

Locating a Barrier

Design Manual
Chapter 8
Roadside Safety

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This section presents the method used to lay out a generic barrier installation. The goal is to provide a barrier with a length and offset that adequately shields an obstacle.

Careful identification of the obstacle being shielded is critical to barrier design. In some cases, there may be multiple obstacles to be considered, such as at bridge locations where the bridge endpost, the embankment, the stream bank, and other obstacles may be present. Another situation arises when hazards are located on or in front of backslopes. It may be prudent to consider the slope behind the hazard as an obstacle also, since vehicles traveling in this area may be diverted back into the hazard.

Proper identification of the obstacle(s) will aid in achieving the goal of adequately shielding the obstacle(s) with a minimum length of barrier. Unnecessarily long barriers cost more to install and maintain, increase concerns for snow drifting, and are more likely to be impacted.

Because crashes into barriers may cause injury to vehicle occupants, the intent is to place a barrier only where the risk associated with impacting the barrier is less than the risk associated with impacting the obstacle.



NOTE: This section assumes that an obstacle exists within the design clear-zone distance (Section [8A-2](#)), that the obstacle warrants treatment (Section [8A-4](#)), and that the chosen method of treatment is to shield with a barrier (Section [8A-3](#)).

Establishing the Vehicle Departure Path

Before a barrier can be laid out to protect an obstacle, the obstacle's position in relation to adjacent traffic must be evaluated. Note that there is an area in advance of an obstacle where impacts from errant vehicles are most likely to originate. This area lies between the obstacle and the traveled way, and its upstream boundary is defined by a theoretical line: the vehicle departure path (refer to Figure 1).

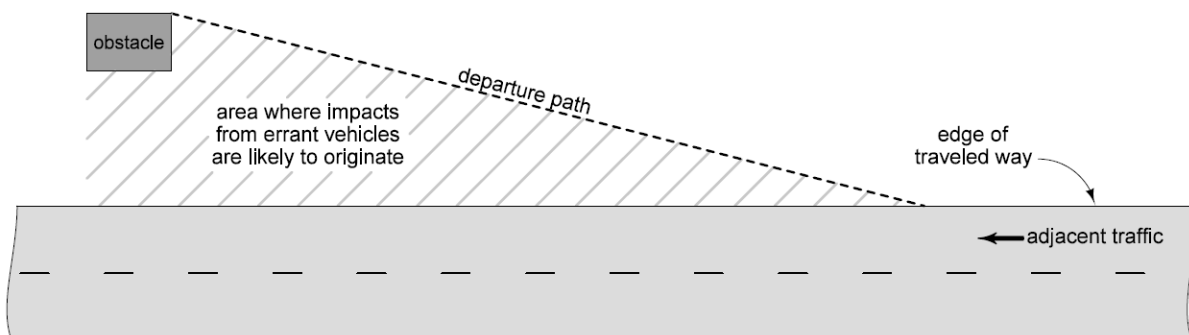


Figure 1: Concept of the vehicle departure path.

The vehicle departure path is an estimate of the longest route that an out-of-control vehicle could follow and still be expected to impact the obstacle, prior to stopping. The location of this path directly affects the length of barrier needed to shield an obstacle. Therefore, establishing an appropriate departure path is a critical step in the barrier design process.

The departure path is assumed to be a straight line, and it is defined by two variables: lateral extent of the obstacle and runout length.

Lateral extent of the obstacle (L_A)

Lateral extent is the distance from the edge of traveled way to the far side of the obstacle, or the design clear-zone distance, whichever is smaller. As shown in Figure 2, the L_A for obstacle 1 extends to the far side of the obstacle. However, the L_A for obstacle 2 is limited by the design clear-zone distance.

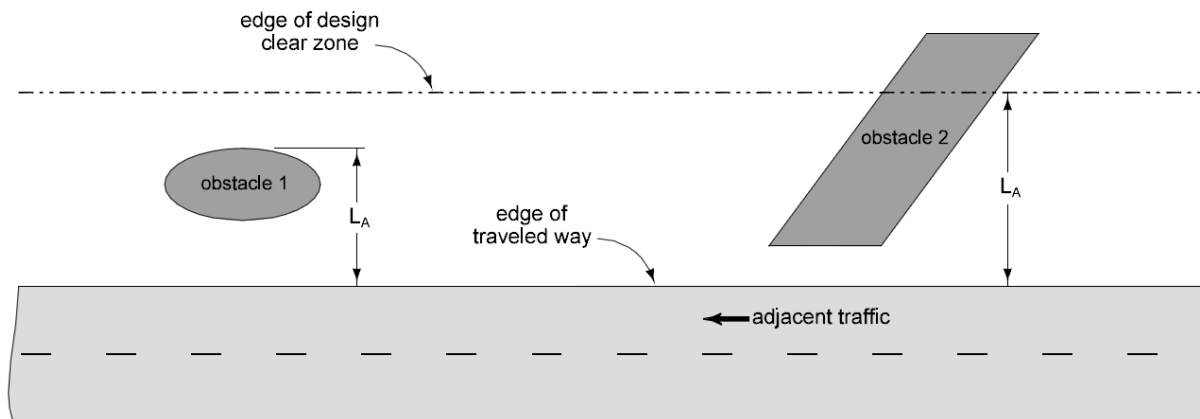


Figure 2: Comparison of L_A distances for different obstacles.

Runout Length (L_R)

Runout length is defined as the theoretical distance needed for a vehicle that has left the roadway to come to a stop. Runout length is based on design speed and traffic volume, and is determined using Table 1.

Table 1: Runout lengths.

Design Speed (mph)	Traffic Volume			
	ADT \geq 10000	5000 \leq ADT $<$ 10000	1000 \leq ADT $<$ 5000	ADT $<$ 1000
	L_R (ft)	L_R (ft)	L_R (ft)	L_R (ft)
70	360	300	260	220
60	260	210	180	170
50	210	170	150	130
40	160	130	110	100
30	110	90	80	70

Once L_A and L_R are determined, the departure path can be established graphically (refer to Figure 3):

1. Identify the location where the obstacle warrants protection, for example, the leading edge of a fixed object or where a slope first becomes hazardous.
2. Draw a line from this point toward, and perpendicular to, the centerline. The intersection of this line with the edge of traveled way marks the beginning of the runout length.
3. Scale off the runout length along the edge of the traveled way, working upstream from the obstacle.
4. Draw the departure path by connecting the end of the runout length to the leading, far-side edge of the obstacle (or the edge of the clear zone, whichever is less).

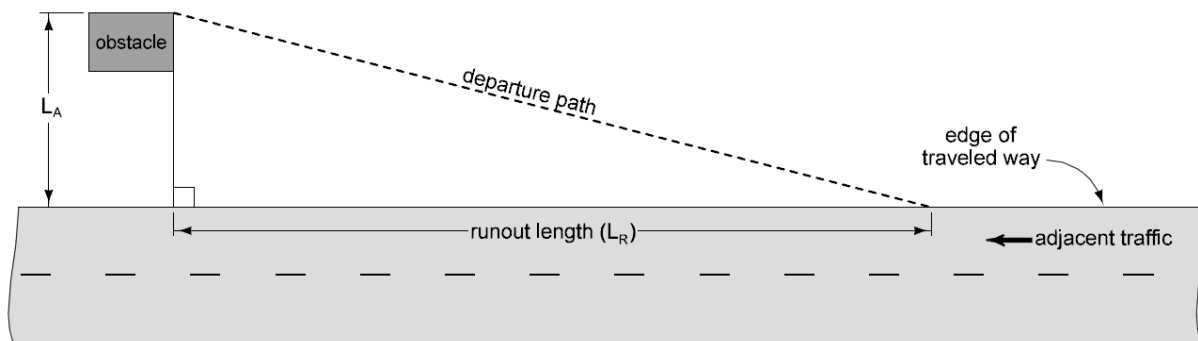


Figure 3: Establishing the departure path.

Departure path for opposing traffic

A departure path is established for each obstacle within the clear zone of adjacent traffic. For obstacles that are also located within the clear zone of any opposing traffic, the process is completed twice—once for the adjacent traffic, and once for the opposing traffic.

Consider the situation shown in Figure 4. Note that the edge of traveled way for opposing traffic in this case is the painted centerline. Therefore, the L_A distance and departure path originate from this line.

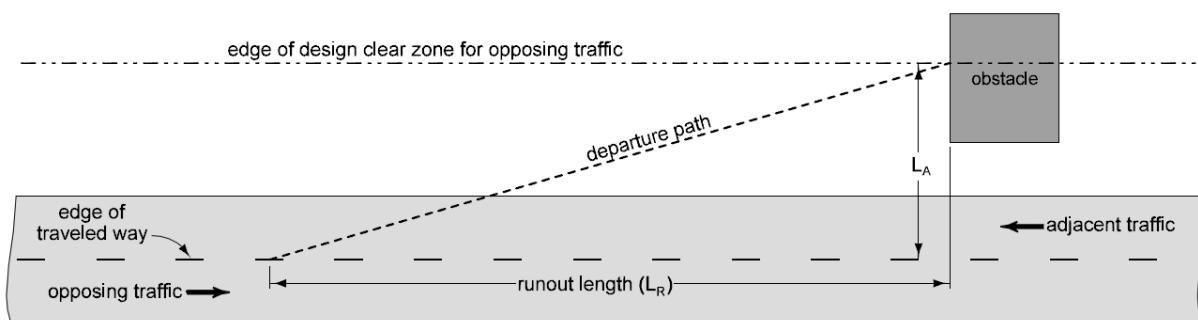


Figure 4: Departure path for opposing traffic.

If opposing traffic is separated by a median, the edge of traveled way for opposing traffic is the inside edge of the opposing travel lane.

Effect of curvature on departure paths

All previous examples of establishing departure paths have assumed a straight roadway. In practice, however, many obstacles are located on or near curved roadways. The effect of roadway curvature varies depending on the degree of curvature and whether the obstacle is located on the outside or inside of the curve.

Obstacles on the outside of a curve

Vehicles leaving the roadway on the outside of a curve can be expected to follow a path that is tangent to the curve. Such a path may vary from the path assumed for a straight roadway. Therefore, the departure path for this situation must be determined and compared to the departure path based on the runout length (refer to Figure 5):

1. Draw the departure path using the process described previously. However, when scaling out the runout length, make sure to follow the curvature at the edge of traveled way.
2. Draw a line from the leading, far-side edge of the obstacle (or the edge of the clear zone, whichever is less) to a point on the edge of traveled way that is tangent to the curve. This line defines the tangential departure path.
3. Compare the two departure paths. Use the one that is shorter.

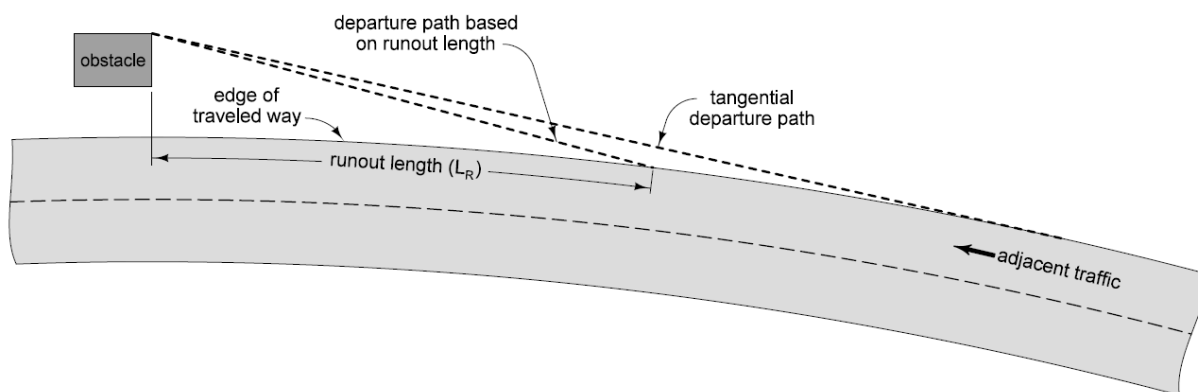


Figure 5: Departure paths on the outside of a curve.

Obstacles on the inside of a curve

Follow these steps to establish the departure path for an obstacle located on the inside of a curve (refer to Figure 6):

1. Locate the point at the leading, far-side edge of the obstacle (or the edge of the clear zone, whichever is less).
2. Using this point as the center, draw an arc with a radius of L_R .
3. Draw a line from the far side of the obstacle (or the edge of the clear zone) to the point where the arc intersects the edge of traveled way. This line defines the departure path.

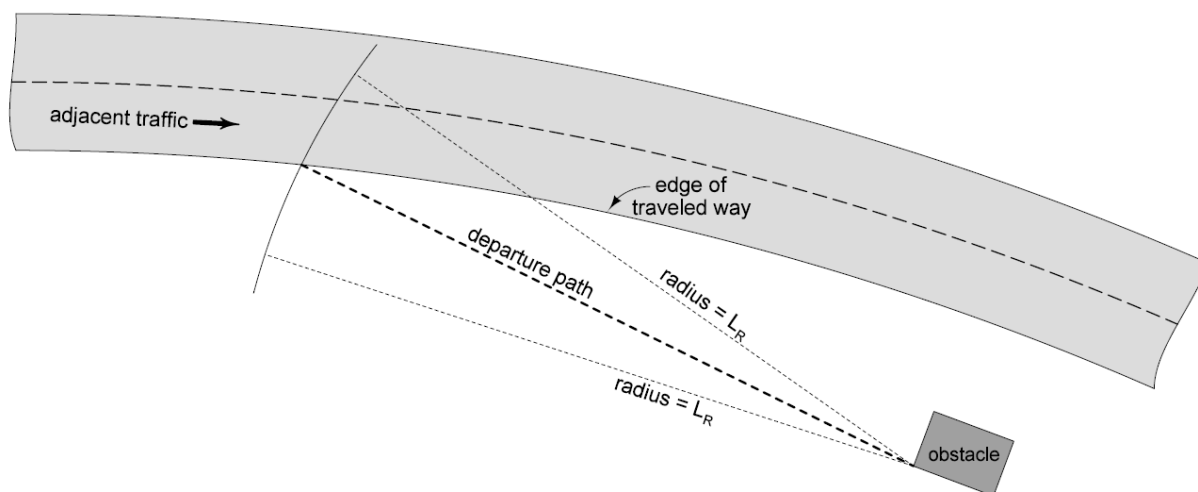


Figure 6: Departure path on the inside of a curve.

Effect of obstacle shape and orientation on departure paths

Most obstacles used in the previous examples have been rectangular-shaped and oriented parallel to the roadway, making the establishment of departure paths relatively straightforward. However, the shape and orientation of obstacles in the field varies widely. Selecting appropriate departure paths for such obstacles requires further examination.

Take, for example, the obstacle shown in Figure 7. Assuming that point 1 is a point of concern on the obstacle, the L_A distance at point 1 can be combined with the runout length to establish a vehicle departure path into point 1. Note, however, that point 2 could also be considered a point of concern on the obstacle. The L_A distance at point 2 can be combined with the runout length to establish a vehicle departure path into point 2.

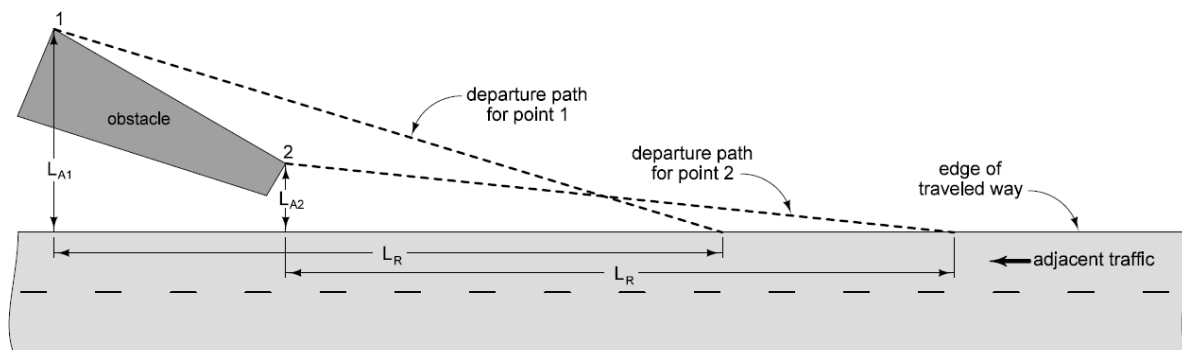


Figure 7: Departure paths for skewed or irregularly-shaped obstacles.

There is no way of knowing which of the two paths better describes how an errant vehicle might impact the obstacle. To account for this, the paths must be combined. A composite departure path is formed by combining the outer limits of each individual departure path, as shown in Figure 8.

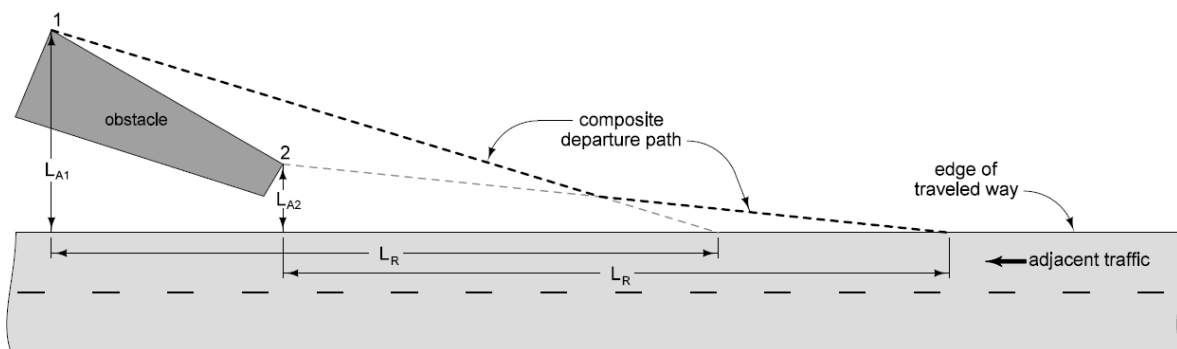


Figure 8: Defining a composite departure path.

This same process is used when defining a departure path for multiple obstacles that are located within close proximity to each other, for example, a bridge endpost and the nearby stream bank.

Length of Need

The minimum length of a barrier needed to protect the approach end of an obstacle is called the length of need. The departure path serves as a basis for determining the length of need. As shown in Figure 9, a barrier placed in front of an obstacle that is long enough to intersect the departure path would be expected to shield the obstacle from most potential impacts. Also consider the following:

- Motorists leaving the traveled way at the end of the runout length, but at an angle sharper than the departure path, should not be able to reach the obstacle.
- Motorists leaving the traveled way upstream of the end of the runout length should have sufficient opportunity to slow or stop their vehicles prior to reaching the obstacle.

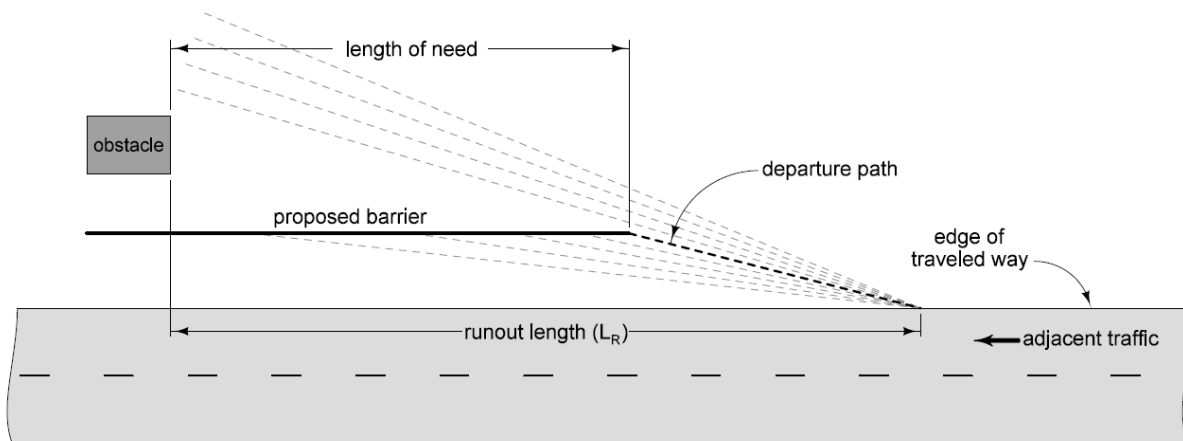


Figure 9: Theory behind length of need.

Offset from the traveled way

The offset of a barrier from the edge of traveled way has a large impact on the length of need for that barrier. Note in Figure 10 that each of the proposed barriers intersects the departure path and therefore adequately protects the obstacle. However, it is quite apparent that the farther a barrier is located from the edge of traveled way, the shorter that barrier needs to be.

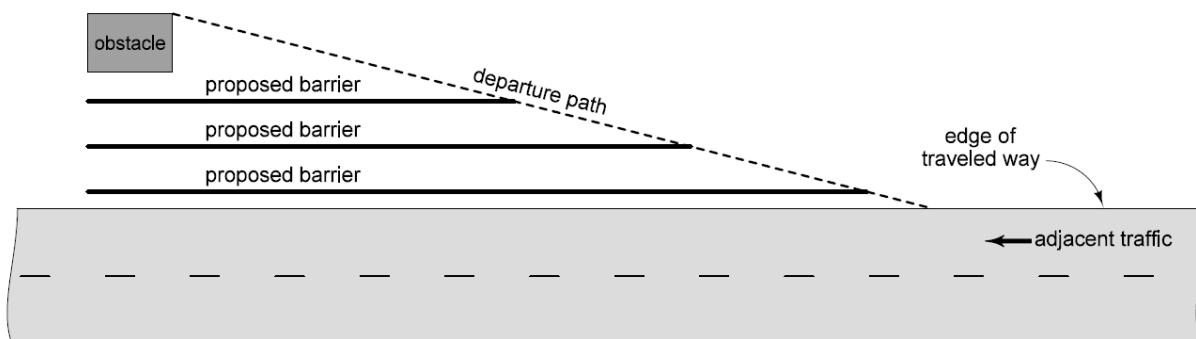


Figure 10: Effect of barrier offset on length of need.

Choosing how far to offset a barrier from the traveled way is somewhat of a balancing act. On one hand, it is preferable to place a barrier as far from the road as possible. This makes impacts into the barrier less likely, as it provides a wide area for errant motorists to regain control and stop their vehicles prior to impacting the barrier. Such a placement can also result in a maintenance cost savings, since fewer impacts means less frequent repairs.

On the other hand, placing a barrier far from the road may be less preferable because it tends to increase installation costs. Since most barriers must be installed on relatively flat slopes, the amount of earthwork required might increase significantly. Also, any out-of-control vehicle that happens to reach the barrier may impact it at a sharper angle than usual, which could increase the severity of such a crash.

A good compromise in most cases is to locate the face of the barrier 2 feet beyond the edge of the normal shoulder. This places the barrier close enough to the pavement that earthwork will not be excessive, yet far enough from the traveled way that the likelihood of impacts into the barrier is reduced. However, alternative offsets may be used depending on site conditions and the type of barrier chosen.

For example, in areas with steep slopes, it may be preferable to place the face of the barrier even with the edge of the shoulder to minimize earthwork requirements. In locations with restricted widths, such as at bridge underpasses, barrier placement on the shoulder may be the only alternative to provide the necessary deflection distance behind the barrier. However, if placing a barrier on the shoulder reduces the effective shoulder width to less than the minimum width allowed for a project, this must be documented in accordance with Section [1C-8](#).

Flare rate of the barrier

Flaring a barrier can also have a large impact on the length of need for that barrier. Note in Figure 11 that each of the proposed barriers intersects the departure path and therefore adequately protects the obstacle.

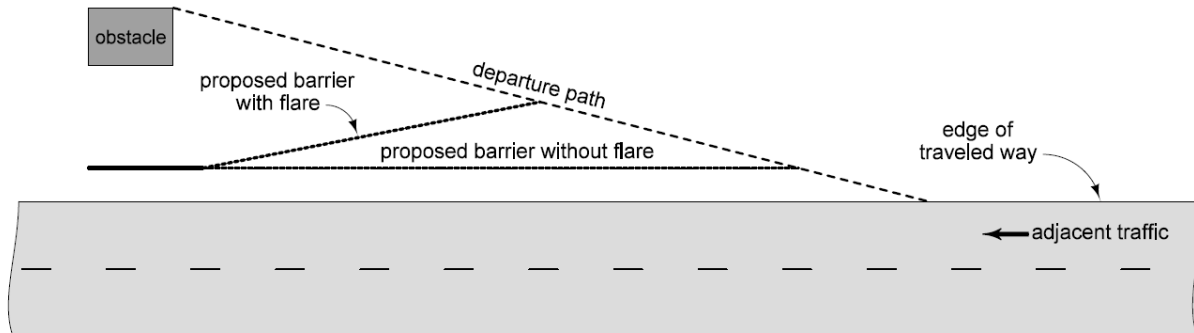


Figure 11: Effect of barrier flare on length of need.

While flaring a barrier does reduce its length of need, it also increases the angle at which an errant vehicle might impact the barrier. Because this can increase the severity of an impact, flare rates of barriers are limited depending on the type of barrier being used. For a discussion of allowable flare rates for a certain barrier, refer to the section of this manual that covers that particular barrier type.

Terminating a Barrier

In order to adequately protect an obstacle, the length of need portion of a barrier must be of a crashworthy design, such as those shown in the [BA Series](#) Standard Road Plans. This portion of a barrier is meant to withstand impacts from the side, but not necessarily at the end. Impacting the blunt end of a barrier could be very hazardous. Therefore, if a barrier terminates within the clear zone of any approaching traffic, it must include a crashworthy end treatment.

An obstacle being shielded for adjacent traffic might not be within the clear zone for opposing traffic, but the barrier often is. Therefore, if the downstream end of a proposed barrier installation is within the clear zone of any opposing traffic, that end of the barrier must also be terminated with a crashworthy end treatment. Refer to Figure 12.

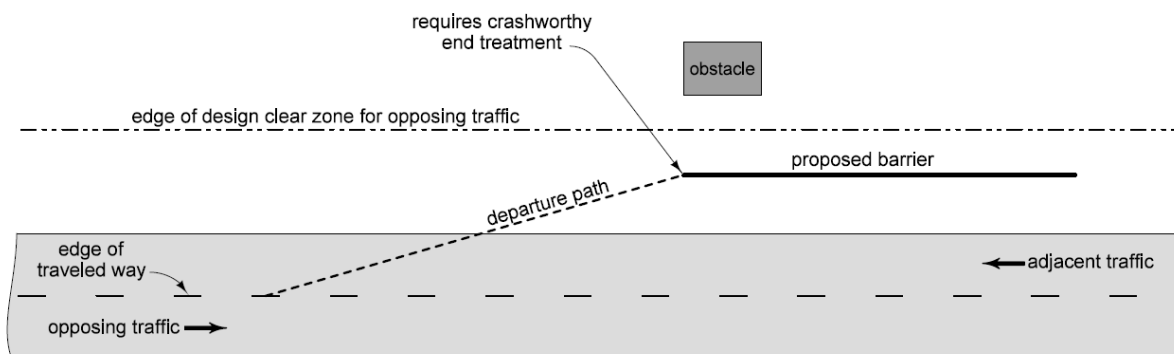


Figure 12: Barrier located within clear zone of opposing traffic.

Gaps between barrier installations

Numerous barrier installations may be required along a given roadway. The ends of barriers are the most critical and require the most maintenance when impacted. Therefore, the number of barrier ends should be minimized whenever possible.

Gaps of 200 feet or less between individual barrier installations should be eliminated by extending the barrier through the intervening gaps, resulting in one continuous barrier shielding two or more objects.

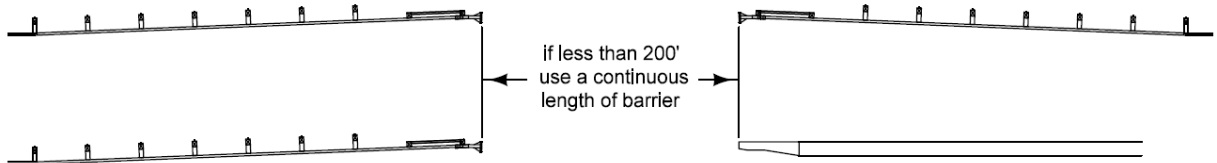


Figure 13: Examples of gaps between barrier installations.

Short gaps often occur because the locations of existing barrier installations are either unknown or are not considered. In other cases, gaps occur because objects that warrant barriers, such as bridges and overhead sign trusses, are constructed as part of the same project, but under different contracts. Therefore, seek to identify the locations of both current and future obstacles so that barrier designs are coordinated and short gaps are avoided.

Chronology of Changes to Design Manual Section:

008B-006 Locating a Barrier

12/30/2011 Revised
Reformatted bullets in 'Length of Need' section.

11/30/2011 NEW
New