Waikato Regional Transport Model

Four Step Model Validation 2006

Technical Note No 34

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Four Step Model Validation 2006

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Quality Assurance Statement

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1. Purpose

The purpose of this note is to document the procedure followed for checking the validation of the 2006 Four Step model (version 101) during the 2013 census update and provide the results. Technical Notes 26, 33 and 29 have covered Generation, Distribution and Mode Split respectively.

This note covers the validation of the re-estimated model at 2006. Technical Note 35 covers the application of the four step model using the 2013 census data as the land use data inputs, and its resulting bus vehicle and passenger volumes.

2. Introduction

Once the trip matrices by mode have been formed, the final step is the assignment of the public transport trips to the bus services, and vehicle trips to the road network, at which time a number of validation checks can be performed. The 2006 public transport services have been coded onto the vehicle network, and the loaded network speeds and times have been used to determine bus running speeds, with allowances made for passenger loading and unloading times.

The routes coded are shown in **Appendix A** as Figure A1 for those within Hamilton, and Figure A2 for those serving the area around Hamilton from Ngaruawhahia to Te Awamutu and Cambridge. These are the services in place in July 2008, which is consistent with the time at which the bus intercept survey was undertaken. It was not plausible to model the bus services at base year (2006) conditions because there was no detailed data available to validate against for 2006. The corresponding timetables for both modelled periods are included as **Appendix B**.

The fare structure is presented in **Table 1**.

<table>
<tr><th>No.</th><th>Location and Provider</th><th colspan="2">Fare</th></tr>
<tr><td>1</td><td>Hamilton (Hamilton Urban Services)</td><td colspan="2">$2.00</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Cambridge (Cambridge Travel Lines)</td><td>1 section</td><td>$3.00</td></tr>
<tr><td>2 sections</td><td>$5.50</td></tr>
<tr><td>3 sections</td><td>$6.00</td></tr>
<tr><td>3</td><td>Te Awamutu (Go-bus Hodgsons)</td><td colspan="2">$6.00</td></tr>
<tr><td>4</td><td>Orbiter Hamilton</td><td colspan="2">$2.00</td></tr>
<tr><td>5</td><td>CBD Shuttle</td><td colspan="2">Free</td></tr>
</table>

Table 1: Modelled Waikato Region Bus Services and Fares

3. Public Transport Assignment

The following section briefly details the development of the public transportation 2006 model. There is much technical detail included and no attempts have been made to simplify the text beyond its technical status.

3.1 The Assignment Process

The PT assignment model is analogous to the vehicle assignment and is used for assigning PT trips onto the network.

Unlike conventional vehicle assignment, PT assignment assigns the bus passenger matrix onto a fixed set of routes. Similar to vehicle assignment the decision of which route is taken is based on least cost algorithm. The main difference between the vehicle and public transport assignment is in the way the matrix is loaded.

Public transport represents a dynamic assignment model where the modelled period and the matrix are divided into slices and passengers are released in intervals starting from the beginning of the modelled period. A dynamic assignment approach is necessary because of the way that buses run following a fixed timetable. The decision is made by each passenger as to which service or services will be taken, given the time that a service is available, and the time between two or more services connecting.

(i) The single ride trip will occur if:

$$T^1_A > T^i_S + T_F + T_C$$

Where:

T^1_A = the time at which the first available bus arrives at the bus stop A

T^i_S = slice release time where the number of slices is i

T_F = access and egress time by foot

T_C = access time by car to/from the park'n'ride station

The difference between the left and right hand side in the inequality above represents the waiting time T_W:

$$T_W = T^1_A - T^i_S + T_F + T_C$$

The waiting time has to be greater or equal to 0 and less or equal to maximum waiting time otherwise the trip cannot occur.

$$T_{W(max)} \geq T_W \geq 0$$

(ii) The multi ride trip will occur if the single ride trip condition is satisfied for the first bus service used, and

$$T^2_B \geq T^1_B + 30\text{sec}$$

Where:

T^1_B is the time at which the first bus arrives at the bus stop B

T^2_B is the time at which the second bus departs at the bus stop B

30sec is the minimum time allowed for the passenger transfer

The difference between the first bus arrival and the second bus departure represents the waiting time:

$$T_W = T^2_B - T^1_B$$

Therefore T_W and has to be greater or equal to 30 seconds and less or equal to maximum waiting time $T_{W(max)}$ for the trip to occur:

$$T_{W(max)} \geq T_W \geq 30\text{sec}$$

If the maximum number of transfers is 3, then another condition has to be met for the trip to occur:

$$T^3_C > T^2_C + 30, \text{ and}$$

$$T_{W(max)} \geq T_W \geq 30sec$$

Where:

T^2_C = *the time at which the second bus arrives at the bus stop* C

T^3_C = *the time at which the third bus departs at the bus stop* C

T_W = $T^3_C - T^2_C$

$T_{W(max)}$ = *the maximum waiting time*

Further constraints are the maximum inter-zonal cost and the maximum number of transfers. They cannot exceed values specified in the parameter file.

The inter-zonal cost for PT trips is derived as the weighted sum of several components:

- Wait time cost
- Walking time cost at each end of the trip
- Park'n'ride cost (if used)
- Fare cost
- A penalty for transferring between services

All bus routes are divided into a number of fare sections and the bus fare is derived depending of which fare section crossed. In the base model, a new ticket has to be purchased if a transfer is needed.

If a car is used as part of a PT trip (for example a park'n'ride trip) then the car cost is added and it consists of:

- In vehicle time cost
- In vehicle distance cost
- Parking cost

Time and distance costs are derived from the loaded vehicle network. During the assignment the link time is multiplied by 1.3 to allow for the time lost at bus stops where the boarding and alighting of buses occurs. The route file defines express routes where passengers can board buses only at certain stops, and no additional allowance is made for pick up times.

3.2 Public Transport Model Outputs

The public transport assignment outputs a series of matrices representing various time and cost components, and are a weighted average of the cost of all trips between each zone pair:

- In vehicle time
- Average walk time
- Average wait time
- Average car cost
- Average fare cost

Other matrices output by the public transport assignment are:

- Average number of fare sections crossed
- Average number of transfers

It is also possible to establish the services used between each zone pair for each slice of loading. Also available are the origin and destination nodes for each bus service used and the park 'n ride nodes if these facilities are used to complete the trip. The path file also contains information about each of the slices loaded, the release time and the cost in dollars for that trip portion. If the trip happens to be the one where passengers transferred from one bus to another, then the node at which the transfer occurs is recorded.

Passenger patronage per service with the time component included is reported in a separate file, which lists all services and the number of passengers getting on and off the buses along the route.

Similar to vehicle assignment a loaded network is produced at the end of each run, and this will contain either PT passenger numbers or the number of buses depending on the option selected. The number of buses is a graphical check on the coding and is a direct reflection of input.

4. Validation Criteria

The checks on the public transport model as included in the Model Specification Report are:

4.1 Public Transport Distribution and Assignment

Model Output: Bus numbers
Check: That the number of buses on each link matches observed. This is essentially a check on service coding.
Criteria: Absolute match

Model Output: Bus journey times
Check: That the journey time for each service matches observed. In part a check on timetable coding and in part that the stopped and network travel times are correct.
Criteria: Journey times within ± 5% of expected for each service

Model Output: Passenger numbers per service
Check: That the number of passengers on and off for each service match observed
Criteria: Overall within +/- 10%, R^2 >0.6, and +/- 40% on most services

Model Output: Screenline link passenger volumes
Check: That the number of passengers on each and all links in a screenline match observed
Criteria: That each screenline is within ± 20% of observed and most individual links are within ± 50% of observed

Model Output: Elasticities
Check: That the modelled response to changes is in accordance with international experience
Criteria: Fare change has an elasticity of - 0.3, and frequencies -0.1 in peak periods and slightly higher elasticities off peak

Model Output: Three step vs Four Step traffic volume comparison
Check: That the two models are consistently replicate traffic volumes
Criteria: Overall R^2 > 0.95 for counts and R^2 > 0.95 for sector to sector trip totals
Most screenline GEH statistics < 4

These checks were specified during the model build and stipulated in the Model Specification Report. At that time, NZTA's Economic Evaluation Manual (EEM) did not provide any guidance on criteria for validating the public transport assignment. Since then, the NZTA Transport Model Development Guidelines have been released, which does include criteria for public transport assignment validation. The criteria in the NZTA Guideline have been taken on board and results are reported on this basis in this technical note.

5. Model Convergence

5.1 Assignment and Validation Loop

Time and distance matrices are required as inputs for trip distribution. As assigning the trips to the network generates these matrices, after each assignment the trip distribution needs to be re-run and the trips re-assigned until the time and distances matrices converge.

In practice, it is unlikely that absolute convergence occurs. The assignment and distribution steps are run iteratively until the totals of both the time and distance matrices between successive runs remain close to each other and relatively constant.

The totals for the time and distance matrices for two successive Assignment/Distribution Loops (after many previous runs) are shown below in **Table 2** where:

TVM = Total Vehicle Minutes

TVK = Total Vehicle Kilometres

And the mode split convergence results for both morning peak and inter peak are presented in **Table 3**.

PERIOD	AM PEAK		INTERPEAK	
	TVM	TVK	TVM	TVK
Last Run	2,721,270	2,540,955	2,192,564	1,970,872
Difference from Previous Run	1665	756	-2411	-614
% Diff	0.06%	0.03%	-0.11%	-0.03%

Table 2: Model Convergence

Variable	Previous Iteration	This Iteration	Difference	%
AMP				
Active Trips	43,407	43,409	2	0.00%
Bus Passengers	4,729	4,719	-10	-0.21%
Car Passengers	114,927	114,892	-35	0.03%
Drivers	240,831	240,872	41	0.02%
INP				
Active Trips	37,816	37,802	-14	-0.04%
Bus Passengers	1,905	1,968	63	3.20%
Car Passengers	66,941	66,915	-26	-0.04%
Drivers	220,831	220,809	-22	-0.00%

Table 3: Mode Split Convergence

The percentage change in generalised user cost between consecutive loops should be less than 1%. As the total vehicle minutes and total vehicle kilometres change less than 1% between runs (shown above), and unit time and distance costs are constant between runs, generalised user cost also changes less than 1% between runs.

When validating the model it is difficult to get a long series of runs prior to convergence because of the continual changing of the model components to get a better fit, even though these changes were often small. In general the model re-converged after two or three iterations. The periods were then run several times after convergence and remained stable.

For any model, if the network is heavily congested, convergence may not occur. Although the model is currently stable, when any changes are made to the model inputs (e.g. option testing or land use), then convergence must be checked to ensure the model is still stable. In the unlikely event of the model not stabilising, modifications will have to be made to the network so that it will converge. These modifications should then be incorporated into the option or year being tested.

Another check on the assignment convergence stability is that the proportion of links in the entire network with flows changing less than 5% from the previous iteration, and consecutive iterations with proportions greater than 95% (EEM Worksheet 8.4). This is reported in the next section.

5.2 Link Flow Convergence

The EEM requirement for link flow stability is that 95% of all links should not change by more than 5% between the ultimate and penultimate distribution/assignment convergence loops. The percentage of total links with changes of less than 5% for the three modelled periods is shown in **Table 4** below, with the results well within the guidelines.

Period	Criteria	Links	Percentage	Less than 5%
AMP	0% - 2.5%	22292	99.64%	99.88%
	2.5% - 5%	53	0.24%	
	> 5%	27	0.12%	
Total		**22372**	**100%**	
INP	0% - 2.5%	22284	99.61%	99.74%
	2.5% - 5%	29	0.13%	
	> 5%	59	0.26%	
Total		**22372**	**100%**	

Table 4: Model Convergence

6. Model Validation

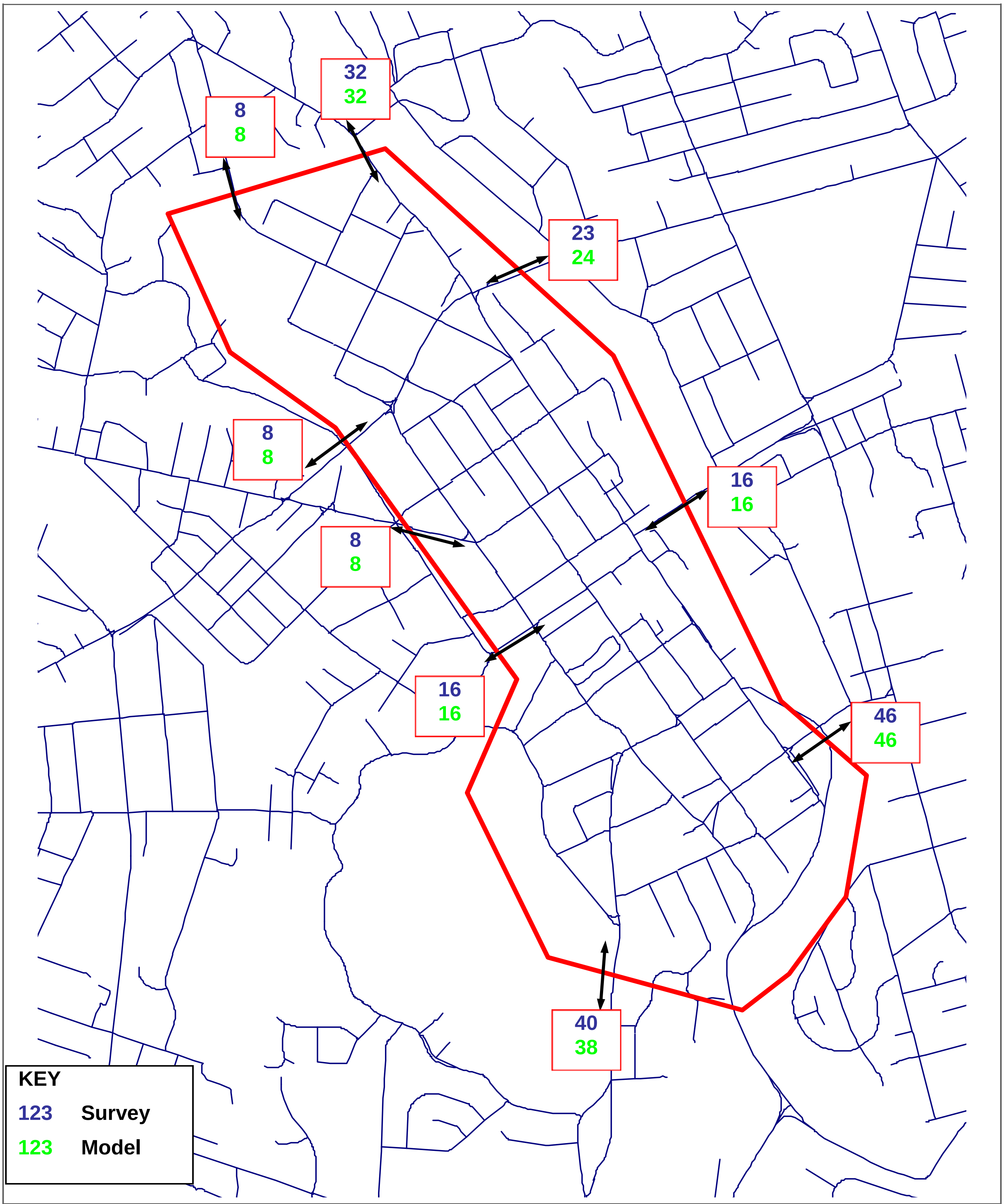
6.1 Bus Numbers

The number of buses passing a particular point during the modelled time period is a function of the service routes, the frequency of the service, and the extent to which a bus driver has managed to keep to the timetable.

The check that the model is assigning buses to the correct routes and in the correct numbers is a check on input service coding, and can be derived from an analysis of the timetables. Alternatively, the number of buses on a link can be derived directly from a classified count.

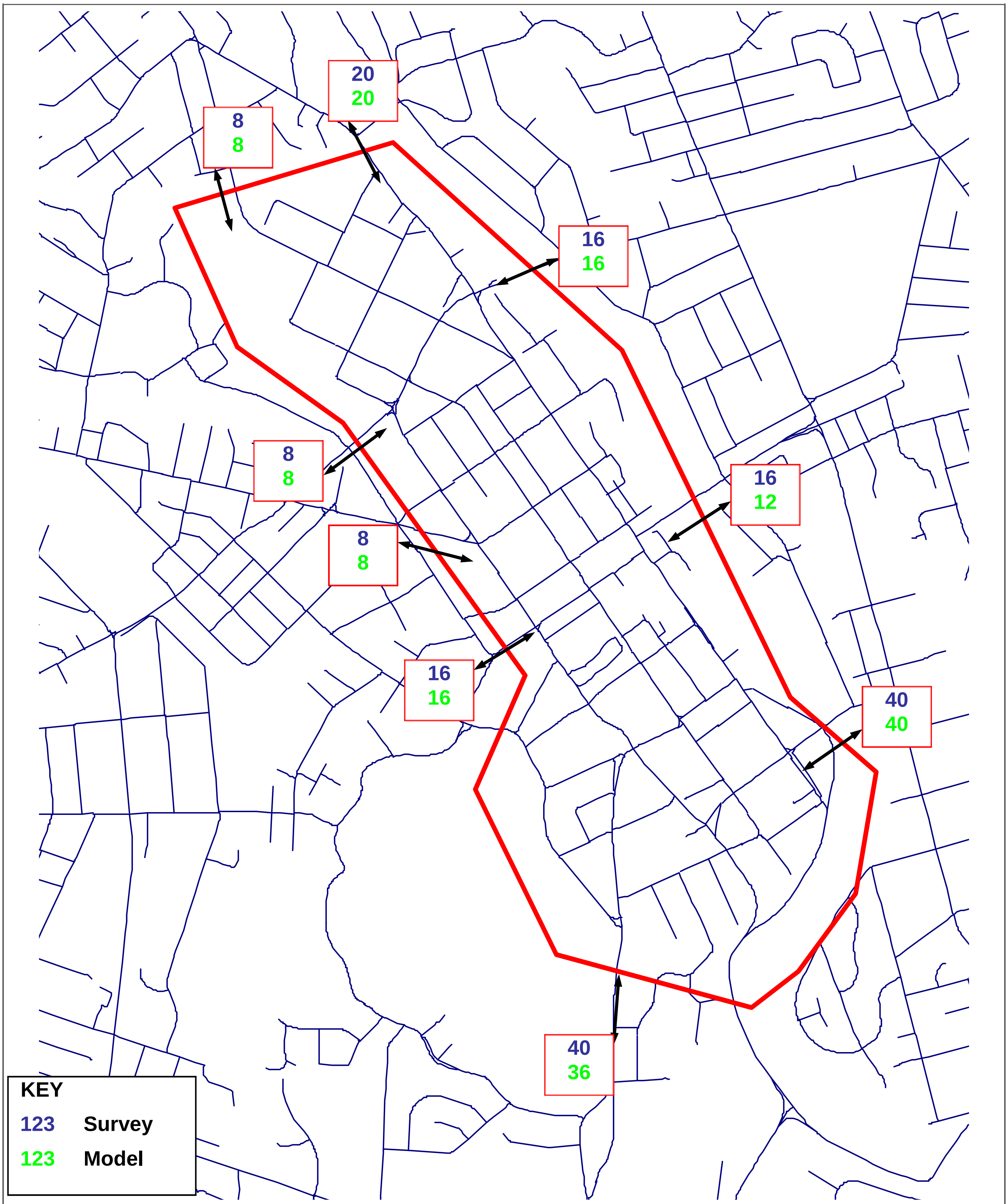
In Hamilton, the latter course was not followed as the automatic classified counts available to the study identified buses as a vehicle class, but these do not distinguish between buses, coaches and school buses, with only scheduled public services included in the model.

Accordingly, the number of buses that should have been on the links around a CBD cordon was calculated from the timetables and checked back against the modelled bus vehicle assignment. The CBD cordon used in this analysis and the AM peak and inter peak bus number validation is shown in **Figure 1** and **Figure 2**. These figures indicate that the model is replicating the timetables correctly.



Hamilton CBD Cordon
AM Peak Bus Vehicle Validation

1



Hamilton CBD Cordon
Inter Peak Bus Vehicle Validation

TDG

2

6.2 Bus Journey Times

The Model Specification Report suggested a check against bus journey times. It was initially intended that this data be extracted from the Environment Waikato electronic bus data and it was understood that this would be readily available. Unfortunately time-specific data, which is available from EW is limited to the time at which patrons boarded services, therefore it is not possible to extract an arrival time for the bus reaching the last stop. It is also evident that patrons may board the service at the first stop a number of minutes prior to the start of a run.

The WRTM assumes that bus travel times in urban areas are 30% longer than travel times in private vehicles when no bus priority measures are imposed. The 30% is an allowance for the time taken for boarding and alighting the service. This value was calibrated in 1971 in Christchurch and has recently been confirmed using real-time GPS data in each of Dunedin, Christchurch and Kuala Lumpur. Analysis of the public transport assignment outputs confirmed that the model is accurately calculating bus travel times on this basis.

Unfortunately there was insufficient recorded data from the GPS information collected by Environment Waikato to verify the 30% figure on the local services. However, this assumption could be tested using GPS units on a selection of Hamilton City bus services if required. In any event, this assumption has invariably held when it has been tested in urban areas.

6.3 Screenline Link Passenger Volumes

The number of bus passengers passing a particular point during the modelled time period is again a function of the service routes, the frequency of the service, and the extent to which a bus driver has managed to keep to the timetable. The check that the model is assigning bus passengers to the correct routes and in the correct numbers is a check on input service coding and the ability of the model to replicate observed.

Accordingly, the number of bus passengers that should have been on the links around a CBD cordon was calculated from the bus intercept survey data where these observed bus trips are assigned to the network ("survey"), and these are compared against the modelled public transport assignment where the demands are calculated from the Generation/Distribution/Mode split models and then also assigned to the network ("model"). The CBD cordon used in this analysis, together with the AM peak and inter peak bus passenger volumes, is shown in **Figure 3** and **Figure 4**. While there are some areas the model is high and others where it is low, overall the modelled result is about the same as the survey in the morning peak and about 33% less in the inter peak.

Table 5 shows the GEH and other comparisons of bus patronage across the Hamilton CBD cordon. As a result of limited survey data, the GEH analysis is based on two-way volumes, not directional on each link. Overall the model meets the Guideline criteria very well, with the exceptions being the morning and interpeak target GEH less than 5 at 33% and 44%, respectively, rather than the target of 50%, the morning GEH < 12 at 78% rather than the target 85%, and the lines of best fit slightly high in the morning and low in the evening peak periods. Overall, this is considered acceptable and sufficient for option testing.

PT PATRONAGE INDIVIDUAL COUNT COMPARISON TO NZTA TRANSPORT MODEL GUIDELINES				
		Target	**Morning Peak**	**Inter Peak**
Individual PT Routes	GEH < 5.0	>50%	33.3%	44.4%
	GEH < 7.5	>60%	66.7%	66.7%
	GEH < 10	>70%	66.7%	88.9%
	GEH < 12	>85%	77.8%	100%
Line of Best Fit		Y=0.85x-1.15x	Y=1.18x	Y=0.69x
R^2		>0.80	0.92	0.83

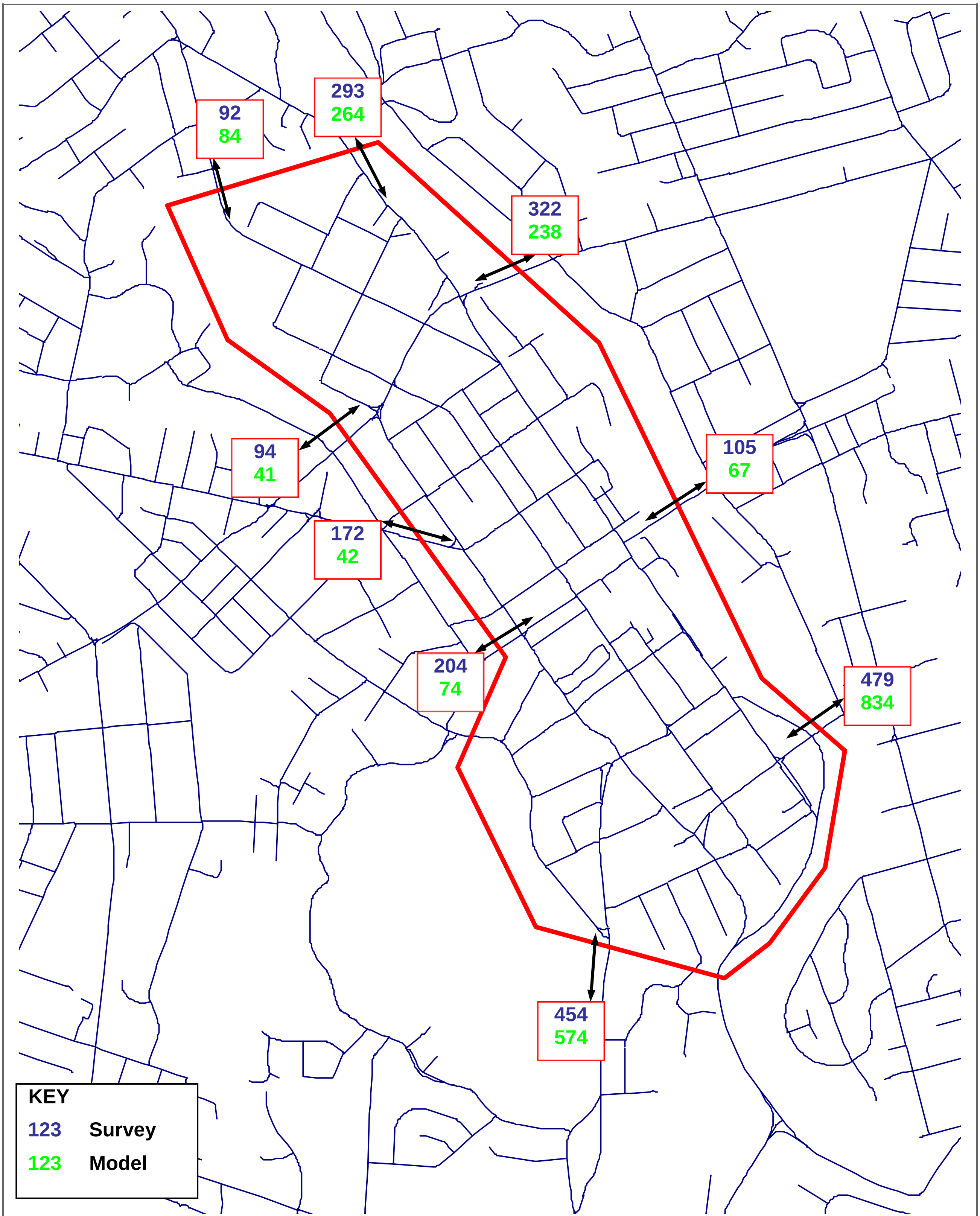
Table 5: PT Patronage Individual Count Comparison to NZTA Guidelines

Volume plots of bus passengers for all bus routes within Hamilton for both the morning peak and inter peak, are shown **Figure 5** and **Figure 6**.

6.4 Passenger Numbers per Service

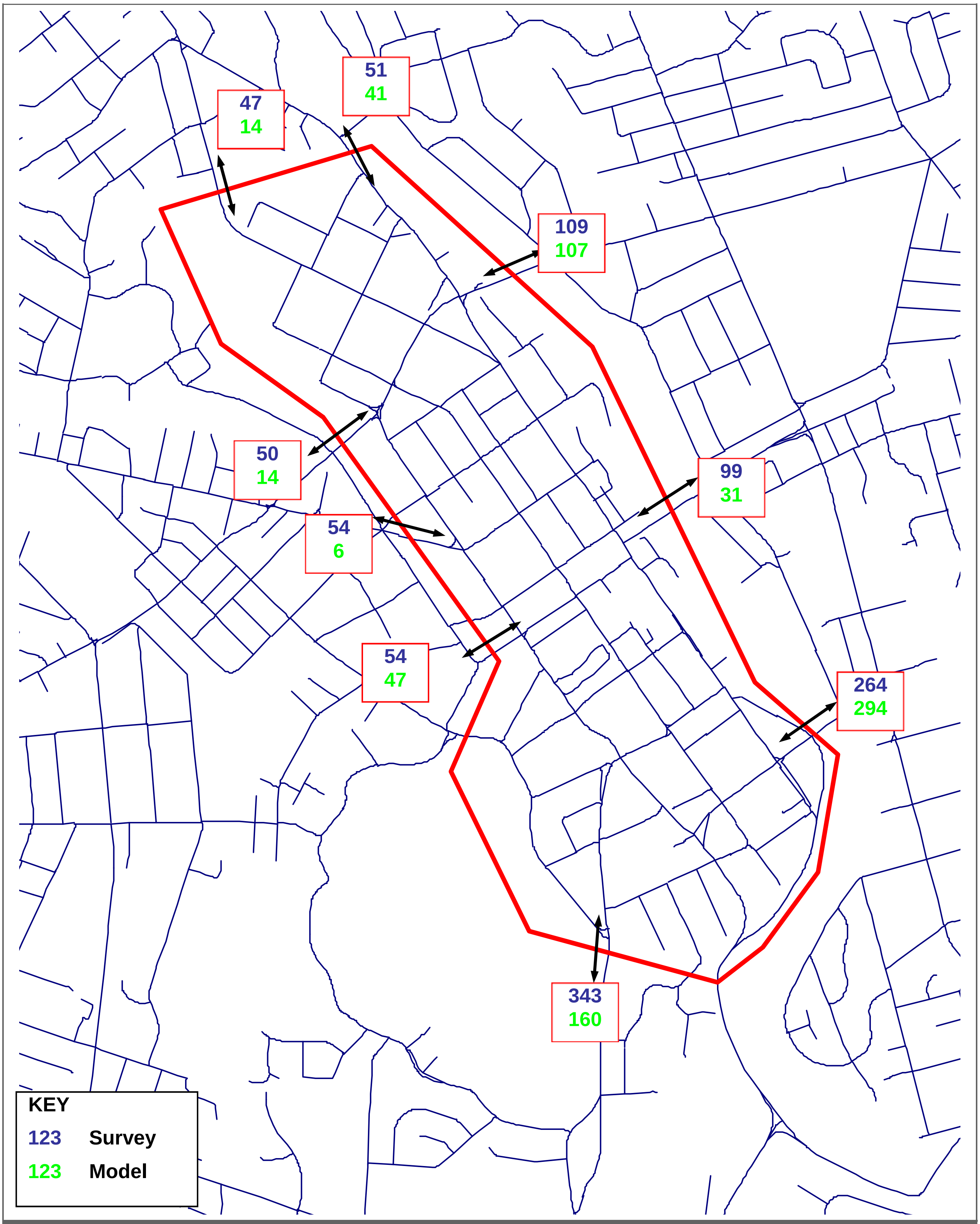
Another check is a comparison of surveyed service use against modelled service use. In this instance the total number of passengers for all services during each period was compared as well as the number of passengers on each route during each period. **Table 6** details the total passenger numbers by route and overall for each period. **Table 7** highlights GEH statistical comparison against NZTA Transport Model Development Guidelines.

A scatterplot of surveyed versus modelled patronage by route for each time period is also presented in **Figure 7.** The R-Squared measure of fit is R^2 = 0.6841and 0.80 for the AM Peak and interpeak respectively. Note that these are a better fit than the application of the model using the 2009 (900 zone) system on which the model was calibrated.



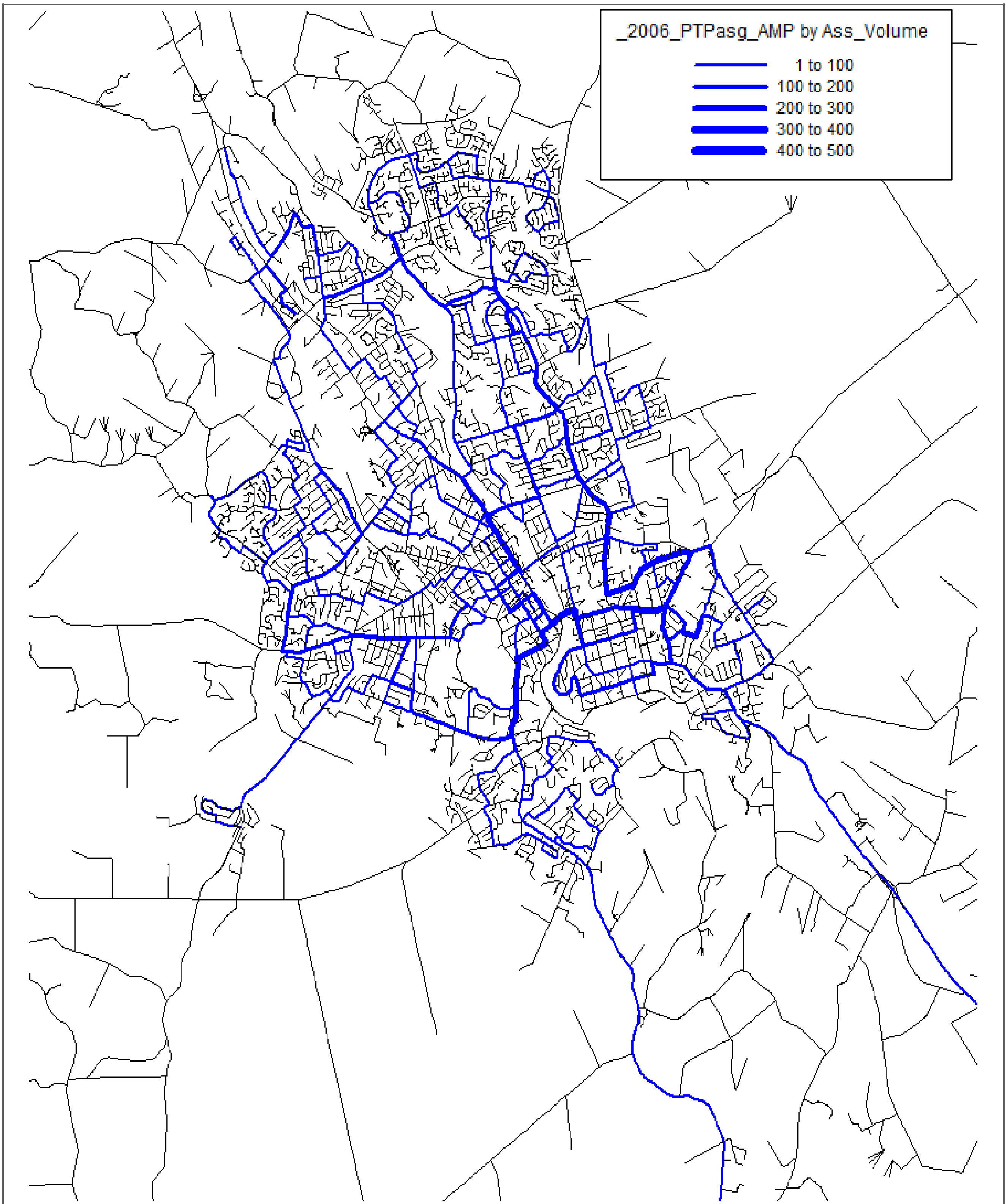
Hamilton CBD Cordon
AM Peak Bus Passengers

3



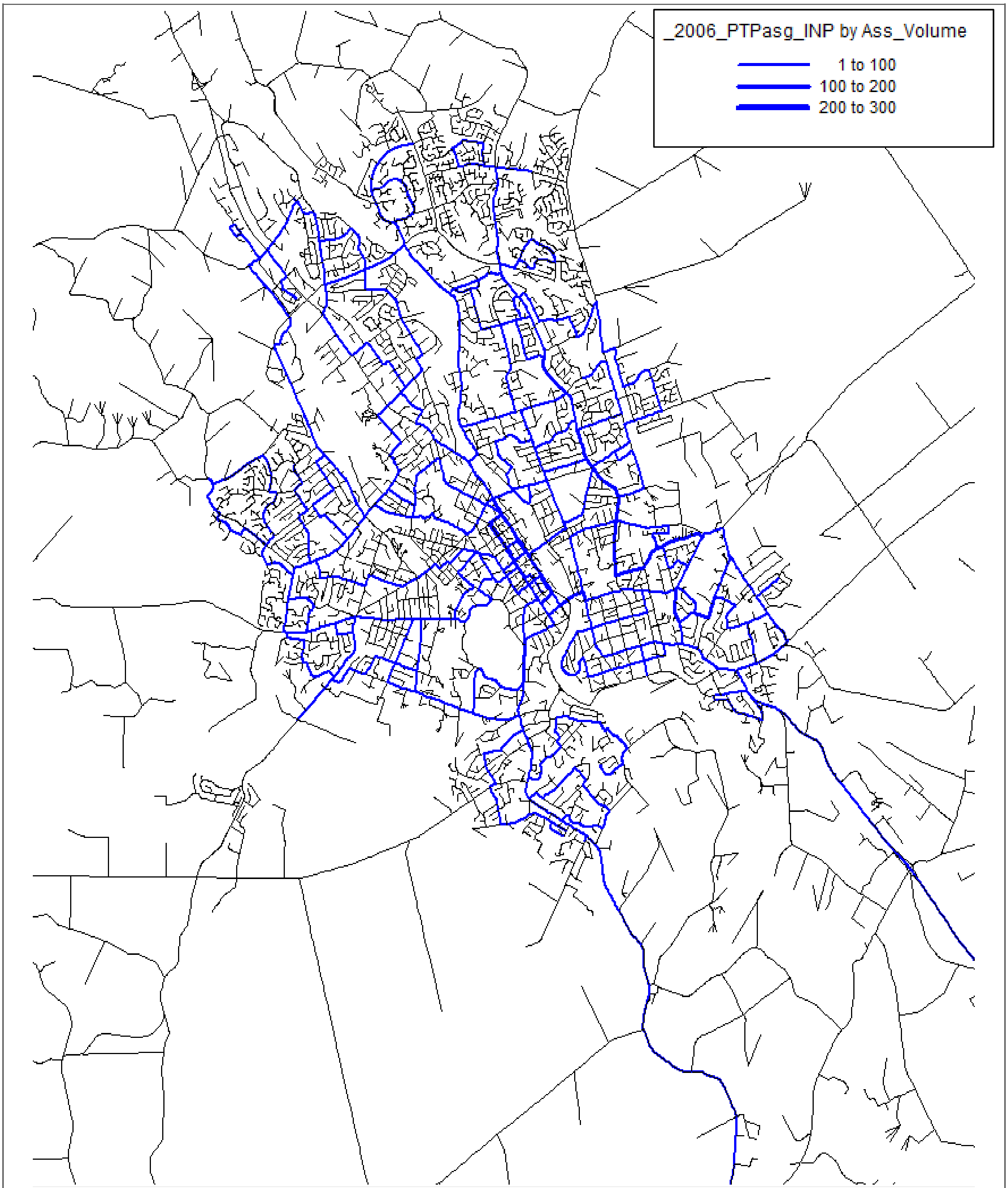
Hamilton CBD Cordon
Inter Peak Bus Passengers

4



Hamilton Bus Patronage
AM Peak Bus Passengers

5



Hamilton Bus Patronage
Inter Peak Bus Passengers

6

ROUTE	ROUTE NAME	MORNING PEAK			INTER PEAK		
		Survey	Model	Difference	Survey	Model	Difference
1	Pukete In	166	66	-101	13	3	-10
1a	Pukete Out	21	30	9	49	7	-42
2	Silverdale In	153	188	35	36	57	21
2a	Silverdale Out	51	198	147	15	54	39
3	Dinsdale In	156	90	-66	33	53	20
3a	Dinsdale Out	18	24	6	50	7	-43
4	Flagstaff In	134	105	-29	30	31	1
4a	Flagstaff Out	52	59	7	16	14	-2
5	Chartwell In	79	20	-59	11	4	-7
5a	Chartwell Out	23	23	0	28	3	-25
6	Mahoe In	144	70	-74	58	30	-28
6a	Mahoe Out	23	35	12	59	8	-51
7	Glenview In	153	53	-100	53	20	-33
7a	Glenview Out	56	58	2	59	16	-43
8	Frankton In	147	48	-99	38	9	-30
8a	Frankton Out	87	40	-47	53	5	-48
9	Nawton-TC IN	101	41	-60	36	31	-5
9a	Nawton-TC OUT	77	43	-34	32	11	-21
10	Hillcrest-TC IN	82	129	47	47	28	-19
10a	Hillcrest-TC OUT	112	61	-52	52	20	-32
11	Fairfield-TC IN	113	39	-74	45	13	-32
11a	Fairfield-TC OUT	33	30	-3	27	3	-25
12	Fitzroy-TC IN	169	58	-112	78	51	-27
12a	Fitzroy-TC OUT	25	31	6	63	6	-57
13	University-TC IN	87	35	-52	33	59	26
13a	University-TC OUT	95	45	-50	43	94	51
14	Claudelands-TC IN	103	42	-61	36	6	-30
14a	Claudelands-TC OUT	33	42	9	26	6	-20
15	Ruakura-TC IN	33	71	38	11	55	44
15a	Ruakura-TC OUT	36	111	75	4	67	63
16	Rotoruna-TC IN	189	188	-1	64	119	55
16a	Rotoruna-TC OUT	55	111	56	45	35	-10
17	Hamilton East Uni-TC IN	62	177	115	11	78	67
17a	Hamilton East Uni-TC OUT	167	262	95	61	110	49

ROUTE	ROUTE NAME	MORNING PEAK			INTER PEAK		
		Survey	Model	Difference	Survey	Model	Difference
18	Te Rapa-TC IN	142	68	-74	52	47	-5
18a	Te Rapa-TC OUT	77	75	-2	20	20	-1
26	Bremworth/Temple View-TC IN	104	40	-64	34	12	-22
26a	Bremworth/Temple View-TC OUT	54	27	-27	54	9	-45
30	Northerner-TC IN	25	18	-7	5	3	-2
30a	Northerner-TC OUT	10	6	-4	8	1	-7
16rd	Rototuna Direct In	137	47	-90			
16rda	Rototuna Direct Out	9	36	27			
51	CBD Shuttle	0	0	0	450	439	-11
20	Hamilton to Cambridge	2	90	88			
20	Cambridge to Hamilton	25	164	139	0	59	59
24	Hamilton to Te Awamutu	3	28	25			
24a	Te Awamutu to Hamilton	55	46	-9	0	2	2
52a	OrbiterC: Base to Base	574	675	101	227	190	-37
52	OrbiterA: Base to Base	422	698	276	199	146	-53
1pd	Pukete Direct In	37	100	63			
1pda	Pukete Direct Out	22	61	39			
3dd	Dinsdale Direct In	3	80	77			
3dda	Dinsdale Direct Out	0	27	27			
Trips with no transfer		4357	4286	-71	1999	1848	-151
Trips with transfer		313	383	70	83	96	13
TOTAL TRIPS		4670	4670	0	2082	1944	-138

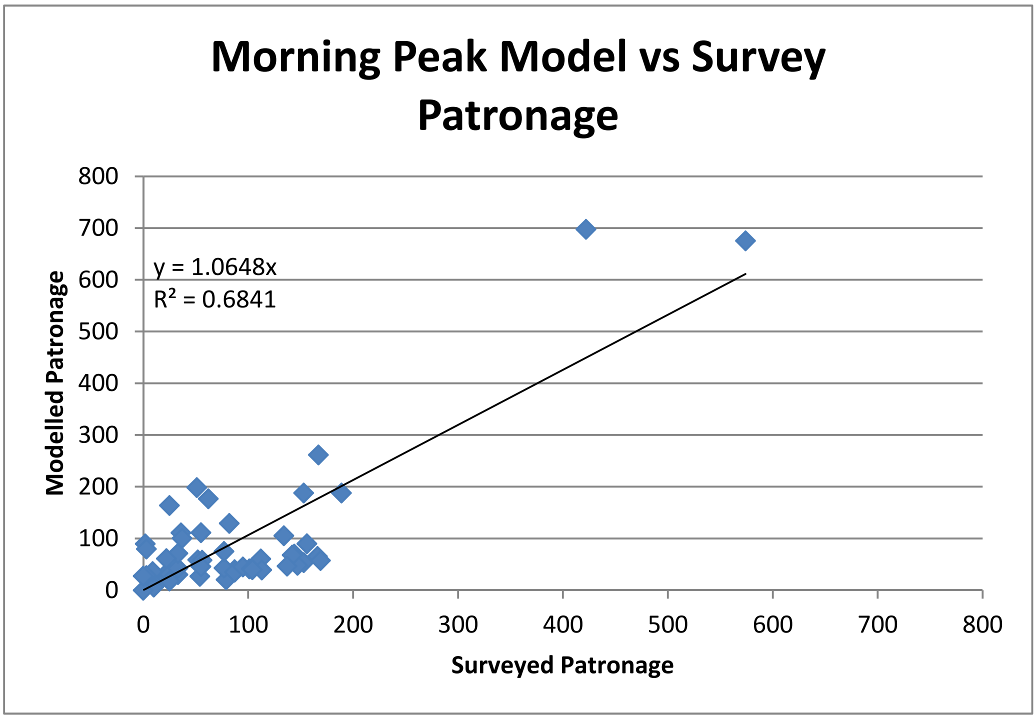
Table 6: Total PT Boarding Comparison

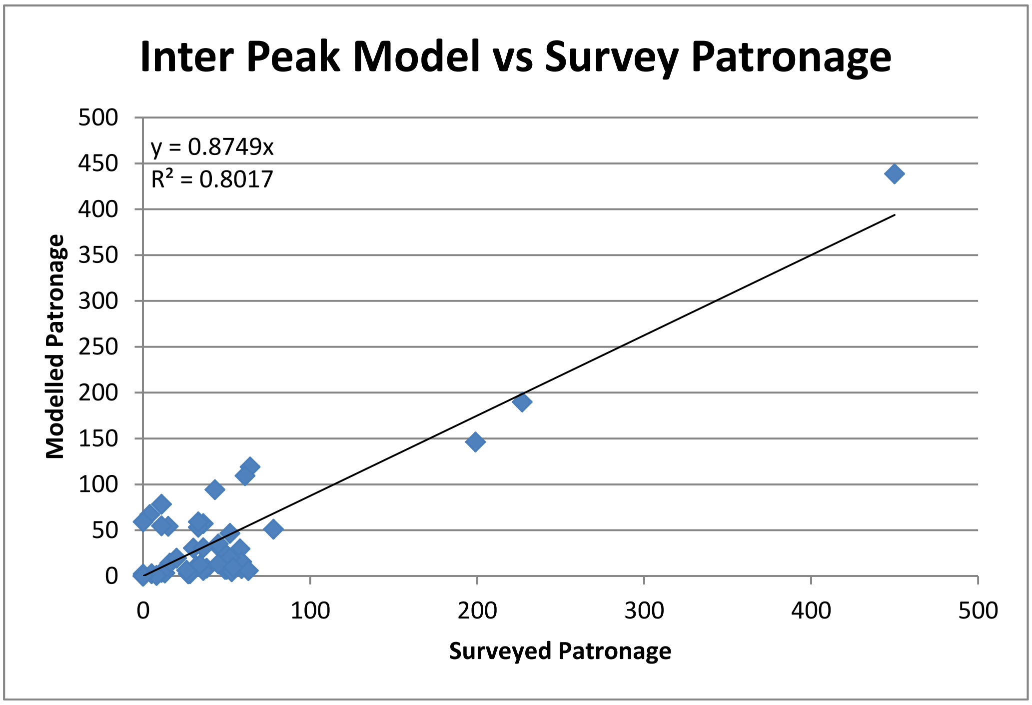
While there is some considerable variation on a route by route basis, this is typical when reproducing relatively small figures.

PT BOARDING COMPARISON SUMMARY TO NZTA TRANSPORT MODEL GUIDELINES				
		Target	Morning Peak	Inter Peak
All Individual PT Routes	GEH < 5.0	>50%	59.6%	81.1%
	GEH < 7.5	>60%	90.4%	100%
	GEH < 10	>70%	98.1%	100%
	GEH < 12	>80%	100%	100%
Line of Best Fit		Y=0.85x-1.15x	Y=1.07	Y=0.88
R^2		>0.80	0.7	0.8

Table 7: PT Boarding Comparison Summary to NZTA Transport Model Development Guidelines

The model is within the NZTA guidelines with the exception of the morning peak R^2. Other metrics indicate that the morning peak meets the NZTA Guideline criteria. The results are considered acceptable given the small observed volumes that are being replicated.





Hamilton Service Patronage Validation by Route Scatterplot	TDG	7

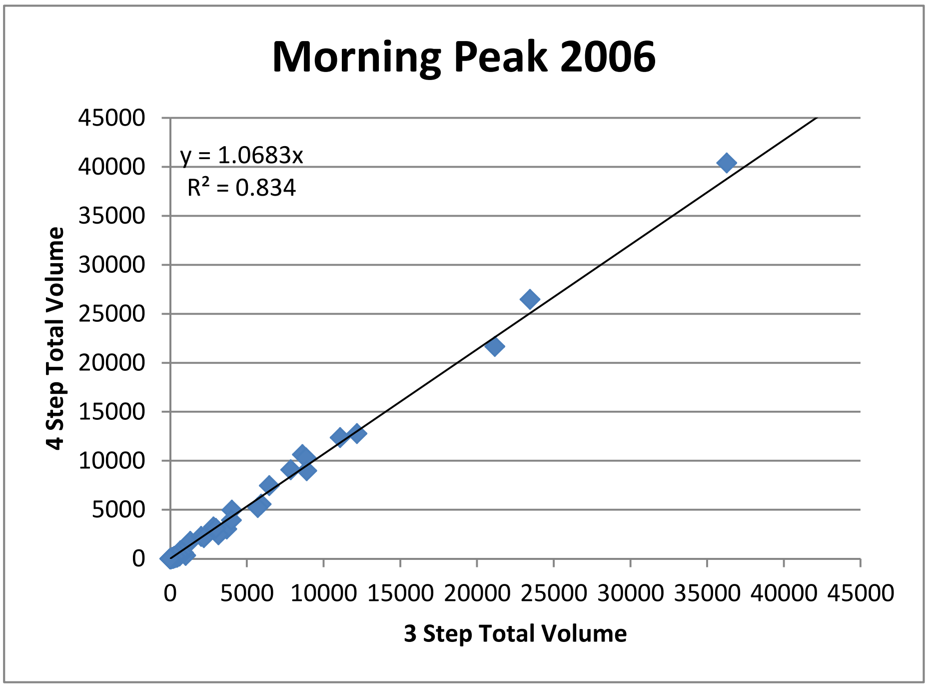
6.5 Correlation with the Three-Step Vehicle Driver Matrix

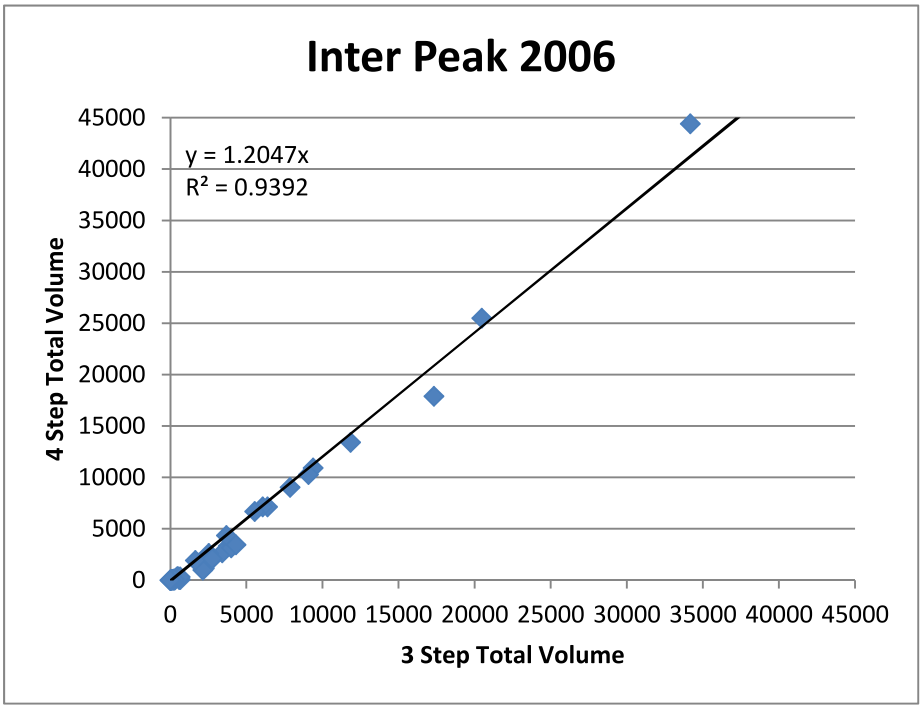
The intention of this section is to establish that the vehicle driver matrices resulting from the AM peak and inter peak mode split processes are statistically similar to those produced in the three step processes. The three and four step vehicle driver matrices have been aggregated into Territorial Local Authority areas and compared on a sector-to-sector level. The results of those comparisons are shown in **Figure 8**, and yield correlation coefficients of R^2=0.834 and 0.939 for the AM peak and inter peak periods respectively.

However, in comparison with the three step model the screenline GEH statistics are not as good and as such we would expect that analysis of roading projects be carried out using the three step model while the four step model would generally be used for public transport analysis.

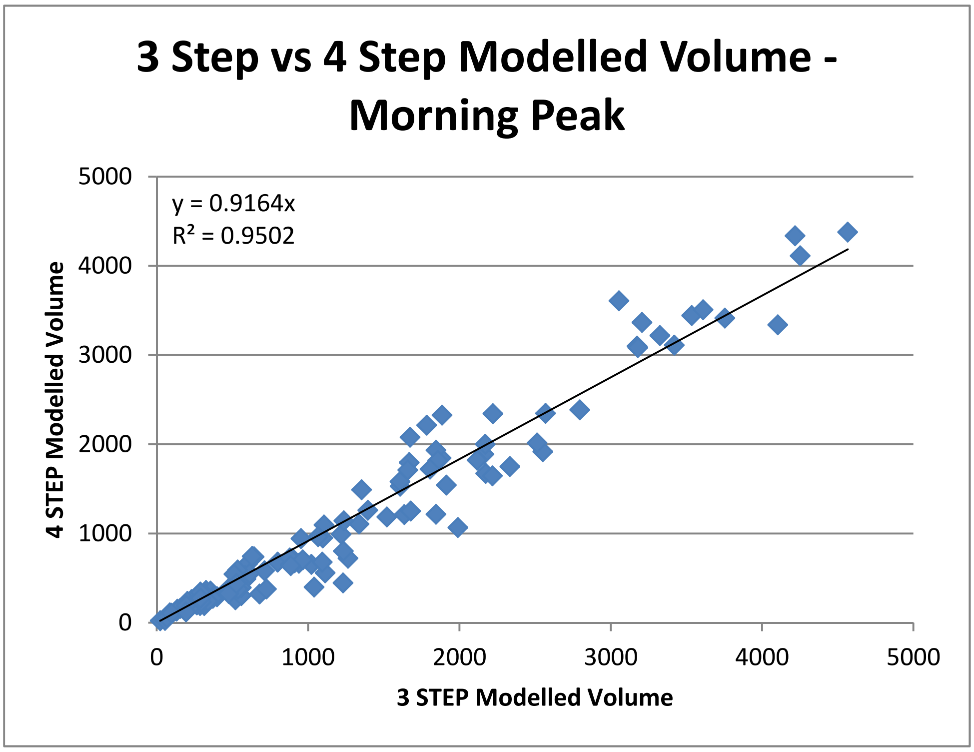
The correlation between the three and four step models is shown in a scatterplot of modelled verses observed counts as **Figure 9** with R-squared statistics of 0.95 and 0.86 for each period.

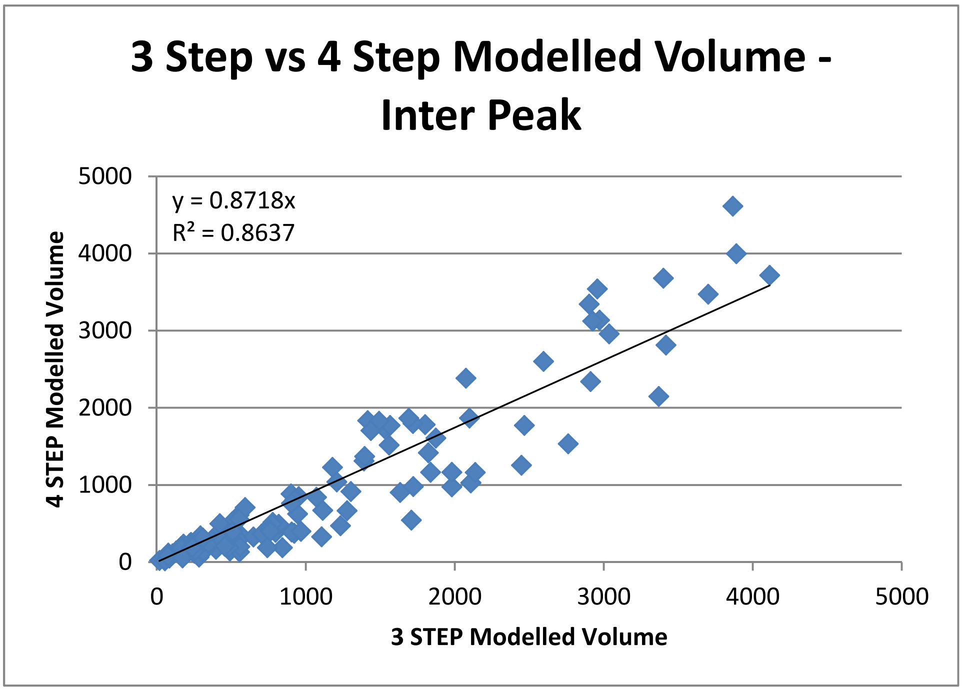
The morning peak and inter peak two-hourly volume changes between the three and the four step models are shown in **Figure 10** though **Figure 13**. A cut-off of 100 vehicles per hour, which is approximately 1000 vehicles per day, has been applied. The four step model has marginally shorter trip lengths resulting in fewer trips in outlying areas and more trips within the well serviced public transport area of Hamilton City.





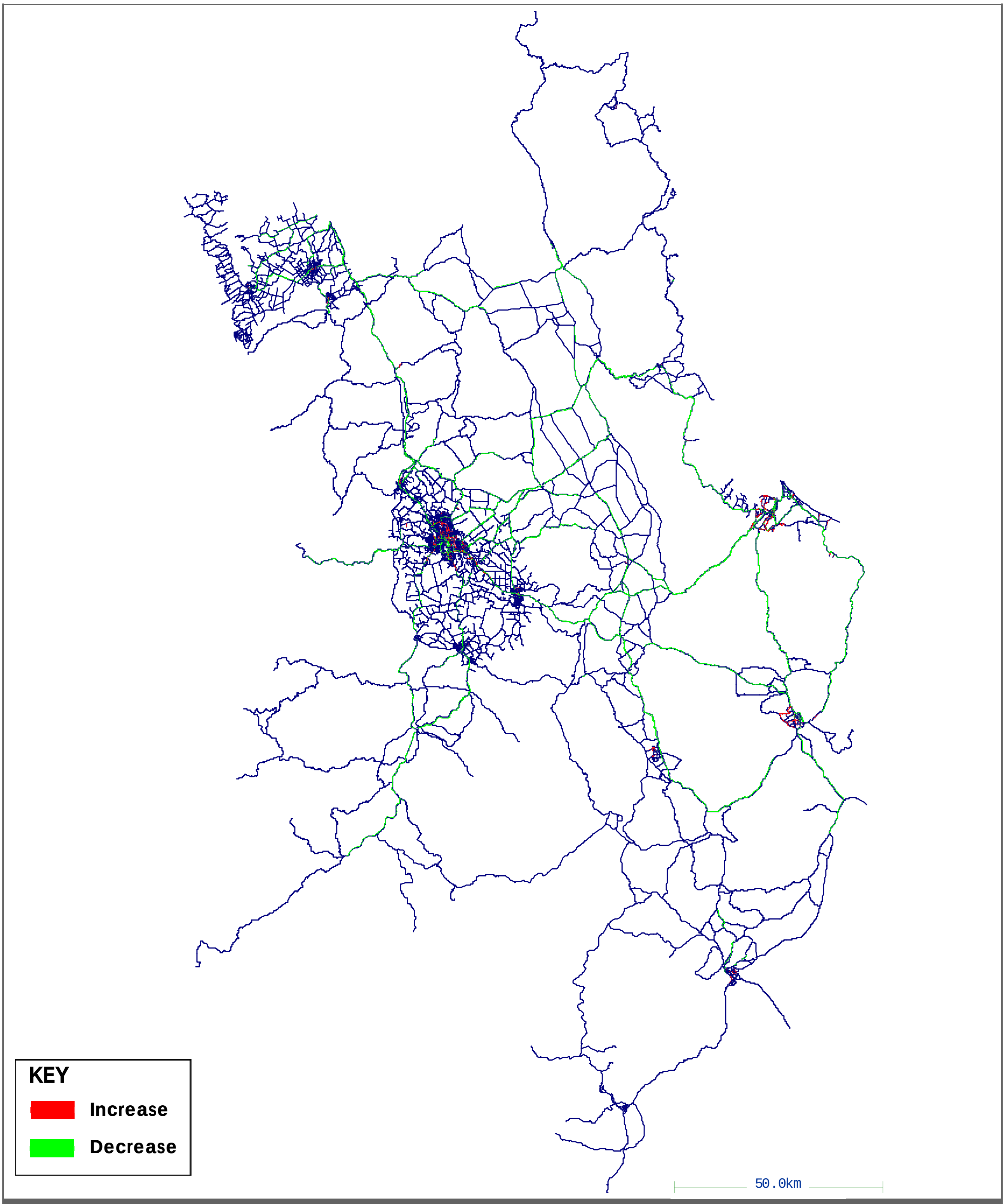
Three Step vs Four Step Sector Level Trip Matrix Comparison	TDG	8





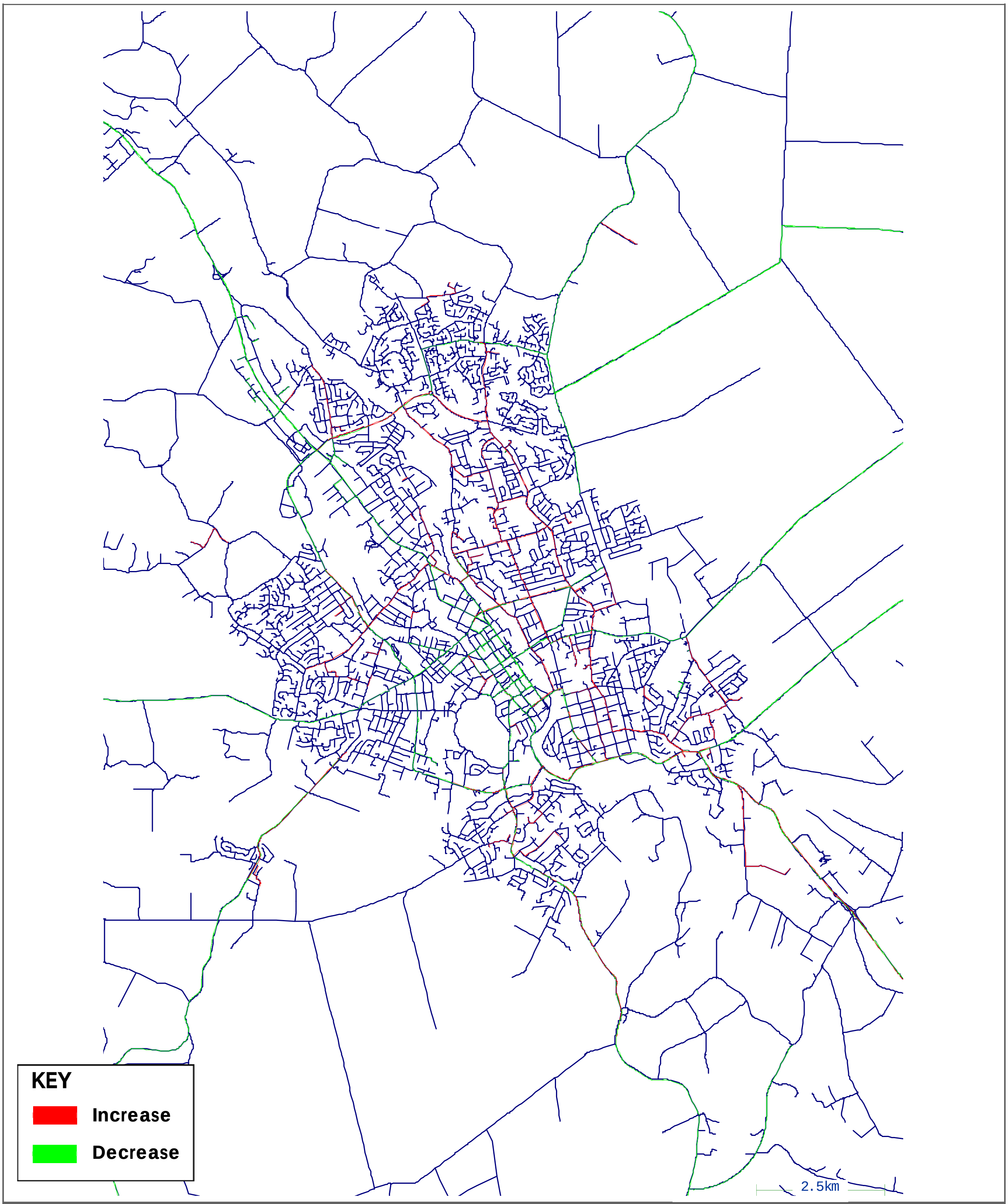
Three Step vs Four Step Modelled Volumes Comparison

9



Three Step vs Four Step Volume Changes
Study Area Overview – Morning Peak

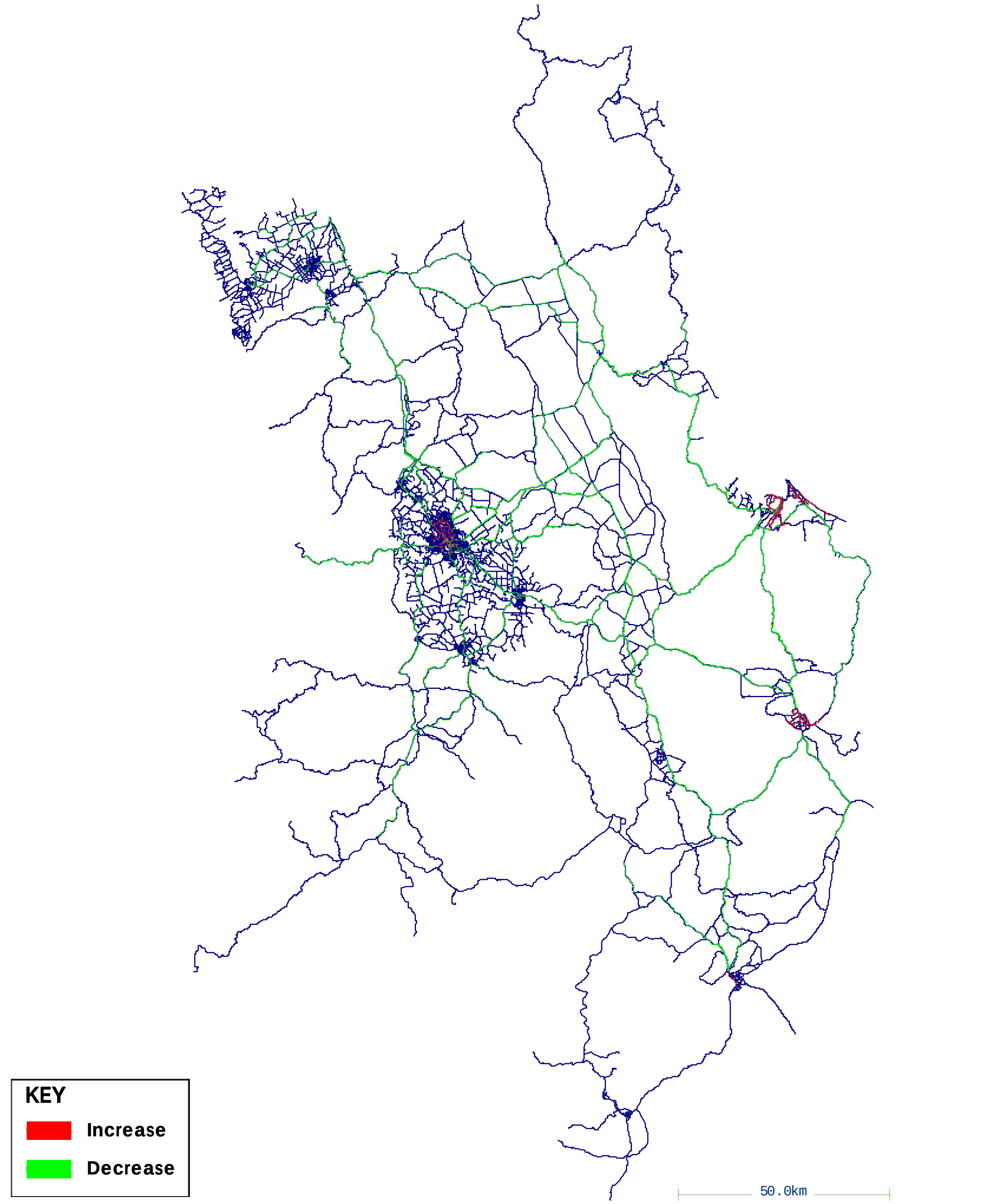
10



Three Step vs Four Step Volume Changes
Hamilton – Morning Peak

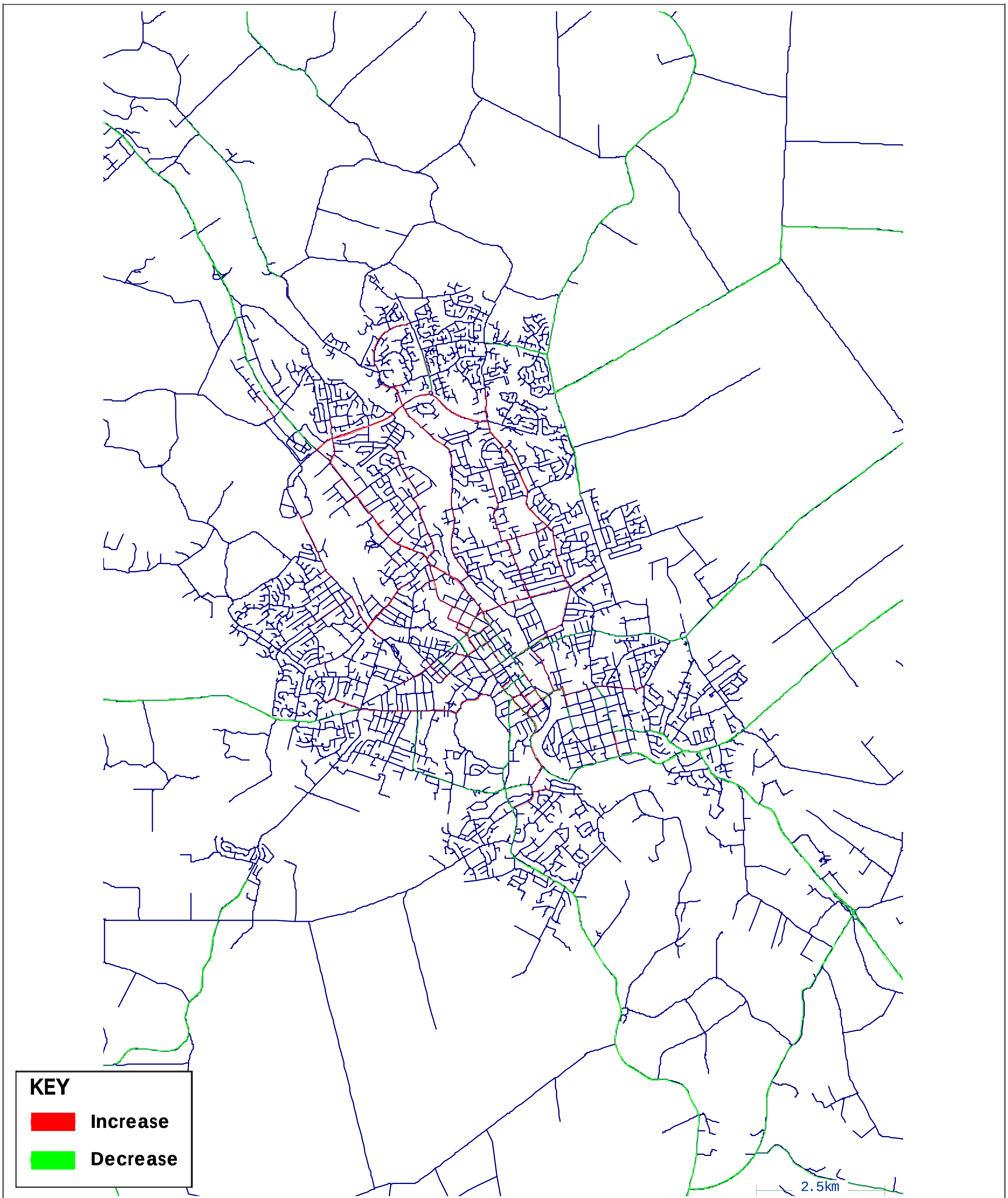
TDG

11



Three Step vs Four Step Volume Changes
Study Area Overview – Inter Peak

12



Three Step vs Four Step Volume Changes
Hamilton – Inter Peak

13

7. Conclusion

Overall, the four step model is considered sufficiently validated.

Compared with the three step model, the road vehicles do not replicate observed as well as the three step model. We would expect that roading projects be assessed using the three step model while the four step model would generally be used for public transport analysis.

Irrespective of this, any roading or public transport project assessments should be preceded by local area validation checks.

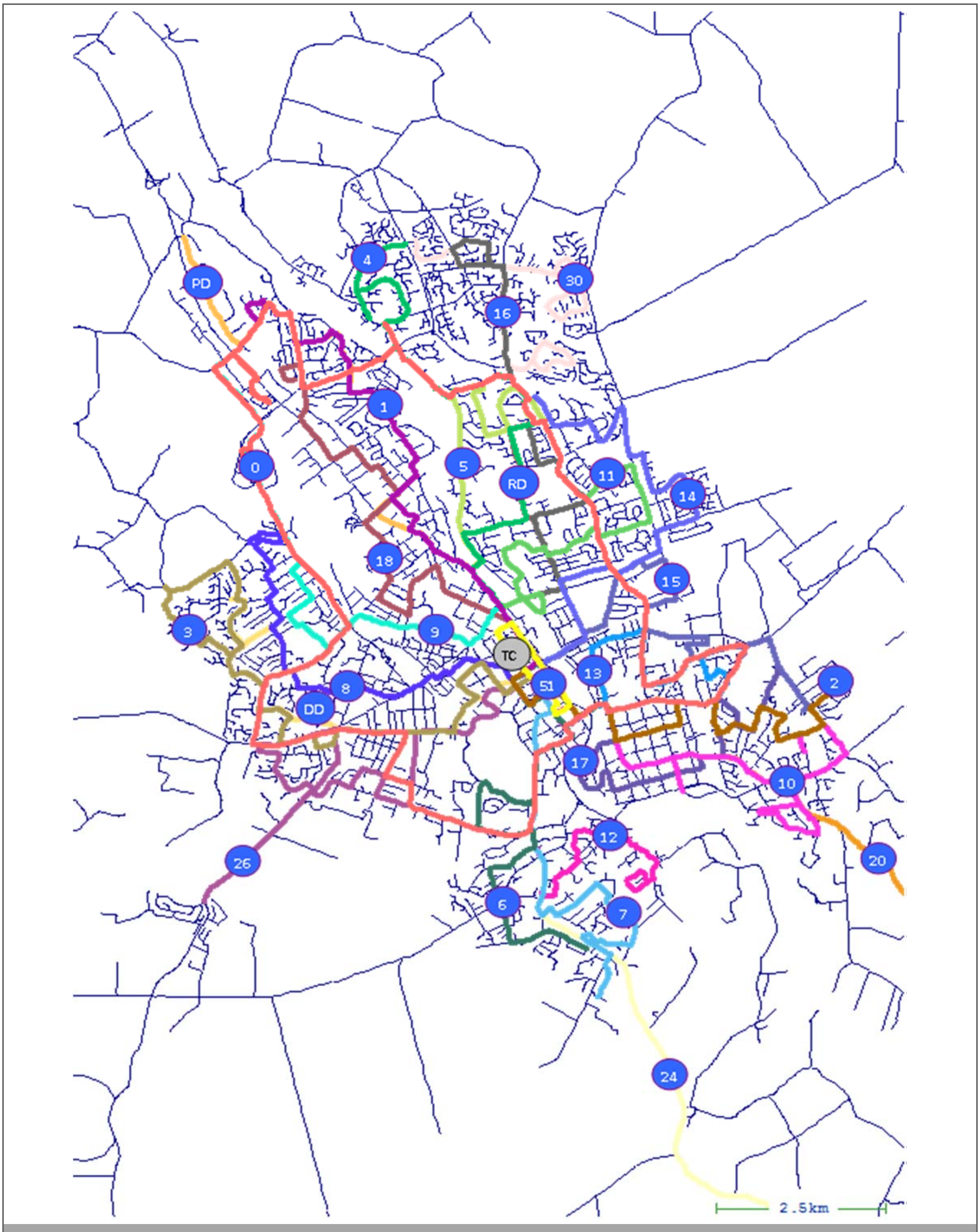
Appendix A

Hamilton Bus Routes

The bus route names are listed in **Table A1** below and displayed in **Figure A1** and **Figure A2** following.

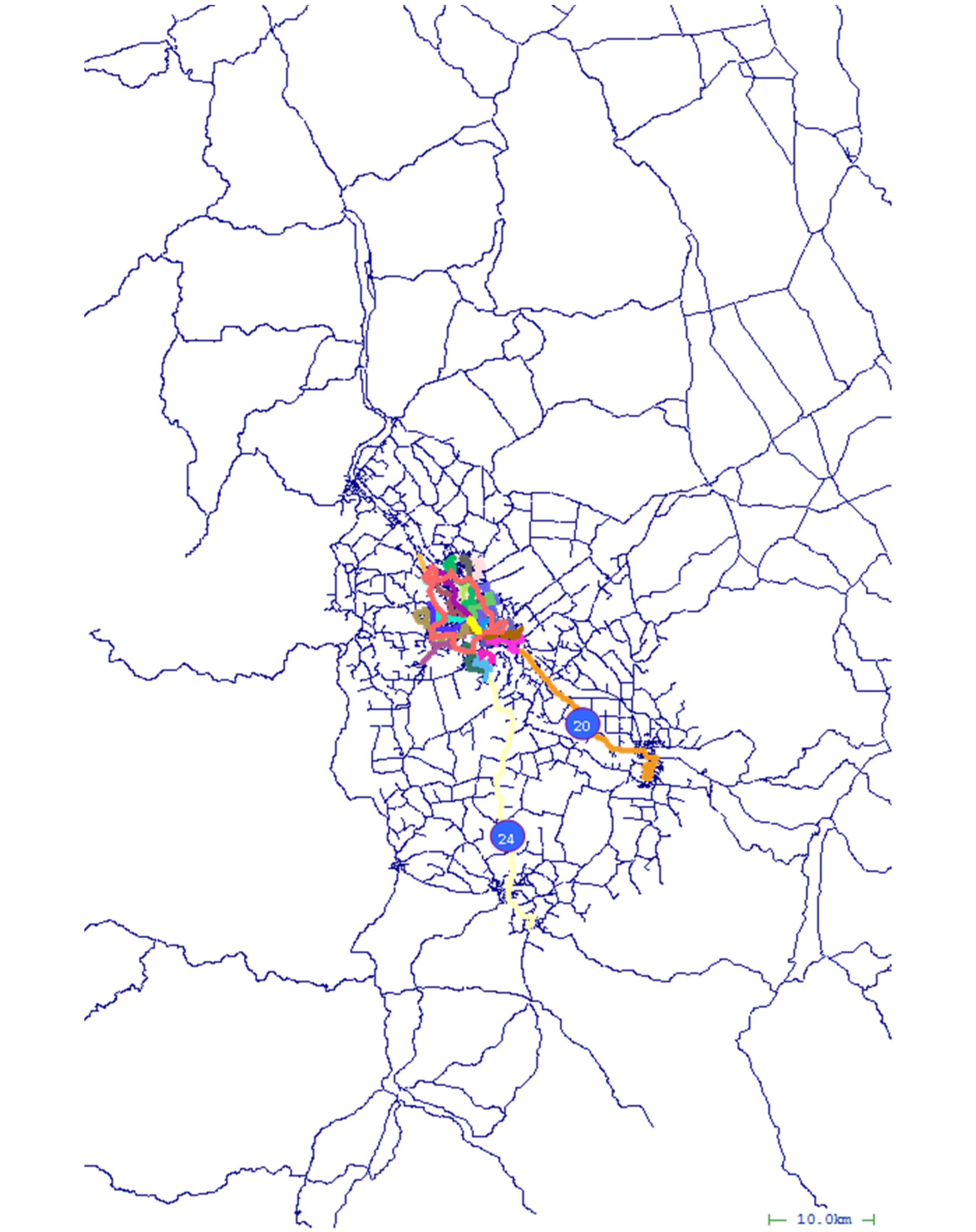
Existing Bus Routes	
O	Orbiter
1	Pukete
2	Silverdale
3	Dinsdale
4	Flagstaff
5	Chartwell
6	Mahoe
7	Glenview
8	Frankton
9	Nawton
10	Hillcrest
11	Fairfield
12	Fitzroy
13	University
14	Claudelands
15	Ruakura
16	Rototuna
17	Hamilton East Uni
18	Te Rapa
20	Cambridge
24	Te Awamutu
26	Bremworth Temple View
30	Northerner
51	CBD Shuttle
RD	Dinsdale Direct
PD	Pukete Direct
RD	Rototuna Direct

Table A1: Existing Bus Routes



All Bus Routes

A1



All Bus Routes Inset

A2

Appendix B

Hamilton Bus Route Frequencies

A list of the times at which each service runs is in the table below. The format of the bus frequencies file is:

- **1 30 0720** (Fixed headway); means Route 1 (Pukete In) service runs every 30 minutes in morning peak, starts at 07:20
- **5 0 @ 0715 0745 0815 0850** (Variable headway); means Route 5 (Dinsdale In) service runs at specified time in morning peak, starts at 07:15, then 07:45, 08:15, 08:50

Route	Service Time	Service Name
1	30 0720	Pukete In
2	30 0721	Pukete Out
3	30 0720	Silverdale In
4	30 0719	Silverdale Out
5	0 @ 0715 0745 0815 0850	Dinsdale In
6	30 0721	Dinsdale Out
7	30 0715	Flagstaff In
8	30 0720	Flagstaff Out
9	30 0720	Chartwell In
10	30 0723	Chartwell Out
11	30 0720	Mahoe In
12	30 0723	Mahoe Out
13	30 0720	Glenview In
14	30 0723	Glenview Out
15	30 0720	Frankton In
16	30 0723	Frankton Out
17	30 0720	Nawton-TC IN
18	30 0719	Nawton-TC OUT
19	30 0720	Hillcrest-TC IN
20	30 0718	Hillcrest-TC OUT
21	30 0720	Fairfield-TC IN
22	30 0722	Fairfield-TC OUT
23	30 0720	Fitzroy-TC IN
24	30 0723	Fitzroy-TC OUT
25	30 0710	University-TC IN
26	30 0710	University-TC OUT
27	30 0715	Claudelands-TC IN
28	30 0723	Claudelands-TC OUT

Route	Service Time	Service Name
29	30 0715	Ruakura-TC IN
30	30 0723	Ruakura-TC OUT
31	30 0700	Rotoruna-TC IN
32	30 0705	Rotoruna-TC OUT
33	30 0725	Hamilton East Uni-TC IN
34	30 0727	Hamilton East Uni-TC OUT
35	30 0720	Te Rapa-TC IN
36	30 0718	Te Rapa-TC OUT
37	30 0715	Bremworth/Temple View-TC IN
38	30 0722	Bremworth/Temple View-TC OUT
39	0 @ 0715 0750 0815 0850	Northerner-TC IN
40	0 @ 0725 0800 0825	Northerner-TC OUT
41	30 0715	Rototuna Direct In
42	30 0715	Rototuna Direct Out
43	10 0700	CBD Shuttle
44	60 0920	Leamington to Hamilton
45	60 0740	Hamilton to Te Awamutu
46	0 @ 0705 0740	Te Awamutu to Hamilton
47	83 0615	OrbiterC: The Base to The Base
48	83 0611	OrbiterC: Hospital to Hospital
49	83 0615	OrbiterC: Dinsdale to Dinsdale
50	83 0630	OrbiterC: Chartwell to Chartwell
51	83 0615	OrbiterC: University to University
52	83 0615	OrbiterA: The Base to The Base
53	83 0623	OrbiterA: Hospital to Hospital
54	83 0615	OrbiterA: Dinsdale to Dinsdale
55	83 0615	OrbiterA: Chartwell to Chartwell
56	83 0615	OrbiterA: University to University
57	0 @ 0645 0730 0740 0830	Pukete Direct In
58	0 @ 0655 0710 0755 0810	Pukete Direct Out
59	0 @ 0700 0730 0800 0830	Dinsdale Direct In
60	0 @ 0705 0735 0805	Dinsdale Direct Out

Table B1: Waikato Morning Peak Model 7-9am - 2008 Bus Frequencies

Route	Service Time	Service Name
1	30 1120	Pukete In
2	30 1121	Pukete Out
3	0 @ 1120 1150 1250	Silverdale In
4	0 @ 1119 1219 1249	Silverdale Out
5	30 1120	Dinsdale In
6	30 1121	Dinsdale Out
7	0 @ 1115 1145 1245	Flagstaff In
8	0 @ 1120 1220 1250	Flagstaff Out
9	0 @ 1120 1150 1250	Chartwell In
10	0 @ 1123 1223 1253	Chartwell Out
11	30 1115	Mahoe In
12	30 1123	Mahoe Out
13	0 @ 1120 1150 1220 1245	Glenview In
14	30 1123	Glenview Out
15	30 1120	Frankton In
16	30 1123	Frankton Out
17	30 1115	Nawton-TC IN
18	30 1119	Nawton-TC OUT
19	0 @ 1120 1150 1250	Hillcrest-TC IN
20	0 @ 1118 1218 1248	Hillcrest-TC OUT
21	30 1120	Fairfield-TC IN
22	30 1122	Fairfield-TC OUT
23	30 1050	Fitzroy-TC IN
24	30 1053	Fitzroy-TC OUT
25	30 1110	University-TC IN
26	30 1110	University-TC OUT
27	0 @ 1115 1145 1245	Claudelands-TC IN
28	0 @ 1123 1223 1253	Claudelands-TC OUT
29	0 @ 1115 1145 1245	Ruakura-TC IN
30	0 @ 1123 1223 1253	Ruakura-TC OUT
31	30 1100	Rotoruna-TC IN
32	30 1105	Rotoruna-TC OUT
33	30 1125	Hamilton East Uni-TC IN
34	30 1127	Hamilton East Uni-TC OUT
35	30 1120	Te Rapa-TC IN

Route	Service Time	Service Name
36	30 1118	Te Rapa-TC OUT
37	30 1115	Bremworth/Temple View-TC IN
38	30 1122	Bremworth/Temple View-TC OUT
39	0 @ 1050 1150 1255	Northerner-TC IN
40	60 1100	Northerner-TC OUT
43	15 1100	CBD Shuttle
48	83 1100	OrbiterC: The Base to The Base
49	83 1100	OrbiterC: Hospital to Hospital
50	83 1100	OrbiterC: Dinsdale to Dinsdale
51	83 1100	OrbiterC: Chartwell to Chartwell
52	83 1100	OrbiterC: University to University
53	83 1100	OrbiterA: The Base to The Base
54	83 1100	OrbiterA: Hospital to Hospital
55	83 1100	OrbiterA: Dinsdale to Dinsdale
56	83 1100	OrbiterA: Chartwell to Chartwell
57	83 1100	OrbiterA: University to University

Table B2: Waikato Inter Peak Model 11am-1pm - 2008 Bus Frequencies