KINGS FOREST SERVICE STATION
TRAFFIC IMPACT ASSESSMENT

FOR

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1. INTRODUCTION

1.1 BACKGROUND

Bitzios Consulting was engaged by Project 28 Pty Ltd to prepare a traffic impact assessment for the proposed service station development in Kings Forest, New South Wales (NSW). The development is located on Lot No. 7 (DP875447) on Tweed Coast Road as shown in Figure 1.1.

Source: Google Earth – NSW Globe 2013

Figure 1.1: Site Location

The proposed development site has previously been approved for a "Rural Retail" development. The approval as part of the Stage 1 of the Kings Forest development included a GFA of 2,036m^2 and 135 parking spaces. This site generated a total of 122 trips in the AM and 244 trips in the PM peak hour. The previously approved plans are shown in Figure 1.2.

Figure 1.2: Previous Approved Development Plans

1.2 DEVELOPMENT DETAILS

The proposed development includes the construction of a Service Station with convenience store and six other tenancies which are envisaged to be high turnover restaurants, fast food or similar developments. The development details are summarised as follows:

- Petrol Station / Convenience Store – 180m^2; and
- Tenancies and Eating Area – 760m^2.

The development will have separate entry and exit access. The exit is restricted to left-out (southbound) only. The proposed development plan is shown in Figure 1.3.

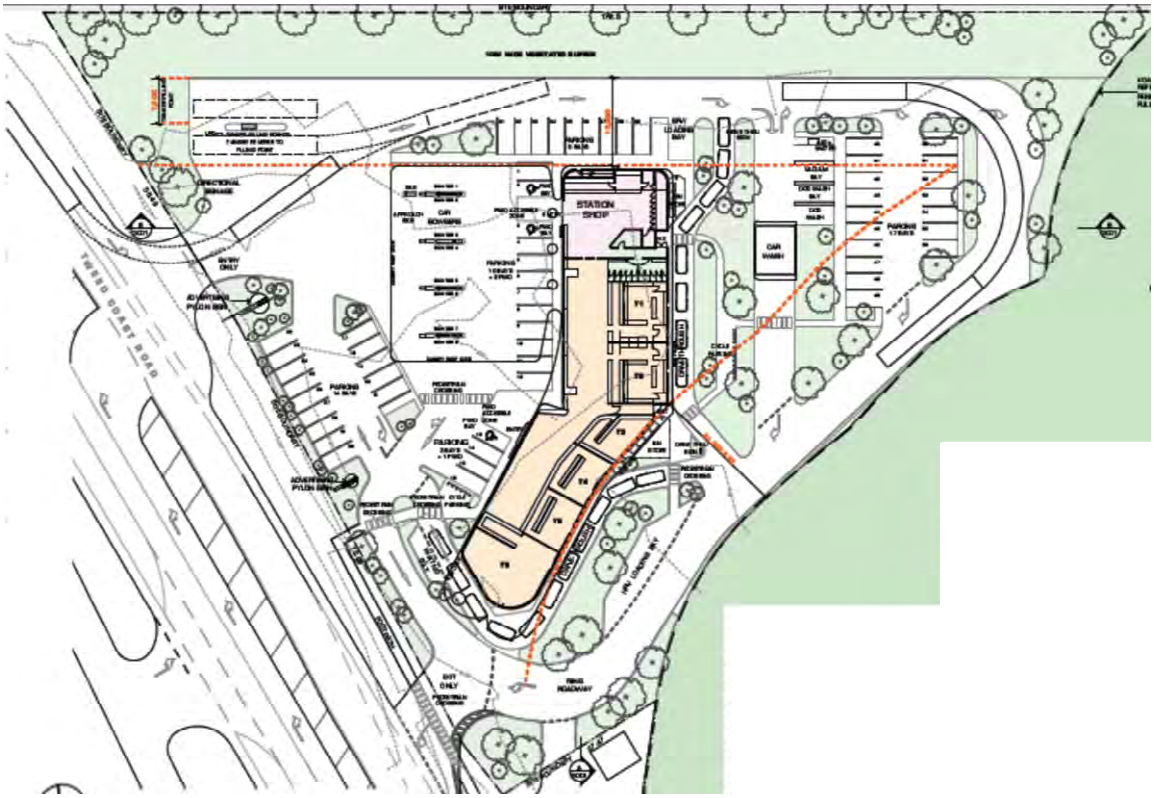

Figure 1.3: Proposed Development Plan

Detailed development plans are presented in Appendix A.

1.3 SCOPE

The scope of the assessment is as follows:

- assessment of the existing conditions of the surrounding area;
- estimation of the likely traffic generation of the proposed development;
- assessment of the impact of the development traffic on the surrounding road network considering other nearby developments;
- assessment of on-site parking and servicing requirements;
- assessment of the site access location and form; and
- assessment of alternative transport modes such as public transport, pedestrian and cycling.

2. EXISTING CONDITIONS

2.1 SURROUNDING ROAD NETWORK

The surrounding road network attributes are presented in Table 2.1.

Table 2.1: Road Network Attributes

Road Name	No. of Lanes (two way)	Jurisdiction	Posted Speed (km/h)	Divided	Comments
Tweed Coast Road	2	Tweed Shire Council	80	No	Development frontage
Old Bogangar Road	2	Tweed Shire Council	50	No	Nearby local street
Depot Road (Kings Forest Parkway)	2	Tweed Shire Council	50	No	Nearby development site

It is understood that Tweed Coast Road will be reduced to 60km/h in the vicinity of the development site as a result of the Kings Forest development access intersection.

2.2 SIGNIFICANT DEVELOPMENTS

The subject site is a part of Kings Forest development area. The overall Kings Forest Masterplan includes a total of approximately 4,500 dwellings (attached and detached) across ten stages.

The subject site has been granted approval as a 'Rural Retail' development as part of Stage 1 of Kings Forest. Stage 1 also includes the following:

- Precinct 5 residential development (approximately 500 dwellings); and
- a two-lane roundabout will be constructed at the Tweed Coast Road / Kings Forest Parkway intersection.

Further to the point above, it is important to note that Condition Number 26 in the Consolidated Project Approval 08_0194 (incorporating Mods 1 and 2) states that '*a two lane roundabout shall be constructed in general accordance with Mortons Urban Solutions Drawing Number 12301-EMAW-101 (Amendment D) at the intersection of Tweed Coast Road and the Kings Forest Parkway prior to the release of the first residential lot in Precinct 5 or the development of Precinct 1*'. The Service Station is located in Precinct 1.

2.3 BACKGROUND TRAFFIC

A Traffic Survey undertaken on Tweed Coast Road in October 2012 at the intersection of Tweed Coast Road and Dianella Drive. The AM and PM peak traffic volumes are shown in Figure 2.1. It is important to note that the volumes shown are two hour peaks.

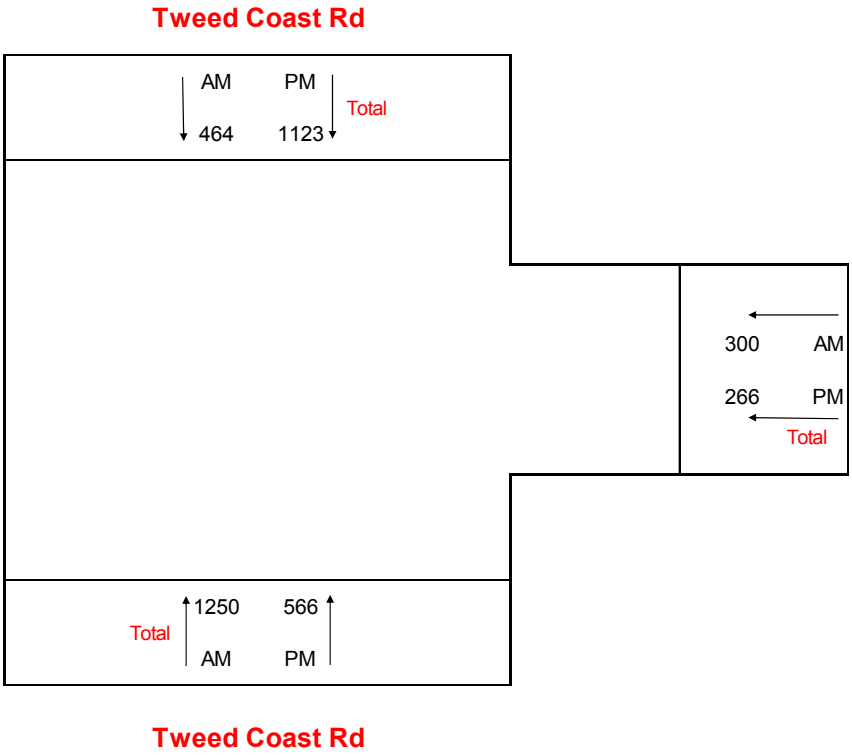

Figure 2.1: Tweed Coast Road Background Traffic Volumes

2.4 TRAFFIC GROWTH

The background traffic on Tweed Coast Road was conservatively factored using a growth rate of 2% per annum (compounding). This rate has been used in a previous traffic report for the approved "Rural Retail" development as part of King Forest Stage 1.

3. TRAFFIC ASSESSMENT

3.1 DEVELOPMENT TRAFFIC GENERATION

The RMS *Guide to Traffic Generating Developments* (2002) and *ITE Trip Generation Handbook (8th Edition)* were used to source traffic generation rates for the development. The areas attributed to each use are detailed as follows:

- tenancies 1 and 6 were assumed to be the 'Fast Food with Drive Through' land uses; and
- tenancies 2, 3, 4, and 5 were assumed to be High Turn Over Restaurant' land uses.

The RMS Guide or ITE Handbook do not include car wash and dog wash uses so a first principles assessment was used to anticipate the traffic generated by the uses. The first principles assessment assumes a worst case scenario (i.e. peak trade - one customer after another) and is summarised as follows:

- Dog Wash (1 wash every 15 minutes per bath, 4 washes per hour per bath, 8 trips per hour); and
- Car Wash (1 wash every 10 minutes per car wash, 6 washes per hour per car wash, 6 trips per hour).

Survey data of a similar development (i.e. service station + convenience store + fast food + car wash) was obtained from RMS and is provided in Appendix F. An analysis of the data showed that a service centre style development typical experiences peak traffic between 11AM – 1PM. This is different to background traffic on Tweed Coast Road which experiences typical peaks (i.e. 7-9 AM and 3-5PM) which is attributed to commuter traffic. Figure 3.1 shows traffic profile of a service centre that fronts on to a major traffic route and Figure 3.2 shows the traffic profile for Tweed Coast Road during May 2013.

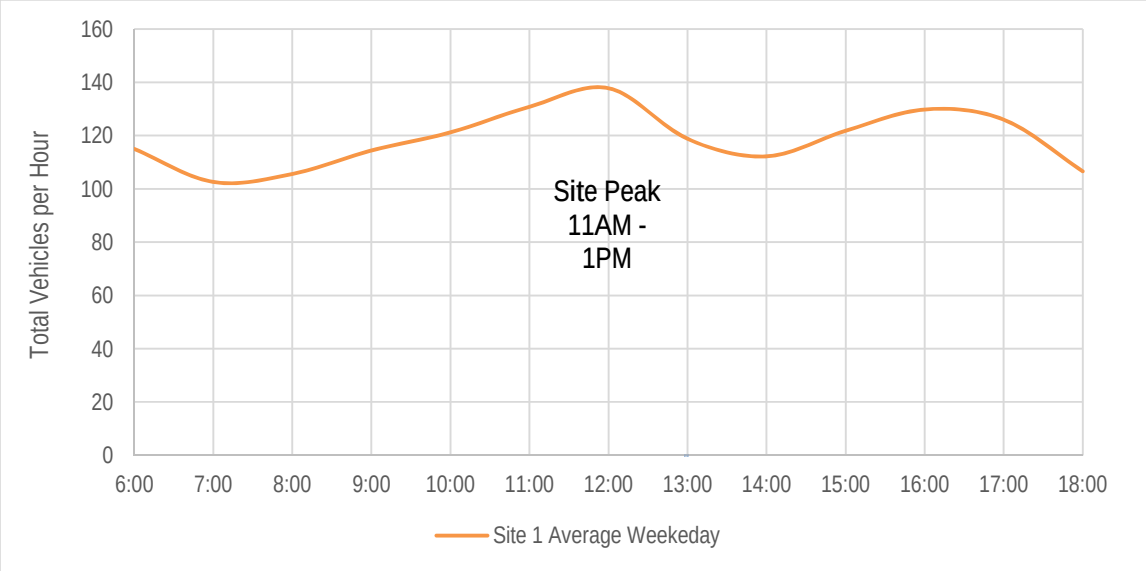

Figure 3.1: Example Service Centre Traffic Profile

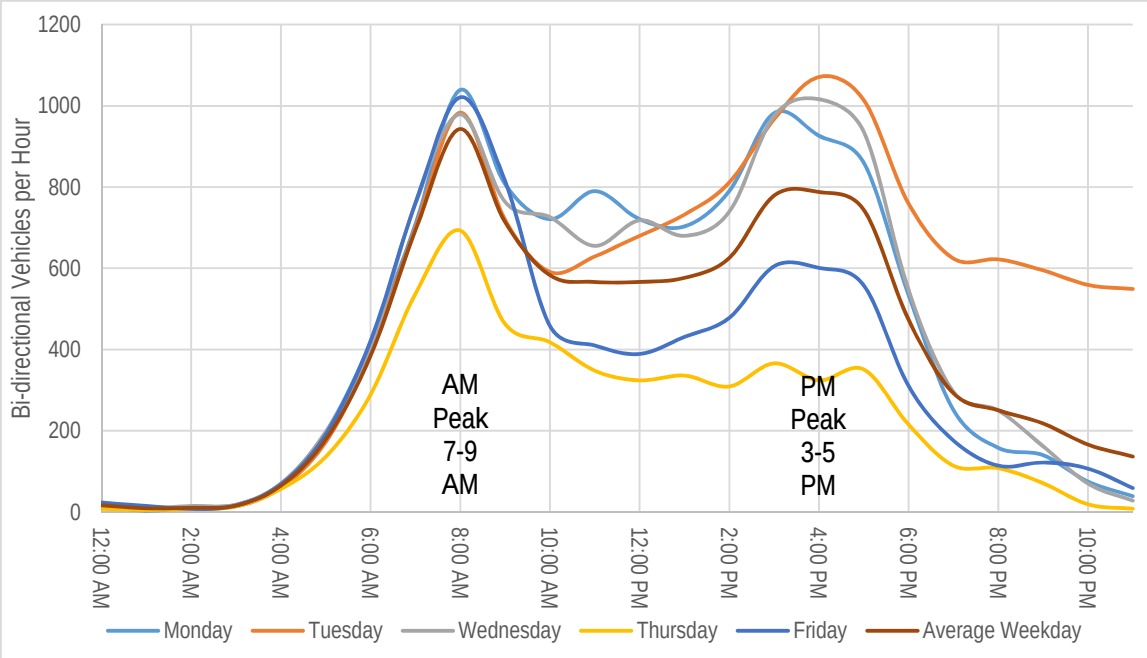

Figure 3.2: Tweed Coast Road Traffic Profile

The graph shows that the site's peak occurs between 11AM - 1PM which does not coincide with the typical commuter peaks. As the site's peak occurs outside of the background traffic peak, the actual impact on Tweed Coast Road is expected to be insignificant.

The AM and PM peaks of the example development site were found to be 36% and 22% respectively lower than the site's peak. These reduction factors were applied to peak hour trip generation so that an accurate peak hour analysis could be undertaken. It is important to note that the peak hour reduction factors were not applied to the 'Fast Food with Drive Through' uses as these rates account for differences in the AM and PM peaks.

Table 3.1 details the anticipated traffic generated by the development.

Table 3.1: Development Traffic Generation

Land Use	Generation Rate		Source	Unit / GFA	Peak Hour Traffic	
	AM	PM		(m^2)	AM	PM
Service Station + Convenience Store	#66.0 trips per 100m^2 GFA		RTA	180	76	92.7
*Fast Food w/drive through	53.1 trips per 100m^2 GFA	36.0trips per 100m^2 GFA	ITE	148	0	53.3
Fast Food w/drive through	53.1 trips per 100m^2 GFA	36.0trips per 100m^2 GFA	ITE	175	92.9	63
High Turnover Restaurant	#12.0 trips per 100m^2 GFA		ITE	438	33.6	41
Car Wash	#6 trips per hour		1st Principles	1	3.8	4.7
Dog Wash	#4 trips per hour		1st Principles	2	5.1	6.2
				Total Trips	211.4	260.9

* *KFC and similar restaurants typically open after the AM peak, approximately 10AM*

\# *Rates reduced by 36% in the AM and 22% in the PM peak periods*

The development trips have been reduced by 15% to account for 'multipurpose' trips as not all trips to the development will be one land use only. For example, a proportion of trips travelling to one the of fast food restaurants is also likely to utilise the service stations components of the site. This reduction has been retained as per the previous assessment as both the RMS Guide and the ITE Handbook only consider stand-alone developments and not a service centre style development. Furthermore, the peak reduction factors applied in Table 3.1 do not account for multipurpose trips rather a reduction to the peak hour trip generation as detailed in the survey data.

Table 3.2 details the development traffic generated distribution in to and out of the development.

Table 3.2: Development Traffic Distribution

Potential Land Use	AM				PM			
	In	Out	In	Out	In	Out	In	Out
Service Station + Convenience Store	50%	50%	38	38	50%	50%	46.4	46.4
*Fast Food w/drive through	50%	50%	0	0	50%	50%	26.7	26.7
Fast Food w/drive through	50%	50%	46.5	46.5	50%	50%	31.5	31.5
High Turnover Restaurant	50%	50%	16.8	16.8	50%	50%	20.5	20.5
Car Wash	50%	50%	1.9	1.9	50%	50%	2.4	2.4
Dog Wash	50%	50%	2.6	2.6	50%	50%	3.1	3.1
Total			105.8	105.8			130.6	130.6
15% Reduction			90	90			111	111

* *KFC and similar restaurants typically open after the AM peak, approximately 10AM*

It should be noted that for the proposed land uses (i.e. service station and fast food), not all of these trips will be 'new' trips on Tweed Coast Road. The RMS Guide and ITE Handbook suggest that 35% of '*service station with convenience store*' trips and 50% of '*fast food with drive through*' are 'pass by' trips (i.e. already exist on Tweed Coast Road). Table 3.3 shows the 'total', 'new' and 'pass by' trips split on to Tweed Coast Road. These trips have also been split in to northbound and southbound trips based on comments made by Tweed Shire Council (TSC) as part of the Stage 1 assessment.

Table 3.3: Development Traffic Split to Tweed Coast Road

Direction	AM		PM	
	In	Out	In	Out
Total Trips				
North	63	63	45	45
South	27	27	67	67
New Trips				
North	37	37	26	26
South	16	16	39	39
Pass By Trips				
North	26	26	19	19
South	11	11	28	28

3.2 TRAFFIC MODELLING

Aimsun microsimulation models were recently developed to test intersection layouts and network configurations for the section of Tweed Coast Road in proximity to Kings Forest. The approved "Rural Retail" development located on the site of the Service Station was included in the previous modelling. The previous modelling included the following scenarios:

- 2016 (Year of Opening): Stage 1 of Kings Forest which includes the Rural Retail development on the eastern side of Tweed Coast Road and 500 dwellings on the western side of Tweed Coast Road; and
- 2026 (10 Year Design Horizon): includes the Rural Retail development on the eastern side of Tweed Coast Road and 2,500 dwellings on the western side of Tweed Coast Road, which assumes Kings Forest's continuing construction at a rate of 200 dwellings per year from 2016 to 2026.

As part of this Traffic Impact Assessment the models have been updated to include the Service Station and assess the traffic network operations in comparison to the approved Rural Retail development. The previous *Kings Forest Intersection Assessment* report which details the development of the Aimsun models and the outcomes of the previous assessment (i.e. Rural Retail assessment) is provided in Appendix C.

3.2.1 Modelled Volumes

The 2016 volumes used to update the models are based on the following:

- the proposed Service Station development on the on the eastern side of Tweed Coast Road;
- through traffic volumes based on 2012 surveys at the Tweed Coast Road / Dianella Drive Intersection with 2% growth compounding per annum from 2012 to 2016; and
- 500 residential dwellings on the western side of Tweed Coast Road accessed via Kings Forest Parkway.

Figure 3.3 shows the 2016 AM and PM volumes.

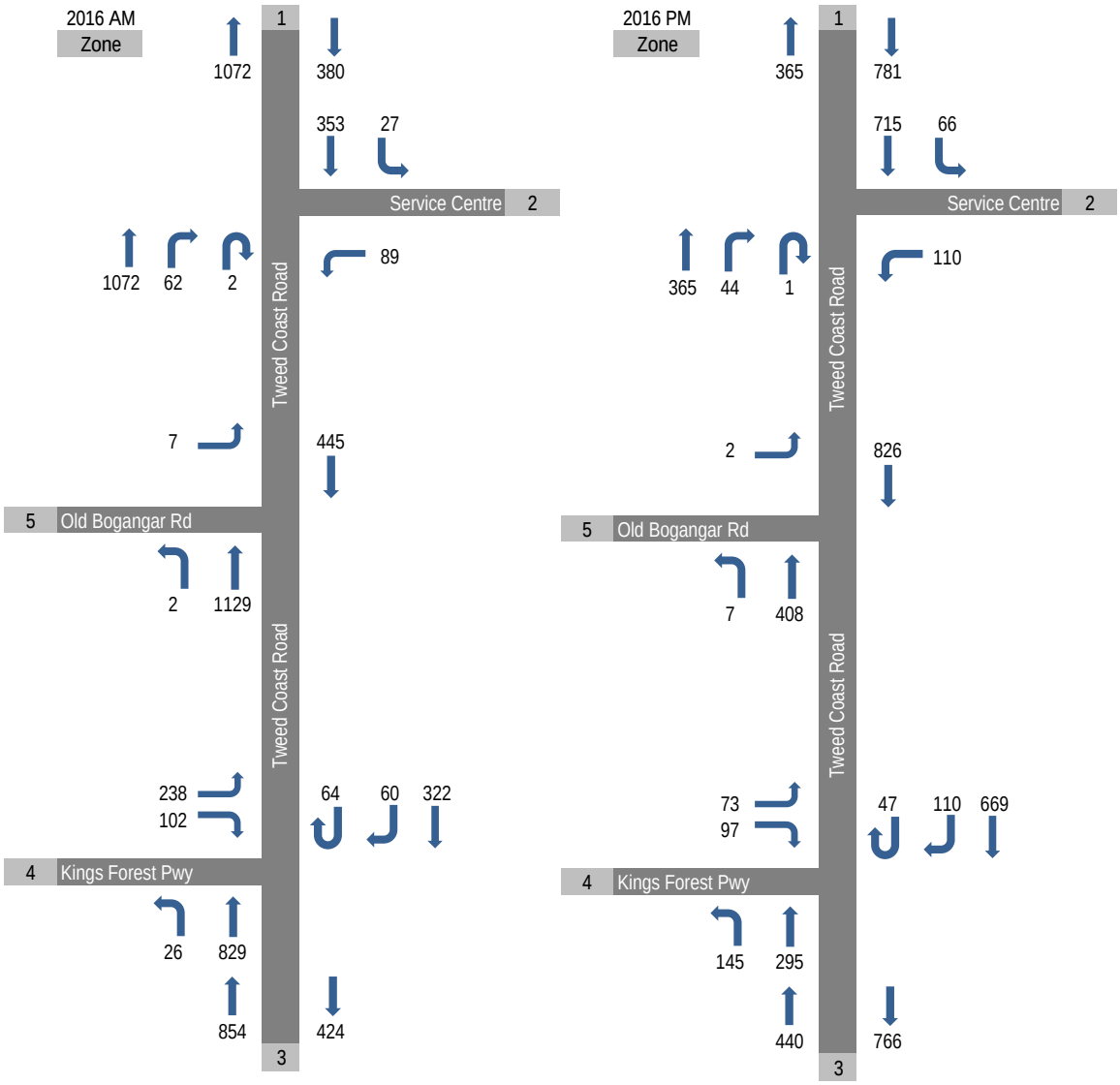

Figure 3.3: 2016 Aimsun Model Volumes (with development)

The 2026 model volumes are based on the following:

- the proposed Service Station development on the eastern side of Tweed Coast Road;
- through traffic volumes based on 2012 surveys at the Tweed Coast Road / Dianella Drive Intersection with 2% growth compounding per annum from 2012 to 2026; and
- 2,500 residential dwellings on the western side of Tweed Coast Road accessed via Kings Forest Parkway.

Figure 3.4 shows the 2026 AM and PM volumes.

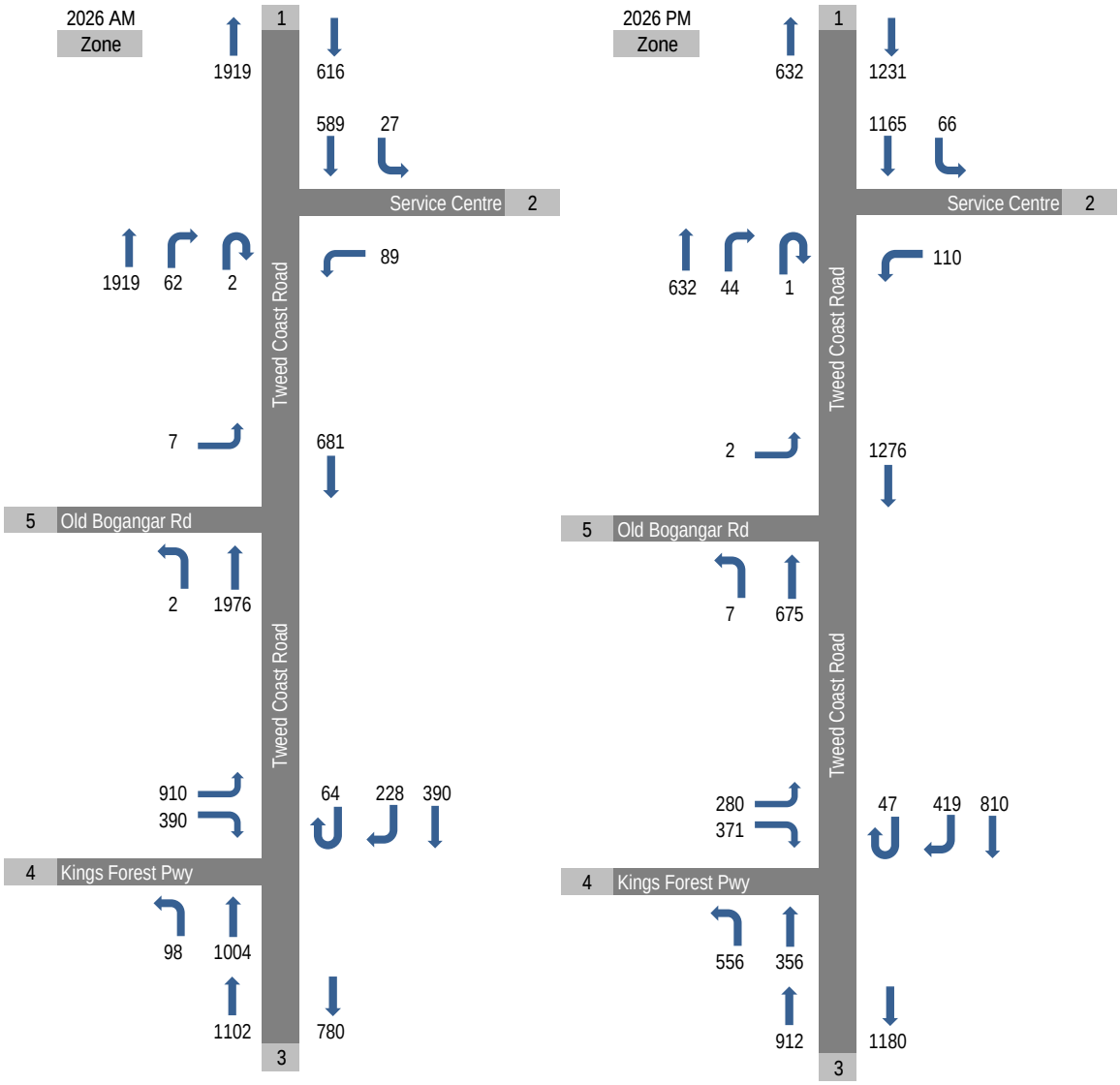

Figure 3.4: 2026 Aimsun Model Volumes (with development)

3.2.2 Modelled Networks

The previously modelled network including details of the road and intersection configurations is shown in Figure 3.5. It should be noted that both a two lane and four lane cross section for Tweed Coast Road was modelled to continue the carrying capacity requirements through the intersections under the future development scenarios. The network shown in Figure 3.5 is sufficient for 2016 volumes with the proposed Service Station.

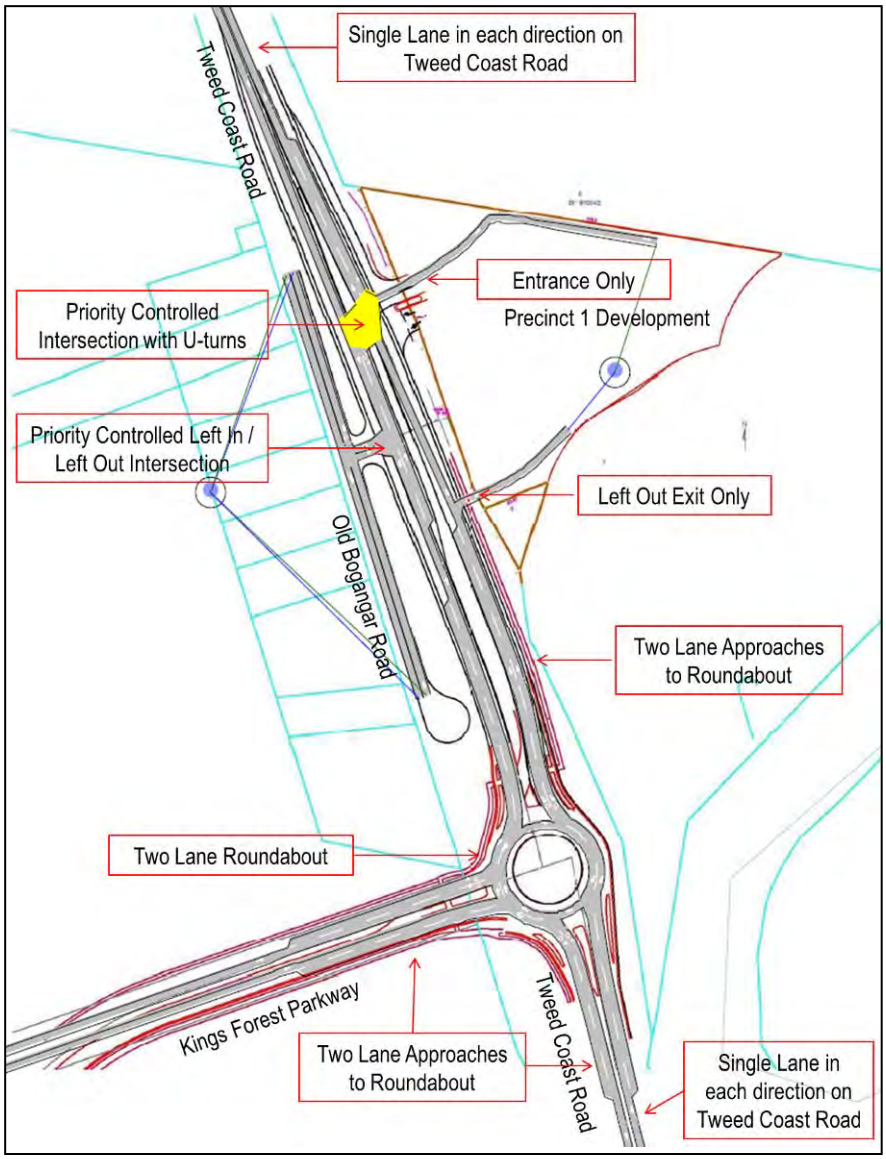

Figure 3.5: 2016 Modelled Network – Rural Retail

As a result of the Service Station modelling, the above network upgrades were required:

- Tweed Coast Road northbound lanes extended to north of the Service Station access; and
- Kings Forest Parkway on approach to the Tweed Coast Road roundabout extended to allow for additional queuing.

Figure 3.6 shows the 2026 modelled network for the proposed Service Station.

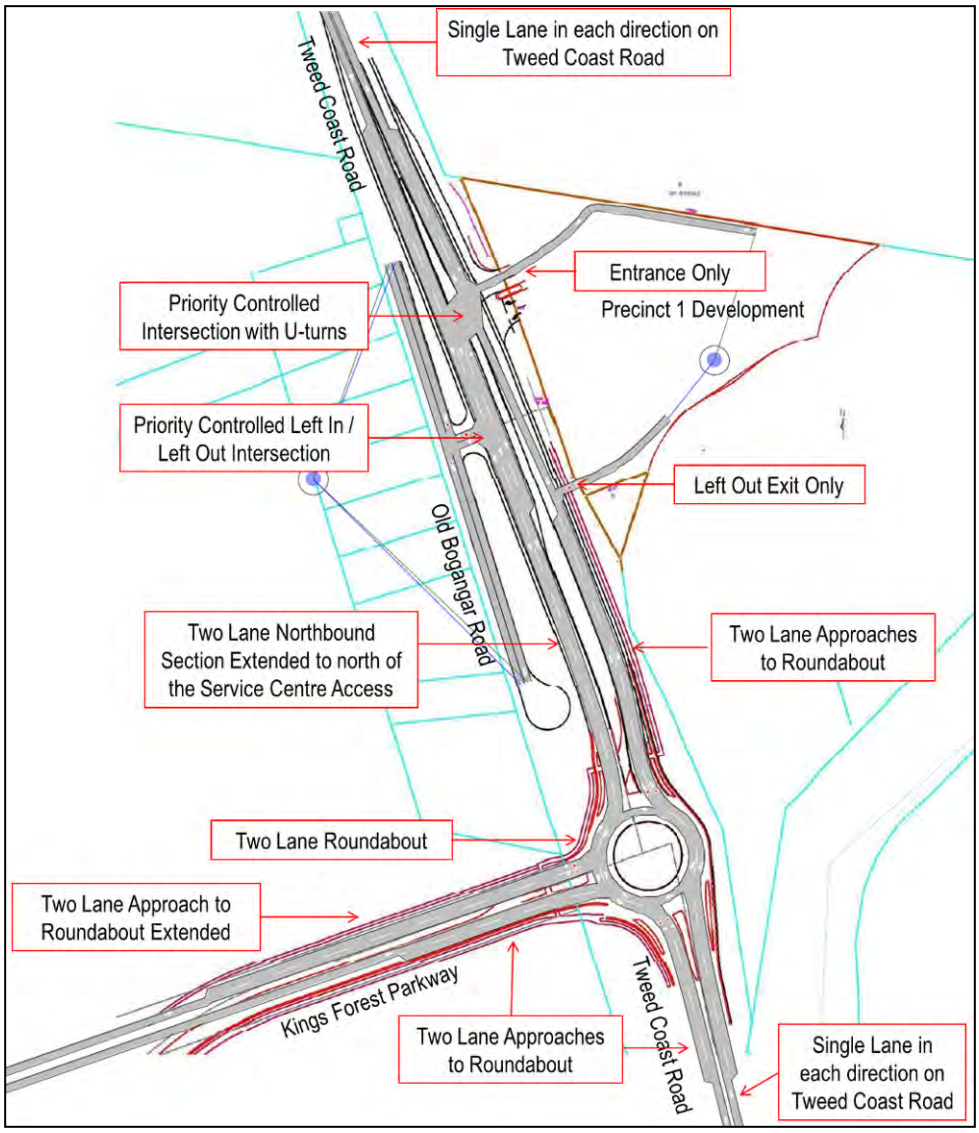

Figure 3.6: 2026 Modelled Network – Service Station

3.2.3 Modelling Outputs

Average Delay and Maximum Queues for each roadway section were extracted from the Aimsun models. Figure 3.7 below shows the legend corresponding to the output figures (Figure 3.8 to Figure 3.11). Average delays and the corresponding Level of Service (LOS) are measured in seconds and maximum queues are measured in the number of vehicle within the queue.

LOS	Average Delay (s)	Colour
A	0 to 10	
B	10 to 20	
C	20 to 35	
D	35 to 55	
E	55 to 80	
F	80 to ∞	

Max Queue (veh)	Colour
0 to 3	
3 to 6	
6 to 9	
9 to 12	
12 to ∞	

Figure 3.7: Modelling Output Legends

The Average Delays and Maximum Queues for each modelled scenario are shown in Figure 3.8 to Figure 3.11.

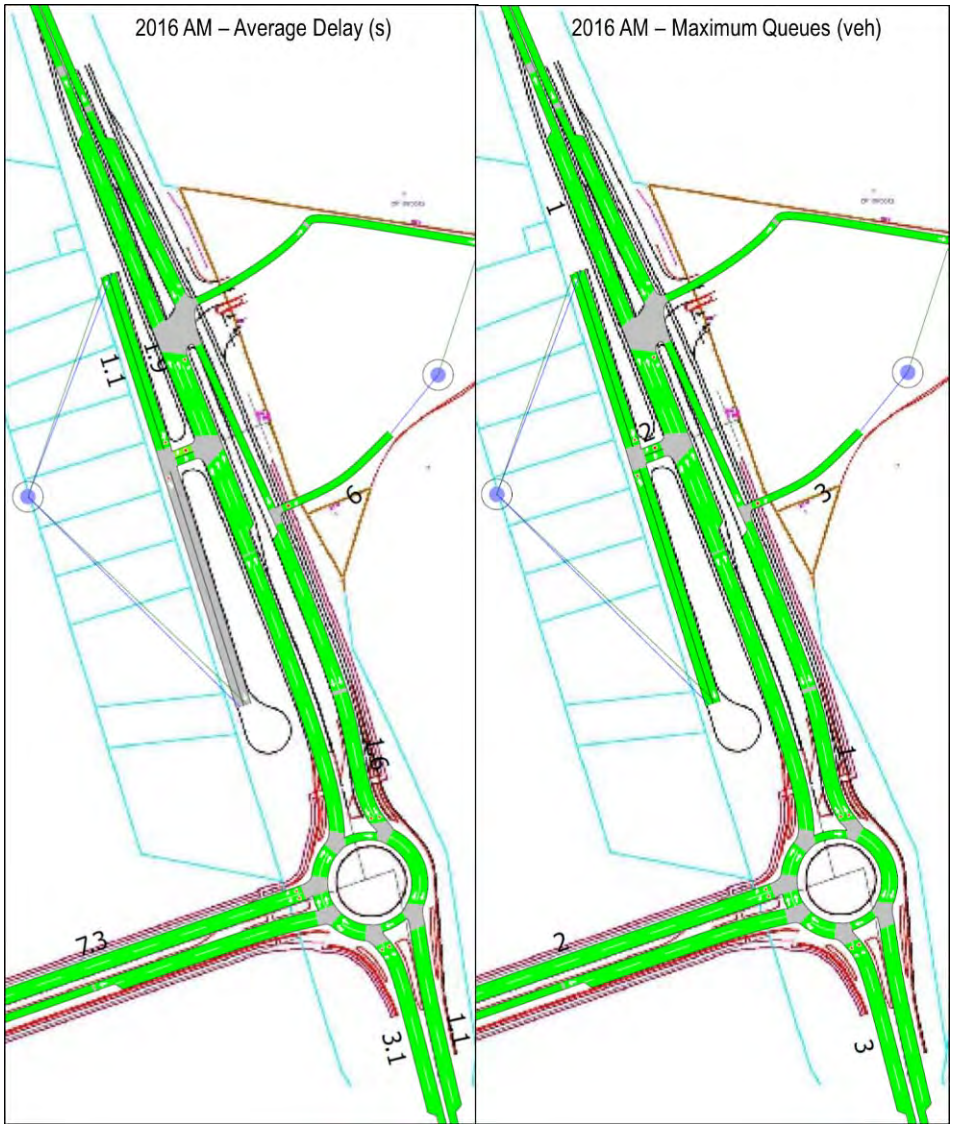

Figure 3.8: 2016 AM Model Outputs

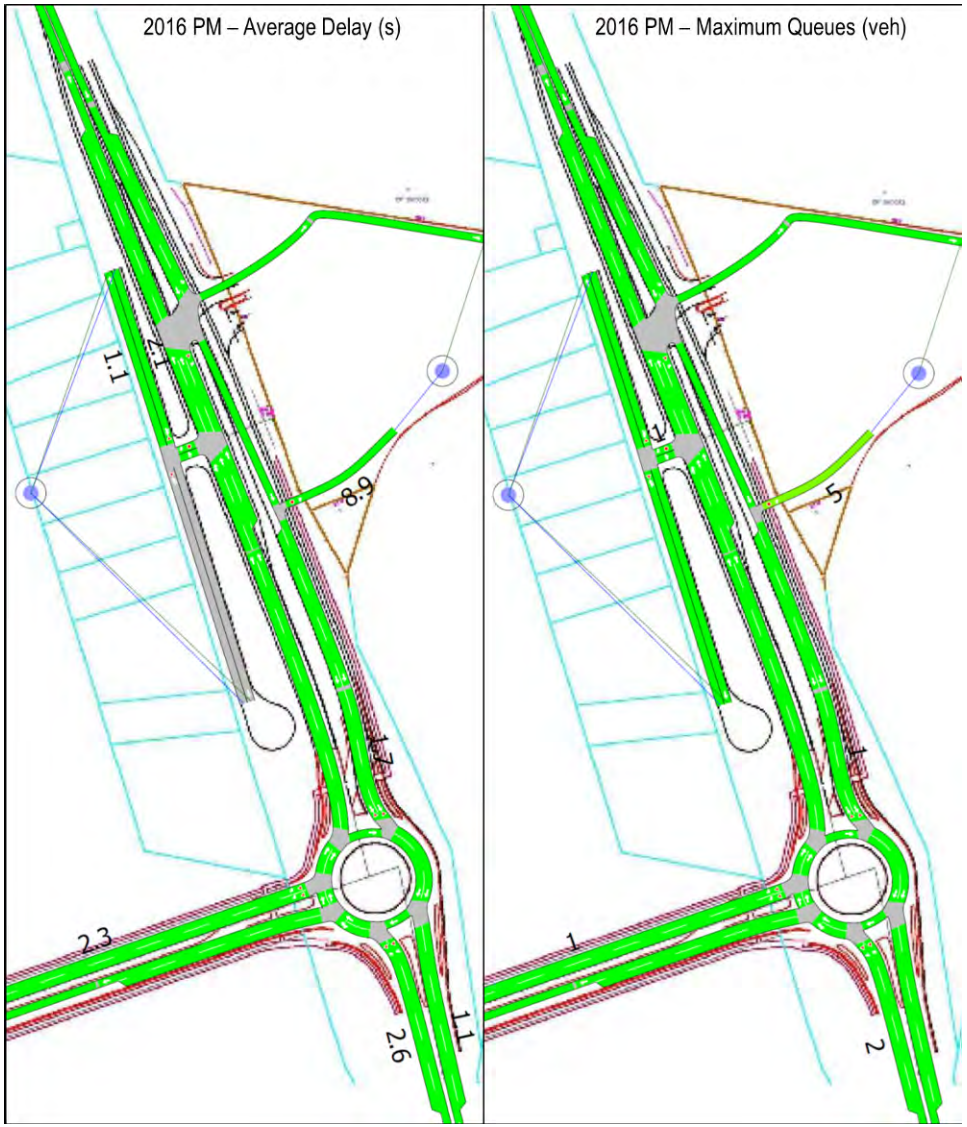

Figure 3.9: 2016 PM Model Outputs

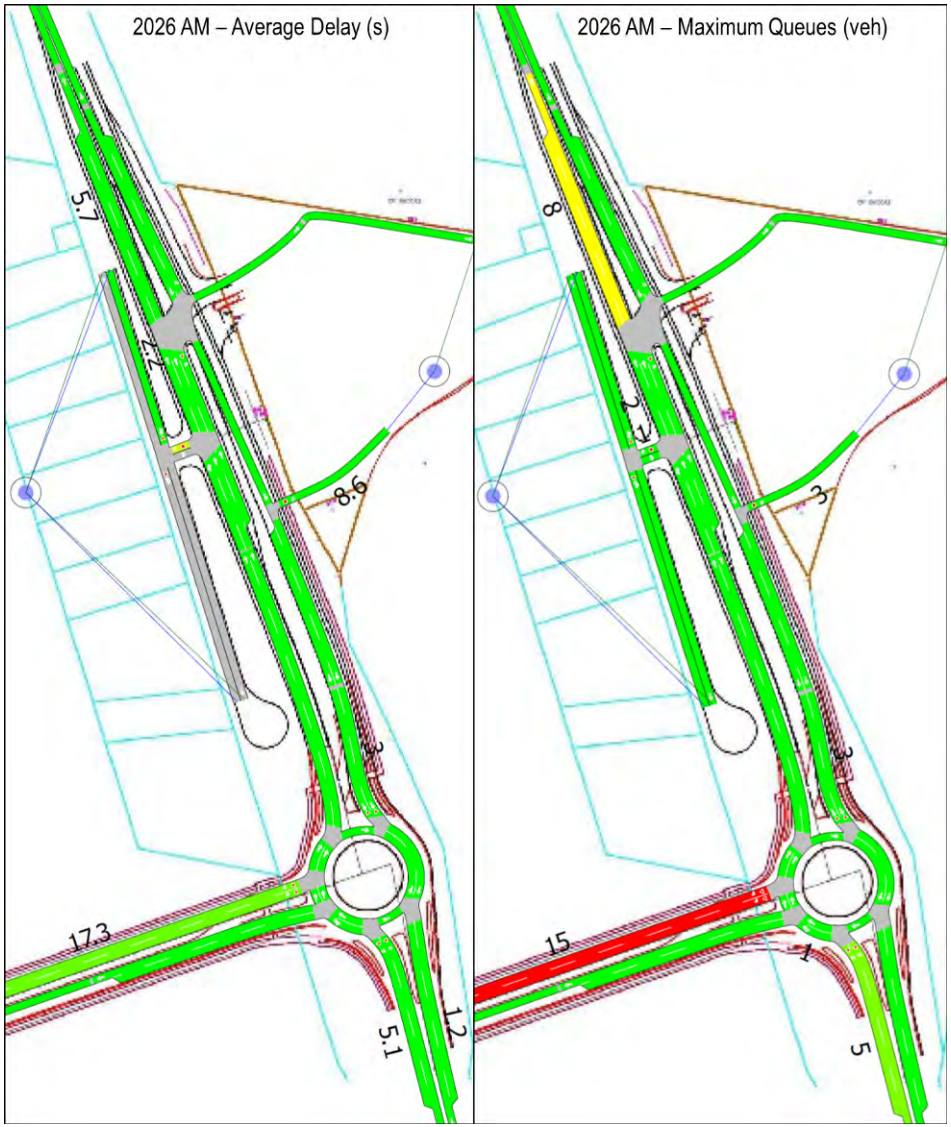

Figure 3.10: 2026 AM Model Outputs

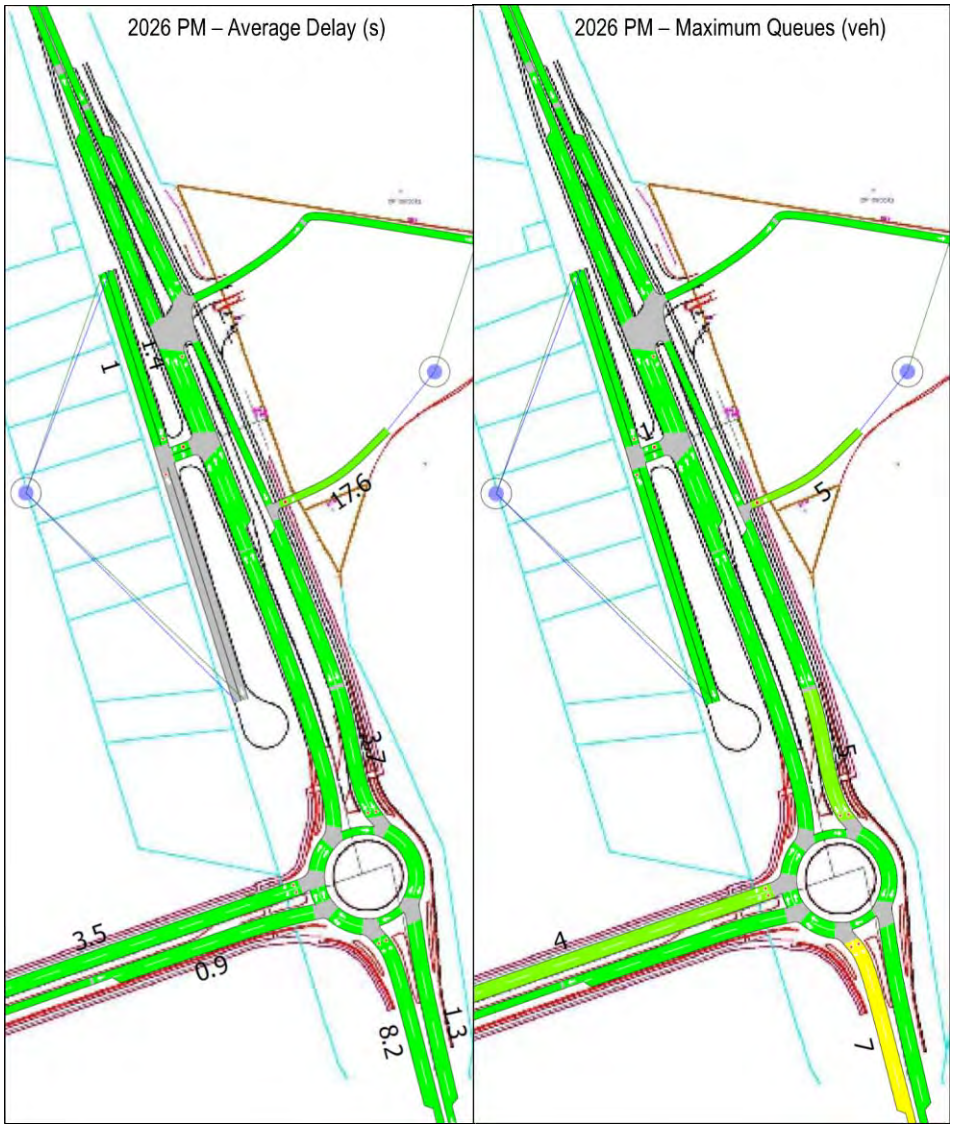

Figure 3.11: 2026 PM Model Outputs

3.2.4 Modelling Assessment

Tweed Coast Road / Service Station Entrance Intersection

The priority controlled Service Station access intersection shown in Figure 3.12 below provides sufficient capacity for all movements into the Service Station development as well as catering for the low volume of U-turn movements. There are no adverse queuing impacts or significant delays experienced at the intersection in 2016 or 2026. The single lane cross section through the intersection on Tweed Coast Road is sufficient for 2016, whilst a two lane northbound cross-section (as shown) is required for the 10-year (2026) design horizon.

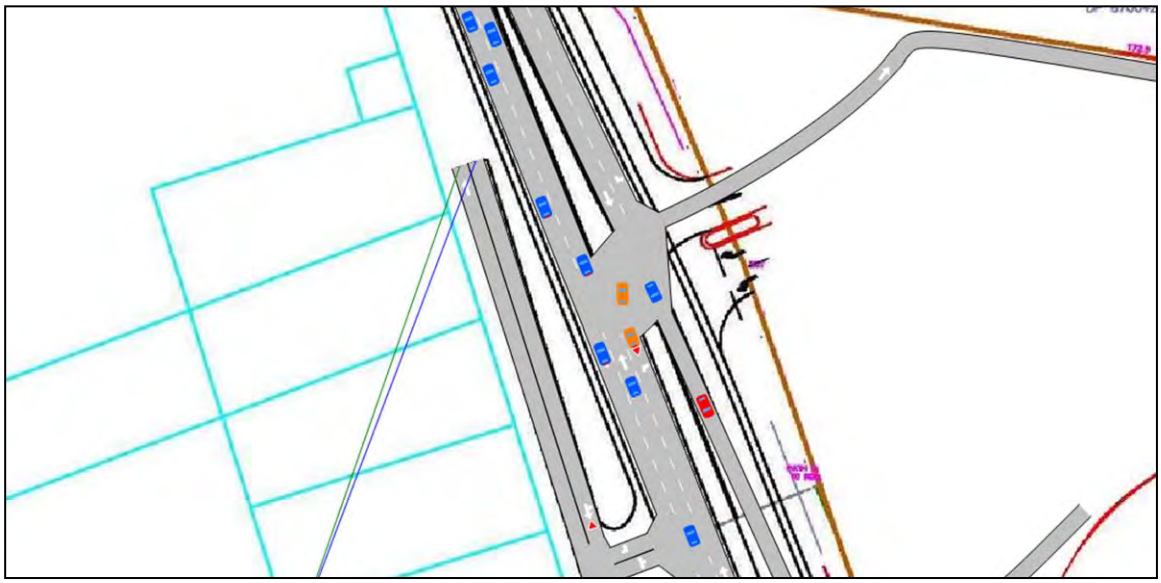

Figure 3.12: Tweed Coast Road / Service Station Entrance Intersection

Tweed Coast Road / Old Bogangar Road Intersection

The Old Bogangar Road left-in / left-out intersection shown in Figure 3.13 operates satisfactorily in all scenarios. There is an average delay of 21.1 seconds (LOS C) on the Old Bogangar Road approach to Tweed Coast Road in the 2026 AM model, which is an improvement from the previous modelling with a single northbound lane on Tweed Coast Road which resulted in a 45 second delay (LOS D).

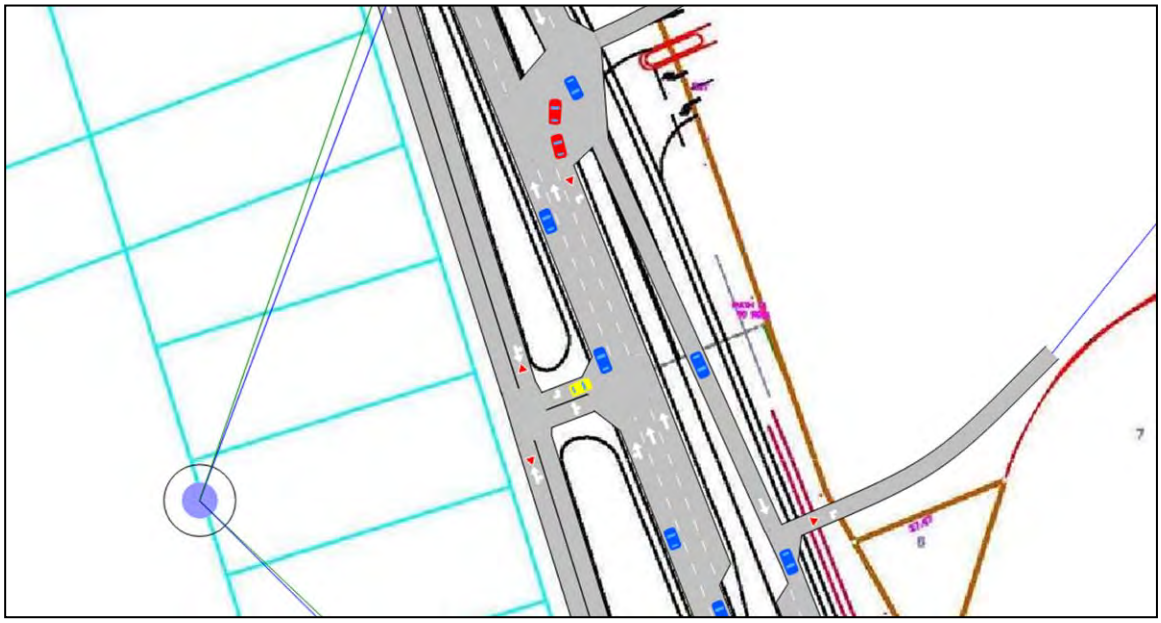

Figure 3.13: Tweed Coast Road / Old Bogangar Road Intersection

Tweed Coast Road / Service Station Exit Intersection

The Service Station egress intersection shown in Figure 3.14 performs satisfactorily in all scenarios with a peak 2026 PM average delay of 16.6 seconds (LOS B) and a maximum queue of five vehicles. Both the left-out only configuration and the U-turn at the Tweed Coast Road / King Forest Parkway roundabout do not result in any significant impacts to the operation or performance of the roundabout or Tweed Coast Road.

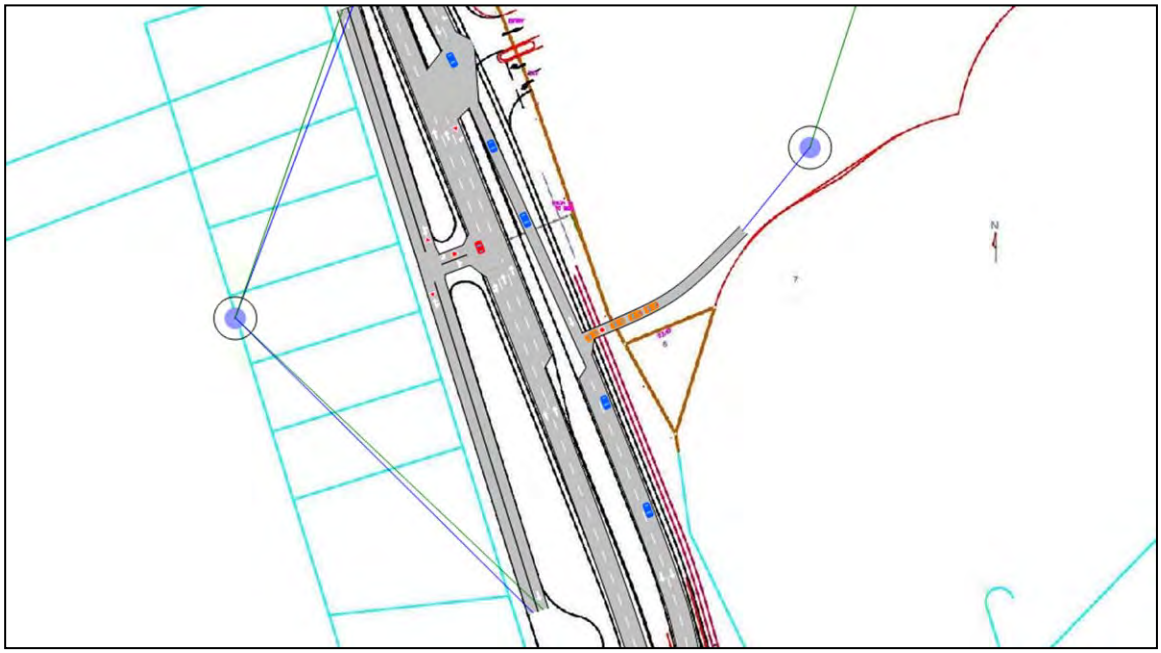

Figure 3.14: Tweed Coast Road / Service Station Exit Intersection

Tweed Coast Road / Kings Forest Parkway Roundabout

The proposed two lane roundabout at the Tweed Coast Road / Kings Forest Parkway intersection shown in Figure 3.15 performs adequately in all scenarios. The worst performing approach is the Kings Forest Parkway approach to Tweed Coast Road which in the 2026 AM model results in a maximum queue of 15 vehicles and an average delay of 17.3 seconds (LOS B). This two lane approach was extended, compared to the previous modelling, so the queues were contained within the two lane section. Although the maximum increase, the delays are relatively low and the queue dissipates quickly.

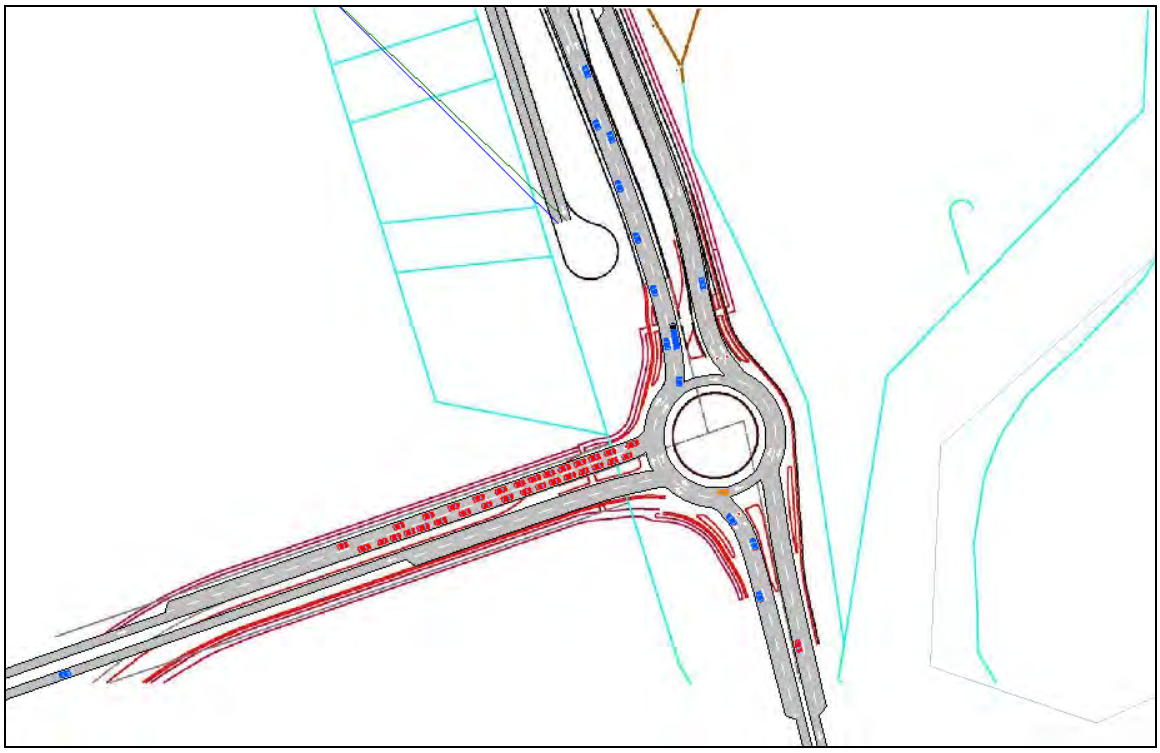

Figure 3.15: Tweed Coast Road / Kings Forest Parkway Intersection

3.2.5 Modelling Summary

Overall, the operations and performance of the traffic network is adequate to cater for both 2016 and 2026 demands with the inclusion of the proposed Service Station. Although the Service Station does increase queues and delays when compared to the approved Rural Retail development, these remain within acceptable thresholds and do not adversely impact the traffic network in the scenarios tested.

The two lane Tweed Coast Road cross-section is sufficient to cater for through traffic volumes on Tweed Coast Road in 2016 but requires an extension to the two lane northbound section by 2026. In comparison from the previous modelling of the Rural Retail development, the required upgrades to the 2026 traffic network as a result of the Service Station are shown in Figure 3.16 below.

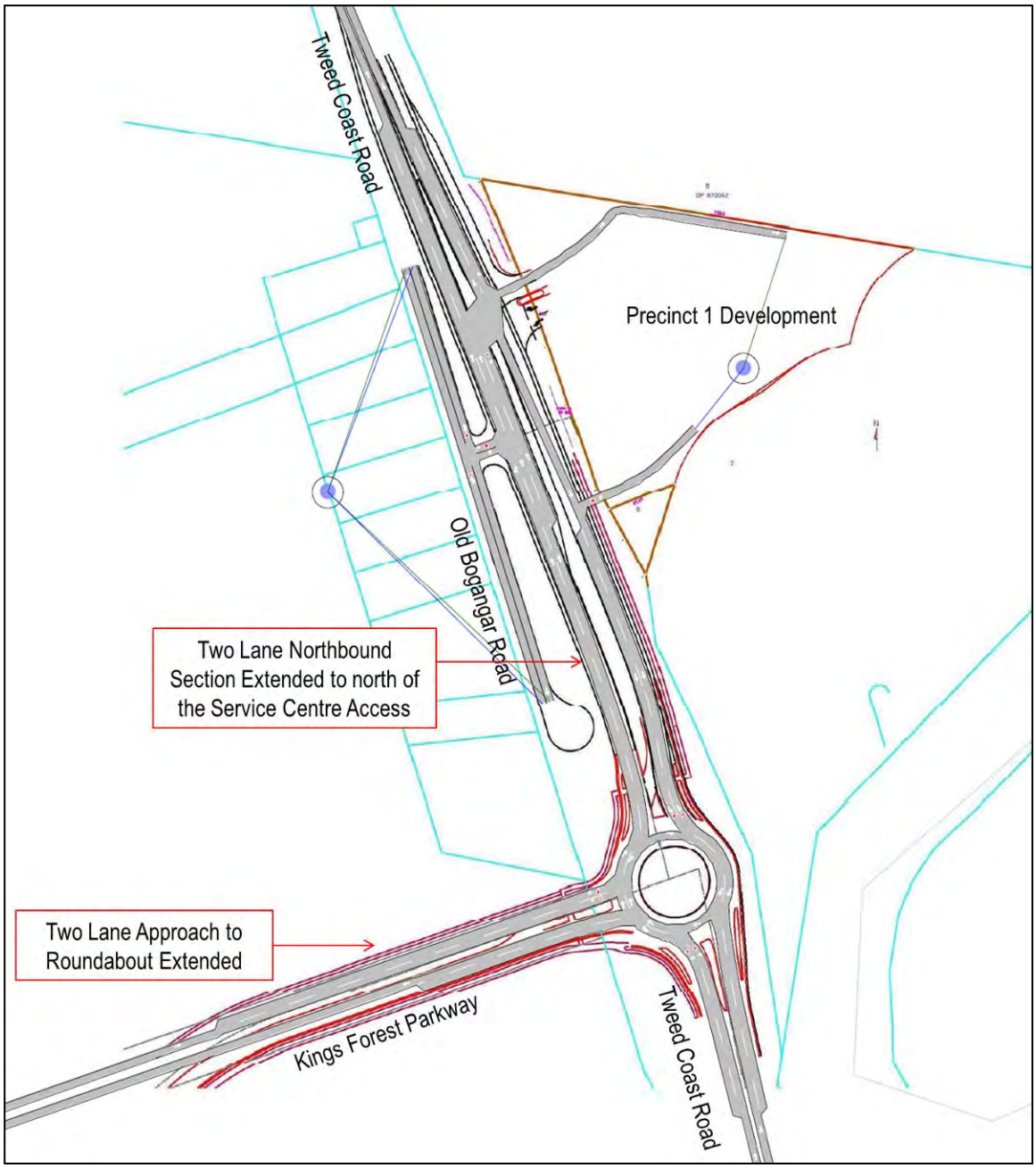

Figure 3.16: Service Station Traffic Network Upgrade Requirements

3.3 STAKEHOLDER CONSULTATION

On 14 November 2014, Tweed Shire Council provided written confirmation that the proposed road layout shown for Tweed Coast Road (between the Kings Forest Parkway roundabout and northern development site access) in the original assessment attached at Appendix C could proceed to design and was deemed to satisfy Conditions of Consent Item 27 relating to Old Bogangar Road. A copy of the correspondence is attached at Appendix D for reference. Given that the revised road layout shown above in Figure 3.16 is fundamentally the same, it is considered that Conditions of Consent Item 27 remains satisfied.

3.4 TURN WARRANTS

3.4.1 Austroads Assessment

Due to the traffic volumes on Tweed Coast Road and the development generated volumes, a turn warrants assessment was undertaken in accordance with *Austroads Guide to Road Design Part 4a: Unsignalised and Signalised Intersections*. Figure 3.17 shows the 2026 AM peak (with development) turning and through traffic volumes plotted on Figure 4.9 (b) from *Austroads*.

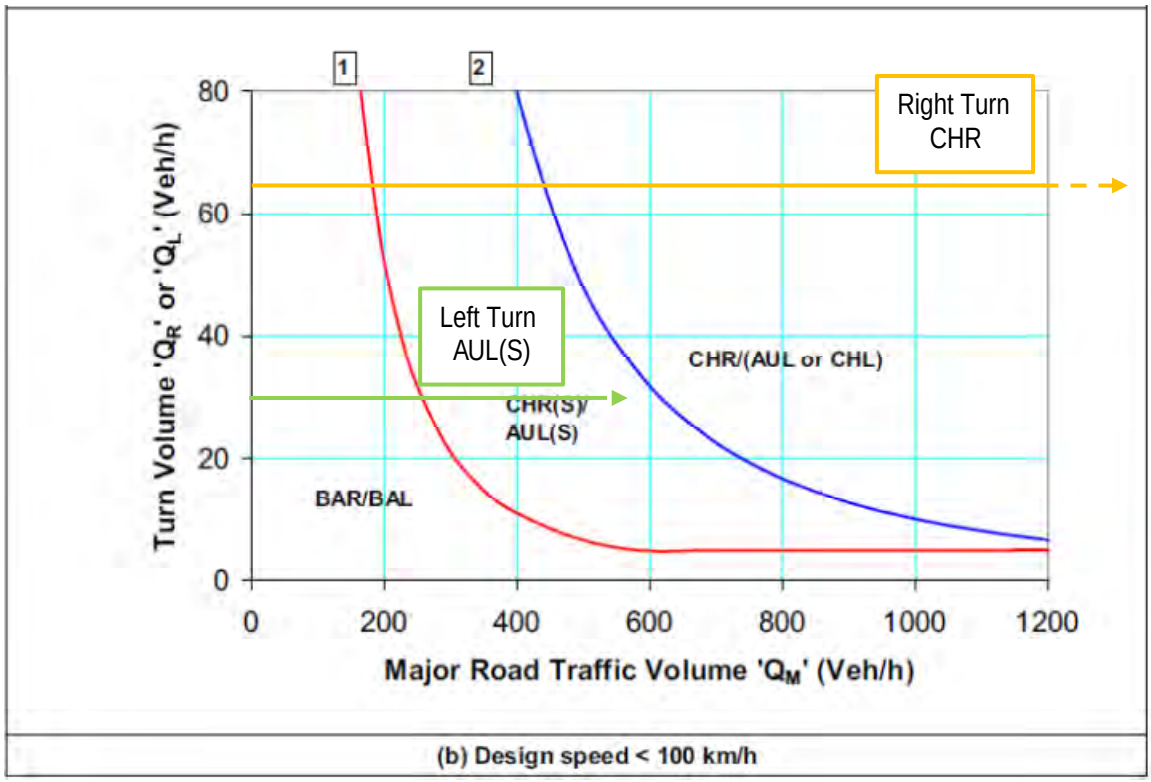

Figure 3.17: 2026 AM Turn Warrants Assessment

In the 2026 AM peak, an auxiliary short left turn (AUL[S]) treatment and a channelised right turn (CHR) treatment are required.

Figure 3.18 shows the 2026 PM peak (with development) turning and through traffic volumes plotted on Figure 4.9 (b) from *Austroads*.

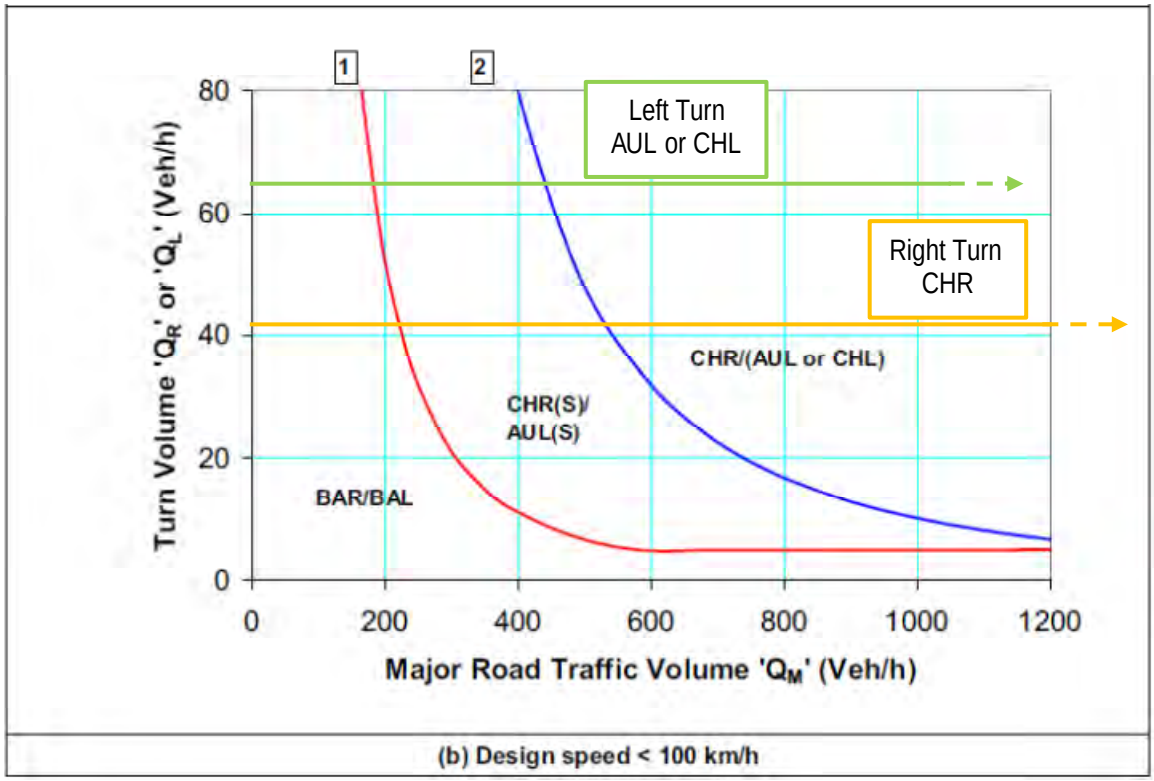

Figure 3.18: 2026 PM Turn Warrants Assessment

In the 2026 PM peak, an auxillary left turn (AUL) or channelised left turn (CHL) treatment and a CHR treatment are required.

In order to satisfy both peak periods, an AUL and CHR treatment are required for the Tweed Coast Road / development ingress access.

3.4.2 Design Overview – AUL and CHR

The turn treatments have been designed in accordance with *Austroads Guide to Road Design Part 4a: Unsignalised and Signalised Intersections*. The following points summarise the design parameters of the AUL and CHR treatments:

- the treatments have been designed to a 70km/h design speed (60km/h posted speed);
- 23 metre merge taper length;
- 75 metre deceleration length to allow full deceleration within the turn lane;
- the storage lengths cater for a 19.0 metre Articulated Vehicle (AV);
- design caters for future widening of Tweed Coast Road to four lanes and 1.5 metre on-road bicycle lanes;
- no right turn out of the development; and
- the CHR treatment into the development and the development ingress driveway cater for a Refuse Collection Vehicle (RCV) to perform a U-turn.

Concept designs of an AUL and CHR treatment have been provided in Appendix E.

4. PARKING ASSESSMENT

4.1 PARKING REQUIREMENT

The *TSC DCP Section A2 - Site Access and Parking Code* (*2014*) was used to source car parking rates for the development. The six tenancies are likely to either be a 'take-away food and drink premises' or a 'restaurant or café' however the parking rate for a restaurant was selected as both rates are the same. Table 4.1 details the parking requirement and supply.

Table 4.1: Development Car Parking Requirement

Land Use	Parking Rate	Unit / GFA (m^2)	Parking Required	Parking Supplied
Service Station + Convenience Store	1 space per staff; plus 2.8 spaces per $100m^2$	180	2* 6	2 6
Restaurants (tenancies combined)	1 space per staff at peak; plus 3.5 spaces per $100m^2$	760	14* 27	15 31
Car Wash and Dog Wash	1 space per vacuum unit; 1 space per dog wash unit	1 1	1 1	1 1
		Total Staff Total Visitor	16 35	17 39

**Number of staff has been assumed based on GFA*

The proposed development has supplied in excess of Council's parking requirements. The total supply includes 3 PWD car parks located in close proximity to the building entrances.

The TSC DCP also stipulates bicycle parking rates. For the bicycle parking assessment, it has been assumed that half of the tenancies will be 'take-away food and drink premises' and half will be a 'restaurant or café'. Table 4.2 details the bicycle parking requirement and supply.

Table 4.2: Development Bicycle Parking Requirement

Land Use	Parking Rate	Unit / GFA (m^2)	Parking Required
Service Station + Convenience Store	1 space per 4 car parks	8	2
Take-away food and drink	1 space per $100m^2$; plus 1 space per $50m^2$	380	3.8 7.6
Restaurant or Café	1 space per $50m^2$; plus 2 spaces	380	7.6 2
		Total Class 2 Total Class 3	14 10

The development plans show that 18 spaces have been provided, 6 spaces fronting the site for visitors (Class 3) and 12 spaces to the rear of the site for staff (Class 2). Though the development has provided marginally fewer spaces than required by Council's DCP, the provision is considered appropriate given the type of land uses and that there is additional space for more bicycle parking should the need arise.

The development includes toilets and is expected to include staff areas (end-of-trip facilities) to cater for cyclists on site.

4.2 PARKING AND INTERNAL ROAD LAYOUT

The proposed parking and internal road layout has been assessed against the provisions of Council's DCP and *AS2890.1 Off-street Car Parking Facilities* with the outcomes detailed as follows:

- the parking bay dimensions have been provided in accordance with the relevant AS2890 User Class requirements (User Class 2 – 2.5 metres wide for employees and medium-term visitors, User Class 3 – 2.6 metres wide for short-term visitors and User Class 4 – 2.4 metres wide plus an adjacent shared area of the same dimensions for PWD);
- aisle widths in parking aisles have been provided as per the User Class requirements of AS2890;
- where blind aisles exist sufficient width has been provided to allow a vehicle to turnaround and a minimum 1 metre extension has been provided;
- where drive through facilities exist a minimum queue length of 10 vehicles has been provided;
- car wash includes provision for 4 vehicles to queue plus an extra wide vacuum bay;
- the site has provided an internal roadway sufficient for the largest vehicle turn path, a 19.0 metre Articulated Vehicle (AV), to circulate and exit the gear in a forward gear; and
- the site includes two service vehicle bays for a 6.4 metre Small Rigid Vehicle (SRV) and a 12.5 metre Heavy Rigid Vehicle (HRV) in accordance with AS2890.2.

Swept paths have been provided in Appendix B which shows critical movements.

4.3 SERVICING AND REFUSE COLLECTION

The development has supplied a Small Rigid Vehicle (SRV) service bay and a Heavy Rigid Vehicle (HRV) service bay which is in accordance with TSC's Parking Code for the likely land uses. Swept paths provided in Appendix B show that each vehicle is able to access the respective service bay and circulate without impacting parking bays or vehicle obstructions.

TSC's Refuse Collection Vehicle (RCV) is able to enter and exit the site in a forward gear and access both service areas in accordance with TSC's *Waste Management and Minimisation* guideline.

5. ALTERNATIVE TRANSPORT

5.1 ACTIVE TRANSPORT

Walk trips generated by the site are expected to be relatively local and primarily between the service station and neighbouring residential precincts. Furthermore, it is understood that the Kings Forest residential subdivision will include footpath frontage works and on-road bicycle provisions. Figure 5.1 below shows the approximate pedestrian and cycle linkages for the service station development and surrounding area.

The existing pedestrian refuge is located across Tweed Coast Road will be retained to the south of Old Bogangar Road. Footpath provisions will be included along the frontage of the site to connect to the crossing point.

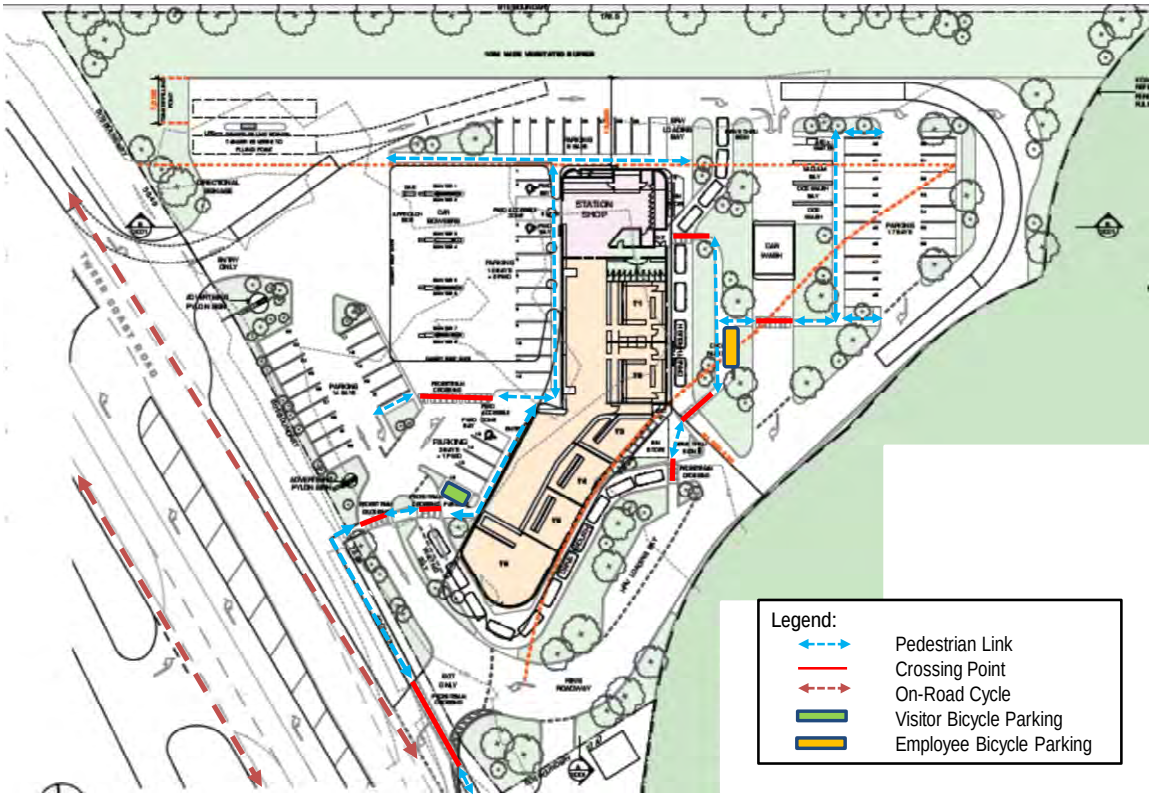

Figure 5.1: Pedestrian Links On-site

5.2 PUBLIC TRANSPORT

Currently there are no bus routes present on Tweed Coast Road in the vicinity of the subject site. Immediately to the south of the site is a bus stop that caters to school buses. It is proposed to relocate the existing bus stop and indent the bus stop in the verge. Aside from this the nearest bus routes exist on Casuarina Way and operate between Casuarina and Kingscliff.

The Kings Forest Development will include bus stops and cater for school and public bus services. Routes will be updated over time as the development expands and is likely to integrate with existing services to connect to key local and regional generators (i.e. Kingscliff, Tweed Heads).

6. CONCLUSION

The key findings of the Kings Forest Service Station traffic impact assessment are as follows:

- the site was previously approved for a "Rural Retail" development which included a GFA of 2,036m^2 and 135 parking spaces. This site generated a total of 122 trips in the AM and 244 trips in the PM peak hour;
- it is important to note that Condition Number 26 in the Consolidated Project Approval 08_0194 (incorporating Mods 1 and 2) states that '*a two lane roundabout shall be constructed in general accordance with Mortons Urban Solutions Drawing Number 12301-EMAW-101 (Amendment D) at the intersection of Tweed Coast Road and the Kings Forest Parkway prior to the release of the first residential lot in Precinct 5 or the development of Precinct 1*'. The Service Station is located in Precinct 1;
- the development is calculated to generate 180 trips in the AM and 222 trips in the PM peak hour;
- the results of the Aimsun traffic model of Tweed Coast Road including the Service Station and Kings Forest residential development are as follows:
  - overall, the operations and performance of the traffic network is adequate to cater for both 2016 and 2026 demands;
  - queues and delays remain within acceptable thresholds and do not adversely impact the traffic network in the scenarios tested; and
  - the four lane (median divided) Tweed Coast Road configuration is sufficient to cater for traffic in 2016 but requires extensions by 2026 to the Tweed Coast Road northbound lanes and the Kings Forest Parkway approach to the roundabout as shown previously in Figure 3.16;
- a turn warrants assessment showed that the development access warrants an AUL and CHR treatments. The design of these treatments was undertaken in accordance with *Austroads Guide to Road Design Part 4a: Signalised and Unsignalised Intersections*;
- the development has provided car parking in excess of Council's requirements;
- the development provides 6 visitor and 12 staff bicycle parking spaces which is less than Council's requirement but considered appropriate given the type of land uses and that there is additional space for more bicycle parking should the need arise;
- the parking and internal road layout was designed in accordance with AS2890 and Council's Parking Code;
- the development has supplied an SRV and HRV parking spaces in accordance with Council's Parking Code;
- swept paths have shown that a RCV is able to enter and exit the site in a forward gear and access the bins in a safe and efficient manner; and
- the development has catered for active transport trips by including direct pedestrian links and crossing points.

We conclude that the proposed development does not introduce any significant traffic or transport impacts that would preclude its approval.

APPENDIX A

DEVELOPMENT PLANS

8
DP 870042

CONNECT TO EXISTING KOALA EXCLUSION FENCE

1.2MH KOALA EXCLUSION FENCE

SITE BOUNDARY

172.5

10M WIDE VEGETATED BUFFER

KOALA EXCLUSION FENCE

50M ECOLOGICAL BUFFER

7.000 TANKER FILLING POINT

LPG TANKER FILLING POINTS. TANKER REVERSE TO FILLING POINT

SITE BOUNDARY

56.49

DIRECTIONAL SIGNAGE

ENTRY ONLY

ADVERTISING PYLON SIGN

TWEED COAST ROAD

PARKING 14 BAYS

SITE BOUNDARY

ADVERTISING PYLON SIGN

PEDESTRIAN CROSSING

CYCLE PARKING

72.99

FOOTPATH

EXIT ONLY

PEDESTRIAN CROSSING

RING ROADWAY

SITE BOUNDARY

27.47

REGIONAL SEWER PUMP STATION

CONNECT TO EXISTING KOALA EXCLUSION FENCE

PARKING 9 BAYS

13.500

SRV/ LOADING BAY

DRIVE THRU SIGN

GAS

BOWSER 1

BOWSER 2

APPROACH SIDE

CAR BOWSERS

BOWSER 3

BOWSER 4

BOWSER 5

BOWSER 6

BOWSER 7

BOWSER 8

CANOPY ROOF OVER

PWD BAY

PWD ACCESIBLE ZONE

ENTRY

PWD BAY

PARKING 10 BAYS +2 PWD

CANOPY ROOF OVER

PEDESTRIAN CROSSING

PWD ACCESIBLE ZONE

PWD BAY

ENTRY

PARKING 3 BAYS +1 PWD

STATION SHOP

BIN STORE

EXIT

T1

T2

T3

T4

T5

T6

CANOPY ROOF OVER

DRIVE THROUGH

BIN STORE

DRIVE THRU SIGN

21.000 APZ

PEDESTRIAN CROSSING

WAITING BAY

CANOPY ROOF OVER

DRIVE THROUGH

HRV LOADING BAY

CYCLE PARKING

AIR + WATER

VACUUM BAY

DOG WASH BAY

DOG WASH

CAR WASH

PARKING 17 BAYS

1 SITE PLAN
1:500

FLOOR PLAN AREA SUMMARY

GROUND LEVEL

	GFA AREAS
STATION SHOP	TOTAL 180m²
AMENITIES	TOTAL 58m²
TENANCIES & EATING AREA	TOTAL 760m²
	TOTAL GFA 998m²

DEVELOPMENT SUMMARY

ORIGINAL APPLICATION

PROPOSED SERVICE STATION INCLUDING SHOP WITH FOOD OUTLETS, CARWASH AND DOG WASH FACILITIES

AREAS

TOTAL SITE AREA	10870 m²
GFA	1063 m²
TOTAL STRUCTURAL BUILDING FOOTPRINT	APPROX 2026 m²
CARWASH & DOG WASH	APPROX. 150 m²

PARKING

GENERAL CARPARKING BAYS	53
STAFF CARPARKING BAYS	17
PWD CARPARKING BAYS	3
TOTAL CARPARKING BAYS	73
BICYCLE PARKING CAPACITY	20 BIKES

DEVELOPMENT SUMMARY

AMENDED APPLICATION

PROPOSED SERVICE STATION INCLUDING SHOP WITH FOOD OUTLETS, CARWASH AND DOG WASH FACILITIES

AREAS

TOTAL SITE AREA	10870 m²
GFA	998 m²
TOTAL STRUCTURAL BUILDING FOOTPRINT	APPROX 1974 m²
CARWASH & DOG WASH	APPROX. 150 m²

PARKING

GENERAL CARPARKING BAYS	36
STAFF CARPARKING BAYS	17
PWD CARPARKING BAYS	3
TOTAL CARPARKING BAYS	56
BICYCLE PARKING CAPACITY	20 BIKES

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architecture + master planning + interiors
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NEWSTEAD Q 4006
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info @ push.net.au

project: KINGS FOREST SERVICE STATION

location: TWEED COAST ROAD

client: LEDA DEVELOPMENTS PTY LTD

title: **PROPOSED SITE PLAN**

scale	date	job number
1:500 @ A3	SEP 2016	738.12

drawn	checked	approved
PJN	PJN	

stage	drawing no.	issue
DA	1000	0

ABN 94 109 752 310

APPENDIX B

SWEPT PATHS

GCCC Front End RCV

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 41.4

DESIGN VEHICLE

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REVISIONS

Issue	Revisions/Descriptions	Drawn	Date
006	Development Plan Swept Paths	B.N	04.10.2016

Project: Kings Forest Service Station

Title: Vehicle Swept Paths

FOR INFORMATION ONLY

Date: 04.10.2016

Project Number: P1745

Sheet Number: 1

Issue: 006

S ARTICULATED 19M meters

Tractor Width	: 2.50	Lock to Lock Time	: 6.0
Trailer Width	: 2.50	Steering Angle	: 27.7
Tractor Track	: 2.50	Articulating Angle	: 70.0
Trailer Track	: 2.50		

DESIGN VEHICLE

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Project: Kings Forest Service Station

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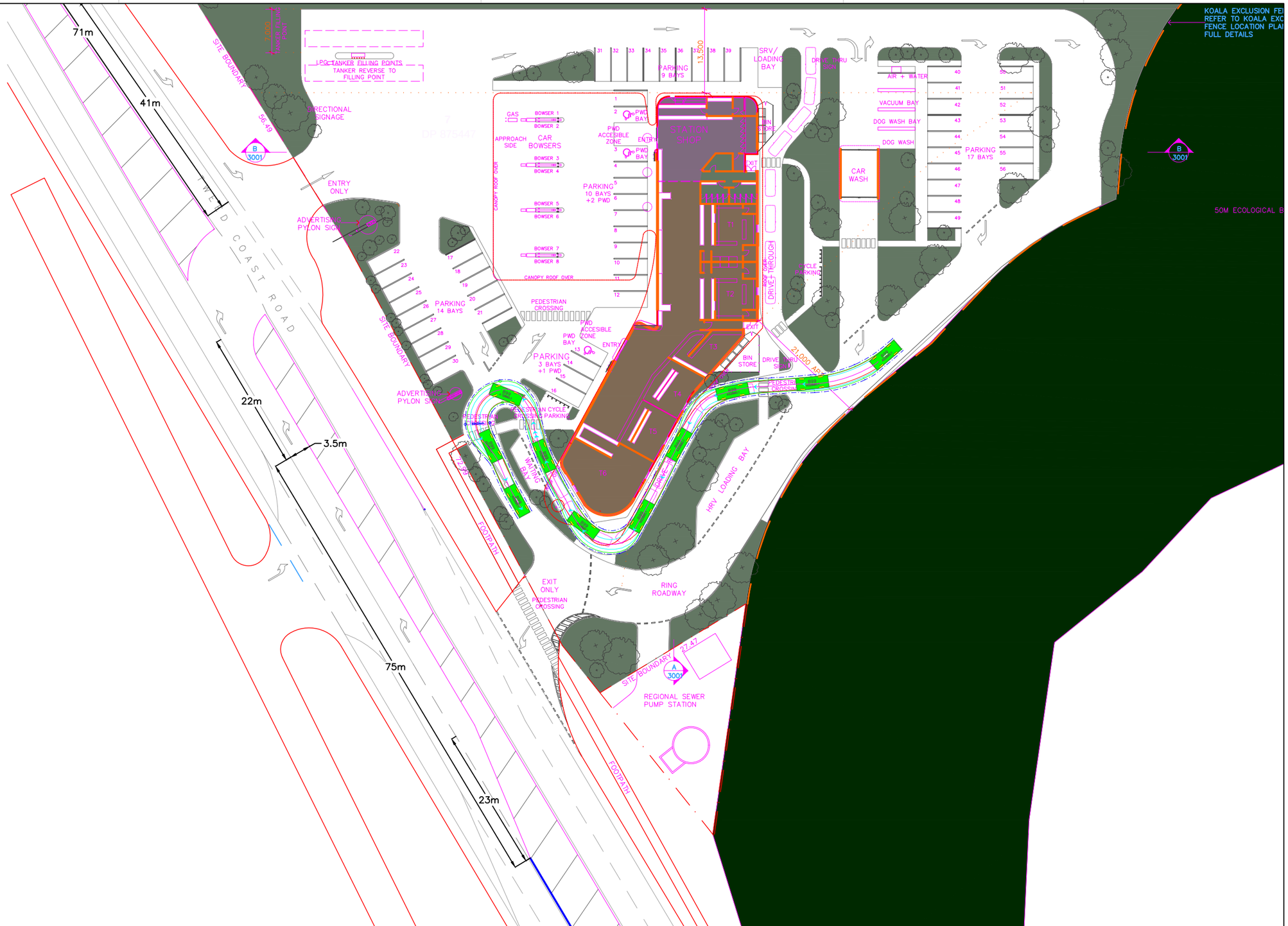
FOR INFORMATION ONLY

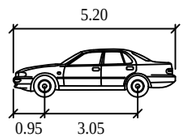
Date: 04.10.2016

Project Number: P1745

Sheet Number: 2

Issue: 006





B99 meters

Width	:	1.94
Track	:	1.84
Lock to Lock Time	:	6.0
Steering Angle	:	38.0

DESIGN VEHICLE

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REVISIONS

Issue	Revisions/Descriptions	Drawn	Date
006	Development Plan Swept Paths	B.N	04.10.2016

Project: Kings Forest Service Station

Title: Vehicle Swept Paths

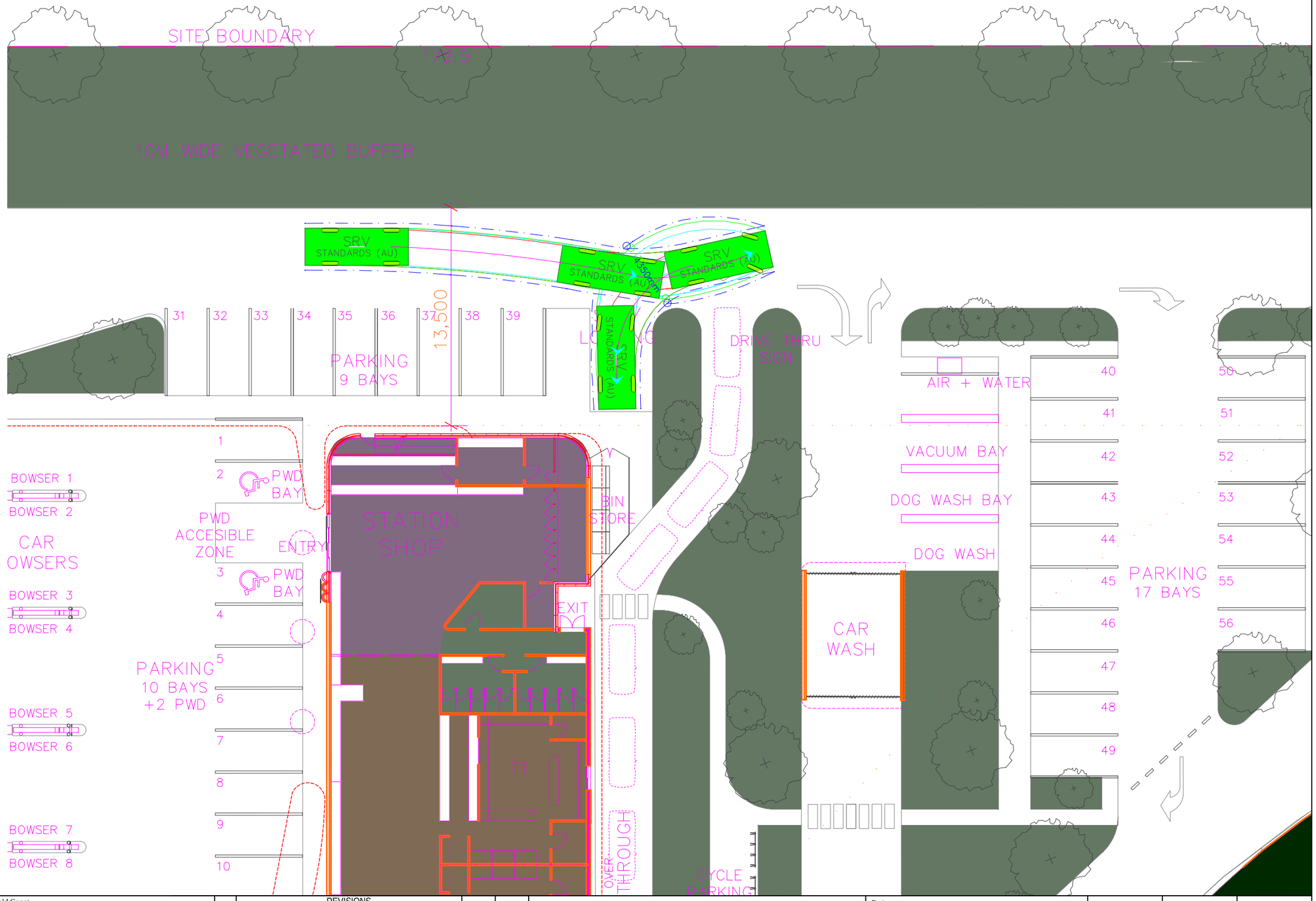
FOR INFORMATION ONLY

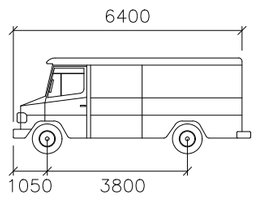
Date: 04.10.2016

Project Number: P1745

Sheet Number: 3

Issue: 006





SRV	mm
Width	: 2300
Track	: 2300
Lock to Lock Time	: 6.0
Steering Angle	: 38.0

DESIGN VEHICLE

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Project: Kings Forest Service Station

Title: Vehicle Swept Paths

FOR INFORMATION ONLY

Date: 04.10.2016

Project Number	Sheet Number	Issue
P1745	5	006

SU TRUCK meters

Width	:	2.50
Track	:	2.50
Lock to Lock Time	:	6.0
Steering Angle	:	36.6

DESIGN VEHICLE

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REVISIONS

Issue	Revisions/Descriptions	Drawn	Date
006	Development Plan Swept Paths	B.N	04.10.2016

Project: Kings Forest Service Station

Title: Vehicle Swept Paths

FOR INFORMATION ONLY

Date: 04.10.2016

Project Number: P1745

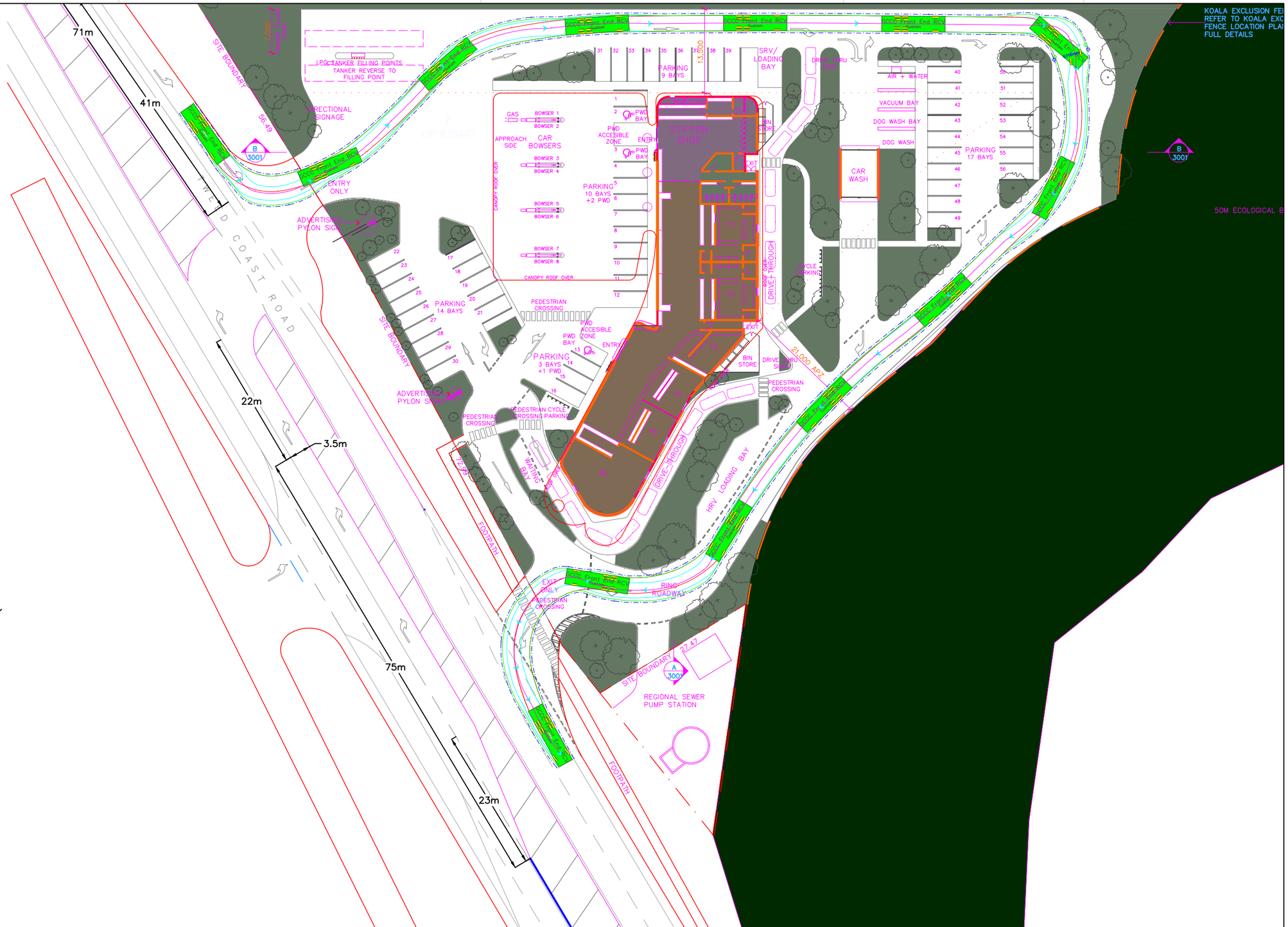
Sheet Number: 6

Issue: 006

GCCC Front End RCV

	meters
Width	: 2.50
Track	: 2.50
Lock to Lock Time	: 6.0
Steering Angle	: 41.4

DESIGN VEHICLE



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REVISIONS			
Issue	Revisions/Descriptions	Drawn	Date
006	Development Plan Swept Paths	B.N	04.10.2016

Project: Kings Forest Service Station

Title: Vehicle Swept Paths

FOR INFORMATION ONLY

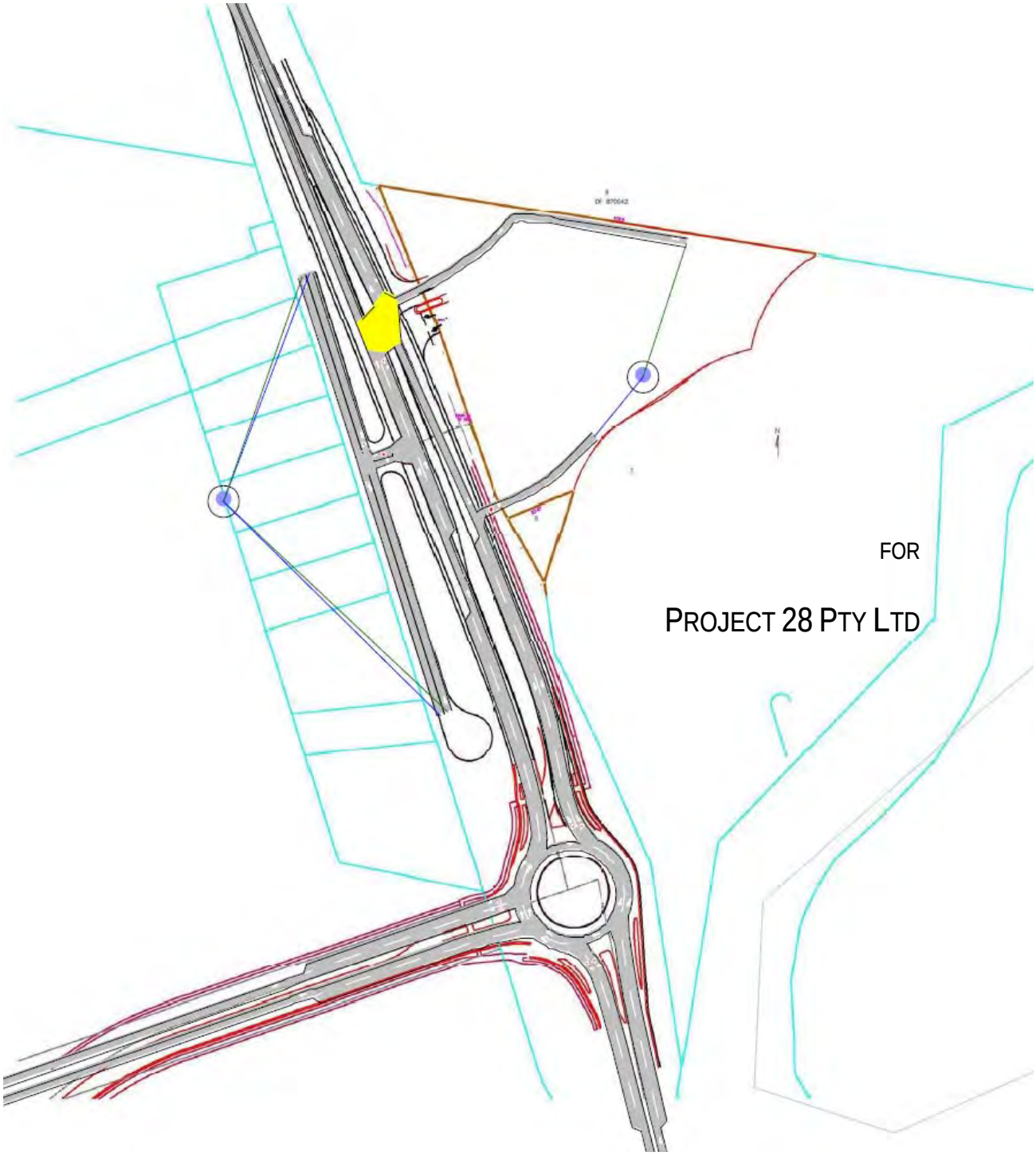
Date: 04.10.2016

Project Number	Sheet Number	Issue
P1745	1	006

APPENDIX C

KINGS FOREST RURAL RETAIL INTERSECTION ASSESSMENT

KINGS FOREST INTERSECTION ASSESSMENT



FOR

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Project No: P1784 Version No: 001 Issue date: 16th October 2014

DOCUMENT CONTROL SHEET

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Report File Name	Prepared by	Reviewed by	Issued by	Date	Issued to
P1784.001R Kings Forest Intersection Assessment	M.Kimmins	A.Eke	A.Eke	16/10/2014	Michael Geale mgeale@ledaholdings.com.au

CONTENTS

Tables

Figures

Appendices

1. INTRODUCTION

1.1 PURPOSE

Bitzios Consulting was commissioned by Project 28 Pty Ltd to assess the intersections on Tweed Coast Road proposed to be constructed as part of the Kings Forest development. CRG had previously undertaken an initial assessment of the intersections using SIDRA modelling, however a more detailed assessment of the intersections was undertaken to assess the interaction of intersections in response to the Department of Planning (DoP)'s Conditions of Approval for Stage 1 of the development. Aimsun microsimulation modelling has therefore been undertaken to assess the intersections.

1.2 LOCATION

The study area including the modelling extents is shown in Figure 1.1 below.

Figure 1.1: Study Area

1.3 SCOPE

The scope of this traffic assessment included the following tasks:

- development of a microsimulation (Aimsun) model of the study area (Figure 1.1) for Stage 1 year of opening (2016) for both an AM and PM peak period;
- determining 2016 year of opening traffic demands based on Stage 1 traffic from previous reports and previous traffic counts and growth for Tweed Coast Road;
- assessment of the 2016 models to identify any specific intersection requirements and confirm the operations of the road network, specifically with respect to the capacity and operations of the proposed left-in/left out treatment for Old Bogangar Road;
- development of 2026 (10 year design horizon) models for AM and PM peaks based on interim staging of the Kings Forest development and Tweed Coast Road growth; and
- assessment of the 2026 models to identify any specific intersection requirements and confirm the operations of the road network, specifically with respect to the road and intersection capacity and vehicle movements between the three intersections on Tweed Coast Road.

2. PROPOSED DEVELOPMENT

For the purpose of this intersection assessment the proposed Kings Forest development has been simplified into two sections, as follows:

- Eastern side of Tweed Coast Road: Precinct 1 - Rural Retail; and
- Western side of Tweed Coast Road: Precincts 2 to 14 - Mixed Use.

The above areas are shown in Figure 2.1 below.

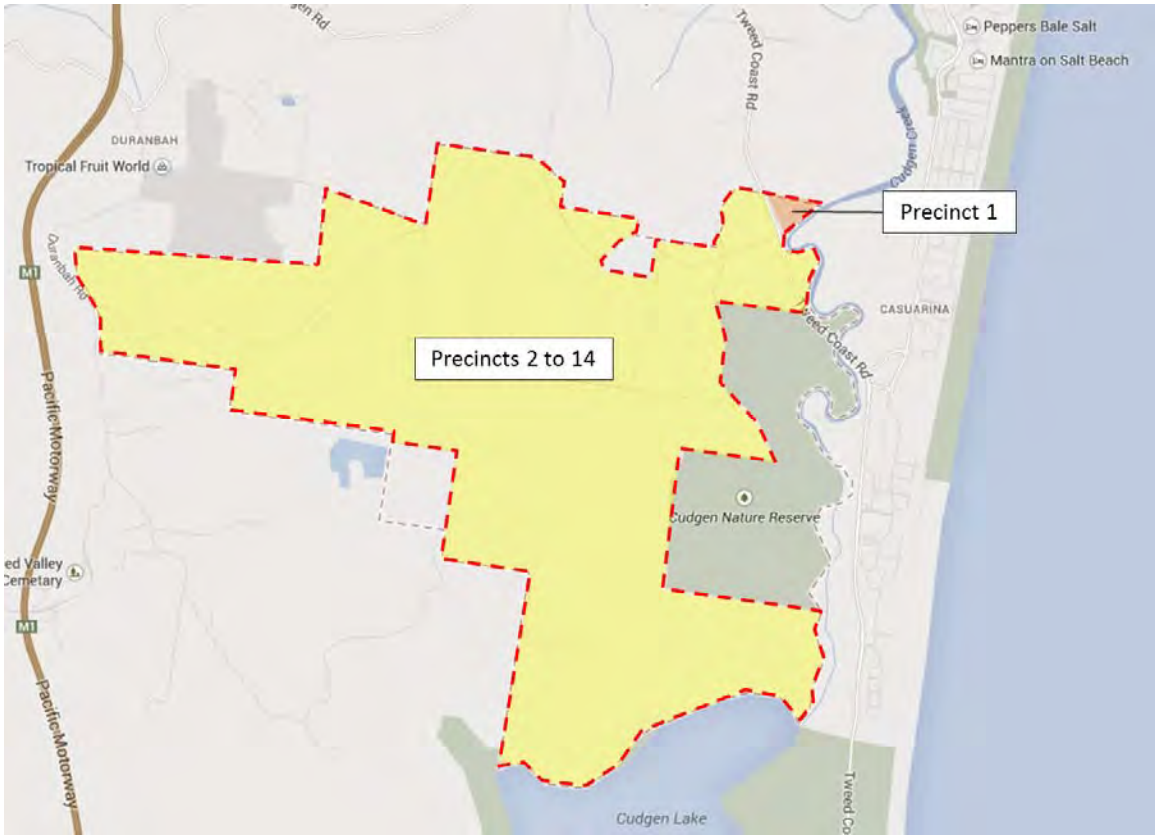

Figure 2.1: King Forest Development

Stage 1 of the development approved by DoP includes the following components:

- residential lots (376 residential lots); and
- rural retail (1,995m^2).

Although the DoP approved number of residential lots 376, to be consistent with the previous traffic assessments, 500 residential dwellings have been assumed for Stage 1 to provide a conservative assessment of traffic impacts.

3. MODEL DEVELOPMENT

3.1 OVERVIEW

The Aimsun models have been developed to test network intersection layouts and network configurations to identify traffic impacts. The following scenarios have been developed:

- 2016 (Year of Opening): Stage 1 of Kings Forest which includes the Rural Retail development on the eastern side of Tweed Coast Road and 500 dwellings on the western side of Tweed Coast Road; and
- 2026 (10 Year Design Horizon): includes the Rural Retail development on the eastern side of Tweed Coast Road and 2,500 dwellings on the western side of Tweed Coast Road, which assumes Kings Forest's continuing construction at a rate of 200 dwellings per year from 2016 to 2026.

The Kings Forest development also includes a number of other land uses which are taken into account in the trip generation for future development over time.

3.2 NETWORK

The modelled network including details of the road and intersection configurations is shown in Figure 3.1 below. It should be noted that both a two lane and four lane cross section for Tweed Coast Road was modelled to confirm the carrying capacity requirements through the intersections under the future development scenerios.

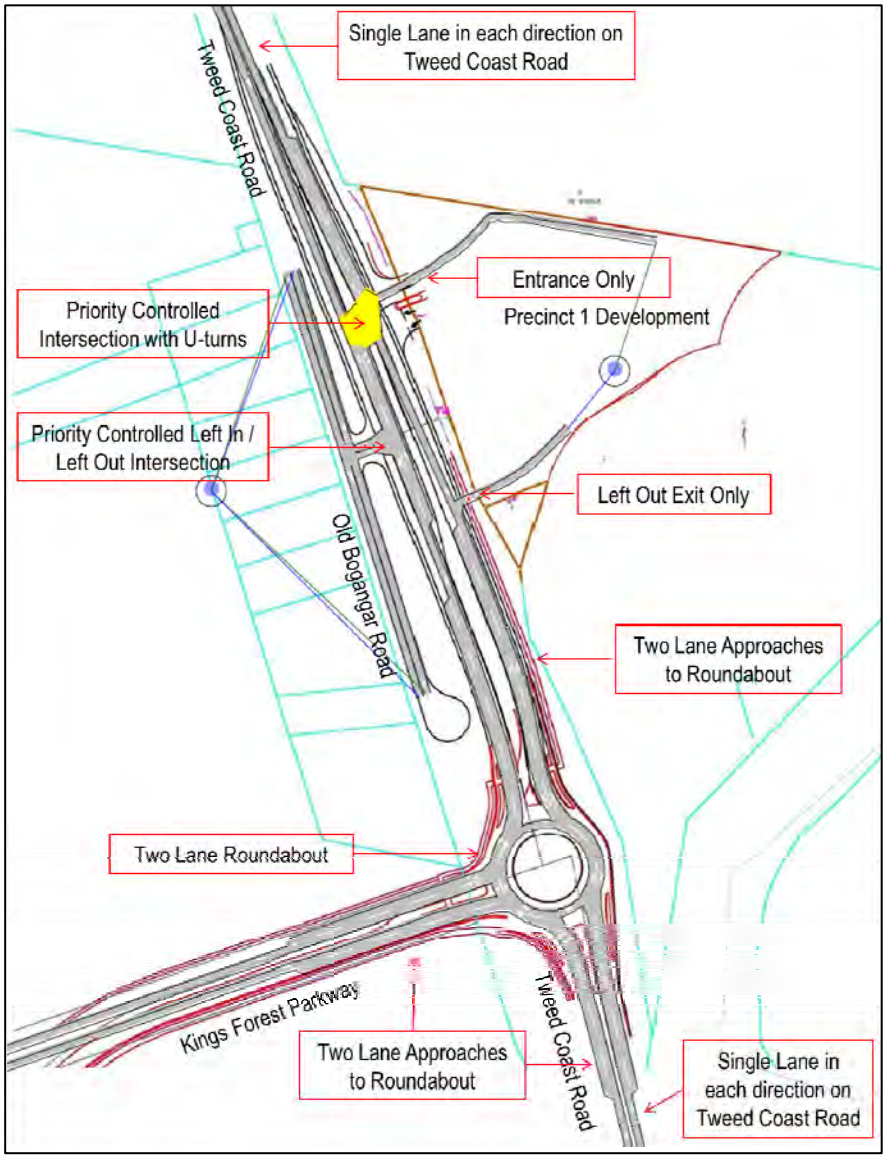

Figure 3.1: Modelled Network

3.3 DATA

The data used in the development of the Aimsun models included an intersection count previously undertaken by Traffic Data and Control (TDC) on the 23 October 2012 at the Tweed Coast Road / Dianella Drive Intersection, located approximately 1km south of Kings Forest. As there are no side roads or property accesses between Kings Forest and the intersection, the intersection counts provide an accurate survey of Tweed Coast Road volumes past Kings Forest. The intersection count survey is provided in Appendix A.

3.4 DEMANDS

3.4.1 Development Trip Generation

Kings Forest

Development traffic generation was determined based on Road and Maritime Services (RMS) *Guide to Traffic Generating Developments* for Stage 1 of Kings Forest (500 dwellings). The trip generation for the Interim stage of Kings Forest is based on a previously accepted rate used in the CRG report for the Ultimate Kings Forest development. The Interim rate is an interpolation of the trip generation rate for Stage 1 and the Ultimate staging of Kings Forest. Table 3.1 below shows the estimated peak hour traffic volumes generated by the Kings Forest.

Table 3.1: Kings Forest - Traffic Generation

Scenario	Rate Source	Unit	Peak Hour Trip Generation Rate	No. of Units	Trips
Stage 1	RMS	dwellings	0.85 per dwelling	500	425
10 year Design Horizon	Interim Interpolation	dwellings	0.65 per dwelling	2,500	1,625
Ultimate	CRG – Accepted Assessment Rate	dwellings	0.45 per dwelling	4,503	2,026

The above reducing trip generation rates are considered appropriate given the increasing level of internalisation as a result of additional land uses within Kings Forest over time.

For the purpose of this assessment only Stage 1 year of opening (2016) and the 10 year design horizon (2026) stages of Kings Forest have been assessed. Table 3.2 summarises the trip generation splits for each peak period for each stage of development.

Table 3.2: Kings Forest - Trip Generation Splits

		AM Split (%)		AM Trips (veh/h)		PM Split (%)		PM Trips (veh/h)	
Scenario	Trips	In	Out	In	Out	In	Out	In	Out
2016 Stage 1 Year of Opening	425	20%	80%	85	340	60%	40%	255	170
2026 10 Year Design Horizon	1,625	20%	80%	325	1,300	60%	40%	975	650

Rural Retail

Development traffic generation for the Rural Retail component was determined based on Road and Maritime Services (RMS) *Guide to Traffic Generating Developments*. Table 3.3 below shows the estimated peak hour traffic volumes generated by the Rural Retail development.

Table 3.3: Rural Retail - Traffic Generation

Land Use	Unit	Trip Generation Rate	No. of Units	Trips	
				AM	PM
Rural Retail	GFA (m2)	12.3 PM Peak trips per 100m^2 (RMS Retail)	1,995 m^2	122*	244

** AM Peak trips were assumed at 50% of the PM Peak Rate*

The above trip generation rates are consistent with the previous CRG traffic reports.

Table 3.4 summarises the trip generation splits for the Rural Retail development in each peak period.

Table 3.4: Rural Retail - Trip Generation Splits

Land Use	Trips		AM Split (%)		AM Trips (veh/h)		PM Split (%)		PM Trips (veh/h)	
	AM	PM	In	Out	In	Out	In	Out	In	Out
Rural Retail	122	244	60%	40%	73	49	50%	50%	122	122

Old Bogangar Road

Old Bogangar Road traffic generation was determined based trip generation rates from the Road and Maritime Services (RMS) *Guide to Traffic Generating Developments*. Table 3.5 below shows the estimated peak hour traffic volumes generated by the Old Bogangar Road land uses.

Table 3.5: Old Bogangar Road - Traffic Generation

Land Use	Unit	Trip Generation Rate	No. of Units	Trips
Residential Lots	dwellings	0.85 per dwelling (RMS)	11	9

Table 3.6 summarises the trip generation splits for Old Bogangar Road in each peak period.

Table 3.6: Old Bogangar Road - Trip Generation Splits

Land Use	Trips	AM Split (%)		AM Trips (veh/h)		PM Split (%)		PM Trips (veh/h)	
		In	Out	In	Out	In	Out	In	Out
Residential Lots	9	20%	80%	2	7	80%	20%	7	2

3.4.2 Traffic Distribution

Table 3.7 summarises the direction al splits on the Tweed coast Road for each development in each peak period.

Table 3.7: Trip Distribution

Generator	AM (%)		PM (%)	
	North	South	North	South
Kings Forest	70%	30%	43%	57%
Rural Retail	50%	50%	50%	50%
Old Bogangar Road	70%	30%	43%	57%

3.4.3 Background Traffic and Growth

Background traffic growth for Tweed Coast Road was based on the previous growth agreed within the Stage 1 Traffic Impact Assessments at a rate of 2% compounding per annum. This rate has been applied to the 2012 Tweed Coast Road surveyed volumes to determine 2016 and 2026 through traffic volumes.

3.4.4 2016 Volumes

2016 volumes are based on the following:

- through traffic volumes based on 2012 surveys at the Tweed Coast Road / Dianella Drive Intersection with 2% growth compounding per annum from 2012 to 2016;

- Rural Retail development on the on the eastern side of Tweed Coast Road; and
- 500 residential dwellings on the western side of Tweed Coast Road accessed via Kings Forest Parkway.

Figure 3.2 shows the 2016 AM and PM volumes.

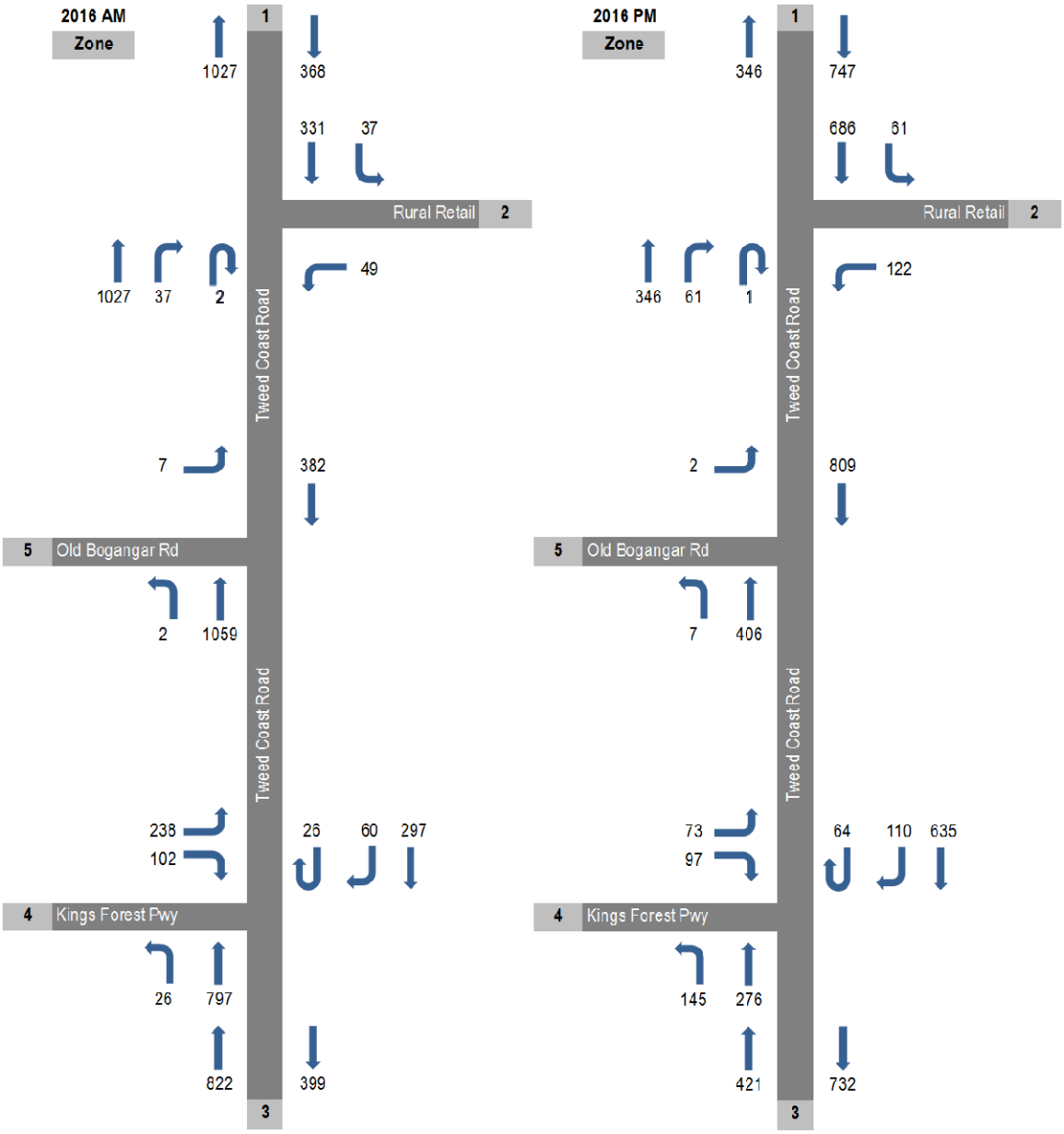

Figure 3.2: 2016 Volumes

3.4.5 2026 Volumes

2026 volumes are based on the following:

- through traffic volumes based on 2012 surveys at the Tweed Coast Road / Dianella Drive Intersection with 2% growth compounding per annum from 2012 to 2026;
- Rural Retail development on the on the eastern side of Tweed Coast Road; and
- 2,500 residential dwellings on the western side of Tweed Coast Road accessed via Kings Forest Parkway.

Figure 3.3 shows the 2026 AM and PM volumes.

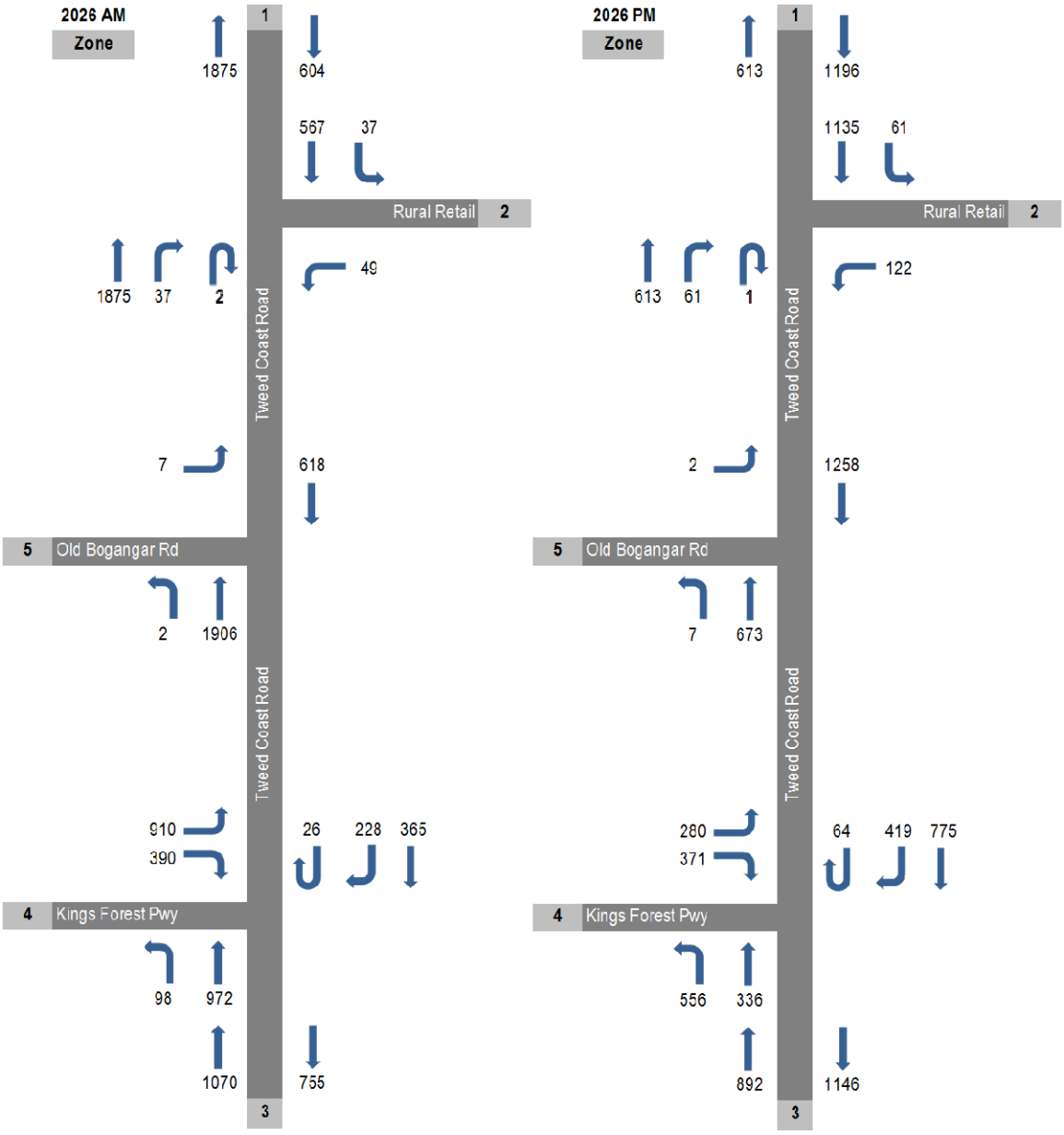

Figure 3.3: 2026 Volumes

3.5 MODELLED PERIODS

The Base models were developed for the following one hour periods which were determined from the Tweed Coast Road / Dianella Drive Intersection Survey:

- 2014 AM Base model: 8:00am to 9:00am; and
- 2014 PM Base model: 4:15pm to 5:15pm.

The Base models also include a warm up period to load traffic onto the network prior to the above periods.

3.6 TRAFFIC ASSIGNMENT

Traffic Assignment is based on a stochastic route choice model as there is no route choice available in the modelled network.

4. MODELLING OUTPUTS

Average Delay and Maximum Queues for each roadway section were extracted from the Aimsun models. Figure 4.1 below shows the legend corresponding to the output figures (Figures 4.2 to 4.5). Average delays and the corresponding Level of Service (LOS) are measured in seconds and maximum queues are measured in the number of vehicle within the queue.

LOS	Average Delay (s)	Colour
A	0 to 10	
B	10 to 20	
C	20 to 35	
D	35 to 55	
E	55 to 80	
F	80 to ∞	

Max Queue (veh)	Colour
0 to 3	
3 to 6	
6 to 9	
9 to 12	
12 to ∞	

Figure 4.1: Modelling Output Legends

The Average Delays and Maximum Queues for each modelled scenario are shown in Figures 4.2 to 4.5.

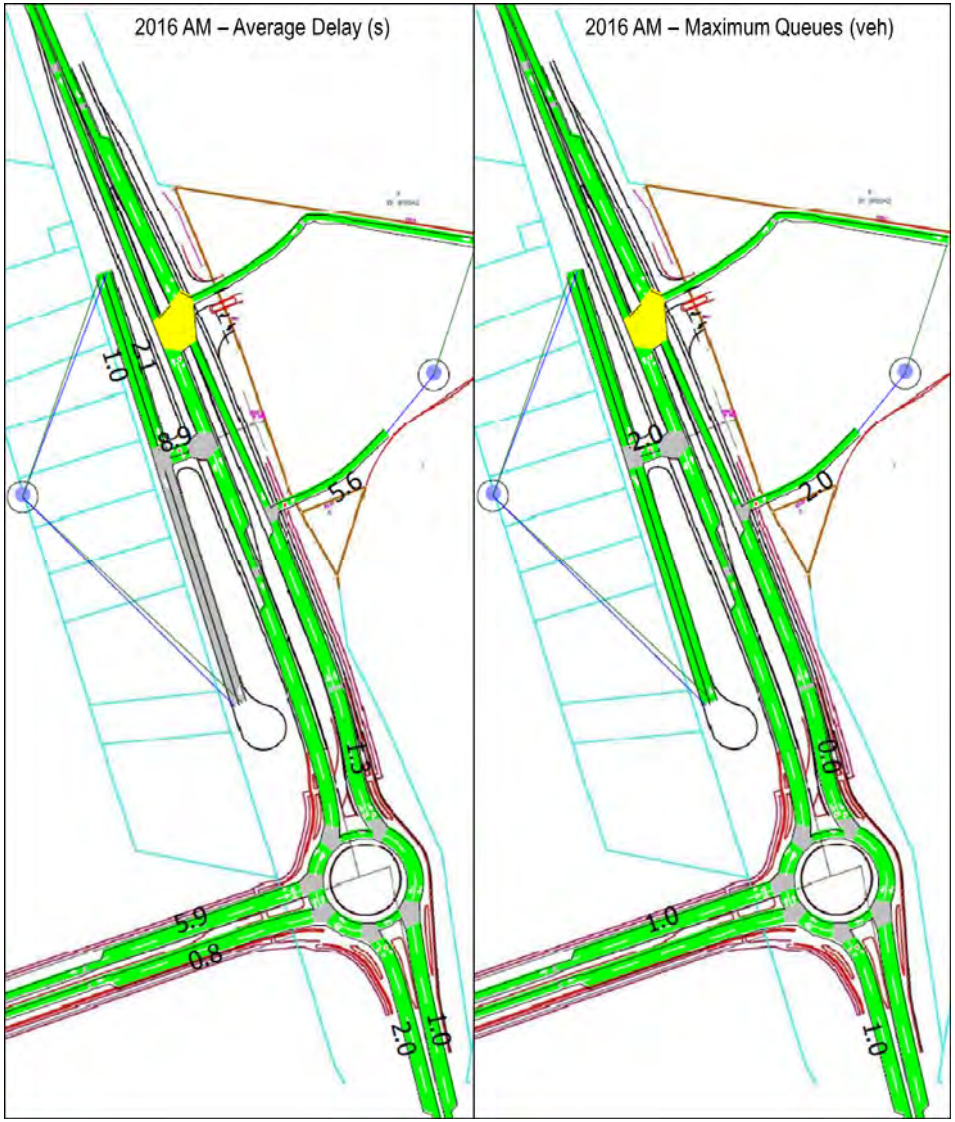

Figure 4.2: 2016 AM Model Outputs

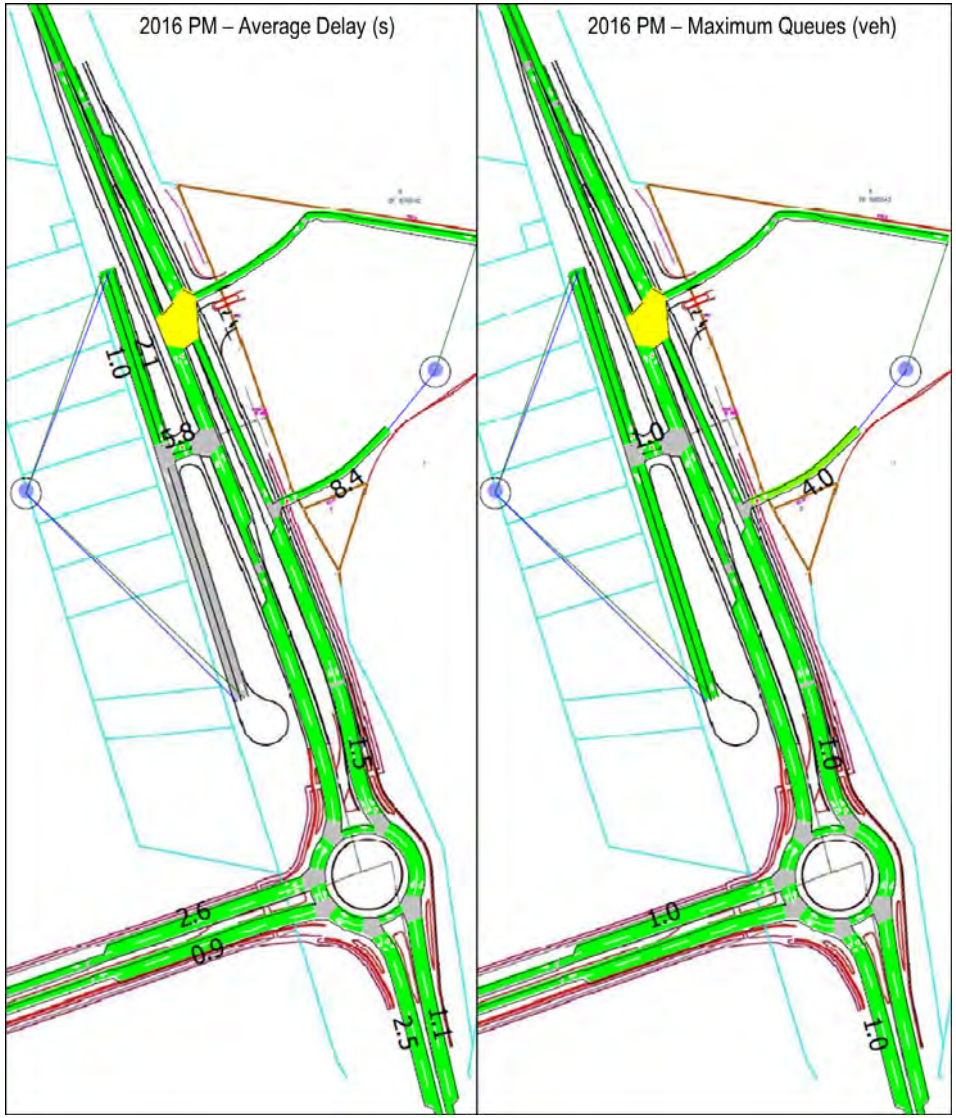

Figure 4.3: 2016 PM Model Outputs

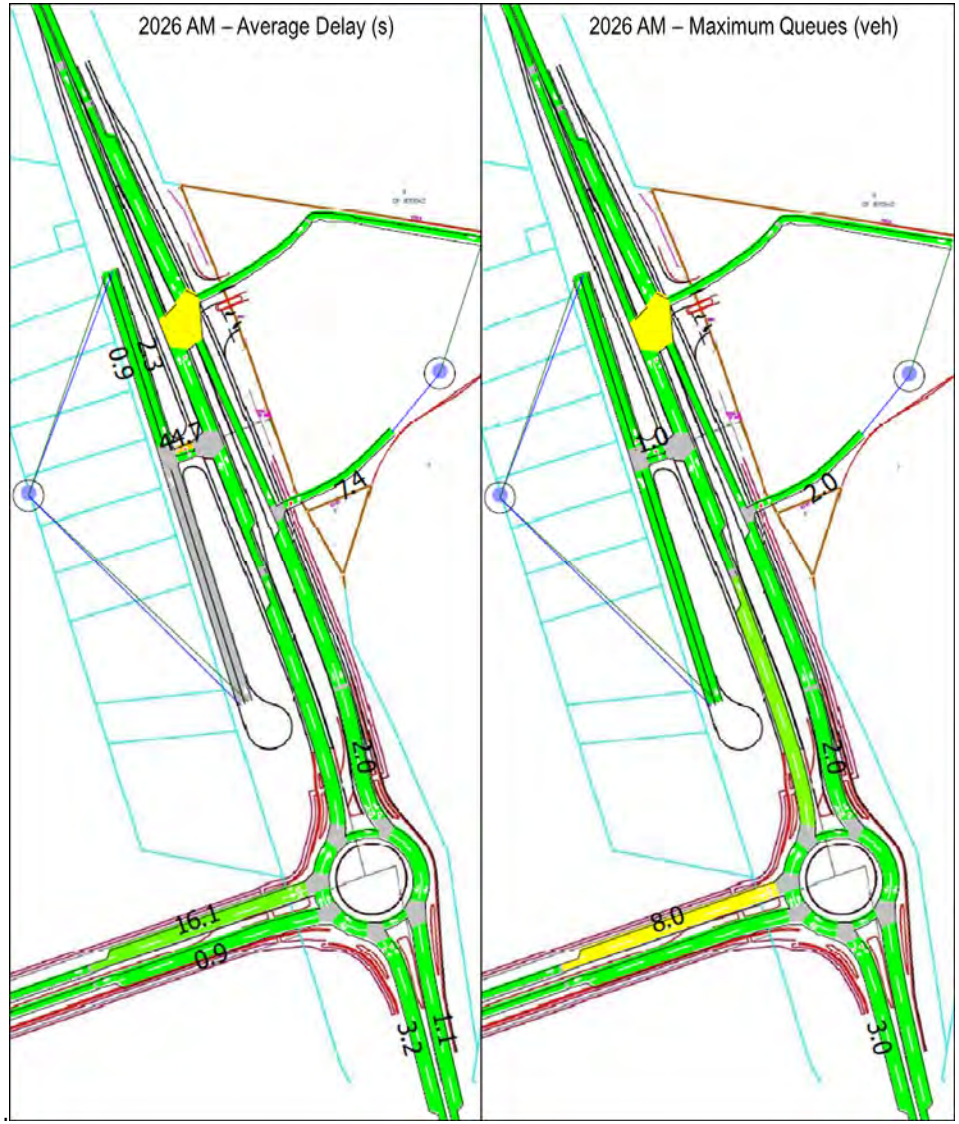

Figure 4.4: 2026 AM Model Outputs

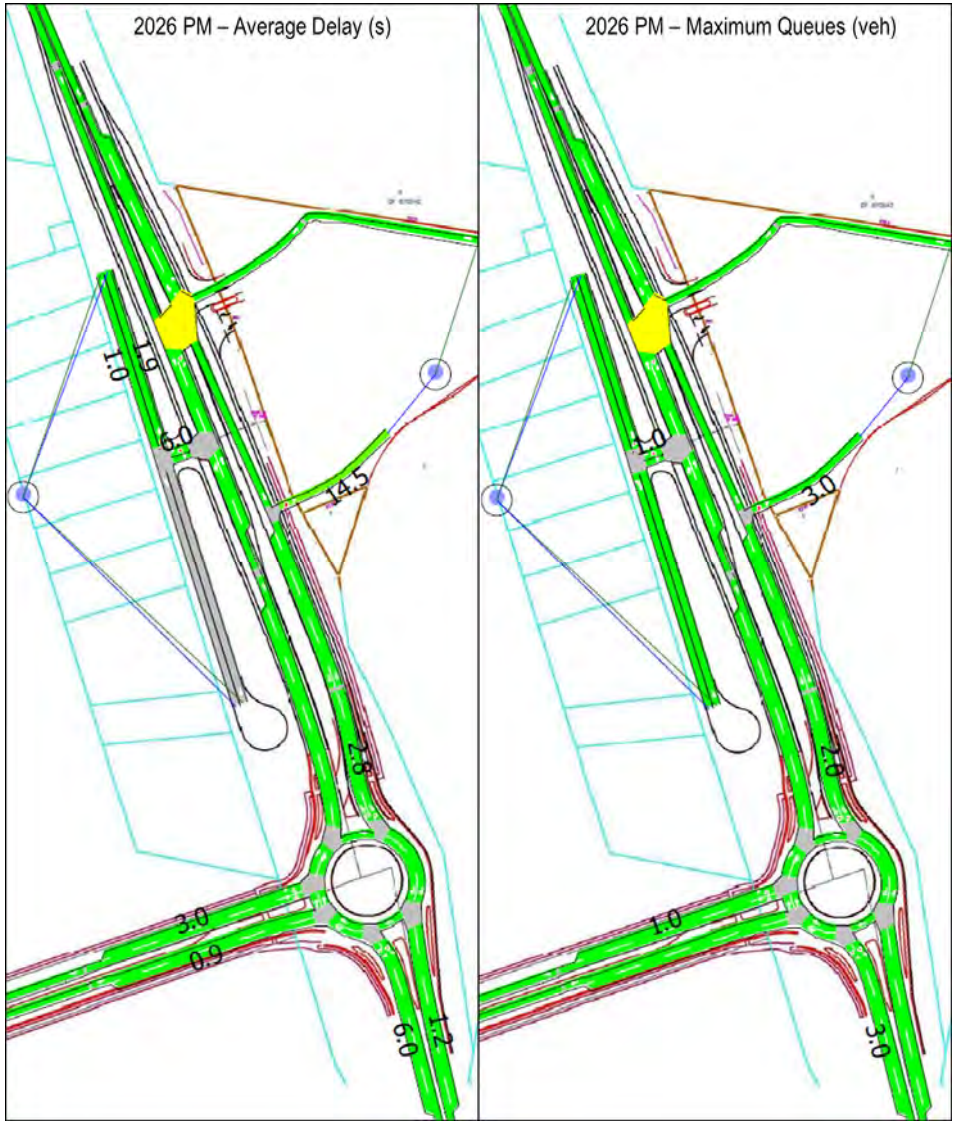

Figure 4.5: 2026 PM Model Outputs

5. TRAFFIC ASSESSMENT

5.1 TWEED COAST ROAD / RURAL RETAIL ENTRANCE INTERSECTION

The Rural Retail access intersection as shown in Figure 5.1 below provides sufficient capacity for all movements into the Rural Retail development whilst adequately catering for the low volume of U-turns movements. There are no adverse queuing impacts or significant delays experienced at the intersection in 2016 or 2026. The single lane cross section on Tweed Coast Road is sufficient out to the 10 year (2026) design horizon.

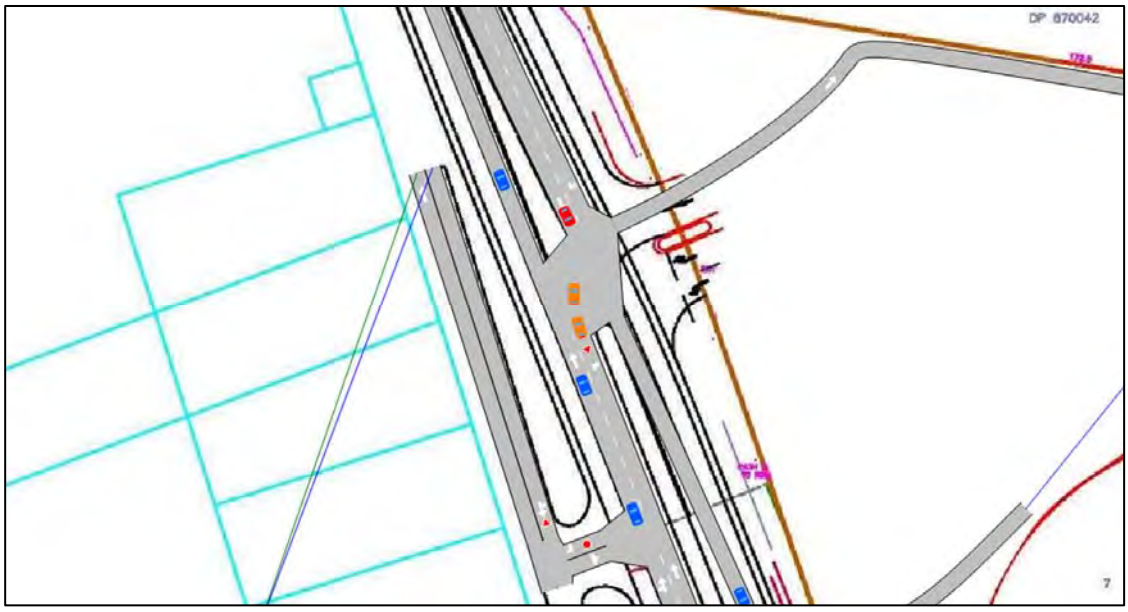

Figure 5.1: Tweed Coast Road / Rural Retail Entrance Intersection

5.2 TWEED COAST ROAD / OLD BOGANGAR ROAD INTERSECTION

The Old Bogangar Road Left in / Left out intersection shown in Figure 5.2 operates satisfactorily in all scenarios. There is an average delay of 44.7 seconds (LOS D) on the Old Bogangar Road approach to Tweed Coast Way in the 2026 AM model, however given that only 7 vehicles are required to undertake this movement, the resultant maximum queue is one (1) vehicle in the 2026 AM peak hour. This operation remains within acceptable parameters.

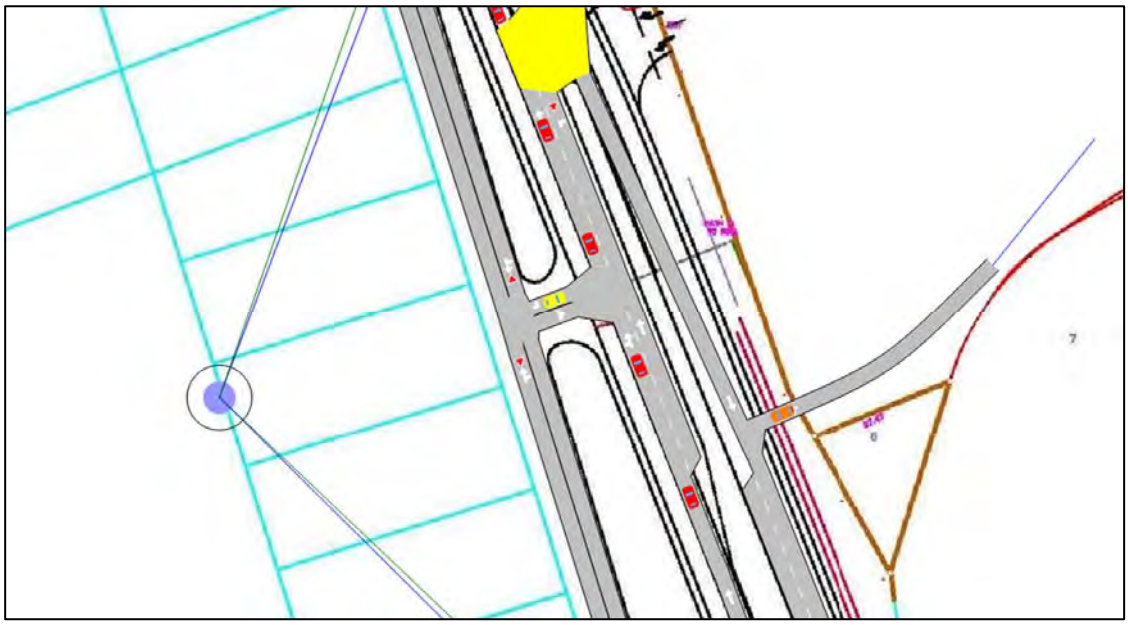

Figure 5.2: Tweed Coast Road / Old Bogangar Road Intersection

5.3 TWEED COAST ROAD / RURAL RETAIL EXIT INTERSECTION

The Rural Retail egress intersection shown in Figure 5.3 performs satisfactorily in all scenarios with a peak 2026 PM average delay of 14.5 seconds (LOS B) and a maximum queue of three vehicles. The left out only configuration for this intersection and the required U-turn at the Tweed Coast Road / King Forest Parkway Roundabout does not result in any impacts to the operation or performance of the roundabout or Tweed Coast Road.

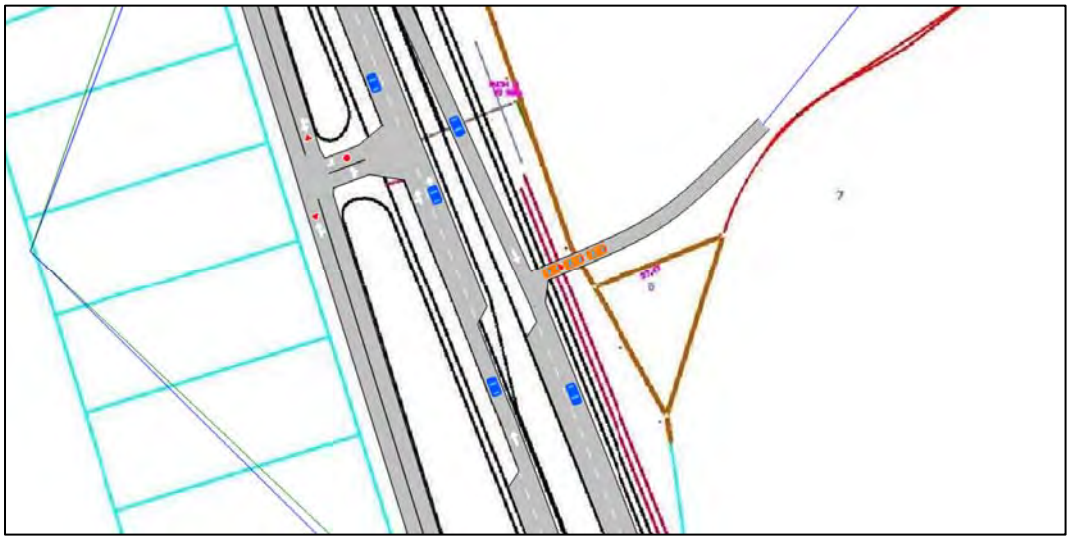

Figure 5.3: Tweed Coast Road / Rural Retail Exit Intersection

5.4 TWEED COAST ROAD / KINGS FOREST PARKWAY ROUNDABOUT

The proposed two lane roundabout at the Tweed Coast Road / Kings Forest Parkway intersection shown in Figure 5.4 performs adequately in all scenarios. The worst performing approach in the 2026 AM model results in a maximum queue of 8 vehicles with an average delay of 16.1 seconds (LOS B) on the Kings Forest Parkway approach to Tweed Coast Road.

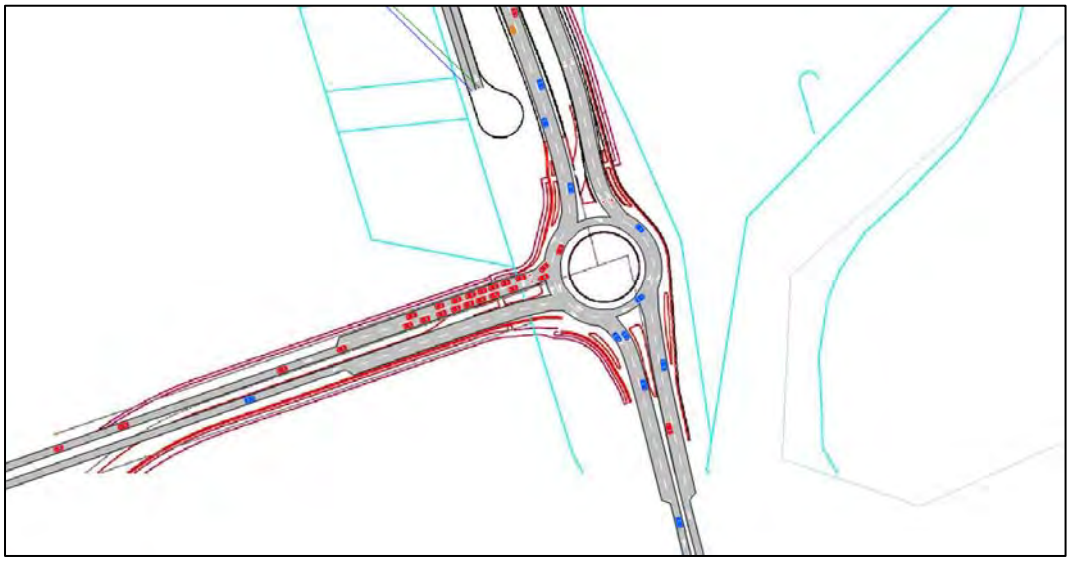

Figure 5.4: Tweed Coast Road / Kings Forest Parkway Intersection

5.5 SUMMARY

Overall, the operations and performance of the traffic network is adequate to cater for both 2016 and 2026 demands. There are no significance delays or queues that adversely impact the traffic network in any scenario tested. The two lane cross section with the provision of associated turning lanes remains sufficient to cater for through traffic volumes on Tweed Coast Road out to the 2026 10 year design horizon. The proposed road network and intersection configurations are therefore deemed appropriate.

6. CONCLUSIONS

The key outcomes of the Kings Forest Intersection Assessment include:

- the 2016 Stage 1 Aimsun model which includes the Rural Retail and 500 dwellings performs satisfactorily in both the AM and PM peak periods;
- the 2026 Aimsun model which includes the Rural Retail development and 2,500 dwellings also performs satisfactorily in both AM and PM peak periods;
- the priority controlled Tweed Coast Road / Rural Retail Entrance Intersection provides sufficient capacity for all movements into the Rural Retail development and adequately caters for the U-turn movements for southbound Old Bogangar Road traffic;
- the Tweed Coast Road / Old Bogangar Road Intersection operates satisfactorily with a worst case average delay of 44.7 seconds (LOS D) in the 2026 AM model, resulting in a maximum queue of one (1) vehicle;
- the Tweed Coast Road / Rural Retail Exit Intersection performs satisfactorily in all scenarios with a peak 2026 PM average delay of 14.5 seconds (LOS B) and a maximum queue of 3 vehicles;
- the Tweed Coast Road / Kings Forest Parkway Roundabout performs adequately in all scenarios with the worst approach in the 2026 AM model resulting in a maximum queue of 8 vehicles and an average delay of 16.1 seconds (LOS B); and
- Tweed Coast Road performs within an acceptable level of service through the proposed intersection configurations without the provision of a continual four lane cross-section out to 2026. As such, two lane cross section on Tweed Coast Road with associated turning lanes and the two lane roundabout at Kings Forest Parkway intersection is sufficient to cater for the 2026 design horizon.

Overall, the proposed road layout and intersection configurations are adequate to cater for the 2026 (10 year) design scenario and do not result in any unacceptable peak period delays, queues or levels of service.

APPENDIX D

STAKEHOLDER CORRESPONDENCE

From: Ray Clark [mailto:rayc@tweed.nsw.gov.au]
Sent: Friday, 14 November 2014 3:05 PM
To: Andrew
Subject: RE: Kings Forest intersection

Andrew
The proposed layout as described in your document dated 16 October is consistent with previous discussions and I have no concerns with the progression of the design on this basis to satisfy Condition Item 27.
Regards

Ray Clark | Traffic Engineer
Engineering | Roads and Stormwater

TWEED SHIRE COUNCIL

p (02) 6670 2578 | **f** (02) 6670 2147 | **e** rayc@tweed.nsw.gov.au | **w** www.tweed.nsw.gov.au
Civic and Cultural Centre Tumbulgum Road Murwillumbah NSW 2484 | PO Box 816 Murwillumbah NSW 2484

Customer Service: (02) 6670 2400 or 1300 292 872 ABN: 90 178 732 496
Our values: transparency | customer focus | fairness | reliability | progressiveness | value for money | collaboration

From: Andrew [mailto:Andrew@bitziosconsulting.com.au]
Sent: Wednesday, 12 November 2014 3:24 PM
To: Ray Clark
Subject: Kings Forest intersection

Hi Ray,

Just touching base on progress for the Stage 1 Kings Forest Intersection Layout review?

Any indications on timing for when Council will provide a response? Feel free to give me a call to discuss.

Regards,

ANDREW EKE
MANAGER – GOLD COAST & NORTHERN NSW
SENIOR TRAFFIC ENGINEER & TRANSPORT PLANNER

BITZIOS consulting
traffic engineering • transport planning

Gold Coast: Suite 26, 58 Riverwalk Avenue, Robina QLD 4226, P: (07) 5562-5377 F: (07) 5562-5733
Brisbane: Level 2, 428 Upper Edward Street, Spring Hill 4000, P: (07) 3831-4442 F: (07) 3831-4455
Sydney: Studio 203, 3 Gladstone Street, Newtown NSW 2042, P: (02) 9557 6202 F: (02) 9557 6219
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Web: www.bitziosconsulting.com.au
Mobile: 0432-082-422

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APPENDIX E

AUL AND CHR CONCEPT DESIGNS

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P: (02) 9557 6202

Issue	REVISIONS Revisions/Descriptions	Drawn	Date
006	Development Plan Swept Paths	B.N	04.10.2016

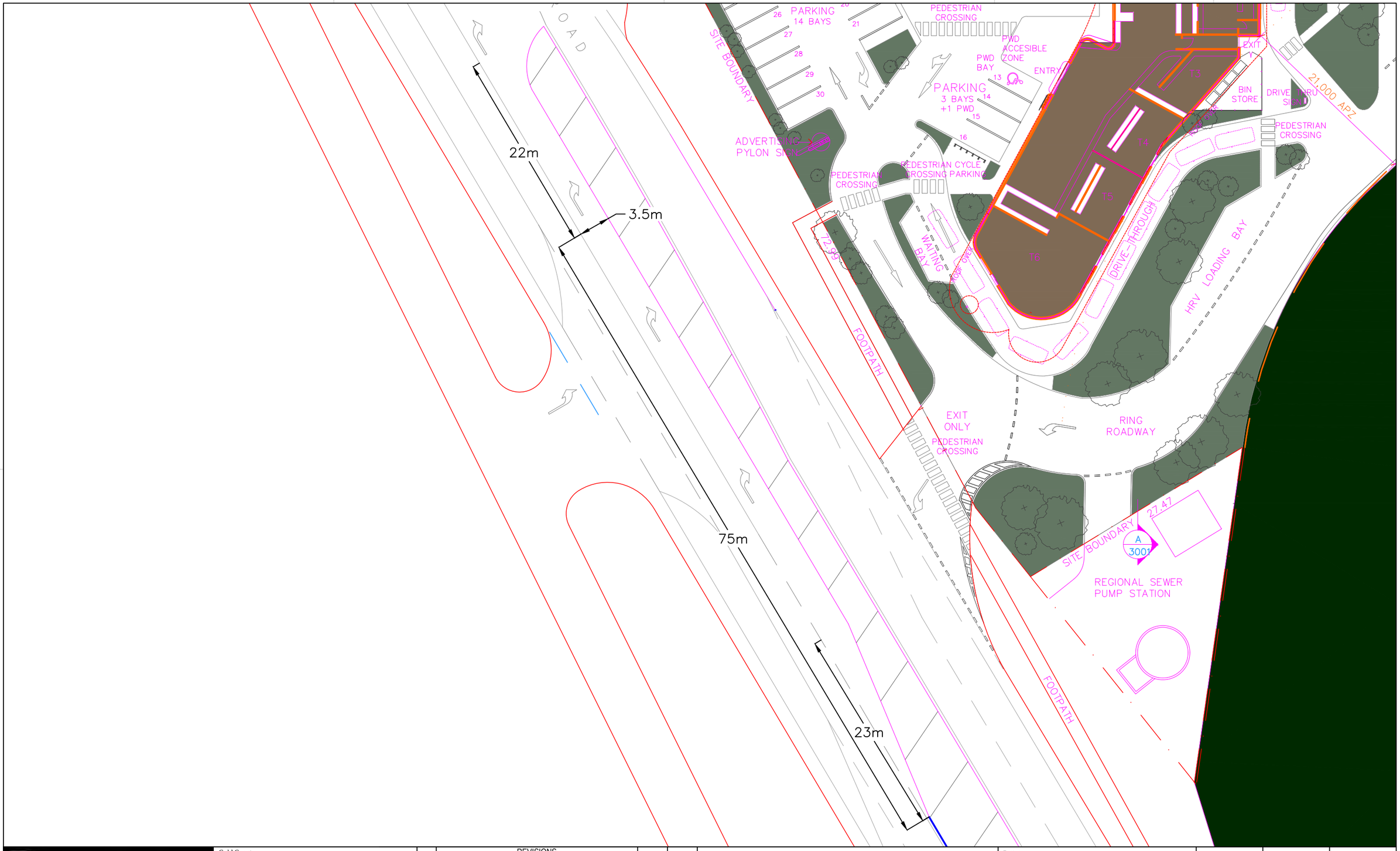
Project: Kings Forest Service Station

Title: Auxiliary Left Turn (AUL) Treatment

FOR INFORMATION ONLY

Date: 04.10.2016

Project Number	Sheet Number	Issue
P1745	1	006



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Sydney
Studio 203, 3 Gladstone Street, Newtown NSW 2042.
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Issue	REVISIONS Revisions/Descriptions	Drawn	Date
006	Development Plan Swept Paths	B.N	04.10.2016

Project: Kings Forest Service Station

Title: Channelised Right Turn (CHR) Treatment

FOR INFORMATION ONLY

Date: 04.10.2016

Project Number	Sheet Number	Issue
P1745	2	006

APPENDIX F

RMS SURVEY RESULTS

TRAFFIC, ENVIRONMENTAL & FORENSIC ENGINEERS
TEF CONSULTING

Address PO Box 215, Bondi NSW 2026
Phone 02) 9332 2024 / (02) 9523 9212
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www http://www.tefconsult.com.au

NSW GOVERNMENT Transport Roads & Maritime Services

ROADS AND MARITIME SERVICES

TRIP GENERATION SURVEYS

SERVICE STATIONS

ANALYSIS REPORT

Report Document Control	
Title	TRIP GENERATION SURVEYS SERVICE STATIONS
Date	June 2013
Author(s)	O Sannikov
Client	ROADS AND MARITIME SERVICES
Job No.	13008
Quality Control Reviewer	S Samuels
Keywords	Trip generation/ service stations/ NSW Roads and Maritime Services
Disclaimer	**This report is believed to be true and correct at the time of writing. It is based on the information and data provided by the client and other relevant organisations during preparation. TEF Consulting does not accept any contractual, tortuous or other form of liability for any consequences arising from its use. People using the information in the report should apply and rely on their own skill and judgement to a particular issue they are considering.**

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Tables

Figures

1 INTRODUCTION

1.1 Study Brief / Outcomes

The former Roads and Traffic Authority (RTA) published its Guide to Traffic Generating Developments ("*Guide"*) in the mid-1990s. This document drew on the results of a number of trip generation and parking demand surveys covering a range of land uses. These surveys had been progressively conducted since 1978. The trip generation and parking requirement data in the Guide is becoming increasingly out-of-date. Several new business types are not adequately represented (eg factory outlet centres) and there is evidence of ongoing industry rationalisation (eg larger service stations, hardware supercentres, etc).

The Guide contains trip generation and parking demand information derived from a 1979 survey of ten Service Stations across greater Sydney. Half of the sites were self-service, and half offered the then-traditional driveway service. Since that survey was undertaken:

- self-service has displaced driveway service
- service stations are now much larger
- it is now rare for a service station to also contain a vehicle service workshop or bay
- service stations now also offer convenience items and groceries
- service stations are often attached to fast food outlets
- much petrol retailing is now allied to large supermarket chains and loyalty schemes
- petrol pricing is highly variable day-to-day, with consequent wide variations in customer patronage.

Given these changes, there is now a need to validate (or otherwise) the 1979 trip generation and parking demand data for Service Stations, to assist with traffic impact assessment and planning.

TEF Consulting (the Consultant) was appointed to undertake a validation study of trip generation and parking demand of service stations. The study includes surveys of traffic characteristics relating to vehicle trips and parking demand.

1.2 Service stations

Five service stations out of 10 selected for this Study did not contain any ancillary services. Three stations had a fast food restaurant on site, four had a car wash drive-through and one of the latter stations also had a car service garage.

1.3 Approach

The approach to this trip generation study is described below:

- The Consultant has initially compiled a list of 14 prospective survey sites. A list of required attributes and other criteria for the area selection is provided in the Brief. These attributes and criteria are hereby acknowledged.
- The Consultant has assessed the suitability of the sites for the Study in consultation with the RMS Project Manager and have found that four of the provided sites were less suitable than the others, conforming to a lesser extent with the selection criteria than the other 10 sites, eventually adopted as subjects for the study.
- The Consultant then undertook site inspections and collection of site characteristics.
- The Consultant then arranged traffic counts on a weekday at all sites between 6:00 am and 7:00 pm (except Site 1 which was chosen for a special 24/hour 7-day survey). The surveys were undertaken on an either a Tuesday, Wednesday or Thursday. The survey data included vehicle

classification counts entering and exiting each site as well as classification counts of traffic flows on the main road adjacent to the site.

- A count of vehicles parked on site in marked parking spaces as well as outside formal parking areas was also carried out, at 15 minute intervals. The observers also collected petrol pricing information (price of E10 petrol) at 15 minute intervals.
- The Consultant studied the data using linear and non-linear regression analysis and considered the generated data as a function of a number of the key variables.
- The Consultant prepared a report to summarise the findings of the survey and data analysis.
- The reporting is presented in two documents. The first, this report, contains the analysis covering all of the calculations and comparisons. The second report contains the raw data from the surveys and other data such as survey site plans and tabulated vehicle-trip and person-trip data.

1.4 Report Structure

This analysis report has the following structure:

- **Chapter 1: Introduction** – This contains the background to the study, approach and report structure;
- **Chapter 2: Survey methodology** – This contains a description of the survey and survey area selection process;
- **Chapter 3: Survey analysis** – This section analyses the survey results using linear and non-linear regression;
- **Chapter 4: Summary**

2 SURVEY METHODOLOGY

2.1 Selection of survey sites

The survey areas were selected according to the specifications set out in the RMS Brief.

2.2 Survey site Selection Methodology

- Consultation with the RMS
- Detailed examination of cadastral maps and aerial photographs
- Identification of survey site characteristics
    - Survey site location
    - Identification of access points
    - Identification of additional services
- Initial survey planning to check suitability in terms of ease of observations
- Confirmation of 10 survey sites including one site for a special 7-day survey.
    - Survey area visits and collection of specific details
    - Questionnaire survey of all establishments within each site (to gauge the information about the number of employees, floor areas, opening hours, specifics of operations, etc.)
    - Photographic and video records of access locations

The details of the selected survey areas are summarised in **Table 2.1** (a full summary table, including trip and parking statistics is contained in the **Appendix**). The locations of the survey areas are shown on **Figure 2.1**.

Table 2.1 Details of the selected survey sites.

Site ID	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Site operator	Shell - Coles Express	BP	Caltex	APW	7-Eleven	BP	Caltex - Woolworths	Caltex - Woolworths	7-Eleven	BP
Site address	867 South Dowling St, Waterloo	9 Davies Road, Padstow	1403 Princes Highway, Heathcote	449 Great Western Hwy, Greystanes	15-19 Aspen St, South Penrith	162 Sunnyholt Rd, Kings Park	59 Orange Grove Rd, Liverpool	1 Woodland St, Riverstone	Hume Hwy, Bargo	146-152 Moorefields Rd, Kingsgrove
Day/date of survey(s)	Fri 17/05/13 to Thu 23/05/13	Tue, 21/05/13	Tue, 26/03/13	Wed, 27/03/13	Thu, 28/03/13	Thu, 28/03/13	Wed, 27/03/13	Tue, 26/03/13	Wed, 27/03/13	Mon, 27/05/13
Duration of survey - site and frontage road	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00
Duration of survey - site trip generation	24 hrs 7 days									
Surrounding area characteristics:										
Surrounding landuse	commercial / retail / residential	industrial / residential / open space	residential / park	industrial / residential / commercial	commercial / residential	industrial / residential / commercial	commercial / retail / residential	commercial / retail / residential	open space	residenial
Frontage road - AM peak period (weekday)	07:00-08:00	07:15-08:15	06:15-07:15	11:00-12:00	07:45-08:45	11:45-12:45	07:15-08:15	07:45-08:45	07:30-08:30	08:00-09:00
Frontage road - PM peak period (weekday)	17:15-18:15	15:45-16:45	16:30-17:30	17:15-18:15	15:00-16:00	17:15-18:15	17:00-18:00	17:00-18:00	17:00-18:00	17:00-18:00
Frontage road - daily peak period (Saturday & Sunday) [NB: for 7-day surveys only]										
Development details:										
Year opened	1995	pre-2005	2006	pre-2002	pre-2005	pre-2005	pre-2002	pre-2002	pre-2003	pre-2005
Other services / businesses on site	fast food & car wash	fast food & car wash	none	car wash	none	car wash & car service	none	none	fast food	none
Total site area (m^2)	3540	3957	1860	1652	4392	1031	3798	3187	11030	988
Gross Floor Area (m^2):										
o Convenience store	140	261	193.5	144.5	265	90	443	197	200	245
o Fast food area	150	220							138	
o Car wash & car service				38		173			53	
TOTAL GFA (m^2)	290	481	193.5	182.5	265	263	443	197	391	245
No. of pumps	12	12	12	8	6	4	20	16	16	8
No. of service channels	6	6	6	4	6	4	10	8	12	4
No. of seats in fast food area	38	26	N/A	N/A	N/A	N/A	N/A	N/A	28	N/A

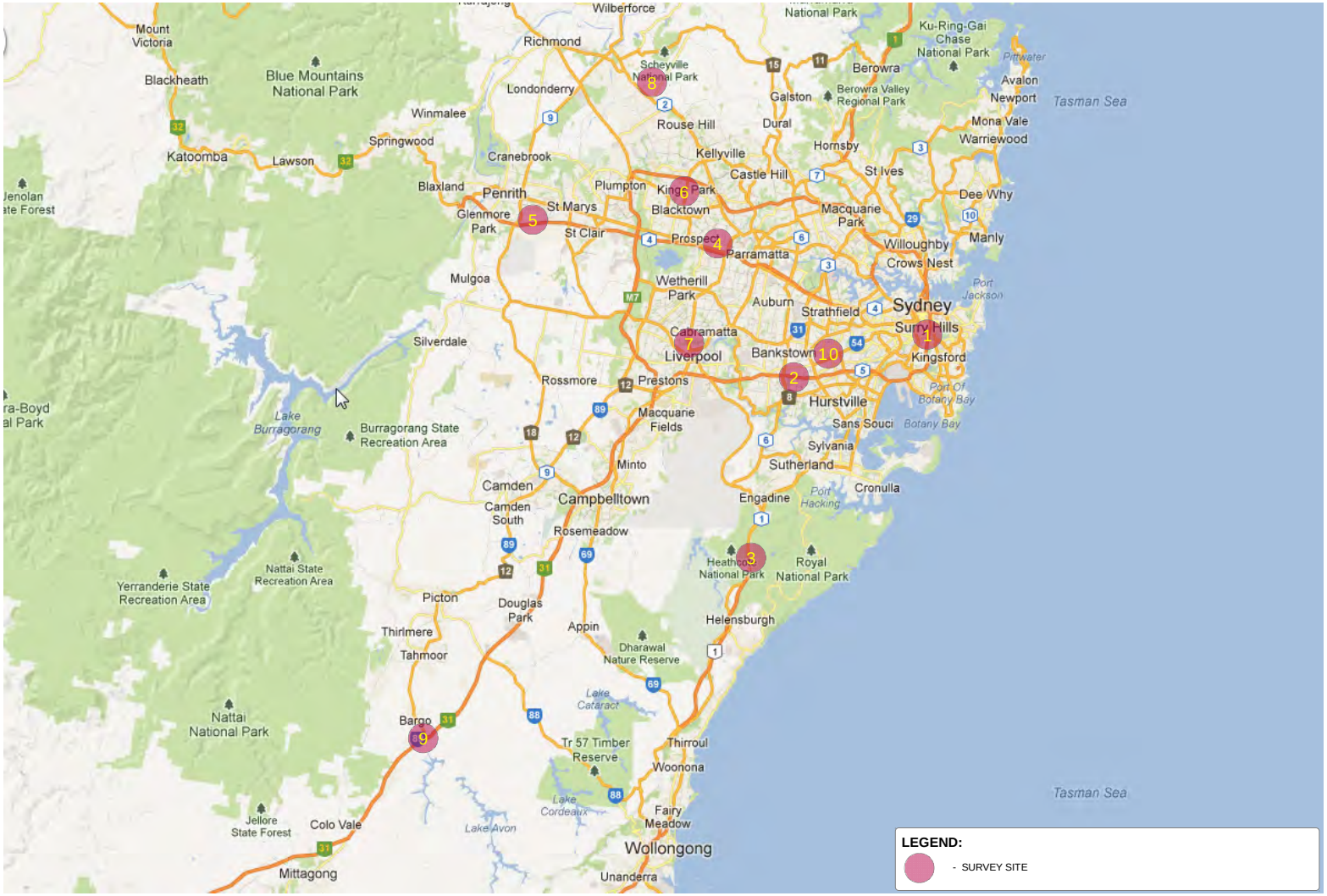

Figure 2.1 Survey site locations - Sydney

2.2.1 Survey site selection and survey conduct issues

- There were no technical issues with the manual counts and video surveys, except obtaining permissions from the service station operators.
- Most operators could not provide information about the year when the station was opened; available information was only approximate.

2.3 Survey Process

Conduct of surveys

Survey period	March – May 2013 Outside school holidays and public holidays
Day of the week	Monday, Tuesday, Wednesday or Thursday One survey day for each of the survey sites Special survey (Site 1) – 7 consecutive days
Survey times	6.00 am to 7.00 pm Special survey (Site 1) –24 hours per day for all vehicles entering the development

Data Recorded by traffic surveyors

- A count of vehicles parked on-site in marked parking spaces [ie excluding vehicles parked for refuelling] at the commencement of the survey
- A count of vehicles (broken down into customer cars / customer heavy vehicles / service & delivery vehicles) entering and leaving the site, in 15-minute bands
- A count of the number of vehicles parked on-site in marked parking spaces taken at 15-minute intervals
- Recording of the advertised price per litre of E10 fuel at 15-minute intervals
- An hourly light/heavy vehicle classification count on the frontage road, to establish the impact of the development on underlying hourly traffic patterns.
- For Site 1 (special survey over 7 days): a 15-minute video camera count of all vehicles entering the development for each 24 hours over the full 7-day period, to establish daily and hourly visitation patterns.
- Questionnaire surveys of businesses to obtain information about the mode of operation (opening times, number of staff, etc.)
- Information about the site design parameters – site area, building area, number of seats in the fast food area, number of service channels and the number of pumps (note that for the purpose of this survey the number of pumps was defined as the number of vehicles able to be served at once).

3 SURVEY ANALYSIS

3.1 Survey Output Requirements

The data was analysed with the key parameters needing to be established being

- Daily Vehicle Trips (ie inward trips + outgoing trips)
- Peak Vehicle Trips (ie the maximum number of vehicle trips to/from the site in any one-hour period)
- Peak Vehicle Trips in the AM and PM peak (ie the number of vehicle trips to/from the site during the morning and afternoon peak hours on the frontage road)

3.2 Average Trip Rates for Service Stations

The trip generation calculation that was to be performed would depend upon the variable that was interrogated. Several variables were interrogated, as listed below.

- number of pumps
- number of service channels
- total Gross Floor Area (GFA) of buildings on site
- convenience store GFA
- fast food GFA (where applicable)

The summary of the survey data for each of the surveyed areas is shown in **Table 3.1**. Average trip generation rates are summarised in **Table 3.2**. Site 9 (Bargo) was considered to be substantially different from all other sites (due to its remote location from the metropolitan area, large site area and its function as a rest/refresh stopping point on a major highway) to justify a separate analysis of the average trip rates for all site but Site 9.

The detailed results are contained in a separate "Data Report".

A review of the data reveals a number of observations

- The surveys were undertaken at service stations with the floor space varying from 182.5 m^2 to 481 m^2 and with the total site area varying from 988 m^2 to 11,030 m^2 .
- The results of the analyses for both peak hour and daily trips rates indicate high values of standard deviation in all cases, with somewhat lower standard deviation for the number of trips per service channel and per 100 m^2 of total GFA. The base data is therefore regarded as wide-spread and average rates are not recommended to be used for predicting the trip generation because of wide prediction intervals around the mean estimated values.

Table 3.1 Traffic survey results summary.

Site ID	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Site operator	Shell - Coles Express	BP	Caltex	APW	7-Eleven	BP	Caltex - Woolworths	Caltex - Woolworths	7-Eleven	BP
Site address	867 South Dowling St, Waterloo	9 Davies Road, Padstow	1403 Princes Highway, Heathcote	449 Great Western Hwy, Greystanes	15-19 Aspen St, South Penrith	162 Sunnyholt Rd, Kings Park	59 Orange Grove Rd, Liverpool	1 Woodland St, Riverstone	Hume Hwy, Bargo	146-152 Moorefields Rd, Kingsgrove
Day/date of survey(s)	Fri 17/05/13 to Thu 23/05/13	Tue, 21/05/13	Tue, 26/03/13	Wed, 27/03/13	Thu, 28/03/13	Thu, 28/03/13	Wed, 27/03/13	Tue, 26/03/13	Wed, 27/03/13	Mon, 27/05/13
Duration of survey - site and frontage road	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00
Duration of survey - site trip generation	24 hrs 7 days									
Vehicle Trips:										
o Peak 1-hour vehicle-trips (in+out) *	143	160	159	183	203	178	216	161	318	95
o Time of peak 1-hour vehicle-trips	17:00-18:00	16:45-17:45	16:30-17:30	17:45-18:45	15:15-16:15	13:30-14:30	07:30-08:30	16:15-17:15	17:00-18:00	17:15-18:15
o Peak vehicle-trips per pump	11.9	13.3	13.3	22.9	33.8	44.5	10.8	10.1	19.9	11.9
o Peak vehicle-trips per service channel	23.8	26.7	26.5	45.8	33.8	44.5	21.6	20.1	26.5	23.8
o Peak vehicle-trips per 100m^2 of total GFA	49.3	33.3	82.2	100.3	76.6	67.7	48.8	81.7	81.3	38.8
o Peak vehicle-trips per 100m^2 of convenience store GFA	102.1	61.3	82.2	126.6	76.6	197.8	48.8	81.7	159.0	38.8
o Peak vehicle-trips per 100m^2 of fast food GFA	95.3	72.7	N/A	N/A	N/A	N/A	N/A	N/A	230.4	N/A
o Total daily vehicle-trips	1543	1276	1449	1463	1629	1399	2329	1472	3234	720
o Total daily vehicle-trips per pump	128.6	106.3	120.8	182.9	271.5	349.8	116.5	92.0	202.1	90.0
o Total daily vehicle-trips per service channel	257.2	212.7	241.5	365.8	271.5	349.8	232.9	184.0	269.5	180.0
o Total daily vehicle-trips per 100m^2 of total GFA	532.1	265.3	748.8	801.6	614.7	531.9	525.7	747.2	827.1	293.9
o Total daily vehicle-trips per 100m^2 of convenience store GF	1102.1	488.9	748.8	1012.5	614.7	1554.4	525.7	747.2	1617.0	293.9
o Total daily vehicle-trips per 100m^2 of fast food GFA	1028.7	580.0	N/A	N/A	N/A	N/A	N/A	N/A	2343.5	N/A
o Vehicle-trips during adjacent road's AM peak **	101	81	152	86	126	85	214	114	217	59
o Vehicle-trips during adjacent road's PM peak **	130	136	159	154	202	112	178	143	318	78
Parking:										
o No of reserved car spaces	0	0	0	2	0	0	0	0	0	0
o No of public car spaces	31	16	14	7	12	3	22	17	18	8
o No of staff car spaces	1	2	0	0	0	0	0	0	0	0
o No of Disabled car spaces	1	0	1	0	0	0	1	0	0	0
o No of Loading / unloading bays	1	2	0	1	0	1	1	0	1	1
TOTAL parking spaces	34	20	15	10	12	4	24	20	19	9
o Peak Parking Accumulation	12	12	8	10	7	11	7	5	52	4
o Time of Peak Parking Accumulation	12:00-12:15	12:00-12:15	08:15	18:45-19:00	06:45, 16:15 & 16:45	12:45	14:45; 18:45	17:30	17:00	18:30
o Parking Accumulation per 100m^2 total GFA	4.1	2.5	4.1	5.5	2.6	4.2	1.6	2.5	13.3	1.6

Note: * - the number of trips for Site 1 is average over five week days

** - number of vehicle trips in adjacent road is for one direction only, on the petrol station side of the road.

Table 3.2 Trips rate summary.

	Sites 1 to 10				Sites 1 to 10 except Site 9			
	Min	Max	Avg	St Dev	Min	Max	Avg	St Dev
Vehicle Trips:								
o Peak 1-hour vehicle-trips (in+out) *	95.0	318.0	181.6	58.4	95.0	216.0	166.4	35.3
o Time of peak 1-hour vehicle-trips								
o Peak vehicle-trips per pump	10.1	44.5	19.2	11.5	10.1	44.5	19.2	12.2
o Peak vehicle-trips per service channel	20.1	45.8	29.3	9.1	20.1	45.8	29.6	9.6
o Peak vehicle-trips per 100m^2 of total GFA	33.3	100.3	66.0	22.2	33.3	100.3	64.3	22.8
o Peak vehicle-trips per 100m^2 of convenience store GFA	38.8	197.8	97.5	50.3	38.8	197.8	90.7	48.2
o Peak vehicle-trips per 100m^2 of fast food GFA	72.7	230.4	132.8	85.3	72.7	95.3	84.0	16.0
o Total daily vehicle-trips	720.0	3,234.0	1,651.4	679.6	720.0	2,329.0	1,475.6	414.4
o Total daily vehicle-trips per pump	90.0	349.8	166.0	86.4	90.0	349.8	162.0	90.7
o Total daily vehicle-trips per service channel	180.0	365.8	256.5	62.2	180.0	365.8	255.0	65.8
o Total daily vehicle-trips per 100m^2 of total GFA	265.3	827.1	588.8	198.8	265.3	801.6	562.4	191.2
o Total daily vehicle-trips per 100m^2 of convenience store GFA	293.9	1,617.0	870.5	446.1	293.9	1,554.4	787.6	382.8
o Total daily vehicle-trips per 100m^2 of fast food GFA	580.0	2,343.5	1,317.4	916.5	580.0	1,028.7	804.3	317.3
o Vehicle-trips during adjacent road's AM peak **	59.0	217.0	123.5	55.0	59.0	214.0	113.1	46.8
o Vehicle-trips during adjacent road's PM peak **	78.0	318.0	161.0	64.9	78.0	202.0	143.6	36.2
Parking:								
o Peak Parking Accumulation	4.0	52.0	12.8	14.1	4.0	12.0	8.4	3.0
o Parking Accumulation per 100m^2 total GFA	1.6	13.3	4.2	3.4	1.6	5.5	3.2	1.3

Note: * - the number of trips for Site 1 is average over five week days

** - number of vehicle trips in adjacent road is for one direction only, on the petrol station side of the road.

3.3 Regression analysis

As agreed in the project brief, the data has been analysed to determine the most consistent measure of trip generation, using a simple linear regression approach.

The coefficient of determination (R^2) has been used to provide a measure of the usefulness of the regression equation. It measures the proportion of variation in Y (trip behaviour) that is explained by the independent variable X (such as gross floor area or the number of pumps) in the regression model. The values vary from 0 to 1 with higher values representing a higher degree of correlation. In this study, R^2 above 0.8 are considered to provide the desired level of correlation. In other words, at least 80% of the variation in trip behaviour can be explained by the variability in the independent variable in the acceptable level.

A number of simple linear regression models did not fit the data at an acceptable level, returning low R^2. For this reason, non-linear regression models were trialled as well.

3.3.1 Relationship between the number of trips and principal independent variables

The following key independent variables were used for this regression analysis.

- total building GFA
- convenience store GFA
- total site area
- number of pumps
- number of service channels
- number of seats in the fast food area (where applicable)
- petrol price

The analysis was carried out for the following trip characteristics

- Daily Vehicle Trips (ie inward trips + outgoing trips)
- Peak Vehicle Trips (ie the maximum number of vehicle trips to/from the site in any one-hour period)
- Peak Vehicle Trips in the AM and PM peak (ie the number of vehicle trips to/from the site during the morning and afternoon peak hours on the frontage road).

3.3.1.1 Total building GFA

- R^2 for all trip characteristics for all service stations is low and indicates little correlation between the number of trips and the overall gross floor area.

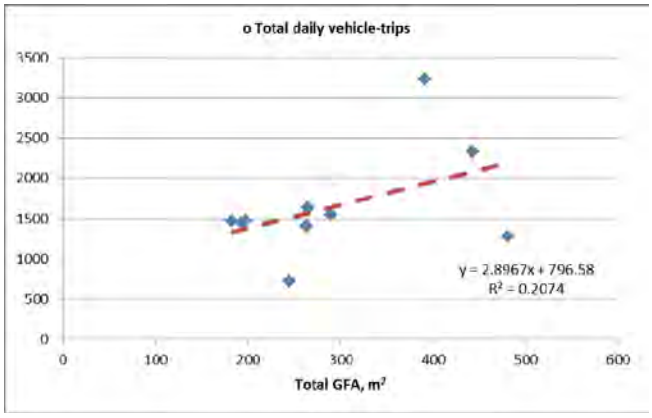

Figure 3-2 Total daily vehicle trips vs total building GFA – Linear type

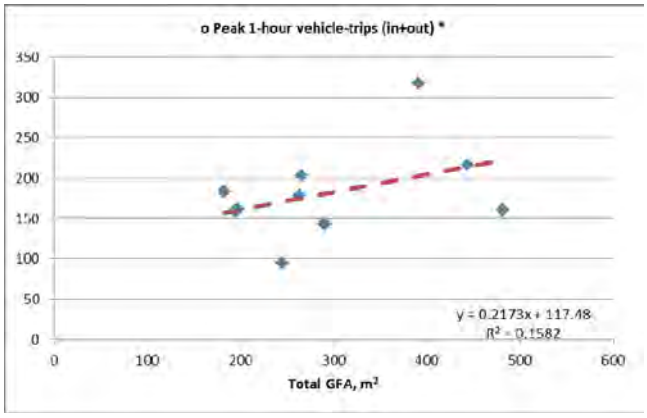

Figure 3-3 Peak hour vehicle trips vs total building GFA – Linear type

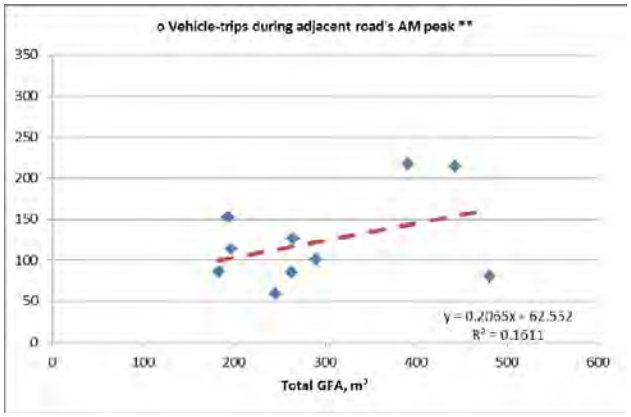

Figure 3-4 Vehicle trips vs total building GFA – Linear type - during AM Peak Hour on adjacent road

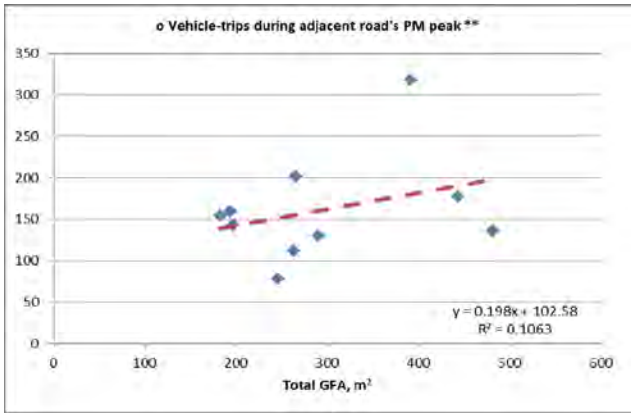

Figure 3-5 Vehicle trips vs total building GFA – Linear type - during PM Peak Hour on adjacent road

3.3.1.2 Convenience store GFA

- R^2 for all trip characteristics for all service stations is low and indicates little correlation between the number of trips and the convenience store gross floor area.
  - Note that the convenience store area equals to the total building area if there are no ancillary services like fast food or car wash.

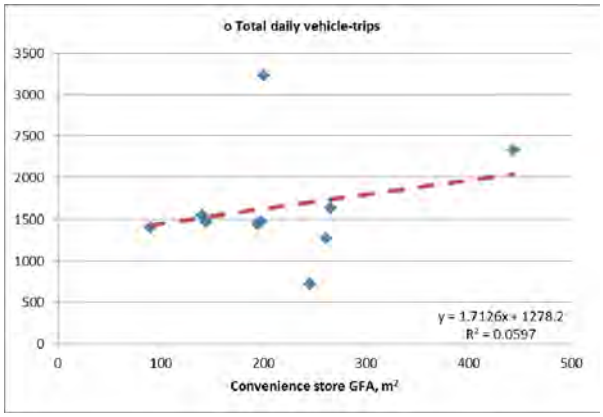

Figure 3-6 Total daily vehicle trips vs convenience store GFA – Linear type

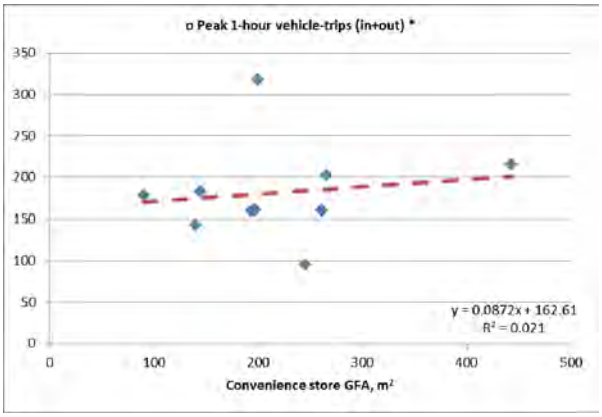

Figure 3-7 Peak hour vehicle trips vs convenience store GFA – Linear type

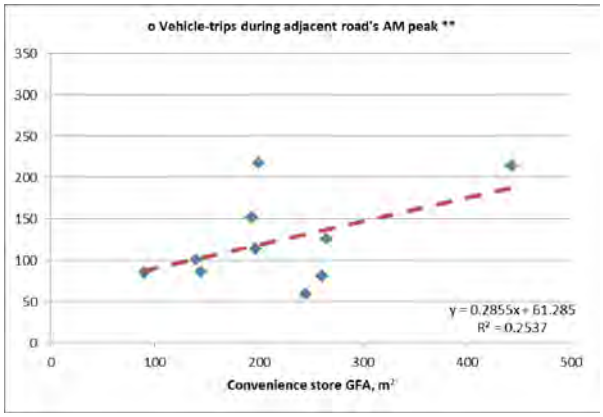

Figure 3-8 Vehicle trips vs convenience store GFA – Linear type - during AM Peak Hour on adjacent road

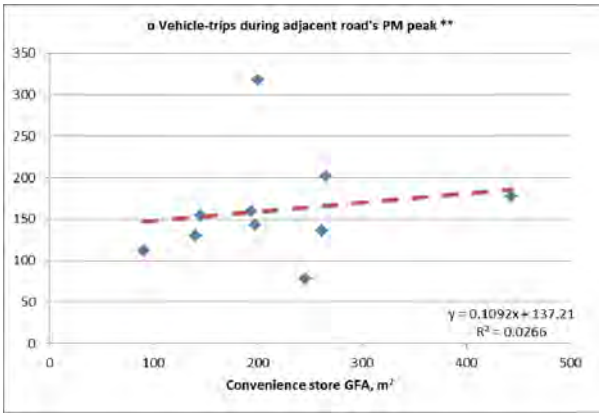

Figure 3-9 Vehicle trips vs convenience store GFA – Linear type - during PM Peak Hour on adjacent road

3.3.1.3 Total site area

- R^2 for the number of trips during the AM peak hour on adjacent road for all service stations is low and indicates little correlation between the number of trips and the total site floor area.
- However, R^2 for the total daily trips (0.77), peak hour trips (0.74) and in particular for the number of trips during the PM peak hour on adjacent road (0.84) for all service stations is near or above 0.8 and indicates good correlation between the number of trips and the total site floor area.

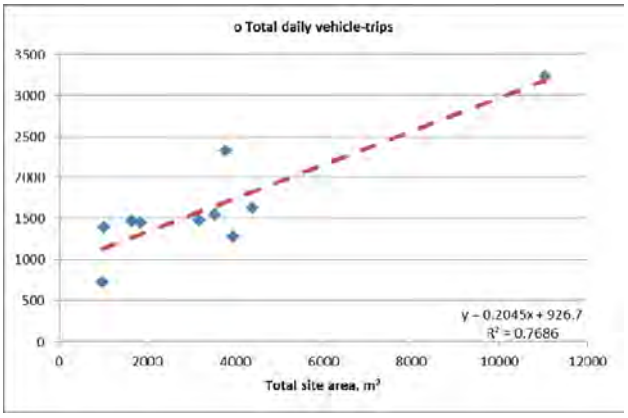

Figure 3-10 Total daily vehicle trips vs total site area – Linear type

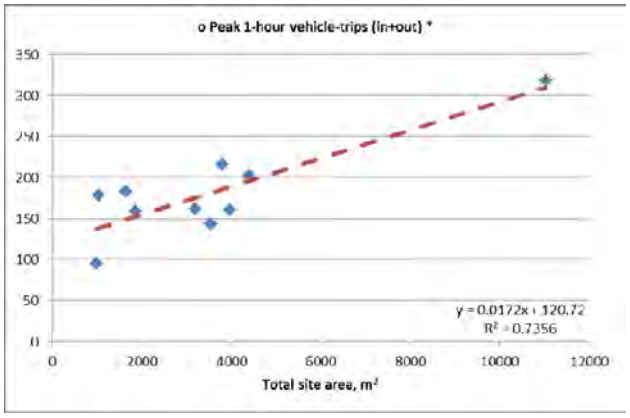

Figure 3-11 Peak hour vehicle trips vs total site area – Linear type

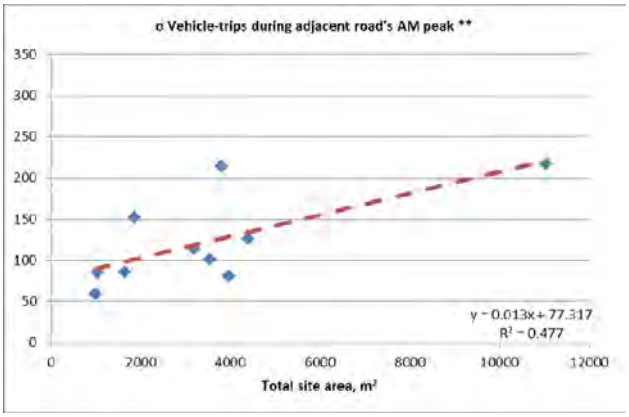

Figure 3-12 Vehicle trips vs total site area – Linear type - during AM Peak Hour on adjacent road

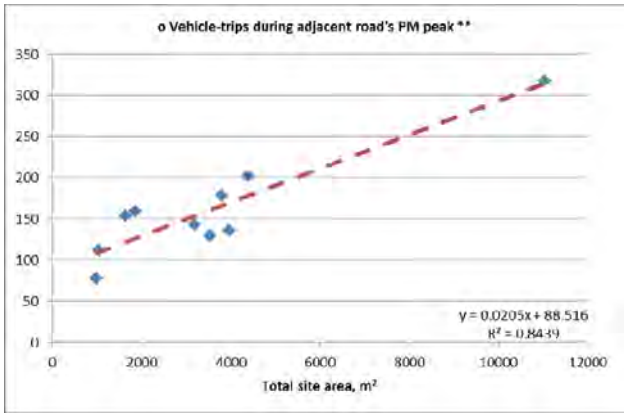

Figure 3-13 Vehicle trips vs total site area – Linear type - during PM Peak Hour on adjacent road

3.3.1.4 Number of pumps

- R^2 for all trip characteristics for all service stations is low and indicates little correlation between the number of trips and the number of pumps.
  - note that for the purpose of this survey the number of pumps was defined as the number of vehicles able to be served at once.

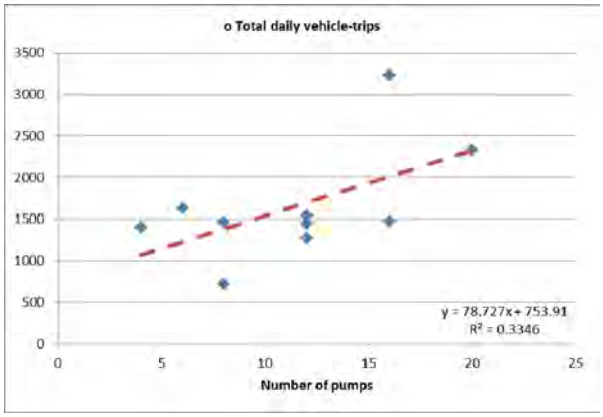

Figure 3-14 Total daily vehicle trips vs number of pumps – Linear type

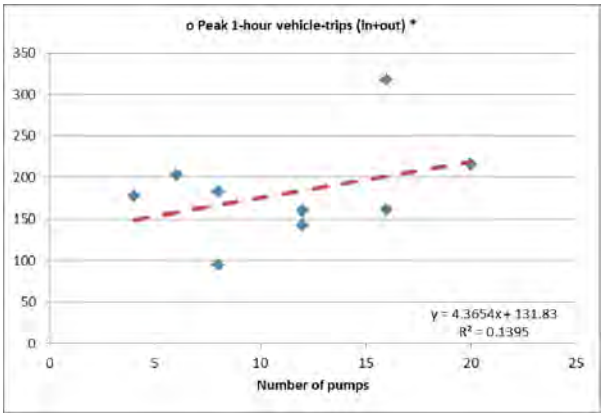

Figure 3-15 Peak hour vehicle trips vs number of pumps – Linear type

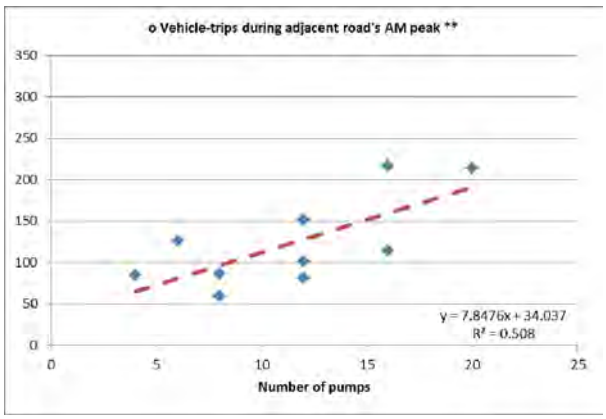

Figure 3-16 Vehicle trips vs number of pumps – Linear type - during AM Peak Hour on adjacent road

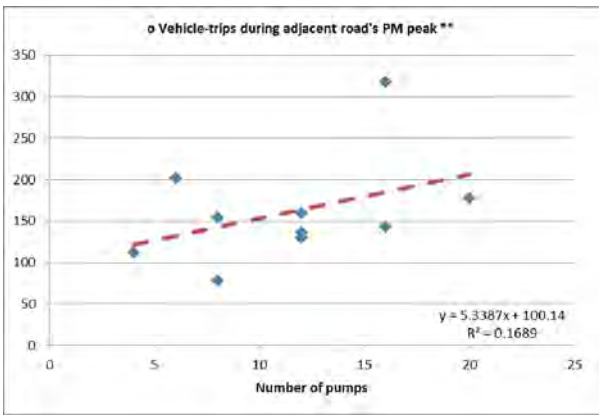

Figure 3-17 Vehicle trips vs number of pumps – Linear type - during PM Peak Hour on adjacent road

3.3.1.5 Number of service channels

3.3.1.5.1 Linear regression analysis

- R^2 for peak hour trips (0.61) and the number of trips during the PM peak hour on adjacent road (0.60) for all service stations is low and although it indicates some correlation between the number of trips and the number of service channels, it is not high enough to be utilised for trip prediction for new developments.
- However, R^2 for the total daily trips (0.80) and for the number of trips during the AM peak hour on adjacent road (0.80) indicates good correlation between the number of trips and the number of service channels.

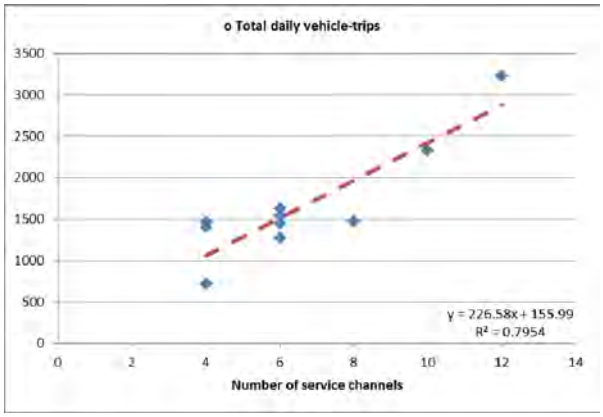

Figure 3-18 Total daily vehicle trips vs number of service channels – Linear type

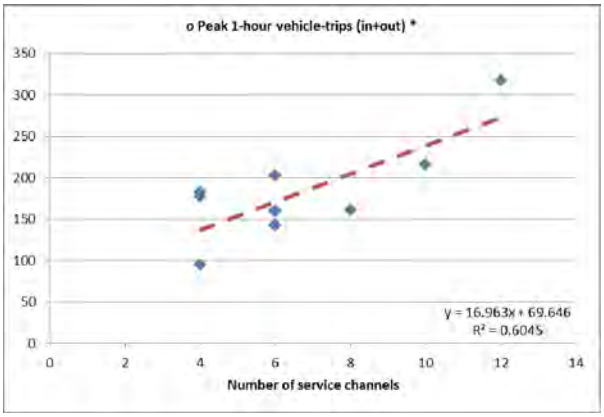

Figure 3-19 Peak hour vehicle trips vs number of service channels – Linear type

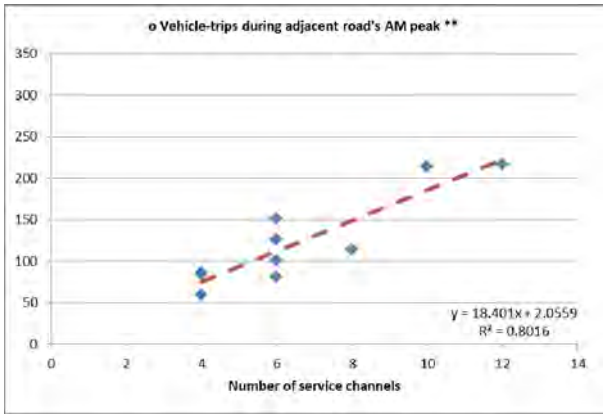

Figure 3-20 Vehicle trips vs number of service channels – Linear type - during AM Peak Hour on adjacent road

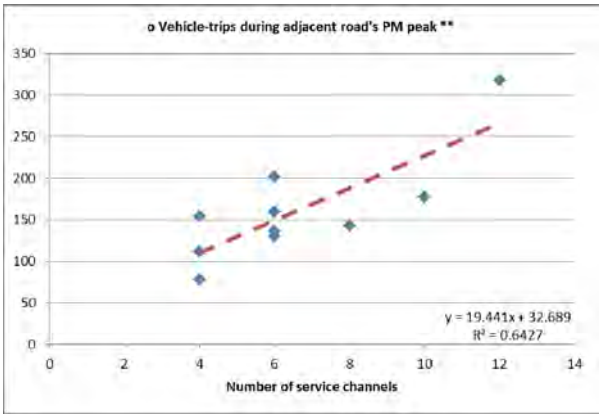

Figure 3-21 Vehicle trips vs number of service channels – Linear type - during PM Peak Hour on adjacent road

- Based on the observation of the above scatter diagrams it was considered worthwhile analysing whether application of a non-linear relationship would improve the correlation between the number of service channels and the trip characteristics. The results of this analysis are presented in the next subsection.

3.3.1.5.2 Non-linear regression analysis

- R^2 for peak hour trips (0.74) and the number of trips during the PM peak hour on adjacent road (0.71) have improved, however in both cases they remained at a level which is not high enough to be utilised for trip prediction for new developments.
- R^2 for the total daily trips (0.87) improved significantly, whilst R^2 for the number of trips during the AM peak hour on adjacent road (0.80) remained the same as that for the linear relationship. Both continued to indicate good correlation between the number of trips and the number of service channels.

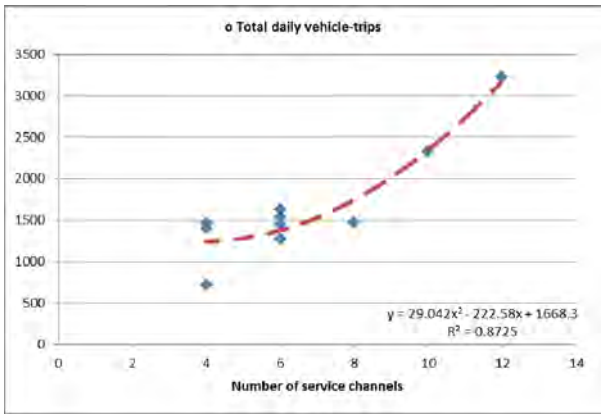

Figure 3-22 Total daily vehicle trips vs number of service channels – Non-linear type

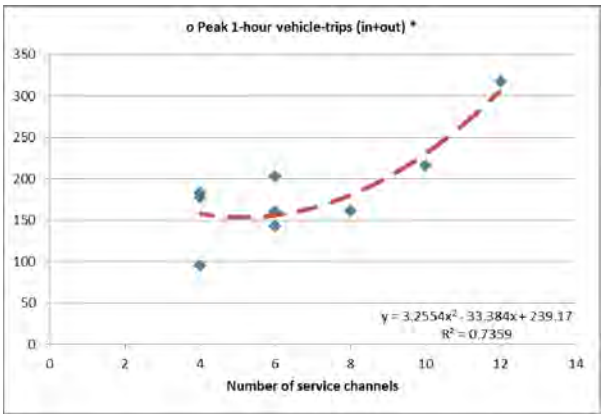

Figure 3-23 Peak hour vehicle trips vs number of service channels – Non-linear type

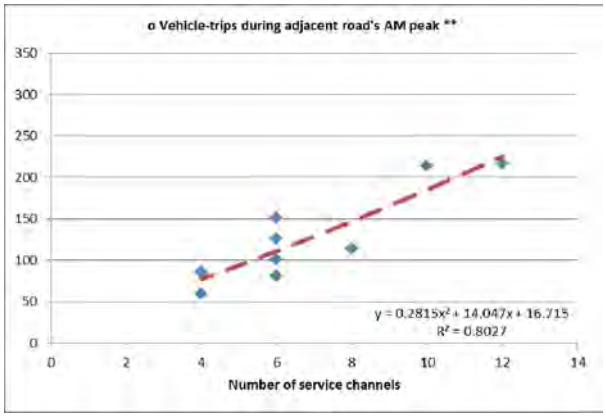

Figure 3-24 Vehicle trips vs number of service channels – Non-linear type - during AM Peak Hour on adjacent road

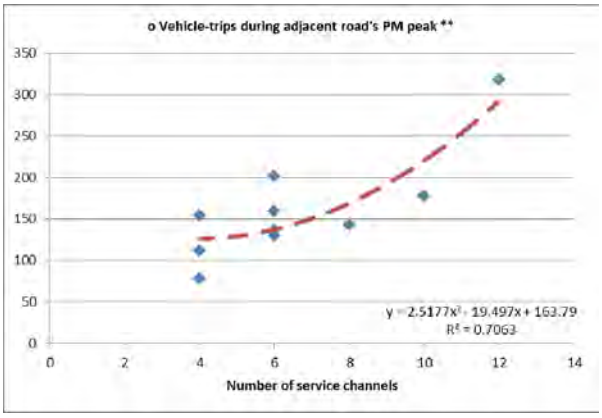

Figure 3-25 Vehicle trips vs number of service channels – Non-linear type - during PM Peak Hour on adjacent road

3.3.1.6 Number of seats in the fast food area

- R^2 for all trip characteristics for all service stations is low and indicates little correlation between the number of trips and the number of seats in the fast food area.
  - note that only three of the surveyed stations had fast food facilities on site; the sample was thus very small and further research is required for better understanding of possible dependency between the two variables.

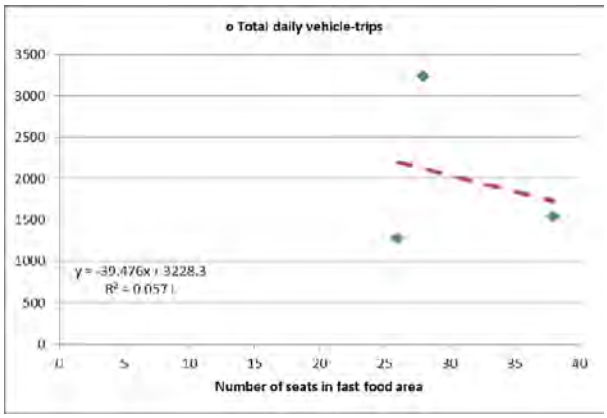

Figure 3-26 Total daily vehicle trips vs number of fast food seats – Linear type

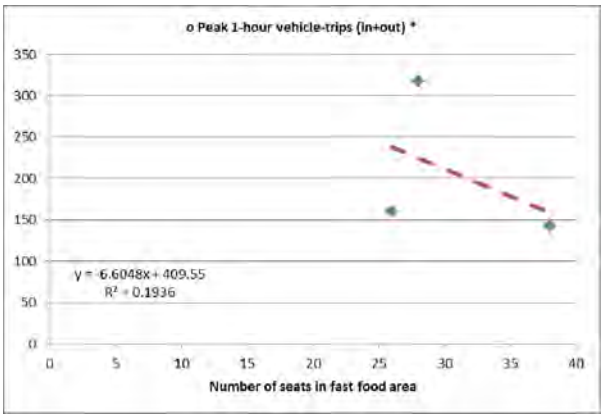

Figure 3-27 Peak hour vehicle trips vs number of fast food seats – Linear type

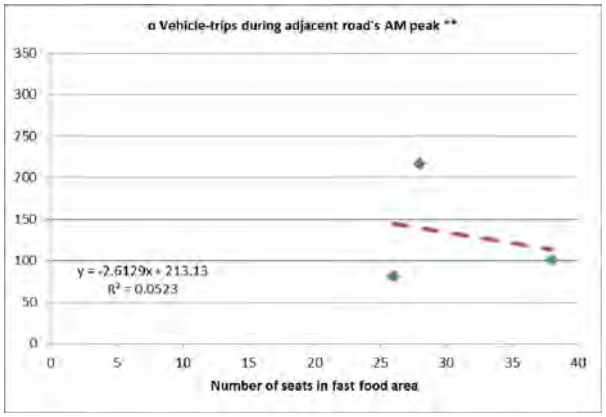

Figure 3-28 Vehicle trips vs number of fast food seats – Linear type - during AM Peak Hour on adjacent road

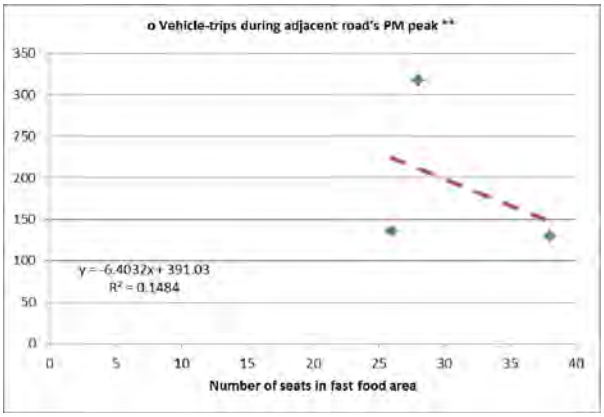

Figure 3-29 Vehicle trips vs number of fast food seats – Linear type - during PM Peak Hour on adjacent road

3.3.1.7 Petrol price

- R^2 for all trip characteristics for all service stations is very low and indicates no correlation between the number of trips and the average or maximum petrol price on the survey day.
  - Charts below show the results of the analysis for the average petrol price. Analysis of the correlation with the maximum prices showed very similar results.

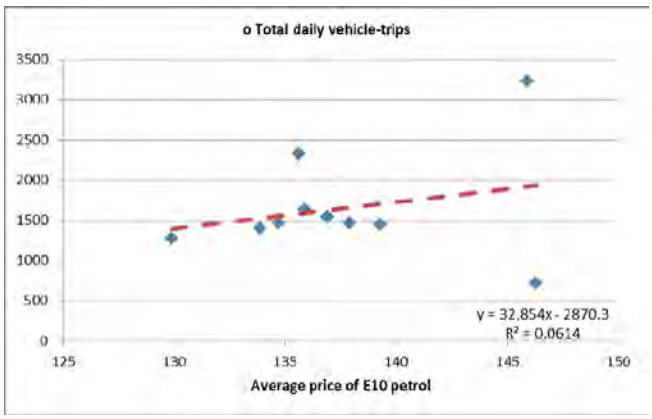

Figure 3-30 Total daily vehicle trips vs average price of E10 petrol – Linear type

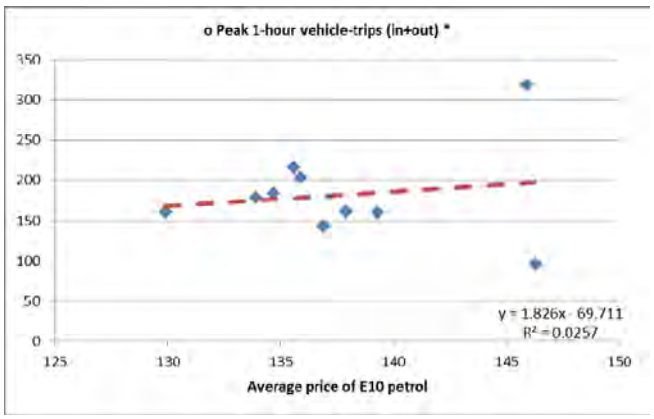

Figure 3-31 Peak hour vehicle trips vs average price of E10 petrol – Linear type

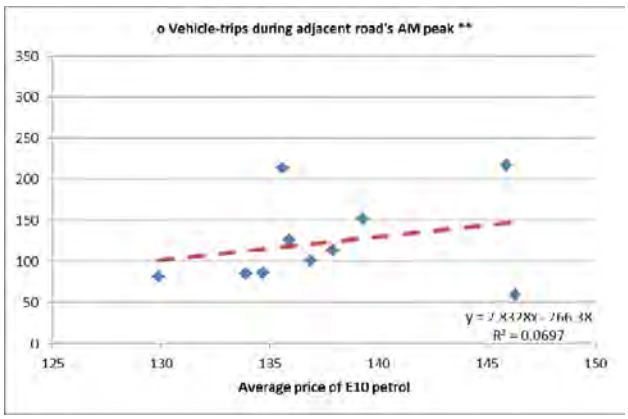

Figure 3-32 Vehicle trips vs average price of E10 petrol – Linear type - during AM Peak Hour on adjacent road

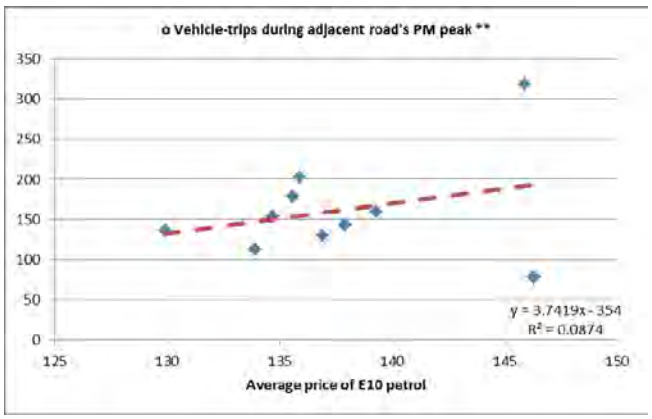

Figure 3-33 Vehicle trips vs average price of E10 petrol – Linear type - during PM Peak Hour on adjacent road

- Analysis for daily variations of petrol prices at Site 1 for a 7- day period revealed similar results to those described above. R^2 for all trip characteristics for all survey days is very low and indicates no correlation between the number of trips and the average or maximum petrol price.
  - Refer to Figures **3-34** and **3-35** overleaf.

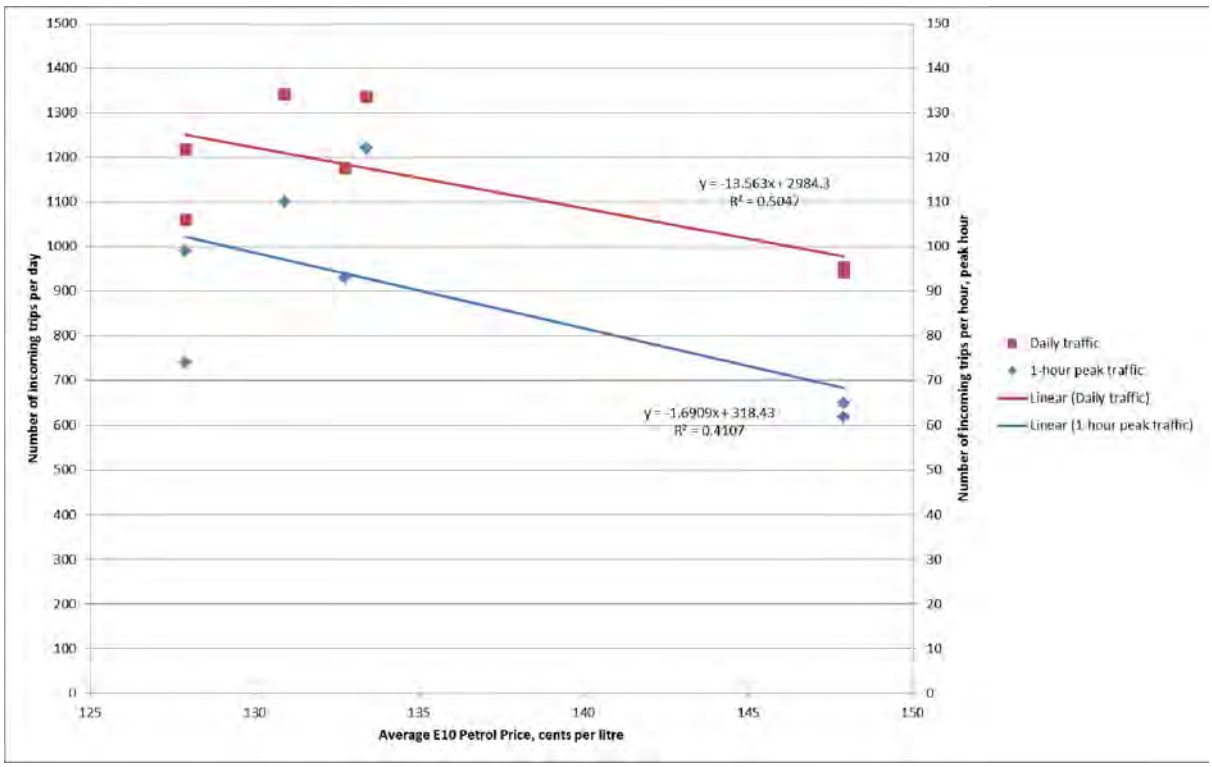

Figure 3-34 Total daily and peak hour vehicle trips vs average price of E10 petrol – 7 days at Site 1 - Linear type

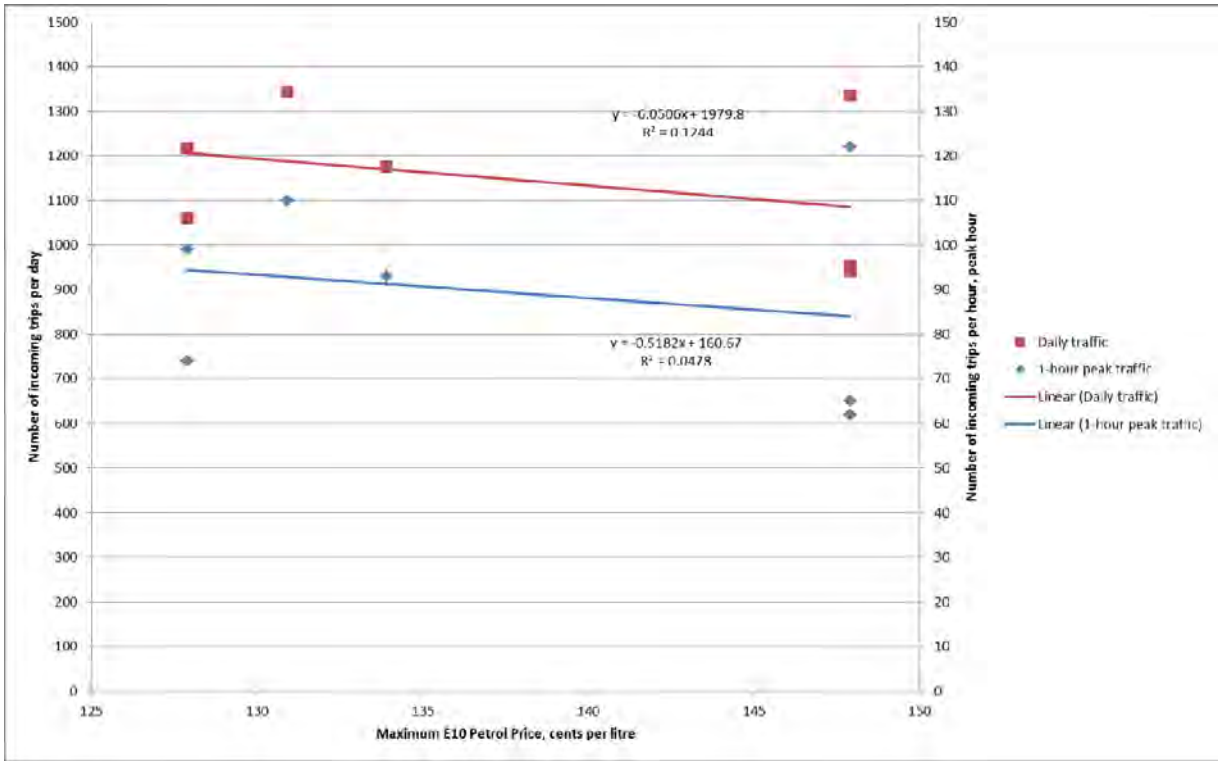

Figure 3-35 Total daily and peak hour vehicle trips vs maximum price of E10 petrol – 7 days at Site 1 - Linear type

3.3.1.8 Multiple regression analysis

- Further analysis has been undertaken to determine whether multiple regression based on two or more independent variables yields a more reliable estimate of peak and/or daily trip behaviour.
- Of all independent variables under examination only two were considered suitable for multiple regression analysis – the total site area and the number of service channels.
- A check for inter-correlation between the above two independent variables has been carried out in the form of linear regression analysis and revealed correlation level under 0.80 ($R^2 = 0.71$).

Table 3.3 Total daily vehicle trips vs (total site area & number of service channels).

Regression Statistics	
Multiple R	0.921
R Square	0.849
Adjusted R Square	0.806
Standard Error	299.293
Observations	10

ANOVA

	df	*SS*	*MS*	*F*
Regression	2	3529764.659	1764882.330	19.703
Residual	7	627033.741	89576.249	
Total	9	4156798.400		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	409.427	308.666	1.326	0.226
Total site area (m2)	0.101	0.064	1.580	0.158
No. of service channels	134.133	69.383	1.933	0.094

- Adjusted R^2 of 0.81 is greater than the 0.80 benchmark. It is also better than that for the independent relationship for the total site area (0.77).
- It is, however, less than R^2 of 0.87 for the independent relationship for the number of service channels. The latter non-linear regression equation thus provides a more reliable estimate.

Table 3.4 Peak hour vehicle trips vs (total site area & number of service channels).

Regression Statistics	
Multiple R	0.864
R Square	0.746
Adjusted R Square	0.673
Standard Error	33.364
Observations	10

ANOVA

	df	*SS*	*MS*	*F*
Regression	2	22860.243	11430.121	10.268
Residual	7	7792.157	1113.165	
Total	9	30652.400		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	104.912	34.409	3.049	0.019
Total site area (m2)	0.014	0.007	1.972	0.089
No. of service channels	4.099	7.735	0.530	0.613

- Adjusted R^2 of 0.67 is less than 0.80 benchmark. It is also less than R^2,for the independent relationships for both the total site area (0.74) and the number of service channels (0.74).
- All of the relationships are below the 0.80 benchmark and thus cannot be used for reliable estimates.

Table 3.5 AM Peak Hour vehicle trips vs (total site area & number of service channels).

Regression Statistics	
Multiple R	0.903
R Square	0.816
Adjusted R Square	0.763
Standard Error	26.748
Observations	10

ANOVA

	df	*SS*	*MS*	*F*
Regression	2	22194.280	11097.140	15.510
Residual	7	5008.220	715.460	
Total	9	27202.500		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-8.522	27.586	-0.309	0.766
Total site area (m2)	-0.004	0.006	-0.738	0.485
No. of service channels	22.259	6.201	3.590	0.009

- Adjusted R^2 of 0.76 is less than 0.80 benchmark. It is, however, substantially better than that for the independent relationship for the total site area (0.48).
- Nevertheless, R^2 of 0.80 for the independent relationship for the number of service channels provides a more reliable estimate.

Table 3.6 Multiple regression analysis – PM Peak Hour vvehicle trips vs (total site area & number of service channels).

Regression Statistics	
Multiple R	0.920
R Square	0.846
Adjusted R Square	0.803
Standard Error	28.820
Observations	10

ANOVA

	df	*SS*	*MS*	*F*
Regression	2	32057.679	16028.840	19.298
Residual	7	5814.321	830.617	
Total	9	37872.000		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	79.770	29.723	2.684	0.031
Total site area (m2)	0.019	0.006	3.048	0.019
No. of service channels	2.268	6.681	0.339	0.744

- Adjusted R^2 of 0.80 is at the 0.80 benchmark. It is also substantially better than that for the independent relationship for the number of service channels (0.71).
- Nevertheless, R^2 of 0.84 for the independent relationship for the total site area provides a more reliable estimate.

3.3.1.9 Relationship among trip-making statistics

- A separate analysis was carried out to determine relationships between peak hour vehicle trips and the total daily trips (the latter as an independent variable).
- In all cases R^2 was equal to or greater than 0.80, indicating that peak hour traffic generation could be reliably predicted based on the total daily trip data.

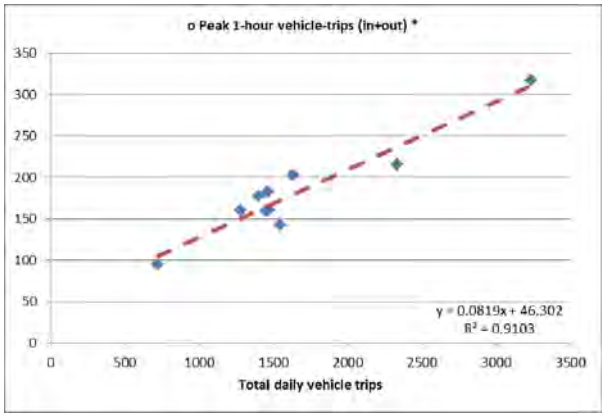

Figure 3-36 Peak hour vehicle trips vs total daily trips

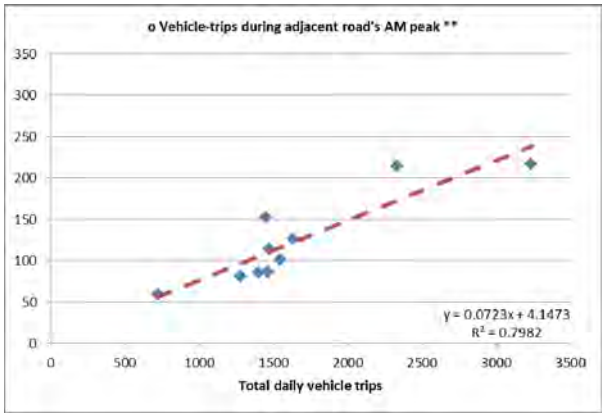

Figure 3-37 AM Peak Hour vehicle trips vs total daily trips

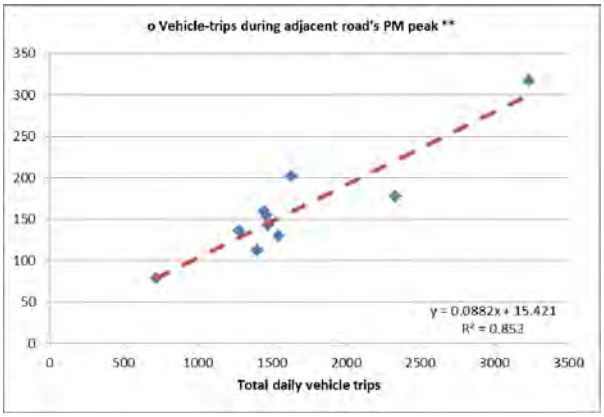

Figure 3-38 PM Peak Hour vehicle trips vs total daily trips

3.3.1.10 Comparison of findings with the 1979 data

- The total site area was the most reliable independent variable determined in the 1979 Study. Of the dependent variables, the number of peak hour vehicle movements is the only one which was studied both in the previous and the present Studies.
- A graph below illustrates the difference in the relationships between the peak hour trips and the site area from the two studies. It may be seen from the graph that the 1979 data indicates a steeper increase of the peak hour trips with the increase of the site area. However, overall the 2013 peak hour trip generation rates were found to be much greater than those in 1979 for the comparable range of the independent variable (1,110 – 4,570 m^2).

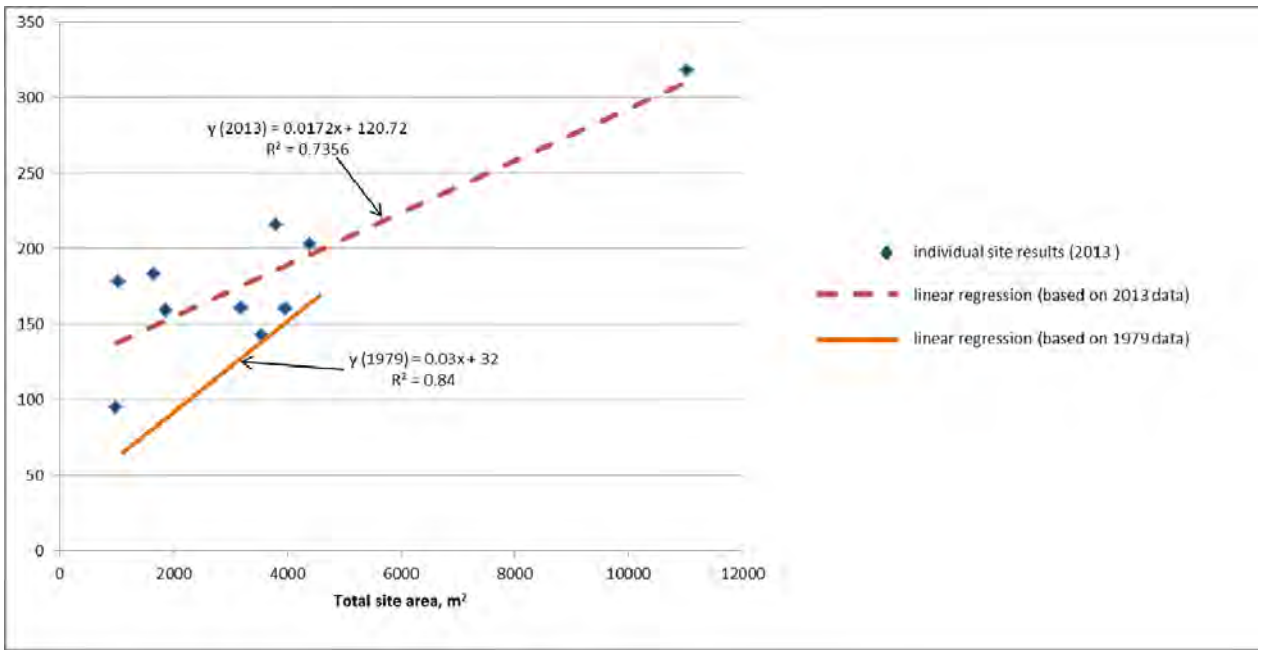

Figure 3-39 Peak hour vehicle trips versus total site area – comparison of 1979 and 2013 data

- It is noted that in the 1979 Study no reliable dependency was found between the trip generation statistics and the number of service channels, whereas the present Study has found this independent variable to provide reliable estimates.

3.4 Special survey

A special 7-day survey was carried out at Site 1. In addition to the same survey format as for the one-day surveys at all other sites, classification vehicle movement counts were carried out for 24-hour periods for each day of the survey.

The aim of the special survey was to establish daily and hourly visitation patterns.

Graphs in **Figure 3-40** and **3-41** and **Table 3.7** show the daily and hourly incoming trips for the whole survey period.

The following observations have been made.

- The trip generation on Saturday and on Sunday between 9 am and 4 pm was generally greater than that on the weekdays.
- Of the weekdays, Monday and Friday were the busiest days, whilst daily trip generation values on Tuesdays, Wednesdays and Thursdays were generally lower than those on Monday and Friday by 10% to 23% for the day totals.
- Generally, peak trip generation occurred in the late morning and early afternoon on all days except Monday when the peak was closer to the evening.
- One-hour peak trip generation levels on Tuesday and Wednesday were the closest to both the weekday average and the 7-day average.

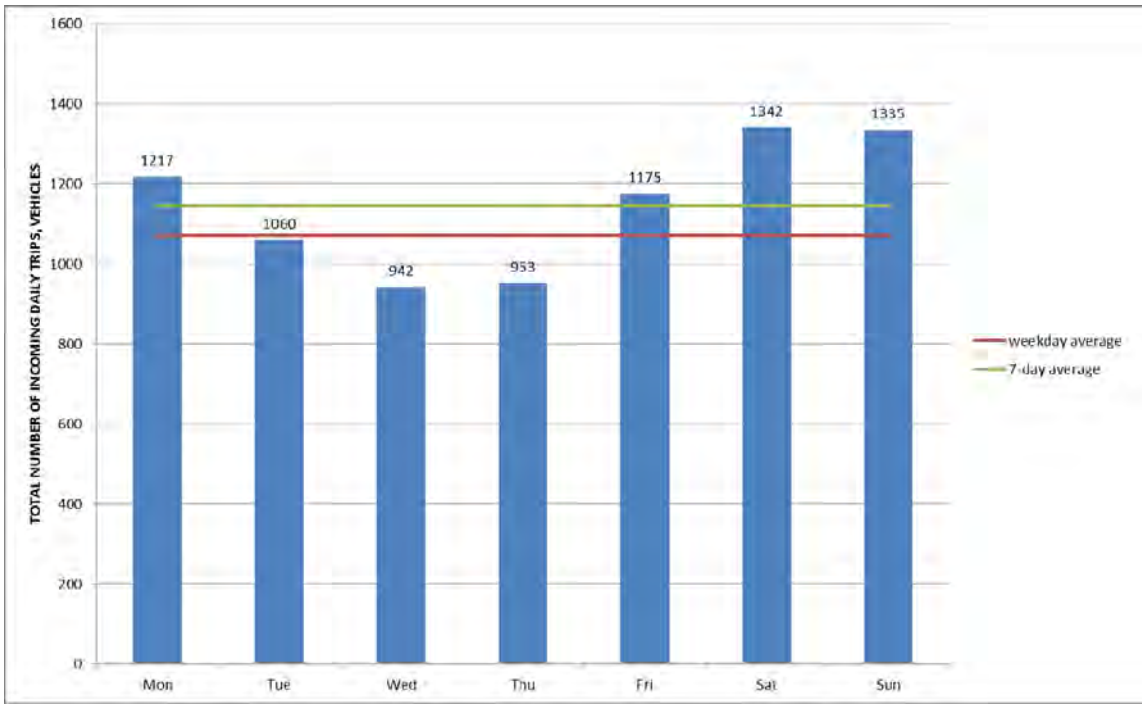

Figure 3-40 Daily trip data for Site 1 over a 7-day period.

Table 3.7 Hourly trip data for Site 1 over a 7-day period.

17/05/13-23/05/13 1-hour Data	Coles Express, South Dowling St, Waterloo																		
WEATHER Fine	All vehicles																		
	IN									OUT									
								Average									Average		
TIME	Mon	Tue	Wed	Thu	Fri	Sat	Sun	5 days	7 days	Mon	Tue	Wed	Thu	Fri	Sat	Sun	5 days	7 days	
0:00 to 1:00	28	19	21	15	20	32	49	21	26	27	22	26	18	24	45	47	23	30	
1:00 to 2:00	14	21	19	16	14	24	26	17	19	14	26	20	16	21	29	29	19	22	
2:00 to 3:00	10	11	15	9	20	17	28	13	16	13	10	17	18	18	20	35	15	19	
3:00 to 4:00	13	8	15	10	13	9	24	12	13	13	10	16	15	20	10	33	15	17	
4:00 to 5:00	12	11	13	16	20	15	22	14	16	13	9	14	13	15	18	20	13	15	
5:00 to 6:00	36	31	30	31	26	20	25	31	28	30	28	23	30	30	20	21	28	26	
6:00 to 7:00	65	59	58	60	59	53	37	60	56	63	59	60	60	59	45	34	60	54	
7:00 to 8:00	50	58	46	50	57	49	31	52	49	53	59	54	51	52	53	33	54	51	
8:00 to 9:00	50	64	60	54	57	55	48	57	55	45	60	59	54	74	56	48	58	57	
9:00 to 10:00	62	69	60	62	63	73	71	63	66	63	68	61	59	60	72	68	62	64	
10:00 to 11:00	66	73	65	62	57	77	73	65	68	63	66	66	70	52	76	72	63	66	
11:00 to 12:00	86	72	48	61	78	84	80	69	73	92	81	50	56	75	80	78	71	73	
12:00 to 13:00	79	74	48	60	93	100	86	71	77	81	70	59	64	85	95	76	72	76	
13:00 to 14:00	82	48	37	44	84	104	122	59	74	74	64	36	43	86	111	116	61	76	
14:00 to 15:00	74	45	40	45	74	89	102	56	67	78	45	40	52	68	84	117	57	69	
15:00 to 16:00	81	50	50	49	81	110	108	62	76	88	48	49	45	72	95	112	60	73	
16:00 to 17:00	88	64	53	42	76	82	69	65	68	86	68	39	47	86	92	77	65	71	
17:00 to 18:00	99	57	41	40	77	84	67	63	66	101	56	46	42	72	83	68	63	67	
18:00 to 19:00	88	43	39	43	51	68	91	53	60	88	50	36	45	52	72	92	54	62	
19:00 to 20:00	26	42	40	47	11	41	51	33	37	29	47	52	52	14	52	52	39	43	
20:00 to 21:00	26	37	43	40	29	36	36	35	35	44	44	47	41	41	41	45	43	43	
21:00 to 22:00	30	41	42	37	43	36	30	39	37	39	38	45	42	57	47	43	44	44	
22:00 to 23:00	29	34	30	31	36	35	36	32	33	39	40	31	46	42	53	47	40	43	
23:00 to 0:00	23	29	29	29	36	49	23	29	31	24	24	42	47	37	51	27	35	36	
Total	1217	1060	942	953	1175	1342	1335	1071	1146	1260	1092	988	1026	1212	1400	1390	1114	1197	

1-hour peak as % of							
weekday average	139%	104%	92%	87%	131%	155%	172%
7-day average	129%	96%	84%	81%	121%	143%	158%

Average 1-hour Data IN + OUT	
5 days	7 days
44	56
36	41
28	35
27	30
27	31
59	54
120	110
106	100
115	112
125	130
128	134
140	146
143	153
120	150
113	136
122	149
130	139
126	133
107	122
72	80
78	78
83	81
72	76
64	67
2185	2343

Legend: 99 - peak hour of station trip generation

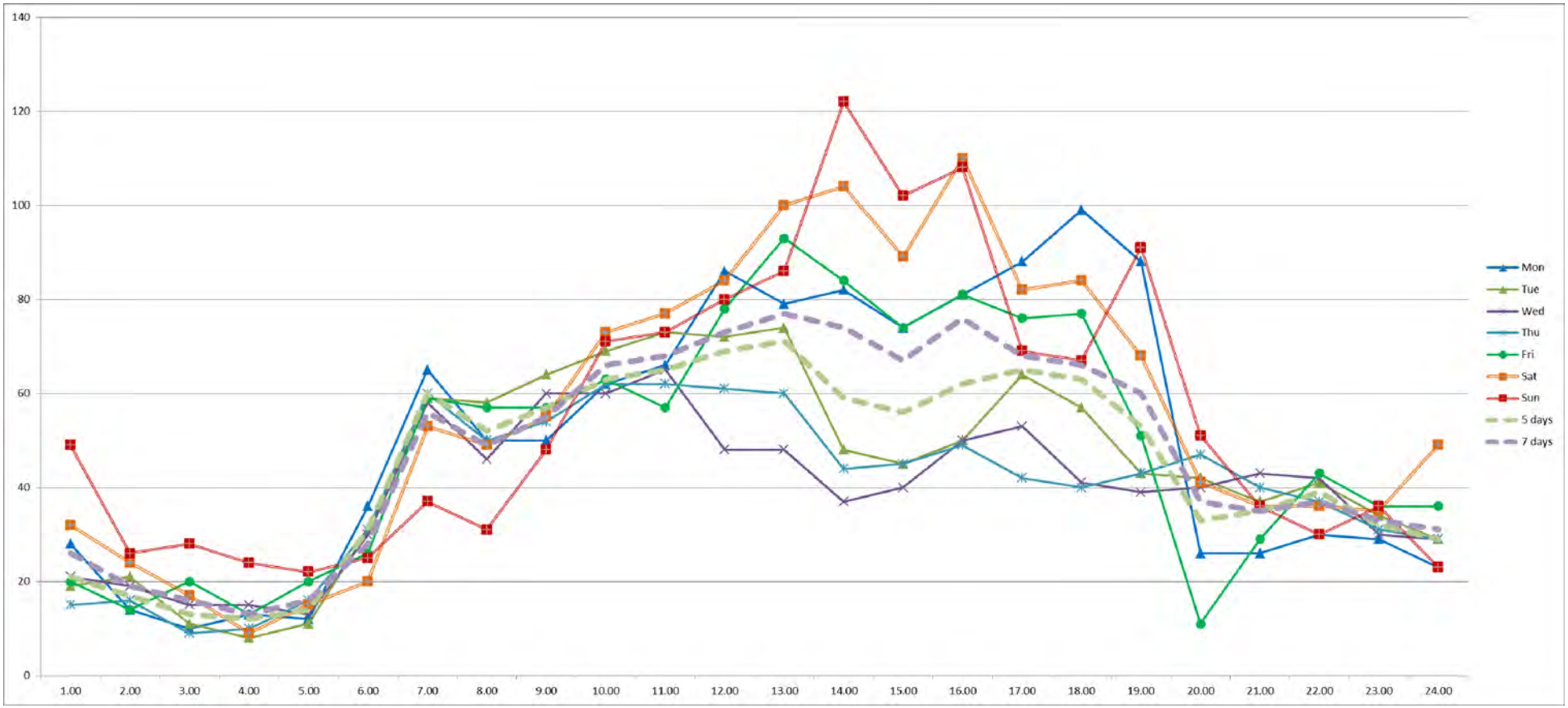

Figure 3-41 Hourly trip data for Site 1 over a 7-day period.

4 SUMMARY

The former Roads and Traffic Authority (RTA, now Roads and Maritime Services) published its Guide to Traffic Generating Developments ("Guide") in the mid-1990s. The trip generation and parking requirement data in the Guide is becoming increasingly out-of-date. The Guide contains trip generation and parking demand information derived from a 1979 survey of ten Service Stations across greater Sydney. Half of the sites were self-service, and half offered the then-traditional driveway service. A number of changes have occurred since then in terms of service stations' mode of operation, services offered and size. Given these changes, there is now a need to validate (or otherwise) the 1979 trip generation and parking demand data for Service Stations, to assist with traffic impact assessment and planning.

Nine (9) sites within the Sydney Metropolitan Area (SMA) and one (1) site outside SMA on a major highway were selected in consultation with RMS Project Manager.

There were no technical issues with the conduct of the surveys, except obtaining permissions from the service station operators and collecting information about the year when the station was opened.

Surveys of trips generation were carried out in March-May 2013, outside school holidays. Classification counts of vehicles entering and leaving the sites were undertaken at each site generally between 6 am and 7 pm on Monday, Tuesday, Wednesday or Thursday. Site 1 was chosen for a special survey where the entering and leaving traffic was counted for each 24 hours over a full 7-day period, to establish daily and hourly visitation patterns.

4.1 Average rates

A review of the data revealed a number of observations

- The surveys were undertaken at service stations with the floor space varying from 182.5 m^2 to 481 m^2 and with the total site area varying from 988 m^2 to 11,030 m^2.
- Slightly higher station trip rates were observed during the PM peak on the adjacent road than during AM peak.

The results of the analyses for both peak hour and daily trips rates indicated high values of standard deviation in all cases for vehicle trips. The base data was therefore regarded as wide-spread. The average rates are thus not recommended to be used for predicting the trip generation because of wide prediction intervals around the mean estimated values.

4.2 Regression analysis

The trip generation rates were then analysed in terms of their dependency on a number of variables, using linear and non-linear regression analysis. The interrogated variables are listed below.

- total building GFA
- convenience store GFA
- total site area
- number of pumps
- number of service channels
- number of seats in the fast food area (where applicable)
- petrol price

The regression analysis showed that the number of trips generated by the service stations showed good level of correlation with some variables, as summarised in **Table 4.1**.

Table 4.1 Trip generation relationships

	Variable	
	X_1 = Total site area, m^2	**X_2 = Number of service channels**
Variable range	988 m^2 to 11,030 m^2	4 to 12
Y = Total daily vehicle trips		$Y = 29.042X_2^2 + 222.58X_2 + 1668.3$ **R^2=0.87**
Y = Peak 1-hour vehicle trips (in+out)	No reliable relationship has been found	
Y = Vehicle trips (in+out) during AM peak hour on adjacent road		$Y = 0.2815X_2^2 + 14.047X_2 + 16.715$ **R^2=0.80**
Y = Vehicle trips (in+out) during PM peak hour on adjacent road	$Y = 0.0205\ X_1 + 88.52$ **R^2=0.84**	

Although no reliable relationships has been found between the site parameters and the peak 1-hour vehicle trips, the latter have been found to be closely related to the total daily vehicle trips (R^2=0.91). The following equation may be used to estimate the peak 1-hour trips from the total daily trips.

Y = 0.0819 X + 46.302, where

Y = Peak 1-hour vehicle trips (in+out)

X = Total daily vehicle trips

In summary, the analysis of data highlighted the following facts:

- Average trip rates should not be utilised for planning purposes.
- Good linear and non-linear relationships were established between the number of total daily and AM and PM peak trips and two independent variables: the total site area and the number of service channels.
- Peak 1-hour vehicle trips can be reliably estimated from the total daily trips.

4.3 Special survey

A special 7-day / 24-hour survey designed to establish daily and hourly visitation patterns revealed the following.

- The trip generation on Saturday and on Sunday between 9 am and 4 pm was generally greater than that on the weekdays.
- Of the weekdays, Monday and Friday were the busiest days, whilst daily trip generation values on Tuesdays, Wednesdays and Thursdays were generally lower than those on Monday and Friday by 10% to 23% for the day totals.
- Generally, peak trip generation occurred in the late morning and early afternoon on all days except Monday when the peak was closer to the evening.

- One-hour peak trip generation levels on Tuesday and Wednesday were the closest to both the weekday average and the 7-day average.

4.4 Comparison with 1979 data

- Of the dependent variables, the number of peak hour vehicle movements is the only one which was studied both in the previous and the present Studies.
- The 1979 data indicates a steeper increase of the peak hour trips with the increase of the site area. However, overall the 2013 peak hour trip generation rates were found to be much greater than those in 1979 for the comparable range of the independent variable (1,110 – 4,570 m^2).
- It is noted that in the 1979 Study no reliable dependency was found between the trip generation statistics and the number of service channels, whereas the present Study has found this independent variable to provide reliable estimates.
- The trip generation relationships based on the 1979 data are considered to be out-dated and are not recommended for further use.

Appendix

A summary of collected site data

Table A.1 Details of the selected survey sites and traffic survey results summary

Site ID	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Site operator	Shell - Coles Express	BP	Caltex	APW	7-Eleven	BP	Caltex - Woolworths	Caltex - Woolworths	7-Eleven	BP
Site address	867 South Dowling St, Waterloo	9 Davies Road, Padstow	1403 Princes Highway, Heathcote	449 Great Western Hwy, Greystanes	15-19 Aspen St, South Penrith	162 Sunnyholt Rd, Kings Park	59 Orange Grove Rd, Liverpool	1 Woodland St, Riverstone	Hume Hwy, Bargo	146-152 Moorefields Rd, Kingsgrove
Day/date of survey(s)	Fri 17/05/13 to Thu 23/05/13	Tue, 21/05/13	Tue, 26/03/13	Wed, 27/03/13	Thu, 28/03/13	Thu, 28/03/13	Wed, 27/03/13	Tue, 26/03/13	Wed, 27/03/13	Mon, 27/05/13
Duration of survey - site and frontage road	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00	6:00-19:00
Duration of survey - site trip generation	24 hrs 7 days									
Surrounding area characteristics:										
Surrounding landuse	commercial / retail / residential	industrial / residential / open space	residential / park	industrial / residential / commercial	commercial / residential	industrial / residential / commercial	commercial / retail / residential	commercial / retail / residential	open space	residenial
Frontage road - AM peak period (weekday)	07:00-08:00	07:15-08:15	06:15-07:15	11:00-12:00	07:45-08:45	11:45-12:45	07:15-08:15	07:45-08:45	07:30-08:30	08:00-09:00
Frontage road - PM peak period (weekday)	17:15-18:15	15:45-16:45	16:30-17:30	17:15-18:15	15:00-16:00	17:15-18:15	17:00-18:00	17:00-18:00	17:00-18:00	17:00-18:00
Frontage road - daily peak period (Saturday & Sunday) [NB: for 7-day surveys only]										
Development details:										
Year opened	1995	pre-2005	2006	pre-2002	pre-2005	pre-2005	pre-2002	pre-2002	pre-2003	pre-2005
Other services / businesses on site	fast food & car wash	fast food & car wash	none	car wash	none	car wash & car service	none	none	fast food	none
Total site area (m^2)	3540	3957	1860	1652	4392	1031	3798	3187	11030	988
Gross Floor Area (m^2):										
o Convenience store	140	261	193.5	144.5	265	90	443	197	200	245
o Fast food area	150	220							138	
o Car wash & car service				38		173			53	
TOTAL GFA (m^2)	290	481	193.5	182.5	265	263	443	197	391	245
No. of pumps	12	12	12	8	6	4	20	16	16	8
No. of service channels	6	6	6	4	6	4	10	8	12	4
No. of seats in fast food area	38	26	N/A	N/A	N/A	N/A	N/A	N/A	28	N/A
Vehicle Trips:										
o Peak 1-hour vehicle-trips (in+out) *	143	160	159	183	203	178	216	161	318	95
o Time of peak 1-hour vehicle-trips	17:00-18:00	16:45-17:45	16:30-17:30	17:45-18:45	15:15-16:15	13:30-14:30	07:30-08:30	16:15-17:15	17:00-18:00	17:15-18:15
o Peak vehicle-trips per pump	11.9	13.3	13.3	22.9	33.8	44.5	10.8	10.1	19.9	11.9
o Peak vehicle-trips per service channel	23.8	26.7	26.5	45.8	33.8	44.5	21.6	20.1	26.5	23.8
o Peak vehicle-trips per 100m^2 of total GFA	49.3	33.3	82.2	100.3	76.6	67.7	48.8	81.7	81.3	38.8
o Peak vehicle-trips per 100m^2 of convenience store GFA	102.1	61.3	82.2	126.6	76.6	197.8	48.8	81.7	159.0	38.8
o Peak vehicle-trips per 100m^2 of fast food GFA	95.3	72.7	N/A	N/A	N/A	N/A	N/A	N/A	230.4	N/A
o Total daily vehicle-trips	1543	1276	1449	1463	1629	1399	2329	1472	3234	720
o Total daily vehicle-trips per pump	128.6	106.3	120.8	182.9	271.5	349.8	116.5	92.0	202.1	90.0
o Total daily vehicle-trips per service channel	257.2	212.7	241.5	365.8	271.5	349.8	232.9	184.0	269.5	180.0
o Total daily vehicle-trips per 100m^2 of total GFA	532.1	265.3	748.8	801.6	614.7	531.9	525.7	747.2	827.1	293.9
o Total daily vehicle-trips per 100m^2 of convenience store GF	1102.1	488.9	748.8	1012.5	614.7	1554.4	525.7	747.2	1617.0	293.9
o Total daily vehicle-trips per 100m^2 of fast food GFA	1028.7	580.0	N/A	N/A	N/A	N/A	N/A	N/A	2343.5	N/A
o Vehicle-trips during adjacent road's AM peak **	101	81	152	86	126	85	214	114	217	59
o Vehicle-trips during adjacent road's PM peak **	130	136	159	154	202	112	178	143	318	78
Parking:										
o No of reserved car spaces	0	0	0	2	0	0	0	0	0	0
o No of public car spaces	31	16	14	7	12	3	22	20	18	8
o No of staff car spaces	1	2	0	0	0	0	0	0	0	0
o No of Disabled car spaces	1	0	1	0	0	0	1	0	0	0
o No of Loading / unloading bays	1	2	0	1	0	1	1	0	1	1
TOTAL parking spaces	34	20	15	10	12	4	24	20	19	9
o Peak Parking Accumulation	12	12	8	4	7	11	7	5	52	4
o Time of Peak Parking Accumulation	12:00-12:15	12:00-12:15	08:15	18:45-19:00	06:45, 16:15 & 16:45	12:45	14:45; 18:45	17:30	17:00	18:30
o Parking Accumulation per 100m^2 total GFA	4.1	2.5	4.1	2.2	2.6	4.2	1.6	2.5	13.3	1.6