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Abstract

This study was commissioned to provide a description of rural traffic crashes in Queensland using available mass data and to investigate regional effects on these crashes. The sample comprised 1078 fatal and hospital admission crashes occurring in rural areas during 1984. In general, results were consistent with findings from other States and particularly highlighted the significant proportion of single vehicle crashes, the severity of impacts with roadside objects and control difficulties experienced when vehicles ran on road shoulders.

KEYWORDS: Rural, crashes, region, collision, taxonomy, time distribution, speed zone, road surface, alignment, shoulders, seat belt, age, alcohol, control response.

NOTES:

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RURAL TRAFFIC CRASHES

IN QUEENSLAND, 1984

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Executive Summary

This investigation was designed to describe fatal and hospital admission traffic crashes in Queensland. Available mass data was used and regional effects analysed. For 1984, 1078 police reports were available and classified by a taxonomy focussing on the pre-impact phase of the crash. Crash types so defined were then tested against driver, vehicle and enviornmental factors.

Regional effects were present for crash distribution, crash type and location within the region although it appeared these variations would reduce if improved exposure indices were available. Other regional differences were found in the monthly distribution of crashes, the origin of crash involved drivers and the ratio of in-town/out-of-town sites. These differences suggested an influence of trip purpose (which was not available), as did the age dependent distributions of crash type and day-of-week.

Impacts with roadside objects increased the probability of a fatality and such impacts occurred more frequenly in the Moreton region when vehicles left the road. These crashes were about as likely to occur on straight as on curved (horizontal and vertical) roads, as were impacts between approaching vehicles, irrespective of region.

Crashes of single vehicles accounted for 61.3% of all crashes, two-thirds of which involved some form of control problem; this figure could be as much as 48% of all crashes by including specific multiple vehicle types. Road shoulder running was associated with many such crashes, with drivers' reactions appearing to aggravate the situation. The implications of this observation were discussed.

The investigation of the effects of alcohol and seat belt wearing was limited by he data available, although no regional differences were associated with these factors. The high proportion of the most severely injured wearing seat belts (or about 50%) suggested a more detailed investigation is warranted. Similarly, incomplete data on driver BACs limited the information able to be derived.

Overall, the results were consistent with findings for other Australian States. The significant proportion of single vehicle crashes was highlighted, as was the severity of impacts with roadside objects and the control difficulties experienced from road shoulder running.

1. INTRODUCTION

1.1 Objectives of the Study

Two main objectives were set for this study and have been addressed by this report. These objectives were -

1. To describe rural traffic crashes in Queensland using available mass data; and

2. To investigate regional differences between crashes.

Although basic summary data has been extracted for a number of variables, an attempt has been made to best utilise the resources available by concentrating the investigation on combinations of variables to provide insight into specific areas, and identifying areas where more or improved data would be desirable.

1.2 Overview of the Report

The report essentially confines itself to an analysis of the mass data obtained from the Australian Bureau of Statistics and the Queensland Department of Transport. A literature review was not undertaken as several have been completed and reported in recent times, such as by Sanderson and Fildes (1984) for run-off-the road crashes and Dorsch, Lane, McCaul, MacLean, McLean and Somers (in print) in preparation for an investigation into South Australian rural crashes.

Section 2 deals with the procedure adopted, including details of the sample and the approach taken to data coding and analysis. This latter task involved the testing of two and three-way contingency tables using chi-square and log linear modelling. All statistical tests were evaluated with respect to a 5% level of significance. Section 3 presents the results and discussion under four main categories - the collision taxonomy, regional variations, road and environmental factors and driver and vehicle factors. Finally, the conclusions are given in Section 4.

2. PROCEDURE

2.1 The Sample

The sample consisted of all fatal and hospital admission crashes occurring in rural areas of Queensland during 1984. Rural crashes were defined as those occurring in Shires, and on roads with a 100km/h speed limit in other areas of the State - that is, the higher speed roads in areas defined as towns or cities under the Local Government Act 1936, as amended.

A listing of all 1984 crashes was obtained from the Australian Bureau of Statistics from which individual files kept by the Department of Transport were identified. Three hundred and three files could not be identified - a process whereby Police district, crash location and crash date were matched with the computor listing - and 57 identified files were not found in the filing system. Late reports received by the Bureau of Statistics are entered under a new date consistent with the period covered by the computor file open at the time of receipt; crashes are sometimes investigated by Police from districts other than that in which the crash occurred, such as during periods when smaller Police stations are unmanned.

The final sample consisted of 1,078 rural traffic crashes. This data was analysed using the following procedure and methods.

2.2 Data Analysis

2.2.1 Collision Taxonomy

The initial phase of data analysis involved the physical sorting of report forms into a taxonomic classification developed by McDonald and McDonald (1983). This process allowed the researchers to gain a qualitative understanding of the data and to develop hypotheses of relationships between variables which could be formally tested.

The taxonomy as described by McDonald and McDonald (1983) is essentially a diagrammatic representation of multi-way tables with each additional subclassification introducing a further variable. For the purposes of the current study, it was thought desirable to limit the taxonomic classification to the immediate pre-impact phase of the collision, about which objective information was generally available.

Several existing classification systems were considered, including that reported by the Road Safety and Traffic Authority of Victoria (Daltry, 1983). It was concluded that the detail offered by such a system was not essential for this study, nor was time available to code in such detail and the decision was taken to base the collision taxonomy on the CALAX system (Terhune, 1983). The collision types selected for coding are to be found in Appendix One. It was felt that this system offered economy of description with reasonable coding time, yet with sufficiently fine detail to allow investigation of the effects of various environmental and behavioural factors.

2.2.2 Data Coding

Besides coding each crash with its collision taxa, variables were also taken from the Police Accident Report Form, while others were developed from the written description often appended to the form. These latter variables were usually related to the driver's behavioural characteristics. A summary of parameters coded is as follows:

* time of day,
* day of week, and month
* light conditions
* road type, road surface and condition
* road alignment
* special features including merging lanes, intersections and railway crossings (as per Police Accident form)
* speed limit: used in the analysis to identify in-town (60km/h) and out-of-town (100km/h) collisions
* pedestrian movements
* object struck including natural (tree, rock, ditch etc.), construction (bridge, embankment, wall etc.) and introduced (service pole, guide/sign post etc.) elements
* Details of unit 1 (and 2, if applicable)
* Driver details: age, sex, BAC level, licence type, residential address
* crash location
* number injured per unit involved and most severe injury
* seat belt wearing behaviour

* driver response: Nil - asleep, medical condition, distracted, loss of vision (glare, fog/rain/smoke/dust, eye related), unknown. Misjudge - where visual information was misleading or had been wrongly interpreted. Inappropriate - where the steering and/or braking response initiated or aggravated loss of control situation.

The "ruralness" of the crash site could not always be determined from the crash report form so a surrogate measure was used. As noted in the above list, two extremes of speed limit were taken to define "in-town" (60km/h) and "out-of-town" (100km/h) crash locations.

The coding of driver control responses preceding impact was made directly from the Police report, or inferred from the information available. The assistance of an experienced racing driver and professional driving instructor (with knowledge of most motor vehicle types) was sought for the latter exercise.

It is evident from the totals of some contingency tables that information on particular variables was not available for some crashes. In any such table, however, the proportion of uncoded crashes was less than 0.5%; the missing data did not appear to be confined to any particular category and was taken to be random omissions occurring during the recording process.

2.2.3 Statistical Analysis

As previously stated, both two-way and three-way contingency tables were formed to test hypotheses of relationships between variables. Two-way tables were tested using the chi-square statistic; **higher order** contingency tables were analysed using log linear analysis as discussed by Fienberg (1977). While even higher order relationships were sometimes suggested by the data, it was not considered feasible to undertake this more complex level of analysis at this stage.

Possible sources of variation within tables were tested using a method for unplanned multiple comparisons developed by Goodman (1969). This essentially involved the calculation of confidence limits for the difference between nominated proportions. All tests were made using a 5% level of significance

3. RESULTS AND DISCUSSION

3.1 Taxonomy of 1984 Rural Crashes

3.1.1 Overview

As discussed in Section 2.2.1, a collision taxonomy was carried out on the rural crash data. From the original taxonomy prepared by physically sorting crash report forms, collision taxa were identified and a collision taxonomy prepared, as shown in Figure 1; the key to specific crash types is given in Figure 2. Such a taxonomy contains a significant proportion of basic summary data and some of this will be discussed in this section. Other summary data such as crash distributions by time of day, day of week, age and sex of involved drivers have been addressed in following sections of the report (usually in relation to other variables such as region).

A total of 1078 crashes were available for analysis. Single vehicle crashes comprised 660 (61.2%) of these, of which 104 (9.7%) also involved a pedestrian or an animal. These figures have been extracted and are shown in Table I.

TABLE I.

QUEENSLAND RURAL CASUALTY CRASHES, 1984 BY TYPE

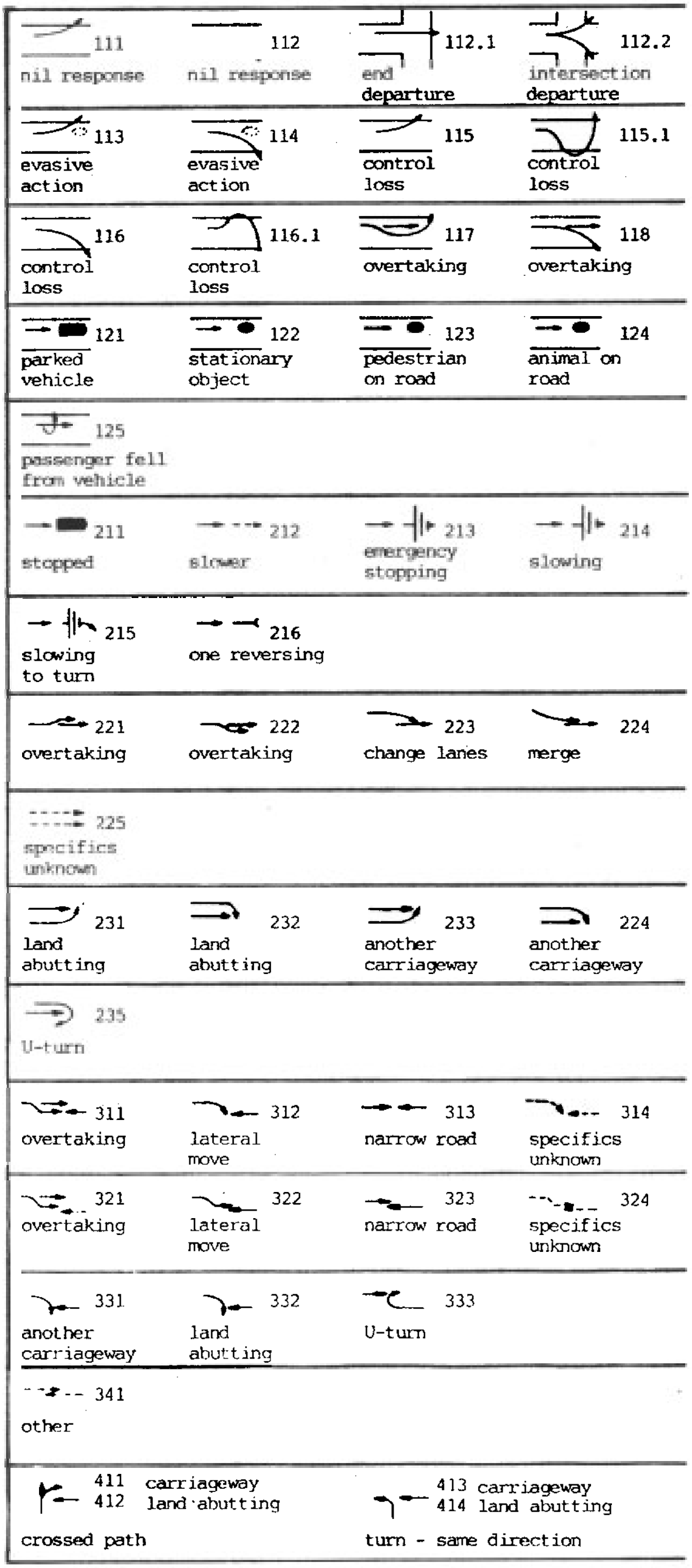
TYPE	No.	%
Single Vehicle	556	51.6
Pedestrian	70	6.5
Animal	34	3.2
Multiple Vehicle	418	38.7
TOTAL	1078	100

FIGURE 1

COLLISION TAXONOMY FOR 1984 QUEENSLAND RURAL CRASHES (FATAL AND HOSPITAL ADMISSIONS)

Gross Types	Intermediate Types	Specific Types			
SINGLE DRIVER [1--] 660 (61.2%)	LEAVE CARRIAGEWAY [11-] 538 (49.9%)	[111]	86(8%)	[115]	107(9.9%)
		[112]	64(5.9%)	[115.1]	9(<1%)
		[112.1]	6(<1%)	[116]	101(9.4%)
		[112.2]	1(<1%)	[116.1]	48(4.5%)
		[113]	60(5.6%)	[117]	9(<1%)
		[114]	33(3.1%)	[118]	14(1.3%)
	CARRIAGEWAY IMPACT [12-] 122 (11.3%)	[121]	2(<1%)	[124]	34(3.2%)
		[122]	2(<1%)	[125]	14(1.3%)
		[123]	70(6.5%)		
SAME CARRIAGEWAY SAME DIRECTION [2--] 133 (12.3%)	REAR IMPACT [21-] 66 (6.1%)	[211]	17(1.6%)	[214]	13(1.2%)
		[212]	24(2.2%)	[215]	5(<1%)
		[213]	6(<1%)	[216]	1(<1%)
	SIDESWIPE [22-] 21 (1.9%)	[221]	1(<1%)	[224]	1(<1%)
		[222]	11(1.0%)	[225]	1(<1%)
		[223]	7(<1%)		
	TURNING FROM CARRIAGEWAY [23-] 46 (4.3%)	[231]	3(<1%)	[234]	13(1.2%)
		[232]	14(1.3%)	[235]	13(1.3%)
		[233]	3(<1%)		
SAME CARRIAGEWAY OPPOSITE DIRECTION [3--] 261 (24.3%)	HEAD ON [31-] 116 (10.8%)	[311]	10(<1%)	[313]	10(<1%)
		[312]	76(7.1%)	[314]	20(1.9%)
	SIDESWIPE [32-] 59 (5.5%)	[321]	7(<1%)	[323]	4(<1%)
		[322]	39(3.6%)	[324]	9(<1%)
	TURNING FROM CARRIAGEWAY [33-] 75 (7.0%)	[331]	51(4.7%)	[333]	7(<1%)
		[332]	17(1.6%)		
	OTHER [34-] 11 (1.0%)	[341]	11(1.0%)		
INTERSECTING PATHS [4--] 24 (2.2%)	STRAIGHT PATHS [41-] 24 (2.2%)	[411]	11(1.0%)	[413]	3(<1%)
		[412]	9(<1%)	[414]	1(<1%)

FIGURE 2 KEY TO SPECIAL CRASH TYPES OF FIGURE 1



3.1.2 Single Vehicle Crashes

Of the 660 single vehicle crashes, 127 involved another unit such as a pedestrian, animal or vehicle (where no impact occurred). The largest proportion of crashes, however, was associated with some form of control loss involving a single vehicle. Four hundred and twenty-two crashes fell into this category (or 39.1% of all rural crashes).

It is also possible that multi-vehicle collisions resulting from a lateral move of one vehicle - types [312] and [322] - were similar in nature to single vehicle loss-of-control crashes; data were not available, however, to determine if the control loss was influenced by the other vehicle. (Inclusion of these latter collisions would bring the total loss-of-control crashes to 522, or just less than half of all rural crashes.)

Although a proportion of single vehicle, leave carriageway crashes involved distracted, temporarily blinded or asleep drivers and the like who made no attempt to steer the vehicle (150 or 19.9% of all crashes), the majority of these crashes was associated with an inappropriate or late response. The latter actions either initiated the control loss or aggravated a situation where it appeared control could have been regained; they will be discussed later in the report in relation to road and vehicle characteristics. Evasive action was cited in 93 crashes (8.7% of the total).

3.1.3 Multiple Vehicle Crashes

Of the multi vehicle crashes, the largest single group involved collisions between approaching vehicles on the same carriageway (24.3%). Vehicles travelling in the same direction on a carriageway were involved in a further 12.3% of all collisions, while those approaching on intersecting paths contributed 2.2%; 14 of these latter collisions (or 1.3% of all crashes) occurred at intersections.

Entering, leaving or crossing a carriageway

A listing of all crashes involving intersections is given in Table II.

TABLE II

PROPORTION OF INTERSECTION CRASHES BY RELATIVE APPROACH DIRECTION

APPROACH	TAXA	No.	%
Same Direction	215,233, 234	21	24.4
Opposite Direction	331	51	59.3
Intersecting Carriageways	411,413	14	16.3
TOTAL		86*	100

* 8% of all cases

From Table II it can be seen that more than half (59.3%) of the crashes at intersections involved vehicles approaching on the same carriageway. A further 24.4% of intersection crashes involved vehicles travelling in the same direction; these figures include collisions between vehicles where the impacted vehicle was either slowing or stopped in preparation for a turn into another carriageway.

Where one of the vehicles was entering or leaving land abutting the carriageway, the crashes were more evenly distributed over the three approach categories, as shown in Table III. As might be expected, the probability of collision was higher when a driver was intending to leave, rather than enter, the carriageway.

TABLE III

PROPORTION OF ENTERING/LEAVING CARRIAGEWAY CRASHES BY RELATIVE APPROACH DIRECTION

APPROACH	TAXA	NO.	%
Same direction	231,232	17	38.6
Opposite Direction	332	17	38.6
Entering carriageway	414,415	10	22.8
TOTAL		44*	100

*4% of all cases

Overall, impacts between vehicles on intersecting paths or with one turning from the same carriageway on which the collision occurred accounted for 13.5% of all crashes. Five times as many of these collisions occurred between vehicles on the same carriageway, compared with vehicles initially on intersecting paths. Motorcycles were involved in 54% of all the turning-from- carriageway crashes, usually as the "struck" unit in approaching vehicle collisions.

In general, it appeared that relevant information such as appropriate signalling was available - particularly for vehicles travelling in the same direction. Furthermore, these collisions were more often associated with straight sections of road (as is shown in Section 3.2.2, Table XVI)

The perceptual factors associated with car/motorcycle crashes are well documented - see, for example, Williams (1976) and Hurt (1979); there were insufficient data, however to fully describe the perceptual factors in relation to collisions between four wheeled vehicles. It was not possible to determine, for example, whether the information failure related to perception, late detection or misjudgement, nor what environmental and behavioural factors may have contributed to such a failure.

Overtaking

An overtaking manoeuvre was being undertaken in 29 multi vehicle collisions, with 17 of the impacts occurring between approaching vehicles. These figures may under-represent the number of overtaking collisions as the details of 29 impacts between approaching vehicles were unknown.

Even with the latter collisions included, however, the proportion - 4.2% of all crashes - is still less than the 7.4% of overtaking collisions recorded by Jamieson, Allen, Moore, Scott and Wilson (1974). Their sample of 81 rural crashes in the Brisbane area is not strictly comparable, although the apparent reduction in head-on overtaking collisions in 1984 may reflect an increase in the proportion of overtaking lanes and multi-laned roads.

Miscellaneous

Rear impacts occurred in 66 (6.1%) of all crashes with 13 (1.2%) involving emergency stopping by the leading, struck vehicle. As with impacts where the struck vehicle was turning, the point of breakdown in the information receiving and processing sequence was not clear from the mass data, although the stopping or turning manoeuvre appeared unexpected by the striking driver.

While being useful in itself as an economical yet comprehensive description of crashes, the collision taxonomy also highlights collision types which require further description by other variables before counter-measures can be developed. This is done in the following sections of the report.

3.2 Regional Comparisons

3.2.1 Regional Characteristics

In response to one of the major objectives set for the study, certain regions were defined which - from qualitative considerations - may have characteristics affecting the type and distribution of crashes occurring therein. Initially, ten of the eleven statistical divisions were selected as the basis for analysis.*

The statistical divisions of Queensland (as at the 1981 census) are shown in Figure 3. Preliminary data extraction, however, indicated that particular groupings of divisions appeared similar based on the variables used (such as the proportion of crashes and collision type); also, with the sample so divided, only small or zero frequencies were occurring for some areas when crashes with specific characteristics were selected. Furthermore, since contingency tables with ten categories in one variable could have proved unwieldy to analyse and interpret, a decision was taken to reduce the number of areas.

After considering various demographic and geographic features, primary and secondary industries, population centres and the like, certain "like" statistical divisions were combined. This resulted in five regions being defined for analysis. These regions are shown in Figure 4.

* Statistical Divisions are districts intended to contain the anticipated development of the urban centre and associated smaller centres for a period of at least twenty years. They are designed to provide comparable statistics over time for the urban centres. Queensland Year Book, 1984.

Figure 3. Queensland Local Authorities

Figure 4. REGIONS DEFINED FOR RURAL CRASH STUDY

In essence, four regions have been established running inland from the coast, with the western statistical divisions combined to form one large region characterised by sparse population and large distances between population centres. It is to a large extent flat open country which encompasses the lower rainfall areas of Queensland.

Moreton, the smallest of the regions by area, represents the most densely populated region and includes those crashes defined as rural occurring in the Brisbane statistical division. The South-East Region is characterised by relatively close urban centres with 200 or more persons. It also supports significant agricultural and some mining industries. Major population centres such as Bundaberg, Maryborough, Toowoomba and Warwick are found in this region.

The Central Coast Region has its urban centres concentrated along the coast and includes cities such as Mackay and Rockhampton. Inland, this region supports a significant mining industry. While the Northern Region includes Cape York Peninsula, development is concentrated towards the eastern coastal strip stretching between Bowen and Cooktown. Other significant urban centres include Townsville and Charters Towers. A majority of crashes occurred south of Cooktown. Some further characteristics of these regions are to be found in Table IV

3.2.2 Regional Effects on Rural Crashes

The proportion of crashes in each region is shown in Figure 5. The distribution of crashes bears some relationship to the distribution of parameters given in Table IV. Higher correlations might be found if more specific exposure indices were available for 1984.

TABLE IV

CHARACTERISTICS OF REGIONS COMPARED

CHARACTERISTIC (to 30th June, 1984)	REGION				
	MORETON	SOUTH-EAST	CENTRAL COAST	NORTHERN	WESTERN
Area (sq. km)	19,280	142,210	190,360	367,560	1,004,760
Population	378,130	332,350	253,890	314,250	81,070
Roads (km)	20,814*	44,907	23,972	22,660	51,062
Sealed	13,926	14,948	6,255	6,861	8,370

* includes Brisbane Statistical Division

Source ABS Catalogue No. 1306.3 Local Authority Areas Statistical Summary

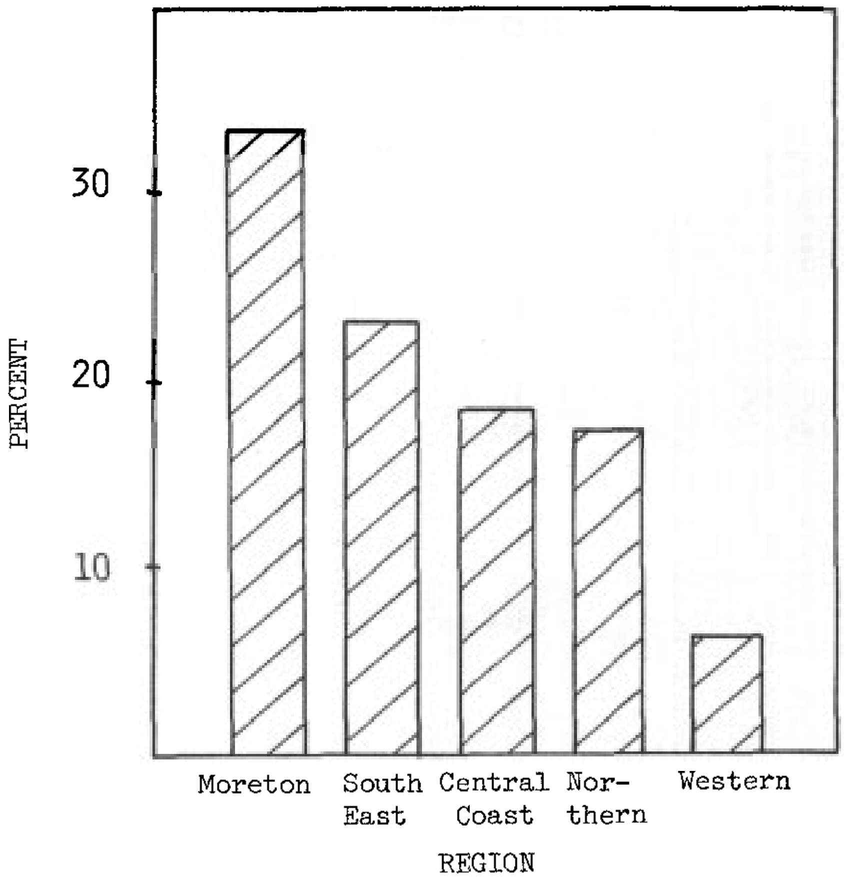


FIGURE 5. PROPORTION OF RURAL CASUALTY CRASHES IN EACH REGION

Collision Type

Table V gives the crash distribution by collision type for each region. There was a significant difference in the proportion of the various collision types in each region, brought about by the variations in single vehicle and multi vehicle (opposite direction) crashes in the Moreton and Western regions.

While single vehicle crashes were the dominant category in all regions, they were much more a feature of the Western region (or 72.6% of Western crashes). Multi vehicle opposite direction collisions were relatively more prominent in Moreton (being 29.5% of Moreton crashes) than in the Western region. The remaining regions fall somewhere between these two extremes and were not significantly different.

TABLE V.

COLLISION TYPE BY REGION

COLLISION TAXA	REGION									
	MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN	
	No.	%	No.	%	No.	%	No.	%	No.	%
1--	193	53.8	164	65.1	128	63.7	119	63.0	53	72.6
2--	51	14.2	33	13.1	20	10.0	18	9.5	9	12.3
3--	106	29.5	52	20.6	44	21.8	49	25.9	11	15.1
4--	9	2.5	3	1.2	9	4.5	3	1.6	0	0.0
TOTAL	359	100	252	100	201	100	189	100	73	100

$\chi^2_8 = 18.8$; $p<.02$ (collapsed, across 3--/4--)

The degree of urbanisation of each region could, of course, be reflected in the distribution of crash types; rural towns would usually differ in such characteristics as road alignment (straighter), number of intersections (greater), traffic density (higher) and speed limit (lower) from out-of-town areas.

In-town/Out-of-Town

As discussed in Section 2.2.2 the crash coding data did not specifically identify "in-town/out-of-town" crashes so the speed zone at the crash site was taken as a surrogate for this variable; that is, 100km/h represented "out-of-town" crashes, while 60km/h was taken to represent "in-town" crashes.

A log linear analysis revealed the presence of two interactions in the full set of data given in Table VI - a region by speed zone and a collision type by speed zone interaction. The two-way interactions are given in Tables VII and VIII.

Irrespective of region, where a crash occurred out-of-town it was more likely to involve a single vehicle than two or more vehicles; that is, 82.5% of all single vehicle crashes occurred out-of-town compared with 69.7% of multiple vehicle collisions. The distribution of collision types by region (as shown in Table V) was, in fact, related to variations in the ratio of in-town/ out-of-town crashes between these regions (Table VII refers).

The proportions in Table VII appear generally ranked by the degree of urbanisation of each region (as described by the parameters given in Table IV) and the

TABLE VI

REGIONAL CRASH DISTRIBUTION
BY COLLISION TYPE AND SPEED ZONE (IN TOWN/OUT OF TOWN)

SPEED ZONE (km/h)	COLLISION TYPE	REGION									
		MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN	
60	Single	51	17.2	11	4.7	18	9.5	24	13.9	3	4.1
	Multiple	48	16.2	13	5.5	24	12.7	21	12.1	2	2.7
100	Single	117	39.4	146	61.8	103	54.5	89	51.4	50	68.5
	Multiple	81	27.2	66	28.0	44	23.3	39	22.6	18	24.7
TOTAL		297	100	236	100	189	100	173	100	73	100

Log linear Model: [Region * Speed Zone] [Collision Type * Speed Zone]

TABLE VII

INTERACTION OF REGION AND SPEED ZONE IN TABLE VI.

SPEED ZONE (km/h)	REGION				
	MORETON %	SOUTH-EAST %	CENTRAL COAST %	NORTHERN %	WESTERN %
60	33.4	10.2	22.2	26.0	6.8
100	66.6	89.8	77.8	74.0	93.2
TOTAL	100	100	100	100	100

TABLE VIII

INTERACTION OF COLLISION TYPE AND SPEED ZONE IN TABLE VI

SPEED ZONE (km/h)	COLLISION TYPE			
	Single	%	Multiple	%
60	107	(17.5)	108	(30.3)
100	505	(82.5)	248	(69.7)
TOTAL	612	100	356	100

Queensland Year Book, 1984. The notable exception was the South-East Region which was not significantly different from the Western Region in the proportion of out-of-town crashes, indicating that the distribution of crashes is unlikely to be explained by simple exposure measures.

It should be noted that Moreton had the highest proportion of crashes occurring in intermediate speed zones (17% compared with a regional average of just under 9%). Although not specifically stated, such areas often appeared to be buffer zones on the outskirts of towns. The nature of the crash may, therefore, have been affected depending on whether drivers had entered the zone from "in-town" or "out-of-town". The driver's experience just prior to the collision (whether rural or town driving) may, of course, bear some relationship to the nature of the crash. A more specific examination of crashes in intermediate zones could be worthwhile, particularly as site variables such as standard of engineering are likely to be more uniform.

Time of Day

As shown by the results in Table IX, there was no regional effect on distribution of crashes by time of day (nor by prevailing lighting conditions, as shown in Table X).

The majority of crashes (391 or 36.4%) occurred during the late afternoon/early evening hours (4pm-10pm), with a further 305 crashes (28.4%) occurring during the midday hours (10am-4pm). The remaining crashes were evenly distributed between the midnight hours (10pm-4am) and the early period of the day (4am-10am).

TABLE IX

PROPORTION OF RURAL CRASHES BY TIME OF DAY

REGION	4am-10am		10am-4pm		4pm-10pm		10pm-4am		TOTAL
	No.	%	No.	%	No.	%	No.	%	No.
Moreton	71	19.8	98	27.3	135	37.6	55	15.3	359
South-East	43	17.1	79	31.3	79	31.3	51	20.3	252
Central Coast	39	19.4	57	28.4	74	36.8	31	15.4	201
Northern	28	14.8	50	26.5	73	38.6	38	20.1	189
Western	9	12.3	21	28.8	30	41.1	13	17.8	73

$\chi^2_{12} = 10.43$; N.S.

TABLE X

PROPORTION OF RURAL CRASHES BY REGION AND LIGHT CONDITIONS

REGION	DAYLIGHT		DAWN/DUSK		NIGHT		TOTAL	
	No.	%	No.	%	No.	%	No.	%
Moreton	201	56.1	17	4.7	140	39.2	358	100
South-East	134	53.8	10	4.0	105	42.2	249	100
Central Coast	110	55.0	15	7.5	75	37.5	200	100
Northern	96	51.1	13	6.9	79	42.0	188	100
Western	36	49.3	7	9.6	40	41.1	73	100

$\chi^2_8 = 707$, NS

TABLE XI

DISTRIBUTION OF REGIONAL CRASHES BY DAY OF WEEK

DAY OF WEEK	REGION										AVERAGE
	MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN		
	No.	%	No.	%	No.	%	No.	%	No.	%	%
Saturday/ Sunday	136	38.1	116	45.8	79	39.3	65	34.4	30	41.1	39.7
Monday	47	13.2	28	11.1	18	9.0	32	16.9	11	15.1	13.1
Tuesday	40	11.2	23	9.1	16	8.0	22	11.6	6	8.2	9.6
Wednesday	35	9.8	30	11.9	29	14.4	18	9.5	9	12.3	11.6
Thursday	47	13.2	25	9.9	32	15.9	22	11.6	6	8.2	11.8
Friday	52	14.5	31	12.2	27	13.4	30	16.0	11	15.1	14.2
TOTAL:	357	100	253	100	201	100	189	100	73	100	100

$\chi^2_{20} = 21.1$, NS

Day of Week

There were no regional differences detected for the distribution of crashes by day of week. These figures are shown in Table XI. While this trend is similar to the State average for casualty collisions, the weekend proportion is 8% higher than the State weekend average for 1984 (ABS Catalogue No. 9406.3, Road Traffic Accidents, 1984).

Monthly Variation

The monthly distribution of crashes by region is given in Table XII and this data is presented graphically in Figure 6.

There were significant differences between regions and these can best be seen from Figure 6. The Moreton Region generally accounts for the highest proportion of crashes, reaching a maximum of 46.3% for January/February; conversely, during this period the South-East proportion was significantly lower. The Northern region was associated with an increase from January through December, while the Central and Western varied no more than about 5% throughout the year.

Road Surface

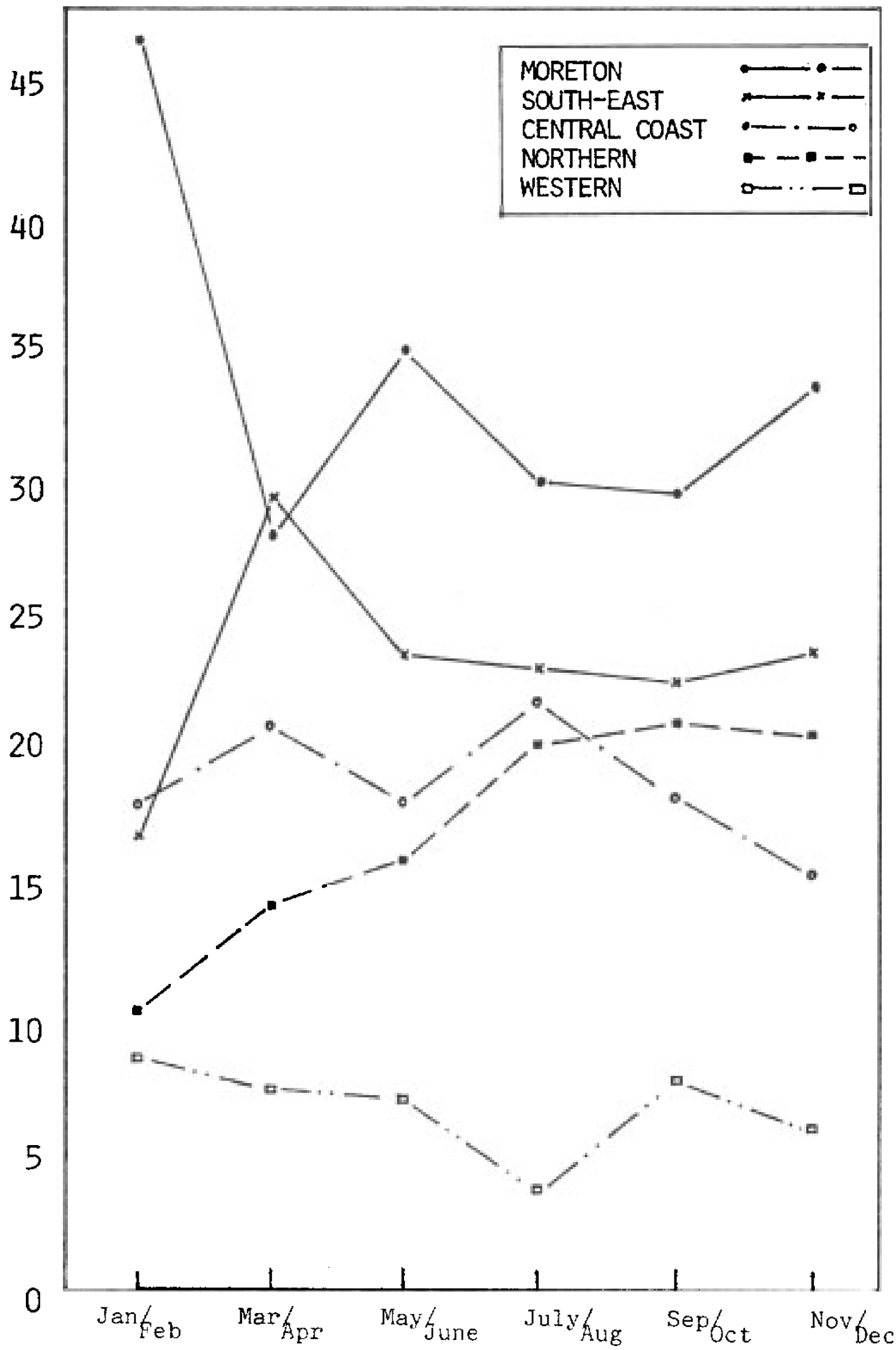
Table XIII gives the proportion of regional crashes occurring on sealed roads. While there is a significant difference among regions, the distribution of crashes reflects the proportion of sealed roads in each region (r=.86) when regressed against data given in Table IV.

TABLE XII

DISTRIBUTION OF REGIONAL CRASHES BY MONTH

MONTH	REGION										TOTAL	
	MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
January	35	43.2	16	19.8	17	21.0	8	9.9	5	6.1	81	100
February	36	49.3	10	13.7	11	15.0	8	11.0	8	11.0	73	100
March	22	26.8	25	30.5	18	22.0	10	12.2	7	8.5	82	100
April	25	29.4	24	28.2	17	20.0	14	16.5	5	5.9	85	100
May	34	33.7	21	20.8	19	18.8	16	15.8	11	10.9	101	100
June	33	36.3	24	26.4	16	17.6	15	16.4	3	3.3	91	100
July	23	30.3	19	25.0	17	22.4	14	18.4	3	3.9	76	100
August	34	30.6	24	21.6	24	21.6	25	22.6	4	3.6	111	100
September	31	33.0	21	22.3	17	18.1	15	16.0	10	10.6	94	100
October	27	26.5	24	23.5	19	18.6	27	26.5	5	4.9	102	100
November	26	36.1	17	23.6	14	19.4	14	19.4	1	1.5	72	100
December	32	31.1	25	24.3	12	11.7	23	22.2	11	10.7	103	100

$\chi^2_{55} = 77.07, p<.05$



GURE 6. DISTRIBUTION OF RURAL CASUALTY CRASHES FOR EACH REGION.

TABLE XIII

PROPORTION OF RURAL CRASHES BY REGION AND ROAD SURFACE

REGION	SEALED		UNSEALED		TOTAL
	No.	%	No.	%	No.
Moreton	345	96.4	13	3.6	358
South-East	233	92.5	19	7.5	252
Central Coast	181	90.5	19	9.5	200
Northern	168	89.4	20	10.6	188
Western	60	82.2	13	17.8	73

$X_4^2 = 21.6$, $p<.001$

Road Alignment

Road alignment has often been implicated in motor vehicle crashes - see, for example, Sanderson and Fildes (1984) - and this was investigated for region and collision type. Table XIV considers horizontal alignment with vertical alignment presented in Table XVII. Both sets of data (Table XIV and Table XVII) were represented by two two-way interactions, viz. [region and collision type] and [alignment and collision type]. Tables XV and XVI present the interactions for horizontal alignment, while Tables XVIII and XIX refer to Table XVII (considering vertical alignment).

It is interesting to note the absence of regional influence on the relationship between collision type and road alignment (both horizontal and vertical); that is,

TABLE XIV

REGIONAL CRASH DISTRIBUTION BY HORIZONTAL ALIGNMENT AND COLLISION TYPE

COLLISION TYPE	HORIZONTAL ALIGNMENT	REGION									
		MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN	
		No.	%	No.	%	No.	%	No.	%	No.	%
1--	Straight	104	29.0	90	35.6	80	39.8	68	36.2	33	45.8
	Curve	89	24.8	74	29.2	48	23.8	50	26.6	19	26.4
2--	Straight	47	13.1	31	12.3	19	9.5	15	8.0	7	9.7
	Curve	4	1.1	3	1.2	1	0.5	3	1.6	2	2.8
3--	Straight	63	17.5	27	9.8	28	13.9	23	12.2	7	9.7
	Curve	43	12.0	25	10.7	16	8.0	26	13.8	4	5.6
4--	Straight	6	1.7	3	1.2	6	3.0	3	1.6	0	0.0
	Curve	3	0.8	0	0.0	3	1.5	0	0.0	0	0.0
		359	100	253	100	201	100	188	100	72	100

Log linear Model [Region * Collision Type] [Horizontal Alignment * Collision Type]

TABLE XV

INTERACTION OF REGION AND COLLISION TYPE IN TABLE XIV

COLLISION TYPE	REGION				
	MORETON	SOUTH-EAST	CENTRAL COAST	NORTHERN	WESTERN
	%	%	%	%	%
1--	53.8	64.8	63.6	62.8	72.2
2--	14.2	13.5	10.0	9.6	12.5
3--	29.5	20.5	21.9	26.0	15.3
4--	2.5	1.2	4.5	1.6	0.0
TOTAL	100	100	100	100	100

TABLE XVI

INTERACTION OF HORIZONTAL ALIGNMENT BY COLLISION TYPE IN TABLE XIV

COLLISION TYPE	HORIZONTAL ALIGNMENT				TOTAL	
	Straight		Curve			
	No.	%	No.	%	No.	%
1--	375	57.3	280	42.7	655	100
2--	119	90.1	13	9.9	132	100
3--	148	56.5	114	43.5	262	100
4--	18	75.0	6	25.0	24	100

TABLE XVII

REGIONAL CRASH DISTRIBUTION BY VERTICAL ALIGNMENT AND COLLISION TYPE

COLLISION TYPE	VERTICAL ALIGNMENT	REGION									
		MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN	
		No.	%	No.	%	No.	%	No.	%	No.	%
1--	Level	120	33.4	104	41.3	86	42.8	76	40.2	39	53.4
	Grade	73	20.3	60	23.9	42	20.9	43	22.8	14	19.3
2--	Level	37	10.3	19	7.5	13	6.5	15	7.9	9	12.3
	Grade	14	3.9	14	5.6	7	3.5	3	1.6	0	0.0
3--	Level	57	15.9	26	10.3	26	12.9	34	18.0	5	6.8
	Grade	49	13.7	26	10.3	18	8.9	15	7.9	6	8.2
4--	Level	7	1.9	3	1.2	7	3.5	3	1.6	0	0.0
	Grade	2	0.6	0	0.0	2	1.0	0	0.0	0	0.0
TOTAL		359	100	252	100	201	100	189	100	73	100

Log linear Model [Region * Vertical Alignment] [Vertical Alignment • Collision Type]

TABLE XVIII

INTERACTION OF REGION AND COLLISION TYPE IN TABLE XVII

COLLISION TYPE	REGION				
	MORETON	SOUTH-EAST	CENTRAL COAST	NORTHERN	WESTERN
	%	%	%	%	%
1--	53.7	65.1	63.7	63.0	72.7
2--	14.2	13.1	10.0	9.5	12.3
3--	29.6	20.6	21.8	25.9	15.0
4--	2.5	1.2	4.5	1.6	0.0
TOTAL	100	100	100	100	100

TABLE XIX

INTERACTION OF VERTICAL ALIGNMENT AND COLLISION TYPE IN TABLE XVII

COLLISION TYPE	VERTICAL ALIGNMENT				TOTAL	
	Level		Grade			
	No.	%	No.	%	No.	%
1--	425	64.7	232	35.8	657	100
2--	93	71.0	38	29.0	131	100
3--	148	56.5	114	43.5	262	100
4--	20	83.3	4	16.7	24	100

drivers encountered the same degree of difficulty with curves or crests wherever they occurred. Two possibilities exist to explain this phenomenon, although they cannot be tested from the existing data.

Firstly, the absence of a regional effect could indicate similar engineering standards throughout the State. Alternatively, drivers may have adjusted their behaviour to maintain (apparent) risk levels as varying engineering standards were encountered (in accordance with risk homeostasis theory as discussed by Wilde [1982]). Should the latter be the case, the quality of information about curve difficulty available to the driver assumes central importance; for example, drivers experience difficulty in assessing horizontal curves of particular radius and curvature as noted in design standards (NAASRA, 1980) and suggested by Fildes and Triggs (1983).

With respect to horizontal alignment, Table XVI indicates that single vehicle crashes are as likely to happen on a curve as on a straight section of road; the same result was obtained for impacts between approaching vehicles. The influence of variables other than specific curve characteristics are addressed in Section 3.2.3 (Road and Environmental Features).

Horizontal curves played a far smaller role in collisions between vehicles travelling in the same direction or on intersecting paths; only one in ten of the former collisions occurred on or near a curve, as did one in four of the latter. Vertical curves were a little more prominent for same direction impacts (29% as shown in Table XVIII) and featured most strongly in collisions between approaching vehicles (or 43.5% of all such collisions).

It is possible that the presence of a vertical curve for these impacts, and between vehicles on intersecting paths, may have had an adverse effect on sight distance, although such information was not recorded. Factors influencing the overtaking decision, including reduced opportunities for overtaking due to traffic volumes or road geometry, perceptual and other information deficiencies, may also be worthy of investigation. It is not known, for example, if misjudgement or intentional risk taking was displayed by the overtaking driver. Crash involvement arising from the former is likely to be reduced by improving the quality of the information available. Without knowing the particular influence such a feature had, however, specific countermeasures cannot be devised.

Roadside Objects

Where a vehicle leaves the carriageway, one of the factors likely to influence the severity of the crash is the type of object hit, as demonstrated by Good and Joubert (1973) and Sanderson and Fildes (1984). The presence and nature of such objects might in turn be expected to be associated with the geography and development of a region. This proposition was investigated for single vehicle run-off-road crashes. The results, which differ significantly between regions, are presented in Table XX.

In the Moreton region, more than two-thirds of all crashes where vehicles left the road involved impact with some object (either naturally occurring or introduced, as defined in Section 2.2.2). This is contrasted with the remaining regions where about half of the crashes did not

TABLE XX

OBJECT STRUCK IN SINGLE VEHICLE RUN-OFF-ROAD CRASHES BY REGION

OBJECT STRUCK	REGION									
	MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN	
	No.	%	No.	%	No.	%	No.	%	No.	%
Natural	45	30.8	32	21.6	22	21.4	18	19.1	14	34.1
Construction/ Introduced	58	39.7	44	29.7	25	24.3	30	31.9	5	12.2
None	43	29.5	72	48.7	56	54.3	46	49.0	22	53.7
TOTAL	146	100	148	100	103	100	94	100	41	100

$\chi^2_8 = 27.2$, $p<.001$

involve impact with an object. The remaining impacts for South-East and Central Coast regions were approximately evenly divided between natural and introduced objects; impacts in the Northern region were most likely with an introduced object (31.9%) while natural objects such as trees were most common in the Western Region (34.1%).

The majority of those crashes where the vehicle left the carriageway without impacting a specific object involved a rollover (92%). The beneficial effects of seat belt wearing on this and other collision types in reducing injuries is well documented - see, for example, the proceedings of the Seat Belt Seminar (Commonwealth Department of Transport, 1976) - so that differences in regional wearing rates of seat belts could influence the distribution of casualty crashes.

Seat Belt Wearing

An investigation (limited to some extent by the data coding) was carried out. Seat belt wearing by region was tested for the most severely injured person in single vehicle run-off-road crashes; the sample was further restricted to either passenger cars or derivatives where a seat belt was generally available for use. The results are given in Table XXI.

It can be seen that the proportion of restrained, yet injured occupants was not significantly different across regions at 54.8%. As a comparison, this figure appears a little lower than the "Queensland average" wearing rate of 68.8% reported by Hartwig (1985) for 1983/84 (although this average draws on widely varying samples). It may have been that these impacts were characterised by factors which tended to negate the benefits of seat belts - such as intrusion into the passenger compartment - although this could not be determined from the mass data.

TABLE XXI

SEAT BELT WEARING BY DRIVERS OF PASSENGER CARS INVOLVED IN RUN-OFF-ROAD CRASHES

SEAT BELTS	REGION									
	MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN	
	No.	%	No.	%	No.	%	No.	%	No.	%
Wearing	66	55.5	76	60.3	51	62.2	31	43.7	21	52.5
Not Wearing	53	44.5	50	39.7	31	37.8	40	56.3	19	47.5
TOTAL	119	100	126	100	82	100	71	100	40	100

$\chi^2_4 = 6.83$ N.S.

Alcohol Involvement

Another behavioural characteristic of drivers which did not differ across regions was the proportion of drivers identified with blood alcohol concentrations (BACs) exceeding .05mg/100ml. These results are given in Table XXII. An average of 15% of drivers fell into this category, although a significant proportion of the remaining drivers did not appear to have been tested. The compulsory testing of drivers involved in crashes for BAC is not required under the Queensland Traffic Act (1949 as amended); it is, therefore, unlikely these figures accurately reflect the proportion of drivers who exceeded the prescribed limit. More detailed results are presented in Section 3.4.

Driver Response

A number of the crashes were attributed to a failure of the driver to respond and correct a deviation of the vehicle. Crashes where drivers failed to respond to the impending collision were identified by the investigating Police Officer, who nominated where possible the factor most likely involved. A range of factors were listed in Section 2.2.2, although the majority of such crashes involved falling asleep, a medical condition or a distraction.

It appeared that regional differences might exist in the distribution of such factors; longer trip lengths could, for example, lead to fatigue and decreased vigilance. The proportion of crashes where drivers failed to respond was, however, not significantly different among regions. The results are given in Table XXIII, where it

TABLE XXII

BACs OF CRASH INVOLVED DRIVERS BY REGION

BAC	REGION									
	MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN	
	No.	%	No.	%	No.	%	No.	%	No.	%
<.05	8	2.2	5	2.0	1	0.5	1	0.5	1	1.4
>.05/ Suspect	54	15.0	32	12.7	36	17.9	31	16.4	8	11.0
Other/ Unknown	297	82.8	214	85.3	164	82.6	157	83.1	64	87.6
TOTAL	359	100	251	100	201	100	189	100	73	100

$\chi^2_8 = 10.09$ N.S.

TABLE XXIII

THE ABSENCE OF DRIVER RESPONSE BY REGION

DRIVER RESPONSE	REGION									
	MORETON		SOUTH-EAST		CENTRAL COAST		NORTHERN		WESTERN	
	No.	%	No.	%	No.	%	No.	%	No.	%
NIL	38	10.6	35	13.9	27	13.4	28	14.8	11	15.1
OTHER/ UNKNOWN	321	89.4	217	86.1	174	86.6	161	85.2	62	84.9
TOTAL	359	100	252	100	201	100	189	100	73	100

$\chi^2_4 = 2.89$, N.S.

can be seen that an average of 13.5% of all crashes involve this factor.

Driver Origin and Crash Location

Tables XXIV and XXV investigate the origin of crash involved drivers for single vehicle and multi vehicle collisions. Local drivers were taken as those whose residential address fell in the same statistical division as the one in which the crash occurred. Both Tables show a significant difference between regions with a tendency for Moreton and the Northern region to have significantly more local drivers involved in crashes than for the other regions; the actual proportion was, however, consistently greater for the single vehicle crashes, as can be seen in Figure 7.

It is appreciated, however, that because of the size of each statistical division, this result may not necessarily reflect a greater degree of driving difficulty for visitors to particular regions.

A proportion of "local" drivers could also have been on unfamiliar roads. A much finer classification - by Local Authority Area - was available for driver origin and crash location, although time precluded coding and analysing the data. It could, however, give additional insight into the difficulty experienced by drivers on unfamiliar roads.

TABLE XXIV

RESIDENTIAL ADDRESS FOR DRIVERS IN SINGLE VEHICLE CRASHES

REGION	LOCAL		VISITOR		TOTAL	
	No.	%	No.	%	No.	%
Moreton	132	84.6	24	15.4	156	100
South-East	79	56.0	62	44.0	141	100
Central Coast	69	65.7	36	34.3	105	100
Northern	73	75.3	24	24.7	97	100
Western	30	58.8	21	41.2	51	100

$\chi^2_4 = 33.93, p<.001$

TABLE XXV

RESIDENTIAL ADDRESS FOR DRIVERS IN MULTIPLE VEHICLE CRASHES

REGION	ALL LOCAL		ONE OR MORE VISITOR		ALL VISITORS		TOTAL	
	No.	%	No.	%	No.	%	No.	%
Moreton	163	78.0	40	19.1	6	2.9	209	100
South-East	50	50.0	30	30.0	20	20.0	100	100
Central Coast	57	59.4	33	34.3	6	6.3	96	100
Northern	65	66.3	28	28.6	5	5.1	98	100
Western	12	42.9	9	32.1	7	23.0	28	100

$\chi^2_8 = 54, p<.001$

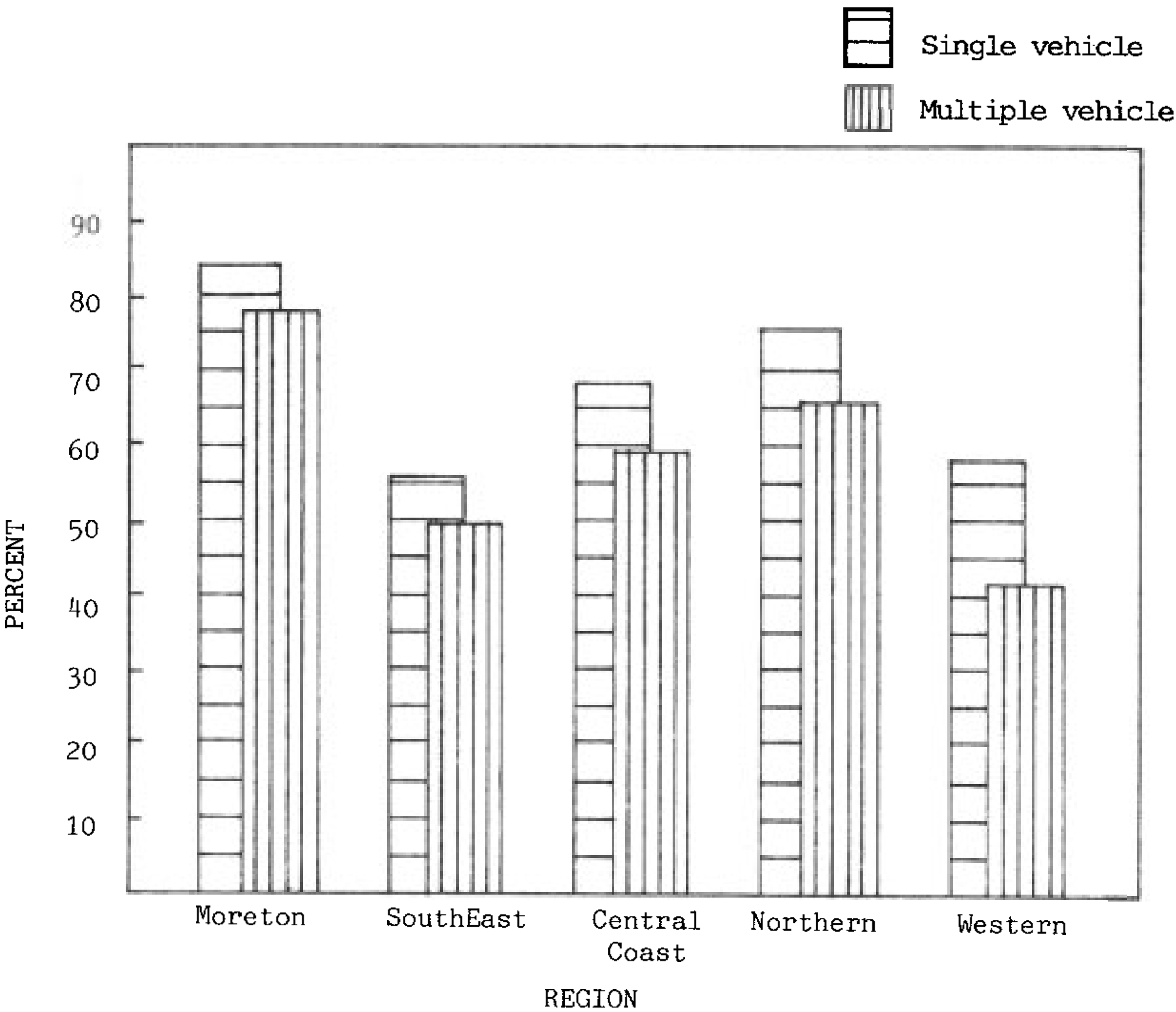


FIGURE 7. PROPORTIONS OF RURAL CASUALTY CRASHES IN EACH REGION INVOLVING ONLY LOCAL DRIVERS.

3.2.3 Summary - Regional Effects

With respect to regions, variations were found in the distribution of the proportion of crashes, as well as crash type and location within the region. It is suspected that some of these variations would be significantly reduced if adequate indices of exposure were available.

For example, the number of crashes in each region, as shown in Figure 5, appears to vary with the parameters related to traffic activity. Some readily available indices were given in Table IV, including length and proportion of road sealed, population and number of registered vehicles. More specific indices for the study period (1984) such as number of licensed drivers and annual distances travelled for each region may go further in explaining the distribution of crashes. Similarly, the higher proportion of single vehicle crashes in the Western region may reflect the lower traffic density and fewer intersections; the opportunity for involving another vehicle would be significantly reduced.

Nevertheless, the number of single vehicle crashes in the Western region are still significantly less than those in the other regions. Single vehicle crashes and impacts between approaching vehicles accounted for more than three-quarters of crashes in each region, although Moreton differed from the remaining coastal regions with about one out of every three collisions occurring between approaching vehicles. It is not certain whether this reflects a greater opportunity for impact by an out-of-control vehicle or a difference in some other factor such as overtaking behaviour, which in turn might be influenced by overtaking opportunities and traffic volumes.

The interaction between speed zone and region was most likely representative of the degree of urbanisation of various regions, rather than a factor primarily related to road safety. The other interaction in Table VI - that eight out of ten single vehicle crashes occurred out-of-town compared with two out of three multiple vehicle collisions - is significantly different from the relative proportions reported for South Australia (Dorsch et. al., in print) (assuming that a 60km/h speed limit represents an "in-town" crash as reported for South Australia). In South Australia, about half of the single vehicle crashes, and almost three-quarters of the multiple vehicle collisions occurred "in-town". This may reflect a difference in the urbanisation of the two States and, if so, may be associated with differences in road standards.

There were no regional influences detected for time of day and day of week distributions of crashes. The overall patterns remain of interest, however, in relation to enforcement activities or in suggesting the presence of human and other factors essential to the crash.

Most regions displayed a relatively stable distribution of crashes by months (and, therefore, seasons). The significant difference between the Moreton and South-East regions for January and February might be a result of tourist activity associated with the Christmas period; the level of activity could fall during the winter months, compared with the relatively more stable distribution of tourist activity in the central zone.

Visitors are relatively more likely to be involved in both single and multiple vehicle collisions in zones other than Moreton (Tables XXIV and XXV). Why visiting drivers to Moreton are less likely to be involved in a crash was not apparent from the data. It may be that their number is proportionately smaller in relation to the number of resident drivers; road and environmental factors could also be of a standard that does not give the visitor undue difficulty.

This latter proposition was not immediately obvious from the investigations between road alignment and crash type, as there was no regional variation in the degree of involvement of curves and crests. It may also be, of course, that defining "local" and "visiting" drivers in terms of statistical division does not truly reflect familiarity or otherwise with the route nor a constancy in driving conditions within the one statistical division.

Single vehicle crashes appear to occur in all regions without prejudice on straight or curved roads as previously discussed, as do collisions between approaching vehicles. It is not known if the horizontal curves involved in these collisions met acceptable engineering standards or whether it was the curve per se which made the major contribution. Vertical curves also played a significant part in all crashes, but more so in those between approaching vehicles. A proportion of these vertical curves were recorded as slight grade and it is possible that perceptual factors came into play depending on the delineation and engineering of the road. Furthermore, it is not known where (in relation to the crest) the crash occurred. Whatever the feature involved, it does not appear to be something specific to one region.

With respect to roadside objects, vehicles leaving the carriageway were more likely to strike an object - either natural or introduced - in the Moreton region. The higher proportion of casualty crashes in the other regions where no object was struck (in about 50% of leave-road crashes where the majority involved roll-overs) suggested a lower wearing rate for seat belts in those regions.

The crashes had been coded so that a limited investigation could be carried out and it was found that about 50% of the most severely injured persons in each single vehicle crash was wearing a seat belt, irrespective of the location of the crash. This suggests that a more specific investigation is warranted to determine the nature of such single vehicle crashes, and the mechanism of injury to the relatively high proportion of restrained, yet injured, occupants. The proportion of occupants ejected in these crashes was not known.

There was no difference between regions in terms of proportion of drivers with BACs greater than .05 (11.8% of all drivers), nor of drivers failing to respond to an impending collision (13.5% of all crashes). Because testing for the presence of alcohol is not a legal requirement in Queensland the BACs of a significant proportion of crash involved drivers were not recorded. Thus, the true involvement of alcohol in regional crashes cannot be ascertained from this data; a region with a high proportion of alcohol involvement coupled with a low testing rate might superficially appear similar to a region with a lower alcohol involvement but a higher testing rate.

3.3 Road and Environmental Features

Object Struck

In Section 3.2 reference was made to the variation by region in the type of object struck when vehicles left the carriageway. The significance of the variation between regions is to be found in the severity of the resulting impacts. Table XXVI shows this relationship (between accident severity and the object struck).

The difference was due to a doubling of the probability of a fatality occurring when the object was relatively unyielding such as for trees, service poles and construction elements, as defined in Section 2.2.2. Such impacts had a fatality rate of 20% or more, compared with 10% where no object was involved; it is not known if ejection from the vehicle was a feature of these latter crashes.

Of those crashes where an object was struck, slightly more than half (160 or 55.4%) involved an introduced or construction element where some control over the hazard presented by the object could have been exercised at the design stage. Speed of impact could have been a dominant feature of these impacts rendering any realistic protective measures ineffective. Additional information including the location of the object relative to the carriageway and its role in the energy exchange leading to injury is required to give an adequate description prior to considering countermeasures.

Similar information is also required in relation to naturally occurring objects such as trees, before the feasibility of creating a recovery zone adjacent to the carriageway can be assessed (after the recommendations of Good and Joubert, 1973).

TABLE XXVI

SEVERITY OF SINGLE VEHICLE RUN-OFF-ROAD CRASHES BY OBJECT STRUCK

SEVERITY	NATURAL				CONSTRUCTION		INTRODUCED				NONE	
	Tree		Other				Service Pole		Other			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Fatal	20	20.2	3	10.0	23	27.0	7	20.5	8	19.5	22	9.4
Hospital Admission	79	79.8	27	90.0	62	73.0	27	79.5	33	80.5	213	90.6
TOTAL	99	100	30	100	85	100	34	100	41	100	235	100

$\chi^2_5 = 18.6$, $p<.001$

Horizontal Alignment and Road Shoulders

Horizontal curves have been associated with a significant proportion of crashes, as discussed in Section 3.2.2. It was, therefore, possible that this feature compounded the apparently unsettling effect when a vehicle ran on the road shoulders (taken to be where the road shoulder was not sealed). While collision types [115.1] and [116.1] often involved initial running on the shoulders prior to loss of control, collision types [115] and [116] were included in the analysis as road shoulder involvement was sometimes cited in the latter's crash report as a factor possibly reducing the probability of control being regained.

Table XXVII contains the initial frequencies analysed, with Table XXVIII showing the frequencies collapsed across the variable of horizontal alignment. While collision types [115.1/116.1] were predominantly associated with shoulder running (84.2%) the proportions were constant for both straight and curved road sections; that is, horizontal curves did not appear to aggravate the situation, and road shoulder running on straight sections of road was just as likely to result in loss of control of the vehicle.

This contribution of road shoulders is, of course, not unknown as shown by the work of researchers like Armour and McLean (1983). While these authors note the benefits of a sealed shoulder - not necessarily full width - they also cite various aspects which need reviewing before the specific benefits of this approach can be fully evaluated. This countermeasure, of course, only addresses one essential factor in the sequence of events leading to injury; other essential factors in the chain may also be amenable to control.

TABLE XXVII

INVOLVEMENT OF HORIZONTAL ALIGNMENT AND ROAD SHOULDERS IN SINGLE VEHICLE LOSS OF CONTROL CRASHES

HORIZONTAL ALIGNMENT	ROAD SHOULDER RUNNING	COLLISION TYPE			
		 115·1 116·1		 115 116	
		No.	%	No.	%
Straight	Yes	18	31.6	4	1.9
	No	3	5.3	88	42.3
Curve	Yes	30	52.6	6	2.9
	No	6	10.5	110	52.9
TOTAL		57	100	208	100

Log linear Model:[Collision type • Road Shoulder Running]

TABLE XXVIII

INTERACTION OF ROAD SHOULDER RUNNING AND COLLISION TYPE IN TABLE XXVII

ROAD SHOULDER RUNNING	COLLISION TYPE			
	 115·1 116·1		 115 116	
	No.	%	No.	%
Yes	48	84.2	10	4.8
No	9	15.8	198	95.2
Total	57	100	208	100

Written and diagrammatic descriptions of pre-crash trajectories on Police Accident Report forms indicate that the driver's "over reaction" to road shoulder running has initiated or aggravated a loss of control; gradually steering the vehicle back to the sealed surface would often be the most appropriate course of action. Consequently, it would be advantageous if drivers could be encouraged to persist with normal control responses in unfamiliar situations - to replace an "over reaction" with a measured steering or braking response. The potential of giving drivers positive guidance (through educational publicity or perhaps a simple training programme) would, of course, have to be validated by a pilot study before the feasibility of this approach could be established.

Wet versus Dry Surfaces

An insensitivity to horizontal alignment was previously seen in the data of Table XIV (Section 3.2.2) for all single vehicle crashes. It was possible, however, that a wet surface could influence the probabilities of certain crash types and this proposition was tested using the data in Table XXIX. A three-way interaction between the type of collision, the type of surface and the presence of water was found.

The majority of crashes (944 or 87.6%) occurred on dry roads for both sealed and unsealed surfaces, although this may reflect little more than a simple correlation with exposure to wet conditions. It was noted, however, that collisions between approaching vehicles on sealed roads were relatively more likely when the surface was wet; vehicles on intersecting paths were relatively less likely to collide in the wet.

TABLE XXIX

DISTRIBUTION OF COLLISION TYPES BY ROAD SURFACE AND CONDITION

ROAD SURFACE	SURF E CONDI ON	COLLISION TYPE							
		1--		2--		3--		4--	
		No.	%	No.	%	No.	%	No.	%
Sealed	Dry	538	81.5	115	86.5	195	74.7	23	95.8
	Wet	61	9 2	16	12.0	45	17.2	1	4.2
Unsealed	Dry	50	7.6	2	1.5	21	8.1	0	0.0
	Wet	11	1.7	0	0.0	0	0.0	0	0.0
TOTAL		660	100	133	100	261	100	24	100

Log linear Model:[Collision Type * Surface Condition * Surface Type]

If the wet surface simply increased the control difficulty of the vehicle, all collision types should be affected similarly. It may, in fact, be the atmospheric conditions associated with wet road surfaces which drivers do not readily adjust to; the increased visual "noise" would increase threshold contrast levels leading to later detection of oncoming vehicles, and adversely affect perception and judgement - areas where driver's performance is often flawed under good driving conditions (Hills, 1980).

The relative proportions of collisions between wet and dry surfaces changed when unsealed roads were considered, giving the three-way relationship (represented graphically in Figure 8). Unsealed road data were conspicuous by the absence of multi-vehicle crashes in wet conditions.

Whether this reflected a change in driver behaviour (due to a disproportionate increase in perceived risk levels when compared to a wet sealed surface), the low traffic density on such roads or simply that many of the roads became untrafficable when wet was not apparent from the mass data. Furthermore, it is unlikely that a specific investigation could be justified given that only 11 crashes were recorded in those conditions.

Wet roads, of themselves, did not increase the overall difficulty of negotiating curves as shown by the results in Table XXX. Drivers did appear to have more trouble in general, however, adjusting to curves on unsealed rather than on sealed roads.

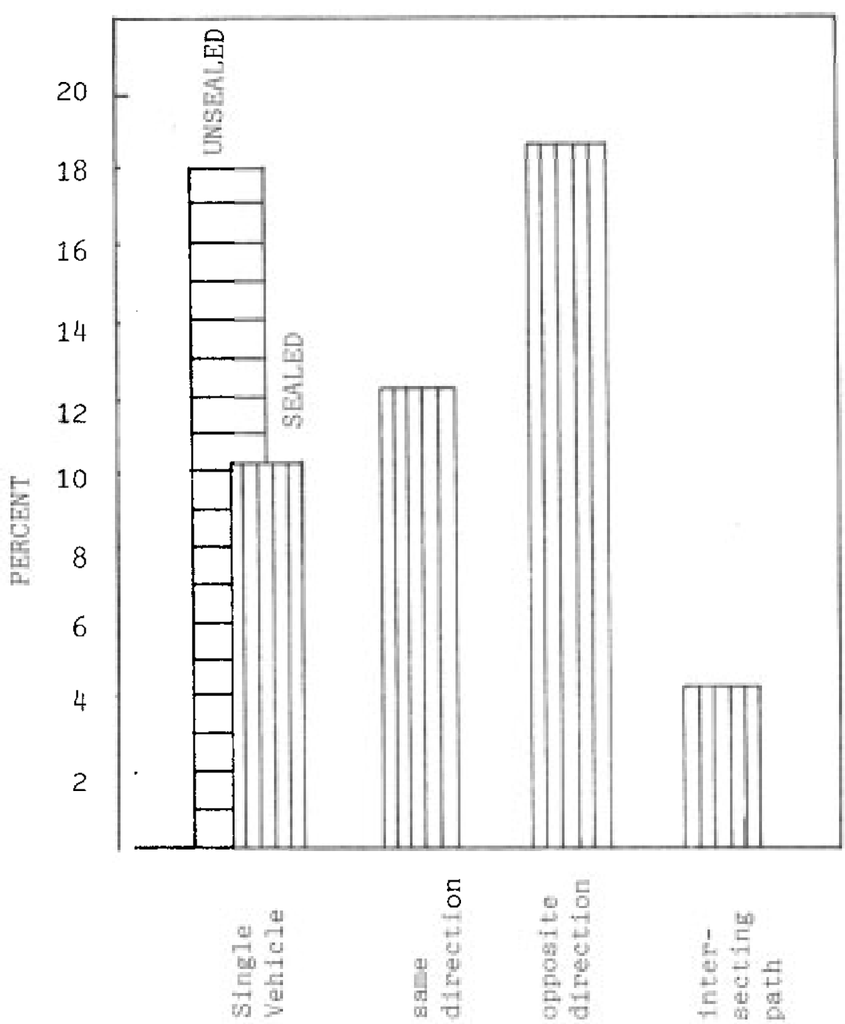


Figure 8. PROPORTION OF EACH CRASH TYPE ON WET SURFACES - SEALED VERSUS UNSEALED ROADS.

TABLE XXX

THE EFFECT OF HORIZONTAL ALIGNMENT, ROAD SURFACE AND CONDITION ON CRASH DISTRIBUTION

ROAD SURFACE	SURFACE CONDITION	HORIZONTAL ALIGNMENT			
		Straight		Curve	
		No.	%	No.	%
Sealed	Dry	562	84.4	309	75.0
	Wet	71	10.7	52	12.6
Unsealed	Dry	30	4.4	43	10.5
	Wet	3	0.5	8	1.9
TOTAL		666	100	412	100

Log linear Model:[Horizontal Alignment * Road Surface][Surface Condition]

As well as the obvious difference in surface friction coefficients between unsealed roads and sealed roads, it is not known if the standards of road geometry and road construction were otherwise similar for both types of road. This could have some bearing on the observed relationship as different demands on perceptual and control skills would then be required for each road type.

3.4 Driver/Vehicle Characteristics

Human Factors

The distribution of crash involved drivers by age and sex is given in Table XXXI. There was no significant change in the proportion of males to females in each age group, with more than three times as many males as females being involved in crashes. Just over 40% of crash involved drivers were under 25 years of age, slightly less than the 46.1% falling between 25 and 50 years of age. 13.8% of drivers were older than 50 years. This is shown graphically in Figure 9. In an endeavour to put these proportions in perspective, proportions of road traffic casualties from all 1984 Queensland traffic crashes are shown in Table XXXII.

TABLE XXXI

CRASH INVOLVED DRIVERS BY AGE AND SEX

SEX	YEARS					
	<25		25-50		>50	
	No.	%	No.	%	No.	%
MALE	485	79.8	532	76.1	160	76.9
FEMALE	123	20.2	167	23.9	48	23.1
TOTAL	608	100	699	100	208	100

$X^2_2 = 2.6$, N.S.

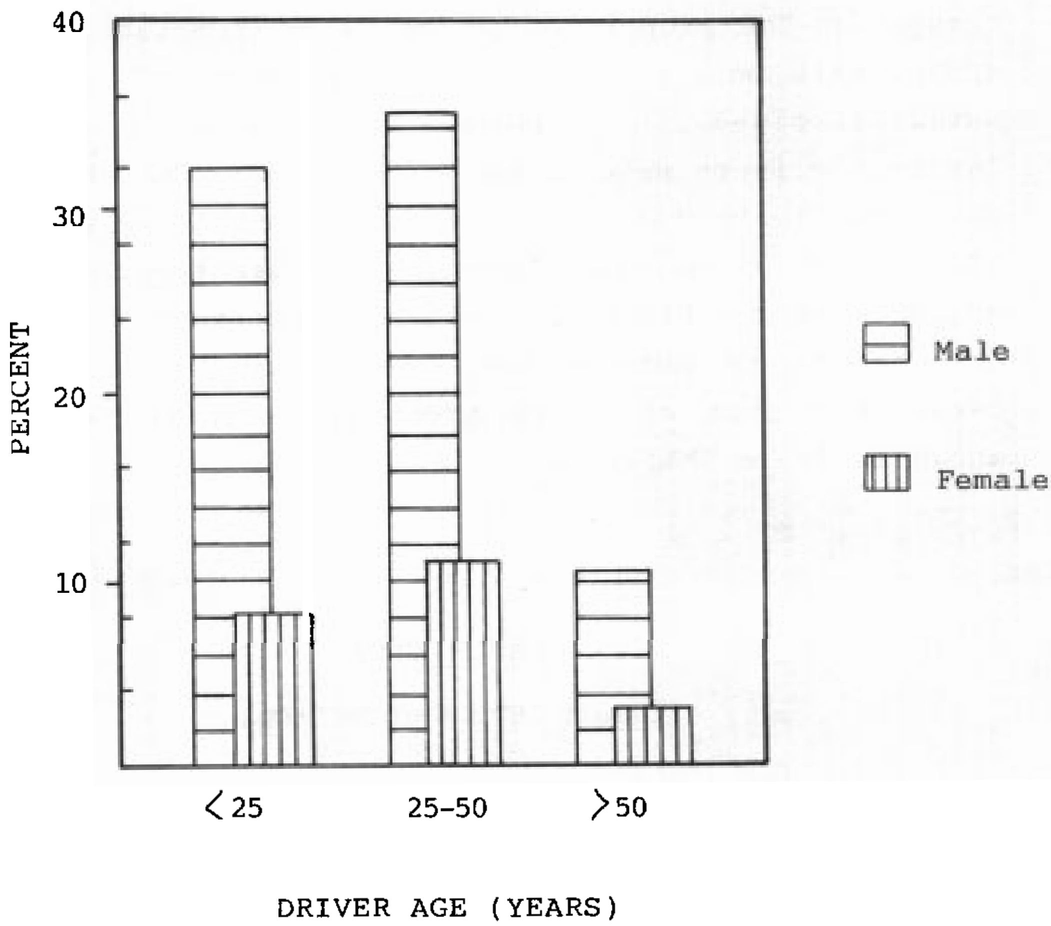


Figure 9. DISTRIBUTION OF RURAL CASUALTY CRASHES BY DRIVER AGE/SEX GROUPS.

It must be remembered that these proportions may not be strictly comparable as the figures used in Table XXXI are those for crash involved drivers (irrespective of whether the driver received injuries in the crash). Two figures are, therefore, given in Table XXXII to encompass the range of possibilities. One is the proportion of injured motor drivers and motorcyclists, while the other includes the number of passengers injured in each group.

The proportion of young drivers in the study population was less than that in each of the other two groups depicted in Table XXXII, while that for 25-50 year old drivers was greater (variations for both being of the order of 5%). This may reflect variations in age distribution of drivers between rural and urban areas, or that less rural driving is done by the younger age group. However, this data is not able to take account of exposure, either in terms of the number of young drivers in the total driving population, or in terms of distance travelled. Young drivers may be over-represented on either of these criteria.

TABLE XXXII

AGE DISTRIBUTION OF VARIOUS CRASH SAMPLES

SAMPLE	DRIVER AGE			No.
	< 25 %	25-50 %	> 50 %	
Rural Crashes - drivers	40.1	46.1	13.8	1515
*Qld - Injured Drivers/Riders	44.9	41.7	13.4	4970
*Qld - Injured Drivers/Riders/ Passengers	45.9	38.6	15.4	7198

*Source: ABS Catalogue 9406-3. Road Traffic Accidents, 1984.

Age was related to the day of week on which crashes occurred, as well as to the distribution of crash types. Table XXXIII shows that a relatively greater proportion of the younger age group were involved in crashes on Saturday and Sunday. The proportion of drivers involved in crashes from Monday to Friday increased from 52.3% of the younger drivers to 70.1% of those older than 50 years of age. A similar trend can be observed in Table XXXIV in relation to single vehicle crashes.

TABLE XXXIII

AGE OF CRASH INVOLVED DRIVERS BY DAY OF WEEK

DAY OF WEEK	DRIVER AGE					
	< 25		25-50		> 50	
	No.	%	No.	%	No.	%
Saturday/ Sunday	254	47.7	234	34.2	56	29.9
Monday - Friday	278	52.3	451	65.8	131	70.1
Total	532	100	685	100	187	100

χ^2_2 =30.3, p<.001

Almost half of the young crash involved drivers were involved in single vehicle crashes, compared with 36.5% for those older than 50 years. A young driver was not as likely to be involved in a collision between approaching vehicles (although the proportion was still significant at 27.3%), while over 40% of each of the other groups are involved in impacts between approaching vehicles. This involvement can be seen in Figure 10.

TABLE XXXIV

PROPORTION OF CRASH INVOLVED DRIVERS BY COLLISION TYPE

COLLISION TAXA	DRIVER AGE					
	< 25		25-50		> 50	
	No.	%	No.	%	No.	%
11-	231	41.1	237	36.2	57	29.7
12-	47	8.3	47	7.2	13	6.8
21-	48	8.5	55	8.4	18	9.4
22-	15	2.7	15	2.3	6	3.1
23-	40	7.1	21	3.2	11	5.7
31-	56	10.0	123	18.8	34	17.7
32-	29	5.2	71	10.8	12	6.3
33-	56	10.0	63	9.6	31	16.1
34-	12	2.1	10	1.5	5	2.6
41-	28	5.0	13	2.0	5	2.6
Total	562	100	655	100	192	100

$X^2_{18} = 103.4$, $p<.001$

It may be useful to know the nature of the trip at the time of the crash. Trips for social or recreational purposes are likely to reflect the involvement of different behavioural characteristics and occur at different times than other trips, a difference which should influence the development of countermeasures.

Alcohol and Driving

Alcohol involvement was shown to be consistent through the various regions (Table XXII, Section 3.2) and this results in Table XXXV which indicates that it is equally as likely to be a factor in single as in multiple

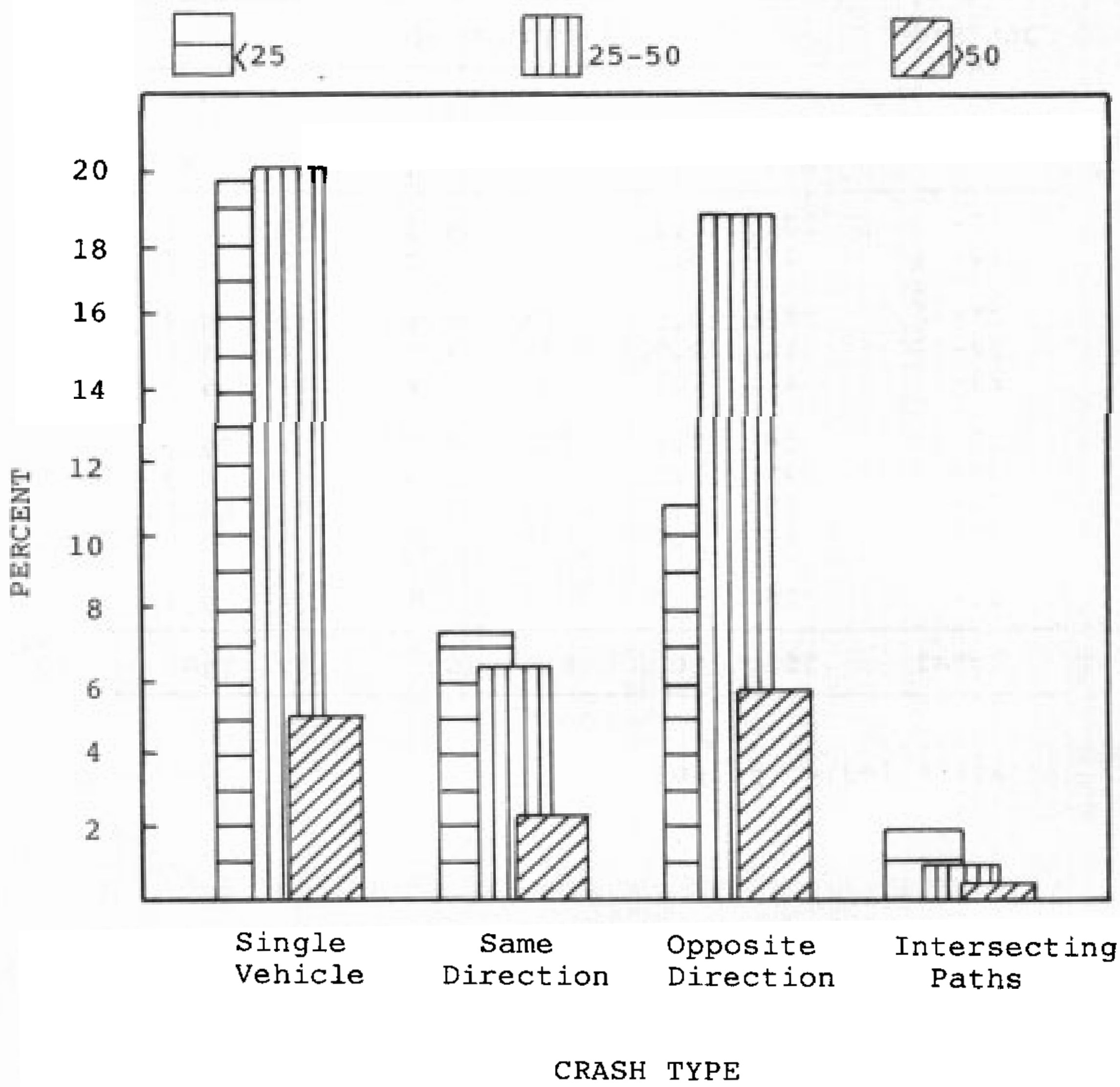


Figure 10. THE INVOLVEMENT OF DRIVER AGE/SEX GROUPS BY CRASH TYPE AS A PROPORTION OF ALL RURAL CASUALTY CRASHES.

vehicle crashes. It should be noted, however, that more than 80% of drivers involved in rural casualty crashes were not tested. Compulsory BAC testing of such drivers is not a requirement under the Queensland Traffic Act (1949 as amended), with the relevant sub-section of Section 16A yet to be proclaimed.

Because of this, the proportions must be treated with some caution. As a comparison, alcohol involvement in run-off-road rural crashes investigated by Sanderson and Fildes (1984) was found in 48% of all casualty crashes; this figure rose to 56% for fatal crashes. It is likely that this apparent difference arises from an inadequate description of the problem in Queensland. Detailed information on BACs of crash involved drivers (and preferably of the distribution of BAC levels in the general driving community) is necessary if adequate responses to the problem are to be developed.

TABLE XXXV

PROPORTION OF CRASHES WITH ALCOHOL INVOLVEMENT BY COLLISION TYPE

BAC	COLLISION TYPE			
	Single Vehicle		Multiple Vehicle	
	No.	%	NO.	%
<.05	10	1.5	8	1.9
>.05/ Suspect	114	17.3	63	15.1
Unknown	536	81.2	347	83.0
TOTAL	660	100	418	100

$\chi^2_2 = 1.1$, N.S.

Figure 11 gives the proportion of crashes of each type where alcohol was identified or suspected as a factor. Because the presence of alcohol may have gone undetected in many crashes as previously discussed, however, these results may only reflect the likelihood of a particular collision type being investigated, rather than the true distribution of alcohol involvement. If this is the case, it appears the normally more severe collision types receive greater attention; that is, single vehicle run-off-road and head-on crashes, followed by side-swipes between vehicles travelling in the same direction (which may have resulted in a control loss and secondary impact).

Vehicle Type

During the coding process, the impression was formed that certain vehicle types may be over represented in particular crash categories. This hypothesis was tested using the data in Table XXXVI which revealed a significant difference between the distribution of vehicle types in single and multiple vehicle crashes.

This difference was primarily due to the relatively smaller proportion of motorcycles being involved in single vehicle crashes; of the 68.2% of motorcycles involved in multiple vehicle collisions, about half of the riders were considered by the investigating Police Officer to have made the major contribution to the collision.

As the relative proportion of utilities involved in single vehicle crashes just failed to be significantly higher than that of car involvement (for a 5% level of significance), a further investigation was suggested, particularly for run-off-road crashes.

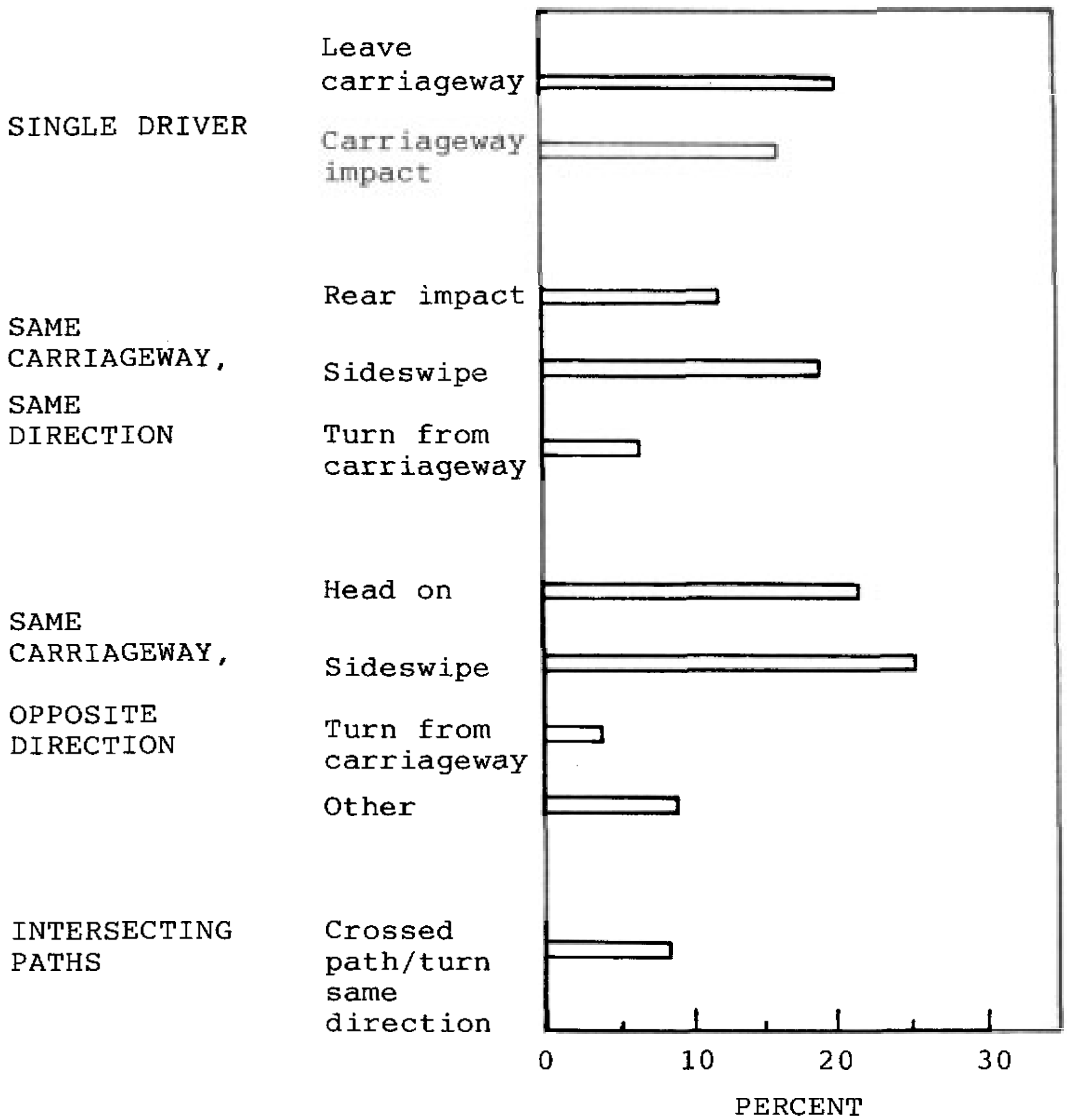


Figure 11. PROPORTION OF CRASHES WITH ALCOHOL INVOLVEMENT FOR EACH COLLISION TYPE.

TABLE XXXVI

INVOLVEMENT OF DIFFERENT VEHICLE TYPES IN SINGLE AND MULTI-VEHICLE CRASHES

VEHICLE TYPE	COLLISION TYPE				TOTAL	
	Single Vehicle		Multiple Vehicle			
	No.	%	No.	%	No.	%
Car	412	48.1	445	51.9	857	100
Utility	131	53.9	112	46.1	243	100
Motor Cycle	47	31.8	101	68.2	148	100
Other	84	39.6	128	60.4	212	100

$X^2_3 = 23.1, p<.001$

Horizontal alignment was selected as a factor which may have discriminated between handling characteristics of vehicles, and the results are presented in Table XXXVII. There was, however, no evidence to suggest that drivers of utilities had any more difficulty in negotiating curves than did car drivers.

TABLE XXXVII

SINGLE VEHICLE RUN-OFF-ROAD CRASHES BY VEHICLE TYPE AND HORIZONTAL ALIGNMENT

VEHICLE TYPE	HORIZONTAL ALIGNMENT				TOTAL	
	Straight		Curve			
	No.	%	No.	%	No.	%
Car	29	30.2	67	69.8	96	100
Utility	11	35.5	20	64.5	31	100

$X^2_1 = .3$, N.S

As an adjunct to Table XXXVII, Table XXXVIII considers the driver response (defined in Section 2.2.2) in relation to various vehicle types. While there was an overall difference within the data, this was related to vehicles other than cars and utilities; cars and utilities were of equal proportions in crashes where control loss was identified, although it should be noted that driver response was not known in more than half of all crashes. Overall, there was no evidence to suggest utilities were over represented in crashes when compared with cars.

TABLE XXXVIII

CRASH INVOLVEMENT BY VEHICLE TYPE AND DRIVER RESPONSE

DRIVER RESPONSE	VEHICLE TYPE					
	Car		Utility		Other	
	No.	%	No.	%	No.	%
Control Loss	54	6.3	18	7.4	6	1.7
Misjudge	42	4.9	13	5.5	11	3.1
Nil	96	11.2	35	14.4	14	3.9
Other	124	14.5	44	18.1	55	15.3
Unknown	541	63.1	133	54.6	274	76.0
Total	857	100	243	100	360	100

$X^2_8 = 74.0$; $p<.001$

4. CONCLUSIONS

As well as providing a general description of rural crashes in Queensland, this study was designed to explore the possible effect of regional differences on the occurrence of rural crashes. To some extent, the lack of precision in mass data leads to "suggested" rather than "definite" relationships between variables. Within these confines, however, the current data points to a number of areas worthy of further investigation.

In general, it appears that many of the differences identified between regions in the raw data are likely to be reduced if relevant controls for exposure could be devised. Traffic density and the distribution of licences by age group, for example, was thought to play its part in the variations of crash numbers and the type of crashes in the various regions.

The regional differences found in the monthly distribution of crashes, the origin of crash involved drivers and the ratio of in-town/out-of-town sites may be of more importance. These variations raise questions in relation to the nature of the trip - whether for recreational, social or work purposes - and associated factors, as do the age dependent distributions of crash type and occurrence by day-of-week; these factors could also influence the time of day when crashes occur.

It was also noted in the discussion on the effect of in-town/out-of-town crash sites that crashes occurring in "buffer" 80 km/h zones between rural areas and rural towns (or near the boundary of rural towns) might be worthy of investigation. A sample from such crash sites should give a better contrast between "in-town" and "out-of-town" behavioural characteristics of drivers by offering a degree of control over confounding variables

It was noted that vehicles leaving the road in the Moreton region were more likely to strike a roadside object and that such crashes had a higher probability of resulting in a fatality than when no object was struck. The severity of these impacts is consistent with experience in other States. Additional information on the position and nature of struck objects would be of use in determining the feasibility of creating a "clean" roadside environment. Construction or introduced elements were about equally represented in these impacts as were naturally occurring elements (such as trees).

The majority of vehicles not striking an object after running off the road overturned. A limited investigation showed that 54.8% of the most severely injured occupant in each passenger car or derivative involved in such crashes was wearing a seat belt. It would be desirable to know if the effectiveness of seat belts in this type of crash could be improved.

Single vehicle crashes were the largest specific type with almost 40% of these being associated with some form of control problem (a figure which could be increased to 48% by including specific types of multiple vehicle crashes). A significant proportion of these crashes were associated with the vehicle running on the road shoulder, either prior to or during control loss. It was noted that sealing of the road shoulder offers potential for reducing this type of crash, although a complementary approach was suggested, based on the observation that drivers generally appear to react in ways which, if anything, aggravate the situation.

While the data showed no variation by alcohol involvement across regions, it was suggested that conclusions should not be readily drawn because a significant proportion (83.5%) of crash involved drivers were not tested. That this data was incomplete was highlighted in a comparison with Victorian rural accidents. Before adequate responses can be developed, or programmes (designed to reduce alcohol involvement) be evaluated, a reliable base line should be available.

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APPENDIX ONE

SINGLE DRIVER 1--	LEAVE CARRIAGEWAY 11-	111 nil response	112 nil response	112.1 end departure	112.2 intersection departure
		113 evasive action	114 evasive action	115 control loss	115.1 control loss
		116 control loss	116.1 control loss	117 overtaking	118 overtaking
	CARRIAGEWAY IMPACT 12-	121 parked vehicle	122 stationary object	123 pedestrian on road	124 animal on road
		125 passenger fell from vehicle			
SAME CARRIAGEWAY, SAME DIRECTION 2--	REAR IMPACT 21-	211 stopped	212 slower	213 emergency stopping	214 slowing
		215 slowing to turn	216 one reversing		
	SIDESWIPE 22-	221 overtaking	222 overtaking	223 change lanes	224 merge
		225 specifics unknown			
	TURN FROM CARRIAGEWAY 23-	231 land abutting	232 land abutting	233 another carriageway	224 another carriageway
		235 U-turn			
SAME CARRIAGEWAY, OPPOSITE DIRECTION 3--	HEAD ON 31-	311 overtaking	312 lateral move	313 narrow road	314 specifics unknown
	SIDESWIPE 32-	321 overtaking	322 lateral move	323 narrow road	324 specifics unknown
	TURN FROM CARRIAGEWAY 33-	331 another carriageway	332 land abutting	333 U-turn	
	OTHER 34-	341 other			
INTERSECTING PATHS 4--		411 carriageway 412 land abutting crossed path		413 carriageway 414 land abutting turn - same direction	