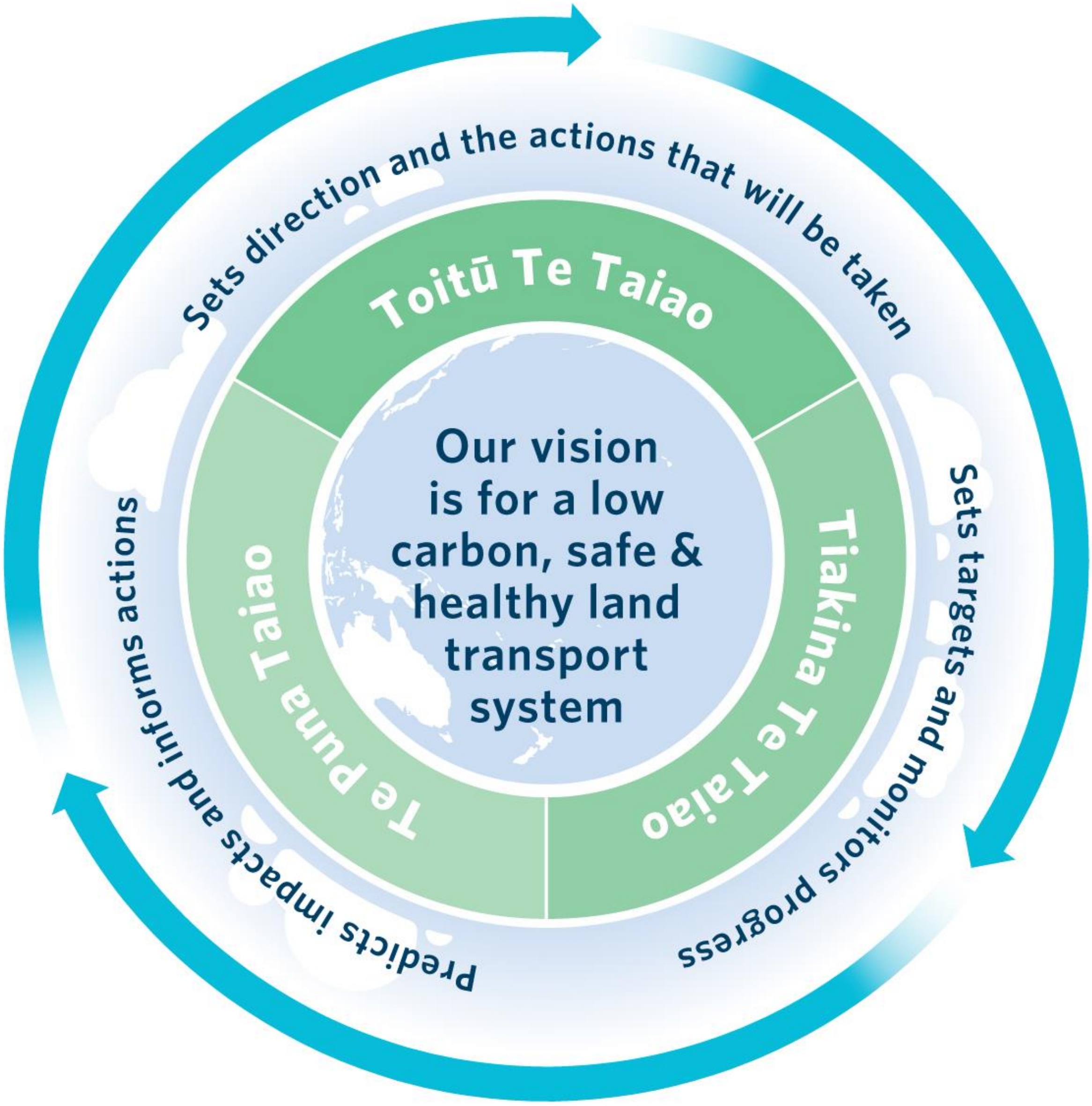

Household travel in our major urban areas

Te Puna Taiao strategic insight

WSP NZ

21 December 2022

Compiled briefing papers

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WSP Author/Presenter bios for TKH Event + Abstract

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The Emissions Reduction Plan (ERP) has a target to reduce total kilometres travelled by the light vehicle fleet by 20 per cent by 2035 through improved urban form and providing better travel options, particularly in our largest cities. With a focus on major urban areas, this research piece investigates the feasibility of achieving a 20% reduction in light vehicle (LV) vehicle kilometres travelled (VKT).

We find that mode shift alone is unlikely to achieve the goals of the emissions reduction plan. 25% of LV-VKT in Tier 1 is from journeys travelled in main urban areas, under 15 kilometres, and for one of three purposes: commute to work, personal/shopping, or social/entertainment. While these journeys are potentially more feasible to shift to an alternative mode, targeting this subset, which contribute only 25% of total LV-VKT in Tier 1, will not achieve the reductions required to meet the ERP target.

The target is ambitious; achieving it will likely require measures dissuading the use of personal vehicle travel. Longer journeys, which often don't have feasible alternative mode options, contribute too many kilometres of travel. In Tier 1, about 20% of driven journeys contribute 60% of LV-VKT. These are over 15 km. Inversely, 54% of Tier 1 journeys taken are under 6 km, yet these contribute only 18% of Tier 1 LV-VKT. Minimising short driven journeys is important, but less rewarding in terms of the ERP target. If all current journeys under 6 km, every single one, were suddenly not driven, it still wouldn't reduce Tier 1 LV-VKT by 20%. And Tier 1 will need a reduction larger than 20%. Main urban areas have more travel options; it will be even more difficult to cancel or shift driven trips in rural areas. Achieving the ERP target will require a suite of measures targeting driven journeys of all distances and purposes.

Initial Investigations on Light Vehicle Kilometres Travelled

Executive Summary

The Emissions Reduction Plan (ERP) has a target to reduce total kilometres travelled by the light vehicle fleet by 20 per cent by 2035 through improved urban form and providing better travel options, particularly in our largest cities. With a focus on major urban areas, this research piece investigates the feasibility of achieving a 20% reduction in light vehicle (LV) vehicle kilometres travelled (VKT).

We find that mode shift alone is unlikely to achieve the goals of the emissions reduction plan. 25% of LV-VKT in Tier 1 is from journeys travelled in main urban areas, under 15 kilometres, and for one of three purposes: commute to work, personal/shopping, or social/entertainment. While these journeys are potentially more feasible to shift to an alternative mode, targeting this subset, which contribute only 25% of total LV-VKT in Tier 1, will not achieve the reductions required to meet the ERP target. Similar proportions are found for kilometres driven in Tier 2 areas.

The ERP target is ambitious; achieving it will likely require measures dissuading the use of personal vehicle travel. Longer journeys, which often don't have feasible alternative mode options, contribute too many kilometres of travel. In Tier 1, about 20% of driven journeys contribute 60% of LV-VKT. These are over 15 km. Inversely, 54% of Tier 1 journeys taken are under 6 km, yet these contribute only 18% of Tier 1 LV-VKT. Minimising short driven journeys is important, but less rewarding in terms of the ERP target. If all current journeys under 6 km, every single one, were suddenly not driven, it still wouldn't reduce Tier 1 LV-VKT by 20%. And Tier 1 will need a reduction larger than 20%. Main urban areas have more travel options; it will be even more difficult to cancel or shift driven trips in rural areas. Again, similar proportions are found for Tier 2. The most notable difference is how journeys in distance bins over 15km contributed their proportion of LV-VKT. Journeys over 50km contributed 35% of LV-VKT in Tier 2, compared to 22% in Tier 1. Ultimately, achieving the ERP target will require a suite of measures targeting driven journeys of all distances and purposes.

The question arises – which are easier to target: fewer long journeys or many short journeys? It's a redundant question; all journey types need to be reduced to achieve the ERP target. Shorter journeys are easier to target by providing safe and effective alternative travel options. But longer journeys must be reduced – they contribute too many kilometres and the ERP target cannot be achieved without reducing long driven journeys.

Urban planning and land use play a critical role in our future. Development at urban fringes, without reliable and frequent public transport services or local amenities, creates reliance on cars and introduces frequent longer journeys by car. Anecdotal examples of this include Rolleston Fields and Plimmerton Farm developments. Creating urban sprawl creates longer journeys and more LV-VKT. The 15-minute city framework, providing access rather than mobility, could help reduce the distance we need to travel.

Further work with raw household travel survey data is planned to investigate differing travel behaviour within smaller localised Tier 1 areas. It will also transparently show the multiple trips which make up different journeys and the proportion of individual journeys driven in different area types.

Abbreviations and Definitions

Abbreviation	Definition
AKL	Auckland
BOP	Bay of Plenty
CAN	Canterbury
Covid	Corona Virus Disease
ERP	Emissions Reduction Plan
HTS	Household Travel Survey
HV	Heavy Vehicle
LV	Light Vehicle
MUA	Main/Major Urban Area
NZ	New Zealand
PDF	Probability Distribution Function
RSR	Road Safety Reports
TLA	Territorial Local Authority
TMS	Traffic Management System
VKT	Vehicle Kilometres Travelled
WFH	Work From Home
WKT	Waikato
WLG	Wellington

[1] Definitions | Waka Kotahi NZ Transport Agency (nzta.govt.nz)
[2] CAS Glossary (catlearn.nz)

Contents

Table of Figures

1 Introduction

This research piece supports Waka Kotahi's development of a macro-level, integrated environmental outcomes modelling initiative: Te Puna Taiao. This modelling initiative will inform commitment to deliver a low carbon and healthy land transport system.

1.1 The Emission Reduction Plan

The emissions reduction plan (ERP) contains a target of reducing light vehicle VKT in 2035 to 20% below the baseline projected VKT forecast for 2035. Auckland, Wellington, and Christchurch generate over a third of the national light VKT and therefore offer the greatest opportunity for reductions.

The ERP has a section on transportation. This section's first focus area is to:

> "Reduce reliance on cars and support people to walk, cycle and use public transport."

As a target, the ERP proposes the following:

> *"Reduce total kilometres travelled by the light fleet by 20 per cent by 2035 through improved urban form and providing better travel options, particularly in our largest cities."*

The 20% reduction desired by 2035 is not a reduction from current LV-VKT levels. Instead, it applies to the projected 2035 LV-VKT, and it is unlikely to be uniform across New Zealand given the higher dependency on light vehicles outside main urban areas.

2 Defined areas

2.1 MUAs

We use the road safety reports (RSR) Peer group in CAS, defined as:

Major urban areas with some rural areas on the outskirts. (Population > 97,500 and/or rural crashes less than 30 percent)

Geographically, this includes the following Territorial Local Authorities (TLA) by region as outlined in (Table 1 and Table 2). Note that the Auckland TLA is equivalent to the Auckland region.

Table 1: Territorial Local Authorities Constituting Main Urban Areas by Region

	Main Region	TLA
MUAs	Auckland	Auckland
	Bay of Plenty	Tauranga City
	Waikato	Hamilton City
	Wellington	Wellington City Lower Hutt City
	Canterbury	Christchurch City
	Otago	Dunedin City

2.2 Tiers 1 and 2

Tiers are defined by TLA in the draft Waka Kotahi research note: "VKT and GHG Emissions Baseline Report". These include the following TLAs by region (Table 2). Any TLAs not listed are considered rural areas, or Tier 3+.

Table 2: Territorial Local Authorities constituting defined Tiers with their Main Region

	Main Region	TLA
Tier 1	Auckland	Auckland
	Bay of Plenty	Tauranga City Western Bay of Plenty District
	Waikato	Hamilton City Waikato District Waipa District
	Wellington	Wellington City Porirua City Lower Hutt City Upper Hutt City Kapiti Coast District
	Canterbury	Christchurch City Selwyn District Waimakariri District
Tier 2	Northland	Whangarei District
	Bay of Plenty	Rotorua District
	Hawkes Bay	Napier City Hastings District
	Taranaki	New Plymouth District
	Manawatu-Wanganui	Palmerston North City
	Nelson	Nelson City
	Tasman	Tasman District
	Otago	Queenstown-Lakes District Dunedin City

Figure 1 depicts TLA by region in New Zealand:[3]

Figure 1: NZ Territorial Local Authorities and Regions

[3] By Korakys - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=56957024

3 Projections of Vehicle Kilometres of Travel

In this section we look at the projection of vehicle kilometres of travel. To understand what a 20% reduction in 2035 would look like, we must first establish a projected 2035 LV-VKT estimate. To do so, it is necessary to establish how many people there will be and how much they will travel.

Key points:

- Stats NZ's medium population projection for NZ in 2035 is 5.76 million people.
- Given a population of 5.76 million people, 50.32 billion km of LV-VKT is projected for 2035 using linear extrapolation.
- Assuming population reaches 5.76 million people, we have a target of less than 40.26 billion km of LV-VKT – approx. 2015 LV-VKT value.
- The Draft Waka Kotahi Research Note: "VKT and GHG Emissions Baseline Report" projects 54.49 billion km of LV-VKT in 2035, giving a target of 43.59 billion km – approx. 2017 LV-VKT value.
- Reducing average national LV-VKT per capita by 20% better defines the reduction target and is not dependent on actual population change.
- A 20% reduction in LV-VKT per capita takes us well outside our historic driving behaviour – the scenario achieving the target will require a monumental change in the function of our mobility as a society.

3.1 National projection

Stats NZ have different levels of population projections, from a base year of 2018, to 2048. We fit a cubic spline[4] to Stats NZ's medium projection and estimate a 2035 population of 5,760,423 people (Figure 2).

An additional Stats NZ dataset gives NZ resident population between the years 1990 and 2020. Four instances of population estimates are recorded every year. We observed that the projection dataset uses the second instance; we do the same for consistency. Rather than the interpolation, we use this recorded data for national population before 2020.

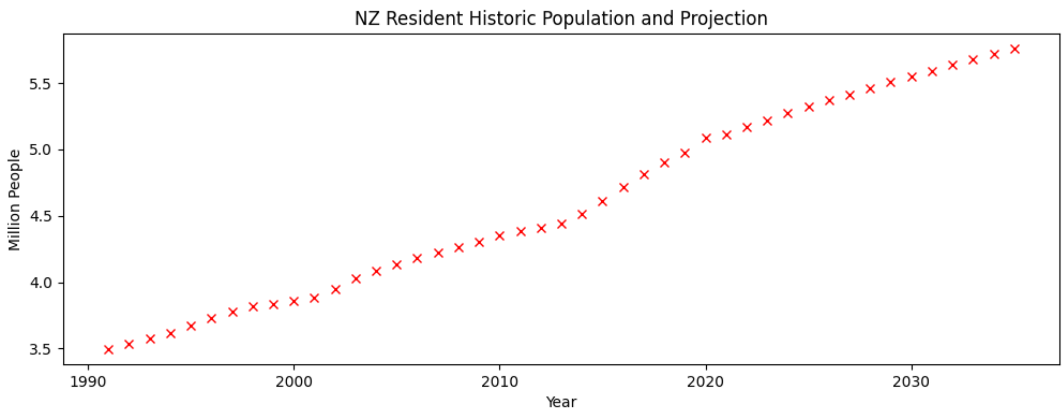

Figure 2: NZ Resident Historic Population and Cubic Spline Fit of Medium Projection from Stats NZ

The Ministry of Transport has the best annual national LV-VKT estimates based on WoF and CoF odometer readings[5] (Figure 3).

[4] Cubic Spline Interpolation — Python Numerical Methods (berkeley.edu)
[5] Road transport | Ministry of Transport

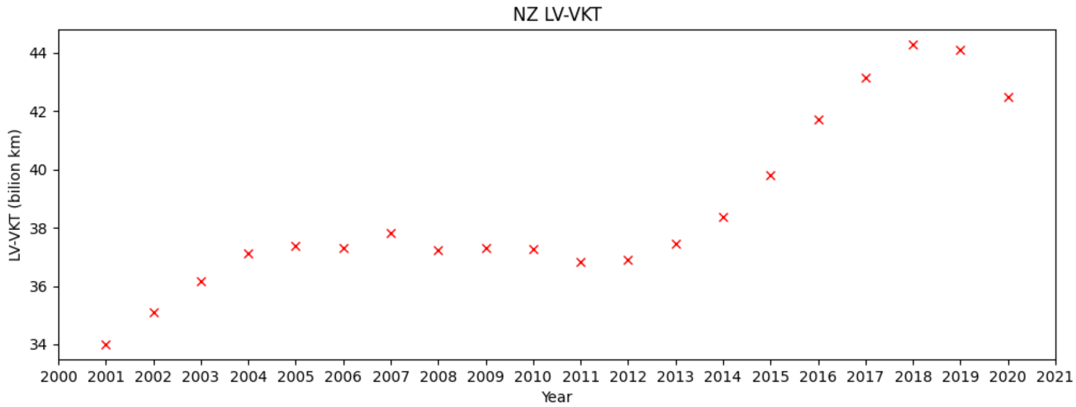

Figure 3: NZ National LV-VKT by Year

We found a linear fit between national resident population and LV-VKT. The strength of correlation between national population and LV-VKT was very strong, having a value of 0.933 (Figure 4).

Using this relationship, and the forecast 2035 population of 5,760,423, we project 50.32 billion kilometers being travelled by light vehicles. The ERP target, given medium population projection, would hence be to keep 2035 LV-VKT below 40.26 billion kilometers (Figure 4). This target is dynamic based on actualised population – it is important we don't set a defined distance target nationally and measure against this. Using national population as the indicator for kilometres travelled, the target will be dependent on net population as of 2035. This is equivalent to reducing kilometres travelled per capita by 20%.

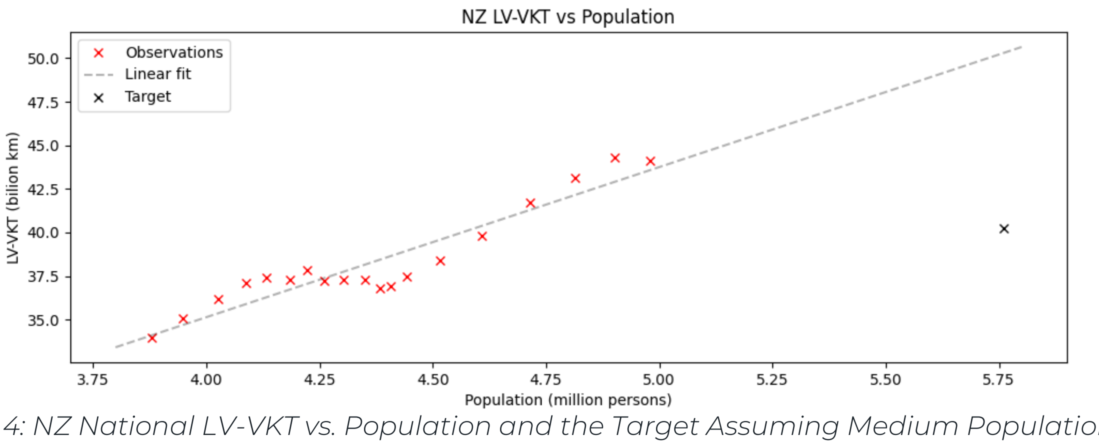

Figure 4: NZ National LV-VKT vs. Population and the Target Assuming Medium Population Projection and the Found Linear Best Fit

3.2 Different regions, different relationships

One issue in taking the national population to project LV-VKT is that populations in different regions have differing travel behaviour. Urban areas have denser land use patterns, and more travel options, such as public transport and cycle infrastructure. Therefore, their populations will be less reliant on driving. Fitting a linear relationship, for years 2001 to 2019, between MOT's regional total VKT estimates, and Stats NZ's interpolated regional population projections, gives the following for Auckland, Wellington, and Canterbury (Figure 5):

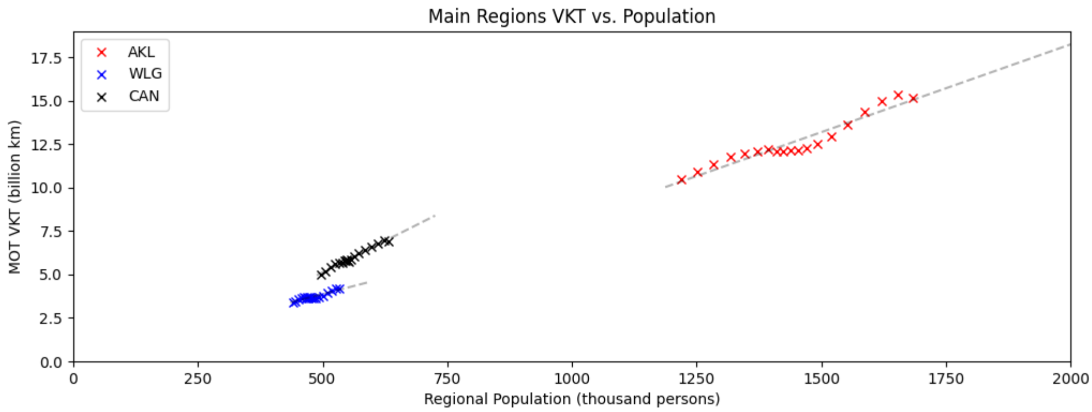

Figure 5: Auckland, Wellington, and Canterbury LV-VKT vs. Regional Population

We identify a very strong linear relationship between national population and LV-VKT. Similarly, between regional population and VKT (Figure 5), which is a close approximation to LV-VKT (Table 3).

Table 3: Linear Best Fit Gradient, Correlation Strength, and p-value for Pearson-r Linear Correlation Test

Region	Gradient (VKT per person increase)	Correlation Strength	p-value
National	8,611 (LV-VKT)	0.937	3.47e-9
Auckland	10,112	0.958	1.11e-10
Wellington	7,417	0.939	2.74e-9
Canterbury	14,495	0.991	2.09e-16

For correlation strength, we use the Pearson correlation coefficient.[6] The p-value gives the probability that the linear correlation found occurred by chance and in all cases the relationship is not coincidental.

Some observations are:

- Wellington region has substantially lower VKT increase with respect to population than either Auckland or Christchurch.
- Canterbury VKT is almost twice as sensitive to population increase than Wellington. The VKT increases much faster with respect to population.
- Auckland region produces the highest VKT of the three main regions by a significant margin (Figure 5). Its population is much higher and its growth very fast.

3.3 Draft Waka Kotahi Research Note: "VKT and GHG Emissions Baseline Report"

Projection estimates have recently been completed for LV-VKT sub-nationally.[7] Using Stats NZ's medium population projection, the research projects that we will reach 54.487 billion LV-VKT nationally in 2035. This gives a target of maximum 43.590 billion LV-VKT in 2035. This target is comparable to the research note's baseline 2019 LV-VKT value of 43.964 billion, meaning that LV-VKT nationally needs to stay stagnant as population increases to achieve the target.

[6] Pearson correlation coefficient - Wikipedia
[7] Draft Waka Kotahi Research Note "VKT and GHG Emissions Baseline Report"

Tier 1, Tier 2, and other areas were defined in this research using territorial local authorities (TLAs). Methodology for their estimates took 2019 LV-VKT per capita, localised by TLA, then multiplied these values by the projected population for the area. The LV-VKT per capita values were calculated by dividing a defined area's LV-VKT (supplied by MOT) by the area's population (using interpolated sub-national Stats NZ population projections from 2019). This was done for all three of Stats NZ's projection levels – Low, Medium, and High.

One limitation of this estimate is the use of LV-VKT per capita in 2019 as the baseline. MOT's LV-VKT per capita values vary over time (Figure 6). Using one observation instance may not accurately capture the relationship between population and LV-VKT.

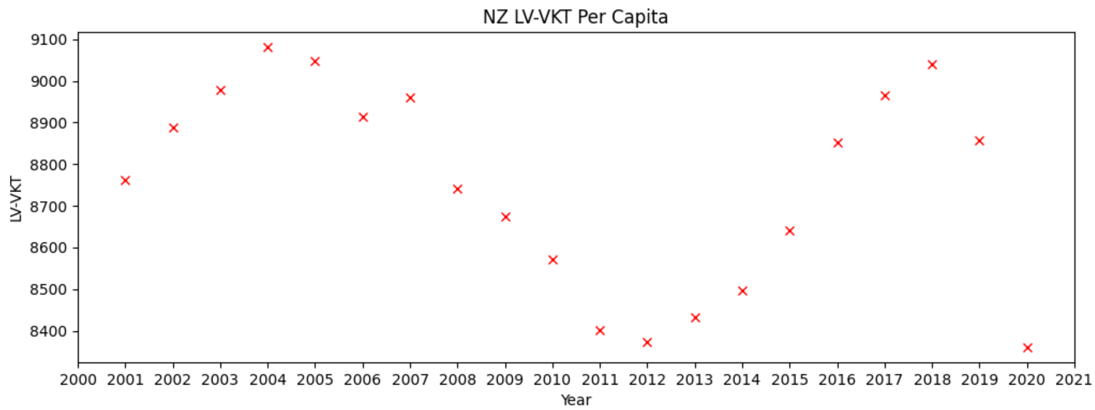

Figure 6: NZ National Average LV-VKT per capita by Year

For more informed projections, fitting a linear equation to observed historic data would provide a value for how much LV-VKT increases in a defined area with respect to population. This should then be used to predict an area's LV-VKT change with respect to difference in population, from the baseline.

3.4 Comparison of projections

With our projected LV-VKT of 50.32 billion km, we are working to reduce national LV-VKT back to 2015 levels by 2035 (target of). Alternatively, using the draft research note projection of 54.49 billion km, we would be aiming to reduce LV-VKT to below around or below 2017 levels.

Table 4: NZ National LV-VKT Values by Year

Year	Light vehicle travel (billion km)
2012	36.90
2013	37.45
2014	38.37
2015	39.82
2016	41.72
2017	43.14
2018	44.29

To depict the gravity of this LV-VKT reduction, we plot the 40.26 billion km target against forecast national population using the estimates and linear relationship found before (Figure 7).

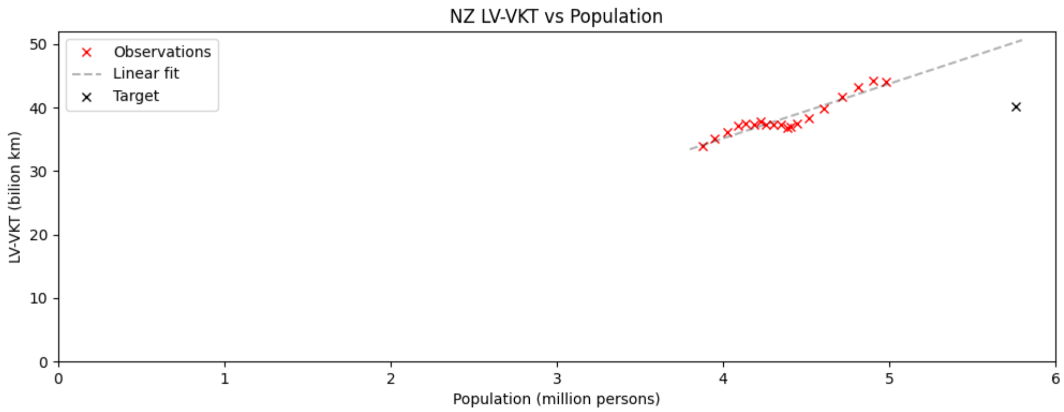

Figure 7: Linear Fit of National LV-VKT vs. Resident Population and the Target Given Population Reaches Medium Forecast

A more acute depiction of the LV-VKT per capita reduction is plotted below in a box and whisker plot (Figure 8). The circle plotted is LV-VKT per capita achieving the ERP target with a 20% reduction from mean LV-VKT per capita between the years 2001 to 2020.

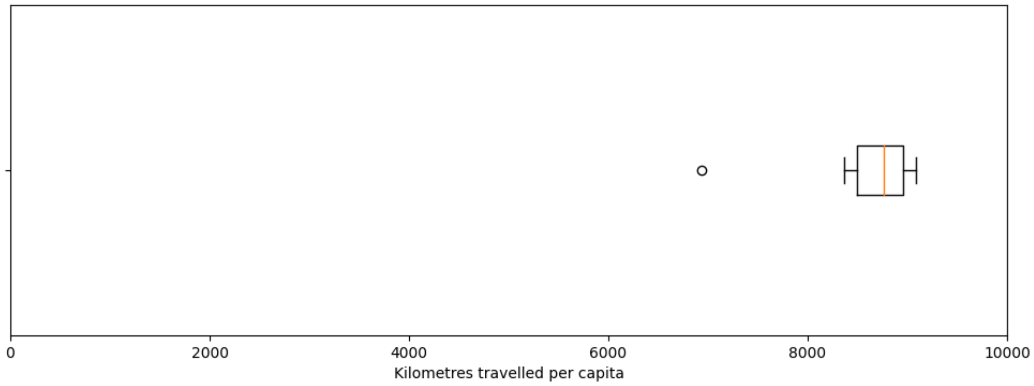

Figure 8: Historic National LV-VKT per capita and Target

3.5 Section summary

A 20% reduction in LV-VKT per capita is monumental. New Zealanders have never been anywhere close to driving this few kilometres per person since records began over 20 years ago.

4 Reduction feasibility in Tier 1

This section looks at current travel patterns and behaviour in Tier 1. It looks at journey distances and purposes. It is worth noting the distinction between trips and journeys. In the household travel survey, journeys are made up of multiple trip legs. For example, a stop via the supermarket on the way home from work is two trips. The first being purpose shopping/personal business between work and the supermarket, and the second with purpose 'going home'.

Key points:

- In Tier 1, 54% of journeys are under 6km. These contribute only 15.6% of LV-VKT in Tier 1.
- In Tier 1, 2.5% of journeys are greater than 50km. These contribute 22% of LV-VKT in Tier 1.
- Kilometres driven for purpose education contribute less than 1% of LV-VKT in Tier 1.
- 25.5% of Tier 1 LV-VKT is from journeys we think easier to shift to another mode. These are under 15km, in a main urban area, and for purpose either commute to work, shopping/personal, or social/entertainment.
- Longer journeys contribute disproportionately to LV-VKT. Potential solutions to reduce these include:
  - improved urban planning to satisfy their purpose with shorter journeys
  - improved public transport to shift these journeys to an alternative mode
  - dissuading longer driven journeys from being taken
  - increasing vehicle occupancy for longer journeys i.e., carpooling.

4.1 Datasets

We have a three HTS datasets which form the basis of this analysis (Table 5).

Table 5: Datasets

Dataset Name	Description
HTS Estimates by mode and roadtype 2011-07 to 2014-06	Annual million km travelled for trips by mode, urban class, tier, and road type. From the 2011-14 HTS.
HTS Estimates 2011-07 to 2014-06	Annual million km travelled for trips by mode, urban class, tier, age bin, distance bin, and purpose. From the 2011-14 HTS.
HTS Estimates 2011-07 to 2014-06 – WSP revised 2022-08-29	Annual million km travelled for journeys by mode, urban class, tier, age bin, revised distance bin, and purpose. From the 2011-14 HTS.
HTS – NZTA AAM – Distance by Region, MUA, Mode, Purpose	Annual million km travelled for trips by Region, MUA (y/n), mode, and purpose. From the 2018-21 HTS.

The datasets differ, in that some are from the 2018-21 HTS survey and some from the 2011-14 HTS survey. It takes time to request and receive data relating to the HTS, and we were not allowed to access the raw data.

Limitations:

- Trips are not necessarily independent. Trip legs form a journey. Consider a journey where a driver leaves home and drops their child at school, then drives to Park & Ride, then catches a train to the city, then walks to work from the city station. This journey is made up of 4 trips. The drive from school to their local train station could be short, let's say 1km. But this trip is not independent. They may have driven 6km to drop their kid at school first. It may seem feasible to divert a 1km driven trip in isolation, but the context of the journey affects the trip. Trip chaining is common. People often drive for multiple purposes.

- Journey purposes are allocated based on the longest distance travelled by that mode. If a journey consists of 3km driving, 2km on the train, and 500m walking, then it will be classed as a driven journey of distance 4-6km. These journeys are grouped together, with other attributes as well as distance, and the data shows total kilometres travelled cumulatively by category of journey.
- Area attributes of journeys (such as Tier, region, area type) are assigned based on the traveler's place of residence, not where the journey necessarily took place. We assume that journeys taken are within this area for the study's purpose.

4.2 LV-VKT by Tier and urban area

Over 60% of all LV-VKT is driven by residents of Tier 1 areas (Figure 9). For Tier 1, we assume that residents of an area drive their journeys in this area type. Tier 1 areas will need the heaviest reduction in LV-VKT since alternative travel options are more accessible.

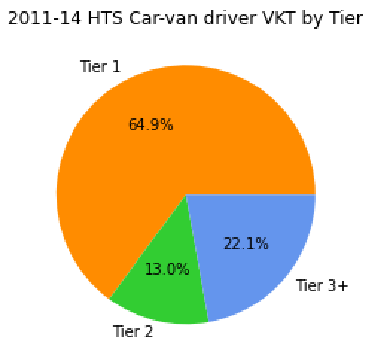

Figure 9: 2011-14 HTS Car/van driver VKT by Tier

Draft Waka Kotahi Research Note "VKT and GHG Emissions Baseline Report" shows a very similar prediction for how much LV-VKT will be travelled in each tier in year 2035 (Figure 10). This proportion is assuming travel behaviour has not changed and is based on 2019 LV-VKT per capita.

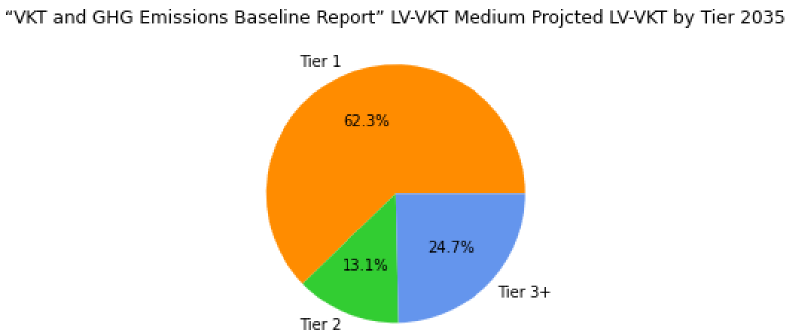

Figure 10: VKT and GHG Emissions Baseline Report Car/van VKT by Tier

4.3 Urban class

In Tier 1, only 81.1% of VKT by drivers is driven in main urban areas (Figure 11). We consider it unlikely that rural Tier 1 trips will be diverted to an alternative mode. Public transport is often not viable rurally. Roads in these areas are also more dangerous to travel on by active modes.

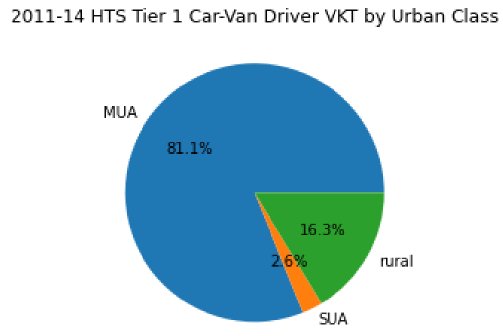

Figure 11: 2011-14 HTS Tier 1 Car/van Driver VKT by Urban Class

For the different tiers, their rural, Secondary Urban Area (SUA), and Main Urban Areas (MUA) split is as follows: (Table 6)

Table 6: 2011-14 HTS Tier 1 Car/van Driver VKT by Urban Class and Tier

Car/Van Driver VKT Proportions	MUA	SUA	Rural
Tier 1	81.1%	2.6%	16.3%
Tier 2	75.5%	0%	24.5%
Tier 3+	14.7%	24.4%	60.9%

In Tier 3+ areas, a majority of VKT driven is on rural roads (Table 6). These journeys will be difficult to divert to any other mode.

We investigate what scale of reduction can be achieved within Tier 1 MUAs.

4.4 Tier 1 MUA journey purposes

Already, 18.9% of VKT in Tier 1 areas will be less feasible to divert due to not being in an MUA (Figure 11). We focus on the remaining 81.1%.

To begin with, we consider for what purposes reductions may be able to occur. In Tier 1 MUAs, LV-VKT is distributed by journey purpose as below: (Figure 12)

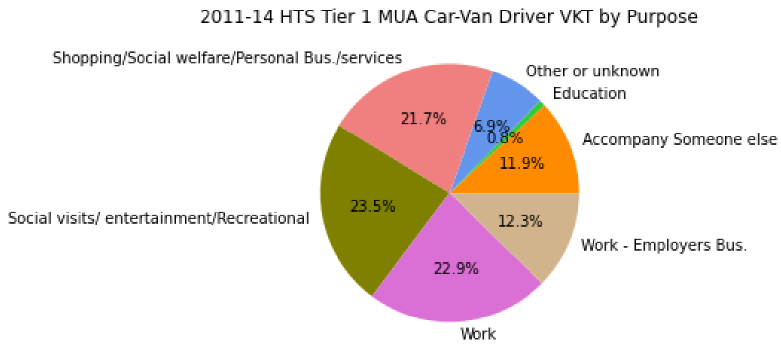

Figure 12: 2011-14 HTS Tier 1 MUA Car/van driver Journey VKT by Purpose

We think that three purposes have the potential for a significant VKT reduction:

1. went to work,
2. shopping/personal business, and
3. social visit/entertainment.

These three purposes make up 68.1% of LV-VKT in Tier 1 MUA areas and are the three largest purpose contributors to LV-VKT. Some observations are:

- Completing study/education as a journey purpose contributes less than 1% of LV-VKT; VKT reduction from a change of mode for this trip purpose will be negligible.
- Journeys made for work are unlikely to be diverted. Trades people need these vehicles and journeys in company cars are unlikely to be diverted due to travel time, convenience, and the nature of business.
- Journeys accompanying someone are also unlikely to be diverted. Some of these may be taking someone to hospital, dropping someone off far away, taking kids to extra-curricular activities, etc.
- LV-VKT from 'other or unknown' trips is mostly made up of trips over 50km in length. As we do not know the purpose, it is hard to speculate their reduction.
-

The following two tables show LV-VKT and sample proportions for Tier 1 MUA journeys by purpose (Table 7 and 8).

Table 7: Tier 1 MUA % of VKT travelled of mode car/van drivers by distance bin by purpose

Tier 1 MUA % of VKT travelled of mode car/van drivers by distance bin by purpose	Accompany Someone else	Education	Other or unknown	Shopping/ Social welfare/ Personal Bus./ services	Social visits/ entertainment/ Recreational	Work	Work - Employers Bus.
[0,2)	5.36%	1.88%	0.85%	6.45%	2.21%	1.39%	1.35%
[2,4)	10.68%	6.92%	1.87%	11.3%	6.24%	4.16%	3.13%
[4,6)	10.41%	7.19%	2.87%	10.53%	7.03%	5.89%	4.33%
[6,8)	9.14%	11.09%	1.89%	8.54%	7.0%	7.21%	4.44%
[8,10)	8.34%	11.84%	2.46%	6.33%	5.87%	6.75%	4.62%
[10,15)	14.02%	12.42%	3.78%	11.78%	11.49%	18.37%	14.01%

[15,20)	10.25%	28.01%	4.83%	8.02%	10.33%	14.84%	12.78%
[20,25)	8.87%	13.67%	4.62%	6.45%	7.43%	13.22%	10.79%
[25,30)	4.53%	6.97%	2.52%	3.63%	4.62%	10.33%	7.0%
[30,40)	5.9%	0%	4.21%	3.6%	4.75%	8.65%	8.69%
[40,50)	2.2%	0%	2.83%	2.51%	4.05%	3.25%	4.12%
[50,Inf)	10.3%	0%	67.27%	20.83%	28.98%	5.95%	24.74%

Table 8: Tier 1 MUA % of sampled journeys travelled of mode car/van drivers by distance bin by purpose

Tier 1 MUA % of sampled journeys travelled of mode car/van drivers by distance bin by purpose	Accompany Someone else	Education	Other or unknown	Shopping/ Social welfare/ Personal Bus./ services	Social visits/ entertainment/ Recreational	Work	Work - Employers Bus.
[0,2)	22.59%	14.14%	14.85%	28.9%	17.89%	12.87%	13.97%
[2,4)	22.64%	20.2%	16.35%	23.22%	19.47%	15.13%	14.05%
[4,6)	14.72%	11.11%	13.46%	15.31%	14.87%	13.59%	12.06%
[6,8)	10.95%	15.15%	7.59%	9.04%	11.19%	11.63%	10.39%
[8,10)	6.74%	11.11%	7.05%	5.5%	7.83%	8.8%	7.6%
[10,15)	9.02%	10.1%	8.44%	7.9%	10.49%	14.32%	13.46%
[15,20)	5.28%	10.1%	7.05%	3.86%	6.19%	8.67%	9.08%
[20,25)	3.22%	4.04%	4.17%	2.35%	3.68%	6.34%	6.45%
[25,30)	1.65%	4.04%	3.31%	1.23%	2.04%	3.72%	3.98%
[30,40)	1.57%	0%	3.85%	0.88%	1.88%	2.94%	3.5%
[40,50)	0.44%	0%	1.82%	0.46%	1.21%	0.87%	1.79%
[50,Inf)	1.18%	0%	12.07%	1.34%	3.28%	1.1%	3.66%

4.5 Public transport trip purposes

Diverting longer distance journeys to public transport (PT) will be effective at reducing LV-VKT. The viability of purposes is reflected by PT's current use. Almost 30% of PT person-VKT is from people travelling to work (Figure 13). Note that the distribution is not public transport VKT (e.g., how far a bus travels), rather the person-VKT travelled. A bus with 30 people will contribute three times as much PT person-VKT as a bus with 10 people for the same distance.

Completing study/education contributes almost 20% of PT person-VKT (Figure 13). This is in strong contrast to the mere 0.8% of LV-VKT contributed for the same purpose. Other/unknown trip purposes account for almost 40% (Figure 13).

No PT person-VKT is contributed by those making a trip for work (Figure 13). This demonstrates how unviable its purpose is for being diverted from driving. Likewise, for accompanying someone/dropping someone off, suggesting it will be difficult to divert journeys of this purpose to PT. This reinforces our belief that going to work, shopping/personal, and social/entertainment trips will be the most feasible to divert to public transport. Completing study/education could also be feasible trips to divert, but because they make up less than 1% of driven VKT (Figure 12), it will contribute negligibly towards achieving the ERP target. The proportion of unknown PT journey purposes is concerning.

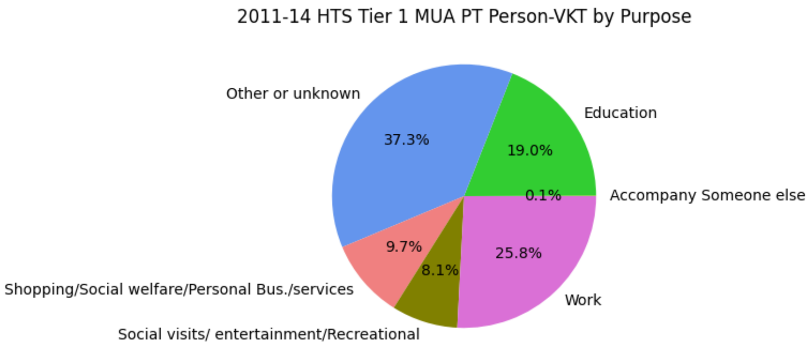

Figure 13: 2011-14 HTS Tier 1 MUA Person-VKT on PT by Purpose

4.6 Journey distances

Overall, in Tier 1 across all purposes, 60% of car driver VKT is by trips of journey length greater than 15km (Figure 14). These journeys will be difficult to divert to an alternative mode.

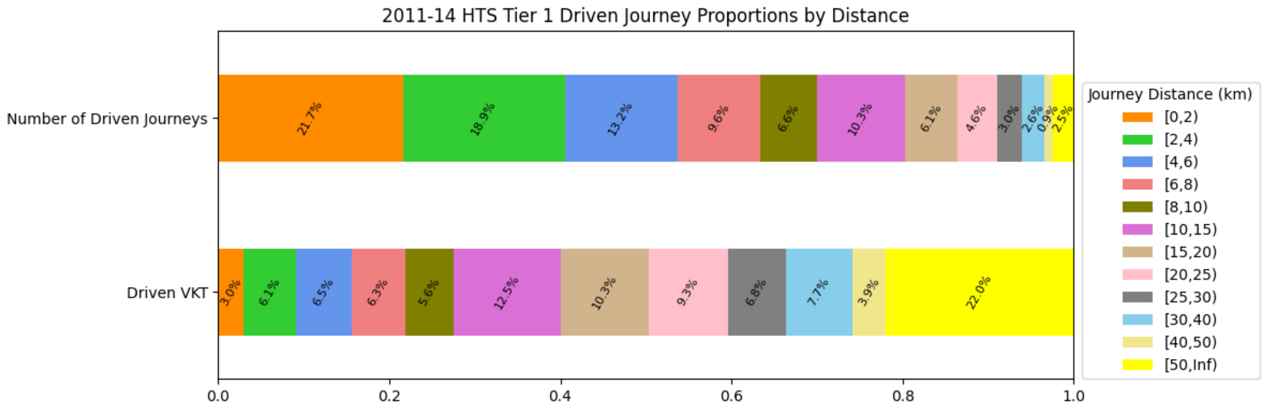

Figure 14: 2011-14 HTS Tier 1 Car/van driver Journey Numbers and VKT by Journey Length

2.5% of journey's contribute over 20% of VKT (Figure 14). These journeys are over 50km in length and are practically infeasible to be diverted to another mode. At the other extreme, 54% of driven journeys are under 6km – these contribute only 15.6% of LV-VKT (Figure 14). Let's imagine we diverted every Tier 1 driven trip in the entire country under 6km – we would not achieve a 20% LV-VKT reduction in the area (Figure 14).

For all of driving, walking, cycling, and passenger modes, over 20% of journeys taken in Tier 1 are under 2km in length (Figures 14, 15, 16, 17, and 18). Public transport is the exception to this rule (Figure 15). This indicates short driven journeys, under 2km, are less likely to be shifted to public transport. Instead, journeys under 2km are more likely to be taken by active modes.

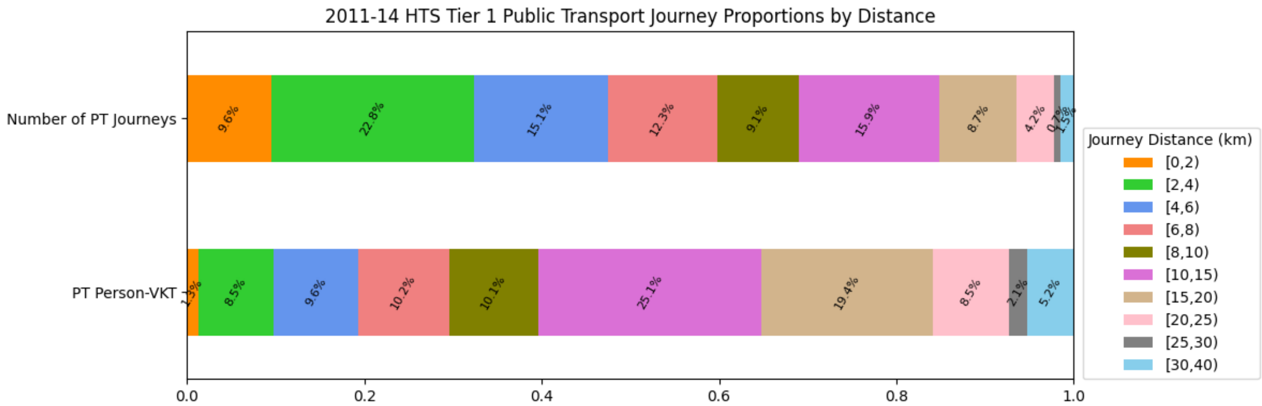

Figure 15: 2011-14 HTS Tier 1 PT Journey Numbers and Person-VKT by Journey Length

Pedestrian journeys are short. About 90% are under 2km (Figure 16). About 40% of cycled journeys are under 2km, and all cycled journeys in the 2011-14 HTS were under 25km (Figure 17).

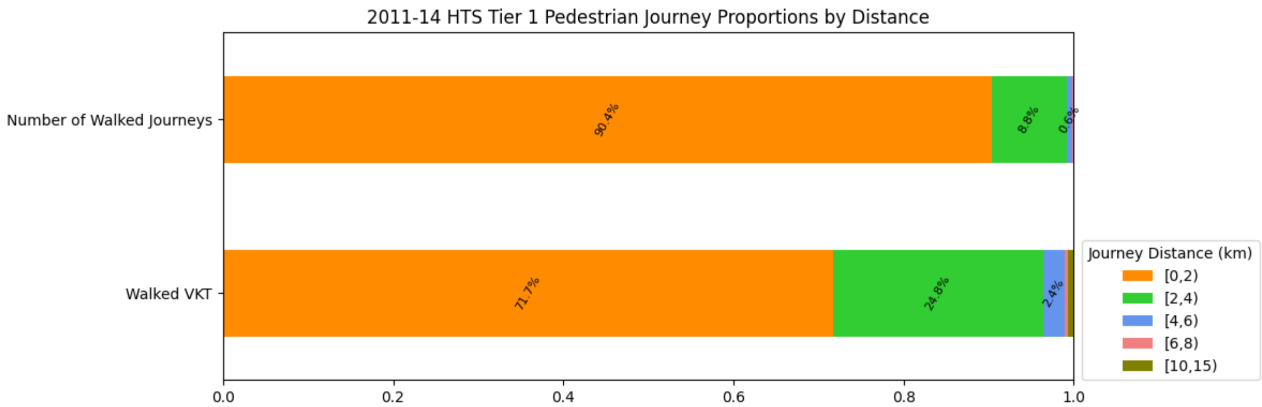

Figure 16: 2011-14 HTS Tier 1 Pedestrian Journey Numbers and Walked Kilometres by Journey Length

With 25km being the maximum cycled distance (Figure 17), current driven journeys over 25km are left with two feasible alternatives: public transport or carpooling. 25km isn't extraordinarily far by car, it takes about 30 minutes to drive. By public transport, it would be significantly longer and, depending on your journey constraints, completely infeasible. Carpooling as a passenger is the alternative, enabling this mode of transport to divert current drivers is its own challenge.

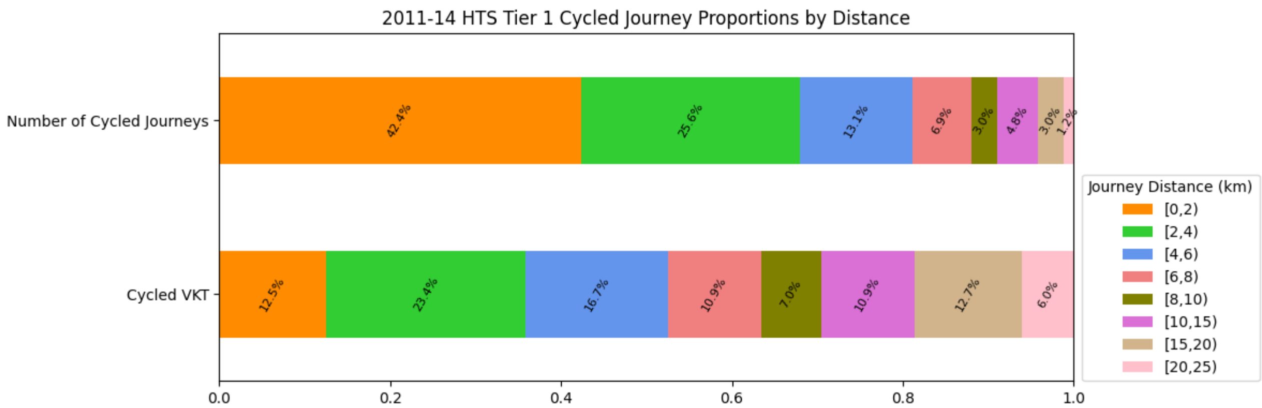

Figure 17: 2011-14 HTS Tier 1 Cycled Journey Numbers and Cycled Kilometres by Journey Length

Car/van passengers travel the most significant proportion of their cumulative person-VKT in long journeys over 50km. Still, most passenger journeys are under 15km in length.

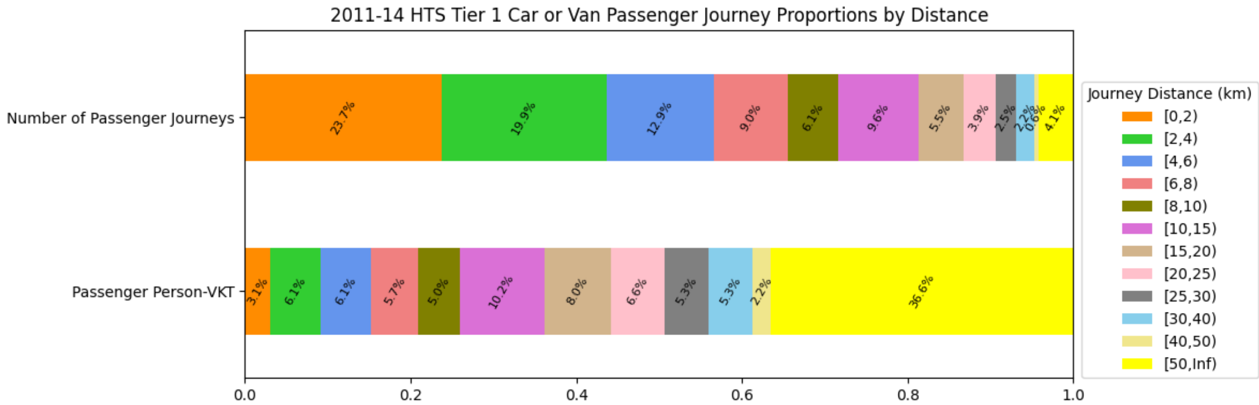

Figure 18: 2011-14 HTS Tier 1 Car/van Passenger Journey Numbers and Passenger-VKT by Journey Length

To tackle the 20% reduction target in LV-VKT, driving needs to be disincentivized, especially journeys of longer distances. If long trips can be changed to local trips, through urban planning, then it will reduce LV-VKT substantially. Public transport needs to improve such that it can service longer trips effectively. The 20% of driven journeys over 15km in length contribute 60% of kilometres travelled.

Focusing on Tier 1 MUA journeys which could be diverted to an alternative mode, of the three identified target purposes (going to work, social/ entertainment, and shopping/ personal), we find driver proportional journey number and VKT split as follows: (Figure 19)

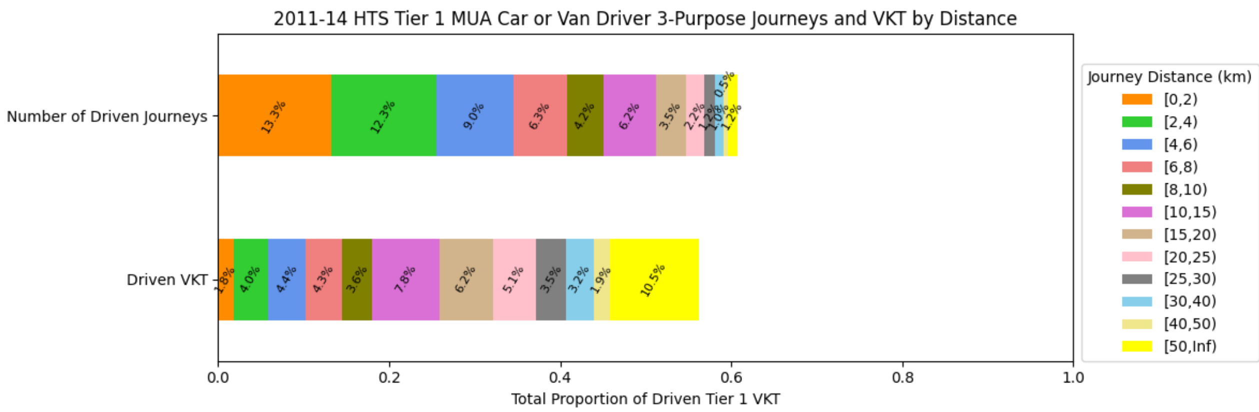

Figure 19: 2011-14 HTS Tier 1 MUA Car/van driver VKT by Journey Distance for Purposes 'Going to work', 'Social/entertainment', or 'Shopping/personal'

We consider public transport being the most feasible alternative mode for longer vehicle journeys. Most PT journeys taken are under 6km in length (Figure 15). We think that vehicle driven journeys under 15km are more likely to have any chance of being diverted to another mode. 15% of Tier 1 PT journeys taken are over 15km, contributing 35% of PT Person kilometres travelled (Figure 15). For driven journeys, 19.7% of journeys are over the distance of 15km, yet they contribute over 60% of LV-VKT (Figure 14).

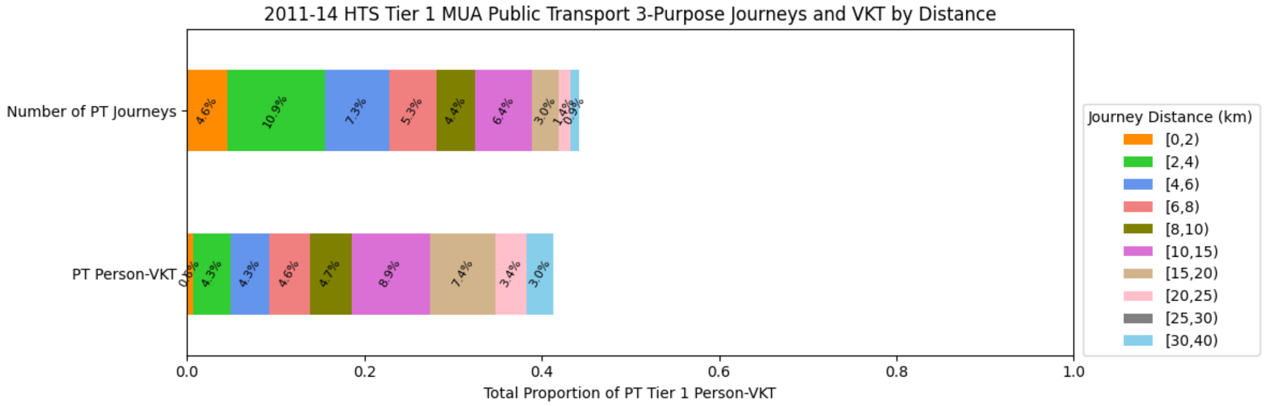

Figure 20: 2011-14 HTS Tier 1 MUA Public Transport VKT by Journey Distance for Purposes 'Going to work', 'Social/entertainment', or 'Shopping/personal'

Taking only journeys of Tier 1 MUA 3-purpose LV-VKT (Figure 19), 46.1% of VKT is less than 15km and hence available for reduction. In total, this leaves only 25.5% of Tier 1 LV-VKT having higher potential to be diverted. This figure of 25.5% represents 46.1% of the proportion of LV-VKT represented by the 3 purposes identified. If we wanted a 20% reduction of LV-VKT in Tier 1 areas, without touching longer trips or other purposes, 78.6% of these journeys would have to be taken by another mode. This is unrealistic.

5 Reduction feasibility in Tier 2

An equivalent analysis to Section 4 was undertaken, except using Tier 2 rather than Tier 1 areas. Tier 2 samples from the 2011-14 HTS are substantially smaller than those for Tier 1. The number of total journey samples by mode are as follows: (Table 9)

Table 9: Journey Sample Sizes by Mode and Tier

Mode	Tier 1 Journey Sample Size	Tier 2 Journey Sample Size
Driving	32,181	7,964
Passenger	17,388	4,048
Cyclist	694	111
Pedestrian	8,252	2,076
PT	1,839	101

Tier 2 sample sizes for cyclists and public transport are too small and are excluded from any analysis.

One interesting observation from the sample sizes is the ratio of driven journeys to public transport journeys. In Tier 1, for every 1 public transport journey there were 17.5 driven journeys (Table 9). In Tier 2, there were almost 80 driven journeys per PT journey. The ratio of driven journeys to PT journeys is over 4-times as large in Tier 2 compared to Tier 1. Perhaps this indicates an opportunity to achieve more mode shift in Tier 2 MUAs.

5.1 Urban class

Considering Tier 2, about 75% of VKT is contributed by drivers residing in main urban areas (Figure 21). This is less than the 81% driven in Tier 1 (Table 6). Like the previous section, we consider it unlikely that rural Tier 2 trips will be diverted to an alternative mode.

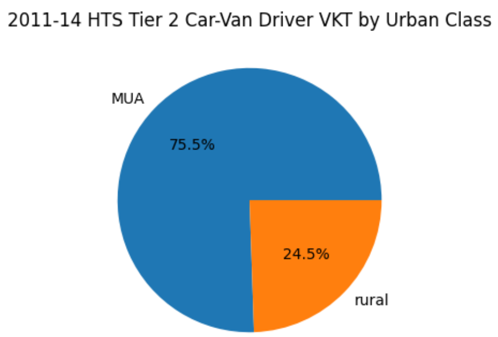

Figure 21: 2011-14 HTS Tier 2 Car/van Driver VKT by Urban Class

5.2 Tier 2 MUA journey purposes

In Tier 2, 24.5% of VKT will be less feasible to divert due to not being in an MUA (Figure 21). As in the previous analysis, we focus on the remaining 75.5%.

To begin with, we consider for what purposes reductions may be able to occur. In Tier 2 MUAs, LV-VKT is distributed by journey purpose as below: (Figure 22)

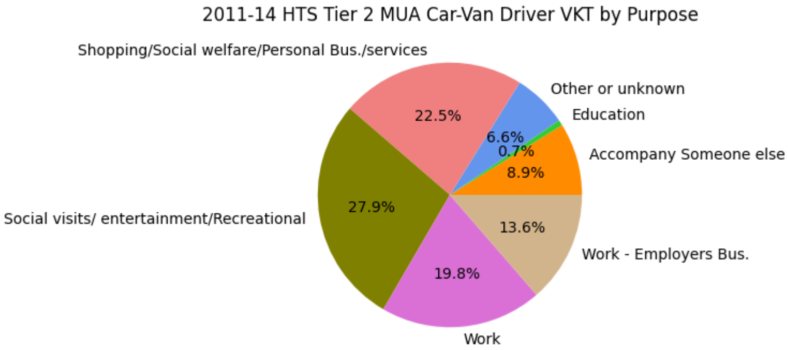

Figure 22: 2011-14 HTS Tier 2 MUA Car/van driver Journey VKT by Purpose

We think the same three purposes have higher potential for significant VKT reduction:

1. Went to work.
2. Shopping/personal business.
3. Social visit/entertainment.

These three purposes make up 70.2% of LV-VKT in Tier 2 MUA areas and are again the three largest purpose contributors to LV-VKT (Figure 22). The distribution of distance driven in Tier 2 MUAs by purpose is very similar to that in Tier 1. The same observations can be made:

- Completing study/education as a journey purpose contributes less than 1% of LV-VKT; VKT reduction from a change of mode for this trip purpose will be negligible.
- Journeys made for work are unlikely to be diverted. Trades people need these vehicles and journeys in company cars are unlikely to be diverted due to travel time, convenience, and the nature of business.
- Journeys accompanying someone are also unlikely to be diverted. Some of these may be taking someone to hospital, dropping someone off far away, taking kids to extra-curricular activities, etc.
- LV-VKT from 'other or unknown' trips is mostly made up of trips over 50km in length. As we do not know the purpose, it is hard to speculate their reduction.

The following two tables show LV-VKT and sample proportions for Tier 2 MUA journeys by purpose (Table 10 and 11).

Table 10: Tier 2 MUA % of VKT travelled of mode car/van drivers by distance bin by purpose

Tier 2 MUA % of VKT travelled of mode car/van drivers by distance bin by purpose	Accompany Someone else	Education	Other or unknown	Shopping/ Social welfare/ Personal Bus./ services	Social visits/ entertainment/ Recreational	Work	Work - Employers Bus.
[0,2)	8.58%	1.26%	0.77%	7.38%	2.84%	3.07%	1.38%
[2,4)	19.4%	10.49%	2.73%	15.58%	8.06%	9.54%	4.24%
[4,6)	15.55%	63.54%	5.3%	11.47%	8.16%	11.58%	4.39%
[6,8)	12.16%	24.71%	1.76%	5.77%	5.92%	8.94%	3.05%
[8,10)	6.02%	0.00%	0.96%	3.92%	3.68%	6.14%	2.01%
[10,15)	10.94%	0.00%	3.96%	9.35%	7.24%	13.46%	5.48%
[15,20)	7.74%	0.00%	4.57%	6.49%	5.52%	15.18%	5.38%
[20,25)	5.91%	0.00%	3.13%	2.19%	4.17%	8.17%	3.3%
[25,30)	1.68%	0.00%	3.9%	1.81%	3.25%	1.39%	2.9%
[30,40)	0.00%	0.00%	0.00%	1.21%	2.49%	5.37%	1.91%
[40,50)	0.00%	0.00%	0.00%	1.89%	3.69%	1.61%	4.98%
[50,Inf)	12.01%	0.00%	72.93%	32.95%	44.97%	15.54%	60.99%

Table 11: Tier 2 MUA % of sampled journeys travelled of mode car/van drivers by distance bin by purpose

Tier 2 MUA % of sampled journeys travelled of mode car/van drivers by distance bin by purpose	Accompany Someone else	Education	Other or unknown	Shopping/ Social welfare/ Personal Bus./ services	Social visits/ entertainment/ Recreational	Work	Work - Employers Bus.
[0,2)	30.55%	12.24%	15.0%	32.07%	24.02%	21.6%	20.31%
[2,4)	25.85%	22.45%	20.0%	26.41%	21.81%	21.32%	20.7%
[4,6)	17.27%	36.73%	22.69%	16.92%	17.44%	18.4%	15.82%
[6,8)	9.52%	28.57%	8.85%	7.11%	10.2%	10.57%	8.79%
[8,10)	4.82%	0.00%	3.46%	3.84%	5.53%	5.75%	5.27%
[10,15)	5.17%	0.00%	8.08%	6.14%	7.0%	9.43%	9.57%
[15,20)	3.17%	0.00%	5.0%	3.22%	4.24%	6.89%	5.66%
[20,25)	1.65%	0.00%	2.31%	0.88%	2.7%	2.36%	2.73%
[25,30)	0.71%	0.00%	2.31%	0.57%	1.35%	0.57%	1.56%
[30,40)	0.00%	0.00%	0.00%	0.31%	0.98%	1.23%	1.37%
[40,50)	0.00%	0.00%	0.00%	0.44%	0.8%	0.57%	1.76%
[50,Inf)	1.29%	0.00%	12.31%	2.08%	3.93%	1.32%	6.45%

From the Tier 2 MUA journeys, no driven education journeys were longer than 8km. Driven journeys for education are completed by older high-school children or university students. A vast majority of tertiary students study at institutions in Tier 1 areas. In 2021, approximately 90% of all students studied in a region containing a Tier 1 area.[8] We think educational institutions in Tier 2 areas are much more likely to have accommodation near to location of study at an affordable student price, and hence long journeys to education are not necessary.

5.3 Journey distances

Overall, in Tier 2 across all purposes, about 60% of car driver VKT is by trips of journey length greater than 15km (Figure 23). These journeys will be difficult to divert to an alternative mode.

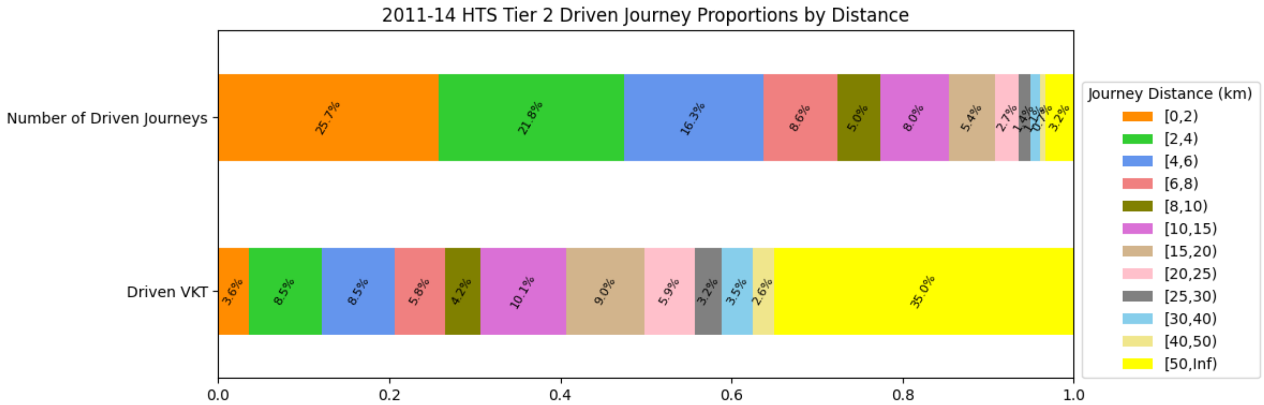

Figure 23: 2011-14 HTS Tier 2 Car/van driver Journey Numbers and VKT by Journey Length

3.2% of journey's contribute over a third of VKT in Tier 2 (Figure 23). These journeys are over 50km in length and are practically infeasible to be diverted to another mode. At the other extreme, 63.8% of driven journeys are under 6km – these contribute 20.6% of LV-VKT, (Figure 23). Diverting every Tier 2 driven trip in the entire country under 6km would only just achieve a 20% LV-VKT reduction in the area (Figure 23).

It is worth mentioning, again, the limitation that journey area attributes are assigned based on location of residence. Tier 2 areas will be particularly sensitive to this assumption. If a journey is travelled rurally but is completed by a person who resides in a Tier 2 MUA, the journey will be classed as within Tier 2 MUA. We think journeys over 50km, within a Tier 2 MUA, are quite likely to be predominantly driven through rural areas. Investigation into the more granular HTS data will address these limitations.

The distribution between Tier 1 and 2 differs most significantly for longer journeys over 20km. We first look at journeys between 20 and 50km in length. In Tier 2, 5.9% of journeys are in this distance range, contributing 15.2% of LV-VKT. In Tier 1, these same proportions are 10.5% and 27.7% respectively – almost double. From a Tier 2 area, we suspect that driving 20km will take you past the edge of the urban area, at which point the driver is either travelling to a rural location or to a different town altogether. Towns are often located more than 50km apart. Locations at a distance between 20 and 50km from a Tier 2 urban area likely few.

Journeys over 50km contribute 35% of LV-VKT in Tier 2 compared to 22% in Tier 1. We look at the ratio of proportionate driven LV-VKT against the proportionate number of journeys taken. The higher the ratio, the more disproportionately trips of that distance contribute to the total LV-VKT. An interesting task for future work may be breaking these down further by journey purposes. Do certain purposes tend to be significantly longer?

[8] https://www.educationcounts.govt.nz/statistics/tertiary-participation Provider-based enrolments

Table 12: Proportion of LV-VKT divided by Proportion of Sample Size for Journey Distance Bins by Tier

Distance Bin	[0, 2)	[2, 4)	[4, 6)	[6, 8)	[8, 10)	[10, 15)	[15, 20)	[20, 25)	[25, 30)	[30, 40)	[40, 50)	[50, Inf)
Tier 1	0.13	0.32	0.49	0.66	0.85	1.21	1.69	2.02	2.27	2.96	4.33	8.8
Tier 2	0.14	0.39	0.52	0.98	0.84	1.26	1.67	2.19	2.29	3.18	3.71	10.94

We plot the above values below, using a bin's maximum along the horizontal axis and excluding the 50+ km journey bin (Figure 24).

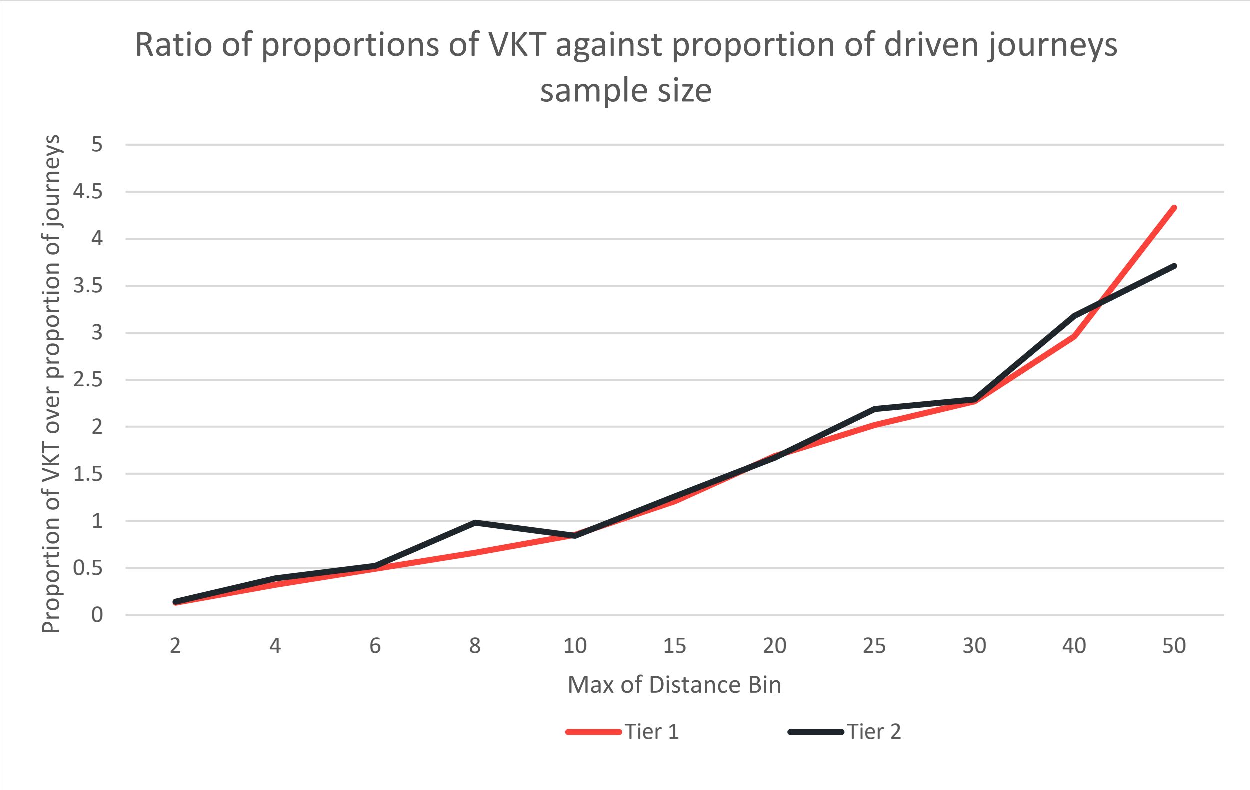

Figure 24: Percentage of VKT divided by Percentage of Total Sample for Journey Distance Bins by Tier

At about 12km journey distance, the curve crosses one. So, the proportion of journeys travelling 12km contribute an equal proportion of LV-VKT.

Similar to Tier 1, all of driving, walking, and passenger modes, over 25% of journeys taken in Tier 2 are under 2km in length (Figures 23, 25, and 26).

Pedestrian journeys are short. About 90% are under 2km (Figure 25).

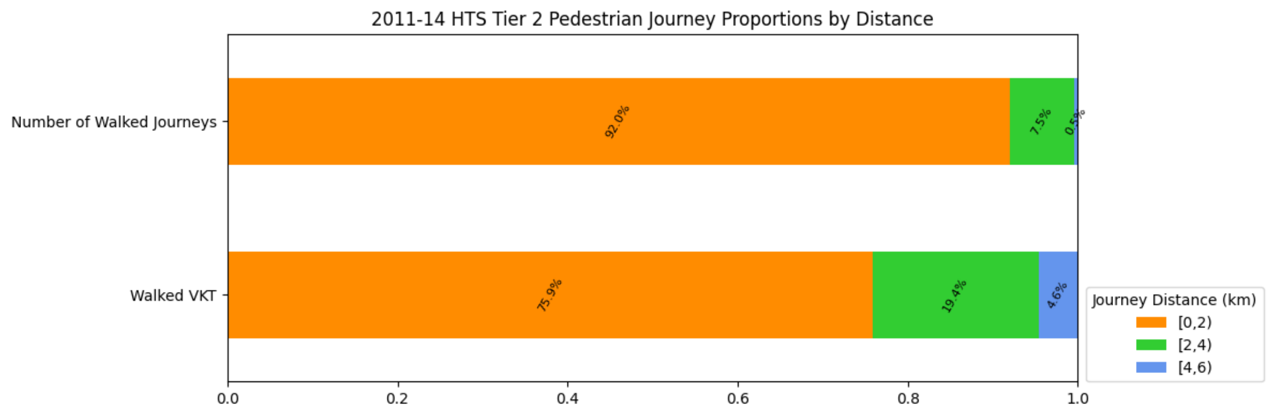

Figure 25: 2011-14 HTS Tier 2 Pedestrian Journey Numbers and Walked Kilometres by Journey Length

Car/van passengers travel over half of their cumulative person-VKT in long journeys over 50km in Tier 2. Still, about 90% of passenger journeys are under 15km in length.

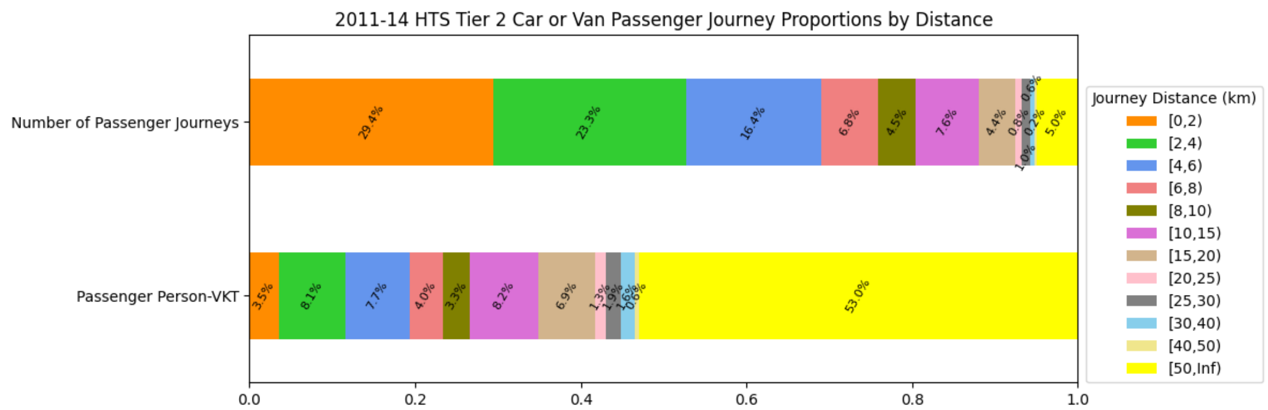

Figure 26: 2011-14 HTS Tier 2 Car/van Passenger Journey Numbers and Passenger-VKT by Journey Length

To tackle the 20% reduction target in LV-VKT, driving needs to be disincentivized, especially journeys of longer distances. If long trips can be changed to local trips, through urban planning, then it will reduce LV-VKT substantially. Public transport needs to improve such that it can service longer trips effectively. The 20% of driven journeys over 15km in length contribute 60% of kilometres travelled.

Focusing on Tier 2 MUA journeys which could be diverted to an alternative mode, of the three identified target purposes (going to work, social/ entertainment, and shopping/ personal), we find driver proportional journey number and VKT split as follows: (Figure 27)

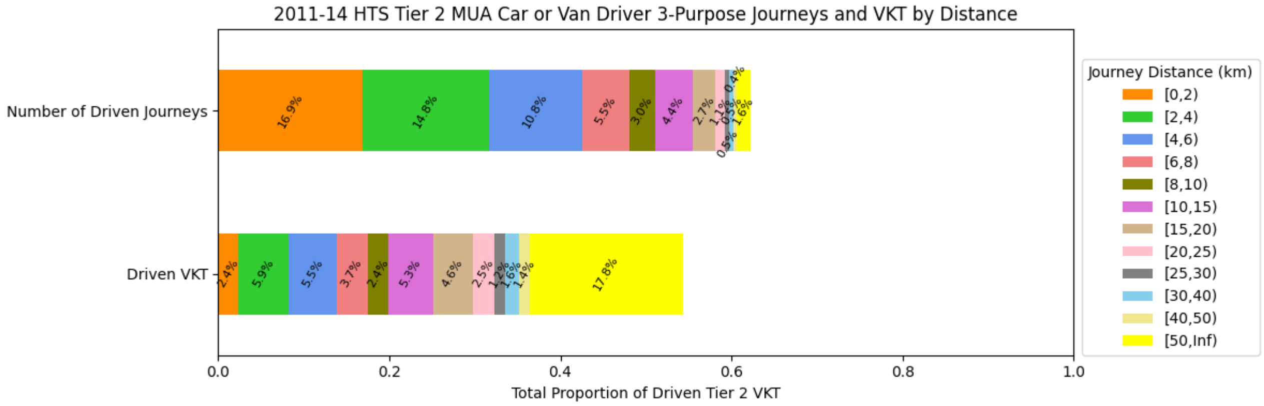

Figure 27: 2011-14 HTS Tier 2 MUA Car/van driver VKT by Journey Distance for Purposes 'Going to work', 'Social/entertainment', or 'Shopping/personal'

In Tier 2 areas, journeys over 15km are almost guaranteed to involve rural travel, or travel between different towns. Take Nelson for example – a relatively large city within Tier 2. The distance from the south-western edge of Richmond to the north-eastern edge of Nelson is approximately 15km (Figure 28). This is about the furthest distance feasible to travel within the urban area[9] as depicted by Google Maps' colour scheme.

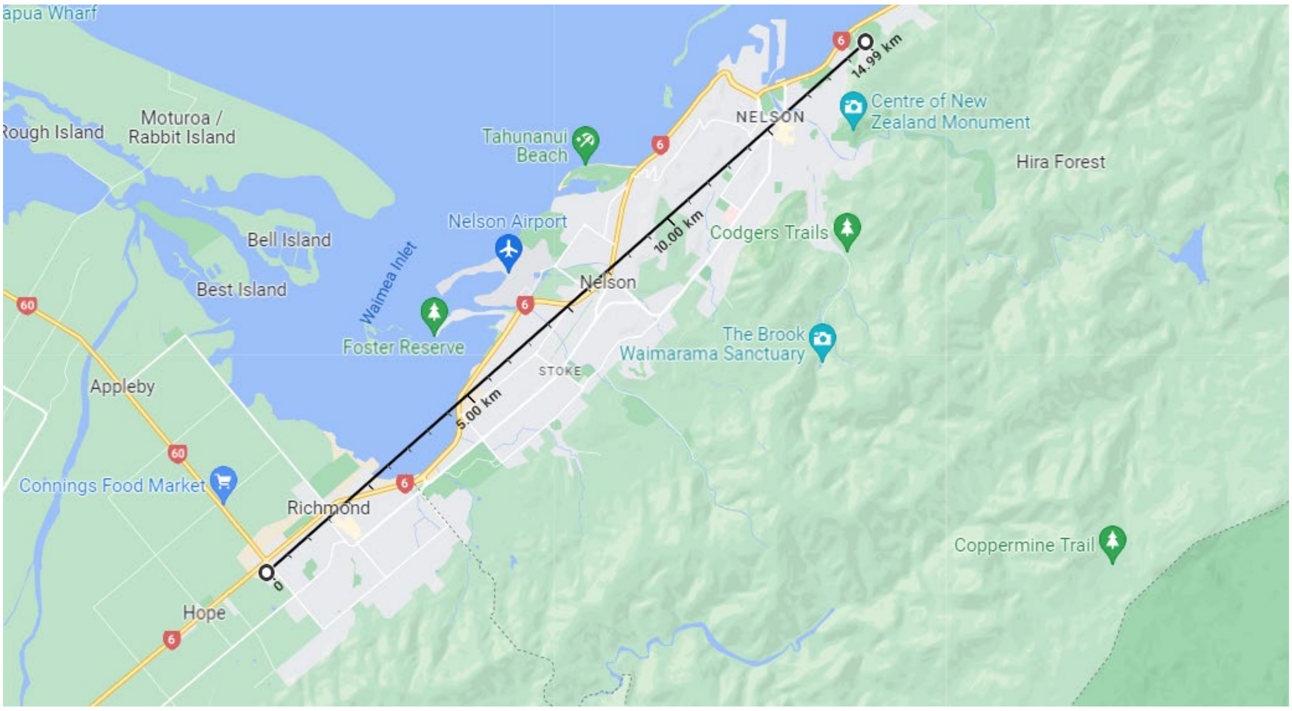

Figure 28: Google Maps Screenshot of Nelson

Taking only journeys of Tier 2 MUA 3-purpose (going to work, social/ entertainment, and shopping/ personal) LV-VKT (Figure 27), 46.4% is from journeys less than 15km and hence potentially available for reduction. In total, this leaves only 25.2% of Tier 2 LV-VKT having higher potential to be diverted – an almost identical figure to Tier 1. This figure of 25.2% represents 46.6% of the proportion of LV-VKT represented by the 3 purposes identified. If we wanted a 20% reduction of LV-VKT in Tier 2 areas, without touching longer trips or other purposes, 79.3% of these journeys would have to be taken by another mode. Again, this is unrealistic.

[9] Not equivalent to main urban area or other area definitions used.

Tier 2 includes both the Nelson and Tasman District territorial authorities (Table 2). The Tasman District is a huge land area within which we suspect very little LV-VKT is feasible to shift to an alternative mode such as public transport. Driven journeys will most likely be between small towns, which frequent public transport does not serve. So, to further constrain Tier 2's potential, the threshold of 15km should likely be lowered since a journey of this length from Tier 2 MUAs are unlikely to be fully within an urban area (see Figure 28 above depicting that a journey of 15km is unlikely to be fully within an urban area).

6 Conclusion

To conclude, we are unlikely to achieve a 20% reduction in LV-VKT in Tier 1 or Tier 2 areas by simply diverting existing trips to alternative modes. Trips will have to be cancelled, most likely by disincentivizing driving as a mode of travel. Carpooling, especially for work, could provide some reduction. Public transport will need to improve significantly to cater journeys of length greater than 15km at a level of service which competes with driving. Vehicle journeys over 20km in length contribute about half of total Tier 1 VKT.

In Tier 1, we predict 25.5% of LV-VKT has higher feasibility of being diverted. These journeys are:

- under 15km in length.
- in main urban areas.
- for purposes going to work, shopping/personal, or social/entertainment.

If we were to achieve a 20% reduction in Tier 1 areas, almost 80% of these trips would have to be diverted to another mode. This is simply unrealistic. Instead, driving needs to be disincentivized. To achieve the national target, Tier 1 areas will need a much greater reduction in LV-VKT than just 20%.

A very similar proportion is found in Tier 2, except longer journeys contribute an even higher proportion of kilometres than in Tier 1. Many of these are most likely driven through rural areas.

The scope for reduction of journey types needs to be significantly expanded from the above to achieve the ERP target. Longer journeys need to be discouraged and ultimately cancelled. This requires disincentivizing driving as a mode of transport altogether and providing alternative options. Longer journeys often don't have feasible alternative mode options, but they contribute too many kilometres of travel. In Tier 1, 20% of driven journeys contribute 60% of LV-VKT. These are over 15 km. Inversely, 54% of Tier 1 journeys taken are under 6 km, yet these contribute only 18% of Tier 1 LV-VKT. Minimising short driven journeys is important, but less rewarding in terms of the ERP target.

The question arises – which are easier to target: fewer long journeys or many short journeys? It's a redundant question; all journey types need to be reduced to achieve the ERP target. Shorter journeys are easier to target by providing safe and effective alternative travel options. But longer journeys must also be reduced – they contribute too many kilometres travelled and the ERP target cannot be achieved without reducing long trips.

Urban planning and land use hence plays a critical role in our future. Development at urban fringes, without reliable and frequent public transport services or local amenities, creates reliance on cars and introduces frequent longer journeys by car. Examples of this include Rolleston Fields and Plimmerton Farm developments. Creating urban sprawl creates longer journeys and more LV-VKT.

Before tackling kilometres travelled, firstly consider the question of why people drive. It's often faster, it's weather-proof, safe, convenient, and versatile. People love having flexibility. In a car, we can go anywhere at a moment's notice. We can chain trips together, take any route we wish, and visit places in any direction. We have designed the entire transportation system to accommodate cars. How are we going to dissuade people from driving? Long trips are often cheapest by car.[10] Driving saves time, gets you door to door, and gives the user flexibility. Considering elasticities, how do make longer distance trips (over 15km) unattractive enough such that current drivers won't use their car?

[10] Generalised cost.

7 Next Steps

A beginning step would be to identify where long journeys in Tier 1 are currently originating from and going to. What times they are taken for what purposes is also important. How feasible are these journeys to cancel?

Considerable work to reduce LV-VKT will be needed to meet the target of the emissions reduction plan. We suggest the following next steps:

- Gain access to the full household travel survey data to undertake more detailed or specific investigations relating to the ERP LV-VKT reduction target.

- Undertake a detailed literature review into why people drive in New Zealand and what their feasible alternatives are. Some identified literature is listed below as a starting point.

  - Driver Travel (transport.govt.nz)
  - NZ's car ownership culture can't be our future - The University of Auckland
  - Research Report 394 Development and application of NZ car ownership and traffic forecasting model (nzta.govt.nz)
  - The x-minute city: Measuring the 10, 15, 20-minute city and an evaluation of its use for sustainable urban design - ScienceDirect
  - New Zealand's most walkable towns and cities ranked | Stuff.co.nz
  - Reducing our reliance on cars: The shifting future of urban transportation | MIT Sloan
  - A global analysis of urban design types and road transport injury: an image processing study - The Lancet Planetary Health

- Develop technological solutions which will help reduce reliance on cars, such as smart sharing mobility platforms that allow for flexible, reliable, and environmentally-sustainable travel (NZ's car ownership culture can't be our future - The University of Auckland).
- Using raw HTS data find:

  - What proportion of driven journeys start and finish within 1km total walk of PT facilities serviced without transfers?
  - Can we use Google maps travel planning to observe how many journeys are within X% of driven travel time by public transport? Or cycling/micro-mobility?
  - Of journeys over 15km, how many of these have viable PT alternative? How could we measure this?
  - How do Tier 1 cities differ in their travel behaviours?
  - Investigate how many trips various journeys are comprised of.

Appendix: Raw Datasets

Description	File Name
MOT LV-VKT and LV-VKT per capita by year	LV-VKT.csv
MOT LVKT by region by year	regionalVKT.csv
Stats NZ quarterly estimated resident population of NZ by year	resPop.csv
Stats NZ population projections, birth, deaths, increase, and migration to 2048 by region area and age.	2018to2048_subnational_population_projections.xlsx
Annual million km travelled for trips by mode, urban class, tier, and road type. From the 2011-14 HTS.	HTS Estimates by mode and roadtype 2011-07 to 2014-06.xlsx
Annual million km travelled for trips by mode, urban class, tier, age bin, distance bin, and purpose. From the 2011-14 HTS.	HTS Estimates 2011-07 to 2014-06.xlsx
HTS Estimates 2011-07 to 2014-06 – WSP revised 2022-08-29	Annual million km travelled for journeys by mode, urban class, tier, age bin, revised distance bin, and purpose. From the 2011-14 HTS.
Annual million km travelled for trips by Region, MUA (y/n), mode, and purpose. From the 2018-21 HTS.	HTS – NZTA AAM – Distance by Region, MUA, Mode, Purpose.xlsx