# State Practices on Barrier Use in Wide Freeway Medians

*Requested by*

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# Executive Summary

## Background

Median barrier is recognized as a safety device that can reduce the risk of vehicles crossing the median and colliding with opposing traffic. Caltrans' Freeway Median Barrier Study Warrant does not currently address locations where the median is wider than 75 feet. However, California has experienced some crossover crashes in such locations. Caltrans is interested in learning about other state DOTs' approaches to using barriers in wide medians.

To assist with this effort, CTC & Associates gathered information on the criteria used by other states to determine whether barriers should be implemented in medians wider than 75 feet, including traffic levels, maintenance considerations, site geometry, elevation, freeze-thaw factors, at-grade intersections, and site accident history.

## Summary of Findings

The installation of barriers in medians wider than 75 feet is an uncommon, but not unheard of, practice. For example, a recent update to Oregon DOT's technical guidance dictates that the state's Highway Design Manual will be changed to direct closure of medians up to 100 feet wide, and a bill encouraging Oregon DOT to install barriers in all medians up to 100 feet wide has been approved by the state Senate and is currently under review in the state House. Michigan DOT has also installed barriers in medians up to 100 feet wide when the site's history of cross-median crashes and cost-benefit analysis supports it. Washington State DOT also installs barriers in wide medians (typically 80 to 110 feet) at sites with a significant cross-median crash history.

Installation of barriers in medians wider than 75 feet is an exception in nearly all other states; maximum median widths for which barriers are required or optional under state warrants generally range from 40 to 72 feet. In states that do install barriers in wide medians, the specific site's history of cross-median crashes is the most common factor used to identify sites where installation of a barrier is appropriate. Additionally, a relatively flat median slope (often but not exclusively 6H:1V) is a common geotechnical prerequisite for cable barrier installation.
States that do not install barriers in wide medians typically have warrants that only recommend barriers in narrower medians. These warrants are often established in state highway design guides and based on median width and traffic levels.

This Preliminary Investigation is organized in three sections:

- Review of Published Research, including federal guidance, state research related to median barriers, and state median barrier policies.
- Survey of Practitioners.
- Interviews with Practitioners.

Following is a summary of findings by section.

## Review of Published Research

- The use of median barriers in medians wider than 75 feet is relatively uncommon. Common criteria used in determining whether to install a median barrier include median width, median slope, traffic and accident history.
  - Median width is generally the first factor considered in determining whether to install a barrier. Installation of barriers in medians wider than 75 feet is an exception in nearly all states; maximum median widths for which barriers are required or optional under state warrants generally range from 40 to 72 feet.
  - In general, cable barriers are only recommended if the median slope is 6:1 or flatter, and a few sources recommend flatter (10:1) slopes. A 2009 Texas DOT study reports that a few states have successfully implemented cable barriers on 5:1 slopes, and Colorado's policy permits their use on 4:1 slopes if regrading the slope is not feasible.
  - Traffic levels for which median barriers are warranted or recommended typically range from 20,000 to 36,000 vehicles per day. However, state median barrier warrants are often based on a combination of median width and traffic levels, so that barriers are not warranted above a certain width no matter how much traffic the road carries. A 2009 Midwest States' Regional Pooled Fund report found that a road with an 80-foot median would require daily traffic of more than 200,000 vehicles for installation of a median barrier to have a favorable benefit/cost ratio.
  - Several states' guidance documents include provisions that barriers in wide medians may be justified at sites with a history of cross-median crashes. While this is a fairly common provision, only a few states offer specific guidance for a collision rate that justifies barrier implementation: Minnesota adds priority to sites with any severe crashes or more than 3.3 non-severe crashes per mile, while Utah recommends barriers if the crossover crash rate exceeds expected values.
- A few reports offered alternative methods for determining appropriate sites for cable median barrier installation. A 2009 Midwest States' Regional Pooled Fund report estimated benefit/cost ratios for cable barrier installation based on median width and traffic volumes. A Minnesota DOT report assigns sites a rating of zero to four stars based on how many criteria it meets (median width of 55 feet or less, traffic volume above 20,000 average daily traffic [ADT], severe crash density above 0.0 crashes per mile and non-severe crash density above 3.3 crashes per mile) and prioritizes sites with more stars.
- In Oregon, the state Senate passed a bill in April 2015 that would direct Oregon DOT to install barriers in all medians up to 100 feet wide, which is consistent with a recent update to Oregon DOT's technical guidance. Oregon's House is currently reviewing the measure.

## Survey of Practitioners

Thirteen state DOTs responded to a survey about barrier installation in wide medians. Of these, four states reported installing barriers in medians wider than 75 feet.

- Michigan reported installing barriers in medians up to 100 feet wide based on a documented history of cross-median crashes and a cost-benefit analysis. The analysis requires a thorough field evaluation and considers average traffic volume, median width, slope pitch, roadway curvature, superelevation, drainage features, roadside devices or obstructions that may interfere with barrier installation, and other site-specific features that may affect barrier installation or maintenance.

- Oklahoma considers cable barrier in medians up to 80 feet wide in general, with very rare exceptions in wider medians. ODOT considers cable barrier in all locations with a significant crossover crash history (0.23 crashes per mile for five years or more). In other locations, the agency considers installing cable barrier in sites with a benefit/cost ratio above 2:1, which is calculated considering crossover crash history, traffic level, speed limit, access control, median cross slope and median width. However, the survey respondent emphasized that while other states may derive value from the methodology used to develop Oklahoma's guidelines, the specific guidelines are not applicable to other states.
- Oregon issued a Technical Bulletin in March 2015 directing that barriers be added to medians with widths of 100 feet or less, based on an analysis of crossover crashes.
- Iowa's survey respondent noted that the state has occasionally installed cable barrier in short sections of wide medians in facilities where the median is otherwise narrow, but that the state focuses on installing barriers in narrower medians.

### Interviews with Practitioners

We conducted interviews with four states that Caltrans thought might have implemented barriers in wide medians but that did not respond to our survey. These states were Arizona, Kansas, North Carolina and Washington.

- Neither Arizona nor Kansas reported installing barriers in medians wider than 75 feet.
- North Carolina has installed a small number of barriers in medians wider than 70 feet, including possibly a few in medians wider than 75 feet. The decision to install barriers in medians wider than the state's 70-foot standard is based on the site's overall crash history.
- Washington also installs cable barriers in wide medians based on a site's crash history; typically 0.75 cross-median crashes of any severity per 100 million vehicle miles traveled is the threshold at which a site will be considered for barrier installation. While the state has installed barriers in medians as wide as 375 feet, 80 to 110 feet is a more typical width at which barriers are likely to be installed.

## Gaps in Findings

We received a low response rate to our survey of state practices. While we endeavored to account for other states' practices by examining state design manuals and published research and interviewing states believed to have implemented barriers in wide medians, it is possible that not all states' current practices were captured by these measures.

## Next Steps

Moving forward, Caltrans could consider:

- Following up with Oregon DOT to learn more about the agency's recent decision to install barriers in medians up to 100 feet wide, and to understand how the agency's policy change and pending state legislation are related.
- Contacting Washington State and Michigan DOTs for more detail on circumstances that have led to barrier installation in wide medians.

# Detailed Findings

## Review of Published Research

Below we summarize published research and guidance about the use of median barriers in wide medians, including national research, state-level information including research and news stories, and state median barrier policies.

### National Research and Guidance

**Guidance for the Selection, Use, and Maintenance of Cable Barrier Systems**, NCHRP Report 711, 2012.
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_711.pdf
The literature review section of this report (Chapter 2) cites a 2007 Washington State DOT report that summarizes 10 states' guidelines on installing cable median barriers (see page 13). Eight of these states recommend a maximum median width for cable barriers to be used; this width is at least 75 feet for only two states. Arizona recommends installation on medians up to 75 feet wide, with a maximum slope of 6:1, in the center of the median, using a 33-inch low-tension cable barrier. Ohio recommends installation of high-tension cable barriers on medians up to 76 feet wide with minimum daily traffic of 36,000 vehicles. Maximum recommended slope is 6:1, and the barrier should be installed more than 8 feet from the bottom of the ditch.

Chapter 3 of this report summarizes a survey of current practices, which received responses from 40 states. This survey revealed that at least some states utilize cable median barriers on wide medians, with some in use on medians at least 100 feet wide. Nineteen states cited median width as a warranting factor in the use of cable median barriers. The report does not specify which states provided which responses, however.

Chapter 6 summarizes guidelines for installation of cable barriers; however, it does not address median width.

**Cable Median Barriers**, FHWA Priority, Market-Ready Technologies and Innovations, 2006.
http://www.fhwa.dot.gov/resourcecenter/teams/safety/safe_mrt_cable.pdf
This FHWA document does not specify the appropriate median width for cable barrier implementation, but it states that "The increased use of cable barriers in relatively wide medians where a barrier is warranted will decrease the number of severe cross-median crashes." It also observes that cable median barriers perform better than other barriers when installed on medians with moderate slopes.

**Cable Median Barrier**, AASHTO Innovation Initiative, 2004.
http://aii.transportation.org/Pages/CableMedianBarrier.aspx
Cable median barriers were an AASHTO Innovation Initiative Focus Technology in 2004. This web site addresses several topics, including:

- **Barrier designs** from North Carolina, Washington, Texas and Utah
  http://aii.transportation.org/Pages/BarrierDesign-CMB.aspx

- **Roadway design issues,** including then-current information about traffic volume and speed, vehicle mix, median width, cross slope, number of lanes, roadway alignment and crash history.
http://aii.transportation.org/Pages/RoadwayDesignIssues-CMB.aspx

- **Maintenance issues,** including mowing, vehicle removal, cable cutting, snow removal, repair time and tension monitoring.
http://aii.transportation.org/Pages/MaintenanceIssues-CMB.aspx

## State Research and News

**"New Bill for Cable Barrier Requirements on Its Way to the House,"** KOBI-TV, April 14, 2015.
http://kobi5.com/news/local-news/item/new-bill-for-cable-barrier-requirements-on-its-way-to-the-house.html
This news story reports that the Oregon state Senate approved Senate Bill 921 (see http://gov.oregonlive.com/bill/2015/SB921/), which would direct the state DOT to make efforts to install barriers in medians with widths up to 100 feet. The bill has received a first reading in Oregon's House, and a public hearing has been held.

**Study of High-Tension Cable Barriers on Michigan Roadways**, Michigan DOT, 2014.
http://www.michigan.gov/documents/mdot/RC1612_474931_7.pdf
This report evaluates the 317 miles of high-tension cable median barrier systems installed in Michigan between 2008 (when the state began installing them) and 2013. In addition to evaluating cable barrier performance, the report includes an economic analysis of the cost-effectiveness of cable barriers and guidelines for screening freeway locations to identify candidates for cable barrier installation.

As detailed in Chapter 6, the economic analysis calculated a 13.36-year Time of Return for the benefits of an installed cable barrier to outweigh the costs.

Chapter 7 provides cable barrier installation guidelines. While AASHTO recommends that barrier installation be considered for roads with medians up to 50 feet wide and annual average daily traffic (AADT) greater than 20,000 vehicles, the report states that "Recent research suggests that barrier installation may be warranted across a wider range of median configurations." The report considered six factors as screening criteria for potential cable barrier locations: average daily traffic, median width, number of lanes, lateral offset of the barrier from the travel lane, annual snowfall and horizontal curvature.

These guidelines provide baseline expected crash rates based on traffic level and median width. Other factors provide modifiers to these baseline rates. For example, a road with a curve of radius 3,500 feet or more uses the baseline crash rates, but a radius between 2,500 and 3,500 feet increases median-related crash rates by 70.2 percent.

A case study in Appendix B of the report demonstrates how agencies can use the economic analysis and the anticipated crash rates to determine whether a specific site is a good candidate for cable barrier installation.

**"ALDOT: Median Barriers Coming to Alabama Highways—Eventually,"** AL.com, June 26, 2014.
http://www.al.com/news/birmingham/index.ssf/2014/06/cable_barriers_along_i-459.html
According to this news report, Alabama DOT has identified locations on state highways for installing median barriers, although barrier cost makes the speed of implementation uncertain. The article states that Alabama is implementing barriers in medians narrower than 70 feet.

**Recommendations for the Implementation of High Tension Cable Barrier in Minnesota,** Minnesota DOT, 2013.
http://www.dot.state.mn.us/trafficeng/reports/htcbfinalreport.pdf
This report uses a system of risk factors for identifying sites for the implementation of high-tension cable barriers in Minnesota. Four factors are considered: Median width of 55 feet or less, traffic volume more than 20,000 ADT, severe crash density of more than 0.0 crashes per mile and non-severe crash density of greater than 3.3 crashes per mile. Each segment is given one "star" for each factor that it meets, and segments with more stars have a higher risk for cross-median crashes and therefore are priorities for cable median installation.

The report recommends that high-tension cable barriers be installed in all freeway and Interstate medians, as well as expressways where they are deemed the best safety improvement option. It also describes maintenance requirements, including snow and ice removal, mowing, and training.

**Use of Barriers in Rural Open Road Conditions—A Synthesis Study**, Indiana DOT, 2012.
http://ntl.bts.gov/lib/46000/46100/46144/fulltext.pdf
This study seeks to determine the practicality of using barriers in conjunction with a narrower median (about 45 feet). It uses crash modification factors as a method of evaluating the effectiveness of a variety of site features, including both median width and installation of a median barrier. However, the crash modification factors from the installation of a median barrier provided are independent of median width, so they are of limited value in assessing the effectiveness of barriers in wide medians.

The report does offer some general guidance on barrier placement and selection. According to Section 3.3, "Barriers should only be installed where needed." The guide recommends barriers be placed on slopes with a 1V:10H or flatter slope. It also cites the AASHTO Roadside Design Guide's assertion that barriers are not typically used in medians greater than 30 feet wide, although engineering investigations of a specific site may indicate that they are warranted for sites where the median is 30 to 50 feet and daily traffic volume is greater than 20,000 vehicles per day. The AASHTO guide also notes that individual transportation agencies are afforded the flexibility to determine their own guidelines regarding median barrier usage.

Factors in selecting barrier type include barrier performance, deflection, site conditions, cost and maintenance. The report's guidance for specific barrier types includes:

- **High-tension cable barriers:** The best-performing barriers on 1V:6H slopes when the vehicle travels downhill before impact. Some vehicles can under-ride the barrier, but this is less likely if the distance from the ditch line is increased. Increasing this distance also maximizes vehicle redirection.

- **Concrete median barriers:** The F-shape barrier has typically provided better performance than the New Jersey shape, although caution needs to be taken with the height of the barriers to avoid overturning large vehicles.

**Development of Guidelines for Cable Median Barrier Systems in Texas**, Texas DOT, 2009.
http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/0-5609-2.pdf
This report recommends guidelines for cable median barrier use in Texas. The report recommends barriers for all roads with median widths between 30 and 60 feet if the road's average annual daily traffic exceeds 30,000 vehicles per day, and on wider medians if an engineer's evaluation determines that a barrier is needed and cost-effective. Cable barrier systems are recommended only for medians wider than 25 feet, and on medians with slopes no steeper than 6:1 (although the report notes that some states, such as Missouri, have successfully used cable barriers on 5:1 slopes). Where possible, the report recommends installing on even flatter (10:1) slopes.

**Cable Median Barrier Guidelines**, Midwest States' Regional Pooled Fund, 2009.
http://www.ksdot.org/PDF_Files/TRP-03-206-08-Final-Revised.pdf
In this report, researchers conducted a benefit/cost analysis for the implementation of cable barriers based on Kansas' accident records and crossover median crash rates. Researchers calculated the traffic volumes at which benefit/cost ratios of installing cable barriers are 2.0 and 4.0 for a variety of different median widths. (The researchers recommended only considering installation of cable barriers where the benefit/cost ratio is greater than 2.0, in part because of concerns that the average cost of cable median crashes is understated in the analysis, which would lead to an overestimation of the benefit/cost ratio.)

In a 70-foot median, a benefit/cost ratio of 2.0 was found at a traffic volume of 97,000, and a ratio of 4.0 was achieved at a traffic volume of 121,000. In wider medians, necessary traffic volumes to result in favorable benefit/cost ratios increase quickly, to more than 200,000 if the median width is 80 feet. As a result, the research generally does not recommend barriers in medians wider than 70 feet.

Kansas DOT Bureau of Road Design Engineering Manager James Brewer confirmed in an interview (see below) that Kansas still uses these guidelines for installation of median barriers.

**Putting the Brakes on Crossover Crashes: Median Barrier Research and Practice in the U.S.**, Wisconsin DOT, Transportation Synthesis Report, 2007.
http://wisdotresearch.wi.gov/wp-content/uploads/tsrmedianbarriers.pdf
This survey of median barrier practices found that most states primarily used AASHTO's Roadside Design Guide for guidance on where to install median barriers, although more than half of survey respondents also developed supplemental policies or guidelines. At the time of the report, the RDG recommended closure of medians 50 feet or less; while some respondents warranted barriers in wider medians, none reported that their guidelines included medians more than 75 feet wide.

**Ohio's Median Design Practices**, AASHTO Innovation Initiative presentation, 2006.
http://aii.transportation.org/Documents/OhioPresentationtoAFB20%287-2006%29.pdf
At the time of this presentation, the AASHTO Roadway Design Guide stated that barriers are not normally considered for medians over 15 meters (50 feet) wide. Ohio's Median Warrants similarly did not recommend median barriers for any median over 15 meters, regardless of

traffic. Based on the effect of cable barriers on crashes, the state had proposed installing cable median barriers for wider medians if they show a history of cross-median crashes. Note that these guidelines have been updated since this presentation; see Ohio DOT Location and Design Manuals, Volume 1, below for details.

**High Tension Cable Median Barrier: A Scanning Tour Report**, FHWA/Illinois DOT, 2006.
http://ftp.dot.state.mn.us/trafficeng/reports/scanningtour/Scanning Tour Report.pdf
This report describes the results of a 2005 scanning tour with visits to Ohio, Oklahoma and Texas to learn from states with experience in the use of high-tension cable barriers. The tour found that in Ohio, a benefit-cost analysis was used to select candidates for cable barrier installation. The highest priority was given to multilane roadways with median lanes less than 76 feet and AADT greater than 36,000, but multilane roadways with median widths between 76 feet and 84 feet, traffic volumes greater than 26,000 AADT and a poor crash history were also considered for cable installation. Ohio DOT also recommended against mid-slope barriers if the median slope is greater than 6:1.

The report does not specify the width of medians in Oklahoma where barriers were used, but it notes that in some cases steep median slopes were reduced to a maximum of 6:1.

**Cable Barrier—A High Tension Transformation: The Utah Experience**, Utah DOT, May 2005.
http://aii.transportation.org/Documents/Utah-HighTensionBarrier%282005%29.pdf
This presentation offers two case studies of high-tension cable barrier use in medians, finding that while the number of incidents increased, the severity of accidents decreased. Offsetting the barrier 6 feet to one side appeared to increase the number of hits on that side. However, both case studies were done on sites where the median was 36 feet wide. Lessons learned from the state's experience include the need for medians to have a compacted surface, a slope no steeper than 1:6, concrete foundations flush with the ground to avoid contact with vehicles and cable that is offset from water flow to facilitate winter maintenance and avoid erosion around foundations.

## State Median Barrier Policies

**Arkansas State Highway and Transportation Department Policy for the Use of Cable Median Barriers**, 2012.
ftp://ftp.arkansashighways.com/outgoing/Connecting_Arkansas_Program/AHTD Standards/Cable Median Barrier Policy.pdf
Arkansas' cable median barrier policy considers median width, average daily traffic, fatal or serious injury crash history and percentage of trucks in identifying locations for cable barrier installation. Specifically, the policy assigns priority for cable barrier installation in the following order:

1. All segments with a median less than 40 feet wide.
2. Segments with a median width between 40 and 60 feet "where a safety analysis recommends cable median barriers due to the occurrence of fatal or serious injury median crossover crashes."
3. Other segments with a median width between 40 and 60 feet.

4. Segments with a median width greater than 60 feet "where a safety analysis recommends cable median barriers due to the occurrence of fatal or serious injury median crossover crashes."
5. Locations "where a safety analysis recommends cable median barriers due to the occurrence of fatal or serious injury median crossover crashes involving vehicles entering the median and striking trees or rock."

Cable median barriers are not permitted on expressways with a raised median as they have not been tested according to NCHRP Report 350.

**Colorado DOT Cable Barrier Guide**, 2009.
https://www.codot.gov/business/designsupport/bulletins_manuals/cdot-cable-barrier-guide
Colorado's policy does not specify a median width appropriate for cable barrier installation. It states: "National experience has shown that cross-median crashes occur even on highways with median widths greater than 60 feet. Roadways should not be excluded from consideration for cable barrier solely on the basis of a large median width. However, installation of cable barrier in very wide medians will increase the number of crashes involving vehicles that would have regained control or come to rest without a crash if there had been no barrier."

The guide states that cable barrier is intended for use on slopes that are 6:1 or flatter, but that some systems can be used on slopes as steep as 4:1 if regrading the slope is not feasible.

**Connecticut DOT Highway Design Manual**, 2013 revision.
http://www.ct.gov/dot/lib/dot/documents/dpublications/highway/cover.pdf
Page 4(13) of Connecticut's design manual suggests that median barriers are warranted only in medians 66 feet wide or less.

**Georgia DOT Design Policy Manual**, Revision 4.7, 2015.
http://www.dot.ga.gov/PartnerSmart/DesignManuals/DesignPolicy/GDOT-DPM.pdf
Section 6.12.1 of Georgia's manual states that positive barrier separation is required on interstates where median widths are less than or equal to 52 feet, and optional for median widths up to 64 feet, as well as at all medians with a history of cross-median accidents.

**Cable Barrier Systems**, Indiana DOT.
http://www.in.gov/indot/3250.htm
According to this page on the Indiana DOT web site, Indiana DOT has installed 370 miles of cable median barriers along Interstates, typically in medians between 30 and 60 feet wide, with plans to install 128.5 additional miles between 2014 and 2017.

**Massachusetts DOT Project Development and Design Guide**, Chapter 5, 2006.
https://www.massdot.state.ma.us/Portals/8/docs/designGuide/CH_5_a.pdf
According to Exhibit 5-33, the need for barriers should be evaluated in medians up to 30 feet wide if average daily traffic is more than 30,000 vehicles, optional in medians up to 50 feet, and not normally considered in medians wider than 50 feet (see page 5-75 of the guide).

**New Jersey DOT Roadway Design Manual**, Section 8, 2015.
http://www.state.nj.us/transportation/eng/documents/RDM/sec8.shtm#medbar
New Jersey typically warrants barriers in medians 60 feet or less. The manual states that "for relatively wide medians the probability of a vehicle crossing the median is also low," although barriers in wider medians are optional depending on cross-median crash history.

**New York State DOT Highway Design Manual**, Chapter 10, 2012.
https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/rev_64_HDM_Ch10.pdf
Median barriers are warranted on freeways and expressways with speed limits 50 mph or greater, volume greater than 20,000 vehicles per day, a median slope less than 10 percent and median width less than 50 feet. Barriers may also be installed if a site has a history of crossover accidents, hazards in the median compromise the clear zone width in either or both travel direction, or if wrong-way movements would be possible onto exit or entrance ramps. Cable barriers may only be used on slopes up to 1:6. The state's median barrier warrant, as established in Figure 10-7, states that clear zones are generally sufficient if the median is 72 feet or wider.

**Ohio DOT Location and Design Manuals, Volume 1**, 2012.
http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Location and Design Manual/Entire_Manual_January_2015.pdf
Section 601.2 describes Ohio DOT's Median Barrier Warrants based on median width and traffic volume. As described in figure 601-2 on page 42 of section 600, median barriers are recommended for roadways with average daily traffic of more than 20,000 vehicles if the median is 59 feet or less, optional for medians up to 70 feet and not required if the median is 70 feet wide or more. These guidelines were established in October 2010.

**Utah DOT Median Barrier Selection Process**, 2012.
http://www.udot.utah.gov/main/uconowner.gf?n=9512116393049875
Utah's barrier selection process provides guidelines for type of barrier following test level selection. Barriers are generally only used if the median width is less than 50 feet, unless crossover crash rate exceeds expected values or if recommended by UDOT Traffic and Safety. TL-3 barriers are generally required for all median barriers, although crash history, roadway geometry, or high traffic volumes may justify TL-5 barriers. When TL-3 barriers are required, cable barrier is the default type chosen unless it is incompatible with the site or if roadway geometry, crash history, or deflection and redirection capability justify another type of barrier.

**Utah DOT Standard Specification Book, Section 02845M**, 2012.
http://www.udot.utah.gov/main/uconowner.gf?n=7595110753741942
This document provides specifications for cable barrier, but it does not provide information about appropriate sites for installation. Limited guidance for site preparation specifies a bare-ground treatment using bare-ground herbicide for 2 feet on each side of the cable system.

**Washington State DOT Design Manual**, July 2014.
http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/design.pdf
Chapter 1600.05 (page 1600-9) addresses medians. The manual directs designers to "Provide median barrier on full access control multilane highways with median widths of 50 feet or less and posted speeds of 45 mph or higher," but medians may be considered on highways with

wider medians where there is a history of cross-median collisions. Design factors to be considered include:

- Type of median: According to Chapter 1610.05(6), “In wider medians, the selection of barrier might depend on the slopes in the median. At locations where the median slopes are relatively flat (10H:1V or flatter), unrestrained precast concrete barrier, beam guardrail and cable barrier can be used depending on the available deflection distance... In general, cable barrier is recommended with medians that are 30 feet or wider... In wide medians where the slopes are steeper than 10H:1V but not steeper than 6H:1V, cable barrier placed near the center of the median is preferable.” A diagram, Exhibit 1610-13a, specifies that the cable barrier should be within 1 foot of the centerline of the ditch.
- Left-side shoulder widths (described in Chapters 1130 and 1140).
- Shy distance: an additional 2 feet of widening should be provided if a barrier is installed where the roadway is to be widened and the shoulder width will be less than 8 feet. (From Chapter 1610.05(2)).
- Ensuring the shadow from the barrier will not hinder ice-melting (described in Chapter 1230).
- Drainage.
- Lateral clearance on the inside of curves (described in Chapter 1260).
- Median crossovers (Described in Chapter 1370).
- HOV enforcement (Described in Chapter 1410).

**West Virginia DOT Design Directives**, 2013.
http://www.transportation.wv.gov/highways/engineering/DD/2006 DD Manual MASTER 06112013.pdf
West Virginia’s Design Directives specify that cable guardrail design should follow the recommendations in NCHRP Report 711.

# Survey of Practitioners

To collect up-to-date information about state practices, we conducted an email survey of state representatives of the AASHTO Subcommittee on Safety Management. In this survey, we asked the following questions:

1. Has your state installed barriers in any medians wider than 75 feet?
2. If so, what factors (including Average Daily Traffic, maintenance considerations, site geometry, elevation, freeze-thaw factors, at-grade intersections and accident history of the site) affect your decision whether or not to install barriers in wide medians? Please describe these factors in as much detail as possible—i.e., what traffic level would prompt you to consider a barrier in a wide median, what geometric features would be necessary for a site to be a good candidate for a barrier, what criteria (such as repair, maintenance or employee exposure) you use to determine what type of barrier to install, and so on.
3. If available, please provide documentation for your decision-making process and any design guidance you have related to barriers for wide medians.

We received responses to this survey from 13 state DOTs:

- Delaware.
- Hawaii.
- Idaho.
- Iowa.
- Michigan.
- Missouri.
- Nebraska.
- Nevada.
- Oklahoma.
- Oregon.
- South Dakota.
- Texas.
- Wisconsin.

Of these, only four states (Michigan, Oklahoma, Oregon and Iowa) reported installing barriers in medians wider than 75 feet. Oregon recently issued a Technical Bulletin directing that barriers be installed in all medians with widths of 100 feet or less. Michigan and Oklahoma both utilize crossover crash history as the first criteria for wide median candidates to have a barrier installed; final selection of sites requires a cost-benefit analysis considering many factors, including traffic volume, median width and median slope (in both states); roadway curvature, superelevation, drainage and roadside devices or obstructions (in Michigan); and speed limit and access control (in Oklahoma). Iowa has installed only a small number of barriers in short median segments wider than 75 feet where the median in the rest of the facility is narrow.

Full survey results appear below.

## Delaware

Contact: Adam S. Weiser, Safety Programs Manager, Delaware DOT, Adam.Weiser@state.de.us.

1. **Barriers in wide medians?** "This is an easy one to answer from Delaware's perspective. We have some medians in the southern part of our state that are wider than 75 feet (about 90 feet max) and have not installed barriers in those locations."
2. **Factors in decision to install?** [No response.]

## Hawaii

Contact: Sean Hiraoka, Traffic Safety Section, Hawaii DOT, 808-692-7684, Sean.Hiraoka@hawaii.gov.

1. **Barriers in wide medians?** "No. We don't have prior experience with installing barriers in medians wider than 75 feet."
2. **Factors in decision to install?** [No response.]
3. **Documentation?** "We use the Roadside Design Guide as a guideline for installing median barriers."

## Idaho

Contact: Ted Mason, Design/Traffic Services, Idaho Transportation Department, 208-334-8500, Ted.Mason@itd.idaho.gov.

1. **Barriers in wide medians?** "Idaho has followed the median barrier warrants given in Chapter 6 of the AASHTO Roadside Design Guide."
2. **Factors in decision to install?** [No response.]
3. **Documentation?** "The Wisconsin DOT Transportation Synthesis Report 'Putting the Brakes on Crossover Crashes: Median Barrier Research and Practice in the U.S.' (available at http://wisdotresearch.wi.gov/wp-content/uploads/tsrmedianbarriers.pdf) gave a summary of what states were using for barrier warrants."

## Iowa

Contact: Chris Poole, Safety Programs Engineer, Iowa DOT, 515-239-1267, Chris.Poole@dot.iowa.gov.

1. **Barriers in wide medians?** "Iowa does not typically install barriers in wide medians. We have, on occasion, installed cable barrier in short sections of wide medians on a facility with otherwise narrow medians, as part of a larger median cable project. But generally, we are focusing on getting our facilities with narrow medians covered with barrier before we address facilities with wider medians (of which we have very few)."
2. **Factors in decision to install?** [No response.]

## Michigan

Contact: Carlos Torres, Crash Barrier Engineer, Geometric Design Unit, Michigan DOT, 517-335-2852, TorresC@michigan.gov.

1. **Barriers in wide medians?** “Yes. The Michigan DOT has installed barriers in medians up to 100 feet wide. However, the decision to install barrier in wide medians is based on a documented history of cross-median crashes and supported by a time-of-return (cost-benefit) analysis.”
2. **Factors in decision to install?** “The decision to install barriers in wide medians is based on a documented history of cross-median crashes, and supported by a time-of-return (cost-benefit) analysis. However, each site has to be individually evaluated to determine if barrier is well-suited, and also to determine the barrier type that is best suited for each location. This involves a thorough field evaluation of the site, and requires the collection of the following data: average traffic volumes, median width, slope pitch, roadway curvature, superelevation (especially when there is a significant height differential between opposing bounds of a divided freeway), drainage features, other roadside devices or obstructions that may interfere with barrier installation, and other site-specific features that may interfere with barrier installation or maintenance.”
3. **Documentation?** “MDOT does not have specific guidelines pertaining to wide medians. As indicated previously, the decision is governed primarily by crash history, supported by a cost-benefit analysis. A thorough field evaluation must be conducted to determine if barrier is well-suited for the location, and the barrier types that are most suitable.”

## Missouri

Contact: Michael Curtit, Traffic Liaison Engineer, Missouri DOT, 573-526-0121, Michael.Curtit@modot.mo.gov.

1. **Barriers in wide medians?** “We do not normally install barriers in wide medians.”
2. **Factors in decision to install?** [No response.]
3. **Documentation?** Missouri’s current guidance on median barriers is online at http://epg.modot.mo.gov/index.php?title=231.1_Median_Width.

## Nebraska

Contact: Dan Waddle, Nebraska Department of Roads, Dan.Waddle@nebraska.gov.

1. **Barriers in wide medians?** “No.”
2. **Factors in decision to install?** “Accident history.”
3. **Documentation?** “Over 50 feet, a barrier is not considered unless data-driven by a crash history.”

## Nevada

Contact: Ken Mammen, Chief Traffic Safety Engineer, Nevada DOT, 775-888-7335, kmammen@dot.state.nv.us.

1. **Barriers in wide medians?** “Nevada DOT currently evaluates locations with widths 50 to 75 feet for cable rail installation. We have not installed past 75 feet of width.”
2. **Factors in decision to install?** [No response.]
3. **Documentation?** Sections 3.5 and 3.7 of the Nevada Road Design Guide, available at http://www.nevadadot.com/uploadedFiles/NDOT/About_NDOT/NDOT_Divisions/Engineering/Design/2010_Road_Design_Guide.pdf, provides guidance related to barriers.

## Oklahoma

Contact: Matt Warren, Traffic Engineering Division, Oklahoma DOT, mwarren@odot.org.

1. **Barriers in wide medians?** “Oklahoma’s past policy has been in general to consider cable barrier in medians up to 80 feet wide, with very few exceptions on wider medians. Although our data on very wide medians is poor (the maximum recordable median width is 99 feet), the most recent analysis has suggested that the probability and severity of crossovers does not decrease as much with increasing median width as had previously been supposed. As a result, ODOT now considers cable median barrier in locations with significant history of crossovers, regardless of median width.”
2. **Factors in decision to install?** “Many factors would ultimately figure into the decision to install or not install cable median barrier. The factors for initial screening are crossover history, ADT, speed limit (55 mph or greater), access control, median cross slope (6:1 or flatter) and median width. Median width is considered only as it divides locations into three groups for consideration: less than 35 feet, 35-80 feet, and greater than 80 feet.”
3. **Documentation?** Excerpt from the ODOT cable barrier policy (see Appendix C):

   **Method of Analysis**

   The specific numbers in the guidelines were obtained by computer analysis to obtain the greatest possible benefit from median cable barrier projects on Oklahoma highways not yet equipped with median cable barrier. The target B/C ratio was taken to be 2:1. Insofar as possible with a simple set of rules and given the considerable flaws in the data, these guidelines are calculated to favor projects with B/C ratio above 2:1 at the expense of projects with B/C ratio less than 2:1.

   The threshold values for AADT and crash rate (i.e., 3,500 AADT, 10,500 AADT, 0.23 crashes/mile/5 years) were arrived at by testing all possible combinations of relevant values against the available data on all remaining potential candidate segments for median cable barrier installation in Oklahoma. The selected values are those which, taken together, yielded the greatest projected aggregate benefit from future installations of median cable barrier.

   Warren added: “**The specific results obtained by this method might be highly inappropriate for other states**. As one example, the ODOT guidelines cannot be met by crossover crash history alone, no matter how high. The reason is that at the time this policy was developed, all high crossover locations on the Oklahoma highway system either met one of the other guidelines or had already been treated with cable barrier, so no additional benefit was accrued by including such a guideline.

"At the present time, ODOT has no special cable barrier design guidance specifically for very wide medians. As far as I know, concrete median barrier has not been considered or installed in Oklahoma where medians are wider than 75'."

In a follow-up email, Warren said, "The guidelines are for screening. Not every location that meets the guidelines would necessarily be provided with cable barrier, due to other practical obstacles to installation or to simple lack of funds. I must stress again that while the *method of development* for these guidelines might be appropriate to other states, the specific guidelines themselves are not. They were greatly influenced by the progress of cable deployment in Oklahoma at the time they were developed, and also by the limitations of the available data and resources."

## Oregon

Contact: Tracy Harris, Value Engineer, Oregon DOT, Tracy.M.Harris@odot.state.or.us.

1. **Barriers in wide medians?** "Yes, in 2008 Oregon DOT issued a Technical Bulletin to close medians with widths of 60 feet or less. There have been a few projects that had widths of 76 feet that have been closed. In March 2015, Oregon DOT issued a Technical Bulletin to close medians with widths of 100 feet or less. Within the 2015 Technical Bulletin is a priority list by region."
2. **Factors in decision to install?** "ODOT developed a scatter graph of crossover crashes to determine at what width to close medians. Oregon DOT is generally placing cable barrier in the wide medians."
3. **Documentation?** Attached documentation includes:
    - Technical Bulletin RD08-01(B), effective June 1, 2008, which changed the Highway Design Manual to require barriers on Interstate medians 60 feet or less and on Interstate medians wider than 60 feet at sites where there is a history of median penetration. (See Appendix D.)
    - Technical Bulletin RD09-02(B), effective November 1, 2009, regarding closure of open medians less than 60 feet wide on non-Interstate freeways. (See Appendix E.)
    - **Technical Bulletin RD15-04**, effective March 27, 2015, which changes the Highway Design Manual to direct that Interstate and non-Interstate medians less than 100 feet should be closed, and specifying freeway segments of high and low priority. http://www.oregon.gov/ODOT/HWY/TECHSERV/docs/tech_bulletins/RD15-04b.pdf

ODOT also created graphs of fatal and serious injury crossover crashes from both 2002-2005 and 2006-2014. (See Appendix F.) These graphs show accidents by type (fatality, injury, or [in 2002-2005 only] property damage only), average daily traffic and median width.

The five permitted barrier types include 42-inch F-shape precast concrete barrier, modified thrie-beam for medians, high-tension/low-maintenance cable barrier, 32-inch F-shape concrete barrier, and metal median guardrail. The cable barrier is the only type that can be placed on a 1:6 slope.

## South Dakota

Contact: Mark Leiferman, South Dakota DOT, Mark.Leiferman@state.sd.us.

1. **Barriers in wide medians?** "In South Dakota, continuous barriers are not installed in any medians wider than 75 feet."
2. **Factors in decision to install?** [No response]
3. **Documentation?** South Dakota DOT Road Design Manual, Chapter 10—Roadside Safety (available at http://sddot.com/business/design/docs/rd/rdmch10.pdf) provides guidance on installing barriers. According to the guide's median barrier warrants (Figure 10-7), barriers are recommended in medians less than 30 feet wide if the average daily traffic is more than 20,000 vehicles, "recommended unless a study finds it to be inappropriate" in medians 30 to 50 feet wide, and "not normally considered except in special circumstances" in medians wider than 50 feet. The state typically uses the Jersey safety shape (32-inch) concrete barrier, although thrie-beam and W-beam steel-beam guardrails and three cable guardrails and high-tension cable guardrails are also available options. According to the guide, "Cable guardrail shall not be placed on slopes steeper than 10:1."

## Texas

Contact: Darren McDaniel, Texas DOT, Darren.mcdaniel@txdot.gov.

1. **Barriers in wide medians?** "We are not aware of any locations that have barriers installed in medians wider than 75 feet on Texas highways."
2. **Factors in decision to install?** [No response.]
3. **Documentation?** "Median barriers are considered when the median widths are less than the widths shown in Table 8-10 of the TxDOT Roadway Design Manual. [See Appendix G.] Median barriers are also considered whenever the clear zone requirements in Table 2-12 are not met. [See Appendix H.] Both tables and the applicable sections of the TxDOT Roadway Design Manual are attached."

## Wisconsin

Contact: Erik Emerson, Standards Development Engineer—Roadside Design, Bureau of Project Development, Wisconsin DOT, 608-266-2842, Erik.Emerson@wi.gov.

1. **Barriers in wide medians?** "Historically, we do not install a barrier system in medians that are wider than 60 feet unless there is a crash history (i.e., cross-median crashes) or there is some hazard in the median."
2. **Factors in decision to install?** [No response.]

# Interviews with Practitioners

Caltrans identified several states as likely to have experience with cable barriers in wide medians. Some of these states responded to the survey, and we followed up with the non-responding states (Arizona, Kansas, North Carolina and Washington) to learn their policies. These interviews are summarized below.

## Arizona

**Interviewees:**

Chris Cooper, Roadway Standards Engineer, Arizona DOT, 601-712-8365, CCooper@azdot.gov.

Joseph M. (Mike) Phillips, Roadway Design Manager, Arizona DOT, 602-712-7993, JPhillips@azdot.gov.

Phillips offered the state's **Roadway Design Guidelines**, which state that median barriers "shall be installed on high-speed fully controlled-access highways having traversable medians under the following conditions: Median widths 50 ft. and less; and Median widths 75 feet and less when there are three or more through lanes in each direction." (See Appendix A.) Key design elements for the use of cable barrier include adequate available deflection distance, approach slopes of 6:1 or flatter, placement of end anchors at intervals that do not exceed the system's design, and a uniform surface for system placement. The guidelines also recommend reducing post spacing to decrease deflections, and note that proprietary manufacturers' information should also be considered for each system.

In a phone interview, Cooper said he was not aware of any barriers in the state in medians wider than 75 feet. He said that when Arizona DOT developed its policy in the late 1990s, the agency considered using crossover crash history as a criterion for barrier implementation, but ultimately decided to use a simple formula based on median width and number of lanes (which serves as an indicator of traffic levels).

Cooper did note that the state is considering changing its approach in response to pending lawsuits and an FHWA study on road-runoff crashes. Cooper said it is possible that policy changes could include implementing barriers in wider medians, but he said the state has no timetable for making any such changes and there is no clear indication what those changes may ultimately be.

## Kansas

**Interviewee:** James Brewer, Engineering Manager, Bureau of Road Design, Kansas DOT, 785-296-3901, JBrewer@ksdot.org.

Brewer stated that Kansas DOT does not implement barriers in medians wider than 75 feet, and that the typical median width in the state is 60 feet. The state's implementation of cable median barriers is guided by the Midwest States' Regional Pooled Fund's 2009 **Cable Median Barrier Guidelines** (http://www.ksdot.org/PDF_Files/TRP-03-206-08-Final-Revised.pdf), which estimate benefit/cost ratios of installing cable barriers for a variety of median widths and traffic volumes. (For a summary of the guidelines, see page 9 of this Preliminary Investigation.) Brewer said that

Kansas prioritizes locations with a benefit/cost ratio of 4.0 under these guidelines for installation of cable barrier.

Brewer also provided the state's **Policy on the Use of Cable Median Barriers on Freeways**. (See Appendix B.) In addition to prioritizing locations based on benefit/cost ratio, these guidelines state that the minimum length of a median barrier is one-quarter mile, that the state will use high-tension cable barriers with short post spacing (16 feet maximum, 10 to 12 feet preferred) with a TL-3 or higher crash rating, and that a 4-foot-wide concrete mow strip will be used where feasible.

Generally, Brewer noted that cable barriers are "not a cure-all," and that one in 20 impacts still result in a serious injury or fatality. He said that while crossover accidents typically lead to highly emotional situations and there is often public outcry for cable barriers when one occurs, the state's approach is an effort to make decisions based on data and facts and to be cost-effective in its response.

## North Carolina

**Interviewee:** Anthony Wyatt, Central Regional Field Operations Engineer, Traffic Safety Unit, North Carolina DOT, 919-773-2887, adwyatt@ncdot.gov.

Wyatt stated that North Carolina's policy is to install barriers in medians 70 feet or narrower, based on a 1998 analysis of crashes in the state that found that most crossover crashes occurred on medians less than 70 feet wide. (See **Saving Lives by Preventing Across Median Crashes in North Carolina**, http://aii.transportation.org/Documents/NCAcrossMedianAnalysis-September1998.pdf.) Wyatt added that a few sites with wider medians that have a pattern of crashes or encroachments do have barriers installed. He was uncertain if any of those sites are 75 feet or wider, however.

Wyatt said there is no specific trigger for the number of collisions that would lead to a site with wide medians having barriers installed; a single incident could lead to barrier installation, but a site's overall history is considered.

In many cases, the state's wide medians have trees in the median that generally prevent cross-median crashes. In a few instances, the state has installed barriers to shield those trees, but Wyatt said that was very rare.

In general, Wyatt recommended considering rumble strips as a mechanism to reduce run-off-road crashes, potentially even installing them before barriers, as they provide an opportunity to regain control of a vehicle in a drifting situation. He also noted that crossover placement is an important consideration, and recommended coordinating with emergency responders so they can adequately develop response strategies with the positioning of median barriers in mind.

Wyatt also pointed to Section 3-6 of the state's **Roadway Design Manual** (https://connect.ncdot.gov/projects/roadway/roadway design manual/03. guardrail, barriers and attenuators.pdf), which specifies that median barriers will be used on all freeways where the median width is 70 feet or less. Cable can be used on slopes of 6:1 or less, while steel beam guardrail requires a slope of 10:1 or flatter. (Cable is typically used if the median is 46 feet or wider; the barrier is placed 4 feet from the center of the ditch, or 8 feet from the center of the ditch if the median is 60 feet or wider.)

## Washington

**Brad Manchas**, Design Research Analyst, Washington State DOT, 360-704-6309, manchab@wsdot.wa.gov.

Manchas said that Washington's design policy mandates barriers in medians narrower than 50 feet, but that wider medians also have barriers at sites where there are clusters of cross-median events. Typically 0.75 cross-median crashes of any severity per 100 million vehicle miles traveled is the point at which a barrier would be considered for installation. (See the **WSDOT Design Manual**, http://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/design.pdf; see page 12 of this Preliminary Investigation for a summary of relevant sections of the manual.)

Barriers used in wide medians are typically cable. The state has installed cable barriers in medians as wide as 375 feet, but typically 80 to 110 feet is the width at which the state has found cable barriers to be justified.

The state installs cable barriers only on 6:1 or flatter slopes. Manchas also said that it's typically better for the cable to be offset from the middle of the ditch, which increases the number of barrier collisions from one side but decreases them from the other, and produces a net reduction of barrier incidents. Other geometric factors the state takes "straight out of the AASHTO Green Book," he said.

Manchas urged concern for the dynamics of vehicles as they leave roadways. He noted that cables can be overridden by SUVs or underridden by small passenger vehicles if improperly placed.

# Contacts

In addition to our contact with those who completed the online survey, we interviewed or corresponded with the following individuals during the course of our research for this Preliminary Investigation.

**Arizona DOT**
Chris Cooper
Roadway Standards Engineer
601-712-8365, CCooper@azdot.gov

Joseph M. (Mike) Phillips
Roadway Design Manager
602-712-7993, JPhillips@azdot.gov

**Kansas DOT**
James Brewer
Engineering Manager, Bureau of Road Design
785-296-3901, JBrewer@ksdot.org

**North Carolina DOT**
Anthony Wyatt
Central Regional Field Operations Engineer, Traffic Safety Unit
919-773-2887, adwyatt@ncdot.gov

**Washington State DOT**
Brad Manchas
Design Research Analyst
360-704-6309, manchab@wsdot.wa.gov

### 303.9 - Special Slope Treatments

The highway designers should coordinate with Roadside Development Section regarding special slope treatments necessary to encourage re-vegetation, to reduce erosion potential, or to accommodate landscaping requirements. Special treatments may include laying back or varying the side slopes, incorporating slope steps, mini-benching, slope mattresses or other soil stabilization treatments.

## 304 - Medians

### 304.1 - General

This section covers State highways only. Medians in local roads at traffic interchanges are covered in Chapter 500 – Traffic Interchanges.

The median width on divided roadways is the distance between edges of the inside through travel lanes.

Median width on rural highways should be based upon the characteristics of the terrain through which the highway passes.

In rural areas, the desirable median width of 84 ft should be used where the terrain or other physical features do not make construction impractical or overly costly and where right-of-way costs are not disproportionate to the total project costs. A wider or variable width median should be used where the terrain lends itself to independent roadway alignments for economic or aesthetic reasons (see Section 204.6).

In establishing the median width, careful consideration should be given to the grading and drainage of the median with special attention to the roadway superelevation and the depth of the pavement structural section. In addition, the capacity and operation of the intersection is affected by the median width. Consideration must be given to the operational characteristics of very long trucks and other vehicles using the intersection.

**The minimum median width on rural highways shall be 50 ft.** See Section 304.4 for discussion on guidelines for median barriers.

A closed median section may be used for rural divided highways in those instances of very restricted rights-of-way, or where the terrain or other physical features make wider medians impractical or costly. In such cases, the roadways should be separated by a concrete barrier and the median shoulders widened by 2 ft. The areas where the closed section is used must have very limited side road access requirements. Barrier breaks for necessary crossings or turn lanes must be restricted to areas with acceptable sight distances for both mainline and side roads.

In improving the capacity of rural highways, it is often prudent to utilize the existing two-lane highway as one direction of a new divided highway. In such cases, the median width should be set (or varied) to minimize the total project cost, including both construction and right-of-way, but with consideration of drainage, median slopes, maintenance of traffic, superelevation, and cross access. It is important to provide sufficient separation to allow generally independent construction of the roadways where possible and feasible to facilitate maintenance of traffic.

For non-controlled-access highways in urban areas, curbed medians should generally be 16 ft wide from face of curb to face of curb.

For controlled-access highways in urban areas, the median width should be based on the need to provide for potential future additional traffic lanes or for possible alternative modes of transportation. In general, a 50 ft wide median should be provided. This width median will accommodate future construction of an additional lane in each direction, an increased median shoulder width and offset to the median barrier.

### 304.2 - Widening for Bridge Piers

In designing highways with closed medians in either the initial or ultimate configuration it is important to check the horizontal clearance to bridge piers located in the median and to the barrier protection provided for the piers. The horizontal clearance to the pier should be as discussed in Section 308; i.e., the clear shoulder width shall be provided as per Table 302.4.

Where the horizontal clearance to a pier cannot be provided as required by Section 308, the median should be widened. If the pier is located in a tangent section, the widening should be accomplished from one curve to the next; if in a curve, the widening should be limited to the curve.

### 304.3 - Median Cross Slopes

Examples of median cross slope design are shown in Figures 304.3A-C.

Figure 304.3A shows 46-50 ft median configurations in rural or fringe-urban settings. The highway median should be sloped downward from the subgrade hinge point at slope rates 6:1 or flatter but no steeper than 4:1. Slopes intersecting at 6:1 or flatter may require offset median control grades and are preferred over 4:1 slopes in the medians as long as drainage requirements can be met (See Chapter 600). Where 4:1 slopes are used and the median intersect is located toward a lower roadway, consideration may be given to utilization of barrier on the high side roadway, especially when on the outside of curvature.

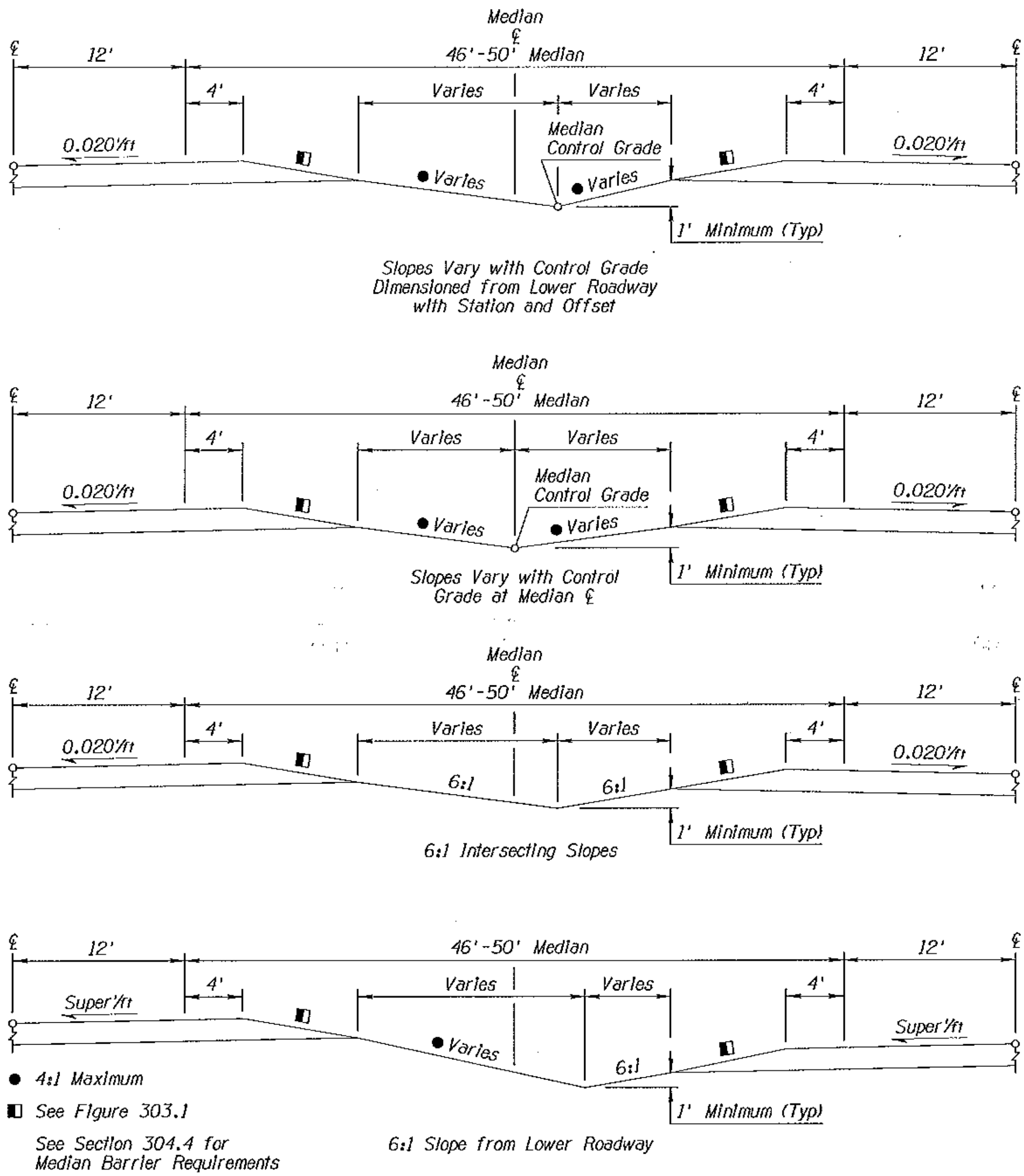
Figure 304.3B shows the standard rural median width of 84 ft for freeways and major arterials. Slopes of 6:1 or flatter are desired and the slopes may be controlled at median centerline, at an offset intersect control line or may randomly intersect. Depressed medians are commonly used, however, when rocky material is encountered, the median area may be left undisturbed with appropriate cut ditch widths and slopes coordinated with Geotechnical Services.

Figure 304.3C shows 50 ft urban controlled access median treatments. Slope rates of 10:1 are desirable with 6:1 as the minimum desired rate. If slopes steeper than 6:1 are required due to curvature and profile controls, selection type and location of the median barrier must be considered. The design of urban controlled access highway medians must consider both the ultimate build-out condition and the interim condition of initial construction. The open median for the interim condition should be based upon the ultimate design. Generally, the ultimate condition will be a median barrier with contiguous shoulders and traffic lanes. The configuration of the median can vary depending upon the elevation differences of the two roadway edges and the median drainage requirements. The profile grade lines of the two roadways should be designed to minimize the vertical separation of the roadways at the median, balanced with providing an overall economical design with the bridge structures controlled by vertical clearances. Other design features such as utility locations, drainage systems and median barriers must be considered.

The ultimate design should be completed with the initial design so that final plans for the future median closure are available and can be utilized for the future median closure projects. Doing this will eliminate potential problems created by profiles and geometry that have not been adequately evaluated for final median closures. See Figure 302.1 for the treatment of urban median shoulders outside of the pavement width.

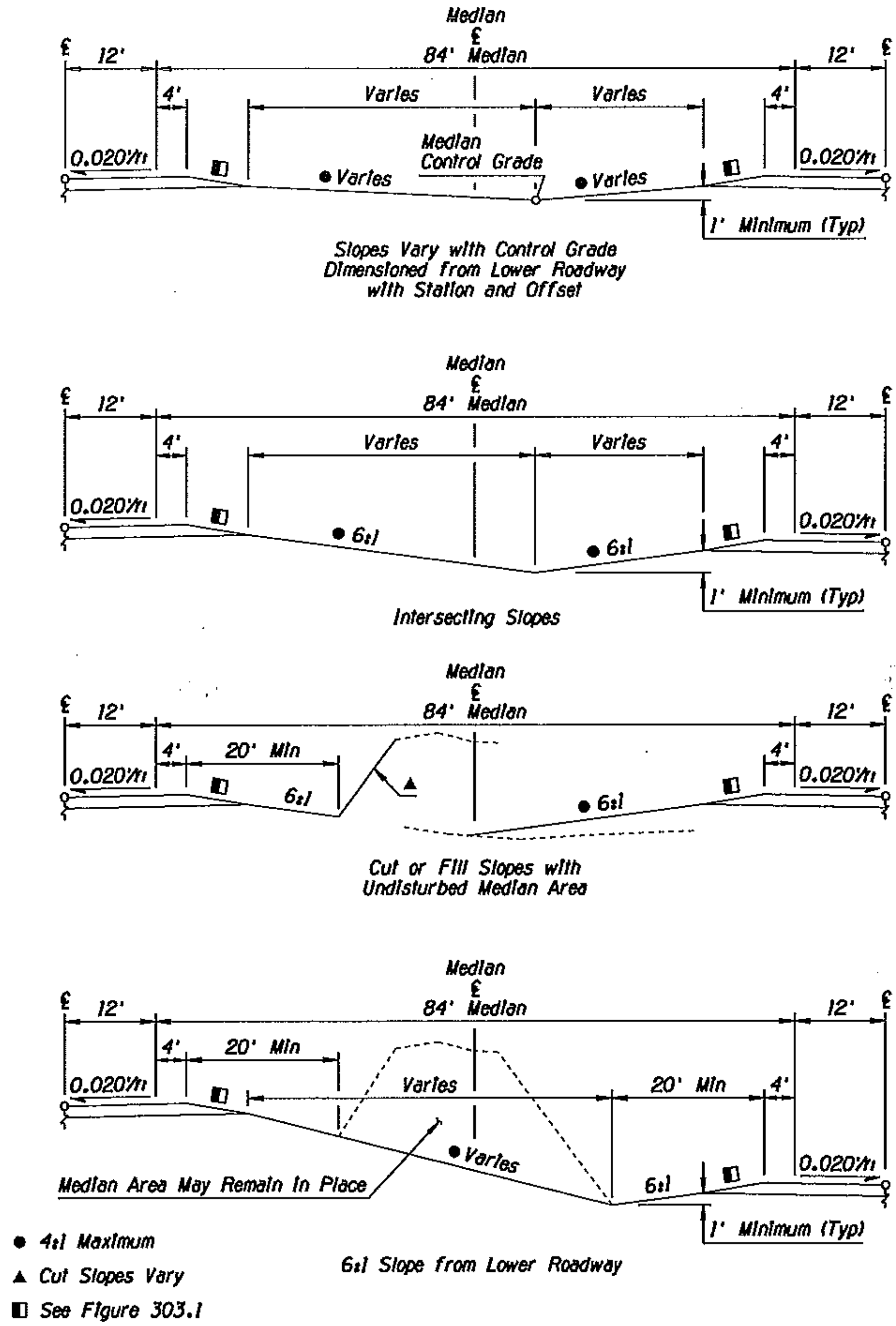
Unpaved raised curb medians should be graded to drain toward the center of the median, at a slope of 10:1 or flatter, with 20:1 preferred.

Paved medians, including those with raised curbs, should be crowned at the center.



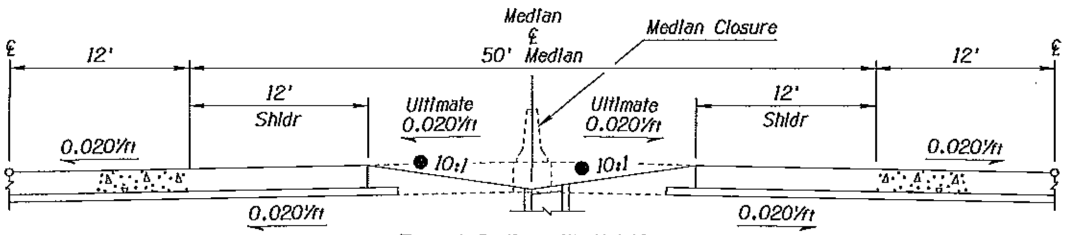

**RURAL & FRINGE-URBAN DIVIDED HIGHWAYS**
**46'-50' MEDIAN CONFIGURATIONS**

**FIGURE 304.3A**

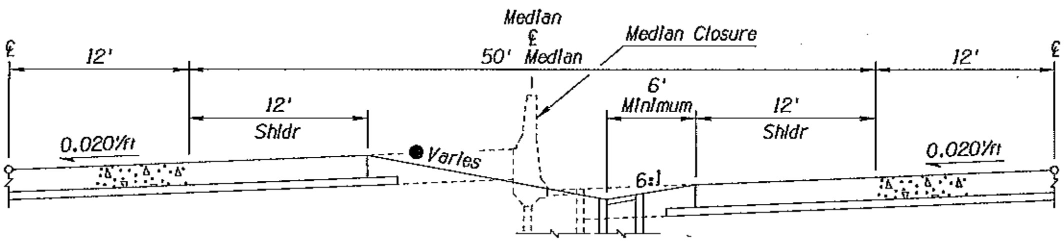



**RURAL 84' MEDIAN CONFIGURATIONS**

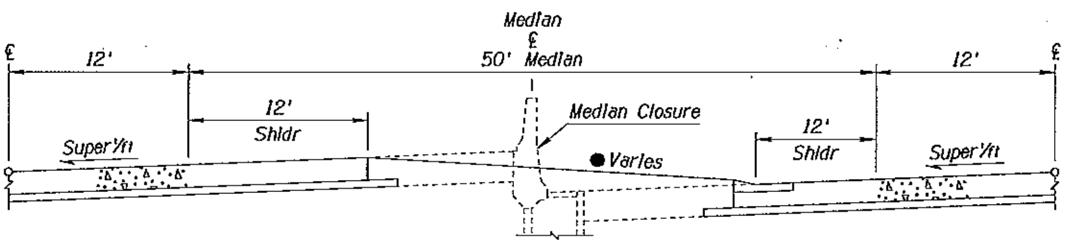
**FIGURE 304.3B**



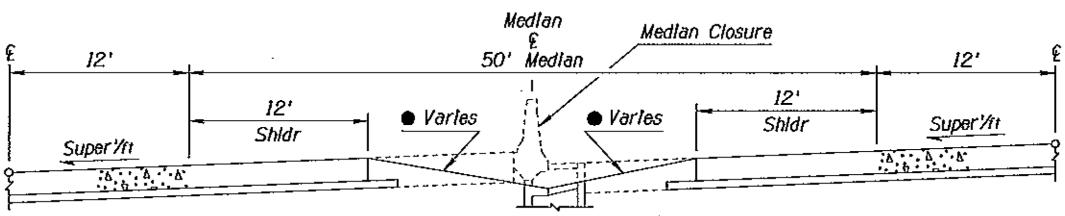

Tangent Section with Matching Profile Elevations on Both Roadways




Curved Section Without Median Curb and Matching Profile Elevations on Both Roadways




Curved Section With Median Curb and Matching Profile Elevations on Both Roadways




● 6:1 Maximum

Curved Section Without Median Curb and Different Profile Elevations on Both Roadways (Reduced Median Barrier Height Differential)

**URBAN CONTROLLED ACCESS 50' MEDIAN CONFIGURATIONS**

**FIGURE 304.3C**

### 304.4 - Median Barriers

The following guidelines apply for placement of median barriers with new construction:

**Median barriers shall be installed on high-speed fully controlled-access highways having traversable medians under the following conditions:**

a) **Median widths 50 ft and less.**

b) **Median widths 75 ft and less when there are three or more through lanes in each direction.**

In addition to the above criteria, median areas may require protection with barriers as warranted for other conditions such as steep slopes or fixed objects within the clear zone. See Section 305.2 for discussion on barrier types.

With closed paved medians, glare screens should be provided for 32 in. and 42 in. high median barriers except that median barriers for urban freeway areas are constructed at a height of 42 in without glare screen when overhead lighting is provided.

### 304.5 - Median Curbs

See Construction Std. Drawing C-05.10.

Type A or A-1 or single curb is used for non-controlled access urban and fringe urban highways. Raised landscaped medians having irrigation should use Type A-1 deeper curbing to serve as a moisture barrier in protecting the pavement structural section. Curb and gutter is used where catch basins are needed to pick up pavement drainage.

Controlled-access urban highways use urban freeway curb and gutter alternates in the median when required. Type E urban freeway curb (4" high) is used when PCCP is overlaid with 1" asphalt to achieve quiet pavement and maintain a 3" height for drainage design. Type C-1 and E-1 urban freeway curb and gutter alternates, sloping away from the high side of roadway, are used for continuity when the roadway curb section rotates to the high side.

### 304.6 - Paved Medians

Raised medians not subject to landscaping, should be paved with a low maintenance surface material. The highway designer should consult with Roadside Development Section regarding the surface treatment. Treatment selection should be based upon ease of construction, cost, maintainability and aesthetics.

## 305 - Barriers

### 305.1 - General

Warrants for embankment section barrier are shown in Figure 303.2.

**Barriers shall be used as required to shield errant vehicles from striking fixed obstructions within the roadside recovery area.** Obstructions include unyielding obstacles which cannot be made "breakaway". Application of the roadside recovery area criteria is described in Section 303.2.

### 305.2 - Barrier Types

Barrier types commonly utilized by ADOT include guardrail, safety-shape barriers, cable barriers and crash cushions. See the AASHTO Roadside Design Guide for discussion on all types of approved barriers. Barrier systems utilized on new projects are adopted for use through the ADOT Product Evaluation Program (PEP). New roadside barriers must meet the crash test requirements established by NCHRP and approved for use by FHWA.

### 305.3 - Guardrail

The ADOT Construction Standard Drawings provide details for "W-beam" and "Thrie beam" types of guardrail with various support post systems. The W-beam guardrail is preferred for most applications. Either steel or timber strongpost W-beam systems may be used.

The Thrie beam type of guardrail installation is not generally used for new construction. Normal use is limited to those reconstruction projects where it is required to match existing guardrail, particularly on bridges and guardrail transitions to concrete barrier.

In the interest of overall economy and maintainability, guardrail should be installed parallel to the edge of pavement (i.e., not flared). With new construction, guardrail should be offset 2 ft from the outside edge of roadway shoulder (See Construction Standard Drawings for Type B guardrail installation). See the Roadway Design Memorandum entitled "2-Foot Offset Distance to Roadside Barriers" on the Roadway Design website. Where embankment guardrail is used, the fill slope hinge point is to be set a minimum of 9 ft from the normal edge of shoulder. (See Figure 303.1)

When guardrail is flared from one offset width to another, the maximum flare rates for semi-rigid barrier in Table 5.7 of the AASHTO Roadside Design Guide should not be exceeded.

Guardrail end terminals should be provided at the approach end of a guardrail run and a guardrail anchor at the departure end. On undivided highways the guardrail end terminals should be used at each end of the guardrail run. Alternative guardrail end treatments are shown on the Barrier Summary Sheet in the project plans. Design memorandums providing guidelines for the usage of various guardrail end terminals have been issued and are available on the Roadway Design website.

W-beam guardrail should be located at least 3 ft in front of an obstruction to provide space for the guardrail to deflect when struck by a vehicle. Other types of guardrail should be located to accommodate their maximum dynamic deflections upon impact (See AASHTO Roadside Design Guide). The distance is to be measured from the back of guardrail post to the nearest point on the rigid object.

### 305.4 - Safety-Shape Barriers

ADOT Construction Standard Drawings give details for concrete safety-shape half barriers and median barriers with heights of 32 in. and 42 in.

The dimensions of the safety-shape barrier have been developed to redirect an errant vehicle back to the roadway in a controlled manner. The dimensions of the roadway face of the safety-shape barrier should not be changed from those given in the Standard Drawings. In particular, the 3 in. vertical or battered face at the base of the barrier must not be increased. (The sole purpose of the face is to accommodate future pavement overlays.)

Barrier heights of 32 in. and 42 in. are shown in the Construction Standard Drawings. When conditions require greater heights, the upper face may be extended either in its plane or vertically as necessary. Higher barriers should be checked for stability and structural adequacy.

The safety-shape barrier redirects vehicles through its mass and shape; it is a rigid barrier. Since it does not deflect like the flexible guardrails, there is no need for an offset between the back of the barrier and a roadside obstacle. This barrier is most effective when placed parallel to the roadway and offset from the shoulder by 2 ft. The paved shoulder should be extended to the barrier. See the Roadway Design Memorandum entitled "2-Foot Offset Distance to Roadside Barriers" on the Roadway Design website.

Where concrete barriers flare from one offset width to another, the maximum flare rates for rigid barriers shown in Table 5.7 of the AASHTO Roadside Design Guide should not be exceeded.

Cutouts/leaveouts in the median barrier face for placement of lighting poles or other utilities should be avoided in order to avoid possible vehicle snagging.

### 305.5 - Cable Barriers

Cable barrier systems are flexible systems which may be applied in medians or on the roadside. Cable barrier systems have commonly been utilized for median applications as a temporary barrier system until such time that the ultimate median closure having permanent concrete barrier is programmed and constructed. Cable barriers on the outside of the roadway are used only for special applications.

Cable barrier systems having pre-stretched cables are now available and offer the advantages of lower deflections, improved containment of errant vehicles and improved ease of maintenance.

The key design elements in utilizing cable barrier systems are a) insuring adequate deflection distance is available; b) placement of system on approach slopes of 6:1 or flatter; c) placement of end anchors at intervals not to exceed the system design and d) placement of system on a uniform surface. Deflections may be decreased by reducing the post spacing. Most of the new pre-stressed cable systems are proprietary and additional information is available from the various manufacturers.

### 305.6 - Crash Cushions

Crash cushions are protective devices to prevent errant vehicles from impacting obstructions within the recovery area that cannot be otherwise removed, relocated, or made breakaway. When hit head on, a crash cushion smoothly decelerates the vehicle to a stop.

Most crash cushions are redirectional and when hit at an angle can redirect an errant vehicle away from the obstruction. Sand barrels, however, are not redirectional and should not be used in gore areas where side impacts are likely to occur. In urban areas, sand barrels are preferred over safety shape barriers to shield individual obstructions within the recovery area (e.g. temporary light structures in the median). In rural areas, guardrail should normally be used.

**When considering various crash cushions for use, the Roadway Engineering Group "Crash Cushion Selection Procedure" shall be utilized and is available on the Roadway Design website.** The designer must become familiar with the design requirements for each device considered and insure that the layout details are properly utilized according to the manufacturer recommendations. Design manuals are available to designers from the various manufacturers. The manufacturers provide technical assistance for their products upon request.

### 305.7 - Guardrail and Embankment Curbs

**Where embankment curbs are required to prevent slope erosion in high speed areas, guardrail shall be provided along the length of the required curb and inlet treatments in accordance with the Construction Standard Drawings.** The curb height should not exceed 4 inches.

Where guardrail is provided for steeper slopes or high embankments, embankment curb can be considered a suitable erosion control measure. In other areas that do not require guardrail for slope protection, other erosion control measures, if needed, should be implemented to eliminate the need for embankment curb.

In limited applications for low speed areas, embankment curb may be used without guardrail where the slopes behind the curb do not warrant the use of guardrail.

KDOT POLICY ON THE USE OF CABLE MEDIAN BARRIERS ON FREEWAYS

Median barriers are longitudinal barriers that are most commonly used to separate opposing traffic on a divided highway and are similar to other roadside barriers, except that they are designed for vehicles striking either side of the barrier. The AASHTO *Roadside Design Guide* is referenced for further information.

Cross median crashes (CMC) are random events which often result in injuries and deaths. Some may be prevented with barrier protection; however, barriers should not be used arbitrarily because they can present an obstacle to errant vehicles or encroach on the available clear recovery area.

Cable median barriers are one type of median barriers that have emerged as a popular treatment for CMC, considering such factors as median width, traffic volume, median geometrics, and general weather conditions of the region.

The Kansas Department of Transportation (KDOT) will employ the findings and methodology presented in the report, *Cable Median Barrier Guidelines*, March 4, 2009, by Dean L. Sicking, PhD., P.E., professor and Director of the Midwest Roadside Safety Facility. This report provides a benefit/cost (B/C) method to identify the need, and justified selection of locations, for cable median barrier and is the basis for this policy.

When a cable median barrier project is authorized by KDOT through normal processes, the following applies:

- Priority will be given to locations with a $B/C \geq 4$.
- The listing of locations should be refreshed approximately every three years.
- Locations in a construction program are not candidates for a separate median barrier project.
- The minimum length of a median barrier project is one-quarter mile.
- Cable barrier will not be installed in medians of 20 feet or less in width.
- Physical conditions of selected locations may preclude installation of cable barrier.
- The cable median barrier system to be used is high-tension, with four cables and short post spacing (16 feet maximum with 10-12 feet preferable) which meets TL-3 or higher test level.
- A four-foot-wide concrete mow strip will be used where feasible.

Jerome T. Younger, P.E.
Deputy Secretary of Engineering and
State Transportation Engineer

4/27/09
Date

*Midwest States' Regional Pooled Fund Research Program*
*Fiscal Year 2007 (Year 17)*
*Research Project Number SPR-3(017)*
*NDOR Sponsoring Agency Code RPFP-07-02*

# Cable Median Barrier Guidelines

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Nebraska Department of Roads
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MwRSF Research Report No. TRP-03-206-08 (revised)

March 4, 2009

# OKLAHOMA DEPARTMENT OF TRANSPORTATION

**DATE:** March 2014
**UPDATED**: October 28, 2014

**TO:** Field Division Engineers, Design Engineers, Senior Staff

**FROM:** Casey Shell, Chief Engineer

**SUBJECT:** **Cable Barrier Guidelines**

---

**Guidelines for Median Cable Barrier Installation**

The following guidelines are based on analysis of roadway and safety data with the intent of obtaining the optimum benefit/cost ratio from median cable barrier installation. For this purpose, a total B/C ratio of 2:1 or better was considered desirable. These guidelines apply only to median cable barrier intended to protect against crossover collisions. Any highway segment meeting any of these guidelines should be considered a candidate for installation of median cable barrier.

**List of Guidelines**

Guideline 1 (Controlled Access): **(A)** All fully-controlled access highways with a median width of eighty feet or less; **(B)** all partially-controlled access highways with AADT 3,500 or greater and a median width of eighty feet or less.

Guideline 2 (Crash History & AADT): The entirety of any portion of a highway, not less than one mile, with substantially similar characteristics of traffic flow, speed, median width, access density, terrain, and geometrics, within which 0.23 or more crossovers *per mile* have occurred within a five year period, and having an average AADT of 10,500 or greater. This guideline is illustrated below as Figure 1.

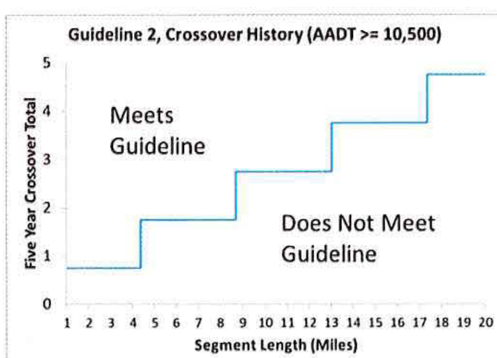


Figure 1.

Guideline 3 (High Speed Narrow Median): Any highway with speed limit 65 MPH or greater, AADT 3,500 or greater, and median width less than 35'.

Guideline 4 (Gaps): Any portion of highway up to 1 mile long, adjacent to a portion of the same highway that is provided with median cable barrier, that has substantially similar characteristics of traffic flow, speed, median width, access density, terrain, and geometrics.

**Additional Requirements**

All candidate locations for median cable barrier installation should meet the following requirements:

1. Posted speed limit of 55 MPH or greater.
2. At least two through travel lanes in each direction of travel.
3. No existing barrier in the median, excepting short overlaps at transitions or where the existing barrier is protecting a fixed object.
4. All cable barrier median openings should be located not less than 0.40 mile away from each other and from any interchange overpass or underpass.
5. No uninterrupted length of cable barrier longer than 2.00 miles should exist without a median opening or interchange overpass or underpass permitting crossing of the median by emergency vehicles.
6. A 6:1 median cross slope should be achievable, unless cable barrier is to be placed on both sides of the median.
7. The uninterrupted length of any median cable barrier installation should not be less than 0.20 mile.

**Method of Analysis**

The specific numbers in the guidelines were obtained by computer analysis to obtain the greatest possible benefit from median cable barrier projects on Oklahoma highways not yet equipped with median cable barrier. The target B/C ratio was taken to be 2:1. Insofar as possible with a simple set of rules and given the considerable flaws in the data, these guidelines are calculated to favor projects with B/C ratio above 2:1 at the expense of projects with B/C ratio less than 2:1.

The threshold values for AADT and crash rate (i.e., 3,500 AADT, 10,500 AADT, 0.23 crashes/mile/5 years) were arrived at by testing all possible combinations of relevant values against the available data on all remaining potential candidate segments for median cable barrier installation in Oklahoma. The selected values are those which, taken together, yielded the greatest projected aggregate benefit from future installations of median cable barrier.

**Explanation of Guidelines**

Guideline 1 (Controlled Access) is the principal guideline and covers all full- and partially-controlled access ODOT highways in Oklahoma, except for those with medians wider than eighty feet and for a few small gaps covered by the Gaps guideline.

Guideline 2 (Crash History & AADT) is expected to cover less than 50 miles not covered by other guidelines. Most of this mileage is on US-69 and US-75.

Guideline 3 (High Speed Narrow Median) is based on judgment, rather than data, because speed limits could not be included in the analysis. Data show decreasing crossover risk for medians less than 35'. We assume that this is due to the correlation of narrower medians with lower speeds, and not because narrower medians are intrinsically safer. This guideline provides a means to cover sites that may be underrated by our methods of risk prediction. The 3,500 AADT minimum is taken from guideline 1. The number of highway miles that might be covered by this guideline but not any other guideline is unknown but estimated at about 100 miles.

Guideline 4 (Gaps) is intended to eliminate nonsensical gaps that might otherwise appear in a corridor. Provisions in guideline 2 serve the same purpose, requiring that a corridor of consistent characteristics be considered as a whole rather than isolating a small segment because of a single crossover accident.

**Explanation of Requirements**

Requirement 1 (55 MPH Speed) is meant to exclude lower speed transition zone facilities where the severity of crossovers is much less than on high (rural or access-controlled facility) speeds.

Requirement 2 (4 lanes or more) is meant to exclude possible divided two lane facilities. Due to lack of crossover collision history on such facilities, there is currently no basis for justifying median cable barrier on them.

Requirement 3 (No existing barrier) is meant to preclude cable barrier as a retrofit when effective median barrier already exists. The B/C ratio of such retrofitting is unknown but likely to be much less than the B/C ratio for new installations.

Requirement 4 (Minimum median opening spacing) is meant to preclude installations with excessive density of median openings, which increase cost and reduce barrier efficacy.

Requirement 5 (Maximum median opening spacing) is meant to ensure that sufficient crossover points are available for the use of emergency vehicles.

Requirement 6 (Maximum median cross slope) reflects the manufacturer's specification. The efficacy of cable barrier is unproven at steeper slopes.

Requirement 7 (Minimum uninterrupted cable length) is meant to preclude extremely short cable runs which would not be cost effective.

| OREGON DEPARTMENT OF TRANSPORTATION TECHNICAL SERVICES Traffic-Roadway Section BULLETIN | | | | |
|---|---|---|---|---|
| SUBJECT<br>Median width and barrier warrant on the Interstate Freeway System | FINAL NUMBER<br>RD08-01(B) | EFFECTIVE DATE<br>06/01/2008 | VALIDATION DATE<br>00/00/0000 | SUPERSEDES or RESCINDS<br>New |
| | WEB LINK(S)<br>http://egov.oregon.gov/ODOT/HWY/TECHSERV/techguidance.shtml | | | |
| TOPIC/PROGRAM<br>Highway Design Manual | APPROVED SIGNATURE<br>Edward L. Fischer<br>Edward L. Fischer, P.E., PTOE<br>State Roadway Engineer | | | |

## PURPOSE

Cross-over crashes in open medians on Interstate Freeways are occurring at an increased rate. While it has been common practice to install barrier in an open median in reaction to median cross-over head-on fatal crashes, it is now desirable to establish a standard for the installation of barriers in open medians. Adopting a standard for barriers in medians should reduce the number of Oregon's most severe crashes.

## GUIDANCE

The warrant width for barrier placement in medians will be increased to reflect current trends of traffic crossing over open medians. Site specific crash data will also be utilized. This will revise Section 5.8 of the Highway Design Manual with a new bulleted item. An addition will also be made to the Interstate Design Features table of Appendix C. It does not change current policy regarding medians less than 30 feet in width.

## DEFINITIONS

AASHTO American Association of State Highway Transportation Officials
The primary guidance for highway construction for all states

## BACKGROUND

Investigation of median cross-over crashes on Oregon interstate highways has enabled designers to be more predictive about crash potential at specific sites. By closing certain open medians, serious head-on crashes can be prevented, thereby reducing fatal and serious injury numbers. The Department's Transportation Safety Action Plan recommends incorporating preventive measures before accidents occur.

## *EXPLANATION*

The width of an open median, as defined by AASHTO, is measured between the inside fog lines of opposing directions of traffic. The 2006 amended warrant to close an open median, as set by AASHTO guidelines is:

30 feet or less in width, barrier recommended
30 – 50 feet in width, barrier use should be considered
Over 50 feet in width, barrier use is optional

Median crash statistics on Interstate Highways in Oregon have indicated a higher cross-over head-on fatality rate across narrow open medians (46 – 60 feet wide) than across wider medians (64 feet or more). The ratio is approximately 2:1. There are however, still an alarming number of fatal events occurring across the wider medians, a statistic that cannot be ignored. Two criteria will be used to determine when barriers will be required in open medians: 1) By raising the minimum barrier warrant for narrow medians, and 2) for wide medians, by applying site specific crash data in accordance with the Department's Highway Safety Program Guide.

## *ACTION REQUIRED*

Section 5.8/ Interstate Median Barrier Warrant will be added to the Highway Design Manual (HDM) to provide project teams and designers with the information they need to enact the changes. The supplemental language is included below:

HDM 5.8 supplemental subsection

- Median Barrier Warrant on Interstate Highways

For warranting median barrier on an Interstate Highway use the following:

  - Any open median 60 feet in width or less shall be closed with an appropriate barrier. The median width is measured between the inside fog lines of opposing directions of traffic.
  - For open medians wider than 60 feet, at specific sites with history of median penetration, apply the historic evidence identifying median cross-over potential as outlined in Section 2.6 of the ODOT Highway Safety Program Guide, which is managed by the Traffic Engineering Services Unit.

There are five barrier systems appropriate for use in the medians of Interstate Highways in Oregon. They are listed below:

| Barrier Type | Test Level | TL 3 Tested Deflection | Minimum Median Width | Comments |
|---|---|---|---|---|
| 42-inch F-Shape Precast Concrete Barrier | 4 | 30 inches (unanchored) | 8'-4" | Anchored deflection estimated to be 0 – 6 inches. Requires asphalt pad for placement. |
| Modified Thrie-Beam for Medians | 4 | 20 inches | 8'-4" | Installed system approximately 42 inches wide |
| High Tension/ Low Maintenance Cable Barrier | 3, 4 | Variable 6 – 9 feet | 30 feet | Only system that can be placed on a 1:6 slope. Easy to maintain. Consider using TL 4 if trucks are a known problem. |
| 32-inch F-Shape Concrete Barrier | 3 | 30 inches | 8'-4" | Is not considered tall enough to stop semi trucks. |
| Metal Median Guardrail | 3 | 24 inches | 24 feet | System is not adequate to stop trucks. |

Median barrier should be installed on a transverse slope of 1:10 or flatter. In medians wider than 30 feet it is preferred to use cable barrier placed near the center of the median. If placed away from the center, ensure that there is enough room for deflection to the closer side. For help in determining how to install barrier in a variable median see Section 5.6 and 6.6 of AASHTO's Roadside Design Guide.

The Interstate Maintenance Design Features table of Appendix C will receive an additional Project Element shown below:

| Project Element | Corrective Measure | | Technical Resource |
|---|---|---|---|
| | "Have To" | "Like To" | |
| Open Median | Any open median 60 feet in width or less shall be closed with an appropriate barrier. The median width is measured between the inside fog lines of opposing directions of traffic. | For open medians wider than 60 feet, at specific sites with history of median penetration, apply the historic evidence identifying median crossover potential as outlined in Section 2.6 of the ODOT Highway Safety Program Guide, which is managed by the Traffic Engineering Services Unit. | Roadway Section |

## *CONTACT INFORMATION*

If you have any questions regarding these guidelines please don't hesitate to contact us.


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OREGON DEPARTMENT OF TRANSPORTATION TECHNICAL SERVICES

**Traffic-Roadway Section** BULLETIN

| SUBJECT | FINAL NUMBER | EFFECTIVE DATE | VALIDATION DATE | SUPERSEDES or RESCINDS |
|---|---|---|---|---|
| Freeway Median Closure Warrant | RD09-02(B) | 11/01/2009 | 00/00/0000 | new |
| | WEB LINK(S) http://egov.oregon.gov/ODOT/HWY/TECHSERV/techguidance.shtml | | | |
| TOPIC/PROGRAM Highway Design Manual (HDM) | APPROVED SIGNATURE Edward L. Fischer, P.E., PTOE State Roadway Engineer | | | |

## PURPOSE

Median cross-over head-on crashes have become too common on Oregon's freeway systems. A new standard was established in 2008 regarding interstate open median closures increasing the width of medians requiring closures from 30 to 60 feet. Now it is desirable to introduce a similar standard regarding non-interstate freeway systems. Adopting a standard for barriers in medians will reduce the number of Oregon's most severe crashes.

## GUIDANCE

The language being added to Section 6.1 of the Highway Design Manual (HDM) regarding interstate median closures will be modified to allow non-interstate freeway systems to be considered as well for median closure. This does not change current policy regarding medians less than 30 feet in width.

## DEFINITIONS

**Freeway** A facility employing full access control (no at-grade approaches) which moves large volumes of traffic and typically having a minimum of two through-traffic lanes for each direction of travel

## BACKGROUND/REFERENCE

There are currently approximately 28 miles remaining of open medians on three freeways in Oregon. However, 17 miles of these openings are scheduled for closure on ARRA stimulus projects in 2009. Investigation reveals that all of these sections of freeway currently have cross-over crash statistics adequate enough to justify their closure.

## EXPLANATION

The decision to utilize the same 60-foot-and-less criteria established for interstate median closures onto freeways is based on the following comparison:

1. They both share a common trait by definition set by AASHTO in that there is total access control. There are no at-grade approaches on either facility.
2. Interstate open medians in Oregon currently range between 46 feet to over 100 feet in width. Current design width is 76 feet. The existing freeway medians range from 37 to 60 feet in width, the majority are 60 feet wide. One exception exists as a 5.5-mile paved median between 6 feet and 10 feet in width.
3. Design speed for both facilities is 70 mph in most cases. The posted speed on interstates is 65 mph, and freeways are posted at 55 mph.

Checking crash statistics in the freeway study indicates that all of the open medians show cross-over events regardless of width. This gives a positive indication that closing all of the open medians is a good safety measure. The posted speed difference is negligible because in a head-on crash the speeds of the opposing vehicles are combined thereby increasing potential for higher severity in a single crash.

## *ACTION REQUIRED*

Section 6.1/ Medians/ of the Highway Design Manual, in the first sentence of the first paragraph "nontraversible" will be deleted. It will read: "Freeway medians provide a separation between the travel ways of opposing traffic."

Section 6.1/ Freeway Median Barrier Warrant will be added to the Highway Design Manual to provide project teams and designers with the information they need to enact the changes. The supplemental language is included below:

HDM 6.1 supplemental subsection

- Freeway Median Barrier Warrant :

For warranting median barrier on Interstate freeways and Non-Interstate freeways use the following:

  - Any open median 60 feet in width or less shall be closed with an appropriate barrier. The median width is measured between the inside fog lines of opposing directions of traffic.
  - For open medians wider than 60 feet and at specific site with history of median penetration, apply the historic evidence identifying median cross-over potential as outlined in Section 2.6 of the ODOT Highway Safety Program Guide, which is managed by the Traffic Engineering Services Unit.

For Non-Interstate freeway medians, the placement of barriers in open medians 60 feet or less is only required for 4R projects. 3R projects will not have to place barriers in non-Interstate freeway open medians 60 feet or less.

There are five barrier systems appropriate for use in the medians of freeways in Oregon. They are listed below:

| Barrier Type | Test Level | TL 3 Tested Deflection | Minimum Median Width | Comments |
|---|---|---|---|---|
| 42-inch F-Shape Precast Concrete Barrier | 4 | 30 inches (unanchored) | 8'-4" | Anchored deflection estimated to be 0 – 6 inches. Requires asphalt pad for placement. |
| Modified Thrie-Beam for Medians | 4 | 20 inches | 8'-4" | Installed system approximately 42 inches wide |
| High Tension/ Low Maintenance Cable Barrier | 3, 4 | Variable 6 – 9 feet | 30 feet | Only system that can be placed on a 1:6 slope. Easy to maintain. Consider using TL 4 if trucks are a known problem. |
| 32-inch F-Shape Concrete Barrier | 3 | 30 inches | 8'-4" | Is not considered tall enough to stop semi trucks. |
| Metal Median Guardrail | 3 | 24 inches | 24 feet | System is not adequate to stop trucks. |

Median barrier should be installed on a transverse slope of 1:10 or flatter. In medians wider than 30 feet it is preferred to use cable barrier placed near the center of the median. If placed away from the center, ensure that there is enough room for deflection to the closer side. For help in determining how to install barrier in a variable median see Section 5.6 and 6.6 of AASHTO's Roadside Design Guide.

## *CONTACT INFORMATION*

If you have any questions regarding these guidelines please don't hesitate to contact us.


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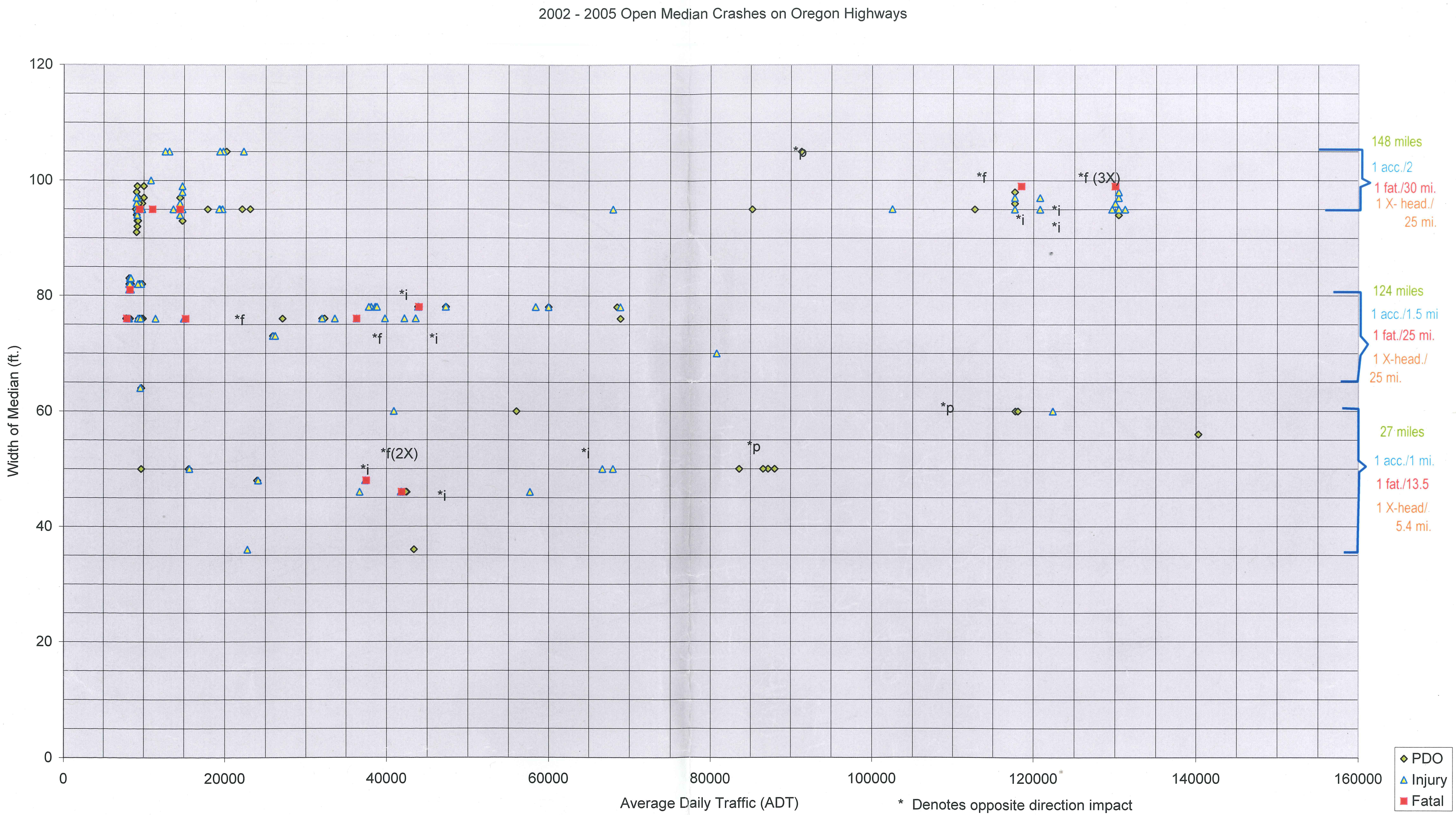
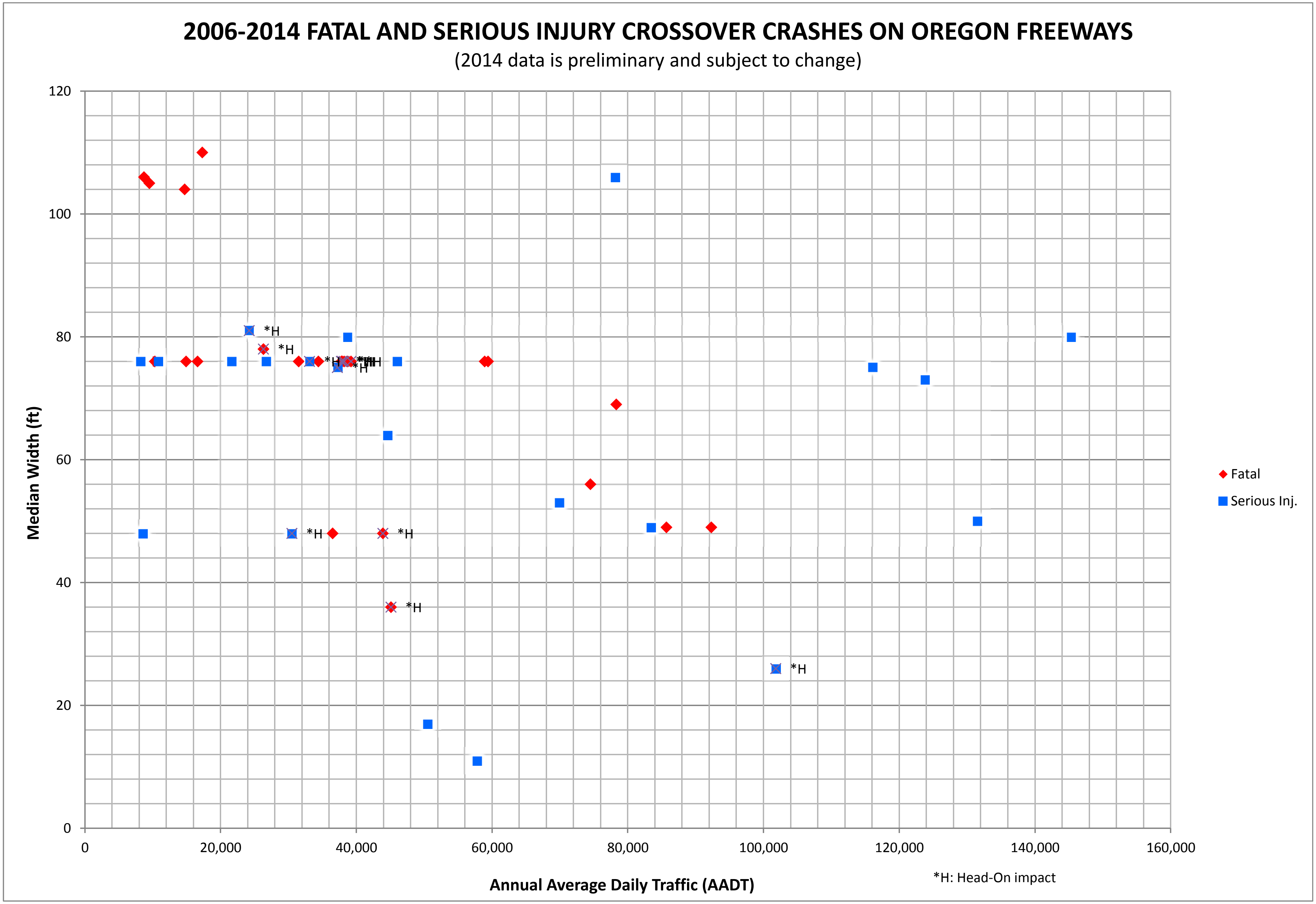

2002 - 2005 Open Median Crashes on Oregon Highways
Width of Median (ft.)
Average Daily Traffic (ADT)
* Denotes opposite direction impact
PDO
Injury
Fatal
148 miles
1 acc./2
1 fat./30 mi.
1 X- head./
25 mi.
124 miles
1 acc./1.5 mi
1 fat./25 mi.
1 X-head./
25 mi.
27 miles
1 acc./1 mi.
1 fat./13.5
1 X-head/
5.4 mi.
*f
*f(2X)
*f (3X)
*i
*p



2006-2014 FATAL AND SERIOUS INJURY CROSSOVER CRASHES ON OREGON FREEWAYS
(2014 data is preliminary and subject to change)
Median Width (ft)
Annual Average Daily Traffic (AADT)
0
20
40
60
80
100
120
0
20,000
40,000
60,000
80,000
100,000
120,000
140,000
160,000
Fatal
Serious Inj.
*H
*H: Head-On impact

## Section 3 — Roadside Design Criteria

### Horizontal Clearance

The horizontal clearance distances are shown in Table 8-10.

NOTE: Online users can click here to see the below table in PDF format.

**Table 8-10: Horizontal Clearance Distances (US Customary)**

| Design Speed (mph) | Horizontal Clearance Distance (ft) |
|---|---|
| 85 | 80 |
| 90 | 80 |
| 95 | 90 |
| 100 | 100 |
| **(Metric)** | |
| **Design Speed (km/h)** | **Horizontal Clearance Distance (m)** |
| 140 | 24 |
| 150 | 28 |
| 160 | 30 |

### Slopes

For safety reasons, it is desirable to design relatively flat areas adjacent to the travelway so that out-of-control vehicles are more likely to recover or make a controlled deceleration. Design guide values for the selection of earth fill slope rates in relation to height of fill are shown in Table 8-11. Particularly difficult terrain may require deviation from these general guide values. Where conditions are favorable, it is desirable to use flatter slopes to enhance roadside safety.

NOTE: Online users can click here to see the below table in PDF format.

**Table 8-11 Earth Fill Slope Rates**

| Height of Fill | Usual Max[1] Slope Rate, Vertical:Horizontal | |
|---|---|---|
| - | Type of Terrain | |
| | Flat or Gently Rolling | Rolling |
| 0 - 5 ft [0 - 1.5 m] | 1V:8H | 1V:6H |
| 5 ft and over [1.5 m and over] | 1V:6H | 1V:6H |

**Table 8-11 Earth Fill Slope Rates**

| |
|---|
| 1 Deviation permitted for particularly difficult terrain conditions |

The slope adjacent to the shoulder is called the front slope. Ideally, the front slope should be 1V:8H or flatter, although steeper slopes are acceptable in some locations.

The back slope should typically be 1V:6H or flatter. However, the slope ratio of the back slope may vary depending upon the geologic formation encountered. For example, where the roadway alignment traverses through a rock formation area, back slopes are typically much steeper.

The intersections of slope planes in the highway cross section should be well rounded for added safety and increased stability of out-of-control vehicles. Where barrier is placed on side slopes, the area between the roadway and barrier should be sloped at 1V:10H or flatter.

## Medians

The median width is the distance between the inside edge of travel lanes of opposing traffic. Median barriers should be considered when the median widths are less than those shown in Table 8-10.

- Reduce the travel lane encroachments from occasional parked and disabled vehicles
- Improve travel lane capacity
- Minimize contact from vehicle mounted intrusions (e.g., large mirrors, car doors, and the overhang of turning trucks.

As a minimum, as long as the obstruction is located beyond the recommended paved shoulder of a roadway, it will have minimum impact on driver speed or lane position and meet the lateral offset requirement. Where a curb is present, the lateral offset is measured from the face of curb and shall be a minimum of 1.5 ft [0.5 m]. A minimum of 1 ft [0.3 m] lateral offset should be provided from the toe of barrier to the edge of traveled way.

## Clear Zone

A clear recovery area, or clear zone, should be provided along high-speed rural highways. A clear zone is the unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles. The clear zone includes shoulders, bike lanes, and auxiliary lanes, except those auxiliary lanes that function like through lanes. Such a recovery area should be clear of unyielding objects where practical or shielded by crash cushions or barrier. Table 2-12 shows criteria for clear zones.

**Table 2-12: Clear Zones**

| Location | Functional Classification | Design Speed (mph) | Avg. Daily Traffic | Clear Zone Width (ft)[3,4,5] | |
|---|---|---|---|---|---|
| - | - | - | - | Minimum | Desirable |
| Rural | Freeways | All | All | 30 (16 for ramps) | |
| Rural | Arterial | All | 0 - 750<br>750 - 1500<br>>1500 | 10<br>16<br>30 | 16<br>30<br>-- |
| Rural | Collector | ≥ 50 | All | Use above rural arterial criteria. | |
| Rural | Collector | ≤ 45 | All | 10 | -- |
| Rural | Local | All | All | 10 | -- |
| Suburban | All | All | <8,000 | 10[6] | 10[6] |
| Suburban | All | All | 8,000 - 12,000 | 10[6] | 20[6] |
| Suburban | All | All | 12,000 - 16,000 | 10[6] | 25[6] |
| Suburban | All | All | >16,000 | 20[6] | 30[6] |
| Urban | Freeways | All | All | 30 (16 for ramps) | |
| Urban | All (Curbed) | ≥ 50 | All | Use above suburban criteria insofar as available border width permits. | |
| Urban | All (Curbed) | ≤ 45 | All | 4 from curb face | 6 |
| Urban | All (Uncurbed) | ≥ 50 | All | Use above suburban criteria. | |
| Urban | All (Uncurbed) | ≤ 45 | All | 10 | -- |

[1] Because of the need for specific placement to assist traffic operations, devices such as traffic signal supports, railroad signal/warning device supports, and controller cabinets are excluded from clear zone requirements. However, these devices should be located as far from the travel lanes as practical. Other non-breakaway devices should be located outside the prescribed clear zone or these devices should be protected with barrier.

[2] Average ADT over project life, i.e., 0.5 (present ADT plus future ADT). Use total ADT on two-way roadways and directional ADT on one-way roadways.

[3] Without barrier or other safety treatment of appurtenances.

[4] Measured from edge of travel lane for all cut sections and for all fill sections where side slopes are 1V:4H or flatter. Where fill slopes are steeper than 1V:4H it is desirable to provide a 10 ft area free of obstacles beyond the toe of slope.

[5] Desirable, rather than minimum, values should be used where feasible.

[6] Purchase of 5 ft or less of additional right-of-way strictly for satisfying clear zone provisions is not required.

NOTE: Online users can view the metric version of this table in PDF format.

The clear zone values shown in Table 2-12 are measured from the edge of travel lane. These are appropriate design values for all cut sections (see "Drainage Facility Placement"), for cross sectional design of ditches within the clear zone area) and for all fill sections with side slopes 1V:4H or flatter. It should be noted that, while a 1V:4H slope is acceptable, that a 1V:6H or flatter slope is preferred for both errant vehicle performance and slope maintainability. For fill slopes steeper than 1V:4H, errant vehicles have a reduced chance of recovery and the lateral extent of each roadside encroachment increases. It is therefore preferable to provide an obstacle-free area of 10 ft[3.0m] beyond the toe of steep side slopes even when this area is outside the clear zone.