VOLUME 6 ROAD GEOMETRY
SECTION 3 HIGHWAY FEATURES

PART 5

TD 51/03

SEGREGATED LEFT TURN LANES AND SUBSIDIARY DEFLECTION ISLANDS AT ROUNDABOUTS

SUMMARY

This document sets out the design standards, methodology and good design practice for the provision of segregated left turning lanes and subsidiary deflection islands for trunk road roundabouts. Measures to ensure safe operation for all road users are described.

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THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

Segregated Left Turn Lanes and Subsidiary Deflection Islands at Roundabouts

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Contents

Chapter

1. INTRODUCTION

General

1.1 The treatment of segregated left turn lanes (SLTL) and subsidiary deflection islands (SDI) at roundabouts has been the subject of a study which has reviewed the guidance and advice contained in Standard **TD 16 (DMRB 6.2.3)**. It made recommendations on amendments and additions to the document based on current good practice.

1.2 This document provides details of the latest requirements and recommendations on general design principles and safety aspects of design.

1.3 This standard shall apply to all new roundabouts and to existing roundabouts that are to be modified or improved, that will include either segregated left turn lanes or subsidiary deflection islands.

1.4 This document supersedes the following paragraphs and figures of Standard **TD 16 (DMRB 6.2.3)** which are hereby withdrawn:

(i) Paragraphs 1.7 text "and segregated left turning lanes" and 1.9 i and v;

(ii) Paragraph 5.5;

(iii) Paragraphs 7.11, 7.36 and 7.69 to 7.76 inclusive;

(iv) Figures 7/12, 7/18, 7/29, 7/30 and 7/31.

Definitions

1.5 In addition to the Geometric Design Parameters defined in **Chapter 7, TD 16 (DMRB 6.2.3)**, there are special features that can improve the operation of a roundabout, including:

- **Non-physical Segregated Left Turn Lane:** a left turn lane from a roundabout entry to the first exit, separated from the roundabout entry, circulatory carriageway and exit by means of an island delineated using road markings only **(see Fig 2/1(a))**;
- **Physical Segregated Left Turn Lane:** a left turn lane from a roundabout entry to the first exit, separated from the roundabout entry, circulatory carriageway and exit by means of a kerbed island and associated road markings **(see Fig 2/1(b))**;
- **Traffic Deflection Island (TDI):** a raised kerbed island and associated road markings on the carriageway, located between an entry and exit on the same roundabout arm and shaped so as to direct and also separate opposing traffic movements onto and from a roundabout circulatory carriageway **(see Fig 3/1)**;
- **Physical Subsidiary Deflection Island:** a raised kerbed island and associated road markings on the carriageway, located between two entry lanes on the approach arm of a roundabout and shaped so as to direct, deflect and also separate traffic movements onto the roundabout **(see Fig 3/2(a))**;
- **Non-physical Subsidiary Deflection Island:** a shaped island delineated by road markings alone, located between two entry lanes on the approach arm of a roundabout and shaped so as to direct, deflect and also separate traffic movements onto the roundabout **(see Fig 3/2(b))**;

1.6 The term **Large Goods Vehicles (LGV)** is used in this document to identify those vehicles (defined as over 3.5 tonnes gross weight) classified as LGV for licensing purposes in accordance with European harmonisation of terminology.

Scope

1.7 Guidance on the choice of the most appropriate form of junction is given in **TA 30 (DMRB 5.1)**.

1.8 This document defines the main types of segregated left turn lanes and subsidiary deflection islands at roundabouts for application to new and improved junctions on trunk roads.

1.9 Requirements are defined in relation to the size of roundabout, approach speed, approach and exit layout, visibility, entry width, entry deflection and the width of circulatory carriageway.

1.10 Recommendations are given on the size and siting of:

- Physical and non-physical segregated left turn lanes.
- Physical and non-physical subsidiary deflection islands.

Implementation

1.11 This document should be used forthwith on all schemes for the construction, improvement and maintenance of trunk roads including motorways, currently being prepared provided that, in the opinion of the Overseeing Department, this would not result in significant additional expense or delay progress. Design Organisations should confirm its application to particular schemes with the Overseeing Department.

Design Speed

1.12 Certain geometric standards for segregated left turn lanes and subsidiary deflection islands are related to the design speed of the approach and exit road, and this is defined in **TD 9 (DMRB 6.1.1)**. Reference should therefore be made to **TD 9 (DMRB 6.1.1)** in order to determine the appropriate design speed when applicable.

General Principles

1.13 The use of a segregated left turn lane **[see Chapter 2]** is a method to improve the overall capacity of a roundabout entry where a significant volume of left turning traffic is expected. This is achieved through the provision of a dedicated lane, commencing on the approach to the roundabout, which is segregated from the circulatory carriageway and allows traffic to leave at the first exit without using the roundabout circulatory carriageway.

1.14 The use of a subsidiary deflection island **[see Chapter 3]** is a method for introducing deflection at a roundabout entry. It shall not be used in the design of new roundabout junctions, but may be considered as part of an improvement scheme to an existing roundabout where sufficient deflection cannot be provided by conventional design to **TD 16 (DMRB 6.2.3)** due to site or other constraints, e.g. abnormal load routes, statutory undertakers' apparatus or land availability.

1.15 Consideration of the need for, and layout of, traffic signs and road markings **(see DMRB 8.2)** should be an integral part of the design process for both segregated left turn lanes and subsidiary deflection islands at roundabouts. Traffic signs and road markings must comply with the **Traffic Signs Regulations and General Directions**. Guidance on their correct use can be found in the **Traffic Signs Manual**.

1.16 Designers should consider maintenance issues and activities in developing any design including the need for the robust and disciplined inspection of road studs and markings. It should also be recognised that the use of physical segregated left turn lanes and physical subsidiary deflection islands has implications for maintenance activities such as sweeping, resurfacing and winter maintenance operations. Signs and road markings should be located where they can be safely maintained using existing methods and equipment.

1.17 Designers shall consider whether pedestrian, cyclist and equestrian facilities are necessary and if so consider whether they can be adequately catered for within a junction design that includes a segregated left turn lane or subsidiary deflection island. In some cases this will not be possible and designers may need to use alternative layouts.

1.18 A project appraisal should be carried out in accordance with the Overseeing Organisation's current procedures.

Mandatory Sections

1.19 Mandatory sections of this document are contained in boxes. The Design Organisation must comply with these sections or obtain agreement to a departure from standard from the Overseeing Organisation. The remainder of the document contains advice and explanation, which is commended to users for consideration.

Departures from Standard

1.20 In exceptional situations the Overseeing Organisation may be prepared to agree to a Departure from Standard where the standard, including permitted Relaxations, is not realistically achievable. Design Organisations faced by such situations and wishing to consider pursuing this course shall discuss any such option at an early stage in design with the Overseeing Organisation. Proposals to adopt Departures from Standard must be submitted by the Design Organisation to the Overseeing Organisation and formal approval received BEFORE incorporation into a design layout.

2. SEGREGATED LEFT TURN LANES

General

2.1 This chapter outlines the criteria for the provision of segregated left turn lanes at roundabouts and the geometric features to be considered in their design. Many of the features are considered separately, and Designers should adopt a systematic approach to achieve a satisfactory design incorporating only the appropriate features.

2.2 Segregated left turn lanes can improve journey time reliability for vehicles intending to leave a roundabout at the first exit after entry.

2.3 Segregated left turn lanes can present particular difficulties for non-motorised users due to:

- the extra width of carriageway to cross;
- vehicle and non-motorised user conflicts due to a large differential in speed at the segregated left turn lane merge and diverge points;
- insufficient width provided on pedestrian refuge islands within physical segregated left turn lanes;
- confusion as to vehicle flow direction due to the segregated nature of the left turn lane.

2.4 The designer shall determine whether facilities for non-motorised users are necessary and if so determine whether they can be catered for adequately with a reasonable degree of safety and convenience within the junction design. In some cases this will not be possible and designers may have to consider alternative layouts. Suitable measures and advice relating to provision for non-motorised users are provided in **Chapter 4**.

2.5 The two basic types of segregated left turn lane, namely segregation by road markings (non-physical) and physical segregation are shown in **Fig 2/1**. In both types vehicles are channelled into the left hand lane by road markings, supplemented by advance direction signs. They proceed to the first exit without having to give way to other vehicles at the entry onto the roundabout. Segregation by road markings is more common but can be less effective because it can be subject to abuse by vehicles over-running the non-physical island.

2.6 All traffic signs and road markings shall be designed and applied in accordance with the **Traffic Signs Regulations and General Directions (TSRGD)**, the **Traffic Signs Regulations (Northern Ireland)** and the **Traffic Signs Manual** including **Chapter 3 Regulatory Signs**, **Chapter 4 Warning Signs** and **Chapter 5 Road Markings**.

2.7 The use of segregated left turn lanes requires the designer to consider a number of factors including safety, capacity and non-motorised users and shall only be considered where their introduction:

- would result in an increase in the overall capacity of the entry or roundabout in question when compared to alternative design or improvement measures; or
- would result in an improvement to the junction's safety i.e. a reduction in accident numbers or severity; and
- would safely make provision for non-motorised users including pedestrians, cyclists and equestrians.

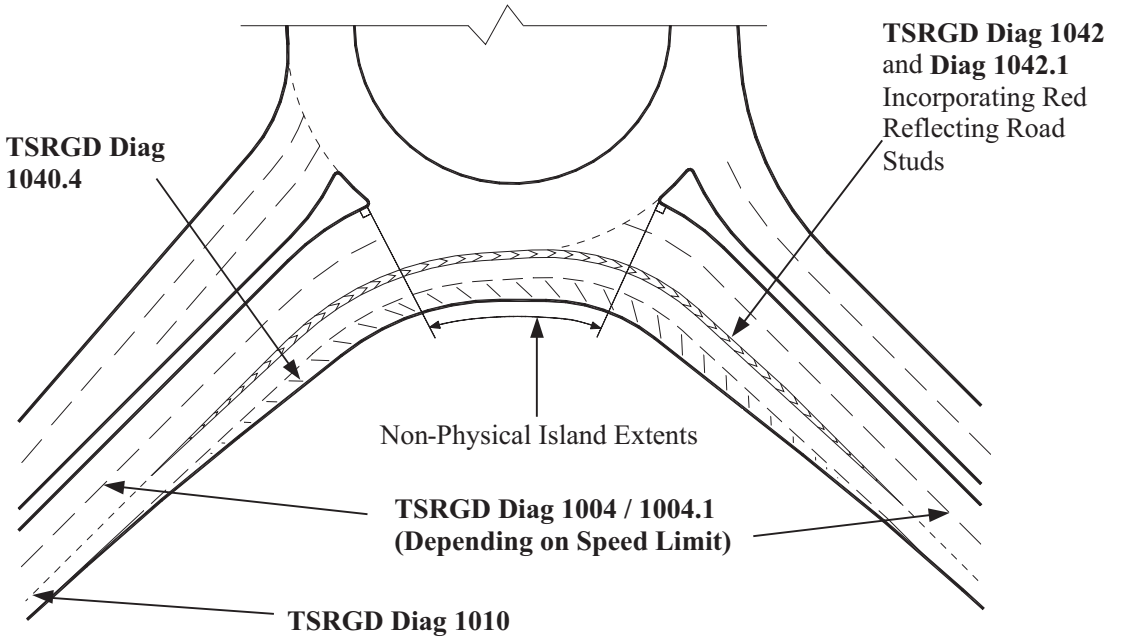
Traffic Flows and Capacity

2.8 When considering the use of segregated left turn lanes, vehicle composition and the total inflow at the roundabout entry, the proportion of left turning vehicles and the number of entry lanes should all be examined. The following procedure can be used as an initial assessment to determine whether the provision of a segregated left turn lane merits further consideration.

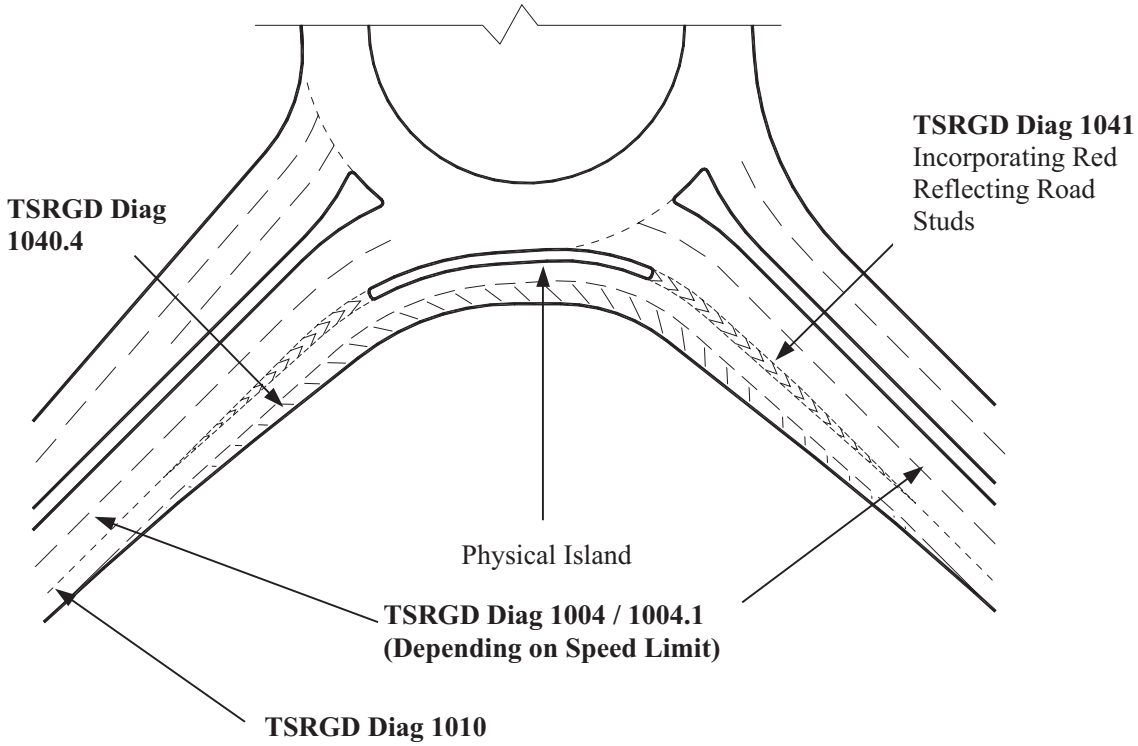
The inclusion of a segregated left turn lane should be considered if:

$$\mathbf{L} \geq \frac{\mathbf{F}}{\mathbf{E}}$$

Where: **L** is the flow of left turning vehicles;
F is the total entry arm inflow in vehicles per hour;
E is the number of proposed entry lanes onto the roundabout including the segregated left turn lane.



(a) Generic Non-Physical Segregated Left Turn Lane with No Provisions Made for Cyclists



(b) Generic Physical Segregated Left Turn Lane with No Provisions Made for Cyclists

Figure 2/1

The following examples illustrate the use of this initial assessment process. In **Example 1**, a segregated left turn lane is being considered at an existing roundabout and in **Example 2**, as an addition to a new roundabout layout.

Example 1

An existing roundabout currently has a 3-lane entry, a left turn flow of 500 vehicles per hour and a total entry inflow of 1200 vehicles per hour. The provision of a left turn lane will result in the loss of one entry lane onto the circulatory carriageway. L is 500, which is greater than F/E (1200/3 = 400), indicating that further examination is worthwhile.

Example 2

A new roundabout is proposed, the left turn flow is 250 vehicles per hour, the total inflow is 1000 vehicles per hour and the left turn lane can be provided in addition to two entry lanes. L is 250, which is less than F/E (1000/3 = 333), indicating that a segregated left turn lane may not improve the capacity of the roundabout entry. Designers should therefore consider alternative measures such as additional entry width (i.e. a three lane entry) or a longer flare length.

2.9 For marginal cases where the value of F/E is close to L, the provision of a segregated left turn lane may merit further consideration where other factors such as safety need to be considered.

2.10 The composition of the turning proportions at the entry, the number of exit lanes and the capacity of the approach road should also be examined when considering the provision of a segregated left turn lane.

2.11 The capacity of a segregated left turn lane is dependent on the entry and exit treatments and lane width. The maximum capacity of a segregated left turn lane occurs when a dedicated lane on the approach and exit is provided and a minimum lane width of 3.5m is available. Capacity will be reduced if flared or diverge approaches or give way or merge exits are provided. The impact of these alternative design features on the capacity of the segregated left turn lane is dependent on specific site conditions, including traffic turning proportions, the Large Goods Vehicle content and geometric features.

2.12 The impact of introducing a segregated left turn lane should be assessed taking into account the entry and exit treatments. Due to the interaction of the various elements of a segregated left turn lane the use of computer programs based on the formula contained in **LR942, The Traffic Capacity of Roundabouts**, and time-dependent queuing theory, is only recommended for simple layouts incorporating a dedicated lane on approach and exit, and where the turning proportions at the entry are evenly balanced. For all other layout options the use of a traffic micro-simulation program or similar technique is recommended.

2.13 The relevant peak periods for the junction being analysed should be used, and should include forecast commuter, development usage and other peak periods. The effect of the lane on traffic flows at different periods of the day should also be considered. The results of any assessment should be carefully examined to ensure that the provision of a segregated left turn lane is the most appropriate form of improvement, compared with alternatives such as modifications to flare lengths or entry widths.

Geometric Design Standards

2.14 Segregated left turn lanes should not be designed to induce high speeds. Any desirable speed reduction should be achieved on the approach to the lane rather than within it. Where the segregated left turn lane follows a tight radius relative to the approach speed, the use of “slow” road markings to **TSRGD Diag 1024** is recommended in conjunction with associated warning signs to **Diag 512** (Bend Ahead), plated with either **TSRGD Diag 511** (Reduce Speed Now) or **Diag 513.2** (Max Speed). Care should be taken to ensure that these signs are located to avoid “sign clutter” or confusion to drivers not using the segregated left turn lane.

2.15 Count down signs to **Diags 823**, **824** and **825** should only be provided on the approach to the roundabout when there is no risk of confusion between the distance to the commencement of the segregated left turn lane and the distance to the roundabout “Give Way” line.

2.16 The curve radius used for the segregated left turn lane will be dependent on both the design speed of the approach road and site constraints. The driver’s perception of the approach and segregated left turn lane radii will be a determining factor in their approach speed. The designer should therefore consider the need for speed reduction measures on the approach depending on the minimum curve radii used. Inside curve radii of less than 10m are not recommended. The exit radius used should be greater than, or equal to, the entry radius.

2.17 Superelevation along the segregated left turn lane shall be applied in accordance with **Table 3** of **TD 9** subject to a maximum value of 5%.

2.18 The Desirable Minimum Stopping Sight Distance (SSD) throughout the segregated left turn lane shall be the lesser of (a) the SSD obtained from **TD 9/93 Table 3** for the design speed of the approach or (b) the SSD given in **Table 2/1** appropriate to the maximum nearside curve radius. The Desirable Minimum SSD shall be applied to the section of segregated left turning lane between the end of the entry taper and the start of exit taper.

2.19 The maximum curve radius used to determine the SSD from **Table 2/1**, shall be the greater of either the entry or exit radius of the segregated left turn lane, these being defined as the radius that occurs immediately after the entry taper and immediately before the exit taper in the direction of travel. See **Figs 2/6** and **2/7** for definitions of entry and exit tapers.

2.20 The carriageway widths specified in column 2 of **Table 2/2** shall be used to accommodate the swept path of a Large Goods Vehicle and hatch markings provided on the inside of the curve to reduce the marked lane width to a minimum of 3.5m as shown in the typical cross sections on **Fig 2/4**.

2.21 It is not necessary to make allowances for broken-down vehicles where segregation is by road markings. Such vehicles can be overtaken with caution. Where physical segregation is introduced, this shall permit a left turn at the roundabout in the normal way from the non-segregated part of the approach as shown on **Fig 2/1(b)**. Where a physical island in excess of 50m in length is proposed, the lane widths specified in Column 3 of **Table 2/2** shall be used.

2.22 For roundabouts ≤ 50m inscribed circle diameter, the segregated left turn lane width used shall be based on the minimum curve radius on the entry or exit. For roundabouts with an inscribed circle diameter > 50m, the designer shall have discretion to reduce the segregated left turn lane width on the section of segregated left turn lane between the entry and exit, depending on the radius used on that section. The widths specified in **Table 2/2** shall be used.

2.23 The use of two-lane segregated left turn lanes is not permitted, as these can result in high vehicle speeds and potential conflict at the exit or merge point. Where left turn flows are very high alternative junction forms or method of junction control shall be considered.

2.24 Where cyclists are expected to use a segregated left turn lane, a cycle lane shall be provided. The extra widening along the segregated left turn shall be equal to the width of the cycle lane, subject to a desirable minimum width of 2m and an absolute minimum width of 1.5m, see **Figs 2/4** and **2/5**.

2.25 1m hardstrips shall not be provided on segregated left turn lanes. They shall be terminated at the start of the entry taper and started at the end of the exit taper as shown on **Fig 2/5**.

Maximum Curve Radius (m)	Desirable Minimum Stopping Sight Distance (m)
less than or equal to 20	35
21 to 40	70
41 to 80	90
81 to 100	120
Greater than 100	215

Table 2/1: Desirable Minimum Stopping Sight Distances

Minimum Inside Corner Radius or Curve Radius (m) (1)	Segregated Left Turn Lane Carriageway Width (for physical island lengths < 50m) (m) (2)	Segregated Left Turn Lane Carriageway Width (for physical island lengths ≥ 50m) (m) (3)
10	8.4	10.9
15	7.1	9.6
20	6.2	8.7
25	5.7	8.2
30	5.3	7.8
40	4.7	7.2
50	4.4	6.9
75	4.0	6.5
100	3.8	6.3
> 100	3.5	6.0

Table 2/2: Minimum Corner and Curve Radii and Carriageway Widths

2.26 Where road markings are used to create the lane segregation, the overall width of the island shall be a minimum of 1.0m. Physical islands shall be a minimum width of 1.5m, subject to the provisions for non-motorised users contained in **Chapter 4** and the requirements for bollards and signs contained in paragraph 2.33. Physical islands shall extend a minimum of 1.5m and 6m into the entry and exit roads respectively beyond the traffic deflection islands where no pedestrians are expected, as shown on **Fig 2/3(a)**.

2.27 Where pedestrian facilities are provided adjacent to the roundabout entry or exit, the physical island shall extend a minimum of 1.5m on both the entry and exit beyond the pedestrian crossing point as shown on **Fig 2/3(b)**.
Non-physical islands shall start and finish at the entry and exit road limits respectively as shown on **Fig 2/1(a)**.

2.28 Segregated left turn lanes can often be incorporated into a traffic signal controlled roundabout. Only physical segregated left turn lanes shall be used in conjunction with traffic signals at roundabouts, to prevent vehicles cutting across onto the roundabout circulatory carriageway from the segregated left turn lane in order to bypass queues at the traffic signal control stop line.

2.29 Segregated left turn lanes shall not be used at the end of steep downhill gradient approaches, this being defined as a longitudinal gradient in excess of 4% within the immediate approach to the junction as defined in **TD 9**, applicable to the design speed of the approach measured back from the start of the entry taper. The longitudinal gradient along the segregated left turn lane shall not exceed 4%.

2.30 Significant cross-sectional level differences between the segregated left turn lane and any adjacent approach, circulatory and exit lanes should be avoided where pedestrians are expected.

2.31 Traffic signs and street furniture may be placed on physical islands. Their number should be limited however, as proliferation can create confusion, distract, reduce visibility, add to sign clutter and have significant maintenance implications. Reference should be made to the Overseeing Organisations' current standard for vehicle restraint systems for details on protection from roadside hazards.

2.32 The use of physical segregated left turn lanes at unlit junctions is not permitted.

2.33 Where a physical island is to be provided, a plain lit bollard shall be installed at the start of the island. A minimum clearance of 0.6m between the edge of the sign or bollard and edge of the physical island shall be provided. Road markings shall be provided in accordance with paragraph 2.44 of this standard.

2.34 The presence of pedestrian, cyclist and/or equestrian crossings shall be signed in accordance with **Chapter 4** of the **Traffic Signs Manual, Warning Signs**. The signs to be used shall be **TSRGD Diag 543** for a signal-controlled crossing, **TSRGD Diag 544** for a zebra crossing, **TSRGD Diag 950** for a cycle route and **TSRGD Diag 550.1** for equestrians.

Approach Layout

2.35 The approach arrangements can consist of either a dedicated lane or diverge on approach.

2.36 Dedicated lanes on approach, see **Fig 2/6**, provide the highest capacity entry to a segregated left turn lane. They require careful design of signing and road markings such as the use of signs to **Diag 2019** and road markings to **Diag 1038** on the approach, to avoid driver confusion that may result in lane changing manoeuvres occurring adjacent to the segregated left turn lane entry.

2.37 Diverge layouts, as shown on **Fig 2/7**, are a means of starting a segregated left turn lane, either as an enhancement to an existing layout or where the approach road is single carriageway as shown on **Fig 2/8**.

2.38 Dedicated lanes on approach can create difficulties for cyclists and should only be used if either few cycle movements are expected, or cycle movements are provided for off the carriageway. Diverge layouts are more cycle friendly than dedicated lanes.

2.39 The entry arrangements consist of an approach taper, if required, and an entry in accordance with **Table 2/4** and as shown on **Figs 2/6** to **2/8**.

2.40 The approach taper will be dependent on site constraints and the use of the minimum taper values contained in **Table 2/3** is recommended.

Design Speed	Minimum Taper
≤ 60 kph	1:10
> 60 kph	1:15

Table 2/3: Minimum Approach Tapers

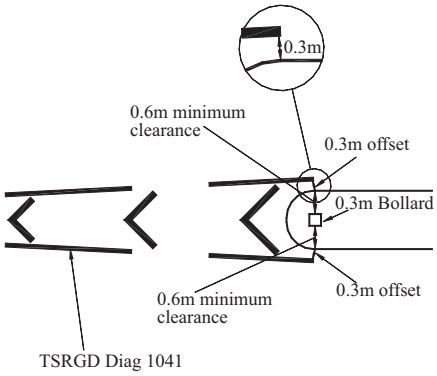
2.41 The entry taper length for the segregated left turn lane shall be provided in accordance with **Table 2/5**. The segregated left turn lane width shall be a minimum of 3.5m at the start of the entry taper, as shown on **Fig 2/6**.

2.42 Any widening required to accommodate a cycle lane and the swept paths of Large Goods Vehicles shall be developed along the length of the entry taper. The length of the entry taper shall be calculated using the following method:

The length of the entry taper shall be dependent on the widening required to accommodate either the segregated left turn lane island width, subject to a minimum width of 1.0m for a non-physical and 2.1m (1.5m island width plus 0.3m marking offset on each side) for a physical island, or the widening required to accommodate the swept path of a Large Goods Vehicle **(Table 2/2)** and the provision of a cycle lane (if required). The larger of the two values shall be used to calculate the entry taper length using the factors contained in **Table 2/5**.

2.43 **Fig 2/9** shows an example of how to calculate the entry taper length for a 1.5m wide physical island less than 50m in length, for a 70 kph single carriageway approach.

2.44 The taper for the hatching shall be developed asymmetrically on the segregated left turn lane side of the entry taper as shown on **Fig 2/9** and shall terminate in a position offset 0.3m from the edge of a physical island as shown on **Fig 2/2**. The 0.3m offset may be reduced to 0.15m where the speed limit is 40mph or less.



Termination of Taper Hatching at Physical Island
Figure 2/2

Approach Type	Approach Taper	Entry Taper
Dedicated Approach Lane	No	Yes
Diverge	Yes	Yes

Table 2/4: Segregated Left Turn Lane Approach Treatments

Design Speed (kph)	Entry/Exit Taper Length Factor
50	20
60	20
70	20
85	25
≥100	30

Table 2/5: Desirable Minimum Entry/Exit Taper Length Factors (see example in Fig 2/9)

Exit Layout

2.45 The three basic types of exit layout from a segregated left turn lane are:

- Dedicated lane consisting of an exit taper as shown on **Fig 2/6**.
- Merge consisting of an exit and end taper as shown on **Fig 2/7**.
- Give-way as shown on **Fig 2/8**.

2.46 The dedicated exit lane [see **Fig 2/6**], provides a free running exit for traffic from the segregated left turn lane. This exit type does not reduce the link capacity of the segregated left turn lane and is considered a safer layout compared with a merge exit.

2.47 Merge exits consist of a merge manoeuvre between the traffic leaving the roundabout circulatory carriageway and the segregated left turn lane. Merge exit layouts inherently include risks associated with vehicles exiting the roundabout being in the wing mirror "blind spot" for traffic using the segregated left turn lane. This can be associated with collisions between merging vehicles and nose-to-tail collisions. This is a particular problem for those motorists with a limited ability to look over their shoulders and for drivers of some large vehicles and left-hand drive vehicles.

2.48 Merge exits shall only be provided where two or more lanes can be provided on the exit [see **Fig 2/7**]. For the case where only one lane can be provided at the segregated left turn lane exit point, a give way from the segregated left turn shall be provided [see **Fig 2/8**].

2.49 The exit taper for the segregated left turn lane shall be provided in accordance with **Table 2/5**. The segregated left turn lane width shall be a minimum of 3.5m at the end of the exit taper, as shown on **Fig 2/6**. Any widening required to accommodate the swept paths of Large Goods Vehicles through the segregated left turn lane shall be removed along the length of the exit taper. As with the entry taper, the length of the exit taper

shall be calculated by using the larger value when comparing the width of the segregated left turn lane island with the width reduction required between the start and end of the exit taper, as shown on **Fig 2/9**.

2.50 The taper for the hatching shall be developed asymmetrically on the segregated left turn lane side of the exit taper as shown on **Fig 2/9** and shall terminate in a position offset from the edge of a physical island in accordance with paragraph 2.44 of this Standard.

2.51 **TD 16 (DMRB 6.2.3)** recommends that at the beginning of a roundabout exit, its width should allow for an extra traffic lane over and above that of the link downstream. This extra width should be reduced on the nearside, normally at a taper of 1:15 to 1:20. Where a segregated left turn lane is present, the exit width reduction must be completed upstream of the end of the segregated left turn lane exit taper. This may require extending the segregated left turn lane exit taper to accommodate the roundabout exit width reduction.

2.52 The end taper will be dependent on site constraints and the use of the minimum taper values contained in **Table 2/6** is recommended.

Design Speed	Minimum Taper
≤ 60 kph	1:10
> 60 kph	1:15

Table 2/6: Minimum End Tapers

2.53 A give way exit from a segregated left turn lane should be located as close as practicable to the roundabout, at a minimum entry angle of 20° between the give way and vehicle. The entry angle is defined as the angle between the line of the give way marking to **Diag 1003** and the centreline of the vehicle at the give way as shown on **Fig 2/8**. The position of the vehicle at the give way should be determined by carrying out a swept path analysis.

2.54 Where signs and street furniture are placed on the physical island in the vicinity of the exit, they should be located so as not to obstruct intervisibility between the segregated left turn lane exit and adjacent roundabout exit lane.

Non-Physical Segregated Left Turn Lanes

2.55 Non-physical segregated left turn lanes are subject to abuse by drivers resulting in conflicts on the approach to or exit from a roundabout and on the circulatory carriageway section, especially on older existing roundabout junctions. The use of a physical island is therefore recommended where possible.

2.56 The use of raised or domed surfaces, flush kerbs or infilling with marking material to reinforce road markings is not permitted.

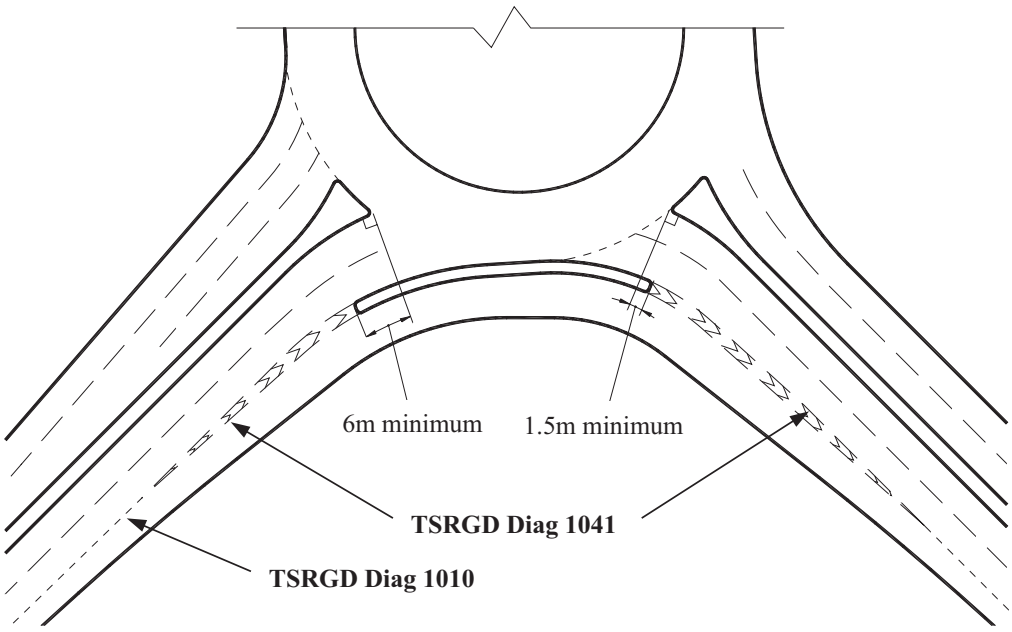
2.57 Physical segregated left turn lanes shall be used where vehicles using the segregated left turn lane have to give way at the exit.

Buses

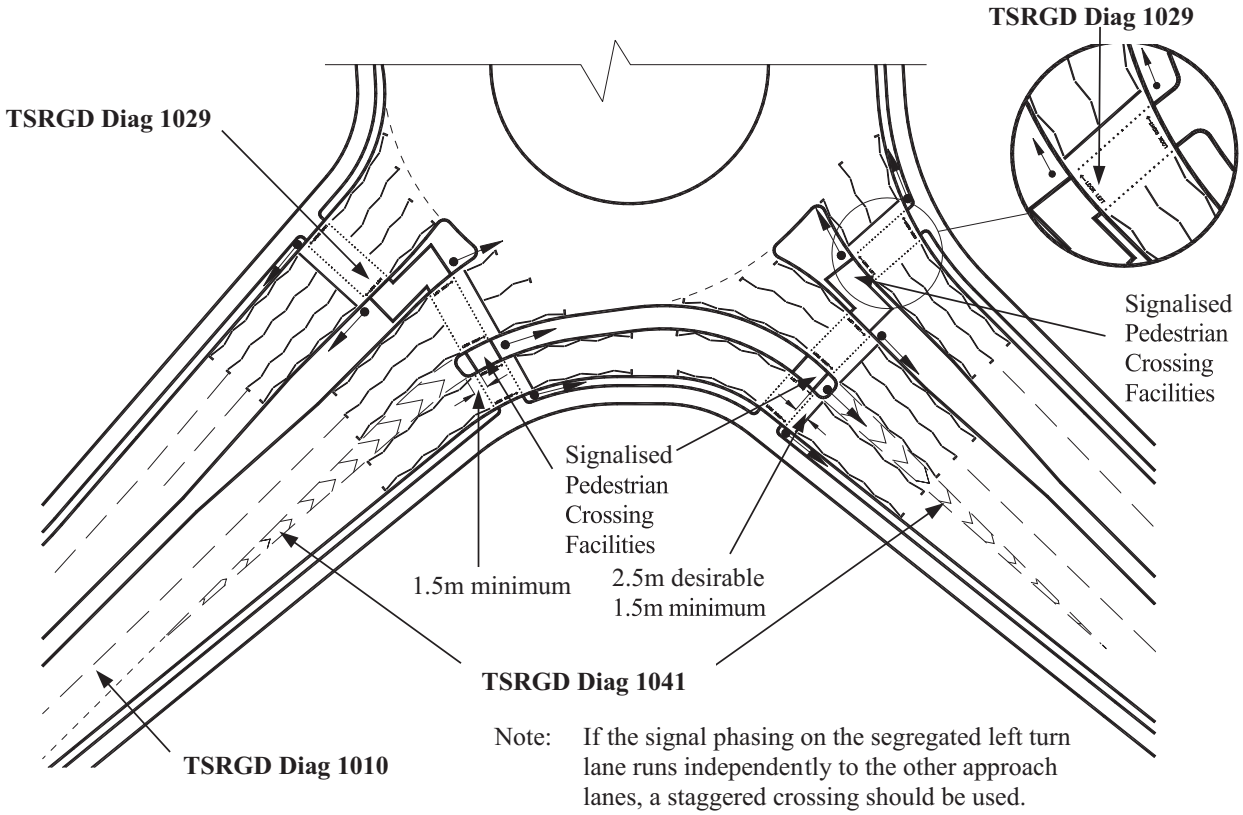
2.58 Segregated left turn lanes give priority to all vehicles turning left at a junction including buses. These facilities can therefore improve journey time reliability on bus routes, either in isolation or as part of a larger traffic management proposal.

2.59 The use of bus only segregated left turn lanes to provide priority for left turning buses at roundabout junctions requires careful consideration. Factors including the number of buses using the dedicated lane and any detrimental impact on the overall capacity of the roundabout entry and affected exit will need to be taken into account.

2.60 Bus stops shall not be located within segregated left turn lanes.



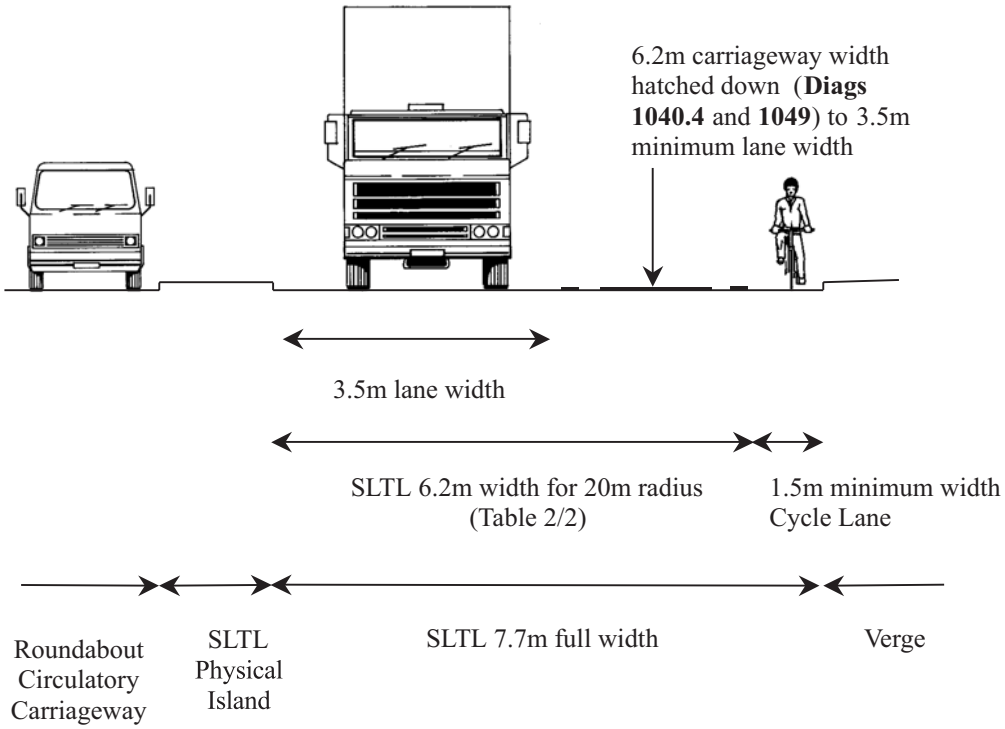
(a) Physical Segregated Left Turn Lane without Pedestrian Facilities



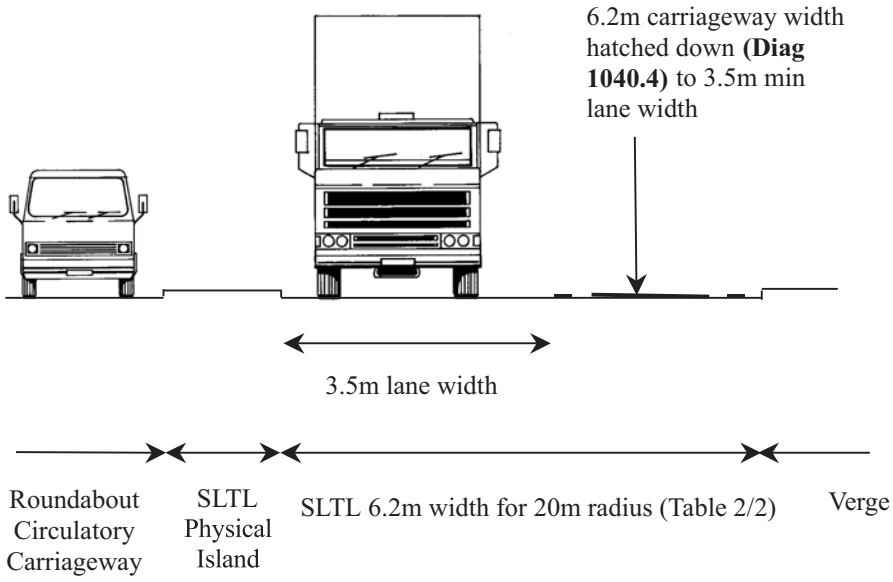
Note: If the signal phasing on the segregated left turn lane runs independently to the other approach lanes, a staggered crossing should be used.

(b) Physical Segregated Left Turn Lane with Pedestrian Facilities
Approach/Exit Design Speed ≤ 85kph

Figure 2/3

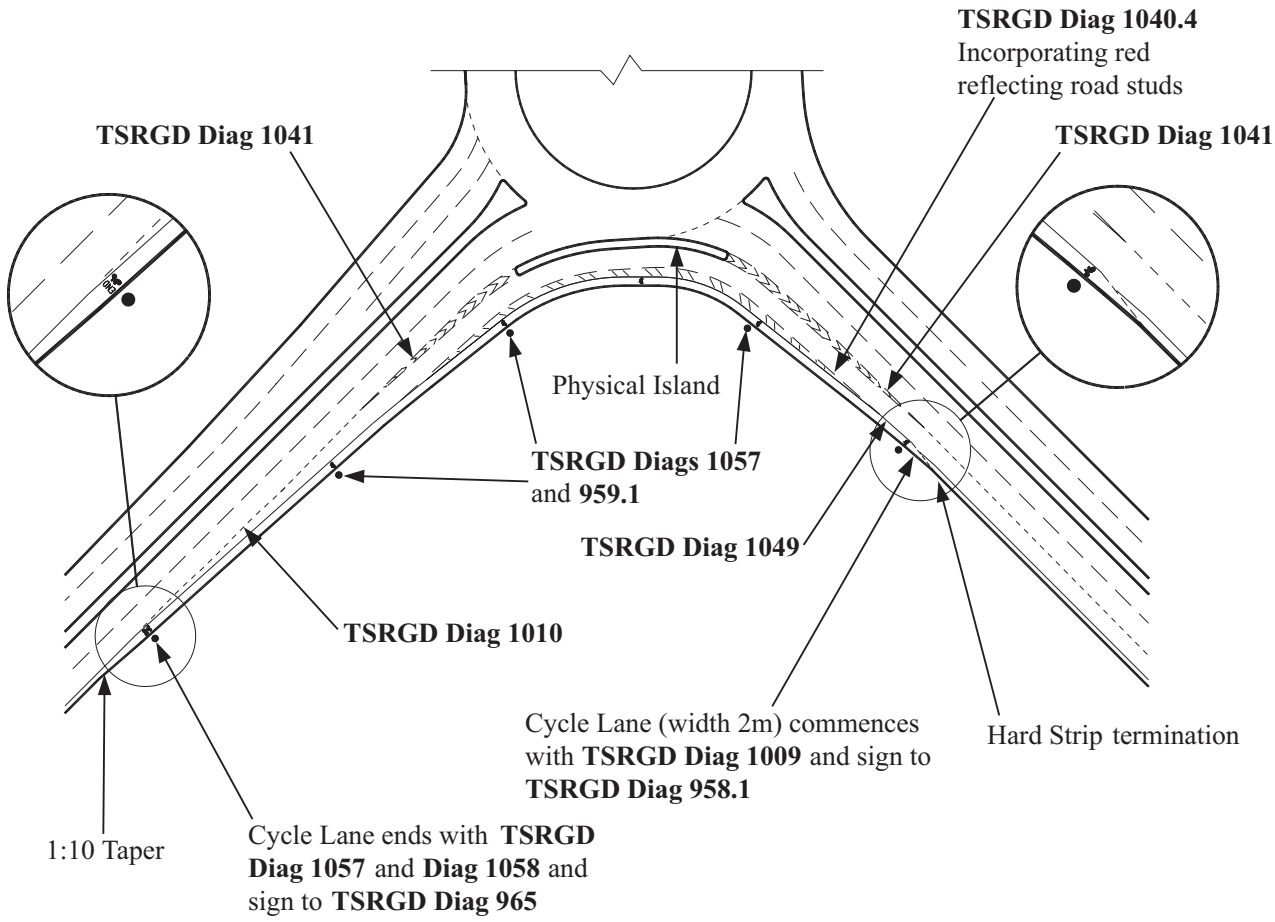


(a) Segregated Left Turn Lane Island Less Than 50m in Length
Cross Section Allowing for Cyclists



(b) Segregated Left Turn Lane Island Less Than 50m in Length
Cross Section with No Allowance for Cyclists

Typical Cross Sections
Figure 2/4

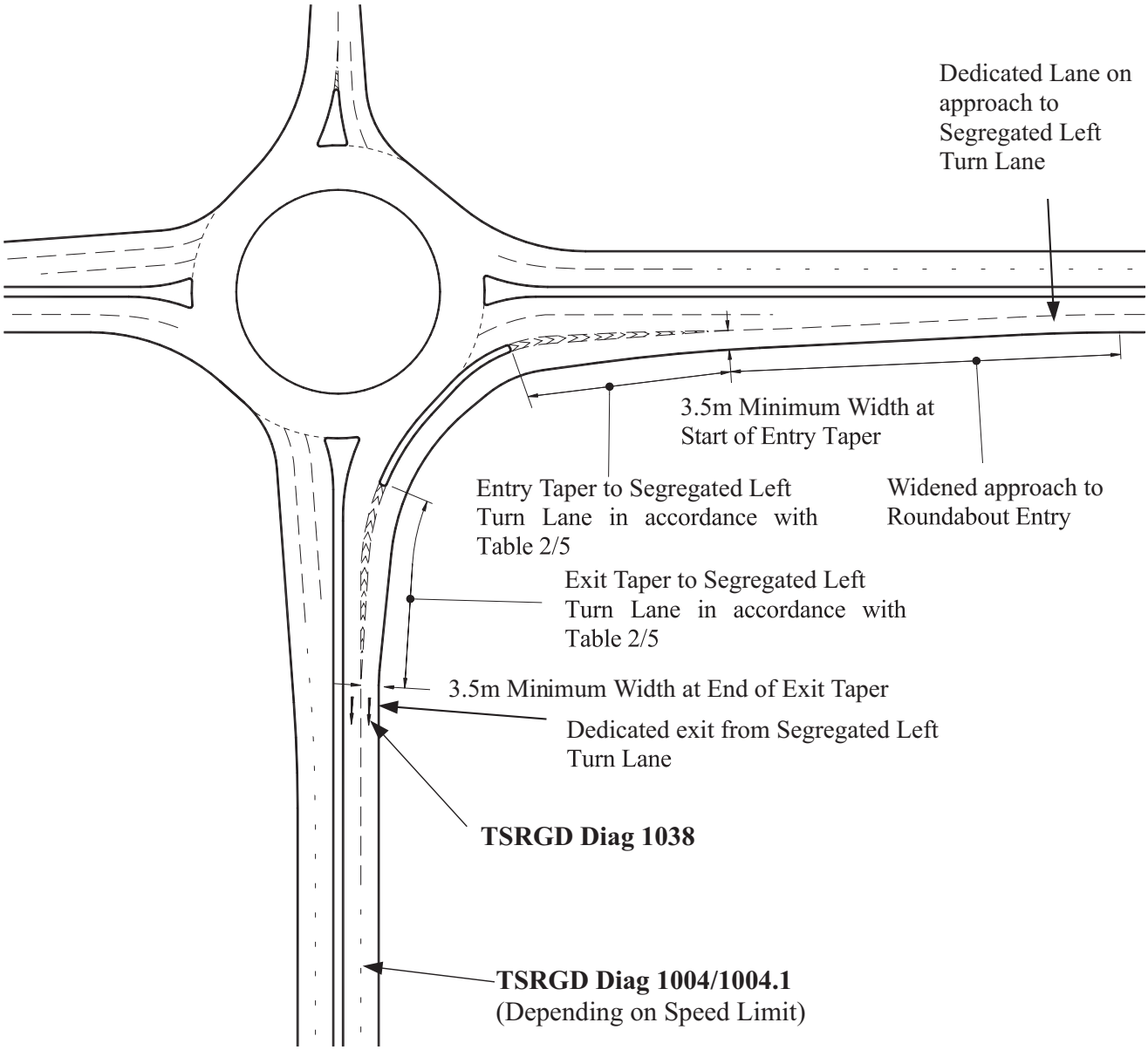


Note:- For additional requirements refer to **Fig 2/1**

Example of Segregated Left Turn Lane with Cycle Lane and Hard Strip on Approach and Exit

Figure 2/5

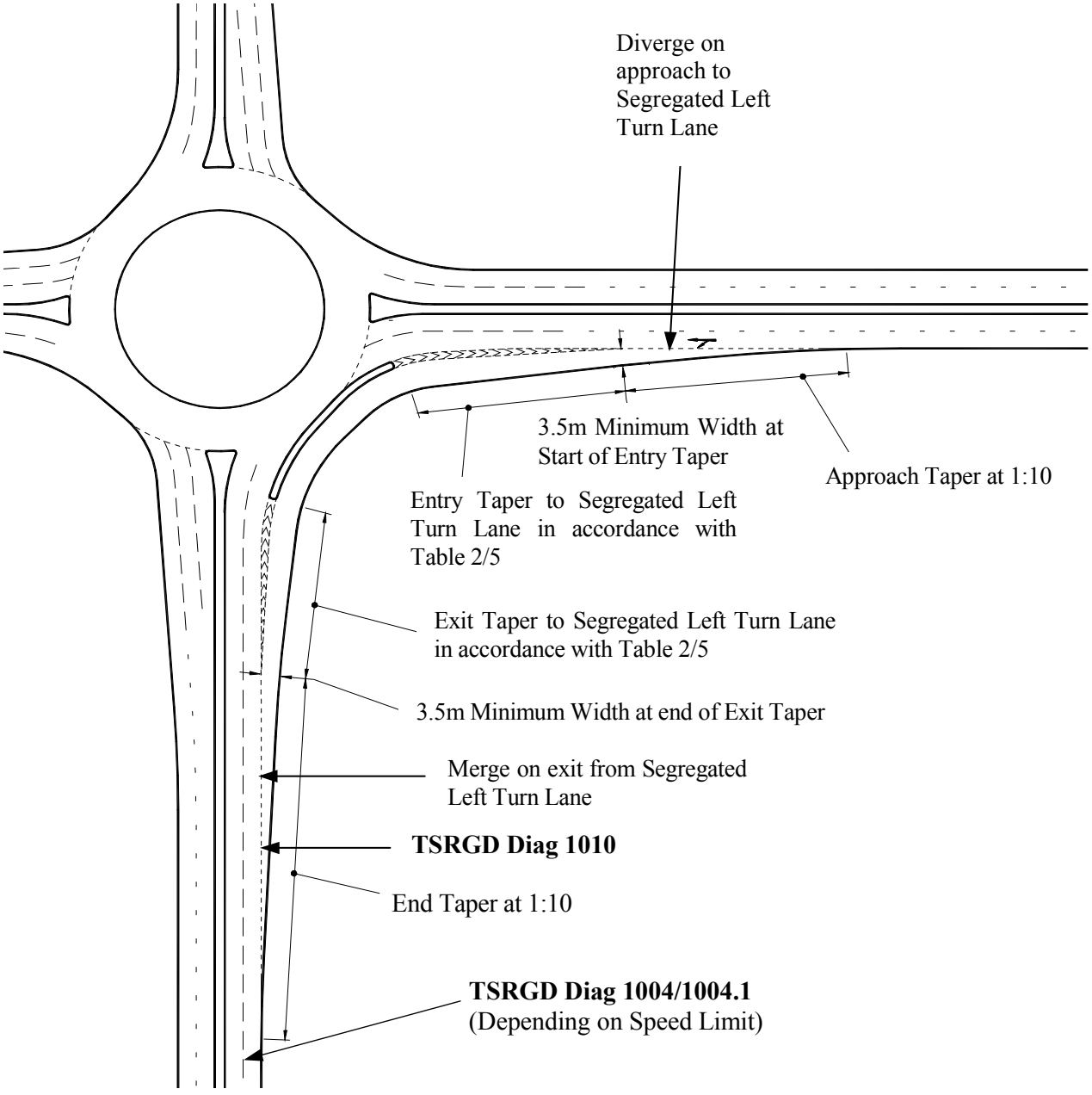
Note: For Cyclist Provision on approach/exit to/from Segregated Left Turn Lane, see **Fig 4/1**.



Dedicated Approach and Exit for Segregated Left Turn Lane
Approach and Exit Design Speed ≤ 60kph

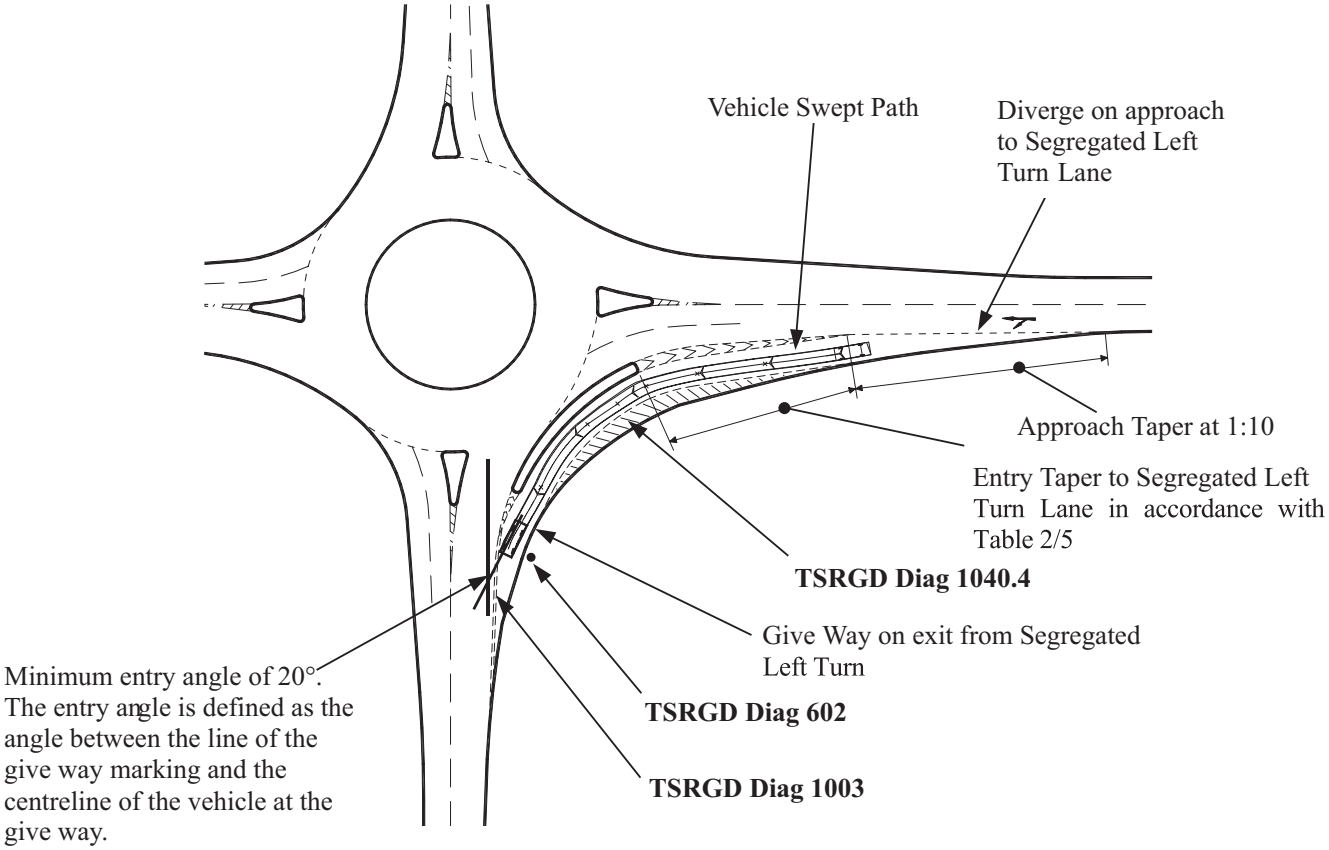
Figure 2/6

Note: For Cyclist Provision on approach/exit to/from Segregated Left Turn Lane, see **Fig 4/1**.



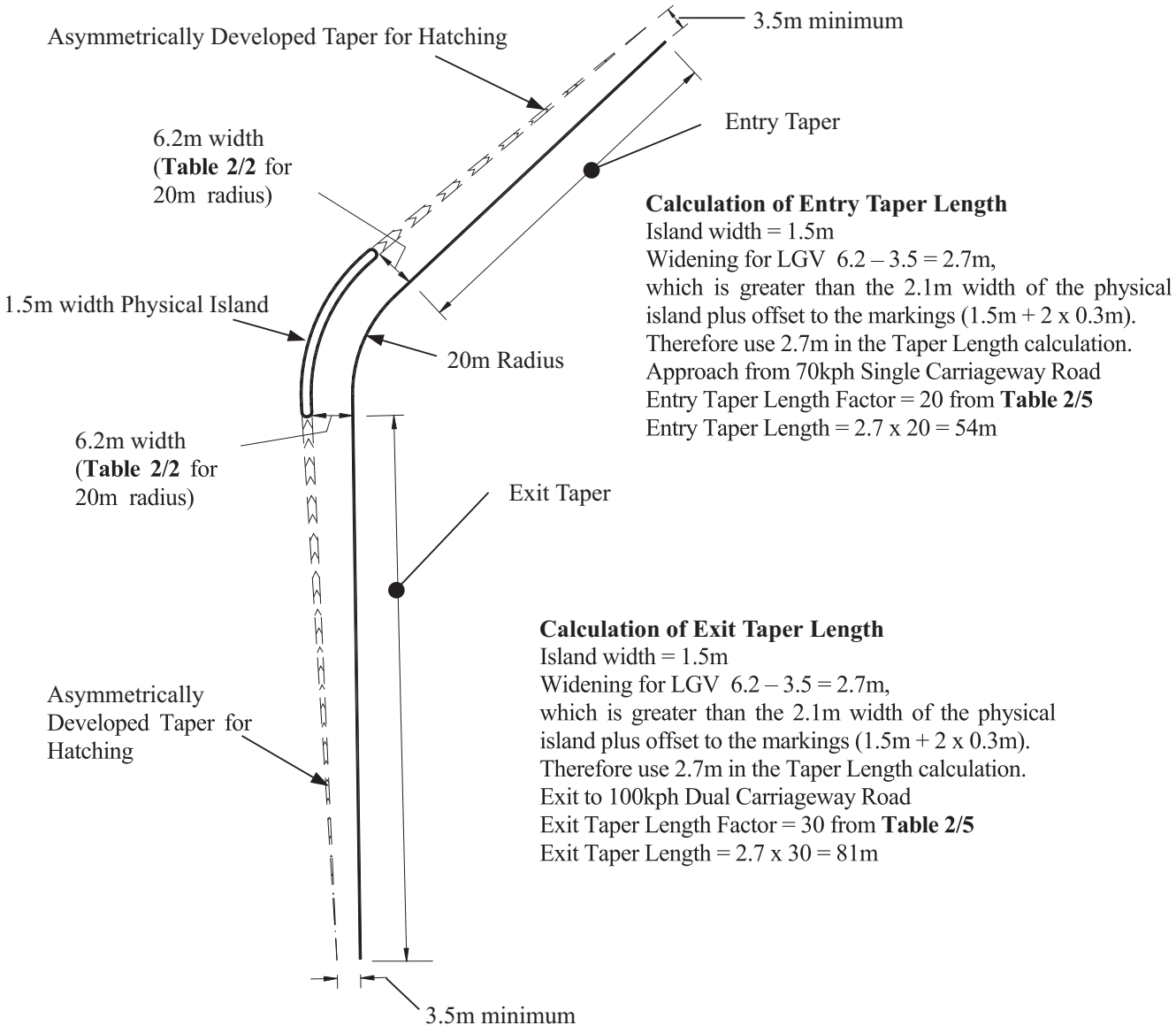
Diverge/Merge Layout Segregated Left Turn Lane Island < 50m in Length
Approach and Exit Design Speed ≤ 60kph

Figure 2/7



Physical Segregated Left Turn Lane with Give Way on Exit
Approach and Exit Design Speed ≤ 60kph

Figure 2/8



Example of Calculation of Entry/Exit Taper Lengths
(1.5m wide island less than 50m long, 70kph approach design speed)

Figure 2/9

Safety

2.61 The presence of a segregated left turn lane shall be signed on the approach using an advance direction sign in accordance with the **TSRGD**. On a primary route this will be a green background version of **Diag 2118**. Designers should refer to **Chapter 7** of the **TSM** (paragraphs 5.43 and 5.44) for guidance on the design of the route symbol. In the case of a lane drop layout, a left turn arrow to **Diag 1038** should be placed in the lane at its commencement and repeated if necessary until the chevron marking commences.

2.62 The use of road markings to **Diag 1035** to supplement Advance Direction Signs is also recommended.

2.63 Where kerbed islands are used, the kerb height above the carriageway should be 100mm.

2.64 The effectiveness of a non-physical island incorporated in a segregated left turn lane layout can be enhanced through the use of continuous, rather than broken, road markings to **TSRGD Diag 1042** and **Diag 1042.1** infilled with coloured surfacing.

2.65 The conspicuity of the approaches to physical segregated left turn lane islands can be enhanced using coloured surfacing infill to the **TSRGD Diag 1041** entry taper road markings.

2.66 Red reflecting road studs shall be used with **Diag 1040.4** in conjunction with road markings to **Diag 1041**, **Diag 1042** and **Diag 1042.1** and shall be used only when laid on the nearside. Guidance on the use of reflecting road studs is contained in **Chapter 5** of the **TSM**.

2.67 Designers should ensure that where a segregated left turn lane has been widened to accommodate the swept paths of Large Goods Vehicles, the widened lane does not encourage high vehicular speeds or two vehicles to attempt to use the lane side by side. The operational lane width shall be narrowed down on the nearside to a minimum of 3.5m width through the use of hatching to **Diag 1040.4**. Subject to the provisions of paragraph 2.69 below, hatching to **Diag 1040.4** shall be a minimum width of 1.0m.

2.68 Consideration should be given to increasing the conspicuity of hatching to **Diag 1040.4** through the use of differential coloured surfacing.

2.69 Where cyclists are expected, the hatching shall not be laid at the nearside but shall be used to separate the motor traffic from the cycle lane as shown on **Fig 2/4** and **Fig 2/5**.

2.70 The provision of a segregated lane for the first exit at a three arm roundabout can result in the provision of a segregated lane for straight ahead traffic movements. This arrangement is relatively uncommon and it has not been possible to carry out comprehensive studies on its operation and therefore specific recommendations on its use cannot be made.

2.71 Designers considering the use of a segregated lane for a straight ahead traffic movement should be aware that there are a number of issues that could result in unsafe layouts. They are:

a. High entry speed.

b. Higher speed of vehicles exiting the straight ahead lane compared with slower traffic leaving the roundabout, which can result in merging problems.

c. The use of reverse curves both on the approach and through the roundabout and abrupt changes in crossfall.

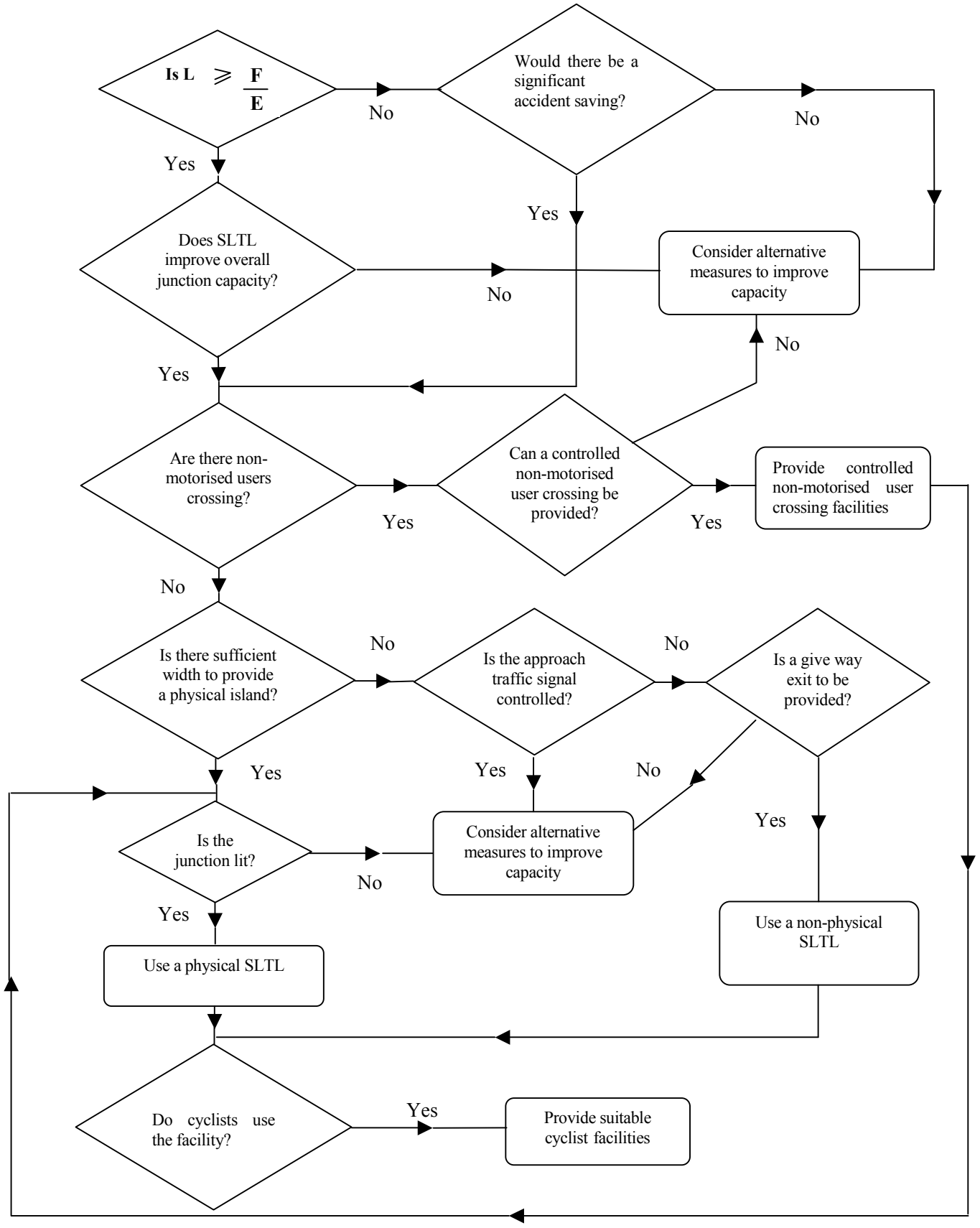
d. The difficulties presented to pedestrians and cyclists.

e. Difficulties in signing the layout.

2.72 Designers should exercise particular caution in the design of segregated lanes for straight ahead traffic movements in order to avoid these problems, and if necessary consider alternative layouts.

Design Procedure

2.73 The objective of the design procedure is to achieve a safe design and optimal value for money within budget constraints. Having identified a need for capacity or safety improvements to the roundabout, the flow chart shown in **Fig 2/10** can be used to identify the need for a segregated left turn lane and the type to be used.



Example of Flow Chart Decision Process For incorporation of Segregated Left Turn Lanes
Figure 2/10

3. SUBSIDIARY DEFLECTION ISLANDS

General

3.1 This chapter outlines the criteria for the provision of subsidiary deflection islands (SDI) at roundabouts and the geometric design features to be considered in their design. Many of the features are considered separately, and Designers should adopt a systematic approach to achieve a satisfactory design incorporating only the appropriate features.

3.2 As stated in **Chapter 1**, the use of a subsidiary deflection island is a method for introducing deflection at a roundabout entry. It shall not be used in the design of new roundabout junctions, but may be considered as part of an improvement scheme to an existing roundabout to overcome existing substandard entry path curvature, where sufficient deflection cannot be provided by conventional design to **TD 16 (DMRB 6.2.3)** due to site or other constraints, e.g. abnormal load routes, statutory undertakers' apparatus or land availability.

3.3 Subsidiary deflection islands, as shown on **Fig 3/1**, should only be considered where the required deflection as defined and measured according to **TD 16 (DMRB 6.2.3)** cannot be achieved through conventional design measures. These conventional design measures include:

a. Realignment of the approach to the roundabout.

b. Enlargement or realignment of the roundabout central island.

c. Changes to the roundabout entry.

d. Enlargement or realignment of the traffic deflection island.

3.4 In urban areas, the restrictions on space available coupled with the turning width requirements of Large Goods Vehicles may result in small normal roundabouts, which do not provide sufficient entry deflection to the left by means of the central island alone. In these cases deflection should be generated by means of enlarged traffic deflection islands **(Fig 3/4)** or, if these cannot be provided, by non-physical subsidiary deflection islands in the entry as shown on **Fig 3/5**.

3.5 Entry deflection can be achieved at difficult sites through the use of subsidiary deflection islands situated at the immediate entry to the circulatory carriageway. These enhance the deflection created by traffic deflection islands adjacent to the roundabout entry as shown on **Fig 3/2**.

3.6 The designer shall take into consideration, at the earliest opportunity, the needs of non-motorised users such as pedestrians, cyclists and equestrians. Suitable measures and advice relating to provision for non-motorised users are addressed in **Chapter 4**.

3.7 All traffic signs and road markings shall be designed and applied in accordance with the **Traffic Signs Regulations and General Directions (TSRGD)**, the **Traffic Signs Regulations (Northern Ireland)** and the **Traffic Signs Manual**.

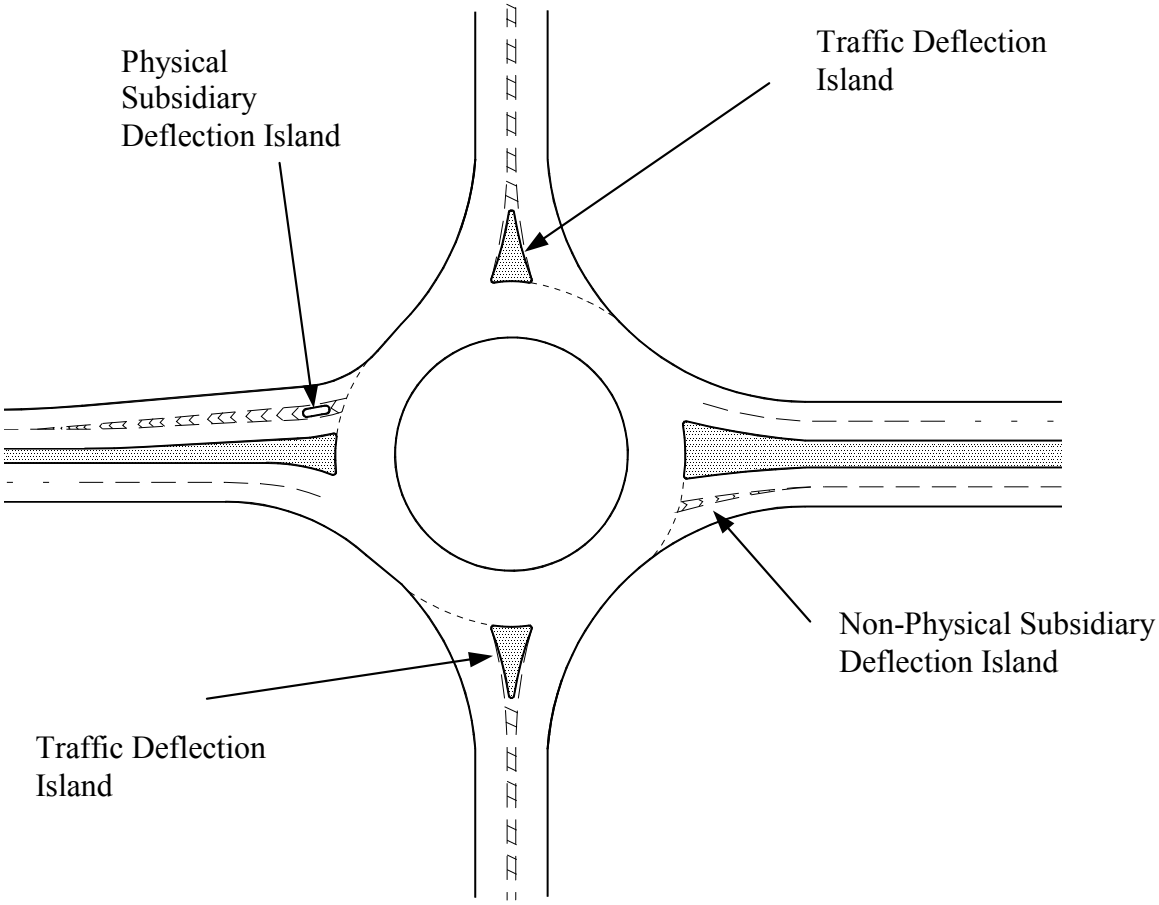
3.8 Non-physical subsidiary deflection islands are areas defined by road markings only. They shall not be raised. Solid markings or those infilled with marking material shall not be used.

3.9 Care should be taken in the design of subsidiary deflection islands to avoid any confusion with traffic deflection islands.

Geometric Design Standards

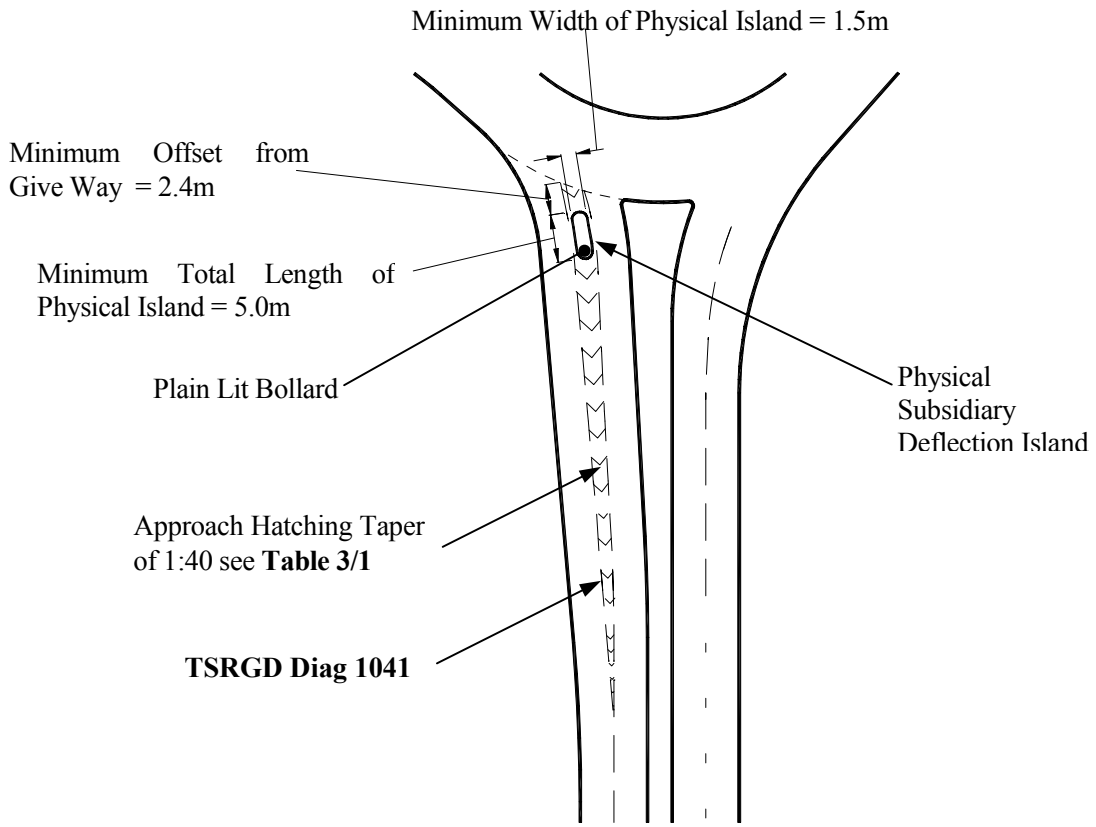
3.10 Physical subsidiary deflection islands shall be a minimum width of 1.5m, subject to the provisions for pedestrians contained in **Chapter 4**. Non-physical islands shall be a minimum width of 1m. Physical subsidiary deflection islands shall be positioned no closer than 2.4m from the roundabout give-way line to avoid the lit bollard obstructing visibility. The island shall be a minimum total length of 5m as shown on **Fig 3/2**.

3.11 Road markings to **TSRGD Diag 1041** shall be used to guide vehicles past the physical island, see **Fig 3/2**. The approach hatching for both physical and non-physical subsidiary deflection islands shall be in accordance with **Table 3/1**.

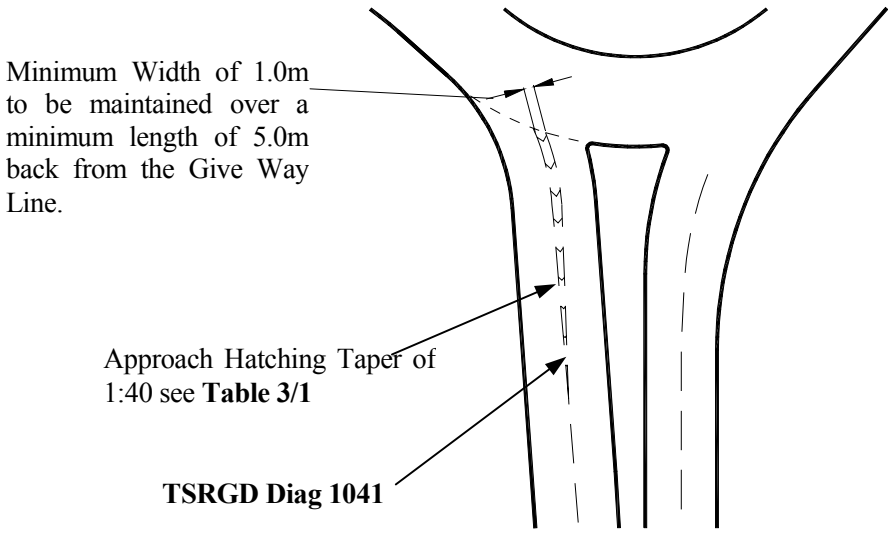


Example of Traffic Deflection Islands and Physical and Non-Physical Subsidiary Deflection Islands

Figure 3/1



(a) Example Showing Generic Physical Subsidiary Deflection Island for a 60kph Approach Design Speed



(b) Example Showing Generic Non Physical Subsidiary Deflection Island for a 60kph Approach Design speed

Figure 3/2

Design Speed (kph)	Approach Hatching Taper
50	1:40
60	1:40
70	1:45
85	1:45
≥100	1:50

Table 3/1: Approach Hatching Taper

3.12 The approach hatching shall be developed symmetrically and shall terminate at a position offset from each side of a physical island in accordance with paragraph 2.44 of this Standard. The road markings to **TSRGD Diag 1041** shall continue at full width up to the roundabout give way as shown on **Fig 3/2**.

3.13 The use of physical subsidiary deflection islands at unlit junctions is not permitted.

3.14 Where a physical island is to be provided, a plain lit bollard shall be installed at the start of the island. A minimum clearance of 0.6m between the edge of sign or bollard and edge of carriageway shall be provided.

3.15 The entry path curvature shall be measured in accordance with the guidance contained in **TD 16 (DMRB 6.2.3)** and as shown on **Fig 3/3**, where a subsidiary deflection island is provided.

3.16 Subsidiary deflection islands created with road markings are subject to abuse by drivers and are less effective than physical islands. The use of physical islands is therefore recommended wherever possible.

Safety

3.17 The conspicuity of subsidiary deflection islands can be enhanced through the use of differential coloured surfacing in addition to the road markings.

3.18 Where kerbed islands are used, the kerb height above the carriageway should be 100mm.

3.19 Red reflecting road studs shall be used in conjunction with road markings to **Diag 1041**. Guidance on the use of reflecting road studs is contained in **Chapter 5** of the **TSM**.

3.20 The most common problem affecting safety is excessive speed, either at entry or within the roundabout. Factors contributing to high entry and circulatory speeds include:

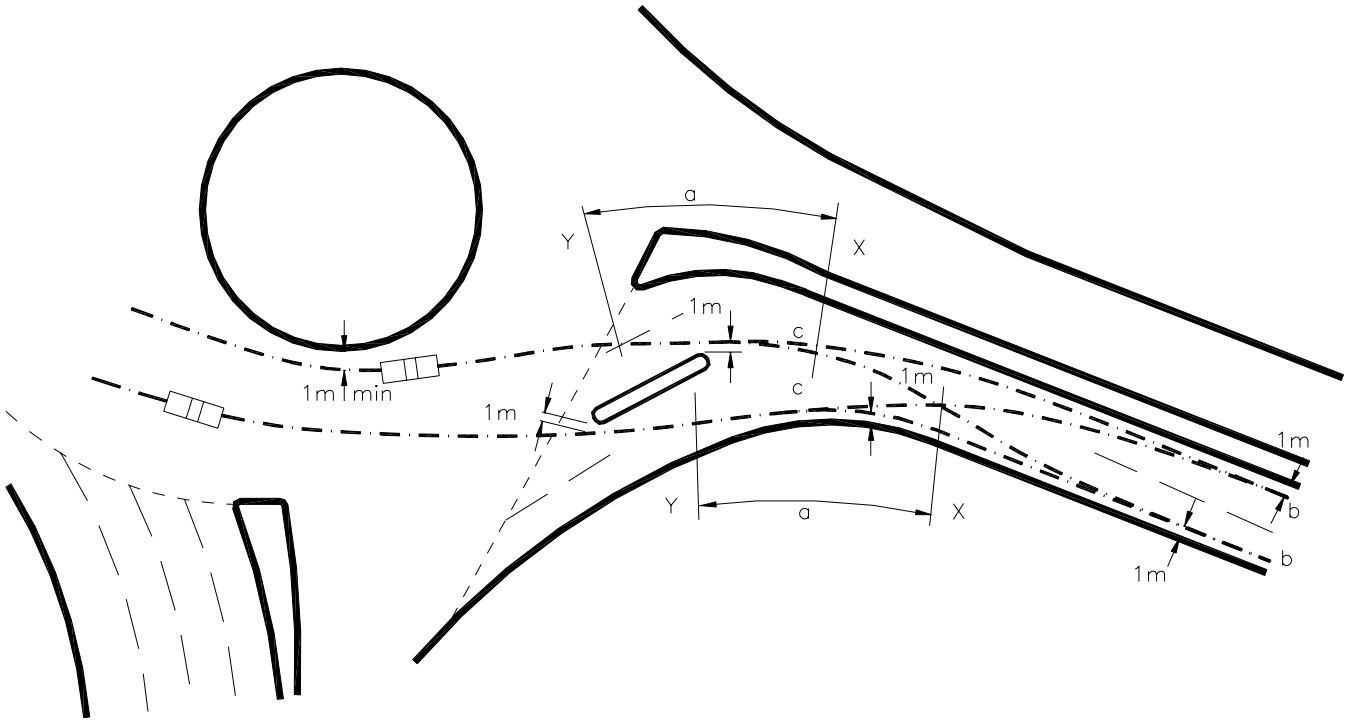
a. Inadequate entry deflection;

b. Excessive entry width.

3.21 The use of subsidiary deflection islands will contribute to increasing entry deflection and slowing traffic due to the narrowing of the entry width. Subsidiary deflection islands can therefore be considered as an alternative measure as part of a safety scheme at a roundabout, where conventional roundabout layouts cannot be achieved. However, it is essential that subsidiary deflection islands are correctly signed and marked in order that the island itself does not present a hazard to road users.

Design Procedure

3.22 The objective of the design procedure is to achieve safe design and optimal value for money within budget constraints. The decision process shown on **Fig 3/6** can be used to identify both the need for and type of subsidiary deflection island.



Determination of Entry Path Curvature (when subsidiary traffic deflection island incorporated)

a. The radius should be measured over a distance of 20 – 25m; it is the minimum that occurs along the approach entry path in the vicinity of the Give Way line but not more than 50m in advance of it.

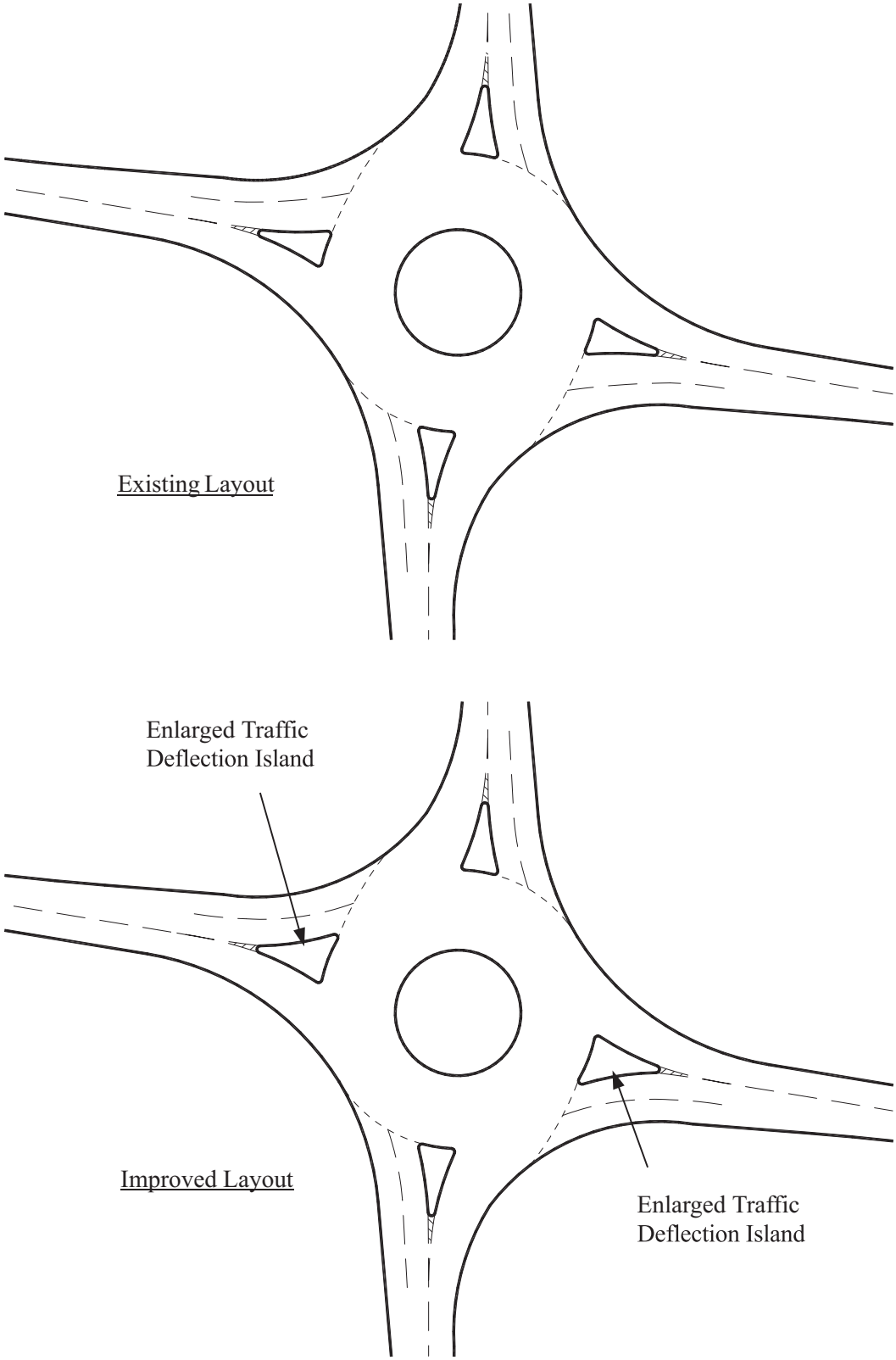
b. Commencement point either 1m from nearside kerb or 1m from offside kerb for dual two-lane carriageway; 1m from nearside kerb or 1m from centreline for single two-lane carriageway, at a point not less than 50m from the Give Way line.

c. — · — · — · Vehicle entry path.

Figure 3/3

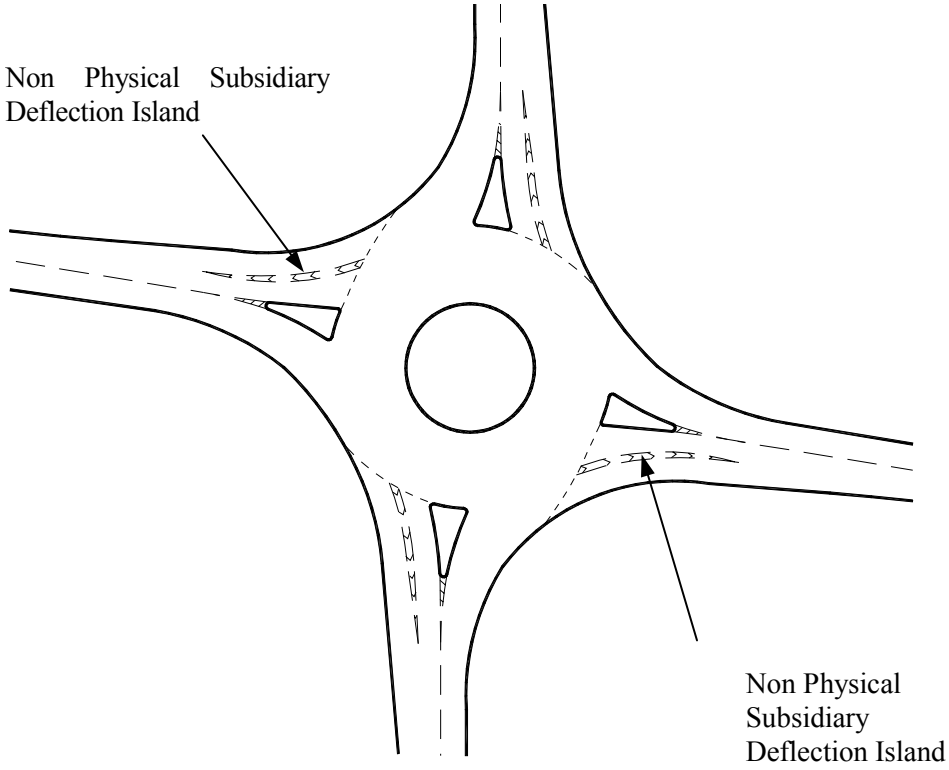
Note

This Figure is for illustration purposes only and is intended to show the method of calculation of entry path curvature where Subsidiary Deflection Islands are present.



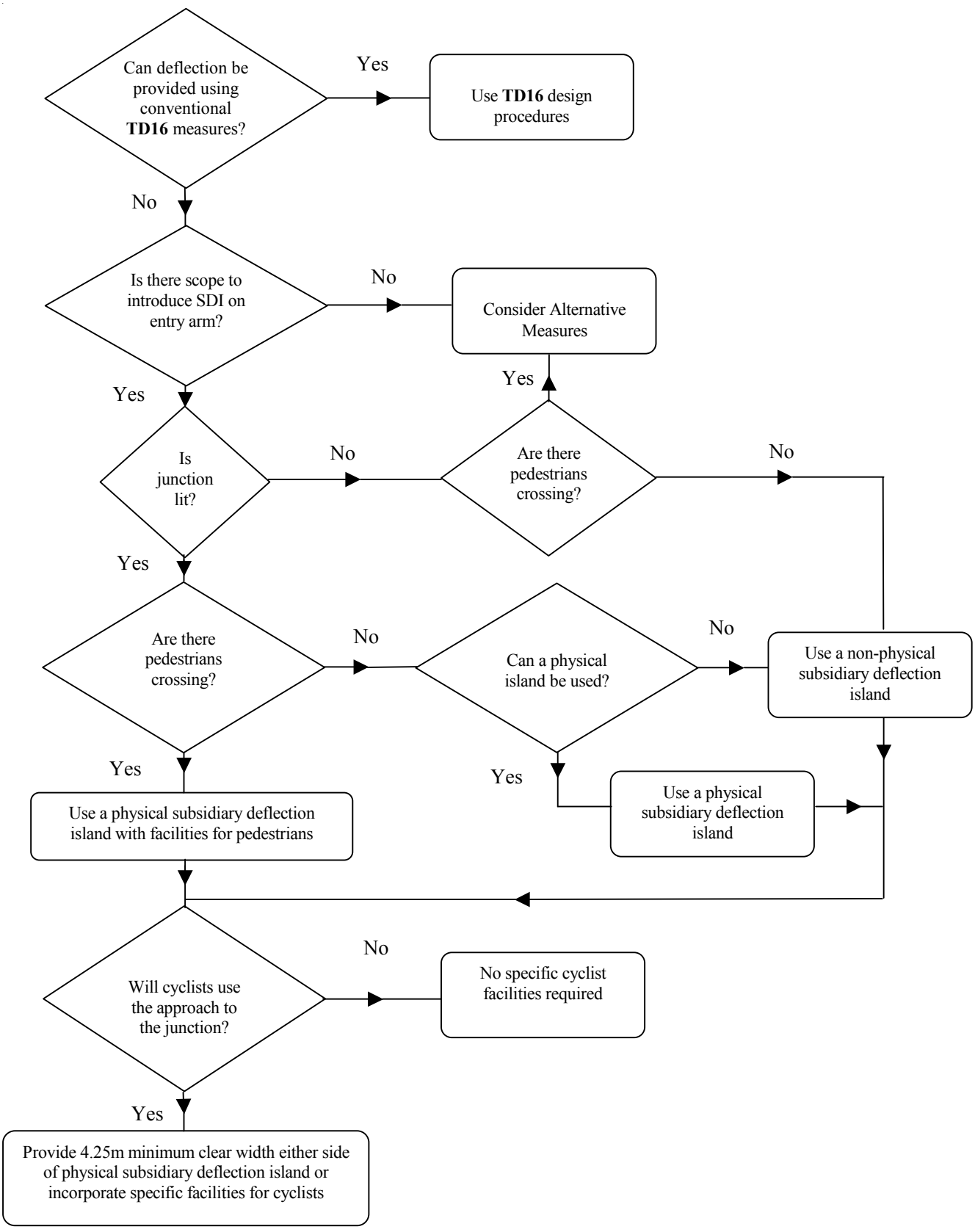
Example showing how Traffic Deflection Island Design can increase Entry Deflection at an Existing Roundabout

Figure 3/4



Example showing how a Non-Physical Subsidiary Deflection Island can increase Entry Deflection at an Existing Roundabout

Figure 3/5



Example of Flow Chart Decision Process for Incorporation of Subsidiary Deflection Island

Figure 3/6

4. ROAD USERS' SPECIFIC REQUIREMENTS

Specific Measures for Pedestrians

4.1 Guidance on the provision of pedestrian crossings and their lighting and signing, can be found in **TA 68 (DMRB 8.5.1)** and **Local Transport Notes (LTN) 1/95 The Assessment of Pedestrian Crossings** and **2/95 The Design of Pedestrian Crossings**.

4.2 The use of segregated left turn lanes and subsidiary deflection islands in urban areas where significant flows of pedestrians are expected to cross is not recommended and alternative layouts should be considered.

4.3 Where a pedestrian need is established, appropriate facilities shall be provided in accordance with the guidance contained in **LTN 1/95** and **2/95**, **TD 16 (DMRB 6.2.3)** and **TD 50 (DMRB 6.2.3)**. **TA 57 (DMRB 6.3.3)** contains guidance on kerbing and guardrails, and guidance on the use of tactile paving surfaces is available from the **DfT** Mobility Unit. Additional information on the provision of pedestrian facilities is contained in documents referred to in the **DfT** publication list.

4.4 Special consideration should be given to pedestrians when segregated left turn lanes are provided at roundabouts. Uncontrolled crossing points are not permitted across segregated left turn lanes or within the immediate approach to the junction (on both approach and exit arms), as defined in **TD 9**, measured from the start of the entry taper for the segregated left turn lane approach arm and the end of the exit taper for the exit arm.

4.5 Suitable controlled crossings or grade-separated facilities shall be provided where pedestrians are expected to cross a segregated left turn lane. Pedestrians shall be directed with the use of guardrail or suitable hard landscaping to the appropriate crossing points.

4.6 The use of zebra crossings on roads subject to a 30mph speed limit or less, or traffic signal control on roads with a 50mph speed limit or less, to assist pedestrians in urban areas is recommended, as shown on **Fig 4/1**. Guidance is provided in **LTN 1/95** and **2/95**.

4.7 Islands shall be of sufficient size to accommodate the anticipated peak number of pedestrians. Where a pedestrian refuge or physical segregated left turn lane island is provided, it shall be a minimum width of 2.0m and the hatching a minimum width of 2.6m (or 2.3m where the speed limit is 40mph or less) adjacent to the refuge as shown in **Chapter 5** of the **TSM** and on **Fig 2/2**.

4.8 Special consideration shall be given to pedestrians when subsidiary deflection islands are provided at roundabouts. These islands can appear to create refuges that will encourage pedestrians to cross at these locations. Non-physical subsidiary deflection islands shall not be used as pedestrian refuges. Where islands are intended to be used by pedestrians, they shall be physical islands and measures taken to direct pedestrians to specific crossing points.

4.9 The use of tactile paving, drop and flush kerbs at pedestrian crossing points is recommended. Where the islands are not intended for pedestrian use, measures should be taken to discourage pedestrians from using them and direct pedestrians to the appropriate crossing points.

Specific Measures for Cyclists

4.10 Additional information on the provision of dedicated cyclist facilities is contained in documents referred to in the **DfT** publication list and **TA 67 (DMRB 5.2.4)**.

4.11 Consideration should be given to the provision of facilities at segregated left turn lanes. Measures may include segregated cycle tracks outside the roundabout, and controlled cyclist crossing facilities across deflection islands, central islands and segregated left turn lanes, see **Fig 4/1**. These facilities require appropriate signing to both instruct cyclists and warn approaching motorists.

4.12 Where cyclists are expected and no segregated facilities are being provided for their use, a minimum width of carriageway of 4.25m shall be maintained between kerbs where a physical subsidiary deflection island is provided.

4.13 Where cyclists are expected to cross segregated left turn lane physical islands, as shown on **Fig 4/1**, or a physical subsidiary deflection island, a minimum island width of 3.0m shall be provided.

4.14 Where unsegregated cycle lanes are provided on the segregated left turn lane, they shall be a desirable minimum width of 2m and an absolute minimum width of 1.5m. The cycle lane shall be demarcated from the segregated left turn lane using a road marking to **Diag 1049** and marking to **Diag 1057** and associated sign to **Diag 959.1**. **Diag 958.1** shall be used on the approach to the segregated left turn lane, to warn drivers of the start of the cycle lane.

4.15 The use of differential coloured surfacing to increase the conspicuity of the cycle lane is recommended.

Landscaping

4.16 The use of planting and hard landscaping techniques can be used to assist in directing pedestrians to the appropriate crossing points at roundabouts, and to discourage them from crossing at unsafe locations.

4.17 Planting and hard landscaping shall not obstruct forward visibility around segregated left turn lanes.

Large Goods Vehicles

4.18 The problem of Large Goods Vehicles overturning or shedding their loads at roundabouts has no obvious solution in relation to layout geometry. Whilst this type of accident may infrequently cause personal injury, there are considerably more damage only incidents. Load shedding often results in congestion and delay, and is expensive to clear, especially if occurring at major junctions. Experience suggests that roundabouts where these problems persist usually exhibit one or more of the following features:

a. Inadequate entry deflection leading to high entry speeds;

b. Long straight sections leading into deceptively tight bends;

c. Excessive visibility to the right;

d. Low circulating flow past the entry;

e. Tightening of the line on circulation;

f. Sharp turns into exits;

g. Excessive crossfall changes;

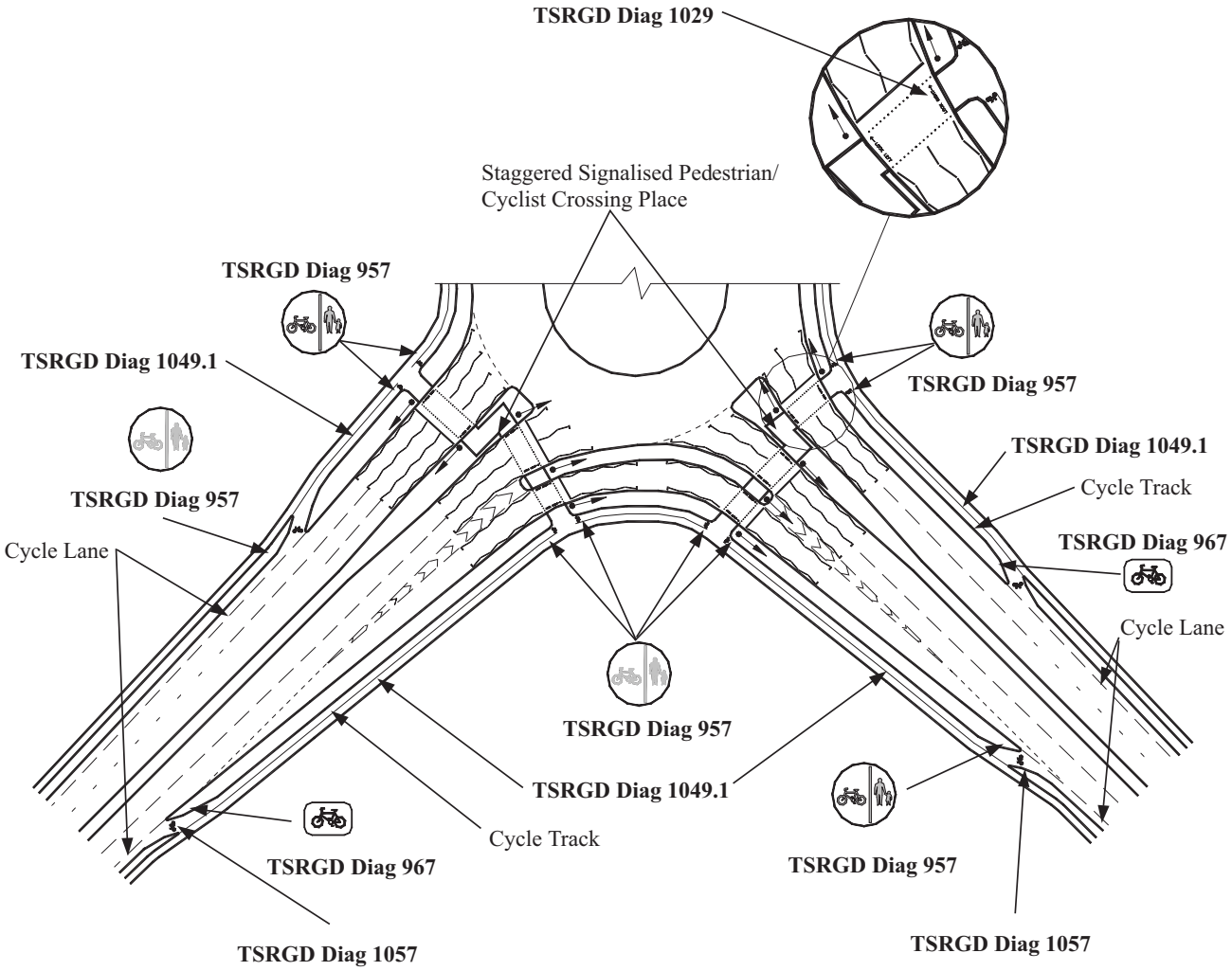
h. Excessive adverse crossfall on circulatory sections;

i. Double or reverse curvature.

4.19 A problem for some vehicles may be present even if speeds are not high. Research has shown that an articulated large goods vehicle with a centre of gravity height of 2.5m above the ground can overturn on a 20m radius bend at speeds as low as 15 mph (24 kph). This is reported in **TRL Report LR 788**. Layouts designed in accordance with the recommendations in this standard should avoid the problems listed in **Para 4.18**. However, designers should recognise that each site will be different and designs should be specifically checked to ensure that such problems are avoided. During construction, particular attention should be paid to ensure that pavement surface tolerances are complied with and that abrupt changes in crossfall are avoided.

Abnormal Load Routes

4.20 If the roundabout is situated on an abnormal load route the use of physical islands may not be appropriate if sufficient carriageway width between kerbs cannot be provided. In these circumstances non-physical islands may be considered provided other conditions laid down in **Figs 2/9** and **3/6** are met.



Cycle Tracks and Toucan Signal Controlled Crossing Places at Segregated Left Turn Lane

Figure 4/1

Note: **TSRGD Diag 957** shown is indicative and would require left and right hand versions for the cycle track depending on the direction of the approach.

If the segregated lane runs independently to the other approach lanes the crossing should be staggered.

5. REFERENCES

1. DESIGN MANUAL FOR ROADS AND BRIDGES (DMRB) : STATIONERY OFFICE

a. Volume 2 - Highway Structures

b. Volume 4 - Geotechnics and Drainage

c. Volume 5 - Assessment and Preparation of Road Schemes

d. Volume 6 - Road Geometry

e. Volume 7 - Pavement Design and Maintenance

f. Volume 8 - Traffic Signs and Lighting

g. Volume 10 - The Good Roads Guide

h. Volume 11 - Environmental Assessment

i. Volume 12 - Traffic Appraisal of Road Schemes

j. Volume 12a - Traffic Appraisal of Road Schemes

k. Volume 13 - Economic Assessment of Road Schemes

l. Volume 14 - Economic Assessment of Road Maintenance

2. TRAFFIC SIGNS REGULATIONS

a. The Traffic Signs Regulations and General Directions : STATIONERY OFFICE

b. Traffic Signs Regulations (Northern Ireland): STATIONERY OFFICE

c. The Zebra, Pelican and Puffin Pedestrian Crossings Regulations and General Directions: STATIONERY OFFICE

3. TRAFFIC SIGNS MANUAL

a. Chapter 3: Regulatory Signs: STATIONERY OFFICE

b. Chapter 4: Warning Signs: STATIONERY OFFICE

c. Chapter 5: Road Markings: STATIONERY OFFICE

d. Chapter 7: The Design of Traffic Signs: STATIONERY OFFICE

4. DEPARTMENT FOR TRANSPORT

a. TM Division and CLT Division Publications Lists – These two Divisions are responsible for the development of policy on traffic control and management issues, including:

- Cycling;
- Traffic Calming;
- Pedestrianisation;
- Traffic Signs and Traffic Signals/ Pedestrian Crossings;
- Bus Priority Systems;
- Guidance on the use of Tactile Paving Surfaces;
- Parking.

b. Guidelines for Cycle Audit and Cycle Review (September 1998)

5. TRANSPORT RESEARCH LABORATORY

a. TRL Report 127, Transport supplementary grant for safety schemes - Local authorities' schemes from 1992/93 allocations (1995); TRL

b. TRL Contractors Report 319 – Speed/Flow/ Geometry Relationships for Rural Single Carriageway Roads

c. The Design of Roundabouts – State of the Art Review (1995)

d. Laboratory Report 942 – The Traffic Capacity of Roundabouts (1980)

e. Laboratory Report 788 – Articulated Vehicle Roll Stability – Methods of Assessments and Effects of Vehicle Characteristics

6. MISCELLANEOUS

a. Road Accidents Great Britain (The Casualty Report) - Published annually: STATIONERY OFFICE

b. Road Safety Engineering Manual: ROSPA

c. Department of Transport (1996): Cycle-Friendly Infrastructure – Guidelines for Planning and Design

d. The Institution of Highways and Transportation (2000) : Guidelines For Providing For Journeys On Foot

e. Department of Transport: LTN 1/95 – The Assessment of Pedestrian Crossings: STATIONERY OFFICE

f. Department of Transport: LTN 2/95 – The Design of Pedestrian Crossings: STATIONERY OFFICE

g. The National Cycle Network Guidelines and Practical Details Issue 2 1997: SUSTRANS

6. ENQUIRIES

All technical enquiries or comments on this Standard should be sent in writing as appropriate to:

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