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EVALUATION OF THE TRANSPORT SITUATION & THE ENERGY DEMAND FOR NORTHERN CHRISTCHURCH, NEW ZEALAND

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Abstract: This paper reviews the transport situation in the northern sector of the greater Christchurch area, in New Zealand. It provides an overview of the specific geographical situation, highlighting the land use and allowing a good understanding of the modal choices of commuters. Its focus is on the commuter traffic situation in this area of increased low-density residential development, assessing whether residential living on large sections of land is sustainable long-term with peak-oil in the background. The study evaluates traffic data reports and surveys that deal with southbound traffic, including assessing the public transport option. The data is assessed in terms of consistency and checked against other available information. The analysis outlines the importance of consistency when collecting transport data to ensure coherent decision-making.

The approximate energy demand for commuting from Rangiora to Christchurch is calculated using a simulation model developed by the author based on available data.

Key Words: Traffic data consistency, transport energy demand

1 INTRODUCTION

New Zealand is characterised by a low population density and suburban sprawl encouraged by cheap land development at a distance up to 50km from established areas. This is certainly not new as it is similar in places like Canada, Australia and the United States. This is not to say that countries of high density populations do not face similar problems but they have reacted early by allowing suburban sprawl only along existing public transport (PT) corridors or planning for both, PT and new residential developments in a coordinated way. They seem to have better systems in place by having invested substantially in efficient light rail systems allowing quick connections to city centres in conjunction with financial disincentives to use private motor vehicles in city centres. Transport planners, traffic engineers, policy and decision makers face constant challenges for dealing with people wishing to live in rural areas. On the one hand they look to increase the roading network capacity to reduce congestion and improving mobility in accord with society's expectations and on the other hand they encourage a shift towards sustainable transport by producing glossy promotional material without setting tangible targets. How does this present to the general public who are to be encouraged to practice modal shift? Building more lanes or better roads on roads leads to induced travel demand and hence increased demand for energy. It is a matter of fact, that growth of population in a suburban district

generates more taxes that can be re-invested to improve the district's infrastructure thereby encouraging further growth. New Zealanders have a love affair with 1-4 ha rural lifestyle properties as space is part of their cultural disposition. Such properties are located further away from the main centres and their prices are related to the distance from the nearest urban centre. An increased demand for such residential locations is often triggered by new immigrants who moved to New Zealand looking for liberating lifestyle. It has generated many land subdivisions in areas devoid of any public transport. The low population density in these areas will never justify any form of public transport. However, their owners still wish to see some value in return for their property rates. The response from local authorities is to advance modern and safe transport infrastructure by seeking to extract funding from central and regional government to build the necessary roads.

Sustainability is closely linked with a carbon-constrained future, something that will clash with the current "kiwi" (New Zealand) lifestyle. Some effort is currently being made to implement sustainable transport by improving the efficiency of public transport in major urban areas in New Zealand, including setting up bus routes in smaller urban centres. Unfortunately, these moves are hampered by societal perceptions of buses being inferior means of transport, unabated suburban sprawl, the low cost of owning and operating cheap imported vehicles from Japan and, up to a few years ago, cheap fuel. The general population is more inclined to push for increased provision of energy rather than stand still, or worse, reduce energy through saving schemes such as adopting different transport behaviours. There is a general feeling that an expanding economy requires more energy and that should be the focus for the country's decision-makers rather than conservation of energy from greater use of public transport.

2 OBJECTIVES

The objectives are to look at the transport situation between Rangiora and Christchurch:

1. To understand the dynamics of the Waimakariri District in relation to provision for transport, planning for land use and meshing with the Greater Christchurch Urban Development Strategy (UDS).
2. To identify previous consultancy reports and assess their data with respect to southbound morning commuter traffic.
3. Examine the current situation by estimating the energy demand and looking at ways that might help mitigate that energy requirement.

3 SETTING THE SCENE

This study looks specifically at Rangiora, a satellite town approx. 35 km north of Christchurch city centre. The whole Waimakariri District has a population of 42,834 with Rangiora accounting for 12,444 (Waimakariri DC, 2006). Up to a few years ago, this rural town's development was dependent only from decisions of its local authority, the Waimakariri District Council (WDC),. However, since 2005, WDC has become party to the Greater Metropolitan Christchurch Urban Development Strategy that is known as the UDS. The theme of 'integrated land use, infrastructure and funding' underpins much of the strategy and associated implementation actions (Urban Development Strategy, 2007). The UDS is a collaboration between the regional authority, Environment Canterbury, and a number of local authorities such as the Christchurch City Council, Selwyn District Council, Waimakariri District Council, and the New Zealand Transport

Agency. The Strategy reinforces the importance of addressing issues in a more integrated manner by focusing on the entire metropolitan region. Figure 1 shows the Greater Urban Development Strategy Linkages.

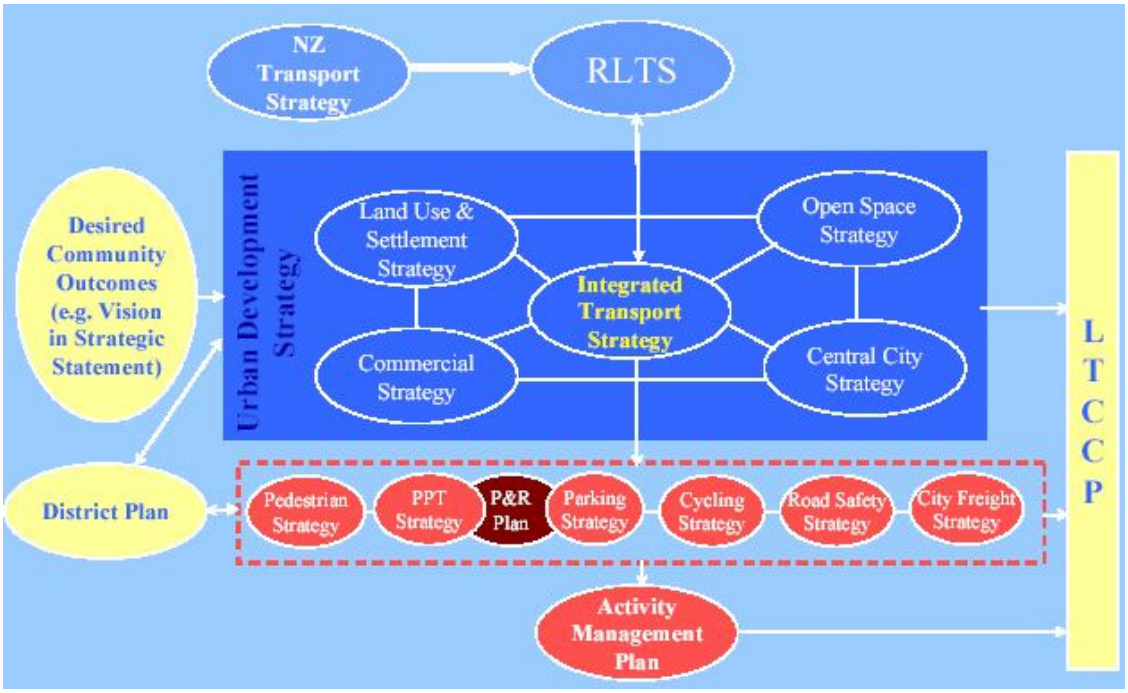

Figure 1: UDS in conjunction with all links (in Woods, 2006)

This includes planning strategies for the location of future residential housing and the development of activity centres with the long-term perspective of providing areas for new employment and assessing the impact of land use change on infrastructure including transportation networks. This type of strategic approach, where local authorities jointly focus on strategic planning, is not new but crucial when suburbia expands into neighbouring districts. These joint ventures will in the future question the existing way of funding infrastructure and may require new ways to access funding from central government or from other sources.

It also highlights the need to address issues in a more integrated and holistic manner. The main aim of the UDS is to provide a greater quality of life for citizen and businesses. The UDS also includes a broad spectrum of objectives which relate generically to environmental, cultural, social, and economic desires. When it comes to look at potential ways to reduce traffic or energy, the UDS is silent on these issues. Park & Ride, parking strategies or Public Transport (PT) are not high on the wish list. They are merely seen as tools for travel demand management at a third level only. This reflects local politics which determine what are the prime objectives. Interestingly, energy demand is often looked upon as a side issue that nobody in authority wants to address, as it is not yet well ingrained in the general public mindset. The same observation can be extended to consideration of waste water, solid waste or nuclear waste. It will only turn up on the political radar screen when there is an emergency situation.

4. SPECIFICS ABOUT RANGIORA

4.1 Introduction

This section provides basic data and information that is used in the energy demand model. It identifies the number of motor vehicles registered in Rangiora, the employment situation of Waimakariri residents, the public transport situation and the perception of people living in the district who were surveyed.

4.2 Number of motor vehicles registrated in Rangiora (Statistics NZ, 2008)

Table 1 shows the number of households and vehicles registered in Rangiora.

Table 1 Rangiora statistics on number of households and motor vehicles

Rangiora	**2006**
Number of households	3,597
registered motor vehicles	6,036
Motor vehicles per household	1.68

4.3 Employment situation and mode of transport to place of work

The following two tables look at the employment situation in 2001 and 2006 by identifying different ways of displaying outcomes. Table 2 identifies the employment situation (full-time or part-time) in relation to their work place for 2001.

Table 2 2001 Employment situation of Waimakariri District population in relation to work location (in Transit NZ, 2008)

Usual place of work for Waimakariri DC residents in 2001	**Resident Labour Force**	**Percentage split**
Waimakariri DC (38% worked from home; 47% drove to work; 9% walk or cycle)	7,686	50.9%
Christchurch City (80% drove to work; 1% use PT)	7,416	49.1%
TOTAL	15,099	100%

Table 3 identifies the 2006 situation. It was not possible to assess where the 'Rest of Canterbury' workplaces may be. From a transport point of view there are many possible destinations such as Lyttelton (including the workforce around the maritime Port). Others may work at Christchurch airport or in the suburbs, or worked from home as do many professionals and may have wrongly interpreted the location. Hence, surveys need to be precise if they are to be useful for interpreting patterns of transport.

Table 3 2006 Employment situation of Waimakariri District population in relation to work location (Statistics NZ, 2006)

Usual place of work in 2006	**Resident Labour Force**	**Percentage split**
Waimakariri DC	9,033	41%
Christchurch City	8,931	40.5%
Selwyn DC	126	0.6%
Rest of Canterbury	267	1.2%
Rest of New Zealand	3,672	16.7%
TOTAL	*22,029*	*100%*

The model takes into account approx 42% (9,250 workers - including Selwyn DC in the south and 50% of the rest of NZ) working regularly south of the Waimakariri River, keeping in mind that the whole Waimakariri District has a population of 42,834 with 12,444 living in Rangiora (Waimakariri DC, 2006). It can also be noted that the District has an active resident labour force of 51% (22,029/42,834). Some 17% work totally outside the area.

The Transit NZ study yields slightly lower figures for 2001 that were based on the 2001 census data. However, they picked up that 1,125 people working in the Waimakariri DC originated from Christchurch. The 2006 study above did not pick that up.

Table 4 2006 Employment situation of Waimakariri District population in relation to work location by taking the same format as table 2 (Statistics NZ, 2006)

Usual place of work for Waimakariri DC residents in 2006	Resident Labour Force	Percentage split
Waimakariri DC	9,033	50.3%
Christchurch City	8,931	49.7%
TOTAL	17,964	100%

Table 4 shows the 2006 employment situation by taking a similar display as in table 2. Given the rapid growth in the District, it is somewhat amazing to see that the percentage modal split is nearly identical to 2001 highlighting the continued dominance of private motoring.

Tables 3 and 4 outline the same basic data but in a different format which can lead to mis-interpretations. It is important to appreciate this as it is similar in the analysis of traffic data. It can only be repeated that it is most desirable that surveys and data collection apply a similar methodological approach to avoid wrongful interpretations. The analysis of the transport situation in Waimakariri District proved tricky as it required interpretation of several sets of information that had not been compiled in a consistent manner. Politicians and decision makers often only consider the latest consultant report and thereby risk overlooking relevant contextual information.

4.4 Public Transport

The public transport system linking the Waimakariri District with Christchurch is operated by bus services operated by bus companies under the rules stipulated by the regional authority, Environment Canterbury (ECan). The Regional Land Transport Strategy aims to increase the proportion of all trips made by public transport to six percent or more by 2011. By evaluating the outcome of the surveys mentioned above, it is clear that this objective will not be met easily.

The current bus services linking Christchurch with the Waimakariri District are limited, probably in response to the low level of demand. There are four services that connect Christchurch with Kaiapoi, Rangiora, Woodend and Waikuku in the north. A bus trip from Rangiora takes one hour to reach the bus exchange in Christchurch. This is considerably longer than taking the car, especially keeping in mind that the work places are wide-spread in Christchurch and parking space is usually not a big problem. Parking costs in the central city are often as low as $NZ 5/day $US 3) by walking 5 min and hence there is little incentive to switch to using public transport. A further negative factor is the high bus fees as Rangiora is classified in the third zone. Thus, most people do not see any monetary advantage from taking the bus to work, especially when

experiencing overcrowded buses at morning peak times. Unless the services are improved in peak times and the zoning system altered, no change is likely to take place. These are areas that would require central government funding, if its objectives of increased sustainability are given higher priority. The general public will make a modal shift if they cannot readily access their destination by the current mode, or the cost difference between two modes has reached a switch point. This trigger point will differ according to the economic situation of different population groups. Keeping in mind that the socio-economic group living on rural properties is often higher than for those in central cities, the trigger point to modal shift will be much higher and thus the probability of achieving a quick modal shift relatively is low.

4.5 Attitude towards accessibility to Christchurch and fuel efficient motor vehicles

The 2007 Waimakariri community survey indicates that 95% of Waimakariri residents consider the prevailing level of accessibility to Christchurch as quite/very accessible (Waimakariri, 2008). The same survey questioned whether the Waimakariri population would purchase a more fuel efficient vehicle as a result of increasing fuel prices by the end of 2007. Twenty two percent indicated that they had already purchased a more fuel efficient vehicle, 32% were thinking of it and 46% responded that it was quite/very unlikely.

5 CURRENT TRANSPORT SITUATION

5.1 Introduction

This chapter gives an overview of various consultancy reports and surveys in regard to the transport situation of commuters living on the northern side of the Waimakariri bridge, by concentrating specifically on the Rangiora community. Figure 2 shows the location of the counting stations.

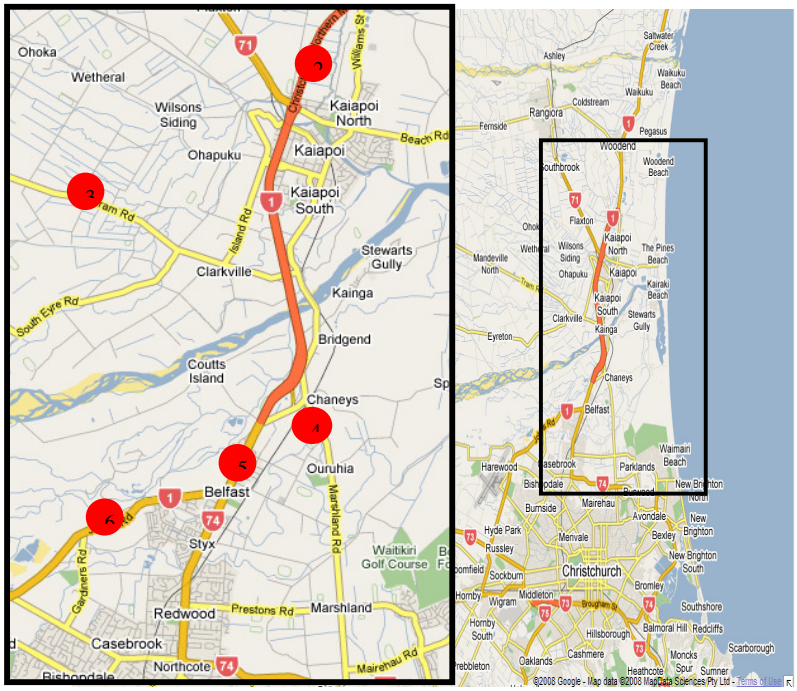

Figure 2: Study area including 2006 traffic count points (2-6) (Adam, 2009)

It starts with 2006 traffic counts from Traffic Design, a Christchurch consultancy, followed by a 2007 Transit New Zealand traffic survey. A morning peak passenger count on the Rangiora bus service was sought for mid December 2008 as neither authorities nor the bus company were willing to provide accurate data for this study. This survey was undertaken by a Lincoln University transport student as part of one of his supervised graduate projects.

5.2 Traffic count

This section shows two individual traffic data, the first done by Traffic Design in 2006 and the second by Transit New Zealand in 2007 (Transit NZ, 2008).

5.2.1 Traffic Design

Figure 2 indicates the geographic location of Rangiora in relation to Christchurch and clearly identifies a bottle neck situation at the Waimakariri River. There are two bridges crossing the Waimakariri River. Neither allow for any short-cuts to reduce commuter distances. They both face congestion in peak traffic times.

Table 5: Traffic counts (Traffic Design, 2006)

Station	Location	AM peak (7AM-9AM)
1	State Highway (SH)1, north of Ashley river (not on map)	422 vehicles
2	SH1, Main North Road, south of Ashley River	495 vehicles
3	Tram Road, Swannanoa, west of Two Chain Road	131 vehicles
4	Marshlands Road Chaneys, south of Main North Line railway crossing	2,112 vehicles
5	State Highway 1, Main North Road, Belfast, South of Dickeys Road.	4,538 vehicles
6	State Highway 1, Johns Road, Harewood	2,076 vehicles

Table 5 above shows the traffic count on State Highway 1, Tram Road, Marshlands Road, and Johns Road at morning peak time from 7am to 9am. The Waimakariri River can only be crossed at two places, SH1 motorway and the old state highway south of Kaiapoi. However, by looking at the vehicle counts, it is difficult to assess the situation and it is not possible to derive how many vehicles may come via SH71 from Rangiora or how many vehicles originate from Kaiapoi. It is pertinent to highlight that it is crucial to have sufficient funding for enough traffic counts to ensure robust traffic analysis.

The morning peak of vehicles heading into Christchurch via Marshlands road (2,112 vehicles - 32% at location 4) or via Belfast (4,538 vehicles - 68% at location 5) added up to 6,650 vehicles.

5.2.3 Transit New Zealand

The Transit study identified an average trip length of 25km from Waimakariri District to Christchurch. Table 6 below indicates 50% of the trips are under 25km and 90% of the trips under 35km. Thull (2008) estimated 35km for his energy demand study for Rangiora commuters. This fits with the Transit study as there is a large residential catchment living around Kaiapoi and Woodend which lowers the average distance.

Table 6 indicates that the average distance from home to shopping is lower than the trip to employment. An increase of shopping centres (e.g. Mega Mitre10 in Rangiora) will decrease the

distance and hence the fuel demand in the future. It is important to mention that specific retail outlets require a certain hinterland size (population catchment) to be viable financially. The Waimakariri District is likely to decrease its energy fuel demand with respect to shopping trips with any increase in retail establishments, in response to increases in population. The type of population served will require more specific retail than found in city suburbs due to the nature of the dwellings (e.g. rural lifestyle blocks).

Table 6 Trip lengths and distribution over 12h survey time in 2007 (Transit NZ, 2008)

Purpose	**Trips**	**Average Trip Length (km)**
Total	20,749	24.68
HB Work	7,436	24.17
HB Employment	1,855	26.74
HB School	865	23.55
HB Shopping	1,057	21.48
HB Other	4,736	24.76
NHB Employment	2,913	26.27
NHB Other	1,887	24.37

<5km	<10km	<25km	<35km	<65km
0.5%	4.5%	50.3%	90.2%	100.0%

HB - home based
NHB - non home based

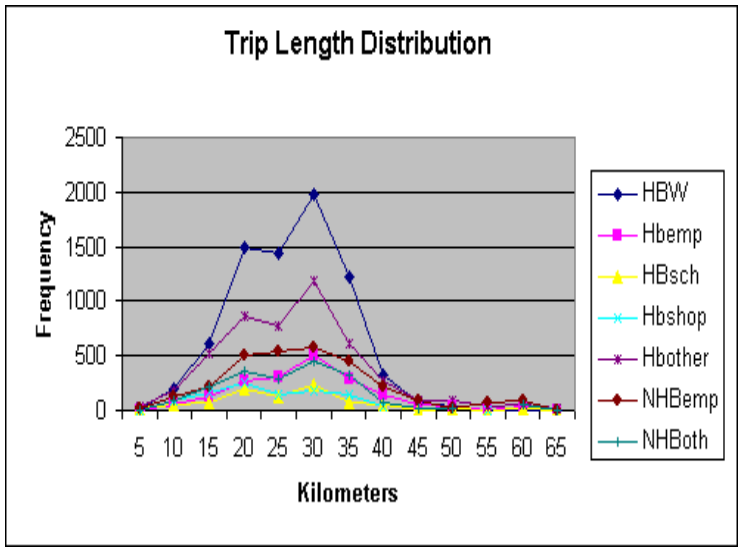

Table 7 Trip distances in relation to number of vehicles for total trips

Trip Distance km)	Sum of Trips	% of Total	Cumulative %
0 - 5	103	0.5	0.5
5 - 10	828	4	4.5
10 - 15	1,934	9.3	13.8
15 - 20	3,949	19	32.8
20 - 25	3,616	17.4	50.3
25 - 30	5,137	24.8	75
30 - 35	3,143	15.1	90.2
35 - 40	1,113	5.4	95.5
40 - 45	323	1.6	97.1
45 - 50	204	1	98.1
50 - 55	122	0.6	98.7
55 - 60	244	1.2	99.8
60 - 65	34	0.2	100
65 - 70			100
Sum	**20,749**	**100**	

The Transit NZ survey was completed over a 12 hour period and unfortunately there is no formula readily available to isolate the morning peak to enable a reliable comparison with the Traffic Design study. Viastrada, an experienced Christchurch traffic engineering consultancy, estimated that taking 18% as a 2 hour morning peak may be a reasonable guess (Wilke, 2008).

This would bring the total of 20,749 vehicles down to a morning peak of 3,735. The study indicates that 9,291 trips are related to work/employment which represents 45% of all trips. By comparing this number with Wilke's estimation, it suggests that approximately 40% of all workers would start work around 9am and travel in the morning peak time to work. This is an interesting outcome that certainly requires further enquiry. The 9,291 trips are close to the 9,250 identified in section 4.3.

Table 7 above provides additional information on the total trip distance by assessing the various trip lengths. Generally speaking, hardly any of the trips listed below will include leisure trips or sports activities as they usually occur in the evening or weekends.

The Transit NZ study indicates that approx 22% of the morning trips of vehicles heading south are not made by people living in the district (Transit NZ, 2008). The Waimakariri DC study (in Adam, 2009) indicates that approximately 70% travelled to work by car, van or truck. Less than one percent (0.7% for Rangiora) took the bus to go to work. It was unclear how the remaining approx. 30% were travelling but probably as passengers. This would signify that car pooling is already relatively wide-spread, despite lack of park & ride opportunities.

5.2.4 Summary of southbound vehicle counts across the Waimakariri River

The Transit study was a 12 hour volume count. Wilke (2008) suggested using 18% to approximate a 2 hour morning peak situation. The tables 8 and 9 below indicate the number of vehicles travelling south in relation to the different studies and trip purposes.

Table 8 Southbound traffic for all trips

Report issued by	All purpose trips	
	12 hours	Morning peak 7am-9am
Traffic Design (2006)		6,650
NZ Transport Agency (2007)	20,749	3,735 Estimation Wilke 18%

By taking Wilke's estimation from 18% to 32%, the morning peak situation would be similar to Traffic Design.

Table 9 Southbound traffic for work trips only

Report issued by	only work/employment related trips	
	12 hours	Morning peak 7am-9am
Traffic Design (2006)		n/a
NZ Transport Agency (2007)	9,291	1,672 Estimation Wilke 18%

By adjusting Wilke's estimation from 18% to 32%, the morning peak for southbound traffic would be approximately 3,000 vehicles.

Adam (2009) found in his study that Waimakariri DC identified that 70% of workers used a private motor vehicle, only 1% public transport. It could be concluded that 29% were passengers in a vehicle. This equals to 2,683 car passengers working south of the district.

By taking the original Wilke approach of 18%, this may mean that many vehicles would carry two passengers plus driver. The 32% version would reduce it to one passenger plus driver.
The outcome is obvious but confusing - because of lack of consistency in methodology applied to employment data and vehicle surveys. It emphasises just how difficult the transport planning task

is for authorities and why so many errors are made. Funding authorities should be alerted by this type of research and allocate more funding to standardised basic data collection.

5.3 Public transport

The perception of public transport by people living in the Waimakariri district is reflected in table 10. Approximately half of the people surveyed have no connection to public transport though the other half has put some thought towards the option of public transport which is promising.

The Transit NZ study identified that 1% of Waimakariri citizens used public transport (Transit NZ, 2008). By taking the basic assumption of the 8,931 people working in Christchurch (see Table 4), this means 89-90 people would be expected in the morning peak times using the bus services into Christchurch. It was not possible to extract patronage data, neither through the operating bus company, nor though the regional transport authority, due to commercial sensitivity. This is relevant for consultants when assessing project costs when bidding for work.

Table 10 Perception of public transport services in Waimakariri district split by households with & without members working in Christchurch (Waimakariri DC, 2008)

Views about bus services	**Households with people working in Christchurch**		**Households without people working in Christchurch**		**Total**	
	Number	**%**	**Number**	**%**	**Number**	**%**
Too few bus services	25	20.3	23	8.2	48	11.8
The service is about right	41	33.3	103	36.7	147	36.1
Too many bus services	9	7.3	11	3.9	20	4.9
No need for bus services	0	0	3	1	3	0.7
No opinion/no response	48	39.1	141	50.2	189	46.5
Total	**123**	**100**	**281**	**100**	**407**	**100**

Adam monitored on 16th December 2008 the bus patronage passing through Belfast and counted 165 passengers, excluding school children. This included the Rangiora direct service (route 90) and the indirect route via Woodend (route 92) from 6.50am - 9.20 (departure time Rangiora). The methodology used was to identify two bus stops that were close, riding the bus from one bus stop to the next and walking back to the first bus stop. This random passenger count on 16th December 2008 means that it is likely that the patronage increased from 1-2% over a period of one year. This rise is explicable given the escalation in fuel prices mid year which may have contributed to a long-term modal shift. It would be interesting to evaluate patronage data throughout the year but they were not made available for this research.

From a long-term perspective, patronage is only likely to increase if petrol prices rise above $2/litre, the bus companies introduce wireless LAN across their Rangiora service, reduce the price zoning from zone 3 to zone 2 for Rangiora, keep Kaiapoi and Rangiora in the same price zone to increase bus patronage between these two towns and introduce a fast service from Rangiora along the motorway, allowing a special bus lane for quick travel. The last measure would bring the advantage of allowing the bus service to be time competitive with the private motor vehicles, avoiding congested vehicles lanes on the northern motorway and parking costs at destination. Such as bus lane could be extended to HOV -high occupancy vehicles or any other vehicles happy to pay road user fees for avoiding congestion (Kissling, 2009).

6 ENERGY

6.1 Introduction

This section provides about a consideration of the energy being used by commuters living in Rangiora. It provides background information about the New Zealand fuel demand, the motor vehicle fleet and simulates two scenarios to reduce the fuel demand in the future. This section will not deal with energy debates, nor consider oil price elasticity.

6.2 Basics on Energy Demand in New Zealand

The topics of oil and CO_2 are rather complex and in the case of motor vehicles closely linked through the fuel consumption. It is difficult to source coherent data on energy demand associated with transport for New Zealand. It seems that this information is difficult to obtain in other countries too. The main information in New Zealand is held by the Ministry of Economic Development (MED) & Statistics New Zealand. Table 11 below shows the energy demand for national transport, involving all modes, land, maritime and air transport from 2002 to 2006 (MED, 2007).

Table 11 Energy Demand of National Transport from 2002-2006 (Thull, 2008)

National Transport Demand [PJ or 10^{15} J]	2002	2003	2004	2005	2006
Petrol (91/95/98)	104.17	107.82	110.96	109.24	110.26
Diesel	71.3	74.09	75.76	77.46	84.11
Aviation Fuel	15.34	17.21	17.71	15.1	16.58
Others (fuel oil, LPG)	6.28	6.27	5.82	6.68	5.87
SUM	**197**	**205**	**210**	**208**	**217**

Generally speaking, the energy demand for national transport is approximately 86% of the total oil consumption in New Zealand and land transport (Road & Rail) represents about 74% of national transport (Table 12).

Table 12 does not give specific details on how the Diesel demand is split between various modes (heavy vehicles, light vehicles) as it is unknown and highly speculative as the author discovered. It is relevant however to identify such details to better understand transport movement and enable appropriate decisions to be made in regard to transport directions in the future (e.g. should light vehicles be directed to Diesel to improve energy efficiency or will a higher vehicle fuel efficiency induce more travelling as is apparent in some European countries? Countries like New Zealand need to ensure that they consider how to use best the country's own energy reserves to minimise if possible imports in the future,.

Table 12: Energy Demand in 2006 for national transport and land transport (Thull, 2008)

National Transport [PJ]	Land Transport [PJ]
100%	74.40%
216.82 PJ	161.3 PJ

Table 13 below indicates the number of new or used vehicles imported to NZ between 2001 and 2006. The figures are published regularly by the New Zealand. Transport Agency.

Table 13 Registration of new and used motor vehicles in NZ from 2001-2007 in relation to cc rating (Thull, 2008)

CAT	cc rating	SUM 2001-2007	per annum	2007	2006	2005	2004	2002	2001
CAT 1	up to 1,200	9,093	1,516	2,231	1,976	1,543	1,740	897	706
		0.7%	0.7%	1.1%	1.0%	0.7%	0.8%	0.4%	0.4%
CAT 2	1,201 - 1,500	209,461	34,910	35,642	36,433	38,680	36,555	33,440	28,711
		17%	16.8%	18.0%	18.2%	16.8%	16.0%	16.7%	15.4%
CAT 3	1,501 - 2,000	525,759	87,627	79,433	82,843	94,137	88,721	87,533	93,092
		42%	42.2%	40.2%	41.4%	40.9%	38.8%	43.7%	49.8%
CAT 4	2,001 - 3,000	330,804	55,134	53,542	52,672	63,771	65,763	52,211	42,845
		27%	26.6%	27.1%	26.3%	27.7%	28.7%	26.0%	22.9%
CAT 5	3,001 +	169,382	28,230	26,988	26,270	32,182	36,018	26,423	21,501
		14%	13.6%	13.6%	13.1%	14.0%	15.7%	13.2%	11.5%
	TOTAL	1,244,499	207,417	197,836	200,194	230,313	228,797	200,504	186,855

Table 13 indicates that petrol price rises over the last few years did not change purchasing behaviour. It will be interesting to see if there is a change in the 2008 data following fuel prices peaking in mid 2008 and a worldwide recession impacting on New Zealand. A reduction of car sales is likely. The 1.5l-2.0 litre range dropped from approx 50% of market share in 2001 to 40% in 2007. These 10% were split between larger cc vehicles (2/3) and only 1/3 for smaller vehicles.

The explanations are simple:

- vehicle registration costs in NZ are the same across all CC ratings
- households translated their increased assets through rising house prices into luxury vehicles
- fuel prices were expected to fall back to 89 Cents/litre.
- increase of cheap luxury high performance European cars & SUV imports from Japan

High fuel prices did not necessarily lead to a reduction of fuel demand in the short term but raised the awareness of many households how dependent they were on fuel. A long-term prognosis is more difficult to predict for a number of reasons: by 2010 the first plug-in electric vehicles will test the market - hence the electricity grid capability will be challenged and by around 2015, it is expected to see 5-10% of new vehicles registered in NZ to be electric hybrid plug-ins, authorities and companies taking hopefully the leadership for promotional purposes. It will take 2020 and new infrastructure in place (e.g. battery swap, plug-in infrastructure) for the financially wealthy part of society to replace one older vehicle in each household with a new electric one.

By 2020 the oil producers will have more certainty about oil availability as most of them have only started to invest heavily in new technology and equipment. The oil price is likely to reflect the general economy and the technological advance (e.g. oil wells 4km instead of 2km deep) and the fuel price may stabilise between 100-150USD. The future costs of driving will be less reflected by oil prices but by a number of other environmental and infrastructure usage charges.

7 RANGIORA CASE STUDY ENERGY DEMAND SIMULATION

7.1 Introduction

The energy demand situation is based on a number of input parameters described below. Two energy demand scenarios are highlighted - existing motor vehicle fleet and fuel efficient motor vehicle fleet. The model does not include bus services.

7.2 Input Parameters for motor vehicles

The motor vehicles types are randomly chosen for simulating the current fleet - however most models are listed in the Land Transport New Zealand (LTNZ) (now NZTA) fuel saver website (FUELSAVER, 2008). The fuel consumption data are mainly taken from the LTNZ fuelsaver website, though some are sourced directly from manufacturers or specialised overseas websites (e.g. German 'Spritmonitor' that allows every motorist to enter their personal fuel consumption (Fuelsaver, 2008; Spritmonitor, 2008).

Current fleet input parameters

There is a mix of motor vehicles types (Petrol, Hybrid Petrol, Diesel), differentiated by 5 cc rating categories (A-E) including light commercial vehicles and SUV's.

A < 1,200cc B 1,201<X<1,500cc C 1,501<x<2,000cc D 2,001<x<3,000cc E >3,001cc

- 20% added to consumption (air conditioning, 85% in urban area traffic, short distances).
- Assumption that of current fleet is composed of 80% petrol and 20% Diesel vehicles.

Fuel efficient fleet input parameters

This simulation includes a number of specific fuel-efficient vehicles that are available in Europe but not in NZ and a modification of the current CC rating distribution by deleting 3,000cc+ cars and having category D > 2,000cc.

Annual Driving distance

The fuelsaver website (2008) classifies New Zealand drivers into 5 categories (Table 14).

Table 14 LTNZ classification of annual mileage of New Zealanders

mostly around town	10,000km
typical NZ driver	14,000km
working parent -Taking the kids to school, daily trips to work and weekend chores, but no long trips	15,000km
suburban commuter - Living in an outer suburb and working in the city	20,000km
family commuter - Driving the children to school, daily commuting, some longer trips at weekends and frequent long journeys	30,000km

These distances match well the two scenarios that are tested:

- Commuter trips between Rangiora and Christchurch are estimated overall to be around 30,000km, including weekend sports or leisure trips and allowing that only a proportion of all vehicles registered in Rangiora go to Christchurch every day.
- A park & ride option north the Waimakariri bridge will reduce the distance travelled to approximately 20,000km. This does not represent fully the 48km daily trip saved by using

public transport to the central city (48km * 5 days/week * 48 weeks/year = 11,520km), as there will be occasions commuters will use their vehicle to concentrate trip purposes. Hence the 20,000km annual commuter distance is believed to be a fair estimation.

7.3 Simulation outcomes - energy consumption

The following tables provide an indication of annual fuel consumption for various scenarios by taking the current fleet (Table 15) and looking at potential savings by shifting to a more efficient vehicle fleet (Table 16) in relation to vehicle kilometre travelled (VKT).

Table 15 Annual fuel consumption per vehicle (current fleet) by distance &CC ratings (Thull, 2008)

Annual fuel consumption by CC rate & distance		l/100km (+20%)		30,000 Km/a		20,000 Km/a		14,000 Km/a	
				Fuel consumption / annum					
		Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol
A	< 1200cc		6.1		1,836		1,224		857
B	1201cc <X< 1500cc	5.6	7.2	1,701	2,162	1,122	1,441	785	1,009
C	1501cc < X < 2000cc	7.0	9.8	2,059	2,928	1,405	1,952	983	1,366
D	2001cc < X < 3000cc	10.5	11.8	3,139	3,528	2,093	2,352	1,465	1,646
E	> 3001cc	12.7	14.2	3,816	4,262	2,544	2,842	1,781	1,989

Table 16 Annual fuel consumption per vehicle (fuel efficient fleet) by distance & cc ratings (Thull, 2008)

Annual fuel consumption by CC rate		l/100km (+10%)		30,000 Km/a		20,000 Km/a		14,000 Km/a	
				Fuel consumption / annum					
		Diesel	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Petrol
A	< 1200cc		5.2		1,551		1,034		724
B	1201cc <X< 1500cc	5.0	5.5	1,500	1,650	1,000	1,100	700	770
C	1501cc < X < 2000cc	6.0		1,800		1,200		840	
D	> 2001cc	6.6		1,980		1,320		924	

The following Tables 17 and 18 indicate the overall fuel consumption for commuter purposes of Rangiora households in relation to distance travelled, taking into account the average percentage of NZ cc rating. Table 17 provides an overview of the current fleet whereas Table 18 looks at a potential fuel efficient fleet. PJ stands for Petajoule in the following tables.

Table 17 Annual fuel consumption for Rangiora commuters with current vehicle fleet (Thull, 2008)

Annual fuel consumption by CC rating & distance		30,000 Km/a		20,000 Km/a		14,000 Km/a	
		Fuel consumption / annum					
		Diesel	Petrol	Diesel	Petrol	Diesel	Petrol
A	< 1200cc		80,784		53,856		37,708
B	1201cc <X< 1500cc	345,303	1,757,706	227,766	1,171,533	159,355	820,317
C	1501cc < X < 2000cc	1,050,176	5,973,120	716,550	3,982,080	501,330	2,786,640
D	2001cc < X < 3000cc	1,007,619	4,528,171	671,853	3,017,616	470,265	2,111,818
E	> 3001cc	625,824	2,800,134	417,216	1,867,194	292,084	1,306,773
	SUM Diesel & SUM Petrol [litres]	3,028,922	15,139,915	2,033,385	10,092,279	1,423,034	7,063,256
	SUM Diesel & SUM Petrol [PJ]	0.11	0.53	0.08	0.35	0.05	0.25
	SUM Diesel & Petrol [PJ]	**0.65**		**0.43**		**0.30**	
	SUM Diesel & Petrol [litres]	**18,168,837**		**12,125,664**		**8,486,290**	

Table 18 Annual fuel consumption for Rangiora commuters with fuel efficient fleet (Thull, 2008)

Annual fuel consumption by CC rating & distance		30,000 Km/a		20,000 Km/a		14,000 Km/a	
		Fuel consumption / annum					
		Diesel	Petrol	Diesel	Petrol	Diesel	Petrol
A	< 1200cc		468,402		312,268		212,608
B	1201cc <X< 1500cc	1,584,000	747,450	1,056,000	498,300	739,200	348,810
C	1501cc < X < 2000cc	4,888,800		3,259,200		2,281,440	
D	> 2001cc	2,987,820		1,991,880		1,394,316	
	SUM Diesel & SUM Petrol [litres]	9,460,620	1,215,852	6,307,080	810,568	4,414,956	561,418
	SUM Diesel & SUM Petrol [PJ]	0.36	0.04	0.24	0.03	0.17	0.02
	Sum Diesel & Petrol [PJ]	**0.40**		**0.27**		**0.19**	
	Sum Diesel & Petrol [litres]	**10,676,472**		**7,117,648**		**4,976,374**	

Table 18 highlights that shifting to a fuel efficient vehicle fleet will reduce the fuel demand by approximately 41% for performing the same tasks. Both tables point out clearly that a fuel demand reduction of 33% is possible by lower annual km driven (30,000km to 20,000km) through Park & Ride north of the Waimakariri bridge or of 53% compared to people living in Christchurch. The earlier part in the study showed that it was not clear whether the existing traffic counts were able to be considered as a number of data were not consistent. It is important to

remember at any stage that transport data needs to be collected in a consistent way to avoid poor modelling outcomes.

In summary, there are means to reduce the energy demand for growing rural residential areas at the wider metropolitan fringe. However, unless a modern, quick, efficient, safe, convenient public transport mode is put in place by government - so it does not overwhelm the budget of a small district - or any other restrictions to private motor vehicles are put in place, these rural townies - usually wealthy - will not change behaviour. It is possible to encourage the financially wealthy people to replace their current vehicles with fuel efficient ones. Unfortunately, unless we see large electric vehicles (SUV or station wagon type) emerging quickly in New Zealand, a change is not likely to happen rapidly as households living on rural properties have different needs from townies (e.g. transporting lawnmowers, DIY, pets). A start could be made by government offering the equivalent of EUR 2,500 for every vehicle over 10 years replaced by a vehicle that has a CO_2 rating of less than 150g/km.

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REFERENCES

Adam, S. (2009). A Demand Estimation Study for Park & Ride in Waimakariri District; TRAN 698 student report, Transport Studies, Lincoln University, New Zealand

Fuelsaver (2008). Fuelsaver website launched by Land Transport New Zealand in 2007; www.fuelsaver.govt.nz

Kissling, C. C. (2009). Personal information from Chris Kissling, Professor for Transport Studies, Lincoln University, New Zealand

LTNZ /LTSA (2001- 2008). Motor vehicle registrations 2001, 2002, 2004, 2005, 2006

MED (2007). New Zealand Data File, June 2007, Ministry of Economic Development, New Zealand, June 2007

Spritmonitor (2008). German fuel consumption data website made up by individual motorists; www.spritmonitor.de

Statistics NZ (2008). Census data 1996-2006; retrieved http://www.stats.govt.nz/census/default.htm

Thull, J.-P. (2008). Transport Energy Minimisation & Kiwi Urban /Peri-Urban Lifestyle Change, in *NERI - National Energy Research Institute (www.neri.co.nz) conference proceedings*, 26-27 June 2008, Wellington, New Zealand; www.neri.org.nz/pdfs/e5/thull_paper.pdf

Traffic Design Group (2006). *Christchurch Transport Model Update (2006 census) Data Collection Report*. Christchurch, New Zealand.

Transit New Zealand (2008). *RSI Surveys (2007): Northern Access Package UDS TG Workshop 31 October 2007.* Christchurch, New Zealand.

Waimakariri DC (2006). Waimakariri District profile 2006, New Zealand

Waimakariri DC (2008). 2007 Community Survey, Waimakariri DC, April 2008, 122 pages.

Wilke, A. (2008). Personal information by Axel Wilke, director of Viastrada, ww.viastrada.co.nz

Woods, S. (2006). The Implications of Park & Ride for Urban Development Strategies in Major Metropolitan Areas in New Zealand, Masters thesis at Canterbury University, New Zealand, June 2006.