Determining the Transport Effects of Alternative Landuse Scenarios

Laura Skilton

Senior Transportation Planner, GHD
laura.skilton@ghd.co.nz

ABSTRACT

Transportation models are often used to assess alternative roading projects, but they can also be used to assess transport patterns and impacts arising from alternative landuse scenarios.

This presentation is based on actual projects using alternative future landuse forecasts. These can provide direction to planners to identy the most efficient transportion needs based on alternative growth distributions. In addition these are able to quantify mitigation measures for alternative growth areas. The overall cost to the community, in terms of transport, can be determined using transport models to enable planners to make better informed decisions when determining Council growth strategies

. 1 INTRODUCTION

This paper examines a case study of how a transport model was used to assess alternative landuse scenarios and estimate the transport costs to a community and to provide a tool for Council Officers to make informed decisions on landuse policies.

2 TRANSPORT MODEL MATRICES

Travel demand in a transport model is based on a matrix of trips between origin zones and destination zones. Matrices can be estimated using three basic methods. Often a combination of methods is used.

2.1 Direct Survey

Matrices can be determined by direct observation at sites around the study area or by undertaking a series of household interview and roadside interview surveys. However, only a sample of observations or surveys are made so the remainder of the matrix has to be estimated, normally based on the demographic attributes of each zone, for example the number and type of households.

2.2 Matrix Estimation

Many transport model software packages have a matrix estimation component built into it. A starting matrix is iteratively updated by altering each origin-destination pair within the matrix to actual observed flows, based on travel routes in a network. The technique allows a matrix to be constructed relatively simply using whatever data is available. However there are shortfalls to this method.

Matrix estimation relies on a good calibrated network to ensure that the paths between zones are accurate. If the paths do not reflect drivers' route choice, the matrix will still calibrate on the observed flows, but the distribution of trips within the matrix will be inaccurate.

Matrix estimation also requires independent traffic counts to validate the model after the estimation procedure. If the validation counts are the same as the counts used to estimate the matrix, then the output matrix will appear to be better than it is.

Future matrices can not be estimated using this technique, so an alternative method must be introduced, which may make the future year matrices inconsistent with the validated base model.

2.3 Gravity Model

Many transport model software packages have a "gravity model" routine to distribute trips amongst origins and destinations. In a gravity model, the trips generated from each zone are estimated from landuse data and then iteratively distributed to the other zones based on the attractiveness between the zones. The attractiveness is based on a combination of the travel cost (time and distance) and the number of trips from each zone. The output matrix is more accurately defined if the trip generation and distribution is divided by trip purpose (work, shop, recreation, etc), as origin-destination pairs are then better matched.

Gravity models generally contain a trip length frequency parameter, so that the average trip length for each trip purpose can be calibrated based on observed data.

Different demand matrices will be created for different networks under the same landuse scenario as the cost of travel between two zones will differ for alternative networks.

Future matrices can be estimated using the exact same method as the base matrix by simply updating the landuse for each zone. Therefore the future model is directly consistent with the validated base model.

3 WAIRAU PLAINS LANDUSE STUDY

The Wairau Plains Landuse study was a joint study between the New Zealand Transport

Agency and Marlborough District Council. Historically there have been a number of cases where there has been growth outside of the existing urban area. One of the objectives of the study was to support policy to direct and manage such growth.

A transport model was developed using Saturn and calibrated to a base year of 2006. Landuse data for each zone was derived from the 2006 census. The trip generation for each zone was estimated by trip purpose from household interview surveys undertaken in other towns in New Zealand. Trip length distributions for work trips were based on the journey to work data from the 2006 census. A variable demand matrix was used using the subroutine, Sateasy, within Saturn, enabling the trip distribution to alter in alternative networks based on the travel cost between zones. The outputs presented in this paper are for the do-minimum network only.

As no traffic count data was used during the matrix building process, the model could be validated using all of the available existing traffic count data.

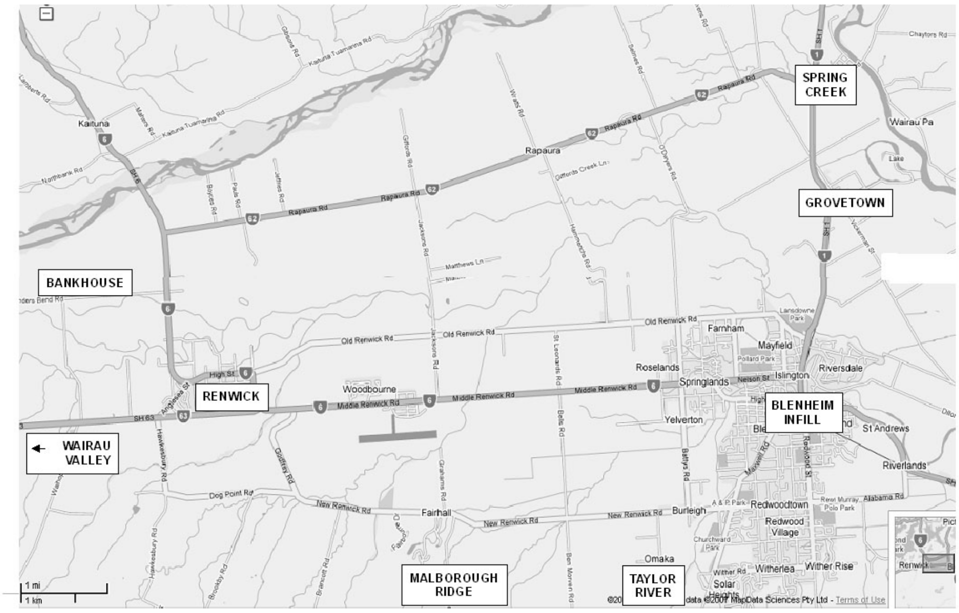
3.1 Alternative Landuse Scenarios

The number of additional households required to cater for growth between 2006 and 2026 was estimated based on the average growth rate over the previous 15 years. Three alternative distributions for these new households were estimated, based on a high proportion of infill within existing urban areas, a high proportion of new households in surrounding towns or a combination.

The location of the additional households are provided in the table and map below.

Location	Intensification	Satellite Towns	Combination
Blenheim Infill	2890	600	1700
Renwick	300	700	500
Grovetown	100	1200	700
Spring Creek	10	50	50
Taylor River	700	300	500
Bankhouse		700	350
Marlborough Ridge		200	100
Wairau Valley		250	100

Table 1 Distribution of Additional Households for each Landuse Scenario



3.2 Rural Deficiencies

The level of service of one lane rural roads is determined by the traffic volume on the road. As traffic volumes increase, the opportunity for overtaking manoeuvres decrease.

Deficiencies in the rural network were determined by which rural roads had more than 750 vehicles per hour per lane. Link plots were created with bandwidths representing the volume of traffic on each link. The thicker the line, the greater the traffic volume. The links with traffic volumes greater than 750 vehicles per hour are shaded darker.

Figure 1 2006

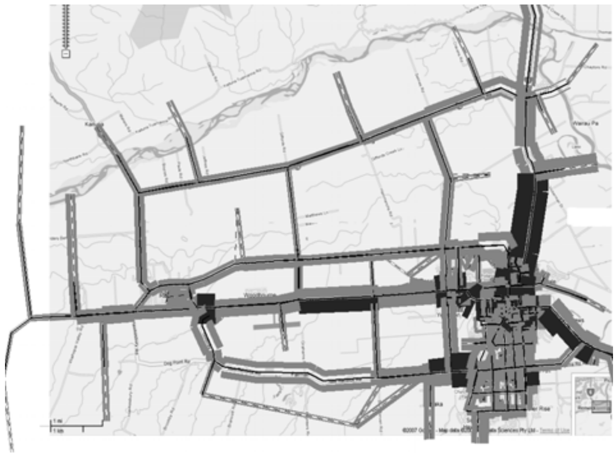


Figure 2 2026 Combination

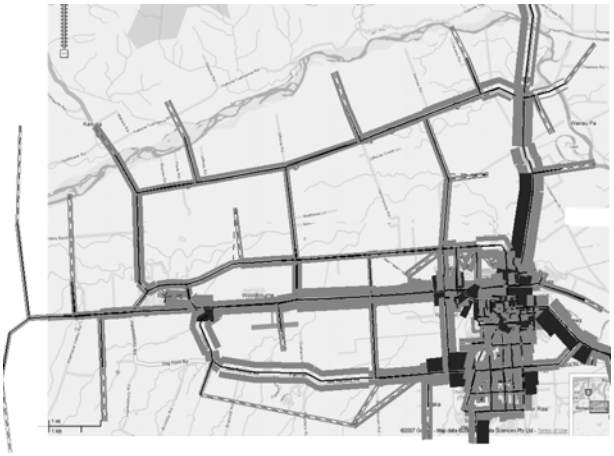


Figure 3 2026 Intensification

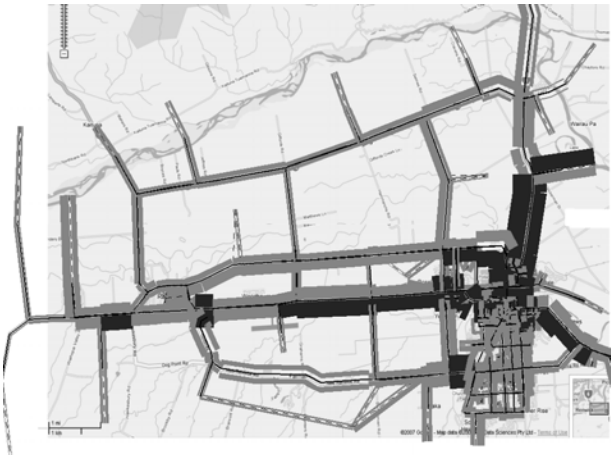


Figure 4 2026 Satellite Towns

Not surprisingly, the satellite town options had a greater impact on the rural roads.

3.3 Urban Deficiencies

Urban traffic congestion is primarily a result of intersection delay. The difference in travel time between peak periods and non-peak periods is due to the increased pressure at intersections.

Delays at intersections were extracted from Saturn to determine the mitigation that may be required for each scenario.

Generally there were high delays on side roads of rural intersections under the satellite town scenario, while many urban intersections would require upgrading under the intensification scenario. Many of the rural intersections had a high level of conflict when there was a significant increase in households.

Overall, the satellite town scenario required more mitigation to relieve intersection capacity.

3.4 Network Summary Statistics

The network wide statistics were extracted and are tabulated below together with the 2006 results for comparative purposes.

Scenario	2006	2026 Intensification	2026 Satellite Towns	2026 Combination
Travel Time (hrs)	966.0	1650.9	2307.6	1904.6

Scenario	2006	2026 Intensification	2026 Satellite Towns	2026 Combination
Travel Distance (km)	53049.3	80098.4	100047.5	89084.6
Fuel Consumption (l)	4145.9	6656.9	8511.8	7465.6
Average Speed (kph)	54.9	48.5	43.4	46.6

Table 2 Network Summary Statistics – Evening Peak

The 2026 Satellite Town scenario has over double the distance travelled and fuel consumption to the existing situation. The scenario with the least impact on the environment is the Intensification scenario. As households are closer to employment, this result is not surprising.

4 TESTING BCRs ON ALTERNATIVE LANDUSE SCENARIOS

Another use for using alternative future landuse distributions within a transport model is to test the robustness of a roading project under alternative future landuse scenarios.

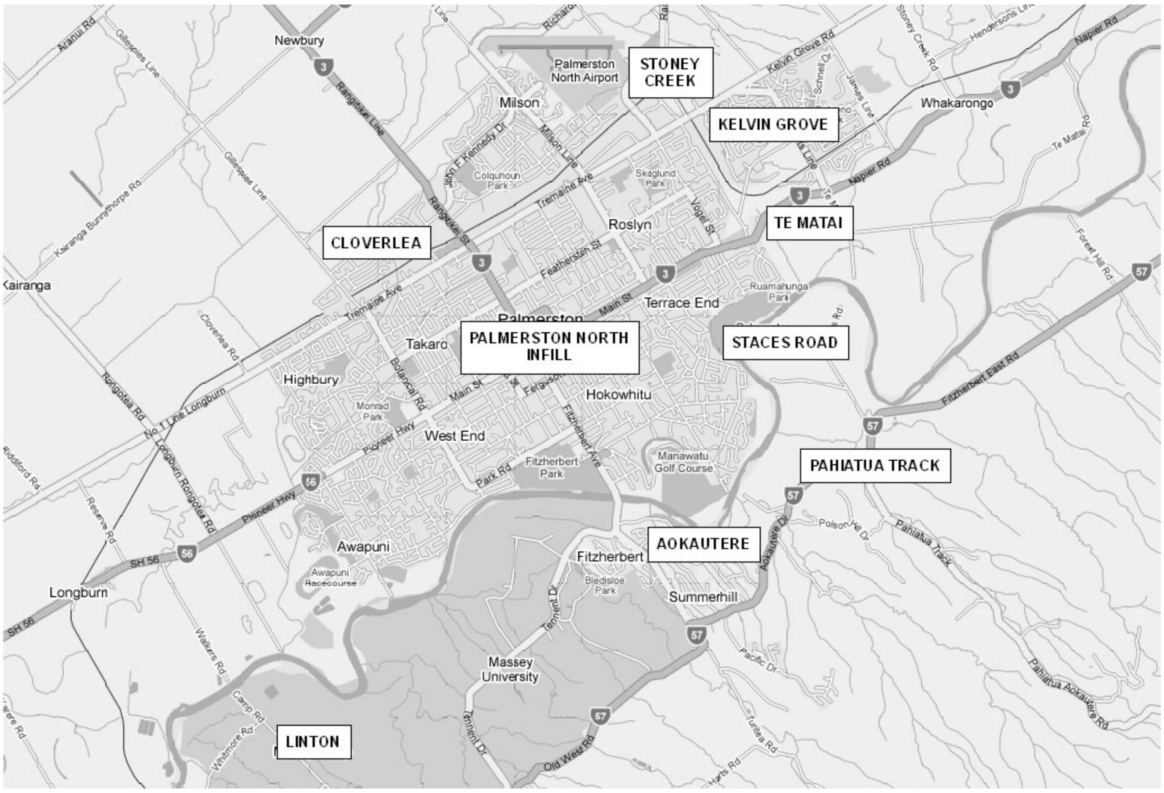
The scheme assessment for the Upstream Bridge Crossing of the Manawatu River was undertaken using the Palmerston North Transport Model. The model uses the gravity model routine within the Tmodel software suite and was extensively updated after the 2006 Census release.

A preferred bridge location was identified by evaluating several alternative networks using the medium general landuse scenario. Since the model uses a gravity model, and therefore uses a variable demand matrix, the total number of trips across the river varied with each bridge location due to the different cost in travel between alternative zones.

As the Councils future growth policy was still in draft form, and had not yet been finalised, the preferred bridge location was then assessed using 6 alternative future landuse scenarios, being a high growth scenario and 5 alternative household distributions under medium growth. The landuse scenarios that were tested are summarised below:

Growth Scenario	High	Medium General	Medium South	Medium North	Medium Stoney	Medium Linton
Palmerston North Infill	2,270	940	940	940	940	940
Aokautere	1100	650	1200	-	650	650
Pahiatua Track	570	320	670	-	320	320
Kelvin Grove	750	450	100	870	450	450
Cloverlea / Gillespies	600	400	100	700	-	-
Te Matai / Napier Road	1,000	600	100	1100	-	-
Stoney Creek	-	-	-	-	1,000	-
Staces Road	400	250	500	-	250	250
Linton	-	-	-	-	-	1,000

Table 3 Distribution of Household Growth



Each landuse scenario was ranked in terms of likelihood of that growth scenario occurring. A BCR of the preferred crossing location was calculated for each landuse scenario based on total travel time and travel distance in the network. A weighted average BCR was then estimated.

Growth Scenario	High	Medium General	Medium South	Medium North	Medium Stoney	Medium Linton
Ranking	6	2	1	4	3	5
BCR	2.43	2.17	2.42	1.41	2.27	2.25

Table 4 Benefit Cost Ratios of Alternative Landuse Scenarios

Overall the weighted average BCR was 2.2.

10 CONCLUSION

Transport models are a useful tool to determine the effects of alternative landuse scenarios on the roading network and the transport cost to the community, so that decision makers have better information to make informed decisions on landuse policies.

Alternative landuse distributions are also a useful way of determining the robustness of a transport project.

11 ACKNOWLEDGEMENTS

I would like to convey my appreciation to the New Zealand Transport Agency and Marlborough District Council for allowing the Wairau Plains Landuse Study to be used as a case study and to Palmerston North City Council for allowing the Upstream Bridge Crossing Study to be used as a case study.