CHAPTER 37

BARRIERS

37.1 General

These guidelines are based on the current **Roadside Design Guide, AASHTO**. This section is intended to serve as guidelines that will assist the designer in determining conditions that warrant the installations of guiderail and traffic barriers. 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.

In some cases, another type of traffic barrier may be more effective than guide rail. The designer should consider alternatives and chooses the most suitable solution based on safety requirements, economic limitations, maintenance, and aesthetic considerations. It should be emphasized that guiderail and barriers should not be installed indiscriminately. Every effort should be made to eliminate the obstruction for which the guiderail is being considered. In the District, many roadways are off-system and guide rails or median barriers are not practical; in such cases the curbs may be considered reasonable barriers.

37.2 Guiderail Warrants

37.2.1 General

Guiderail 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.

37.2.2 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 guiderail is warranted. Special cases will arise which there is no clear choice about whether or not guiderail is warranted. Such cases must be evaluated on an individual basis, and, in the final analysis must usually be solved by engineering judgment.

37.2.3 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 (L_c) varies with the speed, roadside slope and horizontal roadway

alignment. The design speed should be used when determining the clear zone.

Table 37-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 **AASHTO Roadside Design Guide** – later version, the designer may provide clear zone distances greater than 30 ft. as indicated in Table 37-A, where such occurrences are indicated by accident history.

Table 37-B contains examples of determining clear zone distances. Horizontal alignment does affect the clear zone width. Therefore, clear zone widths on the outside of horizontal curves must be adjusted as shown in Table 37-C.

37.2.4 Warrants

A warranting obstruction is defined as a non-traversable roadside or a fixed object located within the clear zone. The 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.

37.2.4.1 Non-traversable Roadside

A non-traversable roadside that may warrant guiderail 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.

37.2.4.2 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, guiderail might be warranted if it is not practical to flatten the slope. Guiderail warrants for critical slopes are shown in Table 37-A.

Table 37-A:
Critical Slope Warrants

Critical Embankment (fill) Slopes	Maximum Height Without GuideRail
1.5H:1V	3 ft.
2H:1V	6 ft.
2.5H: 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. 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.

37.2.4.3 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; and, 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:

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

- Guiderail 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.

37.2.5 Drainage Features

Channels should be designed to be traversable. Where feasible, existing channels should be reconstructed to be traversable. According to the **Roadside Design Guide, AASHTO,** ***1***: "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".

37.2.6 Fixed Objects

Fixed objects that may warrant guiderail are: overhead sign supports, traffic signals and luminaires supports of non-breakaway design, concrete pedestals extending more than 4 in. above the ground, bridge piers, abutments and ends of parapets and railings, wood poles or posts with a cross sectional area greater than 50 sq. in. and drainage structures.

In no case shall breakaway, bendaway or non-breakaway design supports, highway lighting, trees, utility poles, fire hydrants, mailboxes and signs on new or upgraded guiderail installations remain in front of guide rail.

Overhead sign supports should be located as close to the ROW line as practical. Guiderail 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.

37.2.7 Trees

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

- On freeways and interstate routes, trees shall not be located within the clear zone.
- The aesthetic appeal of the trees will cause opposition to their removal, Removal of the trees will not be environmentally acceptable. Factors such as accident experience, traffic volume, speed and roadway geometry should be evaluated.
- Sick and diseased trees that are beyond reasonable repair, along with dead trees, trees that cause sight distance problems and trees with a significant accident history shall be removed. Also, trees that will be

harmed beyond reasonable repair due to construction shall be removed. The Urban Forestry Division should be consulted for the tree's physical assessment.

- Cityscape trees shall not be removed without permission from the District's Urban Forest Administration. As a minimum, branches overhanging the roadway shall be removed up to a height of 16 ft. The following areas should be checked for sight distance problems:
  - Along the inside of horizontal curves.
  - Ramp and jug handle entrances and exits.
  - Within the sight triangle at intersections.
  - 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.

37.2.8 Utility Poles

On existing highways, where the utility pole offset does not meet the requirements, the designer should prepare an accident analysis of existing pole locations to determine if the relocation of the utility poles further from the edge of a through lane is warranted.

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 lower than the posted speed.

In no case, shall utility poles on new or upgraded guiderail installations remain in front of the guide rail. Relocate the pole behind the guide rail. 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. In the case when a pole will be located directly behind a post, the minimum pole offset should be no closer than 18 in. from the back of the rail. Guiderail is an obstruction in itself and should be placed as far from the traveled way as possible.

37.2.9 Fire Hydrants

The fire hydrants shall be the breakaway type, or locate the hydrants as far from the traveled way as possible. However, the hydrants must be located to be readily accessible at all times.

Where guiderail 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.

37.2.10 Pedestrians

Guiderail or barrier may be used where there is a reasonable possibility of an errant vehicle encroaching into an unprotected area used by pedestrians in playground and schoolyard areas. The basis for assessing the needs should be the accident experience of the immediate area and the specifics for the cause(s) of the accidents.

There are locations where existing guiderail and the top of the slope of a steep slope are both located directly behind a pedestrian sidewalk area. If new guiderail is installed in front of the sidewalk area, the existing guiderail should be removed and a fence installed in its place.

37.3 Dimensional Characteristics

37.3.1 General Design Considerations

- Guiderail should not restrict sight distance. Sight distances should be checked when guiderail is to be installed at intersections, ramp terminals driveways, along sharply curving roadways, etc. If the sight distance is determined to be inadequate, the guiderail placement shall be adjusted.
- Whenever part of an existing guiderail run is lengthened, reset or upgraded, then the entire run shall be upgraded to current standards including the bridge attachments. Also, always end a project outside the limits of a guiderail run.
- Gaps of 200 ft. or less between individual guiderail or concrete barriers installations should be avoided.
- Guiderail should not be installed beyond the ROW unless easements or necessary ROW is acquired.
- Concrete barriers should be connected with concrete barriers between the parapet gaps with minimum height of 2.25 ft. Avoid use of different type of barriers and transitions in a short length.
- Proposed guiderail set flush with the curb line along intersection radius returns should be checked. Existing guiderail along radius returns that experience truck overhang or over steering accidents shall either be reset farther from the curb line or redesign the radius returns for a larger design vehicle.
- The grading work necessary for the construction of the guiderail end treatments shall be shown on the construction plans.
- 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 guiderail posts.

- Nonvegetative Surface Under Guiderail– In order to reduce soil erosion and highway maintenance costs associated with spraying or trimming vegetation underneath guide rail, nonvegetative surfaces shall be applied underneath guiderail.

37.3.1.1 Without a Curb or Raised Berm in Front of Guide Rail

It is desirable to place the guiderail at a distance beyond that which will not be perceived as a threat by the driver. In general, the following offsets and slopes should be used:

- To the extent possible, guiderail should be located as far as possible away from the traveled way to provide a recovery area for errant vehicles and to provide adequate sight distance along horizontal curves and at intersections.
- On interstate highways and freeways, the front face of the guiderail should desirably be 4 ft. or more from the outside edge of shoulder. Where this offset is not possible, the guiderail should be installed flush with the gutter line.
- On roadways where there is a sidewalk or a sidewalk area used by pedestrians, the front face of the guiderail should desirably 7 ft. or more from the outside edge of shoulder. Where this offset is not possible, the guiderail should be installed flush with the gutter line or offset no more than 3 in. from the face of the curb.
- On roadways where there is no sidewalk, and the border area is not used by pedestrians, the front face of the guiderail may be placed any distance from the gutter line; however, an offset of 4 ft. or more is preferred.
- Where guiderail is located at the top of an embankment slope, the posts should be a minimum of 2 ft. from the top of slope to the center of the post. When less than 2 ft. is provided, the following post lengths, shown in the Table 37-B should be used:

Table 37-B:
Additional Post Length Requirements Where Distance from the Top of Slope to Center of Post is less than 2 ft.

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.

- Guiderail shall be placed on slopes 10H:1V or flatter provided the rollover between the shoulder slope and the embankment slope is not greater than 10 percent.

37.3.1.2 Curb or Raised Berm in Front of Guide Rail

Curb or a raised berm in front of guiderail should be avoided.

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 in.

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.

37.3.2 Rub Rail

When guiderail is constructed less than 3 ft. from a curb or raised berm that is 4 in. 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 guiderail 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 in. 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 guiderail or the upgrading of existing guide rail, every effort should be given to the elimination or reduction in the use 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 feasible.

37.3.3 At Fixed Objects

Where guiderail is used to shield an isolated obstruction it is more important that the guiderail be located as far from the traveled way as possible to minimize the probability of impact. The distance form the back of the rail element to the face of obstruction should desirably be 4 ft. or greater. If less than 4 ft. must be used, the guiderail system must be modified.

37.3.4 On Bridges

On existing freeway and interstate structures with safety walks where it is not feasible to remove and provide a concrete, barrier-shaped parapet, the

crashworthy steel traffic rail shall be carried across the structure along the gutter line. The guiderail should not be installed across the structure. When there is a difference in the offset to the approach guiderail and the offset to the bridge parapet, a transition flare of 15:1 should be used.

37.3.5 End Treatments

37.3.5.1 Guiderail Terminals

Use the current Department's approved standard guiderail terminals and anchorage on the approach and trailing ends of beam guiderail.

A guiderail terminal shall be placed a minimum distance of 12.5 ft. beyond the length of need.

A guiderail terminal shall not be installed behind a curb greater than 4 in. in height. Where there is an existing curb or proposed curb greater than 4 in. in height, 75 ft. of the curb immediately in advance of and 50 ft. beyond the front of a guiderail terminal shall be removed and replaced with a 4 in. mountable vertical curb.

A clear area shall be provided behind a guiderail terminal installation. Slopes in front of guiderail and 6 ft. behind the guiderail terminal shall be graded at 10H:1V or flatter.

Where guiderail is installed along a horizontal curve, the post offsets for the parabolic flare is measured from a line tangent to the horizontal curve.

37.3.5.2 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. 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 to the gore area, the closer the L.O.N. to the gore area, therefore the more limited the guiderail treatment becomes. The preferred treatments for gore areas are no guiderail warrants at all.

37.4 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.

37.4.1 Warrants for Median Barriers

37.4.1.1 Interstate and Freeways

At low ADT's, the probability of a vehicle crossing the median is relatively small. Therefore, for ADT's less than 20,000, a median barrier is warranted only if there has been a history of cross-median accidents. Likewise, for relatively wide medians the probability of a vehicle crossing the median is also low. Thus, for median widths greater than 30 ft. and within the optional area of the figure, a median barrier may or may not be warranted, again depending on the cross-median accident history. Flat medians that are wider than 50 ft. do not warrant a barrier unless there is a significant history of across-the-median accidents.

37.4.1.2 City Roads/Highways

Careful consideration should be given to the installation of median barriers on city roads/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, accident history, alignment, sight distance, design speed, traffic volume and median width should be made before installation of median barriers on highways. Each location should be looked at on a case-by-case basis with the prevailing reason for its installation being the number of crossover accidents.

37.4.2 Median Barrier Types

Median barrier type, when warranted, is related to median width as shown in Table 37-C.

Table 37-C:
Median Width vs. Median Barrier Type

Median Width	Median Barrier Type
Up to 12 ft.	Concrete Barrier Curb
13 – 26 ft.	Concrete Barrier Curb (Preferred) or Dual Face Beam Guide Rail
Above 26 ft.	Dual Face Beam Guide Rail

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-degree) and may strike the obstruction behind it. Concrete

barrier or guiderail must be used to shield an obstruction of bridge piers, abutments, sign bridges, etc.

Architectural barriers with stone facing or stamped concrete should be considered for aesthetic requirements. The barrier should be flushed with the curbs or mountable curbs may be considered when it is not practical to flush with the curb.

37.4.3 End Treatments

When terminating the approach end of dual face, beam guiderail beyond the clear zone, and end anchorage with end section (buffer) is required. When terminating the approach end of a concrete barrier curb beyond the clear zone, a tapered concrete terminal section is required. Where a median barrier terminates within the clear zone area on freeways and interstate highways, a crashworthy end treatment shall be used.