



TN19 - WELLINGTON TRANSPORT ANALYTICAL TOOLS 2019-22 UPDATE – TRIP PRODUCTION CALCULATIONS

PREPARED FOR GREATER WELLINGTON REGIONAL COUNCIL

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TN19 - Wellington Transport Analytical Tools 2019-22 update – Trip Production Calculations

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APPENDICES

- Appendix A Supplementary Tables
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1. Introduction

This technical note is part of a series documenting the 2019-2022 update of components of the Wellington Regional Transportation Planning Analytical Tools. The higher-level Analytical Tools are maintained and operated by Greater Wellington Regional Council (GWRC), who are the client for this project. This project is being primarily delivered by Stantec and Jacobs, supported by GWRC transport planners.

The purpose of this note is to document the procedure followed to calculate the trip production model. The trip production model takes the form of a category model. The two dimensions of the category model are persons by age group and the vehicles available for the household that the people reside in.

The age categories have been identified to align with Census definitions and to reflect potential lifestyle characteristics such as school age, young adult, family-aged, retired aged, etc. The age groups are:

- 0-14 years
- 15-19 years
- 20-29 years
- 30-64 years
- 65+ years

Vehicles per household (HH) are grouped as zero, one, two, or three or more. This reflects mobility and the propensity to travel rather than vehicle trips per se.

The primary data source for these calculations is the Household Travel Survey (HTS).

This technical note covers:

- CBD analysis for sample size and trip rate
- Population analysis
- Trip production rate calculations
- Geographic check of application of trip rates to Census population

Note that in this technical note, "trip rate" refers to daily trip productions per person for an average weekday.

2. Central City Trip Rate Analysis

The client group has suggested that trip rates in the CBD may be lower than elsewhere in the region. This could occur if there is more trip chaining resulting in fewer unlinked trips. It could also be due to the current model producing too many short car trips in the CBD, although this is likely a result of the simplified representation of active mode trips rather than a real difference in travel patterns. Nevertheless, in this section, the sample size for the CBD is analysed followed by trip rates in the CBD compared with the rest of the region.

2.1 CBD Sample

To determine if the CBD and the rest of the modelled area in Wellington (non-CBD) have different trip-making characteristics, the HTS data was compared to Census data for the CBD to determine if the small sample in the HTS was statistically significant.

A stratified sampling test was used to determine whether the amount of data for each age group and vehicles/household category in the HTS was significant enough within the CBD to enable separate analysis.

The sample size in the HTS and the 2018 Census data for the CBD for persons by age and vehicles/household (**Table 2-2**) are shown below.

Table 2-1: HTS Sample and Census Data within the CBD, by Age Group

Age Band	HTS Sample CBD	2018 Census CBD
0-14 yrs	6	1,429
15-19 yrs	5	4,150
20-29 yrs	96	13,061
30-64 yrs	92	11,196
65+ yrs	24	2,098
ALL	223	31,934

Table 2-2: HTS Sample and Census Data within the CBD, by Vehicles/Household

Vehicles/HH	HTS Sample CBD	2018 Census CBD
0	78	5,381
1	106	5,338
2	14	1,506
3+	25	351
ALL	223	31,934

For the HTS CBD data to be significant, the number of data points has to be a higher value than the stratified sampling calculation, which is below.

$$\text{Stratified Sample Test} = \frac{(\text{Group Census Population, CBD Area})}{(\text{Total Census Population, CBD Area})} * (\text{Group HTS Sample, All Areas})$$

The results of the stratified sample test are shown below for population by age (**Error! Reference source not found.**) and population by vehicle availability (**Error! Reference source not found.**).

Table 2-3: Sample Significance, CBD, Population by Age

Age Band	HTS ALL Sample	Census CBD Population	Stratified Sampling	HTS CBD Sample	PASS?
0-14 yrs	405	1,429	18	6	No
15-19 yrs	179	4,150	23	5	No
20-29 yrs	372	13,061	152	96	No
30-64 yrs	1479	11,196	519	92	No
65+ yrs	427	2,098	28	24	No
ALL	2862	31,934	174	223	Yes

Table 2-4: Sample Significance, CBD, Population by Vehicle/Household

Vehicles/HH	HTS ALL Sample	Census CBD Population	Stratified Sampling	HTS CBD Sample	PASS?
0	272	5,381	46	78	Yes
1	1096	5,338	183	106	No
2	1053	1,506	50	14	No
3+	441	351	5	25	Yes
ALL	2862	31,934	174	223	Yes

The statistical significance tests show that there is insufficient sample for the CBD, by age group and vehicles per household to separate the CBD from the rest of the region.

2.2 CBD vs non-CBD Trip Rates

While the last section demonstrated that the sample in the CBD is not statistically significant, a comparison of trip rates in the CBD compared with the rest of the region has been undertaken.

The CBD sample in the HTS by age and vehicles per household categories is shown below.

Table 2-5: HTS CBD Sample by Age and Vehicles per Household

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	0	3	45	27	3	78
	1	6	0	31	49	20	106
	2	0	1	8	5	0	14
	3+	0	1	12	11	1	25
	ALL	6	5	96	92	24	223

This shows that for many categories, there is no sample or a very small sample.

The expanded trip rates by category irrespective of trip purpose were calculated for both areas. The trip rates for the CBD and non-CBD are provided in **Table A 1** and **Table A 2** in the Appendix, with the difference in trip rate provided below. Where there was no sample in the CBD, no difference is shown.

Table 2-6: Difference in Trips Per Person, CBD minus Non-CBD

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0		-0.90	0.10	0.02	-2.11	-0.23
	1	-0.74		0.08	-0.96	-1.95	-0.82
	2		1.12	-1.40	-0.08		-0.41
	3+		0.09	-0.05	0.10	3.75	0.23
	ALL	-0.66	-0.27	0.03	0.05	-0.91	-0.02

In total, the trip rate in the CBD is almost identical to the rest of the region. By age band irrespective of vehicle availability, the trip rates are very similar. This is also the case for vehicles per household where trip rates are similar when age band is not considered. By age band and vehicles per household, there are some notable differences, however, in almost all but a couple of categories, the sample in the CBD is extremely small.

2.3 Summary

The sample in the HTS for the CBD has been demonstrated to be too small to produce statistically reliable trip rates.

Nevertheless, in total, the trip rate for the CBD is almost identical to the rest of the region and has the expected magnitude.

There are some differences by category although in almost all instances, the sample in the CBD is very small producing a less reliable trip rate.

In summary, there is no evidence that trip rates in the CBD are statistically different to the rest of the region noting that the sample size in the HTS for the CBD is very small. The trip production model will therefore not be geographically segmented.

3. Persons by Category

Population by age band and vehicles per household was extracted from the HTS and the following matrix was produced.

Table 3-1: Persons from HTS by Age Group and Vehicles per Household

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	3,636	3,594	10,434	14,171	7,571	39,407
	1	34,035	8,052	17,379	82,063	33,316	174,845
	2	47,823	13,420	17,352	116,837	27,684	223,116
	3+	15,406	8,991	12,839	46,777	4,295	88,307
	ALL	100,900	34,058	58,004	259,848	72,866	525,675

Persons are weighted based on the population expansion factor in the HTS. Only trips within the Greater Wellington Regional Council area were extracted.

Population is defined as Estimated Resident Population (ERP).

The same cross-tabulation is shown below for the 2018 Census. This was sourced from Statistics NZ through a specific data request, which provided Census Usually Resident Population (CURP) and included population in unallocated/unidentified categories. The Census data was processed to factor from CURP to ERP definition and to shift the unallocated population proportionally to the categories shown below.

Table 3-2: Persons from Census by Age Group and Vehicles per Household

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	3,660	2,702	9,504	13,922	7,440	37,228
	1	34,354	8,442	21,193	79,108	33,122	176,218
	2	48,383	12,900	23,300	100,993	25,031	210,608
	3+	14,511	10,004	21,959	47,547	8,085	102,107
	ALL	100,908	34,048	75,956	241,570	73,678	526,160

The difference between the Census and the HTS population is shown below.

Table 3-3: Difference in Persons by Category, Census minus HTS

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	24	-892	-930	-249	-131	-2,179
	1	319	390	3,814	-2,955	-194	1,373
	2	560	-520	5,948	-15,843	-2,653	-12,508
	3+	-894	1,013	9,121	770	3,790	13,800
	ALL	8	-9	17,952	-18,278	812	485

There are differences in the population matrix which arise from the need to aggregate groups for the HTS expansion due to the limited sample size. So in the Census, there are slightly more people aged 20-29 years old than in the HTS with an equivalent reduction for the 30-64 years old age band. This is because people aged 20 to 64 years old were used in the HTS expansion (i.e. two age bands combined). Similarly, the population with two or three plus vehicles per household shows a difference between the HTS and the Census, and this is because the HTS expansion considered two or more vehicles (i.e. two vehicle availability groups combined).

This analysis is provided because when trip rates from the HTS are applied to Census population and then directly compared with trips in the HTS, the population differences will lead to some differences in trips. This does not mean the HTS trip making is incorrect - the population and trips have consistent expansion factors. But it does mean that comparison between the Census and the HTS for some levels of disaggregation will show disparities.

4. Trip Production Rates

The trip productions are split into the following trip purposes:

- **HBW** - Home Based Work
- **HBE** - Home Based Education
- **HBSH** - Home Based Shop
- **HBO** - Home Based Other
- **NHB** - Non-Home Based
- **BSN** - Business

“Home Based” trip productions include the trip in and out of the home. This is the same for Non-Home Based and Business trips for which we are calculating the overall control totals, so the trips are in and out of the home location.

Trips were weighted based on the trip expansion (trExp) in the HTS. Only trips within the Greater Wellington Regional Council area were extracted.

The trips per person were calculated for each purpose using the persons matrix in **Table 3-1**, and an equivalent matrix of trip productions. These trip rates were found to vary considerably by category due to the small sample of the HTS, and so the trip rates were adjusted/smoothed so that the trip rates were logical.

The following sections show the expanded trips, smoothing methods for specific groups/bands, and final smoothed trip rates for each of the purposes described above.

4.1 HBW

The following table is the expanded home-based work trips from the HTS.

Table 4-1: HBW Expanded Trips

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	0	1,865	8,222	9,865	628	20,580
	1	907	628	12,917	71,202	7,159	92,814
	2	1,040	3,394	13,481	104,216	7,679	129,810
	3+	146	2,732	11,681	38,986	1,079	54,624
	ALL	2,094	8,619	46,301	224,268	16,545	297,827

The approach used to smooth the HBW trip rates are tabulated below.

Table 4-2: Smoothing Methods Applied to Certain HBW Trip Rates

Age Group	Veh/HH	Smoothing Method
0-14 yrs	All	Zeroed
15-19 yrs	0, 1	Overall proportion applied
20-29 yrs	0	Overall proportion applied
30-64 yrs	3+	Trip rate set to adjacent band
65+ yrs	0, 2	Overall proportion applied

The “smoothing” process is described below for HBW, which explains the smoothing methods listed above, which are applied for all trip purposes. The raw HBW trip rates from the HTS are shown below.

Table 4-3: Raw Trip Rates for HBW

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	Total
Vehicles/HH	0	0.00	0.52	0.79	0.70	0.08	0.52
	1	0.03	0.08	0.74	0.87	0.21	0.53
	2	0.02	0.25	0.78	0.89	0.28	0.58
	3+	0.01	0.30	0.91	0.83	0.25	0.62
	Total	0.02	0.25	0.80	0.86	0.23	0.57

For 0-14 years old, there is a negligible work trip rate which may be associated with after-school jobs or miscoding in the HTS. As most children do not work, their work trip rate has been set to zero (“zeroed”).

For 15-19 years old, the overall work trip rate is 0.25 with a similar rate occurring for those living in households with two or three plus vehicles. For the zero or one vehicle per household categories, the trip rates are very different and the sample number of trips are ten or less (i.e. the sample size is small). In these

two categories where the trip rate is anomalous and the sample is small, the trip rate has been replaced with an overall proportion ("overall proportion has been applied"). As an example, for 15-19 years old with zero vehicles, this is the total trip rate for zero vehicles (0.52) as a proportion of the overall trip rate (0.52/0.57), multiplied by the total trip rate for 15-19 years old ($0.52/0.57 * 0.25 = 0.23$).

For 30-64 years old, the daily person trip rate increases as expected with vehicles per household aside from the three plus vehicle category, where the trip rate reduces. In this category, the trip sample rate is slightly smaller, about a third of the two vehicles category. So the raw trip rate for 30-64 year olds with three plus cars as been set the same as two vehicles ("trip rate set to adjacent band").

For 65+ years old, the trip rate for zero households is very low and there is a small sample of trips. Similarly, the trip rate for three plus vehicles is lower than two vehicles and the trip sample is small. So for these two vehicle categories, the method of "overall proportion applied" as been used to replace the raw with a representative trip rate.

The methods described above (and shown in italics) for HBW are the same for other purposes. That is, when we specify "overall proportion applied", this means the method described for 15-19 years old for HBW has been used.

The final, smoothed trip rates are in the table below.

Table 4-4: Final Smoothed Trip Rates for HBW

		Age Band				
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs
Vehicles/HH	0	0.00	0.23	0.74	0.70	0.21
	1	0.00	0.24	0.74	0.87	0.21
	2	0.00	0.25	0.78	0.89	0.23
	3+	0.00	0.30	0.91	0.89	0.25

4.2 HBE

The following table is the expanded home-based education trips from the HTS.

Table 4-5: HBE Expanded Trips

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	3,899	860	2,195	1,582	19	8,555
	1	34,619	4,915	2,330	18,250	132	60,247
	2	56,151	9,012	2,581	29,625	335	97,704
	3+	20,494	6,244	2,621	9,753	336	39,448
	ALL	115,162	21,032	9,727	59,209	823	205,954

The method used to smooth the HBE trip rates are listed below.

Table 4-6: Smoothing Methods Applied to Certain HBE Trip Rates

Age Group	Veh/HH	Smoothing Method
0-14 yrs	All	Aggregated trip rate applied
15-19 yrs	All	Aggregated trip rate applied
20-29 yrs	0	Overall proportion applied
30-64 yrs	0, 3+	Overall proportion applied
65+ yrs	All	Zeroed

The “*aggregated trip rate applied*” method means that categories have been grouped and a combined trip rate calculated. For 0-14 years old, the trip sample for zero vehicles was only 12. So the zero and one vehicles per household categories were aggregated to calculate the trip rate. Similarly, two and three plus vehicles per household categories were combined.

The final, smoothed trip rates are in the table below.

Table 4-7: Final Smoothed Trip Rates for HBE

		Age Band				
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs
Vehicles/HH	0	1.02	0.50	0.09	0.13	0.00
	1	1.02	0.50	0.13	0.22	0.00
	2	1.21	0.68	0.15	0.25	0.00
	3+	1.21	0.68	0.20	0.26	0.00

4.3 HBSH

The following table is the total expanded home based shopping trips from the HTS.

Table 4-8: HBSH Expanded Trips

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	1,023	2,456	4,112	8,636	5,428	21,654
	1	9,439	2,593	6,989	48,779	24,996	92,796
	2	12,435	6,614	8,621	69,843	21,505	119,018
	3+	5,903	2,505	3,827	30,534	3,660	46,430
	ALL	28,800	14,168	23,548	157,791	55,590	279,898

The methods used to smooth the HBSH trip rates are below.

Table 4-9: Smoothing Methods Applied to Certain HBSH Trip Rates

Age Group	Veh/HH	Smoothing Method
0-14 yrs	2, 3+	Aggregated trip rate applied
15-19 yrs	All	Aggregated trip rate applied
20-29 yrs	2, 3+	Trip rate set to adjacent band
30-64 yrs	0	Trip rate set to adjacent band

The final, smoothed trip rates are in the table below.

Table 4-10: Final Smoothed Trip Rates for HBSH

		Age Band				
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs
Vehicles/HH	0	0.28	0.42	0.39	0.59	0.72
	1	0.28	0.42	0.40	0.59	0.75
	2	0.29	0.42	0.40	0.60	0.78
	3+	0.29	0.42	0.40	0.65	0.85

4.4 HBO

The following table is the expanded home-based other trips from the HTS.

Table 4-11: HBO Expanded Trips

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	2,515	2,924	5,623	9,698	5,506	26,265
	1	26,626	8,027	13,551	80,450	39,344	167,998
	2	35,158	9,642	9,640	121,683	42,008	218,131
	3+	9,211	6,026	10,339	40,017	6,593	72,187
	ALL	73,510	26,618	39,154	251,848	93,451	484,581

The methods used to smooth the HBO trip rates are below.

Table 4-12: Smoothing Methods Applied to Certain HBO Trip Rates

Age Group	Veh/HH	Smoothing Method
0-14 yrs	1, 3+	Trip rate set to adjacent band
15-19 yrs	All	Aggregated trip rate applied
20-29 yrs	1, 2	Overall proportion applied
30-64 yrs	All	Aggregated trip rate applied

The final, smoothed trip rates are in the table below.

Table 4-13: Final Smoothed Trip Rates for HBO

		Age Band				
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs
Vehicles/HH	0	0.69	0.78	0.54	0.94	0.73
	1	0.69	0.78	0.70	0.94	1.18
	2	0.74	0.78	0.72	0.99	1.52
	3+	0.74	0.78	0.81	0.99	1.54

4.5 NHB

The following table is the expanded non home-based other trips from the HTS.

Table 4-14: NHB Expanded Trips

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	4,285	4,194	12,018	16,433	7,350	44,280
	1	24,380	14,543	19,611	127,638	41,750	227,921
	2	30,725	11,648	19,468	204,139	39,302	305,282
	3+	11,292	9,679	18,145	86,555	7,759	133,430
	ALL	70,681	40,064	69,241	434,766	96,160	710,913

The methods used to smooth the NHB trip rates are below.

Table 4-15: Smoothing Methods Applied to Certain NHB Trip Rates

Age Group	Veh/HH	Smoothing Method
0-14 yrs	0, 1, 2	Overall proportion applied
15-19 yrs	All	Overall proportion applied
20-29 yrs	0, 2	Overall proportion applied

The final, smoothed trip rates are in the table below. These are applied to calculate a control total for non home-based other trips with linear regression attraction models applied to calculate the origin and destination locations.

Table 4-16: Final Smoothed Trip Rates for NHB

		Age Band				
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs
Vehicles/HH	0	0.58	0.98	0.99	1.16	0.97
	1	0.68	1.13	1.13	1.56	1.25
	2	0.71	1.19	1.21	1.75	1.42
	3+	0.73	1.31	1.41	1.85	1.81

4.6 BSN

The following table is the expanded business trips from the HTS.

Table 4-17: BSN Expanded Trips

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0	0	0	494	628	261	1,383
	1	65	716	3,145	15,143	1,245	20,314
	2	0	8,251	3,190	53,437	3,568	68,445
	3+	548	318	4,990	17,915	2,698	26,470
	ALL	613	9,286	11,819	87,122	7,771	116,612

The methods used to smooth them for BSN trip rates are below.

Table 4-18: Smoothing Methods Applied to Certain BSN Trip Rates

Age Group	Veh/HH	Smoothing Method
0-14 yrs	All	Zeroed
15-19 yrs	All	Zeroed
20-29 yrs	All	Aggregated trip rate applied
30-64 yrs	0, 3+	Trip rate set to adjacent band
65+ yrs	All	Aggregated trip rate applied

The final, smoothed trip rates are in the table below. Similar to non home-based trips, the trip production model for business trips is applied to calculate the control total, with linear regression attraction models applied to calculate the origin and destination locations.

Table 4-19: Final Smoothed Trip Rates for BSN

		Age Band				
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs
Vehicles/HH	0	0.00	0.00	0.20	0.18	0.11
	1	0.00	0.00	0.20	0.18	0.11
	2	0.00	0.00	0.20	0.46	0.11
	3+	0.00	0.00	0.20	0.46	0.11

5. Trip Rates Applied to Census Population

This section shows the application of the smoothed trip rates by purpose to population from the 2018 Census by age band and vehicles per household. This is a check of the impact on total trips from smoothing the trip rates.

Census and HTS data were aggregated into 11 sectors shown graphically in **Figure 5-1**.

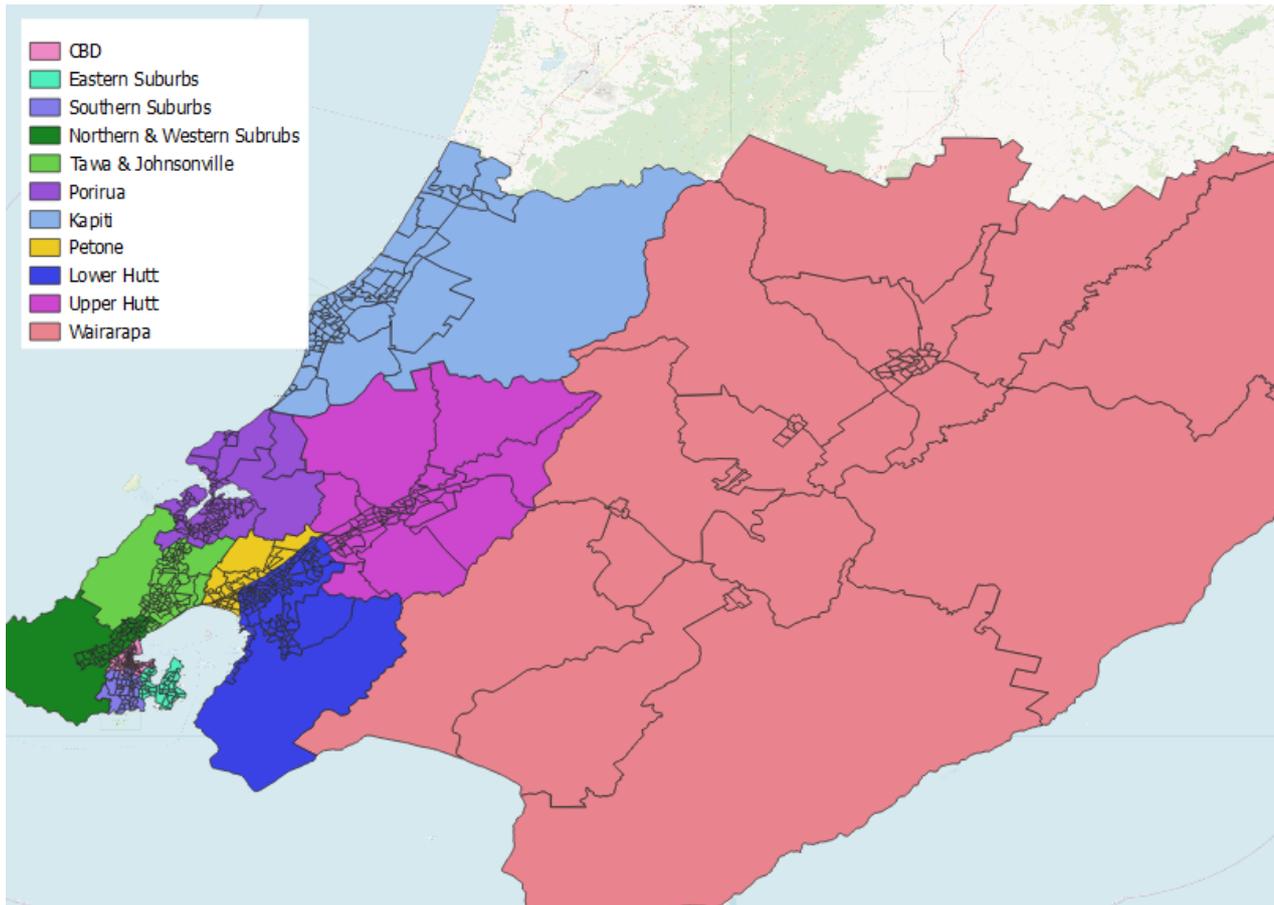


Figure 5-1: 11 Sectors

5.1 Population

Population by geographic area in the HTS and the 2018 Census is shown below.

Table 5-1: Population by Area, Census and HTS

Sector Name	Population		
	Census	HTS	Diff
CBD	36,009	36,751	-742
Eastern suburbs	36,677	47,944	-11,266
Southern suburbs	41,004	30,851	10,153
North and Western suburbs	42,166	39,002	3,164
Tawa and Johnsonville	55,233	56,436	-1,203
Porirua	59,127	58,888	238
Kapiti	55,055	55,187	-133
Petone	25,948	26,857	-909
Lower Hutt	82,792	83,921	-1,129
Upper Hutt	45,340	43,037	2,302
Wairarapa	46,810	46,800	10
Total	526,160	525,675	485

Census population in **Table 5-1** was derived from the cross-tabulation (by age and vehicle availability) provided by Statistics NZ, factored to ERP. There are some minor differences in the Census population derived from this source compared with straight Census population (i.e. not cross tabulated), with a maximum difference of 1,700 at an 11 sector aggregation. This is not significant.

Notably, there is a large difference in the population from Census compared with the HTS for the Eastern and Southern suburbs. This is because during expansion of the HTS, the Eastern and Southern suburbs were combined with other areas to form an “inner suburbs” group and not expanded separately. Similarly, Petone, Lower Hutt, and Upper Hutt were grouped during expansion and so some differences between Census and population in the HTS might appear at the geographically disaggregate level.

This will have occurred in the expansion of the HTS and ensuring it is representative of many different demographics and characteristics (not just population). This difference will be apparent in the subsequent analysis, where trip rates derived from the HTS are applied to Census population, and then compared with trip productions in the HTS.

This difference in population will likely result in trips to the Eastern suburbs being underestimated and trips to the Southern suburbs being overestimated. This is a difference in population definition between the two datasets rather than a discrepancy in the calculation of trip productions.

5.2 Trips by Purpose

The smoothed trip rates described in the previous section were applied to the sectored Census population by age and vehicles per household, and then compared to the trip productions by sector from the HTS.

The four home-based trip purposes (HBW, HBE, HBSh and HBO) were analysed geographically and reported below. The two non home-based purposes (NHB and BSN) are not used geographically in the model, but produce the control totals, so these purposes are not considered by sector.

The comparison between observed (HTS) and modelled (smoothed trip production rates applied to population from the 2018 Census by age and vehicles per household category) for the four home-based trip purposes are tabulated in **Table 5-2** and illustrated in the following figures.

Table 5-2: Trip Productions by Purpose and Sector, Modelled vs Observed – HBW and HBE

Sector Name	HBW			HBE		
	HTS, Obs	Mod	% Diff	HTS, Obs	Mod	% Diff
CBD	25,206	23,357	-7%	8,976	8,711	-3%
Eastern suburbs	27,501	21,446	-22%	27,763	14,121	-49%
Southern suburbs	22,501	25,191	12%	7,981	14,467	81%
North and Western suburbs	24,581	24,094	-2%	11,588	17,261	49%
Tawa and Johnsonville	39,321	31,731	-19%	24,345	23,446	-4%
Porirua	27,945	31,982	14%	29,144	26,514	-9%
Kapiti	27,551	28,359	3%	14,044	19,773	41%
Petone	19,949	15,232	-24%	8,008	10,446	30%
Lower Hutt	45,584	45,721	0%	34,123	33,885	-1%
Upper Hutt	22,809	25,248	11%	24,182	18,567	-23%
Wairarapa	16,262	24,767	52%	16,514	18,018	9%
Total	299,210	297,127	-1%	206,669	205,209	-1%

Table 5-3: Trip Productions by Purpose and Sector, Modelled vs Observed – HBSH and HBO

Sector Name	HBSH			HBO		
	HTS, Obs	Mod	% Diff	HTS, Obs	Mod	% Diff
CBD	20,647	18,140	-12%	35,346	30,018	-15%
Eastern suburbs	25,692	19,084	-26%	43,560	33,062	-24%
Southern suburbs	14,331	20,655	44%	24,331	35,555	46%
North and Western suburbs	20,259	21,869	8%	36,436	38,434	5%
Tawa and Johnsonville	32,807	28,535	-13%	53,224	50,313	-5%
Porirua	29,237	30,266	4%	58,718	53,882	-8%
Kapiti	36,615	31,086	-15%	59,020	54,035	-8%
Petone	14,680	13,640	-7%	23,109	23,923	4%
Lower Hutt	43,048	43,220	0%	82,782	75,752	-8%
Upper Hutt	22,119	24,053	9%	33,062	42,098	27%
Wairarapa	21,750	25,819	19%	38,613	45,335	17%
Total	281,186	276,367	-2%	488,202	482,407	-1%

In total, work and education trips are the same magnitude as the HTS, while shopping and home-based other trips are slightly underestimated (circa 2%).

Home-based work production trips are shown below.

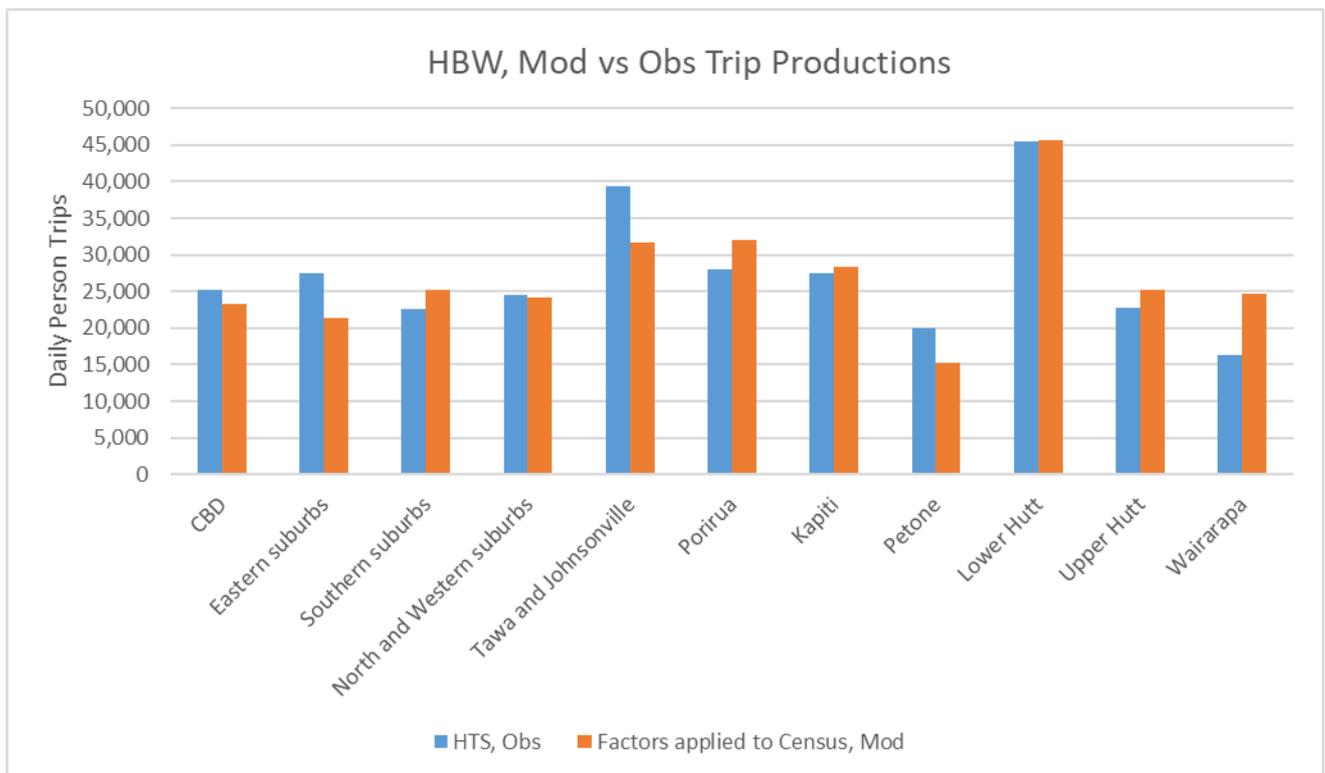


Figure 5-2: HBW Trip Productions, Observed (HTS) vs Modelled (Trip Rate applied to Census) by Sector

Work trips productions in Wairarapa are slightly overestimated while Tawa & Johnsonville and the Eastern suburbs are underestimated. This is associated with the underlying population difference in the HTS compared with the Census. Again, it is only an issue in comparing two datasets with different definitions, it does not necessarily represent a problem in the model.

Home-based education production trips are shown below.

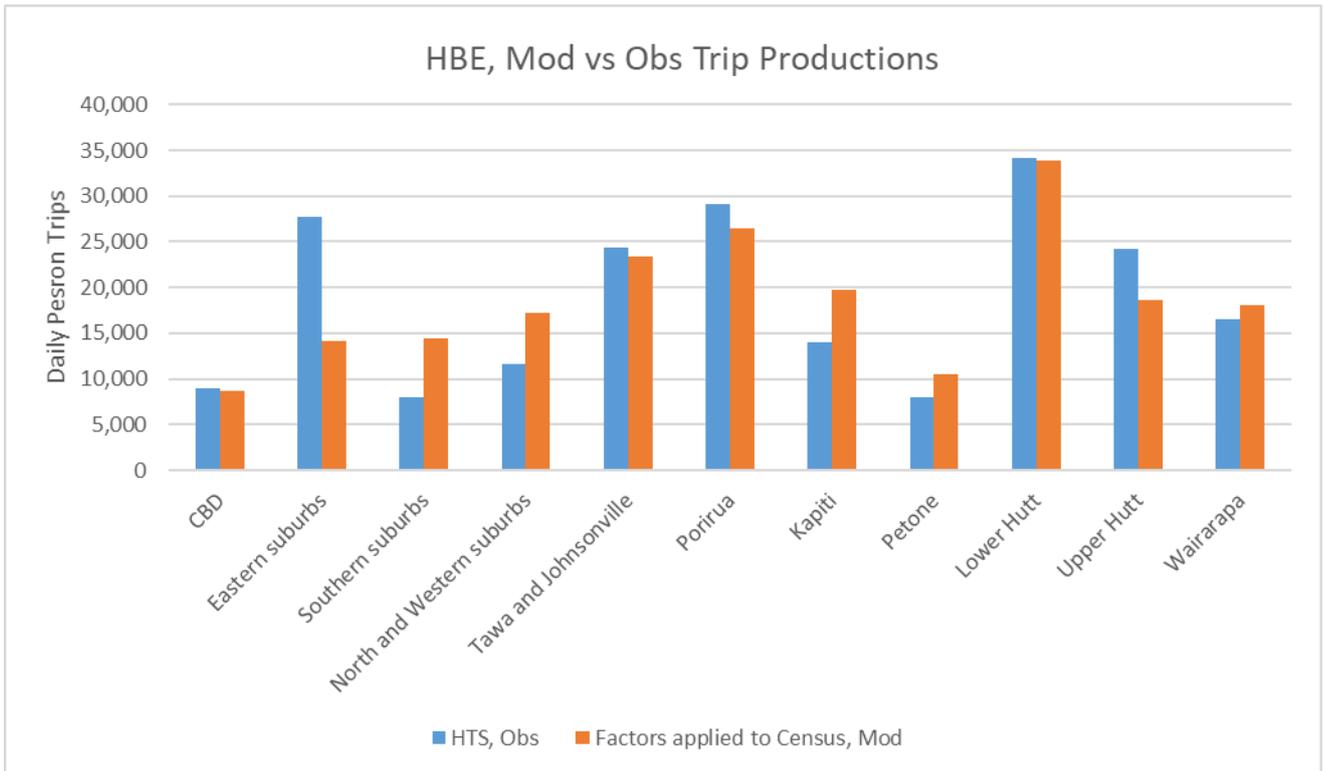


Figure 5-3: HBE Trip Productions, Observed (HTS) vs Modelled (Trip Rate applied to Census) by Sector

The Eastern suburbs are notably underestimated, and a similar pattern is observed for all the home-based trip purposes. This is a result of a different population number in the HTS and Census for the Eastern suburbs, so it is not a completely like-for-like comparison. Similarly, the Southern suburbs are overestimated. Again, the pattern of the Southern suburbs being overestimated appears in all the home-based trip purposes and is a result of the different population figures in the two data sources.

Home-based shopping production trips are shown below.

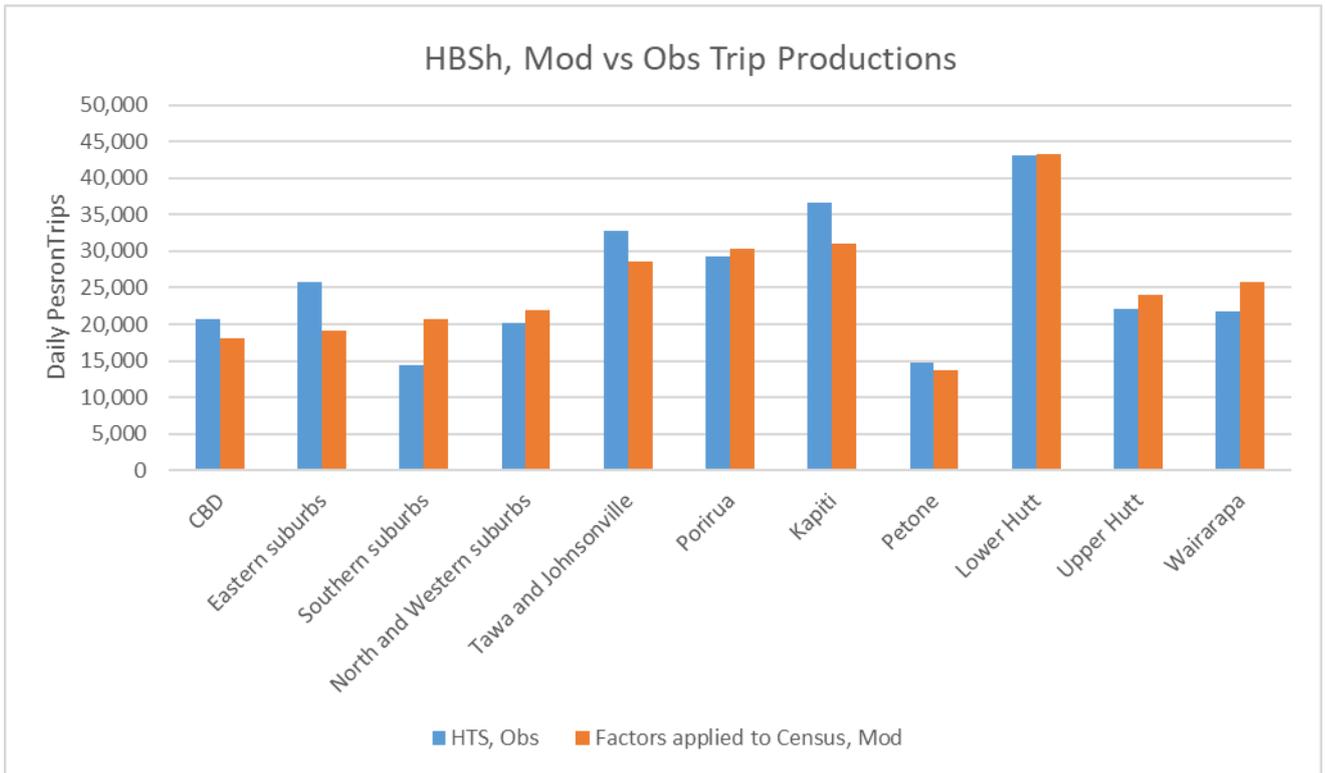


Figure 5-4: HBSH Trip Productions, Observed (HTS) vs Modelled (Trip Rate applied to Census) by Sector
 The smoothed trip rates applied to Census replicate the HTS relatively well geographically.

Home-based other production trips are shown below.

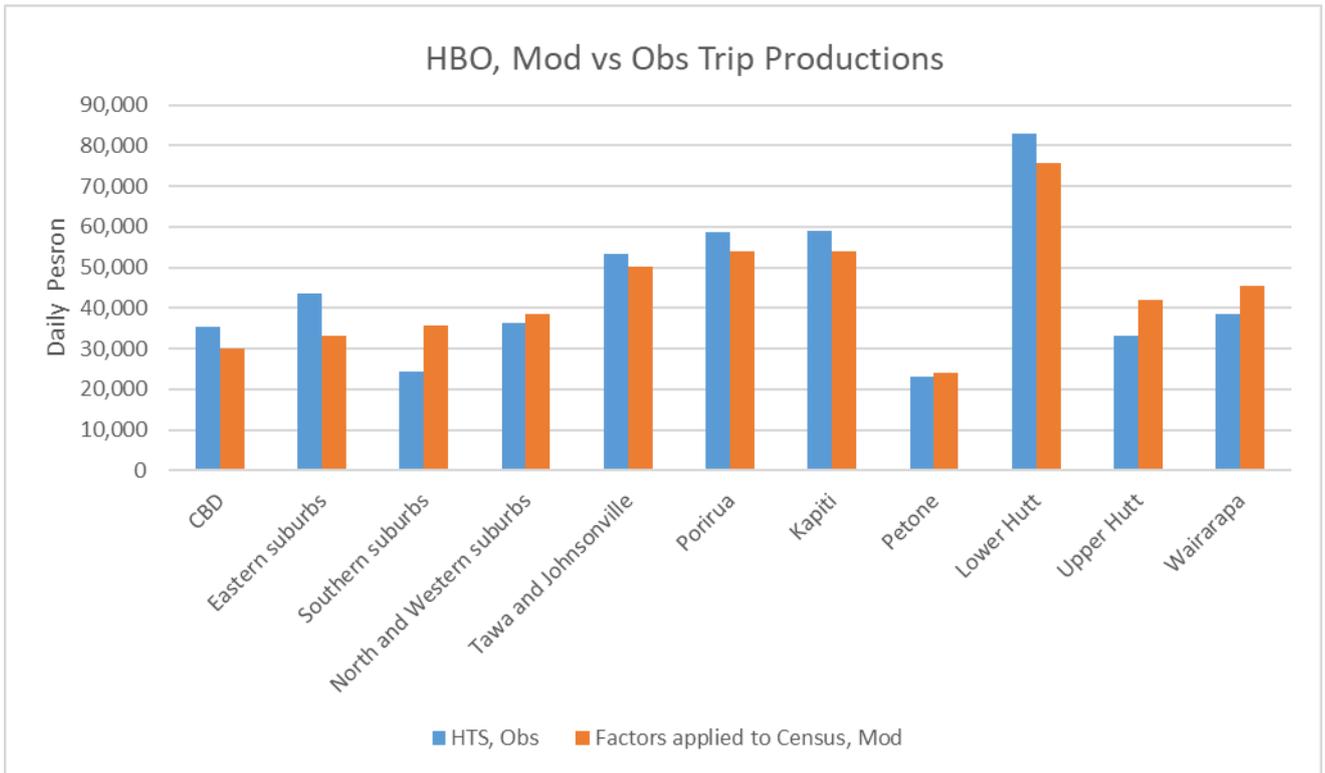


Figure 5-5: HBO Trip Productions, Observed (HTS) vs Modelled (Trip Rate applied to Census) by Sector

The smoothed trip rates applied to Census replicate the HTS relatively well geographically, although the pattern of overestimating the Eastern suburbs and underestimating the Southern suburbs due to the population mismatch is evident.

Modelled trip productions by zone are shown in the figures below.

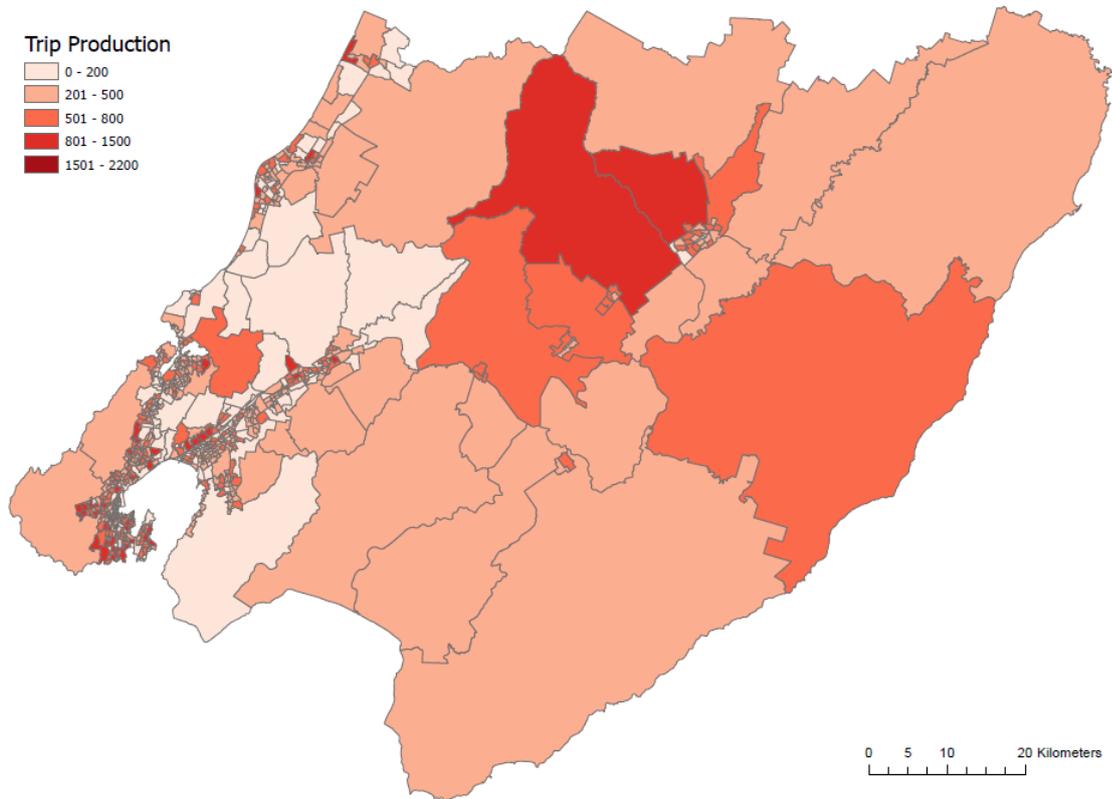


Figure 5-6: HBW Trip Productions - Modelled by Zone

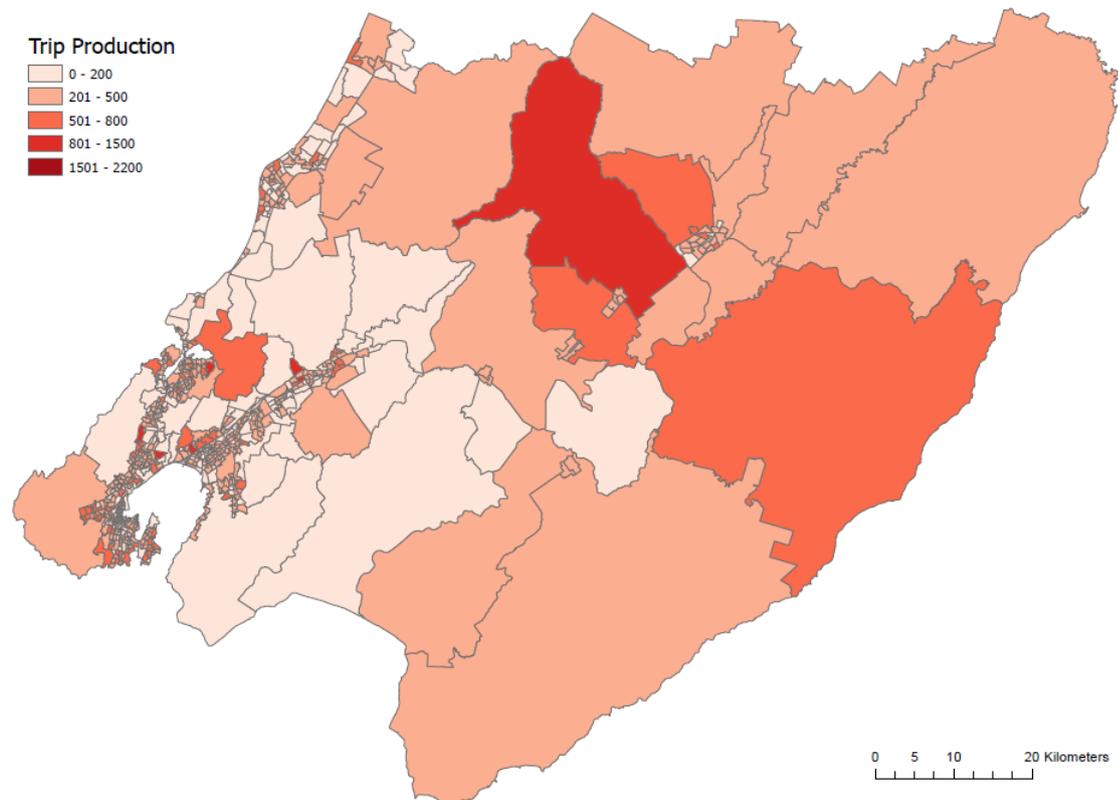


Figure 5-7: HBE Trip Productions - Modelled by Zone

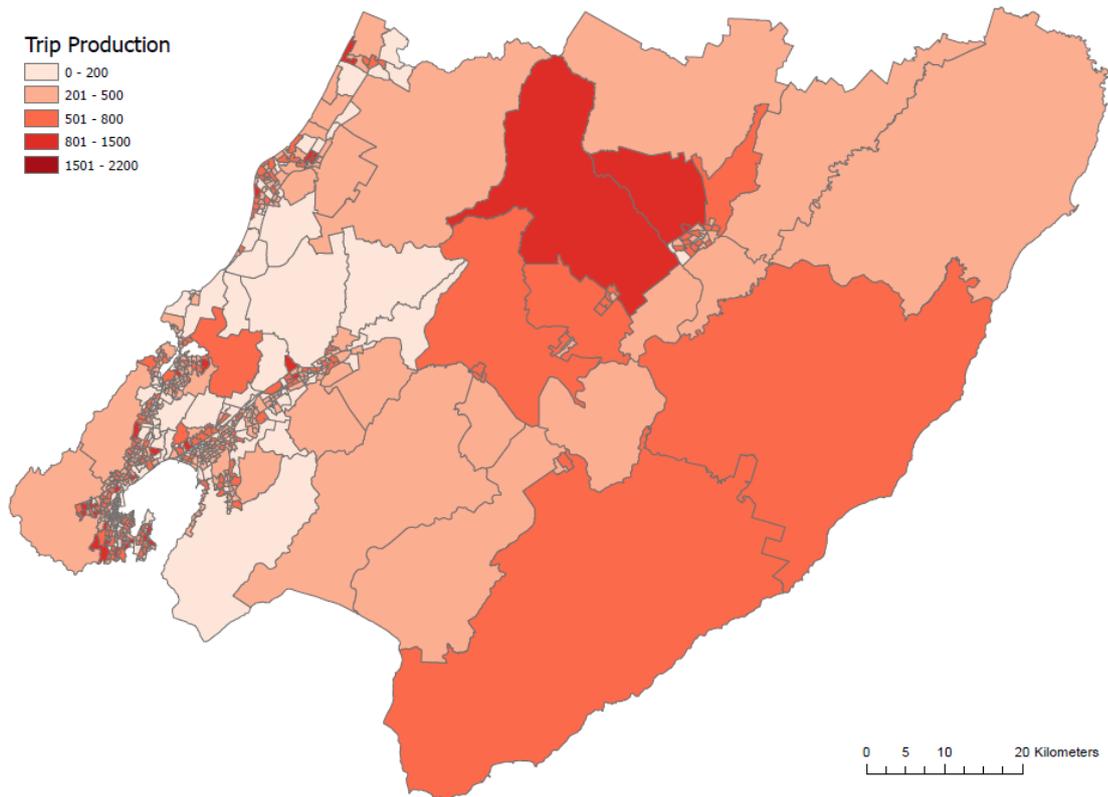


Figure 5-8: HBSH Trip Productions - Modelled by Zone

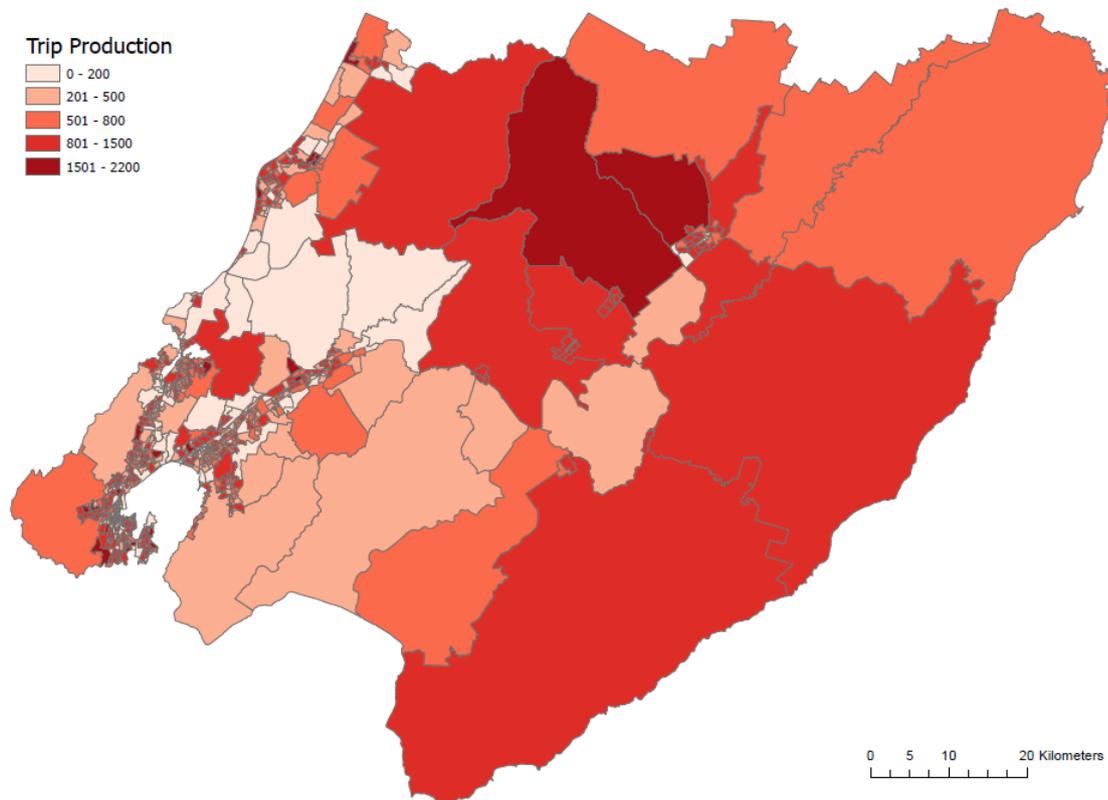


Figure 5-9: HBO Trip Productions - Modelled by Zone

5.3 Trips for All Home-Based Purposes

The four home-based trip purposes have been summed and are shown in **Table 5-4** and **Figure 5-10**. It is noted that this excludes the non home-based other (numerically significant) and business trips whose origin and destinations are produced in the attraction model.

Table 5-4: All Home-Based Trip Productions by Sector, Modelled vs Observed

Sector Name	All HB				
	HTS, Obs	Mod	Diff	% Diff	% Diff of Total
CBD	90,175	80,226	-9,949	-11%	-1%
Eastern suburbs	124,516	87,712	-36,804	-30%	-3%
Southern suburbs	69,144	95,869	26,725	39%	2%
North and Western suburbs	92,864	101,658	8,794	9%	1%
Tawa and Johnsonville	149,697	134,025	-15,673	-10%	-1%
Porirua	145,044	142,643	-2,401	-2%	0%
Kapiti	137,231	133,254	-3,977	-3%	0%
Petone	65,746	63,240	-2,506	-4%	0%
Lower Hutt	205,538	198,578	-6,961	-3%	-1%
Upper Hutt	102,173	109,966	7,793	8%	1%
Wairarapa	93,140	113,940	20,800	22%	2%
Total	1,275,267	1,261,109	-14,158	-1%	-1%

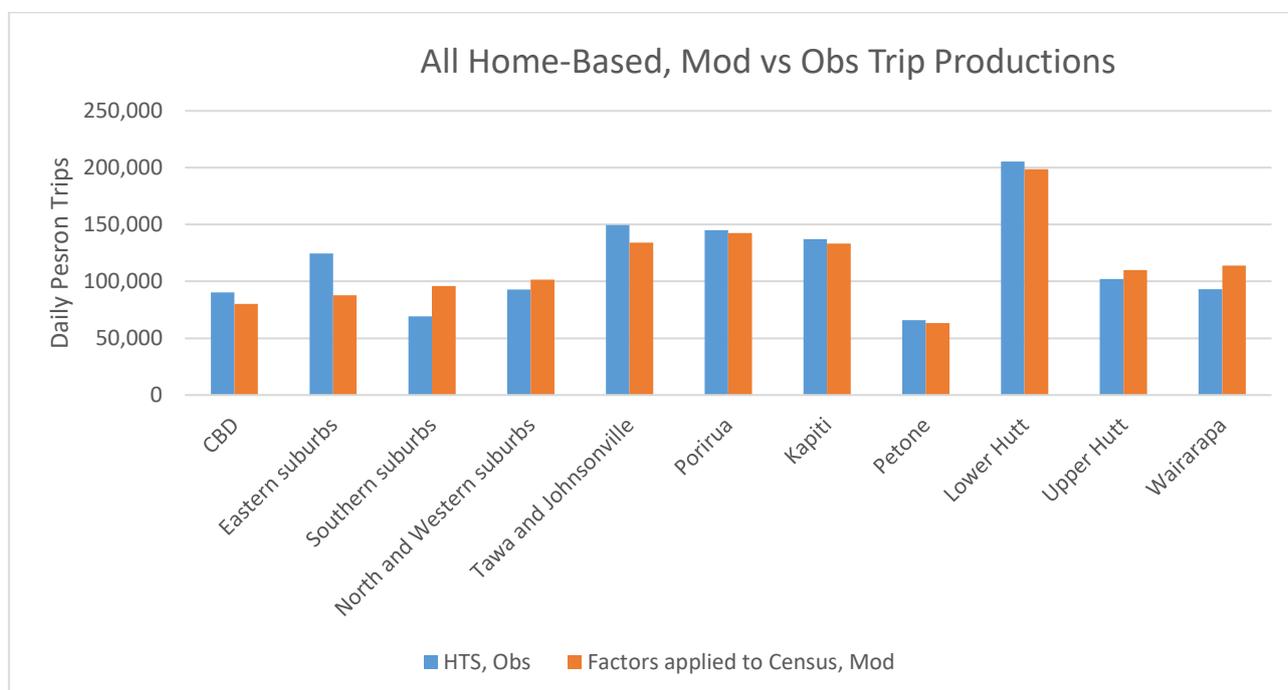


Figure 5-10: All Home-Based Trip Productions, Observed (HTS) vs Modelled (Trip Rate applied to Census) by Sector

Trip production rates are calculated region-wide and not by area as the sample is small particularly when broken down into purpose, age band, and vehicle availability. However, applying the region-wide smoothed trip production rates to Census population and comparing the resulting trips to the HTS by area shows a good geographic representation. The overestimate in the Eastern suburbs and underestimate in

the Southern suburbs is a result of a slight difference in population in the Census and HTS – it is a dataset differential and is not a like-for-like comparison so the difference is not concerning.

6. Summary

The HTS in the CBD was evaluated to see if the sample size was statistically significant when disaggregated by age band and vehicles per household group. It was found not to be statistically significant and therefore trip production rates could not be robustly calculated for the CBD separately.

Nevertheless, differences in total daily trip rates for the CBD and rest of the region were assessed. In total, the trip rate in the CBD is almost identical to the rest of the region. By age group or by vehicle availability group, the trip rates in the CBD were similar to the rest of the region. By age and vehicle category, there were some variations in trip rates but this was mostly where the CBD sample was very small.

It was concluded that trip rates in the CBD were mostly the same as the rest of the region and no geographic differentiation was required.

Daily trip production rates by purpose were then calculated from the HTS by age group and vehicle availability per household band. These were quite variable due to the sample size and hence they were smoothed to form a consistent pattern.

The smoothed trip rates were then applied to population by age and vehicle availability from the Census. The trips from the HTS (observed) and from applying trip rates to Census population (modelled) were compared geographically by 11 sectors. While there appears to be an underestimate of trips in the Eastern suburbs and an overestimate for the Southern suburbs, this is due to slightly different population figures in the Census and HTS for these two sectors. The difference in population is because the Eastern and Southern sectors were expanded as part of a larger geographic area and therefore differences will appear at a more disaggregate level. Aside from the Eastern and Southern suburbs, the application of region-wide trip production rates reproduces observed relatively well on a geographic basis.



Appendices

Appendix A Supplementary Tables

Table A 1: CBD Trip Productions Per Person, All Purposes

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH	0		4.03	3.08	3.29	4.58	3.29
	1	3.54		3.31	5.31	5.28	4.56
	2		2.51	4.59	5.07		4.61
	3+		2.97	4.06	4.69	1.80	4.00
	ALL	3.54	3.77	3.42	4.62	4.59	4.00

Table A 2: Non-CBD Trip Productions Per Person, All Purposes

		Age Band					
		0-14 yrs	15-19 yrs	20-29 yrs	30-64 yrs	65+ yrs	ALL
Vehicles/HH		3.22	3.13	3.19	3.31	2.47	3.06
	1	2.80	3.90	3.38	4.35	3.34	3.74
	2	2.83	3.63	3.20	4.99	4.13	4.20
	3+	3.09	3.06	4.01	4.79	5.54	4.23
	ALL	2.88	3.51	3.45	4.68	3.68	3.99

Appendix B Client Comments and Consultant Responses

No.	Comment By	Comment	Response
1	Andrew Ford	Do we have analysis / knowledge from other jurisdictions regarding CBD households having similar trip rates? Intuitively this seems right – whilst you might live closer to amenities in the CBD, you are as likely to go to work, head out for a coffee, go shopping as people who live elsewhere in the region (if anything CBD trip rates might be higher as it is easier to make short trips if amenities are close by...)	Trip production rates are calculated region-wide so we do not have data readily available for CBD's in other jurisdictions. The rates are region-wide due to the theory, which is if people are disaggregated into representative categories, the trip rates by purpose will be consistent by area and over time by population segment.
2	Andrew Ford	A more general point applicable to all of the analysis – the HTS sample is what it is, but can we draw on other jurisdictions to sense check what we are seeing?	Yes. The overall trip production rate is the expected order of magnitude at 3.99 person trips per day. For comparison, the 2001 Wellington HTS had a similar trip rate of 4.31. Auckland and ChCh 2006 had rates of 4.44 and 4.63 respectively. Nationally, the MoT 2016 dataset has a trip rate of 4.07 while MoT 2017 is 4.21. So we believe the Wellington trip production rates (both CBD and rest of region) are an appropriate magnitude. Furthermore, the proportions of trips by purpose align with our expectations based on other geographies.
3	Andrew Ford	I assume the trip rates for HBW (Table 4.3) include both the 'to' and 'from' work trips, which effectively shows that the average 30 – 64 yr old makes 0.86 trips to or from work each day? And using the same logic, the average 0 – 14 yr old makes 1.21 trips either to or from education? Would be useful just to confirm this in the note	Yes, home-based includes to and from the home, and we've added text to make this clearer. While the value of 0.86 home-based work trips may appear low, in reality many "commuting" trips will include an intermediate stop (say to drop/pick-up kids at school, or to the shop), resulting in these being included in other home-based purposes as well as non-home based. The same applies to HBE.
4	Andrew Ford	It is interesting that HBE trip rates for 30-64 yr olds are greater than 20 – 29 yr olds? Could this be due to the "head office" effect whereby some trips to education establishment offices (i.e. Polytech HQs, Learning Institutes) are coded as HBE when they should be HBW?	The trip rates are likely due to 30-64 years old more likely being parents and taking their children to/from school. The 20-29 years old will include some people attending tertiary education and others not. Education and work purposes are explicitly separated in the HTS and therefore in the trip production as well, regardless of the attractor being an education facility so there should be no "head office" issue.

No.	Comment By	Comment	Response
5	Andrew Ford	Table 5.1 – the reason for the southern / eastern discrepancies being due to different definitions population definitions is noted, but it does stand out in the comparisons in section 5; whilst I note and understand that this “does not necessarily represent a problem with the model”, given the likely focus of LGWM on this area, perhaps consideration should be given to any alternative ways of showing that the modelled trip productions are plausible in the southern / eastern suburbs? Can we look at trip rates by area / purpose? I suppose what I am saying is that I don't have enough information to take an informed view of the validity of the model in this area?	<p>We appreciate this difference stands out, but the only data from the HTS used for trip productions is a global trip rate.</p> <p>We could report the comparison at a more aggregate level, matching the areas used for the HTS expansion. This would combine the suburbs together, and results for this larger sector are a good match.</p> <p>To provide reassurance, the only trip production information that is used are trip rates by age and vehicle availability. These differ by purpose, but the same rates are applied network-wide, so trips to/from the Southern suburbs will not be underestimated.</p>
6	Andrew Ford	The CBD trip rate analysis refers to a trip rate per household, and is thus only focussed on people who live in the CBD. Has any analysis been done of the Non-home base trip rates from the HTS for people who live outside of the CBD, commute to work in the CBD and then undertake non-home-based trips in the CBD during the workday? I accept that the short trip issue in WTSM 2013 is likely to be a mode split issue as opposed to a trip generation issue, however it would be useful to understand more about non-home-based trip rates / production within the CBD	The origin and destination of non-home-based trips is calculated in the trip attraction model (TN20). We did find that the CBD had quite a different pattern compared with the rest of the region and a CBD adjustment factor was included. For both NHB origins and destinations, trips in the CBD had to be reduced.
7	Andrew Ford	It would be useful to have some GIS outputs at a zonal level showing trip productions by zone – in absolute terms or as a function of activity (population / employment) in a particular zone – just as a high-level sense check of what the model is coming up with, however it could be this is more useful as a check during the cal / val stage	We have added figures showing trip productions by zone for each home-based purpose.
8	Ian Clark	<p>There is some great stuff on how Wellington trip making compares with that around other NZ cities.</p> <p>CBD trip making: I've just had a look at info from RMS in Australia. Unfortunately, the RMS reporting (TDT 2013/4a) only relates to vehicle trips – even though the consultants reports that sit behind this summary gave some multi modal information. So while there could be info out there, it would take quite a bit to turn into anything meaningful.</p>	We appreciate your research efforts and agree this information is complex and can be difficult to extract robust statistics.

No.	Comment By	Comment	Response
		The points around HTW trips seeming apparently low is important. We have tended elsewhere to apply TDM factors to future HTW trips and have been initially surprised at the low TDM outcomes – and think it is due to the fact acknowledged below about some apparent HTW are applied to other trip types, due to the trip chaining issue. This may be a point to bear in mind later.	This is a fundamental limitation of a trip-based model, where home-school drop off-work, for example, are not classified as a work trip. TDM measures therefore need to be applied to a proportion of non-home-based trips as well to account for this. Agree that understanding this is important.
9	Ian Clark	I wonder if the key point is in the short para at the start of section 2: that the issue is less around less trip making in the CBD and more around the current/previous mode having too many short car trips. If we put greater effort into adequately reflecting the disincentive to short car trips (probably the time to park the car at both ends of the trip) we may get an improved outcome.	The current model has a very simplistic representation of active modes, taking proportions off car or PT (depending on purpose). This is likely to be a key contributor to the issue in the current model of too many short car trips in the CBD. We are aware of this issue in the current model and will be monitoring trip lengths by mode and by area during the development of the new model.
	Ian Clark	I was about to ask a question about the apparent discrepancies in eastern and southern populations in Table 5-1, but there is an explanation. Is this saying a geographical difference in the two sets of data, or some other difference? And do these population differences then explain some of the trip differences for these sectors in Tables 5-2 to 5-4, or have any corrections been made?	The HTS and Census have slightly different populations for the Eastern and Southern suburbs. This is because the HTS was expanded with these two sectors combined. So when we apply trip rates to the Census, and compare this to trips in the HTS, we see a difference in these two sectors. This is not an issue. In the model, trip rates will be applied to Census. Any comparisons to HTS will bear in mind that we would expect the Southern and Eastern suburbs to show a discrepancy.
	Ian Clark	And should we be heartened by the apparently reasonable correlation in CBD trips in Table 5-4 (ie only 10% out) (given other comments about this issue).	Yes, this demonstrates that network-wide trip rates do replicate CBD home-based trip productions. It is noted that the majority of trips within the CBD will not be productions (i.e. in and out of the home), so issues with CBD trips will more likely occur in the trip attraction model, where a CBD adjustment was required and applied.

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