Environmental Capacity of Local Streets with Street Treatments

ENTR 680 Research Project

Andrew Leckie

3/5/2012

Abstract

“I want my street to be like an extension to my driveway, where the kids can play safely and where the traffic does not bother us,” said one resident. Another said that she “likes traffic... We live in a city.” This gives an idea of the broad range of opinions and views that exist on traffic.

Traffic in local streets in a concern for residential amenity. There is always conflict between the residential amenity and traffic access functions of local streets. There is much debate on what a true local road is. The concept of environmental capacity was developed to identify a suitable maximum traffic volume on local streets, without overly adversely affecting residents. It was first introduced by Buchanan and Appleyard in separate research in the 1960s. Both men settled on thresholds of 2,000-3,000 vehicles per day. Chesterman, in 2009, carried out a study in Christchurch, surveying residents on four local streets with varying traffic volumes. He found residents living on busier streets felt that their streets were busier, noisier and less safe. There was also an increasing trend for these residents to have their houses turned away from the street and they tended to have less personal involvement with their neighbours. He found that perhaps a more suitable environmental capacity estimate was between 1,500 and 2,000 vehicles per day.

This study looked at further Christchurch streets, this time with street treatments, such as street calming and tree plantings, aiming to find an environmental capacity for these streets as well as seeing whether the street treatments affected the perceived environmental capacity. As well as reinforcing most of the conclusions found by Chesterman, a higher environmental capacity of around 2,000 vehicles per day was found for the surveyed streets. This suggests that indeed, street treatments such as those used in the surveyed streets can increase the environmental capacity, which has implications for local councils who want to maintain road traffic carrying capabilities without having unsatisfied residents.

Table of Contents

List of Figures

List of Tables

1.0 Introduction

The impacts of motor vehicle traffic on residents in local streets can seriously affect quality of life. Since the introduction of the private motor vehicle, these impacts have been felt in local streets. Throughout the 20th century, as individual car use grew rapidly, these effects became increasingly a problem for residents. Noise and vibrations, particularly from large vehicles, can seriously impact on peoples' lives, affecting sleeping patterns and day to day activities. Traffic along streets can be dangerous, especially when speeds are excessive. This can lead to fear amongst residents, meaning they are less likely to interact with the street and their neighbours.

Due to peoples' perceptions and opinions differing greatly, residential amenity effects are very subjective and qualitative. However, there is almost certain to be some correlation between increasing traffic volumes and the degradation of residential amenity. This suggests that it might be possible to take an existing street and define the volume and character of the traffic permissible in the street so that it is consistent with good environmental conditions.

This issue was first raised by Buchanan (1963) in his seminal these Traffic in Towns, where he introduced the concept of 'environmental capacity.' Buchanan suggested that, as traffic increased, it was inevitable that the assessment of environmental capacity would become more significant. Since then, environmental capacity has been a point of debate, with particular interest in the acceptable upper limit of tolerable traffic on local streets.

The differences in environmental capacities are due to many varying factors including traffic volumes as well as street widths, speeds and building setbacks. These issues can also be perceived differently from one resident to the next, so the answer is still not clear.

A widely used rule of thumb in traffic planning and engineering is that the environmental capacity of local residential streets is between 2,000 and 3,000 vehicles per day. These figures are still largely based on work carried out nearly half a century ago by Buchanan (1963) and also Appleyard (1981). Chesterman found in 2009, in a Christchurch context, that perhaps a traffic volume between 1,500 and 2,000 vehicles per day was more acceptable on local streets. This paper looks to further shed light on this topic of environmental capacity. Once again, it is based on research undertaken in Christchurch, New Zealand.

The main objective of this research is to determine the environmental capacity for some further selected local streets in Christchurch. This research will follow on from Chesterman's (2009) work, aiming to build on his findings and create a more in depth understanding of the environmental capacity concept. As an extra, this research will focus on streets which have had some form of traffic calming treatment, such as the introduction of speed humps or road narrowing. An additional objective then is to see if these kinds of street treatments have an effect on the environmental capacity. It is the aim that the feedback from the residents of the chosen sites will be able to be combined with that gathered by Chesterman (2009) previously, in order to have a greater understanding of the environmental capacity concept, and what traffic level is acceptable on a local street.

2.0 Literature Review

2.1 Definitions

Before looking into the important literature, there are some key terms that require some clarification. These are local streets, residential amenity and environmental capacity.

Austroads (2004) and Brindle (2003) both state that local residential streets serve many, often conflicting functions. These functions can be classified into two broad groups:

- Movement (access and service) functions
- Amenity and social functions associated with the use and enjoyment of the street-space and the land abutting the street

This clearly implies that not all the elements in the road network serve predominantly as a transport function. This conflict between quality of place and mobility is at the heart of a transport crisis facing modern day planners. This research attempts to lift the veil on some of the more obscure impacts caused by traffic on residential streets, and in so doing add to the continuing dialogue about how to improve livability and quality of life in our cities, towns and neighbourhoods, while retaining levels of accessibility that allow people to carry out the responsibilities of daily life.

The Resource Management Act (1991) does not specifically mention urban amenity, however it does define amenity values as being those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes.

Amenity is therefore a measure of the pleasantness and livability of an area, in its public and private spaces. Austroads (2004) suggests that amenity can be expressed in terms of such things as:

- Local environmental quality
- Sense of security
- Degree of relaxation about children, pets, possessions being unsupervised outside the property
- Freedom to use the street space for a range of purposes
- Privacy
- Lack of constraints on what one chooses to do in and around the home
- Sense of community and local identity
- Property value and
- Compatibility for pedestrian and cycle movement

These measures of amenity can be adversely affected by many aspects of traffic, such as:

- Quantity of traffic
- Noise and vibration caused by vehicles
- Air quality
- Percentage of commercial vehicles, motor cycles etc
- Vehicle speed

- Intrusion by strangers
- Overspill parking from nearby commercial activities and
- Lack of care for other road users

In a traffic context and in the words of Colin Buchanan (1963), all of this suggests that with further knowledge it (might) be possible to take any existing street and after examination of its dimensions, the uses and character of the adjoining buildings, and the amounts of pedestrian traffic along and across it, to define the volume and character of the traffic permissible in the street consistent with the maintenance of good environmental conditions. This amount of traffic might be called the "environmental capacity" and in all probability it would be much lower than the sheer numbers of vehicles that the street could cater for geometrically.

2.2 General Background

In 2009, Rhys Chesterman carried out an in depth look into the environmental capacity concept and the long history behind it. This work looked at the linkages between urban amenity and traffic through the 20th century.

Chesterman's review of the general background began in the first half of the 20th century with the Garden City Movement. One of the most important planned city concepts, the Garden City Movement, arose in 19th century England as a reaction to the pollution and crowding of the Industrial Revolution (Hardy, 1902, cited by Chesterman, 2009).

The review then looked at the decades from the 1960s through to the 1990s and present day. During the 1960s, the car became increasingly popular as a means of transport. In addition the automotive industry was regarded as the 'engine' of a growing economy.

In the 1970s, the concepts of "traffic integration" and "traffic calming" in the environmental capacity zones were originally not well received by the British policymakers, because they seemed to run counter to the major governmental policies of promoting economic development through road construction and railway improvements.

Throughout the 1980s, traffic calming continued and this decade also saw the advent of the New Urbanism movement. At the start of the 1990's the concept of sustainable road safety and management was introduced to avoid a situation from developing where the attention paid to road safety would disappear from the (political) agenda entirely (de Wit & Talens, 2008).

Since the 1990's the environmental movement and concept of sustainability has gained more momentum. For a more in depth summary of the history of environmental capacity, see Chesterman (2009).

2.3 Environmental Capacity

Once again, Chesterman (2009) carried out a very thorough review on the relevant literature. This research is not intended to repeat the work of Chesterman, but to build on it.

Therefore, this section of the report will only touch briefly on the two main pieces of work relevant to this research; those carried out by Buchanan and Appleyard. Following on from this will be an in-depth look at the work carried out by Chesterman in his Christchurch study of 2009. His work is of particular interest because it is intended that his findings be combined with the findings of this study, to allow for a broader understanding of the environmental capacity concept.

2.3.1 Buchanan

Buchanan, a British architect, civil engineer and planner, first raised the concept of environmental capacity in his thesis Traffic in Towns (Buchanan, 1963). Traffic in Towns was an influential report and popular book on urban and transport planning policy for the United Kingdom's Department of Transport. Buchanan never intended to write about environmental capacity, however the issue arose, and he subsequently made an attempt to calculate it.

Buchanan recognised that traffic on residential streets affects the environment in many ways, such as noise, fumes, vibration and danger for people wishing to cross the street. He looked into the possibility that the environmental capacity could be assessed, for practical purposes, by the ease in which pedestrians could cross the street. He proposed that if the pedestrians could cross easily, it would be likely that other problems, such as noise and fumes, would be minimal.

Buchanan suggested that the level of risk to a pedestrian could be measured by the delay to which they are subjected when waiting to cross the street. The average pedestrian delay would depend on the volume of traffic and the width of the road. An average delay of two seconds was decided upon as being the border line between an acceptable and unacceptable wait. A delay greater than two seconds would suggest that most people would need to adapt their movements to give way to motor vehicles. This situation would not be compatible with the idea of an 'environmental area'.

Buchanan further refined his method to consider the proportion of "vulnerable" pedestrians (i.e. children, elderly, parents with prams, etc) and the level of "protection" afforded by the street (i.e. parked cars, vehicle speeds, footpath continuity, etc). In order to explore the practical effect of these variables, Buchanan studied some 50 examples of residential streets with traffic flows ranging from 10 to 1500 vehicles per hour. From all this work, Buchanan was able to derive a series of graphs that enabled the environmental capacity to be determined for any carriageway width and for any levels of 'vulnerability' and 'protection.' Figure 1 shows an example of one such graph, for streets with a high level of pedestrian protection ("Type A").

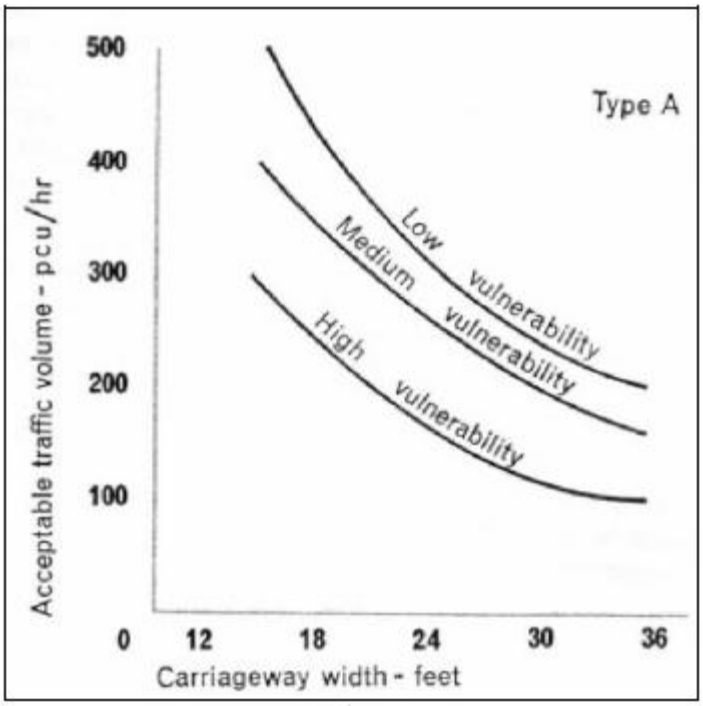


Figure 1: Example of Maximum Acceptable Traffic Volumes (Buchanan, 1963)

In the New Zealand context, where residential streets are typically at least 10 m (33 ft) wide, Buchanan's work suggests that maximum daily traffic volumes of 2,000-3,000 vehicles/day are acceptable, although that figure will be less where there are low levels of pedestrian protection or high proportions of vulnerable pedestrians.

2.3.2 Appleyard

In the late 1960s, Donald Appleyard (a Professor of Urban Design at the University of California, Berkeley) conducted a renowned study on liveable streets, comparing three residential streets in San Francisco that (on the surface) did not differ on much else but their levels of traffic (Appleyard, 1981). One of these streets carried 2,000 vehicles per day (which he termed as a "Light Street"), one carried 8,000 vehicles/day (termed a "Medium Street"), and the final street carried 16,000 vehicles/day (termed a "Heavy Street"). In simple terms, Appleyard's research showed that residents on the Light Street had three more friends and twice as many acquaintances on the street than the people on the Heavy Street. Further, as traffic volume increased, he found that the space people considered to be their "territory" shrank.

Appleyard suggested that the Light Street was a "closely knit community." For example, front steps of the residential houses were used for sitting and chatting, sidewalks were used by children to play and the carriageway was even used by others to play more active games like football. Moreover, the street was seen as a whole and no part was out of bounds. The Heavy Street, on the other hand, had little or no sidewalk activity and was used solely as a corridor between the sanctuary of individual homes and the outside world. Residents kept very much to themselves, and there was virtually no feeling of community. The difference in the perceptions and experience of children and the elderly across the two streets was especially striking.

Appleyard clearly identified the connection between residential amenity and traffic volume. Although he settled on a maximum reasonable environmental capacity for a residential street of

around 3,000 vehicles per day, he made the point that the 2,000 vehicles per day level was a threshold point above which increasing numbers of residents would become concerned about traffic levels on their street. There was however no real rationale as to why he reduced the 'desirable' threshold from 3,000 to 2,000, although it was interesting to note that his lower threshold level aligned with Buchanan's research. Thus, any street with greater than 200-300 vehicles per hour (or 2,000-3,000 per day) was seen as an indicator of exceeding environmental capacity.

Appleyard's work, despite being based on perceptions that could be construed as being location-specific and somewhat subjective, appeared to be simple, yet credible and logical at the same time.

2.3.3 Other Environmental Capacity Methods

More recently, a variety of techniques have been identified, particularly in North America and Australia, which aim to determine the relative effect of new developments on existing local streets. Chesterman (2009) looked into these in further detail.

Although some of the methods incorporate other research, most of it still has some basis in the work of Buchanan and/or Appleyard. Of interest in all these different methods is the fact that they all settle on a maximum traffic figure of 2,000-3,000 vehicles per day for local residential streets. It appears that none of these organisations have challenged Buchanan's or Appleyard's findings with their own research to confirm (or otherwise) whether 2,000-3,000 vehicles/day is still acceptable. Given that some of this work was almost 50 years ago it is highly possible that attitudes have changed during this time. (Chesterman, 2009)

In summary, the idea of environmental thresholds or environmental capacity with regard to traffic volumes has been bandied around for some time, yet there appears to be little modern guidance or research on the topic – either because it is not well understood or too complex. Both Buchanan (1963) and Appleyard (1981) settled on broad-brush traffic thresholds of 2,000-3,000 vehicles per day, which were based on their own observations, surveys, other findings and assumptions. A literature review on the environmental capacity concept reveals that all other research since then heavily relies on the original Buchanan and Appleyard findings and that there has been little questioning of the validity of the original information in the present day.

2.3.4 Chesterman

As mentioned previously, this research follows on directly from the work carried out by Chesterman in 2009. The following is a summary of his study and findings.

Chesterman surveyed residents on four local streets, with varying traffic volumes in Christchurch. The techniques and questions used were similar to those used by Appleyard (1981). Four streets in the suburb of Bryndwr were selected because they were similar in appearance, yet quite different in their traffic levels. The intention was to include streets with traffic flows around 500, 1,000, 2,000 and >3,000 vehicles per day.

Murdoch and Jennifer Streets along with two different sections of Aorangi Road were chosen for the study. These streets were labelled LIGHT, LOW, MEDIUM and HIGH according to their volumes, which are displayed below, in table 1.

	Murdoch St	Jennifer St	Aorangi Rd (South-east)	Aorangi Rd (North-west)
Traffic Volume (veh/day)	564	1,096	2,124	3,537
No. Of Households	14	67	99	42

Table 1: Chesterman's Streets Surveyed

The study looked at resident perceptions using a letterbox questionnaire. The survey asked questions relating to issues of residential amenity, such as whether they know their neighbours, whether the road is noisy and whether they would let their children play on the street.

Given that the traffic volumes of the streets were known, the responses to the questions could be compared to the overall traffic volumes. This information could then be used to examine the impact of traffic on street life. Essentially it was a simple, yet structured way to analyse the variables that might take part in the complicated interaction between traffic and residents' liveability. (Chesterman, 2009)

The dominance of traffic as a problem on all street types was the most salient finding of Chesterman's study. Based on the results, unsurprisingly, residents on the LIGHT and LOW volume streets were the most contended; however they were not without their traffic problems.

More than half of the residents along the LIGHT street still had a fence in their front yard that blocked views to and from the street and they would not let their children play on or near the street. While more residents along the LIGHT street personally knew their neighbours, 80% of them believed the overall speed was ''a little bit fast.'' In addition, 40% believed it was noisy or at least '' a little bit noisy.'' this however was further confused by the response that only 20% of the residents were bothered by traffic during some daily activities.

These conflicting comments confirmed the subjective nature and the variability in opinions in relation to traffic issues along streets. Overall, the perception held by residents living on the busier streets was that their streets were indeed busier, noisier and less safe. The outlook was also not positive, with an increasing trend for residents on busier streets believing that their traffic will continue to get worse. This was coupled with an increasing trend for the same houses to be turned away from the street through construction of high front yard fences. This in turn limits passive surveillance and possibly explains why residents along busier roads were found to have less personal involvement with and/or knowledge of their neighbours.

In order to make a quantitative judgement on a qualitative issue, Chesterman (2009) derived a simple scoring system from his survey information for each of the four streets. This was derived from responses to ten of the main survey questions. The score allocated to each question is a reflection of the percentage of positive responses to that question. This reflects the proportion of responses that are considered to enhance the overall residential amenity and satisfaction of the area, for example the percentage of people who said that the street is not noisy at all. The overall street score is the percentage of positive responses across all ten questions. He considered 50% to be the threshold or environmental capacity. This decision aligns with Buchanan's (1963) theory that simply separates acceptable from unacceptable, i.e. the majority of people will find it acceptable or unacceptable. The results of the scoring system plotted against the varying traffic volumes are shown in figure 2.

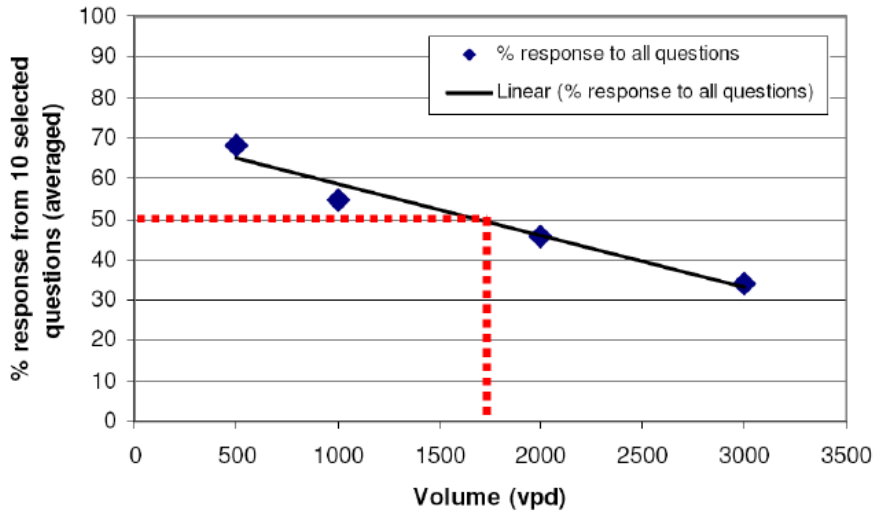


Figure 2: Chesterman's Environmental Capacity Calculation

Chesterman said that this is by no means considered to be an all-encompassing model for determining environmental capacity; however it may provide some insights into the issue, especially in relation to his four surveyed streets. If the environmental capacity is set at the 50% acceptable point, then this would correspond to a traffic volume of between 1,500 and 2,000 vehicles per day. This is less than the regularly quoted 2,000 to 3,000 vehicles per day limit. Chesterman's survey implies that the typical environmental capacity is perhaps not as high as what previous literature has suggested.

The choice to use a delivered questionnaire, which the resident could post back, was largely based on limited resources. To save time and cost, the questionnaire method was chosen ahead of formal interviewing and/ or direct observation. The questionnaire had the advantage of protecting the privacy of the participants, making honest responses more likely. Chesterman acknowledged that his method may have limited the response rate and also led to a response bias.

Chesterman's questionnaire survey achieved response rates of between 34% and 43%. This saw just five questionnaires returned from the LIGHT street and 36 returned from the MEDIUM street. He acknowledged that the limited number of respondents on some streets may have been susceptible to random variation; however his resulting trends did prove to be remarkably consistent.

2.4 Street Treatments

2.4.1 Traffic Calming

As mentioned earlier, this research has a secondary objective of seeing whether or not street treatments, such as traffic calming measures, can increase the environmental capacity of a local street. Several papers looking at the effects of traffic calming treatments were reviewed.

Traffic calming schemes refer to a combination of road network planning and engineering measures to minimise undesirable effects of traffic in residential areas (Grana, Giuffre, Guerrieri, 2010). It is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behaviour and improve conditions for non-motorised street users. (ITE Journal, 1997)

Speeding and unsafe driving practices on neighbourhood streets lead to increased concern by residents. Excessive speed and reckless driving both jeopardise the safety and livability of neighbourhoods.

According to Litman (1999), potential benefits include road safety, increased comfort and mobility for non-motorised travel, reduced environmental impacts, increased neighbourhood interaction, and increased property values. Traffic calming can help create more livable communities, tending to provide the greatest benefits to pedestrians, bicyclists and local residents.

From this short review it is clear that street treatments, such as traffic calming measures can have positive effects on many components of residential amenity. This research will go on to see whether residents perceive this improvement in a real life survey. It is felt that city councils should be interested in whether or not environmental capacity can be increased by street treatments, as it would lead to fewer complaints about traffic for them, without reducing the street's capacity to carry traffic.

2.4.2 Trees

Besides the obvious, that trees make a street look more attractive, streets trees are proven to provide numerous benefits to residents.

Firstly, cars drive more slowly on streets with trees. Trees have a calming effect, and drivers are at least subconsciously aware that where there are trees, there are often pedestrians and children playing. Wide streets where the buildings are small and set back lose their definition, unless this effect is mitigated by lining the street with trees (Jacobs, 1995). Otherwise it feels primarily like a transportation corridor, not a place where people live. Jacobs also cites research showing that for many people trees are the most important single characteristic of a "good street".

Another benefit of trees alongside streets is that they reduce the amount of engine noise created in the first place, because drivers go more slowly. But a line of large leafy trees can also absorb a great deal of noise, preventing it from reaching private yards and homes.

When cars drive more slowly, pedestrians feel safer. In addition, kerbs and trees provide a physical and psychological buffer between footpath and car traffic that increases this feeling of safety. The busier the street, the more this safety buffer is needed. And of course, trees provide an environment in which it is more pleasant to walk - something attractive and green to look at, shade in the summer, a canopy from rain in the winter.

The whole neighbourhood benefits when people get out of their houses to walk. Residents are more likely to meet up regularly with their neighbours, to keep an eye on each other's property, to use their local parks and to patronize local businesses.

3.0 Study Method

3.1 Study Design

The survey method was to be as similar to that used by Chesterman (2009) as possible. This meant that data and survey findings would be more comparable with Chesterman's discoveries.

Streets with varying levels of traffic flows were once again required. Ideally, the streets chosen would have traffic volumes that could be categorised as LIGHT, LOW, MEDIUM and HIGH. These categories would once again correspond to annual average daily traffic volumes of approximately 500, 1,000, 2,000 and 3,000 vehicles per day.

The streets investigated by Chesterman (2009) were very typical of older streets. They were wide, and they were straight. There was no apparent level of street hierarchy associated with them.

Of extra interest in this research was how much of an effect local environmental street treatments, such as speed humps and street narrowing, as well as visual things like trees, have had on residential amenity and environmental capacity. This has added an extra dimension to the amount of analysis that is possible once survey results have been gathered.

It was thought that residents on streets with traffic calming devices would be able to tolerate higher daily volumes of traffic. This was because vehicles would hopefully be travelling at more acceptable speeds, making less noise and creating less perceived danger for local residents.

Other treatments to a street can be more environmental, such as having vegetation planted along the side of the road to possibly reduce sight distances or create some side friction. Both of these effects are aimed at again slowing drivers down.

3.2 Street Selection and Observations

A major consideration when looking for streets to study was the earthquakes that had been hitting Christchurch, particularly that of February 2011. In order to obtain results from the survey that could be compared with other research, particularly that of Chesterman's (2009), then the streets looked at would need to be as undamaged and unaffected by the earthquakes as possible. This was difficult, given that so many streets in Christchurch had been affected. If not structurally damaged, many streets would still be seriously affected by the altered traffic patterns across the city. In the end, the main criterion was just that the streets were not physically damaged by the earthquakes.

Initially, it was targeted to use some streets in the same area as Chesterman (2009) had surveyed. This would minimise as many variables as possible, keeping things such as socio-economic factors the same or very similar. However, upon observation, the older streets in the areas of Bryndwr, Burnside and Bishopdale did not have the level of street treatments that was desired.

It was felt that it would not be too much of a problem; using streets from another part of Christchurch, because eventually it is hoped that these combined findings can be applied to planning processes not just in Bryndwr, but across the whole city and even further afield.

New developments, such as subdivisions on the edge of the city, were looked at, in the search for a group of streets with the desired level of treatments. However these sorts of developments did not have high enough traffic volumes to make them feasible for the study.

A group of local streets in the Papanui area, with high levels of treatment, was found. The area, known as the Papanui Cluster, was re-designed within the last 10 years to reduce vehicle intrusion into the residential area. This was an emerging problem in the area, which is situated near the busy Papanui Road and the Northlands shopping centre. Section 3.2.1 below, gives some more on the Papanui Cluster and the works that were carried out.

The Papanui area has a median income of $25,000, which is slightly higher than the $23,200 median income in the Aorangi area, which Chesterman's (2009) study area is a part of. This data was found from Statistics New Zealand's 2006 CENSUS data. It was deemed that this difference in median income was small enough that the areas cannot be too dissimilar in terms of socio-economic factors.

The NZ Transport Agency's Crash Analysis System (CAS) was used to find the average daily traffic volumes along the streets in the area. It was not clear how old these traffic volumes were, however initially they were the only available numbers to base decisions on. From these numbers, it was obvious that across the area, there is a good range of flows on the different streets. With this determined, the area was deemed appropriate for the study.

When the street treatments were made to the area, intersections were re-designed, and it appeared as though these re-aligned intersections would certainly have affected the traffic patterns. However, as already mentioned, it was not obvious how old the traffic volumes, obtained from CAS were, and whether they reflected the current situation or not.

Because of this, some traffic counts were organised and carried out on selected streets. The findings of these will be mentioned below, in the appropriate street observation sections. Some more information on the traffic counts is provided in Appendix A5, including the detailed results.

3.2.1 The Papanui Cluster

The Papanui Cluster is the name given to a group of streets in the eastern part of the Christchurch suburb, Papanui. The Christchurch City Council renewed the kerb and channel on a number of streets in this area, between 2004 and 2008. The project involved streetworks, an extension to the Papanui Stream Esplanade Reserve, landscaping, drainage/ stormwater work and art features.

The project was based on the Living Streets philosophy. From an August 2005 Christchurch City Council Consultation Update Newsletter:

> "Living Streets is about applying a philosophy that aims to involve people with interests in the street to jointly create a new balance between on street activities pedestrians, bicycles, general traffic and adjacent land uses. On a higher level it is about balancing land use, transport, environment and health."

The Papanui Cluster area is bordered along its western edge by the very busy Papanui and Main North Roads. These roads are associated with much commercial activity, including the nearby Northlands Mall, as well as high traffic volumes and congestion during peak times. Grants Road as well as Frank, Wyndham, Loftus, Mary and Proctor Streets, local streets in the area, have one end at

either Papanui or Main North Road. The ends of these streets have a few small businesses on them, along with the associated car parking spaces and traffic. They do generally have kerb narrowings near their starts, to show drivers that they are leaving the main road and entering a local street.

This had to be considered when surveying residents, always being wary of having perceptions affected by the busy main roads, when the study is only interested in the local streets.

Associated with the location of the Papanui Cluster and its proximity to the busy shopping area of Papanui is a high level of parked vehicles for a residential area. Most of the streets in the area have cars parked for long periods every day, particularly during weekdays. A risk with this study was that the issue of parking, which many residents feel strongly about, could overshadow what the study is actually about. It was important to separate the residents' negativity stemming from their parking concerns, from their perceptions of the traffic levels on their street and how it is affecting them.

There were several common treatments used throughout the Papanui Cluster area. Several intersections were redesigned, to alter how the traffic flows through the area. The photo below, figure 3, shows a realigned intersection.

Figure 3: The Re-designed Gambia St/ Frank St Intersection

Care has to be taken by drivers, as they navigate their way through these intersections, which has the effect of slowing vehicles down. Intersections are also raised and cobbled as another technique to slow down vehicles. Kerb narrowings occur along lengths of some of the longer streets too, such as on Mary and Proctor Streets. The photo below, figure 4, shows a kerb narrowing on Proctor Street.

Figure 4: Kerb Narrowing on Proctor St

Despite these treatments however, there is still a path through the area which has the right of way from Main North Road all the way to Grants Road. The path runs along Mary Street, into Frank Street and then along Gambia Street to Grants Road. From there, vehicles cross Grants Road and head along Rayburn Avenue. From observations, it was very apparent that this path is commonly used by vehicles trying to avoid the very busy section of Papanui Road, which includes the intersection with Harewood Road. Maps of the study area, as well as the Papanui Cluster and road layout are attached in Appendix A6.

All streets decided on for surveying are classified as local roads in the Christchurch City Plan.

The following sections introduce each of the streets where surveys were carried out, and identifies characteristics specific to each one.

Due to the short lengths of some of the streets, and the desire to gather large samples, it was deemed necessary to combine streets with similar traffic volumes.

3.2.2 HEAVY VOLUME STREET OBSERVATIONS

3.2.2.1 Rayburn Avenue

Figure 5: Rayburn Ave

Rayburn Avenue is the only street that is not within the Papanui Cluster area. As a result it has no physical street treatments, such as speed humps or kerb narrowing. However, the street, which is used as a continuation of Gambia Street, to the east of Grants Road, is unique in that it has large trees flanking the street. These trees have grown over the road and in places meet with the trees from the opposite side. Since it was an objective of this study, to see whether environmental treatments, such as road side greenery has an effect on environmental capacity, it was decided to include Rayburn Avenue in the study. Of interest was whether or not residents' responses about their traffic were better on Rayburn Avenue than on a street with comparative traffic levels. This would suggest that the trees possibly create some side friction for drivers, slowing them down, or

perhaps they just make the street feel nicer for residents, leading to more positive attitudes towards undesirable things like traffic. Section 2.3.2, earlier in the report, introduced some views on how trees can benefit local streets and their residents. Whether these were perceived by the local residents during the survey would be of particular interest.

The section of Rayburn Avenue between Perry Street and Grants Road was chosen to be one of the HIGH volume streets. The CAS (NZTA) data showed a traffic volume of slightly under 3,000 vehicles per day. Rayburn Avenue is the only street or section of street surveyed that has a bus route along it. It is serviced by the No.18 St Albans/ Huntsbury bus. 20 of the 25 households along this section of road were able to be questioned as part of this survey, which is a very satisfactory response rate.

3.2.2.2 Mary Street

Figure 6: Mary St

The Mary Street study area was split into two groups due to the initial traffic volume statistics. According to the CAS (NZTA) numbers, the traffic volume on the section between Main North Road and Wyndham Street was significantly greater than that between Wyndham and Frank Streets. According to the numbers, about 3,000 vehicles per day used the western section of Mary Street, and only about 2,000 vehicles per day used the eastern section.

However, from observations, it appears that these numbers are outdated. With the realignment of some of the intersections, the major traffic flow through the area goes along Mary Street all the way to Frank Street, before, as already mentioned, following Gambia Street and Rayburn Avenue.

As previously mentioned, three traffic counts were carried out in selected locations. These counts lasted for 24 hours and were done between 11am on Thursday February 23 and 11am on Friday February 24. The three counts were done in locations identified as important, to validate, or otherwise, the traffic counts obtained from CAS (NZTA). One of these counts was done on Mary Street, near the Horner Street intersection. This count showed just over 3,000 vehicles using Mary Street which was consistent with the CAS (NZTA) traffic count. The traffic count outputs are attached in Appendix A5.

Despite the assumption that traffic volumes are roughly the same along Mary Street, from Main North Road all the way to Frank Street, the two Mary Street sections were kept separate throughout the data analysis stage since they still display different characteristics. For example, the section

further from Main North Road seems to have many more new houses compared with the older looking western section.

As has already been mentioned, Mary Street joins with Main North Road at its western end. Main North Road is a busy road through the commercial centre of the Papanui area. As a result, at the end of Mary Street, there are some commercial buildings, including the Papanui police station. Near the Main North Road end there is a narrowing of the road, beyond which Mary Street becomes a residential street. Only properties on the inside of this threshold were contacted for questioning, to try and minimise the problem of being too close to Main North Road and the associated commercial activity.

Along its length, Mary Street has kerb 'narrowings' aimed at slowing vehicles down. Often two vehicles cannot pass each other within the narrowed street width, which results in one vehicle having to stop to allow the other to pass. This process usually results in both vehicles having to slow down first.

The daily traffic volume using the two sections of Mary Street will be taken as being about 3,000 vehicles per day. The traffic count carried out recorded about 3,100 vehicles in the 24 hour period, but some fluctuations are expected along the length of the street.

In the western section of Mary Street, 15 out of 19 households were contacted for questioning, while 11 of the 12 properties along the eastern section were able to be contacted. Again, this is a very good response rate.

3.2.3 MEDIUM VOLUME STREET OBSERVATION

3.2.3.1 Gambia Street

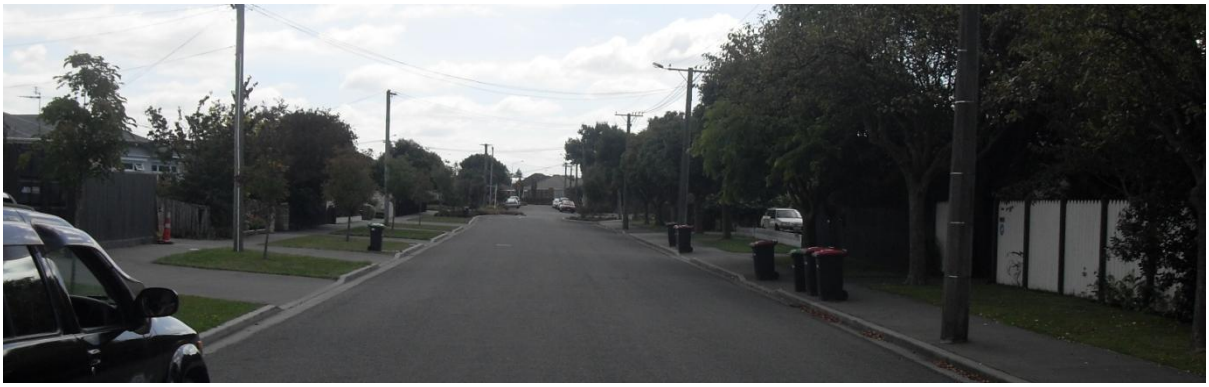


Figure 7: Gambia St

From the initial traffic volume readings, Gambia Street, along with Loftus Street, was going to be categorised as a LIGHT street, carrying 500 vehicles, or less, daily. However, from observations, it appeared that Gambia Street was certainly much busier than this. Upon inspection, it was clear that the previously mentioned intersection realignments had resulted in a large increase in traffic on the section of Gambia Street between Frank Street and Grants Road. To confirm this, the second of the three traffic counts carried out was done on Gambia Street, about halfway between Frank Street and Grants Road. This traffic count confirmed that the amount of traffic now using Gambia Street is far

higher than it used to be, with about 2,400 vehicles using this section of road in the 24 hour period surveyed. See Appendix A5 for the traffic count output.

As a result of this, Gambia Street was categorised as MEDIUM in terms of traffic flow. Along Gambia Street the only physical treatment as a result of the Papanui cluster project is the alteration to the Frank Street intersection. The intersection is no longer a cross roads, but rather a right of way exists south along Frank Street and then east into Gambia Street and vice versa. There is a raised platform at the intersection of the southern part of Frank Street and the western part of Gambia Street, where traffic has to give way to the main flow around the previously described corner. Figure 8 shows the intersection, from Gambia Street, looking west.

Figure 8: The Gambia St/ Frank St Intersection from Gambia St

To the west of this intersection, Gambia Street does appear to have less traffic than the eastern section which, as already mentioned, is part of the 'by-pass' which vehicles use to avoid Main North and/or Papanui Roads. Due to time restrictions, and some other factors, traffic counts were not able to be carried out on all sections of road where resident surveys took place. This will be discussed further in the later part of this report, but it has meant that the responses of the entire length of Gambia Street have been grouped together.

The traffic count recorded about 2,400 vehicles using Gambia Street, however a figure of 2,000 will be used later in the calculation of the environmental capacity to better represent the entire street. 15 out of the 21 households on Gambia Street were able to be contacted for questioning.

3.2.4 LOW VOLUME STREET OBSERVATIONS

There were three streets in the area that, according to CAS (NZTA), all had similar daily traffic volumes of around 1,000 vehicles per day. These three streets; Grants Road, Frank Street and Wyndham Street all run basically parallel to each other, from Papanui Road. The sections of these streets of interest were just the parts between Papanui Road and Gambia Street, since traffic flows diminished below 1,000 vehicles per day beyond Gambia Street. These three streets have some similar characteristics, such as the fact that they each have some commercial activity at their Papanui Road ends. They also have some specific characteristics which will be discussed below.

3.2.4.1 Grants Road

Figure 9: Grants Rd

Grants Road is home to several considerate traffic generators. The Papanui Seventh-day Adventist Church is located on Grants Road adjoining the Christchurch Adventist School. The church does not generate traffic everyday but the school certainly means that Grants Road is busy before and after school each day. Further down the road, outside of the study area is the Ngaio Marsh Retirement Village, which also has an effect on the traffic levels along Grants Road. There is a kerb narrowing near the school to slow drivers. 19 out of the 28 residencies on Grants Road were successfully contacted for questioning.

3.2.4.2 Frank Street

Frank Street has quite a few businesses at the Papanui Road end as well as a second entrance to the school. There is quite considerable parking on Frank Street, given that the end of it is near the heart of the Papanui shopping area. 11 out of the 14 households were reached for this study.

3.2.4.3 Wyndham Street

Figure 10: Parked Cars on Wyndham St

For similar reasons as Frank Street, Wyndham Street has a high level of parked cars throughout weekdays in particular. The street is very narrow in points, meaning that cars cannot pass each other comfortably, leading to slow speeds. 18 out of the 28 houses on Wyndham Street were able to be contacted for the survey.

3.2.5 LIGHT VOLUME STREET OBSERVATIONS

3.2.5.1 Proctor Street

Initially, Proctor Street was going to be considered a MEDIUM street, due to a daily flow of around 2,000 vehicles being reported by CAS (NZTA). However from observations, Proctor Street seemed very quiet. It seemed that perhaps the alterations carried out during the Papanui Cluster project had diverted traffic from Proctor Street to elsewhere. For this reason, it was decided that the third of the traffic counts carried out would be done on Proctor Street. This count, which was done near the Frank Street intersection, showed that indeed the Proctor Street traffic level was much lower than it had previously been. Only about 400 vehicles were counted over the 24 hour period.

Along its length there are several very narrow points, one of which is the bridge over the Papanui Stream, next to the Papanui Stream Esplanade Reserve, which is shown below in figure 11.

Figure 11: Bridge on Proctor St

42 out of the 67 properties along Proctor Street were able to be contacted for this study.

3.2.5.2 Loftus Street

Loftus Street is a short street running from Main North Road to Wyndham Street. There is one intersection midway along its length where drivers have to give way to vehicles on Horner Street. CAS (NZTA) data showed that the daily traffic levels on this street were less than 500 vehicles per day and during interviews it indeed seemed a quiet street. Like many of the other streets, there is quite a high amount of on street parking, however the 'feel' of the street is enhanced by the large 'green zone' on the northern side of the street, between the road and the footpath, shown in figure 12.

Figure 12: Green Zone on Loftus St

As with most of the streets in the area there are kerb narrowings and raised intersections to slow drivers down at the very least, possibly even discouraging car use in the area. There was some concern that at the Main North Road end of Loftus Street, there was high commercial activity, including a popular public bar. For this reason, the surveying of residents was stopped well short of the Main North Road end of Loftus Street, to minimise the effect of the busy commercial area on residents' perceptions. 11 out of the 13 properties on Loftus Street were able to be contacted for questioning.

Overall, there was a very high proportion of the area questioned, with 162 out of the 227 properties in the area contributing to the study.

	Number Surveyed	Traffic Flow
HIGH Volume	**46**	~3,000 veh./day
MEDIUM Volume	**15**	~2,000 veh./day
LOW Volume	**48**	~1,000 veh./day
LIGHT Volume	**53**	~500 veh./day

Table 2: Number of Surveys by Traffic Volume Category

3.3 Data Gathering

It was felt that the best method for questioning the residents would be going door to door and interviewing them in person. As many residents as possible were interviewed during late November and early December 2011. Interviews were carried out mostly during the daytime but also over several evenings. This was done to try and capture the residents who were at work during the day. As mentioned earlier, it was noted that a large proportion of the study population were in the retired age group, meaning that they were often able to be contacted during the daytime.

Conducting interviews in person had the advantage of being able to avoid confusion and misinterpretations from the questions. There was also more opportunity for residents to describe their thoughts and give more comments.

Despite these advantages, there is some danger associated with the interview process. The risk of biasing the respondents had to be managed carefully. It was important that the responses of the residents being questioned were in no way influenced by the way the question was asked.

A letter was first sent out to inform residents that there would be an upcoming visit to their house, hopefully involving a short interview. A copy of this letter is in Appendix A2. For the people who could not be contacted, or who wished not to participate, a questionnaire was prepared, which they could fill out at their own leisure and return. A copy of the questionnaire used is in Appendix A3.

3.4 Survey Questions

Questions asked in surveying the residents were the same as those asked by Chesterman (2009). These questions were based broadly on the questions posed in earlier research by Appleyard (1981).

There were 19 questions asked during the interview process and on the questionnaires. The questions were identical to those posed by Chesterman (2009) in his previous Christchurch work. They ask a mixture of things, including personal demographic information as well as resident's perception on the traffic and how it affects them. Other aspects of the questioning include the resident's house and its orientation, as well as how well they know their neighbours.

The following section outlines the 19 questions and gives some insight into why they were asked.

3.4.1 Question 1: Is your home a front or rear section property?

This question was mostly for use in the analysis, when only front or rear section properties were specifically of interest. Also, it was to see if there were more rear section properties on busier streets, as people try to get away from the traffic.

3.4.2 Question 2: Does your main living area face towards or away from the street?

As for the first question, this one is to see whether people on busy roads try to turn away from the traffic, in this case by having their main living area face away from the street.

3.4.3 Question 3: If you live on a front section, do you have a fence in the front yard that blocks the views to and from the street?

As for the first two questions, this one tries to see whether people on busier streets are more likely to try and shelter themselves from the effects of the traffic on their street, in this case by having a big fence block the views, sounds and so on.

3.4.4 Question 4: If you have children (or have had/ were to have children) would you feel comfortable with them playing unsupervised on or near the street?

This question gives some insight into how safe people feel their street and the surrounding environment is. Is it hypothesised that, as streets get busier, people will be less likely to feel comfortable with kids playing on the street.

3.4.5 Question 5: Do you know any of your neighbours?

This question is aimed at determining how much social interaction occurs on the street. Appleyard (1981) showed that people on busier streets have less social connections, and this question looks to validate his findings in the Papanui Cluster context.

3.4.6 Question 6: Do the traffic volumes along this road create a barrier to social interaction?

This question is similar to question 5; however this question asks the residents directly whether they feel that the busyness of their road prevents them from interacting with their neighbours.

3.4.7 Question 7: For a residential street, how would you rate the amount of traffic on this street?

For this question, the residents have to rate the amount of traffic on their street from very light, light or average through to fairly heavy and heavy. This gives an idea of whether they think the amount of traffic on their street is acceptable. This question also gives an idea of how positively the resident feels about his/ her street. It was thought that residents on busier streets would answer that the traffic levels they experience are heavier than those experienced by residents on lighter volume streets.

3.4.8 Question 8: Do you think that the overall speed of traffic on this street is too fast, a little bit fast or about right?

Similar to question 7, this one asks instead how the resident feels about the general speed of vehicles on their street. Once again the question gives insight into whether the resident has a positive or negative feeling towards their street. It was predicted that residents on busier streets would be more likely to feel like the traffic generally is too fast.

This question is of particular interest to this study, because street treatments, such as traffic calming are aimed at slowing down traffic. It will be of interest to see whether people are more content with the overall speeds in their streets compared with the untreated streets of Chesterman's (2009) study.

3.4.9 Question 9: At which time of day do you consider traffic on this street is the heaviest?

This question asks the resident whether there is a time of day that they feel the traffic is heaviest on their street. On a quiet street, it is thought that there would be no obvious time period that the traffic is busiest, while on a busy street, flow levels would likely be high around peak times.

3.4.10 Question 10: Has traffic over the past few years improved, got worse or remained similar?

Whether the street has actually got busier or not, this question gives an idea of how positively or negatively the residents feel about their street. It was thought that the people living on the busier streets, who do not feel a high level of attachment to their street, would be more likely to respond that their street has got worse in the past few years.

3.4.11 Question 11: In the next few years, do you think the traffic on this street will improve, get worse or remain similar?

As for question 10, this gives insight into how the resident feels about their street. If someone is happy with their street, feels positive about it, and maybe feels attached to it, it seems reasonable to expect that they would be less likely to respond that they think things are going to get worse, than someone who does not have the same good feelings about their street. Similar to above, it was hypothesised that residents on busier streets would be more likely to predict deterioration in the traffic conditions on their streets.

3.4.12 Question 12: Do you consider this road to be noisy, a little bit noisy or not at all?

Nobody wants noise on their local street, but logically, people who live on busier roads are more likely to have to deal with traffic noise. It was thought that there would be more people answering that their streets are noisy in some way on the busier streets surveyed. It will be unavoidable, that some people find their streets a little bit noisy. The environmental capacity calculation involves finding a level of traffic at which the number of people responding negatively, such as by saying their road is noisy, is acceptable.

3.4.13 Question 13: Does traffic in your street bother you when watching TV, doing outdoor activities, sleeping, eating, working or talking in the house?

This question looks at exactly how the traffic affects the residents who say their traffic is bad. Similarly to the previous question about noise, there will always be some residents bothered by traffic but it is important to have traffic volumes at a level at which only an acceptable amount of people are adversely affected. It was not anticipated that many people in the local streets in question would have problems with the activities named.

3.4.14 Question 14: How long do you usually have to wait for traffic before crossing the street?

Ideally, people would never have to wait to cross the street in front of their house. If the local street was indeed an extension of one's driveway, as some think local streets should be, crossing delays would be nearly always zero. However, as local roads become busier, it is inevitable that typically, local residents will have some wait before crossing their street. It was expected that residents on the local streets being surveyed would very rarely have to wait more than a few seconds to cross.

3.4.15 Demographic Questions

Questions 15 and 16 ask the respondent their sex and age. This information was to be collected so that during the analysis stage, resident responses could be grouped with responses from similar demographics, to see if there are any trends. Questions 17, 18 and 19 simply ask for how many people are living in the house, whether the house is owned or rented and how long they have been living at their current address. These were again collected for statistical purposes, in case they would prove to be useful during the later analysis stages.

4.0 Results and Discussion

4.1 Survey Question Findings

The following section looks at the results from each of the survey questions posed. Findings from each individual street are largely kept separate to avoid missing any results specific to a street. This is despite initially selecting groups of streets to fill the HIGH, MEDIUM, LOW and LIGHT categories. Where appropriate, such as the final calculation of environmental capacity though, the grouped findings are used.

4.1.1 Question 1: Is your home a front or rear section property?

This question simply asked the resident whether their house was built on a front or rear section. During interviews this was simply just observed and not asked.

To clarify, when interviews were being carried out, for a house to be considered a rear section property, there had to be another house built in front of it. There was some unclearness with houses built well back on large front sections, as to whether they should be considered rear section properties, due to how far they are from the road and the related traffic effects. For the purposes of this study, it was noted that they were built well back from the road, but they were still counted as front sections.

Figure 13 below, shows the percentages of front section properties on each of the streets studied.

As will be the procedure throughout this report, the plot will show the HIGH volume streets at the left, with the streets shown in descending order, in terms of traffic volume. Where appropriate, Chesterman's (2009) findings will be displayed for comparison. The corresponding bar for each of the nine street sections is shown despite Chesterman having only questioned four streets of residents.

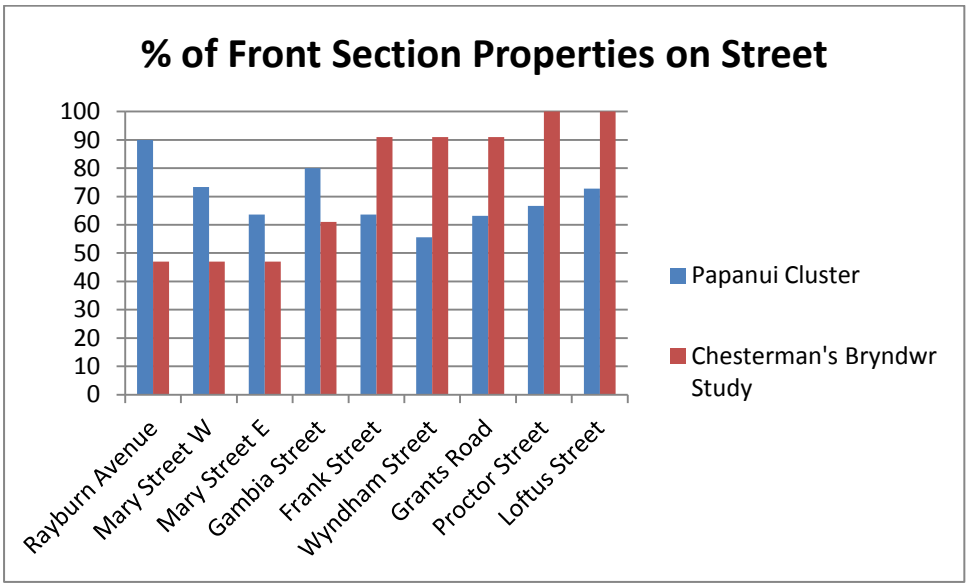


Figure 13: Percentage of Front Section Properties on Each Street

Chesterman's (2009) percentages for the four categories of streets; HIGH, MEDIUM, LOW and LIGHT are plotted alongside the corresponding Papanui findings. Unlike in Chesterman's Bryndwr study, there is no apparent trend towards houses on busier streets being more like to be built on rear sections. Generally the percentage of houses built on front sections is similar across the entire study area.

It is felt that a large contributor to the amount of rear section properties is the degree of subdivision of land that has occurred. Old houses naturally get deconstructed and replaced, often by two or more smaller houses, with landowners trying to maximise what they get for their land.

The study area contained lots of small, low maintenance sections along with smaller homes, making the area very suitable for older people. It was noted during the interview process that there was a high proportion of older people, many of whom were contactable during the daytime, suggesting a large number of retired people in the area. This was somewhat confirmed by looking at the 2006 CENSUS data. Over 19% of the Papanui population is over 65 years old, compared with the Canterbury average of 13.9%. Chesterman's (2009) Aorangi area also has quite a high number of older people, with 17.7% of the population over 65 years old.

The highest proportion of front section properties, unexpectedly, was on the busiest street; Rayburn Avenue. This street was slightly different to the rest of the study area in that it had lots of big, old houses built on big sections. The feel of the street was slightly different, as though the population was generally more affluent.

Many of the quietest streets, such as Wyndham and Loftus Streets, had a high level of subdivision that had occurred in the past. They had many new townhouse style buildings as well as flats built on rear section properties.

These findings show that there are many factors influencing how many front section or rear section properties there are on a street. Chesterman's (2009) research would certainly suggest that one of these factors is the level of traffic; however this is not evident in this study.

4.1.2 Question 2: Does your main living area face towards or away from the street?

This question is similar to the first in that it is related to the layout and orientation of the resident's house. Some residents on back section properties were left out of the analysis of this question, since their main living areas look straight at the back of the houses in front of them. Once again, Chesterman (2009) had previously found that residents on busier streets were more likely to have their main living area face away from the street.

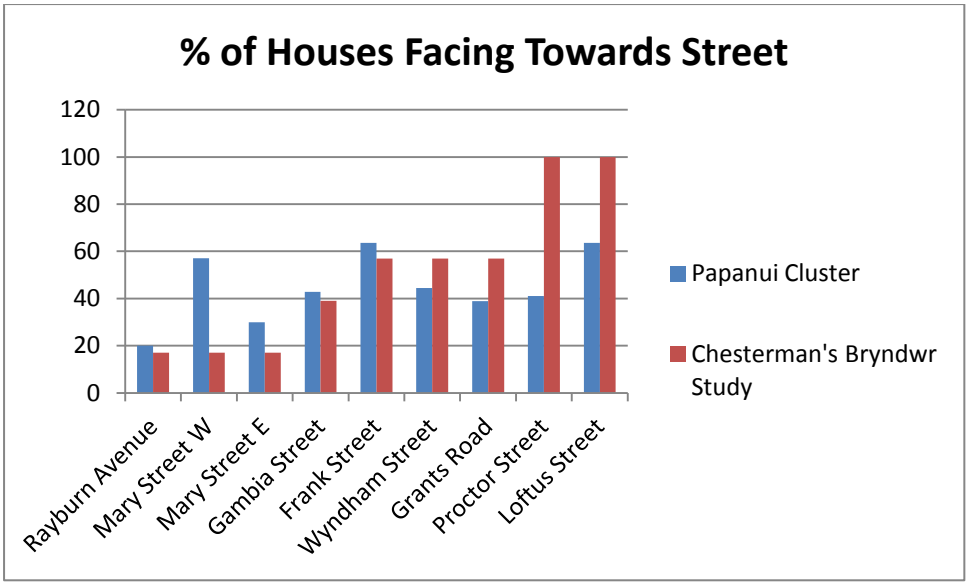


Figure 14: Percentage of Living Areas Facing Towards the Streeet

Unlike for the first question, there is a small trend visible in the results from the Papanui study. Generally, there are fewer houses with their main living areas facing the street on the busier streets than there are on the quieter streets. There are exceptions though.

The section of Mary Street closer to Main North Road has a much higher proportion, nearly 60%, of houses with the main living area facing towards the street. It is felt that this could be for similar reasons as to some of those discussed for the previous question. The houses along the western section of Mary Street generally appeared older than those along the eastern section. When those older houses were first built, Mary Street would certainly have been a much quieter street. Since then, in the eastern part of the street particularly, old houses have begun being replaced by new townhouses and other denser developments. These new houses are very likely being built with the living areas facing away from the now busy Mary Street. The western part of the street is lagging behind somewhat, as is evident from the results show in figure 14 above.

The LOW and more particularly the LIGHT streets are less likely to have the living area facing towards the street than those surveyed by Chesterman (2009) in Bryndwr. Perhaps this is a reflection of the overall area being not quite as friendly. Also, many of the houses on the quiet Proctor Street have large sections. If you have a large back lawn and garden it would seem more likely that you would want your living area facing towards that, rather than the street.

Once again this question has shown that there are more things contributing to where and how a house is positioned than just how busy the road is. However a trend is apparent and it makes sense that houses would be more likely to face away from busy roads than quiet ones.

4.1.3 Question 3: Fence in front yard blocking street views?

This question was for residents living in front section properties only, and it asked whether or not they had a fence in the front yard that blocked their view to the street. Once again this could be observed while carrying out the interviews. Hedges or other shrubbery that blocked the views to the street were also considered as fences for the purposes of this survey.

The findings from this question, shown below in figure 15, show a definite trend for less and less fences blocking street views as the streets get quieter.

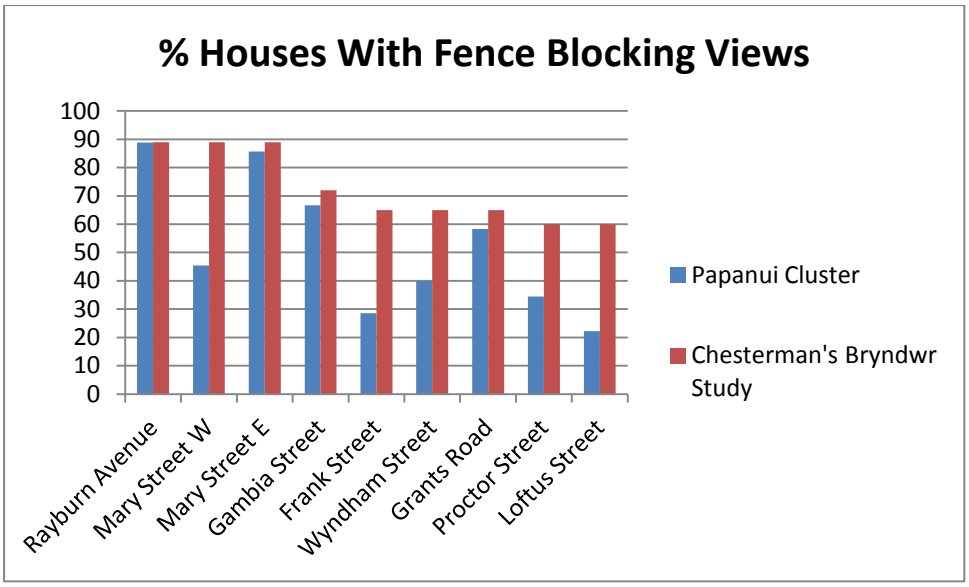


Figure 15: Percentage of Front Section Properties with Fence Blocking Street Views

A lot of the results from this part of the study are very comparable with the Chesterman (2009) findings. There is a definite decline in the percentage of fences as the traffic volumes decrease. The decline is actually more obvious in the Papanui Cluster than that observed in the Bryndwr study. Chesterman found that there were fences blocking street views in around 60-70% of all properties for MEDIUM, LOW and LIGHT streets. However on Proctor and Loftus Streets there are as little as 20-30% of properties with fences blocking the street views.

This may suggest that the area is in fact safer, or the residents feel safer living in this area. Being so close to the busy roads means there is more chance of passive surveillance. Also the high proportion of older people perhaps makes the area safer since they are less likely to perform crimes. The streets in Bryndwr by comparison do not feel as friendly and perhaps the residents perceive a higher level of danger, so erect high fences for security reasons.

Once again the older section of Mary Street does not follow the trend of the other HEAVY sections of road. Perhaps being only a block or two down from the police station makes the residents feel comfortable, but more likely the older style houses never had big fences to start with. It takes considerable effort for someone to get a high fence built, but for some it is necessary. One man had just built a fence on the HIGH volume Rayburn Avenue, and another was planning on building one soon.

Despite all this, the trend is obvious for this question, and certainly people on busier streets are far more likely to have a high fence blocking views to and from the street.

4.1.4 Question 4: Comfortable with kids playing on the street?

This question asked people whether or not they would feel comfortable letting kids play on or near the street unsupervised. This was asked regardless of whether people have ever had kids or not. Commonly the residents responded that it would depend on the age of the kids. However, many also

said that it is not a good idea anywhere to let your kids play unsupervised, citing 'the way things are these days' as a reason.

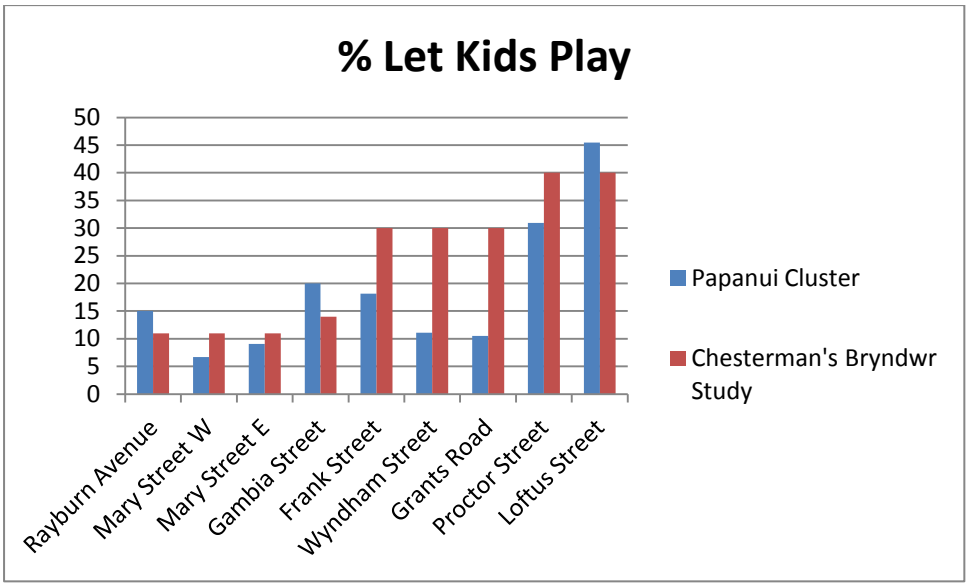


Figure 16: Percentage of People Comfortable with Kids Playing on the Street

Despite these factors, once again there is a trend; this time that more people would let kids play unsupervised on quieter streets. The results from the HIGH volume streets are consistent with Chesterman's (2009) study on Aorangi Road in Bryndwr. Some of the LOW streets have a lower than expected proportion of people who would let kids play on the street than expected. Particularly this is true on Wyndham Street and Grants Road. Upon inspection, neither street seem fit for kids to be playing on, with speed being raised as a problem consistently on Grants Road, while parking is a major concern on Wyndham Street. For these reasons these streets are less suitable for kids to be playing on than the Bryndwr streets studied by Chesterman (2009), which were wider and clear of obstacles, making a far safer environment to play on. This goes some way to explaining why Wyndham Street and Grants Road results were as they are but then interestingly, in the LIGHT category, Proctor Street and Loftus Street compare well with Murdoch Street in Bryndwr.

Proctor Street does have effective traffic calming devices and Loftus Street the wide green area between the footpath and the road, which may make them more appropriate for kids to play on or near.

Many comments were received regarding kids playing on the streets. A young Indian man said that he would not feel comfortable with kids playing on any streets. He said that in India you cannot drive until you are 21, and he thinks that 15 year olds here are a hazard. He also raised drink driving in New Zealand as a concern and reason to not allow kids to play on streets. Most of the comments were to do with how narrow the streets are and/ or the parked cars making the street unsuitable for child's play. A parent in Gambia Street said, "We never play on or near the street but in yard.'' Another on Gambia Street said that the speed that cars go is the reason kids should not play on the street.

Someone on Gambia Street said that they did not buy the property to have kids. If they were going to have kids they would live somewhere quieter. This raises the important consideration, that people choose to put up with the traffic where they are living. People have the freedom, usually, to choose to some extent where they live.

On Grants Road someone thought that the 'generous pathway' and speed humps made it safe for kids to play, but most people on Grants Road disagreed as already mentioned.

4.1.5 Question 5: Do you know any of your neighbours?

This question asked whether the resident knew any of their neighbours. They were required to answer either yes, I know them personally, yes I kind of know them but not very well or no, I don't know them at all. There was some difficulty for respondents to decide whether they know their neighbours personally. It was unclear how many neighbours they had to know personally, or how well they had to know them for it to count as personally. Some people would count knowing the person across the road's name as knowing them personally, while some people would say they hardly know them. Another problem with asking this question was that there were people who had not been living in the area long, and so did not know their neighbours at all. There is the possibility that respondents felt embarrassed at not knowing their neighbours at all, and so made an excuse like this when answering the interview face to face. There could also have been this sort of bias with people claiming to know their neighbours personally during the face to face interview, so it does not look as though they are unsociable.

The following chart, figure 17, shows comparisons for the streets surveyed as well as for Chesterman's (2009) surveyed streets, for how well people know their neighbours. To get a score for how well people know their neighbours, the percentage of people who answered that they know their neighbours personally was doubled and added to the percentage of people who their neighbours, but not so personally.

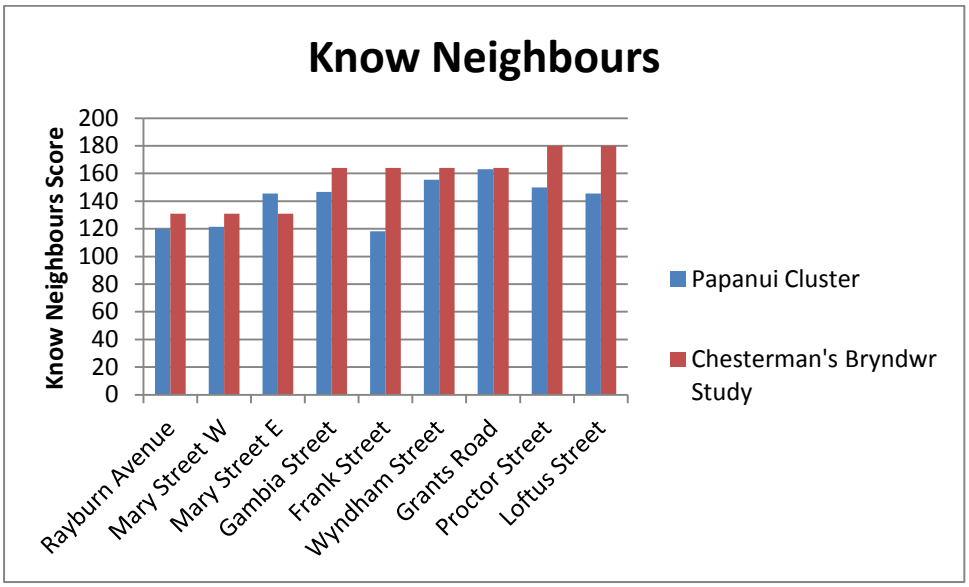


Figure 17: Chart Showing How Well People Know Their Neighbours

The results for this question are definitely comparable to Chesterman's (2009) findings. The trend is not as clear as what he found; however the amount that people know their neighbours definitely increases as streets get quieter.

Frank Street is one street that demonstrates a lower level of people knowing their neighbours. Four out of the eleven people surveyed on Frank Street said they do not know their neighbours at all. This can be typical of the type of living on Frank Street, with many flats. These are associated with people who have not been living in them for long, or people living alone who like to live a solitary life.

The two quietest streets, Proctor and Loftus Streets, did not score quite as well as Murdoch Street in Bryndwr. This again could be to do with the type of people living in the area. Loftus Street has also got lots of flats, similar to Frank Street, while Proctor Street has many elderly folk who may not leave the house or else people who have only recently moved into the area. Some of this could be attributed to the 2011 Christchurch earthquake and the relocation of many people around, as well as into and out of, the city.

Overall though a trend of more people knowing more of their neighbours is evident on the quieter streets in the study area.

4.1.6 Question 6: Is the traffic a barrier to social interaction?

This question asked residents whether they felt that the traffic volumes on their street could be a barrier to social interaction. There was some confusion about what this actually meant. It was explained to people being interviewed that a barrier to social interaction could prevent you crossing the road to talk to someone. Some people felt like the parking outside their houses could be a barrier to social interaction because it can stop visitors from parking outside their house. This sort of response had to be carefully considered because parking concerns were not priorities of this study.

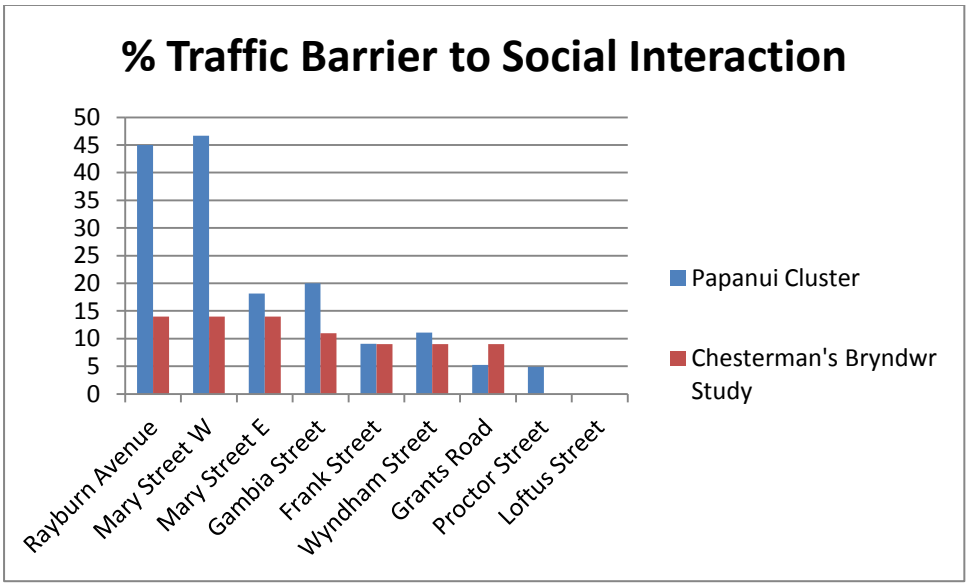


Figure 18: Percentage of Respondents Answering that Traffic on Their Street is a Barrier to Social Interaction

The obvious thing that can be observed on this chart is the high proportion of people on both Rayburn Avenue and the western section of Mary Street that said that their traffic is a barrier to social interaction. More than three times as many people said that the traffic on these streets is a barrier to social interaction when compared with the busier section of Aorangi Road from Chesterman's (2009) study. It is difficult to know why such a high proportion, when compared with the previous study, of residents responded in this way.

It seems obvious that these roads are too busy though. Obviously, as the roads get quieter, dramatically, the number of people saying that traffic is a barrier to social interaction decreases.

A few comments were received relevant to this question. Somebody on Loftus Street said that perhaps traffic used to be a barrier to social interaction. But now, since the Papanui Cluster project, there are no trucks and other heavy vehicles on their street, and traffic is certainly not a barrier to social interaction.

On Mary Street traffic is certainly a barrier to social interaction for one older lady, who just simply does not bother trying to cross the road due to the level of traffic.

On another HIGH traffic street, Rayburn Avenue, one resident said that it is a "very impersonal" street and another resident said that they '' don't know the people over the road.''

4.1.7 Question 7: For a residential street, how would you rate the amount of traffic on this street?

This question asked the resident to say whether they felt the overall volume of traffic on their street was either very light, light, average, high or very high. Once again with this question, many respondents found the opportunity to mention their problems with the number of cars parking on their streets. Again though, the questioning was carefully brought back onto topic, and overall people were able to answer the question well. It was felt that different demographics answered this question very differently.

Young people seemed much more likely to be blasé about the traffic, answering even on busy streets that the volume was light. Also, people on quieter streets can just as easily say that their street is busy, as someone who lives on a very heavily trafficked road. This question is very much to do with what people live with and what they would prefer to live with. If you have always lived on a quiet street, then you will find even a small increase in traffic to be undesirable. Some people have lived on much busier roads before, and so despite them living on a HIGH street in this study, they may find it quiet compared to what they have experienced before. This question is very relative to each individual's own experience and expectations.

Despite this though, there is an apparent trend on the following chart, figure 19.

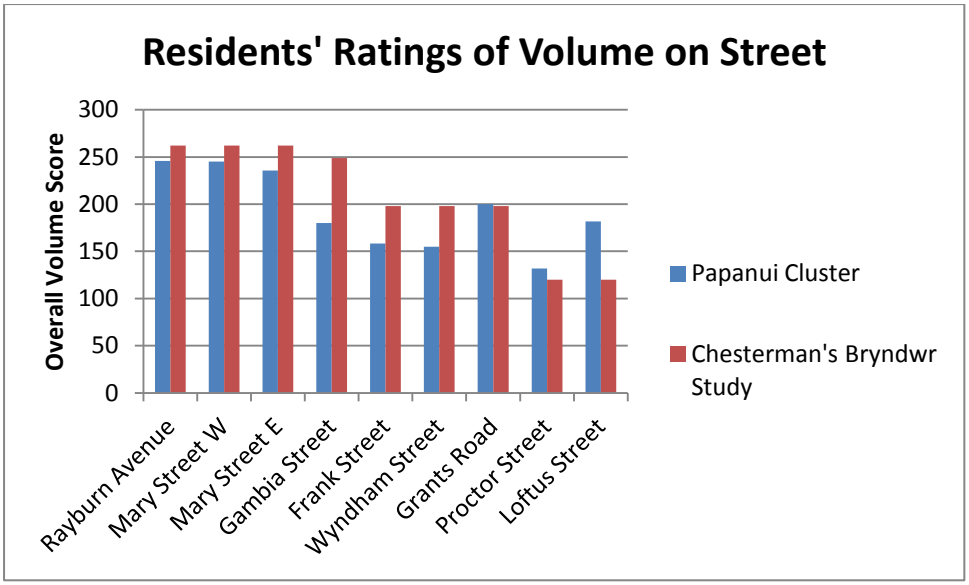


Figure 19: Resident Volume Ratings for Each Street

The graph shows a score which represents the overall street volume rating for all the residents surveyed. The percentage of people saying that the volume was very high was multiplied by four and added to the percentage of people responding that the volume was high, multiplied by three, the percentage of people saying that the volume was average, multiplied by two, and the percentage of people responding that the volume was light. This score could be easily compared across the different streets.

As the chart shows, less people on the quieter streets consider their traffic to be heavy, however as mentioned previously, there can still be some people who think it is. The results compare reasonably well with Chesterman's (2009) numbers. The only small discrepancy is between the LIGHT streets Loftus and Murdoch. The feeling of the residents is that Loftus Street is busier than Murdoch. This could certainly be to do with the parking of vehicles going to the nearby shopping centre as well as the associated foot traffic and such from the shopping centre. Another possible influence could be the fact that Loftus Street is so close to the very busy Main North Road, which could cause the locals to feel a little more negatively about the traffic in their area.

4.1.8 Question 8: Do you think that the overall speed of traffic on this street is too fast, a little bit fast or about right?

This question asked whether residents felt that the overall speed on their street was too fast, a little bit fast or about right. Many responded that there is the occasional 'idiot' going too fast, but most were still able to give a reasonable assessment of the overall speed considering all vehicles. In the following chart, figure 20, once again an overall score for the residents' perceptions was developed. This time an overall speed score was made by doubling the percentage of people who responded by saying that the traffic is too fast and adding it to the percentage of people who said that the overall speed is a little bit fast.

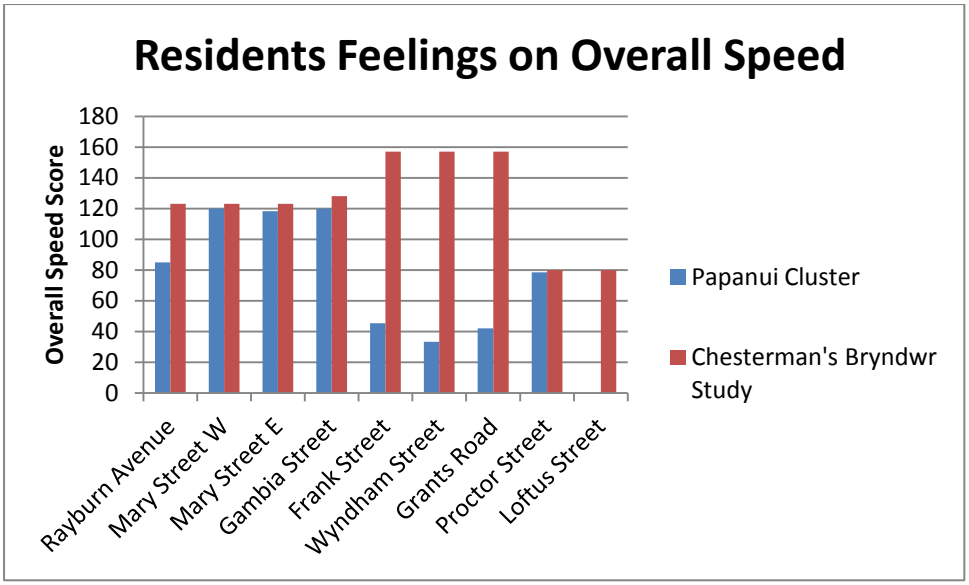


Figure 20: Residents' Perceptions of Speed on Their Streets

The results of this question are of particular interest because the street treatments carried out as part of the Papanui Cluster project should reduce vehicle speeds throughout the area.

Generally, residents have responded that on the busier streets, the overall speeds are higher than on the quieter streets. This is different to what Chesterman (2009) found, with his fastest street being the LOW volume one. Residents on the LOW volume streets in the Papanui Cluster do not have many problems with the overall speed on their streets. This is quite likely due to the combination of the street treatments; these streets are very narrow in places, as well as the parked vehicles along both sides making the road narrow and reducing sight distances. Nobody on Loftus Street even thought the speed was overall a little bit fast, suggesting that the narrowness of the street, along with the parked cars make the overall speed acceptable.

On Rayburn Avenue, residents responded that the speeds are not as bad as the other HIGH volume streets. This suggests that possibly the large trees growing over the road are slowing cars down, or else they are causing residents to feel better about their street and thus not notice the speed of the vehicles as much. This finding backs up what was mentioned earlier in section 2.3.2 about the possible benefits of street trees.

4.1.9 Question 9: What time of day is traffic worst?

This question asked the resident for a time period during the day when the traffic is worst. It is very difficult, and probably too much to expect of someone, to be able to discern at which time of day the traffic is worst. Many people responded that it is worst in the morning before work as well as after school and after work in the evening. It is very hard to judge at which time it is worst.

Even if a time of day is identified as being the worst for traffic, the worth of this is questionable. Perhaps, as Chesterman (2009) described, residents on quieter streets are more likely to respond that the traffic is always about the same, rather than noticing it being busy during peak times. The following chart, figure 21, shows the proportion of respondents saying that the traffic is always about the same on their street.

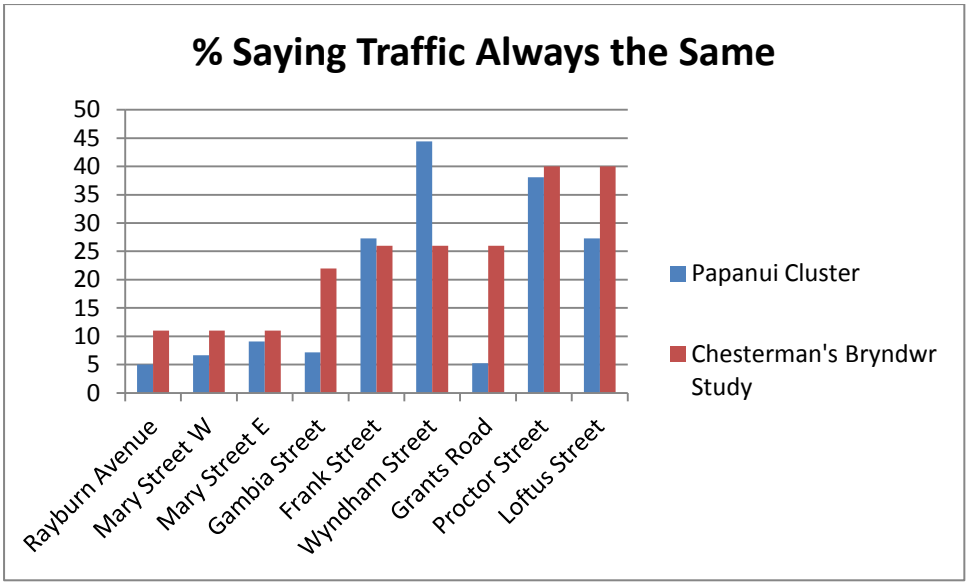


Figure 21: Percentage of People Who Think Their Traffic is Always About the Same

Generally it is the case that as the roads get quieter, more people are unable to identify a time of day that the traffic is worst. Grants Road has a much lower proportion of respondents saying that traffic is always the same, compared to the other LOW streets. This can be explained by the fact that there is a school on Grants Road, and a larger than usual number of residents identified that the traffic is worst on their street before and after school.

Otherwise, the numbers compare well with those attained by Chesterman (2009) in his Bryndwr study. Wyndham Street has a very high number of people saying that the traffic is always the same. It is thought that this is simply due to the fact that Wyndham Street is not used at all for a shortcut and thus does not have much or any peak time traffic that the other more busy streets experience.

4.1.10 Question 10: How has traffic changed over the past few years?

This question asked respondents what they thought had happened to the traffic over the past few years. They could either answer that the traffic on their street had got better, remained similar or got worse. The ability of the respondents to answer this question depended on how long they had been living in their house. If people had not been living there for two or three years then they simply could not answer the question.

This question was the most affected by the February 2011 earthquake. There were many people who said that the traffic was worse since the events of February 2011.

Despite the earthquake however, it is thought that traffic patterns would have already been changing in the Papanui area. With development to the north of Christchurch city proving popular, leading to more and more people making the commute into the city each day, Papanui Road was already badly congested during busy periods. As mentioned previously, many residents mentioned that the Papanui Cluster area is used by people trying to shorten their journey time by missing Papanui Road for as far as possible.

The following chart, figure 22, shows whether people feel like the traffic has stayed the same or got worse over the past few years. Only one or two people responded that they felt the traffic had

improved, despite the Papanui Cluster project being completed within the last five years, so these responses were not plotted.

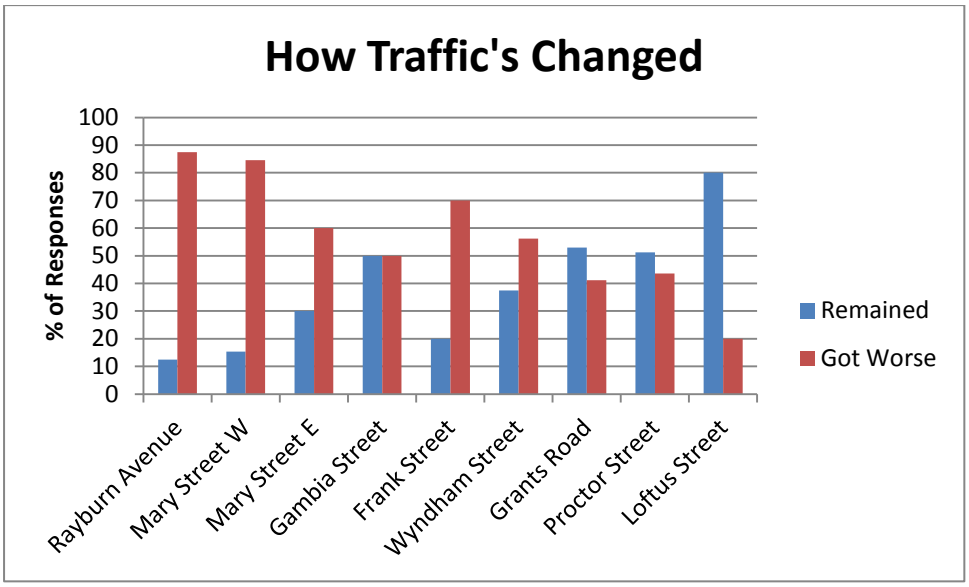


Figure 22: Resident's Perceptions on how the Traffic has Changed in the Last Few Years

The graph shows a clear trend that people on the busier streets are more likely to feel that their traffic has got worse than those on quieter streets. People on quiet streets are more likely to think their traffic has remained the same than got worse. This is consistent with what Chesterman (2009) found in his Bryndwr study.

There are minor fluctuations in the results, most likely just due to the small sample sizes when the streets are treated individually, but the main trends in the above results are obvious.

Some comments were received for this question. Someone on Grants Road thinks the traffic has got worse due to the fact that more school kids are driving cars to school than in the past. Someone on the busy Rayburn Avenue says that the speed has increased and the road has got busier and as a result they do not want to be there anymore.

Someone on Frank Street made the point that the street is better now that there are no trucks, again as a result of the area wide street treatments.

4.1.11 Question 11: How do you think the traffic will change in the next few years?

This question followed the previous one by asking the resident what they thought the traffic would be like in a few years from now. They were offered answers corresponding to those offered for the previous question; that the traffic would improve, remain similar or get worse. Quite a few people had difficult trying to answer this question, noting that it would depend on several things which they could not predict. However, people were usually able to end up having a guess and figure 23, below, shows the results for each of the streets.

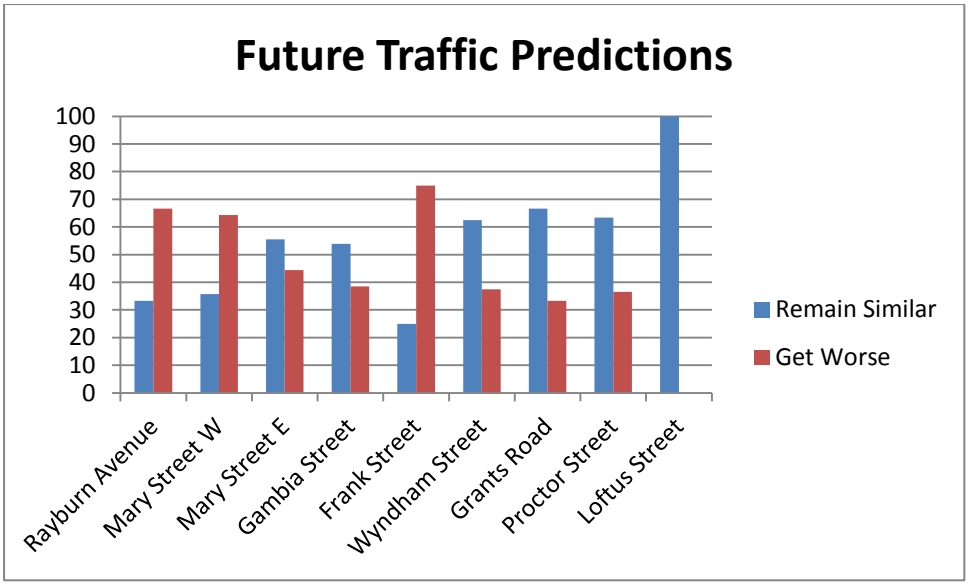


Figure 23: Residents' Prediction of Future Traffic Changes

As for the question about the past few years, there are two trends apparent in the data about residents' predictions for their traffic in the future. The outlook is poor for the busiest streets with over half the residents predicting that the traffic will get worse. This directly mirrors the result on Proctor Street where over sixty percent of residents think the traffic will remain as it is now. On Loftus Street everyone interviewed thought the traffic on their street would remain as it is.

As for the previous question, the results on Frank Street are different to the other streets with similar volumes. Far more people are negative about the past few years as well as the prospects of the next few years regarding their traffic than on the other LOW streets. Again, the sample sizes of some of the single streets are quite small, so if there are two or three particularly negative people, the results can be skewed.

It is however clear that people do indeed have more positive outlooks on how their street will be in a few years time on quieter streets.

4.1.12 Question 12: Is your street noisy at all?

This question asked residents whether their street was noisy. Residents could answer yes, it is noisy, yes, it is a little noisy, or no, it is not noisy at all.

As for some of the previous questions, a scoring system was used to compare the streets. The percentage of people answering that their street was noisy was multiplied by three and added to the percentage of people answering that their street was a little noisy. Figure 24, below, shows the results.

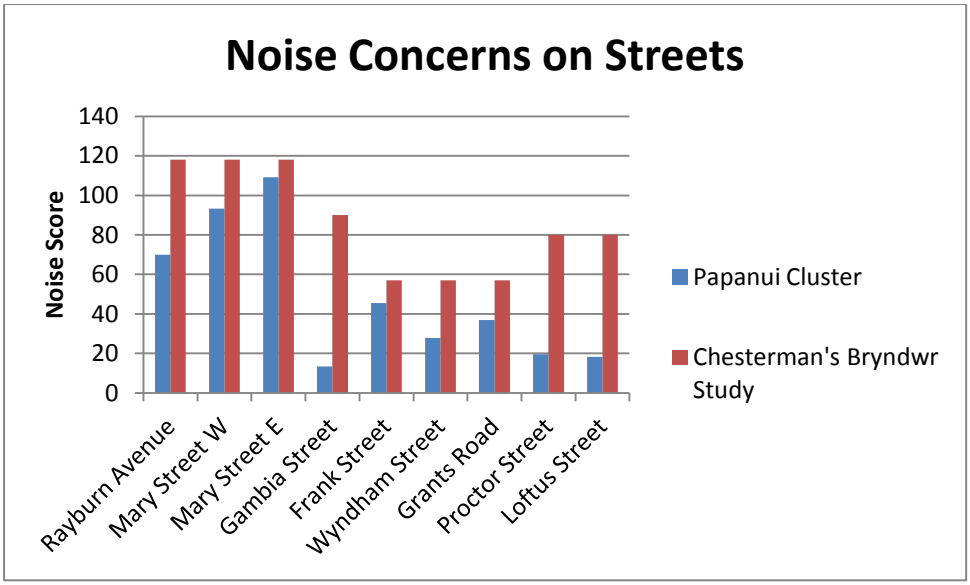


Figure 24: Residents' Perceptions of Noise on Their Streets

As expected, generally the score for the noise being a problem is much higher for the HIGH streets. Rayburn Avenue has the lowest score out of the three sections of HIGH volume street. Possibly this could be another benefit of having the tree cover; to effectively block some of the road noise from reaching the houses. It was mentioned in section 2.3.2 that trees can reduce noise by firstly simply slowing vehicles down, and secondly by absorbing sound, and it is possible that this is happening on Rayburn Avenue.

Noise is not a concern for the MEDIUM street, Gambia Street, which is a surprising result. However, due to the small sample sizes of the individual streets, this should not be considered too significant. All it would take would be for two people to have said the street is noisy and the result would fit with all the others. As mentioned earlier in this report, Gambia properties to the west of the Frank Street intersection experience lighter traffic levels than those of the eastern section. The responses from these residents have most likely affected the Gambia Street results for many of the questions, but this is most obvious on this graph.

Unlike for Chesterman (2009), the noise concerns of the LOW and LIGHT streets kept decreasing, which is a logical result. It appears as though the Papanui Cluster treatments have lead to reduced noise level over the whole area, meaning that residents are more comfortable with their noise levels than those surveyed in Bryndwr, by Chesterman (2009).

Noise, like traffic volumes and speeds, is very subjective by nature. Some people can tolerate lots of traffic noise without it bothering them. And others are easily agitated by the slightest vehicle noise.

Despite this though, once again there is a clear trend that people on busier streets are more likely to be bothered by traffic noise.

4.1.13 Question 13: When does traffic bother?

This question asked whether the traffic on the resident's street affected them when doing typical daily activities, such as sleeping or watching television. Almost everyone answered that the traffic did not affect them at all when doing their daily activities. There were no obvious trends or results. The table of how many people's ability to complete the listed activities is affected by the traffic is in Appendix A4, which includes all the raw data obtained in the interviews.

4.1.14 Question 14: wait to cross?

This question asked the resident typically how long they would have to wait before crossing the street. The graph below, figure 25, shows, for each street, a 'crossing wait score'. This score was found by multiplying the percentages of responses in the different time categories by factors, from five for the longest wait down to one for a wait of a few seconds.

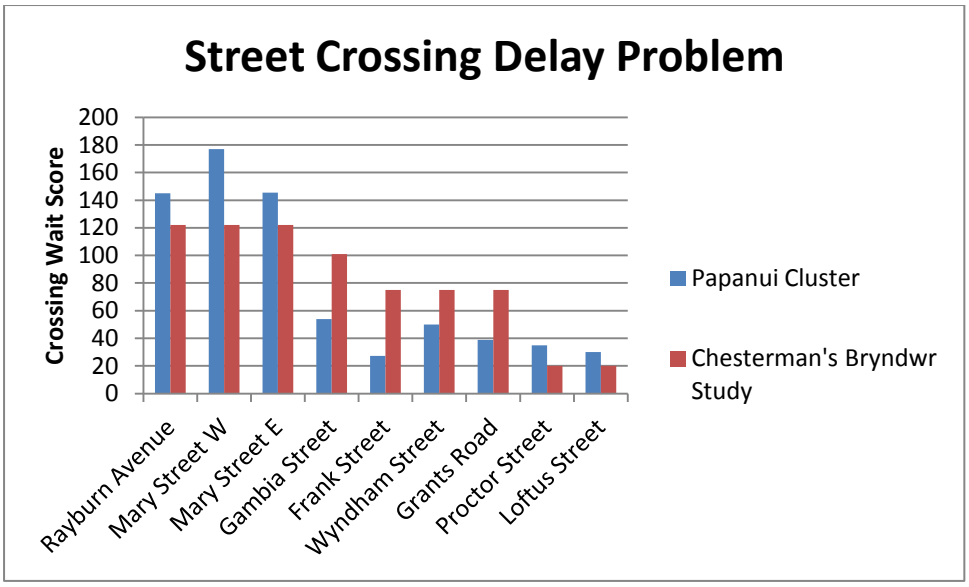


Figure 25: The Extent to Which People Must Wait to Cross Their Street

As expected, the trend in this graph is obvious. The busiest streets require residents to have long waits, sometimes one minute or longer in length, to cross the street. The scores quickly decline on the quieter streets, since very long waits are particularly uncommon.

Tables of all the results in raw form are presented in Appendix A4.

4.2 Other Findings

With the extra demographic data collected on survey respondents, attempts were made to find some trends in how different demographics answered questions. Also, just some other interesting questions were posed in this section.

The following analyses were carried out on the Proctor Street responses only. This is because Proctor Street was the largest sample, and by keeping all the street variables the same, trends in other factors could be analysed.

During the interview process, it was felt that the age of the respondent was a key determining factor in how respondents answered certain questions. As has already been mentioned earlier, it seemed like young people were more blasé about the traffic and its effects. The following chart, figure 26, somewhat supports this feeling, with the younger people much more likely to be comfortable with kids playing on the street than older people.

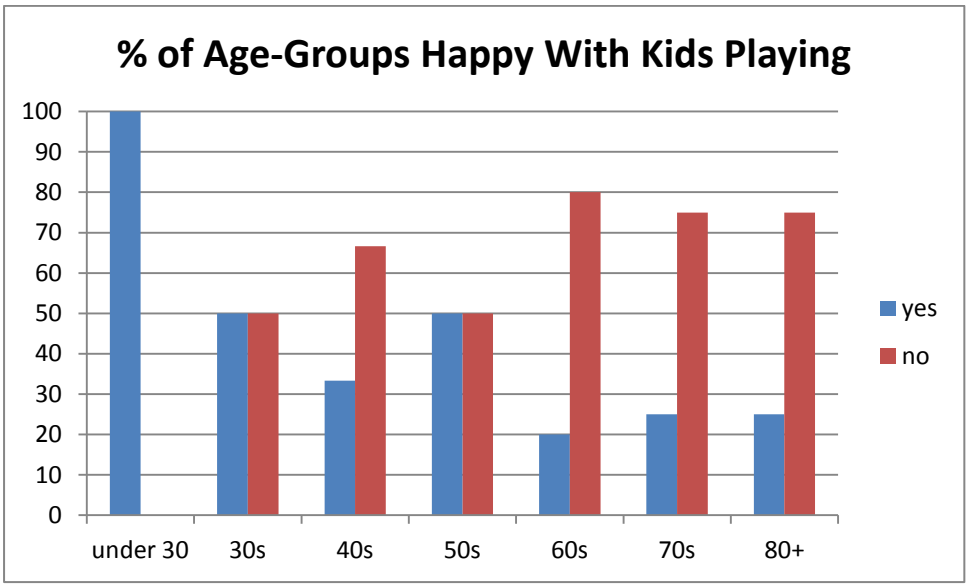


Figure 26: Different Age Groups Feelings on Allowing Kids to Play on the Street

The same phenomenon is visible in the following two graphs. Figure 27 shows that young people are less likely to think their street is busy when compared to older people. And similarly, figure 28 shows that older people are more likely to think that the speed is a problem. These two graphs make use of scores to combine more than one set of data as was done for several of the charts in the previous results section. It is acknowledged that, when the Proctor Street sample is broken into age groups, some of the sample sizes are small. However, it seems obvious that there are some trends to do with age groups and their responses to certain questions. It demonstrates how subjective traffic issues are and confirms the difficult nature of saying what an acceptable level of traffic, on a local street, is.

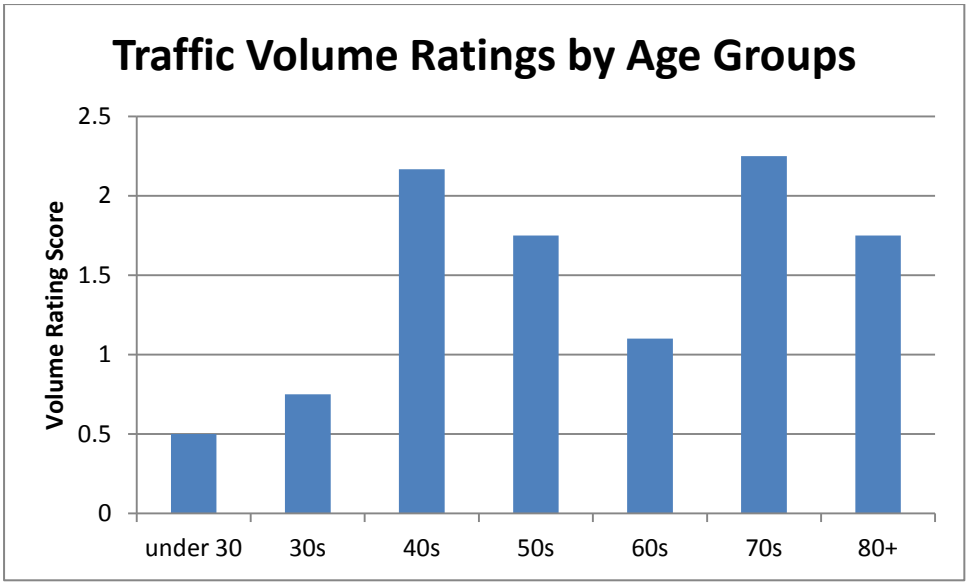


Figure 27: Different Age Groups' Thoughts on Traffic Volume

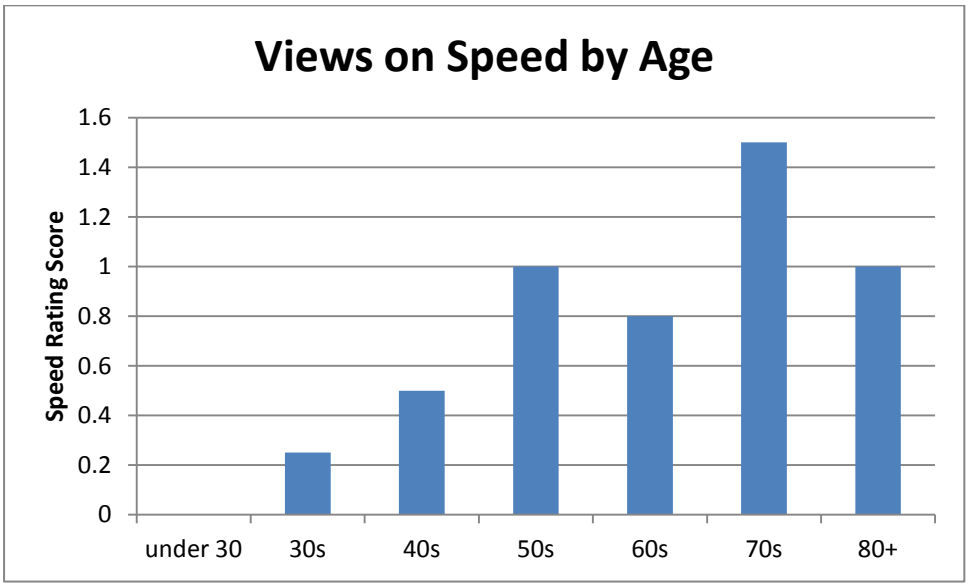


Figure 28: Different Age Groups' Thoughts on Overall Traffic Speed

Figure 29, below, shows that the older age groups are more likely to feel negatively about how the traffic has changed in the past few years, as well as about how the traffic will change over the next few years. The traffic change score is attained by multiplying the proportion of negative responses by three and adding it to the proportion of neutral responses. It is not a surprise that the older generation are more likely to be cynical about the outlook of their street and its traffic. Also, a factor for this could be that they remember a time years ago, when the streets were much quieter. Once again, this result shows how one person's opinion or thoughts on something traffic related can differ greatly from someone else's.

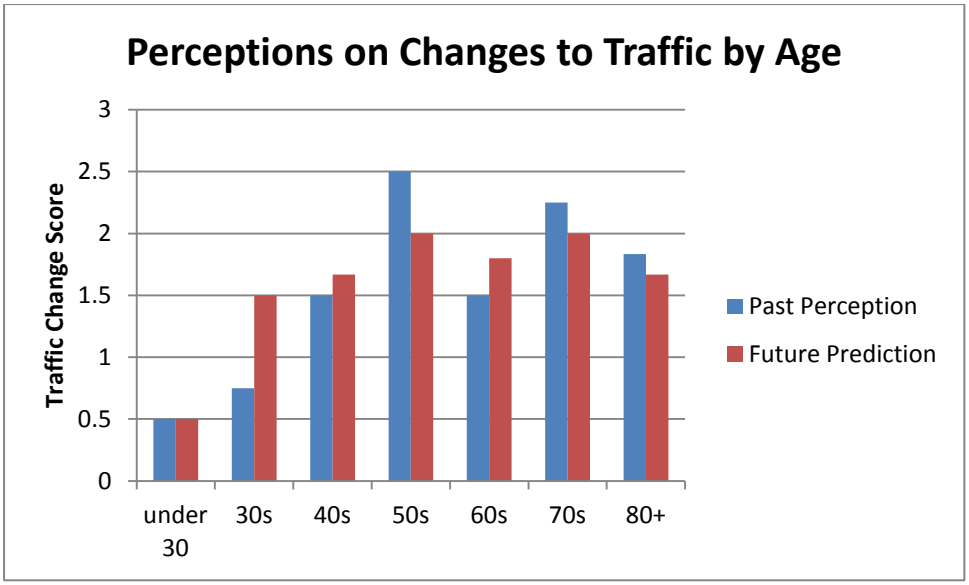


Figure 29: Differences in Perceptions of Traffic Changes by Age Group

An interesting finding over the whole survey, which was very evident on Proctor Street, was how few people answered that traffic had improved in the past few years. Only two people on Proctor Street said that traffic had improved, despite the street now appearing much quieter that it once was, following the Papanui Cluster project. Old traffic data from CAS (NZTA) showed daily volumes of around 2,000 vehicles. A traffic count carried out as part of this research suggests that daily traffic levels could be one quarter of what they were. If this shows anything, it is that it is human nature to be quick to point out problems or be negative. There were many complaints from residents about the new road layouts, and how dangerous they are because your view is obstructed at the new intersections. And, as can be seen from the graph above, many people think their traffic has got worse, despite the large reduction in traffic. It shows that it is far easier to complain about things than recognise and acknowledge improvements and positive things.

As well as young people, during the interview process it was noted that men seemed more relaxed about the traffic and the associated problems. This was evident when it was investigated whether there was a difference between men and women, and whether they would be comfortable with kids playing on the street. 5/15 men surveyed on Proctor Street said they would feel comfortable with kids playing on the street, whereas only 6/28 women surveyed said the same. This small sample suggests that men are nearly twice as likely to be comfortable with kids playing on the street than women.

4.3 Environmental Capacity Calculation

The same method as Chesterman (2009) used to find an environmental capacity for his studied streets was used to find an environmental capacity for the Papanui Cluster study. For the same ten key questions, the percentages of positive answers were added together for the four categories of streets. Table 3, below, shows the results for the four categories.

		LIGHT	LOW	MEDIUM	HIGH
	Daily Traffic	**500**	**1000**	**2000**	**3000**
1	Fence- No	68	57	33	25
2	Kids play- Yes	34	13	20	11
3	Neighbours- Personally	55	58	60	40
4	Barrier to social- No	96	94	80	61
5	Volume- V. Light, Light, Average	77	79	67	13
6	Speed- About Right	17	15	20	26
7	Future- Same or Better	70	50	54	35
8	Noisy- Not at all	81	69	87	39
9	Traffic- Doesn't Bother	100	94	93	83
10	Crossing- no wait	74	67	46	14
	Total	**672**	**596**	**560**	**347**

Table 3: Environmental Capacity Calculation Numbers

The total scores were plotted against the traffic volumes of the four street categories from LIGHT up to HIGH. This is shown in figure 30. The 500 out of 1000 point corresponds to a traffic volume where only half of the respondents would be happy. For the purposes of this exercise, this is the environmental capacity point. It would be unacceptable to have more than half of all responses to be negative, and it could be argued that more than half of all responses would be positive on a nice, friendly local street.

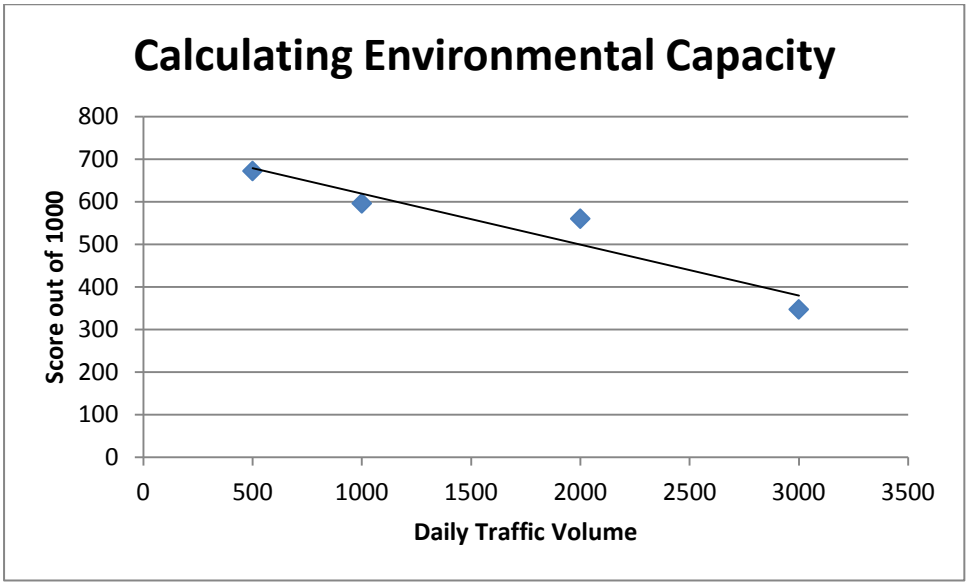


Figure 30: Environmental Capacity Calculation Chart

Looking at the graph above, it can be seen that around 2,000 vehicles per day is the traffic volume where about half of the responses would be positive. This value is higher than the value that Chesterman (2009) found, which was near the midpoint between 1,500 and 2,000 vehicles per day.

The fact that this value is higher than what Chesterman (2009) found, suggests that it is possible street treatments, such as those performed on the Papanui Cluster, can increase the environmental

capacity of local streets. Logically, it makes sense that traffic calming and trees would slow traffic down, resulting in less noise and danger, among other benefits, but it is a positive that the results of the interviews suggest that the environmental capacity is higher for the Papanui Cluster than for the plain streets in Bryndwr.

5.0 Conclusion and Recommendations

5.1 Conclusion

The main aim of this research was to find the environmental capacity for a group of streets in the Papanui area. Using the same techniques as Chesterman (2009) used, in his study of Bryndwr, Christchurch, a value of around 2,000 vehicles per day was settled on as an acceptable traffic level in local streets. At this point, half of all question responses would be negative. Beyond this, it is deemed that it would be an unacceptable amount of traffic intrusion into the residential area.

The secondary objective of this research was to see whether or not street treatments, such as traffic calming and plantings could increase the environmental capacity of local streets, by altering driver behaviour and making them more livable. It was found that residents were more comfortable with the speeds and noise levels on the Papanui streets than those surveyed by Chesterman (2009) in Bryndwr, where the streets were untreated. As a result, the environmental capacity of around 2,000 vehicles per day is higher than that of about 1,750 vehicles per day calculated by Chesterman (2009). This at least confirms the possibility that environmental street treatments can increase the environmental capacity.

As well as finding the environmental capacity, there were some interesting findings that came from the interview process. A first-hand experience of how many opinions there are on traffic was obtained. So many residents think they could fix the traffic problems that they think they have. There are lots of negative attitudes towards the city council and other decision makers. Talking to so many people, from all backgrounds, was an extremely interesting and invaluable experience.

Seeing just how subjective traffic related issues are was also very valuable. One person would say that the traffic is noisy or that it goes too fast, and then a minute later their neighbour would say the complete opposite. This confirmed this researcher's feeling of what an interesting field traffic and transportation in general is.

There were some limitations to this study, which should be noted. A lot of these limitations stem from the fact that the traffic volumes of all the streets were not known at an early enough stage. It was clear that the traffic numbers obtained from CAS (NZTA) were outdated, and traffic counts were not used until too late, so only three sites could be surveyed. This lead to there being a small sample size for the MEDIUM street, since Gambia Street was the only one. Combining streets comes with its problems too, since each street is unique and has its own characteristics.

Despite this though, it is felt that for the purposes of the environmental capacity calculation, which was very approximate, combining the streets into the four categories was appropriate.

An interesting problem associated with this sort of work is that many people who are unhappy with their traffic would move to live somewhere else. Not everyone has the luxury of choosing to live wherever they like, however possibly some of the people worst affected by traffic in an area, are indeed no longer living there. This reality cannot be escaped however, and the research still found clear trends of declining residential amenity as traffic volumes increased.

This research has been successful in adding to the amount of information known regarding environmental capacity in a Christchurch context. It has built on the work done by Chesterman (2009), meaning now that there is even more information on how people are affected by traffic in their local streets. Chesterman acknowledged that his four streets surveyed do not represent all of Christchurch, however as more and more knowledge is gathered, it may be possible to generalise an environmental capacity for local streets in a much wider area.

Chesterman thought that further research using the same questionnaire for a number of other streets would be beneficial because it could reinforce the current conclusions further. This research has certainly reinforced most of the conclusions around people on busier streets having much less residential amenity than the quieter streets.

5.2 Recommendations for Further Study

It is thought that it would be beneficial to continue exploring the relationships between traffic volumes and residents perceptions on the matters questioned on during the interview process. The more knowledge that can be gathered, the better the understanding of the environmental concept will become. This can only be good for residents, in that hopefully fewer developments that generate high traffic volumes will go ahead and affect local residents.

It is acknowledged that the streets used in this research were very complex. They were probably too close to the busy Main North and Papanui roads as well as the busy Northlands Mall and other shops. The parking on most of the streets was a concern, as was the level of traffic using this area as a shortcut. If this sort of research is ever replicated in the future, care should be taken to find some more suitable streets, probably further away from busy commercial areas.

More analysis could go into some of the other demographical questions and the differences between the demographics. For example there could be some trends when comparing whether residents own or rent their property and how they feel about the traffic. Also, of more interest could be how long the resident has been living in their house, comparing quiet streets with busy streets.

It is felt that it would definitely be worthwhile to continue work in this field because the issue of residential amenity is an important one, and with more and more traffic on the roads, it will only continue to become more of an issue.

6.0 References

AUSTROADS (2004) Local Area Traffic Management, Guide to Traffic Engineering Practice. Austroads. Sydney, Australia.

Appleyard, D. (1981) Livable Streets. University of California Press, United States of America.

Brindle, R.E. (2003) 'Road Functions, Hierarchy and Classification' in Institute of Transport Studies, Monash University (2003) Traffic Engineering and Management, Vol 1., pp. 3.1.13.1.30., Monash University, Victoria, Australia.

Buchanan, C. (1963) Traffic in Towns: A Study of the Long Term Problems of Traffic in Urban Areas. Her Majesty's Stationary Office, London, England.

CAS (NZTA). New Zealand Transport Agency- Crash Analysis System. Obtained through University of Canterbury.

Chesterman, R. (2009) Traffic Volumes and Residential Amenity: Is the Environmental Capacity of a Local Residential Street Really 2,000-3,000 Vehicles Per Day? University of Canterbury, Christchurch, New Zealand.

Christchurch City Council (2005, November 21) Christchurch City Plan. Available online at: http://www.cityplan.ccc.govt.nz

De Wit, T, & Talens, H. (2008) Traffic Calming in the Netherlands. Retrieved 30/08/2008 from: http://www.ite.org/traffic/documents/AHA99B04.pdf

Grana, Giuffre, Guerrieri (2010) Exploring effects of area-wide traffic calming measures on urban road sustainable safety from Journal of sustainable development, vol 3, no.4 December 2010

ITE Journal, July 1997, p.23, author unknown

Jacobs, A.B. (1995), Great Streets, ISBN-10: 0262600234

Litman, T. (1999) Traffic Calming Benefits, Costs and Equity Impacts, Victoria Transport Policy Institute

Resource Management Act 1991 (2011, reprint as at 1 October). Retrieved 28/11/11, from: http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html

Statistics New Zealand's 2006 CENSUS. Retrieved 5/12/11, from http://www.stats.govt.nz/Census/2006CensusHomePage.aspx

Appendices

A1: Study Proposal

A2: Interview Warning Letter

A3: Questionnaire

A4: Raw Data

A5: Traffic Counts

A6: Maps

A1: Study Proposal

ENTR680 Research Project

"Environmental Capacity of Local Residential Streets"

Andrew Leckie

Supervisor: Dr Glen Koorey

Context

A local road, by definition, is to provide access for residents to their properties. However, there is always conflict between residential amenity and traffic access functions. This means that it is difficult to define a true local road. Buchanan introduced the concept of environmental capacity in the 1960s. Both he and Appleyard settled on traffic volumes of 2,000-3,000 vehicles per day as being acceptable on a local road. These values have been widely used since. However Chesterman came to the conclusion that a value of 1,500 -2,000 vehicles per day would be more appropriate as an environmental capacity for local streets in Christchurch, in the present time. Chesterman found that residents living on streets with higher volumes felt their streets were noisier and less safe. Residents on these streets were also most likely to have less interaction with their neighbours and have their houses turned away from the street.

Objectives

The main objective of this research is to determine the environmental capacity for further selected local Christchurch streets. This research will follow on from Chesterman's work, aiming to build on his findings and create a more in depth understanding of the environmental capacity concept. As an extra, this research will focus on streets which have had some form of traffic calming treatment, such as the introduction of speed humps or road narrowing. The aim is to find whether these features have an effect on the perceived environmental capacity.

Hopefully, the information gathered from this study will be relevant and useful. It is the aim that the feedback from residents from the chosen 4 sites will be able to be combined with that gathered previously by Chesterman, in order to have a greater understanding of the environmental capacity concept, and what flow level is acceptable on a local road.

Methodology

- Street selection

Want four streets with similar flows to the streets used by Chesterman (2009). These four streets had flows of about 500, 1000, 2000 and >3000 vpd and were labelled light, low, medium and high. Ideally, the streets will be close to each other to keep as many variables, such as socio-economic factors, equal. It will be best if the streets are in the vicinity of the four streets studied by Chesterman, to make the survey results more comparable. The focus will be on finding streets with environmental calming treatments.

- Survey questions

Questions will be the same as those asked by Chesterman. These questions were based broadly on the questions posed in earlier research by Appleyard. Of extra interest in this research is how much of an effect local environmental street treatments, such speed humps and street narrowing, as well as visual things like trees, have had on residential amenity and environmental capacity. This will add an extra dimension to the amount of analysis that will be possible once survey results have been gathered.

- Questioning

It is felt that best results for the surveys will be achieved by doing interviews in person with residents. Therefore, I will go door to door speaking with as many residents as possible on the four chosen streets. This will hopefully help in clearing up any possible confusions and misinterpretations stemming from the questions. Interviews will also allow more descriptive answers by the residents. A letter will be sent out first, informing residents that I plan to visit their house, hoping to conduct a short interview with them. Of course not all people will be able to be met with or some people will not want to take part in an interview. For these people I will also have questionnaires which I will leave with the, with the hope that they will be able to fill it out and post it back to me, at their convenience.

Timeline

- Confirm streets for research- hopefully by end of October
- Write letter to inform of interviews and deliver- early November
- Design questions for interview- by Mid November
- Conduct interviews- Mid November - Christmas

- Analysis of results- by early February
- Report- by end of February

Resources

- Printing resources for preparing the letters to send out in advance of interviews
- Envelopes for these letters
- Printing resources for the questionnaires to be used in place of an interview
- Pre paid postage and envelopes for these questionnaires to be returned
- Possibly a prize for returning questionnaires

A2: Interview Warning Letter

College of Engineering

Department of Civil & Natural Resources Engineering
Tel: (03) 364-2951, Fax: (03) 364-2758, Mob: (027) 739-6905
Email: *glen.koorey@canterbury.ac.nz*

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

November 2011

TO THE HOUSEHOLDER

My name is Andrew Leckie. I'm a post-graduate student in transportation engineering at the University of Canterbury. This summer I am conducting a research project into the effects of traffic on residents, living on several local streets here in Christchurch.

I am writing to you because your street has been selected as one of the streets that will be studied. In the coming weeks I will be making my way around the chosen streets, hoping to conduct a short interview with residents. The interview would be unlikely to take more than five minutes of your time. If it does not suit, then firstly I would hope to reschedule a time that would suit you. And finally, if you would prefer not answer the questions in person, I will have a paper questionnaire (along with a postage paid envelope) which I would hope you could fill out in your own time and send back to me.

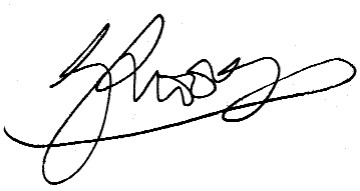
I'm hoping that the results of this research will be relevant and also useful for future planning purposes. I would very much appreciate your cooperation, hoping that one day my research will help you, me and our fellow residents in protecting our local streets from too much traffic.

Of course, your privacy will be respected, and the interviews will remain completely anonymous. I will require a name and contact number if you wish to enter the draw to win a prize, to thank you for assisting me with my research. Like the survey, this draw will be completely voluntary. I would also like to point out the study is in no way associated with the Christchurch City Council or any other such organisation.

My supervisor, Dr Glen Koorey's details are provided at the top of this letter in case you wish to contact him for any reason regarding this research.

Thank you and hopefully I'll see you soon

Yours sincerely



Dr Glen Koorey

Senior Lecturer in Transportation Engineering

Andrew Leckie

Student

A3: Questionnaire

QUESTIONNAIRE ON EFFECTS OF TRAFFIC ON LOCAL RESIDENTS

1. Is your home a... (circle one)

Front section? Rear section?

2. Does your main living area in your house generally... (circle one)

Face towards the street? Face away from the street?

3. If you live on a front section, do you have a fence in the front yard that blocks the views to and from the street? (circle one)

Yes No n/a

4. If you have children (or have had children/ were to have children) would you feel comfortable with them playing unsupervised on or near the street?

Yes No Any extra comments? _____

5. Do you know any of your neighbours? (circle one)

Yes, I know them personally Yes, I kind of know them but not very well No, I don't know them at all

6. Do the traffic volumes along this road create a barrier to social connection? (i.e. does it or could it stop you crossing the street to talk to a neighbour?)

Yes No Any extra comments? _____

7. For a residential street, how would you rate the amount of traffic on this street? (circle one)

Very light Light Average Fairly heavy Heavy

8. Do you think that the overall speed of traffic on this street is... (circle one)

Too fast? A little bit fast? About right?

9. At which time do you consider traffic on this street is the heaviest? (circle one)

First thing in the morning Around lunch time After school Late afternoon (i.e. after work)

Evenings (say 7-11pm) During weekends It's about the same all the time

10. What about traffic on this street over the past few years? Has it... (circle one)

Improved? Got worse? Remained similar?

PLEASE TURN OVER AND COMPLETE OTHER SIDE

11. Looking ahead to five years from now, do you think traffic on this street will... (circle one)

Improve? Get worse? Remain similar?

12. Do you consider this road to be... (circle one)

Noisy? A little bit noisy? Not noisy at all? Any comments? _____

13. Does traffic in your street bother you when... (please circle all that apply to you)

Watching TV? Walking along the street? Sleeping? Talking in the house? Working in the house?

Eating? Children playing outside? No, the traffic hardly bothers me

14. How long do you usually have to wait for traffic before crossing the street? (circle one)

No wait A few seconds Around 10-15 seconds Around 30 seconds One minute or longer

15. Are you...

Male? Female?

16. What is your age?

<20 20-30 31-40 41-50 51-60 61-70 >70

17. How many occupants ling in this house? (please specify)

Number of adults _____ Number of children_____

18. Do you...

Rent this house? Own this house?

19. Roughly how long have you been living in your current residency? (please specify) _____

THANK YOU FOR COMPLETING THIS SURVEY. PLEASE POST IN THE PROVIDED POSTAGE PAID ENVELOPE BY JANUARY 14

If you wish to enter the draw to win the $50 grocery voucher, please provide a name and contact number below. Also I need an address so I know which houses have been surveyed already. These details will remain separate from the survey responses for your privacy.

Name: _____ Phone number:_____

Street name: _____ House number: _____

A4: Raw Data- Question by Question

Question 1: Front or rear section?

	Front	Rear	% Front
Rayburn Avenue	18	2	90
Mary Street W	11	4	73
Mary Street E	7	4	64
Gambia Street	12	3	80
Frank Street	7	4	64
Wyndham Street	10	8	56
Grants Road	12	7	63
Proctor Street	28	14	67
Loftus Street	8	3	73

Question 2: Living area face towards or away from street?

	Towards	Away	% Towards
Rayburn Avenue	4	16	20
Mary Street W	8	6	57
Mary Street E	3	7	30
Gambia Street	6	8	43
Frank Street	7	4	64
Wyndham Street	8	10	44
Grants Road	7	11	39
Proctor Street	16	23	41
Loftus Street	7	4	64

Question 3: Fence in front yard?

	Fence	No Fence	% Fence
Rayburn Avenue	16	2	89
Mary Street W	5	6	45
Mary Street E	6	1	86
Gambia Street	8	4	67
Frank Street	2	5	29
Wyndham Street	4	6	40
Grants Road	7	5	58
Proctor Street	10	19	34
Loftus Street	2	7	22

Question 4: Comfortable with kids playing on the street?

	Yes	No	% Yes
Rayburn Avenue	3	17	15
Mary Street W	1	14	7
Mary Street E	1	10	9
Gambia Street	3	12	20
Frank Street	2	9	18
Wyndham Street	2	16	11
Grants Road	2	17	11
Proctor Street	13	29	31
Loftus Street	5	6	45

Question 5: Do you know your neighbours?

	Personally	Kind of	No
Rayburn Avenue	7	10	3
Mary Street W	6	5	3
Mary Street E	5	6	0
Gambia Street	9	4	2
Frank Street	6	1	4
Wyndham Street	10	8	0
Grants Road	12	7	0
Proctor Street	23	17	2
Loftus Street	6	4	1

Question 6: Traffic a barrier to social interaction?

	Yes	No	% Yes
Rayburn Avenue	9	11	45
Mary Street W	7	8	47
Mary Street E	2	9	18
Gambia Street	3	12	20
Frank Street	1	10	9
Wyndham Street	2	16	11
Grants Road	1	18	5
Proctor Street	2	39	5
Loftus Street	0	11	0

Question 7: Rate the volume of traffic on your street?

	V Light	Light	Average	Heavy	V Heavy
Rayburn Avenue	1	1	1	12	5
Mary Street W	0	0	2	7	6
Mary Street E	0	0	1	9	1
Gambia Street	0	0	10	4	1
Frank Street	0	5	4	2	0
Wyndham Street	1	5	10	2	0
Grants Road	0	4	9	6	0
Proctor Street	7	13	13	9	0
Loftus Street	1	3	4	3	0

Question 8: How do you rate the overall speed on your street?

	Too Fast	A Little Fast	About Right
Rayburn Avenue	4	5	11
Mary Street W	5	3	7
Mary Street E	3	4	4
Gambia Street	5	3	7
Frank Street	1	2	8
Wyndham Street	2	0	16
Grants Road	1	5	13
Proctor Street	8	9	25
Loftus Street	0	0	11

Question 9: Is there a time of day that the traffic is worst?

	Morning	Lunch	Aftr School	Aftr Work	Evenings	Wknds	Always
Rayburn Avenue	6	0	6	7	0	0	1
Mary Street W	5	0	3	5	1	0	1
Mary Street E	2	0	2	6	0	0	1
Gambia Street	2	0	6	4	1	0	1
Frank Street	1	0	3	2	1	1	3
Wyndham Street	5	0	2	3	0	0	8
Grants Road	3	0	15	0	0	0	1
Proctor Street	9	2	3	11	0	1	16
Loftus Street	5	0	0	3	0	0	3

Question 10: How has the traffic changed over the past few years?

	Improved	Remained	Got Worse
Rayburn Avenue	0	2	14
Mary Street W	0	2	11
Mary Street E	1	3	6
Gambia Street	0	7	7
Frank Street	1	2	7
Wyndham Street	1	6	9
Grants Road	1	9	7
Proctor Street	2	20	17
Loftus Street	0	8	2

Question 11: How do you think the traffic will change in the next few years?

	Improve	Remain	Get Worse
Rayburn Avenue	0	6	12
Mary Street W	0	5	9
Mary Street E	0	5	4
Gambia Street	1	7	5
Frank Street	0	2	6
Wyndham Street	0	10	6
Grants Road	0	12	6
Proctor Street	0	26	15
Loftus Street	0	11	0

Question 12: Do you think the traffic on your street is noisy?

	Noisy	A Little	Not At All
Rayburn Avenue	1	11	8
Mary Street W	2	8	5
Mary Street E	3	3	5
Gambia Street	0	2	13
Frank Street	0	5	6
Wyndham Street	1	2	15
Grants Road	0	7	12
Proctor Street	0	8	33
Loftus Street	0	2	9

Question 13: Does the traffic bother you doing any daily activities?

	Nothing	TV	Outside	Sleeping	Talking	Eating	Working
Rayburn Avenue	18	1	0	1	0	0	1
Mary Street W	11	1	2	2	0	0	1
Mary Street E	9	0	1	0	1	0	0
Gambia Street	14	0	0	0	0	0	0
Frank Street	11	0	0	0	0	0	0
Wyndham Street	15	0	3	0	0	0	0
Grants Road	18	0	0	1	0	0	0
Proctor Street	38	1	4	1	1	1	0
Loftus Street	11	0	0	0	0	0	0

Question 14: How long do you typically have to wait when crossing the street?

	No Wait	Few Sec.	10/15 Sec	30 Sec.	1 min. +
Rayburn Avenue	5	8	2	3	2
Mary Street W	0	8	2	1	2
Mary Street E	1	5	4	1	0
Gambia Street	6	7	0	0	0
Frank Street	9	1	1	0	0
Wyndham Street	10	4	2	0	0
Grants Road	11	7	0	0	0
Proctor Street	30	7	2	1	0
Loftus Street	7	3	0	0	0

A5: Traffic Counts

The MetroCount roadside unit, which uses rubber pneumatic tube axle sensors was used to carry out the following traffic counts.

MetroCount Traffic Executive
Vehicle Counts

VehicleCount-11

DATASETS:

Site:	**[Mary st] MCSurvey field repair setup**
Direction:	2 - East bound, A hit first., **Lane:** 0
Survey Duration:	10:01 Thu 23 Feb 2012 to 11:25 Fri 24 Feb 2012
File:	C:\Users\Andrew\Desktop\Mary st27FEB2012.EC0 (Plus)
Identifier:	L780WQGQ MC56-6 [MC55] (c)Microcom 02/03/01
Algorithm:	Factory default

PROFILE:

Filter time:	**10:01 Thu 23 Feb 2012 to 11:25 Fri 24 Feb 2012**
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
Speed range:	10 - 160 km/hr.
Direction:	North, East, South, West (bound)
Headway:	All
Scheme:	TNZ 1999
Name:	Factory default profile
Method:	Vehicle classification
Units:	Metric (m, km, m/s, km/hr, kg, tonne)
In profile:	3094 Vehicles

*** Thu 23 Feb 2012 - Total=2302(incomplete) , 15 minute drops,**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
-	-	-	-	-	-	-	-	-	-	**153**	**190**	**186**	**171**	**204**	**322**	**292**	**327**	**193**	**113**	**70**	**35**	**29**	**17**
-	-	-	-	-	-	-	-	-	-	26	46	46	46	52	72	**83**	76	60	27	17	14	8	3
-	-	-	-	-	-	-	-	-	-	34	47	46	48	38	**97**	62	97	51	42	15	7	7	7
-	-	-	-	-	-	-	-	-	-	47	52	52	31	41	**84**	77	82	47	27	19	6	5	4
-	-	-	-	-	-	-	-	-	-	46	45	42	46	73	**69**	70	72	35	17	19	8	9	3

PM PkHr 15:15 to 16:15 (n=333), PM PHF=0.86

*** Fri 24 Feb 2012 - Total=792(incomplete) , 15 minute drops,**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
8	**4**	**5**	**4**	**7**	**16**	**16**	**103**	**229**	**169**	**163**	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	1	0	3	4	1	15	41	49	35	48	-	-	-	-	-	-	-	-	-	-	-	-
1	1	2	2	3	4	2	21	67	40	30	20	-	-	-	-	-	-	-	-	-	-	-	-
1	0	1	0	1	3	8	29	57	35	52	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	1	2	0	5	5	38	64	45	46	-	-	-	-	-	-	-	-	-	-	-	-	-

MetroCount Traffic Executive
Vehicle Counts

VehicleCount-14

DATASETS:

Site: **[Gambia st] MetroCount Factory Test Setup**
Direction: 2 - East bound, A hit first., **Lane:** 0
Survey Duration: 09:29 Thu 23 Feb 2012 to 11:13 Fri 24 Feb 2012
File: C:\Program Files\MetroCount v225\User\Data\Gambia st23FEB2012.EC0
(Plus)
Identifier: CZ32T90W MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default

PROFILE:

Filter time: **09:29 Thu 23 Feb 2012 to 11:13 Fri 24 Feb 2012**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
Speed range: 10 - 160 km/hr.
Direction: North, East, South, West (bound)
Headway: All
Scheme: TNZ 1999
Name: Factory default profile
Method: Vehicle classification
Units: Metric (m, km, m/s, km/hr, kg, tonne)
In profile: 2409 Vehicles

*** Thu 23 Feb 2012 - Total=1726(incomplete) , 15 minute drops,**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
-	-	-	-	-	-	-	-	-	-	**99**	**115**	**129**	**140**	**139**	**257**	**241**	**275**	**141**	**94**	**49**	**25**	**16**	**6**
-	-	-	-	-	-	-	-	-	-	25	33	30	35	28	55	61	**71**	42	29	11	12	5	0
-	-	-	-	-	-	-	-	-	-	1	19	27	29	42	28	82	45	**84**	37	30	14	6	3
-	-	-	-	-	-	-	-	-	-	36	27	18	42	28	33	58	**72**	70	35	20	14	2	3
-	-	-	-	-	-	-	-	-	-	24	28	37	28	35	50	62	**63**	50	27	15	10	5	5

PM PkHr 16:30 to 17:30 (n=290), PM PHF=0.86

*** Fri 24 Feb 2012 - Total=622(incomplete) , 15 minute drops,**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
2	**1**	**1**	**2**	**2**	**4**	**17**	**89**	**233**	**130**	**118**	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	2	0	1	12	47	39	22	23	-	-	-	-	-	-	-	-	-	-	-	-
0	0	1	1	0	1	2	15	75	29	36	-	-	-	-	-	-	-	-	-	-	-	-	-
1	0	0	0	0	1	7	22	68	37	32	-	-	-	-	-	-	-	-	-	-	-	-	-
1	1	0	1	0	2	7	40	43	25	28	-	-	-	-	-	-	-	-	-	-	-	-	-

MetroCount Traffic Executive
Vehicle Counts

VehicleCount-13

DATASETS:

Site: **[Procter st] MCSurvey field repair setup**
Direction: 2 - East bound, A hit first., **Lane:** 0
Survey Duration: 10:27 Thu 23 Feb 2012 to 11:33 Fri 24 Feb 2012
File: C:\Program Files\MetroCount v225\User\Data\Procter st23FEB2012.EC0
(Plus)
Identifier: CZ33MNKK MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default

PROFILE:

Filter time: **10:27 Thu 23 Feb 2012 to 11:33 Fri 24 Feb 2012**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
Speed range: 10 - 160 km/hr.
Direction: North, East, South, West (bound)
Headway: All
Scheme: TNZ 1999
Name: Factory default profile
Method: Vehicle classification
Units: Metric (m, km, m/s, km/hr, kg, tonne)
In profile: 344 Vehicles

*** Thu 23 Feb 2012 - Total=236(incomplete) , 15 minute drops,**

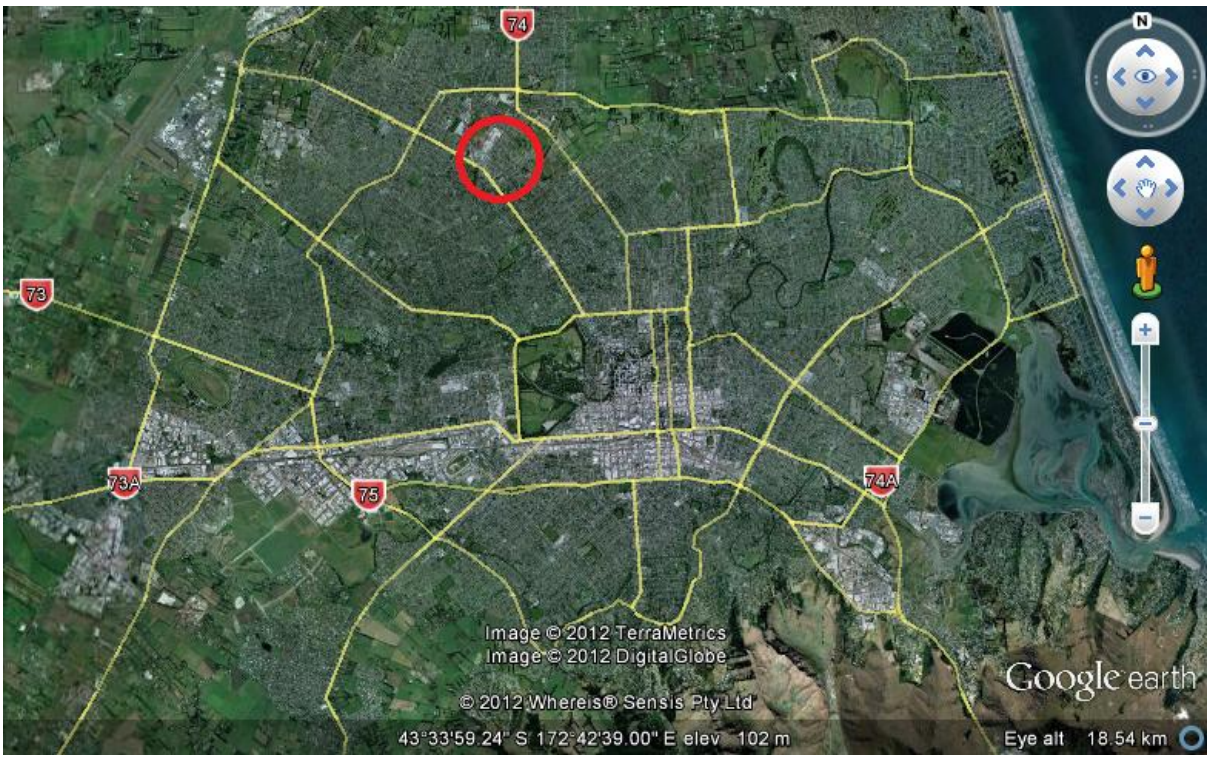
0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
-	-	-	-	-	-	-	-	-	-	-	**34**	**21**	**13**	**22**	**23**	**28**	**31**	**18**	**20**	**15**	**9**	**1**	**1**
-	-	-	-	-	-	-	-	-	-	-	5	5	2	1	7	2	**9**	6	9	2	1	0	1	0
-	-	-	-	-	-	-	-	-	-	0	7	7	2	5	4	5	**11**	4	6	6	4	0	0	0
-	-	-	-	-	-	-	-	-	-	2	10	4	2	7	5	**9**	4	4	3	5	4	0	0	0
-	-	-	-	-	-	-	-	-	-	5	12	5	7	9	7	**12**	7	4	2	2	0	1	0	0

PM PkHr 16:30 to 17:30 (n=41), PM PHF=0.85

*** Fri 24 Feb 2012 - Total=101(incomplete) , 15 minute drops,**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
0	**0**	**0**	**4**	**1**	**2**	**6**	**16**	**18**	**27**	**19**	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	1	0	0	1	2	2	4	7	4	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	1	3	6	9	5	4	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	1	1	0	7	3	8	3	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	3	0	1	4	4	7	6	4	-	-	-	-	-	-	-	-	-	-	-	-	-

A6: Maps



Map of Christchurch, showing the Papanui area in the red circle

Map of some of the Papanui area, showing the study area enclosed in red

Map of the Papanui Cluster, showing the road layouts and the way traffic flows around the area