

Road Safety Investigation at Roundabouts in Toowoomba

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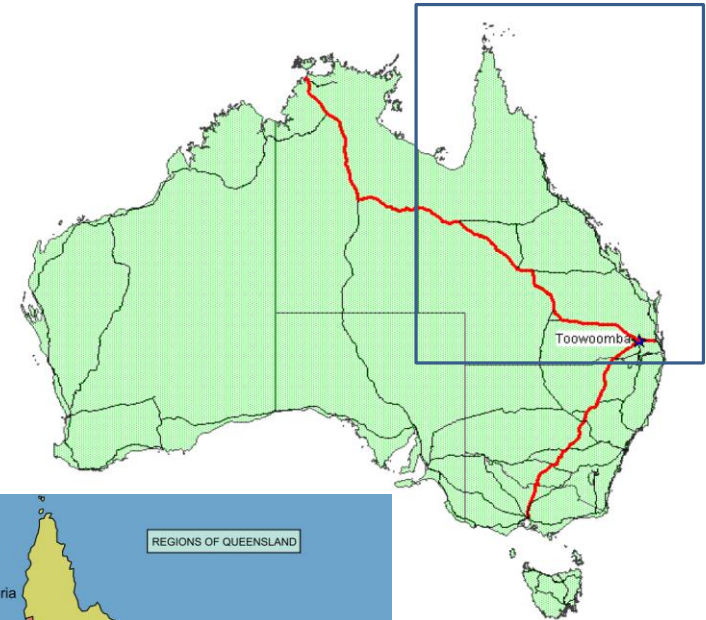
Toowoomba, Australia

Toowoomba

- Major city for 'Darling Downs' area (160,000 area population)
- About 120 km from Brisbane City (A rural city)
- City population 113,000 (2015)
- Major Hub; Two airports
- Garden city of Queensland



Jacaranda trees – Ruthven St



Queensland

Road network - Toowoomba

- Three major highways
- Traffic management
 - Toowoomba regional council (TRC)
 - Department of Transport and Main Roads (DTMR)
- Roundabouts have been growing in popularity for the last 50 years.
- **Over 50 roundabouts** in Toowoomba



Arial view – City

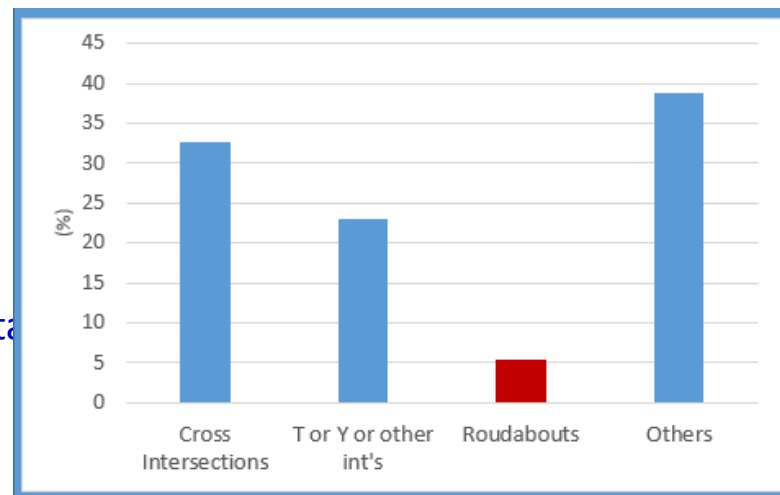


Toowoomba's street map

(Source: Street Directory 2014)

Road safety in QLD

- The Queensland road toll was 250 fatalities for 2016,
 - 31 fatalities (or 3.2%) more than the previous year (2015)
 - 21 fatalities (or 7.0%) more than the previous five year average (2011-15)
- Major contributory factors includes:
 - Alcohol/drugs (25%)
 - Fatigue (21%)
 - Speed (21%)
 - Illegal Manoeuvres (14%)
 - Failure to Give Way or Stop (11%)
- Toowoomba Regional Council
 - 2011-2015 - 1301 crashes (Web Crash data)
 - 61% - intersection related crashes
 - 9% at roundabouts



Objectives

The objectives of this study is to:

1. identify worst performing roundabouts
2. carryout field investigation at the poorly performing roundabouts
3. propose suitable recommendations

Trend in similar researches

Number of things that
go wrong is as low as
possible

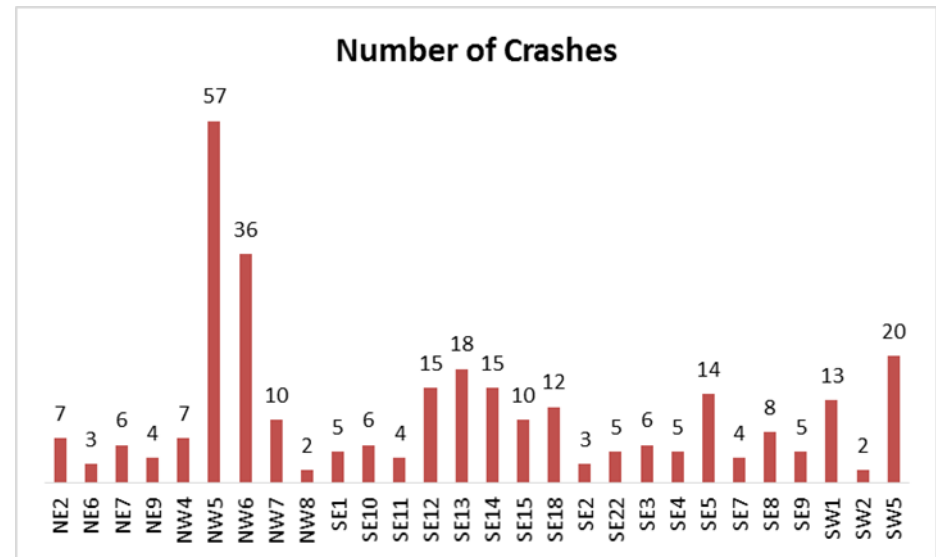


Focussing of what goes
right rather than on
what goes wrongs

Methodology

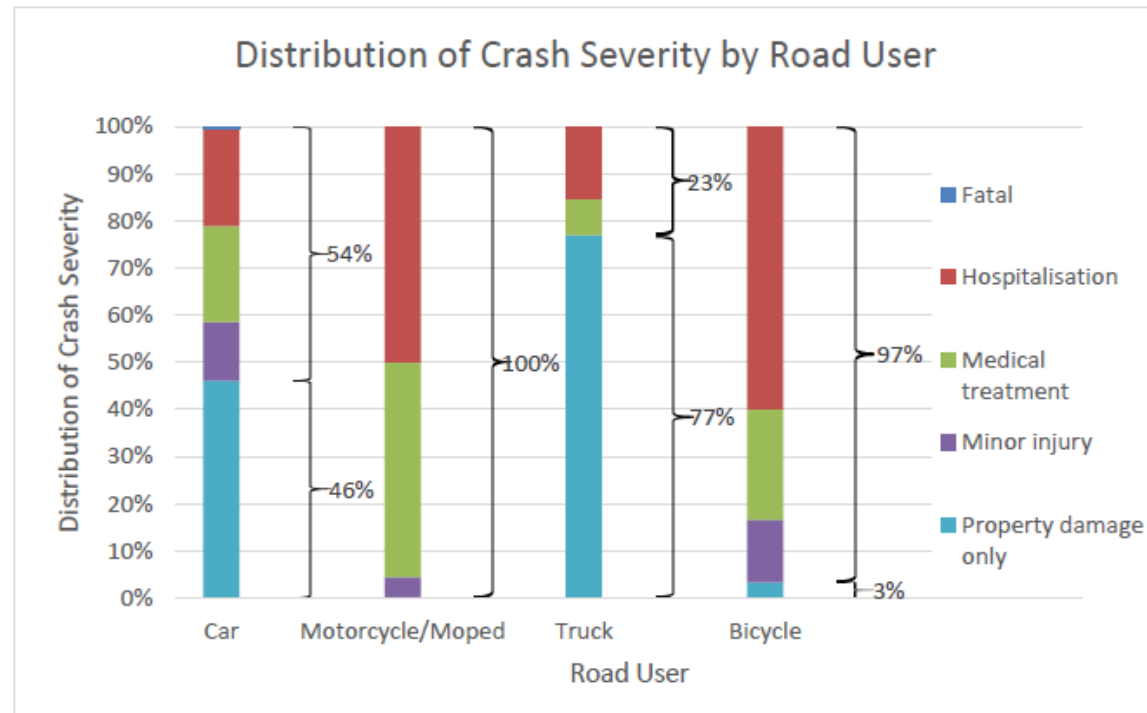
The following are about 13 problem identification methods (FHWA 2016), including

- Average Crash Frequency
- Critical crash rate (CCR)
- Weighted average crash rate
- Relative Severity Index (RSI) - societal crash costs based on the type of crash that are assigned to each crash at each site to develop a RSI value



Crashes at selected roundabouts

Weighting factors based on users



Non-PD type: Motorcycle – Car = $100 - 54 = 46\%$

Weighting factor for motorcycle road users = 1.46

Definitions for coding crashes-QLD

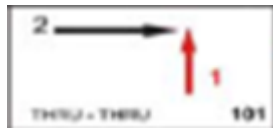
DEFINITIONS FOR CODING ACCIDENTS

NOTE:- 1 = Key vehicle direction. ie; The direction in which the key vehicle was travelling as it approached the crash location.

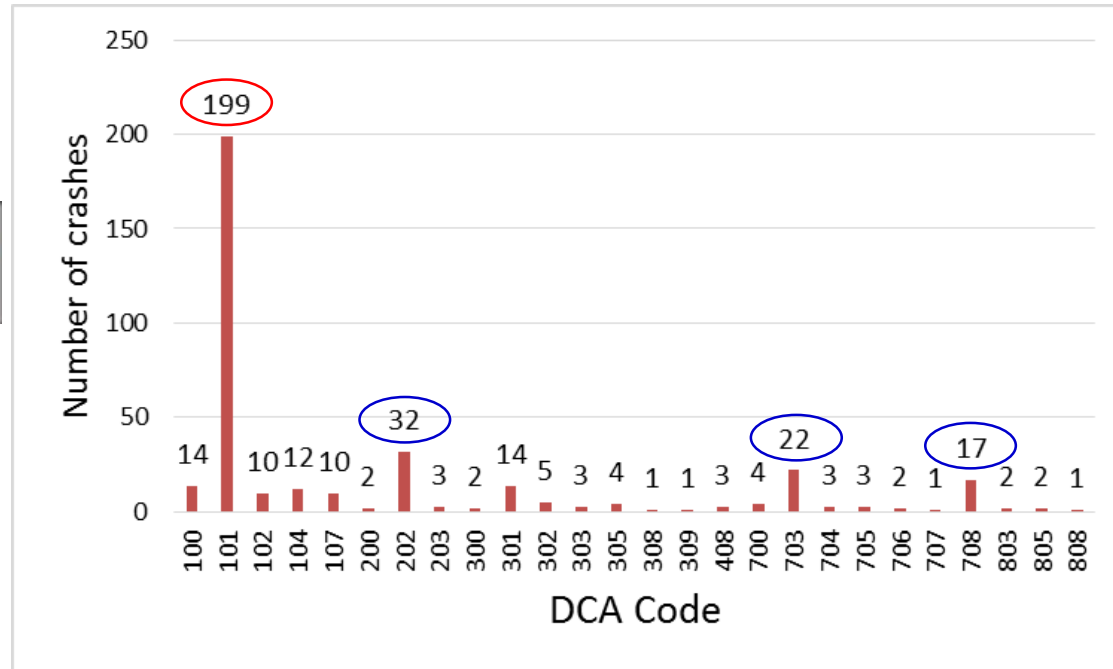
	00 PEDESTRIAN on foot or in toy/pram	10 INTERSECTION vehicles from adjacent approaches	20 VEHICLES from opposing directions	30 VEHICLES from one direction	40 MANOEUVRING	50 OVERTAKING	60 ON PATH	70 OFF PATH ON STRAIGHT	80 OFF PATH ON CURVE	90 PASSENGERS & MISCELLANEOUS
	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER	OTHER
	000	100	200	300	400	500	600	700	800	900
1	NEAR SIDE 001	THRU + THRU 101	HEAD-ON 201	REAR-REAR 301	LEAVING PARKING 401	HEAD-ON 501	PARKED 601	OFF CARRIAGEWAY TO LEFT 701	OFF CARRIAGEWAY RIGHT BEND 801	FELL BY FROM VEHICLE 901
2	EMERGING 002	RIGHT + THRU 102	THRU + RIGHT 202	LEFT REAR 302	PULLING 402	OUT OF CONTROL 502	DOUBLE PARKED 602	OFF CARRIAGEWAY TO RIGHT 702	OFF CARRIAGEWAY LEFT BEND 802	
3	FAR SIDE 003	LEFT + THRU 103	RIGHT + LEFT 203	RIGHT REAR 303	PULLING VEHICLES ONLY 403	PULLING OUT 503		LEFT OFF CARRIAGEWAY INTO OBJECT 703	OFF RIGHT BEND INTO OBJECT 803	HIT TRAIN 903
4	PLAYING WORKING (LYING, STANDING) ON CARRIAGEWAY 004	THRU + RIGHT 104	RIGHT 204	U TURN 304	REVERSING IN TRAFFIC 404	CUTTING IN 504	CAR DOOR 604	RIGHT OFF CARRIAGEWAY INTO OBJECT 704	OFF LEFT BEND INTO OBJECT 804	HIT RAILWAY SIGNAL FURNITURE 904
5	WALKING WITH TRAFFIC 005	RIGHT + RIGHT 105	THRU + LEFT 205	LANE SIDE SWIPE 305	REVERSING INTO FIXED OBJECT 405	PULLING OUT REAR END 505	HIT PERMANENT OBSTRUCTION 605	OUT OF CONTROL ON CARRIAGEWAY 705	OUT OF CONTROL ON CARRIAGEWAY 805	HIT ANIMAL OFF CARRIAGEWAY 905
6	FACING TRAFFIC 006	LEFT + RIGHT 106	LEFT + LEFT 206	LANE CHANGE RIGHT 306	LEAVING DRIVEWAY 406	OVERTAKING RIGHT TURN 506	HIT TEMPORARY ROADWORK 606	LEFT TURN 706	LEFT TURN 806	PARKED VEHICLE RAN AWAY 906
7	DRIVEWAY 007	THRU + LEFT 107	U TURN 207	LANE CHANGE LEFT 307	FROM LOADING BAY 407		HIT TEMPORARY OBJECT ON CARRIAGEWAY 607	RIGHT TURN 707	RIGHT TURN 807	VEHICLE MOVEMENTS NOT KNOWN 907
8	ON FOOTWAY 008	RIGHT + LEFT 108		RIGHT TURN SIDE SWIPE 308	FROM FOOTWAY 408		ACCIDENT ON BROKEN DOWN 608	MOUNTS TRAFFIC ISLAND 708	MOUNTS TRAFFIC ISLAND 808	
9	STRUCK WHILE BOARDING OR ALIGHTING 009	LEFT + LEFT 109		LEFT TURN SIDE SWIPE 309			ANIMAL 609			
0				PULLING OUT 310			LOADING VEHICLE 610			

(Source: Austroads 2009)

Types of crashes at roundabouts



101



101 – Vehicles from adjacent approaches collide

202 – Vehicles from opposing directions with one turning right

703 – Vehicle heading left of carriageway into an object

708 – Non-collision on straight – right onto traffic island

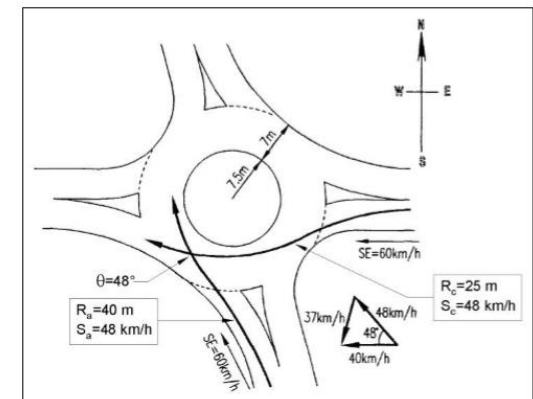
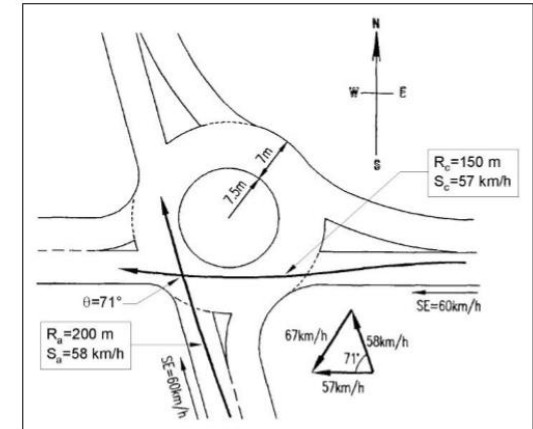
Types of crashes at roundabouts



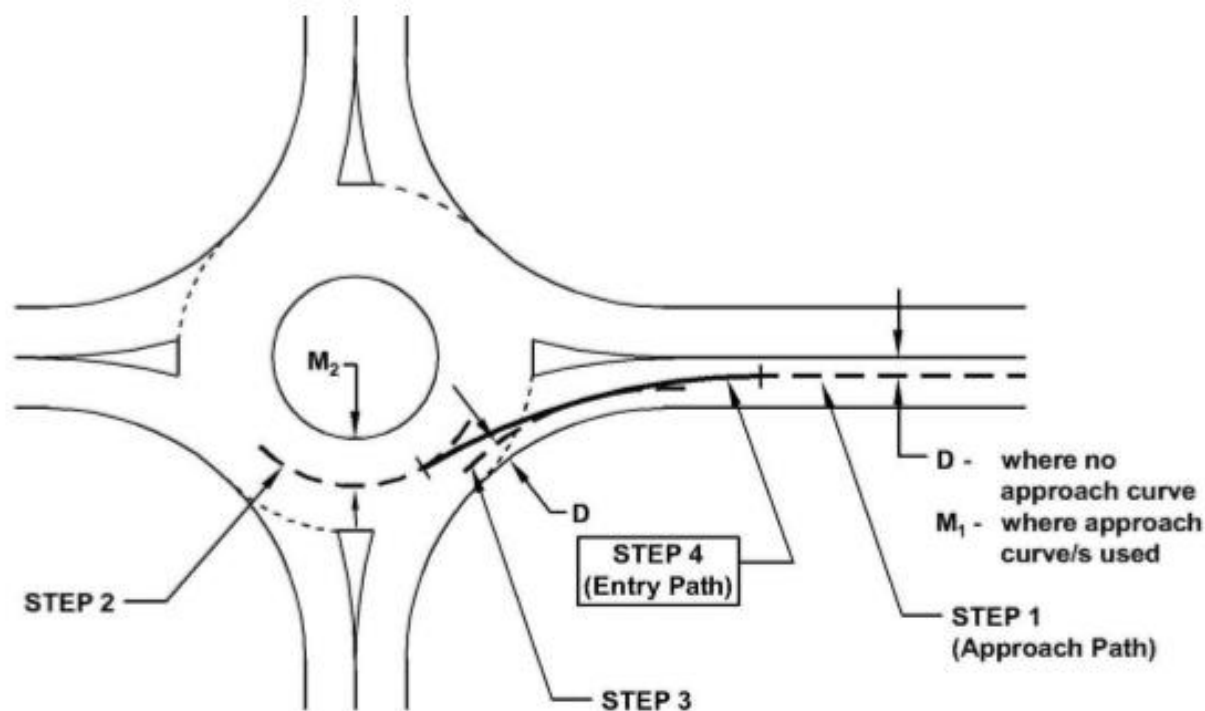
- Code 101 - Accounted over half of all crashes.
- Collisions occurred more frequently at entrances to roundabouts.
- About three-quarters of the crashes involved property damage only.
- The crashes often involved unsafe speeds.

Design concept

- No mandatory speed control criterion is given for the circulating carriageway
- Previous design accommodates a moderate radius of deflection to reduce the circulating speed ($R < 100\text{m}$)
- Austroads (2011) realised that entry path radii can help to reducing the entering speed ($R < 50\text{ m}$)



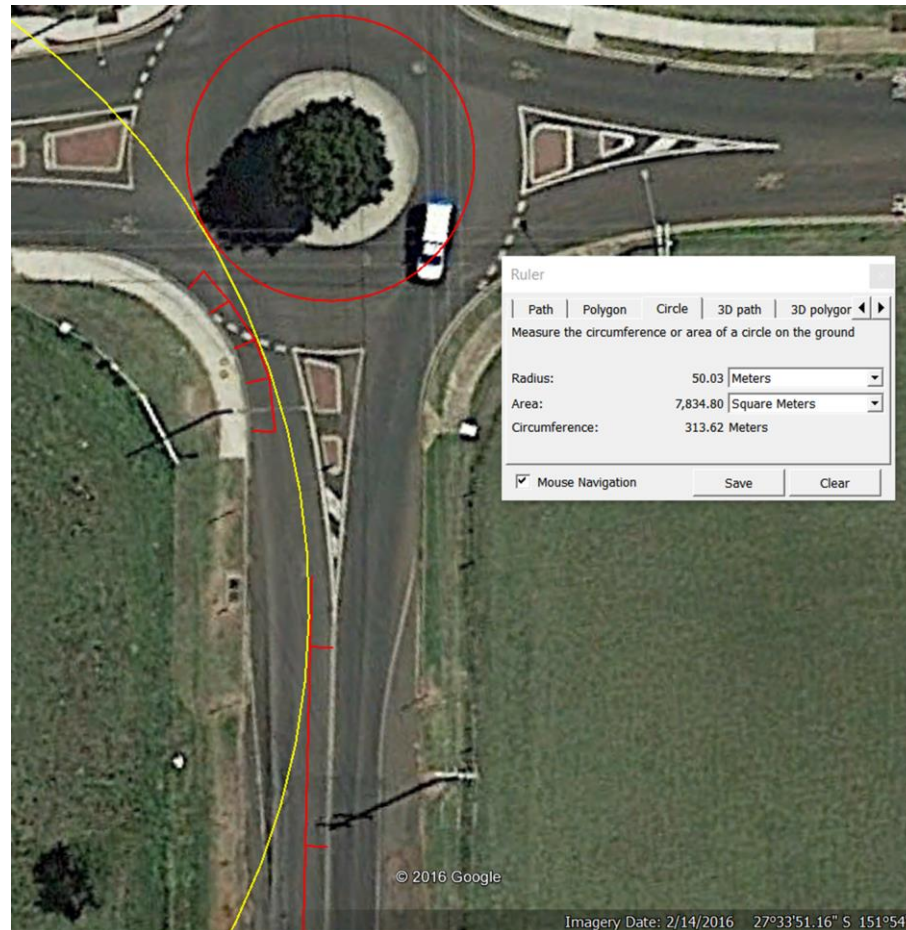
Entry path for a single-lane entry



D = 1.5 m when measuring from a road centreline or kerb face, 1.0 m when measuring from an edge line.
 M_1 = Half the width of the approach lane.
 M_2 = Half of the width of the circulating carriageway.

Note: STEP 1 – STEP 4 show the procedure followed to develop the entry path.

Measuring Radii- Google Earth Pro



SW7 - Glenvale Rd and McDougall St

Road classification

Local collector roads

Speed zone: 60km/h

Crash history

Rear-end Crashes – 12; Hit Object Crashes – 0; Other Crashes – 0; Total Crashes -12
(all multivehicle)

Road safety audit

Trafficable Apron - Yes

Vegetation on centre island - Tree

Shared cycle zone- East approach has a fade yellow line for bike, West approach-
yellow line for bike

Poles in clearance zone – 8 posts(North -3, South – 3, East – 1 & West 2)

Trees in clearance zone - 1

Sight Distance to right – North & West – Excessive, East average, South – below
average

Linemarking condition - Adequate

Results

ID	Roundabout	More Entry width	Poles in clear zones	Trees in clear zone	Sight distance for vehicle from	Deflection radii (m) < 100m	Entry path radii more than maximum
SW7	Glenvale Rd & McDougall St	All (4/4)	8	1	South – (BA)	Adequate	All approaches
NW6	Anzac Ave, Russell Street & West St	3/5	8	6	South – (BA) East – Poor South-West – (BA)	North (130), East (200), North-west (140)	S, E, S-W approaches (3 out of 5)
SW6	Glenvale Rd & Greenwattle St	All	4	1	East - (BA)	West (180)	E & W approaches
NW7	North St & Tor St	All	8	0	North, South & East – (BA)	Adequate	S & E approaches (2 out of 4)
SE21	Spring St & Hume St	All	5	1	West – (BA)	East (180)	S & E approaches (2 out of 4)
SE14	Alderley St & Ramsay St	All	8	3	Adequate	Adequate	N, S & E approaches (3 out of 4)
SE12	South St & Mackenzie St	All	6	1	East –Poor	Adequate	All approaches
SE13	Alderley St & Hume St	All	7	10	West – Poor	Adequate	N approach (1 out of 4)
SE15	Alderley St & Mackenzie St	Ok	8	0	South – Poor East – (BA) West – (BA)	East (130)	S & E approaches (2 out of 4)
SW1	Alderley St & Drayton Rd	Ok	6	1	South – (BA) East –Poor	North (120)	S approach (1 out of 4)

Note: (BA) – below average

Results

- Wider entry widths at many roundabouts
- The number of poles are significantly high which can leads to increase the crash severity
- Many roundabouts' approaches have limited sight distance to approaching vehicles from the right.
- The entry path radii of about 80% of the roundabouts were more than the allowable maximum.



Rank 2 – NW6 (Anzac/West/Russell)

- 36 Road Crashes
- 0F, 5H, 7MT, 6MI & 18PDO
- Traffic Volume = 23,387 vph



Black Spot Program Completed in 2015

Anzac-Avenue roundabout

Problem: 54 crashes (18 life-threatening Injuries)

- High approach speeds
- High traffic volumes (17K)

Solution:

- Vehicle Activated Sign (VAS)
- Delineation
- Surface friction improvements

Project Costs: \$300,000

- Crash Reduction: 65%
- Benefit Cost Ratio (BCR): 14.3
- Outcome: 1 PDO crash since Sept 2015!



Before



After

Before and after

[Anzac-Ave, Holberton St and Hursley Rd]



Before



After

South and Rowbotham Street

Problem: 12 crashes (7 life-threatening injuries)

- Control, sight distances, vertical Curve
- High conflict volumes (2,900 and 1,900 AADT's)

Solution:

- Single lane Roundabout

Project Costs: \$700,000

- Crash Reduction: 85%
- BCR: 4.7

Outcome

- Zero crashes since completion June 2015



Margaret / Dawnie Street Intersection

Problem: 10 crashes (6 life-threatening injuries)

- Crest vertical intersection
- Control resembles 'T-Intersection'

Solution:

- Single lane roundabout

Project Costs: \$600,000

- Crash Reduction: 85%
- BCR: 4.2

Outcome: Zero crashes



Conclusion

- The analysis helped to identify poorly performing roundabouts
- Entry with, poles, limited sight distance and trees within the roundabouts play a vital role
- Analysis of DCA codes revealed that there were a correlation between increased crashes and entry path radii

Recommendations

- Use low aprons only when necessary
- At old roundabouts - reduce entry widths and modify approach curves to reduce speed on entry
- Use forgiving roadside furniture
- Required to develop strategies to minimize injury outcomes for cyclists.

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Thank you!