Section 8

Guidelines for Guide Rail Design and Median Barriers

8.1 Introduction

These guidelines are based on the Roadside Design Guide, AASHTO, 2006.

The information in this section is intended to serve as guidelines that will assist the designer in determining conditions that warrant the installation of guide rail and the dimensional characteristics of the installations. Also, this section contains information to serve as guidelines to assist the designer in determining conditions that warrant the installation of a median barrier.

It is important that application of these guidelines be made in conjunction with engineering judgment and thorough evaluation of site conditions to arrive at a proper solution.

It should be emphasized that guide rail should not be installed indiscriminately. Every effort should be made to eliminate the obstruction for which the guide rail is being considered.

In some cases, another type of traffic barrier may be more effective than guide rail. For example, obstructions in gores can often be more effectively shielded with a crash cushion. The designer should consider such alternatives and choose the most suitable solution based on safety requirements, economic limitations, maintenance, and aesthetic considerations.

8.2 Guide Rail Warrants

8.2.1 General

Guide rail is considered a longitudinal barrier whose primary functions are to prevent penetration and to safely redirect an errant vehicle away from a roadside or median obstruction.

8.2.2 How Warrants are Determined

An obstruction's physical characteristics and its location within the clear zone are the basic factors to be considered in determining if guide rail is warranted. Although some wide ranges of roadside conditions are covered below, special cases will arise for which there is no clear choice about whether or not guide rail is warranted. Such cases must be evaluated on an individual basis, and, in the final analysis must usually be solved by engineering judgment. In the absence of pertinent criteria, a cost-effective analysis could be used to evaluate guide rail needs, such as "Appendix A Cost-Effectiveness Selection Procedure" in the Roadside Design Guide, AASHTO, 2006.

8.2.3 Clear Zone

Clear zone is defined as the area starting at the edge of the traveled way that is available for safe use by errant vehicles.

The width of the clear zone (Lc) varies with the speed, roadside slope and horizontal roadway alignment. The design speed should be used when determining the clear zone. Use "Table 2-1 Design Speed vs. Posted Speed" to determine the design speed.

Figure 8-A contains the suggested range of clear zone distances on tangent sections of roadway based on selected traffic volumes, speed and roadside slopes. Clear zones may be limited to 30 ft. for practicality and to provide a consistent roadway section if previous experience with similar projects or designs indicates satisfactory

performance. According to the Roadside Design Guide, AASHTO, 2006, the designer may provide clear zone distances greater than 30 ft. as indicated in Figure 8-A, where such occurrences are indicated by crash history.

Figure 8-B contains examples of determining clear zone distances. More examples and further explanation are contained in the Roadside Design Guide, AASHTO, 2006.

Horizontal alignment does affect the clear zone width. Therefore, clear zone widths on the outside of horizontal curves should be adjusted as shown in Figure 8-C.

8.2.4 Warrants

A warranting obstruction is defined as a non-traversable roadside or a fixed object located within the clear zone and whose physical characteristics are such that injuries resulting from an impact with the obstruction would probably be more severe than injuries resulting from an impact with guide rail.

A. Non-traversable Roadside

Examples of a non-traversable roadside that may warrant guide rail are: rough rock cuts, large boulders, streams or permanent bodies of water more than 2 ft. in depth, roadside channels with slopes steeper than 1H:1V and depths greater than 2 ft., embankment slopes and slopes in cut sections as described in the following.

1. Embankment (Fill) Slopes

A critical slope is one in which a vehicle is likely to overturn. Slopes steeper than 3H:1V generally fall into this category. If a slope steeper than 3H:1V begins closer to the traveled way than the suggested clear zone distance, guide rail might be warranted if it is not practical to flatten the slope. Guide rail warrants for critical slopes are shown in Table 8-1.

Table 8-1

Critical Slope Warrants

Critical Embankment (Fill) Slopes	Maximum Height Without Guide Rail
1 1/2H:1V	3 ft.
2H:1V	6 ft.
2 1/2H:1V	9 ft.

A non-recoverable slope is defined as one that is traversable but the vehicle can be expected to travel to the bottom of the slope before steering recovery can be obtained. Embankments between 3H:1V and 4H:1V generally fall into this category. Fixed objects should not be constructed or located along such slopes that begin closer to the traveled way than the suggested clear zone distance. A clear runout area at the base of these slopes is desirable; see Figure 8 B for an example. The designer should, therefore, evaluate each site before providing 3H:1V slopes without guide rail. When flattening existing slopes to remove guide rail, the proposed side slopes should be recoverable, that is, 4H:1V or flatter. Where embankment slopes are being constructed, the designer should investigate the feasibility of providing a recoverable slope instead of a critical slope with guide rail. Rounding should be provided at slope breaks; see Figures 5-B, 5B-1, 5B-2, 5-H and 5-I.

CLEAR ZONE (L_c)

FIGURE: 8–A

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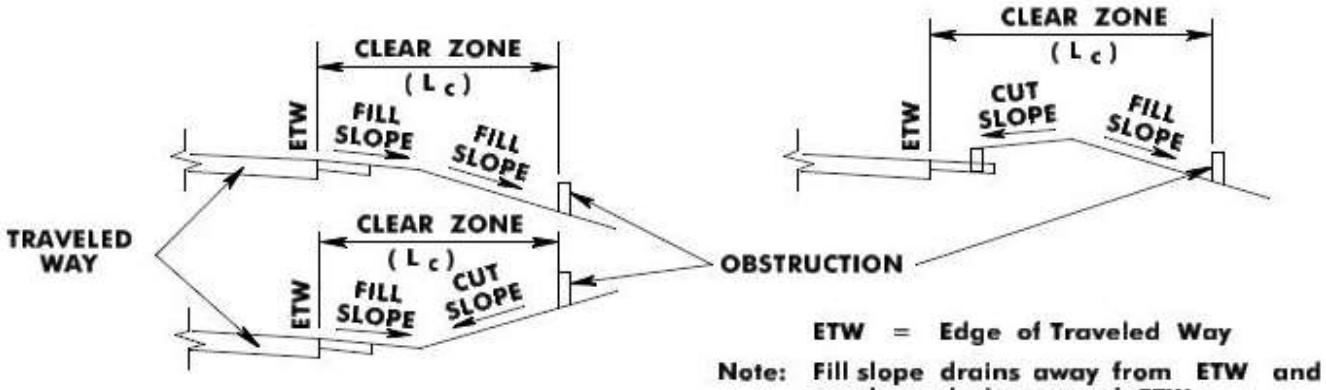
The following table contains the suggested range of clear zone distances on tangent sections of roadway based on selected traffic volumes, speed and roadside slopes:

DESIGN SPEED	DESIGN ADT	CLEAR ZONE DISTANCES (IN FEET FROM EDGE OF THROUGH LANE)				
		FILL SLOPES		CUT SLOPES		
		6: 1 OR FLATTER	5: 1 TO 4:1	3: 1 OR STEEPER	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
	1,500–6,000	12–14	14–16	12–14	12–14	12–14
	OVER 6,000	14–16	16–18	14–16	14–16	14–16
45 – 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
	1,500–6,000	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
	1,500–6,000	20–22	24–30	14–16	16–18	20–22
	OVER 6,000	22–24	26–32	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	26–32	12–14	16–18	20–22
	1,500–6,000	26–30	32–40	14–18	18–22	24–26
	OVER 6,000	30–32	36–44	20–22	24–26	26–28
65 – 70 MPH	UNDER 750	18–20	20–26	10–12	14–16	14–16
	750–1,500	24–26	28–36	12–16	18–20	20–22
	1,500–6,000	28–32	34–42	16–20	22–24	26–28
	OVER 6,000	30–34	38–46	22–24	26–30	28–30



ETW = Edge of Traveled Way

Note: Fill slope drains away from ETW and cut slope drains toward ETW.

FILL AND CUT SLOPES

SOURCE:
"Chapter 3: Roadside Topography and Drainage Features."
Roadside Design Guide, AASHTO, Washington D.C., 2006

CLEAR ZONE EXAMPLES

FIGURE: 8–B

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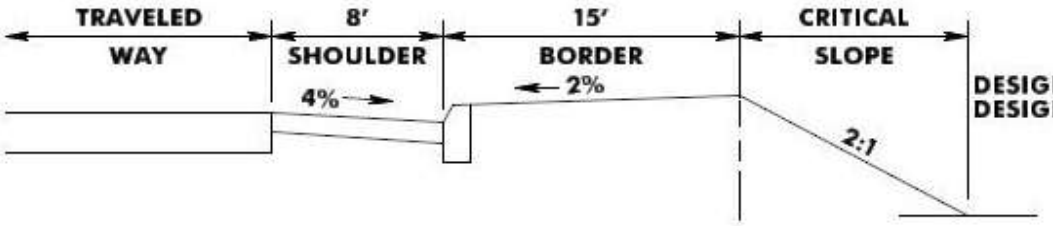
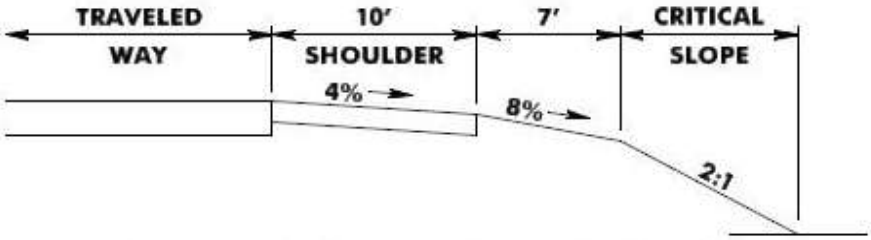


DESIGN SPEED = 50 M.P.H.
DESIGN A.D.T. = OVER 6,000

The suggested clear zone distance for the 2% slope (See Figure 8–A, Cut Slope, 6:1 or flatter) = 20–22 feet.

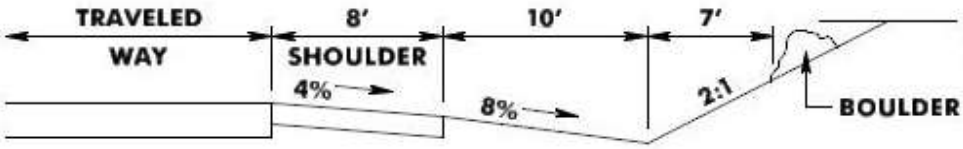
The available 23 feet is 1 to 3 feet greater than the suggested recovery area, therefore, the critical slope (2:1) is outside the clear zone.



DESIGN SPEED = 60 M.P.H.
DESIGN A.D.T. = OVER 6,000

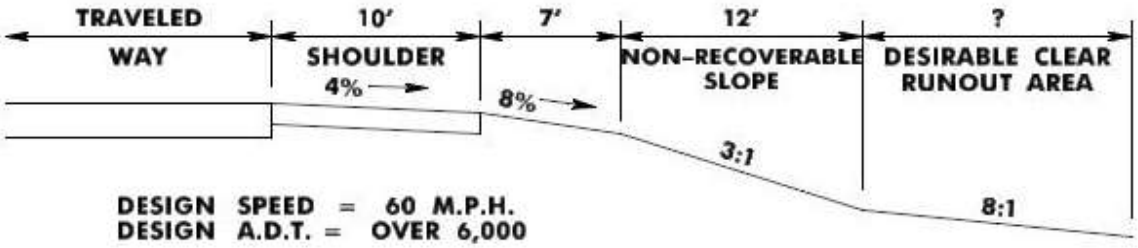
The suggested clear zone distance for the 8% slope (See Figure 8–A, Fill Slope, 6:1 or flatter) = 30–32 feet.

The available 17 feet is 13 to 15 feet less than the suggested recovery area, therefore, the critical slope (2:1) is inside the clear zone.



DESIGN SPEED = 55 M.P.H.
DESIGN A.D.T. = OVER 6,000

The suggested clear zone distance for the 8% slope (See Figure 8–A, Fill Slope, 6:1 or flatter) = 22–24 feet. The available 18 feet to the channel is 4 to 6 feet less than the suggested recovery area for the fill slope. The channel is not within the preferred cross section area of Figure 8–U, but to the boulder there is 25 feet available, which is 1 to 3 feet outside the clear zone for the fill slope. Since the channel bottom and backslope are free of obstructions within the clear zone, guide rail is not required.



DESIGN SPEED = 60 M.P.H.
DESIGN A.D.T. = OVER 6,000

The suggested clear zone distance for the 8:1 slope in the clear runout area (See Figure 8–A, Fill Slope 6:1 or flatter) = 30–32 feet. The recovery distance before breakpoint of non–recoverable slope = 17 feet. Therefore the desirable clear runout area is : 30–32 feet minus 17 feet = 13 to 15 feet.

HORIZONTAL CURVE ADJUSTMENTS FOR CLEAR ZONE

FIGURE: 8–C

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The clear zone widths obtained from Figure 8–A should be increased on the outside of curves. The amount of increase can be determined by the following table:

RADIUS (Ft.)	Kcz (CURVE CORRECTION FACTOR) DESIGN SPEED, MPH						
	40	45	50	55	60	65	70
2,860	1.1	1.1	1.1	1.2	1.2	1.2	1.3
2,290	1.1	1.1	1.2	1.2	1.2	1.3	1.3
1,910	1.1	1.2	1.2	1.2	1.3	1.3	1.4
1,640	1.1	1.2	1.2	1.3	1.3	1.4	1.5
1,430	1.2	1.2	1.3	1.3	1.4	1.4	
1,270	1.2	1.2	1.3	1.3	1.4	1.5	
1,150	1.2	1.2	1.3	1.4	1.5		
950	1.2	1.3	1.4	1.5	1.5		
820	1.3	1.3	1.4	1.5			
720	1.3	1.4	1.5				
640	1.3	1.4	1.5				
570	1.4	1.5					
380	1.5						

$$CZc = (Lc)\,(Kcz)$$

CZc = CLEAR ZONE ON OUTSIDE OF HORIZONTAL CURVE, FEET.
Lc = CLEAR ZONE DISTANCE FROM FIGURE 8–A, FEET.
Kcz = CURVE CORRECTION FACTOR.

NOTE:

Clear zone correction factor is applied to outside of horizontal curves only. Curves flatter than 2,860 ft. do not require an adjusted clear zone. Also, adjustments are not necessary for design speeds less than 40 MPH.

SOURCE:

"CHAPTER 3: ROADSIDE TOPOGRAPHY AND DRAINAGE FEATURES."
ROADSIDE DESIGN GUIDE, AASHTO, WASHINGTON D.C., 2006

2. Slopes in Cut Sections

   Slopes in cut sections should not ordinarily be shielded with guide rail. However, there may be obstructions on the slope that warrant shielding, such as bridge piers, retaining walls, trees, rocks, etc. that may cause excessive vehicle snagging rather than permit relatively smooth redirection. Slopes in cut section of 2H:1V or flatter may be considered traversable. As the cut slope steepens, the chance of rollover increases. Where feasible, slopes steeper than 2H:1V should be flattened. If there is a warranting obstruction on the cut slope, the following apply:

   a. Guide rail should be installed if the warranting obstruction is on a slope flatter than 0.7H:1V and is within the clear zone width specified in Figure 8-A for a 3H:1V slope.

   b. Guide rail should be installed if the warranting obstruction is on a slope of 0.7H:1V or steeper and is less than 6 ft. (measured along the slope) from the toe of the slope and is within the clear zone width specified in Figure 8-A for a 3H:1V slope.

   c. Guide rail is not required if the warranting obstruction is on a slope of 0.7H:1V or steeper and is 6 ft. or more (measured along the slope) from the toe of the slope.

3. Drainage Features

   Channels should be designed to be traversable. Where feasible, existing channels should be reconstructed to be traversable.

   Figures 8-U and 8-V show criteria for preferred cross sections for channels. According to the Roadside Design Guide, AASHTO, 2006:

   ". . .Cross sections which fall in the shaded region of each of the figures are considered to have traversable cross sections. Channel sections which fall outside the shaded region are considered less desirable and their use should be limited where high-angle encroachments can be expected, such as the outside of relatively sharp curves. Channel sections outside the shaded region may be acceptable for projects having one or more of the following characteristics: restrictive right-of-way; rugged terrain; resurfacing, restoration, or rehabilitation (RRR) construction projects; or on low-volume or low-speed roads and streets, particularly if the channel bottom and backslopes are free of any fixed objects. If practical, roadside channels with cross sections outside the shaded regions and located in vulnerable areas may be reshaped and converted to a closed system (culvert or pipe), or in some cases, shielded by a traffic barrier.

B. Fixed Objects

   Examples of fixed objects that may warrant guide rail are: overhead sign supports, traffic signals and luminaires supports of non-breakaway design, concrete pedestals extending more than 4 inches above the ground, bridge piers, abutments and ends of parapets and railings, wood poles or posts with a cross sectional area greater than 50 square inches (except as modified by subsection 8.2.4.B.2. "Utility Poles"), and drainage structures. In no case on new or upgraded guide rail installations shall breakaway, bendaway or non-breakaway design supports, highway lighting, trees, utility poles, fire hydrants, mailboxes and signs remain in front of guide rail.

   Signs with bendaway (steel U-post) supports may be placed in front of dual faced guide rail in the median. Desirably, allow 7 feet between face of rail

element and nearest sign post. If possible, relocate sign behind guide rail at nearest structure or place single post sign inside the dual faced guide rail (between the two rail elements).

Overhead sign supports should be located as close to the right-of-way line as practical. Guide rail protection for all overhead sign supports should be provided regardless of location beyond the clear zone. This will limit severe implications resulting from impacts to the sign support.

1. Trees

   Trees, 6 inches in diameter or greater, are considered fixed objects. However, trees are not considered a warranting obstruction for guide rail since guide rail is not installed solely for shielding trees. The following guidance is provided for the treatment of existing trees within the clear zone:

   a. On freeways and interstate routes, trees shall not be located within the clear zone.

   b. Although it is desirable to provide a clear zone free of trees on land service roads, it is likely that situations will be encountered where removal of trees within the clear zone cannot be accomplished. For instance, the aesthetic appeal of the trees may cause local opposition to their removal, the trees may not be within the right-of-way, or removal of the trees may not be environmentally acceptable.

      In some cases it may be appropriate to plant replacement trees outside the clear zone so that the removal of trees in close proximity to the roadway may be accomplished without public criticism.

      Factors such as crash experience, traffic volume, speed, clearance from the traveled way and roadway geometry should be evaluated when determining whether it is appropriate to leave trees within the clear zone.

      Sick and diseased trees that are beyond reasonable repair, along with dead trees, trees that cause sight distance problems and trees with a significant crash history shall be removed regardless of public criticism. Also, trees that will be harmed beyond reasonable repair due to construction shall be removed (i.e. new curb that destroys the main root system). The Office of Landscape Architecture should be consulted for the tree's physical assessment.

   Trees that have grown behind guide rail, that are less than 4 ft. from the back of the rail element, shall be removed regardless of size. Trees, shrubs and overhanging branches shall be removed where they block or obscure horizontal sight distance whether they are behind guide rail or not. As a minimum, branches overhanging the roadway shall be removed up to a height of 16 ft. Trees and shrubs within the roadside recovery area at the approach guide rail terminal should be removed. The following areas should be checked for sight distance problems due to vegetative interference:

   a. Along the inside of horizontal curves (mainline, ramps and jughandles).

   b. Ramp and jughandle entrances and exits.

   c. Within the sight triangle at intersections.

   d. Sign obstructions.

   If clearing work is necessary within existing utility lines, the designer should request the utility company to perform regular trimming maintenance (at

their cost) in the locations during the utility notification process. However, if clearing work is necessary where poles are to be relocated, then the utility company or the contractor shall be compensated for this work.

Table 8-2 provides guidance for the location of new plantings on Interstate Highways, freeways and land service highways.

Table 8-2
Guidance for Landscape Plantings

Interstate and Freeways	Land Service State Highways
No plantings in median areas except for glare screen	Plantings in median area will be limited to flowers and/or small shrubs, unless for glare screen
No plantings in clear zone except for flowers (no shrubs)	Plantings in clear zone will be limited to flowers and small shrubs
Plantings behind guide rail shall be at least: • 8' minimum for shrubs* • 10' minimum for shade trees* • 14' minimum for evergreen trees*	Plantings behind guide rail shall be at least: • 6' minimum for shrubs and shade trees* • 10' minimum for evergreen trees*
No plantings within the roadside recovery area (see 8-03.3) except flowers	No plantings within the roadside recovery area (see 8-03.3) except flowers
No plantings within the sight triangle on curves and ramps	No plantings within the sight triangle on curves and ramps
On curves and ramps, plantings shall be placed at least 2' from the sight triangle for shrubs and shade trees and 10' for evergreen trees	On curves and ramps, plantings shall be placed at least 2' from the sight triangle for shrubs and shade trees and 6' for evergreen trees
No planting of trees above underground utility lines	No planting of trees under aerial facilities or above underground utility lines and service connections

* Measured from back of guide rail post.

2. Utility Poles

   Although utility poles have a cross-sectional area greater than 50 square inches (8 inches diameter.), utility poles should not be handled the same as other warranting obstructions. It is questionable whether a safer roadside would result from installing guide rail for the sole purpose of shielding utility poles within the clear zone. Utility poles shall be located as close to the right-of-way line as practical. For the offset to the utility pole from the traveled way, the designer should refer to the current Utility Accommodation Regulation (NJAC 16:25). For a quick and easy reference refer to the current NJDOT Design Criteria for Above Ground Utilities.

   Desirably on projects where new right-of-way is to be purchased, sufficient right-of-way should be acquired to permit the placement of the poles beyond the clear zone.

   On existing highways, where the utility pole offset does not meet the Department standards (Utility Accommodation Regulation (NJAC 16:25)), the designer should prepare a crash analysis of existing pole locations to determine if the relocation of the utility poles further from the edge of a through lane is warranted. Any utility pole that has been struck three times or more within three years, will require corrective action. Also,

neighboring poles that have been struck a total of three or more times within three years will require corrective action. If corrective action is necessary, safety measures such as utility pole relocation and/or the improvement of the contributing roadway feature should be considered instead of guide rail.

Utility poles should not be placed in vulnerable locations, such as in gore areas, small islands or on the outside of sharp horizontal curves. For the purpose of these guidelines, a sharp horizontal curve is considered as any horizontal curve with a safe speed less than the posted speed.

In no case, shall utility poles on new or upgraded guide rail installations remain in front of the guide rail. The guide rail offset has preference to existing utility pole offsets where there is sufficient right-of-way. Therefore, where practical, do not place the guide rail closer to the road, instead, relocate the pole behind the guide rail. Guide rail is an obstruction in itself and should be placed as far from the traveled way as possible.

Where utility poles are placed behind guide rail, desirably the face of the pole should be 4 ft. or greater from the back of the rail. Where the offset is less than 4 ft., provide reduced post spacing and double rail element as per the Standard Roadway Construction Details. However as a minimum, the face of the pole shall be no closer than 1 ft. from the back of the rail.

It should be noted that spacing of guide rail posts at long runs of guide rail or at bridge installations may conflict with the spacing of the utility poles. In this case when a pole will be located directly behind a post, the minimum pole offset should be no closer than 20 inches from the back of the rail, which equals 6 inches from the back of the post.

Utility poles shall not be located within the shaded adjacent recovery area shown in Figure 8-D. Also, utility poles should be at least 25 ft. or greater in advance of a flared or tangent guide rail terminal.

3. Fire Hydrants

   Since fire hydrants do not meet the current AASHTO definition for breakaway design, they fall into the category of fixed objects that may warrant guide rail. The same reasoning applies here as was applicable to utility poles.

   The acceptable solution is to locate the hydrants as far from the traveled way as possible. In no case shall fire hydrants be located in front of the guide rail. However, the hydrants must be located to be readily accessible at all times.

   Where guide rail is required for some other reason and will be in front of a hydrant, the preferred treatment is to raise the hydrant to permit connection to be made over the guide rail. Usually, the connection may be a maximum of 3 ft. above grade. It is the responsibility of the designer to confirm with the local Fire Department that such a treatment is acceptable. A less desirable treatment is to provide a short opening in the guide rail at the hydrant. Where an opening is provided, a flared guide rail terminal, tangent guide rail terminal or anchorage must be provided in accordance with Section 8.3.2. The guide rail must be modified as per Section 8.3.1.C when the offset to the hydrant face from the back of a rail element is less than 4 ft.

ROADSIDE RECOVERY AREA AT FLARED AND TANGENT TERMINALS

FIGURE: 8–D

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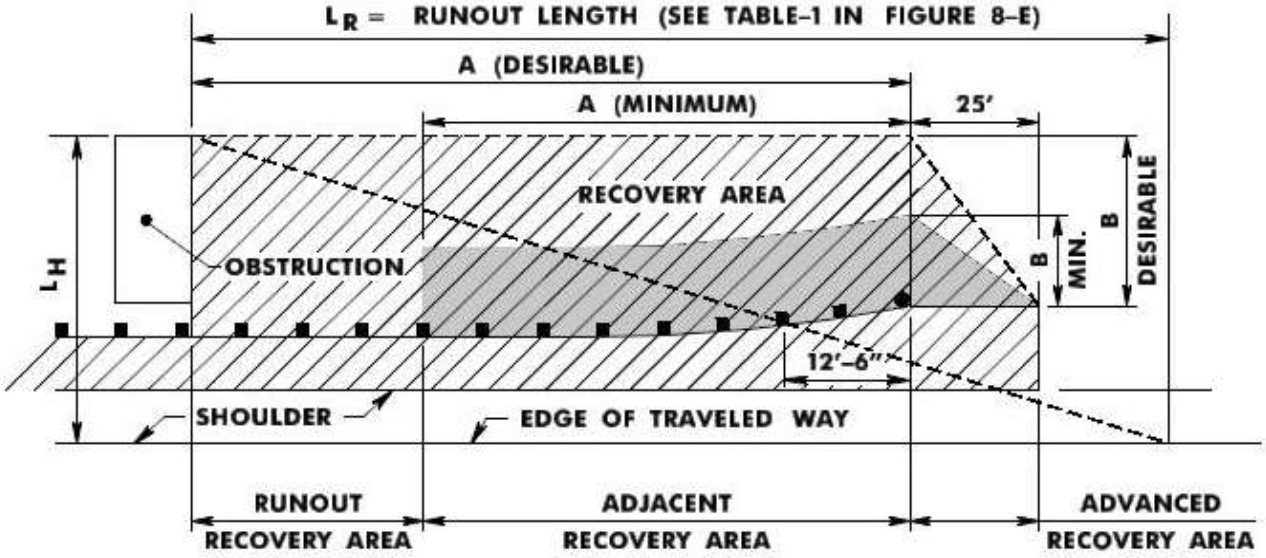


TABLE–1

MINIMUM ADJACENT RECOVERY AREA BEHIND GUIDE RAIL (SHADED AREA)

Design Speed (mph)	A(ft.)	B(ft.) See Note C
40 or less	50	10
45	55	12
50	60	15
55	65	18
60 OR GREATER	75	20

Note "A": No fixed objects should be within the crosshatched area. Desirable, dimension (A) should equal the L.O.N. plus 12'–6", and dimension (B) should extend from the face of the terminal to the offset L_H (see note B). When it is not practical to provide a roadside recovery area behind the guide rail based on the desirable dimensions, the minimun adjacent recovery area dimensions in table 1 may be used along with the advance recovery area.

Note "B": If dimension (B) extends the area to be cleared beyond the R.O.W. line or L_H, the roadside recovery area should extend to the R.O.W. line when L_H is out side of the R.O.W. line, and no further than L_H when L_H is within the R.O.W. line.

Note "C": If the typical lateral roadside recovery area in advance of the terminal is smaller than shown in table 1, a lesser value for dimension (B) may be used but it should be consistent with that available elsewhere along road.

Note "D": See section 8.2.4.B.2 for discussion on utility placement.

4. Mailbox Supports

   Limited crash data has shown that mailbox supports can contribute to the severity of a crash. The following guidelines should be followed on new construction, reconstruction and projects that involve resurfacing: No more than two mailboxes may be mounted on a single support structure unless the support structure and mailbox arrangement have been shown to be safe by crash testing. Lightweight newspaper boxes may be mounted below the mailbox on the side of the mailbox support. Mailbox supports shall not be set in concrete unless the support design has been shown to be safe by crash tests when so installed. A single 4 by 4 inch wooden post or a 4 inch diameter wooden post or a 1.5 inch to 2 inch diameter standard steel or aluminum pipe post, embedded no more than 2 ft. into the ground, is the maximum acceptable as a mailbox support. A metal post shall not be fitted with an anchor plate, but it may have an anti-twist device that extends no more than 10 inches below the ground surface. In areas where snow removal is a problem or the mailbox is placed behind guide rail, a cantilever mailbox-type support may be permitted to allow snow plows to sweep under or near mailboxes without damage to their supports. For information on cantilever mailbox design, see the Roadside Design Guide, AASHTO 2006. The post-to-box attachment details should be of sufficient strength to prevent the box from separating from the post top if the installation is struck by a vehicle. The Roadside Design Guide, AASHTO 2006 shows acceptable attachment details. The minimum spacing between the centers of support posts shall be 75 percent of the height of the posts above the ground line. For more information on mail stop design and mailbox location, see the Roadside Design Guide, AASHTO 2006.

C. Pedestrians

Guide rail may be used where there is a reasonable possibility of an errant vehicle encroaching into an unprotected area used by pedestrians. Some examples are where a playground, schoolyard, or a public beach is adjacent to the right-of-way line. The basis for assessing the needs should be the crash experience of the immediate area and the specifics for the cause(s) of the crashes. There may be times when no causative factor can be isolated, and sound engineering judgment must be applied.

This policy is not intended to indiscriminately permit the installation of guide rail at every location where a request for guide rail has been received, but to offer some flexibility to the designer when unique circumstances occur.

There are locations where existing guide rail and the PVI (top of the slope) of a steep slope are both located directly behind a pedestrian sidewalk area. If new guide rail is installed in front of the sidewalk area, the existing guide rail should either be left in place or the existing guide rail should be removed and a fence installed in its place. When guide rail is placed between the roadway and the sidewalk, a rail element may be attached to the back of the guide rail post so that pedestrians are shielded from the exposed back of post. The rail element, if added, shall not be located within the 37.5 ft. length of a flared guide rail terminal or within the 50 ft. of a tangent terminal.

8.3 Dimensional Characteristics

8.3.1 Clearance from the Traveled Way

A. Without Curb or Raised Berm in Front of Guide Rail

A highly desirable characteristic of any roadway is a uniform clearance from the traveled way to the guide rail. It is desirable to place the guide rail at a distance beyond which it will not be perceived as a threat by the driver, see Figure 8-E, Table-1: Shy Line Offset. In general, the following offsets and slopes should be used:

1. To the extent possible, guide rail should be located as far as possible from the traveled way to provide a recovery area for errant vehicles and to provide adequate sight distance along horizontal curves and at intersections.
2. On interstate highways and freeways, the front face of the guide rail should desirably be 4 ft. or more from the outside edge of shoulder. Where this offset is not possible, the guide rail should be installed flush with the gutter line.
3. On land service highways where there is a sidewalk or a sidewalk area used by pedestrians, the front face of the guide rail should desirably be 7 ft. or more from the outside edge of shoulder. Where this offset is not possible, the guide rail should be installed flush with the gutter line.

   On land service highways where there is no sidewalk and the border area is not used by pedestrians, the front face of the guide rail may be placed any distance from the gutter line; however, an offset of 4 ft. or more is preferred.

   Where providing an offset of 7 ft. or more, the designer is advised that additional right-of-way or slope easements may be necessary to construct a flared offset and/or provide the 5 ft. flat area (10H:1V minimum slope) adjacent to a flared guide rail terminal as shown in Figure 8-F. If the purchase of additional right-of-way is infeasible, a tangent terminal should be provided at an offset of 7 ft. or more, instead of a flared guide rail terminal. If this is still infeasible, then the guide rail should be installed flush with the gutter line to permit the construction of a flared guide rail terminal with a flared offset and flat area.
4. Where guide rail is located at the top of an embankment slope, the posts should be a minimum of 2 ft. from the PVI to the center of the post.

   When less than 2 ft. is provided, the following post lengths, shown in Table 8-3 below, should be used:

Table 8-3

Additional Post Length Requirements Where Distance From PVI to Center of Post is Less Than 2 Feet

Embankment Slopes	Additional Post Length
Flatter Than 6H:1V	No Change
6H:1V to 4H:1V	1 ft.
3H:1V to 2H:1V	2 ft.
Steeper Than 2H:1V	4 ft.

5. Guide rail shall be placed on slopes 10H:1V or flatter provided the rollover between the pavement slope and the embankment slope is not greater than 10 percent. Rollovers greater than 10 percent are prone to occur where superelevation slopes in the opposite direction of the embankment slope. Where this happens, install guide rail flush to the gutter line.

6. Figure 8-F illustrates the slope treatment for embankment slopes at flared and tangent guide rail terminal.

B. Curb or Raised Berm in Front of Guide Rail

Curb or a raised berm in front of guide rail should be avoided, see Section 5.6, "Curbing", for the type and location of curb.

On freeways and Interstate highways, new installations of vertical curb shall not be constructed. However, sloping curb may be constructed on urban freeways and urban Interstate highways but the overall curb height shall not exceed 4 inches. On land service highways, a design without curb or raised berm in front of guide rail should be provided where possible.

On projects that involve upgrading existing roadways, where there is a curb or a raised berm in front of guide rail, removal or modification of the curb or raised berm should be the first consideration. If a raised berm in front of the guide rail cannot be removed, it shall be regraded at 10H:1V. Where curb in front of guide rail cannot be removed, 75 ft. of curb in advance of and 50 ft. beyond the front of a flared guide rail terminal or a tangent terminal shall be no greater than 4 inches.

If curb (vertical and/or sloping curb) is present and cannot be removed, the following apply (along with Section 8.3.1.A.4, 5 and 6):

1. Highways With a Posted Speed of More than 40 MPH:

   When installing new guide rail, the preferred guide rail offset is flush with the gutter line and rub rail shall be installed in accordance with Section 8.3.1.B.3, "Rub Rail". On freeways and interstate highways where sufficient roadside width is available, new guide rail installations may be placed 10 ft. or more behind the gutter line.

   On land service roadways where there is a sidewalk or sidewalk area used by pedestrians, new guide rail installations may be placed at 7 ft. or more behind the gutter line. Existing guide rail that is located 10 ft. or more behind the gutter line on freeways and interstate highways and 7 ft. or more behind the gutter line on land service highways may be retained at its current location.

   Where providing an offset of 7 ft. or more, the designer is advised that additional right-of-way or slope easements may be necessary to construct a flared offset and provide a standard 5 ft. flat area (10H:1V minimum slope) adjacent to the flared guide rail terminal as shown in Figure 8 F. If the purchase of additional right-of-way is infeasible, a tangent terminal may be provided at an offset of 7 ft. or more, instead of a flared guide rail terminal and/or a 2 ft. flat area provided behind the terminal as shown in Figure 8-F. If this is still infeasible, then the guide rail should be installed flush with the gutter line to permit the construction of either a flared or tangent guide rail terminal with the standard grading treatment.

2. Highways With a Posted Speed of 40 MPH or Less:

   When installing new guide rail, the preferred guide rail offset is flush with the curb line. However, guide rail may be placed any distance behind the gutter line. Usually an offset of 4 ft. or more (freeway or Interstate ramps), or 7 ft. or more (land service roadways) should be used. Existing guide rail that is located 4 ft. or more behind the gutter line on freeways and interstate ramps and 7 ft. or more behind the gutter line on land service highways may be retained at its current location.

APPROACH LENGTH OF NEED ON EMBANKMENT (FILL) SLOPE

FIGURE: 8–E

BDC10MR–01

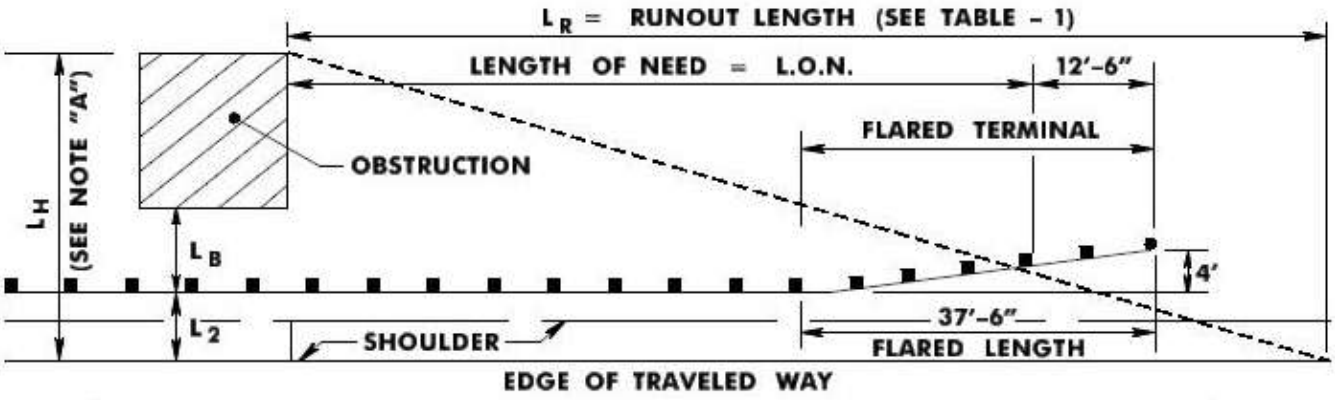


TABLE – 1

DESIGN SPEED (M.P.H.)	TRAFFIC VOLUME (A.D.T.) OVER 6,000 L_R	2,000–6,000 L_R	800–2,000 L_R	UNDER 800 L_R	SHY LINE OFFSET	STRAIGHT FLARE RATE
70	475	445	395	360	9.2	15:1
60	425	400	345	330	7.9	14:1
55	360	345	315	280	7.2	12:1
50	330	300	260	245	6.6	11:1
45	260	245	215	200	5.6	10:1
40	230	200	180	165	4.6	8:1
30	165	165	150	130	3.6	7:1

STEP 1. DETERMINE THE REQUIRED L.O.N. :

FLARED TERMINAL

$$L.O.N. = \frac{L_R\ (L_H - L_2 - 2.7)}{L_H}$$

NO FLARE (TANGENT TERMINAL)

$$L.O.N. = \frac{L_H - L_2}{L_H / L_R}$$

NOTE A: If obstruction extends beyond clear zone, make L_H equal to clear zone, except if obstruction is critical slope, See Figure 8–H.

NOTE B: If roadway is curved, draw layout to scale and obtain L.O.N. directly by scaling from drawing.

STEP 2. Increase L.O.N. to nearest multiple of 12'–6", which is the length of one rail element.

STEP 3. Add an additional 12'–6" to get required L.O.N. including the flared or tangent terminal.

STEP 4. Compare the required length in Step 3 to the minimum functional length shown in Table 2 and to the suggested recovery area (A) in Table 1 Figure 8–D. Use the greater of the three lengths.

TABLE – 2

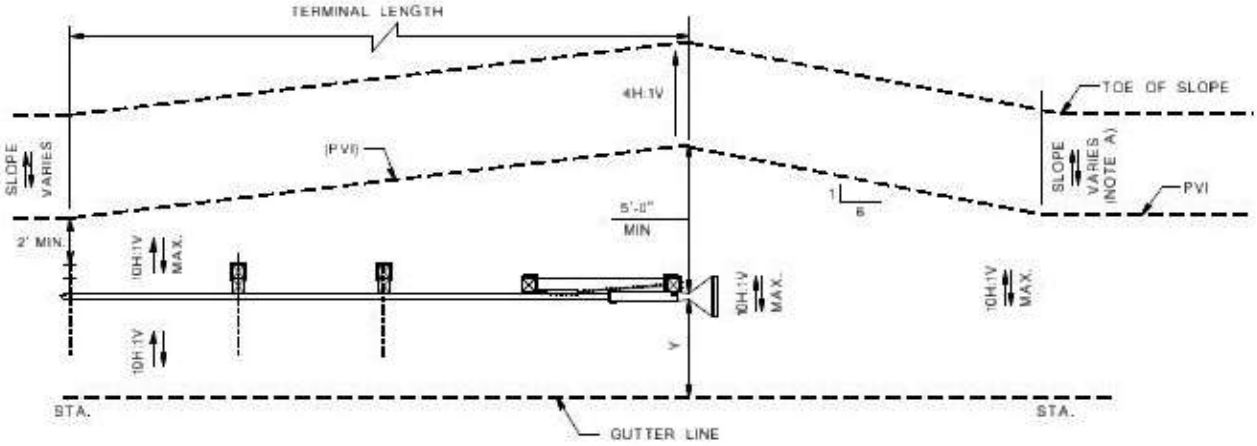
DISTANCE FROM BACK OF RAIL ELEMENT TO OBSTRUCTION (L_B)	MINIMUM FUNCTIONAL LENGTH: FLARED TERMINAL	TANGENT TERMINAL
$L_B \geq 4'$	50'–0"	50'–0"
$2' \leq L_B < 4'$	50'–0"	62'–6"
$L_B < 2'$	62'–6"	75'–0"
THRIE BEAM ATTACHMENT	56'–3"	68'–9"
W–BEAM ATTACHMENT	62'–6"	75'–0"

NOTE C: The total length of a freestanding guide rail installation including approach and trailing end treatments should not be less than 62'–6".

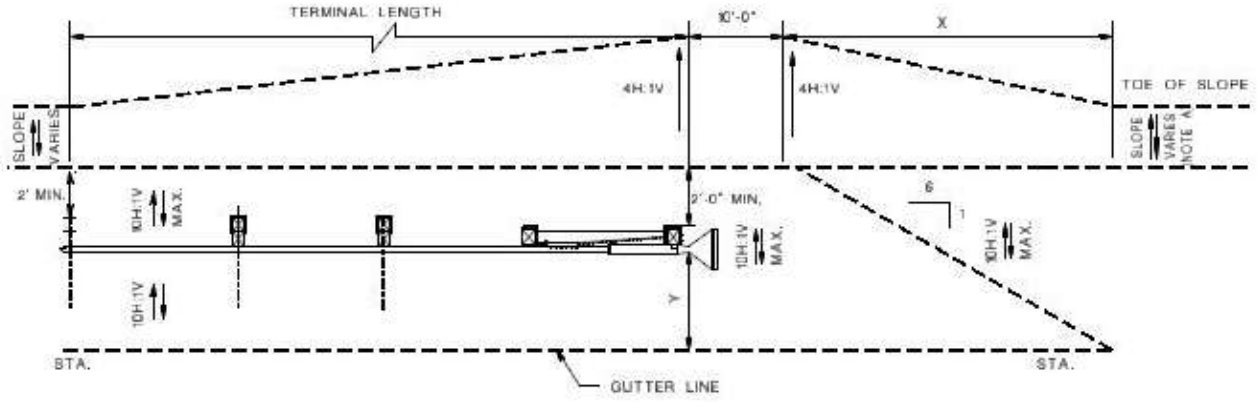
GRADING TREATMENT AT FLARED AND TANGENT TERMINALS

FIGURE: 8–F

BDC10MR–01



STANDARD GRADING



ALTERNATE GRADING

TABLE–1		
Y = OFFSET FROM GUTTER LINE	X	X+10 (DES.)
1'-0"	24'-0"	34'-0"
4'-0"	42'-0"	52'-0"
7'-0"	60'-0"	70'-0"
10'-0"	78'-0"	88'-0"

NOTE 'A':

Grading only needed if approaching slope is steeper than 4H:1V

Where the 4 ft. or more and 7 ft. or more offsets are not possible, the guide rail should be installed in accordance with the previous discussion in 8.3.1.B.2 (use 4 ft. or more instead of 7 ft. or more when addressing freeway or interstate ramps).

3. Rub Rail

   When guide rail is constructed less than 3 ft. from a curb (vertical and/or sloping curb) or raised berm that is 4 inches or greater in overall height, the mounting height is measured from the top of the curb or raised berm and rub rail is required. Where guide rail is set flush to the gutter line and goes across short sections (i.e. less than 100 ft. long at each location) of the curb, 4 inches or less in height; the mounting height may be measured from the gutter line, in which case, rub rail is not required.

   On all projects involving new guide rail or the upgrading of existing guide rail, every effort should be made to eliminate or reduce in the use of rub rail.

   Acceptable methods for reducing or eliminating the need for rub rail includes: providing sufficient offsets, removing or revising earth berms, providing designs without curb, and eliminating the existing curb where economically feasible.

C. At Fixed Objects

Where guide rail is used to shield an isolated obstruction, it is most important that the guide rail be located as far from the traveled way as possible to minimize the probability of impact. The distance from the back of the rail element to the face of obstruction should desirably be 4 ft. or greater, see Standard Roadway Construction Details CD-609-8.3. If less than 4 ft. must be used, the guide rail system must be modified (See CD-609-8.1, 8.2 and 8.6). If the guide rail in advance of the obstruction is to be flared, no portion of the flare should be within the modified section of guide rail.

D. On Bridges

1. Safetywalks range in width from 1.5 ft. to less than 4 ft. On existing freeway and interstate structures with safetywalks, where it is not feasible to remove the safetywalk and provide a concrete, barrier-shaped parapet, the guide rail shall be carried across the structure along the gutter line. However, on existing freeway and Interstate ramps where the posted speed or advisory speed is 40 mph or less and the safetywalk is 2.5 ft. or less in width, it is not necessary to carry guide rail across the structure since vaulting is not likely to occur. In this case, guide rail should only be provided across the structure if the parapet does not meet NCHRP 350 crash test criteria.

2. Where the roadway approaching a structure has curbs or berms, the guide rail mounting height on the structure should be measured from the top of curb and rub rail is required. However, on long structures, the guide rail mounting height may be measured from the gutter line provided the face of guide rail is flush with the curb face. In this case rub rail will not be required.

   The guide rail mounting height should be measured from the gutter line on those structures where the approach roadway is an umbrella section and the face of guide rail is set flush with the curb face on the structure.
   Where guide rail is set flush with the curb face and the mounting height is measured from the gutter line, rub rail is not required.

3. Where there is a difference in the offset to the approach guide rail and the offset to the bridge parapet, the approach guide rail should be flared at 15:1 prior to the standard guide rail transition to the bridge parapet.
4. Attachment of guide rail to bridges and structures shall be in accordance with the Department's Standard Roadway Construction Details, revised or modified Standard Details or Special Details. The designer shall specify at each location on the construction plans the guide rail attachment detail to be used and whether it is Type "A" or "B".
5. Where there is considerable pedestrian traffic, the guide rail may be set flush to the curb face to physically separate pedestrians from vehicular traffic if feasible (see Section 8.2.4.C).

8.3.2 End Treatments

A. Flared Guide Rail Terminals

1. Flared guide rail terminals shall be used on the approach ends of beam guide rail installations terminating within the clear zone, unless covered by conditions noted in Section 8.3.2.B, 8.3.2.C, 8.3.2.D or 8.3.2.E.

   If the approach end of guide rail for opposing traffic is within the clear zone, a flared guide rail terminal shall be used (see Figure 8-I). The clear zone for the opposing traffic should also be adjusted for horizontal curvature (see Figure 8-C). On two lane highways where passing is permitted, the clear zone shall be measured from the outside edge of the approaching traffic lane.

   A 37.5 ft. length straight flare shall be used with all flared guide rail terminal end treatments. This flare provides for a flare offset of 4 ft., see Standard Roadway Construction Details. The approach end of a flared guide rail terminal shall be placed a minimum distance of 12.5 ft. beyond the length of need.
2. A flared guide rail terminal shall not be installed behind a curb greater than 4 inches in height. Where there is an existing curb or proposed curb greater than 4 inches in height, 75 ft. of the curb immediately in advance of and 50 ft. beyond the front of a flared guide rail terminal shall be removed and replaced with 9 by 16 inch (4 inch face) concrete vertical curb, see Figure 8-X.
3. A roadside recovery area should be provided behind a flared guide rail terminal installation. See Section 8.3.3 for additional discussion of Roadside Recovery Area.
4. Rub rail, reduced post spacing, and double rail elements shall not be used within the 37.5 ft. flare of a flared guide rail terminal.
5. Where a flared guide rail terminal is installed along a horizontal curve, see Figure 8-X.

B. Tangent Guide Rail Terminals

1. At locations where it is not possible to construct a flared guide rail terminal with a 4 ft. flared offset, a tangent terminal should be used. A tangent terminal can be erected parallel to the roadway without needing a flare to function properly. The approach end of the tangent terminal shall be placed a minimum distance of 12.5 ft. beyond the length of need.
2. Where the guide rail is installed flush with the gutter line, a tangent terminal shall be constructed with a 50:1 straight flare with the approach end of the terminal offset 1 foot from the gutter line to reduce nuisance hits.

3. A roadside recovery area shall be provided behind a tangent guide rail terminal installation. See Section 8.3.3 for additional discussion of Roadside Recovery Area.
4. Where a tangent guide rail terminal is installed along a horizontal curve, see Figure 8-Y.
5. The curb requirements for a flared guide rail terminal in A.2 above are applicable to a tangent terminal.
6. Rub rail, reduced post spacing, and double rail elements shall not be used within 50 ft. from the end of a tangent terminal.
7. The designer is advised that the tangent terminal pay limit is 50 feet regardless of the length of the manufacturer's terminal used.

C. Beam Guide Rail Anchorages

1. On a one way roadway or a divided roadway with a non-traversable median, trailing ends of guide rail installations should be anchored with a beam guide rail end anchorage, as shown in Standard Roadway Construction Details CD-609-4.
2. In special cases, where the approach end of a guide rail installation is located so that an end hit is unlikely, the end may be anchored with a Beam Guide Rail End Anchorage as shown in Standard Roadway Construction Details CD-609-4. One example would be where the approach end of a guide rail installation for opposing traffic is outside the clear zone, see Figure 8 I, Step 1.

D. Telescoping Guide Rail End Terminals

1. A telescoping guide rail end terminal shall be used when terminating dual face beam guide rail within a grass median, see Figure 8-J.
2. A telescoping guide rail end terminal shall be installed on relatively flat surfaces (8 percent or flatter slope). Use on raised islands or behind curbs is not recommended. If there is a cross slope of more than 8 percent at the telescoping guide rail end terminal location, a leveling pad must be used.

   All curbs, islands, or elevated objects (delineators, signs) present at the telescoping guide rail end terminal site and over 2 inches high should be removed. Curbs greater than 2 inches high should be removed a minimum of 75 ft. in front of the telescoping guide rail end terminal system and as far back as the rear of the system, and replaced with 2 inch high curb.
3. The telescoping guide rail end terminals are 31.25 ft. long (measured from the centerline of first post to the centerline of sixth post) or 31.5 ft. long (measured from the centerline of anchor assembly to the centerline of sixth post). A tail end attachment to dual face beam guide rail is also required which is an additional 12.5 ft. See Standard Roadway Construction Details CD-609-7.
4. There are two end terminals permitted for use as a telescoping guide rail end terminal. Both the Crash Cushion Attenuating Terminal (C.A.T.) and Brakemaster are permitted when this item is required. Redirection for a side hit begins at the fourth post (18.75 ft.) from the approach end.

E. Controlled Release Terminals (CRT)

1. If a raised berm in front of a CRT cannot be removed, it shall be regraded at 10H:1V. Where curb in front of the CRT cannot be removed, curb shall be no higher than 2 inches.

2. A clear area free of any obstructions and graded to 10H:1V or flatter shall be provided behind the CRT. See Figure 8-P and Standard Roadway

Construction Details CD-609-6 for the required clear area dimensions.

F. Buried Guide Rail Terminal

In cut sections, the approach end of guide rail should be buried in the backslope as shown in Figure 8-N and in the Standard Roadway Construction Details. A straight flare should be used where the guide rail is buried in a cut slope. Table 1 of Figure 8 E shows the straight flare rate allowable for various speeds. A minimum L.O.N. measured from the point where the guide rail crosses the PVI of the foreslope and backslope to the obstruction being shielded shall not be less than 75 ft.

In cut sections where the border area slopes towards the roadway, the clearance to the bottom rail along the flared portion of the guide rail shall be maintained at 15 inches above the ground line as shown in Figure 8-N, CUT FORESLOPE GRADED TOWARD SHOULDER - SECTION VIEW.

In cut sections where the border area slopes away from the roadway, the height of the flared portion of the guide rail shall be constant relative to the normal guide rail offset until the guide rail is buried in the backslope as depicted in Figure 8-N, FILL FORESLOPE GRADED AWAY FROM SHOULDER - SECTION VIEW. If the clearance from the ground to the bottom of rail exceeds 18 inches, a rub rail and 8 foot long posts shall be used throughout the portion where the clearance exceeds 18 inches.

To provide the necessary anchorage, the rail shall be attached to the last two posts according to the Standard Construction Detail. The beginning of the flare and the location of the buried end post shall be indicated by station and offset on the construction plans.

G. Existing Slotted Rail Terminals (SRT), Breakaway Cable Terminals (BCT) and Eccentric Loader Terminals (ELT)

An existing SRT, BCT or ELT shall be replaced with the end treatments previously discussed in this section at the following locations:

1. An SRT, BCT or an ELT that must be replaced due to crash damage shall be upgraded with an end treatment other than an SRT, BCT or an ELT. An SRT can be replaced in kind if it has a minimum adjacent recovery area of 175 feet long.
2. Any SRT, BCT or ELT installed within the clear zone shall be replaced in conjunction with regularly scheduled roadway work in the same area with an end treatment other than an SRT, BCT or an ELT. An SRT does not have to be replaced if it has a minimum adjacent recovery area of 175 feet long.

   Where an SRT, BCT or an ELT require replacement in '1.' and '2.' above, upgrade the entire run of guide rail that the SRT, BCT or ELT is attached.

8.3.3 Roadside Recovery Area

Research has shown that over half of all fatal guide rail collisions involve a secondary event, either a second impact or a rollover. Many of these secondary events, e.g. trees, poles, and rollovers, typically carry a much higher fatality risk than a guide rail impact. Therefore, a roadside recovery area void of fixed objects is required, adjacent to, and behind the approach guide rail terminal. Figure 8-D shows the required roadside recovery area that should be provided at Flared and Tangent Guide Rail Terminals.

The adjacent recovery distance (A) behind guide rail in Figure 8-D should desirably extend from the beginning of the guide rail terminal to the obstruction. However, where it is not practical to provide the desirable distance, the minimum adjacent recovery distances (A) shown in Table 1 of Figure 8-D should be provided behind the guide rail. On land service highways where the length of guiderail in advance of the obstruction is restricted due to the location of driveways, intersecting streets or other features, and the minimum adjacent recovery distances (A) shown in Table 1 of Figure 8-D cannot be provided, the adjacent recovery distance will extend from the guiderail terminal to the obstruction.

An advanced recovery area shown in Figure 8-D shall also be provided. On land service highways where there are utility poles, the location of utility poles should comply with the criteria in Subsection 8.2.4.B.2.

Desirably the lateral recovery distance (B) should equal the distance from the face of the guide rail terminal to the back of the obstruction. When it is not practical to provide the desirable lateral recovery distance, the minimum lateral recovery distances (B) shown in Table 1 of Figure 8-D should be used. If the distance from the face of the guide rail to the back of the obstruction is less than the minimum lateral recovery distance (B) shown in Table 1 of Figure 8-D, the minimum lateral recovery distance should be provided. However, in no case should the lateral recovery distance (B) extend beyond the clear zone or the R.O.W. line whichever is less.

On land service highways, the minimum lateral recovery distance (B) in Figure 8-D may be reduced when the typical lateral recovery distance in advance of the terminal is less than shown in Table 1 of Figure 8-D. The lateral recovery distance (B) that is selected should be consistent with that available elsewhere along the highway and is measured from the edge of roadway to existing roadside obstructions (trees, rock cuts, etc.).

In addition to providing a clear area void of fixed objects, proper grading in advance of, adjacent to, and behind the terminal is required to be sure the vehicle remains stable after hitting the terminal. Based upon the 2003-2005 New Jersey Crash Record System (NJCRASH) and the 2000-2005 Fatality Analysis Reporting System (FARS), 14% of all fatal guide rail crashes in New Jersey result in rollover. The Standard Grading treatment shown in Figure 8-F shall be used wherever practical. However, when upgrading existing guide rail sites or when there are site limitations at new guide rail locations (limited R.O.W., environmental constraints, etc.), the Alternate Grading treatment in Figure 8-F may be used.

The designer must provide on CD-609-9.1 of the Standard Roadway Construction Details the required longitudinal (A) and lateral (B) recovery distances for each flared and tangent guide rail terminal site. Furthermore, additional quantities for clearing site, selective clearing, and/or tree removal, and the necessary earthwork to provide the proper grading shown in Figure 8-F will be required to be shown on the contract plans. Also, the location for each site along with the type of grading treatment Standard or Alternate shall be provided on CD 609-9.2 of the Standard Roadway Construction Details.

8.3.4 Approach Length of Need (L.O.N.)

The approach length of need is the minimum length of guide rail required in front of the warranting obstruction to shield it effectively.

A. On Embankment Slopes

The approach L.O.N. on embankment (fill) slopes should be determined in accordance with Figures 8-E and 8-G. On a two-way, undivided highway or on a

divided highway with a narrow traversable median, an "approach end" treatment may be required for both directions of traffic; see Figure 8-I to determine the approach L.O.N. for opposing traffic on the embankment (fill) slopes. The guide rail treatment for critical embankment slopes is shown in Figure 8-H. Figure 8-J shall be used when determining the approach L.O.N. when shielding an obstruction on an embankment slope in the median.

B. In a Cut Section

See Figure 8-M for an example of determining L.O.N. in a cut section.

When the distance from the ground to the bottom of the guide rail exceeds 18 inches, a rubrail shall be provided from that point to the slope. See Section 8.3.2.F for further guidance.

C. At Driveways

If the existing driveway falls outside the L.O.N., design guide rail as shown in Figure 8-E.

Where existing driveways are located within the L.O.N., the designer's first consideration should be to relocate the driveway as far away from the warranting obstruction as the property line allows. If the relocated driveway falls outside the L.O.N., design guide rail as shown in Figure 8-E.

If a driveway cannot be relocated beyond the L.O.N., use treatments shown in Figures 8-O or 8-P. The CRT shown in Figure 8-P is the preferred design. Where the minimum functional length of a flared guide rail terminal in Figure 8-O is longer than the space available from the obstruction to the driveway or the right-of-way purchase is impractical for the CRT in Figure 8-P, consideration should be given to using a crash cushion.

Driveway openings sometimes fall within a continuous guide rail run. An example of a guide rail treatment at this location is shown in Figure 8-Q.

D. At Gore Areas

It is desirable to provide a traversable and unobstructed gore area since the gore area may serve as a recovery area for errant vehicles. Every effort should be made to keep the gore area clear of warranting obstructions. However, urban areas, wetlands, parklands, etc. can put restrictions on this policy by placing warranting obstructions, such as critical embankment slopes, parapets or abutments close to gore areas. The closer the obstruction is to the gore area, the closer the L.O.N. is to the gore area, and the more limited the guide rail treatment becomes. Figures 8-R and 8-S provide guide rail treatment examples for gore areas, starting from less restricted or open gore areas in Figure 8-R to more restricted or limited gore areas in Figure 8-S.

8.3.5 Guide Rail Details

The dimensions and other characteristics of beam guide rail posts, rail elements, fasteners, etc. are shown in the Standard Roadway Construction Details.

8.3.6 General Comments

A. Guide rail should not restrict sight distance. Sight distances should be checked when guide rail is to be installed at intersections, ramp terminals, driveways, along sharply curving roadways, etc. If the sight distance is determined to be inadequate, the guide rail placement shall be adjusted.

B. Wherever part of an existing guide rail run is lengthened, reset or upgraded, then the entire run where practical shall be upgraded to current standards

including the bridge attachments. Project limits should end outside the limits of a guide rail run where practical.

C. Gaps of 200 ft. or less between individual guide rail installations should be avoided where possible.

D. Guide rail should not be installed beyond the right-of-way unless easements or necessary right-of-way is acquired.

E. For the guide rail treatment at adjacent bridges, see Standard Roadway Construction Details CD-609-7.4. Guide rail between parapets is not required if there is a concrete connecting wall 2.25 feet high (minimum) between parapets.

F. Proposed guide rail set flush with the curb line along intersection radius returns should be checked with a truck turning template. Existing guide rail along radius returns that experience truck overhang or oversteering crashes shall either be reset farther from the curb line or redesign the radius returns for a larger design vehicle.

G. The preferred method for locating all end treatments on construction plans is to dimension from physical objects (i.e.; lateral offset from edge of road, longitudinal dimensions from utility pole). Another method is by station and offset.

H. The grading work necessary for the construction of the guide rail end treatments shall be shown on the construction plans. The grading shall conform to the Standard Roadway Construction Details.

I. Conduits

The plans shall indicate the location of existing conduits or shall include a notation where there is a possibility of conflict in driving the guide rail posts.

J. Nonvegetative Surface Under Guide Rail

In order to reduce soil erosion and highway maintenance costs associated with spraying vegetation killer or trimming vegetation underneath guide rail, nonvegetative surfaces shall be applied underneath guide rail as follows:

Table 8-4

Guide Rail Types
Conditions Warranting Use of Nonvegetative Surfaces

Existing Guiderail	Where upgrading Where regrading berms Where resetting guide rail
New Guide Rail	All cases

All nonvegetative surfaces require maintenance to spray emergent non-selective herbicide treatment for total control of vegetation on the nonvegetative surface area.

Nonvegetative Surface, Hot Mix Asphalt (HMA), can be used wherever guide rail is placed. The net increase in impervious surface, including Nonvegetative Surface, Hot Mixed Asphalt, should be kept below one-quarter acre per project as per storm water management requirements. Also, the net increase in area of disturbance should be kept below one acre per project. If you exceed the above requirements, and other permits (IE: wetlands, tidal, C.A.F.R.A., etc.) are required by the Division of Land Use Regulations of the NJDEP for the project;

then NJDEP will review the Storm Water Management Plan as part of the permit review. If you exceed the above requirements and no other permit is required by the Division of Land Use Regulations of the NJDEP for the project; then the Stream Encroachment and Storm Water Unit of the Bureau of Landscape Architecture and Environmental Solutions at NJDOT will review the Storm Water Management Plan.

Three types of porous nonvegetative surfaces are available in order to keep the net impervious surface to a minimum:

- Nonvegetative Surface, Porous Hot Mix Asphalt,
- Nonvegetative Surface, Polyester Matting, and
- Nonvegetative Surface, Broken Stone

These three porous types are limited on where they can be placed, see Table 8-5:

Table 8-5

Placement of Porous Nonvegetative Surfaces Based on Guide Rail Offset

	Curb Section	Berm Section			Umbrella Section		
	Guide Rail Offset	Guide Rail Offset			Guide Rail Offset		
Nonvegetative Surface	All	0′	4′	7′ or more	0′	4′	7′ or more
Porous HMA 4″ Thick	Yes	Yes	No	Yes	Yes	No	Yes
Porous HMA 6″ Thick	No	No	Yes	No	No	Yes	No
Polyester Matting	Yes	No	No	Yes	No	No	Yes
Broken Stone 4″ Thick*	Yes	No	No	Yes	Yes	Yes	Yes

*Note: New Broken Stone installations must have a minimum shoulder width of 8 feet adjacent to it. Broken Stone is limited only in areas where broken stone exists. For example: additional guide rail is being provided in a project and the existing guide rail within the project limits has broken stone underneath. Concurrence is needed from the Regional Maintenance Engineer.
Broken Stone is the least expensive nonvegetative surface, followed by Polyester Matting, HMA, then Porous HMA.

The nonvegetative surface shall be constructed as shown in Standard Roadway Construction Details CD-608-1.

8.4 Median Barrier

A median barrier is a longitudinal system used to prevent an errant vehicle from crossing that portion of a divided highway separating traveled ways for traffic in opposite directions.

8.4.1 Warrants for Median Barriers

A. Interstate and Freeways

Figure 8-T presents the warrants for median barriers on high speed, access-controlled highways with traversable slopes 10H:1V or flatter.

When the need for a median barrier is determined to be optional from Figure 8-T, an evaluation of the cross median crash history should be made to determine

if a median barrier is warranted regardless of the median width and volume. The warrant for a median barrier based on crash history should meet one of the following conditions:

1. 0.50 cross median crashes per mile per year of any crash severity
2. 0.12 fatal cross median crashes per mile per year

Note: The calculation of conditions 1. and 2. above requires a minimum of three crashes occurring within a five (5) year period.

Research of cross median crashes indicate that crashes are more likely to occur within one (1) mile of an interchange and this factor has been included as a median barrier warrant in Figure 8-T.

Figure 8-T depicts the relationship of low ADT's to median widths less than 60 feet to determine if a median barrier is warranted. As presented in Figure 8-T, if the median width is 60 feet or less and the ADT is greater than 50,000 a median barrier is warranted. At low ADT's, the probability of a vehicle crossing the median is relatively small. Thus, for ADT's less than 20,000 and median widths within the optional areas of Figure 8-T, a median barrier is warranted only if there has been a history of cross-median crashes. Likewise, for relatively wide medians the probability of a vehicle crossing the median is also low. Thus, for median widths greater than 60 ft. and within the optional area of the figure, a median barrier may or may not be warranted, again depending on the cross-median crash history.

B. Land Service Highways

Careful consideration should be given to the installation of median barriers on land service highways or other highways with partial control of access. Problems are created at each intersection or median crossover because the median barrier must be terminated at these points.

An evaluation of the number of crossovers, crash history, alignment, sight distance, design speed, traffic volume and median width should be made before installation of median barriers on land service highways. Each location should be looked at on a case-by-case basis. If the crash history meets either of the conditions in 1 and 2. above for Interstate and freeways, a median barrier should be installed. For the clear zone for median cross over protection on land service highways, see Figure 8-A.

C. Median Barrier Type

Median barrier type, when warranted, is related to median width as shown in Table 8-6.

Table 8-6	
Median Width vs. Median Barrier Type	
Median Width	**Median Barrier Type**
Up to 12 ft.	Concrete Barrier Curb
13 ft. to 26 ft.	Concrete Barrier Curb (Preferred Treatment) or Beam Guide Rail, Dual Faced or Modified Thrie Beam, Dual Faced
Above 26 ft.	Beam Guide Rail, Dual Faced or Modified Thrie Beam, Dual Faced

It is recommended to use modified thrie beam, dual faced in lieu of beam guide rail, dual faced where:

1. The horizontal radius of the roadway is less than 3000 feet or there is a split profile with 6H:1V side slopes or steeper creating opposing roadways with different elevations.
2. Guide rail is placed flush with the edge of a shoulder 5 feet or less in width.
3. Modified thrie beam is to be installed in the median and there is existing beam guide rail in the median shielding obstructions, the existing beam guide rail shall be replaced with modified thrie beam.
4. There are 12 percent or more trucks in the project area.
5. The traffic volume is greater than 15,000 vehicles per lane (IE: 4 lane section>60,000 AADT).

Where barrier curb is used to shield an obstruction (bridge piers, abutments, sign bridges, etc.), a minimum offset of 3.25 ft. from the gutter line to the face of the obstruction shall be used, since high profile vehicles have a tendency to lean when impacting barrier curb at a high speed (60 mph or greater) and angle (25 degrees) and may strike the obstruction behind it, see Figure 5-K.

D. End Treatments

When terminating the approach end of dual face, beam guide rail or dual face modified thrie beam guide rail beyond the clear zone, an end anchorage with end section (buffer) is required as shown in the Standard Roadway Construction Details CD-609-2 and 609-18 respectively. When terminating the approach end of a concrete barrier curb beyond the clear zone, a tapered concrete terminal section is required as shown in the Standard Roadway Construction Details CD-607-3.5.

When terminating the approach end of dual face beam guide rail, dual face modified thrie beam guide rail or concrete barrier curb within the clear zone area on freeways and Interstate highways, a crashworthy end treatment shall be used. Acceptable methods of developing a crashworthy end treatment would be to use a crash cushion with concrete barrier curb; or use a telescoping guide rail end terminal with dual face beam guide rail or modified thrie beam guide rail.

In the past, on land service highways, tapered concrete terminal sections have been provided where the concrete barrier curb terminated at an intersection. Since pavement edge markings are not generally provided through intersections, there is no visual reference for the guidance of the driver through the

intersection during adverse weather and visibility conditions. Therefore, at existing concrete barrier curb locations, a crashworthy end treatment may be appropriate on the concrete barrier curb end located on the outside of a horizontal curve with a radius of approximately 1000 ft. or less. A dotted line may be used to extend markings as necessary through the intersection to guide vehicles making left-turn moves from the cross street or to guide vehicles in the high speed through lanes.

On land service highways where the posted speed exceeds 40 mph, all concrete barrier curb that terminates within the clear zone on any roadway segment shall have the exposed concrete barrier curb end protected by a crash cushion at the following locations:

1. New concrete barrier curb.
2. New concrete barrier curb that is being installed to replace substandard height barrier curb.
3. Existing locations of the concrete barrier curb on a reconstruction project.
4. A new, relocated or widened opening in existing barrier curb for emergency "U" turns, pedestrian crossings, jughandles or intersections.

The introduction of new or existing median concrete barrier curb within the clear zone other than at intersections shall be protected with a crash cushion regardless of the posted speed.

The designer is advised that the Federal Highway Administration has taken the position that on any project that includes existing or proposed tapered concrete terminal sections within the clear zone, on any roadway segment where the posted speed exceeds 40 mph, for the locations previously discussed, without providing a crash cushion, will make the entire project ineligible for Federal-Aid highway funds, except if proper documentation is provided in the Scope Summary. The documentation should be provided on all projects regardless of the funding source.

See Figures 6-J and 6-K for treatment of the concrete barrier curb at median openings.

E. Median Barrier Location

Roadside slopes between the traveled way and the median barrier can have a significant effect on the barrier's impact performance. When a vehicle traverses a roadside slope(s) in the median, the vehicle's suspension system can be compressed or extended. As a result, a vehicle that traverses a roadside slope prior to impact with beam guide rail, dual face beam guide rail or dual faced modified thrie beam guide, a vehicle may go over or under the rail, or snag on the support posts. For concrete barrier curb, a vehicle could go over the barrier, or the barrier could impart an additional roll moment thus increasing the potential for vehicle rollover.

The following guidelines are recommended for the placement of median barriers:

1. Concrete Barrier Curb

   Concrete barrier curb is normally placed at or near the centerline of the median. The area between the traveled way and the concrete barrier curb should be paved and the slope should not exceed 10 percent.

2. Beam Guide Rail, Dual Faced or Modified Thrie Beam, Dual Faced

   Umbrella Sections

In umbrella sections, dual faced beam guide rail or dual faced modified thrie beam should be placed 6 feet from the centerline of the median swale when the median slopes are 10H:1V or flatter (Figure 8-WA). The centerline of the median swale is determined by the centerline of the median inlets.

Existing guide rail, dual faced may be retained on a 6H:1V side slope, provided the face of rail is installed 6 feet from the centerline of the median swale and a minimum of 12 feet from the slope break with rubrail installed on the swale side of the barrier (Figure 8-WB).

For proposed guide rail installations on 6H:1V side slopes, dual faced beam guide rail or dual faced modified thrie beam shall be installed 2 feet in advance of the slope break with rubrail installed on the swale side of the barrier (Figure 8-WC).

For median slopes that are steeper than 6H:1V, beam guide rail or modified thrie beam shall be place on both sides of the median a minimum of 2 feet in advance of the slope break (Figure 8-WD).

Where the median is on a split profile (opposing roadways constructed with different elevations) and the cross slope from the higher roadway is equal to or greater than 6H:1V, the dual faced beam guide rail or modified thrie beam guide rail should be placed on the high side of the median 2 feet in advance of the slope break with the rubrail installed on the swale side of the barrier (Figure 8-WE).

Where there is insufficient width between the edge of shoulder and the slope break to provide the 2 foot offset, the face of the barrier shall be placed flush with the edge of shoulder and additional post lengths provided in accordance with Table 8-3.

Curbed Sections

Where curb is required in the median, the preferred treatment is to use concrete barrier curb.

Existing Curbed Sections

The preferred treatment for existing unprotected curbed medians up to 26 feet wide is to replace with concrete barrier curb and shoulders. This reduces maintenance costs and keeps drainage out of the lanes.

If it is not practical to install concrete barrier curb and shoulder, as mentioned above, due to environmental issues, convert the curbed section to an umbrella section with dual faced beam guide rail or dual faced modified thrie beam. Place a non-vegetated surface across the entire median if mowing and trash collection is a problem due to safety and median width.

8.5 Diversionary Roads (Road Closure with Diversion)

During construction when traffic must be diverted onto the opposing side of a freeway or Interstate highway that is not divided by a barrier curb, the existing guide rail in the median must be revised when the duration of the diversion road will be greater than two weeks. Since traffic will now be traveling in the opposite direction adjacent to the median, existing guide rail lengths may need to be increased. The L.O.N. shall be checked based upon the proposed design speed of the diversionary road and revised if required. See Section 14 for guidance on design speed of diversionary roads. In addition, existing guide rail trailing end treatments shall be upgraded to crash worthy end treatments and bridge attachments Type B shall be converted to Type A. New or reconstructed pylons may be required on some existing bridges to accommodate the Type A attachment.

In addition to the above, when it is anticipated that the diversion road will be in place for 1.5 years or more, new guide rail in the median shall be lapped in the direction of traffic and existing guide rail in the median shall be re-lapped in the direction of traffic. Also, a clear runout area shall be provided behind new approach flared or tangent terminals in the median.

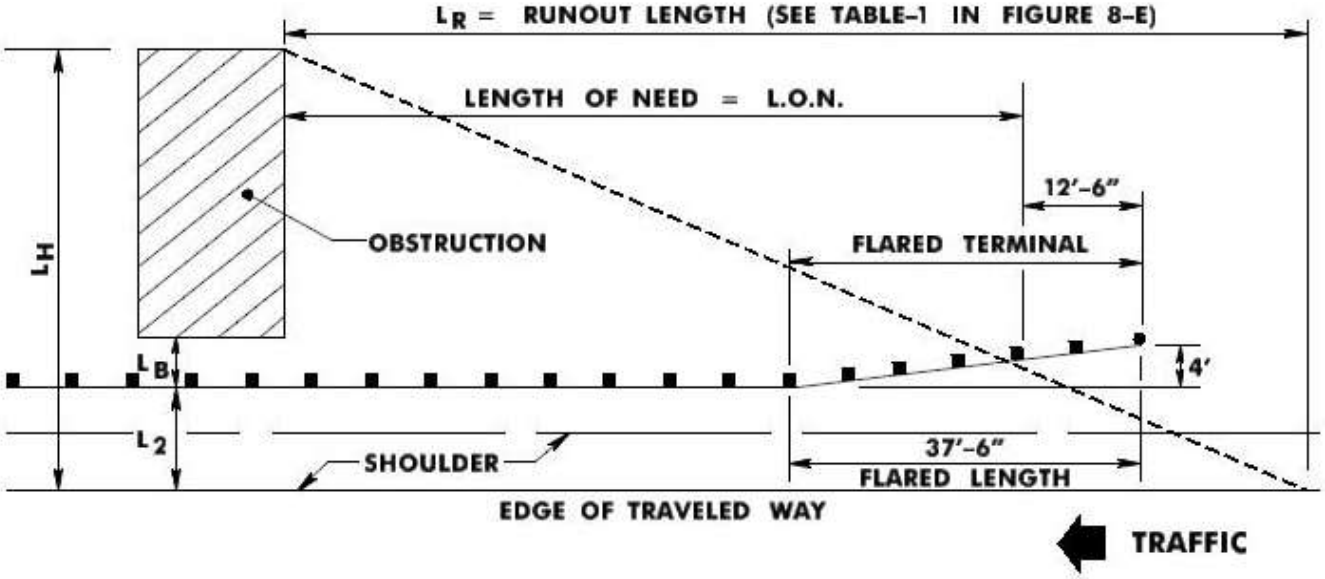
After the diversionary road is no longer required, the guide rail in the median shall be re-lapped in the direction of traffic if the diversion road has been in place for more than 1.5 years. Furthermore, any additional lengths of guide rail installed in the median due to the diversion should be removed and appropriate end terminals added. However, bridge attachments that were converted to Type A may be retained when the guide rail on the trailing end of the bridge parapet is to remain.

The above requirements also apply to land service highways with grass medians or those separated by development between the opposing roadways when a diversionary road is required.

EXAMPLE OF APPROACH LENGTH OF NEED ON EMBANKMENT (FILL) SLOPES

FIGURE: 8–G

BDC10MR–01



EXAMPLE

DESIGN SPEED = 70 M.P.H.

TANGENT ROADWAY

A.D.T. = 7000

L_B = 4′

L_H = 22′

L_R = 475′

L_2 = 16′

STEP 1. $$\text{L.O.N.} = \frac{L_R\,(L_H - L_2 - 2.7')}{L_H}$$

$$\text{L.O.N.} = \frac{475'\,(22' - 16' - 2.7')}{22'}$$

L.O.N. = 71.25′

STEP 2. Increase 71.25′ to nearest multiple of 12′–6″, L.O.N. = 75′.

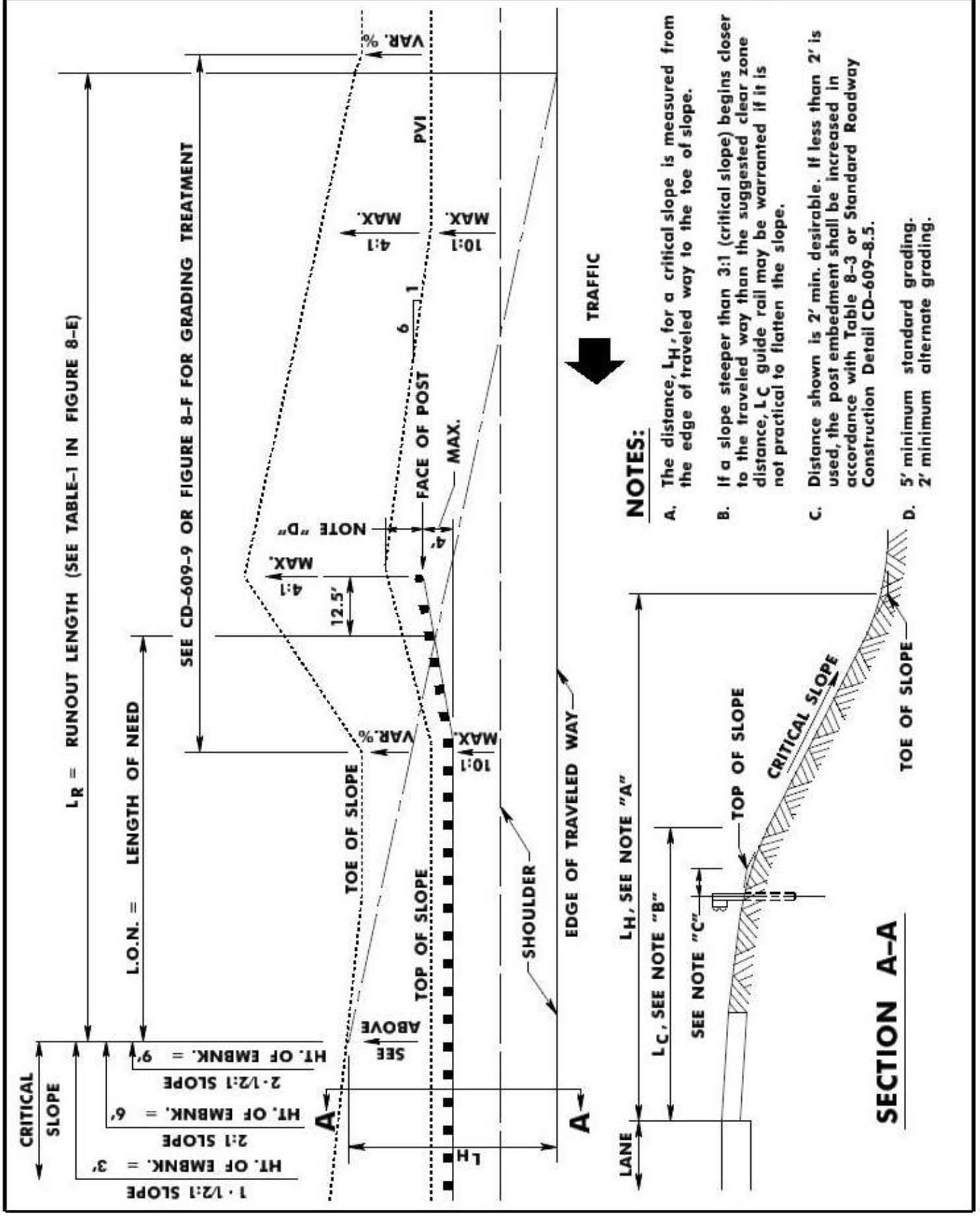
STEP 3. Add an additional 12′–6″ to get required L.O.N. including flare terminal, use L.O.N.–plus–flare terminal = 87.5′.

STEP 4. From Table 1, Figure 8–D and Table 2, Figure 8–E, the minimum length = 75′. Since L.O.N.–plus–flare terminal is greater than 75′, use 87.5′.

GUIDE RAIL TREATMENT FOR CRITICAL EMBANKMENT SLOPES

FIGURE: 8–H

BDC10MR–01



APPROACH LENGTH OF NEED OPPOSING TRAFFIC ON EMBANKMENT (FILL) SLOPES

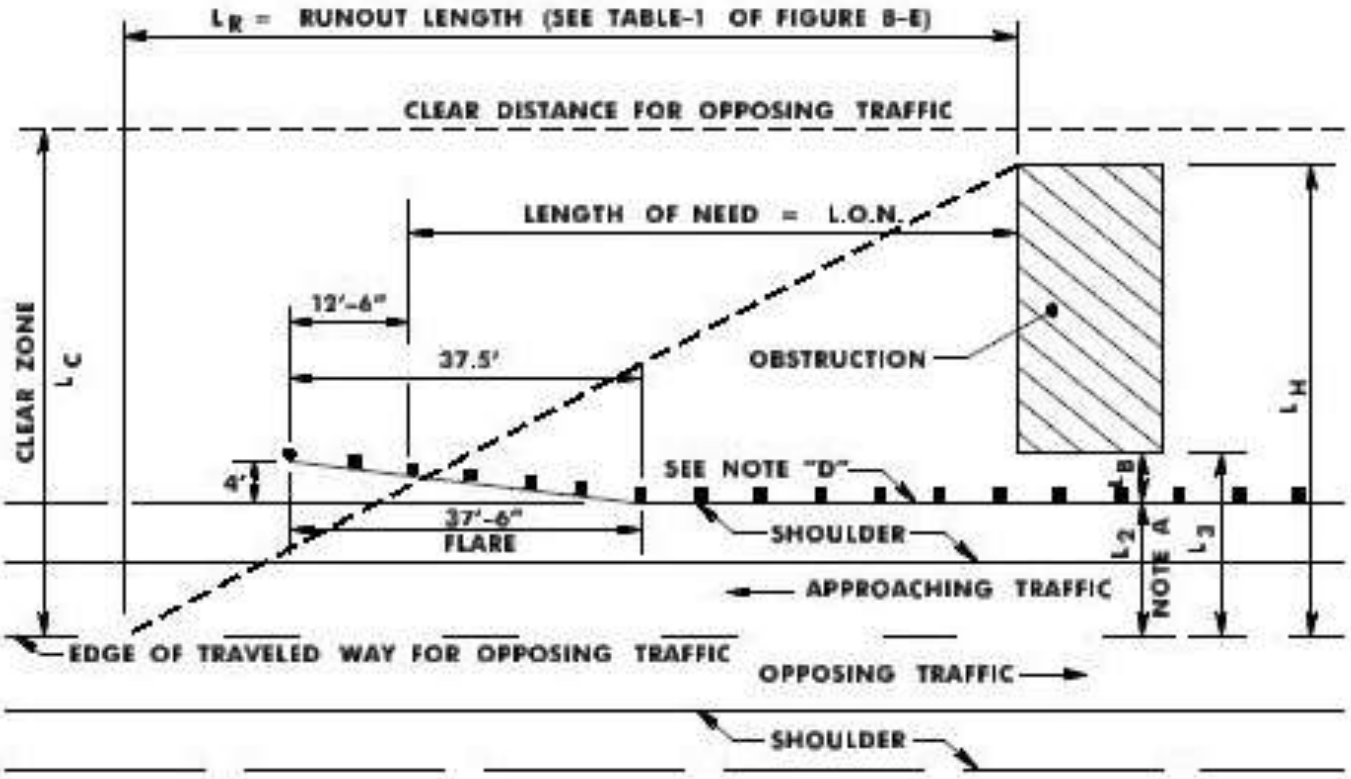
FIGURE: 8–I

BDC10MR–01

STEP 1. $L_2 > L_C$:
If guide rail is outside the clear zone (L_C). No additional guide rail and no crashworthy end treatment is required: Therefore, use beam guide rail end anchorage as shown in the Standard Roadway Construction Detail CD–609–4.

STEP 2. $L_2 < L_C$ and $L_3 > L_C$:
If guide rail is within the clear zone, but the obstruction is beyond it, use a flared or tangent terminal with the minimum functional lengths shown in Table–2 in Figure 8–E.

STEP 3. $L_3 < L_C$:
If the obstruction is within the clear zone (L_C), see below. Use variables as shown below and Steps 1 through 4 as shown in Figure 8–E to determine the required L.O.N.



NOTES:

A. L_2 shall be measured from the outside edge of the approaching traffic lane where passing is permitted.

B. If there is a traversable median separating traffic, the median width should be included when determining L_2, L_3, and L_H for opposing traffic.

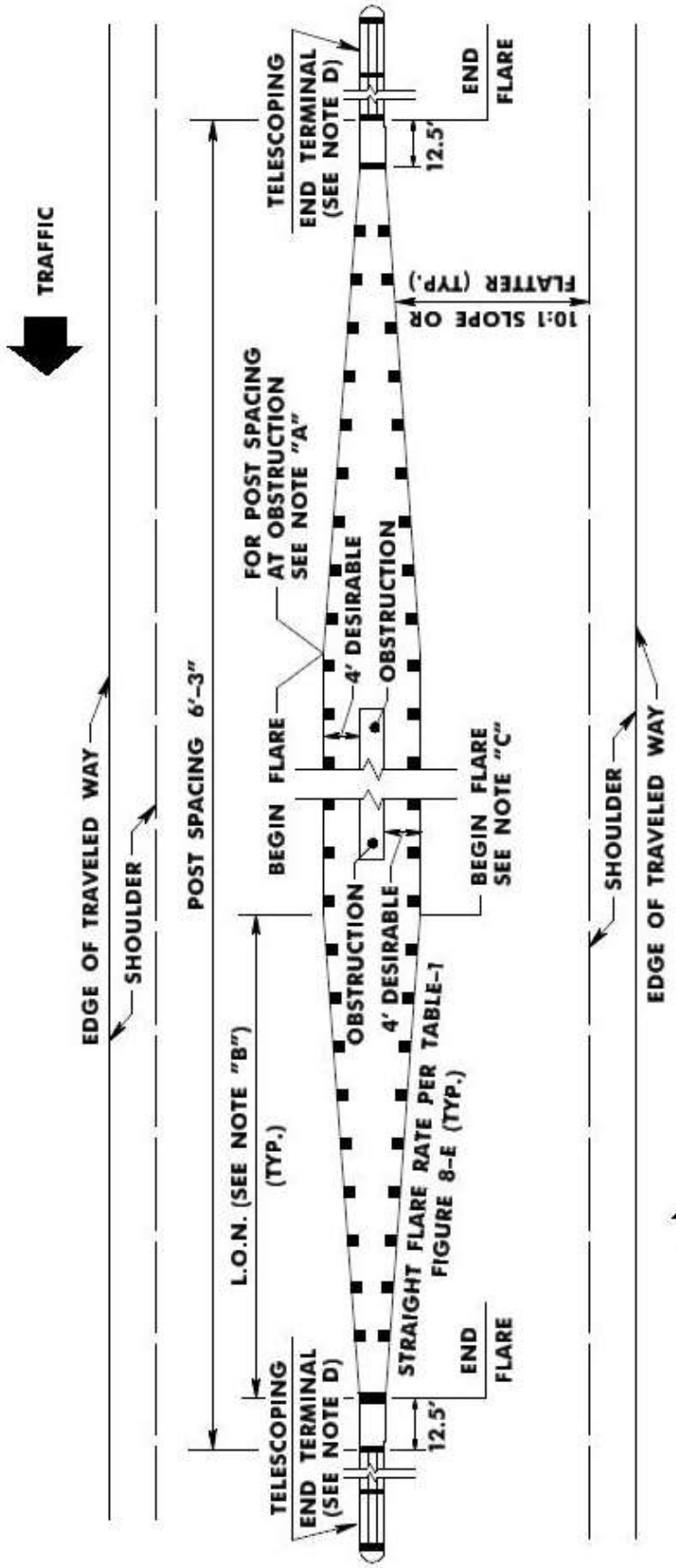
C. For a divided highway with a nontraversable median, use beam guide rail end anchorage, shown in the Standard Roadway Construction Detail CD–609–4.

D. See Standard Roadway Construction Detail CD–609–8 for required post spacing and double rail element requirements.

OBSTRUCTION IN MEDIAN APPROACH END TREATMENT

FIGURE: 8–J

BDC10MR–01



NOTES:

A. For post spacing at obstruction see Standard Roadway Construction Details.

B. Determine L.O.N. using straight flare rate in Table–1 of Figure 8–E.

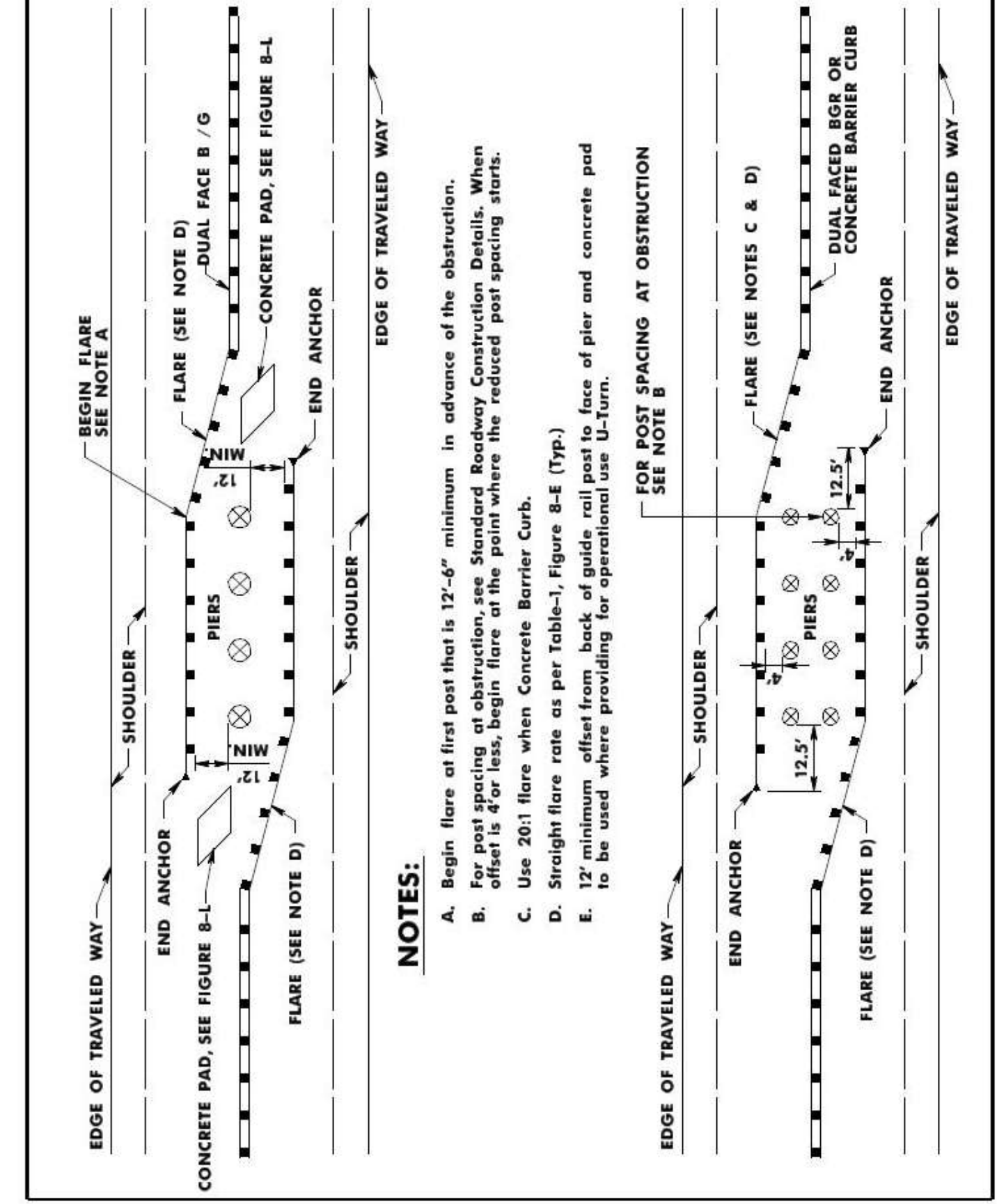
C. Begin flare at first post that is 6'–3" minimum from obstruction.

D. Telescoping end terminal shall not be installed on slopes steeper than 8%.

OBSTRUCTION IN MEDIAN APPROACH END TREATMENT

FIGURE: 8–K

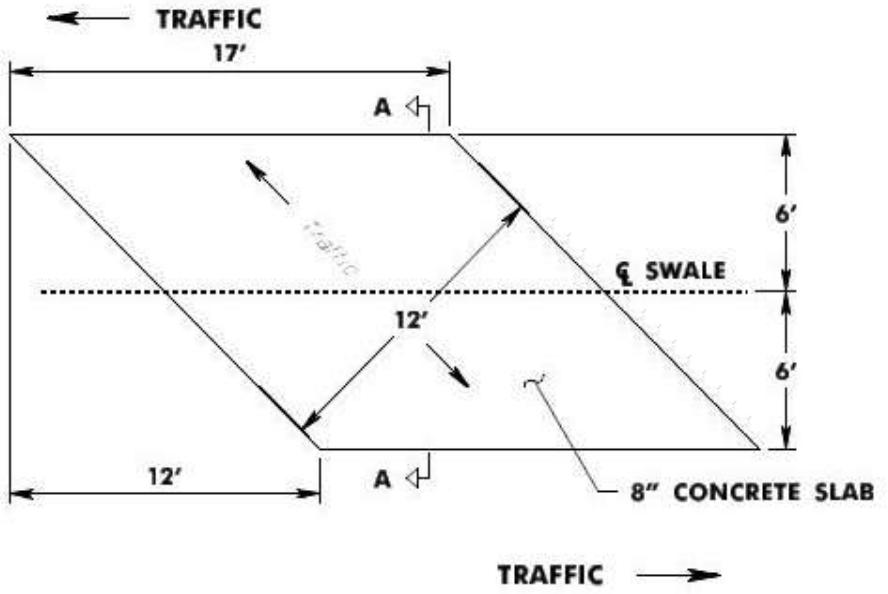
BDC10MR–01



CONCRETE PAD

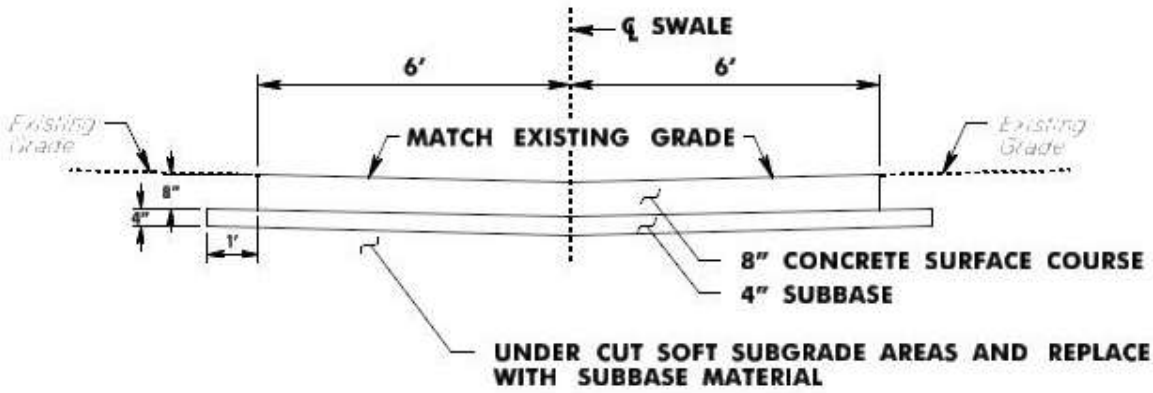
FIGURE: 8–L

BDC10MR–01



PLAN

17′ x 17′ CONCRETE PAD



SECTION 'A–A'

NOTES:

A. USE SU TURN TEMPLATE TO FIT CONCRETE PAD ON SWALE.

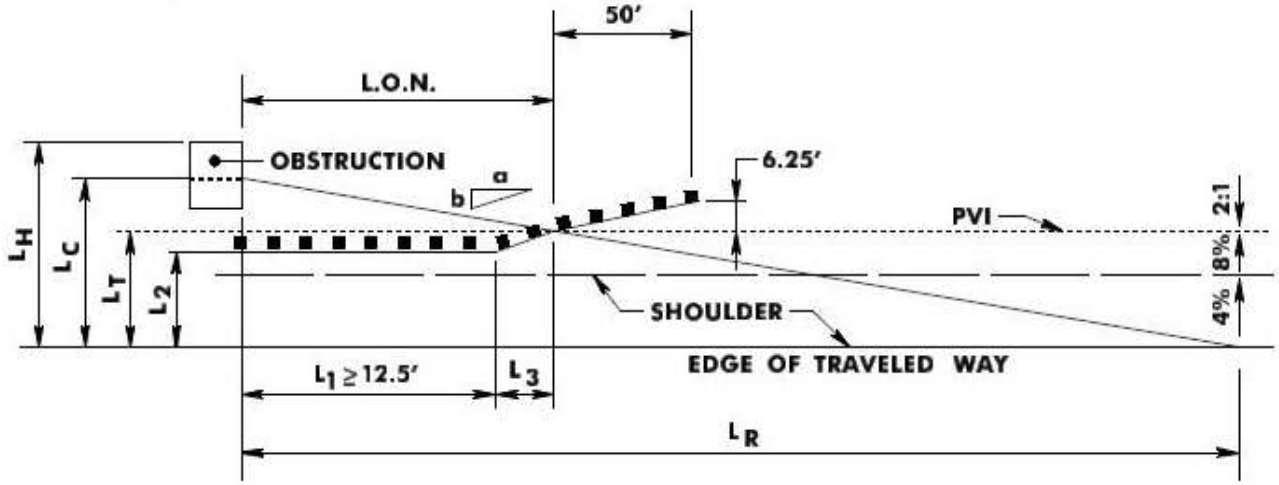
APPROACH LENGTH OF NEED IN CUT SECTIONS

FIGURE: 8–M

BDC10MR–01

Where an obstruction is encountered in a cut section and it is to be shielded with guide rail, it is desirable that the length of need (L.O.N.) end at the PVI, See Figure 8–N. In order to accomplish this, the length of guide rail (L_1) parallel to the PVI must be obtained. The following example shows how the L.O.N. is computed:

EXAMPLE



V = 60 M.P.H.

A.D.T. = 6,000

L_2 = 16 FEET

L_H = 32 FEET

L_R = 425' (FROM FIGURE 8–E, TABLE–1)

L_T = 19 FEET

a/b = 14:1 STRAIGHT FLARE (FROM FIGURE 8–E, TABLE–1)

L_C = 30 FEET (FROM FIGURE 8–A, L_C = 26' TO 30') FOR 8% FILL SLOPE

IF $L_H > L_C$ USE L_C IN FORMULA BELOW, IF $L_H < L_C$, REPLACE L_C WITH L_H IN FORMULA BELOW

$L_1 = L_R - (L_R L_T / L_C) - a/b\ (L_T - L_2)$

L_1 = 425 – (19 X 425/30) – 14/1 (19 – 16) = 113.8'

113.8'/6.25' POST SPACING = 18.21 POSTS, THEREFORE, USE 19 POSTS AT 6.25' = 118.75 FT. = L_1

FLARE LENGTH $L_3 = (L_T - L_2)\ a/b$ = (19 – 16) 14/1 = 42 FT.

42'/6.25' POST SPACING = 6.72 POSTS, THEREFORE, USE 7 POSTS AT 6.25' = 43.75 FT. = L_3

L.O.N. = 118.75 FEET + 43.75 FEET = 162.5 FEET

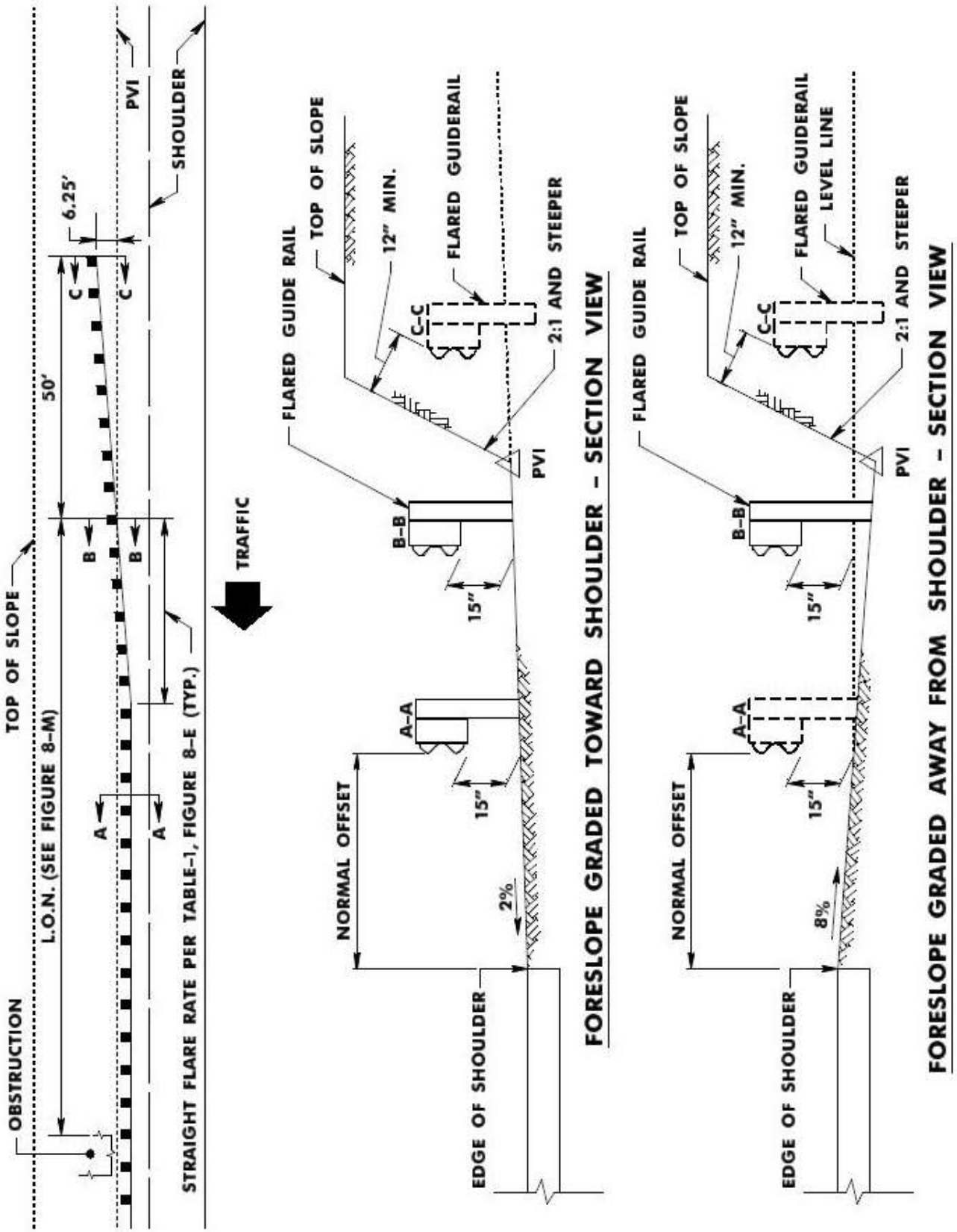
FROM TABLE 1, FIGURE 8–D MINIMUM RECOVERY AREA = 75'

SINCE L.O.N. IS GREATER THAN 75', USE L.O.N. = 162.5'

BEAM GUIDE RAIL TREATMENT FOR APPROACH END BURIED IN SLOPE

FIGURE: 8–N

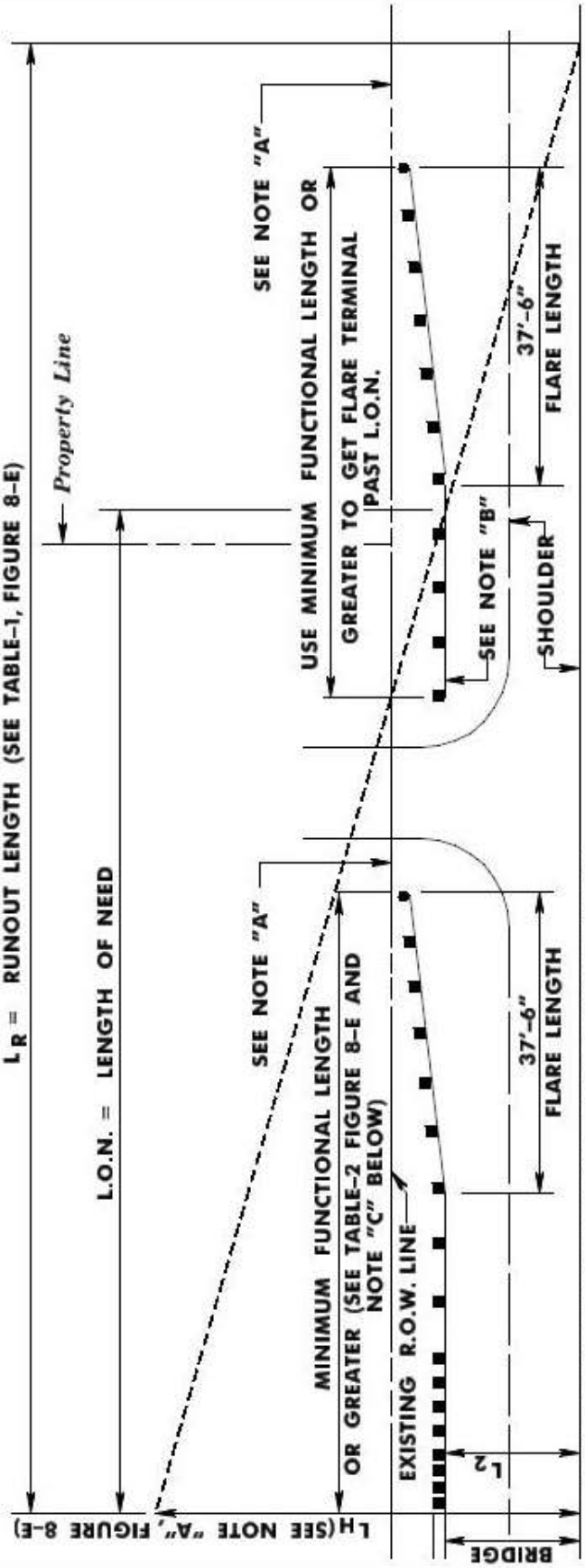
BDC10MR–01



EXAMPLE OF GUIDE RAIL TREATMENT AT DRIVEWAY LOCATED WITHIN LENGTH OF NEED

FIGURE: 8–O

BDC10MR–01



STEP 1. DETERMINE L.O.N., SEE FIGURE 8–E.

STEP 2. IF DRIVEWAY FALLS WITHIN L.O.N., RELOCATE DRIVEWAY AS FAR AWAY FROM OBSTRUCTION AS THE PROPERTY LINE ALLOWS. SEE THE NEW JERSEY HIGHWAY ACCESS MANAGEMENT CODE FOR THE MINIMUM DRIVEWAY OFFSET TO PROPERTY LINE (LOT LINE).

STEP 3. IF DRIVEWAY STILL FALLS WITHIN L.O.N., USE TREATMENTS SHOWN IN FIGURES 8–O OR 8–P. IF DRIVEWAY FALLS OUTSIDE L.O.N., DESIGN GUIDE RAIL AS SHOWN IN FIGURE 8–E.

STEP 4. CHECK SIGHT DISTANCE AT DRIVEWAY, SEE FIGURE 6–A. DRAW THE LINE OF SIGHT FOR VEHICLE EXITING DRIVEWAY. POSITION GUIDE RAIL AT DRIVEWAY SO IT DOES NOT INTERFERE WITH LINE OF SIGHT.

NOTE "A": THE SLOPE TREATMENT AT A FLARED TERMINAL MAY REQUIRE SLOPE EASEMENT PARCELS. SEE FIGURE 8–F FOR SLOPE TREATMENT.

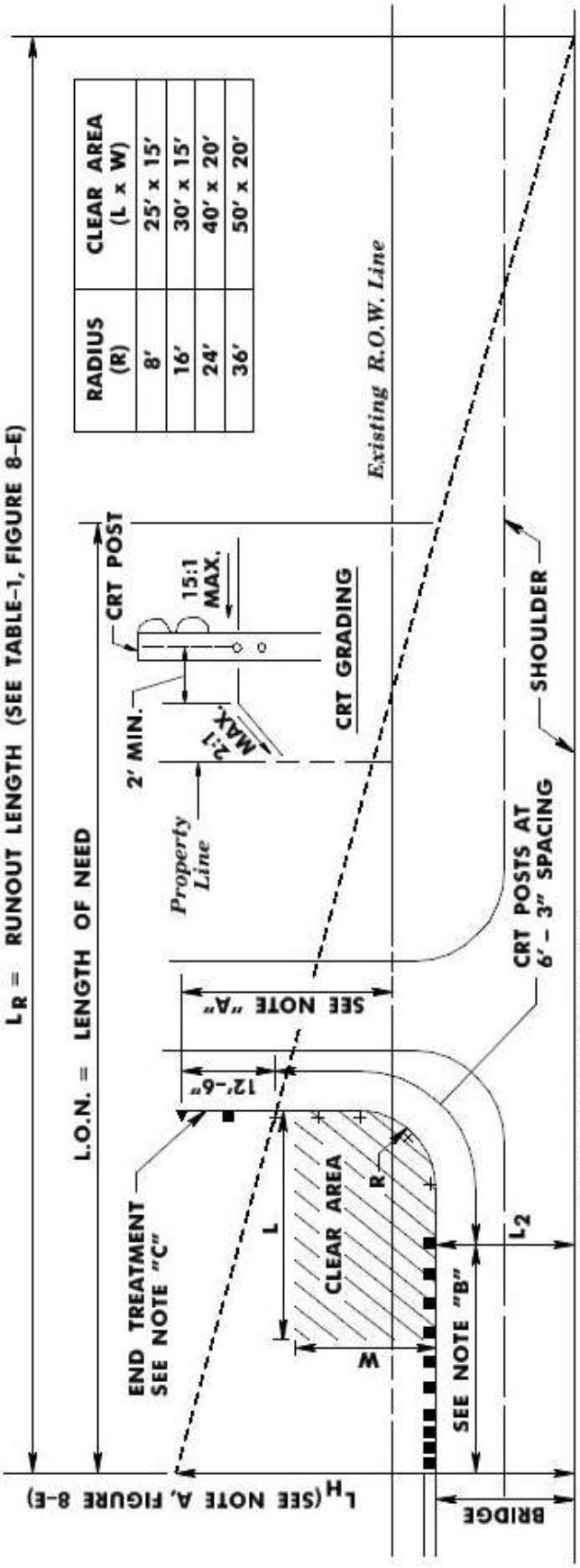
NOTE "B": FOR THE END TREATMENT, SEE FIGURE 8–I. A FLARE TERMINAL MAY BE REQUIRED TO OBTAIN PROPER SIGHT DISTANCE OF VEHICLE IN DRIVEWAY.

NOTE "C": IF YOU CANNOT FIT THE MINIMUM FUNCTIONAL LENGTH OF A FLARED TERMINAL BETWEEN THE OBSTRUCTION (BRIDGE)AND DRIVEWAY, TRY USING FIGURE 8–P OR A CRASH CUSHION.

EXAMPLE OF GUIDE RAIL TREATMENT AT DRIVEWAY LOCATED WITHIN LENGTH OF NEED

FIGURE: 8–P

BDC10MR–01



RADIUS (R)	CLEAR AREA (L x W)
8'	25' x 15'
16'	30' x 15'
24'	40' x 20'
36'	50' x 20'

STEP 1. SEE STEPS 1 TO 4 IN FIGURE 8–O

NOTE "A": A RIGHT OF WAY FEE PARCEL IS REQUIRED FOR THE GUIDE RAIL SYSTEM AND GRADING OUTSIDE THE R.O.W. LINE. A CONSTRUCTION AND MAINTENANCE EASEMENT PARCEL IS REQUIRED FOR THE CLEAR AREA OUTSIDE THE R.O.W. LINE. IF THE GUIDE RAIL SYSTEM TIES INTO EXISTING GUIDE RAIL OUTSIDE THE R.O.W. LINE, THEN A CONSTRUCTION AND MAINTENANCE EASEMENT IS REQUIRED FOR THE GUIDE RAIL SYSTEM, GRADING AND CLEAR AREA.

NOTE "B": STANDARD GUIDE RAIL OR BRIDGE GUIDE RAIL TRANSITION AS REQUIRED.

NOTE "C": WHERE THE DRIVEWAY IS "IN ONLY", USE THE CONTROLLED RELEASE TERMINAL ANCHORAGE. WHERE THE EXIT DRIVEWAY SPEED IS 25 M.P.H. OR LESS, USE THE CONTROLLED RELEASE TERMINAL ANCHORAGE. WHERE THE EXIT SPEED IS GREATER THAN 25 M.P.H., USE A FLARED OR TANGENT TERMINAL.

NOTE "D": THIS GUIDE RAIL TREATMENT IS NOT APPLICABLE WHERE SIDEWALK IS LOCATED BEHIND GUIDE RAIL.

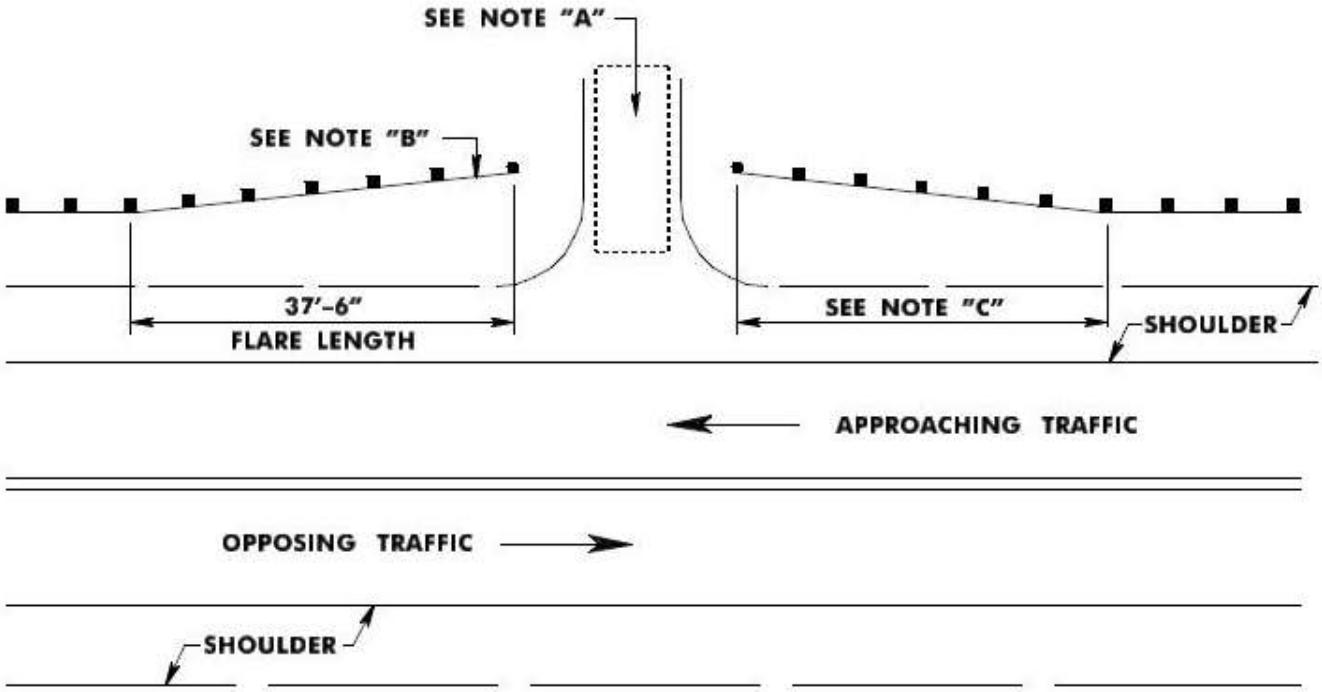
NOTE "E": FOR THE VARIOUS CRT RADIUS DESIGNS & HARDWARE, SEE N.J.D.O.T. STANDARD ROADWAY CONSTRUCTION DETAIL CD-609-6. THESE DESIGNS ARE BASED ON AN INTERSECTION ANGLE OF 90 DEGREES. IF FIELD CONDITIONS VARY CONSIDERABLY FROM 90 DEGREES, A SPECIAL DETAIL SHALL BE MADE OF THE CURVED GUIDE RAIL SECTION SO THAT THE CURVED RAILS WILL FIT THE DRIVEWAY OR INTERSECTION GEOMETRY AND THAT ONLY FULL SECTIONS OF RAIL ELEMENT WILL BE SHOP BENT FOR INSTALLATION.

NOTE "F": IF CURB OR BERM IS PRESENT AND CANNOT BE REMOVED, SEE SECTION 8.3.2.E.1

EXAMPLE OF A TREATMENT AT DRIVEWAY OPENING LOCATED WITHIN A CONTINUOUS GUIDE RAIL RUN

FIGURE: 8–Q

BDC10MR–01



NOTE "A": CHECK SIGHT DISTANCE AT DRIVEWAY, SEE FIGURE 6–A. DRAW THE LINE OF SIGHT FOR VEHICLE EXITING DRIVEWAY. POSITION GUIDE RAIL AT DRIVEWAY SO IT DOES NOT INTERFERE WITH LINE OF SIGHT.

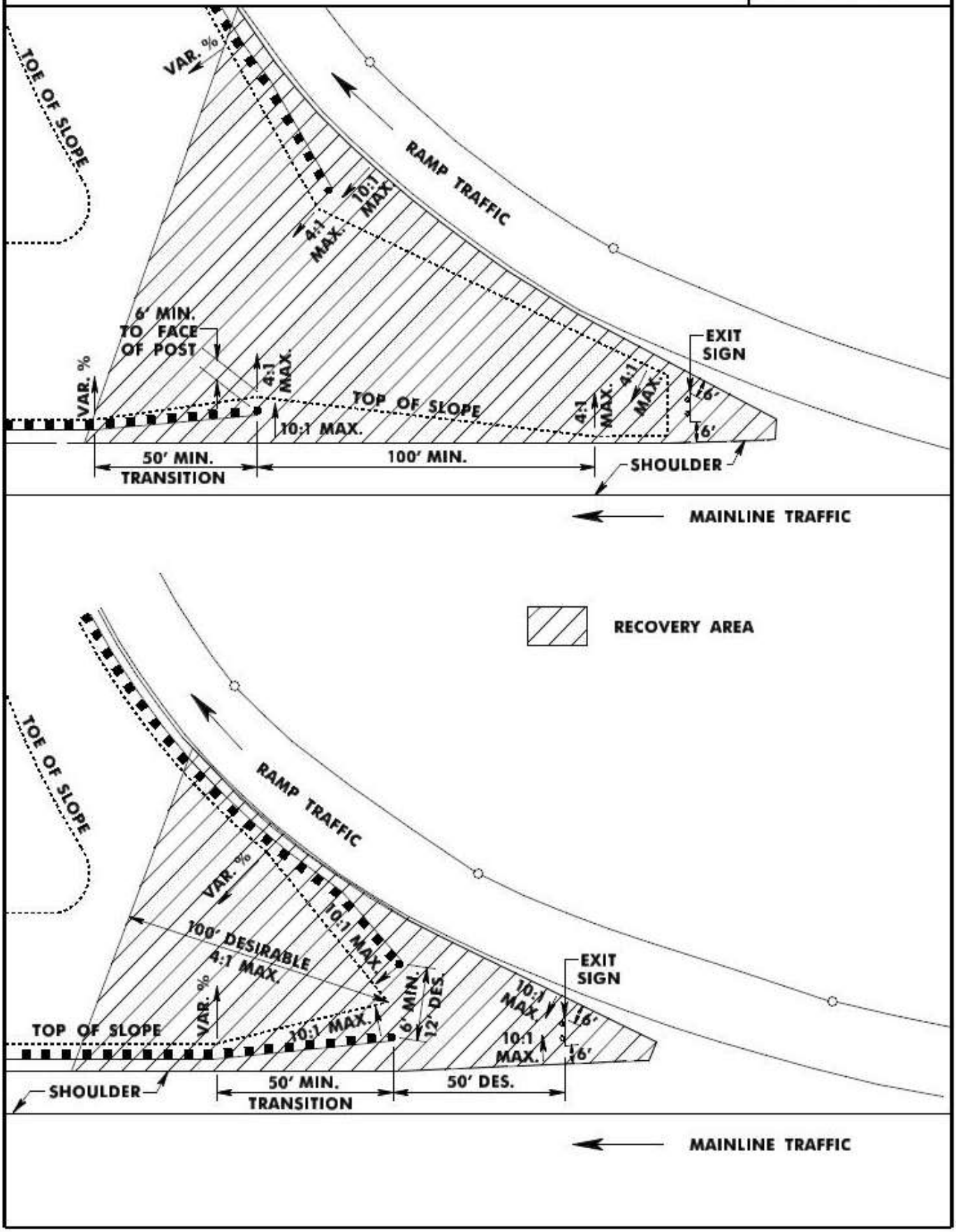
NOTE "B": THE SLOPE TREATMENT AT A FLARED TERMINAL MAY REQUIRE SLOPE EASEMENT PARCELS. SEE FIGURE 8–F FOR SLOPE TREATMENT.

NOTE "C": FOR THE END TREATMENT, SEE FIGURE 8–I. A FLARED TERMINAL MAY BE REQUIRED TO OBTAIN PROPER SIGHT DISTANCE OF VEHICLE IN DRIVEWAY.

GUIDE RAIL TREATMENT EXAMPLES FOR OPEN GORE AREAS

FIGURE: 8–R

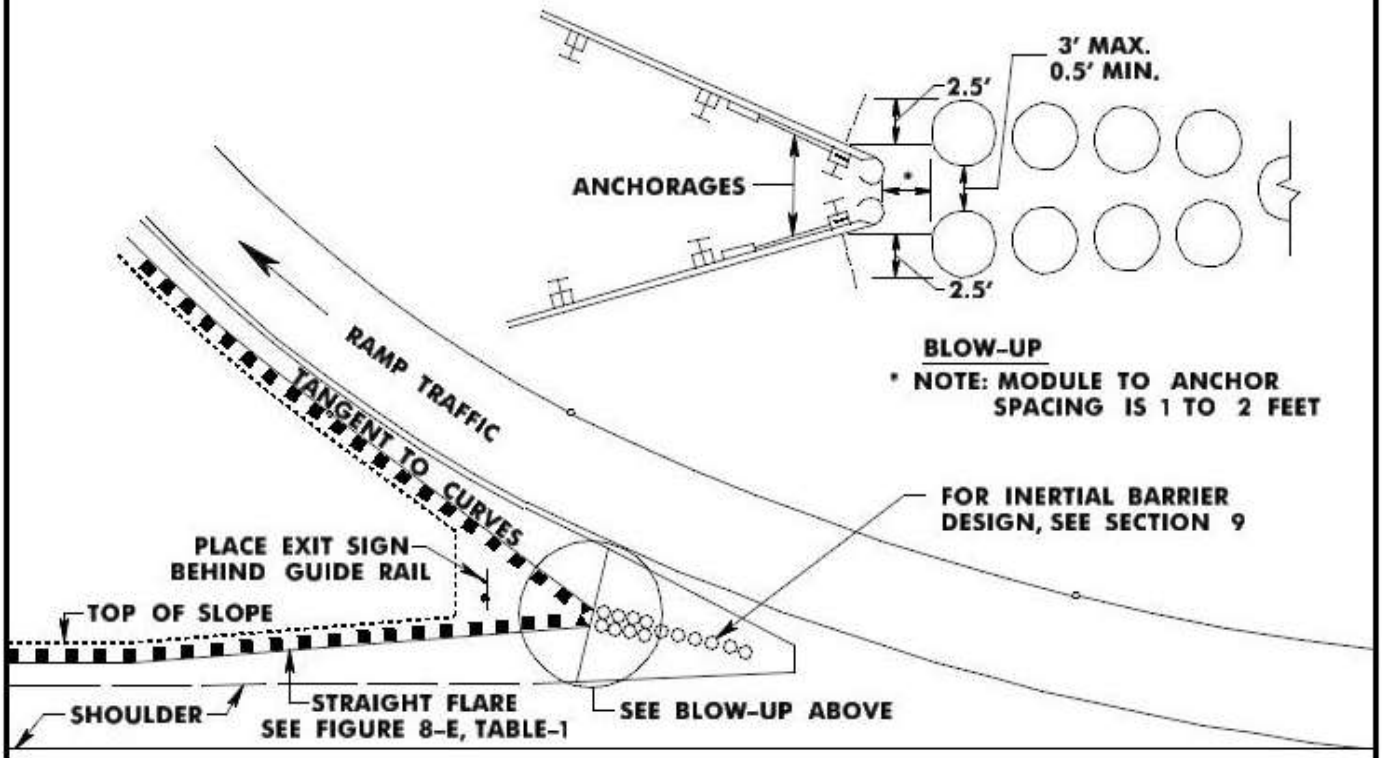
BDC10MR–01



GUIDE RAIL TREATMENT EXAMPLES FOR LIMITED GORE AREAS

FIGURE: 8–S

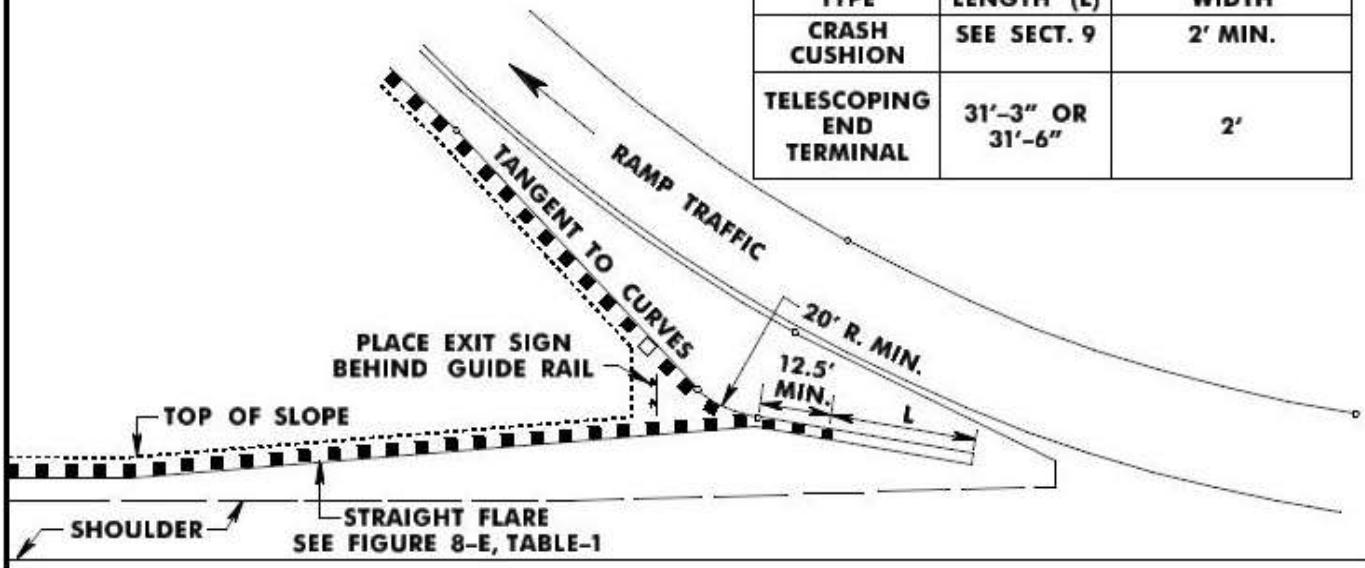
BDC10MR–01



NOTE "A": The impact attenuators shown below are preferred over the inertial barrier system at locations where nuisance hits may be common or where there is a high probability of crashes.

NOTE "B": Providing the widest crash cushion to fit the site, from the table below, usually provides the greatest offset from the physical nose.

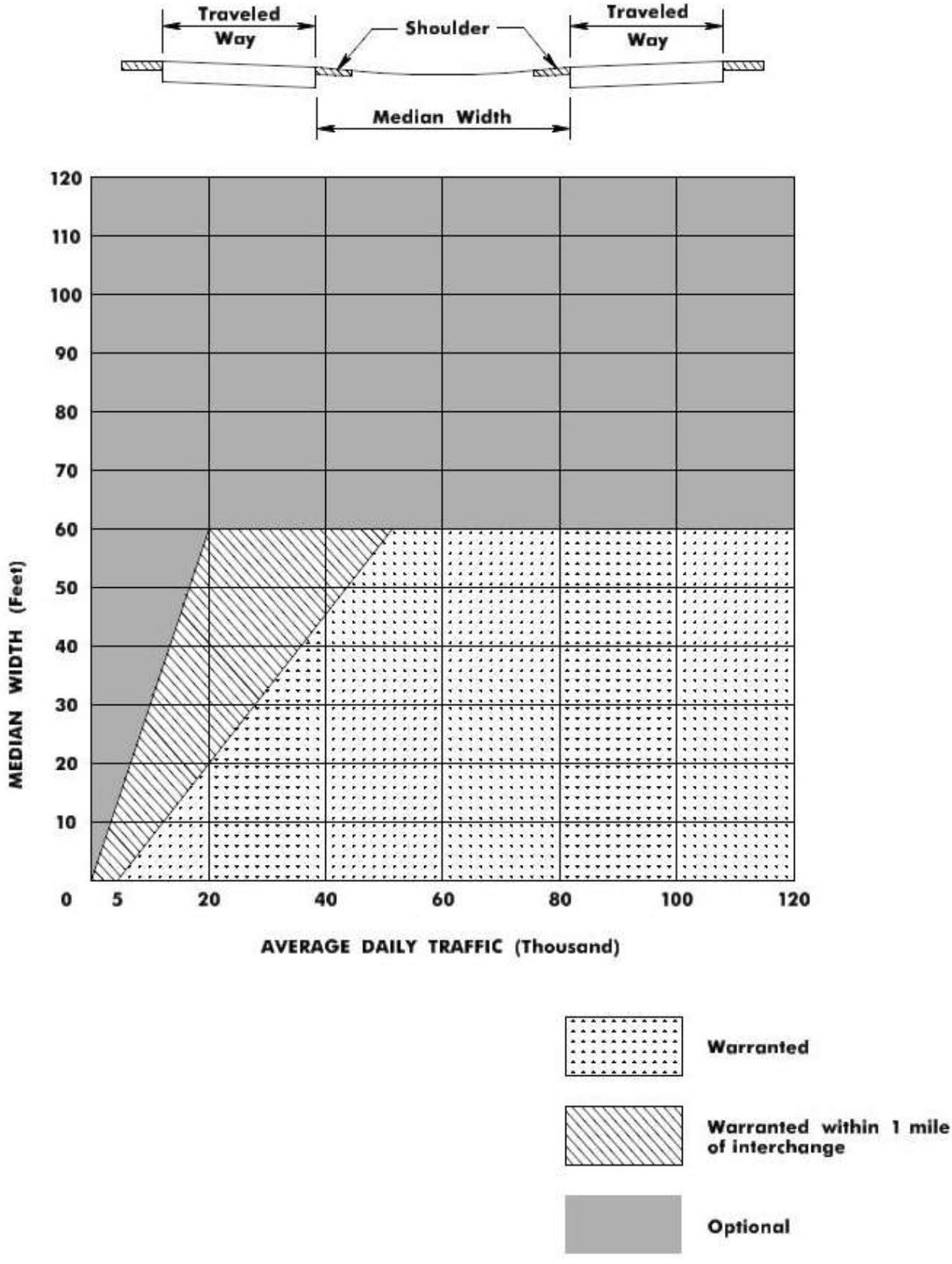
IMPACT ATTENUATOR		
TYPE	LENGTH (L)	WIDTH
CRASH CUSHION	SEE SECT. 9	2′ MIN.
TELESCOPING END TERMINAL	31′–3″ OR 31′–6″	2′



WARRANTS FOR MEDIAN BARRIER FOR FREEWAYS AND EXPRESSWAYS

FIGURE: 8–T

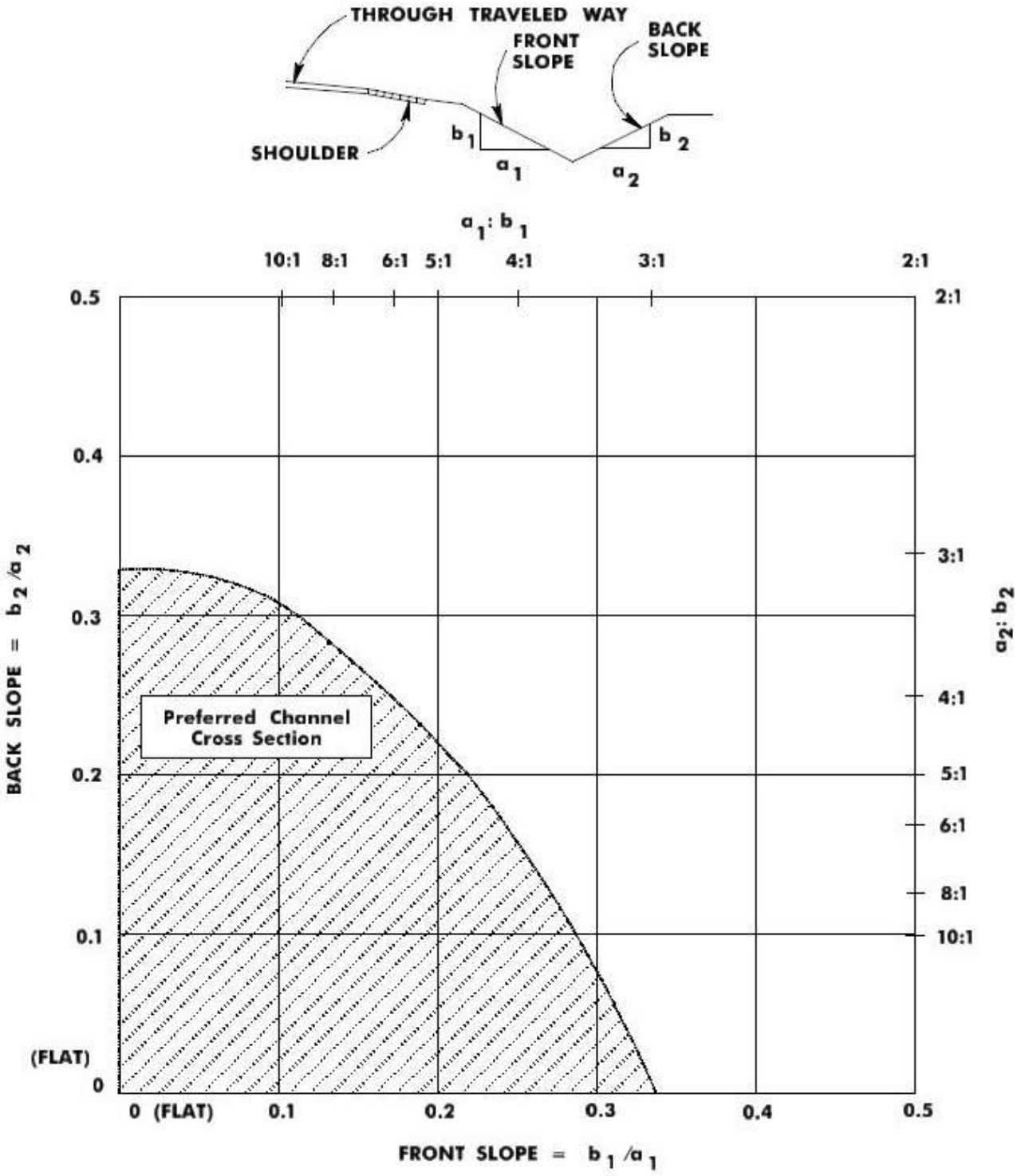
BDC10MR–01



PREFERRED CROSS SECTIONS FOR CHANNELS WITH ABRUPT SLOPE CHANGES

FIGURE: 8–U

BDC10MR–01



NOTE:

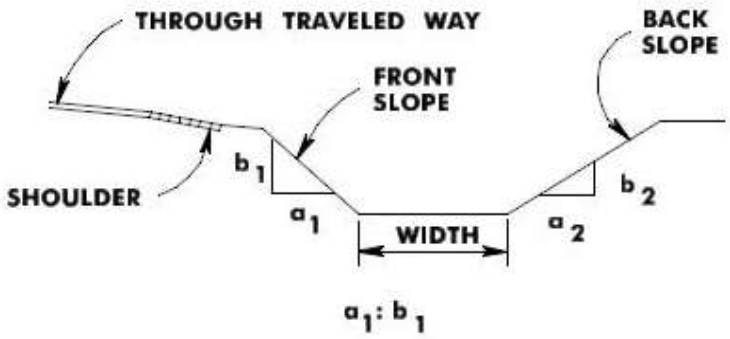
This chart is applicable to all vee ditches, rounded channels with a bottom widths less tha 8 feet, and trapezoidal channels with bottom widths less than 4 feet.

SOURCE: 2006, A.A.S.H.T.O. *ROADSIDE DESIGN GUIDE*

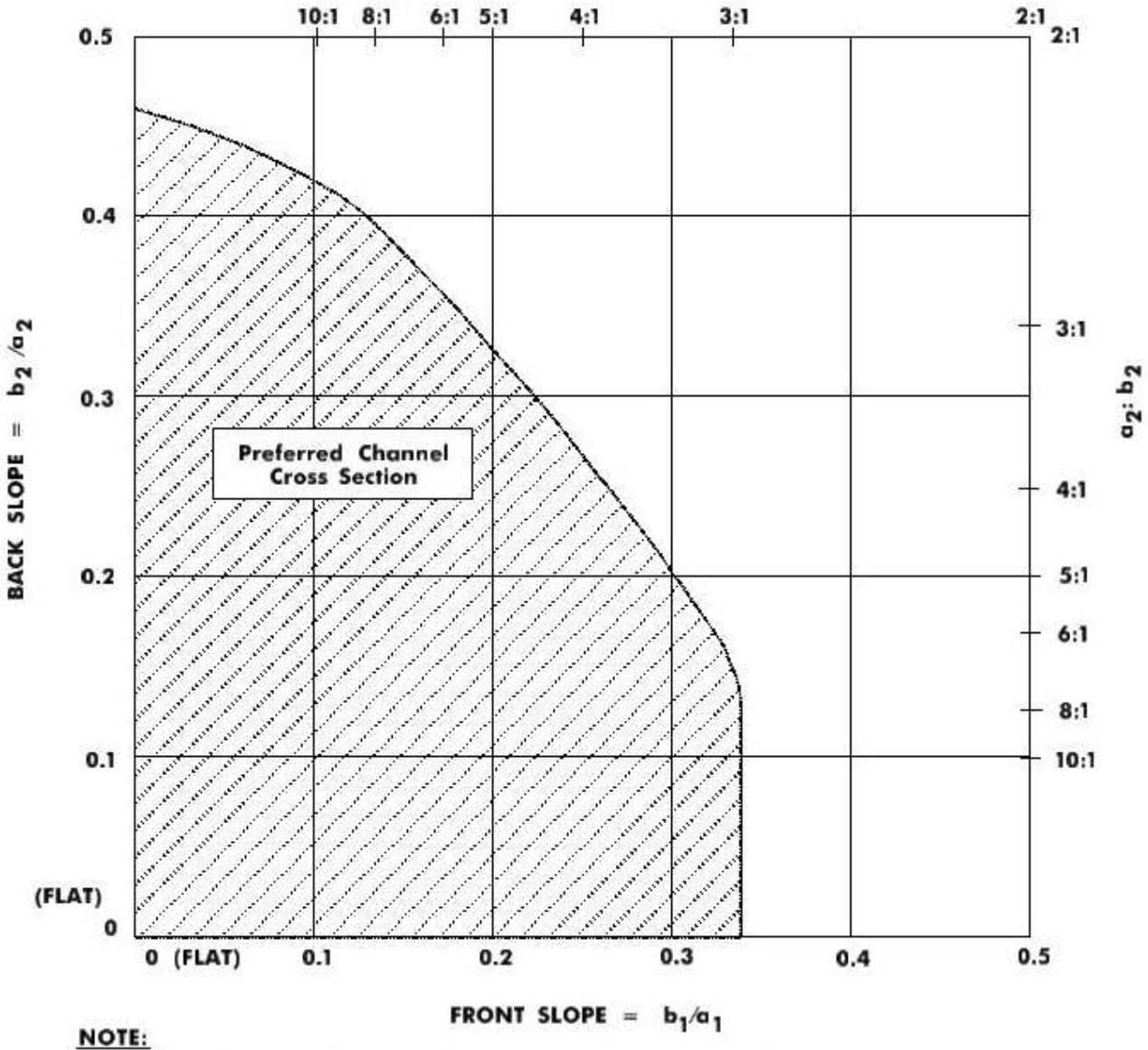
PREFERRED CROSS SECTIONS FOR CHANNELS WITH GRADUAL SLOPE CHANGES

FIGURE: 8–V

BDC10MR–01



$a_1 : b_1$



NOTE:

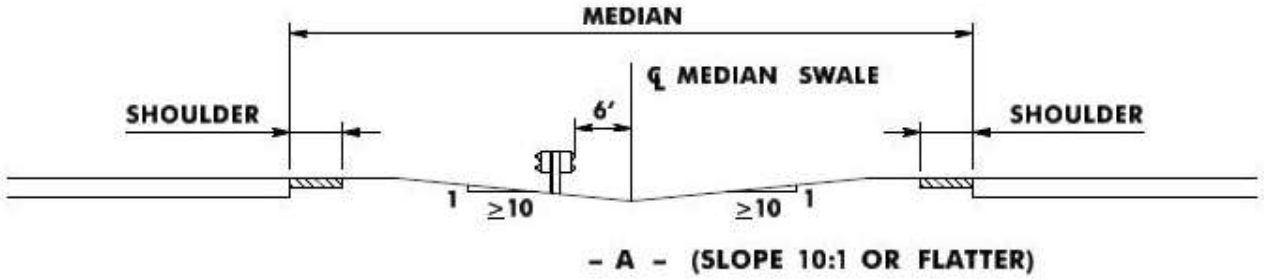
This chart is applicable to rounded channels with bottom widths of 8 feet or more, and to trapezoidal channels with bottom widths equal to or grater than 4 feet.

SOURCE: 2006, A.A.S.H.T.O. *ROADSIDE DESIGN GUIDE*

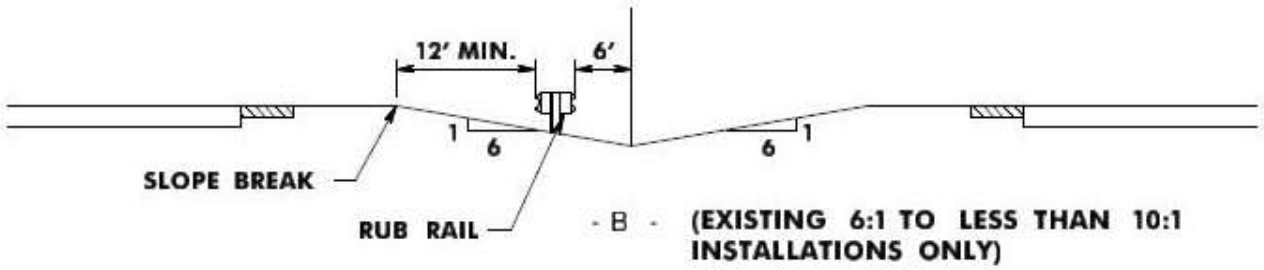
MEDIAN GUIDE RAIL PLACEMENT

FIGURE: 8–W

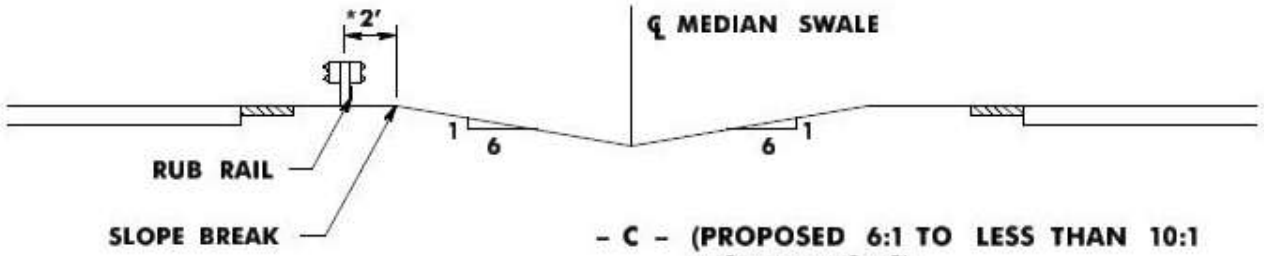
BDC10MR–01



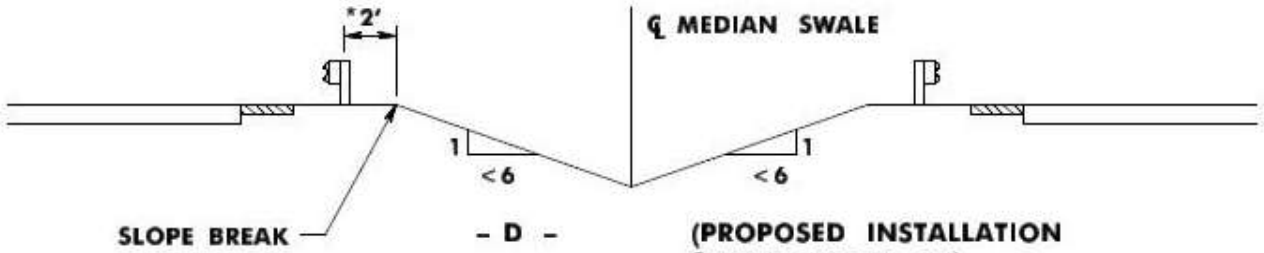
– A – (SLOPE 10:1 OR FLATTER)



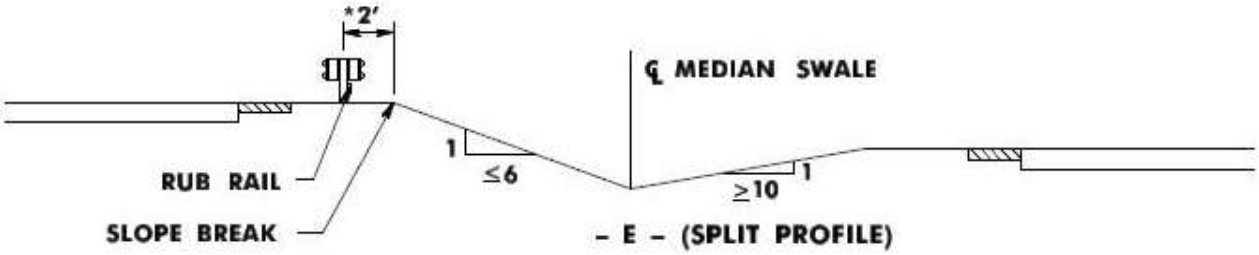
– B – (EXISTING 6:1 TO LESS THAN 10:1 INSTALLATIONS ONLY)



– C – (PROPOSED 6:1 TO LESS THAN 10:1 INSTALLATIONS)



– D – (PROPOSED INSTALLATION STEEPER THAN 6:1)



– E – (SPLIT PROFILE)

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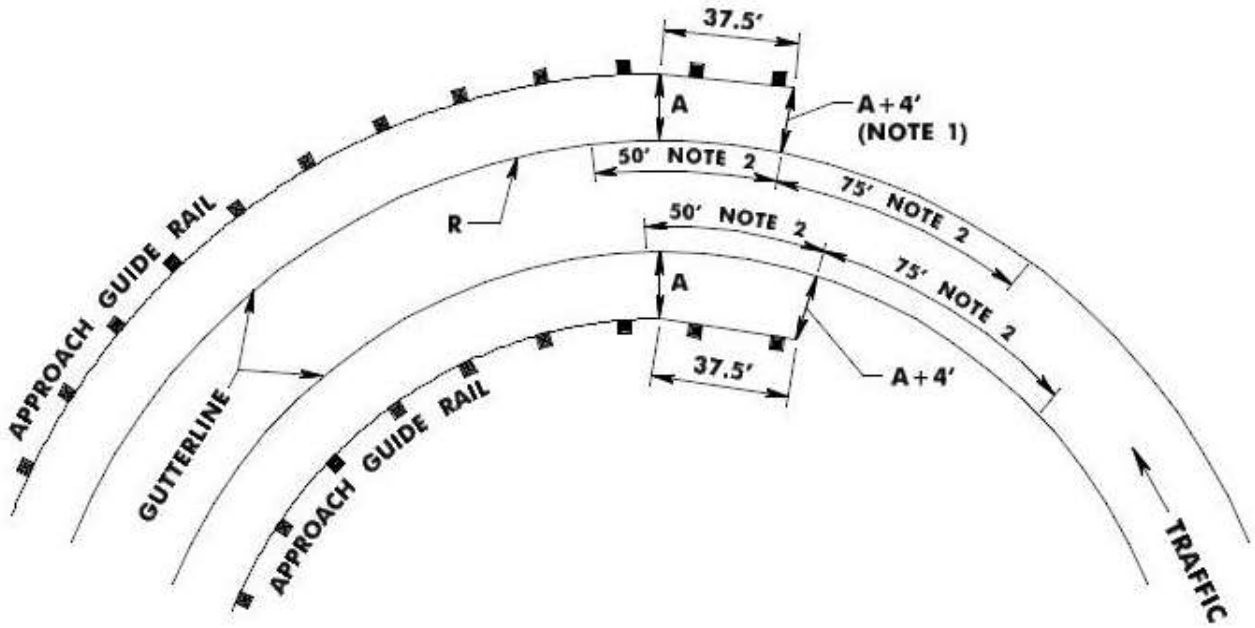
* Distance shown is 2′ min. If less than 2′ is used, the post embedment shall be increased in accordance with Table 8–3.

FLARED GUIDE RAIL TERMINALS ON HORIZONTAL CURVES

FIGURE: 8–X

BDC10MR–01



"A" = Approach guide rail offset.

NOTE 1: To avoid installing the flared terminal within the roadway, the horizontal radius(R) must not be sharper than 175 ft. where the approach guide rail offset(A) is flush with the gutterline on the outside of the curve. If the radius is sharper than 175 ft., the warranting obstruction should be relocated or the guide rail extended to a point where the radius is 175 ft. or flatter.

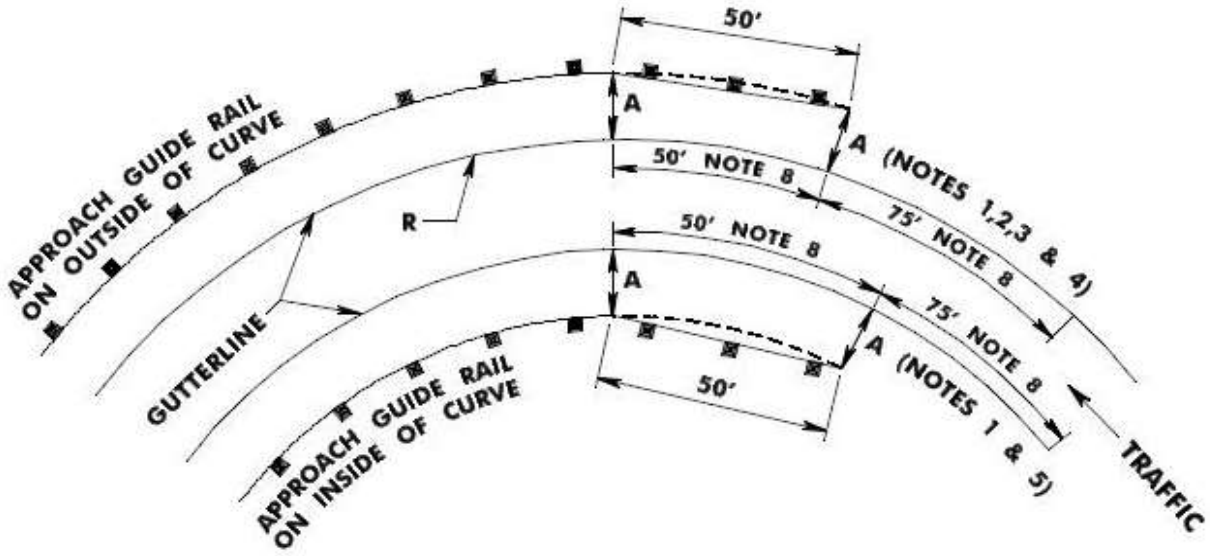
NOTE 2: Where curb exists, use curb face equal to or less than 4".

NOTE 3: See figure 8–F "Grading Treatment at Flared and Tangent Terminals."

TANGENT GUIDE RAIL TERMINALS ON HORIZONTAL CURVES

FIGURE: 8–Y

BDC10MR–01



"A" = Approach guide rail offset.

NOTE 1: Desirable the end of the tangent terminal should be at the same offset as the approach guide rail.

NOTE 2: Where the horizontal radius(R) is flatter than 1250 ft. and the approach guide rail offset(A) is flush with the gutterline, the end of the tangent terminal should be offset 1 ft. from gutterline.

NOTE 3: Where the horizontal radius(R) is 625 ft. or flatter but less than 1250 ft. and the approach guide rail offset(A) is flush with the gutterline, the end of the tangent terminal should be offset 2 ft. from gutterline.

NOTE 4: For other combinations of radii and offset, the designer should make sure the tangent terminal does not encroach into the roadway. In no case should the end of the tangent terminal be offset more than 2 ft. greater than the approach guide rail offset.

NOTE 5: Where the approach guide rail offset(A) is flush with the gutterline, the end of the tangent terminal should be offset 1 ft. from gutterline.

NOTE 6: Where the approach guide rail is flush with the back of sidewalk, the offset to the end of the tangent terminal from the back of sidewalk should be in accordance with the offsets referenced in Notes 2, 3, 4, and 5 above.

NOTE 7: See Figure 8–F "Grading Treatment at Flared and Tangent Terminals".

NOTE 8: Where curb exists, use curb face equal to or less than 4".