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TRAFFIC DISTRIBUTION IN A RESIDENTIAL CELL: A CASE STUDY

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ABSTRACT:

An intensive study of the trip generation and traffic distribution within an outer-suburban residential cell was made in response to problems of high traffic volumes on certain streets in the cell, and a corresponding belief that the internal street system was used extensively by through traffic. A traffic survey was conducted to record traffic volumes and vehicle movements in the cell. Simultaneously a questionnaire survey was conducted to determine the trip generation rates and demographic characteristics of the households concerned. It was found that only 4% of the observed traffic was through traffic. The remainder was generated internally. The data were used to study proposals for the redistribution of traffic in the cell, assuming full residential development of the area. Conclusions were reached regarding the environmental design of local street systems and the provision of access to residential areas.

TRAFFIC IN A RESIDENTIAL CELL

INTRODUCTION

A basic transport problem very real to many members of our communities concerns the flow of traffic past their doors; the intrusion of transport vehicles into the thresholds of residences and workplaces. The problem is compounded by a large number of factors, including the surrounding land uses and activities, the type of traffic, the temporal distribution of the traffic, freedom of access to property, the safety of street users, and the attitudes and perceptions of residents, occupants and vehicle users. This paper describes the example of a suburban residential cell in which traffic volumes were considered as either excessive or potentially excessive. Although the individual situation may not seem particularly important by itself, the replication of the situation across an urban area leads to significant problems of conflict between urban activities. These problems must command the attention of urban and transport planners.

Design of Local Street Systems

In recent years considerable research and development has been conducted regarding the design of urban areas, notably residential areas, and the street systems servicing those areas. The problem has been examined from a number of viewpoints, and design procedures based on the concept of a hierarchy of street types to match street functions have been developed. Brotchie (1974), Clark and Lee (1974), Rockliffe and Paterson (1976) and Thomas (1976) have discussed various aspects of the design of residential street systems. Modern subdivision design has made extensive use of the principle of matching street type to intended function. However, there are still subdivisions under development in Australian cities which do not conform to modern design practice. These are usually areas which were subdivided some time ago, but which were not developed until recently. The test area described in this paper is an example of such a subdivision.

The Study Area

An area of Bayswater North in the City of Croydon, Victoria, was selected for study of its trip generation and traffic characteristics because of local concern about the level of traffic on certain streets in the area, coupled with a belief that its street system was used extensively by through traffic. The study area was considered as a complete residential cell because it comprised a clearly defined area with a limited number of access points (6 in all) to surrounding areas and main roads. A plan of the residential cell is shown in Fig. 1. A number of physical and legislative features place definite boundaries on the cell. At the south end of the cell is Canterbury Road, the eastern edge is defined by a creek, while the western edge is the boundary between the municipalities of Croydon and

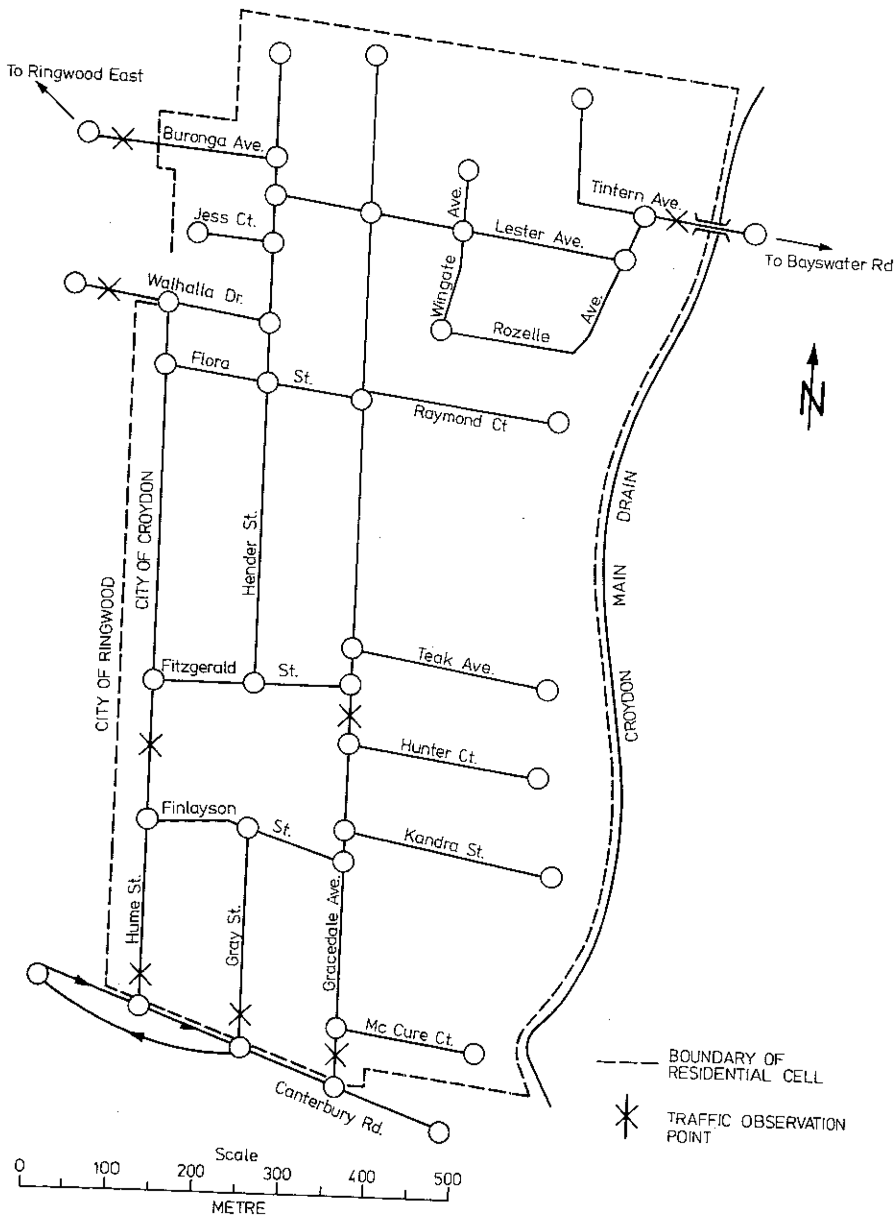

Fig. 1: The Bayswater residential cell

Ringwood. School grounds define the northern boundary of the cell. A small shopping centre and a timber yard, on Canterbury Road between Gray Street and Gracedale Avenue, were excluded from the study area.

Three of the six outlets from the cell fed on to Canterbury Road. However, movement restrictions (the inability to make a right-hand turn out of Hume Street, due to the median strip in Canterbury Road) meant that these outlets would not share equally traffic entering or leaving the cell by Canterbury Road (see Fig. 1).

The cell occupied an area of about 67 ha, and at the time of data collection (April 1974) it contained 352 households, all in single-unit dwellings. Residential living was the sole land use in the cell. There were an estimated 88 vacant blocks left in the cell at that time. The population of the cell was estimated to be approximately 1320.

As can be seen from the plan in Fig. 1, the internal street system of the cell was planned as a stretched grid pattern, with long north-south links and short east-west cross connections. This pattern, coupled with the locations of the access points, could be expected to concentrate the larger street traffic volumes on the southern sections of the north-south links, notably Gracedale Avenue. This expectation was supported by the observations of local residents, and council officers, who felt that traffic volumes on these southern links were becoming excessive. It was further believed that considerable volumes of through traffic were intruding into the area, presumably moving between Canterbury Road and Bayswater Road, via Tintern Avenue, and the Ringwood East area, via Buronga Avenue (refer to Fig. 1).

All streets in the cell were constructed to the same width, apart from some small unsealed sections at the northern end of the area. There was no preferential street design in terms of the traffic capacity of the streets, nor was there any recognition of the different functional performances required for different streets in the cell (e.g. local street, principal local street, or collector-distributor road status).

In view of the fact that about 20% of the area still remained to be developed, it was felt that some measures to counter through traffic and redistribute local traffic more evenly throughout the cell might be needed in the near future. Some ideas for full or partial street closures had been suggested by local people to impede through traffic in the cell. The duplication of the remaining single carriageway of Canterbury Road would also require consideration of the median openings along that road. This could be useful for the potential redistribution of local traffic.

THE DATA SURVEYS

To study the distribution of traffic in the residential cell, data were collected on

(a) numbers of occupied dwellings, houses under construction, and vacant lots in the cell;
(b) traffic volumes at specified points inside the cell and at the access points (see Fig. 1); and
(c) demographic and trip generation characteristics of the households in the cell.

A full description of the data surveys is available in Chin et al. (1974).

Dwellings and Vacant Lots

Information regarding the number of occupied dwellings in the cell was used to determine the number of households in the cell. The overall characteristics of the cell population could then be inferred using the household survey information gathered under part (c) above. The numbers of dwellings under construction and vacant lots in each street inside the cell were used to estimate the ultimate number of residences in the cell. The new homesites were scattered almost uniformly throughout the cell.

Traffic Counts

The locations of the traffic observation stations in the residential cell are shown in Fig. 1. Automatic traffic counters were used at the two internal stations, and also at the Gracedale Avenue access point. A 12-hour manual traffic count, vehicle occupancy count and numberplate origin-destination survey was conducted between 7.00 a.m. and 7.00 p.m. on Wednesday, 3 April 1974. The number plates of all vehicles entering or leaving the cell in that interval were collected, sorted and matched to provide information on the movements of vehicles across the test areas. The automatic traffic counts were conducted over a number of successive days, including the 12-hour manual count period. This additional data provided information about traffic volume fluctuations between different days, and for the night time period (7.00 p.m. - 7.00 a.m.).

Household Survey

A small, reply-paid questionnaire was distributed to all households in the residential cell. The questionnaire was intended to provide data about

(a) the distribution of household size in the test area;
(b) the distribution of vehicles per household;
(c) numbers of licensed drivers per household;
(d) the age distribution of residents; and

(e) the trip generation characteristics of household members, by role (vehicle driver or vehicle passenger).

A total of 190 of the 352 households replied to the questionnaire, and 185 of the replies were usable. Thus the survey yielded a response rate of 53%, which could be taken as an indication of a high degree of interest and concern about local traffic problems. Unfortunately it was not possible to ascertain the distribution of questionnaire replies from within the cell.

SURVEY RESULTS

By conducting separate surveys of vehicle movements and the trip-making behaviour of households in the cell, it was possible to describe the traffic characteristics of the study area, and to infer some aspects of travel behaviour for other outer-suburban, low-density residential developments.

Traffic Surveys

An immediate and most important result from the origin-destination survey was that only 4% (91 of 2502 recorded vehicle trips) of traffic entering and leaving the cell was through traffic. The relatively large traffic volumes in the southern section of the cell were almost entirely due to local trip generation, at least during the 12-hour survey period! The automatic traffic counts over several days suggested that the survey period volumes represented typical traffic conditions in the cell. This very small percentage of through traffic contradicted the earlier belief that the area was extensively used by through traffic. Any proposed solution to traffic problems in the cell needed to be considered accordingly.

The distribution of traffic between cell outlets for the survey period is shown in Table 1. Not surprisingly, in view of the street configuration, Gracedale Avenue received the largest share of both inward and outward traffic. The other outlets onto Canterbury Road showed significant directional influences. For comparison of the survey conditions with "average" conditions, see Table 2, which lists the summary results for the automatic traffic counter observations. Table 2 also suggests that about 80% of the total daily traffic in the cell travelled in the 12-hour period 7.00 a.m. - 7.00 p.m., and thus about 20% of daily traffic travelled at night.

Person trips by vehicle It was possible to estimate trip generation rates from the observations of vehicle movements. All vehicle trips crossing the cell boundaries were available, as was a count of the number of people in each vehicle. If it was assumed that all vehicle trips generated by households in the cell crossed a cell boundary,

Table 1

Observed Traffic Counts at Access Points to the Bayswater Cell

(7.00 a.m. - 7.00 p.m., Wednesday 3.4.74)

Site (a)	Entering	Leaving	Two-way	% of Total two-way traffic at all access points	Two-way peak hour	
					8.00-9.00 a.m.	5.00-6.00 p.m.
Gracedale Avenue	543	545	1088	43.5	129	130
Gray Street	67	143	210	8.3	21	24
Hume Street	153	54	207	8.3	14	35
Tintern Avenue	193	204	397	15.9	38	48
Buronga Avenue	214	237	451	18.0	79	67
Walhalla Drive	64	85	149	6.0	18	22
Totals	12234	1268	2502	100.0	299	326

Note: (a) Refer to Fig. 1 for locations of observation points

Table 2

Summary of Automatic Traffic Counts in the Bayswater Cell

Site	Average 24-hour vehicle count	Average 7am-7pm vehicle count	Average 7pm-7am vehicle count	% of total traffic travelling between 7am-7pm
Gracedale Avenue at Canterbury Road	1458	1172	286	80.4
Hume Street between Fitzgerald Street and Finlayson Street	437	355	82	81.2
Gracedale Avenue between Hunter Court and Fitzgerald Street	1111	891	220	80.2

Note: All counts are average two-way totals over the period Monday 1.4.74 to Friday 5.4.74

then the total number of trips generated in the cell was the number of observed vehicle trips less the number of through trips, i.e. 2502 - 91 = 2411 trips. This yielded a mean vehicle trip generation (VTG) of 6.9 vehicle trips/household/12-hour day. If it was further assumed that 20% of vehicle trips were generated in the 7.00 p.m. - 7.00 a.m. period, the observed daily trip generation rate was 8.6 veh. trips/hhld/day.

The observed mean car occupancy rate[1] was 1.6 persons/vehicle from the survey, although this occupancy did vary widely over times of the day (e.g. from 2.0 persons/vehicle for the interval 8.00 - 9.00 a.m., to 1.4 persons/vehicle during the interval 1.00 - 2.00 p.m.). If the mean occupancy value was applied to all observed vehicle trips, the mean daily person trip (by vehicle) rate (PTGPV) was 13.4 person trips/hhld/day.

Daily trip generation data, in more detailed form, was also available from the household questionnaire survey. The calculations of generation rates were only intended for comparison with the household data.

Household Questionnaire Survey

The household questionnaire survey was intended to provide data about the demographic characteristics of households in the residential cell, and their home-based trip-making behaviour. The topic of trip generation analysis has been widely studied. Golding (1972, 1974) and Golding and Olsen (1976) have provided detailed discussions of several trip generation modelling techniques, notably household category analysis, and their applications to Australian situations. The household characteristics commonly taken to be responsible for systematic variations in household trip generation include

(a) car ownership;
(b) household size and age groupings; and
(c) disposable incomes.

The present survey sought information on (a) and (b) above, plus the numbers of licensed drivers in each household. Direct measures of income were not sought for a variety of reasons, including

(a) the small number of households, in a relatively homogeneous area;

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1 The observation of car occupancy is probably less accurate than the other observations, as it required a quick head count of all individuals in each vehicle. It is now known how many children were omitted, nor how many canines were included!

(b) the presumed correlation between car ownership and income (e.g. Golding 1972); and

(c) the concern that questions regarding household income would prejudice the response to a small, informal survey.

For the initial applications at least, it was decided that mean statistics, such as VTG and PTGPV were adequate for an understanding of traffic generation within the cell. The household characteristics would be necessary for comparisons between this survey and others. An important limitation on the applicability of the results to other areas is that only person trips by motor vehicle were considered, and no information was sought about travel by other modes.

Household characteristics Table 3 shows the distribution of household size for the sample of 185 households. Households of sizes 2-5 accounted for 91% of all households in the sample. The intuitive belief that the cell residents were predominantly young families was supported by this result, and the age distribution of the population as shown in Table 4, where 79% of the sample were under 36 years of age.

Table 3

1974 Distribution of Household Size in the Bayswater Cell

Household size	1	2	3	4	5	6	7	8	9
Observed frequency	2	39	38	60	30	8	3	3	2
Observed proportion	0.01	0.21	0.21	0.32	0.16	0.04	0.02	0.02	0.01

Mean household size = 3.76   Std. dev. = 1.45

Table 4

Age Distribution of Survey Sample (1974)

Age group (years)	0-5	6-17	18-35	36-60	60 +
Observed frequency	153	148	252	127	15
Observed proportion	0.22	0.21	0.36	0.18	0.02

The distribution of vehicles/household is very interesting (see Table 5). For the sample, 58% of the households had more than one vehicle. The percentage of households with 2 vehicles was 47%. King (1977), using 1971 Census data, examined vehicles/household for a sample of Melbourne Local Government Areas and found that 34.9% of households in Croydon had more than one vehicle at that time.

Table 5

1974 Distribution of Vehicle Ownership in the Bayswater Cell

Vehicles/household	0	1	2	3	4	5
Observed frequency	1	77	87	15	4	1
Observed proportion	0.01	0.42	0.47	0.08	0.02	0.01

Mean vehicles/household = 1.71   Std. dev. = 0.76

The highest recorded percentage of multi-vehicle households in 1971 was 50.0% in Doncaster-Templestowe. Fig. 2 shows the joint frequency distribution of household size and car ownership for the survey sample. The joint frequencies of car ownership and numbers of driver's licenses/household are shown in Fig. 3.

A general, sweeping classification of the residential cell would be as a recently settled, low-density outer-suburban area of average socio-economic status, and with predominantly young to middle-aged residents. As such it is probably typical of extensive tracts of suburban residential development in Australian cities.

Household trip generation Trip generation data for each household in the survey sample were collected in terms of home-based vehicle trips/day (trips made by individuals as drivers of vehicles) and home-based person trips by private vehicle/day (trips made by individuals as drivers or passengers). For the immediate purposes of the study it was sufficient to consider mean household trip generation rates (VTG and PTGPV) only. A current research topic is to investigate statistical models which relate the observed household trip generation rates to household characteristics. A sample mean VTG of 7.0 veh. trips/hhld/day (std. dev. = 4.8) was found, together with a mean PTGPV of 12.8 person trips/hhld/day (std. dev. = 9.0). These results may be compared to the trip generation rates determined from the traffic survey (i.e. 8.6 veh. trips/hhld/day and 13.4

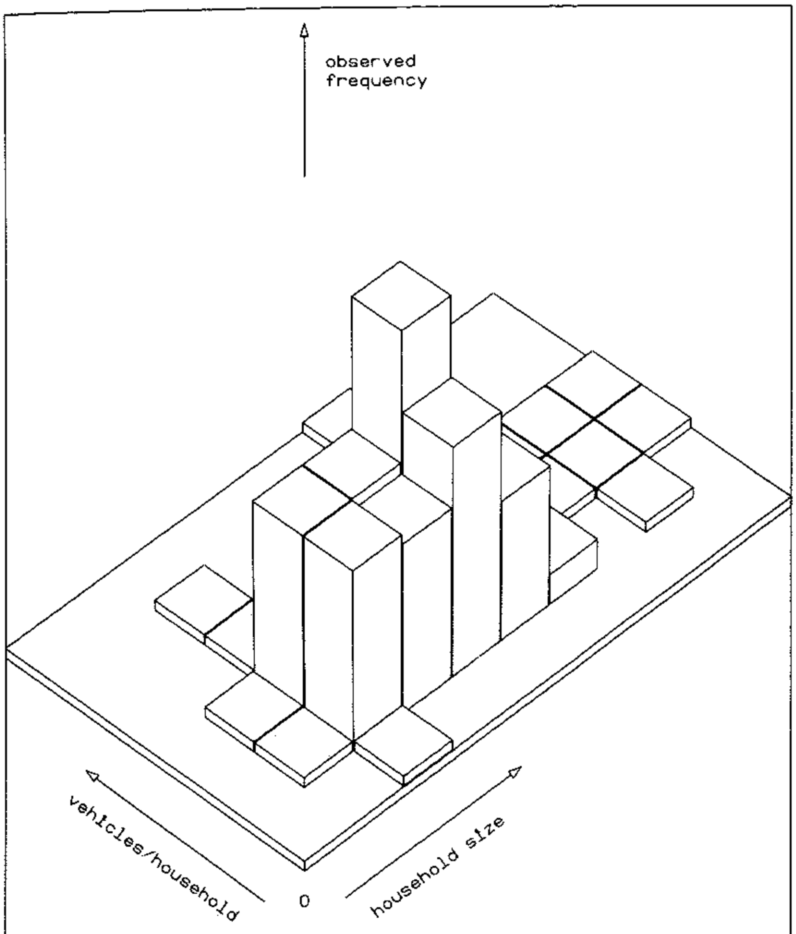

Fig. 2: Joint observed frequency distribution of household size and vehicle ownership

vehicles/hhld										
5	-	-	-	-	-	-	1			
4	-	-	1	-	-	2	-	1		
3	-	-	1	3	6	2	-	1	1	1
2	-	1	18	18	31	12	4	1	1	1
1	-	1	18	17	23	14	3	-	1	
0	-	-	1							
	0	1	2	3	4	5	6	7	8	9

household size

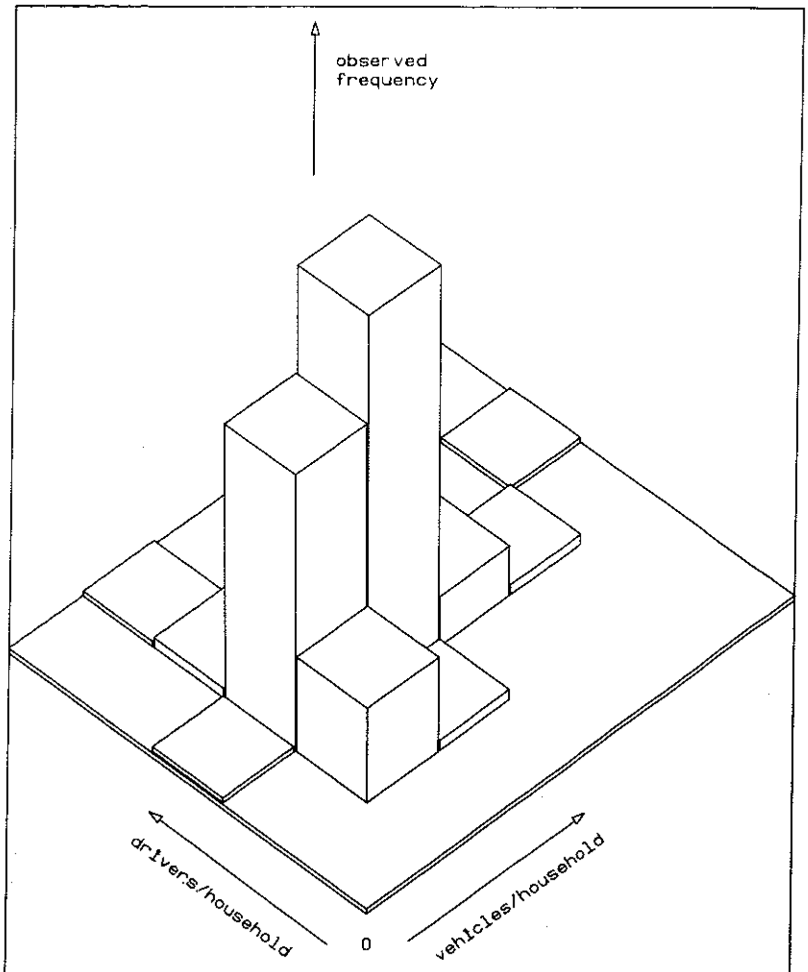

Fig. 3: Joint observed frequency distribution of vehicle ownership and drivers/household

drivers/hhld	0	1	2	3	4	5
4	-	1	-	1	2	
3	-	2	9	4	-	1
2	1	55	76	10	2	
1	-	19	2			
0	-					

vehicles/household

person trips/hhld/day, respectively). The household survey results are smaller than the corresponding traffic survey results, because the former only considered trips made by household members, while the latter considered all observed trips. Trips made by non-residents of the cell (e.g. service, social and recreation trips) were therefore included. The survey suggested a rate of about 1.5 veh. trips/hhld/day to and from the cell by non-residents.

Some idea of the variation of household trip generation rates over the range of household sizes and vehicle ownership can be gained from Figs. 4 and 5. Fig. 4 shows vehicle trip rates against household size and vehicles/household, while Fig. 5 is a similar plot for person trip rates.

SYNTHESIS OF TRAFFIC IN THE CELL

Observations of street traffic volumes within the cell were only available at a limited number of sites (see Fig. 1). To obtain further information about traffic movements in the cell, and for comparisons of street traffic volumes with suggested environmental capacities, the traffic flows in the cell were simulated using the local area traffic analysis package (LATM) described by Taylor (1978). The LATM package was developed from an earlier experimental local area traffic assignment model (Taylor 1977). Synthesis of traffic in the cell also enabled predictions of future traffic flows in the study area to be made, for example, under conditions of full residential development of the area. Likely consequences of this development and possible remedial design measures could then be investigated.

Environmental Capacity of a Local Street

Quantitative measures of the environmental capacities of local streets are still tantalizingly elusive. However, a useful value for local street environmental capacity was given by Loder and Bayly (1974) as 1000 veh./day, with 100 veh./h as a peak-hour equivalent. This result would apply to all streets whose principal design function was only to provide access to abutting properties, and would thus include culs-de-sac, crescents, and "principal" locals(1). Under this definition, all of the streets in the cell would be classified as "local". Support for the choice of 1000 veh./day as the environmental capacity came from the complaints of residents about traffic volumes on Gracedale Avenue. Tables 1 and 2 show observed volumes up to 50% in excess of this figure.

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1 A suggested environmental capacity for collector roads would be about 3000 veh./day (300 veh./h in peak).

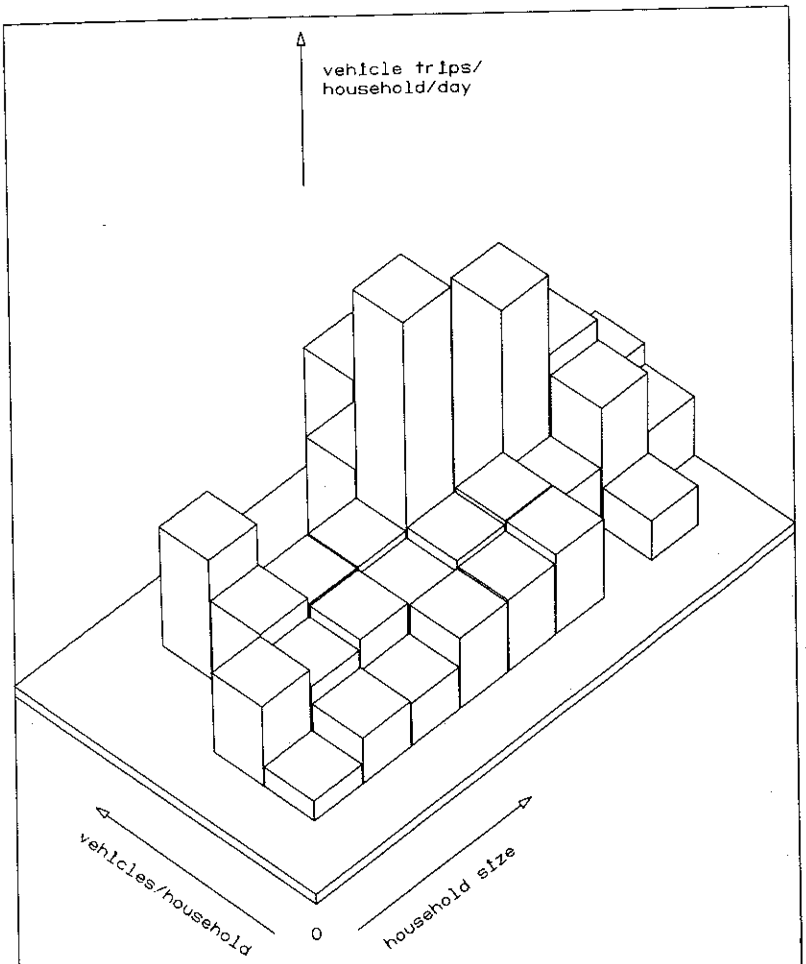


Fig. 4: Observed daily vehicle trip rates versus household size and vehicle ownership

vehicles/hhld	0	1	2	3	4	5	6	7	8	9
5	-	-	-	-	-	-	12.0			
4	-	-	12.0	-	-	10.0	-	8.0		
3	-	-	8.0	7.3	7.3	28.0	-	22.0	14.0	8.0
2	-	8.0	6.2	7.2	6.7	7.7	8.0	6.0	12.0	6.0
1	-	2.0	4.6	4.2	7.0	7.1	8.0	-	4.0	
0	-	-	0.0							

household size

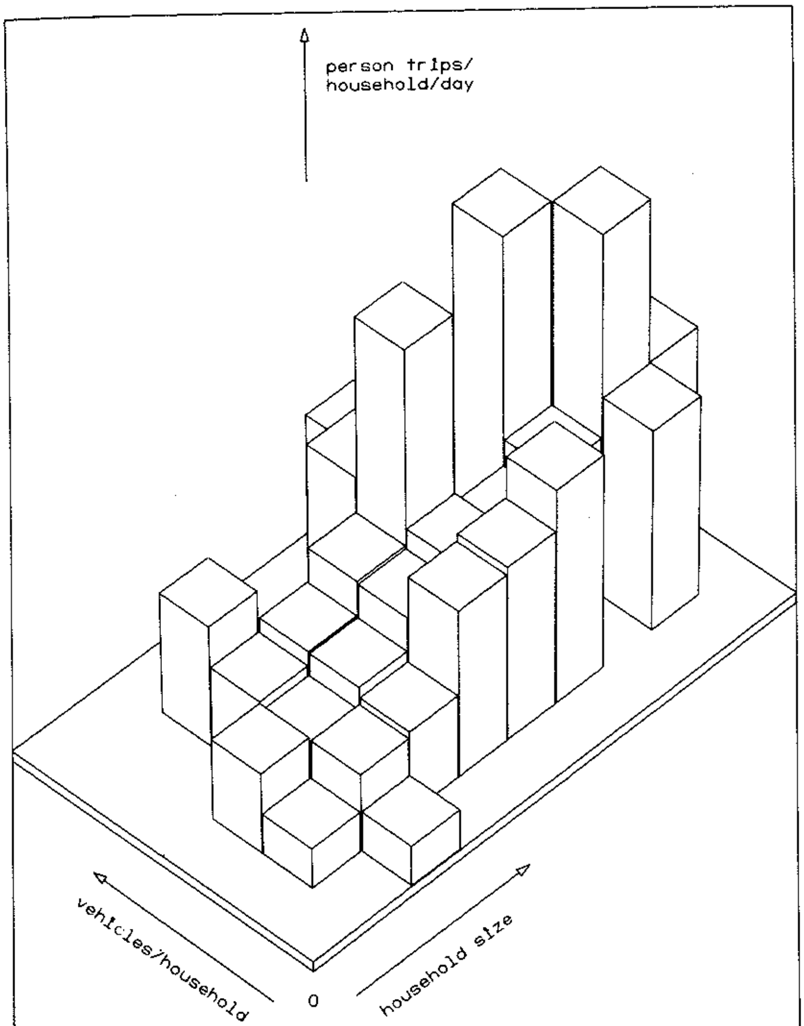


Fig. 5: Observed daily person trip rates versus household size and vehicle ownership

vehicles/hhld	0	1	2	3	4	5	6	7	8	9
5	-	-	-	-	-	-	12.0			
4	-	-	12.0	-	-	16.0	-	16.0		
3	-	-	8.0	9.3	12.7	32.0	-	36.0	28.0	22.0
2	-	8.0	7.1	9.2	12.5	14.3	13.5	16.0	36.0	20.0
1	-	4.0	7.7	8.2	16.6	17.3	21.3	-	20.0	
0	-	-	4.0							

household size

Simulation of Existing Traffic Flows

A simulation of the traffic flow in the test area, corresponding to the conditions observed in the traffic survey, was conducted using the minimum-path sub-model of the LATM package. The simulation was for the 12-hour period 7.00 a.m. - 7.00 p.m. The simulated flows were compared to those observed, and the results are shown in Table 6. From this table it is apparent that the model was able to reproduce the observed traffic conditions to a reasonable degree of accuracy, assuming the average vehicle trip generation rates given earlier in this paper. Observed traffic counts are given in Tables 1 and 2.

Assuming that 20% of the daily traffic flow occurred in the period 7.00 p.m. - 7.00 a.m., the simulation suggested that the sections of Gracedale Avenue between Finlayson Street and McCure Court (1250 veh./day) and McCure Court and Canterbury Road (1360 veh./day) were the only street sections in the network which exceeded environmental capacity at the time of the survey (April 1974).

Synthesis of Future Traffic Flows

Traffic flows in the cell for 1984 were estimated, assuming

(a) that the area would then be fully settled, i.e. a 20% increase in the number of households;

(b) average vehicle ownership in the cell rose from the observed 1.71 vehicles/hhld to 2.15 vehicles/hhld, i.e. a 25% increase, based on ageing of the cell population;

(c) vehicle trip generations per vehicle would remain constant; and

(d) the duplication of Canterbury Road would be extended beyond the boundaries of the cell (see Fig. 1).

Under these conditions it would be useful to know where any median openings should be provided on Canterbury Road, and whether any internal reorganization of the cell's street system should be contemplated to protect the environmental conditions for its residents? The following situations were modelled:

(a) a median opening at Gracedale Avenue only;

(b) median openings at Hume Street and Gracedale Avenue;

(c) median openings as for (b), together with diagonal closures of the Gracedale Avenue/Flora Street and Hender Street/Flora Street intersections; and

(d) median openings as for (b), together with diagonal closure of the Hender Street/Flora Street intersections, prevention of all access to Gracedale Avenue south of its intersection with Lester Avenue, and prohibition of the through movements at the

Table 6

Simulation of Survey Period Traffic in the Bayswater Cell

(7.00 a.m. - 7.00 p.m. volumes based on 1974 data)

Site	Modelled traffic volumes		
	North-bound	South-bound	Two-way
Gracedale Avenue at Canterbury Road	558 (+2.8%)[a]	546 (+0.2%)	1104 (+1.5%)
Gray Street	97 (+45.8%)	154 (+7.7%)	251 (+19.5%)
Hume Street at Canterbury Road	136 (-11.1%)	45 (-16.7%)	181 (-12.6%)
Tintern Avenue	197 (+2.1%)	228 (+11.8%)	425 (+7.1%)
Buronga Avenue	217 (+1.4%)	225 (-5.1%)	442 (-2.0%)
Walhalla Drive	77 (+20.3%)	89 (+4.7%)	166 (+11.4%)
Hume Street, between Fitzgerald Street and Finlayson Street	88 (-)	222 (-)	310 (-3.4%)
Gracedale Avenue, between Hunter Court and Fitzgerald Street	290 (-)	344 (-)	634 (-24.2%)

Note: (a) Percentages in parentheses show variations between modelled and observed traffic volumes

Hender Street/Fitzgerald Street intersection.

Fig. 6 displays the alternatives graphically, and indicates road sections on which estimated traffic volumes exceeded environmental capacity.

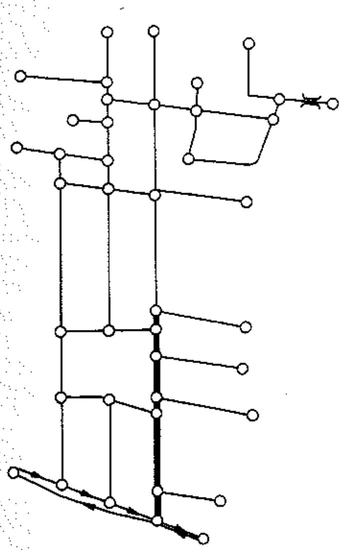
For alternative (a), the model suggested that traffic volumes exceeding environmental capacity would occur on Gracedale Avenue between Canterbury Road (2270 veh./day) and Fitzgerald Street (1490 veh./day). The provision of the second median opening (alternative (b)) drew some traffic away from Gracedale Avenue, but not sufficient to greatly improve the environmental conditions. The critical section of Gracedale Avenue still experienced volumes above 1000 veh./day (ranging from 1380 veh./day at Fitzgerald Street to 2110 veh./day at the Canterbury Road access point). The internal street closure options were then tested. Although these led to some reductions in street traffic volumes on Gracedale Avenue, other street sections then experienced volumes exceeding the environmental criterion adopted. In particular, sections of Hume Street and Lester Avenue were adversely affected (see Fig. 6). Table 7 lists the modelled daily volumes on critical street sections in the network. It also shows the amount of internal travel (vehicle-km/day) for each alternative.

Modelling was conducted under the assumptions that in 1984 20% of total traffic would be generated between 7.00 p.m. and 7.00 a.m., and that the distribution of traffic between the northern and southern access points would remain in the same proportions as observed in 1974. It would appear that to prevent wholesale deterioration of the environment of the cell through excessive traffic volumes, encouragement should be given for traffic to use the Tintern Avenue outlet. This outlet connects to Bayswater Road, a north-south sub-arterial road which intersects Canterbury Road close to the cell. The study suggested that internal street closures would not alleviate traffic conditions in the area. Volumes were lowered in some parts of the cell, but were increased in others. Further the estimated amount of travel *by local traffic* in the cell was increased by up to 29% (see Table 7).

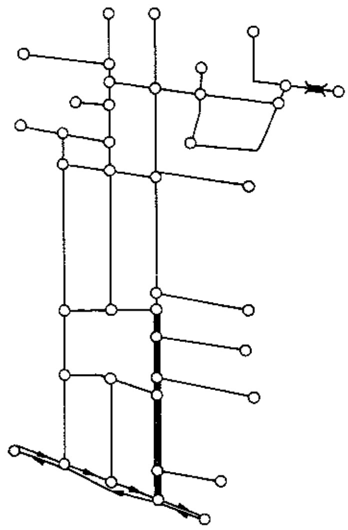
REMARKS AND CONCLUSIONS

This paper has described the collection of some most useful data concerning the generation of motor vehicle traffic in a residential area which primarily depends on private transport. The data were used to gain insight into the flows of traffic in and around the test area, and for the estimation of future traffic flows in it. Modelling of traffic flows was possible using a new procedure (the LATM package) specifically designed for local area use. Such procedures have not been readily available in the past.

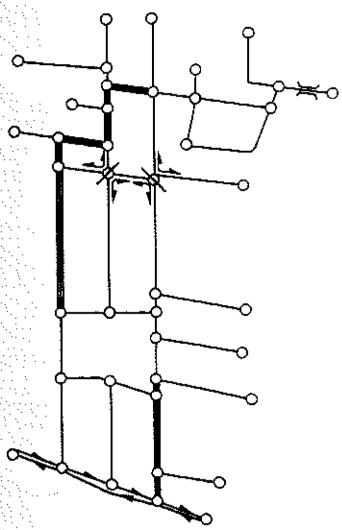
For the particular study area, despite relatively



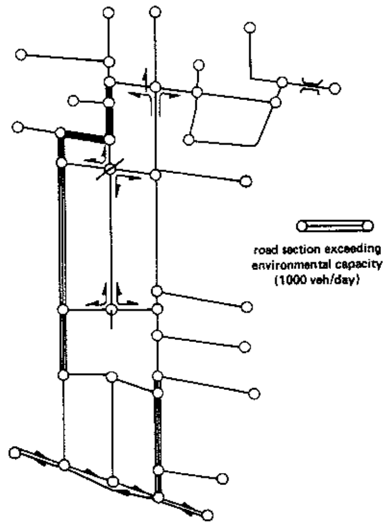
(a) Median opening at Gracedale Avenue



(b) Median openings at Gracedale Avenue and Hume Street.



(c) Median openings at Gracedale Avenue and Hume Street, with diagonal closures of the Gracedale Avenue/Flora Street and Hender Street/Flora Street intersections.



(d) Median openings at Gracedale Avenue and Hume Street, with diagonal closure of the Hender Street/Flora Street intersection and further access restrictions

Fig. 6: Road sections with 1984 estimated traffic volumes exceeding environmental capacity

Table 7

Predicted 1984 Traffic Volumes on Critical Street Sections in the Bayswater Cell

Street	Section	Modelled traffic volume (veh /day) for alternative			
		(a)	(b)	(c)	(d)
Gracedale Avenue	Canterbury Road – McCure Court	2270	2110	1790	1870
	McCure Court – Finlayson Street	2050	1890	1570	1700
	Finlayson Street – Kandra Street	1700	1590	1260	1190
	Kandra Street – Hunter Court	1580	1590	1140	(960) (e)
	Hunter Court – Fitzgerald Street	1490	1380	1220	(760)
Hender Street	Walhalla Drive – Jess Court	(650)	(650)	1430	1390
	Jess Court – Lester Avenue	(650)	(650)	1440	1400
Hume Street	Finlayson Street – Fitzgerald Street	(300)	(411)	(740)	1090
	Fitzgerald Street – Flora Street	(420)	(420)	1530	1540
	Flora Street – Walhalla Drive	(360)	(360)	1130	1150
Lester Avenue	Hender Street – Gracedale Avenue	(630)	(630)	1170	(990)
Walhalla Drive	Hume Street – Hender Street	(360)	(360)	1090	1060
Total internal travel by local traffic (veh.-km/day)		2470 8	2477.1	2881 4	3180.4

Notes:
(a) Median opening at Gracedale Avenue only
(b) Median openings at Gracedale Avenue and Hume Street
(c) Both median openings, diagonal closures of Hender Street/Flora Street and Gracedale Avenue/Flora Street intersections
(d) Both median openings, diagonal closure of Hender Street/Flora Street intersection, partial closure of Fitzgerald Street/Hender Street and Gracedale Avenue/Lester Avenue intersections
(e) Parentheses indicate volumes less than the assumed environmental capacity of 1000 veh /day for local streets

large traffic flows on some parts of the street system, it was found that most of the traffic was generated inside the area. Only 4% of the surveyed traffic travelled through the area. This was contrary to earlier beliefs. Traffic problems in the cell were thus related to the design of the internal street system and the provision of access to the area. The modelling analysis suggested that in the absence of large volumes of through traffic in local areas, internal street closures appear to be poor measures for the regulation of street traffic flows. The provision of adequate access points to the local area and the careful study of the role of each street in the area is most important. These conclusions are probably well known already to practitioners in this field. The usefulness of the research project just described is its theoretical and empirical support for the principles of hierarchical design for local street systems.

A number of areas for further research can be identified. These include a better understanding of the factors influencing household trip generation, particularly in terms of vehicle availability and interactions between household members, the establishment of definite measures of environmental capacities for streets, concepts of the level of service to land-use activities provided by local areas, and the further development of local area traffic modelling techniques.

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