

# **ADELAIDE IN-DEPTH ACCIDENT STUDY**

1975-1979

## **PART 2: PEDESTRIAN ACCIDENTS**

by

**A.J. McLean**

**N.D. Brewer**

**B.L. Sandow**

**Sponsored by**  
**The Office of Road Safety,**  
**Commonwealth Department of Transport**  
**and the Australian Road Research Board.**

**THE UNIVERSITY OF ADELAIDE**

ADELAIDE, 1979

## INFORMATION RETRIEVAL

McLEAN, A.J., BREWER, N.D. and SANDOW, B.L. (1979) : ADELAIDE IN-DEPTH ACCIDENT STUDY, 1975-1979, PART 2 : PEDESTRIAN ACCIDENTS. Adelaide, Road Accident Research Unit, The University of Adelaide.

KEYWORDS : Pedestrian/accident/cause/sample (stat)/emergency vehicle/driver/vehicle/traffic flow/severity (accid, injury)/drunkenness/Adelaide, South Australia\*

ABSTRACT : This report contains descriptions of the causes and consequences of the pedestrian accidents contained in a representative sample of road traffic accidents to which an ambulance was called in metropolitan Adelaide. Reviews of the relevant characteristics of the pedestrians and drivers, the vehicles, and the road and traffic environment are also included. All but one of these 40 accidents occurred on busy roads. Some measures designed to increase the rate of flow of vehicular traffic are detrimental to the safety of the pedestrian, to the extent that some urban arterial roads are very hazardous for some pedestrians, particularly children and the elderly. The pedestrian was more likely to have been careless, or to have made a mistake, than was the driver, but alcohol intoxication was less apparent as a causal factor in these pedestrian accidents than in other types of accidents covered by this survey. The injuries sustained by the pedestrians were much more likely to be dangerous to life than were the injuries sustained by other road users involved in other types of accident. The front of the striking car, including the upper surface of the bonnet, accounted for more than half of the injuries. A number of possible countermeasures and topics worthy of further investigation are listed at the end of the report.

\*Non IRRD Keywords

The views expressed in this publication are those of the authors and do not necessarily represent those of the University of Adelaide, the Commonwealth Government or the Australian Road Research Board.

## FOREWORD

This study was conducted by the Road Accident Research Unit of the University of Adelaide and was jointly sponsored by the Office of Road Safety, Commonwealth Department of Transport and the Australian Road Research Board.

The general aims were to evaluate the effectiveness of many existing safety measures and to identify other factors related to accident or injury causation in road accidents in metropolitan Adelaide. The areas studied included characteristics of road users, the vehicles and the road and traffic environment.

To achieve these aims a representative sample of all road accidents to which an ambulance was called in the Adelaide metropolitan area was studied in the 12 months from March 1976. Two teams, each comprising a medical officer, an engineer and a psychologist attended 304

randomly selected accidents and collected medical, engineering and sociological data.

The findings are presented in a series of reports, each covering a specific topic. Part I provides an overview, and is followed by reports dealing with pedestrians, pedal cyclists, motorcyclists, commercial vehicles, passenger cars and road and traffic factors. The final report in the series provides a summary of the findings and recommendations.

Basic data from the study are held on computer by both the Road Accident Research Unit, University of Adelaide and the Australian Road Research Board. Access to these data can be arranged for bona fide research workers on application to the Australian Road Research Board. Further copies of this report and copies of other reports in the series are available from the Office of Road Safety, Commonwealth Department of Transport.

## ACKNOWLEDGEMENTS

The collection of data at the scene of the accident and in the follow-up investigations was performed by:

H.S. Aust and C.T. Hall  
(Engineers)

N.D. Brewer and B.L. Sandow  
(Psychologists)

J.R. Lipert and P.J. Tamblyn  
(Medical Officers)

The completion of this study was due mainly to the willingness of these team members to work exceptionally long hours under difficult and often hazardous conditions.

Much of the road and traffic data was collected by W.J. Offler, who also attended the scenes of the accidents during the final three months.

The recorded information was processed by the above personnel, assisted by J.K. Darwin, G.M. Haymes, O.T. Holubowycz and C.A. Latta.

The Steering Committee for the study provided valuable assistance and advice. Its members were: Professor R.E. Luxton (Chairman), Professors: I.D. John, R.B. Potts, J.S. Robertson, A.T. Welford, Drs.: B.L. Cornish (representing the Director-General of Medical Services),

I.R. Johnston (D.O.T.), J.B. Metcalf (A.R.R.B.), G. Sved, A.P. Vulcan (D.O.T.), and Messrs. J.F.M. Bryant (A.R.B.B.), R. Culver, H.E. Roeger (later R.W. Scriven and then M. Knight) (representing the Commissioner for Highways), R. Ungers (D.O.T.) and F.E. Yeend (D.O.T.). The first Chairman was the late Professor N.T. Flentje.

The St. John Ambulance Transport Division played an essential role in the conduct of this study by notifying the Road Accident Research Unit when an ambulance was called to attend a road accident. The South Australian Highways Department, the Road Traffic Board, and the Police Department cooperated in many ways in the execution of this study, as did the Hospitals Department. The proprietors and operators of towing services and crash repair shops facilitated inspections of the damaged vehicles.

The sponsorship and advice of the office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board are gratefully acknowledged.

The final acknowledgement is due to the persons who were involved in the accidents studied and who cooperated freely with the members of the research teams.

## TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION	1
2. THE ACCIDENTS	2
Time of Day, Day of Week and Alcohol Usage	2
Type of Striking Vehicle	2
Accident Location	2
2.1 Midblock Accidents	2
Child Ran Across the Road	4
Obstruction to Vision	4
Child Misjudged Gap in Traffic	6
Accidents at Night	6
Prevention of Accidents Involving a Child Pedestrian	6
Pedestrian did not see the Vehicle: No Obstruction to Vision	6
Pedestrian Claimed to have Looked	8
Pedestrian did not Look	8
Accident at Night, Pedestrian Intoxicated	8
Pedestrian Stood in Centre of Road	10
Pedestrian Crossed through Banked-up Traffic	10
Pedestrian Crossed from behind Parked Vehicle	12
Miscellaneous Pedestrian Actions	14
Pedestrian Hesitated, then Continued on	14
Pedestrian Deliberately Ran into Vehicle	14
Miscellaneous Driver Actions	14
2.2 Accidents at Signalised Locations	14
Zebra Crossing	15
School Crossing	15
The Advantages of Pedestrian-Actuated Traffic Signals	15
Signalised Intersection Accidents	16
3. CHARACTERISTICS OF THE PEDESTRIANS	17
Information from the Follow-up Interview	17
3.1 Demographic Characteristics	17
3.2 Physiological Characteristics	17
Vision and Hearing	17
Alcohol Intoxication	17
Blood Alcohol Levels	17
Usual Drinking Habits	20
Drugs other than Alcohol	20
Medical Condition	20
Fatigue	20
3.3 Clothing	22
Conspicuity of Clothing	22
Footwear	22
3.4 Behaviour and Experience	22
Journey Schedule	22
Social Interactions	22
Incidents during the Journey	22
Pre-Accident Emotional Reactions	22
Preoccupations before the Accident	22
Accident History	23
Familiarity with the Accident Environment	23
3.5 Errors made by Pedestrians	23
Visual Distractions	23
Failure to Accommodate to a Visual Restriction	23
Secondary Activities	25
Inadequate Monitoring of the Relevant Environment	25
Failure to Respond Appropriately in an Emergency	25
Inappropriate Crossing Behaviour	25

	<u>Page</u>
4. CHARACTERISTICS OF THE DRIVERS	27
Age and Sex	27
Alcohol Intoxication	27
Prior Convictions for Driving Offences	27
5. THE CONSEQUENCES OF PEDESTRIAN ACCIDENTS	29
5.1 The Injuries	29
Overall Injury Severity	29
Injury Severity Score	29
Body Regions Injured	29
5.2 Objects Causing Injury	29
Front Bumper Bar	39
Leading Edge of Bonnet	39
Front Edge of Front Mudguard	39
Upper Surface of the Bonnet	42
5.3 Kinematics of the Car-Pedestrian Collision	42
5.4 Consequences of Injuries to Pedestrians	42
Length of Hospital Stay	42
Period of Restriction of Normal Activities	42
Extent of Residual Disability	44
6. ROAD AND TRAFFIC FACTORS	45
6.1 Traffic Flows, Road Layout and Pedestrian Movement	45
Clearways on Two-Lane Carriageways	45
Pavement Markings Illegible when Wet	47
Reduction in the Quality of Street Lighting	47
6.2 Median Refuges and Pedestrian Crossings	47
Pedestrian Crossings	47
6.3 Traffic Speeds, Road Widths and Pedestrian Safety	48
7. CONCLUSIONS	51
8. RECOMMENDATIONS	52
REFERENCES	54
APPENDIX	55

## 1. INTRODUCTION

A sample of road accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed observation of traffic behaviour at the accident site and examination of the injured persons in hospital and of the vehicles in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road

accidents as defined above. The sample was representative of this accident population by time of day and day of week. The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series together with a review of the types of accidents investigated and an outline of the general conclusions.

This report contains descriptions of the 40 pedestrian accidents in this sample of 304 accidents to which an ambulance was called. These descriptions are followed by a detailed review of the characteristics of the pedestrians who were involved in these accidents, and a concise presentation of certain characteristics of the drivers and riders. The consequences of pedestrian accidents are then considered, with particular emphasis on the nature, severity, and causes of the injuries sustained by the pedestrians. The final section of this report deals with the role of road and traffic factors in the causation and prevention, of pedestrian accidents.

## 2. THE ACCIDENTS

Four of the 40 accidents involved two pedestrians who were struck by a vehicle. In the discussion of the characteristics of these 44 pedestrians no reference is made to one of them, an infant who was seated in a stroller which was being pushed by the mother. Hence many of the Tables show a total of 43 pedestrians. In some accidents the pedestrian who was struck was in the company of others who were not hit. This is noted in the text in those instances in which it was relevant to the causation of the accident.

### TIME OF DAY, DAY OF WEEK AND ALCOHOL USAGE

More than half of these 40 accidents happened between 3 p.m. and 8 p.m. on a weekday, as shown in Figure 1. Fewer pedestrian accidents occurred on a Saturday or Sunday than might have been expected on the basis of the day of week distribution of the whole sample of 304 accidents.

There were seven accidents in which either the driver or the pedestrian had a BAC of .10 or greater. Five of the 11 night-time accidents involved an intoxicated pedestrian, and in one other accident at night the driver was intoxicated. The role of alcohol is discussed in detail later in this report.

### TYPE OF STRIKING VEHICLE

Most of the striking vehicles were passenger cars, as shown in Table 1, but there were some commercial vehicles and three motorcycles. There was no accident in which a pedestrian was hit by more than one vehicle. The parts of the striking vehicles which injured the pedestrians are described in Section 5.2.

### ACCIDENT LOCATION

The characteristics of the locations at which these accidents occurred are discussed in some detail in Section 6 of this report, but the movements of the pedestrian and the vehicle, and the type of road layout and traffic control, if any, are summarised in Table 2.

The characteristic pedestrian accident was one that happened on a midblock section of a busy road in daylight. The midblock accidents at uncontrolled locations are reviewed first.

### 2.1 MIDBLOCK ACCIDENTS

Thirty-eight pedestrians were involved in the 35 accidents which occurred away from

TABLE 1: TYPE OF STRIKING VEHICLE

<u>Type of Vehicle</u>	<u>Number of Vehicles</u>
Passenger car or derivative	28
Passenger car with trailer	3 <sup>1</sup>
Multipurpose passenger vehicle	1
Truck, van	3
Semi-trailer	1
Motorcycle	3
<hr/>	
Total	40
<hr/>	

Note: <sup>1</sup> The pedestrian was struck by the trailer in one accident



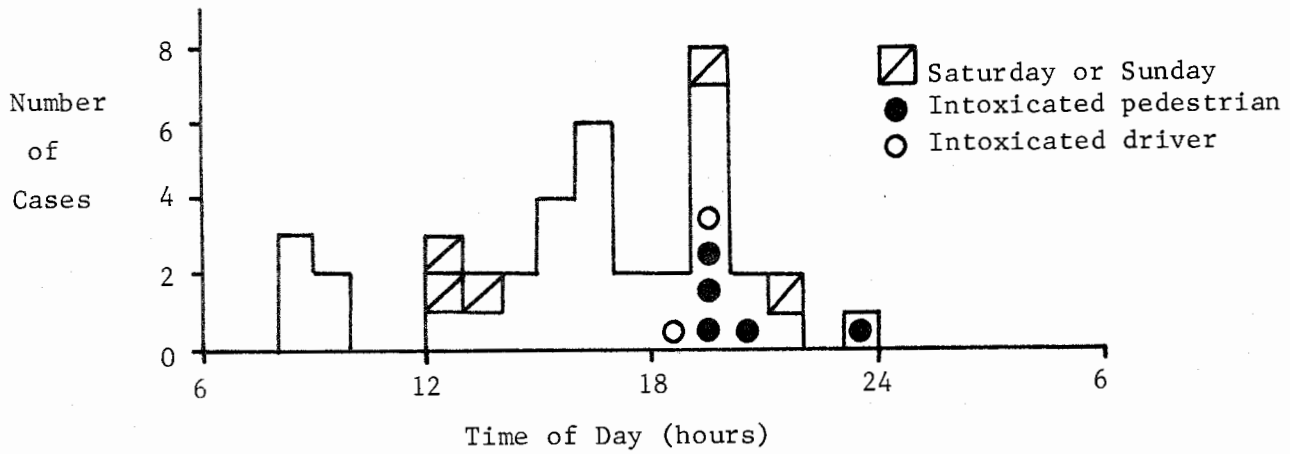


FIGURE 1: Pedestrian Accidents by Time of Day, Day of Week and Alcohol Usage.

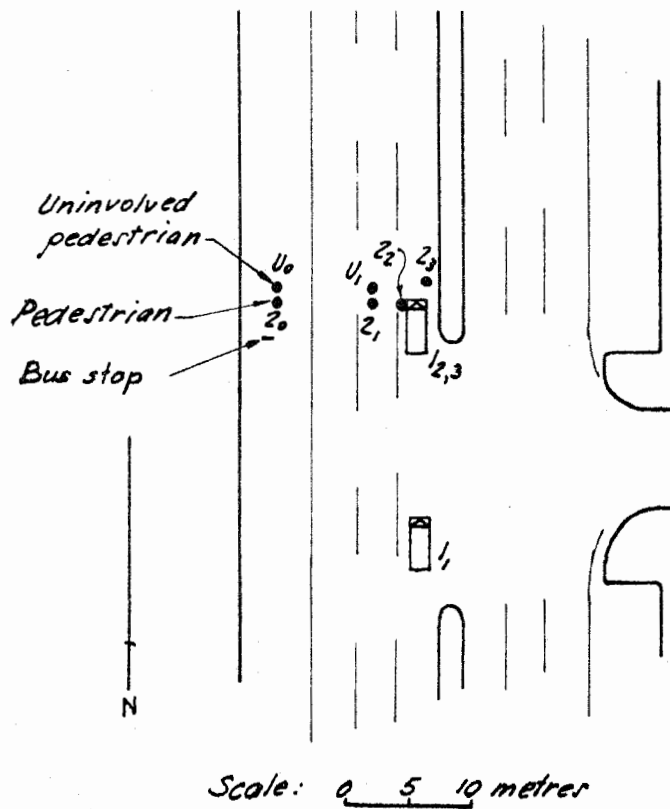







FIGURE 2: Accident 287.

(See page 55 for a legend to the plans.)

TABLE 2: MOVEMENTS OF THE PEDESTRIAN AND THE VEHICLE BY TYPE OF LOCATION

Pedestrian and Vehicle Movements (pedestrian ● →)	Type of Location			Intersection Signalised	Total
	Divided	Midblock Undivided	Signalised		
	10	11 <sup>1</sup>	2	1	24
	-	5 <sup>2</sup>	-	-	5
	5	3	-	-	8
	1	-	-	-	1
	-	-	-	2	2
<b>Total</b>	16	19	2	3	40

- Notes:
- <sup>1</sup> In two accidents the pedestrian deliberately ran into the path of the vehicle.
  - <sup>2</sup> In one accident a motorcyclist was playing "chicken" with a pedestrian.
  - <sup>3</sup> Pedestrian standing in centre of roadway.
  - <sup>4</sup> Vehicle reversing.

an intersection or a controlled crossing. The most common actions of these pedestrians immediately before their accident are listed in Table 3, together with those factors which were identified as having contributed in some way to the causation of one or more of these accidents. On inspection of this Table it will be obvious that in many accidents more than one contributing factor was thought to have been involved. There are also four entries, shown in parentheses, in this Table which do little more than list the number of accidents since for each entry the contributing factor which is listed and the action of the pedestrian are very similar, if not identical. This listing of contributing factors is not intended to be exclusive, and some additional factors are noted later in this report.

#### CHILD RAN ACROSS THE ROAD

Nine of these 35 accidents involved children who ran onto the road. The youngest child was 17 months old and the oldest was 12 years of age.

In only one accident did the driver

have a lengthy and unobstructed view of the young pedestrian. This was in Accident 244, in which an 11 year old girl ran from the right hand side of a wide two-lane road to rejoin a car parked on the far side of the road. The driver assumed that the child knew that the car was approaching and therefore expected her to wait at the centre of the road. By the time that the driver realized that the pedestrian was not going to stop it was too late to avoid a collision.

#### Obstruction to Vision

The most common obstruction to vision was an unoccupied parked vehicle. The four accidents of this type involved children who ranged in age from 17 months to six years. They all ran on to the road from behind a car parked on the left hand side of the approach path of the striking vehicle. Three of these accidents occurred on two-lane roads and the fourth was on a four-lane undivided road. In this fourth accident (125) a three year old girl ran out into the side of a car which was travelling in the left hand lane. She sustained only minor injuries.

TABLE 3: MIDBLOCK PEDESTRIAN ACCIDENTS<sup>1</sup>: ACTIONS OF PEDESTRIANS AND OTHER CONTRIBUTING FACTORS

\* excludes 2 pedestrian accidents at signalised midblock locations

Contributing Factors	Actions of Pedestrians						Totals
	Child ran across	Did not see vehicle	Stood in centre of road	Crossed through banked-up traffic	Crossed from behind parked vehicle	Other actions (see text)	
<u>Pedestrian</u>							
Intoxicated	-	1	1	-	-	2	4
Incapacitated	-	1	-	-	-	1	2
Ran across	(9)	2	-	2	-	-	13
Did not look	9	(3)	-	5	1	1	19
<u>Driver</u>							
Intoxicated	-	1	1	-	-	-	2
Inexperienced	-	1	1	-	2	-	4
Did not look	-	3	-	-	-	2	5
Overtaking on left	-	1	-	1	-	-	2
Waved pedestrian across	-	-	-	1	-	-	1
<u>Vehicle</u>							
(see text)	-	1	3	-	-	1	5
<u>Environment</u>							
Obstruction to vision by:							
Vehicle:							
- parked	5	-	-	-	(2)	-	7
- stationary	1	-	-	(5)	-	-	6
- moving	-	1	-	-	-	-	1
Roadside object	2	-	-	-	-	-	2
Poor street lighting	-	-	1	-	-	1	2
Glare from headlights	-	-	3	-	-	-	3
Pavement markings							
illegible	-	-	1	-	-	-	1
Weather conditions							
Parked vehicle deflected traffic	-	-	1	-	-	-	1
Total number of accidents <sup>2</sup>							
	9	7	4	5	2	8	35

Notes: <sup>1</sup> Excludes two accidents at signalised midblock locations.

<sup>2</sup> More than one contributing factor listed for some accidents.

The other three children were far less fortunate. The youngest child was with its mother in a laundromat when it wandered out and then ran on to the road where it was struck by a motorcycle (Accident 221). The resulting brain injuries, which appeared to have been caused by being thrown to the road surface, were extremely severe and the child will require institutional care for the rest of her life. A two year old boy ran from his parent's property out on to the road and was struck by the front left corner of a passing car and was killed instantly (Accident 060). A six year old schoolgirl was hit by a car which was travelling in a relatively slowly-moving traffic stream when she ran from behind a car parked on the left (Accident 178). She sustained a fracture of the right femur and concussion. This accident occurred near a school but about 100m past the point at which there was provision for placing flags warning of the presence of schoolchildren crossing the road. These flags were not displayed at the time at which the accident occurred (4 p.m. on a school day).

In a similar accident to those involving unoccupied parked vehicles, an eight year old boy was struck by a car when he ran across the road from in front of a bus from which he had just alighted (Accident 208). This accident, and Accidents 133 and 299, which will be reviewed below, were the only accidents involving children which did not occur during daylight hours.

#### Child Misjudged Gap in Traffic

A 12 year old schoolgirl waited for a minute or two for a gap in the traffic approaching from her right on a four-lane divided road (Accident 185). She decided that she could run across in front of a car that was in the right lane, but as soon as she started to cross the road she turned to look to her left to see whether there was any traffic coming from that direction. She did not realize that she had misjudged the gap in the traffic until she was hit by the car. Fortunately the driver had been able to brake and swerve to the left and so the resulting impact was not very severe. The pedestrian said that she usually crossed the road by using an overpass at a nearby subway, but did not do so on this morning because she was running late and thought that she might miss her train.

#### Accidents at Night

The remaining two cases in which a child ran onto the road each involved a child who was playing with other children at night. In Accident 133 three children were playing on a grassed median reserve. They ran across to the edge of the median where two of them saw a car approaching and stopped. The third child, a six year old boy, continued on to cross the road and was struck by this car. The driver said that he had seen the children well in advance, but on seeing two of them stop

for him he assumed that the third one would do the same. In Accident 299 a nine year old boy ran out on to the road to retrieve a rubber band which he and his friends had been playing with in the driveway of his parent's house. A telephone call box on the footpath was a partial obstruction to the driver's view of the child.

#### Prevention of Accidents Involving a Child Pedestrian

In most of these accidents there was very little that the driver could have done to have avoided hitting the child, particularly in those cases in which a child ran from behind a parked vehicle. On a divided road where there is more than one lane available for traffic it is likely that a driver will have some chance, albeit small, of avoiding a child who runs from behind a parked car, or at least be able to slow his car down before hitting the child, if he chooses to travel in a right hand lane rather than in the left hand lane adjacent to the parked vehicles. Under such circumstances the requirement that a motorist should keep to the left on a multi-lane road may increase the risk of a collision with a child pedestrian.

If young children could be taught to take greater care when crossing roads, or when playing near a road, then the frequency of their involvement in pedestrian accidents obviously would be greatly reduced. While there is doubtless much that can be done to educate children in road safety practices there are reasons to believe that the degree of skill required to assess a traffic situation and then to decide whether it is safe to cross a road may often be beyond the capacities of the young child (Sandels, 1968). This implies a need for constant supervision of young children in the traffic environment and also that there may be considerable benefits to be gained by making it easier to cross the road safely. This latter point will be considered in more detail later in this report.

#### PEDESTRIAN DID NOT SEE THE VEHICLE: NO OBSTRUCTION TO VISION

There were nine accidents in which the pedestrian did not see the approaching vehicle even though there was no known obstruction to vision. One of these cases involved a child, but seven of the other eight pedestrians were all over sixty years of age. The proportion of elderly pedestrians (78%) is in marked contrast to that for the other 26 accidents in which only three pedestrians (12%) were over sixty years of age (taking the oldest pedestrian when more than one was actively involved). A difference as great as this between two proportions is most unlikely to have arisen by chance (Chi square = 14.3,  $p < 0.001$ ).

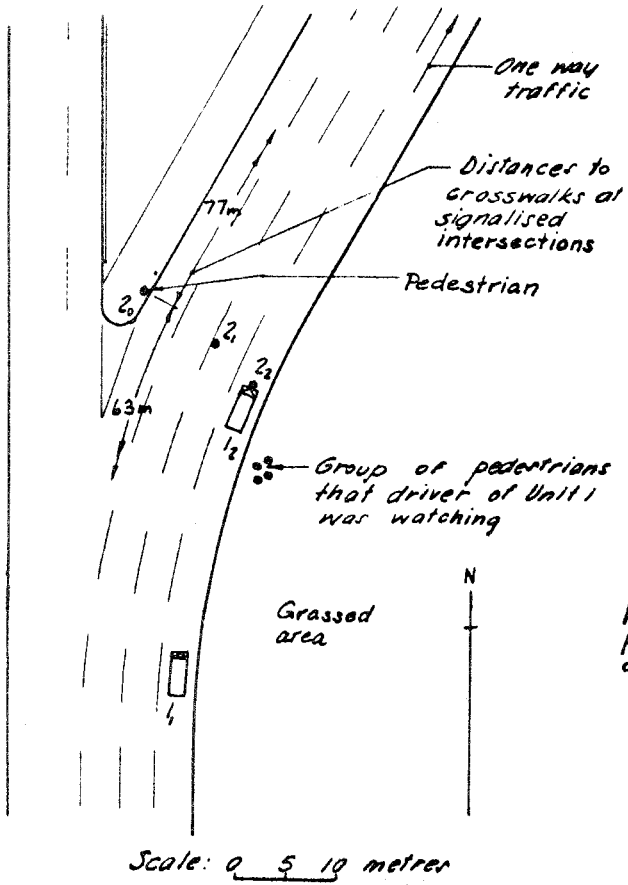


FIGURE 3: Accident 166.

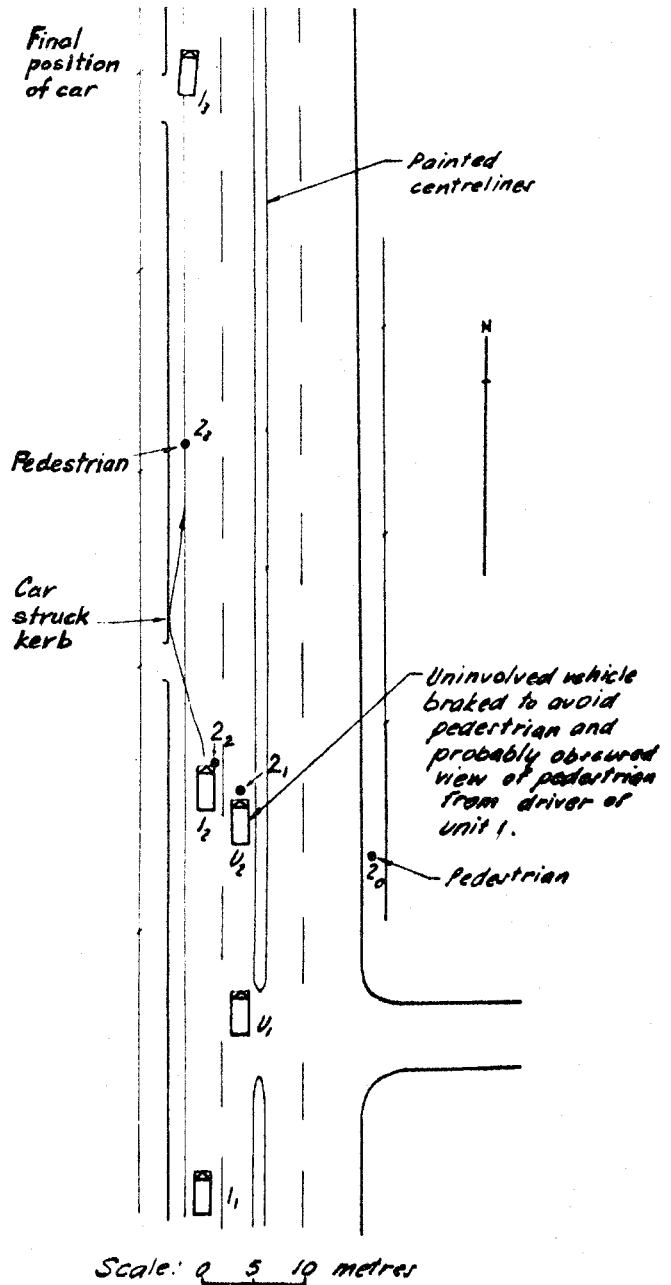


FIGURE 4: Accident 256.

One of the accidents in which there was no obstruction to vision and yet the child pedestrian did not see the striking vehicle was described in the previous section (Accident 244). The remaining eight accidents are reviewed here.

#### Pedestrian Claimed to have Looked

In four accidents the pedestrian claimed to have looked for traffic approaching before starting to cross the road. In Accidents 213 and 287 the drivers did not realise that the pedestrian was about to walk in front of them until it was too late to avoid hitting them. Neither the driver nor the pedestrian in Accident 213 could account for their failure to see the other party until immediately before the collision. The driver in Accident 287 had a blood alcohol level (BAC) of .13 and was looking for a street on her right. The pedestrian, who was retarded and walked with a stoop, thought that the road was clear. At this location the pedestrian crossed the equivalent of three traffic lanes from the point at which she left the footpath until she was struck by the car and so the road may well have been clear when she first looked to her right (Figure 2).

The pedestrian in Accident 166 also had to cross three lanes before reaching the lane in which the striking car was travelling (Figure 3). He had waited on the footpath for a platoon of cars to pass and then, seeing no more cars coming, set off across the road. The driver was watching a group of pedestrians on the footpath on his right, and so did not see the other pedestrian crossing the road towards him. At this location it is possible for a pedestrian to look to his right and not see any vehicles approaching and yet still not be able to complete a crossing without risking being hit by a car, as did happen in this case. This is because the pedestrian's sight distance is limited by bushes and trees planted in the city square which the road deviates around, and he has to cross four traffic lanes of a one-way road. Another pedestrian accident in this survey occurred at a similar location on the opposite side of this square (Accident 145, described below).

During the preceding three calendar years there were 12 pedestrian accidents in the vicinity of the location of Accident 166, and three at the location of Accident 145. This accident history is not unexpected because many pedestrians choose to cross at these locations, even though signalled cross walks at the adjacent intersections are no more than 70 metres away. Elsewhere in this square a signalled pedestrian crossing has been installed midway between two intersections which have crosswalks that are about 160 metres apart. It may be that additional crossings of this type could be installed without serious disruption of the vehicle traffic flow or, alternatively, some physical barrier erected to discourage

pedestrians from crossing the road at places other than protected crossings.

The fifth accident in which the pedestrian claimed to have looked, but still did not see the striking vehicle, involved a man who got out of his parked car, looked right, then left, and started to cross the road. He ran into the left rear side of a motor scooter which was approaching from his right (Accident 198). The pedestrian had good eyesight when wearing spectacles, which he was, but said that he had been listening to the loudspeaker of an auction mart across the road. The motorcyclist saw the pedestrian move off and tried to blow the horn to warn him, but the horn button was not where the rider expected it to be (it was on the opposite handle bar). This confusion arose in part because he had been riding this scooter for only ten days, but it does indicate a need to standardize the location of such controls.

#### Pedestrian did not Look

A woman was hit by a car as she ran from the median to catch a bus which was about to move off from a bus stop (Accident 103). She was trying to attract the attention of the bus driver and did not look to her left. She was concussed, and also sustained fractures of the upper arm and pelvis which necessitated 34 days in hospital.

In one other accident an elderly woman walked at an angle across a four-lane road into the path of two cars coming from behind and to her left (Accident 256, Figure 4). The driver in the right-hand lane managed to brake in time to avoid her, but she was hit by a car which was overtaking in the left lane. The driver of this car said that he was looking at his speedometer and did not see the pedestrian at all before the impact, and then only briefly because the pedestrian was thrown back over the roof of the car before falling to the road. The car then swerved to the left, almost certainly as a consequence of the collision, and hit the kerb. It eventually came to rest 75 metres away from the point where it hit the pedestrian who was, in turn, thrown almost 40 metres. The pedestrian was killed, and so we do not know whether she thought the road was clear, or forgot to look, or may even have chosen to step out in front of these cars. This accident also illustrated that overtaking is a potentially hazardous manoeuvre if the driver does not anticipate, and attempt to allow for, the possibility that there may be some third party concealed by the vehicle which is being overtaken.

#### Accident at Night, Pedestrian Intoxicated

The above seven accidents all occurred in daylight. The final case in this group happened early in the evening, about an hour after last light (Accident 135). An elderly intoxicated pedestrian (BAC 0.32) staggered from a parking area on a

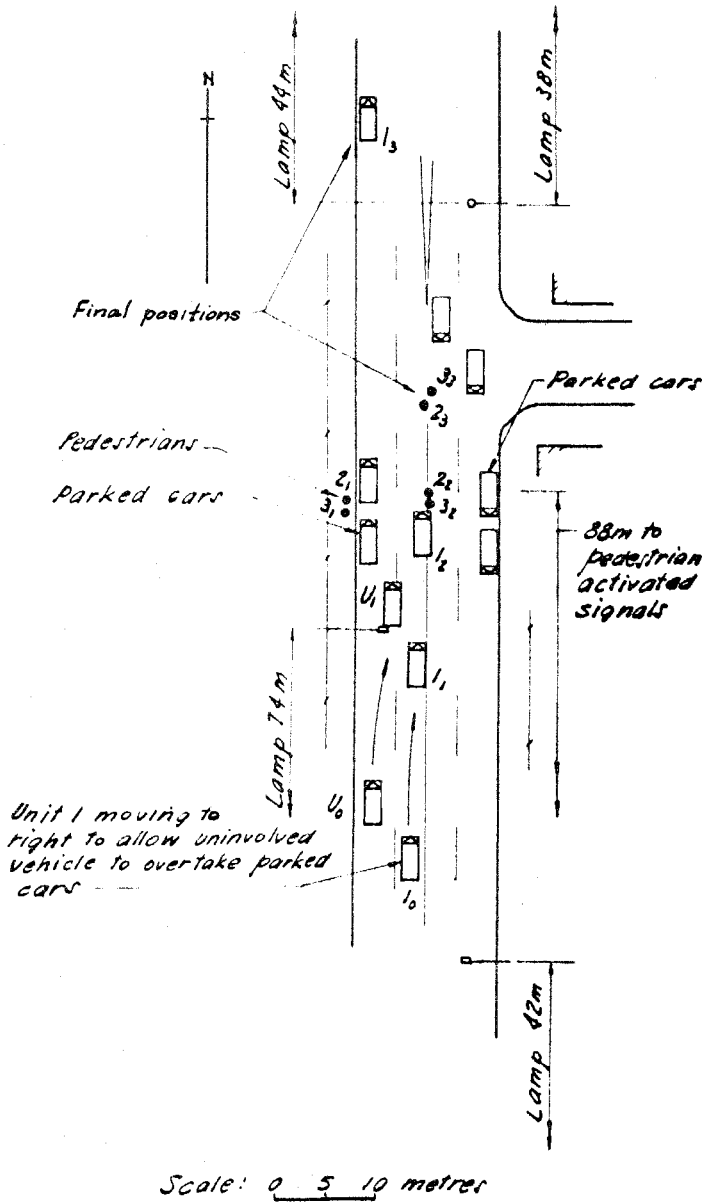


FIGURE 5: Accident 026.

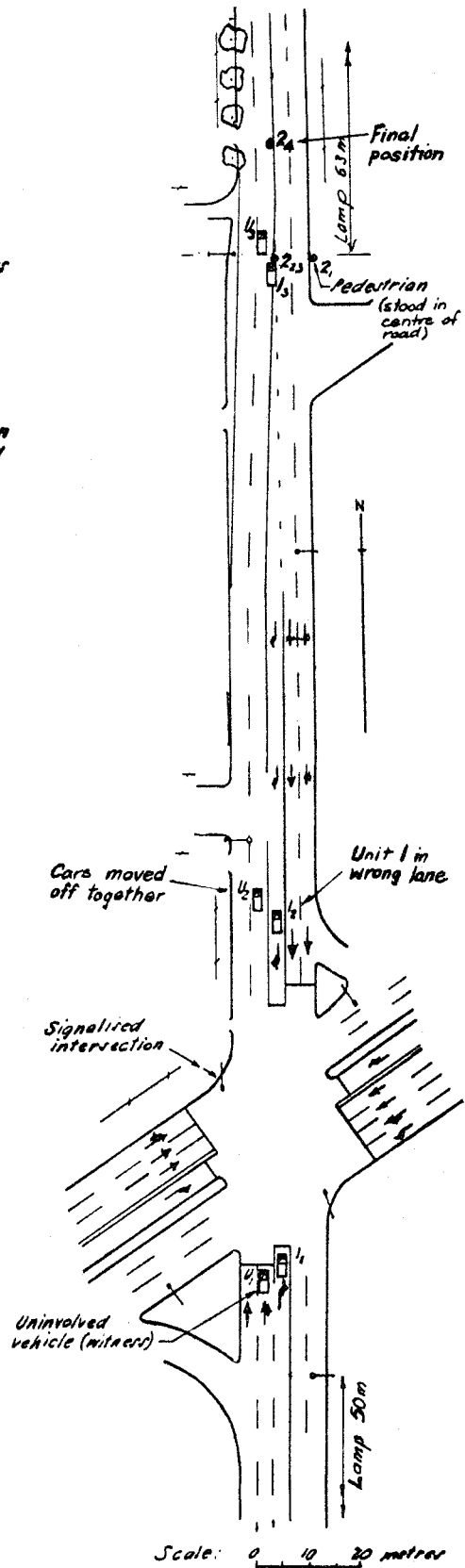


FIGURE 6: Accident 144.

wide median reserve across a three-lane road. Cars were approaching in each of the three lanes, with the one in the right hand lane leading. The driver in the centre lane could not see the pedestrian initially because he was concealed by the car on the right. When this driver realized that the pedestrian was about to walk into his lane he braked but could not avoid the collision. He did not try to swerve out of the centre lane because there were cars alongside in the other two lanes. The pedestrian had been drinking for some time at a hotel adjacent to the accident site. The barman had taken away his car keys when it became obvious that he was intoxicated. When he got to his car the pedestrian realized that he did not have his keys. He was on his way back to the bar to try to get them back when the accident happened.

#### PEDESTRIAN STOOD IN CENTRE OF ROAD

Three of the four accidents in which a pedestrian was hit while standing in the centre of the road occurred at night, and in two of these three cases the driver's view of the pedestrian was hindered by the effect of glare from oncoming headlights being accentuated by vinyl deposits or road grime on the windscreen.

In Accident 191 the pedestrian had alighted from a bus and crossed to the centre of a well-lit four-lane road where he stopped to wait for a gap in the heavy traffic on his left. But instead of waiting on or close to the centreline he stood back about one metre into the right hand lane (for traffic approaching from his right) because he was wary of being struck by any of the vehicles travelling in the other direction. While he was standing in this position he was hit by a car which approached from his right. This driver, who was aware of the presence of a car following his and had noticed another car about to enter from a side street on his left, saw the pedestrian at the last moment. He braked and tried to swerve to the left, but the right front corner of the car hit the pedestrian, who sustained severe concussion, skull fractures, multiple fractures of the pelvis and a fracture of his right femur. These injuries required treatment in hospital for 93 days, and have left the pedestrian with a major permanent disability which forces him to spend most of his time in a wheel-chair. This pedestrian said that he had usually tried to avoid crossing through heavy traffic, either by travelling home on another bus route or by asking the bus driver to let him off at the nearest set of traffic signals (about 700 metres away from the accident site).

The driver in Accident 191 was sober, but the other driver who was also affected by glare from oncoming headlights had a blood alcohol level of .22 (Accident 026). He was driving in the right hand lane of a four-lane undivided road, but was forced to veer across to the right to allow room for the car on his left to pass a car

which was parked at the kerb. He did not see two pedestrians who were standing in the centre of the road waiting for a gap in the oncoming traffic. Both pedestrians were struck by the car and were seriously injured. They now have minor permanent disabilities. This location is well illuminated and is within 100 metres of a pedestrian-actuated signalised crossing (Figure 5).

The third night-time accident in this group was one of the few in this study which occurred when it was raining (Accident 144, Figure 6). Some 300 metres before the accident site the driver had approached a signalised intersection along a four-lane undivided road. On this approach the right-hand lane becomes an exclusive right-turn lane, and a third lane is formed on the left by widening the carriageway. This driver stopped at the lights in the right-turn lane, but proceeded straight ahead on the green light and exited from the intersection by driving the wrong way along the opposing right-turn lane, with another car alongside him on his left. Under the prevailing weather conditions the painted pavement markings were virtually illegible, and the quality of the street lighting changed from a uniformly high-level at the intersection to alternating dark and light patches on the exit road. The type of lamp also changed from sodium vapour to mercury vapour. At the point at which the car was almost back on the correct side of the road it hit a pedestrian who was standing on the centre-line. The pedestrian was thrown up and completely over the car as described in detail in Sections 5.2 and 5.3. He was hospitalized for 19 days, off work for more than three months, and still has a minor residual disability.

The one daytime accident in which the pedestrian was standing in the centre of the road involved a driver who was not familiar with his vehicle, a light truck (Accident 106). As in Accident 026, the driver kept as close as he could to the right in the right-hand lane of a four-lane undivided road because the car on his left had to pass a parked car. Unlike the driver in Accident 026, this driver saw the pedestrian, and thought that he had left enough room to pass safely. Being unfamiliar with the truck he did not allow for the fact that the exterior rear vision mirror on the right hand side protruded well beyond the bodywork of his vehicle, and this mirror hit the pedestrian's head. The pedestrian, a young woman, sustained a sprained neck and scalp lacerations.

#### PEDESTRIAN CROSSED THROUGH BANKED-UP TRAFFIC

The five accidents of this type occurred in daylight. They all involved a pedestrian who crossed through one or more lanes of stationary vehicles and was hit by a vehicle in the next lane. In each case a signalised intersection was within 100 metres of the accident site.



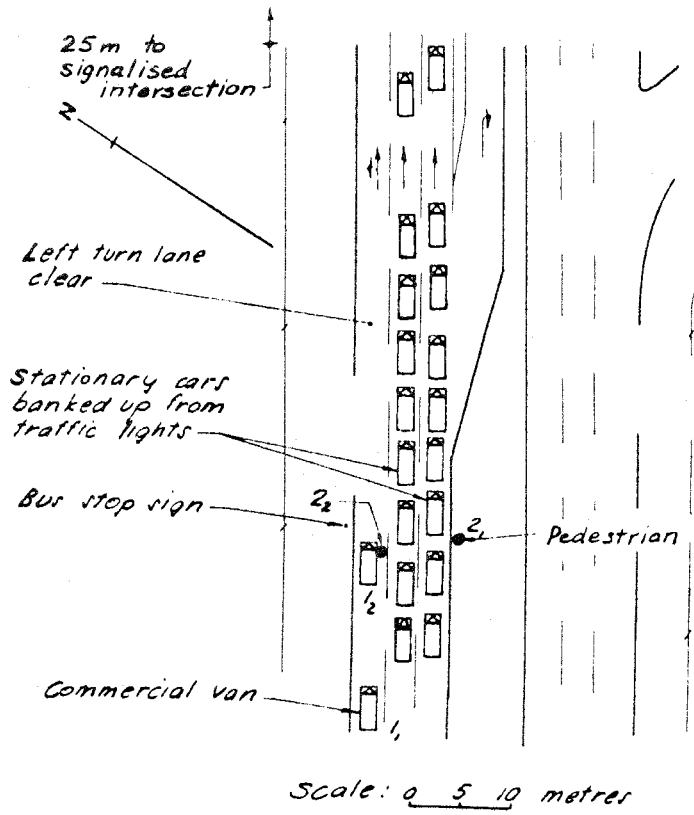


FIGURE 7:  
Accident 037.

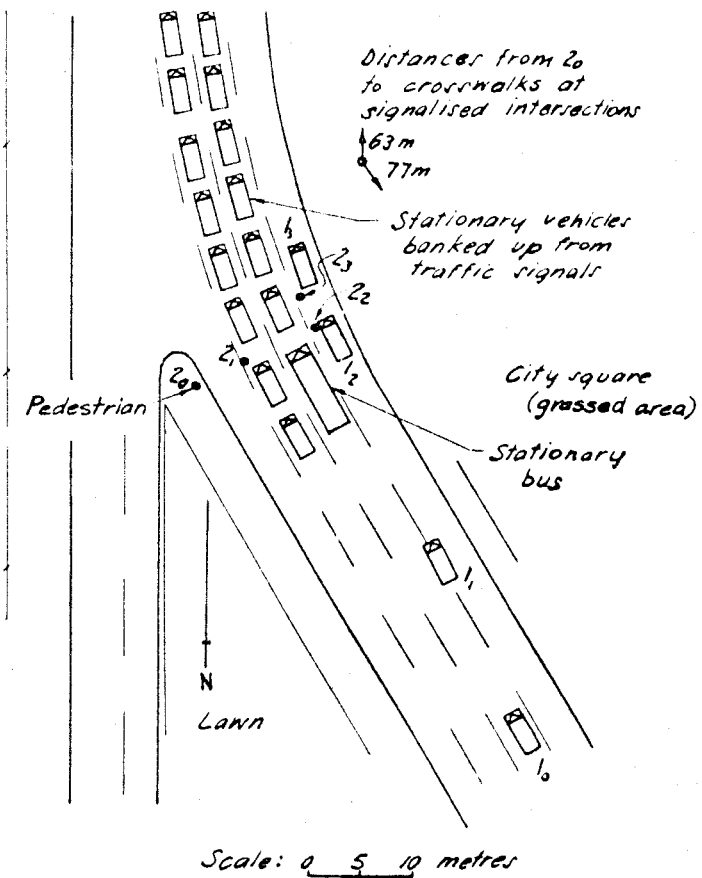


FIGURE 8: Accident 145.

In Accident 037 the pedestrian was running across from the median to a bus stop. Traffic was banked up from a signalised intersection in the two lanes adjacent to the median, but the kerb lane was clear because the vehicle which had been in that lane had been able to turn left at the intersection on a green arrow. The pedestrian had never crossed this road before and did not realize that traffic might be moving freely in the kerb lane. The driver saw the pedestrian running through between the stationary cars, but assumed that she realized that his van was approaching and that she would stop to let it pass. In fact, the pedestrian ran into the side of the van (Figure 7).

In the other accidents in this group the pedestrian was crossing from the left-hand side of the road and entered the apparently vacant right-hand lane without looking for vehicles approaching from the right. In Accident 175 the pedestrian, who had run through a line of parked cars and one lane of stationary vehicles before he reached the right-hand lane, was looking to his left, to see if the far side of the road was clear of traffic, when he was hit. He did not see the striking car at all before the impact. The driver saw the pedestrian at the last moment, in time to brake but not in time to avoid the collision. The pedestrian in Accident 190 was crossing to a raised median strip, and so may be thought to have had less need than the pedestrian in Accident 175 to have been concerned about traffic approaching from her left. However, she was encouraged to assume that the right hand lane was clear by the driver whose car was stationary in the lane closer to her. He waved her across in front of his car.

One of these accidents occurred on the four-lane one-way road around the central square in the City (Accident 145, Figure 8). This road has been discussed previously in this report in connection with Accident 166. The pedestrian was running to catch a bus at a stop about 100 metres away across the square. The kerb lane nearest to him was clear, but traffic was banked up in the next two lanes, with a truck blocking his view of any traffic approaching in the fourth lane. Believing that lane to be clear, the pedestrian ran across without stopping to look to his right and was hit by a car. The car driver said that she had been in the third lane, but when she realized that the vehicle ahead of her was stopping she changed lanes. She did not see the pedestrian at all before he ran out in front of her car.

In the remaining accident of this type (Accident 003) a woman with a four year old child stepped out from in front of a stationary truck into the path of a car towing a trailer. The truck was in a queue of stationary vehicles, and alongside a row of parked cars. The car was passing the truck and was in the centre lane adjacent to a raised median strip. When the pedestrians appeared from in

front of the truck the car driver braked and almost avoided the collision. The child was thrown to the roadway, but this may have been due as much to his mother pulling him back as it was to a direct impact from the front of the, by then, almost stationary car.

These five cases have some similarities to other accidents in this study that occurred when a vehicle attempted to turn through a gap in a stationary queue of cars and collided with a car which was overtaking the stationary vehicles in the far lane. In particular, it appears to be foolish to wave another driver or a pedestrian across in front of one's stationary car because the other person then tends to assume that no other vehicle is approaching from that direction.

#### PEDESTRIAN CROSSED FROM BEHIND PARKED VEHICLE

There were seven accidents in which the pedestrian entered the road from behind a parked vehicle. Five of them involved children running onto the road, and they have been described under that heading. In each of these five cases the parked vehicle was a significant factor in the causation of the accident.

One of the other two accidents was similar to Accident 208 in which an eight year old boy ran across the road from in front of a bus from which he had just alighted. In Accident 140 an elderly male walked out from in front of a bus to cross three traffic lanes before reaching a raised median strip. He did not look for traffic approaching from his right and was hit by a car which was passing the bus in the lane immediately adjacent to it. The pedestrian claimed to have crossed this road without any difficulty many times before.

The remaining accident in this category was unusual in that the young pedestrian looked to his right but did not notice the car which was later to hit him because it was stationary at the kerb beyond a row of parked cars. The pedestrian then looked to his left and waited for a gap in the traffic approaching from that direction. He then walked out across the road without looking again to his right because no vehicles had been approaching from that direction when he had first looked. The car driver, a 16 year old male, had pulled out from the kerb and was still accelerating when the pedestrian walked out in front of his car. He braked, but was unable to avoid a collision.

All but one of the seven pedestrian accidents involving a parked vehicle occurred in daylight. This is partly a reflection of the fact that this pedestrian action is particularly likely to involve young children who are most often on the roads in the daytime.

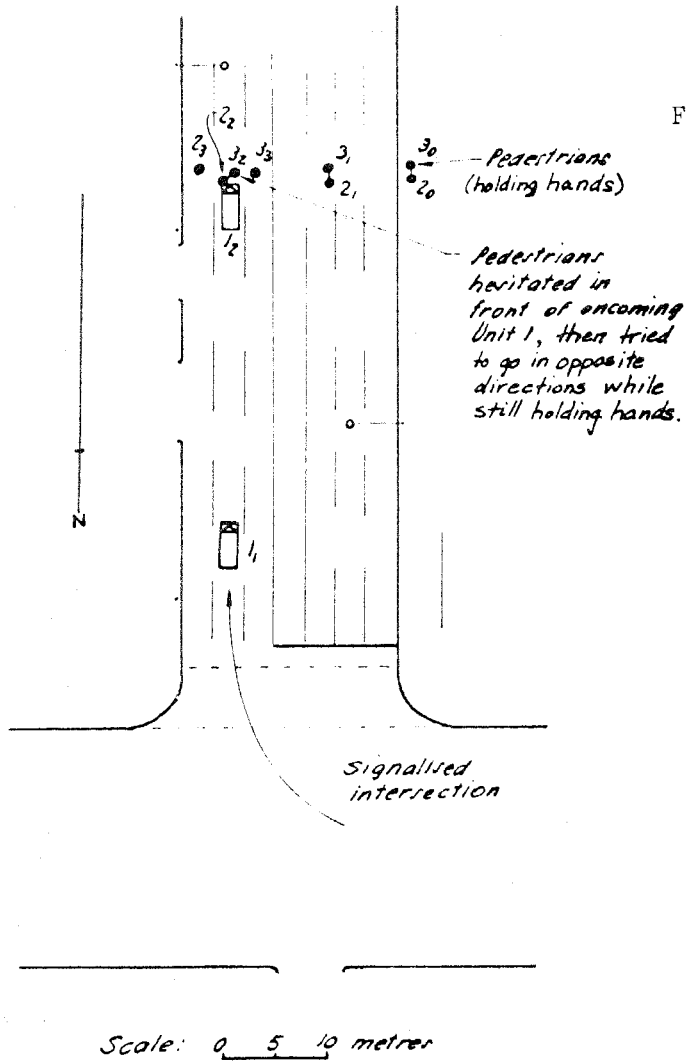


FIGURE 9: Accident 209.

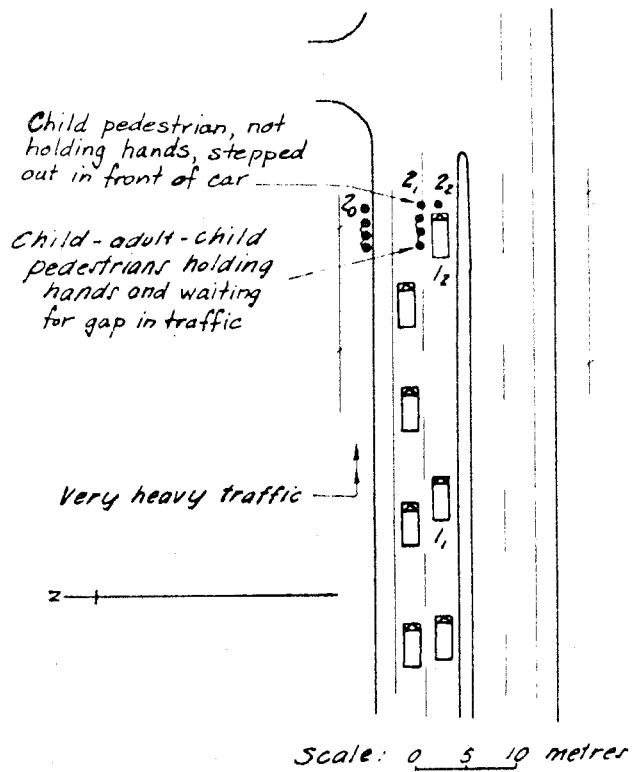


FIGURE 10: Accident 247.

## MISCELLANEOUS PEDESTRIAN ACTIONS

### Pedestrian Hesitated, then Continued On:

Three accidents resulted from the pedestrian hesitating, and then acting in a manner which the driver of the approaching car had not anticipated.

In Accident 158 the pedestrian, who was intoxicated (BAC .23), walked from a poorly illuminated median reserve across one lane of a three-lane road. He paused on the lane markings and the driver of a car travelling in the centre lane of the three lanes assumed that the pedestrian was waiting for him to pass through. At the last moment the pedestrian suddenly started to run across, and was hit by the car. A second car was following the striking car, but in the lane adjacent to the median. It is possible that when the pedestrian saw this second car he decided that it was not safe to remain standing on the lane marking.

Accident 209 (Figure 9) involved two pedestrians who were crossing a city street near a T-junction at night. A car turned right into that street and the pedestrians, who were holding hands, appeared to be undecided what to do; one tried to go on, and the other held back. The driver claimed that he did not see them initially because of the poor level of illumination provided by the street lighting. When he did see the pedestrian he could not predict which way they were going to go, and could not stop in time to avoid hitting them. It is interesting to note that pedestrians who choose to cross a road of this width close to an intersection run the risk of being placed in a situation in which they may have to rely for their safety entirely on the car driver seeing them, as does the pedestrian who stands in the centre of the road.

In another accident a five year old child was in the company of its mother and two other children. The mother was attempting to lead them across a four-lane divided road through heavy traffic. They had reached the first lane marking and then had to stop to allow traffic in the right-hand lane to clear. When it had done so, the mother told the children to continue on but, almost at once, saw a car approaching in the right-hand lane and so she told the children to stay where they were. The five year boy, however, either thought that he could get across to the raised median or did not hear his mother tell him to wait. He was struck by the car before he was able to reach the median strip. This child had his mother standing between him and the approaching car, which implies that he would not have been able to have seen the car even if he had looked in that direction (Accident 247, Figure 10).

### Pedestrian Deliberately Ran into Vehicle:

Whereas the three preceding cases involved pedestrians who hesitated, in two other

cases the pedestrians appeared to have deliberately run into the vehicle. In one of these the pedestrian had been drinking (BAC .10) and had been involved in an argument with his girlfriend, with the result that he had threatened to throw himself under a car (Accident 280). He then appeared to have made sure that the car he selected had time to slow down, whereupon he jumped onto the bonnet.

The other accident (117) was almost certainly a genuine suicide attempt. The pedestrian was suffering from an incurable disease and had made a prior attempt at suicide. On this occasion he ran out into the side of a passing semi-trailer. He sustained concussion and abrasions.

## MISCELLANEOUS DRIVER ACTIONS

One of these three remaining accidents was unusual in that the vehicle was reversing into a parking space from a double-ranked position (Accident 262). The pedestrian, who was crossing three traffic lanes from a median reserve, was looking to his left to watch for oncoming traffic. The driver did not know that he was there and reversed into him, knocking him to the ground. The pedestrian's right forearm was fractured. He was hospitalized for four days and was left with a minor permanent disability.

In another accident an 18 year old girl sustained multiple bruises and abrasions when a friend on a motorcycle played "chicken" by riding straight at her (Accident 300). She, reasonably enough, did not know on which side the rider intended to pass and stepped across into the path of the swerving motorcycle. Her clothing caught on the motorcycle and she was pulled to the roadway.

The final accident (080) resulted from the driver failing adequately to monitor the road ahead of his car (he said that he was checking for cars entering from the street on his left) and from the pedestrian misjudging the speed of the approaching car. When the pedestrian realized that she might not get across in front of the car she expected the driver to swerve to the left to avoid hitting her. By the time that the driver looked back from checking on the side street he was so close to the pedestrian that he instinctively braked hard rather than swerve, but was unable to stop his car in time to avoid a collision.

## 2.2 ACCIDENTS AT SIGNALISED LOCATIONS

Five pedestrian accidents happened at signalised locations: three at intersections, one at a zebra crossing, and one at a school crossing.

## ZEBRA CROSSING

A zebra crossing has alternating black and white stripes painted parallel to the road centreline and extending across the full width of the carriageway. At least two pairs of yellow lights, each pair mounted on a black and white striped post, face motorists as they approach the crossing. These lights are mounted side by side on each post, and flash alternately. Standard warning signs and pavement messages, each bearing the legend 'PEDESTRIAN CROSSING AHEAD' are used in advance of the crossing. A zebra crossing operates continuously and gives a pedestrian priority over vehicular traffic at all times.

The one accident on a zebra crossing (Accident 305) involved a truck, and a pedestrian who had been drinking (BAC .10). The accident occurred at night, but both parties saw each other well before the pedestrian was hit. Their versions of the events which resulted in this accident did not agree. The driver stated that he was travelling at about 60 km/h, and the length of the skidmarks at the scene is consistent with this estimate. Even though the legal speed limit is 60 km/h, most motorists travel more slowly at this location at this particular time of day and day of week. In fact 60 km/h is the 90 percentile of the distribution of travelling speeds at that site (based on 182 vehicles), and so the pedestrian may well have underestimated the speed of the truck. The driver also reported that the pedestrian was unsteady on his feet and appeared to decide to cross the road at the last moment. Although he claimed that he began to slow down when he saw the pedestrian, he obviously did not allow himself sufficient time to react to what would appear to have been a likely action by the pedestrian.

## SCHOOL CROSSING

A school crossing differs in several respects from a zebra crossing. The most important difference is that, as noted above, a zebra crossing operates continuously, affording a pedestrian priority over vehicular traffic at all times, whereas a school crossing operates only during predetermined periods when children are known to cross in appreciable numbers, usually before and after school. The pavement marking at a school crossing consists of two transverse broken lines, which define the width of the crossing, with an unbroken STOP line preceding them. The legend on the warning signs and pavement messages is 'SCHOOL CROSSING AHEAD'. There is a speed limit of 25 km/h over the final 30 metres of the approach, and the pairs of flashing yellow lights, mounted on blue and white posts, carry the numerals 2 and 5 on the left and right-hand lenses respectively to act as a reminder to motorists to observe this limit.

When these lights are operating a school crossing assigns priority to the

pedestrian, as does a zebra crossing, but when the lights are not operating a school crossing has no legal significance. Child monitors usually control the movement of pedestrians at a school crossing but this was not the case in the one pedestrian accident in this survey which happened on one of these crossings (in another accident a cyclist was hit by a car while wheeling a bicycle across an inoperative school crossing).

A school boy was playing with other children on the footpath adjacent to a school crossing. Although marked as only a two-lane road, traffic was flowing in two streams on that side of the centreline. Without warning, the pedestrian swung around the signal post and ran onto the crossing, where he was knocked down by a car which was moving slowly in the traffic stream closest to the kerb. He was pushed along the road for eight metres, wedged under the front of the car, and sustained severe abrasions to his abdomen and left thigh (Accident 001).

Both the pedestrian and the driver of the car said that the crossing lights were operating at the time of the accident, and this was confirmed by the other school children who were present. The crossing monitors had gone off duty shortly before the accident. The duty of the monitors is to keep other children on the footpath until there is a gap in the traffic and then to walk on to the crossing holding a STOP sign which is displayed to stop approaching vehicles at the crossing until the group of children has reached the other side of the road. The flashing lights were turned off automatically at a pre-set time which happened to be a minute or two after the accident.

## THE ADVANTAGES OF PEDESTRIAN-ACTUATED TRAFFIC SIGNALS

Pedestrian-actuated traffic signals have several advantages when compared with zebra and school crossings. They greatly reduce the risk of a driver being surprised by a pedestrian suddenly claiming priority, whether it be an intentional act by the pedestrian or a careless one. The frequency with which the vehicular traffic flow is interrupted can be controlled without reliance on monitors (although when a crossing is used by young children there may be considerable advantages in retaining the monitors to ensure that correct crossing procedures are observed). Finally, the pedestrian-actuated traffic signal has the major advantage, when compared to the school crossing, of being in operation continuously, and thereby affording all pedestrians some protection in crossing the road at any time of the day or night. Accident 191, a midblock pedestrian accident reviewed in the previous section, would most likely have been prevented had the adjacent school crossing been operating at the time at which the pedestrian wished to cross the road. This pedestrian now has to spend much of his time in a wheel chair as a

direct consequence of the injuries sustained in that accident.

For reasons such as these, school and zebra crossings on arterial roads are being replaced by pedestrian-actuated traffic signals in South Australia. This change can readily be supported by reference to the relevant accidents in this survey.

#### SIGNALISED INTERSECTION ACCIDENTS

One of the three accidents in this category involved a collision between a pedestrian who stepped off the kerb as soon as the WALK signal was displayed and a car that had just crossed the intersection (Accident 183). The pedestrian acknowledged that he had not looked to his right, and the car driver claimed to have been unaware of the presence of the pedestrian, until he heard a 'thump' from the front left side of his car. Pedestrian traffic was heavy at this location, but the car was in the second of three marked lanes and so both participants had ample opportunity to detect the approach of the other party. Unless the car was travelling unusually slowly (no reliable speed estimate was available) it presumably entered the intersection during the all-red phase. The 90 year old driver, who had passed the annual driving test for elderly drivers earlier on the same day, could not account for his late departure from the intersection.

It is obvious that pedestrians crossing on the 'down-stream' side of a signalised intersection have less protection from the all-red phase of the traffic signals than do those crossing on the up-stream side. When the WALK signal appears there is still a risk that a vehicle may not have cleared the intersection, as in this case. A review of existing traffic engineering practice in this respect may be justifiable, although there is no obvious solution.

The other two pedestrian accidents at signalised intersections each involved a vehicle which was turning left (Accidents 196, 224). In both accidents the turning vehicle was longer than a car, in one case a large bus, and in the other a car towing a trailer. Each of the pedestrians stated that they had not looked to their right before starting to cross the road. Had they done so these accidents may not have happened. However, the drivers involved could have been expected to have watched the pedestrians who were both walking towards the crossing and to have allowed for the possibility that they would continue on to cross the road, because the pedestrian has priority over the turning vehicle under such circumstances. This is particularly important with vehicles which are longer than the conventional passenger car, since they take correspondingly longer to clear the cross walk at the intersection and the rear wheels may track much closer to the inside of the corner than do the front ones.

In one of these accidents the pedestrian was crossing with the WALK signal. In the other case the signal may have changed to DONT WALK, either flashing or steady. This latter case had a tragic outcome; an infant in a pusher was crushed beneath the rear wheels of the bus. There may be value in presenting frequent reminders in the media of the need for both the pedestrian and the driver to take particular care when a pedestrian wheeling a child in a pusher is about to cross a street.

As these cases illustrate, it is not reasonable for a driver to assume that a pedestrian realizes that he is about to turn left. The legal onus is already on the driver to yield to the pedestrian. The frequency with which this requirement is observed may be increased by selective enforcement by the Police.

### 3. CHARACTERISTICS OF THE PEDESTRIANS

#### INFORMATION FROM THE FOLLOW-UP INTERVIEW

Most of the information presented in this section was obtained by interviewing or examining the pedestrian some days or weeks after the accident. Completed interviews were obtained with 30 pedestrians, and partial information was obtained from another four, the difficulties with the latter group being language (even with an interpreter), the age of the pedestrian (very young children) and, in one case, concern about possible legal proceedings.

Four pedestrians could not be located at their nominated address, despite three attempts to contact two of them and five and seven visits to the addresses given by the remaining two. Another person refused to cooperate on two occasions. The pedestrian whose accident appeared to be the result of a genuine suicide attempt had been admitted to a mental institution and a psychiatric report revealed that he had no recall of the events leading up to the accident. The parents of the young child who was killed were not aware of his movements before the accident, nor was the mother of the infant who was totally incapacitated by the collision. The remaining pedestrian was walking by herself when she was struck by a car and killed.

#### 3.1 DEMOGRAPHIC CHARACTERISTICS

The age and sex distributions of these pedestrians are shown in Table 4, together with the ratio, for each age group, of the percentage in the accident sample over the percentage in the population of South Australia. (The total number of pedestrians listed here is 43, one less than the overall total, because the infant riding in a pusher is not included.) Although the number of cases is small, it appears that the risk of being involved as a pedestrian in a pedestrian accident is highest for children and the elderly, as has been reported several times before (e.g. see Robertson, McLean and Ryan 1966, McLean 1971).

There were no cases in which the marital, educational, occupational or the employment status of the pedestrian appeared to have any direct relevance to his or her involvement in the accident. In general, these characteristics were consistent with those which might be expected for each age group.

#### 3.2 PHYSIOLOGICAL CHARACTERISTICS

##### VISION AND HEARING

Snellen tests of visual acuity were administered to the 30 pedestrians for whom complete follow-up data was obtained. Only one of these individuals suffered limitations of visual acuity that may have contributed, in conjunction with other factors, to his pre-accident performance. This person (Accident 135) was a severely intoxicated male, aged 61 years, who recorded scores on the Snellen test of 6:24 for each eye. He normally used bifocals but he was not wearing them at the time of the accident. This pedestrian was struck when crossing one of the major arterial roads at night, and although he had detected the lights of an approaching vehicle he had assumed it to be a considerable distance away.

Ishihara Tests for Colour Blindness did not reveal any accident-related impairments of colour vision among these pedestrians.

Although the hearing ability of these pedestrians varied considerably, none had any hearing loss which was likely to have contributed to their accident involvement.

##### ALCOHOL INTOXICATION

Eight pedestrians reported having consumed alcohol in the 12 hour period before the accident. Six of these persons had been drinking at hotels and one at home, and all had stopped drinking less than two hours before the accident. No information relating to the amount of alcohol consumed was available for one pedestrian who died as a result of the accident (her blood alcohol level, post mortem, was .03). The quantities of alcohol reportedly consumed by the other pedestrians are shown in Table 5. These quantities are categorized in terms of number of glasses consumed, each glass being approximately equivalent in terms of alcohol content to one eight oz. glass of beer.

##### Blood Alcohol Levels

The sources of information on the blood alcohol (BAC) levels of these pedestrians are shown in Table 6. Eleven pedestrians were under 14 years of age and thus were not required, by law, to provide a blood sample when admitted to hospital. Another pedestrian, who was old enough to have a blood sample taken for this purpose, was taken to the Children's Hospital and so no sample was obtained.

TABLE 4: PEDESTRIAN AGE AND SEX DISTRIBUTION AND  
POPULATION-BASED ACCIDENT-INVOLVEMENT RATIO

Age (years)	Female	Male	Percentage of:		Ratio A/B
			Accident Sample (A)	Population (B)	
0 - 9	2	7	20.9	17.2	1.2
10 - 19	4	5*	20.9	18.8	1.1
20 - 29	3#	3*	14.0	16.6	0.8
30 - 39	4#	-	9.3	12.4	0.8
40 - 49	-	3*#	7.0	11.0	0.6
50 - 59	-	3*	7.0	10.5	0.7
60 - 69	3#	3*	13.9	7.7	1.8
70 - 79	1*	2	7.0	4.1	1.7
80+	-	-	-	1.7	-
Total	17	26	100.0	100.0	

\* Indicates positive BAC for one pedestrian.

# Indicates BAC not known for one pedestrian (no BAC data obtained for children).

TABLE 5: SELF-REPORTED AMOUNT OF ALCOHOL CONSUMED  
IN THE 12 HOURS BEFORE THE ACCIDENT

Amount	Number of Pedestrians
1 glass <sup>1</sup>	1
2 glasses	1
5 glasses	1
7 glasses	1
9 glasses	1
Considerable quantity: amount unknown	2
Unknown amount	1
Not applicable (had not been drinking)	35
Total	43

Note: <sup>1</sup> See text for definition of 'one glass'.



TABLE 6: SOURCES OF INFORMATION ON BAC LEVELS OF PEDESTRIANS

Category of Pedestrian	Source of Information and Outcome					Total
	Blood Sample Taken in Hospital			Breath Test by Research Team		
	Yes	No	Not Known	Yes	No	
<u>Conveyed to Hospital:</u>						
Above 13 years of age:						
General Hospital	26	1 <sup>1</sup>	1 <sup>2</sup>	-	-	28
Children's Hospital	-	1	-	-	-	1
Under 14 years of age:						
Children's Hospital	-	11	-	-	-	11
<u>Not Taken to Hospital:</u>						
BAC measurement obtained	-	-	-	1	-	1
Test refused	-	-	-	-	1 <sup>3</sup>	1
Not approached	-	-	-	-	1 <sup>4</sup>	1
<b>Total</b>	<b>26</b>	<b>13<sup>4</sup></b>	<b>1<sup>4</sup></b>	<b>1</b>	<b>2</b>	<b>43</b>

Notes: 1. Uninjured mother accompanied fatally injured child to hospital.  
 2. Admitted to hospital, no record of admission available.  
 3. Had been drinking, but no subjective evidence of impairment.  
 4. No evidence of having consumed alcohol before the accident.

TABLE 7: BLOOD ALCOHOL LEVELS OF PEDESTRIANS

BAC (mgm %)	Number of Pedestrians
.00	21
.03	1
.10	2
.16	1
.23	1
.32	1
Not applicable (< 14 years)	11
Unknown	5
<b>Total</b>	<b>43</b>

The blood alcohol levels recorded for these pedestrians are shown in Table 7. Six pedestrians recorded positive BACs and in five of these cases the levels were .10 or greater.

The amounts of alcohol which these persons had reportedly consumed prior to the accident were, with one exception, consistent with the recorded BACs. The exception was a male pedestrian who reported that he had consumed only five glasses of beer, and yet recorded a BAC of .23 (Accident 158).

The five pedestrians who had a BAC of .01 or above were all involved in accidents at night, and four of them recalled having noticed the headlights of an approaching car and then having, mistakenly, decided that they could get across the road before the car reached them. (The pedestrian in the fifth accident deliberately ran out in front of the car.) There may be value in a more rigorous examination of the mechanisms underlying the effect of alcohol intoxication on the ability of a pedestrian to judge the speed, and distance away, of an approaching vehicle.

#### Usual Drinking Habits:

It is interesting to compare the usual consumption habits of the intoxicated pedestrians with those of the ones who were sober. The usual frequency of alcohol consumption and the average amounts consumed are shown in Tables 8 and 9 respectively. This information was not obtained for one of the pedestrians who had a positive blood alcohol at the time of the accident. The other five pedestrians who also had positive BACs included three males whose ages ranged from 44 to 61 years, and two young men aged 19 and 23 years. Two of these five pedestrians reported that they consumed alcohol on from two to four occasions per week, and the other three reportedly drank more frequently. All of these individuals were beer drinkers and, with one exception, they reported that they regularly consumed substantial amounts of alcohol. The other claimed that he generally consumed only about five glasses, although a similar figure given in relation to his alcohol consumption prior to the accident was not supported by his BAC reading. At least one of these pedestrians (Accident 135) had a history of admissions to casualty wards of hospitals for treatment of injuries sustained when intoxicated, and furthermore, a history of treatments for alcoholism.

In summary, for those pedestrians who were intoxicated at the time of their accidents there existed a clear pattern of regular and substantial alcohol consumption.

#### DRUGS OTHER THAN ALCOHOL

Information on drug taking was obtained from 37 of these 43 pedestrians. Seven pedestrians had been taking prescribed drugs for some medical condition. In six of these cases the drugs taken have no known effect on the likelihood of a person being involved in an accident and in the remaining case any effect that may have been present would probably have been beneficial.

Non-prescription drug usage was reported by two pedestrians but, again, the drugs involved are not known to impair the performance of tasks which are important to a pedestrian.

None of these pedestrians reported using any illegal drug prior to the accident.

#### MEDICAL CONDITION

Thirty-one of the 40 pedestrians for whom this information was available reportedly were in good health prior to the accident. Three pedestrians had minor ailments, one was pregnant (but with no evidence of complications) and five were in relatively poor health.

In four cases it was apparent that the described medical condition was not a relevant factor underlying the pre-accident performance of the pedestrian. For another two pedestrians the relevant medical condition at most constituted a marginal disability. The ability of a third person to cross a busy road quickly (Accident 103) may have been impaired to some degree by an arthritic condition. One other pedestrian, who was severely intoxicated, had previously encountered some problems of balance which derived from an inner ear condition (Accident 158). However, it was not possible to determine whether this condition had assumed any significance immediately prior to the accident.

In one accident (117) the pedestrian's actions were almost certainly a consequence of his poor mental and physical health. This person was suffering from Huntington's Chorea, a progressively worsening and irreversible condition, and from severe depression. He had attempted suicide some weeks before the accident and his behaviour on this occasion suggested that his involvement in the accident was deliberate.

#### FATIGUE

The recent sleep patterns of these pedestrians were compared with their normal patterns to provide some subjective indication of possible fatigue. Only one pedestrian (Accident 280) reported that his sleeping habits prior to the accident

TABLE 8: USUAL FREQUENCY OF ALCOHOL CONSUMPTION

<u>Usual Frequency</u>	<u>Number of Pedestrians</u>
Never	17
< 1/month	2
1/month	4
1/fortnight	2
1/week	2
2 - 4/week	4**
> 4/week	4***
Unknown	8*
<hr/>	
Total	43

\* denotes one pedestrian with positive BAC.

TABLE 9: USUAL AMOUNT OF ALCOHOL CONSUMED

<u>Usual Amount</u>	<u>Number of Pedestrians</u>
1 glass	3
2 glasses	2
3 glasses	1
4 glasses	2*
5 glasses	1
6 glasses	1
17 glasses	1*
Limited quantity: amount unknown	4
Variable quantity: 1 glass daily to more than 10 glasses at least 1/week	1*
Considerable quantity: amount unknown	2**
Not applicable (non-drinker)	17
Unknown	8*
<hr/>	
Total	43

\* denotes one pedestrian with positive BAC.

differed significantly from his usual pattern. He had had an average of about three hours interrupted sleep on the previous nights, compared with a usual amount of about eight hours. This departure from his normal sleeping habits, which was associated with a period of considerable emotional stress, resulted in a level of fatigue which probably contributed to his being involved in this accident.

### 3.3 CLOTHING

#### CONSPICUITY OF CLOTHING

Seven pedestrians were wearing brightly-coloured clothing, and 14 others were in light-coloured clothes. Nineteen pedestrians were in dull or dark attire. None of these 40 pedestrians was wearing any reflective garment or material (the clothing of three other pedestrians was not available for our inspection).

In the environmental conditions that prevailed at the scene of the accident, 24 pedestrians were considered to have been at least reasonably conspicuous. Although another eight pedestrians were dressed in relatively inconspicuous clothing, this lack of conspicuity was not relevant because these individuals were detected by the driver before the impact. However, there were eight other pedestrians, seven of whom were involved in night accidents, who were not seen by the driver until shortly before the impact. It is reasonable to assume that these eight accidents might have been avoided altogether, or the severity of the impact reduced, had the pedestrians worn more conspicuous clothing.

#### FOOTWEAR

None of these pedestrians was hindered, or otherwise exposed to an increased risk of being hit by a vehicle, by any characteristic of their footwear.

### 3.4 BEHAVIOUR AND EXPERIENCE

#### JOURNEY SCHEDULE

Twenty-seven pedestrians reported that they had no fixed schedule associated with their journey. Eight pedestrians did have a schedule to maintain and four of them were late (Accidents 145, 183, 185, 224). Three of these pedestrians were hurrying to catch a bus or tram, and the other was late for a business appointment (Accident 183). Their consequent attempts to meet their schedule resulted in them taking less care when crossing the road than might otherwise have been the case. No information was obtained on whether any of the remaining eight of the 43 pedestrians were trying to keep to a set schedule for their journey.

#### SOCIAL INTERACTIONS

There were six pedestrians who reported having experienced other than quite routine prior social interactions. Four of these six individuals described their interactions as exciting, one as stressful, and another as hostile. The reactions of these pedestrians to these events were all important factors in the causation of their accidents.

#### INCIDENTS DURING THE JOURNEY

Unexpected incidents either directly or indirectly contributed to the accident involvement of three pedestrians. In two cases, the incident sufficiently delayed the journey to place the pedestrian behind schedule. One of these two pedestrians, who was pushing a child in a stroller, was about to negotiate a pedestrian crossing at a major intersection when she had to retrace her path for a short distance to retrieve a dropped purse (Accident 224). The other pedestrian had to return some distance to her home for a similar purpose (Accident 185). These delays made the two pedestrians late, for a bus and a train, and their consequent state of anxiety undoubtedly contributed to their accident involvement.

The third pedestrian, a male with a BAC of .32 (Accident 135), had left a hotel and crossed a major arterial road to the site of his parked car. As noted above, he was then unable to find his car keys, which had been confiscated by a barman, and was returning to the hotel when he was struck by a car.

#### PRE-ACCIDENT EMOTIONAL REACTIONS

Eighteen of the 26 pedestrians who could recall the nature of their emotional reactions prior to the accident said that they were unemotive or contented.

The other eight of these 26 pedestrians were affected by their emotional state immediately before the accident. Four of them were the pedestrians who were behind schedule. Three children, aged from six to 11 years, were excited by playing with other young children (Accidents 133, 244 and 299). The reaction of the remaining pedestrian, who deliberately ran into the path of a car, reflected, among other things, his anger as a result of an argument with a female with whom he had recently been living (Accident 280).

#### PREOCCUPATIONS BEFORE THE ACCIDENT

In the preceding paragraph it is noted that eight pedestrians were under some emotional stress, and hence preoccupied with matters other than the manoeuvre preceding the accident. Another seven pedestrians recalled preoccupations of a mild and varied nature in the few minutes prior to the accident. In one case, at least, this preoccupation may have been significant among the relevant pre-accident

circumstances (Accident 196). This person, who was reflecting on his intended activities for the forthcoming weekend, began to cross at a signalized intersection immediately behind a car which was turning left across the pedestrian crosswalk. However, he had not noticed the trailer attached to the rear of the car and consequently walked into its path. It is not possible to overrule completely the possibility that the actions of the other six of these seven pedestrians were influenced by their preoccupation with other matters, but they said that their preoccupations were relatively minor, and unlikely to have had a significant effect on their performance.

Four pedestrians reported more enduring, although generally only intermittent, preoccupations. Yet only one of these pedestrians indicated that this preoccupation may have been related to his accident involvement. Indeed, as has been indicated under the preceding heading, this pedestrian's actions prior to the accident were the culmination of a series of events which had lasted for several days and were related to his deteriorating relationship with the female with whom he had been living (Accident 280).

The remaining thirteen pedestrians for whom adequate follow-up information was obtained either said that they were not preoccupied with other matters or were unable to recall any specific preoccupations.

#### ACCIDENT HISTORY

Five out of 30 of these pedestrians reported previous involvement in a road accident (no information was available for the other 13 pedestrians). Four of these five pedestrians said that they had been involved in only one previous accident, and in all cases that accident had been a trivial one. The fifth pedestrian, although aged only 23 years, had been involved in three previous accidents, at least two of which were his own fault. In this accident (305), while intoxicated, he stepped out onto a zebra crossing in front of a vehicle that was almost at the crossing. It therefore seems likely that this person's general behaviour on the road was often inappropriate.

#### FAMILIARITY WITH THE ACCIDENT ENVIRONMENT

Nine pedestrians were not familiar with the accident site. This group consisted of three infants who were not accustomed to traffic, three young children, two people who normally resided in the country, and a recent arrival from interstate. Another six pedestrians reported that the prevailing traffic conditions at the time of the accident differed from those to which they were accustomed at these sites.

Apart from the three very young children aged three years or less, who could not be expected at their stage of development to behave in a safe manner

when exposed to general traffic conditions, a lack of familiarity with the prevailing environmental conditions at the accident site was considered to be a significant factor in only one accident. In this case (Accident 037) a 19 year old female, who had recently arrived from another State, stepped from a median strip on a major arterial road and made her way through two lanes of stationary vehicles which were banked up from a signalised intersection about 50m beyond where she was crossing. When she began to cross the third, or kerbside, lane she walked into the side of a passing vehicle. She had not realized that traffic in this lane was moving freely towards the intersection in response to a phase of the traffic signals which permitted left hand turning movements while preventing straight through traffic flow. Although there were other factors which contributed to this person's involvement in the accident, her lack of familiarity with these traffic conditions played an important role.

### 3.5 ERRORS MADE BY PEDESTRIANS

#### VISUAL DISTRACTIONS

One pedestrian (Accident 190) reported that she had been distracted momentarily by the activity of nearby vehicles, while two others (Accidents 198, 247) claimed that they had been distracted by the activities of other pedestrians or bystanders. These three pedestrians were distracted after they had commenced the manoeuvre preceding the accident, and this distraction was one of the reasons why these accidents happened. (The three pedestrians aged less than four years are not included here.)

#### FAILURE TO ACCOMMODATE TO A VISUAL RESTRICTION

There was some obstruction to the view that 19 of these pedestrians could have had of the striking vehicle before the collision, and this obstruction affected the pedestrian's awareness of the presence of this vehicle in 12 instances (Table 10). The numbers of relevant visual restrictions for each type of restriction in Table 10 do not correspond with those in Table 3 because the latter contains cases which were relevant to drivers as well as to pedestrians and is on an accident basis (total: 35 midblock accidents) whereas Table 10 is based on the 43 pedestrians who were actively involved in the events which resulted in the 40 pedestrian accidents in this sample.

The 12 pedestrians who failed to take full account of restrictions on their field of view were aged from one to 78 years (distributed across that range in a manner similar to the distribution for all 43 pedestrians in this sample). Two of these 12 pedestrians were aroused emotionally prior to the accident, one because of a delay in the journey schedule (Accident

TABLE 10: VISUAL RESTRICTIONS: FREQUENCY AND RELEVANCE FOR PEDESTRIANS

<u>Type of Restriction</u>	<u>Number of Pedestrians</u>	
	<u>All Restrictions</u>	<u>Relevant Restrictions</u>
None	22	-
Moving traffic	1	-
Stationary traffic	9	5
Parked vehicles	7	6
Roadside objects (man-made)	3	1
Unknown if restricted	2	-
Total	43	12

TABLE 11: SECONDARY ACTIVITIES

<u>Type of Secondary Activity</u>	<u>Number of Pedestrians</u>	
	<u>All Cases</u>	<u>Relevant Cases</u>
None	15	-
Watching other vehicle or pedestrian	7	4
Interacting with other pedestrians	4	3
Other than the above (e.g. playing)	4	3
Not known or not applicable	13	-
Total	43	10

145) and another as a result of excitement generated in playing with friends (Accident 299). One of these two pedestrians (Accident 299), and a third pedestrian (Accident 175), were engaged in some activity, other than watching for traffic, prior to the collision. Yet another pedestrian (Accident 037) was not familiar with the relevant traffic conditions. It seems reasonable to expect that in circumstances such as these a pedestrian might be likely to fail to take account of any restriction on the field of view.

#### SECONDARY ACTIVITIES

As used here, the term 'secondary activity' refers to one other than the main activity of crossing the road.

Two accidents each involved two pedestrians who were holding hands immediately prior to the accident. In Accident 003 this behaviour apparently was not a causal factor but in the other accident (209), when the pedestrians attempted to get out of the way of the approaching vehicle they moved in opposite directions while still holding hands, thereby preventing the possibility of either avoiding action being effective.

Fifteen pedestrians reported that they had been engaged in some non-physical secondary activity before the accident. As shown in Table 11, this secondary activity interfered with the primary task of crossing the road safely in the case of ten of these 15 pedestrians.

In four cases the secondary activity related to the emotional state of the pedestrian. The secondary activities of two pedestrians (Accidents 224, 299) appear to have produced the emotional reactions which had some influence on their performance. On the other hand, the secondary activities of the other two pedestrians (Accidents 133, 244) appeared to derive, at least in part, from their pre-accident emotional states.

#### INADEQUATE MONITORING OF THE RELEVANT ENVIRONMENT

Twenty-four pedestrians failed to monitor adequately the approach path of the vehicle involved in the collision. They became aware of the presence of that vehicle only fractionally before or at impact, despite the absence of any apparent obstruction to their field of view.

There was some indication that the elderly pedestrians in this sample were

more likely to have made this error than were the younger ones (Table 12). Although the observed difference may have been due to chance, it is consistent with the known tendencies of the elderly to ignore peripheral sources of information when under some speed stress and to find it difficult to change a course of action once it has been initiated (Welford, 1958).

Pedestrians who were involved in some secondary activity, or were otherwise distracted shortly before the accident were also particularly likely not to have looked carefully for oncoming traffic. There were six pedestrians in this category. Similarly, three of the four pedestrians who were running late also committed this error (Accidents 183, 185 and 224) as did three other pedestrians who were unusually excited (Accidents 133, 244) or preoccupied (Accident 196).

This error also was attributed to three of the intoxicated pedestrians (Accidents 135, 144, 305), although the mechanisms of the effects of alcohol on human performance may be such that an individual's performance is impaired regardless of the thoroughness of the inspection of the relevant environment.

#### FAILURE TO RESPOND APPROPRIATELY IN AN EMERGENCY

An intoxicated middle-aged man crossed from the median reserve to the first lane of a three lane road. He stopped there, intending to allow a car to pass by in the second lane, when he saw another car approaching in the lane which he had just crossed (Accident 158). He apparently panicked and rushed across in front of the first car, which hit him. It is possible that this accident may not have happened if the pedestrian had accepted the risk involved in waiting on the lane marking in the hope that the two cars would pass by on either side of him.

#### INAPPROPRIATE CROSSING BEHAVIOUR

Four pedestrians were hit when standing in the centre of the road. These cases have been described earlier in this report where it was noted that pedestrians who choose to stand on or near the centre line, or who are forced to do so to get across the road, must rely entirely on the ability of drivers to see them in time to be able to avoid a collision.

TABLE 12: INADEQUATE MONITORING OF RELEVANT ENVIRONMENT BY AGE OF PEDESTRIAN

<u>Age of Pedestrian</u>	<u>Inadequate Monitoring</u>		<u>Total</u>
	<u>Yes</u>	<u>No</u>	
Less than 60 years	17	14	31
More than 59 years	7	3	10
Total	24	17	41 <sup>1</sup>

Chi square = 0.72    p < 0.3.

Note: <sup>1</sup> Excludes two cases which appeared to be suicide attempts.

TABLE 13: AGE, SEX AND ALCOHOL LEVEL FOR DRIVERS AND RIDERS INVOLVED IN PEDESTRIAN ACCIDENTS

<u>Age (years)</u>	<u>Female</u>	<u>Male</u>
16 - 19	1	7#
20 - 24	2#	5*#
25 - 34	3*##	9
35 - 44	-	4#
45 - 54	1	2#
55 - 64	-	3
65 - 74	-	1
75+	1	1
Total	8	32

\* Indicates BAC > .08 for one driver.

# Indicates BAC not known for one driver.



#### 4. CHARACTERISTICS OF THE DRIVERS

##### AGE AND SEX

Thirty-two, or 80 per cent, of the drivers or riders whose vehicle collided with a pedestrian were males. The percentage of male licensed drivers or riders in South Australia on 30 June 1976 was 60.7, and so this suggests that male drivers are over-represented in their involvement in pedestrian accidents, as in other types of accidents. Part of the reason for this apparent over-involvement may, of course, be a greater exposure to risk for male drivers than for females.

The ages of these drivers or riders are listed in Table 13. Males under the age of 20 years had an involvement rate (based on the number of male licensed drivers or riders) in these accidents which was more than twice that of the older drivers.

##### ALCOHOL INTOXICATION

Three drivers are known to have been drinking prior to being involved in their accident. One of these had a BAC of .02. The other two were a male, aged 23, with a BAC of .22 (Accident 026) and a female, aged 30, with a BAC of .13. Information on blood alcohol levels could not be obtained from seven drivers.

The percentage of these drivers who had been drinking, based on the known-BAC cases, is 7.5, which can be compared with the corresponding figure of 57 per cent for drivers involved in single vehicle crashes (other than pedestrian accidents).

##### PRIOR CONVICTIONS FOR DRIVING OFFENCES

In the review of these accidents in the first part of this report occasional mention was made of driver's actions which were inappropriate under the circumstances which existed at the time of the accident. There were six drivers who admitted that they were not looking where they were going, and one rider who deliberately rode his motorcycle straight towards a pedestrian, albeit in jest. Ten other drivers may have been able to have avoided colliding with the pedestrian had they exercised greater care.

Table 14 lists the number of drivers who reported having had at least one prior conviction for an offence under the Road Traffic Act during the five years preceding the accident. This information is presented for the two groups of drivers defined in the previous paragraph and for the remainder. It can be seen that the proportion of drivers with at least one self-reported prior conviction for a driving offence is much greater for drivers who could be considered to have certainly, or probably, contributed to the causation of the accident than for the remaining group of drivers. When convictions for speeding offences are compared, the proportions for these three groups are 3/6, 4/8 and 3/19 respectively, after deleting the drivers for whom this information was not available. The proportion for the first two groups combined, those drivers who certainly or probably contributed to the causation of the accident, is 7/14 which is greater than 3/19 to an extent which is unlikely to be due to chance (Chi square = 4.46,  $p < 0.05$ ).

TABLE 14: RECORD OF PRIOR CONVICTIONS<sup>1</sup> AND THE ROLE OF THE DRIVER IN THIS ACCIDENT

At Least One Prior Conviction	Driver Contributed to the Causation of the Accident		
	Certainly Yes	Probably Yes	Probably No
Yes	3 (3) <sup>2</sup>	5 (4)	5 (3)
No	3	3	14
Unknown	1	2	4
Total	7	10	23

Notes: <sup>1</sup> Self-reported convictions for offences under the Road Traffic Act.

<sup>2</sup> Number in parentheses refers to drivers convicted for speeding.

A few of the drivers in these pedestrian accidents may have been exceeding the speed limit but there was not sufficient evidence to confirm these suspicions. In those cases in which the vehicle skidded to a stop under braking the length of the skid marks was consistent with a legal

travelling speed. Even so, the information obtained on self-reported prior convictions for speeding does suggest that drivers who have such a record are at a relatively high risk of being involved in a collision with a pedestrian.

## 5. THE CONSEQUENCES OF PEDESTRIAN ACCIDENTS

### 5.1 THE INJURIES

#### OVERALL INJURY SEVERITY

Table 15 lists the distribution of overall injury severity for each category of road user involved in the accidents covered by this survey. Pedestrians sustained a higher average severity of injury than any other type of road user when the percentage who were injured to a degree which was rated as being dangerous to life, or killed, is considered. For the first four types of road user listed in Table 15 these percentages are: 22.7, 13.0, 12.5 and 2.0 respectively.

#### INJURY SEVERITY SCORE

The Injury Severity Score (ISS) provides a more sensitive measure of overall injury severity. It is the sum of the squares of the Abbreviated Injury Scale (AIS) ratings of the three most severe injuries sustained by an individual, taking the most severe injury for defined body regions. In this survey 61 per cent of these pedestrians had an ISS score which was greater than four. (A person who sustained concussion, with a period of unconsciousness lasting less than 15 minutes, and bruises and abrasions, would have an ISS of five). By comparison, the corresponding percentages for other road users were: pedal cyclists, 61 per cent, motorcyclists, 53; and car occupants, 13 per cent.

#### BODY REGIONS INJURED

It is unusual for a person to receive only one injury, if injured at all, in a road accident. This is illustrated by the experience of these pedestrians. The average number of injuries per person was between four and five, with three pedestrians receiving more than nine separate injuries. (For these three pedestrians only the nine most severe injuries are included in the following tabulations.)

The frequency of injury to each body region is shown in Table 16. Eighty per cent of the injuries are to the extremities (arms and legs) and to the head and face. This percentage is reduced to 58 when only severe injuries are considered. An AIS rating of three or more is classed here as a 'severe' injury. Concussion, with a period of unconsciousness ranging from more than 15 minutes up to 12 hours, or a compound fracture of the femur, is rated at level three on the AIS scale.

Four body regions are not represented in the 'Severe Injuries' column in Table 16: the face, elbow, wrist/hand, and ankle/foot. This is partly due to the fact that the last three body regions are unlikely to be severely injured, in the sense in which the term 'severe' is used here. A hand injury, for example is most unlikely to endanger a person's life. Similarly, a facial injury is less likely to be critical than is a head injury. Even so, the absence of severe facial injuries is consistent with the observation made in car/'pedestrian' collision experiments using unembalmed cadavers in which the 'pedestrian', although struck on the side, rotated and hit the upper surface of the bonnet of the car with the side or back of the head, and not with the face (Krieger *et al.* 1976). But not all of these pedestrians were struck by a car, and some of those who were were children who are not thrown up onto the upper surface of the striking car. There were also some cases in which the mechanism of injury was dramatically different from that of the car/adult pedestrian collision. For example, one of the pedestrians who sustained at least nine separate injuries was the child who was crushed under the rear wheel of a bus. In general, however, the injury distributions shown in Table 16 are little changed when cases involving vehicles other than cars are removed.

### 5.2 OBJECTS CAUSING INJURY

The identification of objects contacted by the pedestrian and the correlation of these objects with specific injuries is often difficult. In order not to conceal this difficulty when recording this information the level of confidence was noted in each instance as 'certain', 'probable' or 'possible'. 'Certain' contacts were those in which there was some physical evidence on either the vehicle or the pedestrian. For example, in Accident 144, hair caught in the fractured windscreen glass was convincing evidence that the pedestrian's head hit the windscreen (Figure 11). In some instances more than one object may have been associated with the production of one injury. A head injury to a child may have been caused initially by the leading edge of the bonnet (Figure 12) and possibly aggravated by a subsequent impact with the road surface. In general, the initial object contacted appeared to have been the major cause of injury.

Table 17 lists the objects which caused injury for all injuries and for

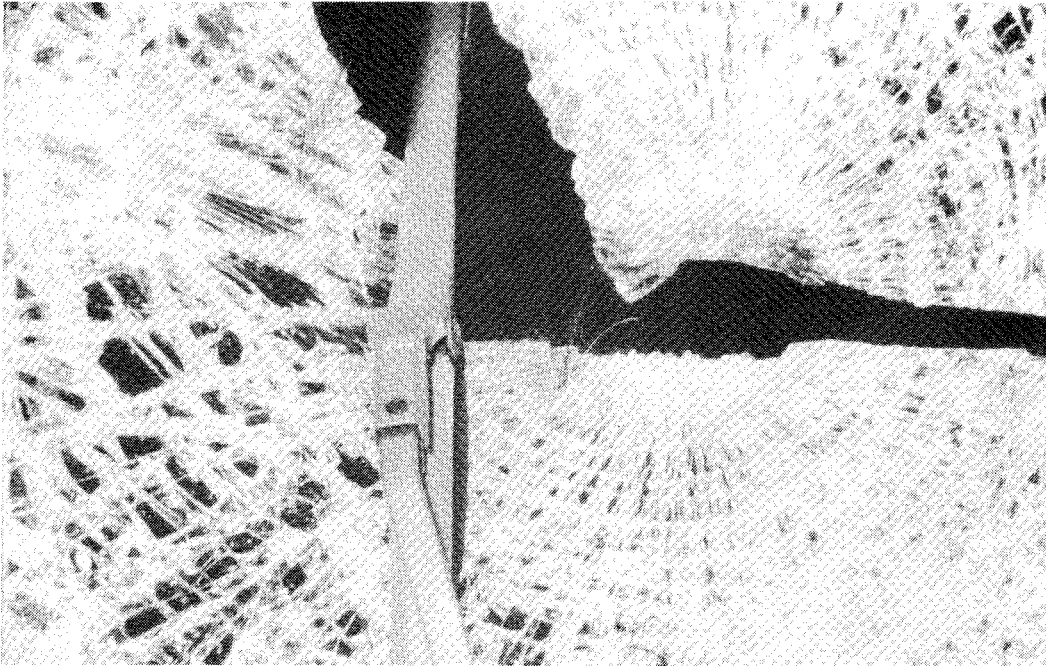


FIGURE 11: Head contact with windscreen. Note hairs caught in glass. See also Figures 16 and 26. Accident 144.

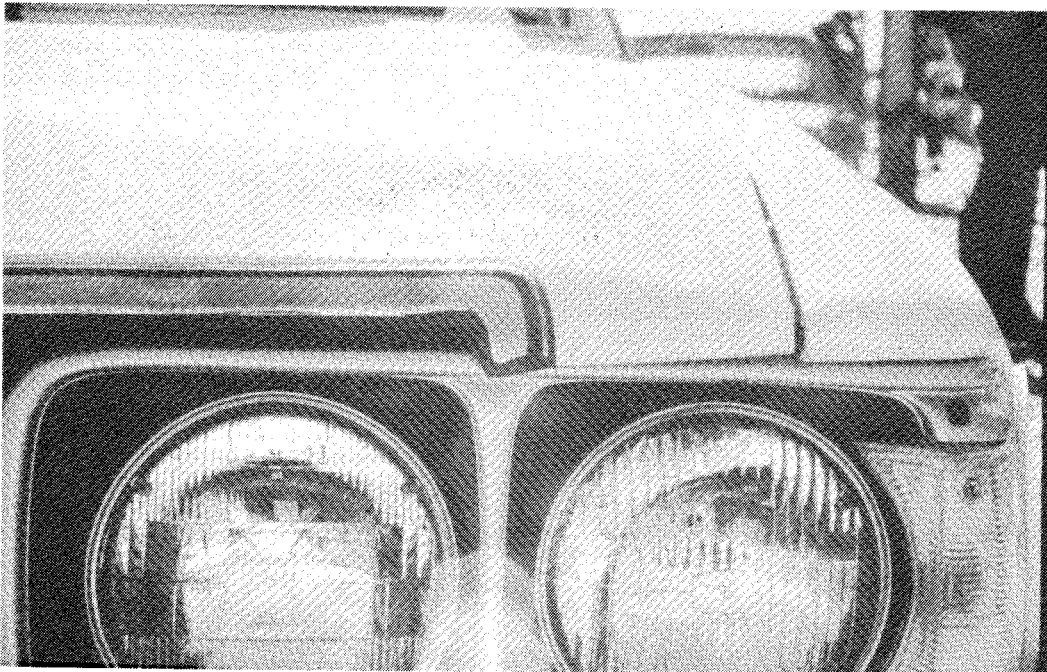


FIGURE 12: Damage to car resulting from impact with the head of a three year old child pedestrian. Accident 060.



FIGURE 13: Distortion of bumper bar due to collision with an adult pedestrian. Accident 144.

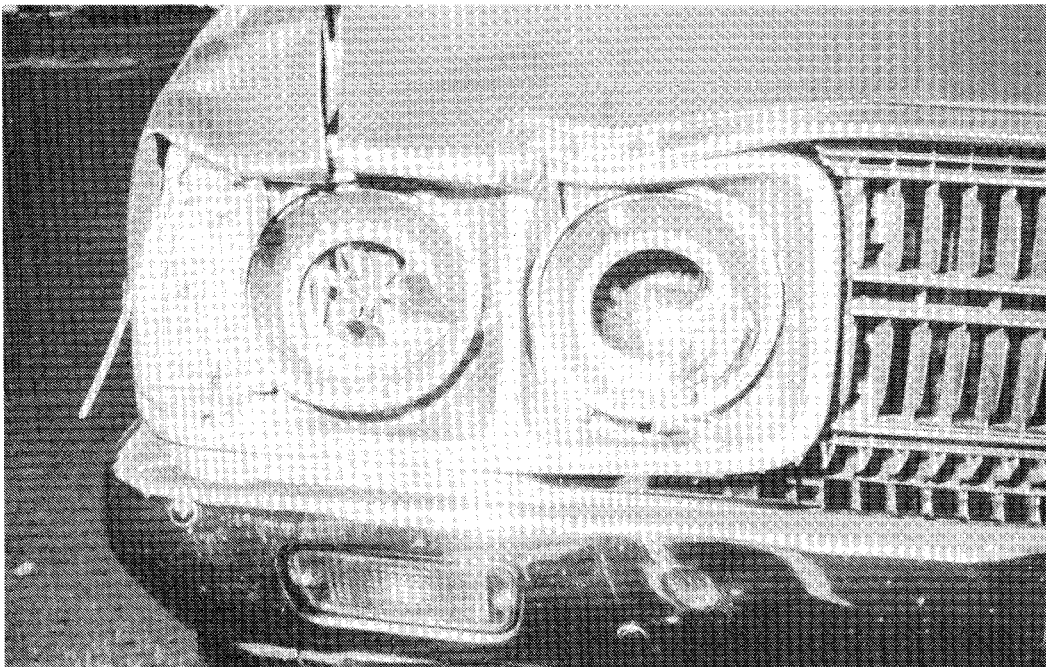


FIGURE 14: Damage resulting from a collision with an elderly female pedestrian. Accident 256.

TABLE 15: OVERALL INJURY SEVERITY FOR EACH TYPE OF ROAD USER

Type of Road User	Overall Injury Severity (Per Cent)*							Total Number of Cases
	Nil	Minor	Moderate	Severe	Serious	Critical	Fatal	
Pedestrian	2.3	25.0	20.5	29.5	11.4	4.5	6.8	44
Pedal Cyclist	4.3	21.7	39.1	21.7	8.7	4.3	-	23
Motorcyclist	3.7	37.5	30.0	16.2	7.5	-	5.0	80
Car Occupant	52.0	32.9	11.0	2.1	1.1	0.8	0.1	727
Occupant of Light Commercial Vehicle	53.3	20.0	26.7	-	-	-	-	15
Occupant of Heavier Commercial Vehicle	81.0	14.3	4.8	-	-	-	-	21
Bus Occupant	18.2	72.7	9.1	-	-	-	-	11
All Road Users	44.5	32.5	13.9	5.0	2.3	1.0	0.9	921

\*Note: The figures for bus occupants show a higher average severity of injury than was actually the case. This is because in one accident the bus was carrying a large number of passengers, possibly as many as sixty, and when the bus stopped after the collision almost all of these passengers transferred to a following bus within a minute or so. Ten car occupants are also not represented in this Table because we were unable to examine them after the accident. One of them probably was injured, the others almost certainly were not.

TABLE 16: PEDESTRIANS: BODY REGION BY FREQUENCY  
AND SEVERITY OF INJURY

<u>Body Region</u>	<u>All Injuries</u>	<u>Severe Injuries<sup>1</sup></u>
Head	20.6%	22.5%
Face	10.8	-
Neck	3.1	7.5
Shoulder	3.1	2.5
Upper Arm	2.6	2.5
Elbow	2.6	-
Forearm	2.6	10.0
Wrist/Hand	6.7	-
Back	2.1	7.5
Chest	3.6	5.0
Abdomen	5.7	12.5
Pelvis	5.7	10.0
Thigh	7.2	7.5
Knee	9.3	5.0
Lower leg	8.8	7.5
Ankle/Foot	5.7	-
<hr/>		
Totals: Per Cent	100.2% <sup>2</sup>	100.0%
: Number of Injuries	194	40

Notes: <sup>1</sup> AIS  $\geq$  3

<sup>2</sup> Total does not sum to 100.0 because of rounding errors.

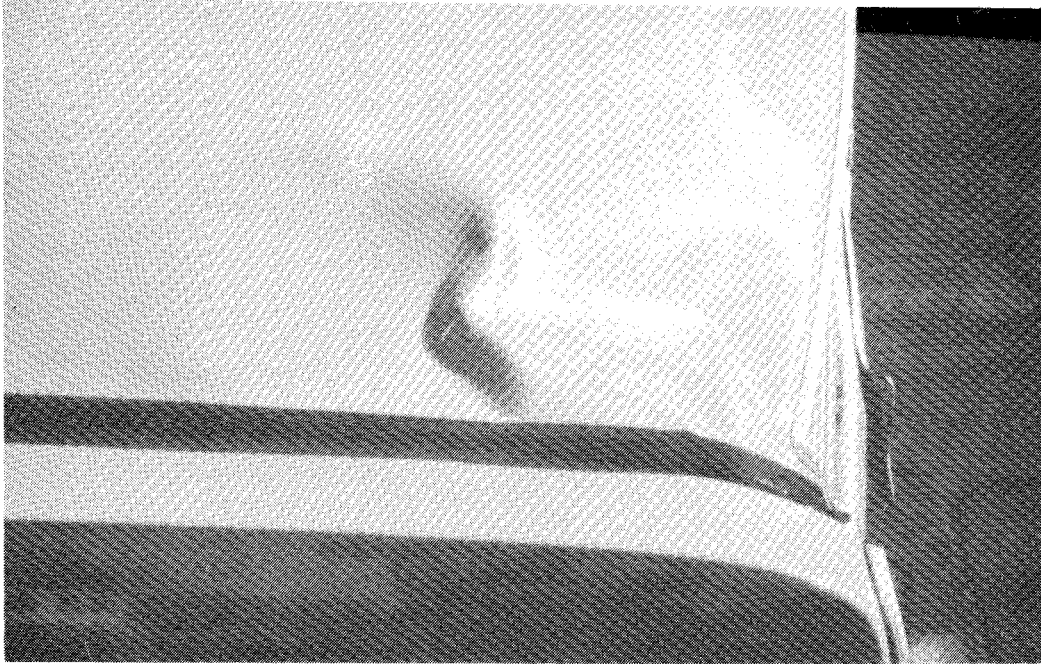


FIGURE 15: Damage to the bonnet of the car in Accident 144.



FIGURE 16: Bumper, bonnet and windscreen contact points in Accident 144.



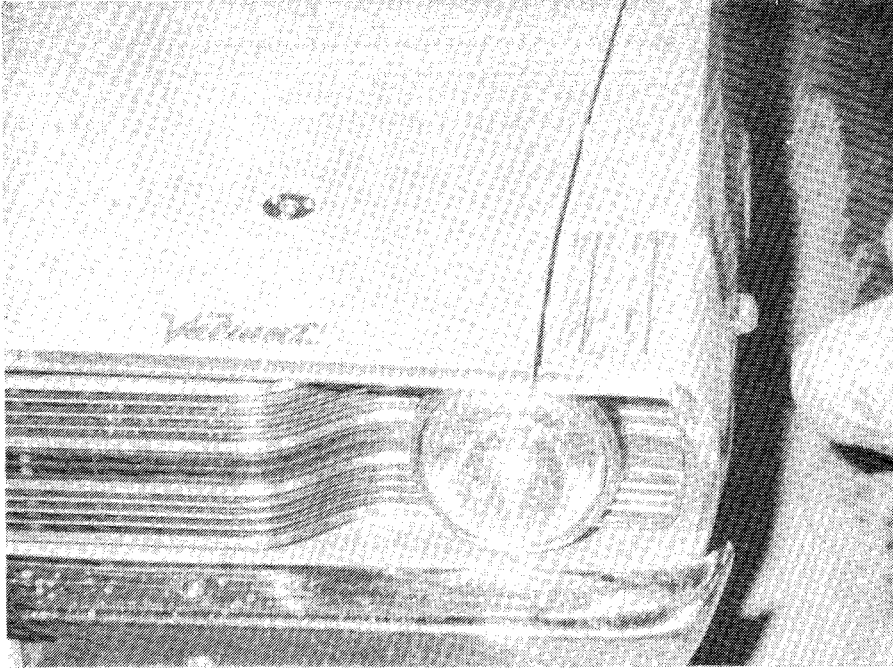


FIGURE 17: See caption to Figure 18.

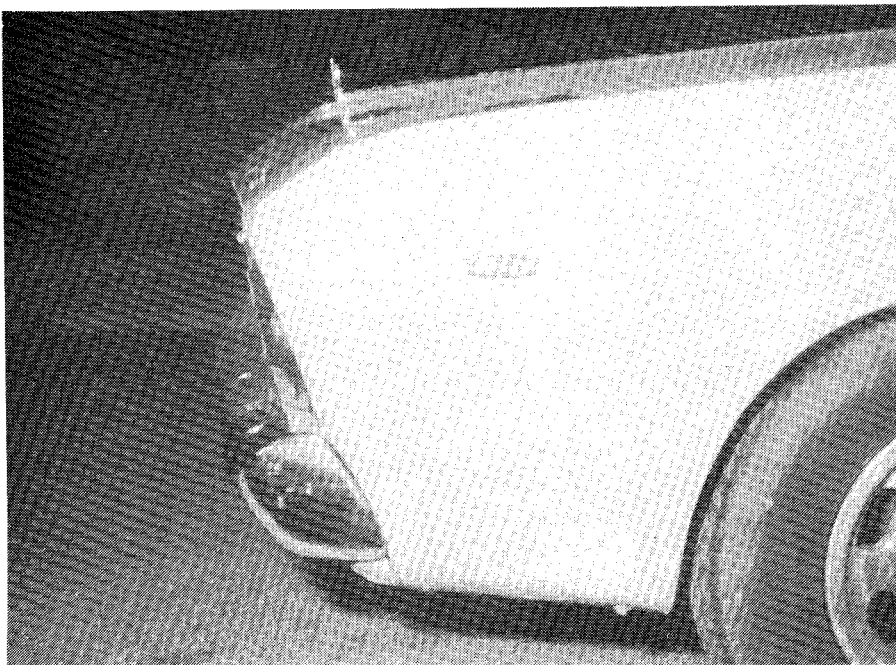


FIGURE 18: An eight year old boy received a ruptured liver and a ruptured kidney when struck on the side by the front corner of this car. Accident 208.

TABLE 17: PEDESTRIANS: OBJECT STRUCK BY FREQUENCY  
AND SEVERITY OF INJURY

Object Struck	All Injuries			Severe* Injuries		
	Number	%	No. of Persons**	Number	%	No. of Persons
Front bumper	26	13.4	(19)	6	15.0	(6)
Bonnet, front edge	22	11.3	(10)	11	27.5	(3)
Front mudguard, leading edge	12	6.2	(6)	7	17.5	(4)
Bonnet, upper surface	25 <sup>1</sup> #	12.9	(13)	4	10.0	(3)
Front mudguard, upper surface	3	1.5	(2)	-	-	-
Other front of vehicle	5 <sup>3</sup>	2.6	(4)	1 <sup>1</sup>	2.5	(1)
Windscreen glass	2	1.0	(1)	-	-	-
Front corner post (A pillar)	3	1.5	(3)	1	2.5	(1)
Header rail	2 <sup>2</sup>	1.0	(1)	-	-	-
Front wheel or tyre	-	-	-	-	-	-
Rear wheel or tyre	9	4.6	(1)	5	12.5	(1)
Other side of vehicle	4 <sup>1</sup>	2.1	(3)	-	-	-
Other back of vehicle	3	1.5	(1)	1	2.5	(1)
Motorcycle, front wheel	1	0.5	(1)	-	-	-
Motorcycle, other part	3	1.5	(3)	-	-	-
Trailer	2	1.0	(1)	-	-	-
Road surface	63 <sup>4</sup>	32.5	(31)	4	10.0	(3)
Object not known	9	4.6	(6)	-	-	-
<b>Total</b>	<b>194<sup>12</sup></b>	<b>100.0</b>		<b>40<sup>1</sup></b>	<b>100.0%</b>	

# Superscript indicates number of listed contacts rated as 'possible'.

\* AIS ≥ 3.

\*\* Number of pedestrians struck by specified object is shown in parentheses.

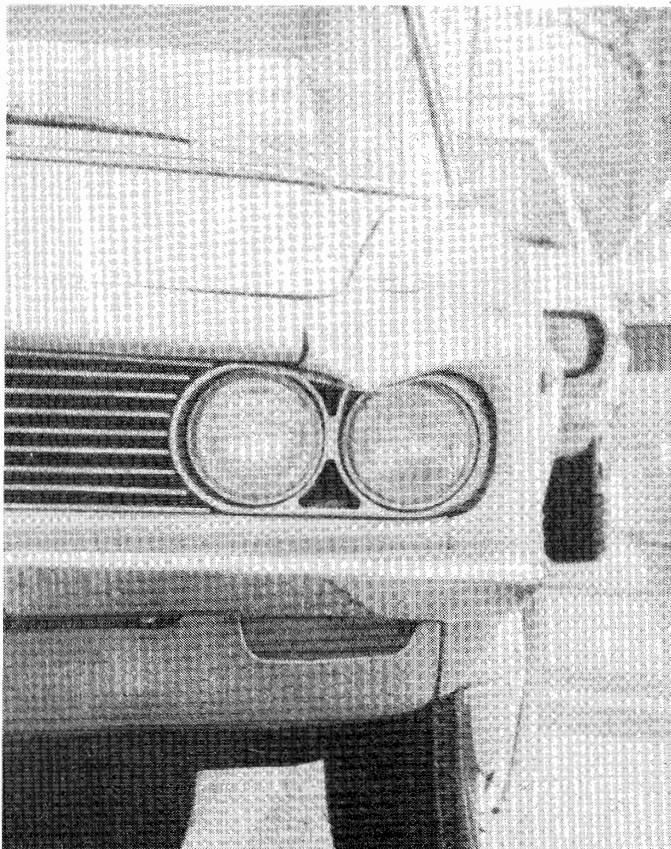


FIGURE 19.  
Damage resulting from a collision with an elderly male pedestrian, who sustained a fractured pelvis. Accident 140 (see frontispiece).

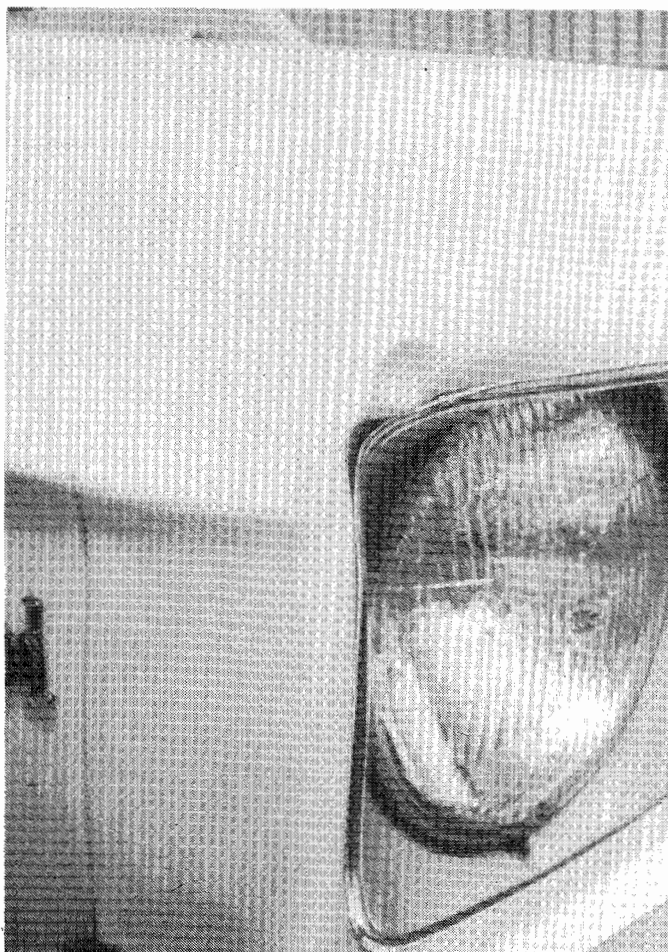


FIGURE 20:  
This impact fractured the right femure and pelvis of a middle-aged male pedestrian. Note damage to paint work of car due to the fabric of the pedestrian's clothing sliding across the vertical edge of the front corner of the car during the impact. Accident 191.

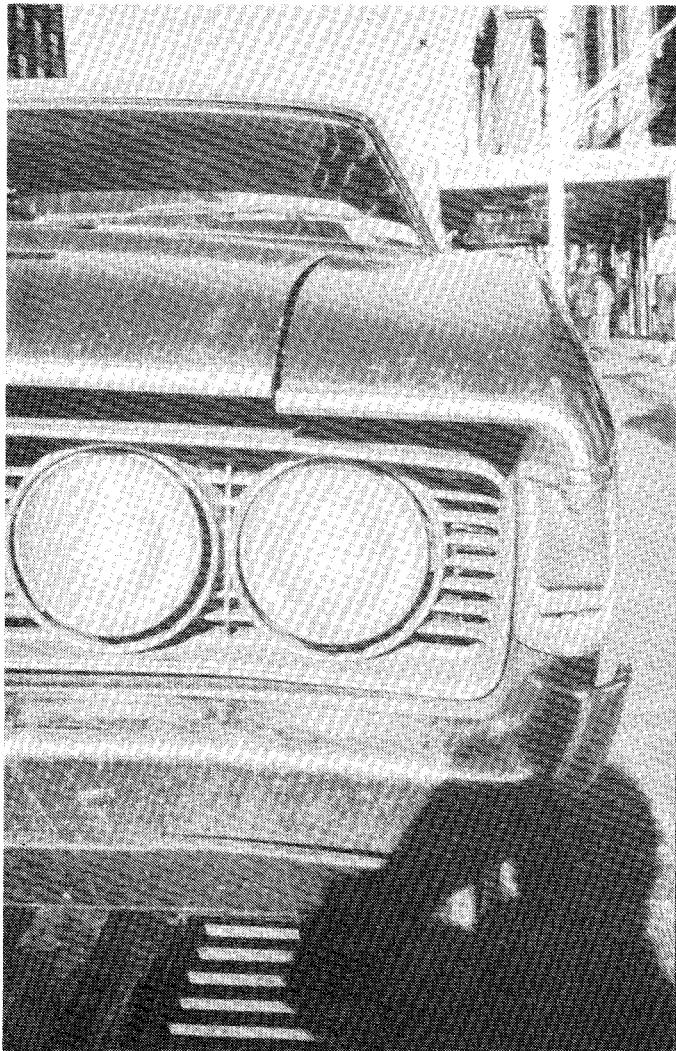


FIGURE 21:  
See caption to Figure 22.

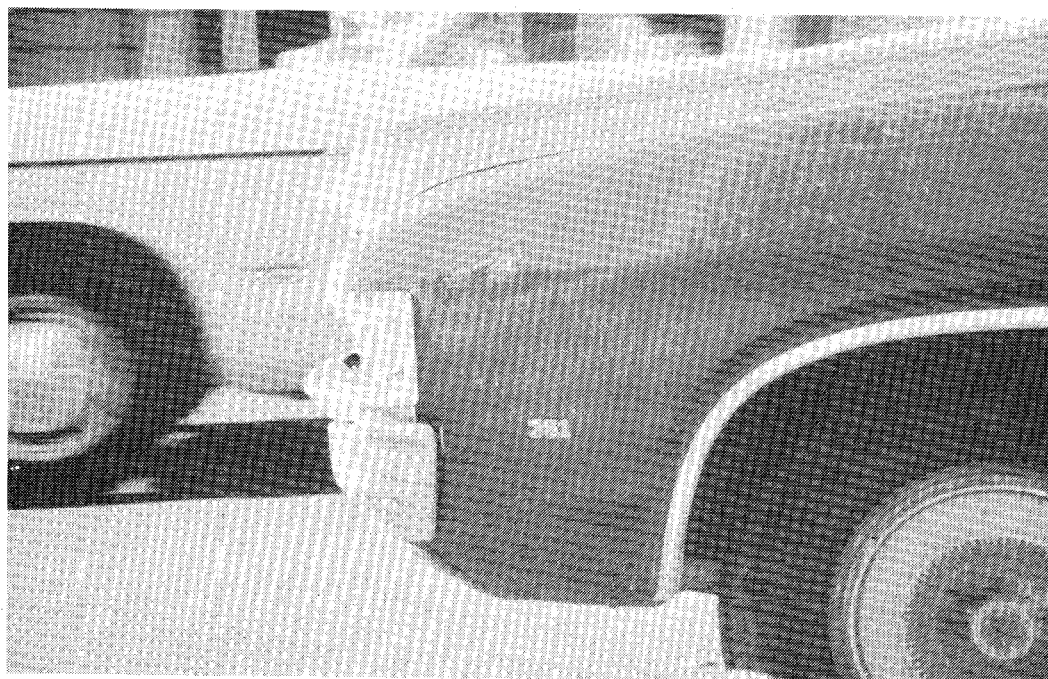


FIGURE 22: The front corner of this car fractured the right femure of a thirty year old female pedestrian (see also Figures 21 and 23). Accident 190.

those rated as severe. The number of pedestrians involved is also listed for each of the specified objects in order to show the frequency of contact, and to permit the identification of objects which caused an unusually large number of injuries per pedestrian. The most notable case in this respect was the one in which a child was run over by the rear wheel of a bus.

The first four objects listed in Table 17 are of the greatest practical importance because they account, together, for 44 per cent of all injuries in this sample of pedestrian accidents, and for 70 per cent of the severe injuries. The nature of some of the impacts with these objects is described in the following sections.

#### FRONT BUMPER BAR

The front bumper bar is likely to be the first part of the car to hit the pedestrian, and the impact is usually on the lower leg of an adult pedestrian. The most common resulting injury is a fracture of both the tibia and fibula, but injuries to the knee joint may be seen. In this sample of accidents there were four pedestrians who sustained severe leg injuries from the bumper bar impact, and two of these injuries were ruptured ligaments at the knee joint. The other two were fractures of the tibia and fibula.

Figure 13 shows the distortion of the front bumper bar of a Datsun 1200 which resulted from a collision with a pedestrian who was standing still in the centre of the road, side-on to the car (Accident 144). The pedestrian was one of the two noted above who sustained a severe knee injury.

#### LEADING EDGE OF BONNET

There were three pedestrians who were severely injured by the impact from the leading edge of the bonnet, but these three pedestrians received a total of eleven severe injuries which were all attributable to this impact.

One of these pedestrians was a small child, whose head was hit on the right side by the edge of the bonnet of a Toyota Corona (Accident 060). The damage to the car was very slight (Figure 12), but the child was killed. The relevant injuries were a fracture of the cervical spine with transection of the spinal cord, and skull fractures with severe contusion of the brain.

Accident 256 was one of the most severe in this sample, in terms of both the severity and the number of separate injuries. The pedestrian was reported, by an independent witness, to have been walking at an angle across the road, with her back partially towards the striking car. The impact with the front edge of the bonnet (and the right front mudguard) resulted in considerable damage to the

car, a Toyota Corona (Figure 14). The pedestrian, an elderly woman, was killed, and it seems likely that at least one of the fatal injuries, a ruptured aorta, was a consequence of this impact by the front edge of the bonnet. Her pelvis was fractured, as was her thoracic spine, and her liver was ruptured. Compound fractures of both forearms were probably also due to a direct impact by the front of the bonnet.

In marked contrast to Accident 256, the pedestrian in Accident 144 sustained only bruises to both thighs from an impact which produced almost as much damage to the car (Figures 15 and 16). The pedestrian in this accident was a middle-aged male who was 178 cm tall, whereas the height of the elderly female pedestrian in Accident 256 was 157 cm. This meant that the older pedestrian, in addition to being more susceptible to injury, received the direct force of the impact on her lower torso, or pelvis, rather than on the thigh, and so her body was mostly translated forwards rather than rotated about the leading edge of the bonnet in the initial stages of the collision. This rapid acceleration of her body to the speed of the striking car in a distance of only a few centimetres would, most probably, account for the multiplicity of internal injuries. The male pedestrian, however, did not receive a severe blow to either his head or torso, as is described later in this section.

#### FRONT EDGE OF THE FRONT MUDGUARD

The term 'mudguard' is somewhat of an anachronism, and the front edge is often, in profile, a continuation of the leading edge of the bonnet. The substructure, however, is often more substantial than it is under the front of the bonnet.

Four pedestrians were severely injured by the front edge of the mudguard. Between them they sustained seven severe injuries, all of which were attributed to this impact.

An eight year old boy received a ruptured liver and a ruptured kidney when hit on the right side by a Chrysler Valiant (Accident 208, Figures 17 and 18).

A 78 year old male pedestrian's pelvis was fractured, followed by abdominal bleeding, when he was hit by a Mazda (Figure 19).

A pedestrian who was standing in the centre of the road (Accident 191), sustained a fractured right femur and a fractured pelvis when he was hit by the right front corner of a Holden sedan. Figure 20 shows the relatively minor damage to the car, which indicates the undesirable rigidity of this part of the vehicle rather than the force of the impact.

The fourth pedestrian in this group, a 30 year old female, had her right femur fractured by an impact from the left front



FIGURE 23:  
Fracture of the right femur  
of the pedestrian struck by  
the car shown in Figures 21  
and 22.

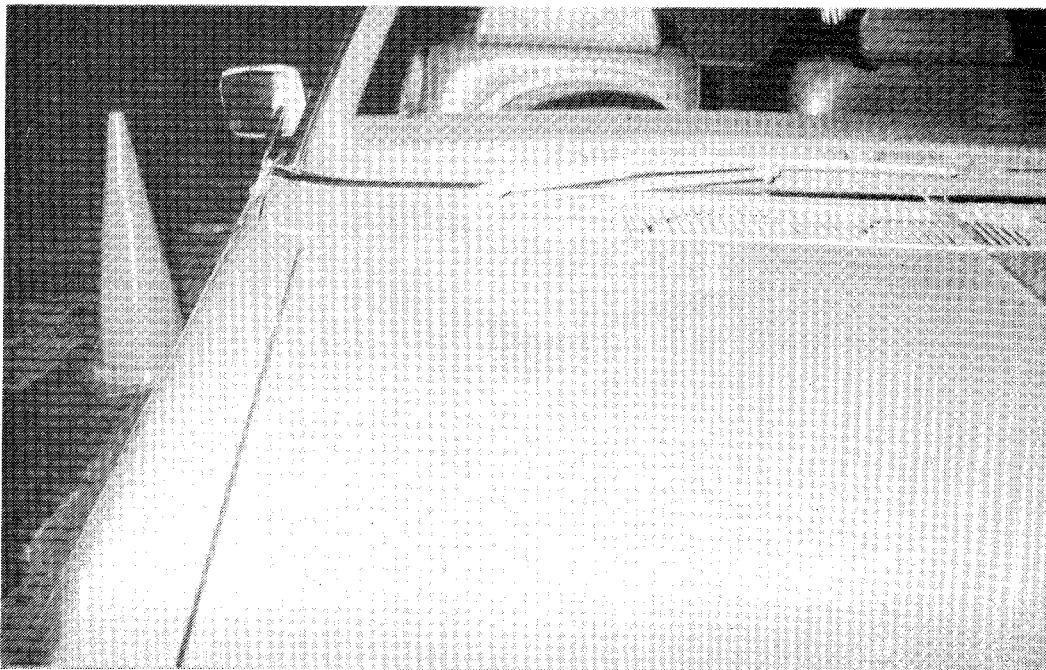


FIGURE 24: Damage to bonnet of car due to impact by  
pedestrian's head. Accident 135.



FIGURE 25: Head contact area at the rear of the top of the bonnet of a Toyota Corona. Accident 256. See also Figures 27 and 28.

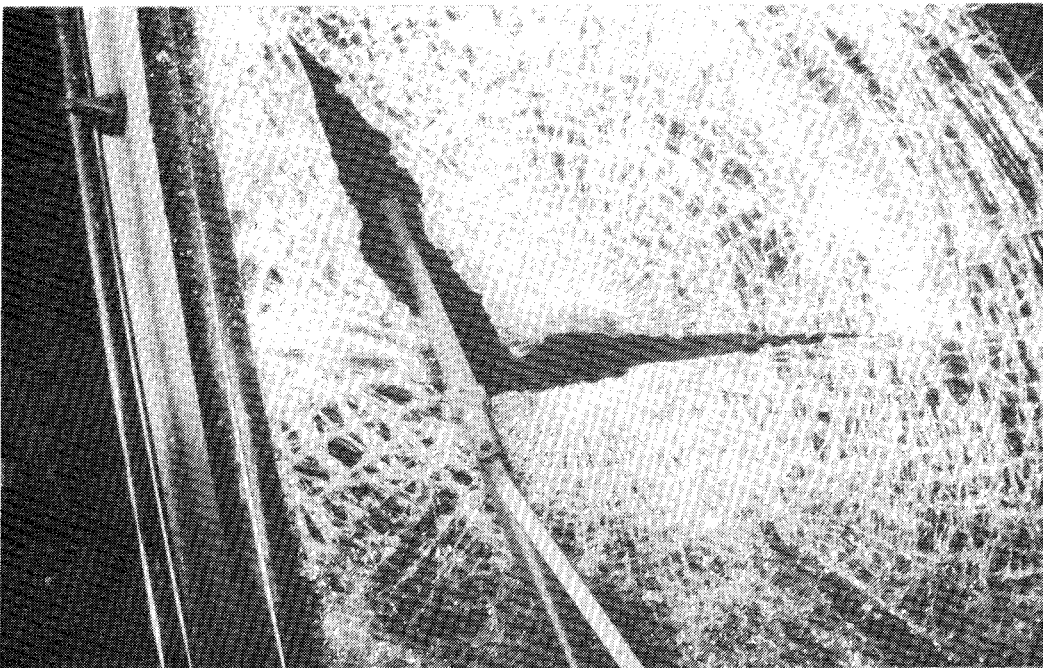


FIGURE 26: Damage to windscreen of car due to impact by pedestrian's head. Accident 144. See also Figures 11 and 16.

corner of a Ford Fairlane sedan (Accident 190, Figures 21 to 23). Her right arm was also broken, near the shoulder, and she was hospitalized for 10 weeks.

#### UPPER SURFACE OF THE BONNET

Thirteen pedestrians were injured by being thrown back onto the top of the bonnet of the striking car, three of them severely.

A 61 year old male pedestrian sustained a fractured skull and concussion when he was hit by a Holden car. A dent in the top of the bonnet (Figure 24, Accident 135) was almost certainly due to his head hitting it, but in this instance there may also have been a significant subsequent impact of his head on the road surface.

In Accident 256, there was little reason to doubt that the head impact with the top of the bonnet was the major, if not the sole cause of fatal head and neck injuries. The damage to the bonnet did not appear to be great, but this was largely due to the force of the impact being taken by an underlying structure (Figure 25).

As can be seen in Table 17, one eighth of all of the injuries to these pedestrians, and one tenth of the severe injuries were caused by the pedestrian hitting the upper surface of the bonnet of the striking car. (These proportions are, of course, even greater when only those accidents in which a car was the striking vehicle are considered.) This means that, as an elementary first step in injury control, no mascots or other protruberances on the bonnet should be permitted as original equipment, nor should any subsequent modifications be allowed which might, in a similar fashion, increase the severity of a pedestrian's injuries.

Windscreen wiper pivots can be hazardous in this context. On some cars the rear edge of the bonnet is elevated and extends back to cover these pivots and the wiper arms. While this presumably is done for cosmetic reasons, the potential exists in such an arrangement to reduce the risk of inflicting severe head injuries on a pedestrian who is struck by the car.

The head injuries received by the two pedestrians in Accidents 135 and 256 were more severe than those for the pedestrian in Accident 144, who was thrown back on impact and hit his head on the laminated glass windscreen (Figure 26). This pedestrian was concussed, although this may have been due to the subsequent impact with the road surface, and received multiple minor facial lacerations.

Accidents 144 and 256 both illustrate the full motions that a pedestrian can be subjected to when hit by a car at a speed of around 50 to 60 km/h.

### 5.3 KINEMATICS OF THE CAR-PEDESTRIAN COLLISION

The first accurate description of the kinematics of the car-pedestrian collision was reported by Ryan and McLean (1965), on the basis of observations made during the first Adelaide in-depth study. The findings of the present study are consistent with those of the earlier investigation: the adult pedestrian is 'run under' by a car, and rarely 'run over'. Initial contact is made by the bumper bar, usually with the lower leg. This is followed almost immediately by the forward edge of the bonnet striking the pelvis. The pedestrian then rotates about this point until his head and shoulders strike the top of the bonnet or the windscreen. If the car is travelling at a sufficiently high speed (possibly little more than 50 km/h) the pedestrian continues to rotate, pivoting about his head and shoulders, and is thrown over the roof of the car. Before he falls to the road he may hit the boot lid or some other part of the rear of the car.

The full sequence of events occurred in the two accidents noted above (Accidents 144 and 256). Figure 16 shows the first three contact points on the car in Accident 144: the bumper, the leading edge of the bonnet and the windscreen, which correspond with knee, thigh and head impacts. A small dent in the trim around the rear window, and in the boot lid, showed that the pedestrian was thrown right over the car. In Accident 256 these three contact points were the bumper bar, the front corner of the bonnet, and the top of the bonnet (Figures 27 and 28). This pedestrian also was thrown over the roof of the car, and contacted the boot lid before falling to the road behind the car.

### 5.4 CONSEQUENCES OF INJURIES TO PEDESTRIANS

#### LENGTH OF HOSPITAL STAY

Forty-six per cent of the 29 pedestrians who were admitted to hospital were there for more than one week. Twenty-seven per cent were there for more than three weeks and three pedestrians (12 per cent of those admitted) were still in hospital three months after their accident.

#### PERIOD OF RESTRICTION OF NORMAL ACTIVITIES

The effect that involvement in the accident had on the pedestrian's ability to resume his or her normal activities soon afterwards is summarised in Table 18.





FIGURE 27: See caption to Figure 28, and Figure 14.

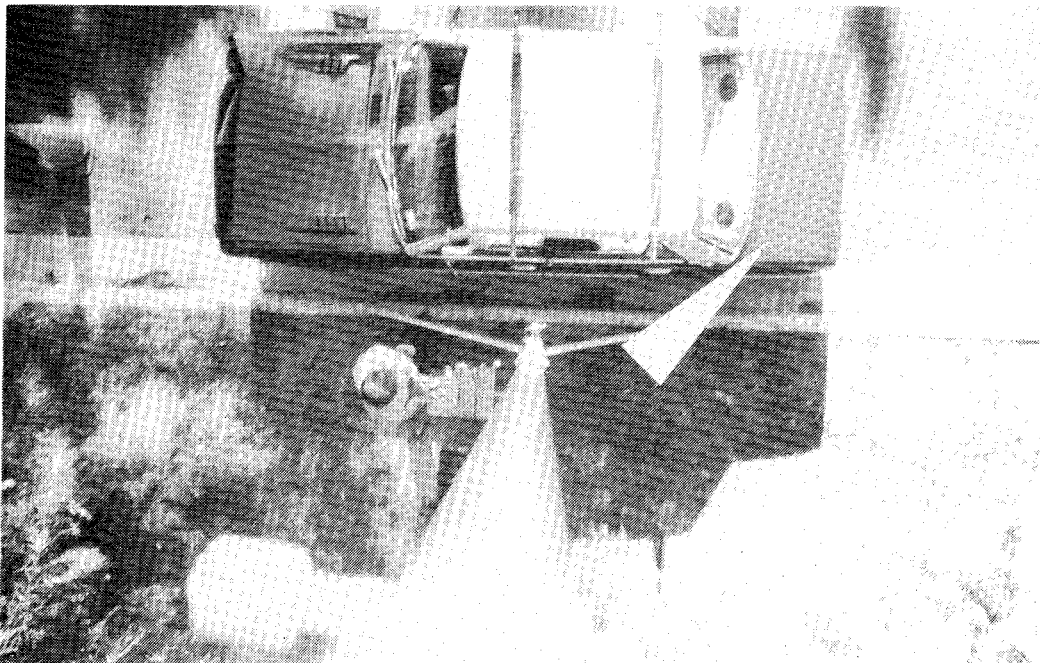


FIGURE 28: Accident 256. Pedestrian contact points are visible at the right front corner of the car, the right rear corner of the bonnet and, arrowed, as a scratch mark across the left side of the boot lid.

TABLE 18: PERIOD OF RESTRICTION OF NORMAL ACTIVITIES

<u>Period of Restriction</u>	<u>Number of Pedestrians</u>	<u>Per Cent of Known Cases</u>
Not Restricted	6	16
Restricted: Up to one week	9	24
: Over one week and up to three months	8	21
: More than three months	12	31
Fatally Injured	3	8
Not known if restricted	6	-
<hr/> Total	<hr/> 44	<hr/> 100

EXTENT OF RESIDUAL DISABILITY

Information on the presence and extent of any residual disability was obtained for 37 of the 41 pedestrians who survived the accident. Twenty-three of these 37 pedestrians made a complete recovery from the

injuries sustained in the accident. Eleven persons were seriously, and permanently, disabled. One pedestrian, a seventeen-month old infant, was totally incapacitated and will remain so for the rest of her life.

## 6. ROAD AND TRAFFIC FACTORS

Certain characteristics of the road layout and traffic control system have been noted earlier in this report in relation to specific accidents. In this section some additional information is presented and the role of certain road and traffic factors is examined in greater detail, concentrating on the 35 pedestrian accidents which occurred at uncontrolled midblock locations.

There were four of these 35 midblock accidents in which road and traffic factors were of no direct relevance: Accidents 117 and 280, in which the pedestrian deliberately ran into the path of the vehicle; Accident 300, which was the result of a motorcyclist playing 'chicken' with a friend on a minor street in a residential area, and Accident 262, which involved a vehicle reversing into a parking place. This section is therefore based primarily on a review of the road and traffic factors in the remaining 31 midblock pedestrian accidents at uncontrolled locations.

### 6.1 TRAFFIC FLOWS, ROAD LAYOUT AND PEDESTRIAN MOVEMENT

Most of these 31 accidents happened on busy roads. The lowest average daily traffic flow (AADT) was 8,100 vehicles, and the highest was over 40,000 (two-way flows). At 27 of the 31 locations the AADT was greater than 15,000 vehicles per day. Two accidents took place during peak hour traffic, one in the morning and the other in the evening.

Because of these relatively high traffic flows it might be thought that many midblock pedestrian accidents were a reflection of the difficulty that pedestrians experience in trying to cross busy roads. In fact this was an obvious factor in only one third of these 31 accidents. This topic is considered further in the discussion of pedestrian crossings which follows later in this section.

As the traffic flow figures indicate, almost all of these pedestrian accidents happened on arterial or sub-arterial roads. There were 15 accidents on divided roads, which had a raised median strip or median reserve, and 16 on undivided roads. The number of marked lanes and the direction from which the pedestrian was crossing are shown in Table 19 together with the number of accidents in which the pedestrian had crossed at least one clear lane before being hit.

### CLEARWAYS ON TWO-LANE CARRIAGEWAYS

The road layout (other than the absence of a median refuge) played an important role in three of the four accidents in which the pedestrian was hit while standing in the middle of the road. In two of these three accidents the striking vehicle was closer to the centre of the road than it would normally have been because a car alongside it in the kerb lane had moved across to its right to pass a parked car. In Accident 026 the kerb lane was four metres wide, with a centre lane of three metres. In Accident 106 these dimensions were five metres and three metres. The layout of both roads was symmetrical about the centreline. The driver in Accident 026 did not see the pedestrians at all before the impact (the accident happened at night, under reasonably good street lighting but with considerable glare from the headlights of vehicles travelling in the opposite direction). In Accident 106, a daytime accident, the vehicle in the centre lane was a truck driven by a person who was not familiar with it and who was having difficulty in judging how much clearance he would have between the pedestrian standing in the centre of the road on his right and the car travelling alongside him on his left. When the car veered to the right to pass a parked car the truck driver also moved his vehicle to the right, closer to the centreline, whereupon the external rear vision mirror hit the pedestrian on the head.

The four-lane roads on which these two accidents happened were designated as Clearways at specified times of the day (which did not include the times at which these accidents happened). During a Clearway period parking or remaining stationary at the kerb is prohibited. These roads were originally two-lane, one in each direction of travel, but when they were designated as Clearways lane markings were added to encourage the formation of two lanes of traffic in the appropriate direction during Clearway hours and to permit, legally, overtaking on the left. Under Clearway conditions the kerb lane is of ample width. Outside Clearway hours, however, the lane marking still encourages the formation of two lanes of traffic on a carriageway which is no longer of adequate width because of the restrictions imposed by parked vehicles.

A study of Clearway operation by the Road Traffic Board of South Australia (referred to by Cameron *et al.*, 1974) reported that at non-Clearway times the lane marking had the effect of causing nearly 40 per cent of the vehicles using

TABLE 19: ROAD LAYOUT AND PEDESTRIAN MOVEMENT

Type of Road	Number of Lanes <sup>1</sup>	Pedestrian Movement			Total No. of Accidents
		Crossed from driver's left	Standing in Centre	Crossed from driver's right	
Divided road	none marked	-	-	1	1
	2	6 (1) <sup>2</sup>	-	1 (1)	7
	3	2 (1)	-	3 (2)	5
	4	2 (1)	-	-	2
Undivided road	none marked	1	-	-	1
	2	4	-	1 (1)	5
	4	4 (3)	4 (4)	1	9
	7	-	-	1 (1)	1
Total		19 (6)	4 (4)	8 (5)	31

Notes: <sup>1</sup> Number of lanes in direction of travel for divided roads, both directions on other roads.

<sup>2</sup> Number of cases in which pedestrian crossed at least one clear lane before being hit is shown in parentheses.

the kerbside lane to 'squeeze' between the lane line and the stationary vehicles parked at the kerb, and that a substantial number of vehicles straddled the lane line. Under these conditions vehicles were observed to be travelling about 600mm nearer to parked vehicles than before the introduction of the lane markings and there was an increase in 'side swipe' accidents.

Cameron *et al.* recommended that the desirability of introducing Clearways on two-lane carriageways should be re-examined. Their recommendations can be supported by reference to the two accidents (Accidents 026 and 106) described above, but it is by no means clear what the result of such a re-examination would be. It is highly likely that the introduction of a 24-hour Clearway, together with the installation of a raised median strip to provide a pedestrian refuge, would prove to be safer than the existing arrangement. An obvious objection to this proposal is that the total prohibition of parking would be detrimental to the profitability of businesses which front on to the Clearway, but this effect may be compensated for, to some degree, by the greater ease with which pedestrians could cross the road after the median strip is installed. Kerbside parking on arterial roads may be profitable in the strictly commercial sense, but it can be argued that these profits should be balanced against the losses sustained in accidents in which these parked vehicles play a role.

A less intrusive change would be simply to alter the location of the lane marking on these roads. As noted above, the centre lane at the sites of Accidents 026 and 106 was three metres wide, and the kerb lanes were four and five metres wide. If the two lanes were made equal in width, or the kerb lane made narrower than the centre lane, then a driver travelling in the kerb lane might be deterred from trying to 'squeeze' between a vehicle travelling alongside him on his right and any stationary vehicles parked at the kerb because it would be more obvious to him that he would have to move out of his lane to do so.

#### PAVEMENT MARKINGS ILLEGIBLE WHEN WET

Accident 144 was the third accident in which the pedestrian was standing in the centre of the road and in which road and traffic factors played a causal role. It has been described briefly earlier in this report. The road layout, pavement markings, and the street lighting were all important factors under the prevailing weather conditions. Because it was raining and the road surface was wet the pavement markings were very hard to see. This meant that a driver could continue straight ahead in the centre lane on the approach to the intersection without realizing that the centre lane had become an exclusive right turn lane. The pavement markings on the far side of the intersection were similarly obscured by water on the road and so the driver was

not alerted to the fact that he was departing from the intersection on the wrong side of the centre line. This accident emphasises the need to improve the wet-road conspicuity of pavement markings, and also highlights the undesirability of having a road layout in which it is possible for a driver to exit from an intersection on the wrong side of the road without having moved out of his approach-lane alignment.

#### REDUCTION IN THE QUALITY OF STREET LIGHTING

As the driver in Accident 144 left the intersection (see the preceding paragraph) the quality of the street lighting changed from a uniformly high intensity of illumination provided by sodium vapour lamps at the intersection to alternating light and dark patches resulting from widely-spaced mercury vapour lamps on the exit road. Fisher and Hall (1973) have emphasised that the cessation of fixed lighting should not be associated with a sudden lowering of road design standards. Although, in this instance, the reduction in the quality of the fixed lighting occurred before the driver reached the point where the carriageway became narrower, he was in the centre of a 16 metre wide road which had an offset centre line and he could not see the pavement markings or, more importantly, the pedestrian. It therefore seems reasonable to assume that his task would have been made easier had the better standard of illumination been continued along this road for some 200 metres either side of the intersection.

#### 6.2 MEDIAN REFUGES AND PEDESTRIAN CROSSINGS

The four accidents in this survey in which a pedestrian was hit when standing in the centre of the road occurred at locations where the carriageway widths ranged from 13 to 15 metres. While it is obvious that most accidents of this type could be prevented by the provision of a median refuge, such as a raised median strip, this may not be able to be done at these locations without banning parking or, possibly, by reducing the width of the kerb lane, as noted previously in the discussion of Clearway operation.

The absence of a median strip does not appear to have contributed to the causation of the twelve remaining mid-block pedestrian accidents which occurred on undivided roads in this survey (Table 19).

#### PEDESTRIAN CROSSINGS

The location of each of the 40 pedestrian accidents which were included in this survey is listed in Table 20 in relation to the availability of a pedestrian crossing and whether or not the pedestrian was thought likely to have used a crossing had one been available.

As noted earlier in this section, there were four accidents which would not have been affected by the provision of traffic controls. One other case has been added to this latter group in the data in Table 20 (Accident 299, in which a child ran onto the road to retrieve a rubber band). These five cases comprise the entry in the last row of this Table.

It is assumed here that in general there is little point in speculating on the likely effect of the provision of a controlled crossing when the accident occurred within 200 metres of an existing crossing, although two accidents occurred at sites at which this assumption may not be valid (Accidents 145 and 166).

There were six accidents which occurred more than 200 metres from a controlled crossing and which probably would still have taken place had there been such a crossing in the immediate vicinity. These six accidents all involved children who ran onto the road without first looking to see if it was safe to do so.

The remaining five accidents are those which may have been prevented if the pedestrian had had the option of using a controlled crossing. At one of these five locations (Accident 191) there was in fact a school crossing within 50 metres, but the accident happened at a time when the crossing lights were not operating. As mentioned in Section 2.2, current policy in this State is to replace school crossings with pedestrian-actuated signals. This change has the beneficial result of extending the availability of the crossing to all pedestrians throughout the day.

Two of the other four locations (Accidents 106 and 153) are adjacent to intersections which since have been, or are about to be, signalised. The traffic conditions at the site of Accident 213 may not satisfy the requirements of the traffic engineering warrants for the installation of a pedestrian crossing. (These warrants specify minimum values for both the pedestrian and vehicular traffic flows, among other requirements: see AS 1742-1975.) The last accident in this group of five, Accident 247, resulted in part from the difficulty that the pedestrians were experiencing in trying to cross through very heavy traffic, and so the vehicular traffic flow requirements of the warrants would certainly be met. We have not been able to obtain recorded information on the numbers of pedestrians who attempt to cross the road at this location.

In summary, five of the 35 pedestrian accidents at uncontrolled midblock locations may have been prevented had a pedestrian crossing been available. At three of these locations some form of controlled crossing has since been installed or is planned; at another the traffic conditions do not satisfy the traffic engineering warrant for the provision of a crossing (although that may not be sufficient reason not to install a crossing), and there is one other location where the

warrants may be satisfied. The remaining accidents either occurred close to a controlled crossing, or the pedestrian involved in the accident was thought to have been unlikely to have used a pedestrian crossing had one been available.

### 6.3 TRAFFIC SPEEDS, ROAD WIDTHS AND PEDESTRIAN SAFETY

It is obvious that a pedestrian will find it more difficult to cross a wide road carrying fast traffic than a narrow road carrying slow traffic, other things being equal. But it is not clear what criteria should be used in deciding what is an acceptable level of risk in terms of these two parameters.

One approach to this problem is to estimate how difficult it is for a pedestrian to decide whether or not it is safe to try to cross the road. If this task is very difficult then the pedestrian is likely to try to cross when it is not safe to do so. Alternatively he may adopt the common, but hazardous, procedure of crossing to the centreline and waiting there for a gap in the traffic on the far side of the road. In either case the pedestrian must rely entirely on being seen by the car driver in time for the latter to avoid a collision. Several of the accidents reviewed earlier in this report show quite clearly that it is dangerous for the pedestrian to assume that the driver will see him and take effective avoiding action.

There are doubtless many factors involved in the task of detecting the presence of an oncoming vehicle and then deciding whether to cross the road at once or wait until the vehicle has passed by. It is not the purpose of this discussion to speculate on what all of these factors might be, but it seems to be reasonable to assume that the difficulty of the pedestrian's task will increase with the distance that the vehicle is from him. This distance is determined by four things: the speed of the vehicle, the width of the road, the rate at which the pedestrian can cross the road, and the time taken by the pedestrian to decide to cross after he has seen the vehicle approaching.

In the course of this survey traffic speeds were measured at most of the accident sites where it was practicable to do so and where information on customary travelling speeds was thought to have been relevant to that particular accident. These speeds were measured, using a radar meter, at the time of day at which the accident happened and on the same day of the week. The width of the road was measured routinely at each site. The rate at which pedestrians cross the road was measured by timing pedestrians who were crossing at a signalised intersection. The platoon of pedestrians which moved off

TABLE 20: THE AVAILABILITY AND RELEVANCE OF PEDESTRIAN CROSSINGS

	<u>No. of Accidents</u>
Accident was at a controlled crossing	5
Accident was within 200 metres of a controlled crossing	19
Accident was more than 200 metre from a controlled crossing, and the availability of a crossing was:	
Relevant	5
Unlikely to have been relevant	6
Not relevant	<u>5</u> 16
<hr/>	
Total accidents	40

TABLE 21: TRAFFIC SPEEDS AND DECISION DISTANCES

Accident Number	Traffic Speeds		Width of Road (m)	Decision Distance
	85th Percentile Speed (km/h)	No. of Vehicles#		
106	60	534	15	242
125	61	603	19	307
135	61	280	15*	245
140	55	648	13*	195
153	63	366	15	254
158	66	320	12.5*	223
178	35	213	13.5*	128
185	60	1043	8.5*	144
191	66	235	13.5	241
198	52	399	15	212
208	64	142	14	242
209	43	87	21	242
244	61	281	13	215
247	64	668	10.5*	169
256	64	213	19	322
299	69	181	9*	174

Notes: \* Distance between kerb and raised median.

# Number of vehicles for which a radar speed measurement was obtained.

when the WALK signal appeared crossed consistently at 5 km/h, but some elderly pedestrians were slower, crossing at only 4 km/h. The slower speed has been used in the following calculations. One second has been allowed for a pedestrian to detect the presence of a vehicle and then decide to cross (it is likely that this is too short a period for many pedestrians).

Using the above information, the minimum safe distance that the vehicle can be from the crossing point when the pedestrian must decide whether or not to cross has been calculated for sixteen accident sites. The results are listed in Table 21 where this distance is labelled 'decision distance', together with the 85 percentile speed of the traffic, the number of vehicles on which this percentile speed is based, and the width of the road. It is assumed that the vehicle is approaching from the pedestrian's left if the road is two-way with no raised median.

It is well-known that the pedestrian's task is easier when a raised median refuge is available. This is shown in Table 21 in which the decision distance is less on such roads than it is for comparable undivided roads. The greatest decision distance in this Table is 322 metres. A pedestrian having 6:12 (Snellen) vision would have great difficulty in detecting the presence of an oncoming car at that distance, let alone trying to decide whether or not it is moving or stationary. Consequently this pedestrian would have to rely on the alertness of the drivers when attempting to cross a road of that width with traffic travelling at the speed listed. Unfortunately this difficulty of not being able to see the oncoming car clearly enough in time to then still be able to cross the road, is most likely

to affect elderly pedestrians. Cole (1972) presented data showing that, in the United States, about 30 per cent of the population over the age of 75 have a static visual acuity which is poorer than 6:12. This particular example of a visual acuity of 6:12 may not be typical, but it does appear likely that some arterial roads in Adelaide represent an unreasonable hazard for many pedestrians.

The two factors in this situation which are amenable to change are the width of the road and the speed of the traffic. The former can, in many situations, be reduced very effectively by the provision of a raised median strip. The speed of the traffic may be affected by a reduction in the urban area speed limit to, say, 50 km/h. It can be argued that such a change has no chance of success, and that drivers, in effect, define the acceptable speed limit by their 'normal' driving behaviour. This argument is not supported by American experience where, in some States, the speed limit in business districts is 40 km/h. Many of these business districts include roads which are similar to arterial roads in the Adelaide metropolitan area, and yet the degree of compliance with this speed limit appears to be high. The level of enforcement may be lower in the Australian setting but that too is amenable to change.

A reduction to 50 km/h, if generally observed, may result in a reduction of perhaps ten per cent in the frequency of pedestrian accidents on arterial roads, and also a reduction in the severity of injuries which are inflicted in those accidents which do occur. This estimate of the likely reduction in accident frequency is based on an overall assessment of the accidents in this sample and is intended to be only an approximate guide to the likely effects of such a change.



## 7. CONCLUSIONS

Many of these pedestrians were involved in an accident because they were careless or made a mistake. Almost all of the child pedestrians ran onto the road, the elderly very often did not see the vehicle approaching, and other pedestrians chose to stand in the centre of the road, or ran through banked up traffic. About one-eighth of the pedestrians were intoxicated at the time of their accident and they had a history of regular and heavy alcohol consumption. Drugs other than alcohol were not an obvious causal factor.

In more than half of these accidents there was an obvious error committed by the driver or rider whose vehicle hit the pedestrian. No driver appeared to have been travelling markedly faster than other traffic at the accident site, although those drivers whose actions did contribute to the causation of the accident were found to be much more likely to have had a prior conviction for speeding. Less than eight per cent of the drivers or riders had been drinking, compared with 57 per cent of those drivers involved in single vehicle accidents which did not involve a collision with a pedestrian.

Vehicle factors were rarely relevant in the causation of these accidents, but vinyl plasticiser deposits on the inside of the windscreen made it harder for one driver to see the pedestrian at night, when viewed against the glare of oncoming headlights, and one other accident may have been avoided had the location of the horn button been standardized on motorcycles.

All but one of these 40 accidents happened on busy roads, and difficulty in crossing the road was a factor in about one third of the 31 relevant midblock accidents.

Some measures designed to increase the rate of flow of vehicular traffic are detrimental to the safety of the pedestrian, to the extent that on some of the arterial roads in the Adelaide metropolitan area some pedestrians, including children and the elderly, may have to rely for their safety on the driver seeing them in time to avoid a collision.

The conversion of a two lane road to a four lane Clearway was a factor in two accidents, and the alignment of the lane

markings at a signalised intersection was a factor in one other. This accident near a signalised intersection was also characterised by the pavement markings being illegible when wet and by a reduction in the quality of the street lighting near a point where the roadway became narrower.

As is well-known, the provision of median refuges or pedestrian-actuated signals makes it much easier for the pedestrian to cross a busy road safely. Based on the accidents investigated in this study, the provision of a median refuge may have prevented four of the 16 accidents which occurred on undivided roads, and pedestrian-actuated signals may have prevented five of 31 midblock accidents.

While it is not possible to demonstrate conclusively that some of these accidents would not have happened had the striking vehicle been travelling 10 km/h slower, it is likely that a reduction in the urban area speed limit from 60 km/h to 50 km/h could result in a reduction of perhaps one-tenth in the overall frequency of occurrence of pedestrian accidents, and in a corresponding reduction in the severity of the injuries sustained in those accidents which still occur.

The injuries sustained by the pedestrians were much more likely to be dangerous to life than were the injuries sustained by other road users. Three of the 44 pedestrians were killed, one was totally incapacitated and two others were left with severe permanent disabilities. Eleven other pedestrians were disabled to a lesser degree. One third of these injuries were caused by being thrown to the road surface. The remaining two-thirds were caused by the striking vehicle. Ninety per cent of the severe or fatal injuries were directly due to an impact with the vehicle. The front of the car, including the upper surface of the bonnet, accounted for more than half of the injuries. Adult pedestrians were run under by the car, not run over, but small children were thrown forwards along the road, or fell to one side of the striking vehicle.

## 8. RECOMMENDATIONS

Child pedestrians often ran onto the road without looking. While educational programmes may be beneficial, there are reasons to believe that the smaller child is particularly at risk of being struck by a vehicle, either as a result of some impulsive act or because he or she is not able to judge accurately when it is safe to cross. Consequently it is recommended that:

*Road safety educational programmes and programmes dealing with the general health and well-being of small children stress the need for young children to be under constant supervision when in the vicinity of a busy road.*

The need for such careful supervision may well be as great in this situation as it is when a small child is near a swimming pool.

Standing in the centre of the road and crossing between banked-up stationary vehicles were shown in some of these accidents to be hazardous activities, and so it is recommended that:

*Road safety educational programmes emphasise that it is dangerous for a pedestrian to stand in the centre of the road or to try to cross through banked-up traffic even, in the latter instance, when waved across by a driver.*

Just as the pedestrian is well-advised not to cross through banked-up traffic even when a driver waves him across, it is similarly recommended that:

*Drivers should be discouraged from waving a pedestrian across in front of their stationary vehicle if it is at all possible that another vehicle could be about to overtake on the far side.*

Most of these pedestrian accidents occurred on busy roads, some of which were difficult for a pedestrian to cross safely. Consequently it is recommended that:

*Median strips be incorporated in existing undivided arterial roads in urban areas wherever practicable.*

Pedestrian-actuated signals obviously make it easier and safer for a pedestrian to cross a busy road, but their installation is limited by application of the traffic engineering warrants which require certain minimum flows for pedestrian and vehicular traffic. Because of the benefits associated with these crossings it is suggested that:

*The likely effects of relaxing the pedestrian and vehicular traffic flow requirements in the warrant for the installation of pedestrian-actuated signals be reviewed.*

The following road and traffic factors also played a role in the causation of one or more of the pedestrian accidents in this study, and so it is recommended that:

*Further consideration be given to the safety implications of the legibility of pavement markings in wet weather, of changes in the quality of the street lighting adjacent to an intersection, and of the introduction of Clearways on two-lane carriageways.*

The speed of the approaching traffic is an important determinant of the difficulty that a pedestrian has in selecting correctly a safe gap in which to cross the road, and it is also directly related to the severity of the impact, and hence to injury severity, in a pedestrian accident. Consequently it is recommended that:

*Consideration be given to the practicability of a reduction in the urban area speed limit from 60 km/h to 50 km/h.*

There were three pedestrian accidents in which some characteristic of the striking vehicle was a significant factor in the causation of the accident. In one accident a motor scooter rider tried to sound the horn to warn a pedestrian of his presence but the horn button was not where he had expected it to be. It is therefore suggested that:

*The Advisory Committee on Safety in Vehicle Design (ACSVD) consider the advisability of requiring that the location of the horn button be standardized on motorcycles.*

Vinyl plasticiser deposits on the inside of the windscreen of a car make it harder for the driver to see a pedestrian at night, particularly when viewed against oncoming headlights, and so it is suggested that:

*The wider use of upholstery and trim materials which do not release amounts of plasticiser sufficient to form visible deposits on the inside of the windscreen be encouraged.*

Any projection from the side of a vehicle is likely to strike a pedestrian. This alone is reason for concern, but

when the presence of the projection is required by law, as in the case of external rear vision mirrors on trucks, it is highly desirable that:

*Consideration be given by ACSVD to the advisability of extending the requirements of ADR 14, Rear Vision Mirrors, to include external mirrors on trucks with the aim of minimising the hazard which these mirrors present to a pedestrian standing in the centre of the road or on a median refuge.*

The front of the striking car causes most of the injuries inflicted on the pedestrian. Consequently it is recommended that:

*The manufacturers of passenger cars, and government regulatory agencies and committees, such as ACSVD, in recognition of the fact that the leading edge of the bonnet and of the front corners of*

*the car can and do hit small children on the head, take whatever action that may be practicable to ensure that the design and construction of the car is such as to minimize the severity of the injuries resulting from such impacts.*

The adult pedestrian's head is not hit directly by the forward-most part of the striking car, but rather by the rear part of the bonnet or by the area at the base of the windscreen and so, as in the preceding paragraph, it is recommended that:










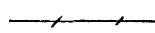

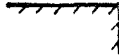












*The car makers and regulatory bodies such as ACSVD, recognizing that the rear section of the bonnet and the area at the base of the windscreen are likely to be struck by a pedestrian's, or pedal cyclist's head, take whatever action may be practicable to ensure that the vehicle characteristics are such that the severity of the injuries resulting from these impacts will be minimized.*

## REFERENCES

- Australian Standards Association (1975).  
*Australian Standard Manual of Traffic Control Devices; Part 2 - Application of Traffic Control Devices to Traffic Situations.* (Standards Association of Australia, North Sydney, AS-1742.)
- Cameron, C., Crinion, J.D. and Summers, J.A. (1974).  
*An Evaluation of Clearway Operation.*  
Aust. Rd. Res. Proc. 7(4), pp. 205-217.
- Cole, B.L. (1972).  
*Visual Aspects of Road Engineering.*  
Aust. Rd. Res., Proc. 6(1), pp. 102-148.
- Fisher, A.J. and Hall, R.R. (1973).  
*The Effects on Vision of Terminations and Isolated Lengths of Fixed Lighting.*  
Aust. Rd. Res. 5(4), pp. 34-39.
- Krieger, K.W., Padgaonkar, A.J. and King, A.J. (1976).  
*Full-Scale Experimental Simulation of Pedestrian-Vehicle Impacts.*  
Proc. Twentieth Stapp Car Crash Conf. (Pub. by Soc. Automotive Engrs., Warrendale, Pa.)
- McLean, A.J. (1971).  
*The Man in the Street - Pedestrian Accidents in the Empire State.*  
Proc. Fifteenth Conf., American Association for Automotive Medicine. (Pub. by Soc. Automotive Engrs., New York.)
- Robertson, J.S., McLean, A.J. and Ryan, G.A. (1966).  
*Traffic Accidents in Adelaide, South Australia.*  
Australian Road Research Board. Special Report, SR1.
- Ryan, G.A. and McLean, A.J. (1965).  
*Pedestrian Survival.*  
Proc. Ninth Stapp Car Crash Conference. University of Minnesota, Minneapolis.
- Sandels, S. (1968).  
*Children in Traffic.*  
Paul Elek, London.  
(Revised edition, 1975).
- Welford, A.T. (1958).  
*Ageing and Human Skill.*  
Oxford University Press for the Nuffield Foundation.

APPENDIX

LEGEND

	Semi-trailer		Separation line
	Bus		Kerb/Stop line
	Car		Unkerbed pavement edge
	Small car		Lane markings
	Motor cycle/ Pedal cycle		Boundary/Fence
	Motor cycle on side		Building
	Pedal cycle on side		Traffic signals
	Subscripts denote accident sequence		Type of street lamp: fluorescent
	Person		mercury vapour
	Unit number with subscript indicating time sequence		sodium vapour
			incandescent
			Utility pole
	Uninvolved vehicle		Tree