South Africa

COTO

Committee of Transport Officials

# TMH 16
# Volume 2

# South African Traffic Impact and Site Traffic Assessment Standards and Requirements Manual

Version 1.0

August 2012

Committee of Transport Officials

TECHNICAL METHODS
FOR HIGHWAYS

# TMH 16
# Volume 2

# South African Traffic Impact and Site Traffic Assessment Standards and Requirements Manual


Version 1.0
August 2012



Committee of Transport Officials

## Compiled under auspices of the:

Roads Coordinating Body (RCB) of the
Committee of Transport Officials (COTO)

## Published by:

The South African National Roads Agency Limited
PO Box 415, Pretoria, 0001

## Disclaimer of Liability

The document is provided “as is” without any warranty of any kind, expressed or implied. No warranty or representation are made, either expressed or implied, with respect to fitness of use and no responsibility will be accepted by the Committee of the authors for any losses, damages or claims of any kind, including, without limitation, direct, indirect, special, incidental, consequential or any other loss or damage that may be arise from the use of the document.

## Technical Methods for Highways:

The Technical Methods for Highways consists of a series of publications that are in the nature of manuals in which methods are prescribed for used on various aspects related to highway engineering. The documents are primarily aimed at ensuring the use of uniform methods throughout South Africa.

Users of the documents must ensure that the latest editions or versions of the document are used. When a document is referred to in other documents, the reference should be to the latest edition or version of the document.

Any comments on the document will be welcomed and should be forwarded to the publisher. When appropriate, such comments may be incorporated in future editions of the document.

## Synopsis:

This manual is the second volume of the TMH 16 South African Manual for Traffic Impact and Site Traffic Assessments. It provides the standards and requirements that apply to the assessment of impacts and proposed transportation facilities undertaken during Traffic Impact Assessments and Site Traffic Assessments.

# Table of Contents

| ITEM | | PAGE |
|---|---|---|

# LIST OF FIGURES

# LIST OF TABLES

# Preface

This manual is the second volume of the TMH 16 South African Manual for Traffic Impact and Site Traffic Assessments (COTO 2012). It provides the standards and requirements that apply to the assessment of impacts and proposed transportation facilities undertaken during Traffic Impact Assessments and Site Traffic Assessments.

The manual is primarily intended to serve as a single comprehensive reference for traffic assessments. It contains most of the standards and requirements that are required for the assessments, even in situations where such standards may be available in other manuals or guidelines. Unfortunately, it is not practical to include all such requirements under one cover and in some cases references are provided to other manuals and guidelines.

Another consideration for the development of the manual was that, in many cases, standards are not available that are appropriate to South African conditions. Many of the existing South African manuals are also out-dated and have not been kept up to date with the latest available research and international best practice.

This manual is mostly based on international standards, but where necessary adjusted for South African conditions. In a number of cases, no such standards were available and new standards had to be devised for inclusion in this manual.

The manual is not intended nor is it suitable to serve as a design guideline since it does not cover all aspects that must be taken into account in the design of transportation facilities. It only addresses those aspects that require assessment during Traffic Impact and Site Traffic Assessments.

# 1 Assessment Standards and Requirements

| | |
|---|---|
| Traffic Impact Assessments | ✓ |
| Site Traffic Assessments | ✓ |

## 1.1 Introduction

1.1.1. Standards and requirements are provided in this manual for both Traffic Impact Assessments and Site Traffic Assessments. The impacts and aspects that must be addressed during each of these assessments are indicated in this manual.

1.1.2. The impacts and aspects that must be addressed are those that are considered the most important for assessment. *It, however, does not cover all possible aspects and it is the responsibility of the Assessor to identify and assess any additional aspects that may be relevant or have an impact on a specific development under assessment.*

1.1.3. Standards and requirements are provided for public transport facilities normally provided on the road and street system such as bus stops and pedestrian sidewalks, but not for facilities such as modal transfer stations, ranks, termini and reserved public transport or high occupancy vehicle. The assessment of these facilities is not required by the South African Traffic Impact and Site Traffic Assessment Manual.

## 1.2 Transportation objectives

1.2.1. The standards and requirements of this manual are aimed at achieving broader transportation objectives such as safety, security, convenience, efficiency, reliability, accessibility, practicality, economy, affordability, sustainability, social and economic development, environment, etc.

1.2.2. Ideally, assessments should evaluate the traffic impacts of a development against norms of acceptability in terms of such objectives. This manual, however, recognises that such assessments are highly complex and cannot readily be undertaken.

1.2.3. An approach is therefore followed in which impact assessments are required where practical, but standards are otherwise provided for transportation facilities. In terms of this manual, facilities that comply with these standards are deemed to have an acceptable impact. It nevertheless remains the responsibility of the designer of the infrastructure to ensure safe and efficient traffic operations.

## 1.3 Variance from standards and requirements

1.3.1. The approach followed in this manual that facilities that comply with the standards and requirements are deemed to have acceptable impacts, does not imply that facilities that do not comply with the standards are necessarily unacceptable. It only means that more detailed assessments may be required to evaluate the impact of the proposed development. In such cases, the consequences of not meeting the standards must be thoroughly investigated and any variance from the standards must be adequately motivated.

1.3.2. Where it is not possible to achieve the standards and requirements of this manual, alternative options or solutions must be developed and evaluated to determine the most preferred option. All impacts of the alternative options or solutions must be assessed, even if such assessment is only made qualitatively.

1.3.3. The preferred solution is the one which would minimise all impacts and at the same time have the greatest overall benefits. This, however, is not always possible and a compromise solution is often required. The preferred compromise solution is one in which impacts are balanced and none of the impacts are excessive.

1.3.4. The requirements related to access provision and spacing (Chapters 4 and 5) are particularly important and shall NOT be compromised unless provision has explicitly been made by the road authority for a reduction in standards in access management plans or frameworks. The municipality will only consider such reduction in standards during the master planning process and not on an ad hoc basis

1.3.5. The requirements related to the traffic management of residential and other sensitive areas (Chapter 12) are also important and shall NOT be compromised without appropriate consultation with the affected community.

## 1.4 Applicable chapters for Traffic Impact and Site Traffic Assessments

1.4.1. The chapters that are applicable to Traffic Impact and Site Traffic Assessments are specified in Table 1. Some of the chapters are only applicable to a specific assessment, but some chapters are applicable to both types of assessment.

1.4.2. During a Site Traffic Assessment where an impact has been assessed during a previous Traffic Impact Assessment or Site Traffic Impact Assessment, an impact must be reassessed when:

a) A change has occurred since the previous assessment that necessitates a new assessment; or
b) The previous analysis was undertaken more than 5 years prior to the date of the Site Traffic Assessment.

**Table 1 Applicable chapters for assessment types**

| Chapter | | Traffic Impact Assessments | Site Traffic Assessments |
|---|---|---|---|
| 1 | Assessment standards and requirements | √ | √ |
| 2 | Functional road network | √ | √ |
| 3 | Capacity analysis | √ | √ |
| 4 | Road access and intersection provision | √ | √ |
| 5 | Access and intersection spacing and separation | √ | √ |
| 6 | Intersection control warrants | √ | √ |
| 7 | Intersection and access configuration | √ | √ |
| 8 | Road and intersection geometric design | | √ |
| 9 | Driveway design | | √ |
| 10 | Access throat lengths | | √ |
| 11 | Sight distance requirements | √ | √ |
| 12 | Traffic management | √ | √ |
| 13 | Pedestrian and bicycle facilities | √ | √ |
| 14 | Public transport facilities | √ | √ |
| 15 | Parking provision and design | √ | √ |
| 16 | Drop-off and pick-up facilities | | √ |
| 17 | Deliveries and refuse collection | | √ |
| 18 | Heavy goods transport | √ | |

## 1.5 References to other standards and requirements

1.5.1. This manual contains most of the standards and requirements that apply to Traffic Impact and Site Traffic Impact Assessments. However, it is not possible to include all such standards in the manual and in some cases reference is made to standards provided in other manuals and guidelines. In such cases, the standards and requirements of such documents must be applied.

1.5.2. The references to the other documents are made to specific editions of these documents. However, the latest available edition of the documents must be used in an assessment.

1.5.3. A list of references is provided in Chapter 19 of this manual that may be used when clarification of a particular standard or requirement is required. However, the standards and requirements of this manual will override those in the other documents, unless otherwise indicated in this manual or adequately motivated by the Assessor.

# 2 Functional Road Network


## 2.1 Introduction

2.1.1. Road design and assessment standards and requirements depend on the functional classification of roads and the classification must therefore be in place before traffic assessments can be undertaken. This applies to both Traffic Impact and Site Traffic Assessments.

2.1.2. During Traffic Impact Assessments, the road functional classification of the Municipality will apply. During Site Traffic Impact Assessments, roads in a township or within a development must be classified in accordance to the requirements of this chapter.

## 2.2 Traffic Impact Assessments

2.2.1. The Municipality must make a network master plan available showing the functional road classification of roads in the network. The Municipality will classify roads into Functional Classes 1 to 5 as defined by the *TRH 26 South African Road Classification and Access Management Manual* of COTO (2012). Differentiation is made between roads in urban and rural areas.

2.2.2. Different standards and requirements are provided in this manual for the different classes of roads. Differentiation is also made between urban and rural roads.

## 2.3 Site Traffic Assessments

2.3.1. In the assessment of internal roads and streets proposed for Township Establishment, a functional classification of the roads shall be proposed in the Site Traffic Assessment based on the requirements of the *TRH 26 South African Road Classification and Access Management Manual* of COTO (2012). Such classification will be incorporated in the road master plan of the Municipality.

Where some of the roads have already been classified by the Municipality, such classification must be used in the assessment and can only be amended with the prior approval of the municipality.

2.3.2. For site developments, it is not a requirement to classify on-site roads, but the principles of a functional road network must also be applied to such roads. Equivalent road classes must be assigned to each road. Major roads on large sites may be provided as Class 4 (or higher) roads while minor roads may be provided as Class 5 roads. These roads must comply with the standards and requirements applicable to the road classes, except that a lower design speed may be motivated for these roads.

2.3.3. For site developments, an additional road class is introduced which is not provided for by the South African Road Classification and Access Management Manual, namely the “driveway”. This classification may only be used for site developments and is not applicable to township establishment.

An on-site road may only be classified as a driveway when it complies with the following requirements:

a) The driveway may not connect to the road network at an intersection.
b) The driveway may only be connected to a Class 4 or 5 road.
c) The driveway access is priority controlled, although no stop or yield sign is required or provided.
d) The road may not carry more than 50 vehicles during any peak hour.

## 2.4 Design speed

2.4.1. Some of the standards and requirements provided in this manual depend on the design speed applicable to a road.

2.4.2. The design speed depends on the road classification as well as whether it is an urban or rural road. Required design speeds are provided in Table 2 for different road classes.

2.4.3. The speed limits on the different road classes should correspond with the design speeds provided in the table. On Class 4b and 5 roads in urban areas, traffic calming measures should preferably be used to limit operating speeds (rather than speed limits).

2.4.4. In situations where the topography or other restrictions do not permit the design speeds provided in the table, a lower design speed may be used provided that corresponding advisory speeds are posted on the road sections where a lower design speed is required. Where the lower design speed is required over the full length of the road, a speed limit may also be used.

2.4.5. For on-site roads within a development sites where roads must be provided in terms of the requirements for Class 4 and 5 roads, the design speed may be reduced to between 30 and 40 km/h, provided that traffic calming measures are implemented to limit speeds. On driveways, a lower design speed of 20 km/h may be used.

**Table 2 Design speeds**

| **Design speeds (km/h) for different road classes** | | | | | | |
|---|---|---|---|---|---|---|
| Area | Class 1 | Class 2 | Class 3 | Class 4a | Class 4b | Class 5 |
| Urban areas | 120*[1] | 80 | 70 | 60 | 50 | 40 |
| Rural areas | 120*[2] | 120 | 100-120 | 80-100 | 80-100 | 60-80 |

*[1] A lower design of 100 km/h may be considered on shorter routes

*[2] Higher design standards should be used where possible with the aim of improving road safety

## 2.5 Design vehicles

2.5.1. Various road design standards depend on the type and size of the design vehicle selected for the road or infrastructure element.

2.5.2. This manual provides for the design vehicles listed in Table 3. Note that provision is made for a Light Delivery Vehicle which is assumed to be equivalent to the AASTHO (2004) Passenger Car (the AASHTO Passenger Car design vehicle includes pick-up trucks).

2.5.3. The selection of design vehicles for design purposes depends on the composition of traffic that will be using a road, which in turn would depend on the type of land-use being served as well as the class of road. Class 1 to 3 roads are intended to serve larger areas and are therefore more likely to carry relatively large-sized heavy vehicles.

2.5.4. Table 4 provides guidance on the selection of design vehicles. Allowance is made for the following operations:

a) Normal operations. The transport facility must accommodate the design vehicle for all operations. All standards and requirements applicable to the design vehicle must be complied with.

b) Occasional use. The transportation facility must be able to accommodate the occasional use of the facility by the design vehicle. It is not necessary to comply with all standards and requirements for the design vehicle, provided that the vehicle can use the facility without significantly affecting or endangering traffic flow.

2.5.5. For development sites, the design vehicle depends on the type of vehicle that will be using the on-site roads. Where loading and offloading occurs on-street rather than on-site, it is not necessary to design the on-site roads for delivery vehicles.

2.5.6. Vehicle turning templates must be used for the assessment of proposed transportation facilities where the facility may significantly be affected by the vehicle turning paths. The vehicle turning templates for both the normal operation and occasional use design vehicles must be used in the assessment. Software may also be used for generating the vehicle turning paths.

**Table 3 Design vehicles**

| Designation | AASHTO (2004) | Description |
|---|---|---|
| Passenger Car | - | Passenger cars |
| LDV | Passenger Car (P) | Light delivery vehicles |
| Bus | City Bus | Passenger bus, non-articulated |
| SU Truck | SU Truck | Single unit truck with no trailers |
| WB-15 | WB-15 (WB-50) | Truck-semitrailer ,Truck with semitrailer |
| WB-20 | WB-20 (WB 65) | Truck-double trailer, Truck with two trailers (interlink) |

**Table 4 Design vehicle selection**

| Application | | Normal operation | Occasional use |
|---|---|---|---|
| Urban roads | Class 1 to 3 roads as well as Class 4 and 5 roads in industrial areas | WB-15 | WB-20 |
| | Class 4a and 4b roads as well as Class 5a roads serving developments such as offices and businesses | Bus | WB-15 |
| | Class 5b roads serving residential developments | LDV | SU Truck |
| Rural | All rural road classes | WB-15 | WB-20 |

2.5.7. When applying the vehicle turning templates, a clearance distance of 1.0 m must be provided between the side of the design vehicle and an obstruction. This clearance distance is primary required to accommodate possible driver error. According to Stover and Koepke (2002), it is possible for vehicles to make turns using the AASHTO clearance distance (0.2 to 0.6 m) but a distance of 1.0 m is more realistic for most drivers.

2.5.8. Unless specifically permitted in this manual, vehicles are not allowed to reverse on or onto public roads (refer to Chapter 17 for more information).

# 3 Capacity Analysis


## 3.1 Introduction

3.1.1. A capacity analysis must be undertaken for those elements of the transportation system and all modes of transport in the study area that may not meet the capacity requirements provided in this chapter.

3.1.2. The capacity analysis must be undertaken for both Traffic Impact Assessments and Site Traffic Assessments. The analysis must be undertaken for elements that are included in the study area of the assessment. Site accesses may require reassessment during a Site Traffic Assessment depending on the requirements of Section 1.4 of this manual.

3.1.3. The purpose of a capacity analysis is to determine whether the transportation system has sufficient capacity to accommodate the expected traffic demand. Such capacity analysis is undertaken for transportation elements such as the following:

a) Signalised and unsignalised or priority controlled intersections and accesses (including driveway accesses), as well as roundabouts (including traffic circles and mini-circles).
b) Basic two-lane and multilane highway segments (where capacity is not restricted by intersections).
c) Basic freeway segments, freeway weaving sections, ramps and ramp junctions, interchange ramp terminals.
d) Pedestrian facilities:
   i) Sidewalks, walkways and stairs (including cross flows).
   ii) Pedestrian queuing (e.g. transit stops and street corners).
   iii) Pedestrian crossings.
e) Bicycle facilities:
   i) Bicycle paths.
   ii) Bicycle crossings.
f) Public transport facilities and services related to the road network.

## 3.2 Capacity analysis models

3.2.1. Except where otherwise indicated in this chapter, the capacity analysis must be undertaken using the methodologies and parameters of the Highway Capacity Manual (TRB, 2010), subject to the requirements of this manual.

3.2.2. The capacity analysis may also be undertaken using microscopic or macroscopic simulation software, provided that such software has been calibrated and validated for South African conditions.

Where such software is used, the level-of-service criteria of the Highway Capacity Manual shall apply. The following is a list of software that has been approved for use in South Africa:

a) SIMTRA Traffic Simulation (Van As and Joubert, 2005).
b) HTModel Highway Traffic Model (Van As, 2008).

3.2.3. Where provision is made in the Highway Capacity Manual or in the above models for a multiple time period method of capacity analysis, such method must be used starting in a time period when traffic volumes are low and queues are short. *Alternatively, an approach must be followed in which the analysis must be undertaken for a single time period of 1 hour assuming that the peak 15-minute traffic volumes occur over the duration of the full hour.* This approach must also be followed when a multiple time period method is not available.

## 3.3 Capacity analysis standards

3.3.1. The level of service provided by a transportation facility is deemed acceptable when the requirements provided in this chapter are met during the worst 15-minute time period during the assessment hours prescribed in Volume 1 of the TMH 16 South African Manual for Traffic Impact and Site Traffic Assessments (COTO 2012). Assessment hours are defined for Normal and Abnormal days.

3.3.2. The requirements of this chapter must be met for each individual traffic stream or movement at all critical locations in the transportation and the assessment may NOT be based on the *average* level of service for all movements at the facility.

3.3.3. In general, and where not otherwise specified in this chapter, traffic operations are acceptable when, during the peak 15-minute period:

a) The volume/capacity ratio does not exceed a maximum of 1.0 (demand volume does not exceed the capacity of the facility) and;
b) The Level of Service (LOS), as defined by the Highway Capacity Manual, is not worse than the service levels given in Table 5. Right-turn movements at traffic signal controlled intersections may, however, operate at a LOS E provided that sufficient provision is made for accommodating the queue lengths ($95^{th}$ percentile).

3.3.4. Additional requirements are provided in subsequent sections of this chapter for the following transportation elements:

a) Priority controlled intersections and roundabouts (also mini-circles).
b) Traffic signal controlled intersections.
c) Basic two-lane road segments.
d) Public transport facilities and services.

**Table 5 Capacity analysis acceptable levels of Service**

| Acceptable Level of Service for Normal and Abnormal Days | | |
|---|---|---|
| **Area/Road Class** | **Normal Days** | **Abnormal Days** |
| Urban | LOS D | LOS E |
| Rural Classes 3 - 5 | LOS C | LOS D |
| Rural Classes 1 - 2 | LOS B | LOS C |

Definitions of Normal and Abnormal days are provided in *TRH 17 South African Trip Data Manual* (COTO 2012).

## 3.4 Priority control intersections and roundabouts

3.4.1. Requirements are provided in this section for the capacity analysis of stop, yield and roundabout (including traffic and mini-circle) controlled intersections. The requirements are NOT applicable to all-way stop controlled intersections.

3.4.2. The capacity analysis of priority controlled intersections and roundabouts should preferably be undertaken using microscopic simulation software. The Highway Capacity Manual methodology may also be used, in which case operations must comply with the level-of-service requirements of this manual as well as the following additional requirement.

The additional requirement is that the sum of the flow on any priority controlled lane and the conflicting flow (as defined by the Highway Capacity Manual) may not exceed the following maximum thresholds. This additional requirement applies to all priority controlled lanes.

| Type of control | Threshold |
|---|---|
| Right-turn from main street (excluding roundabouts) | 1500 vph |
| Two-way stop/yield controlled intersection from the side street | 1250 vph |
| Approach to a single-lane roundabout | 1300 vph |
| Approach to a double-lane roundabout (per lane) | 1500 vph |

## 3.5 Traffic signal controlled intersections

3.5.1. The capacity analysis of traffic signal controlled intersections must be undertaken using the method and model parameters provided in the latest version of the Highway Capacity Manual (TRB, 2010). Microscopic or macroscopic simulation software may also be used for the capacity analysis when calibrated and independently validated for South African conditions.

3.5.2. The simplified “critical movement analysis method” as described in Volume 3 of the South African Road Traffic Signs Manual (SARTSM) may also be used for the capacity analysis as described below. When used, it must be based on the parameters provided in the Highway Capacity Manual.

When the critical movement method is used, operations are considered to operate at a Level-of-Service D or better when, during the peak 15-minute period, both the following conditions are met for each traffic movement:

a) Volume/capacity (v/c) ratio not higher than 0.90, and;
b) Cycle length of the signal does not exceed 100 seconds (may be increased to 120 seconds when four or more signal phases are required).

The above criteria allow for relatively poor operating conditions and it is therefore only possible to establish criteria for a level of service that is not worse than D. Other methods must be used when there is a need for an analysis at other levels of service.

3.5.3. Irrespective of the approach followed in the capacity analysis, the analysis must be undertaken for traffic signal timings that comply with the requirements of Volume 3 of the South African Road Traffic Signs Manual (including those applicable to pedestrians), provided that the green times provided to straight through movements should not be less (but preferably larger) than the values specified in Table 6.

3.5.4. Note that although interchanges would normally be provided on Class 1 roads, traffic signals could be considered in urban areas as a possible interim measure until an interchange is warranted.

**Table 6 Minimum green times for capacity analysis**

| Intersection of: | Minimum green time for straight through movements as a percentage of cycle length |
|---|---|
| Two Class 1 to 3 roads | 30% on both roads |
| Class 1 to 3 road with Class 4/5 road | 40% on Class 1-3 road |

## 3.6 Basic two-lane road segments

3.6.1. Basic two-lane road segments are roads with one lane per direction with no intermediate major intersections that significantly affect operations on such roads. The requirements provided below apply to road segments of longer than 5 km.

3.6.2. The capacity analysis must be undertaken using a suitable microscopic or macroscopic simulation model (such as HTModel). The general standards and requirements provided in this chapter will apply.

3.6.3. The general Level-of-Service (LOS) standards provided elsewhere in this chapter must also be used in the assessment of basic two-lane road segments. However, at locations where overtaking is prohibited (by means of barrier or no-overtaking lines), a LOS one better than the general requirement must be provided (e.g. LOC B instead of the LOS C). It may be necessary to provide overtaking or climbing lanes at locations where this higher standard cannot be met.

3.6.4. *Follower density* must be used as the measure of effectiveness for determining level of service for basic two-lane segments. Follower density is defined as the number of followers per kilometre per lane. A vehicle is classified as following when:

a) The gap (not headway) between the rear and the front ends of the leading and following vehicles respectively are shorter than or equal to 3 seconds.

b) The speed of the following vehicle exceeds $V_{fol}$, where $V_{fol}$ is defined as follows:

$$V_{fol} = \text{Speed of preceding vehicle} - 20 \text{ km/h}$$

The threshold values for determining level of service are provided in Table 7.

**Table 7 Two-lane road Levels-of-Service**

| Level of Service | Follower density (veh/km/lane) |
|---|---|
| A | 0.0 - 1.0 |
| B | 1.0 - 2.5 |
| C | 2.5 - 4.5 |
| D | 4.5 - 7.5 |
| E | 7.5 - 12.5 |
| F | > 12.5 |

# 4 Road Access and Intersection Provision


## 4.1 Introduction

4.1.1. Requirements for the provision of road intersections and accesses are provided in this chapter. Intersections and accesses may be provided in accordance to these requirements.

4.1.2. The requirements and conditions of this chapter apply to intersections on the public road network (including townships) as well as accesses to developments. The requirements are not applicable to roads provided on development sites.

4.1.3. The assessment of the intersection and access provision must be made during Traffic Impact Assessments. A reassessment may, however, be required during a Site Traffic Assessment depending on the requirements of Section 1.4 of this manual.

4.1.4. The requirements of this chapter (in addition to the access spacing requirements of Chapter 5) are particularly important and must NOT be compromised unless provision has explicitly been made by the road authority for a reduction in standards in access management plans or frameworks. The municipality will only consider such reduction in standards during the master planning process and not on an ad hoc basis

4.1.5. The requirements of this chapter are based on the requirements of the *TRH 26 South African Road Classification and Access Management Manual* of COTO (2012). The requirements have been expanded for the purposes of impact assessments.

## 4.2 Access management plans and frameworks

4.2.1. The Municipality may make access management plans or frameworks available indicating the requirements and conditions according to which access may be provided as well as any retrofit measures that must be implemented.

4.2.2. Access management plans or frameworks are particularly needed on roads that do not currently fully comply with the intersection spacing and separation requirements and where retrofit measures are required to provide access. Where no such plans or frameworks are provided, the full requirements of this chapter will apply.

4.2.3. Access management plans are plans showing the locations and types of intersections and how accesses to individual properties will be achieved on the road network. The plans can also be used to show lines of no access, or locations where access will be denied. The plans may also include conceptual designs of the accesses as well as retrofit measures that may be required.

Access management frameworks, on the other hand, only provide general guidance, requirements and conditions for access from a particular road.

## 4.3 Provision of road access

4.3.1. Each portion of land is entitled to one access to the public road network, and the right of access to the road or street system cannot be denied. Nevertheless, this entitlement is subject to the public's right to a safe and efficient road system.

4.3.2. Direct property access is normally provided on Class 4 and 5 roads, subject to the requirements of this manual. Access to individual properties on Class 1, 2 and 3 roads not meeting the requirements of this manual should normally not be allowed, but in order to comply with the right of access, access may have to be considered when all the following conditions apply:

a) The access already exists, and there is no other possible alternative access available to the property.

b) The access may not jeopardise the possible future provision of intersections to the public road network or accesses to other developments in the area. Where provided, accesses must as far as possible be provided to public roads that serve different properties that may benefit from such access.

c) Accesses on arterials should as far as possible serve all the different properties that may benefit from such access.

d) The proposed access must comply with all the requirements for intersections and accesses of this manual, particularly but not limited to the spacing and separation requirements of this manual.

e) Where access is provided to a property, such access should only be allowed on condition that the owner of the property will be responsible for improving the access should such improvements become required. These improvements may include geometric improvements or the installation of a traffic signal, roundabout or interchange when warranted or required by the road authority.

## 4.4 Multiple accesses

4.4.1. Developments such as shopping centres should preferably have separate accesses for private vehicles and for delivery vehicles. A separate access may also be desirable for use by public transport.

4.4.2. A single access to a large development has a limited capacity and such developments should preferably have more than one access. An additional access should be provided for every 1000 to 2000 vehicles/hour generated by a development.

4.4.3. The spacing and separation requirements of this manual, however, are applicable to each individual access and may not be relaxed to accommodate the additional accesses.

4.4.4. Large developments should preferably be located at locations on the road network where suitable multiple accesses can be provided.

## 4.5 Service stations

4.5.1. Access to service (filling) stations is subject to the same conditions and requirements applicable to other types of development, but with the following exemptions:

a) Access may be provided by means of marginal access on all classes of roads in both urban and rural areas.

b) Access separation requirements may be reduced as specified in this manual.

4.5.2. The above exemptions may only be allowed when the access is restricted to the service station only and not to a shared access with any other adjacent erven or other parts of the road network. This restriction is not applicable where the access meets all the requirements provided in this chapter (i.e. if no exemptions are required to accommodate the access).

4.5.3. The service station may include ancillary facilities associated with the service function of the service station and which are intended to serve the driving public making use of the primary service function. The ancillary facilities may not be primary trip generators.

## 4.6 Intersection and access types

4.6.1. Intersections and accesses may be provided in one of three fundamental types (as shown in Figure 1):

a) Full intersections or accesses

b) Partial intersections or accesses

c) Marginal intersections or accesses (including left-in accesses)

4.6.2. For the purpose of this manual, an interchange or roundabout is classified as a full intersection or access.

## 4.7 Full intersections and accesses

4.7.1. Full intersections and accesses allow for all possible movements of travel at the intersection, as illustrated in Figure 1. A T-junction is regarded as a full intersection.

4.7.2. On urban and rural Class 1 roads, full intersections should preferably be provided by means of grade separated interchanges, although at-grade intersections may be used while the roads have not been designated as freeways.

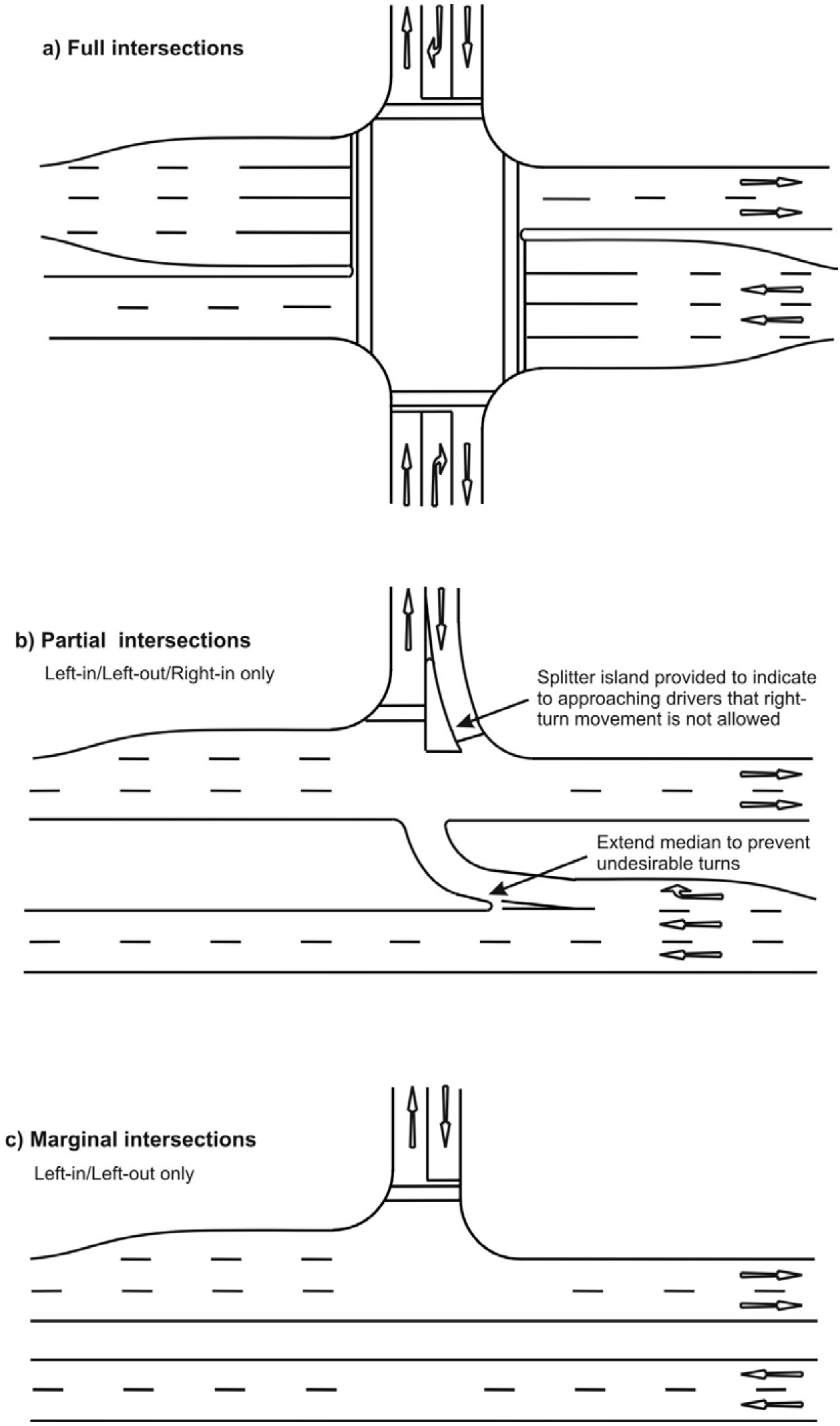



**Figure 1 Intersection types**

4.7.3. On urban Class 2 and 3 roads, full intersections should preferably be traffic signal controlled, although priority control may also be used as an interim measure. Roundabouts may also be provided at suitable locations such as the start and end of a route.

Where traffic signals or roundabouts are not currently warranted, provision must be made for the possible future provision of such control. Grade separation may also be warranted such as at the intersection of two Class 2 roads.

4.7.4. On rural Class 2 and 3 roads, full intersections may be priority controlled (one or two-staged). Roundabouts may only be provided where permitted in terms of the requirements of this manual. Priority control, however, can only handle limited volumes of traffic and grade separated interchanges may be required when traffic volumes are high.

4.7.5. On urban or rural Class 4 and 5 roads, intersections and accesses would normally be priority or roundabout (including traffic circle and mini-circle) controlled, but on urban roads traffic signals could be warranted when traffic volumes are high.

Driveways may only obtain access from Class 4 and 5 roads and then by means of a priority controlled access only.

## 4.8 Partial intersections and accesses

4.8.1. Partial intersections and accesses are provided as at-grade intersections and only allow left-in, left-out and right-in movements, as illustrated in Figure 1.

4.8.2. Partial intersections and accesses are not permitted on rural roads and in urban areas they should be limited to Class 2 and 3 roads but could also be considered on Class 4 roads with medians.

4.8.3. In urban areas, partial intersections have a number of advantages, which make them particularly beneficial on high-order Class 2 to 3 roads. The advantages include the following:

a) Partial intersections may significantly improve the capacity of the road network while still providing a high level of mobility.
b) U-Turns can be made with relative ease at partial intersections, provided that the median is of sufficient width. On roads where marginal intersections are provided, the provision of partial intersections at the two ends of a block can significantly improve accessibility to these accesses.

4.8.4. Partial intersections, however, have certain limitations and may therefore only be provided when:

a) It can be shown that such intersections will be of benefit to the general road user in terms of capacity and road safety considerations
b) The intersection will attract a right-in traffic volume of 150 or more vehicles during a peak hour.
c) The intersection does not attract such large volumes of pedestrians or cyclists that a pedestrian crossing (signalised or unsignalised) becomes warranted;

d) Easily identifiable (by means of road signs) and safe egress routes are available for traffic to leave the area and travel in the direction not served by the partial intersection.

e) A raised constructed median is available that prevents undesirable turning movements. The median must be provided over a distance extending 30 m beyond the length of the longest auxiliary turning lane that may be required on an approach to the intersection, even if such auxiliary lane is currently not provided or warranted.

f) Where traffic signals will be installed or where provision must be made for future signalisation, a minimum median width of 8.0 m must be available to accommodate the traffic signals.

4.8.5. The partial intersection can be either traffic signal or priority controlled. Where signals are not currently warranted, provision should nevertheless be made for possible future signalisation of the intersection.

4.8.6. A partial intersection may be provided opposite another partial or a marginal intersection.

## 4.9 Marginal intersections and accesses

4.9.1. Marginal intersections and accesses are provided as at-grade intersections and only allow left-in and left-out movements, as illustrated in Figure 1.

4.9.2. On one-way roads, marginal intersections and accesses may also be provided on the right-hand side of the road, allowing right-in and right-out movements. Where these movements are accommodated adjacent to each other, the movements must be accommodated by separate roadways to ensure compliance with the keep-left rule of the National Road Traffic Act and Regulations.

4.9.3. Marginal intersections and accesses are not permitted in rural areas and in urban areas should only be considered on Class 2 and 3 roads but could also be considered on Class 4 roads with medians. On other roads, full intersections or accesses must be provided.

4.9.4. Access to service stations, however, may be provided by means of marginal intersections on all road classes in both urban and rural environments.

4.9.5. Marginal intersections may only be provided when:

a) It can be shown that such intersections will be of benefit to the general road user in terms of capacity and road safety considerations

b) The intersection will attract a left-in traffic volume of 150 or more vehicles during a peak hour.

c) The intersection does not attract such large volumes of pedestrians or cyclists that a pedestrian crossing (signalised or unsignalised) becomes warranted;

d) Easily identifiable (by means of road signs) and safe egress routes are available for traffic to leave the area and travel in the direction not served by the marginal intersection.

e) A raised constructed median is available that prevents undesirable turning movements. The median must be provided over a distance extending 30 m beyond the length of the longest auxiliary turning lane that may be required on an approach to the intersection, even if such auxiliary lane is currently not provided or warranted.

4.9.6. Marginal intersection may not be traffic signal controlled but may be provided opposite a traffic signal controlled partial intersection. The marginal intersection may also be provided opposite another marginal intersection or access.

4.9.7. Marginal accesses can also be provided as left-in only intersections or accesses that only allow left-in movements. Such access may only be provided when:

a) A detailed investigation shows that such intersections will improve capacity and road safety for the general road user.
b) The exit path is clearly visible and obvious, both on entry and when returning to the left-in only point to try to exit.
c) Measures can be implemented that will prevent illegal egress movements.

## 4.10 Intersection and access configuration

4.10.1. A possible configuration of full, partial and marginal intersections and accesses is shown in Figure 2 This figure shows that a total of two partial and two marginal accesses can be provided between two full intersections to provide additional access to land on both sides of a road. Provision is also made for a parallel egress route to allow travel in the direction not served by the partial intersections.

4.10.2. The access configuration has the advantage that it can significantly improve road network capacity without sacrificing signal progression. The configuration also serves land on both sides of the road and not only on one side of the road. If the two partial intersections are designed to accommodate U-turns, the intersections can also accommodate drivers that may have incorrectly tried to exit at the intersections.

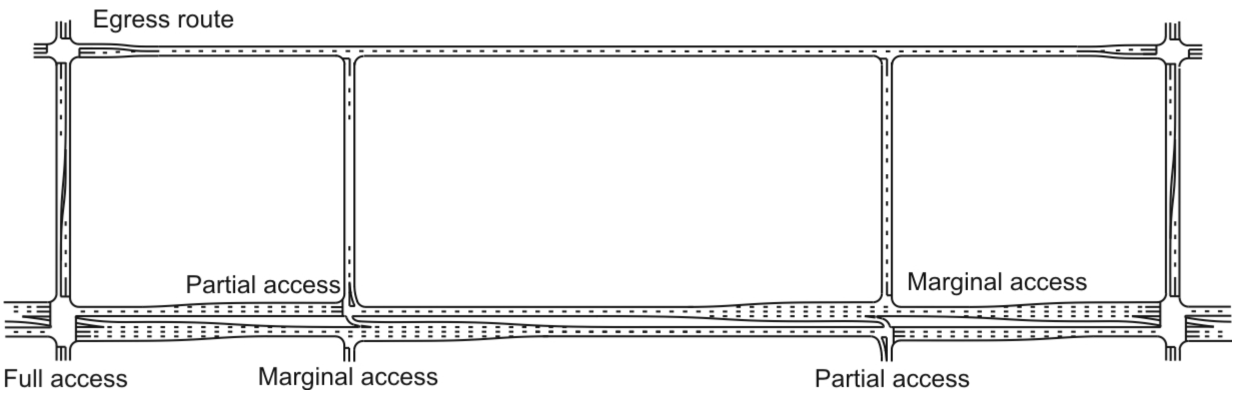



**Figure 2 Partial and marginal access options**

## 4.11 U-Turn facilities

4.11.1. On roads on which marginal intersections are provided, consideration must be given to the provision of U-turn facilities in order to accommodate directions of travel not provided for by these intersections.

4.11.2. Provision for U-turns is best made by means of roundabouts. On Class 2 and 3 roads with signal controlled intersections, the U-turns can also be accommodated at partial intersections. Where such intersections are not available, midblock U-turn facilities may be considered, provided that a raised constructed median of sufficient width is available to accommodate such U-turns.

4.11.3. The location of the U-turn facility must comply with the requirements for partial intersections. An auxiliary lane must also be provided at the facility. The facility must operate under priority control and may not be traffic signal controlled.

# 5 Access and Intersection Spacing and Separation


## 5.1 Introduction

5.1.1. Requirements for the spacing and separation of road intersections and accesses are provided in this chapter. The assessment of the access and intersection spacing and separation must be made during Traffic Impact Assessments. A reassessment may, however, be required during a Site Traffic Assessment depending on the requirements of Section 1.4 of this manual.

5.1.2. The requirements and conditions of this chapter apply to intersections on the public road network (including townships) as well as accesses to developments. The requirements are not applicable to roads on development sites.

5.1.3. The requirements of this chapter are based on the requirements of the *TRH 26 South African Road Classification and Access Management Manual* of COTO (2012), but the requirements have been expanded for the purposes of impact assessments.

5.1.4. The requirements of this chapter (in addition to the access provision requirements of Chapter 4) are particularly important and must NOT be compromised unless provision has explicitly been made by the road authority for a reduction in standards in access management plans or frameworks. The municipality will only consider such reduction in standards during the master planning process and not on an ad hoc basis

## 5.2 Full intersection and access spacing

5.2.1. Minimum intersection and access spacing requirements are provided in Table 8. The intersection and access spacing is the distance between the centre points of adjacent intersections as illustrated in Figure 3.

5.2.2. The spacing requirements provided in the table are applicable to full intersections or accesses only and not to partial and marginal intersections.

5.2.3. The spacing requirements depend on the type of intersection control. The requirements for priority controlled intersections and accesses may only be used when the intersections or accesses will not be roundabout, circle, all-way stop or traffic signal controlled in future. Where different controls are used at adjacent intersections, the longer of the spacing requirements at the respective intersection types shall apply.

5.2.4. On Class 2 and 3 roads, a percentage leeway is allowed on either side of the required spacing. The recommended (or longer) spacing should be maintained as far as possible but the shorter spacing may be considered according to circumstances.

5.2.5. For Class 4 and 5 roads a spacing range is specified. The longer spacing should be maintained as far as possible but the shorter spacing may be considered according to circumstances.

5.2.6. The spacing requirements of Table 8 are subject to the following minimum requirements:

a) On Class 2 and 3 urban roads, the spacing requirements are subject to the separation requirements for marginal and partial intersections.

b) On all classes of roads, full intersections or accesses may not be provided within the functional area of another intersection or access. The functional area includes the area in which auxiliary turning lanes are required by this manual (even when the lanes are currently not provided).

c) The separation between intersections and accesses on all classes of roads may also not be less than the stopping sight distance provided in Table 34 (refer to Chapter 11).

5.2.7. The above spacing requirements are also applicable to property accesses. On Class 4 and 5 roads, however, a driveway access can be provided to each property except when two or more accesses or driveways are required, in which case the spacing requirements apply. Driveways should not be provided within the functional area of an intersection or access, but where such access must be provided, the access must be limited to left-in and out movements only.

5.2.8. Where possible, access to properties on opposite sides of a road should be provided at a single intersection or location. Staggered accesses should be avoided as far as possible.

## 5.3 Partial and marginal Intersection and access separation

5.3.1. Minimum requirements for the separation between marginal or partial and other types of intersections or accesses are provided in Table 9 for Class 2 and 3 roads in urban areas.

Marginal or partial intersections and accesses on other classes of roads are subject to the spacing requirements for full intersections.

5.3.2. Intersection separation is measured between the nearest sides of the road reserves of the intersecting or access roads as illustrated in Figure 3. Where road reserves are not provided, the separation is measured to the nearest side or edge of the intersecting or access road.

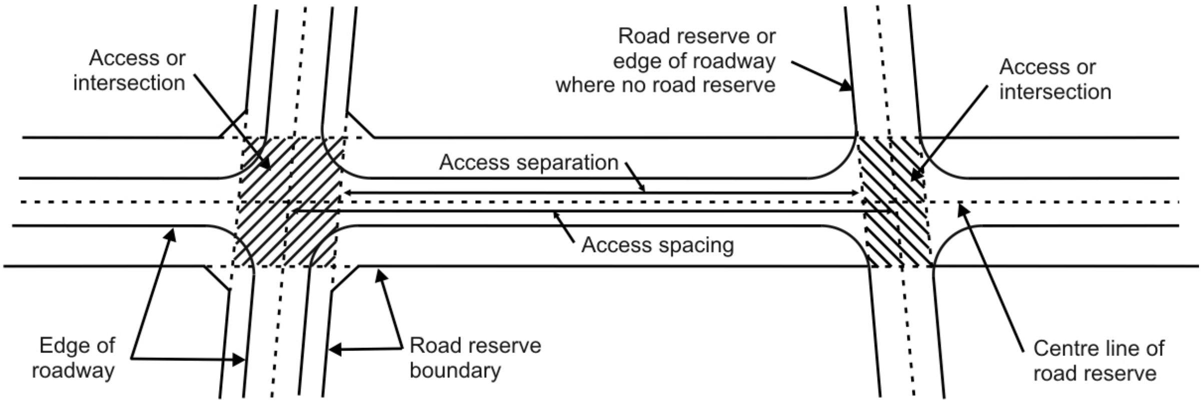



**Figure 3 Access spacing and separation**

**Table 8 Minimum intersection and access spacing requirements**

**Urban Areas** — **Traffic signal controlled intersections**

| Street Type | Class 1 | Class 2 | Class 3 | Class 4a | Class 4b | Class 5a | Class 5b |
|---|---|---|---|---|---|---|---|
| One-way Streets | 1.6-3.2km | 400m±15% | 300m±20% | 150m | 150m | 150m | 150m |
| Two-way T-junctions (1) | 1.6-3.2km | 400m±15% | 300m±20% | 150m | 150m | 150m | 150m |
| Two-way Streets | 1.6-3.2km | 800m±15% | 600m±20% | 200-300m | 150-250m | 150-250m | 150m |

**Urban Areas** — **Roundabouts, Traffic Circles and All-way stops**

| Street Type | Class 1 | Class 2 | Class 3 | Class 4a | Class 4b | Class 5a | Class 5b |
|---|---|---|---|---|---|---|---|
| All streets | 1.6-3.2km | 800m±15% | 600m±20% | 200-300m | 150-250m | 150-250m | 75-150m |

**Urban Areas** — **Priority controlled intersections (2)**

| Street Type | Class 1 | Class 2 | Class 3 | Class 4a | Class 4b | Class 5a | Class 5b |
|---|---|---|---|---|---|---|---|
| All streets | 1.6-3.2km | 800m±15% | 600m±20% | 100m | 75m | 75m | 50m |

**Rural Areas** — **All intersections types including priority controlled intersections**

| Road Type | Class 1 | Class 2 | Class 3 | Class 4a | Class 4b | Class 5a | Class 5b |
|---|---|---|---|---|---|---|---|
| All roads | 8.0km | 5.0km | 1.6km | 600-800m | 600-800 m | 450-600m | 450-600m |

(1) Applicable to side-leg of T-junctions.

(2) The requirements for priority controlled intersections are only applicable when the intersections will not be roundabout, circle, all-way stop or traffic circle controlled in future.

**Table 9 Absolute and preferred minimum intersection and access separation**

| Intersection/Access configuration | Class 2 | Class 3 |
|---|---|---|
| a) Right-turn lanes not required | 150-175 m | 125-150 m |
| b) Right-turn lane required in one direction only | 150-175 m | 125-150 m |
| c) Right-turn lanes required in two directions | 250-300 m | 200-250 m |
| d) Service station without bus stop | 125-150 m | 100-125 m |
| e) Service station with bus stop (includes bus stop) | 150-175 m | 125-150 m |

5.3.3. Differentiation is made in Table 9 between the following intersection and access configurations:

a) The intersection separation does not have to provide for any right-turn lanes on the subject road section (now and in future).

b) The intersection separation must provide for one right-turn lane in either of the travel directions on the road section (now and future).

c) The intersection separation must provide for two right-turn lanes in both travel directions on the road section. The separation requirements for this configuration can be reduced in situations where the right-turn lanes can be provided in parallel rather than in series.

d) Accesses to service stations upstream or downstream from an intersection when no bus stop is required.

e) Accesses to service stations upstream or downstream from an intersection when a bus stop is required.

5.3.4. The access separation for service stations is subject to the condition that the access may not be used to serve developments other than the service stations. Where combined access is required to a service station and other developments, the separation requirements for developments must be used.

# 6 Intersection Control and Improvement Warrants

Traffic Impact Assessments ✓
Site Traffic Assessments ✓

## 6.1 Introduction

6.1.1. A warrant analysis must be undertaken to determine whether proposed intersection controls are warranted. The assessment must be undertaken during both Traffic Impact Assessments and Site Traffic Assessments.

6.1.2. The requirements and conditions of this chapter apply to intersections on the public road network (including townships) as well as accesses to developments. The requirements are not applicable to on-site roads within development sites.

6.1.3. *It is important to note that the fact that an intersection or access does not comply with the capacity analysis or other requirements of Chapter 3 of this manual may not be used as an intersection control warrant. The warrants of this chapter must be used to determine whether the intersection controls are warranted*.

## 6.2 Traffic signal warrants

6.2.1. A traffic signal may be installed at intersections that comply with the road access requirements of this manual AND when the signals are warranted in terms of Volume 3: Traffic Signal Design of the South African Road Traffic Signs Manual (SARTSM).

6.2.2. According to the SARTSM warrant, the installation of traffic signals for the control of junctions and pedestrian or pedal cyclist crossings is warranted when:

a) The traffic signal can meet all the minimum requirements described in the SARTSM manual; AND
b) No viable and feasible alternative solution is available which, when implemented, would obviate the need for traffic signals; AND
c) The traffic signal meets the queue length warrants.

6.2.3. The SARTSM queue length warrant requires that ANY of the following three queue length warrants are met:

a) WARRANT 1: The average length of ANY individual queue equals or exceeds four (4) over any one hour of a normal day.
b) WARRANT 2: The SUM of the average lengths of all queues equals or exceeds six (6) over any one hour of a normal day.
c) WARRANT 3: The SUM of the average lengths of all queues equals or exceeds four (4) over each of any eight hours of a normal day (the hours do not have to be consecutive, but they may not overlap).

Note that a normal day can be any day of the week, including Saturdays or Sundays.

6.2.4. In terms of the requirements of this manual, Queue Length Warrant 1 may be reduced from 4 to 2 when the intersection does not comply with the capacity and level-of-service requirements of Chapter 3 of this manual. This reduction is, however, only allowed on Class 2 and 3 roads and where the intersection fully complies with the intersection spacing/separation requirements of this manual.

6.2.5. It is also a requirement of this manual that traffic signals should not be installed on any of the following classes of roads, even if the SARTSM warrants are met:

a) All rural classes of roads.
b) Urban Class 4b and 5b roads that serve single dwelling residential developments (except at intersections with higher classes of roads).

6.2.6. According to SARTSM, traffic signals may also not be installed on roads with a speed limit higher than 80 km/h.

## 6.3 Roundabout warrants

6.3.1. Roundabouts (including traffic circles and mini-circles) may be installed at intersections that comply with all the road access requirements of this manual AND where the following requirements are met:

a) It must be possible to construct the roundabout in accordance to the design requirements for roundabouts.

b) On urban and rural Class 2 and 3 roads, roundabouts should only be installed at locations where the classification of the roads changes to Class 4 or 5 or where the classification changes from rural to urban where there is a need to reduce speeds. At other locations, roundabouts could significantly affect the mobility function of these roads and should therefore not be used at such locations.

c) On urban and rural Class 4 and 5 roads, roundabouts may be installed at any location, subject to the spacing and separation requirements of this manual as well as the following requirements:

i) The roundabout must have sufficient capacity to accommodate traffic growth over a period of 5 years.

ii) A roundabout may be warranted in terms of capacity considerations. For this purpose, a roundabout is warranted when the average length of any individual queue on any approach lane to the intersection exceeds 3 over any one hour of a normal day.

This warrant may, however, be reduced to a queue length of 1.5 when the intersection does not comply with the capacity and level-of-service requirements of Chapter 3 of this manual, but subject to the condition that the roundabout fully complies with the intersection spacing/separation requirements of this manual.

iii) Roundabouts may also be warranted in terms of road safety and traffic calming considerations. The required spacing of roundabouts to achieve traffic calming is provided elsewhere in this manual.

d) Street lighting must be provided at all roundabouts, irrespective of location.

e) The roundabout may not be installed on roads with a speed limit higher than 80 km/h.

6.3.2. Roundabouts that carry high volumes of traffic are generally not suitable for use by pedestrians or cyclists. Roundabouts are therefore not recommended in situations where formal pedestrian or cyclist crossings may become warranted due to high volumes of traffic and pedestrians (or cyclists). Otherwise, roundabouts are suitable in situations where the volumes of pedestrians or cyclists are low (typical of situations in which formal pedestrian or cyclist crossings are not warranted).

## 6.4 All-way stop control

6.4.1. All-way stop control should not be installed as a permanent form of control on any class of urban or rural road.

6.4.2. All-way stop control may, however, be considered as a temporary measure at intersections where a traffic signal is warranted and when the signal is on the installation programme of the road authority.

## 6.5 Rural road intersections

6.5.1. The provision of intersections on rural Class 1 to 3 roads is a problematic issue due to the high operating speeds on such roads. Drivers do not expect to encounter obstructions on these roads, particularly after driving very long distances without interruption. On rural Class 4 and 5 roads, speeds are not as high and travel can therefore be more readily interrupted.

6.5.2. Interrupting traffic flow on Class 1 to 3 roads can also significantly affect the mobility function of such roads. The use of control measures at intersections that interrupt traffic flow should therefore be minimised on these roads. This applies to all-way stop as well as roundabout control.

6.5.3. Where Class 4 or 5 roads intersect with Class 1 to 3 roads, priority control can be used on the lower order roads. Priority control has sufficient capacity for most such intersections, but the capacity is limited and priority control cannot accommodate high volumes of traffic. This is a particular issue when vehicles must accept a gap in two directions of travel on the main road.

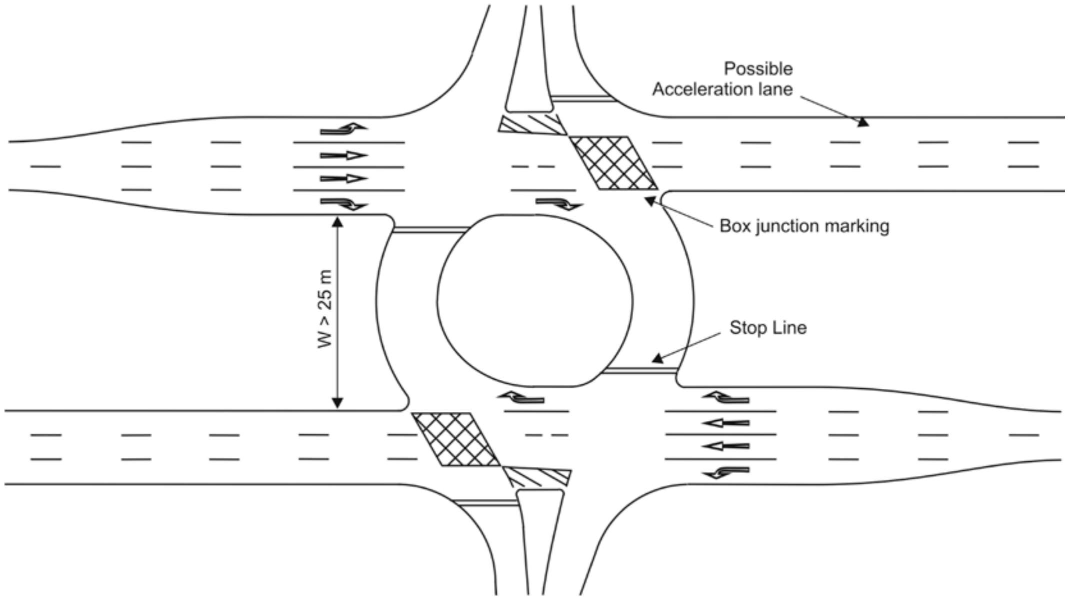



**Figure 4 Two-stage priority control**

6.5.4. Where the capacity of a priority controlled intersection is exceeded, two-stage priority control can be used as shown in Figure 4. This type of intersection can significantly improve the capacity of a priority controlled intersection. Where this capacity is not adequate, a grade separated interchange will be required.

6.5.5. The circular shape of the two-stage priority controlled intersection shown in Figure 4. has the following advantages:

a) The turning paths of heavy vehicles can be more readily accommodated.

b) The layout reduces the possibility of drivers trying to cross the median without stopping (which could be an issue when a wide median is used).

c) It provides a slightly better separation between right-turn traffic from the main road and crossing traffic.

The figure shows that a median width of wider than 25 m is required. This is required to accommodate the longest permitted vehicle on South African roads. Consideration may also be given to providing the box junction markings as shown in the figure to reduce possible queuing onto the main road.

## 6.6 Queue length estimation

6.6.1. The queue lengths required for the warrants of this chapter may be estimated by means of a traffic model, although such estimation must be undertaken with circumspect since models only provide approximate estimations of queue lengths and delays.

6.6.2. Some traffic models can calculate average queue lengths directly. The average queue length is required and not the 90th or 95th percentile queue lengths. Where queue lengths are only provided per approach and not by lane, such queue lengths should be divided by the number of lanes on the approach to establish the average queue length per lane. The queue length on a left-turn lane can be expected to be shorter than the queues in straight-through and right-turn lanes.

6.6.3. The average queues must be determined for the full peak hour without application of the peak hour factor. The queue lengths may be determined for any peak hour of the week (including hours over the weekend). The queue lengths, however, must be determined for normal days and not for abnormal days.

# 7 Intersection and Access Configuration

| | |
|---|---|
| Traffic Impact Assessments | ✓ |
| Site Traffic Assessments | ✓ |

## 7.1 Introduction

7.1.1. The configuration (layout) of an intersection or access can significantly affect the efficiency and traffic safety of intersections or accesses. An assessment must therefore be made of proposed intersection and access configurations

7.1.2. An assessment of intersection and access configurations must be made during Traffic Impact Assessments as well as Site Traffic Assessments. Such assessments are required for public roads as well as on-site roads, including driveways.

## 7.2 Angle of intersection

7.2.1. Intersecting roadways should cross at, or as close as practical to a right angle (90$^o$). Roads intersecting at acute angles need large intersection areas to accommodate turning vehicles while drivers find it difficult to negotiate some of the turning movements. Sight distances are also affected by skewed intersections.

7.2.2. The angle of the intersections should not deviate more than the maximum deviations provided in Table 10 for intersections of different road classes. The deviations are measured from the right angle.

The maximum deviations provided in the table should be adhered to as far as possible. In situations where it is not possible to achieve these deviations, larger deviation angles may be used up to the maximum values shown in Figure 5. Deviation angles of greater than 20$^o$ should however be avoided as far as possible.

**Table 10 Angle of intersection deviation**

| Intersecting road classes | | Maximum deviation |
|---|---|---|
| Class 2/3 | Class 2/3 | 5$^o$ |
| Class 2/3 | Class 4 | 10$^o$ |
| Class 4/5 | Class 4/5 | 15$^o$ |
| Class 4b | Class 4b | 20$^o$ |
| Class 4 | Class 5 | 20$^o$ |
| Class 4/5 | Driveway | 20$^o$ |
| Slipways at intersections | | 20$^o$ |

Based on Stover and Koepke (2003), Austroads (1988), CUTA UTG 1 (1986)

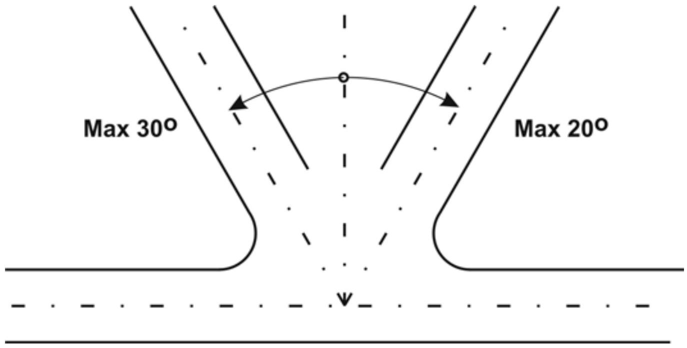



**Figure 5 Angle of intersection deviation**

## 7.3 Maximum gradients at intersections

7.3.1. The gradient of intersecting roads should be as flat as practical on those sections of the roads that are used for the storage of stopped vehicles (referred to as “storage platforms” by AASHTO (2004)).

7.3.2. Grades steeper than 3% significantly affect capacity, traffic operations and driver judgement at intersections. Stopping distances increase significantly on steeper downgrades, particular for heavy vehicles. Longer gap acceptance sight distances are also required. At traffic signals, drivers often also have to stop at increased deceleration rates which further aggravate the situation. At priority controlled intersections, drivers have a longer distance available for adjusting their speeds.

Grades steeper than 3% should therefore be avoided. Where this is not possible, alternative locations for the intersection or access must first be considered and evaluated.

7.3.3. Where steeper grades must be provided, the grades must be limited to a maximum of 6%, provided that the numeric sum of grades to do not exceed 8% (CUTA UTG 5, 1988). On driveways, steeper gradients may be allowed as discussed in Chapter 9 of this manual.

7.3.4. On roundabouts, the entry gradients should not exceed 3%, with 2% being the desirable maximum. It is desirable to match the exit grades and the entry grades but exit grades of up to 4% may be provided (FHWA Roundabouts: An informative guide, 2010).

## 7.4 Auxiliary turning lane provision

7.4.1. Requirements are provided in this section for the provision of the minimum number of auxiliary turning lanes that must be provided at intersections and accesses. Additional lanes may, however, be provided for capacity purposes when warranted, but subject to the maximum widening requirements given in this chapter.

7.4.2. On uncontrolled and traffic signal controlled approaches, the following auxiliary lanes must be provided:

a) *Left-turn auxiliary lanes* should be provided on all uncontrolled and traffic signal controlled approaches to intersections and accesses on Class 1 to 3 roads that are “access managed”. On urban roads where a large number of accesses have been provided and where it is not possible to provide such turning lanes, the outside lane width should be increased to between 4.5 and 5.0 m instead of providing left-turn lanes. Left-turn lanes are not required on Class 4 and 5 roads (including service stations on such roads).

b) *Right-turn auxiliary lanes* should be provided as follows where right-turn movements are possible:

i) At all traffic signal controlled intersections on all classes of roads.

ii) At all uncontrolled approaches to intersections and accesses on Class 1 to 4 roads. On Class 4 roads with one lane per direction, the right-turn lane is not required when the total road width (excluding shoulders) is 9.0 m or wider (for the two directions combined).

7.4.3. Particular care should be taken not to implement “trap” lanes at signal controlled and other intersections. A trap lane is a through traffic lane that terminates in a mandatory left- or right-turn movement at the intersection.

Trap lanes are often not noticed by drivers which result in drivers having to stop at or near the intersection in order to find a gap in the through lane. In some cases, drivers may also attempt to find their way through the intersection which could result in significant conflicts in the intersection.

Trap lanes may be avoided by carrying the lane through the intersection and then dropping it downstream of the intersection as shown in Figure 9. Where this is not possible, the auxiliary turn lane should be introduced before the lane drop to prevent merging of turning vehicles with straight-through traffic, particularly when the turning volumes are high.

In cases where it is only possible to introduce the auxiliary turning lane after the drop lane resulting in traffic having to merge, the merging may be less desirable than the lane drop and in such cases the trap lane could be more acceptable. This situation, however, must be avoided as far as possible.

7.4.4. On priority controlled approaches to intersections and accesses, no minimum auxiliary lanes are prescribed. However, the possibility that the intersection will in future be upgraded to a traffic signal must be considered and the intersection designed accordingly. In such case, a minimum of two lanes should be provided on the priority controlled approach, one of which could in future be used as a right-turn lane when traffic signals are provided.

## 7.5 Auxiliary turning lane length

7.5.1. Auxiliary turning lanes must be of sufficient length to accommodate queues at the intersection and, where possible, the distance required by turning vehicles to clear the through lane, decelerate and to stop behind the queue of vehicles.

7.5.2. Requirements are provided in this section for traffic signal and priority controlled intersections in urban areas. For intersections in rural areas, the requirements of the authority responsible for the road apply.

7.5.3. At priority controlled intersections, relatively short auxiliary lanes may be provided, but not shorter than a minimum of about 15 to 25 m. Longer lanes should be provided when there is a possibility that the intersection will be signal controlled in future.

7.5.4. Auxiliary lane length requirements for signal controlled intersections are provided in Table 11. The specified lane lengths include the lengths of approach tapers, as shown in Figure 6.

For right-turn lanes, the length of the lanes depends on the right-turn flow rate. The future expected right-turn flow rate must be used for this purpose.

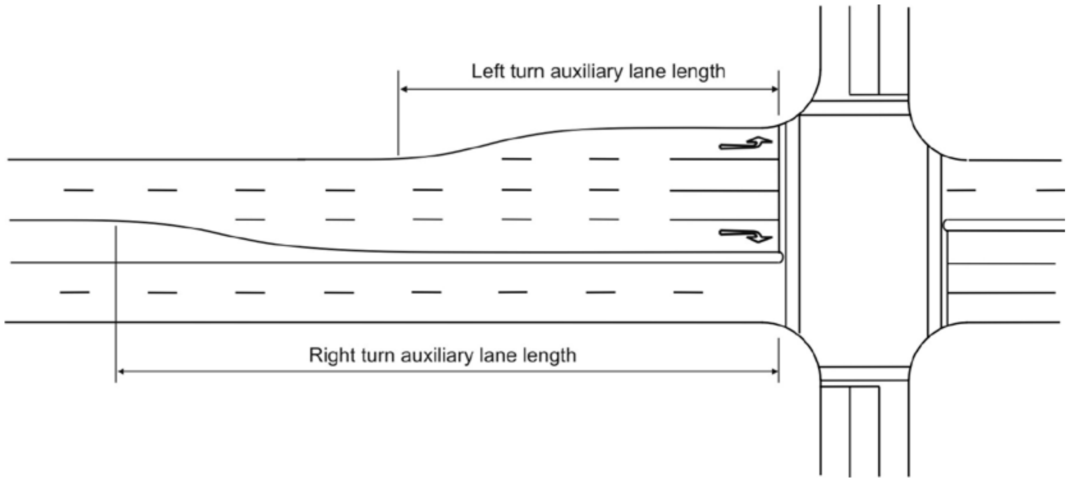



**Figure 6 Auxiliary turning lanes**

**Table 11 Auxiliary turning lane lengths at signalised intersections**

| **Description** | **Left turn** | **Right-turn lane lengths (m) for right-turn flow rates of:** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Right-turn flow rate*** | **Lane** | **100** | **150** | **200** | **250** | **300** | **350** | **400** | **450** | **500** |
| Urban Class 2 Roads | 110 | 110 | 120 | 135 | 150 | 165 | 180 | 195 | 210 | 225 |
| Urban Class 3 Roads | 85 | 90 | 105 | 120 | 135 | 150 | 165 | 180 | 195 | 210 |
| Urban Class 4 Roads | 65 | 80 | 95 | 110 | 125 | 140 | 155 | 170 | 185 | 195 |

1) Right-turn flow rate in units of veh/h per lane

2) Turning lane lengths include approach taper

7.5.5. The following notes apply to Table 11:

a) The left-turn lane lengths provided in the table were obtained from Stover and Koepke (2002). Limiting conditions are assumed (as defined by Stover and Koepke).

b) The right-turn lane lengths were determined by means of simulations of a wide range of traffic conditions. The queue lengths provide for relatively high levels of platooning in arrival flows and long cycle times of between 100 and 120 seconds.

c) The provided turning lane lengths can accommodate $90^{th}$ percentile queues, meaning that lengths will be too short for about 10% of the time (not cycles). The simulations have shown that a queue length/arrival ratio of 1.5 is suitable for most operations (a value of between 1.5 and 2.0 is recommended by AASHTO 2004).

d) The auxiliary turning lane lengths were also determined for an operating speed 20% lower than the design speed since speeds can be expected to be lower during peak hours.

e) A stopped spacing of 6.5 m was used for the determination of the storage length. The spacing must be increased when significant proportions of the traffic stream are heavy vehicles.

## 7.6 Acceleration lanes

7.6.1. Acceleration lanes must be provided on rural Class 1 to 3 priority controlled intersections to allow trucks turning onto a road to accelerate before entering the traffic stream. An example of an acceleration lane is shown in Figure 7.

7.6.2. In terms of the requirements of this manual, acceleration lanes must be provided at priority controlled intersections on rural Class 1 to 3 roads when the 12-hour truck volume that turn onto a main road exceeds the thresholds provided in Table 12. The requirement applies per direction of travel on the main road and the truck volume is the sum of the volumes turning left and right in the particular direction at the intersection. The acceleration lane must be provided when either the daytime or night time volumes are exceeded.

7.6.3. The required length of the acceleration lane is 500 m irrespective of the class of roads. This length will allow trucks to accelerate to a speed near to truck speeds on the roadway. On steep upgrades, this speed would be considerably lower than the operating speed of other traffic on the road, but this issue also applies to other trucks already on the road. Climbing lanes are required to accommodate trucks that are already on the road as well as trucks turning onto the road. Acceleration lane lengths longer than 500 m should therefore not be required to accommodate the lower speeds.

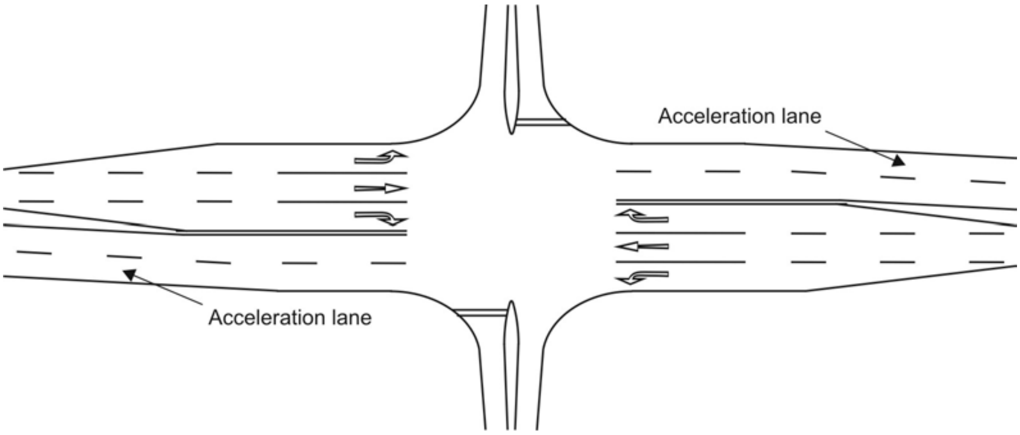



**Figure 7 Intersection acceleration lane**

**Table 12 Acceleration lane provision**

| Rural Road | 12-Hour truck volume | |
|---|---|---|
| Class | Day | Night |
| Class 1 | 10 | 5 |
| Class 2 | 20 | 10 |
| Class 3 | 30 | 15 |

## 7.7 Slipway provision and layout

7.7.1. Slipways should generally be avoided in urban areas where pedestrians are expected or where public transport stops are required.

7.7.2. If there is a need for a slipway, the slipways may be provided as a high- or low-speed slipway as shown in Figure 8. High-speed slipways should only be used where pedestrian volumes are very low and will remain so in future. Low-speed slipways should otherwise be used.

7.7.3. Slipways should preferably not be traffic signal controlled. If there is a need for a signal, then the lanes should rather be provided through the main intersection. Where signals are required, particular care must be taken to prevent vehicles turning right at the main intersection while the slipway receives green. Use may be made of a protected-only right-turn phase to prevent such movements, but this method can only be used in areas where there is a high level of driver compliance with such signals.

7.7.4. High-speed slipways must comply with the following requirements:

a) The slipway must provide for free-flow movement and no intersection control (e.g. yield or stop) must be provided.
b) No pedestrian crossing may be provided across the slipway.
c) The slipway must terminate in an exclusive acceleration lane of sufficient length to accommodate merge movements. The length of such acceleration lane should not be shorter than 100 m, excluding tapers.

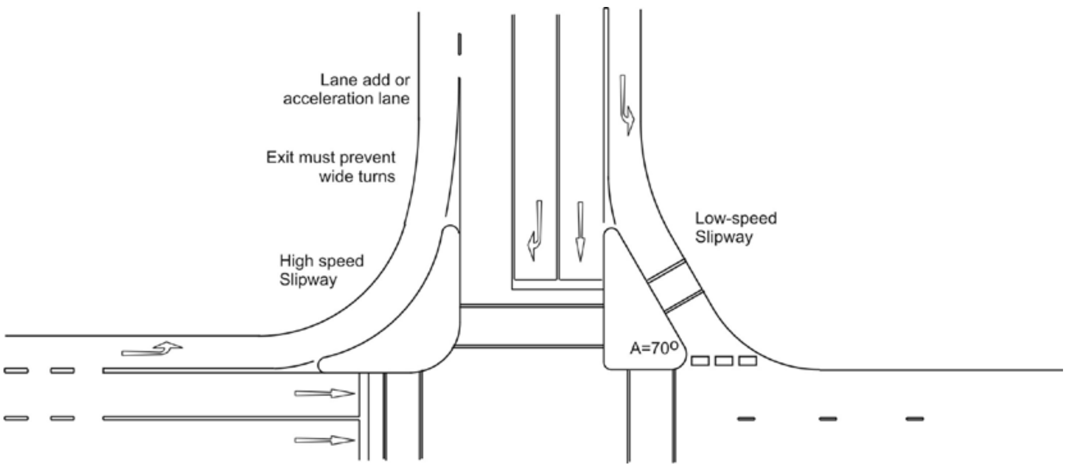



**Figure 8 Slipway layouts at intersections**

d) Where an acceleration lane is provided, sufficient weaving distance must be provided to the next downstream intersection. At least 100 m weaving distance must be provided for each lane change required to reach the start of the auxiliary turning lane at the down-stream intersection (start of taper). Provision must also be made for weaving from either the left or the right.

e) More than one lane may be provided on the slipway provided that the acceleration lanes and merge area are adequately designed. At least 100 m of acceleration lane, excluding tapers, must be provided for each lane merge (or longer on steep gradients).

f) The acceleration lane may not continue into a lane that terminates in a mandatory left- or right-turn movement at a downstream intersection (trap lane).

g) The design of the slipways must prevent vehicles making wide turns over the roadway downstream of the slipway.

7.7.5. Low-speed slipways must comply with the following requirements:

a) Only one lane may be provided when the slipway is stop or yield controlled. If more than one lane is required, the slipway must be signal controlled (subject to the requirements for such control).

b) A pedestrian crossing may be provided across low-speed slipways.

7.7.6. The width of slip lanes must accommodate the swept path of the appropriate design vehicle (refer to Section 8.11 for more information).

## 7.8 Maximum widening

7.8.1. Requirements are provided in this section for the maximum number of lanes to which an intersection or access may be widened. These requirements would normally only be applicable to roads carrying high volumes of traffic.

7.8.2. At stop or yield sign controlled approaches to an intersection, the number of lanes should not exceed more than two lanes, one left-turn and one straight-through plus right-turn lane.

7.8.3. The number of lanes provided at a traffic signal controlled intersection should not exceed the following:

a) Straight-through movements:
   i) Two-way streets - a maximum of 4 through lanes per direction (eight lanes total).
   ii) One-way streets - a maximum of 5 through lanes.

b) Left- or right-turn movements – a maximum of 3 lanes, provided that such lanes are signal controlled.

c) The total number of lanes should not exceed seven on any approach.

7.8.4. The above lanes may be provided subject thereto that lanes are available downstream of the intersection to turn or continue into. Where not available, the exit may be widened by the addition of a maximum of one lane over a merge distance of at least 100 m plus suitable taper. The additional lane must in all instances be provided on the left-hand side of the road as shown in Figure 9.

7.8.5. Sufficient space must be available at the intersection to accommodate the width of the swept path of the design vehicle. For turning movements, exit lane widths of between 4.0 and 4.5 m are normally required to accommodate these paths.

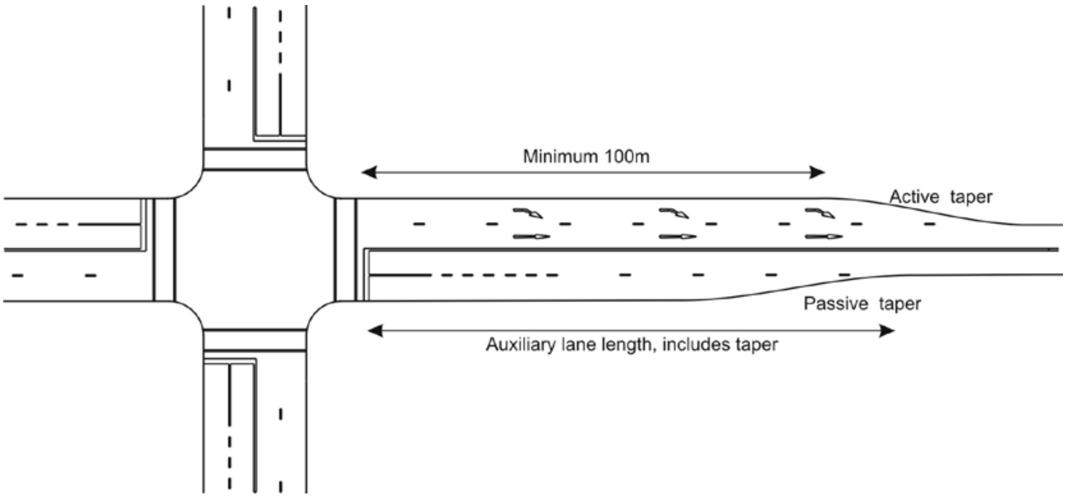



**Figure 9 Auxiliary lane downstream of intersection**

## 7.9 Roundabout layout and dimensions

7.9.1. Requirements for the layout and dimensions of roundabouts are provided in this section. Any other guideline or manual prescribed by the municipality or specific road authority may, however, also be used.

7.9.2. Typical roundabout layouts and dimensions are given in Figure 10 for single-lane roundabouts and in Figure 11 four double-lane roundabouts. The provided inscribed circle diameters ($D_c$ in Figure 10) are considered the minimum that is required for the safe and efficient operation of the roundabout.

7.9.3. The single-lane roundabout dimensions in Figure 10 depend on the applicable design vehicle. To accommodate the occasional use of the roundabouts by larger vehicles, a truck apron may be provided on the island as shown in the figure. Truck aprons should not be used on two-lane circles

To discourage use of the truck apron by light vehicles, the outer edge of the apron should be raised by about 30 mm above the road surface and the apron must be constructed with a different material and colour from the circulating roadway (FHWA Roundabouts: An informal guide, 2010).

7.9.4. The dimensions provided in the figures are applicable to roundabouts in urban areas. In rural areas, larger diameters should be used to improve their visibility.

7.9.5. The number of lanes provided on the approaches to a roundabout should not exceed a total of three (3). A maximum of two (2) circulating plus one (1) left-turn lanes may be provided within the roundabout.

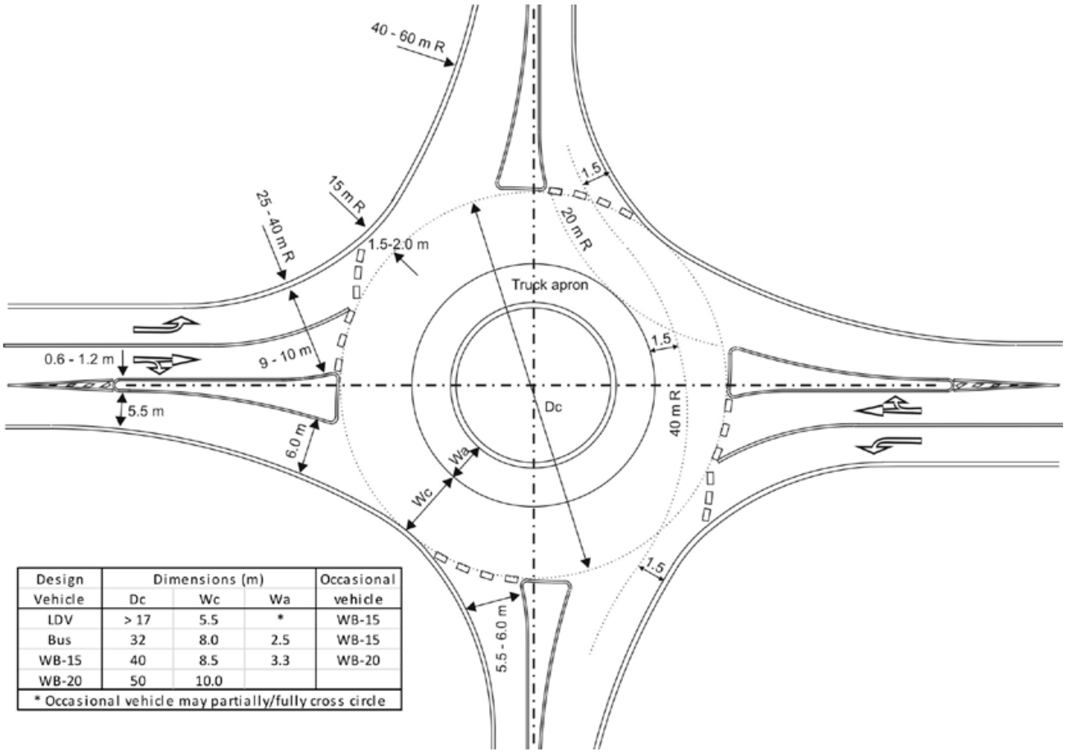
7.9.6. The use of a left-turn lane at a roundabout is shown in Figure 10. The design of the lane should be such that it forms an integral part of the roundabout and care must be taken to prevent traffic using the lane without yielding to circulating traffic.

7.9.7. Slipways should in general not be provided at roundabouts due to the increased accident risk, particularly with pedestrians (FHWA Roundabouts: An informal guide, 2010). The slipways will also lead to high turning speeds while the intention with roundabout design is to reduce speed. The slipways can also lead to considerable confusion amongst drivers and therefore unsafe operating conditions, particularly at night.

7.9.8. At multilane roundabouts, mandatory directional arrows must be provided on approaches showing turning movements allowed from each lane as shown in Figure 11. The lane layout of the roundabout should not require any lane changing when travelling through the roundabout. This can be achieved by the spiral markings as shown in the figure.

7.9.9. A critically important requirement of roundabout design is to reduce vehicular speeds (FHWA Roundabouts: An informal guide, 2010). Entry speeds should be restricted to about 25 km/h while speeds within the roundabout should be restricted to about 35 km/h.

In order to reduce entry speeds, the entry turning radius of the vehicle should be restricted to about 20 m as shown in the Figure 10.




| Design Vehicle | Dimensions (m) Dc | Wc | Wa | Occasional vehicle |
|---|---|---|---|---|
| LDV | > 17 | 5.5 | * | WB-15 |
| Bus | 32 | 8.0 | 2.5 | WB-15 |
| WB-15 | 40 | 8.5 | 3.3 | WB-20 |
| WB-20 | 50 | 10.0 | | |
| * Occasional vehicle may partially/fully cross circle | | | | |

**Figure 10 Single-lane roundabout**

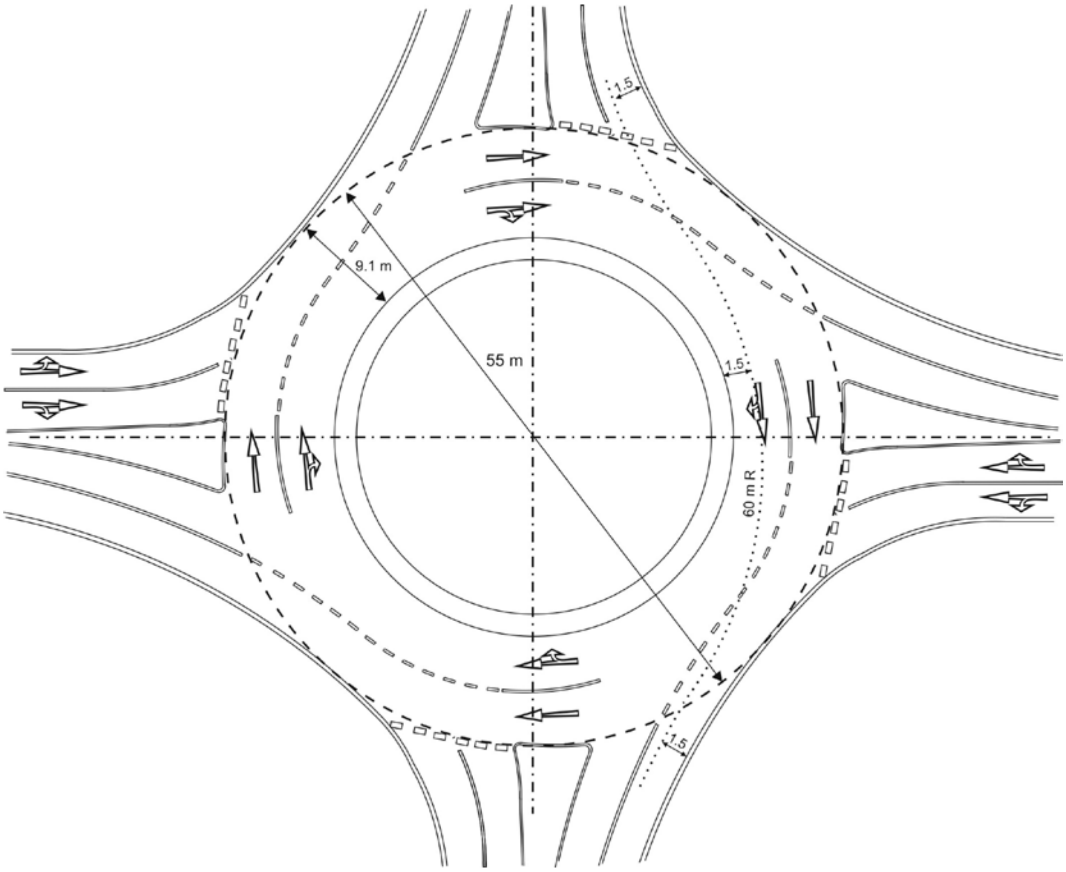


**Figure 11 Double-lane roundabout with spiral markings**

Speeds through the roundabout may be restricted by ensuring that the radius of the fastest travel path through the roundabout does not exceed about 40 m as shown in Figure 10. This requirement, however, is difficult to achieve at two-lane roundabouts and the requirement may therefore be reduced to 60 m as shown in Figure 11. This reduction may, however, lead to high speeds through the roundabout and larger diameter roundabouts should be considered where possible.

The travel paths shown in the two figures are measured at the centreline of a passenger car. A distance of 1.5 m between the travel path and the roundabout edges is used. Any painted islands must be ignored in the determination of the path of fast moving vehicles (the assumption must be made that drivers may ignore the painted islands).

7.9.10. The centre island as well as the splitter island should be designed using the principles of “forgiving highway” design. The islands should be free of obstructions that could lead to serious accidents. The use of barrier kerbs on the islands can also lead to significant damage to vehicles and should therefore also be avoided. If there is a need to prevent illegal parking on the islands, use can be made of bollards fitted with breakaway devices.

## 7.10 Mini circle layout and dimensions

7.10.1. Requirements for the layout and dimensions of mini-circles are provided in this section. Any other guideline or manual prescribed by the municipality or specific road authority may, however, also be used.

7.10.2. The mini-circle is typically characterized by a small diameter island that is traversable by buses and trucks. The circles operate in exactly the same manner as roundabouts with yield control on all entries and clockwise operation around the central island, except that large vehicles may be required to travel over the island.

7.10.3. In terms of the requirements of the manual, the mini-circle may only be used on urban Class 4 and 5 roads with design speeds of 60 km/h or lower.

7.10.4. A typical layout with some dimensions of the mini-circle is given in Figure 12. In practice, circumstances can vary significantly from site to site and it is not possible to provide dimensions that are applicable to all mini-circles. Each mini-circle must therefore be designed. The following are general guidelines that must be followed in such design:

a) The mini circle design can more readily be implemented when roadway widths are not wider than 8 m and kerb return radii are between about 9 and 11 m. On wider roads and other kerb radii, additional construction may be required to achieve the required deflection.

b) The circulating roadway must have a width of between 5.0 and 5.5 m to accommodate light vehicles. A wider width will result in high speeds, while it would be difficult to turn when narrower widths are provided.

c) The visibility of the mini circle is enhanced by providing painted splitter islands as well as a painted edge on the island (alternately painted black and white).

d) The island can be constructed using asphalt or concrete paving blocks, but concrete blocks are preferred. When asphalt is used, the top of the island must be painted yellow.

e) The preferable height of the island is between 100 and 125 mm while a minimum slope of between 2% and 3% is required. At the edge of the island, a slope of between 5% and 6% must be provided.

7.10.5. The mini-circle should be designed for an operating speed of between 20 and 30 km/h. Due to the variety of factors that affect operating speeds at mini-circles, it is not possible to provide a methodology that can be used to determine the deflection required to achieve the design speeds. The size of the circle should therefore be established by means of field experimentation. Cones are placed on the planned edge of the island and a mid-sized passenger vehicle is driven through the intersection. The location of the cones is adjusted until the required operating speed is achieved.

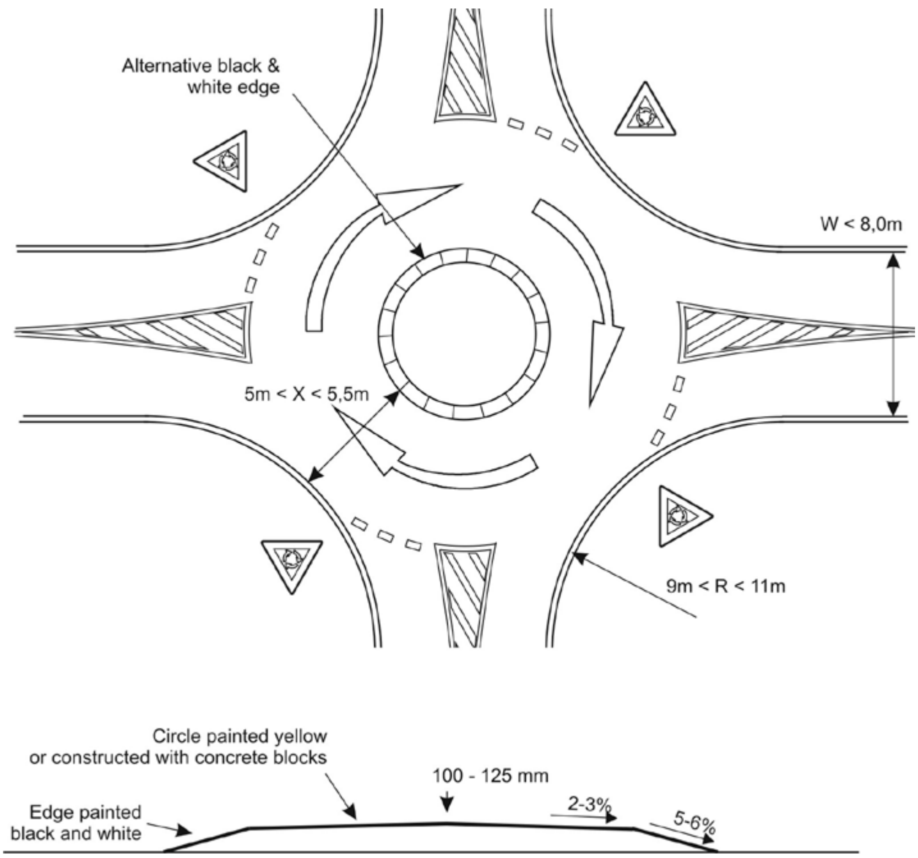



**Figure 12 Mini circle layout**

## 7.11 U-Turn design

7.11.1. U-turn facilities may be provided where permitted in terms of access management requirements. Where possible, such facilities should be combined with a partial access, but exclusive U-turn facilities may also be provided.

7.11.2. The U-turn facilities should be restricted for use by passenger cars and light delivery vehicles, while trucks should be prohibited from using these facilities. Trucks require very wide turning spaces and can significantly affect operations.

7.11.3. A median width of at least 8 m is required to accommodate the U-turns and to provide an auxiliary lane. Auxiliary lanes must be provided at all U-turn facilities. The facility must be designed to accommodate the turning path of a Light Delivery Vehicle (LDV).

## 7.12 Turning spaces

7.12.1. Turning spaces must be provided on cul-de-sac streets to allow vehicles to turn around. Different configuration of such turning spaces are shown in Figure 13. The turning circles should generally be used, while the hammerheads should only be used when existing streets are closed and space is limited.

7.12.2. Recommended dimensions for the turning spaces are provided in Table 13 for a number of design vehicles. Turning templates must be used to establish dimensions for other vehicles.

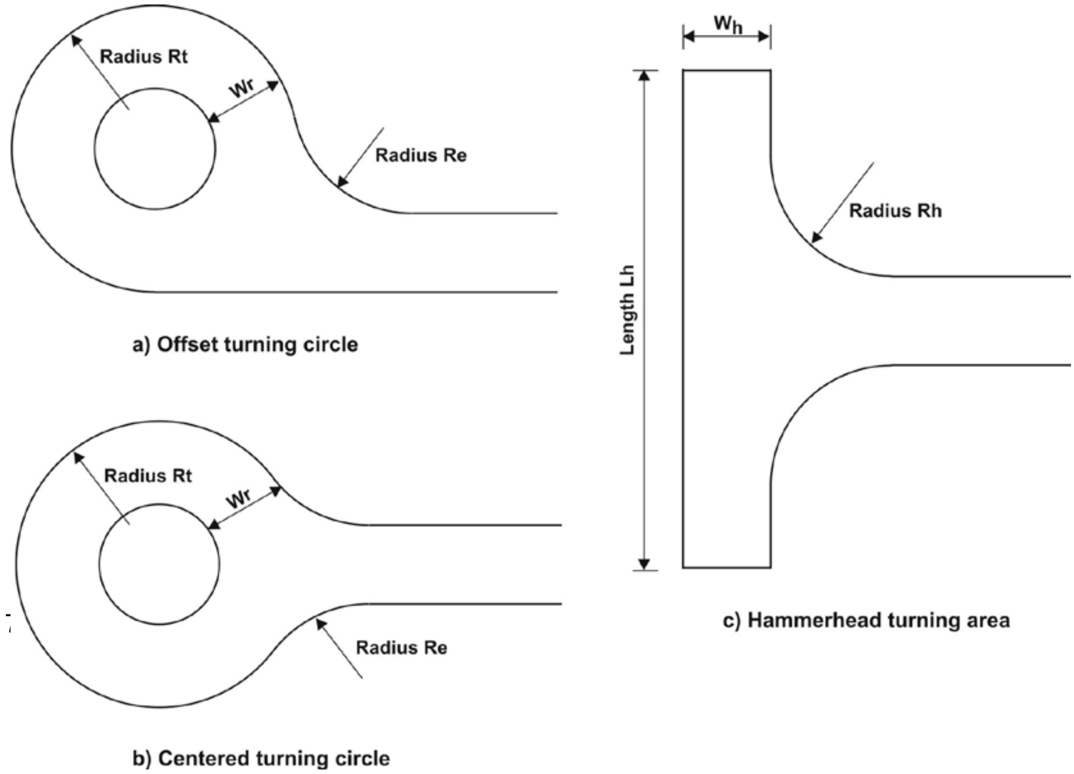



**Figure 13 Turning spaces**

**Table 13 Turning space dimensions**

| Design | Turning circle dimensions (m) | | | Hammerhead dimensions (m) | | |
|---|---|---|---|---|---|---|
| vehicle | Radius $R_t$ | Radius $R_e$ | Width $W_r$ | Length $L_h$ | Radius $R_h$ | Width $W_h$ |
| Passenger car | 10.5 | 8 | 5 | 20 | 6 | 6 |
| Refuse trucks | 12 | 10 | 6 | Not available | | |
| SU Truck | 15 | 12 | 10 | 35 | 8 | 8 |

AASTHO (2004), CUTA UTG 7 (1989), CUTA UTG 10 (1990)

## 7.13 Road reserve width and intersection splay

7.13.1. The municipality or road authority will prescribe minimum road reserve widths. In the absence of such reserve widths, the minimum widths provided in Table 14 must be used for urban areas.

7.13.2. In establishing road reserve widths in urban areas, the following factors must be taken into account:

a) *Roadway width*. The expected future roadway width, depending on the number of lanes that may be required. Provision must also be made for kerb widths.

b) *Median width*. On Class 2 and 3 roads, provision should be made for a median width of at least 5.0 m to accommodate right-turn lanes at intersections (CUTA UTG 1, 1986). Where partial intersections may be required (now or in future), provision must be made for an 8.0 m median width.

c) *Trees*. On roads where trees are provided, allowance should be made for the minimum clear distances between the trees and the roadway provided in Table 14 (based on AASHTO Roadside Design Guide, 2006).

d) *Pedestrian sidewalk*. Provision must be made for a width of 2.0 m to accommodate a paved pedestrian walkway (3.0 m in central business areas). On Class 2, 3, 4a and 4b roads, the sidewalk should preferably be provided behind the trees. On Class 4b and 5b residential streets, the sidewalk can be provided on either side of the trees.

e) *Pedestrian buffer strip*. Provision should be made for the pedestrian buffer strip widths provided in Table 43 in Chapter 13. On Class 5 roads, provision may be made for a 0.6 m wide buffer strip.

f) *Parking*. On Class 4b and 5b residential streets, provision should be made for overflow visitor parking on the road verges. A minimum verge width of 4.5 is required for this purpose.

g) *Engineering services*. Space should be available within the road reserve to accommodate all engineering services. Required widths to accommodate engineering services are provided in Table 15. The services should preferably be installed adjacent to the road reserve boundaries to accommodate future possible widening of the road.

7.13.3. In addition to the above requirements, the road reserve must be widened to accommodate elements such as the following:

a) Auxiliary turning lanes at intersections.
b) Auxiliary straight-through lanes at an intersection.
c) Public transport bays. At such bays it is not necessary to provide the buffer strip between the road and the sidewalk, but additional provision must be made for a 2.25 m wide shelter (Engineering Service Guidelines, 1984).
d) Fills and cuts, natural water streams, drains, etc.

7.13.4. At intersections, splays must be provided to accommodate the following elements:

a) Pedestrian walkway and buffer strip.
b) At intersections serving large volumes of pedestrians, space to accommodate pedestrian queues.
c) Engineering services.
d) Fills and cuts, natural water streams, drains, etc.

The splay must also provide for gap-acceptance and other sight distance requirements. The required sight triangle must be kept clear of all obstructions, including vegetation, public transport shelters, etc.

7.13.5. Where roundabouts (including traffic and mini-circles) are proposed, sufficient road reserve width must be available or provided to accommodate the size of the proposed roundabouts. Provision must also be made for a minimum verge width of 2.0 m to accommodate pedestrians, although a minimum of 3.0 m is preferable to provide a buffer between the sidewalk and the roundabout.

**Table 14 Minimum road reserve widths (urban areas)**

| Road Class | Minimum width (m) | Clear zone width (m) |
|---|---|---|
| Class 2 | 40 – 60 | 6.0 |
| Class 3 | 30 - 40 | 5.0 |
| Class 4a | 25 | 3.5 |
| Class 4b | 20 | 3.0 |
| Class 5a | 20 | 2.5 |
| Class 5b | 10 - 16 | 2.0 |

**Table 15 Road reserve widths for engineering services**

| Engineering Service | Required width (m) |
|---|---|
| Telecommunication | 1.0 |
| Water | 0.7 |
| Sewer | 1.0 |
| Stormwater | 1.1 |
| Electricity | 1.0 |

CUTA UTG 7 (1989)

# 8 Road and Intersection Geometric Design (Townships and Development Sites)


## 8.1 Introduction

8.1.1. In this chapter, standards and requirements are provided for the geometric design of roads and intersection proposed for a township or a development site. An assessment of such design is only required for Site Traffic Assessments and not for Traffic Impact Assessments.

8.1.2. The road and intersection design requirements of the municipality or road authority must be used for the assessment. In the absence of such requirements, the requirements of this chapter will apply. The requirements are applicable to urban roads only.

8.1.3. The requirements provided in this chapter only apply to Class 4 and 5 roads, including on-site roads that must be designed as equivalent Class 4 and 5 roads. Requirements are also provided for intersections and accesses on Class 2 and 3 roads. The design requirements for driveways are provided in Chapter 9.

8.1.4. This chapter only addresses those elements of geometric design that must be assessed during a Site Traffic Assessment. It is not intended to serve as a geometric design manual and other manuals must be consulted for additional information.

## 8.2 Horizontal curves

8.2.1. Minimum horizontal curve radii are provided in Table 16. The radii are based on AASHTO (2004) in which the requirements for low speed roads were significantly reduced from previous versions.

8.2.2. The radii provided in the table are also significantly lower than those provided in South African manuals such as CUTA UTG 5 (1988), although CUTA acknowledges that its curve radii can be reduced by 30% in some situations. The CUTA radius for a design speed of 60 km/h is 220 m compared to the 189 m provided in the table.

8.2.3. The radii given in the table allow for the retention of normal crossfall through the curve. In urban areas, it is not advisable to provide superelevation on horizontal curves. The superelevation can result in stormwater crossing the roadway which could result in dangerous travel conditions.

8.2.4. A check must be made to determine whether the stopping sight distance is adequate on a curve. With the curve widening requirements and clear zone requirements of this manual, the sight distances should be adequate in most situations, except on steep downgrades.

**Table 16 Horizontal curve radii**

| Design speed (km/h) | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|
| Minimum radius (m) | 27 | 60 | 116 | 189 | 297 |

AASHTO (2004)

## 8.3 Vertical curves

8.3.1. Requirements for vertical curves are defined in terms of the K value, or the rate of vertical curvature which is defined as the length of the vertical curve (in units of metres) divided by the algebraic difference between grades on the sides of the curve (in units of percentage).

8.3.2. Minimum K values are given in Table 17 for different design speeds for crest and sag vertical curves. Requirement are also provided for the minimum lengths of vertical curves

8.3.3. The K values in the table only provides for stopping sight distances and not for other types of sight distance, such as decision, gap acceptance and traffic signal sight distances. Higher K values may be needed where such sight distances have to be provided.

8.3.4. Where priority controlled accesses and driveways are provided on or in the immediate vicinity of the crest curves, the K values must be based on gap acceptance sight distances. The required K values for such sight distances are provided Table 18. The table differentiates between marginal accesses, full accesses on 2-lane roads and full accesses on 4-lane roads. The table also provides for the following gradients on the side road or driveway:

a) Any downgrades or upgrades less than 3%.

b) An upgrade of 6%.

Steep gradients on the side road results in longer sight distance requirements which, in turn, require flatter vertical curves.

Table 18 is only applicable where the change in gradient is relatively large. Where the change is small, smaller K values may be acceptable subject to a more detailed investigation.

**Table 17 Design controls for vertical curves without accesses**

| Design Speed (km/h) | Minimum K-Values | | Min Length (m) |
|---|---|---|---|
| | Crest | Sag | |
| 20 | 1 | 3 | 12 |
| 30 | 2 | 6 | 18 |
| 40 | 4 | 9 | 24 |
| 50 | 7 | 13 | 30 |
| 60 | 11 | 18 | 36 |
| 70 | 17 | 23 | 42 |

AASHTO (2004)

**Table 18 Design controls for accesses on crest vertical curves**

| Design Speed (km/h) | K-Values for gap-acceptance sight distance – Crest vertical curves | | | | | |
|---|---|---|---|---|---|---|
| | Marginal access | | Full access on 2-lane road | | Full access on 4-lane road | |
| | 3% Grade | 6% Grade | 3% Grade | 6% Grade | 3% Grade | 6% Grade |
| 20 | 2 | 2 | 3 | 3 | 3 | 4 |
| 30 | 4 | 5 | 5 | 7 | 6 | 7 |
| 40 | 7 | 8 | 9 | 12 | 10 | 13 |
| 50 | 10 | 12 | 13 | 18 | 15 | 20 |
| 60 | 14 | 17 | 19 | 26 | 22 | 28 |
| 70 | 20 | 23 | 26 | 35 | 29 | 39 |

## 8.4 Maximum gradients

8.4.1. Maximum gradients for Class 4 roads are provided in Table 19 and for Class 5 roads in Table 20. On Class 5 roads, steeper gradients may be allowed, provided that such gradients are limited to short sections as provided for in the table. The gradients apply to paved roads only and flatter gradients are required to prevent erosion on unsurfaced or gravel roads.

The gradients provided in the tables are only applicable to road sections between intersections. At intersections, the requirements of Section 7.3 must be used.

8.4.2. On bus routes, the maximum gradient must not exceed 8%. In difficult terrain, the gradient may exceed 10% over a limited number of sections not longer than 100 m. At bus stops, the gradient must not exceed a maximum of 6% (CUTA UTG5 1988).

**Table 19 Maximum gradients on Class 4 roads**

| Topography | Maximum gradients (%) for design speeds of | | |
|---|---|---|---|
| | 40 km/h | 50 km/h | 60 km/h |
| Flat topography | 9 | 8 | 7 |
| Rolling topography | 10 | 9 | 8 |
| Mountainous topography | 12 | 11 | 10 |

CUTA UTG5 (1988)

**Table 20 Maximum gradients on Class 5 roads**

| Road Class | Maximum gradient | Short section gradient | Section length |
|---|---|---|---|
| Class 5a | 8% | 12% | 50 m |
| Class 5b | 10% | 12% | 70 m |

CUTA UTG 7 (1989), CUTA UTG 10 (1990)

## 8.5 Vertical clearance

8.5.1. The minimum vertical clearance from any point on a roadway to an overhead structure is 5.1 m. If the structure is light, such as a pedestrian bridge, then the vertical clearance must be 5.5 m (CUTA UTG 5, 1988).

8.5.2. At traffic signals, a vertical clearance of 5.2 m is prescribed (SARSTM Volume 3).

8.5.3. Future overlays must be taken into account and a higher clearance should be provided to accommodate such overlays (CUTA UTG 5, 1988). A 5.2 m clearance distance should therefore be provided for this purpose.

## 8.6 Road widths

8.6.1. Road width requirements for two-lane Class 4 and 5 roads are provided in Table 21. Where multilane roads are provided, the required lane width is 3.5 m. The road width excludes the width of kerbs.

The 9.0 m road width required for Class 4 roads is required to minimise conflict due to turning movements on the road. Due to the relative short spacing allowed for intersections and accesses on these roads, it is not possible to provide auxiliary turning lanes at each access.

The 7.0 m road width required for Class 5 roads may be reduced according to the policies of the municipality.

8.6.2. On horizontal curves, the lane width must be widened as shown in Table 22 to accommodate the design vehicle paths (assuming two-way operations).

8.6.3. The above road widths are applicable to roads with mountable kerbs. Where barrier kerbs are used, the lane adjacent to the kerb must be widened by 0.6 m.

8.6.4. Medians are not normally required for Class 4 and 5 roads. However, if they are provided, then they must be at least 1.2 m wide.

**Table 21 Road widths (two-lane roads)**

| Road Class | Minimum road width without parking bays (m) | With barrier kerbs |
|---|---|---|
| Class 4 | 9.0 | 10.2 |
| Class 5 | 7.0 | 8.2 |

**Table 22 Road widening on curves**

| Road Class | Design Vehicle | Road widths (m) on curves with radii of | | | | |
|---|---|---|---|---|---|---|
| | | 15m | 25m | 30m | 50m | 75m |
| Class 4a, 4b, 5a | Bus | 13.5 | 11.3 | 10.8 | 9.7 | 9.2 |
| Class 5b | LDV | 7.8 | 7.4 | 7.3 | 7.1 | 7.0 |

AASHTO (2004), Widths for turning roadways at intersections

## 8.7 Intersection road widths

8.7.1. Lane width requirements for approach lanes to signal and priority controlled intersections are provided in Table 23. The preferred lane widths must be provided where possible. If space is not available, the narrow widths may be used. The very narrow lane widths should only be considered in exceptional cases.

The lane widths exclude the width of the kerb. Where a barrier kerb is provided, the lane adjacent to the kerb must be widened by 0.3 m (South African Road Traffic Signal Manual, Volume 3).

**Table 23 Intersection approach lane widths**

| Description | Very narrow | Narrow | Preferred |
|---|---|---|---|
| Straight-through | 3.0 | 3.3 | 3.5 |
| Turn lanes | 2.7 | 3.0 | 3.5 |
| Double turn lanes | | 3.3 | 3.5 |

South African Road Traffic Signal Manual, Volume 3

8.7.2. Exit lanes from intersections should be wider to accommodate the turning paths of turning vehicles, as follows:

a) Where a single turning lane is provided, it must be able to accommodate the design vehicle. Widening is only required when the turn is onto a two-lane road. On multilane roads, vehicles can turn wide and no widening is required.

b) Where a double turning lane is provided, the left lane should be designed to accommodate the design vehicle and the right lane to accommodate a Light Delivery Vehicle (LDV).

Exit widths of between 4.0 and 4.5 m are generally required, but this must be confirmed by means of turning templates.

On two-lane roads, the widening can be provided by setting the stop line on the exit side back to provide space for the turning movement. Where a median is provided, the exit lane may be widened by reducing the width of the median or setting the median back as shown in Figure 14. The outside of the roadway can also be widened to accommodate the turning lanes.

Minimum inside turning radii for right-turn light vehicles should be between 20 and 25 m, measured on the right-hand side of the vehicles as shown in Figure 14.

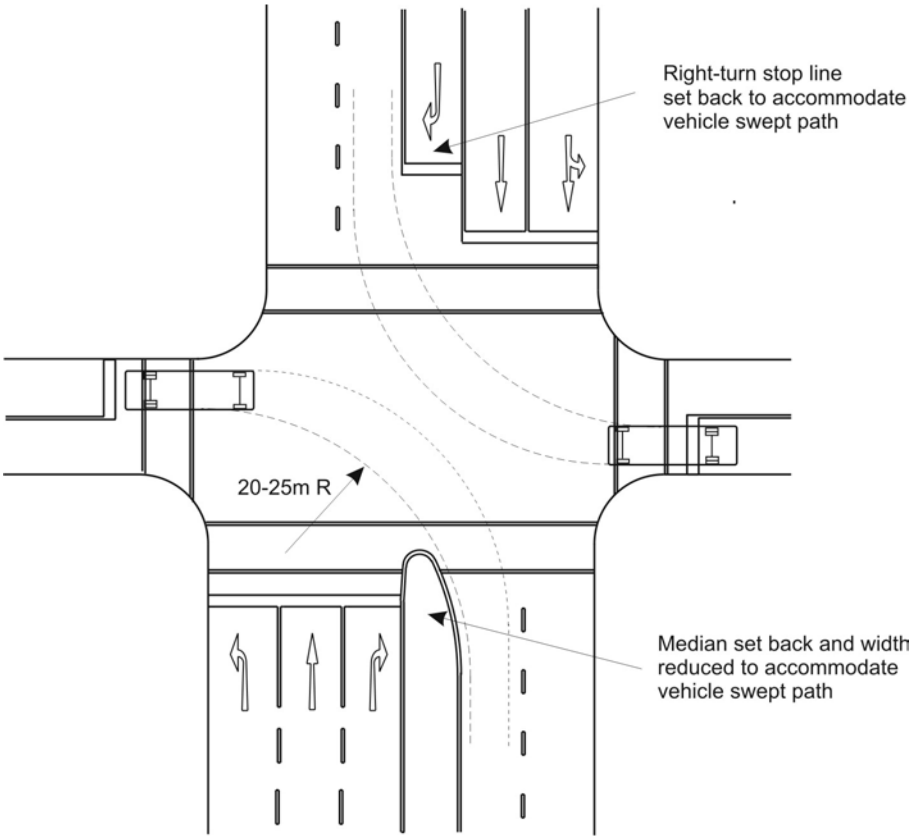



**Figure 14 Lane widths at intersections**

8.7.3. When a median is provided at a traffic signal controlled intersection, the median should preferably be at least 2.0 m wide to accommodate signal heads, although a narrower width of 1.2 m may be provided (South African Road Traffic Signal Manual, Volume 3).

Where pedestrians and cyclists must be accommodated at an intersection, the minimum width is 2.0 m, but a width of 3.0 m is preferable (DOT Pedestrian and Bicycle Facility Guidelines, 2002).

## 8.8 Kerb return radii

8.8.1. Requirements for kerb return radii are provided in Table 24. Kerb return radii of less than 8 m should generally be avoided since they result in significant encroachment onto adjacent lanes by passenger vehicles. Radii of greater than 12 m should also be avoided because they typically result in high turning speeds.

8.8.2. Turning templates must be used to determine if the recommended kerb turning radii can accommodate the design vehicle. If the kerb radius is inadequate, then preference should be given to widening the roadway rather than providing a wider kerb radius. For left-turn movements, a slipway may be required to accommodate the larger heavy vehicles.

8.8.3. Three-centred compound curves should be used when kerb return radii of greater than 12 m are used (Stover and Koepke, 2002).

**Table 24 Kerb return radii for Class 4 and 5 roads**

| Road Class | Minimum kerb return radius (m) |
|---|---|
| Class 4a | 10 - 12 |
| Class 4b | 10 |
| Class 4b | 10 |
| Class 5b | 8 |

## 8.9 Auxiliary lane tapers

8.9.1. Minimum required tapers are provided in Table 25 for the following applications:

a) Start of storage lane. Such lanes normally require a passive taper, but a shorter taper is preferable to accommodate possible long queues of traffic.

b) Passive tapers. These tapers are used when a lane is added which is not used for the storage of vehicles. Such tapers are typically required for turning roadways where storage lengths are not required.

c) Active tapers. These tapers are used where a lane is closed and two lanes must merge into one. These tapers are typically required where an additional straight through lane is provided at an intersection. Differentiation is made between kerbed and painted tapers.

8.9.2. Painted tapers must be provided with straight edges, but kerbed tapers must be smoothed by using reverse curves.

**Table 25 Taper rates**

| Design speed (km/h) | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|
| Start of storage lane | 5.0 | 7.5 | 10.0 | 10.0 | 10.0 |
| Passive tapers | 5.0 | 7.5 | 10.0 | 15.0 | 17.5 |
| Active kerbed tapers | 10.0 | 12.5 | 15.0 | 20.0 | 22.5 |
| Active painted tapers | 20.0 | 22.5 | 25.0 | 35.0 | 37.5 |

CUTA UTG5 (1988)

## 8.10 Right-turn lane design

8.10.1. Right-turn lanes must be provided in accordance to the requirements of Section 7.4 of this manual. The lanes can be provided by means of a constructed median or by road markings, as shown in Figure 15. The constructed median is provided when a median is available on the road. Otherwise, road markings are used.

8.10.2. The figure shows two methods of delineating right-turn lanes by means of road markings. In the one method, a painted island is utilised to provide greater protection to right-turn movements. In the second method, no such island is provided and continuity lines are used to demarcate the turning lane.

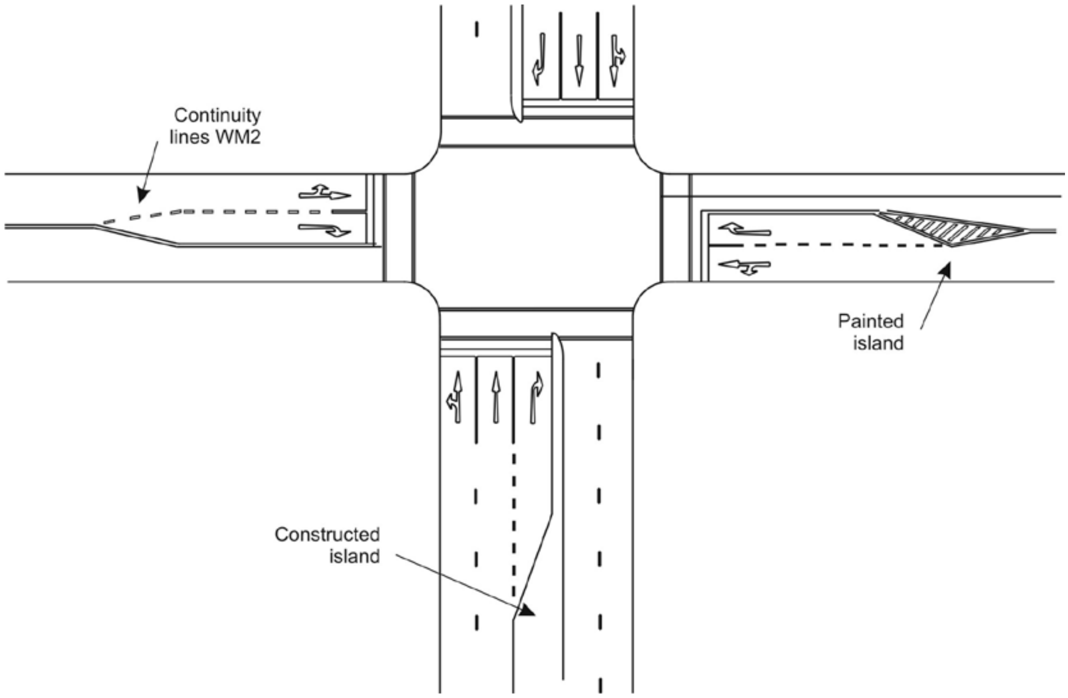



**Figure 15 Auxiliary right-turn lane types**

8.10.3. The painted island design has the advantage that it is more visible than the design without the island, particularly at night. However, in urban areas where speeds are low, the design without the island is adequate. This design has the advantage that it eliminates the S-type of manoeuvre required to make a right-turn which is required for painted islands.

8.10.4. In the design of right-turn lanes, it is important to ensure that sufficient sight distance is provided to avoid the possibility of head-on conflict. The sight-distance of right-turning vehicles is often obstructed by a queue of right-turning vehicles in the opposite direction.

## 8.11 Slipway design

8.11.1. General requirements for the provision and layout of slipways at intersections are provided in Chapter 7 of this manual. In this section, requirements are provided for the design of such slipways, in particular the slow-speed slipway.

8.11.2. A layout of the slow-speed slipway is shown in Figure 16. The slipway can either be priority or traffic signal controlled. Important design features of the slipway include the following:

a) An angle of entry of $70^{o}$ is provided to enhance priority control conditions (Austroads, 1988) and to reduce speed.

b) The slipway is primarily designed for passenger cars, while other design vehicles are accommodated by means of a painted island.

c) The entry width W should be 4.6 m for a single lane slipway and 8.6 m for double lane slipway. Wider widths may be required to accommodate design vehicles.

d) Trucks may be accommodated by means of a circular kerb edge followed by a straight taper. The layout must be designed by means of turning templates applicable to the design vehicles.

## 8.12 Traffic island design

8.12.1. Traffic islands are provided to guide and separate traffic and to provide refuge for pedestrians and cyclists.

8.12.2. The following are a number of requirements for the size of the traffic island:

a) The area of the traffic island should preferably not be less than 10 $m^2$ to enhance conspicuousness, although an area 5 $m^2$ may be acceptable in isolated cases. The minimum width of an island should be preferably 4.5 m, but not less than 3.5 m (AASHTO 2004).

b) The length of the island should at least include the width of any pedestrian crossing provided at the intersection. The dimension of the island should be at least 2 m to accommodate pedestrians and cyclists. According to SARTSM, the preferred minimum width of the crossing is 3.0 m although a 2.4 m width may be provided.

c) Space must be available on the island for road signs and traffic signals. Where signals are not currently provided, provision may have to be made for future signalisation of the intersection.

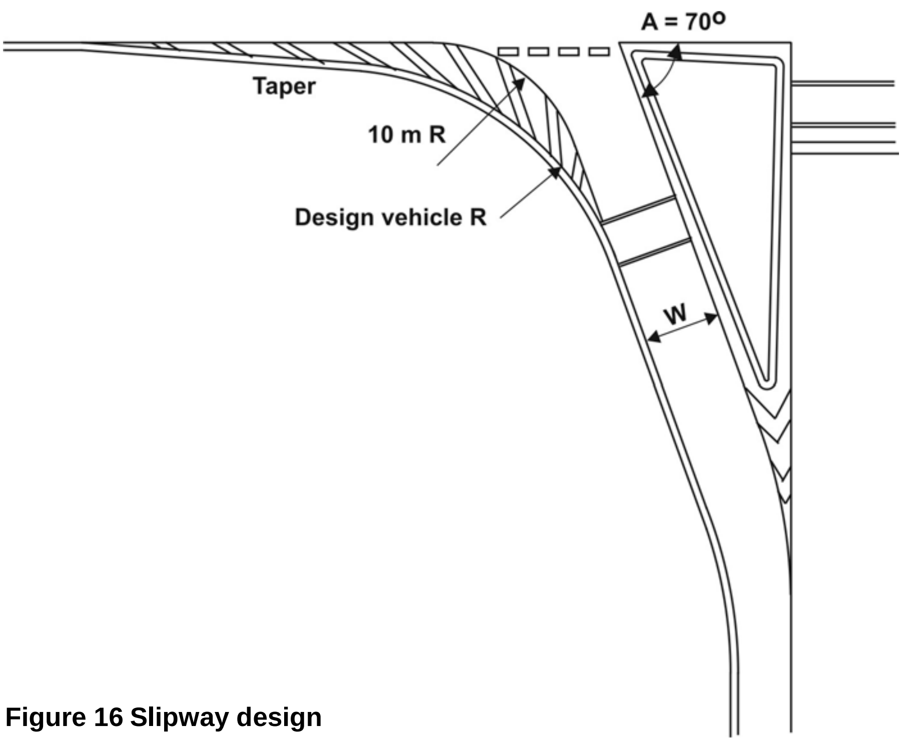



**Figure 16 Slipway design**

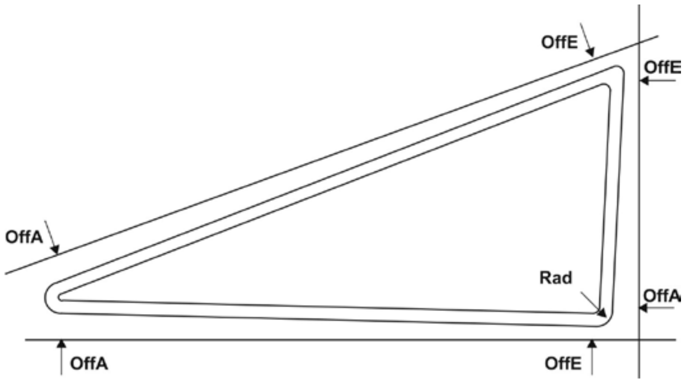



**Figure 17 Channelization Islands**

8.12.3. An offset must be provided between the roadway and the traffic island. The following offsets are recommended (AASHTO, 2004):

a) Approach offset ("OffA" in the figure). An offset of between 1.2 and 2.0 m should be provided on the approach to the island.

b) Exit offset ("OffE" in the figure). The offset must be gradually reduced over the length of the island. The exit offset should be between 0.6 and 1.0 m.

8.12.4. The following corner radii ("Rad" in the figure) are recommended for the islands:

a) At corners where left and right turn movements are prohibited, a radius of between 0.3 and 0.6 m.

b) At corners which serve to split approach lanes, a radius of between 0.6 and 1.5 m depending on angle and available space.

## 8.13 Road traffic signs

8.13.1. It is not possible to provide all requirements applicable to road traffic signs in this manual and the assessment of such signs must therefore be undertaken in terms of the requirements of the SADC and South African Roads Traffic Signs Manuals (Volumes 1 to 4).

8.13.2. The assessment of road traffic signs must be undertaken on all roads classified as "public roads" by the National Road Traffic Act (Act 93 of 1996). According to the act, public roads include *any road, street or thoroughfare or any other place (whether a thoroughfare or not) which is commonly used by the public or any section thereof or to which the public or any section thereof has a right of access*.

This definition includes on-site roads on development sites that are open to the public, even if such roads are not taken over by the Municipality. The assessment is not required for private roads that are not open to the public.

8.13.3. The assessment of road traffic signs must give particular attention to the following aspects related to road traffic signs:

a) Conspicuousness and visibility of the signs.
b) The use of warning signs when sight distance is limited.
c) Location and height of signs.

## 8.14 Traffic signals

8.14.1. Traffic signals must be assessed in terms of the requirements of Volume 3 of the South African Road Traffic Signs Manual as well as additional requirements provided in this section.

8.14.2. In terms of the requirements of this manual, the requirements listed below must be complied with in addition to the requirements of the South African Road Traffic Signs Manual. These requirements apply to new as well as existing traffic signals where a change in signal phasing or timing is required, even if such change does not require physical changes to the signals.

a) Traffic signals must operate in at least a *semi-actuated* mode of operation. Detectors must at least be provided on minor approaches and on right-turn lanes on the main road.
b) Traffic signals on Class 2 and 3 roads must be coordinated. The "green band" method is not adequate for coordinating traffic signals and use must be made of platoon dispersion diagrams as described by SARTSM.
c) Overhead signals must be provided on all Class 2 and 3 approaches to traffic signals.
d) At signalised pedestrian crossings, at least one near side and two far side signal faces must be provided.

8.14.3. Particular attention must be given to the following requirements related to the provision of traffic signals:

a) Number and location of traffic signal faces.
b) Visibility and sight distance requirements.
c) Accommodation of pedestrians (and cyclists).
d) Minimum requirements for green, yellow and all red intervals.
e) Traffic signal phasing and timing.
f) Traffic signal coordination.

# 9 Driveway Design


## 9.1 Introduction

9.1.1. An assessment must be made of the design of driveways that are proposed for a development site (driveways are not provided in townships). Driveways are on-site roads that carry a traffic volume of 50 vehicles or less during the peak hour. The assessments must be undertaken during Site Traffic Assessments and are not required for Traffic Impact Assessments.

9.1.2. The road and intersection design requirements of the municipality or road authority must be used for the assessment. In the absence of such requirements, the requirements of this chapter will apply.

## 9.2 Horizontal curves

9.2.1. No minimum requirements are prescribed for driveways, but horizontal curves must be designed to accommodate the turning path of the design vehicle.

9.2.2. Sufficient horizontal sight distance must be provided, but a low design speed of between 10 and 20 km/h may be used for this purpose.

## 9.3 Driveway profiles

9.3.1. Requirements are provided in this section for the vertical alignment of driveways. These requirements are applicable to operating speeds of 20 km/h and lower.

9.3.2. The requirements applicable to driveway profiles are illustrated in Figure 18. The figure shows a profile starting from the access and continuing along the driveway onto the property.

9.3.3. At the entrance to the driveway, the profile must provide for the smooth entry of vehicles onto the property. To ensure such entry, the algebraic differences in grades $A_o$ and $A_p$ must not exceed a maximum value of 10%.

9.3.4. On the driveway, vertical curves must be provided at locations where changes in the grade occur. The required K-values (Length of vertical curve L in metres divided by the algebraic difference in grade $A_d$) are as follows:

| Vertical curve | $K = L/A_d$ |
|---|---|
| Crest | 0.30 |
| Sag | 0.75 |

Stover and Koepke (2002)

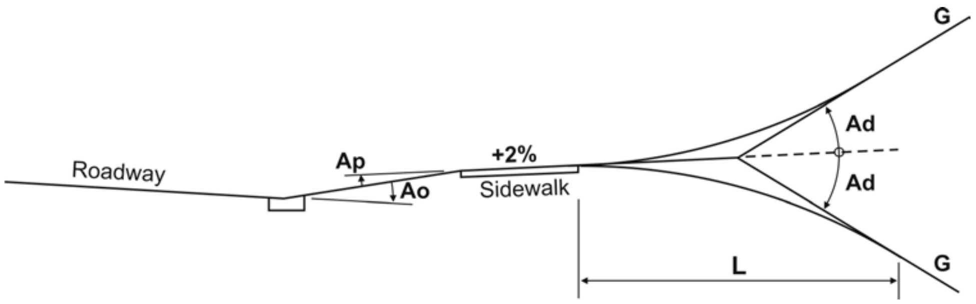



**Figure 18 Driveway profile**

For algebraic differences $A_d$ of 10% or less, the change in grade may be implemented by means of "rounding". For larger differences, a designed vertical curve must be used.

9.3.5. The gradient (G) on the driveway may not exceed the maximum values given below. The flatter gradients must be complied where possible, but the steeper gradients may be used in extreme cases.

| Development | Maximum gradient (%) |
|---|---|
| Residential | 12 - 15 |
| Other developments | 5 - 8 |

CUTA UTG5 (1988), Stover and Koepke (2002)

## 9.4 Driveway widths

9.4.1. Minimum widths for driveways are provided in Table 26. The widths may have to be widened to accommodate the turning paths of the design vehicle.

9.4.2. Where required, the driveway widths must be increased to allow for the safe passage of pedestrians and cyclists.

**Table 26 Minimum driveway widths**

| Description of driveway | | Minimum width (m) |
|---|---|---|
| Residential | Single family | 3 |
| | Low density (10 units) | 5 |
| | Medium density (20 units) | 6 |
| | High density one-way | 5 |
| | High density two-way | 7 |
| Other developments | One-way | 5 |
| | Two-way | 7 |
| Trucks | One-way | 5.5 |
| | Two-way | 7.5 |

## 9.5 Design for emergency services

9.5.1. This section deals with on-site requirements for emergency service vehicles. Where appropriate, separate provision may be made for on-street facilities for emergency vehicles.

9.5.2. Emergency services include services such as ambulances, fire engines and police vehicles. These services have particular requirements in terms of service driveway widths.

9.5.3. Service driveways must have a total unobstructed width of not less than 5.0 m, while property access control gates and accesses to buildings must have a total unobstructed width of not less than 4.5 m.

9.5.4. Adequate turning facilities must also be provided for the emergency vehicles.

9.5.5. Where possible, provision should also be made to accommodate the flow of vehicles that may wish to evacuate the property in the case of an emergency.

# 10 Access Throat Lengths


## 10.1 Introduction

10.1.1. Access throat length is an important factor that could significantly affect the efficiency and safety of traffic operations at development accesses. An assessment of access throat lengths must be made during Site Traffic Assessments and is not required for Traffic Impact Assessments.

10.1.2. Throat length is measured from *the road reserve boundary* to the nearest edge of a cross road or parking area on the access to the development. Where access control is provided, the throat length is measured to the stop line of the control.

10.1.3. Different requirements are provided for egress and ingress throat lengths. Different throat lengths may therefore be provided for the inbound and outbound directions.

10.1.4. The access throat should, where possible, provide for U-turns when access to the site is denied or not possible due to an incident and also where it is necessary to accommodate erroneous traffic movements.

## 10.2 Egress throat lengths

10.2.1. Egress (outbound) throats from a development must be of sufficient length to allow the access intersection to operate efficiently. A capacity analysis is required to determine the required egress throat length. However, the lengths may not be shorter than those provided in Table 27.

10.2.2. An assessment must also be undertaken to determine whether the site circulation system has sufficient capacity to ensure that the access intersection can be adequately utilised during the peak 15-minute period.

**Table 27 Minimum egress throat length**

| Minimum egress throat lengths (m) for control types and number of egress lanes | | | | |
|---|---|---|---|---|
| Control type: | Priority control | Traffic signal control | | |
| Number of egress lanes: | All | 1-2 Lanes(*) | 3 Lanes(*) | 4 Lanes(*) |
| Minimum throat length (m): | 15 – 25 (**) | 25 | 60 | 95 |

(*) Excluding taper lengths

(**) 6 – 25 m for Driveways

## 10.3 Ingress throat lengths

10.3.1. Access throats should, where possible, be designed to provide right of way to the ingress traffic without any form of control on the access (control is only provided on side roads). In such cases, the throat lengths provided in Table 28 must be provided.

10.3.2. Where some form of control is provided on the access, the ingress throat must be of sufficient length to prevent queue spillback onto the road or street system. The required throat length is determined by means of the following formula:

$$L_{Throat} = N_{Que} \cdot S_{Veh} \qquad L_{Throat} \geq L_{Min}$$

In which:

$L_{Throat}$ = Required throat length to prevent spillback (m)
$N_{Que}$ = $90^{th}$ Percentile queue length (No of vehicles per channel)
$S_{Veh}$ = Stopped spacing of vehicles
$L_{Min}$ = Minimum throat length

10.3.3. The throat length determined by means of the above formula is subject to the minimum throat lengths provided in the Table 28.

10.3.4. The throat length should have a low probability of being too short to accommodate the queue of vehicles during the peak hour. This probability must be lower than 10%, meaning that throat lengths should be determined for the $90^{th}$ percentile queue length.

10.3.5. A stopped spacing of 6.5 m must be used for light vehicles. The spacing must be increased when there is a significant proportion of heavy vehicles.

10.3.6. The $90^{th}$ percentile queue length required by the above formula must be determining using the methods described in the following sections of this chapter. Different formulae are provided for the following two forms of control on the access to the development:

a) Priority control (including roundabouts).
b) Access control (gate or boom).

**Table 28 Minimum ingress throat lengths**

| Minimum ingress throat lengths (m) for different road classes | | | | | | | |
|---|---|---|---|---|---|---|---|
| Road Class | Class 2 | Class 3 | Class 4a | Class 4b | Class 5a | Class 5b | Driveways |
| Service Station | 50 | 25 | 15 | N/A | 10 | N/A | N/A |
| Other developments | 100 | 75 | 25 | 15 | 15 | 10 | 5 |

(*) The requirements of the Municipality or authority will apply to Class 1 roads

## 10.4 Ingress throat length with priority control

10.4.1. Where a priority controlled intersection (including a roundabout) is provided on the access to a development, the 90th percentile queue length may be determined by means of the method described below.

10.4.2. The method requires the determination of the volume/capacity (v/c) ratio during the peak 15-minute period by means of the following formula:

$$v/c = \frac{\text{Volume / PHF}}{\text{Capacity}} \cdot 100$$

In which PHF is the peak hour factor required to convert the hourly volume to a peak 15-minute volume.

10.4.3. The 90th percentile queue length $N_{Que}$ (vehicles per lane) that must be accommodated is then determined from Table 29.

**Table 29 Priority control queue lengths on access throats**

| 90th Percentile queue lengths (vehicles per lane) for different v/c ratios | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| v/c ratio (%): | 19 | 33 | 43 | 50 | 56 | 61 | 65 | 68 | 71 | 73 |
| Storage Length $N_{Que}$: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| v/c ratio (%): | 75 | 77 | 78 | 79 | 81 | 82 | 83 | 83 | 84 | 85 |
| Storage Length $N_{Que}$: | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |

The queue lengths provided in the above table were determined by means of simulation of a wide range of traffic conditions. The storage lengths provide for relatively high levels of platooning in arrival flows and are therefore conservative.

10.4.4. The queue lengths may also be determined using the methodologies of the Highway Capacity Manual (2010), provided that the impact of platooning in arrival flows is taken into account.

## 10.5 Ingress throat length with access control

10.5.1. Access control involves the use of some form of gate or boom to control access to a development. The 90th percentile queue length at such access control may be determined by means of the method described below.

10.5.2. For the determination of the queue length, a traffic ratio over all channels must be determined by means of the following formula:

$$\text{Traffic ratio} = \frac{\text{Total Volume / PHF}}{\text{Service flow rate}} \cdot 100$$

In which PHF is the peak hour factor required to convert the hourly volume to a peak 15-minute volume.

10.5.3. Service flow rates required for the above formula are provided in Table 30 for different access control mechanisms.

10.5.4. The 90th percentile queue length $N_{Que}$ (vehicles per channel) is determined from Table 31 for the calculated traffic ratio. The storage lengths provided in the table include the vehicles being served.

**Table 30 Access control service flow rates**

| Service flow rates (veh/h) for different control types | |
|---|---|
| **Control type** | **Service flow (vph)** |
| Swipe magnetic card | 480 |
| Remote controlled gates | 450 |
| Ticket dispenser: Automatic | 390 -450 |
| Ticket dispenser: Push button | 220 - 360 |
| Pin number operated gates | 150 |
| Pay fee on entry | 120 |
| Cell-phone operated gates (gate opens when a call is received) | 100 |
| Manual recording, Visitor completes form | 80 |
| Intercom operated gates (visitor contacts resident by intercom) | 50 |

**Table 31 Access control queue lengths on access throats**

| 95th Percentile queue length (vehicles per channel) at controlled accesses | | | | | | |
|---|---|---|---|---|---|---|
| Storage (Vehs) | Traffic ratio (Percentage) for different Numbers of Channels | | | | | |
| $N_{Que}$ | 1 Channel | 2 Channel | 3 Channel | 4 Channel | 5 Channel | 6 Channel |
| 1 | 23 | 58 | 97 | 140 | 188 | 235 |
| 2 | 39 | 94 | 155 | 220 | 292 | 363 |
| 3 | 49 | 115 | 186 | 261 | 341 | 421 |
| 4 | 56 | 128 | 205 | 283 | 367 | 449 |
| 5 | 61 | 137 | 216 | 297 | 382 | 466 |
| 6 | 65 | 143 | 224 | 306 | 392 | 476 |
| 7 | 68 | 147 | 229 | 312 | 399 | 484 |
| 8 | 70 | 151 | 233 | 317 | 403 | 489 |
| 9 | 71 | 153 | 236 | 321 | 407 | 493 |
| 10 | 73 | 155 | 239 | 324 | 410 | 496 |

The storage lengths provided in the above table were determined by means of simulation of a range of queuing systems. A range of traffic arrival distributions were used in the simulation, while move-up and service times were assumed to follow a lognormal distribution. The storage lengths provide for relatively high levels of platooning in arrival flows.

# 11 Sight Distance Requirements


## 11.1 Introduction

11.1.1. The provision of adequate sight distance is an essential and critical requirement for safe traffic operations. As an irreducible minimum, drivers must be able to see objects with sufficient time to undertake evasive manoeuvres or to stop (NRA Geometric Design Guidelines).

11.1.2. The sight distance requirements provided in this chapter are based on the references given below. Should the requirements provided in these references be changed in future, then the contents of this chapter must be amended accordingly. The references should also be consulted when additional information or clarification is required.

| Sight distances | Manual or guideline |
|---|---|
| Stopping sight distances | AASHTO (2004) |
| | NRA Geometric design guidelines |
| Decision sight distances | AASHTO (2004) |
| Gap acceptance sight distances | AASHTO (2004) |
| Traffic signals | SARTSM Volume 3: Traffic Signal Design |
| Pedestrian and cyclist sight distances | Department of Transport (2002) |

## 11.2 Eye and object heights

11.2.1. Sight distances are measured from the eye height of the driver (or pedestrian/cyclist) to the top of the object that must be visible.

11.2.2. Required eye heights are provided in Table 32 for different design vehicles. Required object heights are provided in Table 33 for different types of sight distances.

11.2.3. The NRA Geometric Design Guidelines recommend that a lower object height should be used when there is a significant risk of events such as washouts, fallen rocks and trees. However, according to AASHTO (2004), the use of a lower object height would substantially increase construction cost without documented safety benefits. It is also doubtful whether the driver’s ability to perceive risks would be increased because the increased stopping sight distances are beyond the capability of most drivers to detect small objects.

**Table 32 Eye heights for sight distances**

| Design vehicle | Eye height (m) | Reference |
|---|---|---|
| Passenger car/LDV | 1.05 m | NRA Geometric design guidelines |
| Bus and SU Truck | 1.80 m | NRA Geometric design guidelines |
| WB-15 and WB-20 | 2.40 m | AASTHO (2004) |
| Pedestrian | 1.05 m | Department of Transport (2002) |
| Cyclist | 1.05 m | Department of Transport (2002) |

**Table 33 Object heights for sight distances**

| Sight distance application | Object height (m) |
|---|---|
| Stopping sight distance | 0.60 |
| Gap acceptance sight distance | 1.05 |
| Decision sight distance | 0.00 |

AASHTO (2004)

## 11.3 Stopping sight distance

11.3.1. Stopping sight distance is the length of roadway ahead that is required to enable the vehicle to stop before reaching a stationary object in its path. It is the sum of the distance traversed during the driver reaction time and the braking distance needed to stop the vehicle. Such sight distance must always be available on all roadways (including horizontal curves).

11.3.2. Stopping sight distances requirements are provided in Table 34. The requirements are applicable to passenger cars and no standards are available for trucks. AASHTO (2004) recognises that such standards may be required for specific circumstances, but does not provide the standards.

According to the NRA Geometric Design Manual, warning and other road signs may be considered if truck stopping sight distances are not adequate. The manual, however, warns that the provision of road signs is not a substitute for appropriate design practice.

AASHTO (2004) indicates that there is one specific situation where every effort must be made to provide truck stopping sight distance, namely at the end of long downgrades where truck speeds may be very high.

11.3.3. The design standards for vertical curves already provide for stopping sight distances and a design check is therefore only required on the horizontal plan. Horizontal sight obstructions that must be taken into account include barriers, bridge piers, vegetation and the back slopes of cuttings.

The horizontal sight distances are measured from an assumed driver eye position at the centre of the lane most affected by a sight obstruction.

**Table 34 Stopping sight distances (AASHTO, 2004)**

| Design speed (km/h) | Stopping sight distance (m) for gradients of: | | | | | | |
|---|---|---|---|---|---|---|---|
| | -9% | -6% | -3% | 0% | 3% | 6% | 9% |
| 20 | 25 | 20 | 20 | 20 | 20 | 20 | 20 |
| 30 | 35 | 35 | 35 | 35 | 35 | 30 | 30 |
| 40 | 55 | 50 | 50 | 50 | 45 | 45 | 45 |
| 50 | 75 | 70 | 70 | 65 | 65 | 60 | 60 |
| 60 | 100 | 95 | 90 | 85 | 80 | 80 | 75 |
| 70 | 125 | 120 | 110 | 105 | 100 | 100 | 95 |
| 80 | 155 | 145 | 140 | 130 | 125 | 120 | 115 |
| 90 | 190 | 175 | 165 | 155 | 150 | 145 | 140 |
| 100 | 225 | 210 | 195 | 185 | 175 | 170 | 160 |
| 110 | 265 | 245 | 230 | 215 | 205 | 195 | 190 |
| 120 | 305 | 285 | 265 | 250 | 235 | 225 | 215 |
| 130 | 350 | 325 | 305 | 285 | 270 | 255 | 245 |

AASTHO (2004)

## 11.4 Decision sight distance

11.4.1. Stopping sight distance provides for normal operations but may be inadequate when drivers must make complex decisions, when information is difficult to perceive or when unexpected or unusual manoeuvres are required (AASTHO, 2004).

11.4.2. Existing guidelines on when decision sight distance should be provided are vague and not clear. AASHTO (2004), for example, states that decision sight distances are required at locations such as the following:

a) Interchange and intersection locations where unusual or unexpected manoeuvres are required.
b) Change in cross section such as lane drops and at toll plazas.
c) At locations where there is significant visual noise from competing sources of information, such as traffic, traffic control devices and roadway elements.

11.4.3. According to Stover and Koepke (2002), two decision sight distance situations are encountered in land development, namely a) the identification of major cross-streets and b) the ability of drivers to identify the geometrics of access connections. The first issue can be addressed by providing large visible signs of each major intersection. The second can be addressed by providing an access design that is visible to drivers.

11.4.4. According to Barriclow and Jacobson (2004), an unexpected or unusual situation also occurs when a driver approaches a signalised intersection and the back of a queue of vehicles is reached while the signalised intersection is not visible.

11.4.5. In terms of the requirements of this manual, decision sight distance must be provided in the following situations:

a) At locations where there is a lane drop, e.g. at the end of an auxiliary through lane at intersections, passing lane, etc.
b) In rural areas where an intersection would not normally be expected, the intersection geometrics as well as the start of auxiliary turning lanes must be visible (object height of 0.0 m). The back of the queue must also be visible (object height of 0.6 m).

11.4.6. Decision sight distances should also preferably be provided in the following situations, but road signs may be provided to warn drivers of these situations. Road markings such as “stop ahead”, “robot ahead” or “circle ahead” can also be effective to warn drivers.

a) In urban areas where intersections would not normally be expected, the intersection geometrics as well as the start of auxiliary turning lanes must be visible. The back of the queue must also be visible (0.6 m object).
b) At locations where there is considerable visual noise due to developments adjacent to the roadway.

11.4.7. Required minimum decision sight distances are provided in Table 35. The table provides for the following two situations:

a) Situation 1 in which the vehicle must make a change in speed, path or direction but is not required to stop. This provides for situations such as lane drops and the start of auxiliary lanes.
b) Situation 2 in which a vehicle is required to stop. This provides for situations such as stopping at intersections or at the back of a queue.

**Table 35 Decision sight distance**

| Design | Decision sight distance (m) | |
|---|---|---|
| Speed (km/h) | Situation 1 (No stop required) | Situation 2 (Stop required) |
| 50 | 145 | 155 |
| 60 | 170 | 195 |
| 70 | 200 | 235 |
| 80 | 230 | 280 |
| 90 | 270 | 325 |
| 100 | 315 | 370 |
| 110 | 330 | 420 |
| 120 | 360 | 470 |
| 130 | 390 | 525 |

AASHTO (2004)

## 11.5 Gap acceptance sight distance

11.5.1. Gap acceptance sight distance is the sight distance required when drivers at intersections must evaluate gaps in opposing traffic streams for acceptance or rejection. Alternative terms for this sight distance are “shoulder” and “intersection” sight distance but “gap acceptance” sight distance is a more precise term.

11.5.2. Gap acceptance sight distance must be available at the following intersections, as shown in Figure 19:

a) Stop or yield controlled approaches at priority controlled intersections.

b) Right-turn movements from:

  i) Uncontrolled approaches at priority controlled intersections.

  ii) Traffic signal controlled intersections during permitted turning phases.

11.5.3. At stop-controlled intersections, the eye must be located 5 m from the edge of the near edge of the main road as shown in Figure 19. For right-turning vehicles, the eye should be located at the most likely position from which drivers would evaluate and accept gaps.

11.5.4. Gap acceptance sight distances must be calculated using the following formula:

Sight distance = Design speed (km/h) x Time gap (seconds)/3.6

The factor 3.6 in the formula is required to convert speed in km/h to units of m/s.

11.5.5. The required gap times are provided in Table 36 for different combinations of vehicle type, turning movement and the width of the roadway to be crossed, with adjustment for gradient.

11.5.6. The width of the roadway to be crossed is measured in equivalent lanes of 3.6 m wide. The method of measurement of this width is shown in Figure 20 and is as follows:

a) Left-turn movements from stop. The crossing width is not taken into account for this movement.

b) Straight-through movements from stop. The width is measured perpendicular to the major road, from the edge of the carriageway from which the vehicle departs, to the far side edge of the road.

**Table 36 Gap acceptance time gaps (AASHTO 2004)**

| | Time gaps (seconds) for different turning movements | | | | |
|---|---|---|---|---|---|
| Design Vehicle | Left-turn from stop | Straight through | Right turn from stop | Right-turn from major road | Right-Turn at traffic signals |
| Passenger car/LDV | 6.5 | 6.0 + 0`5 N | 7.0 + 0.5 N | 5.0 + 0.5 N | 7.5 + 0.5 N |
| Bus/SU Truck | 8.5 | 7.8 + 0.7 N | 8.8 + 0.7 N | 5.8 + 0.7 N | 9.3 + 0.7 N |
| WB-15/WB-20 | 10.5 | 9.8 + 0.7 N | 10.8 + 0.7 N | 6.8 + 0.7 N | 11.3 + 0.7 N |
| Gradient adjustment | 0.1 G | 0.1 G | 0.2 G | - | - |
| N = Equivalent number of lanes to cross | | | | | |
| G = Gradient in percentage. Gradient adjustment only applicable when G > 4% | | | | | |

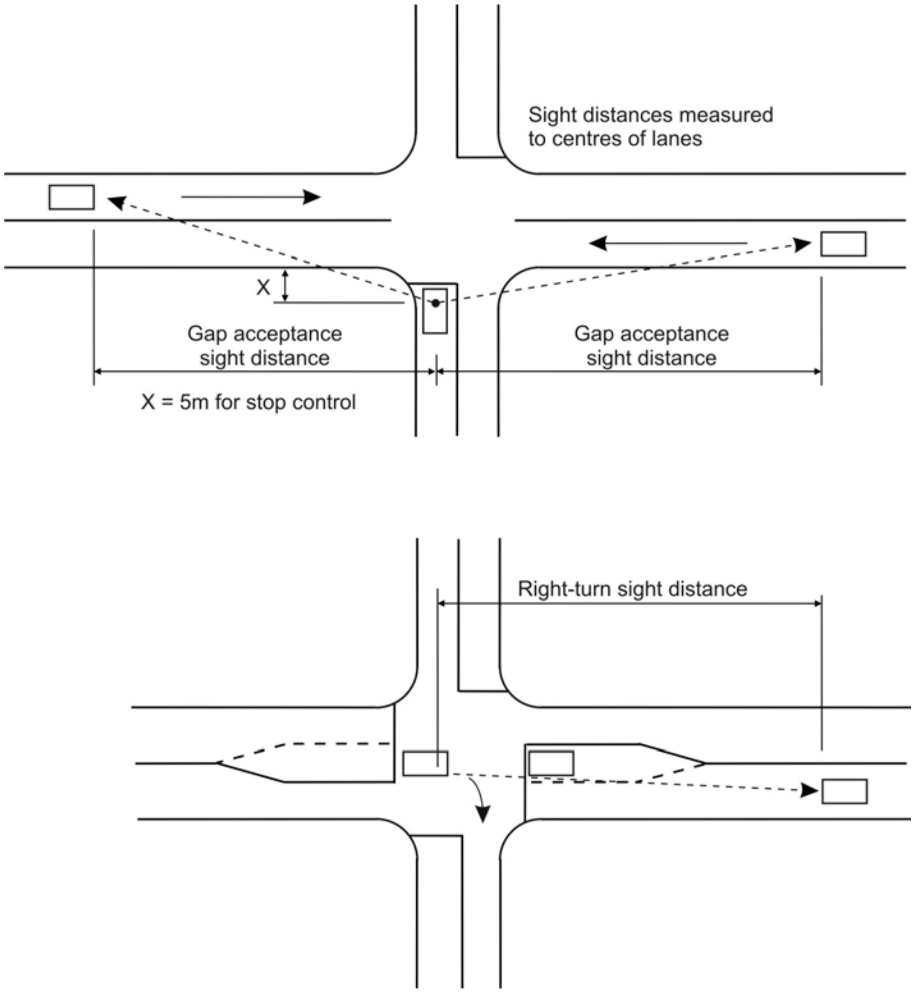



**Figure 19 Gap acceptance sight distance**

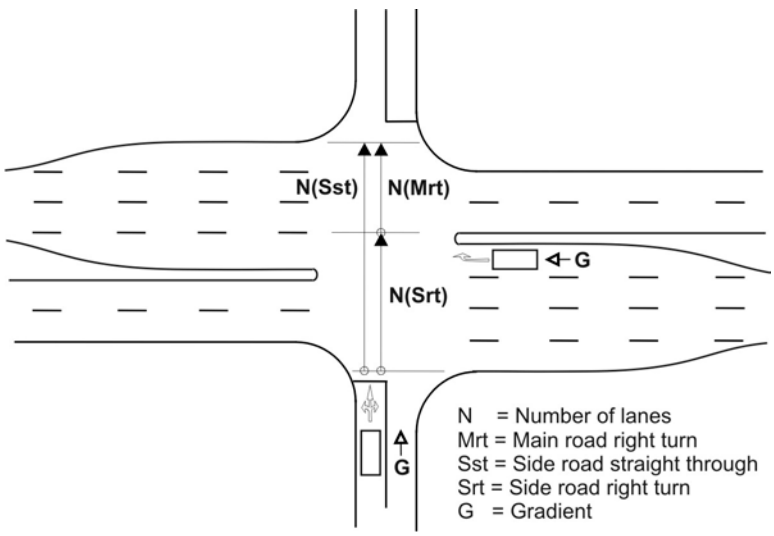



**Figure 20 Gap acceptance crossing width**

c) Right-turn movement from stop. The width is not measured along the path of the turning vehicle, but perpendicular to the major road. The distance is measured from the edge of the carriageway from which the vehicle departs to the nearest edge of the carriageway onto which the right-turn vehicle turns.

d) Right turn movement from uncontrolled or traffic signal controlled approach to an access or intersection. The width is measured between the near and far edges of the opposing carriageway, perpendicular to the major road.

11.5.7. The width of the roadway includes the width of any median that must be crossed during the crossing manoeuvre. Where a median is provided which is wide enough to allow two-stage crossing, the intersection can be treated as two intersections, and the crossing width adjusted accordingly.

11.5.8. The gap time must also be adjusted according to the gradient of the road. This gradient is measured at the rear wheel position of the stopped vehicle waiting for a gap. It is normally not necessary to adjust the gap time according to the gradient of the main road, since conflicting vehicles on the main road would be travelling at lower speeds on uphill gradients. This assumption, however, may not be true at all locations (such as near to sag vertical curves), in which case the gap time should be increased based on the grade of the major road.

## 11.6 Right-turn designs for gap acceptance

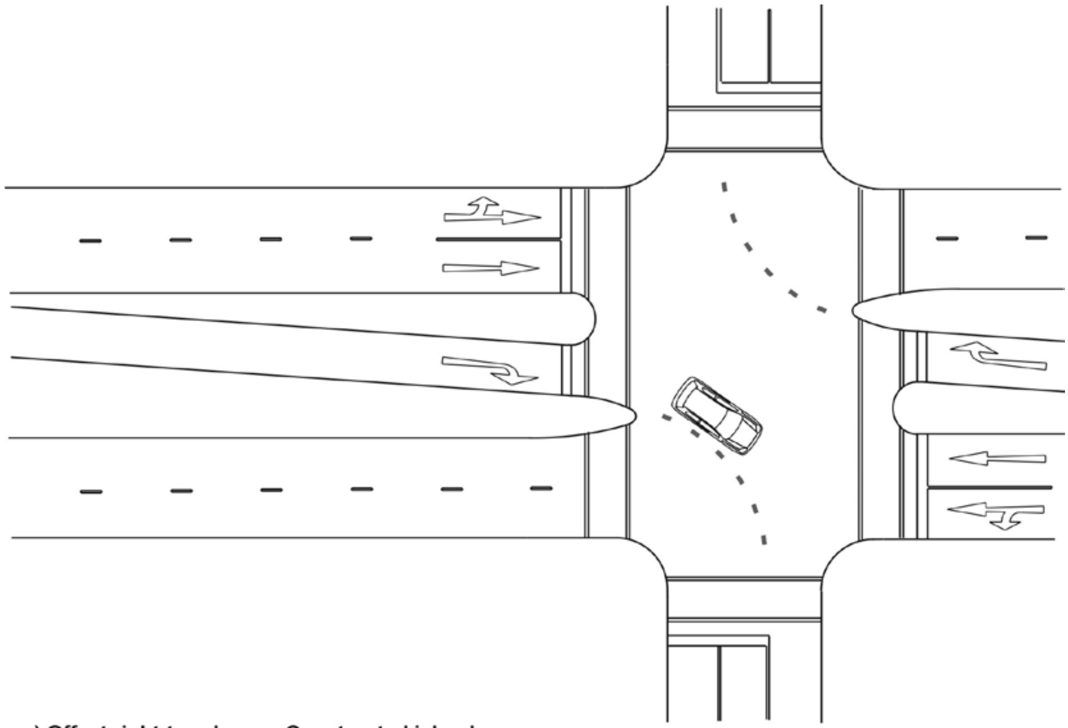
11.6.1. In the design of right-turn lanes, it is important that sufficient gap sight distance should be provided to avoid the possibility of head-on conflict. The sight distance could be restricted due to objects on the opposite median, but most often the sight distance is restricted by a queue of right-turning vehicles in the opposite direction.

11.6.2. The right-turn gap acceptance sight distance can be improved by offsetting the right-turn lanes as shown in Figure 21. Two methods are shown, one requiring a constructed island and the other a painted island.

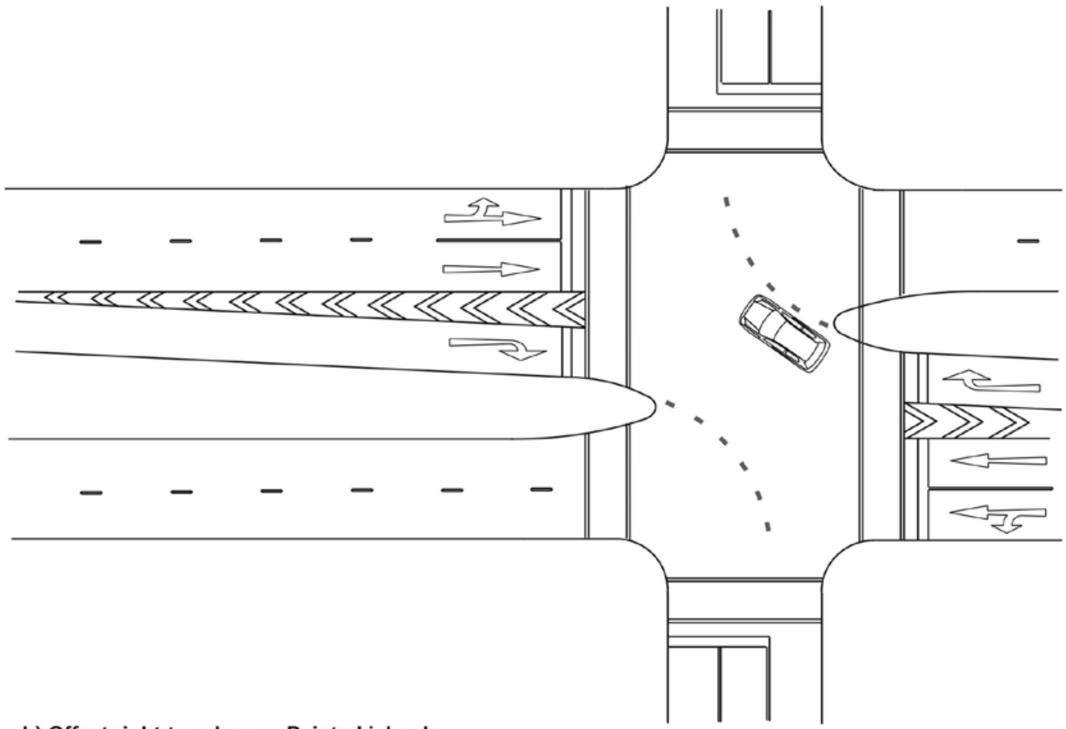
11.6.3. The constructed island has the disadvantage that it could be confusing to pedestrians as well as drivers. Pedestrians are used to be on the lookout for traffic from the left after crossing a median and do not expect traffic from the right as in the design. This often leads to pedestrian-vehicle conflicts.

The design can also be confusing to drivers who are used to turn right immediately after a constructed median. This is particularly a problem when visibility is poor, such as at night or during adverse weather conditions.

11.6.4. The painted island does not have the above issues and is therefore recommended for general application. This method has been successfully applied at a number of locations in South Africa.



a) Offset right-turn lanes - Constructed island



b) Offset right-turn lanes - Painted islands

**Figure 21 Right-turn designs for gap acceptance**

## 11.7 Traffic signal sight distances

11.7.1. Sight distances required at traffic signals are prescribed by the South African Road Traffic Signs Manual (Volume 3). The sight distance requirements of this manual are summarised in Table 37. These sight distances are measured from the stop line of the intersection.

11.7.2. The manual requires that at least two traffic signal faces must be visible at any one time over the sight distance. Minimum and preferred sight distances are given in the table for urban roads. The minimum sight distances given for rural roads are also the preferred distances for urban roads. The minimum sight distances are based on a shorter reaction time, and should only be used at junctions where drivers would expect a traffic signal. The preferred sight distances should be used when traffic signals are not expected and a longer reaction time is required to respond to the signals.

11.7.3. Note that although the sight distances are provided for rural roads in the table, in terms of the requirements of this manual, traffic signals may not be provided on rural roads.

**Table 37 Traffic signal sight distances**

| Speed limit or advisory speed (km/h) | Minimum for urban conditions (where signals are expected) | Preferable for urban conditions and minimum for rural conditions | Adjustments for grades | | | |
|---|---|---|---|---|---|---|
| | | | Add for a downgrade of: | | Subtract for an upgrade of: | |
| | | | -5% | -10%) | +5% | +10% |
| 40 km/h (*) | 55 | 130 | 0 | 5 | -0 | -5 |
| 50 km/h (*) | 80 | 160 | 5 | 10 | -5 | -5 |
| 60 km/h | 110 | 190 | 10 | 20 | -5 | -10 |
| 70 km/h | 140 | 215 | 10 | 25 | -10 | -15 |
| 80 km/h | 170 | 240 | 15 | 35 | -10 | -20 |
| (*) To be used only in conjunction with an advisory speed sign, e.g. at a horizontal curve | | | | | | |

## 11.8 Pedestrian and cyclist sight distances

11.8.1. Sight distances are provided in this section for pedestrians and cyclists. These sight distances allow a pedestrian and cyclist to evaluate a gap in the traffic stream and to cross the roadway during the duration of such gap. The sight distances are based on those provided by the Pedestrian and Bicycle Facility Guidelines of the Department of Transport (2002).

11.8.2. In terms of the requirements of this manual, the sight distance must be measured from an eye height of 1.05 m to an object height of 1.05 m. This differs from the object height of 1.35 m that is prescribed by the guidelines.

11.8.3. For the determination of the sight distance, it must be assumed that the pedestrian or cyclist waits at a position 2.0 m away from the edge of the roadway. At locations where a refuge median island is provided, it can be assumed that the crossing will be undertaken in two stages.

11.8.4. Minimum gap acceptance sight distances required by pedestrians and cyclists depend on traffic speed and the width of road to be crossed. The required sight distances are provided in Table 38. At locations where there are high proportions of elderly or disabled pedestrians, the longer gap acceptance sight distances provided in Table 39 must be provided.

11.8.5. The tables show that relatively long sight distances are required by pedestrians and cyclists to cross a road, particularly when the road is wide and vehicular speeds are high. This indicates the need for reducing crossing widths (by kerb extensions or by providing refuge islands), and by controlling the need for pedestrians and cyclists to cross high-speed roads.

**Table 38 Pedestrian and cyclist sight distances for a 1.2 m/s walking speed**

| Vehicle design speed (km/h) | Gap acceptance sight distance (m) for crossing widths of | | |
|---|---|---|---|
| | **7.5m** | **15.0m** | **22.5m** |
| 40 | 105 | 175 | 245 |
| 50 | 130 | 215 | 305 |
| 60 | 155 | 260 | 365 |
| 70 | 180 | 305 | 425 |
| 80 | 210 | 345 | 485 |
| 100 | 260 | 435 | 605 |
| 120 | 310 | 520 | 725 |

**Table 39 Elderly or mobility Impaired pedestrian sight distances (1.0 m/s)**

| Vehicle design speed (km/h) | Gap acceptance sight distance (m) for crossing widths of | | |
|---|---|---|---|
| | **7.5m** | **15.0m** | **22.5m** |
| 40 | 115 | 200 | 285 |
| 50 | 145 | 250 | 355 |
| 60 | 175 | 300 | 425 |
| 70 | 205 | 350 | 500 |
| 80 | 235 | 400 | 570 |
| 100 | 295 | 500 | 710 |
| 120 | 350 | 600 | 850 |

# 12 Traffic Management


## 12.1 Introduction

12.1.1. It is a specific requirement of this manual that residential and other sensitive areas must be protected against the negative impacts of external road traffic. The function of residential streets is not only to serve vehicular traffic but also to serve other activities such as walking and socialisation. Low speeds and low traffic volumes are essential to the creation and preservation of quality residential areas.

12.1.2. The requirements of this chapter are particularly important and must NOT be compromised without appropriate consultation with the affected community.

12.1.3. The Municipality is responsible for the preparation of Traffic Management Plans aimed at protecting existing residential and other sensitive areas. However, an assessment of the impact of a proposed development must still be undertaken for two purposes during a traffic assessment, namely a) to determine whether such plans will be adequate to protect the area and b) to identify those management measures that must be implemented.

12.1.4. Where an application is made for a residential or other sensitive development, the Applicant is responsible for the preparation and implementation of a Traffic Management Plan for the development. Such plan shall be submitted with the traffic assessment as part of the application. The plan must provide for adequate protection against possible future developments in the area.

12.1.5. The assessment must be undertaken during both Traffic Impact Assessments and Site Traffic Assessments.

## 12.2 Traffic management impact assessment

12.2.1. An assessment must be made of residential and other sensitive areas that may be affected by a development to establish whether the development will have a negative impact on those areas. Assessments are also required when application is made for a residential or other sensitive development.

12.2.2. Where a proposed development consists of a land-use component which is not the same as (or at least compatible with) the land use in the sensitive area and where the development will attract external traffic through the area on Class 4 and 5 roads, traffic management measures shall be implemented aimed at preventing such through traffic.

12.2.3. Where the land uses are the same (or at least compatible), an assessment must be made of whether the trip generation of the proposed development will result in traffic volumes that will exceed the environmental capacity of residential roads as defined in this chapter (refer to Table 41). Where required, measures must be introduced to limit the impact of the development on nearby residential areas.

12.2.4. Where a Municipality has already adopted a traffic management plan for the area, an assessment must be made of whether the plan will adequately address the impact of the development. Where the plan is not adequate (or not available), proposals for mitigating the impacts must be prepared and submitted for inclusion in the traffic management plan.

12.2.5. Where a plan is available or a plan is proposed, measures must be selected from the plan for implementation. Such measures must be listed for implementation as part of the recommendations of the assessment report.

## 12.3 Network considerations

12.3.1. The need for traffic management is often the result of inadequate road network planning. Many of the issues related to speed and traffic intrusion can be addressed by appropriate network planning. Where possible, the objectives of traffic management should be achieved by means of network planning rather than by means of traffic calming measures.

12.3.2. The gridiron street system is typically associated with high speeds and traffic intrusion due to streets that are continuous over substantial distances. No hierarchy of roads exists and any street can become a major thoroughfare (Stover and Koepke, 2002).

12.3.3. The preferred system is a discontinuous pattern. The system should prevent high speeds and through traffic, but at the same time link all internal segments in the area so that residents can circulate in the area without the need to use the major road system (Stover and Koepke, 2002). The primary means by which a discontinuous pattern can be achieved is by means of T-junctions.

12.3.4. The discontinuous pattern may affect pedestrian and cyclist movement in an areas, but this can be addressed by providing a separate system of walkways and cycling roads in addition to the road system.

## 12.4 Speed calming

12.4.1. Speed calming involves the control of speeds in residential and other sensitive areas. Calming measures must be provided to ensure that operating speeds do not exceed the design speed of the roads in these areas.

12.4.2. Speed control measures include any type of measure that will reduce speed to the design speed of the roads or lower. The following are examples of such measures:

a) Roundabout (including traffic and mini-circle) control.
b) Priority intersection control.
c) Speed humps.

12.4.3. Narrow road widths (narrower than about 5.0 m) can also assist in reducing speeds and can create the visual conditions that make motorists aware that they are in a restricted area which is environmentally friendly and safe.

12.4.4. The required spacing of speed control measures to achieve various design speeds are as provided in Table 40.

**Table 40 Speed control spacing to achieve design speeds**

| | | | | |
|---|---|---|---|---|
| Design speed: | 30 km/h | 40 km/h | 50 km/h | 60 km/h |
| Speed control spacing: | 100 m | 150 m | 200 m | 300 m |

## 12.5 Traffic intrusion control measures

12.5.1. Traffic intrusion is probably one of the most significant problems experienced in many residential and other sensitive areas in the urban environment. Traffic intrusion control measures are aimed at limiting or restricting traffic volumes or through traffic in residential areas.

12.5.2. In terms of this manual, traffic volumes in these areas may not exceed the “environmental capacities” provided in Table 41 during any one hour. The preferred standard should generally be used although the maximum standard may be allowed in exceptional circumstances.

**Table 41 Environmental capacity of roads**

| Road class | Preferred (veh/hr) | Maximum (veh/hr) |
|---|---|---|
| Urban Class 4b | 500 | 1 000 |
| Urban Class 5b | 200 | 500 |

12.5.3. According to the Engineering Services Guidelines (1994), through traffic can be limited if the total length of a trip through a residential area is twice the length on higher order roads. In terms of the requirements of this manual, the total *duration* of a trip through a residential area must also be at least twice the duration on higher order roads. The travel time on the higher order roads must be estimated based on the assumption that these roads will become congested in future (and which increase the pressure of traffic intrusion through sensitive areas).

12.5.4. Where a residential road network has not been designed to prevent through traffic, the following measures must be considered for controlling through traffic:

a) Semi-closures at intersections where traffic is diverted to other streets.
b) Full closures in which the street is fully closed, either at an intersection or at some mid-block location.
c) Access control by means of gates which allows access for residents only.

12.5.5. Semi-closures can be an effective form of traffic intrusion control under specific conditions, but it has limited application. The most effective means of intrusion control is by means of full closures and access control.

12.5.6. Full closure of streets will require the provision of a turning area for heavy vehicles. On Class 4b or 5b roads, such turning area is not required when the road is shorter than 100 m.

# 13 Pedestrian and Bicycle facilities

Traffic Impact Assessments ✓
Site Traffic Assessments ✓

## 13.1 Pedestrian and bicycle facility assessment

13.1.1. It is an important requirement of this manual that adequate provision is made for pedestrians and, where necessary, cyclists. An assessment must be made of whether adequate provision has been made in the network layout and the provision of pedestrian and cyclist facilities according to the requirements of this manual.

13.1.2. The requirements provided in this chapter are applicable to developments and townships with normal volumes of pedestrian and bicycle traffic. At locations such as schools and public transport termini with high concentrations of pedestrian and bicycle traffic, the assessment must be undertaken in terms of the Pedestrian and Bicycle Facility Guidelines of the Department of Transport (2002).

13.1.3. During Traffic Impact Assessments, an assessment must be made of the provision of the following on-street pedestrian and cyclist facilities:

a) Network considerations
b) Pedestrian and cyclist crossings (midblock and at intersections).
c) Sidewalks and bicycle lanes.

13.1.4. During Site Traffic Assessments, an assessment must be made of the provision as well as the design of the following pedestrian and cyclist facilities:

a) Pedestrian/cyclist accessibility to the development from the adjacent street network (particularly from on-street public transport facilities).
b) Accommodation of on-site pedestrian movements from public transport facilities, drop-off facilities and parking areas. An assessment must be made of proposed sidewalks, walkways and pedestrian crossings.
c) Accommodation of mobility impaired pedestrians.
d) Bicycle racks and storage facilities.
e) Separation between goods delivery routes and pedestrian or cyclist routes.

## 13.2 Network considerations

13.2.1. It is important that a network of continuous, safe, convenient and clearly defined pedestrian walkways and crossings as well as cyclist facilities must be provided. Walking and cycling routes should be provided that serve natural desire lines as directly as possible and which minimise walking or cycling distances. Particular attention must be given to links to public transport facilities as well as other amenities.

13.2.2. Pedestrian and bicycle facilities should be provided where there is a reasonable expectation that such facilities will be used by pedestrians and cyclists, even if the numbers of pedestrians and cyclists are relatively low (within reason). The standards of such facilities must be such that they will promote increased pedestrian and cycle use.

13.2.3. Provision must be made to accommodate persons with special needs. This not only includes persons with disabilities, but also other vulnerable groups such as young children and older persons.

13.2.4. Particular care must be taken to minimise of potential conflicts between pedestrians, cyclists and vehicles. Care should be taken to prevent excessive vehicular traffic across primary pedestrian and cyclist routes and vice versa. Measures must be implemented aimed at the prevention of jay-walking across roads carrying large volumes of traffic or at high speed, as follows:

a) On Class 1 roads (urban or rural), no pedestrian or cyclist access to a development (formal or informal) may be provided and specific measures must be introduced to prevent or limit pedestrian or cyclist access to such roads, including the provision of pedestrian bridges.

b) On Class 2 and 3 roads, pedestrian and cyclist access should only be provided opposite formal pedestrian and cyclist crossings. Measures must be introduced elsewhere to prevent or limit pedestrian or cyclist access.

c) On Class 4 and 5 roads, pedestrian and cyclist access may be provided at any location, but preference should be given to locations opposite formal pedestrian and cyclist crossings.

## 13.3 Provision of pedestrian and cyclist crossings

13.3.1. Formal pedestrian and cyclist crossings would normally only be required on urban roads. On rural roads, such crossings will normally not be required, but could be considered at intersections or accesses.

13.3.2. No pedestrian or cyclist crossings, formal or informal, may be provided on Class 1 roads (urban and rural) and measures must be introduced to prevent or limit pedestrian or cyclist access to such roads.

13.3.3. On Class 2 to 5 roads, formal pedestrian and cyclist crossings may be provided at full intersections or intersections that are traffic signal controlled. Care should be taken when such crossings are provided at accesses or intersections that are priority controlled as well as at roundabouts.

Pedestrian traffic has a significant impact on the capacity of intersections, particularly in high density development nodes. In such areas grade separated pedestrian facilities should be considered.

13.3.4. Formal pedestrian or cyclist crossings may not be provided at partial or marginal accesses or intersections. Such accesses or intersections must not be provided where pedestrian or cyclist crossing may become warranted in future.

13.3.5. On Class 4 and 5 roads, formal midblock crossings may be provided at any location where such crossings are warranted, provided that such crossings do not affect the operations of signal or roundabout controlled intersections or accesses. Midblock crossings should not be provided on Class 1 to 3 roads.

13.3.6. A formal pedestrian or bicycle crossing (priority or signal controlled) is warranted at locations where the pedestrian volume during any hour (of the year) exceeds 20 pedestrians per hour and where either of the following conditions exists:

a) More than two lanes have to be crossed in one stage without provision of a pedestrian or cyclist refuge (e.g. on a median) or;
b) The traffic volume that must be crossed in one stage exceeds 1 000 vph during any hour of a normal week.

Signalised pedestrian or bicycle crossings may be provided when traffic signals at such crossings become warranted in terms of the traffic signal warrants.

13.3.7. The following are a number of important considerations in the design of pedestrian and cyclist crossings:

a) On roads were parking is provided, kerb extensions should be provided at pedestrian or cyclist crossings in order to reduce crossing width and improving sight distances. Such extensions have been found to be highly beneficial and should therefore be considered at all crossings where parking is provided.
b) Kerb ramps must be provided wherever a pedestrian or cyclist needs to cross a kerb at a crossing. The ramps are mainly provided for use by cyclists, persons using wheelchairs and persons pushing prams, but are also useful for persons with mobility impairments.
c) Where possible, pedestrian and cyclist refuge should be provided by means of a protected area such as a constructed island. Such refuge is one of the most effective facilities that can be provided for use by pedestrians and cyclists.

## 13.4 Pedestrian sidewalks

13.4.1. Pedestrian sidewalk lanes would normally only be required on urban roads. On rural roads, pedestrians currently predominantly use the shoulder of the road, but separate walkway lanes have been installed in a number of locations and have proven to be beneficial. Separate walkway lanes should be considered in areas where pedestrian volumes are high.

13.4.2. No pedestrian facilities may be provided on Class 1 roads (urban and rural) and measures must be introduced to prevent or limit pedestrian access to such roads, including pedestrian bridges.

13.4.3. Pedestrian sidewalks should be provided on all urban roads on all classes of roads except on Class 1 roads. The presence of pedestrians is undesirable along Class 2 roads and walkway lanes should only be considered where it is not possible to restrict pedestrian access to such roads.

13.4.4. Where sidewalks are provided, such sidewalks must be provided on both sides of the road for all road classes except Class 5b, on which a sidewalk is only required on side of the road.

13.4.5. Recommended sidewalk widths are provided in Table 42. According to the Pedestrian and Bicycle Facility Guidelines (Department of Transport 2002), many sidewalks have been constructed to a width of 1.2 m which is not adequate for two pedestrians to walk side-by-side or to allow a person to pass. A minimum width of 1.5 m is required although 1.8 m would be more desirable.

13.4.6. The provision of a sidewalk directly adjacent to the roadway is undesirable and a buffer strip should be provided wherever possible. The advantages of the buffer strip include a greater level of safety and comfort to users of the sidewalk. It also provides a buffer against water splash from passing vehicles.

13.4.7. The buffer strip has the disadvantage that it requires maintenance when vehicles stop or park on the side of the road. Parking should, however, generally not be allowed on most roads, and where allowed, a paved parking area should be provided.

13.4.8. The buffer strip of 0.6 m in Table 42 is the minimum that should only be provided when sufficient road reserve width is not available. Desirable buffer strips are provided in Table 43 for different road classes.

**Table 42 Minimum sidewalk widths**

| Description | Minimum width (m) |
|---|---|
| Sidewalks/walkways with buffer strip | |
| Minimum width | 1.5 |
| Desirable width | 1.8 |
| Minimum buffer strip width | 0.6 |
| Sidewalks/walkways without buffer strip | 1.8 |
| Sidewalks in Business Centres | 2.5 – 3.5 |

Department of Transport (2002

**Table 43 Desirable pedestrian buffer strips**

| Road Class | Desirable buffer width (m) |
|---|---|
| Class 2 | 6.0 |
| Class 3 | 4.5 |
| Class 4a | 3.0 |
| Class 4b | 2.5 |
| Class 5a | 0.6 - 2.5 |
| Class 5b | 0.6 - 1.5 |

Based on Stover and Koepke (2002)

## 13.5 Bicycle lanes

13.5.1. As for pedestrian sidewalks, bicycle lanes would normally only be required on urban roads. On rural roads, cyclist would normally use the shoulder of the road although a separate bicycle road should be considered when cyclist volumes are high.

13.5.2. No cyclist facilities may be provided on Class 1 roads (urban and rural) and measures must be introduced to prevent or limit cyclist access to such roads.

13.5.3. Bicycle lanes may be provided on any class of road, except Class 1 roads and preferably not on Class 2 roads. The municipality or road authority should have a master plan for the provision of such lanes.

13.5.4. Cycle lanes of 1.2 to 1.8 m wide can be provided on the roadway by widening of the carriageway. However, the lanes can also be provided along the pedestrian walkway. Two-way cycle lanes need to be 2.5 to 3.5 m wide.

# 14 Public Transport Facilities

| | |
|---|---|
| Traffic Impact Assessments | ✓ |
| Site Traffic Assessments | ✓ |

## 14.1 Public transport assessment

14.1.1. The provision of public transport facilities is a particularly important requirement of this manual. An assessment must be made of whether provision has been made for public transport facilities in accordance with the requirements of this manual.

14.1.2. During Traffic Impact Assessments, an assessment must be made of the provision of on-street public transport stops and bays.

14.1.3. During Site Traffic Assessments, an assessment must be made of the provision as well as design of on-site public transport stops.

## 14.2 Public transport stops and bays

14.2.1. An assessment must be made of the number of public transport stops required to serve a development. Ranks, holding areas termini and depots are the responsibility of the municipality and are beyond the scope of this manual.

14.2.2. Where stops are provided on the road or street system, the size of a stop should be restricted to the maximum that can be accommodated safely on the road or street. Any additional stops required must be provided on the development site.

14.2.3. The provision of on-street public transport stops is subject to the following requirements (the requirements apply to both rural and urban roads):

a) No stops may be provided on Class 1 roads;
b) Stops on Class 2 roads are restricted to lay-bys downstream of intersections;
c) Stops on Class 3 roads are restricted to intersections, preferably downstream, and should be in lay-bys;
d) There is no restriction on public transport stops on Class 4 and 5 roads, but stops would normally only be provided on Class 4 roads and not on Class 5 roads. Lay-bys are not required, but should be provided on roads that carry high significant traffic volumes, particularly at public transport stops where a high volume of pedestrians can be expected.

14.2.4. Public transport stops should be located within an acceptable walking distance from generators, attractors and modal transfer facilities. Walking distances to the stops should preferably be within 400 m but not more than 800 m. Public transport stops should generally be spaced between 400 and 500 m apart on Class 4 roads. On Class 2 and 3 roads, a stop would normally be provided at each intersection.

14.2.5. Public transport stops must be served by an adequate network of sidewalks and walkways. Care must however, be taken to prevent jay-walking across roads, particularly the higher classes of roads.

14.2.6. On-street public transport stops should be located as near as possible to intersections and accesses. At traffic signal controlled intersections, the stops can be located either on the approach or on the far side of the intersection, but preference should be given to the far side. When provided on approaches, the stops should be located sufficiently far back to prevent the intersection or access being obstructed by the stop.

14.2.7. Where public transport stops are provided on a development site, uninterrupted and convenient vehicular access should be provided to the stops from roads or streets adjacent to the site. The stops should conveniently be located to entrances to the buildings and adequate provision should be made for sidewalks and walkways.

14.2.8. Separate vehicular access from the road network should be allowed to on-site public transport facilities, subject to access spacing requirements. This will improve the management of on-site facilities, encourage public transport operators to make use of on-site facilities and eliminate the need for special arrangements for public transport vehicles at access control gates.

## 14.3 Public transport bay layout

14.3.1. Layouts for public transport stops are shown in Figure 22 for low and high speed roads. The low speed design is appropriate for use on Urban Class 3 and 4 roads, while the high speed design should be used on Urban Class 2 roads as well as rural roads.

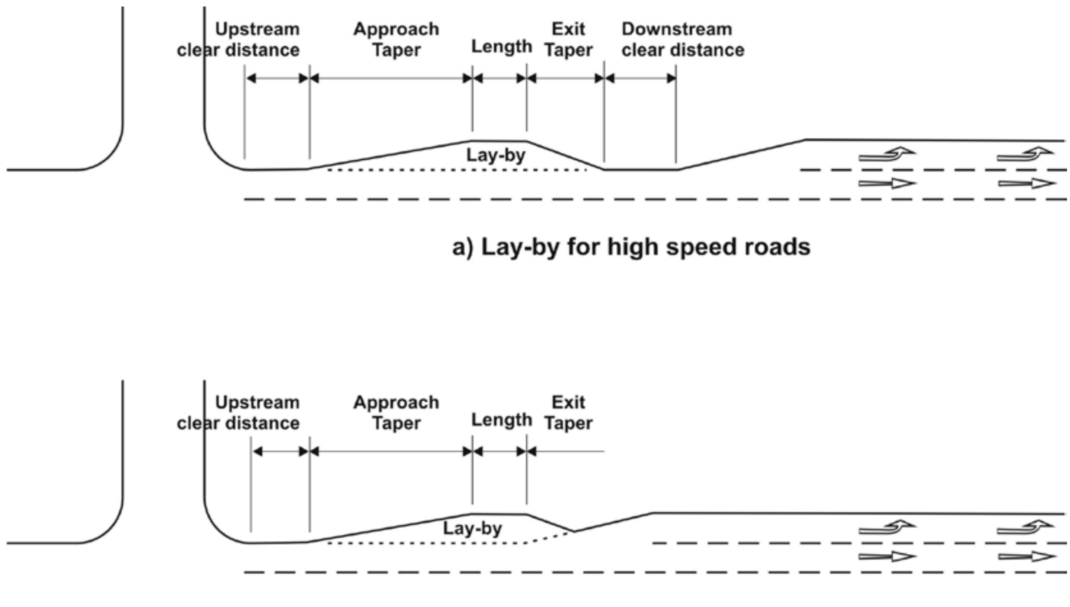
14.3.2. Where limited space is available, the exit taper of the lay-by may overlap with the approach taper of the downstream left-turn lane at an intersection.

14.3.3. Recommended dimensions for the lay-bys on urban roads are provided in Table 44. On rural roads, public transport stops should preferably not be provided as lay-bys but should be located on the road verge away from the roadway (similar to rest stops). This is required to ensure adequate separation of traffic and pedestrians, particularly at locations where larger numbers of persons are offloaded or picked up.

**Table 44 Public transport lay-by dimensions**

| Urban Class | Upstream clear dist (m) | Approach taper | Length (m) | Exit taper | Downstream clear dist (m) | Width |
|---|---|---|---|---|---|---|
| Class 2 | 10 | 1:10 | 25* | 1:6 | 20 | 3.5 |
| Class 3 | 10 | 1:8 | 25* | 1:6(*) | 20* | 3.5 |
| Class4 | 10 | 1:6 | 25* | 1:6(*) | 20* | 3.0 |

(*) Exit taper may overlap with left-turn lane




a) Lay-by for high speed roads

b) Lay-by for low speed roads

**Figure 22 Public transport lay-bys**

# 15 Parking Provision and Design


## 15.1 Introduction

15.1.1. Parking is an important and integral part of the transportation system and is an essential transportation service that is required at most developments. Parking is normally provided on-site but some limited provision can also be made for on-street parking.

15.1.2. The standards and requirements of this chapter are based on the references given below. These documents may be consulted if more information is required.

a) Department of Transport (1985). Parking Standards (2nd Edition).
b) Stover and Koepke (2002), Transportation and Land Development.

15.1.3. In situations where on-street parking is proposed, an assessment of such parking must be made during Traffic Impact Assessments. During Site Traffic Assessments, both on-street and on-site parking must be assessed.

## 15.2 On-street parking

15.2.1. On-street parking has a significant impact on road safety as well as the capacity of the road system. According to Transportation Research Board (2003), the prohibition of on-street parking can lead to a 30% improvement in traffic flow and a 20% to 40% reduction in collisions. In a review of literature on the impact of on-street parking on accidents, Box (2001) found that kerb parking makes an unduly contribution to accidents, ranging from about 40% of total accidents on two-way major streets to 70% on local streets. Higher proportions have been found on one-way streets.

15.2.2. Due to the significant impact of on-street parking on capacity and road safety, such parking may only be allowed on streets where such parking can be provided with a reasonable degree of safety.

15.2.3. In terms of this manual, on-street parking is only allowed on Urban Class 4 and 5 roads where the following requirements and conditions are met:

a) The road must be a destination for vehicular traffic and not carry through traffic.
b) The total traffic volume on the roadway (in the two directions) should not exceed a maximum of 1 000 vph during any hour.
c) Speed control measures must be introduced to limit operating speeds to a maximum of 50 km/h.
d) The longitudinal gradient of the road is less than 5%.
e) Where parallel parking is provided, the lane adjacent to the parking bays must be at least 4.0 m and preferably 4.5 m wide.

f) A demarcated paved parking bay with a width of 2.2 m must be provided.

g) Sufficient sight distances must be available at accesses and at pedestrian crossings. Sight distances may not be blocked by parked vehicles.

h) Arrangements must be in place for the management of the use of the on-street parking.

i) The parking is only aimed at providing convenient short-term parking for patrons and not to replace on-site parking for tenants, residents or long-term visitors.

j) On-site parking requirements may not be reduced due to the on-street parking provision, except where it can be guaranteed that the parking will never be removed for whatever purpose.

15.2.4. The above requirements can readily be met on Class 4a and 5b residential roads where provision should be made for visitor overflow parking on the road verges. The road reserve widths of such roads must be sufficient to accommodate such parking. However, paved demarcated parking bays are not required.

## 15.3 Parking rates

15.3.1. The primary purpose of the requirements of on-site parking provision is to prevent or limit on-street parking or on parking areas provided at other developments due to the inadequate provision of parking at the development itself.

The responsibility to provide adequate on-site parking is that of the property owner and it must be a condition in the granting of any application that mere compliance with the parking requirements of the municipality does not relieve the owner of the obligation to accommodate the full parking accumulation of the development. If on-site parking is not sufficient to serve the peak parking demand, the owner will be required to amend the use of the property or make the necessary arrangements to provide the required number of parking bays.

15.3.2. Parking rates that must be provided at a development are prescribed in the town planning scheme of the Municipality and must be provided accordingly.

Parking for mobility impaired persons must be provided according to the requirements of the National Building Regulations or other statutory requirements. Such parking must be located where it will maximize the convenience of the users.

15.3.3. Parking requirements may be reduced for factors such as low vehicle ownership, transit availability and shared parking. These factors, however, must be used with circumspect since inadequate parking provision could lead to the problems described above. Where parking requirements are reduced, consideration should be given in reserving space on-site which could in future be converted to parking spaces should parking problems materialise.

15.3.4. Parking may also be reduced in multi-use developments when the peak parking demand for the different land-uses occurs at different hours or days of the week and parking can be shared between different developments. Parking can be shared when the parking spaces are specifically dedicated for use by visitors and when the parking is located within reasonable walking distances from the developments. The methodology for the determination of parking reduction is provided in the South African Trip Data Manual (2010).

## 15.4 Parking bay dimensions

15.4.1. The design and dimensions of parking bays must comply with the requirements of the Parking Standards of the Department of Transport (1985), subject to the requirements of this section

15.4.2. Parking may be provided with a non-interlocking or locking layout as shown in Figure 23. The layout without interlocking applies when the parking is provided against a wall of other similar obstruction, while the interlocking layout apples when the two opposite rows of parking are provided. Dimensions for the different parking bay layouts are provided in Table 45.

When head-on parking is provided along a pedestrian sidewalk, kerbing must be used to protect the sidewalk. A very low kerb not higher than 75 mm can be used to serve as a wheel stop, in which case the sidewalk must be widened by 0.8 m to accommodate the front overhang of the vehicle. The length of the parking bay may be reduced correspondingly (Stover and Koepke, 2002).

Maximum gradients over parking bays, aisles and ramps are provided in Table 46. Where roadways link to a ramp, a transition grade must be provided of half the ramp grade over a blending distance of 2.6 m for gradients of less than 10% and 3.6 m for gradients of 10% or more.

15.4.3. Maximum ramp widths are provided in Table 47. The minimum radius for the outer edge on a one-way circular ramp should not be less than 10.0 m.

15.4.4. The vertical clearance in parking areas (clear ceiling height) may not be less than 2.1 m, but a clearance of 2.3 m is required to accommodate combi's and panel vans.

## 15.5 Parking bay and module design

15.5.1. The following requirements are applicable to the design of parking bays:

a) All parking bays should be individually accessible.

b) Where required, design vehicle turning templates must be used to test vehicle manoeuvring in areas where it may be difficult to access a parking area. The reversing distance should not exceed a maximum of 20 m.

c) Parking vehicles must be able to turn within the parking areas and no reversing should be allowed onto off-site roads (reversing may be allowed onto on-site roads).

d) Sufficient sight distances must be available at all locations within the parking areas as well as at accesses to the parking areas. Particular attention must be given to sight distance requirements of pedestrians walking through parking areas.

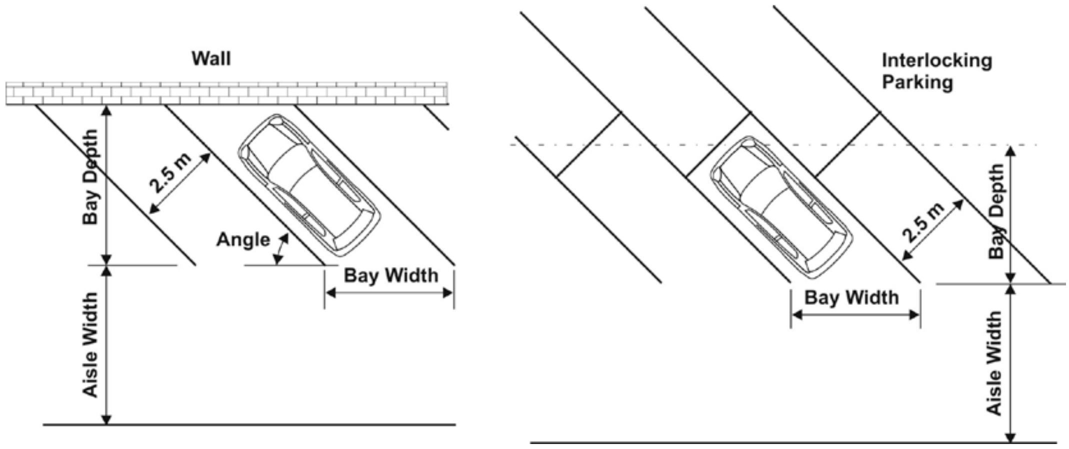



**Figure 23 Parking bay layout**

**Table 45 Parking bay dimensions**

| Bay Angle | Bay* Width (m) | Bay depth (m) | | Aisle width (m) | |
|---|---|---|---|---|---|
| | | No interlock | Interlocked | Two-way | One-Way |
| $90^o$ | 2.5 | 5.0 | 5.0 | 7.5 | 7.5 |
| $60^o$ | 2.9 | 5.3 | 4.8 | 5.2 | 4.4 |
| $45^o$ | 3.5 | 4.9 | 4.2 | 5.2 | 4.2 |

(*) Add 0.35 m for parking bays adjacent to a wall.

**Table 46 Parking bay maximum gradients**

| Description | Preferred maximum (%) | Maximum gradient (%) |
|---|---|---|
| Parking bays – Longitudinal | | 3 |
| Parking bays – Cross-slope | 4 | 5 |
| Aisles – Longitudinal | 4 | 5 |
| Ramps – Excluding final 5 m | 10 | 15 |
| Ramps – Final 5 m of ramp length | 4 | - |

**Table 47 Minimum ramp widths**

| Description | Maximum ramp width (m) | |
|---|---|---|
| | With sidewalks and kerb | Without sidewalks & kerb |
| Straight one-lane ramps | 3.5 | 3.0 |
| Straight two-lane one-way ramps | 6.0 | |
| Straight two-lane two-way ramps | 7.0 | |
| Circular one-lane ramps | | 4.5 |

15.5.2. Parking modules must be designed in accordance to the following requirements (Stover and Koepke 2002):

a) Parking modules should as far as possible be orientated perpendicular to building entrances to minimise random pedestrian movements between parked cars.
b) Aisle lengths should not exceed 100 m without a break for circulation. Such breaks are required for a more efficient search pattern for parking spaces and reducing a concentration of vehicles in parking areas.
c) The layout of parking modules must prevent high-speed diagonal movements. The preferred practice is to provide landscaped strips to prevent such movements. It is recommended that such strips should be provided at every third parking module.
d) Landscaped areas should be provided in parking areas to break up the expanse of pavement and to mitigate the heating impact of such areas. It is recommended that between 10 to 15% of the paved area should be landscaped. Such landscaping should also be provided as a buffer between the parking area and adjacent streets.

## 15.6 Parking end islands

15.6.1. End islands must be provided between parking module and site circulation roadways to ensure that sight distances are available and to protect vehicles parked in the last parking bays. The islands must be kerbed and landscaped to prevent unauthorised parking, but care must be taken that the landscaping does not affect sight distance. The island should be semi-circular to discourage illegal parking.

15.6.2. End islands that are designed to accommodate the turning radii of passenger vehicles tend to be very large and therefore not practical. A more practical design is shown in Figure 24. The design requires drivers to make wide turns when entering into or exiting from a parking module, but this is acceptable in parking areas. Turning templates must be used to check whether sufficient space is available to make such turns.

15.6.3. The end island design includes a narrow paved area adjacent to the parking bay to avoid trampling of the ground cover. The height of the kerb should not be higher than 100 mm to facilitated exiting and entering of the vehicle.

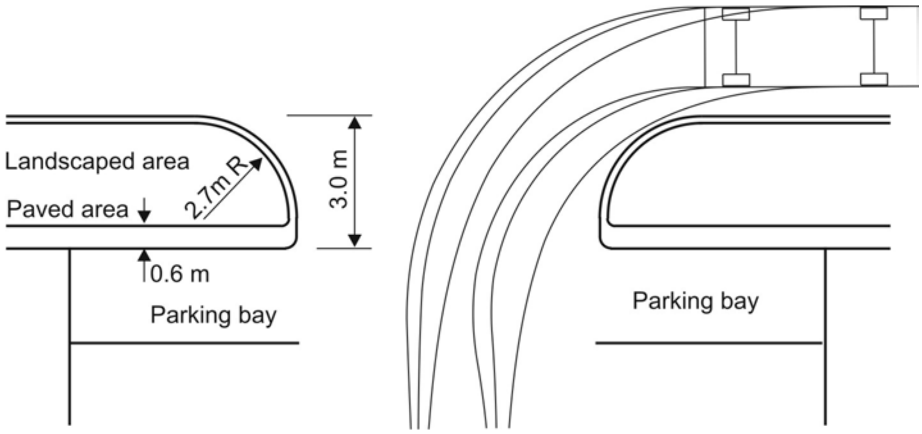



**Figure 24 Parking end islands (Stover and Koepke, 2002)**

## 15.7 Parking area pavement

15.7.1. All parking areas, except those that are infrequently used, must be paved with suitable materials. Such material may include, but is not limited to, the following:

a) Impermeable pavements such as asphalt, concrete or concrete blocks.

b) Permeable pavements such as porous asphalt, porous concrete or open-jointed concrete blocks.

15.7.2. Grass surfacing or grassed pavers may be used and are recommended in parking areas that are infrequently used provided that irrigation systems are provided and the surfaces are adequately maintained. Infrequent parking includes visitor parking in residential developments and parking at developments such as churches and sport stadiums.

15.7.3. Where trees are provided in parking areas, concrete rings must be used to protect the trees.

# 16 Drop-off and Pick-up Facilities


## 16.1 Introduction

16.1.1. Drop-off and pick-up facilities should be provided at all developments where there may be a need for such facilities, such as schools, transit stations, etc. Such facilities are also important to support ridesharing as a mode of transport.

16.1.2. An assessment of proposed drop-off and pick-up facilities must be made during Site Traffic Assessments.

## 16.2 Development drop-off and pick-up facilities

16.2.1. Where drop-off and pick-up facilities are provided on a development site, the location and design of the facilities should be aimed at encouraging the use of such facilities.

16.2.2. The facilities should be located within an acceptable walking distance from the development. Such walking distances should preferably not exceed a maximum of between 100 and 200 m.

16.2.3. Provision should also be made for fast and convenient vehicular access to the facilities. In the facility, provision should be made for dropping off as well as picking up of persons. Picking up may require the provision of some short-term parking facilities.

16.2.4. On Class 4 and 5 roads at small developments where the access volumes are relatively low, the facilities may be provided on the access throat to the development. Provision can be made for dropping off by both private and public transport vehicles. Short-term parking can also be made available to serve as a pick-up facility.

## 16.3 School drop-off and pick-up facilities

16.3.1. Schools typically involve a significant amount of dropping-off and picking-up by both public and private vehicles. Particular care must therefore be given to ensure that the school circulation system will operate efficiently and safely.

16.3.2. The following are a number of important considerations in the provision of drop-off and pick-up facilities at schools (Texas Transportation Institute, 2003):

a) Separate different modes of transport in order to accommodate each mode more efficiently and safely. This applies particularly to pedestrian, bicycle and motorised modes of transport, but also to public and private modes of transport.

b) Provide a network of pedestrian walkways and crossings that will minimise conflicts with vehicles and the number of times pupils cross paths with vehicles.

c) Drop-off and pick-up areas for both public and private transport vehicles should ensure one-way operation in a clockwise direction so that pupils exit and enter vehicles from the left hand side of vehicles. Pupils should not have to walk between vehicles.

d) The preferred method of staging both public and private transport vehicles is “single-file left wheel to the kerb” so that pupils are not required to pass between vehicles. Parking bays on the right hand side of the circulatory road results in pedestrian-vehicle conflict and should be avoided. Two lanes should be provided, one for stopping and the other for passing.

e) Short-term parking should be provided separately from the drop-off and pick-up area for use by persons requiring an extended period of time to drop-off or pick-up. Picking-up and dropping-off in parking areas should be avoided because of the conflicts created between vehicles and pupils.

f) Drop-off or pick-up design should not require reversing of vehicles, except to vacate a parking bay.

An example of a drop-off and pick-up areas incorporating some of the above requirements are provided in Figure 25. The design provides for a one-way clockwise circulation system around a short-term parking area. Dropping off and picking up occurs on the outside edge of the area and pupils therefore do not have pass between vehicles.

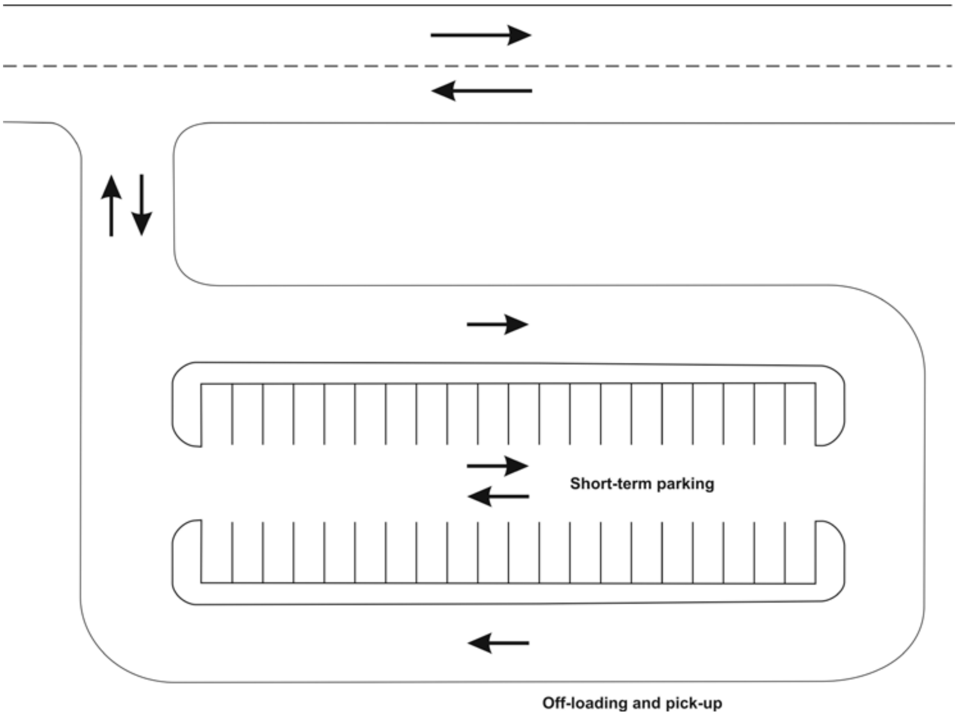



**Figure 25 Example of a school drop-off and pick-up area**

# 17 Deliveries and Refuse Collection


## 17.1 Introduction

17.1.1. The delivery of goods and collection of refuse is a basic but essential transportation function. Facilities for these services should be designed to be as convenient, efficient and safe as possible.

17.1.2. The requirements provided in this chapter were derived from the references listed below. These documents may be consulted if more information is required.

a) Department of Transport (1983). Guidelines for Off-Street Loading Facilities.
b) Department of Transport (1985). Parking Standards (2nd Edition).
c) Stover and Koepke (2002) Transportation and Land Development.

17.1.3. An assessment of delivery and refuse collection facilities must be made during Site Traffic Assessments.

## 17.2 On-street facilities

17.2.1. On-street loading and off-loading could significantly affect the efficiency of the road system as well as traffic safety, particularly on higher order roads. On lower order roads, however, it may be possible to provide some limited on-street services. On-street loading, off-loading and refuse collection facilities must therefore be provided as follows:

a) No facilities whatsoever may be provided on Class 1 roads.
b) Urban Class 2, 3 and 4a roads. No loading and off-loading facilities may be provided on-street and all facilities must be provided on-site in accordance with the requirements of this manual. Vehicles must be able to turn on site and no reversing must be allowed onto or from the road system.
c) Urban Class 4b, 5a and 5b roads. Loading, off-loading and refuse collection at residential developments may be allowed on-street. For other developments, facilities should be provided on-site. On driveways that carry less than 50 vehicles in the peak hour, vehicles may reverse in or out of the site, provided that the reversing distance is restricted to a maximum of 30 m.
d) The practice of on-street loading in industrial areas is out-dated and provision must be made for on-site loading and off-loading. Provision must be made for vehicles to turn around on site and no reversing from or onto the road network shall be permitted.

17.2.2. On rural roads, delivery and refuse collection facilities must be provided on-site and no reversing must be allowed onto or from the road.

## 17.3 Service accesses and roads

17.3.1. Where off-loading occurs on a development site, the service accesses and roads must comply with the requirements for driveways provided in Chapter 9 of this manual.

17.3.2. The provision of accesses to the site as well as the site circulation system should ensure minimal interaction between service vehicles and other traffic. The service accesses and roads should be designed to discourage use by other traffic.

17.3.3. The layout for service roads should be such that vehicles circulate in a clockwise direction. Making right-hand turns with heavy vehicles will enable drivers to see the tail of the vehicle more easily.

## 17.4 Loading docks

17.4.1. Sufficient loading docks and on-site overflow parking must be provided to accommodate the maximum number of delivery vehicles expected to be on-site at any time. The overflow parking is used to accommodate heavy vehicles when all loading docks are occupied or to provide a waiting area in situations where specific service times are allocated to individual vehicles.

17.4.2. A methodology is provided below that can be used to determine the number of loading docks and parking spaces required at a development. The methodology requires as parameters the delivery vehicle trip generation rate and service times at a development.

17.4.3. Delivery vehicle trip rates and average service times are provided in Table 48 for a number of general land uses. The rates are given per 100 $m^2$ Gross Leasable Area (GLA). The inbound split is the proportion of the trip generation rate that arrives at the service area.

17.4.4. The parameters provided in the table may vary widely for a given land use depending on the logistics involved in the deliveries. The parameters provided in the table are therefore only indicative and should be adjusted for particular developments. In critical situations, the parameters may be determined by means of observations at other similar developments.

**Table 48 Delivery vehicle trip generation rates and service times**

| Land-Use | Peak hour trip generation rate/100 $m^2$ | Inbound Split | Average service time per vehicle (min/veh) |
|---|---|---|---|
| Offices | 0.04 | 0.50 | 27 |
| Retail | 28 $GLA^{-0.537}$ | 0.50 | 20 |
| Hyperamas | 28 $GLA^{-0.537}$ | 0.50 | 33 |
| Industrial | 0.004 | 0.50 | 38 |

Department of Transport (1983)

17.4.5. The number of loading bays and parking spaces is determine for a 90% probability that a vehicle will find an available loading dock or parking area. There is thus a 10% chance during the peak hour that a vehicle will have to wait outside the delivery area.

17.4.6. The methodology for the determination of the number of facilities requires that a traffic ratio over all facilities must be calculated by means of the following formula:

Traffic ratio = 100 x Split x Trips x Service time/60

In this formula, “split” is the inbound split while “trips” is the total trips generated during the peak hour. The total number of trips is obtained by multiplying the GLA with the trip rate per 100 $m^2$ GLA (and dividing by 100). Note that the traffic ratio is calculated as a percentage.

17.4.7. The required number of loading docks and parking spaces can be determined from Table 49 for the calculated traffic ratio. A combination of number of loading docks and number of parking spaces must be selected so that the calculated traffic ratio is smaller or equal to the ratios provided in the table. The table was derived for a multi-channel M/M/N queuing system.

## 17.5 Delivery vehicle composition

17.5.1. The total number of loading docks and parking spaces may provide for a mix of design vehicles, thus allowing the provision of smaller and larger loading docks and parking spaces to accommodate the various sizes of vehicles.

17.5.2. Typical delivery truck compositions are provided in Table 50. The composition may be adjusted for specific developments. In critical situations, the composition may also be determined by means of observations at other similar developments.

## 17.6 Loading dock design

17.6.1. Loading docks may be provided as side or rear loading. Rear loading is more efficient than side loading and should therefore be provided for larger developments. Side loading facilities may be provided for small developments.

17.6.2. The loading docks must consist of two areas, namely a loading berth and a manoeuvre apron as shown in Figure 26. The loading berth is the area in which the vehicles park while the apron is used for reversing into the loading berth. Such reversing may be allowed from the service road.

17.6.3. The minimum dimensions of loading berths and manoeuvre aprons are provided in Table 51 for different types of delivery vehicles. Provision is made for berths angles of $90^o$, 60 and $45^o$. Where $60^o$ and $45^o$ berths are used, operations must be one-way.

**Table 49 Number of loading docks and parking spaces**

| No of loading docks | Traffic Ratio (Percentage) for different Number of Parking Spaces | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 32 | 46 | 56 | 63 | 68 | 72 | 75 |
| 2 | 83 | 105 | 121 | 132 | 141 | 147 | 153 |
| 3 | 142 | 170 | 189 | 204 | 215 | 225 | 232 |
| 4 | 207 | 238 | 261 | 278 | 292 | 303 | 312 |
| 5 | 276 | 309 | 335 | 354 | 371 | 383 | 394 |
| 6 | 347 | 383 | 410 | 432 | 449 | 464 | 476 |
| 7 | 421 | 458 | 487 | 511 | 530 | 545 | 559 |
| 8 | 495 | 534 | 566 | 590 | 611 | 628 | 642 |
| 9 | 572 | 612 | 644 | 671 | 693 | 711 | 726 |
| 10 | 650 | 691 | 725 | 752 | 775 | 794 | 810 |
| 11 | 728 | 771 | 805 | 834 | 858 | 878 | 895 |
| 12 | 808 | 851 | 887 | 917 | 941 | 962 | 980 |
| 13 | 888 | 932 | 968 | 1000 | 1026 | 1047 | 1066 |
| 14 | 969 | 1014 | 1051 | 1084 | 1110 | 1133 | 1152 |
| 15 | 1052 | 1097 | 1134 | 1167 | 1194 | 1218 | 1238 |
| 16 | 1133 | 1179 | 1218 | 1251 | 1280 | 1304 | 1325 |
| 17 | 1215 | 1263 | 1302 | 1336 | 1365 | 1389 | 1411 |
| 18 | 1300 | 1346 | 1386 | 1420 | 1451 | 1476 | 1498 |
| 19 | 1383 | 1431 | 1471 | 1507 | 1537 | 1562 | 1585 |
| 20 | 1468 | 1516 | 1556 | 1592 | 1622 | 1650 | 1672 |
| 21 | 1552 | 1600 | 1642 | 1678 | 1709 | 1737 | 1760 |
| 22 | 1637 | 1685 | 1727 | 1764 | 1795 | 1824 | 1848 |
| 23 | 1723 | 1771 | 1815 | 1852 | 1884 | 1911 | 1937 |
| 24 | 1807 | 1858 | 1901 | 1937 | 1970 | 1999 | 2026 |
| 25 | 1893 | 1942 | 1988 | 2025 | 2058 | 2088 | 2112 |
| 26 | 1979 | 2031 | 2072 | 2111 | 2145 | 2176 | 2202 |
| 27 | 2065 | 2117 | 2160 | 2198 | 2233 | 2263 | 2290 |
| 28 | 2153 | 2204 | 2248 | 2288 | 2321 | 2352 | 2380 |
| 29 | 2239 | 2291 | 2335 | 2375 | 2410 | 2439 | 2468 |
| 30 | 2325 | 2376 | 2424 | 2463 | 2499 | 2529 | 2556 |

**Table 50 Delivery vehicle composition**

| Land-Use | % LDV | % SU Truck | % WB-15 |
|---|---|---|---|
| Offices | 85 | 15 | 0 |
| Retail | 30 | 65 | 5 |
| Hyperamas | 30 | 65 | 5 |
| Industrial | 30 | 40 | 30 |

Department of Transport (1983)

**Table 51 Loading dock dimensions**

| Design vehicle | Berth angle | Berth depth (m) | Apron depth (m) | Total depth (m) | Berth width (m) |
|---|---|---|---|---|---|
| LDV | $90^o$ | 5.8 | 7.5 | 13.3 | 3.4 |
| | $60^o$ | 5.0 | 4.4 | 9.4 | 3.4 |
| | $30^o$ | 4.1 | 4.2 | 8.3 | 3.4 |
| SU Truck | $90^o$ | 9.2 | 17.9 | 27.1 | 3.7 |
| | $60^o$ | 8.0 | 9.2 | 17.2 | 3.7 |
| | $45^o$ | 6.5 | 6.5 | 13.0 | 3.7 |
| WB-15 | $90^o$ | 16.8 | 21.0 | 37.8 | 3.7 |
| | $60^o$ | 14.5 | 14.0 | 28.5 | 3.7 |
| | $45^o$ | 11.9 | 10.4 | 22.3 | 3.7 |
| WB-20 | $90^o$ | 22.4 | 25.6 | 48.0 | 3.7 |
| | $60^o$ | 19.4 | 18.8 | 38.2 | 3.7 |
| | $45^o$ | 15.8 | 15.3 | 31.1 | 3.7 |

LDV derived from Department of Transport (1983) and Department of Transport (1985)
Other design vehicles derived from Stover and Koepke (2002)

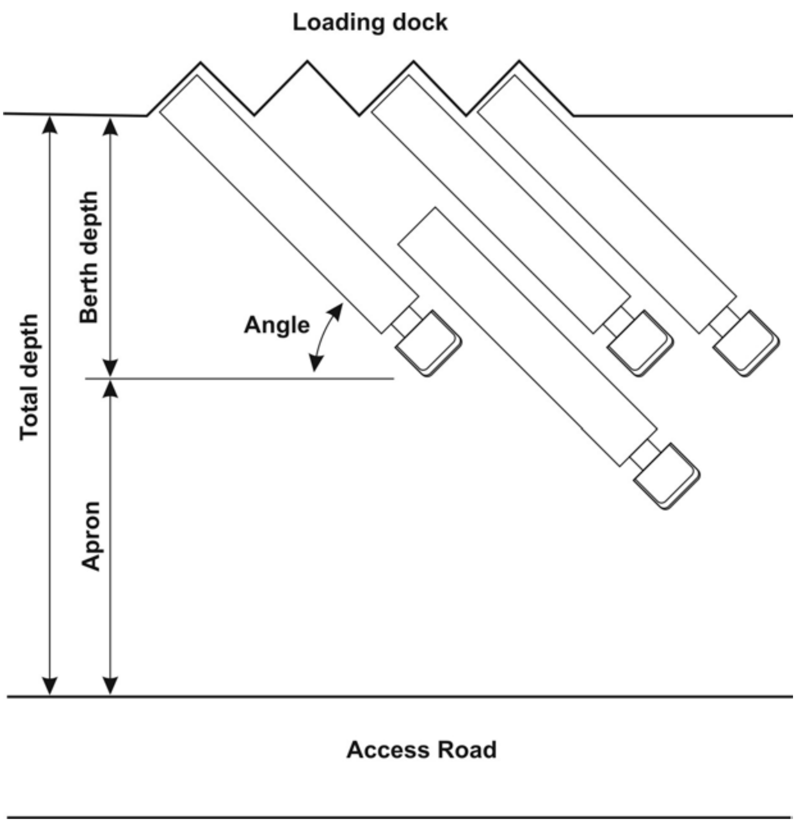



**Figure 26 Loading dock layout**

# 18 Heavy Goods Transport


## 18.1 Introduction

18.1.1. The transport of heavy goods on the road network has a significant impact on traffic operations and safety as well as the environment and the road pavement.

18.1.2. A Traffic Impact Assessment must be undertaken for developments that will require transport of heavy goods. Examples of land uses that typically require such transport and for which such assessments are required include Heavy Industrial/Manufacturing and Mining.

Examples of heavy goods include quarried or mined materials, heavy machinery and heavy products. Mined materials include sand, clay, kaolin, ores and minerals while heavy machinery include machinery used for mining, power generation and the production of goods. Heavy products include bricks, concrete products, refined metals and other similar products.

18.1.3. The assessment must be undertaken for all roads that will be used for the purpose of transporting heavy goods over the full lengths of the trips between origins and destinations (irrespective of the length of the trip (primary and secondary study areas). This may include roads outside the boundary of the Municipality in which the development is located.

## 18.2 Heavy goods transport impact assessment

18.2.1. The following impacts of heavy goods transport must be assessed in the assessment of routes that will be used for such transport:

i) **Capacity analysis**. A capacity analysis must be undertaken on roads where it is likely that the Level-of-Service requirements of this manual cannot be complied with.

ii) **Road Safety**. A road safety assessment (or audit) must be undertaken with the purpose of identifying possible locations where the heavy good transport could significantly affect road safety. Only the specific impact of heavy good transport must be evaluated.

iii) **Road geometry standards**. An assessment must be made of the road geometric standards of the different roads, particularly with reference to the following requirements and standards:

- Two-lane roads must have a total paved width of at least 8 m available, including paved shoulders.
- Climbing lanes should be available at locations were such lanes are warranted in terms of the warrants of the road authority

concerned. Passing or climbing lanes should preferably be available at a spacing of not greater than 8 km.

iv) **Road pavement (paved and gravel)**. An assessment must be made of whether the road pavement will be able to accommodate the heavy vehicle loads. In this assessment, an evaluation must be made of the capacity and policy of the relevant road authority to maintain the road pavement in a serviceable condition. Statements in this regard must be obtained from the relevant authorities and included in the assessment.

v) **Dust**. In situations where gravel roads will be used, an assessment must be made of the impact of dust resulting from the heavy goods transport on vegetation, crops, animals and people that may be affected. Heavy goods transport will only be allowed where such impacts would be minimal.

**vi)** **Road classification.** No heavy goods transport routes may follow Class 4 and 5 roads in both urban and rural areas except where the heavy goods transport will have a minimal impact on traffic operations, road safety and the environment. No heavy goods transport routes may be allowed through or adjacent to residential and other sensitive areas.

18.2.2. In general, heavy transport routes should preferably follow roads on which the above impacts comply with the requirements of this manual. Where this is not possible, recommendations must be made for the implementation of measures that will effectively mitigate the impacts.

# 19 References

American Association of State Highway and Transportation Officials (AASHTO), 2004, A Policy On Geometric Design of Highways and Streets, Washington D.C.

American Association of State Highway and Transportation Officials (AASHTO), 2006,Roaside Design Guide, 3rd Edition, Washington D.C.

Austroads, 1988, Intersections at Grade, Guide to Traffic Engineering Practice, Part 5, Sydney.

Barriclow, P.A. and Jacobson, M.S., 2004, Guidelines for using decision sight distance at signalised intersections near vertical curves, Texas Transportation Institute, Report FHWA/TX-05/0-4084-P2, College Station, Texas.

Box, PC. 2000, Curb Parking Findings Revisited, Transportation Research E-Circular E-C019, Urban Street Symposium, 1999, Dallas, Texas.

Committee of State Road Authorities (CSRA), 1988, Geometric design of rural roads, TRH 17, Pretoria.

COTO, 2012, South African Road Classification and Access Management Manual, TRH 26, Committee of Transport Officials, Pretoria.

COTO, 2012, South African Traffic Impact and Site Traffic Assessment Manual, TMH 16 Volume 1, Committee of Transport Officials, Pretoria.

COTO, 2012, South African Trip Data Manual, TMH 17, Committee of Transport Officials, Pretoria.

Committee of Urban Transport Authorities (CUTA), 1986, Guidelines for the geometric design of urban arterial roads, Draft UTG 1, Pretoria.

Committee of Urban Transport Authorities (CUTA), 1988, Geometric design of urban collector roads, Draft UTG 5, Pretoria.

Committee of Urban Transport Authorities (CUTA), 1989, Geometric design of urban local residential streets, Draft UTG 7, Pretoria.

Committee of Urban Transport Authorities (CUTA), 1990, Guidelines for the geometric design of commercial and industrial local streets, Draft UTG 10, Pretoria.

Department of National Housing, 1994, Guidelines for the Provision of Engineering Services and Amenities in Residential Township Development. Pretoria. Referred to as the “Guidelines for Engineering Services” in this document.

Department of Transport, 1983, Guidelines for off-street loading facilities, Ref No PG1/83, Pretoria.

Department of Transport, 1985, Parking Standards - Second Edition, Report PR 3/85, Pretoria.

Department of Transport, 2002, Pedestrian and Bicycle Facility Guidelines, An Engineering Manual to Plan and Design safe Pedestrian and Bicycle Facilities, Pretoria.

Department of Transport, South African Development Community Road Traffic Signs Manual (SADC RTSM) and the South African Road Traffic Signs Manual (SARTSM), Volumes 1 to 4, Pretoria.

Federal Highway Administration (FHWA), 2010, Roundabouts: An informal Guide, 2nd Edition, NCHRP Report 672, Washington DC.

National Road Traffic Act and Regulations (Act 93 of 1996).

South African National Roads Agency Limited (SANRAL), NRA Geometric design guidelines, Pretoria.

Stover VG and Koepke FJ, 2002, Transportation and Land Development, 2nd Edition, Institute of Transportation Engineers, Washington DC.

Texas Transportation Institute (TTI), 2003, Traffic Operations And Safety At Schools: Recommended Guidelines, Cooner SA, Fitzpatrick K, Wooldridge MD, and Ford GL, Report FHWA/TX-04/4286-2, College Station, Texas.

Transportation Research Board (TRB), 2010, Highway Capacity Manual, Washington DC.

Transportation Research Board, 2003, Access Management Manual, Washington D.C.