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Chapter 7

Cross Section

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Chapter 7 Amendments - September 2004

Revision Register

Issue/ Rev No.	Reference Section	Description of Revision	Authorised by	Date
1		First Issue	Steering Committee	Aug 2000
2	7.2.12	New section	W. Semple	Jan 2001
	7.5.2	Footpaths and Driveways - modification to 2nd paragraph		
3	7.2.8	Modification to 1st paragraph	W. Semple	Feb 2001
	7.10.1	Table 7.18 - modification to notes		
4	7.1.3	Additional definition	Steering Committee	July 2001
	7.2.4	Modifications. Table 7.5 removed		
	7.2.6	Modifications		
	7.2.8	Modifications		
	7.2.10	Modifications		
	7.2.11	Additional dot point		
	7.5.2	Additions		
	7.7.3	Additional subsection		
	7.7.5	‘Sight impaired’ changed to ‘visually impaired’.		
	7.7.6	Additional subsection		
	7.9.2	Figure 7.20 modified. Additions to 3rd paragraph		
	7.9.5	Modifications and additions. Figure 7.21 modified		
	7.9.6	New		
	7.10.1	Additional 2nd paragraph		
	7.10.2	Modifications to 1st paragraph re min. vertical clearance		
	7.10.4	Modifications to Table 7.21		
	7.10.5	Additional paragraph		
	New	Relationship to other chapters		
5	7.2.1	Diagram renumbered as Figure 7.2.1 and referenced in text	Steering Committee	May 2002
	7.2.12	New subsection “Enforcement”. Modifications to Figures 7.2.12.5 to 7.2.12.8		
	7.4.2	Additional text after 3rd paragraph		
	7.4.6	Additional text at the end of 1st paragraph		
	7.5.2	Modifications to Figures 7.7		
	7.9.5	Additional text at the beginning of subsection		
	7.10.1	Additional text after 3rd paragraph		
	7.10.2	Additional text		
	7.10.7	Modifications to Table 7.22		
	7.12	Modifications to Figures 7.27 to 7.29 and 7.32		
	App. 7A	Modifications to diagram		
6	7.3.9	New section - “Change in Shoulder Width”	Steering Committee	July 2002
	7.4.3	Additional text - “Tips for treatment of urban medians”		
	7.7.3	Additional text - limits on crossfall for turning roadways		
7	7.2.4	Inclusion of Chapter no. for reference	Steering Committee	Sep 2004
	7.2.8	Additional text “Parking restrictions at intersections”		
	7.2.11	Correction of section reference number		
	7.2.12	Additional text - “Transit Lanes - Enforcement”		

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Issue/ Rev No.	Reference Section	Description of Revision	Authorised by	Date
7	7.3.1	Correction of table reference number	Steering Committee	Sep 2004
	7.4.3	Additional text - “Urban Roads - Tips for treatment of urban medians”		
	7.4.3	Correction of typical/cross sections reference number		
	7.4.5	Correction to kerb type reference numbers		
	7.4.6	Spelling correction		
	7.4.6	Correction to Typical Cross Section reference number		
	7.5	Modifications to Fig 7.7		
	7.5.2	Correction to text		
	7.5.2	Additional text		
	7.5.2	Removal of reference to Fig 7.14		
	7.5.2	Move text		
	7.6	Additional symbol on Fig 7.12		
	7.6.2	Additional text		
	7.7.1	Spelling correction		
	7.7.3	Additional text - inclusion of Chapter no. for reference		
	7.7	Additional text as 7.7.6		
	7.7.6	Renumbered to 7.7.7		
	7.7.7	Renumbered to 7.7.8		
	7.8	Modification to Fig 7.18(b) - spelling error		
	7.9.1	Correction to kerb type numbers		
	7.9.5	Change of Table 7.9.6 to Table 7.16		
	7.9	Fig 7.21 - correction of dimension in type 3 kerb		
	7.9	Fig 7.21 - Additional note for kerb type 25/26		
	7.9	Fig 7.21 - Additional note for kerb type 18/19/20/21		
	7.9	Fig 7.21 - Removal of kerb types 28 and 29		
	7.9	Fig 7.21 - Rename kerb type 30 to type 28		
	7.9.6	Amendment to table number - “Width Range”		
	7.9.6	Removal of text - “Width Range”		
	7.10.7	Correction to Section number reference		
	7.11.2	Correction to text		
	7.12	Additional text		
	Fig 7.27	Additional note and symbol		
	Fig 7.28	Additional note and symbol		
	Fig 7.29	Additional note and symbol, width correction		
	Fig 7.30	Additional note and symbol		
	Fig 7.31(a)	Additional note and symbol		
	Fig 7.31(b)	Additional note and symbol		
	Fig 7.32(a)	Modifications to diagram		
	Fig 7.32(a)	Change to channel type		
	Fig 7.32(b)	Modifications to diagram		
	Fig 7.32(b)	Change to channel type		
	References	Additional references included		

Chapter 7
Cross Section

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Acknowledgement

This Chapter is based on the Roads and Traffic Authority of NSW Road Design Guide Section 3 - Cross Section. Details of the elements in the Chapter have been modified to suit Queensland practice and conditions, but the structure of the Chapter and much of the text has been adopted from the RTA Guide. The assistance of RTA in developing this Chapter is gratefully acknowledged.

7.1 Introduction

7.1.1 General

The cross section of a road is a vertical plane, at right angles to the road control line, viewed in the direction of increasing chainage, showing the various elements that make up the road's structure. A cross section can show transverse detail from boundary to boundary, detailing the various road components.

The aim of a cross section is to show variations within the design and its interaction with the natural topography. A design should be sympathetic to the natural environment and user expectations, while maintaining a balance between construction, maintenance and operating (including accident) costs.

The major elements of a road cross section are illustrated in Figure 7.1. More extensive details are shown in Section 7.11.

Three factors are fundamental to the use of this section of the Road Planning and Design Manual:

The Total Package

The elements comprising a cross section form part of a package; accordingly, decisions about the dimensions to be adopted for an individual element must recognise the considerable degree of inter-dependence of design considerations that occurs. For instance, decisions on shoulder width can only logically be made in the light of the available sight distance due to vertical and horizontal alignments, the pavement surface treatment, adjoining travel lane widths and predicted traffic volumes and composition. (See also Chapter 10 for coordination with alignment design). A holistic approach has to be taken to the design and the cross section has to be designed in conjunction with the landscape elements (refer Road Landscape Manual, Main Roads 1998).

Relative Costs

For most works the cost of providing the pavement, and its wearing surface, is the most significant factor in the total cost of a road project. It is therefore important to ensure that the width of pavement adopted is the appropriate one for the circumstances. Because pavement materials are expensive, small increases in the width of lanes and shoulders can add significantly to the total cost of the project, even if the percentage increase is relatively small.

Particular care is needed in cases where improvements are being made to roads on the existing formation. Adopting dimensions that will require widening of the formation will cause a large increase in the cost of the work. However, once established on a project, marginal increases in dimensions may not represent a significant increase in the total cost.

Designers should examine the cost of alternatives to ensure that the most cost effective solution is adopted.

Clear Zones

Vehicles run off the road; hence shoulder, verge and batter design must make provision for a clear zone (see Figure 7.1) which will allow an errant vehicle to traverse this area, sustaining minimum damage to itself and occupants (see also Sections 7.5 and 7.6).

The clear zone concept underlines the fact that a reasonably flat, well compacted and unobstructed road side environment is highly desirable, especially on high travel speed roads.

Urban areas have specific problems created by utility poles. However, efforts should still be made to ensure that the appropriate speed related clear zone is provided, especially on new construction. In urban areas, footpaths will provide an adequate clear zone, provided utility poles, sign supports and heavy structures are kept to the rear of the footway, or made frangible, and all planting consists of frangible species. Undergrounding of Public Utility Plant will assist in keeping the footpath clear.

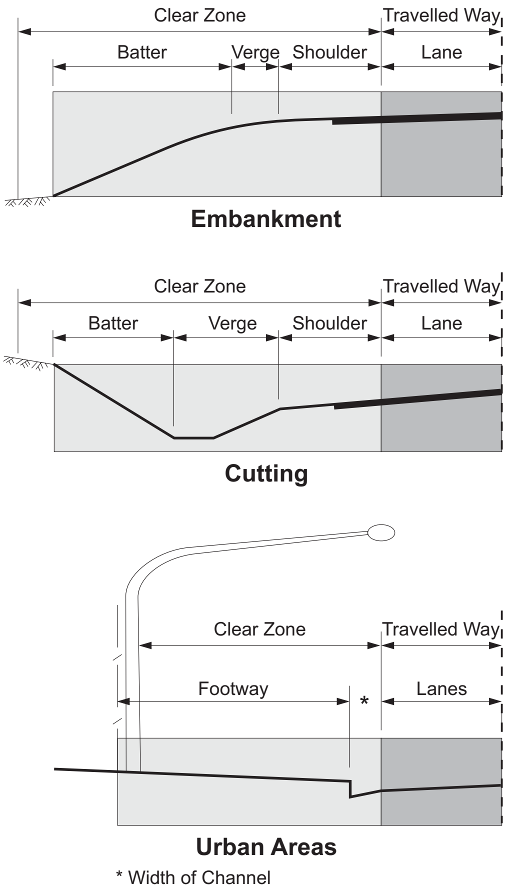

Figure 7.1 Typical Clear Zone

7.1.2 Cross Section Determination

The Flow Chart given as Figure 7.2 details the procedure to undertake in determining the most appropriate cross section to be adopted. References to other sections of the Road Planning and Design Manual are given for assistance.

7.1.3 Terminology

A.A.D.T.

Total yearly traffic volume in both directions, divided by the number of days in the year gives the Annual Average Daily Traffic volume.

Auxiliary Lane

A portion of carriageway adjoining through traffic lanes, used to separate either faster overtaking traffic or slower moving vehicles from through traffic, or for other purposes supplementary to through traffic movement.

Batter

This is the uniform side slope of a cutting or an embankment, expressed as a ratio of 1 unit vertical on X units horizontal.

Batter Drain

A lined open drain for removing stormwater from the top to the toe of the batter in order to reduce scour of the batter face.

Batter Rounding

Curvature that is applied to improve the stability and appearance of the road at the intersection of the extension of the road crossfall and/or existing surface (hinge point), with the batter slope of an embankment or cutting.

Bench

This is a ledge that is constructed on a batter or natural slope for the purpose of providing adequate horizontal sight distance, greater security against batter slippage or to assist with batter drainage.

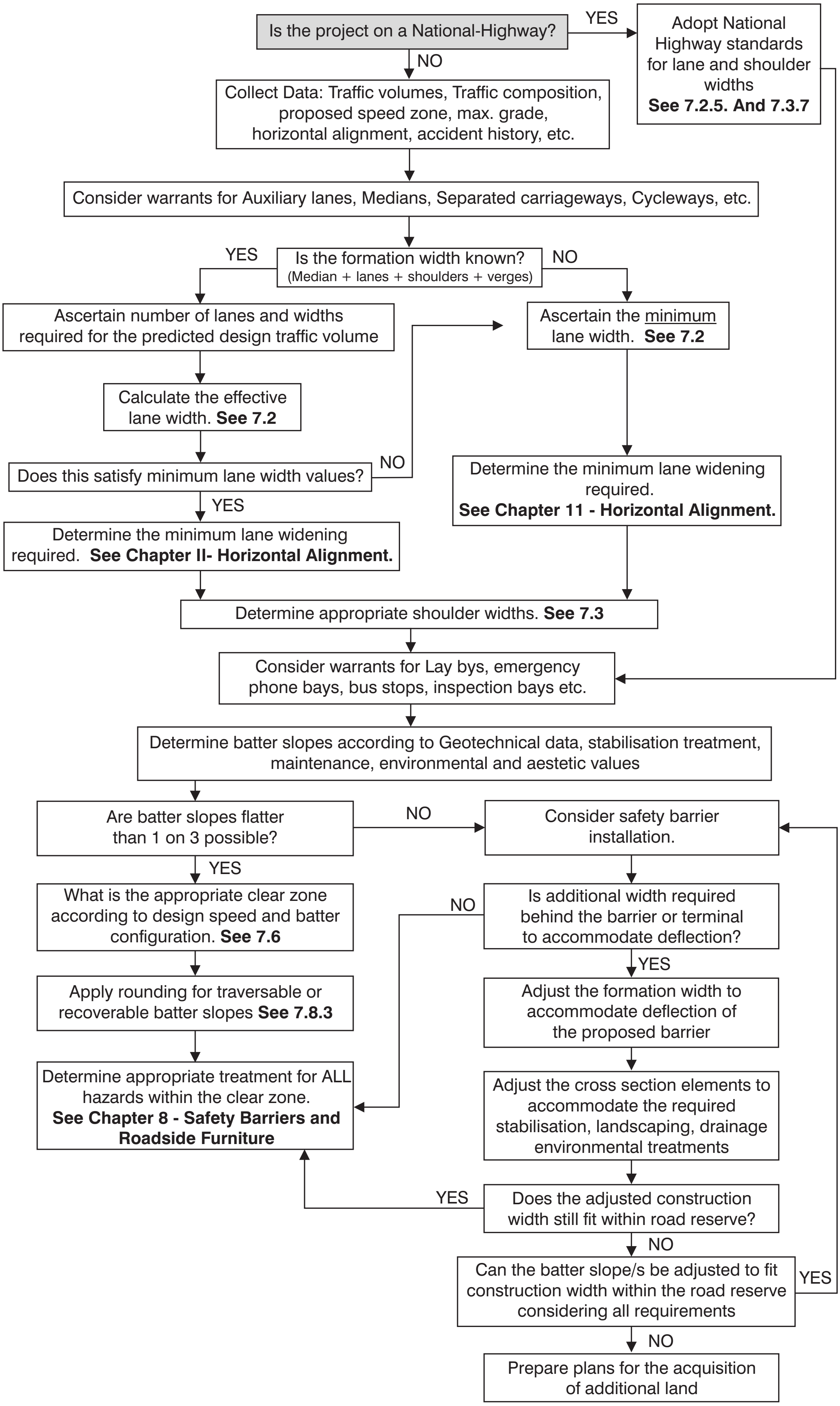

Figure 7.2 Cross Section Determination

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Berm

A ledge formed at the bottom of an earth slope or at some level intermediate between the bottom and the top.

Capacity

The maximum rate of flow at which vehicles can traverse a point or segment of a lane or roadway during a specified time under prevailing roadway and traffic conditions, expressed as vehicles per hour.

Carriageway

That portion of the road formation, including lanes, auxiliary lanes and shoulders that is set aside for the use of vehicles, either moving or stationary.

Catch Bank

A small catch levee constructed along the high side of a cutting to intercept and direct the flow of surface water.

Catch Drain

A surface channel constructed along the high side of a road or embankment outside the batter to intercept surface water.

Clear Zone

This is the border area that begins at the edge of each travelled lane and is available for emergency use by errant vehicles who run off the road. This zone includes any adjoining lane/s, road shoulder, verge and batter.

Crossfall

Expressed as a percentage, this is the cross slope of the road surface at right angles to the road alignment. (Applied for pavement drainage.)

Cross Section

A vertical view made at right angles to the control line, showing the natural ground and the various elements that make up the road's structure.

Curve Widening

Widening is applied, additional to the normal lane width on some curves. This additional width caters for widths of the turning vehicle due to tracking, steering inaccuracies and vehicle slippage.

Cycleway

A separate path or a portion of the road (either shared or exclusive) allotted to the use of cyclists.

Declared Road

Any road in the State of Queensland declared to be a road under the control of the state under the Transport Infrastructure Act 1994.

Design Speed

A nominal speed adopted for the design of the geometric features of the road.

Dyke

A low embankment of earth, asphalt or concrete placed near the edge of embankments to control water movement.

Effective Lane Width

This is the dimension of a lane that is measured from the centre of a lane line to the centre of a lane line or from the centre of a lane line to the face of the kerb.

Footpath

This area is located between the face of the kerb and the property boundary for use by pedestrian traffic, possible bicycle traffic and also for the placement of utility services.

Footway

A pedestrian facility on a bridge.

Hinge Point

The point where the extended crossfall of the verge area meets with the batter slope. This point is associated with rounding where it is applied.

Lane

Part of the roadway set aside for the normal movement of a single stream of vehicles.

Lay Bys

Lay bys are short lengths of widened, sealed shoulder that is provided for the purpose of vehicles to stand clear of the carriageway.

Median

The central strip of road not intended for use by traffic, which separates opposing traffic flows. Median width includes both adjacent shoulders.

Median Cross-over

A sealed section of roadway that is provided between separated carriageways for the purpose of allowing cross-median movements (often for emergency vehicles).

National Highway

High speed route linking the Nation's State capital cities and major provincial centres, as detailed under the National Highway Act of 1986.

Nearside

This is the left hand or kerb side of a vehicle, relative to the direction of travel.

Offside

This is the right hand or median side of a vehicle, relative to the direction of travel.

Outer Separator

This is the portion of road reserve that separates a through carriageway from a service or frontage road.

Parking Lane

Lane primarily used for vehicle parking.

Service Road

A subsidiary carriageway that is constructed between the principal carriageway and the property line, and connected only at selected points with the principal carriageway.

Shoulder

A shoulder is that portion of the carriageway, measured from the outside edge of the outer traffic lane, adjacent to and flush with the surface of the traffic lane. The shoulder excludes any berm, verge, rounding or extra width that is provided for the installation of sign posts, guide posts or safety barriers.

Shy Line

This is the offset to a hazard that a driver perceives to be adequate for his current travel speed adjacent to that hazard.

Split Level Carriageways

Two similarly aligned, separated, and independently graded carriageways.

Superelevation

The continuous transverse slope normally given to the carriageway at horizontal curves.

Table Drain

The drain (lined or unlined) that is located adjacent to the shoulder of the road in cutting, usually having an invert lower than the sub-grade level, and formed as part of the formation.

Terrain

The shape of the natural landscape surrounding a road, broadly classified as follows-

- Easy relatively level terrain, large horizontal radii joined by long straights with cuttings and embankments on average 2m high, with road grades up to 2.5%.
- Average rolling terrain, with cuttings and embankments that are on average 5m high, with road grades up to 5%.
- Difficult mountainous terrain, minimum horizontal radii, where climbing lanes may be required, with cuttings and embankments greater than 10m high and road grades steeper than 5%.

Travelled Way

The portion of the carriageway that is assigned to moving traffic, excluding shoulders and parking lanes.

Traversable Batter

A batter offering errant vehicles safe travel during a run-off-the-road incident, bringing the vehicle to rest in an upright position.

Turning Lane

An auxiliary lane reserved for turning traffic.

Verge

The area located between the outer edge of the shoulder and the batter hinge point, used for the purpose of providing drainage, safety barriers and rounding.

7.2 Lanes

7.2.1 General

The traffic lane is that part of the roadway set aside for the normal one way movement of a single stream of vehicles.

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Traffic lanes carry out a variety of functions important to the overall efficient function of the road hierarchy:

- through road;
- rural or urban;
- special - bus, transit etc.;
- auxiliary (turning or overtaking);
- parking;
- cycleways.

Both the lane width and the road surface condition have a substantial influence on the safety and comfort of users of the roadway. In rural applications, the additional costs that will be incurred in providing wider lanes, will be partially offset by the reduction in long term shoulder maintenance costs. Narrow lanes result in a greater number of wheel concentrations in the vicinity of the pavement edge and will also force vehicles to travel laterally closer to one another than would normally happen at that design speed.

Drivers tend to reduce their travel speed, or shift closer to the lane/road centre (or both) when there is a perception that a fixed hazardous object is too close to the nearside or offside of the vehicle. When there is a perceived fixed hazard there is a movement by the vehicle towards the opposite lane line. The offset of this fixed hazard from the edge of the lane where this reaction starts to be observed is called the “Shy Line”.

The shy line is taken as the distance from the edge of travelled lane to the outer edge of shoulder, provided that there is a significant length of constant width shoulder in advance, or as the distance as shown in Table 7.1, whichever is the greater.

Table 7.1 Shy Line Distances

85th Percentile Speed (km/h)	Shy Line Distance (m) Nearside (Left)	Offside (Right)
≤70	1.5	1.0
80	2.0	1.0
90	2.5	1.5
≥100	3.0	2.0

Depending on the lane configuration and the road alignment, a reduction in lane width/s reduces the lateral clearance between vehicles leading to reduced travel speed and lane capacity. Tables 7.2 and 7.3 show lane capacity reductions according to clearances from lateral fixed hazards.

Table 7.2 Two Lane Roadway

Clearance	Lane Capacity (% capacity of 3.5m lane)			
	3.5m lane	3.3m lane	3.0m lane	2.7m lane
1.8	100	93	84	70
1.2	92	85	77	65
0.6	81	75	68	57
0.0	70	65	58	49

Table 7.3 Four Lane Undivided Roadway

Clearance	Lane Capacity (% capacity of 3.5m lane)			
	3.5m lane	3.3m lane	3.0m lane	2.7m lane
1.8	100	95	89	77
1.2	98	94	88	76
0.6	95	92	86	75
0.0	88	85	80	70

The widths of all lanes adjacent to kerblines exclude the width of the channel.

It must be remembered that the legal width limit of commercial vehicles is 2.5m. The majority of heavy vehicles are built to this maximum width, BUT it does not include the additional 200 mm width on each side of the vehicle generated by wing mirrors.

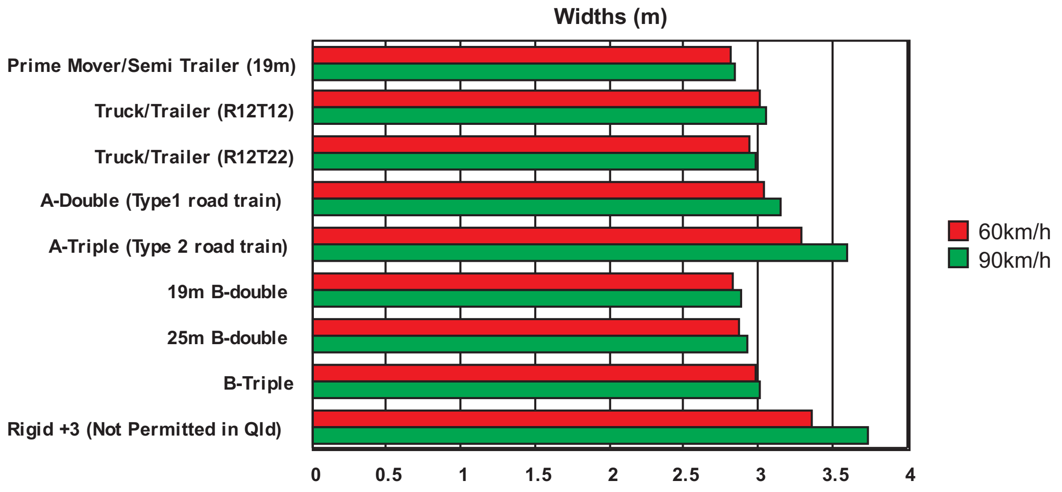


Figure 7.2.1 Minimum Estimated Vehicle Path

ARRB Transport Research was commissioned to develop minimum estimated lane width requirements for various heavy vehicles. Data from this study is presented in the histogram "Minimum Estimated Vehicle Path" (Figure 7.2.1).

This figure does not include a clearance component. Typically an additional 0.5m is added to the given widths to determine the lane width.

These minimum vehicle path width values are based on straight travel, a road roughness of 120 counts/km (NAASRA), average crossfall of 4.5% and two test speeds. This particular combination would be regarded as too extreme for typical situations, but no other data is available at present. Furthermore, a different set of test conditions would need to be considered for roads with geometry other than straight paths.

The research suggests that most vehicles, with the exception of Type 2 road trains or rigid truck plus 3 trailers, could comfortably operate along roads that have a usable lane width of 3.5m, in a speed environment of 90km/h. The operating speed for Type 2 road trains is 80km/h, therefore some reduction of road width requirement from those given could be expected. Generally, past performance suggests that Type 2 road trains can operate adequately in 3.5m lanes with 1m sealed shoulders on straights with 3% crossfall.

7.2.2 Two Lane Two Way Rural Roads

Minimum traffic lane widths for two lane two way rural road applications should be determined from Table 7.4.

Where the intended design speed through mountainous terrain will be in excess of 80 km/h, or 100 km/h in undulating terrain, or where there is a predominantly high percentage of heavy vehicles (20% for 500 AADT and 5% for 2000 AADT), a lane width of 3.5 m is desirable.

Refer to Section 7.2.1 for discussion on various heavy vehicles.

Table 7.4 Guidelines for Traffic Lane Width (Two Lane Rural Roads)

Width of Traffic Lanes		Anticipated AADT at Opening		
		Low Future Growth (<3)%	Reasonable Future Growth (3-6)%	High Future Growth (>6)%
Two Lanes	(6.0)	up to 700	up to 500	up to 300
	(6.5)	700-1700	500-1200	300-900
	(7.0)*	over 1700	over 1200	over 900

* Where local conditions dictate, widths in excess of 7.0m may be considered.

If in using the table, volumes fall near the boundary of groups, consider carefully whether to use higher or lower value.

7

7.2.3 Multilane Rural Roads and Motorways

The lane widths provided on multilane rural roads should be 3.5m. Desirably any rural road consisting of four lanes or more should have a central median, separating opposing traffic flows.

The normal lane width on Motorways is 3.5m. Where a one-way carriageway is three lanes or more, the central lane/s should be 3.7m (see Figure 7.32).

7.2.4 Urban Roads

It is desirable for traffic lanes on urban roads to be 3.5 m wide but if the road reserve is restricted or an on-road bicycle lane is required, the lane width/s may be reduced.

Quite often the designer is faced with the task of "squeezing" an extra lane or bike lane from an existing or partially widened road formation. It has been observed in the Netherlands that where bicycles are mixed with general traffic, either narrow (3.0 to 3.3m) or wide (3.7 to 4.0m) lanes should be used. Intermediate widths (3.5m) tend to be wide enough to encourage cars to pass bicycles, but not wide enough to do so safely. Where bicycles are to be accommodated in the kerb lane, the wider lanes are preferred.

To allocate lane widths on an equitable basis, the differing functions and interfaces of each lane needs to be taken into account.

It should be noted that "effective" lane widths are measured from the centreline of linemarking or from the face of the kerb. See Figure 7.3.

The restrictions encountered will often require lane widths to be reduced to fit the required number of lanes into the available space. These widths can be as low as 3.0m and can vary up to the desired width of 3.5m. The minimum lane widths to be adopted are as follows:

- Straight Alignment — 3.1m for kerbside lanes; 3.0m for other lanes
- Curved Alignment — widening in accordance with Table 11.8 of "Chapter 11: Horizontal Alignment" should be applied.

Where lanes are adjacent to barrier kerbs, it is desirable to locate the kerb at least 0.5m from the edge of the lane to compensate for the tendency of the driver to shy away from the kerb. Usually, the width of the channel is satisfactory for this purpose.

For routes accommodating multicombination vehicles (MCV), allowance has to be made for the size of vehicles and their tracking characteristics. Appendix B sets out the minimum requirements for these routes.

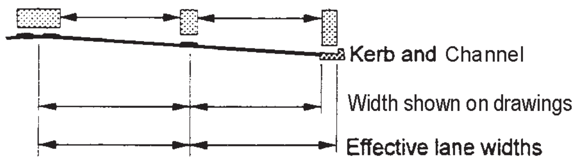


Figure 7.3 Lane Width Notation

7.2.5 National Highways

National Highway design should provide a consistent design form, enhancing a high speed environment in an aesthetically pleasing surrounding. The width of all lanes shall be not less than 3.5m.

7.2.6 Bus Routes

- New construction on roads with bus routes should provide for a desirable kerb lane width of 3.7m and a minimum of 3.3m except where the bus route forms part of the cycle network in which case the minimum kerb lane width will be 4.1m. It may be necessary to take width off other traffic lanes to allow for this. Alternatively, a suitable bicycle route can be dedicated in the same corridor. (Note that buses in Brisbane City occupy 3.15m when mirrors are included.)

- On existing roads with bus routes the following conditions apply:
  1. Kerbside lanes to be marked not less than 3.0m width, from the face of the kerb. Where the lane widths are 3.0 m or less, the kerbside lane should be marked wider than the adjacent lanes to offset the effects of kerbs, channels, power poles and other roadside structures.
  2. Site specific measures to mitigate the effect of the narrow lane should be investigated. These include parking restrictions, median adjustments, indented bus bays and so on.
  3. Discussions should be held with the appropriate Queensland Transport Manager or private bus operator during the planning stage to ensure that arrangements are acceptable.

(See "Guide to Traffic Engineering Practice - Part 11, Parking" (Austroads, 1995b), for bus bays.)

7.2.7 Auxiliary Lanes

For auxiliary lanes other than parking and turning lanes, the lane width should be the same as the adjoining lanes (see Chapter 15, Auxiliary Lanes).

Auxiliary Lanes located on steep grades are to be provided on the offside where analysis shows that they will be cost effective. (See Chapter 15.)

The configuration will require drivers of overtaking vehicles to move to the right, out of the nearside lane. Overtaking vehicles will move to the offside lane, returning to the nearside lane after completing the overtaking manoeuvre. An emergency runoff (sealed hard stand at least 3.0 m wide) is to be provided on the nearside at the end of the merge (see Figure 15.6, Chapter 15).

On some grades, short passing bays are sometimes placed on the nearside of the through lane to allow slow vehicles to pull over. The width is to be the same as the adjacent lane. (See Chapter 15 for details.)

7.2.8 Parking Lanes

Parking Lanes adjacent to urban roads are normal practice. In rural situations, parking lanes are not provided but some provision for parking at rest stops and motorist stopping places may be made - see Chapter 20 for these cases.

In urban roads, the parking lane often fulfils the function of a shoulder as discussed in Section 7.3 but its use is predicated on traffic and service grounds exclusively. It is useful to consider the functions of various types of urban roads to put the decision on the cross section required in context.

Major Routes - Single Purpose

These comprise the through pavements of limited access routes and urban motorways. The road caters for moving traffic and occasional stops and the design parameters are similar to those of rural roads. Traffic lanes and shoulders are provided and rural forms of cross section are acceptable. Parking is not an issue other than providing for stopped vehicles (broken down, fatigue etc.).

Major Routes - Mixed Purpose

These form the bulk of major urban traffic routes. They carry frontage development and hence cater for access movements, parked vehicles and parking and unparking of those vehicles as well as for moving traffic. Design principles differ from those of rural roads. Cross sections include traffic lanes, bicycle lanes and parking lanes (often serving the function of shoulders).

Local Access Roads

The principal design factors relate to property access, property drainage and width between kerbs. Providing for parked vehicles within the cross section is important.

Frontage/Service Roads

These roads are not a separate class but may be either local access or mixed purpose roads. The lowest class of service road provides only for local access (residential access, industrial development, and shopping centres). On major urban corridors in large cities, they can eventually carry significant proportions of traffic other than for local access purposes.

As the through significance of the main pavement of the service road increases, there is a tendency for fewer connections to the rest of the street system. In these cases, the service roads tend to a mixed function status with increasing importance given to other than local accessing traffic. They can ultimately become arterial/collector roads in their own right.

Widths

An exclusive parallel parking lane should be a minimum of 2.5m wide. If a kerb and channel is provided on the road, the width of the channel may be used as part of this minimum width although this is undesirable. This minimum width should only be used in situations where there is no likelihood of the lane being required for traffic purposes in the future and the reduced capacity of the road produced by this arrangement is adequate for the traffic volumes expected.

A parallel parking lane used as a travel lane during peak times, should be the same width as normal urban travel lanes, namely a desirable width of 3.5 m and a minimum of 3.0 m to the lip at the channel. Where bicycles are to use the kerb lane, the desirable minimum width is 3.7m, but a width of 3.5m should be avoided (see 7.2.4).

Shared parallel parking and traffic lanes should be 5.5m wide (3.5 travel lane + 2.0 parking lane to the channel lip) and an additional 1.0 - 1.5m where there is a shared bicycle and parking lane. (Refer to Austroads, 1995b and Chapter 5.) This is the borderline between acceptable and difficult operation.

In areas where frequent parking is combined with reasonable arterial volumes there is merit in putting all spare width into the outer lane/parking lane combination as this is where most of the “frictions” occur. This applies principally to suburban shopping/business areas on arterial roads. In these cases, as speeds tend to be slowed there is merit in reducing through lane widths and using minimum median width between intersections to obtain this additional space.

Where angle parking is adopted, the width and markings defined in the Manual of Uniform Traffic Control Devices should be adopted.

Parking restrictions at intersections

Parking should be designed so as not to interfere with sight distance or impede the flow of traffic turning at an intersection. Regulations prohibit parking within certain distances from the cross road property boundaries.

Table 7.5 indicates the distances over which parking is prohibited at an intersection. Distances given are for both signalised and non-signalised intersections.

7.2.9 Turning Lanes/Turning Roadways and Ramps

The desirable width for turning lanes is 3.2 - 3.5m with a minimum width of 3.0m. The width of right turn storage lanes should be determined in conjunction with median widths. See Chapter 13, Intersections at Grade.

One lane ramps at the interchanges are generally 4.0m wide. If two or more lanes are required, the width of the lanes is to be 3.5m (see Chapter 16).

Table 7.5 Distances over which Parking is Prohibited at an Intersection

<table>
<tr><th></th><th colspan="2">Non-signalised Intersections</th><th colspan="2">Signalised - Major Roads</th><th colspan="2">Signalised - Other</th></tr>
<tr><th></th><th>Approach</th><th>Depart</th><th>Approach</th><th>Depart</th><th>Approach</th><th>Depart</th></tr>
<tr><td>Parallel Parking</td><td>6.0 m</td><td>6.0 m</td><td rowspan="2">100.0 m</td><td rowspan="2">100.0 m</td><td rowspan="2">30.0 m</td><td rowspan="2">15.0 m</td></tr>
<tr><td>Angle Parking</td><td>12.0 m</td><td>9.0 m</td></tr>
</table>

7.2.10 Cycleways

Where bicycle lanes are provided on routes, appropriate widths for shared and exclusive bicycle lanes are given in Chapter 5, which have been derived from "Guide to Traffic Engineering Practice, Part 14 - Bicycles" (Austroads, 1999). See Table 7.6. Exclusive lanes are preferred where space is available.

Table 7.6 On Road Bicycle Lane Widths

Speed (km/h)	Facility	Lane Width (m)
60	Exclusive lane	1.5
80	Exclusive lane	2.0
100	Exclusive lane	2.5
60	Shared with parking lane	4.0*
80	Shared with parking lane	4.5

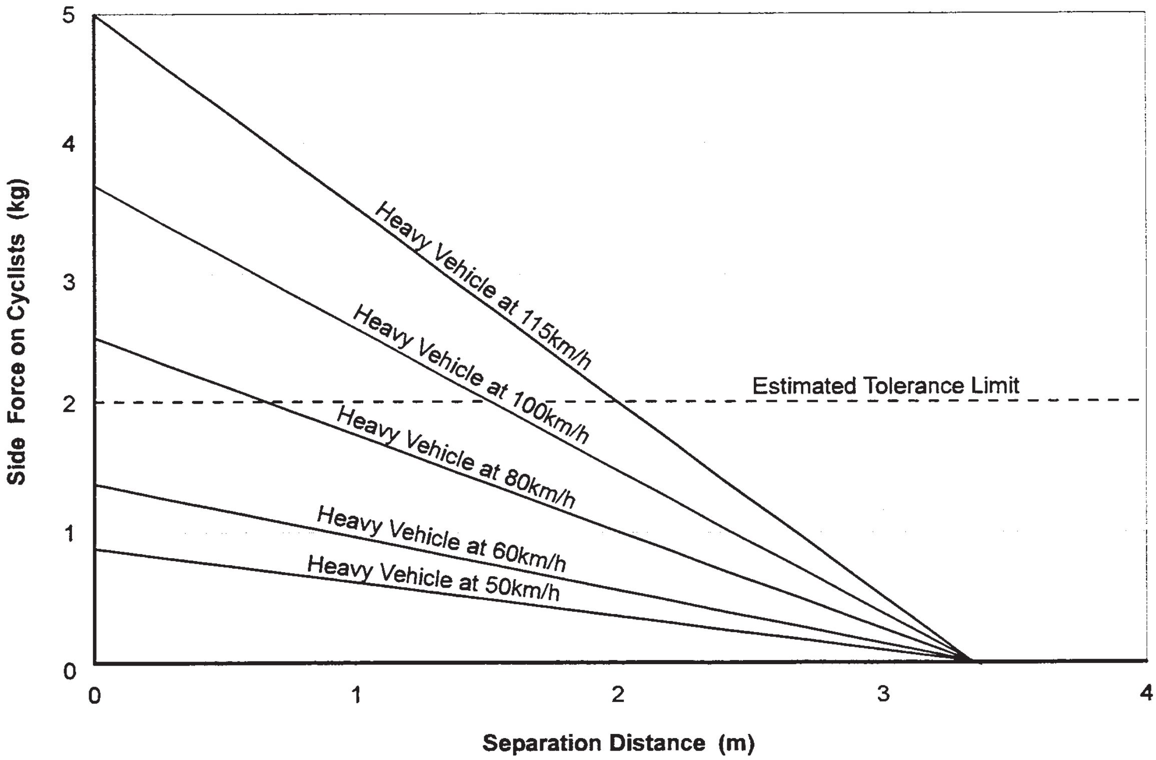
* 4.5m preferred to allow cyclists to avoid opening doors on parked cars.

Figure 7.4 shows the lateral forces which are applied to cyclists when in close proximity to heavy vehicles travelling at speed.

Lane widths that may result in a squeeze point for cyclists should be avoided if possible. On left hand curves, parked cars tend to "truncate" the corner and use up space allocated to cycles in a shared lane. Restriction of parking in these circumstances should be considered.

Cyclists have a legitimate claim to use public roads and provision is to be made for them. They can be on or off the carriageway (i.e. elsewhere within the road reserve or on a separate route). On motorways, cycleways must be separate from the carriageway as required by the motorway legislation.

Elements constructed on the path provided for cyclists are to be designed on the basis that bicycles will have tyres that are a minimum of 20 mm wide (e.g. bicycle safe grates).



Note: Lateral forces may be increased where enclosed roadways (e.g. under bridges) create a "wind tunnel" effect. In these cases, it may be appropriate to encourage cyclists to use the footpath (fencing, signage) to increase the separation distance.

Figure 7.4 Lateral Forces on Cyclists, Induced by Heavy Vehicles

Adjoining furniture is to be free from protrusions that may snag the clothing of cyclists, or cause unnecessary injury in a fall.

Where a safety barrier is erected and there is a warrant to provide additional protection to prevent cyclists suffering injuries from falling over the top of the barrier (such as on bridges with drops of more than five metres), a 75 mm (min.) diameter rail 1400 mm high is to be provided on top of the concrete barrier. The rail must not have potential to spear an impacting vehicle. It is not required where the height of the safety barrier is 1200 mm or higher.

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Where the cycleway is adjacent to guardrail in these conditions, a weld mesh fence 1400mm high should be placed behind the guardrail.

7.2.11 Location of Kerb and/or Channels

In general, kerbs should be avoided in high speed environments. Where they are used, kerb and/or kerb and channel are located outside the travel lanes on both the nearside and offside of the road. A 1.0m offset to the kerb face shall be provided when the design speed is > 80km/h. If the design speed is < 80km/h, an offset of 0.5m is permitted in unlit situations with 0.0 m offset permitted in lit areas. (See Section 7.4.5).

7.2.12 Transit Lanes

Transit lanes are discussed in some detail in Chapter 2. This Chapter deals with the physical layout of various treatments and appropriate dimensions for components.

Design Principles

- Transit lanes should be accompanied by indented bus bays, so through traffic (including express buses) and emergency vehicles can avoid being trapped behind a stopped bus;
- Signal phasing needs to be designed to ensure that bus drivers do not avoid bus queue jump lanes (advance green light for buses) in favour of using the general purpose lanes;
- Bus stops should be placed on the more efficient far side or mid-block locations;
- Designs must accommodate left-turning general purpose vehicles without impeding the flow of through High Occupancy Vehicles (HOVs);
- Queue jumps must be sufficiently long to be practical and must be effectively signed;
- Priority lane signage and pavement marking should be substantially enhanced and designed for high impact;
- Design should support enforcement and must be developed in consultation with the Police;
- The needs of bicyclists should be fully addressed and the synergies between the often-overlapping priority rules for cycling and HOVs should be captured; and
- Transit lanes should be implemented within the context of a network strategy or framework to ensure that they contribute to a treatment long enough to create sufficient time savings to induce modal shift and encourage car-pooling.

Alternative Treatments

Providing priority treatment for HOVs is not a new concept, nor does it necessarily involve radical or unconventional changes to the street system. It can be as simple as putting up some signs designating a certain lane for bus use only during specified hours.

For each case, alternatives are grouped in three categories:

- segment treatments;
- intersection treatments; and
- spot treatments.

There is some overlap, and a single corridor could conceivably use several different treatments over its length, but each alternative can be identified and illustrated as a stand-alone option at this stage. The “do nothing” and “improve general-purpose traffic” options also need to be included when assessing alternatives at the corridor level.

The alternatives are listed below, and are illustrated in Figures 7.2.12.1 to 7.2.12.4. (No distinction is made between use as a T2, T3, or Bus Facility.) The issue of widening versus lane conversion is also not addressed here; it will need to be considered at the individual corridor level. Similarly, care must be taken to distinguish between the priority treatment type and the road type - a kerbside bus lane has the same characteristics no matter what type of road it is on or how the general-purpose lanes are treated. (Reference: PPK, 2000).

Group A: Segment Treatments

A-1: Kerb Lane

A-2: Second Lane

A-3: Median Lane

A-4: Contraflow Kerb Lane

A-5: Contraflow Median Lane

A-6: Single Reversible Median Lane

A-7: Two Way Median Lanes

All of these alternatives are illustrated in Figure 7.2.12.1.

Group B: Intersection Treatments

B-1: Signal Priority	Figure 7.2.12.2
B-2: Queue Jump Lane	Figure 7.2.12.2
B-3: Advance Signal	Figure 7.2.12.2
B-4: HOV Turn Lane	Figure 7.2.12.3
B-5: HOV Grade Separation	Figure 7.2.12.3

Group C: Spot Treatments

C-1: Ramp Meter Bypass Lane	Figure 7.2.12.4
C-2: Priority Link	Figure 7.2.12.4
C-3: Exclusive Ramp	Figure 7.2.12.4

The dimensions of the lanes, medians and separators required for these alternatives should comply in principle with the requirements of this chapter. Some compromise may sometimes be required to accommodate the limited space available on an urban road - the allowable range of dimensions is provided in the relevant parts of this chapter. Typical dimensions of components are shown in the typical cross sections in Figures 7.2.12.5 to 7.2.12.10.

Chapter 5 provides details of the turning requirements for buses and trucks, and discusses the needs of bicycles.

Access

Ingress to and egress from buffer and barrier separated Transit lanes should occur at strategically located openings located sufficiently upstream and downstream of interchange ramps to allow adequate weaving. Typical weaving zone length is 400m located 150m per lane-change from the ramp (see Figure 7.2.12.11).

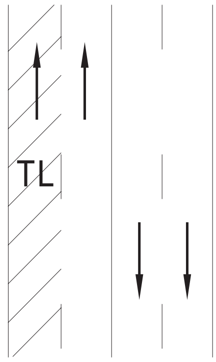
For further details on access requirements, refer to Wilden (1997).

Enforcement

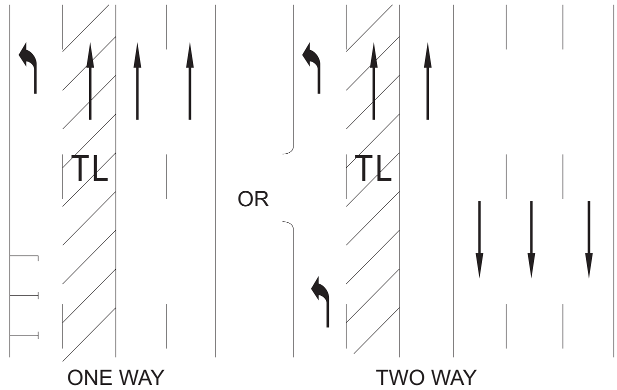
Enforcement of the correct use of transit lanes is required and adequate space to allow safe enforcement activity has to be provided.

This can be achieved by using a continuous 3.5m wide shoulder. This width is required to provide space for the enforcement activity - a lesser width will not be usable. Figures 7.2.12.5 to 7.2.12.8 show typical arrangements for enforcement areas.

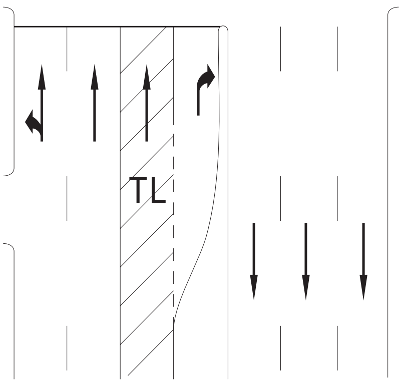
It may be possible to reduce the cost of a continuous 3.5m shoulder by providing intermittent enforcement bays 100m long with appropriate deceleration and acceleration lanes and tapers at each end. The length of the deceleration lane should be based on being able to stop at the start of the bay; the length of the acceleration lane should be based on a start speed of zero at the end of the bay.



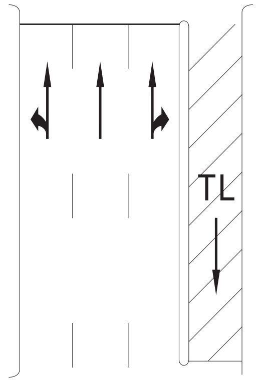
A1: Typical Arrangement,
Kerb Lane HOV Facility



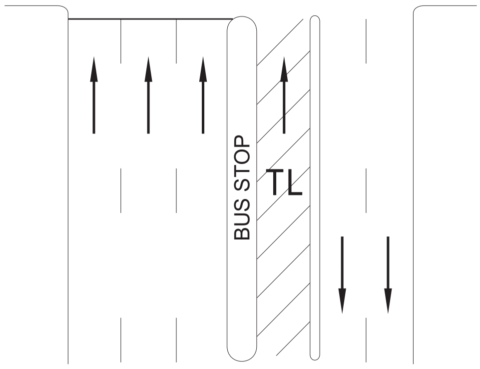
A2: Typical Arrangement,
Second Lane HOV Facility



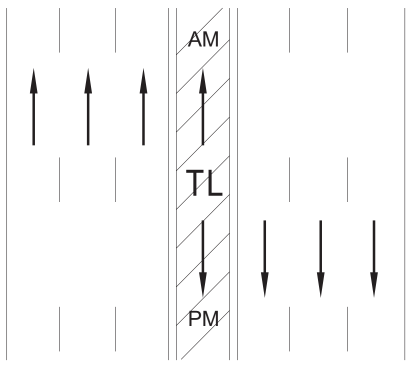
A3: Typical Arrangement,
Median Lane HOV Facility



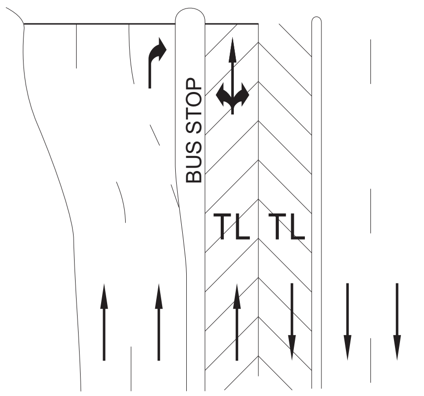
A4: Typical Arrangement,
Contraflow Kerb Lane HOV Facility



A5: Typical Arrangement,
Contraflow Median Lane HOV Facility

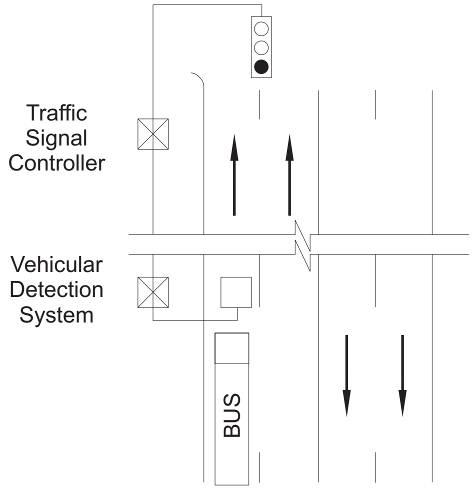


A6: Typical Arrangement,
Single Reversible Median Lane HOV Facility

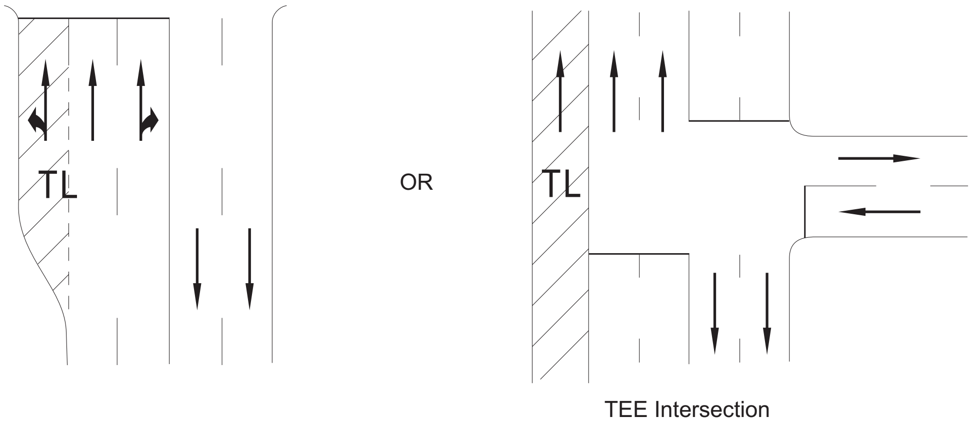


A7: Typical Arrangement,
Two Way Median Lanes HOV Facility

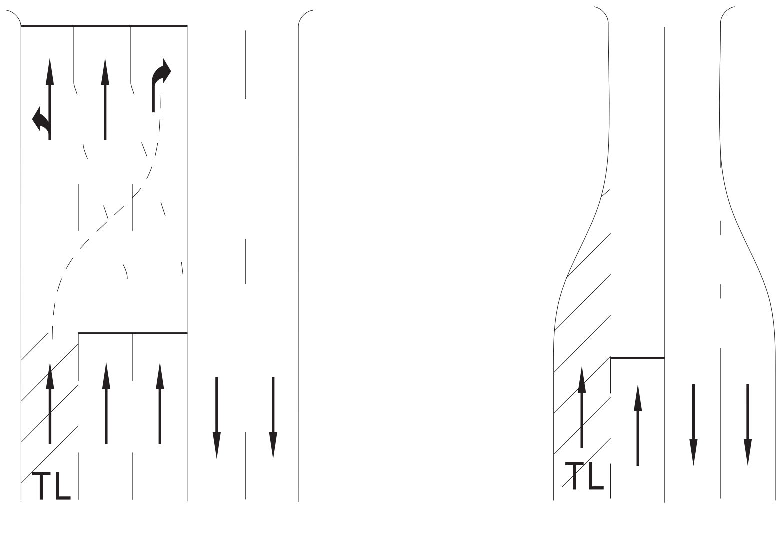
Figure 7.2.12.1



B1: Typical Arrangement, Signal Priority



B2: Typical Arrangement, Queue Jump Lane



B3: Typical Arrangement, Advance Signal

Figure 7.2.12.2

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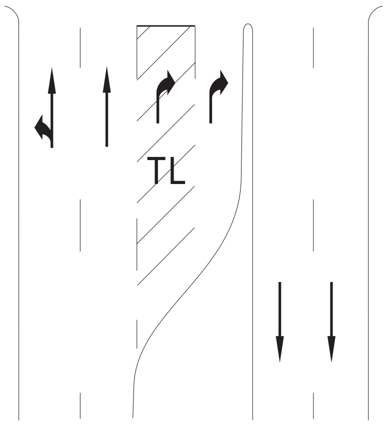
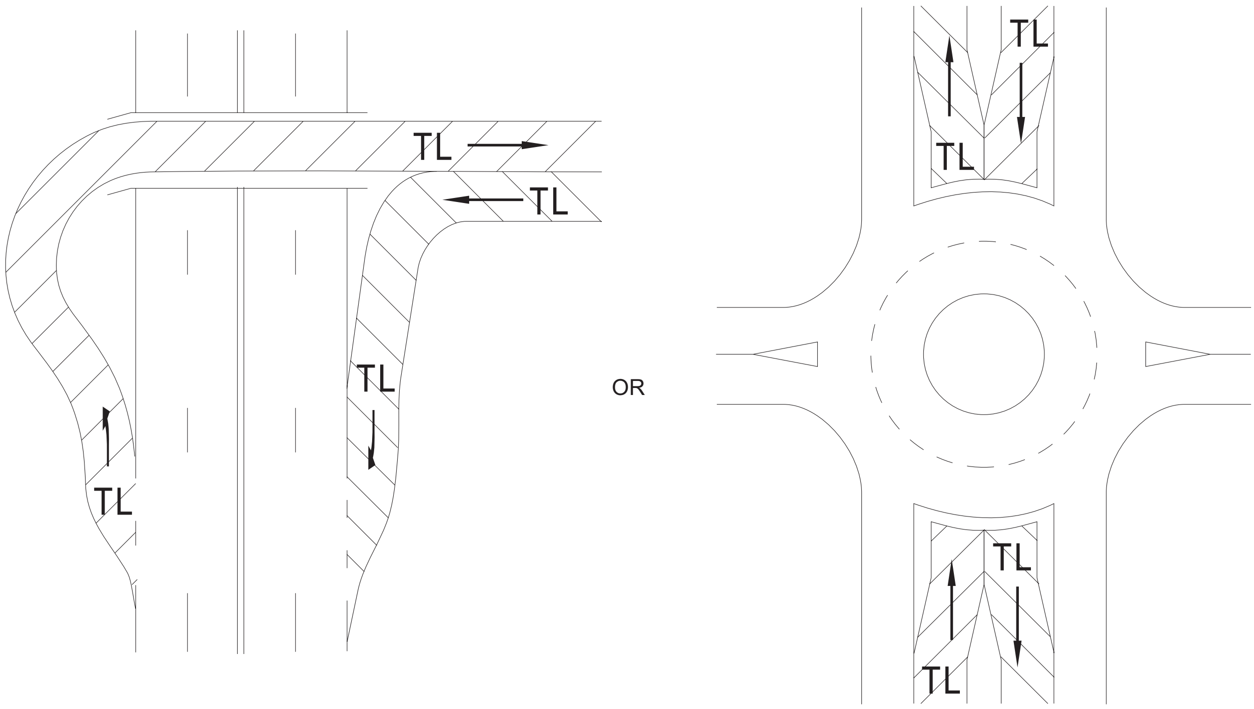
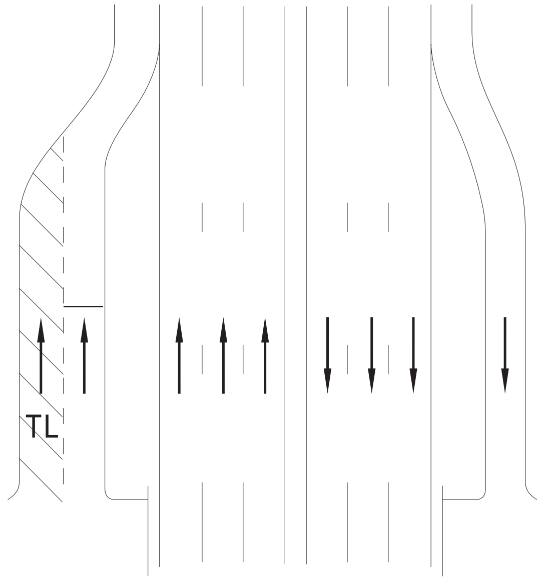


B4: Typical Arrangement, HOV Turn Lane

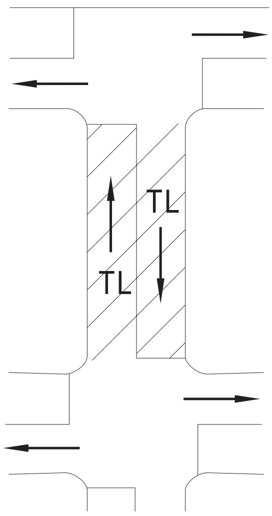


B5: Typical Arrangement, HOV Grade Separation

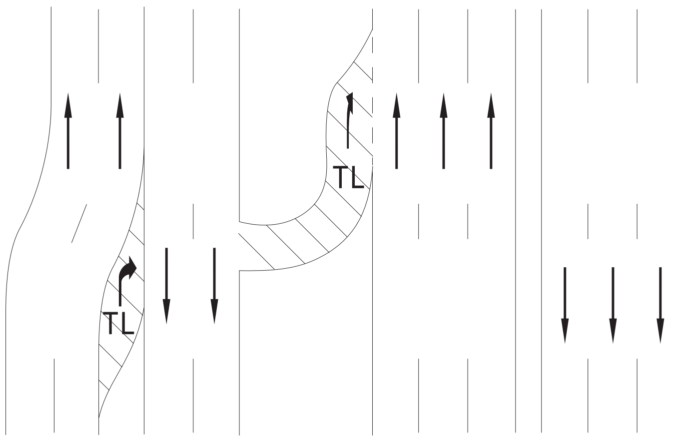
Figure 7.2.12.3



**C1: Typical Arrangement,
Ramp Meter Bypass Lane**



**C2: Typical Arrangement,
Priority Link**



**C2: Typical Arrangement,
Exclusive Ramp**

Figure 7.2.12.4

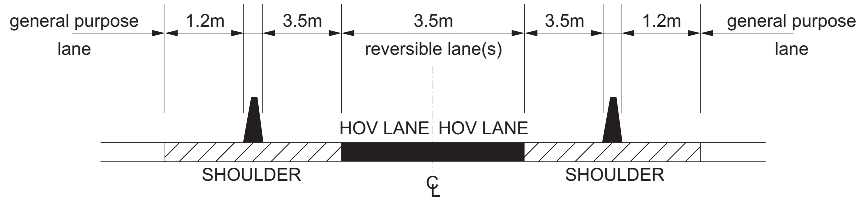


Figure 7.2.12.5 Barrier Separated Reversible Cross Section

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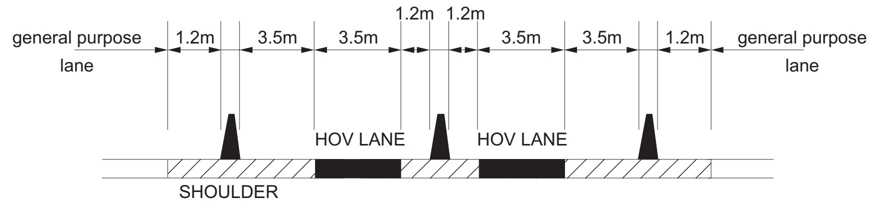


Figure 7.2.12.6 Barrier Separated Two-Way Cross Section

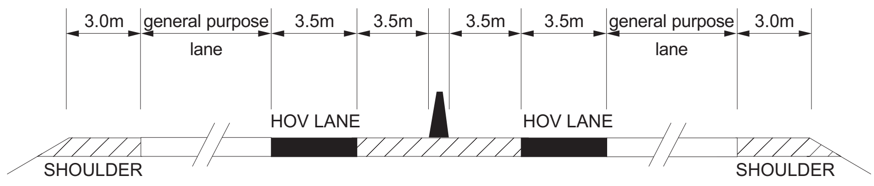


Figure 7.2.12.7 Concurrent Flow - Non-Separated HOV Lanes Cross Section

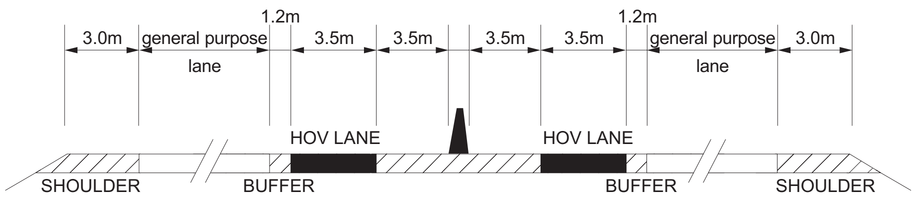


Figure 7.2.12.8 Concurrent Flow - Buffer Separated HOV Lanes Cross Section

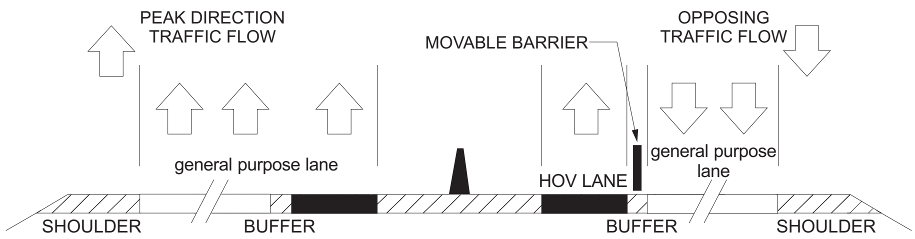
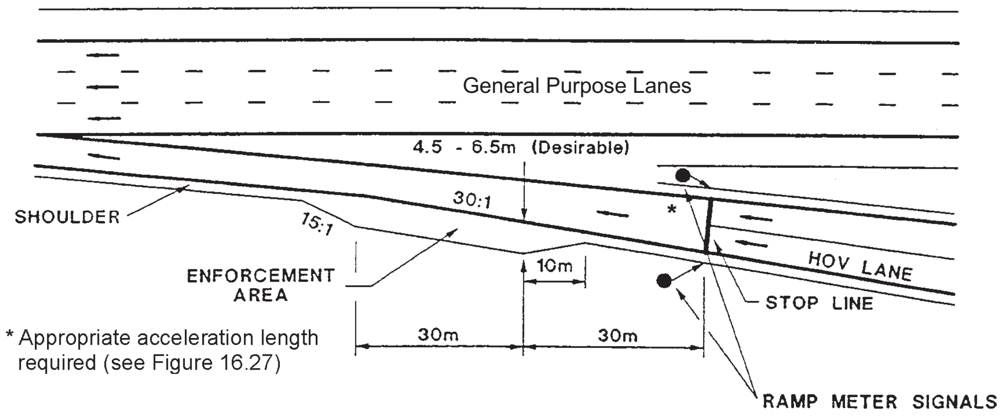
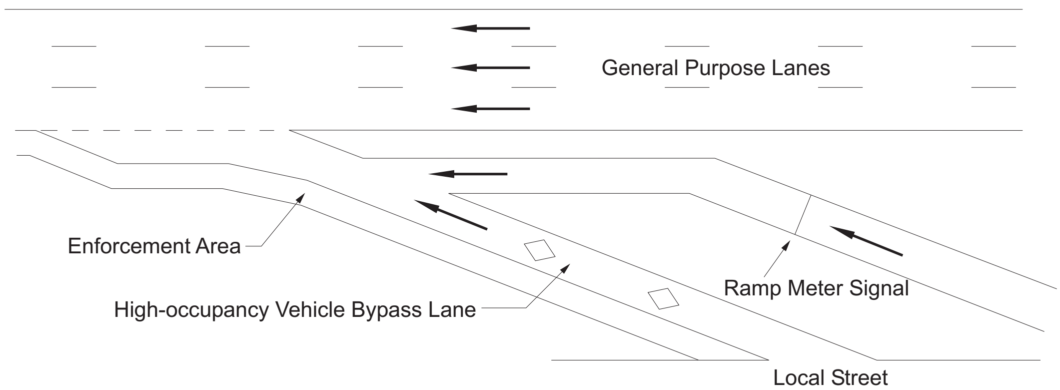


Figure 7.2.12.9 Typical Contraflow Lane Configuration Cross Section



RAMP METERING AND HOV BYPASS LANE



SEPARATED QUEUE BYPASS

Figure 7.2.12.10 Queue Bypass (See also Chapter 16, Figure 16.8)

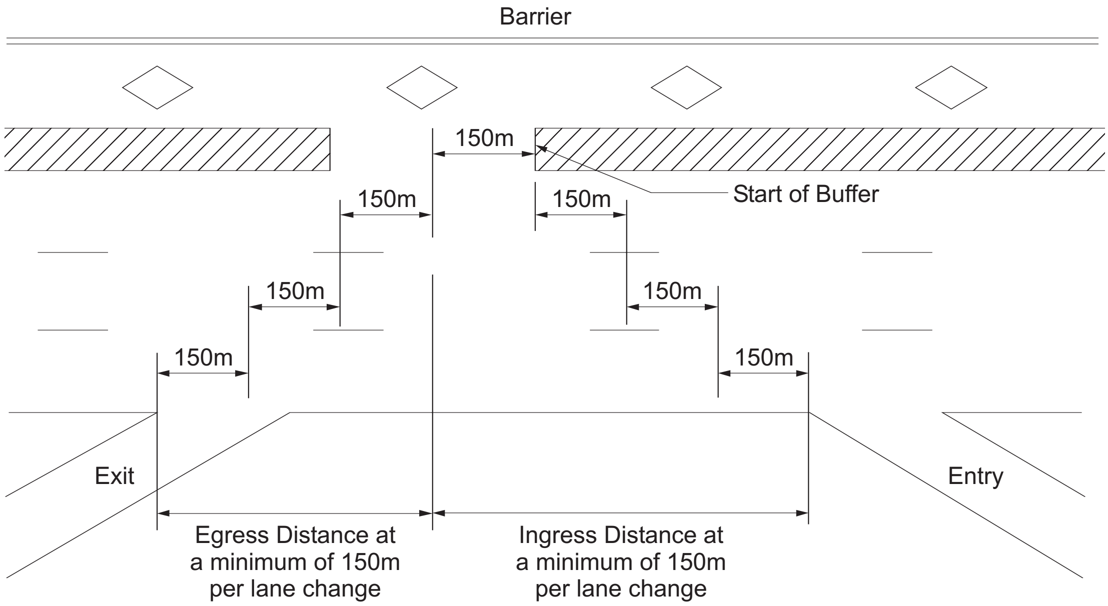


Figure 7.2.12.11 Ingress and Egress Weave Distance at Buffer Separated Facilities

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7.3 Shoulders

7.3.1 General

The shoulder is that portion of the carriageway beyond the traffic lanes, adjacent to, and flush with the surface of the pavement. Its purpose is to accommodate stopped vehicles, provide lateral support to the road pavement layers and, if sealed, offer improved conditions for cyclists.

The shoulder width is measured from the edge of the traffic lane to the verge. All safety barriers, signs, guide posts, drains and kerbs are to be contained outside the shoulder within the verge. Fixed objects within the verge should be frangible or protected with a safety barrier (see Section 7.5, Verges).

Factors to consider in deciding on shoulder width include:

- Support for the pavement structure - 0.5m will accomplish this;
- Space for a driver to use to avoid a collision and regain control - the shoulder width will rarely be sufficient to accomplish this and the “clear zone” will be the area in which this occurs. However, the wider the shoulder, the more use it will be for this purpose - a width of 3.0m would be desirable (North American studies show that the accident risk is halved when hard shoulder width is increased from 0.6 to 3.0m - Ref. 4);
- Clearance to posts and other fixed objects to provide an adequate distance to the shy line (see Table 7.1) - (this will also allow marginal increases in the numbers of vehicles carried at a particular level of service but this effect disappears over widths in excess of 1.5m);
- Space for a stationary vehicle to stand clear or partly clear of the traffic lanes - 2.5m is required for a passenger vehicle to be clear of the traffic lanes and greater widths provide for additional clearance or for larger vehicles to stand clear;
- Provision of a bicycle lane (see Chapter 5 and Figure 7.5);
- Sight distance across the inside of a horizontal curve; and
- Costs of the additional width, particularly where the existing formation is being used - a Cost Benefit analysis should be made.

7.3.2 Two Lane Two Way Rural Roads

Widths

Table 7.7 lists shoulder width requirements for two lane rural roads with minimal pedestrian and/or bicycle traffic.

A taper of 1:50 should be applied between different width shoulders that adjoin one another. This taper transition may need to be lengthened to ensure the taper’s appearance is satisfactory.

Table 7.7 Guidelines for Shoulder Widths

Nominal Shoulder Width (m)	Situation
0.5-1.0*	Normally widths less than 1.0 m will be used only where overlaying is being carried out with full formation sealing, and widening of formation is not justified.
1.0*	Minimum shoulder width for general use (i.e. unless special reasons dictate otherwise). Appropriate also when shoulder seal is desired and material cost/properties dictate full normal paving material.
1.5*	Normal shoulder width with sealed or partly sealed shoulders. Depends on availability of suitable material.
2.0-2.5*	Suitable shoulder width on higher volume roads when periodic provision to stop completely clear of traffic lanes is difficult to provide.
3.0*	Special cases where local issues dictate (e.g. high speed high volume rural routes where incidence of stopped vehicles unable to exercise choice as to location of stop may be significant). Normally only occurs on arterial outlets to major urban areas, especially if recreational routes.

* Shoulders between 0.5 m and 1.5 m do not enable a vehicle to stop clear of traffic lanes. 2.0 m shoulders enable it to stop largely clear. A vehicle travelling 100 km would expect to encounter some 4 to 5 stopped vehicles for every 1000 vehicles/hour using the road. Of these something less than 5% would have little

choice as to the exact location of the stop. There is evidence that safety does not improve significantly for shoulder widths over 1.5-2.0 m. Continuous 2.5 m shoulder can therefore be justified only on the highest volume roads and where speeds are also high. What is important, however, is to provide frequent opportunities to stop completely clear of the road (by flattening slopes on at least some low fills, or making provision at the transition of cut and fill) on all roads with shoulders less than 1.5 m, and also on higher volume roads with shoulders less than 2.5 m.

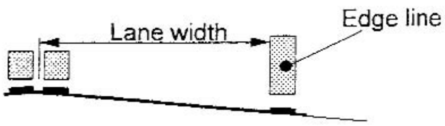
Shoulder Sealing

Shoulders should be sealed to a width of 0.5m (min.) from the edge of the sealed lane when the predicted AADT is less than 2000, and 1.0m (min.) when the predicted AADT is greater than 2000. When provision is made for cyclists, a wider sealed shoulder is required (see Chapter 5).

A full width seal should be provided:

- Adjacent to a lined table drain, kerb or dyke;
- Where a safety barrier is provided adjacent to a 1.0 m wide shoulder;
- On the outer shoulder of a superelevated curve;
- On floodways;
- Where environmental conditions require it;
- Where rigid pavement is proposed;
- Where required to minimise maintenance costs;
- In high rainfall areas.

Edge lines should be marked so that their inside edge corresponds to the outside of the lane.



Note: Sealing is sometimes continued beyond the shoulder point and down the batter slope on the high side to protect the pavement from ingress of water. On floodways, the seal is continued down the batter on both sides where no other protection of the batters is provided.

7.3.3 Multilane Rural Roads and Motorways

Rural Roads

On a rural road with a median and two lanes or more in each direction the shoulders should be 2.0-2.5 m wide on the nearside and 1.0 m wide on the offside (median). Sealing is normally decided on the same grounds as for rural two lane roads.

The need to provide lay bys on multilane roads is not as critical as on two lane two way roads. However, consideration should still be given to providing these facilities, particularly for heavy vehicles, at reasonable intervals (see Chapter 20).

Motorways

Shoulders on motorways will generally be at the upper end of the range because of the high traffic volumes combined with high speed operation. The desirable minimum width of the nearside shoulder (left hand side) is 2.4m but 3.0m will be justified in some cases (e.g. Pacific Motorway). The minimum width of the median shoulder is 1.0m for a two lane carriageway, and 2.0m for a three lane carriageway. Desirably, for 3 or more lanes, a 2.4m median shoulder should be used to allow vehicles to stop clear of the running lane. Note that shy line distances to obstructions must be observed.

7.3.4 Auxiliary Lanes

Nearside shoulder widths adjacent to auxiliary lanes should generally be 1.0 m, widened to 2.0 m adjacent to a safety barrier and 3.0 m at merge areas. At merge locations it is important that the shoulder remain trafficable, thus a full width seal is desirable. (Refer Figure 15.6, chapter 15.)

7.3.5 Ramps

Desirably, minimum shoulder widths on ramps should be 2.0 m on the nearside and 1.0 m on the offside. Shoulder seal shall be full width. Under special circumstances the shoulders may be reduced but the total carriageway width should not be less than 7.0 m. The range of circumstances

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for ramps is complex - detailed requirements are given in Chapter 16.

7.3.6 Urban Roads

On roads where a "traffic lanes + shoulders" design is appropriate the considerations given for rural roads apply similarly. However, urban traffic distributions tend to be different from rural conditions, in that urban arterial roads exhibit frequently repeated peak hour flows. Operating speeds well below free running speeds are normally associated with design volumes. Capacity is more important than speed. It is rare that a full width, fully paved lane can be economically justified as a full length breakdown lane. Table 7.8 sets out guidelines for shoulder widths for urban roads.

Table 7.8 Guidelines for Urban Shoulder Widths

Nominal Shoulder Width (m)	Situation
0.0	No clearance normally required between traffic lanes and semi-mountable kerb (e.g. raised medians). An offset of 0.5 m to kerbs is desirable, and is required on National Highways.
0.5-1.0	Normal median shoulder with depressed median.
1.0	Minimum outer shoulder width for general use (i.e. unless special reasons indicate otherwise).
1.5-2.5	Normal outer shoulder width on major urban roads (isolated stopped vehicles on 1.8 m shoulders have been shown to have negligible effect on capacity or safety).
3.0	Special cases where high volumes and high speeds can coincide, i.e. where the frequency of stopped vehicles (highest because of high volumes) is associated with high speeds of the through traffic. This is normally associated with the arterial outlets to major cities, where recreational peaks are much "flatter" than urban commuter peaks, and high volumes just below those that considerably reduce speeds, can persist for long periods.

7.3.7 National Highways

Table 7.9 gives parameters for the width of shoulders on National Highways.

Table 7.9 Shoulder Widths for National Highways

AADT	One Way		Two Way	
	Left	Right	Left	Right
< 3000	2.0	1.0	1.5	1.5
> 3000	2.0	1.0	2.0	2.0

7.3.8 Cycleways

Where there is an identified requirement to make provision for bicycle traffic, then an additional width of seal may be added to the sealed shoulder width, which may warrant shoulder widening. See Figure 7.5.

Sealed shoulders have a proven road safety benefit for all road users and reduce long term road maintenance costs. Also, most main roads will have some level of cycling as they provide the only connecting routes between regional centres. Therefore, sealed shoulders will generally be required on all main roads with special bicycle facilities necessary on urban main roads.

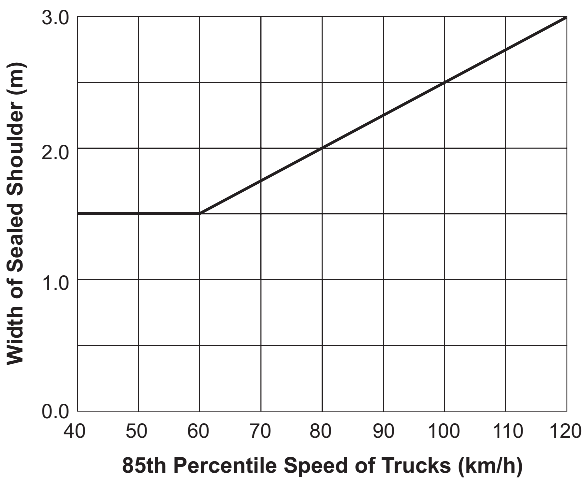

Figure 7.5 Recommended Sealed Shoulder Widths for Cyclists

7.3.9 Change in Shoulder Width

Where the width of shoulder is changed for any reason, the transition from one width to the next is to be accomplished with a taper of 1 in 50.

7.4 Medians

7.4.1 General

A median is the strip of road, that is not normally intended for use by traffic, which separates opposing travelled ways. The median width includes the adjacent shoulders (see Figures 7.30, 7.31 and 7.32).

The strip of road within the median, excluding adjacent shoulders, is called a "residual median".

Medians:

- significantly reduce the risk of collision with opposing traffic;
- improve capacity by restricting access to property and minor side streets;
- provide a safety refuge for pedestrians;
- prevent indiscriminate u-turn movements;
- direct right turn movements to signalised intersections and/or right turn bays,
- provide a place to collect run-off from the road and carry the water to the drainage system; and
- accommodate safety barriers and glare screening.

7.4.2 Rural Roads

It is a requirement for medians to be installed when a rural road is widened to four lanes or more or is constructed initially as a divided road. It is also necessary to provide for a painted median at least 1.0m wide in those cases where passing lanes in each direction overlap. These sections become four lane sections and it is necessary to provide at least this degree of separation of the opposing traffic streams.

When a median is provided on a rural road, it is sometimes desirable to have it in conjunction with independently aligned and graded carriageways. Special attention needs to be given to the carriageway relationship to alleviate the effects of headlight glare. Research has shown that the minimum width median to adequately separate traffic without median barriers on high speed roads is 15 m. In cases where a variable width median is provided, the width should not be less than the minimum widths discussed in 7.4.6.

On dual carriageways where the provision of cross-median access for turning semi-trailers is necessary, a wider median will be required to ensure that turning vehicles are sheltered from the through traffic. In such cases the minimum median width will be governed by the length of the design vehicle expected to utilise the facility. This may be reduced if the through carriageways are widened to accommodate turning vehicles (see Chapter 15, Intersections at Grade). If it is uneconomic to maintain the wide median over the entire length of the road, then local widening may be applied.

Factors that need to be considered in reaching a decision on this include:

- What is the cost of the land required?
- Are there any other reasons why the land should not be taken (buildings, other developments, cane land, etc)?
- How many vehicles will be using the crossing? Is the likelihood of a vehicle having to undertake a two-stage crossing high?
- A 19m median would be desirable if affordable and may allow safety barrier to be omitted; the extra width allows more flexibility in the future - the 15m is a minimum and results in a quite narrow median in the future if widening is undertaken;
- It may be possible to provide the 19m at the intersections and use curves on each side of the intersection to transition back to the "normal" median width;

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- If the intersection will be signalised in the near future, the width should be kept relatively small to avoid excessive clearance times;
- A seagull intersection to accommodate the two stage right turn and maintain a lesser median width may be considered (see Chapter 13);
- If the right-of-way is available, and it is a rural area, it is likely that the costs of providing a wider median can be kept to the same, or close to the same, cost as the narrower median. With a wide enough median, the possibility of independent grading comes into play and the costs may be reduced with smart design.

When future widening is anticipated, it is desirable to allow for it in the median width. The ultimate median width should not then be less than the desirable width of 15 m.

Widening into the median will:

- Minimise traffic disruptions during construction of the widening;
- Minimise interference with roadside furniture, drainage installations and environmental protection devices;
- Prevent further environmental damage during construction of the widening; and
- Avoid disturbing cut batters (particularly important in potentially unstable or erodable country).

There will be circumstances where widening on the outside of the existing pavements will be the appropriate solution. These include:

- Existing ramps have to be remodelled to suit current standards;
- The existing median is inadequate to accommodate the additional lanes and retain sufficient width;
- There is little disruption to the existing drainage and other infrastructure;
- The existing outer lane has less life remaining than the inner lane and a new outer lane will provide for the heavier loads allowing additional life to be achieved for the pavement as a whole;
- The adjoining sections at the start and end of a relatively short project have to be matched.

Care is required to provide for the traffic movements across the construction works at the access points.

The decision on future widening requires careful consideration of the factors impacting on the road in question and adopting the solution that provides the best answer for the particular circumstances.

7.4.3 Urban Roads

In urban roads it is desirable to provide medians on roads of four lanes or more. Where six lanes are required, medians are even more important. In these cases, a carriageway width of >9m between kerbs is required to allow for at least two travel lanes plus a shared parking lane/travel lane. For carriageways less than 9m, parking or breakdowns will restrict flow and reduce road capacity. Medians can be provided on roads with carriageways between 7m and 9m between kerbs if:

- mountable kerb and verge reinforcement are provided to enable vehicles to stop clear of the travel lanes (see Figure 7.28); or
- other kerb types are used and the design hourly traffic volumes can be accommodated in one travel lane and separate right turn lanes are provided for significant turning volumes.

Where signalised intersections are proposed, medians need to be wide enough to accommodate signal posts, lanterns and servicing facilities. A desirable median width of 2.4 m (for maintenance ladder spread) should be provided. At intersections other than six lane divided carriageways with right turn storage lanes, (i.e. locations with three lanes or less at the stop line), the minimum median width of 1.2 m may be applied, provided that all intersection movements can be adequately controlled by overhead lanterns on mast arms.

Table 7.10 gives a guide to recommended widths for medians on urban roads. Typical treatments are illustrated in the Typical/Cross Sections in Figure 7.6.

Table 7.10 Urban Road Median Widths

	Total Median Width	Residual Median	Right Turn Lane
Desirable	5.9	2.4(1)	3.5
Minimum	4.3	1.2(2) (4)	3.1
Minimum (Future traffic barrier, no right turn bays or significant pedestrians)	1.6 (4.0)	1.6(4) (4.0)(3)	-
Absolute Minimum (No right turn bays, no traffic barrier, no traffic signals)	0.9	0.9	-

Notes:

(1) Where traffic signals are proposed, the median width is to continue for a minimum of 3 m each side of the central traffic signal post.

(2) 1.2 m allows for single lantern traffic signal display, minimum pedestrian storage and clearance to signs. 1.5 m allows for dual 200 mm lantern display.

(3) Where two stage mid-block signalled pedestrian crossings are required, the desirable width for pedestrian storage is 4 m.

(4) Where pedestrians are likely to accumulate on medians the width should be a minimum of 1.5 to 2.0 m.

Tips for Treatment of Urban Medians

- Narrow medians and noses of medians at intersections should generally be treated with a "hard" surface. A most effective treatment is stamped concrete (or similar) in an appropriate colour (often terracotta).
- Exposed aggregate treatment should be avoided because the slurry from the process is washed into pipes and waterways thereby causing blockages and/or environmental harm
- Where bedding sand is used under bricks or pavers or concrete slabs, the sand must be treated with a suitable poison to avoid infestation with ants, which create voids under the paving.
- It is preferable to use 5 or 7 mm aggregate as the bedding medium for bricks and pavers, or concrete slabs.
- Where landscaping is used in medians it is preferable to use hardy species that do not require extensive watering once established. (Refer to Metropolitan District for guidelines on their experience.)
- If watering is required, care is required in selecting a suitable system. “Keeping it simple” appears to be the most effective way (e.g. providing watering points in the form of taps in pits in the areas requiring watering). Automatic systems can cause difficulties and must be monitored closely.
- Consideration should be given to safe pedestrian use of raised medians where drainage channels are specified to facilitate cross median flows of pavement runoff. In urban areas, it is not unreasonable for pedestrians to cross the road using the median as a refuge. Drainage slots pose a hazard to pedestrians due to a sudden step down from the median surface. Wherever possible, the use of medians with drainage slots as a pedestrian refuge should be avoided. However, if this is not possible then the following solutions may be considered to improve safety for pedestrians:
  - delineation of the edges of the drainage slot
  - making the drainage slot wider (it then becomes a clear step down and step up)
  - edging the slot with mountable kerb or similar sloped edge
  - replacing the slot with a small box channel
  - covering or plating the slot
  - fencing the median to discourage pedestrian use.

  Replacing the slot with a box culvert or covering/plating the slot is not recommended as this may result in a maintenance issue.

7.4.4 Motorways

Where possible, the median provided for motorways should be as for rural roads above. In constrained urban situations, narrower medians provided with barriers may be appropriate. The width available for the median will dictate the type of barrier to be used based on the deflection of the barrier type chosen but the various types of barrier do have minimum width requirements. Details are provided in Chapter 8.

If future widening is likely, the widening should be applied on the median side of the carriageways. Therefore, the width of the median in the first stage should be such that the width after widening meets the minimum width required. Desirably, this should be at least 15m to provide the safest situation. In constrained cases, however, the minimum will be that required to accommodate a concrete barrier with a clearance of 2.0m (3.0m for 3 or more lanes) to the face of the barrier. This provides for the “shy line” distance on the median side (see Table 7.1).

Extensive use of concrete barriers is not a preferred option on environmental grounds and this should be considered when determining median widths.

7.4.5 Clearance to Medians

In a lit area with a design speed of 80 km/h or less, no lateral clearance is required from the edge of travel lane to a raised median (i.e. one with a mountable kerb). However in an unlit speed zone of 80 km/h or less, a 0.5 m lateral clearance is required to a raised median. The gutter adjacent to the kerb face, if provided, is located outside the lane.

In areas where the design speed is greater than 80 km/h and no street lighting exists, a lateral offset of 1.0 m is required, measured from the edge of the lane to the bottom face of the kerb (Types 8 - 15). If lighting is provided, the clearance may be reduced to 0.5 m.

7.4.6 Rural Median Treatment

In rural areas, depressed medians are preferred and a width of 15 m is the desirable minimum. Where a distance of 15 m cannot be achieved, acceptable widths are those that provide an acceptable clear zone width for traffic in each direction between the edge of travelled lane and the edge of verge of the opposite carriageway. If this width cannot be achieved, median barrier may be required (see Chapter 8).

In depressed medians, slopes of 1 on 10 are preferred with a maximum preferred slope of 1 on 6. A slope of 1 on 4 should only be adopted in constrained areas. Landscaping or fencing may be required to prevent U-turns if safety barrier is not used.

Longitudinal drainage of medians should drain from both sides to appropriate gully pits (i.e. no blocks). Where blocks, levees, median cross overs and the like are required, the slopes facing traffic should be 1 on 20 (1 on 6 absolute maximum). Where longitudinal culverts are required in the median (e.g. under a cross over), the ends shall be sloping (1 on 6 maximum) and provided with parallel bars at right angles to the traffic.

Longitudinal culverts in the median should be avoided if at all possible. A much better arrangement is to collect the water in a drop inlet and dispose of it to the roadside or into adjacent cross drainage installations.

In general, medians should be kept clear of obstructions within the clear zone requirements of the road. Designs should avoid the use of head wall, unprotected culvert openings, solid sign foundations, non-frangible sign posts and light poles in the median. Planting should consist of “frangible” species of ultimate trunk diameter not greater than 80 mm unless it is outside the required clear zone and/or is located behind the appropriate barrier. Landscaping design and species selection will depend on the specific circumstances and requires specialist input.

The design of the median should ensure that it is as maintenance free as possible. This will minimise the amount of time that maintenance personnel will be required to spend on the median thereby reducing their exposure to traffic hazards.

Features limiting the horizontal sight distance on curves must be located such that adequate sight distance is achieved. Offsets needed to achieve this are given in Figure 7.6.

Figure 7.6 shows a range of acceptable treatments for medians in rural areas. More details are shown in the Typical Cross Sections given in Section 7.12.

7.5 Verges, Footpaths and Outer Separators

7.5.1 Verges

The area between shoulder and batter hinge point is the verge and is used for installation of drainage, guardfences, and batter slope rounding.

The recommended minimum verge width on an embankment with guideposts is 0.5 m and with a non-rigid safety barrier, 1.0 m. At difficult sites the verge may be narrowed to 0.75 m for safety barrier placement, however special foundation treatment will be required to ensure that the material behind the safety barrier provides adequate support for the system.

Table 7.12 shows the recommended verge widths and Figure 7.7 shows typical cross sections of various verge treatments.

Table 7.12 Recommended Verge Widths

Formation Configuration	Verge Width (m)	Function
Embankment	0.5	Min. rounding, with space for guide posts
	0.75	Minimum verge for non-rigid safety barrier (special cases only)
	1.0	Desirable rounding, min. verge for safety barrier
	1.0 to 3.0	Safety barrier flare and anchorage
Cutting	2.0 min 1.5 min	Table drain Concrete lined drain

Generally verges are not provided in urban areas. However, if a situation arises where they are required, then the verge widths specified in Table 7.12 should be adopted.

7.5.2 Footpaths

Generally, footpaths provide room for:

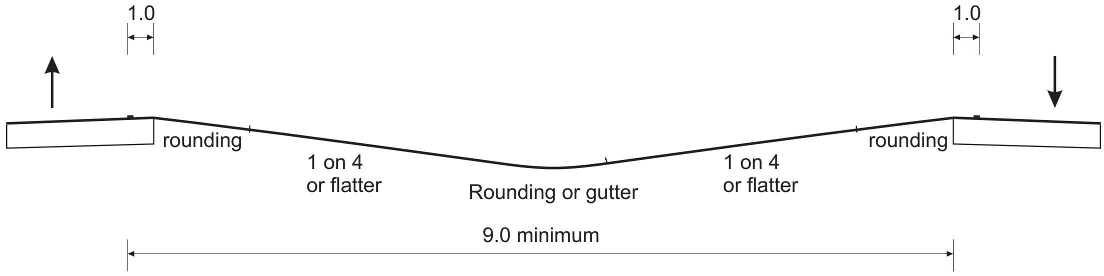
- Pedestrian movement;
- Bicycle travel;
- Public Utility Plant (PUP) installations;
- Turning movements between the carriageways and adjacent property entrances;
- Road signs and lighting standards;
- Landscaping; and
- Bus bays.

Width

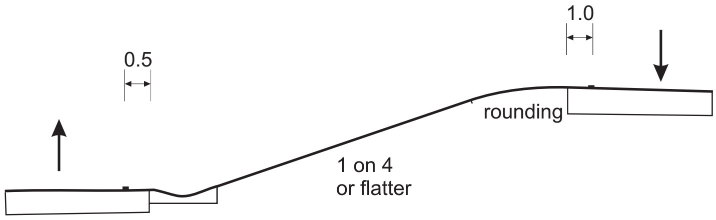
The minimum footpath width to be adopted is 2.0 m. This will provide 1.5 m for pedestrians plus an allowance for lighting standards and road signs. However, much greater widths are required as standard dimensions, particularly in commercial and industrial areas and on Arterial Roads.

This is because the width required for the Public Utility Plant allocations is usually much greater than that required for the pedestrian movement. A minimum width of 3.6 m is required for these reasons and greater widths are sometimes necessary. Detailed footpath requirements should be determined in conjunction with the relevant Local Government and Public Utility Plant Authorities.

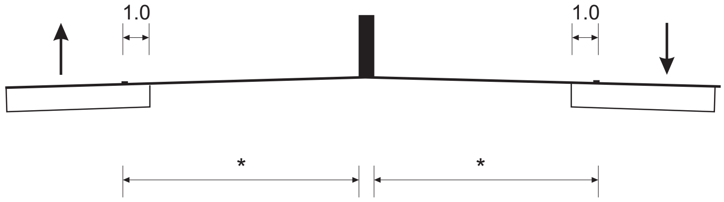
Table 7.13 sets out desirable widths for footpaths on Arterial Roads. Any residual road reserve should be allocated to the footpath to provide additional space for landscaping and driveways.



Dependently aligned with depressed median

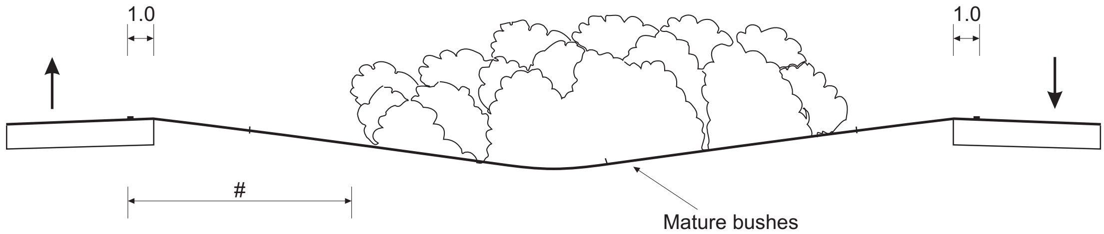


Independently aligned with single slope median



Minimum median

* Allowance for dynamic deflection of barrier needs to be considered. See Chapter 8.



Refer Chapter 11, Section 11.
(Table 7.11 provides an example for 110km/h)

Landscape treatment on right hand curves (see Table 7.11)

Table 7.11
Offsets for Sight Distance at 110km/h

Curve Radius (m)	Offset [1] 110km/h (m)
800	5.5
1000	4.0
1500	2.0[2]
2000	2.0[2]

Notes:
1. Based on median lane width of 3.5m.
2. Minimum for shy line.

Figure 7.6 Median Treatment

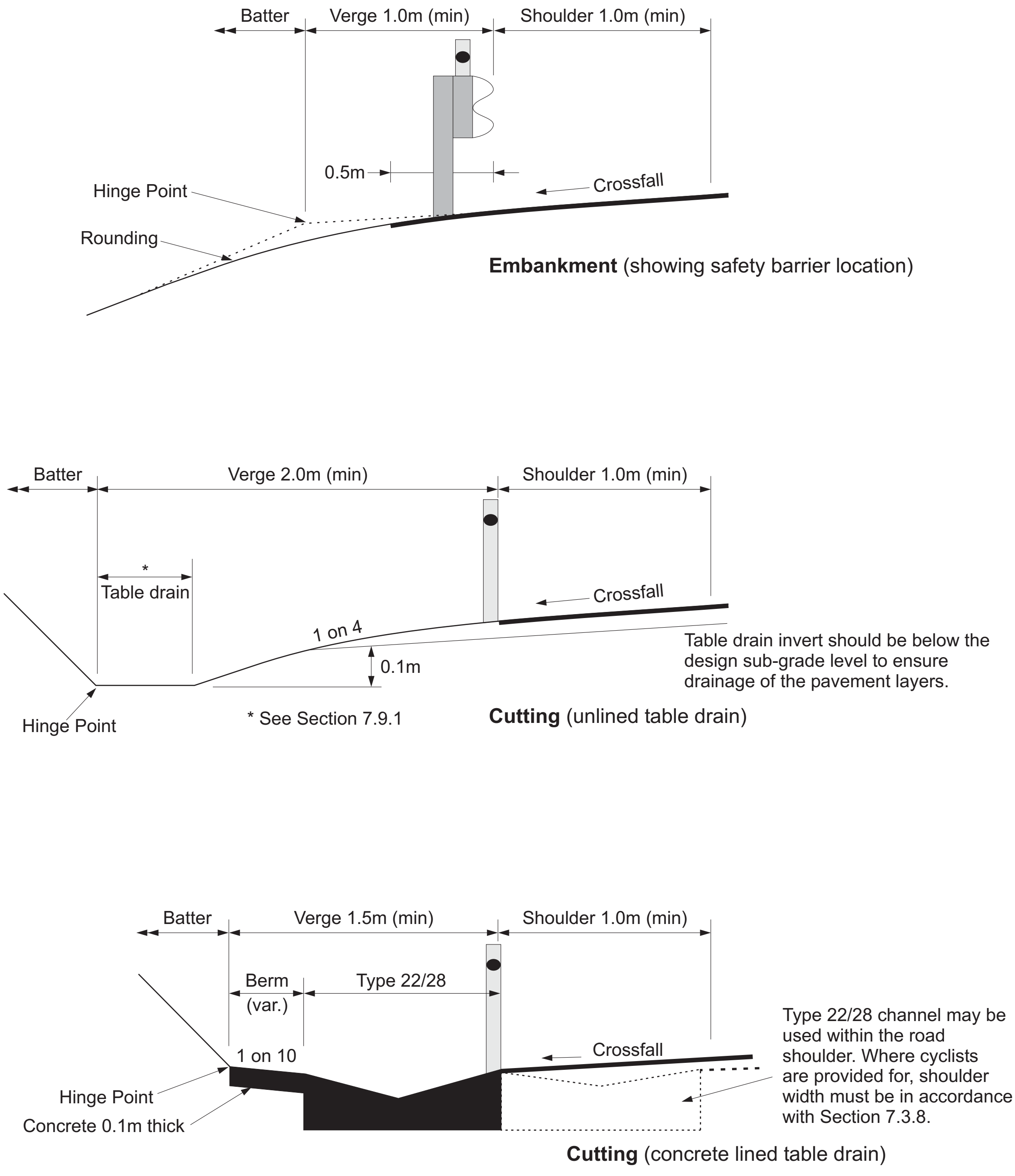


Figure 7.7 Typical Sections Detailing Verge

If kerbed footpaths are not provided then sufficient verge width should be available to enable pedestrians to walk clear of the road carriageway (i.e. lanes and shoulders) preferably outside the clear zone.

For shared pedestrian/bike paths, refer to Chapter 5, Section 5.5.4.

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Table 7.13 Desirable Widths for Footpaths on Arterial Roads

Road Type	Footpath Width (m)	
	Residential	Commercial and Industrial
Urban Arterial Roads	5.5	5.5
Other Urban Roads	4.0	5.5

Based on:

- 4.0m - Services Requirement. Where a footpath is wider than 4.0m, the services allocation should remain at 4.0m.
- 5.5m - Bus Bay and Landscaping Requirement. In order to maintain capacity on major urban roads, bus bays should be provided where possible within the footpath width. A 5m minimum footpath width is necessary at the bus bay site. Between bus bay sites, the width surplus to services requirements may be allocated to landscape planting.

Footpaths and Driveways

Many councils have minimum design requirements which should be considered for the provision of footpaths.

Typical driveway crossings for high and low level footpaths (to be used as a guide in the absence of local council regulations) are given in Figure 7.8.

Depressed footpaths introduce drainage problems and therefore should only be considered where access conditions or the high costs involved in property and utility adjustments restrict alteration to the existing footpath levels.

A desirable verge side slope of ±1 on 6 may be used at locations adjacent to parks, reserves etc. where driveways are not required.

In difficult terrain this side slope may be increased to ±1 on 5.

Vehicle templates for standard large and small passenger cars should be used to ensure that these vehicles can use the driveway without bottoming on any part of it (see Appendix A).

Public Utility Plant (P.U.P.) Allocations

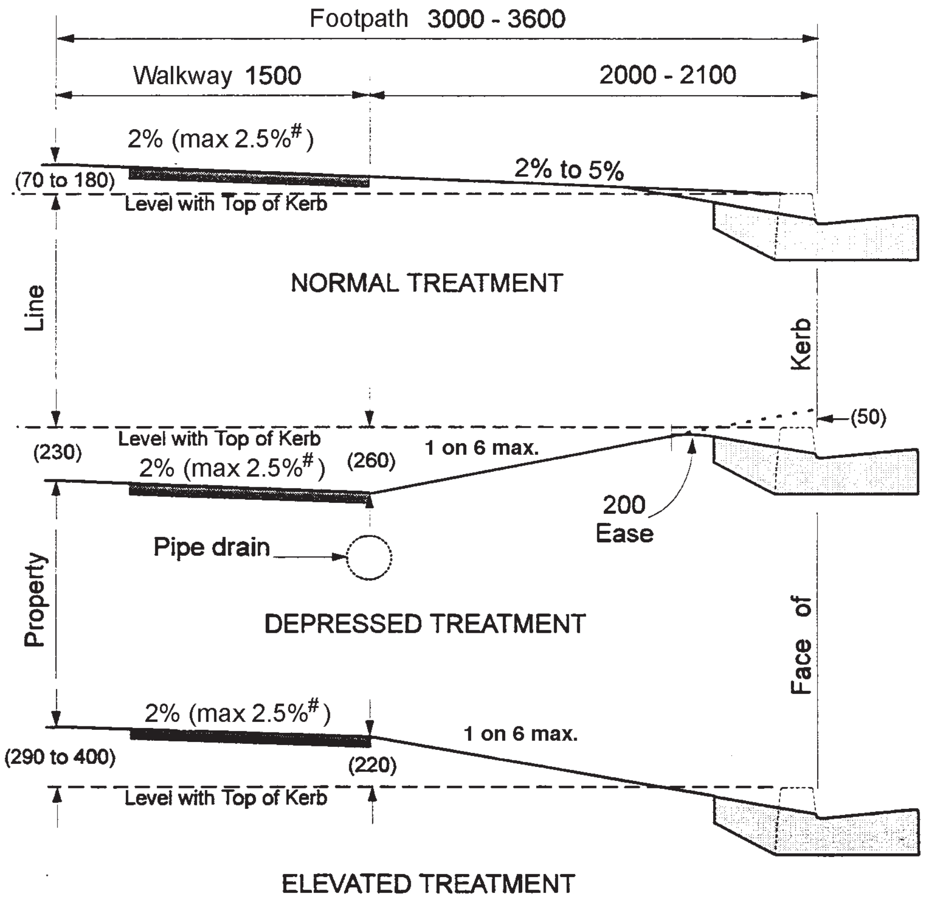
Public Utility Plant is usually located under urban footpaths in accordance with standards negotiated between the various Local Governments and the Service Authorities. While some degree of standardisation has been achieved, there are differences between Local Governments and the actual distribution in any area will have to be determined for that area.

Some typical space allocations are shown in Figure 7.11(a). These are taken from the Standard Drawings prepared for the then Institute of Municipal Engineering Australia, Queensland Division in 1995. All cases must be treated on their merits and the advice of the relevant Local Government obtained to ensure that the standard practice for the area is implemented.

Figure 7.11(b) also provides information on typical depths of cover to services under roads and footpaths. Table 7.14 sets out nominal depths of cover for the various utilities. This information is provided as a guideline only and specific details must be obtained from the relevant Authority for all projects. Notwithstanding the cover given in Figures 7.9, 7.11(b) and Table 7.14 under roads, for crossings under declared roads, the minimum cover (unless otherwise approved) is to be:

- 600 mm below the invert of table drains;
- 1200 mm minimum below the existing or future roadway;
- 600 mm elsewhere;

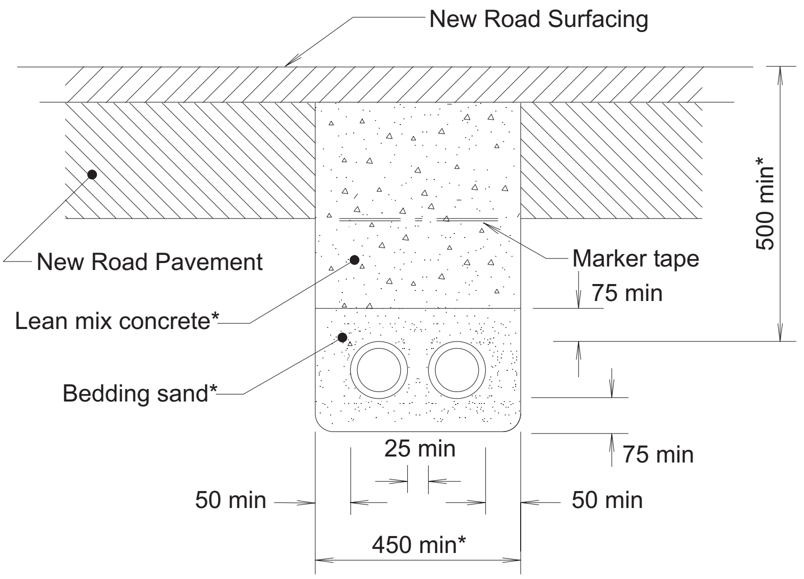
provided that there is also a minimum cover of 300 mm below the level of the existing or proposed sub-grade.



* See Figure 7.21 for details.

\# Required for wheel chair access (Australian Standard AS 1428.1).

Figure 7.8 Typical Driveway FCrossings



* See Standard drawing 1149

TYPE 1A

NEW ROADWAY (AFTER PAVEMENT CONSTRUCTION)

LV (240V)

Refer also to Standard Drawing 1149 Ducts for Underground Electrical Conduit

- New and Existing Roadways;
- Bored Crossings;
- Single and Multiple Conduits

Figure 7.9 Installation of Underground Conduits within the boundaries of Declared Roads

Table 7.14 Nominal Depth of Cover for Various Utilities

Cover	Electricity		Gas		Communications		Water	
	Footway	Roadway	Footway	Roadway	Footway	Roadway	Footway	Roadway
300	Communication cables in shared trench							
450		Communication cables in shared trench	Urban	Urban 500kPa	Local network cables & conduits phone/ pay TV	Local network cables & conduits phone/ pay TV		
500			Rural				100m pipe Intermediate sizes for DICL	
600	LV cables	LV cables	500kPa		Other network cables & conduits	Other network cables & conduits	740mm pipe Intermediate sizes for UPVC & GRP	100mm pipe Intermediate sizes for DICL
700								750mm pipe
750	HV cables to 22kV	HV cables to 22kV	1000kPa	Rural 500kPa				100mm pipe Intermediate sizes for UPVC & GRP
900	HV cables to 33kV & above	HV cables to 33kV & above	1000kPa				750mm pipe	
1000								750mm pipe
1200			3500kPa	3500kPa				

Note: DICL Ductile Iron Cement Lined UPVC Unplasticised Poly Vinyl Chloride
GRP Glass Reinforced Plastic

WARNING

This Table shows nominal laying depths of services by various Authorities and is for information only.
EXISTING SERVICES MAY BE LAID AT DEPTHS AND LOCATIONS OTHER THAN THOSE MENTIONED.
It is important that consultation be made with the respective utility Authorities for an indication of the presence of a service.
Hand excavation to determine the exact utility location is advised prior to using any mechanical equipment.

Designers must consider the potential to protect existing PUP rather than relocating it when a project changes the road alignment. For example, a Telstra access chamber could be left under the pavement and an access provided from the footpath rather than relocating the whole structure.

Appropriate risk assessment should be undertaken together with consultation with the appropriate Authorities, to determine the most economical solution. The resulting plan must be approved by the relevant PUP Authority.

Overhead services require special consideration - see Section 7.10.7 for details.

7.5.3 Outer Separators

General

An outer separator is the portion of road reserve separating a through carriageway from a service or frontage road, as shown on Figure 7.10.

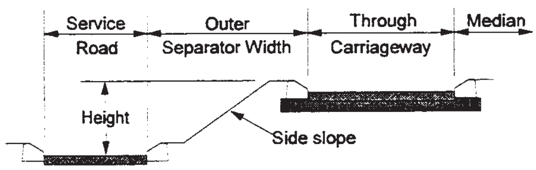


Figure 7.10 Outer Separators

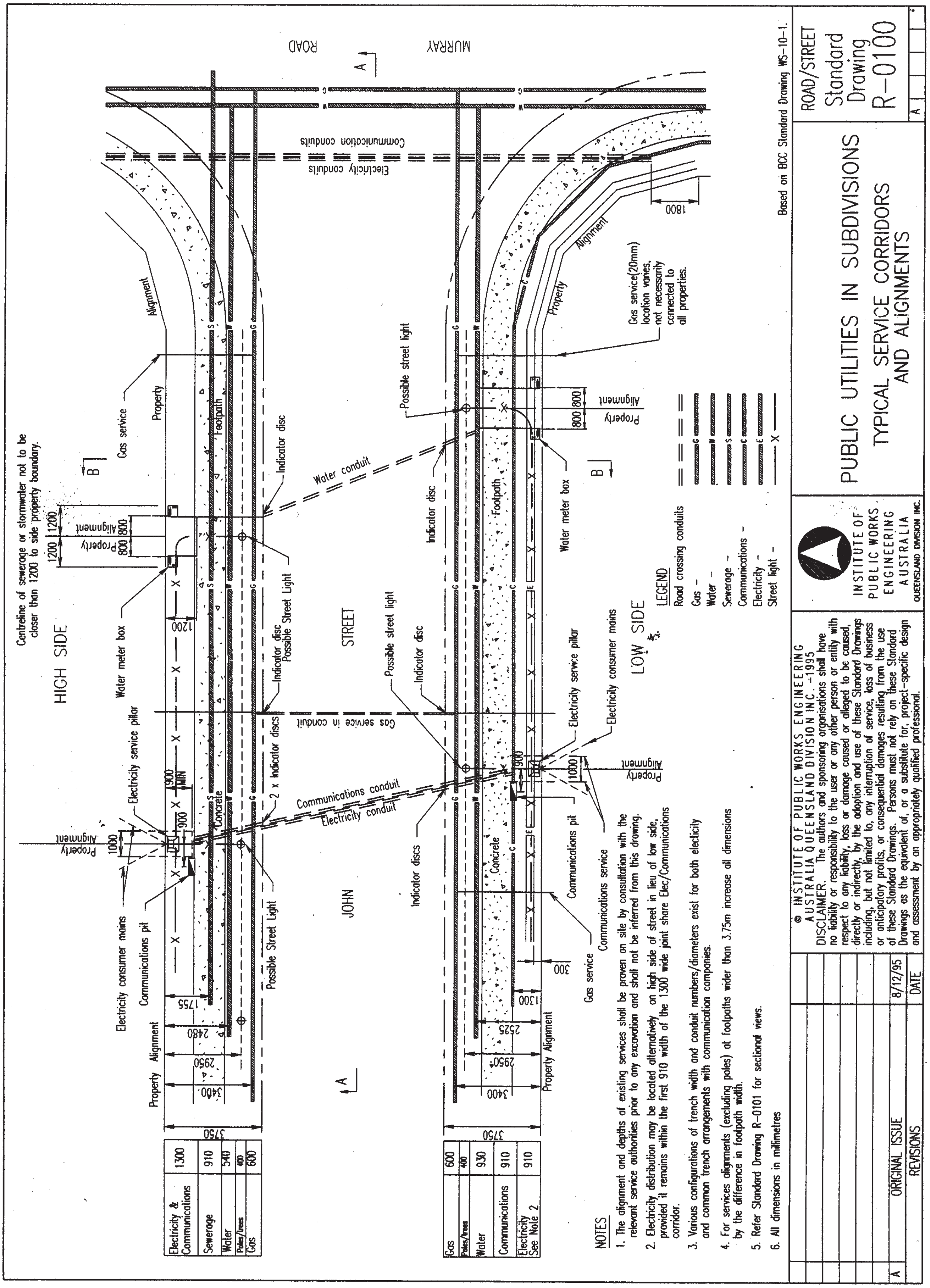


Figure 7.11 (a)   Typical Service Corridors and Alignments

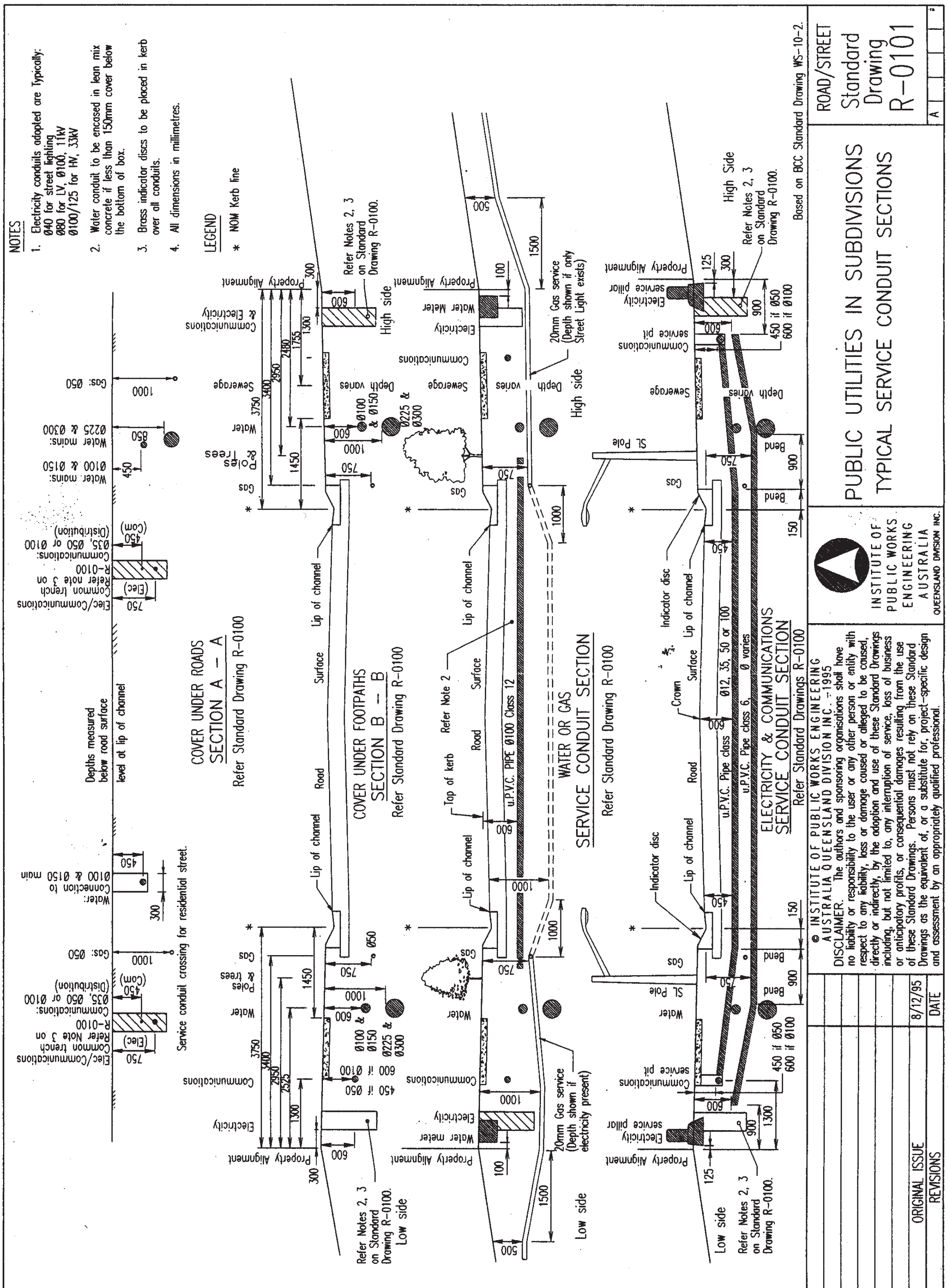


Figure 7.11 (b) Typical Service Conduit Sections

Outer separators:

- separate and act as a barrier between traffic flows on the through carriageway and a service/frontage road;
- provide visual separation of the two flows;
- provide headlight glare screening especially where the service road carries two way traffic;
- provide walking or standing space for pedestrians;
- accommodate roadside planting;
- accommodate guard rails and other barriers, fencing, lighting poles and signs;
- accommodate differences in levels between the through carriageway and the service road;
- provide space for bus bays;
- accommodate service installations in special cases (primarily "trunk" services when the normal footpath allocations are already used);
- reduce the number of conflict points likely to occur through the number and frequency of use of property access points between successive intersections; and
- eliminate the need to provide parallel parking on the through carriageway, thereby increasing the capacity of the through carriageway.

Widths

Table 7.15 provides typical widths that will meet a range of circumstances. These tend to be the minimum required to meet those circumstances and it is desirable to use greater dimensions if possible in the space available. When allocating space to the various components of the cross section, a reasonable balance between the competing needs has to be maintained. For example, where traffic signal control is to be used at intersections, extra width available is better allocated to the outer separator than the median once the minimum needs of the median have been met.

However, it is desirable that an outer separator be of sufficient width to absorb level differences between the through carriageway and the service road and also to allow parking in the service road.

In rural areas, an outer separator width of 15m is desirable, particularly where the service road is two way.

Table 7.15 Typical Widths of Outer Separators

Factor	Situation	Width (m) (excluding shoulders)
Physical Separation	Safety barrier with or without glare screen	0.5
	Safety barrier with kerbs on both sides	1.0
Visual Separation	Two way operation on service road with no artificial glare screen	Light traffic on service road: 5.0 Medium to heavy traffic:>7.0
Headlight Glare Screening	Planting shrubs as the screen	2.0 - 5.0
	Artificial Screen	0.5 - 1.0
Pedestrians Cyclists	Occasional usage *or* if part of a designated bicycle route	2.0
	Shrubs for screening (including walking space)	4.0
	Trees and Shrubs	4.0 - 5.0
Space for Roadside Furniture	Safety barrier, fencing, lighting standards etc.	0.5 - 1.0
Bus Bays	Indented into outer separator	6.0 (min. 5.0)
Intersections	Traffic Signal Control	2.4 min.

Note: Where safety barrier is used, allowance for deflection must be made.

Slope

Where outer separator side slopes exceed 1 on 4 or 1.0m in height, safety barrier protection adjacent to the higher of the two roads, may be warranted.

At intersections where traffic signal control is proposed, the outer separator should have a maximum side slope of 1 on 8 maintained for at least 3 m before and after the signal post.

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7.6 Clear Zone

7.6.1 General

The intent of the clear zone is to provide space for the driver of a vehicle that runs off the road to regain control while sustaining minimum damage to the vehicle and its occupants. It is the width of roadside, beginning at the edge of the travelled way, that is available to the driver to take this action.

This zone will depend on the location of the vehicle at any point along the road and is determined for both sides of the vehicle (right hand side for medians). Accordingly, the clear zone distance is related to predicted traffic volumes and speed (see Figure 7.12), and takes into account the widths of adjacent lanes, shoulders, medians, verges, footways and traversable batters. See also Figure 7.1 and Table 7.21.

7.6.2 Guidelines

To be regarded as part of the clear zone:

- the area should be:
  - relatively flat, with a maximum side slope of 1 on 3 (cutting) and desirably 1 on 4 (embankment) or flatter; and
  - traversable, having slope changes that will keep all wheels of an errant vehicle in contact with the ground (this assists the driver of an errant vehicle to regain control). See Figure 7.16 for determining appropriate rounding for traversable batter slopes within clear zones.
- the area should be kept clear of all large, fixed objects (such as species greater than 80mm in ultimate trunk diameter, structure support piers, culvert headwalls, large solid [i.e. non-frangible] sign support structures, non-traversable gutters and barriers) which are of such a size that they cause unacceptable rapid deceleration rates to the occupants of an impacting vehicle. Only objects which will collapse or break away on impact should be located in the clear zone to ensure minimal damage to an errant vehicle and its occupants.
- the desirable width of a clear zone is dependent on predicted traffic volumes, traffic speed and road geometry.

Figure 7.12 is a nomograph that allows for the appropriate clear zone distance to be determined. These distances represent a reasonable measure of the degree of safety appropriate for a particular road and must be balanced by comparing land use and costs. The widths given are approximate only and the nomograph should not be used to infer a degree of accuracy that does not exist.

Where it is not possible to provide an adequate clear zone, free of non-frangible obstacles for the appropriate distance, a safety barrier should be considered in accordance with Chapter 8 of this manual.

The provision of a clear zone is often better practice than the erection of a safety barrier (due to the length of the safety barrier generally required).

7.7 Crossfall

7.7.1 General

Crossfall is defined as the side slope, normal to the alignment, of the surface of any part of the carriageway. Crossfall is provided primarily to facilitate pavement drainage.

The usual arrangement for straight sections of road is for the pavement crossfall to slope down from either the centreline or the median. However, the designer should not be limited to this arrangement as inwards sloping crossfall, or one way crossfall may be useful for certain grades, drainage or side slope situations.

For wide multilane pavements, it may be appropriate to crown the pavement with one or two lanes draining to the median. This minimises the depth of flow on the pavement surface, reducing aquaplaning potential.

On curved alignments, the carriageway may slope upwards from the centreline or median to help

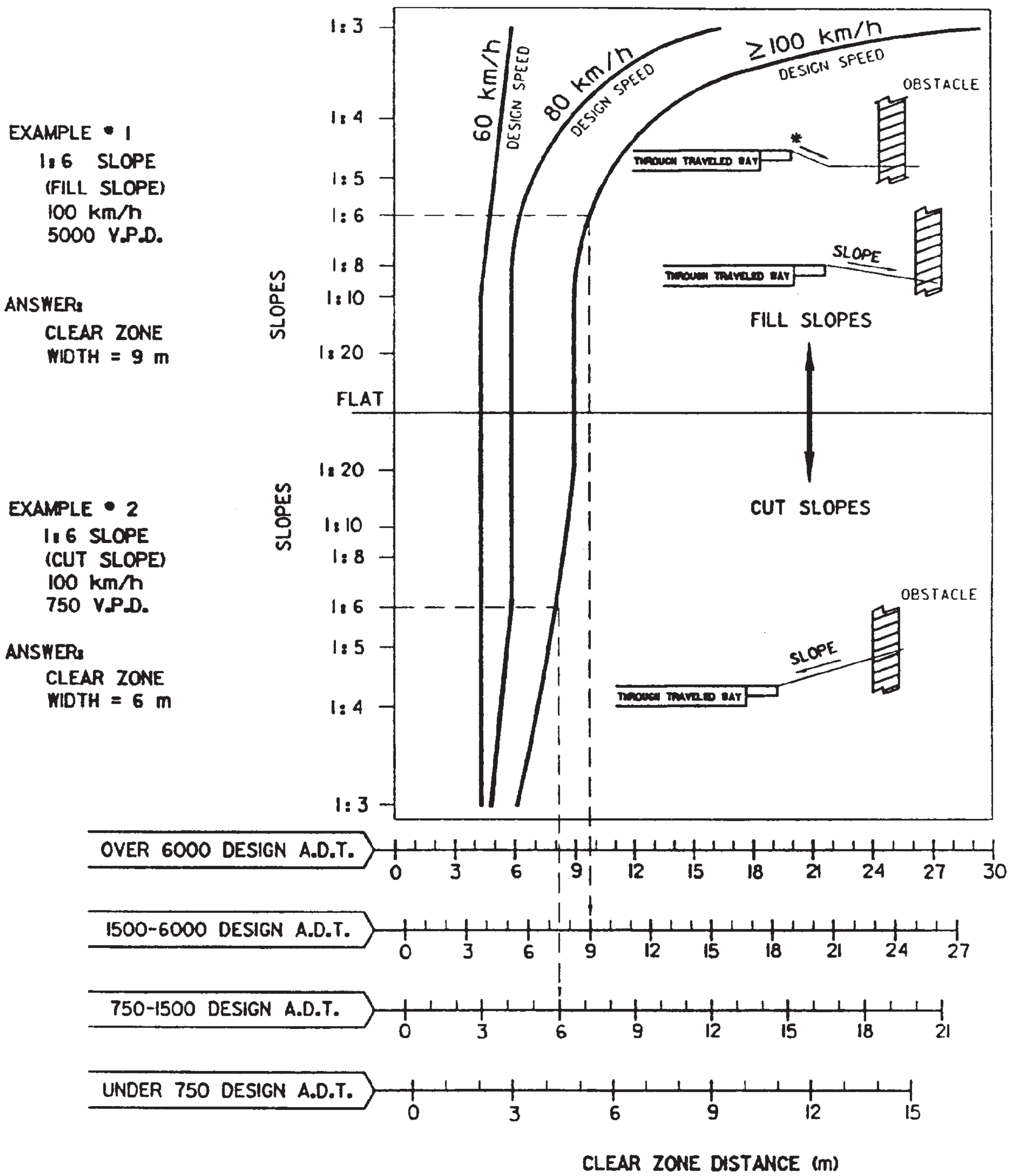

Figure 7.12 Clear Zone Nomograph

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counteract the centrifugal forces on a vehicle travelling around the curve. This form of cross slope is known as superelevation. Chapter 11 details the amount of superelevation required on curves of varying radii, and the methods of superelevation development.

Changes from one crossfall to another shall be transitioned over a length to satisfy the rate of rotation and relative grade requirements given in Chapter 11. Sufficient dimensions, levels, cross-sections and/or profiles should be provided on the construction drawings to enable the design to be accurately reproduced in construction.

7.7.2 Crossfall and Drainage

Crossfall has the important function of shedding water from the roadway to reduce the possibility of a vehicle aquaplaning in wet conditions. Details of the relationship between crossfall and pavement drainage design are given in the Road Drainage Design Manual (Main Roads, 2001).

7.7.3 Road Crossfall

Typical crossfalls, depending on the type of road surface are shown in Table 7.16.

Table 7.16 Typical Pavement Crossfalls

Road Surface	Traffic Lane (%)	Shoulder (%)
Cement Concrete	2.0-3.0	2.0-4.0
Asphaltic Concrete	2.5-3.0	2.5-4.0
Sprayed Seal	3.0-4.0	3.0-4.0
Unsealed	3.5-4.0	4.0-5.0
Within Floodways	1.0-2.0	1.0-2.0

There are many controls in urban areas which force departures from the above values.

Differences in levels between kerb lines can sometimes be taken up by offsetting crown lines or adopting one-way crossfalls (see Section 7.7.6).

If it is necessary to increase traffic lane crossfalls above those given in Table 7.16, then the maximum sustained crossfall should not exceed 4%; local increases to 6% are acceptable, but only in extreme cases. Stability of high vehicles becomes a problem on crossfalls greater than 6%. Clearance of high vehicles to poles, signs, etc. should also be checked (see Section 7.10.3).

Crossfall should be provided on right turn lanes in a manner that ensures that the bay is adequately drained, and minimises the amount of water at the median nose area.

Multicombination Vehicle (MCV) performance is influenced by crossfall. The crossfall on freight routes should not exceed 3%.

However, on low trafficked roads where better surface drainage is required to protect low quality paving material, a crossfall of 4% has been used successfully. This crossfall also tends to encourage MCVs to travel closer to the centre of the pavement with a consequent advantage of reducing damage to the pavement edges.

Cross-over Crown Line

On straight sections of road, the maximum algebraic change in crossfall over a crown line is 7%.

Where a turning roadway exits from a carriageway, and a different crossfall is required on the through road and the turning roadway, the algebraic change in crossfall over the crown line formed must be limited to the values shown in Table 7.16 (a).

Table 7.16 (a) Difference in Crossfall at Crossover Crown Line - Turning Roadways

Speed km/h	Max. algebraic difference in crossfall at crossover crown line, %
< 30	Determined by vehicle clearance
30 - 50	6
> 50	5

Turning roadway with tapers:
speed = ‘average running speed’ of through road

Turning roadway without tapers:
speed = design speed of turning roadway

Turning speeds for various combinations of radius and crossfall are shown in Chapter 13, Figure 13.38. It is preferable to limit adverse crossfall to -3%, with an absolute maximum of -4%. Maximum positive crossfall on turning roadways is 7% (see also Chapter 13, Section 13.8.2.1).

For a turn executed at very slow speed (say <10 km/h), the desirable maximum adverse crossfall should be -5% with an absolute maximum of -7%.

7.7.4 Median Crossfall

Medians up to 8 m wide are generally level or follow the crossfall of the road. Depressed medians greater than 8 m wide should have a desirable crossfall of 1 on 10 (see also Section 7.5, Figure 7.6).

At intersections where signals are to be installed, the median cross slope must match the slope of the road through the intersection and should not be greater than 6%.

7.7.5 Footpath Crossfall

It is usual to slope the footpath towards the road so that water does not drain on to adjoining properties. Where it is not possible to do this, drainage onto adjacent properties will have to be arranged with the property owners. It is not usually an issue in rural areas.

The design of the footpath requires consideration of several factors:

- Drainage across the footpath;
- Pedestrian requirements for a walkway;
- Use by wheel chair bound people; and
- Requirements for visually impaired people.

Drainage is best served by a crossfall of 3% but this conflicts with the need to accommodate wheel chairs. A maximum crossfall of 2.5% should be adopted to accommodate wheel chairs - 2% is preferred (see AS1428.1). In these circumstances, care will be required to ensure that water does not accumulate on the walkway or become a hazard to people with disabilities.

Provision for visually impaired people should be in accordance with Australian Standard AS 1428.4.

Figure 7.13 illustrates these requirements.

7.7.6 Parking Lane Crossfall

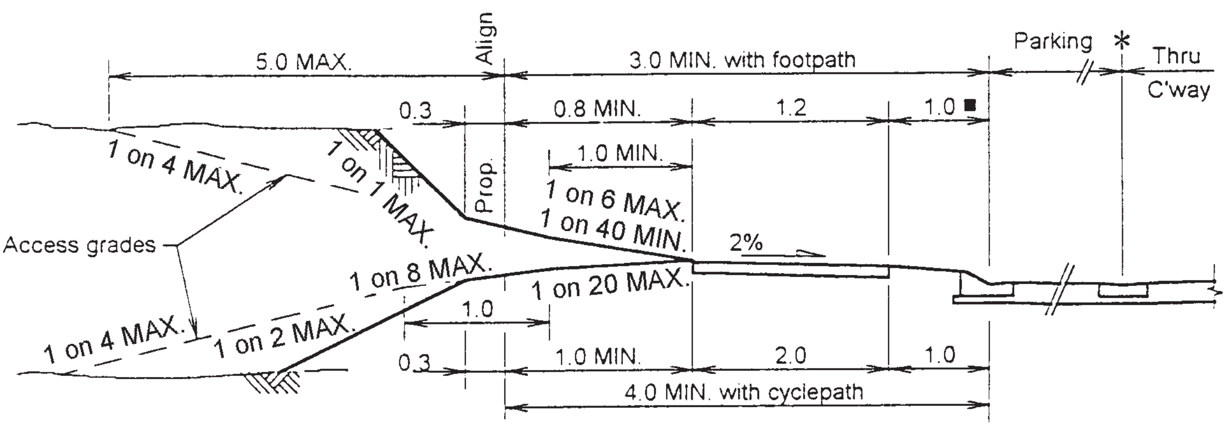
In general, the crossfall on the parking lane should be the same as the through lanes, but in some situations the crossfall may be varied. The maximum crossfall of the parking lane should be 5%. The maximum algebraic difference between the through lane and parking lane should not exceed 8%. (Reference - Qld Department of Main Roads: Urban Road Design Volume 1, 1975 - Chapter 3 and Main Roads Deparment Qld - Road Design Manual Volume 1 - Chapter 7.)

7.7.7 Crossfall Configuration on Side Slopes

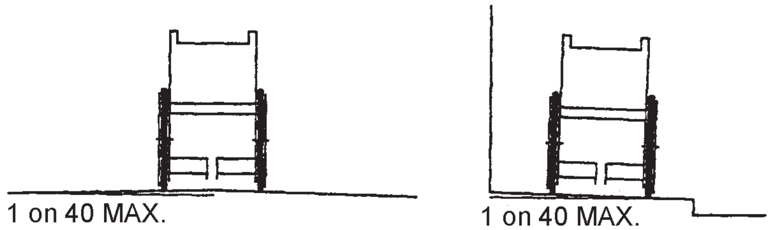
Where there are significant differences in levels between opposite sides of a road, many problems occur with conventional design including restoration of access and costly adjustments to properties or public utilities. An option to consider is to adopt a one way crossfall.

In these circumstances the one-way crossfall should not exceed 4% (3% is preferred). For aesthetic reasons the slope should extend full width between gutters (from lip to lip, including the median). However, if drainage into the gutter on the high side is considerable, the crossfall of the kerbside lane can be reversed to a maximum of 4% to increase the gutter capacity. The resulting break in the crossfall is called an offset crown and is usually located at the offside edge of the kerbside lane. The development of the offset crown requires careful design to avoid having the crown cross vehicle paths. Figure 7.14 shows both desirable and undesirable methods of developing an offset crown.

Whilst a one-way crossfall design is often satisfactory in sloping country, there are areas with steep slopes where this method will not meet requirements. Under these conditions it may become necessary to consider other solutions,



(a) Footpath Details



(b) Maximum Allowable Camber and Crossfall for Ramps and Walkways for Wheelchairs

Figure 7.13 Footpath Crossfalls

such as providing parallel service roads or split level carriageways.

Widening Two Lane Roads - Offset Crown

Where an existing two lane road is to be widened, it may be more economical to widen on one side, retaining the existing crown of the road. This will result in an offset crown to one side of the new centre line. Provided that the offset crown is not more than 1.5m from the new centre line, this result is acceptable. The crown line in these circumstances is barely perceptible to the driver. However, where the offset crown is closer to the edge line than the centre line, the effect is disturbing to the driver and is unacceptable.

7.7.8 Split Level Carriageways

In extreme cases of side slope it may be necessary to adopt a split level carriageway by providing a steep batter or retaining wall in the median.

Attention needs to be given to the following design aspects of split level carriageways in urban areas:

- provision for pedestrians;
- access for local traffic;
- the design of intersections;
- the provision of traffic signals, and
- the provision of a central traffic barrier.

For rural situations, attention must be given to:

- access for local traffic;
- the design of intersections; and
- the provision of a central traffic barrier.

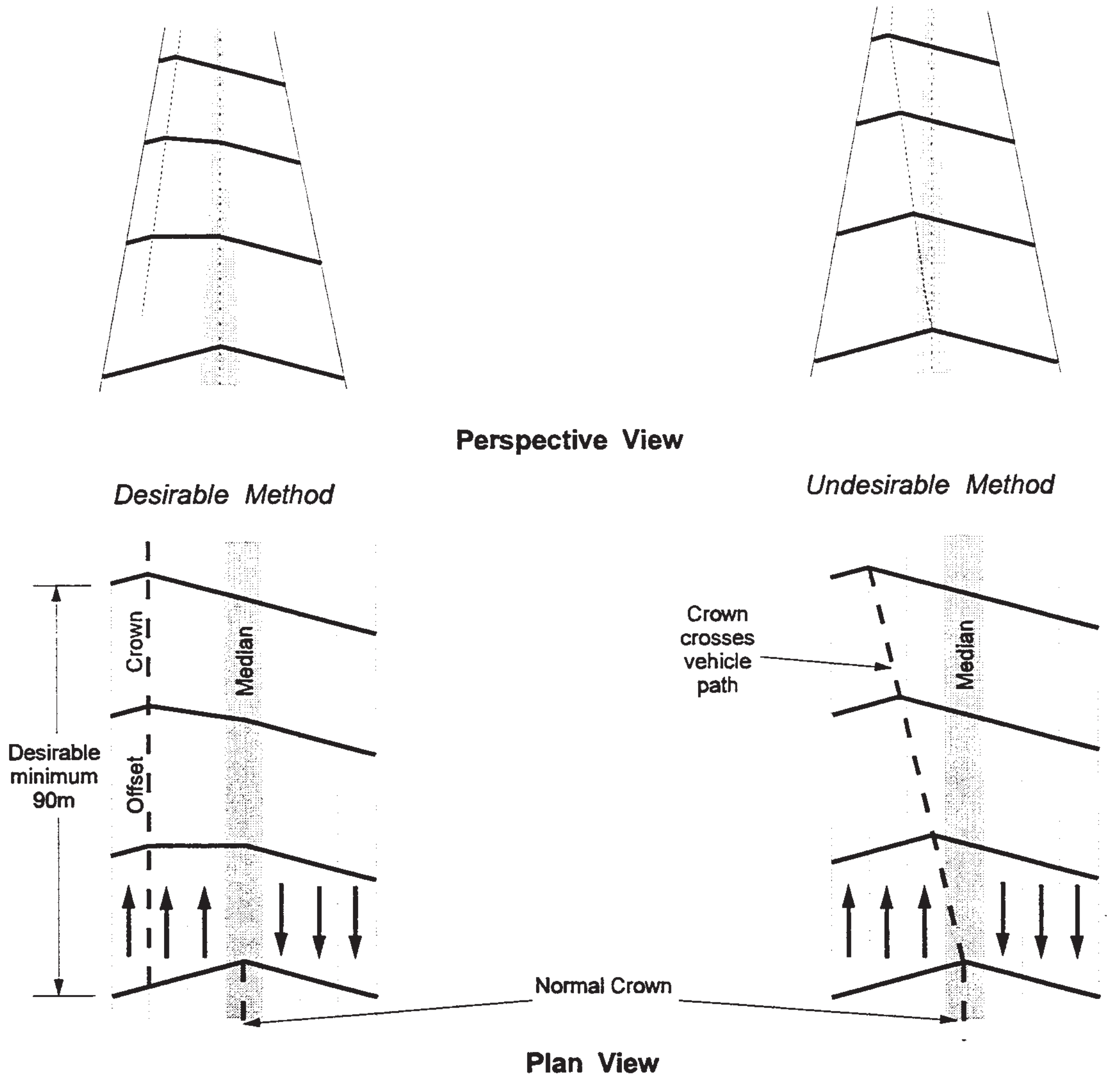


Figure 7.14 Development of Offset Crown

7.8 Batters

7.8.1 Batter Slopes

Batters are the side slopes of cuttings and embankments. The slope is expressed as a ratio, one unit of vertical rise on the horizontal distance X (1 on X).

Maximum slopes are determined from the geotechnical properties of the materials involved. Consideration should be given to the following factors when selecting batter slopes:

- the test results and any recommendations given in the geotechnical report;
- the effects of long term exposure to the elements (weathering) on the stability of the cutting;
- lining the catch drains to minimise failure of the cutting by the leaching of fines through the exposed cut face;
- erosivity of the batter soils;
- the ease and cost of maintaining the adopted batter slope;
- traffic safety and possible economy by eliminating safety barriers and using flatter slopes;
- appearance and environmental effects, and

- the overall economy of the project.

Slopes flatter than the maximum should be used where possible. Generally flatter batter slopes are safer, more resistant to erosion and have a better appearance. The cost of stabilizing, planting and maintaining steep slopes may exceed the cost of the additional earthworks and road reserve required to provide a flatter, possibly traversable slope. Flatter slopes also reduce the extent of safety barrier and reduce potential environmental impacts (erosion and sedimentation). However, the impact of flatter batters must be balanced against the desirability of retaining significant native flora, other environmental issues and property impacts.

Maintenance vehicles can work on slopes up to 1 on 3 but 1 on 4 slopes should be used where practicable.

On cut and fill slopes less than 1m high, batters not steeper than 1 on 6 are preferred.

For initial planning adopt slopes of 1 on 3 to 1 on 4 for heights of cut (excluding rock) and fill up to 2.0 m (3.0 m on Highways and Motorways). Above these heights, 1 on 2 may be adopted but it is preferable to use 1 on 3 maximum wherever practicable at the planning stage. Actual slopes adopted in design must consider all of the factors discussed.

Fill Batters

In addition to the general requirements set out above, it is desirable for fill batters to be as flat as possible. Fill batter slopes flatter than 1 on 4 (1 on 6 preferred) should be used wherever practicable. The maximum fill batter slope should be no steeper than 1 on 2 (1 on 3 preferred) to assist revegetation. Where practicable:

- adopt 1 on 4 slopes wherever mowing is required, and
- flatten batters as a preferred treatment to providing guardrail.

Where excess spoil is available, consider flattening the fill batters to 1 on 6 over the width of the clear zone, increasing the slope beyond the clear zone to a maximum of 1 on 3. Alternatively, a continuous flatter slope not steeper than 1 on 4 could be used.

Cut Batters

Earth cut batter slopes should not exceed 1 on 2 unless the constraints are such that a steeper slope is required and the Geotechnical investigation shows that steeper slopes are stable.

In rock cuttings:

- adopt an absolute maximum slope (subject to geotechnical acceptability) of 1 on 0.25;
- place benches at suitable locations in cuttings over 10 m high (see 7.8.4);
- provide access through any debris barrier to assist removal of debris;
- provide appropriate clearances between the top of the batter and other obstructions and the boundary to assist maintenance including collection of debris from cutting slopes;
- provide catch banks at the top of the batter.

7.8.2 Traversable Batters and Batter Rounding

Rounding at tops of cuttings and embankments can reduce scouring, remove loose material and improve the appearance of the road. The amount of rounding on the top of cuttings usually depends on the material, the depth of rock (if any) and the natural contours of the ground.

Traversable embankment batters assist by providing an errant vehicle an opportunity to recover and return to the through carriageway, by maintaining all wheels in contact with the ground.

Traversable batters shall have the following attributes:

- embankment batter slopes of 1 on 4 or flatter;
- cutting batter slopes of 1 on 3 or flatter;
- roundings shown in Figure 7.16 or greater at hinge points;
- channels with 1 on 4 slopes or flatter.

1 on 3 embankment slopes can be traversed by vehicles but it is unlikely that it can recover on that slope - 1 on 4 accommodates recovery. On cut batters, the 1 on 3 slope directs the vehicle back to the road and therefore allows for recovery. A 1 on 4 slope allows this manoeuvre to be undertaken with better control than on the 1 on 3 slope.

Where batters have a potential impact severity of 3 or more (refer to Chapter 8), the surface finish is to be free of elements that may snag components of errant vehicles, causing them to yaw (spin) at unacceptable rates. The batter slopes are to be formed similar to accepted safety barrier shapes, especially at the entrance to cuttings.

7.8.3 Batter Slope Treatment

Variable batter slopes can be used to improve a road's appearance by blending it into the surrounding terrain. This treatment can smooth the transition between cutting and embankment, assisting the provision of lay-by areas.

Common treatments adopted are constant batter slope or constant batter catch point type. Constant batter catch points are preferred because of the improved appearance by blending various slope batters into surrounding terrain. Catch points at a constant distance (8m suggested) from the formation edge in light earthworks or at the ends of adjoining cuts and fills in heavier earth-works create a pleasing appearance at very small additional cost and should be adopted wherever practicable (see Figure 7.15 and 7.15(a) and the Road Landscape Manual, Main Roads 1998).

The appropriate top and toe of batter surroundings, relative to the road shoulder and to the natural terrain, are based on the following assumptions:

- the 85th percentile angle of departure from the roadway by an errant vehicle has been assumed to be 22° (average).
- the batter slope is suitably compacted and graded, and free of obstacles that may cause vehicle snagging.

Figure 7.16 provides the dimensions to be used.

Cut batters often require some form of treatment to minimise erosion and provide for stabilising the slope surface. Revegetation should be encouraged as far as possible. Where designed landscaping is implemented, the treatments will be defined and may vary from reasonably flat slopes on which formal planting is undertaken, to slopes as steep as 1 on 2 where hydraulic seeding and mulching may be carried out. In other cases, revegetation will occur more readily if the batter slopes are constructed to hold topsoil and minimise erosion. Stepped (or serrated) batters (as illustrated in Figure 7.17) may often provide the necessary conditions for revegetation but these should not be used in dispersive soils (e.g. sodic soils). Further environmental considerations and guidelines for designing batters are provided in Chapter 3.

The slope and treatment to be adopted is influenced by the type of material encountered and the available right of way. Figure 7.18 illustrates several alternative treatments that may be used subject to the stability of the slopes and walls involved.

7.8.4 Benches

A bench is a near horizontal ledge that is constructed on a side slope to provide sight distance, slope stability and assist with batter drainage.

Benches are used on the face of batters to:

- reduce surface water run-off;
- accommodate a change in the batter slope or batter material;
- provide maintenance access, and
- catch falling debris from the batter face.

The normal width of a bench is 5.0m (with a minimum of 3m), the edges of which should not be rounded (see Figure 7.19).

Benches are sloped away from the carriageway and drained towards the ends of the cutting. The longitudinal grade of the bench must be determined in conjunction with the necessary erosion control measures.

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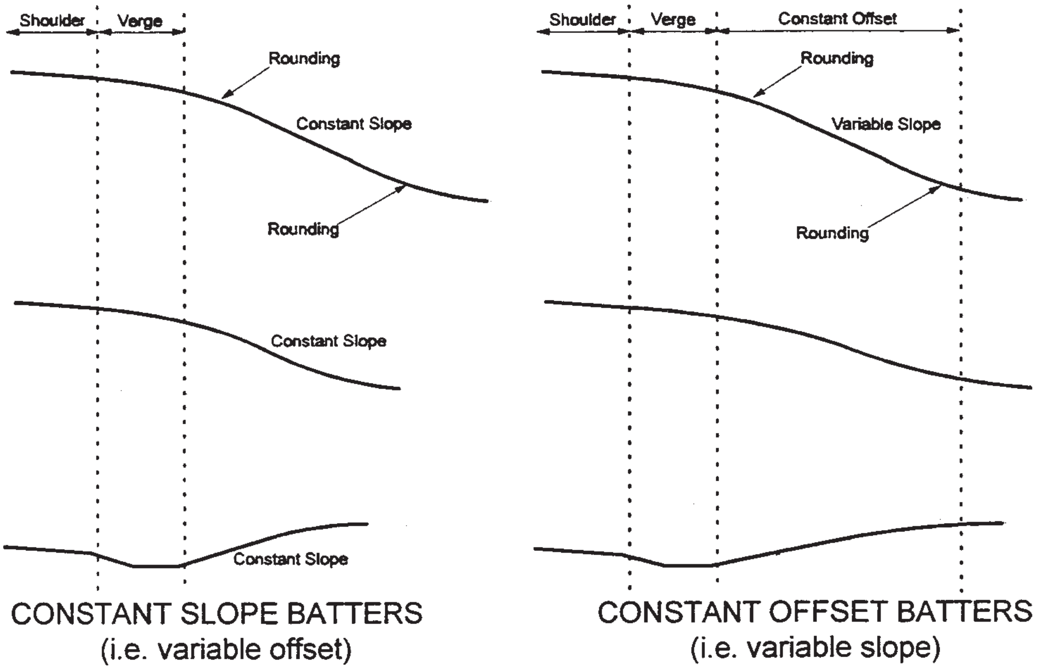

Figure 7.15 Batter Slope Treatments

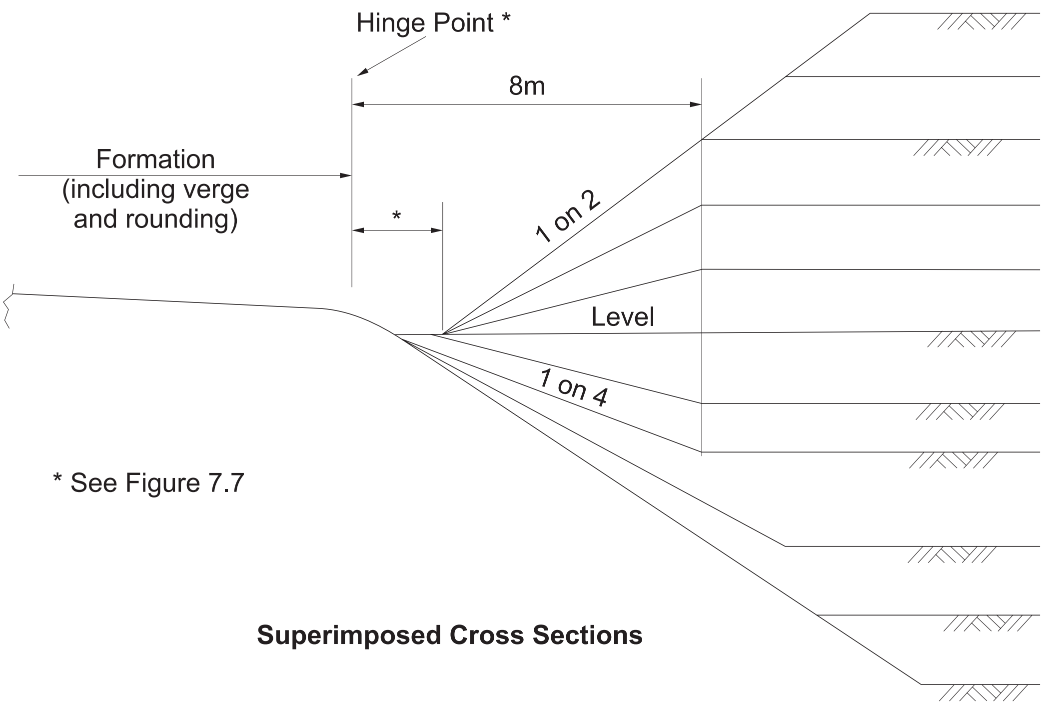

Figure 7.15 (a) Transition of Batters from Bank to Cutting

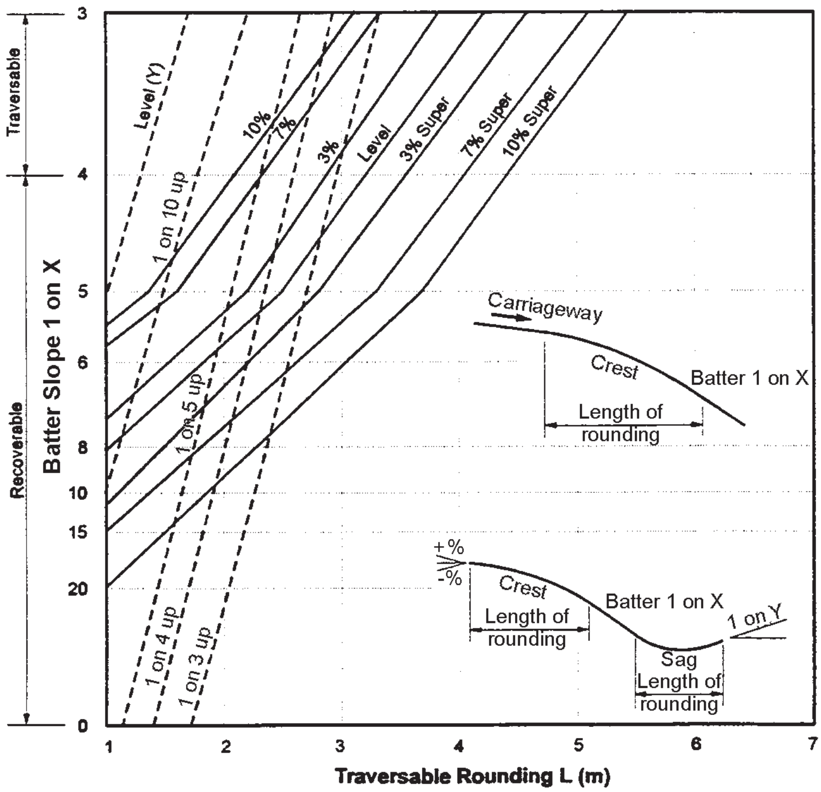

Figure 7.16 Desirable Crest and Sag Roundings

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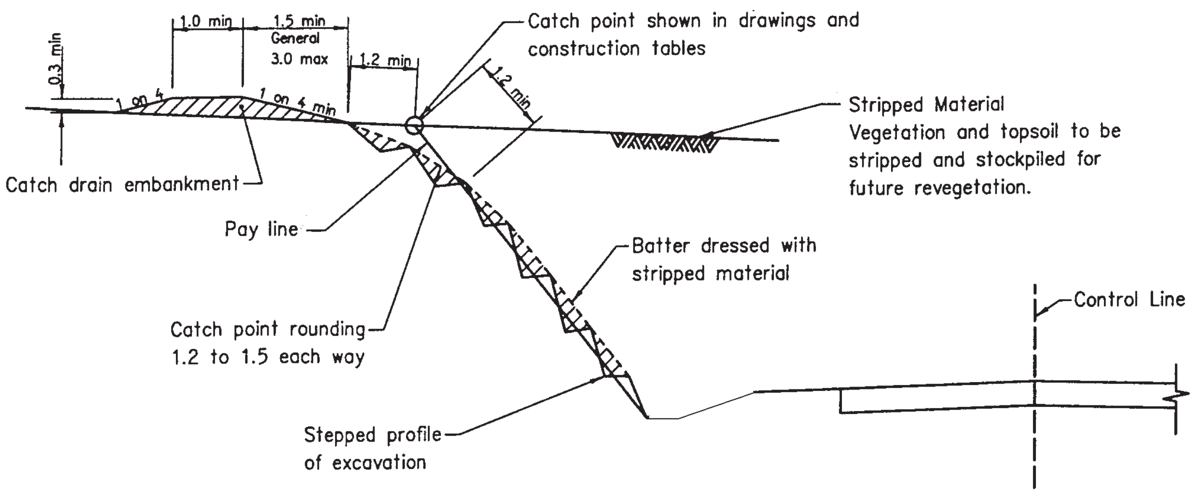
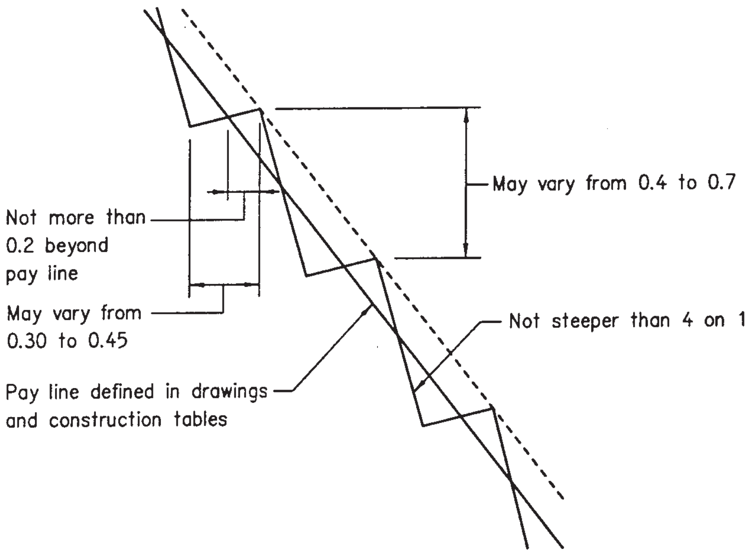


SECTION - STEPPED CUT BATTER



N.B.
- Only suitable for batters between 1 on 3 and 1 on 1.
- Flatter batters should be treated by contour ripping and top soiling.
- Steeper batters require special treatment.
- NOT to be used in dispersive soils.

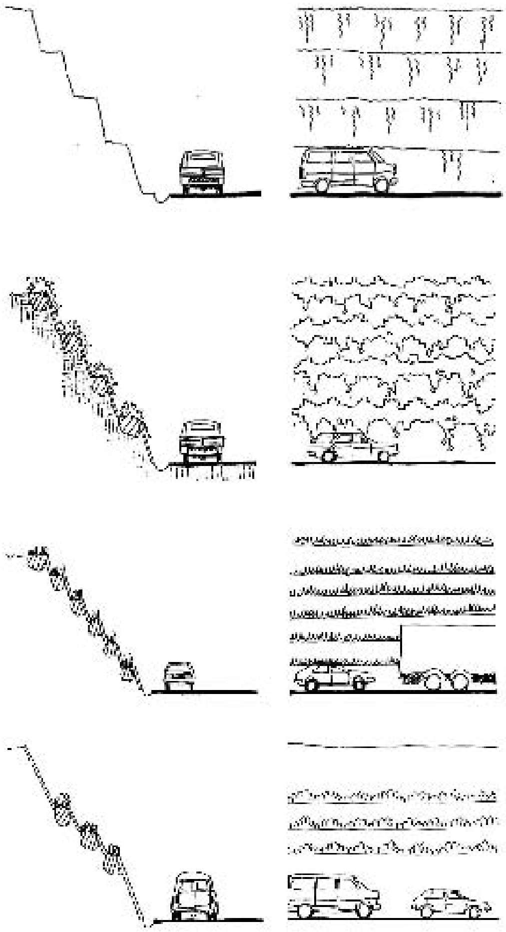
DETAIL

NOTES :
1. ALL DIMENSIONS are in metres.

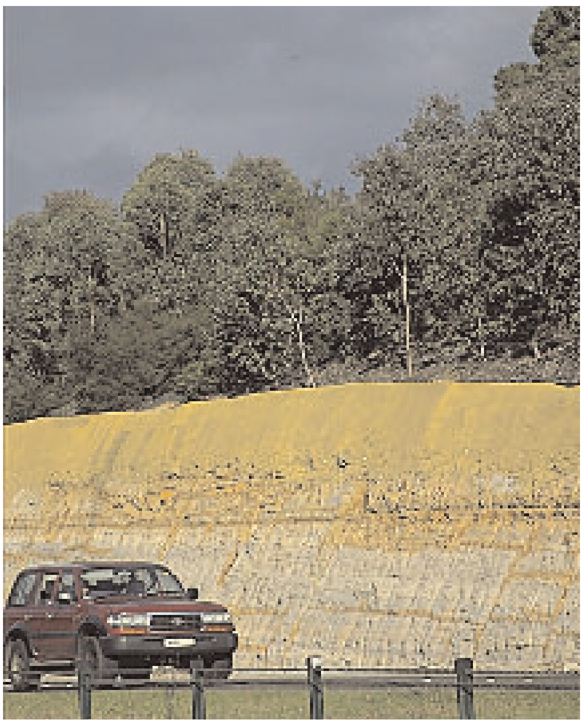
ASSOCIATED DOCUMENTS:
Department of Main Roads Manual of Standard Drawings Roads
Department of Main Roads Manual of Standard Specifications Roads

REFERENCED DOCUMENTS:
Standard Specifications:
General Earthworks

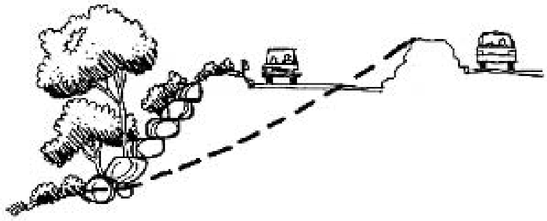
Figure 7.17 Treatment of Cut Batters for Revegetation



Benching



Visual Effect of Steep Cut Slope



Source: RTA (1993)

Rock Armouring Alternative to Fill Slope

Planting at the Base of Steep Slopes

Straw Mulching

Figure 7.18 Alternative Treatment for Batters *(Source: Road Landscape Manual)*

Where visibility benching is required, the preferred treatment is to include the bench as a widened table drain with a flat bottom at least 1.8 m wide. (Refer to Chapter 9 for more details on visibility benching.)

See also 7.11.2.

7.8.5 Rock Fall Protection

Where there is potential for rock falling from the face of a cut batter on to the road surface, action to prevent the rock from rolling on to the surface of the road is required. A table drain with a base at least 1.8m wide would normally be adequate.

However, where a table drain of inadequate width is to be used, the road should be protected with a chain wire fence erected outside the shoulder edge behind the kerb delineating the shoulder. Figure 7.19(b) illustrates this requirement.

7.9 Drainage

7.9.1 Table Drains

Table drains are located within the verges in cuttings. Their purpose is to collect surface water draining from the carriageway and adjacent cut batter, carrying the water to a suitable point of discharge beyond the cutting. The invert of the table drain must be lower than the pavement sub-base to allow efficient drainage of the pavement layers.

Flat bottomed table drains (1.8 m wide for ease of maintenance) are preferred. However, this should not be accomplished at the expense of making the cut batter steeper than 1 on 3. Erosion is less in flat bottomed channels and some advantage is gained even if 1.8 m cannot be achieved. A minimum total verge width of 2.0m (see Figure 7.7) provides space for a mower to operate. For the worst case, the residual grass length will be 90mm longer on one side.

If it is necessary to deepen the table drain, the cutting should be widened so that the maximum 1 on 4 side slope is maintained. Desirably the depth should not exceed 1m.

The minimum longitudinal grade in an unlined table drain is 0.5%. However, flow velocities in unlined table drains should not exceed 1m/s. Velocity of flow must be limited to this or lining will be required.

The arris formed by the side of a table drain and the shoulder should be rounded to minimise damage to errant vehicles.

Lined table drains should be used in place of unlined drains for grades less than 0.5% (minimum 0.2%), or where velocities are likely to cause scouring (1m/s or greater). Lined table drains may be formed in the shape of the Type 28 gutter as shown on Figure 7.21 or specially designed to suit the conditions.

On both the nearside and the offside of each carriageway in a cutting, a 1.0 m wide Type 28 drain will be provided if the drain falls within the shoulder. Where superelevation is provided it will be permissible for the water on the off side to run straight into the median. However, consideration is to be given to the provision of a Type 28 drain on the offside edge.

7.9.2 Catch Drains and Banks

Catch drains are located on the high side of cutting slopes behind the batter rounding. Their purpose is to intercept the flow of surface and seepage water within the upper soil layer to prevent erosion of the batter face.

Catch drains should be constructed to have a rounded or trapezoidal cross section (see Figure 7.20), rather than a 'V' shaped cross section (which are subject to erosion).

Depending on the runoff velocity, catch drains should be stabilized immediately by seeding, turfing, planting in conjunction with jute mesh, bitumen, masonry, rock mattresses or concrete lining. Where an un-lined drain is to be used, the designer must consider both the long term performance of the treatment AND the likely performance of the treatment during the establishment period.

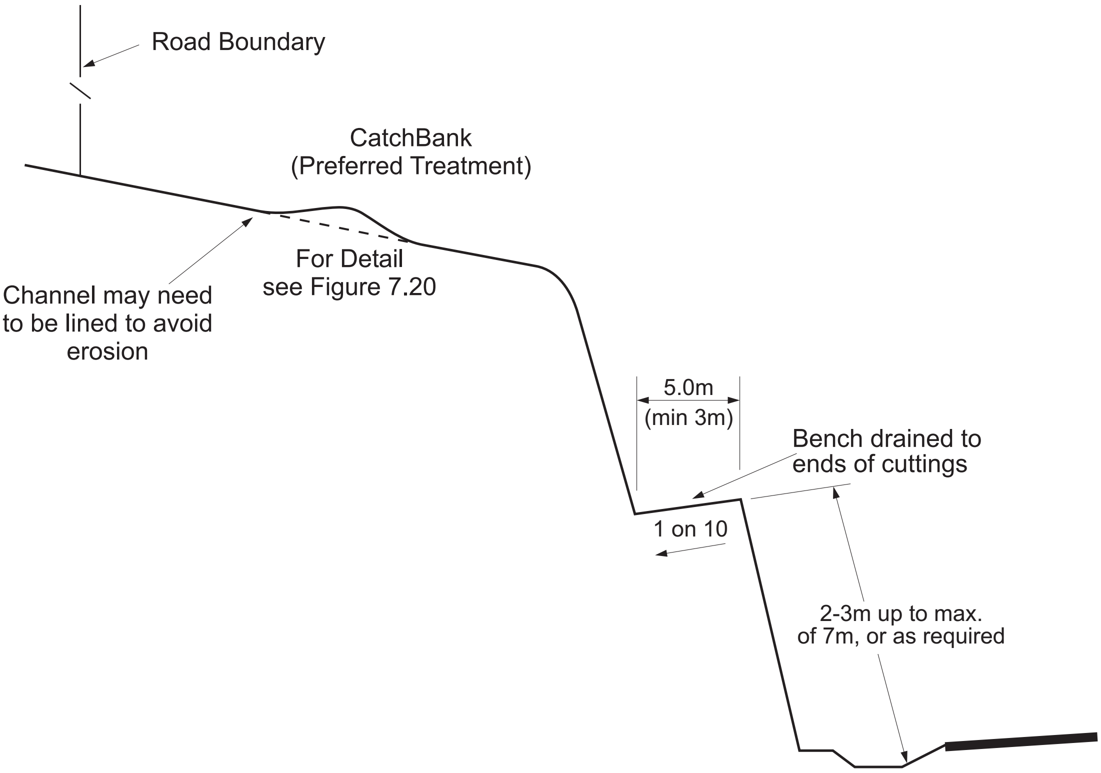


Figure 7.19 Location of Benches in Cuttings

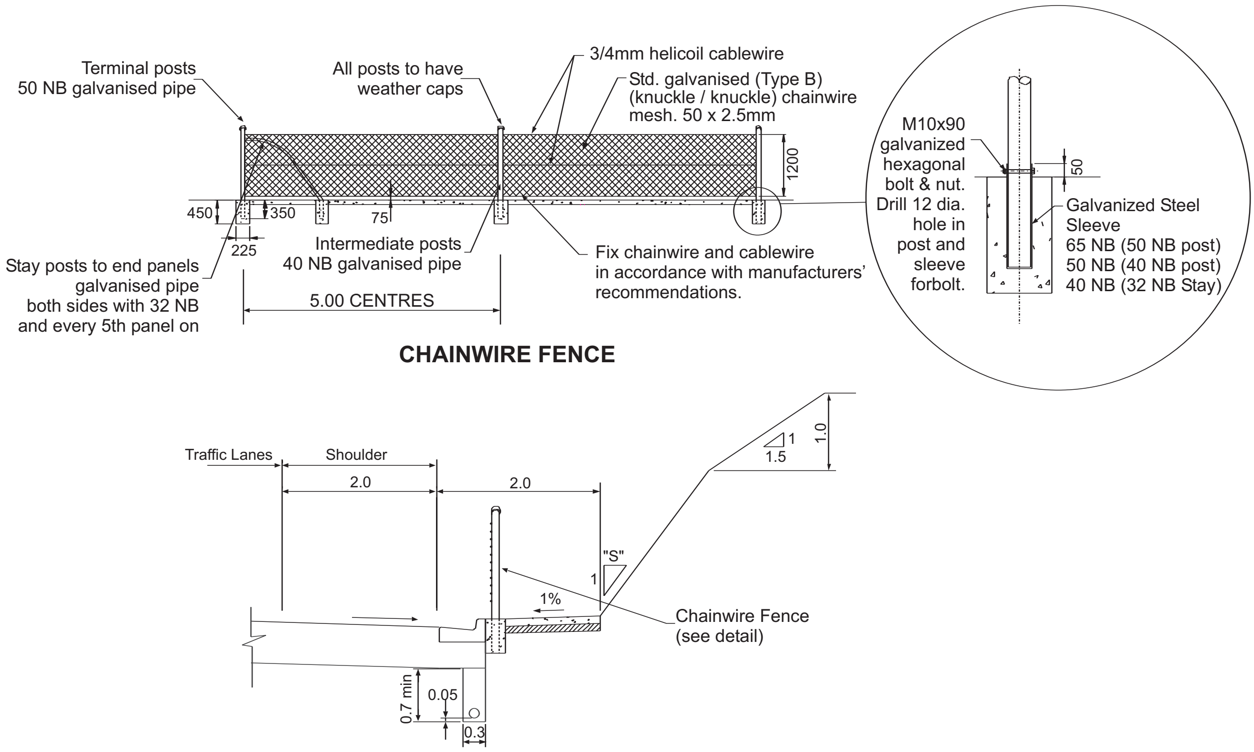


Figure 7.19(b) Rock Fall Protection

In areas where the catch drain is susceptible to scour, the surface water should be intercepted using a catch bank placed on the natural surface on the high side of the batter point. There is no excavation of the surface to provide the earth for the bank or to create the drain. The natural surface is therefore not disturbed and not exposed to erosion to the same degree.

7.9.3 Dykes

A Dyke is a low, longitudinal mound of earth, asphalt or concrete, provided near the edge of embankments when it is required to protect the batters from erosion, by controlling the water movement off the road pavement surface. It is located under the guardfence on the lower side of the pavement crossfall. Location of the dyke with respect to the face of the guardrail is critical for safety reasons. (See Chapter 8.)

7.9.4 Batter Drains

Batter drains are provided on embankments to transport the water from dykes to the bottom of the batter. They are spaced at intervals which meet the maximum flow width criteria. The location and design treatment of batter drains are detailed in the Road Drainage Design Manual (Main Roads, 2001).

7.9.5 Kerbs, Channels and Access Chambers

Kerbs are used to separate areas used by vehicles from areas used by other modes of transport, or areas to be put to other uses. Channels are used to collect and convey surface drainage to a discharge or collection point. Kerbs and channel are usually combined but may be used as separate elements. Stability of a kerb only element may be an issue where the kerb can be impacted by traffic since it can easily be knocked out of alignment.

The main purposes of Kerb and Channel are to:

- Provide lateral support to the pavement;
- Collect surface drainage and convey it to a point of discharge;
- Manage a level difference between the footpath and the carriageway;

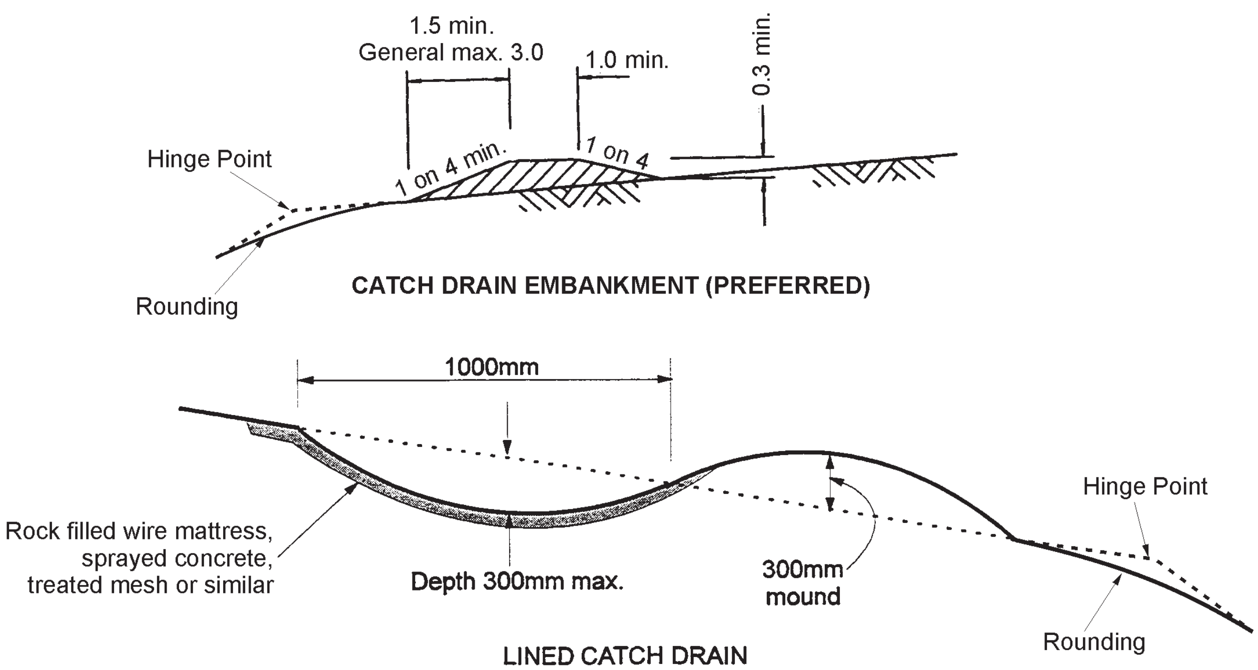


Figure 7.20 Typical Catch Drains

- Act as a longitudinal delineation of the edge of carriageways;
- Separate carriageways from pedestrian and cyclist areas; and
- Reduce the width of cuttings by substituting an underground drainage system for the usual table drains.

The principal types of kerb are:

- Barrier - face sloped at 1 on 0.25;
- Semi-mountable - face sloped at 1 on 1.5; and
- Mountable - face sloped at 1 on 7.5.

Barrier kerb has been used to provide a measure of protection to pedestrians adjacent to traffic lanes and it encourages drivers to steer clear of the kerb. It is therefore an appropriate type of kerb to use on inner city streets where pedestrians are in significant numbers and speeds are low.

Barrier kerbs should not be used on high-speed roads, as it is more likely to trip and overturn a vehicle that is out of control. These kerbs should be avoided on the outside of low radius curves as it can contribute to truck rollovers. If kerb and channel is essential in these cases, sufficient clearance to avoid the outwards tail swing of large trucks (check with VPATH) must be provided.

Semi-mountable kerbs are the standard type of kerb and channel used for delineation and drainage on all intersections.

Mountable kerb is suitable for the outside of curves on interchange ramps, on the approach noses of exposed islands and for the separation of normal traffic lanes from special areas intended for use by over-dimensional vehicles in medians or roundabouts.

Figure 7.21 shows the standard shapes, dimensions and applications of kerbs and/or kerb and channel that may be used. Designers should use the most appropriate kerb type for the specific project.

Designers should:

- avoid barrier kerb adjacent to high speed carriageways;
- provide adequate clearance to mountable or semi-mountable kerbs if used adjacent to high speed carriageways;
- avoid or minimise kerbing near safety barriers to improve safety (details of clearances required are given in Chapter 8);
- include 1.5 m (min.) transitions to change from one kerb type to another (semi-mountable to barrier; new kerb to existing of a different shape);
- adopt 450 mm channel where kerb and channel is required unless special circumstances apply;
- provide 50 mm Asphalt Allowance for all barrier and semi-mountable kerb not installed on a concrete pavement where the traffic volume is expected to exceed 10,000 veh/day within the design life of the project;
- use kerb that includes a backing strip in areas subject to mounting by overdimensional or heavy vehicles;
- ensure that all grates located adjacent to sealed shoulders or bicycle lanes are bicycle safe in accordance with Australian Standard AS3996.

In general, access chambers should be located clear of the carriageway. This provides for easier construction of the pavement and removes a source of potential maintenance problems. It is also safer for workers using the access chambers.

Where it is not possible to locate the access chamber clear of the carriageway, it should preferably be placed in the parking lane. The case of existing access chambers located in the carriageway is discussed in Section 7.5.2.

7.9.6 Floodways

General

Where floodways are used, it is desired to provide reasonable uniformity in selecting floodway widths throughout the State without limiting consideration of particular features of one site or locality in arriving at the appropriate design.

7

Width Range

Long Floodways: The following points refer to floodways comprising more than an isolated dip (the usual case of a floodway taking flood channel flows):

- The general minimum formation width should be 8.6m, with some relaxation possible on roads under 150 veh/day;
- The general maximum formation width should be 10.0m, unless the additional costs of achieving full formation width are not significant;
- The minimum shoulder protection should be 1.0m;
- The maximum shoulder protection should be 1.5m;
- The balance between pavement widening and shoulder width should be determined by local conditions. In the general case where shoulder protection is more expensive than paving material, the former would tend to the narrower limit. In more remote areas where paving material can be more expensive than an "adequate" material for cement treated shoulders, the reverse would occur.

The above criteria lead to Table 7.16 of width ranges related to pavement and shoulder widths (see Section 7.2.2).

Short Floodways: Where the floodway is short and confined to a main flow channel, especially where sight distance is close to the minimum for the operating speed of the road, consideration should be given to providing a full formation width floodway.

Safety Barriers/Bridge Rails

Safety barrier will reduce the efficiency of the floodway in times of flood, but may be desirable from the point of view of traffic safety at other times. Whether safety barrier should be installed in a particular case should be determined locally, but where associated with a bridge structure:

- when the bridge is full floodway width, and the main channel is shallow, consideration should be given to omitting bridge rails and safety barrier. However, road edge guide posts may be provided on the floodway with reflectorised hazard markers at the bridge abutment;
- when the bridge is narrower than the floodway or the channel is deep it may be desirable to use rails with at least the minimum length of safety barrier on the floodway approach to the bridge. The conflict of goals i.e. delineation as against obstruction in flood time cannot be determined by a general policy but must be decided locally by consideration of the specific case.

Table 7.16 Width Ranges

Pavement Width (m)	Shoulder Width (m)	Formation Width (m)	Floodway (m)	
			Elementary Widths	Total Width
4.0	2.5	9.0	7.0 + 2 x 1.0 to 7.0 + 2 x 0.8	9.0 8.6 (1)
6.0	1.5	9.0	7.0 + 2 x 1.0	9.0
6.0	2.0	10.0	7.0 + 2 x 1.5 to 8.0 + 2 x 1.0	10.0 10.0
6.5	1.5	9.0	8.0 + 2 x 1.0	9.0
6.5	2.5	11.5	8.0 + 2 x 1.0	9.0
7.0	2.0	11.0	8.0 + 2 x 1.0	10.0 (2)
7.0	2.5	12.0	8.0 + 2 x 1.0	10.0 (2)

NOTES:

1. The general minimum formation width is 8.6m. However, on lightly trafficked roads at the discretion of the District Director this may be reduced to 7.4 or 8.0m.
2. The general maximum is 10.0m. However, where the cost of maintaining the larger width across the floodway is not excessive, the full width may be maintained at the discretion of the District Director.

7.10 Bridges and Clearances

7.10.1 Road Bridge Widths

Bridges comprise a relatively small proportion of the total road length, but they are proportionally much more expensive. They do, however, have a much longer life than other elements of the road structure and the width determined for a bridge should be based on a longer period of traffic growth than for other elements.

Bridge widths shall be determined from Table 7.17 or from Table 7.18. Departure from the indicated widths may be required to satisfy particular situations.

For example, if the bridge is located in or near built-up areas, or is part of a local or regional cycle route, it will need to be designed to accommodate cycle and/or pedestrian traffic. This may be in form of wider shoulders or a separate pedestrian facility on one or both sides of the bridge.

On roads with significant numbers of road trains, sufficient width is required to allow two road trains to pass safely. This will be particularly important if the bridge is on a curve.

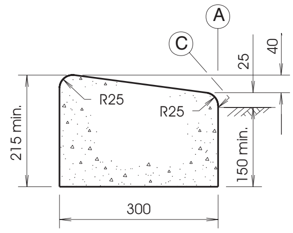
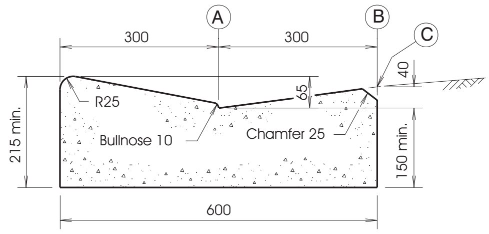
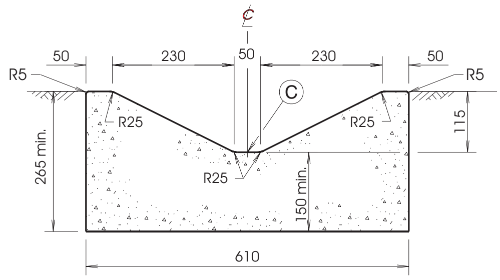
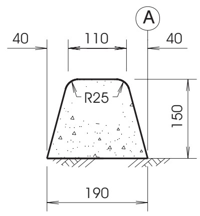
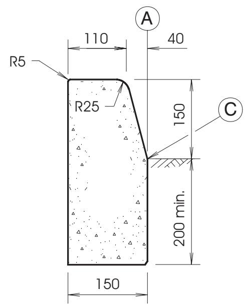
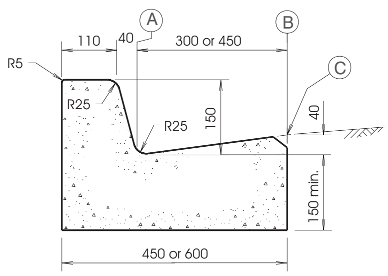
The widths for National Highways shown in Table 7.17 are derived from the published Standards and guidelines for National Highways:

- For lengths less than 20m - the carriageway width (see sections 7.2.5 and 7.3.7 for the elements of width);
- Where the AADT across the bridge is expected to exceed 1000 per lane within 20 years of the works being opened to traffic - the width of the traffic lanes plus 2.4m; and
- For all other cases - the width of the traffic lanes plus 1.2m.

In all cases, the needs of cyclists must be considered and appropriate allowance made.

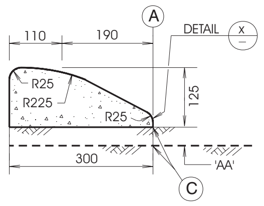
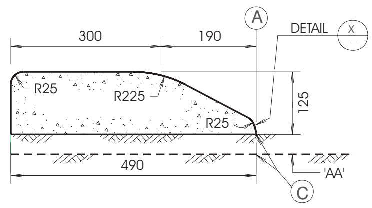
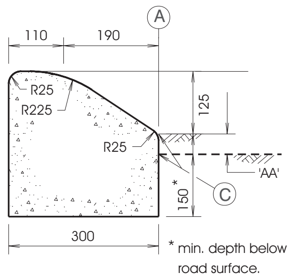
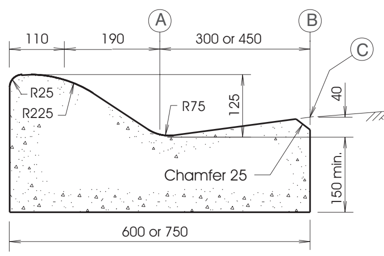
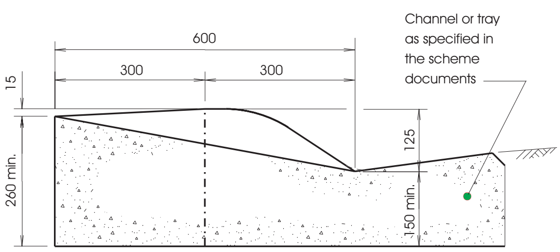
The widths for roads other than National Highways shown in Table 7.18 are based on the following approach:

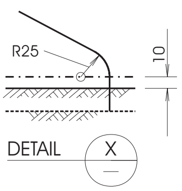
- For bridges shorter than 20m in length - the carriageway width (see section 7.2 and 7.3 for the elements of width);
- For bridges longer than 20m - the width of the traffic lanes plus 1.0m clearance each side.

TYPE	TYPICAL USE	PROFILE AND DIMENSIONS
1	Mountable	
2	Mountable with channel	
3	Channel: Medians and Table Drains	
4	Barrier on road surface: Dykes; Islands and median edges at pedestrain crossings and signals.	
5	Barrier below road surface: As for 4	
6 **(300ch)** **&** **7** **(450ch)**	Barrier Kerb and channel: As for 4	

REFERENCE POSITIONS: Ⓐ Line of kerb Ⓑ Line of channel Ⓒ Height reference

Figure 7.21 Standard Kerb Shapes

TYPE	TYPICAL USE	PROFILE AND DIMENSIONS
8 & 9 (with AA)	Semi Mountable kerb on road surface: Medians and Islands; embankment margins.	
10 & 11 (with AA)	Semi Mountable kerb: Backing strip on road surface As for 8 & 9 where over dimensional vehicles traverse kerb.	
12 & 13 (with AA)	Semi Mountable kerb below road surface As for 8 & 9	
14 (300ch) & 15 (450ch)	Semi Mountable kerb and channel: Parking lanes, medians where drainage required.	 WITH CHANNEL
16 (300 ch or tray) & 17 (450 ch or tray)	Ramped vehicular crossing: Accesses to property	



"AA" = Asphalt Allowance

Figure 7.21 Standard Kerb Shapes

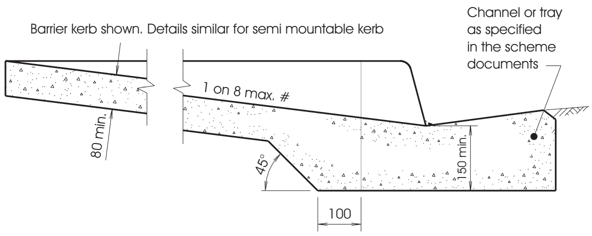
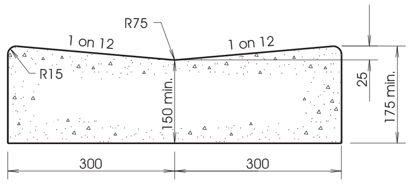
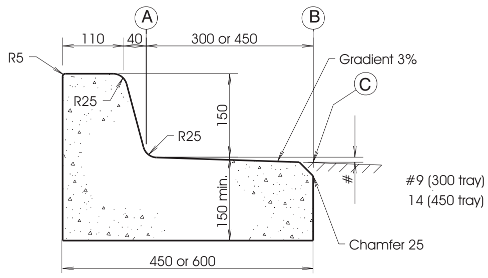
TYPE	TYPICAL USE	PROFILE AND DIMENSIONS
18 **(*BK & 300 ch or tray)** **19** **(*BK & 450 ch or tray)** **20** **(*SMK & 300 ch or tray)** **21** **(*SMK & 450 ch or tray)**	Ramped pedestrian crossing	 * BK = Barrier Kerb * SMK = Semi Mountable Kerb # Max. ramp slope for wheelchair access shall be 1 on 8.
22	Channel Adjacent to shoulders	
23 **(300 tray)** **&** **24** **(*BK & 300 ch or tray)**	Barrier Kerb and Tray: Medians and Islands adjacent pedestrian crossings and signals	

Figure 7.21 Standard Kerb Shapes

<table>
<tr><th>TYPE</th><th>TYPICAL USE</th><th>PROFILE AND DIMENSIONS</th></tr>
<tr><td>25
(300 tray)
&
26
(450 tray)</td><td>Semi Mountable Kerb and Tray

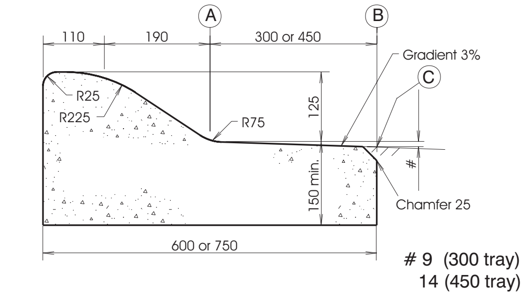
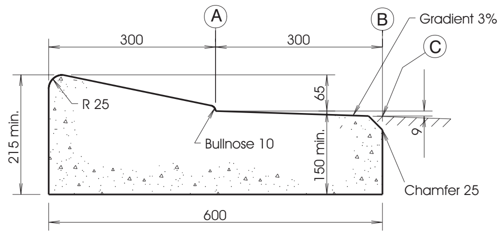
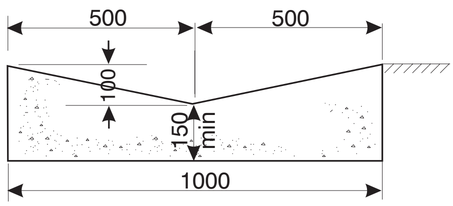
Medians and Island</td><td>
</td></tr>
<tr><td>27</td><td>Dished Crossing</td><td>
</td></tr>
<tr><td>28</td><td>Dished Crossing increased waterway</td><td>
</td></tr>
</table>

Figure 7.21 Standard Kerb Shapes

Table 7.17 Bridge Carriageway Widths - National Highways

Bridge		Two Way								One Way							
		Single Lane				Two Lane				Single Lane				Two Lane			
Length	AADT	Shldr	Lane	Shldr	Width	Shldr	Lanes	Shldr	Width	Shldr	Lane	Shldr	Width	Shldr	Lanes	Shldr	Width
<20	<3000(a)	-	-	-	-	1.5	7.0	1.5	10.0	2.0	3.5	1.0	6.5	-	-	-	-
<20	>3000(a)	-	-	-	-	2.0	7.0	2.0	11.0	2.0	3.5	1.0	6.5	2.0	7.0	1.0	10.0
>20	<1000/ lane	-	-	-	-	0.6(b)	7.0	0.6(b)	8.2	2.0	3.5	1.0	6.5	-	-	-	-
>20	>1000/ lane	-	-	-	-	1.2(b)	7.0	1.2(b)	9.4	2.0	3.5	1.0	6.5	2.0	7.0	1.0	10.0

NOTES:
1. Wherever possible, bridge carriageway widths should equal the approach carriageway widths.
2. Use 3.0m shoulders adjacent to a barrier centreline marking or consider further widening to provide for auxiliary lane/s.
3. Add appropriate lane widths to the two lane configurations to determine multi-lane bridge widths.
4. All culverts are to be designed for full width of formation.
   (a) AADT within 10 years, other AADT's are within 20 years.
   (b) Minimum allowable shoulder widths have been used.
5. If a bridge is part of cycle route and/or is in a built-up area, extra shoulder width will be required to allow adequate cyclist access, and pedestrian facilities will be required.

Table 7.18 Bridge Carriageway Widths - Other than National Highways

Bridge		Two Way								One Way			
		Two Lane				Single Lane				Two Lane			
Length	AADT	Shldr	Lanes	Shldr	Width	Shldr	Lane	Shldr	Width	Shldr	Lanes	Shldr	Width
Any	<100	1.0	6.0	1.0	8.0	0.6	3.0	0.6	4.2	-	-	-	
Any	100-500	1.0	6.0	1.0	8.0	2.0	3.0	1.0	6.0	-	-	-	
Any	500-1000	1.0	6.5	1.0	8.5	2.0	3.25	1.0	6.25	-	-	-	
<20	1000-2000	1.5	6.5	1.5	9.5	2.0	3.25	1.0	6.25	-	-	-	
>20	1000-2000	1.0	6.5	1.0	8.5	2.0	3.25	1.0	6.25	-	-	-	
<20	>2000	2.0	7.0	2.0	11.0	2.0	3.5	1.0	6.5	2.0	7.0	1.0	10.0
>20	>2000	1.0	7.0	1.0	9.0	2.0	3.5	1.0	6.5	1.0	7.0	1.0	9.0

NOTES:
1. Wherever possible, bridge carriageway widths should equal the approach carriageway widths.
2. Use 3.0m shoulders adjacent to a barrier centreline marking or consider further widening to provide for auxiliary lane/s.
3. Add appropriate lane widths to the two lane configurations to determine multi-lane bridge widths.
4. All culverts are to be designed for full width of formation.
5. AADT's are within 20 years.
6. If a bridge is part of cycle route and/or is in a built-up area, extra shoulder width will be required to allow adequate cyclist access, and pedestrian facilities will be required.

7.10.2 Pedestrian/Cyclist Bridges

The minimum vertical clearance to the underside of pedestrian/cyclist bridges over traffic lanes and shoulders is 5.5 m where the bridge is protected by other structures or more generally 5.7m. However, due to their lighter structure, consideration should be given to increasing this clearance to 6.0m, particularly at isolated sites. The requirements of Table 7.21 must be applied. Vertical clearances over footpaths should not be less than 2.4 m and desirably 2.5 m. Clearance over cycleways should not be less than 2.4m. If a lower height is used, signs to warn users of the low clearance should be installed.

Handrails on bicycle bridges are to be in accordance with Chapter 5, Section 5.5.5.

The minimum clear width of a pedestrian bridge should be 1.8 m. This width is adequate for the passage of up to 300 people per hour and allows two wheel chairs to pass.

For shared bicycle/pedestrian bridges, the minimum width is 3.0m. Where the volumes of pedestrians and/or cyclists is high, the two functions should be segregated and the appropriate width for each function applied (see Austroads, 1999).

Pedestrian and cyclist overpasses may need to be fully enclosed to prevent objects being thrown from them on to the roadway below.

7.10.3 Lateral Clearance

(a) Road

The lateral clearance from the edge of the travelled way to bridge piers, abutments, retaining walls and other fixed objects should conform to the requirements for clear zones (see Section 7.6). However, if the desirable clear zone cannot be achieved and it is not possible to remove the object from the clear zone (see Section 7.6), the object should be made frangible or protected by the installation of a traffic barrier, with attention being paid to the shy line effect and working width (see Section 7.2.1). Refer Table 7.19 for lateral clearance to fixed objects.

In general, shop awnings are to be set back a minimum of 0.6m from the kerb face. Clearance to awnings and buildings should be in accordance with the relevant Local Government requirements.

Signs and associated support structures should be located in accordance with the MUTCD (Qld). In general, the sign face should be placed behind the kerb face by a minimum horizontal clearance of 0.6m.

Table 7.19 Lateral Clearance to Fixed Objects

85th Percentile Speed (km/h)	Clear Zone Width (m)	Shy Line Width (m)	
		Left	Right
≤70	3.0-3.5	1.5	1.0
80	3.5-4.5	2.0	1.0
90	4.0-5.0	2.5	1.5
≥100	≥4.5	3.0	2.0

Note: Clear zones vary according to traffic volume - must be assessed using Figure 7.12.

(b) Working Width

The working width is the lateral distance required from the face of a rigid barrier to an element (such as bridge piers, walls etc.). See Figure 7.22.

Table 7.20 gives suggested working widths appropriate for different speed zones.

A 4.3m high rigid and/or articulated vehicle was used to determine the following working width offsets, relative to impact speed and crossfall for standard height rigid barriers only.

Table 7.20 Working Widths

Speed Zone	0% x'fall	3% x'fall	7% x'fall
High - 100km/h	0.8	0.9	1.1
Low - 60km/h	0.5	0.6	0.8

As rigid barriers have no dynamic deflection, the vehicle inertia becomes an issue.

When considering vehicles with high centres of gravity, the vehicle will pivot about the roll axis as shown in Figure 7.22.

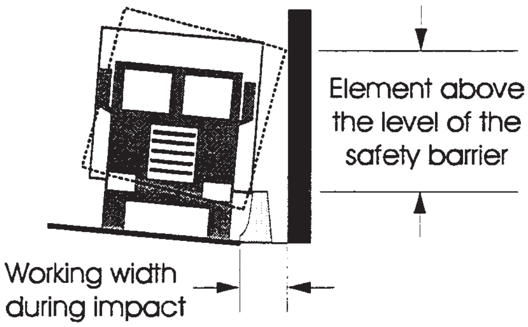


Figure 7.22 Working Width

(c) Boundary

The clearance of the road elements (hinge point of batters) from the boundary of the road reserve has to accommodate space for maintenance of the road elements and frequently Public Utility Plant (e.g. Communications cables, Gas pipelines). Noise barriers and cycle ways are placed in this space where it is convenient.

The actual dimension of the clearance will depend on all of these factors (if known) as well as the ability to acquire the necessary property. The general minimum for all roads is to be 10m, with 15m adopted for motorways and major highways. The absolute minimum width at restricted sites is 5m and this should be tolerated for short distances only - 5m provides for a maintenance vehicle to travel along the road boundary. In all cases, the minimum clearance to the edge of travelled way is to be the clear zone required, provided the clear zone is not to be used for pedestrian or cycle movements - these movements are to be allowed for outside the clear zone.

Note that it is not necessary to acquire additional land for Public Utility Plant. These services are required to acquire their own land but may be permitted to use available space provided the operation of the road is not compromised. Public Utilities are not generally permitted to occupy land on a motorway road reserve.

7.10.4 Vertical Clearance

Clearances are to be based on the ultimate cross section using the method of measurement shown in Figure 7.23. Minimum vertical clearances required for different road types are shown in Table 7.21. Consideration should be given to the use of convenient alternative routes (e.g. using the ramps of a diamond interchange) where a clearance of 6 m or more is required thus allowing a lower (and presumably cheaper) bridge to be built.

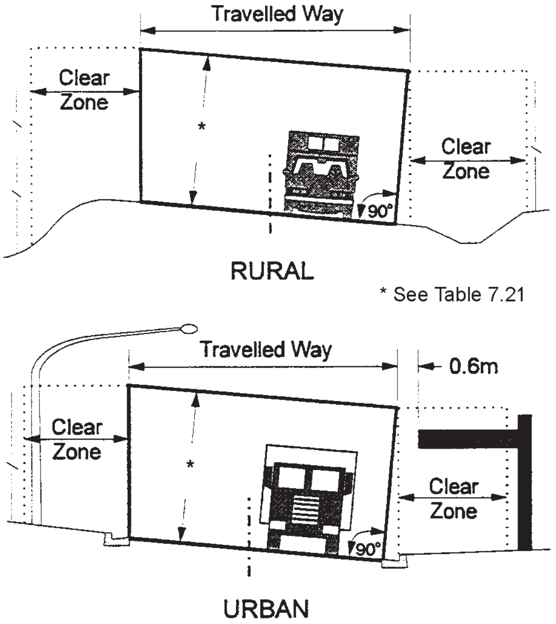
Table 7.21 Minimum Vertical Clearances

Description of of Road	Preferred Minimum	Absolute Minimum
Very High Clearance Routes (where no suitable convenient alternative is available)	6.5m	6.0m
Highways and Motorways	6.0m*	5.5m*
Declared Roads	5.5m*	5.5m*
Other Arterial and Main Roads	5.5m*	5.5m*
Other Roads	5.3m*	4.8m**

* Heights provide 300 mm resurfacing or pavement strengthening to the major road, and 100 mm to “Other Roads”.

** Legal height of livestock and vehicle carrying vehicles is 4.6m. Where it is likely that these types of vehicles will use the road, the minimum clearance must be 4.8m.

Signs are to be placed to provide a minimum vertical clearance of 2.0 m when installed on footpaths and 5.5 m minimum for signs that are located over a traffic lane. For overhead Public Utility Plant, see Section 7.10.7.



NOTES:

1. Clear zone is speed related.
2. Vertical clearance for pedestrians is 2.4m.
3. Vertical clearance for cyclists is 2.5m.
4. Awnings set back 0.6m from kerb face. *For bus stops, where the bus must access the stop at a steep angle, the clearance must be 0.8m. This 0.8m clearance must be provided to all objects in the vertical plane at these locations.*

Figure 7.23 Roadway Clearances

7.10.5 Pedestrian/Cyclist Subways

General

Pedestrian subways are not the preferred method of providing for grade separated pedestrian crossings. They are not favoured by pedestrians and cyclists because of the potential danger posed by the "hidden" nature of the crossing. However, it is sometimes the case that a subway is the only reasonable alternative.

Subways should be lit and care taken with the design to ensure that "hiding" places do not occur. There should be a clear line of sight from one end to the other and this should preferably be available from the adjacent street. Access should be by means of ramps or a combination of ramps and stairs provided that wheel chair access is fully available. The access should be designed to cater for the needs of sight-impaired people and the necessary features to guide them incorporated.

Landscaping and services should be located so as not to obscure sight lines. High quality, vandal proof lighting will be required in subways to enhance personal security. Murals can often be provided to discourage graffiti.

Design should be in accordance with AS1428 and Austroads, 1995a and 1999.

Cross Section

The desirable interior cross section for subways is 6.0m wide by 2.7m high (clear of light fittings, signs and other equipment). In constrained situations, a width of not less than 3.0m may be acceptable. The minimum clear height allowed is 2.4m.

Walkway crossfall is to be not greater than 2.5% with 2.0% preferred to cater for impaired users.

Grades

Longitudinal grades in the subway should be not less than 0.3% in one direction to allow for longitudinal drainage. The maximum grade in the subway should not exceed 5%.

For access ramps, the maximum grade to be adopted is 1 on 14 with landings at intervals not exceeding 6.0m. Landings should be not less than 1.5m x 1.5m in area.

7.10.6 Clearance to Railways

The relevant railway authority sets the clearance requirements over railways. For Queensland Rail, their drawing No. 2231, included here as Figure 7.24, gives the requirements for particular circumstances. **However, it is imperative that it is understood that this is to be used as a guide only and actual clearance requirements at a particular site must be determined in consultation with Queensland Rail.**

The actual clearance allowed will depend on specific site parameters such as future track requirements, track geometry and overhead electric traction geometry. In addition, a number of design and construction issues will need to be addressed. These include:

- Impact loads;
- Erection methods and procedures;
- Temporary clearances during construction; and
- Safe working on Railway property.

Other issues may have to be considered in addition to these at a particular site.

As these issues can have a significant impact on the whole design of the facility, it is imperative that they be addressed at the concept stage of the design. Advice should be sought from the Manager Civil Engineering, Queensland Rail, as early as possible in the process.

7.10.7 Public Utility Plant

Clearances to overhead Public Utility Plant require special consideration. They vary from utility to utility and for classes within a utility (e.g. electricity mains) depending on the specific feature under the overhead service and the characteristics of that service.

The requirements of the Authority involved should be established at the Concept and Planning stages of a project development. Table 7.22 is provided as a guide to the clearances to be expected.

Horizontal allocation of space for underground services is described in Section 7.5.2.

7.11 Special Considerations

7.11.1 Roads on Expansive Soils in Western Queensland

In order to obtain best performance, it is important to take advantage of the low average rainfall and normally short rainfall durations of the western areas. The relatively low traffic volumes also help to lessen impacts on the road performance. All design, construction and maintenance activities should give priority to keeping moisture out of the roadway rather than assuming it will enter and providing measures to remove it. This principle is different from that usually adopted for wet areas and it is important to distinguish the difference.

Some moisture will of course enter the roadway, but the amount and its effect can be minimised and kept clear of the wheel path locations. This is achieved by a combination of:

- moisture control;
- pavement material properties;
- type cross section.

This section deals with the type cross section only.

Figure 7.25 illustrates an unacceptable situation for design through expansive soil areas.

Figure 7.26 illustrates the desirable type cross section features outlined in the following discussion.

Shoulder Protection

Even with the best low permeability/adequate strength paving materials, moisture will still enter the roadway and produce edge effects of pavement and subgrade weakening to about one metre in width. Best performance will be achieved by providing at least one metre of sealed pavement outside the edge of the wheelpath. The wheelpath position should be determined from observations taken of at least 100 heavy vehicles on roads of similar traffic volume and composition, type cross section and alignment. Consideration of any different edge and centre line marking is required. Additional lane width may be required on crests and curves to allow for different wheelpath positions due to visibility restrictions and vehicle tracking characteristics.

Encased Pavements

When the traffic lanes and shoulders are fully sealed, moisture can still be absorbed by pavement material exposed on the batters. Large exposed areas will create problems even with low permeability materials. Situations to avoid include excess pavement width beyond the seal, loose pavement spilled or graded down the batters and very flat pavement batters. These can be overcome by cutting the pavement batter to 1 on 2 at the seal edge, removing excess pavement material and encasing the pavement with embankment at a 1 on 4 slope. Good compaction at the pavement edge is important to minimise moisture entry.

Even more positive encasement can be provided by adding 300 to 500mm of embankment on both sides of the formation. Spraying bitumen (without cover aggregate) on the top 300mm of the pavement batter before encasing would further improve performance, particularly in the first few years.

Road sections constructed initially or through subsequent maintenance with encased pavements have been found to have substantially less edge heave and roughness increase rates. This is attributed to reduced moisture infiltration and evaporation and the greater uniformity obtained.

Pavement Depth

Thin pavements have been shown through computer simulation and monitoring of instrumented pavement sites to absorb less moisture than thicker pavements. With the resultant stronger subgrade and more appropriate traffic loading distribution assessments, these pavements can carry much more traffic than the current pavement design procedures attributed to them.

Pavements as thin as 100mm have been used but are not recommended because of construction tolerances, compaction difficulties and the risk from severe damage from heavily overloaded vehicles. However, many pavements of 250mm and even 150 and 200mm have performed well. There appears to be no advantage in using depths greater than 250 to 300mm.

In addition to the above advantages, a single pavement course (or at most two courses) will conserve material resources, save costs, reduce longitudinal crack widths and shorten construction time. The latter will provide other benefits in decreasing exposure to excess rainfall.

The current pavement depth design process does not appear to replicate the observed road performance. Further development is needed to provide an improved pavement design process. However, issues other than depth are important.

Sealed Pavement Batters

Sealed pavement batters have been used on a number of jobs in conjunction with very permeable base materials. They reduce the severity of moisture entry but will not eliminate it. The more uniform conditions created will reduce roughness increase rates and extend pavement life. Disadvantages include increased construction and reseal costs, and damage from traffic and maintenance operations. Their use as a long term measure is not recommended universally, but they have a possible use as a corrective treatment on existing permeable pavements.

Batter Slope and Formation Height

Flat embankment batters and low formation heights should be used whenever possible as these will minimise moisture changes below the pavement.

Batter slopes of 1 on 4 or flatter should be used on all fills up to 2m. The formation needs to be a positive height above the surrounding terrain but kept as low as possible (say 300 - 500mm at the top of pavement at formation edge).

Longitudinal Drainage

In flat country, table drains should never be constructed as they will hold water for extended periods and adversely affect road performance. Where existing table drains occur they should be filled with embankment. In addition, flatter batters can be used to keep any ponded water further away from the road. Diversion drains to nearby borrow pits can also help.

On gentle grades, table drains may be used to minimise earthworks where positive drainage occurs, provided erosion is not an issue. They should be used in cuttings but long shallow cuttings should be avoided particularly where grades are nearly flat. A table drain depth of 300mm is suggested with flat bottom drains used if excessive siltation is a problem.

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Table 7.22 Minimum Overhead Clearance to Various Utilities

CATEGORY		LOCATION DESCRIPTION	PRESCRIBED DISTANCE	L.V. CONDUCTOR			H.V. CONDUCTOR					
				NEUTRAL SCREENED INSULATED SERVICE LINE	L.V. INSULATED	L.V. UNINSULATED	>1000V <33kV	>33kV <66kV	>66kV <132kV	>132kV <275kV	>275kV <330kV	>330kV <500kV
MINIMUM CLEARANCE FROM GROUND	ROADS	At centre line of carriageway	Vertically	5.5m	5.5m	5.5m	6.7m	6.7m	6.7m	7.5m	8.0m	9.0m
		At other positions	Vertically	-	5.5m	5.5m	5.5m	6.7m	6.7m	7.5m	8.0m	9.0m
		At kerb line	Vertically	4.9m	-	-	-	-	-	-	-	-
		At fence alignment	Vertically	3.7m	-	-	-	-	-	-	-	-
	OTHER	Private driveways & elevated vehicle access	Vertically	4.5m	5.2m	5.2m	5.5m	6.7m	6.7m	7.5m	8.0m	9.0m
		Areas not normally used by vehicles	Vertically	2.7m	5.2m	5.2m	5.5m	6.7m	6.7m	7.5m	8.0m	8.0m
		Land that, because of the steepness or swampiness of its terrain, cannot be crossed by traffic or mobile machinery	Vertically	-	4.5m	4.5m	4.5m	5.5m	5.5m	6.0m	6.7m	7.5m
		Road cuttings, embankments & the like	Horizontally	1.5m	1.5m	1.5m	2.1m	4.6m	4.6m	5.5m	6.0m	7.0m
MINIMUM CLEARANCE FROM STRUCTURES & BUILDINGS		Unroofed terraces, balconies, sundecks etc, subject only to pedestrian traffic with surrounding handrails etc., on which person may stand	Vertical Above	2.4m	2.7m	3.7m	4.6m	5.5m	5.5m	5.5m	7.0m	8.0m
			Vertical below	1.2m	-	-	-	-	-	-	-	-
			Horizontally	0.9m	1.2m	1.5m	2.1m	4.6m	4.6m	5.5m	5.5m	6.0m
		Roofs or similar structures not used for traffic or resort & surrounds on which a person may stand	Vertically	0.5m	2.7m	3.7m	3.7m	4.6m	4.6m	5.5m	5.5m	6.0m
			Horizontally	0.2m	0.9m	1.5m	1.5m	4.6m	4.6m	5.5m	5.5m	6.0m
		Covered places such as verandahs, balconies & windows which can be opened	In any Direction	1.2m	1.2m	1.5m	2.1m	4.6m	4.6m	5.5m	5.5m	6.0m
		Blank walls/windows which cannot be opened	Horizontally	0.2m	0.6m	1.5m	1.5m	3.0m	4.6m	5.5m	5.5m	6.0m
		Other structures not normally accessable to persons	Vertically	1.2m	0.6m	2.7m	3.0m	3.0m	4.6m	5.5m	5.5m	6.0m
			Horizontally	1.2m	0.3m	1.5m	1.5m	3.0m	4.6m	5.5m	5.5m	6.0m
RAILWAY		Railway tracks (non-electrified areas)	Vertically	7.6m	7.6m	7.6m	7.6m	-	-	-	-	-
		Electrified traction wiring & supports (electrified areas)	-	U.G.	U.G.	U.G.	3.0m	-	-	-	-	-
		Telegraph, telephones, stays, signal lines & electrical lines 650V & below	Vertically	0.6m	0.6m	0.6m	1.2m	-	-	-	-	-
		Electrical lines over 650V to 33kV excluding electrical traction wiring	Vertically	1.2m	1.2m	1.2m	1.2m	-	-	-	-	-
TELECOM		Min-apron separation to telecom	Refer Local Electricity Authority for Clearance									
		Stays	In any Direction	1.0m	1.0m	1.0m	2.0m	2.0m	3.0m	5.0m	5.0m	-

Notes
1. All information from: Electricity Regulations (QLD 1994); Draft Agreement for Overhead & Underground Electric Lines crossing Railways in Queensland, 1988; Code of Practice for Overhead Power & Telecommunication in-span Crossings.
2. Confirmation should be sought from Local Electricity Authority regarding the above clearances or voltage of conductors.
3. These are clearances allowed by the Authorities involved. The clearances specified in Table 7.21 are adopted where they exceed those in this table.
4. Allowance for temperature effects on the dimensions of overhead cables must be included.
5. For Communication Lines (Telephone and Cable Television), adopt the requirements for Neutral Screened Insulated Service Line.

Source: Standard Drawing 1333

MINIMUM VERTICAL CLEARANCE

DIMENSION "V"	STRUCTURE CATEGORY
5700 *	NON-ELECTRIFIED 1067mm & 1435mm GAUGE LINES EXCEPT AS BELOW.
5900 * #	FOOTBRIDGES ABOVE ELECTRIFIED 1067mm GAUGE LINES (BASED ON SINGLE STACK CONTAINER TRAFFIC).
6400 * #	1. ELECTRIFIED 1067mm GAUGE LINES (BASED ON SINGLE STACK CONTAINER TRAFFIC). 2. NON-ELECTRIFIED 1067mm GAUGE LINES (BASED ON STACK AND A HALF CONTAINER TRAFFIC). 3. NON-ELECTRIFIED 1067mm GAUGE LINES WHERE PROVISION FOR ELECTRIFICATION IS REQUIRED (BASED ON SINGLE STACK CONTAINER TRAFFIC).
6550 * #	ELECTRIFIED 1435mm GAUGE LINES AND 1435mm GAUGE LINES WHERE PROVISION FOR ELECTRIFICATION IS REQUIRED (BASED ON SINGLE STACK CONTAINER TRAFFIC).
7400 * +	NON-ELECTRIFIED 1435mm GAUGE LINES AND 1435mm DEFINED INTERSTATE RAIL NETWORK LINES. (BASED ON DOUBLE STACKING OF CONTAINERS IN WELL WAGONS).
5200	WAGON LOADING FACILITIES OVER NON-ELECTRIFIED 1067mm AND 1435mm GUAGE LINES FIXED DIRECT TO A CONCRETE SLAB OR TO SPILLAGE PIT GIRDERS. (BASED ON SINGLE STACK CONTAINER TRAFFIC)
5400	WAGON LOADING FACILITIES OVER NON-ELECTRIFIED 1067mm AND 1435mm GUAGE LINES WITH BALLASTED TRACK. (BASED ON SINGLE STACK CONTAINER TRAFFIC)

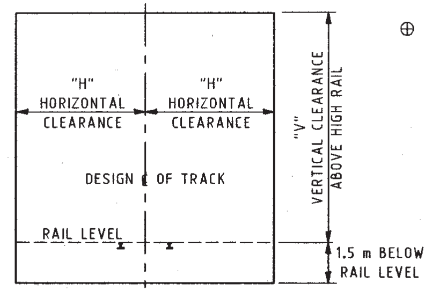
MINIMUM HORIZONTAL CLEARANCE

DIMENSION "H"	STRUCTURE CATEGORY
3500 (NO EXTRA ALLOWANCE REQUIRED ON CURVES) WHERE AN ACCESS ROAD IS REQUIRED, THIS DIMENSION SHALL BE INCREASED TO 7000mm	ALL STRUCTURES (INCLUDING AIR SPACE DEVELOPMENTS) OTHER THAN AS BELOW.
3000	PIERS BETWEEN TRACKS; MASTS ADJACENT TO MAIN LINES AND MAIN LINE CROSSING LOOPS. HANDRAILS ON BRIDGE WALKWAYS AND SIMILAR. BUILDINGS OVER SIDINGS. SUPPORTS FOR WAGON LOADING FACILITIES, CRANE GANTRIES, ETC OVER SIDINGS.
2300 + CANT AND CURVE EFFECTS	MASTS ADJACENT TO SIDING TRACKS ONLY, ISOLATED COLUMNS AND POLES; SIGNS AND SIGNALS GENERALLY.

SPECIAL CASES WHERE REDUCED CLEARANCES MAY BE ALLOWED

REQUIRED CLEARANCES	STRUCTURE CATEGORY
AS DETERMINED BY THE MANAGER CIVIL ENGINEERING	STRUCTURES REQUIRED TO BE CLOSE TO THE TRACK (e.g. PLATFORMS AND AWNINGS, POINTS MACHINERY, SIGNS AND SIGNALS WHERE SPACE IS RESTRICTED). STRUCTURES OVER PRIVATE SIDINGS (e.g. DOORWAYS IN BUILDINGS OVER THE TRACK, WAGON LOADING CHUTES). TUNNELS FALSEWORK AND TEMPORARY FORMWORK

NOTE:
PRIOR TO PROCEEDING WITH ANY PROPOSAL, ADVICE MUST BE SOUGHT FROM THE MANAGER CIVIL ENGINEERING



REQUIRED CLEARANCES

(FOR PROPOSED STRUCTURES UNLESS OTHERWISE APPROVED)

NOT TO SCALE

NOTES :

1. CLEARANCES ALLOW FOR CURVATURE AND CANT EFFECTS UNLESS SHOWN OTHERWISE.
2. NO REDUCTION WILL BE PERMITTED IN THE CLEARANCES SHOWN WITHOUT THE WRITTEN APPROVAL OF THE MANAGER CIVIL ENGINEERING.
3. DIMENSION "H" MAY NEED TO BE INCREASED FOR SIGHT LINES TO SIGNALS, FOR SPECIAL ELECTRIFICATION EQUIPMENT, FOR OTHER SERVICES, OR TO AVOID ANY DELAYS TO TRAIN SERVICES DURING CONSTRUCTION FROM SPEED RESTRICTIONS, TRACK CLOSURES AND/OR ISOLATIONS OF THE OVERHEAD WIRING SYSTEM.
4. DIMENSION "V" MAY NEED TO BE INCREASED OVER ELECTRIFIED LINES WITH TURNOUTS OR LEVEL CROSSINGS NEARBY.
5. FOR CANTED TRACK, MINIMUM VERTICAL CLEARANCES SHALL BE PROVIDED ABOVE THE HIGH RAIL. THIS DIAGRAM SHALL NOT BE CANTED.
6. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SHOWN OTHERWISE.
7. THIS DRAWING SUPERSEDES STANDARD DRAWING No.2231.

* WHERE EXISTING TRACK IS CONCRETE SLEEPERED, DIMENSION "V" MAY BE REDUCED BY 300mm.

BASED ON A 40m MAXIMUM WIDTH ROAD OVERBRIDGE OR 3m WIDTH FOOTBRIDGE AT RIGHT ANGLES TO THE TRACK AND LOCATED MIDWAY BETWEEN OVERHEAD SUPPORTS WITH FREE RUNNING CONTACT WIRE. FOR OTHER CASES, ADDITIONAL VERTICAL CLEARANCE MAY BE REQUIRED. THE VERTICAL CLEARANCE SHALL BE AT LEAST 500mm MORE THAN THE HEIGHT OF ANY EXISTING OR PROPOSED LIVE OVERHEAD LINE EQUIPMENT.

\+ REFER TO MANAGER CIVIL ENGINEERING TO DETERMINE IF A LESSER CLEARANCE CAN BE ADOPTED FOR A SPECIFIC LOCATION.

FILE No.	CM117.1	SCALE: NOT TO SCALE	ALTERATIONS	CALCS.	A.T.	2/01	APPROVED
DRAWING NUMBER 2461	ISSUE			CHECKED	I.R.S.	2/01	I. STEPHENSEN 15/6/01 CIVIL STANDARDS MANAGER DATE
				DRAWN	I.D.L.	2/01	RPEQ No. 3759
				CHECKED	A.J.H.	5/01	ISSUE AUTHORISED B. R. HAGAMAN 15/6/01 MANAGER CIVIL ENGINEERING DATE
				PASSED	A.T.	5/01	

QUEENSLAND RAIL - CIVIL ENGINEERING DIVISION

STANDARD

CLEARANCES

FOR PROPOSED STRUCTURES

DRAWING NUMBER 2461 ISSUE

Figure 7.24 Required Clearances for Proposed Structures

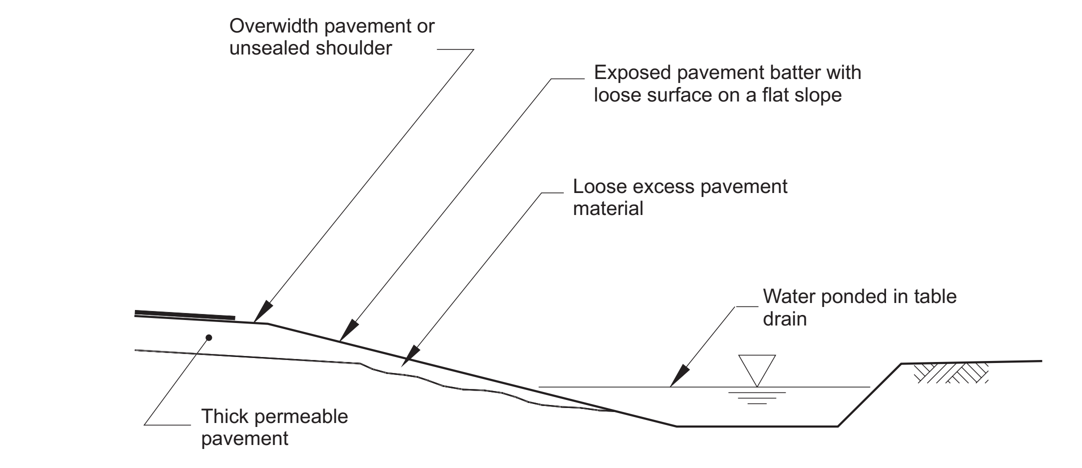
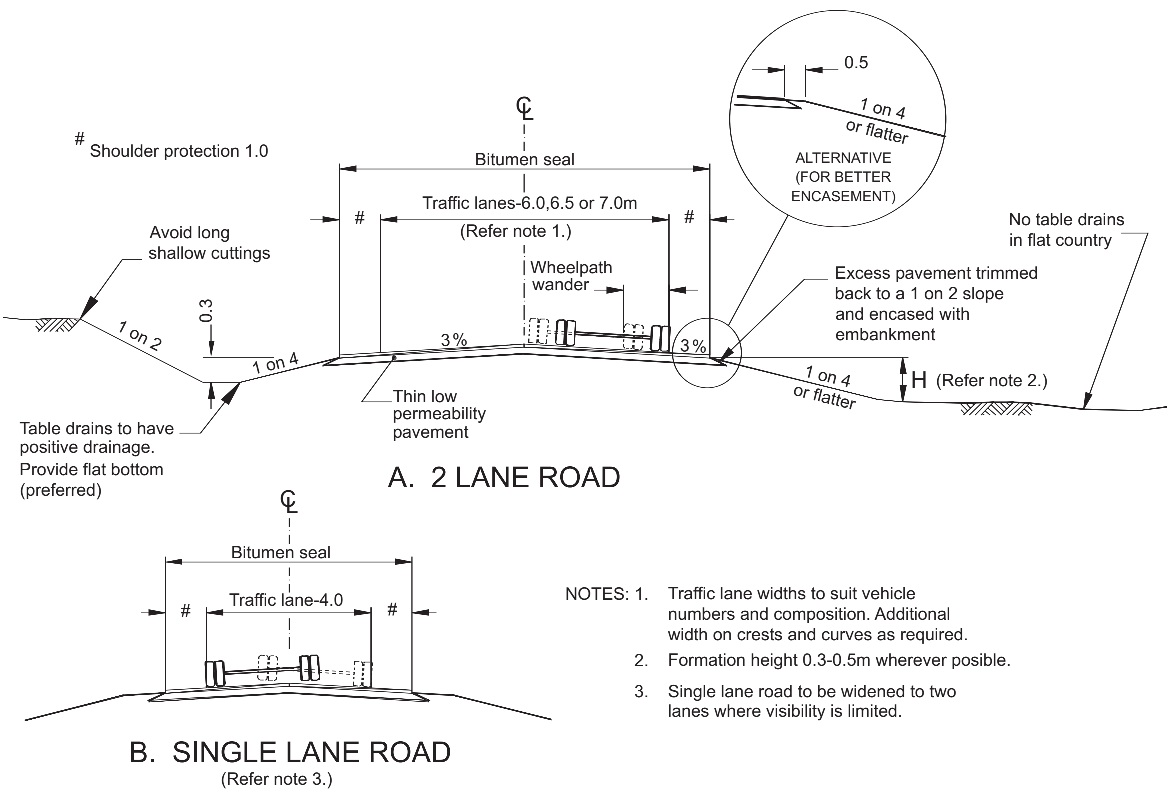


Figure 7.25 Unacceptable Features (Expansive Soil)



NOTES:
1. Traffic lane widths to suit vehicle numbers and composition. Additional width on crests and curves as required.
2. Formation height 0.3-0.5m wherever posible.
3. Single lane road to be widened to two lanes where visibility is limited.

Figure 7.26 Desirable Type Cross Sections (Expansive Soils)

Table 7.23 Checklist for Cross Sections on Expansive Clays (not for floodways, perched water tables or close to ponded water)

Feature	Details
Wheel Path Positions	• Determine OWP position for similar road, traffic volume and composition, type cross section and alignment
Shoulder Protection	• Provide 1m min sealed shoulder protection outside edge of OWP
Crests and Curves	• Adjust widths on crests and curves if appropriate
Encased Pavement	• Provide fully encased pavement with no exposed surfaces
Pavement Depth	• Provide thinnest pavement that will carry the traffic
Batter Slope	• Keep batters 1 on 4 or flatter (up to 2m high)
Formation Height	• Keep formation edge height 300 to 500mm at top of pavement wherever possible
Table Drains	• Avoid table drains in flat country • Provide 300mm deep table drains where positive drainage is available • Avoid pondage of water within 5m of the formation for extended periods • Provide flat bottom table drain if excessive siltation is a problem
Permeable Embankment	• Don't allow the use of permeable materials
Existing Formation	• Consider alignment options which include reuse of any existing formation

Zonal Use of Expansive Materials

The zonal use of expansive materials to place them in the embankment beyond the influence of seasonal effects has application in higher rainfall areas (Technical Note No.10 "Expansive Clay Embankments"). It is not considered practical or necessary in western areas if the recommendations of this technical note are followed.

Permeable materials should never be used as embankment or a selected layer over expansive soils as the increased moisture entry will more than offset any advantages of an improved subgrade.

Use of Existing Formation

Construction on the line of an existing formation can be an advantage, provided sufficient formation height is achieved, as it is liable to provide moisture conditions close to equilibrium. However, good performance has also been achieved on sections of new alignment. The issues discussed in this section, together with moisture control and selection of pavement materials are considered to have a greater influence on performance.

Construction costs and all other relevant factors must be considered when deciding whether to construct on the existing alignment.

Table 7.23 provides a check list summarising the cross section design issues.

7.11.2 Roads in Rainforest (including Wet Tropics)

Carriageway Widths

The width of the road should generally be based on the traffic volume, the type of road being designed, the speed of the traffic and the likely environmental impacts. (See 7.2, 7.3, 7.4 and 7.5.)

Other factors to consider include the following.

Providing carriageway widening on curves for larger vehicles is necessary. Adopting the minimum radius curves in steep terrain may result in the need to provide extensive widening for B doubles and for sight distance. For instance on a 50m radius curve a B double would require the traffic lane to be widened to 6m.

A verge width may also need to be allowed to provide for guard rail, verge drains and verge berms on fill.

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The single most important way to minimise impacts of roads through tropical rainforest is by reducing clearing width for as much of the road length as possible. Planning should therefore identify mechanisms to reduce clearing width as far as possible (such as use of barriers rather than relying on clearing for the necessary recovery width).

On scenic (tourist) 4WD roads or in World Heritage Areas where one lane is desirable (taking into account safety considerations), width can be reduced by providing drainage on one side only (crown shape has drainage each side).

On new two-lane roads, it will rarely be possible to achieve canopy closure. Alternative ways of providing connectivity will be required.

For high volume roads requiring four lanes or more, dual carriageways will be required. Four lane (or more) undivided two-way roads are not acceptable for traffic safety reasons. In these cases, a dual carriageway, which enables retention of natural vegetation in a wide median may provide greater opportunity for fauna crossing the road. Fauna then only has to contend with traffic from one direction over a shorter distance. However, it is preferable to provide interconnectivity with short tunnels and long bridges at suitable locations.

The typical cross-section adopted for the road corridor will impact on the environment in a variety of ways and may need to be varied along a route to minimise a particular impact. Generally, for two lane roads the minimum clearing widths will produce the least impact.

The cross section of roads through natural habitat will need to be determined based on the conservation values requiring protection.

On local access tourist roads two single lanes separated by a wider median may also have less impact than the two lane road.

Importantly, the overall width of the disturbed road corridor is an issue requiring consideration. In general, minimising the overall width from cleared forest edge to cleared forest edge will reduce the impact.

In addition to clearing width, selection of cross sections should consider the potential impacts of side cuts and batters, as in many circumstances they become fauna barriers, in effect impassable cliffs.

Table 7.24 provides some of the advantages and disadvantages of the different carriageway types and suggests areas where they may be used.

It is important to note that best practice will involve the consideration of different cross sections over relatively short sections. As an example, for environmental reasons divided two lane carriageway may only need to be over a short distance to maintain connectivity of a particular habitat (eg. a riparian gallery rainforest, or a steeper gully).

Road Formation/Earthworks

The desired outcome is to minimise earthworks and disturbance. An essential first step is to integrate the design with the site and the design selected should be compatible with the natural characteristics of the area (geological, soil, landform and hydrological limitations).

By designing roads which minimise the area to be cleared, the height and slope of batters and the volume of earthworks, the resultant road alignment will generally be a safe, cost effective and an environmentally sound project that requires minimal ongoing maintenance.

Batters should be designed to a stable slope based on consideration of topography, soil type, vegetation and rock formations for revegetation. Note, this must also consider needs to minimise erosion. Narrower total widths may be achieved by appropriate use of gabions, crib walls and rock.

Consider rounding of batters and using constant batter line in less sensitive areas to provide a more natural cut/fill batter. The constant batter offset also better blends the earthworks into the terrain.

On cuts, it is as important to ensure long term stability as it is to minimise construction disturbance. A steep cut which fails and collapses will result in more disturbance and environmental impacts over time than a wider, less steep cut

Table 7.24 Cross Section Suitability

Cross Section Type and Suitability	Advantages	Disadvantages
Unsealed road	Cheaper construction costs. Suitable for low volume roads with moderate grades. In some circumstances provides presentation opportunity and "character".	As traffic volumes increase, maintenance costs increase significantly along with erosion and sedimentation. Steep grades more readily eroded and may require sealing. May need to close to traffic during the wet season.
Single lane sealed road two way Suitable for low volume access roads only.	Requires minimum width of disturbance. Cheaper solution than a 2 lane sealed road. If in closed forest and narrow clearing, may enable canopy connectivity to be maintained.	Requires widening at crests and curves for safety. Unsuitable for high volume roads. Unsealed verges may erode.
Two lane carriageway, each way separated by a wide median Suitable for low volume roads especially access roads and tourist roads. *Note: this option has not been used in the wet tropics region, most likely application is for short distances to meet specific environmental requirements.*	Requires minimum width for clearing. Enables canopy connectivity to be maintained. Enables refuge area within the median for animals (whilst crossing). In steep sidelong country this design will better match the terrain with less height to cuts and fills.	May be a safety concern with wrong way movements. Need to provide areas for passing disabled/parked cars (only on uphill side). With long lengths and medium traffic volumes overtaking opportunities may need to be provided.
Two lane, two way road This is the normal road cross section for rural roads and is likely to be the usual solution in most cases.	Provide for some canopy connectivity if minimum widths adopted. Generally less total width of disturbance than two single carriageways. Cheaper to construct than two single lane carriageways.	For higher volume roads may require passing lanes. As widths increase with traffic volumes canopy connectivity will be more difficult to maintain. Less gaps in the traffic stream than a divided carriageway.
Four lane divided narrow median (New Jersey barrier) May be an option where increased capacity and safety is required on steep hilly sections and the terrain precludes construction of a second carriageway.	Provides high capacity and overtaking opportunities. Provides increased safety and eliminates head on collisions.	Likely to be more expensive than a four lane undivided facility. New Jersey barrier will prevent fauna crossings across the road although if traffic volumes require a four lane facility it is unlikely that sufficient gaps in the traffic stream will occur to enable animals to cross safely.
Four lane divided wide median May be the preferred solution in environmentally sensitive areas where the median is forested.	Breaks the total width into two parts enabling some canopy connectivity to be maintained. Breaks the traffic stream into two streams producing larger gaps for fauna to cross, however grade separated fauna crossings are the preferred solution. In steep sidelong country this will better match the terrain. Provides safer overtaking opportunities. Prevents head on collisions.	May have a higher construction cost than a four lane undivided facility. Total width of disturbance likely to be greater.

which (although it has a greater area of disturbance during construction) is revegetated with surrounding vegetation species and regains its habitat values.

The design of the batters should be coordinated with the environmental protection measures and the landscaping design. Revegetating steep batters is difficult and expensive and it may be better to tolerate some additional disturbance in the short term to achieve better revegetation in the long term.

Cut and fill can have a major visual impact. The area exposed during earthwork operations also can lead to erosion and sedimentation of watercourses.

The cut and fill can dominate the landscape and it is desirable to minimise the earthworks as far as practicable.

The cut and fill transition zones should be designed so that they do not obstruct escape routes for any fauna.

The distant view of the road alignment should be assessed and if major cuttings or fills will be visible then consideration may need to be given to altering the alignment to avoid the cut being viewed from distant vantage points. Where the cut and fill cannot be avoided then revegetation of the batter should be given a high priority.

Various revegetation techniques are available from hydraulic seeding and mulching to planting with viro cells and spraying of freshly exposed rock with an activator that promotes moss and algae growth.

Water running over steep batters will develop a high velocity and resulting erosion of any unprotected batter. Prevention of runoff water running over batters is essential to prevent erosion.

Consider the use of gabions or other retaining devices in steep sidelong country (especially in sensitive rainforest areas).

Incorporate surface relief on batter faces in the design to provide far greater microhabitat. This can be achieved by roughening cut slopes to provide horizontal steps along the batter or even small (300 mm) benching to enable topsoil to be retained and assist revegetation. (See Figures 7.17 and 7.18.) Contour ripping and top soiling should be used where possible.

The existing rainforest topsoil and humus should be retained and respread on batters in the locations from which it was stripped.

Topsoil should not be transported from other areas due to the possibility of importing exotic weeds and/or plant pathogens.

Note that in the Wet Tropics World Heritage Area, apart from the cut and fill associated with the earthworks, obtaining additional material from borrow pits is prohibited unless specific approval has been obtained from the Wet Tropics Management Authority. Dumping material over the edge of batters is prohibited.

Surface runoff damaging cut and fill batters should be prevented. Catch drains, diversions banks and channels above and below batters, and benches within them, will intercept surface runoff and conduct it to safe disposal points. This will reduce the hazard of sheet erosion and batter slumps.

Berms or benches are recommended on batters with a vertical height greater than 5 metres. The bench should be at least 1 metre wide, but additional width may be necessary to allow for the movement of equipment used to establish and maintain vegetation on the batters. However, this may be avoided by progressively revegetating the cut (hydraulic seeding and mulching) at the level of each bench as the cut is excavated to avoid the need for wide benches. If the batter is relatively steep (and it is unlikely to grow trees) a bench of 2-3m may allow trees to be established, this will effectively stabilise and screen the batter. (See also Section 7.8.4.)

Benches should also be considered for batters over 3m high to facilitate planting.

Benches should have a maximum longitudinal grade of 1% if vegetated or 0.5% if paved. The maximum grades should be restricted to a level consistent with the maximum permissible velocity for the type of lining used. A maximum cross slope of 10% (1 on 10) on the bench towards the toe of the upper batter should apply.

With cut batters, a catch drain or diversion bank (preferred) should be constructed above the top of the cut before excavation commences. Temporary toe drainage should be maintained as the work progresses, with permanent toe drainage installed when the final depth is reached. To prevent erosion, a catch drain will require concrete lining.

For fill batters, permanent toe drainage should be installed prior to construction and should discharge via a sediment basin to a suitable outlet. At the completion of each work period during the construction of the bank, or at the onset of rain, a windrow of suitably compacted soil material should be constructed along the recently completed fill slope.

Early stabilisation of exposed batters is essential. They should be adequately protected from erosion by vegetation, or other means, within 4 days of their construction. Best practice is to revegetate all exposed areas immediately.

In summary, the following principles of erosion and sediment control should be incorporated in the design:

- Integrate the project with the site;
- Plan and integrate erosion control with construction activities;
- Minimise the extent and duration of disturbance;
- Control stormwater flows onto, through and from the site;
- Use erosion control measures to prevent on-site damage;
- Use sediment control measures to prevent off-site damage;
- Stabilise disturbed areas quickly;
- Inspect and maintain erosion and sediment control measures.

(For more detailed discussion, refer to Construction Site Erosion and Sediment Control - Course Notes and Field Guide - References and Other Reading.)

Creeks and streams are the principal corridors for fauna movement in rainforest areas. Therefore the road must be high enough above the stream to enable suitable fauna crossings to be installed in culverts or under bridges (see Chapter 3). Culverts requiring a concrete base should not be used in permanently flowing streams - they cannot be constructed without causing major stream disturbance.

The cut/fill transition zone provides areas for fauna crossings and barriers across these sections should be avoided.

Consider using temporary retaining structures on fill (downhill slopes) to prevent downslope contamination by spoil.

7.12 Typical Cross Sections

The following pages show typical cross sections which may be used as guides for design, although modifications may be needed to meet the requirements of each particular site.

- Figure 7.27 Two Lane Two Way Rural Road
- Figure 7.28 Multi Lane Rural Road
- Figure 7.29 Undivided Urban Road
- Figure 7.30 Multi Lane Urban Road
- Figure 7.31 Alternative Urban Arterial Road Treatments
- Figure 7.32 Motorway Cross Section Elements

Note that these figures are not necessarily drawn to scale.

For routes accommodating multicombination vehicles (MCV), allowance has to be made for the size of the vehicles and their tracking charactristics. Appendix B sets out the minimum carriageway clearance widths for these routes. Table B1 should be used in conjunction with the following cross sections. The lane widths indicated in the table and the following figures do not include allowance for curve widening. Where necessary, curve widening should be applied according to Chapter 11, Section 11.10 “Curve Widening”.

Element	Desirable Widths	Reference
Lane (L) #	3.0m to 3.5m	Table 7.4
Shoulder (S)	1.0m to 3.0m	Table 7.7
Verge (V)	1m (embankment)	Fig. 7.7
	2m (cutting)	Fig. 7.7
Crossfall	2% - 4%	Table 7.16
Lateral Clearance	5m - 15m	Section 7.10.3
Road Reserve	40m (nominal)	
Limit of Clearing	3m	

* Note that appropriate clearances to public utility plant must be considered when determining these dimensions. Allowance for access to the PUP is required.

Note that lane widths do not incorporate any allowance for curve widening. Refer Chapter 11, Section 11.10 “Curve Widening”.

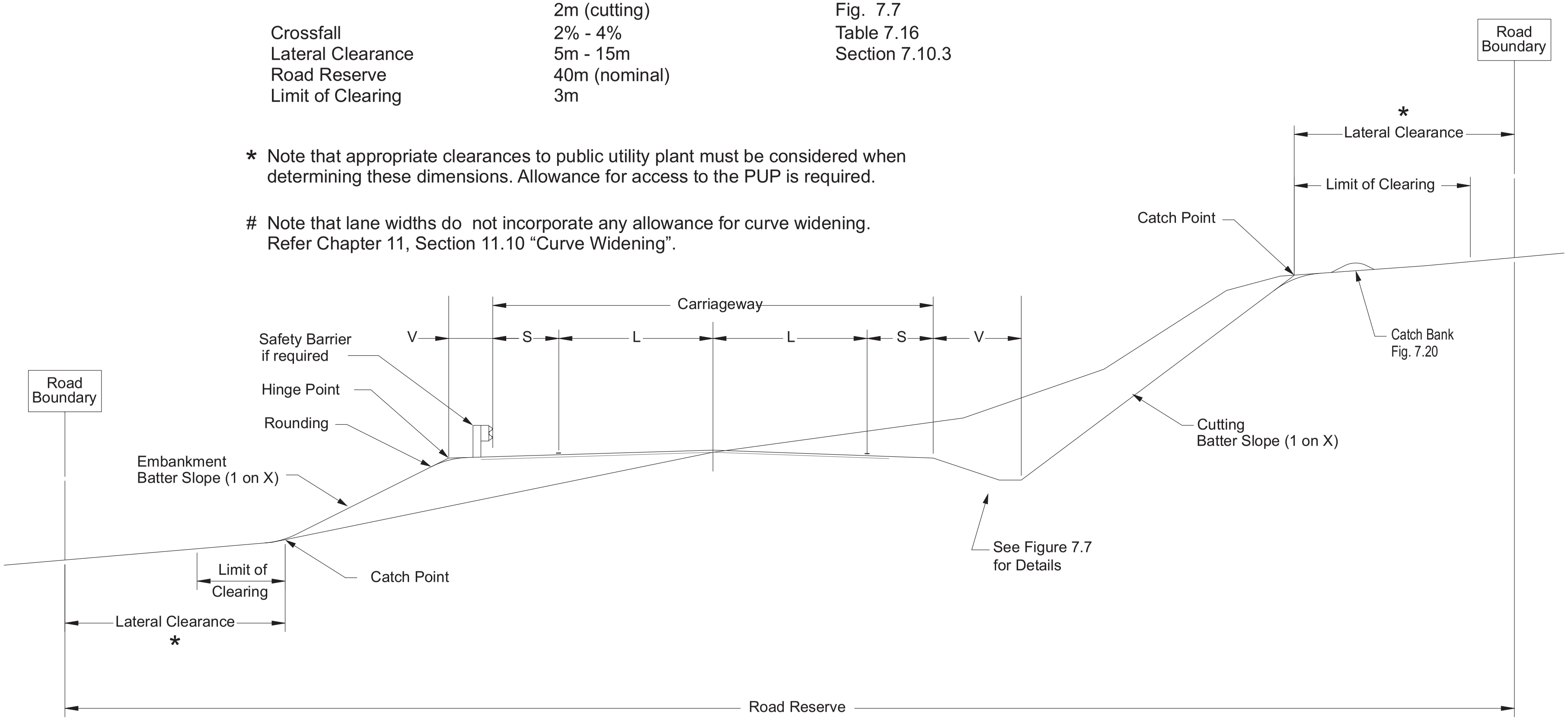

Figure 7.27 Typical Cross Section of Two Lane Two Way Rural Road

Element	Desirable Widths	Reference
Lane (L) #	3.5m	Table 7.4
Shoulder (S)	2.5m* (left) to 1.0m(right)	Table 7.7
Verge (V)	1.0m to 2.0m	Fig. 7.7
Median	15m	Sect. 7.4.6
Crossfall	2% - 4%	
Rounding	2.0m(1.0m + 1.0m)	
Lateral Clearance	5.0m - 15.0m	Table 7.16
Road Reserve	90.0m(nominal)	
Limit of Clearing	3.0m	Section 7.10.3

* 2.5m sealed width required for cyclists where applicable.

** Note that appropriate clearances to public utility plant must be considered when determining these dimensions. Allowance for access to the PUP is required.

Note that lane widths do not incorporate any allowance for curve widening. Refer Chapter 11, Section 11.10 "Curve Widening".

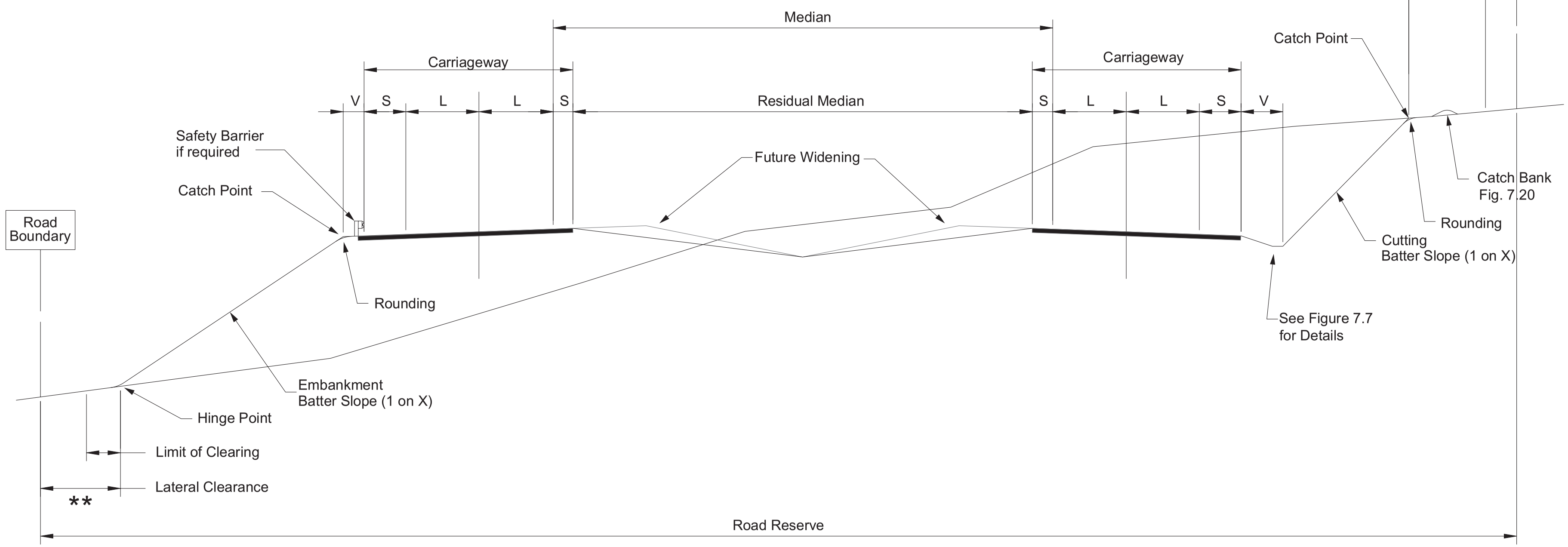

Figure 7.28 Typical Cross Section of Multilane Rural Road

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Element	Desirable Widths	Reference
Traffic Lane	3.5m #	Section 7.2.4
Parking Lane	3.0m*	Section 7.2.8
Channel (G)	Up to 0.5m	Figure 7.21
Footpath	3.5m	Section 7.5.2
Road Reserve	20.0m(nominal)	

* For shared use by parking and cyclists, the desirable width is 5.5m.

\# Note that lane widths do not incorporate any allowance for curve widening. Refer Chapter 11, Section 11.10 “Curve Widening”.

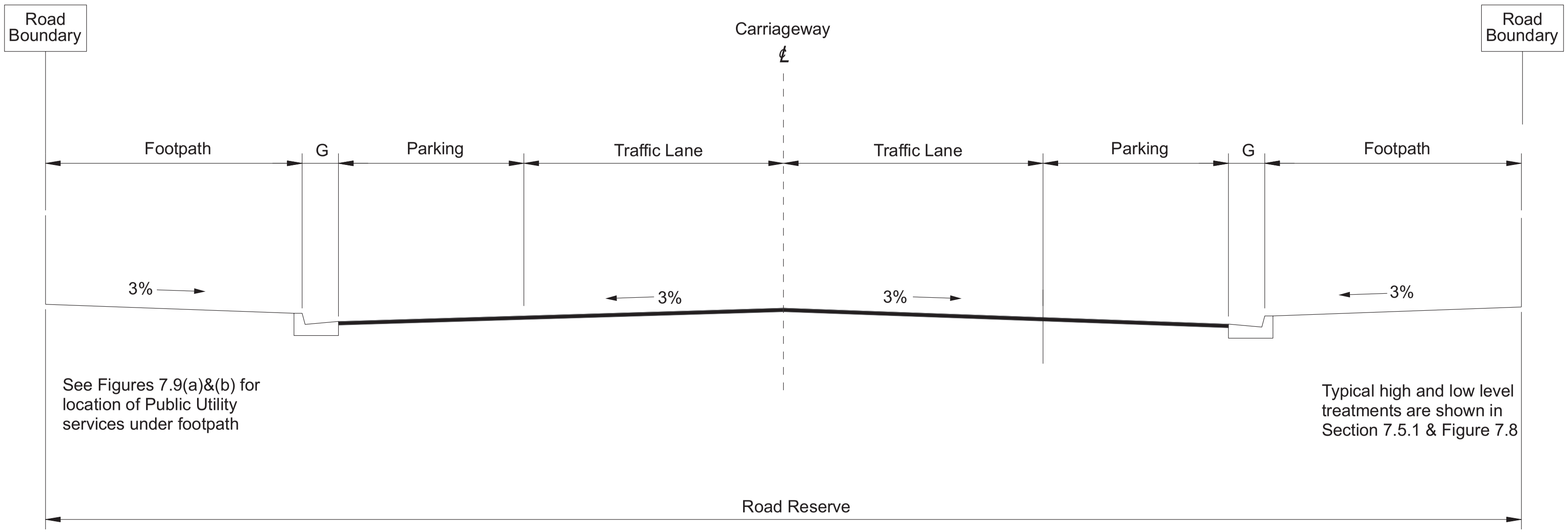
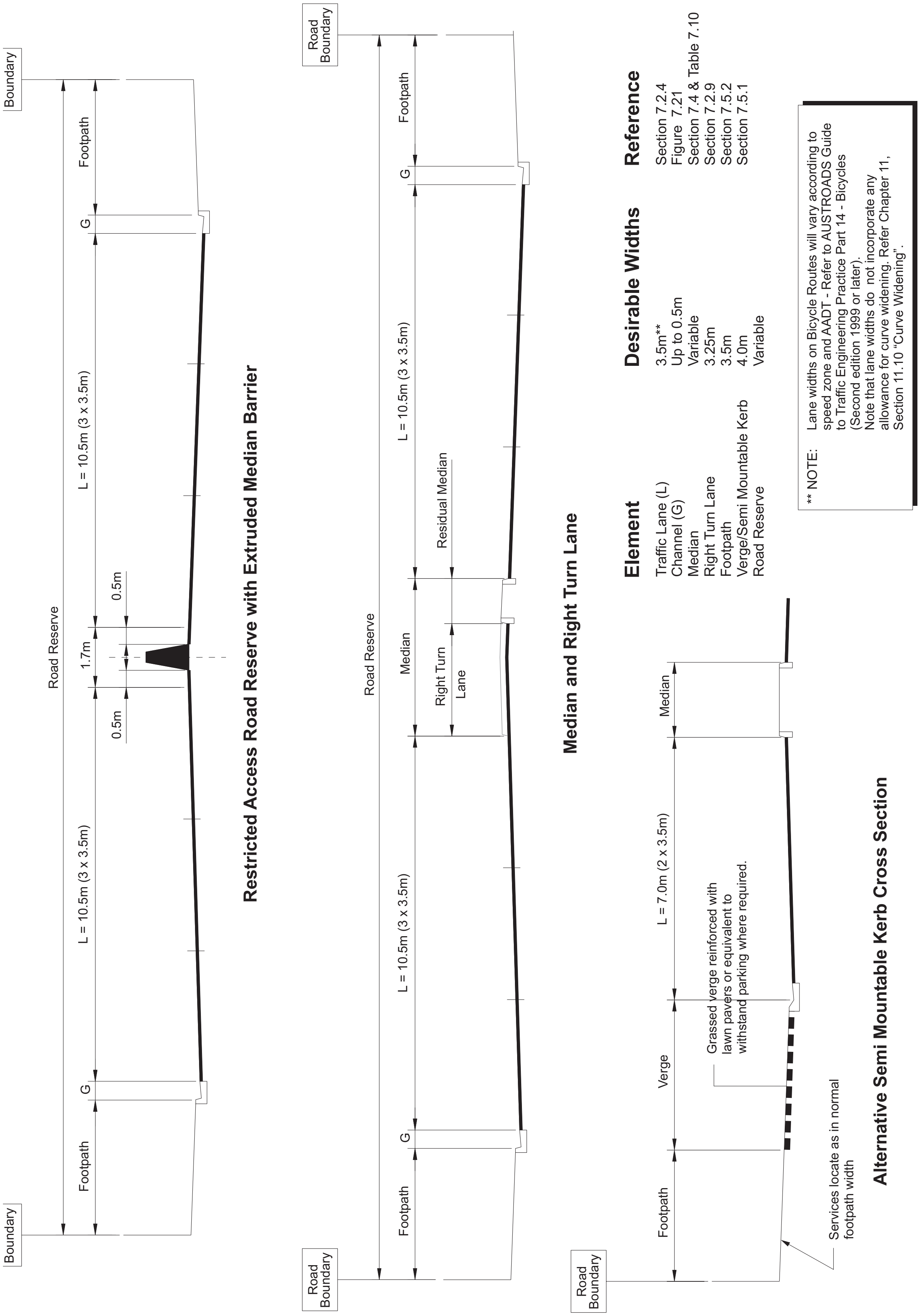


Figure 7.29 Typical Cross Section of Undivided Urban Road



Element	Desirable Widths	Reference
Traffic Lane (L)	3.5m**	Section 7.2.4
Channel (G)	Up to 0.5m	Figure 7.21
Median	Variable	Section 7.4 & Table 7.10
Right Turn Lane	3.25m	Section 7.2.9
Footpath	3.5m	Section 7.5.2
Verge/Semi Mountable Kerb	4.0m	Section 7.5.1
Road Reserve	Variable	

** NOTE: Lane widths on Bicycle Routes will vary according to speed zone and AADT - Refer to AUSTROADS Guide to Traffic Engineering Practice Part 14 - Bicycles (Second edition 1999 or later). Note that lane widths do not incorporate any allowance for curve widening. Refer Chapter 11, Section 11.10 "Curve Widening".

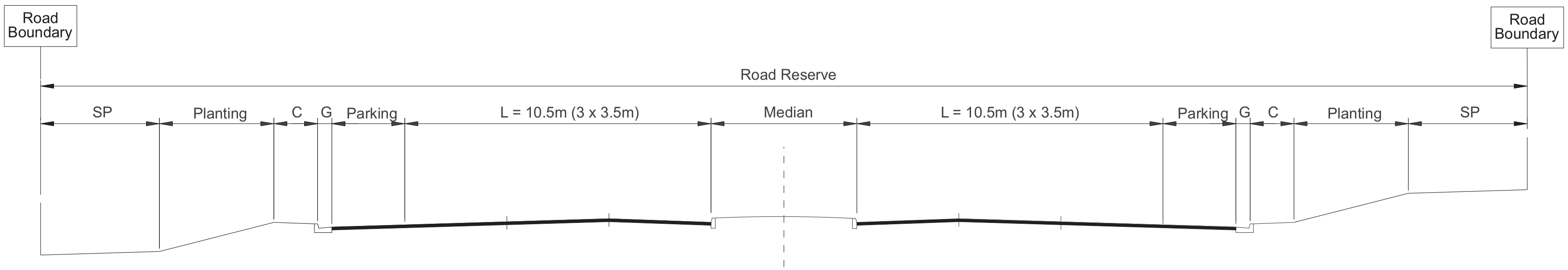
7

Figure 7.30 Typical Cross Section of Multilane Urban Road

Element	Desirable Widths	Reference
Median	5.0m	Section 7.4.3
Traffic Lane (L)	3.5m #	Section 7.2.4
Parking	3.0m *	Section 7.2.8
Channel (G)	Up to 0.5m	Figure 7.21
Clearance (C)	Figure 7.12	Section 7.6.1
Planting	4.0m	
Services & Pedestrians (SP)	4.0m	Figure 7.9(b)

* If shared use by parking and cyclists, the desirable width is 5.5m.

Note that lane widths do not incorporate any allowance for curve widening. Refer Chapter 11, Section 11.10 “Curve Widening”.

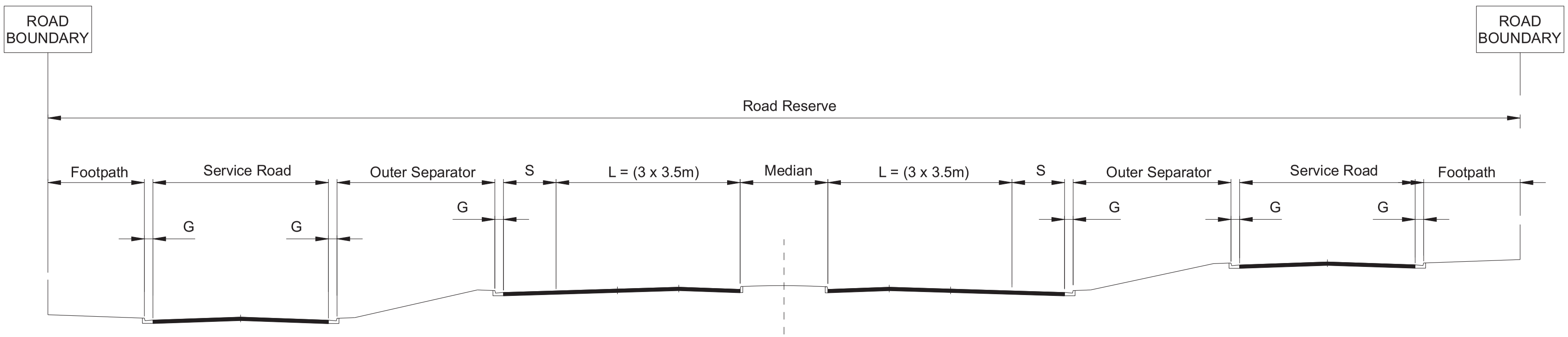


Six Lane Divided with Parking

Figure 7.31(a) Typical Cross Section of Urban Arterial Road - Mixed Function Type

Element	Desirable Widths	Reference
Median	5.9m	Section 7.4.3
Traffic Lane (L)	3.5m #	Section 7.2.4
Shoulder (S)	3.0m	Section 7.3.6
Channel (G)	Up to 0.5m	Figure 7.21
Outer Separator	Table 7.15	Section 7.5.3
Service Road	10.0m	
Footpath	Table 7.13	Section 7.5.2

Note that lane widths do not incorporate any allowance for curve widening.
Refer Chapter 11, Section 11.10 “Curve Widening”.



Six Lane Divided with Two-way Service Roads
(in industrial area)

Figure 7.31(b) Typical Cross Section of Urban Arterial Road - Separated Function Type

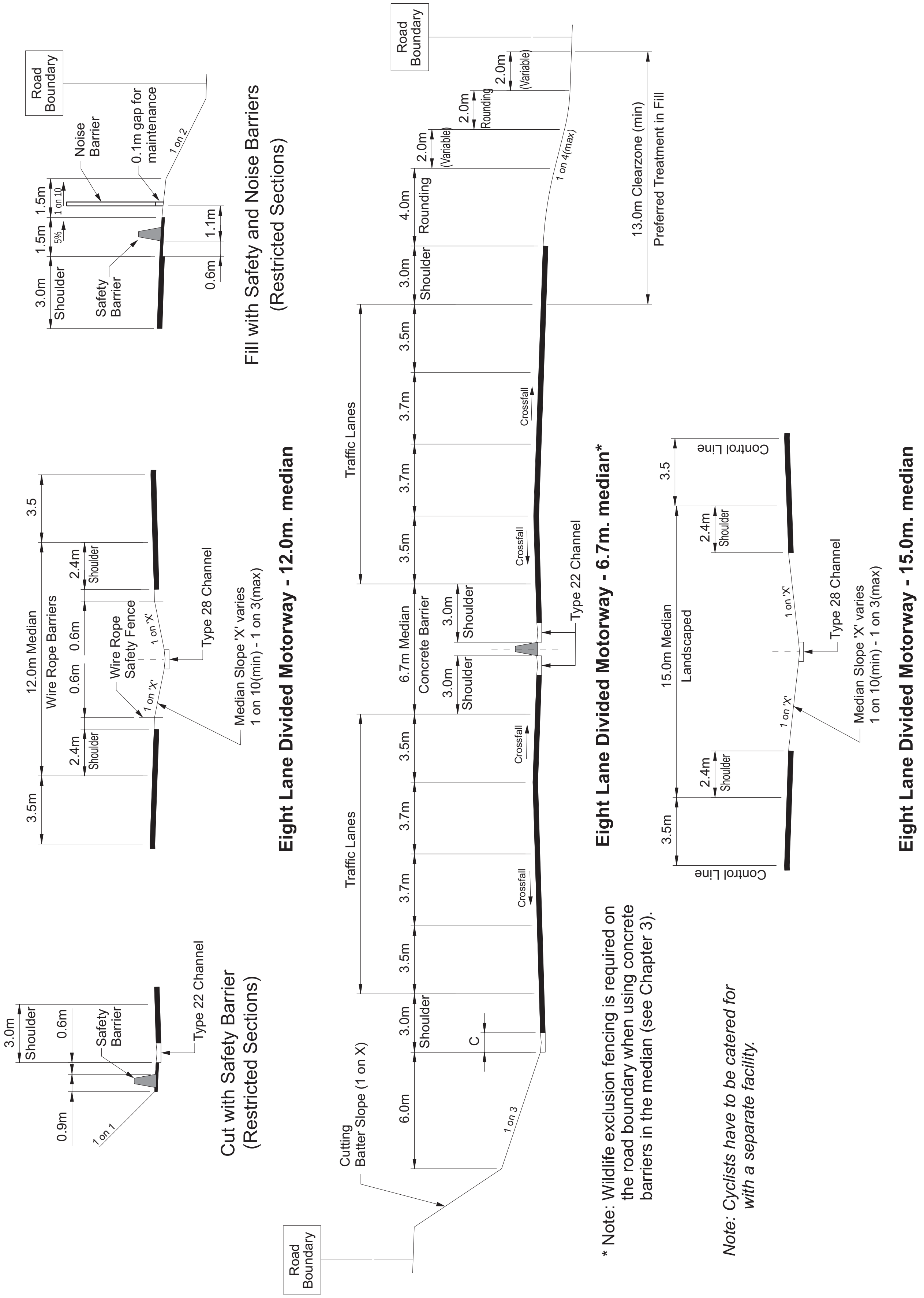


Figure 7.32(a) Typical Cross Section of Multi lane Motorway (No Transit Lanes)

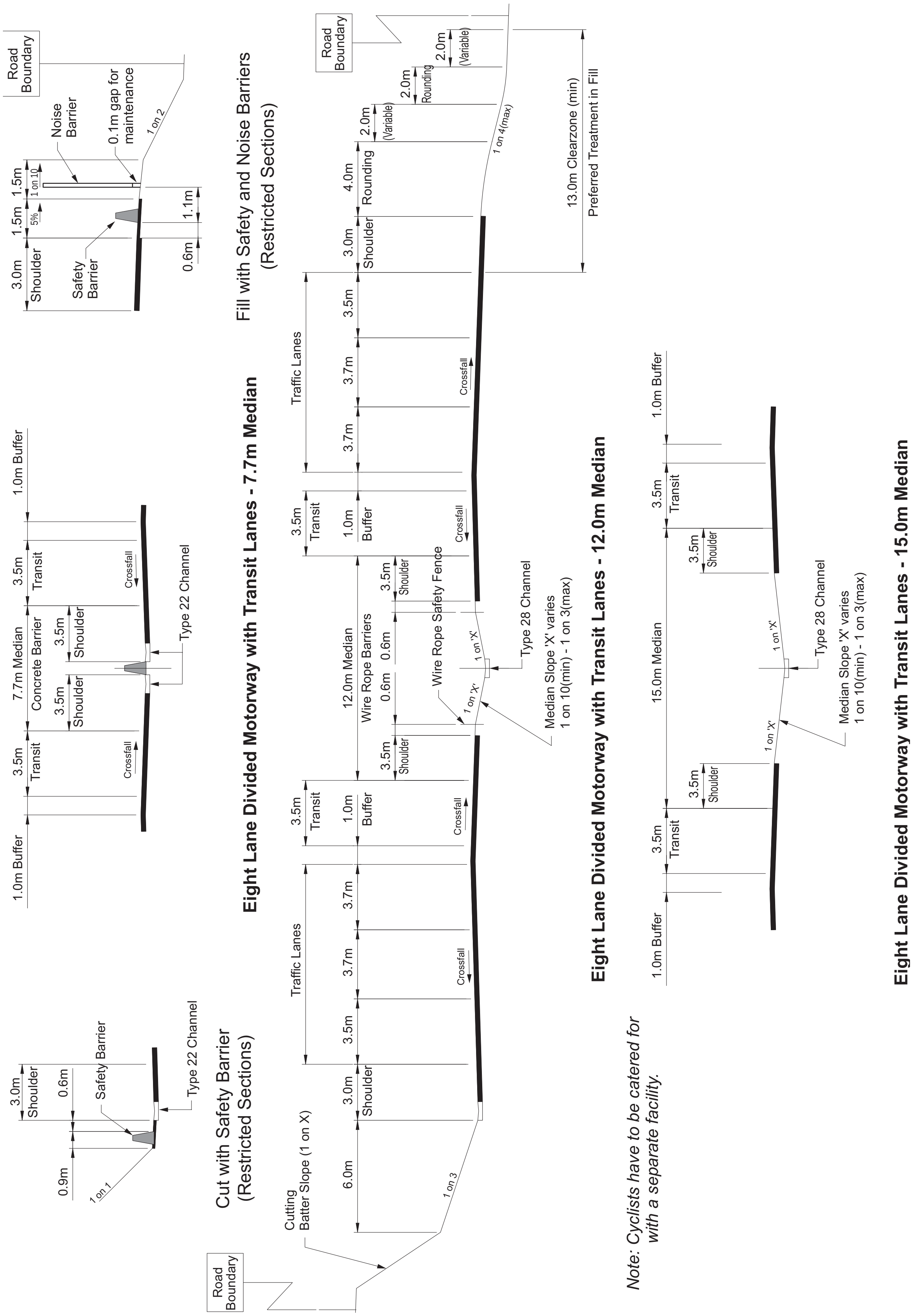


Figure 7.32(b) Typical Cross Section of Multi lane Motorway (With Transit Lanes)

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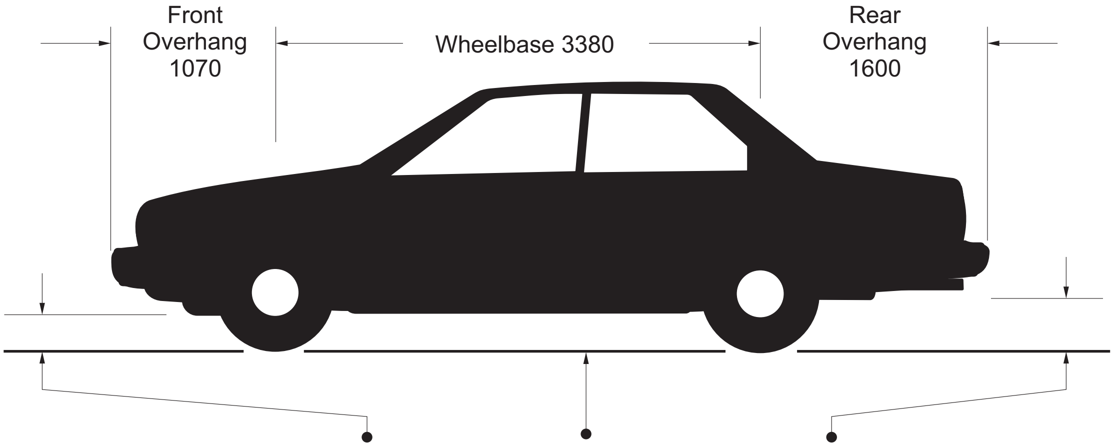
Relationship to Other Chapters

- Chapter 1 deals with the strategic requirements of the road system and will have a significant influence on the type of cross section adopted;
- Chapter 2 describes the planning of roads – the appropriate cross sections for these roads will have a significant effect on the planning outcomes;
- Chapter 3 sets out environmental requirements – these are crucial in the design of cross sections;
- Chapter 4 describes the standards to be applied to roads of different types;
- Chapter 5 describes the particular requirements of various road users –
  - Pedestrians;
  - Cyclists;
  - Road users with a disability; and
  - Motorcyclists; plus
- Chapter 5 defines the dimensions of the various design vehicles;
- Operating speed can be affected by the cross section (Chapter 6);
- Chapter 8 is closely related to this chapter and they must be read in conjunction with each other;
- Sight distance on horizontal curves will affect the cross section (Chapter 9);
- The appearance of a road is affected by the detail of the cross section (Chapter 10);
- Curve widening will affect the cross section (Chapter 11);
- Width of pavement is affected by the radius of crest vertical curves where manoeuvre sight distance is the best available (Chapter 12);
- Intersection elements have dimensions dependent on cross section requirements (Chapters 13 and 14);
- Widths of auxiliary lanes affect the cross section (Chapter 15);
- Interchange elements have dimensions dependent on cross section requirements (Chapter 16);
- Providing for lighting affects the cross section (Chapter 17);
- Traffic signals require space in the cross section (Chapter 18);
- Providing for ITS is an integral part of the cross section (Chapter 19);
- Cross section elements have to be applied to the design of roadside amenities (Chapter 20);
- The road cross section has to be compatible with railway level crossings (Chapter 21); and
- Bridges, retaining walls and tunnels have to be designed to the requirements of the cross section required to serve the traffic carried (Chapter 22).

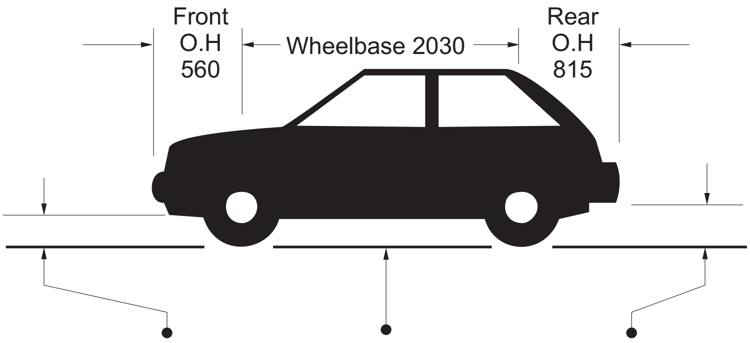
This shows that there is no aspect of road design that is not affected by the cross section requirements. There is an interrelationship between the cross section elements and the other design considerations and all design involves some level of iteration between these considerations and the cross section.

Appendix 7A: Template for Vehicle Clearance at Property Entrances



	Front Clearance	Centre Clearance	Rear Clearance
Normal	280	100	270
Front dive (braking)	180	65	300
Rear jounce	300	65	160
Full jounce	200	25	190

Clearance dimensions under various conditions for composite longest vehicle



	Front Clearance	Centre Clearance	Rear Clearance
Normal	150	125	115
Front dive (braking)	85	100	135
Rear jounce	160	100	45
Full jounce	100	75	65

Clearance dimensions under various conditions for composite shortest vehicle

* Use normal load as a basis for design of entrances, but the effects of greater spring deflections should be checked.

* The dimensions shown relate to those of a composite design vehicle and do not necessarily apply to the particular models shown.

Appendix 7B: Multi-Combination Vehicles in Urban Areas

There are a number of clearance requirements to be considered for MCVs travelling in urban areas. The carriageway widths should take into account various existing features including parking demand, angle of parking and the demand for on-road cycling provisions.

The route should be further evaluated if the minimum carriageway width in the urban area is less than the applicable width shown in Table B1.

Through lanes provide travel without obstruction due to parked vehicles or stationary turning queues and therefore minimise the necessity for lane changing manoeuvres. It is preferable that at least two continuous through lanes are available in the direction of travel. Short sections of single through lane may be permitted.

Table B1 Minimum Carriageway Clearance Widths in Urban Areas

Feature	B-Double		Type 1 Road Train		Type 2 Road Train	
	60-70 km/h*	80-100 km/h*	60-70 km/h*	80-100 km/h*	60-70 km/h*	80-100 km/h*
(Undivided carriageway - 2-way) Width between road edge and road centre	**3.8**	**4.2**	**4.0**	**4.4**	**4.2**	**4.8**
• with marked separation line	4.1	4.8	4.3	5.0	4.5	5.4
• with in-road cyclists	5.3	6.3	5.5	6.5	5.7	6.9
• with regular parallel parking	6.0	6.4	6.2	6.6	6.4	7.0
• with regular angle (45°) parking	9.8	9.9	10.0	10.1	10.2	10.5
(Divided carriageway - single lane) Width between road edge and edge of median/traffic island	**4.1**	**4.8**	**4.3**	**5.0**	**4.5**	**5.4**
• with in-road cyclists	5.3	6.3	5.5	6.5	5.7	6.9
• with regular parallel parking	6.3	6.4	6.5	6.6	6.7	7.0
• with regular angle (45°) parking	9.8	9.9	10.0	10.1	10.2	10.5
(Divided carriageway - 2 lanes) Width between road edge and edge of median/traffic island	**7.2**	**8.3**	**7.4**	**8.5**	**7.6**	**8.9**
• with in-road cyclists	8.4	8.8	8.6	10.0	8.8	10.4
• with regular parallel parking	9.4	9.9	9.6	10.1	9.8	10.5
(Divided carriageway - 3 lanes) Width between road edge and edge of median/traffic island	**10.1**	**10.7**	**10.5**	**11.1**	**10.9**	**11.9**
• with in-road cyclists	11.3	12.2	11.7	12.6	12.1	13.4

* Legal Speed Limit for the particular section of road being assessed.

(Source: Assessing the suitability of routes for Multi-Combination Vehicles Guidelines, WA, 22 March 2000, p.6)