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Chapter 9

Sight Distance

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Chapter 9 Amendments - January 2002

Revision Register

Issue/ Rev No.	Reference Section	Description of Revision	Authorised by	Date
1		First Issue	Steering Committee	June 2000
2	9.3.1	Modification to Table 9.3	W. Semple	Jan 2001
3	9.2.1	Additional sentences on unlit roadways. Modifications to Figures 9.1 and 9.3	Steering Committee	July 2001
	9.2.4	Additional dot point. Modifications to Table 9.2		
	9.3.2	Additions to 'Longitudinal Deceleration' on unsealed pavements		
	9.3.3	Modifications to Figure 9.5		
	New	Relationship to other chapters		
4	9.2.2	Figure 9.2 - Top of the headlight beam assumed to be directed upward at 1°.	Steering Committee	Jan 2002
	9.2.3	Vegetation on benches - Designers required to design for in-service conditions.		
	9.3.1	Widening for manoeuvre sight distance - Volume warrant removed; extent of widening added; Table 9.3 modified to exclude 1.5secs reaction time.		
	9.3.2	Reaction time - Section on Reaction time replaced with new text - 1.5secs removed from Table 9.4.		
	9.3.2	Stopping Distance for trucks - Additional text on providing for trucks and new table for Truck stopping distance. Table 9.5B added.		
	9.3.3	Overtaking SD for MCV conditions - Additional text and Table 9.6B added (in accordance with Western Queensland Best Practice Guidelines)		
	9.3.5	Bicycles - New section cross referencing Chapter 5, Section 5.5.4.		

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Chapter 9
Sight Distance

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9.1 General

This section discusses required sight distances along roadways excluding intersections. For required sight distances at intersections including roundabouts, refer to Chapter 13, Intersections, and Chapter 14, Roundabouts.

Sight distance is defined as the distance, measured along the carriageway, over which visibility occurs between a driver and an object (single vehicle sight distance) or between two drivers at specific heights above the carriageway in their lane of travel. For safety on the road, sufficient sight distance must be provided to enable drivers to control their vehicles to avoid collisions with other vehicles or objects on the road. For this reason, minimum sight distances must be obtained at all points along the roadway for the chosen design speed. However, the longest sight distance possible commensurate with economy should be provided and only in isolated sections should the sight distance approach the minimum using the 85th percentile speed (i.e. where the cost of providing sight distances greater than the minimum is too great).

9.2 Visibility Restrictions

Restrictions to visibility may occur on vertical curves and on horizontal curves. There are 6 general conditions where these restrictions occur and these are shown as Types C1-C2, S1-S2, and H1-H2 in Figures 9.1 to 9.3 and are discussed below:

9.2.1 Crest Vertical Curve Restrictions

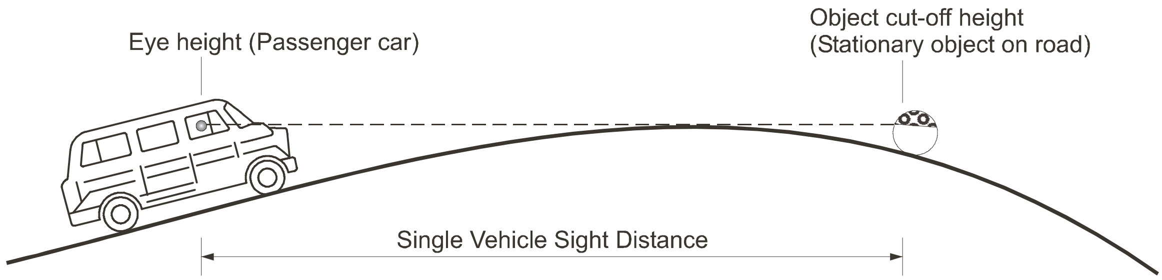
Adequate sight distance needs to be provided over crests to allow a driver to take evasive action once the hazard intrudes into the drivers field of view. Figure 9.1 shows types of restrictions on crest vertical curves (Types C1 and C2). For roadways consisting of one way travel per lane, sight distance must be provided for Type C1 restrictions to visibility. On unlit roadways consisting of one way travel per lane, it is desirable to provide sight distance for type C2 restrictions to visibility within the limits of the illumination capacity of passenger cars. It is required that at least stopping distance be achieved for C2 type restrictions when measured to the tail light height (0.6m) for cases beyond these limits. This is achieved with the minimum radius curves provided for C1 conditions. Vertical height parameters used for the calculation of sight distance are shown in Table 9.1.

Table 9.1 Vertical Height Parameters

Vertical Height Parameter		Height (m)
Height of Eye of Driver		
1. Passenger Car		1.15
2. Commercial Vehicle		1.8
Headlight Height		0.75
Object cut-off Height		
1. Stationary object on road	(a)	0.2*
	(b)	0*
2. Vehicle tail light/stop light		0.6
3. Approaching Vehicle		1.15

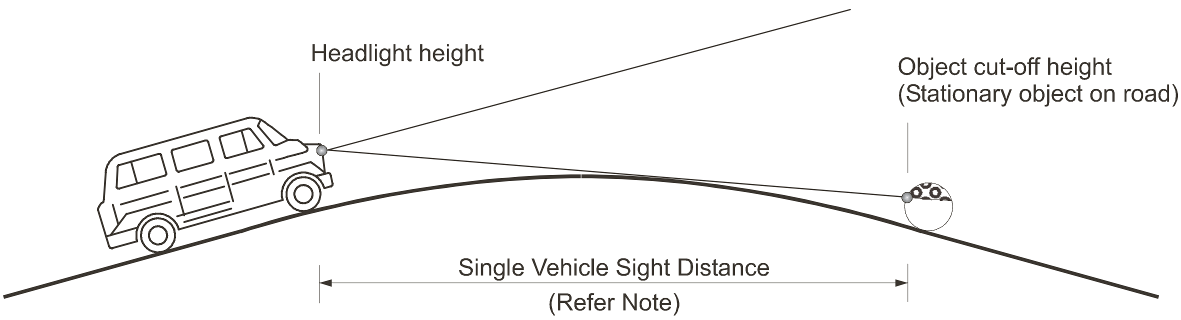
* 0.2 m object height to be used in most situations on crest curves.

0 m object height can be used on crest curves at intersections where it is necessary to see road marking. 0 m is also used for headlight sight distance in sags.



TYPE C1

One Way Travel Per Lane

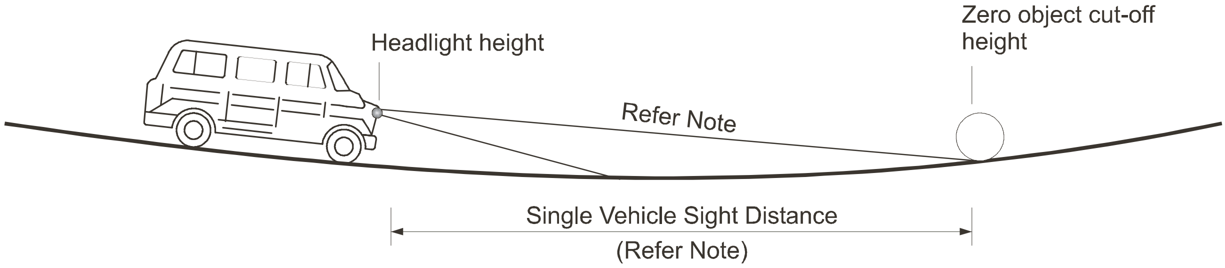


TYPE C2

One Way Travel Per Lane On Unlit Roadways

Note:
Maximum sight distance is confined to the range of a vehicle's light beam (generally 120 - 150m).

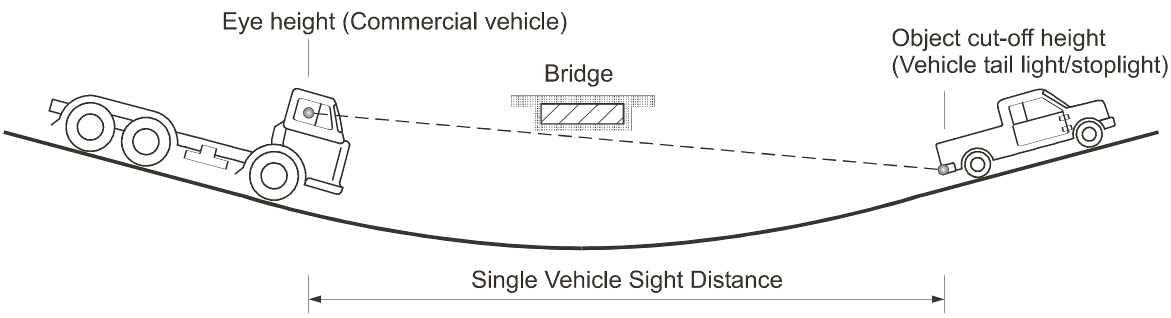
Figure 9.1 Crest Vertical Curve Restrictions to Sight Distance



TYPE S1

Unlit Roadways

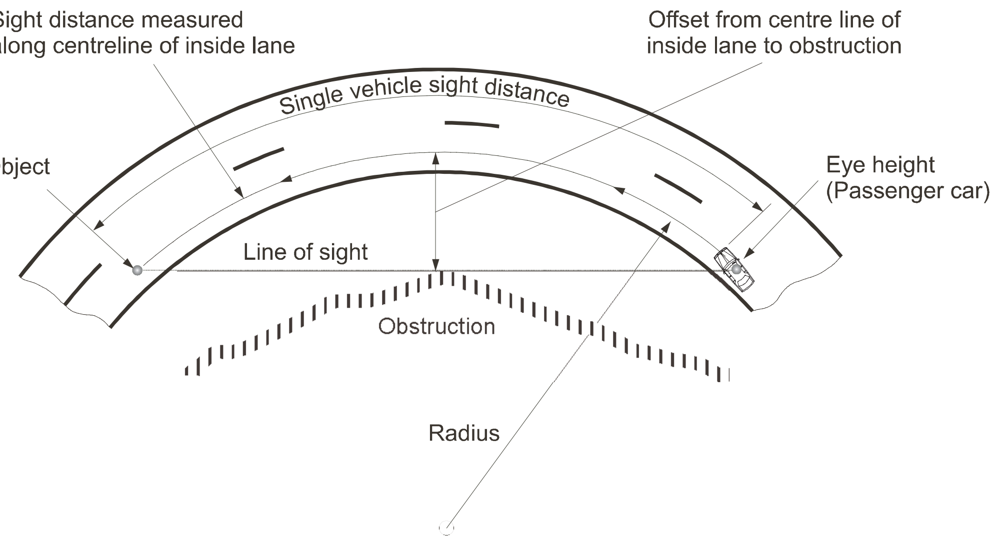
Note:
Top of the headlight beam is assumed to be elevated 1° from the instantaneous grade of the road. This criterion has been used to derive the minimum sag vertical curve radii for headlight criteria given in Chapter 12.



TYPE S2

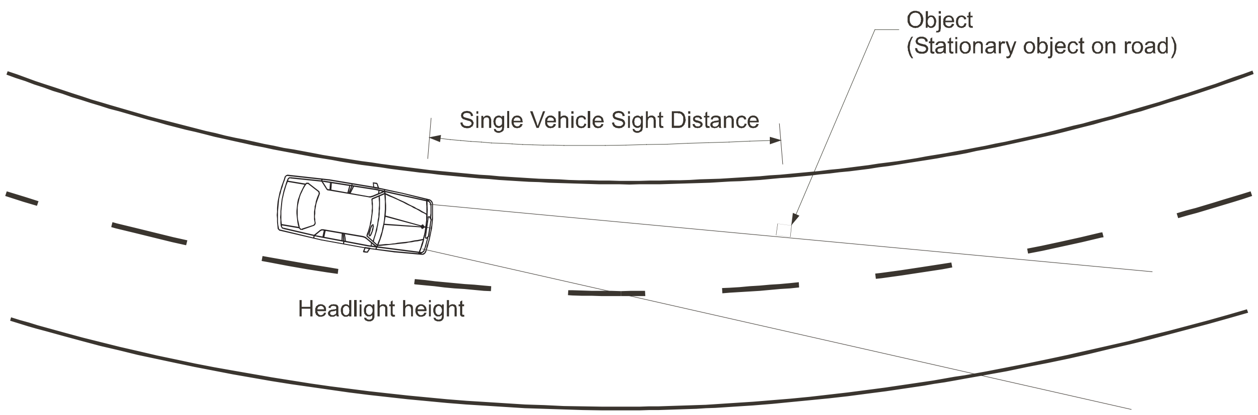
Overhead Obstruction

Figure 9.2 Sag Vertical Curve Restrictions to Sight Distance



TYPE H1

One Way Travel Per Lane



TYPE H2

One Way Travel Per Lane on Unlit Roadways

Figure 9.3 Horizontal Curve Restrictions to Sight Distance

9.2.2 Sag Vertical Curve Restrictions

On unlit roadways, visibility is restricted to the area of road illuminated by the vehicle's headlights as illustrated in Figure 9.2 (Type S1). It is desirable to provide for this condition in the design of sag vertical curves but it is necessary to consider the physical limits of the vehicle lighting system to provide adequate illumination for the full stopping distance at the higher speeds. Application of this principle is further developed in Chapter 12, Vertical Alignment.

If an overhead obstruction is placed in a sag e.g. a bridge, then adequate sight distance must be provided as shown by Type S2 restriction to visibility in Figure 9.2.

Care should be taken in the design of landscaping in these circumstances to avoid the creation of a vegetation canopy that restricts sight distance in a similar way to overhead bridges. Where such a canopy exists, the sight distance requirements are to be dealt with in the same way as at overhead bridges.

9.2.3 Horizontal Curve Restrictions

Visibility may be restricted on horizontal curves due to an obstruction on the inner side of the curve. This is shown by restrictions to visibility Type H1 in Figure 9.3. Sight distance in this case must be provided. If the obstruction is a cut batter slope then benching may need to be employed to provide adequate sight distance. Benching is the widening of the inside of a cutting on a curve to obtain the specified sight distance. It usually takes the form of a flat table or bench over which a driver can see an approaching vehicle or an object on the road.

The height of the bench must allow the line of sight to pass over it unobstructed. Therefore, the plane of the bench must be set at least 300mm (or the maintenance intervention level, whichever is the greater) below the line of sight to allow for growth of grass on the bench to this height. Grass on benches must be low growing varieties and /or kept mowed below this level and other vegetation must not be allowed to be established on the bench.

Designers must take account of the likely service conditions for the road. If a line of sight cannot be guaranteed, then the design cannot assume that it will exist and an alternative treatment must be applied (e.g. larger radius curve).

Where a line of sight must be preserved, this should be included in the maintenance requirements for that road.

In plan view, the benching is fixed by the envelope formed by the lines of sight. The driver and the object being approached are assumed to be in the centre of the inner lane and the sight distance is measured around the centre line of the lane, along the path the vehicle would follow in braking.

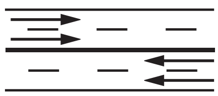
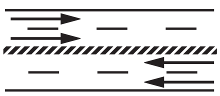
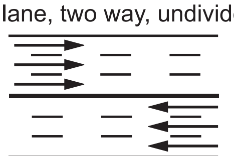
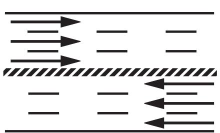
Figure 9.3 shows the restriction to sight distance on horizontal curves on unlit roadways (Type H2). In many cases, it is impractical to obtain single vehicle stopping sight distance around horizontal curves on unlit roadways because of the limitations of the vehicle's headlights. For this reason, this criterion is generally not used in road design.

9.2.4 Other Visibility Considerations

Other visibility considerations include the following:

- If the line of sight is outside the road reserve, additional land will be required to accommodate the line of sight.
- Guard fencing, noise barriers, bridge handrails, median kerbs and similar obstructions can restrict the visibility available at horizontal and vertical curves.
- There is a sizable difference between the length of sight distance available to a driver depending on whether the curve ahead of the driver is to the left or it is to the right.

Table 9.2 Relevant Types of Sight Distances to be adopted for given road types

Roadway description and diagram	Relevant Types of Sight Distance		
	Manoeuvre	**Stopping**	**Overtaking**
Two lane, two way, undivided 	ABSOLUTE MINIMUM *	GENERAL MINIMUM	DESIRABLE ø
Two lane, two way, divided 	ABSOLUTE MINIMUM *	GENERAL MINIMUM	–
Four lane, two way, undivided 	–	ABSOLUTE MINIMUM	–
Four lane, two way, divided 	ABSOLUTE MINIMUM *	GENERAL MINIMUM	–
Six lane, two way, undivided 	–	ABSOLUTE MINIMUM	–
Six lane, two way, divided 	–	ABSOLUTE MINIMUM	–

NOTES:

- \- indicates that the type of sight distance shown is not appropriate to be used with the roadway type.
- * indicates that the type of sight distance shown is only to be used in extremely isolated or constrained cases. (minimum total seal widths apply).
- ø overtaking sight distance is generally not practicable on crests (see Section 12.3.3).

- An “intermediate sight distance” equal to twice the stopping distance and measured from 1.15m to 1.15m may be appropriate in some circumstances where two way travel may occur in the same path, e.g. low volume rural roads with no line marking. Since this approach would increase the length of road subject to restricted sight distance, providing stopping distance only, together with a wider, marked pavement would be preferred.

Examples considering the combined effect of horizontal and vertical restrictions are shown in Example 9A.

9.3 Types of Sight Distance and Their Application

The various types of sight distances and where they should be used is given below. These sight distance types are listed from the least desirable to be used (manoeuvre sight distance - used only in extreme circumstances) to the most desirable (overtaking sight distance). Table 9.2 lists the various types of sight distance and the roadway types to which they are appropriate.

9.3.1 Manoeuvre Sight Distance

Manoeuvre sight distance allows for a driver to react to a hazard and slow down to an acceptable speed in which to manoeuvre around the obstruction. Manoeuvre sight distance, while not recommended as a prime design parameter, is a useful measure when examining variations of geometry in extremely restricted situations. Adequate sealed shoulder widths need to be provided when using manoeuvre sight distance to allow vehicles ‘room to evade’.

Manoeuvre sight distance has been successfully used on isolated vertical curves on a straight or large radius horizontal curve where lowering of the gradeline would mean expensive excavation into hard rock materials. Manoeuvre sight distance criterion is not to be used for restrictions on smaller radius horizontal curves unless a clear area is provided on the outside of the curve. An evasive action to the inside of a small radius horizontal curve is very difficult to undertake.

Manoeuvre sight distance is not to be used for design speeds above 100 km/h.

Derivation

Manoeuvre sight distance, for a single vehicle to manoeuvre around an obstruction is the sum of two components:

1. The distance travelled during the reaction time = $R_T v$
2. The distance travelled during the manoeuvring procedure = S

   i.e. MSD = $R_T v + S =$

$$= \frac{R_T V}{3.6} + S \qquad (9.1)$$

where

MSD	=	manoeuvre sight distance (m)
R_T	=	driver reaction time (sec)
V	=	initial speed of vehicle (km/h)
v	=	initial speed of vehicle (m/s)
S	=	evasive action distance (m)

Values of R_T and S must be assumed in order to compute the values of MSD appropriate to a specified initial speed.

Reaction Time (R_T)

Values of reaction time for calculating manoeuvre sight distance are the same as those for calculating stopping sight distance. These are shown in Table 9.4 with the exception that the 2.5 sec reaction time is not used.

Evasive Action Distance (S)

Evasive action distance is the distance a driver requires to undergo an evasive manoeuvre. The evasive manoeuvre consists of braking to an acceptable speed followed by a swerving manoeuvre to avoid the object. The values given in Table 9.3 appear to provide reasonable evasive action distances based on experience gained from roads in Australia.

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Manoeuvre Sight Distance

Using Equation (9.1) with substituted values of R_T and S, the manoeuvre sight distance for a range of design speeds can be calculated and are shown in Table 9.3.

Combinations of design speed and reaction times not shown in Table 9.3 are generally not used.

Table 9.3 Manoeuvre Sight Distance

Design Speed	Evasive Action Distance (m)*	Manoeuvre Sight Distance (m) R_T = 2.0 S
50	15	45
60	25	60
70	35	75
80	50	95
90	70	120
100	100	155
>100	-	Do not use

* Derived from Austroads "Geometric Design of Rural Roads".

Pavement Widths

Where manoeuvre sight distance is all that can be provided, an adequate total width of sealed pavement (including shoulders) is required to allow adequate space for the evasive action to take place. The minimum width required is:

1. Desirable minimum - 12m.
2. Absolute minimum - 9m.

This may require widening of the pavement over the restricted sight distance zone.

Factors to be considered in reaching a decision on the width to adopt are:

- traffic volumes;
- roadside hazards;
- traversability of batter slopes adjacent to the shoulder edge.

In the case of a two lane, two way divided road, the sealed width on each side of the median is to be 6m.

The full width of the widened formation should be available at the point where the sight distance reduces to the manoeuvre sight distance. Tapers are required on the approach to this point at a rate of 1 in 50.

9.3.2 Stopping Sight Distance

Stopping sight distance allows for a driver to react to a hazard and completely stop prior to the hazard. Stopping sight distance is generally the minimum sight distance that would be provided in most cases.

Derivation

The lengths of stopping sight distance derived below are for a single vehicle stopping prior to a hazard.

Stopping sight distance is the sum of two components:

1. The distance travelled during the total reaction time = R_T x v
2. The distance travelled during the braking time from the design speed to fully stopped

$$= \frac{v^2}{2g(d+0.01a)}$$

i.e.

$$SSD = R_T v + \frac{v^2}{2g(d+0.01a)}$$

$$= \frac{R_T V}{3.6} + \frac{V^2}{254(d+0.01a)} \qquad (9.2)$$

where

SSD = stopping distance (m)

d = coefficient of longitudinal deceleration

g = acceleration due to gravity (9.8 m/s²)

R_T = driver reaction time (sec)

V = initial speed of vehicle (km/h)

v = initial speed of vehicle (m/s)

a = longitudinal grade/percent (+ve uphill, -ve downhill)

Values of R_T and d must be assumed in order to compute the values of SSD appropriate to a specified initial speed.

Reaction Time (R_T)

Reaction time is the time for a driver to perceive and react to a particular stimulus and take appropriate action. This time depends on the complexity of the decision or task involved. Chapter 5 discusses this issue in detail.

Based on research and observation, most drivers can react simply to a clear stimulus in less than 2.5 secs in an emergency. Research has shown that a minimum reaction time of 2.5 secs is required for older drivers at intersections, and not less than 2.0 secs in other situations where drivers can be expected to be alert.

Table 9.4. summarises the usual situations encountered.

Table 9.4 Driver Reaction Time

Reaction Time (s)	Alignment Type
2.0	Few intersections Alerted driving situations Restricted low speed urban areas Consistently tight alignments Very built-up areas - high traffic volumes
2.5	Unalerted driving situations At all intersections Roads with high speed environments Road with isolated geometric features

Longitudinal Deceleration (d)

For sealed pavements, the values of longitudinal deceleration used for design purposes allow for the degradation of pavement skid resistance when wet, and for a reasonable amount of surface polishing. The coefficient of longitudinal deceleration values are given in Tables 9.5A and B. The lower values assumed for the higher speeds reflect the reduction in wet pavements skid resistance with increasing speed and the need for lateral vehicle control over the longer braking distances.

Unsealed road surfaces are highly variable and very little research has been undertaken to quantify friction coefficients under various climatic conditions for these surfaces. The values provided in Tables 9.5A and B may be used for unsealed roads but designers will need to make allowance for reductions in friction factor depending on the type of material on the surface, the moisture environment and vehicle types. These factors, in combination with the likely operating speeds for the conditions may have an impact on the sight distance required (ARRB, 1993).

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Stopping Sight Distance

Using Equation (9.2) with substituted values of R_T and d, the single passenger vehicle stopping sight distances for a range of design speeds for level grades can be calculated and are shown in Table 9.5A. Truck stopping distances can be calculated using the coefficient of longitudinal deceleration shown in Table 9.5B.

To balance between the costs and benefits for making provision for trucks, rural roads are to be designed to cater for cars. Truck stopping distances should be used for checking purposes at locations that could be potentially hazardous for trucks. Note that the operating speed of trucks is generally lower than that of cars on the same road (see Table 6.3).

Potentially hazardous locations include:

- Intersections;
- Railway crossings;
- Speed change areas;
- Merge areas such as lane drops;
- Sag vertical curves, particularly at underpasses;
- Horizontal curves - trucks required extra braking distance on horizontal curves and designers should avoid locating features requiring braking on curves (e.g. intersections).

Table 9.5A Stopping Sight Distance on Level Grade (Cars)

Design Speed (km/h)	Coefficient of Longitudinal Deceleration	Stopping Sight Distance (m)	
		R_T = 2.5s	R_T = 2.0s
50	0.52		45
60	0.48		65
70	0.45		85
80	0.43	115	105
90	0.41	140	130
100	0.39	170	
110	0.37	210	
120	0.35	250	
130	0.33	300	

Note: Combinations of design speed and reaction times not shown in this table are generally not used.

Table 9.5B Stopping Sight Distance on Level Grade (Trucks)

Design Speed (km/h)	Coefficient of Longitudinal Deceleration	Stopping Sight Distance (m)	
		R_T = 2.5s	R_T = 2.0s
50	0.29	68	61
60	0.29	90	82
70	0.29	115	105
80	0.29	142	131
90	0.29	172	159
100	0.28	209	195
110	0.26	258	243

Stopping Sight Distance on Unlit Roadways

On unlit roadways, sight distance is confined to the range of a vehicle's headlight beam. The limitations of headlights on high beam of modern vehicles restrict the sight distance that can be safely assumed for visibility of an object on a roadway, to about 120 - 150m. This corresponds to satisfactory stopping distance up to approximately 90 km/h. This shortfall in vehicle lighting, however, cannot be provided for in road design and is not a design consideration. This criterion does not apply to roads which have street lighting to the standards prescribed by the S.A.A Public Lighting Code, AS 1158, or on roads with high traffic volumes where it is necessary to keep headlights on dipped beam for a relatively high percentage of the travel time.

9.3.3 Overtaking Sight Distance

Overtaking sight distance is the minimum sight distance that must be available to enable the driver of one vehicle to overtake another vehicle safely and comfortably, without interfering with the speed of an oncoming vehicle travelling at the 85th percentile speed should it come into view after the overtaking manoeuvre is started. Overtaking sight distance is considered only on 2 lane undivided roads. Overtaking sections should be provided as frequently as possible.

The extent of overtaking opportunities along a road will depend on the topography and the alignment superimposed on it. It is therefore difficult to establish rigid rules about the frequency of these overtaking opportunities. However, it is desirable for an overtaking opportunity to be available every five kilometres if possible. If this is not possible, a spacing greater than ten kilometres should be avoided.

The designer should be constantly aware of the desirability of such sections and should not hesitate to improve the design to incorporate overtaking sections, more particularly where only a slight improvement is required and/or the extra cost, if any, is relatively small. In cases where it is impracticable or uneconomical to provide the overtaking sight distance something less than standard is of value and is better than nothing. It must be remembered that the 85th percentile speed is not the speed of all vehicles and something less than the overtaking sight distance provides for a large percentage of drivers. Overtaking becomes a design consideration through its effect on capacity.

With two-lane two-way roads, the overtaking of slower moving vehicles is only possible when there is a suitable gap in the oncoming traffic accompanied by sufficient sight distance and appropriate line marking. Overtaking demand increases rapidly as traffic volume increases, while overtaking capacity in the opposing lane decreases as volume increases. That is, sections of road with suitable sight distance and line marking for overtaking no longer provide the same level of overtaking opportunity and motorists are forced to reduce their individual desired speeds and follow other vehicles until there is another section of road that is suitable for overtaking. This is why the level of service provided by two-lane two-way roads is dependent upon traffic flow, the proportion of road that provides potential overtaking opportunities and the interval between overtaking opportunities.

In practice, overtaking zones will usually be the fortuitous result of road alignment and cross section. Because of the large sight distances involved, it is often not practical to achieve overtaking zones through design. However, good design practice will include a check on the overtaking zones that are provided and may result in cases where an overtaking zone can be achieved through a practical refinement of the design. More commonly though, the proportion of road that provides overtaking is used in conjunction with traffic volume to assess the level of service provided by a section of road and hence determine whether overtaking lanes are warranted.

In determining whether a section of road provides sufficient sight distance for overtaking, the overtaking model is based on research into overtaking operation on Australian roads. This is described in more detail in AUSTROADS 1989 and Troutbeck 1981. A potential overtaking zone for one direction of travel is established when sufficient sight distance is available to allow the majority of drivers to assess that there is sufficient length of road available to overtake. This is called the **Establishment Sight Distance** and Table 9.6A lists values for a range of design speeds.

The longer the length of road that provides at least the establishment sight distance, the greater the number of drivers that are able to commence an overtaking manoeuvre (phase 1 in Figure 9.4), especially if there is the need to wait for an oncoming vehicle to clear.

Once a driver has commenced to overtake, a lesser value of sight distance is needed to safely continue with the overtaking manoeuvre (phases 2 and 3 in Figure 9.4). This distance is called the **Continuation Sight Distance** and Table 9.6A lists values for a range of design speeds. Continuation sight distance allows drivers to continue or abort the overtaking manoeuvre with safety, assuming that an on-coming vehicle just came into view at the most critical time, the point of no return (Troutbeck 1981). The point of no return is taken to be the time when the rear of the overtaking vehicle is alongside the rear of the vehicle being overtaken.

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Where the overtaken vehicle is a multi-combination vehicle (MCV), the continuation sight distance required is larger. Table 9.6B lists the values for design speeds normally encountered.

Table 9.6A Overtaking Sight Distances (1.15 m to 1.15 m) for Determination of Start and Finish of Overtaking Zones (Passenger Vehicles)

Design Speed (km/h)	Overtaken Vehicle Speed (km/h)	Establishment		Continuation	
		Time Gap (sec)	Sight Distance (m)	Time Gap (sec)	Sight Distance (m)*
50	43	12.8	330	4.5	165
60	51	13.6	420	5.0	205
70	60	14.4	520	5.4	245
80	69	15.5	640	6.0	300
100	86	17.8	920	7.2	430
110	94	19.4	1100	7.9	500
120	103	21.0	1300	8.7	600
130	111	22.4	1500	9.5	700

* Including 50 m to 60 m clearance at completion.
Note: Time gaps used in derivation of distances also shown.

Table 9.6B Overtaking Sight Distances (1.15 m to 1.15 m) for Determination of Start and Finish of Overtaking Zones (MCVs)

Design Speed (km/h)	Assumed MCV Speed (km/h)	Establishment Sight Distance (m) All Veh.	Continuation Sight Distance (m)		
			B-Double	Type 1 Road Train	Type 2 Road Train
70	60	520	350	400	470
80	69	640	430	470	580
90	77	770	520	590	710
100	86	920	620	730	870
110	94	1100	750	880	>1000

Source: Main Roads (2000).

Normally, the overtaking zone will commence at the point where establishment sight distance is attained and end where the sight distance falls below the continuation sight distance. However, there is a limit to the length of the "continuation sight distance component" of the overtaking zone since most drivers that are prevented from overtaking at the start of the zone because of oncoming traffic will not be encouraged to overtake unless establishment sight distance is regained; hence the term **re-establishment** distance is applied to this limit to the length for which continuation sight distance can apply. Re-establishment distance is assumed to be about 3 minutes of travel, which is equal to a distance of Design Speed/20 km.

Figure 9.5 shows an example of using a sight distance diagram to determine overtaking zones. In determining the proportion of road that provides overtaking in accordance with the overtaking model, the total length of the overtaking zones for both directions is divided by twice the length of the road being considered.

The overtaking model is not used as a warrant for barrier lining. Even though a section of road will not have sufficient sight distance to satisfy the overtaking model, there may be sufficient sight

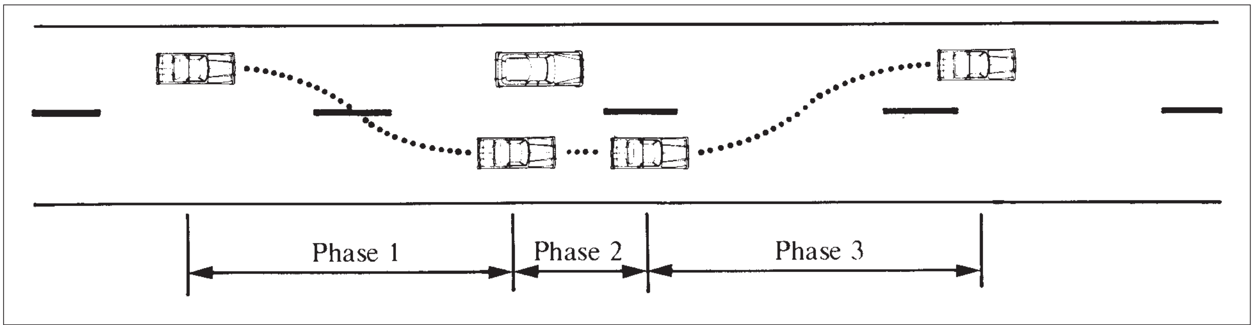

Figure 9.4 Overtaking Manoeuvre

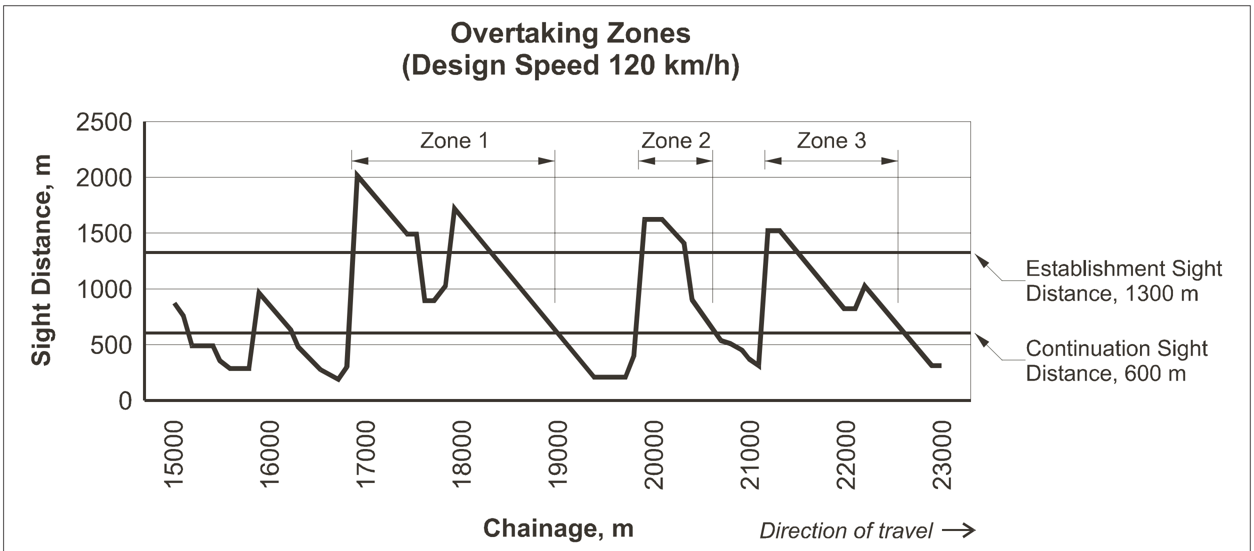

Figure 9.5 Overtaking Zones

distance to allow for the safe overtaking of very slow vehicles. Hence barrier lining is used to indicate areas where it is almost always unsafe for drivers to overtake. For barrier line warrants, see the Manual of Uniform Traffic Control Devices.

9.3.4 Other Types of Sight Distance

Sight distance requirements at interchanges and intersections (including roundabouts) are dealt with in the relevant chapters on those elements. These provisions must be met when designing landscaping and noise amelioration devices in the vicinity, or within the confines of intersections and interchanges. (For detailed background to the landscaping and noise requirements, refer also to the Road Landscape Manual and the Road Traffic Noise Management Code of Practice).

9.3.5 Bicycles

Sight distance requirements for bicycles are discussed in Chapter 5, Section 5.5.4.

References

Australian Road Research Board (ARRB) (1993): Unsealed Roads Manual - Guidelines to Good Practice.

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Relationship to Other Chapters

- Provides input for Chapter 11 - Horizontal Alignment;
- Provides input for Chapter 12 - Vertical Alignment;
- Establishes the parameters for use in Chapters 13, 14 and 16 (Intersections, Roundabouts and Interchanges).

9

Example 9A

It sometimes happens that earthworks in the particular case of a horizontal curve with visibility benching can often be reduced by the simple expedient of increasing the radius, thereby reducing the bench offset and the earthworks. In some cases benching may be completely eliminated. Every case requiring benching should be so examined for optimising cost.

As well as providing lateral offset to the bench, the bench will be required to be at a nominal height depending on the vertical alignment. Example 9A in Figure 9.6 shows an overlapping horizontal curve and crest vertical curve with the line of sight not over the crest but off the formation. Cutting down the crest on the pavement will not increase sight distance as the line of sight is clear of the pavement. The height of the bench is however dependent on the vertical alignment.

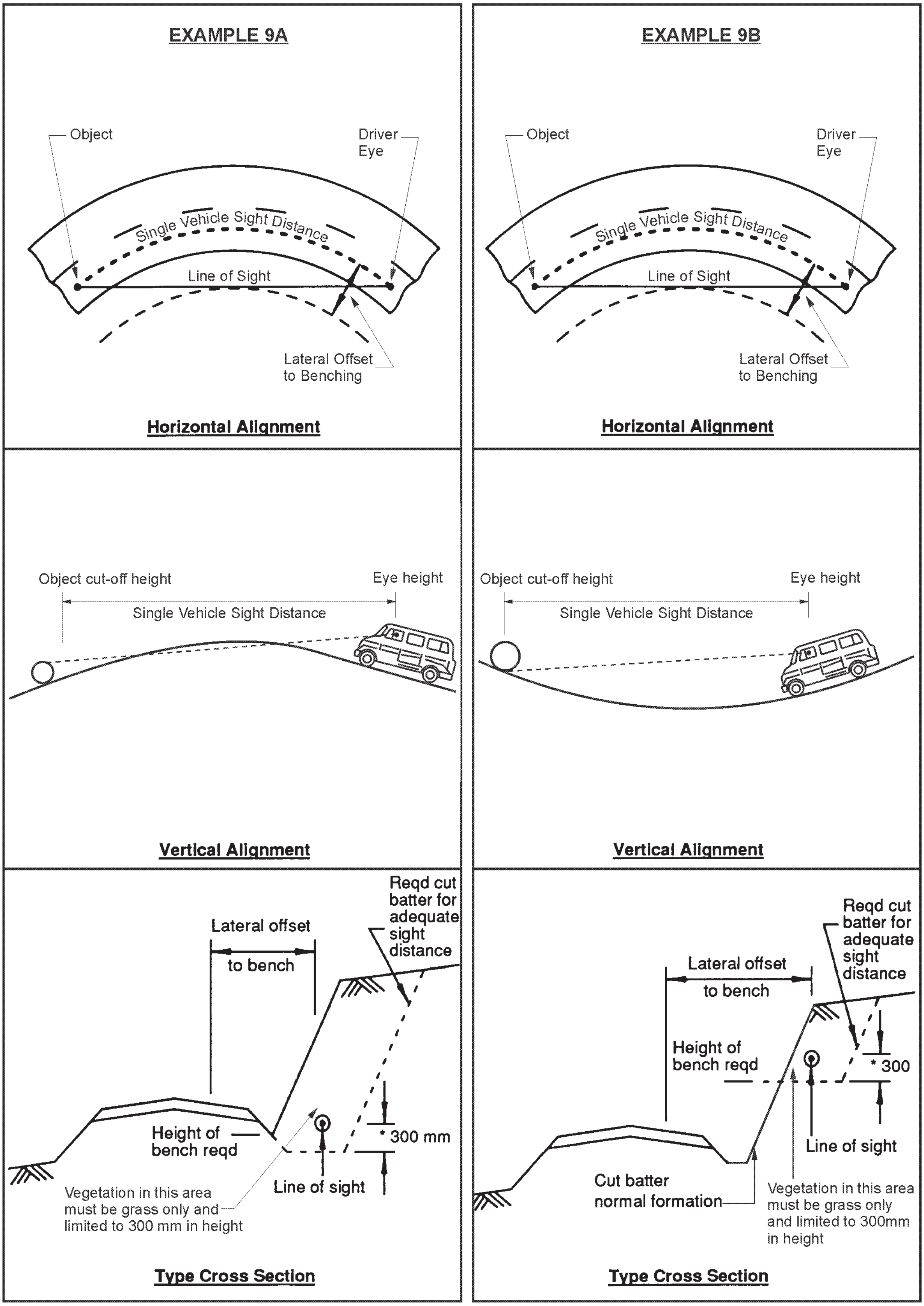
If a very small radius crest curve has been used then the line of sight may be below the pavement surface. The height of the bench needs to be located 300mm below the line of sight to allow for growth of grass (long grasses should not be planted on the bench). Regular maintenance will be required to limit maximum height of grass to 300 mm.

An alternative to this would be to use a larger radius horizontal curve so that the line of sight remains within the formation but this will tend to increase the 85th percentile speed. Each individual case will need to be considered on its own merits to determine the more economical solution.

Example 9B

Example 9B in Figure 9.6 shows an overlapping horizontal curve and sag vertical curve with the line of sight off the formation. The line of sight is above the pavement surface because of the sag vertical curve. The bench in this case would be constructed in the location as shown.

It should be pointed out that cost of earthworks should not be allowed to weigh too heavily against a good vertical alignment, as benching, not done now say, but carried out at a later date, will improve the sight distance, provided the vertical alignment is good, but a low standard vertical alignment can only be improved by regrading.



* 300mm allowance for vegetation growth.

Figure 9.6 Examples 9A and 9B