right	126	134	-8	0.7
William Henry St / Bay St	West	Through	486	507	-21	0.94
William Henry St / Bay St	West	Right	331	340	-9	0.49
Wentworth Park Rd / Cowper St	East	Left	74	72	2	0.23
Wentworth Park Rd / Cowper St	East	Through	323	313	10	0.56
Wentworth Park Rd / Cowper St	South	Left	14	20	-6	1.46
Wentworth Park Rd / Cowper St	South	Right	17	18	-1	0.24
Wentworth Park Rd / Cowper St	West	Through	800	839	-39	1.36
Wentworth Park Rd / Cowper St	West	Right	44	31	13	2.12
Cowper St / Wentworth St	South	Left	12	11	1	0.29
Cowper St / Wentworth St	South	Through	25	17	8	1.75
Cowper St / Wentworth St	South	Right	12	12	0	0
Cowper St / Wentworth St	East	Left	1	0	1	1.41
Cowper St / Wentworth St	East	Through	2	0	2	2
Cowper St / Wentworth St	East	Right	0	0	0	0
Cowper St / Wentworth St	West	Left	12	16	-4	1.07
Cowper St / Wentworth St	West	Through	5	0	5	3.16
Cowper St / Wentworth St	West	Right	12	9	3	0.93
Cowper St / Wentworth St	North	Left	5	3	2	1
Cowper St / Wentworth St	North	Through	87	83	4	0.43
Cowper St / Wentworth St	North	Right	14	17	-3	0.76
Bay St / Wentworth St	South	Through	279	282	-3	0.18
Bay St / Wentworth St	West	Left	12	14	-2	0.55
Bay St / Wentworth St	West	Right	10	13	-3	0.88
Bay St / Wentworth St	North	Through	493	528	-35	1.55

Table B.2 PM Peak GEH Table

Intersection	Approach	Turn	Observed Volume	Modelled 560		
				Volume	Difference	GEH
Wattle St / William Henry St	South	Left	59	45	14	1.94
Wattle St / William Henry St	South	Through	1434	1421	13	0.34
Wattle St / William Henry St	South	Right	429	425	4	0.19
Wattle St / William Henry St	East	Through	337	363	-26	1.39
Wattle St / William Henry St	East	Right	160	181	-21	1.61
Wattle St / William Henry St	West	Left	155	151	4	0.32
Wattle St / William Henry St	West	Through	457	484	-27	1.24
William Henry St / Bay St	East	Left	162	188	-26	1.97
William Henry St / Bay St	East	Through	234	222	12	0.79
William Henry St / Bay St	South	Left	163	163	0	0
William Henry St / Bay St	South	Right	126	134	-8	0.7
William Henry St / Bay St	West	Through	486	507	-21	0.94
William Henry St / Bay St	West	Right	331	340	-9	0.49
Wentworth Park Rd / Cowper St	East	Left	74	72	2	0.23
Wentworth Park Rd / Cowper St	East	Through	323	313	10	0.56
Wentworth Park Rd / Cowper St	South	Left	14	20	-6	1.46
Wentworth Park Rd / Cowper St	South	Right	17	18	-1	0.24
Wentworth Park Rd / Cowper St	West	Through	800	839	-39	1.36
Wentworth Park Rd / Cowper St	West	Right	44	31	13	2.12
Cowper St / Wentworth St	South	Left	12	11	1	0.29
Cowper St / Wentworth St	South	Through	25	17	8	1.75
Cowper St / Wentworth St	South	Right	12	12	0	0
Cowper St / Wentworth St	East	Left	1	0	1	1.41
Cowper St / Wentworth St	East	Through	2	0	2	2
Cowper St / Wentworth St	East	Right	0	0	0	0
Cowper St / Wentworth St	West	Left	12	16	-4	1.07
Cowper St / Wentworth St	West	Through	5	0	5	3.16
Cowper St / Wentworth St	West	Right	12	9	3	0.93
Cowper St / Wentworth St	North	Left	5	3	2	1
Cowper St / Wentworth St	North	Through	87	83	4	0.43
Cowper St / Wentworth St	North	Right	14	17	-3	0.76
Bay St / Wentworth St	South	Through	279	282	-3	0.18
Bay St / Wentworth St	West	Left	12	14	-2	0.55
Bay St / Wentworth St	West	Right	10	13	-3	0.88
Bay St / Wentworth St	North	Through	493	528	-35	1.55