Warringah Council

Dee Why Town Centre Traffic Model Update

Traffic Modelling Report

13 October 2014

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The evaluation of the proposed traffic management option has been undertaken on the basis of traffic performance only. The evaluation of options does not include an analysis of constructability, road safety, accessibility, engineering constraints or capital costs.

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1. Introduction

1.1 Background

GHD has been commissioned by Warringah Council to update the Dee Why Town Centre Traffic Model. This report comprises the initial testing of the revised 'Base Case' and 'Option 2A2' Paramics models previously prepared by GTA Consultants in 2007 to identify potential changes in road network performance as a result development that could be realised under the Dee Why Masterplan. This includes testing of the assumed mix of commercial, residential and retail land uses within Dee Why that are currently permissible under the Warringah LEP.

1.2 Purpose of this report

The purpose of this study is to determine the level of development in Dee Why Town Centre that can be accommodated under the Option 2A2 scenario road network under a revised set of land use assumptions reflecting likely market take-up. This report documents the changes in traffic conditions throughout the Dee Why Town Centre a under range of development densities and using a new mix of land uses with substantially less commercial development.

The model has been developed using the Paramics micro simulation traffic modelling software suite and has been calibrated and validated according to the methodology set out in the *RMS Traffic Modelling Guidelines, 2013.* This calibrated model has been used to test the impacts of likely development under the Warringah LEP 2011 on the basis of performance measures including travel times and intersection Levels of Service under existing, and forecast traffic flows.

1.3 Limitations and Assumptions

As is normal in traffic modelling studies, the scope of this work entails a number of limitations and assumptions on the latitude of this study. The main limitations and assumptions include:

- Traffic count data collected by SkyHigh for Thursday AM and PM peak periods (including turning movement counts, travel time surveys and origin-destination surveys) are a true and accurate representation of existing traffic conditions along Pittwater Road;
- Traffic demand for the Saturday peak period has been determined by applying the growth factor between the surveys conducted by GTA in 2007 and the surveys conducted in 2013 to GTA's surveyed traffic flows for the Saturday peak.
- Information relating to changes in land use provided by Warringah Council for the Cobalt, Woolworths and PCYC sites is correct;
- Traffic generation rates for approved and pending development applications are based on the rates used by GTA Consultants and outlined in their original traffic report.
- Signal timing data provided by RMS is correct (confirmed by site visits);
- Revised intersection arrangements for the proposed option including traffic signal phasing have been taken from the original traffic models produced by GTA Consultants in 2007;
- The right-turn into the Dee Why Hotel development from Pacific Parade West that was originally banned in GTA's traffic model has been permitted to reflect existing traffic conditions (confirmed by site visits);
- The Option 2A2 AM peak modelling scenario has been developed based on GTA's Option 2A2 PM model incorporating updated traffic demand and optimized signal timing; and

- Does not include modelling of cycleways or mid-block pedestrian crossings.

1.4 Report Structure

This report is structured as follows:

- Model Revision and Update – Outlines the scope and methodology used to revise and update the traffic model (Section 2).
- Scenario Testing – Outlines the scenarios tested as a part of this assessment (Section 3).
- Model Results – Outlines the results of scenario testing (Section 4).
- Summary and Conclusions – Outlines the conclusions of the scenario testing and assessment process (Section 5).

2. Model Revision and Update

2.1 Overview

The Dee Why Town Centre micro simulation model was originally developed by GTA consultants in 2007. This model has been revised and updated by GHD to determine changes in traffic conditions throughout the Dee Why Town Centre as a result of increasing the proposed density of development that is currently allowed under the Warringah LEP 2011. The model has been revised and updated using the Paramics micro simulation modelling package (version 6.7.1) with additional functionality provided by the CeeJazz suite of Plugins. Version 6.7.1 G05 of Ceejazz was used, with the following Plugins active:

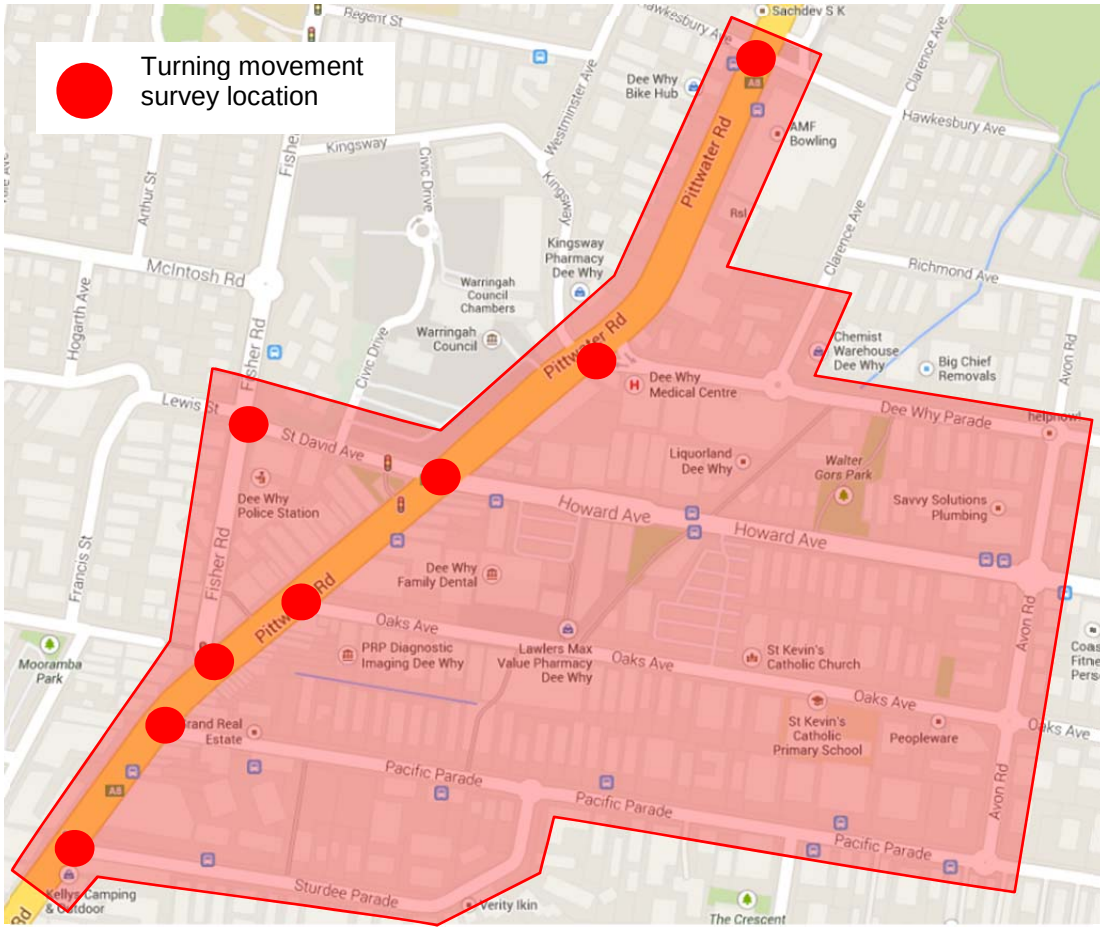
- Lane Choice;
- Validator;
- Level of Service; and
- Trailmaker.

Of these Plugins, only the Lane Choice Plugin has an effect on the model operation, while the other Plugins are used only for reporting purposes.

2.2 Model Extents

The Dee Why Town Centre micro simulation traffic model covers the Dee Why Town Centre bounded by Francis Street in the West, Avon Road in the East, Hawkesbury Avenue in the North and Sturdee Parade in the South. A map of the study area is shown in Figure 1.

Figure 1 Dee Why Town Centre Micro Simulation Model Extents



Source: Warringah Council

The Dee Why Town Centre models have been revised and updated using a synthesis of traffic data from 2013 including surveyed traffic counts and travel time surveys.

2.3 Traffic Data

Traffic data collected by SkyHigh for Thursday AM and PM peak periods was used to update the models to reflect existing traffic conditions and included:

- Classified intersection turning movement counts at the following intersections:
  - Pittwater Road – Sturdee Parade;
  - Pittwater Road – Pacific Parade;
  - Pittwater Road – Fisher Road;
  - Pittwater Road – Oaks Avenue;
  - Pittwater Road – Howard Avenue – St David Avenue;
  - Pittwater Road – Dee Why Parade – Kingsway;
  - Pittwater Road – Hawkesbury Avenue; and
  - Fisher Road – St David Avenue – Lewis Street.
- Travel time surveys undertaken along Pittwater Road between Sturdee Parade and Hawkesbury Avenue.

Since Saturday peak period surveys were not undertaken, the traffic demand for this period was determined by applying a growth factor between the surveys conducted by GTA in 2007 and the surveys conducted in 2013 to GTA's surveyed traffic flows for the Saturday peak.

In addition to the traffic survey data, signal timing data provided by RMS was used in the model calibration and validation process.

2.4 Temporal Coverage

The Dee Why Town Centre micro simulation traffic model covers the following time periods:

- Weekday AM peak (07:00 to 09:00)
- Weekday PM peak (16:00 to 18:00)
- Saturday midday peak (10:00 to 12:00)

These time periods have been updated to represent the intersection survey periods and consist of a “warm-up” hour, which is used to allow the model to reach typical congested traffic conditions during the analysis period (second hour).

2.5 Model Calibration and Validation

Calibration and validation of the Dee Why Town Centre micro simulation model has been undertaken according to the methodology set out in the RMS Traffic Modelling Guidelines, 2013. The results of this process indicate that the model is well-calibrated and validated and meets the standards outlined in the guidelines. A detailed outline of the calibration and validation process used in the development of the Dee Why Town Centre Model is included in Appendix A.

3. Scenario Testing

3.1 Overview

The Base Case and Option 2A2 models originally produced by GTA Consultants in 2007 have been modified and updated to reflect 2013 traffic conditions, optimised signal arrangements and changes in land use proposed by Warringah Council.

The traffic modelling for the scenarios detailed below was undertaken for the AM, PM and Saturday peak periods. This is in contrast to the traffic modelling undertaken by GTA, which only considered the weekday PM and Saturday peak periods.

3.2 Road Network Options

The following road network configurations were tested as part of the modelling process.

3.2.1 Base Case (Existing Road Network)

The base case modelling scenario assumes that no changes will be made to the road network. The models have been revised and tested based on changes in traffic demand identified by traffic count surveys conducted by SkyHigh in October 2013, for the AM, PM and Saturday peak periods.

3.2.2 Option 2A2

Option 2A2 incorporates a one-way road system eastbound on Oaks Avenue and westbound on Howard Avenue. All traffic management measures included in the Option 2A2 road network remains consistent with that originally modelled by GTA, with the exception of the removal of a right-turn ban from Pacific Parade West into the Dee Why Hotel development.

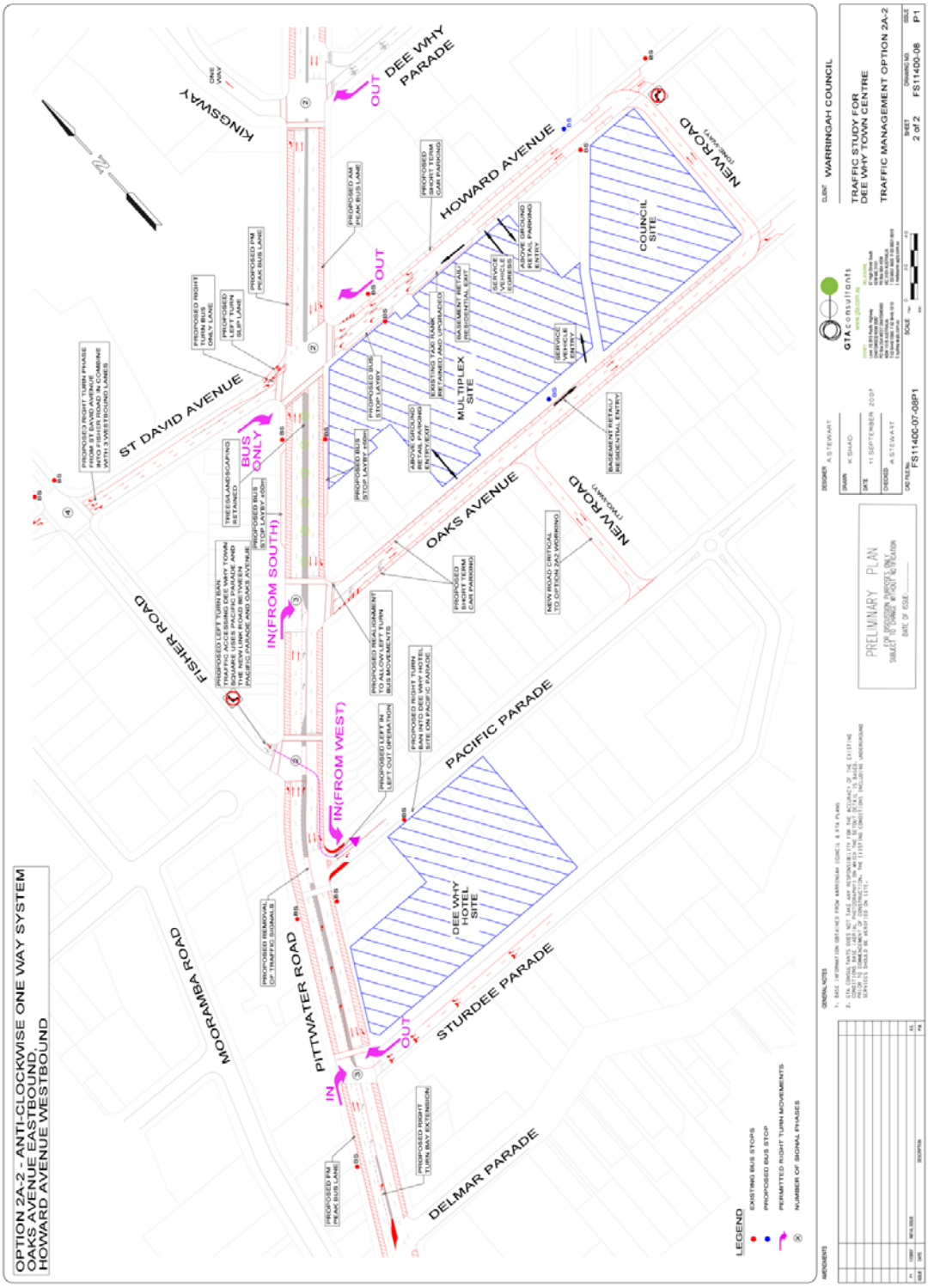
In summary, Option 2A2 applies the following traffic management measures to the existing road network:

- The removal of traffic signals at the intersection of Pacific Parade and Pittwater Road and conversion to a left-in left-out priority controlled intersection arrangement;
- The establishment of a one-way anti-clockwise road system that runs eastbound along Oaks Avenue and westbound on Howard Avenue. This system includes a one-way northbound road link that runs between Oaks Avenue and Howard Avenue.
- The addition of a right-turn signal phase from Sturdee Parade into Pittwater Road.
- The extension of the right-turn bay on the southern approach of Pittwater Road and Sturdee Parade;
- The removal of the right turn from Delmar Parade onto Pittwater Road;
- The establishment of four-phase signal arrangement at the intersection of Pittwater Road and Fisher Road;
- The establishment of a bus-only right-turn bay from St David Avenue onto Pittwater Road;
- The establishment of a left-slip lane from St David Avenue onto Pittwater Road;
- Removal of parking on the southern kerb of Sturdee Parade;
- Restriction of parking during the Saturday peak along the eastern kerb of Fisher Road between Pittwater Road and St David Avenue;

- The right-turn into the Dee Why Hotel development from Pacific Parade West that was originally banned in GTA's traffic model has been permitted to reflect existing traffic conditions (confirmed by site visits); and
- Altering the geometry of the north-eastern corner of the intersection of Oaks Avenue and Pittwater Road to permit left turn bus movements from the northern approach of Pittwater Road into Oaks Avenue.

A preliminary plan showing road network arrangements under Option 2A2 is provided in Figure 2.

Figure 2 Option 2A2 Preliminary Plan



During the revision of the Option 2A2 model, the removal of the road link between Pacific Parade and Oaks Avenue (originally proposed by GTA Consultants as a part of the Option 2A2 scheme) was tested to determine if the one-way road system would perform adequately without this link. Further testing showed that the road link is essential to the operation of the one-way road system, and its removal results in network-wide congestion under all modelling scenarios. This is consistent with the original assumptions made by GTA Consultants.

3.2.3 Inclusion of Signalised Pedestrian Crossing under Option 2A2

Option 2A2 would require the replacement of the existing marked pedestrian crossings on Oaks Avenue and Howard Avenue with mid-block signalised pedestrian crossings. This was not documented within the original GTA report, and these pedestrian crossings were not part of the original model developed by GTA. Paramics does not model unsignalised pedestrian crossings and no data was available regarding the demand at these crossings.

It is expected that the provision of signalised pedestrian crossings on Howard Avenue and Oaks Avenue will formalise pedestrians crossing opportunities and improve safety pedestrian safety, particularly on these proposed one-way streets. These signalised crossings can be coordinated with traffic signals on Pittwater Road to streamline traffic flow and reduce interruption of traffic flow through the one way system.

The introduction of signalised pedestrian crossing on Howard Avenue and Oaks Avenue needs to be further investigated to ascertain the likely traffic implications.

3.2.4 Inclusion of Cycling Lane on Howard Avenue under Option 2A2

The modelling results indicate Howard Avenue is approaching capacity during the AM peak period. In order for the intersection of Howard Avenue and Pittwater Road to operate satisfactorily under Option 2A2, the proposed lane configuration on the Howard Avenue East will require three westbound lanes.

The inclusion of a cycle lane in Howard Avenue will either require the removal of parking or a traffic lane. The latter will have a detrimental effect on the road carrying capacity of Howard Avenue. The other option will be to reduce the footpath width on Howard Avenue to accommodate a cycle lane.

3.2.5 Pacific Parade Swept Path Analysis

A swept path analysis was undertaken for rigid and articulated heavy vehicles turning left from Pittwater Road north into Pacific Parade, plots of which are provided in Appendix E. This analysis determined that due to the physical constraints of the intersection, rigid and articulated heavy vehicles would not be able to complete the left turn manoeuvre unless significant modifications are made to the north-east corner of the intersection to widen the road. If road widening is not undertaken, then any developments along Pacific Parade that are serviced by heavy vehicles need to consider that heavy vehicles will not be able to complete the left-turn manoeuvre from Pittwater Road north. In order to maintain heavy vehicle access along Pacific Parade, these developments would need to arrange alternative access routes for the heavy vehicles; or road widening at the intersection of Pittwater Road and Pacific Parade will need to be undertaken.

3.3 Land Use Options

The land use options tested within the model are described below.

3.3.1 Approved and Pending Development Applications S

Of the identified development applications within the study area, 12 have received Council approval with 5 still pending. The trip generation for the majority of these sites remains consistent with what was originally assumed by GTA Consultants in 2007 and is provided in Appendix C. These trips were assigned to the model based on the spatial distribution assumptions outlined in Section 3.2.

The trip generation for the Woolworths site (27-33 Oaks Avenue) and associated pass-by traffic has been determined based on the land use information provided in the 'Preliminary Redevelopments Concepts' by Marchese Partners (10/09/2012) and the traffic generation rates originally used by GTA consultants in 2007 (presented in Table 1) and is consistent with assumptions provided by Council.

Recent development applications for Woolworths and Cobalt sites have indicated that there is reduced market demand for commercial space within Dee Why Town Centre, with both these development applications proposing no commercial space and a single floor of retail. As residential land uses generally generate fewer trips for the same developable area than commercial trips, the change in land use assumptions from commercial to residential development present the opportunity to develop these sites with greater floor area for the same traffic impact.

3.3.2 Potential LEP Development

A total of 43 sites (listed in Appendix D) have been earmarked by Council for potential development under the Warringah LEP 2011. Some of these sites fall outside what is considered the 'town centre' under the Dee Why Masterplan, but been included as part of trip generation associated with potential LEP developments (refer to Figure 3) as agreed with Warringah Council. The trip generation for these sites is provided in Appendix D and the trip generation rates are provided in Table 1.

The traffic generation for potential LEP developments has been determined based on the assumption that all sites are to comprise the following land-use mix:

- Zero (0) floors of commercial GFA,
- One (1) floor of retail GFA (ground floor)
- Remaining floors assumed to be residential.

The above assumptions reflect the changing trend in market demand away from commercial development and towards residential development (also identified in Section 3.3.1). The aforementioned land-use assumptions were applied to all of the potential LEP developments in the study area, resulting in the following split of GFA by land use type:

- 0% Commercial
- 18% Retail
- 82% Residential

The traffic generation estimated as a part of this exercise differs significantly from that originally estimated by GTA. This difference in traffic generation can be attributed to the following changes:

- Adoption of the updated trip generation rates as prescribed by Roads and Maritime Services NSW in 2013.
- Changes in land-use mix assumptions, as detailed above.

Further sensitivity testing was undertaken to test the capacity of the road network under the current Warringah LEP 2011. This was achieved by increasing the floor-to-space (FSR) ratio for 25 sites within the Dee Why Town Centre by a nominated percentage. Accordingly, the increase in traffic generation for each of the subsequent scenarios (i.e FSR 105, FSR 110) correlates to the percentage increase in FSR. The sites identified within the Dee Why Town Centre for which the FSR were increased are also shown in Appendix D.

The increase in the FSR was then applied uniformly across all of the potential development sites within the Dee Why Town Centre study area, and the resulting traffic was assigned to the model based on the directional and distribution splits outlined in Section 3.2.

Traffic generation for the proposed PCYC development (36-48 Kingsway) has been determined based on the land use information provided in the 'PCYC Project and Car Park Redevelopment, Dee Why Traffic Impact Assessment' by Bitzios Consulting (page 7) updated traffic generation rates (presented in Table 1), and is consistent with assumptions defined by Council.

Figure 3 Location of LEP Developments outside of Dee Why Town Centre

Source: Warringah Council, 2012 modified by GHD

3.3.3 Trip Generation Rates

The following table provides a summary of the trip generation rates used in the development of the models. It compares the old rates originally used by GTA Consultants in 2007 with the updated trip generation rates as prescribed by Roads and Maritime Services NSW in 2013.

Table 1 Trip Generation Rates

Peak	Residential (Trips per Unit Dwelling)			Commercial (Trips/GFA)	Retail (Trips/GLFA)	School (veh/stu)
	House	High Density Sub-metro	Aged/Disabled Housing			
GTA Trip Generation Rates						
AM	0.85	0.29	0.2	0.02	0.01	0.8
PM	0.85	0.29	0.2	0.02	0.04	0.7
Saturday	0.425	0.145	0.1	0	0.052	0
Updated Trip Generation Rates						
AM	0.95	0.19	0.4	0.016	0.046	0.8
PM	0.99	0.15	0.4	0.012	0.046	0.7
Saturday	0.495	0.075	0.2	0	0.061	0

The update of trip generation rates has resulted in a reduction in the number of trips generated by high-density residential dwellings, and an increase in the number of retail trips. With respect to revisions to the Dee Why Masterplan, the replacement of commercial units with high-density residential dwellings has resulted in a reduction in the overall trip generation associated with potential LEP developments.

Directional Distribution

The directional distributions used by GHD in updating the traffic generation are consistent with the original assumptions used by GTA Consultants in 2007. The directional distribution for AM, PM and Saturday peaks is shown in Table 2.

Table 2 Directional Distribution Rates

Period	Residential	Commercial	Retail
AM, PM and Saturday			
North	15%	40%	40%
East	15%	20%	20%
South	40%	20%	20%
West	30%	20%	20%

Directional Split

The directional split used by GHD to determine inbound and outbound trips remains consistent with those originally used by GTA Consultants in 2007. The directional splits for incoming and outgoing vehicle trips are shown in Table 3.

Table 3 Directional Split for Incoming and Outgoing Vehicles

Period	Residential	Commercial	Retail
Incoming			
AM	20%	90%	90%
PM	60%	10%	50%
Saturday	50%	-	50%
Outgoing			
AM	80%	10%	10%
PM	40%	90%	50%
Saturday	50%	-	50%

3.4 Scenario Tests

Traffic model 'Option 2A2' was used by GHD as the basis for further scenario testing, with each scenario being assessed for AM, PM and Saturday peak period traffic conditions. The scenarios that were tested using the 'Base Case' and 'Option 2A2' models include the following:

- Scenario 1: Existing traffic network with 2013 surveyed traffic flows;
- Scenario 2: 'Option 2A2' with 2013 surveyed traffic flows + traffic demand derived from approved and pending development applications;
- Scenario 3: 'Option 2A2' with 2013 surveyed traffic flows + traffic demand derived from approved and pending development applications + traffic demand derived from full (100%) LEP development;
- Scenario 4: 'Option 2A2' with 2013 surveyed traffic flows + traffic demand derived from approved and pending development applications + traffic demand derived from 105% of the full LEP development; and
- Scenario 5: 'Option 2A2' with 2013 surveyed traffic flows + traffic demand derived from approved and pending development applications + traffic demand derived from 110% of the full LEP development

3.5 Trip Generation

The total trip generation associated with each of the land use options is shown in Table 4.

Table 4 Land Use Option Total Trip Generation

Peak	Total Trip Generation
Approved and Pending Development Applications	
AM	857
PM	1,401
Saturday	1,121
LEP FSR 100%	
AM	777
PM	720
Saturday	1,122
LEP FSR 105%	
AM	798
PM	736
Saturday	1,130
LEP FSR 110%	
AM	818
PM	753
Saturday	1,138

A more detailed breakdown of the trip generation is provided in Appendix C and Appendix D. The approved and pending development applications and the LEP developments generate a similar number of trips.

4. Model Results

4.1 Overview

The Dee Why Town Centre traffic models have been evaluated as agreed with Warringah Council on the basis of the following performance measures:

- Network statistics including unreleased vehicles;
- Intersection Level of Service; and
- General traffic travel times.

Analysis of all of the scenarios tested showed that the critical peak period for the operation of the Option 2A2 network was the AM peak period, when the performance of the intersection of Pittwater Road and Howard Avenue is closest to capacity. This is in contrast to modelling work undertaken by GTA, which concentrated on the PM and Saturday peak periods only, and which has overlooked this critical period in the assessment of the capacity of the surrounding road network.

4.2 Network Statistics

Network statistics were collected for each of the models, including the following:

- Vehicle Hours of Travel (VHT);
- Vehicle Kilometres of Travel (VKT);
- Average Network Speed (km/h); and
- Total Unreleased Vehicles.

These statistics are summarised in Table 5 below.

Table 5 AM Peak Network Statistics Summary

Option	VHT (hr)	VKT (km)	Average Travel Speed (km/h)	Total Unreleased Vehicles
AM Peak				
Scenario 1: Base Case (Existing)	387	10,018	26	1
Scenario 2: Option 2A2 + DA	566	13,041	23	22
Scenario 3: Option 2A2 + DA + LEP FSR 100	713	13950	20	295
Scenario 4: Option 2A2 + DA + LEP FSR 105	711	13899	20	326
Scenario 5: Option 2A2 + DA + LEP FSR 110	721	13997	19	341
PM Peak				
Scenario 1: Base Case (Existing)	472	10,722	23	58
Scenario 2: Option 2A2 + DA	564	14,962	27	9

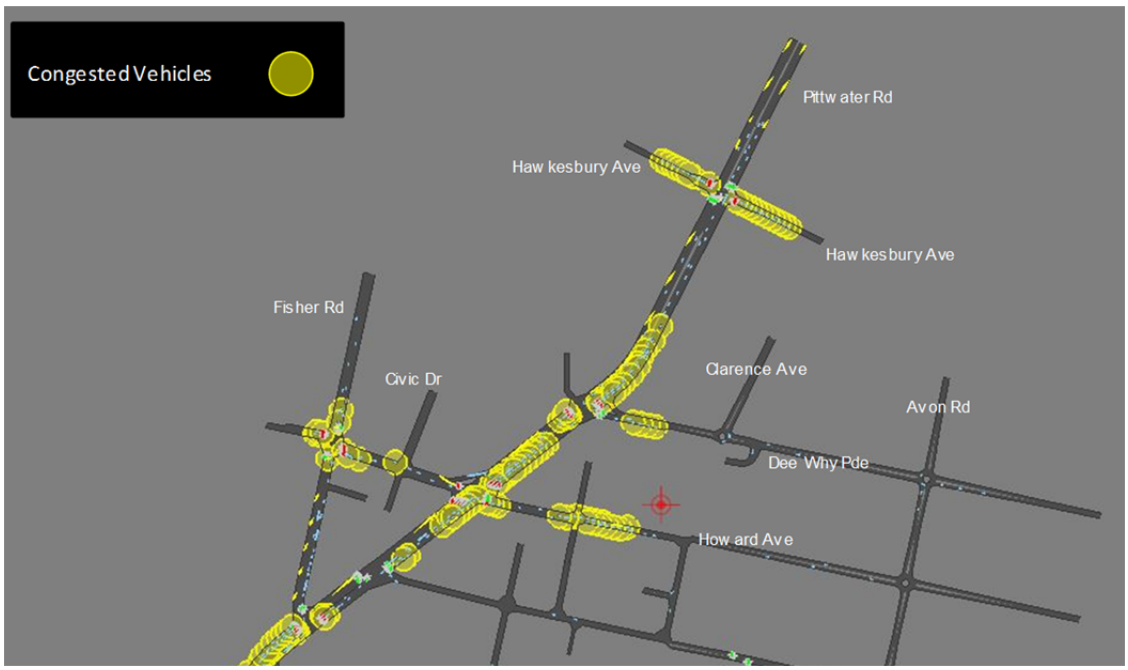
Option	VHT (hr)	VKT (km)	Average Travel Speed (km/h)	Total Unreleased Vehicles
Scenario 3: Option 2A2 + DA + LEP FSR 100	599	16016	27	11
Scenario 4: Option 2A2 + DA + LEP FSR 105	608	15995	26	16
Scenario 5: Option 2A2 + DA + LEP FSR 110	603	16041	27	8
Saturday Midday Peak				
Scenario 1: Base Case (Existing)	433	10,663	25	1
Scenario 2: Option 2A2 + DA	505	14,526	29	0
Scenario 3: Option 2A2 + DA + LEP FSR 100	657	15988	24	4
Scenario 4: Option 2A2 + DA + LEP FSR 105	660	15999	24	13
Scenario 5: Option 2A2 + DA + LEP FSR 110	656	16006	24	29

Analysis of the network statistics shows a general tendency towards increased vehicle hours and kilometres travelled across the network as a result of the introduction of traffic generated by approved and pending development applications, as well as for the potential LEP scenarios.

The number of total unreleased vehicles represents queuing at various locations throughout the Dee Why Town Centre network. The number of total unreleased vehicles increases significantly under both LEP scenarios during the AM peak, which can be attributed to changes in signal timing at the intersection of Pittwater Road and Howard Avenue. The eastern approach of Howard Avenue requires a greater proportion of green-time allocation in order to account for increased traffic as a result of the one-way road system.

The requirement to provide more phase time for east-west traffic at the intersection of Pittwater Road and Howard Avenue results in greater congestion for northbound and southbound traffic on Pittwater Road. Consequently, southbound queues on Pittwater Road tend to increase as development density through Dee Why Town Centre increases. This issue is presented in Figure 4.

Figure 4 Queuing on Pittwater Road during the AM Peak – LEP FSR 105%



Source: Paramics model output from GHD

Analysis of the AM peak LEP scenarios shows that the critical movement in the Option 2A2 network is the westbound movement from Howard Avenue at Pittwater Road. Increasing development results in larger demand and longer queues on this approach. Due to the constrained nature of the one-way pair, excess queuing on this approach will result in extensive congestion through Dee Why Town Centre. Consequently, an increase in development density will generate more traffic in the Dee Why Town Centre and this results in reduced through capacity on Pittwater Road.

It is expected that with 100 percent LEP development, Pittwater Road will have minimal spare capacity to accommodate any additional trips. The theoretical maximum level of LEP development that can be accommodated by the 'Option 2A2' road network before queuing becomes excessive and impacts on the operation of the network is in the order of 105% of full LEP development (refer to Section 3.3.2). This additional 5 percent corresponds to approximately additional 21 trips generated by the development.

Detailed impacts to intersections north of Dee Why town centre were not in the scope of this study. However, it is evident from the amount of unreleased vehicles during the AM peak hour that the network performance may be impacted by the increased number of trips generated by the development. Signal co-ordination will also play a key role in performance of Pittwater Road during the critical AM peak hour.

4.3 Intersection Performance

The assessment of intersection operation is based on criteria outlined in Table 6 as defined in the Guide to Traffic Generating Developments published by the NSW Roads and Traffic Authority (RTA) in 2002.

Table 6 Intersection Levels of Service

Level of Service	Average Delay per Vehicle	Traffic Signals and Roundabouts	Give Way and Stop Signs
A	<14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 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 will require other control mode	At capacity, requires other control mode
F	>70	Over capacity, unstable operation	Over capacity, unstable operation

Source: Guide to Traffic Generating Developments, NSW RTA (2002)

The Level of Service values at the intersections are reported for Weekday (08:00 to 09:00 and 17:00 to 18:00) and Saturday (11:00 to 12:00) peak hours for the following intersections:

- Pittwater Road/Sturdee Parade
- Pittwater Road/Pacific Parade
- Pittwater Road/Fisher Road
- Pittwater Road/Oaks Avenue
- Pittwater Road/Howard Avenue/St David Avenue
- Pittwater Road/Dee Why Parade
- Pittwater Road/Hawkesbury Street
- Pittwater Road/Fisher Road

A summary of the modelled average delays and intersection levels of service in the 'Base Case' and 'Option 2A2' networks is shown in Table 7.

Table 7 Intersection Levels of Service

Intersection	AM Peak		PM Peak		Saturday Peak	
	Av Delay (sec)	LoS	Av Delay (sec)	LoS	Av Delay (sec)	LoS
Scenario 1: Base Case (Existing)						
Pittwater Road and Sturdee Parade	17	B	32	C	16	B
Pittwater Road and Pacific Parade	12	A	17	B	16	B
Pittwater Road and Fisher Road	24	B	16	B	20	B
Pittwater Road and Oaks Avenue	13	A	8	A	16	B
Pittwater Road and Howard Avenue/St David Avenue	20	B	19	B	32	C
Pittwater Road and Dee Why Parade	21	B	18	B	19	B
Pittwater Road and Hawkesbury Street	21	B	25	B	20	B
Fisher Road and St David Avenue/Lewis Street	27	B	27	B	20	B
Scenario 2: Option 2A2 + Pending and Approved DA's						
Pittwater Road and Sturdee Parade	29	C	42	C	25	B
Pittwater Road and Pacific Parade	27	B	14	A	7	A
Pittwater Road and Fisher Road	30	C	21	B	15	B
Pittwater Road and Oaks Avenue	32	C	13	A	17	B
Pittwater Road and Howard Avenue/St David Avenue	40	C	19	B	22	B
Pittwater Road and Dee Why Parade	39	C	19	B	20	B
Pittwater Road and Hawkesbury Street	21	B	20	B	18	B
Fisher Road and St David Avenue/Lewis Street	39	C	22	B	29	C
Scenario 3: Option 2A2 + Pending and Approved DA's + LEP FSR 100%						
Pittwater Road and Sturdee Parade	25	B	36	C	29	C
Pittwater Road and Pacific Parade	51	D	6	A	6	A
Pittwater Road and Fisher Road	26	B	20	B	21	B
Pittwater Road and Oaks Avenue	34	C	15	B	25	B
Pittwater Road and Howard Avenue/St David Avenue	48	D	23	B	41	C
Pittwater Road and Dee Why Parade	55	D	19	B	27	B
Pittwater Road and Hawkesbury Street	27	B	18	B	18	B
Fisher Road and St David Avenue/Lewis Street	43	D	27	B	49	D
Scenario 4: Option 2A2 + Pending and Approved DA's + LEP FSR 105%						
Pittwater Road and Sturdee Parade	24	B	39	C	30	C
Pittwater Road and Pacific Parade	45	D	6	A	5	A
Pittwater Road and Fisher Road	25	B	20	B	20	B
Pittwater Road and Oaks Avenue	33	C	16	B	25	B
Pittwater Road and Howard Avenue/St David Avenue	46	D	23	B	49	D
Pittwater Road and Dee Why Parade	52	D	18	B	38	C
Pittwater Road and Hawkesbury Street	24	B	18	B	19	B
Fisher Road and St David Avenue/Lewis Street	44	D	26	B	48	D

Intersection	AM Peak		PM Peak		Saturday Peak	
	Av Delay (sec)	LoS	Av Delay (sec)	LoS	Av Delay (sec)	LoS
<u>Scenario 5</u>: Option 2A2 + Pending and Approved DA's + LEP FSR 110%						
Pittwater Road and Sturdee Parade	25	B	36	C	31	C
Pittwater Road and Pacific Parade	61	E	6	A	6	A
Pittwater Road and Fisher Road	28	B	21	B	19	B
Pittwater Road and Oaks Avenue	35	C	16	B	24	B
Pittwater Road and Howard Avenue/St David Avenue	49	D	24	B	39	C
Pittwater Road and Dee Why Parade	62	E	18	B	28	B
Pittwater Road and Hawkesbury Street	26	B	19	B	18	B
Fisher Road and St David Avenue/Lewis Street	47	D	27	B	43	C

LEGEND

LoS A	Delay < 14 sec	LoS B	Delay < 15 to 28 sec	LoS C	Delay < 29 to 42 sec	LoS D	Delay < 43 to 56 sec	LoS E	Delay < 57 to 70 sec	LoS F	Delay > 70

Analysis of the modelled intersection Levels of Service show that all of intersections in the study area are forecast to operate satisfactorily, with a Level of Service D or better under both the Base Case and Option 2A2 models.

It should be noted that the intersection delays shown above are for interrelated intersections, hence high delays at one intersection can result in reduced flow to downstream intersections, which in turn reduces delay for those downstream intersections. It is this "gating" effect that can result in some intersection performing better under higher demands.

Under Option 2A2, average delay at some intersections may increase during the weekday AM peak when compared to the Base Case scenario. These average delays are likely to increase further with the introduction of traffic generated by potential LEP developments.

4.4 Travel Time Comparison

Travel time observations were conducted by SkyHigh along Pittwater Road between Sturdee Parade and Hawkesbury Avenue on Wednesday 9th October 2013 during AM (08:00-09:00) and PM (17:00-18:00) peak periods. A comparison of the observed and modelled travel times along this section are presented in Table 8.

Table 8 Comparison of Observed and Modelled Travel Times

Section	Travel Time (min:sec)					
	Observed	Scenario 1: Base Case	Scenario 2: Option 2A2 + DA	Scenario 3: Option 2A2 + DA + LEP	Scenario 4: Option 2A2 + DA + LEP FSR 105%	Scenario 5: Option 2A2 + DA + LEP FSR 110%
Northbound						
Thursday: 08:00-09:00	02:01	01:19	01:33	01:41	01:41	01:41
Thursday: 17:00-18:00	01:50	01:15	01:20	01:46	01:50	01:50
Saturday: 11:00–12:00	-	01:38	01:21	01:38	01:46	01:49
Southbound						
Thursday: 08:00-09:00	01:39	01:25	03:11	04:19	04:21	04:30
Thursday: 17:00-18:00	01:35	01:26	01:58	01:59	01:59	01:59
Saturday: 11:00–12:00	-	01:33	01:38	02:03	02:59	02:59

Analysis of the modelled travel times along Pittwater Road shows that forecast travel times are comparable during the both weekday peak periods under the Base Case and Option 2A2 modelling scenarios. The only exception is the southbound route which increases as a result of traffic generation of approved and pending development applications as well as potential LEP changes. This can be attributed to changes in signal timing at the intersection of Pittwater Road and Howard Avenue. The eastern approach of Howard Avenue requires a greater proportion of green-time allocation in order to account for increased traffic as a result of the one-way road system.

In comparison to the surveyed travel times, the results of the Base Case and Option 2A2 scenarios are generally favourable for northbound vehicles, with ravel times being similar or lower than the Base Case under all modelling scenarios.

5. Summary and Conclusion

5.1 Key Findings

The key findings from the review and update of the Dee Why Town Centre traffic models are given as follows:

- The implementation of a road link between Pacific Parade and Oaks Avenue is essential to the operation of the one-way road system, proposed under Figure 2. Removing this link results in network-wide congestion under all modelling scenarios.
- The intersection of Howard Avenue and Pittwater Road is the critical intersection within the one way system as this intersection controls the overall capacity of the surrounding road network.
- Testing of the various land use scenarios showed that the AM peak period is the critical period, where the intersection of Howard Avenue/Pittwater Road and Pittwater Road/Dee Why Parade experiences the highest delays. This was not identified as part of the assessment undertaken by GTA, as that previous assessment was focussed only on the PM and Saturday peak periods.
- There is likely to be a significant change in the operation for the majority of intersections in Dee Why during the AM peak with the addition of traffic generated by pending and approved developments as well as potential LEP developments. However, the majority of intersections are not likely to change substantially during weekday PM and Saturday midday peak periods under the same circumstances.
- Northbound travel times along Pittwater Road under all development scenarios are likely to remain comparable with observed times. Changes to signal timing at the intersection of Pittwater Road and Howard Avenue under the one-way road system means that southbound travel times are likely to increase under the proposed development scenarios.

5.2 Key Conclusions

The key conclusions from the modelling of the Dee Why Town Centre are:

- The addition of traffic generated by approved and pending development applications can be accommodated by the ‘Option 2A2’ network.
- The theoretical maximum level of LEP development that can be accommodated by the ‘Option 2A2’ road network is in the order of 105% of full LEP development. Increasing the level of LEP development beyond this may result in excessive queuing southbound on Pittwater Road during the AM peak, potentially affecting other intersections to the north of Dee Why.
- Original modelling undertaken by GTA indicated that the road network surrounding the Dee Why Town Centre could accommodate approximately 85% of the proposed LEP development. The difference between the two outcomes is largely a result of the change from commercial land use to residential land use, which generates less traffic.
- The intersection of Pittwater Road and Howard Avenue operates close to capacity with the application of traffic generated by approved and pending development applications, and full (100%) LEP development.

Appendices

Appendix A – Model Calibration and Validation

Data Collection and Validation

Traffic count data for each hour in the AM, PM and Saturday midday peak periods was plotted on a network diagram to identify any mismatches or discrepancies in vehicle flow. No significant discrepancies in vehicle flows were identified during this process.

Model Calibration

Overview

Calibration of the Dee Why Town Centre micro simulation model has been undertaken according to the methodology set out in the RMS Traffic Modelling Guidelines, 2013. Calibration has been undertaken for the weekday AM and PM peak periods based on a comparison against average hourly turning movements for the peak two-hour period.

Model Stability

The flow of traffic and the associated traffic conditions are randomly variable phenomena, and micro simulation models attempt to capture this variability by releasing traffic into the network at randomly varying intervals. Whether or not a vehicle is released from a zone in any given second is dependent on the outcome of a random number generator, and this generator is controlled by the seed value. The same model run under different seed values will results in a different simulation result. For this reason, micro simulation models are generally run using a range of seed values, with results being reported over a range of runs. The Dee Why Town Centre micro simulation model has been run under the prescribed RMS seed values of 560, 28, 7771, 86524, and 2849.

Calibration Statistics

Model calibration was undertaken on the basis of comparison of modelled and observed traffic volumes. The GEH statistic is used in the calibration of traffic models to compare the difference between observed and modelled traffic flows. The GEH statistic is defined as follows:

$$GEH = \sqrt{\frac{(V_{Observed} - V_{Modelled})^2}{\left(0.5 \times (V_{Observed} + V_{Modelled})\right)}}$$

Based on the calibration and validation guidelines presented in RMS *Traffic Modelling Guidelines, 2013*, a calibrated model must conform to the following requirements:

- No flow comparisons with GEH greater than 10; and
- At least 85% of flow comparisons with GEH less than 5.

Based on the adjusted traffic flows, a total of 62 individual turning counts were used in the calibration of the model. Barred turns were omitted from the turning count comparison. The table below shows the turning count comparisons for the AM and PM peak periods.

GEH Turning Count Comparisons

Period	Number of Movements with GEH			
	<3	<5	<10	>10
AM Peak				
07:00-09:00	45 (75%)	53 (88%)	62 (100%)	0 (0%)
PM Peak				
16:00-18:00	47 (78%)	58 (97%)	62 (100%)	0 (0%)

Analysis of the turning flow comparisons for the AM and PM peak periods shows that the model is well calibrated and conforms to the requirements set out in the RMS *Traffic Modelling Guidelines, 2013*. A detailed list of turning movement comparisons is provided in Appendix B.

Model Validation

In order to determine the suitability of the Dee Why Town Centre micro simulation traffic model in forecasting future traffic conditions, it is necessary to validate the model against a set of data that is independent to that used in the calibration process.

Travel times northbound and southbound along Pittwater Road, between Sturdee Parade and Hawkesbury Avenue were used to validate the operation of the model. Validation to travel times demonstrates that the model accurately reflects the volume to delay response that occurs in the field.

For the Dee Why Town Centre micro simulation traffic model, the travel time validation criteria from RMS *Traffic Modelling Guidelines, 2013, Section 11.5* has been adopted. This standard requires that 85% of modelled travel times be within 15% or one minute (whichever is greater) of observed travel times to be considered valid. A summary of the modelled and observed travel times for the AM and PM peak period is presented in the following tables.

Base Model Travel Time Comparison – AM Peak

Route		8 AM – 9 AM		
		Observed	Modelled	%Diff
Pittwater Road	NB	02:01	01:19	-35%
Pittwater Road	SB	01:39	01:25	-14%

Base Model Travel Time Comparison – PM Peak

Route		5 PM – 6 PM		
		Observed	Modelled	%Diff
Pittwater Road	NB	01:50	01:15	-32%
Pittwater Road	SB	01:35	01:26	-9%

Analysis of the observed and modelled travel times shows that all of the ‘base model’ travel times are within 15% or one minute (whichever is greater) of the observed travel times. In general, the modelled travel times are lower than the observed travel times. Comparisons of

travel time for very short sections are difficult to calibrate to within one minute or less and these differences are generally not significant. Overall, comparisons of travel time for the Dee Why Town Centre model show that the model is well-validated with respect to travel times through the study area.

Appendix B – GEH Statistics

AM Peak Turning Movement Comparison

GHD Mvmt	Turn ID	Observed	Modelled	Diff	%	GEH
i1302m1	7:1302:8	87	103	16	18.39%	1.64
i1302m10	8:1302:68	36	86	50	138.89%	6.40
i1302m11	8:1302:63	87	55	-32	-36.78%	3.80
i1302m12	8:1302:7	57	57	0	0.00%	0.00
i1302m2	7:1302:68	422	442	20	4.74%	0.96
i1302m3	7:1302:63	238	193	-45	-18.91%	3.07
i1302m4	63:1302:7	147	157	10	6.80%	0.81
i1302m5	63:1302:8	50	44	-6	-12.00%	0.88
i1302m6	63:1302:68	14	1	-13	-92.86%	4.75
i1302m7	68:1302:63	13	8	-5	-38.46%	1.54
i1302m8	68:1302:7	347	398	51	14.70%	2.64
i1302m9	68:1302:8	36	56	20	55.56%	2.95
i940m10	52:940:62	36	41	5	13.89%	0.81
i940m11	52:940:53	134	144	10	7.46%	0.85
i940m12	52:940:121	23	22	-1	-4.35%	0.21
i940m2	121:940:62	1663	1664	1	0.06%	0.02
i940m3	121:940:53	458	510	52	11.35%	2.36
i940m4	53:940:121	176	195	19	10.80%	1.40
i940m5	53:940:52	70	77	7	10.00%	0.82
i940m6	53:940:62	24	28	4	16.67%	0.78
i940m7	62:940:53	49	43	-6	-12.24%	0.88
i940m8	62:940:121	1057	1044	-13	-1.23%	0.40
i940m9	62:940:52	22	16	-6	-27.27%	1.38
i941m2	61:941:73	1618	1580	-38	-2.35%	0.95
i941m3	61:941a:40	105	142	37	35.24%	3.33
i941m4	941a:941:61	302	286	-16	-5.30%	0.93
i941m5	941a:941:58	85	74	-11	-12.94%	1.23
i941m6	941a:941:73	80	60	-20	-25.00%	2.39
i941m8	73:941:61	826	827	1	0.12%	0.03
i941m9	73:941:58	47	30	-17	-36.17%	2.74
i942m11	85:942:64	251	176	-75	-29.88%	5.13
i942m12	85:942:74	48	58	10	20.83%	1.37
i942m2	74:942:75	1623	1595	-28	-1.73%	0.70
i942m3	74:942:64	75	36	-39	-52.00%	5.24
i942m4	64:942:74	71	50	-21	-29.58%	2.70
i942m5	64:942:85	181	200	19	10.50%	1.38
i942m6	64:942:75	66	56	-10	-15.15%	1.28
i942m8	75:942:74	754	756	2	0.27%	0.07
i942m9	75:942:85	46	29	-17	-36.96%	2.78
i943m2	76:943:80	1604	1634	30	1.87%	0.75
i943m3	76:943:29	85	29	-56	-65.88%	7.42
i943m6	29:943:80	124	80	-44	-35.48%	4.36
i943m7	77:943:29	201	248	47	23.38%	3.14

i943m8	77:943:76	800	786	-14	-1.75%	0.50
i944m10	67:944:945	440	453	13	2.95%	0.62
i944m12	67:944:77	32	87	55	171.88%	7.13
i944m2	80:944:945	1728	1728	0	0.00%	0.00
i944m8	945:944:77	969	943	-26	-2.68%	0.84
i944m9	945:944:67	396	460	64	16.16%	3.09
i945m2	944:945:81	2013	2061	48	2.38%	1.06
i945m3	944:945:21	155	131	-24	-15.48%	2.01
i945m4	21:945:944	170	109	-61	-35.88%	5.16
i945m6	21:945:81	96	80	-16	-16.67%	1.71
i945m8	81:945:944	1195	1296	101	8.45%	2.86
i946m2	82:946:120	2071	2079	8	0.39%	0.18
i946m3	82:946:14	38	39	1	2.63%	0.16
i946m4	14:946:82	38	11	-27	-71.05%	5.45
i946m6	14:946:120	278	241	-37	-13.31%	2.30
i946m7	120:946:14	160	179	19	11.88%	1.46
i946m8	120:946:82	1157	1277	120	10.37%	3.44

Count	60	100%
>10	0	0%
<5	53	88%
<3	45	75%

PM Peak Turning Movement Comparison

GHD Mvmt	Turn ID	Observed	Modelled	Diff	%	GEH
i1302m1	7:1302:8	94	129	35	37.23%	3.31
i1302m10	8:1302:68	37	46	9	24.32%	1.40
i1302m11	8:1302:63	121	89	-32	-26.45%	3.12
i1302m12	8:1302:7	132	118	-14	-10.61%	1.25
i1302m2	7:1302:68	412	394	-18	-4.37%	0.90
i1302m3	7:1302:63	216	184	-32	-14.81%	2.26
i1302m4	63:1302:7	150	149	-1	-0.67%	0.08
i1302m5	63:1302:8	65	62	-3	-4.62%	0.38
i1302m6	63:1302:68	24	14	-10	-41.67%	2.29
i1302m7	68:1302:63	22	5	-17	-77.27%	4.63
i1302m8	68:1302:7	487	464	-23	-4.72%	1.05
i1302m9	68:1302:8	60	99	39	65.00%	4.37
i940m10	52:940:62	41	37	-4	-9.76%	0.64
i940m11	52:940:53	147	162	15	10.20%	1.21
i940m12	52:940:121	28	26	-2	-7.14%	0.38
i940m2	121:940:62	1133	1196	63	5.56%	1.85
i940m3	121:940:53	294	360	66	22.45%	3.65
i940m4	53:940:121	186	190	4	2.15%	0.29
i940m5	53:940:52	127	139	12	9.45%	1.04
i940m6	53:940:62	22	21	-1	-4.55%	0.22
i940m7	62:940:53	110	106	-4	-3.64%	0.38
i940m8	62:940:121	1620	1566	-54	-3.33%	1.35
i940m9	62:940:52	28	35	7	25.00%	1.25
i941m2	61:941:73	1063	1058	-5	-0.47%	0.15
i941m3	61:941a:40	133	185	52	39.10%	4.12
i941m4	941a:941:61	300	296	-4	-1.33%	0.23
i941m5	941a:941:58	113	97	-16	-14.16%	1.56
i941m6	941a:941:73	85	52	-33	-38.82%	3.99
i941m8	73:941:61	1458	1389	-69	-4.73%	1.83
i941m9	73:941:58	59	23	-36	-61.02%	5.62
i942m11	85:942:64	285	224	-61	-21.40%	3.82
i942m12	85:942:74	47	50	3	6.38%	0.43
i942m2	74:942:75	1080	1032	-48	-4.44%	1.48
i942m3	74:942:64	68	69	1	1.47%	0.12
i942m4	64:942:74	112	107	-5	-4.46%	0.48
i942m5	64:942:85	205	200	-5	-2.44%	0.35
i942m6	64:942:75	82	70	-12	-14.63%	1.38
i942m8	75:942:74	1358	1262	-96	-7.07%	2.65
i942m9	75:942:85	29	16	-13	-44.83%	2.74
i943m2	76:943:80	1059	1042	-17	-1.61%	0.52
i943m3	76:943:29	103	55	-48	-46.60%	5.40
i943m6	29:943:80	159	116	-43	-27.04%	3.67
i943m7	77:943:29	324	324	0	0.00%	0.00
i943m8	77:943:76	1387	1282	-105	-7.57%	2.87
i944m10	67:944:945	412	422	10	2.43%	0.49
i944m12	67:944:77	61	33	-28	-45.90%	4.08

i944m2	80:944:945	1218	1157	-61	-5.01%	1.77
i944m8	945:944:77	1650	1573	-77	-4.67%	1.92
i944m9	945:944:67	569	565	-4	-0.70%	0.17
i945m2	944:945:81	1459	1440	-19	-1.30%	0.50
i945m3	944:945:21	171	135	-36	-21.05%	2.91
i945m4	21:945:944	296	246	-50	-16.89%	3.04
i945m6	21:945:81	107	93	-14	-13.08%	1.40
i945m8	81:945:944	1923	1890	-33	-1.72%	0.76
i946m2	82:946:120	1490	1468	-22	-1.48%	0.57
i946m3	82:946:14	76	61	-15	-19.74%	1.81
i946m4	14:946:82	55	42	-13	-23.64%	1.87
i946m6	14:946:120	198	175	-23	-11.62%	1.68
i946m7	120:946:14	334	310	-24	-7.19%	1.34
i946m8	120:946:82	1868	1864	-4	-0.21%	0.09
	Count	60	100%			
	>10	0	0%			
	<5	58	97%			
	<3	47	78%			

Appendix C – Approved and Pending Development Applications

Trips generated by the Dee Why Town Centre Development

AM Peak	Zone	Residential	Commercial	Retail	School	TOTAL
Approved DA's						
25 Fisher Road	12	3	--	--	--	3
4-16 Kingsway	14	25	--	--	--	25
9 Kingsway	14	--	--	--	--	0
2 Clarence Ave	15	1	--	--	--	1
7 Oaks Ave	19	--	35	3	--	39
61-67 Oaks Ave	21	--	--	--	110	110
69-71 Oaks Ave	21	3	--	--	--	3
30 Pacific Pde	19	2	--	--	--	2
629-631 Pittwater Rd	10	10	-14	3	--	-2
697 Pittwater Rd	13	12	-3	2	--	11
701 Pittwater Rd	13	4	14	1	--	19
834 Pittwater Rd (Dee Why Hotel)	20	43	101	68	--	213
Pending DA's						
914-922 Pittwater Rd	15	14	-24	--	--	-10
Multiplex	18	90	38	96	--	224
Council	17	37	99	6	--	141
27-33 Oaks Ave (Woolworths)	19	--	--	88	--	88
Pass-by	13	--	--	-15	--	-10

PM Peak	Zone	Residential	Commercial	Retail	School	TOTAL
Approved DA's						
25 Fisher Road	12	3	--	--	--	3
4-16 Kingsway	14	25	--	--	--	25
9 Kingsway	14	--	--	--	--	--
2 Clarence Ave	15	1	--	--	--	1
7 Oaks Ave	19	--	35	14		49
61-67 Oaks Ave	21	--	--	--	96	96
69-71 Oaks Ave	21	3			--	3
30 Pacific Pde	19	2			--	2
629-631 Pittwater Rd	10	10	-14	11	--	7
697 Pittwater Rd	13	12	-3	6	--	15
701 Pittwater Rd	13	4	14	4	--	22
834 Pittwater Rd (Dee Why Hotel)	20	43	101	273	--	417
Pending DA's						
914-922 Pittwater Rd	15	14	-24	0	--	-10
Multiplex	18	90	38	385	--	513
Council	17	37	99	23	--	159
27-33 Oaks Ave (Woolworths)	19	--	--	130	--	130
Pass-by	13	--	--	-31	--	-31

Saturday Peak	Zone	Residential	Commercial	Retail	School	TOTAL
Approved DA's						
25 Fisher Road	12	1	--	--	--	1
4-16 Kingsway	14	13	--	--	--	13
9 Kingsway	14	--	--	--	--	--
2 Clarence Ave	15	--	--	--	--	--
7 Oaks Ave	19	--	--	18	--	18
61-67 Oaks Ave	21	--	--	--	--	0
69-71 Oaks Ave	21	2	--	--	--	2
30 Pacific Pde	19	1	--	--	--	1
629-631 Pittwater Rd	10	5	--	14	--	18
697 Pittwater Rd	13	6	--	8	--	14
701 Pittwater Rd	13	2	--	6	--	7
834 Pittwater Rd (Dee Why Hotel)	20	22	--	355	--	376
Pending DA's						
914-922 Pittwater Rd	15	7	--	--	--	7
Multiplex	18	45	--	501	--	546
Council	17	18	--	29	--	48
27-33 Oaks Ave (Woolworths)	19	--	--	110	--	110
Pass-by	13	--	--	-40	--	-40

DRAFT

Appendix D – Potential LEP Developments

LEP FSR 100% - AM Peak

Trips generated by the Development

Site	AM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	100%	15	2	0	14	0	16
2	18-22 Howard Ave	100%	22	18	-48	18	0	-12
3	31-35 Howard Ave & 36-44 Oaks Ave	100%	17	31	0	204	0	235
4	9 Oaks Ave	100%	19	5	0	5	0	9
5	19-21 Oaks Ave	100%	19	10	0	12	0	22
6	L8 & 12 Pacific Pde	100%	19	5	0	39	0	44
7	16 Pacific Pde	100%	19	2	0	-41	0	-39
8	900 Pittwater Rd & 10 Howard Ave	100%	22	17	0	-5	0	11
9	854-860 Pittwater Rd	100%	19	15	0	63	0	78
10	836-844 Pittwater Rd & 1 Pacific Pde	100%	20	11	-7	37	0	41
11	627 Pittwater Rd	100%	11	1	-3	-2	0	-4
12	635 Pittwater Rd	100%	11	8	-36	41	0	14
13	643 Pittwater Rd	100%	11	1	0	10	0	11
14	651-661 Pittwater	100%	11	14	-35	33	0	12
15	673-683A Pittwater Rd	100%	23	16	-30	-8	0	-22
16	687-693A Pittwater Rd	100%	23	10	-24	7	0	-7
17	23 Fisher Rd	100%	13	21	0	0	0	21
18	Civic Centre	100%	13	103	0	2	0	105
19	727 Pittwater Rd	100%	13	3	-4	17	0	16
20	10 Fisher Rd	100%	11	2	0	-7	0	-5
21	16-20 Fisher Rd	100%	11	9	-18	62	0	53
22	28-30 Fisher Rd	100%	11	9	-17	62	0	54
23	36 Fisher Rd	100%	11	5	0	30	0	35
24	1-3 St. David; L1 & L2 Fisher	100%	23	10	-11	72	0	71
25	21 Mooramba & 665 Pittwater Rd	100%	11	7	-17	23	0	13
26	14 Dee Why Pde	100%	15	0	0	0	0	0
27	50 Pacific Pde	100%	21	0	0	0	0	0
28	23-27+29 Pacific Pde+ 16-22 Sturdee Pde	100%	20	6	0	0	0	6
29	39-45 Pacific Pde	100%	20	3	0	0	0	3
30	703 Pittwater Rd	100%	23	0	0	0	0	0
31	36-48 Kingsway (PCYC)	100%	13	0	0	0	0	0
32	20-26 Avon Rd	100%	4	2	0	0	0	2
33	30-40 Howard: Park	100%	16	0	0	0	0	0
34	46-50 Oaks Ave	100%	17	0	0	0	0	0

Site	AM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
35	65-69 Howard Ave	100%	17	0	0	-10	0	-10
36	45 Oaks Ave	100%	21	0	0	0	0	0
37	57-59 Oaks Ave	100%	21	0	0	0	0	0
38	74 Pacific Pde	100%	21	0	0	0	0	0
39	73 Oaks Ave	100%	21	0	0	0	0	0
40	755 Pittwater Rd	100%	2	2	0	0	0	2
41	2 Dee Why Pde	100%	15	2	0	0	0	2
42	13 & L36 Redman	100%	11	0	0	0	0	0
43	9 Francis St	100%	11	2	0	0	0	2

LEP FSR 100% - PM Peak

Site	PM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	100%	15	2	0	14	0	16
2	18-22 Howard Ave	100%	22	14	-48	18	0	-16
3	31-35 Howard Ave & 36-44 Oaks Ave	100%	17	24	0	204	0	228
4	9 Oaks Ave	100%	19	4	0	5	0	8
5	19-21 Oaks Ave	100%	19	8	0	12	0	20
6	L8 & 12 Pacific Pde	100%	19	4	0	39	0	43
7	16 Pacific Pde	100%	19	2	0	-41	0	-39
8	900 Pittwater Rd & 10 Howard Ave	100%	22	13	0	-5	0	8
9	854-860 Pittwater Rd	100%	19	12	0	63	0	75
10	836-844 Pittwater Rd & 1 Pacific Pde	100%	20	9	-7	37	0	38
11	627 Pittwater Rd	100%	11	1	-3	-2	0	-5
12	635 Pittwater Rd	100%	11	7	-36	41	0	12
13	643 Pittwater Rd	100%	11	1	0	10	0	11
14	651-661 Pittwater	100%	11	11	-35	33	0	9
15	673-683A Pittwater Rd	100%	23	12	-30	-8	0	-25
16	687-693A Pittwater Rd	100%	23	8	-24	7	0	-9
17	23 Fisher Rd	100%	13	16	0	0	0	16
18	Civic Centre	100%	13	81	0	2	0	83
19	727 Pittwater Rd	100%	13	2	-4	19	0	17
20	10 Fisher Rd	100%	11	2	0	-7	0	-6
21	16-20 Fisher Rd	100%	11	7	-18	62	0	51
22	28-30 Fisher Rd	100%	11	7	-17	62	0	52
23	36 Fisher Rd	100%	11	4	0	30	0	34
24	1-3 St. David; L1 & L2 Fisher	100%	23	8	-11	72	0	69
25	21 Mooramba & 665 Pittwater Rd	100%	11	6	-17	23	0	11
26	14 Dee Why Pde	100%	15	0	0	0	0	0
27	50 Pacific Pde	100%	21	0	0	0	0	0
28	23-27+29 Pacific Pde+ 16-22 Sturdee Pde	100%	20	3	0	0	0	3

29	39-45 Pacific Pde	100%	20	1	0	0	0	1
30	703 Pittwater Rd	100%	23	0	0	0	0	0
31	36-48 Kingsway (PCYC)	100%	13	0	22	0	0	22
32	20-26 Avon Rd	100%	4	1	0	0	0	1
33	30-40 Howard: Park	100%	16	0	0	0	0	0
34	46-50 Oaks Ave	100%	17	0	0	0	0	0
35	65-69 Howard Ave	100%	17	-1	0	-10	0	-11
36	45 Oaks Ave	100%	21	-1	0	0	0	-1
37	57-59 Oaks Ave	100%	21	0	0	0	0	0
38	74 Pacific Pde	100%	21	0	0	0	0	0
39	73 Oaks Ave	100%	21	-1	0	0	0	-1
40	755 Pittwater Rd	100%	2	1	0	0	0	1
41	2 Dee Why Pde	100%	15	1	0	0	0	1
42	13 & L36 Redman	100%	11	0	0	0	0	0
43	9 Francis St	100%	11	1	0	0	0	1

LEP FSR 100% - Saturday Peak

Site	Saturday Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	100%	15	1	0	18	0	19
2	18-22 Howard Ave	100%	22	7	0	23	0	30
3	31-35 Howard Ave & 36-44 Oaks Ave	100%	17	12	0	270	0	283
4	9 Oaks Ave	100%	19	2	0	6	0	8
5	19-21 Oaks Ave	100%	19	4	0	16	0	20
6	L8 & 12 Pacific Pde	100%	19	2	0	51	0	53
7	16 Pacific Pde	100%	19	1	0	-54	0	-53
8	900 Pittwater Rd & 10 Howard Ave	100%	22	7	0	-7	0	0
9	854-860 Pittwater Rd	100%	19	6	0	84	0	90
10	836-844 Pittwater Rd & 1 Pacific Pde	100%	20	4	0	49	0	53
11	627 Pittwater Rd	100%	11	1	0	-3	0	-3
12	635 Pittwater Rd	100%	11	3	0	55	0	58
13	643 Pittwater Rd	100%	11	0	0	13	0	14
14	651-661 Pittwater	100%	11	6	0	43	0	49
15	673-683A Pittwater Rd	100%	23	6	0	-10	0	-4
16	687-693A Pittwater Rd	100%	23	4	0	10	0	14
17	23 Fisher Rd	100%	13	8	0	0	0	8
18	Civic Centre	100%	13	41	0	2	0	43
19	727 Pittwater Rd	100%	13	1	0	23	0	24
20	10 Fisher Rd	100%	11	1	0	-9	0	-9
21	16-20 Fisher Rd	100%	11	3	0	82	0	86
22	28-30 Fisher Rd	100%	11	3	0	82	0	85
23	36 Fisher Rd	100%	11	2	0	40	0	42
24	1-3 St. David; L1 & L2 Fisher	100%	23	4	0	95	0	100
25	21 Mooramba & 665 Pittwater Rd	100%	11	3	0	30	0	33

26	14 Dee Why Pde	100%	15	0	0	0	0	0
27	50 Pacific Pde	100%	21	0	0	0	0	0
28	23-27+29 Pacific Pde+ 16-22 Sturdee Pde	100%	20	1	0	0	0	1
29	39-45 Pacific Pde	100%	20	1	0	0	0	1
30	703 Pittwater Rd	100%	23	0	0	0	0	0
31	36-48 Kingsway (PCYC)	100%	13	0	90	0	0	90
32	20-26 Avon Rd	100%	4	0	0	0	0	0
33	30-40 Howard: Park	100%	16	0	0	0	0	0
34	46-50 Oaks Ave	100%	17	0	0	0	0	0
35	65-69 Howard Ave	100%	17	0	0	-14	0	-14
36	45 Oaks Ave	100%	21	0	0	0	0	0
37	57-59 Oaks Ave	100%	21	0	0	0	0	0
38	74 Pacific Pde	100%	21	0	0	0	0	0
39	73 Oaks Ave	100%	21	0	0	0	0	0
40	755 Pittwater Rd	100%	2	1	0	0	0	1
41	2 Dee Why Pde	100%	15	0	0	0	0	0
42	13 & L36 Redman	100%	11	0	0	0	0	0
43	9 Francis St	100%	11	1	0	0	0	1

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LEP FSR 105% - AM Peak

Site	AM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	105%	15	3	0	14	0	17
2	18-22 Howard Ave	105%	22	19	-48	18	0	-11
3	31-35 Howard Ave & 36-44 Oaks Ave	105%	17	33	0	204	0	237
4	9 Oaks Ave	105%	19	5	0	5	0	10
5	19-21 Oaks Ave	105%	19	11	0	12	0	23
6	L8 & 12 Pacific Pde	105%	19	6	0	39	0	44
7	16 Pacific Pde	105%	19	2	0	-41	0	-39
8	900 Pittwater Rd & 10 Howard Ave	105%	22	18	0	-5	0	12
9	854-860 Pittwater Rd	105%	19	16	0	63	0	79
10	836-844 Pittwater Rd & 1 Pacific Pde	105%	20	12	-7	37	0	41
11	627 Pittwater Rd	105%	11	1	-3	-2	0	-4
12	635 Pittwater Rd	105%	11	9	-36	41	0	15
13	643 Pittwater Rd	105%	11	1	0	10	0	11
14	651-661 Pittwater	105%	11	15	-35	33	0	13
15	673-683A Pittwater Rd	105%	23	17	-30	-8	0	-21
16	687-693A Pittwater Rd	105%	23	11	-24	7	0	-6
17	23 Fisher Rd	105%	13	22	0	0	0	22
18	Civic Centre	105%	13	108	0	2	0	110
19	727 Pittwater Rd	105%	13	3	-4	17	0	17
20	10 Fisher Rd	105%	11	2	0	-7	0	-5
21	16-20 Fisher Rd	105%	11	9	-18	62	0	53
22	28-30 Fisher Rd	105%	11	9	-17	62	0	54
23	36 Fisher Rd	105%	11	5	0	30	0	35
24	1-3 St. David; L1 & L2 Fisher	105%	23	11	-11	72	0	72
25	21 Mooramba & 665 Pittwater Rd	105%	11	8	-17	23	0	13

LEP FSR 105% - PM Peak

Site	PM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	105%	15	2	0	14	0	16
2	18-22 Howard Ave	105%	22	15	-48	18	0	-15
3	31-35 Howard Ave & 36-44 Oaks Ave	105%	17	26	0	204	0	230
4	9 Oaks Ave	105%	19	4	0	5	0	8
5	19-21 Oaks Ave	105%	19	8	0	12	0	21
6	L8 & 12 Pacific Pde	105%	19	5	0	39	0	43
7	16 Pacific Pde	105%	19	2	0	-41	0	-39
8	900 Pittwater Rd & 10 Howard Ave	105%	22	14	0	-5	0	9
9	854-860 Pittwater Rd	105%	19	12	0	63	0	76
10	836-844 Pittwater Rd & 1 Pacific Pde	105%	20	9	-7	37	0	39
11	627 Pittwater Rd	105%	11	1	-3	-2	0	-4

Site	PM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
12	635 Pittwater Rd	105%	11	7	-36	41	0	13
13	643 Pittwater Rd	105%	11	1	0	10	0	11
14	651-661 Pittwater	105%	11	12	-35	33	0	9
15	673-683A Pittwater Rd	105%	23	13	-30	-8	0	-25
16	687-693A Pittwater Rd	105%	23	9	-24	7	0	-8
17	23 Fisher Rd	105%	13	18	0	0	0	18
18	Civic Centre	105%	13	85	0	2	0	87
19	727 Pittwater Rd	105%	13	3	-4	19	0	17
20	10 Fisher Rd	105%	11	2	0	-7	0	-5
21	16-20 Fisher Rd	105%	11	7	-18	62	0	51
22	28-30 Fisher Rd	105%	11	7	-17	62	0	52
23	36 Fisher Rd	105%	11	4	0	30	0	34
24	1-3 St. David; L1 & L2 Fisher	105%	23	9	-11	72	0	69
25	21 Mooramba & 665 Pittwater Rd	105%	11	6	-17	23	0	11

LEP FSR 105% - Saturday Peak

Site	Saturday Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	105%	15	1	0	18	0	19
2	18-22 Howard Ave	105%	22	7	0	23	0	31
3	31-35 Howard Ave & 36-44 Oaks Ave	105%	17	13	0	270	0	283
4	9 Oaks Ave	105%	19	2	0	6	0	8
5	19-21 Oaks Ave	105%	19	4	0	16	0	21
6	L8 & 12 Pacific Pde	105%	19	2	0	51	0	53
7	16 Pacific Pde	105%	19	1	0	-54	0	-53
8	900 Pittwater Rd & 10 Howard Ave	105%	22	7	0	-7	0	0
9	854-860 Pittwater Rd	105%	19	6	0	84	0	90
10	836-844 Pittwater Rd & 1 Pacific Pde	105%	20	5	0	49	0	53
11	627 Pittwater Rd	105%	11	1	0	-3	0	-3
12	635 Pittwater Rd	105%	11	4	0	55	0	58
13	643 Pittwater Rd	105%	11	0	0	13	0	14
14	651-661 Pittwater Rd	105%	11	6	0	43	0	49
15	673-683A Pittwater Rd	105%	23	7	0	-10	0	-4
16	687-693A Pittwater Rd	105%	23	4	0	10	0	14
17	23 Fisher Rd	105%	13	9	0	0	0	9
18	Civic Centre	105%	13	43	0	2	0	45
19	727 Pittwater Rd	105%	13	1	0	23	0	24
20	10 Fisher Rd	105%	11	1	0	-9	0	-9
21	16-20 Fisher Rd	105%	11	4	0	82	0	86
22	28-30 Fisher Rd	105%	11	4	0	82	0	86
23	36 Fisher Rd	105%	11	2	0	40	0	42
24	1-3 St. David Ave; L1	105%	23	4	0	95	0	100

	& L2 Fisher Rd							
25	21 Mooramba & 665 Pittwater Rd	105%	11	3	0	30	0	33

LEP FSR 110% - AM Peak

Site	AM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	110%	15	3	0	14	0	17
2	18-22 Howard Ave	110%	22	20	-48	18	0	-10
3	31-35 Howard Ave & 36-44 Oaks Ave	110%	17	35	0	204	0	239
4	9 Oaks Ave	110%	19	5	0	5	0	10
5	19-21 Oaks Ave	110%	19	11	0	12	0	24
6	L8 & 12 Pacific Pde	110%	19	6	0	39	0	45
7	16 Pacific Pde	110%	19	2	0	-41	0	-38
8	900 Pittwater Rd & 10 Howard Ave	110%	22	19	0	-5	0	13
9	854-860 Pittwater Rd	110%	19	17	0	63	0	80
10	836-844 Pittwater Rd & 1 Pacific Pde	110%	20	13	-7	37	0	42
11	627 Pittwater Rd	110%	11	2	-3	-2	0	-4
12	635 Pittwater Rd	110%	11	10	-36	41	0	15
13	643 Pittwater Rd	110%	11	1	0	10	0	11
14	651-661 Pittwater	110%	11	16	-35	33	0	13
15	673-683A Pittwater Rd	110%	23	18	-30	-8	0	-20
16	687-693A Pittwater Rd	110%	23	11	-24	7	0	-6
17	23 Fisher Rd	110%	13	24	0	0	0	24
18	Civic Centre	110%	13	113	0	2	0	115
19	727 Pittwater Rd	110%	13	4	-4	17	0	17
20	10 Fisher Rd	110%	11	2	0	-7	0	-5
21	16-20 Fisher Rd	110%	11	10	-18	62	0	54
22	28-30 Fisher Rd	110%	11	10	-17	62	0	55
23	36 Fisher Rd	110%	11	6	0	30	0	36
24	1-3 St. David; L1 & L2 Fisher	110%	23	12	-11	72	0	72
25	21 Mooramba & 665 Pittwater Rd	110%	11	8	-17	23	0	14

LEP FSR 110% - PM Peak

Site	PM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	110%	15	2	0	14	0	16
2	18-22 Howard Ave	110%	22	16	-48	18	0	-14
3	31-35 Howard Ave & 36-44 Oaks Ave	110%	17	27	0	204	0	231
4	9 Oaks Ave	110%	19	4	0	5	0	9
5	19-21 Oaks Ave	110%	19	9	0	12	0	21
6	L8 & 12 Pacific Pde	110%	19	5	0	39	0	43
7	16 Pacific Pde	110%	19	2	0	-41	0	-39
8	900 Pittwater Rd & 10 Howard Ave	110%	22	15	0	-5	0	9
9	854-860 Pittwater Rd	110%	19	13	0	63	0	77
10	836-844 Pittwater Rd	110%	20	10	-7	37	0	39

Site	PM Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
	& 1 Pacific Pde							
11	627 Pittwater Rd	110%	11	1	-3	-2	0	-4
12	635 Pittwater Rd	110%	11	8	-36	41	0	13
13	643 Pittwater Rd	110%	11	1	0	10	0	11
14	651-661 Pittwater	110%	11	13	-35	33	0	10
15	673-683A Pittwater Rd	110%	23	14	-30	-8	0	-24
16	687-693A Pittwater Rd	110%	23	9	-24	7	0	-8
17	23 Fisher Rd	110%	13	19	0	0	0	19
18	Civic Centre	110%	13	90	0	2	0	92
19	727 Pittwater Rd	110%	13	3	-4	19	0	18
20	10 Fisher Rd	110%	11	2	0	-7	0	-5
21	16-20 Fisher Rd	110%	11	8	-18	62	0	52
22	28-30 Fisher Rd	110%	11	8	-17	62	0	53
23	36 Fisher Rd	110%	11	4	0	30	0	35
24	1-3 St. David Ave; L1 & L2 Fisher Rd	110%	23	9	-11	72	0	70
25	21 Mooramba & 665 Pittwater Rd	110%	11	6	-17	23	0	12

LEP FSR 110% - Saturday Peak

Site	Saturday Peak	FSR	Zone	Residential	Commercial	Retail	School	TOTAL
1	6 Dee Why Pde	110%	15	1	0	18	0	20
2	18-22 Howard Ave	110%	22	8	0	23	0	31
3	31-35 Howard Ave & 36-44 Oaks Ave	110%	17	14	0	270	0	284
4	9 Oaks Ave	110%	19	2	0	6	0	8
5	19-21 Oaks Ave	110%	19	4	0	16	0	21
6	L8 & 12 Pacific Pde	110%	19	2	0	51	0	54
7	16 Pacific Pde	110%	19	1	0	-54	0	-53
8	900 Pittwater Rd & 10 Howard Ave	110%	22	7	0	-7	0	0
9	854-860 Pittwater Rd	110%	19	7	0	84	0	91
10	836-844 Pittwater Rd & 1 Pacific Pde	110%	20	5	0	49	0	54
11	627 Pittwater Rd	110%	11	1	0	-3	0	-3
12	635 Pittwater Rd	110%	11	4	0	55	0	58
13	643 Pittwater Rd	110%	11	0	0	13	0	14
14	651-661 Pittwater	110%	11	6	0	43	0	50
15	673-683A Pittwater Rd	110%	23	7	0	-10	0	-3
16	687-693A Pittwater Rd	110%	23	5	0	10	0	14
17	23 Fisher Rd	110%	13	10	0	0	0	10
18	Civic Centre	110%	13	45	0	2	0	47
19	727 Pittwater Rd	110%	13	1	0	23	0	24
20	10 Fisher Rd	110%	11	1	0	-9	0	-9
21	16-20 Fisher Rd	110%	11	4	0	82	0	86
22	28-30 Fisher Rd	110%	11	4	0	82	0	86

23	36 Fisher Rd	110%	11	2	0	40	0	42
24	1-3 St. David; L1 & L2 Fisher	110%	23	5	0	95	0	100
25	21 Mooramba & 665 Pittwater Rd	110%	11	3	0	30	0	33

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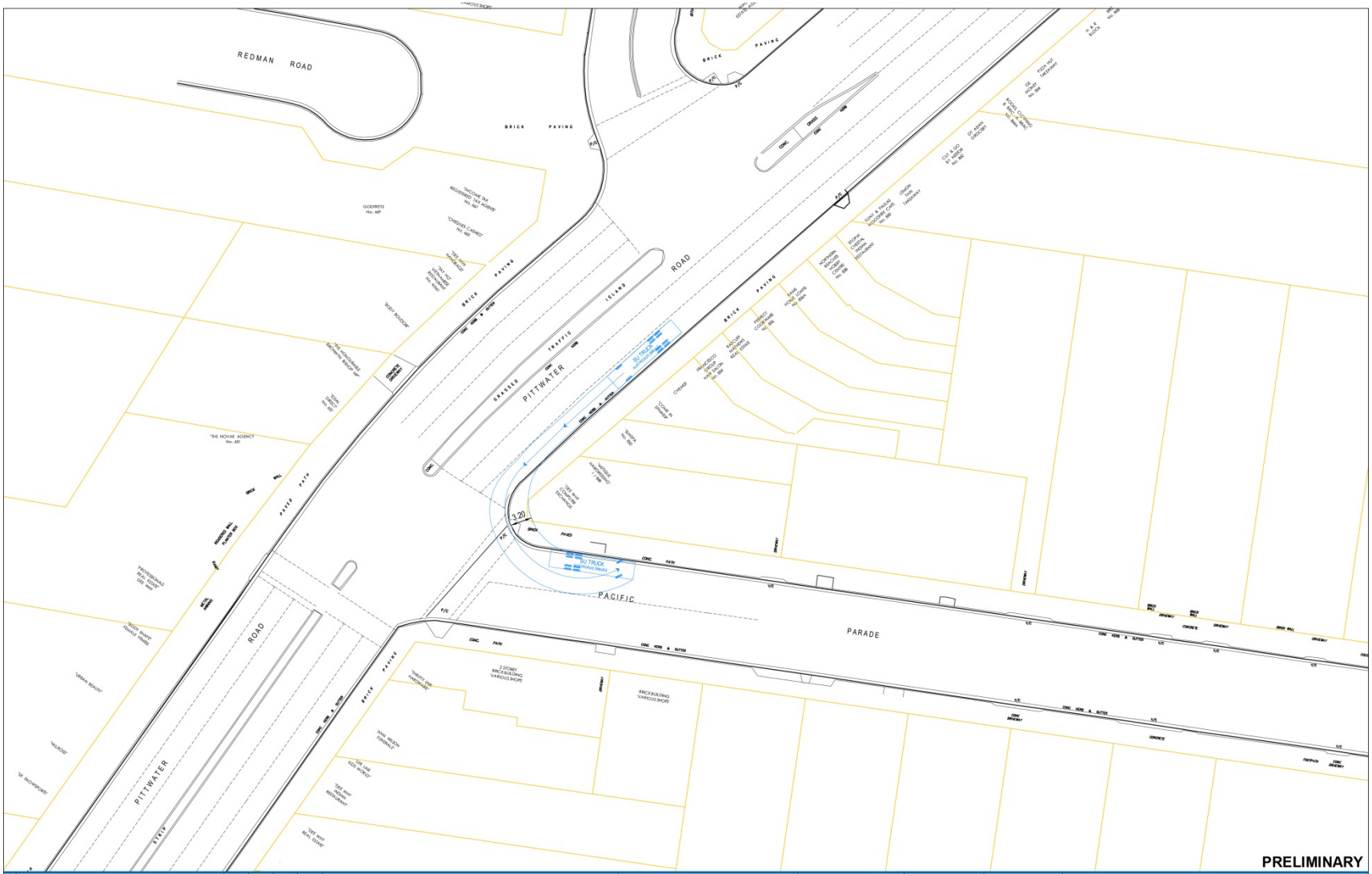
Appendix E – Pacific Parade Turning Path Analysis



No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date

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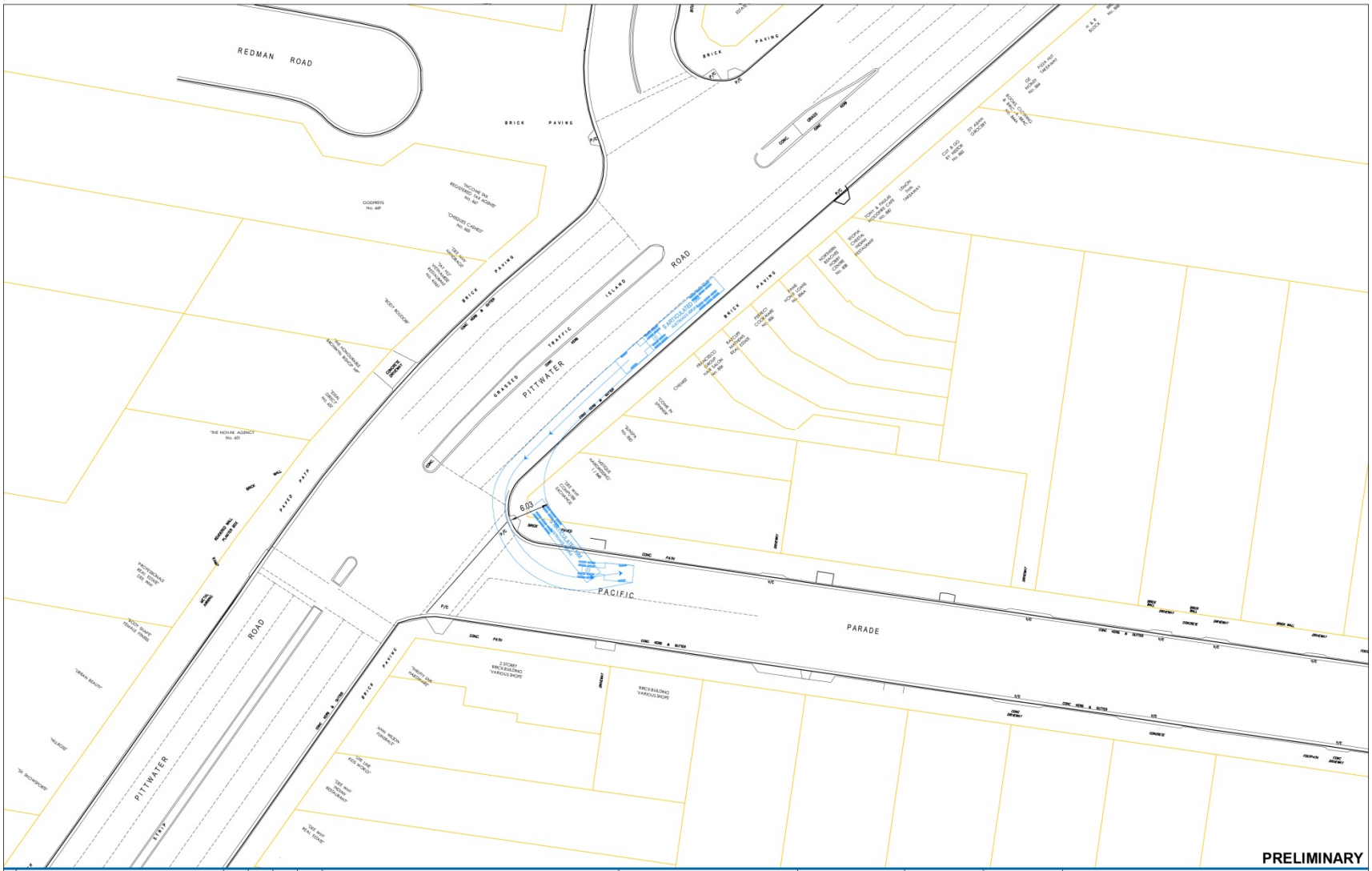
Client
Project
Title **12.5m TRUCK**

Original Size **A3** **Drawing No:** **Rev: A**

Plot Date: 17 February 2014 - 4:36 PM Plotted By: Patrick Mendoza Cad File No: C:\Users\pamendoza\Desktop\21-23957-SK001.dwg



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Project
Title **19m SEMI**

Original Size **A3** **Drawing No:** **Rev: A**

Plot Date: 17 February 2014 - 4:37 PM Plotted By: Patrick Mendoza Cad File No: C:\Users\pamendoza\Desktop\21-22957-SK001.dwg

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Document Status

Rev	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	J. Ticinovic	I. Smith		S. Konstas		24/01/2014
1	J. Ticinovic	I. Smith		S. Konstas		24/02/2014
2	J. Ticinovic	I. Smith		I. Smith		20/03/2014
3	M. Sachdeva	J. Devney	John Devney	J. Devney	John Devney	01/10/2014
4	M. Sachdeva	J. Devney	John Devney	J. Devney	John Devney	13/10/2014

DRAFT

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