Hawkesbury City Council

Attachment 4
to
item 151

Windsor Town Centre Traffic Study
prepared by Christopher Hallam &
Associates Pty Ltd (Job 3103)

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HAWKESBURY CITY COUNCIL

WINDSOR TOWN CENTRE TRAFFIC STUDY

JULY 2011

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1.0 INTRODUCTION

The historic town of Windsor has a road network that was not designed for current traffic conditions, in regard to the widths of core streets in the centre of the town. While major routes such as Macquarie Street and Hawkesbury Valley Way have been engineered to provide for current traffic flows and heavy vehicle movements, there are substantial heritage restrictions on the widening of streets in the centre of the town. However Windsor remains the key retail and commercial hub of the Hawkesbury City.

Due to the restricted widths of streets within the Windsor Town Centre, there have been recent changes to the traffic flow in Windsor to cater for the requirement to retain bus services in and around Windsor Town Centre. As a result, Suffolk Street changed to one-way operation commencing on 20 September 2010.

Other significant changes in and around Windsor Town Centre have been:

- The completion of the Windsor Flood Evacuation route (Hawkesbury Valley Way)
- The Riverview Shopping Centre fronting George Street
- Windsor Marketplace Shopping Centre upgrade, fronting Kable Street
- Windsor Station upgrade, with new car park access from Cox Street

Hawkesbury City Council have recently resolved to undertake a review of the Windsor Masterplan. Input on traffic and transport issues will be of importance to this review. In addition, a number of traffic issues and concerns have been identified by Council, including:

- Traffic "rat-runs" through the town centre to bypass congested intersections on Hawkesbury Valley Way and Bridge Street;
- Traffic conditions following the completion of the Riverview Shopping Centre;
- Traffic circulation in and around Windsor Mall;
- New Windsor Bridge access.

To address these issues, Christopher Hallam & Associates Pty Ltd was commissioned by Hawkesbury City Council to undertake a town centre traffic study. The findings of this study are set out in the following Sections:

- Section 2 discusses the current situation and traffic movements, including analysis of current intersection peak hour operations;
- Section 3 assesses the traffic issues identified by Council, and
- Section 4 sets out the conclusions.

2.0 CURRENT SITUATION

2.1 Road Network

The major traffic routes through Windsor are:

- Windsor Road-Bridge Street, to Wilberforce
- Hawkesbury Valley Way – to Richmond
- Macquarie Street, linking Bridge Street, Hawkesbury Valley Way, through to South Windsor and The Northern Road

Figure 1 shows an aerial view of Windsor, with Figure 2 showing the road network, plus the location of traffic counts. The spine of the town centre is George Street, with most retail and commercial developments accessed off it or off its side streets. Side streets such as Kable Street, Fitzgerald Street, Suffolk Street and Christie Street provide linkages between George Street and Macquarie Street. The Kable Street/Macquarie Street intersection has traffic signal control while the other junctions operate under priority control. Suffolk and Fitzgerald Streets have all movements allowed at Macquarie Street, while at the Christie Street/Macquarie Street junction, a centre median in Macquarie Street restricts movements to left turn in and out of Christie Street.

In the following descriptions of roads and intersections, Macquarie and George Streets have been described as traveling East-West while Suffolk and Fitzgerald Streets have been described as traveling North-South.

2.2 Traffic Flows

In order to assess the current traffic conditions, as a basis for reviewing the issues of concern, traffic counts were undertaken on Thursday 17th February 2011, in the periods 7.30-10.30am and 3.00-6.00pm. Light and heavy vehicle movements were recorded at the following intersections:

1. Bridge Street & Macquarie Street
2. Bridge Street & George Street
3. Bridge Street & Court Street
4. Macquarie Street, Kable & Ross Streets
5. The Terrace & Kable Street
6. George & Suffolk Streets
7. George & New Streets
8. The Terrace & New Street
9. Macquarie & Fitzgerald Streets
10. George & Fitzgerald Streets

11. The Terrace & Fitzgerald Street
12. Macquarie & Suffolk Streets
13. George & Johnston Streets
14. The Terrace & Johnston Street
15. Hawkesbury Valley Way & George Street
16. Hawkesbury Valley Way & Macquarie Street
17. Hawkesbury Valley Way, Moses Street & Cox Street

In addition to these intersection counts, a number plate origin/destination survey was undertaken on Thursday 24th February 2011. This covered all roads leading into Windsor town centre, on:

- Windsor Road (from McGraths Hill)
- Windsor Bridge (from Wilberforce)
- Hawkesbury Valley Way (from McGraths Hill)
- Macquarie Street (West)
- Hawkesbury Valley Way, north of Moses Street

In addition, an east-west screen-line in the centre of the area covered Macquarie Street, George Street and The Terrace. Additional survey locations were in George Street eastof Hawkesbury Valley Way and Moses Street. These survey locations are shown on Figure 2.

At each survey station, the number plates of a sample of vehicles were recorded, together with the time of passing. The sample was all "white" cars. This turned out to be a significant sample. The origin/destination survey results are further discussed in Section 2.3.

Looking at the total intersection flows over the morning and afternoon survey periods, the hours with highest traffic movements were:

TABLE 2.1 Windsor Intersection Peak Hours- Thursday 17 February 2011

Intersection	AM Peak Hour	PM Peak Hour
Bridge/Macquarie	8.00-9.00am	4.00-5.00pm
Bridge/George	8.15-9.15 am	3.30-4.30pm
Macquarie/Kable/Ross	8.30-9.30am	3.45-4.45pm
George/New	9.30-10.30am	4.15-5.15pm
George/Suffolk	9.00-10.00am	3.15-4.15pm
Macquarie/Fitzgerald	7.45-8.45am	3.45-4.45pm
George/Fitzgerald	9.15-10.15am	3.45-4.45pm
Macquarie/Suffolk	8.00-9.00am	3.45-4.45pm
Macquarie/Hawkesbury V Way	7.30-8.30am	4.15-5.15pm
George/Hawkesbury V Way	8.00-9.00am	4.15-5.15pm
Bridge/Court	7.45-8.45am	3.45-4.45pm
The Terrace & Kable	8.45-9.45am	4.00-5.00pm
The Terrace & New	8.45-9.45am	3.15-4.15pm
The Terrace & Fitzgerald	8.00-9.00am	4.15-5.15pm
George/Johnston	9.15-10.15am	3.30-4.30pm
The Terrace & Johnston	8.15-9.15am	3.15-4.15pm
Hawkesbury Valley Way/Moses	9.15-10.15am	4.00-5.00pm

In the analysis, for the major road network of Bridge Street, Macquarie Street and Hawkesbury Valley Way, consistent peak hours of 8.00-9.00am and 4.00-5.00pm have been used. For all other intersections, being on The Terrace and on George Street – but excluding intersections of the latter with Hawkesbury Valley Way and with Bridge Street- the actual peak hours of each intersection have been used. Figure 3 shows the morning peak hour flows, while Figure 4 shows the afternoon peak hour flows.

From Figures 2 and 3, the total peak hour flows on each intersection approach have been added. Table 2.2 shows the current morning peak hour flows, while Table 2.3 shows the current afternoon peak hour flows. To assist in the interpretation of these current peak hour flows, Table 2.4 reproduces a Guide from the Roads & Traffic Authority's *"Guide to Traffic Generating Developments"*.

TABLE 2.2 Current Morning Peak Hour Flows, 17 February 2011 (vehicles per hour)

Road	Location	North/East bound	South/West bound	Total
Macquarie	West HV Way	1060	820	1880
Street	East HV Way	655	816	1471
	East Suffolk	594	798	1392
	East Fitzgerald	508	896	1404
	East Kable	525	898	1423
	West Bridge	461	954	1415
George	West HV Way	327	205	532
Street	East HV Way	454	274	728
	West Suffolk	284	265	549
	East New	150	226	376
	West Fitzgerald	181	278	459
	West Bridge	79	119	198
	East Bridge	22	40	62
The Terrace	East HV Way	150	87	248
(Moses St)	West New	158	154	312
	East New	101	197	298
	West Fitzgerald	155	219	374
	East Kable	119	262	381
Hawkesbury	North Moses	730	685	1415
Valley Way	North George	695	633	1328
	North Macquarie	758	589	1347
	South Macquarie	529	761	1290

TABLE 2.3 Current Afternoon Peak Hour Flows,17 February 2011 (vehicles per hour)

Road	Location	North/East bound	South/West bound	Total
Macquarie	West HV Way	1153	1089	2242
Street	East HV Way	943	802	1745
	East Suffolk	928	606	1534
	East Fitzgerald	937	660	1597
	East Kable	924	660	1584
	West Bridge	929	672	1601
George	West HV Way	359	291	650
Street	East HV Way	373	376	749
	West Suffolk	286	294	580
	East New	160	190	350
	West Fitzgerald	172	273	445
	West Bridge	212	139	351
	East Bridge	37	69	106
The Terrace	East HV Way	164	94	258
(Moses St)	West New	256	235	491
	East New	227	217	444
	West Fitzgerald	230	221	451
	East Kable	210	246	456
Hawkesbury	North Moses	933	1138	2071
Valley Way	North George	963	1081	2044
	North Macquarie	910	1076	1986
	South Macquarie	823	912	1735

TABLE 2.4 Environmental Capacity Performance Standards on Residential Streets

Road class	Road type	Max. Speed (km/hr)	Max.peak hour flow (veh/hr)
Local	Access way	25	100
	Street	40	200 environmental goal
		40	300 maximum
Collector	Street	50	300 environmental goal
		50	500 maximum

Peak hour flows on the arterial routes Macquarie Street and Hawkesbury Valley Way are of the order that would be expected. George Street functions as a town centre distributor and "High Street", as the traditional main commercial street in the town, and centre of the central business district. From Suffolk Street to Fitzgerald Street these flows are at an

appropriate scale for the retail and commercial activities on either side. Flows on Moses Street – The Terrace are in the range 300-500 veh/hr, which is the environmental capacity range between the environmental goal and the maximum for a residential collector street. The level of these current flows is higher than what would be desired for a Local Street with residential frontages. The current peak flows in Moses Street east of Hawkesbury Valley Way generally meet the criteria for a Local Road. East of New Street, with The Terrace functioning primarily as a town centre ring-road or distributor road, the current flows are in keeping with the function.

In addition to these counts, an automatic tube counter was laid in The Terrace west of Johnston Street, with data collected from Tuesday 15th February to Monday 28th February 2011. Table 2.5 shows the daily traffic flows by direction, for this 14 day period.

TABLE 2.5 The Terrace: Daily Traffic Flows, February 2011

Day	South-west bound	North-east bound	Total Two-way
Tuesday 15	2112	1486	3598
Wednesday 16	2057	1395	3452
Thursday 17	2220	1596	3816
Friday 18	2431	1681	4112
Saturday 19	1989	1129	3118
Sunday 20	1699	921	2620
Monday 21	2119	1427	3546
Tuesday 22	2183	1497	3680
Wednesday 23	2064	1456	3520
Thursday 24	2315	1582	3897
Friday 25	2461	1586	4047
Saturday 26	1937	1165	3102
Sunday 27	1630	875	2505
Monday 28	2063	1360	3423
14 day ADT	2091	1368	3459
10 day AWT	2202	1507	3709

Given the proximity of the shopping centre access, the total traffic flows are reasonable. The difference between the South-west bound traffic and the North-east bound traffic is interesting.

Table 2.6 sets out the average weekday (Monday-Friday) hourly traffic flows for the seven day period 15-21 February 2011.

TABLE 2.6 The Terrace: Average Weekday Hourly Flows, 15-21 February 2011

Time	North-east bound	South-west bound	Total Two-way
0-1am	4	5	9
1-2am	0	2	2
2-3am	1	1	2
3-4am	2	2	4
4-5am	3	4	7
5-6am	12	12	24
6-7am	20	32	52
7-8am	40	68	108
8-9am	85	191	276
9-10am	113	155	268
10-11am	104	151	255
11-12noon	120	182	302
12-1pm	122	177	299
1-2pm	108	186	294
2-3pm	116	168	284
3-4pm	169	189	358
4-5pm	149	176	325
5-6pm	132	147	279
6-7pm	90	113	203
7-8pm	51	92	143
8-9pm	37	58	95
9-10pm	21	44	65
10-11pm	12	21	33
11-12 mnight	7	12	19
24 hour	1517	2187	3704

Looking at the North-east bound flows, there is no pronounced morning peak hour. There is an afternoon peak hour at 3.00-4.00pm, with 169 veh/hr. For the South-west bound, there is a morning peak at 8.00-9.00am, with 191 veh/hr, and an afternoon peak of 189 veh/hr in the period 3.00-4.00pm. The combined flows generally reached a plateau from about 8.00am until 3.00pm, after which they rose for the 3.00-5.00pm afternoon period. A Collector Road has an environmental goal of 300 veh/hr and a maximum of 500 veh/hr, based on Roads & Traffic Authority's *Guide to Traffic Generating Developments*, as shown on Table 2.4.

The counts also recorded vehicle classification. There were very few heavy vehicles. Light vehicles accounted for 98% of traffic. Rigid heavy vehicles (AUSTROADS classes 3-5) accounted for 2%. Heavy articulated vehicles were a very low number and included in this 2%.

With traffic speeds, the weekly 85%ile speed for the North-east bound traffic was 41 km/hr, with 45 km/hr for the South-west bound.

2.3 Traffic Origins & Destinations

An origin-destination survey was undertaken in the afternoon peak period on Thursday 24th February 2011, for the north-westbound traffic from Windsor Road (South-east) and Hawkesbury Valley Way (South-east). This covers the "outbound" afternoon traffic. The survey stations are shown on Figure 2. Vehicles were sampled based on their colour, with number plates recorded. Table 2.7 summarises the overall results for overall origins and destinations for traffic arriving from Windsor Road (Bridge Street south of Court Street), for the three-hour afternoon peak period. With the survey over this full period, percentages of movements are not necessarily accurately reflected in the peak **hour** flows shown on Figure 4.

TABLE 2.7 Overall Origin-Destination Results – Afternoon Peak Period
Origin: Windsor Road South-east of Court Street

Destination	Total	Via George St	Via The Terrace
Macquarie St West	20%	1%	1%
Hawks Valley Way North	24%	2%	1%
Windsor Bridge (North)	53%	0%	0%
Other	3%	-	-

As seen in Table 2.7, just over half of the outbound traffic continues across Windsor Bridge, towards Wilberforce and Freemans Reach. Almost 25% of this traffic from Windsor Road drives through Windsor and heads towards Richmond on Hawkesbury Valley Way North. Some 20% continues to Macquarie Street West of Hawkesbury Valley Way. Some of the traffic heading towards Macquarie Street West and Hawkesbury Valley Way North choose to drive through Windsor town, along either George Street or The Terrace. The 1-2% figures shown in Table 2.7 are included in the Total figures for the listed Destinations.

For traffic into Windsor from Hawkesbury Valley Way, south of Day Street, the destinations were:

Origin: Hawkesbury Valley Way South of Day Street (7)

Destination	Percentage
Macquarie Street West (11)	28%
Hawkesbury Valley Way North (10)	36%
Windsor Bridge (North) (3)	28%
Other	8%

While Hawkesbury Valley Way (North) was the primary destination, there were still substantial numbers travelling to Macquarie Street West and Windsor Bridge. The latter vehicles presumably made right turns at George Street and Moses Street, given the No Right Turn restriction from Hawkesbury Valley Way into Macquarie Street East. As previously indicated, with these percentages derived over the full three-hour afternoon period, turning movements shown in Figure 4 do not necessarily add up to the same percentages.

Of particular interest in understanding traffic circulation patterns through Windsor, the internal "screen line" across The Terrace, George Street and Macquarie Street west of Fitzgerald Street identifies traffic distribution. For the Windsor Road-Bridge Street entry point, the percentages of traffic passing through these internal locations was as follows.

Windsor Road-Bridge Street South Entry (1), Westbound Traffic

Internal Station	Percentage
Macquarie Street (4)	71%
George Street (5)	17%
The Terrace (6)	12%

Again, while Macquarie Street logically carries most of this westbound traffic, a not-insubstantial proportion divert to George Street, plus additional diversions to The Terrace.

2.4 Intersection Operation

The peak period operation of the intersections counted has been assessed using the aaSIDRA traffic model. A guide to the significance of the modeling outputs can be found in the Roads & Traffic Authority's *Guide to Traffic Generating Developments.* This has been summarized in Table 2.8 below.

TABLE 2.8 Level of Service Criteria for Intersections

Level of Service	**Average Delay Per Vehicle (secs)**	**Traffic Signals, Roundabout**	**Give way & Stop Signs**
A	< 14	Good operation	Good operation
B	15-28	Good with acceptable Delays & spare capacity	Acceptable delays & spare capacity
C	29-42	Satisfactory	Satisfactory, but accident study required
D	43-56	Operating near capacity	Near capacity & accident study required
E	57-70	At capacity; at signals, incidents will cause excessive delays; Roundabouts require other control mode	At capacity, requires other control mode

The RTA *Guide* states that a Level of Service of "F" indicates the intersection is over-capacity and small increases in traffic flows result in disproportionally large increases in delays.

Based on observations at the traffic-signal controlled intersections, the cycle times were set at 100 seconds.

Table 2.9 shows the results at Macquarie & Bridge Streets, which is a signal-controlled intersection. The analysis of this intersection has assumed a morning peak cycle time of 70 seconds and an afternoon peak cycle time of 100 seconds. These were the mean figures observed during the traffic counts for these peak one hour periods.

TABLE 2.9 Macquarie & Bridge Streets Signals

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Bridge South	Left	Na	8	A	Na	8	A
	Through	44	17	B	145	22	B
Bridge North	Through	60	7	A	42	7	A
	Right	78	20	B	84	31	C
Macquarie	Left	38	21	B	128	32	C
	Right	45	35	C	100	48	D
ALL	All		16	B		26	B
	DS	0.573			0.676		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

Table 2.9 indicates that this intersection is functioning with relatively low delay levels overall, and with spare capacity. Occasionally the southbound approach queues back to the George Street roundabout. As discussed in the following Section 2.5, there is an accident problem involving vehicles making a right turn from Bridge Street North colliding with northbound through vehicles from Bridge Street South. These conflicts can occur in the filtered right turn.

One issue where the SIDRA analysis does not entirely reflect what sometimes happens on the ground is the left turn queue from Macquarie Street into Bridge Street. The 95% queue indicated in Table 2.9, of 128m, takes this queue to just west of Baker Street. Traffic patterns can vary from day to day. We have observed this queue to be substantially longer on occasion, with the worst observed being back as far as Fitzgerald Street. As is further discussed, delays to this left turn movement are forcing some drivers to seek alternative “rat-runs”. The destination of this traffic is across Windsor Bridge, to Wilberforce and to Freemans Reach. Some traffic travelling through Freemans Reach heads back to Bells Line of Road and the Kurrajong area. While longer than via North Richmond, the diversion is the result of peak period delays approaching and through North Richmond.

Table 2.10 sets out the results for the junction of George and Bridge Streets, which is a one-lane roundabout.

TABLE 2.10 George & Bridge Streets Roundabout

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Bridge South	Left	17	8	A	76	9	A
	Through	17	8	A	76	8	A
	Right	17	12	A	76	13	A
George East	Left	4	13	A	4	10	A
	Through	4	13	A	4	10	A
	Right	4	17	B	4	14	A
Bridge North	Left	47	8	A	24	8	A
	Through	47	7	A	24	7	A
	Right	47	11	A	24	11	A
George West	Left	4	9	A	32	19	B
	Through	4	9	A	32	18	B
	Right	4	13	A	32	22	B
ALL	All		8	A		10	A
	DS	0.557			0.743		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

Table 2.10 indicates that this roundabout is currently operating at a very good level of service, with low levels of delay. Higher flows on George Street East probably reflect some "rat-running" of traffic from Macquarie Street, making a right turn into Bridge Street and then a left turn into Court Street, and thence back to Bridge Street, where a right turn is made, to proceed towards Freemans Reach and Wilberforce. The absolute value of these flows and the good level of service do not indicate a major issue.

Table 2.11 sets out the results at the junction of Bridge and Court Streets. This is a priority junction.

TABLE 2.11 Bridge & Court Streets
Priority

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Bridge South	Through	23	2	A	35	3	A
	Right	23	13	A	35	15	B
Court	Left	0	13	A	0	13	A
	Right	4	76	F	3	125	F
Bridge North	Left	0	8	A	0	8	A
	Through	0	0	A	0	0	A
ALL	All		2	(A)		3	(A)
	DS	0.296			0.320		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

The right turn movement out of Court Street suffers significant levels of delay, because of the high traffic flows that the right-turn traffic has to give way to. A driver turning right out of Court Street would typically try to edge into a stationary queue in Bridge Street. The right turn movement out of Court Street is very low, at less than 10 veh/hr. The Level of Service of "F" indicates an unsatisfactory situation with delay levels, with the movement over-capacity. An alternative for a driver originating on this peninsula would probably be to use the George Street/Bridge Street roundabout for egress.

Table 2.12 sets out the results for the junction of Macquarie, Kable and Ross Streets, which is a signal controlled intersection.

TABLE 2.12 Macquarie, Kable & Ross Streets

		Signals					
		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Ross	Left	8	11	A	8	12	A
	Through	8	3	A	8	3	A
	Right	8	11	A	8	12	A
Macquarie East	Left	88	18	B	54	15	B
	Through	88	10	A	54	7	A
	Right	17	19	B	22	20	B
Kable	Left	9	9	A	17	11	A
	Through	9	1	A	17	2	A
	Right	9	9	A	17	10	A
Macquarie West	Left	50	29	C	83	28	B
	Through	50	20	B	83	19	B
	Right	16	38	C	22	31	C
ALL	All		14	A		15	B
	DS	0.376			0.361		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

Overall, this intersection is operating at a good level of service, represented by a level of service of A or B in each peak period and Degrees of Saturation of 0.36-0.38. Some movements are subject to greater delays than other movements, but overall, the junction is operating well.

Table 2.13 sets out the results at The Terrace and Kable Street. This is a priority control junction.

TABLE 2.13 The Terrace & Kable Street

Priority

		Current AM			**Current PM**		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Kable	Left	2	8	A	3	8	A
	Right	2	8	A	3	8	A
The Terrace	Left	9	7	A	8	7	A
East	Through	9	0	A	8	0	A
The Terrace	Through	0	0	A	0	7	A
West	Right	0	7	A	0	0	A
ALL	All		3	(A)		2	(A)
	DS	0.213			0.196		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

The results indicate that this intersection is operating at a very satisfactory level, with low delays and a high level of service.

Table 2.14 sets out the results at the intersection of George and Suffolk Streets, which is a priority control junction, with George Street traffic having priority. This is an offset intersection with the George Street and New Street junction. The two are approximately 10m apart. Following the changes to Suffolk Street, to make it one-way from George Street to Macquarie Street, to facilitate bus movements, there are limited conflicts at this intersection.

TABLE 2.14 George & Suffolk Streets
Priority

		Current AM			**Current PM**		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
George East	Left	0	6	A	0	6	A
	Through	0	0	A	0	0	A
George West	Through	11	2	A	12	2	A
	Right	11	9	A	12	9	A
ALL	All		2	(A)		2	(A)
	DS	0.174			0.189		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

This intersection is currently operating at a very good level of service, with low delay levels and a very good level of service, as would be expected with the simplification of the intersection, with no traffic joining George Street from Suffolk Street.

Table 2.15 sets out the results at the intersection of George and New Streets, which is a priority-controlled junction just to the east of the Suffolk Street intersection.

TABLE 2.15 George & New Streets
Priority

		Current AM			**Current PM**		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
George East	Through	8	1	A	6	1	A
	Right	8	8	A	6	8	A
New	Left	14	12	A	24	14	A
	Right	14	12	A	24	14	A
George West	Left	0	6	A	0	6	A
	Through	0	0	A	0	0	A
ALL	All		5	(A)			(A)
	DS	0.324			0.446		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

As with the Suffolk Street junction, this intersection is currently operating at a very good level of service, with low delay levels.

Table 2.16 sets out the results at the junction of The Terrace and New Street, which is a priority junction.

TABLE 2.16 The Terrace & New Street
Priority

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
New	Left	3	8	A	5	8	A
	Right	3	8	A	5	9	A
The Terrace	Left	0	6	A	0	6	A
East	Through	0	0	A	0	0	A
The Terrace	Through	1	1	A	9	1	A
West	Right	1	8	A	9	8	A
ALL	All		4	(A)		4	(A)
	DS	0.118			0.170		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

This intersection is currently operating at a high level of service, with low levels of delay.

Table 2.17 sets out the results at the Macquarie and Fitzgerald Streets intersection, which is priority controlled.

TABLE 2.17 Macquarie & Fitzgerald Streets
Priority

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Macquarie East	Through	0	0	A	0	0	A
	Right	4	11	A	8	16	B
Fitzgerald	Left	11	37	C	31	75	F
	Right	11	37	C	31	75	F
Macquarie West	Left	0	8	A	0	8	A
	Through	0	0	A	0	0	A
ALL	All		2	(A)		5	(A)
	DS	0.364			0.758		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

While the overall intersection level of service is very good, with overall average intersection delays low, the movements from Fitzgerald Street onto Macquarie Street are subject to substantial delays, as drivers wait for a suitable gap. However the traffic modeling does not adequately pick up the effect of downstream traffic signals and the resulting platooning of traffic, creating gaps. Also, the SIDRA model can be conservative in this situation. Comparative analysis with alternative analysis programs suggests that side street delays can be lower.

The alteration of Suffolk Street to one-way southbound, to facilitate bus movements, was predicted to divert traffic turning from Macquarie Street into Suffolk Street, to turn from Macquarie Street into Fitzgerald Street. Our February 2010 report *"Traffic Impact Assessment of Proposed Change to Windsor Town Centre Road Network"* set out traffic counts in February 2010, prior to the one-way alteration. Figures 1 and 2 of this report set out these flows, as well as the predicted flows with Suffolk Street one-way. The following Table 2.18 sets out the 2010 and 2011 peak hour flows turning from Macquarie Street into Suffolk Street and into Fitzgerald Street, as well as the flows predicted post-change, shown in brackets.

TABLE 2.18 Effect of Suffolk Street One-Way Change on Macquarie Street Vehicles per Hour (Predicted flows in brackets)

Date/Peak	Left turn to Suffolk St	Right turn to Suffolk St	Left turn to Fitzgerald St	Right turn to Fitzgerald St
Feb 2010 AM	48	124	36	85
Feb 2010 PM	61	45	53	67
Feb 2011 AM	0	0	83 (59)	86 (176)
Feb 2011 PM	0	0	103 (81)	104 (107)

Table 2.18 indicates higher 2011 left turn flows into Fitzgerald Street than predicted, but substantially lower right turn flows, in the AM peak hour. In the PM peak hour the actual 2011 left turn flow is more than predicted, while the right turn flow is similar to the prediction. The critical movement, in terms of delays at the Macquarie Street/Fitzgerald Street intersection, is the right turn out of Fitzgerald Street. The predicted delays to this movement in February 2010 (Table 2.8 of our February 2010 report) were 77 seconds in the AM peak and 98 seconds in the PM peak. As shown in Table 2.17 above, the February 2011 predicted flows to the right turn out of Fitzgerald Street are 37 seconds in the AM peak and 75 seconds in the PM peak, figures which are lower than the February 2010 figures. For comparison also, the overall intersection delays predicted in 2010 were 2.9 seconds in the AM peak and 5.5 seconds in the PM peak, compared with 2011 figures of 2.4 seconds and 5.3 seconds. It can be concluded that at this intersection, which is the intersection most affected by the one-way change in Suffolk Street, that this change has not had an adverse impact on road network capacity.

Table 2.19 sets out the results at the priority-controlled intersection of George and Fitzgerald Streets. The eastern end of George Street is the pedestrian mall. This intersection has a raised speed platform, with marked foot crossings across both Fitzgerald Street approaches. It has been assessed assuming traffic speeds of 25 km/hr.

TABLE 2.19 George & Fitzgerald Streets
Priority

		Current AM			**Current PM**		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Fitzgerald South	Left	0	1		0	1	A
	Through	0	0	A	0	0	A
Fitzgerald North	Through	3	1	A	3	1	A
	Right	3	3	A	3	3	A
George West	Left	9	3	A	8	3	A
	Right	9	4	A	8	4	A
ALL	All		2	(A)		2	(A)
	DS	0.232			0.220		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

Table 2.19 indicates that this intersection is operating well. The level of traffic flows in the peak hours is relatively low, and additional traffic diverted due to the one-way restriction in Suffolk Street has not had any adverse impact.

Table 2.20 sets out the results at the junction of The Terrace with Fitzgerald Street. This is a priority junction.

TABLE 2.20 The Terrace & Fitzgerald Street

Priority

		Current AM			**Current PM**		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Fitzgerald	Left	0	6	A	4	9	A
	Right	0	7	A	4	9	A
The Terrace	Left	0	6	A	0	6	A
East	Through	0	0	A	0	0	A
The Terrace	Through	0	0	A	8	1	
West	Right	0	0	A	8	8	A
							A
ALL	All		4	(A)		3	(A)
	DS	< 0.1			< 0.1		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

This intersection is currently operating at a very good level of service, with low delay levels.

Table 2.21 sets out the results at the Macquarie and Suffolk Street intersection, which is priority controlled.

TABLE 2.21 Macquarie & Suffolk Streets

Priority

		Current AM			**Current PM**		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Macquarie East	Through	0	0	A	0	0	A
						.	
Suffolk	Left	3	12	A	9	16	B
	Right	7	69	E	13	100	F
Macquarie West	Through	0	0	A	0	0	A
ALL	All		1	(A)		3	(A)
	DS	0.257			0.471		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

Table 2.21 indicates that that this intersection is currently operating at a good overall level of service, with low delays to most movements. At this intersection, the delays to the traffic entering Macquarie Street from Suffolk Street are moderate for the left turns, but are high for the right turns. The volume of right turning traffic is low, with 16 veh/hr in the morning peak hour and 24 veh/hr in the afternoon peak hour. Similar comments as made for the Macquarie/Fitzgerald Streets intersection apply here – there has not been an adverse impact on road network capacity and operation due to the one-way restriction in Suffolk Street.

Table 2.22 sets out the results at the priority control junction of George Street and Johnston Street.

TABLE 2.22 George & Johnston Streets
Priority

		Current AM			**Current PM**		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
George	Through	9	1	A	9	1	A
East	Right	9	8	A	9	8	A
Johnston	Left	0	9	A	0	8	A
	Right	0	9	A	0	9	A
George	Left	0	6	A	0	6	A
West	Through	0	0	A	0	0	A
ALL	All		1	(A)		1	(A)
	DS	0.150			0.151		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

This intersection is currently operating at a high level of service, with low delay levels.

Table 2.23 sets out the results at the priority control junction of The Terrace and Johnston Street.

TABLE 2.23 The Terrace and Johnston Street
Priority

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Johnston	Left	3	8	A	4	8	A
	Right	3	8	A	4	8	A
The Terrace	Left	0	6	A	0	6	A
East	Through	0	0	A	0	0	A
The Terrace	Through	3	1	A	1	1	A
West	Right	3	8	A	1	8	A
ALL	All		3	(A)		3	(A)
	DS	0.133			0.115		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

This intersection is currently operating at a high level of service, with low delay levels.

Table 2.24 sets out the results at the major traffic-signal controlled intersection of Hawkesbury Valley Way and George Street.

TABLE 2.24 Hawkesbury Valley Way & George Street Signals

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Hawkesbury	Left	109	46	D	131	43	D
Valley Way	Through	109	37	C	131	35	C
South	Right	60	59	E	93	162	F
George East	Left	45	24	B	59	24	B
	Through	45	15	B	59	16	B
	Right	32	26	B	42	26	B
Hawkesbury	Left	94	45	D	123	43	D
Valley Way	Through	126	38	C	521	142	F
North	Right	21	55	D	86	146	F
George West	Left	69	48	D	78	49	D
	Through	69	40	C	78	41	C
	Right	66	49	D	71	49	D
ALL	All		38	C		81	F
	DS	0.740			1.145		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

Table 2.24 indicates that this intersection is moderately busy in the morning peak hour, with a marginal level of service of C and average delay of 38 seconds. However in the afternoon peak hour the increased traffic drives the operation into higher delays and consequently a level of service of F. Anecdotal evidence is that the delay to the right turn out of George Street East is higher than indicated by the modeling, and is a cause for concern, with this perceived as a road network capacity deficiency. Observations made in a Thursday afternoon peak period after the traffic counts were undertaken indicated an overall satisfactory situation for the Hawkesbury Valley Way through traffic, but a less satisfactory situation for drivers on George Street, particularly those making a right turn from George Street East. Table 2.24 indicates that this movement has average delays of 26 seconds, and a level of service of B. However observations indicate that only 4 to 5 cars can make this turn in the PM peak, within the Green time allocated. The difference between the Table 2.24 SIDRA results and the observations made is probably due to the co-ordination timing of this intersection with the nearby Macquarie Street/HVW

intersection, with less Green time allocated to George Street than the SIDRA model calculates as the optimal overall intersection timing.

Table 2.25 sets out the results at the major traffic-signal controlled junction of Hawkesbury Valley Way and Macquarie Street.

TABLE 2.25 Hawkesbury Valley Way & Macquarie Street Signals

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Hawkesbury	Left	25	12	A	61	21	B
Valley Way South	Through	74	40	C	113	46	D
Macquarie East	Left	110	53	D	105	51	D
	Through	110	45	D	105	42	D
	Right	208	1589	F	253	223	F
Hawkesbury	Left	0	8	A	0	8	A
Valley Way	Through	42	16	B	72	17	B
North	Right	51	43	D	122	53	D
Macquarie West	Left	22	15	B	14	13	A
	Through	182	65	E	441	175	F
	Right	168	81	F	168	82	F
ALL	All		55	D		78	F
	DS	1.088			1.219		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

Table 2.25 indicates that this intersection is busy in the peak periods, with a high degree of saturation, and a level of service of F in the afternoon, which means this intersection is "operating over capacity". The delay levels are higher in the afternoon, with the increased traffic flows. The morning has a level of service of D, which is acceptable for peak hour operations. Observations in a Thursday afternoon peak period later in 2011 suggest that the situation on the ground is better than suggested by the delay levels in Table 2.25.

Table 2.26 sets out the results at the priority control junction of Hawkesbury Valley Way and Moses and Cox Streets.

TABLE 2.26 Hawkesbury Valley Way, Moses and Cox Streets
Priority

		Current AM			Current PM		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
HV Way	Left	0	8	A	0	8	A
North	Through	50	6	A	107	21	B
	Right	50	15	B	107	35	C
Moses	Left	2	12	A	8	22	B
	Through	10	32	C	15	150	F
	Right	10	33	C	15	151	F
HV Way	Left	0	8	A	0	8	A
South	Through	48	6	A	123	18	B
	Right	48	15	B	123	28	B
Cox	Left	3	13	A	8	17	B
	Through	0	49	D	2	245	F
ALL	All		8	(A)		21	(B)
	DS	0.366			0.617		

Note: DS is Degree of Saturation; LS is Level of Service
Q is 95% back-of-queue

In the morning peak hour, this intersection is operating at a moderate level of service, with the through and right turn movements out of the side streets – Cox and Moses Streets – suffering some delays. In both peak hours, there were no right turning vehicles out of Cox Street, reflecting the difficulties in making this movement. Such vehicles would divert down Brabyn Street to George Street.

In the afternoon peak, because of the higher traffic flows along Hawkesbury Valley Way, the delays to the side streets are substantially higher. The through movement out of Cox Street was only 1 veh/hr in each peak period, again suggesting that drivers divert via Brabyn Street to George Street. The through movement out of Moses Street is also low, at 2-5 veh/hr. Drivers wishing to make this movement would probably use Tebbutt Street to reach George Street, and hence through the traffic signals on Hawkesbury Valley Way. The right turn out of Moses Street suffers significant delays in the afternoon peak hour, but only 19 veh/hr were observed trying to make this movement, probably suppressed because of the difficulty in finding a traffic gap. As discussed,

delays to the right turn out of George Street into Hawkesbury Valley Way, to travel to Richmond, are also high, so there is an overall capacity deficiency in the road network.

In conclusion, most intersections are currently operating at good levels of service, with spare capacity. The two signal controlled intersections on Hawkesbury Valley Way are operating at capacity, and the intersection of Hawkesbury Valley Way with Moses and Cox Streets also has delay problems for the movements out of the side streets .

2.5 Accident History

The most recent Roads & Traffic Authority five year accident history records for Windsor were reviewed, for the period 2005 to 2009. Trends and repeated accident types were sought. This review is broken down into key streets. The numbers of accidents listed were the total for the five year period.

Hawkesbury Valley Way (HVW)

Macquarie Street

The main accident at this junction involved vehicles making a right turn from Macquarie Street (East) into HVW, colliding with an eastbound vehicle on Macquarie Street. There were 18 accidents of this type in the five years. These accidents are likely due to drivers making right turns in traffic gaps, rather than waiting for a green arrow. However the current signal phasing does not allow right-turning drivers to filter through opposing eastbound traffic, so it appears that a change to the signal phasing has recently occurred. The right turn from Macquarie Street East either has a green arrow – with no eastbound movement along Macquarie Street – or a red arrow at other times.

There were seven accidents involving vehicles making a right turn from Macquarie Street (West) into HVW, colliding with westbound vehicles on Macquarie Street. The right turn from Macquarie Street West initially is subject to a red arrow, which drops out, allowing a right turn filter. It appears that some drivers do not allow sufficient traffic gaps to make this right turn.

Otherwise, there were small numbers of rear-end accidents (two westbound and two eastbound and one southbound) plus some lane change accidents.

George Street

The main accident at this junction involved vehicles making a right turn from HVW (North) into George Street(West), colliding with a northbound vehicle on HVW. There were 10 accidents of this type. They presumably occurred in the main signal phase for HVW, with drivers presumably taking gaps in the opposing traffic that were too short.

Like the right turn problem at the Macquarie Street intersection, it appears that a change has been made to the signal phasing, with this right turn from the North either having a green arrow, with priority, or a red arrow.

There were three accidents involving eastbound vehicles out of George Street (West) colliding with northbound vehicles in HVW. There were also three accidents involving vehicles making a right turn from HVW into George Street (East) colliding with southbound vehicles on HVW. There were several more minor accidents. One accident involved a pedestrian being hit by a southbound vehicle on HVW.

Cox and Moses Streets

There were four accidents involving vehicles from HVW (North) turning right into Cox Street, colliding with northbound vehicles in HVW.

There were two accidents involving southbound HVW vehicles and westbound Moses Street vehicles, plus a further two involving westbound Moses Street vehicles colliding with northbound HVW vehicles. To the south of this intersection there was one accident involving a pedestrian being hit by a southbound vehicle. There were several single frequency accidents in addition, mainly "rear-end" accidents.

Bridge Street

Macquarie Street

The main accident at this junction involved vehicles making a right turn from Bridge Street (North) into Macquarie Street, colliding with northbound vehicles from Bridge Street (South). There were eight accidents of this type. The general through phase from Bridge Street (North) starts without a right turn red arrow, and drivers are generally allowed to make a right turn by filtering through opposing Bridge Street traffic. The option would be to change the signal phasing, to use a red arrow control to reduce the possibility of this conflict.

Court Street

There were only four minor accidents at the Court Street junction, with two involving vehicles apparently making right turns into the Jolly Frog Hotel parking area.

George Street

Only one accident was recorded at this junction, involving a single northbound vehicle hitting the left kerb. Just to the North, one southbound vehicle in Bridge Street hit a pedestrian.

Macquarie Street

The junctions with Hawkesbury Valley Way and Bridge Street are covered above. There were no recorded accidents at the junctions with Dight Street or Christie Street. At the Baker Street junction there were just three rear-end accidents by eastbound Macquarie Street vehicles.

Day Street

There were five accidents involving eastbound Macquarie Street vehicles turning right into Day Street, colliding with westbound Macquarie Street vehicles.

Suffolk Street

There were five accidents involving vehicles turning out of Suffolk Street colliding with north-eastbound vehicles in Macquarie Street. There were two accidents involving vehicles turning right into Suffolk Street. With the one-way system now in place in Suffolk Street, this accident type can no longer occur.

Fitzgerald Street

There was a total of seven accidents at this junction in the five year review period, with three accidents involving vehicles turning right into Fitzgerald Street colliding with eastbound vehicles in Macquarie Street.

Ross and Kable Streets

There was a total of 10 accidents at this junction in the five year period, with five of these involving vehicles turning right into Kable Street colliding with eastbound vehicles in Macquarie Street.

George Street

There were no accidents recorded at the junctions with Dight Street, Tebbutt Street, Christie Street, Kable Street and Baker Street.

At Catherine Street there was one right-angle accident involving a vehicle leaving Catherine Street, plus another accident involving a vehicle leaving the kerb.

At Suffolk Street there was one accident involving a vehicle leaving Suffolk Street. The one-way system will prevent an accident of this type.

At New Street one accident involved a pedestrian and an eastbound vehicle. A new pedestrian crossing point has been located at this approximate location.

At Johnston Street there were no accidents. There were two accidents in George Street west of Johnston Street involving pedestrians.

At Fitzgerald Street there was one accident involving a right-turning vehicle out of Fitzgerald Street (North) and a vehicle traveling from Fitzgerald Street (South). There was an accident involving a pedestrian 100m south of George Street.

Overall, there was a low number of accidents in George Street, with pedestrian accidents more prevalent.

The Terrace

There were only four accidents recorded along The Terrace-Moses Street, with two of these involving single vehicles hitting the kerb or a parked car, and two involving vehicles turning out of Johnston Street colliding with westbound vehicles in The Terrace.

3.0 ASSESSMENT OF TRAFFIC ISSUES

3.1 Traffic Circulation

Bridge Street, Macquarie Street and Hawkesbury Valley Way carry traffic flows commensurate with their function as arterial routes. The other streets in the study area are lesser in function, being either Collector or Local Streets. Table 3.1 presents a guide to peak hour traffic flow levels, in regard to their "environmental capacity", taken from the Roads & Traffic Authority's *Guide to Traffic Generating Developments.* (This Table also appears earlier in this report as Table 2.4).

TABLE 3.1 Environmental Capacity Performance Standards on Residential Streets

Road class	Road type	Max. Speed (km/hr)	Max.peak hour flow (veh/hr)
Local	Access way	25	100
	Street	40	200 environmental goal
		40	300 maximum
Collector	Street	50	300 environmental goal
		50	500 maximum

As the title of the Table indicates, these standards relate to residential streets. While there are some residential land uses adjacent to some of the streets in the study area, they are typically mixed use streets, with part commercial uses. Table 3.1 nevertheless provides some guidance on overall traffic flow levels.

The Terrace is discussed in more detail in Section 3.7, while the streets adjacent to the Riverview Shopping Centre are discussed in Section 3.5.

With George Street and Moses Street, where they meet Hawkesbury Valley Way, flows in Moses Street are lower than flows in The Terrace at New Street, suggesting some use of Tebbutt Street and Catherine Street to access The Terrace. In absolute terms, the flows in Moses Street east of Hawkesbury Valley Way, of about 250 veh/hr, are not unduly high. However, Moses Street is clearly being used as part of the town centre traffic circulation, as indicated by turning patterns shown on Figures 3 and 4.

George Street east of Hawkesbury Valley Way is carrying peak hour flows of 730-750 veh/hr, which are higher than the maximum for a Collector Street. These flows reduce to 550-580 veh/hr west of Suffolk Street and 350-380 veh/hr east of New Street. Much of the additional traffic from George Street to Hawkesbury Valley Way would be traffic from Council offices and other institutions in this part of Windsor.

As discussed in Section 2.3, some peak period drivers entering Windsor from Windsor Road-Bridge Street use streets other than Macquarie Street to pass through the town, with various proportions diverting into George Street and The Terrace. Some of this traffic could well be stopping briefly in Windsor to access businesses on the way to or from work, while there are clearly other drivers who try to avoid traffic delays at the Macquarie Street/Hawkesbury Valley Way intersection by travelling through the town.

One of the recent changes to the road network was the change of Suffolk Street to one-way southbound operation, to facilitate bus routes. At the junction of George Street and Suffolk Street, with no traffic movement out of Suffolk Street, traffic conflicts are reduced, and hence this intersection operates at a very satisfactory level of service. At the junction of Suffolk Street with Macquarie Street, the delays to the right turn out of Suffolk Street result in poor levels of service. This is not a function of the road network change, but simply of the previous and current difficulty in finding gaps in the Macquarie Street traffic to make this turn. Traffic diverted from entering Suffolk Street from Macquarie Street might be using Fitzgerald Street. The delays to the turning movements into Fitzgerald Street from Macquarie Street are acceptable. As with Suffolk Street, traffic turning from Fitzgerald Street into Macquarie Street suffers delays, particularly in the afternoon peak period, but as discussed in Section 2.4, these delays have not increased because of the change to Suffolk Street. In summary, the change to Suffolk Street has not resulted in unacceptable traffic impacts.

3.2 Access to/from Hawkesbury Valley Way

Right-turn access onto Hawkesbury Valley Way (North, towards Richmond) from Macquarie Street, George Street and Moses Street is an identified issue of concern. While the majority of traffic makes the right turn from Macquarie Street – some 280 veh/hr in each peak period, as shown on Figures 3 and 4 – a substantial movement also occurs from George Street, with 107 veh/hr in the AM and 148 veh/hr in the PM peak hours. Moses Street had 51 veh/hr making the right turn in the AM and 19 veh/hr making the right turn in the PM. Delays to this movement at Moses Street are very substantial, particularly in the PM peak, where the flow of 19 veh/hr more reflects the difficulty of making the turn, rather than the underlying demand. Traffic from Moses Street needs to find gaps in the traffic on Hawkesbury Valley Way. The situation at all three junctions is more critical in the PM peak, as would be expected, with the intersection level of service being F at all three locations. This reduces the scope for substantial changes.

At the George Street/Hawkesbury Valley Way junction, the signal phasing and timing offers the best options. Relative signal phase timing might improve the situation but at the potential expense of through traffic delays. While the phase timing of the right-turn out of George Street (East) might be short, at least there is an option of extra turns made through traffic gaps, in the main George Street phase. However, our observations of current peak period conditions is that there is insufficient Green time for the right turn out

of George Street East, allowing about four vehicles to make the turn, followed by a fifth vehicle turning during the intergreen.

The actual signal phase times were surveyed, to compare with the SIDRA recommended phase times. For the movement out of George Street (East), with the exclusive right-turn green arrow, for the AM peak hour the SIDRA model suggested a total phase time (including amber and all red periods) of 28 seconds. The survey of actual phase lengths in this 8-9am period found an average phase time of 16 seconds. The main Hawkesbury Valley Way SIDRA phase time was 31 seconds, compared with a measured average phase time of 59 seconds. For the PM peak hour, the SIDRA model suggested a phase time for the movements out of George Street (East) of 28 seconds. The survey found an average of 16 seconds for this phase. The Hawkesbury Valley Way phase had a SIDRA estimate of 35 seconds, versus a surveyed figure of 46 seconds. The SIDRA model theoretically gives the optimum phase split, for the selected cycle length of 100 seconds. The signal co-ordination on the ground is significantly favouring Hawkesbury Valley Way, possibly driven by the time requirements at the Macquarie Street junction. In summary, the signal timing is not allowing adequate time for the movements out of George Street East. An analysis of the overall signal co-ordination requirements has not been undertaken. It would be appropriate to discuss the signal timing issues with representatives of the Roads & Traffic Authority.

An additional issue at this intersection is the right turn out of George Street West. This needs to filter through the opposing through movements. However, bearing in mind the relatively low volumes making this right turn towards Macquarie Street – 12-41 veh/hr – no changes are recommended. A double diamond phase might be feasible, but could result in additional delays to the heavier through movements along George Street.

With the through movements along George Street across Hawkesbury Valley Way, the eastbound flows are substantially higher than the westbound flows. This possibly represents drivers seeking an alternative route to Macquarie Street, because of delay levels in the latter street at its junction with Hawkesbury Valley Way.

Also, at Hawkesbury Valley Way/Macquarie Street, the signal phasing is appropriate. Here the right turn from Macquarie Street East into Hawkesbury Valley Way (North, towards Richmond) has a green arrow, or otherwise, a red arrow. While right turn filtering is feasible in the Macquarie Street through traffic phase, presumably this has been changed to a red arrow control because of the high number of accidents, with 18 accidents in five years involving this right turn conflicting with eastbound through traffic on Macquarie Street. Because of this situation, a phasing change to permit right-turn filtering is not recommended.

Observations of the PM peak hour have indicated that major road traffic flows along Macquarie Street and Hawkesbury Valley Way are travelling without significant delays. If the overall traffic signal timing is favouring these major roads then these observations are logical. What is harder to casually observe is the degree of the problem in making right turns onto Hawkesbury Valley Way from Windsor town streets, except from

Macquarie Street. With the new traffic counts set out in Figures 3 and 4, it is an opportune time to request the RTA to review all signal timing and operations at the two Hawkesbury Valley Way junctions, bearing in mind the concerns of Council.

The only physical option to increase the capacity of the right turn from Windsor streets to join Hawkesbury Valley Way that has been identified is to install traffic signals at the Hawkesbury Valley Way/Moses Street/Cox Street junction, or possibly to provide "seagull" channelization at this junction, to allow drivers making a right turn out of Moses Street to first take a gap in south-east bound traffic, to move into the median island, and then to select a gap in the northbound traffic flow. This would also require the through and right-turn movements out of Cox Street be prohibited. The main problem with this channelization is the restricted width of Hawkesbury Valley way at this location. A design to normal standards would be difficult to achieve. Any improvement to the capacity of the right turn out of Moses Street would of course attract traffic onto this route.

The installation of traffic signals would provide the required capacity, but would have three issues:

1. Signals at this location would add to delays to through traffic along Hawkesbury Valley Way.
2. Signals at this location would attract traffic onto Moses Street and The Terrace, using side streets such as Tebbutt Street, Catherine Street and New Street.
3. The works would need to be funded.

This option has been tested with the SIDRA model. Table 3.2 sets out the results, for the current AM and PM peak hour flows. The implications of traffic diverting off George Street to make the right turn onto Hawkesbury Valley Way at Moses Street has also been tested. The figures in brackets reflect this traffic diversion, with the Moses Street right turn flow increased from 51 veh/hr to 158 veh/hr in the AM, and from 19 veh/hr to 167 veh/hr in the PM. This assumes ALL right-turning traffic out of George Street diverts to Moses Street. This analysis assumes a fixed signal cycle length of 100 seconds, allowing for signal co-ordination with George Street.

TABLE 3.2 Hawkesbury Valley Way, Moses Street and Cox Street – Signals

		AM Peak Hour			PM Peak Hour		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Hawks Valley	Left	25 (31)	13 (15)	A (B)	47 (47)	13 (13)	A (A)
Way South	Through	110 (132)	8 (12)	A (B)	344 (344)	46 (46)	D (D)
	Right	110 (132)	17 (22)	B (B)	344 (344)	72 (72)	F (F)
Moses St	Left	22 (20)	48 (42)	D (C)	34 (34)	49 (49)	D (D)
East	Through	22 (20)	40 (34)	C (C)	34 (34)	41 (41)	C (C)
	Right	24 (65)	51 (48)	D (D)	10 (89)	52 (79)	D (F)
Hawks Valley	Left	23 (29)	13 (15)	A (B)	46 (46)	13 (13)	A (A)
Way North	Through	104 (127)	7 (12)	A (A)	402 (402)	38 (38)	C (C)
	Right	104 (127)	16 (21)	B (B)	402 (402)	54 (54)	D (D)
Cox St	Left	25 (23)	48 (42)	D (C)	40 (40)	49 (49)	D (D)
West	Through	25 (23)	40 (34)	C (C)	40 (40)	41 (41)	C (C)
	Right	1 (1)	48 (43)	D (C)	1 (1)	49 (49)	D (D)
ALL	All		13 (18)	A (B)		42 (44)	C (D)

Note: Results in brackets reflect Right-turn diversion off George Street to Moses Street

The results for the AM peak hour are satisfactory for both current traffic flows, and with right-turn traffic diversions off George Street. The PM peak results are not as good. While the overall level of service would be generally satisfactory, although approaching the desirable limit with diverted traffic, there would be an impact on through traffic movement along Hawkesbury Valley Way. We have some concern that the resulting situation would be acceptable to all road users.

As is discussed in Section 3.7, there are concerns with the volume of traffic using The Terrace. In theory, restrictions at the Hawkesbury Valley Way/Moses Street/Cox Street intersection might reduce the total traffic using The Terrace. However, restrictions at this intersection could have adverse impacts on accessibility, and result in undesirable traffic diversions. For example, a ban on the left turn from HVW North into Moses Street would force about 100 veh/hr additional traffic to make the left turn from HVW into George Street, which might require additional Green time for HVW, at the expense of George Street traffic. The impact would not be as substantial as banning the right turn, adding more pressure on the right turn into George Street, again with signal timing implications.

While the current situation is not entirely satisfactory, new intersection works are not recommended.

3.3 Access to Bridge Street

One issue that has been addressed is the difficulty of accessing Bridge Street from Macquarie Street, and the potential to use Court Street as part of a bypass route. Looking first at the SIDRA results for the junction of Bridge and Macquarie Streets, the overall intersection level of service is B in each peak period. The movement with the highest delay levels is the right turn out of Macquarie Street, with average peak hour delays of 35-48 seconds for the AM and PM peaks respectively. These delay levels reflect a level of service of C in the AM and D in the PM. The predicted 95% back-of-queue lengths were 45m in the morning peak hour (6 vehicles) and 100m in the afternoon peak hour (14 vehicles).

For the left turn out of Macquarie Street, the predicted delays were 21 and 32 seconds for the AM and PM peaks. These delay levels, being lower than the right turn delays, do not reflect what has been observed on other days, when left-turners suffer substantially higher delays compared with right turners.

As with any traffic situation, flows can vary from day to day, so that delays and queue lengths measured on one day might be different to those measured on other days.

The PM peak sees higher delay levels than the AM peak hour. Looking at the SIDRA computed phase times, including the amber and all red periods, the Bridge Street phase typically has 51 seconds, with 21 seconds for the right turn into Macquarie Street and 28 seconds for the movements out of Macquarie Street. The observed average phase times in the PM peak hour were 50, 21 and 28 seconds respectively, which are almost exactly the same as the ideal modeled times. This suggests that these signals are operating in an optimal manner with regard to signal timing.

Observations made on a different day to the survey day found an afternoon peak hour situation where the queue of vehicles waiting to turn left from Macquarie Street into Bridge Street was substantially longer than modeled, being almost as far as Fitzgerald Street, while the right turn queue was substantially shorter. A driver was followed making a right turn from Macquarie Street into Bridge Street, and then a left turn into Court Street, left turn into Arndell Street, left into George Street and then right at the roundabout into Bridge Street. While the George Street/Bridge Street roundabout appears to have adequate capacity, it is possible that some friction approaching this roundabout from Bridge Street South is affecting the throughput of left-turning vehicles from Macquarie Street. Drivers making the anti-clockwise “rat-run” via Court Street then reach the roundabout and have priority over those travelling northbound on Bridge Street. Our observations of this “rat-run” were confirmed by similar observations by Council staff.

Looking at total traffic movements into and out of the Windsor Peninsula, via George Street and Court Street, these combined movements are:

Peak	Into Peninsula	Out of Peninsula
AM	59 veh/hr	55 veh/hr
PM	144 veh/hr	78 veh/hr

There is substantially more traffic into the Peninsula in the PM compared with the AM. This is what would be expected with tidal flows, with drivers leaving residential areas in the morning, heading to work, and returning in the evening. However the same pattern would see more traffic out of the Peninsula in the AM than in the PM, which is not reflected in the combined flows above. As shown on Figures 3 and 4, there is minimal traffic turning from Court Street into Bridge Street, with total movements of 9-15 veh/hr. There is more traffic leaving George Street east of Bridge Street, with 40 veh/hr in the AM and 69 veh/hr in the PM.

The two-way flows in Court Street were 52 veh/hr in the AM and 116 veh/hr in the PM, while in George Street east of Bridge Street the respective flows were 62 veh/hr in the AM and 106 veh/hr in the PM. In environmental capacity terms – see Table 3.1 – these flow levels are not causes of concern.

The new Windsor Bridge might affect traffic circulation into and out of the Peninsula, depending on the bridge location and form of intersection control at George Street/Bridge Street.

As discussed in Section 2.5, in the five years reviewed, there were 8 accidents involving vehicles making right turns from Bridge Street North into Macquarie Street, colliding with northbound vehicles in Bridge Street. These accidents presumably occur when right-turning drivers make a filter turn, looking for gaps in the northbound Bridge Street traffic. These accidents could be removed if the signal phasing did not allow this right turn filter, with a right-turn red arrow showing during the Bridge Street through traffic phase. This potential change has been assessed using the SIDRA program. Table 3.3 sets out the results. These results should be compared with those in Table 2.9.

TABLE 3.3 Macquarie & Bridge Streets – Revised Signal Phasing

		Current AM			**Current PM**		
Street	**Move**	**Q (m)**	**Delay (secs)**	**LS**	**Q (m)**	**Delay (secs)**	**LS**
Bridge South	Left	Na	8	A	NA	8	A
	Through	53	18	B	145	22	B
Bridge North	Through	97	9	A	42	7	A
	Right	126	73	F	126	75	F
Macquarie	Left	53	28	B	128	32	C
	Right	59	45	D	101	48	D
ALL	All		24	B		31	C
	DS	1.000			0.971		

The impact of the signal phasing change would significantly worsen the Degree of Saturation (DS) and increase the delays to the subject right turn movement into Macquarie Street, with the level of service (LS) reducing from B/C to F in both peak periods.

While no changes to the road network in the eastern part of Windsor are recommended, with the observations we have made, and also made by Council staff, there is a problem with delays to the left turn from Macquarie Street into Bridge Street causing drivers to take alternative routes. We do not recommend any change to the signal phasing at Macquarie Street/Bridge Street. Anecdotal observation is that sometimes the Left Turn Red Arrow that delays the left turn when there is a pedestrian crossing demand remains showing longer than necessary. We recommend that the RTA monitor the situation in peak periods and assess if more Green time to the two phases when Macquarie Street left-turns flow would clear the substantial queue of left-turning traffic. As is next discussed, changes resulting from a new Windsor Bridge might alter the situation for this left turn movement, if signals are installed at George Street/Bridge Street.

As previously noted, the demand for this left turn movement from Macquarie Street into Bridge Street , and also for the observed "rat-runs" to avoid this turn, is increased because peak period delays approaching and through North Richmond are causing drivers with destinations at Kurrajong and beyond to divert via Freemans Reach. While the road capacity through North Richmond is a separate issue to the road capacity of Windsor, traffic circulation over the wider Hawkesbury road network is interrelated.

3.4 Windsor Bridge

At the present time, the preferred option for the new Windsor Bridge has not been adopted. As discussed in Section 2.4, the existing roundabout at the junction of George Street and Bridge Street functions in a satisfactory manner. There have been few accidents at this roundabout.

The location of a new bridge in the vicinity of the existing bridge would leave the current traffic flows in place, through this junction. One bridge option includes controls at this junction, restricting movements from George Street into Bridge Street to Left-turn IN and Left-turn OUT. In intersection capacity terms, this would improve the through movement of traffic along Bridge Street, reducing side friction due to the George Street traffic. This would favour the main road traffic. Clearly, the George Street/Bridge Street junction would have adequate capacity.

However the disadvantage of such an arrangement would be that the accessibility of the residential area east of Bridge Street would be reduced. This would also affect access to the motels in this area. Court Street would need to be used for some access movements.

As shown on Table 2.11, at the intersection of Bridge Street and Court Street, there are significant problems with delays to traffic turning right out of Court Street, even with the current very low movements, probably low because of the difficulty in making this turn. If through and right turn traffic from George Street East was diverted to Court Street, there would be a significant intersection capacity and delay issue.

As discussed in Section 3.3, there is an existing concern with the capacity of the road network for drivers making a left turn from Macquarie Street into Bridge Street and thence across Windsor Bridge, where alternative routes via Court Street and Arndell Street have been observed. If traffic signals were installed at George Street/Bridge Street, and the right turn from George Street East was banned, this alternative route would be blocked. It might place pressure on the left turn out of George Street West, with drivers seeking an alternative route via Baker Street-George Street. As with any significant change to the road network, where turning movements at key intersections are prohibited, there will need to be studies undertaken of the traffic implications of any such restrictions.

The choice of the Windsor Bridge option will need to take into account access to and from the Windsor Peninsula, and road linkages and intersection options developed to ensure that satisfactory accessibility is maintained.

3.5 Riverview Shopping Centre Traffic Review

The construction of the Riverview Shopping Centre has increased the attraction – and hence traffic movements – of Windsor. This has resulted in additional traffic on The Terrace and at its junctions with New Street and Johnston Street, and on George Street and its junctions with New Street and Johnston Street, and with Fitzgerald Street. As set out in Section 2.4, these junctions are currently functioning at a very satisfactory level of service, with low delay level:

Intersection	AM Level of Service	PM Level of Service
George/New	A	A
George/Johnston	A	A
George/Fitzgerald	A	A
Terrace/New	A	A
Terrace/Johnston	A	A
Terrace/Fitzgerald	A	A

In road network capacity terms, the addition of Riverview Shopping Centre traffic to the road network of Windsor has not resulted in adverse traffic issues or unsatisfactory road network capacity. As indicated on Table 3.1, for a Collector Street, the environmental goal is 300 veh/hr and the maximum is 500 veh/hr. George Street, New Street and The

Terrace between New Street and Fitzgerald Street are Collector Streets, as the primary feed roads into the Riverview Shopping Centre. In the morning peak hour – Figure 3 – the two-way traffic flows on George Street near the shopping centre are 376-459 veh/hr, which fit into the range for up to the maximum. In The Terrace the two-way flows are 298-374 veh/hr, while in New Street the flows are 252-331 veh/hr, which are acceptable. In the afternoon peak hour – Figure 4 - the George Street flows are 350-445 veh/hr, with 444-451 veh/hr in the Terrace and 265-358 veh/hr in New Street. These flow levels are in keeping with the road hierarchy classification. Fitzgerald Street is arguably a Collector Street because it forms an integral part of the shopping centre circulation route, with the George Street Mall to the East. The peak hour flows are 161-173 veh/hr in the morning and 174-214 veh/hr in the afternoon, which fit into the acceptable range for a Local Street. However a road hierarchy consequence of the development of the Riverview Shopping Centre is that that section of The Terrace west of New Street is experiencing high traffic levels. This is further discussed in Section 3.7.

The main loading dock for this shopping centre is off Johnston Street. With Johnston Street two-way between the centre and The Terrace, but one-way northbound from George Street to the centre, service vehicles are encouraged to use The Terrace to access the docks. The preferred route is via The Terrace East rather than The Terrace West, to safeguard residential amenity in The Terrace west of New Street. Deliveries made by trucks turning from George Street into Johnston Street have some problems at the junction of George and Johnston Streets, as is further discussed in Section 3.9.

In conclusion, there are no road network or traffic capacity concerns with the operation of the Riverview Shopping Centre. However, trucks travelling to the Johnston Street loading dock from George Street are causing some problems with trucks hitting the awning of the adjacent hotel.

3.6 Windsor Mall

In road network capacity terms, there is no need to open up George Street in the blocks currently closed for the Mall. Traffic circulation around these closed sections is very satisfactory, with minimal delay levels. At the Fitzgerald Street end, the Kable Street central section and the Baker Street end, the main conflicts are between pedestrians and vehicles. This is arguably better than vehicle/vehicle conflicts in the context of low speed intersection treatments and a preference for pedestrian priority.

The Mall of course deletes the option of kerbside parking. However it does gain the use of this kerbspace for outdoor seating and pedestrian circulation space. On our assessment of the parking issues, and this was not a major issue identified in our Brief, the opening of the Mall to simply provide additional kerbside parking would not be justified in the context of parking demand and supply.

The impact of the Windsor Mall extends way beyond purely parking and traffic issues. Urban design, and retail design play important roles. Pedestrian malls can be better suited to some businesses. Again, in traffic and parking terms, we see Windsor Mall as functioning in a very satisfactory manner, and hence we make no recommendations to alter the current design.

An option would be to signpost it as a Shared Zone, with a maximum speed of 10 km/hr. However there does not seem a strong need to change the current situation. We understand that the Mall remains a public road. Options to provide loading zones at the eastern and western ends are discussed in Section 3.9, with loading zones parallel to Baker and Fitzgerald Streets. Such zones would have a benefit in restricting any through traffic movement, while allowing service vehicles to enter each section of the Mall via Kable Street.

3.7 The Terrace

The Moses Street-The Terrace route not only functions as an access street to adjoining residential, sporting and heritage land uses. It also functions as a minor ring-road along the northern side of Windsor town centre, particularly past those sections of the Windsor Mall. As such, it is part Local Street and part Collector Street. From Figures 3 and 4, the current peak hour two-way traffic flows are:

Location	AM (veh/hr)	PM (veh/hr)
East Hawks. Valley Way	248	258
West New St	312	491
East New St	298	444
West Fitzgerald St	374	451
East Kable St	381	456

Tables 2.5 and 2.6 provide more information from the seven day count, with the count taken west of Johnston Street. Two-way flows were 250-360 veh/hr for the day between 8.00am and 6.00pm.

Compared with the environmental capacity criteria listed in Table 3.1, the current flows fit within the maximum flows acceptable for a Collector Street. An important issue with environmental capacity is pedestrian safety. Such streets are safer if the traffic speeds are kept low. The observed speeds west of Johnston Street were 41-45 km/hr (85^{th} percentile) which are appropriate for this situation. Speed surveys were not undertaken between Tebbutt Street and New Street.

However, the section of The Terrace west of New Street is carrying traffic flows in excess of the maximum for a Local Residential Street. The section of The Terrace between Moses and New Streets has been heavily traffic managed, to reduce traffic

speeds, but high traffic flows still occur. The level of traffic remains a concern. In order to reduce traffic flows in this section of The Terrace, an option that is recommended for further investigation is the partial closure of The Terrace at its junction with Moses Street, to restrict movement to only left-turn out of The Terrace, with a sub-option being to allow all westbound movement but prohibit eastbound movement from both Moses Street and Tebbutt Street.

Figure 5 presents a schematic layout of the option, with The Terrace traffic restricted to left turn into Tebbutt Street only. This option would clearly reduce traffic in The Terrace between Moses Street and New Street. Since it would have significant accessibility implications, further traffic studies and public consultation would be required. This is outside of the Brief of the current Study, but is nevertheless recommended. Traffic counts would be required at the junctions of Moses Street/The Terrace/Tebbutt Street, Tebbutt Street/George Street, and possibly George Street/Catherine Street. The implications of traffic diversions on roads mid-block and at intersections would need to be analysed, and the results of the study published for community feedback. We recommend that this option be taken, with a final decision on the controls at the Moss Street/Tebbutt Street/The Terrace intersection made by Council made after consultation has occurred.

3.8 Hawkesbury Mobility Plan

The *Hawkesbury Mobility Plan 2010 (*HMP) dated 11 May 2010 sets out the planning initiatives for cycle and pedestrian networks in the City.

The previous bike planning was set out in the 1997 Bike Plan. Table 5.1 of the HMP discussed Route 9, being George Street, Macquarie Street and The Terrace – Windsor to South Windsor and Bligh Park. The HMP consultants made the following comments on this Route:

- *George Street and Macquarie Street between Blacktown Road and Hawkesbury Valley Way are treated with bicycle shoulder lanes, with the southern section generally on sealed shoulders and kerbside lanes with parking towards the northern end.*
- *General lack of intersection treatments.*
- *Some shoulder widening works required.*
- *Pinch point at the railway overpass.*
- *Moses Street and The Terrace in Windsor are low traffic routes suitable for on-road mixed traffic treatments. Delineation improvements are required for these two streets.*

The HMP makes the following recommendations for regional routes in Windsor:
Regional Route 4: Windsor CBD-Macquarie Street

Regional Route 4 consists of an off-road shared path link on the southwest side of Macquarie Street between Windsor Road and Hawkesbury Valley Way. Local links would be provided in line with the signalized intersections at Ross Street/Kable Street and Day Street to provide access into the Windsor Town Centre. There is currently a shared path installed along this route with a width in the order of 2.0m, with some variations. Required works for this route include treatment of the signalized crossings with bicycle lanterns and general maintenance of the path including tree trimming and edge trimming.

Regional Route 5: Windsor to Mulgrave via Hawkesbury Valley Way

Regional Route 5 consists of on-road bicycle shoulder lanes along the flood evacuation route of Hawkesbury Valley Way and into Mulgrave along Groves Avenue. Hawkesbury Valley Way currently has a shoulder width in the order of 2.0m, which is adequate for a bicycle shoulder lane along a roadway with a speed limit of 70 km/hr. required works for this route include logos and signage to formalize the bicycle facility.

Regional Route 6: Windsor CBD – Hawkesbury Valley Way

Regional Route 6 consists of an off-road shared path link on the north side of Hawkesbury Valley Way between Macquarie Street and Cox Street/Moses Street. This route provides links into the north-south routes for travel to the centres of Windsor and South Windsor. Required works along this route include provision of bicycle lanterns at the signalized crossings at the intersections of Macquarie Street/Hawkesbury Valley Way and Hawkesbury Valley Way/George Street, widening of existing footpath and links to existing path in McQuade Park.

Regional Route 7: Windsor to Richmond

Regional Route 7 follows the alignment of Hawkesbury Valley Way, Windsor Street and into the centre of Richmond via Bourke Street and March Street. The route extends from Cox Street/Moses Street in Windsor to East Market Street in Richmond. The objective for this route is to provide a predominantly off-road facility in the long term to cater for a larger range of cyclists, including young children and less confident cyclists….

Required works for the route include provision of a new shared path on the south side of the carriageway of Hawkesbury Valley Way to make use of the Ham Common section of existi9ng shared path, treatment of the bridge pinch point at the Rickabys Creek crossing (ideally long term provision of an additional bridge

structure), path widening on Windsor Street and Bourke Street, on-road bicycle lanes in March Street and some crossing facilities.

These are off-road paths, and as such, would not impact on road network capacity. Also, any road options near these routes would not affect the ultimate implementation of these off-road options. The addition of bicycle lanterns at traffic signals would not affect intersection capacity or operation. In conclusion, there are no constraints on road capacity relating to these works.

The HMP also makes recommendations for pedestrian facilities. Section 8.3.2 of the HMP sets out these recommendations for Windsor:

8.3.2 Pedestrian Facilities – Windsor

The future initiatives for improving the pedestrian network in Windsor are:

- *Treatment of Windsor Mall transitions at Fitzgerald Street and Baker Street.*
- *Ensure improvements to pedestrian safety and connectivity are implemented as part of the Windsor Transport interchange.*
- *Investigate redesign of intersection of Bridge Street and George Street (eg signals) to accommodate greater pedestrian movement – refer to Windsor River Walk Master Plan for proposed treatments in the vicinity of Thompson Square and Bridge Street/George Street intersection. Note that potential future realignment of Windsor Bridge would open up Thompson Square and allow opportunities for improved east-west connection.*

There are no issues that need to be considered in the first two recommendations. With the third recommendation, this highlights the fact that roundabouts are not good treatments for pedestrian crossings, particularly on major roads. The current roundabout IS a constraint on pedestrian movement and accessibility. Traffic signals at the junction of George and Bridge Streets would improve pedestrian safety and accessibility. As discussed in Section 3.4, the construction of a new Windsor Bridge can offer both constraints and opportunities. If the roundabout is replaced by traffic signals, with no cross or right turn movements allowed, alternative road access to the Peninsula is required. A road link underneath a new bridge approach is an option. The issue of pedestrian pathways will need to be further considered when the option choice for the new Windsor Bridge is made.

3.9 Kerbside Parking and Loading Zones

On-Street Parking Time Limits

The Windsor Business Group Inc. have requested a review of parking time limits. The Group considered that "*the parking restrictions in Windsor are creating a deterrent effect on people wishing to shop or spend time in the area, not to mention the shop owners and staff who have to constantly close up their businesses to go and move their vehicles. The Windsor Business Group would like to request that Council give consideration to changing the times allocated on current signage, eg. 1 hour parking becomes 2 hour, 2 hour parking becomes 3, and 3 hour parking becomes 4, obviously leaving some short stay parking along George Street…*"

The main issues in the Windsor Traffic Study relate to traffic management and movement issues. To further review parking issues, we have undertaken an inventory of on-street parking controls plus some off-street carpark time restrictions. We have not undertaken surveys of current parking usage, or typical lengths of stay.

Most of the on-street kerbside parking within the town centre is subject to a one-hour time limit. The public off-street parking areas such as at the junctions of The Terrace with Kable Street and at Kable Street/Macquarie Street are subject to two-hour time restrictions. The Riverview Shopping Centre parking area has a two-hour time limit signposted. There are pockets of unrestricted parking further from the centre.

For major shopping trips, two hours is generally adequate for most people. Also, for professional visits and visits to restaurants, two hours is generally adequate. For some of the latter visits, a one-hour limit often is satisfactory.

The most convenient parking – on-street – should be kept available for customers rather than staff of businesses and shops. While it may be inconvenient for shop keepers to have to move their cars during the day, it would be less satisfactory if their customers could not find convenient parking. Overall, we do not agree that the general request by the Group would best serve the whole community. As a first point, we consider that kerbside parking along George Street between Catherine Street and Fitzgerald Street should remain at one-hour limits, or as otherwise currently signposted. The one-hour parking on George Street between Catherine Street and Tebbutt Street is possibly less critical, and could be considered for a two-hour restriction. We also recommend that the existing one-hour parking on Fitzgerald, Baker and Kable Streets also be retained.

The bulk of the public parking is on the off-street parking areas, where a two-hour limit generally applies. We consider that this should remain with a two-hour limit.

Without the opportunity to undertake parking usage and length of stay surveys, we are reluctant to recommend any substantial changes to the current situation. However, in general terms, the priority for on-street parking should be for shoppers, visitors and

customers of businesses, not staff of businesses. Workers in the town centre should be able to park on the periphery of the centre, and walk to work, or alternatively, use public transport. In summary, the priority for Council is to ensure that convenient public parking is available for shoppers, visitors and customers of local businesses.

On-Street Parking Bay Delineation

With an objective of maximizing the number of on-street parking spaces, the option of marking specific parking bays has been considered. Marked parallel bays clearly define the space where drivers should park. This helps individuals accessing bays. In a street such as George Street, with a total carriageway width of approximately 10.0m, under the relevant Australian Standard, a mid-block parallel parking space would take up 6.6m of kerb length. Many cars will park in less length. While in angle parking situations, marked parking bays are appropriate, with parallel kerbside parking, marked bays tend to reduce the number of cars that can be parked. While marked bays might assist individual drivers manoeuvre into and out of spaces, when the main objective is to maximize the number of parking spaces, the individual delineation of parallel parking spaces is not recommended.

On-Street Loading Bays

The Project Brief mentions *"The provision of suitably located Loading zones and effects on on-street parking"*. In principle, individual businesses should have individual on-site loading facilities, preferably from a rear lane or street. In practice, in a town centre such as Windsor, older businesses often do not have rear vehicular access. Some reliance on on-street servicing is thus often required. Older businesses with no loading facilities also typically do not have on-site parking. The removal of on-street parking to provide loading zones can compound problems with inadequate public parking.

The principal town centre streets have been surveyed to find what on-street loading zones there currently are:

Street	Block	Loading Zones	Parking Spaces
Baker St	George St –The Terrace	0	18
	George St-Macquarie St	0	26
Kable St	George St-The Terrace	0	34
	Macquarie St-George St	0	9
Fitzgerald St	Macquarie St-George/Union L	0	3
	George/Union L-The Terrace	0	28
Johnston St	George St-The Terrace	0	6
Hawkesbury	Macquarie St-George St	0	0
Valley Way	George St-The Terrace/Moses St	0	20
Macquarie St	Bridge St-Suffolk St	0	22
	Suffolk St-Christie St	0	8
	Christie St-Hawks. Valley Way	0	25
George St	Bridge St-Baker St	1	19
	Fitzgerald St-Suffolk St	0	45
	Suffolk St-Dight St	0	36
	Dight St-Hawks. Valley Way	1	35

It can be seen that there are very few on-street loading zones in the town centre. As to the need to signpost additional on-street loading zones in these streets, this should generally be a reactive situation. If a local business request a loading zone, the request should be considered on its merits, taking into account the objective of maintaining the maximum number of car parking spaces possible. It is not practical to make specific recommendations in this regard, in the context of this study.

For loading zones and service vehicle access to Windsor Mall, standard practice in pedestrian malls is to restrict access to certain hours of the day, and then without designated loading zones. Consultation with the Windsor Business Group Inc would be appropriate to define appropriate hours. What might apply to the Pitt Street Mall in Sydney, and in other major centres might not necessarily be appropriate in Windsor. Nevertheless, we have identified two opportunities to improve loading areas at the ends of the Mall, with no loss of on-street parking. Figure 6 presents schematic layouts of proposed new loading zones at the Kable Street and at the Fitzgerald Street ends of the Mall. These loading zones would permit small to medium size delivery trucks to stop and unload, stopped parallel to these streets, within the designated Mall areas. At the western end, trucks would approach via Fitzgerald Street North and pull into the zone, leaving in a forwards direction to Fitzgerald Street South. At the eastern end, trucks would approach via Baker Street South, pull into the zone, leaving in a forwards direction

to Baker Street North. Bollards and posts would need to be reorganized, while pedestrian movement past these zones would still be provided for. The location of these zones and the repositioned bollards would mean that vehicles would not be able to enter the Mall at these locations.. This could still occur from Kable Street, into either end of the Mall. These new loading zones would be available for any legitimate unloading/loading activity and their use would not be restricted to businesses on the Mall. This option is recommended.

Traffic Circulation and One-Way Streets

The need for an opportunities provided by changes of streets from two-way to one-way has been considered. The One-way change to Suffolk Street was necessitated by the need to alter bus routes. One-way roads can provide additional clearances for traffic movement, and can reduce traffic in sensitive streets, such as with the option recommended at The Terrace/Moses Street/Tebbutt Street. However they can have significant adverse impacts on the accessibility of properties. Apart from at The Terrace, no one-way road changes are recommended.

Intersection of George and Johnston Streets

Johnston Street has a narrow carriageway north of George Street, of just 5.2m. George Street at this junction has a carriageway width of 9.9m. . Johnston Street is restricted to one-way northbound for the initial section from George Street, as far as the access to the Riverview Shopping Centre. On the north-western corner, the Royal Exchange Hotel has an awning facing Johnston Street that slightly overhangs the kerb line. There have been incidents where high trucks turning into Johnston Street have hit this awning. While an easy option would be to require the hotel to reduce the span of this awning, we understand that there are reasons why this is not an easy option.

With the width of Johnston Street, the largest size service vehicle that can feasibly use it is a Medium Rigid Vehicle, 8.8m long. Council have prepared swept path plots of 8.8m long trucks making this turn. In summary:

1. Left turn from George Street, starting within centerline of George Street: Vehicle overhangs kerb on eastern side of Johnston Street.

2. Left turn from George Street, starting on southern side of George Street: Truck can complete manoeuvre within kerbs.

3. Right turn from George Street from southern (correct) side of George Street: Truck can complete manoeuvre within kerbs.

For reference, a 12.5m long Heavy Rigid Vehicle will impact on one or other of the Johnston Street kerbs with any left or right-turn manoeuvre.

Some service vehicle access is required to service the hotel, so provision needs to be made for such vehicles. With on-street parking in the town centre in high demand, options that require the loss of parking are not favoured. The treatment options, not including changes to the hotel awning, are:

1. Impose "No Left Turn, Vehicles Over 8m" at the corner.
2. Extend the north-west kerb into the intersection, to tighten up the throat of the intersection and force left-turning vehicles to move closer to the eastern kerb of Johnston Street.

Option 1 would deal directly with the issue. The disadvantage is that it would require some procedures to be followed, to show that the restriction would not adversely affect other locations. In terms of peak hour traffic flows, the left turn from George Street into Johnston Street is a low volume movement, with 1 veh/hr in the AM peak and 11 veh/hr in the PM peak, as shown on Figures 3 and 4. The very small number of vehicles affected would have to make an alternative left turn at Fitzgerald Street, and hence go around a small block to access the Riverview Centre loading dock. It is assumed that truck drivers servicing the Royal Exchange Hotel know the situation, and know that they need to make a right turn from George Street, instead of a left turn.

Option 2 would theoretically address the problem, but would force trucks towards the eastern kerb of Johnston Street. Even if starting from a position on the southern – "wrong" – side of George Street, the swept path plot shows that they would then overhang the eastern kerb. This might resolve one issue but create another.

If the alteration to the hotel awning is not an acceptable option, then the best Option is Option 1.

4.0 CONCLUSIONS AND RECOMMENDATIONS

1. With the wide ranging nature of this study, it is difficult to set out concise conclusions on all issues. Reference should be made to individual sections to specific conclusions. The following concluding comments cover the thrust of these conclusions.
2. Current peak period traffic conditions see reasonable delay levels, with the road network generally having adequate capacity. The main exception is along Hawkesbury Valley Way, where more substantial delays are experienced at the Macquarie Street and George Street intersections.
3. A major concern is the level of delay to drivers making right turns onto Hawkesbury Valley Way from the Windsor town centre. Traffic signal timing is not optimum for these movements. We recommend that this study and the traffic surveys that have been undertaken be presented to the RTA with a request to review traffic signal timings at these Hawkesbury Valley Way junctions, in particular at the George Street junction.
4. At the Bridge Street intersections, moderate delay levels are experienced to the intersection overall, but the traffic turning left from Macquarie Street into Bridge Street is facing long delays in practice, leading to alternative "rat-run" routes being used by some drivers. Part of this traffic has a destination at Kurrajong and beyond, and is using the route along Bridge Street and through Freemans Reach because of significant delays approaching and travelling through North Richmond. We recommend that the RTA be requested to review signal timing at the Bridge Street/Macquarie Street intersection. Signal phasing changes are not recommended. We also recommend that the issue with the North Richmond road capacity also be brought up with the RTA, given the wider area impacts.
5. The introduction of the Suffolk Street one-way traffic movement, to facilitate bus movements, has not resulted in adverse traffic impacts.
6. The construction of a new Windsor Bridge has the potential to adversely affect the accessibility of the Peninsula, unless appropriate routes are available in the vicinity of George Street. Major access via Court Street is not appropriate. When a decision is made on the design of the new bridge, the treatment of its approaches, and in particular the Bridge Street/George Street junction will need to be considered. Accessibility implications of any changes in movements at this junction will need to be reviewed.
7. The Riverview Shopping Centre appears to be operating with satisfactory traffic levels of service on the adjacent roads and intersections. However, some trucks turning left from George Street into Johnston Street are creating a hazard with the awning of the adjacent hotel. It is recommended to impose a "No Left Turn, Vehicles over 8m" restriction at this intersection.
8. Windsor Mall does not have serious traffic capacity disadvantages. In traffic terms, there is no reason to consider its removal. An option that is recommended is the provision of loading zones at the Baker Street and Fitzgerald Street ends of the Mall, to be available for all loading users.

9. The route of Moses Street-The Terrace performs both a Collector Road function adjacent to the central business district, and a Local Road function west of New Street, with residential frontages. Traffic flows in The Terrace west of New Street are currently excessive for a Local Road. To reduce these flows, we recommend that the intersection of Moses Street/The Terrace/Tebbutt Street be altered, to restrict movements to left turn out of The Terrace only, with all eastbound movements, and the westbound movement from The Terrace to Moses Street also prohibited. This recommendation will require further analysis and public consultation.
10. Specific comments are made about on-street parking and loading. The retention of the existing one-hour and two-hour kerbside parking restrictions is recommended, with no changes. The Hawkesbury Mobility Plan has also been taken into account. Apart from the recommendation at The Terrace/Moses Street/Tebbutt Street junction, no changes are recommended to the general road network, with a predominantly two-way circulation system preferred.
11. The recommended actions are summarized in Table 4.1.

TABLE 4.1 STUDY RECOMMENDATIONS

Action	Recommendation	Responsibility
1	Review traffic signal timing at Hawkesbury Valley Way/George Street junction with a view to increasing Green time to George Street approaches	RTA
2	Review traffic signal timing at Macquarie Street/Bridge Street junction with a view to increasing Green time to Macquarie Street traffic, in particular the left turn into Bridge Street	RTA
3	Seek road capacity improvements on Kurrajong Road approaching and through North Richmond, to alleviate sub-regional traffic diversions through Freemans Reach	RTA
4	Restrict left-turning traffic at the George Street/Johnston Street junction to “No Left Turn Vehicles Over 8m”.	Council
5	Provide new loading zones in the George Street Mall at the Baker Street and Fitzgerald Street ends of the Mall	Council
6	Restrict traffic at the junction of The Terrace/Moses Street/Tebbutt Street to left turn out of The Terrace only.	Council


Windsor New South Wales, Australia
©2010 Google
Eye alt 3876 ft
Image © 2011 Sinclair Knight Merz
33°36'27.95"S 150°49'03.62"E elev 67 ft
Imagery Date: 1/20/2007 2005

FIG 1

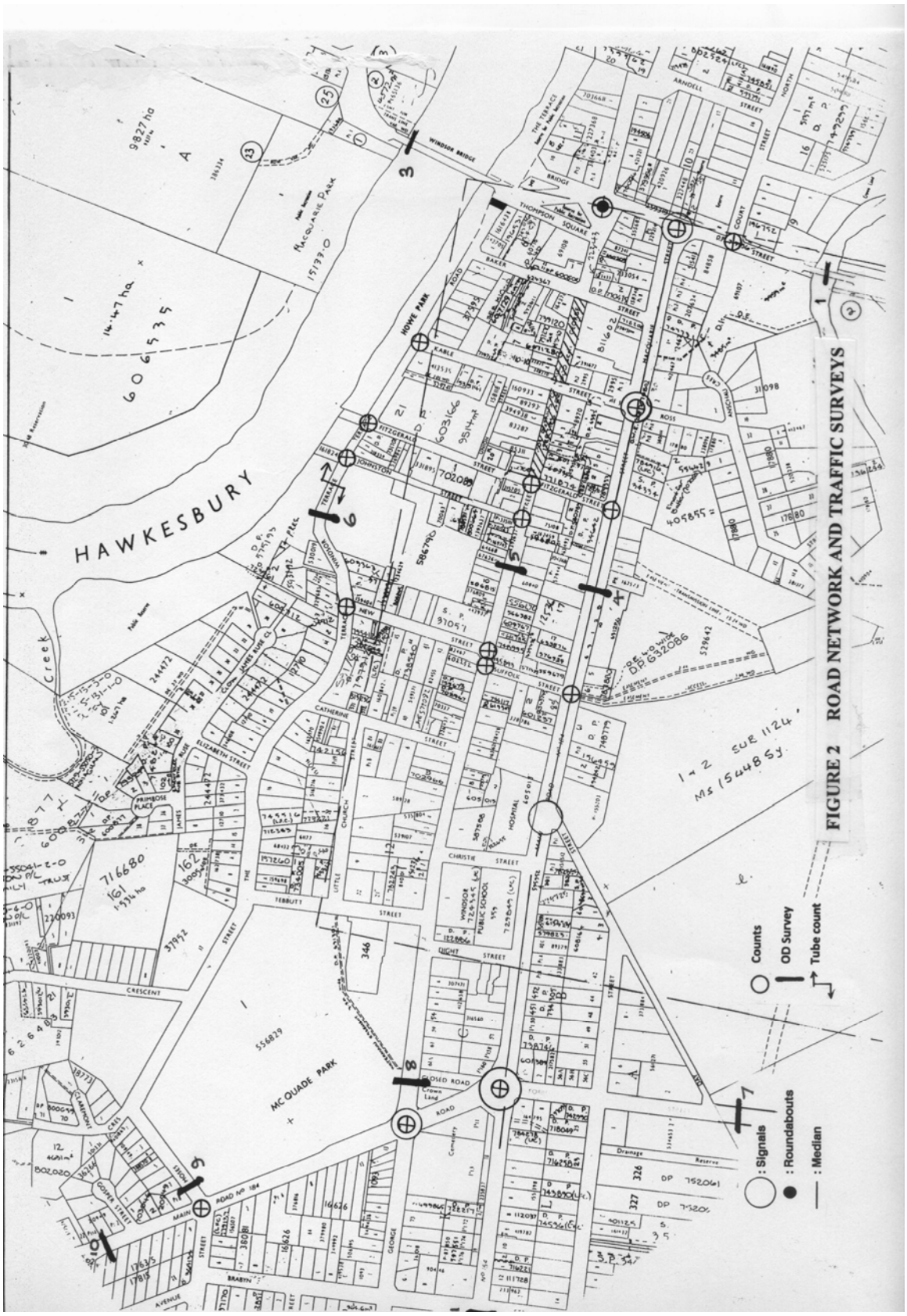
FIGURE 2 ROAD NETWORK AND TRAFFIC SURVEYS
HAWKESBURY
Counts
OD Survey
Tube count
: Signals
: Roundabouts
: Median

FIGURE 2

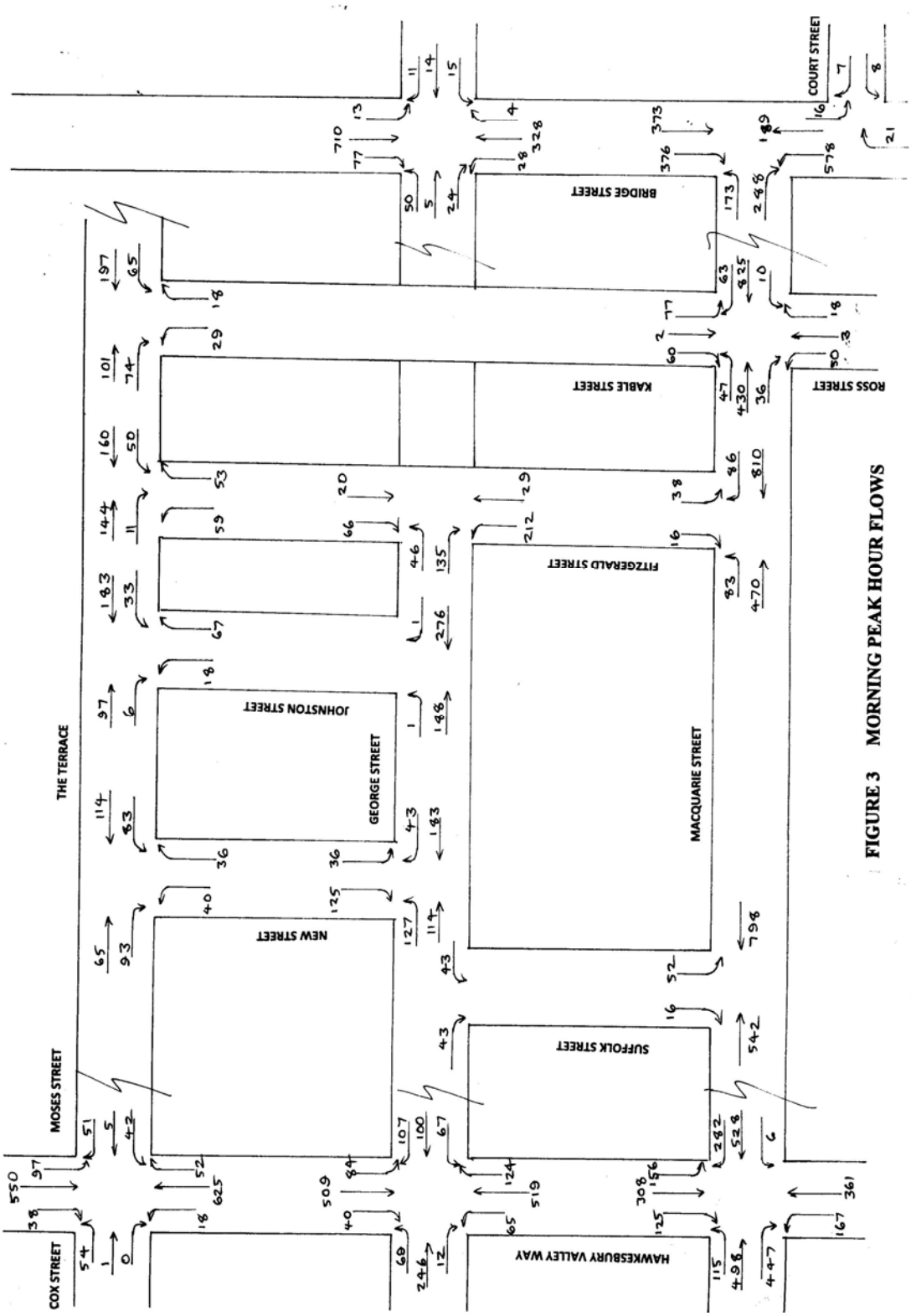

FIGURE 3 MORNING PEAK HOUR FLOWS

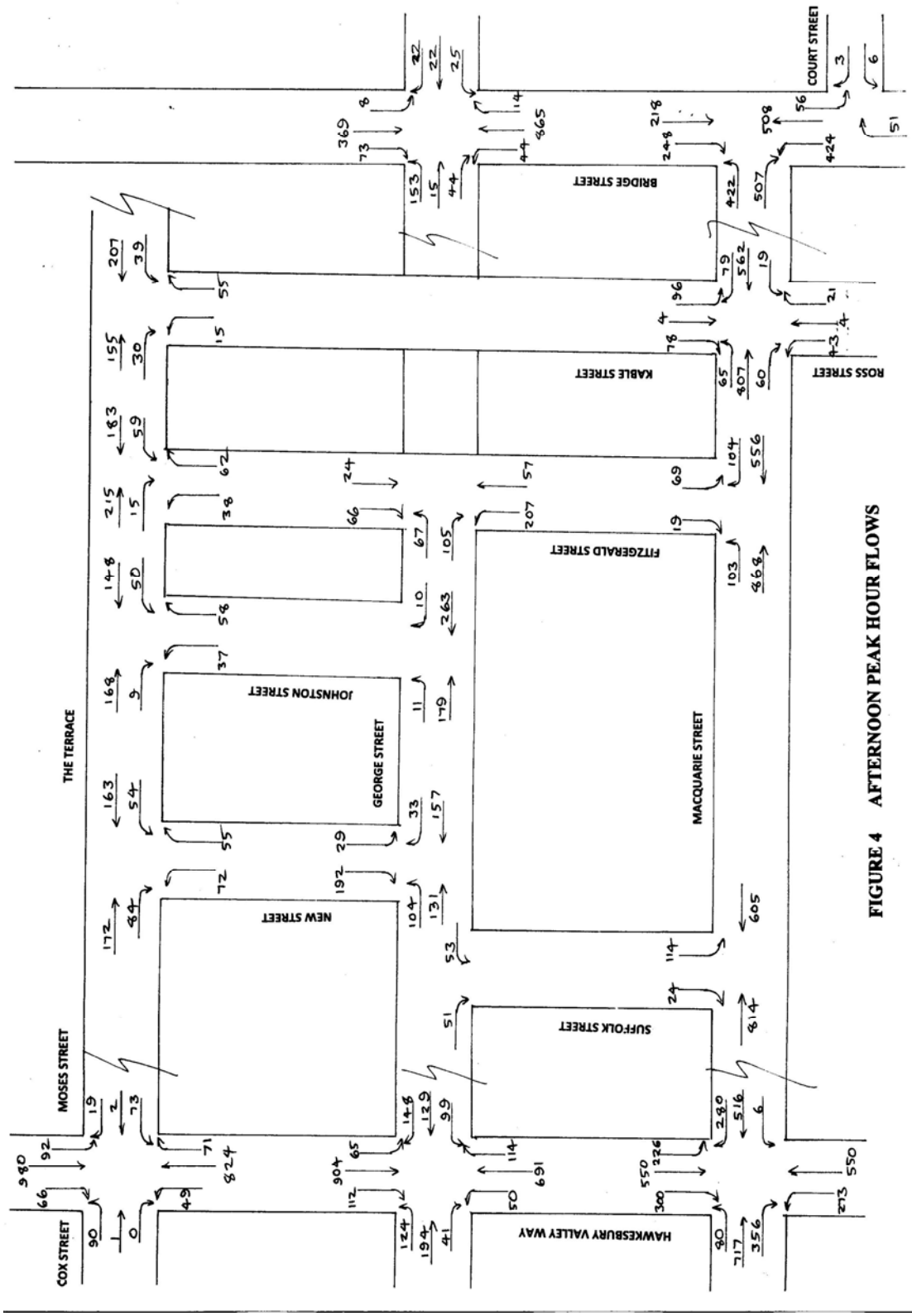

FIGURE 4 AFTERNOON PEAK HOUR FLOWS

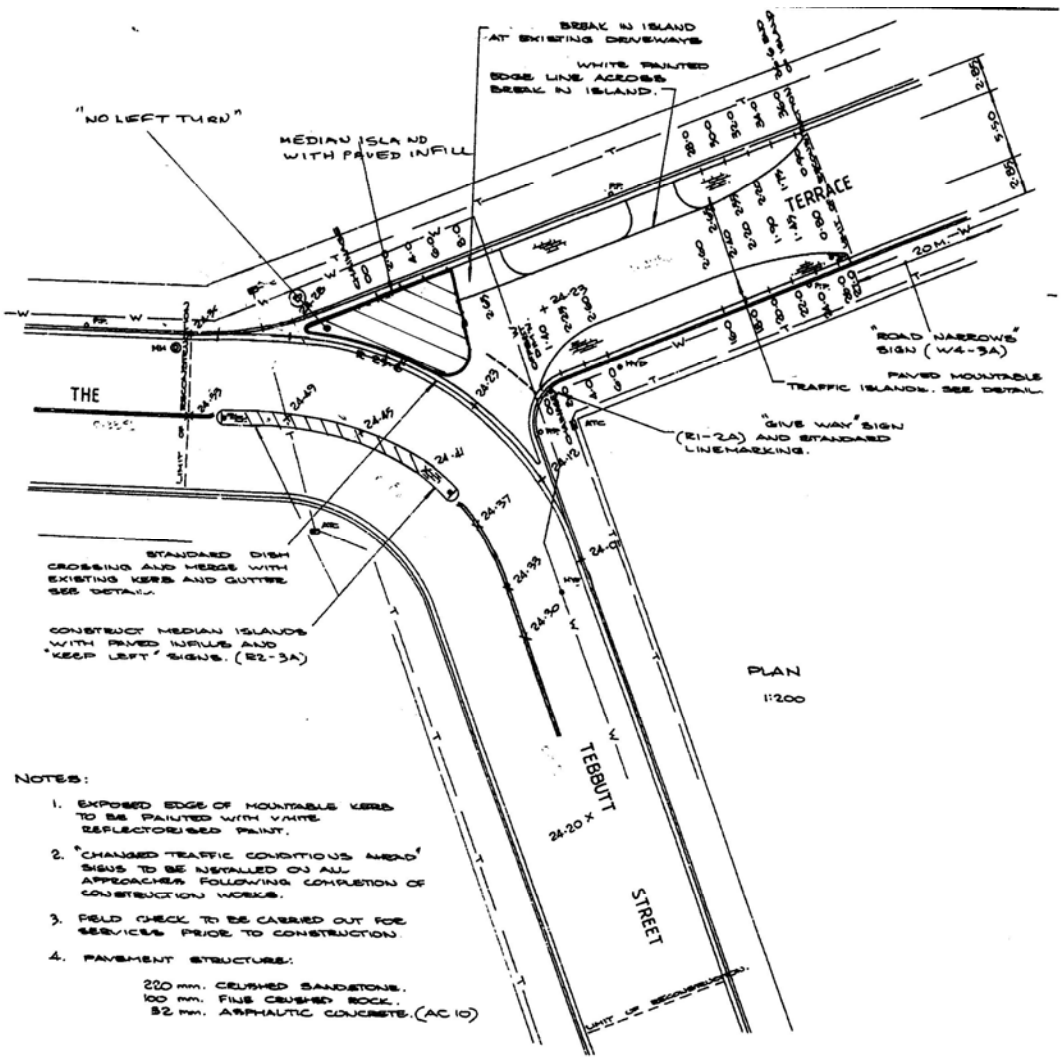

FIGURE 5 SCHEMATIC LAYOUT OF THE TERRACE, MOSES STREET & TEBBUTT STREET

FIGURE 6 PROPOSED LOADING ZONES IN GEORGE STREET MALL