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WELLINGTON TRANSPORT MODELS

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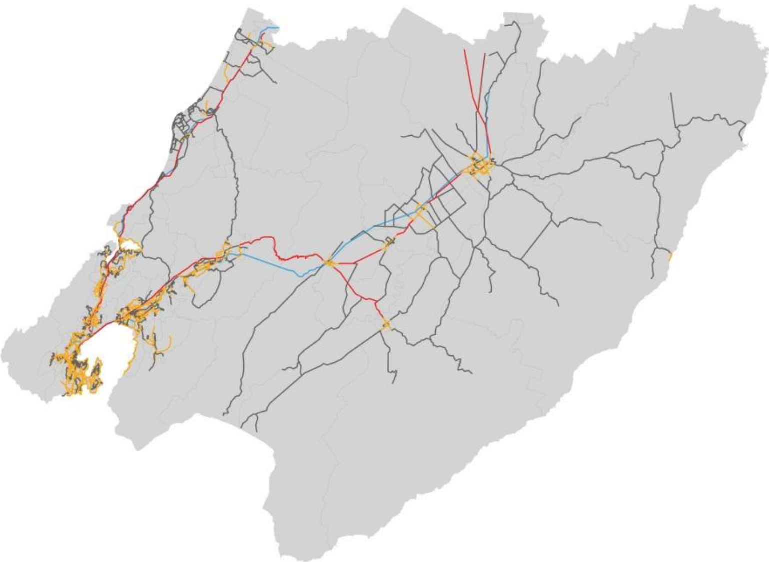

TN22: WPTM Sensitivity Testing

Date: December 2012

ARUP OPUS

Wellington Transport Models

TN22: WPTM Sensitivity Testing

prepared for

Greater Wellington Regional Council

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(Peer Reviewer)

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Contents

1 Introduction

1.1 Background

The Wellington Transport Strategy Model (WTSM) and the Wellington Public Transport Model (WPTM) are the modelling tools that have been updated / developed for Greater Wellington Regional Council (GWRC). The WTSM is a 4-step regional travel demand model whilst the WPTM is a public transport model that is linked to WTSM and shares a common network, but different zone systems:

- WTSM comprises 228 zones, made up of 225 internal zones and 3 external zones (+50 park and ride (P&R) station zones).
- WPTM comprises 780 zones (+50 P&R station zones)

The additional zones in the WPTM allow for more accurate calculation of access times between stops / stations and trip origin / destinations (O-D). The base year demand in WPTM is also highly accurate as it has been built up from observed data rather than from a trip generation / distribution / mode split model as in WTSM. However, WPTM has no functionality to forecast changes in the total public transport (PT) demand for future years. For this reason, WPTM is linked to WTSM to apply the forecast growth rates in PT demand from the WTSM to the WPTM base year matrices.

For the tests reported in this technical note (TN), combined model runs of WTSM and WPTM were undertaken: WTSM provides growth rates in PT demand; WPTM determines the division of PT demand among possible access modes, PT modes, PT routes, stations and stops.

This TN describes the sensitivity testing undertaken to ascertain the response of the combined transport model to changes in selected inputs.

1.2 Relevant Documents

This TN forms part of the suite of reports produced for the WTSM update and WPTM development project. Specifically, it documents the sensitivity testing undertaken using the transport modelling system as a whole (sensitivity testing was also undertaken on the WTSM model alone, this is documented in TN18). Other Technical Notes relating to model performance are listed below:

- TN18 – WTSM Calibration and Validation
- TN19 – WPTM Calibration and Validation

2 List of Sensitivity Tests

A total of seven sensitivity tests were undertaken using the transport modelling system. These are listed in Table 2-1 below.

Table 2-1: List of Sensitivity Tests Undertaken

Sensitivity Test	Description
Test 1	PT Fares +20%
Test 2	Car Fuel Cost +20%
Test 3	New P&R site at Ava Station
Test 4	Equal behavioural weights
Test 5	Route 3 frequency +25%
Test 6	Route 3 to Bus Rapid Transit (BRT). No mode preference.
Test 7	Route 3 to BRT. With mode preference.

All runs except Test 3 were using the transport modelling system. This means that total PT demand was allowed to vary in response to the input changes. Test 3 was run in WPTM only (i.e. no change in total PT demand) as WTSM does not use parking capacity as an input to the PT assignment or mode choice model.

Further details on each of these tests are given in Section 4 with trip tables for each of the tests also included in Appendix A – Trip Tables.

3 Reporting Measures

The results of the sensitivity tests are reported primarily using tables and figures showing changes in public transport travel compared to a base or reference case scenario. Where appropriate, we have also chosen to report demand elasticities as a way of comparing the model response to other documented real-world responses. For uninitiated readers, a short explanation on elasticities is given below.

3.1 The Elasticity Concept[1]

Elasticity is a convenient, quantitative measure of travel demand response to price and service changes that influence demand. When used with caution, elasticities provide a satisfactory means of quickly preparing first-cut, aggregate response estimates for a number of types of system changes and for alternative approaches to land use and site design. When considering demand for transportation, there are a number of elasticities of interest, including elasticities describing traveller response to changes in the overall amount of transit service, transit frequencies, transit fares, vehicular tolls, parking charges, and fuel costs.

Transportation elasticities are informally adopted from the economist's measure "price elasticity". The price elasticity of demand is loosely defined as the percentage change in quantity of commodity or service demand in response to a 1 percent change in price. For instance, a price elasticity of -0.3 indicates that for a 1 percent increase in the price of a good or service, there is a 0.3 percent decrease in the demand for that good or service.

The negative sign signifies an inverse relationship between price and demand. In other words, it indicates that the effect operates in the opposite direction from the cause. For example, an increase in price results in a decrease in demand, and the corresponding elasticity is negative. An increase in service promotes an increase in demand, and the elasticity is positive.

If a 1 percent change in a parameter causes a greater than 1 percent change in demand, demand is said to be elastic. If a 1 percent change in a parameter causes a less than 1 percent change in demand, then demand is said to be inelastic. Many, but not all, transportation system changes elicit responses that are so-called inelastic.

One of the key factors affecting elasticity values is the period for which the elasticity has been defined. Elasticities are often quoted as short-run, medium-run or long-run which typically indicates that the impacts are expected over a period of less than two years, within five years and more than five years, respectively. Elasticities typically increase over time as consumers take price changes into account in longer-term decision making and are less affected by what may be short-term constraints, for instance, in decisions such as whether to buy a car or deciding on where to live or work.

Elasticities should not be taken or used as precise predictive measures. They simply serve to indicate the likely order of magnitude of response to system change, as inferred from aggregate data on the experience in other, hopefully comparable, instances.

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[1] This section contains paraphrased extracts of Appendix A from the Transit Cooperative Research Program's *'Research Results Digest'*, Number 61, September 2003.

4 Sensitivity Test Definitions and Results

4.1 Sensitivity Test 1 – PT Fare Increase

To simulate an increase in PT fares in WTSM, the fare matrix used in the generalised cost calculation was increased by 20%. This resulted in a corresponding increase in PT generalised costs and a reduction in PT patronage (results for this sensitivity test in WTSM are presented in more detail in TN18). In WPTM, flag-fall fare and per-crossing fares were increased by 20%.

As expected, the results show that volumes on trains, buses, and ferry all decreased. In the AM peak the public transport boardings decreased by 8% overall whilst in the IP the volumes decreased by 9% overall (see Table 4-1 for a breakdown by mode).

So we can also calculate the elasticity of boards for fares:

AM elasticity: -0.44
IP elasticity: -0.49

Or alternatively the elasticity of trips (demand) for fares, using the trips from Table 1 of the Appendix:

AM elasticity: -0.31
IP elasticity: -0.26

Based on Wallis (2004) fare elasticities are typically -0.2 to -0.5 in the short run. Based on extensive research, TRL (2004) also calculates that bus fare elasticities average around -0.4 in the short run, -0.56 in the medium run, and -1.0 over the long run. This indicates that the model is responsive to fare changes whilst still keeping within the bounds of generally accepted elasticity of demand with respect to fare values

The AM demand (Table 1 in Appendix A) decreased by 6%, the boardings by 8% and the passenger km by 10%. This difference was likely related to transfer trips. Increasing the fares would have more impact on transfer trips than single leg trips, so the number of boards would decrease more than the demand. It may also be the case that transfer trips have longer than average trip lengths, hence the passenger km would decrease proportionally more.

Table 4-1: Boards and Passenger km by Mode and Access Mode, Test 1 vs. Base

	Boards						Passenger km ('000s)					
	AM			IP			AM			IP		
	Base	Test 1	Diff	Base	Test 1	Diff	Base	Test 1	Diff	Base	Test 1	Diff
Rail – P&R	4830	4510	-7%	230	210	-8%	113	103	-9%	5	4	-9%
Rail – K&R	1020	950	-7%	40	40	-9%	27	24	-11%	1	1	-11%
Rail - Walk	6800	6200	-9%	980	880	-10%	149	131	-12%	17	15	-12%
Rail - ALL	12640	11660	-8%	1250	1130	-10%	290	258	-11%	22	20	-12%
Bus	17520	16190	-8%	5810	5340	-8%	108	100	-7%	37	34	-7%
Ferry	190	160	-14%	20	10	-27%	2	2	-14%	0	0	-27%
Total	30360	28010	-8%	7080	6480	-9%	400	360	-10%	60	54	-9%

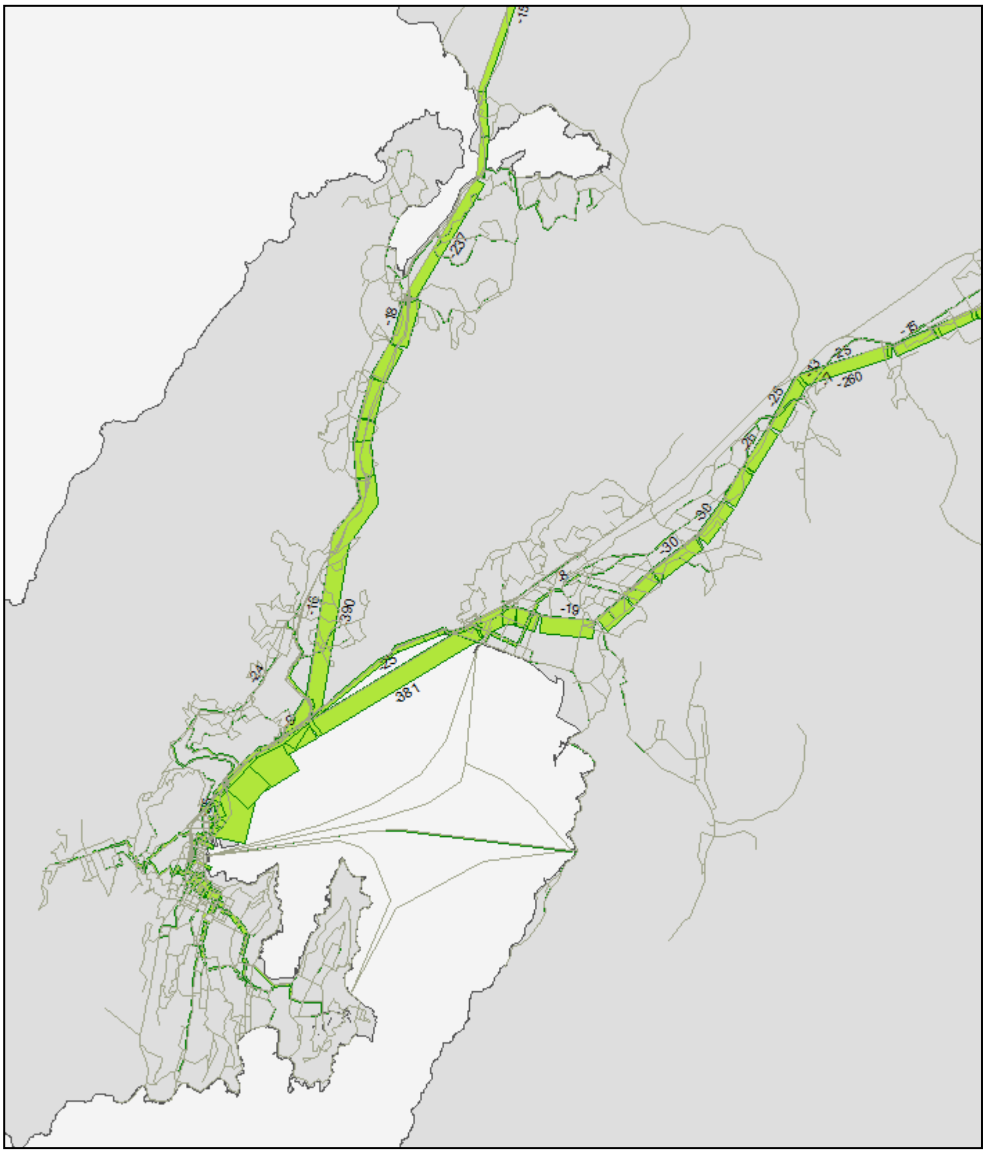

Figure 4-1: Change in PT Vol, AM Peak, Test 1 vs. Base (green=decrease)

The decrease in public transport volume was across all areas of the network, as shown in Figure 4-1.

4.2 Sensitivity Test 2 – Car Fuel Cost Increase

This test simulated a 20% increase in car fuel costs. This was implemented in WTSM by factoring the fuel-related components of the vehicle operating costs, resulting in a shift from car usage to PT (results for this sensitivity test in WTSM are presented in more detail in TN18). In WPTM, the vehicle operating costs for park and ride (P&R) and kiss and ride (K&R) were increased by 20%

Train and bus boards increased slightly, as did overall patronage (see Table 4-2). The results also show an increase in P&R and K&R rail access trips. This is probably because P&R and K&R trips tend to be made from suburbs some distance from rail, where car (driving all the way) is the competing mode. Some of these car trips switch to driving a shorter distance to access rail instead.

The impact on patronage varies by area. Excluding the Wairarapa services, all routes show increases in patronage due to public transport becoming more attractive relative to driving. The apparent drop in patronage on the Hutt Valley rail line in Figure 4-2 is misleading as this is all due to fewer passengers from the Wairarapa i.e. the drop in demand is highest at the Rimutaka Hill tunnel. The negative difference becomes smaller moving from Upper Hutt to Petone but the loss in trips from the Wairarapa still means that the test case demand is lower than the base case through this corridor. The decrease in the Wairarapa demand is something that has been identified as a forecasting issue in WTSM and is currently being investigated. Figure 4-3 shows the same results but with the Wairarapa lines demand removed. It can be seen that for the Hutt Valley line patronage increases.

A slight shift from rail to bus from Lower Hutt (areas such as Waterloo, Ava and Melling) is also observed. This implies that lower congestion levels (and thus lower bus travel times) on the road network in this area coupled with increases in costs for park and ride and kiss and ride access to rail stations increases the competition between bus vs. rail. The impact of increasing car access costs to stations is also apparent at the Days Bay ferry terminal where fewer park and ride / kiss and ride passengers are choosing to use the ferry, and opting to take the bus instead.

The elasticity of boards for car fuel costs can be calculated:

AM elasticity: 0.17
IP elasticity: 0.17

And the elasticity of trips (demand):

AM elasticity: 0.17
IP elasticity: 0.14

The cross-elasticity values are close to the typical value of 0.15 given in Wallis (2004), which suggests the model is performing appropriately in this regard. Litman (2011) also suggests the elasticity of transit ridership with respect to automobile operating costs should lie within the range 0.05 to 0.15 for short term, and 0.2 to 0.4 for long term. The Wellington model results lie in between these two ranges, which seems reasonable.

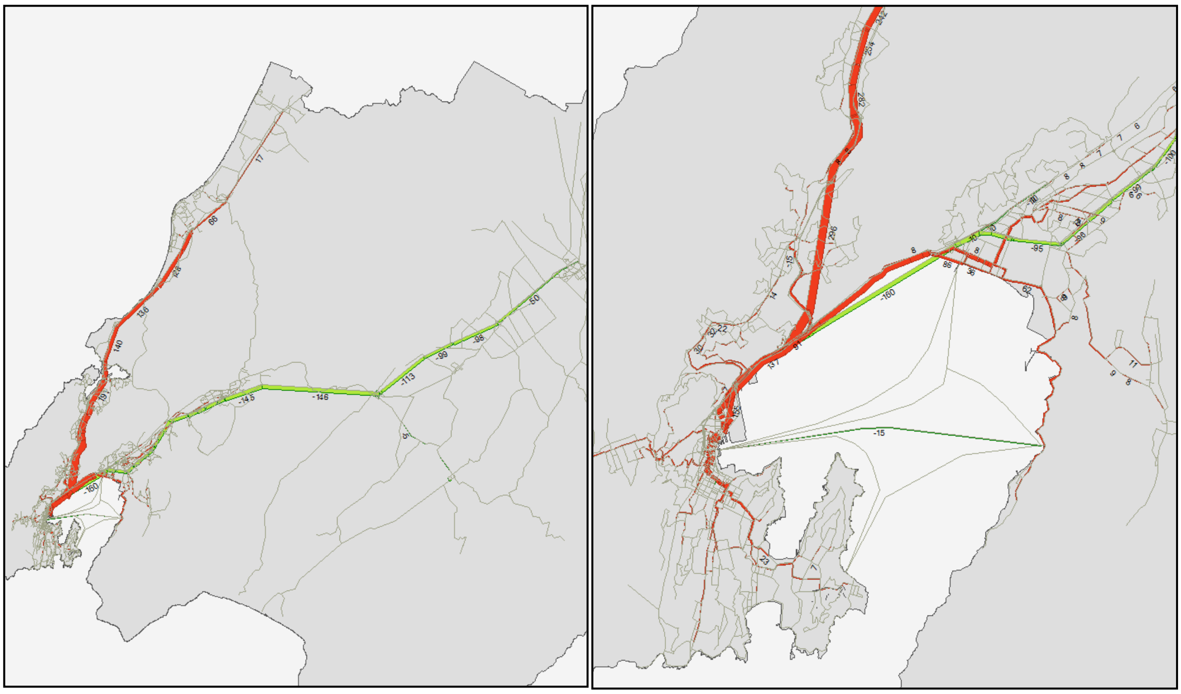

Figure 4-2: Change in PT Vol, AM Peak, Test 2 vs. Base (red=increase, green=decrease)

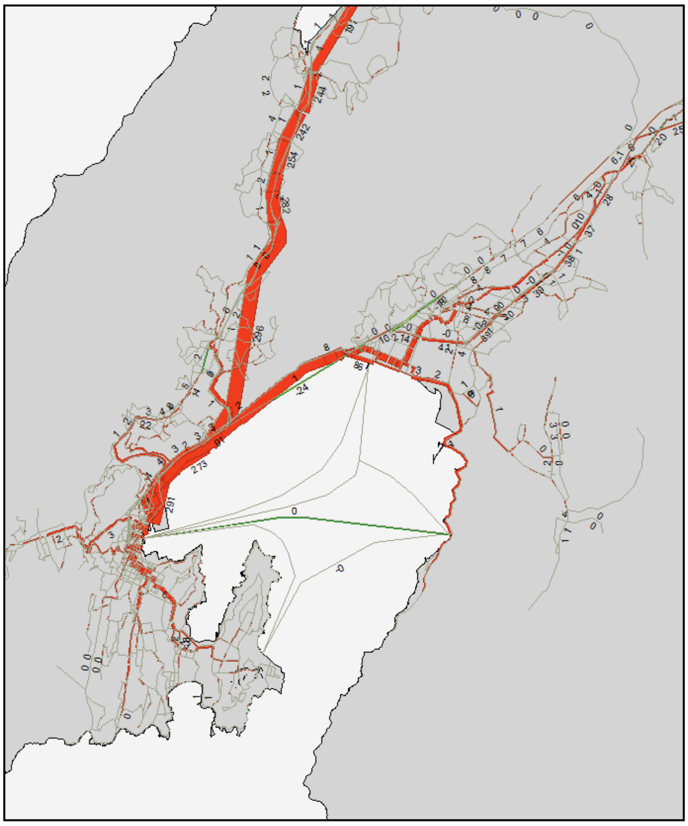

Figure 4-3: Change in PT Vol, AM Peak, Test 2 vs. Base, without Wairarapa Rail Line Demand (red=increase, green=decrease)

Table 4-2: Boards and Passenger km by Mode and Access Mode, Test 2 vs. Base

	Boards						Passenger km ('000s)					
	AM			IP			AM			IP		
	Base	Test 2	Diff	Base	Test 2	Diff	Base	Test 2	Diff	Base	Test 2	Diff
Rail - P&R	4830	4980	3%	230	240	3%	113	114	1%	5	5	3%
Rail - K&R	1020	1040	2%	40	40	5%	27	27	-2%	1	1	5%
Rail - Walk	6800	6820	0%	980	1010	3%	149	149	0%	17	17	3%
Rail - ALL	12640	12840	2%	1250	1290	3%	290	289	0%	22	23	3%
Bus	17520	18290	4%	5810	5990	3%	108	116	7%	37	38	4%
Ferry	190	180	-8%	20	20	6%	2	2	-7%	0	0	5%
Total	30360	31310	3%	7080	7300	3%	400	407	2%	60	62	4%

4.3 Sensitivity Test 3 – New P&R Site at Ava Station

In the base model, P&R is allowed at Ava station even though there is no formal P&R car park provided. The reason it is allowed is because around 75 people are estimated to use Ava for P&R in the AM peak (from the expanded survey records). These people must currently be parking in the surrounding streets, suggesting there may be some suppressed demand for P&R at this location. In the sensitivity test, a new 400 space P&R car park is added at Ava. No changes were made in WTSM. This means that total PT demand remains constant, but can be redistributed among P&R sites, access modes and main modes.

The number of train boardings at Ava increased by 49 overall, mainly due to increased P&R access (see Table 4-3). In the base model, there are 44 park-and-riders at Ava, which increases to 87 in the sensitivity test. There are reductions in boardings at surrounding stations including Petone, Woburn, Waterloo, Epuni, Western Hutt, Melling and some bus stops. There was no net effect on PT usage (because WTSM was not run), and a minimal mode switch from bus to rail of four people.

Because of the hierarchy in the access choice model, we would expect the new P&R site to draw most of its patronage from P&R at other stations, then from K&R, then finally from walk trips. This is in general what appears to be happening, with the changes at most stations largest for P&R.

Table 4-3: Change in Boards by Access Mode, AM Peak, Test 3 vs. Base

	P&R	K&R	Walk	ALL
Bus: all Lower Hutt stops	0	0	-4	-4
Rail: Petone	-19	-3	-1	-22
Rail: Ava	43	8	-2	49
Rail: Woburn	-1	0	0	-1
Rail: Waterloo	-7	0	0	-7
Rail: Epuni	-4	0	0	-4
Rail: Western Hutt	0	-2	0	-2
Rail: Melling	-6	-2	0	-8
RAIL: all stations	6	1	-3	4
ALL	6	1	-8	0

Figure 4-4 below shows the number of boards by access mode at stations around Ava, with the total number of boardings given in brackets.

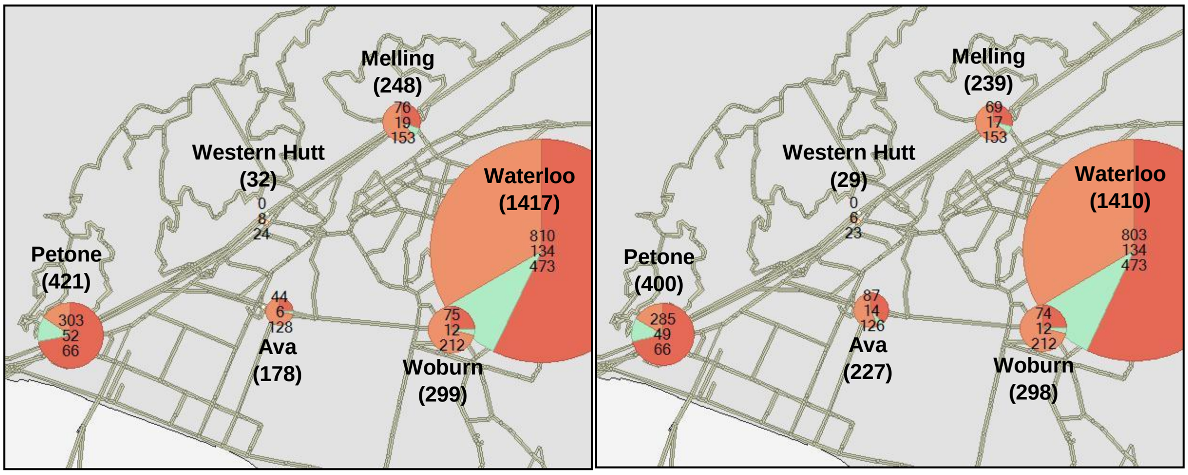

Figure 4-4: Rail Boards by Access Mode, AM Peak, Base and Test 3 (P&R=red, K&R=green, walk=orange)

4.4 Sensitivity Test 4 – Equal Behavioural Weights

In this test, mode preferences were removed by setting behavioural parameters for all modes equal to those for regular bus.

In WTSM, the only PT mode specific behavioural parameter is the in-vehicle time weighting, which was set equal to regular bus for all modes.

In WPTM the parameters changed were: in-vehicle time weighting (@ivt), line boarding time (@lbt) and effective headway calculations (@hdwy).

This resulted in an increase of bus patronage at the expense of rail and ferry (see Figure 4-5, Table 4-4 and Table 4-5). This makes sense as previously behavioural factors favoured rail.

Table 4-5 shows the effect on rail boards by line. For the AM period, the effect was most noticeable on the Johnsonville line, with a 24% reduction in patronage. There is significant bus-rail competition from this area into Wellington. Bus travel times are comparable to rail, and frequencies are high. This line is most sensitive to behavioural parameter changes.

Meanwhile, on the Hutt Valley and Kapiti lines patronage reduced by only 5% and 3%, respectively, reflecting the considerable time advantage provided by rail over bus for most movements from these areas.

The ferry patronage decreased significantly in the test. The ferry is a high-fare, premium service with low volumes compared to other modes. It is generally patronised by those with high incomes, a segment of the market not explicitly modelled. All these factors meant it was difficult to validate, and required different behavioural factors to other modes. So when these parameters were removed, the patronage decreased.

There are also some increases and decreases in patronage around Kilbirnie, due to people shifting from the Airport Flyer to other bus routes. The Flyer is another premium service, which requires behavioural parameters to be represented correctly. The switch is small, with volume differences between 0-20 passengers.

Table 4-4: Boards and Passenger km by Mode and Access Mode, Test 4 vs. Base

	Boards						Passenger km ('000s)					
	AM			IP			AM			IP		
	Base	Test 6	Diff	Base	Test 6	Diff	Base	Test 6	Diff	Base	Test 6	Diff
Rail - P&R	4830	4640	-4%	230	210	-10%	113	110	-3%	5	4	-7%
Rail - K&R	1020	960	-6%	40	40	-9%	27	26	-4%	1	1	-6%
Rail - Walk	6800	6270	-8%	980	750	-24%	149	145	-3%	17	13	-20%
Rail – ALL	12640	11860	-6%	1250	990	-21%	290	281	-3%	22	19	-16%
Bus	17520	18390	5%	5810	6130	6%	108	120	11%	37	42	13%
Ferry	190	50	-75%	20	0	-100%	2	1	-73%	0	0	-100%
Total	30360	30310	0%	7080	7120	1%	400	401	0%	60	61	1%

Table 4-5: Rail Boards by Line, Test 4 vs. Base

	AM			IP		
Line	**Base**	**Test 6**	**Diff**	**Base**	**Test 6**	**Diff**
Johnsonville	1340	1020	-24%	200	170	-17%
Hutt Valley / Melling / Wairarapa	6110	5790	-5%	410	270	-36%
Kapiti / Capital Connection	5190	5060	-3%	630	550	-12%

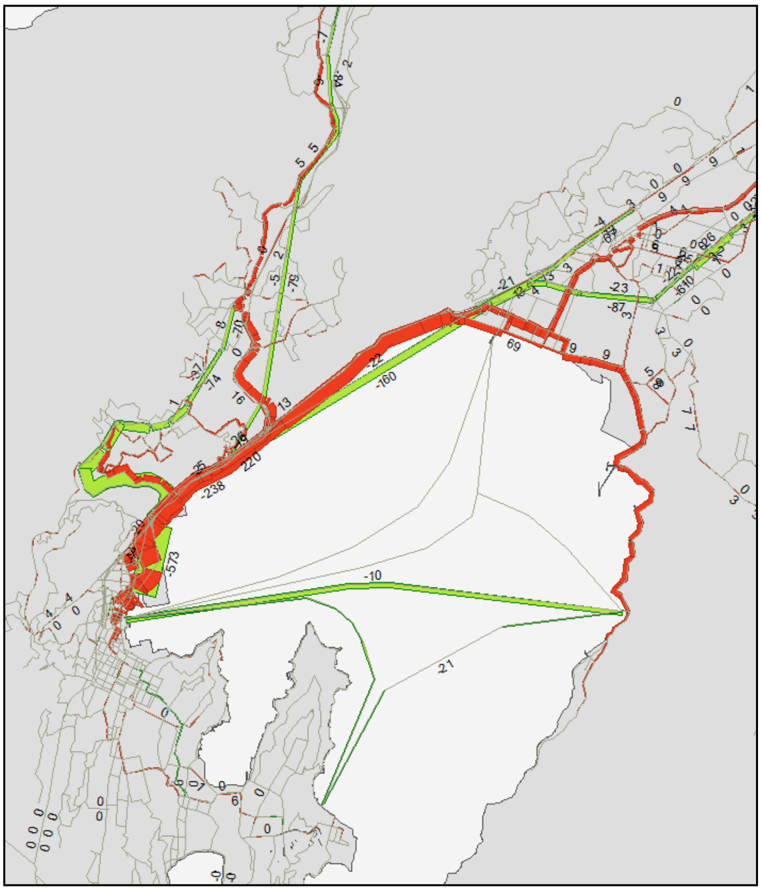

Figure 4-5: Change in PT Vol, AM Peak, Test 4 vs. Base (red=increase, green=decrease)

4.5 Sensitivity Test 5 – Bus Route 3 Frequency Improvement

This test increased the frequency of Route 3 services by 25% in both WTSM and WPTM.

This resulted in a 14% increase in Route 3 boards in the AM peak, from 1377 to 1576 (see Figure 4-6, with Route 3 shown in blue). There was reduced patronage on alternatives such as Route 17 (-13%), Route 6 (-5%) and Route 21 (-5%). There was minimal change to bus use overall – total boards increased by only 11 at a network-wide level. A similar pattern was observed in the Inter peak, but of smaller magnitude.

The elasticity of Route 3 boards with respect to frequency can be calculated as:

AM elasticity: 0.6
IP elasticity: 0.3

The results show that for the AM peak the elasticity is outside the typical range of 0.2 to 0.5 reported in Wallis (2004). However, as documented in TCRP (2004) it is important to note the substantial variations in reported ridership responses to bus frequency changes given the widely varying circumstances attending individual bus route and system headway changes. Some of these variables include:

- The pre-existing level of transit service;

- The geographic, demographic and socio-economic environment; and
- The time period of day or week of the service.

Another complicating factor is that some ridership changes in response to frequency changes reflect primarily diversion of riders from one route to another (route choice), rather than diversion from one mode to another (mode choice, such as between auto and transit).

Given some of the considerations above, the elasticities calculated for the model appear reasonable.

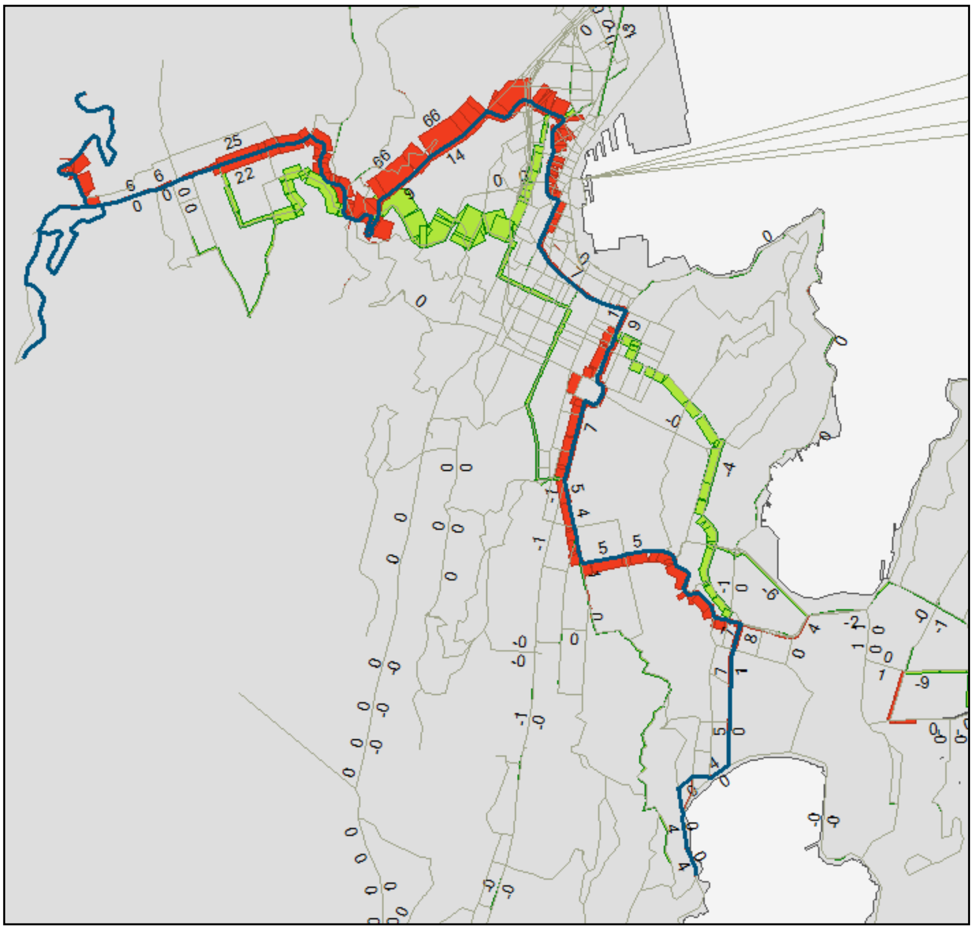

Figure 4-6: Change in PT Vol, AM Peak, Test 5 vs. Base (red=increase, green=decrease, blue line = Route 3)

4.6 Sensitivity Test 6 – Bus Route 3 BRT Conversion, without IVT Change

In this test, Go Wellington Route 3 was converted to bus rapid transit (BRT) and the mode-specific preferences for this route were set equal to regular bus. All other parts of the network and factors for other modes remained as per the calibrated base model. The following assumptions were made:

- Run time was reduced by 15%;
- Service frequency was increased by 25%; and
- No other route benefits from the BRT infrastructure – i.e. other bus routes along the same roads do not have travel time improvements.

In WTSM, a new transit time function was created and applied to Route 3, and the frequency for each Route 3 variant increased. The only PT behavioural parameter used in WTSM is the in-vehicle time weighting, which was set equal to regular bus for the Route 3 converted to BRT.

In WPTM, transit time and service frequency was modified similarly as in WTSM. Also, the mode-specific preferences for the BRT were set to equal the regular bus values. These parameters were: in-vehicle time weighting (@ivt), line boarding time (@lbt) and effective headway calculations (@hdwy).

This test resulted in isolated changes around Route 3 only as shown by the marginal changes in rail and ferry boardings and vehicle kilometres in Table 4-6. Bus boardings, as expected show the biggest increase, although this is relatively small when looking at a network wide context.

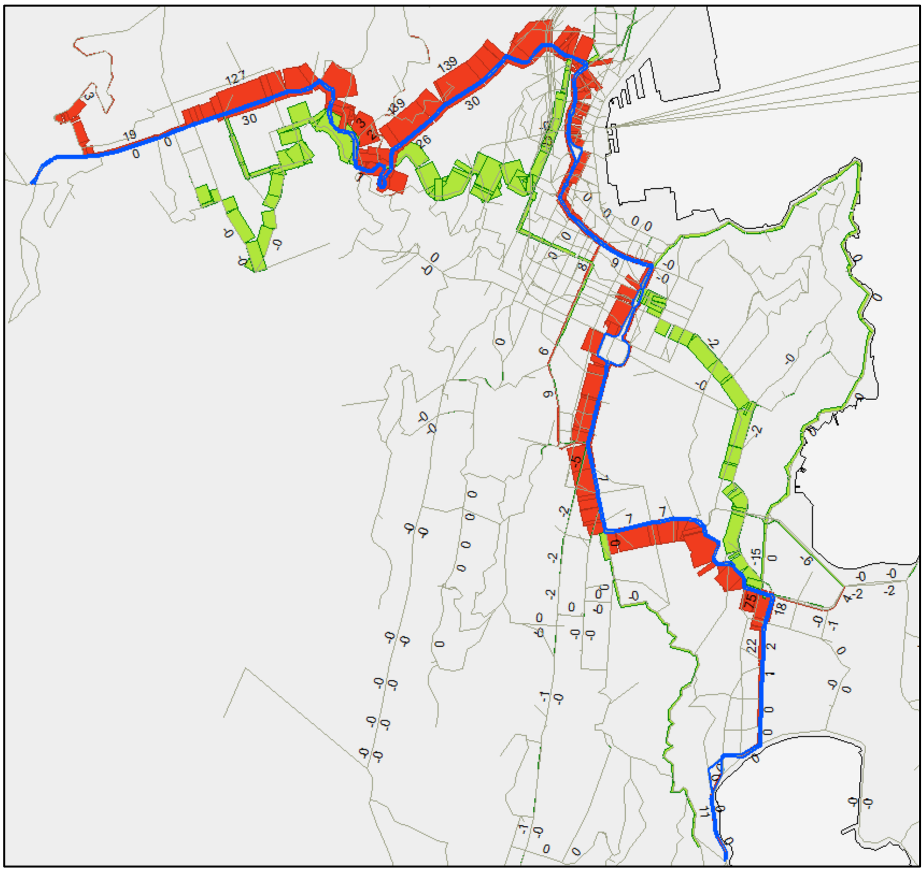

Figure 4-7: Change in PT Vol, AM Peak, Test 6 vs. Base (red=increase, green=decrease, blue line = Route 3)

Table 4-6: Boards and Passenger km by Mode and Access Mode, Test 6 vs. Base

	Boards						Passenger km ('000s)					
	AM			IP			AM			IP		
	Base	Test 4	Diff (%)	Base	Test 4	Diff (%)	Base	Test 4	Diff (%)	Base	Test 4	Diff (%)
Rail - P&R	4830	4820	0%	230	230	0%	113	113	0%	5	4.8	0%
Rail - K&R	1020	1020	0%	40	40	0%	27	27	0%	1	1.0	0%
Rail - Walk	6800	6800	0%	980	980	0%	149	149	0%	17	16.6	0%
Rail - ALL	12640	12640	0%	1250	1250	0%	290	290	0%	22	22.4	0%
Bus	17520	17590	0%	5810	5840	0%	108	108	0%	37	37.2	0%
Ferry	190	190	0%	20	20	0%	2	2	0%	0	0.2	0%
Total	30360	30420	0%	7080	7120	0%	400	400	0%	60	59.9	0%

Looking at the changes around Route 3 more closely, the results show that Route 3 boards increased by 35% in the AM peak and 18% in the IP period. Most of this increase is due to passengers changing from other routes such as Route 17, 21, 24 and 23 (see Figure 4-7).

4.7 Sensitivity Test 7 – Bus Route 3 BRT Conversion, with IVT Change

This is the same as Test 4 (Route 3 BRT) but with a change to the Route 3 in-vehicle time (IVT) factor from regular bus (1.0) to BRT (0.92 – taken from preliminary Public Transport Spine Study testing).

The results of this test are similar to Test 6 but the results show a higher attraction to Route 3 given the more favourable IVT factor. Under this test, Route 3 boards increased by 44% and 24% for the AM and IP periods, respectively, when compared to the base. This is 10% and 6% more than the increase under Test 6.

A difference plot showing the transit volumes in Test 6 subtracted from the transit volumes results in Test 7 can be seen in Figure 4-8.

The significant jump in volumes near Kilbirnie can be attributed to the more favourable IVT factor. Previously, passengers chose to walk to Kilbirnie Interchange (a 'superior' bus stop in WPTM), whereas now they would prefer to reduce their perceived time by boarding at a closer stop and catching the BRT.

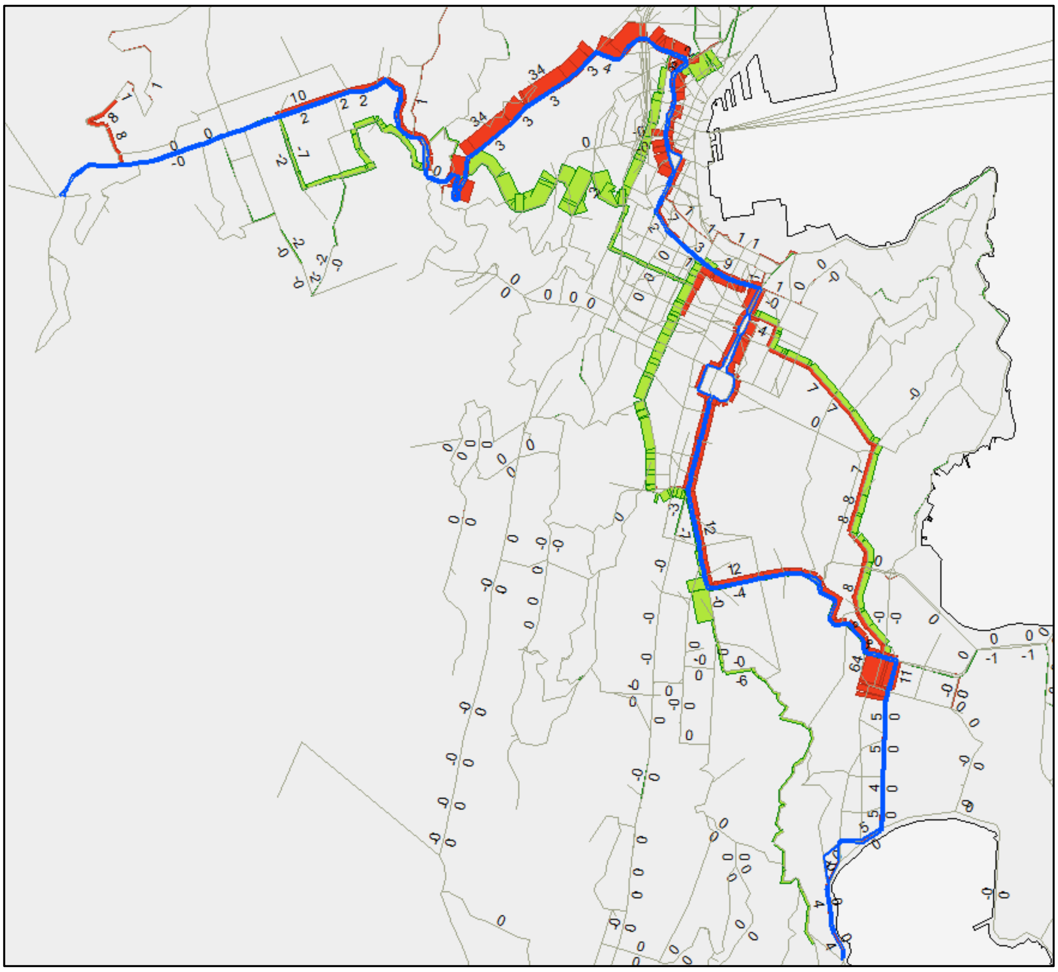

Figure 4-8 Change in PT Vol, AM Peak, Test7 vs. Test6 (red=increase, green=decrease, blue line = Route 3)

Table 4-7: Boards and Passenger km by Mode and Access Mode, Test 7 vs. Base

	Boards						Passenger km ('000s)					
	AM			IP			AM			IP		
	Base	Test 5	Diff (%)	Base	Test 5	Diff (%)	Base	Test 5	Diff (%)	Base	Test 5	Diff (%)
Rail - P&R	4830	4820	0%	230	230	0%	113	113	0%	5	5	0%
Rail - K&R	1020	1020	0%	40	40	0%	27	27	0%	1	1	0%
Rail - Walk	6800	6800	0%	980	980	0%	149	149	0%	17	17	0%
Rail - ALL	12640	12640	0%	1250	1250	0%	290	289	0%	22	22	0%
Bus	17520	17590	0%	5810	5850	1%	108	108	0%	37	37	1%
Ferry	190	190	0%	20	20	0%	2	2	0%	0	0	0%
Total	30360	30420	0%	7080	7120	0%	400	400	0%	60	60	0%

Table 4-8 below shows a summary of the sensitivity tests around Route 3 (sensitivity Tests 5, 6, and 7) which highlights that the model's response to change is commensurate with the level of intervention applied. For example, under Test 5 (+25% frequency) AM peak boardings increased by 14%. Under Test 6 (+25% frequency, -15% travel time) boardings increased by 35%. Whilst under Test 7 (+25% frequency, -15% travel time, better IVT perception factor) the number of boardings increased by 44%.

Table 4-8: Summary of Bus Route 3 boardings for various tests

Case	Total Boardings AM	% Change from Base AM	Total Boardings IP	% Change from Base IP
Base	1,377	-	587	-
Test 5 – frequency	1,576	14%	628	7%
Test 6 – BRT, no IVT	1,852	35%	691	18%
Test 7 – BRT, with IVT	1,985	44%	728	24%

5 Conclusion

The sensitivity tests carried out and documented in this technical note demonstrate that the WPTM model responds in a predictable and sound manner to variations in common input parameters and network supply and/or demands.

The results show that where global parameters are changed (e.g. PT fares, car fuel costs) the response in the model is network wide whilst changing parameters for specific areas (e.g. increase in frequency for a particular service) the impact is limited to the area of influence of that particular route.

The sensitivity tests around Route 3 (sensitivity tests 5, 6, and 7) also show that the model's response to change is commensurate with the level of intervention applied.

These results give confidence that the WPTM will produce sensible results when changes are made to the model inputs.

Appendix A – Trip Tables

The tables in this appendix detail the total number of trips from the WPTM matrices for each test, by access mode and time period.

Table 1: Test 1 (PT Fares +20%), WPTM Trips by Access Mode and Time Period

Access Mode	Period	Base	Test 1	Change	% Change
P&R	AM 2hr	4950	4630	-320	-6%
	IP 2hr	240	220	-20	-8%
K&R	AM 2hr	1040	960	-80	-8%
	IP 2hr	40	40	0	0%
Walk	AM 2hr	21790	20640	-1150	-5%
	IP 2hr	7710	7370	-340	-4%
Total	AM 2hr	27780	26230	-1550	-6%
	IP 2hr	8000	7630	-370	-5%

Table 2: Test 2 (Car Fuel Costs +20%), WPTM Trips by Access Mode and Time Period

Access Mode	Period	Base	Test2	Change	% Change
P&R	AM 2hr	4950	5110	160	3%
	IP 2hr	240	250	10	4%
K&R	AM 2hr	1040	1050	10	1%
	IP 2hr	40	40	0	0%
Walk	AM 2hr	21790	22510	720	3%
	IP 2hr	7710	7920	210	3%
Total	AM 2hr	27780	28680	900	3%
	IP 2hr	8000	8210	210	3%

Table 3: Test 3 (New P&R site Ava), WPTM Trips by Access Mode and Time Period

Access Mode	Period	Base	Test 3	Change	% Change
P&R	AM 2hr	4950	4960	10	0%
	IP 2hr	240	240	0	0%
K&R	AM 2hr	1040	1040	0	0%
	IP 2hr	40	40	0	0%
Walk	AM 2hr	21790	21790	0	0%
	IP 2hr	7710	7710	0	0%
Total	AM 2hr	27780	27790	10	0%
	IP 2hr	8000	8000	0	0%

Table 4: Test 4 (Equal behavioural weights), WPTM Trips by Access Mode and Time Period

Access Mode	Period	Base	Test 4	Change	% Change
P&R	AM 2hr	4950	4710	-240	-5%
	IP 2hr	240	210	-30	-13%
K&R	AM 2hr	1040	970	-70	-7%
	IP 2hr	40	40	0	0%
Walk	AM 2hr	21790	22120	330	2%
	IP 2hr	7710	7750	40	1%
Total	AM 2hr	27780	27800	20	0%
	IP 2hr	8000	8000	0	0%

Table 5: Test 5 (Route 3 frequency +25%), WPTM Trips by Access Mode and Time Period

Access Mode	Period	Base	Test 5	Change	% Change
P&R	AM 2hr	4950	4950	0	0%
	IP 2hr	240	240	0	0%
K&R	AM 2hr	1040	1040	0	0%
	IP 2hr	40	40	0	0%
Walk	AM 2hr	21790	21800	10	0%
	IP 2hr	7710	7710	0	0%
Total	AM 2hr	27780	27790	10	0%
	IP 2hr	8000	8000	0	0%

Table 6: Test 6 (Route 3 to BRT, no mode preference), WPTM Trips by Access Mode and Time Period

Access Mode	Period	Base	Test 6	Change	% Change
P&R	AM 2hr	4950	4950	0	0%
	IP 2hr	240	240	0	0%
K&R	AM 2hr	1040	1040	0	0%
	IP 2hr	40	40	0	0%
Walk	AM 2hr	21790	21850	60	0%
	IP 2hr	7710	7730	20	0%
Total	AM 2hr	27780	27840	60	0%
	IP 2hr	8000	8020	20	0%

Table 7: Test 7 (Route 3 to BRT, with mode preference), WPTM Trips by Access Mode and Time Period

Access Mode	Period	Base	Test 7	Change	% Change
P&R	AM 2hr	4950	4950	0	0%
	IP 2hr	240	240	0	0%
K&R	AM 2hr	1040	1030	-10	-1%
	IP 2hr	40	40	0	0%
Walk	AM 2hr	21790	21850	60	0%
	IP 2hr	7710	7730	20	0%
Total	AM 2hr	27780	27830	50	0%
	IP 2hr	8000	8010	10	0%

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