1 Working Paper

Traffic and Transport

Connell Wagner Pty Ltd
ABN 54 005 139 873
116 Military Road
Neutral Bay
New South Wales 2089 Australia

Telephone: +61 2 9465 5599
Facsimile: +61 2 9465 5598
Email: cwsyd@conwag.com
www.conwag.com

Detailed Traffic and Transport Assessment
Pacific Highway Upgrade – Sapphire to Woolgoolga
Roads and Traffic Authority

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Contents

1. Introduction

1.1 Background to the study

In January 1996, the NSW and Australian Governments announced a joint commitment to a 10-year program to upgrade the Pacific Highway between Hexham and the Queensland border. Funding of $2.2 billion was allocated to improve the standard of the Highway with projects being justified on an individual basis. Following completion of the 10 year program in June 2006, the NSW and Australian governments have agreed to further funding of $1.3 billion for the three years to mid 2009.

As part of the Pacific Highway upgrade program, the NSW Roads and Traffic Authority (RTA) is proposing to upgrade the section of the Pacific Highway between Sapphire (north of Coffs Harbour) and Arrawarra Beach Road (north of Woolgoolga), which is located on the north coast of New South Wales and situated within the Coffs Harbour Local Government Area.

This working paper addresses the issues in relation to traffic and transport associated with the proposed upgrading of the Pacific Highway between Sapphire and Woolgoolga, and in particular examines the existing and future performance of the highway with and without the proposed upgrade.

1.2 Program and project objectives

The principal objectives of the Pacific Highway Upgrading Program are to:

- Significantly reduce road accidents and injuries.
- Improve transport efficiency by reducing travel times and freight costs.
- Develop a route that involves the community and considers their interests.
- Provide a route that supports economic development.
- Manage the upgrading of the route in accordance with Ecologically Sustainable Development (ESD) principles.
- Provide the best value for money.

As well as contributing to the Program objectives, more specific objectives for the Sapphire to Woolgoolga project have been set in the RTA's brief. The project objectives in relation to traffic and transport are as follows:

- Develop a dual carriageway road with the potential to reduce crash rates to 15 crashes per 100Mvkt over the project length.

- Provide transport developments which are complementary with landuse.

- Provide intersections designed to provide at least Level of Service C twenty (20) years after opening for the 100th Highest Hourly Volume.

- Provide rest areas in accordance with the Pacific Highway Rest Area Strategy.

1.3 Study methodology

The following general study methodology has been adopted to examine the traffic and transport issues associated with the upgrade of the highway:

- Analysis of Existing Traffic and Transport Conditions (Section 2)

  This section of the study describes the existing road network and provides an analysis of historical traffic growth along the highway. Details of existing traffic volumes along the Highway including heavy vehicle movements and through traffic are provided based on traffic surveys carried out in May 2001 and May 2005. An assessment of the existing performance (levels of service) of the midblock sections and intersections is included and existing travel times are discussed. The results of an analysis of the historical crash data for the study area are also presented and details are provided in relation to the existing public transport, pedestrian, cyclist and rest area provisions.

- Description of the Proposed Upgrade (Section 3)

  A description of the proposed upgrade that has been developed as part of the study is provided in this section.

- Future Traffic and Transport Conditions (Section 4)

  This section provides details of the future land use developments proposed within and adjacent to the study area and provides an analysis of the associated traffic generation. It outlines the methodology adopted for the prediction of future traffic volumes and provides the traffic forecasts along the highway. An assessment of the future operational performance of the highway based on these forecasts is provided, with and without the proposed upgrade, and the future traffic and transport conditions are examined. Also included is an assessment of the future public transport, pedestrian, and cyclist conditions in the area, and the prediction of crash rates along the highway with the proposed upgrade is presented.

- Economic Assessment (Section 5)

  This section provides details of the economic assessment undertaken for the project including the general input parameters, travel parameters and travel cost parameters, the construction costs and cashflows, and the maintenance costs. The results of the economic analysis are next presented in terms of Net Present Value, Benefit Cost Ratio and First Year Rate of Return, and details of the sensitivity analysis undertaken to test the robustness of the results are provided.

2. Existing traffic and transport situation

2.1 Existing road network

The Pacific Highway road section between Sapphire and Arrawarra Beach Road is currently a two-lane, two-way rural road with a number of overtaking lanes. The subject section of the highway caters for local traffic from the developments situated along the coastal area as well as through traffic travelling between Coffs Harbour and Grafton and vice-versa, and more generally between Sydney and Brisbane and points further a field. The study route has a posted speed limit of 100km/h except for sections at Moonee Beach, north and south of the Woolgoolga township and within Woolgoolga itself where the highway is signposted at either 80 km/h (Moonee Beach and north and south of Woolgoolga) or 60 km/h. A 40 km/h speed limit applies in the Woolgoolga town area during the school opening and closing periods.

The following key intersections are located within the study area, all of which are currently unsignalised.

Sapphire

- Pacific Highway/Headland Road
- Pacific Highway/Split Solitary Road/Gaudrons Road

Moonee

- Pacific Highway/Moonee Beach Road
- Pacific Highway/Bucca Road
- Pacific Highway/Killara Avenue

Emerald Beach/Sandy Beach

- Pacific Highway/Smiths Road
- Pacific Highway/Fiddaman Road
- Pacific Highway/Graham Drive South
- Pacific Highway/Graham Drive North

Woolgoolga

- Pacific Highway/River Street
- Pacific Highway/Clarence Street/Pullen Street
- Pacific Highway/Newmans Road

Mullaway

- Pacific Highway/Safety Beach Drive
- Pacific Highway/Mullaway Drive
- Pacific Highway/Arrawarra Beach Road

A number of other local road intersections and property accesses are located within the study area.

2.2 Historical traffic volumes and growth

Table 2.1 shows the historical annual average daily traffic volumes at RTA permanent and non-permanent count sites within and adjacent to the study area, based on the *RTA Traffic Volume Data for Hunter and Northern Regions (2004)* publication. Note that all values are reported in axle pairs; the

actual volume of vehicles is estimated to be approximately 10%-30% lower (depending on the location) due to a proportion of the vehicles recorded having more than 2 axles.

Table 2.1
Annual Average Daily Traffic Volumes (Axle Pairs)

Station Number	Location along Pacific Highway	Annual Average Daily Traffic Volume (AADT)				
		1990	1995	1998	2001	2004
04.250	Coffs Harbour – North of High Street (MR 151), Coffs Harbour LGA	21,221	25,170	25,275	27,394	39,287
04.150	Moonee Beach – 1.0 km South of Moonee Beach Road, Coffs Harbour LGA	12,314	16,332	16,156	20,171	20,868
04.251	Woolgoolga – North of Clarence Street, Coffs Harbour LGA	12,206	14,722	14,183	16,739	18,527
04.252	Arrawarra Beach - 3.2 km North of Arrawarra Creek, Coffs Harbour LGA	6,820	8,109	7,930	8,931	10,890
04.002*	Grafton - 8.4 km South of SH12, Charles Street, Clarence Valley LGA	6,317	7,855	8,258	9,050	11,524

1. The location marked with an asterisk is a permanent counting station, while locations without an asterisk are non-permanent counting stations. All values are in axle pairs.

From Table 2.1 it is evident that the traffic volumes along the highway decrease substantially heading north out of Coffs Harbour and continue to decrease gradually through to Arrawarra Beach. From Arrawarra Beach onwards to the permanent counting station located south of Grafton, traffic levels are maintained at a relatively constant level. The data reflects the different travel characteristics at each end of the study corridor, with the majority of the traffic at the southern end comprising of local traffic while at the northern end a greater percentage of the traffic is longer-distance through traffic.

Table 2.2 shows the historical traffic growth in axle pairs for the long-term (1990-2004) scenario at points within and adjacent to the study area, calculated from the RTA traffic volume data provided in Table 2.1.

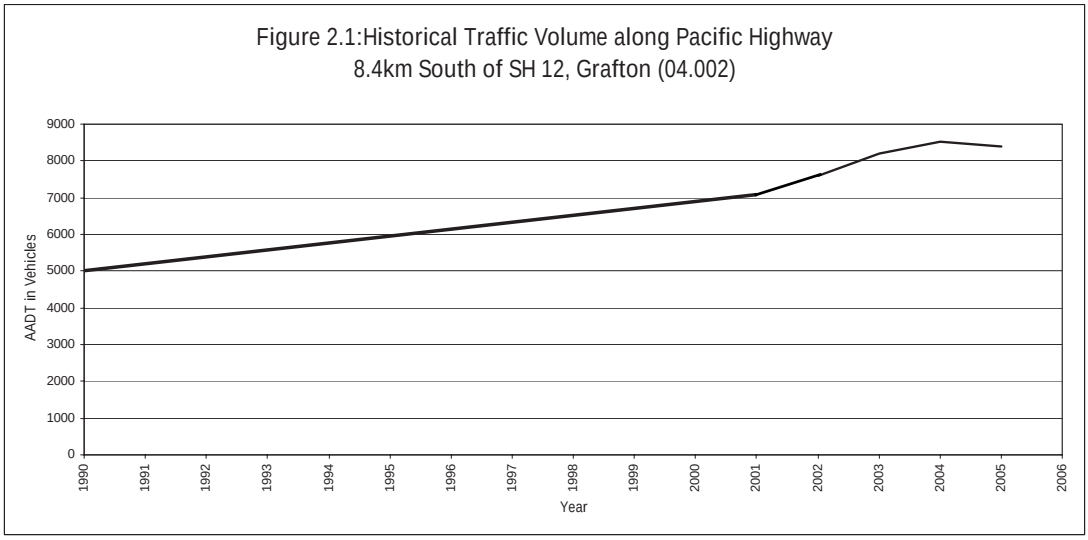
Table 2.2
Historical Traffic Growth

Station Number	Location along Pacific Highway	Traffic Growth (in axle pairs) per annum (axle prs/day/year)
		1990-2004
04.250	Coffs Harbour – North of High Street (MR151), Coffs Harbour LGA	1290
04.150	Moonee Beach – 1.0 km South of Moonee Beach Road, Coffs Harbour LGA	611
04.251	Woolgoolga – North of Clarence Street, Coffs Harbour LGA	452
04.252	Arrawarra – 3.2km North of Arrawarra Creek, Coffs Harbour LGA	291

From Table 2.2, it is evident that traffic growth along the highway has been higher at locations closer to Coffs Harbour compared to locations north of Woolgoolga. Once again this occurs because the traffic volume south of Moonee Beach Road includes a significant amount of local traffic in addition to the through traffic at this location, while the traffic volume north of Arrawarra Creek primarily comprises of through traffic. The difference in growth reflects the impact of urban development on local traffic generation in the study area, with the growth in local traffic occurring at a faster rate than the growth in through traffic (notwithstanding that the latter includes the one-off increase associated with the heavy vehicle increase with the opening of the Yelgun to Chinderah section of the Pacific Highway, as discussed below).

Figure 2.1 shows the trend in historical traffic volumes between 1990 and 2004 at the RTA permanent count station (04.002) located south of Charles Street, Grafton, which is the closest permanent count station to the study area (permanent count sites are generally chosen wherever possible for estimating historical traffic growth rates that will be used for forecasting purposes, since they normally contain more data than non-permanent count sites and therefore provide a more reliable basis for forecasting). The annual increase in vehicles from 1990 to 2001 (approximately 193 vehicles/day/year) was calculated using linear regression, based on the historical traffic volumes for this period presented in Table 2.1 with an adjustment from axle pairs to vehicles using data provided in the *Pacific Highway Upgrading Program Cumulative Impact Assessment, 1998* publication.

Figure 2.1:Historical Traffic Volume along Pacific Highway
8.4km South of SH 12, Grafton (04.002)



Comparison of the trend in volumes between 1990 and 2001 (calculated by linear regression) with the more recent data recorded in 2005 shows that there has been a substantial increase in traffic during 2002/2003 and the traffic volume at this location has not increased during 2005. The sudden increase in traffic volumes has occurred during 2002/2003 as a result of the opening of the Yelgun to Chinderah section of the Pacific Highway, which caused an increase in number of heavy vehicles on the Pacific Highway. This one-off increase does not reflect the underlying traffic growth in the region, and hence the annual increase in traffic between 1990 and 2001 (193 vehicles/day/year) has been adopted for future traffic volume forecasting purposes (refer to section 4.2 for details of the methodology used).

2.3 Existing traffic volumes at midblock locations

Daily Traffic Volumes

Table 2.3 shows the existing (2006) annual average daily traffic volumes (vehicles/day) along the highway. These volumes were derived from vehicle classification surveys that were conducted at selected locations in 2005 in conjunction with intersection surveys previously undertaken in 2001. An allowance for the traffic growth that occurred between 2005 and 2006 has been included based on the historical growth rate as discussed above. Traffic generated by the Moonee Beach Shopping Centre development, which became operational after the surveys were conducted, has also been included. The assessment was based on traffic generation rates provided in the *RTA Guide to Traffic Generating Developments* publication and Gross Leasable Floor Areas (GLFA's) specified in the report *Pacific Highway/Moonee Beach Road Intersection Analysis Report, Northern Transport and Planning and Engineering Pty Ltd*, *October 2005.* The effect of the Moonee Beach Shopping Centre development on local traffic patterns was factored into the analysis.

Table 2.3
Existing Annual Average Daily Traffic Volumes (2006)

Location	Annual Average Daily Traffic Volume – AADT (veh/day)
South of Headlands Road	20508
North of Headlands Road	19690
North of Gaudrons Road/Split Solitary Road	19464
North of Moonee Beach Road	19067
North of Bucca Road	18851
North of Killara Avenue	18649
North of Fiddaman Road	17775
North of Graham Drive South	15096
North of Graham Drive North	17424
North of River Street	11476
North of Pullen Street/Clarence Street	15636
North of Newmans Road	14539
North of Safety Beach Drive	12735
North of Mullaway Drive	10773

From Table 2.3, it is evident that the Pacific Highway currently carries approximately 20,000 veh/day at the southern end of the study area (Sapphire) and approximately 11,000 veh/day at the northern end of the study area (Arrawarra Beach). The traffic volume north of River Street is of a similar magnitude to the volume north of Mullaway Drive since a significant volume of local traffic originating from north and south of Woolgoolga has a destination within Woolgoolga (and vice-versa).

Peak Hour Traffic Volumes

Table 2.4 shows the existing (2006) peak hour traffic volumes along the highway. Once again these volumes were derived from the vehicle classification surveys that were conducted at selected locations in 2005 in conjunction with intersection surveys previously undertaken in 2001 (with an allowance for traffic growth and for the Moonee Beach Shopping Centre Development included as previously indicated).

Table 2.4
Existing Peak Hour Traffic Volumes (2006)

Location	Direction	Peak Hour Traffic Volumes (veh/hr)	
		AM Peak	PM Peak
South of Headlands Road	NB	493	1227
	SB	1466	555
North of Headlands Road	NB	516	1139
	SB	1316	590
North of Gaudrons Road/Split Solitary Road	NB	517	1121
	SB	1297	587
North of Moonee Beach Road	NB	542	1012
	SB	1219	706
North of Hoys Road	NB	542	1000
	SB	1217	706
North of Bucca Road	NB	553	1017
	SB	1209	720
North of Killara Avenue	NB	517	1026
	SB	1141	682
North of Fiddaman Road	NB	774	954
	SB	977	730
North of Graham Drive South	NB	646	664
	SB	677	662
North of Graham Drive North	NB	721	783
	SB	777	757
North of Hearnes Lake Road	NB	733	775
	SB	767	768
North of River Street	NB	371	452
	SB	481	439
North of Pullen Street/Clarence Street	NB	562	770
	SB	778	691
North of Newmans Road	NB	457	543
	SB	623	567
North of Safety Beach Drive	NB	432	444
	SB	519	487
North of Mullaway Drive	NB	340	391
	SB	400	423

2.4 Heavy vehicle movements

The movements of heavy vehicles, including light trucks, buses, semi-trailers and B-doubles, were recorded at discrete locations along the study route using midblock classified counters in May 2005. Details of the heavy vehicle movements recorded are summarised in Table 2.5.

Table 2.5
Heavy Vehicle Movements - 2005

Location along Pacific Highway	Heavy Vehicle Volumes (percentage of total volumes)*		
	Daytime (7am-10pm)	Night-time (10pm-7am)	Total (24 hour)
South of Campbell Close	1668 (10%)	588 (33%)	2256 (11%)
North of Bucca Road	1243 (9%)	572 (38%)	1815 (11%)
North of Diamond Head Drive o/pass	1218 (11%)	572 (45%)	1790 (13%)
North of Mullaway Drive	1138 (14%)	559 (54%)	1696 (17%)

Note: Volumes and percentages calculated from 7-day average traffic counts

From Table 2.5, it is evident that while the percentage of heavy vehicles in the traffic stream gradually increases travelling north from Sapphire to Woolgoolga for both the daytime and night-time periods, the number of heavy vehicles in both periods actually decreases. The data also indicates that heavy vehicles make up a significantly higher proportion of the total night-time traffic when compared to the equivalent proportions for the daytime traffic, although the volumes of heavy vehicles at night-time are considerably lower than during the daytime.

Table 2.6 shows the existing (2006) average daily heavy traffic volumes along the highway. These volumes were derived from the vehicle classification surveys that were conducted at selected locations in 2005 (as shown above in Table 2.5) in conjunction with intersection surveys previously undertaken in 2001 (with an allowance included for the Moonee Beach Shopping Centre Development as previously indicated).

Table 2.6
Existing Average Daily Heavy Traffic Volumes (2006)

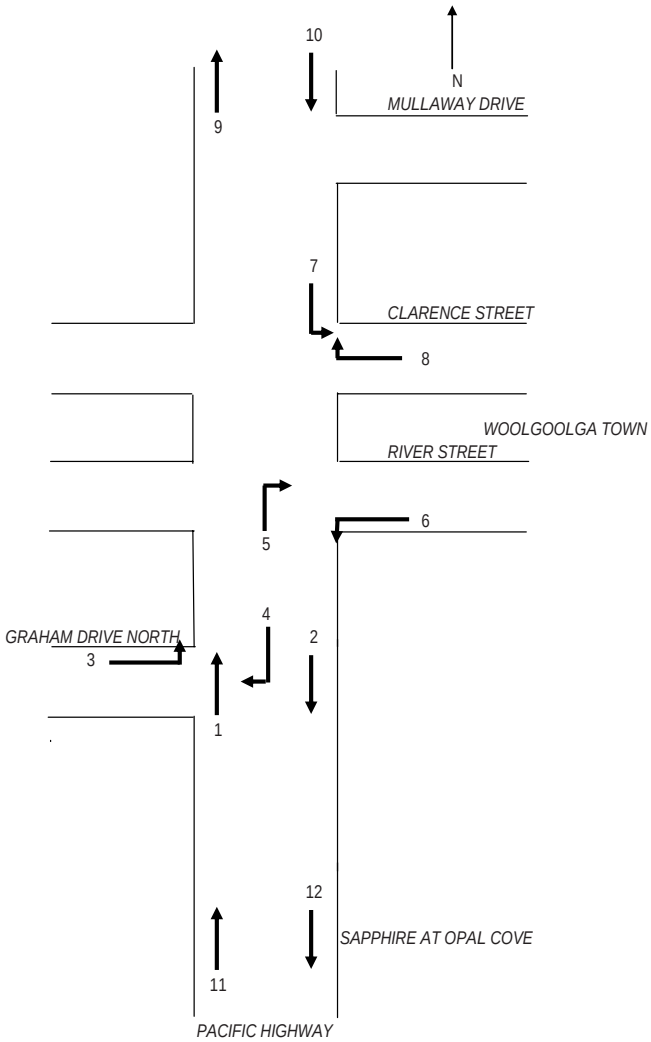
Location	Average Daily Heavy Traffic Volume (veh/day)
South of Headlands Road	2353
North of Headlands Road	2219
North of Gaudrons Road/Split Solitary Road	2186
North of Moonee Beach Road	1998
North of Bucca Road	1988
North of Killara Avenue	1990
North of Fiddaman Road	1974
North of Graham Drive South	1930
North of Graham Drive North	1943
North of River Street	1841
North of Pullen Street/Clarence Street	1910
North of Newmans Road	1890
North of Safety Beach Drive	1871
North of Mullaway Drive	1788

2.5 Results of origin destination survey

An origin-destination (OD) survey was conducted over an 11-hour period between 6.00am and 5.00pm (ie. during daylight hours) on Wednesday 11 May 2005 to determine the existing levels of through and local traffic travelling in each direction between Opal Cove (Sapphire) and Mullaway. The survey station locations are shown in Figure 2.2 and were as follows:

- Station 1 – Pacific Highway at Graham Drive North – Northbound
- Station 2 – Pacific Highway at Graham Drive North – Southbound
- Station 3 – Graham Drive North – Left turn from Graham Drive North onto Pacific Highway
- Station 4 – Graham Drive North – Right turn from Pacific Highway onto Graham Drive North
- Station 5 – River Street – Right turn from Pacific Highway onto River Street
- Station 6 – River Street – Left turn from River Street onto Pacific Highway
- Station 7 – Clarence Street – Left turn from Pacific Highway onto Clarence Street
- Station 8 – Clarence Street – Right turn from Clarence Street onto Pacific Highway
- Station 9 – Pacific Highway – North of Mullaway Exit near service station – Northbound
- Station 10 – Pacific Highway – North of Mullaway Exit near service station – Southbound
- Station 11 – Pacific Highway at Sapphire – Northbound
- Station 12 – Pacific Highway at Sapphire – Southbound

Figure 2.2
Locations of OD - Survey Stations



The number plates of a sample of light vehicles (Austroads Classes 1-2) and all heavy vehicles (Austroads Classes 3-12) were collected separately for each direction of travel as they passed each location (survey station), along with the time at which they were observed. The number plates recorded at each station were subsequently matched to determine the number of vehicles that passed both stations (i.e. 'through' vehicles in the context of trips along the highway) during specific time intervals (otherwise known as trip duration limits). The results were calculated for trip duration limits of 15 minutes, 30 minutes, 2 hours and for an open-ended trip duration (ie. no time limit imposed) to allow the effects of stoppages en-route (e.g. lunch breaks) to be observed.

The levels of through traffic calculated for the sample were subsequently extrapolated to all-vehicle, 24 hour estimates using the results of 24-hour classified automatic tube counts undertaken at the same locations at the time of the OD surveys, in conjunction with assumptions about the level of through traffic expected to occur during the non-survey period (5.00pm to 6.00am). The results of the analysis are presented in the following tables for the 15 minutes, 30 minutes, 2 hours and open-ended trip duration limits, based on a range of through traffic proportions adopted for the non-survey period.

Table 2.7 presents the results of the OD survey analysis for trips with an origin and destination along the Pacific Highway (ie. 'through' traffic).

Table 2.7
Results of OD Survey for Trips along Pacific Highway

From (Origin)/ To (Destination) *	Trip Duration Limit			
	15 minutes	30 minutes	2 hours	Open Match
	Number of Light Vehicles (Number of Heavy Vehicles) in 24 hrs			
Sapphire to north of Mullaway Dr	953 (774)	1487 (924)	1658 (986)	1765 (986)
North of Mullaway Dr to Sapphire	895 (699)	1516 (851)	1726 (875)	1874 (889)
Graham Dr North to north of Mullaway Dr	1637 (943)	1742 (966)	1863 (994)	1925 (994)
North of Mullaway Dr to Graham Dr North	1876 (887)	1958 (916)	2071 (981)	2154 (981)
Sapphire to Graham Drive (North)	2916 (1086)	3000 (1106)	3116 (1123)	3267 (1140)
Graham Drive (North) to Sapphire	2877 (941)	2985 (946)	3094 (989)	3420 (989)

Note: *Refer Figure 2.2 for OD Station Details
The figures within the brackets are heavy vehicles

Although a range of through traffic volumes have been estimated, the bypassable traffic volumes presented in this study have been based on the mid-range value of a 30 minute duration which allows for a short duration stop en-route through the study area (note that 30 minutes is approximately twice the existing travel time between Sapphire and Arrawarra recorded in the morning peak hour period as discussed in section 2.9).

Table 2.8 presents the results of the OD Survey analysis for trips with an origin or destination from/to Graham Drive North or Woolgoolga town centre (via either Clarence Street or River Street).

Table 2.8
Results of OD Survey for Trips with Origin or Destination from/to Graham Drive North or Woolgoolga Town Centre

From (Origin)/ To (Destination)	Trip Duration Limit			
	15 minutes	30 minutes	2 hours	Open Match
	Number of Light Vehicles (Number of Heavy Vehicles) in 24 hrs			
Pacific Highway at Sapphire to River Street	538 (15)	614 (19)	734 (26)	905 (26)
River Street to Pacific Highway at Sapphire	585 (20)	686 (29)	802 (33)	1028 (43)
Pacific Highway at Graham Drive North to River St	1073 (23)	1085 (26)	1110 (28)	1192 (28)
River Street to Pacific Highway at Graham Drive North	1096 (25)	1104 (36)	1141 (39)	1237 (49)
Graham Drive North to River Street	551 (5)	551 (5)	581 (7)	616 (7)
River Street to Graham Drive North	508 (14)	531 (16)	553 (16)	621 (19)
Graham Dr North to Pacific Hwy north of Mullaway Dr	92 (6)	122 (8)	162 (19)	205 (19)
Pacific Hwy north of Mullaway Dr to Graham Dr North	104 (3)	116 (6)	152 (12)	191 (13)
Clarence Street to Pacific Hwy north of Mullaway Dr	701 (32)	731 (34)	770 (37)	882 (37)
Pacific Hwy north of Mullaway Dr to Clarence Street	679 (24)	704 (30)	762 (38)	818 (38)

Note: The figures within the brackets are heavy vehicles

Based on the results of the origin - destination survey presented in Table 2.8, the following observations are made:

- Approximately 46% of the River Road traffic on the day of the survey had an origin/destination from/to a location south of Sapphire
- Approximately 37% of the Clarence Street traffic on the day of the survey had an origin/destination from/to a location north of Mullaway Drive.

From the above it is evident that the Woolgoolga town centre attracts a significant number of traffic movements from outside the study area.

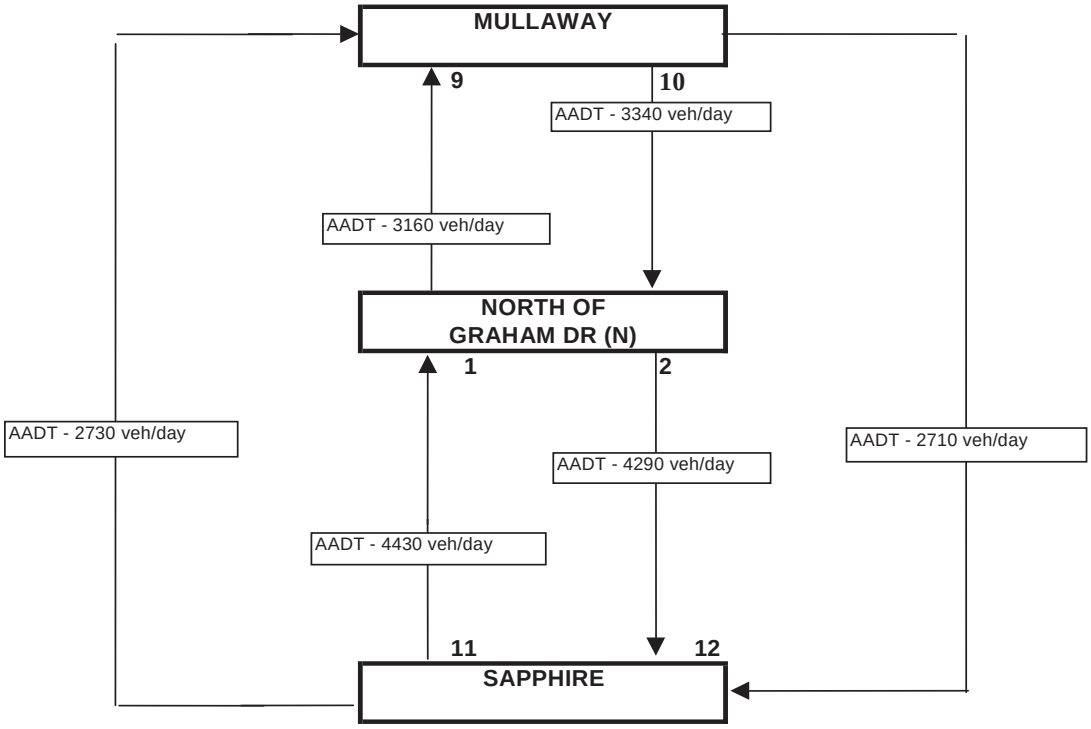
2.6 Estimated through traffic volumes

Total (Light + Heavy Vehicles) Through Traffic Volumes

The traffic volumes presented in Table 2.7 represent the estimated through traffic volumes (light vehicles and heavy vehicles) along the highway on the day of the OD survey. The through traffic volumes estimated for the 30 minute trip duration have been seasonally adjusted to annual average daily volumes based on classification surveys that were undertaken north of Mullaway Drive in March and May 2005.

The estimated 2005 annual average daily total through traffic volumes are shown in Figure 2.3.

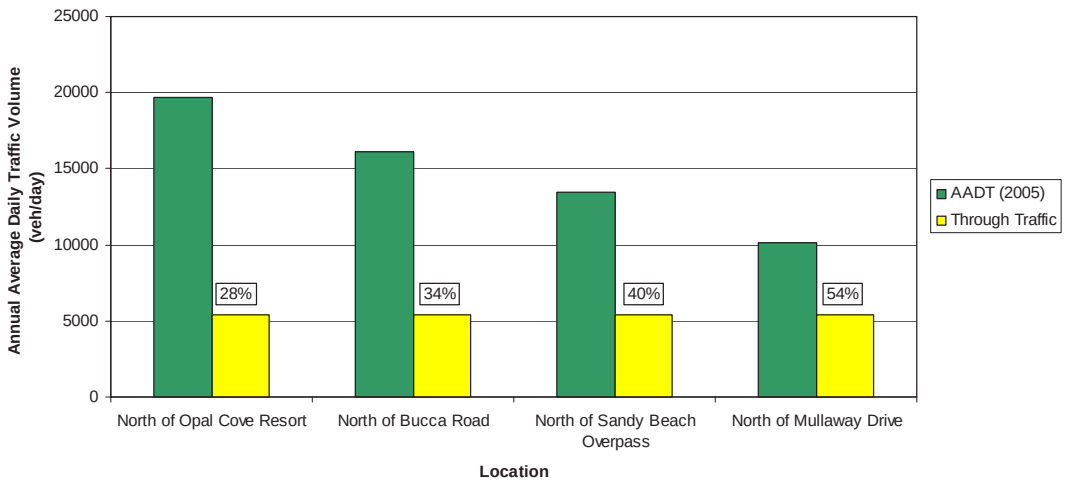
Figure 2.3
Estimated Annual Average Daily Total Through Traffic Volumes – 2005*



*note – OD Station number shown in bold.

Figure 2.3 shows that in 2005 the annual average daily through traffic volume was 6,500 veh/day (two-way) between Graham Drive North and Mullaway and 5,440 veh/day (two-way) between Sapphire and Mullaway. Figure 2.4 provides a comparison between the annual average daily through traffic volumes and the total AADT volumes at the locations where the classification surveys were undertaken.

Figure 2.4: Total Traffic Volume Vs Through Traffic Between Sapphire and Mullaway



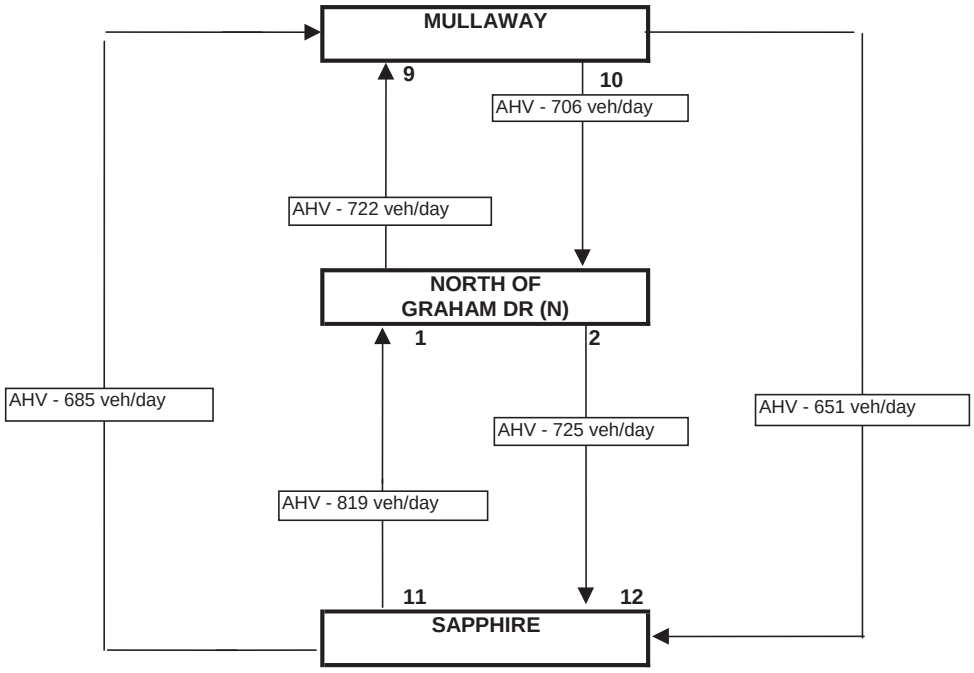
From Figure 2.4, it is evident that the annual average daily through traffic volume between Sapphire and Mullaway represents between 28% and 54% of the total AADT within the study area depending on the section of the highway being considered. The proportion of through traffic is less than half of the

total traffic along most sections and substantially less than this at the southern end, reflecting the impact of the local traffic movements on the total traffic flow.

Heavy Vehicle Through Traffic Volumes

A similar process to that outlined for the total through traffic volumes was used to adjust the heavy vehicle data recorded on the day of the OD survey to average daily volumes. The estimated 2005 average daily heavy vehicle through traffic volumes are shown in Figure 2.5.

Figure 2.5
Estimated Average Daily Heavy Vehicle Through Traffic Volumes – 2005*



*note – OD Station number shown in bold.

Figure 2.5 shows that in 2005 the average daily heavy vehicle through traffic volume was 1,428 veh/day (two-way) between Graham Drive North and Mullaway and 1,336 veh/day (two-way) between Sapphire and Mullaway. These volumes represent approximately 22% and 25%, respectively, of the total through traffic volume at these locations with light vehicles therefore making up the majority of the through traffic movements.

Figure 2.6 provides a comparison between the average daily heavy vehicle through traffic volumes and the total average daily heavy vehicle volumes at the locations where the classification surveys were undertaken.

Figure 2.6: Total Heavy Traffic Volume Vs Through Heavy Traffic Between Sapphire and Mullaway

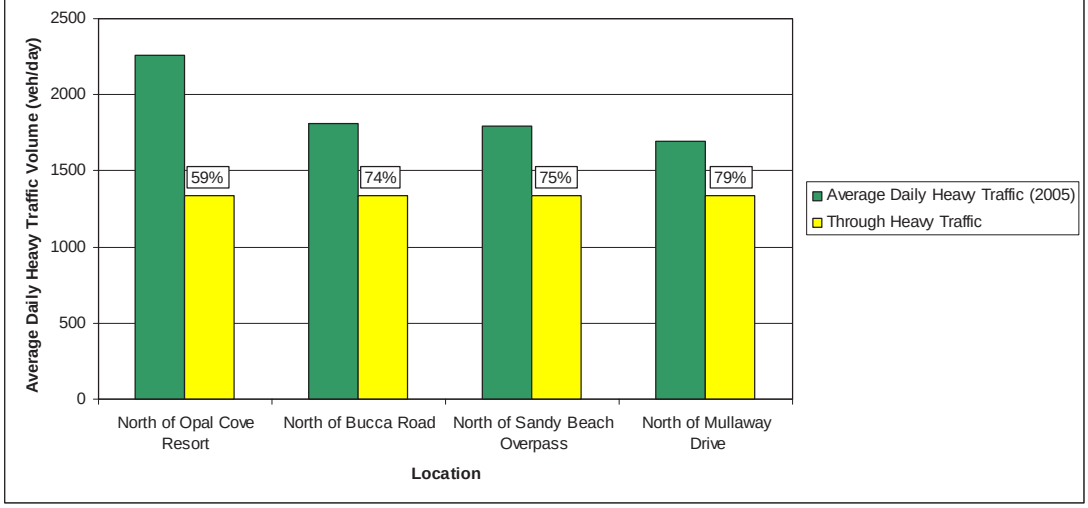


Figure 2.6 shows that the heavy vehicle through traffic volume between Sapphire and Mullaway comprises between approximately 60% and 80% of the total average daily heavy traffic volumes in the study area depending on the section of highway being considered. As expected, the proportion of through heavy traffic at the southern end of the study area is lower than at the northern end reflecting the higher proportion of local heavy traffic movements that are generated at the southern end.

2.7 Existing performance of midblock sections

Road Sections outside of area adjacent to Woolgoolga town centre

The existing performance of midblock sections along the subject section of the Pacific Highway has been assessed using the procedures for a two-lane two-way highway that are provided in the Highway Capacity Manual (HCM 2000). This procedure supersedes the current Austroads procedure (which is based on a previous version of the HCM) and, in addition to assessing the effects of no-passing zones on the general operation of a two lane highway under particular traffic conditions, enables the effects of providing overtaking lanes to be specifically assessed in terms of the flow-on benefits that are generated downstream of the overtaking lane.

The performance of the midblock sections was assessed based on the level of service criteria set out in the HCM for a two lane highway (Class I) as shown in Table 2.9. Class I represents those two lane highways on which motorists expect to travel at relatively high speeds, for which both the percent time-spent-following and the average travel speed are used to determine the level of service. Qualitative descriptions of the Level of Service criteria used in the Highway Capacity Manual (HCM 2000) for a two lane highway (Class I) are provided in Appendix A.

Table 2.9
Level of Service Criteria for Two Lane Highways (Class I)

Level of Service (LOS)	Average Travel Speed (km/h)	Percent Time-Spent-Following
A	> 90	≤ 35
B	> 80-90	> 35-50
C	> 70-80	> 50-65
D	> 60-70	> 65-80
E	≤ 60	> 80

Note: LOS F applies whenever the flow rate exceeds the segment capacity

The performance of the existing midblock sections in the study area was assessed for the morning and afternoon peak hour traffic volumes. The traffic volumes used for the analysis are shown in Table 2.4. Using this traffic information in conjunction with geometric data for the highway, the level of service for the existing highway was estimated at representative locations along the highway. The results are presented in Table 2.10.

Table 2.10
Existing Performance of Midblock Sections in Peak Hours

Road Section	Peak Hour Traffic Volume (veh/hr)*	Average Travel Speed (km/h)	Percent Time-Spent-Following	Level of Service (LOS)
AM Peak				
Headlands Rd to Moonee Beach Rd	1959	77	77	D
Moonee Beach Rd to Fiddaman Rd	1761	81	65	C/D
Fiddaman Rd to Graham Dr South	1759	86	65	C/D
Graham Dr South to Graham Dr North	1324	88	60	C
Safety Beach Dr to Arrawarra Beach Rd	951	99	25	A
PM Peak				
Headlands Rd to Moonee Beach Rd	1782	80	76	D
Moonee Beach Rd to Fiddaman Rd	1718	81	65	C/D
Fiddaman Rd to Graham Dr South	1687	87	65	C/D
Graham Dr South to Graham Dr North	1326	89	60	C
Safety Beach Dr to Arrawarra Beach Rd	931	99	23	A

Note: * Highest traffic volume within the road section

From Table 2.10, it is evident that the midblock performance of the existing highway is currently unacceptable (LOS D) between Sapphire and Moonee Beach Road and is on the borderline between being acceptable and unacceptable on the section north of Moonee Beach Road up to Graham Drive South. At locations further to the north of this point the performance of the existing highway is acceptable (LOS C or better).

Road Sections adjacent to Woolgoolga town centre

The midblock sections around Woolgoolga are more urban in character and as a result their capacity has been assessed based on the *RTA Guide to Traffic Generating Developments, October 2002*. This indicates a typical midblock capacity of 900 veh/hr in the peak direction of travel for a two-lane, two-way highway which is higher than the existing peak hour volumes within this section (refer Table 2.4). Furthermore, the performance of the intersections is currently good along the section of the highway between Graham Drive North and Safety Beach Drive as demonstrated in section 2.8. Since the performance of urban road sections is governed by the level of service of the intersections in the

absence of other constraints, it is concluded that the performance of the midblock sections along the section of highway adjacent to the Woolgoolga town centre is currently acceptable.

2.8 Existing performance of intersections

The existing performance of the key intersections in the study area for the morning and afternoon peak hour traffic volumes has been assessed using the SIDRA intersection analysis software. The traffic volumes that were used for the intersection analysis are provided in Appendix B. The results of the analysis are summarised in Table 2.11.

Table 2.11
Existing Intersection Performance – 2006[1]

Intersection on the Pacific Highway	Peak Hour	Degree of Saturation (DS)	Average Delay (secs/veh)	Level of Service (LOS)
Headlands Road	AM	1.00	>100	F
	PM	0.604	40.0	C
Split Solitary Road/Gaudrons Road	AM	0.692	58.3	E
	PM	0.596	37.9	C
Moonee Beach Road[2]	AM	0.587	30.9	C
	PM	0.586	33.1	C
Hoys Road	AM	0.656	45.7	D
	PM	0.609	40.2	C
Bucca Road	AM	0.301	13.7	A
	PM	0.528	22.5	B
Killara Avenue	AM	0.619	29.4	C
	PM	0.544	27.9	B
Fiddaman Road	AM	0.634	50.8	D
	PM	0.539	49.1	D
Graham Drive South	AM	0.467	37.7	C
	PM	0.426	40.0	C
Graham Drive North	AM	0.367	13.2	A
	PM	0.389	13.9	A
Hearnes Lake Road	AM	0.419	39.7	C
	PM	0.424	27.3	B
River Street/Arkan Avenue	AM	0.296	19.0	B
	PM	0.388	21.8	B
Clarence Street/ Pullen Street	AM	0.334	12.9	A
	PM	0.511	13.5	A
Newmans Road	AM	0.344	23.2	B
	PM	0.325	25.6	B
Safety Beach Drive	AM	0.245	16.1	B
	PM	0.238	19.1	B
Mullaway Drive	AM	0.193	12.3	A
	PM	0.260	16.3	B
Arrawarra Beach Road	AM	0.209	14.9	B
	PM	0.235	16.8	B

1. For roundabout and priority intersections, the maximum DS, delay and LOS for a particular movement is reported.
2. Analysis at Moonee Beach Road intersection has been based on the new seagull intersection layout at this location.

From Table 2.11 it can be seen that the existing performance of the intersections that are situated within the study area is generally assessed as being acceptable (LOS C or better) with the exception of the following intersections:

- Headlands Road, Split Solitary Road/Gaudrons Road and Hoys Road intersections during the morning peak hour period;
- Fiddaman Road intersection during the morning and afternoon peak hour periods

At these locations there are insufficient gaps available for traffic to safely enter into the traffic stream travelling along the highway.

2.9 Existing travel times

Travel times were measured on 18 May 2005 during the morning peak hour period from Sapphire (at the Opal Cove Resort) to Arrawarra Beach Road. The following travel time information was recorded during the site inspection.

- Travel time between Sapphire and Graham Drive North – 10 mins
- Travel time between Graham Drive North and Arrawarra – 6 mins

- Using the HCM model that was set up to predict future travel times, the following estimated travel times were derived for the existing situation based on the modelled morning peak hour traffic volumes.

- Travel time between Sapphire and Graham Drive North – 10.8 mins
- Travel time between Graham Drive North and Arrawarra – 6.2mins

The results indicate good agreement between the modelled and observed travel times for the existing situation.

2.10 Historical crash analysis

An historical crash analysis was undertaken for the 5 year period from July 2001 to June 2006 between Campbell Close and Arrawarra Beach Road. The results of the crash analysis can be summarised as follows:

- A total of 192 crashes occurred during this period, including 10 fatal crashes and 84 injury crashes.
- A total of 9 fatalities and 142 injuries were reported during the analysis period.
- 25 of the crashes were reported as speed-related crashes and 27 crashes were reported as fatigue-related crashes.
- 27 of the crashes (approximately 15% of the total crashes) were reported as heavy vehicle involvement.
- Approximately 38% of the crashes were reported as run-off road crashes.
- Approximately 22% of the crashes were recorded as rear-end crashes.
- Approximately 16% of the crashes were recorded as occurring at intersections.
- Approximately 9% of the crashes were recorded as head-on crashes.
- Approximately 6% of the crashes were reported as pedestrian-related crashes.

The following crash rates per 100 Mvkt (100 million vehicle kilometres travelled) have been calculated for the crashes that were reported between July 2001 and June 2006 within the study area.

- Fatal crashes – 1.4
- Injury crashes – 14
- Total crashes – 29

One of the project objectives of the proposal is to reduce the overall crash rate to 15 crashes per 100 Mvkt over the project length. The current crash rate (29 crashes/100Mvkt) is substantially higher than this. Comparison with the RTA publication *Road Environment Safety Update 22, April 2004* indicates that the stereotypical crash rate for a 2 lane non-divided highway is 32.8 crashes/100 Mvkt, and for a 2 lane non-divided highway with auxiliary lanes (ie overtaking lanes, turning lanes etc) is 30.4 crashes/100 Mvkt. The existing total crash rate for the section of the Pacific Highway from Sapphire to Woolgoolga is slightly lower than these values. The injury and fatal crash for the section of the Pacific Highway from Sapphire to Woolgoolga is slightly higher than the stereotypical crash rates for injury crashes (12.2 crashes/100Mvkt) and fatal crashes (1.3 crashes/100Mvkt) for 2-lane non-divided highway with auxiliary lanes.

2.11 Pedestrians and cyclists

Existing pedestrian and cyclist facilities within the study area are mainly confined to the urban areas of Woolgoolga. Limited facilities are provided within the township.

In 2001, Coffs Harbour City Council formally adopted the Northern Beaches Cycleway plan which is a 24km cycleway that links the Coffs Harbour Urban area and the townships along the northern beaches such as Moonee Beach, Emerald Beach, Sandy Beach, Woolgoolga, Safety Beach, Mullaway and Arrawarra. The construction works for the first stage (7km length of cycleway between Woolgoolga and Arrawarra Beach) commenced in 2002.

A school crossing is provided north of Clarence Street roundabout to enable school children to access Woolgoolga Public School.

2.12 Public transport

Public transport in the study area comprises bus and rail services operating to, from and within the region. Transport services are limited to the narrow urban strip along the Pacific Highway and the North Coast Railway line. Bus services include local connections between Coffs Harbour, Woolgoolga and Grafton, and interstate bus services linking Sydney and Brisbane and major centres along the North Coast. Rail services also operate through the area along the North Coast Railway line between Sydney, Grafton, Murwillumbah and Brisbane daily.

An overview of the public transport services available in the study area as at June 2007 is provided below.

Bus services

Bus services operating in the region comprise local and interstate bus services, providing local and regional travel between major cities and towns. A local bus service operates between Coffs Harbour, Woolgoolga and Grafton, and interstate coach travel is also available between Sydney and Brisbane, with services stopping at Woolgoolga. These are outlined below.

Local bus services

Ryans Bus Service provides a local service between Coffs Harbour, Woolgoolga and Grafton on weekdays only. They operate three routes: one operating between Coffs Harbour and Woolgoolga, a second between Coffs Harbour and Red Rock, and a third between Coffs Harbour and Grafton. These are listed in Table 2.11 below.

Table 2.11
Bus services between Coffs Harbour, Woolgoolga and Grafton

Route	Major Stops	Operates
Coffs Harbour to Grafton via, Woolgoolga	• Coffs Harbour • Korora • Sapphire • Moonee Beach • Emerald Beach • Sandy Beach • Woolgoolga • Safety Beach • Mullaway • Arrawarra	• School days – two return services to Coffs Harbour include services with limited stops • School holidays – two return services • Weekends and public holidays – no service
Coffs Harbour to Woolgoolga	• Coffs Harbour • Korora • Sapphire • Moonee Beach • Emerald Beach • Sandy Beach • Woolgoolga	• Monday to Friday – four return services • School days – one service to Woolgoolga • Saturdays – two return services • Sundays and public holidays – no service
Coffs Harbour to Red Rock via Woolgoolga	• Coffs Harbour • Korora • Sapphire • Moonee Beach • Emerald Beach • Sandy Beach • Woolgoolga • Safety Beach • Mullaway • Arrawarra	• School days only – one return service
Woolgoolga to Red Rock	• Woolgoolga • Safety Beach • Mullaway • Arrawarra	• Monday to Friday – two services to Red Rock / one service to Woolgoolga • School days – one service to Red Rock • Weekends and public holidays – no service

Interstate bus services

In addition to local bus services operating in the area, several coach companies also operate interstate bus services between Sydney and Brisbane along the Pacific Highway. All services stop at Coffs Harbour, Woolgoolga and Grafton. The services include:

- Premier Motor Service: Premier operates two return services daily between Sydney and Brisbane, and one return service daily between Sydney and Byron Bay, stopping at various locations along the Pacific Highway. Each of these services stops at Woolgoolga for local passengers.

- Greyhound Australia: Greyhound Australia operates four return services daily between Sydney and Brisbane, with all four of these stopping at Woolgoolga. A bus service is also provided daily from Brisbane to Coffs Harbour which stops at Woolgoolga.

Rail services

CountryLink operates three return XPT services daily along the North Coast Railway between Sydney and the North Coast. These services include the Grafton XPT, Casino XPT and Brisbane XPT, with all services stopping at Coffs Harbour and Grafton. However, there are no stops situated between Coffs Harbour and Grafton.

2.13 Rest areas

Rest areas provide a point of refuge and rest for motorists and truck drivers, especially when travelling for long distances. The RTA provides a number of rest areas along major routes throughout NSW to enable motorists and truck drivers to stop and rest at frequent intervals. These rest areas are strategically located at points along major routes so that they are spaced approximately two to three hours travel time apart.

Numerous rest areas are provided on the Pacific Highway between Hexham and Tweed Heads, with new facilities provided on newly constructed sections of road (such as Yelgun to Chinderah and Bulahdelah to Coolongolook).

Existing rest areas

There are currently no existing formal rest areas for trucks between Kempsey and Woolgoolga. A total of four rest areas are provided between Woolgoolga and Grafton.

However, existing town facilities (such as toilets, service stations etc) are available off the Pacific Highway at Coffs Harbour and Woolgoolga.

Highway Rest Area Strategy (June 2001)

In June 2001 the RTA released a Highway Rest Area Strategy Background Paper. The Strategy aims to improve and enhance the level of rest areas available, specifically for truck drivers throughout the State. It also has a framework for the hierarchy of rest areas within the State, with a four-tiered approach including towns, commercial service centres, major rest areas and secondary rest areas being adopted for development on major corridors. The Strategy aims to have at least one major truck rest area between each town pair within NSW on major corridors. The strategy envisages rest areas for trucks at 35-50km spacing on primary freight routes such as the Pacific Highway.

3. Description of the proposed upgrade

The proposal consists of the upgrade of approximately 25 km of the Pacific Highway from Campbell Close, Sapphire to Upper Corindi Road, Arrawarra to a Class M (Motorway) standard. From Sapphire to south Woolgoolga, the upgrade entails the duplication of the existing highway to a four lane dual carriageway, controlled-access highway. The proposed upgrade includes local access roads along the whole length of the highway. At the southern approach to the upgrade there would be two at-grade intersections, one a left in-left out intersection into Campbell Close and a right-in / left-out intersection with the eastern local access road (the existing highway). All other access onto and off the highway would only be provided through grade-separated interchanges. The interchanges would be located at: Gaudrons Road/Split Solitary Road, Sapphire; Moonee Beach Road/Hoys Road, Moonee Beach; Fiddaman Road/Graham Drive South, Emerald Beach and Graham Drive North, south Woolgoolga.

From south Woolgoolga to Arrawarra the upgrade comprises of a new bypass to the west of Woolgoolga constructed to a four lane dual carriageway standard, with the existing highway becoming the local access road. Two interchanges, one at south Woolgoolga (at Graham Drive North as mentioned above) and the other at Arrawarra (at Arrawarra Beach Road) would provide access onto the bypass. The bypass would deviate from the existing highway just north of Graham Drive North, and pass through rural and rural residential land as well as forestry land to the west of Woolgoolga before rejoining the existing highway at Arrawarra.

The northern interchange at Arrawarra, as well as providing access to the highway, would connect Arrawarra to Upper Corindi in the north and Woolgoolga in the south. The interchange would also house a rest area for light and heavy vehicles.

The upgrade would provide a dual carriageway highway with a 110 km/h design speed. The posted speed limit of the upgraded highway would be up to 110km/h, while the posted speed limit of the local access roads and bypassed section of the existing highway would generally be between 60 and 80 km/h.

4. Future traffic and transport conditions

An analysis of the future traffic volumes predicted to use the highway and the associated future traffic and transport conditions has been undertaken for the following scenarios:

- Base case

  This scenario represents the existing highway and includes the recent Moonee Beach Shopping Centre development and associated highway improvements.

- Proposal – Class M upgrade

  This scenario represents the highway upgrade proposal described in Section 3.

The future traffic assessments have been undertaken for the proposed opening year of 2011 and the design horizon of 20 years from opening (2031).

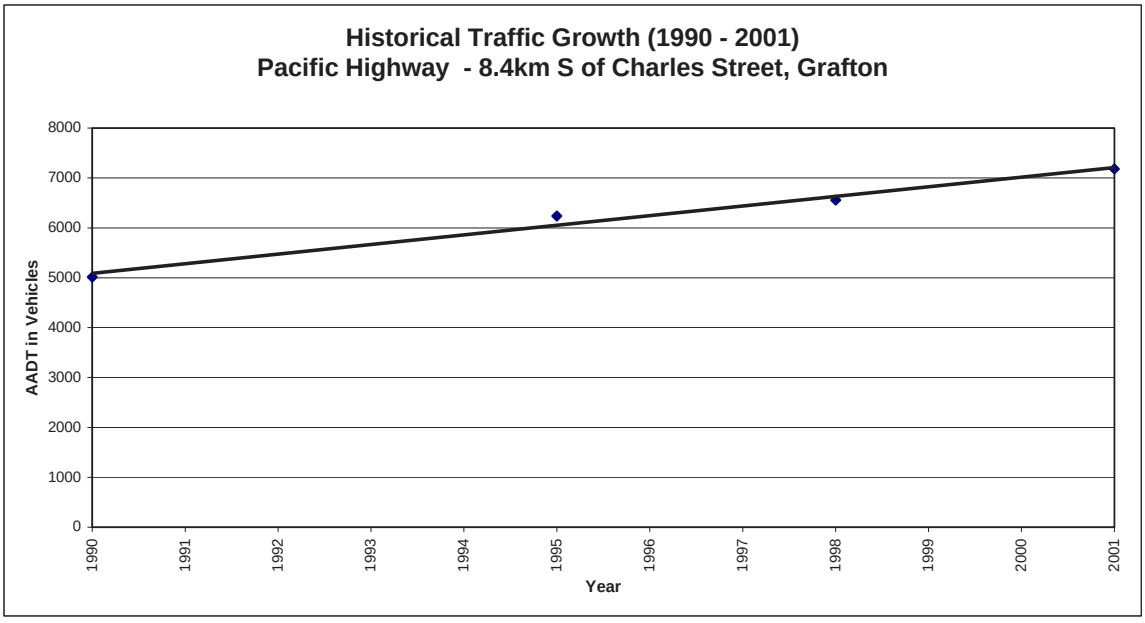
4.1 Traffic forecasting methodology

The following methodology and assumptions have been adopted to predict the future traffic volumes along the highway.

Through Traffic

The annual increase in vehicles from 1990 to 2001 (approximately 193 vehicles/day/year) was calculated at the closest RTA permanent count station (04.002) to the study area using linear regression, based on the historical traffic volumes for this period presented in Table 2.1 (with an adjustment from axle pairs to vehicles using data provided in the *Pacific Highway Upgrading Program Cumulative Impact Assessment, 1998* publication). The analysis is illustrated in Figure 4.1.

Figure 4.1
Historical Traffic Growth along the Pacific Highway



It is assumed that this annual increase represents the underlying rate of traffic growth that occurred in the study area prior to the opening of the Pacific Highway upgrade between Yelgun and Chinderah. Since this permanent count station is located on a rural section of the highway, it is assumed that the traffic growth at this location represents an increase in through traffic volumes. It is further assumed that this historical rate of traffic growth will continue to occur in the future. The annual increase in traffic volumes has therefore been added to the existing Annual Average Daily Traffic (AADT) volumes along the highway presented in Table 2.3, to allow for the growth in through traffic in future years.

Local Traffic

Table 4.1 summarises future land use developments that are planned for implementation within and around the Sapphire to Woolgoolga study area based on the *Coffs Harbour Land Capacity Assessment 2004* publication produced by Coffs Harbour City Council. The table includes details of the number of dwellings that are expected to be released between 2006 and 2021 and by 2031. Values for intermediate years (including the opening year of 2011 for the Project) were estimated by assuming that development occurs at an approximately linear rate between each of these years.

Table 4.1
Proposed Land Use Developments

Area	Routes that would be used by proposed developments	Expected Release by 2021		Expected Release by 2031	
		Zone	Number of Dwellings	Zone	Number of Dwellings
Red Rock, Corindi Beach, Corindi Plateau	Outside Study Area	Village	226	Village	386
Sub Total			226		386
Arrawarra/Mullaway/ Safety Beach	Outside Study Area	7A	52	7A	52
	Mullaway Drive	2A	25	2A	51
	Safety Beach Drive	2A	300	2A	332
	Newmans Road			2A	70
Sub Total			377		505
Woolgoolga	Pullen Street	2A	510	2A	1020
	River Street	2B	50	2B	75
	River Street	2C	400	2C	582
Sub Total			960		1677
Sandy Beach/Emerald Beach	Hearnes Lake Road	2E	223	2E	223
	Graham Dr North/South	2A	55	2A	55
	Graham Dr North/South	2E	161	2E	161
	Fiddaman Road (note 6)	1A	173	1A	173
	Fiddaman Road	2B	50	2B	70
Sub Total			616		636
Moonee/Sapphire	Moonee Beach Road	2A	848	2A	848
	Moonee Beach Road	2E	170	2E	170
	Hoys Road	2A	251	2A	251
	Spilt Solitary Road	2A	365	2A	365
	Tiki Road	1A	3	1A	3
Sub Total			1637		1637
Coffs Urban/Korora	Outside Study Area	2A	1337	2A	2735
	Outside Study Area	2B	29	2B	29
	Outside Study Area	2C	565	2C	565
	Outside Study Area	1B	300	1B	300
	Outside Study Area	2E	740	2E	740
Sub Total			2971		4369

The above table has been prepared based on the Coffs Harbour Land Capacity Assessment 2004 (produced by Coffs Harbour City Council) with the following assumptions:
1. All developments approved or commenced 2001- 2004 listed in the Coffs Harbour Land Capacity Assessment 2004 have already been completed and these developments are currently occupied.
2. All unsubdivided residential lands listed in the Coffs Harbour Land Capacity Assessment 2004 would be released and the associated developments built and occupied by 2021.
3. All potential residential lands listed in the Coffs Harbour Land Capacity Assessment 2004 would be released and the associated developments built and occupied by 2031.
4. The rate of completion of the infill developments listed in the Coffs Harbour Land Capacity Assessment 2004 (shaded in the table above) have been estimated based on local knowledge.
5. Proposed zoning of potential residential lands has been assumed.
6. Number of zone 1A dwellings at Fiddaman Road based on development application.

The traffic generation from these developments was estimated using the *RTA Guide to Traffic Generating Developments* guidelines (note that in the case of the future developments proposed in the Coffs Urban/Korora area, traffic generation was estimated on the basis of the increase in population

forecast by Coffs Harbour City Council for this area). Table 4.2 shows the daily and peak hour traffic generation rates adopted for the analysis.

Table 4.2
Traffic Generation Rates for Proposed Land Use Developments

Zone	Daily Traffic Generation Rates (per dwelling) - veh/day	Peak Hour Traffic Generation Rates (per dwelling) - veh/hr
Village (7A)	9	0.85
Detached Dwellings (1A, 2A)	9	0.85
Townhouses (2B)	6.5	0.65
Units (2C, 2D, 2E)	5	0.5

The resulting traffic generation from each of the proposed developments was distributed onto the adjacent local roads and onto and along the Pacific Highway at each location (for that proportion predicted to use the highway) based on the existing traffic pattern at the intersection providing the connection to the development and using the results of the origin-destination surveys.

Comparison of Local vs Through Traffic Increases

Table 4.3 summarises the daily increase in traffic at 2011 and 2031 predicted to arise at various points along the subject section of highway from the proposed local developments in and around the study area and from the growth in through traffic, respectively.

Table 4.3
Forecast Increase in Local and Through Traffic at 2011 and 2031

Location	Traffic Increase (veh/day)[1]					
	2011		2031		Total	
	Local	Through	Local	Through	2011	2031
South of Headlands Road	4744 (80%)	1158 (20%)	15263 (75%)	5018 (25%)	5902	20281
North of Moonee Beach Road	3303 (74%)	1158 (26%)	11419 (69%)	5018 (31%)	4461	16437
North of Fiddaman Road	3299 (74%)	1158 (26%)	11410 (69%)	5018 (31%)	4457	16428
North of Mullaway Drive	1996 (63%)	1158 (37%)	8103 (62%)	5018 (38%)	3154	13121

1. Values in brackets indicate percentage of total traffic increase arising from increase in local and through traffic respectively.

From Table 4.3 it can be seen that the majority of the increase in the daily traffic volumes at all locations in 2011 and 2031 is predicted to arise from the local developments proposed in and around the study area.

4.2 Predicted traffic volumes

The additional traffic predicted to arise in 2011 and 2031 as a result of the growth in through traffic and the trip generation associated with the future proposed land use developments in the area was added to the existing (2006) traffic volumes to produce the future traffic forecasts in 2011 and 2031. In the case of the proposed upgrade a further step involving the manual reassignment of the predicted traffic volumes was undertaken to reflect the change in access associated with the interchanges and access roads and to assess the proportion of traffic that would use the bypass.

The future daily heavy vehicles traffic volumes were estimated based on the assumption that the current heavy vehicles composition in through and local daily traffic volumes would be maintained in

the future. Based on the results of the origin destination and mid block classification surveys, the current percentages of heavy vehicles for through and local traffic volumes were estimated at different locations within the study area. These heavy vehicle percentages were applied for the future total traffic volumes to estimate the future heavy traffic volumes in 2011 and 2031.

The results are presented in the following sections for the Base Case and the Proposal.

Daily Traffic Volumes - Base Case

The predicted annual average daily traffic (AADT) volumes and average daily heavy traffic volumes for the Base Case scenario are presented in Table 4.4 for the opening year (2011) and 20 years after opening (2031).

Table 4.4
Predicted Daily Traffic Volumes - Base Case

Location	2011		2031	
	Annual Average Daily Traffic Volume (veh/day)	Average Daily Heavy Traffic Volume (veh/day)*	Annual Average Daily Traffic Volume (veh/day)	Average Daily Heavy Traffic Volume (veh/day)*
South of Headlands Road	25427	2898 (11%)	39806	4738 (12%)
North of Gaudrons Rd/Split Solitary Rd	24039	2683 (11%)	37731	4407 (12%)
North of Moonee Beach Road	22784	2412 (11%)	34760	3938 (11%)
North of Fiddaman Road	21489	2396 (11%)	33460	3946 (12%)
North of Graham Drive South	18627	2366 (13%)	30233	3966 (13%)
North of Graham Drive North	21138	2361 (11%)	33109	3901 (12%)
North of River Street	13739	2231 (16%)	22356	3756 (17%)
North of Pullen St/Clarence St	18767	2313 (12%)	30490	3881 (13%)
North of Newmans Road	17670	2301 (13%)	28937	3875 (13%)
North of Safety Beach Drive	15404	2275 (15%)	25588	3861 (15%)
North of Mullaway Drive	13402	2206 (16%)	23369	3836 (16%)

Note * Values within the brackets are estimated percentage of heavy vehicles

From Table 4.4, the Pacific Highway is predicted to carry approximately 25,400 vehicles per day south of Headlands Road at Sapphire and 13,700 vehicles per day north of River Street at Woolgoolga in 2011. These traffic volumes are predicted to increase to approximately 39,800 vehicles per day south of Headlands Road and 22,400 vehicles per day north of River Street in 2031. These forecasts equate to a doubling of the existing traffic volumes by 2031.

Table 4.4 also shows that the Pacific Highway is predicted to carry approximately 2,900 heavy vehicles per day south of Headlands Road at Sapphire and 2,200 heavy vehicles per day north of River Street at Woolgoolga in 2011. These volumes are predicted to increase to approximately 4,700 heavy vehicles per day south of Headlands Road and 3,800 heavy vehicles per day north of River Street in 2031. The existing heavy vehicle traffic volumes are therefore also predicted to double by 2031.

Daily Traffic Volumes – Proposal (Mainline)

The predicted daily traffic volumes in 2011 and 2031 for the upgraded highway (including the bypass) and for the bypassed section of the existing highway are presented in Table 4.5.

Table 4.5
Predicted Daily Traffic Volumes for the Upgraded Highway and Bypassed Section

Location	2011		2031	
	Annual Average Daily Traffic Volume (veh/day)	Average Daily Heavy Traffic Volume (veh/day)*	Annual Average Daily Traffic Volume (veh/day)	Average Daily Heavy Traffic Volume (veh/day)*
Upgraded Highway				
South of Headlands Road	25427	2898 (11%)	39806	4738 (12%)
North of Gaudrons Rd/Split Solitary Rd	24187	2824 (12%)	38003	4630 (12%)
North of Moonee Beach Road	21621	2670 (12%)	33806	4378 (13%)
North of Fiddaman Road	18166	2462 (14%)	29760	4135 (14%)
North of Graham Drive South	18627	2490 (13%)	30233	4163 (14%)
Bypass	8329)	1813 (22%)	13784	3047 (22%)
Bypassed Section				
North of Graham Drive North**	12809	548 (4%)	19325	854 (4%)
North of River Street	5410	417 (8%)	8572	709 (8%)
North of Pullen Street/Clarence Street	10438	499 (5%)	16706	833 (5%)
North of Newmans Road	9341	487 (5%)	15153	828 (5%)
North of Safety Beach Drive	7075	462 (7%)	11803	814 (7%)
North of Mullaway Drive	5073	392 (8%)	9585	788 (8%)

Note * Values within the brackets are estimated percentage of heavy vehicles
** North of Hearnes Lake Road

From Table 4.5, the upgraded Pacific Highway is predicted to carry approximately 25,400 vehicles per day south of Headlands Road at Sapphire and 8,300 vehicles per day along the Woolgoolga Bypass in 2011. These traffic volumes are predicted to increase to approximately 39,800 vehicles per day south of Headlands Road and 13,800 vehicles per day along the Woolgoolga Bypass in 2031.

Table 4.5 also shows that the Pacific Highway is predicted to carry approximately 2,900 heavy vehicles per day south of Headlands Road at Sapphire and 1,800 heavy vehicles per day along the Woolgoolga Bypass in 2011. These volumes are predicted to increase to approximately 4,700 heavy vehicles per day south of Headlands Road and 3,000 heavy vehicles per day along the Woolgoolga Bypass in 2031.

The daily traffic volumes along the bypassed section of the highway are predicted to range from approximately 12,800 vehicles per day (with 550 heavy vehicles) north of Graham Drive North to 5,100 vehicles per day (with 400 heavy vehicles) north of Mullaway Drive in 2011. These volumes are predicted to increase to approximately 19,300 vehicles per day (with 850 heavy vehicles) north of Graham Drive North and 9,600 vehicles per day (with 800 heavy vehicles) north of Mullaway Drive in 2031. Overall, the forecast daily traffic volumes in 2031along the bypassed section of the highway are predicted to be at levels that are similar to the existing traffic volumes, while the heavy vehicle traffic volumes would be substantially lower.

Daily Traffic Volumes – Proposal (Ramps)

The predicted daily traffic volumes in 2011 and 2031 along the ramps of the proposed upgrade at each interchange are presented in Table 4.6.

Table 4.6
Predicted Daily Traffic Volumes along the Ramps

Location	Predicted Daily Traffic Volumes (veh/day)	
	2011	2031
Gaudrons/Split Solitary Road Interchange		
On Ramp – Northbound	590	733
Off Ramp – Northbound	1161	1554
On Ramp – Southbound	1347	1862
Off Ramp – Southbound	678	879
Moonee/Hoys Road Interchange		
On Ramp – Northbound	2188	3204
Off Ramp – Northbound	3450	5288
On Ramp – Southbound	3083	4561
Off Ramp – Southbound	1779	2450
Fiddaman/Graham Drive South Interchange		
Entry at Graham Drive South – Northbound	974	1078
Off Ramp - Northbound - South of Fiddaman Road	995	1108
Exit at Graham Drive South – Northbound	1379	1540
Entry at Fiddaman Road – Southbound	2460	2938
Off Ramp at Graham Drive South – Southbound	867	935
Graham Drive North/Woolgoolga Bypass Interchange		
On Ramp – Northbound	139	150
Off Ramp – Southbound	134	144
Off Ramp from Pacific Highway – Northbound	5382	8525
On Ramp from Access Road – Southbound	5189	8218
Arrawarra Beach Interchange[1]		
On Ramp – Northbound	1827	3853
Off Ramp – Northbound	439	548
On Ramp – Southbound	391	479
Off Ramp – Southbound	2086	3878

1 Excludes traffic using the rest area

Peak Hour Traffic Volumes – Base Case

The predicted peak hour traffic volumes along the highway in 2011 and 2031 for the Base Case are presented in Table 4.7.

Table 4.7
Predicted Peak Hour Traffic Volumes – Base Case

Location	Direction	Peak Hour Traffic Volumes (veh/hr)			
		2011		2031	
		AM Peak	PM Peak	AM Peak	PM Peak
South of Headlands Road	NB	611	1521	957	2382
	SB	1818	688	2846	1078
North of Gaudrons Road/Split Solitary Road	NB	638	1385	1001	2174
	SB	1602	726	2514	1139
North of Moonee Beach Road	NB	647	1209	988	1845
	SB	1456	844	2222	1288
North of Fiddaman Road	NB	935	1032	1456	1607
	SB	1181	883	1840	1375
North of Graham Drive South	NB	774	819	1194	1330
	SB	836	817	1357	1318
North of Graham Drive North	NB	875	950	1370	1489
	SB	943	919	1476	1439
North of River Street	NB	445	541	724	880
	SB	575	484	936	787
North of Pullen Street/Clarence Street	NB	681	890	1158	1335
	SB	917	778	1434	1241
North of Newmans Road	NB	555	660	909	1081
	SB	757	689	1239	1128
North of Safety Beach Drive	NB	502	537	767	891
	SB	627	589	1042	978
North of Mullaway Drive	NB	423	486	737	848
	SB	498	526	869	917

Peak Hour Volumes – Proposal (Mainline)

The predicted peak hour traffic volumes in 2011 and 2031 for the upgraded highway (including the bypass) and for the bypassed section of the existing highway are presented in Table 4.8.

Table 4.8
Predicted Peak Hour Traffic Volumes for the Upgraded Highway and Bypassed Section

Location	Direction	Peak Hour Traffic Volumes (veh/hr)			
		2011		2031	
		AM Peak	PM Peak	AM Peak	PM Peak
Upgraded Highway					
South of Headlands Road	NB	611	1521	957	2382
	SB	1818	688	2846	1078
North of Gaudrons Rd/Split Solitary Rd	NB	671	1422	1022	2247
	SB	1637	675	2601	1034
North of Moonee Beach Road	NB	696	1299	1036	1964
	SB	1505	700	2436	1045
North of Fiddaman Road	NB	729	920	1144	1443
	SB	952	675	1578	1142
North of Graham Drive South	NB	774	820	1194	1330
	SB	1029	785	1659	1268
Bypass[1]	NB	433		717	
	SB	650		1075	
Bypassed Section					
North of Graham Drive North[2]	NB	623	628	965	979
	SB	757	703	1147	1009
North of River Street	NB	164	209	273	345
	SB	359	189	568	285
North of Pullen Street/Clarence Street	NB	400	558	707	800
	SB	701	483	1066	739
North of Newmans Road	NB	274	328	458	546
	SB	541	394	871	626
North of Safety Beach Drive	NB	221	205	316	356
	SB	411	294	674	476
North of Mullaway Drive	NB	142	154	286	313
	SB	282	231	501	415

1. 100th highest hourly volume (13% of AADT) is provided for the bypass.
2. North of Hearnes Lake Road

4.3 Future performance of midblock sections

The future performance of midblock sections along the subject section of the Pacific Highway has been assessed for the opening year (2011) and 20 years after opening (2031) for the Base Case option and for the Class M upgrade option using procedures provided in the Highway Capacity Manual (HCM 2000).

Base Case - road sections outside of area adjacent to Woolgoolga town centre

For those sections that are outside of the area adjacent to Woolgoolga town centre for the Base Case, the procedures for a two-lane two-way highway (Class I) have been adopted as per the analysis in Section 2.7, with the level of service criteria the same as specified in Table 2.9. Qualitative descriptions of the Level of Service criteria are provided in Appendix A. The traffic volumes used for the analysis are shown in Table 4.7. Using this traffic information in conjunction with geometric data for the highway, the level of service for the Base Case was estimated at representative locations along the highway. The results are presented in Table 4.9.

Table 4.9
Predicted Performance of Midblock Sections - Base Case

Location	2011				2031			
	Peak Hour Traffic Volume (veh/hr)*	Average Travel Speed (km/h)	Percent Time-Spent-Following	Level of Service (LOS)	Peak Hour Traffic Volume (veh/hr)*	Average Travel Speed (km/h)	Percent Time-Spent-Following	Level of Service (LOS)
AM Peak								
Headlands Rd to Moonee Beach Rd	2429	70	83	E	3803	49	89	F
Moonee Beach Rd to Fiddaman Rd	2104	75	69	D	3210	58	75	F
Fiddaman Rd to Graham Dr South	2117	80	69	D	3296	60	75	F
Graham Dr South to Graham Dr North	1610	85	64	C	2551	70	71	D
Safety Beach Dr to Arrawarra Beach Rd	1129	97	26	A	1810	88	31	B
PM Peak								
Headlands Rd to Moonee Beach Rd	2210	73	78	D	3460	55	88	F
Moonee Beach Rd to Fiddaman Rd	2053	76	68	D	3133	59	73	F
Fiddaman Rd to Graham Dr South	1915	83	68	D	2982	66	73	D
Graham Dr South to Graham Dr North	1636	85	64	C	2648	68	72	D
Safety Beach Dr to Arrawarra Beach Rd	1125	99	27	A	1870	87	31	B

Note: * Highest traffic volume within the road section

Based on Table 4.9, it is evident that:

- The performance of the midblock sections of the highway in the Base Case in 2011 is generally predicted to be worse than the existing performance (refer Table 2.10), with an unacceptable level of service (LOS D or worse) predicted for the road section between Sapphire and Graham Drive South. The road sections from Graham Drive South to south of Woolgoolga and from north of Woolgoolga (Safety Beach Drive) to Arrawarra are predicted to perform with an acceptable level of service in 2011.

- By 2031 the performance of the existing highway in the Base Case is predicted to have deteriorated further, with an unacceptable level of service (LOS D or worse) predicted for the entire road section between Sapphire and south of Woolgoolga. However, the road section north of Woolgoolga (Safety Beach Drive) to Arrawarra is predicted to continue to perform with an acceptable level of service at this time.

Base Case - Road Sections adjacent to Woolgoolga town centre

The midblock sections around Woolgoolga are more urban in character and therefore (as per section 2.7) their capacity has been assessed based on the *RTA Guide to Traffic Generating Developments, October 2002*. This indicates a typical midblock capacity of 900 veh/hr in the peak direction of travel for a two-lane, two-way highway. In the absence of any midblock constraints, the performance of urban road sections is governed by the level of service of the intersections.

In 2011, the performance of the intersections is predicted to be good along the road section between Graham Drive North and Safety Beach Drive with the exception of the Hearnes Lake Road intersection (refer section 4.4). However, the traffic volumes within this section would potentially exceed the typical midblock capacity of 900 veh/hr between Graham Drive North and River Street and between Clarence Street and Newmans Road. As a result, the performance of the highway in the area adjacent to the Woolgoolga town centre in the Base Case is predicted to be unacceptable by 2011.

Over time the performance of this section of the highway is predicted to deteriorate further, with all intersections between Graham Drive North and Safety Beach Drive predicted to be operating at an unacceptable level of service (LOS D or worse) in the Base Case in 2031. The traffic volumes in each direction of travel at most of the locations along this section of highway are also predicted to exceed the typical midblock capacity of 900 veh/hr by 2031.

Proposal – Upgraded Highway

For the Class M upgrade proposal the procedures for basic freeway segments specified in the Highway Capacity Manual (HCM 2000) have been used and the corresponding level of service criteria (which are based on lane density measured in passenger cars per kilometre per lane) are as shown in Table 4.10. Qualitative descriptions of the Level of Service criteria used for basic freeway segments are provided in Appendix C.

Table 4.10
Level of Service Criteria for Basic Freeway Segments

Level of Service (LOS)	Density Range (pc/km/ln)*
A	0-7
B	> 7-11
C	> 11-16
D	> 16-22
E	> 22-28
F	> 28

*passenger cars per kilometre per lane

The road section between Sapphire and the proposed Woolgoolga Bypass was assessed using the morning peak hour traffic volumes at Sapphire which are the highest traffic volumes within the study area (refer Table 4.8).

For the proposed Woolgoolga Bypass, the Design Hour Volume (DHV) which is the 100th highest hourly volume in a year was used for the assessment. The following information, which is based on an analysis of the existing hourly traffic volumes recorded at the RTA Permanent Count Station at Tick Gate, was used in the assessment.

- Design hour volume (DHV) – 13% of AADT
- Percentage of heavy vehicles in the DHV – 5%
- Percentage of recreational vehicles in the DHV – 50%
- Directional split for the DHV – 40:60 (NB:SB)
- Terrain – Level
- Free flow speed – 110km/h

Table 4.11 shows the predicted performance of the upgraded highway in 2011 and 2031 based on the relevant predicted traffic volumes from Table 4.8. A sensitivity analysis was also undertaken based on a 10% increase in the predicted traffic volumes and the results of this are included in Table 4.11.

Table 4.11
Predicted Performance of Midblock Sections – Upgraded Highway

Year	Design Volume (veh/hr)[1]	Average Travel Speed (km/h)[2]	Lane Density (pc/km/ln)	Level of Service (LOS)
Road Section between Sapphire and Woolgoolga Bypass				
2011	2429	109	9.3	B
2031	3803	109	14.6	C
Road Section between Sapphire and Woolgoolga Bypass – Sensitivity Analysis				
2011	2672	109	10.2	B
2031	4183	108	16.0	C
Woolgoolga Bypass				
2011	1083	109	3.5	A
2031	1792	109	5.9	A
Woolgoolga Bypass – Sensitivity Analysis				
2011	1191	109	3.9	A
2031	1971	109	6.4	A

1. Morning peak hour volume at Sapphire used for section between Sapphire and Woolgoolga Bypass; Design Hour Volume (DHV) used for Woolgoolga Bypass
2. Average Travel Speed for the upgrade proposal is an output from the basic freeway segments analysis but is not used to determine the level of service (which is based on lane density only).

From Table 4.11, the following observations are made:

- The midblock performance of the proposed upgrade on the section between Sapphire and the Woolgoolga Bypass is predicted to be good (LOS B) in 2011 for the predicted traffic volumes. By 2031, the performance of this section of the upgraded highway is predicted to be LOS C which is acceptable.

- For the Woolgoolga Bypass section, the midblock performance in 2011 is predicted to be good (LOS A) for the predicted traffic volumes and it is predicted that the bypass would continue to operate at this level until 2031 and beyond.

- The sensitivity analysis indicates that the predicted level of service for the proposed upgrade (both for the section of highway between Sapphire and the Woolgoolga Bypass and for the Woolgoolga Bypass itself) would not change if the predicted traffic volumes were 10% higher.

- Overall, the results indicate that the upgraded highway will operate with an acceptable level of service through to 2031 and provide a substantial improvement in performance relative to the Base Case. The proposed upgrade would result in a substantial increase in average speed thereby reducing travel times (refer section 4.5).

Proposal – Bypassed Section of the Highway

The midblock performance on the bypassed section of the highway around Woolgoolga associated with the upgrade proposal has been assessed using the *RTA Guide to Traffic Generating Developments, October 2002*. This section of highway would remain as a two-lane two-way road for which a midblock capacity of 900 veh/hr in the peak direction of travel typically applies as discussed in previous sections. The analysis has been based on the predicted peak hour traffic volumes provided in Table 4.8. As indicated previously, in the absence of any midblock constraints the performance of urban road sections is governed by the level of service of the intersections.

The analysis indicates that in 2011 the predicted traffic volumes along the bypassed section of highway are less than the typical midblock capacity of 900 veh/hr at all locations. The performance of the intersections is also predicted to be good (LOS A or B) at all locations except for Hearnes Lake Road for which LOS C is predicted (refer section 4.4). This level of service is still acceptable. As a result, the performance of the bypassed section of the highway is predicted to be acceptable in 2011.

By 2031, the performance of the Hearnes Lake Road intersection would be unacceptable (although all other intersections along the bypassed section of the highway would continue to operate at an acceptable level of service), and the typical midblock capacity of 900 veh/hr would be exceeded on the road sections between Graham Drive North and River Street and between Clarence Street and Newmans Road (southbound).

Overall, comparison of the results for the upgrade proposal with those for the Base Case indicates that the proposed Woolgoolga Bypass substantially reduces the extent of improvements required along the bypassed section of highway adjacent to the Woolgoolga town centre. The proposal also potentially delays the timing for the implementation of midblock capacity improvements along the bypassed section of highway.

4.4 Future performance of intersections

Base Case

An analysis of the future performance of the key intersections during the morning and afternoon peak hour periods has been undertaken for the Base Case option for the opening year (2011) and 20 years after opening (2031) using the SIDRA intersection analysis software. Traffic volumes used for the analysis are provided in Appendix D. The results of the analysis are presented in Table 4.12.

Table 4.12
Future Performance of Intersections – Base Case[1]

Intersection on the Pacific Highway	Peak Hour	2011			2031		
		Degree of Saturation (DS)	Average Delay (secs/veh)	Level of Service (LOS)	Degree of Saturation (DS)	Average Delay (secs/veh)	Level of Service (LOS)
Headlands Road	AM	1.437	>100	F	1.582	>100	F
	PM	0.757	92.9	F	1.207	>100	F
Split Solitary Rd/Gaudrons Rd	AM	0.848	>100	F	1.974	>100	F
	PM	0.733	>100	F	1.154	>100	F
Moonee Beach Road[2]	AM	0.686	47.2	D	2.600	>100	F
	PM	0.844	49.2	D	2.506	>100	F
Hoys Road	AM	0.771	>100	F	1.162	>100	F
	PM	0.717	>100	F	1.095	>100	F
Bucca Road	AM	0.360	15.3	B	0.563	26.9	B
	PM	0.634	31.3	C	0.978	>100	F
Killara Avenue	AM	0.741	37.2	C	1.142	>100	F
	PM	0.661	32.7	C	1.021	76.0	F
Fiddaman Road	AM	0.773	>100	F	1.568	>100	F
	PM	0.576	74.9	F	0.857	>100	F
Graham Drive South	AM	0.636	51.2	D	1.750	>100	F
	PM	0.598	54.5	D	1.118	>100	F
Graham Drive North	AM	0.455	16.5	B	1.500	>100	F
	PM	0.479	17.8	B	2.000	>100	F
Hearnes Lake Road	AM	0.579	62.5	E	0.790	>100	F
	PM	0.512	64.3	E	0.807	>100	F
River Street/Arkan Avenue	AM	0.478	24.5	B	1.500	>100	F
	PM	0.556	28.9	C	1.325	>100	F
Clarence Street/ Pullen Street	AM	0.384	13.3	A	1.163	>100	F
	PM	0.585	14.5	B	0.943	40.9	C
Newmans Road	AM	0.503	35.6	C	1.000	>100	F
	PM	0.393	38.9	C	0.926	>100	F
Safety Beach Drive	AM	0.390	20.7	B	1.042	>100	F
	PM	0.345	25.2	B	0.775	>100	F
Mullaway Drive	AM	0.237	13.8	A	0.450	29.2	C
	PM	0.354	21.3	B	0.608	85.8	F
Arrawarra Beach Road	AM	0.263	18.1	B	0.466	48.9	D
	PM	0.297	20.9	B	0.520	79.4	F

1. For roundabout and priority intersections, the maximum DS, delay and LOS for a particular movement is reported.
2. Analysis at Moonee Beach Road intersection has been based on the new seagull intersection layout at this location.

From Table 4.12, the following observations are made:

- The performance of the Headlands Road, Split Solitary Road/Gaudrons Road, Moonee Beach Road, Hoys Road, Fiddaman Road, Graham Drive South and Hearnes Lake Road intersections along the highway is predicted to be unacceptable (LOS D or worse) in the Base Case in 2011. The performance of the other intersections is satisfactory or good.

- The performance of all the key intersections would deteriorate to an unacceptable level (LOS D or worse) during at least one of the peak hour periods by 2031.

From the above analysis, it is evident that the performance of the existing intersections in the Base Case would deteriorate over time to a level at which sufficient gaps would potentially not be available for traffic to enter safely into the main traffic stream along the highway. This would occur in particular during the peak hour periods (on which the analysis is based), but could also occur during the holiday periods by 2031.

The Proposal

The predicted performance of the intersections that are proposed for the Class M upgrade option, including both the at-grade connections to the highway and the intersections proposed at the interchanges, has been assessed for the opening year (2011) and 20 years after opening (2031) using the SIDRA intersection analysis software. The performance of the intersections that are located along the bypassed section of the highway is also provided in this section. Traffic volumes used for the analysis are provided in Appendix E.

Table 4.13 summarises the predicted performance of the at-grade connections (excluding merges and diverges) and intersections that are proposed at the interchanges.

Table 4.13
Intersection Performance – Proposed Upgrade (Interchanges and At-grade Connections)[1]

Intersection on the Pacific Highway	Peak Hour	2011			2031		
		Degree of Saturation (DS)	Average Delay (secs/veh)	Level of Service (LOS)	Degree of Saturation (DS)	Average Delay (secs/veh)	Level of Service (LOS)
Connection to Eastern Access Road at Sapphire[2]							
NB Pacific Highway/Eastern Access Road	AM	0.764	>100	F	1.000	>100	F
	PM	0.389	15.2	B	0.614	25.1	B
Split Solitary Road/Gaudrons Road Interchange[3]							
Gaudrons Rd/NB Ramps	AM	0.075	10.9	A	0.097	11.3	A
	PM	0.126	10.2	A	0.172	10.7	A
Split Solitary Rd/SB Ramps	AM	0.183	10.5	A	0.204	9.5	A
	PM	0.099	9.6	A	0.153	8.4	A
Moonee Beach Road/Hoys Road Interchange							
Hoys Rd/NB Ramps	AM	0.220	9.9	A	0.321	11.5	A
	PM	0.480	12.8	A	0.749	19.1	B
Moonee Beach Rd/SB Ramps	AM	0.284	9.0	A	0.531	10.5	A
	PM	0.420	9.9	A	0.543	13.1	A
Fiddaman Road/Graham Drive South Interchange							
Fiddaman Rd/Access Rd	AM	0.172	9.7	A	0.192	10.9	A
	PM	0.194	10.3	A	0.216	11.2	A
Graham Dr South/Access Rd	AM	0.114	10.8	A	0.138	11.1	A
	PM	0.169	11.0	A	0.189	11.2	A
Graham Drive North/Woolgoolga Bypass Interchange							
Graham Dr North/Access Rd	AM	0.386	12.0	A	0.626	12.5	A
	PM	0.393	12.0	A	0.639	12.5	A
Access Rd/Southbound Off Ramp from the Bypass	AM	0.394	26.7	B	0.600	>100	F
	PM	0.366	25.6	B	0.625	>100	F
Arrawarra Beach Interchange							
Access Rd/SB Ramps/Access Rd	AM	0.239	8.8	A	0.377	10.3	A
	PM	0.254	10.9	A	0.447	12.2	A

1. For roundabout and priority intersections, the maximum DS and delay and lowest LOS is reported.
2. Results based on priority T-intersection layout with right turn out not permitted. Performance analysed for scenario in which 50% of northbound traffic from Headlands Road and resorts travelling towards Coffs Harbour uses the access road and this intersection as means of access onto highway (and vice-versa for southbound traffic). Balance of traffic is assumed to use Split Solitary Road/Gaudrons Road I/C.
3. Performance analysed for worst case scenario in which all traffic to/from Headlands Road uses Split Solitary Road/Gaudrons Road interchange as means of access

From Table 4.13, it is evident that the performance of the intersections is predicted to be good (LOS A or B) at all of the intersections proposed at the interchanges and at the at-grade connections to the highway during the morning and afternoon peak hour periods up to the design horizon (2031) with the following exceptions:

- NB Pacific Highway /Eastern Access Road connection at Sapphire during the AM peak
- Access Road/Off Ramp intersection at Woolgoolga during both peaks

The performance of the northbound Pacific Highway/Eastern Access Road connection at Sapphire is predicted to provide a level of service (LOS) F at the year of opening (2011) during the AM peak period. During the AM peak hour, 68 vehicles are predicted to potentially turn right from the Pacific Highway onto the eastern access road at the intersection. The estimated 95th percentile queue length for vehicles in the proposed right turn bay on the highway is 10m in 2011 and 119m in 2031 during the

AM peak hour period. Based on the RTA Road Design Guide, in 2011the proposed 175m long right turn bay would provide for deceleration from in excess of 100 km/h with the 95th percentile queue length of vehicles. In 2031, the right turn bay would provide for deceleration from 70 km/h to the 95th percentile queue length of vehicles. Traffic may choose to use the alternative means of access from the highway via the proposed Split Solitary Road/Gaudrons Road interchange to avoid delays turning into the eastern access road,. The results in Table 4.13 indicate that the Split Solitary Road/Gaudrons Road interchange has plenty of spare capacity to accommodate the additional movements if required.

For the southbound off ramp intersection with the existing highway at Woolgoolga, the performance is predicted to be good (LOS B) in 2011 but would deteriorate to a level of service (LOS) F between 2011 and 2031. When required, the control at intersection could be upgraded to a signal/roundabout to provide an improved level of service.

The predicted performance of the intersections along the bypassed section of the highway for the proposal is provided in Table 4.14.

Table 4.14
Intersection Performance – Proposed Upgrade (Bypassed Section of Highway)[1]

Intersection on the Pacific Highway	Peak Hour	2011			2031		
		Degree of Saturation (DS)	Average Delay (secs/veh)	Level of Service (LOS)	Degree of Saturation (DS)	Average Delay (secs/veh)	Level of Service (LOS)
Hearnes Lake Road[2]	AM	0.461	13.3	A	0.702	19.4	B
	PM	0.445	12.6	A	0.640	16.4	B
River Street/Arkan Avenue	AM	0.322	13.8	A	0.892	32.9	C
	PM	0.399	13.7	A	0.648	19.5	B
Clarence Street/ Pullen Street	AM	0.320	12.9	A	0.607	16.9	B
	PM	0.536	13.2	A	0.847	18.9	B
Newmans Road	AM	0.292	15.2	B	0.651	39.9	C
	PM	0.214	15.4	B	0.354	28.0	B
Safety Beach Drive	AM	0.239	12.7	A	0.595	22.3	B
	PM	0.164	12.1	A	0.390	17.7	B
Mullaway Drive	AM	0.156	10.5	A	0.243	13.0	A
	PM	0.158	11.0	A	0.256	14.4	B
Arrawarra Beach Road	AM	0.137	10.9	A	0.256	14.9	B
	PM	0.119	10.8	A	0.222	14.5	B

1. For roundabout and priority intersections, the maximum DS, delay and LOS for a particular movement is reported.
2. A roundabout would be provided at the Hearnes Lake Road intersection with the highway upgrade

From Table 4.14, it is evident that the intersections which are located along the bypassed section of the highway are predicted to perform with an acceptable level of service (LOS C or better) up until the design horizon (2031).

Comparison of the results with those for the Base Case indicates that all intersections (including the Hearnes Lake Road intersection) along the bypassed section are predicted to perform substantially better with the proposed upgrade.

4.5 Predicted travel times

Table 4.15 shows the predicted travel times along the highway during the morning peak hour period in 2011 (opening year) and in 2031 (20 years after opening) for the Base Case (existing highway) and the Proposal. The predicted travel times are based on the predicted travel speeds on the midblock sections provided in section 4.3.

Table 4.15
Estimated Future Travel Times

Section	Estimated Travel Time (mins)	
	Base Case (existing highway)	Proposal*
2011		
Between Sapphire at Opal Cove and Graham Drive North	11.7	8.1
Between Graham Drive North and Arrawarra Beach Road	6.3	5.2
Total Travel Time between Sapphire and Arrawarra Beach Road	18.0	13.3
2031		
Between Sapphire at Opal Cove and Graham Drive North	15.6	8.1
Between Graham Drive North and Arrawarra Beach Road	7.0	5.2
Total Travel Time between Sapphire and Arrawarra Beach Road	22.6	13.3

* estimated for travel along the upgraded highway and the proposed Woolgoolga Bypass

Based on Table 4.15 it can be seen that the proposed upgrade would potentially yield approximately 5 minutes travel time savings in 2011 and 9 minutes travel time savings in 2031 during the morning peak hour periods.

4.6 Predicted crash rates

Table 4.16 shows the estimated annual number of crashes and crash rates in 2011 (opening year) and in 2031 (20 years after opening) for the Base Case and the Proposal along the subject section of highway. These estimates have been based on the historical crash data for the 5 year period between July 2001 and June 2006 (refer Section 2.10), and the assumption that the number of crashes would increase at the same rate as the increase in traffic volumes predicted to occur between now and the future analysis year in the absence of any road improvements (using the traffic volume projections that are based on historical growth and the traffic generated from the future land use developments). Crash reductions are then applied to reflect the benefits of duplicating the highway (in the case of the Class M upgrade proposal).

The estimated crash rate for the Proposal (20 crashes per 100Mvkt) is based on advice provided in the RTA Economic Analysis Manual in relation to crash rates for the economic analysis of dual carriageway highways. It is noted that the rate of 20 crashes per 100Mvkt in the RTA Economic Analysis Manual is slightly higher than the stereotypical crash rate (18.8 crashes/100Mvkt) for a 4- lane Freeway in the RTA's publication *Road Environment Safety Update 22, April 2004* and, consequently could be considered to be a conservative estimate of the accident reduction likely to be achieved by the Proposal. It is also noted that the rate of 20 crashes per 100Mvkt in the RTA Economic Analysis Manual is higher than the RTA's target crash rate of 15 crashes per 100Mvkt for the upgrade of the Pacific Highway.

Table 4.16
Estimated Number of Crashes and Crash Rates

Year	Number of Crashes (Crash Rate in Crashes per 100 Mvkt)[1]	
	Base Case	Proposal
2011	50 (29)	36 (20)
2031	79 (29)	56 (20)

Mvkt = million vehicle kilometres travelled

Based on Table 4.16, the Proposal is predicted to reduce the accident rate on the highway by approximately 30%.

4.7 Pedestrians and cyclists

It is anticipated that pedestrians and cyclists would use the access roads proposed as part of the upgrade to access the townships and land uses along the coast. The access roads would be expected to provide a safer environment for these road users due to the lower traffic speeds on these roads compared to the existing highway and the separation of the through traffic (and in particular the larger articulated and B-Double heavy vehicles) from the local traffic using these roads.

Coffs Harbour City Council has proposals for an off-road regional cycleway facility along the northern beaches. The Proposal would provide pedestrian and cycle facilities on key overbridges across the proposed highway that would be consistent with council's cycleway strategy for the northern beaches area.

4.8 Public transport

The proposed highway upgrade would potentially reduce the travel time for long distance/regional buses and coaches within the study area, particularly during holiday periods and during the peak hour periods of a normal (average) day. The proposed upgrade provides an 12m wide median. This arrangement improves road safety for buses along the study route since any head-on collisions with vehicles (and particularly trucks) would potentially lead to multiple injuries and fatalities on a two-lane highway.

Local buses would use the access roads to access the townships located along the study corridor. The proposed Woolgoolga bypass would be of little benefit to public transport, since most of the buses/coaches currently travel via Woolgoolga to pick up/set down passengers.

4.9 Rest areas/truck stops

No rest areas are currently provided within the study area. However, as part of the upgrade proposal it is planned to provide a rest area for both light and heavy vehicles at the Arrawarra Beach interchange. This would be expected to assist in reducing the number of fatigue-related crashes within the study area.

4.10 Freight costs

Based on the midblock level of service analysis, it is expected that freight costs would reduce with the proposed highway upgrade due to the reductions in travel time for all vehicles that are predicted to occur.

5. Economic analysis

This section presents the results of the road user cost benefit analysis (RUCBA) undertaken as part of the environmental assessment for the Sapphire to Woolgoolga project. The cost estimates were prepared in accordance with the standard procedures developed by the RTA's Project Management Office and the road user economic analysis has been undertaken in accordance with the RTA's *Economic Analysis Manual (2005*). This manual incorporates the NSW Treasury Guidelines for Economical Appraisal and Financial Appraisal issued in June and July 1997 respectively.

5.1 General parameter values

The following general parameter values have been used for the road user cost benefit analysis (RUCBA).

Base Year

The current year (2006) has been used as the base year for discounting purposes.

Discount Rates

A discount rate of 7% has been used to discount future capital costs and road user costs to the base year. Discount rates of 4% and 10% have also been used for the purpose of sensitivity analysis.

Evaluation Period

An evaluation period of 30 years from the anticipated opening year of the project (2011) has been used for the economic analysis.

Annual Expansion Factor

An annual expansion factor of 2700 (1.8 x 1500) was used to convert peak hour travel costs to annual costs based on the following conversion factors:

- Peak hour to 2hr peak period - 1.8
- 2 hr peak period to Annual Manual) - 1500 (based on RTA Economic Analysis

5.2 Travel parameter values

Table 5.1 shows the travel parameter values during the morning peak hour that were used for the economic analysis for the Base Case and the Proposal.

Table 5.1
Travel Parameter Values

	Base Case		Proposal	
	2011	2031	2011	2031
Vehicle Kilometres of Travel (VKT)				
Vehicle Travel	41,063	64,695	43,502	67,430
Vehicle Hours of Travel (VHT)				
Vehicle Hours	603	2,542	475	787

Crashes

The estimated number of crashes for the Base Case and the Proposal were obtained from Table 4.16 of this report.

5.3 Travel cost parameters

Table 5.2 shows the travel cost parameters that have been used in the economic analysis to estimate vehicle operating, travel time and accident costs. Rural cost parameters have been used to estimate the travel costs for vehicles travelling along the highway, based on the *RTA Economic Analysis Manual, Appendix B, Economic Parameters for 2005*.

Vehicle operating costs were estimated based on Table B1 of the Appendix B in the Economic Analysis Manual while the value of travel time was estimated based on the weighted average value of travel time that was derived using the value of travel time by vehicle type on rural roads based on Table 17 of Appendix B in the Economic Analysis Manual and the results of the midblock classification surveys which provided the percentage of vehicle type in vehicle fleet. The average cost of a rural crash based on NSW crash data for 1998-2001 was used for the accident cost per crash.

Table 5.2
Travel Cost Parameters

Item	Cost
Vehicle Operating Costs per Vehicle km Base Case (2 lane highway) Proposal (dual carriageway)	 $0.34 $0.33
Value of Time per hour	$30.97
Accident Cost per crash	$151,500

5.4 Construction costs and cash flows

The estimated construction costs and assumed cash flows for the Proposal are shown in Table 5.3. A detailed summary of the construction cost estimates is provided in Appendix F.

Table 5.3
Construction Costs and Cash Flows

Year	Construction Cost ($M)
2007	36
2008	68
2009	120
2010	120
2011	120
Total	464

The following sensitivity analysis has been carried out in terms of project costs.

- 10% reduction in project cost;
- 15% increase in project cost.

5.5 Maintenance costs

An allowance for future routine and periodic maintenance has been made in the analysis based on a typical maintenance schedule and associated unit costs for a concrete pavement surface specified in the *RTA Economic Analysis Manual*. The maintenance schedule and unit costs used are summarised in Table 5.4.

Table 5.4
Maintenance Schedule and Unit Costs

Treatment	Year	Cost Per m^2 of pavement
Routine Maintenance	1-30 inclusive	$0.15
Cross stitching 20m cracks	2, 6, 12, 20	$0.06
0.5% slab replacement	2, 5, 10, 15, 20, 25, 28, 30	$1.03
Cross stitching 40m cracks	28	$0.12
Remove and Replace Sealant	10, 20, 30	$2.19
30% retexture	20	$0.84

The salvage value of the pavement beyond the 30 year period from opening is assumed to be zero.

5.6 Results of economic analysis

Road user benefits for a transport project are measured in terms of the reduction in road user costs that arise from building an option compared to the Base Case scenario of doing nothing. The road user costs assessed for this purpose include:

- Vehicle Operating Costs, VOC
- Travel Time Costs
- Accident Costs

The changes in VOC, travel time and accident costs were derived between the base case and each option for the future traffic volume prediction years of 2011 and 2031. Values for intermediate years between 2011 and 2031 were derived by interpolation. Values beyond 2031 were extrapolated by assuming that growth would continue at the same rate as calculated between 2011 and 2031.

The resultant time-stream of road user cost savings (or increases) were discounted and summed over the 30 year evaluation period from opening, to provide the total present value of benefits for each option (PVB). A similar process of discounting and summation was carried out for the capital and maintenance costs previously identified, to provide the equivalent present value of costs for each option (PVC).

A summary of the results for the economic analysis in terms of Net Present Value (NPV) and Benefit Cost Ratio (BCR) are provided in Table 5.5. These were calculated from the estimates of PVB and PVC assessed in accordance with the method outlined above. The First Year Rate of Return (FYRR) is also provided. Detailed spreadsheets used in the analysis are attached in Appendix G.

Table 5.5
Results of Economic Analysis

Parameters	Results of Economic Analysis
Discount Rate – 7%	
Present Value of Costs ($M)	$371
First Yr Rate of Return (FYRR)	2.3%
10 Year Period	
Present Value of Benefits ($M)	$211
Net Present Value ($M)	($159)
Benefit Cost Ratio	0.6
20 Year Period	
Present Value of Benefits ($M)	$506
Net Present Value ($M)	$135
Benefit Cost Ratio	1.4
30 Year Period	
Present Value of Benefits ($M)	$752
Net Present Value ($M)	$380
Benefit Cost Ratio	2.0

From Table 5.5 it can be seen that the proposed upgrade over the full 30 year evaluation period has an NPV of $371M and a BCR of 2.0. The proposed upgrade option is therefore predicted to achieve the RTA's highway improvement program target for BCRs of 2.

5.7 Sensitivity analysis

A sensitivity analysis was carried out for the following factors.

- Discount Rate of 4%
- Discount Rate of 10%
- Reduction in construction cost of 10%
- Increase in construction cost of 15%
- Annual expansion factor of 3000 (peak hour to annual)

The results of the sensitivity analysis in relation to the BCR are summarised in Table 5.6 and detailed spreadsheets are attached in Appendix G.

Table 5.6
Results of Sensitivity Analysis

Parameters	Benefit Cost Ratio (Operation of 30 Years)
4% Discount Rate	3.3
10% Discount Rate	1.3
10% Reduction in Construction Cost	2.2
15% Increase in Construction Cost	1.8
Annual expansion factor of 3000	2.2

From Table 5.6, it is observed that:

- The BCR is more sensitive to the assumed discount rate than to variations in the construction cost.
- All sensitivity analysis scenarios continue to show acceptable BCRs (>1). This is the case even if higher construction costs are assumed.

Appendix A

Qualitative descriptions of the Level of Service criteria - Two Lane Highways and Freeways

Level of Service (LOS) Criteria for Two Lane Highways – Class I Highways

LOS A

LOS A describes the highest quality of traffic service, when motorists are able to travel at their desired speed. Without strict enforcement, the highest quality would result in average speeds of 90km/h or more on two lane highways on Class I. The passing frequency required to maintain these speeds has not reached a demanding level, so that passing demand is well below passing capacity, and platoons of three or more vehicles are rare. Drivers are delayed no more than 35 percent of their travel time by slow-moving vehicles.

LOS B

LOS B characterises traffic flow with speeds of 80km/hr or slightly higher on level terrain Class I highways. The demand for passing to maintain desired speeds becomes significant and approximates the passing capacity at the lower boundary of LOS B. Drivers are delayed in platoons up to 50 percent of the time.

LOS C

LOS C describes further increases in flow, resulting in noticeable increases in platoon formation, platoon size, and frequency of passing impediments. The average speed still exceeds 70km/hr on level terrain Class I highways, even though unrestricted passing demand exceeds passing capacity. At higher volumes the chaining of platoons and significant reductions in passing capacity occur. Although traffic flow is stable, it is susceptible to congestion due to turning traffic and slow moving vehilces. Percent time-spent-following may reach 65 percent.

LOS D

LOS D describes unstable flow. The two opposing traffic streams begin to operate separately at higher volume levels, as passing becomes extremely difficult. Passing demand is high, but passing capacity approaches zero. Mean platoon sizes of 5 to 10 vehicles are common. Although speeds of 60km/h still can be maintained under base conditions in Class I highways. The proportion of no-passing zones along the roadway section usually has little influence on passing. Turning vehicles and road side distractions cause major shock waves in the traffic stream. Motorists are delayed in platoons for nearly 80 percent of their travel time.

LOS E

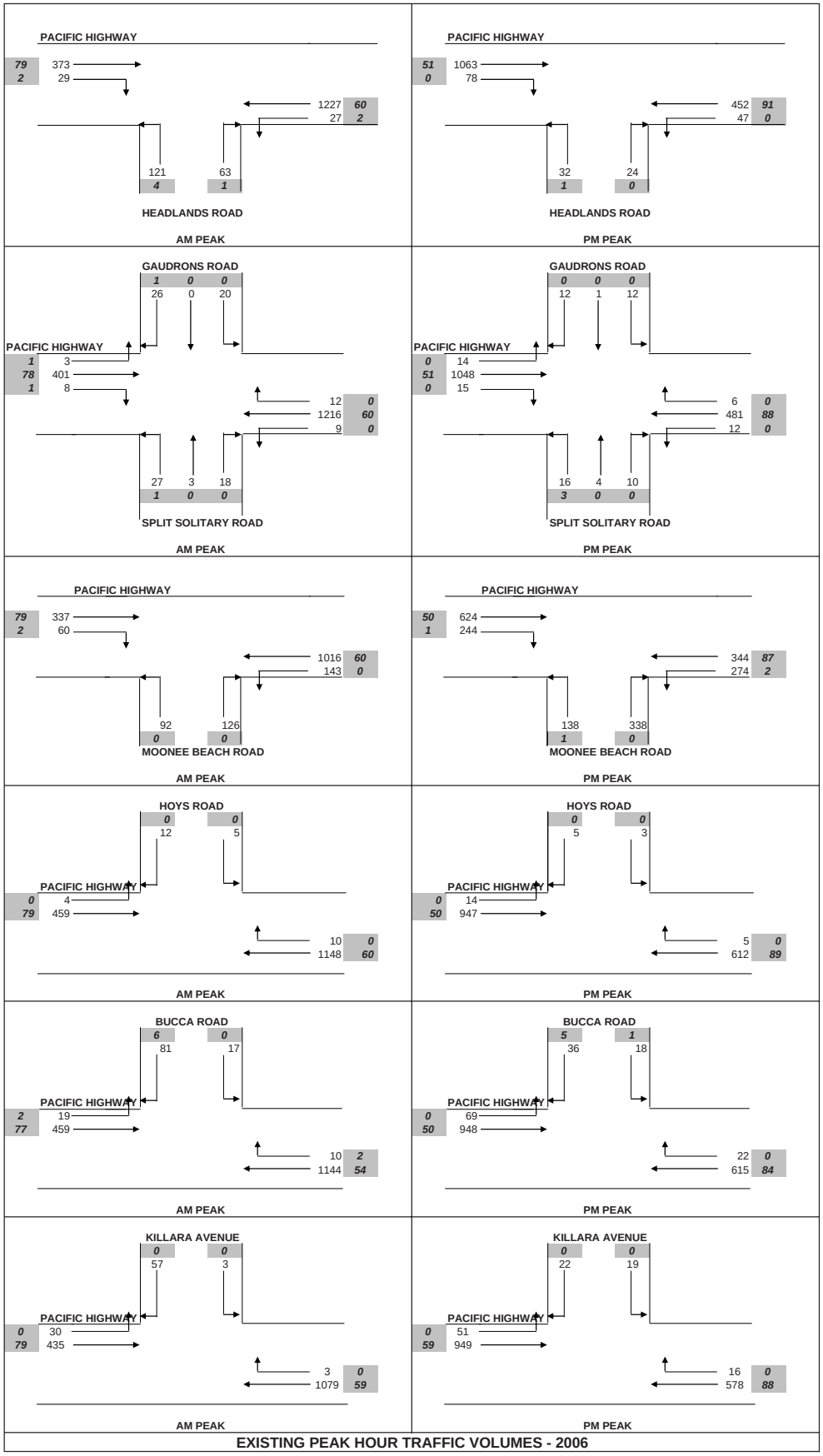
At LOS E, traffic flow conditions have a percent time-spent-following greater than 80 percent on Class I highways. Even under base conditions, speeds may drop below 60km/hr. Average travel speeds on highways with less than base conditions will be slower, even down to 40km/h on sustained upgrades. Passing is virtually impossible at LOS E, and platooning becomes intense, as slower vehicles or other interruptions are encountered.

LOS F

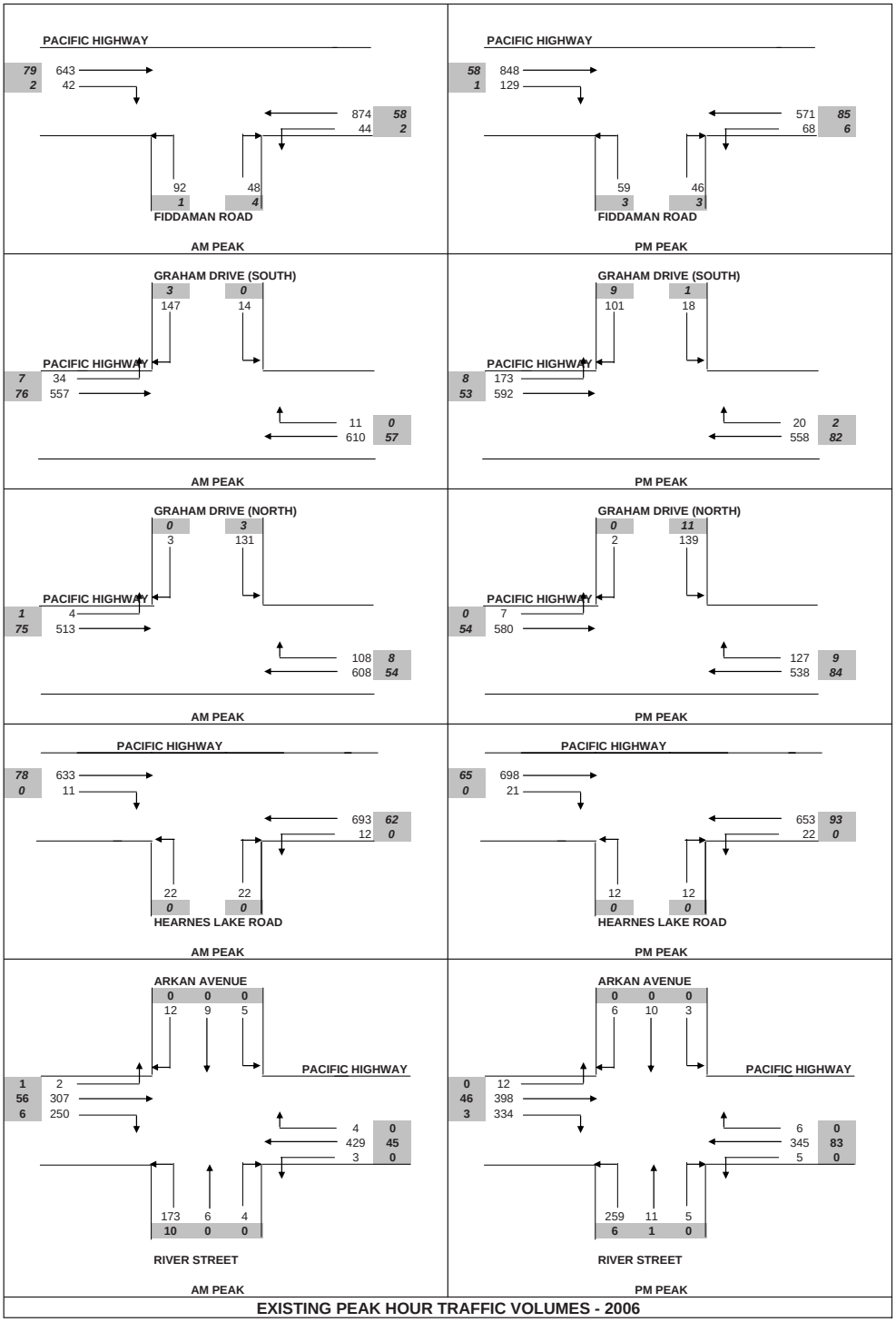
LOS represents heavily congested flow with traffic demand exceeding capacity.

Appendix B

Existing peak hour traffic volumes - 2006



EXISTING PEAK HOUR TRAFFIC VOLUMES - 2006



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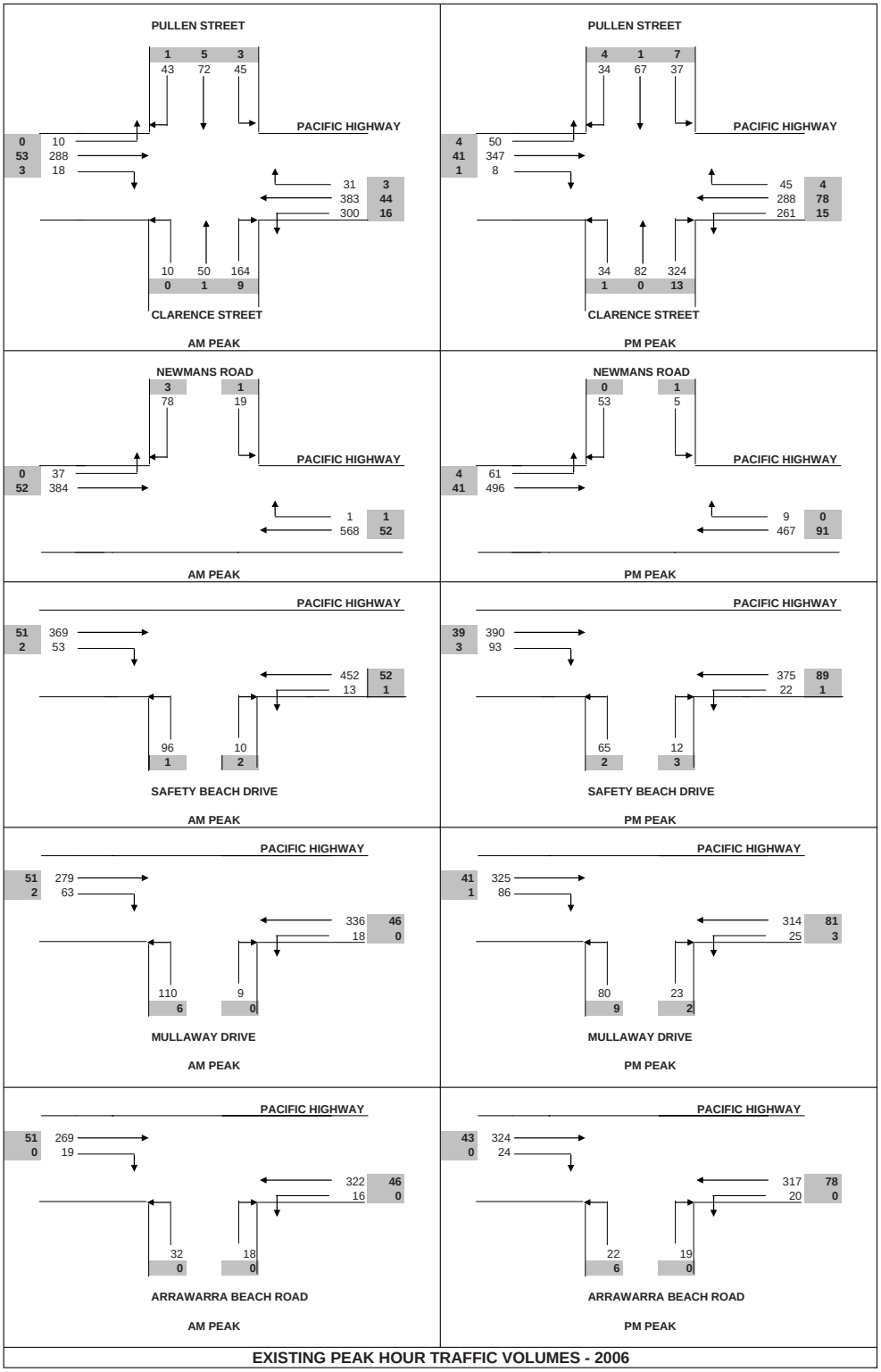


EXISTING PEAK HOUR TRAFFIC VOLUMES - 2006

Appendix C

Qualitative descriptions of the Level of Service criteria - Basic Freeway

Level of Service (LOS) Criteria for Basic Freeway Segments

LOS A

LOS A describes free-flow operations. Free flow speeds prevail. Vehicles are almost completely unimpeded in their ability to manoeuvre within the traffic stream. The effects of incidents or point breakdowns are easily absorbed at this level.

LOS B

LOS B represents reasonably free flow, and free-flow speeds are maintained. The ability to manoeuvre within the traffic stream is only slightly restricted, and the general level of physical and psychological comfort provided to drivers is still high. The effects of minor incidents and point breakdowns are still easily absorbed.

LOS C

LOS C provides for flow with speeds at or near the FFS of the freeway. Freedom to manoeuvre within the traffic stream is noticeably restricted, and lane changes require more care and vigilance on the part of the driver. Minor incidents may still be absorbed, but local deterioration is service will be substantial. Queues may be expected to form behind any significant blockage.

LOS D

LOS D is the level at which speeds begin to decline slightly with increasing flows and density begins to increase somewhat more quickly. Freedom to manoeuvre within the traffic stream is more noticeably limited, and the driver experiences reduced physical and psychological comfort levels. Even minor incidents can be expected to create queuing, because the traffic stream has little space to absorb disruptions.

LOS E

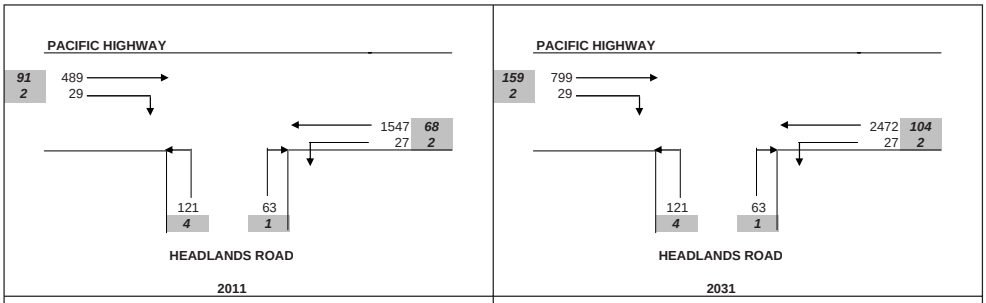
At its highest density value, LOS E describes operation at capacity. Operations at this level are volatile, because there are virtually no usable gaps in the traffic stream. Vehicles are closely spaced, leaving little room to manoeuvre within the traffic stream at speeds that still exceed 80km/h. Any disruption of the traffic stream, such as vehicle entering from a ramp or a vehicle lane changes, can establish a disruption wave that propagates throughout the upstream flow. At capacity, the traffic stream has no ability to dissipate even the most minor disruption, and any incident can be expected to produce a serious breakdown with extensive queuing. Manoeuverability within the traffic stream is extremely limited, and the level of physical and psychological comfort afforded is poor.

LOS F

LOS F describes breakdowns in vehicular flow. Such conditions generally exist within queues forming behind breakdown points. LOS F operations within a queue are the result of a breakdown or bottleneck at a downstream point. LOS is also used to describe conditions at the point of the breakdown or bottleneck and the queue discharge flow that occurs at speeds lower than lowest speed for LOS E, as well as the operations within the queue that forms upstream. Whenever LOS F conditions exist, they have the potential to extend upstream for significant distances.

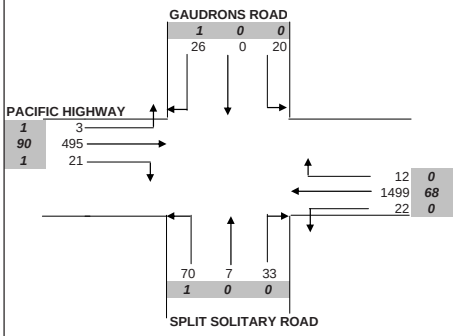
Appendix D

Predicted Peak Hour Traffic Volumes – Base Case



2011

2031



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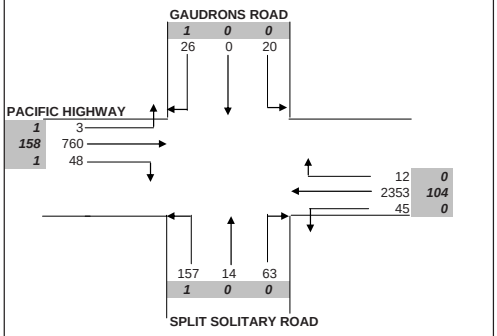

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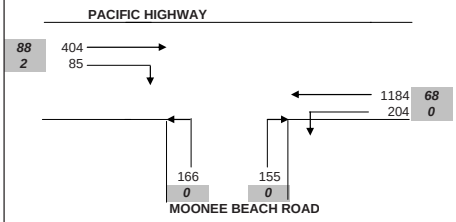

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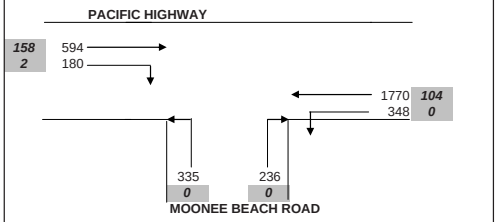

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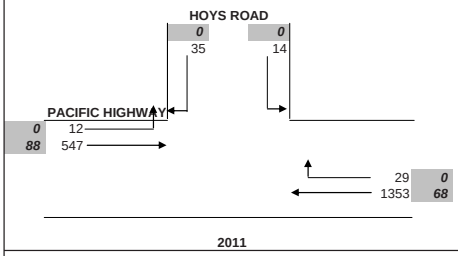

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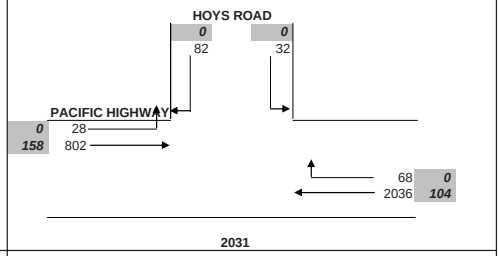

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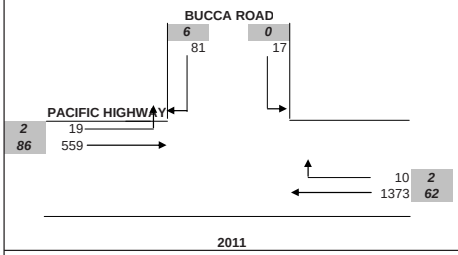

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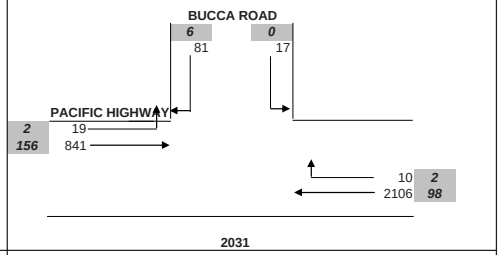

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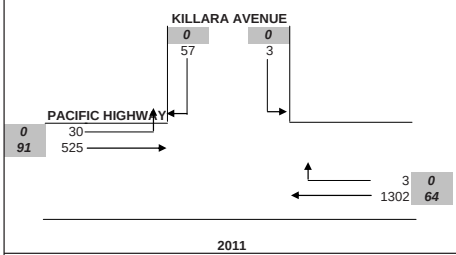

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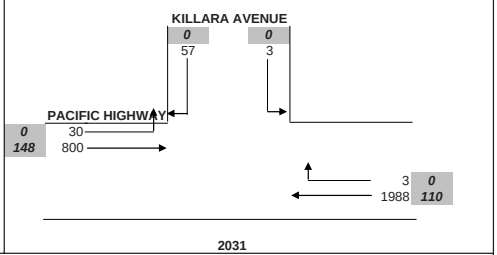

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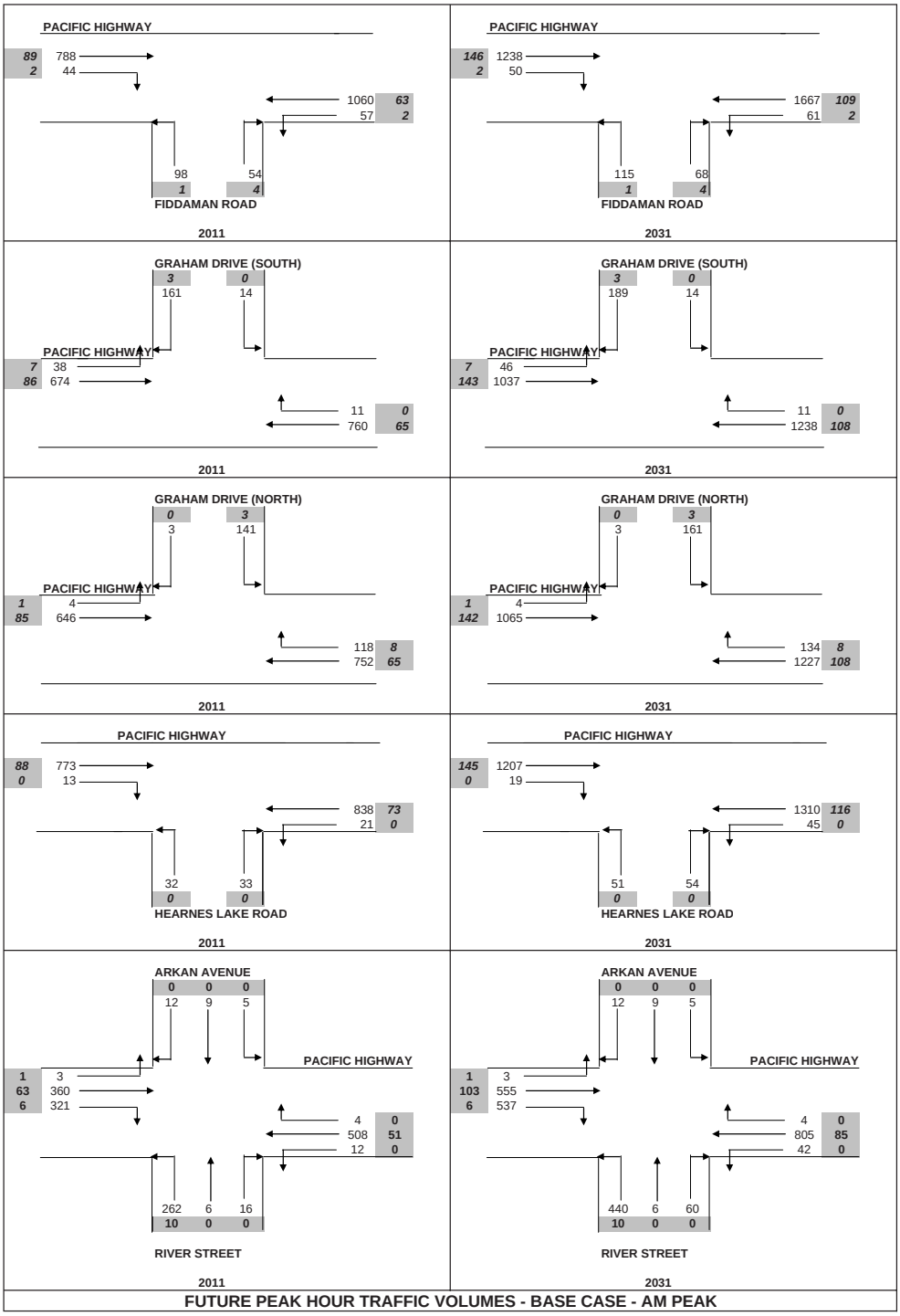
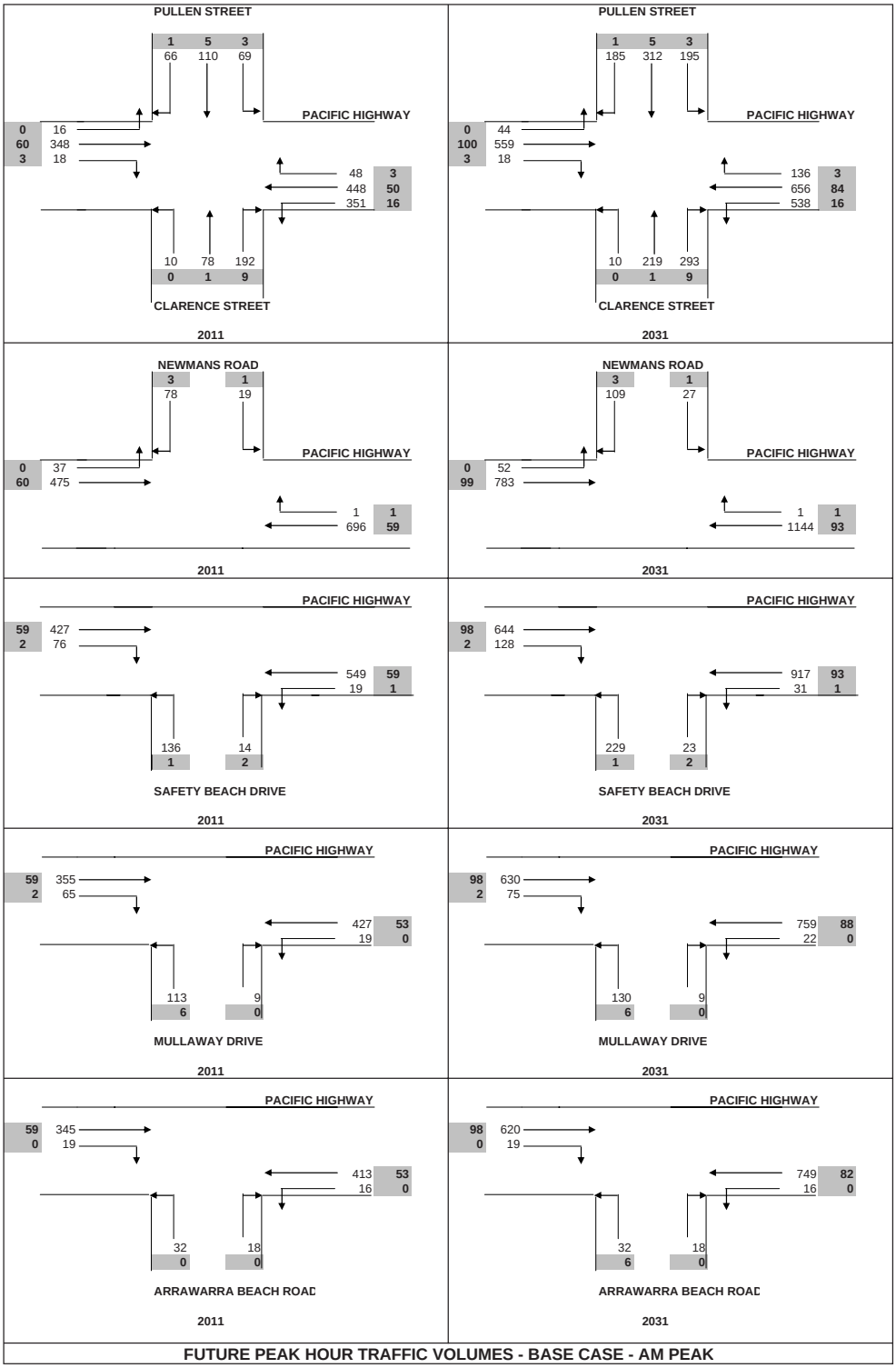
FUTURE PEAK HOUR TRAFFIC VOLUMES - BASE CASE - AM PEAK



FUTURE PEAK HOUR TRAFFIC VOLUMES - BASE CASE - AM PEAK



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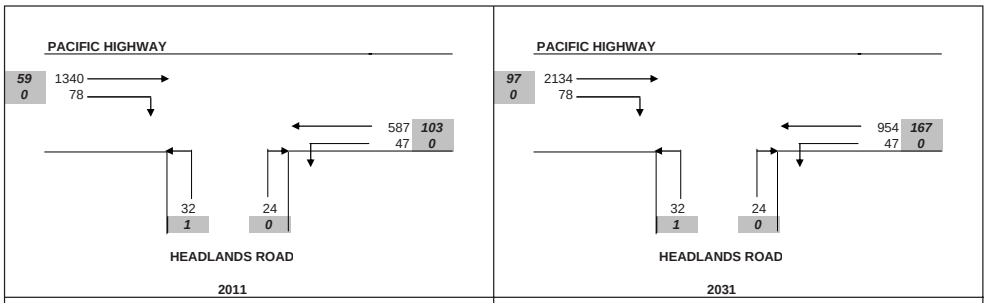

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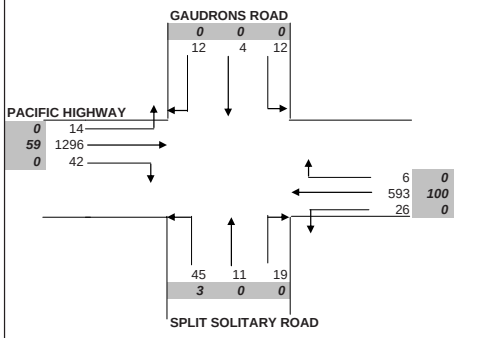

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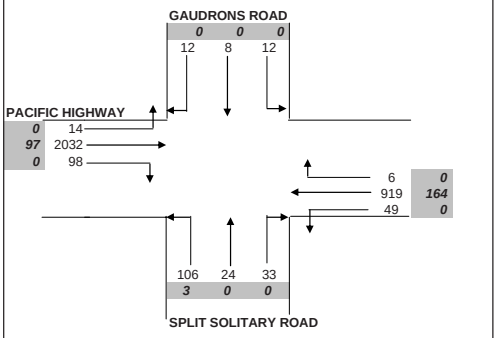

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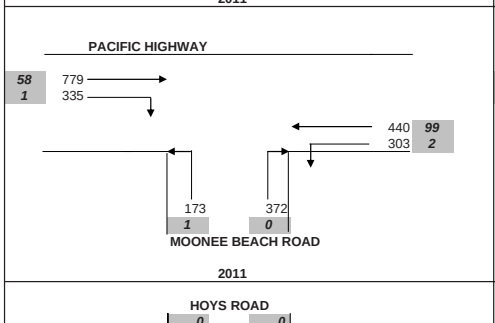

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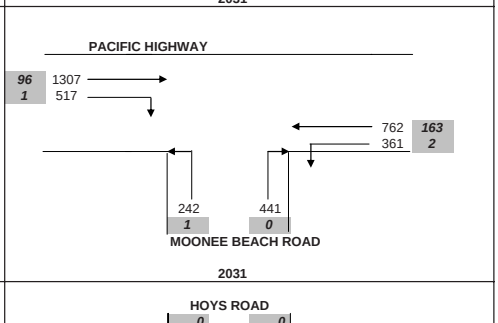

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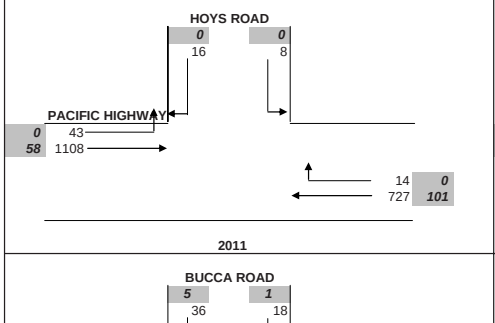

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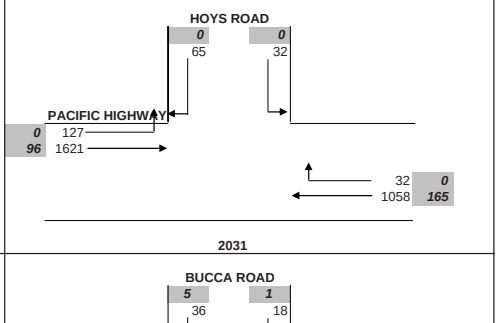

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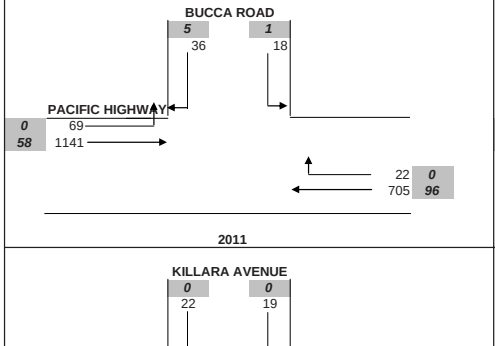

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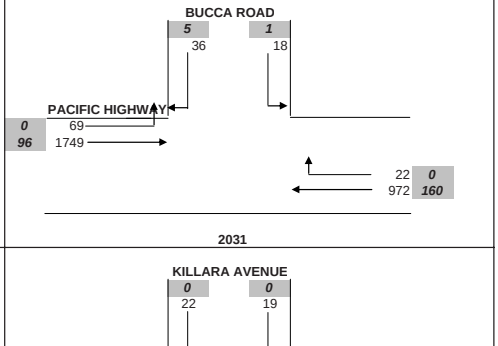

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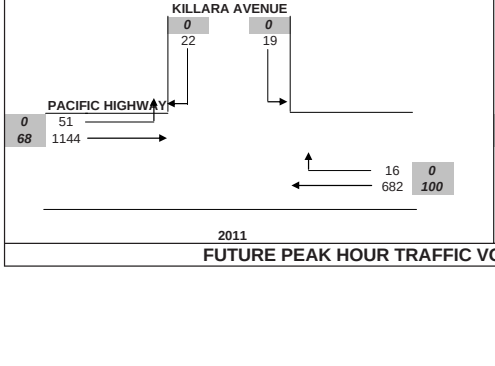

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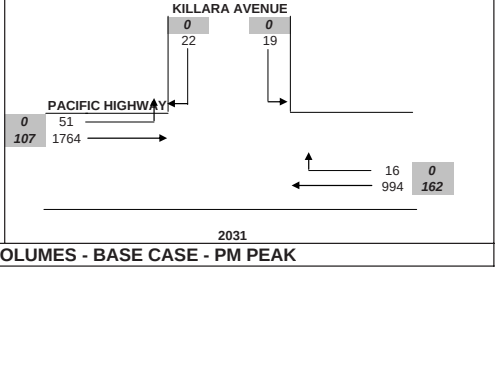

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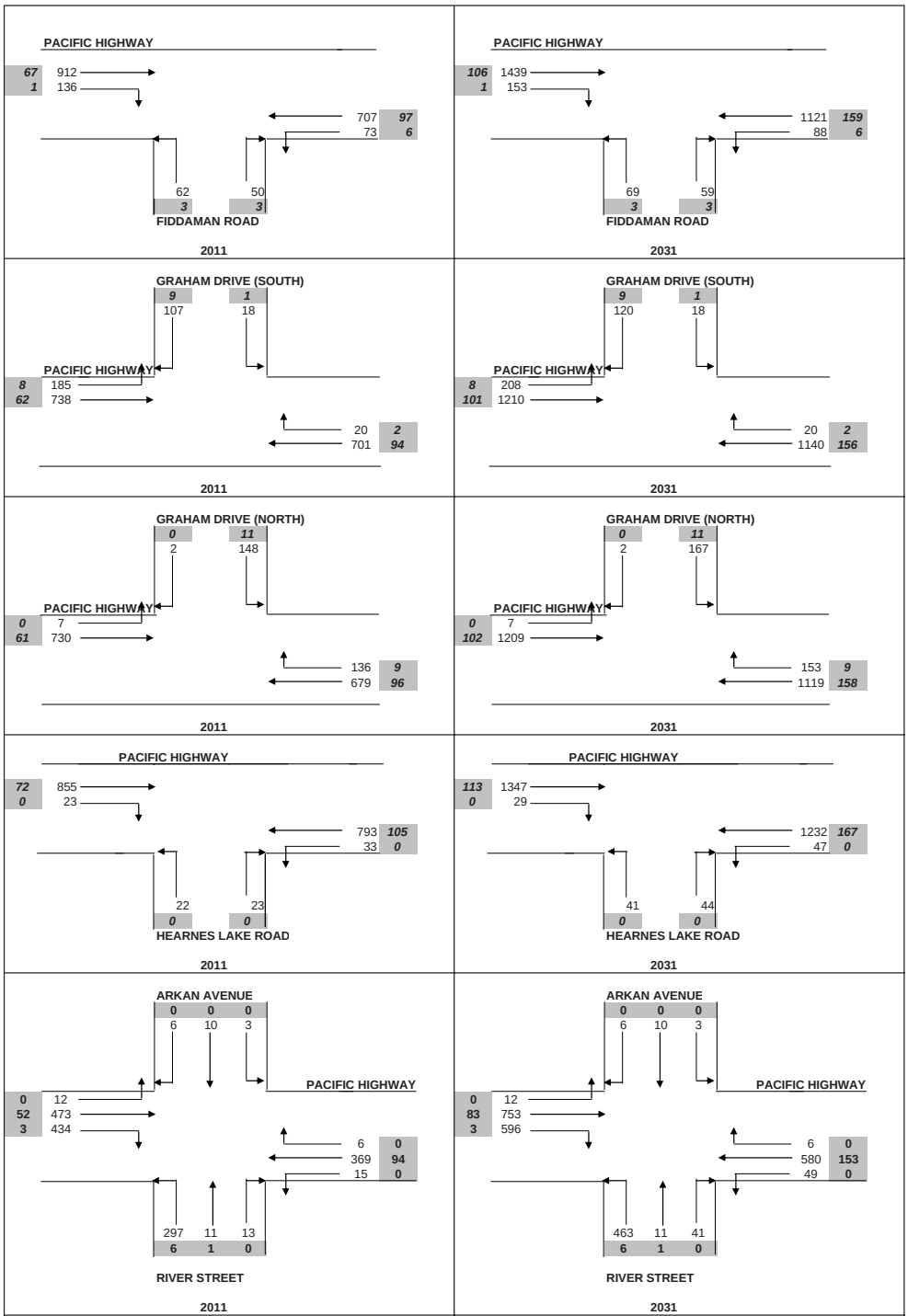
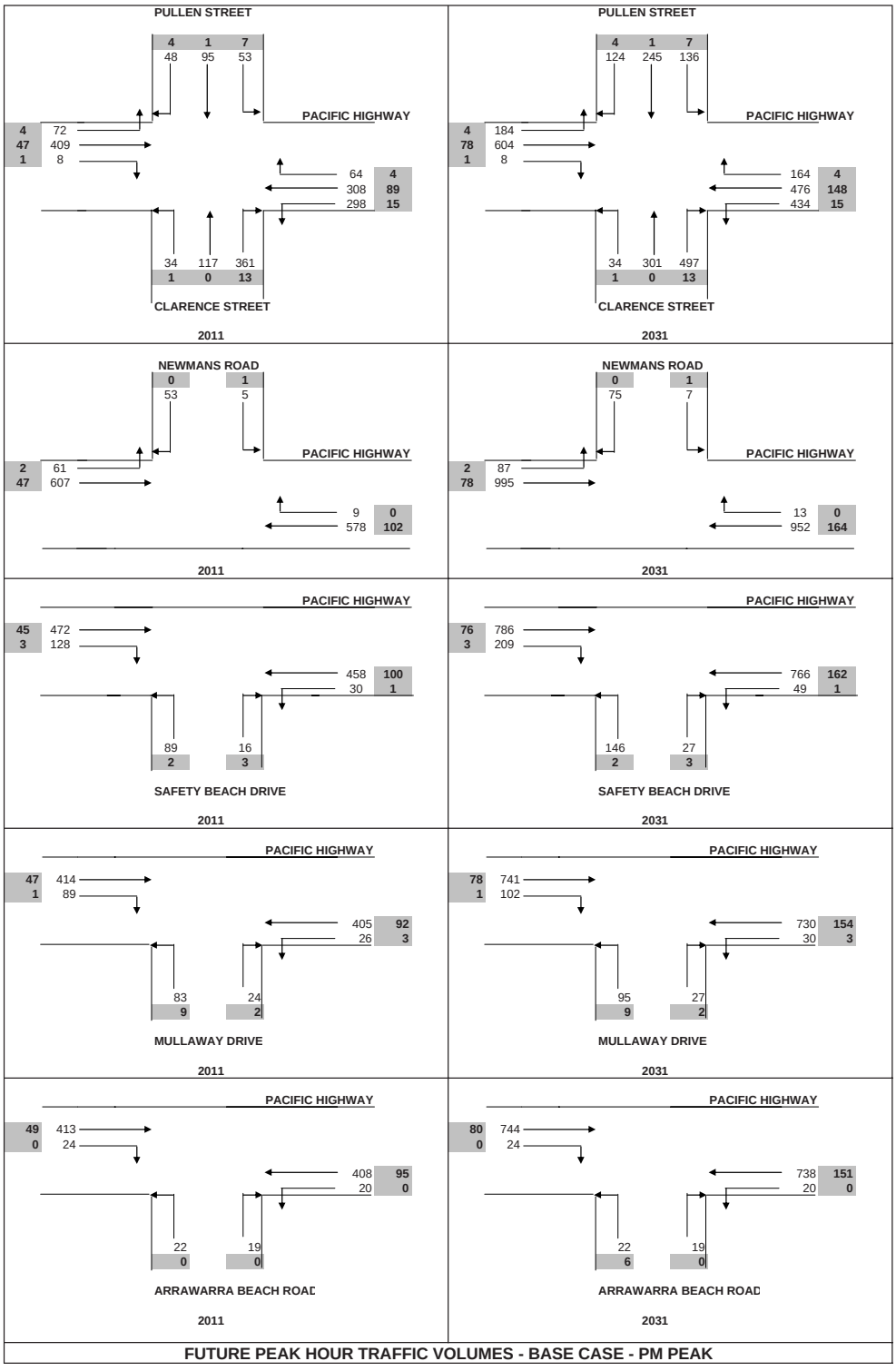
FUTURE PEAK HOUR TRAFFIC VOLUMES - BASE CASE - PM PEAK



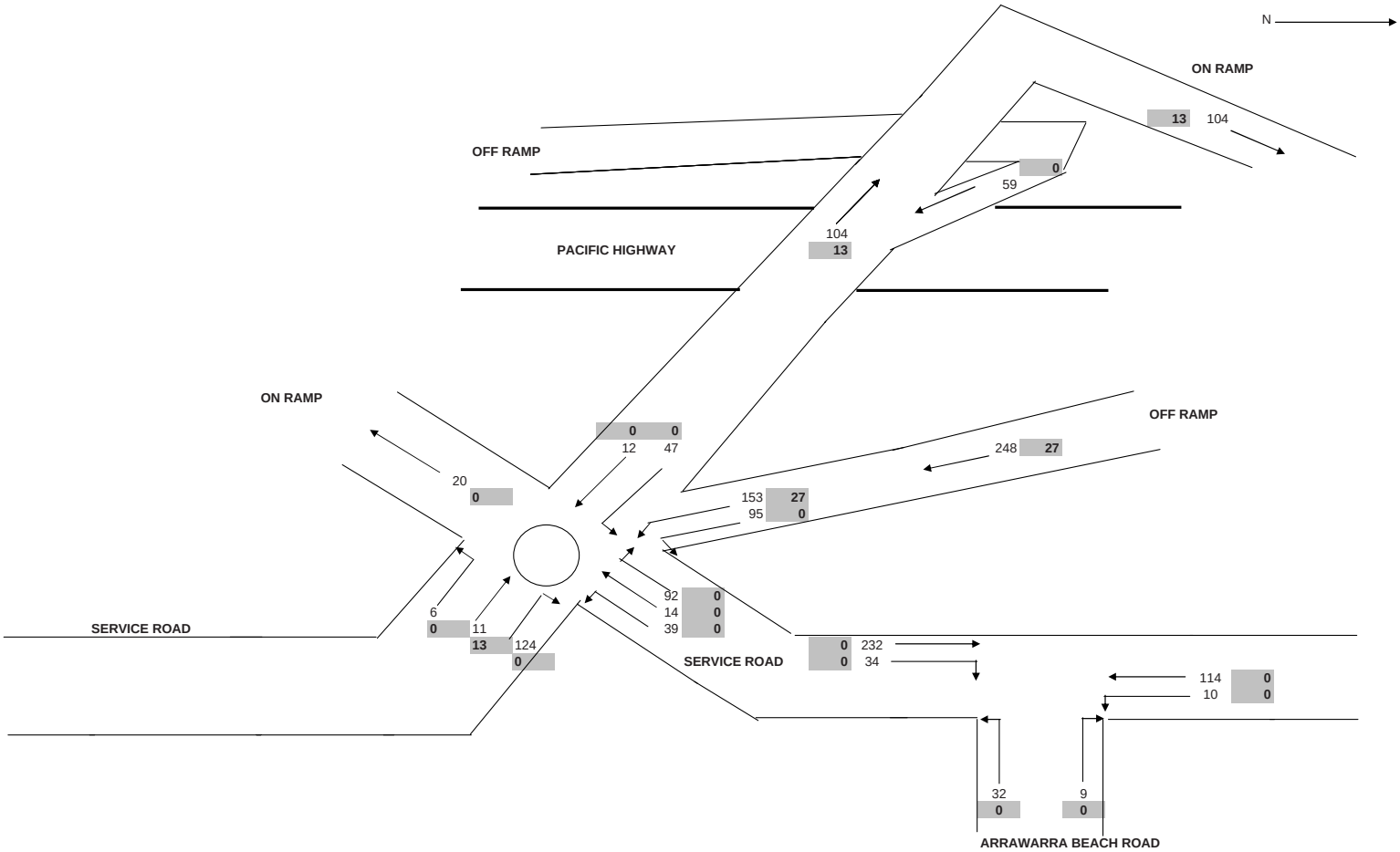
FUTURE PEAK HOUR TRAFFIC VOLUMES - BASE CASE - PM PEAK



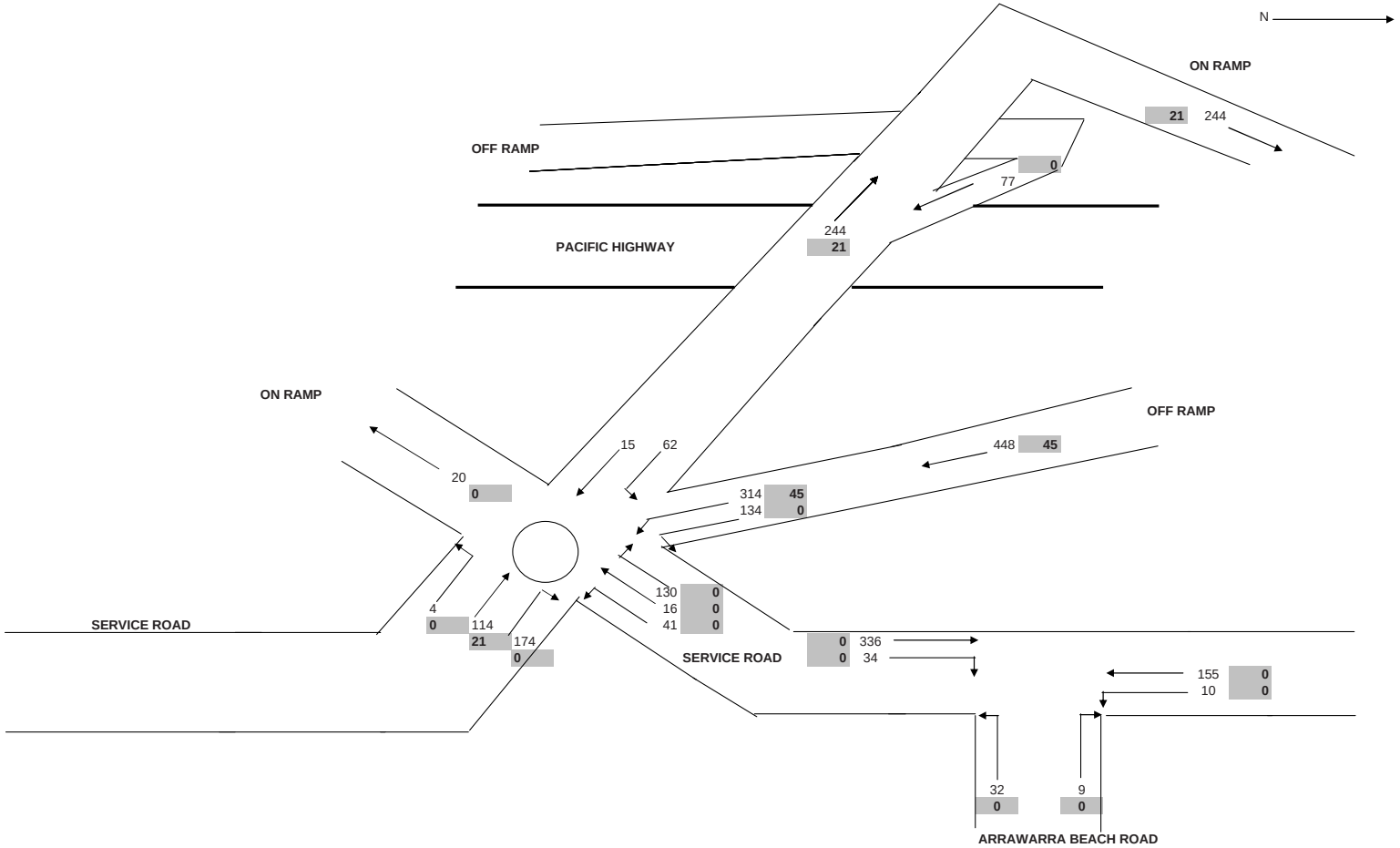
FUTURE PEAK HOUR TRAFFIC VOLUMES - BASE CASE - PM PEAK

Appendix E

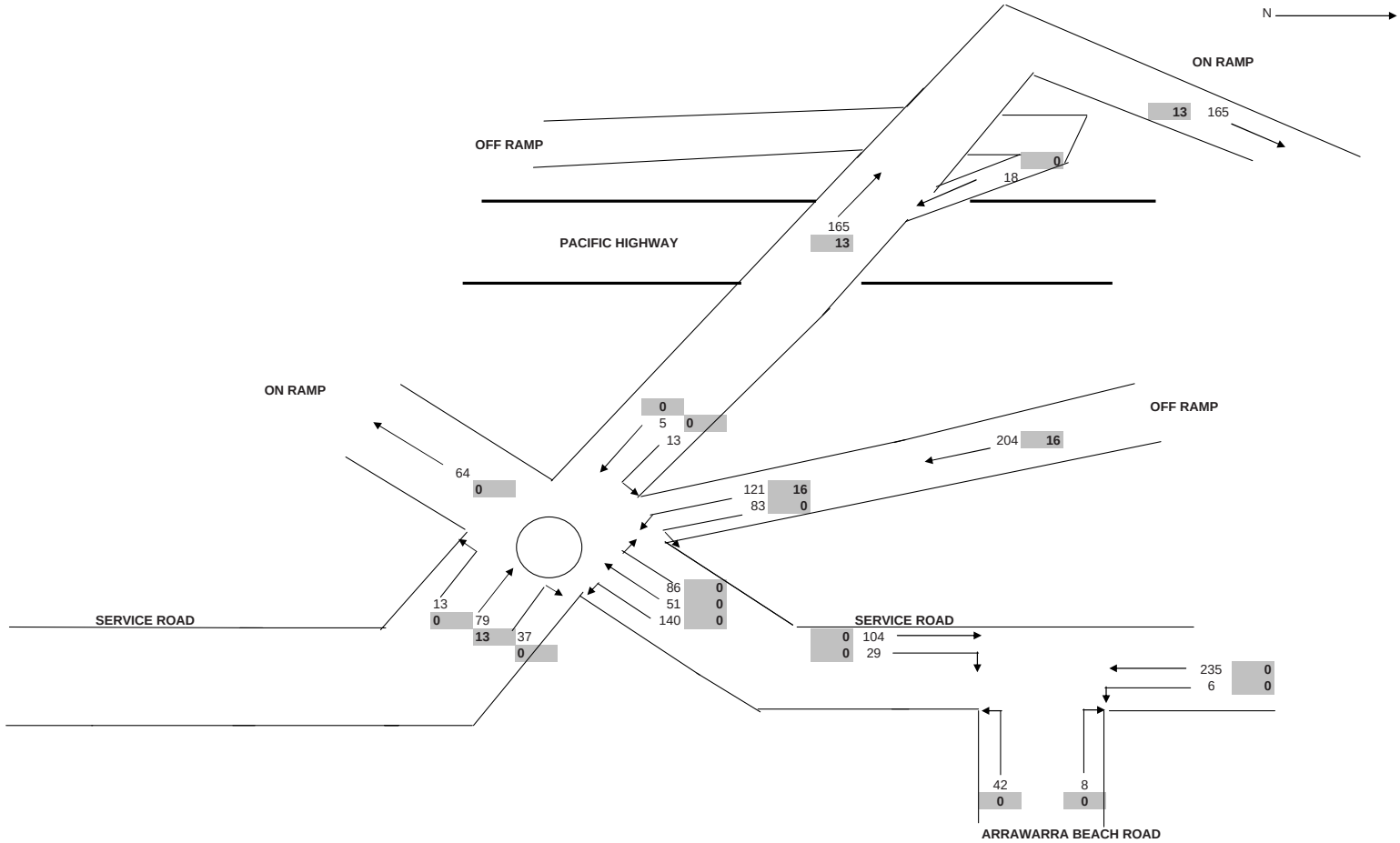
Predicted Peak Hour Traffic Volumes – Proposal



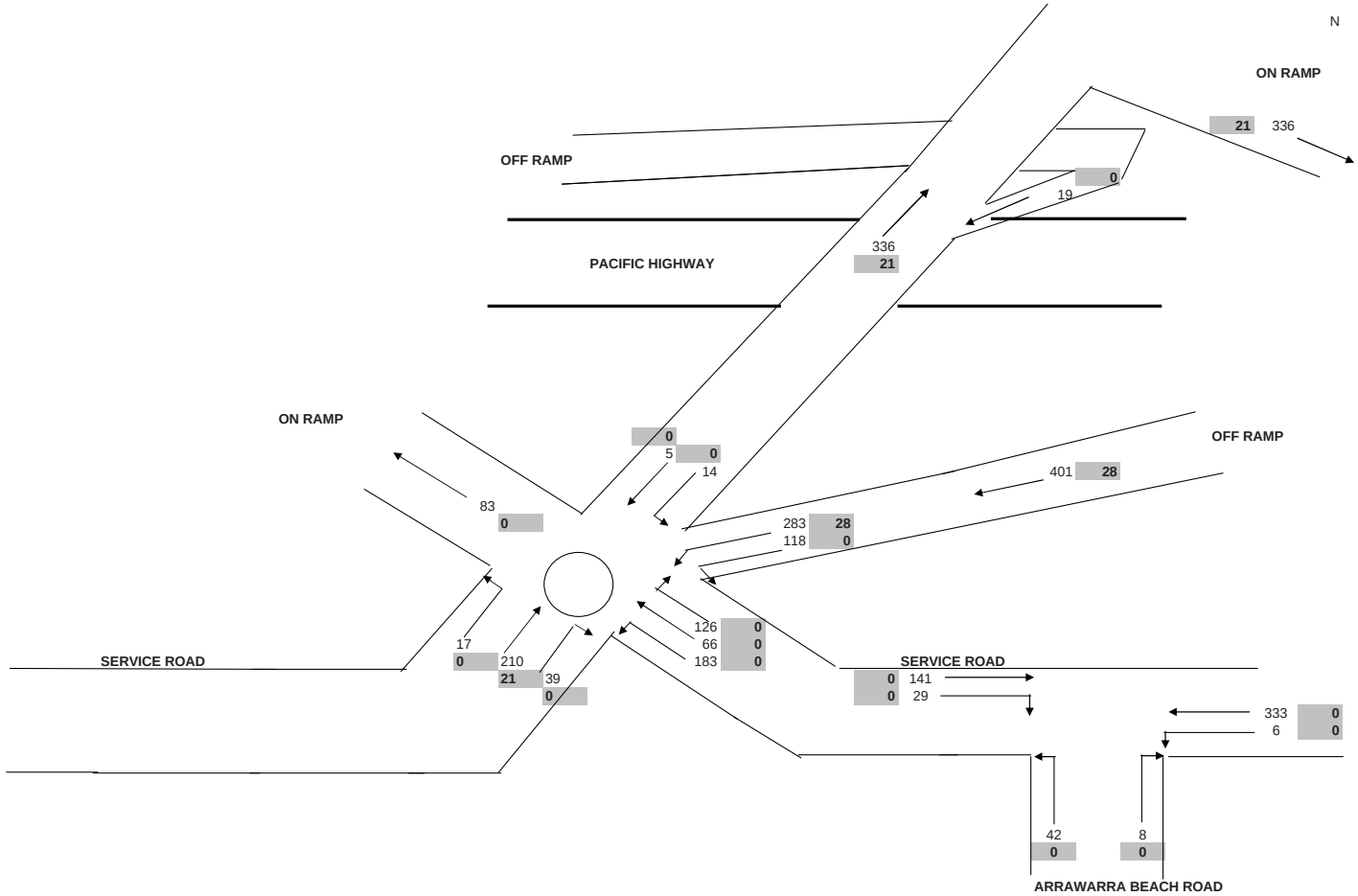
ARRAWARRA BEACH INTERCHANGE - 2011 - PM PEAK



ARRAWARRA BEACH INTERCHANGE - 2031 - PM PEAK



ARRAWARRA BEACH INTERCHANGE - 2011 - AM PEAK



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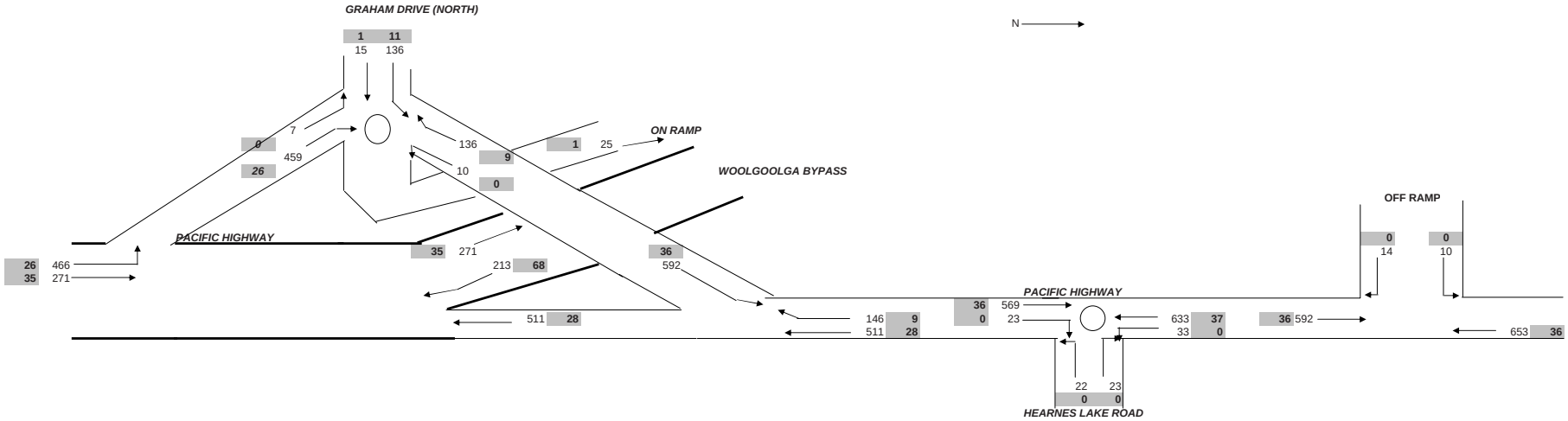
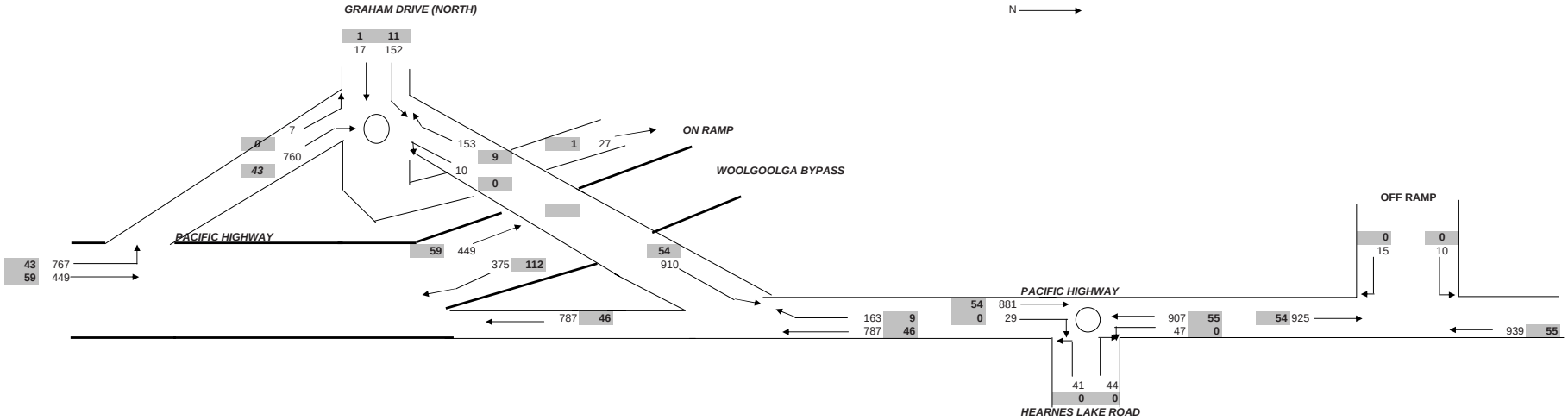


GRAHAM DRIVE (NORTH)/WOOLGOOLGA BYPASS INTERCHANGE - 2011 - PM PEAK



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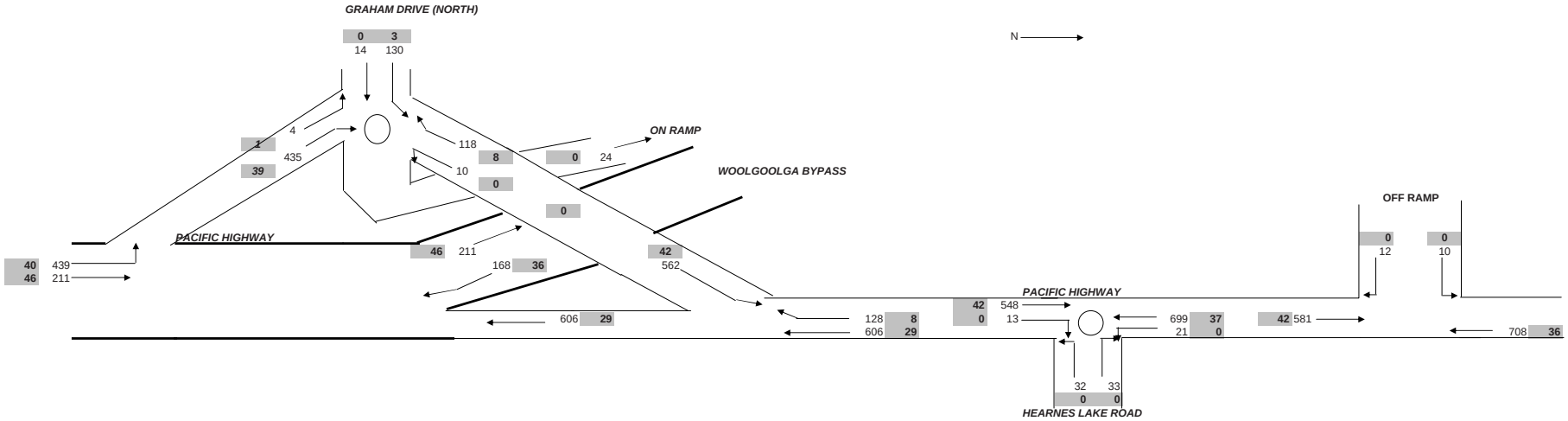

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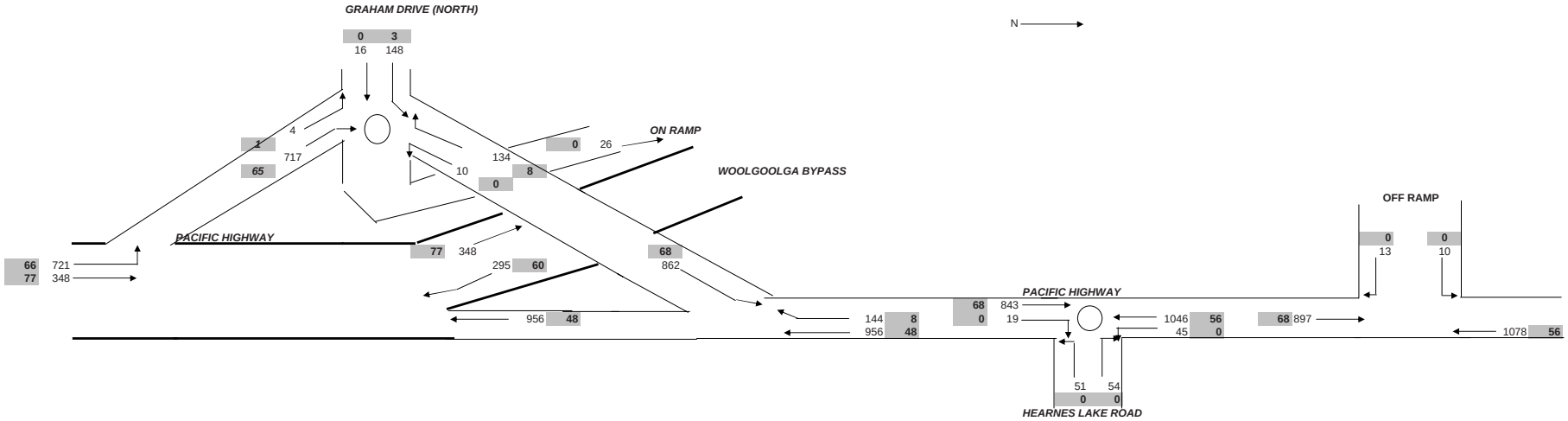

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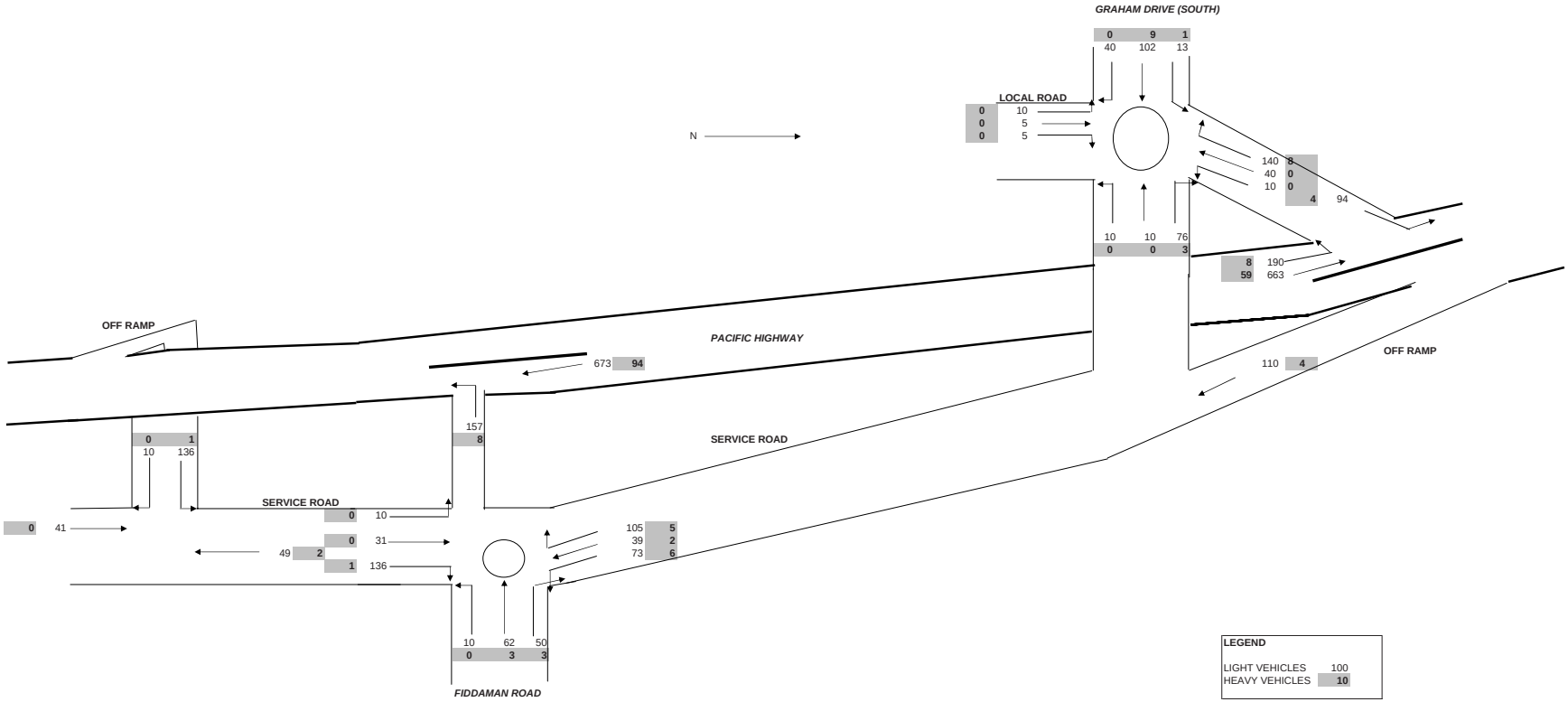
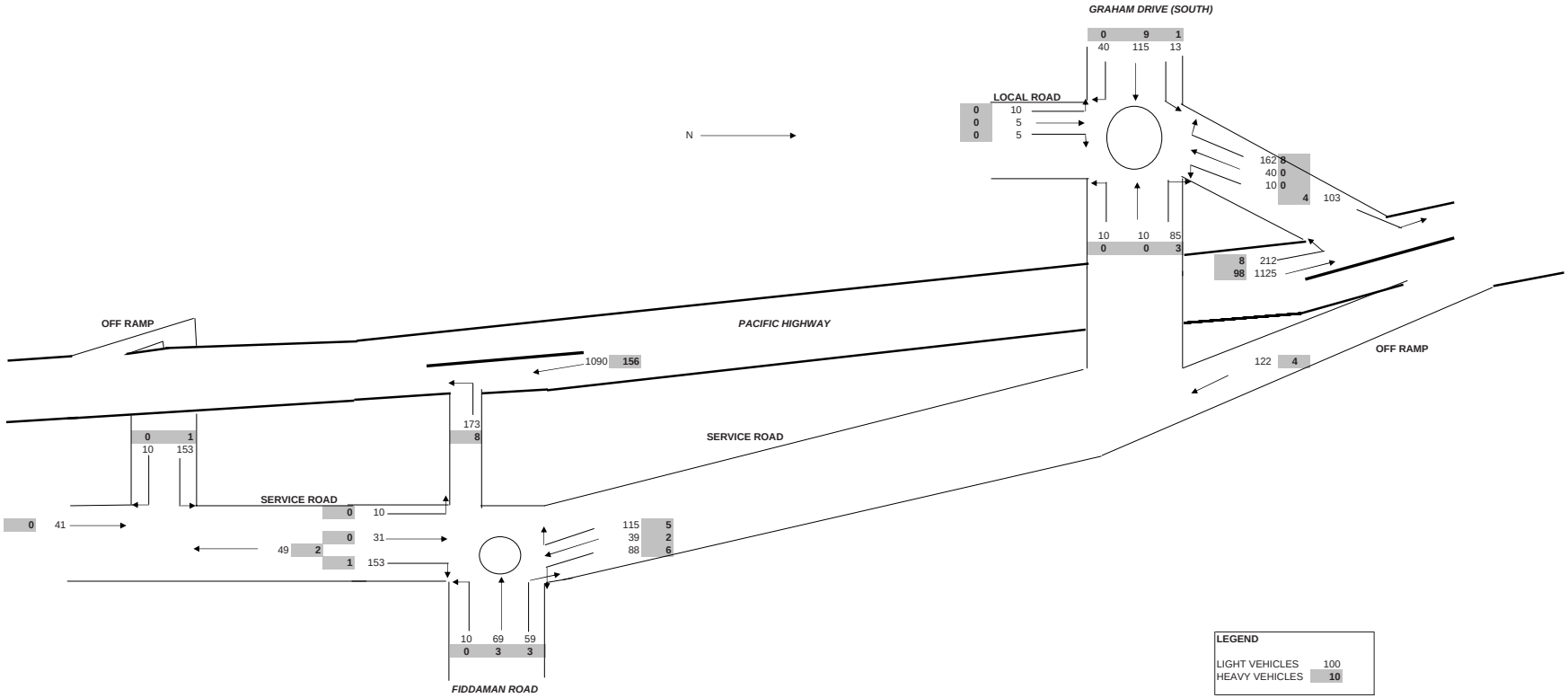


FIDDAMAN ROAD/GRAHAM DRIVE (SOUTH) INTERCHANGE - 2011 - PM PEAK



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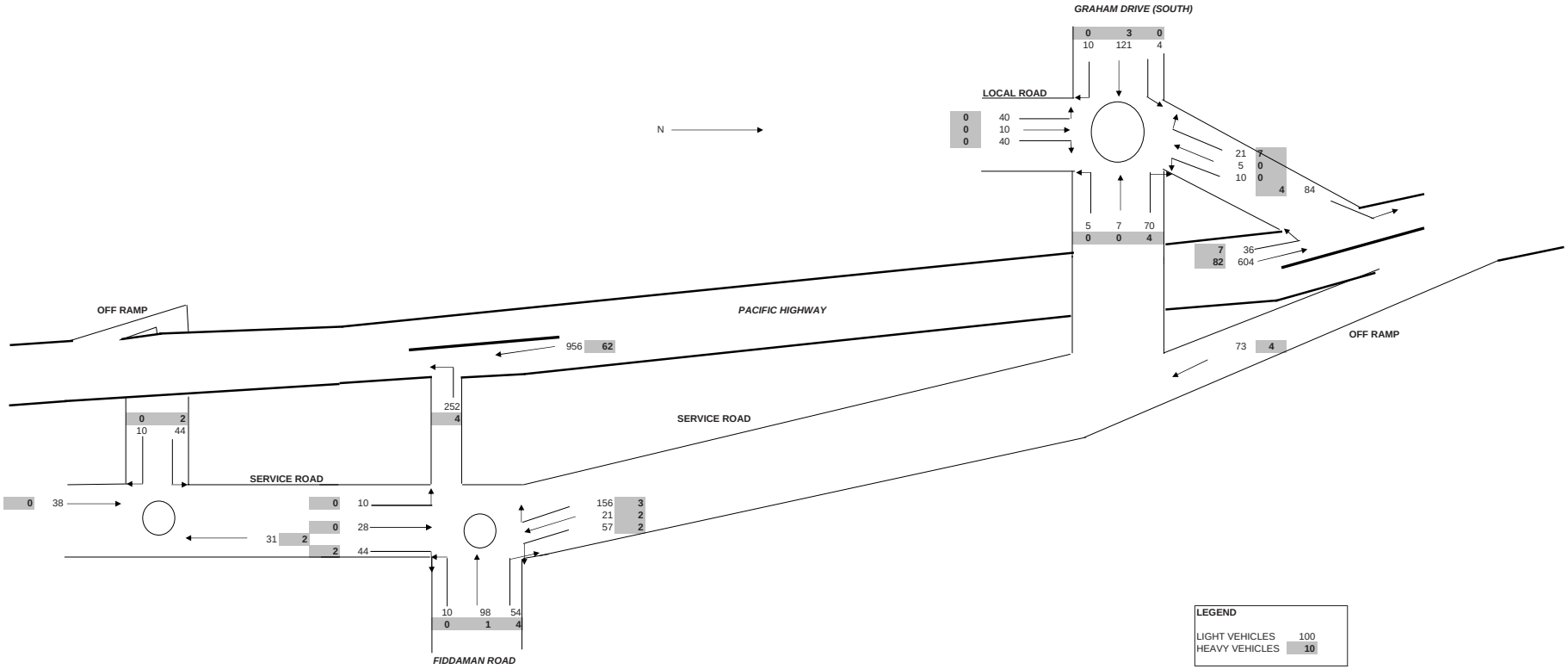

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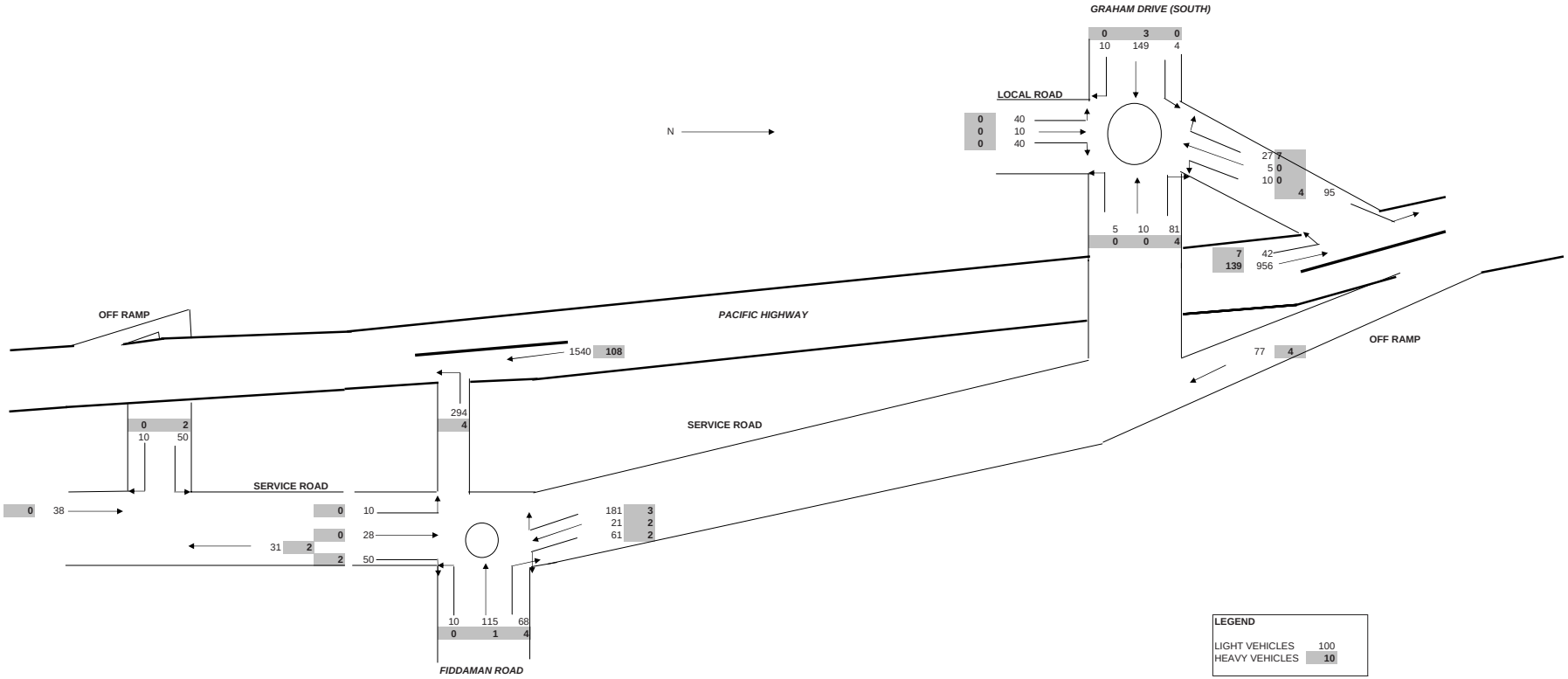

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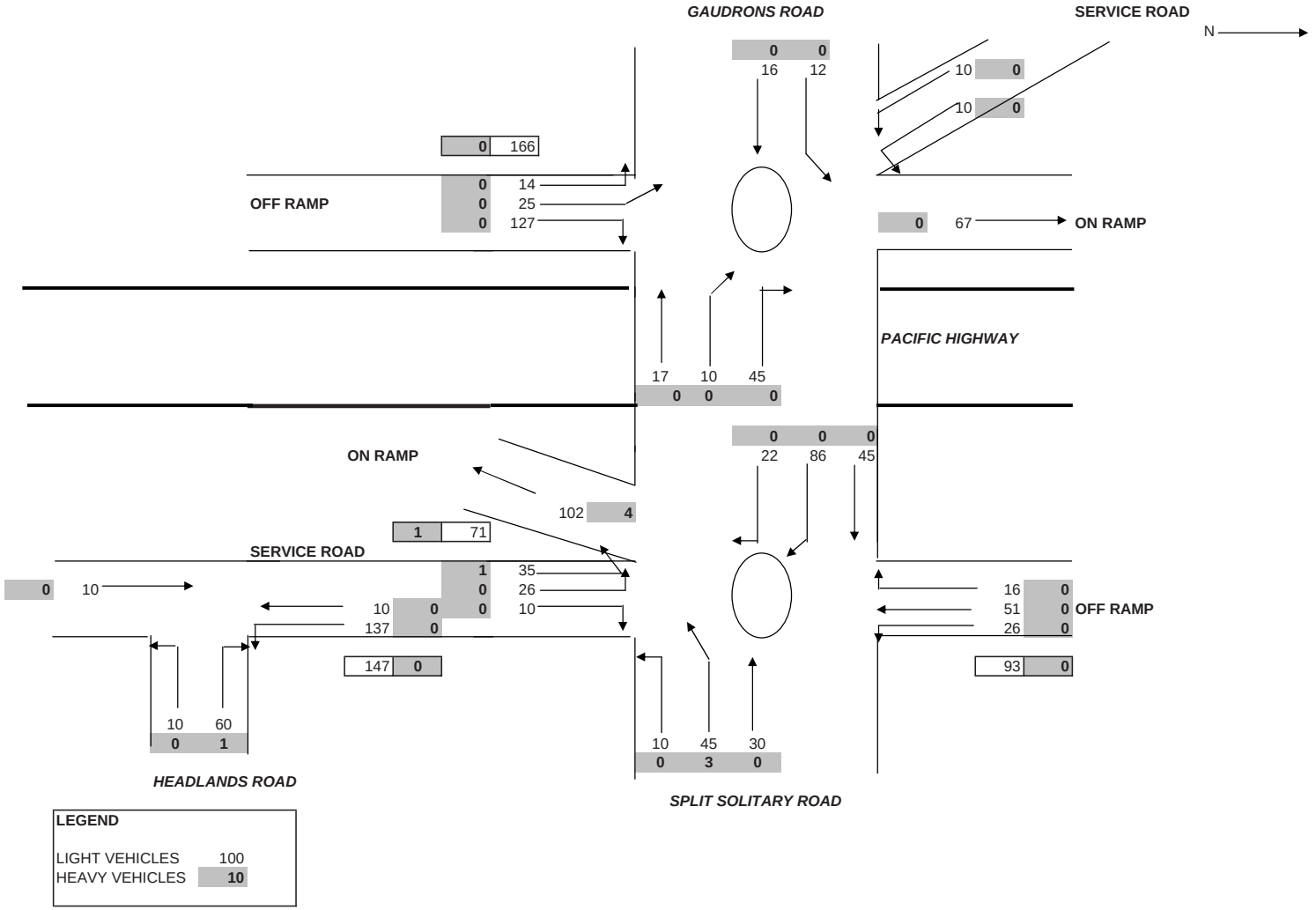
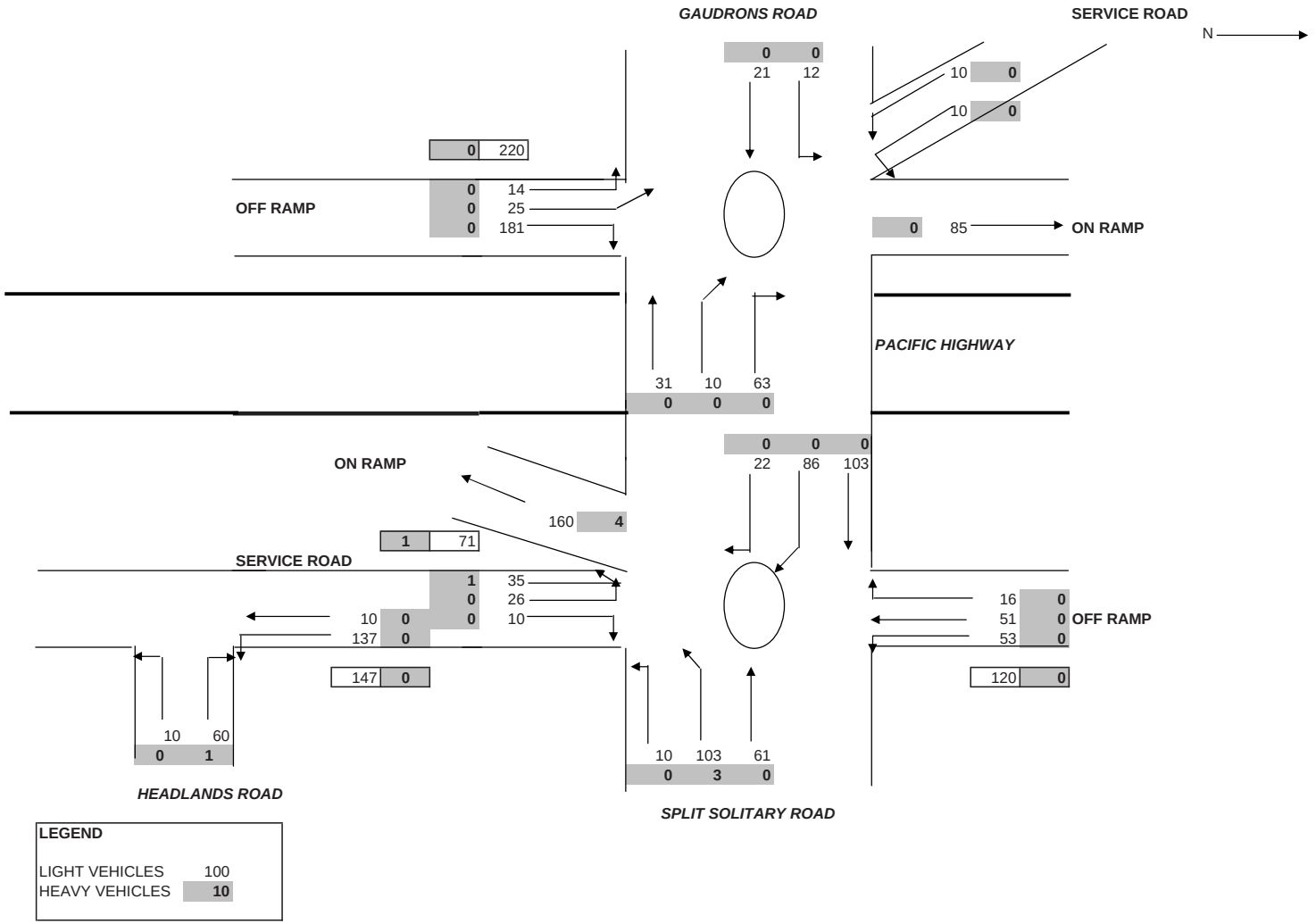
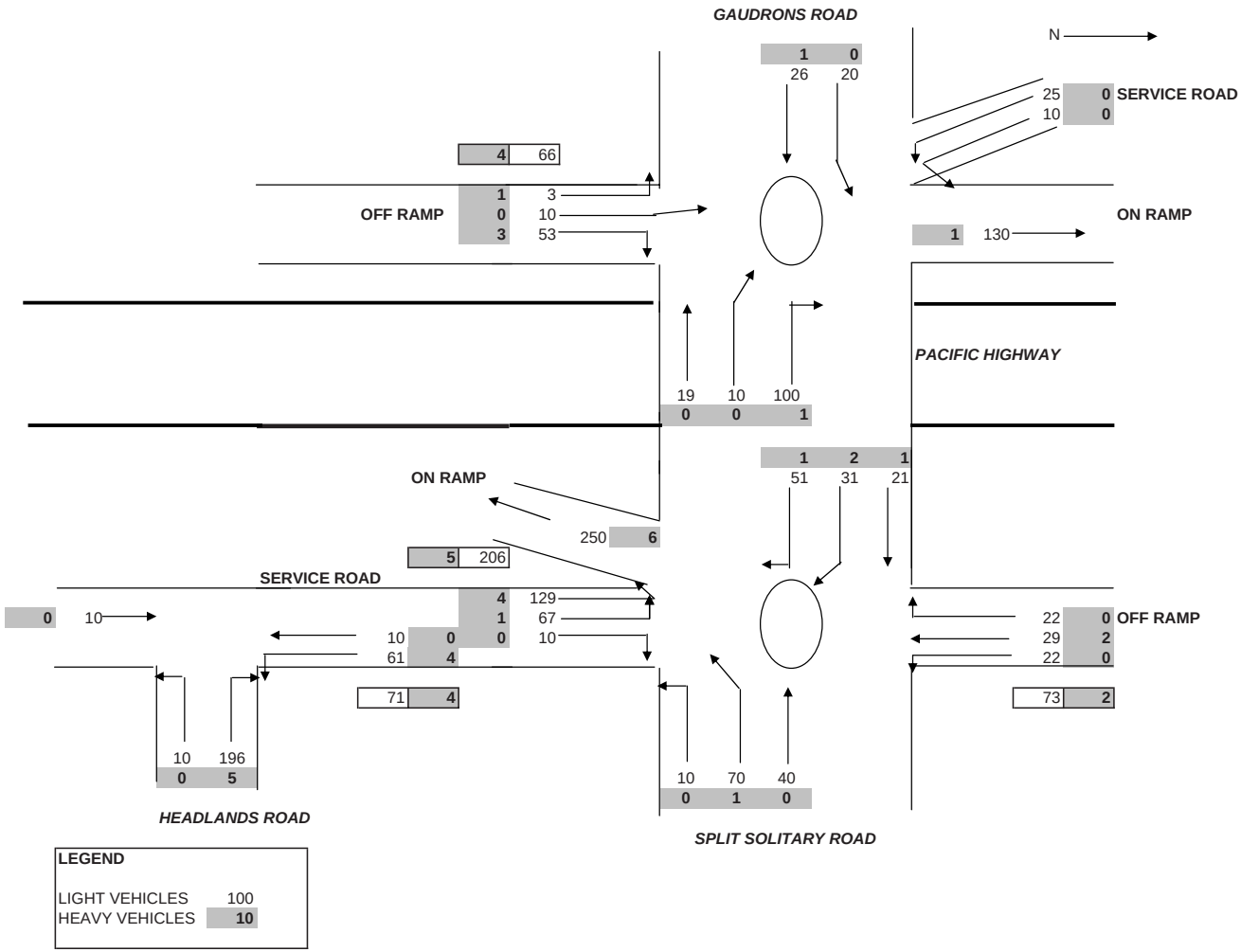


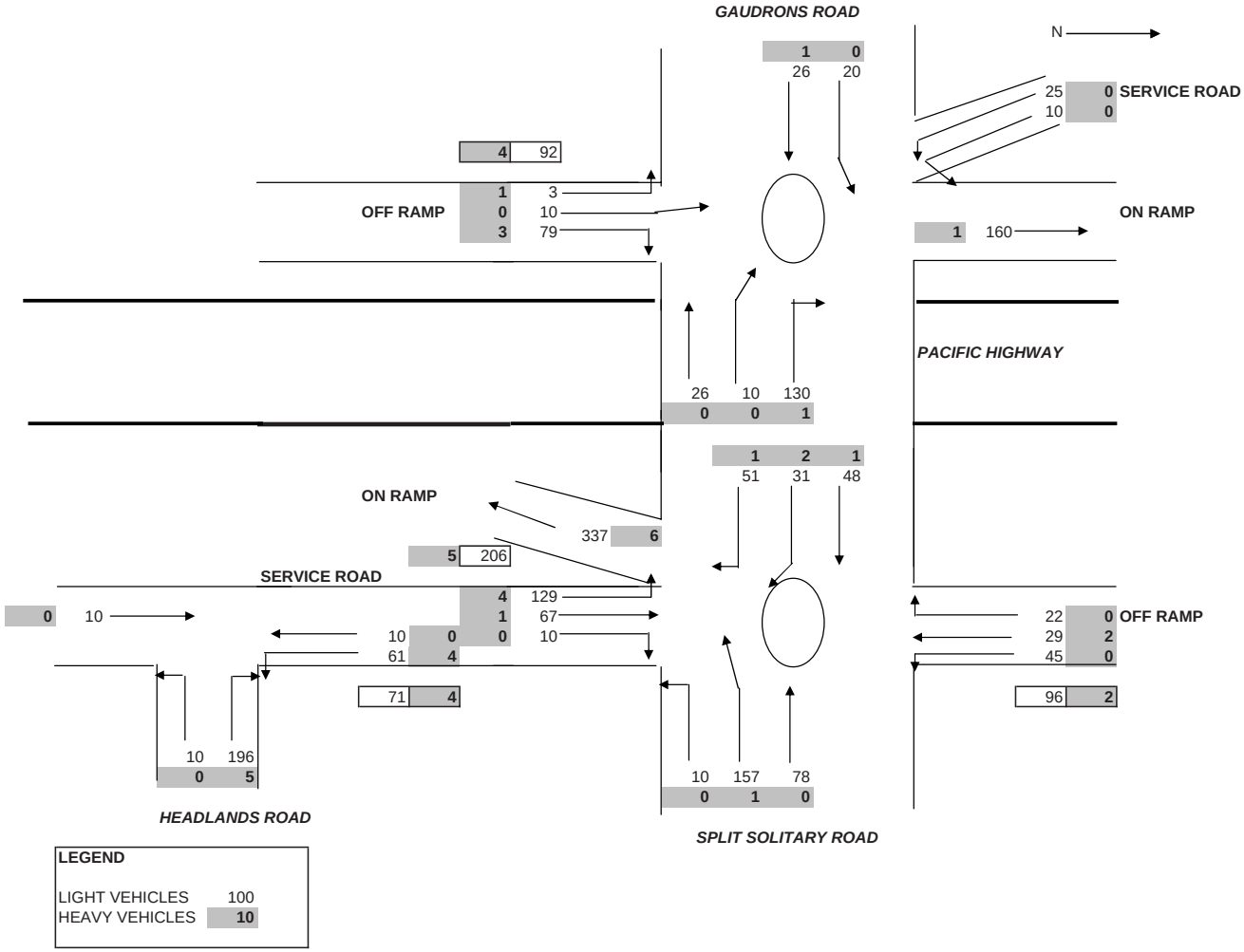
SPLIT SOLITARY ROAD/GAUDRONS ROAD INTERCHANGE - 2011 - PM PEAK



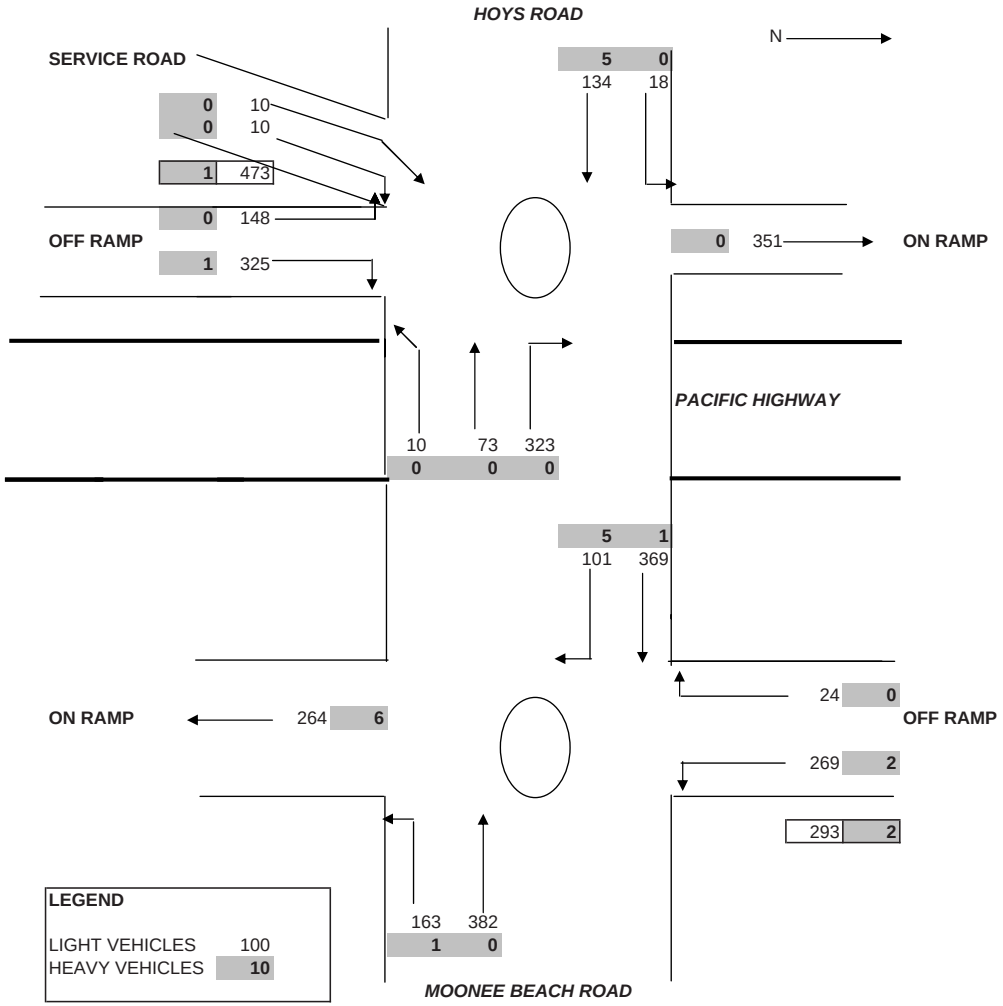
SPLIT SOLITARY ROAD/GAUDRONS ROAD INTERCHANGE - 2031 - PM PEAK



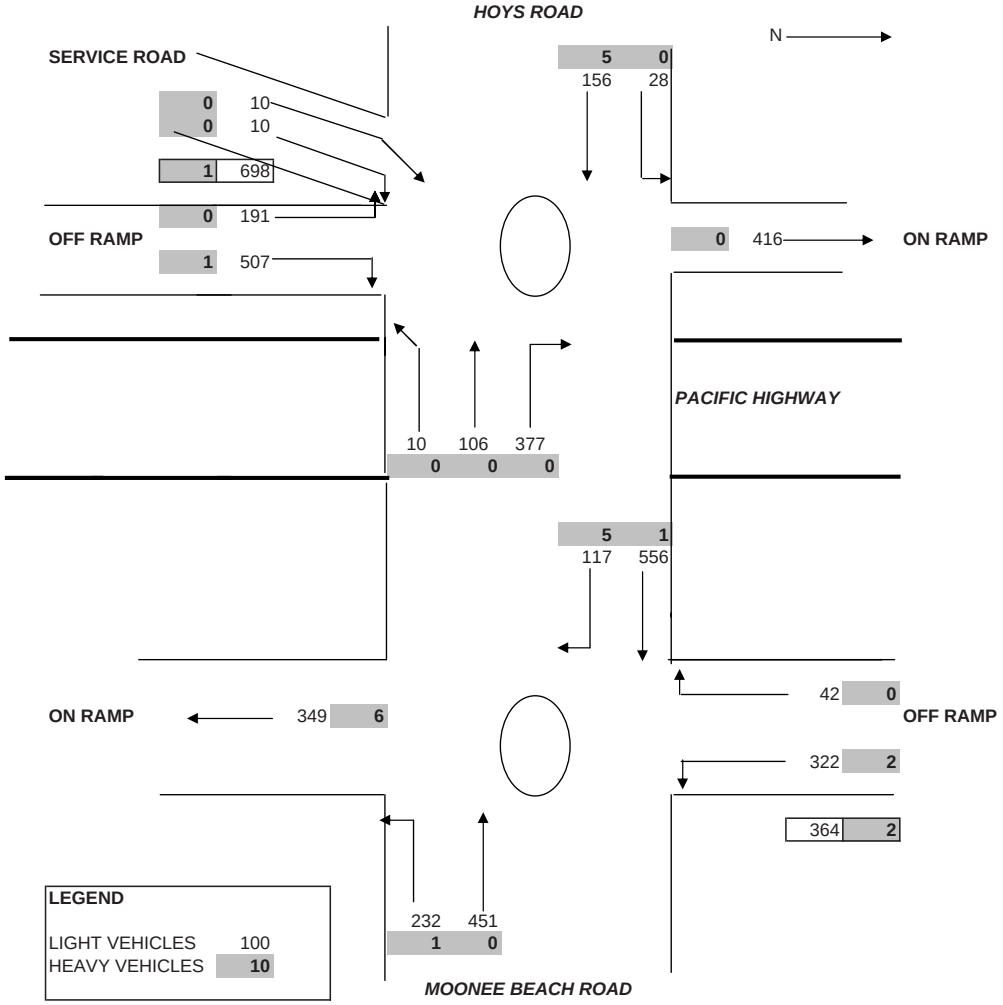
SPLIT SOLITARY ROAD/GAUDRONS ROAD INTERCHANGE - 2011 - AM PEAK



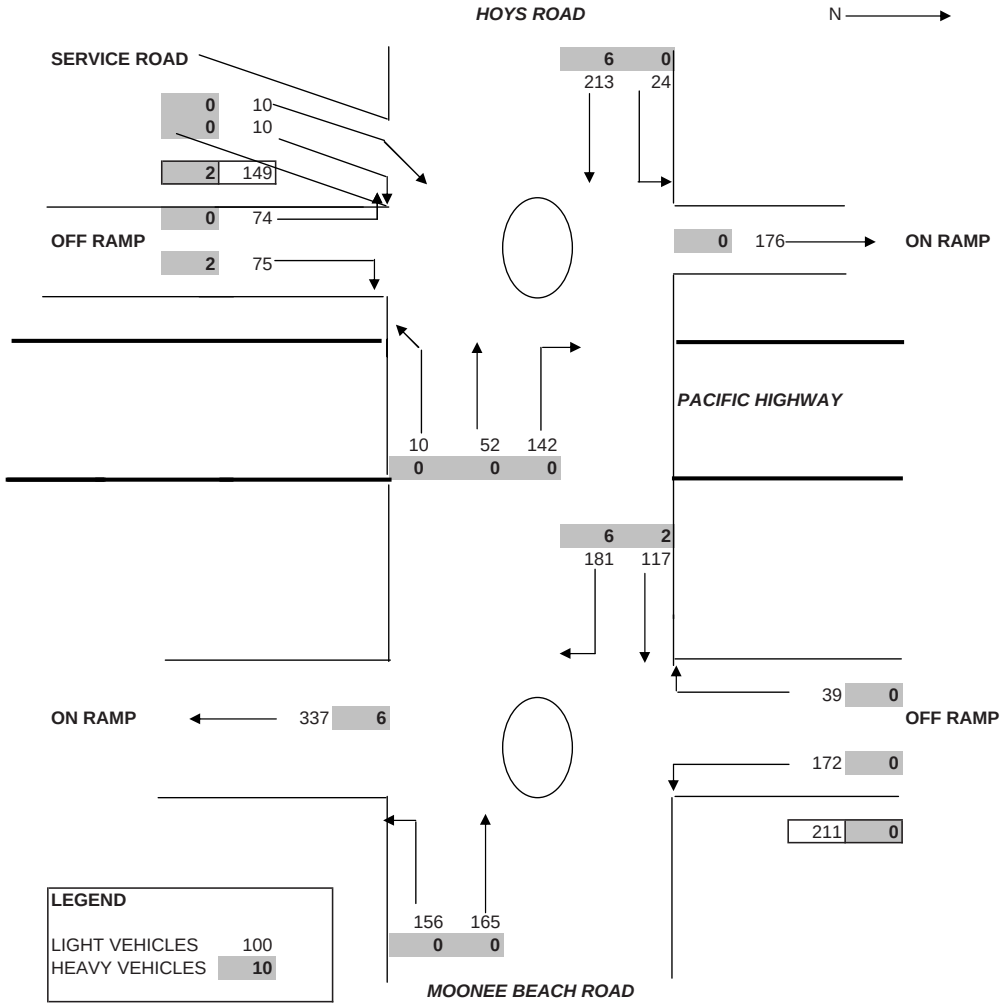
SPLIT SOLITARY ROAD/GAUDRONS ROAD INTERCHANGE - 2031 - AM PEAK



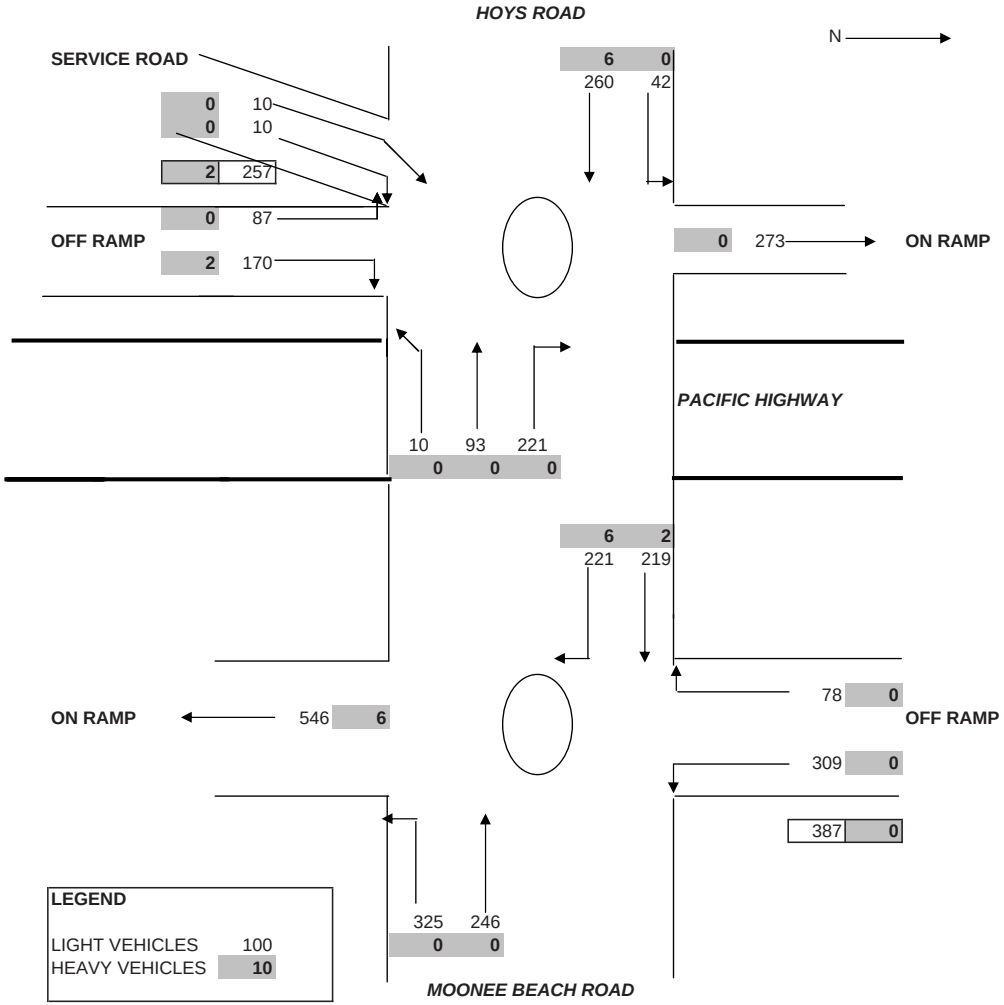
MOONEE BEACH ROAD/HOYS ROAD INTERCHANGE - 2011 - PM PEAK



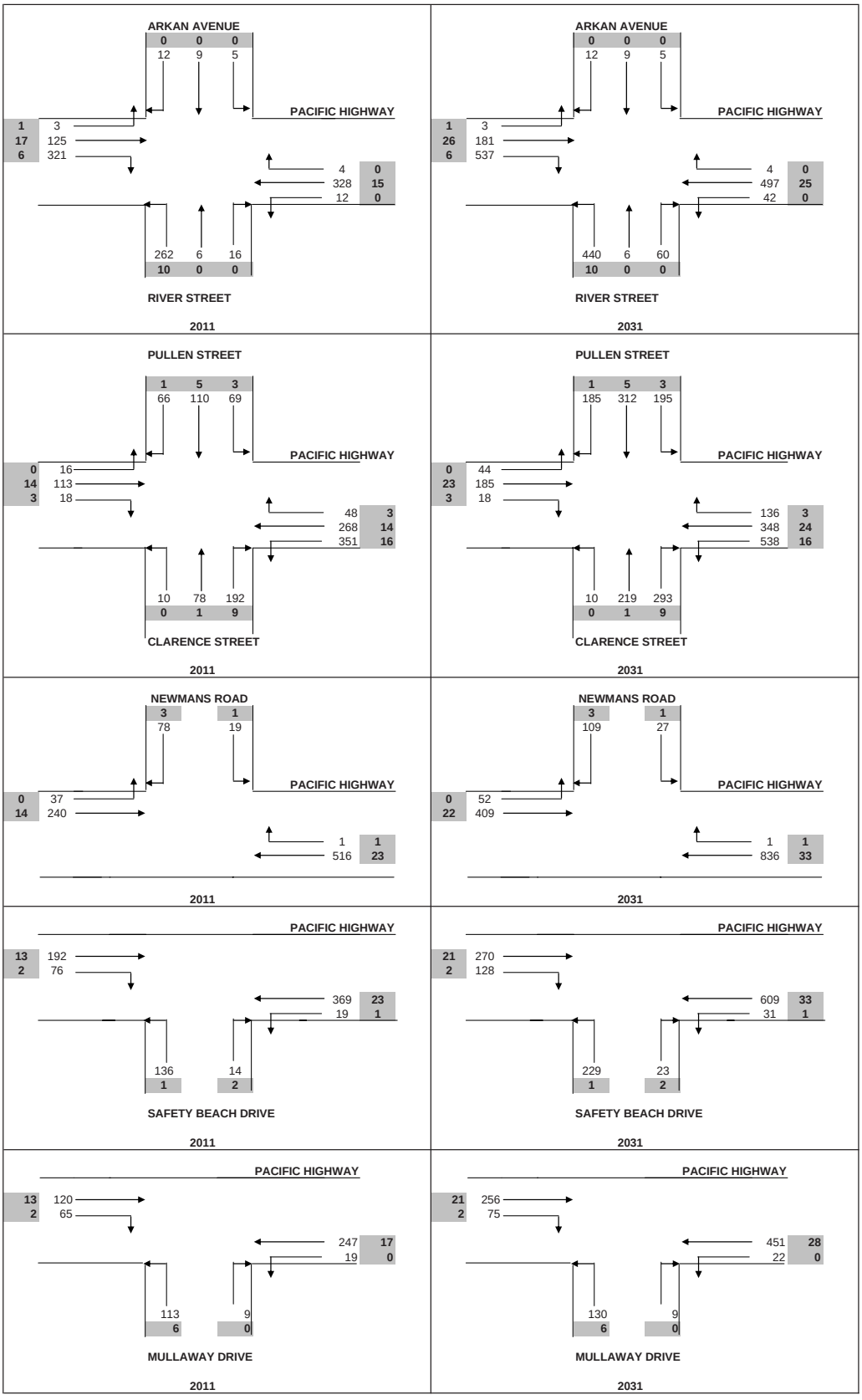
MOONEE BEACH ROAD/HOYS ROAD INTERCHANGE - 2031 - PM PEAK



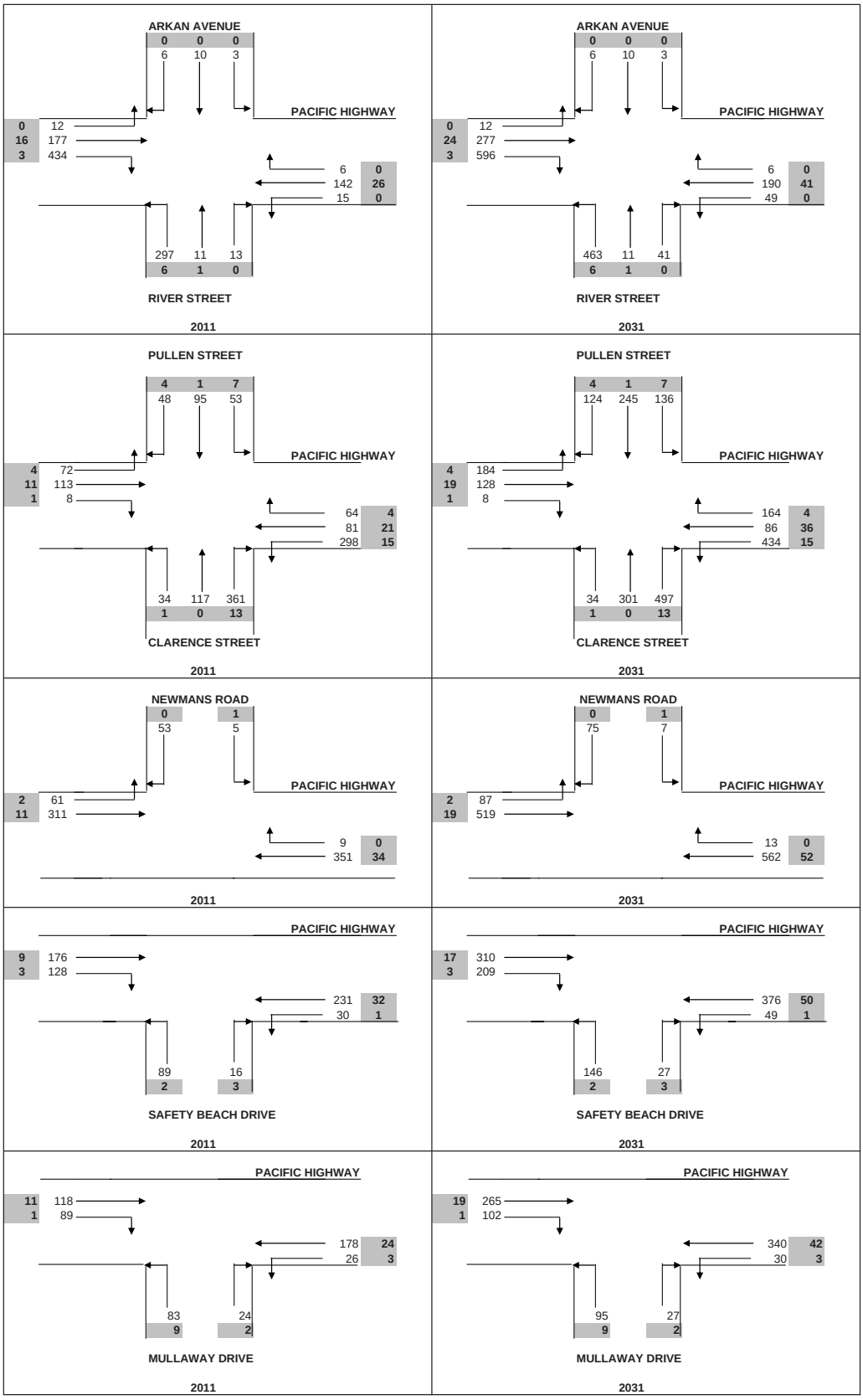
MOONEE BEACH ROAD/HOYS ROAD INTERCHANGE - 2011 - AM PEAK



MOONEE BEACH ROAD/HOYS ROAD INTERCHANGE - 2031 - AM PEAK



FUTURE PEAK HOUR TRAFFIC VOLUMES - BYPASSED SECTION - AM PEAK



FUTURE PEAK HOUR TRAFFIC VOLUMES - BYPASSED SECTION - PM PEAK

Appendix F

Construction Cost Estimates

ROADS AND TRAFFIC AUTHORITY
Concept Estimate Class M - Summary Sheet

Project: SH10 (Sapphire - Woolgoolga) Upgrade — **Connell Wagner**
Description: Summary of all stages Including Arrawarra Interchange
Section: Sapphire to Woolgoolga — **9-Aug-07**

Item	Estimate $ (Excluding Contingency)	Contingency %	Contingency Amount ($)	Estimate ($) (Including Contingency)	% of Total Estimate
1. Project Development					
1.1 Route / Concept / EIS / Reps Report	$7,000,000	40%	$2,800,000	$9,800,000	
1.2 Project Management Services	$350,000	40%	$140,000	$490,000	
1.3 Client Representation	$70,000	40%	$28,000.00	$98,000	
Sub Total 1	**$7,420,000**		**$2,968,000**	**$10,388,000**	**2.24%**
2. Investigation and Design					
2.1 Detail Design and Documentation	$10,000,000	40%	$4,000,000	$14,000,000	
2.2 Project Management Services	$1,000,000	40%	$400,000	$1,400,000	
2.3 Client Representation	$100,000	40%	$40,000	$140,000	
Sub Total 2	**$11,100,000**		**$4,440,000**	**$15,540,000**	**3.35%**
3. Property Acquisitions					
3.1 Professional Services for Acquisitions	$3,060,000	40%	$1,224,000	$4,284,000	
3.2 Property Acquisition Costs	$35,685,000	40%	$14,274,000	$49,959,000	
3.3 Project Management Services	$153,000	40%	$61,200	$214,200	
3.4 Client Representation	$30,600	40%	$12,240	$42,840	
Sub Total 3	**$38,928,600**		**$15,571,440**	**$54,500,040**	**11.74%**
4. Public Utility Adjustments					
4.1 Adjust Utility Services	$12,000,000	50%	$6,000,000	$18,000,000	
4.2 Project Management Services	$600,000	50%	$300,000	$900,000	
4.3 Client Representation	$80,000	50%	$40,000	$120,000	
Sub Total 4	**$12,680,000**		**$6,340,000**	**$19,020,000**	**4.10%**
5. Construction					
5.1 Infrastructure - Environmental Works	$13,072,000	30%	$3,921,600	$16,993,600	3.66%
5.2 Infrastructure - Noise Mitigation	$9,634,750	30%	$2,890,425	$12,525,175	2.70%
5.3 Infrastructure - Earthworks	$35,243,301	35%	$12,335,155	$47,578,457	10.25%
5.4 Infrastructure - Drainage	$37,239,718	30%	$10,313,915	$47,553,634	10.24%
5.5 Infrastructure - Pavement	$78,077,901	20%	$15,615,580	$93,693,482	20.18%
5.6 Infrastructure - Structures	$48,101,650	25%	$12,025,413	$60,127,063	12.95%
5.7 Infrastructure - Interchanges and Local Road Adjustments	$20,961,650	35%	$7,336,578	$28,298,228	6.09%
5.8 Infrastructure - Miscellaneous	$10,350,703	35%	$3,622,746	$13,973,449	3.01%
5.9 Infrastructure - General Activities	$8,607,600	35%	$3,012,660	$11,620,260	2.50%
5.11 Principal Arranged Insurance	$4,477,550	40%	$1,791,020	$6,268,570	1.35%
5.12 Infrastructure - Site Management	$10,535,411	40%	$4,214,164	$14,749,575	3.18%
5.13 Project Management Services	$5,267,705	40%	$2,107,082	$7,374,788	1.59%
5.14 Client Representation	$526,771	40%	$210,708	$737,479	0.16%
Sub Total 5	**$284,192,711**		**$79,397,047**	**$364,637,758**	**78.52%**
6. Project Handover					
6.2 Project Data and Performance	$150,000	35%	$52,500	$202,500	
6.3 Project Management Services	$50,000	35%	$17,500	$67,500	
6.4 Client Representation	$20,120	35%	$7,042	$27,162	
Sub Total 6	**$220,120**		**$77,042**	**$297,162**	**0.06%**
TOTAL	**$354,541,431**		**$108,793,529**	**$464,382,960**	**100.00%**

	Total Amount	% of Total Estimate
Project Management	$10,446,488	2.2%
Client Representation	$1,165,481	0.3%
Site Management	$14,749,575	3.2%

Reality Checks (Incl Contingency)			
1. Cost $M / km	$19	23.9km	
2. Cost $M / Lane km	$4	5 lanes - full length service road	
3. Earthworks Cost / m^3	$17	Average unit rate of all earthworks items	
4. Structurs Cost / m^2	$2,436	15836m^2 road bridges	
5. Pavement Cost / m^2	$76	Average unit rate of all pavement items 760000m^2 total pavement	

Appendix G

Detailed Results of Economic Analysis

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Sapphire to Woolgoolga Upgrade

PARAMETER VALUES

General	
Base Year for Discounting	2006
Annual Expansion Factor (AM Peak Hour to Annual)	2700
Discount Rate	4%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
VOC per Vehicle Km	
Existing Highway	$0.34
New Highway	$0.33
Value of Time per hour	$30.97
Accident Costs per Crash	
Accident	$151,500

CAPITAL COST ($M)

Option
$464

ESTIMATED NUMBER OF CRASHES

Base Case	
2011	50
2031	79
Option	
2011	36
2031	56

TRAVEL STATISTICS (MORNING PEAK HOUR)

	Base Case		Option	
	2011	2031	2011	2031
Vehicle Kilometres of Travel (VKT)				
Vehicle Travel	41,063	64,695	43,502	67,430
Vehicle Hours of Travel (VHT)				
Vehicel Hours	604	2,542	475	787

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$5.22	$4.11	$2.53

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$411	$1,365	$955	3.3	$799	$390	2.0	$284	-$124	0.7	2.4%

* includes maintenance cost for 30 year period

4% Discount Rate

TRAVEL AND ACCIDENT COSTS ($M)

	Base Case		Option	
	2011	2031	2011	2031
Peak Hour Travel Costs				
Vehicle Operating Costs	$0.014	$0.022	$0.014	$0.022
Travel Time Costs	$0.019	$0.079	$0.015	$0.024
Accident Costs	$0.003	$0.004	$0.002	$0.003
Hourly Travel Costs	$0.035	$0.105	$0.031	$0.050
Annual Travel Costs	$96	$284	$84	$134

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base Case	Base Case Discounted	Option	Option Discounted
2011	96	$79	84	$69
2012	105	$83	86	$68
2013	115	$87	89	$67
2014	124	$91	91	$67
2015	133	$94	94	$66
2016	143	$96	96	$65
2017	152	$99	99	$64
2018	162	$101	101	$63
2019	171	$103	104	$62
2020	180	$104	106	$61
2021	190	$105	109	$60
2022	199	$106	111	$59
2023	209	$107	114	$58
2024	218	$108	116	$57
2025	227	$108	119	$56
2026	237	$108	121	$55
2027	246	$108	124	$54
2028	256	$108	126	$53
2029	265	$108	129	$52
2030	275	$107	131	$51
2031	284	$107	134	$50
2032	293	$106	136	$49
2033	303	$105	139	$48
2034	312	$104	141	$47
2035	322	$103	144	$46
2036	331	$102	146	$45
2037	340	$101	149	$44
2038	350	$100	151	$43
2039	359	$98	154	$42
2040	369	$97	156	$41
Discounted Costs				
10 Year Period		$936		$652
20 Year Period		$2,010		$1,211
30 Year Period		$3,032		$1,667
Present Value of Benefits				
10 Year Period				$284
20 Year Period				$799
30 Year Period				$1,365

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option	Option Discounted
2007	$36.0	$34.6
2008	$68.0	$62.9
2009	$120.0	$106.7
2010	$120.0	$102.6
2011	$120.0	$98.6
Total	**$464**	**$405**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Sapphire to Woolgoolga Upgrade

PARAMETER VALUES

General	
Base Year for Discounting	2006
Annual Expansion Factor (AM Peak Hour to Annual)	2700
Discount Rate	7%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
VOC per Vehicle Km	
Existing Highway	$0.34
New Highway	$0.33
Value of Time per hour	$30.97
Accident Costs per Crash	
Accident	$151,500

CAPITAL COST ($M)

Option
$464

ESTIMATED NUMBER OF CRASHES

Base Case	
2011	50
2031	79
Option	
2011	36
2031	56

TRAVEL STATISTICS (MORNING PEAK HOUR)

	Base Case		Option	
	2011	2031	2011	2031
Vehicle Kilometres of Travel (VKT)				
Vehicle Travel	41,063	64,695	43,502	67,430
Vehicle Hours of Travel (VHT)				
Vehicel Hours	604	2,542	475	787

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$3.19	$2.73	$1.88

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$371	$752	$380	2.0	$506	$135	1.4	$211	-$159	0.6	2.3%

* includes maintenance cost for 30 year period

7% Discount Rate

TRAVEL AND ACCIDENT COSTS ($M)

	Base Case		Option	
	2011	2031	2011	2031
Peak Hour Travel Costs				
Vehicle Operating Costs	$0.014	$0.022	$0.014	$0.022
Travel Time Costs	$0.019	$0.079	$0.015	$0.024
Accident Costs	$0.003	$0.004	$0.002	$0.003
Hourly Travel Costs	$0.035	$0.105	$0.031	$0.050
Annual Travel Costs	$96	$284	$84	$134

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base Case	Base Case Discounted	Option	Option Discounted
2011	96	$68	84	$60
2012	105	$70	86	$57
2013	115	$71	89	$55
2014	124	$72	91	$53
2015	133	$73	94	$51
2016	143	$73	96	$49
2017	152	$72	99	$47
2018	162	$72	101	$45
2019	171	$71	104	$43
2020	180	$70	106	$41
2021	190	$69	109	$39
2022	199	$67	111	$38
2023	209	$66	114	$36
2024	218	$65	116	$34
2025	227	$63	119	$33
2026	237	$61	121	$31
2027	246	$59	124	$30
2028	256	$58	126	$29
2029	265	$56	129	$27
2030	275	$54	131	$26
2031	284	$52	134	$25
2032	293	$51	136	$23
2033	303	$49	139	$22
2034	312	$47	141	$21
2035	322	$45	144	$20
2036	331	$43	146	$19
2037	340	$42	149	$18
2038	350	$40	151	$17
2039	359	$39	154	$17
2040	369	$37	156	$16
Discounted Costs				
10 Year Period		$712		$501
20 Year Period		$1,330		$824
30 Year Period		$1,775		$1,023
Present Value of Benefits				
10 Year Period				$211
20 Year Period				$506
30 Year Period				$752

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option	Option Discounted
2007	$36.0	$33.6
2008	$68.0	$59.4
2009	$120.0	$98.0
2010	$120.0	$91.5
2011	$120.0	$85.6
Total	**$464**	**$368**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Sapphire to Woolgoolga Upgrade

PARAMETER VALUES

General	
Base Year for Discounting	2006
Annual Expansion Factor (AM Peak Hour to Annual)	2700
Discount Rate	10%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
VOC per Vehicle Km	
Existing Highway	$0.34
New Highway	$0.33
Value of Time per hour	$30.97
Accident Costs per Crash	
Accident	$151,500

CAPITAL COST ($M)

Option
$464

ESTIMATED NUMBER OF CRASHES

Base Case	
2011	50
2031	79
Option	
2011	36
2031	56

TRAVEL STATISTICS (MORNING PEAK HOUR)

	Base Case		Option	
	2011	2031	2011	2031
Vehicle Kilometres of Travel (VKT)				
Vehicle Travel	41,063	64,695	43,502	67,430
Vehicle Hours of Travel (VHT)				
Vehicel Hours	604	2,542	475	787

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$2.09	$1.90	$1.43

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$338	$441	$104	1.3	$332	-$6	1.0	$159	-$178	0.5	2.2%

* includes maintenance cost for 30 year period

10% Discount Rate

TRAVEL AND ACCIDENT COSTS ($M)

	Base Case		Option	
	2011	2031	2011	2031
Peak Hour Travel Costs				
Vehicle Operating Costs	$0.014	$0.022	$0.014	$0.022
Travel Time Costs	$0.019	$0.079	$0.015	$0.024
Accident Costs	$0.003	$0.004	$0.002	$0.003
Hourly Travel Costs	$0.035	$0.105	$0.031	$0.050
Annual Travel Costs	$96	$284	$84	$134

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base Case	Base Case Discounted	Option	Option Discounted
2011	96	$59	84	$52
2012	105	$59	86	$49
2013	115	$59	89	$45
2014	124	$58	91	$43
2015	133	$57	94	$40
2016	143	$55	96	$37
2017	152	$53	99	$35
2018	162	$51	101	$32
2019	171	$50	104	$30
2020	180	$48	106	$28
2021	190	$45	109	$26
2022	199	$43	111	$24
2023	209	$41	114	$23
2024	218	$39	116	$21
2025	227	$37	119	$19
2026	237	$35	121	$18
2027	246	$33	124	$17
2028	256	$31	126	$16
2029	265	$30	129	$14
2030	275	$28	131	$13
2031	284	$26	134	$12
2032	293	$25	136	$11
2033	303	$23	139	$11
2034	312	$22	141	$10
2035	322	$20	144	$9
2036	331	$19	146	$8
2037	340	$18	149	$8
2038	350	$17	151	$7
2039	359	$15	154	$7
2040	369	$14	156	$6
Discounted Costs				
10 Year Period		$549		$390
20 Year Period		$913		$581
30 Year Period		$1,112		$670
Present Value of Benefits				
10 Year Period				$159
20 Year Period				$332
30 Year Period				$441

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option	Option Discounted
2007	$36.0	$32.7
2008	$68.0	$56.2
2009	$120.0	$90.2
2010	$120.0	$82.0
2011	$120.0	$74.5
Total	**$464**	**$336**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Sapphire to Woolgoolga Upgrade

PARAMETER VALUES

General	
Base Year for Discounting	2006
Annual Expansion Factor (AM Peak Hour to Annual)	2700
Discount Rate	7%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
VOC per Vehicle Km	
Existing Highway	$0.34
New Highway	$0.33
Value of Time per hour	$30.97
Accident Costs per Crash	
Accident	$151,500

CAPITAL COST ($M)

Option
$418

ESTIMATED NUMBER OF CRASHES

Base Case	
2011	50
2031	79
Option	
2011	36
2031	56

TRAVEL STATISTICS (MORNING PEAK HOUR)

	Base Case		Option	
	2011	**2031**	**2011**	**2031**
Vehicle Kilometres of Travel (VKT)				
Vehicle Travel	41,063	64,695	43,502	67,430
Vehicle Hours of Travel (VHT)				
Vehicel Hours	604	2,542	475	787

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	**30 Year Period**	**20 Year Period**	**10 Year Period**
Option	$3.19	$2.73	$1.88

RESULTS OF ECONOMIC ANALYSIS

Scenario	**PVC* ($M)**	**30 Year Period**			**20 Year Period**			**10 Year Period**			**FYRR**
		PVB ($M)	**NPV ($M)**	**BCR**	**PVB ($M)**	**NPV ($M)**	**BCR**	**PVB ($M)**	**NPV ($M)**	**BCR**	
Option	$334	$752	$417	2.2	$506	$172	1.5	$211	-$122	0.6	2.6%

* includes maintenance cost for 30 year period

10% Reduction in Constrction Cost

TRAVEL AND ACCIDENT COSTS ($M)

	Base Case		Option	
	2011	2031	2011	2031
Peak Hour Travel Costs				
Vehicle Operating Costs	$0.014	$0.022	$0.014	$0.022
Travel Time Costs	$0.019	$0.079	$0.015	$0.024
Accident Costs	$0.003	$0.004	$0.002	$0.003
Hourly Travel Costs	$0.035	$0.105	$0.031	$0.050
Annual Travel Costs	$96	$284	$84	$134

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base Case	Base Case Discounted	Option	Option Discounted
2011	96	$68	84	$60
2012	105	$70	86	$57
2013	115	$71	89	$55
2014	124	$72	91	$53
2015	133	$73	94	$51
2016	143	$73	96	$49
2017	152	$72	99	$47
2018	162	$72	101	$45
2019	171	$71	104	$43
2020	180	$70	106	$41
2021	190	$69	109	$39
2022	199	$67	111	$38
2023	209	$66	114	$36
2024	218	$65	116	$34
2025	227	$63	119	$33
2026	237	$61	121	$31
2027	246	$59	124	$30
2028	256	$58	126	$29
2029	265	$56	129	$27
2030	275	$54	131	$26
2031	284	$52	134	$25
2032	293	$51	136	$23
2033	303	$49	139	$22
2034	312	$47	141	$21
2035	322	$45	144	$20
2036	331	$43	146	$19
2037	340	$42	149	$18
2038	350	$40	151	$17
2039	359	$39	154	$17
2040	369	$37	156	$16
Discounted Costs				
10 Year Period		$712		$501
20 Year Period		$1,330		$824
30 Year Period		$1,775		$1,023
Present Value of Benefits				
10 Year Period				$211
20 Year Period				$506
30 Year Period				$752

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option	Option Discounted
2007	$32.4	$30.3
2008	$61.2	$53.5
2009	$108.0	$88.2
2010	$108.0	$82.4
2011	$108.0	$77.0
Total	**$418**	**$331**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Sapphire to Woolgoolga Upgrade

PARAMETER VALUES

General	
Base Year for Discounting	2006
Annual Expansion Factor (AM Peak Hour to Annual)	2700
Discount Rate	7%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
VOC per Vehicle Km	
Existing Highway	$0.34
New Highway	$0.33
Value of Time per hour	$30.97
Accident Costs per Crash	
Accident	$151,500

CAPITAL COST ($M)

Option
$534

ESTIMATED NUMBER OF CRASHES

Base Case	
2011	50
2031	79
Option	
2011	36
2031	56

TRAVEL STATISTICS (MORNING PEAK HOUR)

	Base Case		Option	
	2011	2031	2011	2031
Vehicle Kilometres of Travel (VKT)				
Vehicle Travel	41,063	64,695	43,502	67,430
Vehicle Hours of Travel (VHT)				
Vehicel Hours	604	2,542	475	787

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$3.19	$2.73	$1.88

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$427	$752	$325	1.8	$506	$80	1.2	$211	-$214	0.5	2.0%

* includes maintenance cost for 30 year period

15% Increase in Constrction Cost

TRAVEL AND ACCIDENT COSTS ($M)

	Base Case		Option	
	2011	2031	2011	2031
Peak Hour Travel Costs				
Vehicle Operating Costs	$0.014	$0.022	$0.014	$0.022
Travel Time Costs	$0.019	$0.079	$0.015	$0.024
Accident Costs	$0.003	$0.004	$0.002	$0.003
Hourly Travel Costs	$0.035	$0.105	$0.031	$0.050
Annual Travel Costs	$96	$284	$84	$134

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base Case	Base Case Discounted	Option	Option Discounted
2011	96	$68	84	$60
2012	105	$70	86	$57
2013	115	$71	89	$55
2014	124	$72	91	$53
2015	133	$73	94	$51
2016	143	$73	96	$49
2017	152	$72	99	$47
2018	162	$72	101	$45
2019	171	$71	104	$43
2020	180	$70	106	$41
2021	190	$69	109	$39
2022	199	$67	111	$38
2023	209	$66	114	$36
2024	218	$65	116	$34
2025	227	$63	119	$33
2026	237	$61	121	$31
2027	246	$59	124	$30
2028	256	$58	126	$29
2029	265	$56	129	$27
2030	275	$54	131	$26
2031	284	$52	134	$25
2032	293	$51	136	$23
2033	303	$49	139	$22
2034	312	$47	141	$21
2035	322	$45	144	$20
2036	331	$43	146	$19
2037	340	$42	149	$18
2038	350	$40	151	$17
2039	359	$39	154	$17
2040	369	$37	156	$16
Discounted Costs				
10 Year Period		$712		$501
20 Year Period		$1,330		$824
30 Year Period		$1,775		$1,023
Present Value of Benefits				
10 Year Period				$211
20 Year Period				$506
30 Year Period				$752

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option	Option Discounted
2007	$41.4	$38.7
2008	$78.2	$68.3
2009	$138.0	$112.6
2010	$138.0	$105.3
2011	$138.0	$98.4
Total	**$534**	**$423**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Sapphire to Woolgoolga Upgrade

PARAMETER VALUES

General	
Base Year for Discounting	2006
Annual Expansion Factor (AM Peak Hour to Annual)	3000
Discount Rate	7%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
VOC per Vehicle Km	
Existing Highway	$0.34
New Highway	$0.33
Value of Time per hour	$30.97
Accident Costs per Crash	
Accident	$151,500

CAPITAL COST ($M)

Option
$464

ESTIMATED NUMBER OF CRASHES

Base Case	
2011	50
2031	79
Option	
2011	36
2031	56

TRAVEL STATISTICS (MORNING PEAK HOUR)

	Base Case		Option	
	2011	2031	2011	2031
Vehicle Kilometres of Travel (VKT)				
Vehicle Travel	41,063	64,695	43,502	67,430
Vehicle Hours of Travel (VHT)				
Vehicel Hours	604	2,542	475	787

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$3.19	$2.73	$1.88

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$371	$835	$464	2.2	$563	$192	1.5	$235	-$135	0.6	2.6%

* includes maintenance cost for 30 year period

3000 expansion factor

TRAVEL AND ACCIDENT COSTS ($M)

	Base Case		Option	
	2011	2031	2011	2031
Peak Hour Travel Costs				
Vehicle Operating Costs	$0.014	$0.022	$0.014	$0.022
Travel Time Costs	$0.019	$0.079	$0.015	$0.024
Accident Costs	$0.003	$0.004	$0.002	$0.003
Hourly Travel Costs	$0.035	$0.105	$0.031	$0.050
Annual Travel Costs	$106	$315	$93	$149

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base Case	Base Case Discounted	Option	Option Discounted
2011	106	$76	93	$66
2012	117	$78	96	$64
2013	127	$79	98	$61
2014	138	$80	101	$59
2015	148	$81	104	$57
2016	159	$81	107	$54
2017	169	$80	110	$52
2018	180	$80	112	$50
2019	190	$79	115	$48
2020	200	$78	118	$46
2021	211	$76	121	$44
2022	221	$75	124	$42
2023	232	$73	126	$40
2024	242	$72	129	$38
2025	253	$70	132	$36
2026	263	$68	135	$35
2027	274	$66	138	$33
2028	284	$64	140	$32
2029	295	$62	143	$30
2030	305	$60	146	$29
2031	315	$58	149	$27
2032	326	$56	151	$26
2033	336	$54	154	$25
2034	347	$52	157	$24
2035	357	$50	160	$22
2036	368	$48	163	$21
2037	378	$46	165	$20
2038	389	$45	168	$19
2039	399	$43	171	$18
2040	410	$41	174	$17
Discounted Costs				
10 Year Period		$791		$557
20 Year Period		$1,478		$916
30 Year Period		$1,972		$1,137
Present Value of Benefits				
10 Year Period				$235
20 Year Period				$563
30 Year Period				$835

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option	Option Discounted
2007	$36.0	$33.6
2008	$68.0	$59.4
2009	$120.0	$98.0
2010	$120.0	$91.5
2011	$120.0	$85.6
Total	**$464**	**$368**