R.O.A.R. DATA

Reliable, Original & Authentic Results
Ph.88196847, Fax 88196849.
Mobile.0418239019

Client : EMGA
Job No/Name : 4642 MANYANA Intersection Counts
Day/Date : Tuesday 28th May 2013

PEDS	NORTH	EAST	SOUTH	
Time Per	*Princess*	*Bendalong*	*Princess*	TOT
1500 - 1515				**0**
1515 - 1530				**0**
1530 - 1545		NOT		**0**
1545 - 1600		REQUIRED		**0**
1600 - 1615				**0**
1615 - 1630				**0**
1630 - 1645				**0**
1645 - 1700				**0**
1700 - 1715				**0**
1715 - 1730				**0**
1730 - 1745				**0**
1745 - 1800				**0**
Per End	**0**	**0**	**0**	**0**

PEDS	NORTH	EAST	SOUTH	
Peak Per	*Princess*	*Bendalong*	*Princess*	TOT
1500 - 1600	0	0	0	**0**
1515 - 1615	0	0	0	**0**
1530 - 1630	0	0	0	**0**
1545 - 1645	0	0	0	**0**
1600 - 1700	0	0	0	**0**
1615 - 1715	0	0	0	**0**
1630 - 1730	0	0	0	**0**
1645 - 1745	0	0	0	**0**
1700 - 1800	0	0	0	**0**
PEAK HR	**0**	**0**	**0**	**0**

Lights	NORTH		EAST		SOUTH		
	Princess		*Bendalong*		*Princess*		
Time Per	T	L	R	L	R	T	TOT
1500 - 1515	79	3	2	7	5	51	**147**
1515 - 1530	84	0	5	4	5	53	**151**
1530 - 1545	55	5	2	0	3	54	**119**
1545 - 1600	60	7	2	7	4	53	**133**
1600 - 1615	63	5	2	2	9	43	**124**
1615 - 1630	59	4	6	2	5	48	**124**
1630 - 1645	70	11	4	2	7	55	**149**
1645 - 1700	67	5	3	1	6	49	**131**
1700 - 1715	77	1	1	0	7	39	**125**
1715 - 1730	62	13	1	3	10	44	**133**
1730 - 1745	58	8	1	3	5	33	**108**
1745 - 1800	59	8	3	3	7	35	**115**
Per End	**793**	**70**	**32**	**34**	**73**	**557**	**1559**

Heavies	NORTH		EAST		SOUTH		
	Princess		*Bendalong*		*Princess*		
Time Per	T	L	R	L	R	T	TOT
1500 - 1515	2	0	0	0	0	2	**4**
1515 - 1530	1	0	0	0	0	2	**3**
1530 - 1545	1	0	0	0	0	1	**2**
1545 - 1600	3	0	0	0	0	2	**5**
1600 - 1615	1	0	0	0	2	2	**5**
1615 - 1630	0	0	0	0	0	4	**4**
1630 - 1645	1	0	0	2	0	3	**6**
1645 - 1700	1	0	0	0	0	3	**4**
1700 - 1715	1	0	0	0	0	2	**3**
1715 - 1730	1	0	0	0	0	2	**3**
1730 - 1745	1	0	0	0	0	0	**1**
1745 - 1800	0	0	0	0	0	0	**0**
Per End	**13**	**0**	**0**	**2**	**2**	**23**	**40**

Combined	NORTH		EAST		SOUTH		
	Princess		*Bendalong*		*Princess*		
Time Per	T	L	R	L	R	T	TOT
1500 - 1515	81	3	2	7	5	53	**151**
1515 - 1530	85	0	5	4	5	55	**154**
1530 - 1545	56	5	2	0	3	55	**121**
1545 - 1600	63	7	2	7	4	55	**138**
1600 - 1615	64	5	2	2	11	45	**129**
1615 - 1630	59	4	6	2	5	52	**128**
1630 - 1645	71	11	4	4	7	58	**155**
1645 - 1700	68	5	3	1	6	52	**135**
1700 - 1715	78	1	1	0	7	41	**128**
1715 - 1730	63	13	1	3	10	46	**136**
1730 - 1745	59	8	1	3	5	33	**109**
1745 - 1800	59	8	3	3	7	35	**115**
Per End	**806**	**70**	**32**	**36**	**75**	**580**	**1599**

Lights	NORTH		EAST		SOUTH		
	Princess		*Bendalong*		*Princess*		
Peak Per	T	L	R	L	R	T	TOT
1500 - 1600	278	15	11	18	17	211	**550**
1515 - 1615	262	17	11	13	21	203	**527**
1530 - 1630	237	21	12	11	21	198	**500**
1545 - 1645	252	27	14	13	25	199	**530**
1600 - 1700	259	25	15	7	27	195	**528**
1615 - 1715	273	21	14	5	25	191	**529**
1630 - 1730	276	30	9	6	30	187	**538**
1645 - 1745	264	27	6	7	28	165	**497**
1700 - 1800	256	30	6	9	29	151	**481**
PEAK HR	**278**	**15**	**11**	**18**	**17**	**211**	**550**

Heavies	NORTH		EAST		SOUTH		
	Princess		*Bendalong*		*Princess*		
Peak Per	T	L	R	L	R	T	TOT
1500 - 1600	7	0	0	0	0	7	**14**
1515 - 1615	6	0	0	0	2	7	**15**
1530 - 1630	5	0	0	0	2	9	**16**
1545 - 1645	5	0	0	2	2	11	**20**
1600 - 1700	3	0	0	2	2	12	**19**
1615 - 1715	3	0	0	2	0	12	**17**
1630 - 1730	4	0	0	2	0	10	**16**
1645 - 1745	4	0	0	0	0	7	**11**
1700 - 1800	3	0	0	0	0	4	**7**
PEAK HR	**7**	**0**	**0**	**0**	**0**	**7**	**14**

Combined	NORTH		EAST		SOUTH		
	Princess		*Bendalong*		*Princess*		
Peak Per	T	L	R	L	R	T	TOT
1500 - 1600	285	15	11	18	17	218	**564**
1515 - 1615	268	17	11	13	23	210	**542**
1530 - 1630	242	21	12	11	23	207	**516**
1545 - 1645	257	27	14	15	27	210	**550**
1600 - 1700	262	25	15	9	29	207	**547**
1615 - 1715	276	21	14	7	25	203	**546**
1630 - 1730	280	30	9	8	30	197	**554**
1645 - 1745	268	27	6	7	28	172	**508**
1700 - 1800	259	30	6	9	29	155	**488**
PEAK HR	**285**	**15**	**11**	**18**	**17**	**218**	**564**

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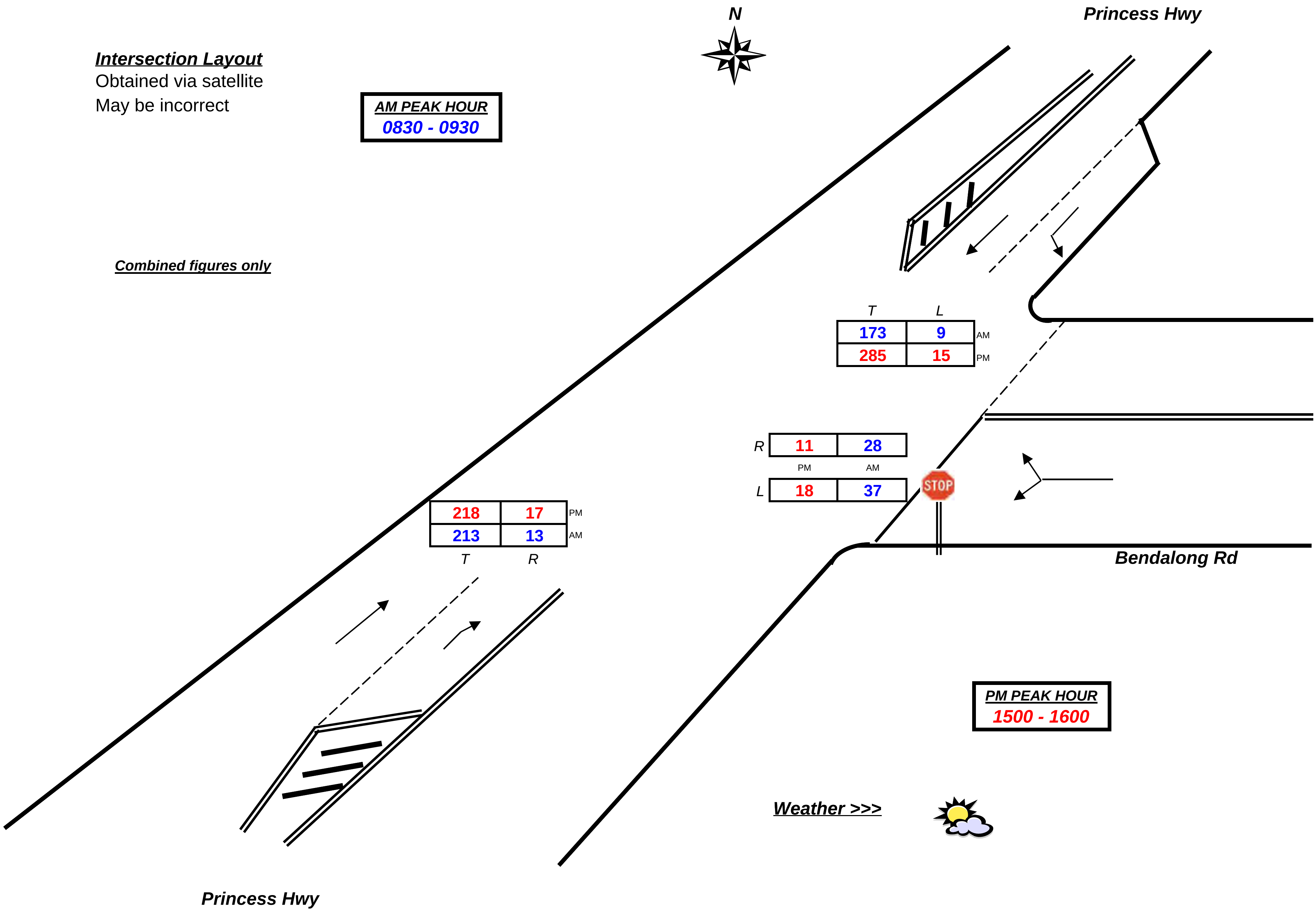


Appendix B

Austroads Guide to Road Design

7.3 Right-turn Bans at Signalised Intersections

Consideration should be given to banning a right turn where:

- a right-turn lane cannot be provided and the right-turning traffic would cause a safety and/or a capacity problem
- sight distance is poor and cannot be corrected, and other options such as erecting advance signs are not satisfactory.

If the right-turn can be banned, several options may be considered as described in Section 2.2.3 of the *Guide to Traffic Management – Part 6: Intersections, Interchanges and Crossings* (Austroads 2007) and illustrated in Section 4.14 of this guide.

7.4 Right-turn Lanes for Cyclists

Right-turn lanes for cyclists are rarely used and should generally not be provided for cyclists at right-turn treatments on arterial roads or busy traffic routes because of the difficulty and crash risk for cyclists moving from the left of an intersection to the centre of the road in order to utilise such treatments. Conditions for the use of cyclist right-turn lanes and illustrations of their use at an intersection are provided in Section 10.6.4 of this guide.

7.5 Rural Right-turn Treatments – Undivided Roads

All the turn treatments described in this section are applicable to two-lane two-way rural roads. They can also be applied to multi-lane rural roads (divided and, less commonly, undivided), except for the BAR turn treatment.

7.5.1 Rural Basic Right-turn Treatment (BAR)

The basic right-turn treatment (BAR) shown in Figure 7.5 is the minimum treatment for right-turn movements from a through road to side roads and local access points. This treatment provides sufficient trafficable width for the design through vehicle to pass on the left of a stationary turning vehicle. This is achieved by widening the shoulder to provide a minimum width sufficient to allow the vehicles to pass. Substantial speed reduction (potentially half of the design speed) is a feature of this layout.

Other aspects of the design are:

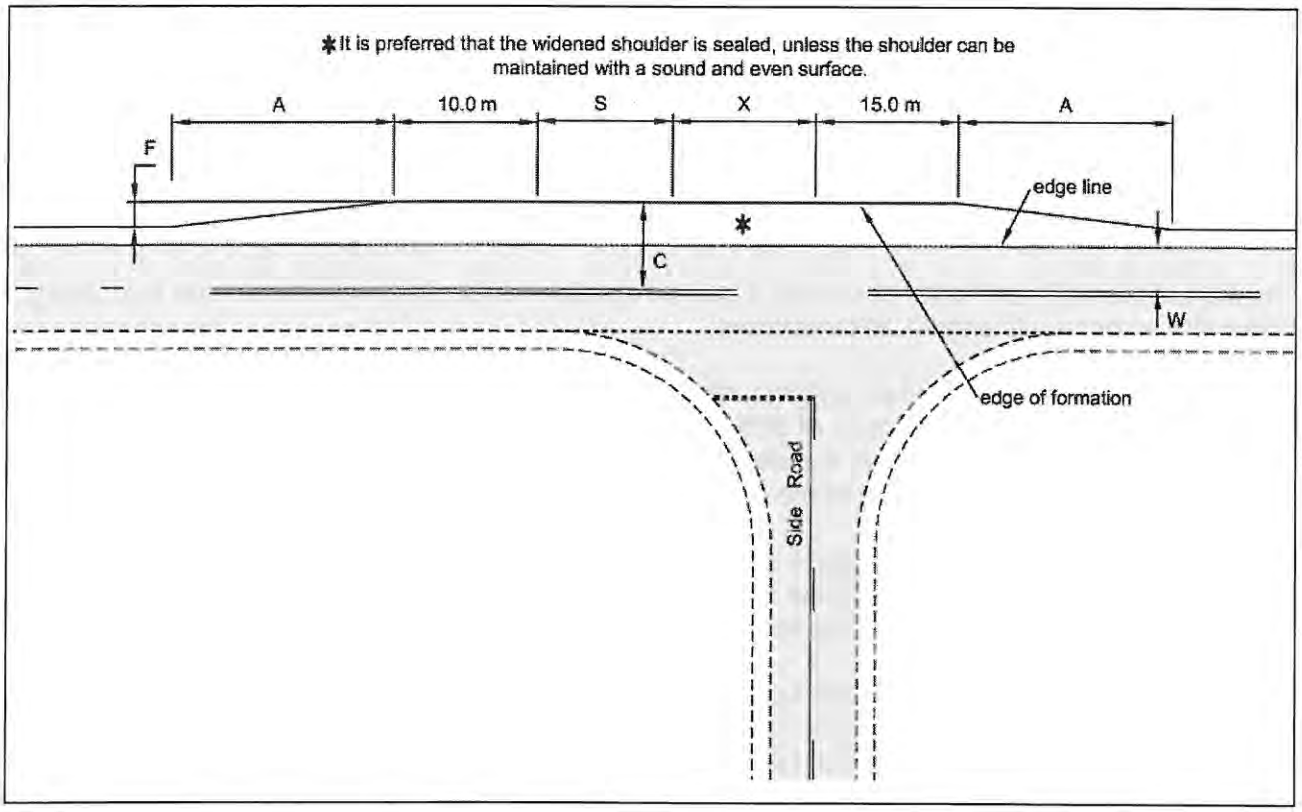
- on a terminating intersection leg no special provision is usually made for right-hand turns when a BAR is used
- this layout can be used on both sealed and unsealed roads
- it is preferred that the widened shoulder at BAR turn treatments is sealed, unless the shoulder can be maintained with a sound and even surface
- this layout should not be used where there is reduced visibility to the turn treatment. Right turning drivers on the major road need to perceive the location of the side road and stop if necessary in the through lane before the intersection.

Where adequate through sight distance exists, BAR turn treatments will generally be marked with a broken centreline to allow overtaking on the major road through the intersection. This will not restrict overtaking opportunities, thereby minimising delays. However, there may be instances where a BAR turn treatment on a section of road with good overtaking opportunities will yield a high likelihood of crashes resulting from inappropriate overtaking through the intersection. In such cases, a barrier line should be used. Examples of such instances include the following:

- The turn treatment is located after a significant length of roadway that has no overtaking opportunities. This geometry would result in drivers often overtaking through the intersection because of the large amount of time spent following other vehicles prior to the intersection. The increased exposure of overtaking may result in an excessively high overtaking-intersection vehicle crash rate.
- There are reasonably high right-turning volumes.
- The warrants dictate that a higher-level turn treatment is appropriate.

It is suggested that BAR treatments should generally have a barrier line on the major road approaches to reduce the likelihood of overtaking vehicles colliding with vehicles entering from the side road. Consideration should only be given to the use of a broken centreline in situations where overtaking opportunities are limited and the volume on the side road is very low.

The BAR turn treatment on a two-lane rural road as shown in Figure 7.5 has limited applications. It is mainly applicable at the junction of side roads and rural arterial roads with lower traffic volumes. Such turn treatments can record high crash rates, especially in high-speed areas. A more desirable treatment at such sites is a CHR(S) turn treatment discussed in Section 7.5.2.



Notes:

1. This treatment applies to the right turn from a major road to a minor road.
2. The dimensions of the treatment are defined thus:

W = Nominal through lane width (m) (including widening for curves). Width to be continuous through the intersection.

C = On straights – 6.5 m minimum

7.0 m minimum for Type 1 & Type 2 road trains

On curves – widths as above + curve widening (based on widening for the design turning vehicle plus widening for the design through vehicle).

A = $\dfrac{0.5VF}{3.6}$

Increase length A on tighter curves (e.g. those with a side friction demand greater than the maximum desirable). Where the design through vehicle is larger than or equal to a 19 m semi-trailer the minimum speed used to calculate A is 80 km/h.

V = Design speed of major road approach (km/h).

F = Formation/carriageway widening (m).

S = Storage length to cater for one design turning vehicle (m) (minimum length 12.5 m).

X = Distance based on design vehicle turning path, typically 10–15 m.

Source: QDMR (2006).

Figure 7.5: Basic right (BAR) turn treatment on a two-lane rural road

7.5.2 Rural Channelised T-junction – Short Lane Type CHR(S)

The CHR(S) turn treatment shown in Figure 7.6 is a more desirable treatment than the BAR treatment because it provides greater protection for vehicles waiting to turn right from the centre of the road. This treatment is suitable where there are low to moderate through and turning volumes. For higher volume sites, a full-length CHR turn treatment (Figure 7.7) is preferred.

This type of intersection can only be used with linemarking. It is not to be used with raised or depressed islands as the turn lane is short and it is desirable that right-turning drivers travel over the painted chevron to exit the through traffic stream as soon as possible.

For the CHR(S) turn treatment, all through traffic is required to deviate, hence the deviation must be designed to suit the operating speed. A minimum shoulder width of 1.0 m must be used on the through lane deviation.

The start of the right-turn taper occurs as a painted median width of 2.0 m, in lieu of the full turning lane width as per a full length CHR treatment.

The length of turn slot is based on a right-turning vehicle slowing to 80% of the design speed on the approach (i.e. a speed reduction of 20% in the through lane), prior to moving into the turn lane and decelerating. This is based on the assumption that drivers decelerate at a maximum value of 3.5 m/s^2 from the start of the taper to the start of the storage length.

Although some deceleration of the right-turning vehicles occurs in the through lane, this treatment records far fewer rear-end crashes than do BAR turn treatments. The good safety performance occurs by removing stationary turning vehicles from the through traffic stream.

CHR(S) turn treatments should not be used where there is reduced visibility to the turn treatment. Right-turning drivers on the major road need to perceive the location of the deceleration lane and the side road in time to make the necessary speed reduction in the through lane prior to diverging.

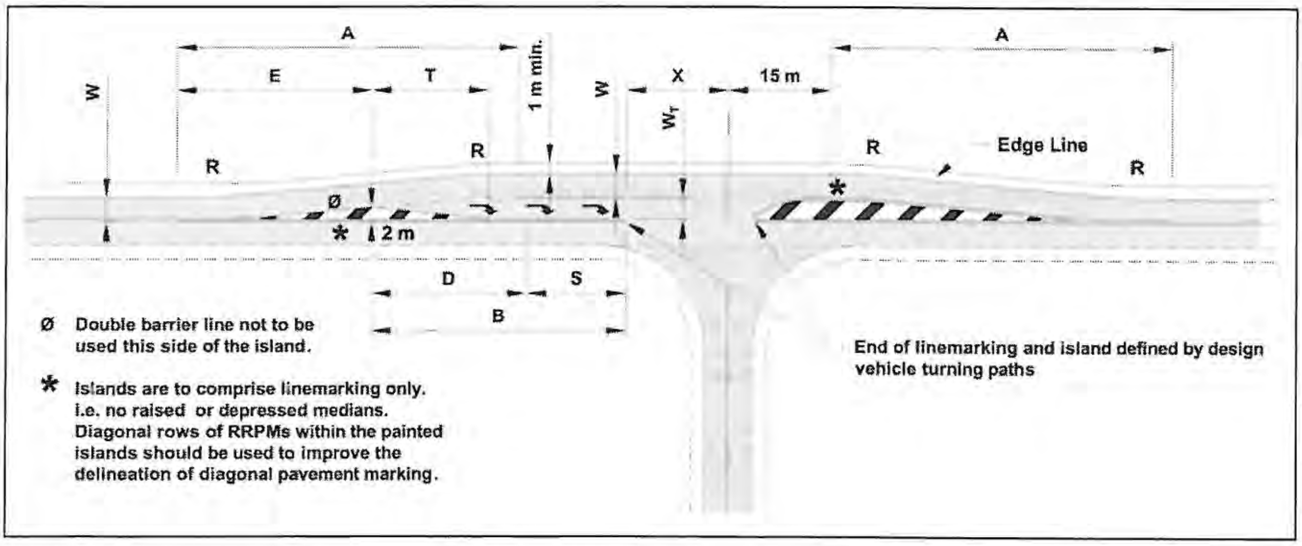
Table 7.1 provides the dimensions of the CHR(S) treatment for various design speeds.

Table 7.1: Dimensions of CHR(S) treatment for various design speeds

Design speed of major road approach (km/h)	Lateral movement length A (m)1	Diverge/ deceleration length D (m)2	Desirable radius R (m)	Taper length T (m)3
50	40[4]	15	110	15
60	50[4]	25	175	15
70	60	35	240	20
80	65	45	280	20
90	75	55	350	25
100	85	70	425	30
110	95	85	500	30
120	100	100	600	35

Notes:

1. Based on a diverge rate of 1m/sec and a turn lane width of 3.0 m. Increase lateral movement length if the turn lane width >3 m. If the through road is on a tight horizontal curve (e.g. one with a side friction demand greater than the maximum desirable), the lateral movement length should be increased so that a minimal decrease in speed is required for the through movement.
2. Based on a 20% reduction in through road speed at the start of the taper to a stopped condition using a value of deceleration of 3.5 m/s^2 (Table 5.2). Adjust for grade using the 'correction to grade' factor in Table 5.3.
3. Based on a turn lane width of 3.0 m.
4. Where Type 2 road trains are required, minimum A = 60 m.



Note: The dimensions of the treatment are defined below and values of A, D, R and T are shown in Table 7.1:

W = Nominal through lane width (m) (including widening for curves). For a new intersection on an existing road, the width is to be in accordance with the current link strategy.

W_T = Nominal width of turn lane (m), including widening for curves based on the design turning vehicle = 3.0 m minimum.

B = Total length of auxiliary lane including taper, diverge/deceleration and storage (m).

E = Distance from start of taper to 2.0 m width (m) and is given by:

$$E = 2\left(\frac{A}{W_T}\right)$$

T = Taper length (m) and is given by:

$$T = \frac{0.33xVxW_T}{3.6}$$

S = Storage length to cater for one design turning vehicle (m).

V = Design speed of major road approach (km/h).

X = Distance based on design vehicle turning path, typically 10–15 m.

Source: QDMR (2006).

Figure 7.6: Channelised right-turn treatment with a short turn slot [CHR(S)] two-lane rural road

7.5.3 Rural Channelised T-junction – Full Length (CHR)

For this layout, all traffic is required to deviate and therefore the road alignment for the through movement must be designed to suit the operating speed. This deviation requires the pavement to be widened to provide a full-length right-turn lane as shown in Figure 7.7.

The minimum lengths of deceleration (D) for different design speeds are shown in Table 5.2 and should be based on the comfortable deceleration rate of 2.5 m/s^2. The storage length (S) is usually determined through the use of computer programs such as aaSIDRA.

Details of the departure end of the right-turn lane should be determined using turning path templates (minimum radius 15.0 m). This will depend on the width and the angle of intersection of the road that the turning vehicle is entering.

There are no numerical warrants for the provision of raised medians in lieu of the painted medians, and some jurisdictions may require road lighting where raised medians are provided.

Pavement marking should be provided as shown in Figure 7.7. If the painted separation between opposing traffic flows is wider than a double white line, then the median should be delineated with diagonal markings and raised retroreflective pavement markers (Figure 6.5).

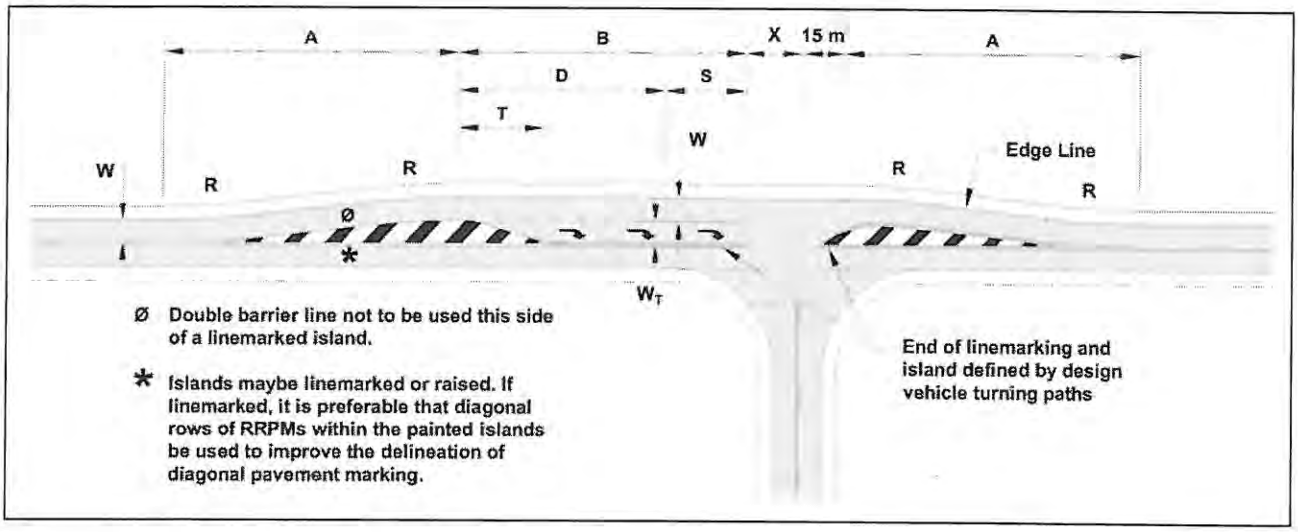
Table 7.2 provides the dimensions of the CHR treatment for various design speeds.

Table 7.2: Dimensions of CHR treatment for various design speeds

Design speed of major road approach (km/h)	Lateral movement length A (m) (1)		Desirable radius R (m)
	W_T=3.5 m	W_T=3.0 m	
50	50 (2)	40 (2)	110
60	60	50 (2)	175
70	70	60	240
80	80	65	280
90	90	75	350
100	100	85	425
110	110	95	500
120	120	100	600

Notes:

1. Based on a diverge rate of 1 m/sec. If the through road is on a tight horizontal curve (e.g. one with a side friction demand greater than the maximum desirable) increase the lateral movement length so that a minimal decrease in speed is required for the through movement.
2. Where Type 2 road trains are required minimum A = 60.0 m.



Notes:

1. An alternative to the double white line on the offside edge of the right-turn slot is a 1.0 m painted median. The 1.0 m median is particularly useful when the major road is on a tight horizontal curve and oncoming vehicles track across the centreline. Provision of this median will require the dimension 'A' to be increased.
2. A raised concrete median on the minor road may be used with this treatment to minimise 'corner cutting', particularly for higher turning volumes.
3. The dimensions of the treatment are defined below and values of A, D, R and T are shown in Table 7.2:

W = **Nominal through lane width (m) (including widening for curves). For a new intersection on an existing road, the width is to be in accordance with the current link strategy.**

W_T = **Nominal width of turn lane (m), including widening for curves based on the design turning vehicle. Desirable minimum = W, absolute minimum = 3.0 m.**

B = **Total length of auxiliary lane including taper, diverge/deceleration and storage (m).**

D = **Diverge/deceleration length including taper. Adjust for grade using the 'correction to grade' factor (Section 5)**

T = **Physical taper length (m) and is given by:**

$$T = \frac{0.33VW_T}{3.6}$$

S = **Storage length (m) should be the greater of:**

1. the length of one design turning vehicle or

2. (calculated car spaces –1) x 8 m (*Guide to Traffic Management – Part 3: Traffic Studies and Analysis* (Austroads 2009h), or use computer program e.g. aaSIDRA).

V = **Design speed of major road approach (km/h)**

X = **Distance based on design vehicle turning path, typically 10–15 m**

Source: Based on QDMR (2006).

Figure 7.7: Channelised right turn (CHR) on a two-lane rural road

7.5.4 Rural Right-Left Staggered T

Basic two-lane two-way road

This layout should be designed to ensure that:

- the stagger distance between the minor legs is large enough to discourage drivers from 'taking a short-cut on the wrong side of the traffic islands (e.g. at least 15 m to 25 m depending on the site characteristics)
- the island treatments in the minor roads are long enough to also discourage wrong way movements
- sufficient width is provided on the major road within the intersection to enable through vehicles to pass slowly to the left of vehicles waiting to turn right (e.g. 12 m), a similar principle to the BAR treatment.

The type of slow vehicle influences the nature of overtaking demand. Some vehicles can be overtaken easily anywhere along a route, while for others an upgrade overtaking opportunity is desirable. In evaluating the need for auxiliary lanes, attention should be given to the type of slow vehicles involved, and whether the overtaking demand is continous along a route, or confined to specific problem locations.

9.1.3 Overtaking Opportunities

On two-lane roads, the availabilty of overtaking opportunities depends on sight distance (section 6.7) and gaps in the opposing traffic stream. As opposing traffic volume increases, overtaking opportunities become restricted even if sight distance is adequate. Sight distance which appears adequate may also be unusable on occasions due to the size of the vehicle in front, particularly on left-hand curves.

On an existing road, overtaking opportunities can be increased either by improved alignment or the provision of auxiliary lanes. Of the two options, auxiliary lanes will generally prove to be the most cost-effective in reducing the level of traffic bunching. This is because realignment to provide overtaking opportunities is likely to be a much more expensive option, and even then the opportunities are only available when opposing traffic permits. This has been demonstrated by ARRB simulation studies, which showed that the provision of auxiliary lanes at regular spacings often led to greater improvements in overall traffic operations than even major alignment improvements (Hoban 1983).

Improved alignment may, however, be required for reasons of safety or a consistent speed environment (Section 2.4). In this context it should be noted that alignment consistency may be more important for traffic safety than simply applying high geometric standards. Particularly when road funds are limited, the greatest safety benefits will generally be achieved through improving consistency and upgrading hazardous road features on a large number of roads, rather than reconstructing some specific road sections to high standards of width and design speed.

A two lane road with auxiliary lanes at regular intervals provides an intermediate level of service between those of two lanes and four lanes. The auxiliary lanes thus offer an economical means for deferring the need for the provision of dual carriagways. Where a four lane road has already been provided, and traffic volumes are consistently high, the need for auxiliary lanes on grades may still arise when there is a high proportion of heavy vehicles.

9.2 Justification for Auxiliary Lanes

9.2.1 General

When determining whether an auxiliary lane is justified on a two-lane road, whether it is climbing, descending or overtaking, the evaluation needs to be carried out over a significant route length and not be isolated to the particular length over which the auxiliary lane might be constructed. Overtaking opportunities outside the particular length can affect the result considerably. These considerations may not apply to multi-lane roads, since the need for auxiliary lanes on these roads depends only on a localised reduction of capacity and level of service, usually due to grades.

The guidelines presented in Sections 9.2.2 to 9.2.5 are based on initial ARRB research using traffic simulation and benefit-cost analysis (Hoban and Morrall 1985). Alternatively, the need for auxiliary lanes can be evaluated in terms of level of service. In special circumstances, a more detailed evaluation may be undertaken using traffic simulation or the results of prior ARRB research (Hoban 1983).

9.2.2 Overtaking Lanes

The justification for overtaking lanes is based on the traffic volume, the percentage of slow vehicles (including light trucks and cars towing) and the availability of overtaking opportunities on adjoining sections. The determination of the percentage of road allowing overtaking is defined in Section 6.7.

Table 9.1 gives the current-year design volumes (AADT) at which overtaking lanes would normally be justified. These guidelines apply for short low-cost auxiliary lanes at spacings of 10 to 15km or more along a road in a given direction. The length, location and cost of auxiliary lanes are discussed in further detail in Section 9.3. If auxiliary lane spacings are closer or construction costs are high, the volume guidelines in Table 9.1 may need to be modified accordingly, that is, higher volumes may be required to justify construction.

Table 9.1 Recommended Volume Guidelines for Consideration of Overtaking Lanes

Overtaking Opportunities Over Preceding 5 km (a)		Current-year design volume (AADT)		
	Percent Length Providing Overtaking(b)	Percentage of slow vehicles(c)		
Description		5	10	20
Excellent	70 - 100	5670	5000	4330
Good	30 - 70	4330	3670	3330
Moderate	10 - 30	3130	2800	2470
Occasional	5 - 10	2270	2000	1730
Restricted	0 - 5	1530	1330	1130
Very Restricted(d)	0	930	800	670

(a) Depending on road length being evaluated, this distance could range from 3 to 10km.
(b) See Section 6.7.
(c) Including light trucks and cars towing trailers, caravans and boats.
(d) No overtaking for 3 km in each direction.

4.5.4 Output

The output of this process of considering the layout options for the site will be a number of intersection layouts, and forms of control, that are clearly ***inappropriate***. The remaining options and forms of control are then carried forward into the evaluation process. This process is detailed in **Section 4.6.**

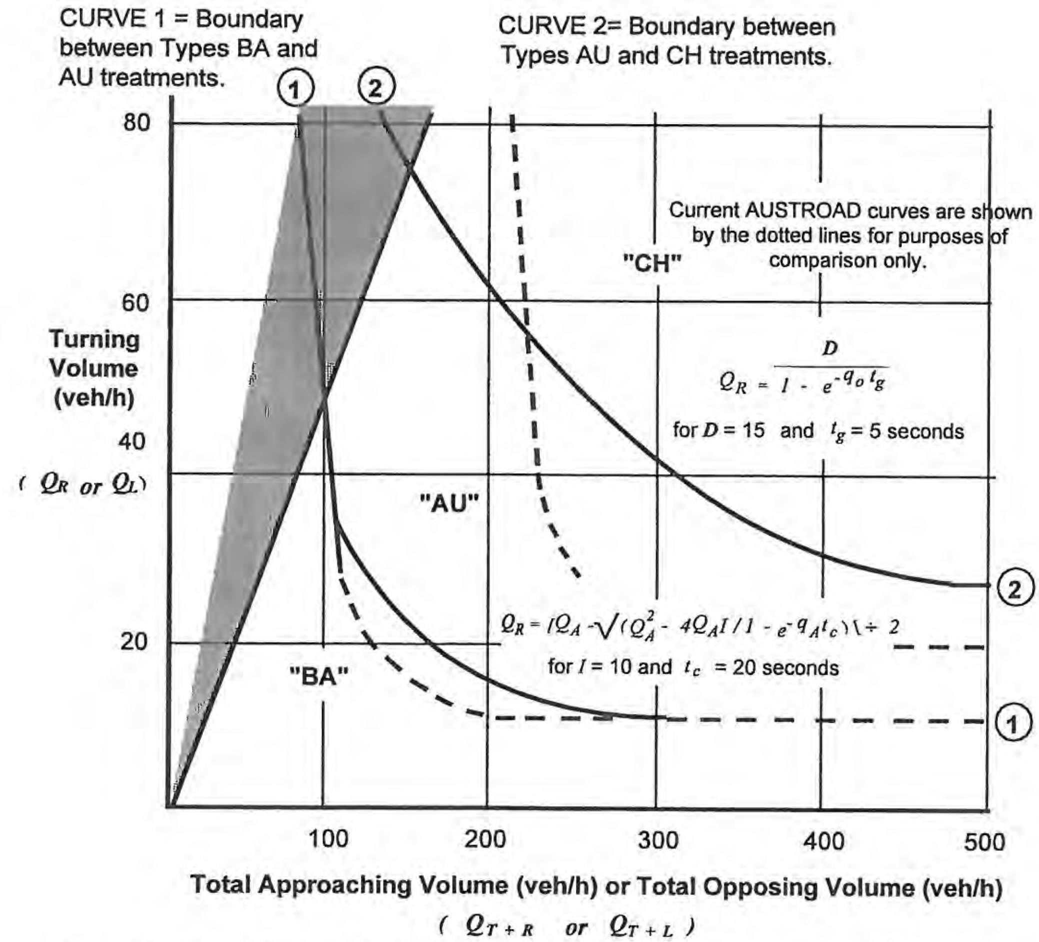
In the absence of any other information, **Table 4.5.3** can assist in identifying layout options, and forms of control, which are not suited to a site.

At RURAL sites McKerral, Leong & Dominis (ref 11) considered the probability of interference to a through vehicle by a turning vehicle slowing down, or stopping in front. This is shown in **Figure 4.5.12** below.

Curve 1 shows the relationship where 10 vehicles are required to slow each hour (I=10) and the conflict time (t_c) is 20 seconds. In the formula, Q_A is the total approach volume (veh/hr), Q_R (or Q_L) the turning volume (ie. Q_A) (veh/hr), and q_A the total approach volume given as veh/sec.

Curve 2 shows where 15 veh/h must stand waiting for a gap (t_g) of 5 secs. Here q_0 is the volume of opposing traffic in veh/sec., and tg is the gap necessary to turn (assumed as 5 secs.

It must be stressed that **Figure 4.5.12** <u>is only a guide</u> and the final choice should take into account strategic aspects such as planning for more consistency in driver expectations along key routes.



NOTES:

1. *Where peak hour volumes are not available, assume the design peak hour volume equals 15% of the AADT. for 500 hours each year; use 5% of AADT for the rest of the year. See Section 1.4. for further details.*
2. *Use graph "AU" to select need for an auxiliary lane. Use "CH" to determine if a sheltered right turn is required. On high speed roads with substantial volumes of heavy vehicles, the use of Type "AU " and "CH" is preferred for safety reasons.*
3. *Use of Types "AU" and "CH" is preferred on high speed and/or heavy vehicle routes to enhance safety.*

In this region more than 50% of the approaching traffic turns. Hence consideration needs to be given to possible realignment of the intersection to suit the major traffic movement.

Figure 4.5.12 - Warrants for Rural Turn Lanes

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