1130. Cross Sections

1130.1. Roadway Surfaces

1130.1.1 Vertical Clearance

Vertical clearances over roadways, bikeways, and pedestrian facilities should conform to Table 1130-1.

1130.1.2 Cross-Slopes (See Figure 1130-1)

1. Two-lane and wider two-way undivided roadways on tangents should be crowned on the centerline dividing traffic flow. Traveled ways should slope downward from the crown to the outside edges in a plane surface at a slope not flatter than 0.02 ft/ft for paved surfaces and not flatter than 0.03 ft/ft for unpaved gravel surfaces.

2. One-way traveled ways on tangent divided roadways with two lanes may slope downward from the median or left edge of the traveled way in a single plane at a slope no flatter than 0.02 ft/ft or may be crowned as in two-lane, two-way undivided roadways. We suggest that you use a crowned section if you anticipate future widening. Crown one-way traveled ways on tangent divided roadways with three lanes or more with slopes not flatter than 0.015 ft/ft or slopes no greater than 0.02 ft/ft.

3. On all superelevated sections where the rate of cross-slope exceeds the normal shoulder rate, the superelevated rate may be carried across the entire shoulder area, or the upper shoulder may be rolled over, but the algebraic difference in slopes shall not exceed 8 percent.

1130.1.3 Lane and Shoulder Widths

New Construction and Reconstruction

National Highway System roadway widths shall conform to the recommendations of AASHTO.

On rural roadways, off the National Highway System, with design ADT less than 2,000, you should use the lane and shoulder widths shown in Tables 1130-2 through 1130-7. If design ADTs exceed 2,000, lane widths should be used as recommended by AASHTO.

For all urban roadways, follow AASHTO's recommendations for width of lane and shoulder, and the widths should be compatible with the level of service specified for the project.

Rehabilitation (3R)

For rural roadways, use the lane and shoulder widths as determined by the performance requirements of Section 1160.

Urban roadways must have lane and shoulder widths as determined for new construction.

Interstate

Section 1120.2. provides the minimum roadway top width for interstate.

1130.2. Roadside Geometry

1130.2.1 General

The term "clear zone" describes a roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. The width of the clear zone is a function of vehicle speed, ADT, and sideslope. The speed used to determine the width of the clear zone should be the design speed. The general design procedure using the clear zone concept consists of:

1. Delineating the clear zone

2. Identifying obstacles in the clear zone

3. Determining alternative treatments for obstacles within the clear zone. Except where modified by sections 1130.2, 1130.3, and 1130.4, discussion, graphs, figures, and examples from the 2002 *AASHTO Roadside Design Guide* should be the basis of roadside design. Section 1130.6 presents a cost-effective method of selecting treatment alternatives.

This chapter applies to new construction. Section 1160 applies to 3R projects.

1130.2.2 Low-Speed Roadways

Where curbs exist, establish the minimum horizontal clearance as recommended by the AASHTO *A Policy* *on the Geometric Design of Highways and Streets 2001*, for urban roadways.

1130.2.3 Clear Roadside Concept

Statement of the Clear Zone Concept

It is desirable to provide a roadside clear of hazardous objects or conditions for a distance consistent with the speed, traffic volume, and geometric conditions of the site. Provide clear zone or cost-effective alternative obstacle treatment for all new construction and reconstruction highway designs.

Clear Zone Width

Table 1130-2 defines clear zone width adjacent to the traveled edge of a highway. The clear zone is measured from the edge of the traveled way, and clear zone width includes the shoulder width.

Where there are through-auxiliary lanes (passing, truck climbing, and truck descending lanes) the clear zones widths are measured from the edge of the auxiliary lane travel way. In the absence of traffic studies on similar auxiliary lanes, assume when performing cost-effective analysis that the auxiliary lanes carry 50 percent of the one-way traffic at the same speed as on adjacent segments of the road.

Chapter 3 of the *AASHTO 2002 Roadside Design Guide* provides guidance and methods for determining clear zones where combinations of foreslopes and backslopes are within the roadside.

Special Situations Requiring Greater Width

The basic conditions assumed in the definition of the clear zone are 1) a tangent roadway section; and 2) level or near-level roadside slopes. For varying geometric conditions including slopes, curvature, and grade, errant vehicles may require lesser or greater clear recovery zones. You may also evaluate the horizontal width of the clear zone for non-tangent, non-level roadway sections using the procedures in Section 1130.6., Cost-Effective Analysis. This procedure allows adjustments to the clear zone based on varying geometric alignments and a roadside equated to a near-level clear zone.

- **Example 1130-1**

  Referring to Table 1130-2, for a given sideslope, you may determine the appropriate clear zone width for a given speed. For example, a 6:1 fill sideslope for 50 mph and 5,000 ADT requires an 18-foot clear zone, while a 6:1 side slope for 60 mph and 500 ADT requires a clear zone of 16 feet.

- **Example 1130-2**

  There are occasions when roadway sections may have compound slopes within the clear zone, for example, low fills with natural ground in the clear zone and ditch bottoms within the clear zone. In this case, average the slopes beginning at the edge of the traveled way. A slope steeper than 3:1 is not traversable without hazard and must be addressed as an obstacle (see 1130.3.2.). Slopes steeper than 4:1 cannot be used in averaging calculations. See Examples C through G at the end of Chapter 3 of the *AASHTO 2002 Roadside Design Guide* for example calculations.

Comply with DOT&PF Policy and Procedure 5.05.030, Beautification of the Highway Right-of-Way (P&P 5.05.030), when placing landscaping in a project right-of-way. P&P 5.05.030 is available online at: http://www.dot.state.ak.us/admsvc/pnp/assets/chapt_5/05_05_030.pdf.

If clear zone is not provided, evaluate beautification using cost-effective analysis in Section 1130.6 to determine the appropriate treatment.

Treatment of Hazards and Obstacles

There are six treatments for hazards or obstacles:

1. Remove or relocate the obstacle or hazard outside of the clear zone width.
2. Redesign the obstacle or hazard so that it is traversable.
3. Provide bases that are designed to break away upon vehicle impact for engineered obstacles that must remain in the clear zone to be functional (such as a sign or illumination pole), or are too expensive to relocate (such as utilities). Breakaway fixtures meet the NCHRP 350 Test Level 3 requirements.
4. Provide clear zone by flattening slopes.
5. Shield the obstacle or hazard with traffic barriers or crash cushions.
6. Leave the obstacle or hazard in place and provide delineation that marks the hazard and increases the motorist's awareness of it.

Determine the best treatment alternative through the procedures in Section 1130.6., Cost-Effective Analysis.

Culvert Ends in Clear Zone

Refer to Chapter 3 of the *AASHTO 2002 Roadside Design Guide* for treatment of obstacles and traversable features, including approach culvert ends and cross slope pipe ends.

Standard Drawings D-42.01, 43.01, 44.01, and 45.01 show Type C and D inlets, which have traversable designs. Verify hydraulic capacity will meet design flows before using in the project design. Other treatments are described in sections 3.4.2 and 3.4.3 of the *AASHTO 2002 Roadside Design Guide.*

Trees in the Clear Zone

Remove all trees greater than 4 inches in diameter, or those that are likely to be greater than 4 inches in diameter at full maturity, from the clear zone unless there are unusual circumstances—for example, an eagle nesting tree, or the existence of cost-effective alternate treatments.

If clear zone is not provided, evaluate the trees using cost-effective analysis in Section 1130.6 to determine the appropriate treatment.

1130.2.4 Clear Zones on Horizontal Curves

Where accident rates indicate a need for an improvement, you may use widening of the clear zone as a mitigating technique.

The following method may be used to determine widening clear zones on horizontal curves:

CZ_c = $K_{cz} \times CZ_t$

$$K_{cz} = \frac{L_o + W_r}{W_r}$$

$$L_o = \sqrt{R^2 + \left[\frac{(0.9V + 15)^2}{13}\right]^2} - R$$

V = Design speed

W_r = Roadside width constant

L_o = Increased width factor

K_{cz} = Curve correction multiplier

CZ_c = Clear zone for curved roadways

CZ_t = Clear zone for tangent roadways

R = Radius of curve

Figure 1130-2 provides values for W_r and shows the method for tapering into the additional width that occurs on horizontal curves.

- **Example 1130-3:**

The radius of the roadway in Example 1130-1 is 2,292 feet.

The fill sideslope is 6:1.

The design speed is 50 mph.

$$L_o = \sqrt{(2292)^2 + \left[\frac{(0.9 \times 50 + 15)^2}{13}\right]^2} - 2292$$

L_o = 17 ft

W_r = 108 ft

$$K_{cz} = \frac{17 + 108}{108} = 1.16$$

CZ_t = 18 ft (From Table 1130-2 for 50 mph and 5,000 AADT)

CZ_c = 1.16 x 18 ft = 21 ft

You may evaluate the horizontal width of the clear zone for non-tangent roadway sections using cost-effective analysis procedures of Section 1130.6 of this manual.

1130.2.5 Clear Zones on Slopes Steeper Than 4:1

Where embankment slopes are steeper than 4:1, but equal to or flatter than 3:1, a vehicle is considered to have the ability to traverse that slope but not recover. Slopes steeper than 3:1 are not considered traversable and should be treated as obstacles.

In short, the recovery area is the required clear zone plus the horizontal distance occupied by slopes steeper than 4:1. Do not use slopes steeper than 4:1 as part of the clear zone. For additional guidance on traversable slopes, see Section 3.2 of the *AASHTO 2002 Roadside Design Guide*, and see Example C (Chapter 3) for evaluation methods. The clear runout area shown in the

AASHTO 2002 Roadside Design Guide should have a desirable minimum width of 10 feet.

1130.3. Sideslopes, Roadway Sections and Drainage Channels

1130.3.1 Transverse Sideslopes

Refer to the *AASHTO 2002 Roadside Design Guide,* Section 3.2.3 Transverse Slopes, for guidance in designing transverse slopes within the clear zone.

1130.3.2 Roadway Sections

Roadway sections should reflect the clear roadside concept. Provide recoverable slopes unless more cost-effective alternatives are used.

One strategy to reduce costs for high fills is to use a "barn roof" section where clear zone width is provided with a recoverable slope (4:1 or flatter), then a steeper slope (non-traversable, non-recoverable, typically 1.5:1 or 2:1) is constructed to the toe of the fill. Examples D and E from Chapter 3 of the *AASHTO 2002 Roadside Design Guide* illustrate this construction.

While the barn roof section complies with desirable clear zone guidelines, there are other issues to consider. The Department has had to reevaluate these sections after construction due to public perception they are unsafe. Also, the steeper slope, even though outside of the clear zone, is an obstacle. Studies indicate that on high speed highways (greater than 45 mph) a width of 30 feet or more from the edge of the through traveled way allows about 80 percent of the vehicles leaving a roadway out of control to recover.

Another strategy for reducing costs for high embankments is the use of traffic barriers.

There is no one solution that can be applied to all high fill situations. However, cost-effective analysis procedures in 1130.6 can be used to select one of the four roadside alternatives (recoverable slopes, traversable slopes, barn roof, and barriers) on the basis of least combined accident and construction costs over the project life.

1130.3.3 Ditches and Drainage Channels

Figure 1130-3 shows recommended ditch section in rock slopes. The recommended rock excavation section uses the additional consideration of trapping falling debris by dissipating kinetic energy prior to reaching the traveled way.

The *AASHTO 2002 Roadside Design Guide* Figures 3.6 and 3.7 present traversable channel configurations and design considerations. Figure 3.6 is also applicable to rounded trapezoidal channels with bottom width less than 4 feet, and Figure 3.7 is applicable to rounded trapezoidal channels with bottom width greater than or equal to 4 feet.

Other examples of slope averaging and ditch section calculations with regard to clear zones are shown in Examples C through I of Chapter 3 in the *AASHTO 2002 Roadside Design Guide*. In some circumstances, these recommended sections will not be adaptable to certain design demands. Use the cost-effective analysis procedures in Section 1130.6 to justify other designs.

1130.4. Mailboxes

Mailboxes are generally found in the clear zone and, to maintain mail service, they usually cannot be relocated outside of the clear zone. Although a mailbox and the supporting structure are obstacles, you can reduce the hazard to an acceptable level.

The vertical support in the single mailbox installation is the critical member. The support should yield on impact. The vertical support member size and its ground embedment length establish stiffness. Chapter 11 in the *AASHTO 2002 Roadside Design Guide* addresses mailboxes, location, and mailbox turnout design. Alaska Standard Drawings M-20 and M-23 comply with the AASHTO guide. Cantilever supports are preferable because the vertical member is offset farther from the traveled way and there is less conflict with snow removal.

With multiple mailbox installations, the vertical support system is stiffer because of the horizontal member that transfers load. The horizontal member itself is a problem because its level allows it to penetrate a windshield. Avoid this situation; Alaska Standard Drawings M-20 and M-23 show acceptable mountings.

Existing mailbox installations that resemble the Alaska standards from the standpoint of structural stiffness may remain in the clear zone based on the designer's judgment. Remove other installations from the clear zone unless this is not cost-effective in accordance with Section 1130.6.

Table 1130-1
Vertical Clearance

VERTICAL CLEARANCE

Minimum vertical clearances for the entire roadway width, should be provided according to the following table.

RECOMMENDED VERTICAL CLEARANCE *

OVERPASSING FACILITY / UNDERPASSING FACILITY	STATE HIGHWAY		LOCAL ROADS OR STREETS	RAIL-ROAD	PEDES-TRIAN STRUC-TURES	SIGN BRIDGES	BOTTOM SIGNAL HOUSING	OVERHEAD UTILITIES
	INTER-CHANGE	GRADE SEPARATION						
LOCAL ROADS OR STREETS	16 ft - 6 in.	16 ft - 6 in. **			17 ft - 6 in.	18 ft - 6 in.	17 ft - 6 in.	20 ft - 6 in.
STATE HIGHWAY	16 ft - 6 in. **							
RAILROAD	23 ft							27 ft - 6 in.
PEDESTRIAN FACILITY	8 ft - 6 in.							

* Clearance values shown include a 6 in. allowance for future resurfacing of the roadway.
** From the Port of Anchorage to the North Slope the clearance of roadways underpassing railroads shall be 18 ft.

Table 1130-2
Clear Zone Distance

CLEAR ZONE DISTANCE

In feet from the edge of traveled way.

Use low side clear zone values as related to lower speed and ADT for each range.
Use high side clear zone values as related to higher speed and ADT for each range.

Design Speed	Design ADT	FILL SLOPES			CUT SLOPES ***		
		6:1 or flatter	5:1 to 4:1	3:1	3:1	4:1 to 5:1	6:1 or flatter
40 mph or less	Under 750	7-10	7-10	**	7-10	7-10	7-10
	750-1,500	10-12	12-14	**	10-12	10-12	10-12
	1,501-6,000	12-14	14-16	**	12-14	12-14	12-14
	Over 6,000	14-16	16-18	**	14-16	14-16	14-16
45 to 50 mph	Under 750	10-12	12-14	**	8-10	8-10	10-12
	750-1,500	14-16	16-20	**	10-12	12-14	14-16
	1,501-6,000	16-18	20-26	**	12-14	14-16	16-18
	Over 6,000	20-22	24-28	**	14-16	18-20	20-22
55 mph	Under 750	12-14	14-18	**	8-10	10-12	10-12
	750-1,500	16-18	20-24	**	10-12	14-16	16-18
	1,501-6,000	20-22	24-30	**	14-16	16-18	20-22
	Over 6,000	22-24	26-30 *	**	16-18	20-22	22-24
60 mph	Under 750	16-18	20-24	**	10-12	12-14	14-16
	750-1,500	20-24	26-30 *	**	12-14	16-18	20-22
	1,501-6,000	26-30	30 *	**	14-18	18-22	24-26
	Over 6,000	30 *	30 *	**	20-22	24-26	26-28
70 mph	Under 750	18-20	20-26	**	10-12	14-16	14-16
	750-1,500	24-26	28-30 *	**	12-16	18-20	20-22
	1,501-6,000	28-30 *	30 *	**	16-20	22-24	26-28
	Over 6,000	30 *	30 *	**	22-24	26-30	28-30

* Clear zones in this table are limited to 30 feet for practicality and economy. Consider increasing the clear zone where a specific site investigation or engineering judgment indicate that an area has a higher probability of crashes and high severity conditions are present beyond 30 feet. Figure 3-1b and Table 3-1 of the *AASHTO 2002 Roadside Design Guide* provide guidance for increased clear zones.

** Because recovery is less likely on the unshielded, traversable 3:1 fill slopes, fixed objects should not be present near the toe of these slopes because high-speed vehicles that encroach beyond the edge of shoulder may continue and travel beyond the toe of slope. Determination of the width of the clear runout area at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety needs, and accident histories. The width of the clear runout area should conform to the recommendations presented in Figure 3.2, example C (chapter 3), and sections 3.2.1 and 3.3.2 of the *AASHTO 2002 Roadside Design Guide*. The desirable minimum width of clear runout area is 10 feet.

*** The slopes shown are the ditch backslopes. To use these values, the foreslopes and ditch should be traversable.

See Examples C through I at the end of Chapter 3 of the *AASHTO 2002 Roadside Design Guide* for example calculations in situations where there are multiple foreslope and backslope combinations.

Table 1130-3
Off the National Highway System

Rural Local Roadway

Lane and Shoulder Widths for New Construction and Reconstruction

(For Rehabilitation Projects, see 3R Standards, Section 1160 and for ADTs greater than 2,000, reference the AASHTO *A Policy on the Geometric Design of Highways and Streets 2001*)

Lane width presents distance from centerline marking lines to the shoulder marking line.

Local Roads

Design Year ADT 0-2000 vpd

≤10% Trucks – (Reference NCHRP Report 362 Table 29(a))

Design Year Traffic Volumes (ADT) in Vehicles per Day									
Design Speed (mph)	0-400	401-600		601-750		751-1500		1501-2000	
		Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder
LEVEL TERRAIN									
30	Use AASHTO GDVLVLR -	10	5	10	5	10	5	10	6
40		10	5	10	5	10	5	10	6
50*		11	4	11	4	11	4	11	6
ROLLING TERRAIN									
30	Use AASHTO GDVLVLR	10	5	10	5	10	5	10	6
40*		10	5	10	5	10	5	10	6
50		11	4	11	4	11	4	11	6
MOUNTAINOUS TERRAIN									
20	Use AASHTO GDVLVLR	9	2	10	5	10	5	10	6
30*		9	2	10	5	10	5	10	6
40		10	5	10	5	10	5	10	6

*Recommend Design Speed for Terrain, AASHTO GB 2001 Exhibit 5-1

Table 1130-4
Off the National Highway System

Rural Local Roadway

Lane and Shoulder Widths for New Construction and Reconstruction

(For Rehabilitation Projects, see 3R Standards, Section 1160 and for ADTs greater than 2,000, reference the AASHTO *A Policy on the Geometric Design of Highways and Streets 2001*)

Lane width presents distance from centerline marking lines to the shoulder marking line.

Local Roads Design Year ADT 0-2000 vpd >10% Trucks – (Reference NCHRP Report 362 Table 29(b))									
Design Year Traffic Volumes (ADT) in Vehicles per Day									
Design Speed (mph)	0-400	401-600		604-750		751-1500		1501-2000	
		Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder
LEVEL TERRAIN									
30	Use AASHTO GDVLVLR	10	5	10	5	10	5	10	6
40		10	5	10	5	10	5	10	6
50*		11	4	11	4	11	4	11	6
ROLLING TERRAIN									
30	Use AASHTO GDVLVLR	10	5	10	5	10	5	10	6
40*		10	5	10	5	10	5	10	6
50		11	4	11	4	11	4	11	6
MOUNTAINOUS TERRAIN									
20	Use AASHTO GDVLVLR	9	2	10	5	10	5	10	6
30*		9	2	10	5	10	5	10	6
40		10	5	10	5	10	5	10	6

*Recommend Design Speed for Terrain, AASHTO GB 2001 Exhibit 5-1

Table 1130-5
Off the National Highway System

Rural Collector Roadway

Lane and Shoulder Widths for New Construction and Reconstruction

(For Rehabilitation Projects, see 3R Standards, Section 1160 and for ADTs greater than 2,000, reference the AASHTO *A Policy on the Geometric Design of Highways and Streets 2001*)

Lane width presents distance from centerline marking lines to the shoulder marking line.

Collector Roads **Design Year ADT 0-2000 vpd** **≤10% Trucks – (Reference NCHRP Report 362 Table 29(c))**									
Design Year Traffic Volumes (ADT) in Vehicles per Day									
Design Speed (mph)	0-400	401-600		601-750		751-1500		1501-2000	
		Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder
LEVEL TERRAIN									
40	Use AASHTO GDVLVLR	10	5	10	5	10	5	10	6
50*		11	4	11	4	11	4	11	6
60		11	4	11	4	11	4	11	6
ROLLING TERRAIN									
30	Use AASHTO GDVLVLR	10	5	10	5	10	5	10	6
40*		10	5	10	5	10	5	10	6
50		11	4	11	4	11	4	11	6
60		11	4	11	4	11	4	11	6
MOUNTAINOUS TERRAIN									
20	Use AASHTO GDVLVLR	9	2	10	5	10	5	10	6
30*		9	2	10	5	10	5	10	6
40		10	5	10	5	10	5	10	6
50		11	4	11	4	11	4	11	6

*Recommend Design Speed for Terrain, AASHTO GB 2001 Exhibit 6-1

Table 1130-6
Off the National Highway System

Rural Collector Roadway

Lane and Shoulder Widths for New Construction and Reconstruction

(For Rehabilitation Projects, see 3R Standards, Section 1160 and for ADTs greater than 2,000, reference the AASHTO *A Policy on the Geometric Design of Highways and Streets 2001*)

Lane width presents distance from centerline marking lines to the shoulder marking line.

Collector Roads **Design Year ADT 0-2000 vpd** **>10% Trucks – (Reference NCHRP Report 362 Table 29(d))**									
Design Year Traffic Volumes (ADT) in Vehicles per Day									
Design Speed (mph)	0-400	401-600		601-750		751-1500		1501-2000	
		Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder
LEVEL TERRAIN									
40	Use AASHTO GDVLVLR	10	5	10	5	10	5	10	6
50*		11	4	11	4	11	4	11	6
60		11	4	11	4	11	4	11	6
ROLLING TERRAIN									
30	Use AASHTO GDVLVLR	10	5	10	5	10	5	10	6
40*		10	5	10	5	10	5	10	6
50		11	4	11	4	11	4	11	6
60		11	4	11	4	11	4	11	6
MOUNTAINOUS TERRAIN									
20	Use AASHTO GDVLVLR	10	5	10	5	10	5	10	6
30*		10	5	10	5	10	5	10	6
40		10	5	10	5	10	5	10	6
50		11	4	11	4	11	4	11	6

*Recommend Design Speed for Terrain, AASHTO GB 2001 Exhibit 6-1

Table 1130-7
Off the National Highway System

Lane and Shoulder Widths for New Construction and Reconstruction

(For Rehabilitation Projects, see 3R Standards, Section 1160 and for ADTs greater than 2,000, reference the AASHTO *A Policy on the Geometric Design of Highways and Streets 2001*)

Lane width presents distance from centerline marking lines to the shoulder marking line.

Arterial Roads Design Year ADT 0-2000 vpd ≤10% Trucks – (Reference NCHRP Report 362 Table 29(e))												
Design Year Traffic Volumes (ADT) in Vehicles per Day												
Design Speed (mph)	0-250		251-400		401-600		601-750		751-1500		1501-2000	
	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder
LEVEL TERRAIN												
40	9	3	9	3	10	5	10	5	10	7	10	7
50	11	2	11	2	11	4	11	4	11	6	11	6
60*	11	2	11	2	11	4	11	4	12	6	12	8
70*	12	2	12	2	12	4	12	4	12	6	12	8
ROLLING TERRAIN												
40	9	3	9	3	10	4	11	4	11	6	11	8
50*	10	3	10	3	11 or 10[a]	4 or 5[a]	11 or 10[a]	4 or 5[a]	11	6	11	8
60*	11	2	11	2	11	4	11	4	11	4	11	8
MOUNTAINOUS TERRAIN												
20	9	3	9	3	10	5	10	5	10	5	10	6
30	10	2	10	2	10	5	10	5	10	5	10	6
40*	10	3	10	3	11	2	11	2	11	6	11	6
50*	10	3	10	3	11	2	11	2	11	6	11	6

*Recommend Design Speed Range for Terrain, AASHTO GB 2001 Discussion page 448

[a]10-foot lane, 5-foot shoulder if shoulder is not paved. Otherwise use 11-foot lane 4-foot shoulder.

Table 1130-8
Off the National Highway System

Rural Arterial Roadway

Lane and Shoulder Widths for New Construction and Reconstruction

(For Rehabilitation Projects, see 3R Standards, Section 1160 and for ADTs greater than 2,000, reference the AASHTO *A Policy on the Geometric Design of Highways and Streets 2001*)

Lane width presents distance from centerline marking lines to the shoulder marking line.

Arterial Roads

Design Year ADT 0-2000 vpd

>10% Trucks – (Reference NCHRP Report 362 Table 29(f))

Design Year Traffic Volumes (ADT) in Vehicles per Day												
Design Speed (mph)	0-250		251-400		401-600		601-750		751-1500		1501-2000	
	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder	Lane	Shoulder
LEVEL TERRAIN												
40	10	3	10	3	10	5	10	5	10	7	10	7
50	10	3	10	3	10	5	10	5	10	7	10	7
60*	11	2	11	2	11	4	11	4	11	4	11	8
70*	12	2	12	2	12	4	12	4	12	4	12	8
ROLLING TERRAIN												
40	10	3	11	2	11	4	11	4	11	4	11	8
50*	10	3	11	2	11	4	11	4	11	4	11	8
60*	10	3	11	2	11	4	11	4	11	4	12	8
MOUNTAINOUS TERRAIN												
20	10	3	10	3	10	5	10	5	10	5	10	6
30	10	3	10	3	10	5	10	5	10	5	10	6
40*	10	3	10	3	11	2	11	2	11	6	12	6
50*	10	3	11	2	11	2	11	2	11	6	12	6

*Recommend Design Speed Range for Terrain, AASHTO GB 2001 Discussion page 448

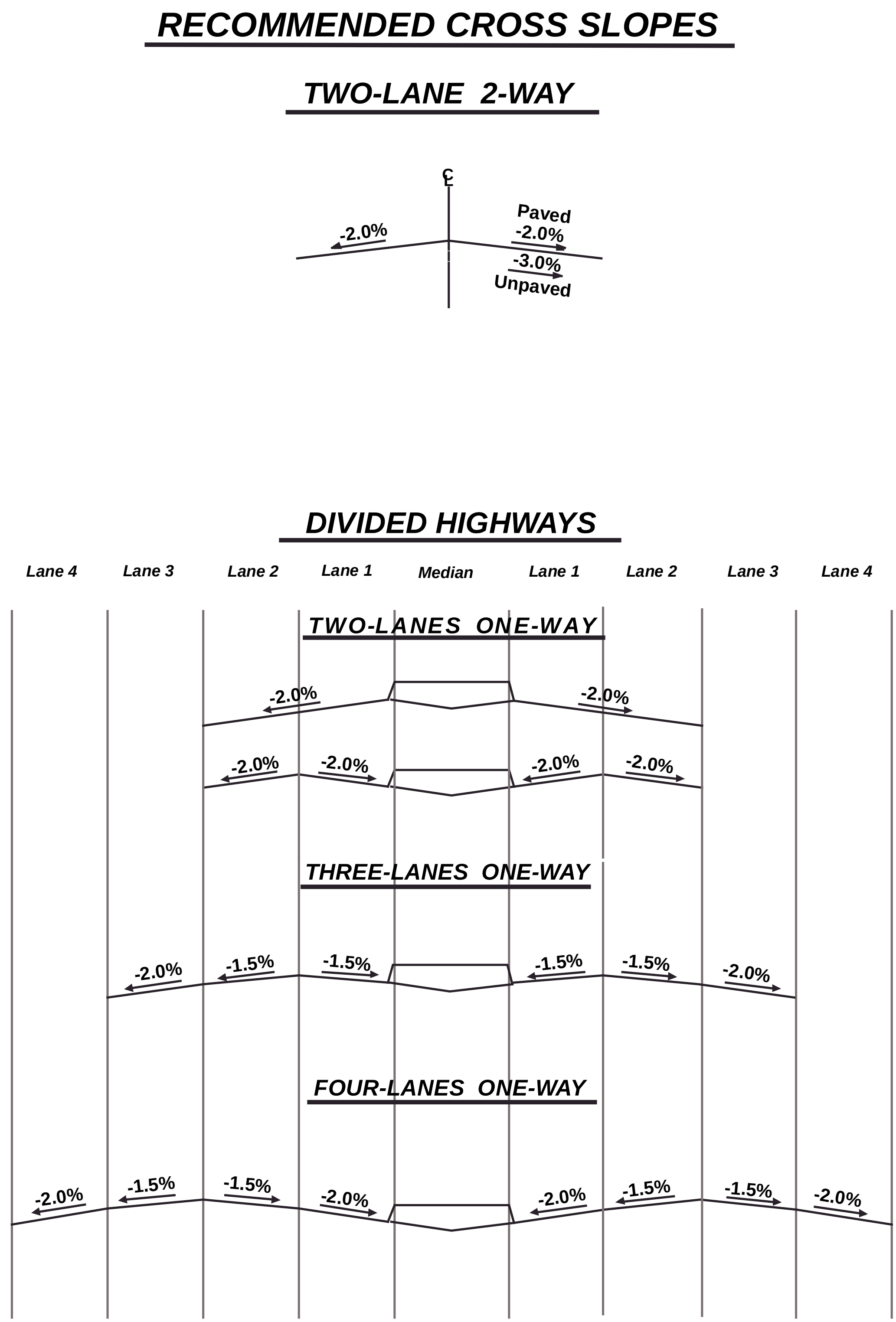
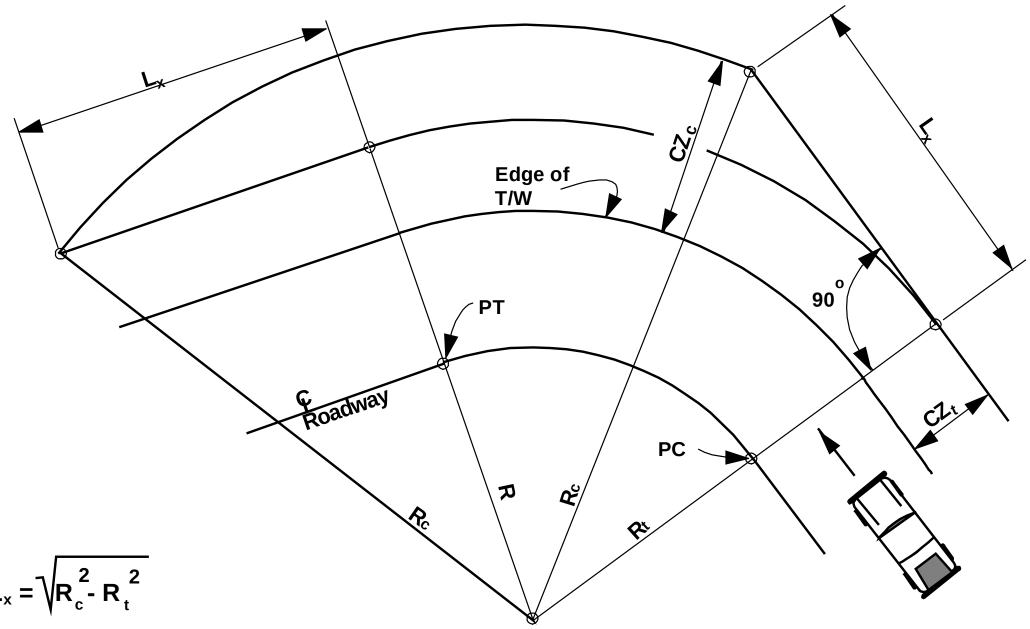


Figure 1130-1
Recommended Cross Slopes

HORIZONTAL CURVE CLEAR ZONE WIDENING OPTION FOR ACCIDENT MITIGATION



$$L_x = \sqrt{R_c^2 - R_t^2}$$

$$CZ_c = K_{cz} \times CZ_t$$

CURVE CORRECTION FACTOR (K_{cz})							
Degree of Curve	DESIGN SPEED (mph)						
	40	45	50	55	60	65	70
2.0	1.08	1.10	1.12	1.15	1.19	1.22	1.27
2.5	1.10	1.12	1.15	1.19	1.23	1.28	1.33
3.0	1.11	1.15	1.18	1.23	1.28	1.33	1.40
3.5	1.13	1.17	1.22	1.26	1.32	1.39	1.46
4.0	1.15	1.19	1.25	1.30	1.37	1.44	
4.5	1.17	1.22	1.28	1.34	1.41	1.49	
5.0	1.19	1.24	1.31	1.37	1.46		
6.0	1.23	1.29	1.36	1.45	1.54		
7.0	1.26	1.34	1.42	1.52			
8.0	1.30	1.38	1.48				
9.0	1.34	1.43	1.53				
10.0	1.37	1.47					
15.0	1.54						

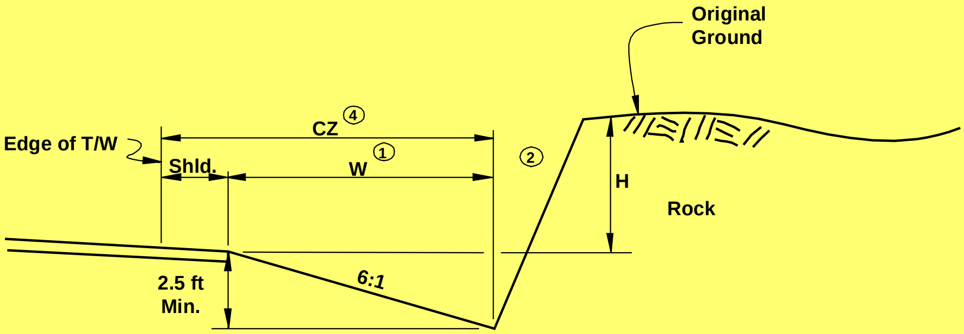
V = Design Speed (mph)
W_r = See Table
K_{cz} = Curve Correction Factor
CZ_t = Clear Zone Distance (ft) Tangent Roadway (See Figure)
CZ_c = Clear Zone Distance (ft) Curved Roadway
L_o = Increased Width Factor
R = Radius of Curve (ft)
R_t = Distance Radius Point to Normal Clear Zone at Curve PC
R_c = $R_t + (CZ_c - CZ_t)$

V (mph)	W_r (ft)
40	91
45	100
50	108
55	117
60	125
65	134
70	142

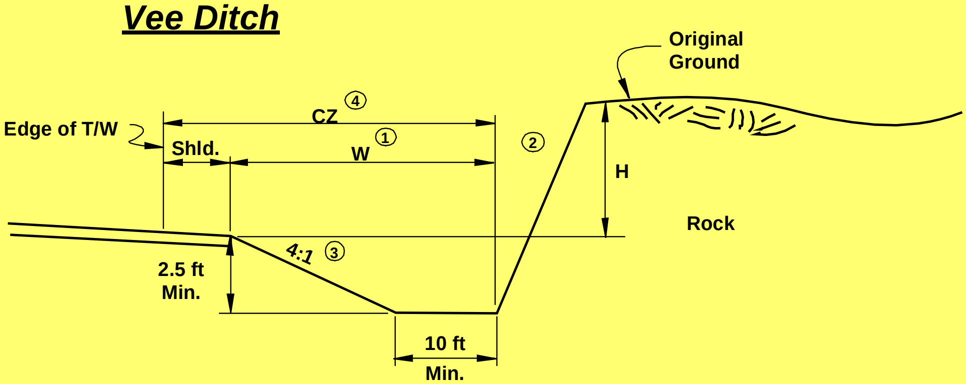
$$K_{cz} = \frac{L_o + W_r}{W_r}$$

$$L_o = \sqrt{R^2 + \left[\frac{(0.9V + 15)^2}{13}\right]^2} - R$$

Figure 1130-2
Horizontal Curve Clear Zone Widening Option for Accident Mitigation



Vee Ditch



Flat Bottom Ditch

Rock Slope	H (ft)	W (ft)
Near Vertical to 0.50:1	0-20 20-30 30-60*	CZ - Shld. 16 19

(1) The greater value shall govern -- CZ or (W+Shld.).

(2) Rock slope: As per geotechnical recommendations.

(3) If a slope steeper than 4:1 is used then barrier may be warranted. (See 1130.5). The width of slopes steeper than 4:1 shall not be included in the CZ dimension (See 1130.2.5).

(4) CZ = Clear Zone (See 1130.2).

* 1. Refer cuts over 60‘ to regional or state geotechnical engineer for roadside ditch design.

2. For cuts over 20’ in height and 1/2 mile in length it may be desirable to request design from regional or state geotechnical engineer to insure cost effectiveness.

ROCK CATCHMENT DITCH WIDTH

Recommended Sections for All ADTs

Figure 1130-3
Rock Excavation

1130.5. Traffic Barriers

1130.5.1 Introduction

There are two types of protective barriers commonly used on Alaska roadways: longitudinal barriers and end terminals. These serve as less severe obstacles that redirect traffic from impacting more severe hazards. Strong post w-beam guardrail is the most common longitudinal barrier, though concrete barrier, weak post box-beam, and other types of solutions are available to meet site-specific needs.

Common end terminals use posts similar to longitudinal guardrail, with specially designed systems for gating at the end and redirecting traffic along the face, while still anchoring the longitudinal barrier. In gores and medians where gating is not desirable, crash cushions may be used to bring vehicles to a stop.

Because no policy can address every real-world condition, temper these guidelines with engineering judgment. See Figure 1130-9 for guidance in evaluating when barrier use is appropriate. In general, if eliminating the hazard and barrier installation are equally cost-effective, eliminate the hazard.

1130.5.2 Guardrails

General

Barriers shall comply with NCHRP 350 test level 3, but may be increased to higher test levels as discussed in *AASHTO 2002 Roadside Design Guide* Section 5.3.

Guardrail Warrants for Embankments

The primary highway factors contributing to embankment accident severity are the height and slope of the embankment. The embankment height comprises the height of a fill, a natural hillside, or a combination of both. An "embankment" can also be a cut if the subject road exists at the top of that cut.

A cost-effective analysis is necessary to determine if guardrail is warranted (see Section 1130.6.). Where cost-effective, the flattening of warranting slopes is preferable to guardrail installation.

Guardrail Warrants for Roadside Obstacles

Roadside obstacles may be classified as non-traversable or fixed objects. Guardrail is warranted for roadside obstacles when shown to be cost-effective (see Section 1130.6.).

Longitudinal Non-Traversable Hazards

Examples of longitudinal non-traversable hazards that may warrant guardrail are:

- Rough rock cuts
- Permanent bodies of water over 3' deep
- Drop-offs with slopes steeper than 3:1

Because of the extended length of the hazard along the roadway, the probability of an errant vehicle striking the non-traversable hazard is greater than that of a vehicle hitting a fixed object. Barrier need for rough rock cuts is a matter of judgment.

Fixed Objects

Examples of fixed objects that may warrant guardrail are:

- Bridge piers and abutments
- Retaining walls
- Fixed sign bridge supports
- Trees
- Approach roadway embankment

For clear zone widths, see Table 1130-2. Clear zones on horizontal curves may be adjusted as shown in Figure 1130-2 if widening is cost-effective.

Length of Need

Length of need is equal to the length of guardrail needed for the hazard plus a length in advance to prevent vehicle penetration behind the rail into the hazard. The hazard may be a "point" hazard such as a tree, or a hazardous area such as a roadway section with severe side slopes.

Where slopes back of the graded shoulder are flat enough (see Guardrail Position Requirements: Guardrail Beyond Shoulder Edge), locate the guardrail as far away from the graded shoulder as possible to minimize this length of need, but with adequate clearance for guardrail deflection.

In the more common instances, where slopes are steeper, the guardrail will run along the shoulder. The barrier may be flared away from the traveled way. Where terrain allows, the barrier end may be buried in the backslope as a way to minimize the length of need. The flare is a method to transition the barrier to a hazard, minimizing driver reaction. The flare also allows for a shorter barrier installation while locating the terminal end farther from the traveled way. Table 1130-10 shows recommended flare rates (b/a).

The recommended flare rates are related to the location of the barrier with respect to the Shy Line Offset. The Shy Line Offset is defined as the distance from the edge of the traveled way, beyond which a roadside object will not be perceived as hazardous and result in a motorist reducing speed or changing vehicle positions on the roadway. Table 1130-9 provides Shy Line Offsets to be used in the flare rate determination.

For additional information on calculating the length of need, as shown in Example 1130-5, refer to the *AASHTO 2002 Roadside Design Guide.* The Department has not developed any methods for calculation of length of need other than the one illustrated in Example 1130-5. The assumption of a specific encroachment angle to determine a length of barrier, as mentioned in the 2002 *AASHTO Roadside Design Guide*, is not an approved method in Alaska.

- **Example 1130-4:**

Refer to Figure 1130-4a and Figure 1130-4b.

Definitions:

L_R : The theoretical distance needed for a vehicle that has left the roadway to come to a stop

L_H : The distance from the edge of the traveled way to the far side of the hazard that falls within the clear zone

L_C : The distance from the edge of the traveled way to the clear zone line

L_1 : The length of barrier upstream of the obstacle that is parallel to the traveled way

L_2 : The distance from the edge of the traveled way to the face of the barrier at the obstacle

L_3 : The distance from the edge of the traveled way to the near face of the obstacle

P : The parabolic offset, obtained from Figure 1130-4a.

Given:

- G-4W barrier
- Obstacle 15 feet deep by 10 feet long
- ADT = 1,800
- Design Speed: 55 mph
- Shoulder: 6 feet
- Near face of obstacle 10 feet from edge of traveled way

Using the design speed and traffic volume, determine the desirable Run Out Length (L_R) from Table 1130-11. With a volume of 1,800 vehicles per day and design speed of 55 mph., L_R is 315 feet.

The Shy Line Offset is 7.2 feet from Table 1130-9.

Position barrier 3 feet in front of the obstacle (measured face of obstacle to face of barrier).

Therefore L_2 = 7 ft, L_3 = 10 ft, & L_H = 25 ft

L_1 = 6.25 ft (See Standard Drawings for spacing from obstacle).

L_2 < Shy Line Offset. Therefore, from Table1130-10, the flare rate b/a = 1:24.

Solve equation for a tangent and flared guardrail with a parabolic end terminal (assume SRT 350). Equation is:

$$x = \frac{L_H - L_2 + \frac{b}{a}L_1 - \frac{a \times P}{\sqrt{a^2 + b^2}}}{\frac{L_H}{L_R} + \frac{b}{a}}$$

And:

$$x = \frac{25 - 7.5 + \frac{1}{24} \times 6.25 - \frac{24 \times 1.79}{\sqrt{24^2 + 1^2}}}{\frac{25}{315} + \frac{1}{24}}$$

x = 131.97 feet, or 132 feet

Guardrail Position Requirements

Guardrail Beyond Shoulder Edge

At fixed objects, it is best to locate guardrail as far away from the shoulder as practical to maximize recovery area and minimize the length of need. Adequate deflection space must be allowed between the guardrail and the object (See the *AASHTO 2002*

Roadside Design Guide Appendix B for deflection data.) If the deflection space cannot be attained, use a stiffer rail section. For installations where the guardrail is located within 20 feet of the shoulder edge or hinge point, negative slopes in front of the guardrail shall be 10:1 or flatter, and the algebraic difference between the shoulder slope and the slope in front of the guardrail should not be greater than 0.10 in order to ensure the proper impact height. Guardrail placed more than 20 feet from the hinge point should have at least 12 feet of 6:1 or flatter slope in front of the rail, and the hinge point need not be rounded.

Guardrail Back of Curb

Curbs in front of guardrail should be avoided where possible. Where no alternative is available, refer to the *AASHTO 2002 Roadside Design Guide* Sections 3.4.1 and 5.6.2.1 for additional guidance on the design of traffic barriers near curbs.

Bridge Approaches

Guardrail at bridge approaches shall have appropriate transitions to alleviate pocketing for impacts just in front of the abutment or bridge rail ends. Determine the length of need using procedures of 1130.5.2, Guardrails: Length of Need. Generally, embankments at bridges are steep and may also warrant guardrail protection.

Gaps Between Warranting Features

Avoid gaps in guardrail less than 200 feet where possible to minimize guardrail endings, which are obstacles.

Road Approaches, Driveways, and Turnouts

Where a road approach, driveway, or vehicle turnout interrupts a normal guardrail alignment parallel to the through roadway, or causes a guardrail section to be terminated short of the normal terminal point based on length of need, guardrail ends must be treated. You may do this with a Controlled Release Terminal or any DOT&PF-approved and NCHRP 350 Test Level 3 certified end terminal.

Other Guardrail Considerations

One of the problems with guardrails is they must end somewhere. It is desirable to bury the rail end in the backslope. All guardrail ends must be anchored.

All upstream guardrail ends must be crashworthy. All downstream guardrail ends must be crashworthy except:

1. On one-way roadways
2. On divided highways or two-lane roadways where the downstream end is outside the clear zone for opposing traffic

Consider the use of crashworthy downstream terminals outside of the opposing traffic flow’s clear zone when in the engineer’s judgment it is likely that there will be a higher than normal incidence of vehicle encroachment beyond clear zone.

1130.5.3 Median Barriers

The principles of guardrail usage are equally applicable to median barriers. However, median barriers additionally prevent errant vehicles from crossing the median area of divided highways and entering the opposing traveled ways. Therefore, they must be capable of containing and redirecting from two directions and on both sides.

Available median width may limit the choice of barrier. If a narrow median exists, a rigid barrier, which does not deflect into the opposing travel lanes, is necessary.

If space limitations present a borderline choice between rigid (concrete “safety shape”) and semi-rigid (back-to-back blocked-out W sections) barrier, then take into account economic and other considerations for the particular site. While the concrete “safety shape” (“F-shape”) barrier may have a slightly higher initial cost, yearly maintenance costs of the W-section barrier may be substantially more than that of the concrete median barrier. Sloped medians may require special consideration. See 2002 *AASHTO Roadside Design Guide.*

A true median barrier usually requires a different end treatment than a single guardrail unless the median widens sufficiently to terminate outside the clear zones of the two roadways, in which case only structural (anchorage) considerations are mandatory.

Operational median barrier end treatments consist of those in the 2002 *AASHTO Roadside Design Guide*.

Again, eliminate gaps where possible. Coordination with emergency services and enforcement agencies in the design stage may allow elimination of unnecessary emergency crossovers.

Warrants for Median Barriers

Low speed and intermediate speed urban section roadways generally do not require median barriers. Rural section intermediate speed roadways and all high-speed roadways may require median barriers.

Section 6.2 of the *AASHTO 2002 Roadside Design Guide* provides information on median barrier applications and warrants procedures. Median barrier warrants for rural intermediate and all high-speed roadways are shown in Figure 6.1 of the *AASHTO 2002 Roadside Design Guide*.

1130.5.4 Bridge Rails

Refer to Section 1120.3.5 and Chapter 7 of the *AASHTO 2002 Roadside Design Guide* for information on Bridge Rails. The "Alaska Two Tube" Bridge Rail is used for new projects. The Department's Bridge Section supplies the drawings on a project-by-project basis. Transition drawings are in the standard drawings (G-30.00 and G-31.00).

1130.5.5 Crash Cushions

Crash cushions are sometimes used to absorb vehicle energy at a rate that is tolerable to the average, properly restrained vehicle occupant. In many cases, such as at elevated gore areas and bridge piers in medians at underpasses, they should also provide for redirection in side-angle impacts to alleviate pocketing near the fixed object.

Crash cushions are usually corrective measures, but may be included in the design phase if there is no feasible alternative, or if the crash cushion is the more cost-effective treatment. For example, at a rural, immovable "point" obstacle where the likelihood of impact is relatively small but the consequences of such impact great, it may be better to install a crash cushion, as opposed to a length of guardrail, to keep the collision cross-section small.

Continuing maintenance considerations for crash cushions is extremely important. For proper performance, almost all crash cushions depend on meticulous attention to functional details during installation, routine maintenance, and post-crash replacement or rehabilitation.

Refer to Chapter 8 of the *AASHTO 2002 Roadside Design Guide* for additional information about crash cushions. For areas of documented repeat impacts, consider using low maintenance or reusable crash cushions, which can be reconstructed in place. Chapter 8, Section 8.4.4 and Table 8.5 of the 2002 *AASTHO Roadside Design Guide* have additional information, including maintenance and crash repair.

1130.5.6 Guardrail End Terminal Replacement

Replace guardrail terminals in accordance with Table 1130-12.

Table 1130-9
Recommended Shy Line Offsets

Design Speed (mph)	Recommended Shy Line Offsets (feet)
80	12.1
75	10.5
70	10.0
60	8.0
55	7.2
50	6.5
45	5.5
40	5.0
30	3.5

Table 1130-10
Flare Rates for Barrier Design
(b/a)

Design Speed (mph)	Flare Rate for Barrier inside the Shy Line (b/a)	Flare Rate for Barrier Beyond Shy Line (b/a)	
70	1:30	1:20*	1:15**
60	1:26	1:18*	1:14**
55	1:24	1:16*	1:12**
50	1:21	1:14*	1:11**
45	1:18	1:12*	1:10**
40	1:16	1:10*	1:8**
30	1:13	1:8*	1:7**

* Suggested maximum flare rate for rigid barrier systems.

** Suggested Maximum flare rate for semi-rigid systems.

Table 1130-11
Recommended Runout Lengths for Barrier
Advancement Length Determinations

	Traffic Volume (ADT)			
	Over 6,000	2,000 to 6,000	800 to 2,000	Under 800
Design Speed (mph)	Runout Length LR (ft)	Runout Length LR (ft)	Runout Length LR (ft)	Runout Length LR (ft)
70	475	445	400	360
60	425	400	345	330
55	360	345	315	280
50	330	300	260	245
45	260	245	215	200
40	230	200	180	165
30	165	165	150	130

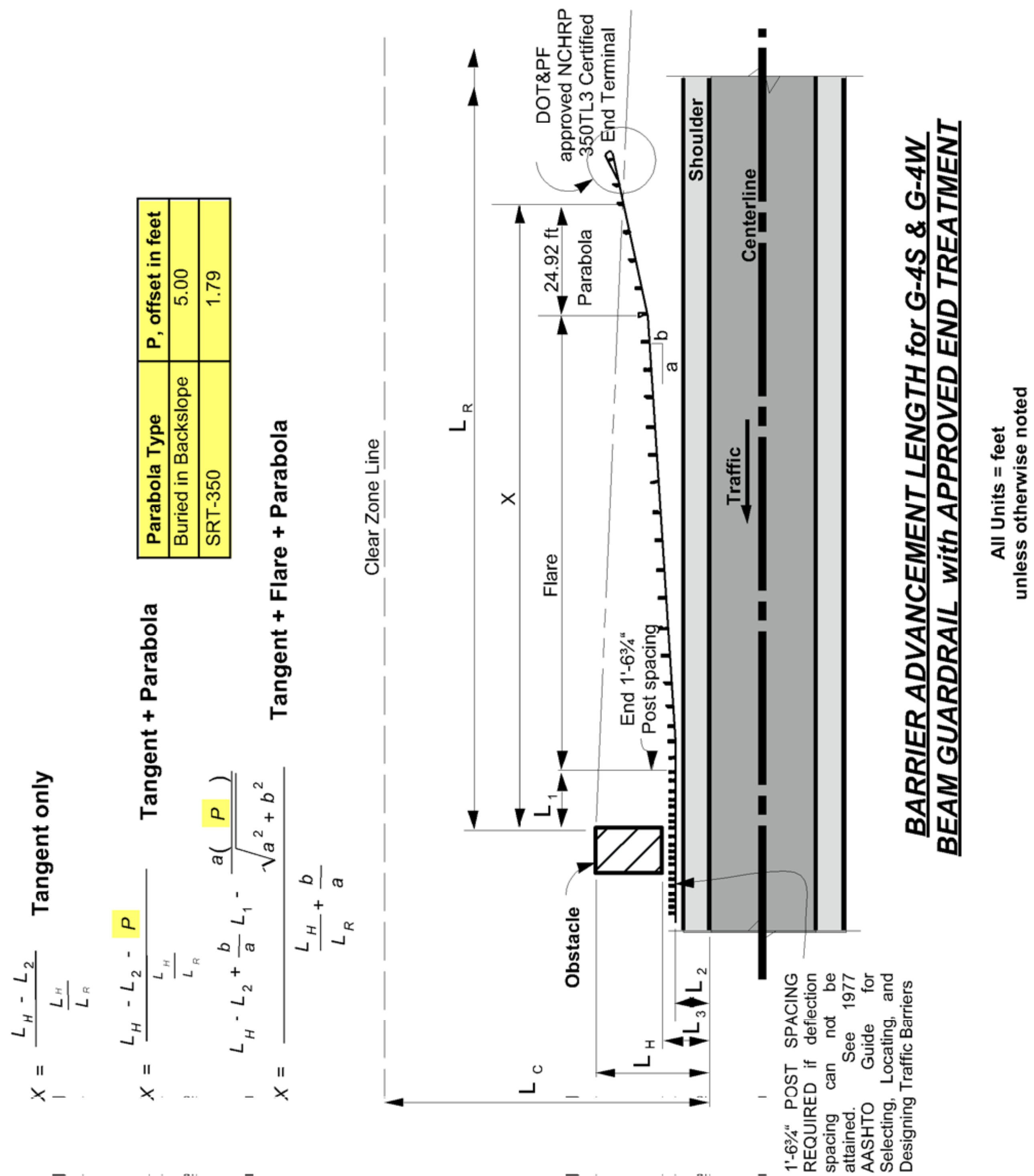
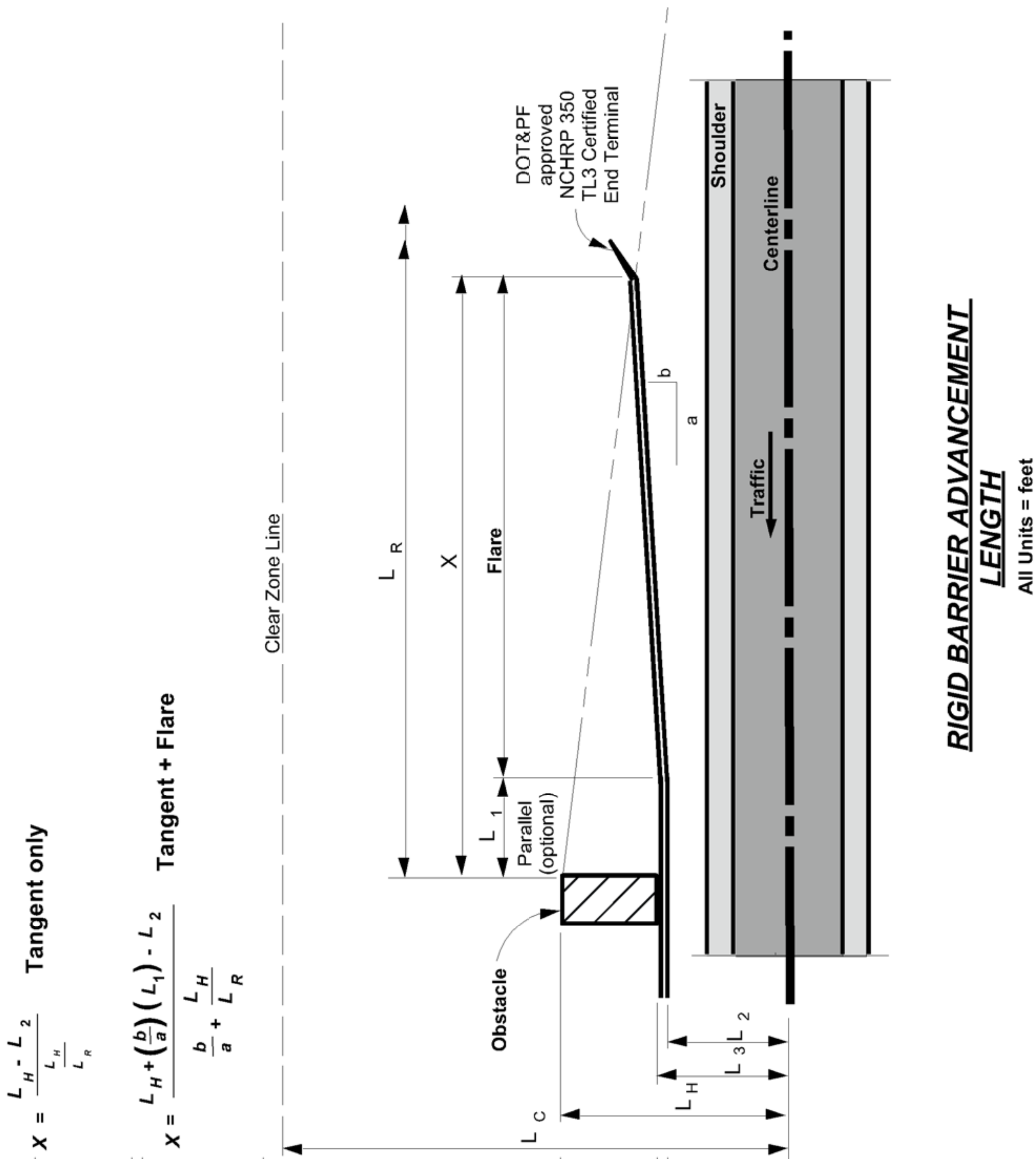


Figure 1130-4a
Barrier Advancement Length for G-4S & G-4W Beam Guardrail with Approved End Treatment



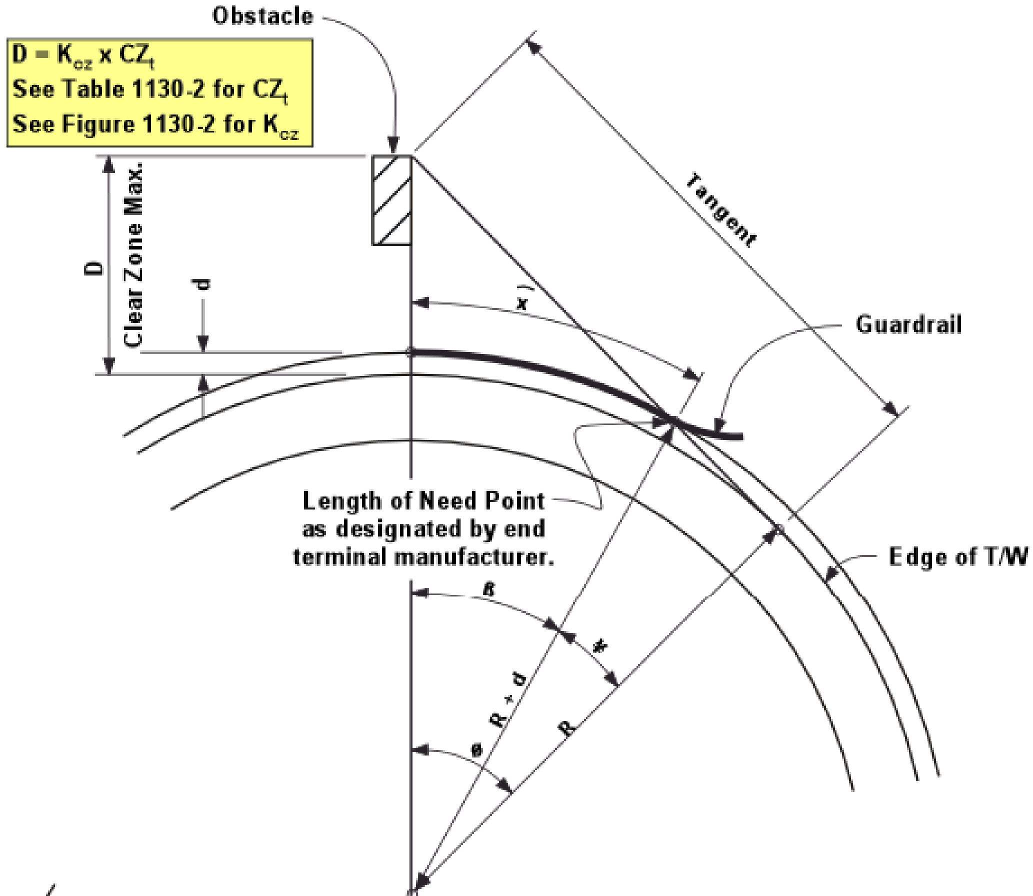
Flare rates are not used on horizontal curves

Figure 1130-4b
Rigid Barrier Advancement Length

TRAFFIC BARRIER ADVANCEMENT

LENGTH on OUTSIDE of HORIZONTAL CURVE

TANGENT ≤ L_R



$\angle ø$ = ARC TAN T/R

$\angle ¥$ = ARC COS R /(R+d)

$\angle ß$ = ø - ¥

$\widehat{x} = \pi (R+d)\, ß/180$

T = Tangent (feet), $T = \sqrt{(R + D)^2 - R^2}$

L_R = Runout Length Table 1130 -11

R = Radius to edge T/W

D = Distance from edge T/W to back of hazard

d = distance from edge T/W to face barrier

$\widehat{X}$ = Advancement Arc Length

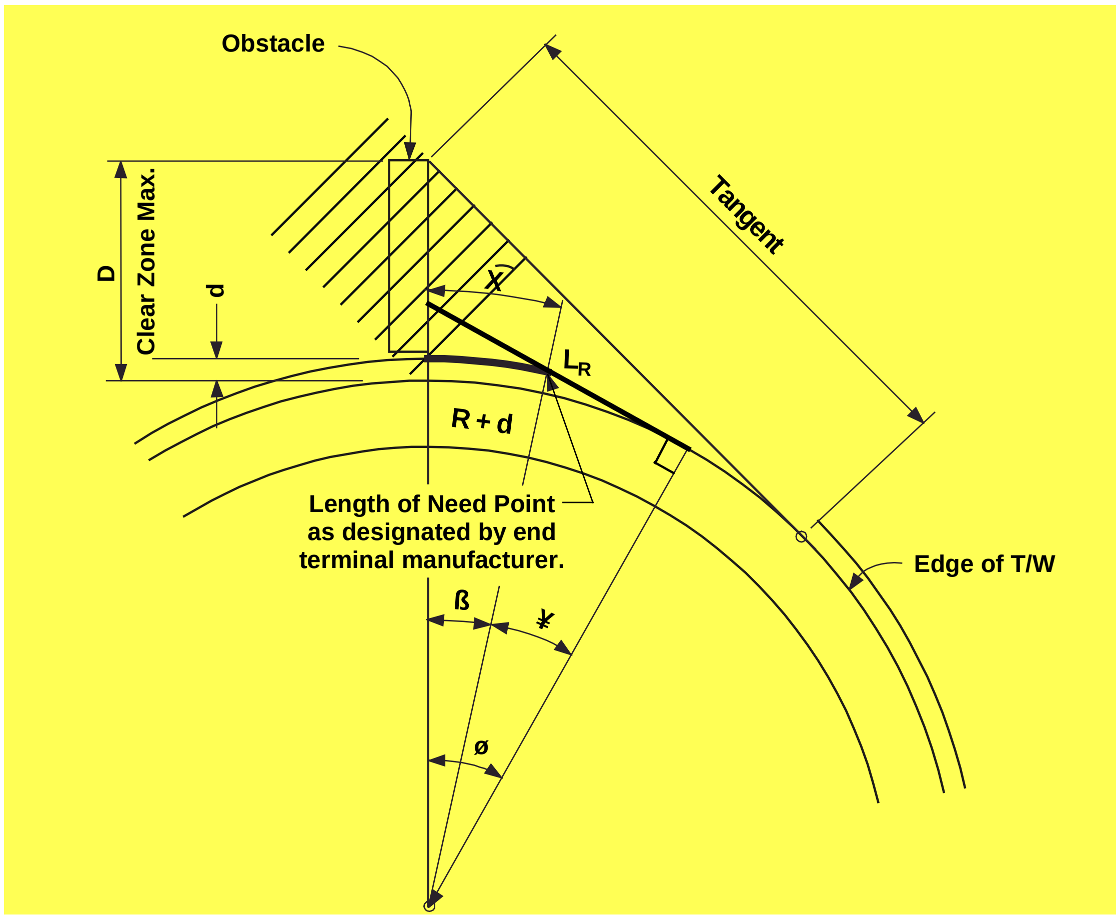
Flare rates are not used on horizontal curves

Figure 1130-5
Traffic Barrier Advancement Length on Outside of Horizontal Curve Tangent ≤ L_R

TRAFFIC BARRIER ADVANCEMENT

LENGTH on OUTSIDE of HORIZONTAL CURVE

TANGENT > L_R



∠ø = ARC TAN (L_R/R)

∠¥ = ARC C0S R /(R+d)

∠ß = ø - ¥

$\frown{x}$ = ? (R+d) ß/180

T = Tangent (feet), T = $\sqrt{(R + D)^2 - R^2}$

L_R = Runout Length Table 1130 -11

R = Radius to edge T/W

D = Distance from edge T/W to back of hazard

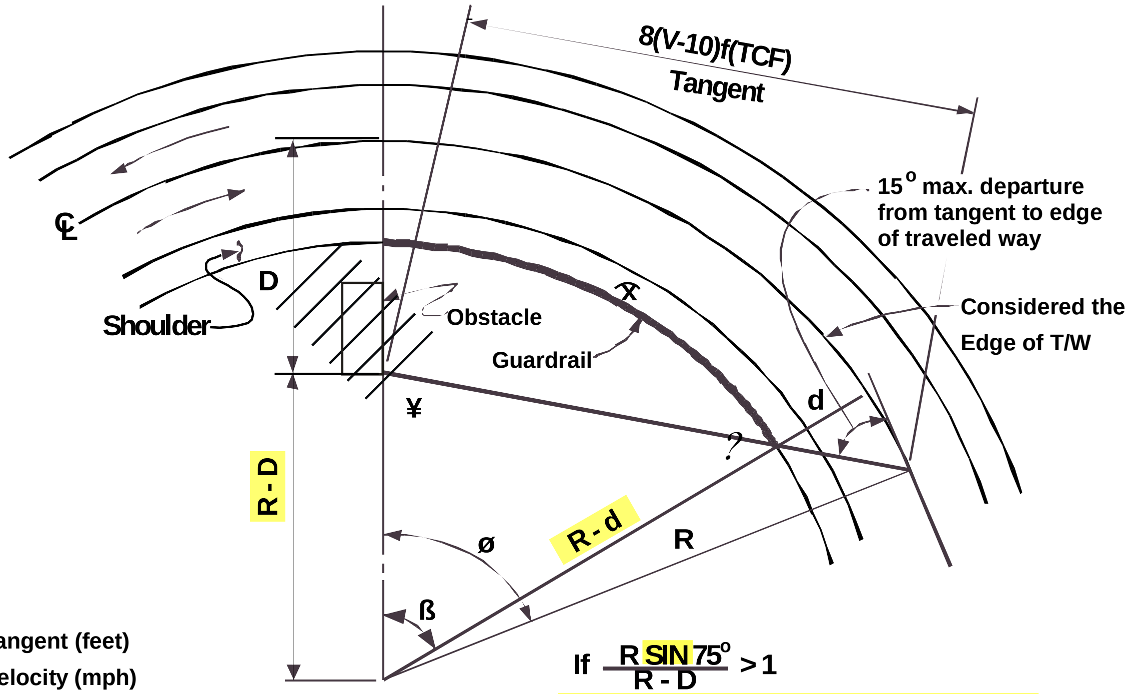
d = distance from edge T/W to face barrier

$\frown{X}$ = Advancement Arc Length

Flare rates are not used on horizontal curves

Figure 1130-6
Traffic Barrier Advancement Length on Outside of Horizontal Curve Tangent >L_R

TRAFFIC BARRIER ADVANCEMENT LENGTH on INSIDE of HORIZONTAL CURVE



T = Tangent (feet)
V = Velocity (mph)
R = Radius to edge T/W
D = Distance from edge T/W to back of hazard
d = distance from edge T/W to face barrier
$\widehat{x}$ = Advancement Arc Length

If $\frac{R \; SIN \; 75^{o}}{R - D} > 1$

Then evaluate as if on a tangent section.

If $\widehat{x}$ >> 8(V/2) f (TCF) then the curve is too shallow and should be treated as a tangent.

Tangent Correction Factors (TCF)	
Design Speed (mph)	TCF
40	0.923
45	1.000
50	1.000
55	1.000
60	1.000
65	1.048
70	1.091

∠¥ = 2 ARC TAN r

∠? = ARC SIN $\frac{(R\text{-}D) \; SIN \; ¥}{R - d}$

∠ß = 180 - ¥ -

$\widehat{x}$ = ? (R-d) ß/180

S = 1/2 [2R - D + 8 f(V-10) (TCF)]

$$r = \sqrt{\frac{[S\text{-}R\text{+}D]\,[S - 8\,(V/2)\,f\,(TCF)]}{S\,[S\text{-}R]}}$$

ADT Factors	
Design ADT	f
> 6,000	1.00
2,000-6,000	0.90
800-2,000	0.82
250-800	0.75
< 250	0.67

Figure 1130-7
Traffic Barrier Advancement Length on Inside of Horizontal Curve

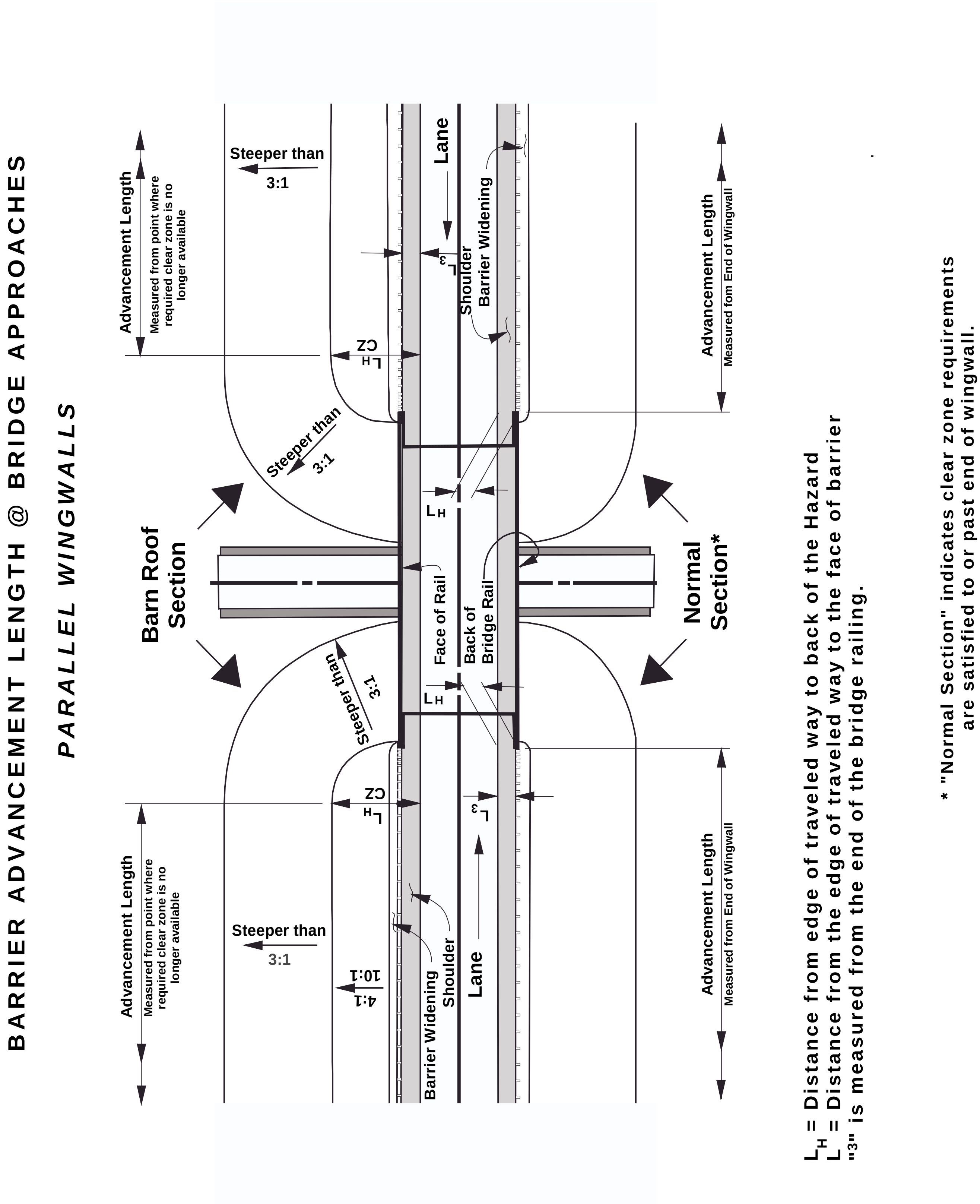


Figure 1130-8a
Barrier Advancement Length at Bridge Approaches (Parallel Wingwalls)

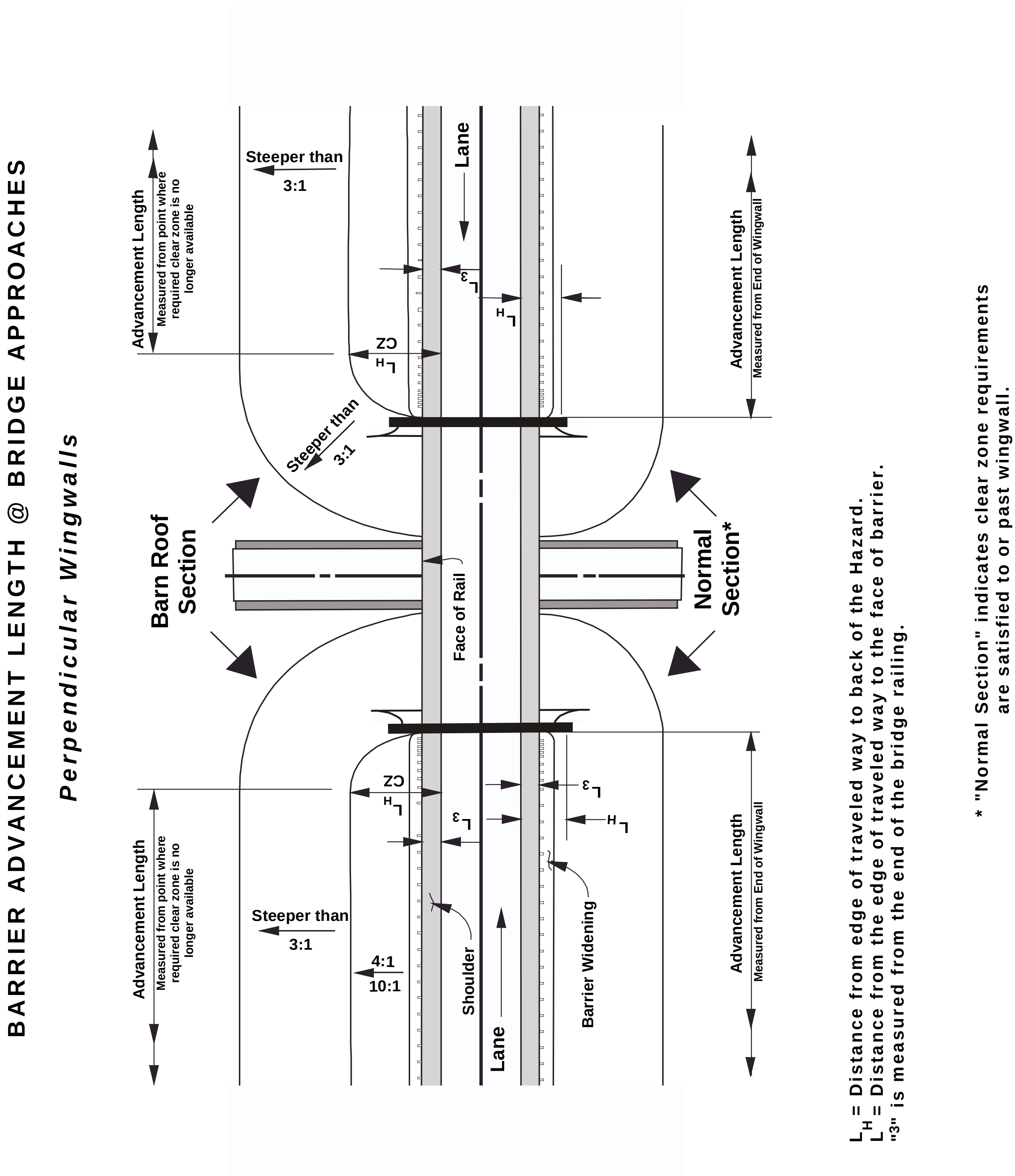


Figure 1130- 8b
Barrier Advancement Length at Bridge Approaches (Perpendicular Wingwalls)

Table 1130-12
Guardrail End Treatment Replacement

Alaska DOT&PF Guardrail End Terminal Replacement Requirements (Rev 8-2-02)													
Existing Guardrail End Terminal (GET)	***Type of Project or Maintenance***	***Non-NHS***				***National Highway System (NHS)***							
						Non-Hi Spd/Hi Vol				***Hi Spd / Hi Vol***			
		GET Condition				***GET Condition***				***GET Condition***			
		OK	***Def-icient***	***Damage***		***OK***	***Def-icient***	***Damage***		***OK***	***Def-icient***	***Damage***	
				Major	***Minor***			***Major***	***Minor***			***Major***	***Minor***
Any or None	New Construction Projects	I350	I350	I350	I350	I350	I350	I350	I350	I350	I350	I350	I350
Breakaway	4R Projects	>40 MPH: R350	>40 MPH: R350	>40 MPH: R350	>40 MPH: R350	R350	R350	R350	R350	R350	R350	R350	R350
Cable	3R Projects (Including Gravel to Pavement)	RNR	RNR	RNR	RNR	R350	R350	R350	R350	R350	R350	R350	R350
Terminal	Surface Repair Maintenance Projects	RNR	RNR	RNR	RNR	R350	R350	R350	R350	R350	R350	R350	R350
(BCT)	State-funded maintenance (non-project)	RNR	RNR	>40 MPH: R350	RNR	RNR	RNR	R350	RNR	RNR	RNR	R350	R350
Turned Down	All projects (4R, 3R, Maintenance)	R350	R350	R350	R350	R350	R350	R350	R350	R350	R350	R350	R350
or Blunt Ends	State-funded maintenance (non-project)	RNR	RNR	R350	RNR	R350	R350	R350	R350	R350	R350	R350	R350

Note. Terminal replacement requirements may be waived for a current project if a separate guardrail project that will correct terminal deficiencies within the limits of the current project is included in the STIP and is scheduled to receive construction funding no later than one year after construction begins on the current project.

Definitions

I350: Install new NCHRP-350 compliant terminals conforming to current installation standards.

R350: Replace Non-NCHRP-350 compliant guardrail end terminals within project limits with Alaska-approved, 350-compliant terminals, with the following exceptions:

1) Upstream breakaway cable terminals outside of the clear zone for both directions of traffic.

2) Downstream breakaway cable terminals outside of the clear zone for the opposing direction of traffic.

When replacing a terminal, make sure embankment widening at the terminal conforms to standard drawing G-20. If not, grade and/or widen as necessary to achieve conformance. Consider relocating terminals if widening can be more easily constructed elsewhere (length of need must be verified where a relocated terminal would result in a reduced length of guardrail). If building embankment widening in accordance with G-20 is not feasible due to slope steepness, height and constraints on extension of the road footprint, the reasons for not doing it should be documented (in the design study report for design projects).

>40 MPH R350: Replace in accordance with R350 above if the speed limit is greater than 40 MPH. If the speed limit is 40 MPH or less, comply with RNR below.

RNR: Replacement Not Required: It is not mandatory to replace terminals with those that are 350-compliant. However, if terminals are not replaced, damaged parts still must be repaired. If terminals are replaced, replacements must be 350-compliant.
Hi Spd / Hi Vol: High-speed, high volume - 50 MPH or more and 6000 ADT or more.

Table 1130-12 cont.
Guardrail End Treatment Replacement

Surface Repair Maintenance Projects: Surface repair projects funded under the federal Preventive Maintenance Program, not including crack sealing or projects that are eligible under the 3R program (3R-eligible projects must conform to the 3R requirements in the matrix). Preventive Maintenance Program projects include asphalt surface treatments, rut filling, profiling, and similar work and may be done either by DOT&PF maintenance or contractors.

Deficient: Deficient terminals include those that have, after project completion, improper flares, improper approach cross slope, rail height too high or low (lower than 24" or higher than 30" on strong-post W-beam), breakaway hardware stub height over 4", etc.

Minor Damage: Post and rail damage, no foundation damage, less than half of the terminal posts need replacement.

Major Damage: Damage to concrete foundations, or when half or more of the terminal posts need replacement

1130.6. Cost-Effective Analysis

1130.6.1 General

The cost-effective analysis procedure is an annualized cost method that has evolved over many years of use in highway economics. Use cost-effective analysis to determine the most efficient alternative when mitigating obstacles or choosing roadway cross sections. The method uses standard economic analysis procedures. In addition, it predicts the annual accident costs for a given highway location.

Figure 1130-9 demonstrates the process and alternative outcomes for cost-effective analyses.

Each alternative can be broken down into the following cost components:

Annual Cost = Initial Costs + Maintenance Costs + Accident Costs + Salvage Value

where:

- **Initial Costs** = Construction Costs + Right-of-Way Costs + Utilities Costs. The initial costs are calculated by developing estimates to construct each alternative, including the costs to acquire right-of-way and relocate utilities. These values are converted to annual costs using standard economic factors.
- **Maintenance Costs** = Annual cost of repairing and maintaining obstacles. This can be the cost of repairing and reinstalling items such as damaged barrier, breakaway luminaries and load centers. The selection of barrier and steeper slopes may affect the ability to perform routine operations such as snow removal and brush clearing. Carefully evaluate the relative effect of each alternative on routine maintenance.
- **Accident Costs** = Predicted annual costs of vehicles impacting obstacles or slopes for each alternative being studied. Use the Department's cost-effective analysis to predict these annual costs. Obstacles may be fixed objects such as barriers, luminaires, load centers, trees, utility poles, and mailboxes. Slopes may be simple slopes, multiple slopes, or ditches.
- **Salvage Value** = Value of the material or hardware at the end of the economic life. This could be applied to items such as lighting, barriers, or utility poles. The salvage value is commonly considered zero for highway applications.

Roadside Safety Analysis Program (RSAP) is a roadside evaluation model that was developed under National Cooperative Highway Research Program Project 22-9 to assist designers in cost-effective evaluation. Appendix A of the *AASHTO 2002 Roadside Design Guide* introduces the program and goes into considerable detail on the program and model background.

RSAP estimates accident severity for a wide range of roadside and median obstacles and hazards. Accident costs are then computed by applying the KABCO severity costs that are provided at http://www.dot.state.ak.us/stwddes/dcsprecon/pop_costeff.shtml. The designer is responsible for computing other costs for input. The model is capable of evaluating several alternatives and roadway segments in each analysis run.

The engineering economy model requires that the designer choose an analysis period and an interest rate. The analysis period should be equal to the project life. The current interest rate is provided at http://www.dot.state.ak.us/stwddes/dcsprecon/pop_costeff.html.

RSAP presents the cost-effective results in a Benefit-Cost (B-C) Ratio format. This is common for public works projects, where the public accrues the project benefits (in this case, annual accident reduction savings over the "do-nothing" or base alternative), but the sponsor agency bears the capital and maintenance costs (RSAP uses an annual worth equivalence).

An alternative with a B-C ratio greater than or equal to "1" is a worthy investment. However, when comparing several alternatives, do not rely on the magnitude of the B-C ratio as the indicator of the best alternative, but use incremental B-C ratios to determine the most cost-effective solution. RSAP does this for you, but you should have an understanding of this method.

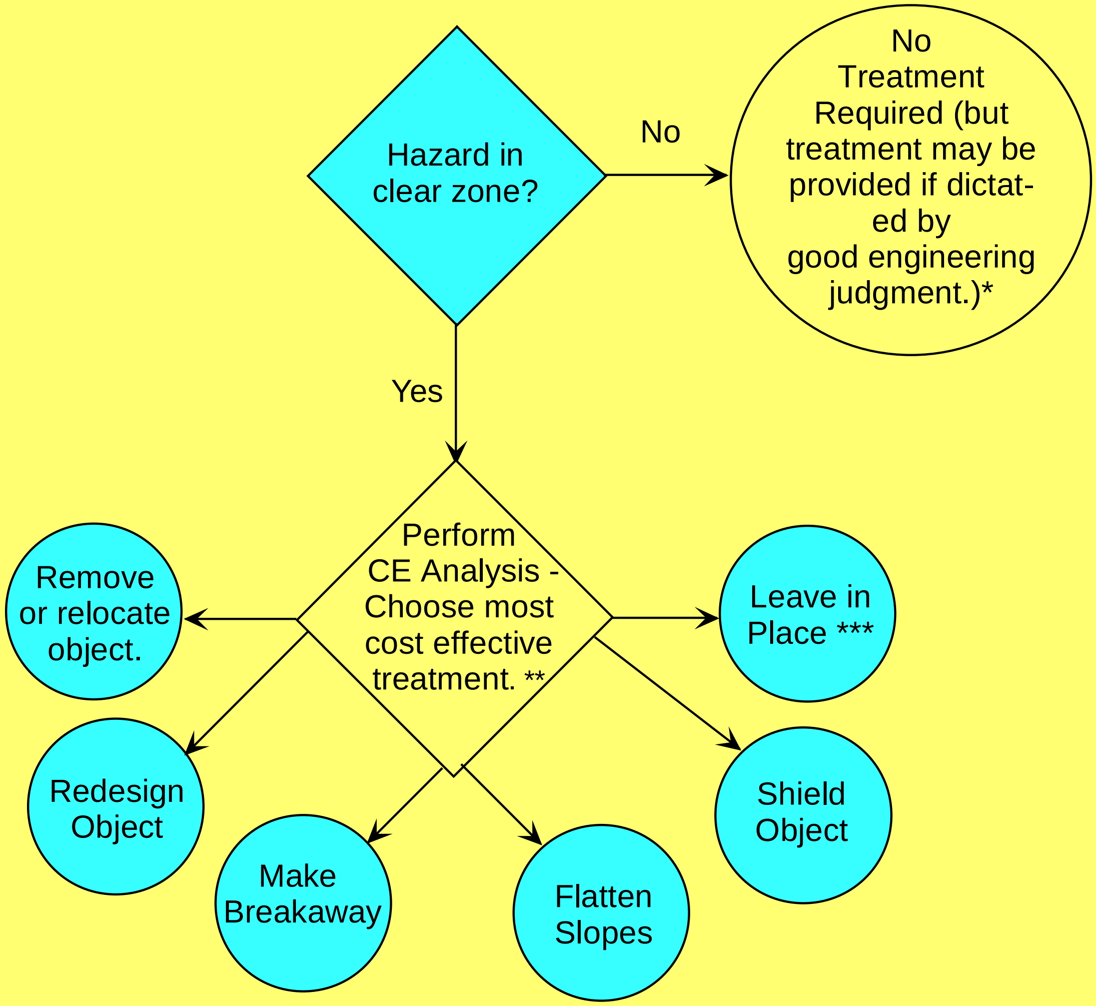
Benefits and costs are presented in a uniform annual worth basis as well by reports that can be generated by the program.

In addition to the RSAP software, obtain the companion *User's Manual* and *Engineer's Manual*. The *User's Manual* is the reference for software. The *Engineer's Manual* provides theory and background information for the program.

The RSAP software and manuals are available from http://gulliver.trb.org/bookstore/.

The RSAP software and manuals are also available online at: http://www4.trb.org/trb/crp.nsf/All+Projects/NCHRP+22-09.

Process for Determining Treatment of Roadside Hazards for new construction and reconstruction projects



CZ = Clear Zone

* Instances where pedestrians congregate near roadways (such as school play yards or other high use pedestrian facilities), especially adjacent to the outside of curves on medium to high speed roadways and in areas with histories of run off the road type accidents, should receive special consideration.

** Perform cost effective analysis in accordance with subsection 1130.6 of this section. If the engineering manager determines that the most cost effective treatment is not the desirable treatment present justification for selecting a less cost effective treatment in the design study report.

*** Delineate the hazard when in the judgment of the engineer delineation would be effective in reducing accident frequency or severity.

Figure 1130- 9
Process for Determining Roadside Treatments on New and Reconstruction Projects

1130.7. Pedestrian Crossings

1130.7.1 Separation Structures for Pedestrian Crossings

Guidelines for Pedestrian Structures

A pedestrian grade separation may be considered if any of the following conditions (volumes, gaps, geometrics) are met:

Volumes

Consider pedestrian grade separations:

- When for each of any eight hours of an average day, the traffic volume is at least 600 vehicles per hour and the crossing pedestrian volume is at least 150 pedestrians per hour during the same eight hours; or
- When on an officially designated safe route to school, the vehicular volume is at least 400 vehicles per hour and the crossing school-age pedestrian volume during the same hour is at least 150 pedestrians, during any one-hour period of an average day.

Gaps

Consider pedestrian grade separations if all of the following requirements are met:

- 85^{th} percentile speed of vehicles approaching the crossing site exceeds 40 mph
- The width of traveled way (exclusive of shoulders or median) exceeds 40 feet
- The average vehicular volume exceeds 750 vehicles per hour during the two heaviest pedestrian crossing hours
- There are less than 60 gaps per hour in the vehicular stream adequate for pedestrian crossings during both peak pedestrian crossing hours. Determination of gap adequacy (time required for pedestrian to cross) is presented in the ITE Recommended Practice *"A Program for School Crossing Protection."*

$$Gap\ Time = \frac{W}{3.5} + 3 + (N - 1) \times 2 \quad \text{seconds}$$

W (feet) = Curb to curb width of roadway

N = Number of rows of pedestrians

Geometrics

Consider pedestrian grade separations if one of the following circumstances occurs:

- The available sight distance is less than the stopping sight distance required by the 85^{th} percentile approach speed, and no other crossings are available for a distance of 500 feet from this location.
- A full freeway intersects a pedestrian way where no vehicular structure is to be built, and no other pedestrian crossing of the freeway is available within a minimum distance of 500 feet.

Access

Access Control

Prevent pedestrian access to the vehicular roadway by a 6-foot-high fence or other physical barrier for:

1. Five hundred feet each direction along both sides of the vehicular way from each end of the pedestrian structure
2. One thousand feet each direction along one side of the vehicular way from one end of the pedestrian structure, or
3. An unspecified distance each direction if the structure's use by pedestrians is guaranteed because the route via the structure requires substantially less time and effort than a route across the roadway at the vehicular grade

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