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Mulpha Norwest

The Greens Residential Development
Norwest Town Centre East Precinct
Norwest Business Park

Mulpha NORWEST

Traffic and Parking Report for Amended Planning Proposal

June 2016

Mulpha Norwest

The Greens Residential Development
Norwest Town Centre East Precinct
Norwest Business Park

Traffic and Parking Report for Updated Stage 1 Master Plan

Quality Assurance Statement

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1. Introduction

1.1 Background

The Norwest Town Centre East Precinct known as 'The Greens' is the final stage of the development of the Norwest Town Centre site. Mulpha-Norwest is currently developing a mixed use residential development off Solent Circuit at Norwest. The development comprises the Peninsula (West Precinct), Central Park (Central Precinct) and the green (East Precinct).

Approval was granted by Council for the development of 328 residences in The Greens precinct including some 88 townhouses and 240 apartments within six (6) buildings. The application was the subject of a parking requirement and traffic assessment report (Gennaoui, 2013). Since then approval has been granted to increase the height and number of units in Buildings A1 and A2 to 100 units. Furthermore approval was granted to replace 25 townhouses west of the new link road with a new building A3 to accommodate 76 apartments and 400 m^2 of neighbourhood shops.

Mulpha-Norwest is currently seeking to amend the approved Master Plan to provide on the eastern side of the new Central roadway, nine (9) high rise mixed use residential and commercial buildings. The total number of units including the approved Buildings A1 to A3 is anticipated to be 1,038 on the site. Some 6,000 m^2 GFA of commercial use will also be provided.

TDG in association with Gennaoui Consulting Pty Ltd has been commissioned to investigate the traffic implications and parking requirements of the latest Planning proposal, and associated access.

1.2 Site Location and Study Area

The site of the proposed developments is shown on **Figure 1**. The Greens precinct will be situated on the northern side of Solent Circuit. Access to all accommodation will be via Solent Circuit and Spurway Drive to underground car parking. The immediate study area has been defined as the area bounded by and including Norwest Boulevard, Solent Circuit and Fairway Drive.

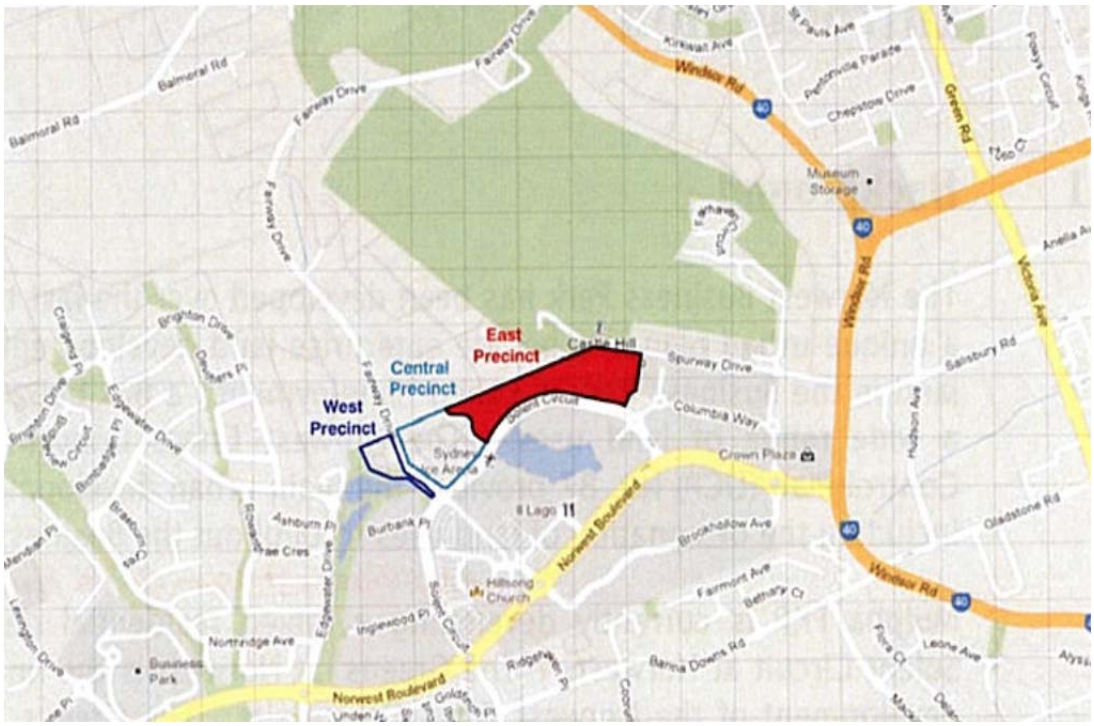

Figure 1: Location of the Greens Estate

1.3 Study Approach

The approach adopted to assess the traffic impacts of The Greens proposed development submitted with the Planning Proposal and Master Plan was previously agreed with Council's traffic manager and included the following steps:

- The estimated car parking requirements will be determined in relation to RMS and Council requirements.I In this regard the impact of public transport, including the rail effects, on traffic demands and car parking will be determined for this planning proposal;
- Assessment of existing traffic conditions using traffic counts previously carried out at the intersections of Norwest Boulevard with Solent Circuit (roundabout) and with Solent Circuit East (T junction), and also at the roundabout located at the junction of Solent Circuit with Fairway Drive;
- Estimate traffic generation and distribution of each type of residential dwelling and commercial land use proposed in the Master Plan; a comparison has been made between this proposal and the previous approved Master Plan;
- Assessment of traffic impacts of proposed Master Plan on all major and local approach roads and critical intersections to assess their suitability to accommodate future traffic; and
- Assessment of access and egress to the site.

1.4 Scope of Report

This report summarises the findings, conclusions and recommendations with respect to the parking requirements and traffic impacts of proposed Master Plan. All major access to the estate has also been assessed.

2. Access and Parking

2.1 The Proposal

Mulpha Norwest is currently developing a residential estate, on the northern side of Solent Circuit at the Norwest Business Park, as shown in **Figure 1**. The following part of the development has been completed or is under construction:

- The Peninsula (West) Precinct:- the western side of Fairway Drive with access from Fairway Drive. Completed with 11 detached dwelling, 12 townhouses and 12 apartments;
- Central Park (Central) Precinct:- Construction completed between Fairway Drive and the Dam; this area consists of 36 detached dwellings and 50 townhouses. Access is provided onto Fairway Drive (all movements) and Solent Circuit (left turn in and out only);
- The Greens (East) Precinct:- Buildings A1 to A3 accommodating 176 apartments and including 400 m^2 of neighbourhood shops;

Mulpha Norwest now propose to amend the existing Master Plan for the eastern part of the estate to provide some 864 new apartments in nine buildings (B to J) as illustrated on **Figure 2**. Buildings B to D will also include some 6,000 m^2 of commercial development.

Figure 2: The Proposal

The proposed access and parking locations shown on the plan in **Figure 2**, prepared by Krikis Tayler Architects are described below:

- Vehicular access to and from Buildings B and C will be via a common driveway off Solent Circuit;

- Vehicular access to and from Buildings D, E and F will be via a common driveway off Solent Circuit.
- Vehicular access to and from Buildings G and H will be via a common driveway off Spurway Drive.
- Vehicular access to and from Buildings I and J will be via separate driveways off Spurway Drive;
- New Link Road consisting of an 8.5m carriageway with 3.5m footpath on both sides to provide access to Spurway Drive from Solent Circuit.

The median in Solent Circuit will be retained along the whole length of the development thus restricting all access to the estate to left turn in and out only. All driveways off Solent Circuit will be designed in accordance with Council's requirements.

In addition to providing some 864 new apartments in nine buildings (B to J) as illustrated in **Figure 2**, the proposal will also include the provision of 2,000 m^2 of offices, a 1,500 m^2 Gymnasium, retail and restaurant/coffee covering 2,000 m^2 and a Child Care Centre catering for 50 children (500 m^2 GFA). This information is summarised in **Table 1**.

Land Use Residential	Access from Solent Circuit Buildings B to F	Access from Spurway Drive Buildings G to J	Total
Residential			
1 Bedroom Units	96	69	165
2 Bedroom Units	311	145	456
3 Bedroom Units	171	72	243
Total Units	**578**	**286**	**864**
Commercial			
Office/medical	2,000	-	2,000
Gymnasium	1,500	-	1,500
Retail	1,100	-	1,100
Restaurant	900	-	900
Child Care Centre	500	-	500
Total GFA m^2	**6,000**	**0**	**6,000**

Table 1: Proposed Solent Circuit Residential Development

2.2 Parking Requirements

2.2.1 Council's Requirements

Council's approval for the current Master Plan of the residential development on the Greens Estate has accepted the following parking provisions for apartments:

- **Residential**:
  - 1 space per 1 bedroom units;
  - 1.5 spaces per 2 bedrooms units;
  - 2 spaces per 3 bedrooms units; and
  - 2 visitor spaces per 5 units.
- **Commercial**:
  - Office:- 1 space per 25 m^2 GFA;
  - Gymnasium: -1 space per 25 m^2 GFA;
  - Retail:- 1 space per 18.5 m^2 GLFA;
  - Restaurants:- During daytime 1 space per 25 m^2 GFA; After hours 15 spaces per 100 m^2 applies; and
  - Child Care Centre: 1 space per employee and 1 space per 6 children. The proposed Centre is likely to cater for 50 children looked after by up to 10 staff.

Applying the above rates, some 1,681 spaces including visitor parking spaces would be needed for the apartments in the updated Master Plan to comply as noted in **Table 2**. An additional 253 spaces are required for the office and retail components of this Master Plan for the area to the East of the central roadway.

Residential Parking Requirements		Council accepted Rates		RMS Sepp 65	
Type of Units	**Units**	**Rates**	**Spaces**	**Rates**	**Spaces**
1 Bedroom	165	1	165	0.6	99
2 Bedrooms Small and Medium	456	1.5	684	0.9	410
3 Bedrooms	243	2	486	1.4	340
Sub Total	**864**		**1,335**		**850**
Visitors		0.4	346	0.2	173
Total			**1,681**		**1,022**

Commercial Parking Requirements	Council DCP		RMS Sepp 65		
Office	2,000	1 per 25 m^2	80		80
Gymnasium	1,500	1 per 25 m^2	60		60
Retail	1,100	1 per 18.5 m^2	59		59
Restaurant	900	1 per 25 m^2	36		36
Child Care Centre	500	1 per staff and 1 per 6 children	18		18
Total	**6000**		**253**		**253**
Overall Total Spaces			**1,934**		**1,276**

Table 2: Council and RMS Parking Requirement for Development

At night time and on weekends, the restaurants would require about 135 parking spaces. During those periods, the offices, retail and child care centre are generally closed or operate with much reduced staff levels. It would therefore be appropriate for the restaurants patrons and staff to have access to the spaces required by these developments during the day.

2.2.2 SEPP 65 Requirements

Recent changes to SEPP 65 include a number of standards which if met cannot be used as grounds for refusal of a development application. These are contained in Clause 30 (1) (a) which relates to parking:

> *"if the car parking for the building will be equal to, or greater than, the recommended minimum amount of car parking specified in Part 3J of the Apartment Design Code" which states for development in the following locations:*
>
> - *On sites that are within 800m of a railway station or light rail stop in the Sydney Metropolitan area; or*
> - *On land zoned, and sites within 400m of land zoned B3 Commercial Core, B4 Mixed Use or equivalent in a nominated regional centre;*
> - *The minimum car parking requirement for residents and visitors is set out in the Guide to Traffic Generating Developments, or the car parking requirement prescribed by the relevant council, whichever is the less"*

The site is well within 800m of the Norwest Railway Station which is under construction. SEPP 65 therefore could apply. It should be noted that the railway station is certain and would most probably be operational by the time any of the proposed residential flat buildings B to J were ready for occupation.

The Guide to Traffic Generating Developments (RTA, 2002) stipulates the following parking requirement for High Density Residential Flat Buildings (Metropolitan Sub-Regional Centre)

- 0.6 space per 1 bedroom unit;
- 0.9 space per 2 bedrooms units;

- 1.4 spaces per 3 bedrooms units; and
- 1.0 visitor space per 5 units.

Applying the above rates, some 1,022 spaces would be required for the proposed residential component of the development as noted in **Table 2**. A total of 1,276 spaces would thus be required to comply with the requirement of SEPP 65.

2.3 Proposed Parking Supply

The following rates were adopted for the residential component of the development:

- 1.0 space per 1 bedroom units;
- 1.5 spaces per 2 bedrooms units;
- 2.0 spaces per 3 and 4 bedrooms units; and
- 1.0 visitor space per 5 units.

It should be noted that the proposed parking rates for one and three bedrooms apartments are similar to Council rates. The proposed variation applies for visitor spaces which are lower than Council's accepted rates but equal to those in the RMS Guide to Traffic Generating Developments (RTA, 2002).

The usage of available commercial spaces during the evenings and weekends is not affected. Thus 1,761 spaces would be required if the proposed rates were adopted; 1,508 spaces for residents and their visitors, and 253 spaces for the commercial components as noted in **Table 3**.

Proposed Parking Supply			
Residential Parking Requirements			
Type of Units	**Units**	**Rates**	**Spaces**
1 Bedroom	165	1 per unit	165
2 Bedrooms Small and Medium	456	1.5 per unit	684
3 Bedrooms	243	2.0 per unit	486
Sub Total	**864**		**1,335**
Visitors		1 per 5 units	173
Total			**1,508**
Commercial Parking Requirements	**m^2 GFA**		
Office	2,000	1 per 25 m^2	80
Gymnasium	1,500	1 per 25 m^2	60
Retail	1,500	1 per 18.5 m^2	59
Restaurant	500	1 per 25 m^2	36
Child Care Centre (50 children, 10 staff)	500	1 per staff and 1 per 6 children	18
Total	**6,000**		**253**
Overall Total Spaces			**1,761**

Table 3: Proposed Parking Supply

Whilst the proposed parking supply of 1,761 spaces is lower than Council's requirement, it is well in excess of the requirements of SEPP 65 and is therefore considered appropriate given its proximity to the forthcoming Norwest railway station.

3. Existing Traffic Conditions

3.1 The Road Network

Access to all areas within the Norwest Business Park is provided by Norwest Boulevard, which connects Windsor Road to Old Windsor Road then onto the M7 Motorway. The main access to the proposed residential development will be via Solent Circuit; access to buildings G to J will be provided by Spurway Drive.

Solent Circuit has a four lane divided carriageway. At Burbank Place it has a continuous median restricting access to and from Burbank Place to left turning only movements.

Spurway Drive has a two lane carriageway providing access to a large number of residential dwellings between Windsor Road and the Golf Club. It will be extended along the northern boundary of the Greens Estate to connect with the proposed Central Roadway. Access from and to Windsor Road is restricted to left turn in and out of Spurway Drive.

Fairway Drive provides access to the Balmoral Estate to the north of the Business Park. It has a four-lane undivided carriageway including parking on both sides. It is controlled by a one lane circulating roundabout at Solent Circuit; the roundabout also provides access to the Hillsong site.

Norwest Boulevard has a four lane divided carriageway between Windsor Road and Old Windsor Road. Two-lane circulating roundabouts control most intersections along Norwest Boulevard, between Windsor Road and Old Windsor Road. Windsor Road has a four lane divided carriageway excluding long turning lanes at Norwest Boulevard and Showground Road.

Traffic signals are installed at the intersections of Norwest Boulevard with Windsor Road and with Old Windsor Road. The NSW Roads & Maritime Services (RMS) has recently provided additional capacity at this location by providing a third right turning lane from Norwest Boulevard into Windsor Road.

3.2 Operation of Existing Road System

3.2.1 Traffic Counts

The base peak hourly volumes obtained in August 2013 (Gennaoui, 2013), shown in **Appendix A**, at the following intersections were adopted for this study:

- Norwest Boulevard with Windsor Road (signalised);
- Norwest Boulevard with Solent Circuit (roundabout);
- Solent Circuit with Fairway Drive (roundabout);
- Norwest Boulevard with Solent Circuit east (T-junction).

Traffic volumes peaked between 8.00 and 9.00 am and from 4.30 to 5.30pm during the morning and afternoon respectively.

3.2.2 Operation of Major Approach Roads

The existing traffic volumes along Solent Circuit, Norwest Boulevard, and Windsor Road are summarised in **Table 4**, together with their appropriate level of service.

The concepts of carriageway capacity and Level of Service (LoS) are discussed in **Appendix B** together with criteria for their assessment. The absence of traffic movements entering/crossing Windsor Road and Norwest Boulevard from major developments, being access denied roads, means that the service one-way hourly volumes included in Table B1 of **Appendix B** could be used for these two roads.

Location	Lanes	AM Peak			PM Peak		
		East/ North	South/ West	LoS	East/ North	South /West	LoS
Solent Circuit							
Norwest Bvd to Inglewood Pl	4DP	677	372	A	205	567	A
West of Fairview Dr	4DP	208	453	A	429	384	A
East of Fairway Dr	4DP	198	102	A	159	208	A
Norwest Bvd to Maitland Ct	4DP	325	61	A	76	294	A
Norwest Boulevard*							
Windsor Rd to Columbia	4DCL	837	2645	C	2245	1307	A
Columbia to Solent Cir (east)	4DCL	822	1988	A	1628	1130	A
West of Solent Cir (east)	4DCL	876	1778	A	1363	1083	A
Brookhollow to Reston Gr	4DCL	1229	1674	A	1572	1472	A
Solent Cir to Westwood Dr	4DCL	1235	1817	A	1716	1571	A
Windsor Road							
North of Norwest Boulevard	4DCL	783	2536	B	2189	1372	A
South of Norwest Boulevard	4DCL	1583	1528	A	1526	1647	A

Table 4: Existing Carriageway Level of Service

4DCL 4 lanes divided carriageway with clearway and limited access and limited intersections
4DP 4 lanes divided carriageway with parking
Interrupted volumes (Table 1 Appendix C)
Uninterrupted volumes (Table 2 Appendix C

Norwest Boulevard operates at a satisfactory LoS of "C" or better. To the north of Norwest Boulevard, Windsor Road operates at a Level of Service "B" improving to a very good level of service "A" to the south of Norwest Boulevard.

Solent Circuit operates at a very good Level of Service "A".

3.2.3 Operation of Existing Critical Intersections

The concepts of intersection capacity and level of service, as defined in the Guidelines published by the RTA (2002), are discussed in **Appendix C** together with criteria for their assessment. The assessment of the level of service of traffic signals is based on the evaluation of the average delay (seconds/vehicle) of vehicles on all approaches. The assessment of the level of service of roundabouts and signed controlled intersections is based on the average delay (seconds/vehicle) of the critical movement.

An analysis of the operation of critical intersections in the vicinity of the site was carried out using the SIDRA computer modelling program. The results of this analysis are summarised in **Table 5** and presented in **Appendix D**.

Intersection	AM		PM	
	Delay sec/v	LoS	Delay sec/v	LoS
Traffic Signals				
Norwest Boulevard with:				
■ Windsor Road	30.9	C	34.5	C
Roundabouts				
Solent Circuit with:				
■ Norwest Boulevard / Reston Grange	35.0	C	47.6	D
■ Fairway Drive	13.0	A	12.7	A
Signs				
Norwest Boulevard with:				
■ Solent Circuit (East)	14.8	B	>70	F

Table 5: Existing Operation of Intersections

The unsignalised intersection of Solent Circuit East with Norwest Boulevard currently operates at a good level of service "B" during the morning peak hour. Conditions worsen to a very poor Level of Service "F" during the afternoon peak; this is largely due to the extensive delays experienced by vehicles left turning out of Solent Circuit as a result of the heavy traffic volumes along Norwest Boulevard. Traffic signals are currently planned for installation at this location.

The traffic signals at the intersection of Norwest Boulevard with Windsor Road operates at a satisfactory level of service "C" during the morning and afternoon peak periods. This good operation is a reflection of the recent construction of a third right turning bay from Norwest Boulevard into Windsor Road, and a second left turning lane from Windsor Road into Norwest Boulevard.

During the morning peak period, the roundabout controlling the intersection of Norwest Boulevard with Solent Circuit and Reston Grange operates at satisfactory level of service "C". Conditions worsened in the afternoon when it operates near capacity at a lesser level of service "D'. It is understood that the RMS and Council are planning to replace the roundabout with traffic signals in the next few years. The roundabout at the intersection of Fairway Drive with Solent Circuit operates at a very good Level of Service "A".

The Central roadway will provide access to Building A3 to the west of the roadway and to buildings G to J off Spurway Drive. At Solent Circuit, movements to and from Central roadway are restricted to left turn in and out only.

4. Traffic Impact of Proposed Development

4.1 Peak Hourly Trip Generation and Distribution

4.1.1 Trip Generation of Proposed Developments

The following approach was adopted to estimate the trip generations of the latest proposed development.

Residential: - The RMS Technical Directive 04a (2013) indicates that the average trip generation rates for high density residential buildings near railway stations is an average 0.19 trips/units based on a range of 0.07 to 0.32 trips/units (from 8 high density buildings) during the morning peak hour. During the afternoon peak hour, is 0.15 trips/units based on a range of 0.06 to 0.41 trips/units.

The higher rate of 0.32 trips per unit has been adopted for the proposed Greens Estate being the upper level of surveyed high density residential developments. This rate was used for both the morning and afternoon peak periods noting that the afternoon high rate of 0.41 trips/units was for a smaller building with the remaining seven buildings generating between 0.06 and 0.18 trips per units.

Office: - The rates determined in the Norwest Business Park Master Plan Study (Gennaoui, 2003) for office of 1.68 and 1.41 trips per 100 m^2 GFA for morning and afternoon peak hour respectively were used to estimate the trip generation of the office component of the development.

Gymnasium: - The RTA guidelines (2002) suggest a peak rate of 9.0 trips per 100 m^2 which occur between 6.00 and 7.00pm. As this period is outside the peak on-street traffic in Norwest, a rate of 4.51 trips per hour was adopted for the morning and afternoon on-street peak hour periods. This rate was determined from a relationship developed for a study of five gymnasiums (Gennaoui, 2013).

Retail: - The rates determined in the Norwest Business Park Master Plan Study (Gennaoui, 2003) for retail of 9.9 trips per 100 m^2 GFA for afternoon peak hour were used to estimate the trip generation of this component of the development. A trip generation rate equivalent to 25 percent of the afternoon peak was adopted for the morning peak hour.

Restaurant: The restaurant/cafe would generate most of their traffic during the evening peak periods and weekends and to a lesser extent during the lunch time period. Trip generation during the morning and afternoon would be at its minimum. A nominal trip generation rate of 0.1 trips per 100 m^2 GFA has been assumed.

Child Care Centre: - The proposed development would cater for up to 50 children and will be operated five days a week by about 10 staff including the manager at any one time, from 7.00am to 6.30pm. Trip generation rates published by the RMS (RTA, 2002) of 0.80 and 0.7 trips per child were used to estimate the number of trips likely to be generated by the proposed long day Childcare centre during the morning and afternoon peak hour respectively.

East of the Central roadway, the Greens development is expected to generate about 450 and 525 vehicle trips during the morning and afternoon peak hours respectively as noted in **Table 7**.

Land Use	Trip	Buildings B to F		Buildings G to J		Buildings A1 and A2		Buildings A3		Total
AM Peak	**Rates**	**Units/m^2**	**Trips**	**Units /m^2**	**Trips**	**Units /m^2**	**Trips**	**Units /m^2**	**Trips**	
Residential	0.32	578	**185**	286	**92**	100	**32**	76	**24**	**333**
Commercial										
Office	1.68	2,000	34							**34**
Gymnasium	4.51	1,500	68							**68**
Retail	2.5	1,100	28					400	10	**38**
Restaurant	1	900	9							**9**
Child Care Centre#		500	40							**40**
Total Commercial		**6,000**	**178**		**0**		**0**		**10**	**188**
Total GFA m^2			**363**		**92**		**32**		**34**	**521**
PM Peak		**Units/m^2**	**Trips**	**Units /m^2**	**Trips**	**Units /m^2**	**Trips**	**Units /m^2**	**Trips**	
Residential	0.32	578	185	286	92	100	32	76	24	**333**
Commercial Trips per 100m^2										
Office	1.41	2,000	28							**28**
Gymnasium	4.51	1,500	68							**68**
Retail	10	1,100	110					400	40	**150**
Restaurant	1.0	900	9							**9**
Child Care Centre#	0.7	500	35							**35**
Total Commercial		**6,000**	**250**		**0**		**0**		**40**	**290**
Total GFA m^2			**435**		**92**		**32**	**400**	**64**	**623**

No of children in child care centre is 50. Trips are 0.8 per child for AM, and 0.7 per child PM

Table 7: Trip Generation of Proposed Development East of Central Roadway

4.1.2 Trip Distribution and Assignment

The median in Solent Circuit will be retained along the whole length of the development thus restricting all direct access to the estate to left turn in and out only.

Furthermore, it has been assumed that traffic signals proposed at the intersection of Solent Circuit east with Norwest Boulevard would be in place at which time the right turning movement from Solent Circuit east into Norwest Boulevard would be permitted. It has further been assumed that the planned replacement of the roundabout at the intersection of Norwest Boulevard with Solent Circuit and Reston Grange with traffic signals is completed.

The route distribution for approaching and departing traffic, included in **Table 8**, was adopted to assign the additional traffic to the road network. The distribution adopted in previous studies has been slightly adjusted to include the Fairway Drive access to Norwest.

Approach Routes	AM Peak		PM Peak	
	Arr	Dep	Arr	Dep
From the west Norwest Bvd, Solent Ct	25%	38%	38%	23%
Reston Grange, Solent Ct	17%	10%	10%	16%
Windsor Rd (N), Norwest Bvd, Solent Ct	28%	17%	17%	26%
Windsor Rd (S), Norwest Bvd, Solent Ct	15%	20%	20%	23%
Fairway Dr, Solent Ct	5%	5%	5%	5%
Sub-Total	**90.0%**	**90.0%**	**90.0%**	**90.0%**
Market Town	3%	5%	3%	5%
Brookhollow Ave Businesses	3%	1%	3%	1%
Business west of Solent Ct	4%	4%	4%	4%
Sub-Total	**10%**	**10%**	**10%**	**10%**
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 8: Peak Trip Distribution for Proposed Development

The distribution in **Table 8** was then applied to the trips generated by developments within "The Greens" to derive the origin and distribution of trips as presented in **Table 9**. Traffic was then assigned to the road network as follows:

- Vehicular access to and from Buildings B to F will be off Solent Circuit;
- Vehicular access to and from Buildings G to J will be off Spurway Drive;
- Vehicular access to and from Buildings A1 and A2 will be off Solent Circuit;
- Vehicular access to and from Buildings A3 will be off the link roadway to Rosetta Crescent which connects to Spurway Drive;
- All traffic travelling to the west of the development would either use the proposed right turn from Solent Circuit east to Norwest Boulevard or make a U-turn at the Mailtand Place roundabout;
- Traffic accessing Buildings B to F arriving from the east of the development would have the choice to travel along Norwest Boulevard and either turn right at the roundabout at Reston Grange or turn right at the eastern arm of Solent Circuit then do a U-turn at the roundabout at Fairway Drive to gain access to the proposed development; the latter is more likely and was used;
- Traffic arriving to buildings G to J from the south or departing those buildings to the north would use Windsor Road and Spurway Drive;
- Traffic to Fairway Drive, would access Solent Circuit, then U turn at the Maitland Place roundabout to access Fairway Drive.

Approach Routes	Buildings B to F		Buildings G to J		Building A1&2		Building A3	
Morning Peak	**Arr**	**Dep**	**Arr**	**Dep**	**Arr**	**Dep**	**Arr**	**Dep**
From the West Norwest Bvd, Solent Ct	38	79	7	24	2	9	5	5
Reston Grange, Solent Ct	26	21	5	6	2	2	1	4
Windsor Rd (N), Norwest Bvd, Solent Ct	43	36	8	11	3	4	2	5
Windsor Rd (S), Norwest Bvd, Solent Ct	23	42	4	13	1	4	2	5
Fairway Dr, Solent Ct	8	10	1	3	0	1	1	1
Sub-Total	**136**	**188**	**25**	**57**	**8**	**20**	**11**	**20**
Market Town	5	10	1	3	0	0	0	1
Brookhollow Ave Businesses	5	2	1	1	0	0	0	0
Business West of Solent Ct	6	8	1	3	0	1	0	1
Sub-Total	**16**	**20**	**3**	**7**	**1**	**1**	**1**	**2**
Total	**152**	**208**	**28**	**64**	**9**	**21**	**12**	**22**
Afternoon Peak	**Arr**	**Dep**	**Arr**	**Dep**	**Arr**	**Dep**	**Arr**	**Dep**
From the West Norwest Bvd, Solent Ct	87	47	21	8	5	5	13	7
Reston Grange, Solent Ct	23	33	5	6	3	1	3	5
Windsor Rd (N), Norwest Bvd, Solent Ct	39	47	9	8	5	2	6	7
Windsor Rd (S), Norwest Bvd, Solent Ct	46	47	11	8	3	3	7	7
Fairway Dr, Solent Ct	12	10	3	2	1	1	2	1
Sub-Total	**207**	**184**	**50**	**32**	**17**	**12**	**31**	**27**
Market Town	7	10	2	2	1	1	1	1
Brookhollow Ave Businesses	7	2	2	0	1	0	1	0
Business West of Solent Ct	9	8	2	1	1	1	1	1
Sub-Total	**23**	**20**	**6**	**3**	**3**	**2**	**3**	**2**
Total	**230**	**204**	**56**	**35**	**20**	**14**	**34**	**29**

Table 9: Peak Trip Distribution of Proposed Development

4.2 Traffic Impact of Proposed Development

4.2.1 Impact on Major Approach Roads

The carriageway traffic volumes along Solent Circuit and other major approach roads are summarised in **Table 10**, together with their appropriate level of service, for traffic conditions including the proposed Greens Estate development.

The proposed development will only marginally affect the level of service of all major approach roads to the site. Solent Circuit would continue to operate at Level of Service "A". The section of Norwest Boulevard between Windsor Road and Columbia Place would operate at level of service "B". All other roads would continue to operate at their current levels of service.

Location	Lanes	AM Peak			PM Peak		
		East/ North	South/ West	LoS	East/ North	South/ West	LoS
Solent Circuit							
Norwest Bvd to Inglewood Pl	4DP	781	372	A	395	567	A
West of Fairway Dr	4DP	312	453	A	619	384	A
East of Fairway Dr	4DP	390	195	A	471	327	A
Norwest Bvd to Maitland Ct	4DP	418	334	A	181	540	A
Spurway Drive							
Adjacent to Buildings G to J	2U	33	56	A	54	35	A
Norwest Boulevard*							
Windsor Rd to Columbia.	*4DCL*	*934*	*2723*	*C*			
					2353	*1412*	*B*
Columbia to Solent Cir (east)	*4DCL*	*919*	*2066*	*A*	*1736*	*1235*	*A*
West of Solent Cir (east)	*4DCL*	*876*	*1954*	*A*	*1363*	*1221*	*A*
Brookhollow to Reston Gr	*4DCL*	*1229*	*1844*	*A*	*1572*	*1613*	*A*
Solent Cir to Westwood Dr	*4DCL*	*1294*	*1943*	*A*	*1852*	*1648*	*A*
Windsor Road							
North of Norwest Boulevard	*4DCL*	*823*	*2590*	*B*	*2252*	*1430*	*A*
South of Norwest Boulevard	*4DCL*	*1613*	*1591*	*A*	*1591*	*1710*	*A*

4DCL 4 lanes divided carriageway with clearway and limited access and limited intersections
4DP 4 lanes divided carriageway with parking
4UC 4 lanes undivided carriageway with clearway
2UC 2 wide lanes with clearway and limited access
Interrupted flows Uninterrupted Flows

Table 10: Carriageway Level of Service with The Greens Development

4.2.2 Impact on Critical Intersections

For the purpose of this assessment, it has been assumed, as described above, that traffic signals will be in place at the intersections of Norwest Boulevard with Solent Circuit east, and with Reston Grange and Solent circuit. An analysis of the operation of the four intersections likely to be affected by the proposed expanded development was also carried out using the SIDRA computer intersection modelling program. The results of this analysis are summarised in **Table 11** and also included in **Appendix D.**

Intersection	AM		PM	
	Delay sec/v	LoS	Delay sec/v	LoS
Traffic Signals				
Norwest Boulevard with:				
■ Windsor Road	33.6	C	42.7	D
■ Solent Circuit (east)	17.9	B	14.9	B
■ Solent Circuit Reston Grange	29.2	C	28.0	B/C
Roundabouts				
Solent Circuit with:				
■ Fairway Drive	13.4	A	14.1	A/B

Table 11: Operation of Intersections with Developments

The roundabout at the intersection of Fairway Drive with Solent Circuit would continue to at a good Level of Service "B" or better.

The traffic signals at the intersection of Norwest Boulevard with Windsor Road would continue to operate at a satisfactory level of service "C" during both the morning and afternoon peak periods.

A signalised intersection of Solent Circuit East with Norwest Boulevard would operate in the future at a level of service B during the morning peak and the afternoon peak.

The replacement of the roundabout controlling the intersection of Norwest Boulevard with Solent Circuit and Reston Grange with traffic signals would operate at a satisfactory level of service "C" during the morning and afternoon peak periods.

5. Summary and Conclusions

5.1 Access and Parking

Mulpha-Norwest is currently seeking to amend the approved Master Plan to provide some 864 new apartments in nine buildings to the east of the Central roadway which would also include the provision of 2,000 m^2 of offices, a 1,500 m^2 Gymnasium, retail and restaurant/coffee covering 2,000 m^2 and a Child Care Centre catering for 50 children (500 m^2 GFA). The total number of units including the approved Buildings A1 to A3 is anticipated to be 1,040 on the site.

All tenant and visitors parking spaces needed for the development would be provided on-site. The nine buildings will accommodate 1,508 tenant and visitor spaces for the residential component, and some 253 spaces for the commercial component.

5.2 Traffic Impact

The proposed Greens development east of the Central roadway is expected to generate about 450 and 525 vehicle trips during the morning and afternoon peak hours respectively. Including the trip generation of Buildings A1 to A3, already approved, a total of about 520 and 620 trips are likely to be generated during the morning and afternoon peak hours respectively.

The proposed development will only marginally affect the level of service of all major approach roads to the site. Solent Circuit would continue to operate at Level of Service "A". The section of Norwest Boulevard between Windsor Road and Columbia Place would operate at level of service "B". All other roads would continue to operate at their current levels of service.

The proposed development would not adversely affect the current operation of the intersections of Norwest Boulevard with Windsor Road and of Solent Circuit with Fairway Drive.

The provision of traffic signals at the intersections of Norwest Boulevard with Solent Circuit East and with Reston Grange and Solent Circuit East would result in considerably improved conditions in the future.

5.3 Conclusions

The Greens Proposal would only have a minor impact on the road network.

Therefore, there are no traffic reasons why, with the recommended improvement works, approval should not be granted for the Planning Proposal and Master Plan.

6. References

Baulkham Hills Council (2004). "Development Control Plan No 12 Parking". September.

Gennaoui Consulting Pty Ltd (2003). "Traffic Master Plan – Norwest Business Park." Norwest Limited and Baulkham Hills Shire Council. May. Sydney.

Gennaoui Consulting Pty Ltd (2013). "Plus Fitness Studios – Parking Demand Study." Australian Fitness Management. January.

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

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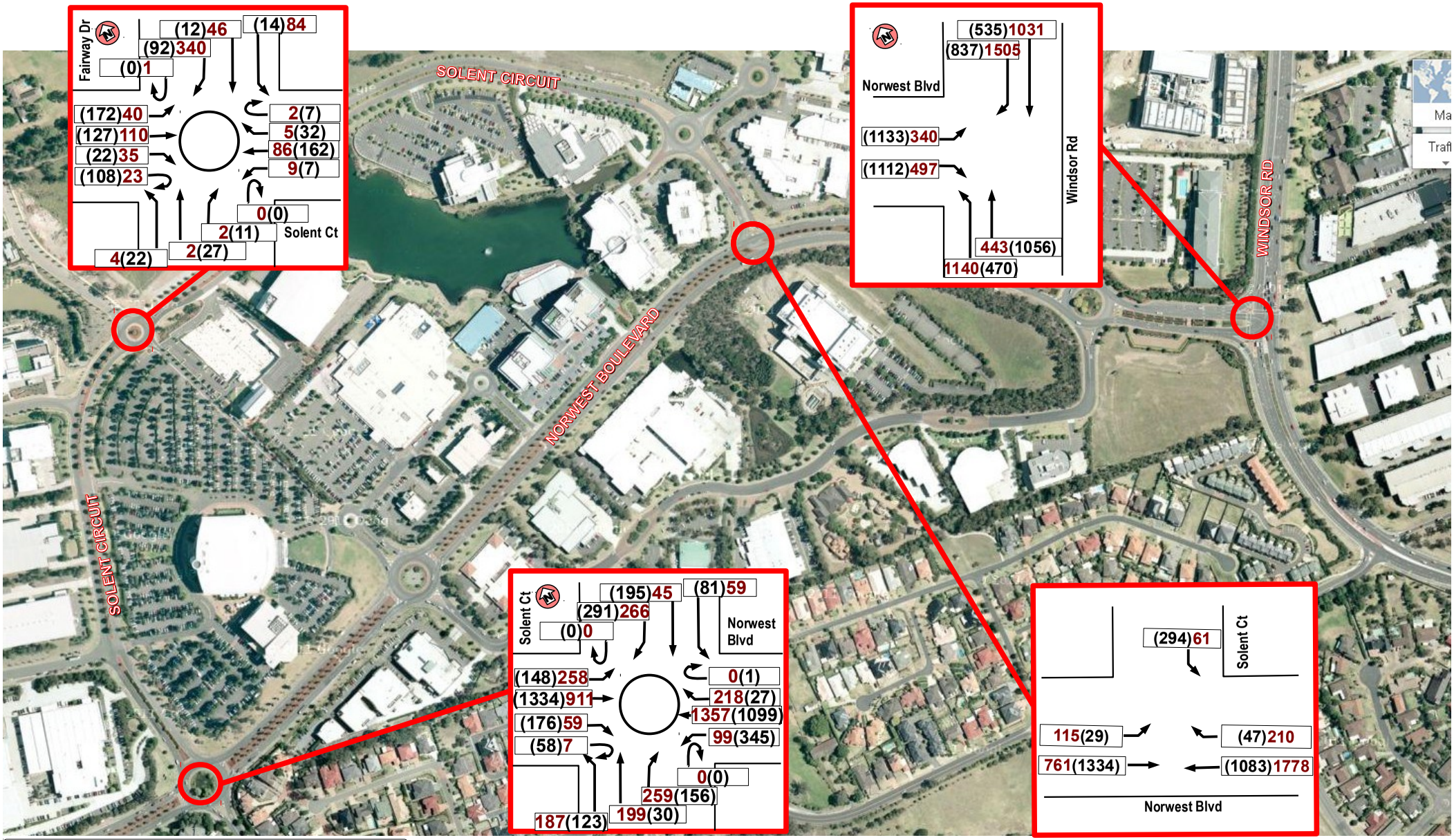
Appendix A

Existing Traffic Volumes

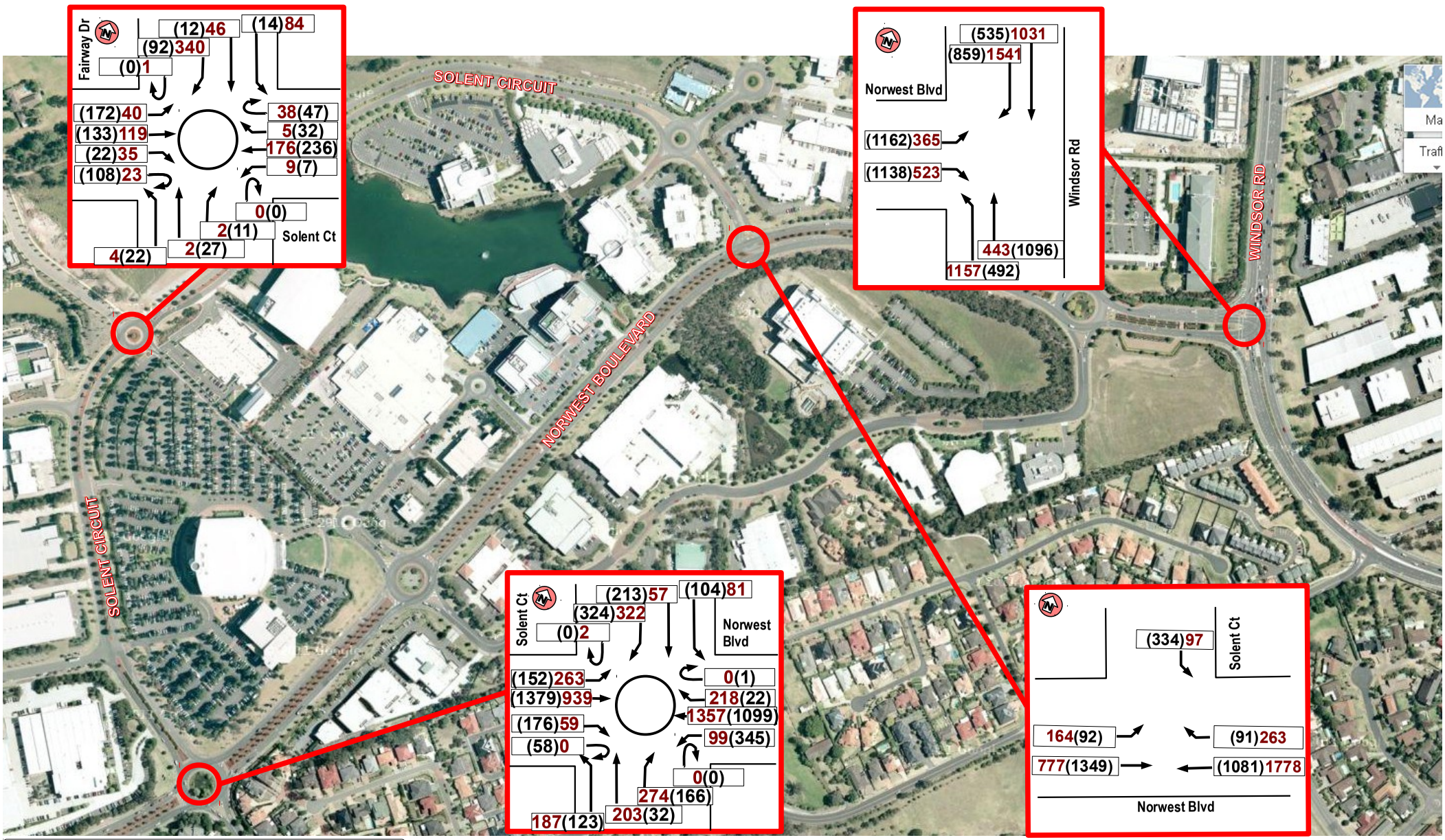


LEGEND

000(000) – AM(PM) flows, veh/hr

AM (8:00 am – 9:00 am)
PM (4:30 pm – 5:30 pm)

Figure 1
Existing Volumes



LEGEND

000(000) – AM(PM) flows, veh/hr

AM (8:00 am – 9:00 am)
PM (4:30 pm – 5:30 pm)

Figure 2
With Future Proposed Development

Appendix B

Concept of Carriageway Capacity and Level of Service

The capacity of major streets within an urban area can be based on an assessment of their operating Level of Service. Level of service is defined by NAASRA (1988) as a "qualitative measure of the effects of a number of features, which include speed and travel time, traffic interruptions, freedom to manoeuvre, safety, driving comfort and convenience, and operating costs. Levels of service are designated from A to F from best (free flow conditions) to worst (forced flow with stop start operation, long queues and delays) as follows:

***LEVELS OF SERVICE**

A - Free flow (almost no delays);

B - Stable flow (slight delays);

C - Stable flow (acceptable delays);

D - Approaching unstable flow(tolerable delays);

E - Unstable flow(congestion; intolerable delays); and

F - Forced flow (jammed).

A service volume, as defined by Austroads, is the maximum number of vehicles that can pass over a given section of roadway in one direction during one hour while operating conditions are maintained at a specified level of service. It is suggested that ideally arterial and sub-arterial roads should not exceed service volumes at level of service C. At this level, whilst most drivers are restricted in their freedom to manoeuvre, operating speeds are still reasonable and acceptable delays experienced. However, in urban situations, arterial and sub-arterial roads operating at Level of Service D are still considered adequate. Traffic Volumes along urban roads with interrupted and uninterrupted flow conditions are included in Table B1 and B2 respectively.

Description	Level of Service					
	A	B	C	D	E	F
2 Lane Undivided	540	630	710	810	900	F
4 Lane Undivided	900	1050	1200	1350	1500	O
4 Lane Undivided with Clearways	1080	1260	1440	1620	1800	R
4 Lane Divided with Clearways	1140	1330	1520	1710	1900	C
4 Lane Divided with Clearways, Limited Access and Limited Intersections	1610	1870	2140	2410	2670	E
6 Lane Undivided	1440	1680	1920	2160	2400	D
6 Lane Divided with Clearway	1740	2030	2320	2610	2900	

Table B1: Level of Service Interrupted Flow Conditions along Urban Roads (One Way Hourly Volumes)

Description	Level of Service					
	A	B	C	D	E	F
4 Lane Undivided (13m)	1260	1470	1680	1890	2100	O
4 Lane Undivided with Clearways	1510	1760	2010	2270	2520	R
4 Lane Divided with Clearways	1600	1860	2130	2400	2660	C
4 Lane Divided with Clearways, Limited Access and limited intersections	2250	2620	3000	3380	3740	D
6 Lane Undivided	2020	2350	2690	3020	3360	D
6 Lane Divided with Clearway	2440	2840	3250	3660	4060	
6 Lane Divided with Clearways, Limited Access and Limited Intersections	3375	3930	4500	5070	5610	

* 40% higher than base volumes in Table C1

Table B2: Level of Service Uninterrupted Flow Conditions along Urban Roads (One Way Hourly Volumes)

Appendix C

Guidelines for Evaluation of Intersection Capacity

The RTA has included in the "Guide to Traffic Generating Developments" (Dec 1993, 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 (seconds/veh) (all forms of control)
(b) delay to critical movement (seconds/veh) (all forms of control)
(c) degree of saturation (traffic signals and roundabouts)
(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 - control 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 which 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 C1 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 C1. In assigning a level of service, the average delay to the motoring public needs 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 D1 provides a recommended baseline for assessment.

Level of Service	Average Delay per Vehicle (seconds/veh)	Traffic Signals, Roundabout	Give Way and Stop Signs
A	less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 - 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and 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

Table C1: Level of Service Criteria for Intersections

The figures in **Table C1** 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 C2**.

Level Of Service	Optimum Cycle Length (Seconds) (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 required	>140	>0.85	> 0.90

Table C2: Criteria for Evaluating Capacity Of Signalised Intersections*

** Source: Roads & Traffic Authority (2002)*