Chapter 1600 Roadside Safety

1600.01 General

Roadside safety addresses the area outside the roadway and is an important component of total highway design. There are numerous reasons why a vehicle leaves the roadway, including driver error and behaviors. Regardless of the reason, a roadside design can reduce the seriousness of the error and the subsequent consequences of a roadside encroachment. From a crash reduction and severity perspective, the ideal highway has roadsides and median areas that are flat and unobstructed by objects. It is also recognized that different facilities have different needs and considerations, and these issues are considered in any final design.

It is not possible to provide a clear zone free of objects at all locations and under all circumstances. The engineer faces many tradeoffs in design decision-making, balancing needs of the environment, right of way, and different modes of transportation. The fact that recommended values for guardrail are presented in this chapter does not require the Department to modify all locations to meet the specified criteria; those locations are addressed as appropriate through the priority array.

Elements such as sideslopes, fixed objects, and water are features that a vehicle might encounter when it leaves the roadway. These features present varying degrees of deceleration to the vehicle and its occupants. Unfortunately, geography and economics do not always allow ideal highway conditions. The mitigative measures to be taken depend on the probability of a collision occurring, the likely severity, and the available resources.

In order of priority, the mitigative measures the Washington State Department of Transportation (WSDOT) uses are:

1. Removal
2. Relocation
3. Reduction of impact severity (using breakaway features or making it traversable) and
4. Shielding with a traffic barrier.

Factors for selecting a mitigative measure include, but may not be limited to:

- Cost (initial and life cycle costs)
- Maintenance needs
- Collision severity

Use traffic barriers when other measures cannot reasonably be accomplished and conditions are appropriate based on engineering analysis. (See Chapter 1610 for additional information on traffic barriers.)
1600.02 References

1600.02(1) Federal/State Laws and Codes

Revised Code of Washington (RCW) 47.24.020(2), Jurisdiction, control
RCW 47.32.130, Dangerous objects and structures as nuisances

1600.02(2) Design Guidance

Highway Safety Manual, AASHTO

Local Agency Guidelines (City and County Design Standards), M 36-63, WSDOT


Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT

1600.02(3) Supporting Information

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 2011

Understanding Design Clear Zone – This e-learning course for WSDOT employees covers how to determine the appropriate Design Clear Zone for recoverable and nonrecoverable slopes as well as ditches. Request this training via the web-based Learning Management System.

Highways Over National Forest Lands, MOU, 2013, US Forest Service and WSDOT,
www.wsdot.wa.gov/publications/manuals/m22-50.htm

Utilities Manual, M 22-87, WSDOT. Chapter 9 provides guidance for utilities in the WSDOT right of way.

1600.03 Clear Zone

A clear roadside border area is a primary consideration when analyzing potential roadside and median features (as defined in 1600.04). The intent is to provide as much clear, traversable area for a vehicle to recover as practicable given the function of the roadway and the potential tradeoffs. The Design Clear Zone is used to evaluate the adequacy of the existing clear area and proposed modifications of the roadside. When considering the placement of new objects along the roadside or median, evaluate the potential for impacts and try to select locations with the least likelihood of an impact by an errant vehicle.

In situations where the Design Clear Zone is beyond WSDOT right of way, evaluate options on a case-by-case basis. Consider the nature of the objects within the Design Clear Zone, the roadway geometry, traffic volume, and crash history. Coordinate with adjacent property owners when proposed options include any work beyond WSDOT right of way. At a minimum, provide clear zone to the limits of the WSDOT right of way.

1600.03(1) Design Clear Zone on Limited Access State Highways and Other State Highways Outside Incorporated Cities and Towns

Evaluate the Design Clear Zone when the Clear Zone column on the design matrices (see Chapter 1100) indicates Full Design Level (F) or when considering the placement of a new fixed object on the roadside or median. Use the Design Clear Zone Inventory form (Exhibit 1600-3) to identify potential features to be mitigated and propose corrective actions.
Guidance for establishing the Design Clear Zone for highways outside incorporated cities is provided in Exhibit 1600-2. This guidance also applies to limited access facilities within the city limits. Providing a clear recovery area that is consistent with this guidance does not require any additional documentation. However, there might be situations where it is not practicable to provide these recommended distances. In these situations, document the decision as a deviation as discussed in Chapter 300.

For additional Design Clear Zone guidance relating to roundabouts, see Chapter 1320.

For state highways that are in an urban environment, but outside an incorporated city, evaluate both median and roadside clear zones as discussed above using Exhibit 1600-2. However, there is flexibility in establishing the Design Clear Zone in urbanized areas adjacent to incorporated cities and towns. To achieve this flexibility, an evaluation of the impacts, including safety, aesthetics, the environment, economics, modal needs, and access control, can be used to establish the Design Clear Zone. This discussion, analysis, and legal agreement development takes place early in the consideration of the median and roadside designs. A legal agreement on the responsibility for design, construction, operation, and maintenance for these median and roadside sections must be formalized with the city and/or county. Justify the design decision for the selected Design Clear Zone as part of the design approval or a project or corridor analysis (see Chapter 300).

Because AASHTO’s A Policy on Geometric Design of Highways and Streets had addressed the concept of operational offset within the discussion of clear zone, some practitioners misinterpreted this offset as providing an adequate clear zone. The 18-inch operational offset beyond the face of curb is a lateral clearance for opening car doors or for truck mirrors.

1600.03(2) Design Clear Zone Inside Incorporated Cities and Towns

For managed access state highways within an urban area, it might not be practicable to provide the Design Clear Zone distances shown in Exhibit 1600-2. Roadways within an urban area generally have curbs and sidewalks and might have objects such as trees, poles, benches, trash cans, landscaping, and transit shelters along the roadside.

For projects on city streets as state highways that include work in those areas that are the City’s responsibility and jurisdiction (see Exhibit 1600-1), design the project using the city’s Development/Design Standards. The standards adopted by the city must meet the requirements set by the Design Standards Committee for all projects on arterials, bike projects, and all federal-aid projects.
1600.03(2)(a) Roadside and Median

For managed access state highways inside incorporated cities, it is the city’s responsibility to establish an appropriate Design Clear Zone in accordance with guidance contained in the City and County Design Standards (Local Agency Guidelines, Chapter 42.) Exhibit 1600-1 shows an example of state and city responsibilities and jurisdictions. Document the Design Clear Zone established by the city in the Design Documentation Package. Have the responsible transportation official from the City (e.g., City Engineer) document the Design Clear Zone, and their acknowledgement and acceptance of the design and maintenance responsibilities for project roadsides and medians, in a letter addressed to WSDOT, and file this letter as part of the local agency coordination in the Design Documentation Package. Respond to the sender by letter acknowledging receipt. Sample templates for these letters will be made available online at the Design Support website under the Design Documentation section.

1600.03(3) Design Clear Zone and Calculations

The Design Clear Zone guidance provided in Exhibit 1600-2 is a function of the posted speed, sideslope, and traffic volume. There are no distances in the table for 3H:1V fill slopes. Although fill slopes between 4H:1V and 3H:1V are considered traversable if free of fixed objects, these slopes are defined as nonrecoverable slopes. A vehicle might be able to begin recovery on the shoulder, but likely will not be able to further this recovery until reaching a flatter area (4H:1V or flatter) at the toe of the slope. Under these conditions, the Design Clear Zone distance is called a recovery area. The method used to calculate the recovery area and an example are shown in Exhibit 1600-4.

For ditch sections, the following criteria determine the Design Clear Zone:

(a) For ditch sections with foreslopes 4H:1V or flatter (see Exhibit 1600-5, Case 1, for an example), the Design Clear Zone distance is the greater of the following:
   • The Design Clear Zone distance for a 10H:1V cut section based on speed and the average daily traffic (ADT).
   • A horizontal distance of 5 feet beyond the beginning of the backslope.

When a backslope steeper than 3H:1V continues for a horizontal distance of 5 feet beyond the beginning of the backslope, it is not necessary to use the 10H:1V cut slope criteria.

(b) For ditch sections with foreslopes steeper than 4H:1V and backslopes steeper than 3H:1V, the Design Clear Zone distance is 10 feet horizontal beyond the beginning of the backslope (see Exhibit 1600-5, Case 2, for an example).

(c) For ditch sections with foreslopes steeper than 4H:1V and backslopes 3H:1V or flatter, the Design Clear Zone distance is the distance established using the recovery area formula (see Exhibit 1600-4; also see Exhibit 1600-5, Case 3, for an example).
1600 Mitigation Guidance

There are three general categories of features to be mitigated: sideslopes, fixed objects, and water. This section provides guidance for determining when these objects present a significant risk to an errant motorist. For each case, the following conditions need added consideration:

- Locations with high expected collision frequency.
- Locations with pedestrian and bicycle usage. (See Chapters 1510, Pedestrian Design Considerations, 1515, Shared-Use Paths, and 1520, Roadway Bicycle Facilities.)
- Playgrounds, monuments, and other locations with high social or economic value.
- Redirectional land forms, also referred to as earth berms, were installed to mitigate objects located in depressed medians and at roadsides. They were constructed of materials that provided support for a traversing vehicle. With slopes in the range of 2H:1V to 3H:1V, they were intended to redirect errant vehicles. The use of redirectional land forms has been discontinued as a means for mitigating fixed objects. Where redirectional land forms currently exist as mitigation for a fixed object, provide designs where the feature they were intended to mitigate is removed, relocated, made crashworthy, or shielded with barrier. Landforms may be used to provide a smooth surface at the base of a rock cut slope.

The use of a traffic barrier for features other than those described below requires justification.

1600.04(1) Side Slopes

1600.04(1)(a) Fill Slopes

Fill slopes can present a risk to an errant vehicle with the degree of severity dependent upon the slope and height of the fill. Providing fill slopes that are 4H:1V or flatter can mitigate this condition. If flattening the slope is not feasible or cost-effective, the installation of a barrier might be appropriate. Exhibit 1600-6 represents a selection procedure used to determine whether a fill sideslope constitutes a condition for which a barrier is a cost-effective mitigation. The curves are based on the severity indexes and represent the points where total costs associated with a traffic barrier are equal to the predicted cost of collisions over the service life for selected slope heights without traffic barrier. If the ADT and height of fill intersect on the “Barrier Recommended” side of the embankment slope curve, then provide a barrier if flattening the slope is not feasible or cost-effective.

Do not use Exhibit 1600-6 for slope design. Design slopes consistent with guidance in Chapters 1130 and 1230, evaluating designs with clear, traversable slopes before pursuing a barrier option. Also, if Exhibit 1600-6 indicates that barrier is not recommended at an existing slope, that result is not justification for a deviation. For example, if the ADT is 4,000 and the embankment height is 10 feet, barrier might be cost-effective for a 2H:1V slope, but not for a 2.5H:1V slope. This process only addresses the potential risk of exposure to the slope. Obstacles on the slope can compound the condition. Where barrier is not cost-effective, use the recovery area formula to evaluate fixed objects on critical fill slopes less than 10 feet high.

1600.04(1)(b) Cut Slopes

A cut slope is usually less of a risk than a traffic barrier. The exception is a rock cut with a rough face that might cause vehicle snagging rather than providing relatively smooth redirection.
Analyze the potential motorist risk and the benefits of treatment of rough rock cuts located within the Design Clear Zone. Conduct an individual investigation for each rock cut or group of rock cuts. A cost-effectiveness analysis that considers the consequences of doing nothing, removal, smoothing of the cut slope, and other viable options to reduce the severity of the condition can be used to determine the appropriate treatment. Some potential options are:

- Graded landform along the base of a rock cut.
- Flexible barrier
- More rigid barrier
- Rumble strips

1600.04(2) Fixed Objects

Use engineering judgment when considering the following objects for mitigation:

- Wooden poles or posts with cross-sectional areas greater than 16 square inches that do not have breakaway features.
- Signs, illumination, cameras, weather stations, and other items mounted on nonbreakaway poles, cantilevers, or bridges.
- Trees with a diameter of 4 inches or more, measured at 6 inches above the ground surface.
- Fixed objects extending above the ground surface by more than 4 inches; for example, boulders, concrete bridge rails, signal/electrical/ITS cabinets, piers, and retaining walls.
- Drainage items such as culvert and pipe ends.

Mitigate fixed features that exist within the Design Clear Zone when practicable. Although limited in application, there may be situations where removal of an object outside the right of way is appropriate. The possible mitigative measures are listed as follows in order of preference:

- Remove
- Relocate
- Reduce impact severity (using a breakaway feature)
- Shield the object by using longitudinal barrier or impact attenuator

1600.04(2)(a) Trees

When evaluating new plantings or existing trees, consider the maximum allowable diameter of 4 inches, measured at 6 inches above the ground when the tree has matured. When removing trees within the Design Clear Zone, complete removal of stumps is preferred. However, to avoid significant disturbance of the roadside vegetation, larger stumps may be mitigated by grinding or cutting them flush to the ground and grading around them.

Removal of trees may be beneficial to reduce the impacts of driving errors, which result in angle crashes and roadside and clear zone encroachments. It is recognized that different facilities have different needs and considerations, and these issues are considered in any final design. For instance, removal of trees within the Design Clear Zone may not be desirable in contexts such as within a forest, park, or within a scenic and recreational highway. In these corridors, analyze collision reports’ contributing factors to determine whether roadside vegetation is contributing to collisions. If large vegetation is removed, replace with shrubs or groundcover or consult guidance contained in established vegetation management plans or corridor plans. Additional guidance for maintenance of roadside vegetation can be found in the Memorandum of Understanding between the US Forest Service and WSDOT, *Highways Over National Forest Lands*, dated July 2002.
1600.04(2)(b) Mailboxes

For mailboxes located within the Design Clear Zone, provide supports and connections as shown in the Standard Plans. The height from the ground to the bottom of the mailbox is 3 feet 3 inches. This height may vary from 3 feet 3 inches to 4 feet if requested by the mail carrier. If the desired height is to be different from 3 feet 3 inches, provide the specified height in the contract plans. (See Exhibit 1600-7 for installation guidelines.) Coordinate with homeowners when upgrading mailboxes.

In urban areas where sidewalks are prevalent, contact the postal service to determine the most appropriate mailbox location. Locate mailboxes on limited access highways in accordance with Chapter 530, Limited Access. A turnout, as shown in Exhibit 1600-7, is not needed on limited access highways with shoulders of 6 feet or more where only one mailbox is to be installed. On managed access highways, mailboxes are to be on the right-hand side of the road in the postal carrier’s direction of travel. Avoid placing mailboxes along high-speed, high-volume highways. Locate Neighborhood Delivery and Collection Box Units outside the Design Clear Zone.

1600.04(2)(c) Culvert Ends

Provide a traversable end treatment when the culvert end section or opening is on the roadway sideslope and within the Design Clear Zone. This can be accomplished for small culverts by beveling the end to match the sideslope, with a maximum of 4 inches extending out of the sideslope.

Bars might be needed to provide a traversable opening for larger culverts. Place bars in the plane of the culvert opening in accordance with the Standard Plans when:

• Single cross-culvert opening exceeds 40 inches, measured parallel to the direction of travel.
• Multiple cross-culvert openings that exceed 30 inches each, measured parallel to the direction of travel.
• Culvert approximately parallel to the roadway that has an opening exceeding 24 inches, measured perpendicular to the direction of travel.

Bars are permitted where they will not significantly affect the stream hydraulics and where debris drift is minor. Consult the region Maintenance Office to verify these conditions. If debris drift is a concern, consider options to reduce the amount of debris that can enter the pipe (see the Hydraulics Manual). Other treatments are extending the culvert to move the end outside the Design Clear Zone or installing a traffic barrier.

1600.04(2)(d) Signposts

Whenever possible, locate signs behind existing or planned traffic barrier installations to eliminate the need for breakaway posts. Place them at least 25 feet from the end of the barrier terminal and with the sign face behind the barrier. When barrier is not present, use terrain features to reduce the likelihood of an errant vehicle striking the signposts. Whenever possible, minor adjustments to the sign location may be made to take advantage of barrier or terrain features. (See Chapter 1020 for additional information regarding the placement of signs.) Use the MUTCD to guide placement of the warning sign.

Signposts with cross-sectional areas greater than 16 square inches that are within the Design Clear Zone and not located behind a barrier are to have breakaway features as shown in the Standard Plans.
Sign bridges and cantilever sign supports are designed for placement outside the Design Clear Zone or shielded by barrier.

1600.04(2)(e) Traffic Signal Standards/Posts/Supports

Breakaway signal posts generally are not feasible or desirable. Since these supports are generally located at intersecting roadways, there is a higher potential for a falling support to impact vehicles and/or pedestrians. In addition, signal supports that have overhead masts may be too heavy for a breakaway design to work properly. Other mitigation, such as installing a traffic barrier, is also very difficult. With vehicles approaching the support from many different angles, a barrier would have to surround the support and would be subject to impacts at high angles. Additionally, barrier can inhibit pedestrian movements. Therefore, barrier is generally not an option. However, since speeds near signals are generally lower, the potential for a severe impact is reduced. For these reasons, locate the support as far from the traveled way as possible.

In locations where signals are used for ramp meters, the supports can be made breakaway as shown in the Standard Plans.

1600.04(2)(f) Fire Hydrants

Fire hydrants are allowed on WSDOT right of way by franchise or permit. Fire hydrants that are made of cast iron can be expected to fracture on impact and can therefore be considered a breakaway device. Any portion of the hydrant that will not be breakaway must not extend more than 4 inches above the ground. In addition, the hydrant must have a stem that will shut off water flow in the event of an impact. Mitigate other hydrant types.

1600.04(2)(g) Utility Poles

Since utilities often share the right of way, utility objects such as poles are often located along the roadside. It is undesirable/infeasible to install barrier for all of these objects, so mitigation is usually in the form of relocation (underground or to the edge of the right of way) or delineation. In some instances where there is a history of impacts with poles and relocation is not possible, a breakaway design might be appropriate. Evaluate roadway geometry and crash history as an aid in determining locations that exhibit the greatest need.

Contact the Headquarters (HQ) Design Office for information on breakaway features. Coordinate with the HQ Utilities Unit when appropriate.

Document coordination with the region Utilities Office for evaluations and mitigative measures. For additional guidance, see Chapter 9 of the Utilities Manual.

1600.04(2)(h) Light Standards

Provide breakaway light standards unless fixed light standards can be justified. Fixed light standards may be appropriate in areas of extensive pedestrian concentrations, such as adjacent to bus shelters. Document the decision to use fixed bases in the Design Documentation Package.

1600.04(3) Water

Water with a depth of 2 feet or more and located with a likelihood of encroachment by an errant vehicle is to be considered for mitigation on a project-by-project basis. Consider the length of time traffic is exposed to this feature.
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Analyze the potential risk to motorists and the benefits of treating bodies of water located within the Design Clear Zone. A cost-effectiveness analysis that considers the consequences of doing nothing versus installing a longitudinal barrier can be used to determine the appropriate treatment.

For fencing considerations along water features, see Chapter 560.

1600.05 Medians

Medians are to be analyzed for the potential of an errant vehicle to cross the median and encounter oncoming traffic. Median barriers are normally used on limited access, multilane, high-speed, high-volume highways. These highways generally have posted speeds of 45 mph or higher. Median barrier is not normally placed on collectors or other state highways that do not have limited access control. Providing access through median barrier results in openings; therefore, end-treatments are needed.

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. Consider median barrier on highways with wider medians or lower posted speeds when there is a history of cross-median collisions.

When installing a median barrier, provide left-side shoulder widths as shown in Chapters 1130 and 1140 and shy distance as shown in Chapter 1610. Consider a wider shoulder area where the barrier might cast a shadow on the roadway and hinder the melting of ice. (See Chapter 1230 for additional criteria for placement of median barrier, Chapter 1610 for information on the types of barriers that can be used, and Chapter 1260 for lateral clearance on the inside of a curve to provide the needed stopping sight distance.) Consideration of drainage is an important factor when designing median barrier treatments.

When median barrier is being placed in an existing median, identify the existing crossovers and enforcement observation points. Provide the needed median crossovers in accordance with Chapter 1370, considering enforcement needs. Chapter 1410 provides guidance on HOV enforcement.

1600.06 Other Roadside Safety Features

1600.06(1) Rumble Strips

Rumble strips are grooves or rows of raised pavement markers placed perpendicular to the direction of travel to alert inattentive drivers. There are three kinds of rumble strips: roadway, shoulder, and centerline.

In Washington, most rumble strips consist of grooves milled into the pavement surface. Although most installations have not adversely affected the pavement, there have been a few instances where milled rumble strips have been associated with advanced levels of pavement deterioration, resulting in continuous ruts or large areas of pavement delamination. Poor pavement performance has most commonly been associated with rumble strip installations in bituminous surface treatment (BST) pavement and hot mix asphalt (HMA) pavement with low density, particularly along longitudinal joints. Rumble strip installation should be avoided in open-graded pavements. Consult with the Region Materials Engineer to determine installation procedure and verify that the pavement structure is adequate. When installing both rumble strips and recessed lane markers, follow the Standard Plan to avoid overlapping the grindings. Installing rumble strips in bituminous surface treatment (or BST) or other thin surface treatments can expose pavement structure and lead to delamination.
The best practice is to install the rumble strips immediately prior to placing the surface treatment in order to seal the installation. In all cases, avoid placing HMA pavement joints and centerline rumble strips along the same (coincident) line wherever practical (see Standard Plan 65.10-02). Where rumble strips currently exist and an additional BST application is contemplated, evaluate whether the depth of the grooves following paving will support their continuing function to alert drivers. If not, or in the case of an HMA overlay, it may be necessary to remove existing rumble strips and install new ones. Note: WSDOT experience has shown that BST can be placed over existing rumble strips at least once and still be effective.

For additional guidance on surface preparation and pavement stability, refer to the WSDOT Pavement Policy (June 2011).

1600.06(1)(a) Roadway Rumble Strips

Roadway rumble strips are placed transversely to the traveled way to alert drivers who are approaching a change of roadway condition or object that requires substantial speed reduction or other maneuvering. Some locations where roadway rumble strips may be used are in advance of:

- Stop-controlled intersections.
- Port of entry/customs stations.
- Lane reductions where collision history shows a pattern of driver inattention.
- Horizontal alignment changes where collision history shows a pattern of driver inattention.

They may also be placed at locations where the character of the roadway changes, such as at the end of a freeway.

Contact the HQ Design Office for additional guidance on the design and placement of roadway rumble strips.

Document decisions to use roadway rumble strips in the Design Documentation Package.

1600.06(1)(b) Shoulder Rumble Strips

Shoulder rumble strips (SRS) are placed parallel to the traveled way just beyond the edge line to warn drivers they are entering a part of the roadway not intended for routine traffic use. Shoulder rumble strips are effective in reducing run-off-the-road collisions when the contributing circumstances are human factors related, such as inattention, apparently fatigued, or apparently asleep.

When shoulder rumble strips are used, discontinue them where no edge stripe is present, such as at intersections and where curb and gutter are present. Discontinue shoulder rumble strips where shoulder driving is allowed. Where bicycle travel is allowed, discontinue shoulder rumble strips at locations where shoulder width reductions can cause bicyclists to move into or across the area where rumble strips would normally be placed, such as shoulders adjacent to bridges or longitudinal barrier with reduced shoulder widths.

Shoulder rumble strip patterns vary depending on the likelihood of bicyclists being present along the highway shoulder and whether they are placed on divided or undivided highways. Rumble strip patterns for undivided highways are shallower and may be narrower than patterns used on divided highways. They also provide gaps in the pattern, providing opportunities for bicycles to move across the pattern without having to ride across the grooves. There are four shoulder rumble strip patterns. Consult the Standard Plans for the patterns and construction details.
1. Divided Highways

Install shoulder rumble strips on both the right and left shoulders of rural Interstate highways. Consider them on both shoulders of rural divided highways. Use the Shoulder Rumble Strip Type 1 pattern on divided highways.

Omitting shoulder rumble strips on rural Interstate highways is a design exception (DE) under any of the following conditions:

- When another project scheduled within two years of the proposed project will overlay or reconstruct the shoulders or will use the shoulders for detours.
- When a pavement analysis determines that installing shoulder rumble strips will result in inadequate shoulder strength.
- When overall shoulder width will be less than 4 feet wide on the left and 6 feet wide on the right.

2. Undivided Highways

Shoulder rumble strip usage on the shoulders of undivided highways demands strategic application because bicycle usage is more prevalent along the shoulders of the undivided highway system. Rumble strips affect the comfort and control of bicycle riders; consequently, their use is to be limited to highway corridors that experience high levels of run-off-the-road collisions. Apply the following criteria in evaluating the appropriateness of rumble strips on the shoulders of undivided highways.

- Consult the region and Headquarters Bicycle and Pedestrian Coordinators to determine bicycle usage along a route, and involve them in the decision-making process when considering rumble strips along bike touring routes or other routes where bicycle events are regularly held.
- Use on rural roads only.
- Determine that shoulder pavement is structurally adequate to support milled rumble strips.
- Posted speed is 45 mph or higher.
- Provide for at least 4 feet of usable shoulder between the rumble strip and the outside edge of shoulder. If guardrail or barrier is present, increase the dimension to 5 feet of usable shoulder. Field-verify these dimensions.
- Preliminary evaluation indicates a run-off-the-road collision experience of approximately 0.6 crashes per mile per year. (This value is intended to provide relative comparison of crash experience and is not to be used as absolute guidance on whether rumble strips are appropriate.)
- Do not place shoulder rumble strips on downhill grades exceeding 4% for more than 500 feet in length along routes where bicyclists are frequently present.
- An engineering analysis indicates a run-off-the-road collision experience considered correctable by shoulder rumble strips.
For projects that will remove and potentially replace existing shoulder rumble strips, evaluate the criteria for shoulder width and downhill grades for compliance with placement guidance. Discontinue rumble strips where the downhill grade exceeds 4% for more than 500 feet. If the usable shoulder width between the rumble strip and outer edge of shoulder is less than 4 feet (5 feet if guardrail or barrier is present) reevaluate the appropriateness of the rumble strips. Assess the existing shoulder rumble strip’s impact on run-off-the-road crash experience and bicycling. Assess alternate rumble strip patterns and placement options. Consult the region and Headquarters Bicycle and Pedestrian Coordinators. Document decisions to continue or discontinue shoulder rumble strip usage where the existing usable shoulder width between the rumble strip and outer edge of shoulder is less than 4 feet (5 feet if guardrail or barrier is present).

Consult with the region or Headquarters Bicycle and Pedestrian Coordinator for determining levels of bicycle traffic for your project. The Shoulder Rumble Strip Type 2 or Type 3 pattern is used on highways with minimal bicycle traffic. When bicycle traffic on the shoulder is determined to be high, the Shoulder Rumble Strip Type 4 pattern is used.

Shoulder rumble strip installation considered at any other locations must involve the region and Headquarters Bicycle and Pedestrian Coordinators as a partner in the decision-making process.

Consult the following website for guidance on conducting an engineering analysis:

www.wsdot.wa.gov/design/policy/roadsidesafety.htm

1600.06(1)(c) Centerline Rumble Strips

Centerline rumble strips are placed on the centerline of undivided highways to alert drivers that they are entering the opposing lane. They are applied as a countermeasure for crossover collisions. Centerline rumble strips are installed with no differentiation between passing permitted and no passing areas. Refresh pavement markings when removed by centerline rumble strips.

A March 2011 WSDOT study found that centerline rumble strips were highly effective across the state highway network, and most effective on roadways where: the AADT is less than 8,000, the combined paved lane and shoulder width is 12 to 17 feet, and the posted speed is 45 to 55 mph.

Centerline rumble strips are evaluated using a programmatic approach, starting with a preliminary review of each rural undivided highway as a potential installation site. The HQ Design Office conducts the preliminary review, evaluating cross-centerline crash history and pavement width. A list of sites is generated from this review and periodically updated and distributed to the regions for a more detailed analysis of each site. The presence of a particular site on the preliminary list does not imply that rumble strips must be installed.

The preliminary review conducted in the Design Office does not assess pavement structure; traffic volume and composition; type and volume of nonmotorized users; or proximity to roadside residents. Region project development staff are expected to evaluate these items, and to field-verify roadway widths and appropriate project limits. The final determination about the appropriateness of centerline rumble strips is the responsibility of region project development staff. Although these decisions are made in the region, it is important that they be evaluated in a consistent manner from region to region. Evaluate the following criteria in determining the appropriateness of centerline rumble strips.
1. Crash Experience

WSDOT has evaluated the effectiveness of centerline rumble strips on roadways with various lane and shoulder widths. For roadways with a combined lane and shoulder width of 15 feet or more, the benefits are substantial. These highways exhibited a 50% reduction in fatal and serious injury crashes, when looking at both cross-centerline and run-off-the-road-right (ROTRR) crashes. For roadways with 12 to 14 feet of combined lane and shoulder width, the benefits are more closely aligned with reductions in cross-centerline crashes. There are mixed results with ROTRR crashes on 12- to 14-foot-wide roadways, although when combined with the cross-centerline crashes, the net result indicates an overall 25% reduction in fatal and serious injury crashes. Further evaluation of apparent run-off-the-road vehicles that cross the centerline and end on the opposing roadside may be of value.

Review the collision history to determine the frequency of collisions with human factors contributing circumstances such as inattention, apparently fatigued, apparently asleep, over the centerline, or on the wrong side of the road. These types of cross-centerline crashes are considered to be correctable with centerline rumble strips.

2. Highway Type

Centerline rumble strips are most appropriate on rural roads, but with special consideration, may also be appropriate for urban roads. Some concerns specific to urban areas are more residents impacted by noise in more densely populated areas, the frequent need to interrupt the rumble strip pattern to accommodate left-turning vehicles, and a reduced effectiveness at lower speeds (35 mph and below). Centerline rumble strips are not appropriate where two-way left-turn lanes exist.

3. Roadway Width

A 2004 study of the effects of centerline rumble strips on lateral placement and speed of vehicles determined that drivers tend to shift their lane position 3 to 5½ inches to the right to avoid driving on centerline rumble strips. This results in the vehicle driving closer to the pavement edge and to bicyclists who may be traveling on the outer edges of the lane. Centerline rumble strips are inappropriate when the combined lane and shoulder widths in either direction are less than 12 feet. (See Chapters 1130 and 1140 for guidance on lane and shoulder widths.)

The narrower roadways within this range warrant additional consideration. Where the combined lane and shoulder width is 14 feet or less, consider the level of bicycle and pedestrian use along the route. When drivers shift their lane position away from centerline to avoid the rumble strips, they are moving closer to pedestrians and bicyclists on the shoulder. Also consider the roadside characteristics and the potential for a lane position adjustment to result in a run-off-the-road event, evaluating clear zone width along the route. Balance these issues with the frequency and severity of cross-centerline crashes.

4. Traffic Volume

Higher-volume routes equate to greater exposure, with more opportunities for: cross-centerline crashes, conflicts with nonmotorized users on the shoulder, and incidental contact with the rumble strips. The March 2011 WSDOT centerline rumble strip study noted that lower-volume routes had higher rates of cross-centerline collisions.
5. Noise for Roadside Residents

Most rumble strip noise complaints result from incidental contact where the vehicle might not have been heading toward a crash. Left-turning or passing vehicles, along with the off-tracking of large trucks or trailers may result in incidental contact with centerline rumble strips. With some specific attention to details, some of these contacts can be significantly reduced by discontinuing the rumble strip installations through intersections or frequently used road approaches. For roadways with limited passing opportunities, evaluate the frequency and position of neighboring residents and site-specific crash experience to determine if the rumble strip should be discontinued in a potential passing location. Attention to horizontal curvature, curve widening, and large-vehicle usage may help identify locations where the rumble strips may need to be discontinued through a tight radius curve.

1600.06(2) Headlight Glare Considerations

Headlight glare from opposing traffic can cause potential safety problems. This can include glare from frontage roads. Glare can be reduced by the use of wide medians, separate alignments, earth mounds, plants, concrete barrier, and glare screens. Glare screen fencing may be effective for frontage roads. Consider long-term maintenance when selecting the treatment for glare. When considering glare screens, see Chapter 1260 for lateral clearance on the inside of a curve to provide the necessary stopping sight distance. In addition to reducing glare, taller concrete barriers also provide improved crash performance for larger vehicles such as trucks.

Glare screen is relatively expensive, and its use is to be justified. It is difficult to justify the use of glare screen where the median width exceeds 20 feet, the ADT is less than 20,000 vehicles per day, or the roadway has continuous lighting. Consider the following factors when assessing the need for glare screen:

• Higher frequency of night collision compared to similar locations or statewide experience.
• Higher than normal ratio of night-to-day collisions.
• Unusual distribution or concentration of nighttime collisions.
• Over-representation of older drivers in night collisions.
• Combination of horizontal and vertical alignment, particularly where the roadway on the inside of a curve is higher than the roadway on the outside of the curve.
• Direct observation of glare.
• Public complaints concerning glare.

The most common area with the potential for glare is between opposing main line traffic. Other conditions for which glare screen might be appropriate are:

• Between a highway and an adjacent frontage road or parallel highway, especially where opposing headlights might seem to be on the wrong side of the driver.
• At an interchange where an on-ramp merges with a collector-distributor and the ramp traffic might be unable to distinguish between collector and main line traffic. In this instance, consider other solutions such as illumination.
• Where headlight glare is a distraction to adjacent property owners. Playgrounds, ball fields, and parks with frequent nighttime activities might benefit from screening if headlight glare interferes with these activities.
There are currently three basic types of glare screen available: chain link (see the *Standard Plans*), vertical blades, and concrete barrier (see Exhibit 1600-8).

When the glare is temporary (due to construction activity), consider traffic volumes, alignment, duration, presence of illumination, and type of construction activity. Glare screen may be used to reduce rubbernecking associated with construction activity, but less expensive methods, such as plywood that seals off the view of the construction area, might be more appropriate.

### 1600.07 Documentation

Refer to Chapter 300 for design documentation requirements.
The philosophy behind the recovery area formula is that the vehicle can traverse these slopes but cannot recover if modified by the recovery area formula (see Exhibit 1600-4).

<table>
<thead>
<tr>
<th>Posted Speed (mph)</th>
<th>Average Daily Traffic</th>
<th>Cut Section (Backslope) (H:V) 3:1 4:1 5:1 6:1 8:1 10:1</th>
<th>Fill Section (H:V) 3:1 4:1 5:1 6:1 8:1 10:1</th>
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<td></td>
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</tr>
<tr>
<td>40</td>
<td>Under 250</td>
<td>10 10 10 10 10 10</td>
<td>* 13 12 11 11 11 10</td>
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<tr>
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<td>251 – 800</td>
<td>11 11 11 11 11 11</td>
<td>* 14 14 13 12 11 11</td>
</tr>
<tr>
<td></td>
<td>801 – 2,000</td>
<td>12 12 12 12 12 12</td>
<td>* 16 15 14 13 12 12</td>
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<tr>
<td></td>
<td>2,001 – 6,000</td>
<td>14 14 14 14 14 14</td>
<td>* 17 17 16 15 14 14</td>
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<tr>
<td></td>
<td>Over 6,000</td>
<td>15 15 15 15 15 15</td>
<td>* 19 18 17 16 15 15</td>
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<tr>
<td></td>
<td>251 – 800</td>
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<td>* 18 16 14 14 13 13</td>
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<td>801 – 2,000</td>
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<td>Over 6,000</td>
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<td>* 24 21 19 18 17 17</td>
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<tr>
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<td>801 – 2,000</td>
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<td>* 27 22 20 18 18 18</td>
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<tr>
<td></td>
<td>Over 6,000</td>
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<td>* 29 24 22 20 20 20</td>
</tr>
<tr>
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<td>* 41 34 31 29 28 28</td>
</tr>
<tr>
<td></td>
<td>Over 6,000</td>
<td>20 24 26 27 28 29</td>
<td>* 45 37 34 31 30 30</td>
</tr>
<tr>
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<td>Under 250</td>
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<tr>
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<td>Over 6,000</td>
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<tr>
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<td>Under 250</td>
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<td>18 22 23 24 26 26</td>
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<td>20 24 26 27 28 29</td>
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<tr>
<td></td>
<td>Over 6,000</td>
<td>24 29 31 32 34 35</td>
<td>* 54 44 41 37 36 36</td>
</tr>
</tbody>
</table>

**Notes:**

This exhibit applies to:
- All state highways outside incorporated cities.
- Limited access state highways within cities.

For Roadside and Median areas on managed access state highways within incorporated cities, see [1600.03](#) for guidance. Curb is not considered adequate to redirect an errant vehicle.

Design Clear Zone distances are given in feet, measured from the edge of traveled way.

*When the fill section slope is steeper than 4H:1V, but not steeper than 3H:1V, the Design Clear Zone distance is modified by the recovery area formula (see Exhibit 1600-4) and is referred to as the recovery area. The basic philosophy behind the recovery area formula is that the vehicle can traverse these slopes but cannot recover (control steering); therefore, the horizontal distance of these slopes is added to the Design Clear Zone distance to form the recovery area.*

**Design Clear Zone Distance Table**

*Exhibit 1600-2*
### Design Clear Zone Inventory

<table>
<thead>
<tr>
<th>Region</th>
<th>OR</th>
<th>County Section</th>
<th>Mile</th>
<th>to Mile</th>
<th>Date</th>
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<tbody>
<tr>
<td>Project Number</td>
<td>Project Title</td>
<td>Responsible Unit</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Number</th>
<th>MP to MP</th>
<th>Distance From Transition Zone (L + R)</th>
<th>Description</th>
<th>Corrected Action / Condition (Y/N)</th>
<th>Completed (Y/N)</th>
<th>Comments</th>
</tr>
</thead>
</table>

- **Note:**
  - Only one Item or Half per Item number.
  - Corrections not permitted to be expanded on reverse side.

---

**Design Clear Zone Inventory Form (#410-026 EF)**

*Exhibit 1600-3*

---

**WSDOT Design Manual M 22.01.10**

July 2013  

Page 1600-17
Recovery area normally applies to slopes steeper than 4H:1V, but not steeper than 3H:1V. For steeper slopes, the recovery area formula may be used as a guide if the embankment height is 10 ft or less.

**Formula:**

\[
\text{Recovery area} = (\text{shoulder width}) + (\text{horizontal distance}) + (\text{Design Clear Zone distance} - \text{shoulder width})
\]

**Example:**

Fill section (slope 3H:1V or steeper)

Conditions: Speed – 45 mph  
Traffic – 3,000 ADT  
Slope – 3H:1V

Criteria: Slope 3H:1V – Use recovery area formula

\[
\text{Recovery area} = 8 + 12 + (17 - 8) = 29 \text{ feet}
\]
Cut section with ditch (foreslope 4H:1V or flatter)

Conditions: Speed = 55 mph  
Traffic = 4,200 ADT  
Slope = 4H:1V

Criteria: Greater of:
   1. Design Clear Zone for 10H:1V cut section, 23 feet
   2. 5 feet horizontal beyond beginning of backslope, 22 feet

Design Clear Zone = 23 feet

Case 1

Cut section with ditch (foreslope steeper than 4H:1V and backslope steeper than 3H:1V)

Conditions: NA

Criteria: 10 feet horizontal beyond beginning of backslope

Design Clear Zone = 19 feet

Case 2

Cut section with ditch (foreslope 3H:1V or steeper and backslope not steeper than 3H:1V)

Conditions: Speed = 45 mph  
Traffic = 3,000 ADT  
Foreslope = 2H:1V  
Backslope = 4H:1V

Criteria: Use recovery area formula

Recovery Area = (shoulder width) + (horizontal distance) + (Design Clear Zone distance - shoulder width)
   = 6 + 6 + (15 - 6)
   = 21 feet

Case 3

Design Clear Zone for Ditch Sections

Exhibit 1600-5
Below curve: barrier recommended on new installations

Note:
Routes with ADTs under 400 may be evaluated on a case-by-case basis.

Guidelines for Embankment Barrier

Exhibit 1600-6
Mailbox Location and Turnout Design

Exhibit 1600-7
Glare Screens

Exhibit 1600-8

Chain Link

Vertical Blades

Concrete Barrier