# The Effects of the Pages Road Cycle Lane on Cyclist Safety and Traffic Flow Operations

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## Abstract

This paper discusses the effects the installation of an on-road cycle lane had on traffic flow operations and the safety of its users. Three types of safety have been investigated: inferred safety, based on measurable flow characteristics; perceived safety, based on road users' opinions; and actual safety, based on observed crash rates.

Measurements of two traffic flow characteristics, motor vehicle speed and motor vehicle positioning, were used to give a measure of the cycle lane's inferred safety. A qualitative opinion survey of residents living near the cycle lane was used to gauge perceived safety. An analysis of crash history of similar cycle lane sites compared with control sites was used to predict the effects the Pages Road cycle lane would have on actual cyclist safety. This paper focuses mainly on inferred safety and does not go into great detail about the perceived and actual safety measures.

It was found that mean motor vehicle speeds decreased by 0.9 km/h for the peak periods and 1.5 km/h for off-peak periods. This decrease in motor vehicle speed corresponded to an increase in inferred cyclist safety. However, motor vehicle positioning, another measure of inferred safety, decreased when cyclists were present after the cycle lane installation, as a lower proportion of cyclists used the footpath or parking space.

Residents' opinions indicated no significant change in cyclists' perceptions of safety but those who were motorists perceived an increase in safety.

Crash history data of cycle lane sites compared to control sites indicated that cycle lanes had only a limited effect on cycle safety, as while cycle lane sites displayed a reduction in crash frequency the control sites displayed greater reductions. However several aspects of the method of analysis used and selection of control sites may have affected the accuracy of the actual safety investigation. More detailed analysis of crash history would be required to properly judge the effects of cycle lanes on actual safety.

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# 1.0 Introduction

## 1.1 Project Aim

The primary aim of this research was to assess the effect of an on-road cycle lane on the traffic flow characteristics of vehicle speed and positioning across the road and use this to determine the effect of the cycle lane on cyclists' safety. It was assumed that when adjacent vehicles travel closer to cyclists or at greater speeds there was more chance of injury to the cyclists (Nillson 2001). Safety of cyclists using the cycle lane was also assessed by means of qualitative opinion and crash history research into similar cycle lane locations.

This paper is a revised and condensed version of a much larger report on the study (Fowler 2005). For this reason, some aspects of the report, especially those relating to the more qualitative aspects of the study, are omitted or briefly presented without detailed background explanations.

## 1.2 General Background of Cycle Lanes

New Zealand's Land Transport Safety Authority (LTSA), which is now part of Land Transport New Zealand (LTNZ), acknowledged that it is important to provide for cyclists on the country's roads and specified five general route requirements for all cycleways: safety, comfort, directness, coherence and attractiveness (LTSA 2004). This paper focuses on the safety of cycle lanes. As stated by McClintock (2002, p55):

> "safety is a relative concept. While cycling or walking might feel unsafe, in practice, the environment in which such activities take place, whether on roads or in rural settings, often feels more threatening than it is."

Given the nature of safety it is important to consider the parameters used to judge how the safety of cyclists is affected by the installation of cycle lanes.

Collision reports tend to be less detailed and reporting rates less frequent for crashes involving cyclists than for motor vehicles, hence it is often difficult to effectively measure safety in terms of observed crashes (Newman 2002). Other methods of measuring safety may be used. Buckley and Wilke (2000) suggested two categories of safety: actual, that portrayed by the frequency of crashes; and perceived, that which is experienced by the road user such as motor vehicle speed and separation distances.

The contention of this study is that Buckley and Wilke's use of the term "perceived" is perhaps not appropriate as, according to McClintock's definition, not all road users infer the same level of safety for a given situation. The term "perceived safety" would be better used to describe road users' personal opinions.

Good estimates of actual safety effects due to treatment require observations spanning several years (Persaud 2006) but, by measuring other traffic characteristics that relate to safety, the effects on actual safety can be inferred within a shorter time frame. Motor vehicle speed is used as one measure of inferring safety as crash risk and severity increases with motor vehicle speed (ACC and LTSA 2000) and from this it follows that vehicle-cycle separation distance is also related to cyclist safety as the greater the gap the more chance drivers have to react and change their course or decrease their speed before hitting a cyclist. Thus three measures of safety were used in this study: actual, perceived and inferred, which was gauged by motor vehicle speeds and positioning.

Elvik and Vaa (2004) in their meta-analysis of cycle lane studies concluded that cycle lanes would reduce crashes involving cyclists by 10% on average, however the 95% confidence interval predicted a 20% reduction to a 1% increase, i.e. the evidence suggests a small possibility that cycle lanes may actually induce a small increase in cycle crashes. When considering all crashes, not just those involving cyclists, a reduction of between 35-25% was predicted. Thus cycle lanes were shown to have a protective effect on the actual safety of motorists and pedestrians, if not always cyclists.

Hunter *et al* (1999) found that, compared with wide kerb lanes, marked bike lanes resulted in less wrong-way and sidewalk riding. Meanwhile, Van Houten and Seiderman (2005) observed that the introduction of bike lanes had little effect on the position of the adjacent moving motor vehicles.

From an amalgamation of previous Christchurch City Council (CCC) quantitative studies Newman (2002) observed that, in Christchurch cycle lanes tended to:

- reduce both cyclist-motor vehicle and motor vehicle-motor vehicle crashes,
- cause motor vehicles to drive closer to the left side of the road (when compared with situations of no marked cycle lane present)
- have no noticeable effect on motor vehicle speed.
- have the least obvious of all road markings leading to a high rate of motor vehicle occupation of cycle lanes (this led to a change in marking style from dashed lane lines to solid lane lines, as was used for the Pages Road cycle lane).

A qualitative study was conducted in Christchurch to gauge the effects on safety caused by cycle lane installation in Lyttelton Street (Opinions Market Research Ltd. 2005). Data collected was based on the opinions of residents, cyclists, motorists, parents whose children use the cycle lanes, children who use the cycle lanes and school teachers and school board members of nearby schools. All road users perceived significant increases in safety after the cycle lane installations.

### 1.3 Consideration of Site

The cycle lane studied for this project was located on Pages Road, in the east-Christchurch suburb of Wainoni. Pages Road is a two-lane, major arterial road with average annual daily traffic flows of between 13,000 motor vehicles per day at its eastern end and 27,500 motor vehicles per day at its western end (Page, 2005). Figure 1 indicates the study location.

The cycle lane of interest, located on the eastbound lane, was an extension of one already existing along part of Buckleys Road (which continues on from the western end of Pages Road) to the Breezes Road intersection. It was installed in June 2005, in conjunction with the extension of a painted median between traffic lanes that previously existed along some stretches of the road. As part of the investigation, manual surveys of vehicle speed and positioning were conducted. The site layouts before and after the installation are shown in Figure 2 and Figure 3. Methods, equipment and data collected by these surveys are detailed in the following section.

The manually conducted surveys were located between Ottawa Road and Bickerton Street. This location was chosen because it was one of the few stretches of the road that already included a painted median at the centre of the lanes; hence any possible variation due to installing a painted median as well as a cycle lane was eliminated. Also, no changes were made to the parking areas and bus stops situated adjacent to the site’s eastbound lane.

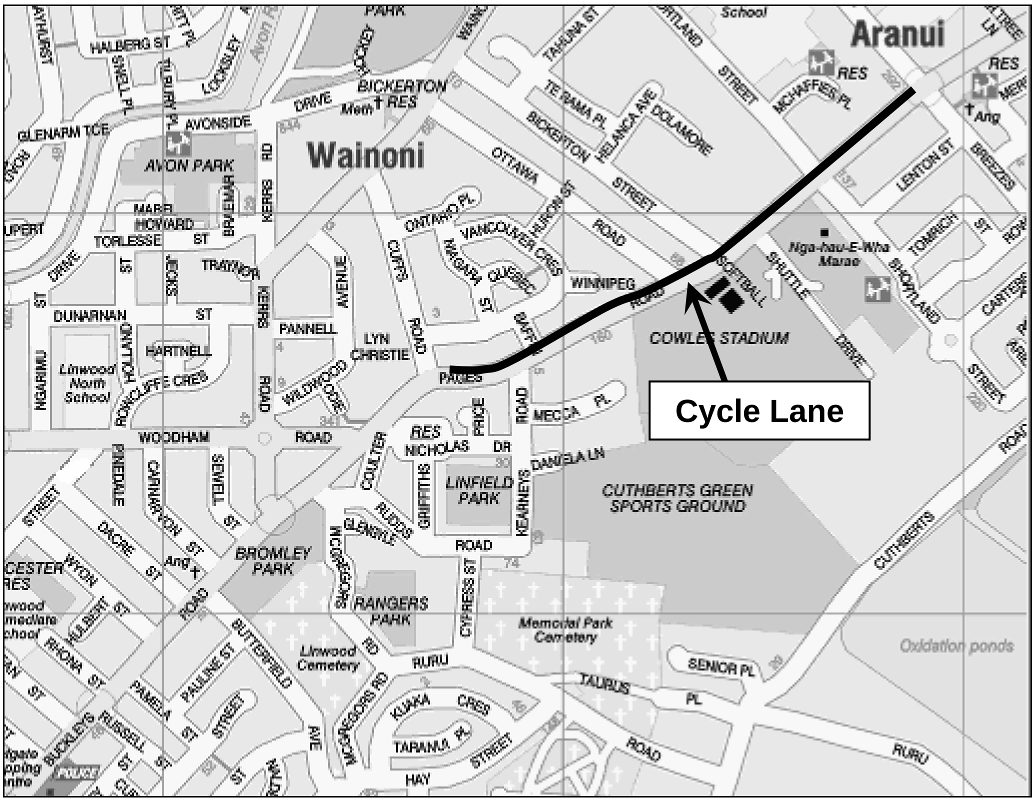


**Figure 1 Pages Road Location, Christchurch (Wises 2005)**

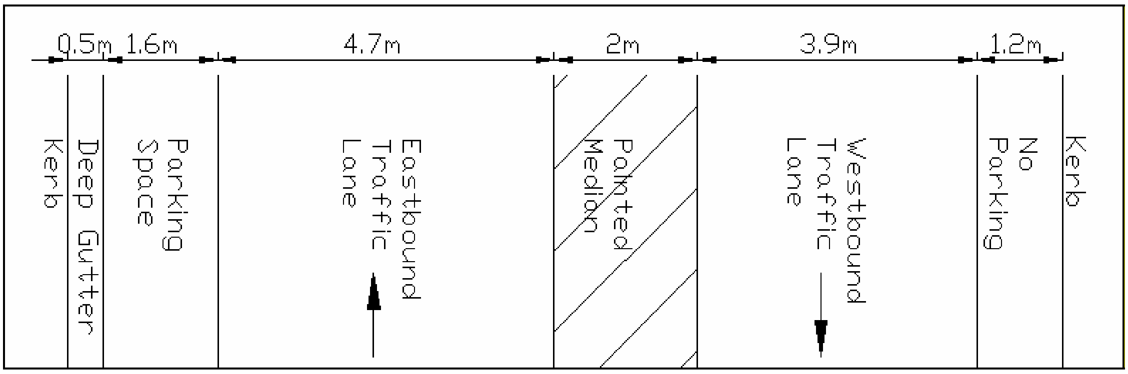


**Figure 2 Site Layout Before Cycle Lane Installation**

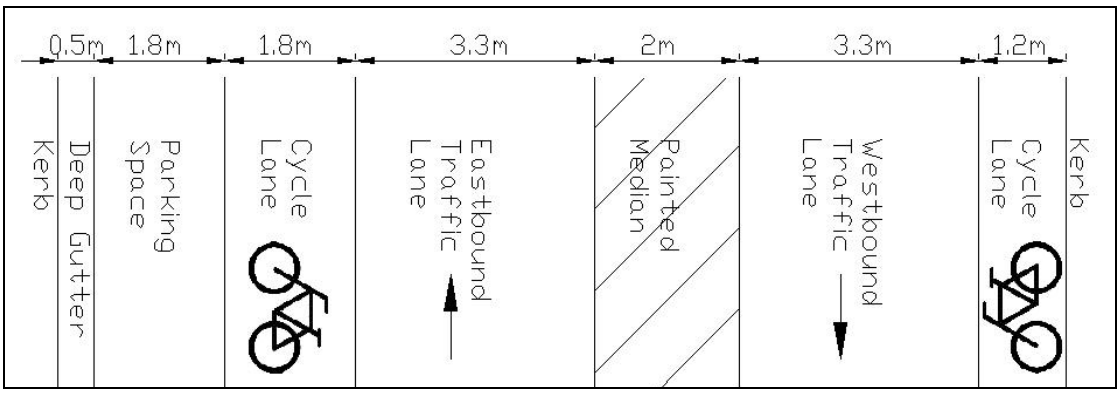


**Figure 3 Site Layout After Installation**

The site was situated prior to a left-hand curve in the road. Left-hand curves are classified as a low severity-high frequency risk for cyclists as motor vehicles often cut corners when turning (Newman 2002). It was assumed that the location of the site relative to the road's curve would allow further information about the behaviour of motor vehicles moving around corners with and without the presence of adjacent cycle lanes. The existence of the curve possibly would have decreased motor vehicle speed at the site however this effect would be present before and after the cycle lane installation so the presence of the curve should not contribute to a change in speed.

Speed data was also obtained from the CCC's MetroCount automated tube counters and the New Zealand Police's speed camera records. The MetroCount station was positioned approximately 140 m eastwards from the manual survey site along Pages Road. The speed camera site was approximately 275 m eastwards of the survey site on the eastbound lane of Pages Road. .

## 2.0 Survey Methods

### 2.1 Motor vehicle Speeds

Raw motor vehicle speed data came from three sources: manual laser-gun surveys; CCC MetroCount records; and Police speed camera records. A method of gathering speed and position data simultaneously by using two lasers to detect position across the road and calculating speeds of motor vehicles travelling between the two lasers was also trialled but was abandoned due to technical difficulties. Fowler (2005) determined that, due to its more accurate exclusion of heavy vehicles and non-free vehicles and more comprehensive sample gained from a complete week's worth of traffic, the MetroCount data gave the most accurate representation of the motor vehicle speeds before and after the cycle lane installation. Therefore, for this paper, it is sufficient to discuss only the MetroCount data, which was provided for two weeklong samples, the first one three weeks before the cycle lane installation and the other six weeks after.

When assessing the speeds of motor vehicles passing through the survey sites, only the "free" motor vehicles were considered using an assumed critical headway of four seconds, based on previous studies (McLean 1989). Similarly, all motor vehicles with speeds less than 40 km/h were disregarded as it was assumed they were either accelerating after entering the stream from a driveway or intersection or decelerating to exit the road.

### 2.2 Motor vehicle and Cyclist Positioning

Four surveys assessing motor vehicle and cyclist positioning were undertaken at the survey site. In order to record the motor vehicle positions, spray-paint marks were made across a section of the road at 0.5-metre intervals. These marks were made to be as inconspicuous as possible to avoid influencing driver behaviour. A video camera was positioned in a car stationed in a parking space several metres behind the marked site.

The recorded videos were later played in slow motion and individual motor vehicle and cycle positions, based on the distance of the left rear wheel from the kerb, were recorded in 0.5 m categories. Further observations were also made regarding cyclist behaviour (e.g. use of footpaths) and rough estimates of each cyclist's ability class according to the four levels of classification: child/inexperienced adult; elderly/disabled; commuter adult; and sports cyclist.

### 2.3 Other Investigations

As inferred safety is the focus of this paper, the method, findings and limitations of investigations into perceived safety and actual safety are only briefly presented in this paper, more information can be found in the full report (Fowler 2005).

In order to understand road users' perceptions of the cycle lane's effect on safety ideally motorists and cyclists passing through the site would have been interviewed. However, due to low cycle numbers and the difficulty involved in stopping motorists, local residents were surveyed instead; it was assumed they would be frequent users of the traffic and cycle lanes. The survey form was designed to assess:

- frequency of use of different modes of transport
- the effect of the cycle lane on motorists opinions about passing cyclists while driving
- cyclists' perceptions of safety
- other issues that may have affected residents' reactions to the cycle lane, such as loss of parking and driveway access or changes in the amount of high speed vehicle noise.

In total 23 people adequately completed the survey, while this sample was not large enough to give statistically valid results, the survey did provide some indication of the level of support for cycle lanes and areas of concern that could be expanded upon in future studies.

Actual safety was assessed with crash history data for the period 1986 to 2004 (obtained from LTNZ) for 87 sites in Christchurch where cycle lanes had been installed. Only crashes involving cyclists were considered. For each site, crash frequencies for the periods before and after the cycle lane was installed were calculated. Crashes from the year of installation were disregarded due to the possibility of a novelty effect.

Other factors may also have contributed to changes in cyclist crash frequencies in recent years therefore control sites were required. These were chosen on the basis that they did not already have cycle lanes and had been identified by the CCC as having high collision rates (CCC 1999) and minimum cycle volumes greater than 100 cyclists per day (CCC 2001). Seven control sites that were similar to Pages road in terms of being single lane, suburban, midblock sites were selected for comparison with similar cycle lane sites to give an estimate of what effect the Pages Road cycle lane would have on crash frequency.

## 3.0 Survey Results and Analysis

### 3.1 Motor vehicle Speeds

The MetroCount data was processed according to the whole weeklong samples, peak periods (assumed as 7:00-10:00am and 4:00-6:00pm Monday to Friday) and off-peak periods, the weeklong speed distributions are shown in Figure 4. Using the Chi-squared goodness of fit test, it was determined that all data sets could be assumed to be normally distributed. Table 1 shows the important statistical parameters for the MetroCount speed data when modelled with a normal distribution. The final column gives the probability that the mean speeds before and after were equal using the test of two means.

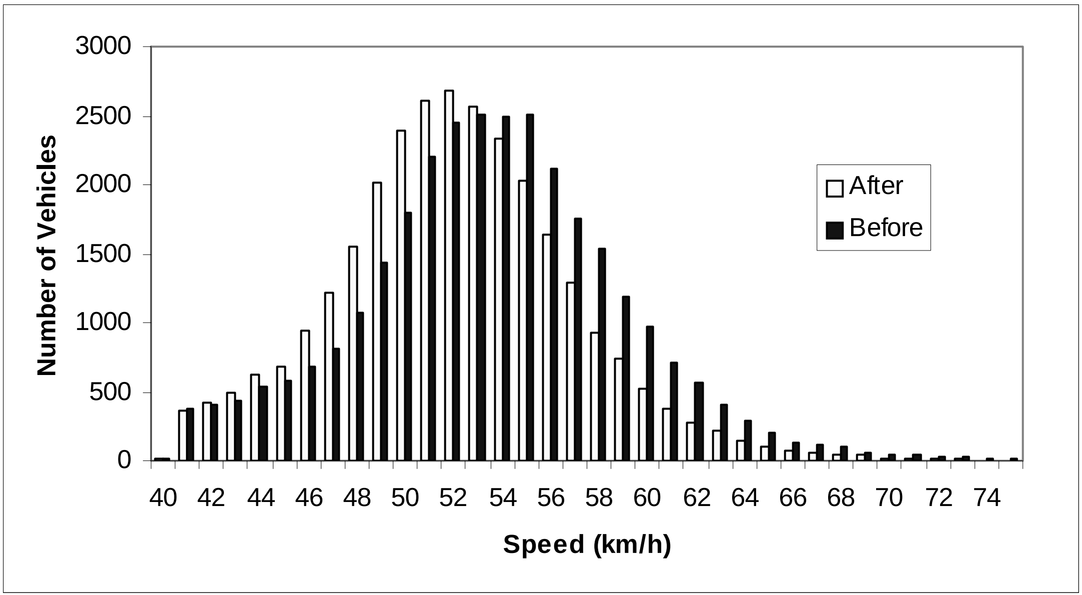


**Figure 4 MetroCount Speed Distributions**

**Table 1 MetroCount Speed Statistics**

| Period | Before/ After | Mean Speed (km/h) | Std. Dev. (km/h) | 85th Percentile Speed (km/h) | Sample size | P($\mu_{before} = \mu_{after}$) |
|---|---|---|---|---|---|---|
| All week | before | 53.1 | 5.6 | 58.3 | 30668 | 0.00% |
| | after | 51.7 | 5.1 | 56.2 | 29496 | |
| Peak | before | 52.5 | 5.4 | 57.2 | 5587 | 0.00% |
| | after | 51.6 | 4.9 | 56.2 | 5934 | |
| Off Peak | before | 53.3 | 5.6 | 58.3 | 25081 | 0.00% |
| | after | 51.8 | 5.2 | 56.2 | 23562 | |

## 3.2 Motor vehicle Positioning

Motor vehicle positioning data for each individual survey was analysed according to the chi-squared method in a similar way to the motor vehicle speed data. Due to low cyclist numbers only the motor vehicle positions when no cyclists were present were analysed. It was assumed that the data was normally distributed as three of the four surveys were well above the 5% statistical significance threshold when using the Chi-squared goodness of fit test.

The nature of the motor vehicle positioning survey method meant that there was a high degree of variability associated with the data. Data collection was heavily reliant on determining which section of lane each car passed over based on painted marks on the road. It was not always easy to judge from the video recordings each motor vehicle' exact positioning on the road as the motion of most motor vehicles was not completely parallel to the direction of view. The collection method also resulted in lumping of data and hence smaller bin sizes could not be determined.

Based on the results from statistical analysis of the four surveys and the nature of the data collection it was assumed that the motor vehicle position data was normally distributed. Data sets were lumped together, depending on whether they represented before or after the cycle lane installation, and tested to find the probability that the means before and after were equal, as shown in Table 2, positions when cycles were present are shown in Figure 5:

**Table 2 Lumped Motor Vehicle Position Parameters**

| Category | Surveys | Mean Dist. to Kerb (m) | Std. Dev. (m) | Number of Motor vehicles | $P(\mu_{before} = \mu_{after})$ |
|---|---|---|---|---|---|
| Motor vehicles, no cycles | Before Total | 4.6 | 0.5 | 2495 | 0.0% |
| | After Total | 4.5 | 0.4 | 2615 | |
| Motor vehicles, cycles present | Before Total | 5.0 | 0.3 | 35 | 81% |
| | After Total | 5.0 | 0.3 | 63 | |
| Cycles | Before Total | 1.5 | 0.7 | 30 | 0.0% |
| | After Total | 2.3 | 0.9 | 38 | |

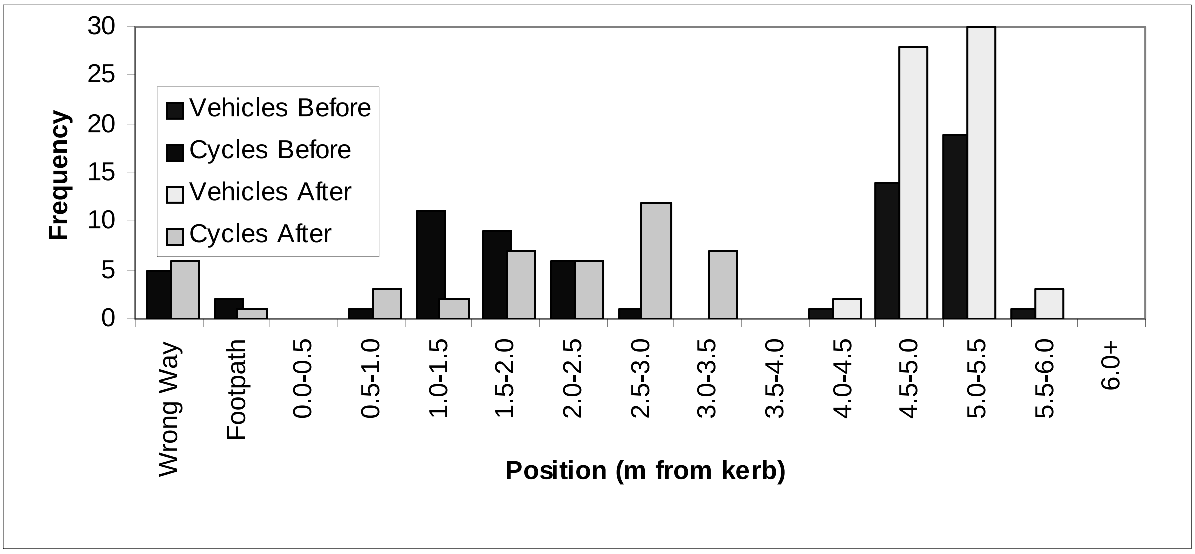


**Figure 5 Positions of Cycles and Motor Vehicle when Cycles Present**

As the distance between the traffic lane and the kerb was altered with the cycle lane introduction but the mean distance between motor vehicles and the kerb remained unchanged when cyclists were present, the actual separation distance between cyclists and passing motorists was also calculated, as shown in Table 3. Table 4 shows the percentages of cyclists who used various parts of the road when travelling in an eastbound direction.

**Table 3 Motor Vehicle - Cycle Separation Distances**

| Surveys | Mean Separation Distance (m) | Std. Dev. (m) | Number of Occurrences | $P(\mu_{before} = \mu_{after})$ |
|---|---|---|---|---|
| Before Total | 3.7 | 0.6 | 33 | 0.0% |
| After Total | 2.5 | 0.7 | 62 | |

**Table 4 Cyclist Position Percentages**

| Surveys | Eastbound Footpath | Westbound Footpath | Parking space | Traffic/Cycle lanes |
|---|---|---|---|---|
| Before Total | 6% | 12% | 62% | 21% |
| After Total | 3% | 0% | 32% | 66% |

It was observed that some cyclists preferred to use the parking space rather than the cycle lane even when they had to alternate between the two to avoid parked cars. The cyclists riding on the footpath were generally school-aged children.

Other occurrences that affected cyclists and vehicle positioning were noted during the surveys. A car was parked directly in front of the survey area for about half of one of the two surveys before the installation, which resulted in a significant increase in motor vehicle distance from the kerb. However, no significant change in positioning was observed when a car was parked for most of the duration of one of the two after surveys. The cycle lane may have been a sufficient buffer to protect people leaving or entering the parked car and therefore motorists felt safer when passing it.

### 3.3 Other Investigations

The qualitative opinion survey of Pages Road residents showed mixed approval of the cycle lane. Motorists agreed that the cycle lane increased cyclists' safety but not all felt more comfortable when passing a cyclist using the cycle lane. There was a slight increase in cyclists' perception of safety after the cycle lane installation but half the respondents still did not feel comfortable when using the cycle lane and one quarter still preferred to use the footpath.

The change in crash frequency for different Christchurch sites that either had or did not have cycle lanes installed in the period 1986-2004 and those from the latter category that were considered appropriate as control sites for comparison with Pages Road are shown below:

**Table 5 Crash Frequency Ratios for Different Site Types**

| Site Type | Crash Frequency After / Crash Frequency Before |
|---|---|
| Cycle Lane | 0.89 |
| Non-Cycle Lane | 0.71 |
| Control | 0.64 |

A complete breakdown of the qualitative survey results and crash history for different site types with different methods of control choice can be found in the full report (Fowler 2005).

## 4.0 Discussions

### 4.1 Motor vehicle Speeds

Statistical evaluation of the MetroCount data suggests that motor vehicle speeds certainly did change after the cycle lane installation. Speeds appear to have decreased by 0.9 km/h for the peak periods and 1.5 km/h for off-peak periods. The overall decrease in mean motor vehicle speed was 1.4 km/h.

This observed decrease in motor vehicle speed does not imply that cyclists cause motorists unwanted delay. The speeds analysed were free speeds that drivers chose themselves and hence the cycle lane's presence simply altered the level of speed that drivers perceived to be appropriate. It is difficult to know whether the change in drivers' perceptions of appropriate speed was due to the presence of the cycle lane or the fact that the traffic lane was narrowed in order to accommodate the cycle lane. It is also worth noting that the average speed after the cycle lane installation was still above the legal speed limit, so motorists' rights have not been affected.

The 85$^{th}$ percentile speeds decreased by 1.0 km/h for peak traffic and 2.1 km/h for off-peak traffic after the cycle lane installation. Variability also reduced in both cases. This suggests that, regardless of their desired free speeds, most motorists felt that the presence of the cycle lane warranted increased caution towards cyclists.

The changes in speeds may also be due to a novelty effect where motorists are initially more cautious than they would normally be, although the 'after' survey was six weeks after installation. It would be useful to obtain speed data at a later date to assess whether or not the change in speed was permanent. Changes in city-wide speed enforcement would also have an effect; although no such change at the time was known of, comparisons with speeds at control sites would prove useful.

The inequality between peak and off-peak period speeds may suggest that not all speeds used in the analysis were actually free speeds; otherwise it would be expected that the changes for the two periods would be more similar. This would indicate that it might have been more appropriate to use a greater critical headway time. Alternatively, the time of day may have affected motorists' willingness to decrease their speed even if they perceive that it would be safer to do so. When driving at peak periods, even if momentarily unconstrained by surrounding traffic, motorists are likely to be more pressured by time constraints and the knowledge that they will likely encounter congestion at some part of their trip so may be less likely to decrease their speed.

## 4.2 Motor vehicle Positioning

The mean distance from the kerb to the left edge of the motor vehicles' left rear wheels decreased slightly after the cycle lane was installed. This result was unexpected as the road layout was considerably altered; the distance from the kerb to the traffic lane edge line had increased by 2.0 metres and the width of the traffic lane had decreased by 1.4 metres. Hence all parts of the traffic lane that drivers would be inclined to judge their positioning against (i.e. edge of lane or centre of road) had moved to the right yet the mean motor vehicle position moved to the left.

The decrease in mean motor vehicle distance from kerb was accompanied by a change in distribution of motor vehicles; prior to the cycle lane installation motor vehicle positions were distributed in a bell-shaped manner, with the majority of motor vehicles driving at the centre of the traffic lane at a distance of 4.5-5 metres from the kerb. After the installation the distribution was right-skewed (i.e. the majority of vehicles were positioned near the left hand side) with the most common motor vehicle position at 4-4.5 metres from the kerb, which coincided with the outer edge of the cycle lane. Variability also decreased slightly in both cases, which would be expected due to the lane width reduction.

While only a small sample of motor vehicles passing cyclists was obtained it appears that motorists generally drove about 0.5 metres further from the kerb when cyclists were present, both before and after the cycle lane installation. However it is interesting to note that after the cycle lane installation the mean distance between motorists and cyclists decreased by about 1.2 metres as fewer cyclists rode in the parking space or on the footpath.

While the decrease in motor vehicle distance from both the kerb and cyclists indicates a decrease in inferred safety it may be linked to an increase in perceived safety. The introduction of the cycle lane encouraged more cyclists to travel closer to the traffic. It also gave motorists a more clearly defined limit of where they could and could not drive and may have been the cause of motorists moving closer to the cycle lane, as they believed that they could safely and legally drive anywhere up to the cycle lane boundary. This distinction would be especially important leading up to the left-hand curve in the road where previously drivers may not have known where they might encounter a cyclist around the corner.

The measure of separation distance to infer cyclist safety may, in this case, be inappropriate due to the anomalies that existed prior to the cycle lane installation. Had all cyclists previously shared the traffic lane they might have experienced greater separation from the motor vehicles after the cycle lane installation. However, as many cyclists had previously used the footpath or parking space they effectively moved closer to the traffic when using the cycle lane and hence inferred safety decreased. The narrowing of the traffic lanes also meant that motorists had less space available with which to distance themselves from the cyclists.

Obtaining large samples of speed data from the MetroCount system proved to be very useful for the speed study, it would be beneficial if this could be directly linked with data on vehicle and cyclist positioning. One way of doing this, the use of two laser devices to detect vehicle presence and positioning and thus vehicle speeds, was attempted during this investigation but useful information was not obtained. It is suggested that future studies make use of this concept and more information can be found in the full report (Fowler 2005).

## 4.3 Other Investigations

The qualitative opinion survey revealed that, in general, motorists felt that cyclists were safer with the cycle lane in place however cyclists themselves did not. Based on this evidence and the relative weightings of motorists and cyclists, only a very slight change in the perceptions of the cycle lane's safety was apparent for this case study. Results from similar studies suggest that a more comprehensive survey might return more positive results, although it is important to note that the similar studies reviewed were based on roads of a more local nature and effects of a cycle lane on a major arterial road such as Pages Road may be less significant.

Although the sample size of the qualitative study was not large enough to draw any significant conclusions its results could be used to identify some of the areas of concern to residents and may be useful for future case studies that aim to develop a more comprehensive method of gauging perceived safety. Ideally surveys would be performed before and after the cycle lane installation using cyclists and motorists intercepted while passing through the site.

From the crash history data where cycle lane sites are compared with control sites it did not appear that cycle lane installations increased actual safety; in fact, in most cases it appeared that the control sites considered similar to Pages Road to experienced greater reductions in crash frequency; only one of the seven sites studied had a crash frequency ratio greater than that of the cycle lane sites.

From this, it appears that cycle lanes have an adverse effect on crash frequency and hence actual cyclist safety but there are several factors worth considering. Firstly, the methodology of this analysis may have been flawed. A more appropriate method might be to use the crashes per cyclist rate for each site instead of the crashes per year for each site. This would normalise the data between sites more effectively as, when using the crash frequency method, sites with high cyclist volumes have more potential to decrease in crash rate. Also, as more cycle lanes were installed throughout the city cyclists may have chosen to use those routes instead of the control sites. Hence cyclist volumes would increase on the cycle lane sites and decrease on the control sites. An increase in cyclist volume would probably lead to an increase in the number of crashes and vice versa.

No additional treatments such as geometric changes, central medians, intersection upgrades or other remedial works performed on the control sites were taken into consideration. Also, many of the control sites were taken from sections of roads that had cycle lanes installed along other adjacent sections. This may have resulted in an increase in safety for the total length of the road as motorists would be more aware of cyclists and would get used to driving with a sufficient gap left available for cyclists thus safety of the non-cycle lane sections would also improve. In a more detailed study it would be advisable to assess each site individually and try to eliminate the effects of other changes made.

## 5.0 Conclusions

Three types of safety were evaluated through the use of different indicators to determine the effect of the installation of the Pages Road cycle lane:

- Inferred safety, as measured by two indicators, motor vehicle speed and positioning
- Perceived safety, as judged by one indicator, qualitative opinions
- Actual safety, as measured by one indicator, crash history of similar sites

Based on data provided by the Christchurch City Council's MetroCount survey, it was determined that the installation of the Pages Road cycle lane resulted in a 1.4 km/h mean speed decrease for all eastbound traffic. As speed is proportional to crash risk and consequence severity this decrease in motor vehicle speed corresponded to an increase in the inferred safety of cyclists.

Results from the video recorded motor vehicle positioning surveys indicated that motor vehicles moved slightly closer to the kerb after the cycle lane installation when no cyclists were present, even thought the traffic lane had moved further outwards. The mean distance between cyclists and motor vehicles decreased after the installation, as fewer cyclists used the footpath or parking space. It was assumed that, the greater the distance between the cyclist and the passing motor vehicle, the greater the safety of the cyclist. Hence, the cycle lane installation decreased inferred cyclist safety in terms of motor vehicle-cyclist separation but the use of this measure may not be appropriate in this case.

Motorists perceived that the cycle lane increased safety of but cyclists did not. A more rigorous study would be required to draw any firm conclusions on the cycle lane's effect on perceived safety. Monitoring the speeds of motor vehicles over a longer period of time after the cycle lane installation would provide insight into the changing perceptions motorists have of the cycle lane as they grow more accustomed to it. This would identify any novelty effect produced.

From the crash history of sites with and without cycle lanes recently installed, it appeared that the control sites experienced a greater reduction in crash rate than the cycle lane sites. To validate or dispute this, a more in-depth analysis of the crash history of other sites with a better understanding of the characteristics of control sites would be beneficial. More consideration should be taken in eliminating the effects of other treatments and campaigns that affect cyclist crash rates.

This study was very specific to an individual site and hence cannot be used to draw any complete conclusions about the safety of cycle lanes in general. However it is hoped that the results from this case study can be combined with those of other studies to gain a more comprehensive understanding of the effects of cycle lanes on the safety of road users and to improve the methodology of subsequent studies.

## 6.0 Acknowledgements

We would like to acknowledge Frank Greenslade, for help in preparing survey equipment, clarifying results and suggesting alternative methods. We are very appreciative of those who supplied information: the Christchurch City Council, especially Michael Ferigo and Bruce Kelly, for supplying MetroCount data; the New Zealand Police, especially Derek Erasmus, for speed camera data; and also Land Transport New Zealand, especially Tim Hughes, for crash data. We would also like to acknowledge Anne Sheard and Hannah Jenkins who assisted with surveys and reviewing of the final report.

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