ASSESSING THE ENVIRONMENTAL CAPACITY OF LOCAL RESIDENTIAL STREETS

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ABSTRACT

The inherent conflict between the residential amenity and traffic access functions of local streets causes debate on what constitutes a true “local” road. The concept of ‘environmental capacity’ was developed to identify a suitable maximum traffic volume on such local streets. It was first introduced by Buchanan and Appleyard in separate research in the 1960’s. Both authors settled on broad-brush traffic thresholds of 2,000-3,000 vehicles per day. Since then, other research has relied heavily on the original Buchanan and Appleyard findings; this paper investigates that presumption in the present day.

A residents’ survey was applied to four “local” streets with varying traffic volumes in Christchurch, New Zealand. Residents living on those streets with higher volumes felt that their streets were busier, noisier and less safe. There was also an increasing trend for residents along higher volume streets to have their houses turned away from the street and they tended to have less personal involvement and/or knowledge of their neighbours. In the Christchurch context, a more appropriate environmental capacity would appear to be around 1,500-2,000 vehicles per day. This has implications for local town planning and street network design guidance if true local roads are to be achieved.

Keywords: town planning, local streets, environmental capacity, traffic volumes, liveability, amenity

INTRODUCTION

Non-residential activities locating in residential zones are not new; however there appears to be an increasing trend for these types of developments to establish along local residential streets, which some people would argue are to the detriment of residential amenity. Many of these non-residential activities – such as educational facilities and health facilities for example – require relevant planning permission. Often these non-residential activities develop in a piecemeal fashion and in a manner that appears to disregard actual or potential cumulative effects that might result from increasing traffic. While it is generally true that the geometric capacity of these streets can cater for these additional traffic volumes, the actual and potential effects on residential amenity are frequently concluded to have effects that are "less than minor". This often appears to be determined without any real justification – whether quantitatively or qualitatively.

While it is accepted that residential amenity effects are rather qualitative and subjective (as one person's perception and opinion often differs from another), there is likely 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, after examination of some key elements, to 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 thesis *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, there has been debate on environmental capacity, particularly in reference to the acceptable upper limits of tolerable traffic on local streets. These differences are probably explained by many varying factors – perhaps volumes themselves, street widths, speeds, building setbacks, etc. These issues may of course also be perceived differently from one resident to another. In any instance the answer is still not clear.

A widely used rule of thumb in the traffic planning and engineering profession is that a local residential street has an environmental capacity of 2,000-3,000 vehicles per day. This paper sheds some light on this presumption; it is based on research undertaken in the New Zealand city of Christchurch (Chesterman 2009). The overall objective of this research was to determine the environmental capacity of selected local residential streets in a Christchurch context, although this method is likely to provide a useful contribution to the international discussion of this topic.

BACKGROUND LITERATURE

The idea of increasing residential amenity and liveability along local residential streets is not new; it goes back to the turn of last century when the "garden city" concept was first introduced in the United Kingdom (Howard 1902). This has since led to a continual desire to balance amenity needs and traffic effects – especially with increasing traffic volumes. The idea of the garden city was particularly influential in the United States, where a number of settlements were planned during the first half of the 20th century using this format, as well as in a number of other countries worldwide (Hardy, 1999).

As the motor car became more widespread and traffic volumes grew, the inherent conflict between the amenity and access functions of local streets created the debate on what constitutes a true "local" road and what functions should take precedence. Such issues also found their way into discussion about urban planning and redevelopment (Jacobs 1961).

The Buchanan Report

This concept of environmental capacity appears to have been first raised by Buchanan (an architect, civil engineer and planner) in his London-based thesis *Traffic in Towns* (Buchanan 1963). This was an influential report and popular book on urban and transport planning policy for the United Kingdom's Department of Transport. Although Buchanan never intended to write about environmental capacity, it was an issue that did arise and he consequently made an attempt to define some possible methods of calculating it.

Buchanan firstly recognised that traffic on residential streets affects the environment in many ways, including noise, fumes, vibration and the danger for people wishing to cross the street. He then explored the possibility that the environmental capacity could be assessed, for practical purposes, by the ease in which the street can be crossed by pedestrians; if this critical condition could be satisfied, then it is likely that needs relating to noise, fumes and so on would also be satisfied.

Buchanan suggested that the level of risk might be measured by the delay to which a pedestrian is subjected when they desire to cross the road. The average delay for pedestrians will depend upon the volume of traffic and the width of the road. Buchanan assumed an average delay of two seconds as a rough guide to the border-line between acceptable and unacceptable conditions. Any greater delay would imply that most people would have to adapt their movements to give way to motor vehicles, a situation not 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").

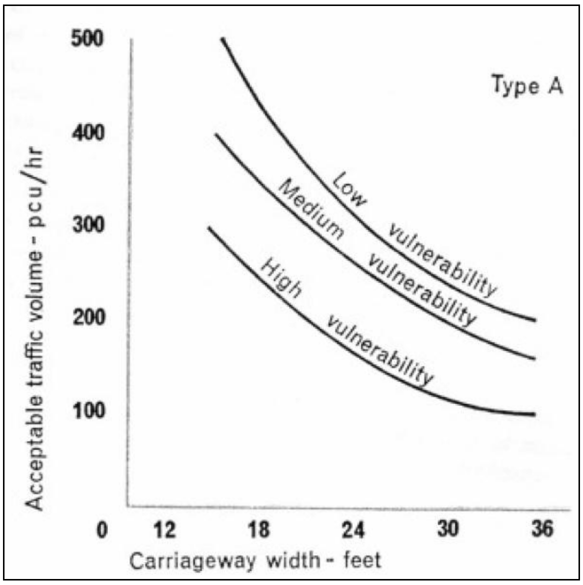

Figure 1: Example of Maximum Acceptable Traffic Volumes (Buchanan 1963)

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.

Appleyard's Livable Streets

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 *et al* 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. It was subsequently used as the basis for other work mentioned below, including the TIRE index (City of Palo Alto 2002) and the Australian Model Code for Residential Development (Commonwealth of Australia 1997).

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. These include:

1. The RTA *Guide to Traffic Generating Developments* (RTA 2002), commonly used by traffic planners and engineers in Australia and New Zealand. The Guide sets out a desirable maximum peak volume (the "environmental goal") of 200 vehicles/hour and an absolute maximum of 300 vehicles/hour for local 40 km/h streets. The Guide suggests that there may be situations where alterations to these levels might be appropriate, e.g. if a street has a central median.

2. The "Traffic Infusion on Residential Environment" (TIRE) index (City of Palo Alto 2002), used in a number of North American cities, is an alternative approach to evaluating impacts on local streets to evaluate the change in average vehicles per day along a street segment. Originally developed by engineering practitioner Donald Goodrich, the TIRE index provides a numerical representation of residents' perceptions of the effect of traffic on residential activities and has values that range from 0.0 to 5.0. In simple terms a change of 0.1 or more indicates that traffic would be noticeable to residents in an affected neighbourhood. This equates to approximately a 25% increase in traffic volumes, irrespective of the initial volume. The TIRE Index however stops short of defining a threshold at which a volume change should be considered unacceptable or a significant impact.

3. The Australian Model Code for Residential Development (AMCORD, Commonwealth of Australia 1997) is a national resource document for integrated residential development containing up-to-date information on the latest urban research material. AMCORD refers to four key performance areas for new developments; namely noise, air pollution, crossing delay, and pedestrian safety (the latter regarded as the most

important criterion). AMCORD proposes different environmental capacity values for each performance criterion. The AMCORD methods provide some insight into the issue of environmental capacity, and, while they do not provide any definitive rule-of-thumb figures (as each situation and local area should be considered on its individual merits), reference is often made to 2,000 vehicles per day in many instances. This is perhaps an indirect admission that a typical daily threshold limit for a local residential street is around 2,000 vehicles.

4. The City of Portland has developed an "Impact Threshold Curve" (City of Portland 2008), which has a purpose of determining whether the secondary or unintentional impacts of Neighbourhood Traffic Management Program projects are acceptable (typically in the form of increased traffic on local roads). The standard impact curve provides for an increase of between 150-400 vehicles/day on local streets, but with the resulting traffic volumes not to exceed 3,000 vehicles/day. Because of the margin of error inherent in the collection of traffic volume data due to daily volume fluctuation, the curve is presented as a wide band of values rather than a single curve. The standard impact curve may also be modified to account for factors such as the proportion of non-local or re-routed traffic, peak hour volumes, and truck traffic.

Although some of the methods mentioned above have incorporated other research (e.g. Sharpe *et al* 1972, Holdsworth & Singleton 1979, Coady & Associates 1982, Song *et al* 1993), 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. While each organisation is commended for their novel approaches in an attempt to simplify and quantify the concept of environmental capacity, 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.

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 *et al* (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. Perhaps one reason lies with the fact that issues involving traffic volumes have traditionally fallen within the domain of traffic engineers and other environmental considerations (such as amenity) have been in the domain of town planners.

CASE STUDY - CHRISTCHURCH

To explore these issues further, a residents' survey (using similar techniques and questions to those used by Appleyard) has been applied to four "local" streets with varying traffic volumes in the New Zealand city of Christchurch. Four Christchurch streets in the same suburb were selected because they were similar in appearance, yet quite different in their volumes of traffic. Table 1 summarises their key characteristics. The intention was to include streets with varying traffic around 500, 1000, 2000 and >3000 vehicles per day; these were labelled LIGHT, LOW, MEDIUM and HIGH accordingly.

Table 1: Christchurch streets surveyed

	Murdoch Street	**Jennifer Street**	**Aorangi Street (northeast)**	**Aorangi Street (southwest)**
Daily Traffic Volume (veh/day)	564 (LIGHT)	1096 (LOW)	2124 (MEDIUM)	3537 (HIGH)
Length of street (m)	170	580	630	300
Number of households	14	67	99	42
Carriageway width (m)	8.0	11.0	14.0	14.0
Mean / 85th %^{ile} speeds (km/h)	37 / 42	46 / 53	50 / 56	51 / 57

Other characteristics that are worthy of mention include:

- All four streets are generally characterised by stand-alone suburban residential houses rather than commercial activity, and are located within the same "Suburban Residential" planning zone.
- All four streets are classified as local roads in the City Plan, and provide through-access to other local streets (i.e. they are not cul-de-sac streets).
- All streets appear to share a similar socio-economic status by virtue of their proximity to each other and with housing stock generally displaying similar characteristics.
- All street are within a 500 m radius of each other, directly linking with Wairakei Road, the main arterial road in the area providing access to and from the inner City.
- All streets generally run in a northeast-southwest direction.
- All streets have a posted speed limit of 50 km/h.
- All streets have no dedicated bus routes running along their length.
- All streets have footpaths along both sides, with no pedestrian crossing facilities.

- All streets display typical residential “tidal flow” characteristics during the peak hour periods (i.e. predominantly one-way flow), which represent around 10% of the total daily volume.

It is acknowledged that there are some differences in street width and length, and this may also be affecting traffic speeds and resulting survey outcomes.

The study generally drew on resident perceptions by means of a letterbox questionnaire, which asked several broad questions in relation to issues of residential amenity such as:

- whether they know their neighbours
- whether the road is noisy
- whether they are delayed in crossing the street
- whether they consider the volume of traffic as high
- whether they would let their children play on the street

Given that the traffic volumes of each street were known, the responses to each question 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.

The choice to use a reply-post questionnaire was largely governed by limited resources (i.e. time and costs), which ruled out formal interviewing and/or direct observation. The use of a questionnaire would also protect the privacy of the participants, as the confidentiality can help ensure that people respond honestly. It is acknowledged that this method may limit response rate and also that there may be a bias in responses received. A $50 lucky respondent prize provided an incentive to respond and the overall response rate for all four streets was 37%. Attempts were also made to word the questionnaire in such a way that no particular answer would be favoured over others, but no random ordering of questions or possible responses was employed. For the purposes of this study any biases mentioned above were largely ignored, but further investigations may be valuable to research this aspect further. It is important to remember that a key aim was to mimic as much as possible the questions posed by Appleyard in his study.

Results

The number of individual survey responses for each street ranged from just five on the LIGHT street to 36 on the MEDIUM street (response rates between 34% - 43%). It is acknowledged that the limited number of respondents on some streets might be susceptible to random variation, although the resulting trends proved to be remarkably consistent. Over 90% of respondents owned their homes (i.e. not renting it), which is high even by New Zealand standards and may also reflect a response bias.

Table 2 summarises results from the key survey questions. Note that some of the questions had multiple-choice options and only the proportion of answers in the worst one or two response options have been presented. Almost consistently, there is a clear trend in responses from the LIGHT street through to the HIGH street.

Table 2: Survey Questionnaire Results

Survey Question	**Murdoch Street**	**Jennifer Street**	**Aorangi Street (northeast)**	**Aorangi Street (southwest)**
Traffic Volume	*(LIGHT)*	*(LOW)*	*(MEDIUM)*	*(HIGH)*
Number of responses	5	23	36	18
Rear-section Property?	0%	9%	39%	53%
Main living area in your house generally faces away from the street?	0%	43%	61%	83%
Front sections: do you have a fence in the front yard that blocks street views?	60%	65%	72%	89%
Would you feel comfortable with children playing unsupervised on or near the street? *No*	60%	70%	86%	89%
Do you know any of your neighbours personally? *No*	20%	32%	33%	58%
Do traffic volumes along this road create a barrier to social connection with neighbours?	0%	9%	11%	14%
How would you rate the amount of traffic on this street? *Heavy / Very Heavy*	0%	26%	48%	57%
Do you think that the overall speed of traffic on this street is: *Too fast*?	0%	35%	28%	28%
Do you think that the overall speed of traffic on this street is: *a bit fast*?	80%	52%	44%	39%
Has traffic on this street *got worse* over past few years?	0%	41%	61%	70%
Looking ahead five years from now, do you think traffic on this street will *get worse*?	20%	39%	58%	68%
Do you consider this road to be: *Noisy / A little bit noisy*	40%	49%	60%	84%
Does traffic in your street bother you during some activities? *Yes*	20%	28%	33%	40%
Do you usually have to wait for traffic before crossing the street? *Yes*	20%	49%	67%	89%

Discussion

The dominance of traffic as a problem on all street types is the most salient finding of this study. Based on the survey results, residents on the lighter and lower volume streets were the most contented; however they were not without their traffic problems. More than half (60%) of the residents along the LIGHT street still have a fence in their front yard that blocks 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 know their neighbours, 80% of them believe the overall speed is “a little bit fast”, yet the same proportion suggest they do not have to wait at all to cross the road. In addition, 40% believe it is “noisy” or a “little bit noisy.” This however is further confused by a response that suggests that only 20% of the residents are bothered by traffic during some activities. The conflicting and contrasting verbatim comments on these topics also confirms the subjective nature and the variability of opinions in relation to traffic issues along their streets.

Overall, the perception held by residents living on the streets with higher traffic volumes is that their streets are busier, noisier and less safe. The outlook is also not positive with an increasing trend for residents along higher volume streets believing the traffic will continue to get worse. This is coupled with an increasing trend for the same houses to turn away from the street through the construction of high fences in their front yards. This in turn could be limiting passive surveillance and the exposure to passers-by, and might explain why residents along busier roads tend to have less personal involvement and/or knowledge of their neighbours.

One interesting item to emerge was that residents on streets with lower daily traffic volumes perceived traffic as being “a little bit fast.” Again, this could be a reflection of people on the higher volume streets becoming accustomed to the overall speeds. This may account for the slightly higher proportion of residents on the higher volumes streets suggesting that the overall traffic speed was “about right.”

What was clear and obvious through the survey responses was the amount of verbatim comments that referred to the Christchurch streets being used as a short-cut route. This was a finding that Appleyard also found on his surveyed San Francisco streets back in the late 1960’s. The issue of extraneous traffic was also referred to heavily in Buchanan’s research whereby he suggested that areas containing only local streets should have all through-traffic removed. This is perhaps an overstatement as it would imply that all local streets should be culs-de-sac only and should not have any linkage with other local streets. In the context of the surveyed Christchurch streets, all were classified as local roads and therefore had a function of providing property access to residential properties. The traffic volumes on all four surveyed streets however carried well in excess of the expected traffic that would be generated solely by the houses located along them. On the basis that a standard residential house generates around ten vehicle trips per day, analysis implies that the four surveyed streets carry extraneous traffic between 1.6 and 8.4 times more than the level of traffic expected based on actual dwelling numbers.

This raises questions as to whether the road classification is correct, or whether the street layout and overall housing pattern is correct. This is highlighted by the fact that many classified local roads in Christchurch carry more than 2,000 vehicles per day (such as Aorangi Road), which is at odds with the local Infrastructure Design Standard's stated threshold that implies a maximum upper limit of 2,000 vehicles per day (Christchurch City Council, 2007). Roads that carry more than this are clearly carrying extraneous traffic and appear to have a dual function of traffic distribution and property access. A closer look at the deeply entrenched view of the inverse relationship between movement and access functions reveals that some local road classifications could be in error. The widespread acceptance of the roading classification system could therefore be a reason why there are apparently some insoluble traffic/environment conflicts. On all four surveyed streets there appears to be some overlapping functions (whether intended or not) and this clouds the issue further of what a true local road is.

In order to progress and validate the idea that the environmental threshold is around 2,000 vehicles per day, it is perhaps appropriate to compare and contrast some of Appleyard's survey results with the Christchurch survey results. As discussed above, Appleyard surveyed a variety of streets in San Francisco in the late 1960's and this included what he called a LIGHT street where the traffic volumes were around 2,000 vehicles/day. This level of traffic coincides with that of Aorangi Road (northeast). Given that some of the same questions were used for both studies it is useful to compare some of the resident responses from the two streets. Note that both streets served stand-alone residential houses.

In nearly every single aspect the overall response rate for the San Francisco street was noticeably more positive than the equivalent Christchurch street. Nearly twice as many of the Christchurch residents suggested that the traffic would get worse in the future, and although the streets carried the same amount of traffic, nearly twice as many of the Christchurch residents had to wait longer to cross the road. A greater proportion of Christchurch residents also implied that the traffic along their street was heavier and faster than the San Francisco equivalent. While all of this suggests that the Christchurch residents express more dissatisfaction in terms of the environmental components that contribute to the liveability of their street, it is interesting to note that the San Francisco street had a greater proportion of residents who were affected by traffic when doing other tasks around their home (i.e. watching television, working in the house and eating). In any instance, the differences between both sets of results emphasises the point that there are many factors that influence environmental quality, both in absolute terms and as perceived by different communities. Given the time difference between the two surveys (over 40 years), it is also highly possible that attitudes have changed in this time with regard to technology, the environment, and traffic in general.

Determining Environmental Capacity

The findings of the Appleyard *et al* (1981) study and the Christchurch surveys clearly show trends that imply a linkage between traffic volumes and other variables. This is perhaps not surprising as common sense would normally suggest that as traffic volumes increase there would be a reduction in other 'environmental' values. Although the overall trend is clear, there is a difficultly in determining what the actual environmental capacity is.

In order to make a quantitative judgement on a qualitative issue, a simple scoring system has been derived from the Christchurch survey information for each of the four streets. This has been 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, e.g. the percentage of respondents who said "yes" when asked if they would be comfortable with their children playing unsupervised on or near the street. The overall street score is the percentage of positive responses across all ten questions (i.e. the average percentage). For the purposes of this exercise, 50% is considered to be the threshold (or environmental capacity). This aligns with Buchanan's rough theory that simply separates acceptable with unacceptable, i.e. the majority (>50%) of people will find it acceptable or unacceptable. The results of the scoring system in comparison with the street traffic volumes are shown in Figure 2.

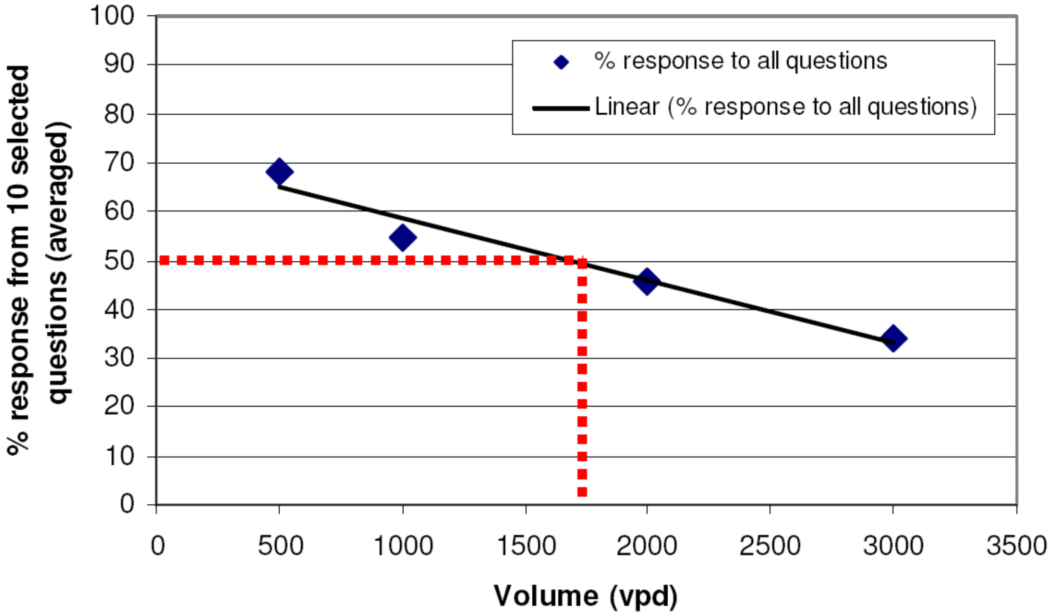

Figure 2: Environmental Capacity Trend-line for Four Christchurch Streets

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 the four surveyed Christchurch streets. If an environmental capacity/threshold limit is set at the "50% acceptable" mark, Figure 2 would imply that the environmental capacity is somewhere between 1,500-2,000 vehicles per day. This is clearly less than the 2,000-3,000 vehicles/day often quoted elsewhere. While this research is not suggesting that the environmental capacity of *all* residential streets is 1,500-2,000 vehicles per day, the Christchurch surveys imply that the typical environmental capacity is perhaps not as high as what previous literature has suggested.

CONCLUSIONS

A review of the literature on environmental capacity reveals that the concept was first introduced by Buchanan in his London-based research, followed by Appleyard's research in San Francisco. Both authors settled on broad-brush traffic thresholds of 2,000-3,000 vehicles per day. Further literature review however reveals that other environmental capacity research heavily relies on the original Buchanan and Appleyard findings and that there have been few questions on the validity of the original information. While this is not a criticism of the original findings, this all occurred nearly 50 years ago when resident perceptions in relation to environmental and amenity values may have been different. Changes in the way we live, technological improvements and a greater (or lesser) acceptance of the motor vehicle maybe partly responsible for any changes.

There are clear and obvious trends that show that environmental amenity decreases as traffic volumes increase. Although it is accepted that the issue is highly subjective and varies from area to area, the traditional rule of thumb that a residential local road could acceptably carry 2,000-3,000 vehicles per day is perhaps set too high. In the Christchurch context, surveys of four local streets suggest that a more appropriate environmental capacity would realistically appear to be around 1,500-2,000 vehicles per day. This has implications for local town planning and street network design guidance if true local roads are to be achieved.

Recommended Further Research

The Christchurch surveys undertaken for this research included only four streets. These of course do not represent all Christchurch streets and caution should be applied if using this information in relation to other local residential roads. Also, although the response rate to the questionnaires was better than anticipated, the sample sizes were not particularly large, ranging from 5-36 responses along each street. The trends however between low and high volume streets were clear and obvious. Further research using the same questionnaire for a number of other streets would be beneficial and, if successful, it might reinforce the current conclusions further.

The four streets also had some differences in road attributes such as carriageway width and traffic speeds. The study focused on the relative effects of traffic volume alone but, like the previous work of Buchanan, it is acknowledged that other road features are likely to allow base environmental capacity values to be adjusted. It would therefore be useful to be able to compare streets with similar volumes but with different attributes in terms of road width, provision for non-motorised modes, traffic calming, and landscaping, to assess their relative effect on residential amenity. For example it may be that, on a well landscaped and traffic calmed street, the residents are able to tolerate a higher traffic volume before it is considered unacceptable. This may provide some useful guidance on physical measures to improve the environmental capacity of existing local streets.

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