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Roads of national significance

1 Wellington Northern Corridor

Transporation Improvements Around the Basin Reserve

Transportation Technical Note

January 2010

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Contents

1 Introduction

1 Introduction

The Basin Reserve gyratory must handle many competing and often conflicting transportation demands including through traffic on SH1, local vehicular traffic, passenger transport, pedestrians, and cyclists.

This Transportation Technical Note aims to provide the reader with an understanding of the current operation and demands at the Basin Reserve by providing an overall view of the Basin Reserve's role in the wider Wellington transportation network. The technical paper then provides a more detailed examination of the Basin Reserve gyratory. Its performance is considered from the perspective of all transport users including pedestrians, cyclists, bus users as well as motorists. However, this work is still indicative in nature and is designed to provide a snapshot of our current understanding of the network performance in the study area. As the project progresses and the options become more refined, the associated analysis of their performance will also become more detailed and certain.

This technical note supplements the Scoping Report prepared for the Basin Reserve Transportation Improvement project. It provides more technical detail about the transport network in Wellington and the existing performance of the Basin Reserve itself. It is intended for a technical audience as a record of the data and information available to the project team at the time of writing. Readers requiring a more holistic view of the project should refer to the Scoping Report.

The final parts of this report provide a review of the indicative performance of the five options identified by NZTA following an 'Inquiry by Design' workshop. The contract for investigating and reporting transport improvements for SH1 around the Basin Reserve requires that these are used as the basis for developing revised options which will be subject to full assessment in accordance with the Resource Management Act 1991.

1.1 Traffic Forecasting Models

Several transportation models have been used to forecast future conditions. The models were used to assess:

- Future travel demand;
- Future mode choice;
- Transport routings;
- Bus patronage; and
- Traffic volumes.

Some models forecast the proportion of trips made using non motorised transport (i.e. on foot or by bicycle). These mode choice models are not sufficiently detailed to forecast the number of pedestrian and cyclists using the streets around the Basin Reserve. This is generally forecast manually on the basis of professional judgement.

This section provides an overview of the models used to forecast future travel conditions. *Figure 1.1* provides a high level summary of the relationship between models used in the Wellington area. For more details on the links between the models refer to the Wellington CBD s-Paramics Model Validation Report.

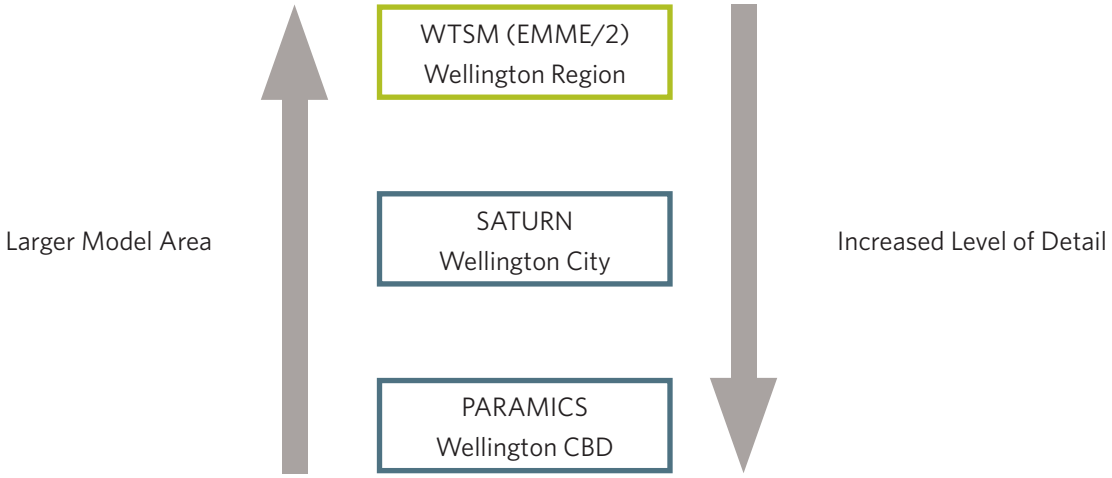


Figure 1.1: Model Relationships

The Wellington Regional Transport Strategy Model (WTSM) model covers the whole Wellington Region. WTSM enables the project team to forecast the number of people that will be travelling by car or by bus. The model also allows the project team to understand at a high level where transport movements within the city will begin and end (trip matrices). These trip matrices are then used as the basis for more detailed trip matrices used within the SATURN and Paramics models. The future year do minimum WTSM model includes:

- Grade separation of SH1 close to the Basin Reserve;
- Terrace Tunnel Tidal Flow system (i.e. two southbound lanes in the AM peak / two northbound lanes in the PM peak); and
- Increased capacity of SH1 between Ngauranga Gorge and the Aotea ramps

The Wellington SATURN model 2006 covers most of the city. It was used to assign the WTSM traffic demand onto the road network and assess route choice. It is a traffic model used to assess re-routing associated with congestion and infrastructure changes. The SATURN model was developed and validated to a base year of 2006[1] before the inner city bypass was complete. The SATURN model has subsequently been updated to reflect the current (2009) road network including the inner city bypass[2].

The do minimum SATURN model only includes new, full time bus lanes in each direction on Adelaide Road and Kent / Cambridge Terrace. The model includes bus movements, but only from a traffic perspective and is not able to forecast bus occupancy. Do minimum forecast are available for 2016 and 2026.

The Wellington s-Paramics model 2009 covers the area between the CBD and Ruahine Street. S-Paramics is a micro-simulation tool that represents individual vehicle movements. The level of detail possible within s-Paramics means that it is well suited for traffic design. It is very good at modelling the operation of signalised intersections and pedestrian crossings. It is therefore the primary traffic engineering design tool for the detailed analysis.

The s-Paramics trip matrices for 2009, 2016, and 2026 were created based on the SATURN trip matrices and 'do minimum' networks in S-Paramics were updated to be comparable to the future year SATURN networks while the 2006 SATURN trip matricies were adjusted to accurately represent 2009 volumes[3]. All future year option testing in S-Paramics will use matrices consistent with the 2016 and 2026 'do minimum' matrices.

1 2006 Wellington City Council Traffic Model –Validation and Forecasting Report, Opus International Consultants Limited, 2009. A peer review of the base model has been completed by Tim Kelly.
2 Throughout this report the SATURN model outputs are described as 2006 despite using a 2009 road network since the trip matrices are from 2006.
3 The S-Paramics model is documented in the following report: Wellington CBD Paramics Modelling Validation Report, Opus International Consultants Limited, 2009. A peer review of the S-Paramics models was completed by Baseplus (now Aurecon).

Initially, the planned approach was to use SATURN for all preliminary modelling, then use s-Paramics once a preferred option was identified. However, the network is much more congested in s-Paramics than SATURN and therefore to test the viability of options, s-Paramics needed to be used for some of the preliminary modelling. As a result, this Technical Note presents some results from SATURN and others from s-Paramics.

Several committed schemes (including grade separation of SH1 close to the Basin Reserve) are included in the WTSM future year do minimum models. Once a preferred option is identified a sensitivity test will be completed to investigate the effects of including all RLTS schemes in the 2026 model.

1.2 Future Transport Infrastructure

The future year WTSM models included those projects incorporated in the Regional Land Transport Strategy from 2006. All predicted future year schemes are in the model. In the immediate vicinity of the model area these schemes include:

- Terrace Tunnel tidal flow - Option T1 increases southbound capacity through the use of a 'reversible' traffic lane which can be used in either direction of travel depending upon the time of day. As such, two-lanes of traffic are given over to southbound vehicles in the morning peak period (with the remaining lane northbound) and vice versa for the evening peak hour as at present.

- Ngauranga to Aotea capacity improvement (8 laning) - The 8-laning of State Highway 1 between the Ngauranga Interchange to the Aotea Quay on / off ramps involves an increase in the number of lanes in each direction from three to four by using shoulder running in the AM and PM Peak periods.

- Bus lanes on Kent / Cambridge Terrace and Adelaide Road (both directions) – but not around the Basin Reserve itself. Bus lanes around the Basin reserve are considered part of the project, and therefore only included in project models.

WCC has plans for an extensive bus lane network within the CBD for 2016 and 2026. However, we have not included these proposals in our do minimum since these designs are not sufficiently developed for inclusion in this instance. Once a preferred scheme is finalized, sensitivity testing can be carried out with the wider bus lane proposals. *Figure 1.2*, over page, shows the extent of the proposed bus lanes on Kent / Cambridge Terrace and Adelaide Road. Both are included in the do minimum network.

Appendix A summarises all the schemes which are included in the WTSM model. Sensitivity tests will be completed to determine the potential impacts and re-routing effects of the Mount Victoria Tunnel Duplication, Wellington Road and Ruahine Street four-laning and any other schemes included in the RoNS projects.

1.3 Land Development Assumptions

A number of assumptions have been made in the development of the models. These assumptions and the reasons for them are summarized below:

- The medium growth scenario was used in the WTSM model to develop the future year traffic demands. Sensitivity tests may be completed for the preferred option using different growth scenarios.

- Only permitted developments are included in the SATURN model. Other developments which have been proposed, but have yet to receive approval from Wellington City Council are not included in the model.

Figure 1.2: Kent/ Cambridge Terrace and Adelaide Road Bus Lanes

2 Transportation in Wellington City

2.1 Traffic

Figure 2.1 below provides an overview of the weekday traffic patterns for flows around the Basin Reserve. Many of the motorists travelling from the eastern suburbs along SH1 through the Mount Victoria tunnel continue on SH1 through the Terrace Tunnel. About 25 percent of these motorists head into the CBD and with approximately 15% turning into Willis Street.

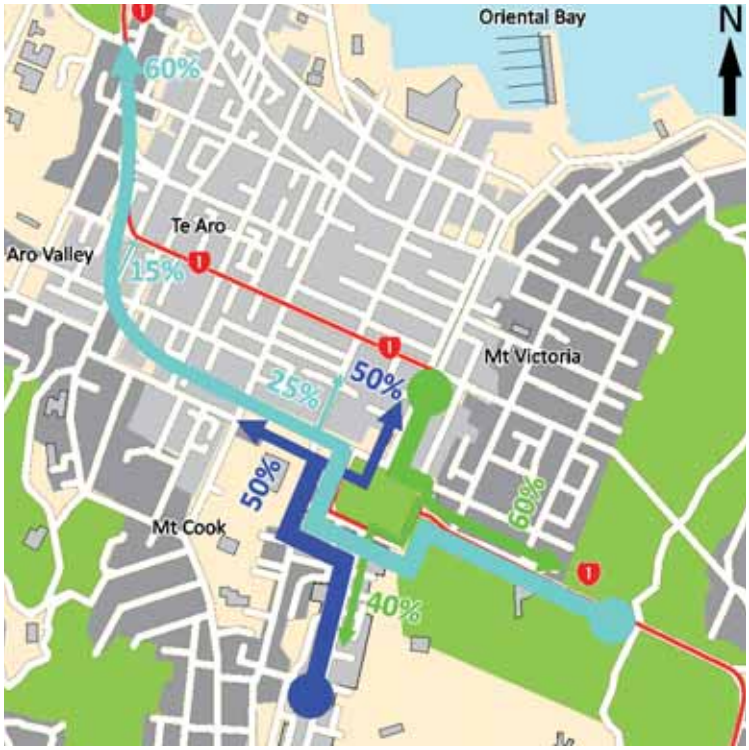


Figure 2.1: Origins and Destinations for Trips Travelling Through the Basin Reserve

On an average day, roughly 60 percent of the motorists approaching the Basin Reserve from Kent Terrace drive through the Mount Victoria Tunnel towards the eastern suburbs. The remaining 40 percent travel towards the southern suburbs via Adelaide Road. Motorists approaching the Basin Reserve from Adelaide Road are evenly split between continuing to head north on Cambridge Terrace and heading towards the Inner City Bypass.

2.1.1 Traffic Screen lines

Three screen-lines were created to gain an understanding of the traffic volumes approaching and egressing from the Basin Reserve in the do minimum scenario. The total traffic flows crossing each nominal screen-line are shown in *Figure 2.2*, over page. The average annual daily traffic (AADT) volumes for 2006 and 2026 are shown on the diagram along with the total percent change in traffic between the two years. The proportion of increase across some screen lines do not balance due to vehicles routing around the screen line on alternative routes, and due to the function of how daily flows are calculated when compared to peak hour flows.

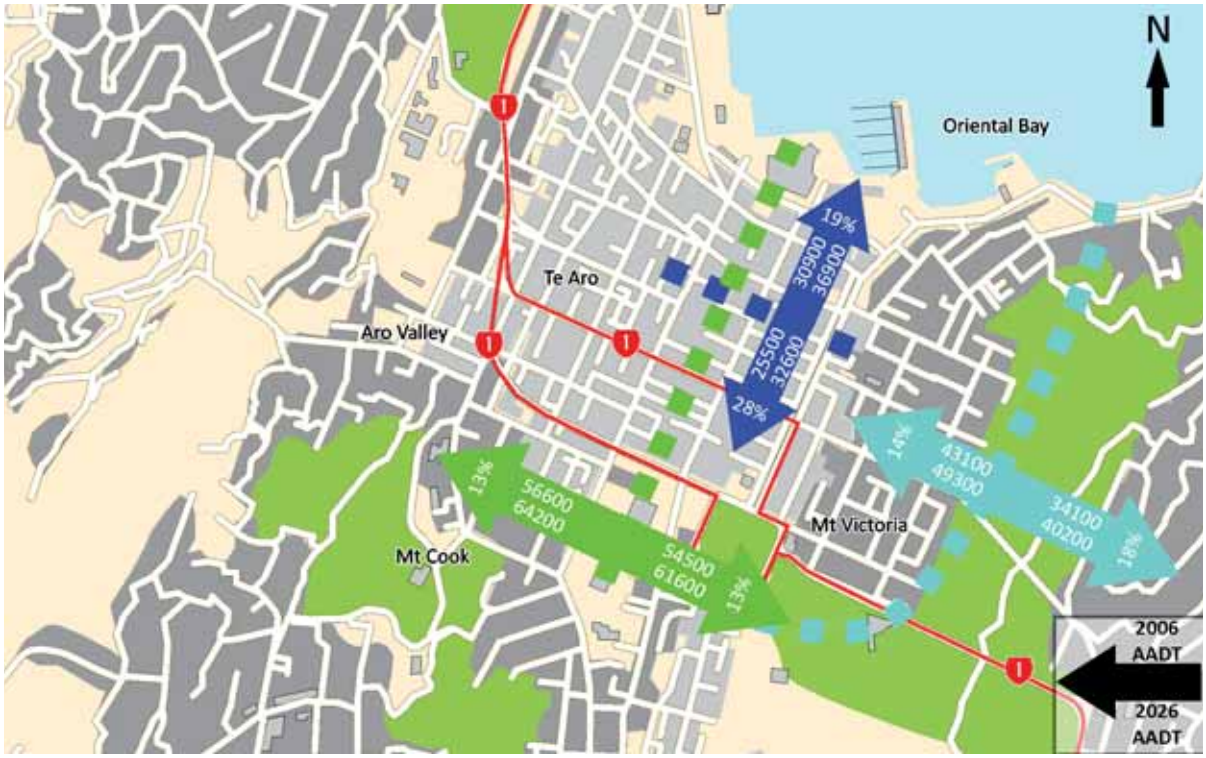


Figure 2.2: AADT Crossing the Screen-lines and Percent Growth

The figure shows that from 2006 to 2026 there is a forecast 14 percent increase in the volume of traffic approaching the CBD from the southern and eastern suburbs (across the blue screen-line in the figure). An 18% increase in traffic volumes is forecast for movements away from the CBD in 2006 and 2026

Table 2.1 shows the forecast AADTs across the screen lines in each direction and the percentage change between 2006 and 2026. The change in flows reflects the degree to which the future year traffic network becomes congested. Parts of SH1 (Mount Victoria Tunnel / Vivian Street / Buckle Street) are already operating close to their theoretical capacity. On these roads there is therefore less opportunity for increases in traffic volumes.

Less popular roads, that currently are not operating at capacity, become more popular as alternative routes become congested. For example, Adelaide Road southbound becomes more popular as a route to Kilbirnie as SH1 through Mount Victoria Tunnel to Wellington Road becomes more congested.

Table 2.1: Do-Minimum Average Annual Daily Traffic across Screen-lines[1]

Direction	South-East Screen-line (Blue)	Year			Change 2006-26
		2006	2016	2026	
Away from the CBD	Oriental	6789	7118	7637	12%
	Pallister	602	656	913	52%
	Mount Vic Tunnel	16838	17437	18778	12%
	Adelaide	9914	11817	12893	30%
	Total	**34142**	**37027**	**40221**	**18%**
Towards the CBD	Oriental	5584	6310	6848	23%
	Pallister	1354	1580	2001	48%
	Mount Victoria Tunnel	15758	15795	16719	6%
	Adelaide	20432	22368	23682	16%
	Total	**43128**	**46053**	**49250**	**14%**
Direction	**Western Screen-line (Green)**	**Year**			**Change 2006-26**
		2006	**2016**	**2026**	
Away from the CBD	Vivian / Buckle	25767	26516	28389	10%
	Courtenay	7162	7897	8691	21%
	Jervois Quay	23654	25137	27135	15%
	Total	56583	59549	64215	13%
Towards the CBD	Vivian / Buckle	23364	24376	25379	9%
	Courtenay	6688	7129	7707	15%
	Jervois Quay	24447	26089	28552	17%
	Total	**54499**	**57594**	**61638**	**13%**
Direction	**Northern Screen-line (Red)**	**Year**			**Change 2006-26**
		2006	**2016**	**2026**	
Away from the CBD	Taranaki	8272	9688	10955	32%
	Tory	8960	9754	10200	14%
	Kent / Cambridge	13710	14506	15756	15%
	Total	**30942**	**33949**	**36911**	**19%**
Towards the CBD	Taranaki	8278	9782	11363	37%
	Tory	7920	8387	9111	15%
	Kent / Cambridge	9296	10708	12149	31%
	Total	**25494**	**28877**	**32622**	**28%**

1 The S-Paramics model is documented in the following report: Wellington CBD Paramics Modelling Validation Report, Opus International Consultants Limited, 2009. A peer review of the S-Paramics models was completed by Baseplus (now Aurecon).

Many motorists driving from the CBD towards the southern and eastern suburbs travel via Taranaki and Wallace Streets through Mount Cook and Newtown. This route avoids the congested SH1 Vivian Street at its intersection with Kent / Cambridge Terraces and around the Basin Reserve. The table indicates that Taranaki Street continues to be popular as traffic volumes continue to grow.

2.1.2 Traffic Level of Service

The Level of Service (LOS) on key traffic links within Wellington City has been analysed based on the do minimum outputs from the SATURN model. Level of service is a measure of traffic performance. It is defined in the new Austroads Guides for Road Design, Road Safety and Traffic Management. Traffic LOS service provides an indication of the delays each motorist would experience when driving in traffic relative to a scenario where they were the only driver on the road.

During the AM peak in 2006 most roads are operating well with a LOS of C or better, however some links heading towards the Basin Reserve experience an LOS of E or worse which results in significant delays. In 2016 and 2026 the AM peak performance is forecast to continue to degrade. The following roads currently operate with a LOS E or worse:

- SH1 (Terrace Tunnel and Buckle Street);
- Adelaide Road heading towards the Basin Reserve;
- Mount Victoria Tunnel (in both directions); and
- John Street eastbound.

During PM peak period in 2006 the Wellington road network is busier than the AM peak with more links approaching capacity or experiencing significant delays. The congestion on these routes continues to increase in 2016 and 2026. *Appendix B* contains a summary of the volume to capacity ratios for key links. Roads currently operating with LOS E or worse include:

- SH1 (in both directions);
- Adelaide Road (northbound);
- Cambridge Terrace;
- Oriental Parade (eastbound);
- Willis Street (southbound);
- Victoria Street (southbound); and
- The Mount Victoria Tunnel (in both directions).

Table 2.2 summarises percent increase in the journey time for some key routes through the Basin Reserve for 2009 to 2016 and 2009 to 2026[2]. The table shows that by 2026 travel times increase significantly.

In future if nothing is done, westbound queues on SH1 through Mount Victoria Tunnel are likely to extend from the Basin Reserve through Ruahine Street past Evans Bay Parade in the AM peak period. This results from insufficient capacity at both the Mount Victoria Tunnel and the Basin Reserve. Due to these queues on SH1 more vehicles are expected to use Evans Bay Parade and Oriental Parade to travel into the city. There may also be a response in terms of lengthening the peak periods however, this is not able to be picked up in the SATURN model.

2 Based on the Paramics model outputs.

Table 2.2: Percent Increase in Journey Times for the Do-Minimum Scenario (Paramics)

Route	2009 to 2016	2009 to 2026
SH1 WB (Evans Bay Parade to Willis Street)	10%	60%
SH1 EB (Willis Street to Evans Bay Parade)	Minimal Change	15%
NB Adelaide Road to Cambridge Terrace	30%	50%
SB Kent Terrace to Adelaide Road	6%	50%
Bus NB through the Basin Reserve	15%	25%
Bus SB through the Basin Reserve	Minimal Change	25%

Also, the southern end of Taranaki Street and Wallace Street are likely to become highly congested. Improvements to the Basin Reserve will help reduce this congestion since Adelaide Road will become a more attractive route for southbound journeys.

Improving traffic operations at the Basin Reserve will help ensure the road network will function effectively now and into the future. Providing sufficient capacity on SH1 will accommodate much of the growth in regional traffic minimising increases in traffic on local routes.

2.2 Passenger Transport

The bus route from the Wellington CBD to southern Wellington via Kent / Cambridge Terrace and Adelaide Road is a major passenger transport spine. A key outcome of the Ngauranga to Airport Strategy Study and hence a core objective of the Basin Reserve project is to improve passenger transport operation along this spine. The planned growth node at Adelaide Road further emphasises the need to create a high quality passenger transport link between the southern suburbs and the CBD.

Figure 2.3: Adelaide Road with light rail

Currently seven different bus routes operate along Adelaide Road and travel directly through the Basin Reserve. In addition to the bus services on Adelaide Road, there are three routes which provide service on Wallace Street then Taranaki Street. *Appendix C* contains further information on the provision of bus services in the study area.

2.2.1 Forecast Passenger Demand

The forecast number of bus passengers for 2006 and 2016 (from WTSM) are summarized in *Table 2.3* below. WTSM takes into account land use changes, population increases, predicted mode shift, and the effects of travel demand management when generating forecasts for future years. Overall passenger transport demand increases by 25 to 30 percent in the peak direction during peak periods (northbound towards the city in the AM and southbound towards the suburbs in the PM). During the other time periods the number of passengers increases by 10 to 15 percent.

Usually where travel behaviour is tidal (i.e. where AM flows are reversed in the PM) traffic volumes towards the CBD in the morning peak would be similar to flows away from the CBD in the PM peak. The forecasts presented in *Table 2.3* indicate that flows away from the CBD in the evening peak are lower than the flows towards the CBD in the morning. This is likely to be because some school age students use scheduled bus services in the morning but would travel home before the PM peak hour.

Table 2.3: Forecast Passenger Transport Demand (Passengers / 2-hour peak)

Period	Location	NB			SB		
		2006	2016	Diff.	2006	2016	Diff.
AM	Riddiford Street	1650	2350	700	550	570	20
	Adelaide Road	1660	2120	460	360	480	120
	Kent / Cambridge Terrace	1430	1920	490	460	610	150
	Wallace Street	860	1290	430	240	190	-50
IP	Riddiford Street	470	500	30	590	670	80
	Adelaide Road	330	380	50	370	460	90
	Kent / Cambridge Terrace	320	390	70	330	420	90
	Wallace Street	180	170	-10	250	250	0
PM	Riddiford Street	640	670	30	1450	2180	730
	Adelaide Road	460	580	120	1360	1710	350
	Kent / Cambridge Terrace	460	690	230	1330	1700	370
	Wallace Street	270	210	-60	360	830	470

3 Local Traffic Conditions for the Basin Reserve Gyratory

During the peak periods the Basin Reserve is operating at or above capacity. Inefficiencies arise from the conflicting requirements of SH1 east / west and local north / south movements. Subsequently both SH1 and local traffic face significant delay and congestion due to the limited road capacity and high demand. *Figure 3.1,* below shows the number of lanes around the Basin Reserve and the signal locations. *Figure 3.2* shows typical street and lane layout along key streets.

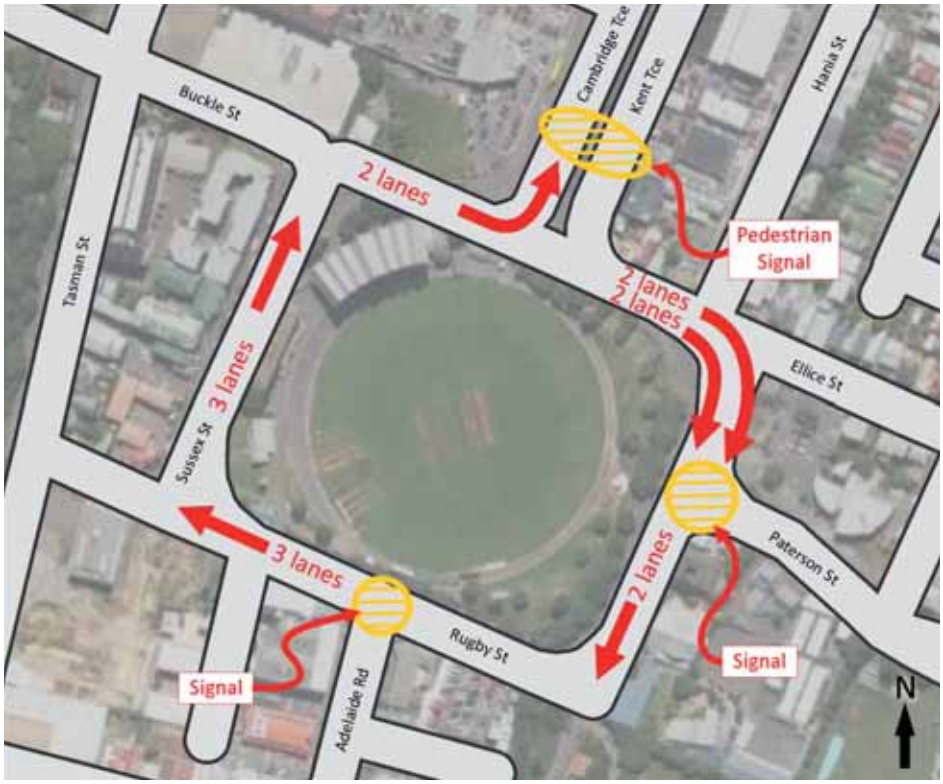


Figure 3.1: Existing Number of Lanes and Signal Locations

Corner of Kent Terrace and Ellis St, looking towards Dufferin St (4 lanes).

Dufferin St looking south towards St Marks and showing school bus drop-off area (2 lanes).

Sussex St – looking south towards Rugby Street (3 lanes).

Rugby Street looking east towards intersection with Adelaide Road (3 lanes).

Figure 3.2: Road Cross Sections at the Basin Reserve

3.1 2009 Recorded Traffic Flows

Traffic counts around the Basin Reserve were completed in February and March 2009. *Figure 3.3* shows the location of each of the counts.

Table 3.1 summarises the number of cars and heavy commercial vehicles counted during each of the peak periods.

The AM, inter-peak and PM peak period counts correspond to 8-9am, noon-1pm, and 5-6pm respectively. Overall heavy commercial vehicles account for approximately two percent of the traffic utilising the Basin Reserve. This is low compared to other parts of the State Highway network and is likely to be more reflective of the high number of light goods vehicles using SH1 for local trips than of the number of HCVs. There are also a small number of HCVs carrying dangerous goods that use Oriental Bay instead of SH1 and the Mount Victoria and Terrace Tunnels.

The data in *Table 3.1* is from surveys that were undertaken on 10 February 2009 and represent a snapshot of travel patterns on this date only.

Figure 3.3: 2009 Traffic Count Locations

Ref.	Movement	AM		IP		PM	
		HCV	Cars	HCV	Cars	HCV	Cars
1	Adelaide (S) left to Rugby (W)	16	964	36	804	10	865
2	Rugby (E) left to Adelaide (S)	15	425	16	498	11	632
3	Rugby (E) through Rugby (W)	22	1694	43	1091	9	1329
4	Paterson (E) left to Dufferin (S)	22	1437	54	1083	20	1247
5	Kent (N) left to Paterson (E)	29	1025	31	1185	11	1485
6	Kent (N) through Dufferin (S)	15	682	5	506	0	714
7	Buckle (W) left to Cambridge (N)	6	951	16	627	5	868
8	Buckle (W) through Dufferin (E)	0	0	0	6	0	62
9	Dufferin (W) left to Hania St	0	28	0	41	0	22
10	Dufferin (W) through Ellice St	0	155	0	79	0	58
11	Hania St (N) through Dufferin St	0	41	0	46	0	98
12	Ellice St (E) left to Dufferin St	0	100	0	50	0	144
13	Sussex (S) left to Buckle (W)	25	1542	71	1293	25	1230
14	Sussex (S) right to Buckle (E)	13	1189	8	633	6	803
15	Rugby (E) through Rugby (W)	0	29	0	38	0	65
16	Rugby (W) left to Sussex (N)	0	61	0	31	0	30

Table 3.1: 2009 Traffic Count Data

3.2 2006 Do Minimum Intersection Performance (SATURN Model)

The overall volume to capacity (v/c) ratios for three key intersections around the Basin Reserve were extracted from the do-minimum SATURN model for 2006, 2016 and 2026 to give a coarse indication of how some of the key intersections will perform in the future if there are no improvements at the Basin Reserve. As the project progresses a more detail analysis of the do-minimum intersection performance will be completed. The model results are summarised in *Table 3.2* along with the corresponding LOS based on the US Federal Highway Capacity Manual. The performance of every intersection degrades between 2016 and 2026.

Table 3.2 shows that LOS of these intersections generally degrades in the future as traffic volumes increase. The change is however not as large as might be expected. This is because many locations already operate at or close to capacity. This limits the amount of additional traffic able to reach these intersections in the future years.

It is important to note that these are overall LOS for the intersection, and some individual movements at any intersection may perform significantly worse. The good overall LOS at the intersection of Paterson Street and Dufferin Street is not representative of the high congestion experienced by vehicles making a left turn from Paterson Street to Dufferin Street (i.e. movements from Mount Victoria Tunnel). The volume to capacity ratio and LOS for the worst performing movement at this intersection was therefore extracted for the AM and PM peak periods in 2006 and 2026.

Intersection		AM			IP			PM		
		2006	2016	2026	2006	2016	2026	2006	2016	2026
Buckle / Tory St	Overall	C	B	D	B	B	C	B	B	B
Adelaide Rd / Rugby St	Overall	C	C	C	B	B	C	C	C	C
Paterson / Dufferin St	Overall	A	A	A	A	A	A	A	A	A
	Worst LOS on key movements	C	-	B	-	-	-	B	-	F

Table 3.2: Level of Service at Intersections

3.3 Do Minimum Network Constraints

If there are no improvements to the Wellington Road network in the future the following links / intersections form major constraints on the road network in the immediate vicinity of the Basin Reserve.

The Dufferin Street / Paterson Street (Mount Victoria Tunnel exit) intersection constrains the traffic flow on the network. There is a high demand for:

- The southbound through movement on Dufferin Street; and
- The westbound left turn from Paterson Street (Mount Victoria Tunnel) to Dufferin Street.

These movements conflict and the traffic signal timing must balance the time allocated to each movement. The intersection of Adelaide Road and Rugby Street is also congested; however the Paterson Street and Dufferin Street intersection is a bottleneck and therefore limits the volume of traffic reaching this intersection. Traffic signal co-ordination between the two intersections also increases the efficiency of the Adelaide Road / Rugby Street intersection. Any capacity improvements to the Dufferin Street and Paterson Street intersection may therefore result in the Adelaide Road / Rugby Street intersection becoming more congested due to increases in traffic reaching it.

In the future additional traffic flows on SH1 are also limited by the capacity of the Mount Victoria Tunnel. Since demand for travel between the eastern suburbs and the CBD or the north continues to grow, additional traffic routes via local roads such as Constable Street / Adelaide Road or Evans Bay Road are used.

Sussex Street is also forecast to become congested due to high volumes of traffic on Tory Street backing up onto Sussex Street. A high number of weaving manoeuvres occur around the Basin Reserve as both vehicles and buses try to get to the correct lane to reach their destination. Weaving manoeuvres are especially high on Sussex Street and result in an increased risk of crashes.

Future work will examine how the proposed improvements will address these constraints and identify additional improvements which are needed on the wider road network to minimise congestion and ensure the envisaged benefits of the Basin Reserve Transportation Improvements are realised.

4 Passenger Transport at the Basin Reserve

4.1 Bus Stops and Bus Priority

Figure 4.1, below shows the locations of the bus stops in the vicinity of the Basin Reserve. It also shows the distance between each stop and a 200m radius zone for each stop.

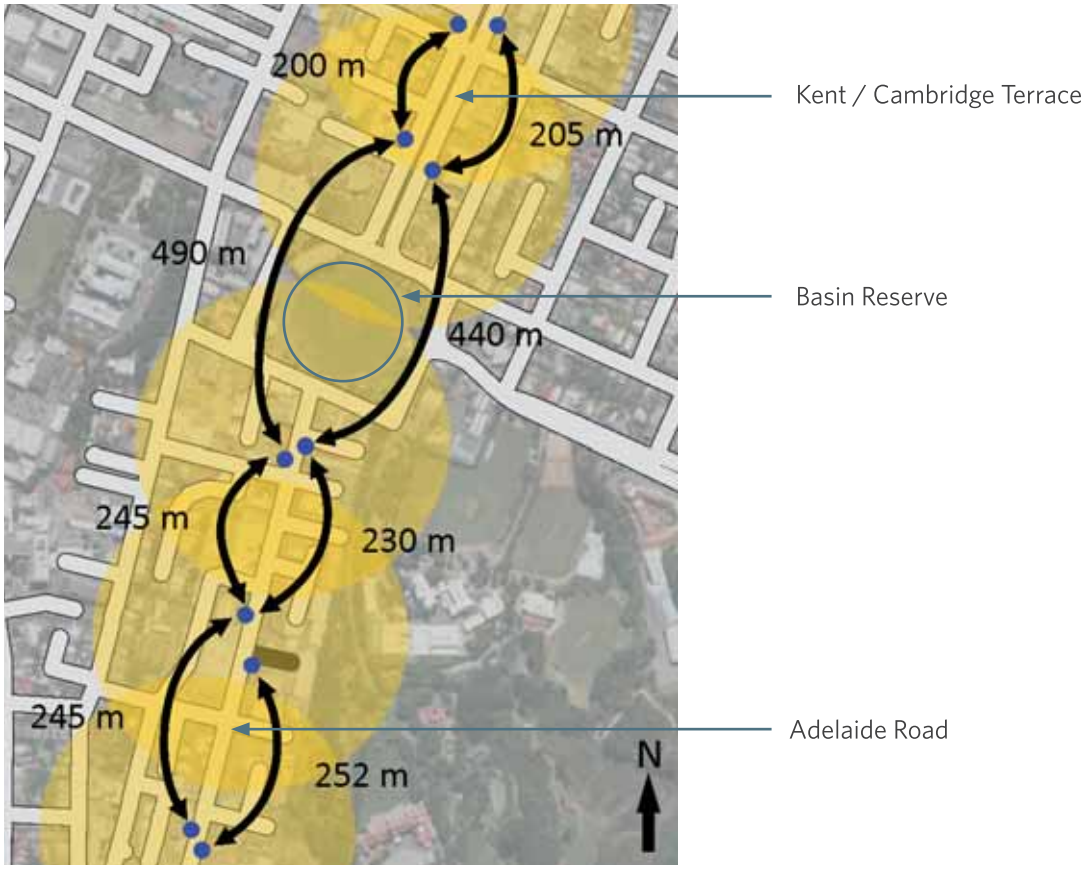


Figure 4.1: Bus Stop Locations and 200m Radius Zones

Southbound bus stop on Kent Terrace south of Dufferin Street.

Southbound bus stop on Kent Terrace south of Rugby Street.

Figure 4.2: Bus Stops near the Basin Reserve

There are currently two bus lanes on the approaches to the Basin Reserve as shown in *Figure 4.2.* Photos of the existing bus lanes are shown in *Figure 4.3*:

- Northbound on Adelaide Road (AM Peak Only); and
- Southbound on Kent Terrace (PM Peak Only).

Existing northbound AM Peak Bus lanes along Adelaide Road – looking south.

Existing southbound PM Peak Bus lanes along Kent Terrace – looking south.

Figure 4.3: Bus Lanes on Adelaide Road and Kent Terrace

Existing northbound AM Peak Bus lanes along Adelaide Road – looking south. Existing southbound PM Peak Bus lanes along Kent Terrace – looking south.

4.2 Boarding and Alighting Patterns

Figure 4.4 and *Figure 4.5* show the average passenger turnover for each of the bus stops surveyed. The data was collected during surveys conducted in September 2009. Surveyors travelling on buses recorded the number of passengers boarding and alighting. At the same time they recorded the time of arrival and departure at each bus stop.

The stops on Kent and Cambridge Terrace adjacent to Vivian/Pirie Streets show reasonable levels of usage, with high levels boarding in the southbound direction and alighting in the northbound direction. This is probably associated with Mount Victoria residents and Wellington East Girls College students travelling to and from Newtown and the Southern suburbs.

The stops on Adelaide Road adjacent to Hospital Road also show reasonable levels of usage, with high levels boarding in the northbound direction and alighting in the southbound direction. This is probably associated with hospital staff and patients travelling to and from the CBD and northern / western suburbs.

The bus stops immediately south of the Basin on Adelaide Road are the busiest in the study area both for boarding and alighting. One reason for this is because these stops are the closest stops to the schools in the area and a significant number of students travel to school via conventional buses as opposed to school buses. This is reflected in the high number of alighting passengers in the AM peak in both directions.

Another reason for the high usage of these stops is because this stop is the limit of the fare boundary for a city section. Passengers who travel south of this point in either direction pay an increased fee, consequently some passengers with destinations south of this point are likely to get off here and complete their journeys on foot and vice versa for northbound journeys. *Appendix C* contains further details bus occupancy and dwell times.

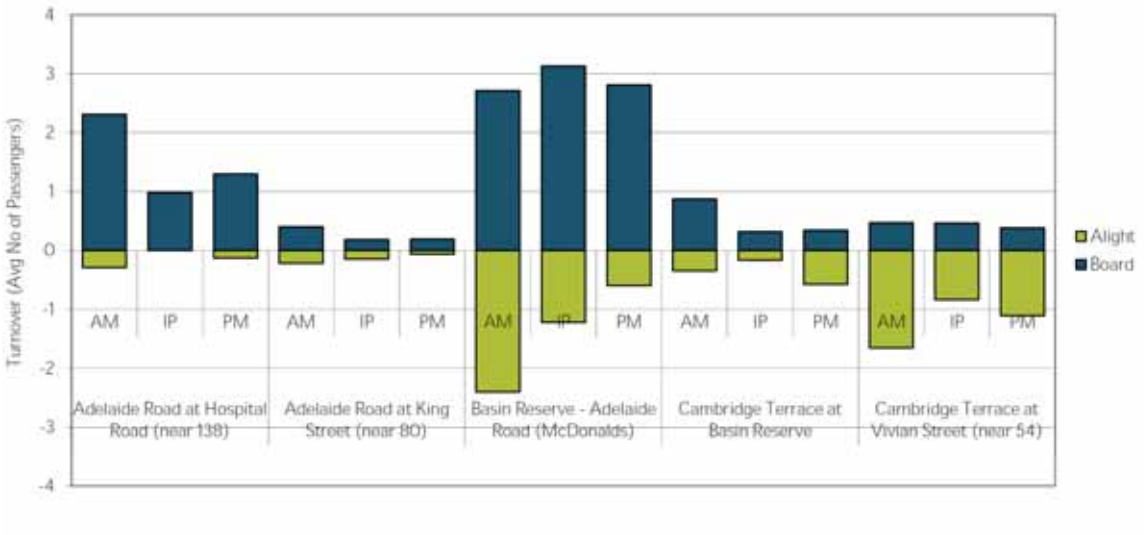


Figure 4.4: Northbound Average Number of Boarding and Alighting Passengers

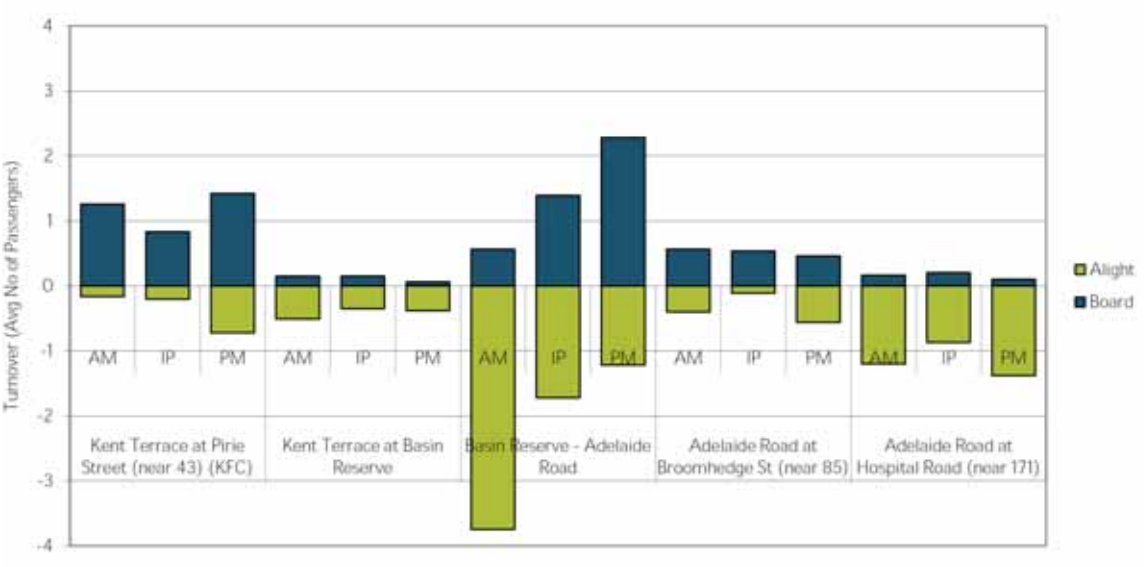


Figure 4.5: Southbound Average Number of Boarding and Alighting Passengers

4.3 Bus Occupancy

Figure 4.6 and *Figure 4.7* show the occupancy rate of buses passing around the Basin Reserve. The occupancy percentage is derived by assuming that the average bus has a maximum capacity of 67 passengers (44 seated and 23 standing)[1]. It should be noted however, that smaller buses are sometimes used on the route. Since *Figure 4.6* and *Figure 4.7* show the average occupancy for a full two hour peak period and all routes travelling around the Basin Reserve, the fact that certain routes are busier than others and that there are peaks in demand within the peak period are not captured by these graphs. However, these figures clearly show the higher occupancy rates associated with the commuter peaks (i.e. northbound in the AM and southbound in the PM).

1 Based on bus capacity data provided by Greater Wellington

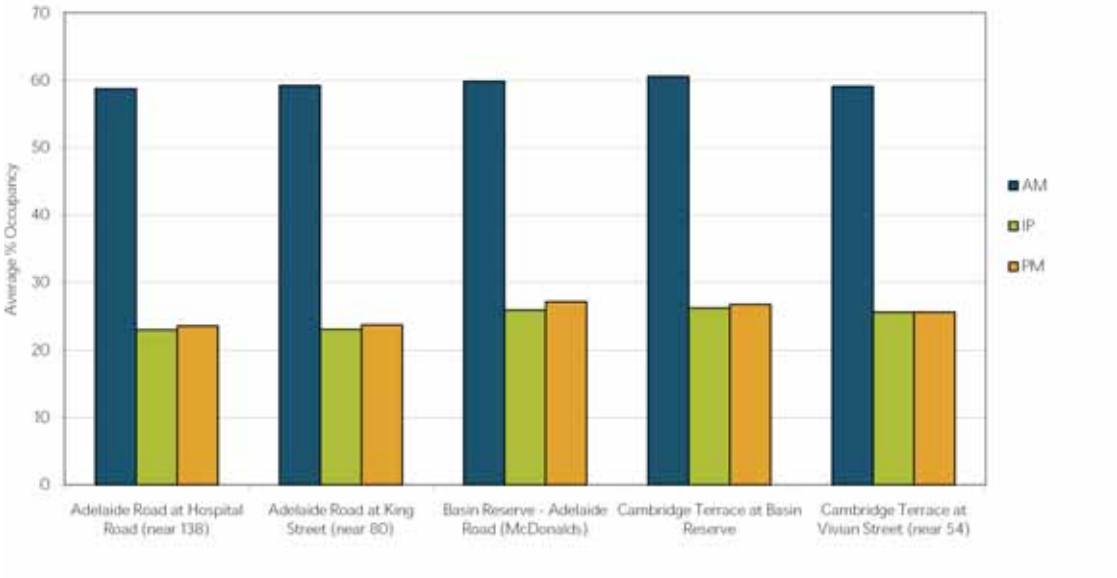


Figure 4.6: Northbound Bus Occupancy (average)

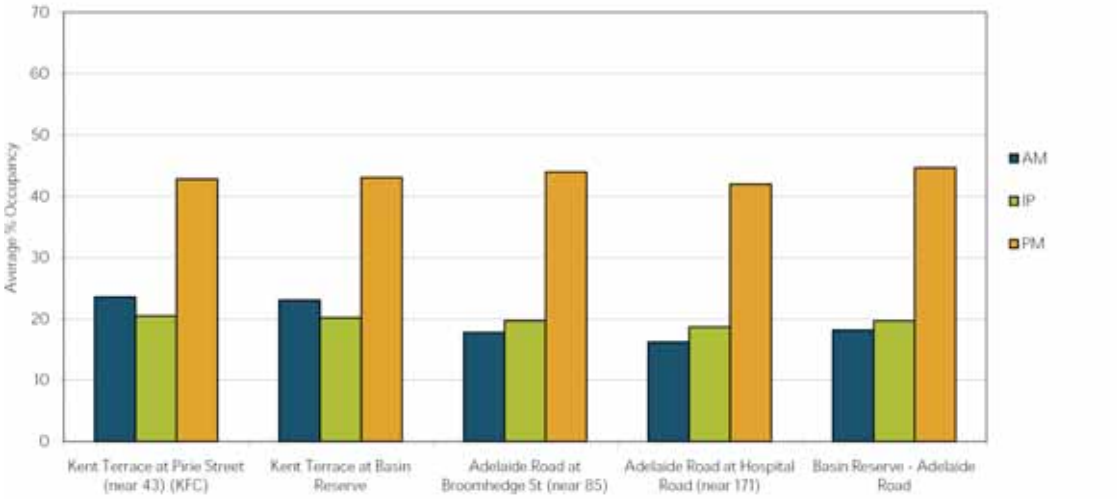


Figure 4.7: Southbound Bus Occupancy

The buses were the most crowded during the Friday PM peak in the southbound direction and in the AM peak in the northbound direction. Generally the key strategic bus routes (1 and 3) were more crowded than the non-strategic bus routes (22, 23, 43 and 44)[2].

A feature of both charts is that bus occupancy remains much the same through the study area, meaning the number of passengers boarding is similar to the number of passengers alighting. This means that currently most bus users travel through the area, rather than travelling to or from it. The proposed development of the Adelaide Road Growth Node is likely to increase the number of passengers in this area.

4.3.1 Travel Speed

Table 4.1 summarises the average travel speed of buses between stops near the Basin Reserve during the AM, IP, and PM periods in the northbound direction. It shows that northbound travel speeds are lowest between bus stops on Cambridge Terrace. Delays for this part of the bus route are caused by the Vivian Street / Cambridge Terrace intersection.

2 Strategic routes 1 and 3 serve Island Bay and Lyall Bay respectively. The non-strategic routes serve Southgate, Houghton Bay and Strathmore.

Table 4.1: Northbound Average Journey Speeds

Section	Average Speeds (km/h)			Bus Lane	No. of Traffic Signals
	AM	IP	PM		
Adelaide Road Southern End	29.2	26.5	21.0	AM Peak only	2
Adelaide Road Northern End	29.5	27.2	20.5	AM Peak only	0
Round the Basin	19.9	19.9	17.4	No	2
Cambridge Terrace	13.8	13.1	12.3	No	1

The Basin Reserve also has low travel speeds relative to Adelaide Road. This is likely to be because of the bus unfriendly geometric alignment. Also the buses have to switch lanes at least once during the route around the Basin; there are also lots of conflict points and poor signal interaction.

All of the peak periods show the same trend of increasing speeds as the distance from the CBD increases. The journey times along Adelaide Road in the AM peak are significantly better than in the PM peak because of the peak hour bus lanes.

Table 4.2 summarises the average travel speed of buses near the Basin Reserve during the AM, IP, and PM periods in the southbound direction. Similar to the northbound direction, it shows that the largest southbound delay between bus stops is on Kent Terrace, closely followed by the Basin Reserve itself. Journey times along Adelaide Road are much better.

The table demonstrates the impact traffic congestion has on bus speeds. The primary reasons why travel speeds are lower on Kent Terrace and around the Basin Reserve are:

- Buses must pass through Vivian / Kent Terrace intersection;
- Buses must pass through the Dufferin / Paterson Street intersection;

Although bus priority is provided for northbound journeys, the buses must still obey traffic signals. In the PM peak, bus priority allows buses to travel faster than private motorists. However they do not totally avoid delays associated with accommodating conflicting traffic flows.

Table 4.2: Southbound Average Journey Speeds

Section	Average Speeds (km/h)			Bus Lane	No. of Traffic Signals
	AM	IP	PM		
Kent Terrace	11.1	12.2	10.5	PM Peak only	1
Round the Basin	14.6	16.5	14.2	No	3
Adelaide Road Northern End	28.1	27.7	27.4	No	0
Adelaide Road Southern End	29.3	24.5	21.4	No	2

5 Pedestrians and Cyclists at the Basin Reserve

There is a pedestrian footpath on both sides of all roads around the Basin Reserve and on the northern side of the Mount Victoria Tunnel. Signalised pedestrian crossings are also provided at the following locations: (shown in *Figure 5.1*):

- Intersection of Dufferin Street and Paterson Street;
- Intersection of Adelaide Road and Rugby Street; and
- Kent and Cambridge Terrace south of Ellice Street and Buckle Street.

There are no pedestrian crossing facilities located on the western side of the Basin Reserve between Adelaide Road and Cambridge Terrace.

Figure 5.1: Signalised Pedestrian Crossing Locations

There are very few facilities for cyclists around the Basin Reserve. There is a small portion of marked cycle lane on the south-east corner of Rugby Street and Adelaide Road. Cyclists are able to cycle through the cricket grounds as an alternative to cycling around the Basin Reserve.

Cyclists are not permitted to cycle on-road through the Mount Victoria Tunnel. Instead cyclists must share the footpath with pedestrians. The footway through the Mount Victoria Tunnel is of insufficient width for a shared-use path. Currently there is a separate tunnel refurbishment project in progress. However, the impact of this project on pedestrian facilities in the tunnel is uncertain.

At the western portal of the Mount Victoria Tunnel there are no facilities for cyclists on Paterson Street. *Figure 5.2* shows that cyclists are not permitted on the footpath between Brougham Street and Dufferin Street. Instead cyclists must use Brougham Street then Ellice Street (or travel through the church car park) to access any locations west of the Mount Victoria tunnel. For a more detailed description of the pedestrian and cyclist facilities see *Appendix D*.

Figure 5.2: No Cyclists Permitted on the Paterson Street Footpath west of Brougham Street

5.1 Current Local Attractors

There are a number of current local features that generate pedestrian and cyclist trips as shown in *Figure 5.3*. There are three schools on the eastern side of the Basin Reserve that attract pedestrian traffic. These are:

- Wellington College, a secondary school on Dufferin Street;
- Wellington East Girls College, a secondary school on Paterson Street; and
- St Mark's School, a primary and intermediate school on the corner of Dufferin and Paterson Streets.

The Basin Reserve is an attractor itself, with national and international cricket games as well as concerts through the summer months. It is also used for rugby training on winter weekends. As there is very limited on-site parking the majority of spectators arrive at the grounds on foot.

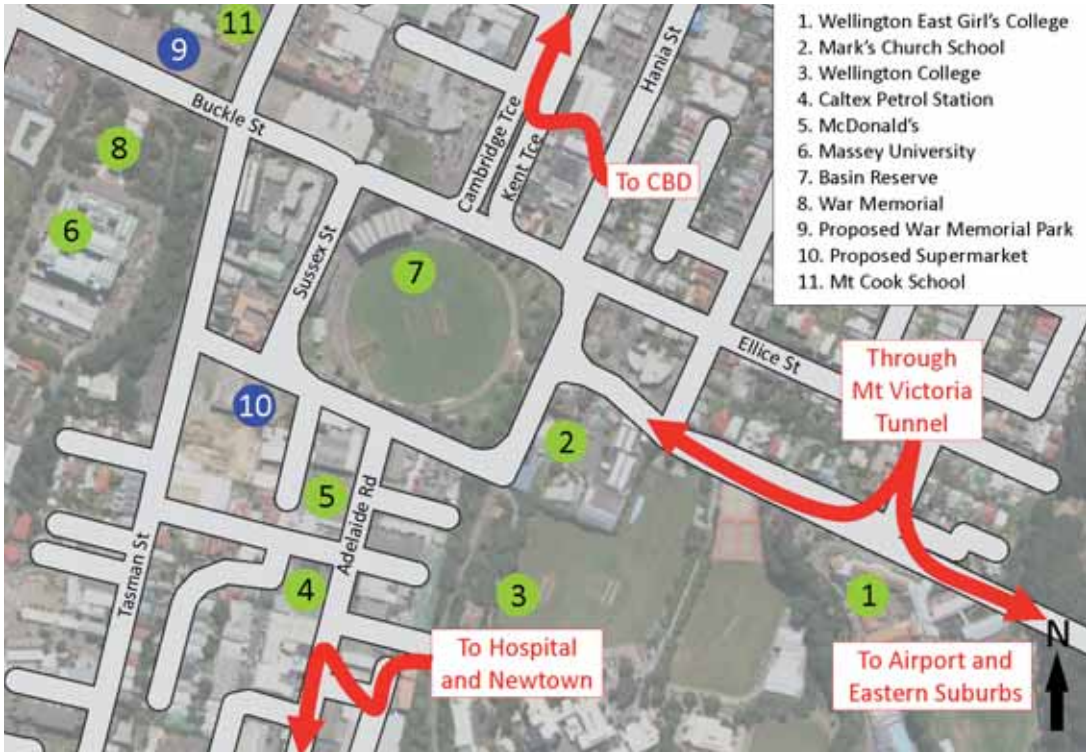


Figure 5.3: Local Attractors

Massey University's Wellington Campus is located just west of the Basin Reserve on Buckle St and also attracts pedestrians and cyclists who would travel around the Basin Reserve to access it. There are student hostels on Sussex Street which also generate pedestrian and cyclists.

At the northern end of Adelaide Road there is a McDonalds and a Caltex Service Station with an attached StarMart convenience store and Subway takeaways. These attract school pupils on foot after school. There are also a number of takeaway bars on Kent and Cambridge Terraces, including a KFC that also attracts pedestrians.

5.2 Future Local Attractors

Figure 5.4: Artist's Impression of the New World supermarket (source: Foodstuffs)

FoodStuffs have recently applied to Wellington City Council for resource consent to build and operate a supermarket on the block of land bounded by Rugby Street, Tasman Street, Douglas Street and Belfast Street. The proposal will see the development of:

- 3,600m^2 GFA New World supermarket;
- 500m^2 GFA commercial / retail unit;
- 22 apartments; and
- Café.

At this stage it is not known when construction would commence or the development would open. However, should the development go ahead it is likely to attract significant numbers of pedestrians to the south-west corner of the Basin Reserve from Mount Victoria, Tasman Street and Adelaide Road with some possible travelling through the Mount Victoria tunnel from Hataitai.

The Ministry of Culture and Heritage is proposing a Memorial Park to be situated on land fronting the National War Memorial on Buckle Street, in between Tory and Taranaki Streets. It is intended to create a memorial precinct which joins the adjacent National War Memorial and Tomb of the Unknown Warrior. The development of the park is likely to attract significant numbers of pedestrians to the western side of the Basin Reserve, particularly during special events such as ANZAC Day.

Wellington City Council is currently exploring opportunities for the future growth and development of the northern end of Adelaide Road (between John Street and the Basin Reserve), which is to the immediate south of the Basin Reserve. The vision provides for significantly more residential development (to accommodate 1550 more people by 2026), supported by good quality public amenities and streetscape, employment opportunities, and good public transport. The additional dwellings and workplaces will attract significant numbers of cyclists and pedestrians to the area in the future given its proximity to the Wellington CBD.

Figure 5.5: Artist's Impression of the Future Development of Adelaide Road (Source: Wellington City Council)

5.3 Existing Pedestrian and Cyclist Demand

There are a number of factors that can influence pedestrian and cyclist demand around the Basin Reserve. People are more likely to walk or cycle during the summer months when the weather is typically warmer and the days longer.

The nearby schools have an impact on pedestrian numbers, especially at the eastern side of the Basin Reserve where they are located. Pedestrian flows are likely to be significantly lower during the summer holiday over December / January as well as during shorter school holidays in April, July and October.

Game days at the Basin Reserve will also impact on pedestrian flows. During summer months both national and international cricket fixtures are held at the ground during weekdays and weekends, and can vary in length from one to five days. These games, especially international fixtures, are likely to attract a significant number of pedestrians. The maximum capacity of the ground is 11,600 people[1]. Crowds of this size can be expected up to 2 times per season with large international fixtures, with numerous other smaller crowd events such as provincial games. With minimal on-site car parking most of the spectators who drive, park on nearby streets or carparks and make their way to the ground on foot. Most of these spectators could be expected to access the ground from Adelaide Road or Kent / Cambridge Terrace.

Concerts such as 'Carols by Candlelight' and 'Summerset' are also held at the Basin Reserve over summer and can typically attract crowds of up to 7,000, again mostly pedestrians.

During winter months club rugby games are held at the Basin Reserve, although these do not typically attract large numbers of spectators.

5.3.1 Travel to Work Statistics - 2006 Census

Data collected during the 2006 census indicates that 16% to 25% of residents living in the Adelaide and Newtown West areas use active modes (walking or cycling) to commute to work as shown in *Figure 5.6* on the following page. Eleven to fifteen percent of residents living in Newtown East also use active modes for their commute to work.

5.3.2 Pedestrian and Cyclist Counts

Pedestrian and cyclist counts were taken at six different intersections around the Basin Reserve as shown in *Figure 5.7* below. Since the counts were undertaken during February 2009 they are assumed to be higher than what would be typical in winter months.

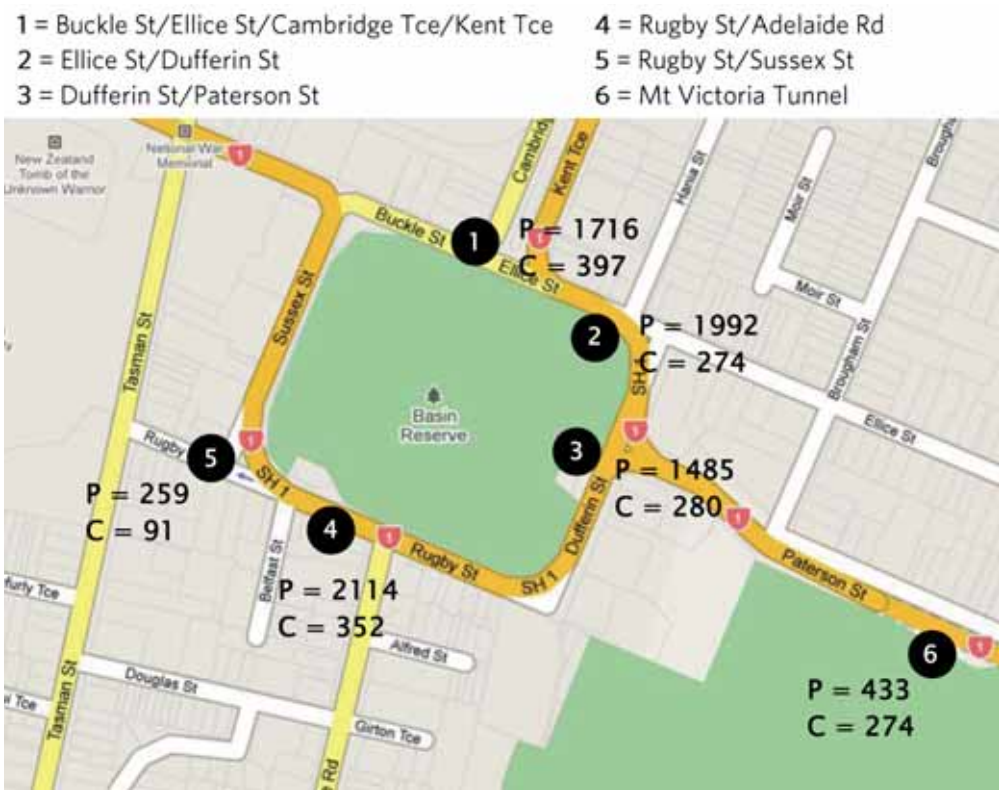


Figure 5.7: Location of Pedestrian and Cyclist Counts around the Basin Reserve (with 7:00am – 6:00pm Pedestrian (P) and

1 Source: http://en.wikipedia.org/wiki/Basin_Reserve

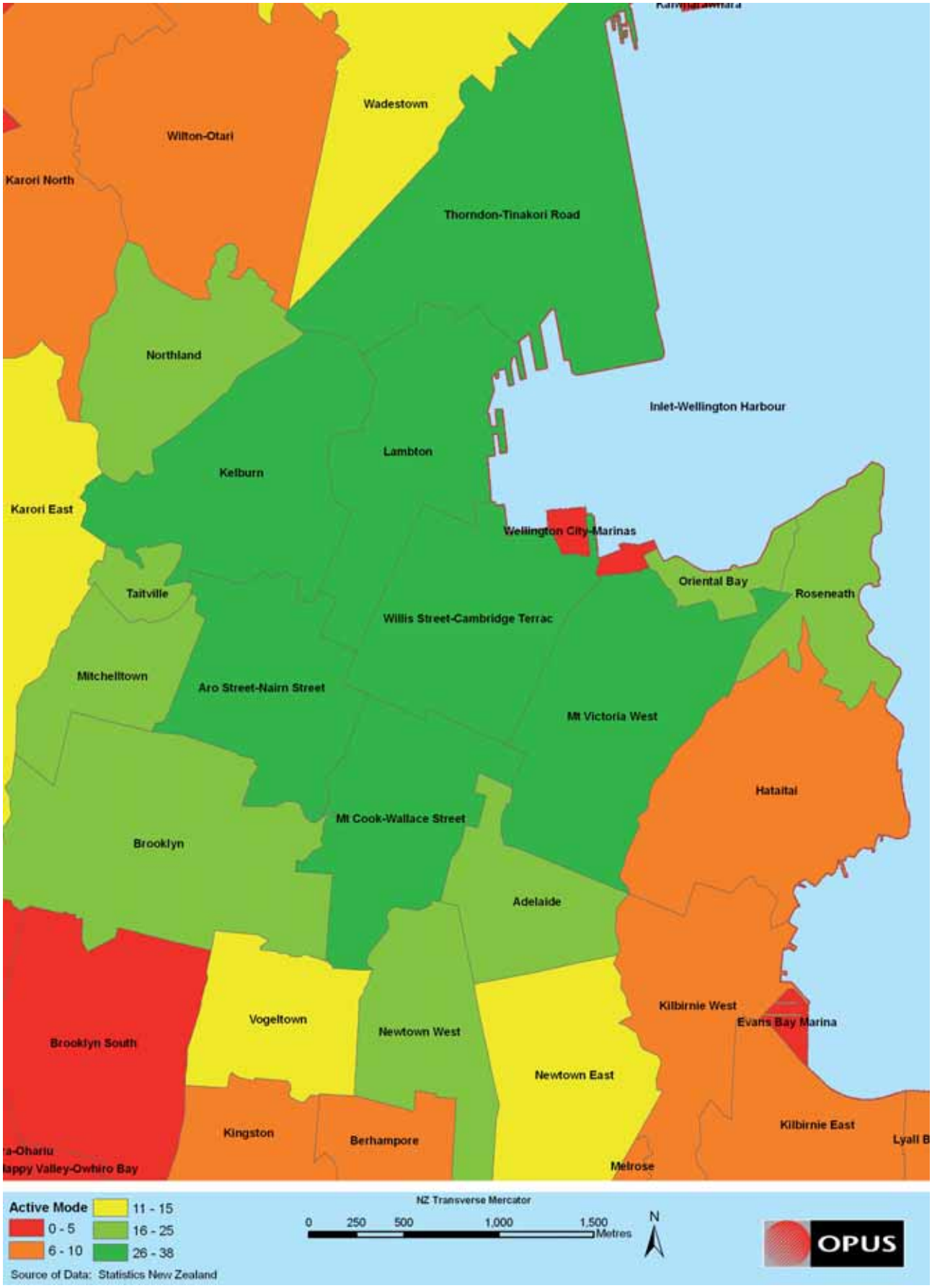


Figure 5.6: Proportion of Residents Using Active Modes to Travel to Work

Cyclist (C) Totals)

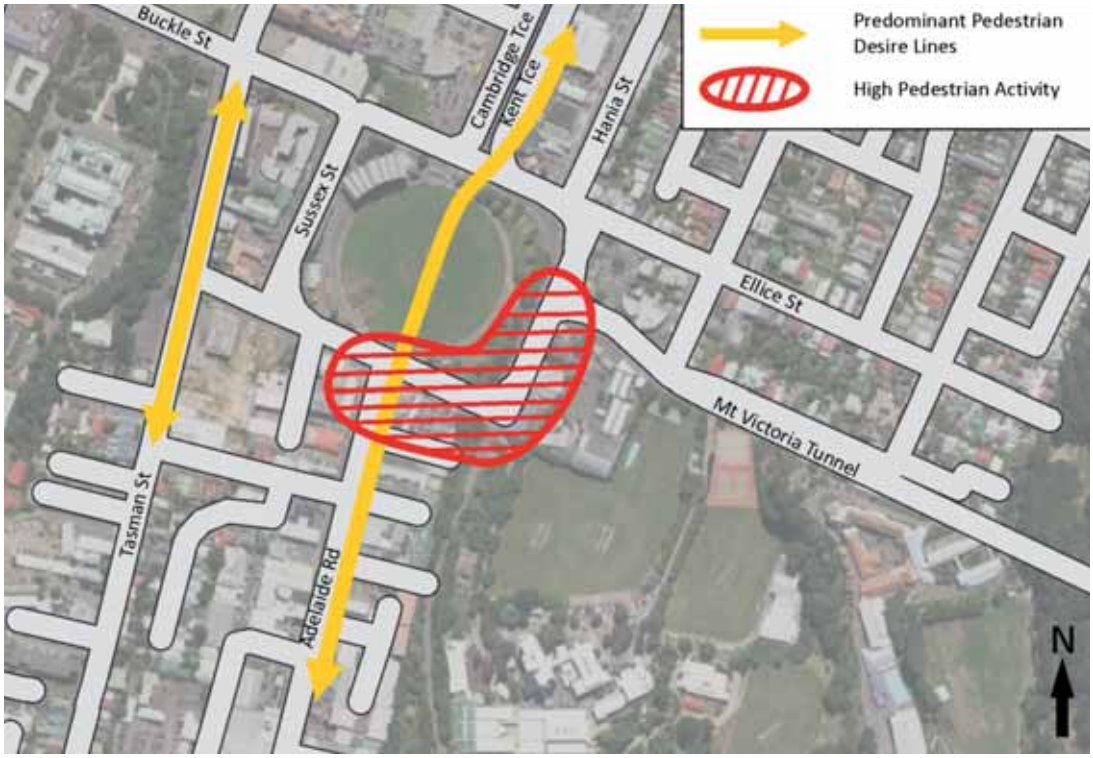
The counts at locations 1 – 5 were taken on Tuesday 10 February 2009 by videotaping the key intersections above between 7:00am and 6:00pm. The numbers in *Figure 5.7* show the total number of pedestrians and cyclist pasting through the intersection for the duration of the counts. Details of specific pedestrians and cyclist movements at each intersections are contained in *Appendix D*.

Pedestrians also cross the road at other uncontrolled locations around the Basin Reserve when traffic flows permit. Numbers of pedestrians making such movements have not been captured in this survey but are expected to be low in comparison to the numbers that cross at controlled crossing points.

5.3.3 Pedestrian / Cyclist Desire Lines

On the basis of the pedestrian / cyclists counts, the key desire lines are assumed to be between Adelaide Road and Kent / Cambridge Terraces.

Key pedestrian desire lines and the zone of high pedestrian activity are shown in *Figure 5.8* below. These desire lines



seem reasonable, but are derived from counts based on one day's observations.

Figure 5.8: Key Pedestrian Desire Lines and High Pedestrian Activity Area

5.4 Design Considerations

There are a number of factors which act as a deterrent to walking and cycling around the Basin Reserve.

- Traffic: High traffic flows around the Basin Reserve are a major deterrent to both pedestrians and cyclists. Pedestrians feel unsafe crossing at informal crossing points and may have to wait (what they feel are) unreasonable times at formal crossing points (signalised and zebra crossings) before being able to cross. Traffic flows and lane configuration make less confident cyclists feel and unsafe and threatened when cycling on the roads around the Basin Reserve.

- Weather: The area around the Basin Reserve is very exposed with no shelter from rain or wind for pedestrians, especially when waiting to cross the road.

- Pedestrian Facilities: There are signalised crossings across Kent and Cambridge Terraces, and at the intersections of Dufferin Street / Paterson Street and Rugby Street / Adelaide Road. However, there are no facilities on the western side of the Basin Reserve between Adelaide Road and Cambridge Terrace. This would act as a barrier for pedestrians wishing to walk along this side of the Basin Reserve and link into facilities further west on the Inner City Bypass.

- Cyclist Facilities: There are very few facilities for cyclists around the Basin Reserve such as marked cycle lanes or

  Toucan crossings. This is a significant deterrent, especially for less confident cyclists who do not wish to cycle in heavy traffic. However, many cyclists ride through the Basin Reserve grounds rather than around the gyratory.

Figure 5.9: Mount Victoria Footpath

- Personal Safety: Many pedestrians may not feel safe walking through either the Basin Reserve or the Mount Victoria tunnel (see *Figure 5.9*) at night time due to a lack of adequate lighting, visibility and the presence of other people. A number of new CCTV cameras have been installed recently in the vicinity of the Basin Reserve, but these focus on monitoring traffic movements and not pedestrian safety.

- The potential impact on pedestrians resulting from the tunnel refurbishment is uncertain. This will need to be considered as options are developed.

All of these factors combined create a lack of amenity around the Basin Reserve which acts as a barrier to walking and cycling and potential discourage people using these modes.

6 School Travel Demand

Three schools are located in the immediate vicinity of the Basin Reserve:

- St Marks' School (Years 1 to 8) with 350 students and 50 staff;
- Wellington College (Years 9 to 13) with 1530 students and 92 staff; and
- Wellington East Girls' College (Years 9 to 13) with 920 students and 115 staff[1].

Schools reported that most staff at the three schools drive to work. There is sufficient on-site parking at each of the schools to accommodate staff vehicles. A small proportion of staff walk, cycle or catch a bus to work.

None of the schools hold specific data on the travel patterns of their staff and students; instead this analysis is based on estimates of the proportion of staff and students utilising each travel mode provided by a staff member at each school.

6.1 School Travel Patterns

These schools contribute significantly to the number of pedestrians, buses, private vehicles to the Basin Reserve area but the exact numbers are difficult to quantify as none of the schools hold data on vehicle movements. When analysing the pedestrian counts for the Basin Reserve, there is a distinctive peak in the number of pedestrians around the Basin Reserve between 3 and 4 pm. This corresponds to the end of school. The number of pedestrians at the key intersections between 3 and 4pm is summarised in *Figure 6.1*. When these counts are compared with the daily pedestrian counts in *Figure 5.7*, we can infer that a high proportion is school students.

At the key intersections of Ellice Street and Dufferin Street, and Ellice Street and Paterson Street 25 to 30 percent of the total daily pedestrians were observed between 3 and 4pm. The McDonalds on Adelaide Road is a key attractor for the secondary students after school. It is more difficult to quantify the number of student pedestrians in the morning since they are typically travelling at the same time as workers walking to the CBD.

The cyclist counts for the area were analysed, but there was no pronounced peak between 3 and 4pm, suggesting that very few students cycle to school and most of the observed cyclists are commuters. This observation is consistent with the mode share estimates provided by the schools.

1 Enrolment figures provided by each school in August 2009

1 = Buckle St/Ellice St/Cambrdige Tce/Kent Tce **4** = Rugby St/Adelaide Rd
2 = Ellice St/Dufferin St **5** = Rugby St/Sussex St
3 = Dufferin St/Patterson St

Figure 6.1: Number of Pedestrians between 3 and 4 pm

6.1.1 St. Mark's School

Figure 6.2: St. Mark's School

Since St. Mark's is a private school it has a large catchment area and no enrolment scheme. Therefore, the students live in a wide range of suburbs and are unlikely to walk or cycle to school. The majority of students at St Mark's School are driven to school. Parents were observed parking in the St. Joseph's Church car park and walking their children across Paterson Street. However, a small proportion of the students also catch the bus to school. There are three dedicated school buses that leave in the afternoon between 3:10 and 3:15; in the morning students are able to share buses with pupils from Wellington East Girls College and Wellington College. Additionally, some students catch regular commuter buses to and from school using the Adelaide Road bus stops.

6.1.2 Wellington College

Figure 6.3: Wellington College

Wellington College estimates that 80% of their students catch a bus to and from school; most use dedicated school buses. There are 13 buses which serve the school in the morning and afternoon. These drop off and pick up students from the dedicated school bus lane on the south-eastern side of Dufferin Street.

In the morning buses arrive between 8:10am and 8:40am, while in the afternoon they depart between 3:25pm and 3:40 pm. Some students also use regular commuter buses to travel to and from the school.

Approximately 10% of the Wellington College pupils drive to school. Year 13 students are permitted to park on school grounds, if there is sufficient space while the remaining students use the on-street coupon parking in Mount Victoria. Roughly 25 students use mopeds to commute to and from school. The remaining students either walk or cycle to school.

The McDonalds on Adelaide Road is a large attractor for students after school which may alter their travel patterns in the afternoon.

Figure 6.4: Wellington East Girls' College

6.1.3 Wellington East Girls' College

The majority of pupils at Wellington East Girls' College use dedicated school buses. Wellington East Girls' College has 9 dedicated school buses in addition to 6 school buses which are shared with the other schools in the area. A few special needs students are dropped off and picked up by taxi. The remaining students either drive or walk to school. The staff at the school did not think any pupils regularly cycle to school.

6.1.4 School Buses

School buses utilise all approaches when travelling to and from the Basin Reserve, including Ellice Street, Paterson Street, Adelaide Road and Kent/ Cambridge Terrace. Many school buses drop off and pick up students on Dufferin Street south of Paterson Street as shown in *Figure 6.5*. Before and after school this area becomes very congested with many buses and students crossing the road and parents dropping off and picking up their children.

School Buses and Student Crossing Patrol

Parents Picking up their Children

Figure 6.5: Photos of the School Bus Stop and Pick Up Area of Dufferin Street

6.2 Design Considerations

The strong pedestrian, bus and vehicle desire lines and movement patterns to and from the schools need to be taken into account. In addition to this these desire lines and key movements, it is critical that bus stop and standing provision (public and school bus) is considered and enhanced where possible. Although the provision of parking is not directly linked to the project objectives, there is a recognised need associated with the schools for parking and safe facilities for parking should be identified as part of the project, particularly if we can minimise the number of pedestrian movements crossing SH1 that are associated with students being dropped off or picked up by car before and after school.

7 Crash History for Roads Close to the Basin Reserve

The road safety analysis for the Basin Reserve is based on the data from NZTA's Crash Analysis System (CAS) for the two year period between the 1st of April 2007 and the 1st of April 2009. The CAS system catalogues fatal, serious, minor and non-injury crashes. There is however no legal requirement to record non-injury crashes where therefore may be understated in this analysis.

Standard practice is to use five years worth of crash data to undertake a complete analysis. However, in this instance a five year analysis period is not possible due to the construction of the Wellington Inner City By-pass (ICB). The completion of the ICB in March 2007 saw major changes to the Wellington road network including the installation of traffic signals at the Adelaide Road / Rugby Street intersection. With traffic patterns having since adjusted; the most recent two year post ICB crash history has been used as the basis for this crash assessment.

7.1 Crash Trends

A total of 103 crashes have been recorded over the two year period in the vicinity of the Basin Reserve. Twenty one of these crashes have resulted in injury, including 2 serious injuries. There have been no fatalities within the Basin Reserve area. Pedestrians and cyclists make up 7 percent of the road users who have been involved in crashes in this area. This is lower than for the CBD as a whole where pedestrians and cyclists make up 15 percent of the road users involved in crashes. There are three peaks in the time of day that crashes are occurring:

- Weekday morning (8-9am);
- Weekday evening (4-7pm); and
- Early hours of the weekend (typically 11pm-3am on Fridays, Saturdays and Sundays).

The weekday crash peaks correspond to the times when there are high volumes of traffic using the Basin Reserve to travel to and from the CBD. The weekend peak is unrelated to normal operational traffic conditions and instead is caused by activities such as 'boy racing'. A number of the crashes occurring during this peak have been caused by excessive speed.

The majority (62%) crashes have occurred at intersections. Environmental conditions (such as wet or dark conditions) have not been a prominent factor in crashes around the Basin Reserve. This percentage is the same for collisions throughout the CBD.

Almost 50 percent of all crashes are of the rear end / obstruction type. This is typical for a highly congested urban area (such as the Basin Reserve). In these locations merging and intersection queuing is often present. With traffic volumes well in excess of 35,000 vehicles per day[1] the potential for this type of conflict is high.

1 NZTA TMS count data base site ID: 01N01076 Paterson St (Sth of Basin Reserve)

7.2 Crash Locations

Any crashes occurring within 35 metres of each other were grouped to identify any locations with a high incidence of crashes. Five key crash locations near the Basin Reserve were found, as shown in *Figure 7.1* and *Table 7.1*.

Figure 7.1: Number of Crashes by Location (Two Year Analysis Period)

Table 7.1: Crash Locations

Crash Location	Total Crashes	Percentage of All Crashes
Adelaide Road / SH1	28	27%
Rugby Street / SH1	17	17%
Tory Street / Buckle Street	13	13%
Paterson Street / Dufferin Street	12	12%
Sussex Street / Buckle Street	11	11%
All other locations	22	21%
Total	**103**	**100%**

Details of the types of crashes and influencing factors at these locations are provided in *Appendix F*.

7.3 Pedestrian and Cyclist Safety

To provide a larger sample size, pedestrian and cyclist crash records for the 5 year period from 1 January 2004 to 31 December 2008 were examined. However, as previously mentioned there have been some infrastructure changes around the Basin Reserve during this time period. For pedestrians and cyclists, the most notable changes are the installation in 2007 of a signalised Toucan crossing for both pedestrians and cyclists, and signalised crossings for pedestrians on Cambridge and Kent Terraces.

During the five year period, a total of 14 pedestrian or cyclist crashes were recorded as shown in *Figure 7.2*. There were 2 serious injuries and 10 minor injuries as a result of these crashes. No fatalities occurred. Despite the intersection of Dufferin Street and Paterson Street being the closest intersection to three schools, there have been no pedestrian or cyclist crashes at this location.

The following sections describe types and seriousness of crashes involving pedestrian and cyclists in different parts of the study area.

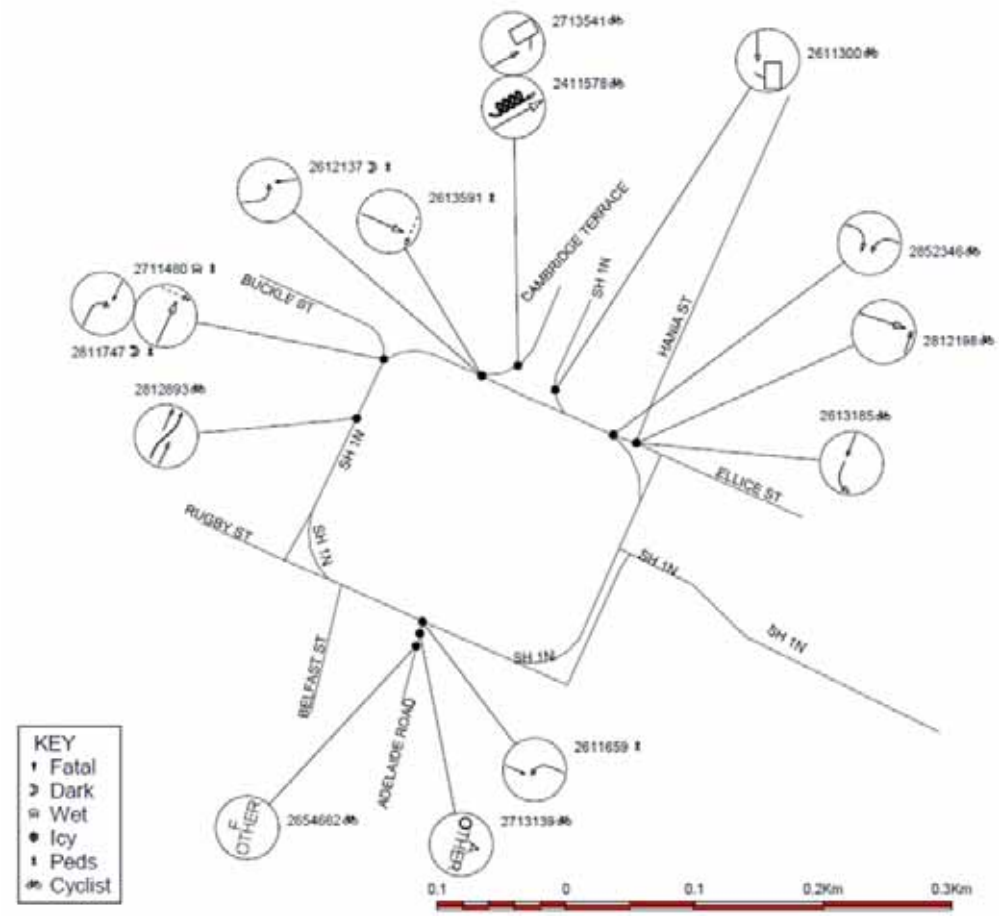


Figure 7.2: Pedestrian and Cyclist Crashes

7.3.1 Intersection of Buckle Street at Kent / Cambridge Terrace and Ellice Street

There have been a total of five collisions in the vicinity of this intersection: two pedestrian crashes and three cyclist crashes. Both pedestrian crashes occurred when a pedestrian was crossing Buckle Street near Cambridge Terrace. Two of the cyclist crashes occurred as a result of motorists opening their door into the path of a cyclist while the third cyclist crash was caused by a bus overtaking a cyclist too closely and causing them to lose control.

7.3.2 Intersection of Ellice Street and Dufferin Street

Three crashes involving cyclists have occurred at this intersection; all three occurred during daylight in fine weather. The crashes were caused by:

- A motorist on Ellice Street failing to give way to the cyclist, resulting minor injuries;
- A motorist and cyclist colliding at a right angle, resulting in a serious injury; and
- A cyclist following a car too closely and hitting its rear end, resulting in minor injuries.

7.3.3 Intersection of Adelaide Road and Rugby Street

There were three crashes recorded at this intersection: two involving cyclists and one involving a pedestrian. Again all crashes occurred during daylight in fine weather conditions. The first crash occurred when a car travelling south on Adelaide Road overtook a cyclist too closely. The second crash was the result of a bus travelling north on Adelaide

Road hitting the rear of a cyclist. Finally, the pedestrian crash occurred when a car turning into Adelaide Road from Rugby Street hit a pedestrian crossing Adelaide Road.

7.3.4 Intersection of Sussex Street and Buckle Street

There were a total of three collisions in the vicinity of this intersection: two involving pedestrians and one cyclist crash. Both pedestrian crashes occurred when a car turning from Sussex Street onto Buckle Street hit a pedestrian crossing Buckle Street, resulting in minor injuries in both cases. The cyclist crash was caused by a cyclist changing lanes and hitting a car on Sussex Street.

7.4 Summary

Based on the above analysis of the crash history of the roads surrounding the Basin Reserve, the following conclusions can be drawn:

- Crashes occurring within the gyratory are unlikely to involve serious injury. The low speed, congested environment means that the majority of crashes are typically non-injury and are of the rear end / obstruction crash type.
- Crashes are most likely to occur within the gyratory during the weekday morning and evening peak periods. These times coincide with the peak movement of people between the suburbs and the CBD. An additional crash peak exists during the early hours of the weekend. On closer inspection these crashes are related to excessive speed. These speed related crashes are particularly evident in the vicinity of Sussex Street.
- In general, environmental conditions are not significant factor in the Basin's crash history. However, as previously mentioned, crashes associated with excessive speed occur at night near Sussex Street.
- Pedestrian and cyclists account for 7 percent of all road users involved in crashes within the last two years. Any Basin Reserve option should look to improve this characteristic by introducing improved pedestrian / cyclist facilities and reducing vehicular conflict.
- Collisions involving cyclists seem to have been caused by driver error, either on the part of the cyclist or vehicle, rather than a lack of facilities. However, improved facilities would reduce the potential for conflict which could reduce the number of crashes.
- A number of the pedestrian crashes, especially those on the western side of the Basin Reserve, are caused by a lack of suitable safe crossing points for pedestrians. Improved facilities would reduce the potential for these crashes.

The majority of crashes are related to the operation of the signalised intersections situated around the Basin Reserve. Conflict occurs between a variety of transport modes and desired movements on a daily basis at these locations.

8 Preliminary Options

8.1 Ngauranga to Airport Strategy Study

The Ngauranga to Airport Strategy Study[1] investigated options to address the transport issues between the Western and Hutt Corridors to the north of Wellington and the Airport and Hospital to the south and east of the City, through the Wellington CBD area. The purpose of the study was to identify the present and future transport needs and possible solutions that support land use, social, business and recreational goals. The study recommended a single option, B3 (later renamed 1A), as the preferred technical scenario to progress to Scheme Assessment. The study also highlighted a need for a high quality passenger transport spine from the Railway Station to Newtown.

Based on the technical work completed as part of the strategy study, the Ngauranga to Wellington Airport Corridor Plan was developed. Improving transport management at the Basin Reserve was identified as an important priority in the plan.

The Corridor Plan has been adopted by the Regional Land Transport Committee and has become part of the Regional Land Transport Programme. As a priority action, the Corridor Plan seeks to implement the Basin Reserve transport initiative within 10 years.

8.2 Inquiry by Design Workshop

NZTA engaged Urbanismplus Ltd in 2008 to facilitate a three day urban design, Inquiry by Design Workshop[2]. The workshop was held to critique the preferred scenario from the Ngauranga to Airport Strategy Study so that robust, well debated and agreed scenarios were produced for the next phase of this project. In advance of the Workshop, a one day scoping session was held. As part of the scoping session 6 supporting strategic scenarios were developed. This was considered the most robust way to spatially interrogate the preferred option from both technical and contextual angles.

Over the three days of the Inquiry by Design workshop an iterative process was adopted in the development of options. Through this process six scenarios were developed in addition to the initial preferred option from the Ngauranga to Wellington Airport Strategic Study and the six strategic scenarios developed during the scoping session (a total of 13 initial options).

By the conclusion of the workshop, the group achieved consensus in selecting five of the thirteen scenarios as the most appropriate for progression to more detailed evaluation and criteria assessment. These five options were provided as a basis for our work and option development and are shown in *Appendix E*.

1 Ngauranga to Airport Strategy Study, Opus International Consultants, 2007
2 Urbanismplus / TTM Consulting, Summary Report on Basin Reserve Workshop, January 2009.

8.3 Preliminary Options

Drawings showing the layout of the five options that warrant further investigation are included in *Appendix E*. A brief description is provided below:

- **Option 1 – Design by Inquiry Workshop Option 1C.** This option involves the realignment of the Kent Terrace approach to Ellice Street, with a new road that branches from Ellice Street to the Victoria Tunnel. Realignment of the Hania and Ellice Street intersection is also proposed. Current roading around the Basin will include a dedicated bus lane. Minor realignment on Dufferin Street, Rugby Street, and Sussex Street is proposed. A new road on an elevated structure is proposed from Paterson Street to Tory Street for west bound traffic.

- **Option 2 – Design by Inquiry Workshop Option 2A.** This option involves the creation of a new elevated structure from Paterson Street to Tory Street for west bound traffic. An on ramp for the elevated structure from Kent Terrace would carry east bound traffic to the Victoria Tunnel. The elevated structure for the new road would be pushed north of Buckle Street (over top of the existing Repco Building). Minor road alignment at grade is proposed between Patterson Street and Cambridge / Kent Terrace, with traffic flow directions being altered; for Rugby and Sussex Streets; and a new alignment for Ellice Street. Through traffic would be on the proposed elevated structure. A new intersection configuration is proposed for Cambridge and Kent Terrace near the new elevated structure. Dedicated bus lanes are proposed around the Basin Reserve. Hania Street access to Ellice Street would be closed under this option.

- **Option 3 – Design by Inquiry Workshop Option 8.** This option involves a similar route alignment as option 2, but with roads at grade. Traffic from Victoria Tunnel would be directed to a new intersection at Cambridge and Kent Terrace north of Buckle and Ellice Streets. Minor road realignment is proposed for the Ellice Street, Patterson Street and Dufferin Street intersection and between Buckle Street and Ellice Street. The left hand turn from Sussex Street to Buckle Street is removed. Dedicated bus lanes around the Basin Reserve are proposed. Hania Street access to Ellice Street would be closed under this option.

- **Option 4 – Design by Inquiry Workshop Option 9A.** This option involves a new intersection and road realignment on Cambridge and Kent Terraces. A new at grade road is proposed between Patterson Street and Cambridge and Kent Terraces to the north of Ellice Street. North bound and east bound traffic is separated. Road realignment is proposed from Adelaide Road to Buckle Street, along Sussex Street. A new intersection at Sussex and Buckle Street is proposed, with a new road extending north of this intersection which will connect to Cambridge Street (at the new intersection). Traffic flow directions are proposed to change along Ellice and Buckle Streets, focussing on west bound traffic. Access to Ellice Street from Hania Street would be closed under this option. A new intersection from Ellice Street to the proposed new road to Kent Terrace is proposed. Dedicated bus routes are proposed on Sussex and Rugby Streets.

- **Option 5 – Design by Inquiry Workshop Option 9B.** This option involves a similar new intersection and road realignment as in Option 9A. The new proposed road north of Sussex Street divides into two roads for north and east bound traffic onto Cambridge Terrace. Road realignment is proposed for the Cambridge / Kent Terrace and Buckle / Ellice Street intersections, including a change in traffic direction. Dedicated bus lanes are proposed for Adelaide Road, Rugby and Sussex Streets.

8.4 Project objectives

NZTA is undertaking this project to:

- Increase the efficiency of through traffic between the Inner City Bypass and Mount Victoria Tunnel.
- Improve the efficiency, reliability and level of service of passenger transport services between Kent / Cambridge Terrace and Adelaide Road.
- Improve safety for those using the transport network within the vicinity of the Basin Reserve.
- Maintain or enhance the present level of service for local traffic between Adelaide Road and Kent and Cambridge terrace, and their connections to SH1.
- Improve pedestrian and cycling access to and around the Basin Reserve and environs, particularly addressing the need for pedestrians to cross significant traffic flows.

In developing options that meet these objectives, the project team will give consideration to:

- Creating options with good economic efficiency.
- Ensuring that the improvements around the Basin Reserve achieve good strategic fit with Government's Roads of National Significance.
- Recognising unique characteristics in the surrounding environment e.g. Basin Reserve, Government House, the proposed Memorial Park and the National War Memorial; education facilities and churches; and spaces of high heritage character.
- Retaining the multi-functional nature of the area including its role as a social and community foci, a centre for recreational use, and the immediate roading network.
- Recognising that the Basin Reserve occupies a pivotal position in the transport network (regional and local), the urban growth spine and Wellington's arterial network.
- Maintaining and enhancing the urban design quality of the area.
- Recognising the relationship to other projects including the Tunnel Refurbishment, the development of Adelaide Road and Buckle Street.

8.5 Considerations for Development of Preliminary Options

The five options were modelled in PARAMICS using the 2009 traffic demand flows. The performance of each option against the following key transportation objectives:

- East west traffic movement (SH1).
- Passenger transport efficiency.
- Safety and capacity issues
- Pedestrian and cycle access.
- Future proofing for enhanced passenger transport.
- Travel time for local trips.

The option performance is only based on the 2009 traffic flow demands since this screening was completed to identify any fatal flaws and if an option fails with 2009 demands, it will also fail in the future. Additionally, the passenger transport efficiency assessment is only based on the journey time. Thus far, the impact of each option on the travel time variability and trip reliability has not been considered.

8.6 Option Performance Summary

The following Chapters 9 – 14 present the performance of the five Inquiry by Design Options against the project objectives. This section provides a high level summary. Understanding of the strengths and weaknesses of each option will help the project team to develop and enhance the options further.

8.6.1 East / West Traffic Movements (SH1)

All options developed in the Inquiry by design workshop, except Option 9b, reduce travel times for motorists travelling towards the west on SH1. In part, westbound travel time reductions on SH1 are achieved by providing a more direct route past the northern side of the Basin Reserve. In each case the distance motorists travel is less than at present where they must deviate around the southern side of the Basin Reserve.

Options 1c and 2a improve travel times by completely separating westbound SH1 traffic from conflicting movements. This means that these options consistently achieve higher travel time reductions (just over a 3 minute saving) in the AM and inter-peaks than Options 8 and 9a (just under a 3 minute saving) which are at –grade.

In the PM peak the grade separated options provide more travel time reductions that Option 8. Option 9a however provides the greatest travel time reduction of just under 3 minutes. The number and complexity of traffic signals proposed for option 9b mean that it would perform worse than the current arrangements.

None of the options reduce eastbound travel times except option 1c, in which travel time reductions are so small as to be almost negligible. All other options increase SH1 eastbound travel time to some degree.

8.6.2 Passenger Transport Efficiency

In all five options there is scope to improve the provision for passenger transport services. Each of the options includes bus priority / lane allocation. In some cases however the addition of new intersections or the requirement to weave across heavily trafficked lanes increases passenger transport travel times.

Option 1c reduces travel times in both directions for every peak. Option 2a also results in some benefit for passenger transport. It is however not forecast to perform better than the existing situation in the PM peak for northbound trips. The two new signalised intersections outside the north-western corner of the Basin Reserve, introduce very small (almost negligible) delays that do not exists for the do minimum scenario.

The effect of Option 8 is also generally positive. Northbound travel times for this option are forecast to be almost the same as for the do minimum scenario. The time taken for southbound trips is forecast to reduce from between about 30 seconds to a minute.

Neither option 9a nor 9b reduces travel times. The smallest travel time increase is of just under 10%. (11 seconds). Peak hour travel times for option 9a increase by as much as a minute and a quarter. Generally travel times for these two options are between a 30 and 50% greater than for the do minimum.

8.6.3 Safety and Capacity Issues

Chapter 11 presents a discussion of the potential issues associated with each option. The preliminary scoping identifies that there is potential to make improvements to each option to address safety concerns relating to:

- Weaving and merging;
- Provision for safe pedestrian and cyclists crossings;
- Queuing and congestion at new signalised intersections; and
- More direct routes for pedestrians and cyclists.

8.6.4 Pedestrian Access to the Basin Reserve

Each of the options improves conditions on roads immediately south of the Basin Reserve (Rugby Street) and close to the schools. This is achieved by re-routing the high volumes of westbound SH1 traffic to the north of the Basin Reserve.

Where SH1 westbound is grade separated (Options 1c and 2a), pedestrian routes are maintained as at present. In these scenarios the ease of crossing and wait times are likely be the same as for the do minimum. Pedestrian and cyclist amenity is likely to change. Option 1c does not adequately cater for pedestrian and cyclist trips from the Mount Victoria Tunnel towards Adelaide Road. This is a flaw that should be resolved.

Some of the options introduce new at-grade intersections north of the Basin Reserve. These new intersections will be heavily trafficked. It will therefore be necessary to provide signalised crossing points (usually at the intersections) to provide for pedestrian safety and the efficiency of SH1. This can increase the number of times pedestrians must wait to cross. Sometimes the increase in traffic volumes on the northern side of the Basin Reserve can increase the length of time pedestrians must wait at signalised crossing or intersections.

Further work is required on each of the options to improve the level of service provided to pedestrians and cyclists. At this stage options 1c, 2a and 8 appear to perform best. Further option development may, however, resolve issues associated with options 9a and 9b.

8.6.5 Future Proofing for Enhanced PT

One of the project objectives is to safeguard for future provision of a high quality passenger transport spine between Kent / Cambridge and Adelaide Road. This is most likely to take the form of bus rapid transit or in the longer term, a light rail system.

Whilst dedicated road space is desirable for bus rapid transit it is not a requirement. Light rail however must have dedicated road space. It is also desirable for safety reasons that light rail has as few intersections as possible.

Options 1c, 2a and 8 all require either passenger transport vehicles to weave across traffic lanes or vice versa. This is most evident on Sussex Street on the western side of the Basin Reserve where motorists driving from the south must weave across the path of buses / trams travelling ahead to Cambridge Terrace. This could make the future implementation of a light rails system particularly problematic.

These options also require motorists to weave across the path of passenger transport services outside the north-eastern side of the Basin Reserve. Each option requires motorists travelling on SH1 Kent Terrace towards the Mount Victoria Tunnel to cross the path of buses / trams travelling ahead to Adelaide Road. The angle at which these paths cross means that the introduction of a new intersection is unlikely to resolve the issue.

Options 9a and 9b both route north and southbound passenger transport services down Sussex Street. Each provides

north and southbound priority lanes which could be later converted to a light rail track. On the northern side of the Basin Reserve passenger transport vehicles are mixed with general traffic. Whilst this is appropriate for buses a light rail system could not be provided without taking more land to provide a dedicated passenger transport lane.

8.6.6 Travel Times for Local Trips

The only option forecast to have lower local travel times that the forecast do minimum is Option 1c. The option is forecast to save around 5 to 20 seconds in each time interval for both (north-south) directions.

Option 2a is expected to have north bound travel times broadly similar to those forecast for the do minimum scenario. Southbound travel times however are forecast to increase by almost a minute in the PM peak. The additional delay results from the introduction of a new traffic movement at the intersection between Paterson and Dufferin Streets.

Options 8, 9a and 9b all increase travel times for motorists travelling in either direction between Adelaide Road and Kent / Cambridge Terraces. This is because of the new at-grade intersections.

9 Option Performance – East / West Traffic Movements (SH1)

Vehicle journey times for the following two routes were extracted from the PARAMICS model and used in the assessment of the SH1 journey times in the eastbound and westbound directions:

- SH1 Eastbound (Willis Street to Evans Bay Parade); and
- SH1 Westbound (Evans Bay Parade to Willis Street).

Table 9.1 and *Table 9.2* show the travel times on SH1 for the westbound and eastbound directions respectively. The percent change from the do-minimum for each of the options is also summarised in the table. Any forecast increases in travel time will need to be mitigated before options are taken forward.

Table 9.1: SH1 Westbound Travel Time –Evans Bay Parade to Willis Street (2009)

Period	Do-min (s)	Option 1c (s)	Option 2a (s)	Option 8 (s)	Option 9a (s)	Option 9b (s)
AM	582	385 (-33.9%)	386 (-33.68%)	418 (-28.22%)	445 (-23.49%)	992 (70.44%)
IP	421	357 (-15.2%)	360 (-14.60%)	388 (-7.89%)	376 (-10.77%)	397 (-5.63%)
PM	654	515 (-21.2%)	544 (-16.79%)	568 (-13.17%)	484 (-26.04%)	925 (41.56%)

Table 9.2: SH1 Eastbound –Willis Street to Evans Bay Parade (2009)

Period	Do-min (s)	Option 1c (s)	Option 2a (s)	Option 8 (s)	Option 9a (s)	Option 9b (s)
AM	397	387 (-2.52%)	398 (0.24%)	424 (7.02%)	940 (137.01%)	433 (9.19%)
IP	356	351 (-1.37%)	360 (1.03%)	385 (8.22%)	407 (14.24%)	364 (2.22%)
PM	402	407 (1.36%)	424 (5.40%)	481 (19.69%)	1094 (172.03%)	458 (13.92%)

9.1 Option 1c

Option 1c results in significant improvements to the journey time on the SH1 road network compared to the do-minimum. Travel time savings of approximately 3, 1 and 2 minutes occur in westbound direction during the AM, IP and PM peak periods respectively. These savings come as a direct result of the grade-separated facility. The grade separation effectively separates SH1 westbound traffic from the local movements. SH1 westbound traffic now effectively moves through two less signalised intersections since the Dufferin Street / Paterson Street and the Adelaide Road / Rugby Street signals are removed from the journey.

Motorists travelling in the eastbound direction experience relatively minor changes compared to those in the westbound direction. A decrease in travel times of approximately 10 and 4 seconds can be expected in the AM and IP peak periods respectively. A slight increase of 5 seconds occurs in the PM peak. The increase in travel time during the PM peak period is likely to be associated with the removal of the existing bus-pre signals on Kent Terrace. In this option, buses will now have to weave within the traffic streams to safely negotiate to Adelaide Road. Any minor increase in the eastbound travel time will be easily offset by the benefits in the westbound direction.

With the journey travel times significantly improving for SH1 westbound traffic, the objective of improving the efficiency of east / west movements on SH1 is fully realised by this option.

9.2 Option 2a

Option 2a performs similarly to that of Option 1c with vast improvements to SH1 travel time performance, particularly in the westbound direction. This is due to the grade-separation of SH1 traffic from the local movements between Kent / Cambridge Terrace and Adelaide Road.

The performance of this option relative to the do-minimum is marginally reduced. However the increased eastbound travel time is easily offset by the substantial travel time savings occurring for westbound SH1 traffic in this Option. The difference between the eastbound SH1 journey times seen in Option 1c and Option 2a is due to the signalised intersection north of the Basin Reserve on Kent / Cambridge Terrace in this option. All eastbound movements will subsequently experience some delay at this intersection and can hence account for the 22 second increase in travel time during the PM peak period.

Similar to Option 1c, the benefits for traffic in the westbound direction far outweigh the increases that occur in the eastbound direction. The objective of improving the efficiency of east / west movements on SH1 is fully realised by Option 2a. This is direct result of the improvements for SH1 westbound traffic brought about through the introduction of a grade-separated structure.

9.3 Option 8

Option 8 results in some improvements to the SH1 road network compared to the do-minimum with travel time reductions in the westbound direction.

Option 8 performs worse than the do-minimum in the eastbound direction, particularly during the PM peak period where an increase in travel time of over a minute can be expected. This occurs due to the introduction of the major at-grade intersection north of the Basin. In the do-minimum, eastbound SH1 movements travelling through the Mount Victoria tunnel are interrupted by the two pedestrian signals located at Dufferin Street and opposite Repco on Kent Terrace. However, Option 8 will add additional delay to these movements as the eastbound motorists now have to wait for westbound SH1 traffic travelling towards the new link to Buckle Street.

For the most part, Option 8 performs better than the do-minimum scenario. However the magnitude of the benefits is much less than those likely for either of the grade separated options.

9.4 Option 9a

Option 9a results in some improvements for westbound SH1 movements, however the travel time reductions in this direction do not compensate for the dis-benefits in the eastbound direction.

The performance of the road network surrounding the Basin Reserve is significantly reduced compared to the do-minimum, especially in the eastbound direction during the AM and PM peak periods. The travel time increases are expected to be in the magnitude of approximately 10 minutes. These increases are related to the complex at-grade design of this option.

While Option 9a results in some improvements for westbound SH1 movement the decreases do not compensate for the dis-benefits in the eastbound direction. As the journey times for the critical SH1 eastbound movements between Willis Street and Evans Bay Parade are substantially worse off than the do-minimum, Option 9a does not meet the objective of improving the efficiency of east / west SH1 movements.

9.5 Option 9b

Similar to Option 9a, Option 9b results in a poorly performing road network surrounding the Basin Reserve. Option 9b is the only option to not have any travel time benefits for the westbound SH1 traffic during the AM and PM peak periods.

Option 9b increases the eastbound travel time during all three peak periods. The increase to journey times is related to the complex at-grade intersection arrangement and the introduction of new signalised intersections.

Option 9b does not meet the objective of improving the efficiency of east / west movements on SH1. Due to the significant travel time increases this option, in its current form, can be considered to be fatally flawed. In other words the intersection operates less efficiently than the existing intersections resulting in negative benefits.

10 Option Performance – Passenger Transport Efficiency

All of the project options have looked to introduce improved bus priority measures around the Basin Reserve to better connect Kent / Cambridge Terrace with Adelaide Road and improve reliability and reduce bus journey times. The efficiency of the bus movements have the potential to vary considerably due to the different intersection and road alignments in each of the options.

Using the PARAMICS model outputs, the journey travel times of bus movements between Kent / Cambridge Terrace and Adelaide Road have been compared between the options and the do-minimum as a measure of passenger transport efficiency. The results of this comparison are summarised in *Table 10.1* and *Table 10.2* for the northbound and southbound directions respectively. The percent change from the do-minimum for each of the options is also summarised in the table.

Table 10.1: Northbound Bus Travel Times 2009 (Adelaide Road to Cambridge Terrace)

Period	Do-min (s)	Option 1c (s)	Option 2a (s)	Option 8 (s)	Option 9a (s)	Option 9b (s)
AM	96	76 (-20.8%)	95 (-1.0%)	98 (2.1%)	177 (84.4%)	118 (22.9%)
IP	99	77 (-22.2%)	90 (-9.1%)	93 (-6.1%)	200 (102%)	148 (49.5%)
PM	100	78 (-22%)	102 (2%)	97 (-3%)	175 (75%)	108 (8%)

Table 10.2: Southbound Bus Travel Times 2009 (Kent Terrace to Adelaide Road)

Period	Do-min (s)	Option 1c (s)	Option 2a (s)	Option 8 (s)	Option 9a (s)	Option 9b (s)
AM	150	98 (-34.7%)	93 (-38%)	100 (-33.3%)	203 (35.3%)	161 (7.3%)
IP	122	104 (-14.8%)	89 (-27%)	96 (-21.3%)	161 (32%)	166 (36.1%)
PM	128	104 (-18.8%)	103 (-19.5%)	101 (-21.1%)	200 (56.3%)	146 (14.1%)

As options are refined, they will all seek to increase reliability through bus priority and improved network efficiency. However, it is important to note that this preliminary assessment focuses only on bus travel times. The PARAMICS model has assumed 2009 traffic demand flows, current bus timetabling and bus dwell times of 20, 30 and 40 seconds during the AM, IP and PM peak periods respectively.

10.1 Option 1c

Option 1c introduces bus priority lanes to circulate the perimeter of the Basin Reserve. It also removes the existing bus-pre signal at the Kent Terrace pedestrian crossing. The removal of SH1 westbound traffic around the southern part of the Basin has resulted in improved passenger transport movements from Adelaide Road to Cambridge Terrace across all peak periods. Journey time savings of approximately 20 seconds will occur during all three peak periods.

In the southbound direction from Kent Terrace to Adelaide Road Option 1c also improves bus journey times by approximately 15 to 50 seconds depending upon the time period. However, this option feature results in buses being required to weave across SH1 eastbound traffic to continue around the Basin Reserve towards Adelaide Road which can be challenging, especially when traffic volumes are high. Option 1c improves the efficiency of passenger transport movements.

10.2 Option 2a

Option 2a improves passenger transport journeys between Newtown and Wellington CBD in a similar manner to that of Option 1c. Bus priority measures are introduced around the perimeter of the Basin Reserve to improve the efficiency of these trips. Option 2a improves bus performance, especially in the southbound direction. However, there is a slight increase in bus journey times during the PM peak period in the northbound direction in comparison to the do-minimum.

The delay for northbound trips is related to the two new signalised intersections as part of Option 2a at the north-western corner of the Basin. Northbound bus movements are delayed at the first intersection to allow Mount Victoria to CBD vehicle trips to access Cambridge Terrace. They are then further delayed at the major intersection connecting the Cambridge / Kent Terrace's with the eastbound new on-ramp facility.

Option 2a improves the efficiency of passenger transport movements. The increases in trip times during the PM peak period are minor considering the improvements that occur during the other time periods.

10.3 Option 8

Similar to the previous options, Option 8 introduces bus priority measures around the perimeter of the Basin. Reductions in bus travel times between Adelaide Road and Kent / Cambridge Terraces occur during all peak periods in both directions, except in the northbound direction during the AM peak. These improvements are most evident in the southbound direction with average bus journey times reduced by at least 30 seconds relative to the do-minimum. A 9 second decrease in travel time also occurs in the northbound direction during the IP period.

Overall, the bus journey time is significantly reduced in Option 8 relative to the do-minimum. The slight increase in the northbound AM travel time is more than offset by the travel time reductions during the other periods.

10.4 Option 9a

Option 9a introduces bus priority measures between Kent / Cambridge Terrace and Adelaide Road around the Western corner of the Basin Reserve. A bus only lane will be available in each direction and will be separated by two northbound general vehicle lanes. This arrangement results in a significant increase to travel times for bus journeys between Adelaide Road and Kent / Cambridge Terraces compared to the existing situation. All peak periods have become less efficient than the do-minimum scenario. During the peak periods, journey time increases of over 1 minute are anticipated to occur for movements in both directions.

The worsened performance can be attributed to the number of signalised intersections that each bus would have to travel through. Delays associated with moving through these new intersections will not improve bus travel times compared to the do-minimum scenario.

10.5 Option 9b

Similar to Option 9a, Option 9b introduces bus priority measures around the western side of the Basin Reserve. Bus only lanes are proposed for Sussex Street and the western end of Rugby Street to allow bus only movements in each direction. As with Option 9a, Option 9b results in an increase in bus travel times across all peak periods compared to the do-minimum situation. These increases are particularly evident during the IP period with increases of at least 35% in each direction. The magnitude of the increases in travel times in Option 9b are significantly less than those occurring in Option 9a. This is because in the southbound direction, bus movements face one less signalised intersection in Option 9b than 9a. In the northbound direction bus movements in Option 9b have a free turn onto Cambridge Terrace unlike Option 9a where they are required to turn left at signalised intersection.

While Option 9b is much improved compared to Option 9a, increases in bus journey travel times still occur across all peak periods relative to the do-minimum.

11 Option Performance – Safety and Capacity Issues

Modifications to the layout and alignments of the road network surrounding the Basin Reserve gyratory will have an impact on both safety and capacity issues. With traffic volumes well in excess of 35,000 vehicles per day[1] the potential for conflict is high.

The proposed options have a number of features that are designed to relieve some of the safety and capacity issues associated with the Basin Reserve. All the options attempt to separate the local and SH1 westbound traffic on the southern side of the Basin Reserve which reduces the potential for conflict. All the options present an opportunity to improve passenger transport capacity and provide better facilities for cyclists. The following sections compare the safety and performance issues of each option compared to the do-minimum scenario.

11.1 Option 1c

The grade separated link for westbound SH1 traffic in Option 1c will remove a large volume of vehicles from the southern side of the Basin Reserve. The removal of these trips reduces the potential for conflict to occur at both the signalised intersections at Dufferin Street / Paterson Street and Adelaide Road / Rugby Street. The closure of Ellice Street from SH1 will also address some of the existing safety concerns at the north-east corner of the Basin.

With SH1 westbound traffic separated, there is the potential for the reprioritisation of available road capacity for local traffic movements around the Basin Reserve. In Option 1c, the existing three lanes of vehicle capacity between Paterson Street and Buckle Street are reduced to one vehicle lane and one bus lane (which is also shared with cyclists). It is recognised that the bus lane may not be heavily used in the Inter Peak, but it is important to retain the bus lane to maintain the corridor width to allow for future transport options. Adherence to bus lane controls will need to be considered as the options are taken forward.

This reduction in the number of lanes for vehicular traffic will eliminate some of the weaving which currently occurs at the Basin Reserve. The provision of cyclist facilities as part of the bus lanes will improve safety for the cyclists who choose to cycle around the Basin Reserve. (Many cyclists choose to cycle through the Basin Reserve rather than around it.) Reduced vehicle volumes south of the Basin Reserve will also minimise the potential for vehicle / pedestrian conflict which could improve pedestrian safety.

Conversely, the reprioritisation of roadway south of the Basin may have some undesired effects for local vehicle movements. The magnitude of congestion relief achieved by this option may be limited due to the reduction in the general vehicle capacity compared to the do-minimum scenario.

Perhaps the most difficult issue created by Option 1c is the safety of pedestrian and cycle movements from Mount Victoria Tunnel to Newtown. In this option, the existing footway on the northern side of SH1 will no longer link to the Dufferin Street / Paterson Street pedestrian signals. No alternative, easy route across the proposed at-grade SH1 eastbound lanes is provided. It is highly likely that both pedestrians and cyclists will subsequently move across the traffic lanes un-aided instead of travelling all the way to the Kent Terrace pedestrian signals to access a safe crossing point. Therefore this option neglects to provide a safe and attractive route for pedestrians and cyclists travelling between Hataitai and Newtown.

1 NZTA TMS count data base site ID: 01N01076 Paterson St (Sth of Basin Reserve)

Detailed design for the area outside the schools on Dufferin Street is yet to be confirmed. However, it is intended that a school drop off zone will be maintained that separates general traffic from school buses and students.

Option 1c will also introduce conflict between bus movements and any traffic wishing to turn left down Buckle Street at the north eastern corner of the Basin.

Overall, the grade separation of strategic traffic from local road movements will reduce traffic conflict and allow the reprioritisation of roadway capacity for local north and southbound movements between Adelaide Road and Kent / Cambridge Terrace. Therefore, Option 1c will, to some degree, address the existing safety and capacity concerns around the Basin Reserve.

11.2 Option 2a

As with Option 1c, Option 2a is characterised by the grade-separation of SH1 westbound traffic and the subsequent reduction in congestion. The removal of SH1 traffic from the southern side of the Basin Reserve will reduce conflicts and therefore improved safety for local vehicular, passenger transport, pedestrian, and cycle movements can be expected.

Similar to Option 1c, Option 2a also reduces the existing three lanes of traffic capacity between Paterson Street to Buckle Street into one vehicle lane and one designated bus lane which can also accommodate cyclists. The provision of these facilities will improve safety for cyclists and will minimise the potential for congestion to occur as a result of any bus breakdown. Due to there being only one general vehicle lane in the proposed arrangement, the potential for weaving to occur around the southern side of the Basin Reserve is also eliminated. However, with the introduction of a bus only lane on the western side of Sussex Street to circulate the Basin, there will inevitably be some conflict associated with traffic desiring to turn left onto Buckle Street. While the number of bus movements is not large, this conflict will be newly introduced by Option 2a. It is recognised that the bus lane may not be heavily used in the Inter Peak, but it is important to retain the bus lane to maintain the corridor width to allow for future transport options. Adherence to bus lane controls will need to be considered as the options are taken forward.

In this option there will also be major safety benefits for pedestrians. The reduction in vehicle volumes south of the Basin Reserve minimises the potential for vehicle / pedestrian conflict. Unlike Option 1c, Option 2a keeps the Ellice Street connection to the gyratory open. This will provide an effective link underneath the grade separated structure permitting a direct and safe route for pedestrians and cyclists for travel towards Adelaide Road. In this layout option, access to the Paterson Street / Dufferin Street signalised crossing is not prohibited. Detailed design for the area outside the schools on Dufferin Street is yet to be confirmed. However, it is intended that a school drop off zone will be maintained that separates general traffic from school buses and students.

Option 2a requires the construction of a large new signalised intersection at the beginning of the proposed on-ramp leading up towards Mount Victoria Tunnel. As part of this arrangement another set of signals will also be provided outside the existing Ellice / Buckle Street entrance to the Basin Reserve. This will inevitably introduce some new conflict to the road network. Pedestrian phases will be included in the signal phasing to help minimise pedestrian safety issues.

Overall, the grade separation of SH1 traffic from local road movements will reduce traffic conflict and allow the reprioritisation of roadway capacity for local north and southbound movements between Adelaide Road and Kent / Cambridge Terrace. Therefore, similar to Option 1c, Option 2a will address the existing safety concerns around the Basin Reserve and provide new capacity for westbound SH1 movements.

11.3 Option 8

Option 8 will shift all SH1 traffic in both the eastbound and westbound directions to the north of the Basin Reserve. Any traffic travelling around the Basin will be local traffic. Similar to the previous grade-separated options, removing the SH1 traffic from the gyratory and shifting it to a separate facility will reduce conflict and improve safety, especially on the southern side of the Basin. However, Option 8 is still not as efficient as the grade separated options due to the new signalised intersection which is required to the north of the Basin Reserve.

By removing the SH1 through traffic from the gyratory the road space around the Basin Reserve can be reallocated to local traffic. The existing three lane arrangement around the southern part of the Basin from the Paterson Street / Dufferin Street intersection through to the Buckle Street / Sussex Street intersection will be reduced to one lane designated for general vehicles and a second lane for buses only. As described in the previous options, this arrangement will reduce the existing weaving and conflict. This reduction in conflict is likely to improve the safety performance of the road for all modes on this section of the network compared to the do-minimum scenario. The bus facilities can also be used for cyclists and will thus improve cycle safety. The safety of pedestrian movements between Mount Victoria Tunnel and Adelaide Road will also be maintained. A pedestrian link can be provided below the SH1 westbound overpass located above Ellice Street. This pedestrian link will allow pedestrians and cyclists to safely cross at the Dufferin / Paterson Street signals. Detailed design for the area outside the schools on Dufferin Street is yet to be confirmed. However, it is intended that a school drop off zone will be maintained that separates general traffic from school buses and students.

While the above aspects of the option design will improve safety around the Basin Reserve, a key feature of this at-grade solution is the introduction of a large signalised intersection linking the SH1 eastbound on ramp and westbound off ramp. The new intersection will also be used by local traffic travelling between Adelaide Road and Kent / Cambridge Terraces. The convergence of these movements at one intersection will result in a high number of trips through it resulting in a very high level of conflict for all modes of travel.

In summary, Option 8 will shift SH1 traffic to the north of the Basin Reserve. The removal of this traffic will improve safety for all road users moving around the Basin Reserve's immediate perimeter. However, the creation of the signalised at-grade intersection to the north of the Basin Reserve will introduce a significant point of conflict. While the design can improve the intersection's safety and capacity performance, having a single node with such high volumes of traffic has the potential to create number of issues which may need to be addressed in the future.

11.4 Option 9a

Option 9a uses an at-grade solution to remove westbound SH1 traffic from the Basin Reserve gyratory. Instead, SH1 westbound traffic will now travel around the north of the Basin, crossing two new signalised intersections at Kent Terrace / Buckle Street and Sussex Street / Buckle Street. The resulting reduction in traffic means the road space on the southern section of the Basin Reserve can be reallocated. The existing three lane cross section between the Paterson Street / Dufferin Street and the Adelaide Road / Rugby Street intersections is reduced to a two lanes in this option. The reduction in the carriageway cross section will address the current issues related the high number of weaving manoeuvres. This will reduce the concerns regarding the weaving which is currently occurring. Detailed design for the area outside the schools on Dufferin Street is yet to be confirmed. However, it is intended that a school drop off zone will be maintained that separates general traffic from school buses and students.

Between Adelaide Road and Buckle Street two lanes of general vehicle capacity will be provided and bus priority measures will be created in both directions. In essence, there will be four lanes along Sussex Street and Rugby Street between Adelaide Road and Buckle Street. To accommodate the southbound bus movements, buses will need to turn right from Rugby Street to Adelaide Road, which will result in increased conflict at this intersection.

To successfully shift SH1 westbound traffic to the northern side of the Basin Reserve and introduce a bus priority corridor along Sussex Street, Option 9a requires the introduction of five new signalised intersections on the northern side of the Basin Reserve. While all the intersections will incorporate signalised pedestrian crossings, their provision will increase vehicular conflict which will likely cause the Basin Reserve's safety record to decline. Overall, Option 9a reduces safety and increases the level of conflict for vehicles travelling around the Basin Reserve.

11.5 Option 9b

Option 9b is virtually the same as Option 9a, except with a revised intersection layout to the north of the Basin Reserve. The general concept is similar to Option 9a in that bus priority measures will be introduced in both directions along Sussex Street. This will require a new right turn movement from Rugby Street into Adelaide Road for buses, which will result in increased conflict levels at the intersection. SH1 westbound movements will be shifted to the northern side of the Basin Reserve creating additional road capacity between the Paterson / Dufferin Street intersection and the Adelaide Road / Rugby Street intersection. Detailed design for the area outside the schools on Dufferin Street is yet to be confirmed. However, it is intended that a school drop off zone will be maintained that separates general traffic from school buses and students.

However as with Option 9a, Option 9b does not separate eastbound SH1 traffic from the local movements heading towards Adelaide Road. Option 9b provides minimal benefits over the do-minimum scenario in terms of both capacity and safety improvements.

Option 9b requires the construction of four new signalised intersections, which will increase the amount of conflict occurring around the Basin and subsequently result in a poor safety record.

12 Option Performance – Pedestrian and Cycle Access

As well as being a central junction for pedestrian travel between Wellington's CBD and the southern and eastern suburbs, there are a number of local attractions for pedestrians around the Basin Reserve. The Basin Reserve is an attraction in itself, with national and international cricket games in addition to concerts and other large festival events. Furthermore, there are a number of educational facilities which generate a large number of pedestrian movements, particularly crossing Paterson Street, and near the bus stops located on Adelaide Road and Cambridge / Kent Terraces.

Businesses that attract pedestrians are also located on the northern and southern side of the gyratory including, number of fast food outlets and petrol stations on Adelaide Road. On Kent / Cambridge Terraces there are car yards, restaurants and commercial premises prior to start of the CBD. The CBD itself is also a major pedestrian generator due to commercial, entertainment and work opportunities.

The existing high traffic volumes at the Basin Reserve are a major deterrent to pedestrian movements between the various attractors. Many pedestrians feel unsafe crossing at informal crossing points and therefore have to wait for significant periods of time to cross at the formal signalised and zebra crossing locations surrounding the Basin Reserve. The conflicting needs for the safe and efficient movement of pedestrians and the circulation of traffic is an important issue to be addressed by the Basin Reserve Improvement Project. The following sections compare the amenity, safety and performance issues for pedestrians in each option compared to the do-minimum scenario.

12.1 Option 1c

The provision of a grade separated structure for westbound SH1 traffic will remove significant volumes of vehicles from the southern portion of the Basin Reserve between Paterson Street and Buckle Street. The removal of these vehicles will create a more pleasant environment for pedestrians with fewer vehicles and associated noise and fumes. Additionally, reduction of the road cross section from three vehicle lanes to one bus lane and one general vehicle lane will shorten the crossing distance for pedestrians. Therefore, the southern side of the gyratory will be much more pedestrian oriented and result in improved safety for school children travelling between the bus stops situated on Adelaide Road and the schools. Option 1c improves access to the Basin Reserve for pedestrians from the southern side of the gyratory.

On the northern side of the Basin Reserve there will be some minor improvements. The existing link between Buckle Street and Kent Terrace / Ellice Street will be removed. This effectively relieves the existing vehicle / pedestrian conflict directly outside the Basin's northern ground entry and means that one less crossing will be required for pedestrian trips to and from the north of the Basin. It will also lead to better amenity values with the grade separated structure acting as a possible archway. The reduction in the number of required pedestrian movements across traffic on the northern side of the Basin will improve access to the Basin Reserve grounds.

However, Option 1c creates a potential problem for pedestrian trips to and from the Mount Victoria Tunnel. The existing footway on the northern side of SH1 will no longer links with the Dufferin Street / Paterson Street pedestrian signals which means there is no easy route across the eastbound lanes for pedestrian. It is highly likely that both pedestrians and cyclists will subsequently move across the traffic lanes un-aided instead of travelling all the way to the Kent Terrace pedestrian signals for a safe crossing point. Therefore, in this option access to the Basin is limited since pedestrians from the eastern suburbs must go all the way to the northern perimeter of the Basin Reserve to use any controlled crossing points.

Option 1c will result in improved pedestrian access to the Basin Reserve grounds. The features proposed as part of Option 1c will in addition provide a safer and more pleasant journey around its southern side.

12.2 Option 2a

Option 2a also provides significant improvements for pedestrian movements. With SH1 traffic shifted away from the gyratory to a grade separated structure, pedestrian access to the Basin and the overall pedestrian amenity of the area will be greatly enhanced from all directions.

The reduced number of circulating lanes around the Basin Reserve means pedestrians will experience less conflict crossing Rugby Street, Sussex Street and Dufferin Street. The amenity of the area will also improve with less traffic congestion which will make it seem more pedestrian orientated. Unlike Option 1c, Option 2a incorporates a connection between the Mount Victoria Tunnel and Dufferin Street for pedestrians; the SH1 traffic will be on an overpass at the north-eastern corner of the Basin, therefore pedestrians will be able to safely cross underneath the overpass and walk towards the Dufferin / Paterson Street signals. This will arrangement will also reduce the number of roads the pedestrians must cross to complete this trip.

At the northern side of the Basin pedestrians will still encounter issues getting from the central islands on Kent / Cambridge Terrace to the Basin Reserve. In Option 2a, traffic travelling from the Mount Victoria Tunnel to the CBD will circulate around the northern perimeter of the Basin Reserve. Therefore pedestrians will encounter conflict issues at the new signalised crossing outside the cricket ground's northern entrance. However, the new signals in this location will provide better protection for pedestrians compared to the existing zebra crossing.

The network layout in Option 2a will significantly improve access to the Basin Reserve and the local schools, particularly from Adelaide Road. The removal of existing SH1 traffic from the area will greatly enhance the amenity of the area for pedestrians and should encourage walking as a viable alternative to driving.

12.3 Option 8

Option 8, one of the at-grade options, achieves similar improvements for pedestrian access to the Basin Reserve as the grade-separated options. By shifting all the SH1 traffic to a large at-grade intersection north of the gyratory pedestrian movements from the south, west and east of the Basin Reserve will significantly improve. The major intersection to the north may off-set some of these benefits, however the presence of the following features will improve upon the do-minimum scenario.

The potential for conflict between pedestrians and buses around the southern portion of the Basin Reserve, between Ellice Street and Buckle Street, will be reduced by the creation of a dedicated bus lane and a one general vehicle lane instead of the current cross section consisting of three lanes. This will also enhance the amenity of the area for pedestrians and improve access to the cricket grounds and schools.

In Option 8, SH1 will pass over Ellice Street, which will allow pedestrians to cross underneath and walk towards the Dufferin Street and Paterson Street signals. With eastbound SH1 movements removed from the Dufferin Street and Paterson Street intersection, pedestrian access to the Basin Reserve from the Mount Victoria tunnel will be much improved since the delays associated with the intersection will be reduced relative to the do-minimum. The reduced delay is a result of the removal of one of the existing pedestrian crossings.

To the north of the Basin Reserve, the existing Ellice Street / Buckle Street and Sussex Street / Buckle Street connections will be removed and a new major intersection will be established to connect the new SH1 alignments. The removal of the Sussex / Buckle Street connection will improve pedestrian connections to the Basin Reserve and CBD from locations to the west such as Massey University. The removal of the Ellice Street / Buckle Street connection will eliminate the existing conflicts at the zebra crossing and allow the creation of an improved entrance to the cricket

grounds. This will improve the amenity of the area. However, these benefits may not fully compensate for the delays created for the north / south pedestrian movements at the major at-grade intersection.

Overall, Option 8 enhances pedestrian access to the Basin Reserve due to the significant improvements made to the southern part of the gyratory.

12.4 Option 9a

Option 9a creates five new signalised intersections on the road network surrounding the Basin Reserve. Each of these intersections includes pedestrian phases, however despite the pedestrian phases; the introduction of new intersections still increases the level of conflict for pedestrians compared to the do-minimum scenario. While the number of crossings required to access different locations in the vicinity of the Basin Reserve may be the same as the do-minimum, the number of vehicles exposed to the pedestrian movements is significantly greater. For example, to access the Basin Reserve from the Kent Terrace bus stop pedestrians must cross two intersections, which is the same as the do-minimum scenario. However the volume of traffic at these crossing points is significantly greater than in the do-minimum resulting in greater exposure for each pedestrian.

Pedestrian exposure also increases at the new Buckle Street / Sussex Street signalised intersection to the west of the Basin, and to the east at the intersection proposed near St Joseph's church.

Unlike the other options, in Option 9a the current 3-lane cross section around the southern portion of the Basin Reserve is maintained. On Rugby Street and Sussex Street two general vehicle lanes will be placed between bus lanes operating in each direction. To provide for these bus movements a new right turn phase must be introduced to the Adelaide Road / Rugby Street intersection. Delays for pedestrian movements can therefore be expected at this location. In Option 9a, there are two lanes for general vehicles between Rugby Street and the Paterson Street off-ramp, which contributes to the creation of an area with similar amenity values for pedestrians compared to the do-minimum.

Option 9a does not improve access to the Basin Reserve compared to the do-minimum scenario. With the introduction of so many new signalised intersections and their associated pedestrian delays, access to the cricket grounds is not any better than the do-minimum scenario. The new intersections raise the level of exposure for pedestrians resulting in increased pedestrian safety concerns. Pedestrian access to the Basin will be more challenging if Option 9a is implemented.

12.5 Option 9b

Option 9b is similar to Option 9a in terms of pedestrian issues except with revised intersection layouts. Option 9b introduces a number of new intersections relative to the do-minimum. While, depending upon the pedestrian's origin and destination, the number of crossings may not increase, the delays associated with these movements will increase. This will not improve access to the Basin Reserve. Also, the number of roads that pedestrians must cross when travelling from locations west of the Basin grounds can be expected to increase compared to the do-minimum.

Similar to Option 9a, Option 9b will increase the level of vehicle exposure pedestrians will face. Along with the two large intersections located at Sussex / Buckle Street and east of the Basin near St Joseph's church, new signals are required at the complex Kent / Cambridge Terrace connection. At this location pedestrians will have to cross eastbound and westbound SH1 traffic as well as the north / south movements between the CBD and Newtown.

With bus a lane in each direction on Sussex Street, a new right turn phase must also be introduced to the Adelaide Road / Rugby Street signals. This will inevitably lead to some delays for the pedestrian movements. The available road capacity is still similar to that of the do-minimum scenario. By maintaining two lanes for all vehicles around the southern side of the Basin, pedestrian amenity will not be improved.

As Option 9b creates new delays and does not significantly alter the amenity values, access to the Basin Reserve for pedestrians is not likely to improve.

13 Option Performance – Future Proofing for Enhanced PT

A key focus of the Ngauranga to Airport Strategy was to provide high quality, reliable and frequent passenger transport systems to connect and serve the proposed growth spines, particularly the intensified mixed use development at Newtown and Kilbirnie. As a result it was determined that the creation of a high quality, reliable and frequent passenger transport link between the railway station and the growth node at Newtown will be a key contributor towards meeting the future transport needs of Wellington City. The Newtown growth node is located near key passenger transport generators such as Wellington Hospital. The combination of population growth with the existing passenger transport generators will make a high quality passenger transport service more viable. Therefore as the city grows and continues to take shape in the way it is envisioned, it will be important to properly design any major changes to the road network with provision for increased passenger transport capacity in the future. For this reason a key objective of the Basin Reserve Improvement Project has been to provide a future proof design so that either a bus-way or light-rail scheme could be implemented in the future, if required.

13.1 Option 1c

Option 1c provides a one directional bus only lane in the lane furthest away from the Basin Reserve Grounds. It is recognised that the bus lane may not be heavily used in the Inter Peak, but it is important to retain the bus lane to maintain the corridor width to allow for future transport options. Adherence to bus lane controls will need to be considered as the options are taken forward.

The southbound bus only lane travels from Kent Terrace, around Dufferin Street, Rugby Street and tying back into Adelaide Road. In the northbound direction the bus lane turns left out of Adelaide Road and goes onto Rugby Street, Sussex Street and right onto Kent Terrace. As the existing capacity on the local roads around the perimeter of the Basin grounds has decreased from three to two lanes in total, there is sufficient room to build a larger passenger transport facility if required.

Similar to the existing arrangement at the north-eastern corner of the gyratory, in Option 1c, bus traffic will have to cross all eastbound SH1 traffic. This complicates the provision of a bus-way or light rail in the future. In this scenario a potential bus-way would have to end prior to Ellice Street then restart after Ellice Street. A light rail option would be more complicated to arrange and some modification to the road layout may be required in the future if light rail is to be implemented.

However, given the proposed layout of Option 1c a bus-way is certainly a possibility. Option 1c is future proofed for increased passenger transport capacity.

13.2 Option 2a

Option 2a provides a similar passenger transport arrangement to that of Option 1c. In both the northbound and southbound directions a bus only lane is provided between Kent / Cambridge Terrace and Adelaide Road. It is recognised that the bus lane may not be heavily used in the Inter Peak, but it is important to retain the bus lane to maintain the corridor width to allow for future transport options. Adherence to bus lane controls will need to be considered as the options are taken forward.

Since the cross section around the Basin Reserve is proposed to decrease from three to two lanes, there is sufficient room to build a larger passenger transport facility if required.

Unlike Option 1c, Option 2a does not require buses to cross all SH1 eastbound traffic near Ellice Street. This movement is instead made further north on Kent Terrace at the bus stop prior to a signalised intersection, which includes the proposed new on-ramp to Mount Victoria Tunnel. However, from this point onwards no interference from other vehicles should be typically expected in the southbound direction. In the northbound direction, buses do not have to complete any crossing movements. However, general vehicles have to cross the bus lane access Buckle Street.

Again light rail is a possibility for the future however, it will be more difficult to construct within the bus lanes included in this option. This is due to the crossing movements that are required at some stage in the road network. Stops will have to be made on the inside of the central islands along Kent / Cambridge Terrace and along a future boulevard on Adelaide Road to avoid any vehicle crossing over the railway lines. However, a bus-way can be easily accommodated within the bus lanes in this option.

Similar to Option 1c, Option 2a is future proofed for increased passenger transport capacity.

13.3 Option 8

Option 8 presents a similar opportunity to that of Option 2a. The bus lanes proposed around the gyratory have the potential to accommodate a much larger passenger transport facility due to the reduction in general vehicle capacity from three lanes into one. In addition, the crossing issues for SH1 bound traffic noted in Option 1c at the north-eastern corner of the Basin grounds near Ellice Street and in Option 2a at the north-western corner of the ground at Buckle Street will not occur in this at-grade option. However as with Option 2a, a movement will be required to get from the Kent Terrace southbound bus stop back into the bus lane.

The designated bus lanes in Option 8 could accommodate a bus-way or light rail, if demand is sufficient in the future and is therefore future proofed for increased passenger transport capacity. Option 8 does not have any of the crossing issues for traffic heading towards Buckle Street or Mount Victoria Tunnel from locations within the gyratory.

13.4 Option 9a

The complex at-grade intersection arrangement required for Option 9a makes it difficult to accept as a future proofed option. Option 9a has bus lanes located on the western side of the Basin Reserve. Both northbound and southbound bus movements would be permitted along Sussex Street and the western half of Rugby Street. This requires the buses to cross a number of new intersections and merge with highly concentrated traffic, especially for buses travelling southbound. The southbound buses must travel along Buckle Street along with all the westbound SH1 traffic and then make a right turn from Rugby Street to Adelaide Road. The establishment of a larger passenger transport facility may also be difficult to achieve in the road space available.

Currently Sussex Street has a three lane cross section. Some parking has to be removed to accommodate the four lane cross section planned as part of Option 9a. Therefore, it may be difficult to create a larger passenger transport facility in this area.

Any large scale passenger transport facility such as light rail or a bus-way will be difficult to implement in this option.

13.5 Option 9b

As with Option 9a, Option 9b locates bus lanes on the western side of the Basin Reserve grounds. Both northbound and southbound bus movements are located on Sussex Street and the western half of Rugby Street. This requires passenger transport vehicles to cross a number of new intersections and merge into highly concentrated traffic. This is particularly evident for passenger transport travel in the southbound direction with movements required into SH1 westbound traffic along Buckle Street and then a right turn across traffic is also needed to get from Rugby Street into Adelaide Road.

Similar to Option 9a, the establishment of a larger passenger transport facility may also be difficult to achieve in the road space available. The two bus lanes and two lanes of northbound general vehicle capacity use the entire available road carriageway on Sussex Street.

Any large scale passenger transport facility such as light rail or a bus-way will be difficult to implement in an Option 9b layout without significant additional changes to the road network.

14 Option Performance – Travel Times for Local Trips

Newtown is considered a key future growth node within Wellington City. This future growth is expected to result in a large influx of trips between Newtown and the CBD. While reducing the travel time for local trips is not an objective of the Basin Reserve Improvement Project, it is still important to consider the impact of any option on the travel time between Adelaide Road and Kent / Cambridge Terrace.

PARAMICS model outputs have been used to assess the journey times for general vehicle movements between Kent / Cambridge Terrace and Adelaide Road. In this analysis a comparison has been made between each option and the do-minimum as a measure of the relative efficiency of these movements. *Table 14.1* and *Table 14.2* summarise the journey times for each of the options and do-minimum scenario for the local road movements along Adelaide Road and Kent / Cambridge Terrace. The percent change from the do-minimum to each option is also summarised in the tables.

As mentioned earlier, all of the proposed project options reduce the road space available for general vehicles around the Basin Reserve and reprioritise it for passenger transport movements instead. For this reason, it can be expected that the benefits of the project options are likely to be low for general vehicle movements.

Table 14.1: Northbound Journey Times (Adelaide Road to Cambridge Terrace)

Period	Do-min (s)	Option 1c (s)	Option 2a (s)	Option 8 (s)	Option 9a (s)	Option 9b (s)
AM	73	59 (-19%)	74 (2%)	78 (8%)	170 (134%)	112 (55%)
IP	67	55 (-19%)	65 (-4%)	76 (13%)	156 (132%)	125 (86%)
PM	71	58 (-19%)	77 (9%)	124 (75%)	146 (106%)	94 (33%)

Table 14.2: Southbound Journey Times (Kent Terrace to Adelaide Road)

Period	Do-min (s)	Option 1c (s)	Option 2a (s)	Option 8 (s)	Option 9a (s)	Option 9b (s)
AM	96	77 (-20%)	77 (-19%)	96 (0%)	206 (115%)	-
IP	79	69 (-13%)	83 (4%)	90 (14%)	171 (117%)	-
PM	86	82 (-5%)	137 (59%)	120 (39%)	205 (138%)	-

14.1 Option 1c

Option 1c reduces the existing capacity around the Basin gyratory to accommodate a designated passenger transport lane in both the north and southbound directions. With the removal of SH1 westbound traffic from the Basin's circulating lanes and with no introduction of new intersections, the travel times of local trips between Adelaide Road and Kent / Cambridge Terraces has improved.

The improvements are particularly evident in the northbound direction with travel times reduced by 19% across all peak periods. An improvement for southbound travel is also present across all peak periods. In particular, journey times in the AM peak will be reduced by up to 19 seconds. The travel time in the PM peak is only reduced by 5%.

Option 1c will improve the average journey time for vehicles across all peak periods between Newtown and the CBD in both directions.

14.2 Option 2a

Option 2a is similar to Option 1c in that it introduces bus priority measures around the Basin gyratory. The amount of road space that is available for general vehicles is reduced to accommodate the bus lanes. Additionally, Option 2a incorporates a new signalised intersection to the north of the Basin Reserve to allow SH1 eastbound traffic to enter the new on-ramp structure. Even with the removal of SH1 westbound traffic from the perimeter of the Basin through the provision of a grade separated structure, the new signalised intersection adds some new delay for trips between the CBD and Newtown. For this reason the improvements seen in Option 1c are not possible in Option 2a.

In Option 2a journey time improvements occur during the AM peak in the southbound direction and during the IP period in the northbound direction. Generally, Option 2a results in worse performance across the other peak periods due to the delays associated with the new intersection. Of particular note is that during the PM peak southbound trips are much worse when compared to the do-minimum. An increase in 51 seconds can be expected during this time.

As Option 2a does not substantially improve the journey times of local trips this will be an important factor to consider when considering the overall performance of this option.

14.3 Option 8

Similar to the previous options, Option 8 introduces bus priority measures around the perimeter of the Basin. However this option also introduces a large at-grade intersection to the north of the Basin Reserve. The delay associated with the operation of this intersection negatively affects local trip movements in both the north and southbound direction.

These local trips, in both directions, are particularly impacted as a result of this at-grade option during the PM peak period. In the northbound direction an increase of 53 seconds is anticipated, while in the southbound direction an increase of 34 seconds is predicted. Option 8 provides no benefits for local trips. Therefore, the wider benefits of this option will need to be significant to offset the increase delay for local trips and ensure the overall transport network operates efficiently.

14.4 Option 9a

Option 9a introduces bus priority measures between Kent / Cambridge Terrace and Adelaide Road around the Western corner of the Basin gyratory. A number of new intersections will also be constructed to the north of the Basin Reserve. Southbound local trips will now become delayed at new intersections north of Buckle Street at the new Ellice Street and reconfigured Adelaide Road intersections. In the northbound direction local trips will be delayed at a new signalised Buckle / Sussex Street intersection and at the signalised connection onto Cambridge Terrace.

The delay associated with these new intersections results in significant increases in the travel time for local trips between Adelaide Road and Kent / Cambridge Terraces compared to the existing situation. Across all peak periods and in both directions, journey times are expected to increase by over one minute. The southbound PM peak is the most affected with increases in travel times of almost two minutes. Option 9a will not improve on the existing situation for local trips.

14.5 Option 9b

Similar to Option 9a, Option 9b again proposes to introduce bus priority measures around the western side of the Basin gyratory. Bus only lanes are proposed for Sussex Street and the western end of Rugby Street to allow the possibility of bus only movements in each direction. As with Option 9a, Option 9b results in an increase in local travel times across all peak periods. It should be noted that the PARAMICS model did not record travel times in the northbound direction for local trips.

While Option 9b is much improved compared to Option 9a, local journey times still increase across all peak periods. Option 9b is again much worse than the do-minimum scenario for local movements.

15 Conclusions

This section provides a high level summary of the five Inquiry by Design Options against the project objectives since understanding of the strengths and weaknesses of each option will help the project team to develop and enhance the options further.

15.1 East / West Traffic Movements (SH1)

All options developed in the Inquiry by design workshop, except Option 9b, reduce travel times for motorists travelling westbound on SH1. The grade separated options (Options 1c and 2a) achieve higher travel time reductions than the at-grade options (Options 8 and 9a).

For the eastbound direction all the options either increase the travel time or essentially have a negligible impact.

15.2 Passenger Transport Efficiency

While all five options include bus priority / lane allocation, the provisions for passenger transport in all the options could be further enhanced. The addition of new intersections or the requirement to weave across heavily trafficked lanes increases passenger transport travel times. Options 1c and 2c have positive impacts on the bus travel times, Option 8 is also generally positive and Option 9a and 9b increases the travel time for buses relative to the do minimum.

15.3 Safety and Capacity Issues

There is potential to make improvements to each option to address safety concerns relating to:

- Weaving and merging;
- Provision for safe pedestrian and cyclists crossings;
- Queuing and congestion at new signalised intersections; and
- More direct routes for pedestrians and cyclists.

15.4 Pedestrian Access to the Basin Reserve

Pedestrian conditions on the roads immediately south of the Basin Reserve (Rugby Street) and close to the schools is improved by re-routing the high volumes of westbound SH1 traffic to the north of the Basin Reserve. However, some of the options introduce new intersections which, for certain journies, increase the number of intersections that pedestrians have to cross.

Further work is required on each of the options to improve the level of service provided to pedestrians and cyclists. At this stage options 1c, 2a and 8 appear to perform best. Further option development may, however, resolve issues associated with options 9a and 9b.

15.5 Future Proofing for Enhanced PT

One of the project objectives is to safeguard for future provision of a high quality passenger transport spine between Kent / Cambridge and Adelaide Road. Whilst dedicated road space is desirable for bus rapid transit, it is not a requirement. Light rail however must have dedicated road space. It is also desirable for safety reasons that light rail has as few intersections as possible.

Options 1c, 2a and 8 all require either passenger transport vehicles to weave across traffic lanes or vice versa. This could make the future implementation of a light rail system particularly problematic.

Options 9a and 9b both provide northbound and southbound priority lanes which could be later converted to a light rail track, however on the northern side of the Basin Reserve passenger transport vehicles are mixed with general traffic. Whilst this is appropriate for buses, light rail would require more land to provide a dedicated passenger transport lane.

15.6 Travel Times for Local Trips

Only Option 1c is forecast to have lower local travel times than the do minimum.

Local northbound travel times for Option 2a are expected to be broadly similar to those forecast for the do minimum scenario. However, southbound travel times however are forecast to increase by almost a minute in the PM peak.

Options 8, 9a and 9b all increase travel times for motorists travelling in either direction between Adelaide Road and Kent / Cambridge Terraces. This is because of the new at-grade intersections.

15.7 Next Steps

This transportation technical note has documented the existing and forecast future transport conditions in Wellington and at the Basin Reserve. The options developed during Inquiry by design have been reviewed to identify areas for improvement. The next stages of the project will build upon this work by identifying revisions / improvements. Amendments will seek to avoid / mitigate the negative aspects of each option of to magnify the positive attributes. Any changes to these initial options will need to make account of the broader context in which the project is being designed (i.e. some transport enhancements may not be appropriate given the social or environmental considerations.

Appendix A
WTSM Do Minimum Network

WTSM Do-Minimum Network inclusions from the WTSM Update –Baseline Forecasting Report prepared by SKM January 2008.

Projects	2006	2016	2026	DoMin Network	Description	Model Changes
MacKays Crossing Overbridge	Y	Y	Y	Y	Grade separation of SH1 and the rail crossing and local roads at MacKays crossing. Refer to Appendix A1 for layout. Construction now complete.	Grade separation implemented as no intersection delay
Inner City Bypass	N	Y	Y	Y	New road layout including new signals between the Terrace Tunnel and the Basin Reserve. Refer to Appendix A2 for layout. Construction now complete.	Implemented
Waiohine Bridge	N	Y	Y	Y	Bridge replacement	No changes implemented as no change in capacity
Centennial Highway Median Barrier - Stage 1	Y	Y	Y	Y	Median barrier installation on SH1	No changes implemented as no change in capacity
Centennial Highway Median Barrier - Stage 2	N	Y	Y	Y	Median barrier installation on SH2	No changes implemented as no change in capacity
Dowse to Petone Interchange	N	Y	Y	Y	Currently under construction	Implemented
Basin Reserve Improvements	N	Y	Y	N	Grade separation in accordance with MWH option F. Refer to Appendix A3 for layout.	Implemented
Kapiti Western Link Road - Stage 1	N	Y	Y	Y	Construction of the WLR Stage 1	Implemented
Kapiti Western Link Road - Stage 2	N	Y	Y	Y	Construction of the WLR Stage 2	Implemented
Kapiti Western Link Road - Stage 3	N	Y	Y	Y	Construction of the WLR Stage 3	Implemented
Melling Interchange	N	N	Y	N	Grade separation of SH2 and Melling bridge. Refer to Appendix A5 for layout.	Implemented
Kennedy Good Bridge Grade Separation	N	N	Y	N	Grade separation of SH2 and Kennedy Good bridge. Refer to Appendix A6 for layout.	Implemented
Rimutaka Corner Easing (Muldoon's)	N	Y	Y	N	Geometric improvements on SH2 Rimutaka Hill Road	No changes implemented as no change in capacity

SH2/58 Grade Separation	N	Y	Y	N	Grade separation of SH2 and SH58. Refer to Appendix A7 for layout.	Implemented
Rugby St / Adelaide Rd Intersection	N	Y	Y	Y	Rugby St / Adelaide Rd Intersection signalisation and amendments to lane markings. Refer to Appendix A10 for layout. Construction completed.	Implemented
Ngauranga to Terrace Tunnel ATMS	N	Y	Y	Y	New ATMS infrastructure (VMS signage, cameras etc.) on SH1 between Ngauranga and the Terrace Tunnel.	No changes implemented
Petone to Ngauranga ATMS	N	Y	Y	Y	New ATMS infrastructure (VMS signage, cameras etc.) on SH2 between Petone and Ngauranga.	No changes implemented
Otaki Roundabout	N	Y	Y	Y	Additional circulating lanes installed on the Otaki Roundabout	Implemented
Old Hautere Road Safety Improvements	N	Y	Y	Y	Intersection safety improvements	No changes implemented
Paekakariki Improvements	N	Y	Y	Y	New seagull layout at the SH1 / Paekakariki Hill Road / Beach Road. Refer to Appendix A8 for layout.	Implemented
Pukerua Bay Improvements	N	Y	Y	Y	Safety improvements at intersections.	No changes implemented as no impact on capacity
Otaki to Waikanae Sth Bd PL	N	Y	Y	Y	SH1 Otaki to Waikanae southbound passing lane - location is from RP 1012/0.47 to RP 1012/2.25 approx.	Not coded in model
Featherston to Greytown Nth Bd PL	N	Y	Y	Y	Northbound passing lane located between Featherston and Greytown	Not coded in model
Greytown to Featherston Sth Bd PL	N	Y	Y	Y	Northbound passing lane located between Featherston and Greytown	Not coded in model
Carterton to Masterton Nth Bd PL	N	Y	Y	Y	Northbound passing lane located between Carterton to Masterton	Not coded in model
Masterton to Carterton Sth Bd PL	N	Y	Y	Y	Southbound passing lane located between Masterton to Carterton	Not coded in model

Judgeford Passing Lane	N	Y	Y	Y	Unknown - check with Transit	Not coded in model
Petone - Horokiwi Cycling Facility						No changes implemented as no impact on capacity
Teihana Road Pedestrian Facilities						No changes implemented as no impact on capacity
Wellington State Highway Strategy						No changes implemented as no impact on capacity
SH2 Petone to Hayward Safety Review						No changes implemented as no impact on capacity
Wellington Cycle Strategic Audit						No changes implemented as no impact on capacity
TDM Impacts	N	Y	Y	Y	Impacts of TDM strategy - the RLTS assumes 5% reduction in trips to the CBD.	Revised approach implemented
Lindale Grade Separation	Y	Y	Y	Y	Already constructed.	No connections in model to modify
Mana - Plimerton Upgrade	Y	Y	Y	Y	Already constructed.	Implemented in 2006 base
Waterloo Quay Rail Grade Separation	N	Y	Y	N	Grade separation of Aotea Quay and the rail line to the port.	Not to be included in the model
Terrace Tunnel Tidal flow	N	Y	Y	N	Installation of two vs one lane tidal flow in the peak periods through the Terrace Tunnel	Implemented
Ngauranga – Aotea Capacity Improvement	N	Y	Y	N	8-laning of SH1 between Ngauranga and Aotea Quay offramp.	Implemented
Grenada - Gracefield Stage 1 to Petone	N	Y	Y	N	New link between SH1 (Grenada North) and SH2 (Petone).	Implemented
Grenada - Gracefield Stage 2 CVL	N	N	Y	N	New link between SH2 (Petone) and Gracefield.	Implemented
SH58 SH2- summit 4 laning	N	N	N	N	4-laning from SH2 to the summit	
Petone - Ngauranga incl cyclelane	N	Y	Y	N		No changes implemented as no impact on capacity

Akatarawa Upgrade	N	N	N	N		
TDM, Western Corridor ATMS+HOV	N	N	N	N		
Transmission Gully Motorway Construction	N	Y	Y	N	Transmission Gully Motorway constructed between MacKays crossing and Linden with all connections as per the Beca Costed viaduct option. Refer to Appendix A9 for layout. Capacity across Mana Bridge reduced to one lane in each direction.	Implemented
SH58 upgrade TGM to SH2	N	N	Y	N	Roundabouts at 7 locations & 70 km/h treatment: • Roundabout at Bradey Road • Roundabout at Sawmill • Roundabout at Belmont Road • Roundabout at Murphys Rd / Flightys Rd • Roundabout at Mulhern Rd • Roundabout at Judgeford Golf Club entrance • Roundabout at Moonshine Road • 70 km/h speed limit from Pauatahanui to Moonshine Road Existing alignment with 100 km/h speed limit from Moonshine	Not implemented in the model
Otaihanga Interchange (2 lane)	N	Y	Y	N	Grade separation of SH1 and Otaihanga Road	Implemented
Waikanae Upgrade	N	N	Y	N	Grade separation of SH1 and Te Moana and Elizabeth Street in Waikanae	Implemented
Rail Station Maintenance and Upgrade	N	Y	Y	Y		No changes implemented in model
Park & ride Carparks	N	Y	Y	Y		No changes implemented in model
Porirua Interchange	N	N	N	N		

Kaiwharawhara Throat Improvements	N	Y	Y	Y	Additional capacity at the Kaiwharawhara throat. Improved reliability.	Not implemented in the model
Integrated Ticketing	N	Y	Y	N	Reduced boarding time as a result of improved ticketing	Reduction in boarding penalty of 0.5 minute
Integrated Fares	N	Y	Y	N	Passengers can pay for whole journey independent of operator	No boarding fare for 2nd/3rd boardings in assignment
Real Time Information Systems	N	Y	Y	N	New automated passenger information signs	1 minute reduction in boarding times based on 5% fare and VoT $6/h
Buslanes	N	Y	Y	N		Implemented
Road Pricing	N	N	N	N		Not implemented in the model

Appendix B
Traffic Data

Volume Capacity Diagram for 2006 Do minimum AM Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagrm

AM

PM

All

P:\projects\5C1617.00 Basin Reserve SAR\900 Modelling\SATURN_v2\Flow PDF

Remember to update the footer when you change options >>>

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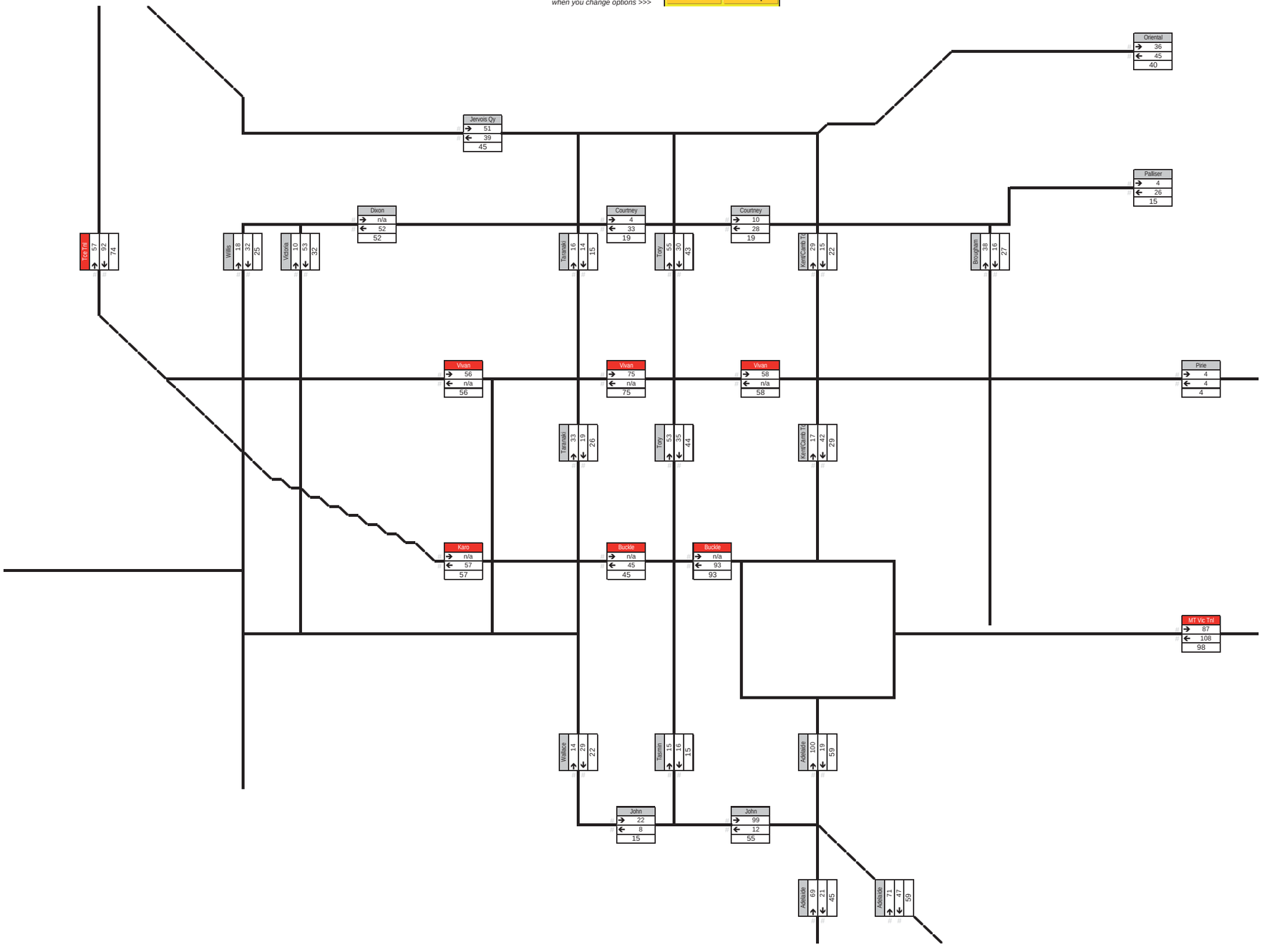
User Class	All
Period	AM
Current Situation	
Footer	Print Opt

(All, 1, 2 or 3. only applied to "h" scenarios)

All flows are in PCUs



Prepared by: Bob Hu
Reviewed by: Roger Burra
WCC_vc Diagram.xlsm:pdk:11/18/2009@10:02 AM

Page 1 of 1

Volume Capacity Diagram for 2006 Do minimum Inter Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagram

PM

All

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Footer	Print Opt

(All, 1, 2 or 3. only applied to "h" scenarios)

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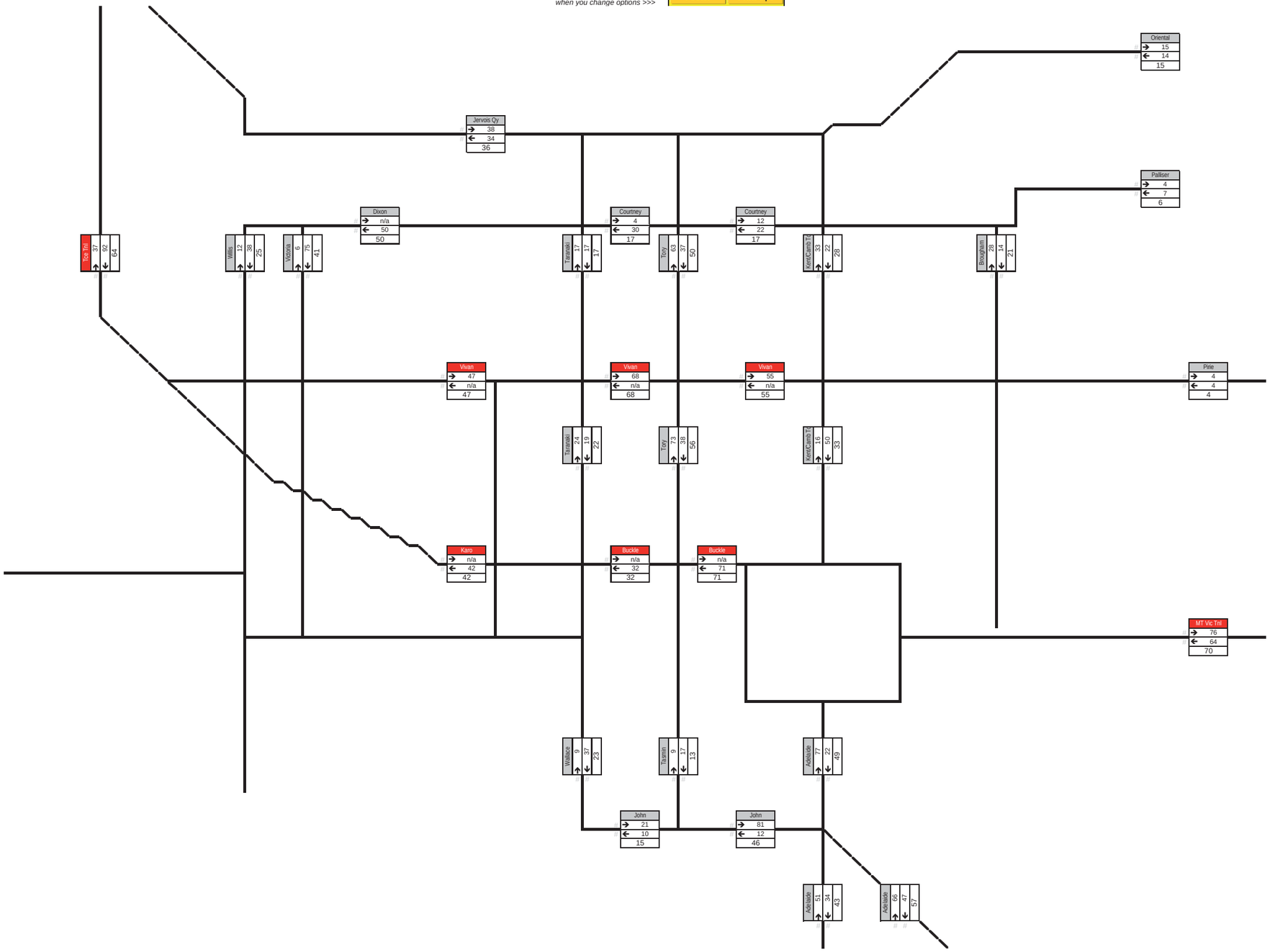

Prepared by: Bob Hu
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Page 1 of 1

Volume Capacity Diagram for 2006 Do minimum PM Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagrm

PM

All

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Remember to update the footer when you change options >>>

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Footer	Print Opt

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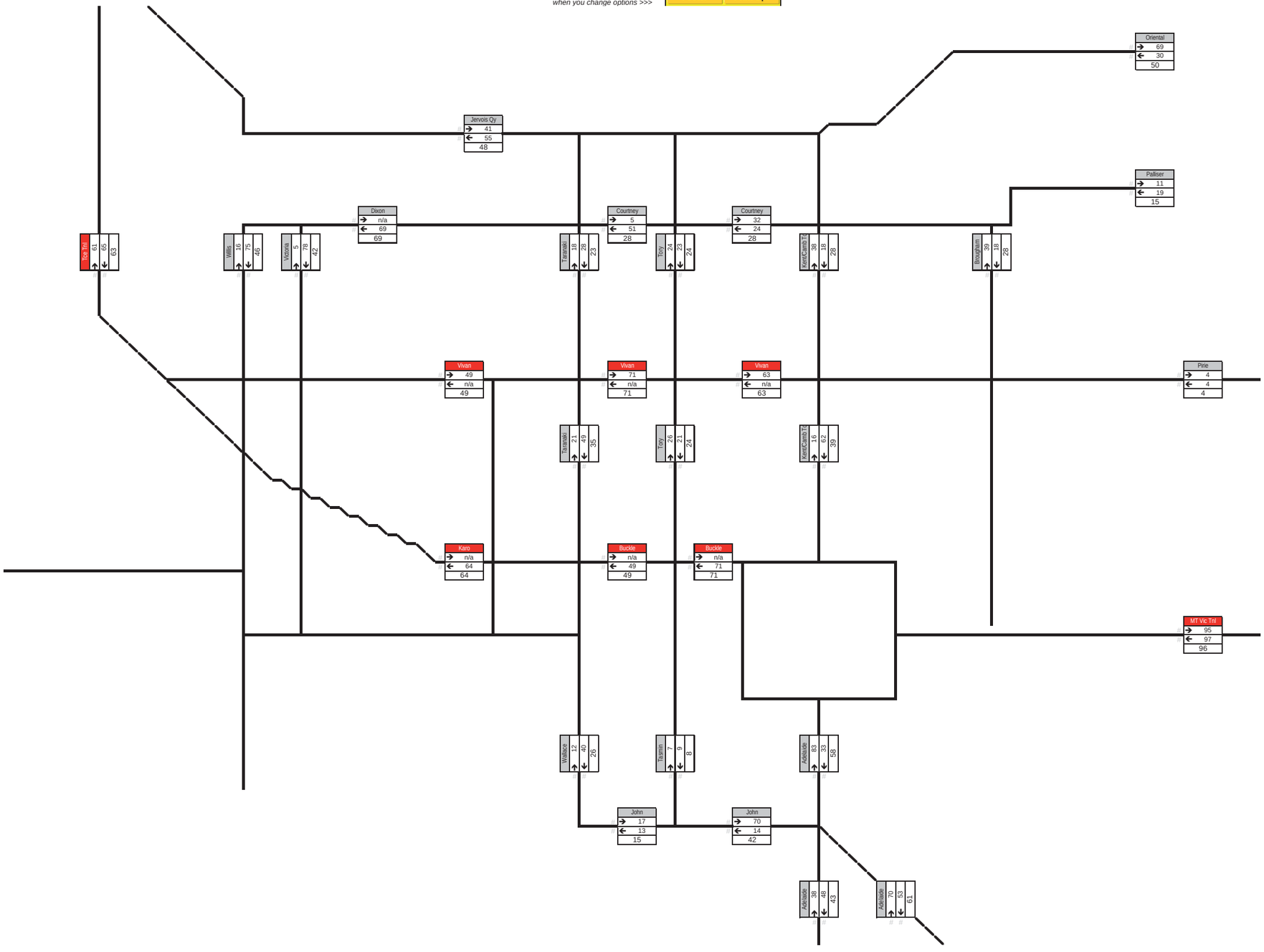

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Volume Capacity Diagram for 2016 Do minimum AM Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagram

PM

All

P:\projects\5C1617.00 Basin Reserve SAR\900 Modelling\SATURN_v2\Flow PDF

Remember to update the footer when you change options >>>

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Period	AM
Do-Minimum	
Footer	Print Opt

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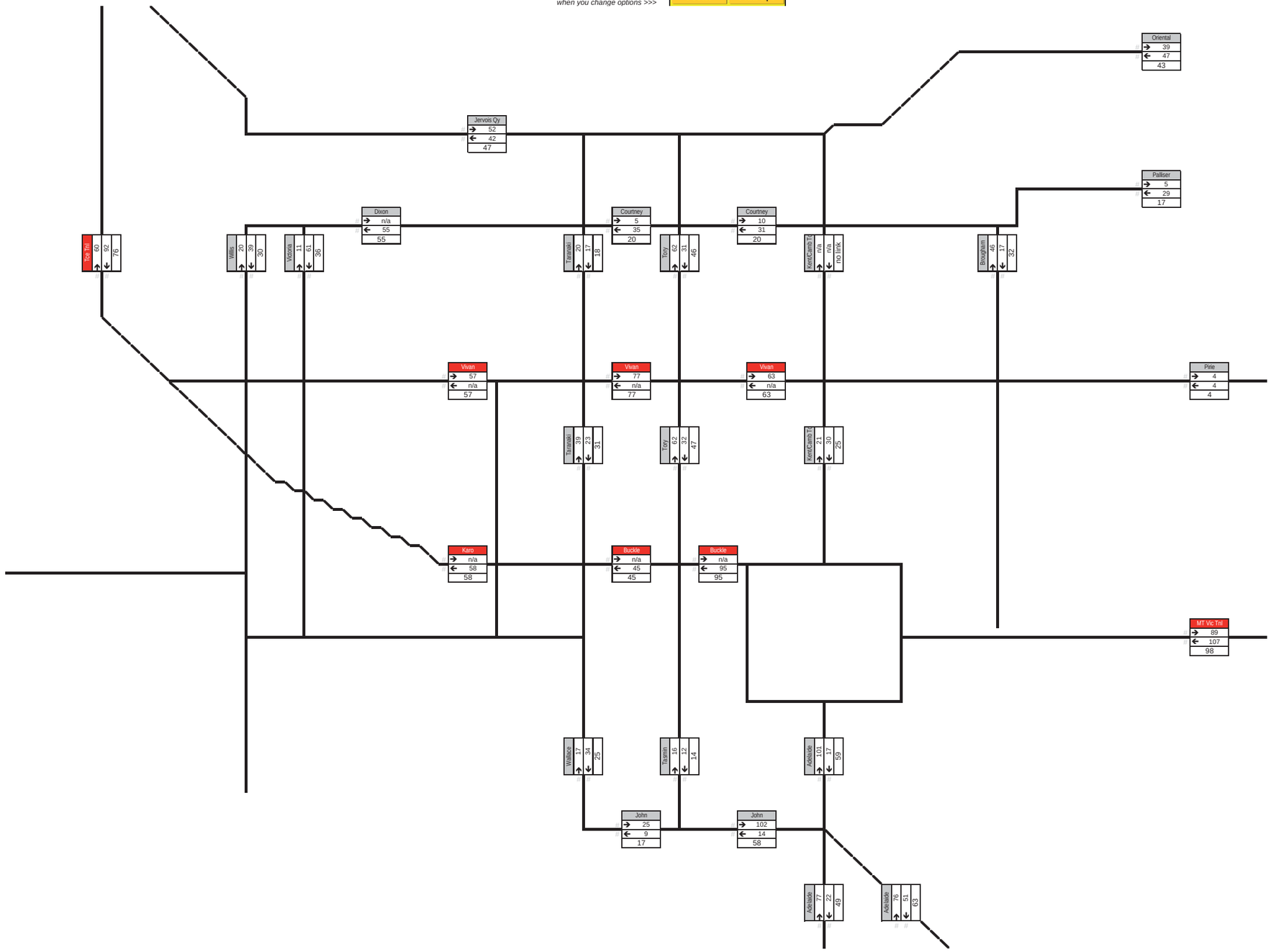

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Page 1 of 1

Volume Capacity Diagram for 2016 Do minimum Inter Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagrm

PM

All

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Remember to update the footer when you change options >>>

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Footer	Print Opt

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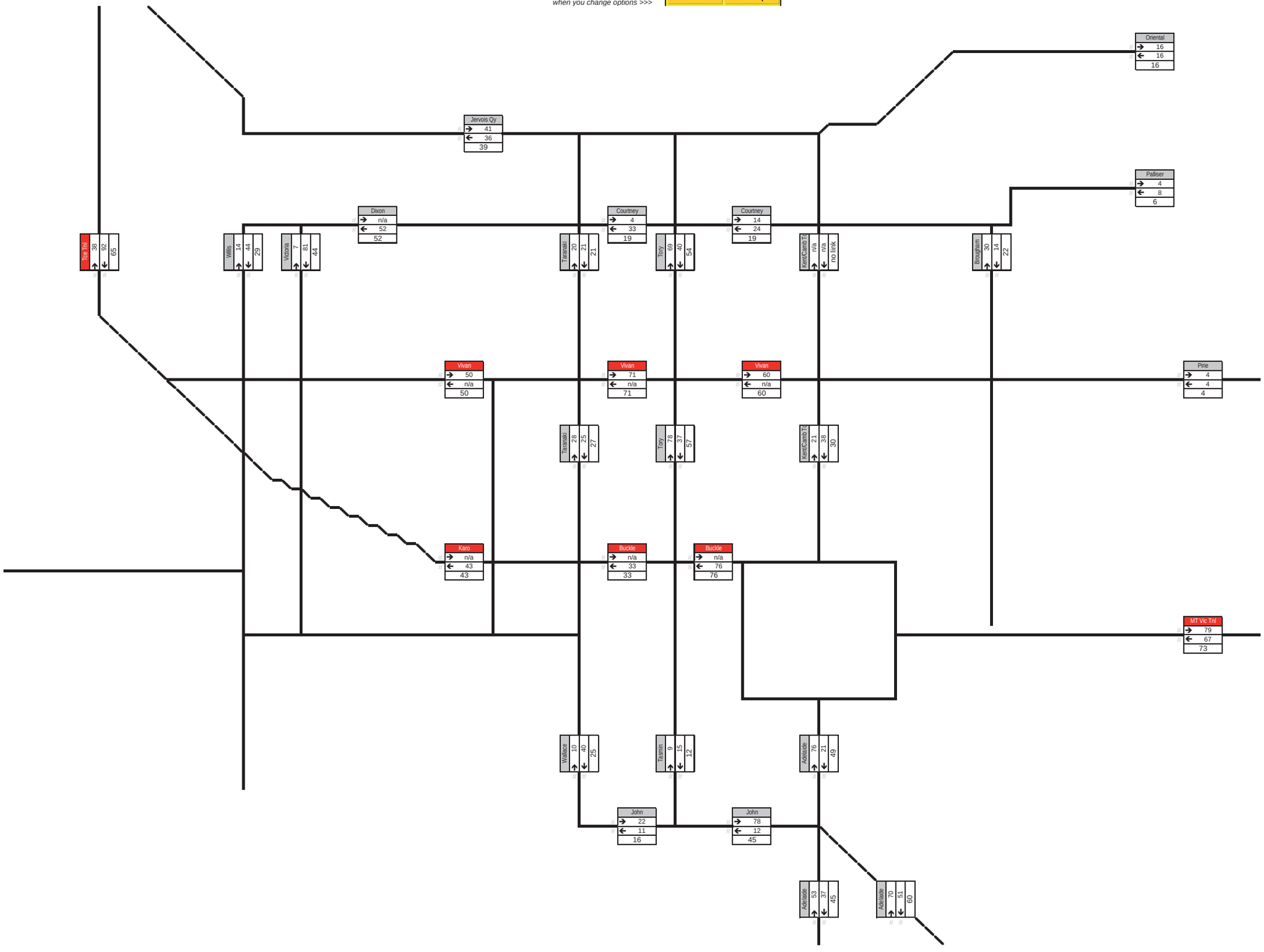

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Volume Capacity Diagram for 2016 Do minimum PM Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagram

PM

All

P:\projects\5C1617.00 Basin Reserve SAR\900 Modelling\SATURN_v2\Flow PDF

Option	16_DM
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User Class	All
Period	PM
Do-Minimum	
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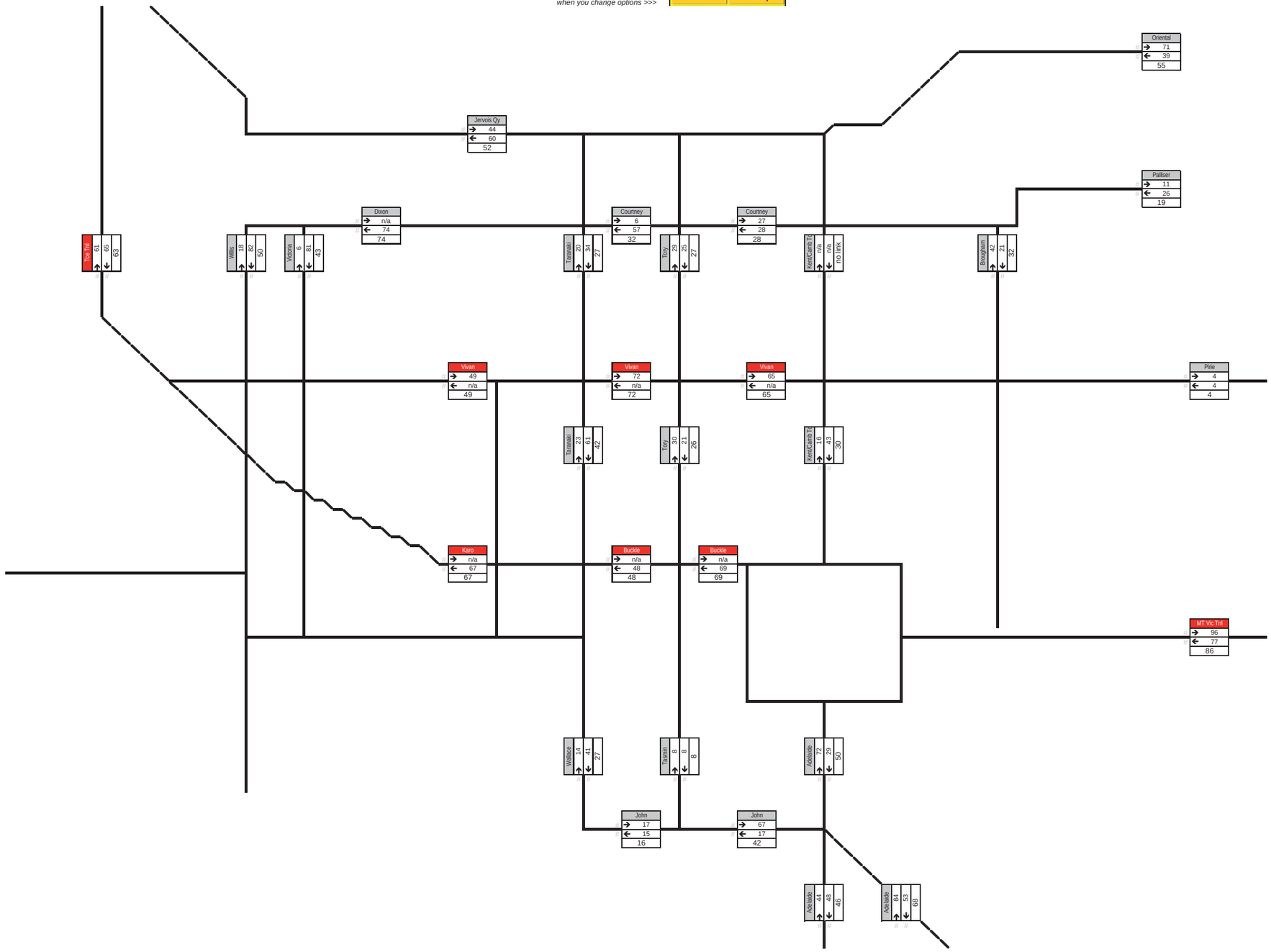
(All, 1, 2 or 3. only applied to "h" scenarios)

All flows are in PCUs



Prepared by: Bob Hu
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Page 1 of 1

Volume Capacity Diagram for 2026 Do minimum AM Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagrm

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

PM

All

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Remember to update the footer when you change options >>>

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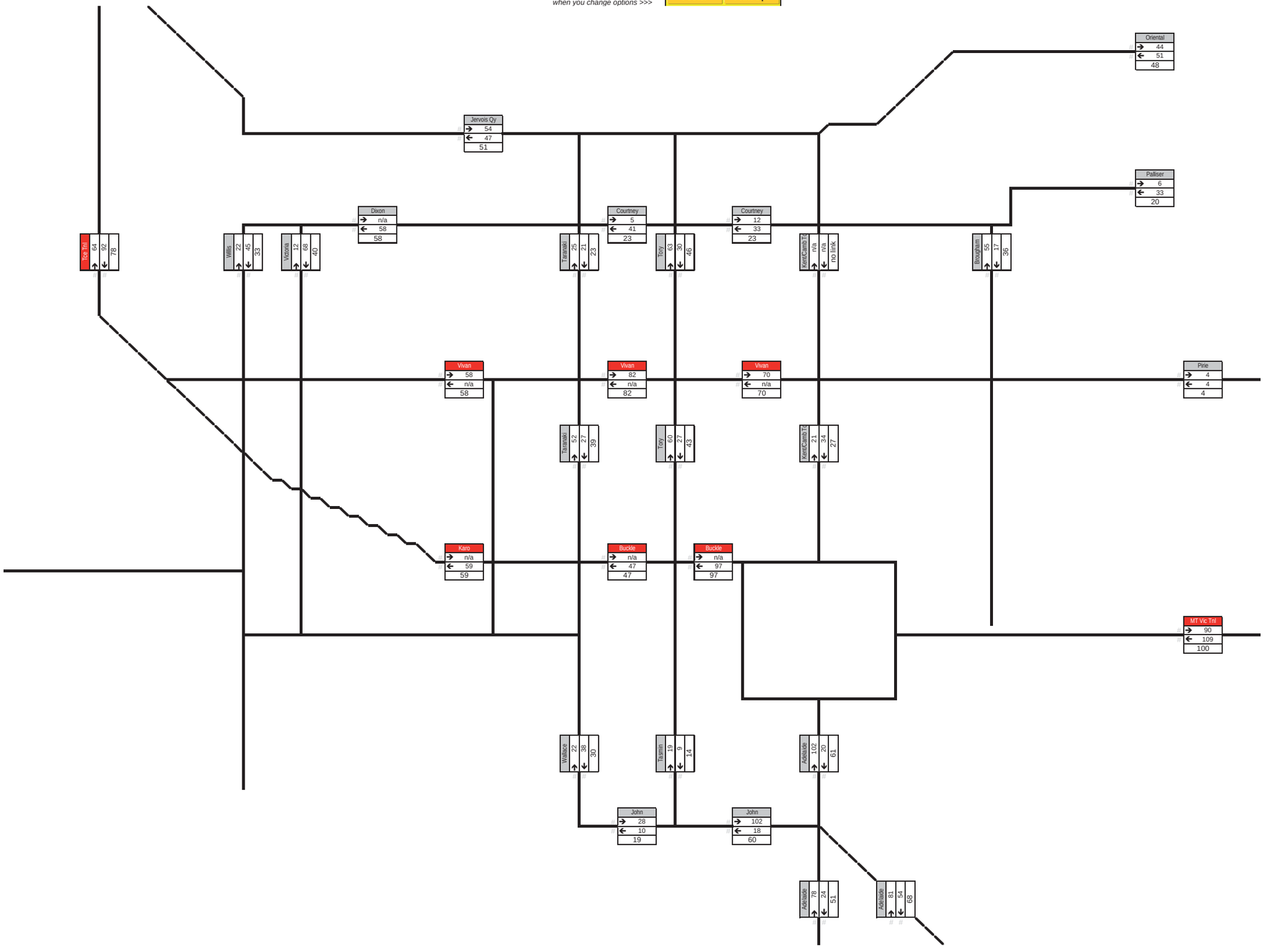
User Class	All
Period	AM
Do-Minimum	
Footer	Print Opt

(All, 1, 2 or 3. only applied to "h" scenarios)

All flows are in PCUs



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Volume Capacity Diagram for 2026 Do minimum Inter Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagram

PM

All

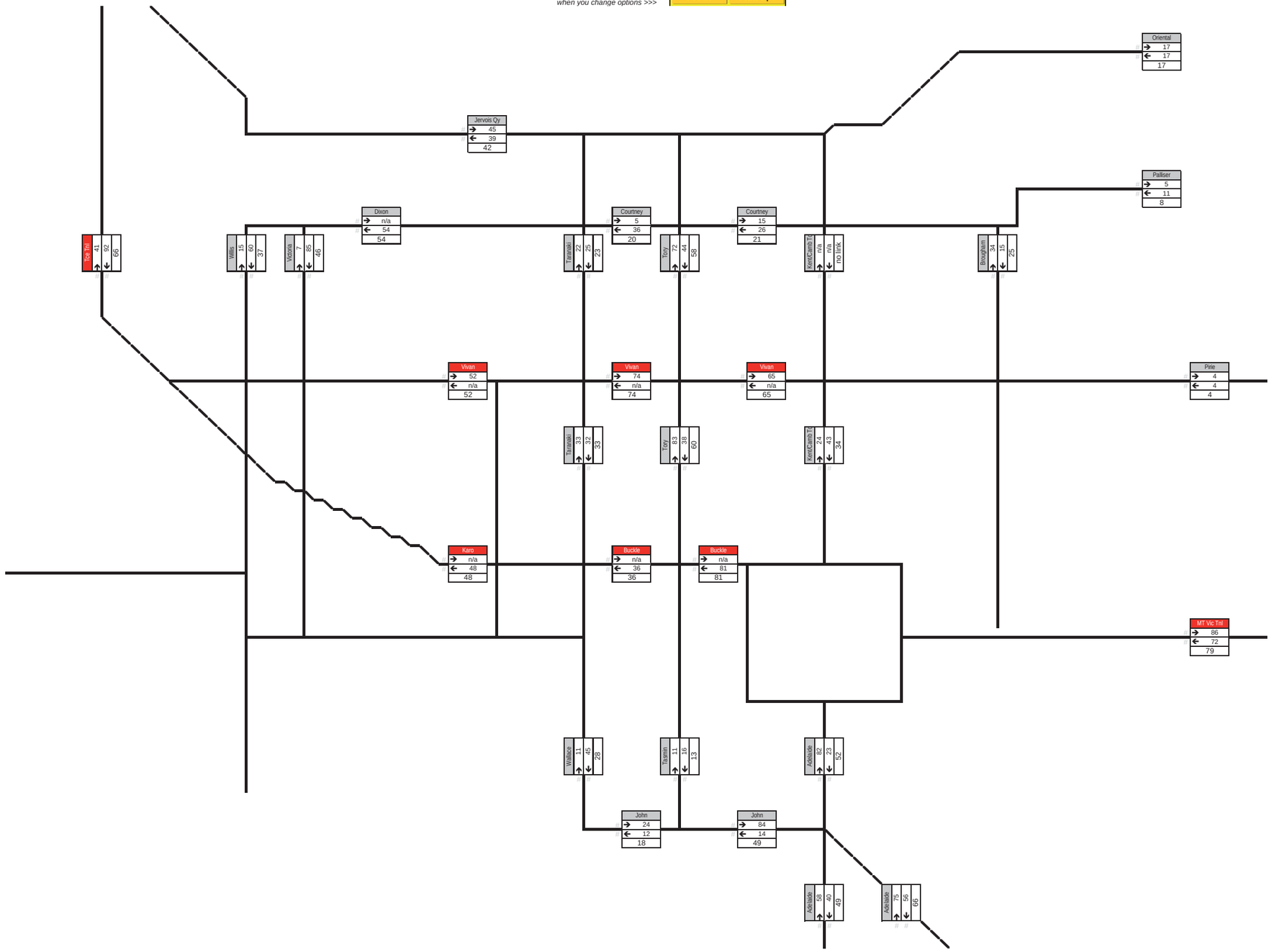
P:\projects\5C1617.00 Basin Reserve SAR\900 Modelling\SATURN_v2\Flow PDF

Option	26_DM
Year	2026
User Class	All
Period	IP
Do-Minimum	
Footer	Print Opt

(All, 1, 2 or 3. only applied to "h" scenarios)

All flows are in PCUs

Remember to update the footer when you change options >>>



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Page 1 of 1

Volume Capacity Diagram for 2026 Do minimum PM Peak

Project: 5-c1617.00 - Basin Reserve SAR

WCC Volume/Capacity Diagrm

PM

All

P:\projects\5C1617.00 Basin Reserve SAR\900 Modelling\SATURN_v2\Flow PDF

Remember to update the footer when you change options >>>

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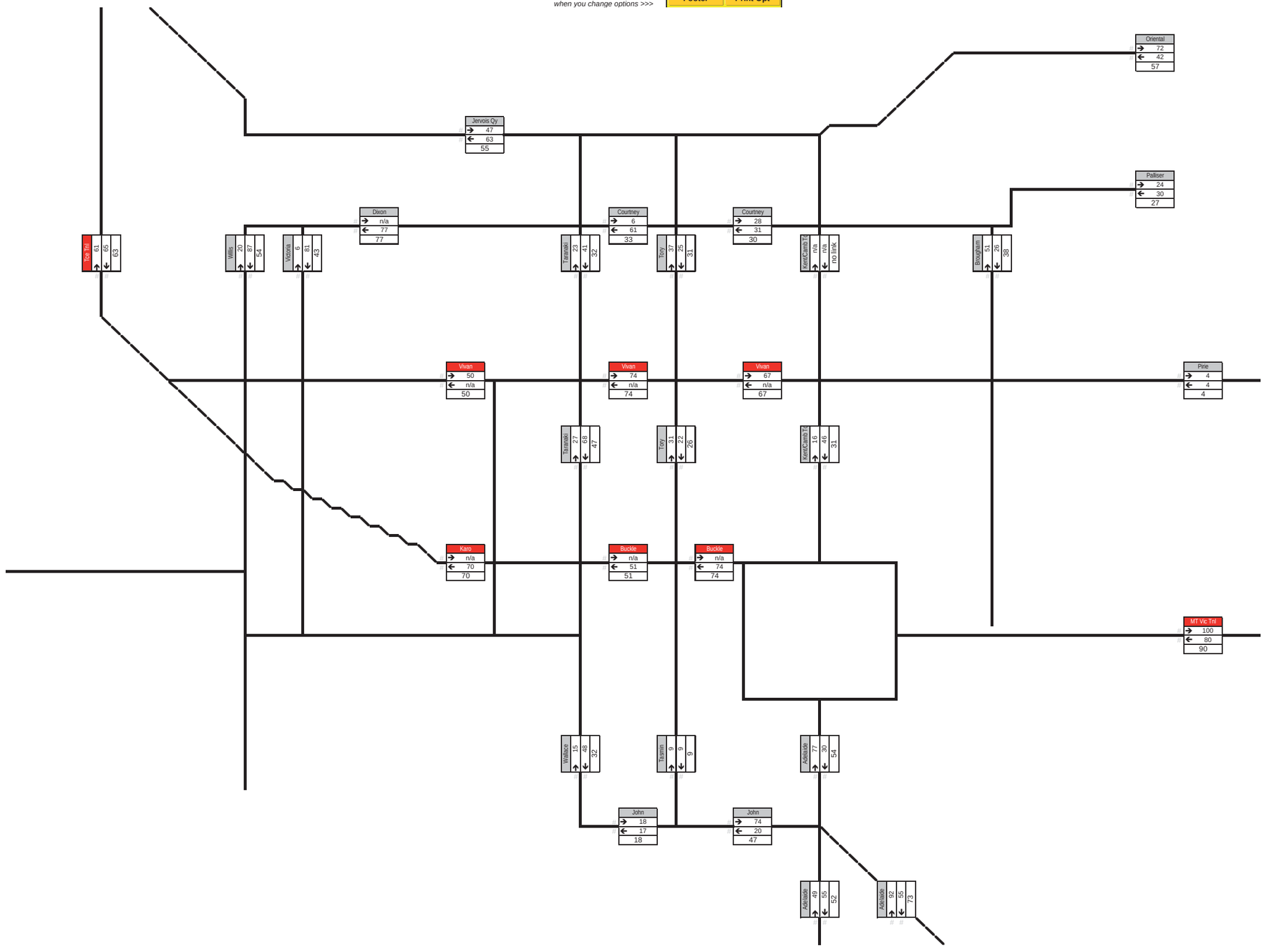
User Class	All
Period	PM
Do-Minimum	
Footer	Print Opt

(All, 1 2 or 3. only applied to "h" scenarios)

All flows are in PCUs



Prepared by: Bob Hu
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Average Annual Daily Traffic based on Saturn Do-Minimum

Direction	South-East Screenline (Blue)	Year			Percentage Change 2006-26
		2006	2016	2026	
Away from the Basin Reserve	Oriental	6789	7118	7637	12%
	Pallister	602	656	913	52%
	Mount Vic Tunnel	16838	17473	18778	12%
	Adelaide	9914	11817	12893	30%
	Total	**34142**	**37027**	**40221**	**18%**
Towards the Basin Reserve	Oriental	5584	6310	6848	23%
	Pallister	1354	1580	2001	48%
	Mount Vic Tunnel	15758	15795	16719	6%
	Adelaide	20432	22368	23682	16%
	Total	**43128**	**46053**	**49250**	**14%**

Direction	Western Screenline (Green)	Year			Percentage Change 2006-26
		2006	2016	2026	
Away from the Basin Reserve	Vivian / Buckle	25767	26515	28389	10%
	Courtenay	7162	7897	8691	21%
	Jervious Quay	23654	25137	27135	15%
	Total	**56583**	**59549**	**64215**	**13%**
Towards the Basin Reserve	Vivian / Buckle	23364	24376	25379	9%
	Courtenay	6688	7129	7707	15%
	Jervious Quay	24447	26089	28552	17%
	Total	**54499**	**57594**	**61638**	**13%**

Direction	Northern Screenline (Red)	Year			Percentage Change 2006-26
		2006	2016	2026	
Away from the Basin Reserve	Taranaki	8272	9688	10955	32%
	Tory	8960	9754	10200	14%
	Kent / Cambridge	13710	14506	15756	15%
	Total	**30942**	**33949**	**36911**	**19%**
Towards the Basin Reserve	Taranaki	8278	9782	11363	37%
	Tory	7920	8387	9111	15%
	Kent / Cambridge	9296	10708	12149	31%
	Total	**25494**	**28877**	**32622**	**28%**

Appendix C
Passenger Transport

C.1 Introduction

C.1.1 Study Area

For assessment purposes the study area for this project has assumed to be two bus stops either side of the Basin Reserve. The northern limit of the study area is the bus stops just to the north of the intersection of Vivian Street and Kent / Cambridge Terrace. The Southern limit of the study area is the bus stops north of the John Street and Adelaide Road intersection. *Table C.1* below shows the bus stops within the study area.

Table C.1: Bus Stops

Northbound		Southbound	
Bus Stop #	**Description**	**Bus Stop #**	**Description**
7016	Adelaide Road at Hospital Road (near 138)	6012	Kent Terrace at Pirie Street (near 43) (KFC)
7015	Adelaide Road at King Street (near 80)	6013	Kent Terrace at Basin Reserve
7014	Basin Reserve - Adelaide Road (McDonalds)	6014	Basin Reserve - Adelaide Road
7013	Cambridge Terrace at Basin Reserve	6015	Adelaide Road at Broomhedge St (near 85)
7012	Cambridge Terrace at Vivian Street (near 54)	6016	Adelaide Road at Hospital Road (near 171)

C.1.2 Bus Surveys

Bus operation surveys were undertaken by Opus staff to assess bus operation performance. Peak time surveys were undertaken between Saturday 5 September and Saturday 19 September.

The number of surveys undertaken is described in *Table C.2* below. The number of surveys undertaken is based upon a representative sample and over such a timeframe to limit unexpected / non-typical variations.

Table C.2: Surveys Undertaken

Period	Number of Surveys		
	Northbound	**Southbound**	**Total**
Weekday AM Peak: 7.00am – 9.00am	55	55	110
Weekday Inter Peak: 11.00am – 1.00pm	54	54	108
Weekday PM Peak: 4.00pm – 6.00pm	47	50	97
Total	**190**	**192**	**382**

The bus surveys recorded journey times, dwell times, passenger transfer and bus occupancy. The results of the survey are presented in the relevant sections to follow.

C.2 Current Demand

This section investigates the current frequency and demand for bus services through the study area.

C.2.1 Bus Frequencies, Routes and Areas Serviced

The tables below outline the routes which travel through the study area and the frequency of each service. Note this analysis does not include school bus services.

Table C.3: Bus Routes through Study Area and daily totals (from Metlink website)

Service number	Route description	Northbound	Southbound
1	Wellington - Island Bay	77	83
22	Mairangi - Wellington - Southgate	16	18
23	Mairangi - Wellington - Houghton Bay / Southgate	24	23
3	The Green Route (Lyall Bay - Wellington - Karori)	84	87
4	Wellington - Happy Valley	10	11
43	Khandallah - Wellington - Strathmore	20	21
44	Khandallah - Wellington - Strathmore	15	18
	Daily Total	**246**	**261**

As can be seen from *Table C.3* above, there is some variety in the types of route that travel through the study area:

- All of the routes service part of the southern suburbs;
- Two of the routes finish at Wellington Station;
- Two of the routes service the northern suburbs (Khandallah);
- Three of the routes service the western suburbs; and
- Two of the routes (No's. 1 and 3) are trolley bus routes and could be considered key strategic bus routes for the Wellington bus network).

Table C.4: Peak Period (Peak Hour) Frequency through Study Area (from Metlink website)

Service number	Northbound			Southbound		
	AM Peak	Inter Peak	PM Peak	AM Peak	Inter Peak	PM Peak
1	5	5	4.5	5	5	8
22	2.5	1	1	1	1	2.5
23	3	1	1	1	1	2.5
3	6.5	6	6	5.5	6	6.5
4	5	0	0	0	0	4
43	0.5	1	1	1	1	1
44	1.5	1	2	2	1	2
Total	**24**	**15**	**15.5**	**15.5**	**15**	**26.5**

Table C.4 shows that apart from routes 1 and 3, most of the routes focus on the peak commuter traffic (i.e. northbound in the AM and southbound in the PM).

There is a high peak frequency of buses using this part of the network (approximately 40 buses per hour during the peak) which is significant by Wellington and World standards for a bus corridor.

C.2.2 School Bus Services

Approximately 18 school buses stop at one or other of the bus stops surrounding the Basin before and after school.

Bus Stop Demand

An indicative survey was undertaken on Thursday 19 November to assess the demand for the school bus stop. The survey recorded the arrival and departure times for buses and general observations.

During the AM peak buses generally just dropped off the students at the bus stop and then drove straight off. During the 19 November survey there was a coach that was waiting to pick up St Marks students for a school bus trip and it parked in the school bus stop. While the coach was parked normal school buses were queued up behind the coach, the bus drivers had to ask the coach driver to drive around the block so that they could leave. A maximum of four buses (including the coach) could fit in the bus stop area. At one point during the survey a car driven by a school parent blocked the bus stop entrance and prevented a bus entering the stop while they waited to move into the adjacent car parking / drop-off area.

Three times during the AM peak school buses could not get into the bus stop area because the area was full or blocked. In one instance the bus waited at the stop line at the Dufferin-Patterson Intersection for one signal cycle until space became available and thus blocked a lane of traffic. Another bus dropped its load off on Dufferin Street adjacent to the bus stop again blocking a lane of traffic. A third bus drove around the corner and dropped it load off at the general bus stop on Adelaide Road.

During the PM peak around 40% of the buses drove up the drive to Wellington College and picked up their passengers at the college and exited the college via an alternative exit to Paterson Street as shown in *Figure C.?*. The remaining 60% of buses used the bus stop facility. The buses were quite evenly distributed between 2.45pm and 3.45pm with the maximum number of buses at the bus stop at any one time being three. Most of the buses pulled up and loaded up their passengers and then departed within a couple of minutes. The first bus to use the bus stop waited for a longer period of time (up to 15 minutes) but this was because they turned up before school had finished.

Some schools drop off and pick up students at Wellington East Girls' College on Ellice Street. These buses then access the Basin Reserve from Ellice Street before heading to Adelaide Road or the Mount Victoria Tunnel.

Figure C.5: School Bus Pick-up Routes and Locations

C.2.3 WTSM Bus Numbers 2006 and 2016

The 2006 (two hour peak period) passenger numbers for the study area are shown in the figures (*Figure C.?, Figure C.? and Figure C.?*). These figures are from the Wellington Transport Strategic Model (WTSM).

The 2016 (two hour peak period) passenger numbers for the study area are shown in the figures below (*Figure C.?, Figure C.? and Figure C.?*). These figures are from the Wellington Transport Strategic Model (WTSM). These figures are for the committed development and medium growth.

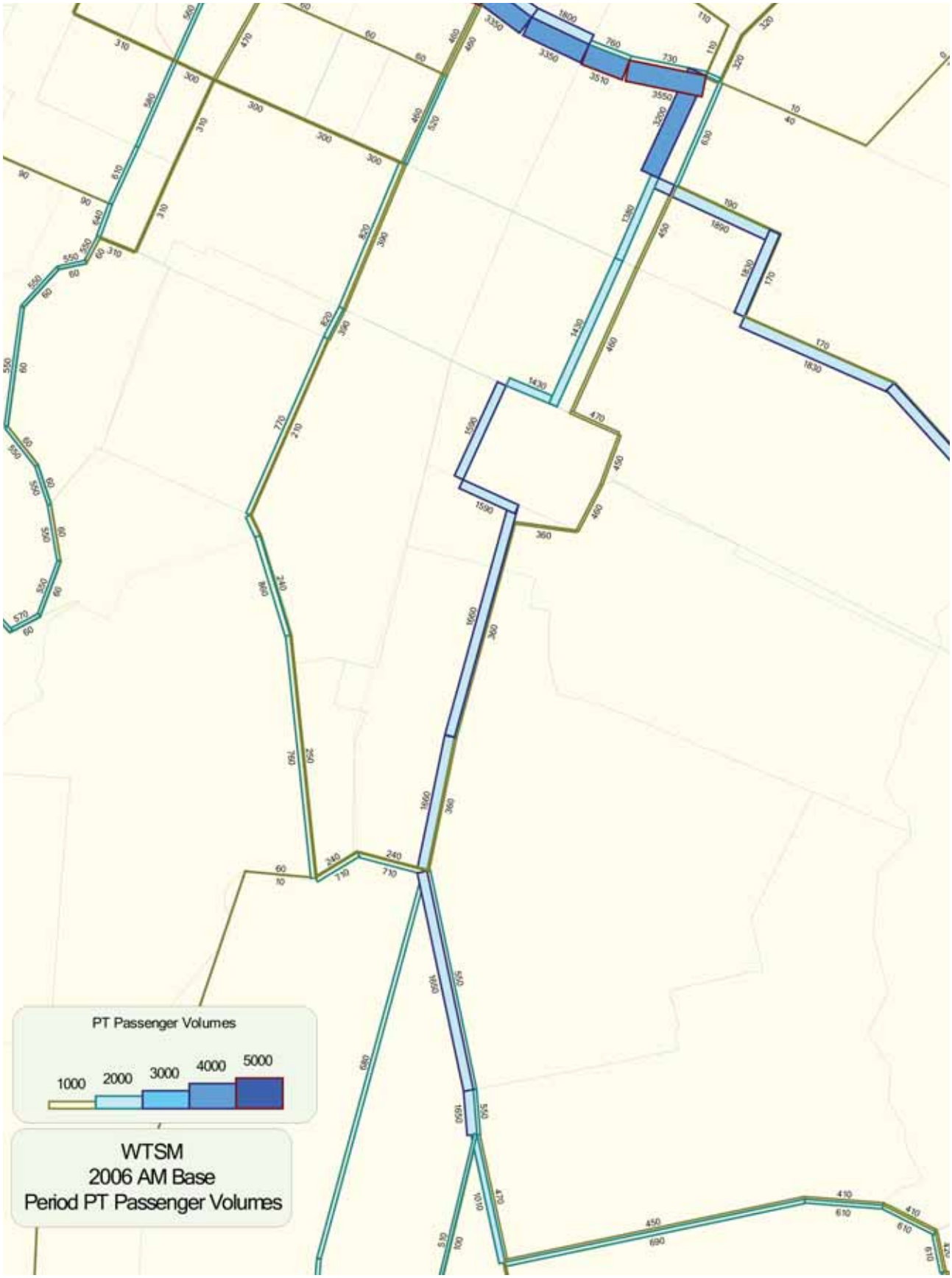


Figure C.6: WTSM 2006 Base AM Peak PT Passenger Volumes

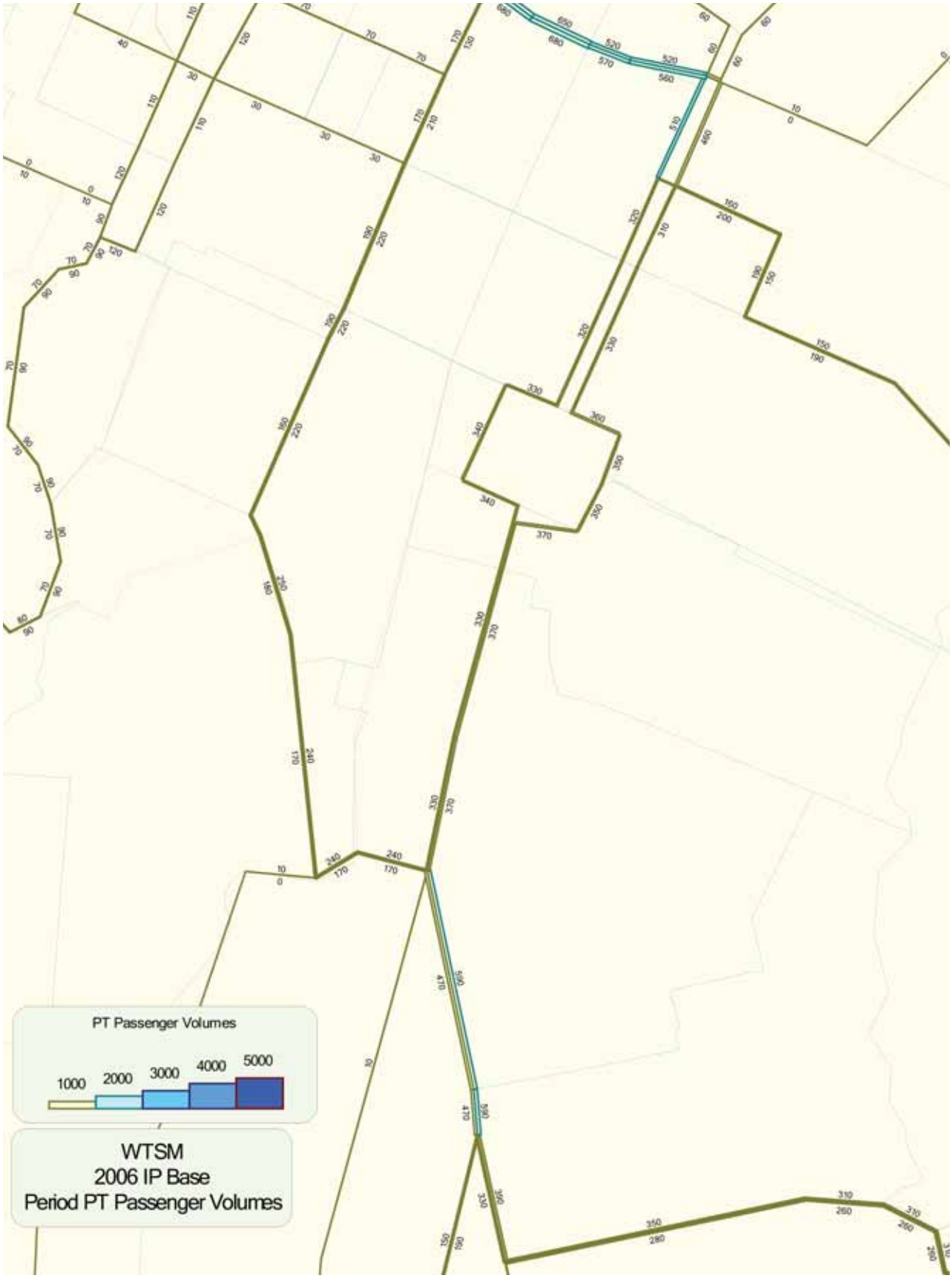


Figure C.7: WTSM 2006 Base Inter Peak PT Passenger Volumes

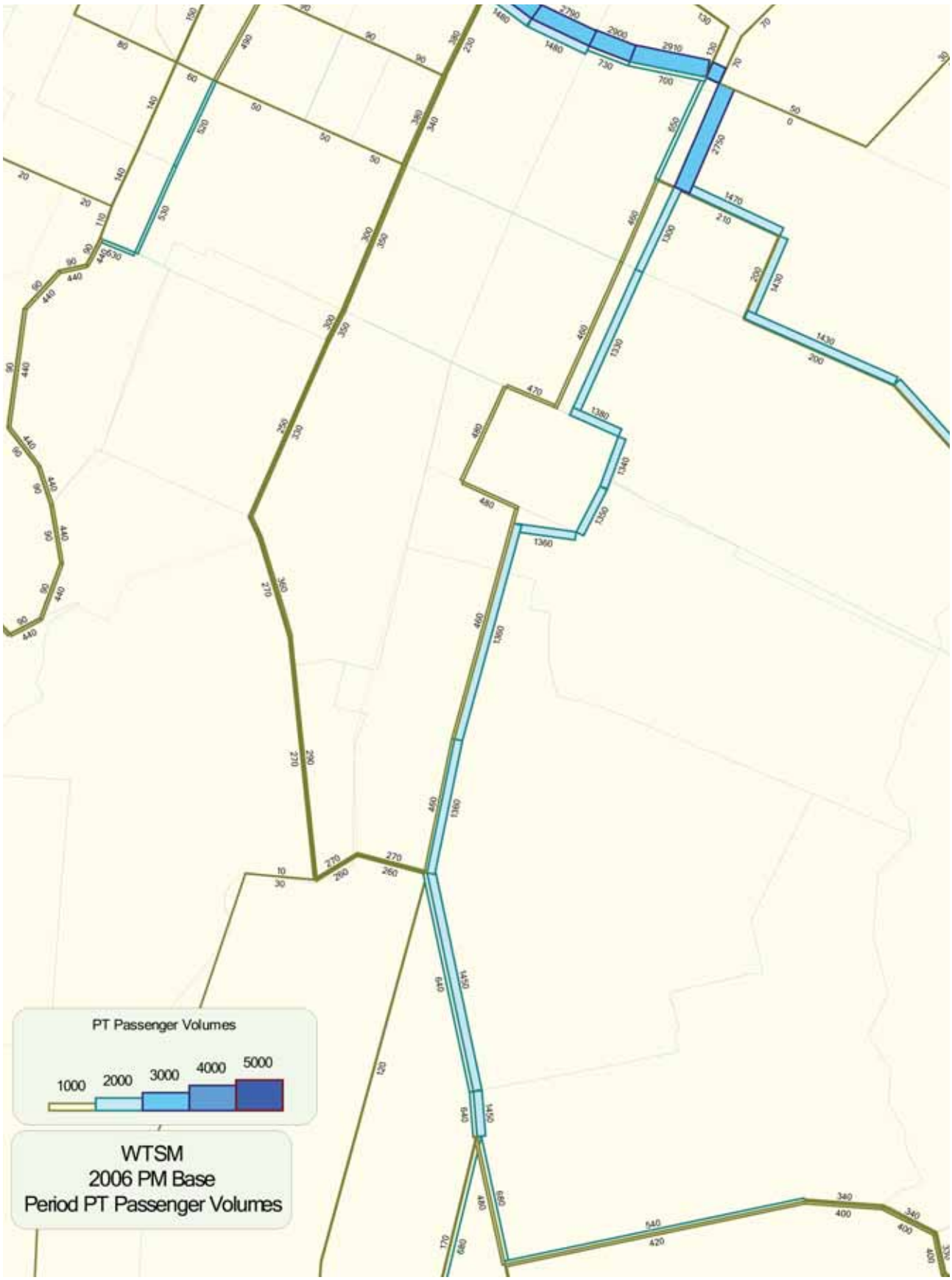


Figure C.8: WTSM 2006 Base PM Peak PT Passenger Volumes

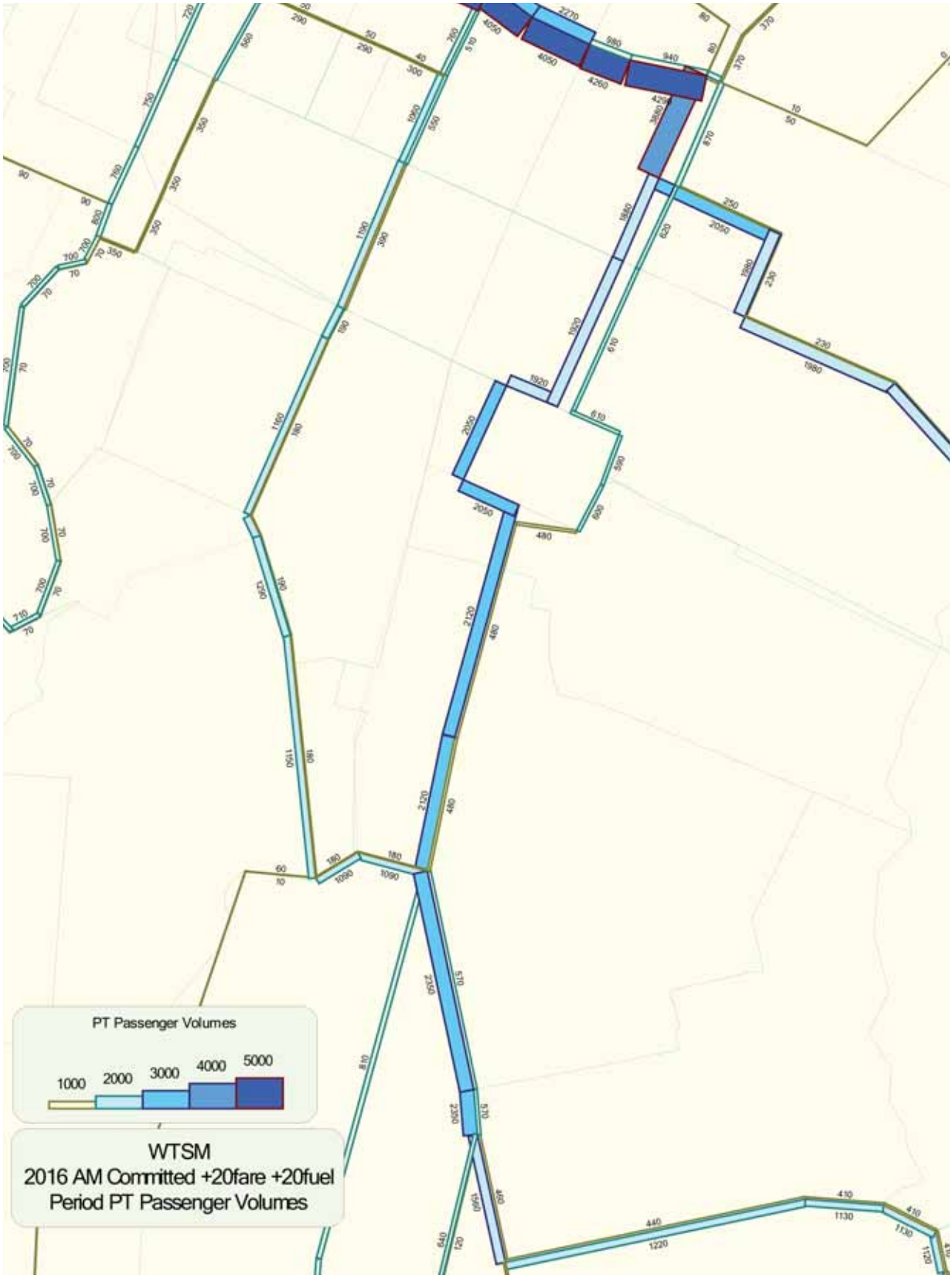


Figure C.9: WTSM 2016 Base AM Peak PT Passenger Volumes

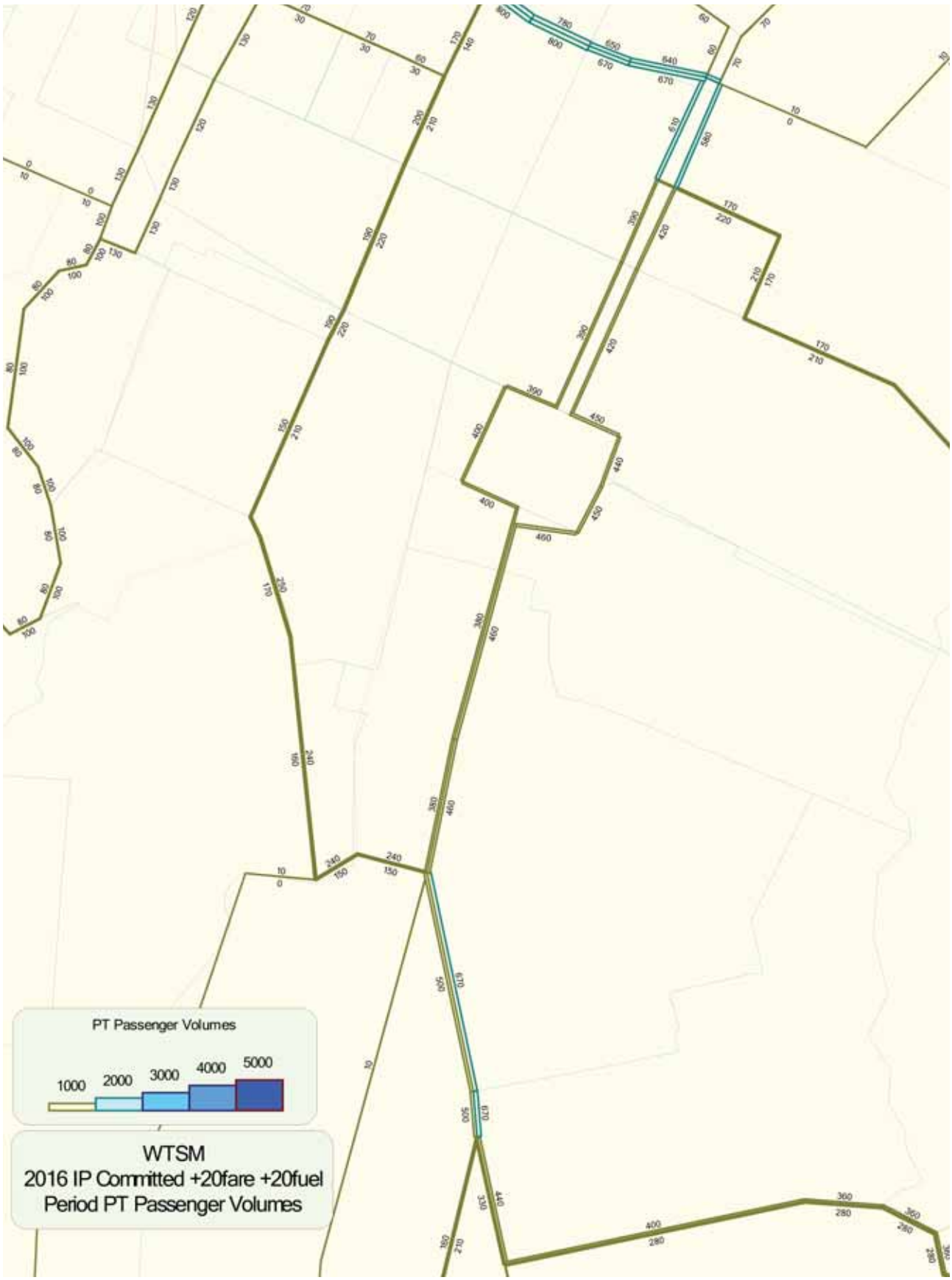


Figure C.10:WTSM 2016 Base Inter Peak PT Passenger Volumes

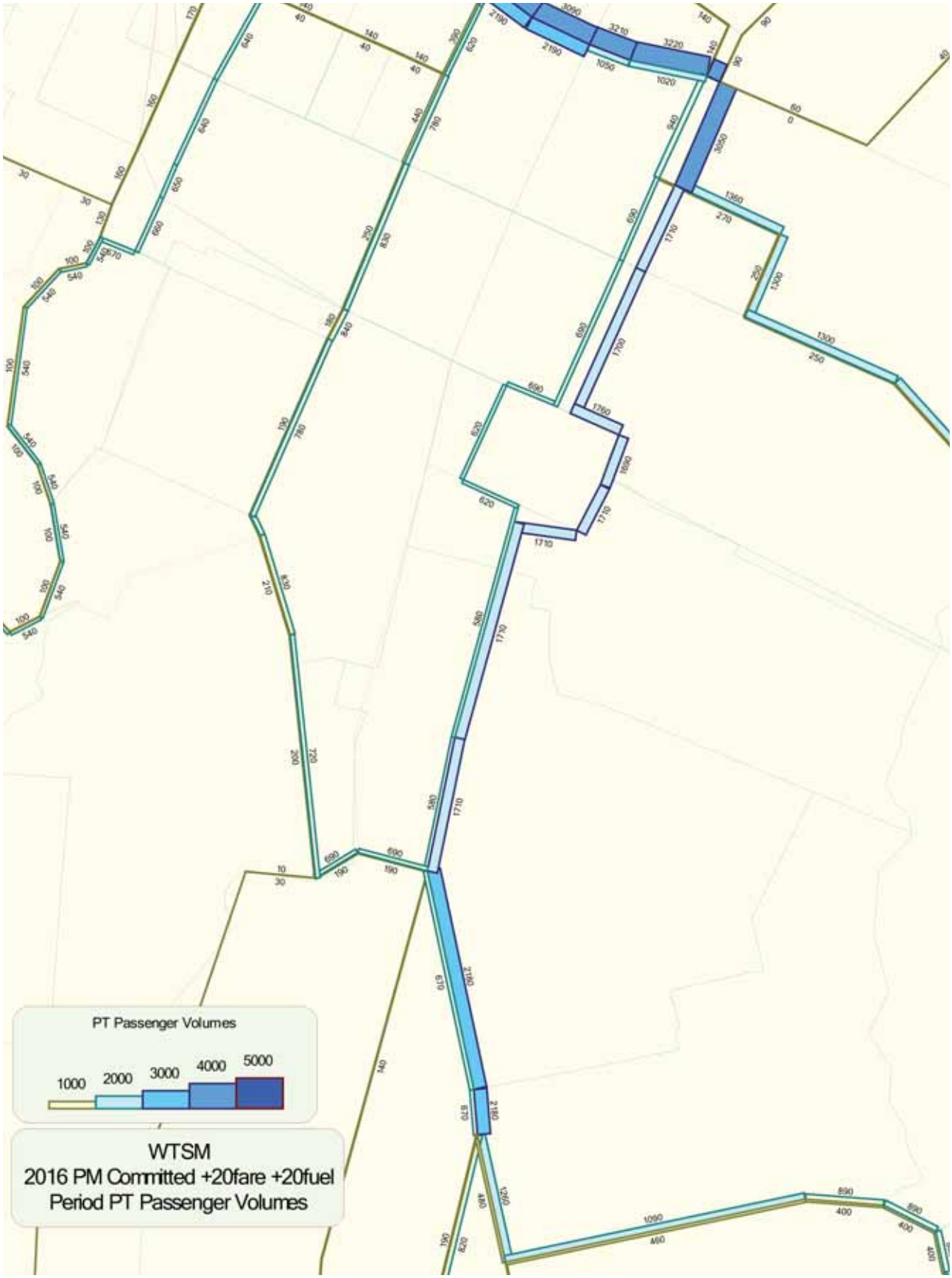


Figure C.11: WTSM 2016 Base PM Peak PT Passenger Volumes

C.4 Current Operation

C.4.1 Dwell Times

Dwell times have been calculated based on the surveyed data and are presented below.

Note: total journey time is the sum of the "total travel time" and "total dwell time".

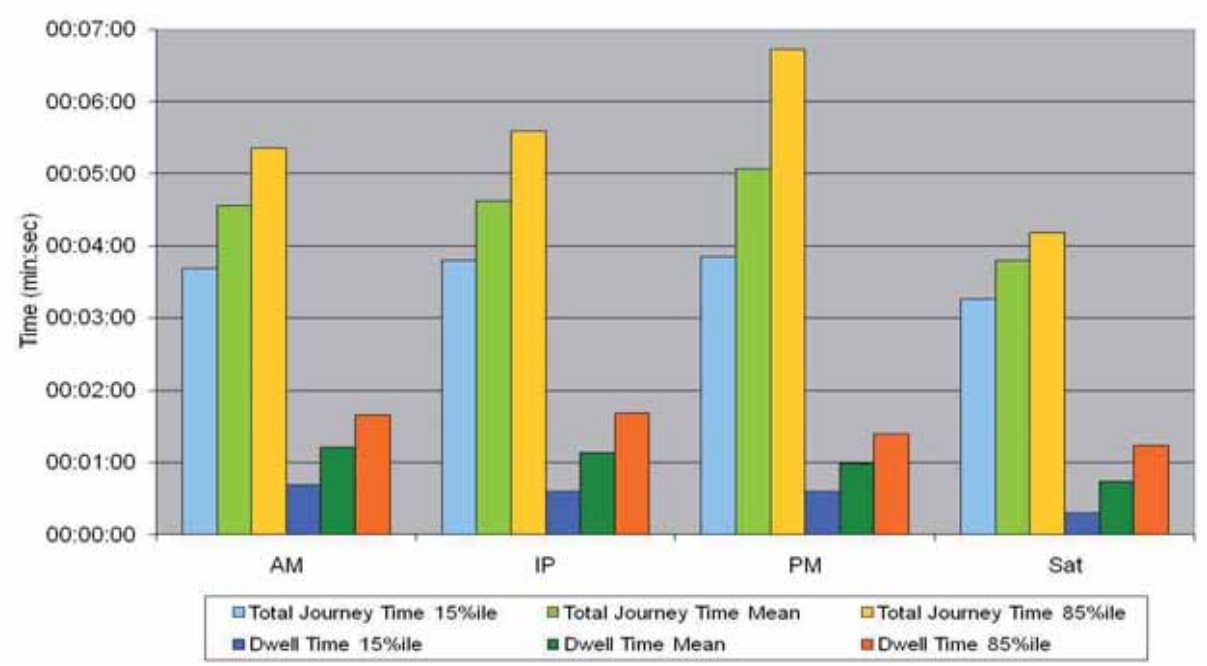


Figure C.12: Average Dwell Time versus Journey Time (Northbound)

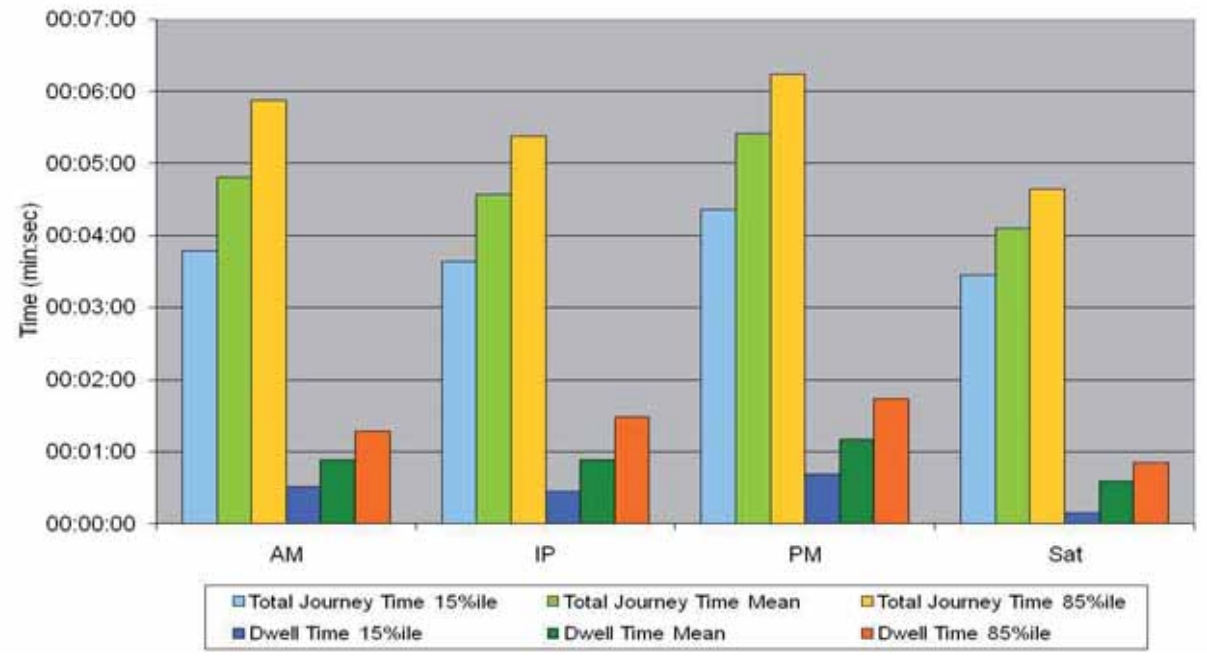


Figure C.13: Average Dwell Time versus Journey Time (Southbound)

Figure C.12 and *Figure C.13* above show that dwell time makes up 20-30% of the total journey time. Dwell time is highest during the peak times in the peak commuter direction (i.e. northbound in the AM peak and southbound in the PM peak) as would be expected with increased bus patronage at these times / directions.

Because dwell time is only a small component of the overall journey time, it means that the best way to improve journey times for buses is to improve the travel time between stops.

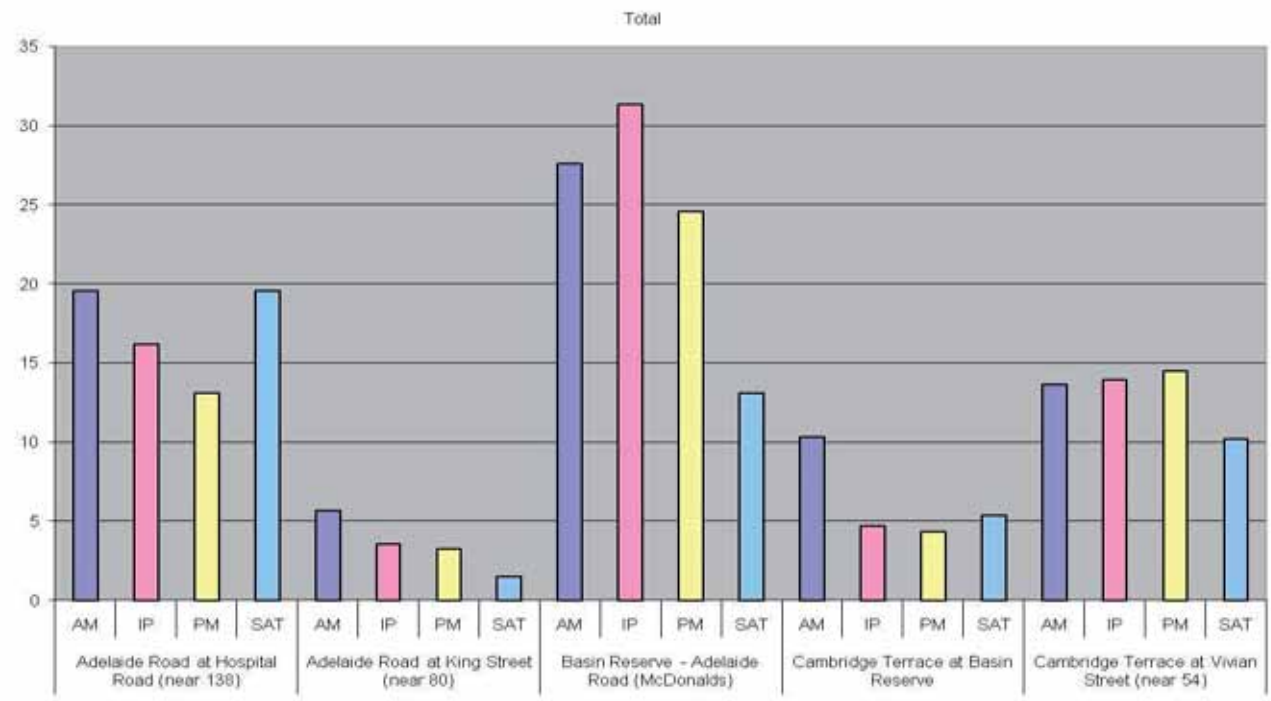


Figure C.14: Average Dwell Time by Stop and Period (Northbound)

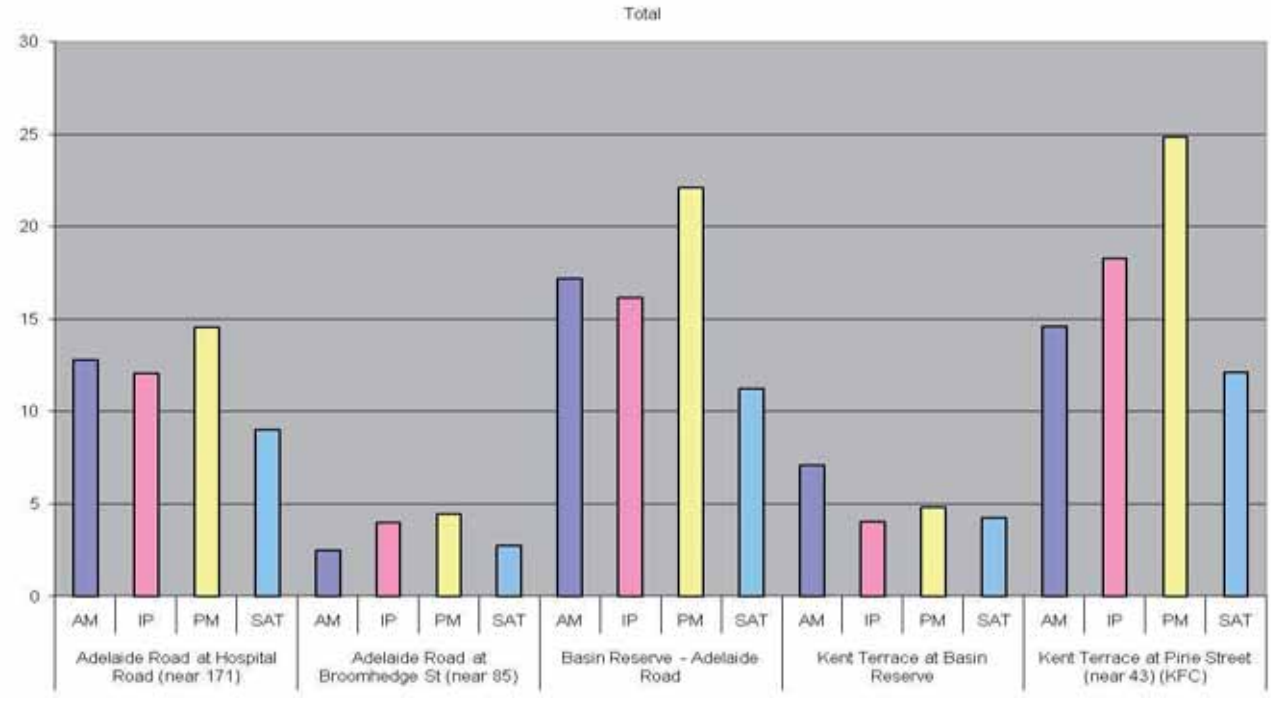


Figure C.15: Average Dwell Time by Stop and Period (Southbound)

Figure C.14 and *Figure C.15* above show that average dwell time at each stop is relatively consistent across the time periods. The bus stops immediately south of the Basin Reserve are the busiest; this is discussed in more detail in the next section.

The figures below show the proportion of dwell time that is spent processing passengers (getting on and off the bus) compared to the time spent manoeuvring the bus into the stop from the traffic (entry delay) and out of the stop and into traffic (exit delay).

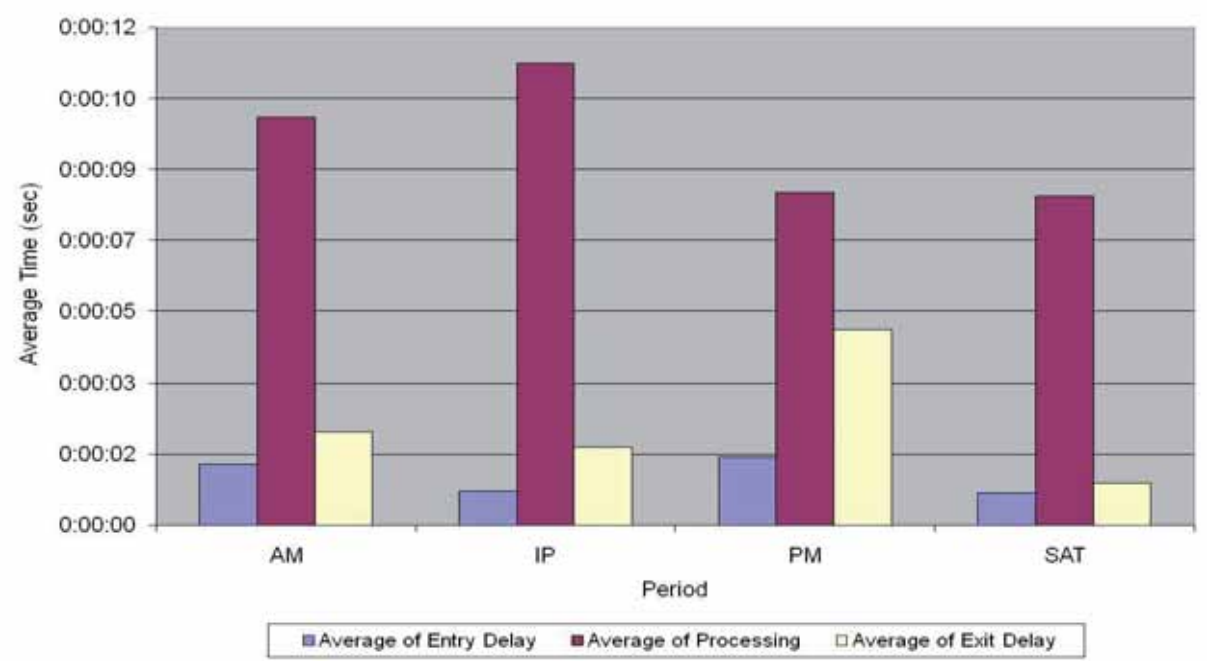


Figure C.16: Average Split of Dwell Time Delays (Northbound)

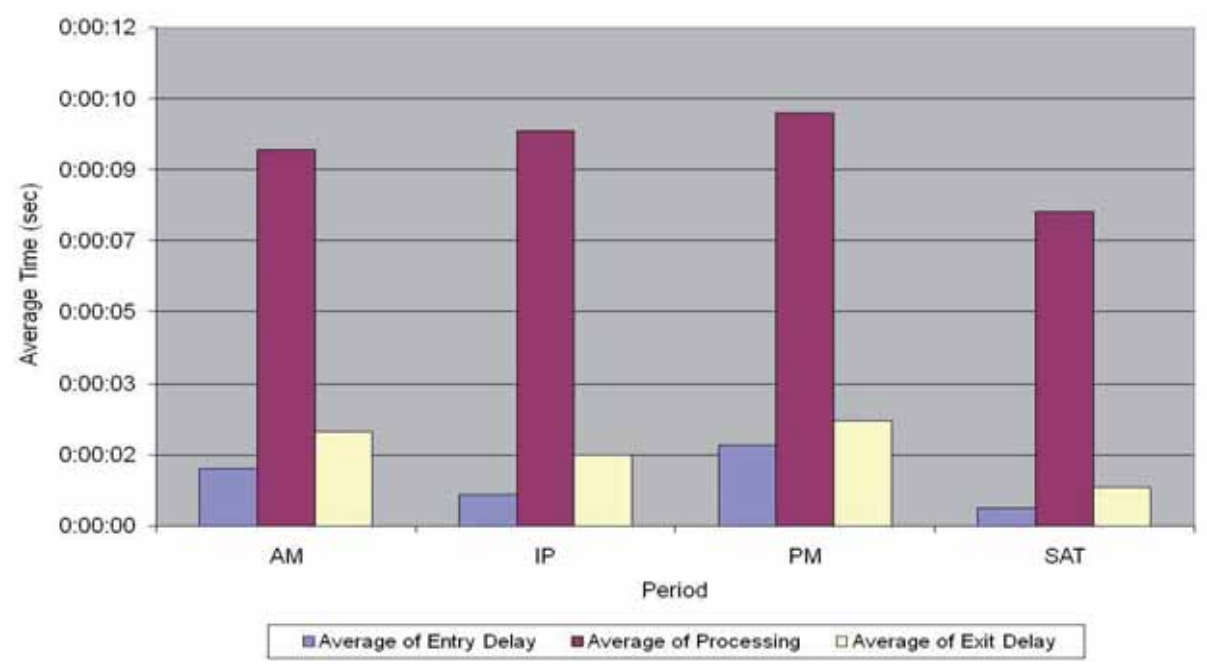


Figure C.17: Average Split of Dwell Time Delays (Southbound)

Figure C.16 and *Figure C.17* above show that the majority of dwell time is related to the processing of passengers (on and off the bus), and that delays getting in and out of the stop are only minor. The PM peak for the northbound direction does however have a higher average exit delay. It is assumed this is related to the fact that the Adelaide Road bus lanes do not operate during the PM peak in the northbound direction and in the busy peak hour conditions there are fewer opportunities for buses to enter the traffic stream especially merging with traffic at the intersection of Rugby Street and Adelaide Road.

None of the individual bus stops had greatly differing proportions of average dwell times. The majority of the delay is associated with processing passengers, this is reflected by the busiest stops for passenger turnover (e.g. outside McDonalds) have the highest dwell times.

C.4.2 Passenger Transport Journey Time Reliability

Typically, passengers are less tolerant of travel time variability that the actual journey time itself. Unreliable journey times are a major cause of passenger dissatisfaction. Reducing the variability in bus journey times represents a significant opportunity for the Basin Reserve Project.

Figure C.18 and *Figure C.19* below show that there is currently a significant degree of variability in travel times. The figures are based on the survey data collected in September 2009. The journey times presented exclude dwell times.

The figures show that during the survey travel times were least consistent in the evening peak hour in both the north and southbound directions. For northbound trips there was almost 3 minutes between the 15%ile and 85% travel time. Southbound there was only about 1.5 minutes difference between the 15%ile and 85% travel times. Better reliability for southbound trips can be attributed to the southbound bus lane on Kent Terrace.

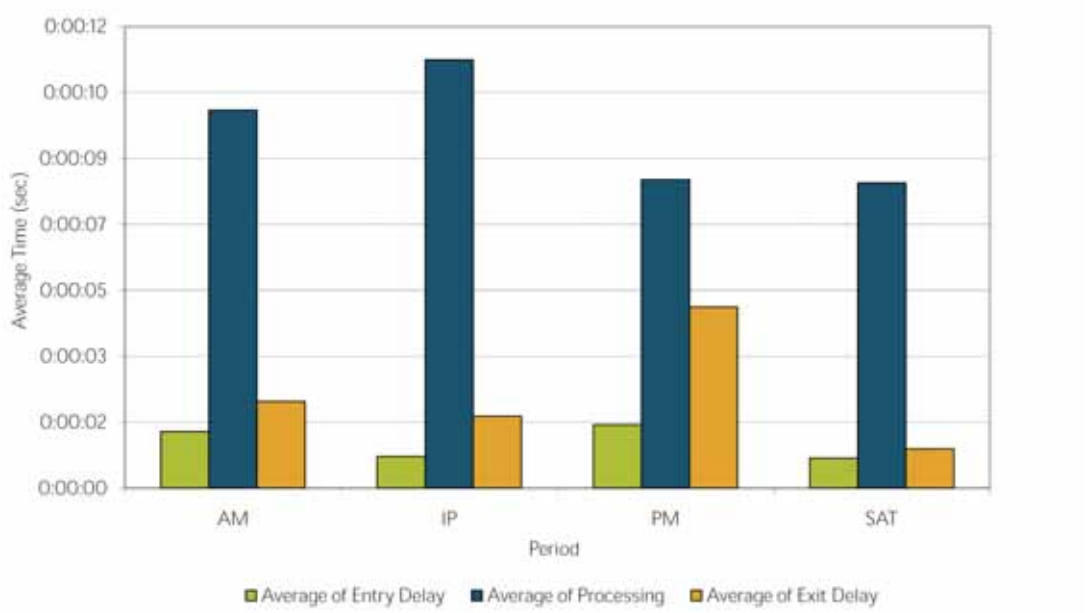


Figure C.18: Northbound Journey Time Reliability

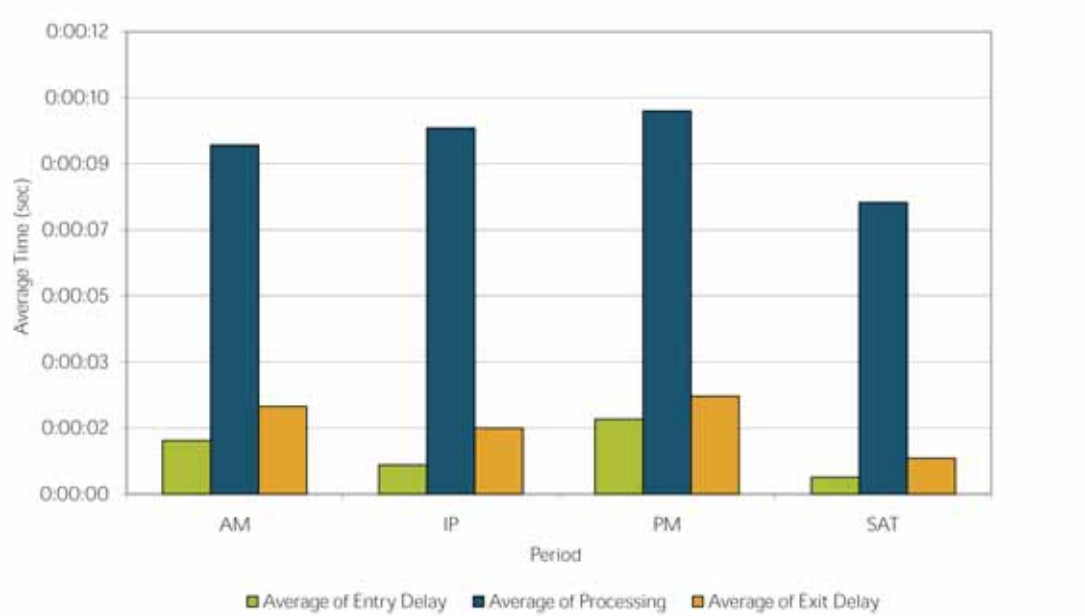


Figure C.19: Southbound Journey Time Reliability

C.5 Future Operation and Demand

C.5.1 Background

The Ngauranga to Airport Strategy Study (the Study) plays a major role in determining the future strategy for Transportation in Wellington City.

The Study identified the route between the Wellington Railway Station and Newtown via the Golden Mile and the Basin Reserve as the key Passenger Transport Spine (PT spine). This spine connects the CBD with the key growth node at Newtown that has been proposed for development by the Wellington City Council.

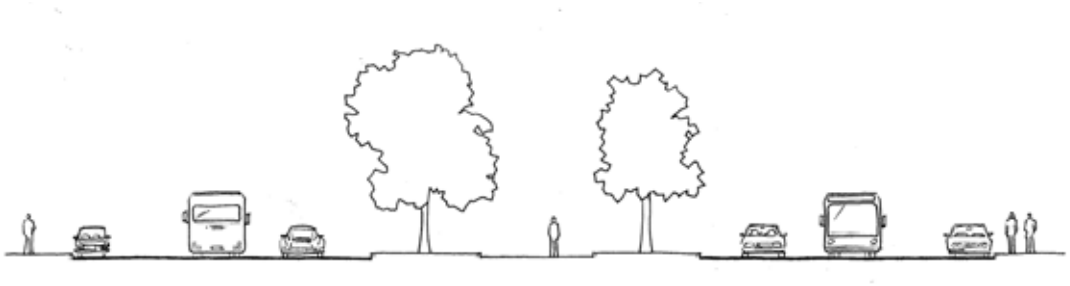


Figure C0.1 - Possible Cross Section of Kent / Cambridge Terrace with Bus Lanes (from Ngauranga to Airport Scheme Dossier)

"The objective of the proposed scheme (proposed as part of the Study) scheme is to give passenger transport priority though the CBD over general vehicles. This could include a reallocation of road space, providing a segregated right-of-way passenger transport facility that will discourage, or even prevent, other vehicles using the road space allocated to passenger transport. In meeting this objective a high quality passenger transport corridor should operate between the railway station and Newtown."

Figure C0.2 - Possible Sketch of Kent / Cambridge Terrace with Central Light Rail Corridor (from Ngauranga to Airport Scheme Dossier)

The proposed scheme for the passenger transport spine between Courtenay Place and Newtown includes providing passenger transport road space on Kent and Cambridge Terrace. Two options were considered as part of the Study, one with the passenger transport 'lanes' adjacent to the median, and the other in the outside lane. The option adjacent to the median was the preferred option. Options for the lane arrangement around the Basin Reserve were not developed as this was to be done in conjunction with development of the options for grade separation of the Basin Reserve.

C.5.2 Modelling Assumptions

All of the future modelling has been derived from the Wellington Transport Strategic Model (WTSM). The outputs from WTSM have been input into the Wellington City SATURN model, and the outputs from the STAURN model have been input into a Wellington Paramics model.

One of the key assumptions is that the wide-spread bus lanes proposed around Wellington City have not been included in the future model except for the existing bus lanes and those proposed along the full length of Adelaide Road and Kent and Cambridge Terraces.

C.5.3 Future Passenger Transport Form and Geometric Requirements

A number of different options were considered as part of the Ngauranga to Airport Strategy Study for different passenger transport forms for the PT spine.

Options included:

- Existing bus fleet using bus lanes
- Existing bus fleet using dedicated busways
- Larger improved bus fleet using dedicated busways (possibly bendy-buses and / or guided buses)
- Trams / light rail vehicles using dedicated 'busways'

The Study assumed minimum geometric requirements for these proposed new forms / mediums for passenger transport as follows:

- Minimum width of 3.5m (excluding platforms etc)
- Minimum turning circle of 20m

Further research has been undertaken to confirm the appropriate geometric requirements for the larger / long term options such as light rail and guided busways. The research concluded that:

Buses

The turning circle for a normal city bus at 50km/h is 75m (using autoturn which is generally quite conservative).

The turning circle for an articulated bus at 50km/h is 75m (using autoturn which is generally quite conservative).

Bus Rapid Transit (BRT)

Bus rapid transit systems vary significantly throughout the world; however the concept is based upon a hybrid between the flexibility offered by traditional bus and the quality and reliability associated with tram services.

Associated with BRT systems is generally a high quality PT corridor with high levels of priority for the BRT service. In order to achieve this level of service there is a requirement to ensure turning radius is maximised and allocation of road space maximised.

Generally BRT systems can operate in much the same network as traditional services, however to achieve the objectives of the BRT system it is deemed desirable to enhance the route and associated infrastructure. In reality it may be possible to operate BRT systems in a tighter environment that traditional bus services through the use of "bendy buses", drivers which are trained and dedicated to the route and the removal of other traffic from the corridor.

Ultimately the turning circle for a BRT system at 50km/h should be designed around a 75m radius and less as speeds drop.

Guided Busways

Guided busways are defined for this report as a separate passenger transport facility where the wheels of the bus are physically guided by a concrete kerb (or similar) on either side of the busway.

Guided busways are generally built to service medium/long distance commuter routes and are designed to operate at high speeds (around 100km/h). As such, tight radius curves that would be experienced in an urban setting like Wellington are not appropriate for busways.

The "Guided Busway: Design Handbook" recommends that the minimum radius curve for a 50mkm/h speed environment is approximately 800m. Guided busways could be used on straighter sections of the route and manual control could be used around the tighter curves but this would not be economical.

Guided busways have not been pursued any further as part of this investigation as the geometric requirements make them unsuitable for the Basin Reserve.

Guided Buses

Guided buses are defined for this report as a physical or electronic guidance system which allows the buses to operate in a normal street environment. There are a number of different types of guidance mechanism including a central rail (physical guidance), optical or magnetic (electronic guidance).

A central rail guidance system is likely to suffer similar draw backs to a guided busway or light rail system where the minimum geometric requirements for the rail would not be suitable for the constrained geometric conditions at the Basin Reserve.

An optical system uses visual markings on the road and a sensor on the bus to determine the buses position on the road and electronically control the bus. A magnetic system uses magnets buried along the length of the road and a sensor on the bus as per the optical system. Both of these systems are very new technology so very little information is available on the geometric requirements.

Guided buses have not been pursued any further as part of this investigation because of the lack of available information. However, guided buses are not likely to be a reality in the short or medium term due to the high capital cost to implement such a system. In the long term, a guided bus system could be appropriate and at that stage more information would be available. In terms of future proofing it is assumed that the geometric requirement would be no more restrictive than light trail (see below).

Light Rail / Trams (LRT)

Light Rail can have several different functions including high speed medium-long term routes as well as tracks embedded in existing urban road environments.

The requirements for high speed medium-long distance routes are similar to guided busways, with large radius curves required.

Where light rail systems are installed in existing urban road environments the tracks are normally permitted to be installed at absolute minimum radii as a concession to the extreme alignment restrictions in urban areas.

Research indicates that the absolute minimum radius for light rail is around 25m, at this speed light rail is limited to 15-20kph.

The "TCRP Report 57: Track Design Handbook for Light Rail Transit" gives the following geometric requirements for light rail:

Table C.3: Geometric Requirements for Light Rail

Speed	Minimum Radius	Super-elevation required	Minimum length of tangent curve
25	30m	150mm	58m
30	45m	145mm	56m
40	80m	145mm	56m
50	120m	150mm	62m

Table C.3 shows that if light rail is to be practicably implemented around the Basin, the speeds on these sections of track will have to be limited to around 30km/h.

We have undertaken a geometric assessment of the proposed lane arrangements for a generic option (clockwise travel only) identified during the Inquiry By Design Workshops. Information from the assessment is shown *Table C.4*.

Table C.4: Geometric Assessment of Radius Provided by Inquiry By Design Option

Corner	Left-most Lane - radius	Right-Most Lane- radius	Lane width
Left turn from Kent onto Ellice	22.7m	28.7m	3.0m
Right turn from Ellice to Dufferin	49.9m	46.7m	3.5m
Right turn from Dufferin to Rugby	47.8m	43.8m	3.75m
Left turn From Rugby to Adelaide	19.9m	23.1m	3.75m
Left turn from Adelaide to Rugby	9.5m	13.5m	3.75m
Right turn from Rugby to Sussex	47.3m	43.3m	3.75m
Right turn from Sussex to Buckle	44.2m	40.2m	3.75m
Left turn from Buckle to Cambridge	17.0m	21.0m	3.75m

As can be seen from *Table C.4* above, all of the right turn's have a turning radius greater than 40m, the left turns are significantly lower with the left turn from Adelaide to Rugby being the worst.

A normal city-bus and an articulated (bendy) bus were tracked around the lane layouts for Option 1C using autoturn. The city bus stayed within the lanes around all of the right turns and only had minor overhang on the left hand turns except for the Adelaide to Rugby turn where there was major overhang. The bendy-bus had minor overhang around all of the right turns except for the Kent to Ellice turn where the narrow lanes caused larger overhang. The left hand turns again caused a minor problem and a major problem at the Adelaide to Rugby turn.

It should be noted that the lane arrangements drawn for the typical option are by no means detailed design drawings and are subject to further development, including possible addition of a third lane (as existing) around the Basin.

Purely on a geometric basis it is apparent that realignment of the left turns at the north and south of the Basin Reserve will be required to make bendy-buses or light-rail a reality.

Figure C0.3 below show the land required to allow Light Rail access at 30km/h around the Basin. To minimise the land required, the light rail would need to operate at significantly slower speeds. XX shows the land required to ensure all corners have a radius of at least 25m. With 25m radius corners the light rail is only able to travel at 15-20km/h. In this case, land would only be required on the Kent and Cambridge Terrace corners.

Figure C0.3: Land Requirements for 45m Radius Light Rail (30km/h)

Figure C0.4: Land Requirements for 25m Radius Light Rail (15-20km/h)

C.5 Conclusions

The following conclusions can be made from this working paper:

- The project study area includes a major passenger transport corridor which will be more important in the future as the roading network reaches capacity and there is an increase in modal shift. This is recognised in the predicted increase in passenger numbers in future years. The importance of this corridor is recognised in regional and local transport strategies as a key passenger transport spine between growth nodes.
- The bus services and occupancy rates are focussed around commuter demand and include services that link the CBD to the southern suburbs as well as routes which connect to the northern and western suburbs.
- Current journey times and speeds are slow, especially around the Basin itself and on Cambridge and Kent Terraces.
- Journey times are quite variable with the main contributing factor being the travel time between stops. Dwell times also vary significantly with the majority of dwell time related to the time it takes to process the passengers as opposed to delay entering or exiting the bus stop.

- The longest dwell times and highest bus stop demand are associated with the bus stops immediately south of the Basin Reserve. The stops immediately north of the Basin and midway down Adelaide Road are very underutilised. The bus stops at the northern and southern limits of the study area are well utilised.

- There is the opportunity to rationalise and improve the bus stop layout and operation within the study area. This rationalisation of bus stops will play an important role in not only improving the passenger transport operation but also improving performance for general traffic. Preferred changes would be a central island at both bus stops on Kent Terrace with possible removal of the southern stop. The preferred location for a 'super stop' would be on Rugby St south of the Basin.

- Bus lanes will be provided throughout the length of the project area. By claiming these areas now as passenger transport space, it safeguards for a future high quality passenger transport system. Further land is likely to be required for the implementation of high quality passenger transport system in the future.

- The grade separated options provide greater benefits for bus operation due to the reduction in the number of intersections along the bus corridor.

Appendix D
Pedestrians and Cyclists

D.1 Pedestrian Facilities

There is a pedestrian footpath on both sides of all roads around the Basin Reserve.

Approximately 50m south of their intersections with Ellice and Buckle Streets there are signalised pedestrian crossings over both Kent and Cambridge Terraces. There is also a zebra crossing over Ellice / Buckle Streets directly outside the northern gates to the Basin Reserve. This leads to central median separating Kent and Cambridge Terraces which is used by pedestrians.

At the intersection of Dufferin and Paterson Streets there is a signalised pedestrian crossing. This is separated into three arms separated by a central pedestrian refuge / median with one crossing to Dufferin Street southbound, one to Paterson Street eastbound (heading into the Mount Victoria tunnel) and one to Paterson Street westbound (leaving the Mount Victoria tunnel). The central pedestrian refuge / median that connects all three crossing arms has extensive guard railing, reflecting the high number of children from nearby schools who use this crossing the need to maintain directional use of the facility and safety issues associated with jay walking.

At the southern end of Dufferin Street on the eastern side there is a traffic lane, separated from the main flow of traffic by a median island and guard railing, to facilitate bus drop-offs and pick-ups to adjacent St Mark's School and Wellington College. There is a zebra crossing across these lanes, away from the main flow of the Basin Reserve traffic.

At the intersection of Adelaide Road and Rugby Street there is a signalised Toucan crossing which allows both pedestrian and cyclists to cross. Again, this has three arms – one across Rugby Street, one across the northbound lane of Adelaide Road and another across the southbound lane. These are all connected by a central pedestrian refuge. The crosswalk lanes are wide than usual with one marked for pedestrians and another for cyclists. There are also separate call buttons with one set higher for cyclists.

There are no pedestrian crossing facilities on the western side of the Basin Reserve between Adelaide Road and Cambridge Terrace. This is reflected in the higher number of pedestrian accidents on this side of the Basin Reserve.

Through the Mount Victoria Tunnel there is a footpath on the northern side of the tunnel only, with adjoining footpaths at both the eastern and western sides. This is elevated from the main stream of traffic and protected by a low wall. The path is shared with cyclists.

Pedestrians heading west on Buckle Street will be able to use the pedestrian facilities on Karo Drive constructed as part of the Inner City Bypass. These include wide shared-use footpaths, upgraded signalised crossings and shelters at intersections.

D.2 Cyclist Facilities

There are very few cyclist facilities around the Basin Reserve. There is a small portion of marked cycle lane on the south-east corner of Rugby Street and Adelaide Road and a signalised Toucan crossing at this intersection which cyclists and pedestrians can both use to cross the road.

Markings at the southern and northern gates of the Basin Reserve indicate that cyclists are allowed to cycle through the ground as a quicker and safer alternative to cycling on the roads around the Basin Reserve.

On the western approach to the Mount Victoria Tunnel the road narrows and there are no shoulders. Cyclists therefore use the footpath on the northern side of Paterson Street to approach the tunnel. There are narrow traffic lanes with no shoulders through the tunnel, making it unsuitable for cyclists. Instead they are encouraged to use a footpath on the northern side of the tunnel. This is elevated from the main stream of traffic and protected by a low wall. The path is shared with pedestrians.

Cyclists are not permitted on the Paterson Street footpath between Dufferin Street and Brougham Street. Instead cyclists must turn onto Brougham Street or cut through the church car park.

Pedestrians heading west on Buckle Street will be able to use the cyclist facilities on Karo Drive constructed as part of the Inner City Bypass. These include wide shared-use footpaths which cyclists can use, upgraded signalised crossings and shelters at intersections.

D.3 Pedestrian Counts

D.3.1 Intersection of Buckle Street, Cambridge Terrace, Kent Terrace and Ellice Street

This intersection had a total of 1,716 pedestrians passing through between 7:00am and 6:00pm on the day of the counts. The busiest time at this intersection was in the AM peak between 8:00am and 9:00am with 352 pedestrians passing through it. In the school peak (3:00-4:00pm) 166 pedestrians passed through, with 171 in the PM peak (5:00pm – 6:00pm).

Over the course of the day the busiest movement by far for pedestrians was crossing from the Basin Reserve north-west across Cambridge Terrace with a total of 470 pedestrians on the day. This is shown in *Figure D.1*.

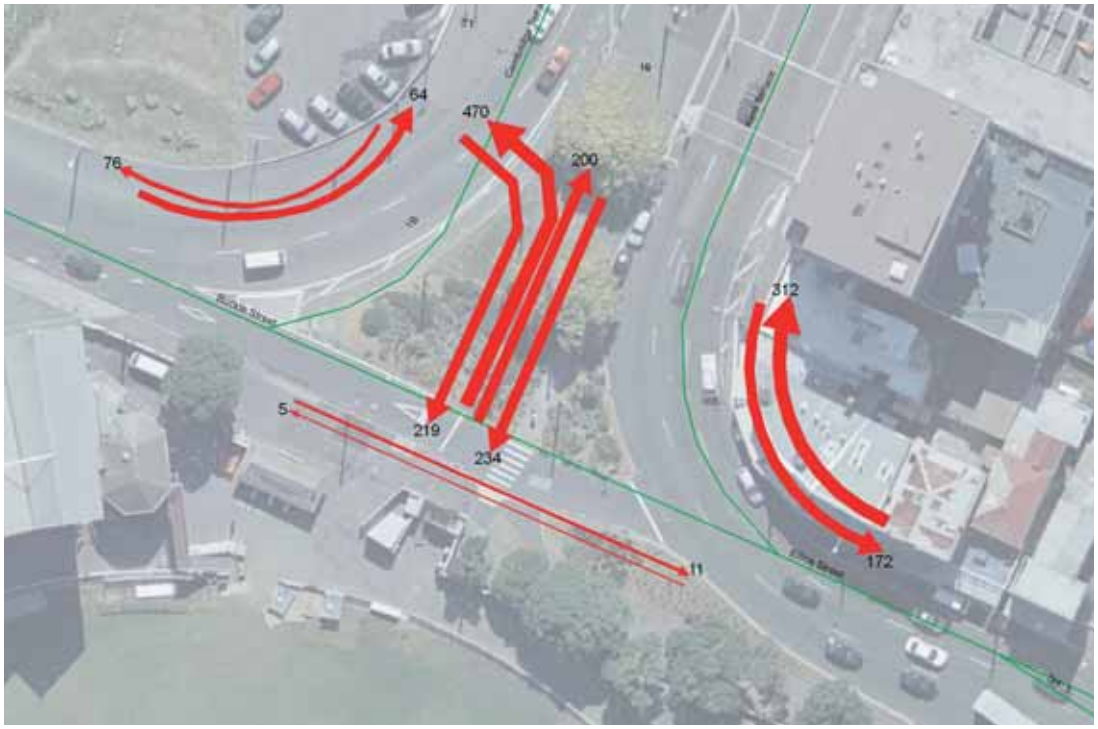


Figure D.1: Total Daily Pedestrian Flows at the intersection of Buckle Street, Cambridge Terrace, Kent Terrace and Ellice Street

D.3.2 Intersection of Ellice and Dufferin Streets

This intersection had a total of 1,992 pedestrians passing through on the day of the counts. The busiest time at this intersection was in the school peak between 3:00pm and 4:00am with 464 pedestrians passing through it. In the AM peak (8:00-9:00am) 367 pedestrians passed through, with 198 in the PM peak (5:00pm – 6:00pm).

Pedestrian movements in both directions on Ellice Street and Dufferin Street were busy in all peak times reflecting the tidal flow of workers walking to and from to the CBD in the northwest, and pupils walking to and from the schools to the southeast. This is shown in *Figure D.2*.

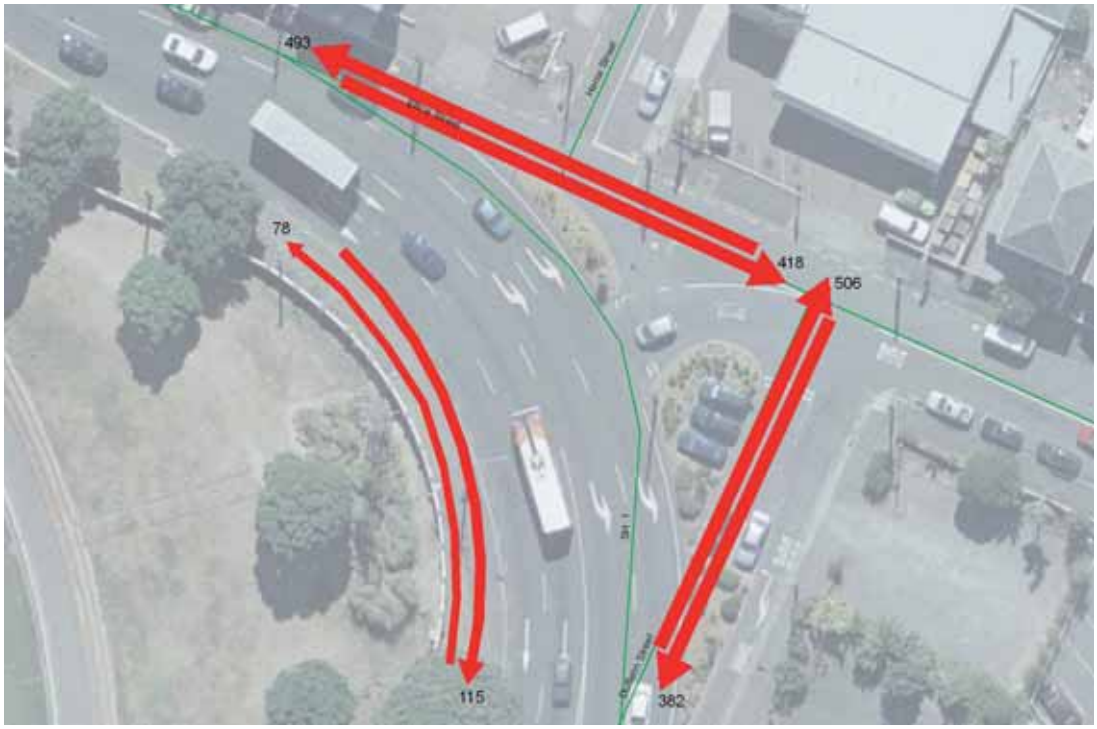


Figure D.2: Total Daily Pedestrian Flows at the intersection of Ellice and Dufferin Streets

D.3.3 Intersection of Dufferin and Paterson Streets

This intersection had pedestrian counts of 1,485 passing through on the day of the counts. The busiest time at this intersection was in the school peak between 3:00pm and 4:00pm with 424 pedestrians passing through it. In the AM peak (8:00am -9:00am) 303 pedestrians passed through, with 110 in the PM peak (5:00pm – 6:00pm).

The two busiest movements were crossing over the eastbound lane of traffic on Paterson Street with 585 pedestrians, and the westbound lane of Paterson Street traffic with 397 pedestrians. This is shown in *Figure D.3*.

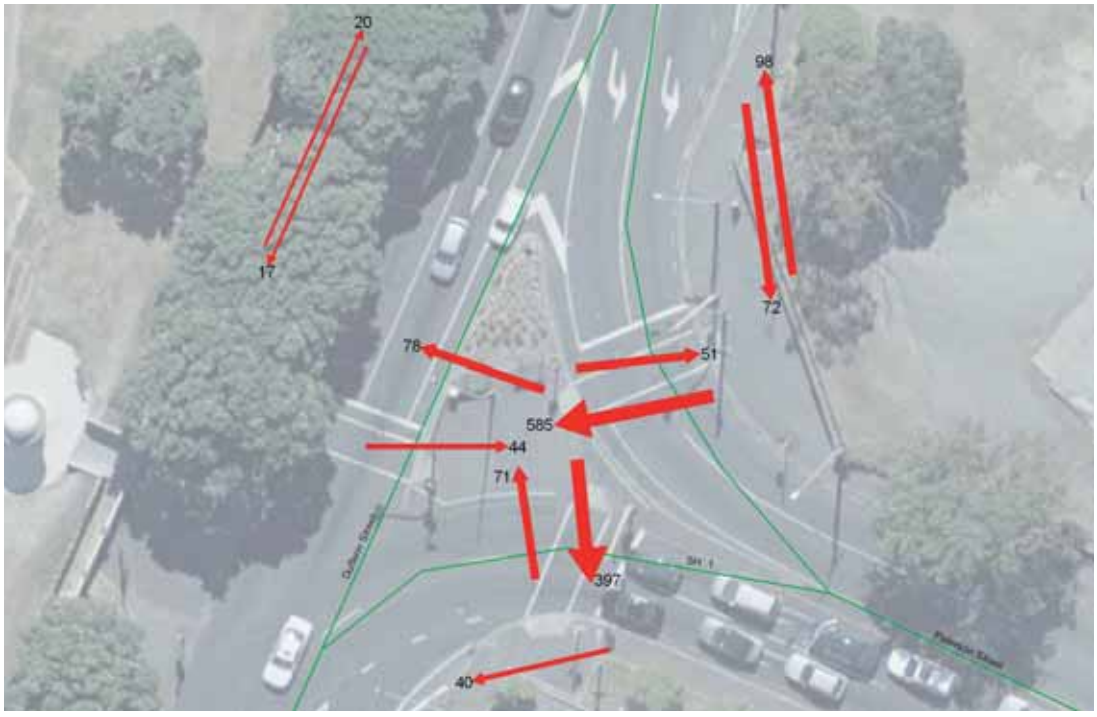


Figure D.3: Total Daily Pedestrian Flows at the intersection of Dufferin and Paterson Streets

D.3.4 Intersection of Rugby Street and Adelaide Road

This intersection has the highest pedestrian counts with a total of 2,114 pedestrians passing through on the day of the counts. The busiest time at this intersection was in the AM peak between 8:00pm and 9:00am with 493 pedestrians passing through it. In the school peak (3:00-4:00pm) 360 cyclists passed through, with 182 in the PM peak (5:00pm – 6:00pm).

The busiest movement by far for pedestrians was crossing eastbound across Adelaide Road with a total of 506, with 317 crossing Rugby Street to the west of Adelaide Road. The westbound lane crossing is busiest in the AM peak with the eastbound lane crossing busiest in the PM peak, reflecting the tidal flow of students travelling to and from the schools to the south of this count site. This is shown in *Figure D.4*.

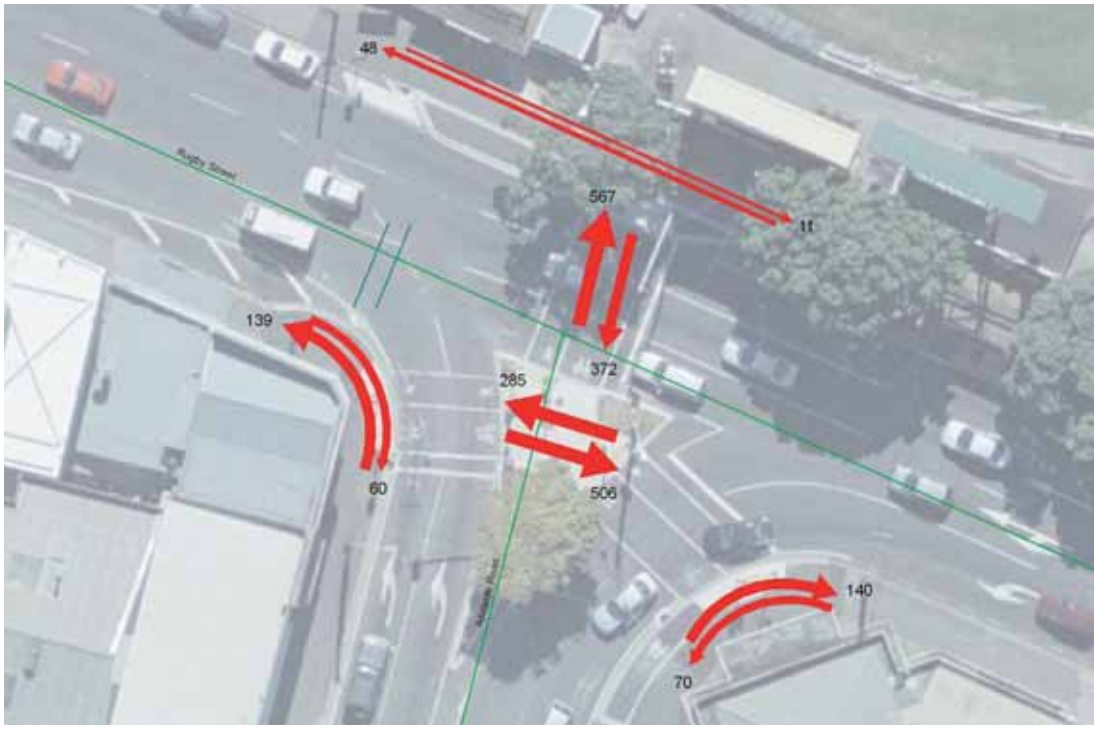


Figure D.4: Total Daily Pedestrian Flows at the intersection of Rugby Street and Adelaide Road

D.3.5 Intersection of Rugby and Sussex Streets

This intersection has the lower pedestrian counts with a total of only 259 pedestrians passing through on the day of the counts. The busiest time at this intersection was in the AM peak between 8:00am and 9:00am with 47 pedestrians passing through it. In the school peak (3:00pm - 4:00pm) 24 pedestrians passed through, with 39 in the PM peak (5:00pm – 6:00pm).

The busiest movements for pedestrians was travelling north in the AM peak and south in the PM peak on the western side of Sussex Street, reflecting the tidal flow of workers to and from the CBD. This is shown in *Figure D.5*.

D.3.6 Mount Victoria Tunnel

Between Monday 23 – Friday 27 February 2009 a total of 2,166 pedestrians were counted walking through the Mount Victoria Tunnel between 7:00am and 6:00pm, an average of 433 per day on weekdays. As expected westbound pedestrians heading to Wellington were highest in the AM peak (8:00-9:00am) with an average of 75 pedestrians during the morning commute period.

In the PM peak (5:00-6:00pm) there is an average of 55 pedestrians on weekdays walking eastbound towards the eastern suburbs. There was a smaller eastbound peak with an average of 36 pedestrians between 3:00-4:00pm on weekdays, coinciding with the end of the school day. These figures are illustrated in *Figure D.6*.

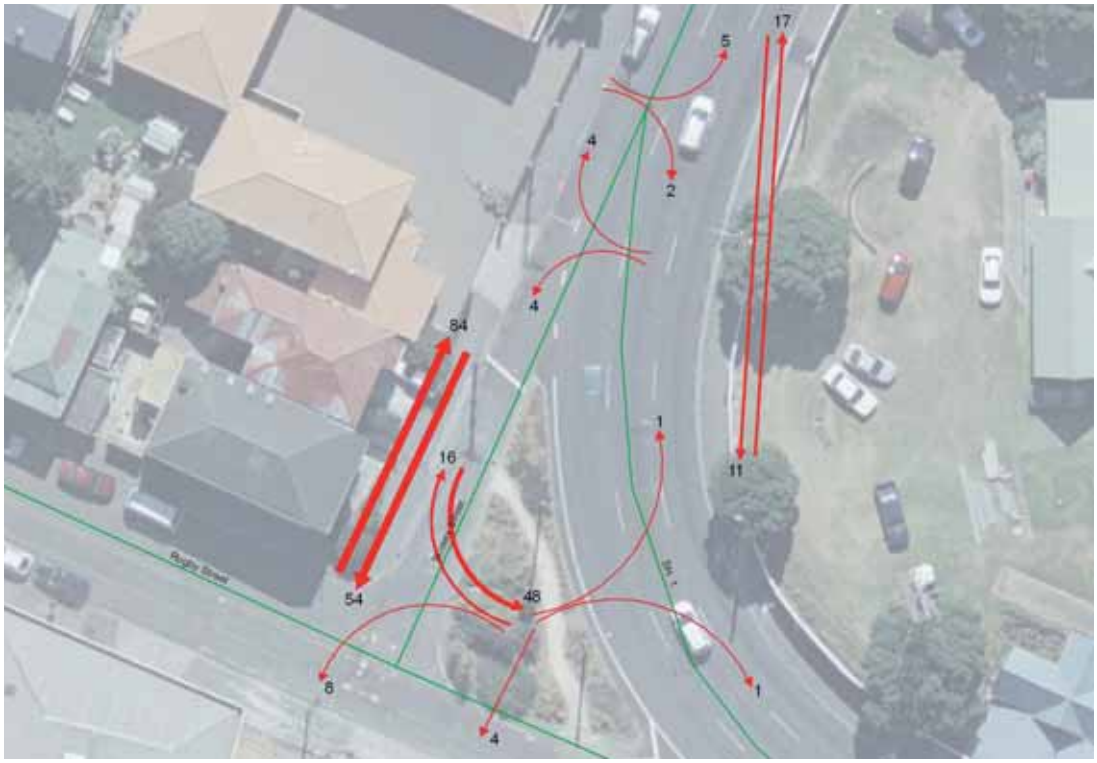


Figure D.5: Total Daily Pedestrian Flows at the intersection of Rugby and Sussex Streets

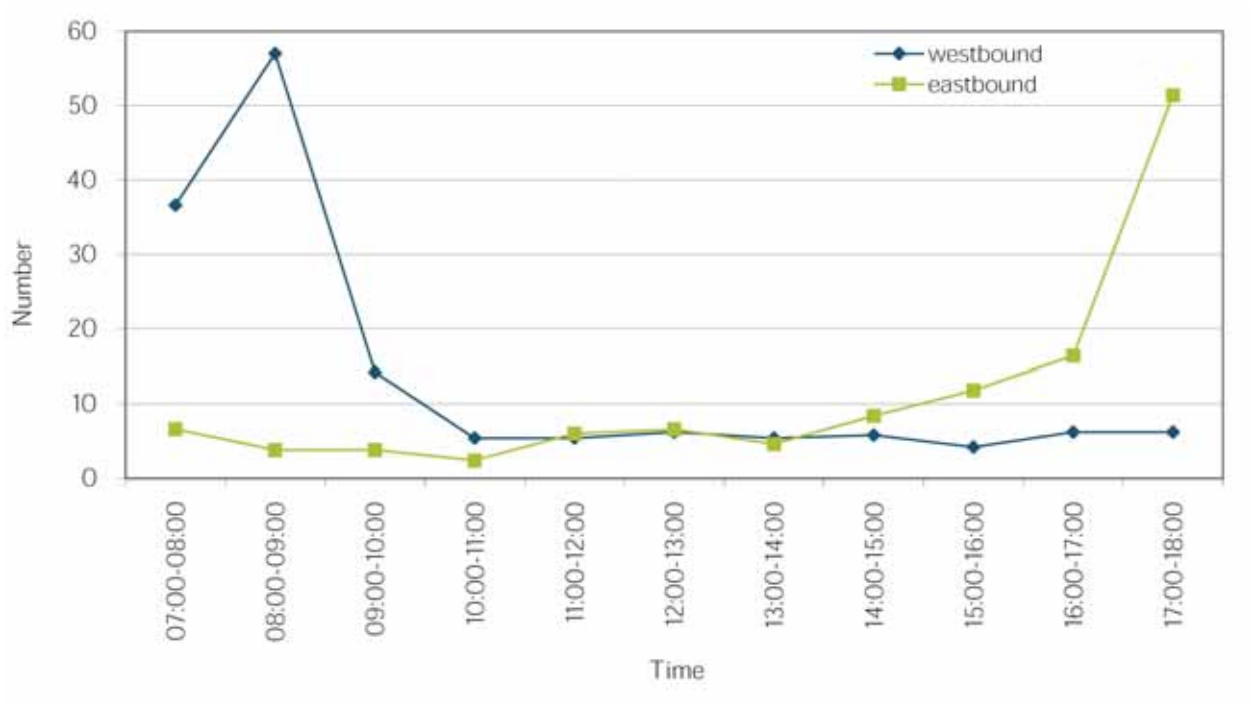


Figure D.6: Average East and Westbound Pedestrians on Weekdays between 7:00am and 6:00pm

These directional flows are consistent with the tidal flow of commuters travelling between Wellington's CBD and suburbs in the morning and evening peaks.

D.4 Cyclist Counts

D.4.1 Intersection of Buckle Street, Cambridge Terrace, Kent Terrace and Ellice Street

This intersection has the highest cyclist counts with a total of 397 cyclists passing through on the day of the counts. The busiest time at this intersection was in the AM peak between 8:00am and 9:00am with 120 cyclists passing through it. In the PM peak (5:00pm – 6:00pm) 37 cyclists passed through. There is no discernable school peak (3:00pm – 4:00pm) with only 17 cyclists being counted.

The busiest movement by far for cyclists was north from the Basin Reserve onto Cambridge Terrace with 221 cyclists. This is shown in *Figure D.7*.

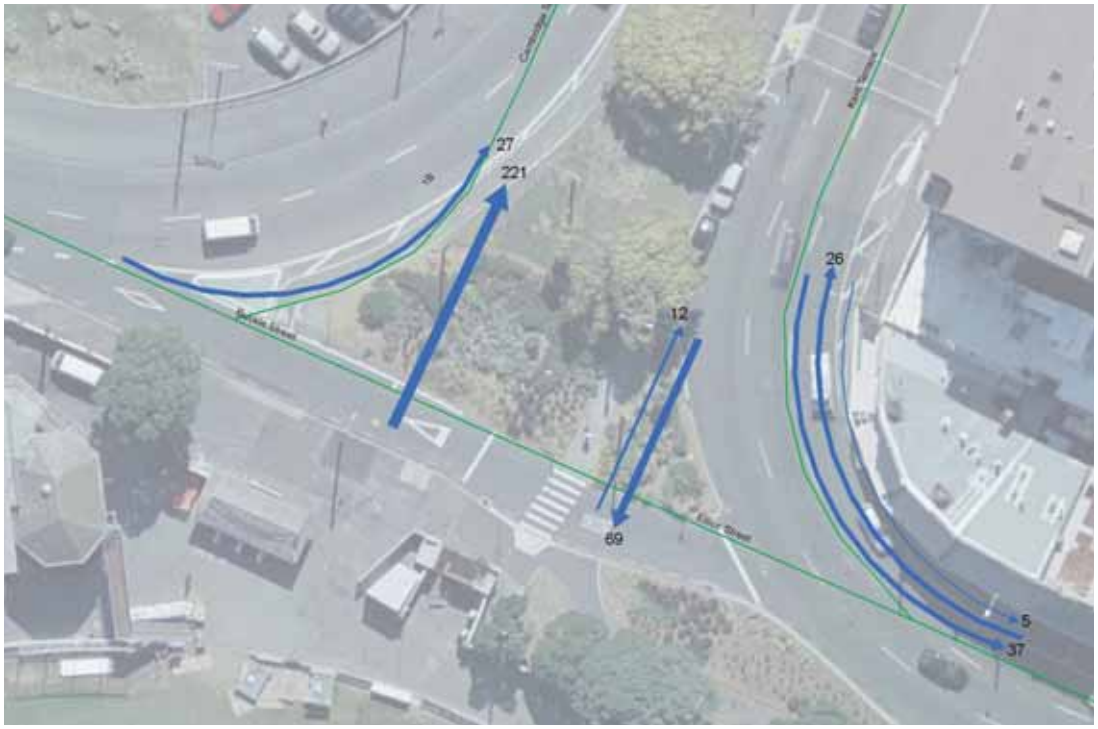


Figure D.7: Total Daily Flows for Cyclists at the intersection of Cambridge Terrace, Kent Terrace Ellice Street and Dufferin Street

D.4.2 Intersection of Ellice and Dufferin Streets

This intersection had a total of 274 cyclists passing through on the day of the counts. The busiest time at this intersection was in the PM peak (5:00pm – 6:00pm) with 84 cyclists passing through it. In the AM peak (8:00am – 9:00am) 36 cyclists passed through. There is a slight school peak (3:00pm – 4:00pm) with 22 cyclists being counted.

The busiest movement by far for cyclists was south-east Ellice Street to Dufferin Street with 115 cyclists. This is shown in *Figure D.8*.

D.4.3 Intersection of Dufferin and Paterson Streets

This intersection had a total of 280 cyclists passing through on the day of the counts. The busiest time at this intersection was in the PM peak (5:00pm – 6:00pm) with 68 cyclists passing through it. In the AM peak (8:00am – 9:00am) 18 cyclists passed through. There is a slight school peak (3:00pm – 4:00pm) with 20 cyclists being counted.

The busiest movement by far for cyclists was south on Dufferin Street with 93 cyclists. This is shown in *Figure D.9*.

Figure D.8: Total Daily Flows for Cyclists at the intersection of Ellice and Dufferin Streets.

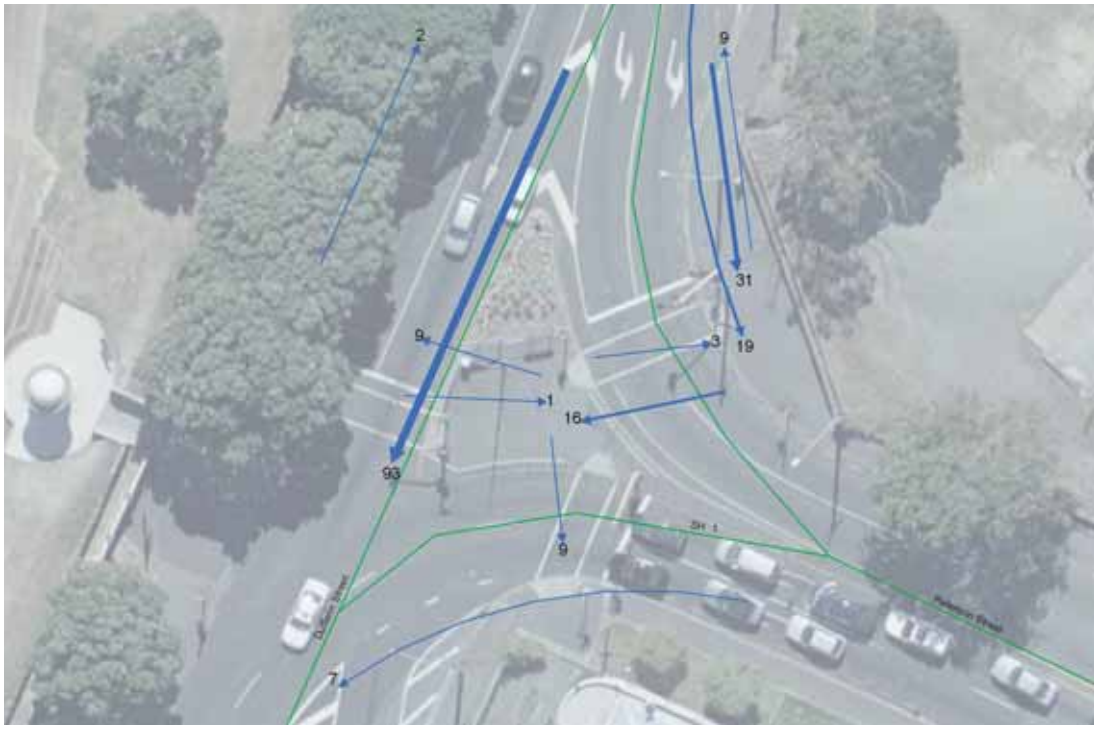


Figure D.9: Total Daily Flows for Cyclists at the intersection of Paterson and Dufferin Streets

D.4.4 Intersection of Rugby Street and Adelaide Road

This intersection had a total of 352 cyclists passing through on the day of the counts. The busiest time at this intersection was in the AM peak (8:00am – 9:00am) with 100 cyclists passing through it. In the PM peak (5:00pm – 6:00pm) 39 cyclists passed through. There is a slight school peak (3:00pm – 4:00pm) with 18 cyclists being counted.

The busiest movement by far for cyclists was north across Rugby Street into the Basin Reserve with 161 cyclists. This is shown in *Figure D.10*.

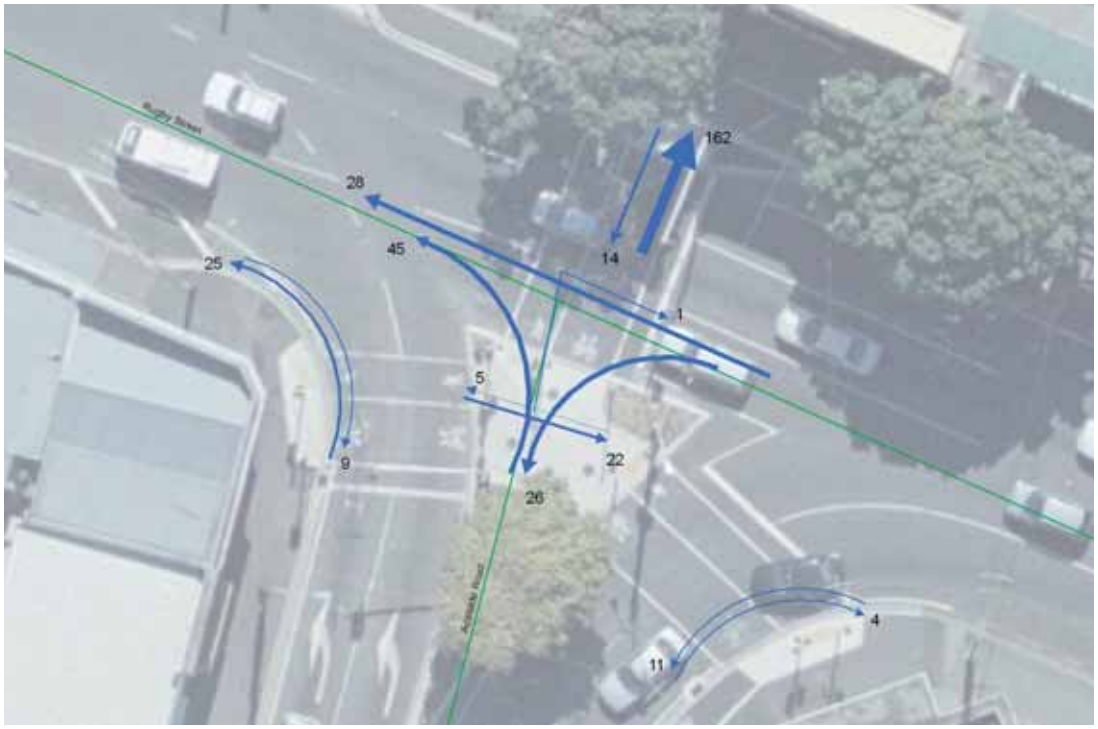


Figure D.10: Total Daily Flows for Cyclists at the intersection of Rugby Street and Adelaide Road

D.4.5 Intersection of Rugby and Sussex Streets

This intersection had the lowest number of cyclists passing through on the day of the counts with only 91. The busiest time at this intersection was in the AM peak (8:00am – 9:00am) with 29 cyclists passing through it. In the PM peak (5:00pm – 6:00pm) 10 cyclists passed through. There is no discernable school peak (3:00pm – 4:00pm) with only 3 cyclists being counted during that time.

The busiest movement by far for cyclists was north-west From Rugby to Sussex Street with 75 cyclists. This is shown in *Figure D.11*.

D.4.6 Mount Victoria Tunnel

Between Monday 23 – Friday 27 February 2009 a total of 1,372 cyclists were counted cycling through the Mount Victoria Tunnel between 7:00am and 6:00pm, an average of 274 per day on weekdays. As expected westbound cyclists heading to Wellington were highest in the AM peak (8:00-9:00am) with an average of 57 cyclists.

In the PM peak (5:00-6:00pm) there is an average of 51 cyclists on weekdays walking eastbound towards the eastern suburbs. There was no peak that coincided with the end of the school day. These figures are illustrated in *Figure D.12*.

These directional flows are consistent with the tidal flow of commuters travelling between Wellington's CBD and suburbs in the morning and evening peaks.

Figure D.11: Total Daily Flows for Cyclists at the intersection of Ellice and Dufferin Streets

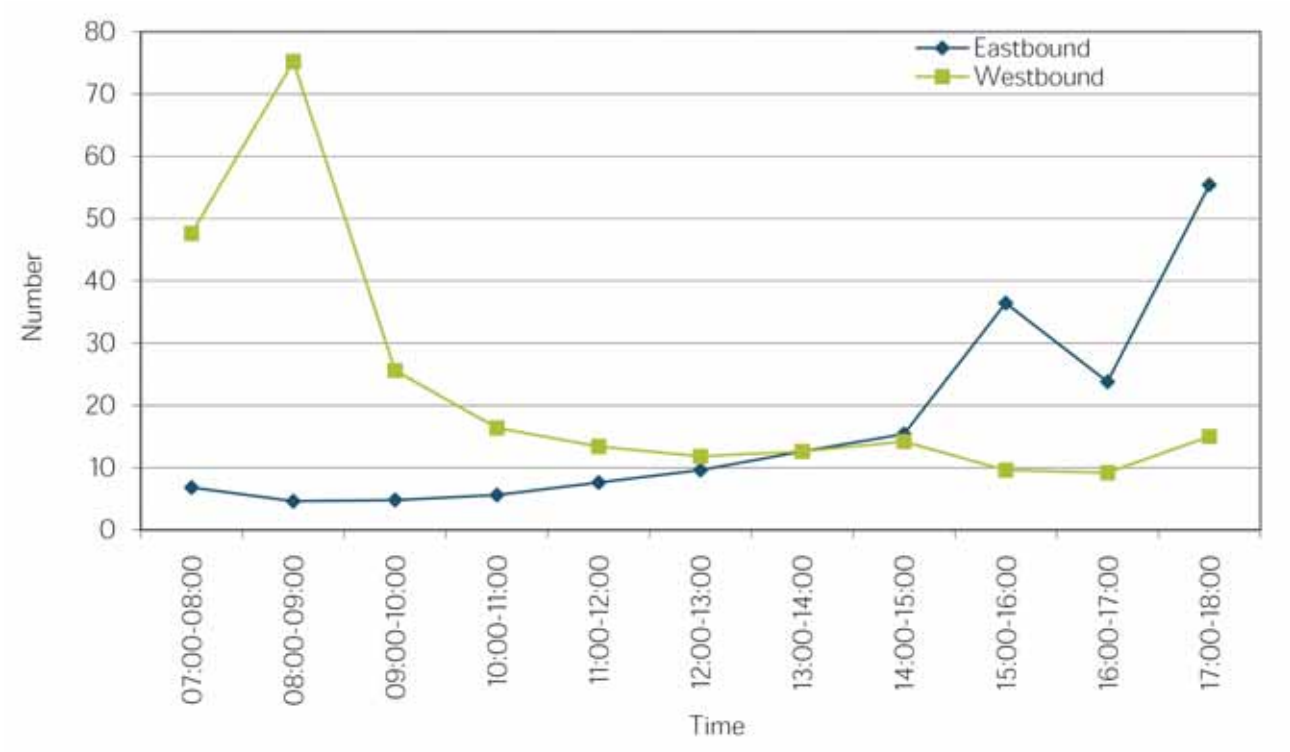


Figure D.12: Average East and Westbound Cyclists on Weekdays between 7:00am and 6:00pm

Appendix E
Inquiry by Design Options

The five options from the Inquiry By Design Workshop are:

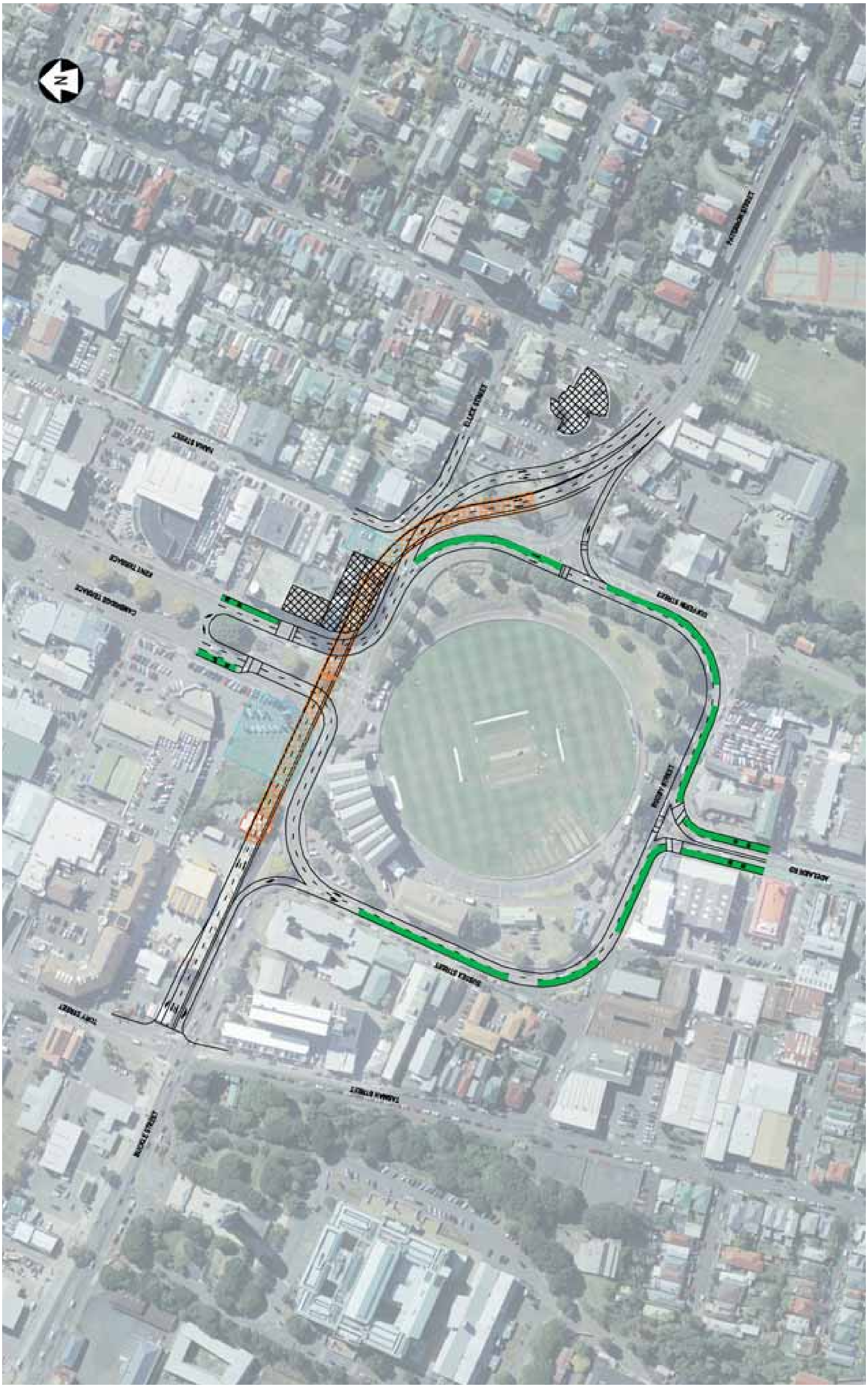
Design by Inquiry Workshop Option 1C. This option involves the realignment of the Kent Terrace approach to Ellice Street, with a new road that branches from Ellice Street to the Victoria Tunnel. Realignment of Hania Street and Ellice Street intersection is also proposed. Current roading around the Basin will include a dedicated bus lane. Minor realignment on Dufferin Street, Rugby Street, and Sussex Street is proposed. A new road on an elevated structure is proposed from Paterson Street to Tory Street for west bound traffic.

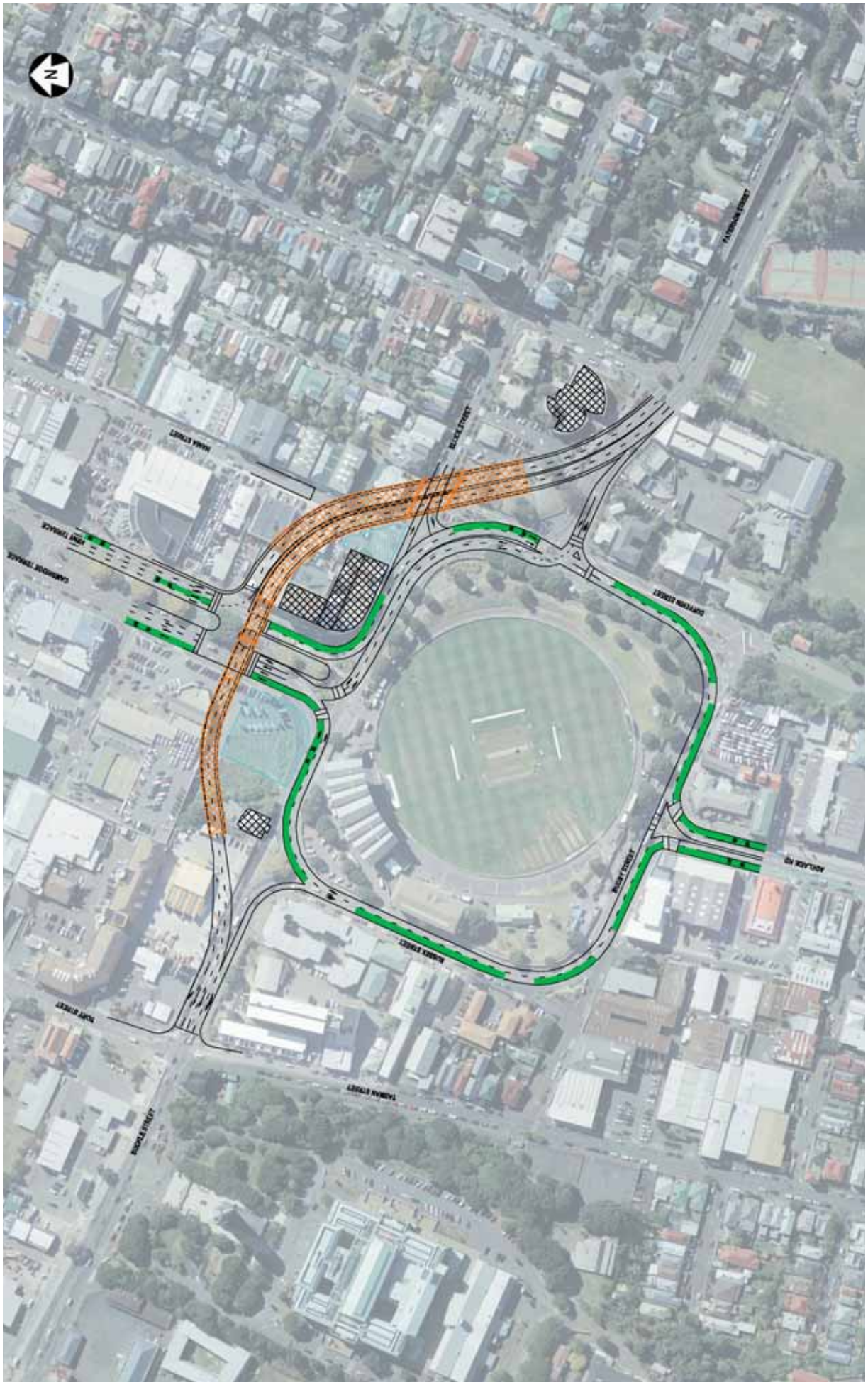
Design by Inquiry Workshop Option 2A. This option involves the creation of a new elevated structure from Paterson Street to Tory Street for west bound traffic. An on ramp for the elevated structure from Kent Terrace would carry east bound traffic to the Victoria Tunnel. The elevated structure for the new road would be pushed north of Buckle Street (over top of the existing Repco Building). Minor road alignment at grade is proposed between Paterson Street and Cambridge / Kent Terrace, with traffic flow directions being altered; for Rugby and Sussex Streets; and a new alignment for Ellice Street. Through traffic would be on the proposed elevated structure. A new intersection configuration is proposed for Cambridge and Kent Terrace near the new elevated structure. Dedicated bus lanes are proposed around the Basin Reserve. Hania Street access to Ellice Street would be closed under this option.

Design by Inquiry Workshop Option 8. This option involves a similar route alignment as option 2, but with roads at grade. Traffic from Victoria Tunnel would be directed to a new intersection at Cambridge and Kent Terrace north of Buckle and Ellice Streets. Minor road realignment is proposed for Ellice Street, Paterston Street and Dufferin Street intersection and between Buckle Street and Ellice Street. The left hand turn from Sussex Street to Buckle Street is removed. Dedicated bus lanes around the Basin Reserve are proposed. Hania Street access to Ellice Street would be closed under this option.

Design by Inquiry Workshop Option 9A. This option involves a new intersection and road realignment on Cambridge and Kent Terraces. A new at grade road is proposed between Patterson Street and Cambridge and Kent Terraces to the north of Ellice Street. North bound and east bound traffic is separated. Road realignment is proposed from Adelaide Road to Buckle Street, along Sussex Street. A new intersection at Sussex and Buckle Street is proposed, with a new road extending north of this intersection which will connect to Cambridge Street (at the new intersection). Traffic flow directions are proposed to change along Ellice and Buckle Streets, focusing on west bound traffic. Hania Street access to Ellice Street would be closed under this option. A new intersection from Ellice Street to the proposed new road to Kent Terrace is proposed. Dedicated bus routes are proposed on Sussex and Rugby Streets.

Design by Inquiry Workshop Option 9B. This option involves a similar new intersection and road realignment as in Option 9A. The new proposed road north of Sussex Street divides into two roads for north and east bound traffic onto Cambridge Terrace. Road realignment is proposed for the Cambridge / Kent Terrace and Buckle / Ellice Street intersections, including an change in traffic direction. Dedicated bus lanes are proposed for Adelaide Road, Rugby and Sussex Streets.




N
PATTERSON STREET
MAIDA STREET
BUCK STREET
CAMBRIDGE TERRACE
CARLTON GORE ROAD
ADELAIDE RD
TASMAN STREET
TAYLOR STREET
BUCKLE STREET


N
ELLICE STREET
TAMAKI DRIVE
ADELAIDE RD
TAMAKI STREET

Appendix F
Crash Details

F.1 Adelaide Road / SH1

The Adelaide Road / SH1 signals is a major convergence point for conflicting vehicular, passenger transport and pedestrian movements between Adelaide Road, SH1 and Wellington CBD. Given the significant volume of traffic that moves through the intersection it is not surprising that this intersection has the highest occurrence of crashes within the gyratory. In summary this location has the following trends:

- A total of 28 crashes have occurred over the study time period within a 35m radius of the signalised intersection. Of these 28 crashes, four have been classified as resulting in a minor injury.
- Rear end / obstruction is the predominant crash type at this intersection accounting for 50 percent all the crashes.
- Environmental conditions are generally not a factor in the crashes at this location. 82% of all crashes have occurred during dry conditions and 75% have occurred during daylight hours.

F.2 Rugby Street / SH1

At the Rugby Street / SH1 give way intersection, there are three lanes available for general traffic. This section of road becomes highly congested during the peak periods. However, the majority of the crashes are related to excessive speed during in the early hours of the weekend as can be seen below:

- A total of seventeen crashes have occurred within a 35m radius of the give way intersection. Of these crashes, four have resulted in minor injuries.
- Thirteen of the crashes (76%) have been classified as "Bend – Loss of Control / Head on".
- Twelve crashes (71%) have occurred at night. In addition, 47% of crashes have occurred during wet weather conditions. These values are significantly higher than the averages for the gyratory.
- The majority of crashes that have occurred at this location have happened during the weekend with six crashes (35%) occurring between the hours of 21:00 and 02:59 over Friday, Saturday and Sunday.

F.3 Tory Street / Buckle Street

The Tory Street / Buckle Street signalised intersection is an important link for SH1 westbound traffic. Large volumes of pedestrians also use this intersection to access the Mount Cook area. This location has the following trends:

- A total of thirteen crashes have occurred over 2 years within a 35m radius of the signalised intersection. Of these crashes, four have resulted in minor injuries.
- Ten of the crashes (77%) have been classified as being of the "Rear End / Obstruction" type. One of the crashes involved a pedestrian crossing without regard for the traffic which had the right of way.
- Eleven crashes (85%) occurred during light and dry conditions. Environmental conditions are not a major factor in the crash history at this location.

F.4 Paterson Street / Dufferin Street

The signalised intersection at Paterson Street and Dufferin Street is a major conflict point in the road network. All SH1 traffic (both eastbound and westbound) utilises the intersection and, in addition to these regional movements, all local traffic travelling from the CBD to Newtown must also use this intersection. This results in many merging conflicts. Pedestrians also use this intersection when travelling from the Mount Victoria Tunnel footpath towards the Basin Reserve grounds. In summary the following key trends have been observed:

- A total of twelve crashes have occurred in the two year period within a 35m radius of this signalised intersection; only one crash resulted in a minor injury.
- The dominant crash types occurring in the vicinity of this intersection are Rear End / Obstruction and Overtaking. Each crash type accounts for 42 percent of all crashes at this location. The overtaking crashes are a result of the significant number of lane change manoeuvres that are taking place in the vicinity of the intersection. Some motorists are trying to get to the left lanes to continue on SH1 through the Mount Victoria Tunnel while other motorists are trying to get to the right lanes to continue around the Basin Reserve to Adelaide Road. To further complicate matters from the bus lane on Kent Terrace, most bus drivers are forced to make two lane changes so that they can to continue straight through the intersection and get to Adelaide Road.
- Eight crashes (66 percent) occurred during light and dry conditions. Environmental conditions are not a major factor in the crash history at this location.

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