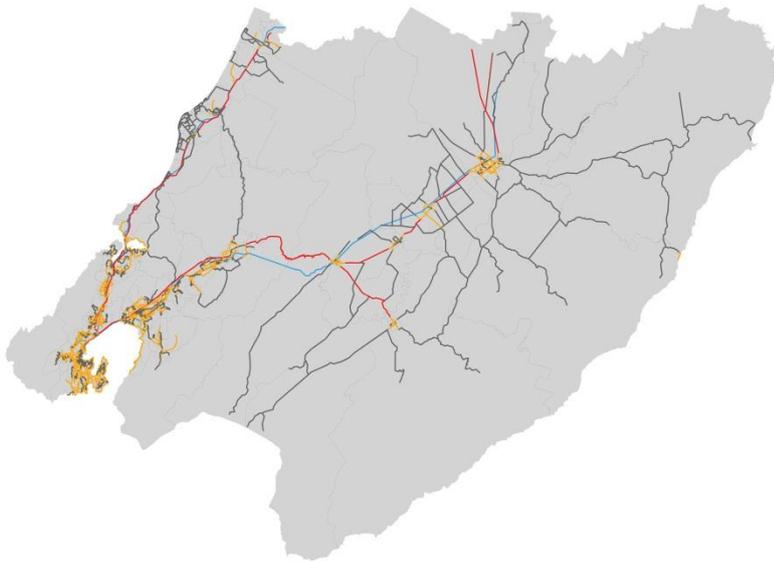OPUS INTERNATIONAL CONSULTANTS AND ARUP

WELLINGTON TRANSPORT MODELS

Contract No C3079

Addendum to TN19 : WPTM Calibration and Validation

Date: December 2012

ARUP OPUS

Wellington Transport Models

Addendum to TN19 : WPTM Calibration and Validation

prepared for

Greater Wellington Regional Council

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Document History and Status

Issue	Rev	Issued To	Qty	Date	Reviewed	Approved
Final	1	Nick Sargent - GW	1 Hard & 1 CD	06/12/2012	Bruce Johnson	Bruce Johnson

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

John Bolland:
(Peer Reviewer)

Nick Sargent:
(GWRC)

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Contents

1 Introduction

1.1 Background

The Wellington Transport Strategic 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 an incremental public transport model that is linked to the WTSM by the sharing of a common network with the distinction of the zone systems in the two respective models:

- WTSM comprises 225 zones (+50 park and ride station zones); and
- WPTM comprises 780 zones (+50 park and ride station zones).

The additional zones in the WPTM allow for more accurate calculation of access between stops / stations and trip origin / destinations. The base year demand in WPTM is also highly accurate as it has been built up from observed data rather than using a trip generation model as in WTSM.

A detailed calibration / validation of the WPTM was finalised in early June 2012 and documented in Technical Note (TN) 19. Following the completion of this document, several minor edits were made to the WTSM and WPTM requiring documentation and confirmation that the changes have not adversely affected the validation of the WPTM.

1.2 Relevant Documents

This Addendum forms part of the suite of reports produced for the WTSM update and WPTM development project. Specifically, it documents the changes made to the WTSM and WPTM since the validation undertaken in early June and the impacts these changes have had on the results of the base year WPTM. Other key Technical Notes relating to the topic documented herein are listed below:

- TN1 – Network Preparation
- TN19 – WPTM Calibration and Validation

1.3 Naming Convention

Throughout this document two WPTM versions are referenced and discussed. The term 'TN19 version' or 'Initial' refers to the WPTM as documented in TN19. The term 'Addendum version' or 'Final' refers to the updated WPTM resulting from the changes documented in this report.

2   Changes Made

2.1   Changes to WTSM

Two changes were made to the WTSM after the initial version, as listed in the sub-sections below. Given that the WPTM shares a common network with the WTSM (with exception of the zone system) the changes in WTSM also impacted on the WPTM.

2.1.1   Capital Connection Rail Service

During model testing it was discovered that the Capital Connection rail service was coded as stopping at all stations when it should have been coded as express Paraparaumu to Wellington. This service was modified in the new version of the base model to reflect the correct stopping pattern.

2.1.2   Walk Tunnel To / From Wellington Station

During model testing it was discovered that the walk tunnel between Wellington Station and the Lambton Quay bus interchange was not represented in the WTSM base network. This was added in to allow better representation of the routing options between these two points (see green links in Figure 2-1 below).
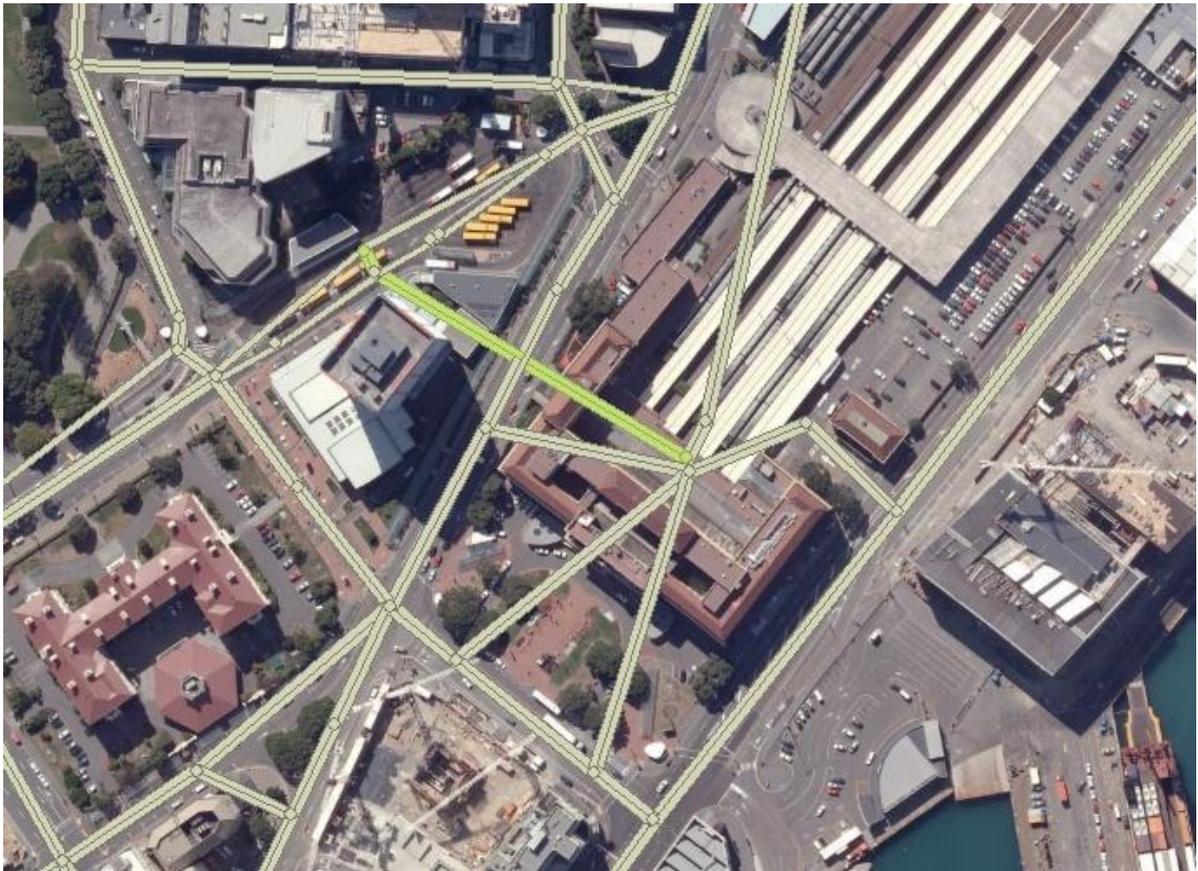

Figure 2-1: New Walk Links Added to Base Model

2.2   Changes to WPTM

A total of four changes were made to the TN19 version of WPTM as listed in the sub-sections below.

2.2.1   Effective Headway Calculation

An inconsistency was corrected in the calculation of the effective headway (@hdwy) value for the WPTM assignment. The inconsistency was focused on the value of the wait time factor used in the @hdwy calculation and was specific to the AM peak for the Airport Flyer service in one of the three WPTM assignment macros (*WA_skim1.mac*).

The discrepancy is shown in bold red text in Table 2-1. The calculation in the addendum version of WPTM was therefore changed to reflect the value in the 'Specified' column.

Table 2-1: Discrepancy in Wait Time Factor Used in @hdwy Calculation

Mode	Calculated		Specified	
	AM	**IP**	**AM**	**IP**
Bus	1.0	1.0	1.0	1.0
Rail	0.8	0.8	0.8	0.8
Flyer	**1.0**	1.0	**0.9**	1.0
Ferry	0.2	0.2	0.2	0.2
Cable Car	0.8	0.8	0.8	0.8

Note: The wait time factors are weighted by 2 in the assignment process.

2.2.2   Bus Travel Time Calculation

The function used to calculate the bus travel time was corrected to ensure that the function matched the specification documented in TN1. This change was minor as it only affected the calculation of bus travel time on links with bus lanes that have a volume-capacity ratio greater than 0.9 of which there was zero in the base year.

2.2.3   Addition of New Modes

To increase the flexibility of the WPTM for testing of different options / scenarios, additional modes were added to the model to enable easier specification of model parameters and referencing of different services. The modes available in the addendum version of WPTM are listed in Table 2-2 below with the new additions shown in bold red text.

Table 2-2: Modes Available in WPTM

Mode	EMME Designator
Bus	b
Super Bus	s
BRT	**u**
Rail	r
Light Rail	**l**
Ferry	f
Cable Car	**d**
Walk	w

As part of the addition of the new modes, all Airport Flyer services have been transferred from mode 'b' (Bus) to mode 's' (Super Bus), once again to allow for easier specification of model parameters and referencing / selection of different services.

2.2.4   Rounding of Value of Time Parameters

Value of Time (VoT) parameters were rounded to two decimal places rather than one decimal place as applied in the TN19 version of the WPTM.

3   Impacts on WPTM Results

The addendum version of the WPTM incorporating the changes mentioned above was run and compared to the TN19 version of WPTM. The results of this comparison and the results of the new model compared to observed data are given in the sub-sections below.

3.1   General

The two changes that had the largest impacts on the model results were the changes made to the WTSM networks.

The change to the Capital Connection service led to little change in the number of overall boardings, but affected the routing and mode choice closer to Wellington. This was driven by the fact that the travel time between Paraparaumu and Wellington (47 minutes) was only applied to the link just preceding the node representing Wellington Station in the WPTM. This meant some passengers alighted at Kaiwharawhara and transferred to bus or other inbound rail services for the remainder of the journey to Wellington. Around 400 passengers chose this, split fairly evenly between bus and other rail. When the Capital Connection was corrected this no longer occurred, so the resulting boards, alights and bus / rail volumes split, particularly across the CBD cordon, were slightly different (see Table 3-1).

Table 3-1*: Validation at CBD Cordon

Mode	Cordon Count	Modelled Assignment (Initial)	Modelled Assignment (Final)	Difference (Final vs. Initial)	Difference (Final vs. Count)
Rail	10,972	10,727	11,033	3%	1%
Bus	9,754	9,405	9,119	-3%	-7%
Ferry	188	182	180	1%	-5%
Cable Car	81	2	2	0%	-97%
Total	**20,995**	**20,316**	**20,334**	**0%**	**-3%**

* This table updates Table 5-7 in TN19

The addition of the rail-bus tunnel at Wellington Station also had some observable effects. There was an increase of around 850 people on Golden Mile southbound buses, and a corresponding decrease of 675 fewer passengers walking along the waterfront. The difference between these values is most likely due to the interaction of the Capital Connection issue. The addition of the tunnel also appeared to add some passengers to rail, with transit volumes on all rail lines increasing by small amounts (fewer than 50 passengers).

Meanwhile, the WPTM changes had little effect. The @hdwy calculation for the AM peak Airport Flyer services caused only very few passengers to switch bus routes. The addition of the new modes were checked and found to be implemented correctly, causing no differences to the results. The modification to the rounding of the value of time, whilst having network wide influence, had negligible impacts.

3.2 Changes to Bus Patronage

Table 3-2 shows the bus passenger cordon in more detail. It emphasises that the only significant differences between initial and final modelled volumes are from the north (Thorndon Quay). The change improves the bus validation at this site in the AM peak but increases the total discrepancy between observed and modelled counts.

Table 3-2*: CBD Cordon Bus Passengers, AM 2 hour Inbound

Links of CBD Cordon	Cordon Counts Average Month	Modelled (Inital)	Modelled (Final)	Difference (Final vs. Initial)	Difference (Final vs. Count)
Oriental Parade	268	189	189	0%	-30%
Cambridge Terrace	1,507	1,548	1,548	0%	3%
Elizabeth Street	1,876	1,597	1,596	0%	-15%
Willis Street	643	546	550	1%	-14%
Taranaki Street	754	621	620	0%	-18%
Tinakori Road	1,056	1,001	1,002	0%	-5%
Kelburn Parade	672	567	563	-1%	-16%
Murphy Street	811	931	910	-2%	12%
Thorndon Quay	2,166	2,405	2,140	-11%	-1%
Total	**9,754**	**9,405**	**9,119**	**-3%**	**-7%**

* This table updates Table 5-11 in TN19

Table 3-3 below shows a comparison of the bus screenlines from the TN19 version of WPTM (labelled 'Initial') and the Addendum version of WPTM (labelled 'Final'). The most significant changes occurred in areas affected by the Capital Connection or the walk tunnel to / from Wellington Station (C1 City cordon, W1 City cordon, W4 North of CBD, L1 SH2 and C4 Paraparaumu cordon). There was a large percentage change on W5 SB, but since it was small in actual terms (only 17 people) this was not judged significant.

Table 3-3: Bus Screenlines, Initial vs. Final

ID	Direction	AM Modelled (Inital)	AM Modelled (Final)	AM Diff %	IP Modelled (Inital)	IP Modelled (Final)	IP Diff %
C1	In	8,710	8,422	-3%	1,697	1,680	-1%
C1	Out	1,839	1,821	-1%	1,137	1,185	4%
C2	In	640	623	-3%	251	251	0%
C2	Out	81	82	1%	142	142	0%
C3	In	1,102	1,084	-2%	642	636	-1%
C3	Out	380	363	-5%	590	579	-2%
C4	In	233	215	-8%	63	63	-1%
C4	Out	79	79	0%	49	49	1%
W1	OUT	2,016	2,061	2%	1,462	1,495	2%
W1	IN	9,156	9,959	9%	2,034	2,084	2%
W2	EB	163	163	0%	180	180	0%

ID	Direction	AM			IP		
		Modelled (Inital)	Modelled (Final)	Diff %	Modelled (Inital)	Modelled (Final)	Diff %
W2	WB	1,197	1,197	0%	254	254	0%
W3	EB	1,076	1,076	0%	202	202	0%
W3	WB	116	116	0%	125	125	0%
W4	NB	301	301	0%	344	339	-2%
W4	SB	3,033	2,737	-10%	538	518	-4%
W5	NB	39	39	-1%	22	22	-2%
W5	SB	64	47	-26%	23	21	-7%
W6	NB	2,979	2,980	0%	589	589	0%
W6	SB	336	336	0%	364	364	0%
L1	NB	215	208	-3%	186	181	-3%
L1	SB	617	591	-4%	265	254	-4%
L2	NB	115	115	0%	95	94	-1%
L2	SB	406	401	-1%	127	125	-2%
L3	EB	392	385	-2%	278	273	-2%
L3	WB	507	490	-3%	314	307	-2%
L4	EB	532	530	0%	324	321	-1%
L4	WB	1,262	1,255	-1%	331	328	-1%
U1	NB	3	3	-1%	11	11	3%
U1	SB	103	102	-1%	14	14	0%
U2	NB	133	133	0%	59	58	-1%
U2	SB	146	143	-2%	77	76	-2%
P1	NB	0	0	-	0	0	-
P1	SB	7	7	0%	0	0	-
P2	EB	0	0	-	0	0	-
P2	WB	0	0	-	0	0	-
P3	NB	77	76	-1%	43	42	-1%
P3	SB	38	39	4%	26	25	-2%
K1	NB	0	0	-	0	0	-
K1	SB	7	7	7%	0	0	-
Total		**38,098**	**38,186**	**0%**	**12,856**	**12,885**	**0%**

Table 3-4 below compares the final modelled bus passenger volumes with the reference assignment volumes as also used in the validation reported in TN19. The proportion of GEH values within different bands is also given in Table 3-5 and scatter plots of the bus screenline data are also given in Figure 3-1 and Figure 3-2 for the AM and IP periods, respectively.

**Table 3-4: Bus Passenger Volumes at Screenlines, Reference vs. Modelled (Final)**

ID	Direction	AM				IP			
		Reference (voltr + volax)	Modelled voltr	Diff %	GEH	Reference (voltr + volax)	Modelled voltr	Diff %	GEH
C1	In	8,571	8,422	-2%	1.14	1,753	1,680	-4%	1.25
C1	Out	2,869	1,821	-37%	15.31	1,227	1,185	-3%	0.87
C2	In	304	623	105%	10.50	211	251	19%	1.84
C2	Out	113	82	-27%	2.22	115	142	23%	1.68
C3	In	1,150	1,084	-6%	1.40	575	636	11%	1.74
C3	Out	468	363	-22%	3.64	502	579	15%	2.35
C4	In	20	215	951%	12.67	45	63	39%	1.70
C4	Out	79	79	0%	0.01	68	49	-27%	1.70
W1	OUT	2,763	2,061	-25%	10.11	1,444	1,495	3%	0.93
W1	IN	9,007	9,959	11%	6.92	2,010	2,084	4%	1.15
W2	EB	163	163	0%	0.01	183	180	-2%	0.17
W2	WB	1,186	1,197	1%	0.23	247	254	3%	0.31
W3	EB	1,116	1,076	-4%	0.86	210	202	-4%	0.39
W3	WB	118	116	-2%	0.17	131	125	-5%	0.40
W4	NB	234	301	29%	2.93	202	339	68%	5.87
W4	SB	2,734	2,737	0%	0.04	451	518	15%	2.13
W5	NB	46	39	-15%	0.75	22	22	0%	0.01
W5	SB	67	47	-29%	1.79	27	21	-20%	0.77
W6	NB	2,959	2,980	1%	0.27	583	589	1%	0.17
W6	SB	339	336	-1%	0.15	348	364	5%	0.59
L1	NB	191	208	9%	0.89	103	181	76%	4.66
L1	SB	716	591	-17%	3.46	211	254	21%	2.02
L2	NB	63	115	82%	3.88	88	94	7%	0.46
L2	SB	327	401	23%	2.75	123	125	1%	0.11
L3	EB	393	385	-2%	0.29	211	273	30%	2.83
L3	WB	595	490	-18%	3.19	273	307	13%	1.42
L4	EB	454	530	17%	2.40	302	321	6%	0.78
L4	WB	1,032	1,255	22%	4.67	318	328	3%	0.40
U1	NB	3	3	-11%	0.15	12	11	-3%	0.08
U1	SB	67	102	53%	2.72	14	14	0%	0.01
U2	NB	81	133	64%	3.53	52	58	13%	0.63
U2	SB	163	143	-13%	1.17	82	76	-7%	0.48
P1	NB	0	0	-	-	0	0	-	-
P1	SB	0	7	1313%	2.38	0	0	-	-
P2	EB	0	0	-	-	0	0	-	-
P2	WB	0	0	-100%	0.62	0	0	-	-
P3	NB	54	76	41%	1.93	28	42	50%	1.69
P3	SB	65	39	-39%	2.50	21	25	21%	0.65
K1	NB	0	0	-	-	0	0	-	-
K1	SB	1	7	1217%	2.44	0	0	-	-
Total		**38,511**	**38,186**	**-1%**	**1.17**	**12,190**	**12,885**	**6%**	**4.39**

* This table updates Table 5-12 in TN19

Table 3-5: GEH Values for Bus Screenlines

GEH	AM		IP	
	#	%	#	%
<5	32	86%	33	97%
5-10	1	3%	1	3%
>10	4	11%	0	0%

* This table updates Table 5-13 in TN19

AM Bus Cordons / Screenlines by Direction

$y = 1.013x$
$R^2 = 0.9834$
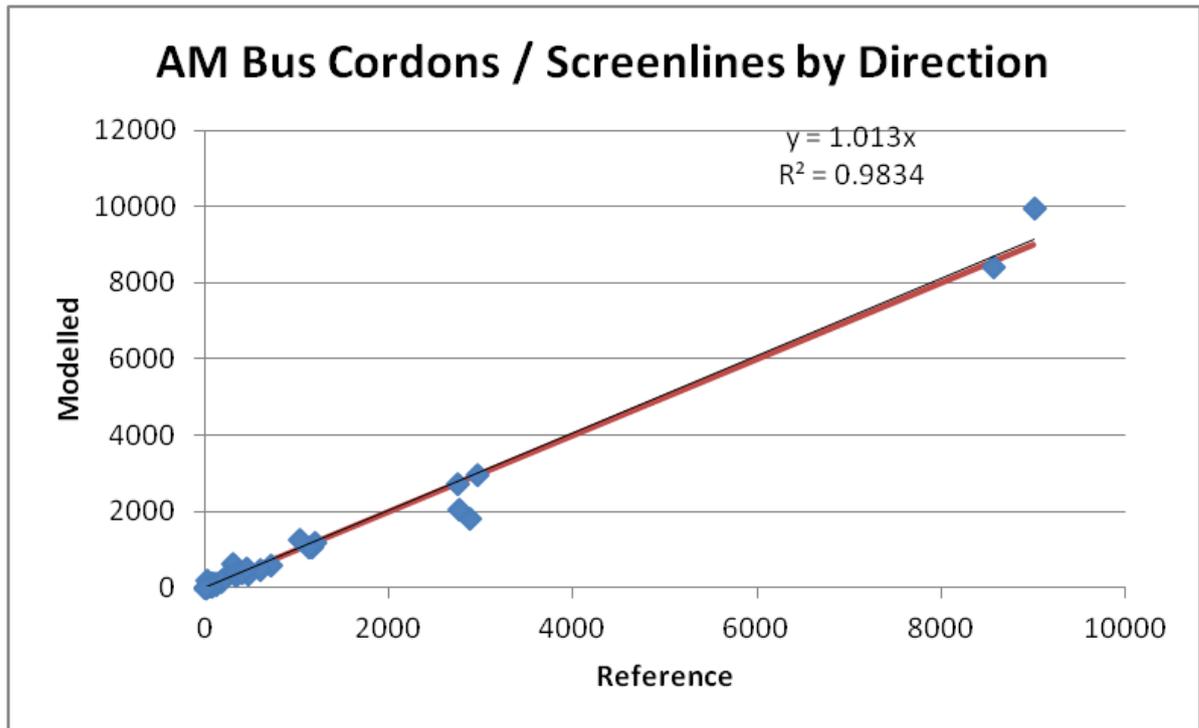
Figure 3-1*: AM Bus Screenlines by Direction

* This figure updates Figure 5-7 in TN19
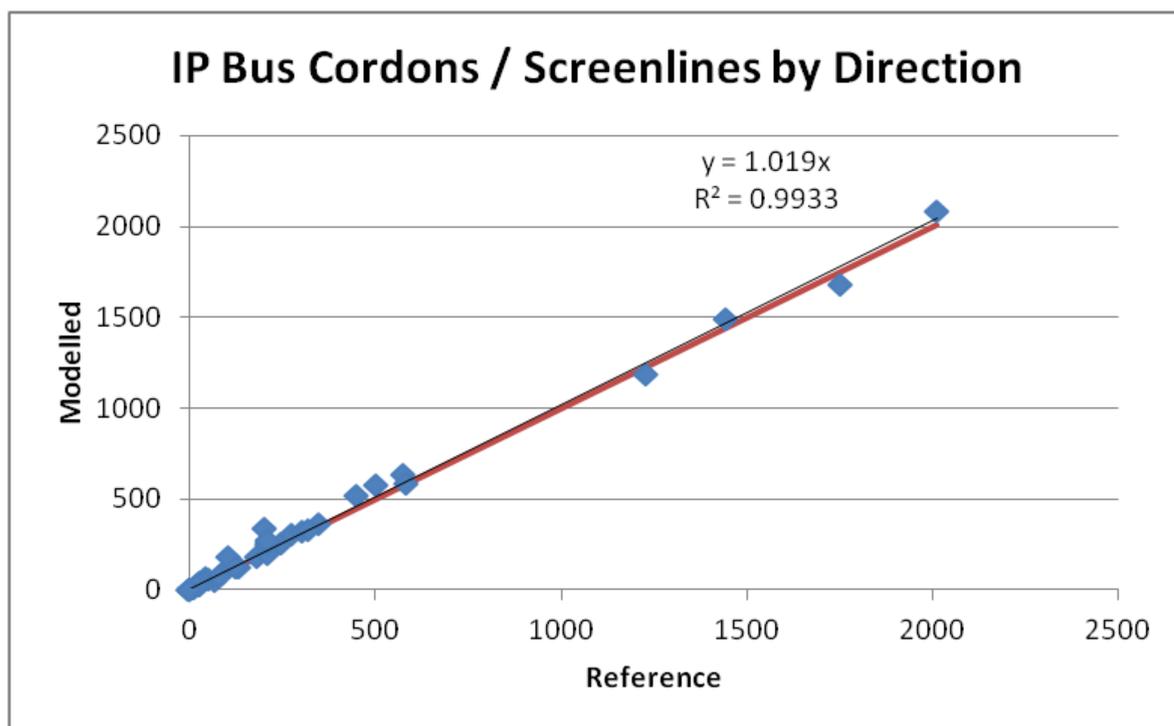
Figure 3-2*: IP Bus Screenlines by Direction

* This figure updates Figure 5-8 in TN19

The results show that the impacts of the changes on the bus validation are localised and do not affect the overall model validation in any significant way.

3.3 Changes to Rail Patronage

Table 3-6 below shows a comparison of the rail screenlines from the TN19 version of WPTM (labelled 'Initial') and the Addendum version of WPTM (labelled 'Final'). This shows there is minimal change between the two versions of the model.

Table 3-6: Rail Screenlines, Initial vs. Final

ID	Direction	AM			IP		
		Modelled (Initial)	Modelled (Final)	Diff %	Modelled (Initial)	Modelled (Final)	Diff %
C1	In	10,727	11,033	3%	584	605	4%
C1	Out	333	341	2%	199	205	3%
C2	In	2,296	2,279	-1%	293	293	0%
C2	Out	3,648	3,635	0%	327	327	0%
C3	In	2,923	2,935	0%	227	231	2%
C3	Out	4,434	4,455	0%	270	279	3%
C4	In	581	581	0%	143	143	0%
C4	Out	1,094	1,096	0%	177	177	0%
W4	NB	353	361	2%	200	206	3%
W4	SB	10,550	10,854	3%	576	596	3%

ID	Direction	AM			IP		
		Modelled (Initial)	Modelled (Final)	Diff %	Modelled (Initial)	Modelled (Final)	Diff %
L1	NB	156	162	4%	77	82	7%
L1	SB	5,343	5,372	1%	236	247	5%
L2	NB	198	198	0%	35	36	3%
L2	SB	1,883	1,886	0%	98	100	2%
L3	EB	118	121	3%	78	82	5%
L3	WB	4,470	4,489	0%	223	230	3%
U2	NB	199	199	0%	35	36	2%
U2	SB	1,878	1,881	0%	98	99	1%
P1	NB	29	29	1%	72	72	0%
P1	SB	1,758	1,750	0%	167	167	0%
P3	NB	83	83	0%	107	107	0%
P3	SB	3,597	3,585	0%	225	225	0%
K1	NB	28	28	-1%	48	48	0%
K1	SB	525	524	0%	85	85	0%
Total		**57,203**	**57,876**	**1%**	**4,580**	**4,678**	**2%**

Table 3-7 below compares the final modelled rail passenger volumes with the observed values from the boarding and alighting counts as also used in the validation reported in TN19. The proportion of GEH values within different bands is also given in Table 3-8 and scatter plots of the bus screenline data are also given in Figure 3-3 and Figure 3-4 for the AM and IP periods respectively.

Table 3-7*: Rail Passenger Volumes at Screenlines, Observed vs. Modelled (Final)

ID	Direction	AM				IP			
		Observed	Modelled	Diff %	GEH	Observed	Modelled	Diff %	GEH
C1	In	11,366	11,033	-3%	2.22	739	605	-18%	3.65
C1	Out	301	341	13%	1.57	398	205	-49%	7.87
C2	In	2,476	2,279	-8%	2.86	356	293	-18%	2.46
C2	Out	3,557	3,635	2%	0.92	374	327	-12%	1.75
C3	In	2,701	2,935	9%	3.11	261	231	-11%	1.33
C3	Out	4,411	4,455	1%	0.47	320	279	-13%	1.65
C4	In	550	581	6%	0.91	148	143	-4%	0.33
C4	Out	756	1,096	45%	7.91	205	177	-14%	1.45
W4	NB	332	361	8%	1.07	395	206	-48%	7.69
W4	SB	11,192	10,854	-3%	2.28	730	596	-18%	3.68
L1	NB	172	162	-6%	0.55	165	82	-50%	5.25
L1	SB	5,416	5,372	-1%	0.42	296	247	-16%	2.09
L2	NB	269	198	-26%	3.27	44	36	-19%	0.93
L2	SB	1,810	1,886	4%	1.25	100	100	0%	0.01
L3	EB	142	121	-15%	1.30	135	82	-39%	3.61

		AM				IP			
ID	Direction	Observed	Modelled	Diff %	GEH	Observed	Modelled	Diff %	GEH
L3	WB	4,467	4,489	0%	0.23	264	230	-13%	1.53
U2	NB	275	199	-28%	3.51	46	36	-21%	1.08
U2	SB	1,774	1,881	6%	1.76	96	99	3%	0.21
P1	NB	28	29	2%	0.09	89	72	-20%	1.38
P1	SB	1,864	1,750	-6%	1.89	189	167	-12%	1.17
P3	NB	102	83	-19%	1.39	157	107	-32%	3.04
P3	SB	3,537	3,585	1%	0.57	271	225	-17%	2.06
K1	NB	27	28	1%	0.03	58	48	-17%	0.95
K1	SB	496	524	6%	0.87	81	85	5%	0.34
Total		**58,023**	**57,876**	**0%**	**0.43**	**5,915**	**4,678**	**-21%**	**12.0**

* This table updates Table 5-8 in TN19

Table 3-8*: GEH values for Rail Screenlines

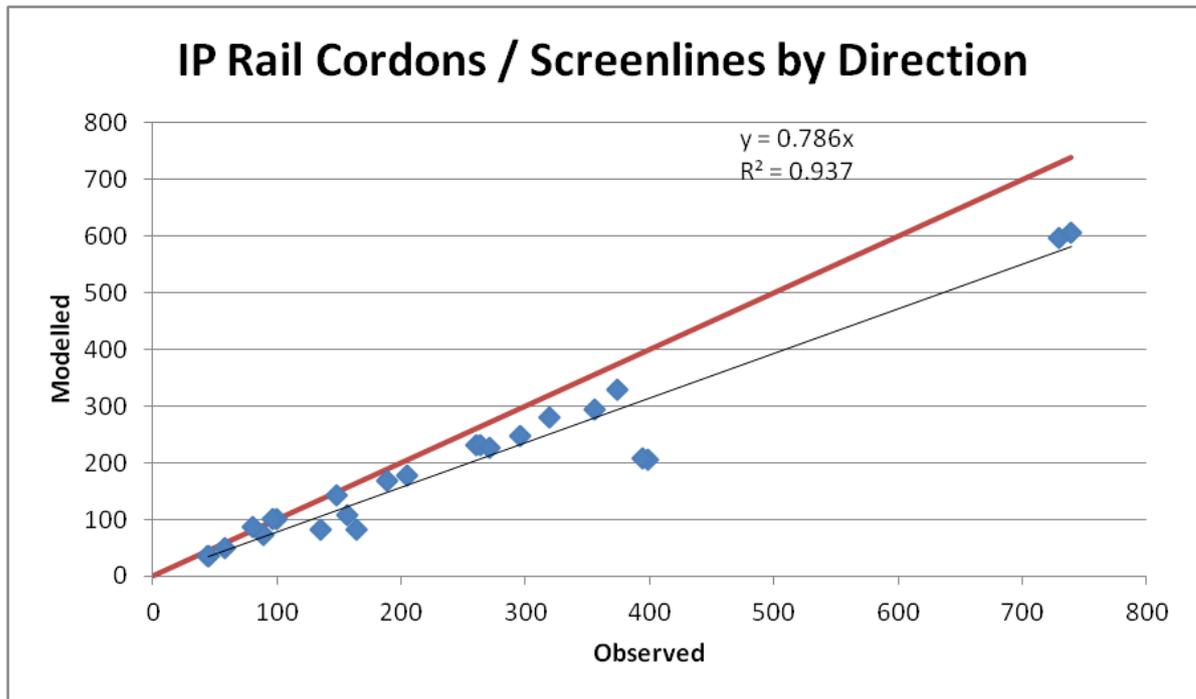|	AM		IP	
GEH	**#**	**%**	**#**	**%**
<5	23	96%	21	88%
5-10	1	4%	3	13%
>10	0	0%	0	0%

* This table updates Table 5-9 in TN19
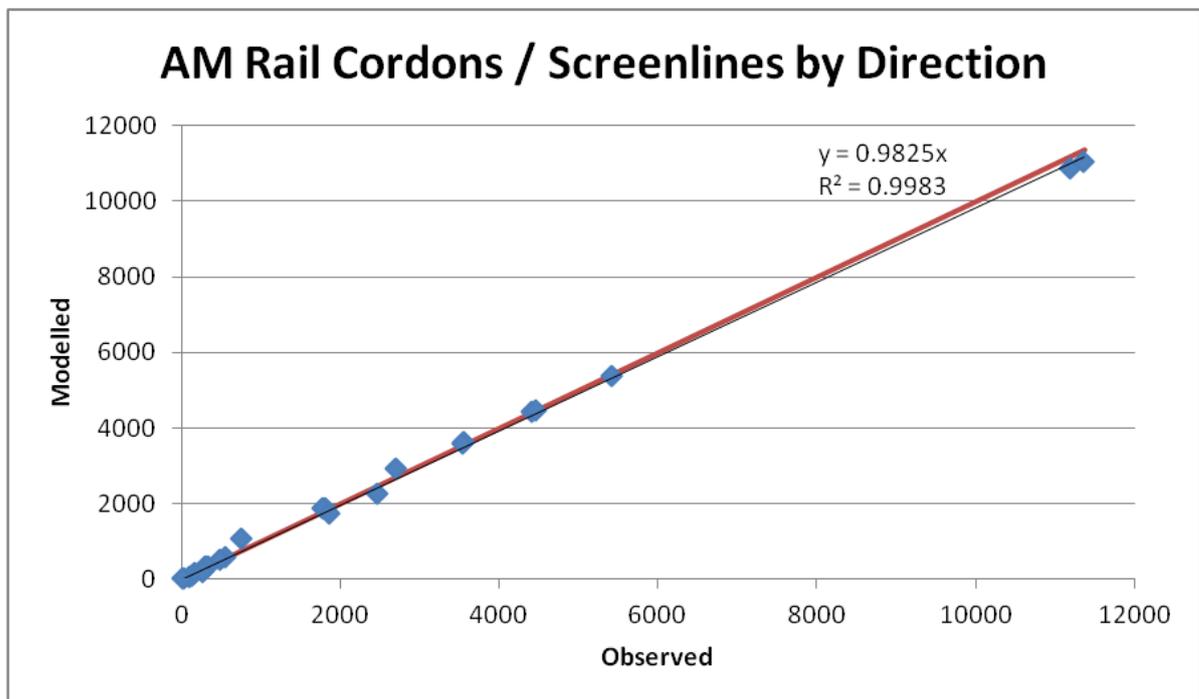
Figure 3-3*: AM Rail Screenlines by Direction

* This figure updates Figure 5-5 in TN19

Figure 3-4*: IP Rail Screenlines by Direction

* This figure updates Figure 5-6 in TN19

The results show that the impacts of the changes on the rail validation are localised and do not affect the overall model validation in any significant way.

4 Conclusion

The results presented in this document show that the changes made to the validated WPTM documented in TN19 do not materially affect the validation of the final version of the model.

Some of the changes have however resulted in some localised differences between the initial WPTM and the final WPTM results. A summary of the impacts of these differences is given below:

- Decrease in bus transit volume at Thorndon Quay leads to better validation for this count site but poorer validation for the CBD cordon as a whole (see Table 3-2).
- Overall bus validation is slightly better in the AM peak and slightly worse in the IP period (see Table 3-3 and Table 3-4).
- Overall rail validation is better in both the AM and IP periods (see Table 3-6 and Table 3-7).