

# **Trips and Parking Related to Land Use**

## **Volume 1: Report**

**Transfund New Zealand Research Report No. 209**

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ISBN 0-478-25067-3  
ISSN 1174-0574

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Douglass, M. & McKenzie, D. 2001. Trips and parking related to land use.  
Volume 1: Report. *Transfund New Zealand Research Report 209*. 103 pp.

**Keywords:** city centre, design hour, land use, New Zealand, parking demand,  
residential, retail, surveys database, trends, trip generation.

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## Executive Summary

This research project was approved by Transfund New Zealand in July 1998. Its primary objective was to review surveyed information related to trip generation and parking demand by individual land uses, and compile a database from this information. The Trip and Parking Surveys Database (Volume 2 of this report) collected and analysed 463 site surveys undertaken since 1990. Earlier New Zealand projects and references were also identified. This was the first comprehensive review of this traffic information since work done in the late 1960s and early 1970s, which was published in Road Research Unit Bulletin 15 in 1972 and 1973.

The work was undertaken in 1998–2001 by Malcolm Douglass, planning and transportation consultant and Director of Douglass Consulting Services Ltd, and Don McKenzie, senior traffic engineer with Traffic Design Group Ltd. Uniquely, Malcolm Douglass, the author of the 1972 Road Research Unit Bulletin, has also undertaken and managed the research in this Transfund project 30 years later.

A major section of the report deals with seasonal factors and design hours. Section 2 is specifically related to retail and visitor-attracting activities which experience major seasonal fluctuations throughout the year. The scale factors vary significantly from large metropolitan areas to smaller holiday settlements which have a major influx of tourists and visitors in summer. The report recommends continuing to use the 30th highest design hour as the most satisfactory basis for assembling traffic data on visitor-attracting land uses in the future.

In Section 3 the report deals with residential trips and parking, and establishes that overall trip making from residential properties has increased in parallel with car ownership growth during the last 30 years. Typical trip making has, for the satisfaction level of 85% of surveyed daily trips, risen from 6.0 vehicle trips per household per day in the 1970s to 10.4 vehicle trips per household per day in the 1990s, a 73% increase. Car ownership has also increased significantly: whereas in the 1970s 26% of households had 2+ cars, this figure increased to 44% in the 1990s. The number of cars per household has increased on average from 1.1 to 1.4, a 27% increase.

Retail trip and parking surveys are covered in Section 4. Despite the additional shopping centres and retail outlets available in the 1990s, trip making and parking demands across all retail establishments have increased at only a moderate rate over the period. There is also now considerable sharing of parking areas, and it is more appropriate to consider a group of outlets together. The modern suburban areas have generally been developed on the basis of shared parking. The 85% surveyed satisfaction for trip making has increased from 135 trips/day/100 m<sup>2</sup> gross floor area (GFA) to around 150 trips/day/100 m<sup>2</sup> GFA, an 11% increase only. On the other hand, parking to meet the demand at the 30th highest hour has reduced from 7 to 6 carparks/100 m<sup>2</sup> GFA.

A brief analysis of central city parking is made in Section 4.6. Eleven cities were studied, ranging in size from Christchurch to Taupo, and the central-city parking demand for retail, commercial, industrial and other activities was relatively constant. The average visitor parking demand is 2 car-parks per 100 m<sup>2</sup> of retail plus commercial GFA, plus 1 car-park for long-term employee parking, yielding an average total of 3 cars per 100 m<sup>2</sup> GFA. The equivalent 30th highest day parking demand is about 4 cars per 100 m<sup>2</sup> GFA. There is, however, a marked variation from city to city in the off-street parking available for long-term and commuter parking.

As outlined in Section 5, selected groups of uses have changed quite dramatically since the 1970s. In educational uses, the increased access is reflected in car arrivals for teachers and students at primary, secondary and particularly tertiary levels. Medical centres, hospitals, rest homes and childcare centres have increased in number and expanded their services. Recreational uses and stadiums are being more intensively used. Larger service stations have become the highest trip-generating land use by site size and GFA.

Contact was made with Australian colleagues involved in similar work in both New South Wales and Queensland. Many parallels between the New Zealand experience and that of transportation planners in Australia and America were identified during the project, and these are discussed in Section 6.

The trends in trip generation and parking demand between the 1970s and the 1990s are discussed in Section 7, according to the land uses defined in Appendix B. In spite of the 150% increase since 1970 in the total number of trips being made in New Zealand communities, the increases in trip generation rates and parking demand at individual sites have not been as great, being typically 20% to 50%. The reason for these modest increases is probably the significant increase in the number of retail outlets and services developed, which have more than matched demand. This, in turn, has led to a wider distribution of traffic throughout the cities and rural areas, adding to ribbon development and the generally dispersed nature of modern New Zealand city living.

Section 8 discusses survey and projection practice, and standard survey forms for use by practitioners are supplied in Appendix D. Gaps in the Trip and Parking Surveys Database are also listed.

Section 9 discusses the future of the Database and makes a plea to develop a central address for the future management of this national resource, including the transfer of information to traffic and planning officers and professional practitioners.

The report's conclusions are summarised in Section 10.

## **ABSTRACT**

The objectives of this research project were to produce a comprehensive national database of information on trips and parking related to land use in New Zealand since 1990, to identify trends that have occurred since the 1970s, and to compare the New Zealand results with those reported in American and Australian publications.

The research project took place in New Zealand between 1998 and 2001. It found that there has been a general increase in total traffic by a factor of 2.2 during the last 30 years but that, while for some land-use activities (education, hospitals, medical centres, large service stations) there has been a considerable increase, for most there has been little change. The main reasons are that this traffic growth is distributed relatively evenly to new developments around New Zealand's urban and rural areas, sharing trip making between existing and new sites, and the shift to weekend trading. The diffusion of traffic is placing greater demand on the road networks, but at individual sites the traffic generation has not increased as much as the rate of car ownership or traffic growth. There is a general consistency between land-use activities in New Zealand and those reported in American and Australian publications.

The report includes a consideration of seasonal factors, the use of the 30th highest design hour, and the requirements for future surveys and data of trip generation and parking demand. The full Trip and Parking Surveys Database is presented in Volume 2.



## 1. INTRODUCTION

### 1.1 Project Brief

This project was approved by Transfund New Zealand in July 1998. The research brief was:

To produce a comprehensive database of trips and parking related to land use, providing access to information relevant to the situation found throughout the country since 1990 and identifying any trends that have occurred since 1970.

To make a comparative review of New Zealand results and those reported in America, ITE Manuals, and Australian publications.

While there has been a range of reports on this topic at various times, trip generation and parking demand were last reported comprehensively in Road Research Unit (RRU) Bulletin 15 (Volumes 1, 2 and 3), published in 1972 and 1973.

The primary objective of this project was to review and develop a new database, to replace that of earlier publications, based as far as possible on current surveyed information. Valid information for this study was collected over the 10 years from 1990.

Goods vehicle movement has not been comprehensively covered in this study. Most of the surveys used have focused on car trips and car parking demand without regard to modal split and arrival by alternative modes of transport.

The project falls within Transfund's Key Topic Area E – Traffic and Transportation, to “improve the efficiency and effectiveness of land transport systems required to support New Zealand's economy by:

- improving the efficient use of the existing infrastructure, in particular appropriate allocation of space for parking and access,
- understanding travel behaviour patterns by bringing together the many surveys undertaken by traffic engineers and planners, local government and the consultation sector, and to consolidate a comprehensive updated index of trip generation and parking demand by different land uses,
- improving demand forecasting by enabling more accurate assessments of trip generation at individual site developments”.

The project comprised four phases:

1. contact and support – completed 31 December 1998,
2. review of existing data and references – completed 30 June 1999,
3. collection of surveyed information and supplementary surveys – completed 30 June 2000,
4. compiling database and preparing report – completed 31st March 2001.

The information and surveys included in this research were drawn from some 28 localities, covering a wide range of city and district councils (including the results

from the Auckland Territorial Local Authorities study 1992–94), together with those from consultants and traffic engineers throughout the country. The research could not have been undertaken without this assistance.

Six peer reviewers experienced in the field (Alan Nicholson, John Chivers, Gary Main, Peter Constantine, Chris Freke and, in the early stages, Ross Hill) were used. Their guidance and comments, together with survey information particularly from Alan Nicholson, were greatly appreciated.

## 1.2 Past Projects and New Zealand References

The New Zealand references from 1970 to 1999 are listed in Section 1 of the References. RRU Bulletin 15, prepared by Malcolm Douglass in 1973, included the reporting of parking surveys undertaken at 78 shopping centres, 130 industries and 40 hotels, as well as schools and churches. Over 1300 residences surveyed as part of the Christchurch 1969 Home Interview surveys were also reported. The surveys of trip generation and travel to work covered 27 city-centre shops, office blocks and industries, and 27 suburban shopping centres and industries – about 300 individual establishments in all. These surveys provided the foundation for a comprehensive overview which still has wide application after all these years.

In 1981 RRU Bulletin 52 by John Burgess dealt with *Trip Generation of Vehicle-Intensive Commercial Land Uses*. This covered liquor stores and fast-food outlets, providing a comprehensive analysis of a range of variables. It was followed by a 1982 report by John Chivers and Des Lovatt, *Parking, Traffic Generation and Planning*, which summarised the trip generation and parking workshops sponsored by the Road Research Unit in 1981. For those workshops Chivers also produced a discussion paper, *Parking and Planning*, which outlined both the management of city-centre parking and the great variety of parking requirements being used in district plans at that time. This was published by RRU as a technical digest.

During the early 1980s there was also a call to maintain survey information on trip generation and parking generation in a readily accessible manner. Road Research Unit Project P/8 was undertaken by Traffic Design Group to establish files of such surveys. However, only a limited number of sites (27) was included.

Throughout the 1980s there was only a small number of published references, mostly relating to major shopping centres. During this period, however, several consultants, including Peter McCombs' team at Traffic Design Group, John Chivers of Transplan Consulting, Grant Smith and John Winter of Gabites Porter, and individual city councils, did undertake surveys of specific locations and developments, which have been reported here. Many other consultants undertook surveys but these did not result in either published reports or widely available documents.

With the advent of the Resource Management Act in 1991 and the need for councils to review their district plans, many councils returned to surveys of specific issues which required determination in the new proposed plans. Complementing these internal reports, several consultants' reports were also prepared dealing with the

various land transport effects of policies for road hierarchy, traffic and parking proposed to be included in the district plans.

One of the more recent reports on this topic is Transit New Zealand Research Report 57, prepared by Gabites Porter Consultants and published in 1996. This report noted that various attempts had been made to pull survey results together, to carry out surveys using standard formats and to make collected information available, but that little real progress had been achieved. It also noted that in 1988 the RRU Traffic Committee had compiled a priority listing of land uses for which data on parking demand and trip generation were required, and concluded that there were five groups of specific land uses for which further data was needed:

- hospitality – hotels, restaurants and small taverns,
- commercial – offices, post shops, banks,
- retail – shopping centres and supermarkets,
- institutions – educational, hospital and rest homes,
- recreational – marinas, sports fields and stadiums.

The report confirmed, from a survey of councils which generated only a few responses, that the existing survey data, both in-house and available from other sources, was not comprehensive. It also noted the definite need for surveys to be undertaken of parking areas which made use of a single parking resource, e.g. a whole shopping centre with a single shared car-park area. The present project has attempted to fill some of those gaps.

Between 1992 and 1994 the Auckland Territorial Local Authorities (ATLA) undertook a traffic and parking generation study for a total of 113 sites. The surveys used a standard form and provided a considerable amount of information on both parking demand and trip generation at varying times of the day. These results were published with due acknowledgment of the five contributing councils and the traffic sections involved. This provided a useful background to the present project and, with the agreement of those involved, these results have been incorporated here. One weakness of those surveys, however, is that they were recorded as unadjusted survey results and were not standardised by any seasonal factoring to a chosen design hour or design period.

Section 2 of the References deals with Australian references. Many are related to the Roads and Traffic Authority, New South Wales (RTA) (see Section 6 of this report).

Another common overseas reference is the Institute of Transportation Engineers (ITE) manual *Trip Generation* (sixth edition, 1997), and its companion volume *Parking Generation* (second edition, 1987: the third edition is currently being prepared and is likely to be published in 2001/02). These and other American references are listed in Section 3 of the References.

Other references from the United States, Canada and the United Kingdom and elsewhere have been researched. It is generally considered that the American and Australian background and data are most appropriate for comparative purposes, and can provide some guidance as to what to expect in New Zealand.



### **1.3 Approach to This Project**

The current research is designed to develop a database and guidelines for use by practitioners in assessing parking demand and trip generation rates for a wide range of land uses and situations. The New Zealand survey results described here were all collected from about 1990 onwards. The report indicates the probable range of demand rather than preparing a standard for application by way of rules.

One objective was to discover whether the global situation, especially for retail and visitor situations, in terms of design hour values, seasonal, weekly and daily traffic flows, and parking demands, has altered greatly since the 1970s.

This project focused on groupings of activities with shared parking supply rather than the previous site-by-site approach. It has further focused on the actual generation of traffic and demand for parking, and has not traversed district plan rules or parking management issues in any detail. The results presented here should be seen as a resource to provide a range for design and assist the judgement of professional advisers to public authorities and private clients. The report therefore emphasises methodology, variations between and within land-use activity levels, and the importance of using the survey data as a guide when practitioners are undertaking more detailed, site-specific studies and future forecasts.

While the adoption of seasonal and daily factors enables greater opportunities for surveys throughout the year, it is also important that future surveys are complete in the basic information required. This includes the dates, times, location and land use, and desirably the observation of the total number of person trips arriving by all modes at the surveyed sites. Survey analysis will need to include assessment of the appropriate daily and seasonal factors to bring the information up to the appropriate design hour.

### **1.4 Difficulties and Pitfalls**

The greatest difficulty in this project has been gleaning information from local authorities throughout the country to add to the database. The amount of basic survey work being undertaken is not the same as in the 1970s. Territorial local authorities (TLAs) are tending to rely more on consultants, who complete their immediate task and have not in the recent past (until this project) contributed their survey results. Issues of client confidentiality and ownership and the availability of the data for inclusion in a national database have also had to be addressed.

Gaining surveyed information that is of uniform quality and embraces the full range of factors is also a major difficulty. It is appropriate, as described in Section 8 of this report, that there be wider support for undertaking surveys of a more uniform standard to obtain all of the relevant information, including modal split as well as parking and trip generation, when sites are being surveyed.

The scarcity of TLA in-house information has meant that many district plans have been revised with a “roll-over” of previous parking standards or those inherited from

other district plans. Uses have changed in various ways in the last 30 years. The most significant are the spreading of shopping hours and the major increase in both the number and scale of shopping establishments and opportunities for retailing, which have resulted in a significant drop in the peak parking demand per establishment.

In the city central business districts (CBDs) another difficulty is recognising the two separate groups of restraints and policies: those affecting all-day and long-term parking in contrast to short-term casual and shopper parking.

## **1.5 Changing Attitudes and Practices**

Attitudes and community dynamics are changing, and this is reflected in the trips and parking information being collected. These changes are also fundamental to current transport reviews, such as those involved in regional land transport studies. The changes include the following:

- Wider changes in society are being reflected in changing shopping patterns, different business hours, new trends in employment structures, changing social patterns, changing recreation patterns and the impact of the emerging information society.
- New types of businesses and enterprises are emerging, giving rise to new land uses and quite radical changes in how traditional land uses, such as industries, function.
- There is a move from traditional rigid land-use zoning, which encouraged segregation of land uses, to planning for integrated multiple land-use complexes, commercial parks and modest employment uses in residential areas.
- Greater concern is being shown for road safety and accident prevention.
- Shifts in government policy reflect the user-pays principle, and the need for interconnection between policies appropriate to a more market-led economy.
- In relation to trips and parking, there is now an overall need to consider accessibility by all modes of transport and to ensure that surveys consider transport as a whole, including all trip modes and all trip purposes and not just vehicle/driver trips.
- When considering trips and parking generation surveys and projections related to individual land uses, the effects external to the site must be assessed as well as the internal design effects.
- The groundswell of professional opinion and community prominence given to the principles of “sustainable transport” means that in all their work transport engineers should be aware of the contribution of:
  - public transport,
  - goods vehicles,
  - pedestrian and cycle movements,
  - car driver and car passenger travel.

- The issues of traffic noise, air pollution and environmental amenities must also be recognised explicitly, as their impacts affect adjacent sites and localities.

These issues have been borne in mind as this research project unfolded. The report refers to the “mobility” and “diversity” of communities as they become more dispersed and populated by a greater number of players who all travel further throughout both the urban and rural areas for both business and pleasure. This leads to greater travel distances in the developing multi-centred communities.

## 2. Seasonal Factors and Design Hours

### 2.1 Selection of Independent Variable

The data available for this research project has limited the scope and number of trip generation and parking demand variables for each of the land uses presented. While it is accepted that one of the most important aspects of predicting trip generation and parking demand is the choice of independent or predictive variables, the survey information available necessarily limits the type of variable that can be used.

These variables range from the physical scale and type of activity through to the number of patrons at a cinema, employees or other staff engaged in activities within the site, the number of doctors at a medical centre, or the number of beds in a hospital. The four most common variables used for this purpose are:

- Gross floor area – the generally accepted definition of gross floor area (GFA) is the area within the external walls of a building, excluding any area dedicated for parking of vehicles but including all common areas shared by customers of joint retail areas.
- Site area – the total area of a site associated with the activity surveyed, including areas used for parking and landscaping.
- Employees – the number of staff employed or engaged at the site. The new trends in employment structures require a degree of caution to be exercised when using total employee numbers, as the increasing use of part-time or shift workers creates increased trips and parking demand at shift change-over times. For some sites, specialists (e.g. doctors at a medical centre) can be a useful variable.
- Activity units – used where the particular activity is best expressed in terms of units related to the function or activity (e.g. restaurant seats, service-station filling positions, number of pupils, sports courts or hospital beds, seating capacity in halls or cinemas).

A wide variety of site variables can therefore be used in the prediction of trip generation and parking demand. The onus rests with the practitioner to select the most appropriate variable for a particular planning or assessment exercise. The limited nature of information available from the New Zealand context is such that this research project cannot provide the necessary confidence levels for different predictive variables, unlike the more significant and larger survey samples in the ITE *Trip Generation* manual. Practitioners should exercise proper judgement in selecting the most appropriate variables, based on the operating characteristics of the land use in question.

The detailed analysis in RRU Bulletin 52 for fast-food outlets and liquor stores, as well as considering the establishment's "employment" and "gross floor areas", included "annual customers", "population, within 4 km (i.e. catchment)", "employment, within 2 km", "adjacent retail activities, within 200 m" and "exposure to traffic, vpd past site". The analysis showed that for annual customers the "catchment" population and "passing traffic" were the most significant. For this

reason, surveys must confirm and record the location in the urban/rural context and the frontage road type/traffic.

The changing nature of employment structures and methods of business will continue to alter the most appropriate predictive variables. For this research, and to provide a consistent basis for comparison between land uses, the authors prefer to use GFA as the common independent predictive variable. It remains the responsibility of practitioners to select any other appropriate variable which, in their judgement, best fits the land use in question. But all sites should include the GFA basis.

In this report, and in Volume 2, the full Trip and Parking Surveys Database, all sites have been calculated on the basis of GFA (normally expressed as the rate per 100 square metres). In addition, some sites have the rates expressed in other units, e.g. number of beds, doctors or students, or per 10 number of audience, etc., where that is also appropriate.

Unless the text indicates otherwise, the term “vph” is vehicles per hour, “vpd” is vehicles per day and “hh” is households.

## 2.2 Discussion of Factors

In order to determine an appropriate standard, i.e. design hour or percentage satisfaction, the following sections of this report discuss the broad patterns of the variation in retail parking and related activity indicators.

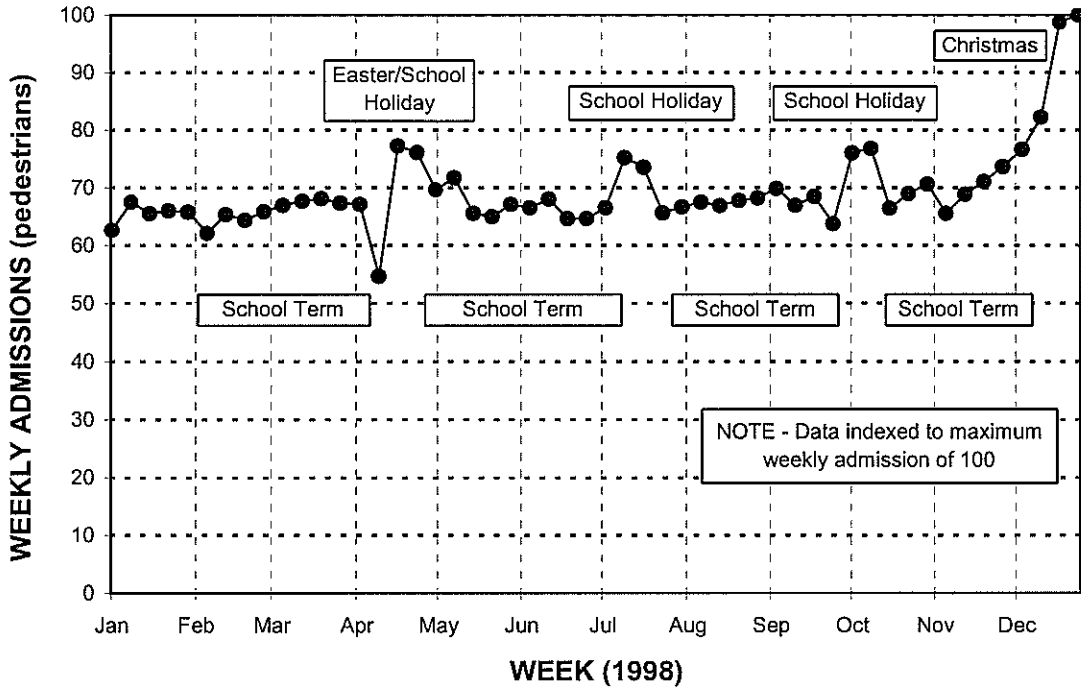
The design of traffic facilities serving a land-use activity involves a wide variety of factors, including:

- type and scale of activity,
- location of site,
- connections to road and networks,
- available public transport services,
- proximity and relationship to other traffic and parking generating activities,
- local authority traffic and parking controls and regulations,
- seasonal, daily and hourly trip generation.

This section of the report, which deals with seasonal, daily and hourly trip generation and parking, applies particularly to retail and visitor attracting uses.

Parking demand and traffic generation are closely linked, with parking demand being a function of both the arrival rate of vehicles and the duration of their stay. Other factors also play a part, such as the size of parking reservoir available and the associated manoeuvre and on-site circulation or queuing time. Both parking demand and traffic generation are dynamic characteristics of land-use activities, and both relate to the activity itself and to the relationship of that activity to the surrounding environment.

Figure 2.1 Weekly pedestrian admissions at a major shopping centre



Ranked Weekly Pedestrian Admissions

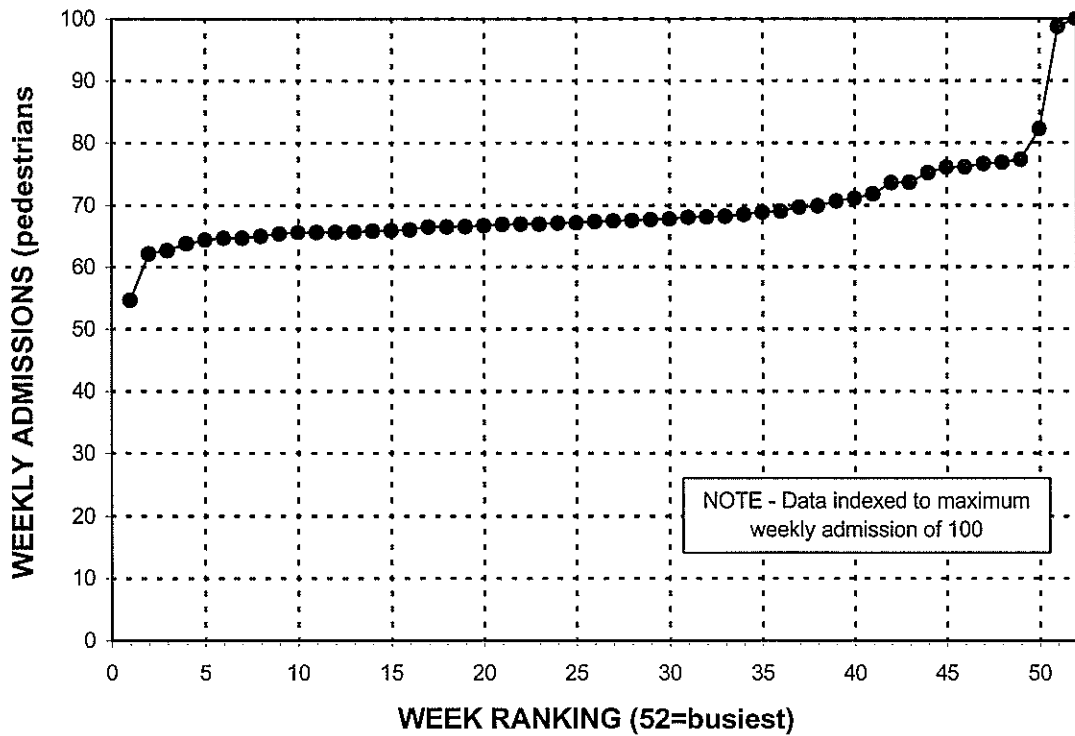
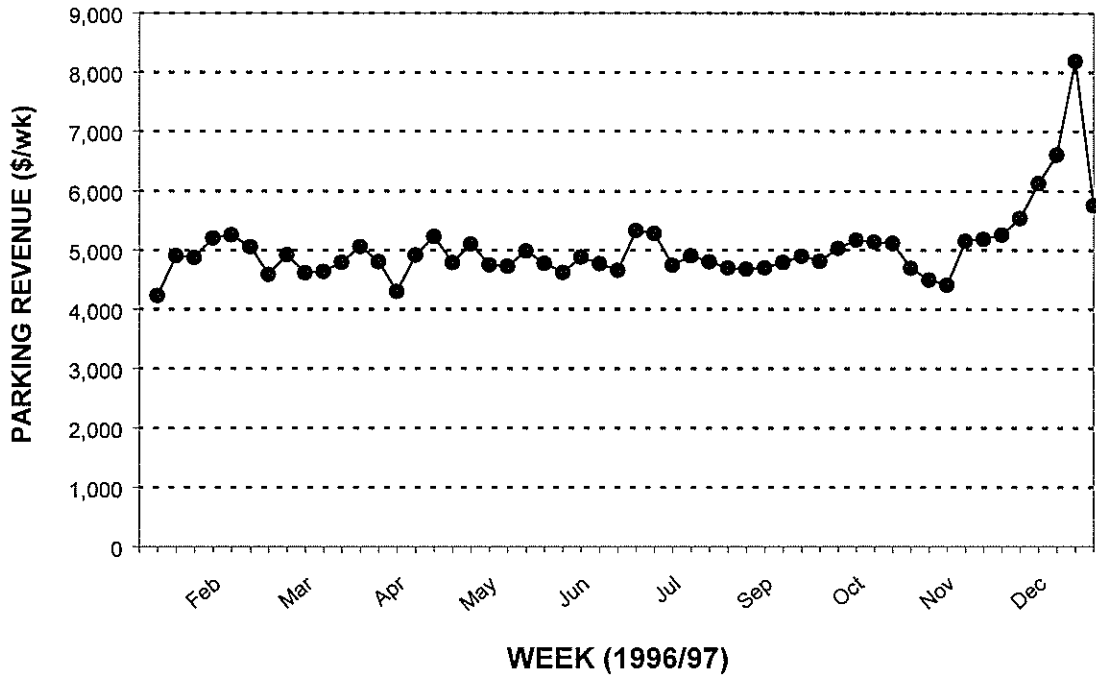


Figure 2.2 Weekly parking revenue for provincial centre (W)



Ranked Parking Revenue

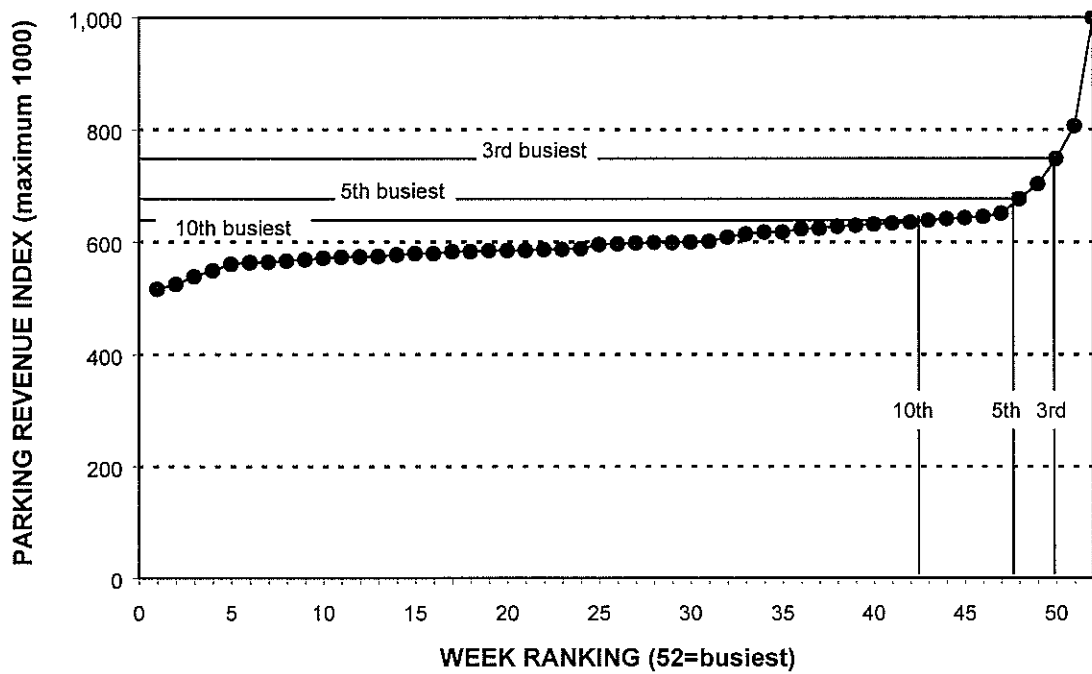
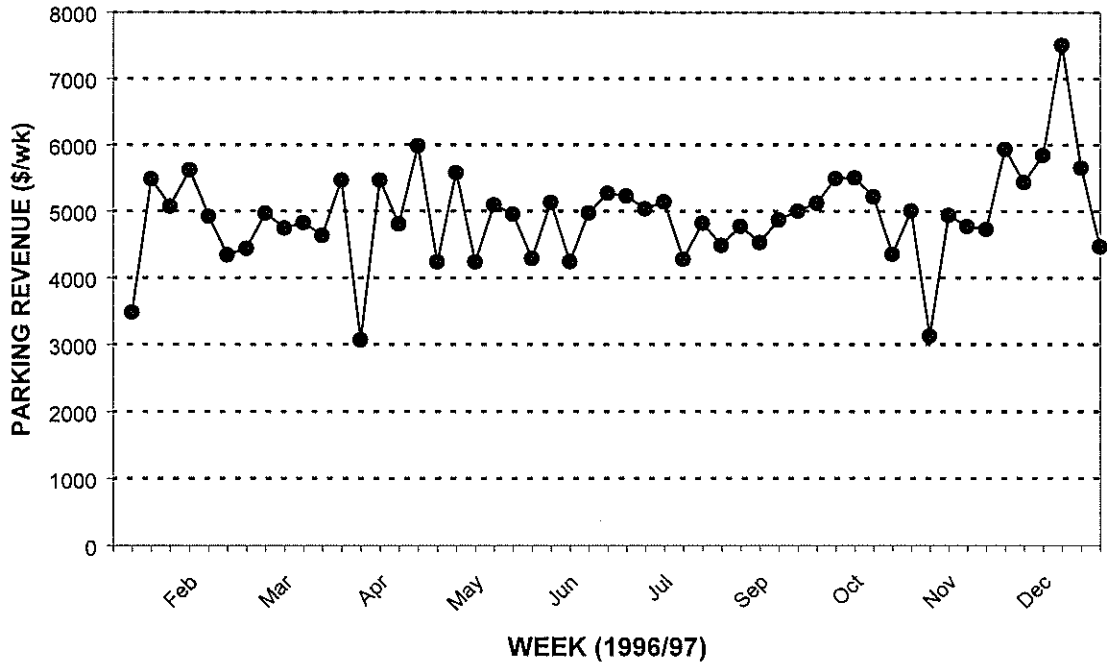
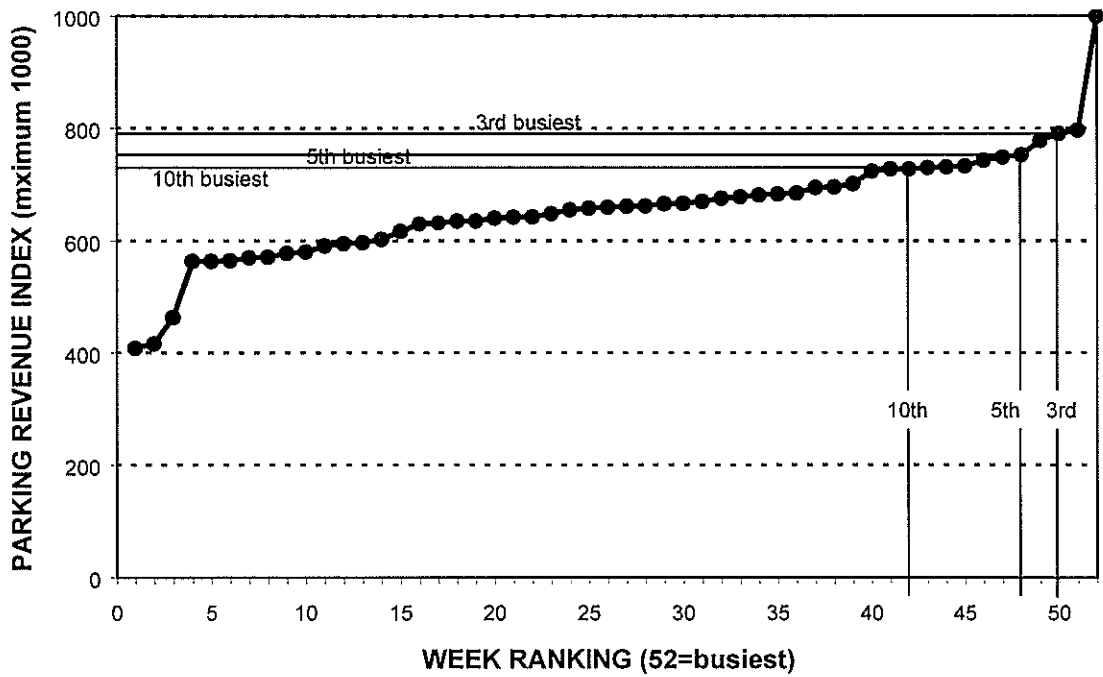


Figure 2.3 Weekly parking revenue for provincial centre (H)



Ranked Parking Revenue





As the design factors have been based primarily on surveyed retail patterns, it is inappropriate to apply these factors to non-retail non-visitor activities. In the absence of any other information on seasonal or hourly trends, the design factors presented here could be used, with due caution and judgement, as guidance for planners and designers of other visitor-attracting activities.

### 2.3 Selection of Seasonal Design Level

A range of data sources has been assessed in the course of this research, including information on vehicle travel, car-parking and pedestrian flows for both town centre areas and separate retail centres. In order to investigate a recommended design level, the data have been collated and ranked in terms of both weekly and (when available) daily activity levels. Owing to the limited information available covering the full course of a year, the following different activity indicators have been adopted: parking revenue, daily and weekly pedestrian arrivals at major shopping centres, and daily urban and rural traffic counts. In a few cases the absolute numbers and specific identities of individual surveyed data sources have been protected in accordance with the wishes of the owners of the data.

Figure 2.1 shows the weekly pedestrian admission pattern over the course of a full year for a major shopping centre with over 20,000 m<sup>2</sup> GFA located in an inner suburban area. The ranked data show that there is a sharp rise in the weekly activity about the fourth or fifth or sixth busiest week of the year. The pattern shows a significant difference in total pedestrian activity from this point in the graph and, by inference, total parking demand patterns through these busiest five weeks of the year, compared with the remaining weeks. In keeping with established traffic practice, it is appropriate to select a design level around the “knee” in this graph. It is found that the fifth busiest week includes the 30th highest hour of the retail trading year. Detailed review of the data available from on-road counts, shopping centre pedestrian counts and council-operated parking facilities shows that the vast majority of these 30 highest hours of activity fall within the five busiest weeks.

Figures 2.2 and 2.3 are graphs of the weekly parking revenue data obtained from two sets of local authority public parking areas where parking revenue records were available over a full year. It is recognised that parking revenue can be considered to be only a proxy for parking demand. For the purposes of this exercise such a measure is a useful daily and weekly indicator for a typical provincial town centre. As with the major retail centre pedestrian pattern presented above, there is an obvious “knee” in both graphs which indicates a significant and important intensification of parking activity at this position on the graph. In comparison with the shopping centre data, the “knee” starts in the ranking order at or about the 47th busiest week of the year, and this is again one of the five busiest weeks of the year.

## **2.4 The 20th, 30th and 50th Highest Design Hour**

The data show that there are significant changes in the parking activity levels associated with all forms of general retail centre. This starts to point to a recommended parking design level to cater for all but the very busy activity periods. The detailed analyses and ranking calculations undertaken as part of this research indicate a “reasonable” design parking demand for general retail and associated customer generating activity is the:

- 5th busiest week, which includes the
- 15th busiest day, which in turn includes the
- 30th highest hour, and provides
- 90% parking satisfaction.

This gives a coincidence of activity levels measured on all three time bases. The 30th highest hour typically occurs in the last week of November or the first week of December in most shopping centres. These design levels of activity have been observed at other times of the year, such as school or public holidays, particularly at Easter and also in the October school holidays.

There is a judgement to be made as to the most appropriate design hour. The 30th highest hour in the year will be about the 90% parking demand satisfaction level.

The 50th highest hour is also a useful guide and coincides with the

- 10th busiest week,
- 30th busiest day,
- 50th highest hour, and provides
- 85% satisfaction.

The investigations of activity levels at larger retail centres have revealed that it is prudent, at locations with particular operational factors (such as limited on-street public parking or low turnover of off-street parking lots), for developers and traffic planners to provide greater levels of available parking. In such situations, on-site parking to satisfy perhaps the demands of the

- 3rd busiest week,
- 10th highest day,
- 20<sup>th</sup> highest hour, and provide
- 95% satisfaction,

may be selected as meeting a greater proportion of the peak period demand. This 20th highest hour could be provided by a shift from, say, 6 car-park spaces/100 m<sup>2</sup> GFA to 7 spaces/100 m<sup>2</sup> and from considering traffic generation rates of 20 vph/100 m<sup>2</sup> GFA to 25 trips per peak hour for the site.

In this way, the particular facility would provide more adequately for the very busiest hours or days of the retail trading year. However, it is then accepted that for a greater proportion of the trading year sections of the parking facility will be under-utilised. This situation must be balanced against the potentially adverse effects at peak events, where overspill may cause severe disruption to both network efficiency and

residents. From a retailer’s perspective, however, such peak and near-peak events provide important revenue streams, and the extra convenience of additional parking at these times will clearly be included in the commercial planning and management decisions made about site development, market share and traffic/parking facilities provided.

The range of data available to practitioners on annual trading or activity patterns is often limited, and selecting the 30th highest hour or any other chosen design level is correspondingly difficult. While arranging for data to be collected, for example, on a busy Thursday evening during the last week in November would provide close to the recommended 30th highest hour level, such situations and timing may be neither available nor convenient. As a means of converting any selected survey period (hour, day or week), the following sections present recommendations and guidance on the conversion from raw survey information to design level activity.

By applying seasonal, daily and hourly design factors to raw survey results, a better estimate of the design level (e.g. 30th highest hour, 15th busiest day or 5th busiest week) can be obtained.

The formula to calculate the selected design hour from survey data is:

$$\begin{array}{ccccccc} \text{Design} & = & \text{Survey} & \times & \text{Hour of day} & \times & \text{Day of week} & \times & \text{Year (seasonal)} \\ \text{hour} & & \text{figure} & & \text{factor} & & \text{factor} & & \text{factor} \\ \text{(D30)} & & \text{(S)} & & \text{(H)} & & \text{(W)} & & \text{(Y)} \end{array}$$

## 2.5 Hour of Day Factors (H)

To establish appropriate guidelines for the design of traffic and parking facilities associated with retail activities, it was decided to review the average weekday patterns of on-road traffic volumes generated by retail centre activity by making foot counts at a shopping centre and hourly parking building occupancy counts for two major urban centres. Data from several of Transit New Zealand’s continuous count stations in larger metropolitan areas were also analysed throughout typical weekdays averaged over a full year. In this way, on-road traffic, pedestrian activity and parking occupancy patterns could be compared.

Figure 2.4 illustrates the general pattern of hourly activity recorded over a typical seven-day week.

From the two data sources, each reflecting slightly different aspects of the total land-use traffic activity environment, a combined factor has been derived for scaling to the design hour. Surveyed hourly activity should then be scaled by an hour-of-day factor in order to obtain the design hourly value for the day of the survey.

Figure 2.5 shows the recommended scale factor pattern for a typical weekday. The scale factors associated with pedestrian activity are closest to unity (i.e. when the pedestrian volume is closest to maximum) at the midday–early afternoon period. On-

Figure 2.4 Hourly patterns by day of week (retail)

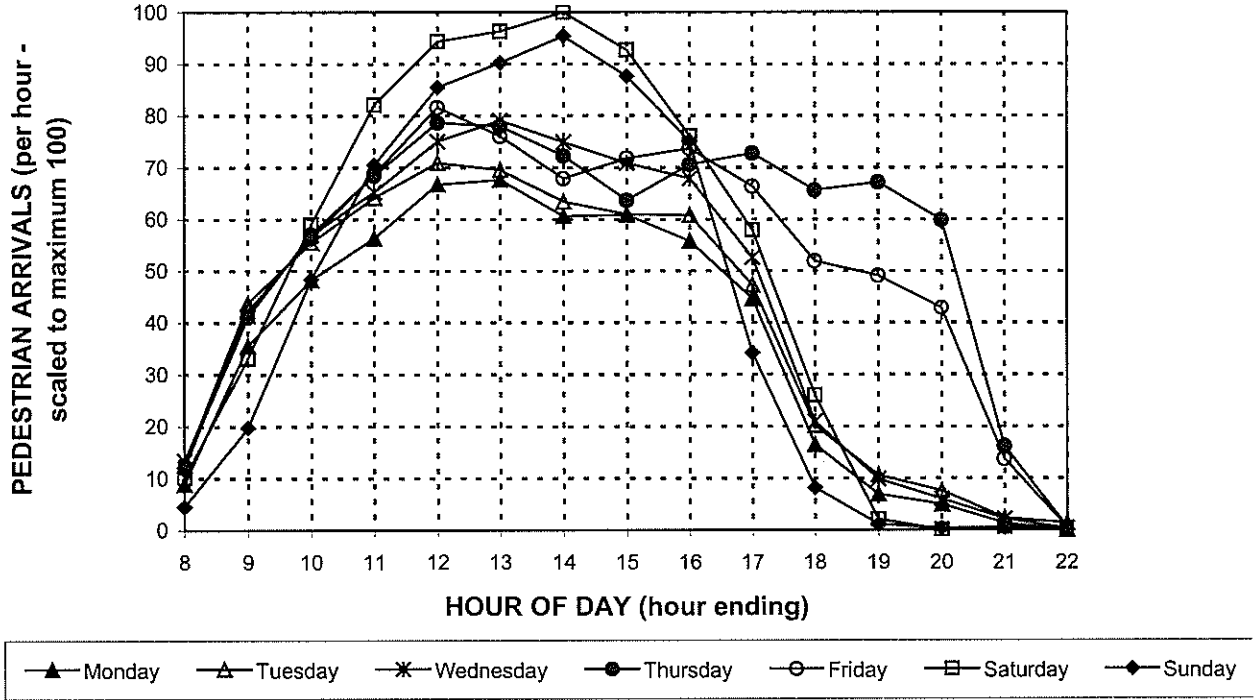
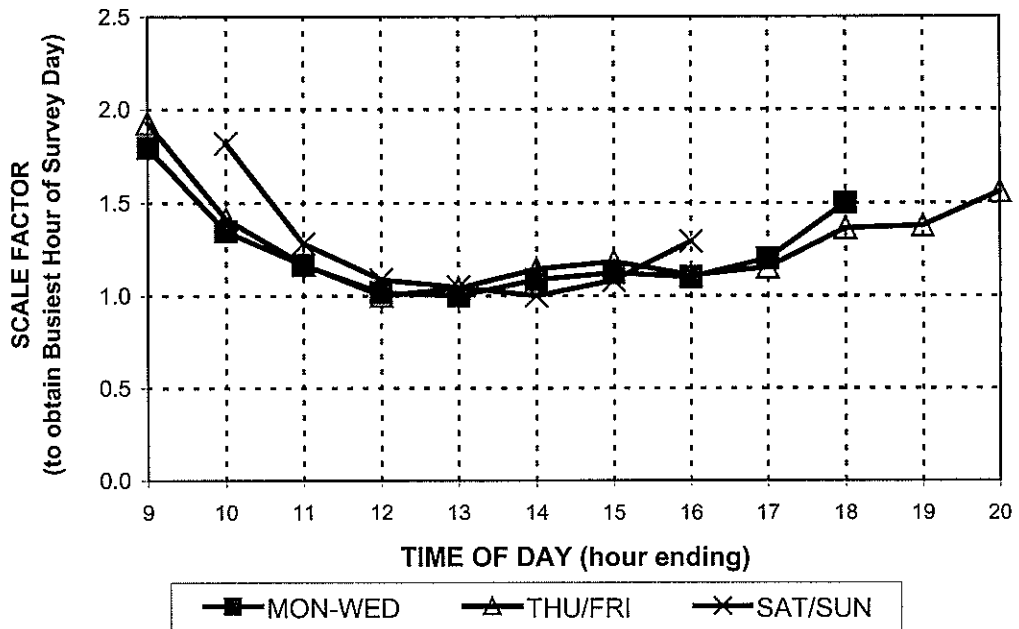


Figure 2.5 Design hour factors (retail)



road traffic flows, meanwhile, demonstrate peaks or scale factors closest to unity during the morning and late afternoon commuter peak hours.

From an appreciation of general retail activity, the “recommended” scale factors have been selected to reflect the various time-dependent influences of both on-road traffic flows and site-generated pedestrian activity. The scale factors maintain the design point (i.e. 1.0) for the hour ending 12 noon with a factor of between 1.1 and 1.5 through the latter part of each weekday.

The recommended weekday design factors for retail parking surveys undertaken during ordinary business hours are provided in Table 2.1.

**Table 2.1 Hourly design factors (H)**

HOUR OF SURVEY (hour ending)	SCALE FACTOR		
	Weekday (non-late night)	Weekday late lights	Weekend
9:00 am	1.83		
10:00 am	1.36		1.82
11:00 am	1.16		1.28
12:00 noon	1.00		1.09
1:00 pm	1.01		1.05
2:00 pm	1.10		1.00
3:00 pm	1.14		1.08
4:00 pm	1.10		1.29
5:00 pm	1.20	1.15	
6:00 pm	1.50	1.36	
7:00 pm		1.38	
8:00 pm		1.56	

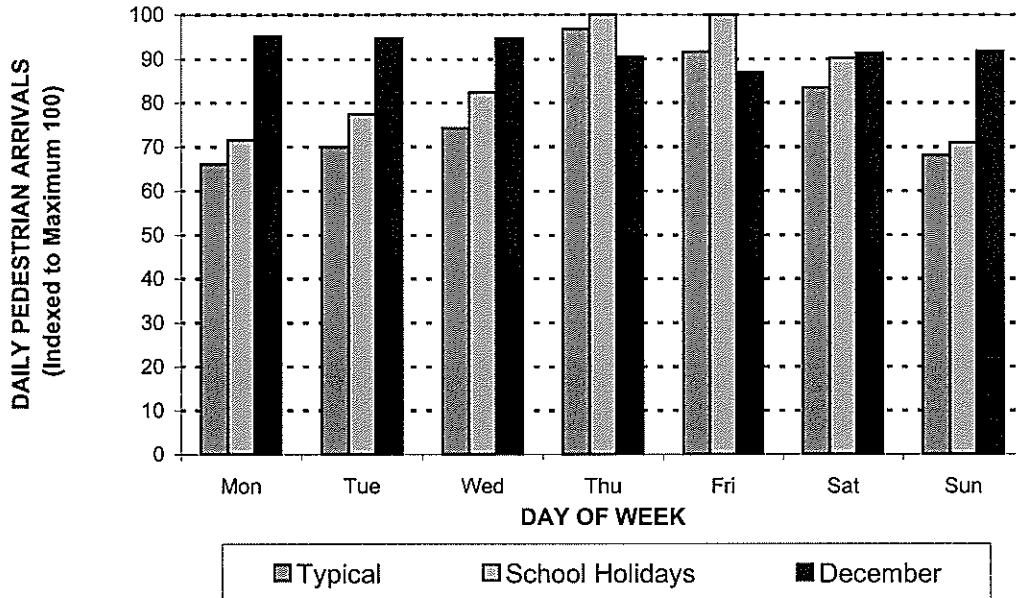
denotes design hour

## 2.6 Day of Week Factors (W)

Over the past decade, retail activity patterns in particular, and other land uses in general, have changed significantly. The results have been a general spreading of visitor parking activity through all seven days of the week and a move away from the traditional activity patterns of employment and shopping during weekdays and recreation and entertainment during the weekend. Retail activity especially is now more dispersed across the entire week, having moved away from “late night shopping” events and spreading into both Saturdays and Sundays. Increased car ownership, with consequent total mobility, has resulted in a lengthening of peak duration and greater numbers of peaks throughout the week. This in turn has spread the peak period rather than lifting the highest demand at a particular time.

Figure 2.6 illustrates the pattern of total daily pedestrian activity recorded at a major suburban shopping centre (>20,000 m<sup>2</sup> GFA) over a seven-day trading week. The combined effects of both school holidays and the traditionally busy period leading

Figure 2.6 Daily pedestrian arrivals at a major shopping centre



up to Christmas are also shown. The bars on the left with the wavy shading represent the average weekly pattern likely during typical non-school holiday, non-December periods. A Thursday during such weeks demonstrates the continuing influence of a late-night peak in activity. However, both Friday and Saturday represent pedestrian activity at around 80% to 90% of the Thursday peak, and so both play significant roles in the peak events of retail centres during non-holiday periods.

During school holidays, there is a slight lessening of the peak Thursday activity and an increase in the Friday activity such that both Thursday and Friday generate about the same total daily activity. Overall, school holidays are between 5% and 10% busier in terms of the total weekly pedestrian activity (and also the vehicle counts) than the equivalent non-holiday times.


More dramatic changes in daily activity patterns are demonstrated by the bars on the right-hand side of the daily groups, representing the fortnight in December immediately prior to Christmas. The relative activity during this period is characterised by a more even level through each of the seven days of the week. At this time operators often extend their opening hours and may have special 12- or even 24-hour promotions generating increased activity throughout the day.

Such patterns of activity show that particular attention needs to be paid to the selection of peak retail activity and parking demand times, especially when considering major retail facilities. When determining design demands during school holiday and December periods, the influence of traditional late-night activity remains important but equally critical are the Saturday and sale-day demand levels. Careful review of site and location characteristics is essential to obtain realistic and appropriate design criteria.

For design factor analysis, the combined effects of the typical, school holiday and December patterns presented above have been condensed into a single set of scale factors. The following factors, derived from the ratios between the busiest hour of each day and the busiest hour of the week, allow a survey result to be scaled accordingly to obtain the design day level equivalent for that activity.

**Table 2.2 Day of week design factors (W) (shopping centres)**

DAY OF SURVEY	SCALE FACTOR	
	Typical	Holiday
Monday	1.46	1.40
Tuesday	1.38	1.29
Wednesday	1.30	1.21
Thursday	1.00	1.00
Friday	1.06	1.00
Saturday	1.16	1.11
Sunday	1.42	1.41

 denotes design hour

Local variations in trading patterns are to be expected. If data more appropriate to a particular location or activity are available, then this should be used at the discretion and judgement of the practitioner. The above factors are recommended for guidance in the absence of more specific information.

## 2.7 Seasonal or Yearly Factors (Y)

The only comprehensive and continuous traffic counts throughout the year are State Highway (SH) road traffic volumes.

Data obtained from Transit's continuous on-road SH count stations throughout the country have been collated to indicate the pattern and scale of general traffic activity levels within the major road network of urban and other centres. Continuous count stations at 16 locations were analysed for the calendar year 1998 to determine a set of scale factors for extrapolating individual survey results in terms of the seasonal or weekly design level. The surrogate measure provided by on-road traffic volume compared with on-site parking and traffic activity is considered to provide appropriate guidance in this instance. However, professional judgement is always required when applying such design factors.

The 16 continuous count sites selected for this analysis were divided into three broad groups:

1. Metropolitan locations – the major metropolitan sites close to the centre of cities, which display little holiday and special event traffic (e.g. Auckland Harbour Bridge and SH1/2 at Ngauranga Gorge, Wellington).

2. Suburban areas and provincial centres – sites on the periphery or within the urban areas of main and provincial centres where low to moderate effects of holiday traffic activity can be discerned (e.g. SH2 at Belmont, SH1 at Timaru).
3. Seasonal holiday traffic – beyond the main urban areas are sites along the main SH routes, often close to popular recreational areas, where strong seasonal and holiday traffic patterns are experienced (e.g. SH2 at Rimutaka, SH1 at Halletts Bay, Lake Taupo).

Figures 2.7, 2.8 and 2.9 show the scale factor for converting a measured count during any week into the annual average and also the design weeks for each group.

Detailed design factors for the design weeks (5th and 3rd busiest weeks) are included in Table 2.3. These weeks have been found, through research of both traffic and parking patterns, to include many of the 30th and 20th highest hours respectively.

The columns for the Group 1 and 2 sites, relating to the inner and peripheral metropolitan areas, show relatively little variation in scale factor. During January and December both groups display higher scale factors, related to the dropping away of commuter and business traffic volumes through the quieter summer months around Christmas and New Year. In Group 2, some small influence of increased holiday period activity (such as at Easter, Queen's Birthday and Labour Weekend) is evident in the reduced scale factors at these times.

For the Group 3 sites, there are definite and significant periods of holiday-related traffic where scale factors become essential in establishing any co-ordinated design traffic level. The table clearly shows the effects of:

1. January summer holidays,
2. Waitangi weekend (February),
3. Easter and school holidays (April),
4. Queen's Birthday (first weekend in June),
5. Mid-term school holidays and busy period for skiing recreation (July),
6. September school holidays,
7. Labour weekend (late October),
8. Christmas and summer holidays.

These Group 3 patterns are expected to be appropriate for many retail and recreational land-use activities associated with small-centre locations relying on recreational tourism and associated service centres alongside the inter-regional SH routes.



Figure 2.7 Weekly Factors (Group 1)

Group 1 : Metropolitan not subject to holiday extremes

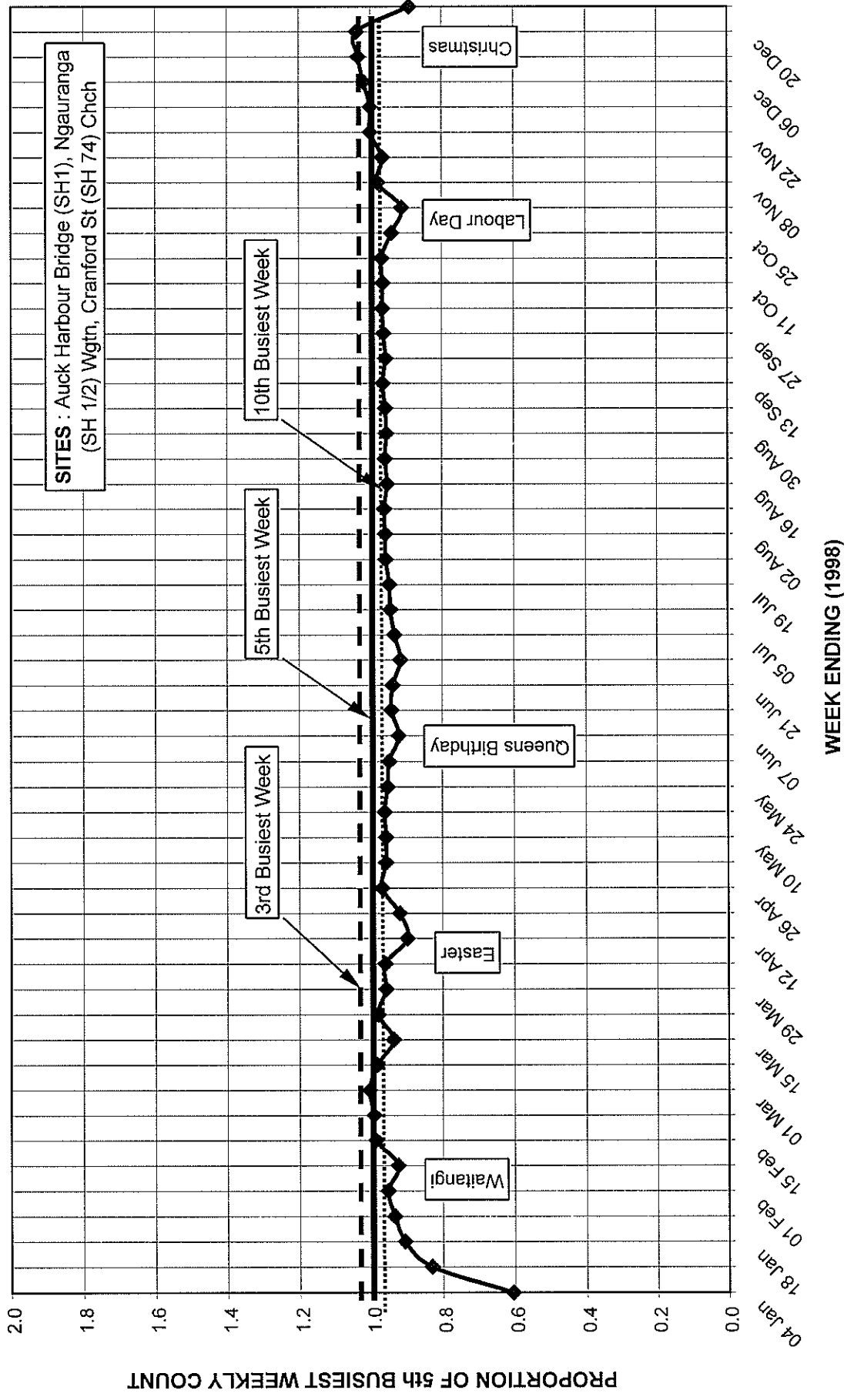


Figure 2.8 Weekly factors (Group 2)

Group 2: Peripheral metropolitan and provincial centres  
where holiday effects are recognisable

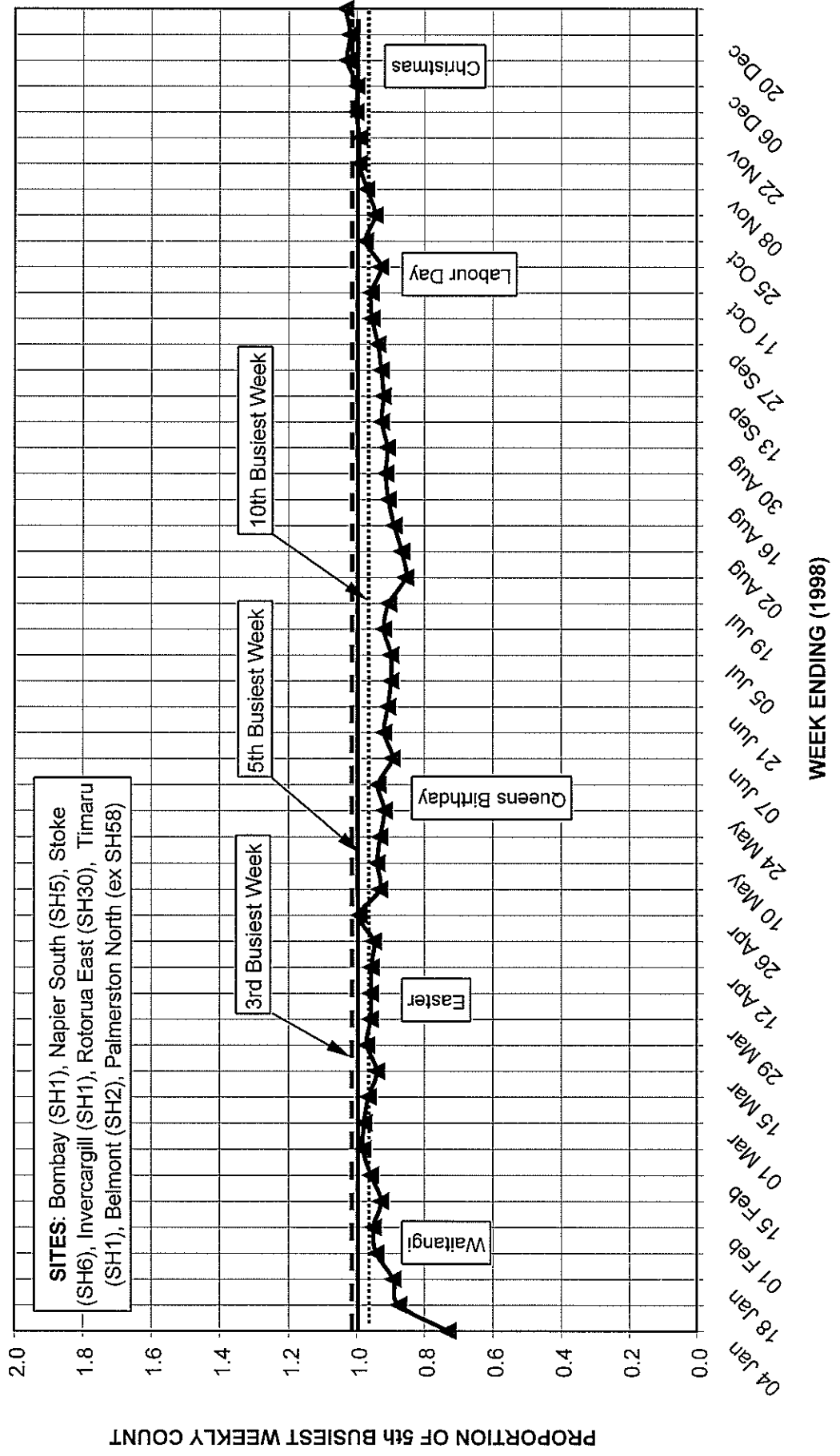
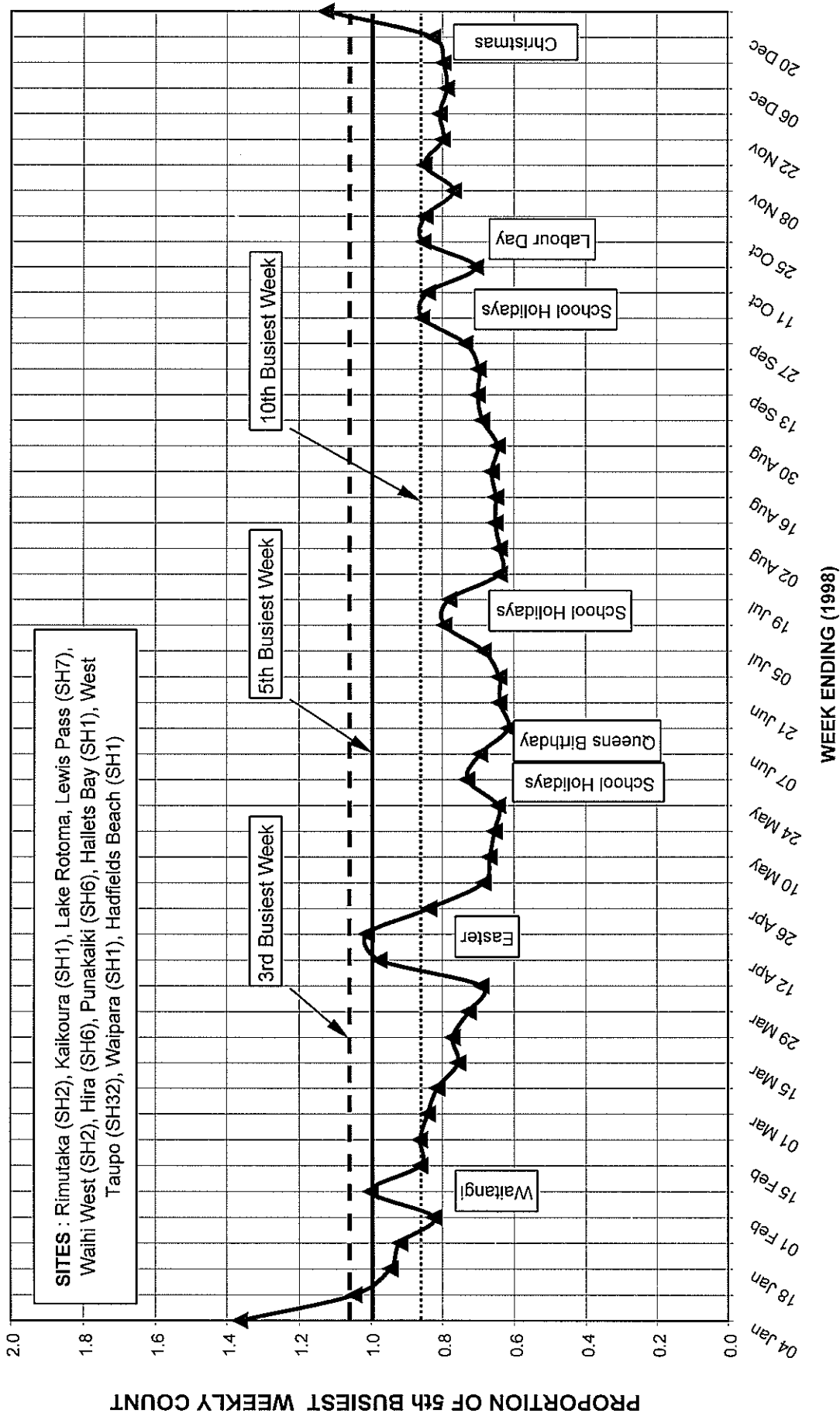


Figure 2.9 Weekly factors (Group 3)

Group 3: Small centres and locations subject to significant holiday effects



2. Seasonal Factors and Design Hours

Table 2.3 Weekly design factors for all sites

Week	for calendar year 1996	Group 1 Sites (metropolitan sites not subject to holiday extremes)			Group 2 Sites (peripheral metropolitan and provincial centres, holiday effects recognisable)			Group 3 Sites (small centres and those subject to holiday extremes)		
		Scale Factor to Obtain Annual Average Week	Scale Factor to Obtain 3rd Busiest Week	Scale Factor to Obtain 5th Busiest Week	Scale Factor to Obtain Annual Average Week	Scale Factor to Obtain 3rd Busiest Week	Scale Factor to Obtain 5th Busiest Week	Scale Factor to Obtain Annual Average Week	Scale Factor to Obtain 3rd Busiest Week	Scale Factor to Obtain 5th Busiest Week
1	04 Jan	1.57	1.68	1.65	1.29	1.40	1.37	1.71	0.77	0.73
2	11 Jan	1.15	1.23	1.20	1.08	1.17	1.14	1.31	1.00	0.96
3	18 Jan	1.05	1.12	1.10	1.06	1.15	1.12	1.18	1.11	1.06
4	25 Jan	1.02	1.09	1.07	1.00	1.08	1.06	1.15	1.14	1.09
5	01 Feb	1.00	1.07	1.05	0.99	1.07	1.05	1.03	1.27	1.21
6	08 Feb	1.03	1.10	1.08	1.02	1.10	1.08	1.25	1.05	1.00
7	15 Feb	0.96	1.03	1.01	0.98	1.07	1.04	1.08	1.21	1.16
8	22 Feb	0.96	1.03	1.01	0.96	1.04	1.02	1.08	1.21	1.16
9	01 Mar	0.95	1.01	1.00	0.96	1.04	1.02	1.05	1.24	1.19
10	08 Mar	0.97	1.04	1.02	0.98	1.06	1.04	1.02	1.29	1.23
11	15 Mar	1.01	1.09	1.07	1.00	1.09	1.06	0.95	1.38	1.32
12	22 Mar	0.97	1.04	1.02	0.97	1.05	1.03	0.97	1.36	1.30
13	29 Mar	0.99	1.06	1.04	0.98	1.06	1.04	0.91	1.44	1.38
14	05 Apr	0.99	1.06	1.04	0.98	1.06	1.04	0.87	1.51	1.45
15	12 Apr	1.06	1.13	1.11	0.98	1.07	1.04	1.22	1.07	1.02
16	19 Apr	1.04	1.11	1.09	0.99	1.07	1.05	1.27	1.03	0.99
17	26 Apr	0.98	1.05	1.03	0.95	1.03	1.01	1.05	1.25	1.20
18	03 May	0.99	1.06	1.04	1.01	1.10	1.07	0.86	1.53	1.46
19	10 May	0.99	1.06	1.04	1.00	1.09	1.07	0.84	1.57	1.50
20	17 May	0.99	1.06	1.04	1.01	1.10	1.08	0.82	1.60	1.53
21	24 May	1.00	1.07	1.05	1.03	1.11	1.09	0.81	1.62	1.55
22	31 May	1.00	1.07	1.05	1.01	1.09	1.07	0.91	1.43	1.37
23	07 Jun	1.03	1.10	1.08	1.05	1.14	1.12	0.87	1.51	1.44
24	14 Jun	1.01	1.08	1.06	1.03	1.11	1.09	0.77	1.70	1.63
25	21 Jun	1.01	1.08	1.07	1.04	1.13	1.10	0.80	1.63	1.56
26	28 Jun	1.04	1.11	1.09	1.05	1.14	1.11	0.80	1.63	1.56
27	05 Jul	1.02	1.09	1.07	1.05	1.14	1.11	0.86	1.53	1.46
28	12 Jul	1.01	1.08	1.06	1.03	1.11	1.09	0.99	1.32	1.26
29	19 Jul	1.00	1.07	1.06	1.04	1.13	1.11	0.98	1.34	1.28
30	26 Jul	0.99	1.06	1.04	1.10	1.19	1.17	0.80	1.64	1.57
31	02 Aug	0.99	1.06	1.04	1.09	1.18	1.15	0.80	1.64	1.57
32	09 Aug	0.99	1.06	1.04	1.06	1.15	1.13	0.82	1.61	1.54
33	16 Aug	1.00	1.07	1.05	1.04	1.13	1.10	0.81	1.61	1.54
34	23 Aug	0.99	1.06	1.04	1.03	1.12	1.09	0.83	1.58	1.51
35	30 Aug	1.00	1.07	1.05	1.04	1.12	1.10	0.81	1.62	1.55
36	06 Sep	0.99	1.06	1.04	1.02	1.10	1.08	0.86	1.52	1.46
37	13 Sep	0.99	1.05	1.04	1.02	1.11	1.09	0.88	1.49	1.43
38	20 Sep	0.99	1.06	1.04	1.02	1.10	1.08	0.87	1.50	1.43
39	27 Sep	0.99	1.06	1.04	1.01	1.09	1.07	0.92	1.42	1.36
40	04 Oct	0.98	1.05	1.03	0.99	1.07	1.05	1.07	1.22	1.17
41	11 Oct	0.99	1.06	1.04	0.98	1.07	1.04	1.05	1.25	1.19
42	18 Oct	0.98	1.05	1.03	1.01	1.10	1.08	0.88	1.48	1.42
43	25 Oct	1.01	1.08	1.06	0.97	1.05	1.03	1.07	1.23	1.17
44	01 Nov	1.04	1.12	1.10	1.00	1.08	1.06	1.06	1.23	1.18
45	08 Nov	0.97	1.04	1.02	0.97	1.05	1.03	0.96	1.36	1.30
46	15 Nov	0.99	1.05	1.04	0.95	1.03	1.01	1.06	1.23	1.18
47	22 Nov	0.95	1.02	1.00	0.95	1.03	1.01	1.00	1.31	1.25
48	29 Nov	0.95	1.02	1.00	0.94	1.02	1.00	1.01	1.30	1.24
49	06 Dec	0.94	1.00	0.98	0.94	1.02	1.00	0.99	1.33	1.27
50	13 Dec	0.92	0.99	0.97	0.92	0.99	0.97	1.00	1.31	1.26
51	20 Dec	0.92	0.98	0.96	0.92	1.00	0.98	1.04	1.27	1.21
52	27 Dec	1.07	1.14	1.12	0.91	0.99	0.97	1.41	0.93	0.89

denotes equivalent design week(s) in series

**Table 2.4 Example of application of scale factors**

<b>LOCATION OF SURVEY</b>	Shopping Centre (size 3240 m <sup>2</sup> GFA) High Street SMALLSVILLE	
<b>SIZE AND POSITION</b>	3240 m <sup>2</sup> GFA, frontage to urban arterial - 8000 vpd	
<b>DATE/TIME OF SURVEY</b>	Tuesday 9 May 200 2:00 - 6:00pm	
<b>SURVEYED TRAFFIC AND PARKING RATES</b>		
	peak trip generation :	131 vph (in) (4:30-5:30pm) <u>119 vph (out)</u> 250 vph (in+out)
	peak parking demand:	115 vehicles on-site (5:15pm) <u>12 vehicles off-site</u> 127 vehicles total
	surveyed trip generation rate (T)	
	250vph / 3240m <sup>2</sup> *100 =	<b>T = 7.7 vph per 100m<sup>2</sup> GFA</b>
	surveyed parking demand rate (P)	
	127 veh / 3240 m <sup>2</sup> * 100 =	<b>P = 3.9 veh per 100m<sup>2</sup> GFA</b>

**DETERMINE SCALE FACTORS**

1. Identify the Hour of Day Factor (Table 2.1 for the time of peak survey or if the survey has been of sufficient length to isolate the peak period, use H = 1.0
  - peak activity 4.30 - 5.30pm, from Table 2.1, H=1.2
  - the survey established a peak activity in this hour and so a scale factor of H=1.0 to 1.2 is appropriate

**H = 1.1**

2. Identify the Day of Week Factor (Table 2.2) for the survey day
  - in this case the survey day was a Tuesday and the scale factor from the table is :

**D = 1.38**

3. Identify the Week of Year or Seasonal Factor (Table 2.3) for the survey week
  - the example survey was conducted in the second week of May so from the table, a scale factor for a minor urban centre falling in Group 2, and having already decided to cater for the 5th busiest week is :

**Y = 1.07**

4. The design trips and parking demand figures are then calculated as follows:

$$T_{30} = T \times H \times W \times Y$$

$$= 7.7 \times 1.1 \times 1.38 \times 1.07$$

**design trip generation = 12.5 vph/100 m<sup>2</sup> GFA**

$$P_{30} = P \times H \times W \times Y$$

$$= 3.9 \times 1.1 \times 1.38 \times 1.07$$

**design parking demand = 6.3 veh/100m<sup>2</sup> GFA**

## **2.8 Application of Scale Factors**

As discussed in Section 2.3, the derivation of these weekly, daily and hourly scale factors has been based on the data available throughout the course of a year for pedestrian activity at a shopping centre in a major suburban centre, car-parking turnover and from a series of SH continuous count sites. It is recommended that the 30th highest hour and the 5th busiest week are the most appropriate parking and trip generation design standards for retail and high visitor-attracting land uses. As shown already, the five busiest weeks of the year also generally include the 30 highest trading hours of the year.

Table 2.4 is a worksheet showing how all those scale factors contribute to determining a suitable 30th design hour.

## **2.9 Longer Time-Scale Patterns**

Figure 2.10 shows data collected by Tauranga District Council from its regular on-road traffic count station in Cameron Road, adjacent to the CBD, showing daily traffic volumes from January 1994 to August 1998. The data related to a weekly two-way traffic count undertaken for one week of each month over the five-year period.

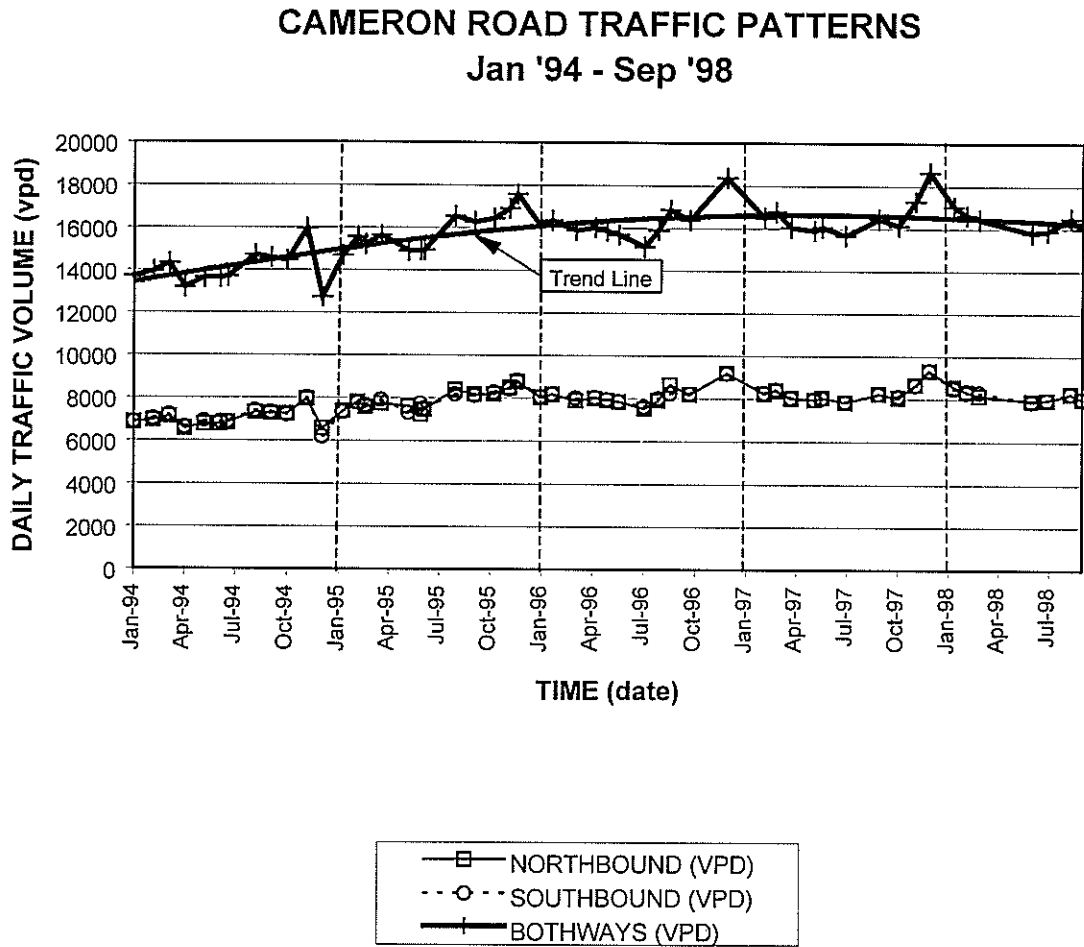
Cameron Road itself is one of the key traffic arterials serving the Tauranga CBD and so provides a useful indicator of general traffic activity associated with the central area. The graph clearly shows the pattern of monthly variation with the significant peaks in activity in the December/Christmas period of each year. It also shows that there is a significant seasonal variation in Tauranga, and a steady trend growth-line from 1994 to 1998.

The key benefit of the data comes in reviewing the underlying long-term trend line. The average two-way traffic volume in Cameron Road over these five years showed a steady increase over the first two to three years, then a tailing off from about 1996. While it is not for this research project to develop theories to explain such trends, it is likely to be for a combination of reasons, including but not limited to:

- Network capacity – the two-way daily volume of up to 18,000 vehicles along this two-lane, undivided section of Cameron Road represents a level of traffic activity at which some drivers would choose alternative routes to and from the city centre.
- Economic and development patterns – with increasing dispersal of retail and service activities around the greater Tauranga area, it is likely that the city centre is experiencing a slight but noticeable slowing in its increased rate of activity.
- Infrastructure improvements – several major roading projects in the greater Tauranga area have resulted in an incremental transfer of traffic activity away from the Cameron Road spine through Tauranga.

Practitioners must be aware of the local network operation and the wider influences on the accessibility and convenience of travel to and from particular sites and land uses. Changes in network performance can potentially alter travel times through a network for

Figure 2.10 Longer time-scale traffic patterns



either private car or public transport modes, while major roading changes can also create impediments for non-motorised modes. Such factors must be recognised when assessing accessibility, trip generation and parking demands for new or redeveloped land uses.

### **3. Residential Trips and Parking**

#### **3.1 Background**

Among recent trends affecting residential trip generation patterns, particularly in the rapidly growing urban centres, is the increasing variety of household types and make-up. Instead of the standard single dwelling-house there is now a range of residential options across a variety of income brackets, from townhouses, unit-titled apartments and long-term serviced hotel-style apartments through to functional single-unit suburban dwellings. On the rural periphery, where a significant amount of the growth in residential-related travel is occurring, a dispersed style of high-cost family home has emerged.

Another trend is for inner-city apartments to be developed on smaller CBD sites. This proximity to the variety of employment, entertainment and recreation options in these areas may result in car ownership and vehicle trip generation rates being marginally lower than for a typical suburban dwelling.

The third significant trend is the dramatic increase in vehicle ownership and general car availability in all income brackets. Between the 1986 and 1996 censuses, the average household car ownership rate rose from 1.32 to 1.40 cars/household, largely reflecting the availability of cheaper vehicles through second-hand vehicles imported from Japan. This has corresponded to a significant drop in bus, cycle and pedestrian trips.

This project has not attempted to isolate the particular factors involved in determining the household trip generation rate for a particular location. In general terms, the primary factors explaining the variation in household trip generation include:

- topography (hill suburbs generate fewer trips and tend to a lower average trip generation rate),
- demographic make-up (younger families tend to make more trips than a retired or ageing population),
- socio-economic factors (car ownership and availability have a large influence on the number of trips made per day),
- proximity to employment centres (satellite commuter towns close to major metropolitan areas typically have lower average residential trip generation rates than suburbs of a metropolitan area),
- increased opportunity to work from home (advances of Internet and other telecommunications technology),
- availability of alternative travel modes and public transport (households with fewer than average vehicles may be located for convenient bus routes or cycle access to schools, etc.).

#### **3.2 Trip Making**

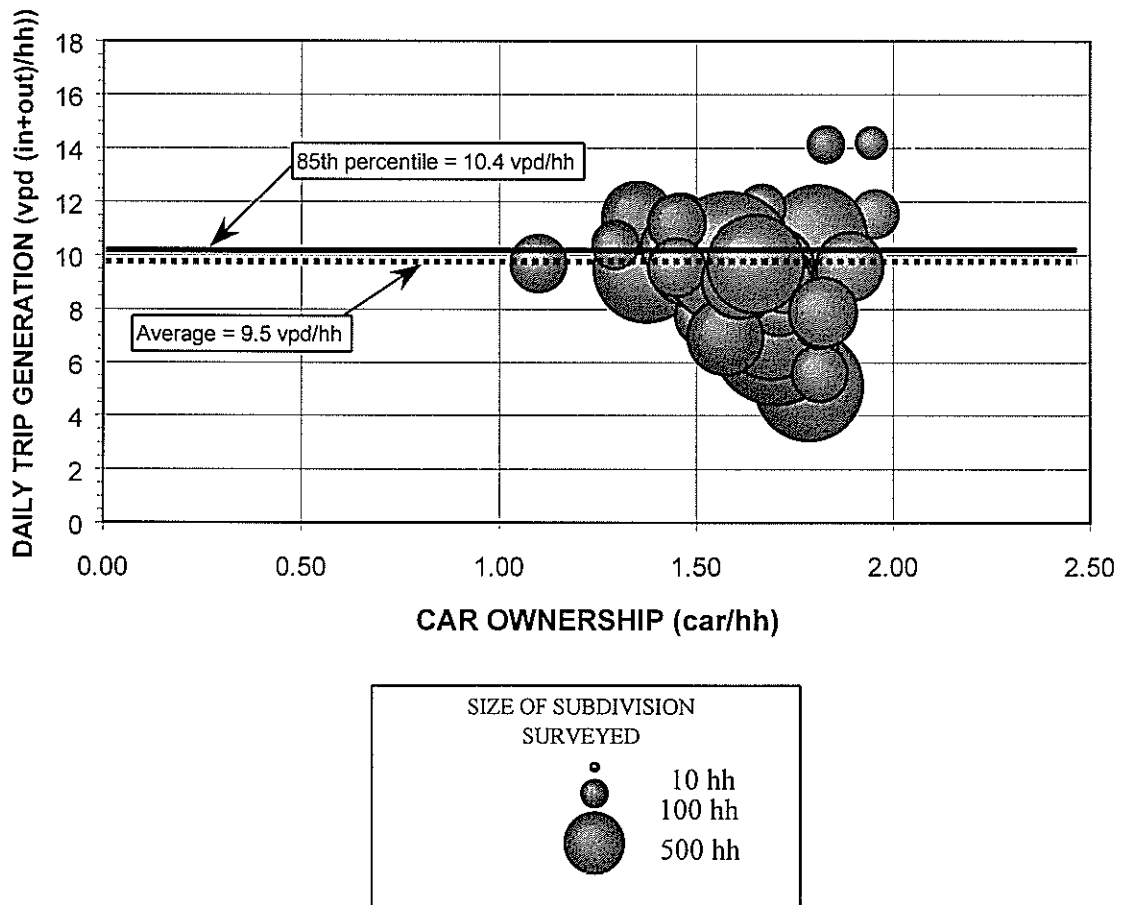
Survey information obtained through this research (and accumulated in the Surveys Database) indicates that typical outer suburban single-unit households generate on



average 9.5 vehicle movements (in + out) per day per household. This average daily rate per household is about four vehicle trips more than in the 1970s.

For each of the suburban residential subdivisions surveyed in the project, the 1996 census data on car ownership rates were also collected. In this way, for each subdivision trip generation rate obtained a corresponding average household car ownership level could also be found. The resulting relationship between these variables is presented in Figure 3.1, which shows the daily trip generation rates, the local household car ownership level and the size of subdivision sampled. The size of the “bubbles” is in direct proportion to the number of households within each subdivision surveyed. As the raw data in the Surveys Database shows (see Volume 2), the smallest subdivision sampled contains 32 households and the largest 538 households.

Figure 3.1 Suburban residential trip generation



Surveys undertaken in Manukau City in 1991 and again in 1996 confirm the range established here. They also point to the key variable of the number of persons based at home with access to a vehicle during the day. It is clear that trip rates per household are not correlated with income or normal socio-economic factors. High rates emerge from households at both ends of the income and valuation scale.

As this research was unable to determine the variation in trip making by sub-groups of houses, household size or car ownership within each of the subdivisions surveyed, the pattern of variation between subdivisions is considered. As Figure 3.1 shows, the 85th percentile figure of 10.4 vpd (in + out) per household is recommended as an appropriate figure for design and assessment purposes when considering the full range of households within a city.

It is noteworthy that car ownership does not appear to be the sole dictator of household trip making: that of a household with 1.8 cars varies widely, from about 4 trips to 13 trips/household/day.

This research largely supports the “rule of thumb” value of 10 vpd (in + out) per household adopted by many practitioners for urban households throughout the country.

As the Surveys Database shows, lower trip generation rates have typically been found in more rural subdivisions. Surveys near Queenstown and Christchurch indicate that daily rates of between 6 and 9 vpd (in + out) per household better reflect the increased trip linking which occurs when the primary employment trip is longer, e.g. greater than 20 minutes, as with rural lifestyle properties located on the outskirts of an urban area.

### **3.3 Car Ownership Patterns and Parking Demand**

In the residential areas in 1970, 20% of all households had no car compared with 12% in the 1990s. In 1970 26% had 2+ cars and this figure increased to 44% in the 1990s. In 1970 there was an average of 1.10 cars/household while this figure had increased in the 1990s to 1.4 cars.

There are some variations in car availability between cities. Figure 3.2 shows the average and distribution of car ownership for the 19 largest urban areas. The variation in the average between cities was 1.27 to 1.60 cars per household. As noted above, however, vehicle trips are not closely related to household vehicle ownership.

The vehicle ownership range varies less between cities than the contrasts from suburb to suburb within a city.

Figure 3.3 shows a range of selected Wellington City area units and the 1996 census data relating to car ownership rates. Wellington has one of the highest proportions of zero household car ownership in New Zealand at 16% across the whole city. This has a strong relationship to the quality and frequency of public transport, residential and employment distributions, geographical/topographical limits on available off-street parking within the city, and a history of lower car ownership rates.

Figure 3.2 Household car ownership in 19 New Zealand centres (1996)

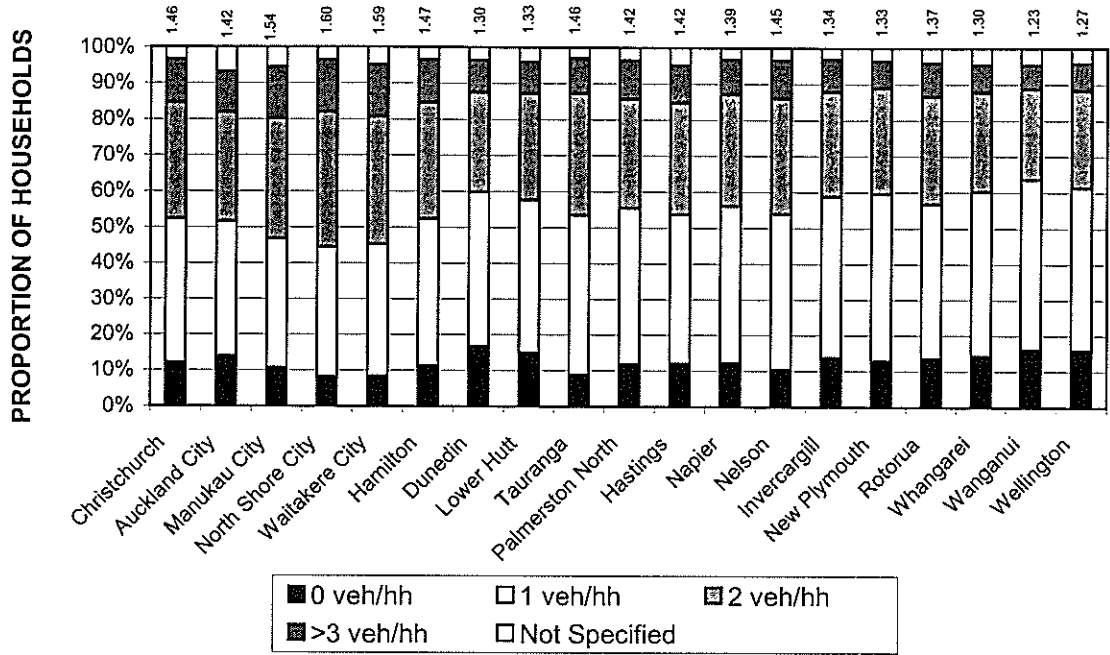
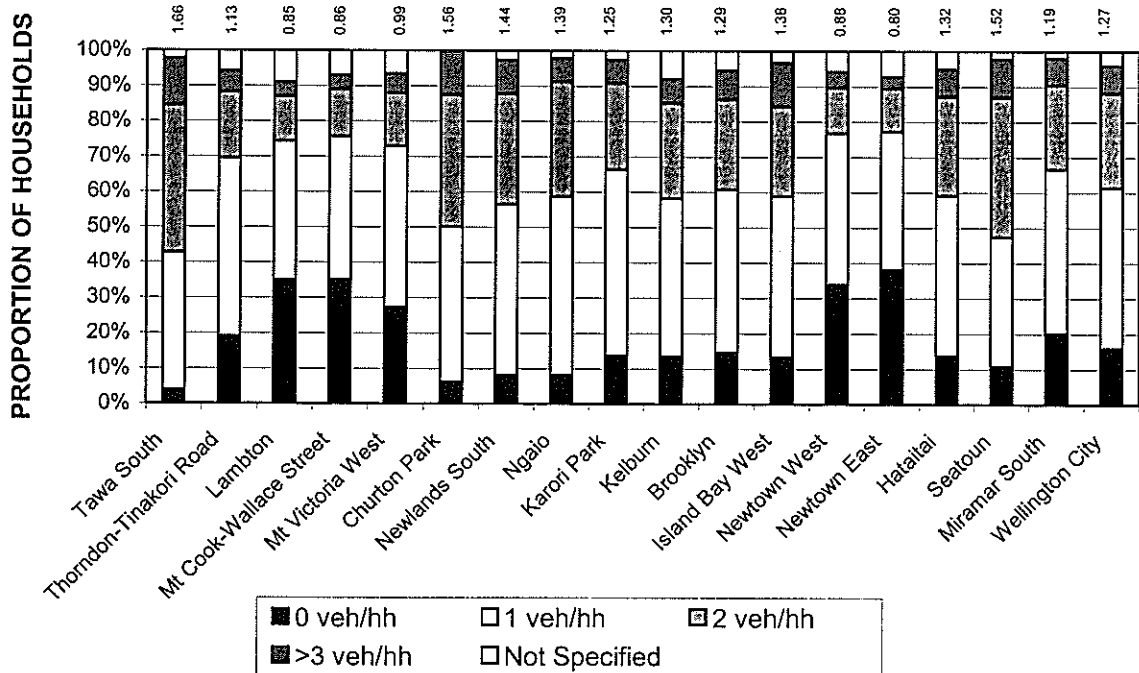


Figure 3.3 Household car ownership in 18 Wellington suburbs



Those census area units closest to the Wellington CBD experience a higher proportion of zero car ownership. Up to 35% of households within the Lambton, Mt Cook–Wallace and Newtown area units have no car available to the household. In stark contrast, those areas further out from the centres of employment and less well serviced by public transport display greater car ownership levels, with typically only 10% of households having no access to a vehicle.

Wellington is a particular example, with large variations in household car ownership across the city. Without attempting to quantify the various factors involved in this, it is recommended that a typical household parking (i.e. for residents and not including visitors) demand of around 1.5 to 1.8 cars/household should be adopted if no other information is available. This means, of course, an off-road parking standard of 2 car-spaces/household.

### 3.4 Inner-city Apartments

#### 3.4.1 Trip Generation

A limited data collection was recently undertaken by traffic planning staff at the Christchurch City Council. The purpose of the week-long survey in May 2000 was to quantify the level of daily household vehicle trip generation from 27 multi-unit residential apartments all in buildings of over 20 units within the Christchurch central area (i.e. the area bounded by Christchurch’s “Four Avenues”).

While the extent of survey reporting was less than anticipated, the response from postal interview survey forms returned gives a useful indication of trip generation rates.

Table 3.1 is reproduced with permission from the council’s report on their findings.

**Table 3.1 Christchurch inner-city apartment vehicle trip generation**

	Units surveyed	DAILY TRIP GENERATION Vehicles/day (in + out)		
		Average	Maximum	85th %ile
One bedroom units	15	3.1	13	6.0
Two or more bedroom units	12	4.8	17	8.0
All units	27	3.9	17	6.8

Note: One respondent did not complete “size of unit” information.

To provide design and assessment guidance here, it is concluded that multi-unit, multi-storey residential dwellings within inner-city areas typically generate between 6.0 and 8.0 traffic movements per household per day. These lower levels of daily trip making may result from, for example:

1. the relative proximity to CBD employment,
2. limited on-site parking availability, dictated by the design of units and owners’ preferences for such accommodation,
3. the composition and small size of the households, which tend to be family units with few children (so there is less “taxi-ing” of children to other venues, etc.).

There is an identified need for further information on inner-city apartment dwellings to be collected by both councils and consultants working in this area, so as to define further the differences between standard detached dwelling-houses and multi-unit apartment developments in both the city centre and the suburbs.

### 3.4.2 Parking Demand

The Christchurch City Council survey also collected information on the relationship between the number of bedrooms in the apartment unit and the number of cars available to each unit. While the low response rate from the survey forms distributed limits the particular value of the information, it is considered useful to show the general relationships developed.

Table 3.2 summarises the car availability for 27 individual units, and hence the on-site parking demand, for these inner-city apartments.

**Table 3.2 Christchurch inner-city apartment parking demand**

NUMBER OF BEDROOMS	UNITS	CARS AVAILABLE TO UNIT		
		0 cars	1 car	2 cars
1	15	1	12	2
2	9	-	7	2
3	3	-	1	2
<b>TOTAL UNITS</b>	<b>27</b>	<b>1</b>	<b>20</b>	<b>6</b>

The average car ownership and hence parking demand for these inner-city apartments was found to be approximately 1.2 vehicles per unit. No statistically significant relationships were developed in this survey between the car ownership levels and the number of bedrooms in each unit.

There is a greater range of family types and car ownership levels in central-city apartments compared with outer suburban residential single-unit dwellings. The combination of various socio-economic characteristics, student flats, retired and elderly occupants, varying partnership arrangements, with and without children, all lead to widely varying vehicle use and associated parking demand and traffic generation. However, the range for trips or parking does not differ greatly from that for other residential suburbs.

There is an urgent need for more surveys of the central-city residential and apartment uses.

## **4. Retail Trips and Parking**

### **4.1 Background**

In the course of this research it became increasingly obvious that there is a range of styles and sizes of retailing locations, each with particular and different traffic and parking activity levels. Of the 460 or so records collected, around 40% related to a variety of retail sites. Shopping centres and groups of local shops made up most of the retail survey database. Information on 90 shopping centres, ranging in size from under 3000 m<sup>2</sup> GFA up to 38,000 m<sup>2</sup> GFA, has been included. While each survey and site did not always yield the full complement of parking and traffic generation survey data, none the less the number of survey sites available allowed a representative sample of these performance indicators to be obtained from a variety of locations and floor area sizes. (Note: GFA here includes all the area, including all usable space and passageways, within the outer walls of the buildings.)

While shopping centres, supermarkets and local shops will be of most interest to many practitioners, survey information has also been obtained for other specific retail activities.

### **4.2 Traditional Town Centre Shopping**

The traditional or suburban shopping precincts around New Zealand were based on the provision of kerbside parking along existing roads directly in front of a small to medium-sized retail footprint. This arrangement of shopping and traffic activity may be appropriate for those centres where most shops remain at that size. When larger stores such as supermarkets are established alongside the local shopping precinct, it is necessary to develop substantial off-street car-parking areas at the rear of the strip-shopping area. This change in focus of both shopping and traffic starts to alter the overall patterns of activity within the town centre.

Shopping centre areas of different sizes offer a predictable range of shop types. The larger the centre, the wider the variety of retail, commercial and service functions available to the catchment area of the town or suburb. With a diverse mix of different land-use activities, the traffic and parking activities which derive from such land uses will also be diverse in both scale and timing. Where there is no single major retailer, such as a department store or discount supermarket, all retailers commonly share the kerbside parking resources, and sometimes modest parking lots are also provided by the local authority.

The proximity of kerbside parking areas to the retail shops leads directly to an expectation by shoppers that they will be able to park their cars for short-term parking relatively close to each of their shopping locations. In smaller centres, it is common to observe shoppers returning to their car after shopping at one retailer, then driving a short distance down the road to visit other premises. The result is a generally high turnover of the kerbside parking spaces with average durations typically between 10 and 20 minutes. The corresponding off-street retail shopper

parking in major shopping centres has a duration of stay of over 30 minutes, and up to 1 or even 1½ hours if multi-destination shopping occurs at a large mall including supermarkets and specialty shops.

Traditional town centre shopping areas experience a range of vehicle and pedestrian journeys. In smaller towns and suburban areas, the proximity of retail areas to residential catchments means that about, say, 10% to 15% of shopping trips are often made on foot or by bicycle. This limits the type of shopping undertaken, because of both the distance able to be walked and the limited carrying capacity of a pedestrian or cyclist.

Small to medium-sized towns and quieter suburban areas within large cities display the lowest visitor/shopper parking demands, about 3–4 spaces per 100 m<sup>2</sup> GFA. Some very busy small centres fronting busy arterial roads, however, have the 30th highest hour design parking rate of 6–8 spaces per 100 m<sup>2</sup> GFA. For the largest centres and supermarkets, there is an intermediate 30th highest hour of 5–6 spaces per 100m<sup>2</sup> GFA.

Medium-sized collections of shops of about 4000–6000 m<sup>2</sup> GFA display trip generation (at a design or 30th highest hour level) rates of 20 vph (in + out) per 100 m<sup>2</sup> GFA at midday or in the late afternoon. Very busy smaller shopping centres of, say, 3000 m<sup>2</sup> can have trip generation rates of 25 vph/100 m<sup>2</sup> GFA. With the larger centres, in excess of 9000 m<sup>2</sup>, there is a lesser rate of trip generation at 10–15vph/100 m<sup>2</sup> GFA.

### **4.3 Major Suburban Retail Shopping Centres**

During the early to mid-1970s the development of supermarkets at suburban shopping centres gained momentum and began to change the concept of town and suburban centres based on the road frontage, as discussed above. Suburban shopping centres brought together a range of retail and service facilities either under one roof or in the form of a “pedestrianised” shopping street. Centres such as Northlands and Riccarton Malls in Christchurch and St Lukes and Pakuranga in Auckland began to develop integrated centres of over 15,000 m<sup>2</sup> GFA or more during the 1960s.

Today the largest shopping centres (and there are now about a hundred of these throughout New Zealand) provide in excess of 30,000 m<sup>2</sup> GFA and create fully air-conditioned environments where shoppers are encouraged to visit various retail outlets as well as food courts and children’s entertainment parlours. The collection of such a wide variety of individual retailers and other services within a single site has the effect of increasing the average length of stay of customers, as well as the duration of vehicle parking in the associated parking lots.

Data provided by the contributors to this research project show that the typical suburban shopping centres providing planned, integrated retail facilities with dedicated off-street parking generate average design parking demands of 5 spaces per 100 m<sup>2</sup> GFA, and average design traffic generation rates of 15 vph (in + out) per 100 m<sup>2</sup> GFA for floor areas of 10,000 m<sup>2</sup>. However, the range about these averages

can be diverse, depending on catchments, exposure to passing traffic and promotion of the centre.

Figures 4.1 and 4.2 show the range of design (i.e. 30th highest hour) trip generation and parking demand rates. Both figures indicate the “economy of scale” effects of a decreasing rate of trip generation with increasing floor area. While the samples of shopping centres available to this project do not permit a rigorous statistical analysis, it is evident that the graphs of the 30th highest hours for both parking demand and trip generation show a reducing and converging relationship with increasing floor area.

The figures also display a large degree of “scatter”, particularly at the smaller floor areas. The degree of scatter appears to reduce with increasing floor area, but this may be due in part to the lower number of data points available for this research relating to floor areas over 10,000 m<sup>2</sup> GFA. Even at the upper end of the ordinate scale, it is clear that different centres with the same floor area do not display identical parking demand or trip generation. The variation in parking demand at around 15,000 m<sup>2</sup> GFA is from 2 to 6 spaces per 100 m<sup>2</sup> GFA. The variation in trip generation at these larger centres is from 7 to 14 trips per 100 m<sup>2</sup> GFA. Many other factors in addition to floor area obviously need to be considered when assessing such developments.

#### **4.4 Bulk Retailing Centres**

In recent years, major whiteware, home improvement and decorating retailers have established the concept of bulk retail or “super” centres. Such centres provide a range of large warehouse and retail areas for the sale of bulky goods such as furniture, whiteware and other home supplies. These centres typically have several major stores, referred to as “anchors”, and other tenancies complementing them.

These bulk retail centres have been shown by surveys, some of which are included in the Surveys Database (see Volume 2) and others to which the research team has had access, to have a design parking demand rate of around 3 spaces per 100 m<sup>2</sup> GFA to match the 30th highest hours. The lower parking demand rate (than if the same floor area was used for a standard major retail shopping centre) is caused by the larger display and warehouse area occupied by these retailers, and by the pattern of customer visits to such centres. The purchase of major items such as a refrigerator or carpet generally occurs less frequently than with groceries or other items, or convenience shopping in a standard shopping centre. However, during promotion periods a 20th highest hour parking supply of around 4.5 spaces per 100 m<sup>2</sup> GFA may be more appropriate.

The surveys reported in the Database indicate that bulk retail centres of the form seen in Auckland and Porirua display trip generation rates of around 4.0 vph (in + out) per 100 m<sup>2</sup> GFA during the weekday late afternoon peak, rising to 6.0 vph (in + out) per 100 m<sup>2</sup> GFA during the midday peak on a Saturday. It is recommended that applying such rates to the planning and assessment of bulk retail centres be



Figure 4.1 Design (30th highest hour) trip generation  
(sample of 27 shopping centres)

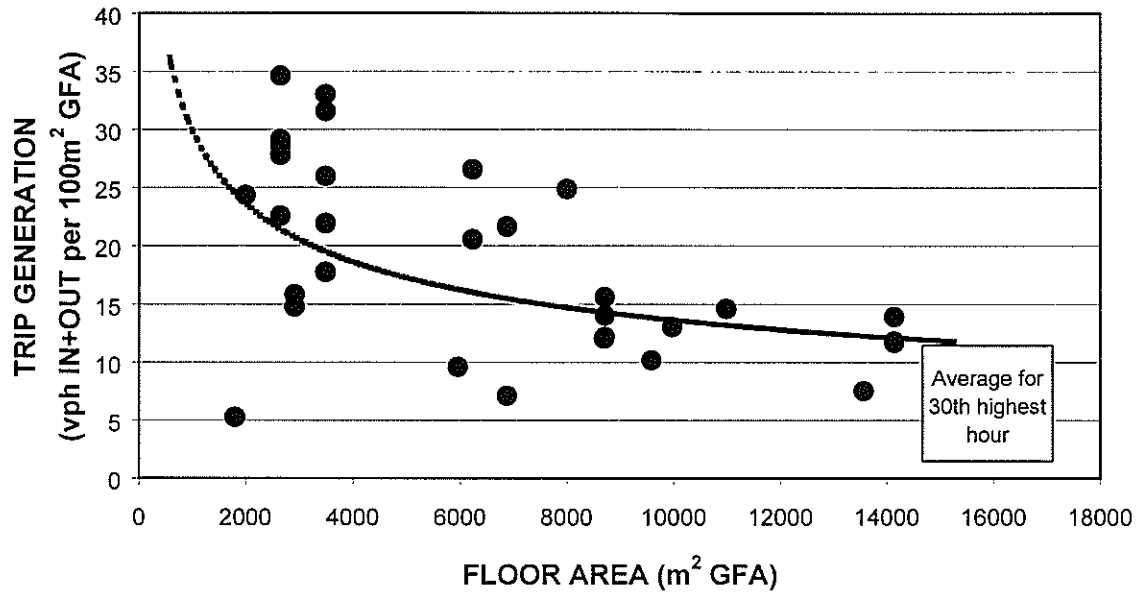
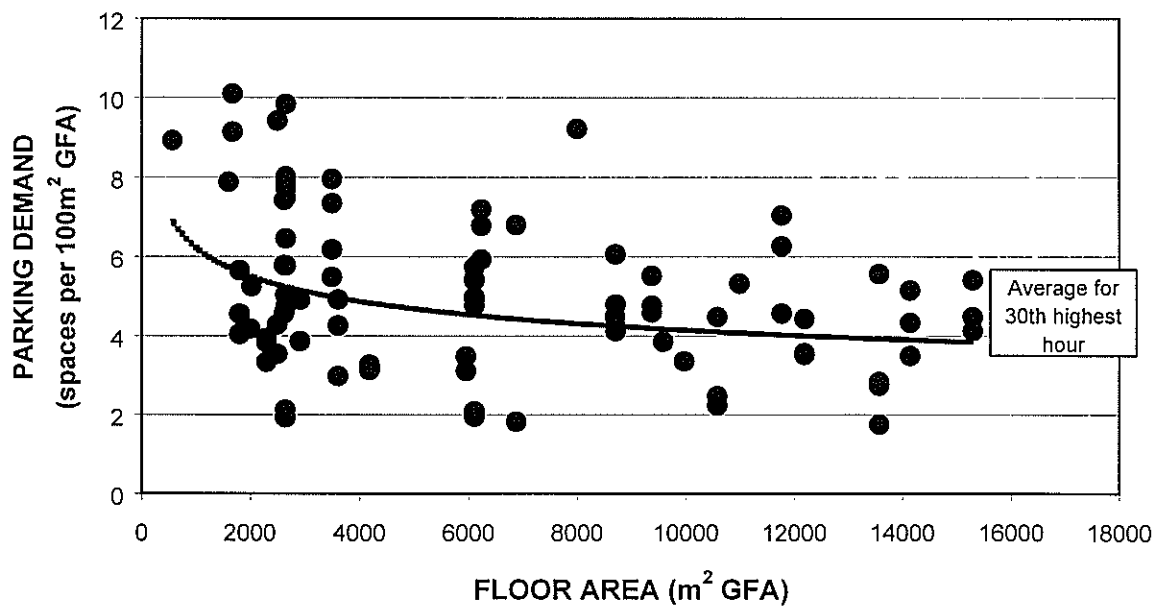


Figure 4.2 Design (30th highest hour) parking demand  
(sample of 76 shopping centres)



Note: for Figures 4.2 and 4.3, on the basis of the trip generation and parking demand figures, the shopping centres can be conveniently grouped according to the following sizes:

- small: under 4000 square metres GFA
- medium: 4000-10,000 square metres GFA
- large: over 10,000 square metres GFA

tempered with a thorough review of the form and scale of the particular activities proposed. Bulk retail centres are characterised by large-scale tenancies (typically each at least 3000 m<sup>2</sup> GFA in area) and dedicated to the sale of bulky goods such as whiteware or major home furnishings. Where possible, the practitioner should undertake a component analysis of all the retail activities within the site and then consider the overall economies able to be achieved by calculating a joint figure for the whole site.

The above rates for both parking demand and trip generation for bulk retailing should be used for guidance only, pending more detailed analysis and further surveys of this new development.

#### **4.5 Shared Parking Areas in Shopping Centres**

While developers and planning authorities may wish to ensure that each development makes due provision off-street for its own parking needs, if done in isolation this is seldom the best or most economical arrangement. As already identified, the range of parking demand at individual sites varies greatly. For new developments of either a standard shopping centre or the bulk retail centres discussed above, it is necessary first to establish a typical design standard figure for the particular site development or for the whole zone. Then due consideration can be given to adjustments for the sharing of parking space covering both low and high generation premises within the zone as a whole, and making allowance for possible changes over time.

#### **4.6 Central-city Parking Supply**

There is a marked difference between the approach by developers and councils to independent and isolated retail and commercial sites and that in the central city as a whole. Some of the larger satellite or suburban areas may be 5% to 10% of the size of the city centre in employment and car-parking, but none of them has the extent of floor area, variety of activities and scale of interaction between land uses present in the city centre. Furthermore, new suburban centres are required to meet all their needs on the site and off the street. Established city centres must work with the historical layout, property ownerships and heritage assets.

As cities become larger and the central areas more diverse, there is an increasing need to consider the area as a whole and how best to determine the policies for parking and management of the car-parking resource. Essentially, this role can be led and managed only by the council on behalf of all the central-city properties and the community as a whole. While the council may not physically or financially manage all of the car-parking spaces and will rely on private landowners to provide much of the parking resource, it is still the council that has both to propose and to oversee policies for parking space supply and management in the city centre.

The principle of correctly locating shared car-parking areas of the appropriate size for both short- and long-term parking, which we have seen is an advantage in suburban areas, applies many times over in the city centre. In addition, the city centre has the highest level of public transport use and may have considerable bicycle

access, a high ratio of car passengers and a high level of pedestrian access compared with the typical suburban shopping area.

Parking provision is the one land use that directly links traffic accessibility and development. It is here where the vehicle trip has its origin or destination and the car drivers and passengers transfer from their vehicles to become pedestrians and bus passengers, so as to gain access to the premises of their choice. The location of parking spaces for both long- and short-term car-parking is basic to the transport system, on the one hand, and the successful functioning of all the activities in the central city, on the other.

The creation of CBD public parking spaces (including street, off-street parking areas and parking buildings) has, over the past 40 years, involved major investment by local authorities in land purchase and parking buildings in all New Zealand cities. Such parking spaces act both as an adjunct to major developments and as revenue-generating facilities within the city's infrastructure. The provision of rental and free spaces, and the identification of all-day (employee) and short-term (visitor) parking, must be incorporated in the management of the parking resource.

Parking policies in district plans and council management policies generally try to match supply to realistic design demands. However, in some areas, particularly in congested parts of the city centre, placing a ceiling on parking supply may be necessary so as to suppress trip making and reduce accessibility in the interests of balanced flows on the network. Thus on the east of Christchurch city centre increased levels of long-term parking can draw higher traffic volumes in the peak commuting hours to that quarter, where the capacity of the eastern one-way pair can accept it. However, in the "River Precinct" to the west, lower parking levels are necessary to discourage overloading of the western one-way pair.

In this way, the planning authority can, by policy on land-use control, redress the imbalance in traffic flows where they would otherwise exceed the planned road capacity. In particular circumstances, limiting parking levels in an area is a legitimate policy of land-use planning control, and additional provision in a complementary area may be needed to offset the first area's shortfall. The issues of management of the parking resource and the importance of adhering to the policy of using parking "in lieu" funds for their intended purpose are not part of this report.

#### **4.7 Comparison of Parking in 11 City CBDs**

It is appropriate to make a brief comparative assessment of the parking reservoirs and their broad characteristics for 11 New Zealand cities, from Christchurch City (the largest, with 319,000 population) to Taupo District (with 34,000 population and about twice that number in summer holidays).

In preparing Table 4.1, Quotable Value New Zealand (formerly Valuation New Zealand) records were used for the floor areas and census information from the Department of Statistics for the population and employee numbers. Unfortunately, these two organisations do not use concurrent boundaries for defining city centres, so

**Table 4.1 City-centre parking supply**

City centre	Christchurch	Dunedin	Hamilton	Hutt City	Tauranga	New Plymouth	Palmerston North	Rotorua	Wanganui	Porirua	Taupo
District population	319,000	119,000	118,000	98,000	87,000	69,000	75,000	65,000	45,000	46,000	34,000
Survey date	1999	1995	1998	Mid 1992	1997	1994	1994	1991	1995	1997	1997
Area of CBD + periphery (km)	1.5 x 1.5	1.7 x 0.6	2.0 x 0.7	0.8 x 0.2	1.5 x 0.4	1.8 x 0.5	1.6 x 2.0	1.1 x 0.9	1.0 x 1.5	1.0 x 0.4	0.7 x 0.5
<b>Floor areas (000m<sup>2</sup> GFA)</b>											
Commercial retail	300	213	181	117	74	179	215	125	220	120	92
Commercial office	400	127	222	120	101	138	95	83	130	46	10
Industrial & other	900	100	124	44	93	117	60	2	30	506	23
<b>Total floor area</b>	<b>1,600<sup>(7)</sup></b>	<b>430<sup>(1)</sup></b>	<b>527<sup>(8)</sup></b>	<b>281<sup>(2)</sup></b>	<b>268<sup>(5)</sup></b>	<b>434</b>	<b>370</b>	<b>210<sup>(6)</sup></b>	<b>380<sup>(3)</sup></b>	<b>216<sup>(6)</sup></b>	<b>125</b>
<b>Residents<sup>(10)</sup></b>	<b>9,000</b>	<b>4,000</b>	<b>1,560</b>	<b>150</b>	<b>1,800</b>	<b>3,600</b>	<b>500</b>	<b>2,000</b>	<b>500</b>	<b>0</b>	<b>1600</b>
<b>Employment</b>											
Retail/wholesale	14,800	7,156	7,430	4,396	4,465	4,653	6,405	4,143	2,672	2,284	2,764
Commercial & admin.	17,900	16,018 <sup>(1)</sup>	15,800	7,999	6,732	5,730	8,301	7,325	3,670	3,129 <sup>(6)</sup>	2,295
Industrial & other	5,000	4,074	1,270	1,344	1,604	1,956	2,231	818	1,530	882 <sup>(6)</sup>	776
<b>Total employment</b>	<b>37,700</b>	<b>27,248</b>	<b>24,500</b>	<b>14,739<sup>(2)</sup></b>	<b>12,801<sup>(1)</sup></b>	<b>12,339</b>	<b>16,937</b>	<b>12,286<sup>(4)</sup></b>	<b>7,872<sup>(3)</sup></b>	<b>6,295<sup>(6)</sup></b>	<b>5,835</b>
<b>Car drivers trip to work %</b>	<b>61.2%</b>	<b>58.0%</b>	<b>59.5%</b>	<b>56.8%</b>	<b>63.2%</b>	<b>59.9%</b>	<b>57.6%</b>	<b>62.3%</b>	<b>59.2%</b>	<b>54.3%</b>	<b>60.6%</b>
<b>Parking supply</b>											
Street	10,000	4,172	2,776	2,730	2,153	2,070	3,385	3,276	2,815	600	1,569
Off street	23,955	8,583	14,136	1,614	3,466	7,190	8,306	2,750	4,504	3,100	1,722
<b>Total survey</b>	<b>34,000</b>	<b>12,755</b>	<b>16,912</b>	<b>4,344</b>	<b>5,618</b>	<b>9,260</b>	<b>11,691</b>	<b>6,026</b>	<b>7,315</b>	<b>3,700</b>	<b>3,291</b>
<b>Parking distribution</b>											
Short term <sup>(11)</sup>	15,000	6,506	5,027	2,438	2,881	4,800	4,618	2,436	4106	2,100	2,161
Long term <sup>(11)</sup>	19,000	6,249	11,885	1,906	2,737	4,200	7,073	3,590	3,209	1,600	1,130 <sup>(8)</sup>
<b>Total survey</b>	<b>34,000</b>	<b>12,755</b>	<b>16,912</b>	<b>4,344</b>	<b>5,618</b>	<b>9,000</b>	<b>11,691</b>	<b>6,026</b>	<b>7,315</b>	<b>3,700</b>	<b>3,291</b>
<b>Parking rates</b>											
Short-term cars/100m <sup>2</sup> GFA (Retail + commercial)	2.14	1.91	1.25	1.02	1.64	1.51	1.48	1.17	1.17	1.26	2.12
Total (ST + LT) cars/100m <sup>2</sup>	2.13	2.96	3.20	1.54	2.09	2.07	3.15	2.86	1.93	1.71	2.63
Total floor area											

1. Dunedin: includes hospital and employment area and floor area extends outside parking on north, west & south – Foreshore Industrial area is excluded.

2. Hutt: covers wider area than CBD parking area surveyed.

3. Tauranga: includes Cameron Road employment area.

4. Rotorua: area excludes hospital & Government Gardens.

5. Wanganui: excludes top of Victoria Avenue – Cooks Gardens unit only.

6. Porirua: hospital and Elsdon industry excluded.

7. Christchurch: whole of area inside the Four Avenues, including inner industry and housing.

8. Hamilton: off-street parking includes surrounding industrial areas (assumed as 24,000m<sup>2</sup>) and Hamilton Polytech area.

9. Taupo: some of long-term parking in adjacent streets omitted.

10. Residents, including residences, flats and commercial hotel/motel accommodation, estimated population based on 50m<sup>2</sup>/residential floor area/person.

11. Parking short term is up to two hours. Long term is not subject to time control but does include all-day leased spaces.

12. The Parking supply and Distribution figures are based on the surveyed spaces supplied for parking. It has not been possible to collect peak or design parking demand figures. It is noted, however, that the street parking and short-term parking areas will as a rule be occupied on all peak days of the year. The off-street and long-term spaces will be subject to greater variation.

a complete match is not possible. The car space numbers have been derived from the councils' own reports and surveys.

The table summarises the general characteristics of each city centre as determined by city population, floor area and employment. The typical average floor area per employee is between 20 and 35 m<sup>2</sup>. The parking rates have been recorded with the floor areas shown. The information is therefore indicative only, and more precise information for planning purposes would require refinement based on more detailed analysis for each centre.

The table shows that the rate of parking provision in the late 1990s (about 40 years after councils began to be involved in this area of developing parking infrastructure) has progressed to a surprisingly similar result, in terms of street and short-term parking, for all cities. Those cities that set out to encourage retail and commercial development have a higher short-term parking provision, as shown by the ratio of short-term street plus off-street parking to the retail plus commercial floor area.

The long-term parking provision is generally correlated to the total floor area and in turn to the total employment in the central city. There is, however, a wide range in the rate of supply of long-term parking, reflecting the physical and geographic character of the city and the balance between travel modes. The availability of peripheral spaces, both on street and in off-street areas, to accommodate all-day employee parking also varies greatly between cities. Such overflow may, in some locations, be at the expense of nearby city-centre residential convenience and amenity.

In summary, for the 11 city centres, the range of factors is:

1. Population	34,000 to 319,000 residents
2. Floor area	0.12 to 1.6 x 10 <sup>6</sup> m <sup>2</sup>
3. Employment	6000 to 37,000 employees (equivalent full-time)
4. Street parking	600 to 10,000 spaces
5. Off-street parking	1700 to 23,000 spaces
6. Short-term parking	1.02 to 2.14 spaces/100 m <sup>2</sup> (retail + office) GFA
7. Total parking	1.54 to 3.20 spaces/100 m <sup>2</sup> total floor area GFA.

The short-term figure is for visitors/customers only and excludes commuter parking of a further 1.0–2.0 spaces/100 m<sup>2</sup>.

There are good reasons for the high and low values, related to the history and topography of the cities involved. For the short-term parking related to retail plus office floor areas, a figure of about 2.0 spaces/100 m<sup>2</sup> GFA emerges. If related to CBD retail space alone, this parking ratio will be 2.5–3.0 spaces/100 m<sup>2</sup> GFA plus employee parking, which adds a further 0.5–2.0 spaces/100 m<sup>2</sup> GFA depending on land-use group.

At first glance it may seem surprising that the actual ratio of parking to floor area is so constant over such a wide range of city centre sizes. But parking is directly related to turnover and economic activity. Thus, for a given modal split of arrival, the parking will be related to turnover per square metre, which does not appear to vary

#### 4. *Retail Trips and Parking*

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greatly from city to city. However, the provision of employee parking is not always adequate, and a lot of the overspill parking is a result.

To ensure that all users have access to central parking, Manukau City District Plan states:

The owner or occupier of a site shall not unreasonably allocate or manage the parking spaces so as to prevent staff, fleet-vehicles, visitors, or particular occupiers associated with that site from utilising this parking.

The above are global figures for entire city centres. This review gives a general overview and provides useful “check sums” for comparison. The results are, however, indicative only and subject to the limitations of statistics. Compared with 1970, the situation has stabilised, with rates of parking supply being within a relatively narrow range for all cities.

## 5. Changes in Selected Uses Since 1970s

### 5.1 Basic Factors of Change

Since the 1971–73 surveys reported in RRU Bulletin 15, there have been some dramatic changes in New Zealand's major urban areas and in transport habits.

Generally, communities have become more dispersed and less structured than 20 years ago. No longer are goods circulated from manufacturer to warehouse to retailer, but rather the retail outlets act as both the display and holding areas for goods, with back-up from a larger number of vehicles delivering the goods more frequently. There is also an increase in “just in time” supply selling direct to the public at warehouse/retail outlets. Many previously industrial areas have converted to this mixed-use activity.

For example, the recent document “40 Years of Change”, prepared for Christchurch City Council, reported the following changes in Christchurch from 1970 to 1996:

- population increased by 20%,
- registered vehicles increased by 2.3 times,
- average number of vehicles parked at households increased from 1.1 to 1.4,
- total vehicle trips increased by 2.2 times,
- car drivers' proportion of all travel modes increased from 43% to 61%,
- professional and administration employment increased by 75%,
- retail employment increased by 40%,
- industrial employment increased by only 5%,
- car trips per household increased by 66%,
- bus passenger numbers decreased by 60% (i.e. from 10% to 4% of all modes),
- motor cycle trips decreased from 3% to 1% of all modes,
- bicycle use decreased from 13% to 3% of all modes,
- walking decreased from 8% to 3% of all modes.

While these figures relate specifically to Christchurch, similar figures would probably be recorded for most other major cities in New Zealand, with the trends being even greater in Auckland.

There is currently some evidence of a recovery in bus passenger numbers and bicycle use. However, even if the figures doubled from 1996 they would be only half of the 1970 percentage mode split and still not equal to the earlier absolute travel numbers.

All these factors might lead one to the view that possibly there has been a major increase in vehicle trip generation and parking at all land uses. In reality, the major urban areas have grown and the shopping centres and industries within them have become dispersed and larger, to the extent that, at the individual site level (with one or two exceptions), the trip generation and parking demand rates (related to floor area and employment figures) are still at levels similar to those presented in 1973 in

RRU Bulletin 15. However, some of the industrial locations which in 1970 were relatively quiet from a traffic generation viewpoint have now been converted to warehouse retailing and other visitor-attracting uses, which bring many more visitors to their front door. Furthermore, residential areas are producing approximately 66% more trips for the same number of households.

It appears that market competition and real estate decisions have seen equal or even better accessibility created for a range of new establishments. Overall, what was the single dominant town centre is now complemented by a range of supermarkets, larger shopping centres and other attractions in the suburbs. This disperses the traffic more evenly between more sites and spreads it throughout the urban area. The traffic generation rates at individual sites have remained relatively constant over time, but the extension of evening and weekend business has also reduced the previously significant Friday peak.

## **5.2 Places of Entertainment and Assembly**

The earlier provision was generally 1 parking space per 10 seats (there are typically 20 seats per 100 m<sup>2</sup> GFA). Figures derived from recent surveys of cinemas and theatres show 2.5 to 4 car-parks per 10 seats (i.e. 5 to 8 spaces/100 m<sup>2</sup>). There are now many more cinemas available to the public and, in multiplex cinemas, up to eight screens at any single site. Overall, however, the cinemas have shrunk in size from 1000 seats per screen to 400 or 200 seats and even smaller. This better reflects the current demand and gives rise to higher car driver/car passenger attendance than in the past. On the other hand, with more venues available, the average occupancy has dropped. This research has not included yearly or seasonal analysis of cinema usage.

Museums, galleries, libraries, gymnasiums and indoor sports courts have also entered the list of uses to be considered. From surveys, the parking demand at museums, galleries and libraries seldom exceeds 2 spaces per 100 m<sup>2</sup> GFA. On the other hand, gymnasiums and sports court activities have been surveyed at 5 spaces per 100 m<sup>2</sup> GFA. This depends, however, on whether the sports hall provides major seating accommodation for events, such as indoor basketball. If so, it may be appropriate to do two calculations, one based on general use by participants and spectators, and the second on the seating area as a place of assembly.

More survey is warranted for this group of activities.

## **5.3 Primary Schools**

All educational institutions at primary, secondary and tertiary levels now have a significantly higher vehicle arrival rate for both staff and students. The most dramatic change has occurred in the primary school pupil's mode of arrival, as car passengers for the trip between home and school. Unfortunately, the Surveys Database includes few primary schools, but intensive survey at one yielded useful information.



Typical mode distribution in the 1970s and 2000s for a school in South Christchurch is shown in Table 5.1.

**Table 5.1 Primary school travel mode**

TRAVEL MODE	1970s	2000s
Car passenger	10%	50%
Walk	40%	34%
Bus	5%	1%
Bicycle	50%	15%
<b>Total</b>	100%	100%

This major mode shift from bicycle to car passenger has greatly affected the arrival patterns and the need for set-down space and school road patrols to control vehicle movements near the school. The near or short home-to-school trips tend to remain pedestrian, while the distant trips within the catchment, which used to be predominantly by bicycle, are now as car passengers, adding to vehicle travel.

It would appear that there is a strong desire among today's parents to take their children to school by car, even within the local primary school catchment, despite the wider system costs and parental obligations of providing this transport service every day. The shift is said to be partly to avoid the risk of misadventure to pupils going to or from school.

There has also been a shift in teacher and staff use of cars. Surveys now show up to 90% of staff arrivals as car drivers, with a corresponding need for off-street staff and visitor parking at the rate of about 1 space per staff member.

The arrival and departure trip and parking rates have lifted correspondingly, as shown in Table 5.2.

**Table 5.2 Primary school traffic activity**

MEASURE	1970s	2000s
Peak hour trip rate vph (in + out) per 100m <sup>2</sup> GFA (equivalent floor area per class of 25 pupils)	8 / 100m <sup>2</sup> GFA or 0.16 trips/hr/pupil	30 / 100m <sup>2</sup> GFA or 0.6 trips/hr/pupil
Peak parking demand (8.30am and 3.00pm) cars per 100m <sup>2</sup> GFA or rate / staff and rate / pupil	Staff + parents 2 + 2.5 = 4.5/100m <sup>2</sup> or 0.7/staff + 0.05/pupil	Staff + parents 3 + 10 = 14/100m <sup>2</sup> or 1.0 /staff + 0.20/pupil

Note: The typical class of 25 pupils occupies a classroom of 50 m<sup>2</sup> and has about 1.5 teachers plus administration staff per classroom.

It is noteworthy that these trips are not spread over a whole hour but all occur within the half-hour 8.20 to 8.50 am and 3.00 to 3.30 pm. The pupil/car occupancy rate is typically 1.2 pupils/car in the morning and 1.4 pupils/car in the afternoon.

For a primary school of, say, 300 pupils and 12 classrooms (typically 600 m<sup>2</sup>) there will be a need for 20 parking spaces on site for staff and site visitors. There will also be a need for kerbside “set-down” space for 60 cars at morning arrival and afternoon departure times. The section of street serving the school will be subject to a peak morning and mid-afternoon traffic generation of 180 vph (two-way).

These are significant changes in the effects of the land use, and few sites have sufficient area to handle such peak flows and parking needs comfortably off-street. Where schools are located on minor streets this situation may be acceptable, but where they front arterial roads sometimes the situation is intolerable and corrective action to provide off-street parking and set-down areas may be necessary.

#### **5.4 Secondary Schools**

Secondary schools reflect many of the same characteristics as primary schools in trip generation, parking and set-down patterns. The five secondary schools in the Surveys Database have not been fully site-surveyed but some information can be obtained from the surveys done so far.

Parking areas are not provided for students at secondary schools and, in the absence of off-site parking surveys, it is not possible to make a full appraisal. However, for these schools, which all have rolls of more than 1000 students, the on-site parking provided varies between 70 and 210 spaces. This parking is primarily for full-time equivalent (FTE) staff, who number between 110 and 150. Part-time staff and supporting administrative staff may bring a further parking demand above that calculated, which is based on FTE staff alone.

Generally, if on-site (i.e. off-street) parking is provided at the rate of one space per staff member, it will yield sufficient for staff and official school visitors during the day. Some secondary schools now have halls or gymnasiums which are available for community use. This may not be associated with site parking, however, and will add to the surrounding street parking.

From these surveys an average figure of only 2.4 car-parks/100 m<sup>2</sup> emerges, equivalent to only 0.07 car-parks/pupil.

Trip rates of arrivals and departures for dropping off and picking up students have been measured at two sites. Morning and afternoon peak hour trips are similar, with arrivals being similar to departures within the hour. Surveys yield peak hour trip rates (in + out) of between 100 and 250 vph. These translate to 10 trips per peak hour per 100 m<sup>2</sup> GFA, equivalent to 0.2 trips per student per peak hour. These low rates are due largely to the omission from the surveys of adjoining street set-down and parking.

Further detailed study of this secondary school land use is needed, in particular the set-down and pick-up rates and the off-site street parking by students. Some questionnaire mode of arrival information would be of great assistance.

## 5.5 Tertiary Educational Institutions

Since the 1970s the tertiary educational institutions have altered dramatically, with a much larger number of students attending for different periods throughout the day. Generally, the traffic generation and consequent parking demand at these institutions have increased significantly. The equivalent full-time student (EFTS) is probably an appropriate tool for assessing car-parking demand. However, this figure itself will fluctuate in the years ahead, regardless of the floor area of the institution involved. It follows that a ratio per GFA should still be applied to achieve a satisfactory long-term standard, although it has not been possible, with the exception of the University of Canterbury, to obtain the GFA figures for the following summary.

### 5.5.1 University and Polytechnic Parking

Here the parking demand for four universities and two polytechnics is considered. They reflect a wide range of situations, including inner-city, suburban and broadfield locations.

**Table 5.3 Car parking at universities and polytechnics (2000)**

	No of students (FTEs) <sup>(1)</sup>	No of staff, teaching and general	No of car parks for staff and students		No of car parks per staff and student	
			Staff	Student	Staff	Student
<b>A. Institutions meeting demand on site</b>						
Canterbury	11,900	1,540	661	3,000 <sup>(5)(7)</sup>	0.43	0.25
Lincoln	4,000	726	120 <sup>(2)</sup>	1,722	0.17 <sup>(2)</sup>	0.43
Waikato	12,000	1,628	864	1,486	0.53	0.12 <sup>(8)</sup>
<b>B. Institutions with restricted supply<sup>(4)</sup></b>						
Otago	14,500 <sup>(1)</sup>	3,950	1,094	(1500) <sup>(6)(7)</sup>	.27	0
Chch Polytech	11,000 <sup>(1)</sup>	709	264	554	.38	0.05
Carrington	5,500	600	200	1,650	0.33	0.30

- Where part-timers are included, their number is reduced by a factor of ½ of that assumed for EFTS. Otago has 5000 and Christchurch Polytechnic 10,600 part-timers.
- Lincoln staff are present over a wide variety of times and the 120 spaces are reserved. Staff also park in the general student car-park. Staff parking is therefore more than the 120 shown.
- All sites have some reliance on off-site street parking for both convenience and overflow. Group A institutions do not rely on street parking at this stage, but those in Group B expect students to find parking off-site.
- The tertiary institutions in Group B with restricted access also have parking charges varying from \$200 to \$700 per annum (depending on circumstances) for staff and \$33 to \$200 for students.
- At Canterbury, the surveys show about 20% or 600 additional student cars are being parked in adjacent residential streets. The on-site parking provided for students is 2380 spaces.
- This 1500 is stated as a number required in the future, i.e. at a rate of 10 students per car-park. Otago has a large number of boarding colleges and flats nearby.
- Universities also provide cycle stands (e.g. Otago 334, Canterbury 1500).
- Waikato, Otago and Canterbury may be lower because of the extent of student hostels on campus.

The parking demand and supply situation for these major institutions is a mix of matching staff needs and where possible meeting student needs on site. Table 5.3 sets out the situation for the five institutions surveyed in 2000.

Staff parking is the first priority, and the site supply is 0.53 to 0.27 car-parks per member, equivalent to about 0.2–0.35 spaces/100 m<sup>2</sup>.

Student parking in the unrestricted Group A institutions shows a ratio varying from 0.12 to 0.43 car-parks per student. For the Canterbury campus, where the on-site figure is 5.0 students/car-park (i.e. 0.20 car-parks/student), the surrounding street parking for students has been included to yield the total demand of 4.0 students/car-park spaces (i.e. 0.25 car-parks/student). The Canterbury demand rate (where the total floor area is 230,000 m<sup>2</sup>) for staff and students combined is equivalent to 1.6 car-parks/100 m<sup>2</sup> GFA. On-site supply there is 1.3 car-parks/100 m<sup>2</sup> GFA.

The parking needs for the Group B institutions (those within CBDs) cannot be met on-site. The few spaces available are in high demand and parking is charged to both staff and students permitted to park on-site. Shared parking with adjacent council or private parking buildings may need to be considered in the future to supply space to meet the demand at these sites.

### **5.5.2 University of Canterbury Modes of Arrival**

For Canterbury University, information has been made available on travel surveys of staff and students since 1966. The 1971/1993/2000 survey results are summarised in Table 5.4.

As in the rest of the community, the mode split has shifted more to car drivers over the period, with over 60% of staff and over 40% of students arriving as car drivers.

Car ownership has lifted to over 90% for staff and 70% for students. On wet days all these car drivers seek a parking space in the university car-parks and parking extends further out on the surrounding residential streets.

The changes in modal split over time are shown in Figure 5.1 for staff and Figure 5.2 for students. For staff, car driving has levelled off and the growth is occurring in the walk to university mode. It is also of interest that the cycle mode is still well used by staff, at a similar level as for students (16% and 18% respectively).

For students, the arrival as car driver continues to climb steadily, while bicycle use has declined markedly. However, the increase in walking, up to 32%, is a useful trend, showing a willingness to relocate to closer residential origins, and is a positive response to increasing congestion and possibly inconvenience when seeking parking.

Figure 5.1 Mode split (staff)

### University of Canterbury, Ilam

Staff modal split through time

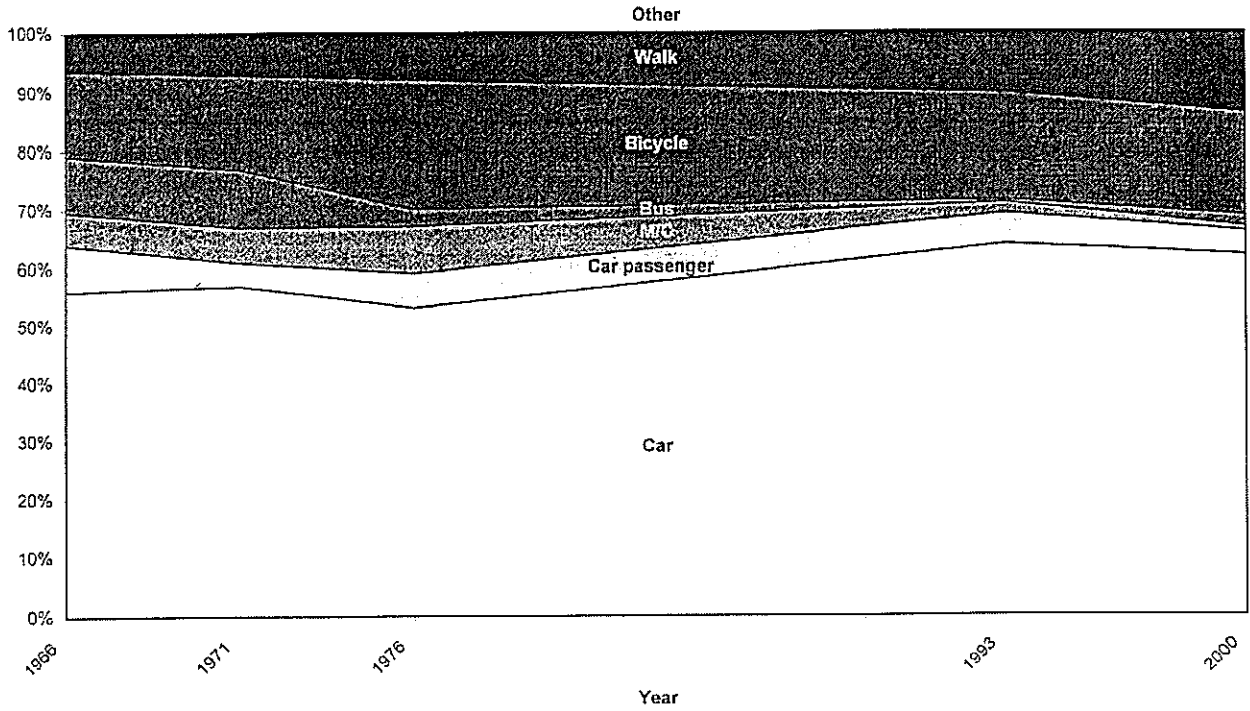
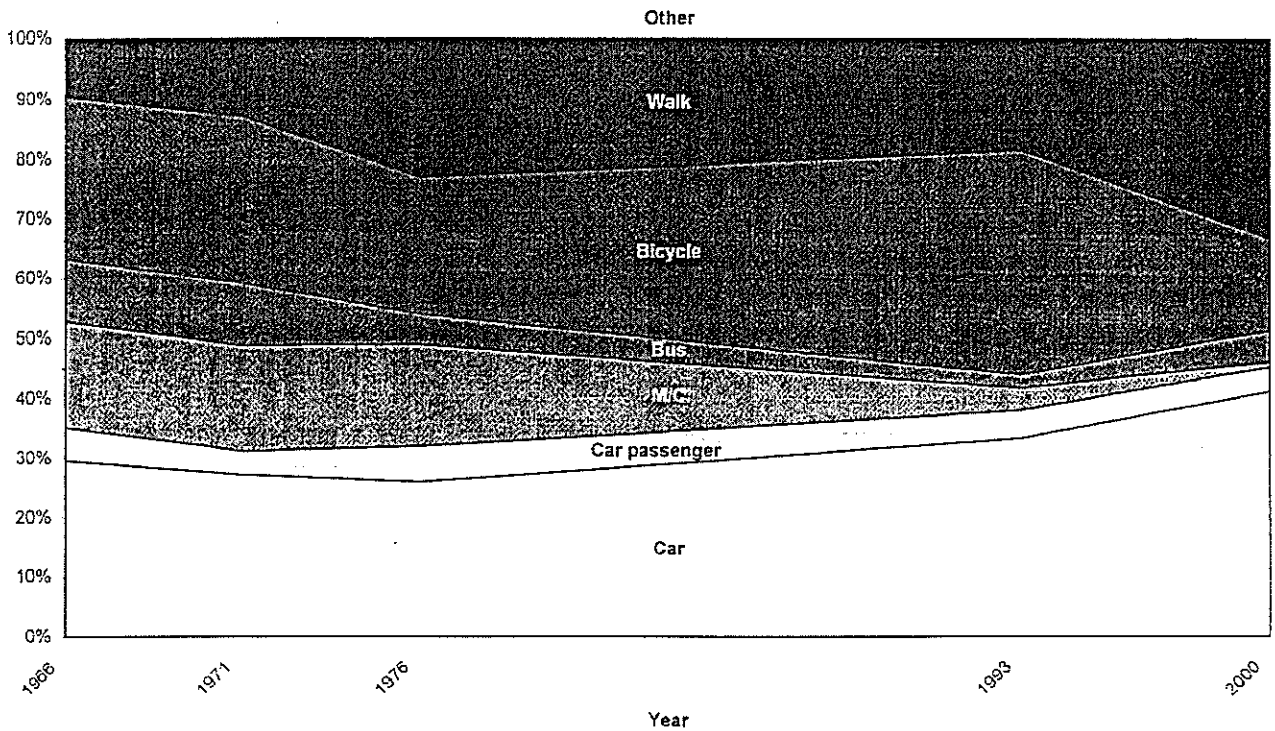


Figure 5.2 Mode split (students)

### University of Canterbury, Ilam

Student modal split through time



**Table 5.4** Canterbury University travel patterns 1971, 1993 and 2000

		Car ownership rate		
		1971	1993	2000
Staff	Male	90%	90%	95%
	Female	53%	90%	95%
Students	Male	45%	65%	70%
	Female	15%	65%	70%

	Travel mode (% mode)					
	1971		1993		2000	
	Staff	Student	Staff	Student	Staff	Student
Car driver	56	17	58	33	62	42
Car passenger	4	4	5	5	5	4
Motorcycle	6	18	2	4	1	1
Bus	11	10	1	2	3	5
Bicycle	16	28	23	38	18	16
Walk	7	13	11	18	11	32
	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>
No of staff and students (space)	820	6923	1275	10,995	1540	11,900
No of car parks	385	1503	611	2549	661	2899
Ratio of car parks per staff/students	4.7	0.22	0.48	0.23	0.43	0.20

Table 5.4 reflects normal or “fine day” travel. The mode of travel for both staff and students varies markedly with weather conditions. Between the driest warm weather and the wet cold weather:

- student car drivers increase from 35% to 85%,
- staff car drivers increase from 53% to 83%.

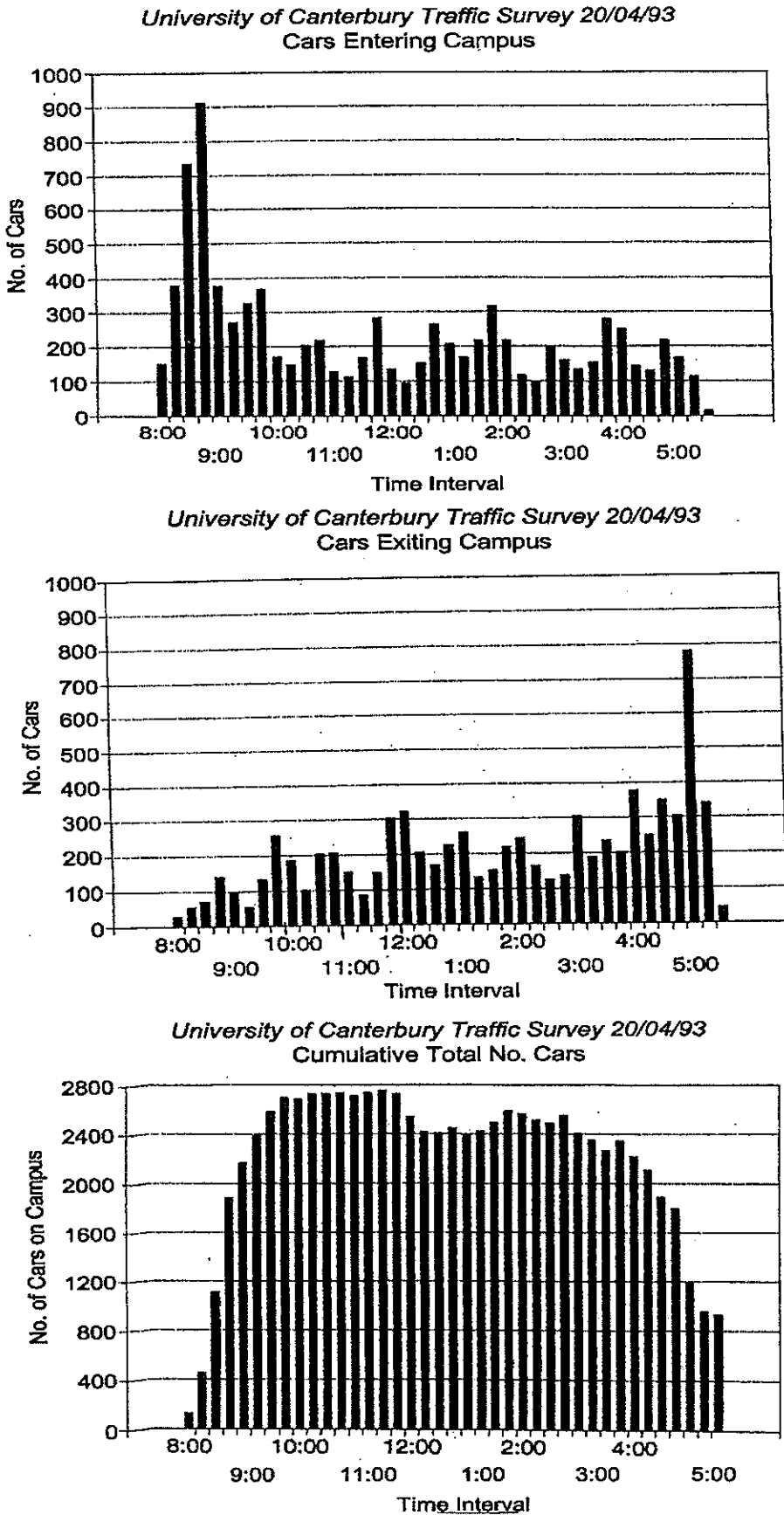
### 5.5.3 Trip Generation

Tertiary institutions are among the highest hourly traffic-generating land uses, due to their size and the arrangement of lectures and attendance. Like schools, there are short peaks (e.g. arrival for 9.00 am lectures and departures after the academic day ends at 5.00 pm).

In April 1993, a traffic survey was done at Canterbury University, with 11,000 students and 1275 staff. The vehicle trip generation rates are shown in Table 5.5 and Figure 5.3.

The corresponding figures for the peak trip generation at Carrington Polytechnic are: morning, 20.5 trips per 100 students plus staff per hour, and afternoon, 18.1 trips per 100 students plus staff per hour – a very similar result.

Figure 5.3 Campus trip generation



**Table 5.5 Car trip generation, Canterbury University (20 April 1993)**

TOTAL TRAFFIC MOVEMENT (Veh/15 min)					
		In	Out	In + Out subtotal	Trip generation staff & student and GFA
<b>AM peak</b>	8.00 - 8.15	140	25	165	2420vph = 20 trips/hr/ 100 S + S or 1.05 trips/100m <sup>2</sup>
	8.15 - 8.30	380	50	430	
	8.30 - 8.45	720	80	800	
	8.45 - 9.00	900	125	1025	
<b>Midday</b>	11.45 - 12.00	160	300	460	1675vph = 14 trips/hr/ 100 S + S or 0.71 trips/100m <sup>2</sup> GFA
	12.00 - 12.55	290	320	610	
	12.15 - 12.30	130	205	335	
	12.30 - 12.45	90	180	270	
<b>PM peak</b>	4.30 - 4.45	130	340	470	2380vph = 19.8 trips/hr/ 100 S + S or 1.03 trips 100m <sup>2</sup> GFA
	4.45 - 5.00	120	300	420	
	5.00 - 5.15	220	780	1000	
	5.15 - 5.30	160	330	490	

This trip generation rate is high because of the numbers of students and the large floor area (Canterbury 230,000 m<sup>2</sup>). This leads to a consideration of design for several entrances and traffic management through an accommodating surrounding city road network.

## 5.6 Recreation Spaces and Stadiums

Another area of considerable interest is reserves, recreation spaces, stadiums and associated facilities. These are often unique and one-off design situations. Several surveys and design calculations have been provided in this project, though more attention and detailed surveys are required in the future. The end result from a design hour viewpoint is given below.

### 5.6.1 Parking for Sports Courts and Fields

The range is from 2 to 3 car spaces per 100 m<sup>2</sup> of court area, and 0.5 to 0.7 car spaces per 100 m<sup>2</sup> of playing field or pitch area for participants.

### 5.6.2 Aquatic Centres

These facilities have increased the popularity of the older, more traditional swimming-pool complexes by offering a wider range of water-based recreations such as splash and wave pools, fitness and other sports facilities. The information in the Surveys Database shows design trip generation at around 1.5 to 2.0 vph (in + out) per 100 m<sup>2</sup> GFA and parking demand of 2.5 to 3.5 spaces per 100 m<sup>2</sup> GFA.

### 5.6.3 Major Stadiums

Several major factors influence travel to and from sports and entertainment events at major stadiums. The inner-city location of the new Wellington Stadium and its proximity to the rail yards, for example, enable high levels of public transport and



pedestrian accessibility. Data from several major Auckland and Hamilton sports events indicate a spectator parking demand equivalent to 1 car space for every 4.2 to 5.8 spectators. Bus parking demand for crowds of around 40,000 spectators has been observed to range from 42 buses for a sports fixture to over 160 buses for an operatic performance. No information is available on the associated traffic generation.

## **5.7 Medical Centres, Hospitals and Rest Homes**

Government policies and the changing face of general medicine in New Zealand have given rise to new facilities (e.g. increased numbers of medical centres) and different modes of operation for existing facilities (e.g. increased outpatient care at base hospitals). While the changes are continuing, the Surveys Database has captured a number of surveys, particularly of community medical practices as well as of several hospitals and rest homes. This information is summarised below.

### **5.7.1 Medical and Health Centres**

These community facilities now offer a range of professional health care and advice, including the services of GPs, physiotherapists, radiographers and dentists, and some level of treatment. On-site pharmacies mean that prescriptions can also be filled without patients travelling elsewhere. The data collected to date show that on-site parking demands and trip generation are most accurately represented on a per health professional basis. The measured design levels based on the survey information are for trip generation from 3.0 to 6.0 vph (in + out per peak hour per health professional) and for parking from 2.5 to 3.5 spaces per health professional. On a 100 m<sup>2</sup> GFA basis, the figures are 5.0 to 12.0 trips per 100 m<sup>2</sup> GFA in the peak hours (generally 10 am to midday, and 3 to 4 pm) and 2.5 to 6.0 car parks per 100 m<sup>2</sup> GFA. Medical centres have a wide range of patronage and may require detailed individual site assessment.

### **5.7.2 Hospitals**

Survey information for hospitals in Auckland, Wellington and Christchurch show design parking demands from 1.0 to 1.5 spaces per bed with an average of 1.3 spaces per bed. Clearly, the range and nature of activities performed on-site will be essential to understanding the total parking demand. Staff and doctor parking varies from 30% to 60% of the total, depending on the type of hospital. Outpatient numbers and consultant specialists are significant indicators of overall parking activity.

Trip generation in the peak morning and afternoon hours is from 0.9 to 1.7 trips per bed per hour and 10 to 16 trips per bed per day. As a rule, the area for hospitals is around 100 m<sup>2</sup> per bed. So bed spaces and GFA, as a general approximation, yield similar parking ratios.

### **5.7.3 Rest Homes**

Rest homes have lower traffic demands than hospitals. The typical parking demand is from 0.5 to 0.7 spaces per bed, with a trip generation rate of from 0.3 to 0.6 per bed in the peak hours and 4 to 6 trips per bed per day.

## **5.8 Childcare Centres**

Childcare centres are increasingly part of community life, and smaller units in residential areas are common. The Surveys Database includes 23 sites surveyed, with between 25 and 100 children attending. Most are in the range up to 40 children.

Maximum on-site parking varies between 4 and 10 spaces with an average of 6 spaces. The area of the buildings ranges from 150 to 250 m<sup>2</sup>.

The trip generation rates at morning and afternoon peak periods are similar, at from 0.41 to 2.9 per hour per enrolled child. The average figure is 1.09 trips/child/vph.

The parking demand varies. For the smaller centres of up to 40 children (16 sites), the lowest number of off-street parking spaces is 4 and the highest is 8, representing between 1.2 and 3.2 car spaces per 100 m<sup>2</sup>. This is equivalent to 0.16 spaces per pupil or 1.6 spaces per 10 pupils. As there are typically 6 employees at each of these childcare centres, there is presumably a lot of set-down ride-sharing for visiting parents.

The area for set-down, either on-site or kerbside, varies greatly. A layby set-down area of 3 to 4 carparks is commonly provided.

## **5.9 Churches**

District plans have been liberal in their approach to off-street parking for churches and have generally accepted such ratios as 1 car-park per 10 congregation members or seats. This has of course meant that about three-quarters of the parking has had to be accommodated on adjacent streets. At sites near the city centre or on busy arterial roads, the need for more off-street parking is frequently evident.

From the surveys in the Database, the parking demand based on actual attendance of the congregation varies from 1 car-park to 5 seats to 1 car-park to 2 seats. However, many churches are full only on particular occasions, for special services, weddings and funerals. For the 18 churches surveyed, some on several occasions, there were only four occasions when the churches were full. Some of these were weekday services, and car-parking needs varied from 2.3 to 4.5 spaces per 10 seats available. As for the mode of arrival at churches, car drivers varied from 30% to 76%, with an average of 46.5%. Car passengers make up about 50% of arrivals at churches.

Seating number is considered to be the best variable for churches and places of assembly, and the rate of car-parks to 10 seats or seating places is convenient. To relate seating to GFA is useful. Analysis of this group of churches shows a range from 64 seats to 120 seats per 100 m<sup>2</sup> GFA with an average of 100 seats per 100 m<sup>2</sup> GFA. In terms of parking per 100 m<sup>2</sup> GFA for the church in full use, i.e. a design figure for, say, the 30th highest occasion, this is equivalent to between 26 and 48 parked cars per 100 m<sup>2</sup>.

It is not suggested here that district plan standards need to be revised from, say, 1 to 10 seats up to 1 to 3 seats. That is a policy, not a research, matter. However, it should be appreciated that, in congested arterial road or inner-city situations, additional parking (above the 1 in 10 rate) of up to 3 more spaces per 10 seats may need to be accepted on-street or at adjacent public parking areas on peak-use occasions.

### **5.10 Summary of Surveys Database**

The Surveys Database of some 463 survey sites (see Volume 2) has been derived from the surveys listed in Appendix A, "Surveys Database – Summary of Data Sources". This Database is available in both electronic and printed form. It is hoped that it will be added to in future and kept up to date.

The land uses in the Database are in 9 major activity groups with between 2 and 12 subgroups in each, as set out in Appendix B. The definitions provided there give 46 two-key-word groups at this stage. Some of the results from the Database are summarised in Appendix C, grouped according to land use and, where appropriate for retail and other visitor uses, adjusted for seasonal, weekly and hourly factors to the 30th highest hour.

The surveys in the Database have all been undertaken since 1990. How their results compare with those for the 1970s is discussed in Section 7.

## 6. Overseas Comparisons

### 6.1 Contact with Australian Counterparts

The authors visited Sydney and Brisbane in June 2000, meeting with the Road Traffic Authority in New South Wales (RTA), the Department of Main Roads in Queensland, university personnel and other Australian authorities interested in the guidelines to traffic generation and parking demand. The close parallels between the Australian and New Zealand situations and the practices adopted by traffic engineers and planners in both countries warrant the reconciliation of the New Zealand work with the Australian experience and equivalent information.

### 6.2 RTA and Australia

A list of Australian references is included in the References in Section 11. The RTA *Guide to Traffic Generating Developments* was the largest single source of information on trip generation and parking demand for individual land uses.

In the 1970s and 80s the RTA undertook surveys of a large number of individual land uses and these were published as self-contained reports. In 1984 the RTA published *Policies, Guidelines and Procedures for Traffic Generating Developments* (known as "The Yellow Book"), which was used widely throughout Australia and New Zealand. In 1993 this was superseded by the RTA *Guide to Traffic Generating Developments*. This publication, which has been widely circulated and used, has been updated, and is also available in electronic form. It provides a comprehensive approach to dealing with both vehicle trips and parking requirements for the particular activities included.

While the RTA guide was initiated to provide a basis for considering land-use developments abutting major and state highways, it also included some traffic generation and parking standards which are widely used by local authorities in New South Wales and other states. The RTA is currently considering the future of this guide and is contemplating changing its emphasis to pay greater attention to mode choices and the availability of public transport as it affects traffic generation and parking demand. While the surveys on which the guide is based are comprehensive (each lasting over a whole week), discussions so far have not produced any process to factor these results to an agreed design day or hour.

The RTA guide has the advantage of describing issues related to individual land uses. From this description, and the material on traffic generation and parking requirements, a useful view of the operating characteristics at the sites surveyed, as well as the traffic and parking figures, can be obtained.

### 6.3 ITE and American Practice

The Institute of Transportation Engineers (ITE) manuals covering trip generation and parking demand in the American commercial and traffic environment provide much

more detail than could ever be contemplated in New Zealand. Many of the categories dealing with shopping and industry involve much bigger developments than exist here. The ITE manuals are based on surveys of 3200 sites and 130 land-use activities.

Both the ITE trip generation and parking demand manuals give very comprehensive coverage of a wide range of land uses under each broad category. Some of these categories differ from the New Zealand definitions (e.g. education structures, and some forms of retailing). In the main, however, the results are applicable to the New Zealand situation when interpreted with appropriate professional judgement. The trip generation manual also includes a user's guide which is useful in its land-use descriptions, definitions of terms and well-trying site survey forms.

It is noteworthy that the ITE encourages users to forward any new data collected to ITE headquarters for inclusion in the US national database and, to further this, standard survey forms are included in its publications.

Another useful group of US references is published by the Urban Land Institute (ULI). This non-profit research and educational organisation has published guideline papers for the use of retail planners, shopping centre owners and managers.

#### **6.4 Comparison of New Zealand, Australian and US Data**

To provide some comparison, Tables 6.1 and 6.2 show the trip generation and parking characteristics of selected land uses (i.e. similar land uses in all three countries).

It will be appreciated that many commercial and industrial land uses in America are distributed even more generously throughout the community than in New Zealand. In addition, some "power centres" and "employment parks" are located outside the urban areas and adjacent to motorway interchanges and similar focal points of traffic movement. In these cases, of course, the trip generation is even more heavily oriented to car arrivals and the parking demands may be higher than in New Zealand, because of the scale of the development and the reservoir effect from the longer stay periods of shoppers.

There appear to be many similarities between the New Zealand, Australian and American parking demand and trip generation figures. This research confirms that survey information from these two countries is generally relevant to the New Zealand situation.

6. Overseas Comparisons

**Table 6.1 Comparison of New Zealand, Australian and American trip generation rates in 1990s**

LAND USE	AUSTRALIAN		AMERICAN		NEW ZEALAND	
	Traffic generation rates		Trip generation rates		Trip generation rates	
	Daily (vpd)	Peak hour (vph)	Daily (vpd)	Peak hour (vph)	Daily (vpd)	Peak hour (vph)
Dwelling houses	9.0/dwelling	0.85/dwelling	9.6/dwelling	1.0/dwelling	10.4/dwelling	1.2/dwelling
Medium density residential flat building	4-5/dwelling	0.4-0.5/dwelling	5.9/dwelling	0.5/dwelling	6.8/dwelling	0.8/dwelling*
Housing for aged and disabled persons	1-2/dwelling	0.1-0.2/dwelling	2.6/avail. bed	0.4/avail. bed	2.0/avail. bed	0.5/avail. bed
Motels	3/unit	0.4/unit	5.6/unit	0.6/unit	11/occ. unit	1.5/occ. unit
Commercial premises/offices	10/100m <sup>2</sup> GFA	2/100m <sup>2</sup> GFA	11.0/100m <sup>2</sup> GFA	1.5/100m <sup>2</sup> GFA	20/100m <sup>2</sup> GFA	2.0/100m <sup>2</sup> GFA*
Shopping centres (<10,000 m <sup>2</sup> )	121/100m <sup>2</sup> GLFA	16/100m <sup>2</sup> GLFA			160/100m <sup>2</sup> GFA	23.8/100m <sup>2</sup> GFA
Shopping centres (10,000-20,000 m <sup>2</sup> )	78/100m <sup>2</sup> GLFA	8/100m <sup>2</sup> GLFA		3.7/100m <sup>2</sup> GFA (week day) and 5.0/100m <sup>2</sup> GLFA (Sat)	87/100m <sup>2</sup> GFA	14.5/100m <sup>2</sup> GFA
Shopping centres (20,000-30,000 m <sup>2</sup> )	63/100m <sup>2</sup> GLFA	7/100m <sup>2</sup> GLFA			47/100m <sup>2</sup> GFA	9.9/100m <sup>2</sup> GFA*
Shopping centres (>30,000 m <sup>2</sup> )	50/100m <sup>2</sup> GLFA	6/100m <sup>2</sup> GLFA	42.9/100m <sup>2</sup> GFA			
Service stations with retail facilities	680/site, 340/100m <sup>2</sup> GFA	40/site, 20/100m <sup>2</sup> GFA	163/filling position	13.6/filling position 97/100m <sup>2</sup> GFA	600/100m <sup>2</sup> GFA 174/filling position	120/100m <sup>2</sup> GFA 10/filling position
Supermarkets	150/100m <sup>2</sup> GLFA	15.5/100m <sup>2</sup> GFA	177/100m <sup>2</sup> GFA	12.3/100m <sup>2</sup> GFA	130/100m <sup>2</sup> GFA	17.8/100m <sup>2</sup> GFA
Markets	18/stall	4/stall	6.7/100m <sup>2</sup> GFA	0.6/100m <sup>2</sup> GFA	-	0.5/100m <sup>2</sup> GFA
Bulky goods/ home improvement stores	30/100m <sup>2</sup> GFA	6.5/100m <sup>2</sup> GFA	35/100m <sup>2</sup> GFA	3.8/100m <sup>2</sup> GFA	40/100m <sup>2</sup> GFA	5.9/100m <sup>2</sup> GFA*
Video stores	200/100m <sup>2</sup> GFA	49/100m <sup>2</sup> GFA	-	13.6/100m <sup>2</sup> GFA	250/100m <sup>2</sup> GFA	36/100m <sup>2</sup> GFA *
Drive-in fast-food restaurant	-	180/site	710/100m <sup>2</sup> GFA	60.2/100m <sup>2</sup> GFA	320/100m <sup>2</sup> GFA	30/100m <sup>2</sup> GFA
Restaurants	60/100m <sup>2</sup> GFA	5/100m <sup>2</sup> GFA	90/100m <sup>2</sup> GFA 2.9/seat	10.8/100m <sup>2</sup> GFA 0.3/seat	66/100m <sup>2</sup> GFA	3.7 - 155.5 / 100m <sup>2</sup> GFA
Gymnasiums	45/100m <sup>2</sup> GFA	9/100m <sup>2</sup> GFA	20/100m <sup>2</sup> GFA	4.3/100m <sup>2</sup> GFA*	35/100m <sup>2</sup> GFA	8.7/100m <sup>2</sup> GFA
Factories	5/100m <sup>2</sup> GFA	1/100m <sup>2</sup> GFA	3.8/100m <sup>2</sup> GFA	0.8/100m <sup>2</sup> GFA	30/100m <sup>2</sup> GFA	2.0/100m <sup>2</sup> GFA* 0.3/100m <sup>2</sup> SA
Road transport terminals	5/100m <sup>2</sup> GFA	1/100m <sup>2</sup> GFA	9.9/100m <sup>2</sup> GFA	0.9/100m <sup>2</sup> GFA	-	0.6/100m <sup>2</sup> GFA
Medical centres	60/100m <sup>2</sup> GFA	15/100m <sup>2</sup> GFA	7.8/employee	4.4/doctor	58/100m <sup>2</sup> GFA 31/doctor	6.5/doctor
Hospitals	7.5/bed	1 bed	11.8/bed	1.4/bed	10/100m <sup>2</sup> GFA 12/bed	1.4/100m <sup>2</sup> GFA 1.3/bed

Notes:

- The above Australian and American retail figures are mean or average for group (i.e. on day of survey, not necessarily adjusted for seasonal peaks). The New Zealand figures are based on surveys adjusted to 30th highest hour for retail and visitor attracting uses.
  - GFA = gross floor area, GLFA = gross leasable floor area, SA = site area
  - \* = small sample, use with caution
  - = not available or applicable.
- This is a comparative chart for identifying the general similarities (and differences) shared by traffic generation in these three countries. It is a summary table and should not be used alone as a basis for preparing detailed advice. More background is available in the reference manuals.
- The New Zealand shopping centres shown in the righthand two columns have been grouped according to the three centre sizes of:
  - Small: up to 4000 m<sup>2</sup> GFA
  - Medium: 4001 to 10,000m<sup>2</sup> GFA
  - Large: over 10,001m<sup>2</sup> GFA

The Land Use column has larger floor areas related to Australian surveys only. The American figures relate only to centres over 30,000m<sup>2</sup> GFA.

**Table 6.2 Comparison of New Zealand, Australian, and American parking demand rates in 1990s**

LAND USE	AUSTRALIAN PARKING REQUIREMENTS	AMERICAN SURVEYS		NEW ZEALAND SURVEYS		
	85%	Average	85%	Average	85%	
Dwelling houses	1-2/dwelling	-	-	1.4/unit	2.8/unit	
Medium density residential	1.5 per unit	-	-	1.2/unit	1.8/unit	
Motels (without restaurant)	1 for each unit + 1 per 2 employees	0.5/room	1.0/room	0.8/100m <sup>2</sup> GFA 0.8/unit	1.3/100 m <sup>2</sup> GFA 1.0/unit	
Commercial premises/offices	2.5/100m <sup>2</sup> GFA	2.8/100m <sup>2</sup> GFA	3.3/100m <sup>2</sup> GFA	2.5 / 100m <sup>2</sup> GFA 2	2.8/100m <sup>2</sup> GFA *	
Shopping centres (GLFA m <sup>2</sup> )	<10000	6.1/100m <sup>2</sup>	-	-	5.5/100m <sup>2</sup> GFA	8.0/100m <sup>2</sup> GFA
	10,000-20,000	5.5/100m <sup>2</sup>	-	-	4.8/100m <sup>2</sup> GFA	6.5/100m <sup>2</sup> GFA
	20,000-30,000	4.3/100m <sup>2</sup>	-	-	4.1/100m <sup>2</sup> GFA	5.4/100m <sup>2</sup> GFA
	>30,000	4.1/100m <sup>2</sup>	4.0/100m <sup>2</sup> GLFA	4.5/ 100m <sup>2</sup> GLFA		
Supermarkets	4.2/ 100m <sup>2</sup> GLFA	3.5/100m <sup>2</sup> GLFA	4.5/100m <sup>2</sup> GLFA	5.8/100m <sup>2</sup> GFA	7.5/ 100m <sup>2</sup> GFA	
Service stations with retail facilities	6/work bay plus 5/100m <sup>2</sup> GFA of store	-	-	5/100m <sup>2</sup> GFA	-	
Roadside stalls	4/stall	-	-	7.7/100m <sup>2</sup> GFA	8.5/100m <sup>2</sup> GFA	
Drive-in liquor stores	-	-	-	2.4/100m <sup>2</sup> GFA	3.0/100m <sup>2</sup> GFA	
Bulky goods retail stores	3/100m <sup>2</sup> GLFA	3.3/100m <sup>2</sup> GLFA	3.8/100m <sup>2</sup> GLFA	2.0/100m <sup>2</sup>	3.0/100m <sup>2</sup> GFA*	
Drive-in fast-food outlets	12/100m <sup>2</sup> GFA	13.6/100m <sup>2</sup> GFA	15/100m <sup>2</sup> GFA	10.3/100m <sup>2</sup> GFA 0.4/seat	11.6/100m <sup>2</sup> GFA 0.5/seat	
Restaurants	15/ 100m <sup>2</sup> GFA, 1/ 3 seats	15.9/ 100m <sup>2</sup> GFA 1/2 seat	17.5/100m <sup>2</sup> GFA 1/1.5 seats	6.5/100m <sup>2</sup> GFA 5 1/ 3 seats	13.5/ 100m <sup>2</sup> GFA 1/ 2 seats	
Gymnasiums	3/100m <sup>2</sup> GFA	4.4/100m <sup>2</sup>	5.0/100m <sup>2</sup>	4.5/100m <sup>2</sup>	7.0/100m <sup>2</sup>	
Factories	1.3/100m <sup>2</sup> GFA	1.6/100m <sup>2</sup> GFA	2. /100m <sup>2</sup> GFA	1.5/100m <sup>2</sup> GFA	2.5/100m <sup>2</sup> GFA*	
Warehouses	1/300m <sup>2</sup> GFA	0.5/100m <sup>2</sup> GFA	1.0/100m <sup>2</sup> GFA	-	-	
Plant nurseries	0.5 spaces/100m <sup>2</sup> of site area	-	-	1.0/100m <sup>2</sup> GFA retail display area	1.5/100m <sup>2</sup> GFA retail display area	
Medical centres	4/100m <sup>2</sup> GFA	4.1/100m <sup>2</sup> GFA	4.5/100m <sup>2</sup> GFA	4.1/100m <sup>2</sup> GFA 3.5/health pro.	6.0 / 100m <sup>2</sup> GFA 4.5/health pro.	
Hospitals	1.2/bed	1.8/bed	2.0/bed	1.6/bed	2.5/bed	

**Notes:**

- Australian figures are requirements for standards assumed at 85% satisfaction.  
New Zealand figures are based on average (50%) and design (85%) surveyed satisfaction.  
American figures are based on surveyed average and estimated design.  
\* = use with caution, limited sample size.
- This is a comparative chart for identifying the general similarities (and differences) shared by parking demand in these three countries. It is a summary table and should not be used alone as a basis of preparing advice. More background is available in the reference manuals.
- The New Zealand shopping centres shown in the righthand two columns have been grouped according to the three centre sizes of:  
Small: up to 4000m<sup>2</sup> GFA  
Medium: 4001 to 10,000m<sup>2</sup> GFA  
Large: over 10,001m<sup>2</sup> GFA.  
The Land Use column has larger floor areas related to Australian surveys only. The American figures relate only to centres over 30,000m<sup>2</sup> GFA.

## 7. Trip Generation and Parking Trends 1970s–1990s

### 7.1 Trip Generation Comparison

Trip generation is assumed to cover all person trips by all modes of travel arriving and departing from any establishment during the survey peak hour or the survey whole day as specified. Much of the survey information in the 1970s report included a comprehensive tally of arrival by all modes at the establishments surveyed. In this 1990s summary, unfortunately, few establishments were surveyed so comprehensively. Most of the 1990s trip generation information is for vehicle drivers only and goods vehicles or other modes of travel are not reported. More comprehensive surveys including all modes will need to be undertaken in the future.

While trips per employee is often a more reliable unit for some activities, this information has not always been available. In addition, there has been an increase in the number of part-time employees, and on-site staff parking demand varies greatly. Relating trips and parking to the number of employees is difficult even if the number is known. For this analysis, it has been necessary, in converting the 1970s data to a floor area basis, to make assumptions as to the number of employees on the site and so arrive at a figure comparable with the 1990s information.

The information available for preparing the 1990s summary was, in some instances, based on a small sample.

Table 7.1 indicates the trip generation rates (including seasonal adjustment for retail and intense visitor uses) by land use derived in the 1970s. With a few exceptions, a similar grouping has been adopted for the 1990s.

The peak hours for retail in the 1970s were 4–5 pm on Thursday and Friday. For city offices, the lunch-hour movements were greatest. For industry, the peak hours were arrival, 7–8 am, and departure, 4–5 pm. In the 1990s the peak hour for major shopping centres was Saturday 2–3 pm, while the other land uses have the same peak hours as in 1970.

Table 7.1 shows marked thresholds in trip generation. The most significant factor is the extent of trips made by visitors to the establishment. Naturally, retail and shopping activity yields the highest trip generation. For comparability, these volumes are for averages for all the establishments surveyed – the 85th percentile trip rates will be a ratio approximately 1.25 times the volumes shown here.

Thus the major changes in vehicle trips and peak hours have been in the following land uses.

- Service stations, due partly to the selected number of larger establishments which were redeveloped in the 1990s (+47%).
- City centre offices, some of which are reflecting the increased levels of car use, personal services and marketing activities (+50%). Some office blocks have changed functions to become motels and residential apartments.



Table 7.1 Summary of design trip generation rates, 1970s and 1990s

	TRIPS (in & out) /100m <sup>2</sup> 1970s				TRIPS (in & out) /100m <sup>2</sup> 1990s		
	Peak hour		Daily total		Peak hour	Daily total	Change peak hour vph%
	Vehicle trips	Total person trips	Vehicle trips	Total person trips	Vehicle trips	Vehicle trips	
<b>Shopping</b> <sup>(1)</sup>							
Suburban supermarket	22	90	100	320	25	130	+14%
Primary road store	30	75	170	345	41	180	+32%
Neighbourhood store	24	55	135	330	36	150	+50%
Service stations	70	100	450	600	103	865	+47%
Drive-in – fast foods					60	370	-
<b>Offices</b>							10.4
Post office (high visitor)	3.4	19	30	180	3.7	80*	10%
Fringe centre (few visitors)	2.4	3.6	21	32	2.0	15*	-17%
City centre (few visitors)	0.8	2.9	14	28	1.2	14*	+50%
<b>Industries</b> <sup>(2)</sup>							
Distributive (high goods veh.)	2.4	3.4	13	23	2.0	18	+12%
Manufacturing (mod. visitors)	1.6	3.0	9	16			
Manufacturing (few visitors)	1.03	2.0	6	10			
<b>Residential</b>							
Warehouse	0.90	1.5	4	8	1.0	4.5	+12%
Trips/household	0.8	1.6	6.0	10.0	1.5	10.4	+80%

\* = small survey sample.

(1) Inferred results derived from groupings not entirely identical to earlier research.

(2) Industrial peak hour is morning and evening peak at commuting times – for 1990s based on 7 sites only.

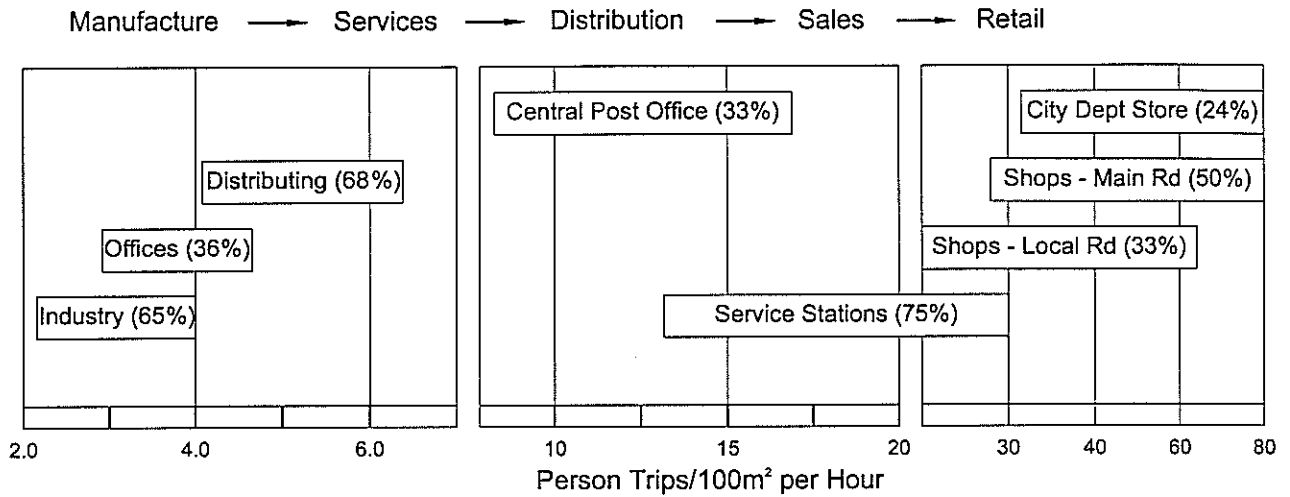
- Shopping centres, because of the increased number of establishments, have generally experienced moderate increases of between 30% and 50% in trip making.
- Residential, a significant increase (+80%) due to increased car ownership and more people at home or running businesses from home.

Most trip rates, based on floor space, have increased, and in the peak hour by between 12% and 50%, from the 1970s to the 1990s.

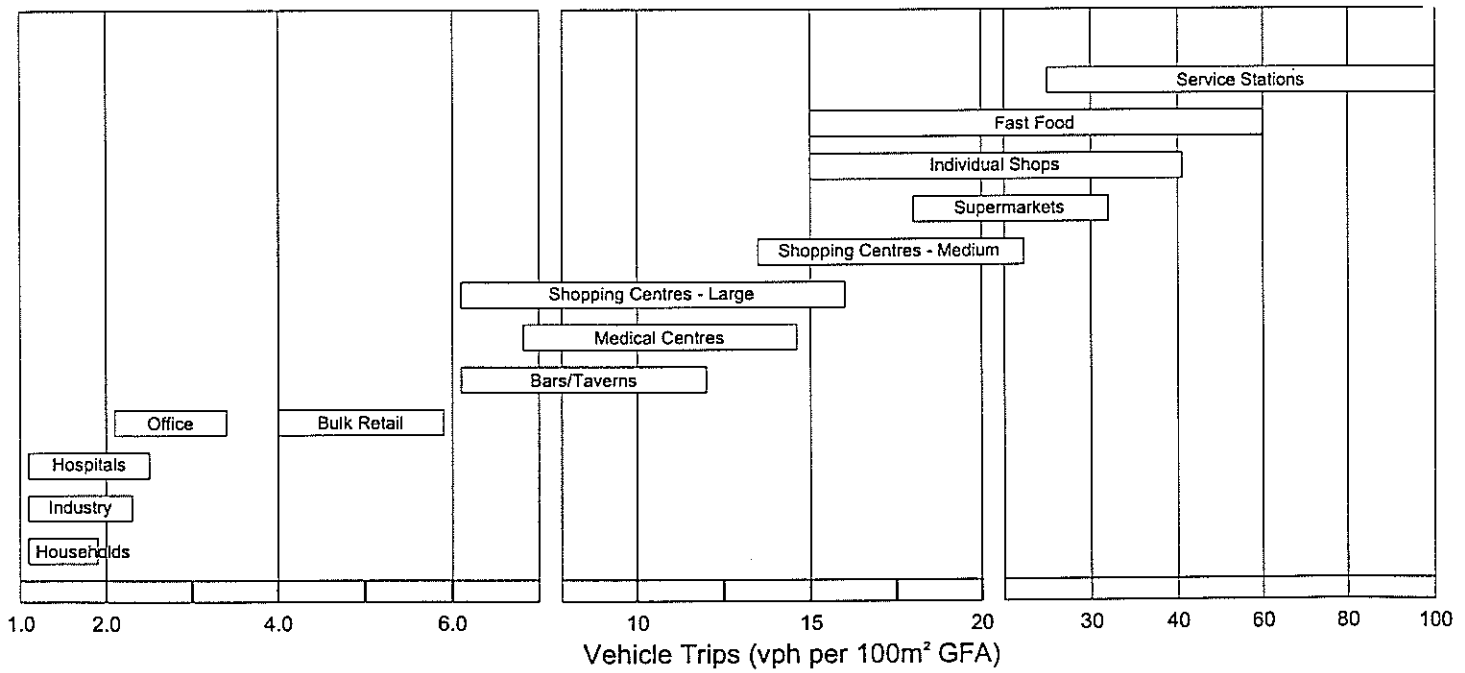
Table 7.1 also includes the person trip generation by land uses in the 1970s. These were not surveyed in the 1990s.

Figure 7.1 illustrates the relative position of these land uses in terms of the peak hour trips. The 1990s figures are for vehicle trips per hour. The 1970s figures are for person trips with the percentage vehicle mode split shown derived from RRU Bulletin 15, so vehicle trips may be inferred if required.

Figure 7.1 Comparison of trip generation between 1970s and 1990s



A. PERSON TRIP GENERATION 1970's  
(Bars Span Between Average to Peak Design Hourly Flows)  
(% arrivals car drivers, source : RRU15)



B. VEHICLE TRIP GENERATION 1990's  
(Bars Span Between Average and Peak Hour Design Rate at 90 % Satisfaction)

## 7.2 Parking Demand Comparisons

A convenient table was included in RRU Bulletin 15, and this is repeated here for both the 1970s and the 1990s as Table 7.2.

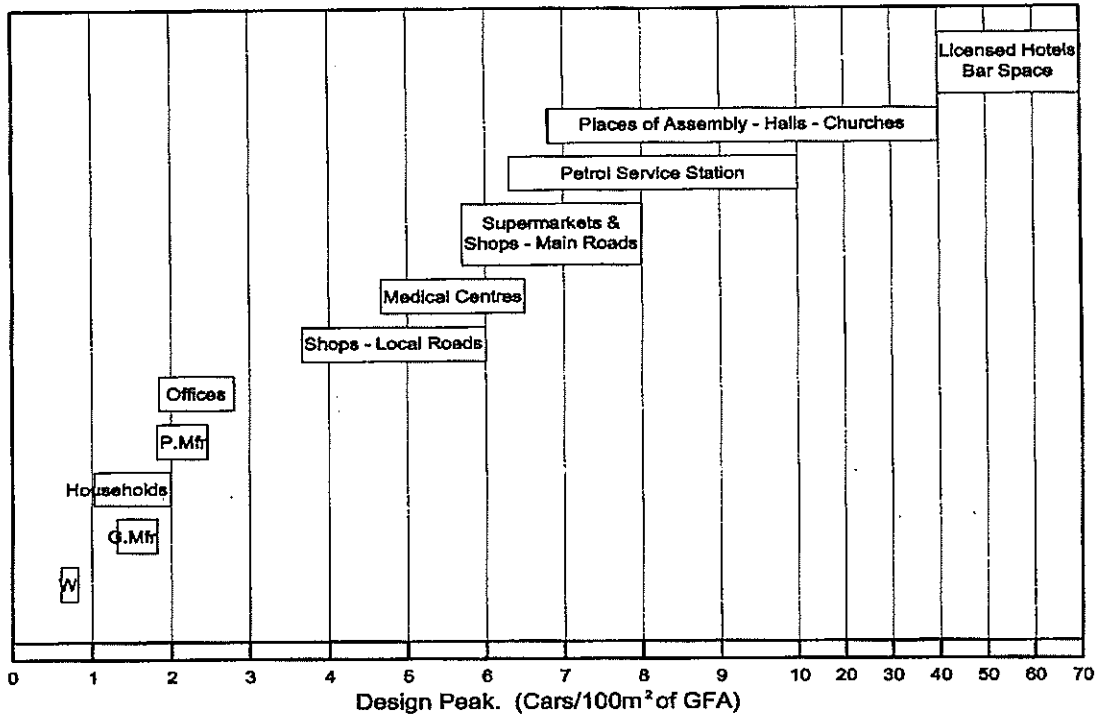
**Table 7.2 Summary of parking demand, 1970s and 1990s**

ACTIVITY	PARKING DEMAND (spaces/100 m <sup>2</sup> GFA)				
	Percentage satisfaction 1970s		1990s		Change
	50%	85%	50%	85%	
Hotel, taverns, bar	60	70	7	11	-84%
Churches, halls and places of assembly	20	40	30	50	+25%
Supermarkets and main road shops	6.0	8.0	5.0	7.0	-12%
Medical centres	4.8	6.5	5.0	6.5	0%
Local road shops	4.0	6.0	3.8	4.6	-23%
Offices	1.5	2.8	2.5	3.7	+32%
Precision manufacture and textiles	1.8	2.5	2.0	2.8	+12%
General manufacture and engineering	1.1	1.7	1.5	2.3	+35%
Warehousing	0.6	0.8	0.8	1.0	+25%
OTHER ACTIVITY UNITS	PARKING DEMAND (spaces per other unit)				
	50%	85%	50%	85%	
Residential (per household)	1.1	2.0	1.4	2.8	+40%
Cinemas and theatres (per patron)	0.3	0.5	0.4	0.6	+20%
Churches (per congregation)	0.2	0.3	0.3	0.4	+30%
Hospitals (per bed)	0.7	1.0	1.6	2.5	+150%
Primary schools (per staff)	0.5	0.7	0.8	1.0	+42%
plus (per pupil (3pm))	0.01	0.05	0.15	0.20	+300%
Sport					
• major fixture (per spectator)	0.2	0.3	0.3	0.5	66%
• club game (per spectator)	0.4	0.7			
Swimming lido (per spectator)	0.15	0.2			
Service station (per employee)	1.0	4.5			
University (per staff)	0.3	0.4	0.4	0.6	+50%
(per student)	0.15	0.2	0.2	0.33	+65%

While the ratio of parking to employees is appropriate to cover a wider range of land uses, the most practicable unit for planning codes is still spaces/100 m<sup>2</sup> GFA. This has the advantage of being measurable and also independent of employee occupancy in the future. Table 7.2, however, gives many uses on a per employee or per patron basis, where floor area is not the most appropriate means of definition.

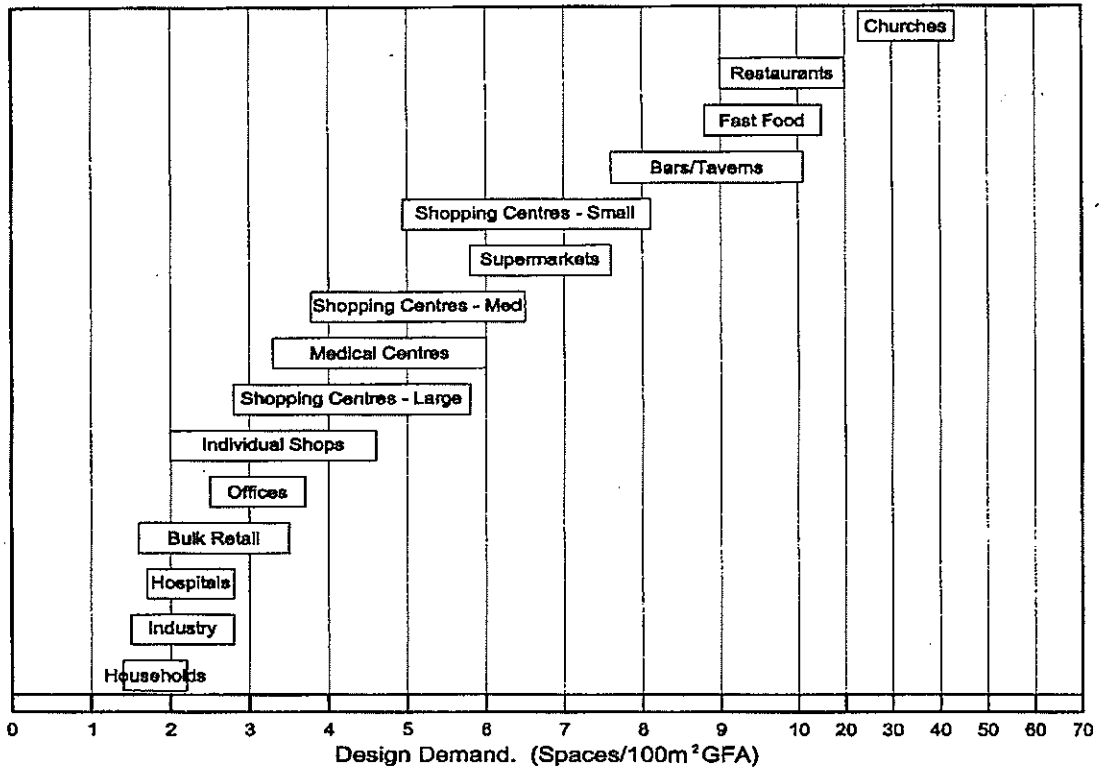
Figure 7.2 illustrates the car parking demand by land use in the 1970s contrasted with that in the 1990s. The trend in parking demand, with the exception of retail, shows an increase of between 20% and 30%. Retail car-parking demand has not increased and in some instances has reduced marginally. Increased parking at hospitals (+15%), universities (+65%) and sporting fixtures (+66%) reflects the major change in demand and community needs and interests. The dramatic drop in hotel car-parking

Figure 7.2 Comparison of parking demand between 1970s and 1990s



A. CAR PARKING DEMAND BY LAND USE 1970's

Bars span between 50% & 80% demand  
 P.Mfr. = Precision & Textile Manufacture  
 G.Mfr. = General & Engineering Manufacture  
 W = Warehouses



B. CAR PARKING DEMAND BY LAND USE 1990's

is due to both a change in the hours of business and a major increase in the number of bars and licensed restaurant outlets.

### 7.3 Travel Changes, 1970s to 1990s

The changes in retailing have been discussed in Sections 2.6, 4.2, 4.4 and 5.1. Two other significant changes in this period have been the disappearance of the central post office, which had a very large employment base, and its replacement by post shops in the retail sections of Figure 7.1, along with the decline in government administrative offices. In addition, some industries which used to have heavy distribution activities are now supported by a much expanded transport and courier service. Thus the distributor industry class has been replaced by transport centres and courier depots, and the latter have not been well surveyed at this stage.

Another change since the 1970s has been the major increase in fast-food outlets, such as McDonald's, Pizza Hut and Burger King. Surveys of such outlets indicate that they are high in vehicle trip generation. When they are located in conjunction with a shopping centre, a large number of patrons arriving on foot may also contribute to the total person trips.

The essence of the pattern of increasing trip generation lies, as it did in the 1970s, in the number of visitors on a personal errand, especially shopping. Employee and business-related trips, including goods vehicles, have remained relatively constant over a wide range of uses. However, where the establishment has a specific distributive or "drive-in" function (e.g. petrol, liquor, fast food), the vehicle trips have increased significantly in relation to both the employment numbers and the floor area.

Service stations have been subject to change, with a smaller number of higher-capacity stations. The abolition of motor spirits trade licensing has meant that many service stations no longer have a mechanical workshop, but now frequently sell food, soft drinks and newspapers, and so serve a "corner store" function.

The various trip types (e.g. home-based work, employees on business or private trips and visitors making business or private trips to an establishment) have not been resurveyed comprehensively for all modes for the 1990s situation. However, based on car driver trips modelled in 1999 for Christchurch, the relative contribution of the trips to the four grouped trip purposes is given in Table 7.3.

**Table 7.3 Trip purposes, 1970s and 1990s**

Purpose	1969	1996
Home to work	26%	12%
Home to visit shops	24%	12%
Home to/from other	16%	25%
Not home-based	34%	51%
Total car trips (24 hours)	350,000	760,000

While the percentage of from home to work and from home to visit shops is less, the absolute number has remained constant. The major increase has been in the additional not home-based trips, most of which are, of course, to shopping centres or on recreation. The increase in this trip purpose, in absolute terms between 1969 and 1996, has been by a factor of 3.3. This is by far the largest growth area, and these additional 270,000 trips are made largely outside the morning and afternoon peak hours.

#### **7.4 Application to District Plans**

The 1982 report by John Chivers discussed the site-specific car-parking requirements in district schemes for business and employment uses:

All New Zealand district schemes contain requirements for private developers to provide off-street car parking for new developments. Different land uses generally have different requirements, based on the expected intensity of the use and its vehicle parking demand and trip generating capability. These standards are partly historic and based on experience and partly based on the results of research into traffic activity at the site specific level (e.g. RRU Bulletin 15) [and now this report].

The report included results from a comparative survey of district scheme codes of ordinances and parking requirements for the more common land uses. Chivers commented:

It would be expected that these car parking standards would be related to fairly specific policies in the Scheme statement about the level of car parking to be provided related to say a 30th highest hour standard or an 85% satisfaction to be achieved. Unfortunately this is rarely the case.

In this situation, car-parking standards may appear somewhat arbitrary.

As with many town planning and resource management matters, control is achieved through the application for a consent to develop or redevelop either by new building or by a change of use not permitted as of right. Where an area is being developed from vacant land, then the car parking requirements will be achieved on all developments as they progressively occur. However in an existing area that was fully developed before the district plan scheme became operative and where there was already a substantial parking deficiency, then the rate at which that overall deficiency will be removed will depend on:–

- (a) The rate at which redevelopment takes place, and
- (b) The standard of car parking prescribed.

These general conclusions also apply to the 1990s. The rate of redevelopment depends on external economic factors largely outside the council's control. In the 30 years since 1970, most retail areas have, due to both council rules and developer investment interest, added extensive off-street parking areas which now more closely match demand.

In the context of the use of a particular building over its life of, say, 50 years, it is difficult to anticipate at the outset whether parking demand will vary with changes in future use. The definition of uses in the current effects-based district plan should use car-parking demand as one of the standards of site performance in each zone. This should then enable the car-parking provisions of a development to be correctly adjusted in the event of an application for a consent to a change in the character of the use. This does require, however, that the district plan rules be explicit in terms of parking thresholds.

This project has recommended that the car-parking standard to be used should be related to an appropriate design hour and, for commercial retail uses, this should generally be equivalent to the 30th highest hour of the year. Councils will wish to include provisions for cash in lieu and parking dispensations, i.e. the number of car-parks supplied in practice may be reduced, subject to pre-determined rules, from the district plan standard. This relationship between the policies, the rules in the district plan, standards for design, and any shared responsibility between the council and the developer, are matters appropriately dealt with in the district plan.

The important issue is that the district plan's objectives, policies and rules should be justified rationally. District plans should not, as several at present unfortunately do, rely on arbitrary definitions of land use or political decisions as to the parking spaces to be provided for different uses.

During this research several district plans which have very low standards were found, e.g. retail activity at 2 spaces per 100 m<sup>2</sup> GFA, restaurants at 1 space per 10 persons, hostels at 1 space per 10 beds, and tertiary educational activities all 1 space per 4 staff and 1 space per 20 students.

It appears that a number of district plans still have parking provisions which were rolled over from the pre-1991 era without any rational or detailed survey and review to update the standards set.

## **7.5 Suburban Shopping Centre Parking Arrangements**

In suburban areas and growing provincial cities, with their single-storey buildings and readily available land for a development and its associated parking, it has generally been possible in the last 30 years to ensure that additional parking was provided off-street and close to the supermarkets, retail warehousing and businesses being developed. For those councils which adopted a rational parking demand figure based on surveys in the 1970s, the balance between parking spaces and floor area in most suburban shopping centres has been satisfactorily resolved.

In the future it may be more appropriate to establish an average figure for the whole suburban shopping centre with all of its mixed uses, with a bias towards higher values for intensive retail supermarkets, rather than have different rates for the many different uses within the centre. This global approach enables full advantage of shared use of spaces to be taken. For any given size of suburban shopping centre, it is generally possible to assess the mixture of "magnet stores", local stores, fashion

stores and other services by comparison with existing establishments. This may involve the council in negotiation and trade-off with different owners.

## **7.6 Industry**

For industrial uses, the figures established in the 1970s generally still apply. The RRU Bulletin 15 figure for all industries was between 1 and 2 spaces per 100 m<sup>2</sup> GFA. In addition, a small provision has to be made for visitors. Over the past 30 years, this figure has been unchanged and generally an adequate provision. However, where industrial buildings are being converted to retail or wholesale (as has occurred, for example, along Blenheim Road in Christchurch, and in the inner-city periphery areas of Dunedin and Wellington), a considerably increased parking supply is required. This applies particularly to the conversion of traditional warehouses to warehouse-retail or bulk retailing establishments, and also to manufacturers starting to sell direct to the public. Obviously, under New Zealand's "effects based" planning, the monitoring of changes should reveal any increased parking demands and ensure that off-street parking is provided.

## **7.7 Discussion of Changes from 1970s to 1990s**

The first conclusion is that the change in trip generation and parking demand for a number of land uses studied has not been as great as might have been expected, largely because of the averaging effect of our more dispersed communities. The higher level of mobility enjoyed by almost everyone and the market-led nature of current developments, where a greater number of retail or service outlets is available, have contributed to a spreading of activities throughout the urban areas. The result is that individual sites enjoy about the same or a modest increase in turnover activity and associated parking and trip characteristics as they did before.

Some sites, however, have experienced an increase in motor vehicle trip generation because of a falling-off in public transport use, bicycle trips and walking trips. Other sites have experienced a marked decrease because of changed shopping or patronage habits (e.g. for hotels and restaurants, the marked change in drinking hours and the increased number of outlets). For retailers, the shift to Saturday and Sunday trading has, in some cases, shifted the design day (i.e. the day containing the nominated 30th highest design hour) from Friday to Saturday.

Parking is provided both on-street and off-street. The combined effect of increased traffic congestion and traffic management improvements, on the one hand, and the gradual implementation of district scheme parking requirements for off-street parking, on the other, has significantly altered the balance between on- and off-street parking over 30 years. In suburban areas, it is now expected that all parking associated with major shopping centres and other land uses will be provided off-street. In the city centre, some of the former street parking areas have now been taken over by "pedestrian only" streets, while others are taken up by bus stops, bus lanes, cycleways and peak hour clearways. However, the first-used short-term parking is still kerbside, and in most cities 1000 or more street spaces are used in that way.



These spaces are limited, however, and are being complemented by off-street parking areas and parking buildings.

Trip generation rates have mostly undergone only small changes. Overall, the mid-morning and afternoon times of the day have seen more trips made. The increase on Saturday and Sunday associated with retail and recreational activities has been dramatic. This change has resulted in many suburban streets and highways carrying their 1990s design hour peaks on Saturday rather than Friday, as in the 1970s, and some roads now have higher off-peak flows throughout the weekend.

## **8. Survey and Projection Practice**

### **8.1 Sources of Information**

A full understanding of the proposed development is essential to predicting vehicle activity levels. The designer and planner must appreciate both the direct effect of the physical features of a site and the indirect factors such as catchment, competition and surrounding transportation systems. The likely catchment areas of the site affect the number of customers and visitors attracted, as well as determining the broad mode of travel characteristics. How the development is expected to interact with neighbouring activities, of a similar or complementary nature, will determine some of the patterns of vehicle activity, such as the duration of parking stay within a shared parking area.

One of the most important elements in determining the effects of traffic-generating activities is the collection of relevant data. In most situations where new developments are proposed, there will be only limited sources of information about the particular site or activity. While a major shopping centre, for example, will generate trip making and parking demand patterns similar to equivalent centres, there will always be variations and influences which surveys at other sites do not reveal.

Section 11 provides useful references for the engineer and planner. The RTA and ITE resources provide what the authors consider to be the most comparable and reliable reference data. The range of resources available is further complemented by information published electronically via the Internet. Some of the documents listed in the References are available electronically, while further trip generation and parking demand studies can be readily accessed via search engines.

It is recommended that any project requiring major investigation into trip generation or parking demand be referenced to existing survey information from either this research report or those listed in the References. The more information and supporting data that can be collected for a project, the more reliable the overall outcome in appropriate provision of traffic movement and parking facilities.

Practitioners should make a properly detailed assessment of the effects of the parking and trip making generated by a land-use development. Larger-scale developments will require quite detailed evaluation of travel characteristics, even extending to the use of transportation models based on land use for estimating the site's future level of vehicle trip generation.

### **8.2 Site Surveys**

It is recommended that traffic site surveys be undertaken at appropriate times so as to justify assumptions and estimates made for either a new development or the performance of an existing facility. In collecting surveys for the Database, the focus has been on identifying peak-period trip generation to and from a site, together with the on-site parking accumulation at the busiest period. The quality of information collected by a site survey is closely related to the activity levels observed and

recorded, and the explanatory factors and variables at the site. The survey sheets included in Appendix D suggest the level of information that should be collected about a site and its activity, in order to gain the necessary predictive power for application to that site and other similar sites.

Site surveys should ensure that all of the particular traffic movement and parking accumulation activity of a site is fully covered, including both on-site and on-street parking demands, particularly where overspill parking occurs or more convenient parking is located on the street. Survey organisers should visit and observe the site in question prior to designing any survey. This will allow an appropriate design for both the type of information collected and the period over which it will be most usefully collected. Frequently, not all the information listed in the survey forms is collected, and some surveys are of only limited coverage. The suggested priority for collection is given below.

1. Essential information:

- dates and times,
- gross floor area,
- land-use activity,
- parking space supply (on-site and off-site),
- short-term visitor parking, also employee/long-term car-parking,
- parking demand at given time (peak hour),
- trip generation (vehicles in + out) at (peak hour and daily).

2. Desirable information:

- arrivals by other modes (e.g. bus, bicycle, pedestrian),
- goods vehicle trips and parking,
- arrivals/departures as passengers in vehicles,
- car passenger occupancy rates,
- visitor/customer head counts at intervals during survey,
- number of employees on the site,
- parking duration and distribution (i.e. average stay and standard deviation),
- road classification and traffic passing site.

3. Useful information:

- site size and percentage building coverage,
- trips (in + out) each hour throughout the day, all modes,
- population within catchment (up to at least 2 km radius),
- customers per year, per week, per day, per hour,
- seasonal turnover and trip generation characteristics,
- location relative to other land-use activities and floor areas within 200 m,
- other variables (e.g. pupils, beds, congregation, spectators, pumps or filling positions),
- distance of trip and location of origin of trip for visitors to the site,
- type of land use at origin of visitor trip (e.g. home, business, shops, recreation),
- trip purpose (e.g. trips from home to shop, not home-based, to/from work).

### **8.3 Land Use Descriptions**

It is necessary to identify the type of land use on the survey site. It may also be necessary to describe the groups of activities or whether the site is isolated from other similar land uses.

For the purposes of this research, a simplified set of land uses has been established under these nine principal groups:

1. Assembly
2. Commercial
3. Educational
4. Industrial
5. Medical
6. Recreational
7. Residential
8. Retail
9. Rural.

Within each group, supplementary definitions or key words have been provided so as to describe the activity precisely (see Appendix B). All sites surveyed in future should be described by these key words at least.

### **8.4 More Mode Split Surveys**

Following on from the discussion on the changing face of general transport activities in New Zealand (see Section 1.5), it is suggested that any site trip generation and parking demand survey should include as much information as it is practicable to collect, including goods vehicles and the different modes of travel, rather than recording only vehicle-based activity. The increasing reference to the principles of “sustainable transport” means that survey design should incorporate increased awareness of the contribution to the total transport system of public transport, pedestrian and cycle trips, and the extent of car passenger travel as well as car drivers. This may require more on-site interview surveys to fill the trip mode gap.

Suggested survey sheets for undertaking such total transport surveys are included in Appendix D. Surveys following this general methodology will capture the total person travel of a site and activity, differentiated by the various modes of travel. The effect of goods vehicle movement is also recognised, including that of heavy goods vehicles (HGVs) as well as the increasing proportion of light goods vehicles (LGVs) and courier van deliveries, particularly to retail and commercial activities.

### **8.5 Adjusting to Design Hours**

As the preceding sections have emphasised, any survey intended to provide design guidance for a particular land-use activity should be adjusted to a suitable design level. Average parking or average trip generation figures are of no value in assessing standards for design or traffic congestion and trip assessments at a particular site.

This report suggests that the 30th highest hour be adopted as an appropriate design level. Section 2 gives guidance on applying seasonal, daily and hourly design factors in order to arrive at an appropriate design level that provides the necessary efficiency and convenience for parking and trip generation. This level recognises that there is some inefficient use of resources if a traffic circulation or parking supply is designed to accommodate the peak demand in a year, and that in most retail and commercial activities the 30th highest hour approximates to the alternative industry standard of 90% satisfaction. The 85% satisfaction standard approximates to the 50th busiest hour and, at the upper extreme, the 20th highest hour approximates to 95% satisfaction.

The methodology in Section 2 provides practitioners with a general approach to the selection of an appropriate design level, while also recognising that local and regional information can be built into the design level assessment.

The planner of a trip generation or parking demand survey should take due cognisance of the time-related and seasonal effects through the course of trading or activity hours when extrapolating the survey data for facility design. Although the particular values and design factors presented in this report may be adjusted at the discretion of the transport planner or engineer, the basic methodology behind the application of seasonal, daily and hourly design factors will remain largely the same.

## **8.6 Rational Projection**

Simple extrapolation of survey data from one site to another, or from one activity to another, should be done with caution. The planner or engineer's discretion should be exercised when applying a set of surveyed trip generation or parking demand values to a new site or a site elsewhere in the country. In the absence of appropriate references, there is no option but to undertake more field surveys.

The prudent planner or engineer will seek out as much information as possible from the references in this report, as well as drawing on any other published information which may be available. The more information relating to a particular planned development that can be collected, providing a range of possible trip generation and parking demand rates, the better the basis upon which to give advice, make projections and recommend designs suited to future needs.

## **8.7 Census and Sample Surveys**

Many business research and household census-type surveys are made throughout our communities. Fortunately, the national five-yearly census still includes the question on mode of travel for "trips to work" and origin and destination. This is invaluable where it can be captured from the "Supermap" software package distributed by the Department of Statistics.

More traffic information could be collected from self-administered “log type” travel survey forms. Even if only 100 people in each city volunteered, it would be a rich source of basic information.

Such research on land-use relationships, and also other traffic-related research, would benefit from more regular and independent trip records.

### **8.8 Areas for Further Survey**

While some areas, such as retail and suburban residential land uses, are well represented in the Surveys Database, there are also some obvious gaps. These include:

1. Trip generation:

- goods movements (all land uses),
- pedestrian movements (all land uses),
- schools, secondary and primary,
- places of assembly and entertainment,
- restaurants, large and small,
- offices, both suburban and in CBD,
- industries and warehouses,
- gymnasiums and keep-fit classes,
- trips to work questionnaire surveys (all land uses),
- hotel residential,
- multi-unit and apartment buildings.

2. Parking demand:

- schools, on-site and street,
- recreation stadiums and arenas, sports fields and courts,
- offices,
- gymnasiums and keep-fit classes,
- goods vehicles (all uses),
- places of assembly and entertainment,
- restaurants, large and small,
- multi-unit and apartment buildings.

These should be surveyed and added to the database as opportunity permits.

## **9. The Way Forward**

### **9.1 A Central Clearing House**

It is important that this newly established, national Trip and Parking Surveys Database is maintained, as a source of information for those making inquiries and also as an ever-expanding technical information base. This work should continue beyond 2001: "It is less work and easier to keep up than to catch up."

Future maintenance of the Database should be undertaken by an independent provider on behalf of those agencies who use the data and undertake such surveys as a routine matter of fieldwork, e.g. city and district councils, and consultants working for both public agencies and private developers.

### **9.2 Transfund Contracts**

Transfund New Zealand has supported this project and it is recommended that, at least for the next year, it remain involved in sponsoring the ongoing development and maintenance of the Database and its transfer into practice.

While it is possible, in the long term, for a user-pays system of maintaining the Database to be developed, this could be established only after all parties had accepted and become accustomed to taking advantage of the information it contains. It is therefore suggested that Transfund enter into an arrangement with a suitable contractor to act as the "post box" for this information and to manage and maintain the Database. The contract should also include provision for the dissemination of information and criteria for responding to requests.

### **9.3 Process for Forwarding Information**

The most important aspect, however, would be the knowledge, for those who do surveys in the field and use the standard survey forms, that they would be able to forward these forms to the managers of the national Surveys Database, thus ensuring its continuous updating and revision. In addition, the survey results presented as part of resource consent applications and evidence at council hearings and Environment Court appeals could also be included.

The city and district councils are in a position to ensure that such surveys and survey results are forwarded to the contractor responsible for the collection and collation of the information as additions to the national Database. Perhaps some incentive like making data available without fee could be offered in the future.

Information from hearings could add as many as 500 more survey sites a year. This in turn would build up the national Database rapidly and facilitate additional research.

It is suggested that the Ministry for the Environment be appraised of this Database and asked to encourage the transfer of the information to practitioners, and to recognise the value of incorporating the results of traffic assessments prepared as part of resource consent Assessments of Environmental Effects into the national Surveys Database.

#### **9.4 Professional Monitoring**

To ensure that the information is maintained in a form that is useful to those who undertake surveys, those who seek information from the Database, and those using the information in expert evidence before the Environment Court, it is desirable that there be a professional monitoring process. Two levels of monitoring are required.

The first is to ensure that there is a good understanding among the profession as to the content, standards, coverage and utility of the information. For this monitoring to be effective it is suggested that there be an annual report from the Database manager to Transfund and the IPENZ Traffic Management Workshop. Suitable performance indicators will need to be identified for the management of the Database.

The second is the more detailed level of interpretation of results, and ensuring consistency in the use of survey forms and any preliminary analysis by the agency or consultant who obtains the results in the field. For this monitoring, it would be desirable for Transfund to appoint a competent transportation planner to act as a peer reviewer, to vet the files and ensure sound methodology in recording the information collected.

This monitoring process would mean publication of a yearly progress report and summary information, possibly in *Transearch*, and could also lead to research papers.

#### **9.5 Exchanges with Overseas Agencies**

While it is always possible and desirable to exchange data with our Australian and American colleagues, there is little likelihood of sharing a common database at this time. It is suggested, however, that this research paper be forwarded to the equivalent Australian, American and British agencies as a basis for future exchange of information. This in turn could facilitate comparative research, giving greater confidence in the quality of the information and leading to the identification of some interesting trends over time.



## 10. CONCLUSION

The research project to develop a New Zealand Surveys Database of “Trip Generation and Parking Demand Related to Land Uses” began in 1998 and has been completed with 463 site surveys collected and analysed. The comparison of New Zealand data with American and Australian information has shown much material and many traffic characteristics in common.

The changes in trips and parking between the 1970s, when the earlier comprehensive RRU Bulletin 15 was prepared, and the 1990s have not, overall, been as dramatic as might have been expected, and in many land uses there has been little change. In some other land uses, there have been increases of about 20%. Overall, however, the intensity of traffic activity at the individual site level has remained much as it was 30 years ago.

Appendix C provides a summary of trip generation and parking demand derived from these surveys. It should be noted that some of these involved only a small sample of sites.

We conclude that, while there has been a general increase in total traffic by a factor of 2.2 during the past 30 years, this growth is distributed relatively evenly to new developments around our urban and rural areas, so that trip making is shared between existing and new sites as New Zealand’s dispersed cities expand further and become more diverse. This diffusion of activities and traffic is placing a greater load on the road networks. But at individual sites the traffic generation has not increased as much as the rate of car ownership or traffic growth.

The comparisons with both the RTA and ITE manuals presented in Section 6 show a general consistency between similar activities across international borders. The vast number of sites for which survey information has been collected by the ITE gives that trip generation manual a particular value in relation to planned land-use development predictions. While the ITE manual covers over 3200 individual trip generation surveys across 130 land-use activities, there are still gaps in the types of land use for which information may be needed in New Zealand.

The feasibility of continuing to maintain the national Surveys Database compiled during this project, and the effective transfer of the information to practitioners as users, have been established and should now be explored further.

## 11. References

### 11.1 New Zealand References

Auckland Territorial Local Authorities (Manukau City Council, Waitakere City Council, North Shore City Council, Auckland City Council, Rodney District Council). 1994. *Parking and traffic generation study 1992–1994*.

Burgess, J. M. 1981. Trip generation of vehicle-intensive commercial land-uses. *Road Research Unit Report No. 52, Vol. 2*.

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### 11.2 Australian References

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Roads and Traffic Authority (New South Wales). 1984. *Policies, guidelines and procedures for traffic generating developments*. Roads and Traffic Authority (New South Wales), Sydney. (See also [www.rta.nsw.gov.au](http://www.rta.nsw.gov.au)).

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Watters, B., Sulieman, S. 2000. *Review of RTA's Guide to Traffic Generating Developments*. Roads and Traffic Authority (New South Wales), Roseberry.

### 11.3 American References

Institute of Transportation Engineers (ITE). 1995. *Trip Generation*, update to fifth edition. ITE, Washington, D.C. (See also [www.ite.org](http://www.ite.org)).

Institute of Transportation Engineers (ITE). 1987. *Parking Generation*, second edition. ITE, Washington, D.C. (See also [www.ite.org](http://www.ite.org)).

Institute of Transportation Engineers (ITE). 1997. *Trip Generation*, sixth edition. ITE, Washington, D.C. (See also [www.ite.org](http://www.ite.org)).

Institute of Transportation Engineers (ITE). 1998. *Trip Generation Handbook – Proposed Recommended Practise*. ITE, Washington, D.C. (See also [www.ite.org](http://www.ite.org)).

Urban Land Institute (ULI). 1998. *Parking Requirements for Shopping Centres*, second edition. ULI, Washington, D.C. (See also [www.uli.org](http://www.uli.org)).

### 11.4 Other Useful Web Sites

Australian Department of Transport and Regional Services  
[www.dotrs.gov.au](http://www.dotrs.gov.au)

AUSTROADS  
[www.austroads.com.au](http://www.austroads.com.au)

Department of Environment, Transport and Regions, United Kingdom  
[www.detr.gov.uk](http://www.detr.gov.uk)

VicRoads Australia  
[www.vicroads.vic.gov.au](http://www.vicroads.vic.gov.au)

## Appendix A

### Surveys Database – Summary of Data Sources

#### AUCKLAND TLA STUDY 1992-1994

Assembly	3
Commercial	7
Education	9
Industry	6
Recreation	7
Residential	6
Retail	68
<b>TOTAL</b>	<b>113</b>

#### CHRISTCHURCH CITY COUNCIL (AND CONSULTANTS)

Assembly	23
Education	5
Medical	3
Residential	15
Retail	48
<b>TOTAL</b>	<b>94</b>

#### OTHER COUNCILS

Industry	1
Residential	35
Retail	2
<b>TOTAL</b>	<b>38</b>

#### TRAFFIC DESIGN GROUP

Commercial	2
Education	5
Industry	1
Medical	5
Recreation	2
Residential	6
Retail	36
<b>TOTAL</b>	<b>57</b>

#### GABITES PORTER CONSULTANTS

Education	2
Medical	2
Recreation	17
Residential	3
Retail	20
<b>TOTAL</b>	<b>44</b>

#### DOUGLASS CONSULTING SERVICES

Education	4
Industry	3
Medical	1
Recreation	1
Residential	3
Retail	4
<b>TOTAL</b>	<b>16</b>

#### TRANSPLAN CONSULTING

Industry	1
Medical	4
Recreation	2
Residential	4
Retail	1
Rural	1
<b>TOTAL</b>	<b>13</b>

#### OTHER CONSULTANTS

Recreation	1
Retail	1
Rural	1
<b>TOTAL</b>	<b>3</b>

#### UNIVERSITY OF CANTERBURY (BE projects)

Recreation	1
Retail	68
<b>TOTAL</b>	<b>69</b>

#### UNIVERSITY OF AUCKLAND (ME Thesis)

Education	16
<b>TOTAL</b>	<b>16</b>

<b>GRAND TOTAL</b>	<b>463</b>
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## Appendix B

### Land-use Activity Groups

This Appendix lists (in alphabetical order) and defines the activity groups adopted for analysing the survey data collected for this project. Nine major groups have been developed, representing the major types of activities, within which there are further subdivisions. The groups generally coincide with land-use descriptions used in district plans. It is accepted that there will be activities which do not neatly fit into any one particular activity group. Any practitioner investigating a particular land use will need to study a range of data categories as well as individual sites in order to select the appropriate description for the activity in question.

Note: it is important that all sites be described by at least two key words selected from the first two levels of definition. Further description may be added but all uses should be assigned first to one of these nine land uses and then to one of its subdivisions, so that future Database searches will not miss items.

#### 1. Assembly

- 1.1 **Church** – traditional church buildings as well as other religious and spiritual meeting-places. The actual building may fall within another activity grouping, e.g. community centre/hall, but at certain times of the week caters for church-based or similar spiritual activities.
- 1.2 **Community centre/hall** – providing generally for the assembly of the public and community groups. These may also involve other ancillary activities, e.g. Citizens' Advice Bureau.
- 1.3 **Gallery** – all art and exhibition spaces.
- 1.4 **Museum** – public and private facilities displaying items of general and specific interest, ranging from small community facilities through to the national museum.
- 1.5 **Cinema** – including traditional single-screen, stand-alone facilities and multi-screen, multiplex cinemas.
- 1.6 **Theatre** – places of live performance and which may also have café/bar facilities on-site.

#### 2. Commercial

- 2.1 **Office** – traditional commercial facilities where administrative and professional consultant services are provided. This category is divided into three sub-categories:
  - 2.1.1 **central business district (CBD)**
  - 2.1.2 **suburban**
  - 2.1.3 **park.**

- 2.2 **Banks** – including financial instruction and mail-service centres with direct service to the visiting public.
- 2.3 **Services** – office operations where personal services such as insurance, accounting and real estate and other personal professional services (excluding medical) are provided.
  
- 3. **Education**
  - 3.1 **Pre-school** – including kindergartens, playschools, creches, Kohanga Reo and Montessori facilities.
  - 3.2 **Primary** – state and private establishments, including intermediate schools, catering for Years 1 to 9.
  - 3.3 **Secondary** – catering for Years 10 to 14.
  - 3.4 **Tertiary** – traditional university and polytechnic institutions as well as the increasing range of “education providers” offering Qualifications Authority-approved tertiary courses.
  - 3.5 **Other** – community and specialist education activities, such as WEA offices, training consultants and other training facilities.
  
- 4. **Industry**
  - 4.1 **Storage** – including warehousing, container storage, repacking and storage facilities for consolidation for forward transport (e.g. containers, couriers, mail centres).
  - 4.2 **Contractor** – activities where a range of construction and manual services are undertaken off-site, with administration, storage and transport based at the yard or site.
  - 4.3 **Transport** – activities where vehicles for the transport of goods are based at the site, but the site itself is not used for the storage or processing of those goods.
  - 4.4 **Manufacture** – production sites where raw materials, goods and services are further processed and then distributed.
  
- 5. **Medical**
  - 5.1 **Centre** – broad category of general and specialist medical facilities, further subdivided according to the number of medical professionals engaged within the centre:
    - 5.1.1 **small** (1 to 5 professionals)
    - 5.1.2 **medium** (6 to 10 professionals)
    - 5.1.3 **large** (11 or more professionals).

**5.2 Hospital** – all public and private hospital facilities providing both day and overnight surgery and care, further subdivided as:

**5.2.1 small** (up to 50 doctors)

**5.2.2 large** (50 or more doctors).

**5.3 Veterinary** – facilities dedicated to the care and treatment of animals, and involving the sale of pet and animal-related products.

## **6. Recreation**

**6.1 Stadium** – indoor or outdoor seated venues catering for both sporting and cultural events.

**6.2 Gymnasium** – facilities for sports and fitness training, either as stand-alone commercial operations or attached to other facilities such as a university or school.

**6.3 Aquatic/pool** – the range of facilities from stand-alone swimming pools to the modern aquatic centre providing water-based activities of many kinds and catering for a wide age range.

**6.4 Indoor courts** – including the traditional range of racquet and ball sports.

**6.5 Outdoor courts** – for sporting activities generally requiring a hard surface, including netball and tennis.

**6.6 Sports fields** – outdoor sporting facilities with primarily grass or artificial turf surfaces for summer and winter team sports but not associated with major audience stands and facilities.

**6.7 Courses** – facilities such as golf courses, and possibly polo fields or similar.

**6.8 Marina** – uses involving the berthing, launching, repair and storage of boats, and associated social activities.

## **7. Residential**

**7.1 Multi-unit** – residential units attached and grouped together and numbering more than 10 individual household units collectively.

**7.2 Townhouse** – groups of attached and semi-detached households generally one or two storeys high, and with 10 or fewer units per site.

**7.3 Dwelling** – traditional detached dwelling-houses, with one or two household units per site.

**7.4 Home** – the range of residential and care facilities for the elderly and other age-groups, sometimes providing on-call and full-time medical and hospital care.

**7.5 Hostel** – communal residential facilities catering for e.g. students and institutional workers such as nurses or project construction workers.

- 7.6 **Motel** – standard travellers’ accommodation facilities catering for vehicle-based travel and typically without on-site drinking or restaurant facilities.
- 7.7 **Hotel** – travellers’ accommodation facilities which include restaurant and bar facilities on-site, and sometimes also catering and conference facilities such as seminar rooms.

There will be variations in many of these main residential uses between locations. For standard family/household residential types (multi-unit, townhouse and dwelling), a further sub-category may need to be added defining the geographic or suburban context, e.g.

- 7.1.1 **inner-city**
- 7.1.2 **intermediate**
- 7.1.3 **outer**
- 7.1.4 **rural.**

## 8. **Retail**

- 8.1 **Shop** – because of the wide range of individual retail outlets, this category has been left relatively broad and further description should be provided within the data record itself.
- 8.2 **Shopping centre** – collection of retail shops and services where joint facilities are shared, such as parking and access, subdivided into:
  - 8.2.1 **small** (up to 4000 m<sup>2</sup> GFA)
  - 8.2.2 **medium** (4001 to 10,000 m<sup>2</sup> GFA)
  - 8.2.3 **large** (over 10,000 m<sup>2</sup> GFA)
  - 8.2.4 **central business district (CBD).**
- 8.3 **Garden centre** – typically an indoor storage and display area in conjunction with an outdoor area, sometimes including other on-site facilities such as a café.
- 8.4 **Discount** – operators such as The Warehouse, K-Mart and Briscoes.
- 8.5 **Supermarket** – a single establishment with a wide range of food and other retailing operations, ranging from the larger convenience store (e.g. Star Shop, 7-11) to the grocery warehouse (e.g. Pak 'n' Save).
- 8.6 **Bulk** – a recent addition to the range of New Zealand retailing facilities, covering large retail activities selling bulky goods including whiteware and home furnishings.
- 8.7 **Restaurant** – eat-in, sit-down restaurant facilities (excluding fast-food and takeaway outlets).
- 8.8 **Fast food** – activities involving the preparation and sale of food to be eaten elsewhere, sometimes including drive-through ordering and pick-up.
- 8.9 **Bar** – a wide range of drinking places, from small licensed café/wine bars to the more traditional taverns and pubs.



- 8.10 **Service station** – a site providing primarily for the sale of petrol and other fuels, often including other motoring accessories and services such as car grooming and car washes. On-site food and other retail facilities are also expected from most modern service stations.
- 8.11 **Market** – an area either formally or informally arranged to provide for the wholesale or direct selling of fruit, vegetables and other items, e.g. Turners and Growers wholesale fruit and vegetable markets/auctions, as well as community markets held in parks, public squares and at schools.
- 8.12 **Produce** – primarily roadside stalls and other specialist fruit and vegetable retailers.

## 9. Rural

- 9.1 **Farming** – includes the raising of livestock and growing of crops for animals or human consumption manually from pastureland.
- 9.2 **Horticulture** – orchards, market gardens and intensive agriculture.
- 9.3 **Factory** – sites where stock and poultry are housed and managed in factory-farm facilities.
- 9.4 **Stalls** – roadside stalls for sale of produce to the passing public.
- 9.5 **Vineyards** – where grapes are grown and processed, often also providing wine sales, tasting and sometimes restaurant facilities.
- 9.6 **Processing** – primary-processing yards, timber mills, cheese factories, milk-processing plants, etc.

This wide group of activities is intended to cover all sites and operations which might come under the scrutiny of traffic engineers and planners. Within these divisions there is scope for adding further specialist activities. Further description can also be provided in the individual survey notes, if necessary.

## Appendix C

## Summary of Design Trip Generation and Parking Demand

LAND-USE CATEGORIES			Surveys sample sites	Design parking demand (spaces/100m <sup>2</sup> GFA)	Design peak hour trips (vph/100m <sup>2</sup> GFA)	Design daily trips (vpd/100m <sup>2</sup> GFA)
<b>1. ASSEMBLY</b>	1.1 Church		23	0.4/seat	-	-
<b>2. COMMERCIAL</b>	2.1 Office		9	2.8	2.5	20*
<b>3. EDUCATION</b>	3.1 Pre-school		23	0.3/child	1.8/child	-
	3.2 Primary		3	0.2/child	0.6/child	12.5/child*
	3.3 Secondary		5	0.0/student	0.2/student	- *
	3.4 Tertiary		11	0.4/stud + staff, or 2.0/100m <sup>2</sup>	0.20/stud + staff, or 1.1/100m <sup>2</sup>	0.015/stud + staff, or 510/100m <sup>2</sup>
<b>5. MEDICAL</b>	5.1 Centre	5.1.1 Small	2		-	- *
		5.1.2 Medium	4	5.7	14.6	69.4
		5.1.3 Large	2	5.5	5.4	* 39.3
	5.2 Hospital	5.2.1 Small	6	2.7	2.5	12.3
		5.2.2 Large	6	2.5	0.4	10.0
<b>6. RECREATION</b>	6.1 Stadium		16	0.2/spectator	-	-
<b>7. RESIDENTIAL</b>	7.1 Multi Unit	7.1.1 Inner-city	4	1.2/unit <sup>(1)</sup>	0.8	6.8 *
		7.3.2 Intermed.	38	1.6/unit <sup>(1)</sup>	1.3	11.4
		7.3.3 Outer	3	1.8/unit <sup>(1)</sup>	1.5	10.4 *
		7.3.4 Rural	4	1.9/unit <sup>(1)</sup>	1.0	8.0
	7.4 Home		14	0.6/bed	0.5/bed	6/bed
	7.5 Hostel		1	1.75/resident	1.1/resident	- *
	7.6 Motel		7	1.3/unit	1.7/unit	11/unit
	7.7 Hotel		4	2.0	1.3	- *
<b>8. RETAIL</b>	8.1 Shop		14	4.6	41.4	95.1
	8.2 Shopping centre	8.2.1 Small	77	8.1	35.7	-
		8.2.2 Medium	46	6.5	22.3	-
		8.2.3 Large	11	5.4	10.0	87
		8.2.4 CBD	7	3.2	-	-
	8.3 Garden centre		8	4.9	28.0	154
	8.4 Discount		4	7.8	23.3	- *
	8.5 Supermarket		10	7.6	25.9	-
	8.6 Bulk		4	1.9	5.9	- *
	8.7 Restaurant		10	13.5	19.4	128
	8.8 Fast Food		14	11.6	60.1	373
	8.9 Bar		21	11.4	12.0	-
8.10 Service station		13	-	102.7	865	
8.11 Market		2	3.4	2.3	22.9	
8.12 Produce		5	6.7	64.4	-	

(1) These household parking rates are median figures from census. The 90% design figure will be approximately plus 0.3 above the values shown.

\* These results are based on small survey samples of 5 or fewer sites.

Note:

The purpose of this summary schedule is to provide a quick "initial median value" at the start of an analysis. Obviously these values are shown from a wide range of sites which, in many cases, vary greatly either side of the median value shown here. Thus the above values are indicative, providing an overall perspective rather than a definitive set of standards.

## Appendix D

### Sample Survey Sheets

D.1	A. Site Location and Activity.....	1
	B. Parking Demand Survey.....	1
	C. Sketch Site Plan.....	2
	D. Trip Making Environment.....	3
	E. Modal Split of Employee Journeys to Work.....	3
	F. Peak Hour Trip Generation Survey.....	3
	G. Daily Trip Generation.....	4
D.2	Summary Report Sheet.....	5

# TRIPS AND PARKING SITE SURVEY

## A SITE LOCATION AND ACTIVITY

SURVEY NO:

Local Authority, Area, City, Suburb \_\_\_\_\_

Site Name and Street Address \_\_\_\_\_

Site Plan (see reverse of this sheet, PTO)

**Land Use Activity:** (Tick)

Residential <input type="checkbox"/>	Recreation <input type="checkbox"/>	Education <input type="checkbox"/>
Assembly <input type="checkbox"/>	Medical <input type="checkbox"/>	Retail <input type="checkbox"/>
Commercial <input type="checkbox"/>	Industry <input type="checkbox"/>	Rural <input type="checkbox"/>

Other, describe as necessary \_\_\_\_\_

**Scale of Activities:** (Tick One)

Single Unit <input type="checkbox"/>	Group Units <input type="checkbox"/>	Suburban Centre <input type="checkbox"/>	City Centre <input type="checkbox"/>
--------------------------------------	--------------------------------------	--	--------------------------------------

**Frontage Road Type:**

Urban Arterial <input type="checkbox"/>	Urban Collector <input type="checkbox"/>	Urban Local <input type="checkbox"/>	Rural Arterial <input type="checkbox"/>	Rural Collector <input type="checkbox"/>	Rural Local <input type="checkbox"/>
---	--	--------------------------------------	---	--	--------------------------------------

**Comment on Site Situation**  
(if necessary)

Site Area: \_\_\_\_\_ m<sup>2</sup>      Gross Floor Area: \_\_\_\_\_ m<sup>2</sup>

**Number of Employees On-Site:**

Full Time _____	Part Time _____	Total _____
-----------------	-----------------	-------------

**Hours of Operation:**

Weekdays _____	Saturday _____	Sunday _____
----------------	----------------	--------------

**Any Special Factors** \_\_\_\_\_

**Parking Spaces Provided On-Site:**

Staff _____	Visitor / Customer _____	Total _____
-------------	--------------------------	-------------

**Parking Spaces Provided Off-Site:**

Kerbside _____	Other Off-Street _____	Total _____
----------------	------------------------	-------------

**Parking Restrictions On-Site: (Times or Prices)** \_\_\_\_\_

## B PARKING DEMAND SURVEY

**Survey Date:** \_\_\_\_\_ **Day of Week:** \_\_\_\_\_ **Time of Surveys:** \_\_\_\_\_

SURVEY			ON-SITE PARKING			KERBSIDE AND OFF-SITE PARKING			TOTAL	RATE (spaces/100m <sup>2</sup> GFA)
Date	Day	Time	Staff	Visitor / Customer	Sub-Total	Staff	Visitor / Customer	Sub-Total		

**Any comments on Parking Situation:** \_\_\_\_\_

# TRIPS AND PARKING SITE SURVEY

## **C** SKETCH SITE PLAN

*Show buildings and parking areas (note key dimensions in metres)*

SURVEY NO:

# TRIPS AND PARKING SITE SURVEY

## D TRIP MAKING ENVIRONMENT

SURVEY NO:

Number of vehicle entrances / exits (incl trade, visitor and staff): \_\_\_\_\_

Number of pedestrian entrances / exits (incl visitor and staff): \_\_\_\_\_

Distance to the nearest bus stop: \_\_\_\_\_

Is any company transport available or car-pooling arranged? \_\_\_\_\_

Number of fleet vehicles based on site: \_\_\_\_\_

Comments (if necessary): \_\_\_\_\_

## E MODAL SPLIT OF EMPLOYEE JOURNEYS TO WORK (If available or surveyed)

Car Drivers	%	Bus Passenger	%
Car Passenger	%	Cyclist	%
Goods Driver	%	Walk	%
Goods Passenger	%	Train	%
		Total	100%

### MODAL SPLIT FOR ALL ARRIVALS (Estimate total person trips by each mode)

Over the period \_\_\_\_\_ to \_\_\_\_\_

	Number	%		Number	%
Car Drivers			Bus Passenger		
Car Passenger			Cyclist		
Goods Driver			Walk		
Goods Passenger			Train		
			TOTAL	100%	

## F PEAK HOUR TRIP GENERATION SURVEY (AM and PM peaks)

Survey Date: \_\_\_\_\_ Day of Week: \_\_\_\_\_ Times: AM PM

ARRIVAL / DEPART	CARS (Drivers)	CARS (Pass)	GOODS (Vehics)	GOODS (Pass)	WALK	CYCLE	BUS	TOTAL	Trips/hr/ 100m <sup>2</sup> GFA
<b>AM Peak Hour (hr ending _____)</b>									
IN									
OUT									
IN + OUT									
<b>PM Peak Hour (hr ending _____)</b>									
IN									
OUT									
IN+OUT									

# TRIPS AND PARKING SITE SURVEY

## G DAILY TRIP GENERATION

SURVEY NO:

Site Location \_\_\_\_\_

Survey Date: \_\_\_\_\_ Day of Week: \_\_\_\_\_ Times: \_\_\_\_\_ am \_\_\_\_\_ pm

TIME	ARRIVAL / DEPART	CARS (Drivers)	CARS (Pass)	GOODS (Veh)	GOODS (Pass)	WALK	CYCLE	BUS	TOTAL PERSON TRIPS
Hour 1 (_____)	IN								
	OUT								
	IN + OUT								
Hour 2 (_____)	IN								
	OUT								
	IN+OUT								
Hour 3 (_____)	IN								
	OUT								
	IN+OUT								
Hour 4 (_____)	IN								
	OUT								
	IN + OUT								
Hour 5 (_____)	IN								
	OUT								
	IN+OUT								
Hour 6 (_____)	IN								
	OUT								
	IN + OUT								
Hour 7 (_____)	IN								
	OUT								
	IN+OUT								
Hour 8 (_____)	IN								
	OUT								
	IN + OUT								
Hour 9 (_____)	IN								
	OUT								
	IN+OUT								
Hour 10 (_____)	IN								
	OUT								
	IN + OUT								
Hour 11 (_____)	IN								
	OUT								
	IN+OUT								
Hour 12 (_____)	IN								
	OUT								
	IN + OUT								
Surveyed Total (in+out)									

Average Stay Minutes: \_\_\_\_\_  
(if available from observation, number plate counts or interviews)

### TRIP GENERATION SUMMARY

Total Trips (drivers (cars+goods): \_\_\_\_\_trips (in+out), Time \_\_\_\_\_ hrs  
Peak Hour Trips (drivers (cars+goods): \_\_\_\_\_trips (in+out), Time \_\_\_\_\_ hr end

## Parking Demand and Trip Generation Survey Summary Sheet

<b>SITE DATA</b>	Site No.						
	Source of Data						
	Territorial Local Authority						
	Suburb						
	Activity Name						
	Land Use Description						
	Date, Day and Time of Survey						
	Gross Floor Area (GFA m <sup>2</sup> )						
	Other Size (specify value and units, e.g. employees, seats, rooms, beds, site area)						
	Parking Spaces Provided On-site						
	Other Parking Spaces Available On-street and Off-site						
<b>PARKING DEMAND</b>	MAX ON-SITE PARKING DEMAND						
	MAX OFF-SITE PARKING DEMAND						
	(at time)						
	SURVEYED TOTAL PARKING DEMAND RATE (spaces/ 100m <sup>2</sup> GFA)						
	SURVEYED TOTAL PARKING DEMAND RATE (spaces/other unit (specify))						
<b>TRIP GENERATION</b>	<b>SURVEYED ARRIVAL/DEPARTURE FLOW (veh/hr)</b>	<b>AM Peak (veh/hr)</b>	IN				
			OUT				
			IN+OUT				
				time			
		<b>PM Peak (veh/hr)</b>	IN				
			OUT				
			IN+OUT				
				time			
		<b>Daily (veh/day)</b>	IN				
			OUT				
			IN+OUT				
				time			
	<b>PEAK TRIP RATE (IN+OUT) (vph or vpd/100m<sup>2</sup> GFA)</b>		AM				
			PM				
			DAILY				
<b>PEAK TRIP RATE (IN+OUT) (vph or vpd/ other unit (specify))</b>		AM					
		PM					
		DAILY					
<b>COMMENTS AND NOTES</b>							