Proposed
Residential Development
Avon Road, Pymble

Parking & Traffic Report

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J479

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1. Introduction

1.1 Background

J W Neale is proposing to develop the site bounded by Beechworth Road, Arilla Road and Avon Road, Pymble **(Figure 1)** for the provision of approximately 350 residential flats occupying a total of about 30,000 m². The design of the buildings is modular allowing a degree of flexibility in the mix of apartments (to be determined in the detailed project application for each stage).

The site is part of the Pymble Town Centre and zoned R4, High Density Residential within that zone.

Cennaoui Consulting Pty Ltd has been commissioned to evaluate and report on the traffic and parking aspects of the rezoning proposal, with particular regard to the alternative access options for the site.

1.2 Site Location and Study Area

The subject site is situated on a parcel of land generally bounded by the railway line, Avon Road, Arilla Road, Mayfield Road and Beechworth Road. Access to the site would be obtained from Avon Road and to a lesser extent from Beechworth Road.

For the purpose of this analysis, the study area for which traffic conditions were analysed, is bounded and includes the Pacific Highway, Beechworth Road, Mayfield Avenue, Arilla Road, Avon Road, Everton Street and Livingstone Avenue. Traffic conditions at Pymble Avenue are also included.

1.3 Scope of Report

This report generally evaluates the parking requirements of the Stage 1 development, and traffic implications associated with the overall proposed development. For the purposes of the traffic assessment an upper limit of 400 2-bedrooms apartments is adopted. The report also focuses on the proposed access arrangements to the site with respect to the following aspects:

- available sight distance;
- traffic volumes on frontage street
- neighbourhood amenity


Bobbin Head Rd
Richard Porter Way
Pacific Hwy
Reservoir Rd
Clydesdale Pl
Park Cres
Taunton St
Graham Ave
Alma St
Beechworth Rd
Mayfield Ave
Avon Rd
Arden Rd
Arilla Rd
Pymble NSW, Australia
Grandview St
Station St
Everton St
Pymble Ave
259 m
© 2009 TrueLocal
Image © 2009 Sinclair Knight Merz
© 2009 MapData Sciences PtyLtd, PSMA
© 2008 Google
33°44'35.89" S 151°08'22.81" E
Jan 20, 2007
Eye alt 910 m

FIGURE 1

2. Parking and Access Evaluation

2.1 The Proposal

The overall development would proceed in five (5) stages as illustrated in **Appendix A**. Stage 1 will consist of 51 units as noted in **Table 2.1**.

Table 2.1: Proposed Stage 1 Development

	Units	Spaces Required	
		Minimum	Maximum
Stage 1			
3 bed units	7	7	14
2 bed units	22	18	36
1 bed units	22	11	22
Sub-Total	**51**	**47**	**72**
Visitors		5	10
Total		**52**	**82**

2.2 Parking Requirements

Parking requirement for the proposed development has been estimated based on the requirement of SEPP 53 and the Ku-ring-gai Sites Report, which stipulates the following car parking provisions:

	Minimum	Maximum
1 bedroom unit	0.5 spaces	1 space
2 bedroom unit	0.8 spaces	1.6 spaces
3 bedroom unit	1 space	2 spaces
Visitor parking	1 space /10 units	1 space/ 5 units

A minimum of 52 spaces would be required for the Stage 1 development including 5 spaces for visitors as noted in **Table 2.1**. A total of 86 spaces are provided as illustrated in **Appendix B**. This is higher than the maximum number required.

Furthermore, a minimum storage for some 22 bicycles is required to meet SEPP 53 requirements of 1 space/ 3 units for residents and 1 space / 10 units for visitors.

2.3 Evaluation of Parking Layout

This assessment, limited to the Stage 1 development, has been made for the 86 spaces provided in two basement levels shown on plan DN° PA1-100 prepared by Ancher/ Mortlock/Woolley Architects. A reduced copy of the latest plan, dated 6 November 2009, is included as **Appendix B**. A two-way circulation pattern is proposed in both car parking levels.

The physical dimensions of the proposed parking layout were compared with the requirements of the Australian Standards (2004) for off-street parking. The requirements of the Australian Standard and the proposed dimensions of the parking facility are shown in **Table 2.2.** Two (2) visitor spaces and six (6) tenant spaces have been designated for the disabled. This is considered adequate and complies with the Standards. The parking layout has been designed in accordance with the Australian Standards 2890.1-2004

Table 2.2: Comparison of Parking Requirements with Proposal

Area		AS 2890.1 – 2004	Proposed Car Park
Car spaces 90⁰ Low Turnover			
to wall or high kerb		2.4 m x 5.4 m	2.5x 5.4 m
between obstructions such as column or walls		3.0 m x 5.4 m	3.1 m x 5.4 m
Obstructions on one side		2.7 m x 5.4 m	3.0 x 5.4m
Disabled parking *	Number	2-3% of spaces	8 spaces
	Dimensions	3.2 m x 5.4 m	3.2 m x 5.4m
Aisles	Two way aisle	5.8m	Min 6.2m
	One-way aisle	5.8m	NA
	Blind aisle	Extend aisle by 1m	Aisle Extended by 1m
Circulation Roadway & Ramps			
	Two way Straight	Min 5.5m + 300mm clearance both sides	Min 6.5m + 300mm clearances both sides
Ramp Gradient			
Private car park	> 20m	Max 1:5	Max 1:8

2.4 Vehicular Access to the Site

2.4.1 Access at N° 1 Avon Road

This access involves the removal of a house and garage. Adequate sight distance exists to the south and east respectively for a vehicle emerging from the proposed driveway to an oncoming vehicle. Vehicles right turning into the site will have to do so at the right angle bend where the proposed access will be situated. This would restrict the free flow of northbound traffic along Avon Road. The provision of a roundabout at the bend near N°1 Avon Road would improve access to the site as well as providing opportunities for vehicles currently U-Turning in the driveway. Serious consideration should be given, if possible, to incorporate a pedestrian refuge in conjunction with the roundabout.

2.4.2 Access at Nº 5 Avon Road

This driveway will provide access to Stage 1 building. Sight distance measurements for this proposed driveway location have indicated that about 45 metres and 65 metres clear sight distance would exist to the south and north respectively for a vehicle emerging from the proposed driveway to an oncoming vehicle. Sight distance to the south is restricted by a curve in the road and foliage, while sight distance to the north is restricted by the right angle bend.

Entering vehicles right turning into the site would have difficulty sighting northbound vehicles along Avon Road.

Under guidelines developed by AUSTROADS (1995), at least 45 metres of stopping sight distance should ideally be available for vehicles emerging from the driveway to oncoming vehicles, for vehicle approach speeds up to 50 kmh.

Whilst the sight distance from the south just meets the requirement, the sight distance from the north is well in excess the desirable minimum standard under the Austroads guidelines (1995).

At this location Avon Road has a 9 metres wide carriageway. Because of its near proximity to the bend in the road, vehicles right turning into the site may restrict the free flow of northbound traffic along Avon Road. It is suggested that a right turning bay be provided through line marking to segregate the two movements.

2.4.3 Access from No 4 Beechworth Road

This driveway will be situated no less than 50 metres from the railway bridge. At that location it would have clear sight distance from both directions for a vehicle emerging or entering the proposed driveway to an oncoming vehicle.

2.4.4 Access from No 1 Arilla Road

This driveway location has adequate clear sight distance to the west and east respectively for a vehicle emerging or entering the proposed driveway to an oncoming vehicle. Arilla Road has a 9.3 metre carriageway at this location. In the event a substantial number of dwellings access the site from this location, vehicles right turning into the site may restrict the free flow of westbound traffic along Arilla Road. The provision of "No standing" restriction in the vicinity of the driveway would minimise any conflict.

3. Traffic Impact of Proposed Development

3.1 Existing Traffic Conditions

3.1.1 Approach Routes to the Site

In order to better ascertain the existing traffic conditions, an inventory of the access routes to the site was carried out, including traffic control.

The major approach route for traffic generated within the study area is the Pacific Highway, a classified National and State Highway, which has a six lane divided carriageway. Access to the Pacific Highway is obtained via traffic signals at the intersections with Beechworth Road and with Livingstone Avenue.

Direct access to the site will be off Avon Road. The section of Avon Road, west of Everton Street has a four lane undivided carriageway (including parking) reducing to three lanes (9m) east of the right angle bend opposite No 1 Avon Road; the remaining section of Avon Road has a three lane undivided carriageway (about 9m). Everton Street has a four lane undivided carriageway.

Arilla Road has a 9m carriageway between kerbs. Mayfield Avenue has a two lane undivided carriageway (8m). The section of Allawah Road, between Arilla Road and Mayfield Avenue, is narrow (8m wide) with an upward grade at Mayfield Avenue.

The sections of Livingstone Avenue and Beechworth Road accessing the Highway have a three lane undivided carriageway. Beechworth Road narrows to two lane over the railway line.

The right turning movement from the Pacific Highway into Beechworth Road is banned. As a result, vehicles entering the area from the north do so at the intersection of Livingstone with the Highway where a right turning bay is provided.

A one lane circulating roundabout controls the intersection of Everton Street with Pymble Avenue and Avon Road

3.1.2 Existing Traffic Counts

For the purpose of the study, traffic movement counts were undertaken at the following intersections,

- Intersections of Pacific Highway with Livingstone Avenue and Beechworth Road;
- Intersection of Everton Street with Livingstone Avenue, and with Pymble Avenue and Avon Road;
- Intersection of Avon Road with Arilla Road;
- Intersection of Beachworth Road with Mayfield Avenue.

The counts were carried out during the week commencing 25 May 2009, between 7.00 and 9.30 am, and from 4.00 to 6.00 pm. These periods were chosen as they are considered to represent typical peak traffic conditions in this vicinity. The results of these counts are included in **Appendix C.**

Analysis of these counts showed that the overall morning and afternoon peak hours occurred from 7.15 to 8.15 am and 4.30 to 5.30 pm respectively.

The traffic volumes, at the six intersections for the morning and afternoon peak hours are illustrated in **Figure 2**. The capacity and operation of these intersections are discussed in section 3.2.4.

3.2 Impact on Approach Roads

3.2.1 Traffic Generation of Proposed Development

The number of vehicles likely to be generated by the proposed development has been estimated for a maximum of about 400 1 or 2-bedroom units.

The RTA guidelines (2002) suggests for high density residential development with good access to public transport, the provision of 0.29 peak hour trips per unit. It has thus been estimated that 400 units would generate about 120 vehicle trips per hour during the morning and afternoon peak hours.

It is understood that about 70 percent of apartments will gain access off Avon Road with the remaining 30 percent accessing the site off Beechworth Road. No internal connection is proposed from Avon Road to Beechworth Road.

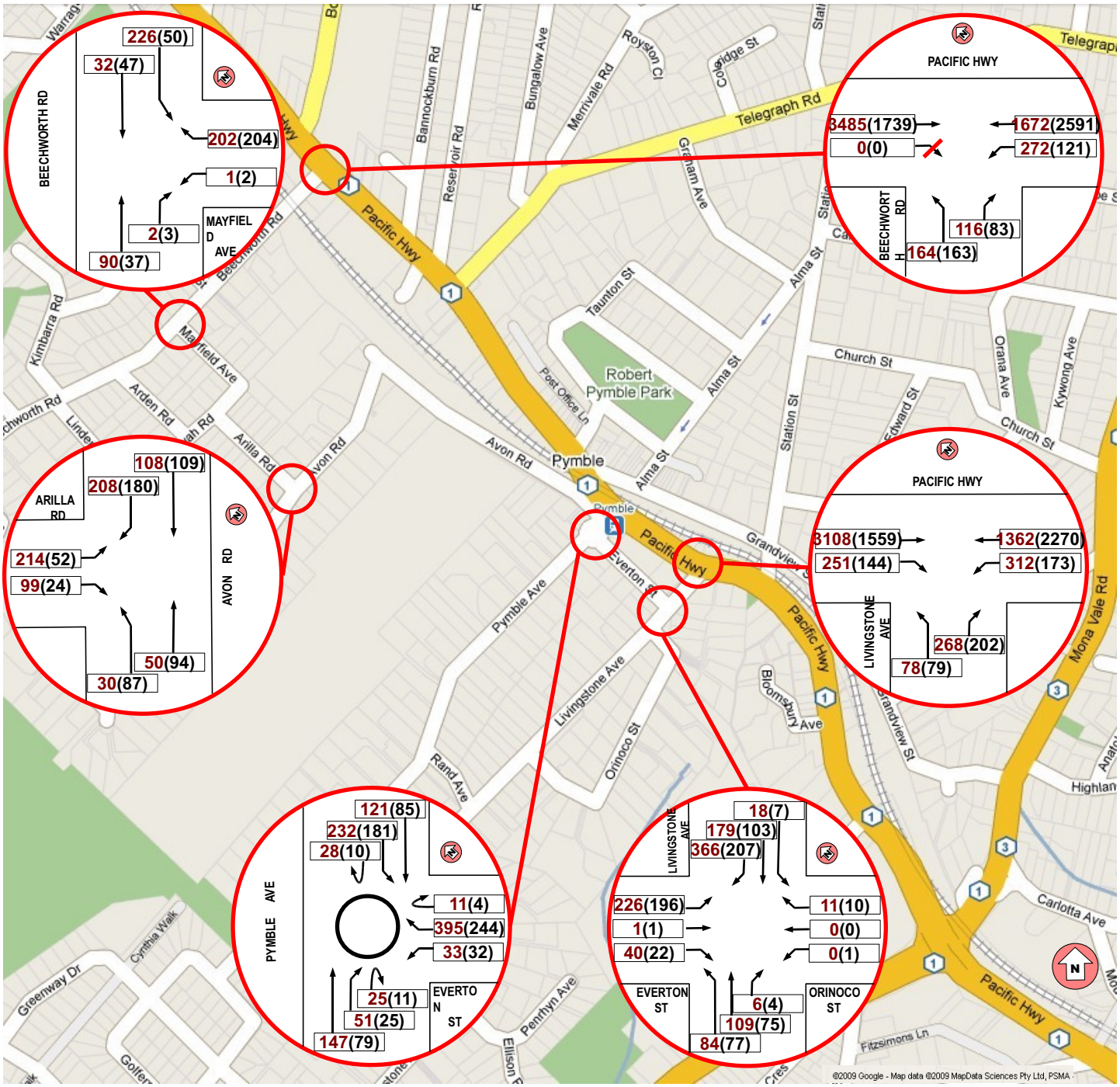
3.2.2 Trip Distribution of Proposed Development

It has been assumed that vehicles arriving and departing the proposed residential development has been assumed to be in accordance with the distribution in **Table 3.1**.

Table 3.1: Directional Trip Distribution

	Arr	Dep	Total	Arr	Dep	Total
AM Peak	30%	70%	100%	35	81	116
PM Peak	70%	30%	100%	81	35	116

The volume of additional residential traffic generated by the proposed development and using each of the major approach routes is given in Table 3.2.



LEGEND

0000(0000) – AM(PM) flows, veh/hr

AM (7:15 am – 8:15 am)
PM (4:30 pm – 5:30 pm)

Table 3.2: Distribution of Traffic on Approach Routes

Approach/Departure Routes			AM Peak			PM Peak		
	Arr	Dep	Arr	Dep	Total	Arr	Dep	Total
Access off Avon Road								
FROM/TO SOUTH								
Pacific Hwy/Livingstone/Everton/Avon	50%	50%	13	29	42	29	13	42
Pymble/Avon	10%	10%	3	6	9	6	3	9
Pacific Hwy/Beechworth/Mayfield/Avon	0%	0%	0	0	0	0	0	0
FROM/TO NORTH								
Pacific Hwy/Livingstone/Everton/Avon	40%	0%	10	0	10	24	0	24
Pacific Hwy/Beechworth	0%	40%	0	24	24	0	10	10
TOTAL	**100%**	**100 %**	**26**	**59**	**85**	**59**	**26**	**85**
Access off Beechworth Road								
FROM/TO SOUTH								
Pacific Hwy/Livingstone/Avon/Beechworth	0%	0%	0	0	0	0	0	0
Pymble/Avon/Mayfield/Beachworth	10%	10%	1	3	4	3	1	4
Pacific Hwy/Beechworth/Mayfield	50%	50%	5	13	18	13	5	18
FROM/TO NORTH								
Pacific Hwy/Livingstone/Everton/Avon	40%	0%	4	0	4	10	0	10
Pacific Hwy/Beechworth/Mayfield	0%	40%	0	10	10	0	4	4
TOTAL	**100%**	**100 %**	**10**	**26**	**36**	**26**	**10**	**36**
All Trips								
FROM/TO SOUTH								
Pacific Hwy/Livingstone/Everton/Avon	36%	34%	13	29	42	29	13	42
Pymble/Avon/Mayfield/Beachworth	11%	11%	4	9	13	9	4	13
Pacific Hwy/Beechworth/Mayfield	14%	15%	5	13	18	13	5	18
FROM/TO NORTH								
Pacific Hwy/Livingstone/Everton/Avon	39%	0%	14	0	14	34	0	34
Pacific Hwy/Beechworth/Mayfield	0%	40%	0	34	34	0	14	14
TOTAL	**100%**	**100%**	**36**	**85**	**121**	**85**	**36**	**121**

3.2.1 Impact on Approach Roads

The expected trip generation of the proposed developments were then assigned to the surrounding road network. The existing hourly traffic volumes along the major approach roads are summarised in **Table 3.3** together with the additional traffic associated with the proposed development.

Table 3.3: Traffic Volumes

Road	Location	Existing Volumes	Development Traffic	Total	% Increase
AM Peak 7.15 to 8.15 am					
Avon Road	n of Pymble Ave	923	69	992	7.5%
Arilla Road	w of Avon Rd	551	32	583	5.8%
Mayfield Avenue	e of Beechworth Rd	431	32	463	7.4%
Beechworth Road	s of Pacific H'way	552	52	604	9.4%
Everton Street	w of Livingstone Ave	717	56	773	7.8%
Livingstone Avenue	s of Highway	909	56	965	6.2%
Pymble Ave	s of Everton St	377	13	390	3.4%
Pacific Highway-	e of Livingstone Ave	5050	60	5110	1.2%
Pacific Highway-	w of Beechworth Rd	5321	48	5369	0.9%
PM Peak 4.30 to 5.30 pm					
Avon Road	n of Pymble Ave	599	89	688	14.9%
Arilla Road	w of Avon Rd	343	24	367	7.0%
Mayfield Avenue	e of Beechworth Rd	259	26	285	10.0%
Beechworth Road	s of Pacific H'way	367	32	399	8.7%
Everton Street	w of Livingstone Ave	503	76	579	15.1%
Livingstone Avenue	s of Highway	598	42	640	7.0%
Pymble Ave	s of Everton St	232	13	245	5.6%
Pacific Highway-	e of Livingstone Ave	4204	60	4264	1.4%
Pacific Highway-	w of Beechworth Rd	4493	48	4541	1.1%

The highest contributor to traffic in the area during the morning peak is the Pymble Ladies College particularly in the vicinity of the main gate in Avon Road. As a result the additional traffic generated by the proposed residential development would generally account for increases of no more than 10 percent during the morning peak

During the afternoon peak hour (4.30 to 5.30 pm), streets in the vicinity of the proposed development will experience percentage increases higher than those during the morning peak period. Notwithstanding these higher percentage increases, the overall traffic volumes along the different roads would still be lower than those estimated during the morning peak period.

It is therefore considered that the additional traffic generated by the proposed residential development would have minimal impact on traffic conditions along the surrounding roads, and a negligible impact on the Pacific Highway which currently carries very high volume of traffic.

3.2.2 Impact on Intersection Operation

The operation of the non signalised intersections was analysed using the INTANAL (version 2004.1) computer-modelling program, to assess the effects of the proposed developments on its operation. **INTANAL** is a software that allows comparisons between different forms of intersection control, and different forms of intersection configurations to be readily evaluated.

The critical movement for the assessment of the level of service of a sign or a roundabout controlled intersection is the one with the highest average delay.

The operation of the two signalised intersections along the Pacific Highway were analysed with the SIDRA Intersection software. The assessment of the level of service of traffic signals is based on the evaluation of the average delay (secs/veh) of vehicles on all approaches. The concepts of intersection capacity and level of service are discussed in **Appendix D** together with criteria for their assessment. The results of this analysis are summarised in **Table 3.4**.

Table 3.4: Operational Characteristic of Intersections

Intersection		AM Peak			PM Peak		
		Deg Sat	Delays	LoS	Deg Sat	Delays	LoS
Traffic Signal Control aSIDRA							
Pacific Highway & Beechworth Rd	Existing	0.82	12.0	A	0.94	19.0	B
	with dev	***0.82***	***12.0***	***A***	***0.94***	***19.0***	***B***
Pacific Highway & Livingstone Avenue	Existing	1.07	>70	F	0.91	13.0	A
	with dev	***1.07***	***>70***	***F***	***0.91***	***13.0***	***A***
Roundabout Control							
Avon Rd, Pymble Ave & Everton St	Existing		10.4	A		8.6	A
	with dev		***10.8***	***A***		***9.3***	***A***
Sign Controlled							
Livingstone Ave & Everton St	Existing		9.3	A		7.4	A
	with dev		***9.4***	***A***		***7.8***	***A***
Avon Rd & Arilla Rd	Existing		7.5	A		7	A
	with dev		***7.6***	***A***		***7.1***	***A***
Beechworth Rd & Mayfield Ave	Existing		6.6	A		6.6	A
	with dev		***6.8***	***A***		***6.7***	***A***

All non signalised intersections currently operate at a very good level of service "A". Traffic generated by the proposed residential development is not likely to affect the operation of these intersections which would continue to operate at a very good level of service "A".

The signalised intersection of the Pacific Highway with Beechworth Road operates at a good level of service "B" or better. The signalised intersection of Pacific Highway with Livingstone Avenue operates at a very poor level of service "F" during the morning peak improving during the afternoon peak. Notwithstanding, these two intersections have very high degree of saturation with very long queues observed along the Pacific Highway during both peak periods. Traffic generated by the proposed residential development is not likely to affect the operation of these two intersections.

3.3 Through Road between Beechworth Road and Avon Road

In 2002, Planning NSW required the provision of a direct link between Beechworth Road and Avon Road. This road was not supported at the time and should not be provided for the following reasons:

- The only real purpose of the road would be to provide a vehicular short cut between Beechworth Road and Avon Road. Internal vehicular connectivity between on-site development is not warranted as residents are not likely to drive if visiting other residents within the same development; it is however recommended that adequate paths be provided to achieve safe pedestrian connectivity between buildings.
- The new link road would function as a collector road with a potential to carry over about 700 vehicles per hour, thus exceeding the suggested maximum volumes and interfering with the residential amenity of future residents along it.
- Furthermore, as this new road provides a direct route between Avon Road and the Pacific Highway via Beechworth Road, it is likely to attract a large proportion of traffic from the surrounding area, which currently exits via Livingstone Avenue.
- The proposed development is not likely to generate more than 120 trips during the peak hour. The two proposed access from Beechworth Road and Avon Road would adequately cater for the expected traffic as noted below:
  - < Beechworth Road 35 cars
  - < Avon Road 85 cars
- As previously recommended the following treatments should be implemented:
  - < Provision of through line marking of a right turning bay at N°5 Avon Road in conjunction with Stage 1
  - < Provision of a roundabout at the bend near N°1 Avon Road in conjunction with Stage 2.

Traffic problems in the area are largely associated with PLC and not likely to unduly affect the proposed residential developments. PLC should be required to address these traffic issues.

3.4 Neighbourhood Amenity

In view of the existing traffic volumes on the surrounding road network, it is unlikely that traffic generated by the proposed residential developments would have an impact on the amenity of residences along these streets.

4. Summary & Conclusions

4.1 Summary

J W Neale is proposing to develop the site bounded by Beechworth Road, Arilla Road and Avon Road, Pymble) for the provision of approximately 350 residential flats occupying a total of about 30,000 m². The design of the buildings is modular allowing a degree of flexibility in the mix of apartments. The overall development would proceed in five (5) stages

The design for Stage 1 which consists of 51 units has been completed. A minimum of 52 spaces would be required for the Stage 1 development including 5 spaces for visitors; some 86 car spaces are proposed. The proposed parking layout and dimensions satisfy all the requirements of the Australian Standards.

Vehicular access to and from the proposed development would mostly be from Avon Road and Beechworth Road. The number of vehicles likely to be generated by the proposed development has been estimated for a maximum of about 400 1 or 2-bedroom units. It has thus been estimated that these 400 units would generate about 120 vehicle trips per hour during the morning and afternoon peak hours.

The traffic generated by the proposed residential development would have minimal impact on traffic conditions along the surrounding roads, and a negligible impact on the Pacific Highway which currently carries very high volume of traffic.

Traffic generated by the proposed residential development will not affect the operation of all nearby intersections which will continue to operate at their current levels of service.

4.2 Conclusions

The proposed residential development satisfies Ku-Ring-Gai Council's parking requirements and is not likely to unduly affect traffic conditions in the surrounding area. Therefore subject to the implementation of the following measures there are no parking and traffic reasons why Council should not approve this development.

- Provision through line marking of a right turning bay at N°5 Avon Road in conjunction with the Stage 1 development
- Provision of a roundabout at the bend near N°1 Avon Road including a pedestrian refuge in conjunction with the Stage 2 development
- Provision of 'No Standing' signs in Arilla Rd adjacent to proposed driveway entrance to site.

5. References

Austroads (1995). '*Guide to Traffic Engineering Practice Part 5 Intersections at Grade*.'

Roads and Traffic Authority of NSW (2002) "*Guide to Traffic Generating Developments*". Issue 2.2. October.

Standards Australia (2004). "*AS 2890.1-2004 Parking Facilities Part 1 Off Street car parking.*"

Appendix A

Staging of Development

revision	date	description	by	verification	initial	signature	date
P6	6 NOV 2009	CONCEPT PLAN - PRELIMINARY ISSUE	SC, MO	checked by	SC		06.11.09
				approved by	DS		06.11.09

note: Do not scale from drawings. All dimensions to be checked on site before commencement of work. All discrepancies to be brought to the attention of the Architect. This drawing is copyright and the property of the author, and must not be retained, copied or used without the express authority of Archer Mortlock Woolley Pty. Ltd.

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project: EA - CONCEPT PLAN APPLICATION
AVON ROAD, PYMBLE

client: Jim Nesle

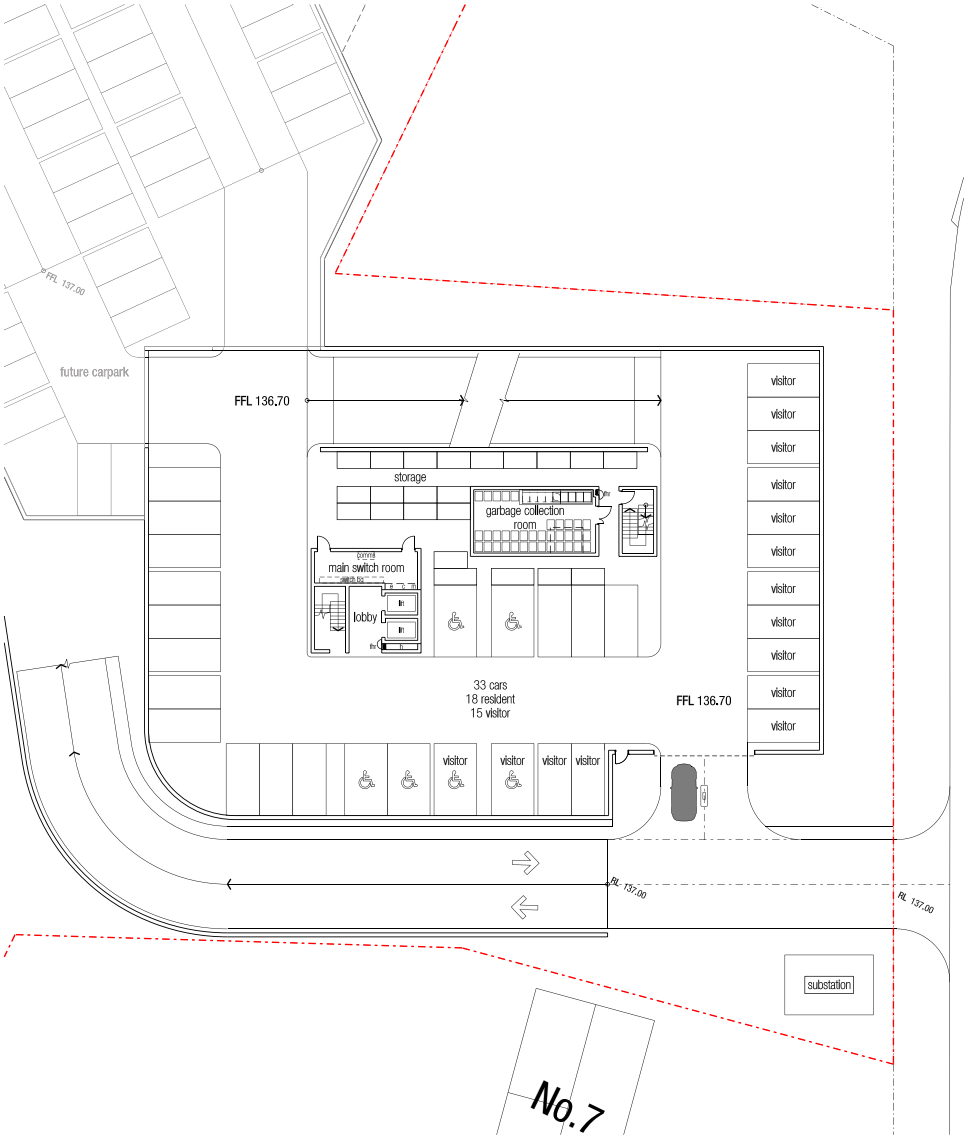
drawing: SITE CONCEPT PLAN

scale: 1:500@A1, 1:1000@A3 (0, 5, 10, 25m)
drawn by: SC,MO
project no: 0909
drawing no: CP-100
revision: P6

Appendix B

Stage 1 Parking Layout

01 B2 LEVEL CARPARK
SCALE 1:200 @ A1



02 B1 LEVEL CARPARK
SCALE 1:200 @ A1

PRELIMINARY

revision	date	description	by	verification	initial	signature	date	note
P7	10 NOV 2009	PA - STAGE 1 - PRELIMINARY ISSUE	SC, MO	checked by	SC		10.11.09	Do not scale from drawings. All dimensions to be checked on site before commencement of work. All discrepancies to be brought to the attention of the Architect. This drawing is copyright and the property of the author, and must not be retained, copied or used without the express authority of Ancher Mortlock Woolley Pty. Ltd.
				approved by	DS		10.11.09	

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project: PROJECT APPLICATION - STAGE 1
AVON ROAD, PYMBLE

client: Jim Neale

drawing: B2 LEVEL CARPARK & B1 LEVEL CARPARK

scale: 1:200@A1, 1:400@A3 | 0 2 4 10m
drawn by: SC,MO
project no: 0909
drawing no: PA1-100
revision: P7

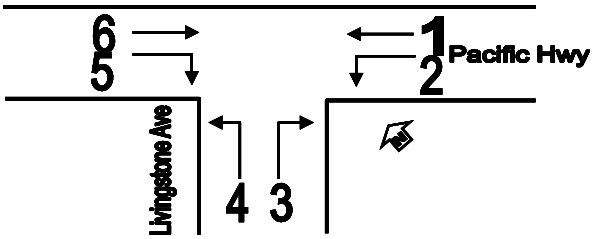
Appendix C

Intersection Traffic Counts

INTERVAL 15

No.9132

CLIENT
DATE 26/05/2009 PM
27/05/2009 AM
DAY TUESDAY
WEDNESDAY
LOCATION PYMBLE
WEATHER FINE
CLOUDY
OBSERVERS Haldey



WEDNESDAY

FROM		TO	1	2	3	4	5	6	TOTAL
			All	All	All	All	All	All	
7:00	-	7:15	398	31	40	6	41	783	1299
7:15	-	7:30	308	43	53	9	47	946	1406
7:30	-	7:45	375	89	55	15	69	716	1319
7:45	-	8:00	310	97	79	30	79	768	1363
8:00	-	8:15	369	83	81	24	56	678	1291
8:15	-	8:30	342	63	64	24	71	658	1222
8:30	-	8:45	301	56	45	21	66	612	1101
8:45	-	9:00	300	38	38	29	64	702	1171
TOTAL			2703	500	455	158	493	5863	10172

TUESDAY

FROM		TO	1	2	3	4	5	6	TOTAL
			All	All	All	All	All	All	
16:00	-	16:15	565	35	28	20	29	355	1032
16:15	-	16:30	615	36	30	11	34	379	1105
16:30	-	16:45	557	37	46	15	33	361	1049
16:45	-	17:00	582	52	48	23	42	415	1162
17:00	-	17:15	520	44	50	25	35	375	1049
17:15	-	17:30	611	40	58	16	34	408	1167
17:30	-	17:45	518	26	24	25	20	410	1023
17:45	-	18:00	563	30	29	24	26	392	1064
TOTAL			4531	300	313	159	253	3095	8651

HOURLY COUNTS

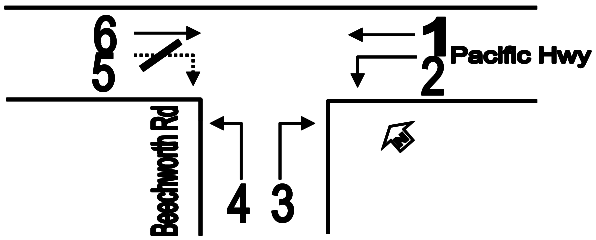
7:00	-	8:00	1391	260	227	60	236	3213	5387
7:15	-	8:15	1362	312	268	78	251	3108	5379
7:30	-	8:30	1396	332	279	93	275	2820	5195
7:45	-	8:45	1322	299	269	99	272	2716	4977
8:00	-	9:00	1312	240	228	98	257	2650	4785

16:00	-	17:00	2319	160	152	69	138	1510	4348
16:15	-	17:15	2274	169	174	74	144	1530	4365
16:30	-	17:30	2270	173	202	79	144	1559	4427
16:45	-	17:45	2231	162	180	89	131	1608	4401
17:00	-	18:00	2212	140	161	90	115	1585	4303

INTERVAL #
No.9132

CLIENT
DATE 26/05/2009 PM
27/05/2009 AM
DAY Tuesday
Wednesday
LOCATION PYMBLE
WEATHER

OBSERVERS



FRIDAY

FROM		TO	1	2	3	4	5	6	TOTAL
			All	All	All	All	All	All	
7:00	-	7:15	368	27	20	15		834	**1264**
7:15	-	7:30	386	33	13	19		889	**1340**
7:30	-	7:45	434	50	21	21		961	**1487**
7:45	-	8:00	432	97	35	53		872	**1489**
8:00	-	8:15	420	92	47	71		763	**1393**
8:15	-	8:30	411	35	39	32		759	**1276**
8:30	-	8:45	360	24	33	22		744	**1183**
8:45	-	9:00	317	26	31	12		581	**967**
TOTAL			**3128**	**384**	**239**	**245**	**0**	**6403**	**10399**

THURSDAY

FROM		TO	1	2	3	4	5	6	TOTAL
			All	All	All	All	All	All	
16:00	-	16:15	625	10	13	29		405	**1082**
16:15	-	16:30	771	40	15	18		500	**1344**
16:30	-	16:45	557	22	14	19		320	**932**
16:45	-	17:00	685	43	26	43		504	**1301**
17:00	-	17:15	719	28	19	59		483	**1308**
17:15	-	17:30	630	28	24	42		432	**1156**
17:30	-	17:45	516	27	22	10		348	**923**
17:45	-	18:00	770	28	14	20		426	**1258**
TOTAL			**5273**	**226**	**147**	**240**	**0**	**3418**	**9304**

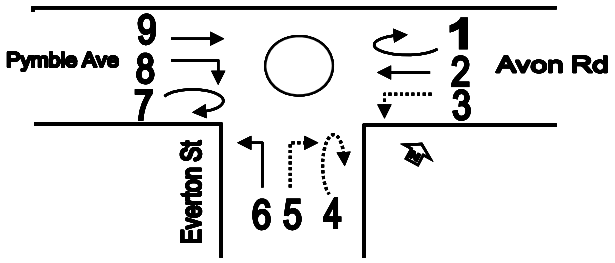
HOURLY COUNTS

7:00	-	8:00	1620	207	89	108	0	3556	**5580**
7:15	-	8:15	1672	272	116	164	0	3485	**5709**
7:30	-	8:30	1697	274	142	177	0	3355	**5645**
7:45	-	8:45	1623	248	154	178	0	3138	**5341**
8:00	-	9:00	1508	177	150	137	0	2847	**4819**

16:00	-	17:00	2638	115	68	109	0	1729	**4659**
16:15	-	17:15	2732	133	74	139	0	1807	**4885**
16:30	-	17:30	2591	121	83	163	0	1739	**4697**
16:45	-	17:45	2550	126	91	154	0	1767	**4688**
17:00	-	18:00	2635	111	79	131	0	1689	**4645**

INTERVAL #
No.9132

CLIENT
DATE 26/05/2009 PM
27/05/2009 AM
DAY TUESDAY
WEDNESDAY
LOCATION PYMBLE
WEATHER FINE
CLOUDY
OBSERVERS G.Rabinovitch



WEDNESDAY

FROM		TO	1	2	3	4	5	6	7	8	9	TOTAL
			All	All	All	All	All	All	All	All	All	
7:00	-	7:15	3	11	31	6	49	8	3	5	20	**136**
7:15	-	7:30	7	20	38	2	67	7	1	3	28	**173**
7:30	-	7:45	8	29	52	5	106	15	4	23	36	**278**
7:45	-	8:00	6	24	52	3	125	5	7	17	38	**277**
8:00	-	8:15	7	48	90	1	97	6	13	8	45	**315**
8:15	-	8:30	1	44	44	1	46	5	4	5	15	**165**
8:30	-	8:45	2	20	39	1	39	5	2	8	26	**142**
8:45	-	9:00	1	15	17	1	17	9	3	10	7	**80**
TOTAL			**35**	**211**	**363**	**20**	**546**	**60**	**37**	**79**	**215**	**1566**

TUESDAY

FROM		TO	1	2	3	4	5	6	7	8	9	TOTAL
			All	All	All	All	All	All	All	All	All	
16:00	-	16:15	2	17	31	3	23	9	6	8	12	**111**
16:15	-	16:30	1	15	19	1	42	7	0	10	16	**111**
16:30	-	16:45	1	21	42	1	47	7	2	2	16	**139**
16:45	-	17:00	4	17	41	0	72	7	4	8	22	**175**
17:00	-	17:15	1	35	61	1	84	4	1	7	27	**221**
17:15	-	17:30	4	12	37	2	41	14	4	8	14	**136**
17:30	-	17:45	0	8	20	0	36	6	5	5	8	**88**
17:45	-	18:00	6	10	13	2	29	9	2	9	15	**95**
TOTAL			**19**	**135**	**264**	**10**	**374**	**63**	**24**	**57**	**130**	**1076**

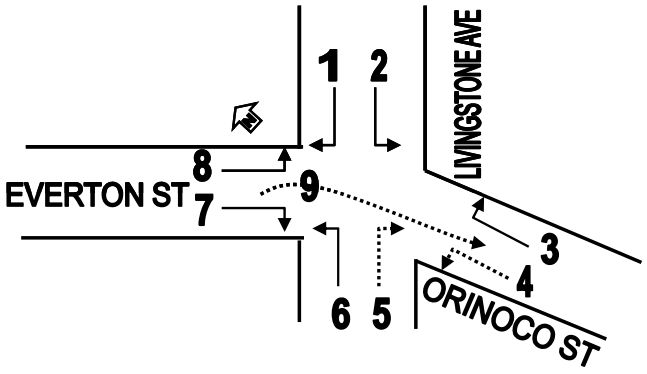
HOURLY COUNTS

7:00	-	8:00	24	84	173	16	347	35	15	48	122	**864**
7:15	-	8:15	28	121	232	11	395	33	25	51	147	**1043**
7:30	-	8:30	22	145	238	10	374	31	28	53	134	**1035**
7:45	-	8:45	16	136	225	6	307	21	26	38	124	**899**
8:00	-	9:00	11	127	190	4	199	25	22	31	93	**702**

16:00	-	17:00	8	70	133	5	184	30	12	28	66	**536**
16:15	-	17:15	7	88	163	3	245	25	7	27	81	**646**
16:30	-	17:30	10	85	181	4	244	32	11	25	79	**671**
16:45	-	17:45	9	72	159	3	233	31	14	28	71	**620**
17:00	-	18:00	11	65	131	5	190	33	12	29	64	**540**

INTERVAL # **No.9132**

CLIENT
DATE 26/05/2009 PM
27/05/2009 AM
DAY TUESDAY
WEDNESDAY
LOCATION PYMBLE
WEATHER FINE
CLOUDY
OBSERVERS R. Rabinovitch



WEDNESDAY

FROM		TO	1	2	3	4	5	6	7	8	9	TOTAL
			All	All	All	All	All	All	All	All	All	
7:00	-	7:15	45	1	2	0	1	16	8	29	1	103
7:15	-	7:30	58	2	1	0	1	18	5	35	1	121
7:30	-	7:45	117	1	4	0	1	24	16	59	0	222
7:45	-	8:00	112	1	4	0	2	24	13	54	0	210
8:00	-	8:15	79	2	2	0	2	18	6	78	0	187
8:15	-	8:30	48	3	1	1	0	7	7	57	0	124
8:30	-	8:45	40	1	5	1	1	7	4	45	1	105
8:45	-	9:00	25	5	3	0	1	4	5	20	0	63
TOTAL			524	16	22	2	9	118	64	377	3	1135

TUESDAY

FROM		TO	1	2	3	4	5	6	7	8	9	TOTAL
			All	All	All	All	All	All	All	All	All	
16:00	-	16:15	25	0	2	0	1	8	10	30	1	77
16:15	-	16:30	44	2	0	0	1	10	4	28	0	89
16:30	-	16:45	51	4	2	0	1	15	5	49	1	128
16:45	-	17:00	65	0	2	0	1	22	2	42	0	134
17:00	-	17:15	59	1	4	0	2	16	6	69	0	157
17:15	-	17:30	32	2	2	1	0	24	9	36	0	106
17:30	-	17:45	27	6	5	1	1	14	6	18	0	78
17:45	-	18:00	33	3	1	0	1	15	6	17	1	77
TOTAL			336	18	18	2	8	124	48	289	3	846

HOURLY COUNTS

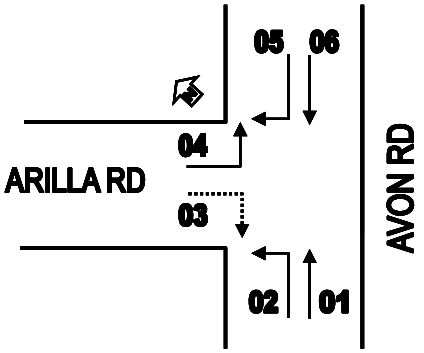
7:00	-	8:00	332	5	11	0	5	82	42	177	2	656
7:15	-	8:15	366	6	11	0	6	84	40	226	1	740
7:30	-	8:30	356	7	11	1	5	73	42	248	0	743
7:45	-	8:45	279	7	12	2	5	56	30	234	1	626
8:00	-	9:00	192	11	11	2	4	36	22	200	1	479

16:00	-	17:00	185	6	6	0	4	55	21	149	2	428
16:15	-	17:15	219	7	8	0	5	63	17	188	1	508
16:30	-	17:30	207	7	10	1	4	77	22	196	1	525
16:45	-	17:45	183	9	13	2	4	76	23	165	0	475
17:00	-	18:00	151	12	12	2	4	69	27	140	1	418

INTERVAL #
No.9132

CLIENT
DATE 26/05/2009 PM
27/05/2009 AM
DAY Tuesday
Wednesday
LOCATION PYMBLE
WEATHER

OBSERVERS



FRIDAY

FROM		TO	1	2	3	4	5	6	TOTAL
			All	All	All	All	All	All	
7:00	-	7:15	10	10	8	22	20	17	87
7:15	-	7:30	10	2	17	33	22	27	111
7:30	-	7:45	9	4	19	46	33	32	143
7:45	-	8:00	16	4	25	60	59	33	197
8:00	-	8:15	15	20	38	75	94	16	258
8:15	-	8:30	12	10	7	29	36	10	104
8:30	-	8:45	4	4	4	22	30	11	75
8:45	-	9:00	2	4	4	22	16	5	53
TOTAL			78	58	122	309	310	151	1028

THURSDAY

FROM		TO	1	2	3	4	5	6	TOTAL
			All	All	All	All	All	All	
16:00	-	16:15	17	21	1	9	16	7	71
16:15	-	16:30	15	12	3	15	21	14	80
16:30	-	16:45	21	13	4	15	38	21	112
16:45	-	17:00	23	19	8	15	49	35	149
17:00	-	17:15	32	35	8	10	58	36	179
17:15	-	17:30	18	20	4	12	35	17	106
17:30	-	17:45	15	11	2	6	24	11	69
17:45	-	18:00	3	6	3	13	31	13	69
TOTAL			144	137	33	95	272	154	835

HOURLY COUNTS

7:00	-	8:00	45	20	69	161	134	109	538
7:15	-	8:15	50	30	99	214	208	108	709
7:30	-	8:30	52	38	89	210	222	91	702
7:45	-	8:45	47	38	74	186	219	70	634
8:00	-	9:00	33	38	53	148	176	42	490

16:00	-	17:00	76	65	16	54	124	77	412
16:15	-	17:15	91	79	23	55	166	106	520
16:30	-	17:30	94	87	24	52	180	109	546
16:45	-	17:45	88	85	22	43	166	99	503
17:00	-	18:00	68	72	17	41	148	77	423

INTERVAL 15

No.9132

CLIENT

DATE 26/05/2009 PM
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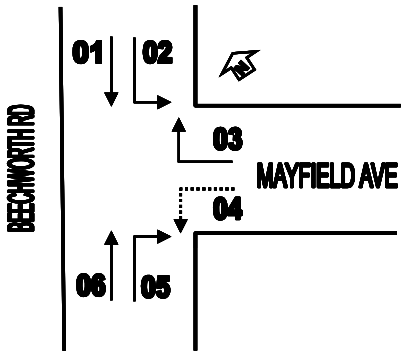
DAY Tuesday
Wednesday

LOCATION PYMBLE

WEATHER

OBSERVERS



FRIDAY

FROM		TO	1	2	3	4	5	6	TOTAL
			All	All	All	All	All	All	
7:00	-	7:15	8	16	18			13	55
7:15	-	7:30	9	25	19	1		17	71
7:30	-	7:45	3	48	27		1	16	95
7:45	-	8:00	7	68	59			26	160
8:00	-	8:15	13	85	97		1	31	227
8:15	-	8:30	5	19	33		1	26	84
8:30	-	8:45	11	15	29	1	1	28	85
8:45	-	9:00	12	11	11			27	61
TOTAL			68	287	293	2	4	184	838

THURSDAY

FROM		TO	1	2	3	4	5	6	TOTAL
			All	All	All	All	All	All	
16:00	-	16:15	7	5	31			13	56
16:15	-	16:30	18	16	19			8	61
16:30	-	16:45	10	13	36	1		6	66
16:45	-	17:00	13	21	55		1	15	105
17:00	-	17:15	12	11	78		2	6	109
17:15	-	17:30	12	5	35	1		10	63
17:30	-	17:45	14	6	19	1	1	9	50
17:45	-	18:00	16	5	22			8	51
TOTAL			102	82	295	3	4	75	561

HOURLY COUNTS

7:00	-	8:00	27	157	123	1	1	72	381
7:15	-	8:15	32	226	202	1	2	90	553
7:30	-	8:30	28	220	216	0	3	99	566
7:45	-	8:45	36	187	218	1	3	111	556
8:00	-	9:00	41	130	170	1	3	112	457

16:00	-	17:00	48	55	141	1	1	42	288
16:15	-	17:15	53	61	188	1	3	35	341
16:30	-	17:30	47	50	204	2	3	37	343
16:45	-	17:45	51	43	187	2	4	40	327
17:00	-	18:00	54	27	154	2	3	33	273

Appendix D

Guidelines for Evaluation of
Intersection Capacity

APPENDIX D

GUIDELINES FOR EVALUATION OF INTERSECTION CAPACITY

The RTA has included in the "Guide to Traffic Generating Developments" (Dec 1995, Issue 2) a section on the assessment of intersections. The assessment of the level of service of an intersection is based on the evaluation of the following Measures of Effectiveness:

(a) average delay (secs/veh) (all forms of control);

(b) delay to critical movement (secs/veh) (all forms of control);

(c) degree of saturation (traffic signals and roundabouts); and

(d) cycle length (traffic signals).

INTANAL was used to calculate the relevant intersection parameters. INTANAL is a software which allows comparisons between different forms of intersection control and different forms of intersection configurations to be readily evaluated. That is at each intersection the priority control, roundabout and signal control options will be examined to determine the most efficient form of control.

The best indicator of the level of service at an intersection is the average delay experienced by vehicles at that intersection. For traffic signals, the average delay over all movements should be taken. For roundabouts and priority control intersections (with Stop and Give Way signs or operating under the T-junction rule) the critical movement for level of service assessment should be that with the highest average delay.

With traffic signals, delays per approach tend to be equalised, subject to any over-riding requirements of signal co-ordination as well as to variations within individual movements. With roundabouts and priority controlled intersections, the critical criterion for assessment is the movement with the highest delay per vehicle. With this type of control the volume balance might be such that some movements suffer high levels of delay while other movements have minimal delay. An overall average delay for the intersection of 25 seconds might not be satisfactory if the average delay on one movement is 60 seconds.

The average delay for level of service E should be no more than 70 seconds. The accepted maximum practical cycle length for traffic signals under saturated conditions is 120 - 140 seconds. Under these conditions 120 seconds is near maximum for two and three phase intersections and 140 seconds near maximum for more complex phase designs. Drivers and pedestrians expect cycle lengths of these magnitudes and their inherent delays in peak hours. A cycle length of 140 seconds for an intersection that is almost saturated has an average vehicle delay of about 70 seconds, although this can vary. If the average vehicle delay is more than 70 seconds, the intersection is assumed to be at Level of Service F.

Table D1 sets out average delays for different levels of service. There is no consistent correlation between definitions of levels of service for road links as defined elsewhere in this section, and the ranges set out in *Table D1*. In assigning a level of service, the average delay to the motoring public need to be considered, keeping in mind the location of the intersection. For example, drivers in inner-urban areas of Sydney have a higher tolerance of delay than drivers in country areas. *Table B1* provides a recommended baseline for assessment.

Table D1: Level of Service Criteria for Intersections

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	less than 14	Good operation	Good operation
B	14 to 28	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
C	29 – 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode	At capacity, required other control mode

Source: RTA (2002)

The figures in *Table D1* are intended as a guide only. Any particular assessment should take into account site-specific factors including maximum queue lengths (and their effect on lane blocking), the influence of nearby intersections and the sensitivity of the location to delays. In many situations, a comparison of the current and future average delay provides a better appreciation of the impact of a proposal, and not simply the change in the level of service.

The intersection degree of saturation (DS) can also be used to measure the performance of isolated intersections. At intersections controlled by traffic signals, both queue length and delays increase rapidly as DS approaches 1.0. An upper limit of 0.9 is appropriate. When DS exceeds 0.8 - 0.85, overflow queues start to become a problem. Satisfactory intersection operation is generally achieved with a DS of about 0.7 - 0.8. (Note that these figures are based on isolated signalised intersections with cycle lengths of 120 seconds. In co-ordinated signal systems DS might be actively maximised at key intersections). Although in some situations additional traffic does not alter the level of service, particularly where the level of service is E or F, additional capacity may still be required. This is particularly appropriate for service level F, where small increases in flow can cause disproportionately greater increases in delay. In this situation, it is advisable to consider means of control to maintain the existing level of absolute delay. Suggested criteria for the evaluation of the capacity of signalised intersections based on the Degree of Saturation are summarised in *Table D2*.

Table D2: Criteria for Evaluating Capacity of Signalised Intersections

LEVEL OF SERVICE	OPTIMUM CYCLE LENGTH (SECS) (CO)	VOLUME/SATURATION Y	INTERSECTION DEGREE OF SATURATION X
A/B Very good operation	< 90	< 0.70	< 0.80
C Satisfactory	90-120	0.70-0.80	0.80-0.85
D Poor but manageable	120-140	0.80-0.85	0.85-0.90
E/F Bad, extra capacity req'd	>140	>0.85	> 0.90

Source: RTA (2002)