ASSESSING PASSING OPPORTUNITIES - STAGE 2

Transfund New Zealand Research Report No. 146

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Transfund New Zealand Research Report No. 146

ISBN 0-478-11554-7
ISSN 1174-0574

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Koorey, G.F., Farrelly, P.M., Mitchell, T.J., Nicholson, C.S., 1999. Assessing Passing Opportunities - Stage 2. *Transfund New Zealand Research Report No. 146.* 81pp. + appendices.

Keywords: rural highway, two-lane, passing lanes, overtaking, driver frustration, safety, simulation, TRARR, project evaluation, New Zealand

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The research detailed in this report was commissioned by Transfund New Zealand.

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ACKNOWLEDGMENTS

The authors wish to acknowledge the valuable assistance received from:

- Mr David Wong-Toi, formerly of Transit New Zealand Head Office
- Mr Peter Farrington
- Mr Ian Melsom, Transfund New Zealand
- Mr Fergus Tate, Institute for Transport Studies, Leeds

as well as staff in various Opus offices throughout New Zealand

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1. To assess measures of driver frustration resulting from inadequate passing opportunities. This may then be used to estimate the drivers' perception of the facilities provided to them and so identify areas where improvements are most urgently needed.

2. To determine the crash reduction potential of passing lane improvements in New Zealand. As well as possible benefits at the passing lane site, there is evidence that such a reduction in crash rate may extend some distance beyond the end of the actual passing lane.

3. To develop a simplified system for assessing the provision of passing lanes. Such a system would need to minimise the construction costs at the same time as maximising the economic benefits of the proposed improved passing opportunities, based on economic grounds continuing to be used as the determining factor in a funding decision.

4. To consider the degree to which the findings of TRARR modelling and more simplified models developed can be replicated in "before and after" field tests. In this way, the models can be properly calibrated for New Zealand conditions.

The key findings of the study were:

1. People become significantly more frustrated on roads with lower proportions of available sight distances. However this did not translate into a significant difference in willingness to pay. Drivers who preferred to travel quickly relative to others or reported passing more often were significantly more likely to become frustrated. Conversely, people who travel slowly also appreciate having somewhere to pull over to let people past.

   Travellers on short sections of road were willing to pay higher amounts per km for improved passing opportunities than on longer routes, while people who travelled on the same road frequently were more likely to become frustrated.

   An average willingness to pay for passing lanes was calculated as between 3.2 and 3.7 cents per vehicle per kilometre of constructed passing lane. Although there was a statistically significant relationship between Unsatisfied Passing Demand (UPD) and Willingness To Pay (WTP), it was not considered suitably robust to apply different WTP values for different road and traffic situations.

2. Typical mid-block injury crash rates for three or four-lane rural highway sections in New Zealand were found to be on average **25%** lower than the equivalent two-lane crash

rates. Where a realignment is being considered in conjunction with a passing lane, this typical crash rate reduction is considered the best solution for both the two-lane and three/four-lane sections of the new alignment.

A detailed passing lane crash study found a 13% reduction in crash rates after the construction of a passing lane, with no significant distinction between directions of travel. Crash reduction was more significant for passing lanes that involved full realignments than for "tack-on" passing lanes (54% compared to 5%).

In terms of crash type, the rate of "Lost-Control" crashes increased significantly (15% for tack-on passing lanes) while "Overtaking" and "Head-On" crashes were dramatically reduced (38% and 62% respectively). "Rear-End/Obstruction" crashes also decreased by 15%.

The only region where crash rates consistently increased was between 0-2 km downstream. This may be a result of merge area problems and higher speeds following the passing lane.

The severity of crashes in the same direction as the passing lane reduced by 15% overall after passing lane construction. For tack-on passing lanes however, this was negated by an increase of severity in opposing direction crashes.

The most significant crash reductions occurred for passing lanes less than 800m long (approximately 25% for both tack-on and all passing lanes). No clear relationship between traffic volume and crash reduction emerged. No pattern could be found between passing lane construction date and change in crash rate.

3. A simplified model for assessing the optimum location of passing lanes has been developed. The model is based on comparing the supply of and demand for passing opportunities along a route. This model requires less input data and analysis time than TRARR and can be used as a "first sieve" analysis tool to determine the need for passing lanes. The model has been formulated so that input data is readily available for State Highways.

4. Mass data-collection techniques, such as number plate surveys, are recommended for the sampling of overall travel times when calibrating a TRARR model, supplemented by a small number of floating car surveys (at least six in each direction) to ascertain the within-trip speed variations.

   Both the conceptual model as it stands and simple "first order" TRARR analysis (to a lesser degree) appear to underestimate actual travel time benefits derived from passing lanes.

ABSTRACT

Stage 2 of Transfund New Zealand's research project "Assessing Passing Opportunities" builds on initial work that investigated ways in which improved passing opportunities can be provided and analysed. The main objectives of this research were:

1. To assess measures of driver frustration resulting from inadequate passing opportunities.
2. To determine the crash reduction potential of passing lanes in New Zealand.
3. To develop a simplified system for assessing the provision of passing lanes.
4. To assess optimum data requirements to calibrate TRARR for New Zealand conditions.

A tangible willingness to pay for passing lanes due to frustration was determined. A number of factors were found to have an effect on passing lane crash rates, including crash type, crash location, and passing lane length. A simplified model for assessing the optimum location of passing lanes was developed. A comparison of both this model and TRARR with "before and after" field data was made.

1. INTRODUCTION

New Zealand's relatively rugged terrain and low traffic volumes have meant that virtually all rural strategic routes have been built as two-lane highways. As traffic volumes have increased, increasing pressures have been placed on maintaining an adequate level of service. Passing opportunities, such as passing lanes and slow vehicle bays, provide a means to relieve these pressures and their construction is greatly encouraged by the general public. Supply, however, is arguably not matching demand. Recent surveys have highlighted the ability to pass (i.e. passing lanes, multiple lanes, wide shoulders) as a major concern identified by virtually all road user groups (A.C.Nielsen 1998, Travers Morgan 1994).

This may be partly explained by the economic climate under which passing lane construction has existed for the past decade or so. Transfund New Zealand are responsible for the funding of all State Highway projects and for part-funding of local road projects (previously, Transit New Zealand incorporated the funding role with its State Highway management role). Transfund requires that all new roading projects be assessed using their standard economic evaluation procedures to produce a "Benefit-Cost Ratio" (BCR). These assess the tangible benefits due to travel-time (TT), vehicle operating cost (VOC), and crash savings against the construction and maintenance costs involved (Transfund 1997).

Some overseas jurisdictions justify passing lane construction by means of warrant requirements, examples of which can be seen in Austroads (1993). However Transfund's requirements mean that specific benefits must be calculated, usually by means of a rural road simulation model, such as ARRB Transport Research's TRARR 4 package (Shepherd 1994). This is a relatively specialised tool and, despite recent improvements in its data collection requirements, it is still fairly time consuming (and hence costly) to make use of.

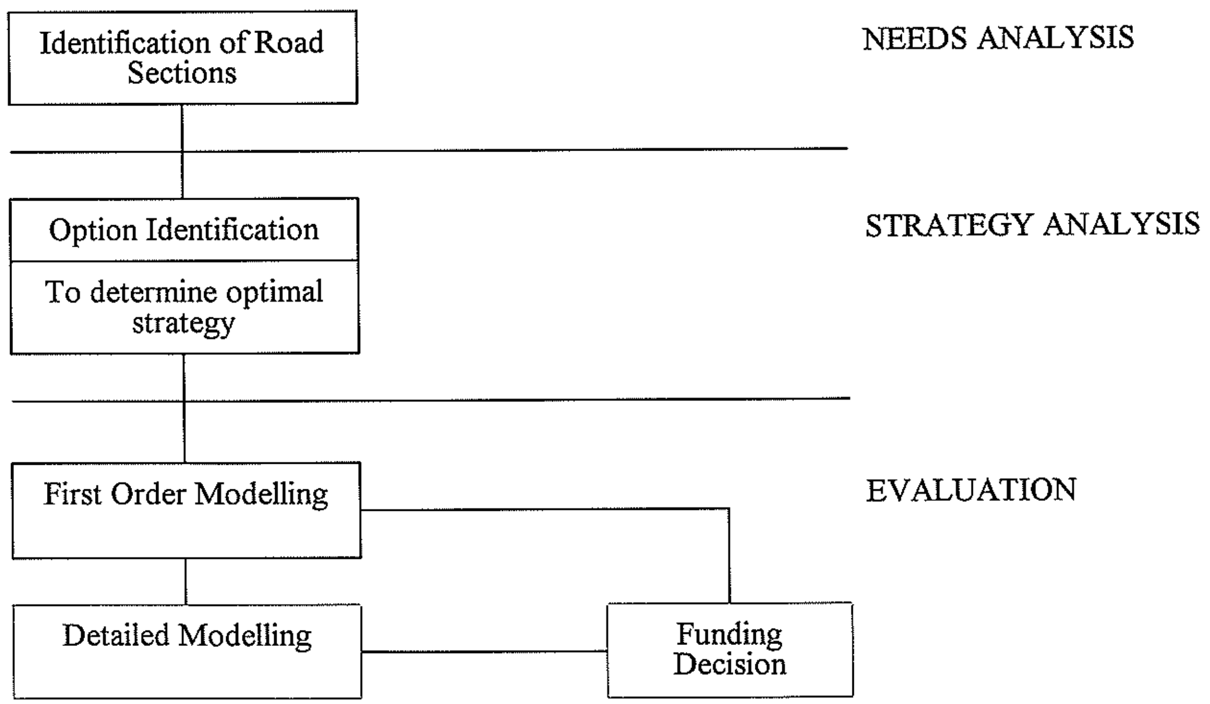
Stage 1 of Transfund research project PR3-0097 "Assessing Passing Opportunities" investigated ways in which improved passing opportunities may be provided and analysed, including a review of literature on the methods available to assess the benefits of improved passing opportunities (Tate 1995, Thrush 1996).

The Stage 1 study, based on a series of desktop analyses, concluded that:

- the analysis of the benefits of improved passing opportunities is a complex task that requires consideration of a number of variables;
- although simplified graphs of likely benefits were produced, the simplifications involved resulted in large variations in the predicted travel times that reduced the usefulness of these graphs;
- savings in analysis have resulted from improved data collection methods (e.g. RGDAS), and it was worthwhile retaining the use of simulation models (e.g. TRARR 4) as a means of producing more reliable assessments;
- applying the simulation models with differing degrees of refinement, provides a staged assessment process which would further reduce the cost of analysis while accounting for a wide range of variables.
- the safety implications of improved passing opportunities are unclear. An investigation into the potential safety implications of passing lanes should be undertaken.

The Stage 1 study suggested that a three level evaluation strategy be used, identifying routes that require improved passing opportunities (needs analysis), options to identify the location of passing opportunities (strategy analysis), and analysing the options to allow a funding decision to be reached (evaluation). This approach is outlined in Figure1.1, which is taken from Tate (1995).

Figure 1.1 Three Level Evaluation Strategy for Assessing Passing Opportunities



The procedure outlined in Figure 1.1 was considered by Tate to greatly reduce the analysis cost to produce a "reliable" benefit/cost ratio. Following discussions with Transit New Zealand staff, it is understood that they seek an even simpler system to determine the:

- need for,
- location of, and,
- benefits to be derived,

from the specific case of providing passing lanes.

1.1 Background

Passing-lanes generate economic benefits by reducing travel times. They do this by releasing impeded vehicles from platoons. Released drivers may then travel at their desired speed until they once again become trapped in slower moving platoons. The length over which passing-lanes are effective is, therefore, generally much greater than the physical length of the passing-lane section. The magnitude of the benefits (derived from increased mean travel speeds) and the length over which they are derived depends on the following factors:

- *Traffic Volume*
  The benefits of passing-lanes increase with greater traffic flows, because of the greater likelihood of bunching or platooning.
- *Composition of Traffic Stream*
  The benefits of passing-lanes increase with greater proportions of heavy vehicles, because of their lower average speeds.
- *Terrain*
  Generally the benefits of passing-lanes increase with more difficult terrain, because of less available passing sight distance (hence fewer natural passing opportunities) and the effect of gradient on heavy vehicle speeds.
- *Passing-lane Frequency*
  There is an optimum distance between passing-lanes which derives the greatest benefits for cost invested.
- *Vehicle Speed Distribution*
  A wider distribution of speeds (i.e. greater standard deviation) increases the likelihood of faster vehicles catching slower vehicles.

These benefits diminish as vehicles bunch up again over time or encounter changes in environment (e.g. urban areas, major intersections).

When drivers are unable to overtake a slower vehicle they are likely to become frustrated. This can lead to an increase in unsafe passing manoeuvres, that can lead to crashes. Provision of passing lanes allow for safe passing manoeuvres and a subsequent reduction in crashes.

1.2 Objectives

The main objectives of this stage of the research are:

1) to assess measures of driver frustration, which may then be used to estimate the drivers' perception of the facilities provided to them and so identify areas where improvements are most urgently needed.

   The Stage 1 literature review identified issues of driver frustration that result from inadequate passing opportunities. A number of measures were identified which seek to assess and predict the levels of driver frustration in terms of quantifiable road and traffic variables. It could be possible to calibrate the measures using a simple driver perception survey (via market research) to identify what is an acceptable level of passing opportunities.

   It may also be possible to translate the intangible frustrations expressed by drivers into a tangible measure of highway performance, suitable for use in project evaluation.

2) to assess the expected crash reduction potential of passing lane improvements. As well as possible benefits at the passing lane site, there is evidence that such a reduction in crash rate may extend some distance beyond the end of the actual passing lane.

   To date, the calculations of safety benefits for passing lane projects have either been done in an *ad hoc* manner for each case or ignored. As well as being inconsistent from project to project, the *ad hoc* method may lead to safety benefits being overstated. The latter alternative of ignoring safety benefits may lead to a potentially viable project being rejected. The current Project Evaluation Manual (PEM) by Transfund New Zealand (1997) gives only a broad crash reduction of 0-25% for passing lanes.

3) to develop a simplified system that would determine the need for, location of, and benefits to be derived from providing passing lanes in an optimal manner.

   Such a system would need to minimise the construction costs at the same time as maximising the economic benefits of the proposed improved passing opportunities, based on economic grounds continuing to be used as the determining factor in a funding decision.

   The system may be in the form of a series of "rules", from which a computer program, expert system, or more manual method could be developed. It is envisaged that such a system would be used as a "first-order-sieve" analysis tool, prior to more detailed evaluation using TRARR.

4) to consider the degree to which the findings of the TRARR desktop study can be replicated in "before and after" field tests. In this way TRARR can be properly calibrated for New Zealand conditions.

Analysis of the TRARR results can identify the accuracy of "first order" modelling (as described in Stage 1) against more detailed modelling. It can also be used to evaluate the accuracy of the simplified system, developed above, in identifying suitable sites.

The methodology for determining potential sites for passing lanes will:
- assist in the optimal allocation of both investigative and construction resources for passing lanes.
- optimally reduce the risk of crashes through unsafe driver manoeuvres.

Transit New Zealand (TNZ) and roading consultants will benefit from a more clearly defined and accurate evaluation procedure, with the elimination of the guesswork that is currently required. This would enable projects to be submitted to Transfund for funding with more confidence.

The general public will benefit from an improved state highway network, which will improve travel times and reduce crashes due to frustration.

1.3 Outline

This research reviews the present procedures, and their applications and, if necessary, develops revised procedures.

To achieve these objectives, Section 2 first investigates measures of driver frustration. It outlines the methodology used to survey drivers and subsequently analyse the results. The implications of the findings are discussed.

Section 3 examines the safety benefits of passing lanes, using a nationwide analysis of crash data. The findings are outlined and discussed along with other research.

Building on this work, a simplified procedure for the optimum location of passing lanes is developed in Section 4. This is tested using a section of NZ highway, and its comparative strengths and weaknesses identified.

Section 5 examines the use of TRARR for modelling passing lanes in New Zealand. Using before and after studies of two recently constructed passing lanes, the optimum data requirements are determined.

Finally, the combined conclusions are presented in Section 6, followed by applicable references. Appendices containing detailed data from the research follow.

1.3.1 Alternative Passing Oppportunities

This research is primarily concerned with the provision of passing lanes, generally of at least 600m in length. Some sources within Transit New Zealand have raised concerns that other means of providing passing opportunities have not been addressed. These include slow vehicle bays (or turnouts) and wide shoulders.

The very nature of both slow vehicle bays and wide shoulders, i.e. the voluntary requirement of slow vehicles to use them, makes their performance often more dependent on the terrain, proportion of slow vehicles, and adjacent passing opportunities. Although they do appear to improve highway performance, it is somewhat harder to incorporate them into general models of passing opportunity assessment.

It is suggested that separate research be undertaken to assess the performance and appropriateness of these alternative passing measures in New Zealand. In the interim, the findings for passing lanes may be applied where deemed suitable. Feedback on their appropriateness in these situations would be useful to gauge what further work is required.

2. ASSESSMENT OF DRIVER FRUSTRATION

Highway performance in New Zealand has traditionally been assessed using standard engineering measures. Measures, such as traffic volumes and travel times, are relatively easy to record and quantify. These measures, however, may not truly reflect the perception that travellers have of the highways in question.

Two surveys have been undertaken in recent years to try to ascertain road users' feelings for the national roading system. ACNielsen (1998) undertook a user perception survey of New Zealand State Highways to gauge road user's assessments. They used a combination of focus groups and interviews to rate the importance and existing performance of a number of desirable highway characteristics. A key finding, identified by virtually all road user groups as a major concern, was the ability to pass (i.e. passing lanes, multiple lanes, wide shoulders).

Previously Travers Morgan (1994) had undertaken a similar user perception survey of New Zealand State Highways. Here too, passing lanes were identified by road users as important but for which performance was relatively poor.

Travers Morgan used a combination of focus groups, telephone surveys, and roadside interviews. The need for frequent, long passing lanes was raised by every focus group, citing their convenience and safety value, particularly for diffusing frustrations.

In telephone surveys, passing lanes ranked 5th out of 24 desired attributes of State Highways, with 80% of respondents identifying them as very important, and no respondents rating them unimportant. However, when rating the actual performance of these attributes, passing lanes were ranked only 19th out of 24, with 20% of respondents rating them less than adequate. This placed passing lanes alongside "providing sufficient capacity" as high priority attributes in most need of attention.

Similar findings surfaced in a roadside survey of commercial drivers, who rated passing lanes 4th for importance (82% very important) and last for performance (35% less than adequate).

As well as giving their views on State Highways in general, respondents were also asked to name the State Highway routes they used most often and to rate the performance of the routes on each specified attribute. Over almost all specified routes, passing lanes rated poorly for performance except for SH1 South Auckland-Hamilton, SH1 Auckland-Wellington, SH1 Christchurch-Dunedin, and SH1/29 Hamilton-Tauranga. It is notable that these "satisfactory" routes are amongst the most trafficked in the country, and already have significant passing lane provision.

2.1 Measures of Driver Frustration

The literature review associated with Stage 1 of PR3-0097 and reported separately (Thrush 1995) identified issues of driver frustration that result from inadequate passing opportunities. A number of measures were identified which seek to measure and predict the levels of driver frustration in terms of quantifiable road and traffic variables. This process is outlined in Figure 2.1. These measures may then be used to estimate the users' (drivers') perception of the facilities provided to them and so identify areas where improvements are most urgently needed.

Figure 2.1. Procedure for relating driver frustration to quantitative measures

Define levels of driver frustration	Qualitative assessments considering the proportion of drivers likely to experience differing levels of frustration
Identify measures or surrogate measures	Consider measures such as: - % journey time spent following - level of service - net passing opportunities - unsatisfied passing demand
Develop predictive equations for surrogate measures based on measurable road and traffic variables	Predictive measure = *fn* (available sight distance, opposing traffic, traffic speeds, etc)

While such work has been undertaken overseas (Kaub 1990), no similar studies have been undertaken in New Zealand. Therefore, it is not possible to consider fully the frustration effects along strategic routes. For example, passing improvement strategies may be based on achieving a criteria such as having no more than 30% of a journey time spent following. However, the merit of such a fixed base may be questioned if, as is suspected, user perceptions change over time. In this case the quantifying measures rather than the level of frustration become an "end in themselves".

This type of analysis framework is required to determine which routes require additional passing opportunities, but the first question should be "What constitutes a route?" It is certainly not a short twisting road section where a driver expresses frustration immediately they are impeded, but it is also not a journey from Auckland to Wellington with regular breaks.

Potential frustration measures need to be identified that can be readily calculated given the existing data and simple field measurements. Having determined a measure which is highly correlated with driver frustration, it would be possible to calibrate the measure using a simple perception survey to identify what is an acceptable level of passing opportunities to road users.

Once such a measure is developed, it provides a target for use in strategy studies and the analyst can determine what additional length of passing opportunities will be required, both at present volumes and in future years.

Given that Transfund is looking towards basing benefits on the willingness of drivers to "pay" to avoid frustrations, the measures may also be related to economic benefits.

To attempt to answer some of these questions, appropriate frustration measures will be selected, based on the availability of data and ease of calculation. Once these are established, the measures will be calculated for a range of road sections and a small scale user survey will be undertaken to determine the "acceptable" level of trial measures. Willingness to pay for improvements in passing opportunities will also be assessed.

It is probable that an "acceptable" frustration level, as determined by other measures, will require a level of road construction funding which is not economically viable. The ramifications of this will need to be investigated further.

2.1.1 Survey Considerations

From the previous discussion, a number of points are raised that need to be considered in the survey design:

- Drivers will have different ways of quantifying their frustration, therefore a number of frustration measures may be required for assessment. This will also enable validation between measures.
- A wide range of route conditions, both in terms of road alignment and traffic volumes, need to be assessed. This would enable the relative impact of such attributes on frustration to be identified. This could be either by directly surveying travellers on a large number of routes, or by general surveying of the effect on drivers of these attributes.
- If specific routes were used, the extent of these routes would need to be determined, taking into account the location of significant settlements and junctions.
- Driver frustrations would be related to
  a) existing passing opportunities (usually sections of road with sufficient clear sight distance and no oncoming traffic), and
  b) how the provision of additional passing opportunities (in the form of passing lanes) can help alleviate these frustrations.
- There would need to be readily obtained and measurable highway engineering measures that could be compared against the driver frustrations. Some possible measures for consideration include:
  - traffic volumes in same and opposing directions
  - proportion of route with adequate overtaking sight distance
  - average travel speeds
  - proportion of heavy commercial vehicles (HCVs)
  - "bendiness" and "hilliness" of route (from road geometry)
- Any attempt to quantify driver frustration would need to avoid "double counting". For example, while drivers may value higher average travel speeds possible by additional passing opportunities, this is already allowed for by travel-time benefits.
- A sufficient sample size is needed, in order to obtain statistically valid results. However the method(s) used must not compromise the choice of routes available for study, and must be cost-effective.

2.2 Methodology

Recent research by Symonds Travers Morgan *et al* (1997) had established a willingness to pay (WTP) for avoiding unsealed roads. This was achieved using both specific route surveys and generalised hypothetical scenario surveys to place valuations on attributes of unsealed roads (roughness, dust, etc). This work was used as a basis for developing a similar survey for passing lanes.

It was felt that, for passing opportunities, it was more useful to consider driver's impressions on actual sections of highway, rather than non-specific observations of roads in general. It was also easier then to tie the results back to engineering measures, as these could be directly measured for the routes in question.

To get a broad range of route characteristics, a number of potential routes were identified throughout New Zealand. In general, routes were selected between major highway junctions, where there were very few or no notable intermediate settlements. For example, SH2 from SH3 Woodville to Masterton was selected, having only the minor settlements of Pahiatua and Eketahuna along the route. Twenty routes were selected for further examination, ranging in length from 27 to 141 km.

For the selected routes, 1996 traffic volume (AADT) and HCV proportion data was obtained from Transit New Zealand (1996). Road Geometry (RGDAS) data was also obtained and processed to produce forward sight distances. The proportions of highway having sight distances >450m were then calculated. This criteria is used in level of service calculations by AUSTROADS (formerly NAASRA, 1988), and 450m is equivalent to the continuation sight distance (CSD) required for overtaking manoeuvres at approximately 100 km/h (AUSTROADS 1993).

Other highway engineering measures were not considered at this stage. Average travel speeds and bendiness/hilliness were considered to be correlated well with the proportion of available sight distance (PASD), hence PASD was taken as a proxy measure of terrain. This assumption may be worth re-examining in future research, particularly if no suitable driver frustration relationship can be found.

Table 2.1 lists the routes studied. A number of them have common junctions, to enable data collection from one location.

Table 2.1 Sections of highway listed in driver frustration surveys

Segment	Length (km)	PASD (%)	AADT (veh/day)	% HCVs	No. Surveys *
SH1n Kawakawa - Whangarei	54	14.6	5900	9	2
SH1n Wellsford - Waipu	44	13.4	6400	7	2
SH1n Taupo - Turangi	52	17.0	6900	13	6
SH1n Turangi - Waiouru	62	23.3	2550	13	24
SH1n Taihape - Bulls	83	26.0	4800	11	12
SH1n Sanson - Levin	49	42.0	7400	10	21
SH2/25 Bombay - Thames	64	27.4	6200	10	2
SH2 Tauranga - Whakatane	96	24.2	5900	16	1
SH2 Dannevirke - Woodville	27	15.1	4550	13	9
SH2 Woodville - Masterton	82	28.6	4000	5	13
SH3 Woodville - Palmerston Nth	27	19.8	5950	10	17
SH3 Wanganui - Hawera	91	17.6	4350	9	1
SH4 Wanganui - Raetihi	91	4.1	1050	7	24
SH4 Raetihi - Taumarunui	77	15.2	1700	12	1
SH49 Raetihi - Waiouru	38	20.4	2150	10	2
SH1s Blenheim - Kaikoura	132	16.8	2100	12	64
SH1s Kaikoura - Amberley	141	14.9	2050	9	24
SH1s Christchurch - Ashburton	76	58.4	8050	12	30
SH1s Ashburton - Timaru	84	58.5	5500	12	20
SH6 Havelock - Nelson	76	10.3	3700	11	16
TOTAL					**291**

* Although all valid surveys were used to derive overall results, comparisons between segments were not considered for segments with fewer than 6 returned surveys.

2.2.1 Pilot Survey

A pilot survey was developed, and handed out to travellers stopping to refuel at two petrol stations in Sanson (junction of SH1 & SH3 near Bulls). Four major strategic routes originate from Sanson, making it ideal for collecting data on multiple routes at once.

Travellers were approached and asked if they would be willing to participate in the survey. Surveyors explained the purpose of the survey and the procedure for filling them in. Each participant would initially select the route that they were about to travel and rate their general expectation of it in terms of passing opportunities. At one station, participants were then required to answer the demographic section of the survey which was read out by the surveyor. Following this they were given the remainder of the survey and asked to complete it at the end of their trip and mail it back. The remainder of the survey included questions on (driver) perceptions about specific routes and two scenario questions relating to the driver's WTP to travel on a hypothetical alternative (improved) route. At the other station, participants were required to take the whole survey away with them, and to complete it at the end of their journey.

47 surveys were distributed in Sanson and of these 19 were returned, giving a response rate of 40%. Response rate was found to be unaffected by the distribution method used. Therefore in subsequent surveys the second method of distribution (respondents take whole survey with them) was employed in order to access as many customers as possible.

Analysis of the pilot survey highlighted the need to alter some items. Initially participants were given two hypothetical scenarios and asked to give a monetary value on having access to passing opportunities. It was found that, although respondents typically experienced a high level of frustration due to being unable to pass, many were reluctant to specify a monetary value to travel an improved route, and therefore most responses were '$0.00'. It is suspected that New Zealand drivers' inexperience with toll roads meant that many respondents could not relate to the concept of directly paying to use a route. With this in mind, a revised questionnaire was created in which the questions relating to WTP was reworded so that drivers specified an extra *time* or *distance* they would be prepared to travel in order to have a road with passing lanes the entire journey. These could then be quantified using the travel-time and vehicle operating costs established in the PEM. The first of the subsequent surveys confirmed that this approach produced the variation in responses expected (e.g. some non-zero values).

The rest of the pilot survey was not fully analysed. However all items were checked for face validity, and response rate. A copy of the scenarios used in the pilot survey is in Appendix A.1 (the other questions were unchanged).

2.2.2 Main Survey

Having made the necessary changes to the questionnaire, consideration was now given to the best means of collecting a sufficiently large sample over a wide range of routes. Three strategies were used in tandem:

- As with the original pilot survey, specific towns were targeted and appropriate petrol stations within that town surveyed for at least four hours. Some locations were selected because they were end-points to particular routes required. For example, SH4 Wanganui-Raetihi has a particularly poor level of sight distance; therefore surveys were distributed at a petrol station in Raetihi. Other locations were chosen because of their proximity to a number of routes. For example, Woodville is sited at the junction of SH2 south to Masterton, SH2 north to Waipukurau, and SH3 west to Palmerston North.

- Drivers waiting to load onto the inter-island ferries at the Wellington and Picton terminals were asked to participate in the survey. This had the advantage of providing a large number of "captive" drivers, many of whom would be continuing a long journey on the other side of Cook Strait. The limited number of routes either side of Cook Strait meant that these could be specifically targeted. For example, travellers heading south from Picton would either be travelling on SH1 to Kaikoura, SH6 to Nelson, or SH63 to the West Coast.

- Surveys were also distributed to non-transportation staff within Opus' two largest offices in Auckland and Wellington. This was timed just prior to Christmas, so that those travelling on a specified route during the holidays could fill in a survey. The concentrated nature of the offices, made this a cost-effective means to improve the sample size, with no field survey costs involved. Unlike the other survey methods however, the number of potential long-distance travellers was lower.

Consideration was given as to whether there was any inherent bias in surveying Opus staff as part of the surveys. By eliminating transportation-related staff from the sample, it was felt that any concerns were largely addressed. Although the predominantly technical, professional, and administrative staff may not be an accurate reflection of the New Zealand population in general, this was not expected to be a significant influence on the results. The subsequent results confirmed that there were no significant differences between the Opus staff and the rest of the sample. Similarly, none of the other survey locations and methods showed any significant differences in results between each other.

The survey forms were distributed during December 1997 and January 1998. Participants were approached at petrol stations, ferry terminals and within Opus, as described above. They were asked to participate, and given surveys if they were travelling on any of the routes specified in the survey. Participants were of varying ages, ethnicity and from different socioeconomic groups. A copy of the main survey is in Appendix A.2.

The same survey was issued to people at the various locations, with only the selection of routes available differing between locations. However the general instructions were altered to suit the survey venue. Travellers at petrol stations were asked to consider the section of highway they were about to travel. Ferry travellers were told to randomly select a route if they were to travel on more than one, as were Opus staff members. The route selection and expectation question had to be filled in prior to travelling and the demographics section of the questionnaire could be filled in before or after the trip. However they were to wait until after their trip in order to fill out the experimental section of the survey.

To improve the response rate, a lucky draw prize of petrol vouchers was provided as an incentive to participants who sent the survey back (contact details were made separable from the main survey to preserve anonymity). There were 876 survey forms distributed, of which 303 were returned, with answers relating to 20 different sections of State Highway in New Zealand. The average return rate was 35% - this is typical of a mail-back survey. Table 2.2 lists the sites where surveys were distributed and their respective response rates.

Table 2.2 Response rates for driver frustration surveys

Survey Location	# of Surveys Distributed	# of Surveys Returned	Response Rate
SH2/3 Woodville	80	26	33%
Opus Wellington Office	150	31	21%
Opus Auckland Office	88	10	11%
Ferry Terminal Wellington	185	70	38%
Ferry Terminal Picton	100	42	42%
SH1 Kaikoura	100	42	42%
SH1 Ashburton	100	49	49%
SH4 Raetihi	73	33	45%
Total - Main Surveys	**876**	**303**	**35%**
SH1/3 Sanson - Pilot Survey	47	19	40%

2.2.3 Surrogate Frustration Measures

To relate the frustration values from the survey to the road sections in question, a surrogate measure for frustration needs to be developed. The favoured measure is Unsatisfied Passing Demand (UPD), based on work by Werner & Morrall (1984) who developed a "Unified Model" for passing.

Tate (1995) suggested the use of the Unified Model in New Zealand as a simplified means of establishing the need for further passing opportunities. This model defines the level of service in terms of the *demand* and *supply* of passing opportunities. This is more in line with how a driver perceives the level of service of a two-lane rural road. Section 4 describes in more detail some of the underlying assumptions presented here.

Demand is based on catch-up rates in a traffic stream due to Wardrop (1952). Wardrop's formula for interaction is:

$$D = (0.56).\sigma.Q^2 / V^2 \qquad (1)$$

where: D = Overtaking demand (overtaking rate/km per hr)
Q = Traffic Stream flow in single direction (veh/hr)
V = Mean free speed (km/h)
σ= Standard Deviation (SD) of free speed distribution (km/h)

This assumes a stream of vehicles with a normal distribution of free speeds (known mean speed and SD). In NZ rural situations, the SD can be taken as 0.14 of the mean speed (Bennett 1994), in the absence of other data. For the survey results, the respondents' assessment of the traffic speed (S1 Q3) was used to determine the mean and SD. Average hourly flows were taken from

AADT data, divided by 24 hours and two directions. Although this simplifies the effect of varying hourly flows throughout the day, it was considered sufficient for this analysis.

Dual speed distribution models have also been developed that model two streams of traffic, such as cars and (slower) HCVs. However their form is rather more complicated, and not suitable for a simple measure. Therefore, to include the effect of terrain and proportion of HCVs, a simplified approach has been taken to convert HCV counts to passenger-car equivalents based on traditional Level of Service calculations (NAASRA 1988). This has the effect of artificially inflating the traffic flow to account for the increased vehicle interactions present with more HCVs and/or hillier terrain.

Supply is dependent on two factors:

a) *The proportion of gaps in the opposing traffic stream*
Values of approximately 30 s have been proposed previously as the minimum opposing headways, h, required to safely overtake. Similarly, headways are often represented as a negative exponential distribution, i.e. $P(h \geq t) = e^{-qt}$. Therefore, the likelihood of finding, say, 30 s gaps in the opposing traffic stream is:

$$P(h \geq 30) = e^{-0.008 \,.\, Qopp} \qquad (2)$$

where Qopp = Opposing traffic stream flow (veh/hr)

b) *The proportion of road with adequate overtaking sight distance (PASD)*
This has been defined as per the LOS calculations in NAASRA (1988) which establish the proportion of sight distances > 450m.

These are multiplied together to give the supply, S, or the probability of successfully overtaking.

If there are any existing passing lanes, then these must be excluded from the above calculations (since they provide 100% supply) and then incorporated again afterwards:

$$S = [L_P + S' \times (L_T - L_P)] / L_T \qquad (3)$$

where S = Overall supply for section of road
S' = Supply for non-passing lane portion (as calculated previously)
L_P = Length of passing lanes within section of road (km)
L_T = Total length of section of road (km)

Frustration at inadequate passing opportunities can then be expressed in terms of Unsatisfied Passing Demand (UPD):

$$UPD = D \times (1 - S) \qquad \text{(overtakings/km per hr)} \qquad (4)$$

This assumes that the available supply is less than or equal to the current demand. In reality, some sections may be able to supply more passing opportunities than currently demanded and thus be able to dissipate previously built up demand from the preceding road section. This is an important consideration when evaluating passing opportunities along a route with varied alignments or traffic flows. However for a simplistic overall route evaluation, the above calculations will suffice.

2.3 Results

Of the returned surveys, 12 were discarded, because of invalid data that could not be resolved. This left 291 valid surveys for consideration. Appendix A.3 summarises all of the survey data. Where necessary, the multi-choice answers have also been converted to a numerical scale (e.g. Section 1 Question 2). The rating questions have been measured as a percentage along the measuring line (e.g. S1 Q4); a higher value indicates greater frustration or dis-satisfaction.

The two WTP questions had provided answers in terms of extra time and distance that people would be willing to give up to have continuous passing opportunities along their particular route. These values had to be converted into a tangible payment per km of passing opportunity provided, for BCR evaluation.

The time values were multiplied by Transfund's value of travel time for rural strategic routes (NZ$20.10/hr per veh) and divided by the length of the section travelled. The distance values were multiplied by Transfund's VOC values (approximately 30 c/km per veh depending on desired travel speed) and again divided by the length of the section travelled.

Appendix A.4 summarises the calculations for both the WTP values and the UPD calculations. The average overall costs per km of passing lane were 3.7 and 3.2 c/km respectively - the relative equality of these values confirmed the validity of the two approaches. The individual respondents' results for time and distance were also plotted against each other and had a significant (at the 99% level) r^2 correlation of 0.42. Obviously there are some differences however in the way that people perceive time and distance concepts.

Basic statistics were performed on the makeup of the survey participants. No major bias was identified in the demographic makeup of the sample. Although the proportion of males to females is very high (4:1), this is comparable with other research which shows that men drive a lot more than women, particularly over long distances (MOT 1990).

2.3.1 Significant Factors of Driver Frustration

The answers for various descriptive survey questions, field data measurements, and subsequent calculated values were tested for their significance on the frustration rating question (S1 Q9) and the calculated time and distance WTP costs. Appendix A.5 summarises the results, with the mean values for each subgroup listed along with the likelihood of differences not being significant (P-value). Many of the factors had a significant effect on frustration, but this was less likely to translate into WTP. The factors that showed significant differences between sub-groups (at the 95% level) were:

- Route Expectation (Preliminary Question B)
- Relative Speed (S1 Q5)
- No. of Vehicles not Passed (S1 Q7)

- Estimated Time Lost as % of section (S1 Q7a)*
- Frequency of Trip (S2 Q5)
- Hourly Traffic Flow (from route data)*
- Length of Road Section (from route data)*
- % of Available Sight Distance (from route data)
- Unsatisfied Passing Demand (calculated)*

All of the above factors had a significant effect on frustration ratings, while those marked * also affected both WTP costs. Despite some factors being significant, the change in means between groups were often not as expected. For example, drivers on the lowest volume roads experienced more frustration than those on higher volume roads (although the WTP values were more in line with expectations).

The significance of UPD and its components of traffic flow and sight distance on frustration and WTP gives credence to the notion of identifying sections in most need of passing opportunities using UPD. This would provide a relatively simple filtering tool for identifying road sections for further investigation - this concept will be picked up again in Section 4 as part of Task 3.

A key finding to be drawn from the survey is that people do become significantly more frustrated on roads that have lower proportions of available sight distances. However this did not translate into a significant difference in willingness to pay. There may be an acknowledgement here of the difficulties in providing passing opportunities in difficult terrain.

It was also found that drivers who preferred to travel quickly relative to others or reported passing more often were significantly more likely to become frustrated. This finding is supported by the similar finding that drivers who drove high powered cars were more likely to become frustrated. However, the small sample of motorcyclists were less likely to be frustrated or willing to pay, no doubt because of their ease of overtaking without passing lanes.

Qualitative reports and additional comments from participants suggest that people who travel slowly appreciate having somewhere to pull over to let people past. It is apparent that the survey's frustration measure did not measure this type of frustration. In support of this, it was found that people driving heavy commercial vehicles and low powered cars were less likely to become frustrated than drivers of other vehicle types. Nevertheless drivers of these types of vehicles were willing to pay more for access to passing lanes, although this result was not statistically significant. Therefore it would be beneficial in future research to differentiate between these types of frustration, i.e. ability to pass and ability to *be* passed.

Travellers on short sections of road were willing to pay higher amounts per km for improved passing opportunities than on longer routes. However, this may be a consequence of people perceiving their trip costs similarly, regardless of length, so that the costs will be spread out more over a longer route. Symonds Travers Morgan *et al* (1997) found a similar effect in their unsealed roads WTP research.

Another statistically significant finding was that people who travelled on the same road frequently were more likely to become frustrated. If they had regularly experienced delays on this route before, this is probably understandable. People were also able to accurately predict ahead of the journey the extent to which they would be frustrated. This suggests that drivers had a good idea of the likely road/traffic conditions as well as knowing their own level of tolerance to being held up.

Some results were not significant but are helpful in order to understand people's perceptions of passing opportunities. Drivers who reported having more aggressive driving styles also reported higher levels of frustration; these people were also unwilling to compromise on time in order to have access to passing opportunities. Younger people have been found to have higher levels of frustration and are less willing to pay in order to have access to passing opportunities. Slightly higher levels of frustration were also reported for those people travelling for work related reasons.

2.3.2 Correlation between Factors

Appendix A.6 tabulates the correlation values between key survey questions, field data measurements, and subsequent calculated values. Note that some of the high correlations presented are due to factors being involved in the subsequent calculation of other factors, e.g. traffic flow in UPD.

Good correlations between the various satisfaction and frustration rating questions were evident, e.g Section 1 Questions 6, 8, & 9. This confirmed the general consistency of most respondents' answers to related topics.

There was a very low correlation between perceived traffic flow (S1 Q2) and actual traffic volume. This may be because people were relating it to their expected volume for the road. For example, parts of SH1 might be expected to have high volumes, so 300 vph (say) might not seem very busy. On SH4, with 1000 veh/day however, even 200 vph would appear very busy. This is supported by the fact that pre-trip expectations (Prelim Q.B) were significantly correlated with actual traffic volume.

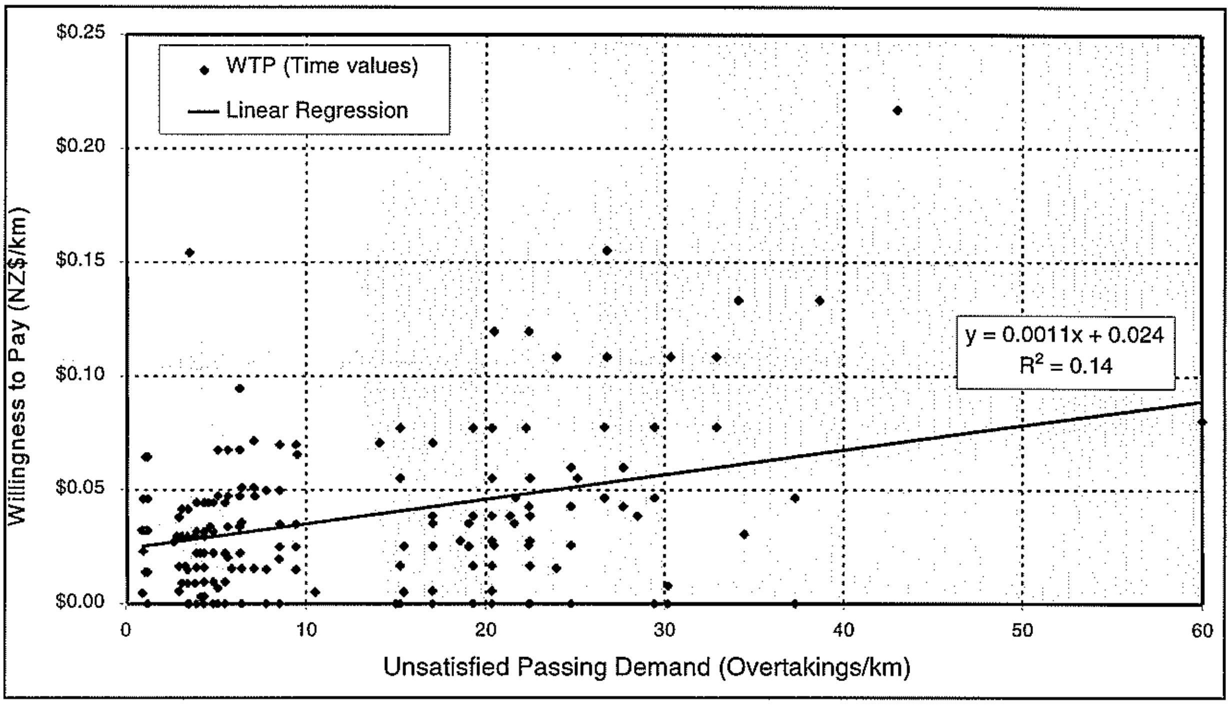
There was also very little correlation between perceived traffic flow and the various satisfaction or frustration ratings. Although perceived heavy traffic flows were associated with more vehicles not passed (S1 Q7), there wasn't a strong subsequent increase in frustration felt by drivers. It would appear that, in a number of situations, drivers are fairly accepting of being impeded.

2.3.3 Frustration vs Willingness to Pay

The UPD was compared with the results from the two scenarios posed which established WTP values. The hypothesis was: that increasing UPD, as a proxy for driver frustration, should result in increased WTP values (this was endorsed above by the findings of the significance tests). This would then enable a quantification of the intangible benefits in providing passing opportunities on a particular section of road, where the traffic and terrain details were known.

The individual payments for time and distance were also plotted against UPD. The r^2 correlations were only 0.11 and 0.14 respectively, but they were significant (at the 99% level). Figure 2.2 shows the relationship between UPD and WTP in terms of time values (a similar plot occurs for WTP in terms of distance).

Figure 2.2. Unsatisfied Passing Demand vs Willingness to Pay (in terms of time)



To attempt to improve the relationships, the WTP values were modified by some arbitrarily defined factors that took into account the personal driving behaviour described by each respondent (S2 Q9), and the trip frequency (S2 Q5). For example, a driver who considered themselves "aggressive" or who drove the route very frequently had their WTP values factored down to counter their likely increased frustration. This, however, did not improve the relationships, in fact they became slightly worse. Therefore this approach was discarded.

Further work is required to improve this relationship. In the meantime, a more practical approach may be to consider the average WTP value for all situations.

2.4 Discussion

At the very least, the results indicate an average tangible WTP of 3-4c/veh per km of passing opportunity provided. A value of 3.5c/km is a suitable compromise. This can be used in Transfund's BCR evaluations to add to the other benefits mostly derived from travel time and safety. Note that this benefit would only apply to vehicles in the same direction as the passing lane.

The effect of this additional benefit on BCRs is likely to be significant. For example, for a 1 km passing lane to be built on a road with 6000 vpd (3000 vpd one way) and 2% growth, the discounted Net Present Value over 25 years is $423,000. This is similar to the construction/maintenance costs for many passing lanes of this length, i.e. it would have the effect of increasing the BCR by an absolute value of about 1.

The lack of a strong relationship between UPD and WTP leads us to two possibilities:

a) Some significant factors may not be incorporated into the proposed model. For example, the UPD calculations may not be adequately reflecting the highway and traffic factors. Certainly there are more complicated variants of the UPD available which could be tried instead. Alternatively, although an attempt was made to incorporate two possible driver factors (driving behaviour and trip frequency), other factors may be more relevant.

b) UPD may not be an appropriate proxy measure for driver frustration. For example, drivers may be considering the practical likelihood of a section of road actually being improved. Although a winding road in a river gorge, say, may have very poor passing opportunities, drivers may not expect it to be ever seriously improved because of construction cost constraints. As a result, their frustration is tempered.

This second possibility suggests that drivers are considering both the expected benefits *and* costs of passing opportunity measures. Therefore it may be that driver frustration is actually better correlated to BCRs than just benefits alone.

3. ASSESSMENT OF SAFETY BENEFITS

Passing lane construction is a measure designed to improve the level of service of a highway for drivers. Their benefits due to travel time and vehicle operating cost savings have been studied extensively and can be calculated using a modelling tool such as TRARR. However there has been limited research on the likely *safety* benefits (due to reductions in crashes), particularly for the New Zealand environment. The current Transfund Project Evaluation Manual gives only a broad typical crash reduction of 0-25%, "with the reduction being dependent on the length of the passing lane and the alignment" (Transfund 1997).

Transfund requires an accurate assessment of all benefits when evaluating highway projects. To date, the calculations of safety benefits for passing lane projects have either been done in an *ad hoc* manner for each case, or ignored. As well as being inconsistent from project to project, the *ad hoc* method may lead to safety benefits being overstated. The latter alternative of ignoring safety benefits may lead to a potentially viable project being rejected.

When drivers are unable to overtake a slower vehicle, a level of frustration is likely to set in, which will increase over time. The expected safety benefits are largely due to a reduction in unsafe passing manoeuvres by these drivers, which can lead to crashes. Kaub (1990) found that even delays of only 5% in total travel time caused erratic and unsafe passing manoeuvres at volumes of 500 veh/hr.

3.1 Previous Research

Thrush (1996) included a summary of previous research on the safety benefits of passing opportunities. These have indicated likely crash rate savings of between 5-38%. However, as McLean (1989) noted, the crash reductions in these and similar studies are specific to the passing lane sections, and hence don't include overtaking-related crashes in adjacent sections. Hence they are likely to underestimate the total safety benefits.

Most of these studies, in summary at least, do not appear to examine the nature of these crash reductions in terms of specific crash types. Some consideration was given to location within the passing-lane, particularly with regard to the merge area (Harwood et al 1985, Homburger 1987), but this wasn't considered a significant problem.

None of the research appeared to identify any safety trends in regard to passing lane length; this seemed to be more a factor in terms of operational effectiveness. Similarly, the relationship between safety benefits of passing lanes and traffic volume was not addressed.

3.1.1 New Zealand Research

McLarin (1997) used a combined database of crash data, road geometry, and other highway characteristics to produce typical mid-block injury crash rates for New Zealand rural passing lanes (three and four lane undivided highways). His research compared the results with the existing PEM two-lane crash rates (Transit New Zealand 1991), which have since been superseded by Transfund New Zealand's updated PEM (1997). These newer results were derived using the same database (Koorey & Tate 1996), and are therefore directly comparable. The results for three-lane highways, in comparison with the equivalent two-lane highway rates are presented in Table 3.1:

Table 3.1. Typical mid-block injury crash rates for New Zealand rural highway sections (crash rates per 100 million veh-km).

TERRAIN	*Flat*		*Rolling*		*Mountainous*		***OVERALL***	
AADT	2-lane	3-lane	2-lane	3-lane	2-lane	3-lane	**2-lane**	**3-lane**
<2500	25	(0)	28	29	40	(10)	**28**	**25**
2500-12,000	18	(6)	25	18	38	(10)	**21**	**16**
>12,000	13	13	23	17	(10)	N/A	**15**	**15**
OVERALL	**19**	**10**	**26**	**18**	**36**	**(10)**	**22**	**16**

(xx) values in parentheses have an insufficient sample size and are therefore not considered significantly robust.

The results show an overall 27% reduction in crash rates, with sub-group reductions (for significant results only) ranging from +4% to -47%. The four-lane undivided highway results were less conclusive, with a 5% reduction overall, partly because of the smaller number of suitable sections (particularly at lower volumes). When combined, three and four-lane undivided highways showed an overall reduction of 23% in crash rates. No clear crash reduction trends in terms of AADT or terrain could be identified.

These results confirm that, on average, a reduction of approximately 25% in injury crashes overall is expected. However, for individual road sections, this does not account for the specific crash types that have occurred there and their likely reduction, which will vary. It also does not consider the effect of passing-lane length.

The crash reductions presented above are also only applicable *over the passing-lane section.* There is no consideration of potential downstream benefits. It is widely acknowledged that the travel-time benefits of passing lanes continue for some distance "downstream", until released (faster) vehicles once again catch up to other slower vehicles. This is also likely to translate into safety benefits through reduced frustration and dangerous overtaking. The actual extent of this effect downstream should also be considered, by examining the crash records of not only the passing lane sections themselves, but also the following sections of highway.

Similarly, there is an argument that the safety benefits may extend upstream for a short distance, where advance warning of passing lanes is provided. Knowledge of an impending passing opportunity may suppress more dangerous overtaking manoeuvres being attempted beforehand. In New Zealand it is common to provide such advance information approximately 2km and 400m prior to the start of each passing lane.

3.2 Analysis Design

Two possible approaches for a passing lane crash study are:

a) to compare the crash records for highway sections before and after the installation of passing lanes; or

b) to compare crash records of existing passing lane sections against "equivalent" (control) sections without passing lanes.

The analysis by McLarin falls under the latter method, although no specific effort was made to match equivalent sections, other than by terrain and AADT. Given the increasing number of passing lanes now constructed in New Zealand, a study using the former method appeared quite feasible.

To be consistent with other crash studies, the use of crash "rates" rather than absolute numbers was considered essential. Rates in terms of "crashes per 10^8 vehicle-km" are commonly used in New Zealand, so this was adopted as a common base.

A number of questions were identified for investigation:

- Is there a significant change in crash rates in the direction opposing the passing lane?
- Are some crash types more or less likely to occur with the introduction of passing lanes?
- How do crash rates change relative to location? (i.e. before, within, and beyond the passing lane?)
- Does passing lane length affect crash rate changes?
- Does traffic volume affect crash rate changes?
- Have the likely effects on crash rates changed over time? (e.g. with changes in design practice)
- Does the average severity of crashes change with the introduction of passing lanes?

To be able to accurately compare before and after crash rates, there must be as few other influencing factors as possible. In particular, it is fairly difficult to isolate passing lane crash effects when constructed as part of a realignment. Therefore "tack-on" passing lanes (i.e. where passing lanes are constructed alongside the existing roadway) are likely to produce the most useful information. Consideration of general changes in crash trends must also be accounted for.

3.3 Methodology

Information about passing lane sections constructed in New Zealand between 1985 and 1993 was obtained from the various Transit New Zealand regional offices. Data was collected on:

- location (SH/RS/RP) and direction of passing lane
- length of passing lane
- time of construction
- type of passing lane (tack-on, realignment, mixed)
- any subsequent improvements in the surrounding area
- AADT near passing lane location at the time of construction and five years either side

The latter data was obtained from annual traffic count records (Transit New Zealand 1980-1996).

For each passing lane section, the Land Transport Safety Authority (LTSA) crash database was used to extract a list of all crashes that occurred in the area 2km upstream from the start of the passing lane, the passing lane itself, and 10km downstream from the end of the passing lane. The crash list was further refined to include only crashes occurring between five years before and after construction of the passing lane. In some cases only a shorter period was available, but a minimum of three years worth of data either side was deemed acceptable.

Although non-injury crashes were collected in the database, it was apparent that the reporting rate varied from site to site. Given the broad time span over which the data was collected (between 1981-1996) and the changes in LTSA reporting procedure that occurred during that time; this was understandable. Therefore it seemed prudent to ignore non-injury crashes from the analysis. This also enabled comparisons to be made with other reported findings, which are generally in terms of injury crashes only.

In total, data on 51 passing lane sections was collected, resulting in a final list of 2715 injury crashes before, during and after construction of passing lanes. Further inspection of the location of each passing lane identified features that would cause problems with analysis. For example a number were identified as being too close to each other; these were discarded from the main analysis. Some upstream or downstream road sections travelled through 50 km/h or 60 km/h (urban) areas. In these cases, where the length of the restricted area was significant, the analysis length was limited to prior to these areas. 70 km/h and 80 km/h areas were not discarded, as these are often located in small towns or on the outskirts of larger towns, and they were not considered to have as great an impact on platooning.

Crashes during roadworks (as evidenced by a 30 km/h speed limit) were discarded from the analysis. In many cases they occurred during construction of the passing lane anyway.

The resulting crashes and sites were stored in two databases, linked by a code identifying each site. The two databases were then used to produce various queries as described below. Appendix A.7 details the layout of the database files.

Table 3.2 gives a breakdown of the original data set. Appendix A.8 summarises the key details for the original 51 sites. As shown, 34 sites were selected for further analysis, containing 1828 injury crashes.

Table 3.2 Summary of Sites and Crashes Studied.

Type of Pass. Lane	Included in analysis	No. of Sites	Total P.L. Length	No. Crashes (Injury only)			
				Before	**Constrn**	**After**	**TOTAL**
Tack-On	N	11	11.05	283	73	377	**733**
	Y	21	17.10	492	92	528	**1112**
Realignment	N	4	4.63	61	6	35	**102**
	Y	5	7.09	169	26	105	**300**
Mixed	N	2	0.73	16	1	35	**52**
	Y	8	8.65	169	32	215	**416**
TOTAL	**N**	**17**	**16.41**	**360**	**80**	**447**	**887**
	Y	**34**	**32.84**	**830**	**150**	**848**	**1828**

For each analysis, crash rates were derived for the analysis periods before and after construction. This was calculated by dividing the number of crashes by the relevant vehicle-kilometres (VKT) travelled.

Rate = $N \times 10^8 / T / L$ (crashes per 10^8 vehicle-km)

where

N = number of injury crashes in five year period (either before or after)

T = total traffic exposure before or after passing lane construction (depending on timing of crash) based on integration of AADTs over the analysis period (usually 5 years)

L = total analysis length before, within, and following passing lane (usually 2 km + PL length + 10 km)

Note that, for analyses involving crash direction, the AADTs have been split evenly between both directions.

This method enabled crash rates before and after to be compared for differences. As well as absolute crash rates, the percentage change in crash rates following construction was also calculated. Where there were fewer than 20 crashes in total before and after, these percentages have been dimmed to indicate the lack of significance in them.

3.4 Results

First, all crashes from the 34 selected sites were examined by type of passing lane and split by crash direction (i.e. direction of key vehicle). Table 3.3 summarises the data.

Table 3.3 All Passing Lanes: Injury Crashes by Passing Lane Type and Crash Direction.

Type of Pass. lane	Crash Dirn.	Crashes Before	VKT Before*	*Rate Before*	Crashes After	VKT After	*Rate After*	% Change	
Tack-On (21 sites)	Opp..	241	1.04e+09	*23.22*	262	1.17e+09	*22.38*	**-4**	**-5**
	Same	251	1.04e+09	*24.18*	266	1.17e+09	*22.72*	**-6**	
Realignmt. (5 sites)	Opp.	83	1.97e+08	*42.07*	49	2.67e+08	*18.33*	**-56**	**-54**
	Same	86	1.97e+08	*43.59*	56	2.67e+08	*20.94*	**-52**	
Mixed (8 sites)	Opp.	90	2.81e+08	*32.05*	102	3.36e+08	*30.38*	**-5**	**6**
	Same	79	2.81e+08	*28.13*	113	3.36e+08	*33.66*	**20**	
TOTAL (34 sites)	**Opp.**	**414**	**1.52e+09**	*27.31*	**413**	**1.77e+09**	*23.28*	**-15**	**-13**
	Same	**416**	**1.52e+09**	*27.44*	**435**	**1.77e+09**	*24.52*	**-11**	

* expressed in scientific notation, e.g. "1.23e+08" = 1.23×10^8

The results show a considerable reduction in crash rates for realignment sites, with negligible change for tack-on or mixed sites. Given that realignments generally improve a number of poor alignment features, the high reduction is not surprising. Indeed, the high pre-construction crash rates for realignments help to explain why these sites were chosen for major treatment. It is interesting that the sites that were a mixture of minor realignment and simple widening were not particularly successful in reducing crashes.

At this broad level, there appears to be no significant differentiation between the two crash directions. This could be symptomatic of errors either in Police/LTSA crash recording or in assigning crashes to a specific direction within this study. For the latter, the compass direction of the key vehicle was compared with the "average" direction of each site, so any site with significant curvature may have some incorrect assignments.

3.4.1 Effect on Crash Types

Passing lanes are generally expected to reduce crashes associated with overtaking. This may include "lane-change", "head-on", and "merging" crashes. The likely speed increases however may result in increases in some other crash types.

To better identify the relative impact on different crash types, the crashes were grouped into the seven Safety Report crash types. Appendix A.9 details the relationship between crash types and LTSA movement codes. Table 3.4 summarises the crash rates.

Table 3.4 All Passing Lanes: Injury Crashes by Crash Type.

Crash Type	Crash Dirn.	Crashes Before	*Rate Before*	Crashes After	*Rate After*	% Change	
Overtaking	Opp.	46	*3.03*	37	*2.09*	**-31**	**-36**
	Same	42	*2.77*	29	*1.64*	**-41**	
Straight Head-On / Lost-Control	Opp.	60	*3.96*	101	*5.69*	**44**	**20**
	Same	81	*5.34*	97	*5.47*	**2**	
Curve Head-On / Lost-Control	Opp.	205	*13.52*	175	*9.87*	**-27**	**-22**
	Same	188	*12.40*	185	*10.43*	**-16**	
Rear-End / Obstruction	Opp.	49	*3.23*	45	*2.54*	**-22**	**-14**
	Same	53	*3.50*	58	*3.27*	**-6**	
Intersection	Opp.	41	*2.70*	46	*2.59*	**-4**	**0**
	Same	39	*2.57*	48	*2.71*	**5**	
Pedestrian	Opp.	9	*0.59*	3	*0.17*	-72	**-19**
	Same	10	*0.66*	15	*0.85*	**28**	
Miscellaneous	Opp.	4	*0.26*	6	*0.34*	28	10
	Same	3	*0.20*	3	*0.17*	-15	

Note: Rates based on VKTs of 3.03e+09 vs 3.55e+09 (34 sites)

There is a clear reduction in "Overtaking", "Curve Head-On/Lost-Control", and "Rear-End/Obstruction" crashes following passing lane construction. Interestingly, "Straight Head-On/Lost-Control" crashes show a significant increase in crash rate. This is also the only crash type to show a significant difference in crash rates by direction, with a lesser trend evident for "Rear-End/Obstruction" crashes.

The latter three crash types would seem to be of little relevance to rural passing lane safety, and certainly aren't showing any significant trends, partly through lack of numbers. This suggests that only the first four "**key crash types**" should be considered further. All further analyses have therefore not included crashes from the other three crash types.

Table 3.5 shows the same analysis, but for tack-on passing lanes only. These tend to agree with the overall group trends, albeit with slightly reduced % changes. The smaller sample size also gives rise to some more variation between crash directions.

Table 3.5 Tack-On Passing Lanes: Injury Crashes by Crash Type.

Crash Type	Crash Dirn.	Crashes Before	*Rate Before*	Crashes After	*Rate After*	% Change	
Overtaking	Opp.	26	*2.51*	22	*1.88*	**-25**	**-30**
	Same	25	*2.41*	18	*1.54*	**-36**	
Straight Head-On / Lost-Ctrl	Opp.	39	*3.76*	61	*5.21*	**39**	**11**
	Same	56	*5.40*	58	*4.95*	**-8**	
Curve Head-On / Lost-Ctrl	Opp.	112	*10.79*	112	*9.57*	**-11**	**-5**
	Same	103	*9.92*	119	*10.17*	**2**	
Rear-End / Obstruction	Opp.	35	*3.37*	32	*2.73*	**-19**	**-15**
	Same	33	*3.18*	33	*2.82*	**-11**	
Intersection	Opp.	21	*2.02*	29	*2.48*	**22**	**5**
	Same	27	*2.60*	28	*2.39*	**-8**	
Pedestrian	Opp.	4	*0.39*	2	*0.17*	-56	22
	Same	4	*0.39*	9	*0.77*	100	
Miscellaneous	Opp.	4	*0.39*	4	*0.34*	-11	-37
	Same	3	*0.29*	1	*0.09*	-70	

Note: Rates based VKTs of 2.08e+09 vs 2.34e+09 (21 sites)

Table 3.6 examines the "Straight Head-On/Lost-Control" category in more detail, breaking it down by the individual crash movement codes. It is quite evident that the key contributor to the increased crash rate is "Lost-Control on Straight/Curve" (BE) crashes. All other crash codes had decreases (significant or otherwise).

Table 3.6 All Passing Lanes: "Straight Head-On/Lost-Control" Injury Crashes by Crash Movement Code.

Movement Code	Crash Dirn.	Crashes Before	*Rate Before*	Crashes After	*Rate After*	% Change	
BA (Head-On Straight)	Opp.	14	*0.92*	7	*0.39*	**-57**	-56
	Same	17	*1.12*	9	*0.51*	**-55**	
BE (Lost-Control on Straight/Curve)	Opp.	6	*0.40*	45	*2.54*	**541**	644
	Same	4	*0.26*	42	*2.37*	**797**	
BO (Head-On Other)	Opp.	2	*0.13*	1	*0.06*	-57	-43
	Same	1	*0.07*	1	*0.06*	-15	
CA (Out-of-Ctrl on Roadway)	Opp.	6	*0.40*	7	*0.39*	0	**-15**
	Same	6	*0.40*	5	*0.28*	-29	
CB (Off Roadway to Left)	Opp.	19	*1.25*	26	*1.47*	**17**	**-26**
	Same	35	*2.31*	21	*1.18*	**-49**	
CC (Off Roadway to Right)	Opp.	13	*0.86*	15	*0.85*	**-1**	**-6**
	Same	18	*1.19*	19	*1.07*	**-10**	

Note: Rates based on VKTs of 3.03e+09 vs 3.55e+09 (34 sites)

Examination of the other three key crash types did not reveal any movement codes as dominant in their group as this. However, in the "Curve Head-On/Lost-Control" crash type, the DA/DB codes ("Lost-Control Turning Left/Right") recorded no overall change in crash rate, while the other codes all recorded decreases. Similarly, with the "Overtaking" crash type, the AD code ("Lost-Control while Overtaking") also went against the general trend in that group. As with the finding above, these suggest that "Lost-Control" type crashes may increase as a result of passing lanes.

To examine this in more detail, the movement codes in these three key crash types (excluding "Rear-End/Obstruction") were regrouped to better identify "Overtaking", "Head-On", and "Lost-Control" crashes. The revised crash types were:

- Overtaking: AA, AB, AC, AE, AF, AG, AO, GB, GE
- Head-On: BA, BB, BC, BD, BO
- Lost Control: AD, BE, CA, CB, CC, CO, DA, DB, DC, DO

"Rear-End/Obstruction" crashes remained classified as before. Table 3.7 shows the revised breakdown for tack-on passing lane sites.

Table 3.7 Tack-On Passing Lanes: Injury Crashes in Revised Key Crash Types.

Revised Key Crash Types	**Crash Dirn.**	**Crashes Before**	***Rate Before***	**Crashes After**	***Rate After***	*%* **Change**	
Overtaking	Opp.	24	*2.31*	18	*1.54*	**-33**	**-38**
	Same	23	*2.22*	15	*1.28*	**-42**	
Head-On	Opp.	31	*2.99*	14	*1.20*	**-60**	**-62**
	Same	28	*2.70*	11	*0.94*	**-65**	
Lost-Control	Opp.	122	*11.75*	163	*13.92*	**18**	**15**
	Same	133	*12.81*	169	*14.44*	**13**	
Rear-End/ Obstruction	Opp.	35	*3.37*	32	*2.73*	**-19**	**-15**
	Same	33	*3.18*	33	*2.82*	**-11**	
TOTAL	**Opp.**	**212**	***20.43***	**227**	***19.39***	**-5**	**-6**
	Same	**217**	***20.91***	**228**	***19.48***	**-7**	

Note: Rates based VKTs of 2.08e+09 vs 2.34e+09 (21 sites)

Although the numbers of "Overtaking" and "Head-On" crashes are relatively small, they indicate expected crash reductions of over 33-65%. Conversely, the "Lost-Control" crashes increase by around 15%. Because there are greater numbers of "Lost-Control" Crashes, they tend to dominate the overall statistics, hence the 6% reduction only in crash rates for the key crash types.

3.4.2 Effect of Location of Crashes relative to Passing Lane

While it is expected that passing lanes will have an effect on crashes within their length, there may also be a safety benefit beyond the ends. Vehicle speed increases continue downstream of a passing lane for some distance until another slow-moving platoon is encountered. This increased speed would be expected to translate into reduced frustration at being delayed, resulting in fewer dangerous manouevres and hence fewer crashes.

Upstream, advance warning of a passing lane may result in drivers holding off overtaking, again resulting in fewer dangerous manoeuvres. In New Zealand, it is common practice to sign a passing lane 2 km in advance, so the safety benefits would be expected to extend back to there.

The "key crash type" crashes were grouped into lengths of 2 km, from 2 km prior to the start of the passing lane to 10 km beyond the end of the passing lane. The passing lane itself was treated as a separate length. Crash rates were compared for all passing lanes and tack-on sites only, with the results summarised in Tables 3.8 and 3.9.

Table 3.8 All Passing Lanes: Injury Crashes (Key Crash Types only) by Location relative to Passing Lane.

Crash Location	Crash Dirn.	Crashes Before	VKT Before	*Rate Before*	Crashes After	VKT After	*Rate After*	% Change	
0-2 km Before PL	Opp.	76	2.34e+08	*32.45*	81	2.74e+08	*29.52*	***-9***	***-9***
	Same	51	2.34e+08	*21.78*	55	2.74e+08	*20.04*	***-8***	
Within Pass. Lane	Opp.	41	1.11e+08	*37.01*	42	1.27e+08	*32.98*	***-11***	***-11***
	Same	30	1.11e+08	*27.08*	31	1.27e+08	*24.34*	***-10***	
0-2 km After PL	Opp.	58	2.34e+08	*24.76*	77	2.74e+08	*28.06*	***13***	***5***
	Same	79	2.34e+08	*33.73*	91	2.74e+08	*33.16*	***-2***	
2-4 km After PL	Opp.	54	2.34e+08	*23.06*	45	2.74e+08	*16.40*	***-29***	***-16***
	Same	51	2.34e+08	*21.78*	58	2.74e+08	*21.14*	***-3***	
4-6 km After PL	Opp.	51	2.34e+08	*21.78*	43	2.74e+08	*15.67*	***-28***	***-35***
	Same	63	2.34e+08	*26.90*	44	2.74e+08	*16.04*	***-40***	
6-8 km After PL	Opp.	46	2.34e+08	*19.64*	43	2.74e+08	*15.67*	***-20***	***-26***
	Same	62	2.34e+08	*26.47*	51	2.74e+08	*18.59*	***-30***	
8-10 km After PL	Opp.	34	2.34e+08	*14.52*	27	2.74e+08	*9.84*	***-32***	***-9***
	Same	28	2.34e+08	*11.96*	39	2.74e+08	*14.21*	***19***	
TOTAL (34 sites)	**Opp.**	**360**	**1.52e+09**	***23.75***	**358**	**1.77e+09**	***20.18***	***-15***	***-14***
	Same	**364**	**1.52e+09**	***24.01***	**369**	**1.77e+09**	***20.80***	***-13***	

Table 3.9 Tack-On Passing Lanes: Injury Crashes (Key Crash Types only) by Location relative to Passing Lane.

Crash Location	Crash Dirn.	Crashes Before	VKT Before	*Rate Before*	Crashes After	VKT After	*Rate After*	% Change	
0-2 km Before PL	Opp.	40	1.61e+08	*24.78*	52	1.83e+08	*28.48*	**15**	**5**
	Same	31	1.61e+08	*19.20*	32	1.83e+08	*17.53*	**-9**	
Within Pass. Lane	Opp.	15	6.94e+07	*21.60*	23	7.52e+07	*30.59*	**42**	**5**
	Same	21	6.94e+07	*30.25*	18	7.52e+07	*23.94*	**-21**	
0-2 km After PL	Opp.	42	1.61e+08	*26.02*	56	1.83e+08	*30.67*	**18**	**17**
	Same	43	1.61e+08	*26.64*	56	1.83e+08	*30.67*	**15**	
2-4 km After PL	Opp.	30	1.61e+08	*18.59*	28	1.83e+08	*15.34*	**-17**	**5**
	Same	24	1.61e+08	*14.87*	36	1.83e+08	*19.72*	**33**	
4-6 km After PL	Opp.	32	1.61e+08	*19.82*	21	1.83e+08	*11.50*	**-42**	**-38**
	Same	45	1.61e+08	*27.88*	33	1.83e+08	*18.08*	**-35**	
6-8 km After PL	Opp.	31	1.61e+08	*19.20*	28	1.83e+08	*15.34*	**-20**	**-27**
	Same	38	1.61e+08	*23.54*	29	1.83e+08	*15.89*	**-33**	
8-10 km After PL	Opp.	22	1.61e+08	*13.63*	19	1.83e+08	*10.41*	**-24**	**3**
	Same	15	1.61e+08	*9.29*	24	1.83e+08	*13.15*	**41**	
TOTAL (21 sites)	**Opp.**	**212**	**1.04e+09**	*20.43*	**227**	**1.17e+09**	*19.39*	**-5**	**-6**
	Same	**217**	**1.04e+09**	*20.91*	**228**	**1.17e+09**	*19.48*	**-7**	

While the overall set of passing lanes shows a good spread of crash rate savings throughout the analysis length, the results for the tack-on sites are less clear. In both cases, the biggest benefits seem to be between 4-8 km downstream of the passing lane, while the 2 km immediately following the passing lane shows a noticeable rise in crash rates.

Similarly, it is hard to identify a pattern in the directional split. While it might be expected that opposing crashes downstream of the site should be unaffected (since they are still approaching the passing lane), they show just as much overall reduction as crashes in the same direction.

The crash rate prior to the passing lane has a slight (8-9%) reduction in the same direction as the passing lane, suggesting that there is some beneficial improvement in advance signing of passing lanes.

Looking at just crashes within the passing lane itself, it is notable that there is 21% reduction in crashes in the same direction as a tack-on passing lane. This is countered somewhat by the 42% increase in opposing crashes however.

The presence of crash reductions throughout the analysis length however suggests that the use of 2 km prior and 10 km following to each passing lane is warranted for further crash investigation.

3.4.3 Changes in Crash Severity

Some types of crashes may not be eliminated with the introduction of passing lanes, but the additional lane space may partially prevent them and reduce their likely severity. Countering that is the likely speed increase of vehicles which usually translates into an increase in average severity.

The "key crash type" crashes in the study were split by injury severity to see if the relative proportions had changed after passing lane construction. The average cost of each crash before and after was also determined by multiplying these proportions by the average 100km/h crash costs from the Project Evaluation Manual (Transfund 1997). For fatal, serious, and minor crashes, these are currently $2,800,000, $250,000, and $20,000 respectively. The subset of tack-on passing lanes was also looked at separately. Tables 3.10 and 3.11 summarise the results.

Table 3.10 All Passing Lanes: Injury Crashes (Key Crash Types only) by Severity.

Direction	Severity	Crashes Before	% of Total	Crashes After	% of Total	% Change
Opp. Dirn.	Fatal	35	9.7%	37	10.3%	0.6%
	Serious	145	40.3%	113	31.6%	-8.7%
	Minor	180	50.0%	208	58.1%	8.1%
	All Injury	**360**		**358**		
	Ave. Cost	**$382,917**		**$379,916**		**-0.8%**
Same Dirn.	Fatal	41	11.3%	35	9.5%	-1.8%
	Serious	137	37.6%	117	31.7%	-5.9%
	Minor	186	51.1%	217	58.8%	7.7%
	All Injury	**364**		**369**		
	Ave. Cost	**$419,698**		**$356,612**		**-15.0%**
TOTAL	Fatal	76	10.5%	72	9.9%	-0.6%
	Serious	282	39.0%	230	31.6%	-7.3%
	Minor	366	50.6%	425	58.5%	7.9%
	All Injury	**724**		**727**		
	Ave. Cost	**$401,409**		**$368,088**		**-8.3%**

Table 3.11 Tack-On Passing Lanes: Injury Crashes (Key Crash Types only) by Severity.

Direction	Severity	Crashes Before	% of Total	Crashes After	% of Total	% Change
Opp. Dirn.	Fatal	21	9.9%	28	12.3%	2.4%
	Serious	82	38.7%	68	30.0%	-8.7%
	Minor	109	51.4%	131	57.7%	6.3%
	All Injury	**212**		**227**		
	Ave. Cost	**$384,340**		**$431,806**		**12.4%**
Same Dirn.	Fatal	26	12.0%	26	11.4%	-0.6%
	Serious	78	35.9%	68	29.8%	-6.1%
	Minor	113	52.1%	134	58.8%	6.7%
	All Injury	**217**		**228**		
	Ave. Cost	**$435,760**		**$405,614**		**-6.9%**
TOTAL	Fatal	47	11.0%	54	11.9%	0.9%
	Serious	160	37.3%	136	29.9%	-7.4%
	Minor	222	51.7%	265	58.2%	6.5%
	All Injury	**429**		**455**		
	Ave. Cost	**$410,350**		**$418,681**		**2.0%**

The findings indicate a definite reduction in severity for passing lanes overall (particularly for crashes in the same direction). However the result is rather more diluted for tack-on passing lanes, with the crashes in the opposing direction negating any benefit in the same direction. This suggests that severity benefits are only occurring as a result of any associated realignment works and not because of the presence of a passing lane.

3.4.4 Effect of Passing Lane Length

Standard design practice usually counsels against very short passing lanes, on the assumption that it forces drivers into completing passing manoeuvres when there is insufficient room (perhaps because their speed differential was not great enough). At the other end of the scale, long passing lanes are not seen to cause any safety concern, and their length is usually only constrained by cost and efficiency considerations. For example, it may be more beneficial in terms of travel time savings to construct two shorter passing lanes rather than one long one.

The passing lane sites were categorised according to their length (excluding tapers), and the crash rates (for key crash types) compared between each category. Comparisons for all passing lane sites and tack-on sites only are given in Tables 3.12 and 3.13.

Table 3.12 All Passing Lanes: Injury Crashes (Key Crash Types only) by Passing Lane Length.

Pass. lane Length	Crash Dirn.	Crashes Before	VKT Before	*Rate Before*	Crashes After	VKT After	*Rate After*	% Change	
0-600m (8 sites)	Opp.	94	3.33e+08	*28.22*	81	4.31e+08	*18.78*	**-33**	**-17**
	Same	85	3.33e+08	*25.52*	111	4.31e+08	*25.74*	**1**	
6-800m (4 sites)	Opp.	51	1.46e+08	*34.89*	50	1.86e+08	*26.90*	**-23**	**-33**
	Same	51	1.46e+08	*34.89*	37	1.86e+08	*19.90*	**-43**	
8-1000m (8 sites)	Opp.	63	3.86e+08	*16.34*	77	4.39e+08	*17.54*	**7**	**-9**
	Same	66	3.86e+08	*17.12*	57	4.39e+08	*12.98*	**-24**	
10-1200m (7 sites)	Opp.	73	3.12e+08	*23.43*	85	3.62e+08	*23.45*	**0**	**-6**
	Same	83	3.12e+08	*26.64*	86	3.62e+08	*23.73*	**-11**	
12-1500m (4 sites)	Opp.	34	2.39e+08	*14.24*	33	2.25e+08	*14.66*	**3**	**37**
	Same	32	2.39e+08	*13.41*	52	2.25e+08	*23.11*	**72**	
>1500m (3 sites)	Opp.	45	1.01e+08	*44.54*	32	1.30e+08	*24.60*	**-45**	**-51**
	Same	47	1.01e+08	*46.52*	26	1.30e+08	*19.99*	**-57**	
TOTAL (34 sites)	**Opp.**	**360**	**1.52e+09**	***23.75***	**358**	**1.77e+09**	***20.18***	**-15**	**-14**
	Same	**364**	**1.52e+09**	***24.01***	**369**	**1.77e+09**	***20.80***	**-13**	

Table 3.13 Tack-On Passing Lanes: Injury Crashes (Key Crash Types only) by Passing Lane Length.

Pass. lane Length	Crash Dirn.	Crashes Before	VKT Before	*Rate Before*	Crashes After	VKT After	*Rate After*	% Change	
0-600m (7 sites)	Opp.	80	2.93e+08	*27.28*	72	3.79e+08	*19.01*	**-30**	**-19**
	Same	79	2.93e+08	*26.94*	95	3.79e+08	*25.08*	**-7**	
6-800m (2 sites)	Opp.	13	4.44e+07	*29.29*	13	6.08e+07	*21.39*	**-27**	**-50**
	Same	15	4.44e+07	*33.80*	6	6.08e+07	*9.87*	**-71**	
8-1000m (6 sites)	Opp.	60	3.24e+08	*18.51*	71	3.71e+08	*19.13*	**3**	**-2**
	Same	51	3.24e+08	*15.73*	53	3.71e+08	*14.28*	**-9**	
10-1200m (3 sites)	Opp.	27	1.82e+08	*14.86*	44	1.89e+08	*23.24*	**56**	**10**
	Same	40	1.82e+08	*22.01*	33	1.89e+08	*17.43*	**-21**	
12-1500m (3 sites)	Opp.	32	1.94e+08	*16.46*	27	1.71e+08	*15.82*	**-4**	**21**
	Same	32	1.94e+08	*16.46*	41	1.71e+08	*24.03*	**46**	
TOTAL (21 sites)	**Opp.**	**212**	**1.04e+09**	***20.43***	**227**	**1.17e+09**	***19.39***	**-5**	**-6**
	Same	**217**	**1.04e+09**	***20.91***	**228**	**1.17e+09**	***19.48***	**-7**	

No clear patterns emerge. It would seem that relatively short passing lanes <800m long have a good improvement in crash rate, whereas most of the other categories are inconclusive. The three longest passing lanes had a particularly good crash rate reduction, however that may be because they are all part of realignments.

3.4.5 Effect of Traffic Volume on Safety Benefits

As traffic volumes increase, the level of interaction between vehicles increases exponentially. Therefore, driver frustration at being impeded is likely to also increase at a similar rate, making higher volume two-lane roads more likely to produce dangerous overtaking manoeuvres and subsequent crashes. Whether the introduction of a passing lane would bring about a greater reduction in crashes on higher volume roads however is unclear.

The passing lane sites were categorised according to their average daily traffic volume (AADT), and the crash rates (for key crash types) compared between each volume category. Comparisons for all passing lane sites and tack-on sites only are given in Tables 3.14 and 3.15.

Table 3.14 All Passing Lanes: Injury Crashes (Key Crash Types only) by Passing Lane Traffic Volume.

Pass. lane AADT	**Crash Dirn.**	**Crashes Before**	**VKT Before**	***Rate Before***	**Crashes After**	**VKT After**	***Rate After***	**% Change**	
0-2500 (7 sites)	Opp.	37	1.37e+08	*26.95*	51	1.87e+08	*27.28*	**1**	**-12**
	Same	40	1.37e+08	*29.14*	41	1.87e+08	*21.93*	**-25**	
25-4500 (14 sites)	Opp.	160	5.26e+08	*30.44*	130	6.57e+08	*19.78*	**-35**	**-27**
	Same	146	5.26e+08	*27.78*	149	6.57e+08	*22.68*	**-18**	
45-6000 (6 sites)	Opp.	43	3.65e+08	*11.78*	69	4.18e+08	*16.52*	**40**	**35**
	Same	52	3.65e+08	*14.25*	78	4.18e+08	*18.67*	**31**	
>6000 (7 sites)	Opp.	120	4.88e+08	*24.57*	108	5.12e+08	*21.10*	**-14**	**-19**
	Same	126	4.88e+08	*25.80*	101	5.12e+08	*19.73*	**-24**	
TOTAL (34 sites)	**Opp.**	**360**	**1.52e+09**	***23.75***	**358**	**1.77e+09**	***20.18***	**-15**	**-14**
	Same	**364**	**1.52e+09**	***24.01***	**369**	**1.77e+09**	***20.80***	**-13**	

Table 3.15 Tack-On Passing Lanes: Injury Crashes (Key Crash Types only) by Passing Lane Traffic Volume.

Pass. lane AADT	Crash Dirn.	Crashes Before	VKT Before	*Rate Before*	Crashes After	VKT After	*Rate After*	% Change	
0-2500 (5 sites)	Opp.	35	1.02e+08	*34.18*	45	1.55e+08	*29.01*	**-15**	-27
	Same	34	1.02e+08	*33.20*	31	1.55e+08	*19.99*	**-40**	
25-4500 (5 sites)	Opp.	54	1.97e+08	*27.47*	40	2.40e+08	*16.70*	**-39**	-32
	Same	48	1.97e+08	*24.42*	44	2.40e+08	*18.37*	**-25**	
45-6000 (5 sites)	Opp.	24	3.12e+08	*7.70*	52	3.45e+08	*15.07*	**96**	73
	Same	35	3.12e+08	*11.22*	61	3.45e+08	*17.67*	**57**	
>6000 (6 sites)	Opp.	99	4.27e+08	*23.18*	90	4.31e+08	*20.89*	**-10**	-9
	Same	100	4.27e+08	*23.41*	92	4.31e+08	*21.35*	**-9**	
TOTAL (21 sites)	**Opp.**	**212**	**1.04e+09**	***20.43***	**227**	**1.17e+09**	***19.39***	**-5**	-6
	Same	**217**	**1.04e+09**	***20.91***	**228**	**1.17e+09**	***19.48***	**-7**	

The passing lanes seem to exhibit the greatest benefits for traffic volumes of <4500 AADT, particularly in the case of tack-on sites. The sites with AADTs between 4500-6000 experience a significant increase post-construction, although it must be noted that they had a very low pre-construction crash rate and the crash rate was still the lowest following construction. No significant differences in directional crash rates was observed.

3.4.6 Changes in Safety Benefits over Time

The safe design of passing lanes is critical if they are to reduce crashes and not introduce new safety problems. The potential problems of poorly designed merge areas, for example, have been previously discussed. It would be hoped that the increasing recognition of safety in highway design, as evidenced by the development of safety auditing for example, would lead to the elimination of bad practice and comparatively safer passing lanes.

To test this theory, the passing lane sites were broadly categorised according to their construction date, and the crash rates (for key crash types) compared between each category. Comparisons for all passing lane sites and tack-on sites only are given in Tables 3.16 and 3.17. Note that the grouping periods were designed to provide sufficient sample sizes and are therefore not even in length.

Table 3.16 All Passing Lanes: Injury Crashes (Key Crash Types only) by Construction Date.

Constrn. Date	Crash Dirn.	Crashes Before	VKT Before	*Rate Before*	Crashes After	VKT After	*Rate After*	% Change	
1985-87	Opp.	103	4.07e+08	*25.33*	91	5.41e+08	*16.83*	**-34**	**-34**
(11 sites)	Same	121	4.07e+08	*29.76*	105	5.41e+08	*19.42*	**-35**	
1988-89	Opp.	174	5.88e+08	*29.62*	179	6.60e+08	*27.13*	**-8**	**-9**
(12 sites)	Same	183	5.88e+08	*31.15*	184	6.60e+08	*27.89*	**-10**	
1990-93	Opp.	83	5.22e+08	*15.90*	88	5.73e+08	*15.35*	**-3**	**7**
(11 sites)	Same	60	5.22e+08	*11.50*	80	5.73e+08	*13.96*	**21**	
TOTAL	**Opp.**	**360**	**1.52e+09**	***23.75***	**358**	**1.77e+09**	***20.18***	**-15**	**-14**
(34 sites)	**Same**	**364**	**1.52e+09**	***24.01***	**369**	**1.77e+09**	***20.80***	**-13**	

Table 3.17 Tack-On Passing Lanes: Injury Crashes (Key Crash Types only) by Construction Date.

Constrn. Date	Crash Dirn.	Crashes Before	VKT Before	*Rate Before*	Crashes After	VKT After	*Rate After*	% Change	
1985-87	Opp.	22	1.65e+08	*13.30*	36	2.11e+08	*17.10*	**29**	**-6**
(4 sites)	Same	38	1.65e+08	*22.97*	36	2.11e+08	*17.10*	**-26**	
1988-89	Opp.	109	4.15e+08	*26.28*	110	4.54e+08	*24.20*	**-8**	**-8**
(8 sites)	Same	123	4.15e+08	*29.66*	125	4.54e+08	*27.50*	**-7**	
1990-93	Opp.	81	4.58e+08	*17.69*	81	5.06e+08	*16.02*	**-9**	**-2**
(9 sites)	Same	56	4.58e+08	*12.23*	67	5.06e+08	*13.25*	**8**	
TOTAL	**Opp.**	**212**	**1.04e+09**	***20.43***	**227**	**1.17e+09**	***19.39***	**-5**	**-6**
(21 sites)	**Same**	**217**	**1.04e+09**	***20.91***	**228**	**1.17e+09**	***19.48***	**-7**	

The results suggest no significant differences between the three construction periods. This may be because the design of these passing lanes pre-dates the beginning of formal safety audits by Transit New Zealand. It would be interesting in the future to review what changes in crash rate have occurred with more recent passing lanes.

3.5 Discussion

The results show some clear trends in crash reduction. These must be treated with caution however, given the limited number of crashes in some of the sample groups. The findings for those sites where realignments were involved are particularly uncertain because of the combined treatments.

Where a realignment is being considered in conjunction with a passing lane, then an analysis of likely passing lane crash savings is largely redundant. The differing alignments before and after make it difficult to attribute crash savings solely to provision of passing opportunities, when the new alignment itself is also likely to have a safety benefit. In these situations, the use of the typical crash rates given in Table 3.1 is considered the best solution for both the two-lane and three/four-lane sections of the new alignment. For an even simpler approach, a 25% reduction to equivalent two-lane crash rates would achieve a similar effect.

For tack-on passing lanes, there were notable reductions in crash rates for "Overtaking" and "Head-On" crashes (as defined in Table 3.7) of more than 30% and 60% respectively. "Rear-End/Obstruction" crashes also experienced a 15% reduction following passing lane construction. However "Lost-Control" crash rates increased by about 15%. Because of the large proportion of the latter type of crashes, the benefits from the other three crash types may be negated.

Lost-control crashes are probably being affected by increased vehicle speeds, both during overtaking and in the road length downstream. Existing wide shoulders are sometimes sacrificed to achieve the width for passing lanes, which may also be an underlying cause. Over time however, design practices may have improved - one would hope that safety audits are helping to eliminate these problems.

Poor design practices have also been attributed with causing merge crashes due to poor placement and layout of the ends of passing lanes, often found just prior to a tight curve. The LTSA movement code list would suggest that code AC ("Cutting-In/Changing-Left") might be the most appropriate code to record these crashes by, however the study found no notable numbers of AC crashes (1 before vs 2 after). It may be that merge area problems are actually translating into head-on or lost-control crashes, particularly where adjacent tight curves are present.

A consequence of this may be the finding that crash rates appear to increase in the 2 km immediately following the passing lane (going against the general trend). If this is the case then, again, improved vigilance of the safety aspects of passing lane design may help to improve this. Alternative reasons for this increase may be the presence of higher speeds by "free" vehicles (leading to more lost-control crashes) and closer following distances at the conclusion of the merge area (leading to more read-end crashes).

Some "indicative" relationships have also been identified for different passing lane lengths and traffic volumes. The greatest crash savings appear to be on roads with 4500 vehs/day or less (29% reduction at tack-on sites), while passing lanes < 800 m long also appeared to be more successful (24% reduction at tack-on sites). It is not clear why these results should be so. Thrush (1996) did not find any literature that specifically identified any safety effects of either of these parameters; they were deemed to be of more interest from an operational efficiency point of view.

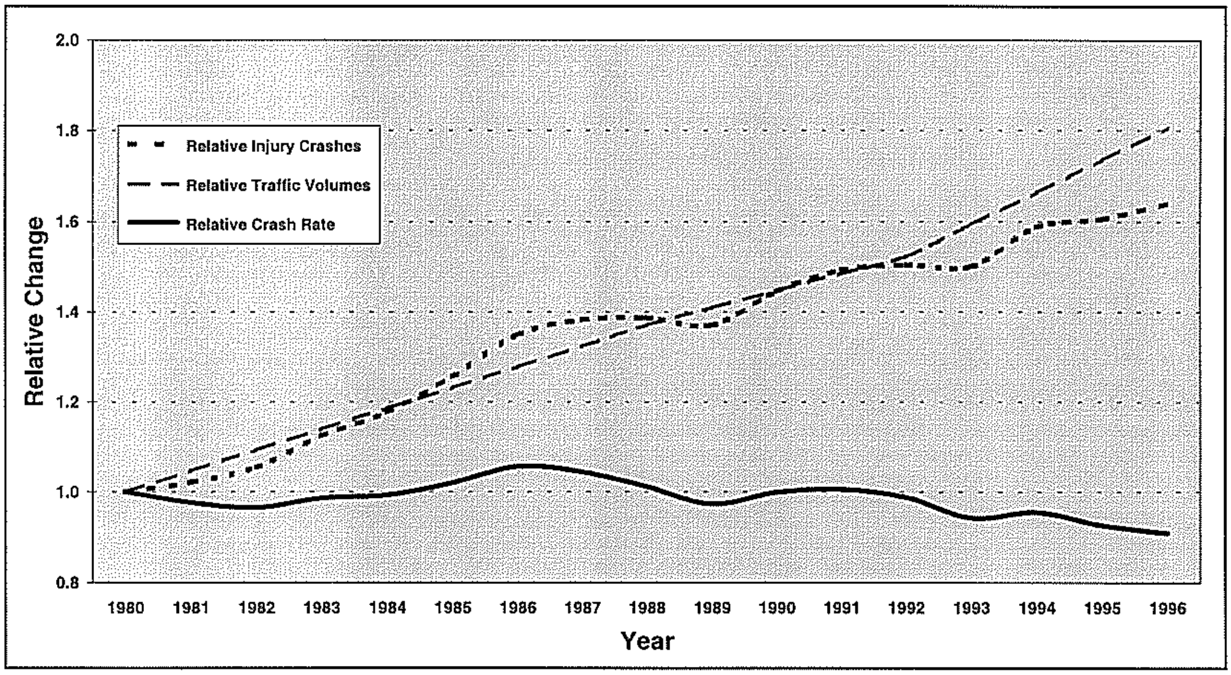
This investigation has revealed that simply constructing a passing lane will not necessarily improve safety overall. Passing lanes constructed as part of realignments have a more significant affect on crash rates than passing lanes that are simply tacked on. This suggests that care should be taken in the design and placement of passing lanes, to ensure that the higher traffic speeds within and following a passing lane can be safely accommodated. Particular care should be taken in assessing the area immediately downstream (i.e. 0-2 km) from the passing lane.

3.5.1 General Changes in Crash Trends Over Time

A factor that may blur the true change in crash rates for passing lanes is the influence over time of institutional factors. For example, the Police and LTSA have developed fairly extensive road safety campaigns over the years, which may be contributing to the perceived drop in crash rates. Initiatives such as random breath testing and speed cameras, for example, may be influencing the figures, so the need for a "control" sample for comparison purposes was recognised.

LTSA injury crash data for the four "key crash types" studied above was collected for all State Highways between 1980 and 1996. Only rural two or three-lane roads were included to be comparable to typical applications of passing lanes. Traffic volume data at 29 representative count sites on State Highways was also obtained and combined to establish the relative growth rate for traffic over the same period. From these two inputs, the relative change in crash rates could be determined. Figure 3.2 shows the changes over time.

Figure 3.1 Change in Crash Rates 1980-1996
(Rural Overtaking/Head-On/Lost-Ctrl/Rear-End Injury Crashes).



The findings show that crash rates did not markedly decrease over this period. Indeed, until about 1992, there was little significant change. Since then however, the rate has dropped a little, to be 91% of the 1980 figure by 1996.

It would appear that many of the original road safety initiatives were targeted more at the urban driver, such as Police checkpoints and traffic calming. The drop in rural rates more recently has probably come about through a number of more current developments:

- The introduction of rural speed cameras
- The use of safety auditing on both existing roads and in new developments
- The increased media publicising of excessive speed and drink-driving in rural areas

The passing lane section crashes studied have been derived from a range of different years. Therefore, it is difficult to identify a universal adjustment factor that could be applied across the board to allow for the general decreasing trend. For the most recent passing lanes studied, the relative rates would suggest no more than a 5% effect on post-construction crash rates, with a lesser effect on passing lanes constructed earlier.

3.5.2 The Use of Series of Passing Lanes

One situation not fully examined is where there is a series of regularly spaced passing lanes. This is becoming more prevalent as an interim measure to four-laning busy sections of highway. By signposting the distance to the next passing lane after the end of the previous one, drivers get into a habit of waiting for the next passing lane instead of trying to overtake (usually against heavy traffic). In this situation, the downstream benefits of one passing lane are also providing upstream benefits for the next lane.

Because of the use of analysis lengths well beyond the actual extent of each passing lane, any series of passing lanes that were too close to each other (within 12km in the same direction) were excluded from the crash study. It is likely that the individual passing lanes were constructed at different dates, so "before and after" studies would prove difficult to implement. A more feasible approach might be to examine the crash rate for entire sections of road with passing lanes, and compare it against similar road lengths with no passing lanes. This would be similar to the comparison discussed in Section 3.1.1. Further investigation is beyond the scope of this project.

3.5.3 Further Analysis

The sample set used was dependent on data provided by Transit New Zealand's Regional Offices. It is known that this was not a complete set of suitable passing lane sites. Some of the information, such as actual construction dates, was also rather sketchy. A revised set of passing lane sites would increase the crash sample size to help confirm (or otherwise) some of the trends identified.

Over time, additional new sites will also become available with sufficient post-construction crash history. More recent sites will have also been subject to stringent safety auditing requirements to ensure that they will not cause any subsidiary safety problems.

This study enabled the development of various database query tools to be able to answer the key questions efficiently. Further analysis could be undertaken using the same tools, simply by updating the crash and site databases.

4. OPTIMAL LOCATION OF PASSING LANES

Identification and analysis of potential passing lane sites is fraught with a number of difficulties. The initial selection of suitable sites is often a result of educated guesswork, particularly the determination of likely costs. To date little work has been done in New Zealand to identify a procedure for determining, from a strategic point of view, suitable locations for passing lanes along a route, with due regard to the actual demand for overtaking.

This is partly because the most widely available analysis tool, ARRB's TRARR package, is a relatively complex program to use. As a result, it is often only used to analyse passing lane projects in detail at a relatively late stage in the investigation process. This approach may be hindering better passing locations being identified at the initial scoping stage.

Transit New Zealand have identified a desire to have a simplified system to locate passing lanes on a selected route in an optimal manner. Ideally, such a system would determine the need for, location of, and benefits to be derived from providing passing lanes in an optimal manner.

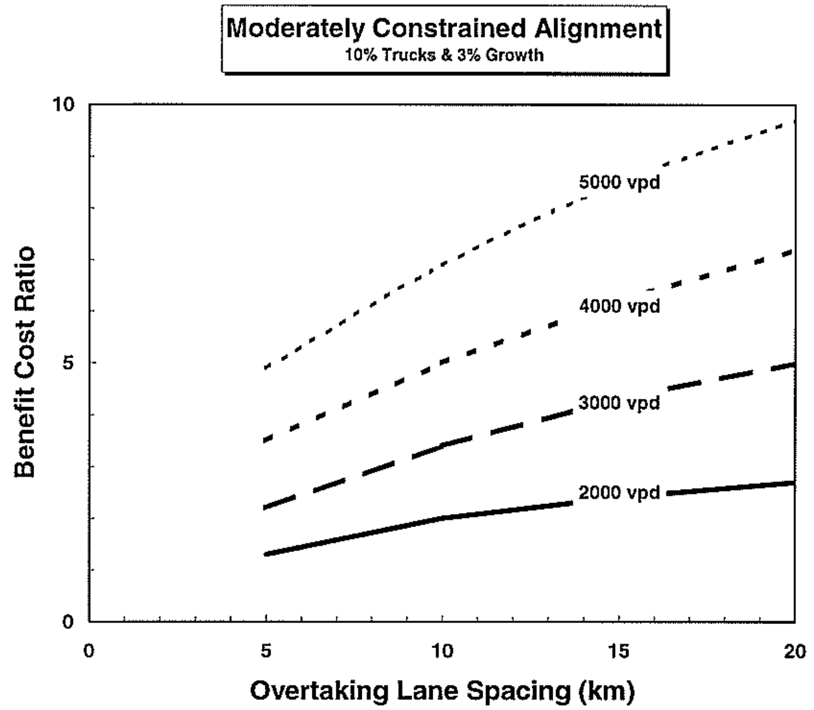
In order to find the optimum locations for passing lanes or other passing opportunities along a route, the "system" would need to minimise construction costs and maximise the economic benefits of the proposed improved passing opportunities. These conflicting requirements are the factors which complicate the present analysis method. This is assuming that economic grounds continue to be used as the determining factor in a funding decision.

Ultimately, the system may be in the form of a series of "rules", from which a computer program, expert system, or more manual method could be developed. It is envisaged that such a system would be used as a "first-order-sieve" analysis tool, prior to more detailed evaluation using TRARR. As a minimum, it should be a means of reducing the set of options that could be analysed. However, for simple passing improvements at least, a simplified evaluation method may be sufficiently robust for Transfund funding.

4.1 Previous Research

Sweetland & Anson (1996) discussed passing lane optimisation techniques as part of a strategic review of arterial routes in Victoria, Australia. Part of their review was a study of the need for additional overtaking lanes on a network-wide basis. Using TRARR, a set of generic graphs were developed based on travel time savings for different overtaking lane spacings and road conditions. From this further generic graphs were produced to relate this to Benefit Cost Ratios. A typical example of these graphs is presented in Figure 4.1. It may be possible to produce similar generic graphs here in New Zealand, although the number of combinations of road terrain/alignment, HCV proportions, traffic volume, traffic growth, and passing lane spacing may require an impractical number of graphs.

Figure 4.1 Example of Generic Benefit Cost Ratios for Overtaking Lanes (from Sweetland & Anson 1996)



An alternative may be to produce an equivalent formula containing the inputs mentioned above, which can be used to determine typical travel speeds for any given combination. Koorey & Tate (1998) used this method to develop a strategic passing lane model for the Australian Bureau of Transport & Communication Economics (BTCE). BTCE had developed a Road Infrastructure Assessment Model (RIAM) that makes strategic predictions about future investment needs for non-urban roads in Australia. The original model used a database describing the physical and traffic characteristics of road segments, but could only analyse two-lane, four-lane, or six-lane configurations.

Because the original model could already determine mean speeds for two and four-lane road segments, a passing-lane model was developed to give a "speed ratio" between these two extremes (i.e. no passing lanes and continuous passing lanes). Koorey and Tate used TRARR to model 1152 different road and traffic combinations. The resulting outputs were used to derive generalised linear equations for the ratio, i.e.

$$F_{Pass\text{-}Ln} = \text{Speed Ratio for specified passing lane combination}$$
$$= f\,(Vol, PL.Freqy, PctRig, PctArt, Terrain) \qquad (1)$$

where

Vol = Traffic Flow (vehicles per hour)
PL.Freqy = Frequency of passing-lanes (lane-km per 100 km)
PctRig = Percentage of Rigid trucks in traffic
PctArt = Percentage of Articulated trucks in traffic
Terrain = Terrain type (flat/rolling/mountainous)

$F_{Pass\text{-}Ln}$ ranges in value from zero (four-lane highway) to one (two-lane highway), depending on the input parameters. Using this ratio and the previously modelled two and four-lane mean speeds, the mean speed for the passing-lane situation could then be determined:

$$MS_{Pass\text{-}Ln} = MS_{Four\text{-}Ln} - \left[F_{Pass\text{-}Ln} \times \left(MS_{Four\text{-}Ln} - MS_{Two\text{-}Ln}\right)\right] \tag{2}$$

where

$MS_{Pass\text{-}Ln}$ = Mean Speed for a passing-lane segment
$MS_{Two\text{-}Ln}$ = Mean Speed for equivalent segment with two lanes
$MS_{Four\text{-}Ln}$ = Mean Speed for equivalent segment with four lanes

A similar approach could be applied in New Zealand. However, the resulting equations for $F_{Pass\text{-}Ln}$ were computationally complex and therefore not suitable for, say, simple project evaluation. They also relied on knowing (or predicting) the two-lane and four-lane mean speeds for the road segment in question. For existing two-lane highways, determination of a likely four-lane speed may be difficult. A suitable alternative might be to assume that the mean *free* speed is representative of the four-lane mean speed (or at least represents the upper bound).

4.1.1 Existing Mathematical Models

Various attempts have been made over the years to represent two-lane highways by a number of theoretical models. Computer programs like TRARR are based on such models, supplemented by field calibration of data.

Tate (1995) identified three types of models:

- *Generalised Models*
  These are used to identify candidate sections for providing improved passing opportunities. The generic charts like Fig. 4.1 would be an example of this.
- *Site specific Models*
  These make use of actual site data to determine the effects of providing improved passing opportunities at a specific location. The models are "macroscopic", i.e. they treat traffic flow as a single entity. The Unified Passing model described in Section 2 is an example of this.
- *Micro-Simulation Models*
  These make use of more detailed site and vehicle data to determine the effects of providing improved passing opportunities at a specific location The models are "microscopic", i.e. they model each individual vehicle separately. TRARR is an example of this.

The key differences between each level of model are the amount of detailed data required, the complexity of the analysis, and the subsequent accuracy of the results. In summary, here is a ranking of the analysis approaches described above in terms of accuracy and effort:

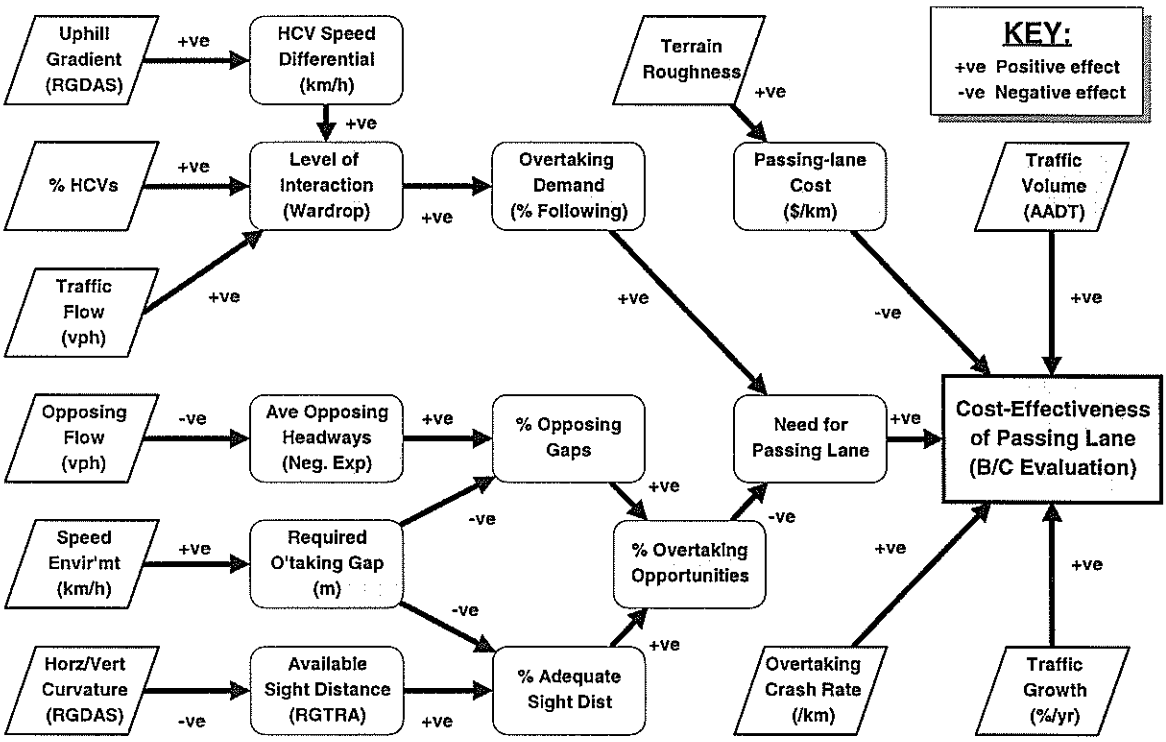
less accurate	**General passing-lane spacing charts**	less effort/cost
	Unified Passing model - one vehicle stream	
	Unified Passing model - two vehicle streams	
	TRARR Analysis - "first order" modelling	
more accurate	**TRARR Analysis - detailed modelling**	more effort/cost

In New Zealand, there has been little use of methods simpler than TRARR to analyse passing opportunities. Clearly there is a need for a model (or two) to fit above TRARR, reducing the amount of input data and analysis, although probably providing less accurate results. For example, the two-stream Unified model could form the basis of a simplified method for site specific analysis, with a one-stream model more practical for general strategic route studies.

4.2 Conceptual Model

Based on the previous research and drawing on first principles, a conceptual model was developed that sought to identify all of the inputs and subsequent effects on passing lane evaluation. In particular, the essential "need" for the passing lane was considered fully, prior to the influences of benefit cost evaluation. Figure 4.2 outlines the final model.

Figure 4.2 Conceptual model for passing lane evaluation



The model has been designed so that the required inputs are readily available for New Zealand State Highways. In some cases, inputs can be assumed or simplified; for example, traffic flow in both directions could be assumed to be the same. Similarly, the underlying processes for some of the subsequent steps could be as simplified or detailed as required; for example, "Level of Interaction"

As shown on Fig. 4.2, each link between items has one of two influences shown:

+ve = preceding item has positive influence on succeeding one, i.e. an increase causes an increase, and vice versa

-ve = preceding item has negative influence on succeeding one

The actual form of these relationships may vary, from simple linear correlations to more complex links. Again, this also depends on the level of simplification desired in the model. The following comments relate to some of the known models and procedures that could be used to proceed between steps:

- *Uplhill Gradient → HCV Speed Differential*
  Gradient is considered the key factor in influencing HCV speeds relative to car speeds. A number of studies have developed speed profiles for vehicles of varying specification over a range of grades, for example Bennett (1994). A more pragmatic approach is to simply observe mean speeds for different vehicle types on the road section in question (for realignment proposals, analysts will have to fall back on predictive methods).

  The simple distinction between "cars" and "trucks" gives rise to potential accuracy problems, particularly in the latter category. Trucks comprise a broad range of vehicles from two-axle small lorries to articulated multi-trailers. As such, their response to grades can vary tremendously within this group. To differentiate between more than two vehicle types considerably increases the complexity (to a level similar to TRARR). Therefore the best solution appears to be to ensure that the measured sample of truck speeds is sufficiently large and all-encompassing so as to be truly representative.

- *HCV Speed Differential & % HCVs & Traffic Flow → Level of Interaction*
  Wardrop (1952) produced the following formula for the catch-up rate between two vehicle streams:

$$R = k^2 \int_0^\infty f(u) . \int_u^\infty (v-u)\, f(v)\; dv\; du \tag{3}$$

where

R = Catch-up rate (catch-ups per km per hr)

k = Traffic Density = Volume/Speed (veh/km)

u, v = Speed of two vehicle streams (km/hr)

$f(u), f(v)$ = Probability Density Functions of speed distribution for each vehicle stream, Mean v > Mean u

Where the situation is simplified to a single traffic stream having a normal distribution of speeds, with mean v and standard deviation s, then the above formula resolves to

$$R = (0.56) \times s \times k^2 \qquad (4)$$

Since k = Volume (q) / Speed, the above equation can also be expressed as

$$R = (0.56) \times s \times q^2 / v^2 \qquad (5)$$

which was seen in Section 2.2.3 as part of the UPD calculations. The adjustments to the volume to allow for HCV proportions and terrain, as described in Section 2, could also be applied. At a strategic route level, where it may be impractical to obtain continuous speed data along the highway, road geometry data could be used to determine an approximate speed profile using the RGDAS advisory speed calculation described by Koorey *et al* (1998).

Troutbeck (1982) outlined the solution to the two stream case, if both streams' speeds are normally distributed. Each stream has an hourly one-way flow, q_A & q_B (veh/hr), a space mean speed, v_A & v_B (km/hr), and a standard deviation of speeds, s_A & s_B (km/hr).

The frequency with which vehicles in stream A catch up to vehicles in stream B (i.e the "demand" for passing) is:

$$R_{AB} = \gamma_{AB} \times k_A \times k_B \times s_A \quad \text{(catch-ups/km/hr)} \qquad (6)$$

where

γ_{AB} = a constant from Table 4.18
k_A = the density of vehicles in stream A = q_A / v_A (veh/km)
k_B = the density of vehicles in stream B = q_B / v_B (veh/km)

To determine γ_{AB} from Table 4.18, two parameters are needed:

$$\alpha_{AB} = (v_A - v_B) / s_A \qquad (7)$$

$$\beta_{AB} = s_A / s_B \qquad (8)$$

Table 4.18 γ_{AB} Values for Catch-up Rates.

$\alpha_{AB} =$	$\beta_{AB} = s_A/s_B$								
$(v_A-v_B)/s_A$	**≤ 0.2**	**0.4**	**0.6**	**0.8**	**1.0**	**2.0**	**3.0**	**4.0**	**≥5.0**
≥2.0	1.22	1.55	1.81	1.94	2.00	2.02	2.01	2.01	2.01
1.8	1.20	1.49	1.70	1.80	1.83	1.83	1.82	1.82	1.82
1.6	1.18	1.42	1.59	1.66	1.67	1.64	1.63	1.63	1.63
1.4	1.16	1.35	1.48	1.51	1.51	1.46	1.45	1.44	1.44
1.2	1.14	1.28	1.37	1.39	1.35	1.28	1.27	1.26	1.26
1.0	1.12	1.22	1.26	1.23	1.20	1.11	1.10	1.09	1.09
0.8	1.10	1.15	1.15	1.10	1.05	0.96	0.94	0.93	0.93
0.6	1.08	1.08	1.04	0.97	0.91	0.81	0.79	0.78	0.78
0.4	1.06	1.02	0.94	0.85	0.79	0.67	0.65	0.64	0.64
0.2	1.04	0.96	0.84	0.74	0.67	0.55	0.53	0.52	0.52
0	1.02	0.90	0.75	0.64	**0.56**	0.45	0.42	0.41	0.41
-0.2	1.00	0.84	0.66	0.54	0.47	0.35	0.33	0.32	0.32
-0.4	0.98	0.78	0.59	0.46	0.39	0.27	0.25	0.24	0.24
-0.6	0.96	0.72	0.51	0.38	0.31	0.21	0.19	0.18	0.18
-0.8	0.94	0.67	0.44	0.32	0.25	0.16	0.14	0.13	0.13
-1.0	0.92	0.62	0.38	0.26	0.20	0.11	0.10	0.09	0.09
-1.2	0.90	0.57	0.33	0.21	0.16	0.08	0.07	0.06	0.06
-1.4	0.88	0.53	0.28	0.17	0.12	0.06	0.05	0.04	0.04
-1.6	0.87	0.49	0.24	0.14	0.09	0.04	0.03	0.03	0.03
-1.8	0.85	0.45	0.20	0.11	0.07	0.03	0.02	0.02	0.02
≤-2.0	0.83	0.41	0.17	0.09	0.05	0.02	0.01	0.01	0.01

Note that, for vehicles catching up to each other *within* a traffic stream (i.e. where streams A & B are the same), $\alpha_{AA} = 0$ and $\beta_{AA} = 1$, giving $\gamma_{AA} = 0.56$. Therefore

$$R_{AA} = 0.56 \times k_A^2 \times s_A \qquad (9)$$

which is the same as the single stream model described above.

- *Level of Interaction → % Vehicles Following*
  The above model calculates catch-up rates (or passing "demand") and not "overtaking" rates. For low traffic flows, vehicles will be able to overtake relatively shortly after catching up to a slower vehicle, and so the two rates are more or less than same. Troutbeck noted that this assumption can be checked by ensuring that the average queue length is less than about two. For longer queue lengths, the possibility of overtaking within the queue increases, which is not accounted for by this model. A maximum flow in each direction of 150 veh/hr was recommended for using this model. For a typical rural strategic route, this equates to a two-way AADT of about 3000-4000 vpd to ensure that all time periods are valid. The alternative is to determine the actual overtaking rate separately, such as by the use of the passing supply model. Troutbeck's original calculations formed the basis for a subsequent simplified NZ procedure by Bennett (1988) which has been used in the past for some simple passing lane analyses here.

- *Opposing Flow → Ave Opposing Headways*
  A random traffic model assumes that vehicle arrivals follow a Poisson distribution, leading to a negative exponential headway distribution. With an opposing flow of X vph, there is an average headway of 3600/X secs. The distribution of headways, H, is therefore

$$P[H>t] = e^{-Xt/3600} \tag{10}$$

In reality, vehicles occupy a non-zero amount of space, so in theory there is a minimum possible headway. If a minimum headway H_{min} is specified then, for $t>H_{min}$,

$$P[H>t] = e^{-X(t-H_{min})/(3600-X.H_{min})} \tag{11}$$

The situation is further complicated by the existence of bunches or platoons in the opposing direction. Some authors, such as Miller (1961), have proposed mixed models; with negative exponential headways between bunches and normally distributed headways within bunches. Needless to say, this further complicates the theoretical formulae, and is not suitable for manual approaches.

- *Speed Environment → Required O'taking Gap*
  McLean (1987) noted that, from field observations, critical gaps for overtaking are generally in the range of 10 to 30 s. Assuming that the two opposing traffic streams are moving at the same speed, this translates into an opposing stream headway of 20 to 60 s. The critical gap for a "typical" overtaking is about 15 s, which translates to a 30 s headway.

  From AUSTROADS (1993), a typical required sight distance as a consequence of these time gaps is approximately 430 m at a design speed of 100 km/h. Similarly, NAASRA (1988) in its Level of Service calculations considers the proportion of highway with sight distance > 450 m as having "available passing sight distance".

- *Horz/Vert Curvature → Available Sight Distance*
  For State Highways, Road Geometry (RGDAS) data can be processed using the RGTRA program provided with TRARR to determine sight distances along a highway. Alternatively, a visual assessment can be made.

- *Ave Opposing Headways & Required O'taking Gap → % Opposing Gaps*
  Using the headway distribution derived above, the proportion of headways that satisfy the required overtaking gap can be determined. For a required gap of 30 s, for example, the resulting negative exponential equation is

$$\begin{aligned} P[H>30] &= e^{-X.30/3600} \\ &= e^{-0.0083X} \end{aligned} \tag{12}$$

- *Required O'taking Gap & Available Sight Distance → % Adequate Sight Distance*

Using the sight distance data derived above, the proportion of sight distance data greater than the required overtaking gap can be determined.

Note that the presence of existing passing lanes it is equivalent to having 100% adequate sight distance. Therefore the overall proportion of adequate sight distance for a long section of road should allow for this (see Section 2.2.3 for further details).

- *% Opposing Gaps & % Adequate Sight Distance → % Overtaking Opportunities*
  By multiplying the two inputs together, the overall proportion of likely overtaking opportunities can be established. For example, if there are 40% opposing gaps of adequate size and 30% of sight distance adequate for passing, then there are adequate overtaking opportunities 12% of the time.

  Note that this is not an absolute number of overtakings, rather it is the proportion of possible overtakings that can be serviced on average. There would however be an upper limit to the absolute number of unopposed overtakings possible, dependent on maximum density and multiple overtaking rates. Theoretically, up to half of a given traffic stream could be overtaking the other half at any time and carry on overtaking subsequent vehicles continuously. In practice, this would be subject to inefficiencies (for example, two relatively slow vehicles occupying both lanes) particularly for higher densities.

  Assuming that a vehicle requires on average 30 seconds to safely overtake (based on the required overtaking gap discussed above), then it could theoretically overtake 3600/30 = 120 vehicles every hour. In reality, there might be some inefficiencies of, say, 10% bringing this figure down to 108 overtakings/hr. Of course if half of all vehicles were attempting to continuously overtake in this manner, the inefficiency would probably be even greater. At a relatively low level of traffic density however, for example 2 veh/km (equivalent to, say, 160 veh/hr @ 80 km/hr), the assumption is probably valid, resulting in a supply of 108 overtakings per km per hour being used. This value will be used in the following analyses, but further work is required to confirm a suitable value.

- *Overtaking Demand & % Overtaking Opportunities → Need for Passing Lane*
  In the Unified model, the comparison between passing supply and passing demand determines the "Unsatisfied Passing Demand" (UPD). A simple approach is to determine the proportion of passing demand that can be met by the available supply

  $$UPD = Demand \times (1 - \%Supply) \qquad \text{(overtakings/km per hr)} \qquad (13)$$

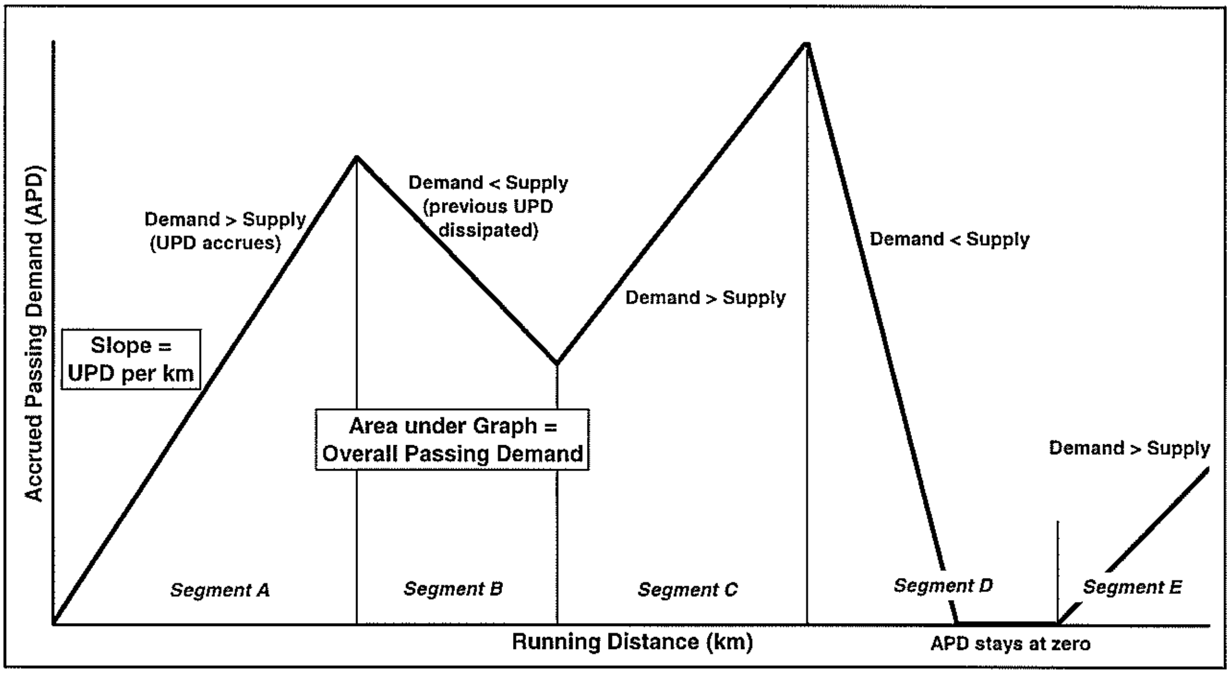
  Therefore, by reducing the demand for or improving the supply of passing opportunities, the UPD will be reduced.

  The problem with this simplified approach is that it doesn't explain what happens to these UPDs. In reality, these vehicles would continue to be unsatisfied further down the road, so that the next road section would accrue not only the UPDs from its length but those of the previous section as well. Conversely, a section of road with a good supply of passing opportunities (for example, with good sight distance or by provision of a passing lane) may be able to dissipate previously built up UPD, i.e it would have a negative UPD (or "oversatisfied passing demand"). To calculate UPD like this requires an absolute determination of Supply in terms of overtakings per km per hr, then

$$UPD = Demand - Supply \qquad \text{(overtakings/km per hr)} \qquad (14)$$

By analysing the change in UPD buildup along a road, the overall passing demand could be determined. Figure 4.3 outlines this situation.

Figure 4.3 Calculation of Overall Passing Demand.



In this way, a comparison between the existing route and various passing lane options could be done to determine the most efficient means of meeting passing demand.

The above figure assumes that there is no "accrued passing demand" (APD) at the start of the analysis section. In many cases, however there will be APD from road sections prior to the analysis section, as evidenced by a level of vehicle bunching. Where the downstream APD doesn't reach zero again, the effect of adding another constant is negligible when comparing between project options. In other cases however, it will affect where the APD returns to zero (as seen in Segment D in Figure 4.3). Two possible approaches are:

a) to start an analysis following a length of road with good passing opportunity (e.g. a passing lane or long straight), on the assumption that there will be negligible APD following this; or

b) to determine a starting APD, based on field data for vehicle bunching. At a fixed point on the road, the APD can be thought of as the number of vehicles going past that point that are following slower vehicles (i.e. waiting to overtake). Therefore

$$APD_x = B_x \times q \quad \text{(unsatisfied o'takings/hr)} \qquad (15)$$

where

APD_x = Accrued Passing Demand at a given point x
B_x = Proportion of vehicles bunched at a given point x
q = One-way Traffic Flow (veh/hr)

The latter approach also makes it possible to validate the APD at any given point downstream by obtaining field data on vehicle bunching at that point.

One complicating factor with this approach arises where vehicles are queued behind a number of vehicles they ultimately wish to pass. In this case, simple bunching measures cannot identify this and will underestimate the APD.

To be compatible with Transfund Project Evaluation, the resulting benefits from reducing bunching would probably need to be expressed in terms of travel time saved. A simple approach is to determine the average time lost by following other vehicles rather than travelling at a desired free speed, i.e.

$$\text{Time Lost} = 3600 / V_{\text{Following}} - 3600 / V_{\text{Free}} \quad \text{(seconds/km)} \qquad (16)$$

where

$V_{\text{Following}}$ = Mean speed for following vehicles (km/h)
V_{Free} = Mean speed for free vehicles (km/h)

From this the overall time lost due to unsatisfied passing can be determined. Note that this only applies to vehicles travelling in the direction of the passing lane. It is assumed that travel times of vehicles in the opposite direction are unaffected by the passing lane.

- *Terrain Roughness → Passing-lane Cost*

Outside of major structures such as bridges, the key factor in passing lane construction cost is the surrounding terrain and how much work is required to provide the additional carriageway width. Note that this applies to passing lanes "tacked on" to existing roadways, as opposed to realignments.

For simple strategic planning, three typical scenarios for tack-on passing-lane construction could be assumed:

a) *Cutting*: need significant cut-to-waste to achieve required width.
b) *Flat*: can build on existing terrain with negligible earthworks.
c) *Embankment*: need fill to achieve required width.

Recent passing lane projects and contract rates have established typical costs per km of $300,000 - 400,000. Whether additional land needs to be purchased adjacent to the road reserve adds another factor, although a typical amount could be allowed for this.

A fourth scenario "major structure" could also be used, by specifying a prohibitively expensive rate (say, \$5million / km), to identify the main constraints in locating suitable passing lanes.

- *Need for Passing Lane & Overtaking Crash Rate & Traffic Volume & Passing-lane Cost & Traffic Growth → Cost-effectiveness of Passing Lane (B/C Evaluation)*
  At this stage, normal Project Evaluation procedures could be applied to determine a Benefit Cost Ratio for the passing improvement. Alternatively, at a more strategic level (e.g. narrowing down a list of options), a system of simple weightings could be applied to each of the inputs to determine the relative benefit of each option.

  Another determinant of passing lane "need" could be the driver frustration considerations from Section 2. For the proposed length of passing opportunity to be provided, the previously derived value of 3.5 cents per vehicle per km of passing opportunity could also be incorporated.

  Generally for simple "tack-on" passing-lane cases (i.e. excluding realignment situations), the vehicle operating cost (VOC) changes are outweighed by the travel time savings by a factor of 10:1 or more. For a typical increase in vehicle speeds on an existing road, there will usually be a marginal decrease in VOC. At a simplified or strategic level, this disbenefit could either be ignored or assumed to proportionally reduce the travel time benefits (say, by 0.95).

  Alternatively, a rough VOC cost could be determined for a simplified procedure. For example, for grades of -2% to 10% and speeds of 80-110 km/h the current VOC cost specified by Transfund (1997) is approximately 0.06 of a cent per km/h increase per vehicle, with little change between grades and speeds. So, assuming that the proposed passing lane has suitable grades and travel speeds and that the average speed increase can be determined, a rough order VOC cost can be established. For, say, a 7 km/h average speed increase over a 10 km section of road with 3000 vpd (two way) and 2% growth, this equals:

  $\$0.0006 \times 7 \times 10 \times 3000/2 \times 365$
  $= \$22,995$ (disbenefit) per year

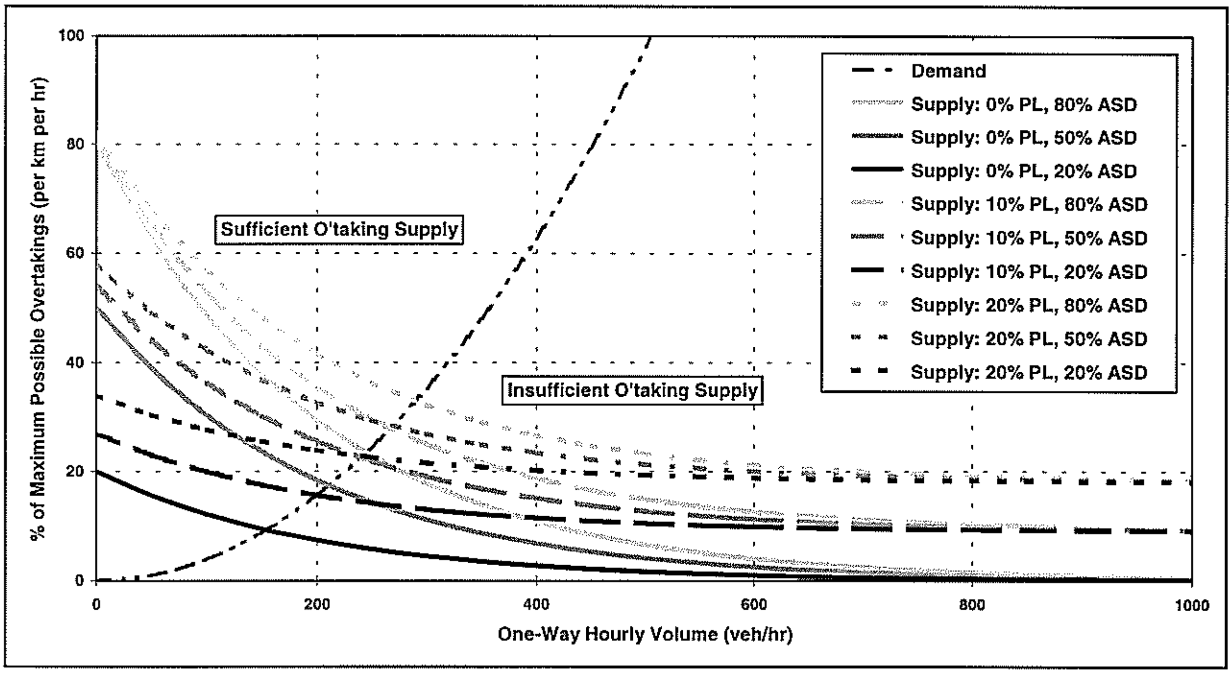
4.2.1 Application of the Conceptual Model

The conceptual model allows passing lane evaluation to be undertaken at a strategic route level or at a site specific level. The level of detail, accuracy, and data requirements is up to the analyst.

For example, for a "long" section of highway (e.g. between major junctions or towns) a more simplistic approach could be taken. Using a spreadsheet or database, the various inputs (AADT, RGDAS, etc) can be combined to get a relative "score" along the highway for locating a passing lane (this could be in, say, 500 m increments). The best ranking sections can then be analysed further for scheme assessment / detailed design, either using a more detailed conceptual model or TRARR.

Figure 4.4 shows how the theory of passing supply and demand is affected by the key variables of traffic volume, proportion of passing lanes (PL), and proportion of available sight distance (ASD). The values have all been expressed in terms of the maximum possible amount of overtaking available, such as provided by passing lanes.

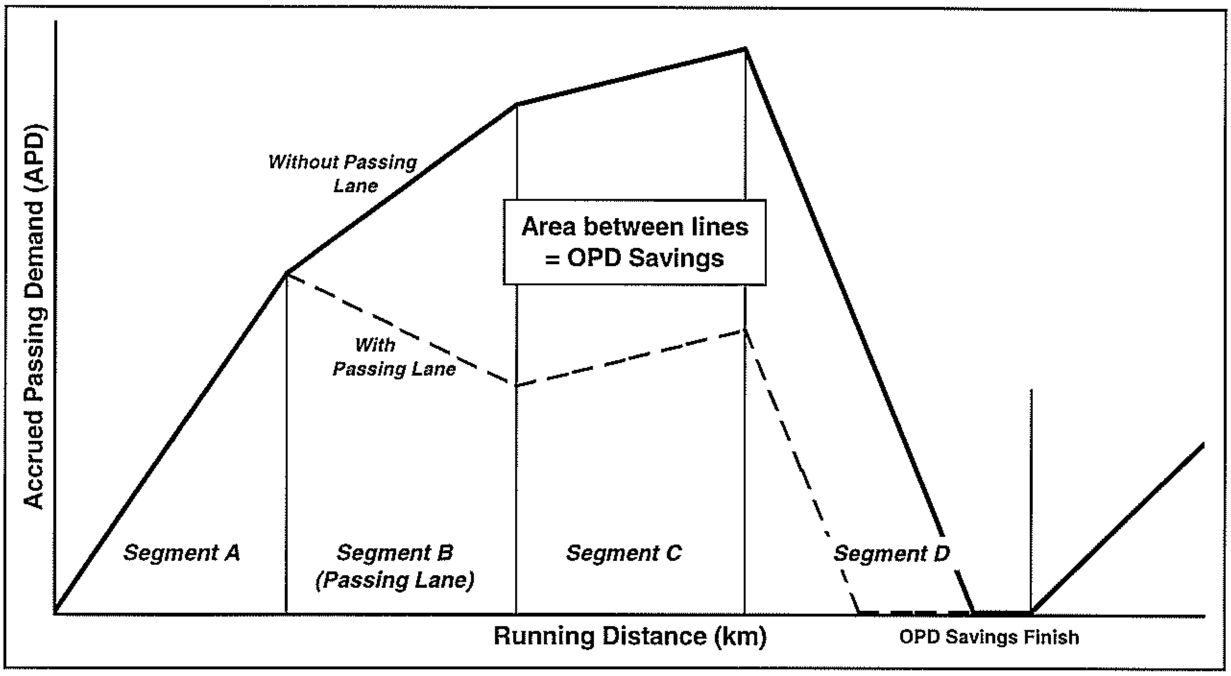
Figure 4.4 Effects of key parameters on Passing Supply and Demand.



It can be seen that traffic volume influences whether or not there is sufficient overtaking supply for the given demand. As traffic volumes tend to zero, the supply is dependent on the available sight distance. As traffic volumes get very large, the supply tends towards the amount of passing provided by passing lanes only. Because of the exponential growth in passing demand with volume, it is also clear that at high volumes not all of the passing demand may be met by providing passing opportunities.

The effect of different passing lane options can be compared with the existing road section. Figure 4.5 shows how a passing lane typically affects the overall passing demand. Within the passing lane, the UPD will be markedly less, reducing the accrued passing demand. This will affect downstream road segments as well, by providing a lower APD, despite the UPD being unchanged. The benefits of the passing lane will finish when the APD reaches zero in both cases (as shown in Segment D).

Figure 4.5 Effects of Passing Lane on Overall Passing Demand.



4.3 Verification of the Conceptual Model

A 50 km road section between route positions 100.0 and 150.0 on SH1s (i.e. north of Kaikoura) was analysed using both TRARR and a simplified form of the conceptual model to assess the model's applicability to strategic studies.

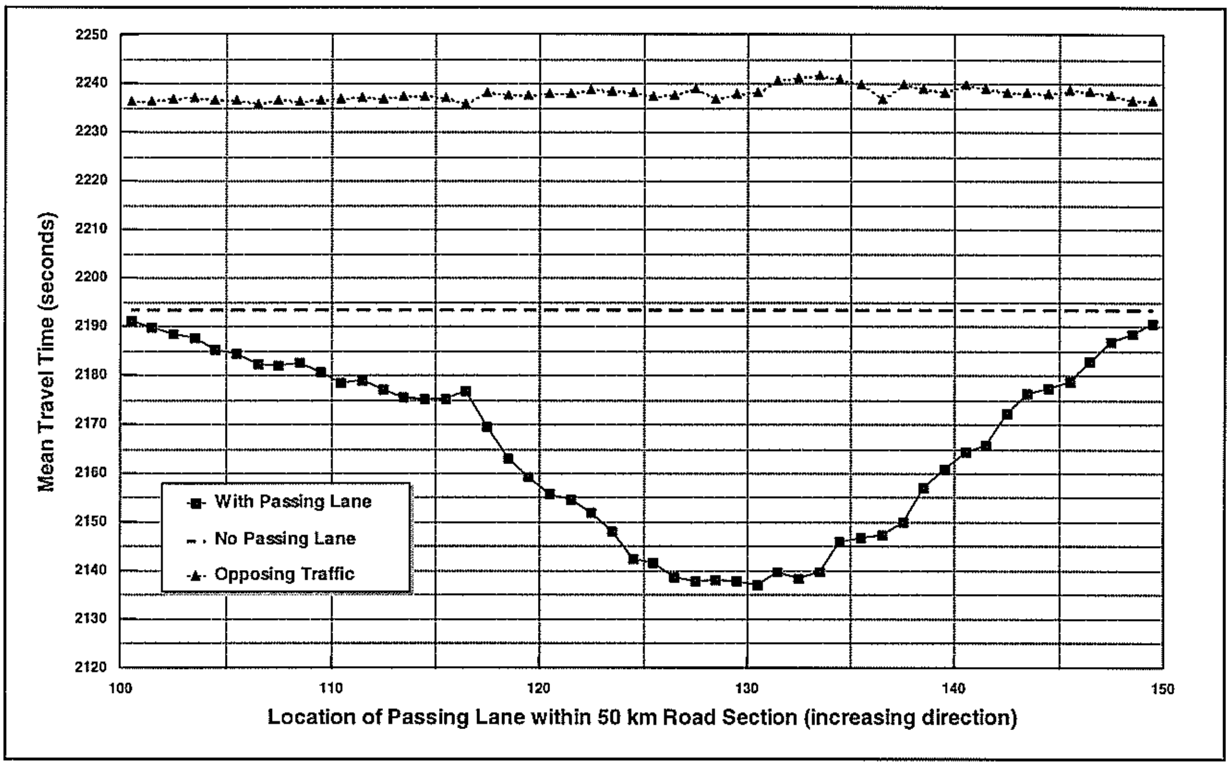
For the TRARR analysis, the existing road section (with no passing lanes) was compared against the same road with a 1 km passing lane (southbound). The passing lane was successively located at each kilometre along the road and the mean travel times for the entire road section noted. No special calibration was carried, since only the relative change in mean travel time was of interest and the accuracy was not essential.

For the simplified model, RGDAS data for the road section was set up in a simple spreadsheet and from this and other traffic data, the UPD at each point was derived. A simple one-stream model was used, with HCV and terrain information used to adjust the traffic flow as described in Section 2.2.3. Mean vehicle speeds were derived from the road geometry data using the RGDAS "advisory speed". From this the APD was determined along the highway. If it is assumed that the introduction of a passing lane will cause a marked reduction in UPD, then the relative OPD savings (and subsequently travel time savings) can be inferred from the resulting change in APD.

In both cases, 150 vehicles per hour (two-way) were used, with 12% HCVs. This is approximately equal to the average 1998 daytime (12 hour) traffic flow obtained from the telemetry site at route position 144 (north of the Hapuka River).

Figure 4.6 contains the mean travel time data (in both directions) from the TRARR analysis for different passing lane locations within the analysis length.

Figure 4.6 TRARR Mean Travel Time vs Passing Lane Location (SH1 north of Kaikoura).



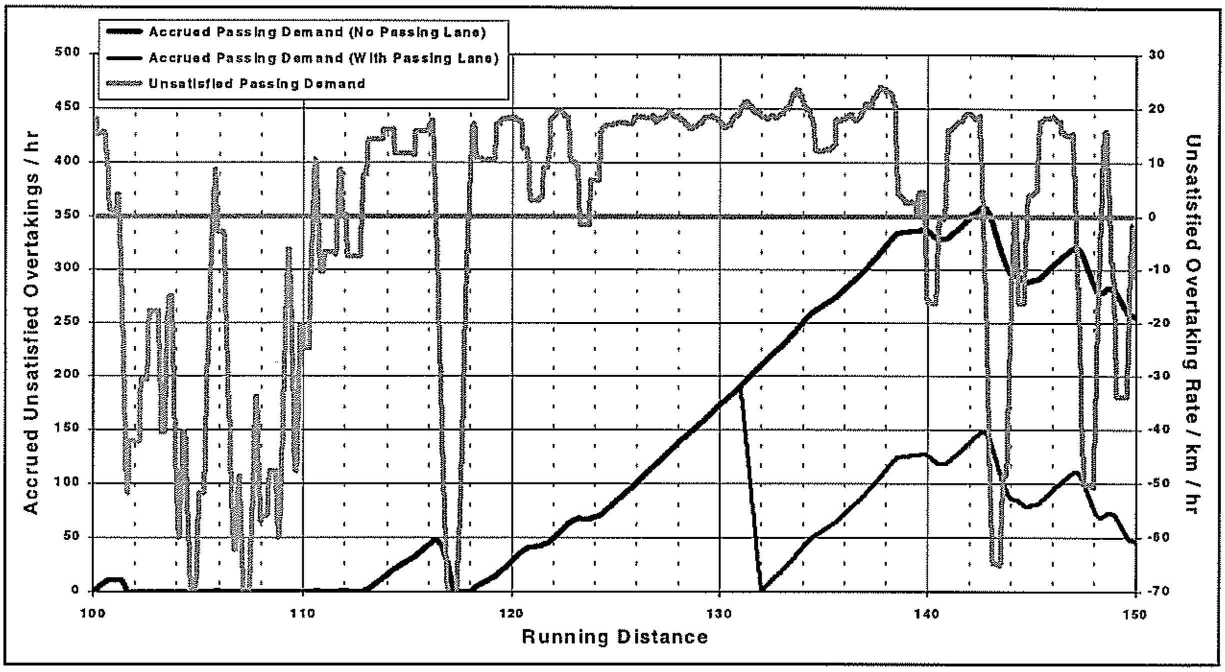
As expected, the mean travel time in the opposing direction is virtually unaffected by the presence or otherwise of a passing lane. By contrast, the mean travel times in the passing lane direction creep downwards as the passing lane is located nearer to the centre of the road section. This is a consequence of two factors which are incorporated in the passing demand model:

- In situations where there is an increasing UPD, a passing lane further along the road section will be able to eliminate a greater amount of previously accrued passing demand.
- Where the increased UPD continues beyond the passing lane, a passing lane earlier in the road section will be able to reduce overall passing demand for much further following the passing lane.

These two competing effects tend to optimise near the middle of the analysis section. Significant changes in UPD along the road section will however affect the actual location of the optimum point. In this case, the optimum location was at route position 131. It is also noticeable that the travel time savings did not reduce as quickly until beyond route position 117.

Figure 4.7 shows the resulting passing demand data using the conceptual model.

Figure 4.7 Accrued Passing Demand without Passing Lanes (SH1 north of Kaikoura).



The reason behind the initially slow travel times savings is evident here. Until route position 118, the UPDs were largely negative, indicating good existing passing opportunities. Beyond this there is a section of poorer alignment through to about route position 138, which results in increasing accrued passing demand. Another relatively "good" section follows, reducing the APD slightly.

The introduction of a passing lane at route position 131 (the optimal location from the TRARR analysis) considerably affects the overall passing demand. Since this location is considered the optimum in terms of travel time savings, it is logical to assume that the APD value will just reach zero at the end of the passing lane, maximising the difference in overall passing demand between the two options. To achieve this with the data used, a maximum passing supply of approximately 210 overtakings/veh/km was specified.

Note however that this analysis does not assume any existing APD at the start of the road section. Without additional field data it is hard to determine whether a starting value is likely, although the analysis could have been run further back to get an indication. Nevertheless, from a desktop study alone, the model appears promising.

By having the model set up in an automated spreadsheet, modification to both the maximum supply rate (previously estimated at 108 overtakings per km per hour) and the initial APD can be made very quickly to assess their effects on the outcome. Similarly, relocation of a proposed passing lane can also be done easily to assess the relative benefit or loss in doing so.

One aspect which hasn't been considered here is the cost of a passing lane relative to these benefits. As discussed previously, a simplified approach could be undertaken to categorise the route in terms of terrain and estimate a typical cost for any given point. A rough-order BCR could then be established.

At a site specific level, a more detailed approach, such as the two-stream unified model, is probably warranted. Using the conceptual model on individual passing lane sites will be evaluated in conjunction with the TRARR calibration task in Section 5.

4.3.1 Key Concerns with the Existing Model

As it stands, the conceptual model presented here appears to evaluate passing opportunities with relative simplicity (certainly compared to TRARR analysis) and reasonable accuracy. Some of the assumptions used are still debatable however, and would benefit from further investigation:

- The determination of already accrued passing demand at the start of an analysis length. The level of vehicle bunching would appear to provide the field data to enable this.
- The maximum practical passing supply. A value of 108 overtakings per km per hour was suggested, but some field studies are needed to ascertain optimum overtaking rates at existing passing lanes.
- The relative effects of more or less detail applied to various parts of the model is unclear. Certainly, if more simplification can be made in places without significant loss in accuracy, then this should be investigated.

4.4 Guidelines for Optimal Location of Passing Lanes

Although the above methods will enable a broad identification of the most suitable locations for passing lanes, these should be modified as appropriate by the following guidelines, to maximise the Benefit Cost Ratio:

- Avoid highway sections with significant intersections where possible (particularly those with right-turn bays).
- Avoid costly physical restraints, such as narrow bridges and culverts.
- Locate passing lanes leading away, rather than into, areas of traffic congestion (such as urban areas).
- Space series of passing lanes at regular intervals
- Consider using a greater number of shorter passing lanes rather than fewer passing lanes of a longer length.
- Locate passing lanes where possible on sections with no-overtaking lines to maximise the increase in net passing opportunities.

Practitioners should refer to chapter 9 of AUSTROADS (1993) for further information.

5. TRARR CALIBRATION

To achieve a greater level of accuracy when assessing the benefits of passing lanes, rural road simulation is still the ultimate resort. This is particularly so when there are complicating factors such as realignments involved. In New Zealand the predominant modelling package for assessing passing lanes is TRARR by ARRB Transport Research. Although the latest version is considerably easier to use than its predecessors, there is still a low level of understanding about the optimal way to use TRARR here in New Zealand.

In the Stage 1 study, Tate (1995) proposed two levels of simulation based modelling, "first order modelling" and "detailed modelling". The different data collection and model calibration requirements of these methods are outlined in Table 5.18.

The Stage 2 investigations will consider the degree to which the findings of the two TRARR modelling approaches replicate the actual "before and after" changes from field tests. The study will also assess the accuracy of the conceptual model, developed in Section 4. First order modelling will be utilised in the project, but enough survey data will be collected, so that detailed modelling can be undertaken if the results of the first order modelling do not provide a suitable level of agreement with the measured travel time savings at the surveyed sites.

For most passing lane projects, field data is collected during the investigation process to help estimate the expected benefits from construction of the project. However, there have been few studies to confirm the stated benefits using data collection after construction. One exception here in New Zealand was BCHF's (1989) work to review the actual benefits of two passing lanes constructed in southern Hawkes Bay. Although they found that the original project evaluation using TRARR had over-predicted the expected travel time savings, a subsequent reworking of the analysis, using more recent traffic data and a newer TRARR model, actually under-predicted the benefits. The results appeared to highlight the sensitivities of TRARR to using accurate field data.

Table 5.1 Data requirements for TRARR modelling.

Data Type	Data Source - First Order Modelling	Data Source - Detailed Modelling
Road Data	Obtained from RGDAS	Obtained from RGDAS
Vehicle Data	NZ standard file	NZ standard file
Traffic Data:		
Composition	NZ standard file	Measured
Mean Desired Speed	Modified to represent site speed measurements	Measured by vehicle classification
Std Deviation of Desired Speed	NZ standard file	Measured
%age HCV's	Measured	Measured (from Composition)
Platooning	As measured at start of modelled length	Measured at start of modelled section, at 1000 m intervals, and at beginning of proposed passing lane.
Settling Down Time	Sufficient to "fill" the road section and pass 200 vehicles before "observation" begins.	Sufficient to "fill" the road section and pass 200 vehicles before "observation" begins.
No. of Vehicles to be "Observed"	1000	To be tested by plotting the Do Nothing mean travel time for increasing numbers of observed vehicles using increments of 200 vehicles up to 3000 vehicles.
Calibration Spot Speeds	Nil	Check spot speeds at 1000 m intervals for each vehicle type.
Validation Process	Mean Desired Speeds altered to best replicate observed travel times.	- Use traffic count data to determine significantly different flow periods. Calibrate the model for one period and validate for the other. - Present details of modelled and predicted speeds and platooning for validation case.

5.1 Methodology

A list of passing lanes to be constructed over the 1997/98 construction season was obtained from Transit NZ regional offices. Requested details included location (route position), traffic volumes, and expected construction period (start date and completion date).

Because of the late supply of some information, a number of passing lanes were already under construction when the list of sites was reviewed. Some other proposed sites still had construction contracts to be confirmed, so it wasn't clear whether post-construction data would be available for the coming year. Of the remaining possible sites two were selected for further study. Both sites involved simple "tack-on" passing lanes, with one site providing new passing lanes in both directions. Table 5.2 details the two sites.

Table 5.2 Passing Lane Sites to be studied.

Site Name	**SH3 Bulls West**	**SH1s Herbert-Maheno**
Passing Lane(s) Location	RP 432 / 8.18-7.03 *(1150 m)*	RP 601 / 9.00-9.90 *(900 m)*, 601 / 8.80-8.00 *(800 m)*
Analysis Section	RP 432 / 0.00-9.80 *(9.80 km)*	RP 601 / 5.04-11.99 *(6.95 km)*
Pre-Construction Survey	14-21 Jan 1998	22-25 Jan 1998
Construction Period	Feb - end Jul 1998	end Jan - mid May 1998
Post-Construction Survey	15-21 Sep 1998	26 Jun 1998

At each site, the analysis lengths were chosen to provide a sufficient length downstream of the passing lanes. These were limited by the presence of nearby restricted speed areas (local townships).

At each site the following "before and after" data was collected:

- Traffic volumes in each direction, classified by vehicle type using an automated (e.g. VDDAS) traffic counter/classifier. At Bulls West, 7 days of data were collected (in 15 minute bins), while 3 days of individual vehicle data were collected at Herbert-Maheno.

- Vehicle bunching data. At Bulls West this involved automated traffic counters collecting headway data for approximately 24 hours. The counters were located at the start and end of the analysis section and at the start and end of the passing lane location. For Herbert-Maheno, visual surveys were undertaken at the start and end of the analysis section, for approximately three hours. These could be supplemented by the automatic traffic counter used to collect count and classification data, which also recorded headway information.

- Travel times recorded between analysis section end points using a floating car survey. At Bulls West, the start and end points of the passing lane and an intermediate downstream point were also used as stages.

Although there were differences in the exact data collected at each site, it should be sufficient in both cases to carry out our investigations. It will also enable a comparative assessment of the relative merits of various data collection techniques.

RGDAS data for the relevant sections were also extracted and sight distances derived, to be used as an input for TRARR ROAD file construction. The sight distance data was also used as an input into the simplified conceptual model.

5.1.1 Comparison between Methods

The key assessment of the relative merits of each analysis approach will be a comparison of the measured or calculated travel time savings. In particular, the amount of effort required to get each model to closely replicate the field data will be examined. The other measures, such as proportion of bunching and vehicle speeds, will be used as necessary to "fine tune" the models.

The conceptual model assesses benefits somewhat differently than TRARR. In the former case, the amount of passing demand saved (in terms of overtakings per hour) is calculated and then multiplied by the average estimated time lost due to following. In TRARR, the change in mean travel time per vehicle is determined. In both cases however, an assessment of the overall time saving to the traffic stream can then be made and compared with the actual travel time data.

5.2 Results

To compare the findings, the results are presented in three sections:

- The actual field data for both sites before and after
- The conceptual model results using a two-stream unified passing analysis
- Simple TRARR analysis

5.2.1 Actual Field Data

In theory, actual field data collected on site before and after construction of a passing lane should establish the "true" benefits of the improved passing opportunity. The findings however depend on how representative the data is in reflecting the traffic conditions at the site. Because of time and cost constraints, the collected data may only be partially successful in doing this.

Table 5.3 sets out the key data obtained from the Bulls West site, both prior to and following construction.

Table 5.3 Bulls West Passing Lane Field Data

(Increasing Dirn is SE)	Before		After	
	Incr Dirn	Decr Dirn	Incr Dirn	Decr Dirn (PL)
AADT (one-way)	1815	1895	2013	2070
%HCVs	14.4%	12.0%	13.3%	15.9%
Mean Travel Time (secs)	339.6±17.3 (8 vehs)	366.3±21.2 (7 vehs)	369.1±23.6 (10 vehs)	347.6±11.7 (10 vehs)
% Bunching				
432/0.00	25.6%	25.6%	26.7%	14.5%
(end PL) 432/7.03	28.6%	26.6%	29.8%	20.2%
(start PL) 432/8.18	29.7%	24.1%	29.0%	N/A
432/9.80	29.9%	21.1%	30.8%	26.0%

The mean travel times are presented with their 95% confidence intervals. The relatively small samples of travel time surveys gave large variations in before and after travel times. This appeared to be particularly sensitive to the proportion of slow-moving vehicles (e.g. trucks) followed in the survey. Differences in traffic volume, due to varying survey times can also play a part. Nevertheless, despite travel times in the direction opposing the passing lane increasing after construction, there was a good reduction in times travelling in the passing lane direction.

This is also reflected in the bunching data (unfortunately equipment damage eliminated one set of data). Whereas traffic in the opposing direction showed no real change in bunching patterns, there was a clear reduction in bunching at the end of the passing lane following construction. Interestingly the bunching continued to decrease further some distance beyond the passing lane too. This is also in spite of slightly increased traffic volumes in the latter surveys.

If the absolute time savings in the passing lane direction (18.7 s) are applied to the annual traffic volume (one-way), an annual travel time saving of 3925 hours is achieved. If the savings are taken relative also to the change in opposing travel times, then the savings are even greater. However, it is probable that time periods with low traffic volumes are not experiencing the same benefits as measured above. Inspection of the 24 hour count data would suggest that no more than 90% of the daily traffic will observe significant travel time savings, or about 3532 hrs of savings annually.

Table 5.4 sets out the key data obtained from the Herbert-Maheno site.

Table 5.4 Herbert-Maheno Passing Lane Field Data

(Increasing Dirn is Sth)	Before		After	
	Incr Dirn	Decr Dirn	Incr Dirn (PL)	Decr Dirn (PL)
AADT (one-way)	1793	1843	N/A	N/A
%HCVs	12.1%	13.0%	N/A	N/A
Mean Travel Time (secs)	272.3±14.8 (12 vehs)	253.4±13.5 (12 vehs)	262.8±15.6 (13 vehs)	250.3±10.3 (10 vehs)
% Bunching				
601/6.00	37.4%	55.0%	21.5%	29.8%
601/11.99	33.9%	29.1%	20.4%	34.7%

In this case, the presence of opposing passing lanes would be expected to provide benefits in both directions. The travel time surveys appear to indicate this, although the savings of 9.5 s and 3.1 s respectively are not particularly large. The change in bunching in the decreasing direction also indicates an improvement, but there is no clear change in the increasing direction, despite a reduction in the actual bunching. The bunching samples in this case were only taken over 3 hours of surveying, as opposed to the 24 hour automated recorders at Bulls.

Using the above travel time savings the annual benefits are calculated as 1959 hours per year (1467 southbound & 492 northbound). This assumes that only 85% of the daily traffic will experience the measured travel time savings (as determined from the 24 hr counts).

5.2.2 Conceptual Model Analysis

The analysis lengths were modelled using a two-stream unified passing model, as described in Section 4. Vehicle speed data was obtained from the field data, and RGDAS data was used to determine the available sight distance. Bunching data was used to determine the initial "accrued passing demand" (APD) by multiplying the one-way hourly traffic volume by the percentage following (this is thought to be a lower bound). By comparing the overall time delayed between the "do minimum" and "passing lane" cases, the overall travel time saved could be determined. Details of the analysis calculations are found in Appendix A.10.

The Bulls West analysis was carried out using two time periods: 300 veh/hr for 5 hrs and 210 veh/hr for 8 hrs. This totals 3180vpd, or about 86% of the AADT. The annual travel time savings were calculated to be 1270 hrs. This is considerably less than the value derived from field data alone, and represents an average time saving to the affected traffic of about 7.9 seconds per vehicle.

Assuming that the field data was correct, this points to a fault in the underlying assumptions used in the conceptual model. One possibility is that the initial APD is understated, because of multiple-vehicle overtaking demand. Doubling the initial APD values used above, for example, produces a new savings figure of 1980 hrs, still somewhat less than the field data however. Another uncertainty identified in Section 4 was the maximum value for passing supply. The model here used a value of 108 overtakings/km/hr. Experimentation with this value, however found that (in this case at least) it was actually near the optimal value. Inspection of the details in Appendix A.10 finds that, following the passing lane, the APD has fallen to zero, yet field data still indicates bunching of about 20%. This suggests that in fact the maximum passing supply value may in fact be too great.

The sensitivity to some of the traffic and road parameters used was also considered. Increasing the car mean speeds by 1 km/h and decreasing the truck mean speeds by 1 km/h produced negligible change. However, adjusting the mean free and following speeds by the same margin increased the savings by almost 30%. Similarly, increasing the hourly traffic volumes by 10% resulted in a 23% increase in savings. Reducing the available passing sight distance proportions by 0.05 produced a smaller increase of 13%. Note that the magnitude of these changes may not be similar in every situation, but they do serve to illustrate some of the potential sources of error in the conceptual model.

The variations also highlight one of the key features of the conceptual model: within each traffic flow and road section used, the traffic and road parameters are considered to be constant. In reality there would be more variation expected, both throughout the day and along the road. It is often these extremes of variation that provide the greatest potential for passing lane savings. For example, in the above model only two "average" traffic volumes were modelled, including 300 veh/hr. However the effect of an actual hour with, say, 330 veh/hr may not necessarily be balanced by another hour with 270 veh/hr. The evidence above suggests that travel time savings may be underestimated when data is aggregated at a fairly broad level.

The Herbert-Maheno analysis also used two time periods: 250 veh/hr for 10 hrs and 150 veh/hr for 4 hrs. This totals 3100vpd, or about 85% of the AADT. In this case, the annual savings were 1211 hrs (680 southbound and 531 northbound), savings per vehicle of 4.3 s and 3.4 s respectively. Although the northbound findings are similar to the field data results, the southbound savings are considerably understated. Sensitivity testing was not carried out on this analysis.

Because of the presence of two passing lanes in this case, two separate directional analyses were undertaken and the benefits simply summed together. These effectively treat the benefits of each passing lane in isolation. Whether the combined benefits are the same as the sum of the individual benefits is unclear.

5.2.3 First Order TRARR Analysis

The two study sites were modelled using a simple TRARR analysis of approximately 1000 vehicles. Initial bunching was set to the level found by the field surveys. Modelled travel times were calibrated to approximate the measured pre-construction field data. No within-trip calibration of speeds or bunching was undertaken. The rate of change in TRARR speeds was then applied back to the measured pre-construction speeds to determine the post-construction speeds and savings were calculated. Details of the TRARR input and out files are contained in Appendix A.11.

As with the conceptual model analysis, two time periods were used for Bulls West: 300 veh/hr for 5 hrs and 210 veh/hr for 8 hrs. The TRARR analysis resulted in northbound travel times of 96.3-96.8% of previous, with negligible change in southbound times. This translated into savings of 11-13 s, and annual travel time benefits calculated were therefore 2036 hrs. This is rather less than the measured travel time savings, although the field data was subject to considerable potential error.

The Herbert-Maheno analysis also used the same two time periods as before: 250 veh/hr for 10 hrs and 150 veh/hr for 4 hrs. The TRARR analysis resulted in travel times of 96.3-98.0% and 97.5-99.0% of previous, for southbound and northbound traffic respectively. This translated into savings of 6-9 s and 3-6 s for the two directions. The annual travel time benefits calculated were 2462 hrs (1476 southbound & 986 northbound). The southbound savings are very similar to the measured findings, but there are virtually double the expected savings in the northbound direction.

It may be possible to adjust the TRARR road model to better match the field bunching data. For example, prior to passing lane construction, the proportion of bunching at the four survey points at Bulls West in the decreasing direction (see Table 5.3) were 21.1, 24.1, 26.6, and 25.6% respectively. The equivalent TRARR points at 210 veh/hr (see Appendix A.11) were 20.7, 19.7, 26.4, and 35.9%. This would suggest that the first section of the modelled analysis length is currently not constrained enough in terms of passing opportunities (hence the slight fall in bunching), while the latter section is too constrained (hence the notable rise). How this would affect the overall travel time savings is not clear.

5.3 Discussion

The field data for travel time savings was hampered by lack of sufficient sample sizes. This made the findings more dependent on the presence of unusually fast or slow vehicles, or the traffic volume at the time of survey. The nature of floating car surveys means that it takes some time to collect a sufficiently large sample. Their strength would appear to lie more in their ability to collect within-trip breakdowns of travel times. Instead, number plate surveys would allow a much larger sample of vehicles to be collected over an equivalent survey period. Assuming that there are few intermediate turn-off points, the matching rate between the ends should be relatively good.

The proposed conceptual model generally appears to underestimate the travel time savings from providing passing lanes. As discussed, this may be partly a result of the initial APD being incorrectly specified. To counter this problem, the use of an analysis length starting from the nearest previous passing opportunity available is advised. In terms of project evaluation, it is preferable for the method to understate the benefits, as there will be more confidence that projects identified using this approach will in fact have a high enough "true" BCR.

The simple "first order" TRARR analysis also appeared to underestimate the measured benefits, although it did appear to be more accurate than the conceptual model. Given the possible error in the available measured data, the TRARR findings may in fact be more correct than at first glance. Again, for quick project evaluation, simple TRARR analysis would appear to be safe in not overstating benefits.

Some of the potential source of error in these approaches appears to be the use of broad averaging, particularly of traffic volumes, to simplify the analysis. This dampens the influence of the extreme values, which may be the source of the most benefits. While simplification is desirable to keep costs down, it may be feasible to model the traffic effect better using some additional preliminary analysis.

The traffic data collection equipment available these days allows the collection of classification, speed, and headway data for individual vehicles with sufficient accuracy. Analysis of this data enables the effect of traffic flow on these parameters to be better determined. For example, at low volumes during the night , the proportion of HCVs is often a large component of the traffic stream compared with daytime. Similarly, the proportion of bunching is inevitably positively correlated to the traffic flow. By making use of the data available from modern counters, a more realistic set of TRARR or conceptual model inputs could be determined, rather than using the same "average" parameters for all traffic flows.

In the same way, the TRARR or conceptual model outputs themselves could also be directly related to the traffic volumes. Experience suggests that travel time savings per vehicle increase with increasing traffic volumes, but at an ever decreasing rate. This effect could perhaps be modelled by a logarithmic or negative exponential relationship. By modelling a wide range of traffic volumes, rather than just selecting volumes based on the existing traffic distribution, such a relationship could be determined and applied to any given volume. For example the relationship could be integrated over the actual annual hourly volume distribution at the site, including its extremes. This has particular benefits when evaluating future travel time savings using TRARR. Linear future traffic growth may not produce linear travel time savings, and this can be established using a relationship derived above.

6. CONCLUSIONS

6.1 Driver Frustration

- Survey findings confirmed that people become significantly more frustrated on roads with lower proportions of available sight distances. However this did not translate into a significant difference in willingness to pay.

- Drivers who preferred to travel quickly relative to others or reported passing more often were significantly more likely to become frustrated. This finding is supported by the similar finding that drivers who drove higher powered cars were more likely to become frustrated.

- The results suggest that people who travel slowly appreciate having somewhere to pull over to let people past. It is apparent that the survey's frustration measure did not measure this type of frustration. Therefore it would be beneficial in future research to differentiate between these types of frustration, i.e. ability to pass and ability to *be* passed.

- Travellers on short sections of road were willing to pay higher amounts per km for improved passing opportunities than on longer routes. However this may be a consequence of people perceiving their overall trip costs similarly, regardless of length, so that the costs will be spread out more over a longer route.

- People who travelled on the same road frequently were more likely to become frustrated. People were also able to accurately predict ahead of the journey the extent to which they would be frustrated.

- An average willingness to pay for passing lanes was calculated as between 3.2 and 3.7 cents per vehicle per kilometre of constructed passing lane.

- Although there was a statistically significant relationship between Unsatisfied Passing Demand (UPD) and Willingness To Pay (WTP), it was not considered suitably robust to apply different WTP values for different road and traffic situations. Therefore an average value of approximately 3.5 cents per vehicle per kilometre is suggested as an additional benefit to be applied to BCR calculations.

- Further work is needed to identify the significance of UPD and its components of traffic flow and sight distance on frustration and WTP. This will enable identification using UPD of road sections in most need of passing opportunities. Using readily available highway data, a relatively simple filtering tool for identifying likely road sections could be developed.

6.2 Safety Benefits

- Typical mid-block injury crash rates for three or four-lane rural highway sections in New Zealand were found to be on average **25%** lower than the equivalent two-lane crash rates. No additional trends in terms of AADT or terrain could be identified. Where a realignment is being considered in conjunction with a passing lane, then the use of the typical crash rates given in Table 3.1 is considered the best solution for both the two-lane and three/four-lane sections of the new alignment.

- A detailed passing lane crash study found a 13% reduction in crash rates after the construction of a passing lane. This included crashes up to 2 km prior to and 10 km following the passing lane, where appropriate. This is fairly evenly split between the two directions of travel: 11% in the same direction as the passing lane, 15% in the opposing direction. Crash reduction was more significant for passing lanes that involved full realignments than for "tack-on" passing lanes (54% compared to 5%).

- In terms of crash type, the rate of "Lost-Control" crashes increased significantly (15% for tack-on passing lanes) while "Overtaking" and "Head-On" crashes were dramatically reduced (38% and 62% respectively). "Rear-End/Obstruction" crashes also decreased by 15%. The high proportion of "Lost-Control" crashes explains to a large extent why overall crash reductions for tack-on passing lanes are relatively low (6%).

- The effect passing lanes have on crash rates varies to a large extent with position relative to the passing lane. When all passing lane types are analysed, there are crash reductions in four of the first five 2 km zones downstream, the 2 km zone upstream, and within the passing lane itself. The only region where crash rates increased was between 0-2 km downstream. This may be a result of merge area problems and higher speeds following the passing lane.

  For tack-on passing lanes only, some of the crash rates increased, including immediately downstream of the passing lane. However, in the same direction as the passing lane, the crash rate was reduced upstream (by 9%) and in the passing lane itself (21%). There appear to therefore be benefits in advance signing of passing lanes.

- The severity of crashes in the same direction as the passing lane reduced by 15% overall after passing lane construction. For tack-on passing lanes however, this was negated by an increase of severity in opposing direction crashes. This suggests that severity reductions arise primarily from any associated geometric improvements.

- The most significant crash reductions occurred for passing lanes less than 800m long (approximately 25% for both tack-on and all passing lanes). Crash rates for 1200-1500m long passing lanes actually increased, by approximately 20-30%.

- Passing lanes reduced crash rates for all traffic volumes except for AADTs of 4500-6000, although these sites still had the lowest crash rates both before and after. No clear relationship between traffic volume and crash reduction emerged.

- No pattern could be found between passing lane construction date and change in crash rate. This may be because the passing lanes investigated in this study were all constructed between 1985 and 1993, which is largely before the introduction of formal safety audits by Transit New Zealand. It would be interesting in future to review what changes in crash rate occur with more recent (safety-audited) passing lanes.

6.3 Optimal Location of Passing Lanes

- A simplified model for assessing the optimum location of passing lanes has been developed as part of this study. This model requires less input data and analysis time than TRARR and can be used as a "first sieve" analysis tool to determine the need for passing lanes. The model has been formulated so that input data is readily available for State Highways.

  The model is based on comparing the supply of and demand for passing opportunities along a route. Passing lane supply is calculated from road geometry data, opposing traffic volume and travel speeds, while demand depends primarily on speed differentials (cars v trucks) and traffic volume. Further research is required to refine the relationships between the various input parameters and to assess if the assumptions behind the model are appropriate.

6.4 TRARR Calibration

- Mass data-collection techniques, such as number plate surveys, are recommended for the sampling of overall travel times when calibrating a TRARR model. This may be supplemented by a small number of floating car surveys (at least six in each direction) to ascertain the within-trip speed variations.

- Both the conceptual model as it stands and simple "first order" TRARR analysis (to a lesser degree) appear to underestimate actual travel time benefits derived from passing lanes. This may be a consequence of the use of broad "averaging" for a number of input parameters, which does not reflect the extreme values where often the most benefits occur.

- The values for travel time savings using the conceptual model appear to be particularly sensitive to (i.e more than directly proportional to) the difference in free/following vehicle speed and traffic volumes. Changes in the proportion of available passing sight distance and the initial accrued passing demand (APD) also have a notable effect on savings.

- With the availability today of traffic counters that can collect highly detailed individual vehicle data, it seems possible to determine how key inputs, such as bunching and proportion of HCVs, are affected by traffic volume. This will enable more precise specification of these parameters, rather than using simple average values throughout. The outputs from the resulting TRARR or conceptual model outputs could also be related directly to traffic volume to allow for more precise calculation of the benefits.

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A. APPENDICES

A.1 Scenarios used in Pilot Surveys

Please read the following scenarios.

*Please remember that the scenarios below are **fictional**, and are **not** being proposed.*

1. Imagine you have two route choices. You may take the road you have just travelled or you may take an alternative route. This alternative route is exactly the same in every regard to the one you have just travelled on, except that it has passing lanes the whole way (therefore, depending on your speed, you may be able to save time). However if you choose to use this road you will have to pay (this will not require you to stop your vehicle or slow down).

    a. Would you prefer to take the alternative route?

    Yes ☐

    No ☐

    b. What is the maximum amount you would be willing to pay to take the alternative route?

    ____

2. Again you have two route choices; the one you have just travelled on or an alternative route. This alternative route has passing lanes the whole way, which will enable you to travel at your **desired** speed. The alternative route is a little longer in distance than the one you have just travelled on (in all other ways the route is identical). Because of this difference in distance, it is likely that you will reach your destination at approximately **the same time**, on both routes.

    You will also need to pay for the use of this alternative route, as in the previous scenario.

    a. Would you prefer to take the alternative route?

    Yes ☐

    No ☐

    b. What is the maximum amount you would be willing to pay to take the alternative route?

    ____

A.2 Example of Final Driver Frustration Survey

(Each survey differed in the list of road sections provided)

PASSING OPPORTUNITIES SURVEY

Kaikoura Survey

Opus Central Laboratories is currently undertaking a Research Project concerned with drivers perceptions of State Highways in New Zealand. The questions should only take you a few minutes to answer and will help the national roads funding authority, Transfund NZ to evaluate priorities for improving the NZ road system.

Thankyou again for agreeing to help with our survey.

All completed surveys go into a draw to win **$50** worth of petrol vouchers. Winners will be notified by phone or mail.

Instructions:
The questionnaire should be filled out at the **completion** of your journey, and should be mailed back to us as soon as possible in the prepaid, self-addressed envelope we have given you.

It would help you to read the questions in the first half of the survey before you commence your trip. This will ensure that you can easily answer the questions **at the completion** your trip.

Please remember that all your answers will be treated as **confidential**. Your name will not be connected to the survey questionnaire. We do however require a name and address/phone number, if you would like to enter the draw for the petrol vouchers. As soon as we receive your questionnaire we will separate this form from the questionnaire, in order to assure confidentiality.

The road section you have indicated you are travelling on in the next couple of days is:
(Please choose one route).

SH 1.	Kaikoura - Blenheim	☐
SH 1.	Kaikoura - Amberly or SH7 turnoff	☐

It is important to remember that we are only interested in **one** of these sections of road, so please do not fill out the questionnaire in regards to any other road sections.

Your general expectation of this route, in terms of passing opportunities, is...

- Terrible ☐
- Poor ☐
- Neutral ☐
- Good ☐
- Excellent ☐
- I have no idea what it will be like ☐

If you have any queries/comments please do not hesitate to contact us.

Survey Organiser:

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SECTION 1: DRIVER IMPRESSIONS

The following Questions are to be answered at the completion of your journey

1. Please describe the weather conditions today along this section of road:
   (Choose 1 from each category)

Category 1: Wetness		Category 2: Wind	
No rain	☐	Calm	☐
Some rain	☐	Breezy	☐
Mostly raining	☐	Very Windy	☐

2. Would you say the traffic flow on the section you travelled was:

Very low	☐
Low	☐
Moderate	☐
Heavy	☐
Very Heavy	☐

3. What was the general speed of the traffic along the route?

<70km/h	☐
70-80km/h	☐
80-90km/h	☐
90-100km/h	☐
100-110km/h	☐
>110km/h	☐

4. How (un)satisfied were you with the overall speed of the traffic?
   (Please mark the line, at the point which best represents your level of satisfaction)

Unsatisfied |————————————————————| Satisfied

5. Please choose the sentence which best represents your speed relative to other vehicles on this route:

   A lot of vehicles passed mine, but I did not pass many ☐

   I was passed by a few more vehicles than I passed ☐

   I passed as many vehicles as passed me ☐

   I passed a few more vehicles than I was passed by ☐

   I passed far more vehicles than passed me ☐

6. Please indicate on the line below the extent to which you feel you were impeded or not, by other vehicles on the road.

   Always Held Up |————————————————————| Never Held Up

7. How many vehicles did you follow that you would have liked to have passed, but weren't able to pass immediately?

   ____

   7a. If you answered 1 or more to question 7, how much **time** do you think you lost by being held up by these vehicles?

   ____

8. How (un)satisfied were you with the available passing opportunities and/or lack of them?

   Satisfied |————————————————————| Unsatisfied

9. In terms of passing opportunities, how frustrated or annoyed were you driving this particular route compared with other routes you have taken in the past?

   Not at all frustrated/annoyed |————————————————————| Very Frustrated/ Annoyed

Please read the following scenarios.

*Please remember that the scenarios below are **fictional**, and are **not** being proposed.*

1. You have two route choices; the one you have just travelled or an alternative route. The alternative route is very similar to the one you have just taken, except it has passing lanes the whole way. However even with the passing lanes the trip will take longer.
   If you were to take the alternative route what is the **maximum** amount of extra time you would be willing to accept in order to have access to passing lanes the whole distance of your trip?

   0 ☐

   0 - 2½ mins ☐

   2½ - 5 mins ☐

   5 - 7½ mins ☐

   7½ - 10 mins ☐

   10 - 15 mins ☐

   15 mins + ☐

2. Again you have two route choices; the one you have just travelled on or an alternative route. The alternative route is exactly the same in every regard to the one you have just travelled except it is a little longer and has passing lanes the whole way. Depending on the distance, you may be able to get there faster.
   If you took the alternative route how much further would you be prepared to travel?
   (Please answer the question with regard to the route you travelled today and the distance of this route. Kaikoura - Blenheim=129km, Kaikoura - Amberley=141km).

   0 ☐

   0 - 1 km ☐

   1 - 2 km ☐

   2 - 3 km ☐

   3 - 5 km ☐

   5 - 7 km ☐

   7 - 10 km ☐

   10 - 15 km ☐

   15 - 20 km ☐

SECTION 2: BACKGROUND INFORMATION

In order to put your views into context, we need some background information.

A. Trip Details

1. From where did you begin your trip today?

____

2. What was your destination on this trip?

____

3. What type of vehicle were you driving?
   Please give:
   1. vehicle type eg: utility; car; motorcycle etc
   2. cc rating
   3. any extras eg: fuel injection; turbo etc

____

____

4. What was your trip purpose?

   Visiting Friends/Family ☐

   Recreation/Leisure ☐

   Work-related ☐

   Other______________________

5. How often do you travel on this stretch of road?
   (Choose the answer which best describes your travel patterns).

   Daily ☐

   > Once a week ☐

   Once a week - Once a month ☐

   Once a month - Once a year ☐

   Once a year - Once every two years ☐

   < Once every two years ☐

   This will be the first time ☐

B. Driver Characteristics

6. To what age group do you belong?

   25 yrs or under ☐

   26 - 40 ☐

   41 - 60 ☐

   60+ ☐

7. Are you:

   Female? ☐

   Male? ☐

8. Are you a New Zealand resident?

   Yes ☐

   No ☐

   a. If you are a New Zealander do you live in a:

   major city ☐

   large town/small city ☐

   town ☐

   very small town/outskirts of town ☐

   rural area ☐

   b. If you are from overseas, what country are you from?

   ____

9. How would you describe your normal driving behaviour?

   Leisurely ☐

   Leisurely/moderate mix ☐

   Moderate ☐

   Aggressive/moderate mix ☐

   Aggressive ☐

10. What speeds do you usually prefer to travel at, on straight stretches of road in 100km/hr zones?

<70km/h ☐

70 - 80km/h ☐

80 - 90km/h ☐

90 - 100km/h ☐

100 - 110km/h ☐

>110km/h ☐

Thank you for completing the questionnaire.

Information for Draw

You will need to provide the following information in order to enter the draw for the $50 worth of petrol vouchers.
(This information will be separated from the survey)

Name: ______________________________

Address: ______________________________

____

and/or

Phone Number: ____________________

A.3 Summary of Driver Frustration Survey Results

		PRE Q A	PRE Q B		S1Q1A	S1Q1B	S1Q2		S1Q3	S1Q4	S1Q5		S1Q6	S1Q7	S1Q7A			S1Q8	S1Q9	SC1	SC2	S2Q1	S2Q2	S2Q3		S2Q4	S2Q5		S2Q6	S2Q7	S2Q8	S2Q8B	S2Q9		S2Q10
COMMENT	SURVNO	SECTION	EXPECTN	XVALUE	WETNESS	WIND	TRAFFLOW	TVALUE	TRAFSPD	SAT-SPD	RELSPD	RVALUE	SAT-IMPD	VEHNOPASS	TIMENOPASS	SECTTIME	PCTSECT	SAT-PASSOP	FRSTH-OTH	XTRATIME	XTRADIST	TRIPFROM	TRIPDEST	VEHTYPE	VEH	TRIPPURP	TRIPFREQ	FVALUE	DRVRAGE	DRVRSEX	DRVRLOCN	OSLOCN	DRVRSTYL	BVALUE	DRVRSPD
	AS1	CHCH-ASH	N	0	D	B	M	3	100	54	N	0	50	6	20	46	43.9%	53	65	8.75	4	ASHBURTON	CHRISTCHURCH	CAR	CAR	VF	1W-1M	4	41	M	LT		M	3	105
	AS10	CHCH-ASH	G	1	D	B	M	3	95	5	1S	-1	5	2	1	48	2.1%	5	0	8.75	4	ASHBURTON	CHRISTCHURCH	CAR	CAR	VF	1W-1M	4	60	M	T		M	3	105
	AS11	CHCH-ASH	G	1		W	M	3	95	10	1F	1	31	3	10	48	20.8%	73	39	12.5	8.5	ASHBURTON	CHRISTCHURCH	CAR	CAR	RL	1W-1M	4	26	F	T		M	3	105
	AS12	ASH-TIM	P	-1	D	C	M	3	95	33	2F	2	87	40	30	53	56.5%	99	43	6.25	8.5	CHRISTCHURCH	DUNEDIN	CAR	CAR	RL	FT	0	60	M	OS	USA	AM	4	105
	AS13	CHCH-ASH	G	1	D	B	M	3	105	0	N	0	52	5	25	43	57.6%	57	22	8.75	8.5	ASHBURTON	CHRISTCHURCH	CAR, 1800, TURBO, INJ, 4WD	CAR	RL	1W-1M	4	25	F	T		M	3	105
	AS14	CHCH-ASH	P	-1	D	C	M	3	85	51	N	0	63	4	20	54	37.3%	68	65	12.5	17.5	TIMARU	CHRISTCHURCH	CAR	CAR	WR	1Y-2Y	2	41	F	OS	USA	M	3	105
	AS15	ASH-TIM	P	-1	D	C	H	4	105	33	2S	-2	54	3		48	0.0%	66	71	8.75	4	ASHBURTON	TIMARU	CAR, 2600, INJ	CAR	RL	1M-1Y	3	26	F	R		M	3	105
	AS16	CHCH-ASH	P	-1	D	C	M	3	95	17	N	0	14	10	10	48	20.8%	80	78	8.75	8.5	CHRISTCHURCH	CLANDY BAY	CAR, 3L	CAR2	WR	1M-1Y	3	26	M	MC		M	3	105
	AS17	ASH-TIM	G	1	D	B	M	3	105	31	1S	-1	30	9	10	48	20.8%	21	33	12.5	8.5	CHRISTCHURCH	ASHBURTON	CAR, 3.8, INJ	CAR2	WR	1W	5	41	M	MC		M	3	95
	AS18	CHCH-ASH	T	-2	D	B	M	3	105	54	1F	1	79	14	12.5	43	28.8%	88	93	12.5	8.5	ASHBURTON	CHRISTCHURCH	TELSTAR, 3000	CAR2	VF	1W-1M	4	26	M	R		M	3	105
	AS19	ASH-TIM	G	1	D	B	M	3	105	3	1S	-1	16	1	5	48	10.4%	51	27	12.5	8.5	TIMARU	AKAROA	CAR, FUEL INJ, 2.8	CAR2	RL	1M-1Y	3	41	M	LT		M	3	105
	AS2	CHCH-ASH	E	2	D	B	M	3	105	70	1S	-1	52	5	4.5	43	10.4%	9	8	6.25	4							0	41	M	T		M	3	95
	AS20	CHCH-ASH	G	1	D	C	L	2	95	2	N	0	4	0		48	0.0%	4	5	3.75	8.5	CHRISTCHURCH	LAKE TEKAPO	SALOON CAR	CAR	RL	FT	0	41	M	OS	H.KONG, UK	M	3	105
	AS21	CHCH-ASH	G	1		B	L	2	95	13	2S	-2	23	6	7.5	48	15.6%	5	6	6.25	2.5	ASHBURTON	CHRISTCHURCH	CAR	CAR	WR	1M-1Y	3	41	F	T		M	3	95
	AS22	ASH-TIM	G	1	D	B	M	3	105	36	2S	-2	17	2	1.5	48	3.1%	65	20	12.5	8.5	ASHBURTON	TEMUKA	SWAGON	CAR	RL	1M-1Y	3	60	M	VS		L	1	95
	AS23	ASH-TIM	T	-2	D	B	H	4	115	95	2S	-2	10	1	5	44	11.4%	89	43	12.5	12.5	RAKAIA	OAMARU	CAR, 1600	CAR	VF	1W-1M	4	26	F	MC		M	3	90
	AS24	ASH-TIM	P	-1	D	B	M	3	115	49	2S	-2	24	0		44	0.0%	72	46			ASHBURTON	TIMARU	CAR, 1600, TWIN CAM	CAR	RL	1W-1M	4						3	105
	AS25	CHCH-ASH	G	1	D	W	M	3	105	3	1S	-1	13	1	5	43	11.5%	8	0	17.5	8.5	OTEMATATA	CHRISTCHURCH	ISUZU, 2.8 TURBO, INTERCOOLER	CAR2	RL	1W-1M	4	41	M	MC		LM	2	105
	AS26	CHCH-ASH	P	-1	D	C	H	4	75	82	N	0	84	15	10	61	16.4%	75	63	8.75	8.5	ASHBURTON	CHRISTCHURCH	CAR, 1350	CAR0	WR	1W-1M	4	41	F	T		M	3	105
	AS27	CHCH-ASH	N	0	D	C	M	3	105	7	1S	-1	7	0		43	0.0%	80	10	12.5	2.5	RAKAIA	ASHBURTON	CAR, 2L, TURBO	CAR	RL	1W	5	60	M	VS		LM	2	95
	AS28	ASH-TIM	P	-1	D	B	H	4	105	34	25	0	33	7	5	48	10.4%	93	72	6.25	4	HINDS	SEADOWN	LARGE TRUCK TRAILER	HCV	WR	D	6	41	M	R		M	3	95
	AS29	CHCH-ASH	G	1	D	C	H	4	95	58	2F	2	74	6	5	48	10.4%	57	61			ASHBURTON	CHRISTCHURCH	CAR, 1600, INJ, TURBO, DOHC	CAR	RL	1W-1M	4	25	M	T		AM	4	115
	AS3	ASH-TIM	P	-1	D	B	L	2	85	53	1F	1	66	5	25	59	42.2%	82	57	1.25	4	RAKAIA	TIMARU	CAR, 1300	CAR0	VF	1W-1M	4	60	M	VS		AM	4	105
	AS30	ASH-TIM	G	1	D	B	M	3	105	29	1S	-1	40	4	20	48	41.7%	34	16	12.5	17.5	CHRISTCHURCH	TIMARU	VAN, 2000	CAR	WR	1M-1Y	3	25	M	R		M	3	115
	AS31	CHCH-ASH	G	1	D	C	L	2	95	26	25	0	15	3	2	48	4.2%	34	3	12.5	17.5	CHRISTCHURCH	DUNEDIN	TRUCK, TRAILER, 2.8	HCV	WR	1M-1Y	3	26	M	MC		M	3	105
	AS32	CHCH-ASH	G	1	D	B	M	3	105	20	1S	-1	14	2	10	43	23.0%	9	12	12.5	8.5	RANGIORA	ASHBURTON	CAMPERVAN, 2380CC	HCV	RL	1M-1Y	3	60	M	T		M	3	95
	AS33	CHCH-ASH	E	2	D	C	M	3	105	58	2S	-2	35	1	0	43	0.0%	5	4	17.5	8.5	ASHBURTON	CHRISTCHURCH	4WD, 1600, INJ	CAR	RL	1W-1M	4	41	F	LT		LM	2	95
	AS34	CHCH-ASH	G	1	D	B	M	3	105	23	1S	-1	18	1	1	43	2.3%	11	16	3.75	4	HINDS	DUNSANDEL	UTE, 4100	CAR2	WR	1M-1Y	3	41	M	VS		LM	2	105
	AS35	CHCH-ASH	P	-1	D	C	H	4	105	15	2F	2	80	4	15	43	34.5%	60	68	12.5	17.5	ASHBURTON	CHRISTCHURCH	SUBARU, TURBO, 2L	CAR	VF	1W	5	26	F	T		M	3	105
CHECK LINES	AS36	CHCH-ASH	G	1	D	B	M	3	105	0	1S	-1	0	0		43	0.0%	0	0	8.75	4	ASHBURTON	CHRISTCHURCH	CAR, 1500	CAR	VF	1M-1Y	3	41	F	T		M	3	99
	AS37	ASH-TIM	P	-1	D	B	L	2	95	57	1S	-1	62	5	5	53	9.4%	90	88	8.75	6	ASHBURTON	TIMARU	CAR	CAR	WR	1W	5	41	M	T		M	3	105
	AS38	ASH-TIM	P	-1		C	M	3	105	17	1S	-1	17	4.5	7.5	48	15.6%	34	12	17.5	17.5	ASHBURTON	TIMARU	CAR, 1500, FUEL INJ	CAR	VF	1W-1M	4	60	M	T		M	3	95
	AS39	CHCH-ASH	N	0	D	B	M	3	95	64	N	0	77	2	5	48	10.4%	73	60	6.25	8.5	ASHBURTON	CHRISTCHURCH	CAR, 4.0, FUEL INJ	CAR2	RL	1W	5	41	M	T		M	3	105
	AS4	CHCH-ASH	G	1	D	C	M	3	105	0	1S	-1	19	0		43	0.0%	0	0	12.5	4	MAYFIELD	CHRISTCHURCH	CAR, 1500	CAR	VF	1M-1Y	3	26	F	R		LM	2	95
	AS40	CHCH-ASH		0	D		M	3	95	49	1F	1	54	5	5	48	10.4%	74	24	3.75	8.5	ASHBURTON	CHRISTCHURCH	CIVIC, 1600, THE WORKS	CAR	WR	1W	5	41	M	R		M	3	115
	AS41	CHCH-ASH	G	1	D		M	3	115	62	N	0	70	4	10	40	25.2%	61	68	6.25	1.5	ASHBURTON	CHRISTCHURCH	CAR	CAR	VF	1W	5	41	F	T		M	3	100
	AS42	ASH-TIM	N	0	D	B	M	3	105	6	2F	2	6	3	0	48	0.0%	93	47	6.25	4	WAIMATE	CHRISTCHURCH	MCYCLE, 1340	MBK	RL	1W-1M	4	26	M	VS		M	3	115
	AS43	ASH-TIM	N	0	D	B	M	3	95	16	1S	-1	55	4	5	53	9.4%	72	29	3.75	4	CHRISTCHURCH	MOSGIEL	SWAGON, 2.8 DIESEL	CAR2	VF	1M-1Y	3	41	M	LT		M	3	95
	AS44	CHCH-ASH	E	2		B	M	3	95	0	1S	-1	0	0		48	0.0%	0	2	3.75	1.5	CHRISTCHURCH	ASHBURTON	MAZDA	CAR	VF	1M-1Y	3	60	F	T		LM	2	85
	AS45	CHCH-ASH	G	1	D	B	M	3	105	17	2F	2	50	6	5	43	11.5%	81	27	3.75	4	ASHBURTON	CHRISTCHURCH	TELSTAR, 2L	CAR	WR	1W-1M	4	26	M	T		M	3	105
	AS46	CHCH-ASH	E	2	D	C	M	3	105	0	1S	-1	0	0		43	0.0%	0	0			ASHBURTON	CHRISTCHURCH	LASER	CAR	OTH	1W-1M	4	60	F	T		M	3	105
	AS47	CHCH-ASH	N	0		B	M	3	105	28	N	0	26	6		43	0.0%	52	48	1.25	2.5	DUNEDIN	CHRISTCHURCH	CAR, 2L	CAR	VF	1M-1Y	3	60	M	MC		M	3	95
	AS5	ASH-TIM	P	-1	D	C	M	3	115	50	1S	-1	59	3	3	44	6.8%	64	24	3.75	6	ASHBURTON	LEESTON	CAR, 2.8	CAR2	RL	1M-1Y	3	60	M	T		M	3	105
	AS7	CHCH-ASH	N	0	D	B	M	3	95	77	2S	-2	42	4	7	48	14.6%	44	66	3.75	4	ASHBURTON	CHRISTCHURCH	CAR, 2200	CAR	WR	1W	5	41	M	VS		M	3	105
	AS8	CHCH-ASH	G	1		B	M	3	105	27	2S	-2	37	4	1	43	2.3%	47	18	17.5	4	ASHBURTON	CHRISTCHURCH	CAR, 1300	CAR0	VF	1W-1M	4	60	M	LT		LM	2	95
	AS9	ASH-TIM	P	-1		C	M	3	95		2S	-2		0		53	0.0%		0	17.5	17.5	AKAROA	GORE			RL	FT	0	41	M	OS	USA	LM	2	95
	F1	BLEN-KAIK	N	0	D	B	M	3	95		1F	1	38	8	15	83	18.0%	48	47	0	8.5	WELLINGTON	CHRISTCHURCH	CAR, 1600, FUEL INJ	CAR	RL	2Y	1	41	F	MC		M	3	105
	F10	BLEN-KAIK	E	2	SR	W	L	2	105	4	2S	-2	4	0		75	0.0%	2	4	6.25	17.5	WELLINGTON	SOUTH ISLAND	CAR, 1000	CAR0	RL	FT	0	25	M	OS	JAPAN	AM	4	85
	F11	BLEN-KAIK	G	1	SR	W	M	3	75	27	1S	-1	41	4	3	106	2.8%	17	4	3.75	4	PICTON	KAIKOURA	STATION WAGON, 2.2L, FUEL INJ	CAR	RL	FT	0	60	M	OS	HOLLAND	LM	2	95
	F12	BLEN-KAIK	P	-1	D	B	M/H	3.5	105		N	0	80	6	22.5	75	29.8%	93	92	8.75	8.5	WELLINGTON	CHRISTCHURCH	CAR, 1600	CAR	VF	1Y-2Y	2	60	F	MC		M	3	105
	F13	HAV-NELS	P	-1	D	C	L	2	85	19	N	0	67	5	5	54	9.3%	28	15	1.25	17.5	PICTON	NELSON	CAMPERVAN, HIACE	HCV	RL	FT	0	26	M	OS	SWITZ.	M	3	105
	F14	BLEN-KAIK	G	1	D	C	M	3	105	10	N	0	12	1	1	75	1.3%	8	10	8.75	6	WELLINGTON	CHRISTCHURCH	FORD LASER 1300	CAR0	RL	2Y	1	41	M	OS	AUSTRALIA	M	3	105
	F15	BLEN-KAIK	E	2	SR	W	H	4	95	55	1S	-1	72	8	20	83	24.0%	89	86	12.5	12.5	WELLINGTON	CHRISTCHURCH	NISSAN 4X4, 2700 DIESEL	CAR	RL	1Y-2Y	2	26	M	MC		M	3	105
	F16	BLEN-KAIK	T	-2		B	M	3	95	72	1F	1	55	4.5	17.5	83	21.0%	94	75	12.5	12.5	PAEKAKARIKI	CHRISTCHURCH	CAR, 4000, TURBO	CAR2	RL	1M-1Y	3	41	M	MC		AM	4	95
	F17	BLEN-KAIK	E	2	D	B	L	2	105	8	2S	-2	2	0		75	0.0%	4	8	17.5	0	PICTON	KAIKOURA	CORTINA, 1.6	CAR	RL	FT	0	41	M	OS	UK	LM	2	95
	F18	BLEN-KAIK	P	-1	D	C	H	4	85	72	2F	2	74	40	15	93	16.1%	66	55	17.5	17.5	WELLINGTON	DUNEDIN	CAR, 1840, FUEL INJ, TURBO 4WD	CAR	RL	1M-1Y	3	41	M	MC		AM	4	115
	F19	BLEN-KAIK	G	1	SR	B	M	3	85	75	2F	2	81	50	45	93	48.3%	70	15	17.5	17.5	PALMERSTON	TE ANAU	CAR, V8, 5000CC	CAR2	RL	1M-1Y	3	41	M	LT		M	3	105
	F2	HAV-NELS	G	1	D	B	L	2	85	29	1F	1	27	1	4	54	7.5%	70	34	8.75	12.5	PICTON	KAITERITERI	SWAGON, 3000CC, FUEL INJ	CAR2	RL	2Y	1	60	M	MC		AM	4	105
	F20	BLEN-KAIK	N	0	SR	B	M	3	95	100	1S	-1	51	2		83	0.0%	97	69	17.5	17.5	UPPER HUTT	CHRISTCHURCH	car, 2l	CAR	RL	2Y	1	41	M	MC		LM	2	105
	F21	BLEN-KAIK	N	0	D	C	M	3	85	70	2F	2	59	30	25	93	26.8%	96	72	17.5	17.5	WELLINGTON	CHRISTCHURCH	CAR, 3000CC	CAR2	WR	1Y-2Y	2	41	M	MC		M	3	105
	F22	HAV-NELS	G	1	D	B	L	2	95	10	N	0	33	0		48	0.0%	30	0	3.75	4	WELLINGTON	MARAHAU	MINIVAN,2.5,DIESEL	CAR	RL	1M-1Y	3	26	M	OS	CZECH REP.	LM	2	105
	F23	BLEN-KAIK	P	-1	SR	W	H	4	85	78	1F	1	73	10	20	93	21.5%	92	60	17.5	12.5	WELLINGTON	CHRISTCHURCH	CAR,1.8	CAR	RL	1M-1Y	3	26	M	MC		AM	4	105
	F24	HAV-NELS	X	0	D	B	M	3	85	19	1F	1	15	1	0	54	0.0%	16	0	0	0		NELSON	CAR,1600CC	CAR	RL	FT	0	26	M	UK		AM	4	105
	F25	BLEN-KAIK	N	0	D	B	M	3	95	19	1F	1	25	5		83	0.0%	75	78	17.5	17.5	WELLINGTON	CHRISTCHURCH	CAR,2000	CAR	VF	1Y-2Y	2	41	F	MC		LM	2	95
	F26	ASH-TIM	G	1	D	B	M	3	105	29	N	0	17	2	3	48	6.3%	23	12	0	0	CHRISTCHURCH	DUNEDIN	CAR	CAR	VF	1Y-2Y	2	41	M	VS		M	3	105
	F27	BLEN-KAIK	N	0	R	W	M	3	95	39	1S	-1	45	5	2	83	2.4%	20	50	3.75	8.5	CARTERTON	CHRISTCHURCH	CAR, 1.6	CAR	VF	2Y	1	25	F	LT		LM	2	105
	F28	HAV-NELS	N	0	D	W	M	3	65	2	2F	2	10	1	1	70	1.4%	4	8	17.5	12.5	ANAKIWA	NELSON	CAMPERVAN, 2.8, DIESEL	HCV	RL	FT	0	26	F	OS	GERMANY	LM	2	95
	F3	HAV-NELS	E	2	D	B	L	2	95	13	0	0	14	0		48	0.0%	4	5	0	0	BLENHEIM	NELSON	CAR, 2000	CAR	VF	2Y	1	60	M	T		L	1	105
	F30	HAV-NELS	P	-1	D	C	L	2	95	14	N	0	61	2	4	48	8.3%	20	14	17.5	17.5	WELLINGTON	GREYMOUTH	CAMPERVAN	HCV	RL	FT	0	41	M	UK		M	3	95
	F31	BLEN-KAIK	P	-1	R	W	M	3	85	50	1F	1	68	9	10	93	10.7%	66	34	8.75	8.5	WELLINGTON	METHVEN	CAR, 4100	CAR2	VF	1Y-2Y	2	26	M	LT		AM	4	105
	F32	HAV-NELS	N	0	D	C	L	2	75	7	1S	-1	4	1		61	0.0%	12	9	0	0	WELLINGTON	GOLDEN BAY	STATION WAGON, 1500	CAR	VF	2Y	1	60	F	MC		M	3	105
	F33	BLEN-KAIK	P	-1	SR	W	M	3	85	90	1S	-1	78	5	45	93	48.3%	100	99	12.5	4	WELLINGTON	CHRISTCHURCH	CAR, 2L	CAR	RL	2Y	1	60	M	MC		L	1	95
	F34	BLEN-KAIK	P	-1	SR	W	M	3	105	54	1S	-1	60	5	17.5	75	23.2%	73	64	12.5	12.5	AUCKLAND	ASHBURTON	4WD, 2.8, TURBO, DIESEL	CAR2	OTH	1M-1Y	3	41	M	T		M	3	105
	F35	BLEN-KAIK	N	0	SR	B	M	3	95	22	2F	2	62	2	2	83	2.4%	42	3	0	17.5	WELLINGTON	CHRISTCHURCH	STATION WAGON, 3.8L INJ	CAR2	VF	2Y	1	41	M	MC		AM	4	105
	F37	ASH-TIM	G	1	D	C	H	4	95	70	N	0	49	10	15	53	28.3%	71	22	8.75	4	CHRISTCHURCH	INVERCARGILL	CAR, 2000	CAR	RL	1Y-2Y	2	26	M	LT		M	3	105
	F38	HAV-NELS	X	0	D	B	L	2	85	11	1S	-1	17	2	2	54	3.7%	18	52	8.75	8.5	WELLINGTON	NELSON	CAMPERVAN	HCV	RL	FT	0	41	M	UK		AM	4	95
	F39	HAV-NELS	P	-1	D	C	L	2	85	18	1F	1	33	2	10	54	18.6%	21	15	8.75	6	WELLINGTON	NELSON	CAR, 2000	CAR	VF	1Y-2Y	2	26	M	MC		M	3	105
CHECK	F4	BLEN-KAIK	T	-2	D	C	M	3	85	78	1F	1	75	15	17.5	93	18.8%	100	100	0	8.5	WELLINGTON	CHRISTCHURCH	CAR, 1800	CAR	VF	2Y	1	41	M	LT		M/AM	3.5	105
	F40	BLEN-KAIK		0	D	B	M	3	95	32	1S	-1	54	3	10	83	12.0%	54	52	12.5	6	PICTON	CHRISTCHURCH	MINI BUS, TURBO, 2.5L	CAR	RL	1Y-2Y	2	41	M	MC		M	3	95
XX	F41	BLEN-KAIK	N	0	D	W	M	3	95	10	1S	-1	8	6		83	0.0%	92		12.5	8.5	PICTON	CHRISTCHURCH	CAR	CAR	VF	1Y-2Y	2	60	M	LT		M	3	95
	F42	BLEN-KAIK	G	1	R	W	M	3	95	60	N	0	69	6	15	83	18.0%	70	27	12.5	6	TAUPO	TIMARU	CAR, 1500	CAR	RL	1Y-2Y	2	26	M	LT		LM	2	95
	F44	BLEN-KAIK	G	1	D	B	L	2	95	4	1S	-1	53	0		83	0.0%	5	10	0	0	WELLINGTON	CHRISTCHURCH	CAR, 2000	CAR	VF	1M-1Y	3	41	M	MC		L	1	95
2 SECTNS MARKED (BUT OK	F45	BLEN-KAIK	G	1	D	W	M	3	95	20	N	0	84	3	17.5	83	21.0%	71	52	1.25	17.5	PICTON	CHRISTCHURCH	CAR, 2000	CAR	VF	2Y	1	26	F	T		M	3	105
	F46	BLEN-KAIK	G	1	R	W	M	3	85	25	N	0	21	3	0	93	0.0%	98	17	12.5	17.5	WELLINGTON	AKAROA	SWAGON, 2400	CAR	RL	FT	0	41	M	OS	AUSTRALIA	M	3	105
	F47	HAV-NELS	N	0	SR	C	L	2	85	24	1F	1	22		1	54	1.9%	15	29	8.75	17.5	PICTON	NELSON	CAR, 1800 TOWING TRAILER	TOW	VF	1M-1Y	3	41	F	MC		M	3	95
	F48	BLEN-KAIK	P	-1	SR	B	M	3	85	64	2F	2	74	15	15	93	16.1%	74	62	8.75	8.5	PICTON	ALEXANDRA	CAR, 3000CC	CAR2	VF	1M-1Y	3	41	M	MC		AM	4	115
	F50	HAV-NELS	P	-1	SR	C	M	3	75	99	2F	2	98	10	30	61	49.3%	98	75	17.5	17.5	PALM. NTH	TAKAKA	CAR, 2000, 4WD	CAR	VF	FT	0	41	M	MC		M	3	115
	F51	BLEN-KAIK	P	-1	SR	B	M	3	105	30	1S	-1	23	3	12.5	75	16.6%	67	71	0	0	AUCKLAND	CHRISTCHURCH	CAR, COROLLA HATCH	CAR	RL	1M-1Y	3	26	F	MC		M	3	105
	F52	HAV-NELS	G	1	D	C	VL	1	75	27	1S	-1	40	2	15	61	24.7%	47	48	8.75	8.5	WELLINGTON	MARAHAU	MINIVAN, 2.5, DIESEL	CAR	RL	FT	0	25	M	OS	CZECH REP.	M	3	105
	F53	ASH-TIM	P	-1	SR	B	H	4	95	95	1F	1	56	23	15	53	28.3%	71	83	17.5	17.5	WELLINGTON	DUNEDIN	CAR, 2L, INJ, TURBO	CAR	OTH	1M-1Y	3	26	M	R		M	3	105
2 SECTNS MARKED (BUT OK	F55	BLEN-KAIK	N	0	R	W	M	3	95	31	1F	1	28	4	3	83	3.6%	74	62	17.5	17.5	PICTON	CHRISTCHURCH	CAR, 1300	CAR0	RL	FT	0	26	M	MC		M	3	105
	F56	BLEN-KAIK	G	1	D	C	L	2	95	7	N	0	60	2.5	20	83	24.0%	59	35	17.5	17.5	WELLINGTON	RANGIORA	LANDCRUISER, DIESEL 3.3	CAR2	WR	1M-1Y	3	26	M	LT		LM	2	100
	F57	HAV-NELS	N	0	SR	B	L	2	95	23	1S	-1	24	2	30	48	62.5%	90	69	12.5	17.5	WELLINGTON	NELSON	CAR, 1.6	CAR	VF	FT	0	26	F	MC		M	3	105
	F58	HAV-NELS	G	1	D	C	L	2	75	34	1F	1	60	2	4	61	6.6%	67	57	3.75	1.5	WELLINGTON	KAITERITERI	CAR, 2000	CAR	RL	2Y	1	26	M	LT		M	3	105
	F59	BLEN-KAIK	G	1	R	C	L	2	95	7	2F	2	27	0		83	0.0%	22	17	8.75	2.5	WELLINGTON	NELSON	CAR, 1.8	CAR	VF	FT	0	41	M	LT		M	3	105
	F6	BLEN-KAIK	G	1	D	C	L	2	105	21	1S	-1	12	5.5	3.5	75	4.6%	3	6	17.5	4	PICTON	CHRISTCHURCH	CAR, 1500	CAR	OTH	FT	0	41	M	R		M	3	105
	F60	BLEN-KAIK	N	0	D	W	M	3	65	0	N	0	68	3	15	122	12.3%	100	18	8.75	12.5	PICTON	CHRISTCHURCH	CAR, 1.6	CAR	RL	2Y	1	41	M	VS		AM	4	95
	F61	BLEN-KAIK	X	0	D	B	L	2	95	31	2F	2	45	10	10	83	12.0%	67	51	12.5	12.5	UPPER HUTT	KAIKOURA	CAR, 1.7, TUNED	CAR	RL	FT	0	26	M	OS	UK	AM	4	115
	F62	BLEN-KAIK	P	-1	SR	W	M	3	85	57	2F	2	87	12	10	93	10.7%	100	72	0	12.5	WELLINGTON	QUEENSTOWN	STATIONWAGON, 3900	CAR2	RL	1M-1Y	3	41	F	MC		M	3	105
	F63	BLEN-KAIK	G	1	SR	C	M	3	95	74	1F	1	55	10	15	83	18.0%	95	82	12.5	8.5	CHRISTCHURCH	PICTON	CAR, 1.8,	CAR	VF	2Y	1	26	M	MC		M	3	105
	F64	BLEN-KAIK	G	1	D	C	L	2	95	6	1S	-1	23	2	2.5	83	3.0%	75	70	12.5	17.5	PAEKAKARIKI	KAIKOURA	VAN, 1500	CAR	RL	2Y	1	41	F	MC		M	3	95
	F65	BLEN-KAIK	N	0	D	B	VL	1	95	5	2S	-2	7	0		83	0.0%	7	4	3.75	1.5	PICTON		CAR	CAR	RL	FT	0	26	M	MC		L	1	95
	F66	HAV-NELS	N	0	SR	B	M	3	95	15	1S	-1	9	1	1	48	2.1%	18	5	12.5	4	WELLINGTON	KAITERITERI	CHARIOT, 1800	CAR	RL	FT	0	41	F	LT		M	3	105
	F67	ASH-TIM	G	1		B	H	4	95	29	2S	-2	16	1	5	53	9.4%	5	20	6.25	4	CHRISTCHURCH	DUNEDIN	L300, VAN, 1600	CAR	VF	1M-1Y	3	41	F	MC		M	3	95
	F68	BLEN-KAIK	G	1	SR	B	M	3	85	84	2F	2	80	10	30	93	32.2%	89	81	17.5	17.5	PICTON	KAIKOURA	CAR, 1800	CAR	RL	2Y	1	41	F	MC		AM	4	115
	F69	BLEN-KAIK	N	0	D	B	L	2	95	22	N	0	27	9	10	83	12.0%	76	72	6.25	6	METHVEN	PICTON	CAR, 1800	CAR	RL	FT	0	60	M	MC		M	3	105
	F7	BLEN-KAIK	E	2		C	L	2	95	0	2S	-2	0	2	1	83	1.2%	0	0	1.25	8.5	WELLINGTON	KAIKOURA	UTE, 2.4, DIESEL CAB	CAR	VF	1M-1Y	3	26	M	T		L	1	105
	F70	BLEN-KAIK	N	0	D	C	M	3	95	61	1F	1	34	2	30	83	36.0%	43	67	17.5	8.5	KAIKOURA	BLENHEIM	4WD, CAR, 3L	CAR2	RL	FT	0	60	M	OS	USA	M	3	105
	F8	BLEN-KAIK	X	0	R	W	VL	1	75	62	1F	1	68	5	10	106	9.5%	73	68	0	8.5	BLENHEIM	BLENHEIM	CAR, 2200	CAR	RL	FT	0	41	M	MC		AM	4	105
	F9	BLEN-KAIK	G	1	SR	W	M	3	95	16	2S	-2	38	0		83	0.0%	5	7	6.25	12.5	PICTON	INVERCARGILL	TOYOTA VAN, DIESEL 2L	CAR	RL	FT	0	26	M	OS	GERMANY	LM	2	95

		PRE Q A	PRE Q B		S1Q1A	S1Q1B	S1Q2		S1Q3	S1Q4	S1Q5		S1Q6	S1Q7	S1Q7A			S1Q8	S1Q9	SC1	SC2	S2Q1	S2Q2	S2Q3		S2Q4	S2Q5		S2Q6	S2Q7	S2Q8	S2Q8B	S2Q9		S2Q10
COMMENT	SURVNO	SECTION	EXPECTN	XVALUE	WETNESS	WIND	TRAFFLOW	TVALUE	TRAFSPD	SAT-SPD	RELSPD	RVALUE	SAT-IMPD	VEHNOPASS	TIMENOPASS	SECTTIME	PCTSECT	SAT-PASSOP	FRSTR-OTH	XTRATIME	XTRADIST	TRIPFROM	TRIPDEST	VEHTYPE	VEH	TRIPPURF	TRIPFREQ	FVALUE	DRVRAGE	DRVRSEX	DRVRLOCN	OSLOCN	DRVRSTYL	BVALUE	DRVRSPD
	FP1	LEV-SAN	G	1	D	B	M	3	105	23	1S	-1	22	1	5	28	17.9%	18	16	6.25	4	BLENHIEM	MARTON	SWAGON, 1600	CAR	RL	1Y-2Y	2	26	M	MC		M	3	95
	FP10	BULL-TAIH	G	1	SR		M	3	115	88	2S	-2	25	2	10	43	23.1%	48	26	17.5	0	BLENHIEM	ELTHAM	CAR	CAR	OTH	1M-1Y	3	26	F	T		M	3	95
	FP11	WAI-TURAN	G	1	SR	C	H	4	85	100	N	0	100	6	30	44	68.5%	77	77	17.5	12.5	PICTON	ROTORUA	SWAGON, 3.9L	CAR2	RL	1Y-2Y	2	26	M	LT		M	3	105
	FP12	WAI-TURAN	G	1	D	B	M	3	85	88	1S	-1	94	4	10	44	22.8%	78	67	6.25	8.5	LEVIN	AUCKLAND	CAR, 2000, FUEL INJ	CAR	RL	1M-1Y	3	60	M	MC		M	3	95
	FP13	WAI-TURAN	G	1	D	B	M	3	105	3	1S	-1	3	0		35	0.0%	5	4	1.25	4	WELLINGTON	HAMILTON	CAR, 2500	CAR	VF	1M-1Y	3	60	M	LT		M	3	105
	FP14	WAI-TURAN	G	1	SR	W	M	3	95	37	1F	1	31	5	2.5	39	6.4%	8	3	8.75	8.5	WELLINGTON	CAMBRIDGE	VAN, 1800	CAR	RL	FT	0	41	M	T		LM	2	105
	FP15	WAI-TURAN	N	0	SR	B	H	4	95	69	2F	2	61	25	45	39	114.9%	59	60	12.5	6	PICTON	WHAKATANE			RL	1Y-2Y	2	26	M	T		AM	4	115
XXX	FP16	MAST-WOOD	G	1	D	B	L	2	95	14	2S	-2	15	0		52	0.0%	4	4	12.5	12.5	LOWER HUTT	TONGARIRO	CAMPERVAN	HCV	RL	FT	0	26	F	OS	GERMANY	LM	2	85
	FP17	WAI-TURAN	E	2	R		M	3	105	39	1S	-1	65	5.5	12.5	35	35.3%	63	58	12.5	12.5	CHEVIOT	CAMBRIDGE	VAN, 2L	CAR	VF	1Y-2Y	2	25	F	LT		LM	2	105
XXX	FP18	LEV-SAN	G	1	SR	W	H	4	95	9	1S	-1	0	0		31	0.0%	0	0	3.75	6	TAKAKA	HALCOMBE	MINIVAN 2.4L	CAR	RL	1M-1Y	3	41	M	OS	UK	M	3	95
	FP2	PALM-WOOD	N	0	SR	B	M	3	85	55	1S	-1	67	2	5	19	26.2%	36	66	8.75	4	PICTON	NAPIER	HOLDEN, SWAGON, 2000	CAR	RL	1M-1Y	3	26	M	LT		LM	2	95
	FP21	PALM-WOOD	P	-1	R		M	3	65	55	2S	-2	0			25	0.0%			17.5	17.5	WELLINGTON	GISBORNE	CAR, 2.6, FUEL INJ	CAR	VF	2Y	1	60	M	MC		LM	2	95
	FP22	LEV-SAN	P	-1	R	B	VL	1	95	74	N	0	70	4	5	31	16.2%	76	67	8.75	8.5	PARAPARAUMU	WANGANUI	CAR, 2000, FUEL INJ	CAR	RL	1M-1Y	3	41	M	LT		M	3	105
	FP23	LEV-SAN	G	1	D	B	VL	1	105	10	1F	1	6	0		28	0.0%	3	5	0	0	LEVIN	STRATFORD	CAR, 1600	CAR	VF	1Y-2Y	2	60	M	VS		M	3	105
	FP24	LEV-SAN	X	0	D	B	M	3	95	52	1F	1	75	2		31	0.0%	55	53	0	2.5	WELLINGTON	AUCKLAND	CAR, 1300, FUEL INJ	CAR0	OTH	FT	0	26	M	MC		AM	4	105
	FP25	PALM-WOOD	N	0	D	B	VL	1	95	14	1S	-1	5	0		17	0.0%	50	4	3.75	1.5	WELLINGTON	NAPIER	CAR, 2000	CAR	RL	2Y	1	41	F	MC		M	3	105
	FP26	MAST-WOOD	T	-2	D	W	M	3	95	23	1S	-1	52	6	5	52	9.7%	49	34	17.5	17.5	WELLINGTON	WAIRAKEI	COACH, FUEL INJ, TURBO	HCV	WR	1W-1M	4	41	M	MC		LM	2	95
ACCIDENT	FP27	LEV-SAN	X	0	SR	B	M	3	95	30	N	0	8	0		31	0.0%	3	5	0	0	BLENHIEM	AUCKLAND	SWAGON, 4L, FUEL INJ	CAR2	RL	2Y	1	41	M	MC		M	3	95
FP29,30 SAME CAR	FP28	WAI-TURAN	N	0	R	W	H	4	95	76	N	0	95		15	39	38.3%	86	56	3.75	6	PICTON	HAMILTON	SWAGON, 2.2L, FUEL INJ	CAR	RL	2Y	1	41	M	MC		M	3	115
	FP29	WAI-TURAN	P	-1	R		H	4	85	73	N	0	72	6	31	44	70.8%	86	66	8.75	2.5	WARD	TAUPO	SWAGON, 2L	CAR	VF	FT	0	60	M	MC		LM	2	105
	FP3	BULL-TAIH	N	0	R	W	VH	5	75	53	2F	2	69	3	3	66	4.5%	3	4	8.75	12.5	BLENHIEM	AUCKLAND	CAR, 3.3, FUEL INJ	CAR2	RL	2Y	1	41	M	MC		LM	2	105
	FP30	BULL-TAIH	P	-1	SR	W	VH	5	85	97	N	0	92	6	30	59	51.2%	93	90	6.25	2.5	WARD	TAUPO	SWAGON, 2L	CAR	RL	FT	0	60	F	MC		LM	2	95
	FP31	MAST-WOOD	N	0	SR	C	L	2	95	51	2F	2	62	2	1.5	52	2.9%	50	51	3.75	8.5	WELLINGTON	HERBERTVILLE	MOTORCYCLE	MBK	RL	1Y-2Y	2	26	M	MC		M	3	115
	FP32	BULL-TAIH	N	0	D	B	M	3	95	53	1S	-1	53	2	7.5	52	14.3%	70	18	6.25	12.5	WELLINGTON	NATIONAL PARK	TOYOTA CORONA, MARK 2, 2000	CAR	RL	2Y	1	26	F	MC		M	3	105
	FP33	WAI-TURAN	G	1	D	C	M	3	105	13	N	0	73	2	5	35	14.1%	44	49	0	8.5	PICTON	TAURANGA	TOYOTA CALDINA, DIESEL 2000	CAR	RL	1Y-2Y	2	41	M	LT		M	3	105
	FP34	MAST-WOOD	G	1	SR	B	M	3	105	9	N	0	26	3	1.5	47	3.2%	16	19	8.75	12.5	WELLINGTON	DANNEVIRKE	CAR, 4WD, 2500, DIESEL, TURBO	CAR	VF	2Y	1	41	M	T		AM	4	105
	FP35	WAI-TURAN	P	-1	D	B	L	2	85	13	1F	1	21	0		44	0.0%	9	9	6.25	8.5	NELSON	TAUPO	LAND, 3.4	CAR2	VF	1M-1Y	3	26	F	MC		M	3	115
	FP36	WAI-TURAN	N	0	D	C	H	4	85	66	1S	-1	80	5	10	44	22.8%	71	42	8.75	12.5	RAUMATI STH	TE PUKE	CAR, DIESEL, AUTOMATIC, 2000	CAR	VF	1Y-2Y	2	41	M	T		M	3	105
	FP37	BULL-TAIH	N	0	D	W	L	2	115	62	2S	-2	55	5	75	43	173.2%	66	53	17.5	12.5	WELLINGTON	AUCKLAND	VAN, 1800	CAR	RL	1Y-2Y	2	41	M	MC		M	3	105
	FP38	LEV-SAN	N	0	R	W	M	3	85	98	N	0	97	10	20	35	57.8%	98	87	6.25	8.5	PICTON	AUCKLAND	VAN, 2.0 DIESEL, FUEL INJ	CAR	VF	2Y	1	41	M	MC		M	3	105
	FP39	BULL-TAIH	P	-1	R	W	H	4	95	31	N	0		6	10	52	19.1%	83	70	8.75	8.5	NELSON	AUCKLAND	VAN, L300, 2.4, TURBO	CAR	RL	1Y-2Y	2	41	M	MC		M	3	105
	FP4	LEV-SAN	G	1	D	C	VL	1	105	4	2F	2	17	2	2.5	28	8.9%	5	7	6.25	6	PAEKAKARIKI	HAMILTON	FORD LASER LIATA 1.3. HATCH	CAR0	WR	1M-1Y	3	26	M	VS		M	3	105
	FP40	LEV-SAN	G	1	SR	W	M	3	85	5	1S	-1	23	2	5	35	14.5%	5	5	8.75	4	WELLINGTON	OHAKUNE	VAN, 2800, DIESEL	CAR2	RL	1Y-2Y	2	41	M	MC		M	3	95
	FP41	WAI-TURAN	N	0		W	M	3	105	100	2S	-2	38	6	60	35	169.4%	0	0		17.5	WELLINGTON	ROTORUA	VAN, 2.4, DIESEL	CAR	VF	1M-1Y	3	26	F	T		M	3	95
	FP42	LEV-SAN	N	0	SR	B	M	3	95	15	N	0	28	2	3	31	9.7%	23	10	6.25	12.5	NELSON	AUCKLAND	CAR, 3000	CAR2	VF	2Y	1	26	M	MC		M	3	105
	FP5	LEV-SAN	X	0	D	W	M	3	115	100	N	0	6	0		26	0.0%	3	32	3.75	4	BLENHIEM	STRATFORD	HIACE, 2R, 2.0	CAR	RL	2Y	1	26	M	T		M	3	115
	FP6	WAI-TURAN	P	-1	D	C	M	3	95	72	2F	2	61	6	10	39	25.5%	68	67	3.75	4	WELLINGTON	AUCKLAND	BMW 1800 FUEL INJ	CAR	RL	1Y-2Y	2	26	M	MC		LM	2	105
	FP7	BULL-TAIH	X	0	D	C	M	3	85	69	2F	2	74	9		59	0.0%	59	54	8.75	8.5	WELLINGTON	AUCKLAND	FORD FALCON	CAR	VF	1Y-2Y	2	41	M	MC		AM	4	105
	FP8	MAST-WOOD	G	1	SR	B	L/M	2.5	105	7	1S	-1	5	0		47	0.0%	3	5	3.75	8.5	PICTON	WAIHI	1972 BEDFORD CAMPVAN 2.3	HCV	RL	FT	0	41	M	VS		M/AM	3.5	115
	FP9	WAI-TURAN	G	1	SR	B	M	3	105	2	1S	-1	20	5.5	1	35	2.8%	15	4	8.75	4	BLENHIEM	MATAMATA	CAR,2000, FUEL INJ	CAR	RL	2Y	1	41	M	T		M	3	105
	K1	KAIK-AMB	G	1	D	C	M	3	95	1	2S	-2	1	0		89	0.0%	8	3	0	0	KAIKOURA	CHRISTCHURCH	19 SEAT, HINO TOUR COACH	HCV	WR	1M-1Y	3	41	M	MC		M	3	95
	K10	BLEN-KAIK	P	-1	D	B	L	2	95	22	N	0	18	1	5	83	6.0%	8	5	8.75	0	KAIKOURA	PICTON	CAR	CAR	VF	2Y	1	41	F	MC		AM	4	95
	K11	KAIK-AMB	N	0	D	B	M	3	105	28	1S	-1	15	2	0	81	0.0%	4	1	17.5	8.5	PICTON	CHRISTCHURCH	CAR, 1800	CAR	VF	1M-1Y	3	60	M	VS		LM	2	95
	K12	KAIK-AMB	P	-1	D	C	M	3	105	52	2F	2	62	7.5	15	81	18.6%	62	57	3.75	4	KAIKOURA	CHRISTCHURCH	VAN,2L	CAR	RL	1M-1Y	3	26	M	MC		AM	4	115
	K13	KAIK-AMB	P	-1	D	B	M	3	95	3	1S	-1	21	3	10	89	11.2%	87	72	17.5	12.5	PENZANCE BAY	RANGIORA	CAR, 4L, WITH BOAT	TOW	RL	1M-1Y	3	41	M	R		M	3	95
	K14	BLEN-KAIK	P	-1	D	C	M	3	75	93	N	0	74	9	30	106	28.4%	84	78	8.75	6	NELSON	TEMUKA	CAR, 2L, INJ	CAR	RL	2Y	1	25	M	VS		M	3	95
	K15	KAIK-AMB		0	D	C	M	3	105	21	1S	-1	40	5	15	81	18.6%	70	64	12.5	6	PICTON	CHRISTCHURCH	CAR, 1.8, TWIN CAM	CAR	RL	1Y-2Y	2	60	M	MC		M	3	115
	K16	BLEN-KAIK	N	0	SR	W	M	3	105	86	2S	-2	68	8		75	0.0%	100	71	0	0	KAIKOURA	SPRING CREEK	VAN, 1600CC	CAR	RL	1Y-2Y	2	26	M	VS		M	3	95
	K17	BLEN-KAIK	G	1	SR	B	M	3	105	31	2S	-2	41	0		75	0.0%	46	39	8.75	6	KAIKOURA	BLENHEIM	CAR, 1500, INJ	CAR	VF	1M-1Y	3	60	F	VS		LM	2	95
	K18	KAIK-AMB	P	-1	D	C	M	3	95	52	1F	1	84	6	10	89	11.2%	77	93	6.25	6	KAIKOURA	CHRISTCHURCH	CAR, 1600, INJ	CAR	VF	1W	5	26	F	R		M	3	105
	K19	KAIK-AMB	G	1	D	C	M	3	95	55	2F	2	15			89	0.0%	32	8	12.5	8.5	BLENHEIM	CHRISTCHURCH	350CC, MOTORCYCLE	MBK	VF	1M-1Y	3	26	M	MC		M	3	115
K7 & K8 ARE SAME PERSON	K2	BLEN-KAIK	P	-1	D	C	VL	1	85	53	2F	2	85	5	20	93	21.5%	84	79	17.5	17.5	KAIKOURA	PICTON	CAR, 1600	CAR	RL	2Y	1	26	F	MC		M	3	105
	K20	KAIK-AMB	T	-2	D	C	M	3	75	22	2S	-2	35	3	0	113	0.0%	80	74	12.5	4	CHRISTCHURCH	KAIKOURA	FUEL TANKER	HCV	WR	D	6	41	M	MC		M	3	95
	K21	BLEN-KAIK	N	0	D	C		3	99		2F	2	27	5		80	0.0%	21	30	1.25	1.5	BLENHEIM	KAIKOURA	CAR, TURBO, INJ, ABS, 2L	CAR	WR	1M-1Y	3	41	M	MC		AM	4	115
	K22	KAIK-AMB	N	0	D	B	M	3	105	3	2F	2	62	3	5	81	6.2%	43	43	17.5	17.5	KAIKOURA	CHRISTCHURCH	CAR, 2.2, INJ,	CAR	WR	1M-1Y	3	41	M	MC		AM	4	115
	K23	KAIK-AMB	P	-1	D	B	M	3	95	8	1S	-1	50	5	10	89	11.2%	52	49	0	0	PICTON	OXFORD	CAR, 1500	CAR	WR	1W	5	41	M	OS	AUSTRALIA	M	3	95
	K24	BLEN-KAIK	N	0		B	M	3	95	27	N	0	78	2	30	83	36.0%	76	68	0	1.5	KAIKOURA	PICTON	CAR, 3800, INJ	CAR2	RL	FT	0	41	M	R		M	3	105
	K25	KAIK-AMB	N	0	D	C	L	2	115	8	1F	1	9	3	7.5	74	10.2%	9	9	12.5	6	BLENHEIM	CHRISTCHURCH	CAR, 1600	CAR	RL	FT	0	25	F	MC		M	3	105
	K26	BLEN-KAIK	P	-1	D	B	M/H	3.5	95	35	N	0	74	22.5	8.5	83	10.2%	77	53	8.75	8.5	CHEVIOT	NELSON	CAR, 2000	CAR	VF	2Y	1	41	M	MC		M	3	105
	K27	BLEN-KAIK	N	0	D	B	M	3	100	39	1S	-1	44	6	17.5	79	22.1%	85	61	8.75	12.5	KAIKOURA	BLENHEIM	CAR, 2000	CAR	OTH	1M-1Y	3	41	F	R		M	3	105
	K28	KAIK-AMB	P	-1	D	C	M	3	95	60	1F	1	56	3	25	89	28.1%	94	83	12.5	17.5	PICTON	CHRISTCHURCH	CAR, 1600	CAR	RL	2Y	1	26	F	OS	UK	M	3	95
	K29	KAIK-AMB	G	1	D	B	M	3	85	57	2F	2	65	5	7.5	100	7.5%	73	57	12.5	12.5	KAIKOURA	CHRISTCHURCH	CAR, 1300	CAR0	RL	1M-1Y	3	25	F	MC		AM	4	105
K7 & K8 ARE SAME PERSON	K3	BLEN-KAIK	X	0	D	C	L	2	95	5	N	0	8	1	2	83	2.4%			12.5	8.5	KAIKOURA	PICTON	CAR, 1600, FUEL INJ	CAR	RL	FT	0	60	M	OS	UK	M	3	95
	K30	BLEN-KAIK	N	0		B	M	3	105	60	N	0	65	4	10	75	13.3%	71	70	12.5	8.5	KAIKOURA	BLENHEIM	CAR, 1200	CAR	VF	1M-1Y	3	25	F	T		M	3	105
	K31	BLEN-KAIK	G	1	D	C	VL	1	105	33	N	0	50	3	15	75	19.9%	74	66	17.5	17.5	CHRISTCHURCH	PICTON	CAR, 2L, INJ	CAR	VF	1M-1Y	3	26	F	VS		AM	4	105
	K32	KAIK-AMB	N	0	D	W	M	3	95	38	1S	-1	22	3	7.5	89	8.4%	25	24	17.5	6	KAIKOURA	CHRISTCHURCH	CAR, 2L, TURBO	CAR	RL	1W-1M	4	60	M	MC		M	3	95
	K33	KAIK-AMB	N	0	D	B	L	2	105	12	1F	1	63	6	20	81	24.8%	100	88	12.5	17.5	PICTON	CHRISTCHURCH	CAR, 1800	CAR	RL	FT	0	26	M	MC		AM	4	105
	K34	BLEN-KAIK	N	0	D	B	L	2	105	69	2S	-2	24	0		75	0.0%	65	9	0	0	CHEVIOT	AUCKLAND	TRUCK, DIESEL	HCV	RL	1M-1Y	3	41	F	T		L	1	95
	K35	KAIK-AMB	N	0	D	C	M	3	95	35	N	0	72	5	12.5	89	14.0%	72	67	12.5	12.5	OKIWI BAY	CHRISTCHURCH	CAR, 1600 RL	CAR	RL	1Y-2Y	2	26	M	MC		M	3	105
	K36	KAIK-AMB	P	-1	D	C	M	3	95	5	1S	-1	44	5	10	89	11.2%	57	48	3.75	4	BLENHEIM	CHRISTCHURCH	DELICA, 1600 VAN	CAR	VF	1M-1Y	3	60	M	OS	DENMARK	M	3	95
	K37	KAIK-AMB	N	0	D	B	H	4	95	27	1F	1	64	4	20	89	22.5%	76	62	17.5	12.5	ANAKIWA	CHRISTCHURCH	CAR, 2000	CAR	OTH	1Y-2Y	2	26	M	MC		M	3	105
	K38	KAIK-AMB	P	-1	D	B	M	3	85	61	1F	1	69	10	12.5	100	12.6%	74	68	3.75	8.5	BLENHEIM	CHRISTCHURCH	MAXIMA, 3000, FUEL INJ	CAR2	VF	1M-1Y	3	41	M	MC		M	3	105
	K39	BLEN-KAIK	G	1	D	C	VL	1	90	5	1S	-1	80	2	2.5	88	2.8%	4	5	17.5	12.5	BLENHEIM	KAIKOURA	COROLLA, 1.6	CAR	RL		0	41	M	OS	GERMANY	M	3	100
	K4	BLEN-KAIK	N	0	D	C	M	3	75	48	2S	-2	77	10	30	106	28.4%	44	14	17.5	12.5	BLENHEIM	KAIKOURA	TRUCK	HCV	WR	D	6	41	M	LT		M	3	95
	K40	KAIK-AMB	N	0	D	C	M	3	105	4	1S	-1	53	4	10	81	12.4%	95	31	17.5	8.5	KAIKOURA	LEITHFIELD BCH	CIVIC, 1300	CAR0	RL	1W-1M	4	41	F	T		M	3	105
	K41	KAIK-AMB	P	-1	D	B	M	3	105	38	1S	-1	19	1	15	81	18.6%	90	16	17.5	17.5	PT UNDERWOOD	RANGIORA	CAR, 4100	CAR2	RL	1M-1Y	3	41	F	T		LM	2	95
	K42	BLEN-KAIK	N	0	D	C	H	4	105	27	2S	-2	44	3	5	75	6.6%	51	44	12.5	6	BLENHEIM	BLENHEIM	3.6, UTE, TURBO	CAR2	WR	1W-1M	4	41	M	LT		M	3	95
	K5	KAIK-AMB	P	-1	D	B	M	3	85	8	2S	-2	19	3.5	15	100	15.1%	93	14	12.5	17.5	PICTON	CHRISTCHURCH	LWB VAN, 1800, LPG	CAR	VF	1M-1Y	3	60	M	MC		L	1	95
	K6	KAIK-AMB	P	-1	D	C	M	3	75	61	1S	-1	83	10	30	113	26.6%	93	56	12.5	12.5	CHRISTCHURCH	PICTON	420hP TRUCK, 40 FT SEMI	HCV	WR	D	6	41	M	MC		LM	2	95
	K7	KAIK-AMB	N	0	D	C	M/H	3.5	85	64	1F	1	55	22.5	15	100	15.1%	81	77	12.5	17.5	CHRISTCHURCH	BLENHEIM	VECTRA, 1.8	CAR	WR	1W-1M	4	41	M	LT		AM	4	110
	K8	BLEN-KAIK	P	-1	D	B	M/H	3.5	95	53	1F	1	61	19	12.5	83	15.0%	79	50	8.75	17.5	CHRISTCHURCH	BLENHEIM	VECTRA, 1.8	CAR	WR	1W-1M	4	41	M	LT		AM	4	110
	K9	BLEN-KAIK	N	0	D	C	L	2	95	18	2S	-2	27	5	5	83	6.0%	89	80	8.75	8.5	CHRISTCHURCH	PALM. NTH	VAN, DIESEL, 1500	CAR	RL	2Y	1	41	M	LT		M	3	95
	OA1	WELL-WAIPU	P	-1	D	C	L	2	75	74	2F	2	68	10	15	35	42.6%	52	10	17.5	17.5	AUCKLAND	TUTAKAKA	CAR, 2.5, FUEL INJ	CAR	RL	1Y-2Y	2	26	F	MC		M	3	105
	OA10	WHANG-KAWA	G	1	SR		M	3	95	12	N	0	50	2	10	34	29.3%	21	29	0	4	AUCKLAND	BAY OF ISLANDS	CAR 2000, 96 TELSTAR	CAR	RL	1Y-2Y	2	26	M	MC		M	3	105
	OA2	TAU-WHAKA	P	-1	D	C	L	2	105	4	N	0	11	2	10	55	18.2%	72	17	8.75	12.5	WHAKATANE	AUCKLAND	CAR,2L, FUEL INJ	CAR	VF	1M-1Y	3	41	M	VS		M	3	105
	OA3	TAUPO-TUR	P	-1	D	C	M	3	85	38	1F	1	37	5	30	37	81.7%	83	57	12.5	1.5	ROTORUA	TAUPO	CAR, 2L, FUEL INJ	CAR	RL	FT	0	26	M	MC		LM	2	105
	OA4	BOM-THAM	G	1	D	C	L	2	95	0	1S	-1	9	0		40	0.0%	0	0	3.75	1.5	WAIHI	AUCKLAND	CAR,2LITRE	CAR	RL	1M-1Y	3	41	M	MC		M	3	105
	OA5	WHANG-KAWA	N	0	D	B	M	3	95	6	N	0	15	5	3	34	8.8%	75	34	1.25	1.5	AUCKLAND	PAIHIA	CAR,2L, FUEL INJ	CAR	RL	1M-1Y	3	26	M	MC		AM	4	95
	OA6	BOM-THAM	P	-1	D	C	H	4	85	72	1S	-1	55	4	12.5	45	27.7%	53	72	12.5	8.5	THAMES	AUCKLAND	CAR, 1.6	CAR	RL	1M-1Y	3	26	F	MC		M	3	105
	OA7	WAI-TURAN	G	1	D	C	VL	1	95	1	N	0		0		39	0.0%	1	1	6.25	12.5	AUCKLAND	CHRISTCHURCH	BUS, FUEL INJ TURBO	HCV	RL	1M-1Y	3	26	F	MC		LM	2	105
	OA8	WAI-TURAN	G	1	D	C	L	2	115	49	N	0	13	1	0.5	32	1.5%	7	13	6.25	6	AUCKLAND	WELLINGTON	FORD TELSTAR, 2000CC	CAR	VF	1M-1Y	3						3	105
	OA9	WELL-WAIPU	N	0	D	C	M	3	85	55	2S	-2	24	2	5	31	16.1%	44	17	17.5	17.5	SILVERDALE	WHANGAREI	CAR, 2200CC, FUEL INJ, TOWED BOAT	TOW	RL	1M-1Y	3	41	M	VS		AM	4	95
	OW1	LEV-SAN	G	1	D	B	H	4	95	65	1F	1	63	9	5	31	16.2%	59	15	6.25	4	PORIRUA	TAUPO	CAR, 1600, FUEL INJ	CAR	RL	1M-1Y	3	25	M	MC		AM	4	105
	OW10	MAST-WOOD	N	0	D	B	L	2	105	22	2F	2	39	4	7.5	47	16.0%	80	36	0	17.5	WELLINGTON	NAPIER	CAR, 2000, FUEL INJ, 16 VALVE	CAR	WR	1W-1M	4	41	M	MC		A	5	115
	OW11	LEV-SAN	E	2	D		M	3	105	49	1F	1	3	0		28	0.0%	4	4	3.75	2.5	WELLINGTON	WANGANUI	CAR, 2000	CAR	VF	1M-1Y	3	41	M	MC		M	3	105
	OW12	LEV-SAN	G	1	D		M	3	115		1S	-1	32	5	15	26	58.7%	39	51	17.5	17.5	WELLINGTON	WANGANUI	CAR,	CAR	VF	1M-1Y	3	41	M	MC		M	3	105
	OW13	BULL-TAIH	P	-1	D	C	VL	1	95	8	1S	-1	30	3	5	52	9.5%	70	6	8.75	8.5	WELLINGTON	TAURANGA	CAR, 2000CC	CAR	VF	1M-1Y	3	26	M	MC		M	3	105
	OW14	WAI-TURAN	N	0	D	C	L	2	95	20	1F	1	18	0		39	0.0%	21	12	3.75	2.5	WELLINGTON	TURANGI	C'DORE SW 3.8 V6 FUEL,INJ TOW TR'LR	TOW	RL	1M-1Y	3	41	M	MC		AM	4	105
	OW15	WAI-TURAN	G	1	SNOW		VL	1	85	30	N	0	31	0		44	0.0%	14	11	12.5	8.5	TE PUKE	WELLINGTON	SWAGON 1300	CAR0	VF	1M-1Y	3	26	M	MC		LM	2	95
	OW16	WAI-TURAN	P	-1	D	C	M	3	85	35	2F	2	40	2	5	44	11.4%	40	29	6.25	6	WELLINGTON	TURANGI	CAR, 3000, FUEL INJ, TOW TRAILER	TOW	VF	1M-1Y	3	41	M	MC		AM	4	105
	OW17	WAI-TURAN	N	0	D	C	M	3	95	51	N	0	54	4	7.5	39	19.2%	52	52	3.75	8.5	PALM. NTH	TAUPO	HYUNDAI, 1600	CAR	VF	1M-1Y	3	26	F	MC		M	3	105
	OW18	LEV-SAN	P	-1	D	B	M	3	95	69	1F	1	84	5	10	31	32.3%	95	90	8.75	4	OTAKI	WANGANUI	TOYOTA HIACE 2.8	CAR2	RL	1M-1Y	3	41	M	R		M	3	105
	OW19	MAST-WOOD	G	1	D	B	M	3	95	0	2F	2	24	3.5		52	0.0%	73	0	12.5	17.5	WELLINGTON	HAVELOCK NTH	CAR, 1600, FUEL INJ	CAR	RL	1M-1Y	3	26	M	MC		AM	4	105
	OW2	BULL-TAIH	P	-1	D	B	M	3	95	60	1S	-1	58	5	5	52	9.5%	45	45	17.5	8.5	WELLINGTON	TAUPO	CAR, 1600, FUEL INJ	CAR	RL	1M-1Y	3	41	M	MC		M	3	105
	OW20	WANGA-HAW	P	-1	D	B	VL	1	95	38	1S	-1	57	2	10	57	17.4%	31	18	0	1.5	WELLINGTON	NEW PLYMOUTH	TOYOTA 1300	CAR0	VF	1M-1Y	3	25	F	MC		M	3	95
	OW21	LEV-SAN	G	1	D	B	M	3	105	0	1F	1	15	1.5	1	28	3.6%	4	23	0	2.5	WELLINGTON	PALM. NTH	CAR, 1600	CAR	VF	1M-1Y	3	41	M	MC			3	105
	OW22	LEV-SAN	N	0	D	B	L	2	105	100	2S	-2	100	0		28	0.0%	44	100	6.25	1.5	WELLINGTON	TAUMARUNUI	CAR, 1600	CAR	VF	1M-1Y	3	41	M	MC		LM	2	95
	OW23	WAI-TURAN	P	-1	SR	B	H	4	75	52	1F	1	65	4	10	50	20.2%	35	48	8.75	4	WHANGAMATA	WELLINGTON	CAR, 2000	CAR	RL	1M-1Y	3	41	M	MC		M	3	105
	OW24	MAST-WOOD	P	-1	D	C	L	2	95	60	2F	2	68	6	7.5	52	14.5%	80	58	3.75	8.5	GREYTOWN	HASTINGS	CAR, 3000, V6, QUADCAM 24V	CAR2	RL	1Y-2Y	2	26	M	MC		M	3	115
	OW25	MAST-WOOD	G	1	D	C	VL	1	105	13	1S	-1	20	0		47	0.0%	20	4	12.5	12.5	UPPER HUTT	GISBORNE	TRUCK, DAIHATSU DELTA	HCV	VF	1M-1Y	3	41	M	LT		M	3	95

		PRE Q A	PRE Q B		S1Q1A	S1Q1B	S1Q2		S1Q3	S1Q4	S1Q5		S1Q6	S1Q7	S1Q7A			S1Q8	S1Q9	SC1	SC2	S2Q1	S2Q2	S2Q3		S2Q4	S2Q5		S2Q6	S2Q7	S2Q8	S2Q8B	S2Q9		S2Q10
COMMENT	SURVNO	SECTION	EXPECTN	XVALUE	WETNESS	WIND	TRAFFLOW	TVALUE	TRAFSPD	SAT-SPD	RELSPD	RVALUE	SAT-IMPD	VEHNOPASS	TIMENOPASS	SECTTIME	PCTSECT	SAT-PASSOP	FRSTR-OTH	XTRATIME	XTRADIST	TRIPFROM	TRIPDEST	VEHTYPE	VEH	TRIPPURP	TRIPFREQ	FVALUE	DRVRAGE	DRVRSEX	DRVRLOCN	OSLOCN	DRVRSTYL	BVALUE	DRVRSPD
	OW26	BULL-TAIH	G	1	D	B	VL	1	105	0	N	0	0	0		47	0.0%	0	0	6.25	8.5	WELLINGTON	TAUPO	CAR, 1600	CAR	RL	1Y-2Y	2	41	M	MC		M	3	105
	OW27	LEV-SAN	G/E	0	D	B	M	3	85	100	1S	-1	100	6	15	35	43.4%	55	100	8.75	17.5	WELLINGTON	KATIKATI	CAR, 1600	CAR	RL	1M-1Y	3	26	F	MC		M	3	105
	OW28	LEV-SAN	G	1	D		M	3	105	54	N	0	24	3	4	28	14.3%	10	0	17.5	17.5	WELLINGTON	WANGANUI	HYUNDAI, 1300 SWAGON	CAR0	VF	1M-1Y	3	41	F	MC		M	3	95
	OW29	WAI-TURAN	T	-2	SR	B	M	3	95	61	1F	1	55	4	5	39	12.8%	77	13	3.75	2.5	TAUPO	WELLINGTON	CAR, 1.5, FUEL INJ	CAR	RL	1M-1Y	3	41	M	MC		M	3	105
	OW3	WAI-TURAN	G	1	D	C	M	3	95	0	2S	-2	23	2	5	39	12.8%	23	0	8.75	12.5	OPOTIKI	WELLINGTON	CAR, 1500, BOARDS & KAYAK	CAR	RL	1M-1Y	3	25	F	MC		LM	2	105
	OW30	BLEN-KAIK	P	-1	D	W	M	3	85	74	2F	2	70	8	10	93	10.7%	78	55	3.75	4	PARAPARAUMU	CHRISTCHURCH	CAR, 1300	CAR0	VF	2Y	1	41	M	LT		M	3	105
	OW31	BULL-TAIH	N	0	D	B	L	2	105	0	N	0	34	2	2	47	4.2%	0	10	1.25	8.5	WELLINGTON	TAUPO	CAR,2.2, FUEL INJ	CAR	RL	1M-1Y	3	41	M	MC		M	3	105
	OW4	BLEN-KAIK	N	0	SR		H	4	85	65	2F	2	63	20	60	93	64.4%	90	89	12.5	12.5	WELLINGTON	INVERCARGILL	CAR	CAR	VF	1Y-2Y	2	26	M	MC		LM	2	105
	OW5	LEV-SAN	G	1	D	C	M	3	95	15	N	0	21	2	10	31	32.3%	49	17	3.75	2.5	HAMILTON	WELLINGTON	TOYOTA, 1.6	CAR	RL	1M-1Y	3	26	M	MC		M	3	105
	OW6	LEV-SAN	N	0	SR	B	L	2	105	2	2F	2	3	0		28	0.0%	0	0	3.75	4	WELLINGTON	TAUPO	CAR, 1800	CAR	VF	1M-1Y	3	41	M	MC		M	3	105
	OW7	WAI-TURAN	G	1	D	C	L	2	85	55	2F	2	47	5	7.5	44	17.1%	48	66	6.25	6	WELLINGTON	AUCKLAND	WAGON, 3000, FUEL INJ	CAR2	VF	1M-1Y	3	25	M	MC		A	5	115
	OW8	MAST-WOOD	G	1	D	B	M	3	105	0	N	0	9	3	5	47	10.7%	11	0	12.5	12.5	WELLINGTON	NAPIER	CAR, 2.5, FUEL INJ	CAR	RL	1Y-2Y	2	60	M	MC		M	3	105
	OW9	BULL-TAIH	P	-1	D	C	L	2	105	38	2S	-2	4	0		47	0.0%	11	10	6.25	6	WELLINGTON	TAIHAPE	CAR,1300	CAR0	RL	2Y	1	25	F	MC		LM	2	95
	R1	RAE-WANG	T	-2	D	C	M	3	75		N	0	100	5	20	73	27.5%	100	100	12.5	8.5	RAETIHI		CAR	CAR	WR	1W	5	26	F	T		L	1	75
	R10	RAE-WANG	T	-2	D	C	M	3	85	63	S2	0	56	4	20	64	31.1%	75	66	17.5	8.5	RAETIHI	MARTON	CAR, 6 CYLINDER, FUEL INJ	CAR	VF	2Y	1	26	F	T		M	3	95
	R11	RAE-WANG	P	-1	D		M	3	75	98	2F	2	97	7	10	73	13.7%	98	98	0	0	RAETIHI	WANGANUI	CAR, 1600	CAR	VF	1W	5	26	M	VS		A	5	115
	R12	RAE-WANG	P	-1	SR		M	3	75	43		0	48	4	5	73	6.9%	95	66	8.75	8.5	RAETIHI	WANGANUI	CAR, 1.8, DIESEL	CAR	RL	1W-1M	4	26	F	R		LM	2	95
	R14	RAE-WANG		0	D	B	M	3	95	27		0				57	0.0%			12.5	8.5	WANGANUI	RAETIHI	TOYOTA SURF, 2.4, DIESEL	CAR	WR	1W-1M	4	26	F	VS		LM	2	105
	R15	TAUM-RAE	P	-1	D	C	VL	1	85	21	N	0	98	1	10	54	18.4%	99	99	3.75	4	RAETIHI	HAMILTON	CAR, 1500	CAR	WR	FT	0	25	M	LT		M	3	105
	R16	RAE-WANG	N	0	SR		M	3	85		1S	-1	67	5	15	64	23.4%	67	74	3.75	2.5	RAETIHI	WANGANUI	CAR, INJ	CAR	WR	1W	5	25	F	VS		M	3	105
	R17	RAE-WANG	T	-2	SR	B	H	4	85	86	2S	-2	52	6	30	64	46.7%	90	90	17.5	0	RAETIHI	WELLINGTON	CAR, L200	CAR	VF	1W	5	26	F	VS		L	1	105
	R18	RAE-WANG	T	-2	SR	W	M	3	75	61	2S	-2	92	1	15	73	20.6%	85	100	8.75	4	RAETIHI	WANGANUI	UTE, 2300	CAR	RL	1W-1M	4	25	M	VS		LM	2	95
	R19	RAE-WANG	T	-2	D	B	M	3	95	2	2S	-2	3	6	5	57	8.7%	98	0	6.25	2.5	RAETIHI	WANGANUI	UTE, 2000	CAR	RL	1W-1M	4	60	M	T		LM	2	95
	R2	RAE-WANG	G	1	D	C	L	2	75	12	2F	2	19	2	10	73	13.7%	19	27	17.5	17.5	TAUMARUNUI	WANGANUI	VAN	CAR	WR	1W-1M	4	26	M	LT		M	3	95
	R20	TAUM-RAE	N	0	SR	C	L	2	95	3	N	0	24	4	2	49	4.1%	34	28	3.75	4	RAETIHI	TAUMARUNUI	CAR, 3800	CAR2	WR	1W-1M	4	26	M	R		M	3	105
	R21	TAUM-RAE	P	-1	D	C	M	3	95	0	N	0	0	2	2	49	4.1%	100	100	8.75	8.5	RAETIHI	TAUMARUNUI	VAN, 2L	CAR	WR	1M-1Y	3	60	M	VS		LM	2	95
	R22	TAUM-RAE	N	0	D	C	L	2	105	20	1S	-1	50	5	6	44	13.6%	67	70	6.25	8.5	RAETIHI	RAURIMU	CAR, 2000	CAR	RL	1M-1Y	3	26	M	VS		M	3	105
	R23	RAE-WANG	P	-1	SR	B	M	3	75	58	2S	-2	14	0		73	0.0%	27	52	12.5	0.5	TAIHAPE	WANGANUI	HOUSE TRUCK	HCV	RL	2Y	1	41	M	R		LM	2	75
	R24	RAE-WANG	G	1	D	C	L	2	105	47	2S	-2	35	2.5	10	52	19.2%	67	72	8.75	6	RAETIHI	WANGANUI	AMBULANCE, 2500	CAR	WR	D	6	26	F	LT		M	3	115
	R25	RAE-WANG	T	-2	SR	B	L	2	85	37	2F	2	80	18	15	64	23.4%	92	87	3.75	4	RAETIHI	WANGANUI	CAR, 3, V6, GX	CAR2	WR	1W	5	60	M	T		M	3	95
	R26	RAE-WANG	P	-1	D	B	M	3	75	28	2F	2	78	2	20	73	27.5%	100	100	12.5	17.5	RAETIHI	WANGANUI	CAR, 1500	CAR	WR	D	6	26	M	R		LM	2	95
27 AND 28 SAME PERSON	R27	TAUM-RAE	G	1	D	C	L	2	95	10	2F	2	37	1	15	49	30.8%	44	16	1.25	0	RAETIHI	TAUMARUNUI	CAR	CAR	VF	1W-1M	4	26	F	T		M	3	95
	R28	RAE-WANG	T/P	-1.5	D	B	M	3	99	84	1F	1	75	3	15	55	27.2%	87	38	1.25	0.5	RAETIHI	WANGANUI	CAR	CAR	WR	1W-1M	4	26	F	T		M	3	95
	R29	RAE-WANG	P	-1	D	B	L	2	75	25	1S	-1	63	1	5	73	6.9%	96	53	8.75	4	RAETIHI	WANGANUI	CAR	CAR	VF	1W-1M	4	60	F	R		M	3	95
	R3	RAE-WANG	T	-2	D	B	M	3	75		2F	2	74	3	20	73	27.5%	91	45	8.75		RAETIHI	WANGANUI	CAR, 454, BIG BLOCK CHEV	CAR		1W-1M	4	25	M	VS		AM	4	115
	R30	RAE-WANG	P	-1	SR	B	VL	1	95	22	1S	-1	73	2	5	57	8.7%	55	17	8.75	6	RAETIHI	WANGANUI	CAR	CAR	VF	1M-1Y	3	25	F	MC		M	3	95
	R31	WAI-RAE	G	1	D	C	L	2	95	55	2S	-2	32	0		24	0.0%	40	21	17.5	12.5	OHAKUNE	WAIOURU	COMMODORE, 82	CAR	RL	1W-1M	4	26	F	VS		L	1	95
	R32	RAE-WANG	P	-1	D	C	L	2	75	10	2F	2	74	2	10	73	13.7%	87	65	12.5	8.5	RAETIHI	WANGANUI	CAR, 2L	CAR	OTH	1W-1M	4	41	F	VS		LM	2	95
	R33	TAUM-RAE	N	0	D	B	L	2	95	64	1S	-1	35	4	30	49	61.7%	80	57	8.75	4	RAETIHI	TE PUKE	HONDA PRELUDE	CAR	VF	1M-1Y	3	25	F	T		M	3	99
	R4	RAE-WANG	G	1	D	B	L	2	85	2		0	19	3	0.3	64	0.5%	30	10	3.75	6	TAUMARUNUI	WANGANUI	TRUCK, 32000CC, DIESEL	HCV		1W-1M	4	41	M	LT		M	3	105
	R5	RAE-WANG	P	-1	D	C	M	3	75	62	1F	1	55	4	30	73	41.2%	47	54	3.75	4	RAETIHI	WANGANUI	CAR, V8, 351	CAR2	VF	1W-1M	4	25	M	VS		LM	2	115
	R6	RAE-WANG	X	0	D	C	L	2	85	43	2F	2	78	2	5	64	7.8%	22	18	8.75	4	KINOHAKA	WANGANUI	car, 1200	CAR0	RL	2Y	1	41	M	OS	UK	LM	2	95
	R7	RAE-WANG	P	-1	D	B	M	3	95	5	N	0	39	6	20	57	34.8%	77	91	8.75	6	RAETIHI	WANGANUI	CAR, V8, 351	CAR	RL	1W-1M	4	25	M	T		AM	4	115
	R8	WAI-RAE	T	-2	D	B	M	3	95	67	1S	-1	52	0		24	0.0%	70	52			RAETIHI	OHAKUNE	CAR, 1.8, INJ	CAR	WR	D	6	26	F	R		M	3	85
	R9	RAE-WANG	P	-1	D	C	M	3	75	6	2S	-2	30	2	3.5	73	4.8%	49	51	17.5	17.5	RAETIHI	WAIKANAE	NISSAN, C20 VAN	CAR	WR	1W-1M	4	60	M	T		M	3	105
	W1	PALM-WOOD	G	1	D	C	M	3	105	37	N	0	16	3	1	15	6.5%	67	15	6.25	1.5	WOODVILLE	PALM. NTH	CAR, 4L, FUEL INJ	CAR2	RL	1W-1M	4	26	M	VS		LM	2	105
	W10	PALM-WOOD	G	1	D	B	M	3	95	55	N	0	64	1	5	17	29.3%	58	10	3.75	1.5	PAHIATUA	MARTON	CAR	CAR	OTH	1M-1Y	3	41	M	T		M	3	105
	W11	WOOD-DANN	G	1	D	B	M	3	95	66	1S	-1	37	1	5	17	29.3%	50	13	1.25	6	ASHURST	NAPIER	CAR, 2000	CAR	VF	1W-1M	4	60	F	LT		LM	2	95
	W12	WOOD-DANN	P	-1	D	C	M	3	105	40	N	0	70	8	10	15	64.8%	75	50	3.75	2.5	WOODVILLE	DANNEVIRKE	CAR, 4L, FUEL INJ	CAR2	WR	D	6						3	105
	W13	WOOD-DANN	P	-1	D	C	L	2	95	53	N	0	75	4	12.5	17	73.3%	85	69	8.75	2.5	WOODVILLE	NORSEWOOD	CAR, 1600	CAR	VF	1M-1Y	3	26	F	T		LM	2	105
	W14	PALM-WOOD	P	-1	D	C	L	2	75	19	2F	2	56	2	4	22	18.5%	43	19	3.75	8.5	PALM. NTH	?	HONDA ACCORD, 2.2	CAR	WR	1W-1M	4	26	M	MC		AM	4	105
	W15	WOOD-DANN	P	-1	D	C	M	3	85	70	2S	-2	67	3	5	19	26.2%	72	35	8.75	6	WANGANUI	DANNEVIRKE	WAGON	CAR	WR	D	6	41	M	R		M	3	95
	W16	PALM-WOOD	P	-1	D	B	M	3	95	5	2S	-2	51	2	10	17	58.6%	75	48	6.25	2.5	WOODVILLE		CAR	CAR	RL	D	6	25	F	VS		M	3	95
	W17	WOOD-DANN	G	1	D	C	M	3	85	38	1F	1		2	3	19	15.7%	49	19	12.5	6	TAKAPAU	PALM. NTH	CAR, 2000, FUEL INJ	CAR	WR	1W-1M	4	41	M	R		M	3	115
	W18	PALM-WOOD	G	1	D	B	M	3	95	4	N	0	4	0		17	0.0%	4	4	0	0	WOODVILLE	PALM. NTH	CAR,1500	CAR	WR	1W	5	60	F	T		M	3	95
	W19	PALM-WOOD	P	-1		C	L	2	105	17	2S	-2	30	3	5	15	32.4%	88	21	6.25	8.5		TAIHAPE	TRUCK	HCV	WR	1W	5	26	M	VS		M	3	95
	W2	PALM-WOOD	G	1	D	C	M	3	85	20	N	0	10	0		19	0.0%	11	15	8.75	8.5	MANGATAINOKA	PALM. NTH	2000, CAR, FUEL INJ	CAR	RL	1W-1M	4	26	F	R		LM	2	85
	W20	MAST-WOOD	G	1	D	B	M	3	115	25	2S	-2	41	0		43	0.0%	73	0	3.75	6	NAPIER	WELLINGTON	WAGON,2.8, FUEL INJ, TURBO	CAR2	VF	1M-1Y	3	41	M	LT		M	3	85
	W21	MAST-WOOD	N	0	D	C	M	3	95	59	1F	1	53	4	7.5	52	14.5%	63	48	12.5	17.5	FEILDING	EKETAHUNA	CAR, 1300	CAR0	VF	1M-1Y	3	25	F	T		LM	2	105
	W22	PALM-WOOD	T	-2	D	C	M	3	75		1F	1	76	4	12.5	22	57.9%	84	50	0	2.5	GISBORNE	WANGANUI	SEDAN, 3.8, FUEL INJ	CAR2	WR	1W-1Y	0	41	M	LT		M	3	115
	W23	MAST-WOOD	P	-1	D	C	L	2	95	3	N	0	53	2	5	52	9.7%	85	47	17.5	17.5	WAIRARAPA	TAUPO	CAR, 4WD	CAR	VF	1M-1Y	3	41	F	R		M	3	95
	W24	PALM-WOOD	T	-2	D	C	M	3	85	15	2S	-2	0	1		19	0.0%	97	72	6.25	6	PAHIATUA	TEAWAMUTU	TRUCK & HORSE	HCV	RL	1M-1Y	3	41	F	R		M	3	105
	W25	WOOD-DANN	P	-1	C	C	L	2	105	4	2S	-2	3	0		15	0.0%	66	0	3.75	6	PALM. NTH	HASTINGS	CAR, 2000, FUEL INJ,CARAVAN	CAR	RL	1M-1Y	3	41	M	MC		M	3	105
	W26	PALM-WOOD	N	0	D	C	H	4	85	80	2F	2	100	5	10	19	52.5%	100	73	6.25	8.5	DANNEVIRKE	PALM. NTH	CAR, 1.5	CAR	RL	1W	5	25	F	T		M	3	95
	W3	WOOD-DANN	P	-1	D	C	L	2	95	72	2F	2	68	4	5	17	29.3%	81	15	1.25	4	NAPIER	PALM. NTH	CAR, 2000	CAR	RL	1M-1Y	3	26	M	MC		AM	4	115
	W4	PALM-WOOD	N	0	D	B	H	4	75	32	2S	-2	34	1	1.5	22	6.9%	34	49	3.75	4	PALM. NTH	NAPIER	TRUCK, 11000, 40 FOOT	HCV	WR	D	6	25	M	VT		LM	2	95
	W5	PALM-WOOD	P	-1	D	C	M	3	95	42	N	0	56	3	0	17	0.0%	72	65	3.75	2.5	NAPIER	WELLINGTON	COMMODRE V8	CAR	VF	1M-1Y	3	41	F	LT		AM	4	105
	W6	WOOD-DANN	G	1	D	C	H	4	95	48	N	0	48	3.5	15	17	88.0%	70	55	8.75	2.5	PALM. NTH	NAPIER	CAR, 2L	CAR	WR	1M-1Y	3	25	M	LT		LM	2	105
	W7	PALM-WOOD	N	0		B	M	3	95	10	2S	-2	10	2		17	0.0%	5	2	6.25	4	WOODVILLE	PALM. NTH	HYUNDAI, 2, 1988	CAR	RL	1W	5	60	M	VS		M	3	95
	W8	PALM-WOOD	?	0	D	B	M	3	105	52	1F	1	38	2.5	1.5	15	9.7%	46	38	3.75	1.5	GISBORNE	WELLINGTON	CAR, 2000, FUEL INJ	CAR	VF	1M-1Y	3	60	M	LT		AM	4	105
	W9	WOOD-DANN	P	-1	D	C	M	3	75	95	2F	2	96	20	10	22	46.3%	96	60	8.75	12.5	NAPIER	WANGANUI	CAR, 2000, FUEL INJ	CAR	WR	1W-1M	4	41	M	LT		AM	4	115
	AS6			0.0											2633	16524	15.9%											2.6						2.9	102.1
	F29																											1.00						1.00	
	F36																																		
2 SECTIONS MARKED	F49																																		
	F5																																		
4SECTIONS MARKED	F54																																		
	FP19																																		
	FP20																																		
2 SECTIONS MARKED	R13																																		
3 SECTIONS MARKED	F43																																		
	SURVNO	SECTION	EXPECTN	XVALUE	WETNESS	WIND	TRAFFLOW	TVALUE	TRAFSPD	SAT-SPD	RELSPD	RVALUE	SAT-IMPD	VEHNOPASS	TIMENOPASS	SECTTIME	PCTSECT	SAT-PASSOP	FRSTR-OTH	XTRATIME	XTRADIST	TRIPFROM	TRIPDEST	VEHTYPE	VEH	TRIPPURP	TRIPFREQ	FVALUE	DRVRAGE	DRVRSEX	DRVRLOCN	OSLOCN	DRVRSTYL	BVALUE	DRVRSPD

A.4 Calculations from Survey Data

		km	%	vpd	vph	level of interactn/km	reqd gap 30	reqd gap * sight dist	Demand/Supply	TT Cost $20.10	PEM Table A5.15a
SURVNO	SECTION	Length	SightDist	TrafficVol	HrFlow	DEMAND	PCT-TIMEGAP	SUPPLY	UPD	WTP-TIME	WTP-DIST
AS1	CHCH-ASH	76	58.4	8050	187.8	27.66	0.209	0.122	24.3	0.039	0.017
AS10	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.039	0.017
AS11	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.055	0.035
AS12	ASH-TIM	84	58.5	5500	128.3	13.59	0.343	0.201	10.9	0.025	0.032
AS13	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.039	0.035
AS14	CHCH-ASH	76	58.4	8050	187.8	32.54	0.209	0.122	28.6	0.055	0.073
AS15	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.035	0.015
AS16	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.039	0.035
AS17	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.050	0.031
AS18	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.055	0.035
AS19	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.050	0.032
AS2	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.028	0.016
AS20	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.017	0.035
AS21	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.028	0.010
AS22	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.050	0.031
AS23	ASH-TIM	84	58.5	5500	128.3	11.23	0.343	0.201	9.0	0.050	0.046
AS24	ASH-TIM	84	58.5	5500	128.3	11.23	0.343	0.201	9.0	0.000	0.000
AS25	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.077	0.035
AS26	CHCH-ASH	76	58.4	8050	187.8	36.88	0.209	0.122	32.4	0.039	0.035
AS27	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.055	0.010
AS28	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.025	0.015
AS29	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.000	0.000
AS3	ASH-TIM	84	58.5	5500	128.3	15.19	0.343	0.201	12.1	0.005	0.015
AS30	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.050	0.067
AS31	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.055	0.073
AS32	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.055	0.035
AS33	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.077	0.035
AS34	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.017	0.017
AS35	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.055	0.073
AS36	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.039	0.016
AS37	ASH-TIM	84	58.5	5500	128.3	13.59	0.343	0.201	10.9	0.035	0.023
AS38	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.070	0.065
AS39	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.028	0.035
AS4	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.055	0.016
AS40	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.017	0.036
AS41	CHCH-ASH	76	58.4	8050	187.8	24.05	0.209	0.122	21.1	0.028	0.006
AS42	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.025	0.015
AS43	ASH-TIM	84	58.5	5500	128.3	13.59	0.343	0.201	10.9	0.015	0.015
AS44	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.017	0.006
AS45	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.017	0.017
AS46	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.000	0.000
AS47	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.006	0.010
AS5	ASH-TIM	84	58.5	5500	128.3	11.23	0.343	0.201	9.0	0.015	0.023
AS7	CHCH-ASH	76	58.4	8050	187.8	29.12	0.209	0.122	25.6	0.017	0.017
AS8	CHCH-ASH	76	58.4	8050	187.8	26.34	0.209	0.122	23.1	0.077	0.016
AS9	ASH-TIM	84	58.5	5500	128.3	13.59	0.343	0.201	10.9	0.070	0.065
F1	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.000	0.020
F10	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.016	0.040
F11	BLEN-KAIK	132	16.8	2100	76.9	6.18	0.527	0.089	5.6	0.010	0.009
F12	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.022	0.020
F13	HAV-NELS	76	10.3	3700	139.4	17.93	0.313	0.032	17.4	0.006	0.073
F14	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.022	0.014
F15	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.030
F16	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.029
F17	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.044	0.000
F18	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.044	0.043
F19	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.044	0.042
F2	HAV-NELS	76	10.3	3700	139.4	17.93	0.313	0.032	17.4	0.039	0.052
F20	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.044	0.042
F21	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.044	0.042
F22	HAV-NELS	76	10.3	3700	139.4	16.04	0.313	0.032	15.5	0.017	0.017
F23	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.044	0.030
F24	HAV-NELS	76	10.3	3700	139.4	17.93	0.313	0.032	17.4	0.000	0.000
F25	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.044	0.041
F26	ASH-TIM	84	58.5	5500	128.3	12.30	0.343	0.201	9.8	0.000	0.000
F27	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.010	0.020
F28	HAV-NELS	76	10.3	3700	139.4	23.45	0.313	0.032	22.7	0.077	0.051
F3	HAV-NELS	76	10.3	3700	139.4	16.04	0.313	0.032	15.5	0.000	0.000
F30	HAV-NELS	76	10.3	3700	139.4	16.04	0.313	0.032	15.5	0.077	0.071
F31	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.022	0.020
F32	HAV-NELS	76	10.3	3700	139.4	20.32	0.313	0.032	19.7	0.000	0.000
F33	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.032	0.009
F34	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.032	0.030
F35	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.000	0.042
F37	ASH-TIM	84	58.5	5500	128.3	13.59	0.343	0.201	10.9	0.035	0.015
F38	HAV-NELS	76	10.3	3700	139.4	17.93	0.313	0.032	17.4	0.039	0.035
F39	HAV-NELS	76	10.3	3700	139.4	17.93	0.313	0.032	17.4	0.039	0.025
F4	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.000	0.020
F40	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.014
F41	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.020
F42	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.014
F44	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.000	0.000
F45	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.003	0.042
F46	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.032	0.042
F47	HAV-NELS	76	10.3	3700	139.4	17.93	0.313	0.032	17.4	0.039	0.071
F48	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.022	0.021
F50	HAV-NELS	76	10.3	3700	139.4	20.32	0.313	0.032	19.7	0.077	0.074
F51	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.000	0.000
F52	HAV-NELS	76	10.3	3700	139.4	20.32	0.313	0.032	19.7	0.039	0.035
F53	ASH-TIM	84	58.5	5500	128.3	13.59	0.343	0.201	10.9	0.070	0.066
F55	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.044	0.042
F56	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.044	0.041
F57	HAV-NELS	76	10.3	3700	139.4	16.04	0.313	0.032	15.5	0.055	0.073
F58	HAV-NELS	76	10.3	3700	139.4	20.32	0.313	0.032	19.7	0.017	0.006
F59	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.022	0.006
F6	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.044	0.010
F60	BLEN-KAIK	132	16.8	2100	76.9	7.13	0.527	0.089	6.5	0.022	0.029
F61	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.030
F62	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.000	0.030
F63	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.020
F64	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.041
F65	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.010	0.004
F66	HAV-NELS	76	10.3	3700	139.4	16.04	0.313	0.032	15.5	0.055	0.017
F67	ASH-TIM	84	58.5	5500	128.3	13.59	0.343	0.201	10.9	0.025	0.015
F68	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.044	0.043

						level of	reqd gap	reqd gap *		TT Cost	PEM Table
		km	%	vpd	vph	interactn/km	30	sight dist	Demand/Supply	$20.10	A5.15a
SURVNO	SECTION	Length	SightDist	TrafficVol	HrFlow	DEMAND	PCT-TIMEGAP	SUPPLY	UPD	WTP-TIME	WTP-DIST
F69	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.016	0.014
F7	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.003	0.020
F70	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.044	0.020
F8	BLEN-KAIK	132	16.8	2100	76.9	6.18	0.527	0.089	5.6	0.000	0.020
F9	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.016	0.029
FP1	LEV-SAN	49	42.0	7400	189.3	26.76	0.206	0.087	24.4	0.043	0.025
FP10	BULL-TAIH	83	26.0	4800	153.2	16.01	0.279	0.073	14.8	0.071	0.000
FP11	WAI-TURAN	62	23.3	2550	89.5	7.39	0.474	0.110	6.6	0.095	0.064
FP12	WAI-TURAN	62	23.3	2550	89.5	7.39	0.474	0.110	6.6	0.034	0.043
FP13	WAI-TURAN	62	23.3	2550	89.5	5.99	0.474	0.110	5.3	0.007	0.020
FP14	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.047	0.043
FP15	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.068	0.031
FP16	MAST-WOOD	82	28.6	4000	101.8	8.55	0.428	0.122	7.5	0.051	0.046
FP17	WAI-TURAN	62	23.3	2550	89.5	5.99	0.474	0.110	5.3	0.068	0.064
FP18	LEV-SAN	49	42.0	7400	189.3	29.58	0.206	0.087	27.0	0.026	0.038
FP2	PALM-WOOD	27	19.8	5950	196.3	35.52	0.195	0.039	34.2	0.109	0.046
FP21	PALM-WOOD	27	19.8	5950	196.3	46.45	0.195	0.039	44.7	0.217	0.201
FP22	LEV-SAN	49	42.0	7400	189.3	29.58	0.206	0.087	27.0	0.060	0.055
FP23	LEV-SAN	49	42.0	7400	189.3	26.76	0.206	0.087	24.4	0.000	0.000
FP24	LEV-SAN	49	42.0	7400	189.3	29.58	0.206	0.087	27.0	0.000	0.016
FP25	PALM-WOOD	27	19.8	5950	196.3	31.78	0.195	0.039	30.6	0.047	0.018
FP26	MAST-WOOD	82	28.6	4000	101.8	8.55	0.428	0.122	7.5	0.071	0.066
FP27	LEV-SAN	49	42.0	7400	189.3	29.58	0.206	0.087	27.0	0.000	0.000
FP28	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.020	0.031
FP29	WAI-TURAN	62	23.3	2550	89.5	7.39	0.474	0.110	6.6	0.047	0.013
FP3	BULL-TAIH	83	26.0	4800	153.2	24.55	0.279	0.073	22.8	0.035	0.048
FP30	BULL-TAIH	83	26.0	4800	153.2	21.66	0.279	0.073	20.1	0.025	0.009
FP31	MAST-WOOD	82	28.6	4000	101.8	8.55	0.428	0.122	7.5	0.015	0.033
FP32	BULL-TAIH	83	26.0	4800	153.2	19.38	0.279	0.073	18.0	0.025	0.048
FP33	WAI-TURAN	62	23.3	2550	89.5	5.99	0.474	0.110	5.3	0.000	0.043
FP34	MAST-WOOD	82	28.6	4000	101.8	7.73	0.428	0.122	6.8	0.036	0.048
FP35	WAI-TURAN	62	23.3	2550	89.5	7.39	0.474	0.110	6.6	0.034	0.044
FP36	WAI-TURAN	62	23.3	2550	89.5	7.39	0.474	0.110	6.6	0.047	0.064
FP37	BULL-TAIH	83	26.0	4800	153.2	16.01	0.279	0.073	14.8	0.071	0.048
FP38	LEV-SAN	49	42.0	7400	189.3	33.06	0.206	0.087	30.2	0.043	0.055
FP39	BULL-TAIH	83	26.0	4800	153.2	19.38	0.279	0.073	18.0	0.035	0.032
FP4	LEV-SAN	49	42.0	7400	189.3	26.76	0.206	0.087	24.4	0.043	0.039
FP40	LEV-SAN	49	42.0	7400	189.3	33.06	0.206	0.087	30.2	0.060	0.025
FP41	WAI-TURAN	62	23.3	2550	89.5	5.99	0.474	0.110	5.3	0.000	0.088
FP42	LEV-SAN	49	42.0	7400	189.3	29.58	0.206	0.087	27.0	0.043	0.081
FP5	LEV-SAN	49	42.0	7400	189.3	24.43	0.206	0.087	22.3	0.026	0.026
FP6	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.020	0.020
FP7	BULL-TAIH	83	26.0	4800	153.2	21.66	0.279	0.073	20.1	0.035	0.032
FP8	MAST-WOOD	82	28.6	4000	101.8	7.73	0.428	0.122	6.8	0.015	0.033
FP9	WAI-TURAN	62	23.3	2550	89.5	5.99	0.474	0.110	5.3	0.047	0.020
K1	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.000	0.000
K10	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.022	0.000
K11	KAIK-AMB	141	14.9	2050	68.1	3.47	0.567	0.084	3.2	0.042	0.019
K12	KAIK-AMB	141	14.9	2050	68.1	3.47	0.567	0.084	3.2	0.009	0.009
K13	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.042	0.027
K14	BLEN-KAIK	132	16.8	2100	76.9	6.18	0.527	0.089	5.6	0.022	0.014
K15	KAIK-AMB	141	14.9	2050	68.1	3.47	0.567	0.084	3.2	0.030	0.014
K16	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.000	0.000
K17	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.022	0.014
K18	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.015	0.013
K19	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.030	0.019
K2	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.044	0.042
K20	KAIK-AMB	141	14.9	2050	68.1	4.85	0.567	0.084	4.4	0.030	0.009
K21	BLEN-KAIK	132	16.8	2100	76.9	4.68	0.527	0.089	4.3	0.003	0.004
K22	KAIK-AMB	141	14.9	2050	68.1	3.47	0.567	0.084	3.2	0.042	0.040
K23	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.000	0.000
K24	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.000	0.004
K25	KAIK-AMB	141	14.9	2050	68.1	3.17	0.567	0.084	2.9	0.030	0.013
K26	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.022	0.020
K27	BLEN-KAIK	132	16.8	2100	76.9	4.63	0.527	0.089	4.2	0.022	0.030
K28	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.030	0.038
K29	KAIK-AMB	141	14.9	2050	68.1	4.28	0.567	0.084	3.9	0.030	0.028
K3	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.032	0.020
K30	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.032	0.020
K31	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.044	0.042
K32	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.042	0.013
K33	KAIK-AMB	141	14.9	2050	68.1	3.47	0.567	0.084	3.2	0.030	0.039
K34	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.000	0.000
K35	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.030	0.028
K36	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.009	0.009
K37	KAIK-AMB	141	14.9	2050	68.1	3.83	0.567	0.084	3.5	0.042	0.028
k38	KAIK-AMB	141	14.9	2050	68.1	4.28	0.567	0.084	3.9	0.009	0.019
K39	BLEN-KAIK	132	16.8	2100	76.9	5.15	0.527	0.089	4.7	0.044	0.030
K4	BLEN-KAIK	132	16.8	2100	76.9	6.18	0.527	0.089	5.6	0.044	0.029
K40	KAIK-AMB	141	14.9	2050	68.1	3.47	0.567	0.084	3.2	0.042	0.019
K41	KAIK-AMB	141	14.9	2050	68.1	3.47	0.567	0.084	3.2	0.042	0.038
K42	BLEN-KAIK	132	16.8	2100	76.9	4.41	0.527	0.089	4.0	0.032	0.014
K5	KAIK-AMB	141	14.9	2050	68.1	4.28	0.567	0.084	3.9	0.030	0.038
K6	KAIK-AMB	141	14.9	2050	68.1	4.85	0.567	0.084	4.4	0.030	0.027
K7	KAIK-AMB	141	14.9	2050	68.1	4.28	0.567	0.084	3.9	0.030	0.040
K8	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.022	0.042
K9	BLEN-KAIK	132	16.8	2100	76.9	4.88	0.527	0.089	4.4	0.022	0.020
OA1	WELL-WAIPU	44	13.4	6400	197.3	40.70	0.193	0.026	39.6	0.133	0.126
OA10	WHANG-KAWA	54	14.6	5900	196.6	31.91	0.194	0.028	31.0	0.000	0.023
OA2	TAUR-WHAK	96	24.2	5900	223.8	37.39	0.155	0.037	36.0	0.031	0.041
OA3	TAUPO-TUR	52	17.0	6900	261.1	62.88	0.114	0.019	61.7	0.081	0.009
OA4	BOM-THAM	64	27.4	6200	188.8	29.41	0.207	0.057	27.7	0.020	0.007
OA5	WHANG-KAWA	54	14.6	5900	196.6	31.91	0.194	0.028	31.0	0.008	0.009
OA6	BOM-THAM	64	27.4	6200	188.8	32.87	0.207	0.057	31.0	0.065	0.042
OA7	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.034	0.064
OA8	WAI-TURAN	62	23.3	2550	89.5	5.47	0.474	0.110	4.9	0.034	0.031
OA9	WELL-WAIPU	44	13.4	6400	197.3	35.91	0.193	0.026	35.0	0.133	0.123
OW1	LEV-SAN	49	42.0	7400	189.3	29.58	0.206	0.087	27.0	0.043	0.026
OW10	MAST-WOOD	82	28.6	4000	101.8	7.73	0.428	0.122	6.8	0.000	0.069
OW11	LEV-SAN	49	42.0	7400	189.3	26.76	0.206	0.087	24.4	0.026	0.016
OW12	LEV-SAN	49	42.0	7400	189.3	24.43	0.206	0.087	22.3	0.120	0.113
OW13	BULL-TAIH	83	26.0	4800	153.2	19.38	0.279	0.073	18.0	0.035	0.032
OW14	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.020	0.013
OW15	WAI-TURAN	62	23.3	2550	89.5	7.39	0.474	0.110	6.6	0.068	0.043
OW16	WAI-TURAN	62	23.3	2550	89.5	7.39	0.474	0.110	6.6	0.034	0.031

						level of	reqd gap	reqd gap *		TT Cost	PEM Table
		km	%	vpd	vph	interactn/km	30	sight dist	Demand/Supply	$20.10	A5.15a
SURVNO	SECTION	Length	SightDist	TrafficVol	HrFlow	DEMAND	PCT-TIMEGAP	SUPPLY	UPD	WTP-TIME	WTP-DIST
OW17	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.020	0.043
OW18	LEV-SAN	49	42.0	7400	189.3	29.58	0.206	0.087	27.0	0.060	0.026
OW19	MAST-WOOD	82	28.6	4000	101.8	8.55	0.428	0.122	7.5	0.051	0.067
OW2	BULL-TAIH	83	26.0	4800	153.2	19.38	0.279	0.073	18.0	0.071	0.032
OW20	WANGA-HAW	91	17.6	4350	141.1	16.42	0.309	0.054	15.5	0.000	0.005
OW21	LEV-SAN	49	42.0	7400	189.3	26.76	0.206	0.087	24.4	0.000	0.016
OW22	LEV-SAN	49	42.0	7400	189.3	26.76	0.206	0.087	24.4	0.043	0.009
OW23	WAI-TURAN	62	23.3	2550	89.5	8.38	0.474	0.110	7.5	0.047	0.020
OW24	MAST-WOOD	82	28.6	4000	101.8	8.55	0.428	0.122	7.5	0.015	0.033
OW25	MAST-WOOD	82	28.6	4000	101.8	7.73	0.428	0.122	6.8	0.051	0.047
OW26	BULL-TAIH	83	26.0	4800	153.2	17.53	0.279	0.073	16.3	0.025	0.032
OW27	LEV-SAN	49	42.0	7400	189.3	33.06	0.206	0.087	30.2	0.060	0.113
OW28	LEV-SAN	49	42.0	7400	189.3	26.76	0.206	0.087	24.4	0.120	0.111
OW29	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.020	0.013
OW3	WAI-TURAN	62	23.3	2550	89.5	6.62	0.474	0.110	5.9	0.047	0.064
OW30	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.010	0.010
OW31	BULL-TAIH	83	26.0	4800	153.2	17.53	0.279	0.073	16.3	0.005	0.032
OW4	BLEN-KAIK	132	16.8	2100	76.9	5.45	0.527	0.089	5.0	0.032	0.030
OW5	LEV-SAN	49	42.0	7400	189.3	29.58	0.206	0.087	27.0	0.026	0.016
OW6	LEV-SAN	49	42.0	7400	189.3	26.76	0.206	0.087	24.4	0.026	0.026
OW7	WAI-TURAN	62	23.3	2550	89.5	7.39	0.474	0.110	6.6	0.034	0.031
OW8	MAST-WOOD	82	28.6	4000	101.8	7.73	0.428	0.122	6.8	0.051	0.048
OW9	BULL-TAIH	83	26.0	4800	153.2	17.53	0.279	0.073	16.3	0.025	0.022
R1	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.046	0.028
R10	RAE-WANG	91	4.1	1050	34.7	1.11	0.749	0.031	1.1	0.064	0.029
R11	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.000	0.000
R12	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.032	0.029
R14	RAE-WANG	91	4.1	1050	34.7	0.99	0.749	0.031	1.0	0.046	0.030
R15	TAUM-RAE	77	15.2	1700	63.3	3.70	0.590	0.090	3.4	0.016	0.016
R16	RAE-WANG	91	4.1	1050	34.7	1.11	0.749	0.031	1.1	0.014	0.009
R17	RAE-WANG	91	4.1	1050	34.7	1.11	0.749	0.031	1.1	0.064	0.000
R18	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.032	0.014
R19	RAE-WANG	91	4.1	1050	34.7	0.99	0.749	0.031	1.0	0.023	0.009
R2	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.064	0.060
R20	TAUM-RAE	77	15.2	1700	63.3	3.31	0.590	0.090	3.0	0.016	0.016
R21	TAUM-RAE	77	15.2	1700	63.3	3.31	0.590	0.090	3.0	0.038	0.034
R22	TAUM-RAE	77	15.2	1700	63.3	2.99	0.590	0.090	2.7	0.027	0.035
R23	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.046	0.002
R24	RAE-WANG	91	4.1	1050	34.7	0.90	0.749	0.031	0.9	0.032	0.021
R25	RAE-WANG	91	4.1	1050	34.7	1.11	0.749	0.031	1.1	0.014	0.014
R26	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.046	0.060
R27	TAUM-RAE	77	15.2	1700	63.3	3.31	0.590	0.090	3.0	0.005	0.000
R28	RAE-WANG	91	4.1	1050	34.7	0.95	0.749	0.031	0.9	0.005	0.002
R29	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.032	0.014
R3	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.032	0.000
R30	RAE-WANG	91	4.1	1050	34.7	0.99	0.749	0.031	1.0	0.032	0.020
R31	WAI-RAE	38	20.4	2150	70.5	4.10	0.556	0.113	3.6	0.154	0.102
R32	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.046	0.029
R33	TAUM-RAE	77	15.2	1700	63.3	3.31	0.590	0.090	3.0	0.038	0.016
R4	RAE-WANG	91	4.1	1050	34.7	1.11	0.749	0.031	1.1	0.014	0.021
R5	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.014	0.014
R6	RAE-WANG	91	4.1	1050	34.7	1.11	0.749	0.031	1.1	0.032	0.014
R7	RAE-WANG	91	4.1	1050	34.7	0.99	0.749	0.031	1.0	0.032	0.021
R8	WAI-RAE	38	20.4	2150	70.5	4.10	0.556	0.113	3.6	0.000	0.000
R9	RAE-WANG	91	4.1	1050	34.7	1.26	0.749	0.031	1.2	0.064	0.061
W1	PALM-WOOD	27	19.8	5950	196.3	28.76	0.195	0.039	27.6	0.078	0.018
W10	PALM-WOOD	27	19.8	5950	196.3	31.78	0.195	0.039	30.6	0.047	0.018
W11	WOOD-DANN	27	15.1	4550	175.9	25.54	0.231	0.035	24.7	0.016	0.069
W12	WOOD-DANN	27	15.1	4550	175.9	23.11	0.231	0.035	22.3	0.047	0.029
W13	WOOD-DANN	27	15.1	4550	175.9	25.54	0.231	0.035	24.7	0.109	0.029
W14	PALM-WOOD	27	19.8	5950	196.3	40.26	0.195	0.039	38.7	0.047	0.099
W15	WOOD-DANN	27	15.1	4550	175.9	28.55	0.231	0.035	27.6	0.109	0.069
W16	PALM-WOOD	27	19.8	5950	196.3	31.78	0.195	0.039	30.6	0.078	0.029
W17	WOOD-DANN	27	15.1	4550	175.9	28.55	0.231	0.035	27.6	0.155	0.072
W18	PALM-WOOD	27	19.8	5950	196.3	31.78	0.195	0.039	30.6	0.000	0.000
W19	PALM-WOOD	27	19.8	5950	196.3	28.76	0.195	0.039	27.6	0.078	0.098
W2	PALM-WOOD	27	19.8	5950	196.3	35.52	0.195	0.039	34.2	0.109	0.096
W20	MAST-WOOD	82	28.6	4000	101.8	7.06	0.428	0.122	6.2	0.015	0.022
W21	MAST-WOOD	82	28.6	4000	101.8	8.55	0.428	0.122	7.5	0.051	0.067
W22	PALM-WOOD	27	19.8	5950	196.3	40.26	0.195	0.039	38.7	0.000	0.030
W23	MAST-WOOD	82	28.6	4000	101.8	8.55	0.428	0.122	7.5	0.071	0.066
W24	PALM-WOOD	27	19.8	5950	196.3	35.52	0.195	0.039	34.2	0.078	0.070
W25	WOOD-DANN	27	15.1	4550	175.9	23.11	0.231	0.035	22.3	0.047	0.070
W26	PALM-WOOD	27	19.8	5950	196.3	35.52	0.195	0.039	34.2	0.078	0.098
W3	WOOD-DANN	27	15.1	4550	175.9	25.54	0.231	0.035	24.7	0.016	0.048
W4	PALM-WOOD	27	19.8	5950	196.3	40.26	0.195	0.039	38.7	0.047	0.046
W5	PALM-WOOD	27	19.8	5950	196.3	31.78	0.195	0.039	30.6	0.047	0.029
W6	WOOD-DANN	27	15.1	4550	175.9	25.54	0.231	0.035	24.7	0.109	0.029
W7	PALM-WOOD	27	19.8	5950	196.3	31.78	0.195	0.039	30.6	0.078	0.046
W8	PALM-WOOD	27	19.8	5950	196.3	28.76	0.195	0.039	27.6	0.047	0.018
W9	WOOD-DANN	27	15.1	4550	175.9	32.35	0.231	0.035	31.2	0.109	0.149
AS6									Average	**0.037**	**0.032**
F29											
F36											
F49											
F5											
F54											
FP19											
FP20											
R13											
F43											

A.5 Driver Frustration Significance Tests

Significant differences between groups (P < .05) are shown in **bold**

EXPECTATIONS (Pre Q.B)	*Sample size*	***Frustration S1.Q9 (%)***	*Time Cost from Sc.1 ($/km)*	*Dist Cost from Sc.2 ($/km)*
Terrible	18	**62.9**	0.034	0.023
Poor	85	**53.9**	0.041	0.037
Neutral	87	**43.6**	0.032	0.031
Good	90	**22.2**	0.040	0.032
Excellent	11	**16.3**	0.028	0.021
Total	291	**40.0**	0.037	0.032
P-value		**0.000**	0.181	0.145

RELATIVE SPEED (S1 Q.5)	*Sample size*	***Frustration (%)***	*Time cost ($/km)*	*Distance cost ($/km)*
Travelled slowly	48	**31.7**	0.048	0.036
Below average	73	**34.5**	0.037	0.029
Average Speed	75	**42.0**	0.036	0.032
Above average	46	**48.1**	0.032	0.028
Travelled quickly	49	**45.7**	0.035	0.039
Total	291	**40.0**	0.037	0.032
P-value		**0.021**	0.077	0.190

NO. OF VEHS NOT PASSED (S1 Q.7)	*Sample size*	***Frustration (%)***	*Time cost ($/km)*	*Distance cost ($/km)*
0 - 5	185	**30.4**	0.038	0.032
5 - 10	72	**56.4**	0.032	0.028
10 - 15	14	**60.6**	0.044	0.041
> 15	15	**63.3**	0.039	0.042
Total	286	**40.1**	0.037	0.032
P-value		**0.000**	0.248	0.096

% OF SECTION IMPEDED (derived from S1 Q.7a)	*Sample size*	***Frustration (%)***	***Time cost ($/km)***	***Distance cost ($/km)***
0 - 20	203	**31.9**	**0.033**	**0.030**
20 - 40	57	**38.8**	**0.040**	**0.033**
40 - 60	19	**57.6**	**0.054**	**0.054**
> 60	12	**57.8**	**0.062**	**0.038**
Total	291	**40.0**	**0.037**	**0.032**
P-value		**0.000**	**0.000**	**0.000**

VEHICLE TYPE (S2 Q.3)	*Sample size*	*Frustration (%)*	*Time cost ($/km)*	*Distance cost ($/km)*
Heavy commercial vehicle	22	26.5	0.042	0.041
Vehicle towing	5	31.8	0.053	0.053
Low powered Car	17	30.7	0.037	0.032
Average Car	197	42.0	0.036	0.030
High powered car	40	44.4	0.037	0.036
Motorbike	3	35.3	0.023	0.023
Total	288	40.2	0.037	0.032
P-value		0.148	0.719	0.185

TRIP PURPOSE (S2 Q.4)	*Sample size*	*Frustration (%)*	*Time cost ($/km)*	*Distance cost ($/km)*
Visiting family/friends	90	39.0	0.035	0.032
Recreation and Leisure	137	38.1	0.038	0.032
Work Related	51	47.2	0.039	0.037
Other	10	45.0	0.037	0.023
Total	288	40.3	0.037	0.033
P-value		0.295	0.819	0.431

FREQUENCY OF TRIP MADE (S2 Q.5)	*Sample size*	***Frustration* (%)**	*Time cost ($/km)*	*Distance cost ($/km)*
Never Before	40	**34.0**	0.033	0.029
Once every 2 years	38	**43.9**	0.031	0.031
Once a year - once every 2 years	35	**47.1**	0.037	0.033
Once a month - Once a year	102	**33.9**	0.038	0.034
Once a week - Once a month	46	**38.9**	0.440	0.0345
Once a week	19	**58.3**	0.035	0.028
Daily	11	**56.5**	0.044	0.030
Total	291	**40.0**	0.037	0.032
P-value		**0.004**	0.452	0.943

AGE (S2 Q.6)	*Sample size*	*Frustration (%)*	*Time cost ($/km)*	*Distance cost ($/km)*
< 26 years old	29	48.0	0.036	0.030
26 - 40	92	44.2	0.040	0.036
41 - 60	123	36.7	0.037	0.033
> 61 years old	44	35.6	0.034	0.026
Total	288	40.0	0.037	0.032
P-value		0.104	0.774	0.192

GENDER (S2 Q.7)	*Sample size*	*Frustration (%)*	*Time cost ($/km)*	*Distance cost ($/km)*
Male	204	38.8	0.036	0.031
Female	84	43.3	0.041	0.035
Total	288	40.0	0.037	0.032
P-value		0.250	0.205	0.240

DRIVING STYLE (S2 Q.9)	*Sample size*	*Frustration (%)*	***Time cost ($/km)***	*Distance cost ($/km)*
Passive	11	33.8	**0.035**	0.021
Passive/Moderate	56	35.9	**0.050**	0.035
Moderate	178	40.6	**0.035**	0.032
Aggressive/Moderate	43	43.0	**0.032**	0.035
Aggressive	3	66.7	**0.011**	0.033
Total	288	40.0	**0.037**	0.032
P-value		0.373	**0.003**	0.606

HOURLY FLOW (vph) (from route data)	*Sample size*	***Frustration (%)***	***Time cost ($/km)***	***Distance cost ($/km)***
30 - 80 veh/hr	120	**51.5**	**0.028**	**0.023**
80 - 130	57	**33.3**	**0.037**	**0.038**
130 - 180	40	**30.4**	**0.045**	**0.040**
180 - 230	73	**31.9**	**0.047**	**0.040**
230 - 280 veh/hr	1	**57.0**	**0.081**	**0.009**
Total	291	**40.0**	**0.037**	**0.032**
P-value		**0.000**	**0.000**	**0.000**

LENGTH OF ROAD SECTION (km)	*Sample size*	***Frustration (%)***	***Time cost ($/km)***	***Distance cost ($/km)***
25 - 45 km	29	**33.0**	**0.077**	**0.062**
45 - 65	50	**34.5**	**0.039**	**0.037**
65 - 85	97	**32.9**	**0.036**	**0.032**
85 - 105	25	**58.8**	**0.033**	**0.021**
105 - 125	0	**N/A**	**N/A**	**N/A**
125 - 145 km	88	**48.2**	**0.025**	**0.023**
Total	291	**40.0**	**0.037**	**0.032**
P-value		**0.000**	**0.000**	**0.000**

SIGHT DISTANCE (from route data)	*Sample size*	***Frustration (%)***	*Time cost ($/km)*	*Distance cost ($/km)*
0 - 20 %	166	**45.7**	0.036	0.030
20 - 40 %	52	**30.9**	0.039	0.040
> 40 %	73	**33.9**	0.038	0.031
Total	291	**40.0**	0.037	0.032
P-value		**0.001**	0.817	0.059

UNSATISFIED PASSING DEMAND	*Sample size*	***Frustration (%)***	***Time cost ($/km)***	***Distance cost ($/km)***
0 - 10	178	**45.4**	**0.031**	**0.028**
10 - 20	29	**32.8**	**0.033**	**0.031**
20 - 30	69	**29.6**	**0.046**	**0.035**
> 30	15	**39.9**	**0.078**	**0.078**
Total	291	**40.0**	**0.037**	**0.032**
P-value		**0.001**	**0.000**	**0.000**

A.6 Correlation of Frustration Survey Answers

(Values given below are Pearson r-values)
* indicates correlations significant at p=.05. Correlations > ± 0.50 are shown in bold.

	Traf Flow	Traf Spd	Sat Spd	Rel Spd	Sat Impd	Vehs NPass	Time NPass	Sect Time	Pct Sect	Sat Pass	Frustr Other	Trip Freq	Drvr Style	Driv Spd	Sect Leng	Sight Dist	Traf Vol	Hrly Flow	Demd	UPD	WTP Time	WTP Dist
Route Expectation (Pre Q.B)	-.03	.30*	-.20*	-.13	-.32*	-.16*	-.15*	-.15*	-.09	-.48*	-.40*	-.15*	-.02	.10	-.08	.23*	.23*	.21*	.12	.10	.05	.02
Traffic Flow (S1 Q.2)		-.04	.30*	-.02	.12	.22*	.14*	-.01	.11	.11	.12	.16*	-.15*	-.01	-.01	.22*	.12	.07	.07	.04	.09	-.03
Traffic Speed (S1 Q.3)			-.22*	-24*	-.41*	-.16*	-.13	-.29*	0	-.22*	-.25*	.08	.03	.08	0	.38*	.28*	.19*	.01	-.03	-.02	-.09
Satisfaction with Traffic Speed (S1 Q.4)				.17*	.54*	.34*	.40*	0	.36*	.35*	.38*	.05	.06	.13*	-.07	.03	0	.02	.04	.04	.14*	.12
Relative Speed (S1 Q.5)					.35*	.34*	.70	.11	-.02	.20*	.17*	-.19*	.37*	.45*	.05	-.11	-.08	-.06	-.02	-.01	-.16*	.05
Satisfaction at being impeded (S1 Q.6)						.35*	.38*	.16*	.29*	**.51***	**.56***	.02	.10	.14*	.05	-.17*	-.17*	-.15*	-.08	-.07	-.04	.09
No. Of Vehs not passed (S1 Q.7)							.38*	.26*	.19*	.30*	.21*	-.01	.18*	.24*	.22*	.01	-.10	-.12	-.11	-.12	-.01	.07
Time lost by not passing (S1 Q.7a)								.25*	**.81***	.35*	.37*	-.10	-.08	.05	.21*	-.14*	-.21*	-.19*	-.17*	-.16*	.03	.03
Section travel time (from route data)									-.22*	.23*	.24*	-.20*	.03	-.05	**.95***	-.38*	**-.66***	**-.71***	**-.69**	**-.68***	-.40*	-.34*
Time lost as % of section time (calculated from 7a)										.22*	.22*	-.02	-.08	.06	-.24*	-.01	.08	.15*	.17*	.18*	.24*	.23*
Satisfaction with passing opps (S1 Q.8)											**.70***	.13	.07	.07	.17*	-.18*	-.24*	-.23*	-.18*	-.16*	-.05	-.03
Frustration with this route vs others (S1 Q.9)												.09	.05	.10	.19*	-.17*	-.26*	-.29*	-.23*	-.22*	-.06	-.09
Frequency of trip (S2 Q.5)													-.07	-.16*	-.20*	.21*	.19*	.08	.10	.06	.11	.30
Driving Style (S2 Q.9)														.41*	.05	.01	.03	.04	.02	.02	-.18*	.08
Preferred Driving Speed (S2 Q.10)															-.01	.07	.06	.07	.05	.05	-.16*	.05
Section Length (from route data)																-.29*	**-.61***	**-.69***	**-.71***	**-.71***	-.42*	-.38*
% of Available Sight Distance (from route data)																	**.79***	**.58***	.46*	.34*	.09	.07
Daily Traffic Volume (from route data)																		**.94***	**.88***	**.81***	.30*	.25*
Hourly Traffic Flow (calculated)																			**.97***	**.94***	.37*	.31*
Passing Demand (calculated)																				**.99***	.39*	.33*
Unsatisfied Passing Demand UPD (calculated)																					.40*	.34*
Willingness to pay based on Time (derived from Sc.1)																						**.59***
Willingness to pay based on Distance (derived from Sc.2)																						

A.7 Crash Database Structures

Note - Field Types:
C - Character D - Date
N - Numeric L - Logical

SITES.DBF

Field Name	Type	Size	Dec	Comment
CODE	C	19		SH/RS/RP location
NAME	C	60		Description of location
TYPE	C	10		Tack-on, Realign, etc
CONS_ST	D			Date of Construction Start
CONS_END	D			Date of Construction End
CONSTRN	N	6	2	Groupings for construction period
LENGTH	N	6	2	Passing Lane Length (km)
PL_LEN	N	6	0	Groupings for PL Length
AADT_NEG5	N	9	0	AADT 5 yrs before construction
AADT_0	N	9	0	AADT during construction
AADT_POS5	N	9	0	AADT 5 yrs after construction
TRAFFIC	N	6	0	Groupings for construction AADT
YRS_BEFORE	N	6	2	Years of crash data before constrn
YRS_AFTER	N	6	2	Years of crash data after constrn
INITL_VOLM	N	9	0	AADT at start of crash data
FINAL_VOLM	N	9	0	AADT at end of crash data
TRAF_BEFOR	N	12	0	Total traffic before construction
TRAF_AFTER	N	12	0	Total traffic after construction
INCLUDE	L			Include this site in analysis? (Y/N)

CRASHES.DBF

Field Name	Type	Size	Dec	Comment
CODE	C	19		SH/RS/RP location
REL_DISP	N	8	2	Crash location relative to passing lane
REL_YR	N	8	2	Time of crash relative to construction
CRASH_CODE	C	2		LTSA crash movement code
CODETYPE	C	1		First letter of crash movement code
SEVERITY	C	2		(F)atal, (S)erious, (M)inor, (N)on-injury
INJURY	L			Injury crash? (Y/N)
SPEED_LIM	N	3	0	Speed limit at crash location
PL_DIRN	C	10		In Same Dirn or Opp Dirn to passing lane
TIME	N	2	0	Before (-1), during (0) or after (1) constrn
LOCATION	N	3	0	Groupings for crash location

A.8 Summary of Passing Lanes Studied

Location (SH/RS/RP)	Description	Type	Construction Period		Length (km)	Traffic before Constrn (5 yrs) (tot vehs)	Traffic after Constrn (5 yrs) (tot vehs)	Include in Analysis (Y/N)	Crashes Before	Crashes After
			Start	End						
10/63/10.5-11.7	Mangonui	REALIGN	01/01/91	31/12/91	1.20	2,135,250	2,518,500	N	6	22
14/0/10.1-8.8	Kara Road	TACK-ON	01/01/88	31/12/88	1.30	6,387,500	6,706,875	Y	22	49
14/0/3.5-4.5	Austins Road	TACK-ON	01/01/87	31/12/87	1.00	6,159,375	7,163,125	Y	27	53
1N/144/8.0-9.0	Piano Hill	MIXED	01/01/86	31/12/86	1.00	8,161,400	11,178,125	Y	40	69
1N/203/14.0-14.7	Brynderwyn South	MIXED	01/01/88	31/12/88	0.70	6,387,500	6,935,000	Y	27	83
1N/220/3.6-1.2	Concrete Works	TACK-ON	01/01/85	31/12/85	2.40	3,920,100	7,573,750	N	16	56
1N/220/7.9-6.2	Kaiwaka North	TACK-ON	01/01/87	31/12/87	1.70	7,135,750	9,599,500	N	4	14
1N/237/8.48-8.91	Littens	TACK-ON	01/01/86	31/12/86	0.43	6,044,400	8,896,875	Y	3	16
1N/248/11.70-12.33	Dome Hill Sthbnd	TACK-ON	01/11/89	31/03/90	0.63	11,446,400	12,770,438	N	42	110
1N/248/13.64-13.08	Dome Hill Nthbnd	TACK-ON	01/09/88	31/03/89	0.56	10,402,500	12,437,375	Y	47	145
1N/264/9.095-9.898	Pohuehue - enlarged	TACK-ON	01/01/90	30/11/90	0.80	12,846,175	15,129,250	N	0	130
1N/274/0.160-0.585	Pohuehue - original	TACK-ON	01/01/86	31/12/86	0.43	8,443,180	14,371,875	N	28	53
1N/274/12.452-11.90	Johnsons Hill	TACK-ON	01/01/89	31/05/89	0.55	13,915,625	18,250,000	N	48	121
1N/274/4.168-2.511	Windy Ridge, enlarged	TACK-ON	01/01/92	31/12/92	1.66	11,862,500	11,767,600	N	0	112
1N/274/4.168-3.644	Schedewys - original	TACK-ON	01/01/89	31/10/89	0.52	11,862,500	14,965,000	N	55	53
1N/592/0.54-1.11	Tutukau Road	TACK-ON	01/01/86	31/12/86	0.57	3,036,800	6,168,500	Y	15	34
1N/592/12.5-11.8	Double D	TACK-ON	01/01/90	31/12/90	0.70	3,713,875	6,168,500	Y	16	22
1N/592/9.7-8.9	Palmer Mill Road	TACK-ON	01/01/90	31/12/90	0.80	3,713,875	6,168,500	Y	25	48
1N/617/10.79-12.55	Earthquake Gully	REALIGN	01/01/87	31/12/87	1.76	4,512,312	6,236,938	Y	29	25
1N/617/19.94-17.57	Hatepe Hill	REALIGN	01/01/87	31/12/87	2.37	4,512,312	6,236,938	Y	37	27
1N/728/7.40-6.50	Nth of Waiaruhe Rd	TACK-ON	01/10/89	28/02/90	0.90	5,365,500	6,624,750	Y	31	37
1N/780/1.15-2.17	Mangaweka South	REALIGN	01/09/85	30/04/86	1.02	4,345,500	6,789,000	Y	39	46
1N/817/5.08-6.40	Mangaraupa	REALIGN	01/10/89	30/04/91	1.32	6,650,300	8,166,875	Y	15	35
1S/247/0.18-0.52	Hurunui	MIXED	01/01/85	31/12/85	0.34	1,443,210	2,819,625	N	5	12
1S/247/4.07-5.22	Greta Cutting	MIXED	01/01/87	31/12/87	1.15	2,281,250	2,819,625	Y	4	18

Location (SH/RS/RP)	Description	Type	Construction Period		Length (km)	Traffic before Constrn (5 yrs) (tot vehs)	Traffic after Constrn (5 yrs) (tot vehs)	Include in Analysis (Y/N)	Crashes Before	Crashes After
			Start	End						
1S/774/4.2-5.5	Lovells Flat	TACK-ON	01/01/93	31/12/93	1.30	13,085,250	8,629,695	Y	28	20
2/130/16.1-15.48	Clarkes Hill	REALIGN	01/10/87	31/05/88	0.62	9,704,438	12,848,000	Y	67	70
2/130/8.4-8.9	Brunnings	TACK-ON	01/06/87	31/05/88	0.50	9,704,438	12,848,000	Y	63	67
2/73/15.79-16.68	Campbell Rd Incr.	MIXED	01/12/86	31/03/87	0.89	6,433,454	8,477,125	Y	18	18
2/73/16.83-16.44	Campbell Rd Decr.	MIXED	01/12/86	31/03/87	0.39	6,433,454	8,477,125	Y	22	43
2/73/3.54-4.08	Turners Hill Incr.	TACK-ON	01/12/91	31/03/92	0.54	6,684,062	8,026,788	Y	57	52
2/73/4.38-3.68	Turners Hill Decr.	TACK-ON	01/12/91	31/03/92	0.70	6,684,062	8,026,788	N	59	58
2/772/8.05-8.51	Tahoriati	TACK-ON	01/02/94	31/05/94	0.46	6,323,625	4,142,996	N	38	39
3/250/0.00-1.00	Mangamahoe South	TACK-ON	01/01/88	31/12/88	1.00	11,223,750	11,205,500	Y	45	76
3/250/1.90-1.00	Mangamahoe North	TACK-ON	01/01/88	31/12/88	0.90	11,223,750	11,205,500	Y	87	91
3/269/0.30-1.30	Waipuku South	TACK-ON	01/01/87	31/12/87	1.00	10,575,875	10,758,375	Y	27	53
3/269/3.00-1.60	Croydon Road Sth	TACK-ON	01/01/89	31/12/89	1.40	9,690,750	10,247,375	Y	43	80
3/279/5.80-5.00	Ngaere North	TACK-ON	01/01/89	31/12/90	0.80	10,046,625	11,251,125	Y	17	69
3/279/6.80-7.60	Ngaere School	TACK-ON	01/01/89	31/12/90	0.80	10,046,625	11,251,125	Y	8	29
3/287/1.10-0.20	Andersons Rd Nth	TACK-ON	01/01/89	31/12/90	0.90	10,046,625	11,251,125	Y	6	23
3/287/4.70-5.20	Mangawhero Road	TACK-ON	01/01/89	31/12/90	0.50	8,563,812	9,581,250	Y	16	31
3/371/12.28-11.89	North of Kaiiwi	MIXED	01/10/87	31/05/88	0.39	5,739,625	6,497,000	N	14	38
3/371/3.80-3.24	Birch Park	REALIGN	01/12/86	31/03/88	0.56	4,546,068	4,763,250	N	15	24
3/371/8.44-6.73	Maxwell-Okehu	REALIGN	01/11/92	31/05/94	1.71	5,164,750	2,641,781	N	25	28
3/450/4.10-5.30	East Sanson	TACK-ON	01/09/94	31/12/94	1.20	10,940,875	5,106,350	N	70	30
45/0/12.80-10.20	Tapuae North	MIXED	01/01/89	31/12/89	2.60	5,146,500	5,803,500	Y	49	50
45/0/12.80-13.80	Tapuae South	MIXED	01/01/89	31/12/89	1.00	5,146,500	5,803,500	Y	30	46
45/15/9.50-10.20	Leith Road	TACK-ON	01/01/89	31/12/89	0.70	3,275,875	3,403,625	Y	19	19
57/0/11.01-12.17	Potts Hill	REALIGN	01/07/94	30/06/95	1.16	8,714,375	2,813,621	N	55	20
7/16/4.93-4.01	Karaka Hill	MIXED	01/01/93	31/12/93	0.92	3,075,125	2,054,220	Y	9	9
8/328/8.10-8.60	Butchers Dam	TACK-ON	01/01/88	31/03/89	0.50	2,427,250	2,573,250	Y	5	17

A.9 LTSA Movement Codes associated with each Crash Type

Crash Type	**LTSA Movement Codes**
Overtaking	A*, GB, GE
Straight Head-On / Lost-Control	C*, BA, BE on straight
Curve Head-On / Lost-Control	D*, BB, BC, BD, BE on curve
Rear-End / Obstruction	E*, F*, M*, GA, GD, GF
Intersection	H*, J*, K*, L*, GC
Pedestrian	N*, P*
Miscellaneous	Q*

Note: to simplify data matching, all BE crashes were taken to be "Straight Head-On / Lost-Control"

A.10 Details of Conceptual Model Analyses

Note: the attached calculations are based on draft worksheets for incorporation into Transfund's Project Evaluation Manual, hence their format. In particular, Worksheets A10.4 are designed to establish monetary values for travel time saved, but the equivalent value in terms of hours saved has also been included here.

Only a sample of Worksheets A10.2 (used to calculate Unsatisfied Passing Demand) have been included for the reader's information. To have included them for every combination of road segment and time period would have involved a considerable number of sheets. The resulting UPD values are summarised in the appropriate Worksheet A10.3.

A.11 Details of Simple TRARR Analyses

Bulls West analysis length with passing lane

H3PL.ROD

DSS	DENDS	DUR	NURD	DESIRED 85%ILE SPEED	BENDINESS	IRI
11700.00	1000.00	100.00	117	108.6	23.8	2.5

CHAINAGE KM	BARRIER LINES (1 OR -1)		AUXILIARY LANES (T OR F)		ROAD SPEED INDICES		SIGHT DISTANCE M	M	GRADE (DIR 1) UP +VE	CURVE RADIUS M	85%ILE SPEED KMH	COMMENTS
428.0	1	1	F	F	81	81	109.00	330.00	0.25	9999	103.6	
428.1	1	1	F	F	61	61	809.00	150.00	-1.56	9999	106.0	
428.2	1	1	F	F	62	62	710.00	149.00	-3.12	9999	97.4	
428.3	1	1	F	F	81	81	610.00	250.00	-1.87	9999	103.6	
428.4	1	1	F	F	61	61	470.00	369.00	-0.35	9999	106.0	
428.5	1	1	F	F	81	81	369.00	510.00	1.49	9999	103.6	
428.6	1	1	F	F	81	81	269.00	620.00	0.88	9999	103.6	
428.7	1	1	F	F	81	81	170.00	750.00	1.45	9999	103.6	
428.8	1	1	F	F	82	82	279.00	869.00	2.09	2700	95.8	
428.9	1	1	F	F	7	7	369.00	980.00	1.07	530	72.4	
429.0	1	1	F	F	23	23	260.00	179.00	0.41	1350	87.4	RS 432
429.1	1	1	F	F	81	81	190.00	279.00	1.53	9999	103.6	
429.2	1	1	F	F	81	81	460.00	379.00	1.11	9999	103.6	
429.3	1	1	F	F	61	61	360.00	229.00	-0.10	9999	106.0	
429.4	1	1	F	F	61	61	230.00	209.00	-0.76	9999	106.0	
429.5	1	1	F	F	81	81	149.00	330.00	1.80	9999	103.6	
429.6	1	1	F	F	81	81	449.00	500.00	1.96	9999	103.6	
429.7	1	1	F	F	81	81	340.00	139.00	0.29	9999	103.6	
429.8	1	1	F	F	81	81	450.00	239.00	1.27	9999	103.6	
429.9	1	1	F	F	81	81	350.00	320.00	0.59	9999	103.6	
430.0	1	1	F	F	81	81	299.00	410.00	0.68	9999	103.6	432/1.0
430.1	1	1	F	F	81	81	239.00	309.00	0.01	9999	103.6	
430.2	1	1	F	F	81	81	230.00	399.00	0.47	9999	103.6	
430.3	1	1	F	F	23	23	290.00	359.00	-0.38	1370	87.4	
430.4	1	1	F	F	46	46	850.00	220.00	-1.20	480	71.2	
430.5	1	1	F	F	63	63	739.00	230.00	-1.37	2080	92.7	
430.6	1	1	F	F	61	61	639.00	300.00	-0.65	9999	106.0	
430.7	1	1	F	F	61	61	540.00	389.00	-0.58	9999	106.0	
430.8	1	1	F	F	61	61	429.00	489.00	-1.06	9999	106.0	
430.9	1	1	F	F	81	81	320.00	579.00	0.16	9999	103.6	
431.0	1	1	F	F	81	81	220.00	679.00	0.68	9999	103.6	432/2.0
431.1	1	1	F	F	81	81	119.00	779.00	1.48	9999	103.6	
431.2	1	1	F	F	81	81	300.00	879.00	2.11	9999	103.6	
431.3	1	-1	F	F	61	61	200.00	119.00	-1.11	9999	106.0	
431.4	1	-1	F	F	61	61	119.00	190.00	-1.29	9999	106.0	
431.5	1	1	F	F	61	61	500.00	290.00	-1.00	9999	106.0	
431.6	1	1	F	F	22	22	369.00	120.00	-4.06	9999	90.8	
431.7	1	1	F	F	61	61	160.00	220.00	-1.35	9999	106.0	
431.8	1	1	F	F	81	81	200.00	359.00	0.41	9999	103.6	
431.9	1	1	F	F	61	61	579.00	450.00	-1.18	9999	106.0	
432.0	1	1	F	F	61	61	449.00	209.00	-1.45	9999	106.0	432/3.0
432.1	1	1	F	F	81	81	289.00	180.00	-2.15	9999	103.6	
432.2	-1	1	F	F	81	81	160.00	419.00	1.53	9999	103.6	
432.3	-1	1	F	F	81	81	100.00	1079.00	5.41	9999	103.6	
432.4	1	-1	F	F	81	81	179.00	109.00	3.55	9999	103.6	
432.5	1	-1	F	F	81	81	669.00	140.00	0.79	9999	103.6	
432.6	1	1	F	F	61	61	559.00	180.00	-0.26	9999	106.0	
432.7	1	1	F	F	81	81	470.00	269.00	0.22	9999	103.6	
432.8	1	1	F	F	81	81	380.00	359.00	0.22	9999	103.6	
432.9	1	1	F	F	61	61	260.00	450.00	-0.29	9999	106.0	
433.0	1	1	F	F	81	81	190.00	559.00	0.63	9999	103.6	432/4.0
433.1	1	1	F	F	81	81	299.00	660.00	0.47	9999	103.6	
433.2	1	1	F	F	61	61	210.00	209.00	-0.34	9999	106.0	
433.3	1	1	F	F	61	61	350.00	209.00	-0.38	9999	106.0	
433.4	1	1	F	F	61	61	540.00	309.00	-0.26	9999	106.0	
433.5	1	1	F	F	61	61	440.00	170.00	-0.82	9999	106.0	
433.6	1	1	F	F	61	61	349.00	270.00	-0.19	9999	106.0	
433.7	1	1	F	F	61	61	250.00	359.00	-0.92	9999	106.0	
433.8	1	1	F	F	81	81	149.00	470.00	0.88	9999	103.6	
433.9	1	1	F	F	26	26	260.00	609.00	1.80	620	75.1	
434.0	1	1	F	F	25	25	979.00	100.00	-0.65	790	79.8	432/5.0

434.1	1	1	F	F	61	61	639.00	190.00	-0.82	9999	106.0	
434.2	1	1	F	F	81	81	520.00	269.00	-1.64	9999	103.6	
434.3	1	1	F	F	61	61	250.00	369.00	-0.72	9999	106.0	
434.4	1	1	F	F	81	81	329.00	489.00	0.18	9999	103.6	
434.5	1	1	F	F	81	81	470.00	589.00	0.20	9999	103.6	
434.6	1	1	F	F	61	61	379.00	680.00	-0.46	9999	106.0	
434.7	1	1	F	F	61	61	290.00	289.00	-0.18	9999	106.0	
434.8	1	1	F	F	61	61	179.00	369.00	-0.58	9999	106.0	
434.9	1	1	F	F	81	81	360.00	480.00	0.46	9999	103.6	
435.0	1	1	F	F	61	61	279.00	170.00	-0.79	9999	106.0	432/6.0
435.1	1	1	F	F	61	61	209.00	250.00	-0.52	9999	106.0	
435.2	1	1	F	F	66	66	370.00	369.00	0.35	710	77.4	
435.3	1	1	F	F	23	23	279.00	259.00	-0.67	1300	87.4	
435.4	1	1	F	F	61	61	179.00	230.00	-1.28	9999	106.0	
435.5	1	1	F	F	61	61	729.00	330.00	-0.40	9999	106.0	
435.6	1	1	F	F	81	81	619.00	390.00	-1.68	9999	103.6	
435.7	1	1	F	F	81	81	510.00	189.00	-2.18	9999	103.6	
435.8	1	1	F	F	61	61	420.00	299.00	-0.23	9999	106.0	
435.9	1	1	F	F	61	61	329.00	410.00	-0.20	9999	106.0	
436.0	1	1	F	F	61	61	229.00	190.00	-0.88	9999	106.0	432/7.0
436.1	1	1	F	T	61	61	139.00	290.00	-0.23	9999	106.0	------
436.2	1	-1	F	T	61	61	220.00	389.00	-0.68	9999	106.0	/|\
436.3	1	-1	F	T	81	81	130.00	239.00	-2.22	9999	103.6	|
436.4	1	-1	F	T	81	81	269.00	239.00	-1.62	9999	103.6	|
436.5	1	-1	F	T	2	2	169.00	170.00	-3.05	9999	99.1	|
436.6	1	-1	F	T	45	45	119.00	270.00	-2.01	610	74.7	Passing
436.7	1	-1	F	T	6	6	620.00	149.00	-3.44	880	77.9	Lane
436.8	1	-1	F	T	69	69	480.00	109.00	-6.38	9999	64.0	|
436.9	1	-1	F	T	64	64	360.00	230.00	-4.26	9999	88.9	|
437.0	1	-1	F	T	81	81	260.00	369.00	-2.19	9999	103.6	|
437.1	-1	1	F	T	81	81	160.00	470.00	-2.40	9999	103.6	------
437.2	1	1	F	F	61	61	210.00	599.00	-1.08	9999	106.0	
437.3	1	-1	F	F	2	2	140.00	119.00	-2.98	9999	99.1	
437.4	1	1	F	F	45	45	250.00	179.00	-4.01	780	74.7	
437.5	1	1	F	F	51	51	1609.00	110.00	-6.65	550	56.3	
437.6	1	1	F	F	51	51	1479.00	190.00	-6.93	1120	56.3	
437.7	1	1	F	F	41	41	200.00	289.00	-4.47	9999	85.3	
437.8	1	1	F	F	61	61	220.00	369.00	-0.50	9999	106.0	
437.9	1	1	F	F	61	61	1179.00	459.00	-1.28	9999	106.0	
438.0	1	-1	F	F	63	63	1079.00	179.00	-2.46	2440	92.7	432/9.0
438.1	1	1	F	F	81	81	679.00	260.00	-2.17	9999	103.6	
438.2	1	1	F	F	61	61	580.00	369.00	-0.76	9999	106.0	
438.3	1	1	F	F	61	61	480.00	479.00	-0.74	9999	106.0	
438.4	1	1	F	F	61	61	380.00	579.00	-0.59	9999	106.0	
438.5	1	1	F	F	61	61	279.00	300.00	-0.57	9999	106.0	
438.6	1	1	F	F	61	61	569.00	410.00	-0.08	9999	106.0	
438.7	1	1	F	F	22	22	480.00	909.00	0.15	1850	90.8	
438.8	1	1	F	F	4	4	369.00	589.00	-0.80	1690	90.0	
438.9	1	1	F	F	4	4	269.00	239.00	-0.41	1670	90.0	
439.0	1	1	F	F	81	81	199.00	809.00	0.60	9999	103.6	432/10.0
439.1	1	1	F	F	61	61	259.00	670.00	-0.16	9999	106.0	
439.2	1	1	F	F	61	61	180.00	259.00	-0.63	9999	106.0	
439.3	1	1	F	F	84	84	999.00	190.00	-1.00	1410	87.9	
439.4	1	1	F	F	87	87	999.00	230.00	-2.23	510	71.7	
439.5	1	1	F	F	81	81	559.00	200.00	-2.00	9999	103.6	
439.6	1	1	F	F	61	61	459.00	320.00	-1.35	9999	106.0	
439.7	1	1	F	F	61	61	360.00	399.00	-1.40	9999	106.0	

Note: the "Do Minimum" case differs from the above only in the removal of the auxiliary lane between 436.1 and 437.1.

Traffic Data for 210 veh/hr (used with Bulls West)

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210 Vehs/hr
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WHERE NOT SPECIFIED UNITS ARE IN SECONDS, METRES AND KM/H.

     1.0  BASIC TIME UNIT FOR THE SIMULATION (TUN)
  3600.0  SETTLING DOWN TIME FOR THE SIMULATION (TSE)
 40000.0  DURATION OF THE SIMULATION (TSI); NOTE THAT THE PROGRAM KEEPS RUNNING
            UNTIL ALL VEHICLES WHICH ARRIVED IN THIS TIME HAVE DEPARTED.
       0  OPTION: 1=STANDARD; 2=USE ITRAF; 3=USE PBAYS; 4=PLOT;
            5=GRAFIC DISPLAY; 6=TIME DISPLAY
   100.0  LENGTH OF NO OVERTAKING TO CREATE BUNCHING IN DIRECTION 1 (DTS1)
   100.0  LENGTH OF NO OVERTAKING TO CREATE BUNCHING IN DIRECTION 2 (DTS2)
    23.0  PERCENT FOLLOWING IN PLATOONS ON ARRIVAL IN DIRECTION 1 (PFOL1)
    19.0  PERCENT FOLLOWING IN PLATOONS ON ARRIVAL IN DIRECTION 2 (PFOL2)
            NOTE ZERO %FOLL GIVES RANDOM ARRIVALS; NEG %FOLL USES DEFAULTS.
       2  NUMBER OF VEHICLE GENERATION CATEGORIES (NSTR); CHECK FORMATS IN THIS
            FILE IF NSTR IS CHANGED.  ONLY NSTR OF THE COLUMNS BELOW ARE READ.
529515.0  RANDOM SEED NUMBER (NSEEDO); RANGE IS 0. TO 999999.
       0  ICHECK: 1=PRINT INPUT DATA TO FILE CHKOUT FOR CHECKING; 0=NO CHECK

THE REMAINING PARAMETERS DESCRIBE THE SIMULATED TRAFFIC STREAM
ADTV: PROPORTIONS OF VEHICLE TYPES IN VARIOUS CATEGORIES
************************************************************************
*    NZ 1986 TRAFFIC GENERATION CATEGORIES USE NSTR 2(1&2 ONLY)    * TYPE   *
************************************************************************
CARS    TRUCKS  RECVEHS LTRUCK  HTRUCK  EXTRA1  EXTRA2  EXTRA3     *        *
0.      0.03    0.      0.      0.00    0.      0.      0.         *   1    *
0.      0.08    0.      0.      0.00    0.      0.      0.         *   2    *
0.      0.11    0.      0.      0.00    0.      0.      0.         *   3    *
0.      0.06    0.      0.      0.00    0.      0.      0.         *   4    *
0.      0.15    0.      0.      0.00    0.      0.      0.         *   5    *
0.      0.19    0.      0.      0.00    0.      0.      0.         *   6    *
0.      0.17    0.      0.      0.      0.      0.      0.         *   7    *
0.      0.21    0.      0.      0.00    0.      0.      0.         *   8    *
0.05    0.      0.      0.53    0.      0.      0.      0.         *   9    *
0.05    0.      0.      0.47    0.      0.      0.      0.         *  10    *
0.03    0.      0.      0.      0.      0.      0.      0.         *  11    *
0.09    0.      0.      0.      0.      0.      0.      0.         *  12    *
0.10    0.      0.      0.      0.      0.      0.      0.         *  13    *
0.20    0.      0.      0.      0.      0.      0.      0.         *  14    *
0.06    0.      0.      0.      0.      0.      0.      0.         *  15    *
0.20    0.      0.      0.      0.      0.      0.      0.         *  16    *
0.20    0.      0.      0.      0.      0.      0.      0.         *  17    *
0.02    0.      0.      0.      0.      0.      0.      0.         *  18    *

ADVGC: PROPORTION OF FLOW IN EACH LANE AND DIRECTION
0.5000  0.5000  0.5     0.5     0.5     0.5     0.5     0.5  DIR1 BASIC LANE
0.0     0.0     0.      0.      0.      0.      0.      0.        AUX. LANE
0.5000  0.5000  0.5     0.5     0.5     0.5     0.5     0.5  DIR2 BASIC LANE
0.      0.      0.      0.      0.      0.      0.      0.        AUX. LANE

VMIT: TWO-DIRECTIONAL TRAFFIC VOLUME(VEH/H) FOR EACH CATEGORY
   183.0   27.0     0.      0.      0.      0.      0.      0.

VMF: MEAN DESIRED SPEED(KM/H)
119.9   111.9    88.5    97.7    86.0    88.3    85.6    85.6

VSDF: STANDARD DEVIATION OF DESIRED SPEEDS(KM/H)
14.7    12.0    12.9    10.2    10.2    10.0    11.5    11.5

LFSD: INDICES INDICATING TYPE OF SPEED DISTRIBUTION
       1       1       1       1       1       1       1       1

PFQ1: DEFAULT PLATOONING-FLOW DISTRIBUTION USED WHEN PFOL IS INPUT AS -1
0.      200.    400.    800.    1200.   1600.   2000.   2800.
0.       15.     30.     50.      65.     75.     90.    100.
```

Note: Traffic data for 300 veh/hr varies from the above only in simulation time (28,000 s) and two-directional traffic volumes (261 & 39 veh/hr for cars and trucks)

TRARR Modelled output for Bulls West (Do Minimum case with 210 veh/hr)

```
210 Vehs/hr    AND H3DM.ROD       COMBINATION (TRARR 4.0)

   TRAFFIC PARAMETERS SPECIFIED AT INPUT:

                                  TIME OF SIMULATION          =   40000.0
                                  SETTLING DOWN TIME          =    3600.0
                                  RANDOM SEED NUMBER          =  529515.0

                                  % FOLLOWING, DIRECTION 1    =      23.0
                                  % FOLLOWING, DIRECTION 2    =      19.0


                                  STREAM     DIR1      DIR2
                                             FLOW      FLOW        TOTAL
                                            (VEH/H)   (VEH/H)
                                  CARS       92.0      92.0        184.0
                                  TRUCKS     14.0      14.0         28.0
                                  TOTAL     106.0     106.0        212.0

   ACTUAL FLOWS - DIRECTION 1:              112. VEH/H
                - DIRECTION 2:              101. VEH/H
                - COMBINED:                 213. VEH/H
   ACTUAL COMPLETION TIME:                40371. SEC
   MAXIMUM NUMBER OF VEHICLES ON ROAD:     56
  -------------------------------------------------------


  **** DIRECTION  1 ****
  POINT OBSERVATIONS:  POSITIONS MEASURED FROM START IN DIRECTION OF TRAVEL

  POSITION    OVERTAKINGS    SPEED (KM/H)    %FOLL    NUMBER MEAN SPEED BY CATEGORY
      M        COMMENCED      MEAN   S.D.                       1     2     3
   1000.           0          91.4  11.2      24.0    1240     91.5  90.9
   8030.         196         109.0  13.9      36.8    1240    110.2 104.9
   9180.          17         106.3  13.5      38.4    1240    107.6 101.9
  10800.         259         102.4  13.1      31.0    1240    103.2  99.8

  * INTERVAL OBSERVATIONS BETWEEN 1000.M AND 10800.M ( 9800.M )

  VEHICLE  TRAVEL TIME  JOURNEY SPEED  %TIME    OVERTAKINGS    PETROL  DIESEL  NO.
  CATEGORY  MEAN  S.D.    MEAN  S.D.   SPENT   NO.  NO. RATE   CONS.   CONS.
            SEC   SEC     KM/H  KM/H   FOLL.   OF   BY   BY     ML      ML

  CARS     338.1  37.6   105.6  11.3   32.7    335  436  .046  1767.5      .0  964
  TRUCKS   355.5  37.9   100.3  10.5   31.2    169   68  .025  1570.3  4913.4  276
  ALL      342.0  38.3   104.4  11.4   32.3         504  .041  1745.5  4913.4 1240


  **** DIRECTION  2 ****
  POINT OBSERVATIONS:  POSITIONS MEASURED FROM START IN DIRECTION OF TRAVEL

  POSITION    OVERTAKINGS    SPEED (KM/H)    %FOLL    NUMBER MEAN SPEED BY CATEGORY
      M        COMMENCED      MEAN   S.D.                       1     2     3
    900.           0         105.6  13.4      20.7    1123    106.9 100.9
   2520.          49         105.8  17.7      19.7    1123    110.6  88.9
   3670.           2         107.5  18.0      26.4    1123    110.7  96.2
  10700.         208          96.8  13.4      35.9    1123     96.7  97.0

  * INTERVAL OBSERVATIONS BETWEEN  900.M AND 10700.M ( 9800.M )

  VEHICLE  TRAVEL TIME  JOURNEY SPEED  %TIME    OVERTAKINGS    PETROL  DIESEL  NO.
  CATEGORY  MEAN  S.D.    MEAN  S.D.   SPENT   NO.  NO. RATE   CONS.   CONS.
            SEC   SEC     KM/H  KM/H   FOLL.   OF   BY   BY     ML      ML

  CARS     338.5  41.3   105.7  12.2   31.4    173  242  .028  1861.1      .0  876
  TRUCKS   366.2  38.0    97.4  10.0   30.5     94   25  .010  1770.8  5359.5  247
  ALL      344.6  42.2   103.9  12.2   31.2         267  .024  1851.0  5359.5 1123

           * INTERVAL INFORMATION FOR BOTH DIRECTIONS COMBINED *
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               ( ASSUMES MATCHING LENGTHS OF  9800.M )

VEHICLE   TRAVEL TIME   JOURNEY SPEED   %TIME      OVERTAKINGS     PETROL   DIESEL   NO.
CATEGORY   MEAN  S.D.     MEAN  S.D.    SPENT    NO.  NO.  RATE    CONS.    CONS.
            SEC  SEC      KM/H  KM/H    FOLL.    OF   BY    BY      ML       ML

CARS      338.3  39.4    105.6  11.7    32.1    508  678  .038   1812.1       .0 1840
TRUCKS    360.5  38.3     98.9  10.4    30.9    263   93  .018   1665.8   5122.7  523
ALL       343.2  40.2    104.2  11.8    31.8         771  .033   1795.8   5122.7 2363

** FREE SPEED DISTRIBUTIONS:  DESIRED SPEEDS IGNORE ROAD CHARACTERISTICS;
UNIMPEDED SPEEDS TAKE ACCOUNT OF ROAD SPEED INDICES, BUT NOT GRADES OR TRAFFIC.

VEHICLE  DESIRED      UNIMPEDED     NUMBER
CATEGORY  SPEED         SPEED
        MEAN  S.D.   MEAN  S.D.

CARS    120.2  14.6 114.1  13.9    1840
TRUCKS  112.9  13.6 108.4  13.0     523
ALL     118.6  14.7 112.8  13.9    2363
```

Summary data for all Bulls West cases:

Option	Traffic Flow	RP Dirn	Mean Travel Time	S.D. Travel Time	Mean Speed	S.D. Speed	% Time Spent Following	No. Vehs Modelled
Do Minimum	210 veh/hr	Incr	342.0	38.3	104.4	11.4	32.3	1240
		Decr	344.6	42.2	103.9	12.2	31.2	1123
	300 veh/hr	Incr	346.1	36.4	103.0	10.6	41.3	1211
		Decr	350.9	38.3	101.7	11.0	40.8	1161
Passing Lane (Decr)	210 veh/hr	Incr	342.1	38.1	104.4	11.3	27.4	1240
		Decr	333.6	40.4	107.2	12.3	25.8	1123
	300 veh/hr	Incr	346.9	36.2	102.8	10.5	36.4	1211
		Decr	337.8	38.0	105.7	11.4	34.9	1161

Herbert - Maheno analysis length with passing lane

mhnorth.ROD

DSS	DENDS	DUR	NURD	DESIRED 85%ILE SPEED	BENDINESS	IRI
8000.00	1000.00	100.00	80	108.6	33.1	2.5

CHAINAGE KM	BARRIER LINES (1 OR -1)		AUXILIARY LANES (T OR F)		ROAD SPEED INDICES		SIGHT DISTANCE M	M	GRADE (DIR 1) UP +VE	CURVE RADIUS M	85%ILE SPEED KMH	COMMENTS
604.9	1	1	F	F	5	5	500.00	140.00	1.61	960	82.0	601/5.0
605.0	1	1	F	F	1	1	400.00	219.00	1.89	9999	103.6	
605.1	1	1	F	F	1	1	300.00	309.00	1.60	9999	103.6	
605.2	1	1	F	F	1	1	210.00	410.00	1.90	9999	103.6	
605.3	1	1	F	F	3	3	140.00	519.00	3.87	2780	94.0	
605.4	1	1	F	F	10	10	70.00	239.00	5.33	260	61.4	
605.5	1	1	F	F	7	7	169.00	80.00	1.68	430	68.8	
605.6	1	1	F	F	8	8	230.00	149.00	-0.59	410	68.5	
605.7	1	1	F	F	7	7	140.00	169.00	0.98	470	70.4	
605.8	-1	1	F	F	1	1	100.00	229.00	0.52	9999	103.6	
605.9	1	-1	F	F	1	1	339.00	90.00	-2.61	9999	99.1	601/6.0
606.0	1	-1	F	F	1	1	119.00	190.00	-0.47	9999	103.6	
606.1	1	1	F	F	1	1	170.00	339.00	1.44	9999	103.6	
606.2	1	1	F	F	6	6	190.00	200.00	1.21	600	74.7	
606.3	1	1	F	F	5	5	190.00	109.00	0.38	1090	83.0	
606.4	1	1	F	F	1	1	289.00	190.00	0.05	9999	103.6	
606.5	1	1	F	F	1	1	179.00	169.00	-0.61	9999	103.6	
606.6	1	1	F	F	5	5	160.00	279.00	1.47	790	78.0	
606.7	1	1	F	F	5	5	399.00	100.00	0.68	1150	83.7	
606.8	1	1	F	F	1	1	290.00	169.00	-1.00	9999	103.6	
606.9	1	1	F	F	1	1	190.00	270.00	1.03	9999	103.6	601/7.0
607.0	1	1	F	F	1	1	289.00	369.00	1.34	9999	103.6	
607.1	1	1	F	F	4	4	290.00	250.00	0.57	1370	87.4	
607.2	1	1	F	F	1	1	190.00	179.00	-0.41	9999	103.6	
607.3	1	1	F	F	1	1	110.00	279.00	0.24	9999	103.6	
607.4	1	1	F	F	1	1	479.00	150.00	-0.36	9999	103.6	
607.5	1	1	F	F	6	6	280.00	140.00	-1.71	720	76.9	
607.6	1	1	F	F	1	1	200.00	299.00	4.26	9999	103.6	
607.7	-1	1	F	F	1	1	179.00	350.00	3.71	9999	103.6	
607.8	-1	1	F	F	1	1	90.00	219.00	3.29	9999	103.6	
607.9	1	-1	F	T	1	1	529.00	179.00	1.90	9999	103.6	------
608.0	1	-1	F	T	1	1	429.00	140.00	-0.37	9999	103.6	/|\
608.1	1	-1	F	T	1	1	320.00	219.00	-0.76	9999	103.6	|
608.2	1	-1	F	T	1	1	489.00	330.00	0.70	9999	103.6	Passing
608.3	1	-1	F	T	1	1	390.00	429.00	0.19	9999	103.6	Lane
608.4	1	-1	F	T	1	1	299.00	530.00	0.85	9999	103.6	|
608.5	1	-1	F	T	1	1	220.00	330.00	-0.11	9999	103.6	|
608.6	1	-1	F	T	4	4	240.00	429.00	0.79	1670	88.9	------
608.7	1	1	F	F	7	7	359.00	270.00	0.73	440	70.4	
608.8	1	1	F	F	3	3	270.00	219.00	0.14	2040	91.5	
608.9	-1	1	T	F	81	81	149.00	200.00	-0.85	9999	103.6	------
609.0	-1	1	T	F	81	81	380.00	309.00	1.03	9999	103.6	|
609.1	-1	1	T	F	81	81	280.00	139.00	-0.45	9999	103.6	|
609.2	-1	1	T	F	81	81	239.00	260.00	0.86	9999	103.6	Passing
609.3	-1	1	T	F	63	63	330.00	320.00	-0.09	2330	92.7	Lane
609.4	-1	1	T	F	81	81	469.00	220.00	-0.34	9999	103.6	|
609.5	-1	1	T	F	81	81	369.00	309.00	-0.81	9999	103.6	|
609.6	-1	1	T	F	81	81	280.00	329.00	-0.53	9999	103.6	\\|/
609.7	-1	1	T	F	81	81	219.00	390.00	-0.67	9999	103.6	------
609.8	1	1	F	F	42	42	270.00	609.00	0.73	980	82.0	
609.9	1	1	F	F	7	7	179.00	230.00	1.62	550	72.4	601/10.0
610.0	1	1	F	F	81	81	400.00	250.00	1.94	9999	103.6	
610.1	1	1	F	F	81	81	300.00	169.00	0.87	9999	103.6	
610.2	1	1	F	F	81	81	210.00	270.00	1.55	9999	103.6	
610.3	1	1	F	F	81	81	119.00	369.00	1.03	9999	103.6	
610.4	1	1	F	F	81	81	219.00	470.00	1.43	9999	103.6	
610.5	1	1	F	F	63	63	150.00	169.00	0.36	2220	92.7	
610.6	1	1	F	F	28	28	200.00	259.00	0.70	370	67.2	
610.7	1	1	F	F	5	5	99.00	169.00	-0.50	1140	83.7	
610.8	1	1	F	F	81	81	250.00	269.00	-0.05	9999	103.6	
610.9	1	1	F	F	4	4	89.00	190.00	-0.60	1540	87.9	601/11.0

611.0	1	1	F	F	6	6	570.00	369.00	1.42	610	74.7	
611.1	1	1	F	F	1	1	460.00	149.00	0.24	9999	103.6	
611.2	1	1	F	F	1	1	339.00	250.00	-0.07	9999	103.6	
611.3	1	1	F	F	1	1	179.00	349.00	1.13	9999	103.6	
611.4	1	1	F	F	1	1	169.00	460.00	3.59	9999	103.6	
611.5	1	1	F	F	3	3	369.00	159.00	2.07	2040	91.5	
611.6	1	1	F	F	6	6	380.00	149.00	0.31	680	76.9	
611.7	1	1	F	F	1	1	169.00	200.00	0.33	9999	103.6	
611.8	1	1	F	F	1	1	440.00	320.00	1.41	9999	103.6	
611.9	1	1	F	F	1	1	349.00	400.00	0.71	9999	103.6	601/12.0
612.0	1	1	F	F	1	1	250.00	179.00	0.24	9999	103.6	
612.1	-1	1	F	F	1	1	150.00	279.00	1.19	9999	103.6	
612.2	-1	1	F	F	1	1	109.00	400.00	1.99	9999	103.6	
612.3	1	1	F	F	1	1	299.00	119.00	-0.89	9999	103.6	
612.4	1	-1	F	F	4	4	289.00	179.00	-1.46	1430	87.4	
612.5	1	-1	F	F	5	5	179.00	260.00	-1.72	1060	83.0	
612.6	1	1	F	F	5	5	270.00	289.00	4.03	930	82.0	
612.7	1	1	F	F	5	5	279.00	100.00	3.27	890	79.9	
612.8	1	1	F	F	5	5	260.00	190.00	3.51	850	79.8	

Note: the "Do Minimum" case differs from the above only in the removal of the auxiliary lanes between 607.9-608.6 (northbound) and 608.9-609.7 (southbound).

Traffic Data for 150 veh/hr (used with Herbert-Maheno)

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MH150HM.TRF (Herbert - Maheno Calibration) - 150 vph
----------------------------------------------------------------

WHERE NOT SPECIFIED UNITS ARE IN SECONDS, METRES AND KM/H.

     1.0  BASIC TIME UNIT FOR THE SIMULATION (TUN)
  1800.0  SETTLING DOWN TIME FOR THE SIMULATION (TSE)
 50000.0  DURATION OF THE SIMULATION (TSI); NOTE THAT THE PROGRAM KEEPS RUNNING
            UNTIL ALL VEHICLES WHICH ARRIVED IN THIS TIME HAVE DEPARTED.
       0  OPTION: 1=STANDARD; 2=USE ITRAF; 3=USE PBAYS; 4=PLOT;
            5=GRAFIC DISPLAY; 6=TIME DISPLAY
   100.0  LENGTH OF NO OVERTAKING TO CREATE BUNCHING IN DIRECTION 1 (DTS1)
   100.0  LENGTH OF NO OVERTAKING TO CREATE BUNCHING IN DIRECTION 2 (DTS2)
    36.0  PERCENT FOLLOWING IN PLATOONS ON ARRIVAL IN DIRECTION 1 (PFOL1)
    29.0  PERCENT FOLLOWING IN PLATOONS ON ARRIVAL IN DIRECTION 2 (PFOL2)
            NOTE ZERO %FOLL GIVES RANDOM ARRIVALS; NEG %FOLL USES DEFAULTS.
       2  NUMBER OF VEHICLE GENERATION CATEGORIES (NSTR); CHECK FORMATS IN THIS
            FILE IF NSTR IS CHANGED.  ONLY NSTR OF THE COLUMNS BELOW ARE READ.
  1067.0  RANDOM SEED NUMBER (NSEEDO); RANGE IS 0. TO 999999.
       0  ICHECK: 1=PRINT INPUT DATA TO FILE CHKOUT FOR CHECKING; 0=NO CHECK

THE REMAINING PARAMETERS DESCRIBE THE SIMULATED TRAFFIC STREAM
ADTV: PROPORTIONS OF VEHICLE TYPES IN VARIOUS CATEGORIES
****************************************************************************
*    NZ 1986 TRAFFIC GENERATION CATEGORIES USE NSTR 2(1&2 ONLY)    * TYPE   *
****************************************************************************
CARS    TRUCKS  RECVEHS LTRUCK  HTRUCK  EXTRA1  EXTRA2  EXTRA3     *        *
0.      0.03    0.      0.      0.00    0.      0.      0.         *   1    *
0.      0.08    0.      0.      0.00    0.      0.      0.         *   2    *
0.      0.11    0.      0.      0.00    0.      0.      0.         *   3    *
0.      0.06    0.      0.      0.00    0.      0.      0.         *   4    *
0.      0.15    0.      0.      0.00    0.      0.      0.         *   5    *
0.      0.19    0.      0.      0.00    0.      0.      0.         *   6    *
0.      0.17    0.      0.      0.      0.      0.      0.         *   7    *
0.      0.21    0.      0.      0.00    0.      0.      0.         *   8    *
0.05    0.      0.      0.53    0.      0.      0.      0.         *   9    *
0.05    0.      0.      0.47    0.      0.      0.      0.         *  10    *
0.03    0.      0.      0.      0.      0.      0.      0.         *  11    *
0.09    0.      0.      0.      0.      0.      0.      0.         *  12    *
0.10    0.      0.      0.      0.      0.      0.      0.         *  13    *
0.20    0.      0.      0.      0.      0.      0.      0.         *  14    *
0.06    0.      0.      0.      0.      0.      0.      0.         *  15    *
0.20    0.      0.      0.      0.      0.      0.      0.         *  16    *
0.20    0.      0.      0.      0.      0.      0.      0.         *  17    *
0.02    0.      0.      0.      0.      0.      0.      0.         *  18    *

ADVGC: PROPORTION OF FLOW IN EACH LANE AND DIRECTION
0.5000  0.5000  0.5     0.5     0.5     0.5     0.5     0.5  DIR1 BASIC LANE
0.0     0.      0.      0.      0.      0.      0.      0.        AUX. LANE
0.5000  0.5000  0.5     0.5     0.5     0.5     0.5     0.5  DIR2 BASIC LANE
0.      0.      0.      0.      0.      0.      0.      0.        AUX. LANE

VMIT: TWO-DIRECTIONAL TRAFFIC VOLUME(VEH/H) FOR EACH CATEGORY
   132.0    18.0     0.      0.      0.      0.      0.      0.

VMF: MEAN DESIRED SPEED(KM/H)
112.36   92.7    88.5    97.7    86.0    88.3    85.6    85.6

VSDF: STANDARD DEVIATION OF DESIRED SPEEDS(KM/H)
11.8     8.5    12.9    10.2    10.2    10.0    11.5    11.5

LFSD: INDICES INDICATING TYPE OF SPEED DISTRIBUTION
       1       1       1       1       1       1       1       1

PFQ1: DEFAULT PLATOONING-FLOW DISTRIBUTION USED WHEN PFOL IS INPUT AS -1
0.      200.    400.    800.    1200.   1600.   2000.   2800.
0.       15.     30.     50.      65.     75.     90.    100.
```

Note: Traffic data for 250 veh/hr varies from the above only in simulation time (30,000 s) and two-directional traffic volumes (220 & 30 veh/hr for cars and trucks)

TRARR Modelled output for Herbert-Maheno (Do Minimum case with 150 veh/hr)

MH150HM.TRF (AND MHEXIST.ROD COMBINATION (TRARR 4.0)

TRAFFIC PARAMETERS SPECIFIED AT INPUT:

TIME OF SIMULATION	=	50000.0
SETTLING DOWN TIME	=	1800.0
RANDOM SEED NUMBER	=	1067.0
% FOLLOWING, DIRECTION 1	=	36.0
% FOLLOWING, DIRECTION 2	=	29.0

STREAM	DIR1 FLOW (VEH/H)	DIR2 FLOW (VEH/H)	TOTAL
CARS	66.0	66.0	132.0
TRUCKS	9.0	9.0	18.0
TOTAL	75.0	75.0	150.0

ACTUAL FLOWS - DIRECTION 1: 77. VEH/H
- DIRECTION 2: 74. VEH/H
- COMBINED: 150. VEH/H
ACTUAL COMPLETION TIME: 50347. SEC
MAXIMUM NUMBER OF VEHICLES ON ROAD: 49

**** DIRECTION 1 ****
POINT OBSERVATIONS: POSITIONS MEASURED FROM START IN DIRECTION OF TRAVEL

POSITION M	OVERTAKINGS COMMENCED	SPEED (KM/H) MEAN	S.D.	%FOLL	NUMBER	MEAN SPEED BY CATEGORY 1	2	3
40.	0	90.7	11.2	36.3	1065	85.5	92.0	
6990.	15	98.6	12.9	50.2	1065	90.6	100.6	

* INTERVAL OBSERVATIONS BETWEEN 40.M AND 6990.M (6950.M)

VEHICLE CATEGORY	TRAVEL TIME MEAN SEC	S.D. SEC	JOURNEY SPEED MEAN KM/H	S.D. KM/H	%TIME SPENT FOLL.	OVERTAKINGS NO. OF	NO. BY	RATE BY	PETROL CONS. ML	DIESEL CONS. ML	NO.
TRUCKS	292.1	31.3	86.6	9.4	42.9	11	2	.001	1165.8	3611.3	206
CARS	267.1	31.8	95.0	10.8	44.3	13	22	.004	1256.1	.0	859
ALL	271.9	33.2	93.3	11.0	44.0		24	.003	1247.9	3611.3	1065

**** DIRECTION 2 ****
POINT OBSERVATIONS: POSITIONS MEASURED FROM START IN DIRECTION OF TRAVEL

POSITION M	OVERTAKINGS COMMENCED	SPEED (KM/H) MEAN	S.D.	%FOLL	NUMBER	MEAN SPEED BY CATEGORY 1	2	3
1010.	0	103.7	13.7	31.0	1021	95.5	106.1	
7960.	21	88.9	10.4	43.1	1021	85.0	90.1	

* INTERVAL OBSERVATIONS BETWEEN 1010.M AND 7960.M (6950.M)

VEHICLE CATEGORY	TRAVEL TIME MEAN SEC	S.D. SEC	JOURNEY SPEED MEAN KM/H	S.D. KM/H	%TIME SPENT FOLL.	OVERTAKINGS NO. OF	NO. BY	RATE BY	PETROL CONS. ML	DIESEL CONS. ML	NO.
TRUCKS	286.0	32.1	88.6	10.3	41.6	12	1	.001	1048.3	3261.8	238
CARS	263.6	31.2	96.2	11.0	44.0	9	20	.004	1186.9	.0	783
ALL	268.8	32.8	94.4	11.3	43.4		21	.003	1171.2	3261.8	1021

* INTERVAL INFORMATION FOR BOTH DIRECTIONS COMBINED *
(ASSUMES MATCHING LENGTHS OF 6950.M)

VEHICLE CATEGORY	TRAVEL TIME MEAN	S.D.	JOURNEY SPEED MEAN	S.D.	%TIME SPENT	OVERTAKINGS NO.	NO.	RATE	PETROL CONS.	DIESEL CONS.	NO.

```
           SEC   SEC      KM/H  KM/H    FOLL.    OF    BY    BY      ML         ML

TRUCKS    288.9  31.8     87.7   9.9    42.2     23     3  .001  1102.6  3424.3  444
CARS      265.4  31.6     95.6  10.9    44.1     22    42  .004  1223.1      .0 1642
ALL       270.4  33.0     93.9  11.2    43.7           45  .003  1210.8  3424.3 2086


** FREE SPEED DISTRIBUTIONS:  DESIRED SPEEDS IGNORE ROAD CHARACTERISTICS;
UNIMPEDED SPEEDS TAKE ACCOUNT OF ROAD SPEED INDICES, BUT NOT GRADES OR TRAFFIC.

VEHICLE   DESIRED      UNIMPEDED     NUMBER
CATEGORY   SPEED         SPEED
        MEAN  S.D.   MEAN  S.D.

TRUCKS  98.3  13.7  94.4  12.9      444
CARS   112.5  11.2 106.8  10.7     1642
ALL    109.5  13.2 104.2  12.3     2086
```

Summary data for all Herbert-Maheno cases:

Option	Traffic Flow	RP Dirn	Mean Travel Time	S.D. Travel Time	Mean Speed	S.D. Speed	% Time Spent Following	No. Vehs Modelled
Do Minimum	150 veh/hr	Incr	271.9	33.2	93.3	11.0	44.0	1065
		Decr	268.8	32.8	94.4	11.3	43.4	1021
	250 veh/hr	Incr	274.7	32.4	92.3	10.5	48.3	1057
		Decr	273.5	32.3	92.8	10.9	47.6	1028
Sthbnd Passing Lane (Incr)	150 veh/hr	Incr	262.5	29.5	96.5	10.5	39.2	1065
		Decr	267.2	32.7	95.0	11.4	39.2	1021
	250 veh/hr	Incr	264.0	29.0	95.9	10.2	42.1	1057
		Decr	271.6	32.2	93.4	11.0	42.8	1028
Nthbnd Passing Lane (Decr)	150 veh/hr	Incr	271.9	33.2	93.4	11.0	39.1	1065
		Decr	260.9	30.0	97.1	10.8	37.7	1021
	250 veh/hr	Incr	274.9	32.4	92.2	10.5	43.1	1057
		Decr	263.9	28.9	95.9	10.2	41.5	1028
Both Passing Lanes	150 veh/hr	Incr	264.0	29.5	95.9	10.4	34.8	1065
		Decr	260.9	30.0	97.1	10.8	33.8	1021
	250 veh/hr	Incr	265.7	29.0	95.3	10.1	37.4	1057
		Decr	263.8	28.9	95.9	10.2	37.2	1028

PASSING LANE ANALYSIS SUMMARY **WORKSHEET A10.1**

Project Name: Bulls West Nthbound Passing Lane

Option: with Passing Lane

Table 1. Road Segments for Analysis

Segment	Segment	CARS (FREE)		TRUCKS (FREE)		MEAN SPEEDS		PASD	Pass Lane (Y/N)?
Number	Length	Mean Speed	Std Devn	Mean Speed	Std Devn	Free	Following		
1	1.62	94.1	12.6	77.9	26.9	93.8	86.6	0.18	N
2	1.15	91.2	13.3	72.6	26.1	91.2	82.4	0.26	Y
3	3.16	97.9	12.0	85.3	22.1	98.3	92.6	0.03	N
4	3.87	99.7	11.1	89.6	21.5	100.2	92.6	0.26	N
	km	km/h	km/h	km/h	km/h	km/h	km/h		

Table 2. Time Periods for Analysis

Time Period	Start Time	Finish Time	Total Hours	One Way Hourly flow	Total Flow	% of Trucks
1	0:00	5:00	5.0	150	1500	13
2	5:00	13:00	8.0	105	1680	13
	Check Hours:		**13.0**	Check AADT:	**3180**	
	hh:mm	hh:mm	hrs	veh/hr	vehs	%

UNSATISFIED PASSING DEMAND **WORKSHEET A10.2**

Project Name: Bulls West Nthbound Passing Lane

Option: with Passing Lane

Passing Lane? Y

	Segment: 2	Time Period:	1
(b)	**(1) V_{Car}**	91.2	km/hr
	(2) Std Dev Car	13.3	km/hr
	(3) V_{Truck}	72.6	km/hr
	(4) Std Dev Truck	26.1	km/hr
(c)	**(5) Hourly Flow**	150	veh/hr
	(6) % of Trucks	13	%
	(7) Car Volume	130.5	veh/hr
	(8) Truck Volume	19.5	veh/hr
(d)	**(9) K_{Car}**	1.43	veh/km
	(10) K_{Truck}	0.27	veh/km
(e)	**(11) X**	1.40	-
	(12) Y	0.51	-
	(13) Z	1.51	-
	(14) $D_{Car-Truck}$	7.73	ot/km/hr
	(15) $D_{Car-Car}$	15.25	ot/km/hr
	(16) $D_{Truck-Truck}$	1.05	ot/km/hr
(f)	**(17) D**	24.04	ot/km/hr
(g)	**(18) PAG**	1.00	-
	(19) PASD	1.00	-
	(20) S	108.00	ot/km/hr
(h)	**(21) UPD**	-83.96	ot/km/hr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Bulls West Nthbound Passing Lane

Option : with Passing Lane Time Period: 1

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	1.62	N	14.92	32.00	56.16	71.41
2	1.15	Y	-83.96	56.16	0.00	18.78
3	3.16	N	16.26	0.00	51.40	81.21
4	3.87	N	6.56	51.40	76.79	248.04
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	71.41	93.8	86.6	3.19	227.9
2	18.78	91.2	82.4	4.22	79.2
3	81.21	98.3	92.6	2.25	183.1
4	248.04	100.2	92.6	2.95	731.4
			Overall Time Delay		1221.5
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Bulls West Nthbound Passing Lane

Option : with Passing Lane Time Period: 2

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	1.62	N	1.79	22.00	24.89	37.98
2	1.15	Y	-96.22	24.89	0.00	3.22
3	3.16	N	7.05	0.00	22.28	35.20
4	3.87	N	-4.76	22.28	3.84	50.54
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	37.98	93.8	86.6	3.19	121.2
2	3.22	91.2	82.4	4.22	13.6
3	35.20	98.3	92.6	2.25	79.3
4	50.54	100.2	92.6	2.95	149.0
			Overall Time Delay		363.1
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL ANNUAL COSTS **WORKSHEET A10.4**

Project Name: Bulls West Nthbound Passing Lane

Option: with Passing Lane

Table 1. Total Annual Travel Time Cost

Time Period	Total Hours	Overall Time Delay	Travel Time Cost	Time Period Cost
1	5.0	1221.5	$21.60	$13,376
2	8.0	363.1	$21.60	$6,362
Total Annual Travel Time Cost (AC):				$19,738
	hrs	s/hr	$/hr	$/yr

914 hrs

Allowance for VOC:
Total Annual Travel Time Cost (AC) X 0.95 = **$18,751** per year

Table 2. Reduction in Driver Frustration
(not for Do-Minimum option)

Value for Driver Frustration	One-Way Daily Traffic Flow	Length of Passing Lane	Total Annual Benefit
$0.035	1590	1.15	**$23,359**
$/veh/km	veh/day	km	$/yr

UNSATISFIED PASSING DEMAND **WORKSHEET A10.2**

Project Name: Bulls West Nthbound Passing Lane

Option: Do Min

Passing Lane? N

	Segment: 2	Time Period:	1
(b)	**(1) V_{Car}**	91.2	km/hr
	(2) Std Dev Car	13.3	km/hr
	(3) V_{Truck}	72.6	km/hr
	(4) Std Dev Truck	26.1	km/hr
(c)	**(5) Hourly Flow**	150	veh/hr
	(6) % of Trucks	13	%
	(7) Car Volume	130.5	veh/hr
	(8) Truck Volume	19.5	veh/hr
(d)	**(9) K_{Car}**	1.43	veh/km
	(10) K_{Truck}	0.27	veh/km
(e)	**(11) X**	1.40	-
	(12) Y	0.51	-
	(13) Z	1.51	-
	(14) $D_{Car\text{-}Truck}$	7.73	ot/km/hr
	(15) $D_{Car\text{-}Car}$	15.25	ot/km/hr
	(16) $D_{Truck\text{-}Truck}$	1.05	ot/km/hr
(f)	**(17) D**	24.04	ot/km/hr
(g)	**(18) PAG**	0.30	-
	(19) PASD	0.26	-
	(20) S	8.46	ot/km/hr
(h)	**(21) UPD**	15.58	ot/km/hr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Bulls West Nthbound Passing Lane

Option : Do Min Time Period: 1

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	1.62	N	14.92	32.00	56.16	71.41
2	1.15	N	15.58	56.16	74.08	74.89
3	3.16	N	16.26	74.08	125.48	315.29
4	3.87	N	6.56	125.48	150.87	534.72
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	71.41	93.8	86.6	3.19	227.9
2	74.89	91.2	82.4	4.22	315.7
3	315.29	98.3	92.6	2.25	710.8
4	534.72	100.2	92.6	2.95	1576.8
			Overall Time Delay		2831.1
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Bulls West Nthbound Passing Lane

Option : Do Min Time Period: 2

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	1.62	N	1.79	22.00	24.89	37.98
2	1.15	N	-0.34	24.89	24.50	28.40
3	3.16	N	7.05	24.50	46.77	112.60
4	3.87	N	-4.76	46.77	28.34	145.33
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	37.98	93.8	86.6	3.19	121.2
2	28.40	91.2	82.4	4.22	119.7
3	112.60	98.3	92.6	2.25	253.8
4	145.33	100.2	92.6	2.95	428.6
			Overall Time Delay		923.3
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL ANNUAL COSTS **WORKSHEET A10.4**

Project Name: Bulls West Nthbound Passing Lane

Option: Do Min

Table 1. Total Annual Travel Time Cost

Time Period	Total Hours	Overall Time Delay	Travel Time Cost	Time Period Cost
1	5.0	2831.1	$21.60	$31,001
2	8.0	923.3	$21.60	$16,176
Total Annual Travel Time Cost (AC):				$47,177
	hrs	s/hr	$/hr	$/yr

2184 hrs

Allowance for VOC:

Total Annual Travel Time Cost (AC) X 0.95 = **$44,818** per year

Table 2. Reduction in Driver Frustration
(not for Do-Minimum option)

Value for Driver Frustration	One-Way Daily Traffic Flow	Length of Passing Lane	Total Annual Benefit
$0.035	1590	0.00	**$0**
$/veh/km	veh/day	km	$/yr

PASSING LANE ANALYSIS SUMMARY **WORKSHEET A10.1**

Project Name: Herbert - Maheno Nthbd Passing Lane

Option: with Passing Lane

Table 1. Road Segments for Analysis

Segment	Segment	CARS (FREE)		TRUCKS (FREE)		MEAN SPEEDS		PASD	Pass Lane (Y/N)?
Number	Length	Mean Speed	Std Devn	Mean Speed	Std Devn	Free	Following		
1	3.19	97.6	13.2	91.9	13.9	96.9	90.2	0.10	N
2	0.80	100.3	13.2	94.4	13.9	99.6	92.7	0.09	Y
3	2.96	105.7	13.2	99.5	13.9	105.0	97.7	0.09	N
	km	km/h	km/h	km/h	km/h	km/h	km/h		

Table 2. Time Periods for Analysis

Time Period	Start Time	Finish Time	Total Hours	One Way Hourly flow	Total Flow	% of Trucks
1	0:00	10:00	10.0	125	2500	12
2	10:00	14:00	4.0	75	600	12
	Check Hours:		**14.0**	Check AADT:	**3100**	
	hh:mm	hh:mm	hrs	veh/hr	vehs	%

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Herbert - Maheno Nthbd Passing Lane

Option : with Passing Lane Time Period: 1

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	3.19	N	7.69	25.00	49.53	118.87
2	0.80	Y	-96.92	49.53	0.00	12.66
3	2.96	N	6.46	0.00	19.13	28.32
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	118.87	96.9110588	90.19445079	2.77	328.8
2	12.66	99.592	92.68958416	2.69	34.1
3	28.32	104.953882	97.6798509	2.55	72.3
			Overall Time Delay		435.2
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL TIME DELAY

WORKSHEET A10.3

Project Name : Herbert - Maheno Nthbd Passing Lane

Option : with Passing Lane

Time Period: 2

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	3.19	N	-1.73	15.00	9.49	39.05
2	0.80	Y	-104.01	9.49	0.00	0.43
3	2.96	N	-1.72	0.00	0.00	0.00
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	39.05	96.9110588	90.19445079	2.77	108.0
2	0.43	99.592	92.68958416	2.69	1.2
3	0.00	104.953882	97.6798509	2.55	0.0
			Overall Time Delay		109.2
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL ANNUAL COSTS **WORKSHEET A10.4**

Project Name: Herbert - Maheno Nthbd Passing Lane

Option: with Passing Lane

Table 1. Total Annual Travel Time Cost

Time Period	Total Hours	Overall Time Delay	Travel Time Cost	Time Period Cost
1	10.0	435.2	$21.60	$9,532
2	4.0	109.2	$21.60	$957
Total Annual Travel Time Cost (AC):				$10,488
	hrs	s/hr	$/hr	$/yr

486 hrs

Allowance for VOC:

Total Annual Travel Time Cost (AC) X 0.95 = **$9,964** per year

Table 2. Reduction in Driver Frustration

(not for Do-Minimum option)

Value for Driver Frustration	One-Way Daily Traffic Flow	Length of Passing Lane	Total Annual Benefit
$0.035	1550	0.80	**$15,841**
$/veh/km	veh/day	km	$/yr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Herbert - Maheno Nthbd Passing Lane

Option : Do Min Time Period: 1

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	3.19	N	7.69	25.00	49.53	118.87
2	0.80	N	7.50	49.53	55.53	42.02
3	2.96	N	6.46	55.53	74.66	192.69
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	118.87	96.9110588	90.19445079	2.77	328.8
2	42.02	99.592	92.68958416	2.69	113.1
3	192.69	104.953882	97.6798509	2.55	492.2
			Overall Time Delay		934.1
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Herbert - Maheno Nthbd Passing Lane

Option : Do Min Time Period: 2

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	3.19	N	-1.73	15.00	9.49	39.05
2	0.80	N	-1.35	9.49	8.41	7.16
3	2.96	N	-1.72	8.41	3.32	17.35
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	39.05	96.9110588	90.19445079	2.77	108.0
2	7.16	99.592	92.68958416	2.69	19.3
3	17.35	104.953882	97.6798509	2.55	44.3
			Overall Time Delay		171.6
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL ANNUAL COSTS **WORKSHEET A10.4**

Project Name: Herbert - Maheno Nthbd Passing Lane

Option: Do Min

Table 1. Total Annual Travel Time Cost

Time Period	Total Hours	Overall Time Delay	Travel Time Cost	Time Period Cost
1	10.0	934.1	$21.60	$20,458
2	4.0	171.6	$21.60	$1,503
Total Annual Travel Time Cost (AC):				$21,961
	hrs	s/hr	$/hr	$/yr

1017 hrs

Allowance for VOC:

Total Annual Travel Time Cost (AC) X 0.95 = **$20,863** per year

Table 2. Reduction in Driver Frustration

(not for Do-Minimum option)

Value for Driver Frustration	One-Way Daily Traffic Flow	Length of Passing Lane	Total Annual Benefit
$0.035	1550	0.00	**$0**
$/veh/km	veh/day	km	$/yr

PASSING LANE ANALYSIS SUMMARY **WORKSHEET A10.1**

Project Name: Herbert - Maheno Sthbd Passing Lane

Option: with Passing Lane

Table 1. Road Segments for Analysis

Segment Number	Segment Length	CARS (FREE)		TRUCKS (FREE)		MEAN SPEEDS	
		Mean Speed	Std Devn	Mean Speed	Std Devn	Free	Following
1	3.96	94.1	13.9	87.2	14.2	93.3	86.3
2	0.90	93.2	13.9	86.3	14.2	92.4	85.5
3	2.09	98.0	13.9	90.8	14.2	97.1	89.9
	km	km/h	km/h	km/h	km/h	km/h	km/h

PASD	Pass Lane (Y/N)?
0.09	N
0.10	Y
0.10	N

Table 2. Time Periods for Analysis

Time Period	Start Time	Finish Time	Total Hours	One Way Hourly flow	Total Flow	% of Trucks
1	0:00	10:00	10.0	125	2500	12
2	10:00	14:00	4.0	75	600	12
	Check Hours:		**14.0**	Check AADT:	**3100**	
	hh:mm	hh:mm	hrs	veh/hr	vehs	%

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Herbert - Maheno Sthbd Passing Lane

Option : with Passing Lane Time Period: 1

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	3.96	N	9.88	31.00	70.13	200.23
2	0.90	Y	-94.30	70.13	0.00	26.08
3	2.09	N	8.50	0.00	17.77	18.57
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	200.23	93.2679579	86.32247167	3.11	621.9
2	26.08	92.3759158	85.49685823	3.14	81.8
3	18.57	97.1334737	89.9001299	2.98	55.4
			Overall Time Delay		759.0
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Herbert - Maheno Sthbd Passing Lane

Option : with Passing Lane Time Period: 2

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	3.96	N	-0.49	18.00	16.06	67.44
2	0.90	Y	-103.07	16.06	0.00	1.25
3	2.09	N	-1.44	0.00	0.00	0.00
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	67.44	93.2679579	86.32247167	3.11	209.4
2	1.25	92.3759158	85.49685823	3.14	3.9
3	0.00	97.1334737	89.9001299	2.98	0.0
			Overall Time Delay		213.4
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL ANNUAL COSTS **WORKSHEET A10.4**

Project Name: Herbert - Maheno Sthbd Passing Lane

Option: with Passing Lane

Table 1. Total Annual Travel Time Cost

Time Period	Total Hours	Overall Time Delay	Travel Time Cost	Time Period Cost
1	10.0	759.0	$21.60	$16,622
2	4.0	213.4	$21.60	$1,869
Total Annual Travel Time Cost (AC):				$18,491
	hrs	s/hr	$/hr	$/yr

856 hrs

Allowance for VOC:

Total Annual Travel Time Cost (AC) X 0.95 = **$17,566** per year

Table 2. Reduction in Driver Frustration

(not for Do-Minimum option)

Value for Driver Frustration	One-Way Daily Traffic Flow	Length of Passing Lane	Total Annual Benefit
$0.035	1550	0.90	**$17,821**
$/veh/km	veh/day	km	$/yr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Herbert - Maheno Sthbd Passing Lane

Option : Do Min Time Period: 1

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	3.96	N	9.88	31.00	70.13	200.23
2	0.90	N	9.73	70.13	78.88	67.06
3	2.09	N	8.50	78.88	96.65	183.44
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	200.23	93.2679579	86.32247167	3.11	621.9
2	67.06	92.3759158	85.49685823	3.14	210.3
3	183.44	97.1334737	89.9001299	2.98	547.0
			Overall Time Delay		1379.1
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL TIME DELAY **WORKSHEET A10.3**

Project Name : Herbert - Maheno Sthbd Passing Lane

Option : Do Min Time Period: 2

Table 1. Overall Passing Demand

Segment Number	Segment Length	Passing Lane?	UPD per km	APD at Start of Segment	APD at End of Segment	Overall Passing Demand
1	3.96	N	-0.49	18.00	16.06	67.44
2	0.90	N	-1.00	16.06	15.16	14.05
3	2.09	N	-1.44	15.16	12.16	28.56
	km		ot/km/hr	ot/km/hr	ot/km/hr	ot/hr

Table 2. Time Lost due to Passing Not Achieved

Segment Number	Overall Passing Demand	Mean Free Veh. Speed	Mean Following Veh. Speed	Average Time Lost per veh per km	Segment Time Delay
1	67.44	93.2679579	86.32247167	3.11	209.4
2	14.05	92.3759158	85.49685823	3.14	44.1
3	28.56	97.1334737	89.9001299	2.98	85.2
			Overall Time Delay		338.6
	ot/hr	km/hr	km/hr	s	s/hr

OVERALL ANNUAL COSTS **WORKSHEET A10.4**

Project Name: Herbert - Maheno Sthbd Passing Lane

Option: Do Min

Table 1. Total Annual Travel Time Cost

Time Period	Total Hours	Overall Time Delay	Travel Time Cost	Time Period Cost
1	10.0	1379.1	$21.60	$30,203
2	4.0	338.6	$21.60	$2,967
Total Annual Travel Time Cost (AC):				$33,169
	hrs	s/hr	$/hr	$/yr

1536 hrs

Allowance for VOC:

Total Annual Travel Time Cost (AC) X 0.95 = **$31,511** per year

Table 2. Reduction in Driver Frustration
(not for Do-Minimum option)

Value for Driver Frustration	One-Way Daily Traffic Flow	Length of Passing Lane	Total Annual Benefit
$0.035	1550	0.00	**$0**
$/veh/km	veh/day	km	$/yr