



Greater Wellington Regional Council

2013 WTSM Update

Technical Note 9: WPTM 2013 Validation

July 2015

Greater Wellington Regional Council

2013 WTSM Update

Technical Note

Quality Assurance Statement

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1. Introduction

This technical note documents the validation of the Wellington Public Transport Model (WPTM) as part of the 2013 update of the model. The validation process ensures that the WPTM is a good representation of observed public transport patterns in the base year 2013, by comparing output from the model against a range of observed criteria.

However it must be noted that the update of the model to 2013 conditions was a limited exercise, due to the short two year period since the model had been developed, and the fact that very little change had occurred in terms of both observed public transport demand and supply. In addition to the update of the transport network shared with the Wellington Transport Strategy Model (WTSM) detailed in *“TN3 – Development of base year networks”* and the update of economic parameters detailed in *“TN5 – Model input parameters”*, the only adjustments that were made were a factoring of rail demand per line to account for the minor changes in patronage that had been observed. More details on measured changes in public transport patterns for the 2011 to 2013 period and on the resulting rationale behind this limited update of the model have been recorded in two separate technical notes which are included in Appendices A and B.

As the model is a representation of an average March 2013 weekday to coincide with the 2013 census, observed data used in the validation was sourced for this period as much as possible. When data for other time periods was used, it was adjusted accordingly to match with usual March conditions. This process is explained in more detail in *“TN1 – Data Collection”*.

2. Methodology

This report does not intend to replicate all validation measures that were presented in the previous calibration / validation report from the 2011 development of WPTM (“TN19 – WPTM Calibration and Validation”). This is due to the following reasons:

- The validation for the 2011 WPTM was reported for all steps in the development of the model (base input matrices development, access choice model, full model with final assignment) to “give the reader an understanding of the process and level of validation at each given step”. In the present case however, this report documents a more limited update of the model and as a result only the final validation for the full model is reported.
- In addition, a lot of the data that was used in the calibration / validation of the 2011 WPTM was collected specifically for the development of the model. This included extensive rail and bus on-board surveys, rail platform surveys, as well as detailed Electronic Ticketing Machine (ETM) data for March 2011. No such data was available this time around, so some components of the model could not be checked. This was not considered to be an issue due to the short period since the model was developed and the very limited apparent changes in terms of actual public transport patterns.

The following table details the validation criteria that were reported in the 2011 WPTM validation report but that are not included in this technical note, as well as the reason why they were omitted.

Criteria	Reason for omission
PT network supply	Shared with WTSM, reported in TN3 – Development of base year networks
Bus travel time comparison	Shared with WTSM, reported in TN8 – WTSM 2013 validation
Rail boarding and alighting graphs	These have not been resurveyed. Comparison would therefore be largely identical to the 2011 model as both observed and modelled would be factored by the same amount to 2013.
Trip purpose, car availability and age split	Not resurveyed for 2013
Access and egress trip length distribution	Not resurveyed for 2013
All access choice measures	Not resurveyed for 2013. These include access mode split, distance distribution, station catchment areas.
Bus vs walk from Wellington rail station	Not resurveyed for 2013
Assigned route	This was included in 2011 due to the new network and bus transit time calculation. However, the network is virtually identical and transit time functions are unchanged for 2013, high level checks show very little changes.

Table 1: Omitted Validation Criteria

Other criteria for which observed data was available are however reported in the following section. Again, due to only two years having passed since the model development and the

very small change in observed movements during this period, it is estimated that these comparisons are sufficient to demonstrate that the 2013 WPTM is a good representation of observed public transport patterns in the region.

3. Demand and Assignment Validation

3.1 GWRC Monthly Passengers Counts

The first source of data used for the validation of WPTM is the GWRC monthly patronage counts, showing the total number of boardings per month separately for rail and bus. The figures from 2013 were obtained from the Metlink website and the same methodology as in the 2011 update was used to convert these to weekday two-hourly values.

- The observed monthly total was obtained by averaging all months from 2013.
- The resulting monthly counts were then reduced using the following formula:

$$\begin{aligned} \text{AM/IP trips} = & \text{ (Monthly total trips)} \\ & * \text{ (weekday trips as \% of weekly trips)} \\ & \div \text{ (Average weekdays in month)} \\ & * \text{ (\% of weekday trips in the AM / IP period)} \end{aligned}$$

Factors from the 2011 update calculated using the ETM data for bus and rail guard counts for rail were used.

The resulting values are shown in Table 2 below. These are not meant to represent exact volumes but rather should be taken as an indication of magnitude. In this respect, modelled numbers appear to be in the right range.

Mode	Observed Average Monthly Total	AM			IP		
		Observed (factored)	Modelled	Difference	Observed (factored)	Modelled	Difference
Rail	947,222	12,496	12,816	3%	1,834	1,215	-34%
Bus	1,966,194	17,407	17,848	3%	7,070	5,881	-17%
Total	2,913,416	29,903	30,664	3%	8,904	7,096	-20%

Table 2: GWRC Monthly Passenger Counts vs all Modelled Trips

3.2 Kiwirail Guard Counts – Volumes at Wellington Station

Modelled inbound volumes at Wellington station were also compared against rail guard counts obtained from Kiwirail, which was assumed to be equivalent to the number of passengers arriving at the station. This was done for each line separately and for the AM peak. Guard count data from February to June 2013 was used and averaged. The results are shown in Table 3.

Line	KiwiRail	Volume at Wellington Station	Difference
JVL	1,112	945	-15%
HVL / MEL / WRL	5,399	5,430	1%
KPL / CC	4,722	4,906	4%
Total	11,233	11,281	0%

Table 3: Kiwirail guard Counts, AM Peak Inbound Only

3.3 CBD Cordon Survey

The total number of PT users entering the CBD during the morning peak was also compared with the annual CBD cordon survey, carried out in March 2013. Observed values were factored to an average month.

Results by mode and overall show a good fit and are well within the validation criterion used for the development of WPTM of +/-15%. The only exception is the cable car, which only carries a very small number of passengers and is mostly aimed at tourists, therefore not driven by time and costs considerations as other users of the public transport network.

Mode	Cordon Count	Modelled Assignment	Difference
Rail	10,970	11,282	3%
Bus	9,951	9,278	-7%
Ferry	212	207	-2%
Cable Car	109	2	-98%
Total	21,242	20,769	-2%

Table 4: CBD Cordon Modelled vs Survey – AM Peak

3.4 Rail Screenline Volumes

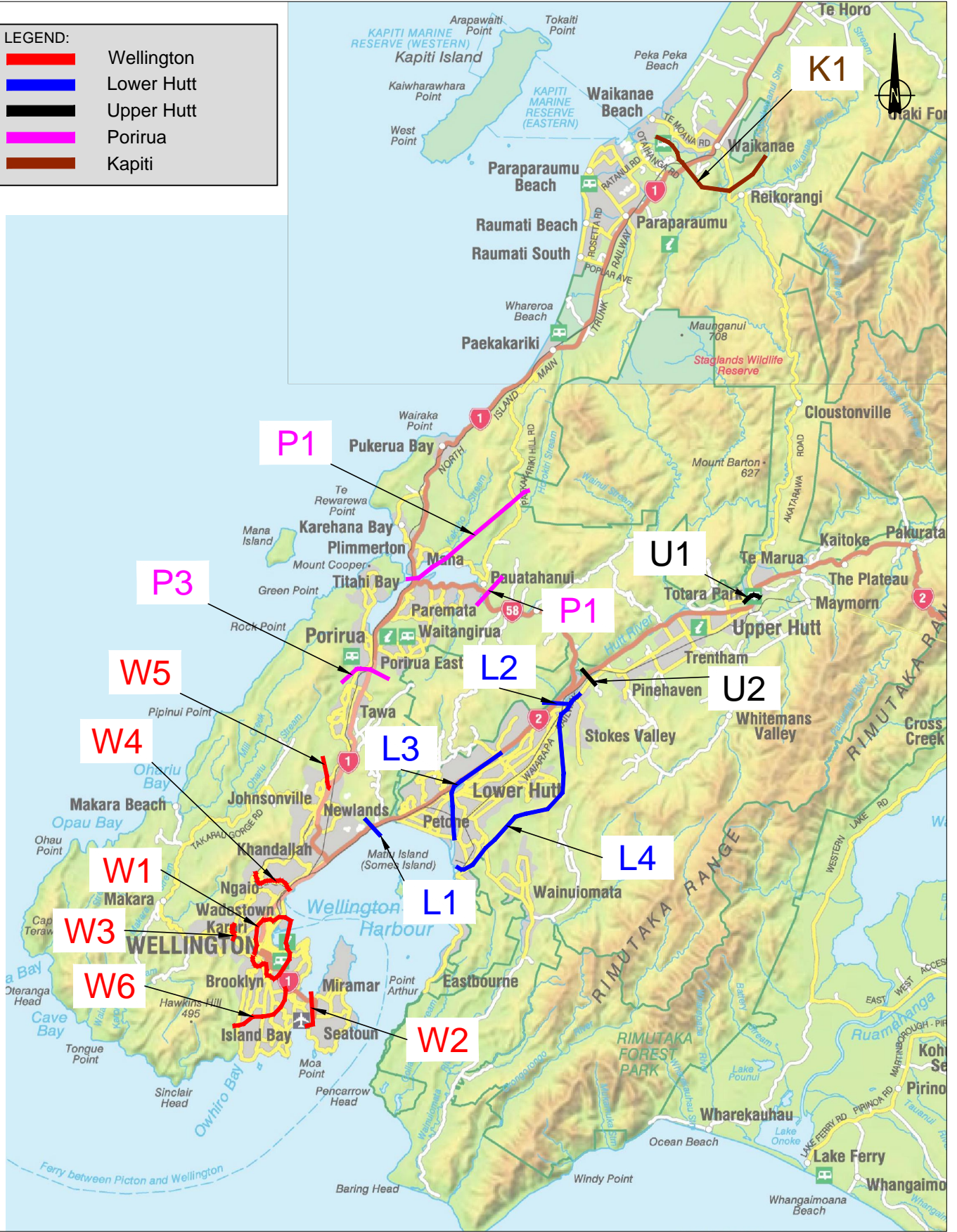
This section presents a comparison of observed and modelled rail passenger volumes across a number of screenlines in the region. These are the same screenlines used in the validation of the WTSM and are shown in Figure 1 and Figure 2. Screenlines without any rail volumes have been excluded.

Fully observed volumes in 2011 were derived from the extensive rail surveys that were carried out for the development of the model, however this information was not available for the 2013 update. Results for each screenline were therefore based on 2011 volumes, factored to match with the observed 2011-2013 growth for each line (Appendix A details how these factors were derived).

The results are detailed in Table 5 which shows the observed and modelled volumes as well as the percentage difference and the GEH, the standard empirical measure used to compare modelled flows against observed volumes.

LEGEND:

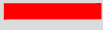
- Wellington
- Lower Hutt
- Upper Hutt
- Porirua
- Kapiti



Wednesday, 17 June 2015 0 20mm

<p>Screenlines</p> <p>----</p>		<p style="font-size: 2em; font-weight: bold;">1</p> <p style="font-size: 0.8em;">SCALE: 1:300,300 @ A4</p>
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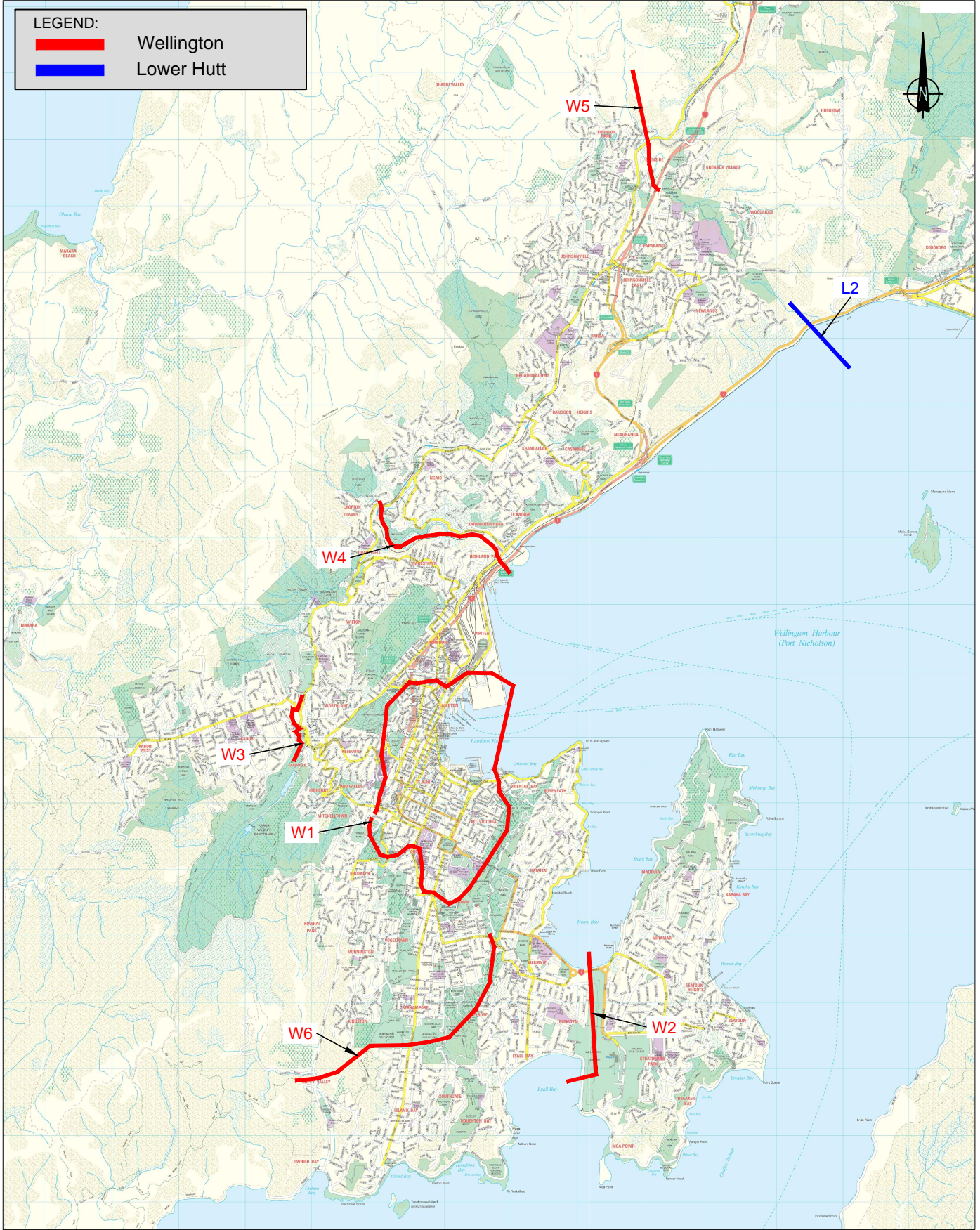
LEGEND:



Wellington



Lower Hutt



Wednesday, 17 June 2015 0 20mm

Screenlines - Wellington City



2

SCALE: 1:80,000 @ A4

ID	Dir.	AM				IP			
		Observed	Modelled	Diff %	GEH	Observed	Modelled	Diff %	GEH
C1	In	11,480	11,282	-2%	1.31	746	549	-26%	5.48
C1	Out	304	352	16%	1.87	402	223	-45%	7.16
C2	In	2,600	2,447	-6%	2.15	374	301	-19%	2.80
C2	Out	3,735	3,793	2%	0.67	393	313	-20%	3.00
C3	In	2,674	3,023	13%	4.62	258	227	-12%	1.42
C3	Out	4,367	4,460	2%	0.99	317	267	-16%	2.06
C4	In	545	610	12%	1.93	147	149	2%	0.14
C4	Out	748	1,151	54%	9.24	203	184	-9%	0.96
W4	NB	335	352	5%	0.64	399	223	-44%	7.06
W4	SB	11,304	11,282	0%	0.15	737	549	-26%	5.25
L1	NB	173	165	-5%	0.44	165	88	-47%	4.84
L1	SB	5,380	5,451	1%	0.68	296	219	-26%	3.39
L2	NB	269	204	-24%	2.99	44	37	-16%	0.78
L2	SB	1,810	1,911	6%	1.66	100	94	-6%	0.43
L3	EB	143	118	-18%	1.57	135	89	-34%	3.07
L3	WB	4,440	4,499	1%	0.62	264	212	-20%	2.38
U2	NB	279	204	-27%	3.42	47	37	-21%	1.06
U2	SB	1,801	1,906	6%	1.73	97	93	-5%	0.32
P1	NB	29	30	2%	0.08	93	74	-21%	1.50
P1	SB	1,957	1,868	-5%	1.44	198	175	-12%	1.21
P3	NB	107	85	-21%	1.59	165	107	-35%	3.51
P3	SB	3,714	3,755	1%	0.48	285	227	-20%	2.54
K1	NB	28	29	2%	0.09	61	49	-20%	1.14
K1	SB	521	551	6%	0.92	85	89	5%	0.30
TOTAL		58,743	59,528	1%	2.28	6,011	4,575	-24%	13.96

Table 5: Rail Passenger Volumes at Screenlines, Observed vs Modelled

Unsurprisingly, values are generally very close to the 2011 model and show a good match to observed volumes, although the same issue with flows being too low overall that was noted during the 2011 development of WPTM is still present. For the AM peak however, the validation criterion used during the development of WPTM of screenlines being within +/-15% of observed is satisfied.

Table 6 shows the ranges of GEH values for each time period. The Transport Model Development Guidelines (TMDG) developed by NZTA specifies a target of 60% of screenlines achieving a GEH of 5 or less. As can be observed, this target is achieved for both periods and most GEH values are acceptable.

GEH	AM		IP	
	#	%	#	%
<5	23	96%	20	83%
>5	1	4%	4	17%
>10	0	0%	0	0%

Table 6: Distribution of Rail Screenline GEH Values

Scatterplots of modelled vs observed patronage by screenline are shown below, as well as the R² coefficient of determination. The recommended values in the TMDG are for the R² to be above 0.85 and the slope of the line of best fit to be between 0.9 and 1.1. These are satisfied for both time periods, with the exception of the slope of the line of best fit in the inter peak confirming the under-estimation of rail patronage in this period.

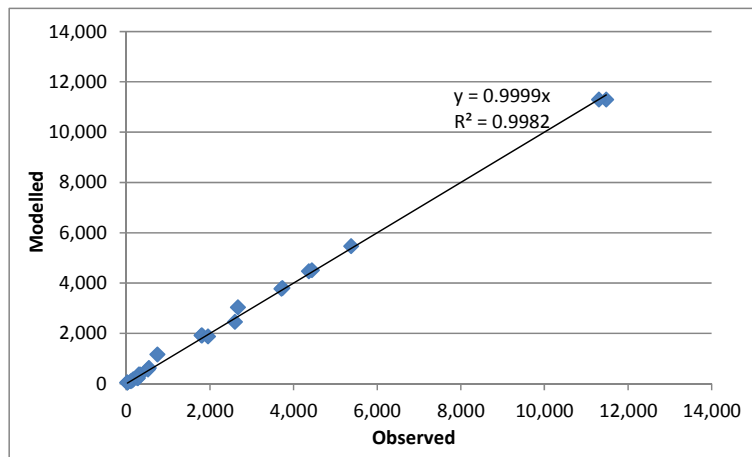


Figure 3: AM Rail Screenlines, Modelled vs Observed

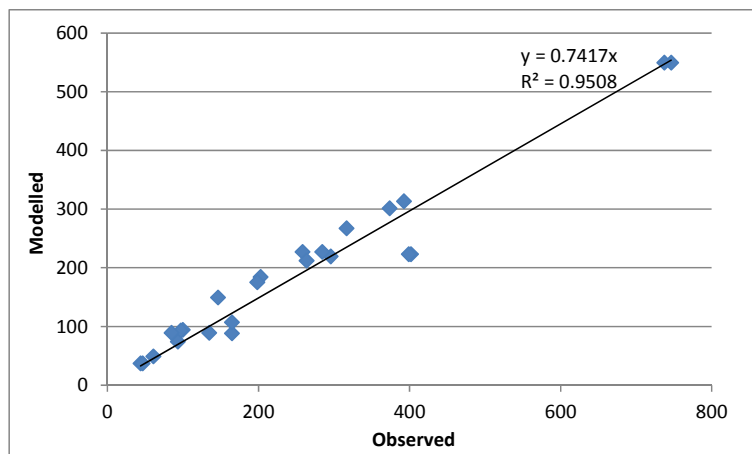


Figure 4: Inter peak rail Screenlines, Modelled vs Observed

3.5 Rail Boardings Counts per Line

Table 7 summarises the total number of boardings per line (as opposed to Table 3 which showed only inbound volumes at Wellington station), comparing modelled boardings

against observed demand. Note that since no new surveys were carried out for 2013, 2011 observed numbers of boardings factored up to match 2011-2013 growth were used.

Results are again very similar to the 2011 WPTM, with most lines achieving a good fit. The only exceptions are the Hutt Valley and Johnsonville lines in the inter peak which are both too low, although this translates to small numbers. This was investigated during the development of the model and was found to be due to competition between bus and rail on these corridors. It was noted that although it would be possible to apply specific parameters to rectify the issue, such an adjustment was rejected as it would detract from the integrity of the model.

Line	AM			IP		
	Observed Boards	Modelled Boards	Diff	Observed Boards	Modelled Boards	Diff
JVL (Johnsonville)	1,537	1327	-14%	319	190	-40%
HVL (Hutt Valley), MEL (Melling), WRL (Wairarapa)	6,147	6173	0%	647	412	-36%
KPL (Kapiti), CC (Capital Connection)	5,410	5316	-2%	788	614	-22%

Table 7: Total Rail Boardings by Line, Observed and Modelled Demand

3.6 Bus CBD Cordon Counts

Table 8 below compares modelled AM peak inbound bus volumes across the CBD cordon with values observed during the March 2013 survey (factored down to an average month).

Links of CBD Cordon	Cordon Counts Average Month	Modelled	Difference
Oriental Parade	320	169	-47%
Cambridge Terrace	1,674	1,560	-7%
Elizabeth Street	1,720	1,829	6%
Willis Street	654	542	-17%
Taranaki Street	638	548	-14%
Tinakori Road	1,099	1,043	-5%
Kelburn Parade	653	643	-2%
Murphy Street	1,193	810	-32%
Thorndon Quay	2,000	2,134	7%
Total	9,951	9,278	-7%

Table 8: CBD Cordon Bus Passengers, Observed vs Modelled, AM Peak Inbound

Modelled volumes are close to the 2011 WPTM results. Cordon counts on the other hand vary by location compared with 2011, which is due to these surveys being only a snapshot of a single day in March and therefore showing quite a bit of natural variability from year to

year. The total observed volumes across the CBD cordon are consistent however, showing a slight increase of 2%. The end result in terms of validation is that some locations improve while others deteriorate slightly, but performance of the model is very close to the 2011 version of WPTM and is considered acceptable compared with observed.

3.7 Bus Screenline Volumes

This section presents a comparison of observed and modelled bus passenger volumes across the same screenlines used for the rail validation, and in the validation of WTSM.

Observed volumes have been extracted from March 2013 ETM data using a tool developed for this purpose. This is the same source of data used for the WTSM validation and more detail on the process to derive this data can be found in Section 6 of “TN8 – WTSM Validation”.

The results are detailed in Table 9 which shows the observed and modelled volumes as well as the percentage difference and the GEH, the standard empirical measure used to compare modelled flows against observed volumes.

Due to the highly sensitive nature of ETM data in terms of confidentiality, some numbers have been removed.

ID	Dir.	AM				IP			
		Observed	Modelled	Diff %	GEH	Observed	Modelled	Diff %	GEH
W1	OUT				3.9				4.2
W1	IN				5.2				0.1
W2	EB				1.9				1.8
W2	WB				4.0				1.4
W3	EB				3.7				0.4
W3	WB				0.7				6.2
W4	NB				1.4				0.0
W4	SB				7.9				11.0
W5	NB				0.0				0.2
W5	SB				2.0				3.3
L1	NB				5.1				4.1
L1	SB				16.6				2.6
L2	NB				1.0				2.3
L2	SB				3.4				4.2
L3	EB				1.0				0.7
L3	WB				9.2				1.6
L4	EB				4.0				2.1
L4	WB				6.4				5.4

ID	Dir.	AM				IP			
		Observed	Modelled	Diff %	GEH	Observed	Modelled	Diff %	GEH
U2	NB				10.7				0.8
U2	SB				0.2				5.2
P1	NB				0.0				0.0
P1	SB				1.4				0.0
P2	EB				0.0				0.0
P2	WB				0.0				0.0
P3	NB				0.0				0.2
P3	SB				0.3				0.2
TOTAL		21,477	20,577	-4%	4.4	6,972	7,199	3%	1.9

Table 9: Bus Passenger Volumes at Screenlines, Observed vs Modelled

Again, results are in line with WPTM 2011 and the model achieves a similar level of validation. The main exception is for screenline L1 southbound, for which modelled volumes have been stable but observed volumes have more than doubled. This could be due to the different process used to derive observed volumes in 2011 and 2013. However the difference in bus patronage is relatively minor compared with total public transport demand in this corridor, with rail being by far the main public transport mode.

Table 10 shows the resulting ranges of GEH values, while Figure 5 and Figure 6 show scatterplots of observed vs modelled patronage by screenline. In all cases, the model achieves suitable levels of validation, and meets the targets set by the TMDG.

GEH	AM		IP	
	#	%	#	%
<5	19	73%	22	85%
>5	5	19%	3	12%
>10	2	8%	1	4%

Table 10: Distribution of Bus Patronage by Screenline GEH Values

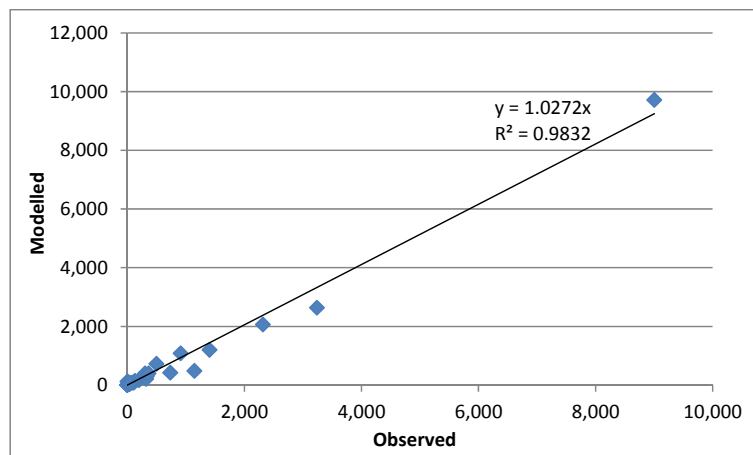


Figure 5: AM Bus Screenlines, Modelled vs Observed

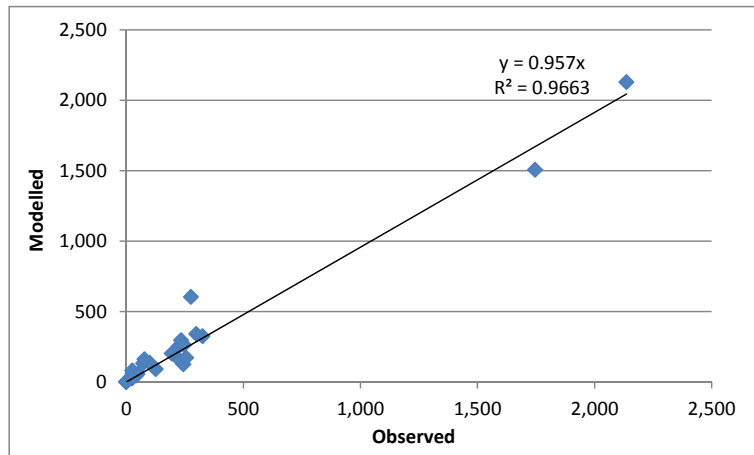


Figure 6: Inter Peak Bus Screenlines, Modelled vs Observed

3.8 Bus Boardings per Route

Figure 7 and Figure 8 below compare observed against modelled total boardings for each route and direction. Again, the observed data was extracted from the ETM data for March 2013.

The R^2 value for the morning peak is above the target of 0.85, while the value for the interpeak is slightly below. This was also the case in the 2011 version of WPTM. The interpeak is considered to replicate observed to a sufficient level even with an R^2 slightly lower than the target.

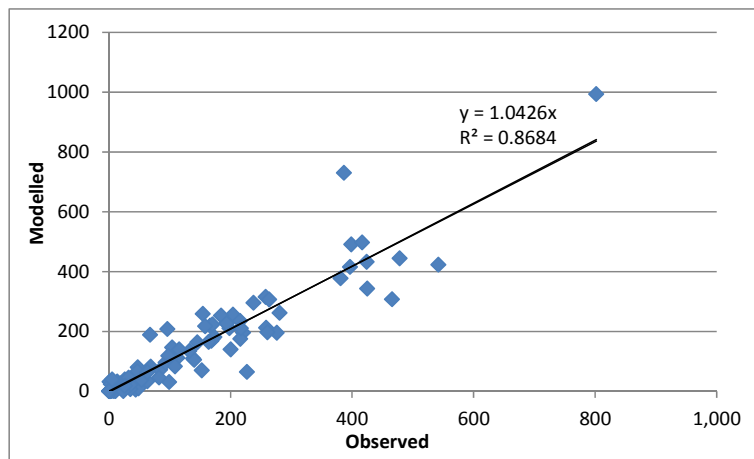


Figure 7: AM Boardings per Service, Modelled vs Observed

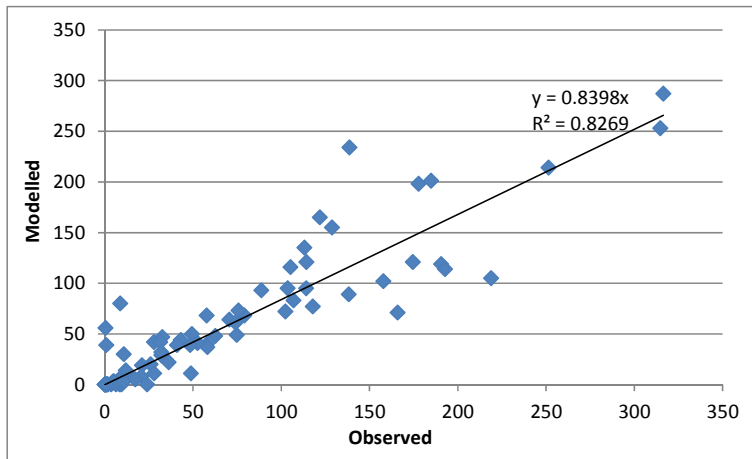


Figure 8: Inter Peak Boardings per Service, Modelled vs Observed

4. Conclusion

This technical note reported the performance of the WPTM updated to 2013 when validating against a number of observed patterns.

As noted previously, this update of the WPTM was limited in scope, due to some of the observed data that was used for the 2011 development of the model not being available for 2013, and to the fact that observed public transport patterns showed very little changes during the 2011 to 2013 period.

Nonetheless, this validation exercise aimed to confirm that the 2013 version of WPTM still provides a good representation of public transport use in the region when compared to a range of observed data:

- GWRC monthly passenger counts
- Kiwirail guard counts
- CBD cordon survey for all modes
- Rail screenline volumes
- Rail boardings per line
- Bus CBD cordon count, per corridor
- Bus screenlines volumes
- Bus boardings per route and direction

In all cases, results were found to be consistent with the 2011 WPTM, and to validate well against observed data.

Appendix A

WPTM Update to 2013

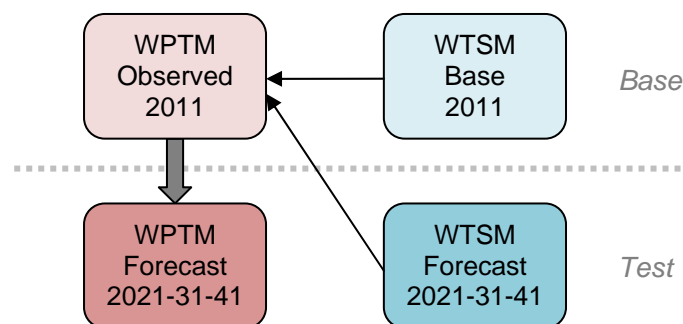
A.1 Introduction

This note discusses suggested approaches for updating the Wellington Public Transport Model (WPTM) to a 2013 base year, and enabling forecasting for 2023, 2033 and 2043 future years.

It describes the suggested options for updating the model together with their pros and cons, summarises observed changes in PT patronage, network and fares between 2011 and 2013, and based on this information recommends the favoured approach.

A.2 Summary of WPTM 2011 Process

WPTM has been designed to run in conjunction with the Wellington Strategy Model (WTSM). The current process for running forecast scenarios with both models is illustrated in the figure below.



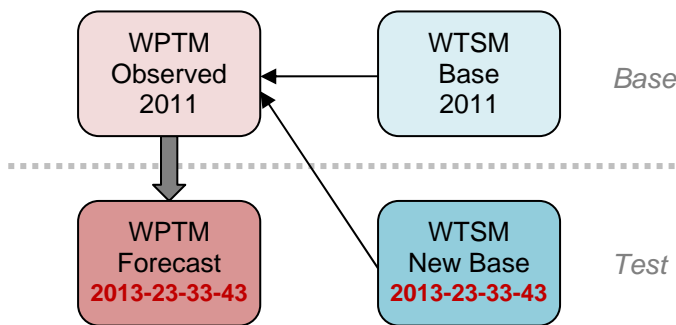
- WPTM has been calibrated and validated against observed demand using various 2011 datasets (Electronic ticketing machine bus data, rail guard counts, on-board and station surveys, etc), and therefore has a base year of 2011;
- To run future or alternative scenarios, two runs need to be undertaken in WTSM: a “Base” run, which essentially corresponds to the base 2011 year in WPTM, and a “Test” run, usually corresponding to a future year scenario;
- Both the Base and Test scenario demands then get passed onto WPTM, and are used to factor (or “pivot”) the observed 2011 matrices to derive the WPTM forecast demand.

As part of the 2013 update of WTSM, this model has been rebased to a new 2013 base year. The question arises then about how to update the Base demand in WPTM to preserve the link between both models. Three options are suggested, which are described in the next section.

A.3 Options for Producing 2013 WPTM Demand

“Forecast” Option

In this option, the 2013 WPTM demand would be produced using the standard forecasting ability of WPTM, and would therefore be considered as a Test scenario (see figure overleaf).



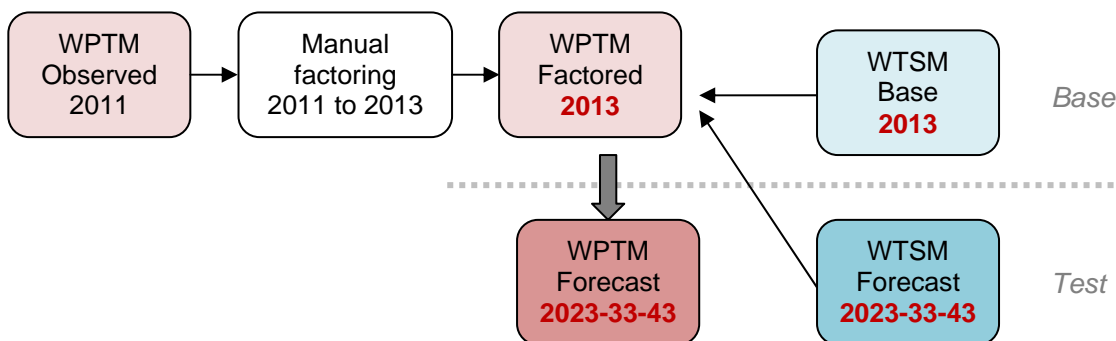
Both 2011 and 2013 demands from WTSM would be passed on to WPTM to factor the observed 2011 demand and produce a “forecast” 2013 demand. Assignment and mode choice parameter files would need to be produced for the year 2013 to reflect the increase in fare and GDP / capita (for the value of time). The results can then be validated against 2013 data (CBD cordon, rail guard counts, and ETM data).

Forecasting for future years (2023 / 2033 / 2043) would work the same as it currently does, and still be factored / pivoted from a 2011 WTSM/WPTM base.

Pros	Cons
<ul style="list-style-type: none"> - Uses existing functionality of model, easy to implement 	<ul style="list-style-type: none"> - 2011 and 2013 WTSM based on different assumptions, especially land-use resulting in quite different PT volumes (e.g. Hutt Valley line was 10% too low in 2011, 10% too high in 2013). This would result in large differences in WPTM 2013, which may not validate. Also would create artificial differences between 2011 and 2023 / 33/ 43 based on the different land-use assumptions. - Has to maintain a link with WTSM 2011 as it is still used as a base demand in WPTM

“Factor” Option

With this approach, the whole modelling system is overhauled from 2011 to 2013. This is already being completed for WTSM as part of the model update, and for WPTM this would be achieved by manually factoring the 2011 observed demand to match 2013 observed data.

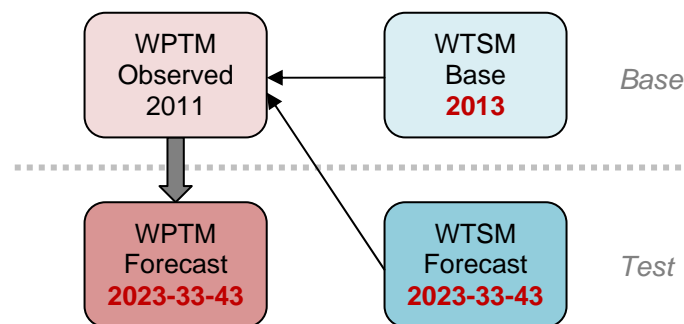


As with the previous option, increases in fares and GDP / capita (for the value of time) will be incorporated through assignment and mode choice parameters. With the whole modelling system rebased to 2013, forecasting would then work as it currently does but for future years 2023, 2033 and 2043 pivoted off 2013 demand.

Pros	Cons
<ul style="list-style-type: none"> - Allows for taking into account observed changes in the 2011-2013 period and helps with validation - Whole modelling system rebased to 2013, no link to 2011 model anymore - Consistency between Base and Test WTSM runs (same 2013 version of the model with same assumptions) 	<ul style="list-style-type: none"> - Manual adjustments, more labour intensive - Adjustments may be superfluous if not significant observed changes (criteria to be agreed with peer reviewer)

“No Change” Option

This option is a simplified version of the “Factor” option. It assumes that no significant changes has occurred between 2011 and 2013, and therefore directly uses the WPTM 2011 observed demand as a replacement for 2013 Base (see figure below) with no adjustment.



Clearly this option can only be used if observed data shows that PT patronage and movements haven’t changed significantly between 2011 and 2013, and that WPTM can validate in 2013 with no manual intervention. The fares and values of time would also need to be updated if necessary, although this is unlikely to have much impact on validation as the two year difference would be minimal. The WPTM observed 2011 demand would potentially be renamed as 2013 demand for consistency.

Plus	Minus
<ul style="list-style-type: none"> - Whole modelling system rebased to 2013, no link to 2011 model anymore - Consistency between Base and Test WTSM runs (same 2013 version of the model with same assumptions) - Easiest and fastest option as no manual adjustments 	<ul style="list-style-type: none"> - Only possible if no significant observed changes between 2011 and 2013 (criteria to be agreed with the peer reviewer)

A.4 2011-2013 Observed Changes

The choice of a preferred option to update WPTM is dependent on how the public transport supply and demand have changed between March 2011 and March 2013. This section looks at how much the PT network, fare structure, and bus and rail patronage have changed during this period.

PT Networks

PT services in the 2013 WTSM and WPTM have been imported directly from the General Transit Feed Specification (GTFS) which contains all services for all modes in the region. This is exactly the same approach that was used in 2011 and comparison of networks for both years therefore allows evaluating changes in the regional network during this two year period.

The figure below shows the difference in service frequency (measured in vehicles per hour) between 2011 and 2013 for the AM peak period, a good indication of how the PT supply has changed. Red indicates an increase, green a decrease.

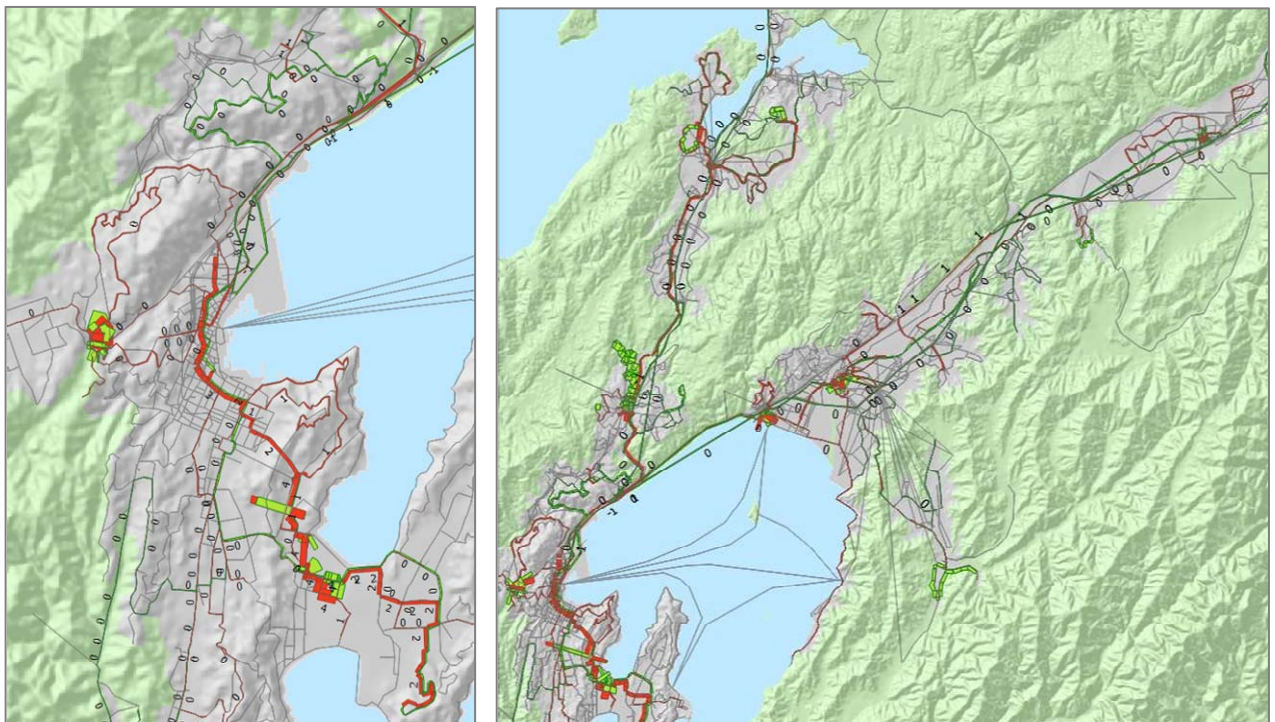


Figure A1: 2011-2013 Change in veh / hour

The figure shows that differences between both networks are minimal (no more than two vehicles/hour in most cases). All the larger differences are caused by routing issues in the 2011 network and by link differences between both road networks (link splits / merges). The outcome is the same for other time periods which are therefore not shown here.

PT Fares

The PT fare structure hasn't changed between 2011 and 2013, with the same zones, boundaries and rules still in place. All types of fares have increased slightly however, with

the uplift being slightly different depending on number of zones travelled or ticket type. The average increase across the whole fare structure is however about 6%.

Bus Patronage

The figure below shows observed inbound passenger counts from the Wellington CBD cordon count, undertaken each year in March during a weekday AM peak (7:00-9:00am). Values are shown for 2011 and 2013, as well as 2012 to identify trends from natural variations.

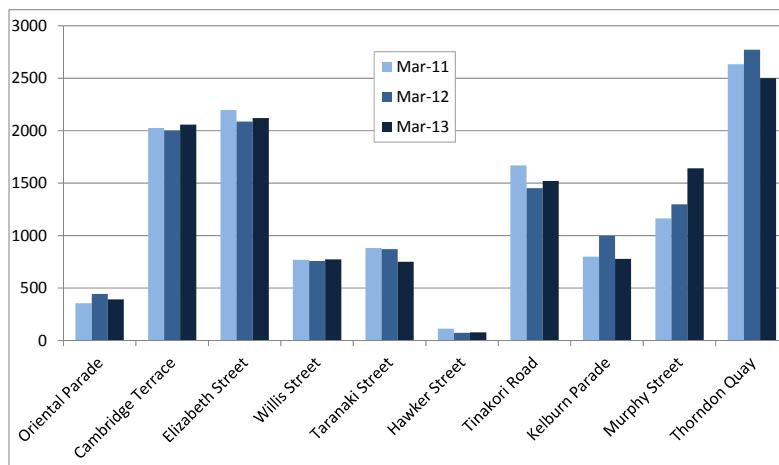


Figure A2: Wellington CBD Cordon Bus Passengers Count (AM Peak)

The total amount of inbound patronage was circa 12,600 in 2011, 12,750 in 2012 (+1%) and 12,600 in 2013 (+0%), so virtually no change during this two year period. Observed volumes on each main corridor show no real trend from year to year, with the possible exception of Murphy Street.

The CBD cordon count is however only a snapshot of demand, being based on only two hours during a single weekday, and only looking at inbound demand to Wellington CBD. For this reason, monthly patronage totals from Metlink were also reviewed and extensive comparison using March 2011, 2012 and 2013 Electronic Ticketing Machine (ETM) data was undertaken. This analysis is detailed in a separate technical note (“ETM Comparison 2011-2013”) included in Appendix B but the main findings are summarised here.

Raw Metlink monthly patronage shows large variations from month to month, but when accounting for the number of weekdays per month and looking at rolling averages, changes between March 2011 and March 2013, as well as the two months before and after are within 1%.

The ETM data analysis compared March 2011, 2012 and 2013 boardings and alightings per fare zone (1 to 9) and per fare sectors as used in WPTM (A to E, Z) to look at origins-destinations in more detail. This was carried out for both the AM and inter peak, but only on Go Wellington services as data for other operators was not available. This was considered suitable as Go Wellington represents in the order of 85% of all bus boardings in the region. Again, the analysis showed no significant changes or clear patterns between 2011 and 2013. Proportion of the various passenger types (adult, children) were constant,

and the only clear trend for ticket type was an increase in the uptake of Snapper card, with a corresponding reduction in other payment, especially cash.

Rail Patronage

The CBD cordon count also includes the number of rail users alighting at Wellington station. This shows a significant increase of 8% between 2011 and 2012, and an increase of 12% between 2011 and 2013.

Again, this is only a snapshot of total rail demand. Review of Metlink monthly patronage actually shows less than 1% difference between March 2011 and 2013 if accounting for the difference in number of weekdays, and both the 'annual rolling average' and 'year to date' for March 2013 are only 1% higher than 2011. The breakdown per line is shown in the table below.

	March Only	Year to Date
PPL	2%	5%
HVL	-2%	-1%
JVL	-6%	-5%
WRL	6%	4%
Total	0%	1%

Table A1: Metlink Rail Patronage Changes 2011-2013

These show that although the total demand growth has been virtually flat, there are notable differences when looking at rail lines separately, with the Kapiti and Wairarapa lines increasing by 4-6%, while the Hutt Valley and especially Johnsonville lines decrease.

Ticket sales from Kiwirail were directly analysed, which confirmed the 1% increase for March 2011 to 2013. It also indicated that the only substantial change in terms of ticket types is a 21% increase in Gold pass users, resulting in a total share of ticket type increasing from 9.5% to 11.5%.

Rail guard counts were also obtained from Kiwirail, showing detailed total volumes per train service and per day. For 2011, data was only available from June to October, so the same period was used for comparison for 2013. It still provides a valuable check regarding the changes in patronage per line, as well as giving the breakdown per peak/off-peak period. Summary results are shown in the table below.

	Peak	Off-Peak	All Day
PPL	4%	2%	4%
HVL	2%	2%	2%
JVL	-2%	0%	-1%
WRL	-	-	2%
Total	3%	2%	3%

Table A2: Kiwirail Guard Counts Changes 2011-2013

Although the total all-day figure shows an overall larger increase than Table 1, with a 3% increase, the breakdown per line is similar: the Kapiti and Wairarapa lines increase the most, followed by the Hutt Valley line and Johnsonville still decreasing.

Results for peak and off-peak periods are consistent, with both periods showing similar levels of growth.

A.5 Summary and Recommendations

The changes in the public transport supply and demand between the March 2011 and 2013 periods can be summarised as follows:

- The public transport network in March 2013 is virtually identical to 2011;
- The fare structure is unchanged in terms of ticket types and fare zones, but there has been a general price increase of 6% on average, which can be considered consistent across all fare products;
- In terms of the usage breakdown for fare products, the only two notable changes are the increase in Gold pass users for rail, and the larger uptake of Snapper card for bus users. However, these translate to relatively small changes in the total make-up of ticket types, with Gold pass increasing only from 9.5% to 11.5% of rail tickets, and Snapper use increasing from 69% to 73% of bus tickets during the AM peak (37% to 41% during the inter peak);
- Bus patronage hasn't experienced any significant changes between March 2011 and March 2013, with flat growth and no change in distribution. This is confirmed by the CBD cordon count, Metlink patronage data and extensive analysis of ETM data;
- Rail patronage for the same period shows only a 1% growth, shown in the Metlink patronage data and Kiwirail ticket sales data. This however varies by services, with the Kapiti and Wairarapa lines increasing by about 5%, whereas the Hutt Valley line and especially the Johnsonville line decrease. The same trends are shown by guard count data, although this is for the June-November periods in 2011 and 2013 which shows a larger increase overall. CBD cordon counts show a different picture but for one day only, and this is not supported by the other datasets.

Based on these, the pros and cons of each option and initial findings from the WTSM validation, the following recommendations were made.

The "Forecasting" approach, while being simple to implement, has the disadvantage of keeping a link with the 2011 version of WTSM as a base demand. Comparison of initial 2013 and 2011 WTSM results has shown both models return quite different volumes on some corridors, especially for rail patronage (the reasons for these are detailed in "TN7 – Production of 2013 Land-use Data"). This will therefore result in differences between the 2011 and 2013 demand for WPTM.

While this is not necessarily an issue for WTSM as it is a synthetic model for which more leeway is acceptable (and indeed some of these differences actually improve with the validation of the model), WPTM is an incremental model based on observed data and therefore is expected to achieve better accuracy. Applying directly the 2011 to 2013 changes in WTSM to factor WPTM demand would result in abrupt changes in patronage

which haven't occurred in reality, and would only be caused by different assumptions between the versions of WTSM. The WPTM model would thus be unlikely to validate.

The "Forecasting" approach is therefore not recommended to be used.

Based on the very small observed changes in patronage between 2011 and 2013, the recommended option is either "No Change", or a simple "Factor" approach with only rail demand factored to match growth (or decrease) observed on each line as shown in Table A1.

As a result, the 2011 demand would effectively be unchanged and used as is for 2013, with potentially the rail matrices factored after being imported into WPTM.

In any case, a number of other slight modifications will have to be undertaken to fully update WPTM to 2013:

- Values of time to be increased in line with WTSM. This will have a very limited impact as it will be minor compared with other planned adjustments to the WPTM values of time (unit correction, resource cost correction, and switch to modal equity based) which have been documented separately in Appendix A of "TN5 – Model input parameters";
- Fares to be increased across the board. To be consistent with WTSM, the nominal 6% increase needs to be discounted based on Consumer Price Index, resulting in a real 2011 to 2013 increase of 3%. This is unlikely to have any impact as only the differential between PT modes is of importance in WPTM;
- The potential changes in average fare structure due to increase in Gold pass and Snapper use is not deemed likely to have a significant impact as it only results in small changes to the make-up of fare products and has a limited effect on the differential between bus and rail costs. This can however be investigated in more detail if necessary, although the spreadsheets used in the initial WPTM fare calculations will have to be sourced;
- Car ownership for 2013, used to separate demand into "car available" and "non-car available" segments will need to be updated.

Appendix B

ETM 2011-2013 Comparison

B.1 Introduction

This note details the analysis carried out using Electronic Ticketing Machine (ETM) information to compare bus patronage volumes and patterns for March 2011 and March 2013. The aim of this analysis is to estimate how much bus patronage has changed in the Wellington region during this period, in order to inform the choice of most appropriate approach to update the Wellington Public Transport Model (WPTM) representation of bus demand.

Ticketing information for March 2011 comes from the original ETM data that was used for the development of the WPTM matrices. Data for 2013 was obtained from the “data cube” set up by the Public Transport department within GWRC, which allows interrogation of ETM data on a centralised server. As a result, there is the potential for some inconsistencies or differing definitions between both sets of data.

Only Go Wellington services were assessed in this analysis, as ticketing data for other regional operators (Mana) is not available internally. However, investigation from the 2011 WPTM development¹ has shown that Go Wellington represents in the order of 85% of all bus boardings in the region so the exclusion of this dataset is not considered significant.

B.2 Metlink Monthly Patronage

Before looking at ETM boardings, patronage data from the Metlink website² was examined for preliminary checking, to investigate if the total patronage for March 2013 was significantly different from March 2011. Results showed that monthly boardings for March 2013 were 11% lower than March 2011. To understand if this was part of a trend or an outlier, results for the two months before and after March were compared, as well as the annual rolling average to each month for both 2011 and 2013. Results are shown in the table below.

Month	MONTHLY PATRONAGE			ANNUAL ROLLING AVERAGE TO MONTH		
	2011	2013	% Difference	2011	2013	% Difference
January	1,407,474	1,346,954	4%	24,035,359	23,863,273	-1%
February	1,905,876	1,985,454	-4%	23,979,466	23,835,260	-1%
March	2,156,225	2,420,297	-11%	23,976,203	23,792,963	-1%
April	1,933,240	1,856,546	4%	23,899,266	23,787,385	0%
May	2,248,618	2,285,733	-2%	23,695,750	23,861,753	1%

Table B1: Total PT Patronage from MetLink Website

Comparison of 2011 and 2013 monthly patronage showed that there was no clear trend when comparing 2011 and 2013, with some months increasing and decreasing, but for all of them except March the variation is less than 4% in absolute terms. Analysis of the annual rolling average confirmed that annual patronage between 2011 and 2013 has varied by no more than 1% in absolute terms.

¹ TN7: Public Transport Matrix Development

² <http://www.metlink.org.nz/customer-services/public-transport-facts-and-figures/patronage/>

The most likely explanation for the large difference in boardings for March is that March 2011 had 23 weekdays, which experience significantly more patronage than weekend days, whereas March 2013 only had 21. This accounts for 9% less weekdays, which would therefore explain most of the difference between these two years. This in turn leaves only a small decrease in boardings between March 2011 and 2013, which is likely to be due more to month-to-month fluctuations than any sort of trend.

Based on this analysis, it was therefore considered that more detailed comparison between March 2011 and March 2013 using ETM data was warranted, as long as it was ensured that ticketing data for the same number of weekdays was extracted for both years to compare like with like.

B.3 Fare Zones Origin and Destination

The 2011 ETM data used for the development of WPTM covered the period between Monday 28 February 2011 to Friday 25 March, i.e. 4 weeks or 20 weekdays. The period from Thursday 28 February 2013 to Wednesday 27 March was therefore used for extracting patronage data from the Public Transport data cube. Boarding numbers from a corresponding period in 2012 were also extracted to help distinguish natural variations from potential trends.

Ticketing information both from the 2011 set of data provided by NZ Bus and from the data cube includes information on the fare zone where someone boarded a bus, and if using electronic payment (e.g. Snapper card) information on the fare zone where the person alighted the bus. The latter is however not available for other types of payment, including cash payment.

This information only includes the fare zone as per the Metlink zoning (i.e. zones 1 to 14, see figure to the right and Metlink website for more details). It does not provide more information as to where in the zone the trip started or finished. As an example, this means that trips from Newlands cannot be distinguished from trips from Miramar. The data was however used to develop matrices showing trips between fare zone origin and destination for 2011, 2012 and 2013.

Analysis of these matrices showed that the trip distribution was similar for all years with no major changes at an O-D level. There was some variation occurring between each year, especially for O-Ds with small numbers of trips, but it appears to be mostly month-to-month fluctuation and showed no consistent trends between 2011-2012 and 2012-2013.



Due to the highly sensitive nature of ETM data in terms of confidentiality, some numbers and figures have been removed.

The matrices are not shown in this note, but the total numbers of boardings and alightings in each zone for the examined periods and during the morning peak (7:00am-9:00am) are shown in the following figures.

Due to the highly sensitive nature of ETM data in terms of confidentiality, some numbers and figures have been removed.

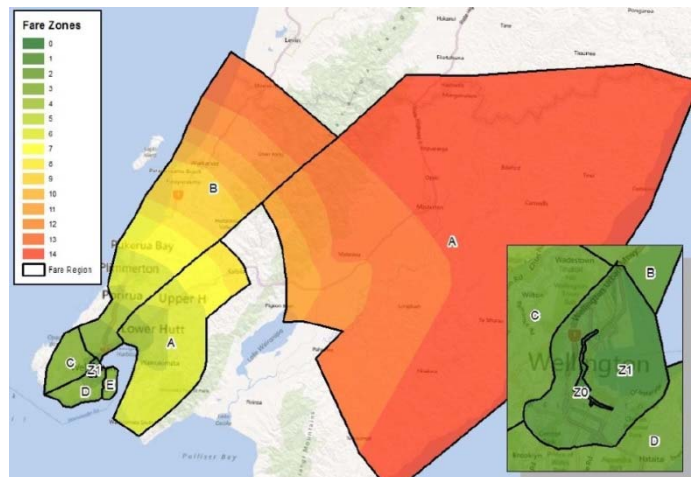
These results show that there is little variation for all years when looking at boardings per fare zone. 2013 is generally slightly lower than 2011 (this is confirmed when looking at total boardings from the ETM data) but the distribution per zone is virtually identical for all three years.

The same largely applies for alighting, with the exception of the “blank” categories, which show a gradual decline every year. This is due to a diminishing share of patrons paying by cash (for whom the alighting stop is not recorded) as the use of Snapper card becomes more prevalent. This is discussed in more detail later in this note. The only notable difference is in alightings for zone 1 which increase by almost 20% between 2011 and 2012, but this is potentially due to more alightings being recorded through the use of Snapper card.

Results for the inter peak are similar and are therefore not presented in this note.

B.4 Sector Origin

Although analysis in the previous section showed that there was little variation in boarding and alighting per fare zone, it was deemed important to investigate if there had been changes in demand in more detail geographically, i.e. separating demand from the north, south, etc. For this purpose, the sectors used during the development of WPTM were used. These are based on zones 0 to 14 from the Metlink fare zone system, but with further disaggregation per corridor. The resulting sector system is shown in the figure to the right.



Due to the highly sensitive nature of ETM data in terms of confidentiality, some numbers and figures have been removed.

Total boardings per combination of sector and fare zone (e.g. Z0, C2, etc) were extracted. These are shown in the graphs below for the AM peak, together with the total for each sector (A, B, C etc).

2013 are again generally lower than the two previous years but results are relatively consistent, with no major variation for the combination of sector and fare zone, or at a sector level. The main difference in absolute terms is for sector A which shows a 5% decrease between 2011 and 2013, but this does not appear to be part of a trend as 2012 was 1% higher than 2011.

The same analysis was undertaken for the inter peak (11:00am to 1:00pm), which is shown in the figures below. In the inter peak, results again show no major variation, although sector E does increase by 14% in 2012, and 20% in 2013 compared with 2011. On the other hand, boardings in zone Z decrease consistently between 2011 and 2013, by a small relative change but which translates to about 2,000 less passengers in 2013 than 2011. It is hard to determine from this data if these changes are trends but they must be taken into account when deciding how to update the representation of bus demand in WPTM.

Due to the highly sensitive nature of ETM data in terms of confidentiality, some numbers and figures have been removed.

B.5 Sector Destination

The same analysis that was carried out for boardings was undertaken for alightings, again comparing patterns from the original March 2011 ETM data to information extracted from the GWRC PT data cube for March 2012 and 2013. Results are illustrated in the figures below.

Due to the highly sensitive nature of ETM data in terms of confidentiality, some numbers and figures have been removed.

As can be expected, a large majority of trips alight in sector Z, particularly Z0 which is the Golden Mile. Patterns are similar for all years, although there is a gradual decrease of trips alighting in sector A, and an increase in sectors D and Z. This increase is likely to be at least partly due to more people using Snapper card in 2013 than 2011 and therefore having their alighting stop recorded (see Section 2) in 2013 whereas they didn't in 2011.

B.6 Sector to Sector Matrices

Finally, sector to sector trip matrices were produced, linking the boardings to alightings. These showed some slightly more pronounced variation when looking at a more detailed level (i.e. sector + fare zones). This was particularly the case between the 2011 data and

the 2012-2013 data, which would indicate that these variations may be caused by some changes in definitions between the two datasets, for examples some inconsistencies between fare zone attributes for some bus stops. More investigation would be needed to pinpoint the cause of this variation, but for the purpose of this exercise it was determined that it would not impact on the main findings.

In order to show the variations in travel patterns between sectors, the share of each origin-destination as a percentage of the whole demand is shown in the tables below for all three years for the morning peak.

Due to the highly sensitive nature of ETM data in terms of confidentiality, some numbers and figures have been removed.

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As can be observed, the patterns are very similar from 2011 to 2013. The only meaningful differences are the decrease in “unknown” destination, again caused by more people using Snapper Card, and the gradual increase in trips to sector Z. As mentioned in Section B5, it is likely that these two changes are linked, as most trips during the AM peak alight in sector Z.

Findings for the inter peak were again similar so they are not shown in this note.

B.7 Ticket Types

Finally, ticket sales per type were compared between the March 2011 and March 2013 datasets, for both the AM and inter peak. Results are shown in the graphs below, and confirm that the main change is an increase in uptake of Epurse use (i.e. Snapper card) to the detriment of other types, especially cash payment.

Due to the highly sensitive nature of ETM data in terms of confidentiality, some numbers and figures have been removed.

B.8 Conclusion

Analysis of the ETM data confirmed travel patterns in March 2013 were generally similar to those in March 2011. Where small differences were noted, no trend was discernible. The increasing use of Snapper Card results in an apparent change in the pattern of alightings in some cases – but this is because there is more observed data in 2013 compared with 2011.

Overall, it was concluded that travel patterns on public transport were similar in March 2013 to March 2011.