INFLUENCE OF PHYSICAL ROAD CHARACTERISTICS ON ROAD CRASHES

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Influence of Physical Road Characteristics on Road Crashes

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Abstract

The objectives of this project were to find correlations between the 'tidal flow' of traffic and the frequency of road crashes, as well as between various broad scale road environment factors and the frequency of road crashes. This was achieved through an in depth examination of crash data for the Southern District, as well as the combined data of the areas covered by the Toowoomba City Council and the Gatton Shire Council. When examining the data for correlations, the traffic flow and crash rate along with various road environment characteristics were considered.

It was found that a greater traffic flow did not mean a greater crash rate would result with the time periods with lower traffic flow having higher crash rates. However, correlations were established between various road environment factors and the frequency of road crashes. Road environment characteristics that were found to influence the amount of road crashes included the seal width, pavement width, formation width, the speed limit zones and the AADT of the road. These correlations can now be used in the prediction of the likelihood of crash zones of roads.

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Signature

Date

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Introduction

1.1 Aims of Project

This project is a result of Mal McIlwaith from Queensland Transport and his interest in the road environment and its involvement of road crashes. He is also interested in whether or not it plays a larger role than is currently thought in crashes. This project has then, in turn, evolved from this query.

The usual approach to investigating road crashes is to report on the characteristics that are specifically related to the drivers of the vehicles involved in the accident. This project investigates if certain road environments play a larger role in accidents than is currently understood.

The initial aim of this project was to find a correlation between the 'tidal flow' of traffic and the frequency of road crashes. The percentage of heavy vehicles in this 'tidal flow' also had to be considered.

The major aim was to find correlations between various broad scale road environment factors and the frequency of road crashes. These correlations were then used to predict the likely crash zones of roads.

1.2 Dissertation Overview

The second chapter of this dissertation gives a background on the project undertaken and also uses a literature review. This review reveals information gained in previous studies relating to the issues of crash data analyses and the correlation of crash rates with influencing parameters.

The third chapter gives an explanation of Southern District and the features of the district such as the size, towns and local government areas included within the boundaries. It also incorporates the road types that are examined with specific examples of these roads.

The fourth chapter describes the three types of data that were required to be analysed in this project. These three data sets were the crash data, road data and the Southern District traffic census. The methodology used to complete the project is also outlined, explaining how each stage was completed.

The fifth chapter reports on the analysis of the factors relating to the 'tidal flow' of traffic and the crash rate. The crash rate, crashes per one million vehicles, for time periods of four hours on certain roads in each area was found. Then it was compared to the other roads and the tidal flow of traffic during these periods

The sixth chapter reports on the analysis of the factors relating to the road environment and the frequency of road crashes. The factors that were analysed as part of the road environment included the seal width, pavement width, formation width, speed limit zones and the AADT vs. Width.

Chapter seven discusses the results gained from the previous two chapters. Each section compares the results of the analyses for each study area. They then go on to report on any correlations that were found concerning the factor that is discussed in each section.

Chapter eight includes conclusions and recommendations from the analysis of the data as well as any further work that could be continued on with as a continuation of this project.

Chapter 2

Background Studies

2.1 Introduction

This chapter gives a background on the project undertaken and how it started. It then goes on to a use a literature review. This review reveals information gained in previous studies relating to the issues of crash data analyses and the correlation of crash rates with influencing parameters. It also looks at the similarities and differences between past studies and how they relate to the aims of the present study.

2.2 Background

The usual approach to investigating road crashes is to report on the characteristics that are specifically related to the drivers of the vehicles involved in the accident. This project investigates if certain road environments play a larger role in accidents than is currently understood.

This project is a result of Mal McIlwaith from Queensland Transport and his interest in the road environment and its involvement of road crashes. He is also interested in whether or not it plays a larger role than is currently thought in crashes. This project has then, in turn, evolved from this query.

2.3 Literature

Before any work could commence on this project, there was a need for a review of literature. This literature is in two specific areas: the analysis of crash data and the correlation of crash rates with influencing parameters. These two issues are comprehensively examined below through the use of a literature review.

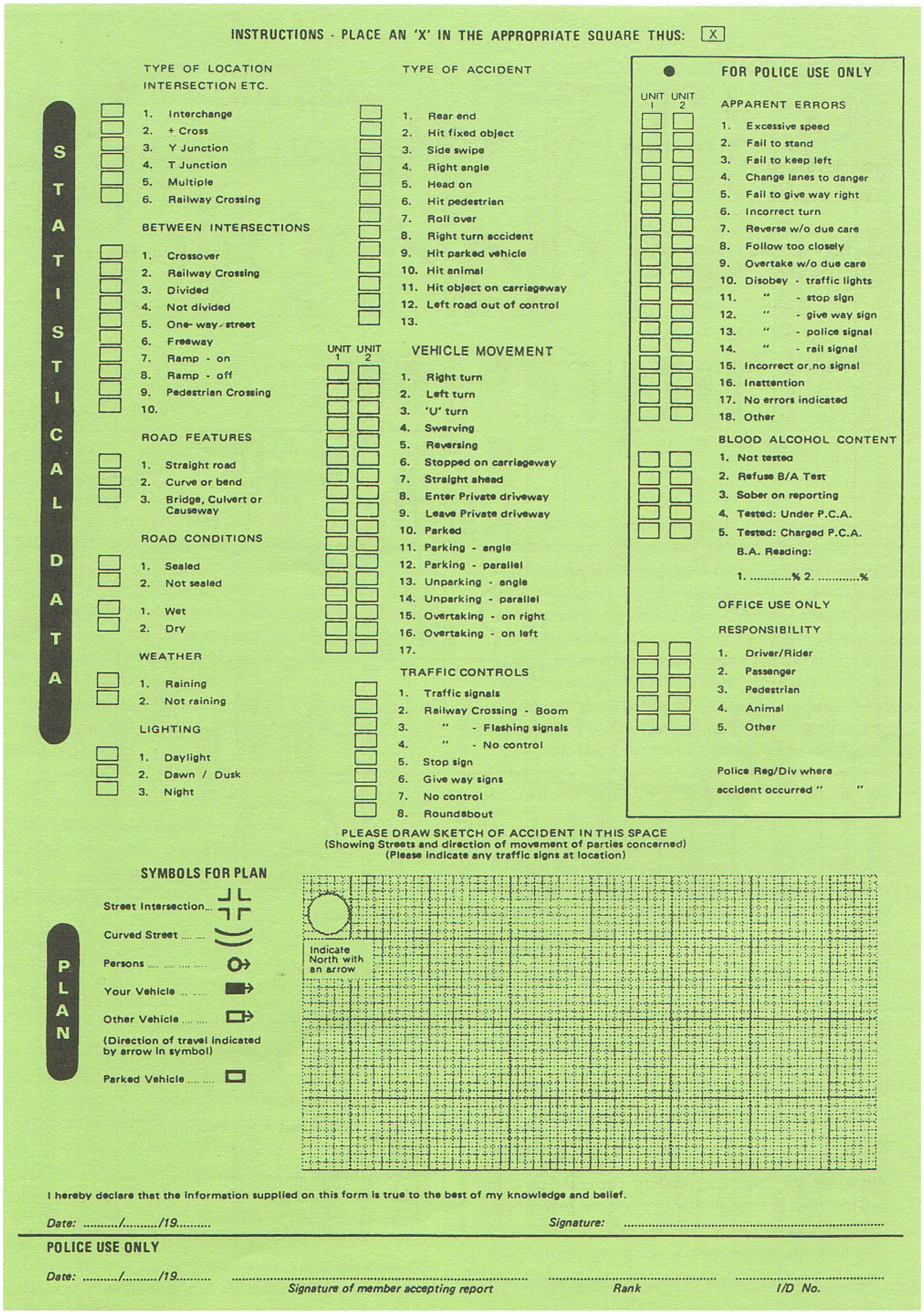
2.3.1 Crash Data

Crash data describing accidents occurring on Australian roads, has been collected since 1911 (NAASRA, 1988). The Bureau of Transport and Communications Economics (1995) report that in Queensland, the Australian Bureau of Statistics recorded this crash data until early 1989 when this responsibility was transferred to the Statistics department of Queensland Transport.

In Austroads (2004) it is noted that if the data recorded is to be considered good, and therefore useful to users of this data, it must be able to achieve various factors. These factors are as follows:

- crash sites can be located accurately,
- the succession of events occurring throughout the accident sequence are able to be determined,
- contributing factors to the crash can be established; and
- common factors relating a number of crashes can be ascertained.

These are considered important so that when the data is analysed for various reasons, it is as complete as possible to be able to determine, for example, if a certain section of road is a problem area or "a black spot". NAASRA (1988) has a recommended road crash report form, which can be seen in Figure 2.1, as used by South Australia.



INSTRUCTIONS - PLACE AN 'X' IN THE APPROPRIATE SQUARE THUS: X

STATISTICAL DATA

TYPE OF LOCATION
INTERSECTION ETC.

1. Interchange
2. + Cross
3. Y Junction
4. T Junction
5. Multiple
6. Railway Crossing

BETWEEN INTERSECTIONS

1. Crossover
2. Railway Crossing
3. Divided
4. Not divided
5. One-way street
6. Freeway
7. Ramp - on
8. Ramp - off
9. Pedestrian Crossing
10.

ROAD FEATURES

1. Straight road
2. Curve or bend
3. Bridge, Culvert or Causeway

ROAD CONDITIONS

1. Sealed
2. Not sealed

1. Wet
2. Dry

WEATHER

1. Raining
2. Not raining

LIGHTING

1. Daylight
2. Dawn / Dusk
3. Night

TYPE OF ACCIDENT

1. Rear end
2. Hit fixed object
3. Side swipe
4. Right angle
5. Head on
6. Hit pedestrian
7. Roll over
8. Right turn accident
9. Hit parked vehicle
10. Hit animal
11. Hit object on carriageway
12. Left road out of control
13.

VEHICLE MOVEMENT (UNIT 1, UNIT 2)

1. Right turn
2. Left turn
3. 'U' turn
4. Swerving
5. Reversing
6. Stopped on carriageway
7. Straight ahead
8. Enter Private driveway
9. Leave Private driveway
10. Parked
11. Parking - angle
12. Parking - parallel
13. Unparking - angle
14. Unparking - parallel
15. Overtaking - on right
16. Overtaking - on left
17.

TRAFFIC CONTROLS

1. Traffic signals
2. Railway Crossing - Boom
3. " - Flashing signals
4. " - No control
5. Stop sign
6. Give way signs
7. No control
8. Roundabout

FOR POLICE USE ONLY

APPARENT ERRORS (UNIT 1, UNIT 2)

1. Excessive speed
2. Fail to stand
3. Fail to keep left
4. Change lanes to danger
5. Fail to give way right
6. Incorrect turn
7. Reverse w/o due care
8. Follow too closely
9. Overtake w/o due care
10. Disobey - traffic lights
11. " - stop sign
12. " - give way sign
13. " - police signal
14. " - rail signal
15. Incorrect or no signal
16. Inattention
17. No errors indicated
18. Other

BLOOD ALCOHOL CONTENT

1. Not tested
2. Refuse B/A Test
3. Sober on reporting
4. Tested: Under P.C.A.
5. Tested: Charged P.C.A.

B.A. Reading:

1. ....% 2. ....%

OFFICE USE ONLY

RESPONSIBILITY

1. Driver/Rider
2. Passenger
3. Pedestrian
4. Animal
5. Other

Police Reg/Div where accident occurred " "

PLEASE DRAW SKETCH OF ACCIDENT IN THIS SPACE
(Showing Streets and direction of movement of parties concerned)
(Please indicate any traffic signs at location)

Indicate North with an arrow

PLAN

SYMBOLS FOR PLAN

Street Intersection...
Curved Street ... ...
Persons ... ...
Your Vehicle ... ...
Other Vehicle ... ...
(Direction of travel indicated by arrow in symbol)
Parked Vehicle ... ...

I hereby declare that the information supplied on this form is true to the best of my knowledge and belief.

Date: ..../........../19.......... Signature: ....

POLICE USE ONLY

Date: ..../........../19.......... Signature of member accepting report .... Rank .... I/D No. ....

Figure 2.1: Appropriate Road Crash Report Form

(Source: NAASRA (1988))

In NAASRA (1988) there are several suggested potential sources that crash data can be obtained from. However, the most commonly accepted and used source from the given range of choices are the Police Road Crash Reports. It is important to understand that not all crashes are reported and there are specific requirements for reporting accidents. NAASRA (1988, p.13) explain that these guidelines in Queensland are,

> "all casualty crashes, and property damage crashes where the estimated cost of damage exceeds $1000."

The minimum figure stated above (damage exceeding $1000) for reporting an accident was raised in December 1991 to an amount of $2500 (Bureau of Transport and Communications Economics, 1995). The crash data is recorded from reported accidents that meet the criteria established above.

Austroads (2004) have stated that a road crash is made up of three components that interact. These components are listed as the human factor, the vehicle factor and the road factor. Austroads have defined that

> "a crash or accident may be considered as a 'failure' in the system" (Austroads, 2004, p.10).

In general, road crash data is analysed using factors that influence the accident, which are then recorded. According to Queensland Transport (2002) and the Victorian Transport Accident Commission (2004), the common factors that are used by these two organizations are the age and gender of involved parties, the type of transport in the accident, and if pedestrians are also involved, the characteristics of the crash and the factors contributing to the crash. Characteristics of crashes concern information regarding the number of vehicles involved in the accident, the time of day and week when the accident happened and if the accident occurred in a metropolitan or rural area. According to Queensland Transport (2002), the major factors contributing to crashes are alcohol involvement, speed, fatigue and seat belt usage.

Symmons, Haworth and Johnston (2004), also used the above statistics when analysing road crashes but also extended these factors to include a limited investigation of the road characteristics of the accident site. These extended factors include if the location was an intersection or not, the road alignment (i.e. if the road was a straight or part of a curve etc.) and if it was a divided or undivided carriageway. The factors included by Symmons, et al. involving the road characteristics will be analysed when the Southern District data is analysed. However these factors will be increased to include more information about the road environment. These increased factors will include such information as road width, seal type etc. as recommended by NAASRA (1988).

Although NAASRA (1988) also suggests that when investigating accidents, the above human or driver influencing factors be used, they also recommend that the investigation be taken further by using relevant site conditions including those described in the previous paragraph. In particular, the most important of these conditions are road, lighting, road surface and visibility. The road factor is the most detailed including features such as width, number of lanes, markings, camber and gradient. Lighting and visibility are as they imply, with lighting describing the illumination of a section of pavement at nighttime and visibility referring to the distance and quality of a drivers view. Finally the road surface factor concerns the type of surface, condition of the surface and the roughness of this surface. Symmons, et al. (2004) used some road characteristics in their analysis and NAASRA (1988) recommended that a number of road environment details that can and will be analysed in more depth. These factors relating to the road environment will be included in the investigation of the influence of the physical road characteristics on road crashes.

Hutchinson (1987) suggests that Great Britain, South Australia, Western Australia and most states of U.S.A also only collect the information that both Queensland and Victorian departments use to analyse crash data. Although the information from Hutchinson appears to be outdated, it can be seen through recent literature from Queensland and Victoria transport departments, that government departments do not use any data concerning the road environment when analysing road crashes. This project, will therefore attempt to develop a correlation between road environments, many factors of which are rarely considered by government departments, and road crashes.

2.3.2 Correlation of Influencing Parameters

The first and often the most examined characteristics are the age and gender characteristics of drivers. According to Queensland Transport (2002) the age category, of three year intervals, that is involved in the most amounts of road crashes is the 17 to 20 year old bracket. Expanding to this category it can also be seen that the group of 17 to 24 year olds, males make up about 85% of the total. Symmons et al. (2004) found that those under the age of 25 years old were the largest group involved in accidents but were mostly passengers. However the drivers that were most involved were in the 25 to 39 year old category. It was agreed that males made up the greatest amount of road users involved in road crashes.

Contrary to the results above was the amount of higher age (above 35) drivers involved in accidents in rural Victoria. Symmons et al. (2004) discovered that in rural Victoria accidents at intersections accounted for 37% of crashes. It was also found that only 21% of crashes occurred on curves. The accidents at intersections were the least severe and accidents on curves were the most severe. However, there were a low percentage of accidents taking place on curves.

Of the factors contributing to crashes alcohol was the most common factor according to Queensland Transport (2002), with disobeying traffic following narrowly behind. Trailing these were inexperience, speed and then a lack of concentration.

The correlations discussed above are mostly about accidents where the human factors causing accidents are analysed. The remainder of this section details studies that investigated the impact of the road environment on accidents. The Bureau of Transport and Communications Economics (1995) stated that the demands that the road environment places on a driver are dependent on the flow of traffic, geometric design features of the road and also the type of road being used. The Bureau of Transport and Communications Economics Bureau (1995) also believes that the performance of the driver needs to increase as the demands of the road environment, which is put on the driver, also increases. Hence, it is when the performance off the driver does not meet the demand of the road environment that road crashes occur.

The Road and Traffic Authority (1996) illustrate how each of the three components of the transport system contributes to road crashes. The Human Factors causing a crash is 95%, the Road Environment contributing 28% of the time and various Vehicle factors being at fault 8% of the time. From Figure 2.2 it can be seen that the Road Environment is the sole cause in 4% of accidents and is a contributing factor when combined with Human factors 24% of the time.

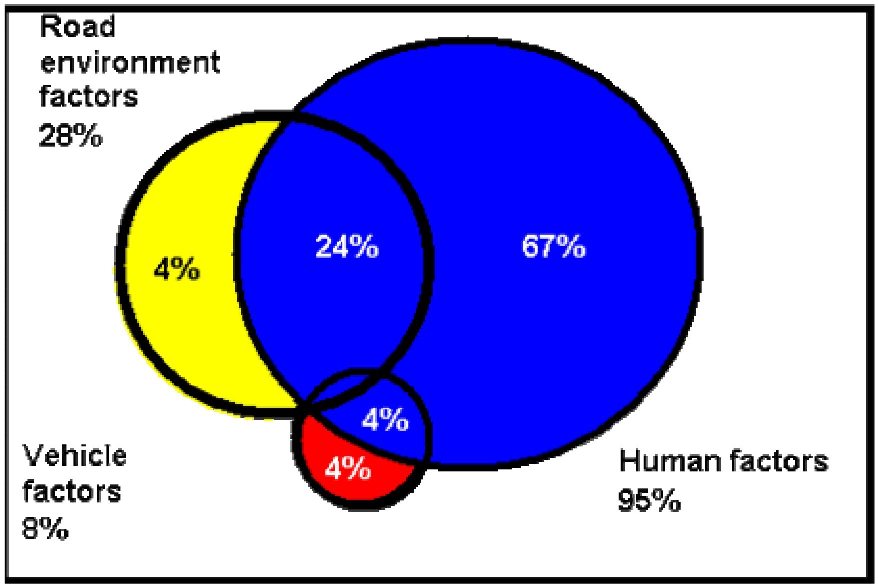


Figure 2.2: Involvement of Factors in Accidents

(Source: Road and Traffic Authority (1996))

The road environment features above were found to be influenced by:

- Road and road side engineering,
- Traffic management; and
- Transport and land use.

Of these factors it can be seen from the Haddon Matrix, Figure 2.3 that before an accident occurs the factors affecting the probability of a crash are:

- Road Engineering factors,
- Traffic Engineering factors,
- Land Use,

- Road Network Features; and
- External factors.

Of these factors, roadside factors and traffic engineering are still factors at work when an accident is occurring.

As mentioned earlier, road side engineering is a consideration included in the road environment. A report by Kloeden, McLean, Baldock and Cockington (1999), on road side hazards, concluded that in 39% of accidents between 1985 and 1996, a road side hazard played a part in fatal accidents. It was also concluded that 38% of hospitalizations between 1994 and 1996 involved an accident involving a road side hazard.

From these conclusions it was recommended by Kloeden et al. (1999) that as the road environment plays a large role in keeping motorists from running off the road, a number of improvements should undertaken with respect to the road environment to assist in this. The aspects of the road environment that were recommended to be improved were the horizontal alignment of the road, an upgrade of the road surface condition and sealed shoulders that incorporate appropriate edge lines.

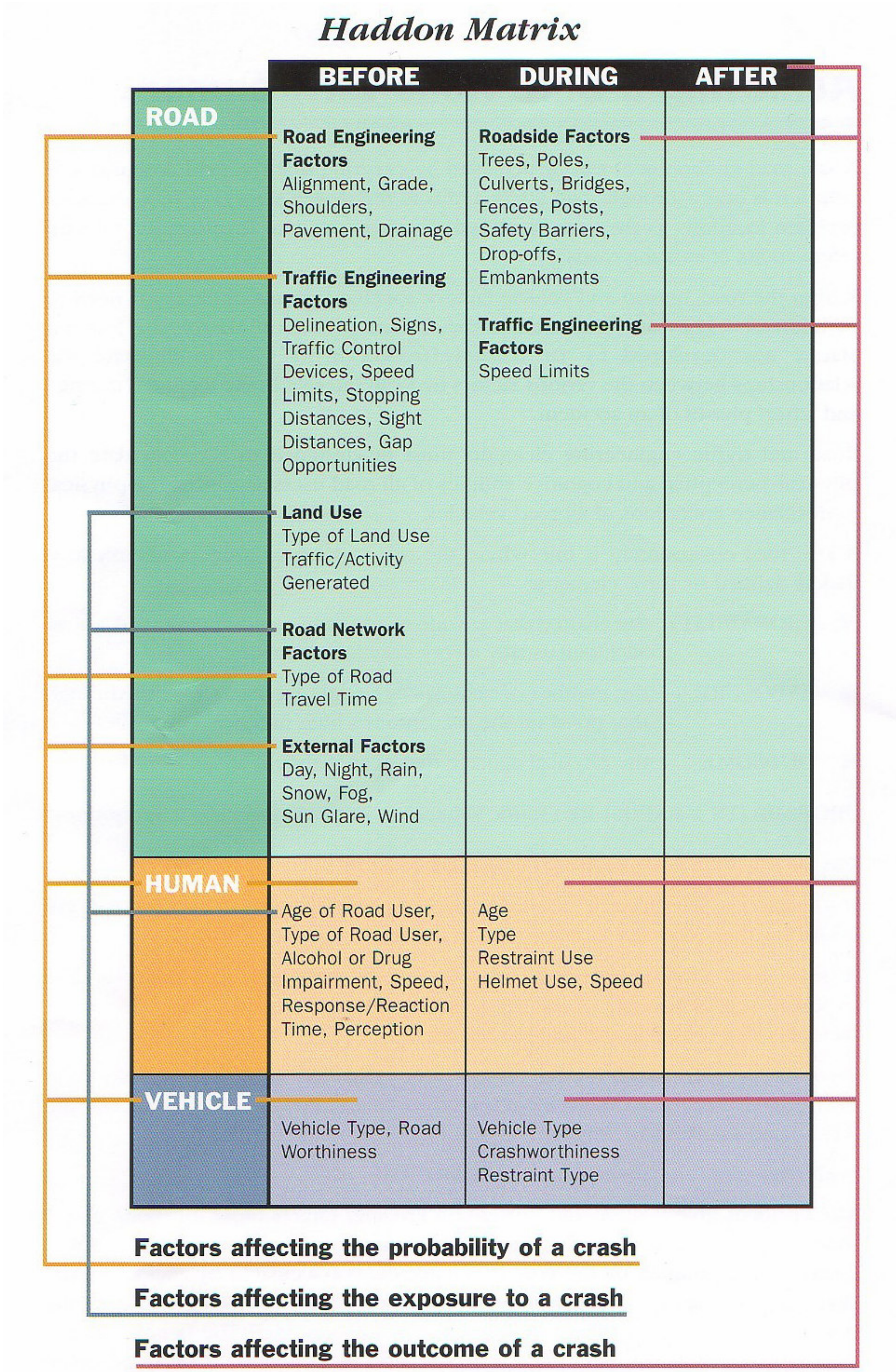


Figure 2.3: The Adapted Haddon Matrix for Road Crashes

(Source: Road and Transport Authority (1996))

2.4 Chapter Summary

This chapter has given a background on this project and how it began. After the background had been established the literature review revealed information gained from past studies on the issues of the analysis of crash data and the correlation of crash rates with influencing parameters.

From the literature review, it was seen previous studies have been undertaken showing that various road environments can be contributing factors to a crash. In spite of these findings very few, if not any, state or federal authorities examine any road data relating to accident sites when analysing crash data and gathering statistics.

Chapter 3

Southern District

3.1 Introduction

As the area of investigation for this project is the Southern District of Main Roads, an explanation of this area is necessary to fully understand the results found. This chapter includes the features of the district such as the size, towns and local government areas included within the boundaries. It also incorporates the road types that are examined with specific examples of these roads.

3.2 Size

The area that is classified as the Southern District by Main Roads is a parcel of land that is located on the western edge of South East Queensland, district number three in Figure 3.1. The most western point of the Western boundary is positioned approximately twenty-five kilometres to the west of Chinchilla and the corresponding point to the East is situated approximately twenty kilometres North of Ipswich. The distance that spans between these points is roughly 250 kilometres.

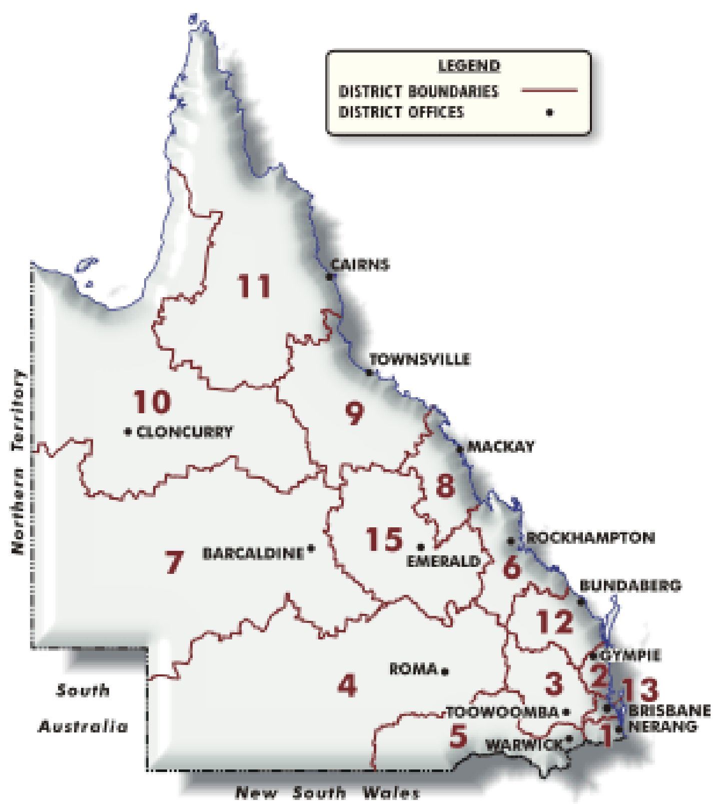


Figure 3.1: Location of Southern District in Queensland

(Source: Main Roads (19/10/2004))

In the North-South direction, the span is almost 300 kilometres with the most Southerly part of the boundary being thirty-five kilometres South of Millmerran and to the North this point is about 125 kilometres North of Chinchilla (Figure 3.2).

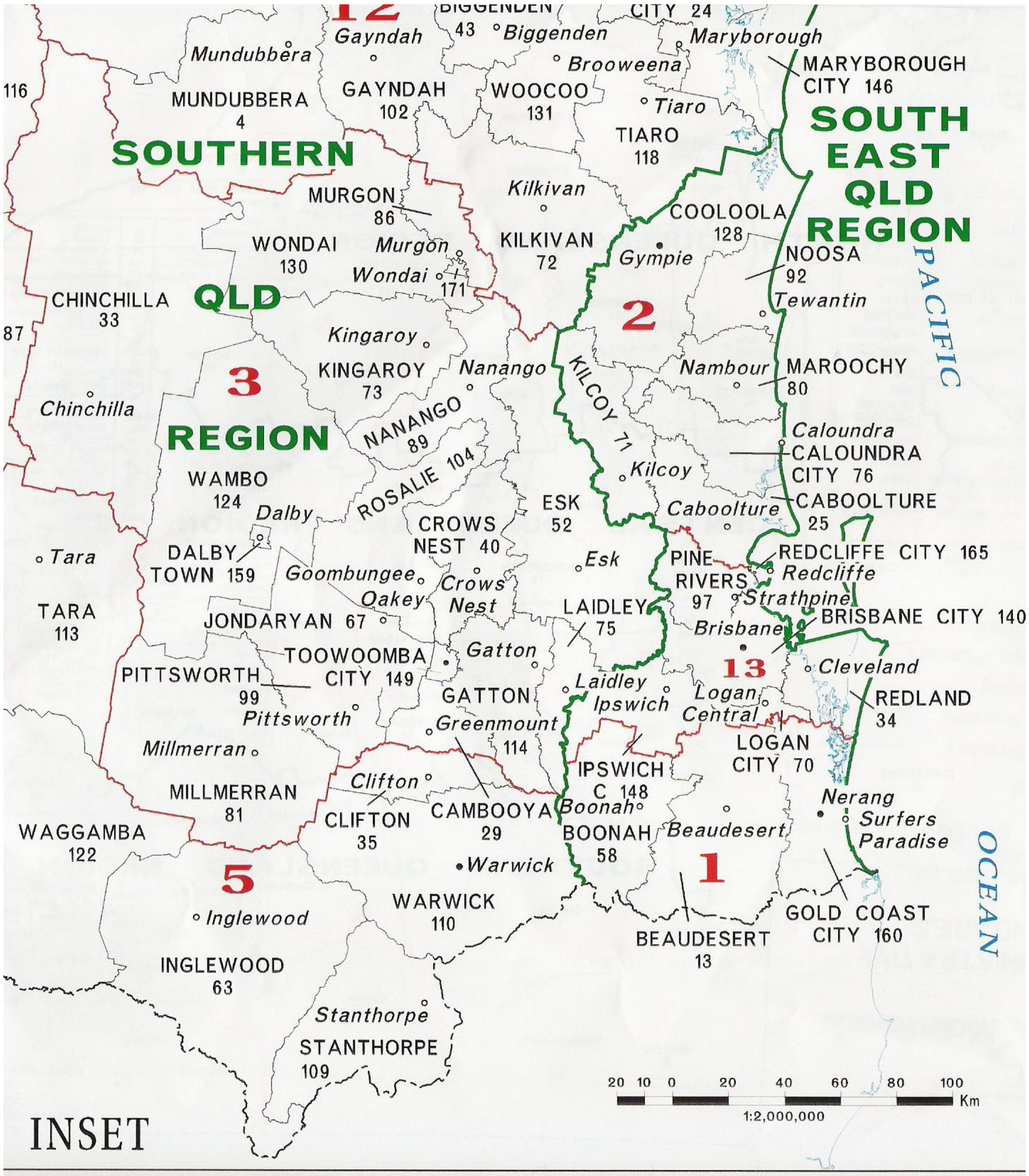


Figure 3.2: Detailed View of the Southern District

(Source: Main Roads Administrative Boundaries)

3.3 Towns and Local Government Areas

3.3.1 Towns

With the Southern District being as large as it is, it is obvious that there are numerous towns in this area. Most towns are only small rural centres but there are a few larger towns of note. These are Murgon, Kingaroy and Nanango to the North, Chinchilla and Dalby to the West, Gatton, Laidley and Esk to the East and Millmerran and Pittsworth. The largest and perhaps most important town in the District, which can be classed as a city, is found centrally in the investigated area. This city is Toowoomba and it is also found along with the one other centrally located town of Crows Nest.

These towns discussed above are considered small rural towns when compared to centres such as Brisbane. The only exception in the entire district is Toowoomba, being much larger than the other towns. Most of the towns above are the principal towns of the shires listed below.

3.3.2 Local Government Areas

Within the southern District there are seventeen different Local Government Areas, as seen in Figure 3.2. Working from North to South they are:

- Chinchilla,
- Wondai,
- Murgon,
- Kingaroy,

- Nanango,
- Wambo,
- Rosalie,
- Dalby Town,
- Crows Nest,
- Esk,
- Gatton,
- Laidley,
- Toowoomba City,
- Cambooya,
- Jondaryn,
- Pittsworth; and
- Millmerran

Most of these shires are rural shires that have to service large areas which contain substantial amounts of roads. More often than not, these shires have restricted budgets that need to be used with careful consideration. However, roads are not the only consideration that these councils need to acknowledge when determining where the funds from their respective budgets are to be spent. As a result, roads can often fall into a below satisfactory condition. The only local authority, from the list above, that has a large budget is the Toowoomba City Council. However, the Toowoomba City Council has a minimal amount of roads that are considered throughout this study, and as a result, minimal maintenance is required.

As a comparison of budgets that councils have available to spend on roads the Kingaroy Shire budget for roads and the Toowoomba City Council budget have been compared. In the Financial year of 2002/2003 Kingaroy Shire Council had an expenditure of approximately $2.272 Million on maintenance and construction (http://kingaroy.qld.gov.au, 2004) and the Toowoomba City Council, in the same financial year, spent $11.04 Million (http://www.toowoomba.qld.gov.au, 2004). This demonstrates the different levels of funds available for expenditure on roads that exists between the rural shires and city councils.

3.4 Road Types

There are three different types of roads that are examined in the Southern District of Main Roads for the purposes of this project. These are state highways, main roads and secondary roads, all of which are described in more detail below.

3.4.1 State Highways

State highways according to the NAASRA Road Classification System (refer to Appendix C1) is a Class 1 road which is described as:

> "those roads which form the principal avenue for communications between major regions of Australia, including direct connections between capital cities." (Bureau of Transport and Regional Economics, 2003)

in the road data, these road classifications range from national highways to state strategic to regional roads. The Main Roads categorisation system, as seen in Appendix

B, classifies roads as state highways with numbers 10 – 49. These numbers are usually followed by a letter 'A', then successively progressing through the alphabet. These letters represent a particular section of the road as the highways pass through many towns. In the case of 18A, the Warrego Highway, the 'A' represents the section of highway between Ipswich and Toowoomba then 18B is the section from Toowoomba to Dalby.

Examples of these roads are, as mentioned above, the Warrego Highway, which travels between Brisbane and Miles. Another example is the New England Highway which starts in Yarraman and travels to Warwick and a final example is the Gore Highway, running from Toowoomba to Goondiwindi. A full list of these roads and the corresponding section is included in Appendix B1.

3.4.2 Main Roads

Main roads are defined as Class 2 in the NAASRA classification system (Appendix C1) which explicitly defines these roads as:

> "those roads, not being Class 1, whose main function is to form the principal avenue of communication for movements:
>
> •Between capital city and adjoining states and their capital cities; or
>
> •Between a capital city and key towns; or
>
> •Between key towns." (Bureau of Transport and Regional Economics, 2003)

the classification received by these roads in the road data is either regional roads or district roads. In terms of Main Roads categorisation, main roads are classified using numbers 100 – 999. Unlike state highways these roads are not followed by any lettering system. This is because these roads consist of only one section.

Main roads generally are roads that connect two towns and thus, take their name from the towns that the road connects. This is by far, the most common road type in the Southern District. Examples of this type of roads are the Oakey – Cooyar Road, Esk – Kilcoy Road, Gatton – Helidon Road and Chinchilla – Tara Road. A complete list containing all of the Main Roads and classifications can be found in Appendix B2.

3.4.3 Secondary Roads

A secondary road according to NAASRA is:

> "those roads, not being Class 1 or 2, whose main function is to form an avenue of communication for movements:
>
> - Between important centres and the Class 1 and Class 2 roads and/or key towns; or
> - Between important centres; or
> - Of an arterial nature within a town in a rural area"
>
> (Bureau of Transport and Regional Economics, 2003)

the road data also refer to these roads as either regional roads but most often are classified as district roads. The classification used for secondary roads by Main Roads is a number between 1000 – 9999. These roads are much like main roads in the respect that they are also roads that join neighbouring towns. However, the towns they join are not as significant. The major difference between main roads and secondary roads, is that secondary roads carry less traffic and therefore are not as frequently used. Examples of these roads include the Millmerran – Cecil Plains Road, Murphy's Creek Road and Bunya Mountains Road.

3.5 Chapter Summary

This chapter has described the area analysed in this project, the Southern District. The first factor relating to the Southern District that was analysed was the size of the district. This revealed the district to be approximately 250 kilometres by 300 kilometres (at maximum distances) in area. Next, the towns and local government areas were reported on, from this it was found that there were seventeen different local government areas in the district. The major towns in the district were also found to be the principal towns of these areas.

Finally, the different types of roads in the district that were of significance were described. There are three different classes of roads contained in the Southern District that were to be considered in the analysis. They were state highways, main roads and secondary roads. In the descriptions of these three road classifications, a description from NAASRA was specified for each, the classification method as used by Main Roads was described also and finally, examples of the particular road type were given.

Chapter 4

Data and Methodology

4.1 Introduction

This chapter describes the three types of data that were required to be analysed in this project. These data sets were the crash data, road data and traffic census data. After the types of data are described, the methodology used to complete the project was outlined, explaining how each stage was completed. The steps that were undertaken throughout the work carried out in this project included how the data was obtained, the initial work undertaken on crash data, the correlation of the road and crash data and the procedure required to be completed in the analysis of this data.

4.2 Data

Three sets of data are required for this project to be undertaken. These data compilations include the crash data for the Southern District, the road data associated with this area and also the Southern District traffic census data. Below is a description of the contents of these files and the particular factors that are considered to be more important than others.

4.2.1 Crash Data

Initially the crash data was sourced from Mal McIlwaith, also one of the supervisors for this project, from Queensland Transport. This data can be accessed by referring to Appendix D. The crash data contains information about crashes for the period, 1998 to 2002. The initial data file contained information on 13 339 accidents and covering from four Main Roads districts namely these were the Southern District, the area of interest for this project, the Wide Bay District, the South West District and the Border District. The number of recorded accidents dropped to 6456 when the data was reduced to only include the Southern District. The crash data not only indicated the district in which the accident has occurred but also other information regarding accidents.

This information includes details such as the severity of the crash, how many vehicles were involved, the age of the driver, the type of vehicle involved in the crash and driver factors which include:

- fatigue,
- speed,

- alcohol; and
- seat belt usage

Furthermore, the crash data also includes other details comprising the date and time that the accident happened, environmental factors, possible driver errors, any vehicle defects before the accident and any violations of the road rules contributing to the accident.

Many factors are recorded in the crash data, but there was a small selection that was the most useful. The factors that are contained within the crash data which were the most useful in examining the data were the local government area in which the accident happened, the Section ID of the offending road, the direction that the vehicle in the crash was travelling and the chainage distance of the road where the accident took place. An explanation of how this information is important is included later in the methodology section of this chapter.

4.2.2 Road Data

The source of the road data is the Southern District Main Roads organisation with the data being received on a floppy disk in the Microsoft Excel format. The road data information describes the physical environment of the roads within the Southern District. As with the crash data, the road data can also be viewed by referring to Appendix E.

The most important factors in the road data, in regard to organising the data as explained below, were the road section, carriageway code and the section of the identified road by the start and end chainage distances of the Road 'TDIST_START' and 'TDIST_END'

The remaining road data contained factors such as:

- Width (Seal, Pavement and Formation),
- Seal Age,
- Pavement Age,
- Pavement Depth,
- AADT data,
- Percentage of Heavy Vehicles,
- Roughness of Road,
- Speed Limit; and
- Terrain Description

Of these factors the particular factors that were considered to be the most important to consider in the analysis were the width including seal, pavement and formation and the AADT data of the roads.

4.2.3 Southern District Traffic Census

The traffic census data is a data set that is mostly concerned with the counting of traffic at different locations through out the Southern District. As with the road data the traffic census is from the Southern District Main Roads organisation but this data is supplied on a CD in PDF format. The main features of this data is the listing of the AADT figures for each road in the Southern District, intersection counts for intersections that are mainly situated around the city of Toowoomba and also there is a break up of the AADT figures into hourly timeslots for selected major roads from the Southern District. This last feature is the most important for the analysis of the data.

4.3 Methodology

This section describes the steps taken before and during the analysis of the data. This extends from obtaining the crash data, to the method used in reviewing and organising the initial data before it could be analysed. Finally, the method used to analyse the data is described.

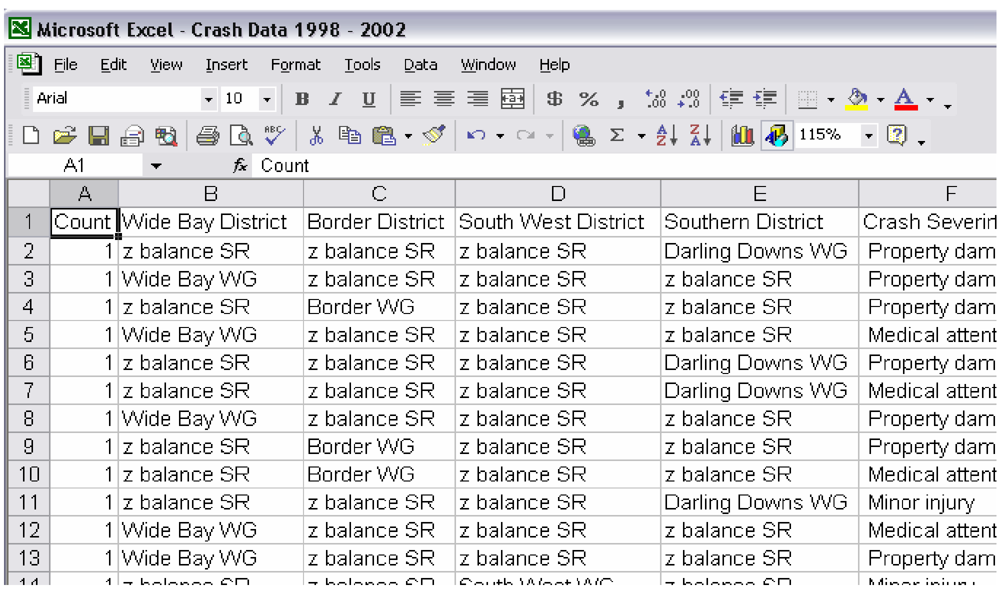
4.3.1 Obtaining the Crash Data

The crash data was obtained by meeting with Mal McIlwaith at Queensland Transport, who had already organised the data. During the meeting, the data was placed in Microsoft Excel format and burnt onto a blank CD-R. Mal then allowed the CD to be taken and the data contained on the CD to be used for the purposes of this project.

4.3.2 Initial Work Undertaken on Crash Data

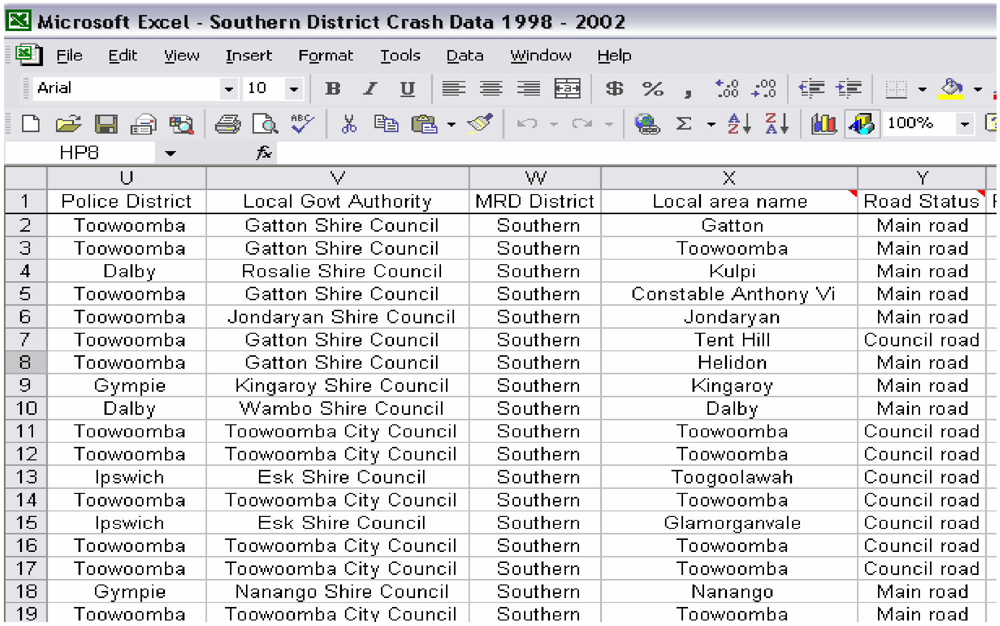
Before the data could be analysed, the data needed to be reviewed and organised into the appropriate format. As was indicated previously in this chapter, the initial crash data contained information on four districts, as shown in Figure 4.1, but for this project only one district, the Southern District, was required. To condense the file to contain data only concerning the Southern District, any line of data in the column labelled 'Southern District' that contained 'z balance SR' was deleted. This removed any accidents that did not occur in the Southern District.

Next, another file needed to be created containing just two local government areas. This was because of the need to examine an initial data area. The two areas chosen for this project were Toowoomba City Council and Gatton Shire Council. To do this any line of data from the Southern District data file, previously created, that didn't contain 'Gatton Shire Council' or 'Toowoomba City Council' under the 'Local Govt Authority', heading were deleted. This can be seen in Figure 4.2. This process organised the crash data into a file primarily concerned with Toowoomba and Gatton data.



	A	B	C	D	E	F
1	Count	Wide Bay District	Border District	South West District	Southern District	Crash Severit
2	1	z balance SR	z balance SR	z balance SR	Darling Downs WG	Property dam
3	1	Wide Bay WG	z balance SR	z balance SR	z balance SR	Property dam
4	1	z balance SR	Border WG	z balance SR	z balance SR	Property dam
5	1	Wide Bay WG	z balance SR	z balance SR	z balance SR	Medical attent
6	1	z balance SR	z balance SR	z balance SR	Darling Downs WG	Property dam
7	1	z balance SR	z balance SR	z balance SR	Darling Downs WG	Medical attent
8	1	Wide Bay WG	z balance SR	z balance SR	z balance SR	Property dam
9	1	z balance SR	Border WG	z balance SR	z balance SR	Property dam
10	1	z balance SR	Border WG	z balance SR	z balance SR	Medical attent
11	1	z balance SR	z balance SR	z balance SR	Darling Downs WG	Minor injury
12	1	Wide Bay WG	z balance SR	z balance SR	z balance SR	Medical attent
13	1	Wide Bay WG	z balance SR	z balance SR	z balance SR	Property dam

Figure 4.1: Initial Crash Data file containing Four Districts

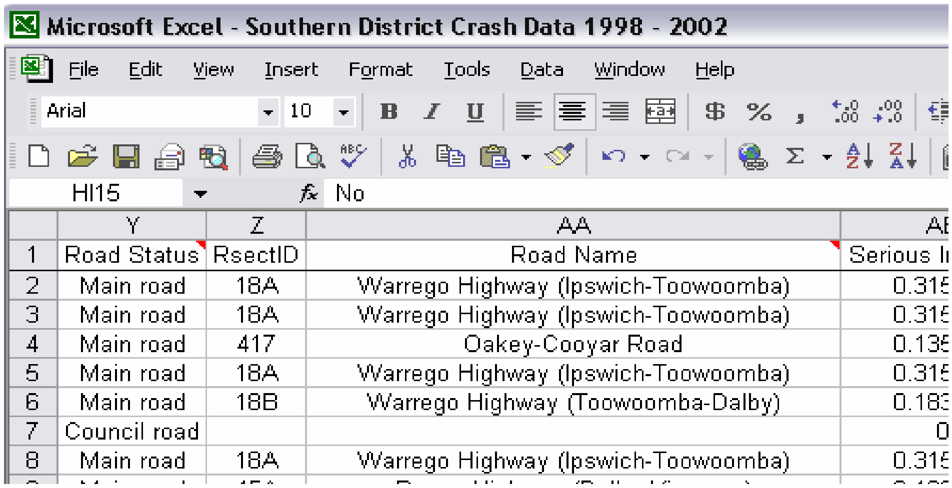

Microsoft Excel - Southern District Crash Data 1998 - 2002

	U	V	W	X	Y
1	Police District	Local Govt Authority	MRD District	Local area name	Road Status
2	Toowoomba	Gatton Shire Council	Southern	Gatton	Main road
3	Toowoomba	Gatton Shire Council	Southern	Toowoomba	Main road
4	Dalby	Rosalie Shire Council	Southern	Kulpi	Main road
5	Toowoomba	Gatton Shire Council	Southern	Constable Anthony Vi	Main road
6	Toowoomba	Jondaryan Shire Council	Southern	Jondaryan	Main road
7	Toowoomba	Gatton Shire Council	Southern	Tent Hill	Council road
8	Toowoomba	Gatton Shire Council	Southern	Helidon	Main road
9	Gympie	Kingaroy Shire Council	Southern	Kingaroy	Main road
10	Dalby	Wambo Shire Council	Southern	Dalby	Main road
11	Toowoomba	Toowoomba City Council	Southern	Toowoomba	Council road
12	Toowoomba	Toowoomba City Council	Southern	Toowoomba	Council road
13	Ipswich	Esk Shire Council	Southern	Toogoolawah	Council road
14	Toowoomba	Toowoomba City Council	Southern	Toowoomba	Council road
15	Ipswich	Esk Shire Council	Southern	Glamorganvale	Council road
16	Toowoomba	Toowoomba City Council	Southern	Toowoomba	Council road
17	Toowoomba	Toowoomba City Council	Southern	Toowoomba	Council road
18	Gympie	Nanango Shire Council	Southern	Nanango	Main road
19	Toowoomba	Toowoomba City Council	Southern	Toowoomba	Main road

Figure 4.2: 'Local Government Authority' Identification

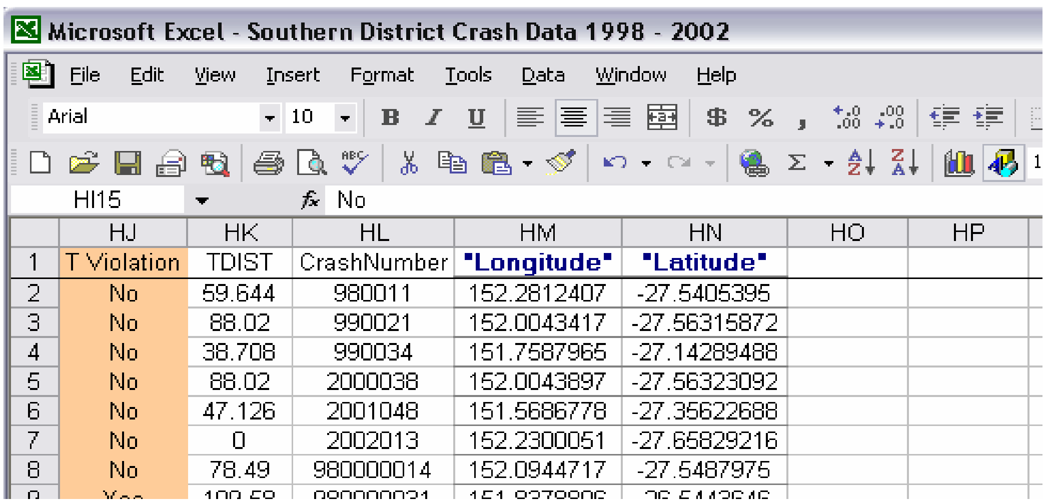
4.3.3 Correlation of Road and Crash Data

Once the crash data had been organised into the two separate files of the Southern District, and the two local government areas, these files needed to be integrated together to create files of road data that matched up to the locations of the crashes. This was achieved by reviewing the crash data file and identifying the road by finding the classification under 'RsectID', or Road Section Identification Number. This is displayed in Figure 4.3. The exact chainage of the road, at which the accident occurred, was recognised in the column headed 'TDIST', as seen in Figure 4.4.



	Y	Z	AA	AE
1	Road Status	RsectID	Road Name	Serious I
2	Main road	18A	Warrego Highway (Ipswich-Toowoomba)	0.315
3	Main road	18A	Warrego Highway (Ipswich-Toowoomba)	0.315
4	Main road	417	Oakey-Cooyar Road	0.135
5	Main road	18A	Warrego Highway (Ipswich-Toowoomba)	0.315
6	Main road	18B	Warrego Highway (Toowoomba-Dalby)	0.183
7	Council road			0
8	Main road	18A	Warrego Highway (Ipswich-Toowoomba)	0.315

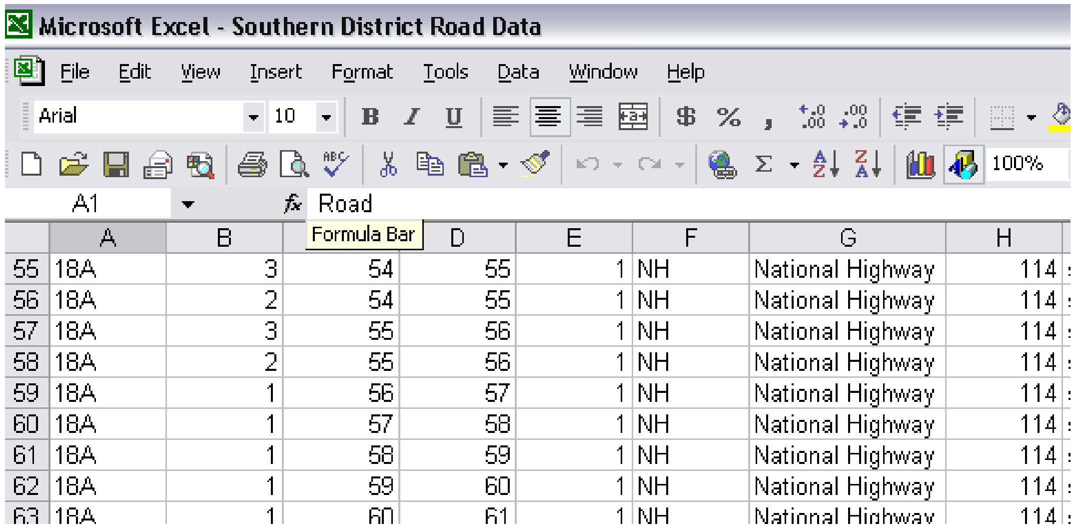
Figure 4.3: Identifying Crash Road 'RsectID'



	HJ	HK	HL	HM	HN	HO	HP
1	T Violation	TDIST	CrashNumber	"Longitude"	"Latitude"		
2	No	59.644	980011	152.2812407	-27.5405395		
3	No	88.02	990021	152.0043417	-27.56315872		
4	No	38.708	990034	151.7587965	-27.14289488		
5	No	88.02	2000038	152.0043897	-27.56323092		
6	No	47.126	2001048	151.5686778	-27.35622688		
7	No	0	2002013	152.2300051	-27.65829216		
8	No	78.49	980000014	152.0944717	-27.5487975		

Figure 4.4: Chainage Distance, 'TDIST', of the Road

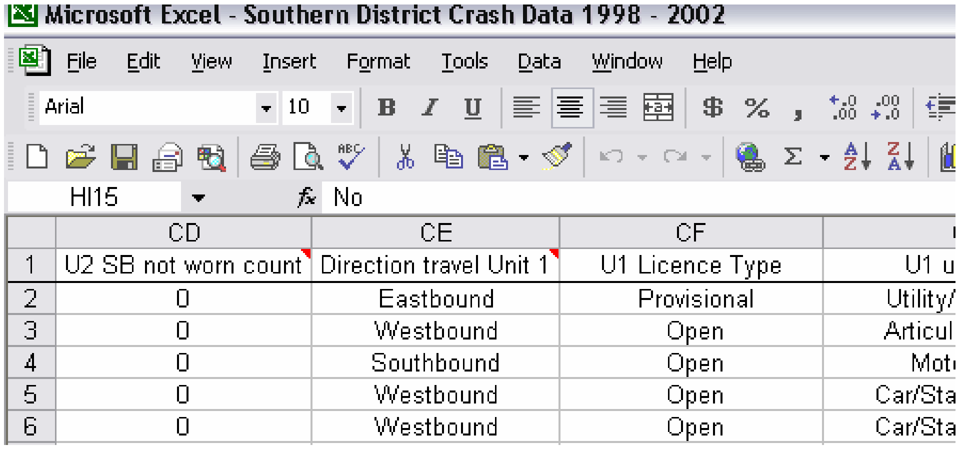
Once these characteristics have been identified, it is possible to refer to the road data and identify the section of road that the accident occurred. For instance, the crash that is described by line one of the crash data in Figures 4.3 and 4.4, matches up to the road data contained in line 62 of Figure 4.5 below. Once the correct sections of road had been identified, the data line describing the road was copied to a new file. To build a data set of road data relating to crashes, the crash data file must be matched line by line to the road data using the method outlined above.



	A	B	C	D	E	F	G	H
55	18A	3	54	55	1	NH	National Highway	114
56	18A	2	54	55	1	NH	National Highway	114
57	18A	3	55	56	1	NH	National Highway	114
58	18A	2	55	56	1	NH	National Highway	114
59	18A	1	56	57	1	NH	National Highway	114
60	18A	1	57	58	1	NH	National Highway	114
61	18A	1	58	59	1	NH	National Highway	114
62	18A	1	59	60	1	NH	National Highway	114
63	18A	1	60	61	1	NH	National Highway	114

Figure 4.5: Road Data Matching Crash Data Above

In Figure 4.5 above, lines 57 and 58 describe the characteristics of the section of road between chainage 55 and 56, as well as the carriageway code in column two. This column differentiates between two carriageways, coded '2' and '3' respectively. This is because this section of road has two carriageways, one in each direction, separated by a median strip. The code '2' refers to the carriageway that travels in the same direction as the originally gazetted direction of the road. In the case of 18A, the Warrego Highway between Ipswich and Toowoomba, the gazetted direction is from Ipswich to Toowoomba. In the crash data it can be determined through the use of the column 'Direction travel Unit 1', as seen in Figure 4.6, which direction the vehicle was travelling. In the case in Figure 4.6 the vehicle was travelling Eastbound on 18A. So, if this accident occurred on a dual carriage way section of road, the carriageway being used by this vehicle would have been coded '3' because it was travelling against the gazetted direction.



	CD	CE	CF	
1	U2 SB not worn count	Direction travel Unit 1	U1 Licence Type	U1 u
2	0	Eastbound	Provisional	Utility/
3	0	Westbound	Open	Articul
4	0	Southbound	Open	Mot
5	0	Westbound	Open	Car/Sta
6	0	Westbound	Open	Car/Sta

Figure 4.6: Direction of Travel factor used to determine Carriageway

4.3.4 Analysis of Data

Tidal Flow

The first step in the analysis of the tidal flow for the Toowoomba and Gatton region and the Southern District was to establish which roads were to be analysed. This was achieved by checking the roads that were included in the Southern District Traffic Census. Once the roads that were to be analysed were established, the data from the crash data for the roads analysed was organised into separate files for each road.

After the files were created it was decided that the time periods to be analysed were to be four hour periods. However the data in the Traffic Census was broken into a percentage of the AADT for only hourly periods instead of the four hourly periods that were desired. To overcome this problem the percentages for the hourly periods were added together to create percentages for the desired periods. Using these percentages the traffic flow during the time period was found from the AADT of the road.

The next step in the process was to sum the amount of accidents in each time period for each road. After this was complete the amount of crashes per one million vehicles could be calculated. First the number of crashes was divided by the traffic flow however the time period that the accidents occurred over was five years. This required the traffic flow to be multiplied by 1826 days, four years of 365 days and a leap year with 366 days. The figures that were obtained were then multiplied by one million to convert the statistics to per one million vehicles.

Seal, Pavement and Formation Width

Before the analysis of these factors could begin the size of the width categories needed to be established. It was decided that a category width of half a metre was likely to produce reliable results. The category widths could have been as low as 0.1 metres but it was felt that this width was unlikely to affect drivers and 0.5 metres was likely to be a greater influence to drivers.

After the width categories were established the road data was sought through, summing the length of road in each width category, for each area. Once this was complete the data for the roads was also sorted then adding the amount of accidents that occurred in each width category. The final step in the analysis of these factors was to divide the amount of accidents by the length of the road. This produced statistics with units of crashes per kilometre of road.

Each width type was then broken up into different road categories. This was achieved with an AustRoads manual, Rural Road Design (2003). The road categories for the seal widths were established with Table 11.1 and Table 11.2 from this publication. Table

11.2 and 11.2 were also used to create categories for the pavement widths. The formation width categories were then found using Table 11.6 also from Austroads 2003.

Speed Limit Zones

The method used to analyse the speed limit zones was very similar to that used to analyse the seal, pavement and formation widths. The first step was to sum the length of roads for each speed limit then the amount of accidents that occurred in each zone was also summed. As before the amount of crashes was divided by the length of the road again producing an amount of crashes per kilometre of road.

AADT vs. Width

From the data found when analysing the width factors it could be seen which road types were possible to analyse in this section. Once the road types to analyse were found from the data, individual files for each width category were created for the road data and the road data correlated from the crash data. These files were then split into the different AADT categories.

Once again the crashes per kilometre of road were found by dividing the amount of crashes in the AADT category for the width category by the length of the road in the AADT and width category.

4.4 Chapter Summary

This chapter described the three types of data that were required to be analysed in this project, the crash data, road data and Southern District traffic census. A description of the contents of these files and the particular factors that were considered to be more important than others was established. Once the data types were described, the methodology used to complete the project was outlined, explaining how each stage was completed. The steps that were described included how the data was obtained, the initial work undertaken on the crash data, the correlation of the road and crash data and the procedure that was completed in the analysis of the data.

Chapter 5

Tidal Flow and Crashes

5.1 Introduction

This chapter reports on the analysis of the factors relating to the 'tidal flow' of traffic and the frequency of road crashes. The crash rate, crashes per one million vehicles, for time periods of four hours on certain roads in each area was found. Then it was compared to the other roads and the tidal flow of traffic during these periods. This analysis was conducted in relation to the two examination areas, the initial area of Toowoomba and Gatton and the entire study area of the Southern District.

5.2 Toowoomba and Gatton

This section seeks to establish if there is a correlation between the tidal flow of traffic and the amount of road crashes in the Toowoomba and Gatton districts. Table 5.1 below was constructed to assist in this task. The Total Flow is the amount of vehicles that travel along the road during the time period shown in one day and the number of crashes being the total amount of crashes that occurred on that road in the time period, in between 1998 and 2002. From these statistics the Crash Rate could be found, the Crash Rate is the number of crashes per one million vehicles that travel the road.

Road		0 - 4	4 - 8	8 - 12	12 - 16	16 - 20	20 - 24
18A	Total Flow	677	1544	2757	2486	2163	902
	# Crashes	11	37	97	99	108	39
	Crash Rate	*8.8*	*13.1*	*19.2*	*21.8*	*27.3*	*23.6*
18B	Total Flow	138	1321	2507	2630	2389	617
	# Crashes	5	21	89	87	84	21
	Crash Rate	*19.8*	*8.7*	*19.4*	*18.1*	*19.2*	*18.6*
22A	Total Flow	148	1657	3868	3902	3822	980
	# Crashes	7	11	46	42	39	22
	Crash Rate	*25.9*	*3.6*	*6.5*	*5.8*	*5.5*	*12.3*
22B	Total Flow	242	960	4973	5747	4760	1521
	# Crashes	2	11	45	70	61	20
	Crash Rate	*4.5*	*6.2*	*4.9*	*6.6*	*7.1*	*7.2*
28A	Total Flow	87	334	559	619	558	197
	# Crashes	3	9	29	24	18	4
	Crash Rate	*18.8*	*14.7*	*28.4*	*21.2*	*17.6*	*11.1*
313	Total Flow	14	79	174	182	135	36
	# Crashes	0	2	7	4	4	0
	Crash Rate	*0*	*13.8*	*22.1*	*12.1*	*16.2*	*0*
314	Total Flow	119	997	2803	2690	2148	508
	# Crashes	2	13	22	25	23	10
	Crash Rate	*9.2*	*7.1*	*4.2*	*5.1*	*5.8*	*10.7*

Table 5.1: Tidal Flow – Toowoomba and Gatton

From Table 5.1 the road 313 can be disregarded due to the small amount of crashes that have occurred, which produces unreliable results. A slight correlation that can be seen from Table 5.1 is that occasionally one of the tired times, 0 – 4 or 20 – 24, has a higher crash rate despite having less accidents occurring than at other times during the day.

There are four particular occurrences of correlation mentioned above including 18A, 22A, 22B and 314. Road 18A has its highest crash rate, although comparable to the other periods, during the time period of 0 – 4 likewise with 22A. This road also has a crash rate that is much higher during this period than any other during the day and is double that of the second highest crash rate. The crash rate of 22B is the highest during the period of 20 – 24 but is also very comparable to the other periods. The road 314 two highest periods occur during both time periods with 20 – 24 being the highest with a crash rate of 10.7 and the second highest period being 0 – 4 with a crash rate of 9.2.

Another correlation that can be seen is that the traffic flow during the period 0 – 4 is consistently much less than the other time periods and the crash rates for this time period are comparable to the other periods, if not greater. Every road in these districts has this statistic in common and a specific example of this is road 314. This road has a traffic flow of 119 and a crash rate of 9.2 which is second only to that of 10.7 occurring during 20 – 24 with traffic flow of 508 and a maximum flow of 2803 vehicles during 8 - 12.

Other examples of this include 22A as mentioned above with a crash rate that is double the period with the second highest crash rate for that road. Also there is 18B with only 138 vehicles utilising the road, compared to 2630 at its busiest period, but a crash rate of 19.8 which is the highest for this road. From this evidence given above it can be seen that in the Toowoomba and Gatton region a larger tidal flow does not mean a larger crash rate.

5.3 Southern District

As with the above section this section seeks to establish if there is a correlation between the tidal flow of traffic and the amount of road crashes but in the Southern District. Table 5.2 below is much the same as Table 5.1 but includes roads that are found outside the Toowoomba and Gatton districts and the traffic flow of the roads that pass through both areas changed, if required, to represent the average flow of the road more accurately. Again the Total Flow is the amount of vehicles that travel along the road during the time period shown in one day, the number of crashes being the total amount of crashes that occurred on that road during the particular time period, between 1998 and 2002 and the Crash Rate the number of crashes per one million vehicles that travel the road.

The roads which flow was changed to more accurately reflect the average flow of the roads that pass through both areas were 22A and 22B. Again there are roads with too few accidents occuring to precisely generate accurate statistics. In the Southern District these roads are 313, 325, 416 and 426. However some examples from these roads are used but with disclaimers to the legitimacy of the statistics generated.

Road		0 - 4	4 - 8	8 - 12	12 - 16	16 - 20	20 - 24
18A	Total Flow	677	1544	1757	1486	2163	901
	# Crashes	20	61	138	143	147	57
	Crash Rate	*16.1*	*21.6*	*27.4*	*31.5*	*37.2*	*34.6*
18B	Total Flow	137	1321	2507	2630	2389	617
	# Crashes	15	45	117	122	126	33
	Crash Rate	*59.9*	*18.6*	*25.5*	*25.4*	*28.8*	*29.2*
18C	Total Flow	44	170	497	521	377	110
	# Crashes	6	7	22	15	15	7
	Crash Rate	*74.6*	*22.5*	*24.2*	*15.7*	*21.7*	*34.8*
22A	Total Flow	12	126	372	349	275	58
	# Crashes	19	24	77	75	75	37
	Crash Rate	*867.1*	*104.3*	*113.3*	*117.6*	*149.3*	*349.3*
22B	Total Flow	55	557	1384	1365	1246	275
	# Crashes	5	17	58	86	68	25
	Crash Rate	*49.7*	*16.7*	*22.9*	*34.5*	*29.8*	*49.7*
28A	Total Flow	87	334	559	619	558	197
	# Crashes	12	31	47	40	42	14
	Crash Rate	*75.5*	*50.8*	*46.1*	*35.3*	*41.2*	*38.9*
28B	Total Flow	70	177	370	395	324	152
	# Crashes	5	2	4	10	2	3
	Crash Rate	*39.1*	*6.1*	*5.9*	*13.8*	*3.3*	*10.8*
35A	Total Flow	39	160	454	444	352	99
	# Crashes	1	2	9	14	10	2
	Crash Rate	*14.1*	*6.8*	*10.8*	*17.2*	*15.5*	*11.1*
40B	Total Flow	40	316	743	748	524	115
	# Crashes	9	10	35	41	25	14
	Crash Rate	*123.2*	*17.3*	*25.7*	*30.1*	*26.1*	*66.6*
40C	Total Flow	49	395	989	900	684	166
	# Crashes	5	3	27	36	31	15
	Crash Rate	*55.8*	*4.1*	*14.9*	*21.9*	*24.8*	*49.4*
45B	Total Flow	87	323	831	815	644	208
	# Crashes	4	9	17	23	27	8
	Crash Rate	*25.1*	*15.2*	*11.2*	*15.4*	*22.9*	*21.1*
313	Total Flow	14	78	174	182	135	36
	# Crashes	0	2	11	4	5	0
	Crash Rate	*0*	*14.1*	*34.6*	*12.1*	*20.2*	*0*
314	Total Flow	119	997	2803	2690	2148	508
	# Crashes	2	15	22	25	24	10
	Crash Rate	*9.2*	*8.2*	*4.2*	*5.1*	*6.1*	*10.7*
325	Total Flow	6	57	143	140	111	21
	# Crashes	0	1	0	2	3	0
	Crash Rate	*0*	*9.6*	*0*	*7.8*	*14.8*	*0*
416	Total Flow	1	18	67	66	39	6
	# Crashes	1	2	4	5	3	1
	Crash Rate	*547.6*	*60.8*	*32.6*	*41.4*	*42.1*	*91.2*
426	Total Flow	6	54	118	113	83	21
	# Crashes	3	3	7	9	12	1
	Crash Rate	*273.8*	*30.4*	*32.4*	*43.6*	*79.1*	*26.1*

Table 5.2: Tidal Flow – Southern District

From Table 5.2 above it can be seen that the crash rate for the road 22A is quite high, much higher than any other road in the Southern District. This high crash rate seems to be due to the low traffic flow that the road 22A has compared to the other roads that were analysed. When this is combined with a high amount of crashes, as is the case, a high crash rate is produced.

The lowest crash rate for this road is 104.3 and the highest 867.1, these figures are quite high when for the majority of roads in the Southern District that were analysed have a crash rate of generally 20 – 40 with some time periods having a crash rate slightly above this figure. Two other roads have crash rates that are similarly high with these roads being 416 and 426 however due to the low number of crashes the accuracy of this figure is questionable. This is due to the considerable difference to the crash rate that one crash difference, to the number of crashes, makes.

A correlation that can be seen from Table 5.2 is, that every road, during 0 – 4 has a low tidal flow compared to other time periods but often has a comparable or higher crash rate. An example of this is road 45B which only has 87 vehicles using the road in this period but has a crash rate of 25.1 which is higher than the other periods for this road. Another example is 40C which has even les traffic during this period with only 49 vehicles but a higher crash rate of 55.8 which is also the highest for this road. In the Southern District all roads have the lowest traffic flow during the period of 0 – 4 for the entire day and all but 18A and 35A have the highest crash rate

Although the period of 0 – 4 has a low traffic flow but a high or comparable crash rate this also occurs in the period of 20 – 24. The examples where the 0 – 4 and 20 – 24 have the two lowest traffic flow but high crash rates include18C, 22A, 22B, 40B and

40C. According to the information above it was shown that the crash rate, where the traffic flow is the lowest, is the highest during the tired times.

5.4 Chapter Summary

This chapter reported on the analysis of the 'tidal flow' of traffic and the crash rate of the roads in the Toowoomba and Gatton areas and the Southern District. The crash rate that was analysed was the number of crashes per on million vehicles using the road and this was compared to the traffic flow of the road during four hour time periods for one day. From the analysis conducted it was found that a higher traffic flow rarely translated into a higher crash rate.

Chapter 6

Road Environment and Crashes

6.1 Introduction

This chapter reports on the analysis of the factors relating to the road environment and the frequency of road crashes. These factors that were analysed as part of the road environment included the seal width, pavement width, formation width, speed limit zones and the AADT vs. Width. These factors were analysed in relation to the two examination areas of the initial area of Toowoomba and Gatton and the entire study area of the Southern District.

6.2 Seal Width

The seal width refers to the width of the bitumous seal that covers the pavement beneath. The seal width of a road is commonly narrower than the pavement or formation width, hence creating shoulders which are usually unsealed. This section endeavours to find a correlation between the width of the sealed road and the frequency of road crashes that occur on these roads.

6.2.1 Toowoomba and Gatton

To accurately depict the amount of crashes that occurs on certain sealed widths the amount of crashes, per kilometre of road that is of a certain width, needed to be found for an accurate analysis of the data. This information is shown in Table 6.1 below. From this the categories of single lane unsealed shoulders, single lane sealed shoulders, double lane unsealed shoulders and four lane unsealed shoulders all have data sets which are too small to establish accurate correlations so for this section are disregarded.

This leaves the categories of double lane sealed shoulders and four lanes sealed shoulders. From Figure 6.1 and Figure 6.2 below it can be seen that a correlation can not be seen for either of these categories. One reason for this could be the lengths of road that are analysed, particularly in the category of four lanes sealed shoulders. The reason the lengths are a problem is that they are very small, with the four lane category having lengths that are at longest two Kilometres in length. This produces statistics that are unreliable and inaccurate, as is the case in this situation.

Width	Length	# Crashes	Crashes/Km
Single Lane Unsealed Shoulders			
3.5 - 3.9	3	1	0.3
4.0 - 4.4	1	1	1.0
Single Lane Sealed Shoulders			
4.5 - 4.9	0	0	0.0
5.0 - 5.4	5	3	0.6
5.5 - 5.9	21	11	0.5
Double Lane Unsealed Shoulders			
6.0 - 6.4	16	18	1.1
6.5 - 6.9	24	21	0.9
Double Lane Sealed Shoulders			
7.0 - 7.4	4	20	5.0
7.5 -7.9	7	21	3.0
8.0 - 8.4	13.23	27	2.0
8.5 - 8.9	5.58	45	8.1
9.0 - 9.4	15	89	5.9
9.5 - 9.9	8	63	7.9
10.0 - 10.4	28	125	4.5
10.5 - 10.9	14.17	50	3.5
11.0 - 11.4	18	54	3.0
11.5 - 11.9	9	53	5.9
12.0 - 12.4	1	3	3.0
Four Lanes Unsealed Shoulders			
12.5 - 12.9	5	28	5.6
13.0 -13.4	2	48	24.0
13.5 - 13.9	1	46	46.0
14.0 - 14.4	4	66	16.5
14.5 -14.9	0	0	0.0
15.0 - 15.4	0	0	0.0
Four Lanes Sealed Shoulders			
15.5 - 15.9	1.27	18	14.2
16.0 - 16.4	2	82	41.0
16.5 - 16.9	1	36	36.0
17.0 - 17.4	1	24	24.0
17.5 - 17.9	2	69	34.5
18.0 - 18.4	2	71	35.5
18.5 - 18.9	1	2	2.0
19.0 - 19.4	1	101	101.0
19.5 - 19.9	0	0	0.0
20.0 - 20.4	1	10	10.0
20.5 - 20.9	1	46	46.0
21.0 - 21.4	1	52	52.0
21.5 - 21.9	0	0	0.0
22.0 - 22.4	0	0	0.0
22.5 - 23.0	1.01	62	61.4

Table 6.1: Seal Width Crashes/Km – Toowoomba and Gatton

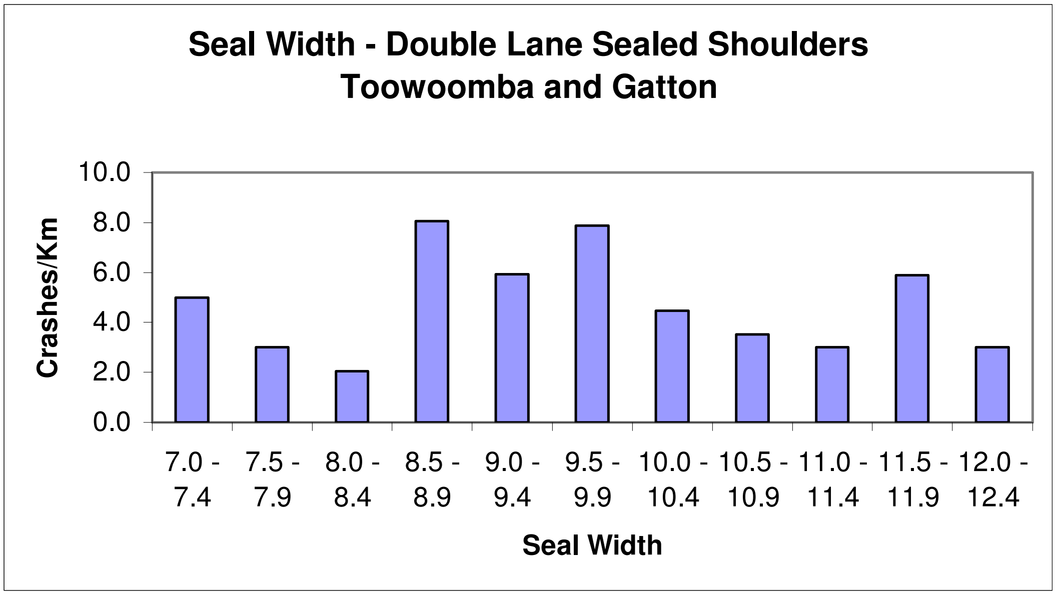


Figure 6.1: Double Lane Sealed Shoulders – Toowoomba and Gatton

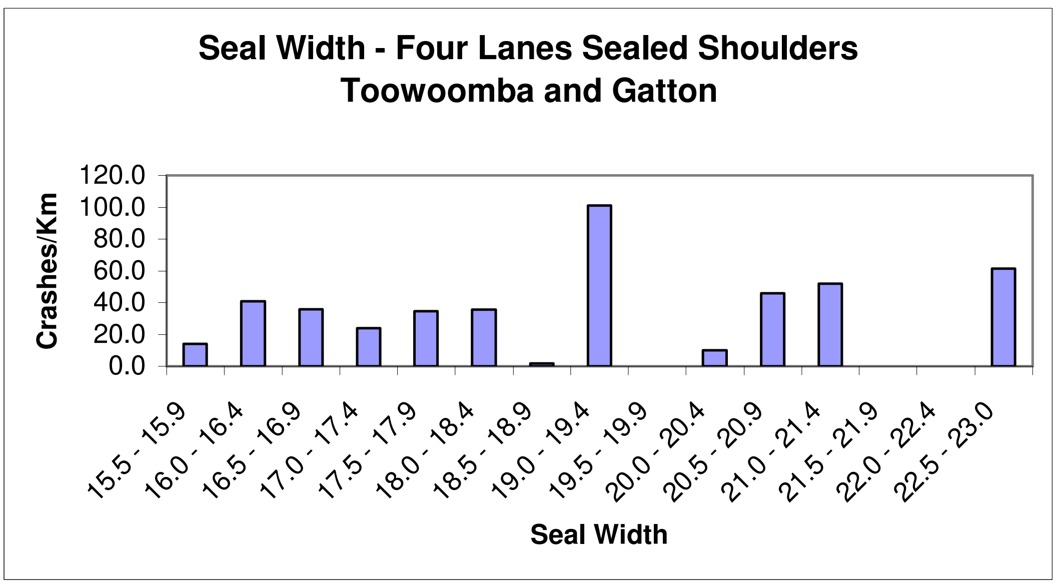


Figure 6.2: Four Lane Sealed Shoulders – Toowoomba and Gatton

6.2.2 Southern District

As with the Toowoomba and Gatton districts there are only two sealed road widths that contain enough information for an accurate analysis. Those roads were that same as above, being double lane sealed shoulders and four lane sealed shoulders as shown in Table 6.2 below.

The graph of double lane sealed shoulders in Figure 6.3 illustrates a good correlation. As the width of the road increases the crashes per kilometre of road is generally increasing. Even though the data on the length of the road for four lane sealed shoulders is considered to be too low to present accurate statistics there is still a slight correlation shown in Figure 6.4. This correlation is the same as in Toowoomba and Gatton, with the crashes per kilometre increasing as the width of the road increases.

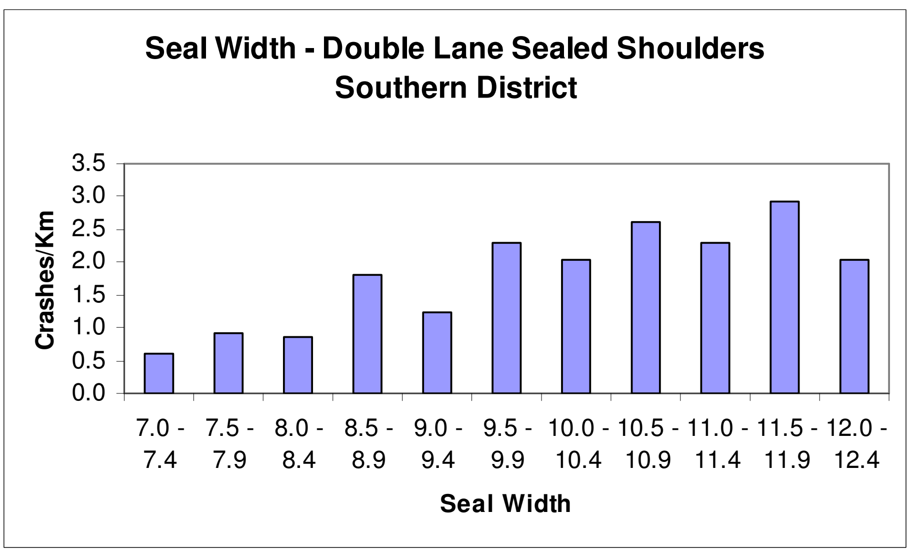


Figure 6.3: Double Lane Sealed Shoulders – Southern District

Width	# Crashes	Length	Crashes/Km
Single Lane Unsealed Shoulders			
2.5 - 2.9	1	3.68	0.3
3.0 - 3.4	4	5	0.8
3.5 - 3.9	26	212.82	0.1
4.0 - 4.4	10	86.46	0.1
Single Lane Sealed Shoulders			
4.5 - 4.9	13	52	0.3
5.0 - 5.4	23	137.87	0.2
5.5 - 5.9	66	233.46	0.3
Double Lane Unsealed Shoulders			
6.0 - 6.4	235	614.12	0.4
6.5 - 6.9	143	208.92	0.7
Double Lane Sealed Shoulders			
7.0 - 7.4	157	257.4	0.6
7.5 -7.9	121	132.23	0.9
8.0 - 8.4	181	212.61	0.9
8.5 - 8.9	162	89.806	1.8
9.0 - 9.4	383	308.892	1.2
9.5 - 9.9	186	81.19	2.3
10.0 - 10.4	204	100.03	2.0
10.5 - 10.9	127	48.88	2.6
11.0 - 11.4	130	56.67	2.3
11.5 - 11.9	99	33.86	2.9
12.0 - 12.4	73	35.65	2.0
Four Lanes Unsealed Shoulders			
12.5 - 12.9	43	10	4.3
13.0 -13.4	82	15	5.5
13.5 - 13.9	62	5.54	11.2
14.0 - 14.4	83	8	10.4
14.5 -14.9	5	2	2.5
15.0 - 15.4	14	2	7.0
Four Lanes Sealed Shoulders			
15.5 - 15.9	18	2	9.0
16.0 - 16.4	95	5	19.0
16.5 - 16.9	41	2.21	18.6
17.0 - 17.4	24	1	24.0
17.5 - 17.9	86	5	17.2
18.0 - 18.4	79	14	5.6
18.5 - 18.9	5	2	2.5
19.0 - 19.4	108	2	54.0
19.5 - 19.9	6	1	6.0
20.0 - 20.4	16	1	16.0
20.5 - 20.9	46	1	46.0
21.0 - 21.4	53	1	53.0
21.5 - 21.9	9	1	9.0
22.0 - 22.4	42	2.96	14.2
22.5 - 23.0	76	1.2	63.3

Table 6.2: Seal Width Crashes/Km – Southern District

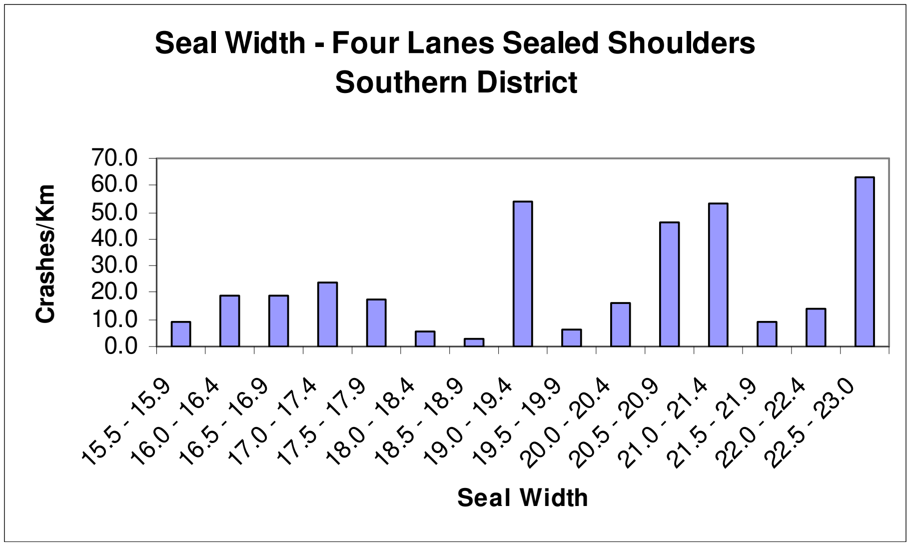


Figure 6.4: Four Lane Sealed Shoulders – Southern District

6.3 Pavement Width

The pavement width is the width of the road that includes the traffic lanes and the shoulders on each side of the road. In this section the correlation is sought between the frequency of road crashes and the width of the formation on these roads.

6.3.1 Toowoomba and Gatton

Of the three different width categories in Table 6.3 only four lanes is not appropriate for analysis due to the minimal lengths of road sections. The first two, single lane and double lane provide visual correlations as shown in Figures 6.5 and 6.6.

Width	# Crashes	Length	Crashes/Km
Single Lane			
6.5 - 6.9	4	6	0.7
7.0 - 7.4	15	10	1.5
7.5 -7.9	26	12	2.2
8.0 - 8.4	51	46.23	1.1
8.5 - 8.9	43	15	2.9
Double Lane			
9.0 - 9.4	92	28	3.3
9.5 - 9.9	44	9	4.9
10.0 - 10.4	136	33	4.1
10.5 - 10.9	85	26	3.3
11.0 - 11.4	37	18.58	2.0
11.5 - 11.9	49	8	6.1
12.0 - 12.4	13	4	3.3
12.5 - 12.9	37	6	6.2
13.0 -13.4	50	3.17	15.8
13.5 - 13.9	46	1	46.0
14.0 - 14.4	40	3	13.3
14.5 -14.9	0	0	0.0
15.0 - 15.4	26	1	26.0
Four Lanes			
15.5 - 15.9	18	1.27	14.2
16.0 - 16.4	82	2	41.0
16.5 - 16.9	36	1	36.0
17.0 - 17.4	24	1	24.0
17.5 - 17.9	27	1	27.0
18.0 - 18.4	31	1	31.0
18.5 - 18.9	84	3	28.0
19.0 - 19.4	101	1	101.0
19.5 - 19.9	0	0	0.0
20.0 - 20.4	0	0	0.0
20.5 - 20.9	0	0	0.0
21.0 - 21.4	108	3	36.0
21.5 - 21.9	0	0	0.0
22.0 - 22.4	9	1	9.0
22.5 - 23.0	62	1.01	61.4

Table 6.3: Pavement Width Crashes/Km – Toowoomba and Gatton

In both Figure 6.5 and 6.6 the crashes per kilometre of road increases as the width of the road increases. In Figure 6.5 this is a gradual increase but in Figure 6.6 the increase does not start until the width of the road is approximately 12.5m. The crashes per kilometre increase until the width reaches 13.9m then the crashes reduce. Hence a correlation exists for both single lane and double lane pavements that suggests the number of crashes increases as the width of the pavement increases.

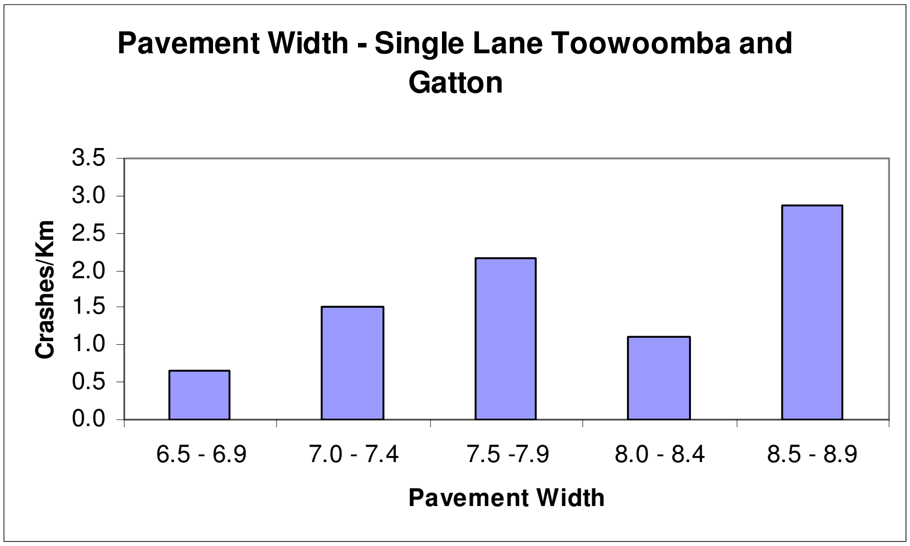


Figure 6.5: Single Lane Pavement Width – Toowoomba and Gatton

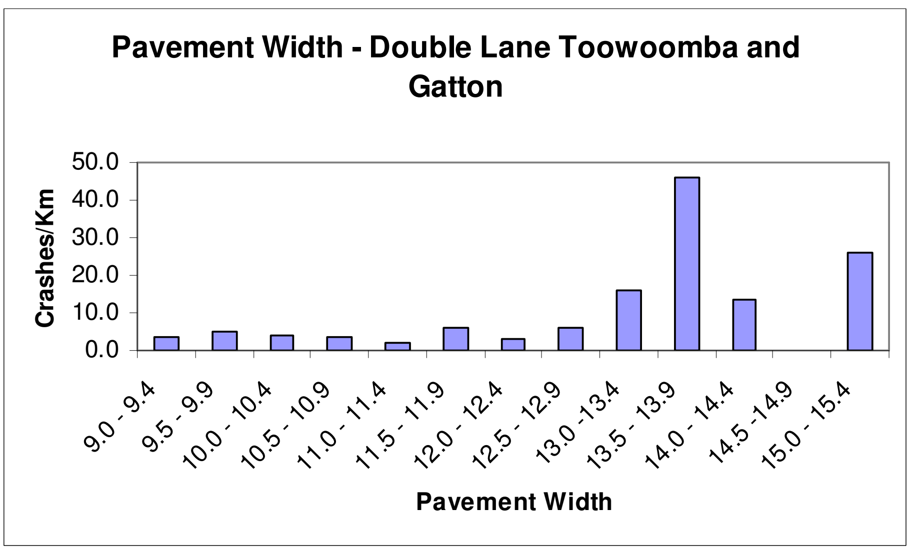


Figure 6.6: Double Lane Pavement Width – Toowoomba and Gatton

6.3.2 Southern District

The Southern district data is much like the data from the Toowoomba and Gatton region with the lengths of the road for four lane pavements being again too small for an accurate analysis. This therefore leaves the categories of single lane and double lane pavements as before.

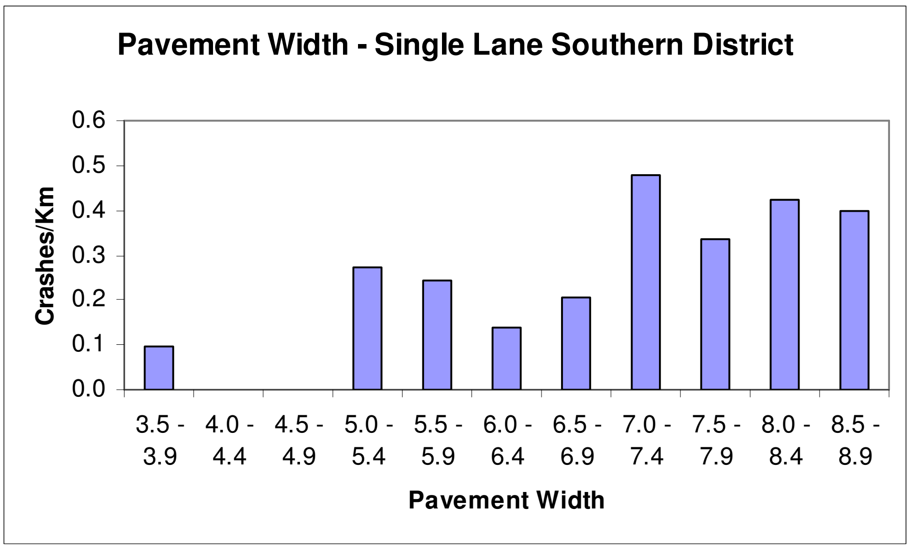


Figure 6.7: Single Lane Pavement Width – Southern District

The correlation displayed in Figure 6.7 for a single lane pavement is not as clear as those seen in previous examples but the overall general trend is for the crashes per kilometre to increase along with an increase in the width. The trend displayed in Figure 6.8 for a double lane pavement is again generally an increase in crashes as the width increases.

Width	# Crashes	Length	Crashes/Km
Single Lane			
3.5 - 3.9	1	10.23	0.1
4.0 - 4.4	0	0	0.0
4.5 - 4.9	0	0	0.0
5.0 - 5.4	1	3.68	0.3
5.5 - 5.9	4	16.47	0.2
6.0 - 6.4	6	43.96	0.1
6.5 - 6.9	11	53.34	0.2
7.0 - 7.4	30	62.59	0.5
7.5 -7.9	72	214.57	0.3
8.0 - 8.4	234	549.6	0.4
8.5 - 8.9	183	456.808	0.4
Double Lane			
9.0 - 9.4	557	716.82	0.8
9.5 - 9.9	228	164.35	1.4
10.0 - 10.4	418	253.29	1.7
10.5 - 10.9	239	141.42	1.7
11.0 - 11.4	152	93	1.6
11.5 - 11.9	121	51.7	2.3
12.0 - 12.4	69	39.97	1.7
12.5 - 12.9	74	19.61	3.8
13.0 -13.4	93	14.17	6.6
13.5 - 13.9	78	11	7.1
14.0 - 14.4	50	5.72	8.7
14.5 -14.9	11	4.31	2.6
15.0 - 15.4	43	5	8.6
Four Lanes			
15.5 - 15.9	18	1.27	14.2
16.0 - 16.4	101	6.41	15.8
16.5 - 16.9	0	0	0.0
17.0 - 17.4	24	1.21	19.8
17.5 - 17.9	41	2	20.5
18.0 - 18.4	34	2	17.0
18.5 - 18.9	97	6	16.2
19.0 - 19.4	108	2	54.0
19.5 - 19.9	0	0	0.0
20.0 - 20.4	6	1	6.0
20.5 - 20.9	0	0	0.0
21.0 - 21.4	123	4.54	27.1
21.5 - 21.9	0	0	0.0
22.0 - 22.4	54	3.96	13.6
22.5 - 23.0	76	1.2	63.3

Table 6.4: Pavement Width Crashes/Km – Southern District

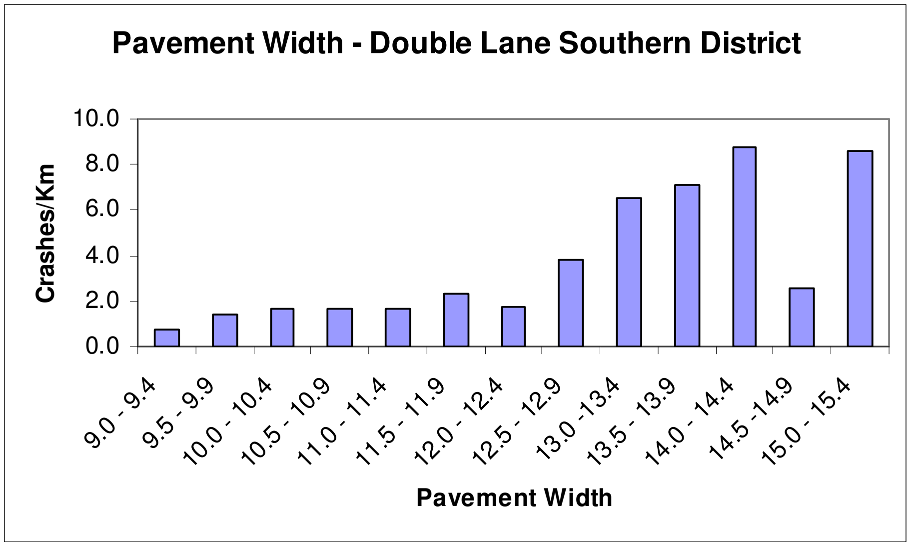


Figure 6.8: Double Lane Pavement Width – Southern District

6.4 Formation Width

The formation width is the total width of the road from one side of the road to the respective opposite side including the verges that support the shoulders and can locate the guide posts. In this section correlation is sought between the frequency of road crashes and the width of the formation on these roads.

6.4.1 Toowoomba and Gatton

From Table 6.5 there is only one category that an analysis would be valid to analyse. This is again because of the minimal lengths of road that exist in the categories of double lane formation width and four lane formation width. This leaves the single lane formation the only category available to be analysed in the Toowoomba and Gatton region.

Width	# Crashes	Length	Crashes/Km
Single Lane			
6.5 - 6.9	4	6	0.7
7.0 - 7.4	15	10	1.5
7.5 -7.9	26	12	2.2
8.0 - 8.4	51	46.23	1.1
8.5 - 8.9	43	15	2.9
9.0 - 9.4	92	28	3.3
9.5 - 9.9	44	9	4.9
10.0 - 10.4	123	32	3.8
10.5 - 10.9	83	25	3.3
Double Lane			
11.0 - 11.4	59	21.58	2.7
11.5 - 11.9	49	8	6.1
12.0 - 12.4	15	5	3.0
12.5 - 12.9	28	5	5.6
13.0 -13.4	50	3.17	15.8
13.5 - 13.9	46	1	46.0
14.0 - 14.4	40	3	13.3
14.5 -14.9	26	1	26.0
15.0 - 15.4	0	0	0.0
15.5 - 15.9	18	1.27	14.2
16.0 - 16.4	82	2	41.0
16.5 - 16.9	36	1	36.0
17.0 - 17.4	24	1	24.0
Four Lanes			
17.5 - 17.9	27	1	27.0
18.0 - 18.4	31	1	31.0
18.5 - 18.9	84	3	28.0
19.0 - 19.4	101	1	101.0
19.5 - 19.9	0	0	0.0
20.0 - 20.4	0	0	0.0
20.5 - 20.9	0	0	0.0
21.0 - 21.4	108	3	36.0
21.5 - 21.9	0	0	0.0
22.0 - 22.4	9	1	9.0
22.5 - 23.0	62	1.01	61.4

Table 6.5: Formation Width Crashes/Km – Toowoomba and Gatton

From Figure 6.9, which aids in the analysis of the single lane formation width, the general trend is shown as increasing the width causing the amount of crashes to also rise.

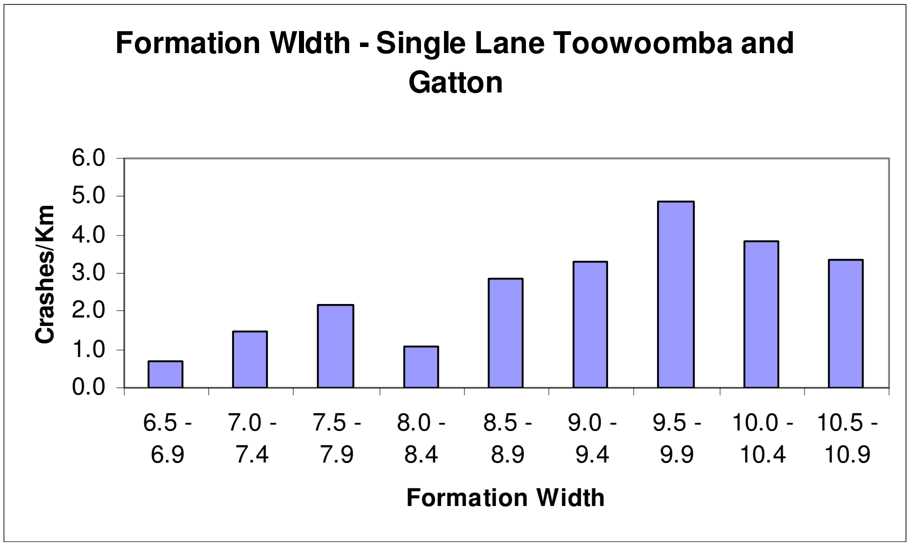


Figure 6.9: Single Lane Formation Width – Toowoomba and Gatton

6.4.2 Southern District

Unlike the Toowoomba and Gatton region the double lane category is able to be analysed due to an increase in the length of roads in these width sections. Due to the increase of data when the analysis area is increased to the entire Southern District the trends that are seen for these roads types becomes clearer. This can be seen in Figures 6.10 and 6.11 below. These correlations that can be seen in these figures are same that have been seen before with the amount of crashes increasing as the width of the formation increases.

Width	# Crashes	Length	Crashes/Km
Single Lane			
5.0 - 5.4	1	3.68	0.3
5.5 - 5.9	1	11.47	0.1
6.0 - 6.4	8	32.23	0.2
6.5 - 6.9	10	36.34	0.3
7.0 - 7.4	28	64.49	0.4
7.5 -7.9	67	228.57	0.3
8.0 - 8.4	235	557.75	0.4
8.5 - 8.9	197	439.658	0.4
9.0 - 9.4	546	373.42	1.5
9.5 - 9.9	232	172.35	1.3
10.0 - 10.4	412	255.29	1.6
10.5 - 10.9	234	144.42	1.6
Double Lane			
11.0 - 11.4	173	92	1.9
11.5 - 11.9	120	49.7	2.4
12.0 - 12.4	71	44.6	1.6
12.5 - 12.9	65	18.61	3.5
13.0 -13.4	93	14.17	6.6
13.5 - 13.9	79	11	7.2
14.0 - 14.4	50	5.72	8.7
14.5 -14.9	37	5.31	7.0
15.0 - 15.4	17	4	4.3
15.5 - 15.9	18	1.27	14.2
16.0 - 16.4	100	5.41	18.5
16.5 - 16.9	36	1	36.0
17.0 - 17.4	24	1	24.0
Four Lanes			
17.5 - 17.9	41	2	20.5
18.0 - 18.4	34	2	17.0
18.5 - 18.9	97	6	16.2
19.0 - 19.4	108	2	54.0
19.5 - 19.9	0	0	0.0
20.0 - 20.4	6	1	6.0
20.5 - 20.9	3	1	3.0
21.0 - 21.4	123	4.54	27.1
21.5 - 21.9	1	1	1.0
22.0 - 22.4	51	2.96	17.2
22.5 - 23.0	76	1.2	63.3

Table 6.6: Formation Width Crashes/Km – Southern District

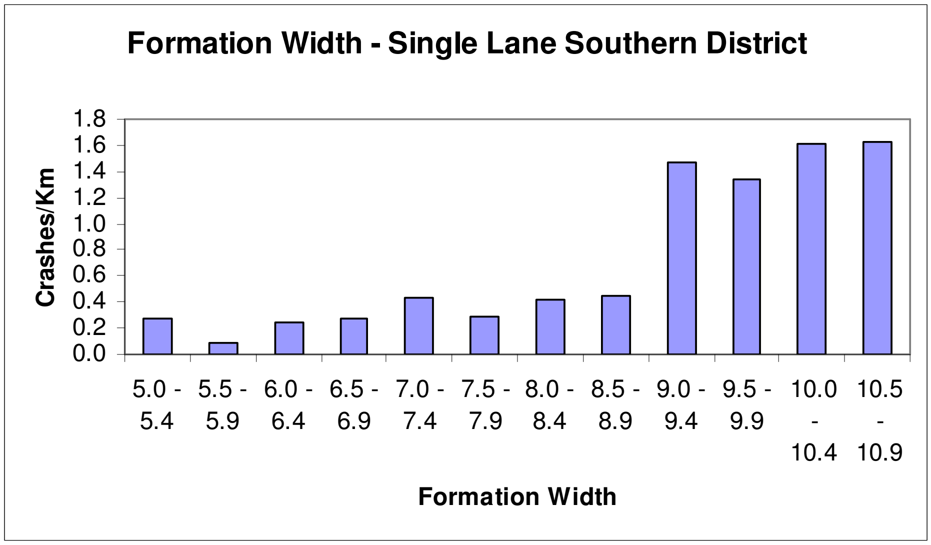


Figure 6.10: Single Lane Formation Width – Southern District

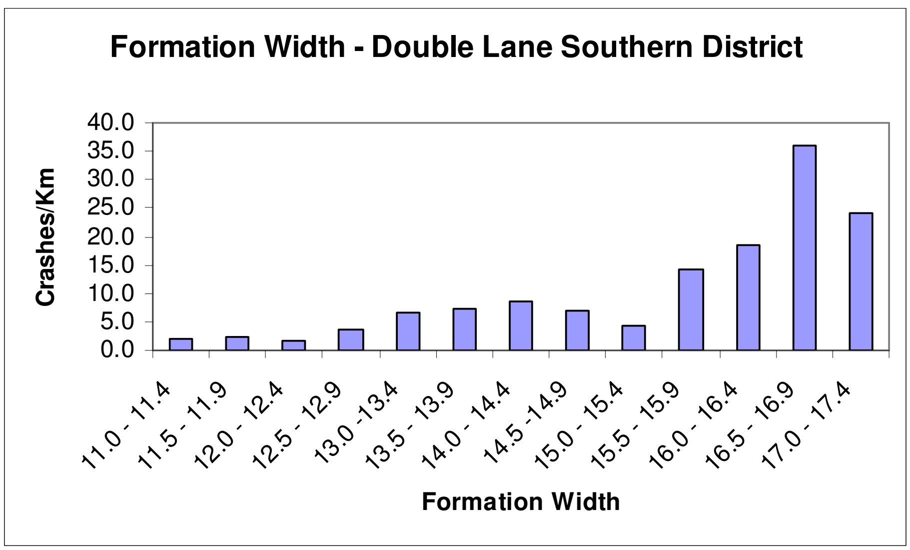


Figure 6.11: Double Lane Formation Width – Southern District

6.5 Speed Limit Zones

This section simply examined the amount of accidents that occur in each speed limit zone in between 1998 and 2002. It is intended to determine whether or not there is any speed limit zone that accidents occur in more than others.

6.5.1 Toowoomba and Gatton

The analysis of the Toowoomba and Gatton areas reveals a very strong correlation between the number of crashes and the speed limit zone that they occur in. This correlation is easy to see in Table 6.7, but is demonstrated even more effectively by the graph in Figure 6.12 below. This figure reveals that more accidents occur per kilometre of road then any other zone as the amount of accidents per kilometre of road decreases as the speed limit rises. Another point of interest is the crashes per kilometre of road in the 60 Km/h zones are much higher than the other zones.

Speed	Length	# Crashes	Crashes/Km
60	50.32	917	18.2
80	19	86	4.5
100	184.74	316	1.7

Table 6.7: Speed Limit Zone Crashes/Km – Toowoomba and Gatton

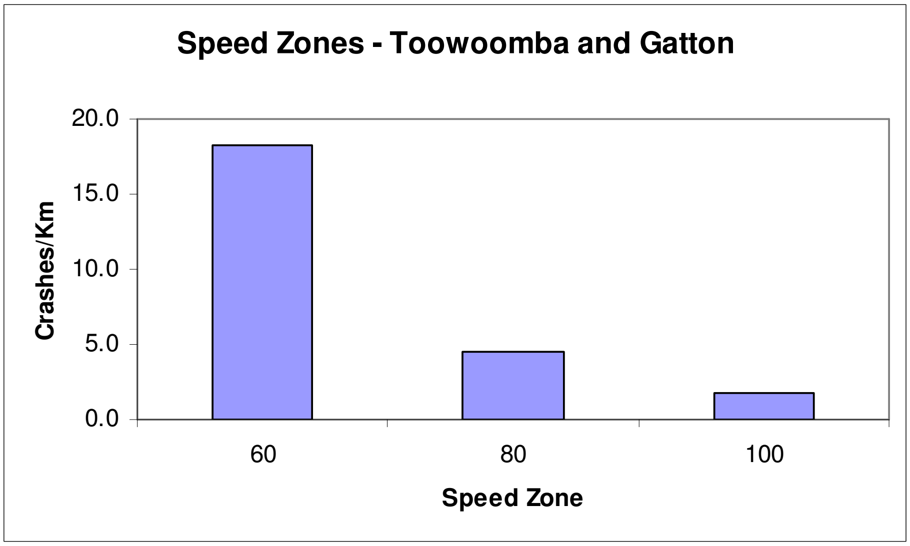


Figure 6.12: Speed Limit Zone Crashes – Toowoomba and Gatton

6.5.2 Southern District

The correlation is also evident in the analysis of the data for the Southern District from Figure 6.13 below. The correlation is the same with the crashes per kilometre being the highest in the 60 Km/h zone and reducing as the speed limit rises. Comparing the two areas it was found that 59% of the crashes per kilometre, in the 60 Km/h zone, in the Southern District occurred in the Toowoomba and Gatton areas. Also 83% of the crashes per kilometre, in the 100 Km/h zones in the Southern District, occurred outside of the Toowoomba and Gatton areas.

Speed	Length	# Crashes	Crashes/Km
60	142.21	1265	8.9
70	1.74	3	1.7
80	118.11	300	2.5
100	2703.428	1739	0.6
110	35.37	9	0.3

Table 6.8: Speed Limit Zone Crashes – Southern District

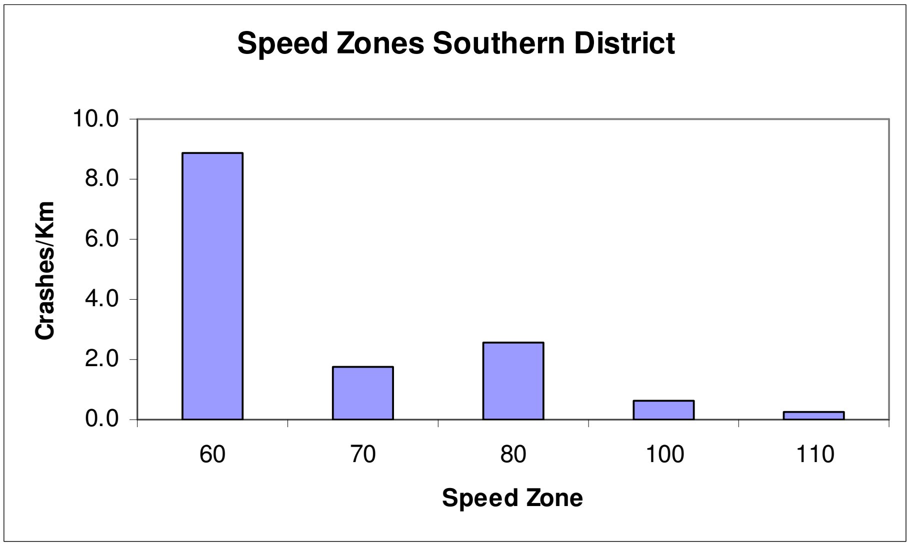


Figure 6.13: Speed Limit Zone Crashes – Southern District

6.6 AADT Vs. Width

This section analyses the relationship between the AADT of the road and the width of the road relating to seal, pavement and formation. The aim of this section is to investigate the affect of the AADT and width of the road on the number of crashes on the road.

6.6.1 Seal Width

Toowoomba and Gatton

The data for the Toowoomba and Gatton was not beneficial to analyse as it would not have provided any accurate statistics. Therefore no analysis was conducted for any category of road in this section.

Southern District

The only road category that would show accurate results after analysis for the Southern District was the double lane sealed shoulders. The analysis of which is found in Table 6.9 below. From Table 6.9 it can be seen that the low flow and medium flow have roughly the same amount of crashes with the high flow category being higher. The low and medium flow can only be analysed up to 9.9 metres but it can be seen that the three categories really do not increase as the width increases.

Width	AADT	Length	# Crashes	Crashes/Km
7.0 - 7.4	< 500	90.86	17	0.2
	500 - 1000	72.59	26	0.4
	> 1000	91.95	114	1.2
7.5 - 7.9	< 500	54	15	0.3
	500 - 1000	19	4	0.2
	> 1000	59.23	102	1.7
8.0 - 8.4	< 500	70.36	19	0.3
	500 - 1000	53.09	13	0.2
	> 1000	89.16	149	1.7
8.5 - 8.9	< 500	16.11	11	0.7
	500 - 1000	15.186	8	0.5
	> 1000	58.51	143	2.4
9.0 - 9.4	< 500	38.31	14	0.4
	500 - 1000	53.282	19	0.4
	> 1000	217.3	350	1.6
9.5 - 9.9	< 500	3.74	3	0.8
	500 - 1000	13	9	0.7
	> 1000	64.45	181	2.8
10.0 - 10.4	< 500	4	1	0.3
	500 - 1000	2	3	1.5
	> 1000	94.03	200	2.1
10.4 -10.9	< 500	2	0	0.0
	500 - 1000	2	1	0.5
	> 1000	45.27	126	2.8
11.0 - 11.4	< 500	1	0	0.0
	500 - 1000	1	1	1.0
	> 1000	55	129	2.3
11.5 - 11.9	< 500	2.36	6	2.5
	500 - 1000	0	0	0.0
	> 1000	30.34	93	3.1
12.0 - 12.4	< 500	3.4	8	2.4
	500 - 1000	0	0	0.0
	> 1000	32.5	65	2.0

Table 6.9: AADT vs. Width - Double Lane Sealed Shoulders Southern District

6.6.2 Pavement Width

Toowoomba and Gatton

There was only one road category for pavement widths to be analysed for this region and that was the single lane. Table 6.10 below provides the analysis of this road type.

Width	AADT	Length	# Crashes	Crashes/Km
6.5 - 6.9	< 500	0	0	0.0
	500 - 1000	7.57	1	0.1
	> 1000	2	3	1.5
7.0 - 7.4	< 500	6	2	0.3
	500 - 1000	3	1	0.3
	> 1000	3	12	4.0
7.5 - 7.9	< 500	0	0	0.0
	500 - 1000	4	1	0.3
	> 1000	8.23	25	3.0
8.0 - 8.4	< 500	1	0	0.0
	500 - 1000	18	8	0.4
	> 1000	27.23	43	1.6
8.5 - 8.9	< 500	0	0	0.0
	500 - 1000	4	3	0.8
	> 1000	12	40	3.3

Table 6.10: AADT vs. Width - Single Lane Pavement Toowoomba and Gatton

It is gain shown that high flow is higher than the medium and low flow categories but there is no data for the low flow section. For medium flow the amount of crashes steadily increase as the width of the road increases while the amount of crashes occurring on high flow roads remains steady as the width increases.

Southern District

The Southern District data provided two road categories that were able to be analysed, they were the single and double lane pavements. The analyses are included in Table 6.11 and 6.12 respectively, below.

For the single lane pavement in Table 6.11 the low flow is analysable throughout the entire width of the road but remains steady and the amount of crashes occurring is again relatively similar to that of medium flow. Medium flow is analysed from 5.5 metres wide onwards but unlike low flow displays a slight increase in crashes as the width increases. High flow can only be analysed from 6.5 metres onwards but again is steady with a higher number of accidents then low and medium flow.

Width	AADT	Length	# Crashes	Crashes/Km
3.5 - 3.9	< 500	28.13	1	0.0
	500 - 1000	0	0	0.0
	> 1000	0	0	0.0
5.0 - 5.4	< 500	6.68	1	0.1
	500 - 1000	0	0	0.0
	> 1000	0	0	0.0
5.5 - 5.9	< 500	18.47	3	0.2
	500 - 1000	6	1	0.2
	> 1000	0	0	0.0
6.0 - 6.4	< 500	51.29	6	0.1
	500 - 1000	3.67	0	0.0
	> 1000	0	0	0.0
6.5 - 6.9	< 500	34.77	3	0.1
	500 - 1000	14.57	2	0.1
	> 1000	4	6	1.5
7.0 - 7.4	< 500	28	13	0.5
	500 - 1000	27.59	5	0.2
	> 1000	7	12	1.7
7.5 - 7.9	< 500	171.57	27	0.2
	500 - 1000	31	15	0.5
	> 1000	15.23	30	2.0
8.0 - 8.4	< 500	317.72	57	0.2
	500 - 1000	152.54	54	0.4
	> 1000	79.34	123	1.6
8.5 - 8.9	< 500	336.04	43	0.1
	500 - 1000	51.768	29	0.6
	> 1000	69	111	1.6

Table 6.11: AADT vs. Width - Single Lane Pavement Southern District

For the double lane pavement width in the Southern district all three traffic flows display a trend that indicates that as the width increases the amount of accidents occurring also increases. Low flow shows a general trend where the accidents occurring increase but can only be analysed up to 12.9 metres. The medium flow can only be analysed up to 11.4 metres with the crash amounts for both low and medium flow again being similar. High flow shows an increase for the whole road category but here is an outlier found in the trend for the width category of 14.5 metres to 14.9 metres. It is also shown again that the amount of crashes for high flow is higher than low and medium flow.

Width	AADT	Length	# Crashes	Crashes/Km
9.0 - 9.4	< 500	235.81	57	0.2
	500 - 1000	131.46	48	0.4
	> 1000	349.55	452	1.3
9.5 - 9.9	< 500	38.03	11	0.3
	500 - 1000	30	22	0.7
	> 1000	96.32	195	2.0
10.0 - 10.4	< 500	28.41	15	0.5
	500 - 1000	33	14	0.4
	> 1000	191.88	389	2.0
10.5 - 10.9	< 500	35.74	7	0.2
	500 - 1000	21	10	0.5
	> 1000	84.68	222	2.6
11.0 - 11.4	< 500	10.86	1	0.1
	500 - 1000	4	5	1.3
	> 1000	78.14	146	1.9
11.5 - 11.9	< 500	6.36	6	0.9
	500 - 1000	1	0	0.0
	> 1000	44.34	117	2.6
12.0 - 12.4	< 500	4.07	3	0.7
	500 - 1000	1	0	0.0
	> 1000	34.53	66	1.9
12.5 - 12.9	< 500	2.61	5	1.9
	500 - 1000	0	0	0.0
	> 1000	17	69	4.1
13.0 - 13.4	< 500	0	0	0.0
	500 - 1000	1	3	3.0
	> 1000	13.17	90	6.8
13.5 - 13.9	< 500	0	0	0.0
	500 - 1000	1	2	2.0
	> 1000	10	77	7.7
14.0 - 14.4	< 500	1	1	1.0
	500 - 1000	0	0	0.0
	> 1000	4.72	49	10.4
14.5 - 14.9	< 500	0.31	0	0.0
	500 - 1000	1	1	1.0
	> 1000	3	10	3.3
15.0 - 15.4	< 500	0	0	0.0
	500 - 1000	0	0	0.0
	> 1000	5	43	8.6

Table 6.12: AADT vs. Width – Double Lane Pavement Southern District

6.6.3 Formation Width

Toowoomba and Gatton

The only road category that could be analysed for the Toowoomba and Gatton region was the single lane formation. Below is Table 6.13 that displays the analysis of the data for this road category.

Width	AADT	Length	# Crashes	Crashes/Km
6.5 - 6.9	< 500	0	0	0.0
	500 - 1000	7.57	1	0.1
	> 1000	2	3	1.5
7.0 - 7.4	< 500	6	2	0.3
	500 - 1000	3	1	0.3
	> 1000	3	12	4.0
7.5 - 7.9	< 500	0	0	0.0
	500 - 1000	4	1	0.3
	> 1000	8.23	25	3.0
8.0 - 8.4	< 500	1	0	0.0
	500 - 1000	18	8	0.4
	> 1000	27.23	43	1.6
8.5 - 8.9	< 500	0	0	0.0
	500 - 1000	4	3	0.8
	> 1000	12	40	3.3
9.0 - 9.4	< 500	0	0	0.0
	500 - 1000	6	1	0.2
	> 1000	22	91	4.1
9.5 - 9.9	< 500	1	0	0.0
	500 - 1000	0	0	0.0
	> 1000	11	44	4.0
10.0 - 10.4	< 500	0	0	0.0
	500 - 1000	1	0	0.0
	> 1000	31	123	4.0
105. 10.9	< 500	0	0	0.0
	500 - 1000	0	0	0.0
	> 1000	25	83	3.3

Table 6.13: AADT vs. Width - Single Lane Formation Toowoomba and Gatton

For the second time with a single lane road in the Toowoomba and Gatton region the low flow category contains no data so is therefore unable to be analysed in this section. Medium flow is able to be analysed up to 9.4 metres and shows and increase in the amount of accidents happening however high flow still has more accidents occurring. High flow does not show an increase but is steady thorough out the entire width of the single lane formation.

Southern District

The two road categories that are able to be analysed for the formation width in the Southern District. Table 6.14 contains the information from the single lane formation and Table 6.14 is for the double lane analysis.

All three flow categories remain steady throughout the width of the single lane formation. Medium flow can only be analysed from 5.5 metres on wards and high flow from 6.5 metres. As with all the previous analysis in this section the high flow category has more accidents occurring than the low and medium category which are both comparable with each other.

Width	AADT	Length	# Crashes	Crashes/Km
5.0 - 5.4	< 500	3.68	1	0.3
	500 - 1000	0	0	0.0
	> 1000	0	0	0.0
5.5 - 5.9	< 500	10.47	0	0.0
	500 - 1000	6	1	0.2
	> 1000	0	0	0.0
6.0 - 6.4	< 500	55.52	8	0.1
	500 - 1000	3.67	0	0.0
	> 1000	0	0	0.0
6.5 - 6.9	< 500	31.77	2	0.1
	500 - 1000	14.57	2	0.1
	> 1000	4	6	1.5
7.0 - 7.4	< 500	29.9	11	0.4
	500 - 1000	27.59	5	0.2
	> 1000	7	12	1.7
7.5 - 7.9	< 500	187.57	23	0.1
	500 - 1000	30	15	0.5
	> 1000	13.23	29	2.2
8.0 - 8.4	< 500	330.87	54	0.2
	500 - 1000	143.54	52	0.4
	> 1000	83.34	129	1.5
8.5 - 8.9	< 500	310.89	46	0.1
	500 - 1000	56.768	31	0.5
	> 1000	72	121	1.7
9.0 - 9.4	< 500	253.81	59	0.2
	500 - 1000	139.46	49	0.4
	> 1000	345.55	438	1.3
9.5 - 9.9	< 500	45.03	13	0.3
	500 - 1000	29	22	0.8
	> 1000	98.32	197	2.0
10.0 - 10.4	< 500	36.41	17	0.5
	500 - 1000	32	13	0.4
	> 1000	186.88	382	2.0
10.4 - 10.9	< 500	38.74	9	0.2
	500 - 1000	22	11	0.5
	> 1000	83.68	214	2.6

Table 6.14: AADT vs. Width - Single Lane Formation Southern District

The double lane analysis can be seen in Table 6.15 below. The only flow category that can be analysed is the high flow category as there is no data on medium flow and not enough data for an accurate analysis to be conducted on low flow. High flow however shows high amount of crashes that increases as the width increases.

Width	AADT	Length	# Crashes	Crashes/Km
11.0 - 11.4	< 500	5.86	1	0.2
	500 - 1000	3	4	1.3
	> 1000	83.14	168	2.0
11.5 - 11.9	< 500	7.36	7	1.0
	500 - 1000	0	0	0.0
	> 1000	42.34	113	2.7
12.0 - 12.4	< 500	8.07	3	0.4
	500 - 1000	1	0	0.0
	> 1000	35.53	68	1.9
12.5 - 12.9	< 500	2.61	5	1.9
	500 - 1000	0	0	0.0
	> 1000	16	60	3.8
13.0 - 13.4	< 500	0	0	0.0
	500 - 1000	1	3	3.0
	> 1000	13.17	90	6.8
13.5 - 13.9	< 500	0	0	0.0
	500 - 1000	1	2	2.0
	> 1000	10	77	7.7
14.0 - 14.4	< 500	1	1	1.0
	500 - 1000	0	0	0.0
	> 1000	4.72	49	10.4
14.5 - 14.9	< 500	0.31	0	0.0
	500 - 1000	1	1	1.0
	> 1000	4	36	9.0
15.0 - 15.4	< 500	0	0	0.0
	500 - 1000	0	0	0.0
	> 1000	4	17	4.3
15.5 - 15.9	< 500	0	0	0.0
	500 - 1000	0	0	0.0
	> 1000	1.27	18	14.2
16.0 - 16.4	< 500	0	0	0.0
	500 - 1000	0.41	1	2.4
	> 1000	5	99	19.8
16.5 - 16.9	< 500	0.21	0	0.0
	500 - 1000	0	0	0.0
	> 1000	1	36	36.0
17.0 - 17.4	< 500	0	0	0.0
	500 - 1000	0	0	0.0
	> 1000	1	24	24.0

Table 6.15: AADT vs. Width - Double Lane Formation Southern District

6.7 Chapter Summary

This chapter reported on the analysis of the factors relating to the road environment and the frequency of road crashes. The factors that were analysed included seal width, pavement width, formation width, speed limit zones and the AADT vs. Width. Throughout the three width categories it was found that as the width increases the amount of crashes also increases. In addition to this it was also seen that as the speed limit increases the amount of crashes decreases. From the AADT vs. Width section it was found that low and medium flow display low amounts of crashes when compared to the amount of accidents occurring for high flow which has higher crash occurrences.

Chapter 7

Discussion of Results

7.1 Introduction

This chapter discusses the results gained from the previous two chapters. This includes an analysis of the ‘tidal flow’ and road environment factors in relation to the frequency of road crashes. Each section compares the results of these analyses for each study area. Furthermore a report on any correlations that were found for each section is included.

7.2 Tidal Flow

I n the Toowoomba and Gatton region it was established that there the periods of 0 – 4 and 20 – 24 have a high crash rate despite a low traffic flow. This was likewise found in the Southern District. From both of the study areas, particularly the Southern District, it was noted that the period of 0 – 4 consistently had low traffic flows but high crash rates that in many cases were the highest for the road.

In the Southern District it was found that the road 22A had crash rates throughout the day that were much higher than any other road in the region the reasons for these are thought to be because of a small traffic flow combined with a high number of crashes causing a high crash rate. The traffic flow was lower than the average for the roads and the number of crashes was also higher for this section of road.

It was concluded from the analysis of the Southern District and the Toowoomba and Gatton region that a high traffic flow does not necessarily translate into a high crash rate.

7.3 Road Environment

The analysis of the road environment in relation to road crashes required the analysis of various factors and their relationship to the frequency of road crashes. Below, these factors are analysed in an attempt to discover if particular features of these factors are more likely to be present at an accident site.

7.3.1 Seal Width

No correlation could be found in the data from the Toowoomba and Gatton regions that indicates a correlation between the seal width of the road and the amount of crashes on these roads. However in the Southern District from the data that analysable it was indicates for both double lane sealed shoulders and four lane sealed shoulders the amount of accidents occurring does increase as the width of the seal of the road increases.

From this section it was found that as the seal width increases the amount of accidents also increases. This was only found throughout the Southern District on double lane sealed shoulders and four lane shoulders. The other categories were not able to be analysed due to insufficient data sets.

7.3.2 Pavement Width

This section analysed the width of the pavement and its relation to the amount of crashes. The roads analysed were single lane roads and double lane roads but four lane roads were disregarded. This is again because of insufficient lengths of road for this road category in the data. Again it was found that the two types of roads analysed indicated a correlation existed between crashes and the pavement of the road. These correlations were also apparent in the data for the Toowoomba and Gatton region and the Southern District.

The correlation that was found again suggests that as the width of the pavement increases the amount of crashes also increases. However the trends that were found sometimes were steady followed by a sudden increase as was the case with double lane roads in the Southern District.

7.3.3 Formation Width

For the Toowoomba and Gatton region the only category of road that could be analysed was the single lane formation. For the Southern District the single lane and double lane formations could be analysed. The reason for the other categories not being able to be analysed is the same as before with the lengths of road, for the formation widths, being too short for an accurate investigation.

For the single lane formation in the Toowoomba and Gatton region the same correlation was found as in the previous sections with the amount of crashes increasing with the formation width increasing. The trends that were found for the two road types in the Southern District data show a steady increase of the number of crashes as the formation width increases.

7.3.4 Speed Limit Zones

Both the Toowoomba and Gatton region and Southern District displayed a conclusive trend between the speed limit zone and the amount of crashes that occur in these zones. The trend for both area shows that the amount of crashes decreases as the speed limit of the road increases. However from the amount of crashes in 60 Km/h zones in the Southern District 59% occurred in the Toowoomba and Gatton region. Furthermore

80% of the accidents in 100Km/h zones in the Southern District happened outside of Toowoomba and Gatton. This suggests that most of the accidents in 60Km/h zones occur in Toowoomba and Gatton and most accidents in 100Km/h zones happen outside Toowoomba and Gatton.

7.3.5 AADT vs. Width

This section found that the higher the flow of the road the higher the amount of accidents. Low and medium flow were found to have comparable amounts of accidents occur on those roads but the high flow roads consistently had more accidents occurring. Occasionally throughout the analysis a trend could be seen where as the width of the road increased the number of accidents occurring also increased. However it was also seen that as the width of the road increased the amount of accidents remained steady.

7.4 Chapter Summary

This chapter discussed the results gained from the previous two chapters. These results included an analysis of the 'tidal flow' and road environment factors in relation to the frequency of road crashes. Each section above compared the results of these analyses for each study area.

Chapter 8

Conclusions and Further Work

8.1 Conclusions

From the tidal flow analysis it could be seen that a higher traffic flow did not necessarily indicate that a higher crash rate would result. In fact the higher crash rates occurred during 0 – 4 and 20 – 24 with these periods have a lower traffic flow. These periods are known as the tired times. The higher crash rate may result from a number of reasons. These reason could be that as these are the tired times the amount of accidents are from drives getting tired and going to sleep at the wheel. The reason that the drivers may go to sleep may be because of the low traffic flow does not make a driver concentrate as much as normal.

The seal, pavement and formation width all show a correlation that indicated that when the width of each of these factors increases the amount of accidents occurring also increases. The factor from these three that influences the drivers the most is the seal width followed by the formation width with the pavement width the factor affecting a driver the least. It was also shown through the analysis of the width vs. AADT that the amount of crashes occurring at very least remains steady as the width increases but usually increases. This is an interesting finding as when the width of the road increases the amount of accidents should decrease as there is a lot more margin for error by the driver. One reason why this may occur is that when the road is narrow a driver concentrates more and when the road width increases the driver relaxes and does not pay as much attention as when the road was narrower.

From the width vs. AADT it was found that higher flow roads have more accidents occurring than the low and medium flow roads. This is unsurprising as the more cars there are on the road the higher the chances of an accident occurring.

The analysis of the speed limit zones produced interesting results that suggested that as the speed limit raised the amount of accidents that occurred reduced. However it was found that most 60 Km/h accidents were in the Toowoomba and Gatton region and the 100 Km/h accidents were outside of Toowoomba and Gatton region. A reason for higher accidents occurring in 60 Km/h zones on main roads could be due to the fact that some drivers slow down and some do not. This creates traffic flows with, generally, half the traffic at one speed and the other half at another. This effect would increase the likelihood of accidents occurring.

8.2 Further Work

Another factor that was not analysed in this project due to lack of data and time is crashes that occur on curves compared to straight sections of road. This data is available from main roads and would be interesting factor to analyse to complement the work which has already been done.

Due to the initial crash data that was received covering four districts this analysis could be reproduced looking at different a different district and focus areas. After this analysis is complete the findings from the other districts analysis could be compared to those found in this project. If this was completed it could be seen if the results found in this district apply to a greater area.

An inadequacy of this project is the fact that the analysis conducted only covered the main roads. An investigation could be completed along the same lines as this project looking at the factors in the inner city. These factors could include footpath widths, trees, power poles and other roadside hazards along with an analysis of the major intersections.

The analysis of crash data in this project was very broad, disregarding the determined cause of the crash and only looking at the road data at every crash location. It would be interesting to analyse each crash individually to only analyse the accidents that have been determined to have been caused by the road environment. Some problems that may arise with undertaking this study is that because most accident are classified as being caused by driver related characteristics, a minimal amount of data could be analysed which would affect the integrity of the analysis.

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Appendix A

Project Specification

University of Southern Queensland
Faculty of Engineering and Surveying

ENG 4111/4112 Research Project
PROJECT SPECIFICATION
Issue: 22nd March 2004

Student Name:Jason JENSEN

Topic: **Influence of Physical Road Characteristics on Road Crashes**

Supervisors: Associate Professor Ron Ayers (USQ)
Mal McIlwaith (Queensland Transport, Toowoomba)

Project Aim: To develop a method which can be used to predict the likely crash rate of a road section based on the physical environment of the road.

Background: Crash data is usually analysed on the basis of driver elated characteristics, such as driver age, gender, blood alcohol level, vehicle, vehicle speed and fatigue. This study will seek to consider an alternate approach where the crash data is considered in relation to the road environment.

Research Programme

1. Review existing literature regarding road crashes, and in particular:
   - Analysis of crash data; and
   - Correlation of crash rates with influencing parameters.

2. Obtain crash data for the Toowoomba District for the past five years.

3. Select a sample of data (e.g. data for Toowoomba City and one shire) and examine the correlation between traffic volume and crash rate. It is likely that additional factors may also need to be considered, such as category of vehicle. The aim is examine if a strong correlation exists between crash rate and the "tidal flow" of traffic.

4. If the work in Step 3 appears promising extend the investigation to all local government areas in the Toowoomba District.

5. Repeat steps 3 and 4 looking at the correlation of broad scale road environment measures of the road and crash rates

6. Report findings through oral presentation at the Project Conference, and in the required written format.

Agreed: ____________________Ron Ayers __________________Jason Jensen

Appendix B

Southern District Road Classifications

B1 State Highways

Road Classification	Road Name and Location
18A	Warrego Highway (Ipswich – Toowoomba)
18B	Warrego Highway (Toowoomba – Dalby)
18C	Warrego Highway (Dalby – Miles)
22A	New England Highway (Yarraman – Toowoomba)
22B	New England Highway (Toowoomba – Warwick)
28A	Gore Highway (Toowoomba – Millmerran)
28B	Gore Highway (Millmerran – Goondiwindi)
35A	Moonie Highway (Dalby – St. George)
40B	D’Aguilar Highway (Kilcoy – Yarraman)
40C	D’Aguilar Highway (Yarraman – Kingaroy)
41A	Burnett Highway (Nanango – Goomeri)
42A	Brisbane Valley Highway (Ipswich – Harlin)
45A	Bunya Highway (Dalby – Kingaroy)
45B	Bunya Highway (Kingaroy – Goomeri)

B2 Main Roads

<u>Road Classification</u>	<u>Road Name and Location</u>
308	Rosewood – Laidley Road
311	Laidley – Plainlands Road
312	Gatton – Laidley Road
313	Gatton – Clifton Road
314	Gatton – Helidon Road
320	Charlton Connection Road
321	Drayton Connection Road
323	Oakey – Pittsworth Road
324	Toowoomba – Cecil Plains Road
325	Dalby – Cecil Plains Road
327	Pampas – Horraine Road
330	Felton – Clifton Road
331	Toowoomba – Karara Road
332	Pittsworth – Felton Road
335	Millmerran – Leyburn Road
337	Millmerran – Inglewood Road
340	Dalby – Kogan Road
341	Chinchilla – Tara Road
342	Kogan – Condamine Road
405	Esk – Kilcoy Road
410	Wivenhoe – Somerset Road
411	Coominya Connection Road
412	Forest Hill – Fernvale Road
414	Esk – Hampton Road
416	Dalby – Cooyar Road
417	Oakey – Cooyar Road
418	Pechey – Maclagan Road
419	Kingaroy – Cooyar Road
421	Dalby – Jandowae Road
422	Macalister – Bell Road
423	Jandowae Connection Road

Road Classification	Road Name and Location
424	Kingaroy – Jandowae Road
426	Chinchilla – Wondai Road
428	Kingaroy – Burrandowan Road
429	Nanango – Tarong Road
435	Munduberra – Durong Road
436	Wondai – Proston Road
437	Murgon – Barambah Road
439	Murgon – Gayndah Road
491	Kilcoy – Murgon Road

B3 Secondary Roads

Road Classification	Road Name and Location
3083	Mulgowie Road
3102	Greenmount – Hirstvale Road
3131	Mount Sylvia Road
3203	Bowenville – Norwin Road
3221	Brookstead – Norwin Road
3251	Millmerran – Cecil Plains Road
3304	Cambooya Connection Road
3308	Nobby Connection Road
3341	Greenmount Connection Road
3401	Daandine – Nandi Road
3402	Tara – Kogan Road
3403	Warra – Kogan Road
4023	Mount Glorious Road
4104	Murphy's Creek Road
4144	Gatton – Esk Road
4161	Bunya Mountains Road
4163	Bunya Mountains – Maclagan Road
4196	Maidenwell – Bunya Mountains Road
4201	Warra – Canaga Creek Road
4202	Kingaroy – Barker's Creek Road
4206	Memerambi – Gordonbrook Road
4261	Auburn Road
4356	Proston – Boondooma Road
4364	Boondooma Dam Road
4365	Byee Road

Appendix C

NAASRA Road Classification System

C1 Rural Areas

Class 1
Those roads which form the principal avenue for communications between major regions of Australia, including direct connections between capital cities.

Class 2
Those roads, not being Class 1, whose main function is to form the principal avenue of communication for movements:
•Between capital city and adjoining states and their capital cities; or
•Between a capital city and key towns; or
•Between key towns.

Class 3
Those roads, not being Class 1 or 2, whose main function is to form an avenue of communication for movements:
•Between important centres and the Class 1 and Class 2 roads and/or key towns; or
•Between important centres; or
•Of an arterial nature within a town in a rural area.

Class 4
Those roads, not being of Class 1, 2 or 3, whose main function is to provide access to abutting property (including property within a town in a rural area).

Class 5
Those roads which provide almost exclusively for one activity or function which cannot be assigned to Classes 1, 2, 3 or 4.

C2 Urban Areas

Class 6
Those roads whose main function is to perform the principal avenue of communication for massive traffic movements.

Class 7
Those roads, not being Class 6, whose main function is to supplement the Class 6 roads in providing for traffic movements or which distribute traffic to local street systems.

Class 8
Those roads not being Class 6 or 7, whose main function is to provide access to abutting property.

Class 9
Those roads which provide almost exclusively for one activity or function and which cannot be assigned to Class 6, 7 or 8.

Appendix D

Crash Data

Appendix E

Road Data