

Carbon Emissions and Vehicle Kilometre Travelled Assessment for Private Plan Change (Drury West)

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Quality statement

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1 Introduction and Background

1.1 Transport Emissions Reduction Pathway

Transport Emissions Reduction Pathway (TERP) sets out a plan to reduce Auckland's transport emissions by 64%, or about half of Auckland's regional emissions against a 2016 baseline, by 2030. The TERP was endorsed by Auckland Transport's board and adopted by Auckland Council in August 2022. It provides formal direction that Auckland Council and Auckland Transport must follow in all of their activities. In the context of a Private Plan Change, TERP is one of many documents that must be considered under the Resource Management Act.

1.2 Private Plan Change (Drury West)

Fisher & Paykel Healthcare Properties Limited (FPH) has engaged Stantec to provide a CO₂ Emissions and Vehicle Kilometre Travelled (VKT) Assessment associated with the proposed Structure Plan and Private Plan Change (PPC) for FPH's site at 300, 328, 350, 370 and 458 Karaka Road, Drury (Site). The purpose of the PPC is to rezone the Future Urban zoned area of the Site to Business – Light Industry. The PPC area excludes the existing Rural – Mixed Rural Zone.

The Structure Plan is proposed in replacement of the Drury-Opāheke Structure Plan for this part of Drury West. The rezoning under the PPC would allow FPH to facilitate the development of a research and development and manufacturing campus on the Site, containing a mix of office, manufacturing and warehousing (FPH Campus). FPH intends to undertake development of the FPH Campus over a period of 30-40 years.

The Structure Plan Area (SPA), in Drury West, is bound by Karaka Road (SH22) to the north and the North Island Main Trunk Railway Line to the south, as shown in Figure 1-1. The SPA comprises 105Ha of land zoned in the Auckland Unitary Plan (AUP) as Future Urban Zone (FUZ) and Rural – Mixed Rural Zone, as shown in Figure 1-2, and the PPC area is shown in Figure 1-3.

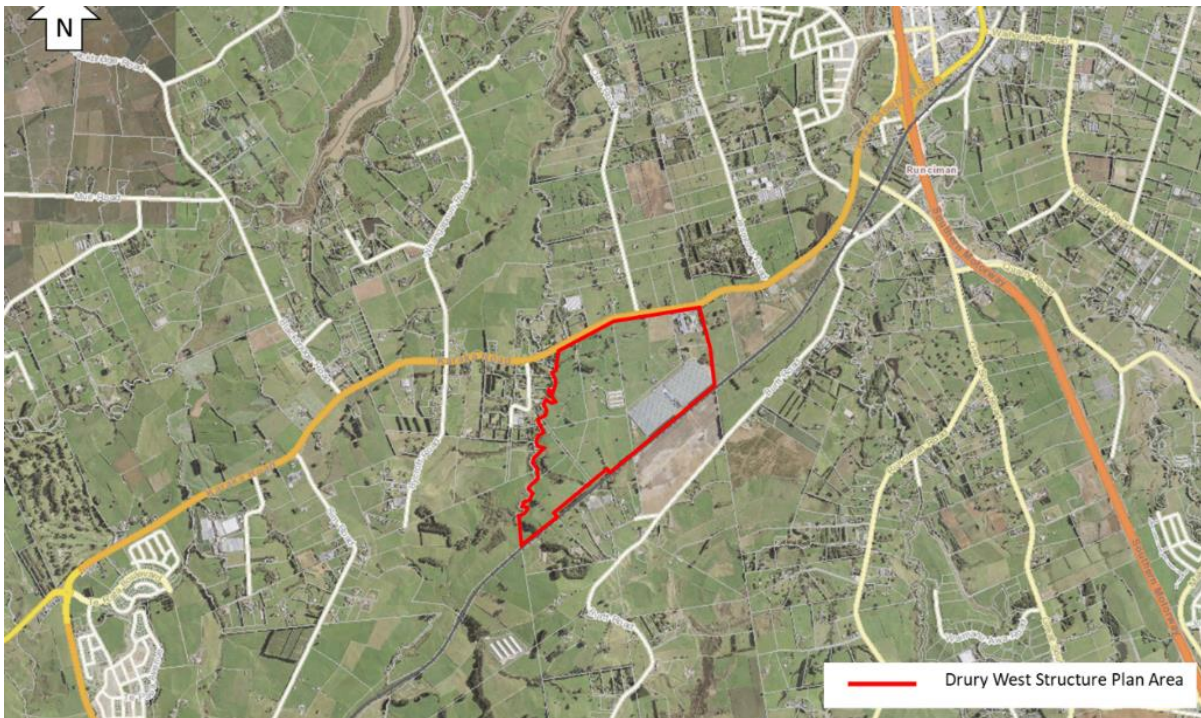


Figure 1-1 Aerial Photography of The Structure Plan Area¹

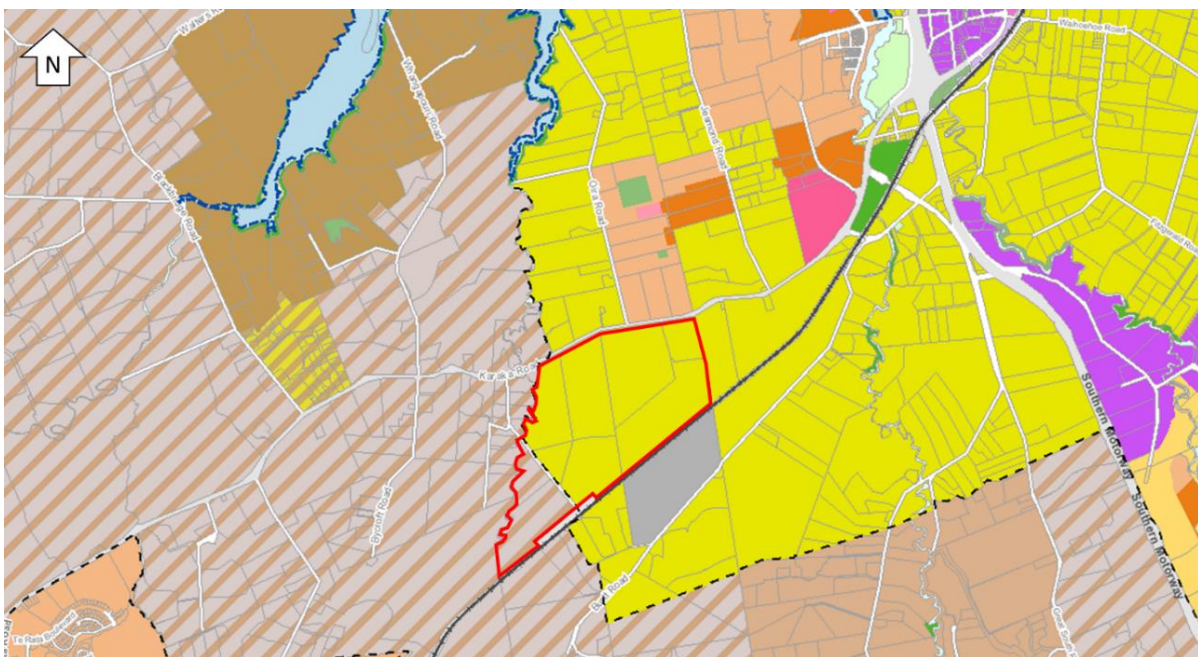


Figure 1-2 Auckland Unitary Plan Zoning for Drury West and the Structure Plan Area²

¹ Image source: Fisher & Paykel Healthcare Campus Two Structure Plan, Karaka – Integrated Transport Assessment (Draft), February 2024

² Image source: Fisher & Paykel Healthcare Campus Two Structure Plan, Karaka – Integrated Transport Assessment (Draft), February 2024



Figure 1-3 The Private Plan Change Area

1.3 Study Objectives and Macro Strategic Modelling

The purpose of this study was to assess transport carbon (CO₂) emission and vehicle-kilometres travelled (VKT), associated with the PPC for the **morning peak, interpeak and evening peak periods**. For this purpose, the Macro Strategic Model (MSM), which is a multi-modal travel demand model covering the whole Auckland region (strategic macroscopic level), was used. The MSM integrates the modelling outcomes with the Vehicle Emissions Prediction Model (VEPM). VEPM has been developed by NZ Transport Agency Waka Kotahi (NZTA) and Auckland Council to predict emissions from vehicles in the New Zealand fleet under typical road, traffic and operating conditions. The model provides estimates that are suitable for air quality assessments and regional emissions inventories.

As outlined in the previous sub-section, FPH intends to complete the development over a period of 30-40 years. However, the nearest forecast year available in the Auckland regional transport model (MSM) is 2048. Therefore, this modelling analysis was based on 2048, assuming 4,675 jobs are provided in this timeframe.

It is not practical to robustly assess the total transport emissions and VKT directly associated with a specific development. There are several reasons for this. Notably VKT and transport emissions require modelling of as-close-as-reasonable to the full length of trips. This requires application of the regional transport model and analysing the outputs across the whole network to isolate the effects of a single development that would suffer from 'noise'. That is, it would not be possible to distinguish between the effects on VKT and emissions from the Development with the effects of many other smaller changes throughout the model area. Therefore, the assessment will be based on comparing emissions 'rates' (or per land use unit), which will further be discussed in Section 2, in the area with and without the development.

This work provides the CO₂ and VKT rates with and without the development in place. Furthermore, the predicted travel demand by vehicle and public transport mode with and without the development were compared. It should be noted that active mode travel is not modelled in the MSM.

To address the objectives above, Stantec commissioned Auckland Forecasting Centre (AFC) to carry out three model runs or scenarios (each having three model periods of morning, interpeak and evening peak) for the year 2048. These scenarios are listed below and further detailed in Chapter 2.

- The scenario with the FPH Campus as proposed in the PPC. This is referred to as the 'With Development' scenario.
- The scenario without any kind of development on the PPC site (i.e., assuming an empty site). This is referred to as the 'No Development' scenario. This scenario allows for the estimate of CO₂ emission and VKT associated with FPH campus by taking the difference between the With Development scenario and this scenario (in Sections 3 and 4).
- The scenario with the FUZ land use development assumption. This scenario is referred to as the Residential Council Structure Plan (**RCSP**) scenario. In this scenario, it is assumed the zone would be developed according to the Auckland Unitary Plan/Council Drury- Opāheke Structure Plan (2019) to include mixed housing and jobs. This is the 'original' model run from the Auckland Forecasting Centre (AFC). Comparisons with this scenario are included within the distribution analysis of CO₂ emissions and VKT per rates (in Section 5), along with the No Development and With Development scenarios.

AFC is a partnership between Auckland Council, NZTA and Auckland Transport. AFC provides data, analysis and advice around growth impacts, travel demand and traffic forecasting. They are also responsible for running and maintaining the MSM.

2 Regional Transport Modelling

2.1 Select Link Analysis

Stantec requested AFC to carry out a 'select link' analysis. Select link allows us to obtain inbound and outbound trip information to and from the Drury West zone for each of the two scenarios. In this report, the PPC is referred to as **FPH Campus Development**.

The Select Link method has been used to avoid the issue of model 'noise' described above. It is not possible to isolate the effects of an individual development from many smaller changes across the entire model network, therefore the Select Link approach has been used so that the inbound and outbound trips associated with the zone, containing the Business-Light Industry development, can be analysed for the with and without FPH Campus Development scenarios.

Additionally, AFC ensures that the total land use in the MSM is maintained across different scenarios, implying that development of the FPH Campus in Drury West would take development opportunity from other locations in Auckland. The basis of this is that demographic projections are maintained, and do not increase over the whole region in the 'with development' scenario.

A drawback of traditional four-stage models such as the MSM is their inability to capture trip chaining. For instance, a trip from home (outside Drury West zone) to work (inside Drury West zone) with an intermediate stop at school (outside Drury West zone), would be recorded only as a non-home-based trip associated with Drury West, while the home-based part (home to school trip) cannot be connected. There is no practical solution to address this issue. The limitation the MSM, as well as other traditional four-stage models, resulted in a minor weakness in the assessment. Despite this, the MSM is currently the best available model to estimate and compare VKT and CO₂ emissions from projects. It is widely accepted in the Industry for assessments of this nature and has been used and approved by Hearing Commissioners in other plan changes in Auckland.

2.2 CO₂ and VKT Rate Method

2.2.1 Overview

Two types of input data were used to compute CO₂ and VKT rates per land use unit (referred to as 'per unit'):

- a) Outbound and inbound trip data, and CO₂ and VKT from trips to and from the Drury West zone for each of the scenarios.
- b) The number of employment and population in the Drury West zone. Note that in this report, employment and employee are used interchangeably as one employment signifies one person employed.
- c) These figures are used to compute 'rates' (detailed in the subsequent section). A combination of employment and population is considered the most appropriate 'unit' for this analysis. The main reasons are because:
 - a. There are various types of households, consisting of different numbers of working adults and dependent children and producing different trip rates, making population a more appropriate unit for computing CO₂ and VKT rates than households.
 - b. Employees (as well as different activities) in a zone also contribute to total CO₂ and VKT produced by a zone, and therefore should be included in the unit calculation.

The method to derive 'rates' are further described below.



2.2.2 Rates (Land Use Unit)

As mentioned above, population and employment data were used to compute rates. To determine how these two elements of land use were combined to form the 'land use unit', a high-level assessment of the number of person trips associated with home and employment locations was carried out.

The New Zealand Household Travel Survey (HTS) data for Auckland Region were used to compute the number of person trips associated with home and employment locations. HTS measures the travel New Zealanders do by asking everyone in randomly selected households to record their travel over two days. HTS data consists of the number of trips by trip purposes and modes (e.g., home to work trips by bus). In the analysis, total trips by purpose were used, summing the different types of transport modes.

There are 18 categories of home-based trips and two categories of non-home based trips in the HTS data. A home-based trip is a trip that has home of the trip maker as either the origin or destination of the trip, such as a home to work trip. A non-home based trip is a trip with neither end of the trip being the home of the trip maker, such as a work to shop trip.

The 18 categories of home-based trips were compiled into one category of the total home-based trips. Similarly, the two categories of non-home based trips were combined into one category. It should be noted that only half of the home-based trips are associated with home location. For instance, for the home to work trip, half of this trip is associated with home location whereas another half is associated with workplace. Thus, half of home-based trips are associated with locations other than home, such as workplaces and supermarkets, so they equate to trips associated with employment location. All non-home based trips, such as trips from workplace to supermarket, could be associated with employment location.

The summary of the trips from HTS for Auckland Region can be found in Table 2-1, with the split of home-based and non-home based categories into home and employment locations being shown in the table.

Table 2-1: Average Daily Trips Associated with Home and Employment Locations

HTS Category	Person Trips	Analysis Category	Person Trips	Note
Home-Based Trips	3,105,322	Home Location	1,552,661	Home Location = 0.5xHome-Based Trips
Non-Home Based Trips	2,170,676	Employment Location	3,723,337	Employment Location = Non-Home Based Trips + (0.5xHome-Based Trips)
Total	5,275,998	Total	5,275,998	

The number of trips associated with employment location (about 3,700,000 person trips) is approximately double the number of trips associated with home location (about 1,500,000 person trips). Therefore, the land use unit that is used to calculate the CO₂ and VKT rates per zone is defined as '2xEmployment+Population'.

It should be noted that this method has some limitations. Some non-home based trips include trips with one end of the trips being in a non-employment location, such as trips from work to school to pick up a child. However, in HTS data, different types of non-home based trips are not differentiated and therefore, it is not possible to exclude this type of non-home based trip from the analysis. The 'land use unit' is considered somewhat approximate, but appropriate for the calculation which compares CO₂ and VKT rates per zone.

2.2.3 CO₂ and VKT per Unit Calculation

CO₂ per unit is calculated using the following formula:

$$\text{CO}_2 \text{ per unit} = \text{Total CO}_2 \text{ in the Drury West zone} / (2 \times \text{Employment} + \text{Population}),$$

where 'total CO₂' is the sum of inbound and outbound CO₂ (for both car and heavy commercial vehicles). In the same manner, VKT per unit is computed.

2.3 Scenarios and Assumptions

Scenarios and assumptions related to land use and public transport (as well as active modes) are described in the subsequent sections, with land use being discussed first.

2.3.1 Land Use

Within the MSM zoning system, the SPA is split between two MSM zones, i.e., Zones 560 and 569, as shown in Figure 2-1. The SPA located in Zone 569 (zoned in AUP as Rural – Mixed Rural Zoned) is relatively small and does not have any direct access to the surrounding road network. The access to this area would be through the site in Zone 560. This area is also outside the plan change area. Therefore, the assessment focused solely on Zone 560 and the plan change area. The majority of the area in this zone (inside yellow boundaries in Figure 2-1.) is zoned as Future Urban Zone (FUZ) in AUP, and assumed to be developed according to the AUP/Drury Opāheke Structure Plan, consisting of housing and jobs.

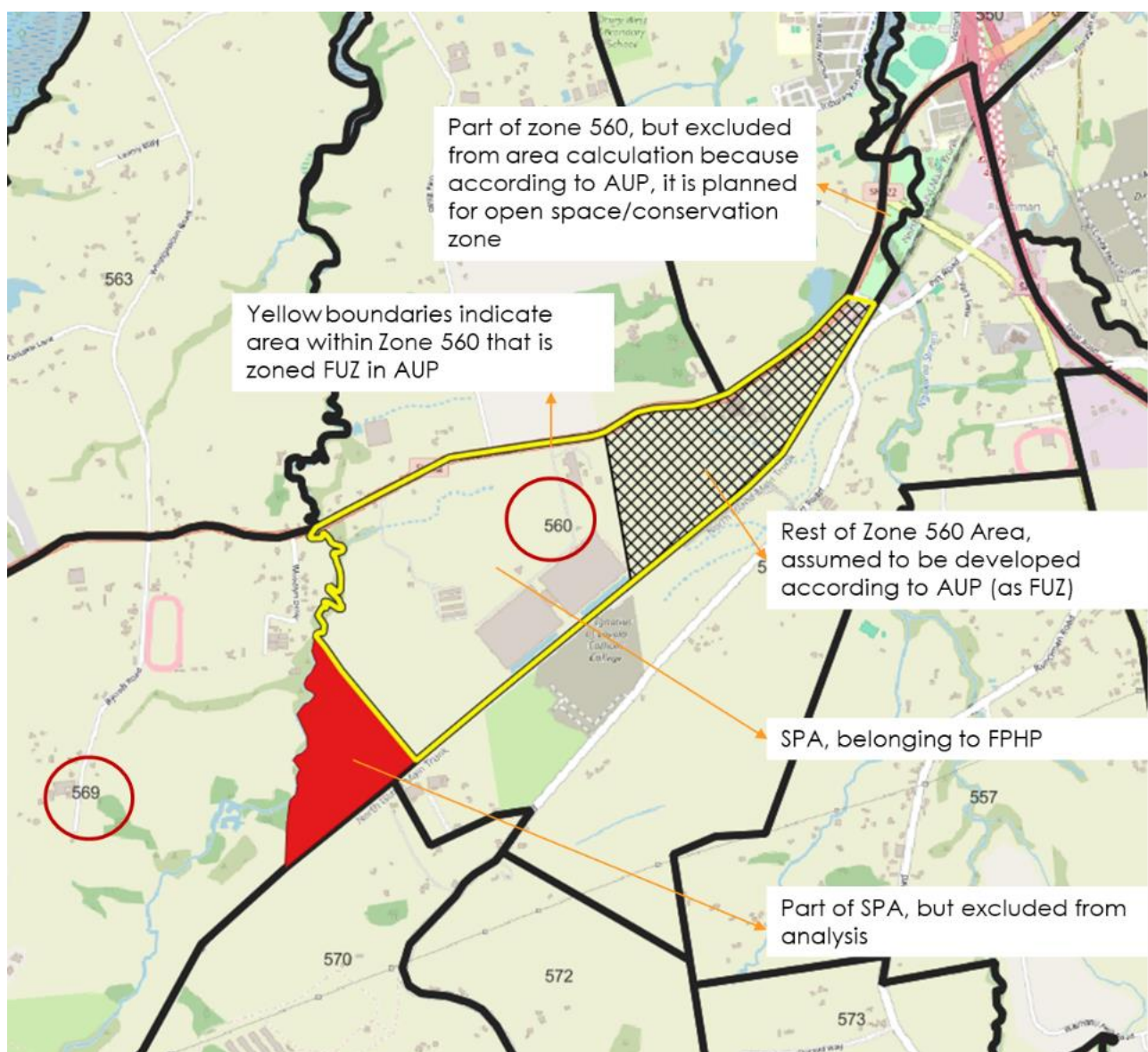


Figure 2-1 SPA and the MSM Zones in the Drury West Area

The MSM uses categories in Table 2-2 for its land use input. There are 78 categories in total, which include eight household categories, 64 person categories (= 8 person segmentations × 8 household segmentations, see Table 2-2), and six employment categories.

Table 2-2: Land Use Categories in the MSM

Household Segmentation	
<i>Classification</i>	<i>Nomenclature</i>
HH1	1 adult, not working or retired HH1
HH2	1 adult, working HH2
HH3	2 adults, none working or retired HH3
HH4	2 adults, 1 working HH4
HH5	2 adults, both working HH5
HH6	3+ adults, none or 1 working HH6
HH7	3+ adults, 2 working HH7
HH8	3+ adults, 3+ working HH8
Person Segmentations	
<i>Classification</i>	<i>Nomenclature</i>
Person type 1 (PT1)	aged<5 PT1 (not included)
Person type 2 (PT2)	aged 5-10 PT2
Person type 3 (PT3)	aged 11-17 PT3
Person type 4 (PT4)	worker aged =< 26 PT4
Person type 5 (PT5)	worker aged >26 PT5
Person type 6 (PT6)	non- worker aged =< 26 PT6
Person type 7 (PT7)	non-worker aged >26 PT7
Person type 8 (PT8)	retired PT8
Employment Segmentations	
<i>Classification</i>	<i>Nomenclature</i>
Employment type 1 (E1)	Industrial
Employment type 2 (E2)	Business Services
Employment type 3 (E3)	Wholesale Trade
Employment type 4 (E4)	Retail Trade
Employment type 5 (E5)	Central Govt. admin & defence; Pre-school & Primary Education; Secondary Education; Tertiary Education; Hospitals; Medical Practices; Public Services
Employment type 6 (E6)	Agriculture, Utilities and Construction

AFC provided Stantec with demographic information for the year 2048 for all zones in the MSM, including Zone 560. This information is summarized in Table 2-3 which follows the sections below.

The 'AFC original' column in the table summarizes the figures from AFC based on the current Auckland Council planning and policy scenario. It is assumed this zone is developed according to the Auckland Unitary Plan as FUZ, which consists of a mixture of dwellings and jobs. This scenario is referred to as the **Residential Council Structure Plan (RCSP) scenario**.

The **No Development scenario** (Table 2-3) was created by assuming there is no development in the SPA. Note that as the PPC area accounts for 70% of total area in Drury West zoned as Future Urban Zone (shown in Figure 2-1), 70% of demographic input in this zone was removed from the **RCSP** scenario to create the No Development scenario. The number of school rolls is maintained across all scenarios, assuming that a school would be built elsewhere within the zone.

The **With Development scenario** (Table 2-3) was created by adding a total of 4,675 employees, split into industrial jobs (E1 = 1,225) and business service jobs (E2 = 3,450). The remaining zones used the

'balanced' 2048 land use, noting that AFC ensures the total land use in the MSM is maintained across different scenarios, as mentioned in Section 2.1.

Table 2-3: Demographic Input, Drury West Zone (MSM Zone 560)

MSM categories	AFC Original	No Development	With Development	Note
Total Household Categories	1,695	508	508	
Total Person Categories	4,460	1,338	1,338	
Total Education (Primary + Secondary)	230	230	230	
Total Employment Categories	455	137	4,812	
E1	67	20	1,245	No Dev + 1,225
E2	66	20	3,470	No Dev + 3,450
E3	43	13	13	
E4	110	33	33	
E5	92	28	28	
E6	76	23	23	

CO₂ emissions per unit and VKT per unit calculated from the With Development scenario have been compared in the analysis that follows with the ones from the No Development scenario, assuming an empty site. The main reason was that the comparisons with the No Development allowed assessment of the added impact of the FPH Campus Development on the zone. The RCSP scenario has a mix of housing and employment development on the SPA. Comparing the With Development scenario with the RCSP scenario would not capture the change of CO₂ emissions and VKT associated with the development of FPH Campus itself.

In later sections of this report, in the Distribution Analysis, the RCSP scenario is included as a comparator along with the No Development and With Development scenarios.

2.3.2 MSM Public Transport and Active Mode

The FPH Campus is located in the same MSM zone as the Drury West Train Station. Bus services also run on Karaka Road. The model assumptions regarding train and bus headway or frequency (in minutes) are shown in the table below and they are applied to both the No Development and With Development scenarios.

Table 2-4 Public Transport Headways (Minute), the Drury West Zone

Direction	Train	Bus
Morning Peak		
Southbound	7	12
Northbound	20	12
Interpeak		
Southbound	30	20
Northbound	30	20
Evening Peak		
Southbound	20	12
Northbound	7	12

Active mode trips are not produced at the zonal level in the MSM. The MSM produces the active mode trips for 24 hours for the entire model area from the demographic information. These trips are then being put aside to be used in Auckland Strategic Active Mode Model (SAMM). As this study used the MSM outputs for CO₂ and VKT assessments, no active mode data could be analysed.

From conversation with AFC, we understand SAMM is able to predict changes in assigned active mode trips due to a major infrastructure project targeted towards active mode travel, such as a development of significant length of dedicated cycleway. However, SAMM isn't able to predict a robust active mode response to land use changes, which is the focus of this assessment, therefore SAMM has not been used in this project to consider active mode changes with and without the development.

3 VKT and CO₂ Emissions Results

3.1 VKT and CO₂ Emissions from Interzonal Trips

Total employment, population and unit in the Drury West zone are summarized in Table 3-1.

Table 3-1 Population, Employment and Land Use Unit, the Drury West Zone

Drury West Scenario	Pop	Emp	LU Unit (2E+Pop)
No Development	1,338	137	1,611
With Development	1,338	4,812	10,961

The number of employees increases by 3,400% compared with the No Development scenario and the overall land use unit (2x Employment + Population) increases by about 580%.

CO₂ and VKT for all vehicles can be seen in Table 3-2.

Table 3-2 CO₂ (kg) and VKT (Veh-Km), Interzonal Trips, the Drury West Zone

Drury West Scenario	CO ₂				VKT			
	CO ₂ (gr)	CO ₂ / (2E+Pop)	Diff (Dev-No Dev)	%Diff	VKT (veh-km)	VKT/ (2E+Pop)	Diff (Dev-No Dev)	%Diff
Morning Peak								
No Development	467	0.3	-	-	6,247	3.9	-	-
With Development	2,298	0.2	1,831.4	392%	34,506	3.1	28,259.4	452%
Interpeak								
No Development	365	0.2	-	-	5,209	3.2	-	-
With Development	1,115	0.1	750.4	206%	16,942	1.5	11,732.8	225%
Evening Peak								
No Development	423	0.3	-	-	6,036	3.7	-	-
With Development	2,135	0.2	1,712.2	405%	32,364	3.0	26,327.9	436%

Compared with the No Development scenario, the increase in total CO₂ emissions in the morning peak (i.e., about 452% increase) is fairly consistent with that in the evening peak period (about 436%). In the interpeak period, the increase is about 225%, and it is about half of the increase in the morning and evening peak periods. These results seem plausible as work-related trips, such as home-based work trips, seem to dominate inbound and outbound trips due to the large number of employees in the zone in the 'with development' scenario.

The increase in total VKT (vehicle-kilometres) in the morning peak (about 452%) period is also consistent with that in the evening peak period (about 436%) compared with the No Development scenario. Similar to the CO₂ figures, the increase in the interpeak period is about half of the increase in other peak periods (about 225%).

CO₂ per unit and VKT per unit are computed using the formula described in Section 2.2. The results can be seen in Table 3-3 for CO₂ per unit and Table 3-4 for VKT per unit.

Table 3-3 CO₂/Unit (Kg/Unit), Interzonal Trips, the Drury West Zone

Drury West Scenario	CO ₂ / Unit			% Difference in CO ₂		
	Car	HCV	Car + HCV	Car	HCV	Car + HCV
Morning Peak						
No Development	0.3	0.035	0.3	-	-	-
With Development	0.2	0.005	0.2	-19%	-86%	-28%
Interpeak						
No Development	0.2	0.023	0.2	-	-	-
With Development	0.1	0.003	0.1	-52%	-85%	-55%
Evening Peak						
No Development	0.2	0.017	0.3	-	-	-
With Development	0.2	0.003	0.2	-22%	-85%	-26%

Table 3-4 VKT/Unit (Veh-Km/Unit), Interzonal Trips, the Drury West Zone

Drury West Scenario	VKT / Unit			% Difference in VKT		
	Car	HCV	Car + HCV	Car	HCV	Car + HCV
Morning Peak						
No Development	3.8	0.059	3.9	-	-	-
With Development	3.1	0.008	3.1	-18%	-86%	-19%
Interpeak						
No Development	3.2	0.039	3.2	-	-	-
With Development	1.5	0.006	1.5	-52%	-85%	-52%
Evening Peak						
No Development	3.7	0.029	3.7	-	-	-
With Development	2.9	0.004	3.0	-21%	-85%	-21%

Although total CO₂ emissions and VKT in the zone increase in the With Development scenario, the CO₂ per unit and VKT per unit decrease. This is mainly due to the increase in the unit (about 580% increase compared with the No Development scenario) as discussed previously (Table 3-1). Although total CO₂ and VKT increase with the FPH Campus, the rate of the increase is lower than the percentage increase in the land use unit.

Total CO₂ per unit decreases with the FPH Campus Development to 0.2 kg from 0.3 kg (the No Development scenario) in the morning and evening peak periods, or about 26%-28% decrease from the No Development scenario (Table 3-3). In the interpeak period, total CO₂ per unit decreases to 0.1 kg from 0.2 kg, or about a 55% decrease.

A relatively similar trend can be observed in VKT per unit figures: About 19%-21% decrease from 3.9 and 3.7 veh-km in the morning and evening peak periods in turn, and about 52% decrease from 3.2 veh-km in the interpeak period (Table 3-4).

It should be noted that CO₂ and VKT in Table 3-2 to Table 3-4 are only associated with interzonal trips, which are inbound and outbound trips to and from the Drury West zone. They exclude local trips within the Drury West zone (called intrazonal trips). VKT and CO₂ emissions from the MSM are calculated at the last stage of the modelling process, after trips are assigned to the road network. In a regional model, such as the MSM, local trips are typically not assigned and therefore, VKT and CO₂ emissions associated with these trips are not included.

To investigate the change in the number of local trips, the origin-destination (OD) matrices, also known as demand trip matrices, were analysed. The results are summarized in the next section. A further analysis was

done to update the VKT per unit and CO₂ emissions per unit, to include the local trips within the Drury West zone.

3.2 Intrazonal Trips

Intrazonal (local) and interzonal trips from the demand matrices are summarized in Table 3-5 for cars, Heavy Commercial Vehicles (HCVs) and cars plus HCVs. The percentage change of these trips in the With Development scenario compared with the No Development scenario can be seen in Table 3-5.

Table 3-5 Intrazonal and Interzonal Trips, the Drury West Zone

Drury West Scenario	Intrazonal Trips			Interzonal Trips			Intrazonal + Interzonal Trips		
	Car	HCV	Car + HCV	Car	HCV	Car + HCV	Car	HCV	Car + HCV
Morning Peak									
No Development	4	0	4	457	7	463	461	7	468
With Development	69	0	69	2,374	6	2,380	2,444	6	2,450
% Diff with No Dev	1515%	-	1515%	420%	-7%	414%	430%	-7%	424%
Interpeak									
No Development	12	0	12	1,207	4	1,211	1,219	5	1,223
With Development	171	0	171	3,797	4	3,801	3,968	5	3,973
% Diff with No Dev	1361%	6%	1342%	215%	3%	214%	226%	3%	225%
Evening Peak									
No Development	4	0	4	468	4	471	471	4	475
With Development	68	0	68	2,209	4	2,212	2,276	4	2,280
% Diff with No Dev	1734%	-	1734%	372%	1%	370%	383%	1%	380%

Compared with the No Development scenario, the total interzonal trips for cars plus HCVs (Table 3-5) increase by about 400% in the With Development scenario compared with the No Development scenario in the morning (414% increase) and afternoon peak (383% increase) periods, and they increase by 226% in the interpeak period.

The intrazonal trips increase substantially by about 1,300% to about 1,700% in the With Development scenario depending on the model periods. However, the number of intrazonal trips in the No Development scenario is very small. As a result, despite the high percentage of increase in the intrazonal trips in the With Development scenario compared with the No Development scenario, and number of trips is still relatively small.

3.3 Updated VKT and CO₂ Emissions

Further work was done to account for local trips in VKT and CO₂ emissions per unit, as summarized in Table 3-6. It is assumed that the average trip length for local trips is 2 kilometres, which is about 2/3rd distance of the Drury West zone boundary (Figure 3-1).

Table 3-6 Updated VKT (veh-km), Trip Length, and VKT/Unit (Veh-Km/Unit), Cars plus HCVs, the Drury West Zone

Drury West Scenario	Land Use Unit	Interzonal				Intrazonal			Intrazonal + Interzonal	
		VKT	Trips	Avg Trip Length (km)	VKT /Unit	VKT	Trips	Avg Trip Length (km)	Updated VKT	Updated VKT Unit
Morning Peak										
No Development	1,611	6,247	463	13.48	3.88	9	4	2	6,255	3.88
With Development	10,961	34,506	2,380	14.50	3.15	139	69	2	34,645	3.16
Interpeak										
No Development	1,611	5,209	1,207	4.32	3.23	24	12	2	5,232	3.25
With Development	10,961	16,942	3,797	4.46	1.55	343	171	2	17,284	1.58
Evening Peak										
No Development	1,611	6,036	468	12.91	3.75	7	4	2	6,044	3.75
With Development	10,961	32,364	2,209	14.65	2.95	135	68	2	32,499	2.96

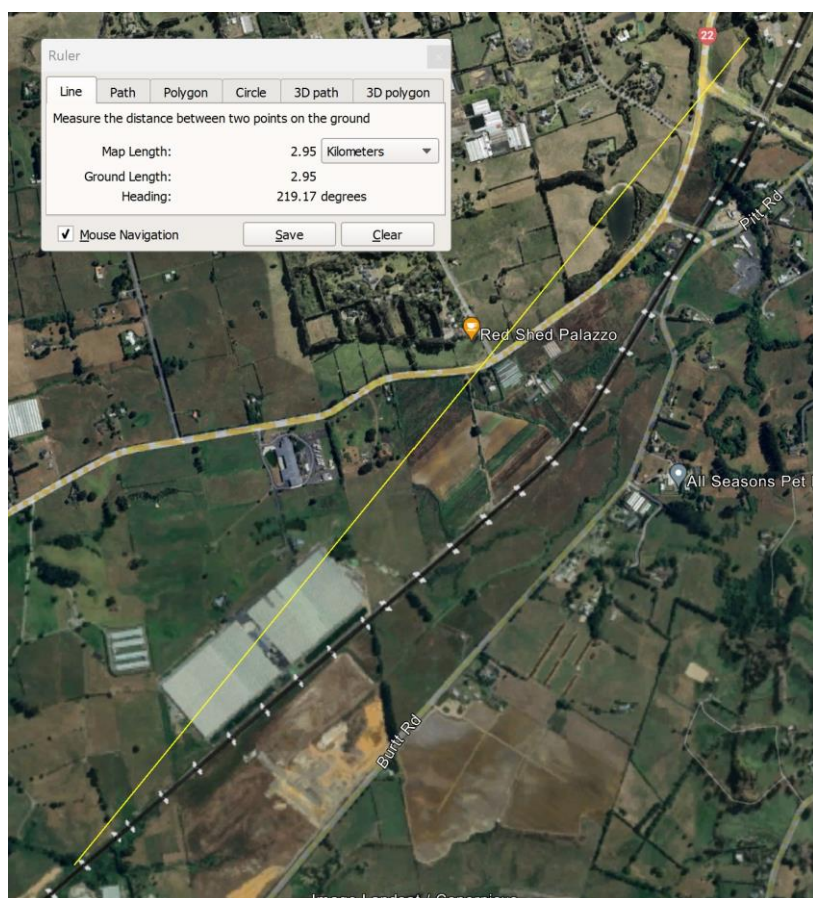


Figure 3-1 The Existing Drury West Area

The average trip length for interzonal trips increases slightly in the With Development scenario, from 13-13.5 kilometres in the No Development scenario to about 14.5 kilometres in morning and evening peak periods. In the interpeak, the average trip length is much shorter than in the other model periods, about 4.3 kilometres and 4.5 kilometres in the No Development and With Development scenarios.

Despite the slight increase in the average trip length, the CO₂ emissions per unit and VKT per unit decrease with the FPH Campus Development as a result of the high increase in the land use unit discussed in Section 3.1.

The updated VKT per unit (with the local trips included) is still relatively similar to the one without the intrazonal trips added as shown in Table 3-6. In the No Development scenario, local trips account for only 1% of the total trips whereas in the With Development scenario, they account for about 3-4% of the total

trips (Table 3-7). As VKT is a product of the number of trips and distance travelled, VKT associated with local trips becomes very small compared with VKT from the interzonal trips.

Table 3-7 Percentage of Intrazonal Trips, the Drury West Zone

Drury West Scenario	Intrazonal Trips			Interzonal Trips			Intrazonal + Interzonal Trips			% Intrazonal / (Intrazonal + Interzonal)		
	Car	HCV	Car + HCV	Car	HCV	Car + HCV	Car	HCV	Car + HCV	Car	HCV	Car + HCV
Morning Peak												
No Development	4	0	4	457	7	463	461	7	468	1%	0%	1%
With Development	69	0	69	2,374	6	2,380	2,444	6	2,450	3%	0%	3%
Interpeak												
No Development	12	0	12	1,207	4	1,211	1,219	5	1,223	1%	4%	1%
With Development	171	0	171	3,797	4	3,801	3,968	5	3,973	4%	4%	4%
Evening Peak												
No Development	4	0	4	468	4	471	471	4	475	1%	0%	1%
With Development	68	0	68	2,209	4	2,212	2,276	4	2,280	3%	0%	3%

CO₂ emissions change depending on assumptions regarding vehicle fleet (e.g., petrol vs. diesel vs. electric vehicles) and fuel efficiency. Additionally, it is also affected by the speed of the vehicles, which is influenced by traffic conditions (e.g., a congested network produces more CO₂ emissions than an uncongested one). The ratio of CO₂/VKT from the interzonal trips was calculated for each of the scenarios and was assumed to be 40% higher than the interzonal ratio to account for the stop/go traffic condition typically associated with local trips. This ratio, plus 40%, was used to estimate the CO₂ for intrazonal trips and the results are provided in Table 3-8.

Table 3-8 Updated CO₂ Emissions (Kg) and CO₂/Unit (Kg/Unit), Cars plus HCVs, the Drury West Zone

Drury West Scenario	Land Use Unit	Interzonal			Intrazonal		Intrazonal + Interzonal	
		CO2 / VKT	CO2	CO2 / Unit	CO2 / VKT	CO2	Updated CO2	Updated CO2 / Unit
Morning Peak								
No Development	1,611	0.075	467	0.29	0.105	1	468	0.29
With Development	10,961	0.067	2,298	0.21	0.093	13	2,311	0.21
Interpeak								
No Development	1,611	0.070	365	0.23	0.098	2	367	0.23
With Development	10,961	0.066	1,115	0.10	0.092	32	1,147	0.10
Evening Peak								
No Development	1,611	0.070	423	0.26	0.098	1	423	0.26
With Development	10,961	0.066	2,135	0.19	0.092	12	2,147	0.20

Similar to the VKT results, CO₂ emission per unit with internal/local trips included is similar to the one without (Table 3-8). This again happens because the proportion of intrazonal (local) trips is very small compared to interzonal trips, as discussed previously and shown in Table 3-7.

There are some limitations with the assessment that are associated with the type of model, which cannot be quantified. The main limitation is the exclusion of all trip chaining from the analysis. Only trips directly to and from the Drury West zone are included in the assessment. For example, a trip from a home outside the Drury West zone to work in the zone with an intermediate stop at a school (school drop-off) outside the zone. The first leg of these trips (i.e., home to school) is not included. The subsequent trip from the school to an office in Drury West is captured. The reason is that many strategic models, such as the MSM, are trip-based models, implying that they model individual person trips and without ability to connect more than one trip made by a trip maker.

4 Public Transport Mode Split

The number of trips (inbound plus outbound) to and from the Drury West zone by public transport (bus and train) were compared to the ones from vehicles (cars plus heavy vehicles) to determine the share of public transport versus vehicles (Table 4-1).

Table 4-1 Intrazonal and Interzonal Trips, Cars, HCVs, and Cars plus HCVs, the Drury West Zone

Drury West Scenario	Intrazonal Trips			Interzonal Trips			Interzonal + Interzonal Trips			% Difference in Interzonal + Interzonal Trips			Mode Share, Interzonal +	
	Car + HCV	PT	Car + HCV + PT	Car + HCV	PT	Car + HCV + PT	Car + HCV	PT	Car + HCV + PT	Car + HCV	PT	Car + HCV + PT	Car + HCV	PT
Morning Peak														
No Development	4	0	4	463	144	607	468	144	612	-	-	-	76%	24%
With Development	69	3	72	2,380	394	2,774	2,450	397	2,846	424%	175%	365%	86%	14%
Interpeak														
No Development	12	0	12	1,211	53	1,264	1,223	53	1,276	-	-	-	96%	4%
With Development	171	2	173	3,801	142	3,943	3,973	144	4,116	225%	170%	223%	97%	3%
Evening Peak														
No Development	4	0	4	471	112	584	475	113	587	-	-	-	81%	19%
With Development	68	3	71	2,212	360	2,573	2,280	363	2,643	380%	223%	350%	86%	14%

The number of intrazonal (local) trips by public transport is very small compared to the ones by vehicles. The number of interzonal trips by public transport is much higher than intrazonal trips and dominates the total trip figures (intrazonal plus interzonal trips).

With the Train Station in the MSM Drury West Zone, the proportion of Public Transport trips predicted by the MSM ranges from 14-24% in the No Development and With Development scenarios in the morning and evening peak periods. The distribution of the Public Transport share across the entire MSM zones shows that the Public Transport share between 14% and 24% sits in the middle range of the distribution, implying that a substantial proportion of zones in the MSM area perform similarly to the Drury West zone PT mode with the FPH development.

In the interpeak period, the public transport share in the No Development scenario is relatively similar to that in the With Development scenario, accounting for about 3% to 4% of the total trips. These results seem plausible, as trips by train are typically associated with medium to long distance trips, such as home to work trips. This type of trip is typically carried out in the morning and evening peak periods.

5 MSM Zone Per Land Use Unit: Distribution Analysis

5.1 Background

The analysis above concentrates on the Drury West area, specifically the MSM model zone that Drury West is within. This does not provide any assessment of how the Drury West zone compares on a VKT and CO₂ per unit basis to other locations across the Auckland region.

Using the outputs provided by AFC, additional analysis has been carried out which examines how the VKT and CO₂ rate per land use unit for the Drury West scenarios compares with the levels across other zones in the MSM Auckland Regional model area. This is described in the sections below.

5.2 MSM Zone Distribution Analysis Method

The analysis described in the sections above has been repeated for all MSM zones. The CO₂ per unit and VKT per unit for outbound and inbound trips (cars plus heavy vehicles) for each zone were calculated for the **RCSP scenario**. The RCSP scenario refers to the 'original' demographic input from AFC unchanged as previously described in Section 2 and shown in Table 2-3. The results of this analysis would give an indication of CO₂ emissions and VKT per unit associated with the Drury West zone if the zone is developed according to the Auckland Unitary Plan as the Future Urban Zone.

The intrazonal trip correction has not been made in this analysis, as described above this will only change per VKT and CO₂ per unit by a small margin.

The MSM 2018 zones areas are shown in Figure 5-1 below, with colours in the figure representing different zones in the MSM model.

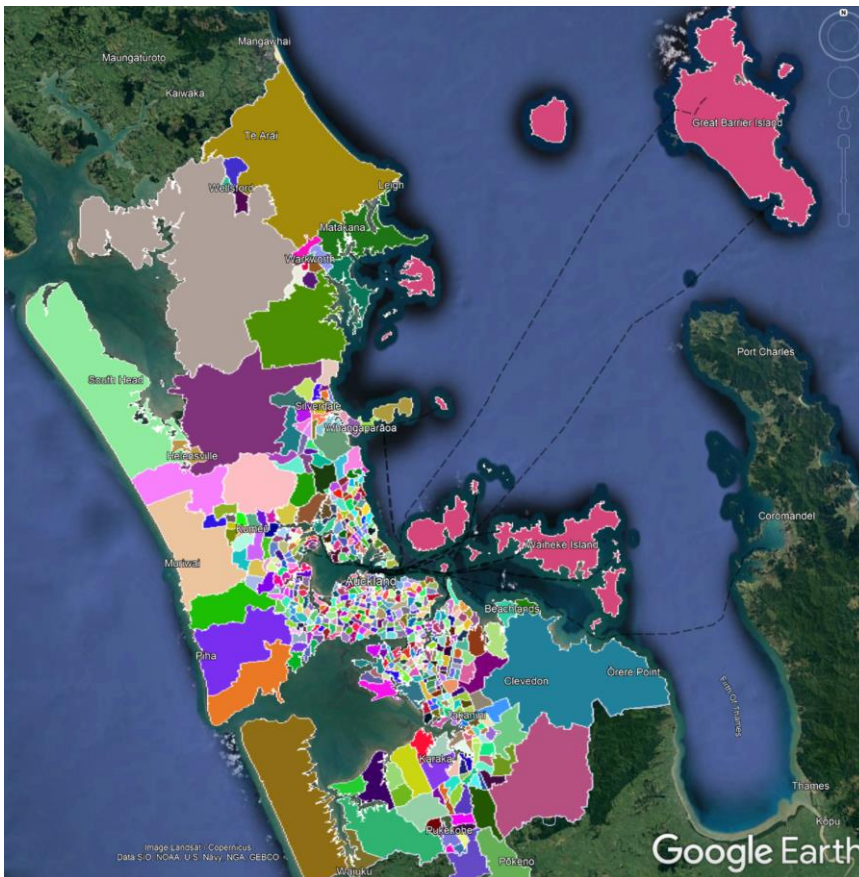


Figure 5-1: MSM 2018 Zone Map

5.3 MSM Zone Distribution Outcomes

The analysis outlined above provides a VKT and CO₂ per unit value for each of the 596 internal MSM zones for cars plus heavy vehicles. These values have been put into bins (ranges) and the percentage of zones in each bin graphed to show the distribution of VKT and CO₂ per unit based on the RCSP scenario. The VKT and CO₂ per unit, associated with the Drury West zone, calculated from the No Development, With Development, and RCSP scenarios are indicated on the graphs in Figures 5-2 and 5-3 below.

The figures indicate what is broadly anticipated across the Auckland region: a small proportion of zones have very low VKT and CO₂ per unit, a larger proportion cluster around the mid-to-low end of the range, and then there is a long tail of a few zones with much higher levels of VKT and CO₂ per unit.

In the VKT per unit distribution derived from the RCSP scenario (Figure 5-2), VKT per unit for the Drury West zone with the FPH Campus Development in place consistently sits around the well-performing low-mid range in the morning and evening peak periods, performing better than the RSCP and No Dev scenarios. In the interpeak period when the FPH Campus Development performs even better, as it lies in the very low range of the distribution of VKT and CO₂ per unit, signifying that it is one of the best performing zones in Auckland. Across the three model periods, VKT per unit calculated from the No Development scenario consistently sits in the mid-high range of the distribution, and VKT per unit from the RCSP scenario consistently sits in about mid-range.

A similar trend can also be observed in the CO₂ emissions per unit results, shown in Figure 5-3. The CO₂ emissions per unit for the Drury West zone from the With Development scenario consistently sits in the low range of the distribution, thus performing better than the RCSP and No Development scenarios.

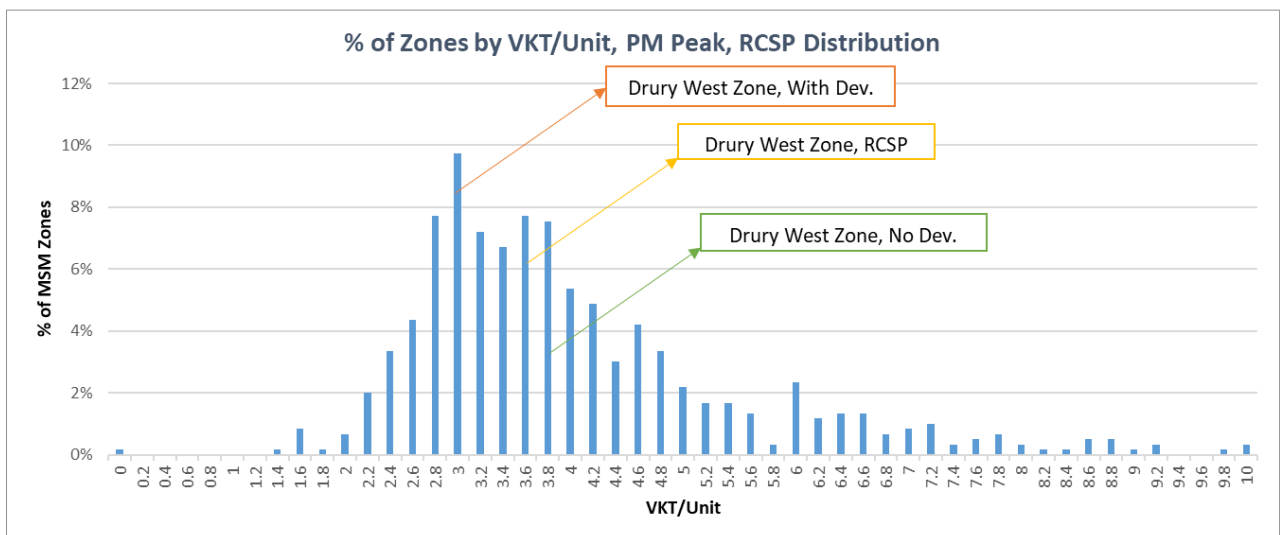
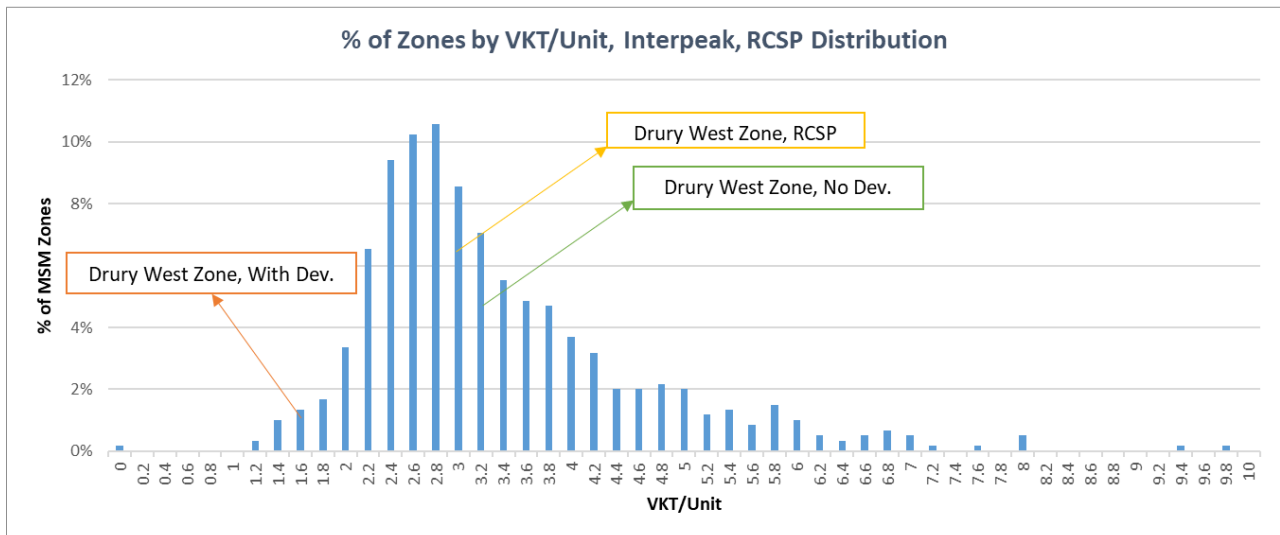
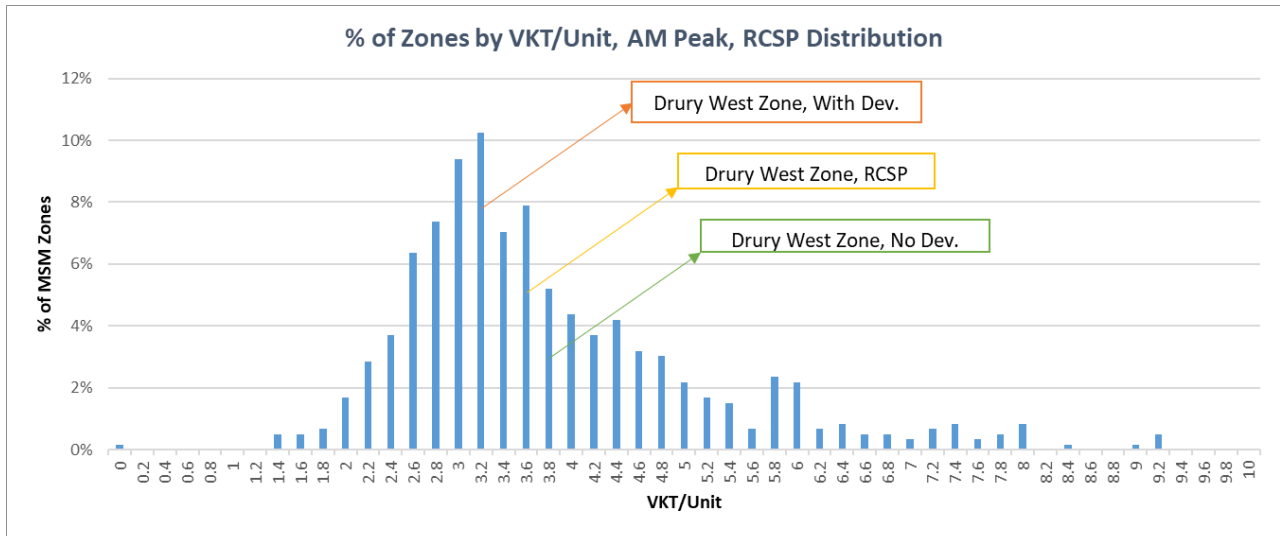


Figure 5-2: Percentage of MSM Zones by VKT/Unit, the RCSP Scenario

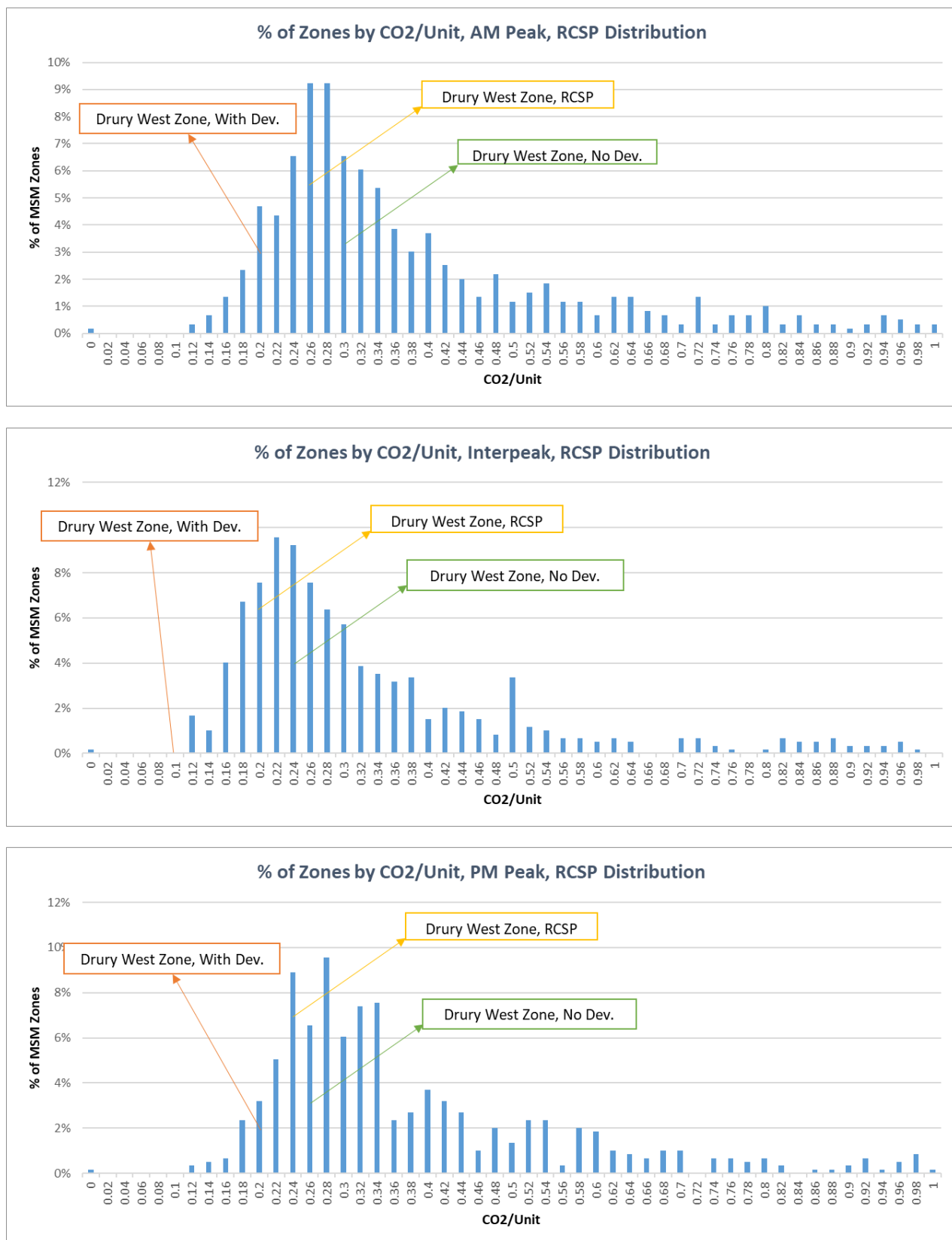


Figure 5-3: Percentage of MSM Zones by CO₂/Unit, the RCSP Scenario

6 Summary

6.1 With Development and No Development Scenarios

This study has assessed the CO₂ emissions and VKT per unit in the morning peak, interpeak and evening peak periods associated with the Drury West zone in 2048. In this study, two scenarios were tested, one of them has the FPH Campus (the With Development scenario) whereas the other does not have any development on the site (the No Development scenario).

6.1.1 Key Outcomes

After accounting for short local (intra-zonal) trips, the assessment produced VKT per unit (for car and heavy vehicle trips) by period as follows:

- Morning peak period: 3.9 veh-km/unit in the No Development scenario, and 3.2 veh-km/unit in the With Development scenario (a reduction of about 19%).
- Interpeak period: 3.2 veh-km/unit in the No Development scenario, and 1.6 veh-km/unit in the With Development scenario (a reduction of about 51%).
- Evening peak period: 3.8 veh-km/unit in the No Development scenario, and 3.0 veh-km/unit in the With Development scenario (a reduction of about 21%).

The assessment also produced the CO₂ per unit rates:

- Morning peak period: 0.3 kilograms/unit in the No Development scenario, and 0.2 kilograms/unit in the With Development scenario (a reduction of about 27%).
- Interpeak period: 0.2 kilograms/unit in the No Development scenario, and 0.1 kilograms/unit in the With Development scenario (a reduction of about 54%).
- Evening peak period: 0.3 kilograms/unit in the No Development scenario, and 0.2 kilograms/unit in the With Development scenario (a reduction of about 25%).

6.1.2 Discussion on Key Outcomes

By having more jobs in Drury West, the total CO₂ emissions and VKT increased in the With Development scenario along with the increasing number of trips associated with the Drury West. However, due to the total number of employees at the FPH Campus, the land use analysis unit (a product of employment and population), increased at a higher rate than the increase in total CO₂ emissions and VKT in the With Development scenario. As a result, CO₂ emissions per unit and VKT per unit (which are the total CO₂ emission or total VKT divided by the land use analysis unit) decreased with the FPH Campus in place, establishing that the proposal would perform better than with no development in place.

Comparing the number of interzonal plus intra-zonal (local) trips by vehicles (cars plus heavy commercial vehicles) and public transport, the public transport share is around 14% in the morning and evening peak periods. The distribution of the Public Transport share across the entire MSM zones shows that the Drury West Public Transport mode share sits in the middle range of the distribution. This demonstrates that the MSM predicts that a substantial proportion of zones in the MSM area perform similarly to the Drury West zone PT mode share with the FPH development.

6.2 Regional Distribution Comparison: RCSP Scenario

Additional analysis was carried out which examined the distribution of CO₂ and VKT per unit across the MSM zones using the demographic input and CO₂ and VKT data from the Regional Council Structure Plan (RCSP) scenario. The RCSP scenario contains the 'original' demographic input from AFC unchanged. This means that in this scenario, it is assumed that the Drury West zone is to be developed according to the Auckland Unitary Plan and the Council Drury- Opāheke Structure Plan (2019), to consist of a combination of dwellings and jobs.



VKT per unit for the Drury West zone with the FPH Campus Development performs better than with no development, or with development as expected in the RCSP, sitting low-mid range in the morning and evening peak periods, and in the low range during the interpeak period. A similar trend can also be observed in the CO₂ emissions per unit results. The CO₂ emissions per unit for the Drury West zone from the With Development scenario consistently sit in the well-performing low range of the distribution. The RCSP and No Development scenarios have higher rates of VKT and CO₂ per unit in all time periods compared to the FPH Campus Development scenario.

With the Development in place, the Drury West zone performs very well as it lies in the low to medium range of CO₂ and VKT per unit. In fact, the results predict that the zone would produce lower CO₂ and VKT per unit than if the zone is developed according to the planned development for the area.