Chapter 4: WSDOT's current policies and programs for use of cable median barrier

Conditions that increase the likelihood of crossover collisions

Barriers can help mitigate – and at the same time add to – the risks when drivers make uncontrolled entries into the median. Another set of opportunities for reducing median entry and crossover risks lie in identifying common roadway and driving conditions that appear to increase the likelihood of uncontrolled median entry. The southbound stretch of I-5 in Marysville appears to be a section where some of these situations prevail in ways that make the highway particularly vulnerable to median entry incidents.

- driving under the influence
- reckless and aggressive driving
- falling asleep at the wheel
- exceeding safe speeds
- increasing traffic volumes
- high traffic speeds
- areas where vehicles merge
- closely spaced interchanges
- curves
- collisions where traffic is deflected into the median
- weather

As discussed in Chapter 2, crossover collisions are a significant concern and contribute to a large portion of the disabling injuries and fatalities on the state highways.

WSDOT employs a number of devices and highway design elements to help drivers stay on the road and away from oncoming traffic, including rumble strips, generous lane widths, guide posts and reflective lane markers. WSDOT reviews all of these features as engineering knowledge about median protection and crossover collisions evolves, and as resources allow.

In general, WSDOT and WSP prefer wide medians because they provide more space for errant vehicles to decelerate and stop. However, in locations where space is limited, like I-5 through downtown Seattle, or in environmentally sensitive areas, wide medians are not practical.

Median barriers help reduce risk for drivers who run off the road, but they are something that motorists can hit. Vehicles that strike highway median barriers, especially concrete barriers, experience a significant force of impact and can be crushed, roll over or redirected back into traffic to strike another vehicle.

Weighing the benefits of any cross-median protection system against the new risks the system itself is a classic benefit-risk tradeoff. WSDOT carefully considers both benefit and risk when adopting policies for the installation of all such cross-median protection systems, with the aim of selecting the most appropriate system for each site.

WSDOT's cable median barrier program

Prior to 2001, WSDOT followed the guidelines in the AASHTO Roadside Design Guide and installed barrier where the freeway median was 30 feet wide or less. In 2001, WSDOT evaluated this policy and decided that increasing the median width where barriers are used to 50-feet wide or less would further enhance safety. WSDOT engineers analyzed the freeway system and, using criteria from the new policy, found approximately 185 miles that were candidates for cable barrier, of which 25 miles already were installed.

As is discussed in Chapter 3, approximately 135 miles of cable median barrier had been installed by the end of 2006 and another 30 miles was under construction. An additional 20 miles is planned for installation in 2007 and 2008. When these sections are complete, all of the freeway medians that are 50 feet or less will have median barrier. WSDOT is studying other applications of median barrier, such as on divided highways that are not freeways.

How does WSDOT make decisions about median barrier and what policies guide them?

WSDOT considers several factors when deciding whether or not to install median barrier, and which type of median barrier systems to use in each location. Engineers currently choose from three primary types of median barrier: W-beam guardrail, high-tension cable barrier and concrete barrier. All of the barrier systems used on WSDOT highways have been tested and met federal and state safety requirements and standards when they were installed. WSDOT's policies regarding median barrier are published in WSDOT's Design Manual. The following are some of the factors WSDOT engineers consider:

Examples of other strategies WSDOT used to reduce the risk of crossover collisions

Cable median barrier is only one option for engineered protection against crossover collisions. Other forms of this protection are illustrated on page 37 of this report, and examples of their use are provided below.

SR 904 in Cheney

A significant number of severe collisions occurred on an eight mile section of SR 904 through Cheney, which serves as the city's main street and primary connection to I-90 and Spokane. WSDOT worked with other state and local agencies to reduce the number and severity of collisions. Emphasis patrols targeted speeding, aggressive driving and impaired driving, which were the major causes of collisions on the road. Driver education campaigns targeted local residents and Eastern Washington University students. Crews added turn pockets, improved illumination at key intersections, installed centerline and shoulder rumble strips along several miles of the highway, and restricted passing on the two-lane highway for several miles. In the two years after the project began, total collisions decreased by 21 percent, alcohol-related collisions decreased by 36 percent and fatal and disabling collisions decreased 70 percent.

US 12 Tri-Cities–Walla Walla

WSDOT first installed centerline rumble strips in 1996 and 1997 along a 38-mile segment of U.S. 12 between the Tri-Cities and Walla Walla. Data revealed a 52 percent decrease in crossover collisions after the rumble strips were installed.

SR 270 Pullman - Idaho state line

For more than a decade, WSDOT had planned to divide nearly nine miles of SR 270 connecting Pullman and Moscow, Idaho, to help prevent head-on and other severe collisions. Increasing development and real estate costs led to funding shortfalls, prompting WSDOT to change its plan. Instead, the rural highway is being expanded into four lanes with turn lanes and a 14-foot paved median separating traffic. Construction is under way.

Median barrier use

WSDOT Design Manual, section 700.06 states: "Provide median barrier on full access control multi-lane highways with median widths of 50 feet or less and posted speeds of 45 mph or more. Consider median barrier on highways with wider medians or lower posted speeds when there is a history of cross-median accidents."

Crashworthiness

Effective Oct. 1, 1998, the Federal Highway Administration required that all new barrier installations on highways on the National Highway System be found crashworthy according to the National Cooperative Highway Research Program Report 350 criteria. Median barriers must be tested according to prescribed test conditions to show that they can contain a vehicle without transferring excessive force to vehicle occupants or rolling the vehicle. Crashworthiness is a balance of these two factors. The challenge is designing a barrier strong enough to stop an errant vehicle, but not so rigid that it will result in serious injury to vehicle occupants when they hit the barrier at 60 mph or more.

Deflection distance

One of the critical considerations is deflection, how much a median barrier moves laterally after a vehicle strikes it. Different barriers have different deflection characteristics because some types of barrier are more rigid than others. In general, barriers that flex when they're struck by a vehicle absorb some of the force of impact. This typically reduces the forces on the people inside the errant vehicle. A large deflection requires additional space for the barrier because any objects that are being shielded, like oncoming traffic or a tree, must be outside the deflection distance. In general, this limits the use of cable barrier to areas with medians wider than 24 feet.

Figure 4.1

A large deflection requires additional space because any objects that are being shielded, like oncoming traffic or a tree, must be outside the deflection distance. This limits the use of cable barrier to areas with medians wider than 24-feet.

WSDOT Design Manual 710.05 (2) directs designers not to place barriers where they could deflect into oncoming traffic: "In median installations, the deflected system must not become a hazard to oncoming traffic. Use a rigid system where deflection cannot be tolerated, such as in narrow medians or at the edge of bridge decks or other vertical drop-off areas."

WSDOT Design Manual 710.05 (5) states: "In narrow medians, avoid placement where the design deflection extends into oncoming traffic."

The WSDOT Design Manual recommends using rigid barriers in locations where there is less than 8 feet between the barrier and nearest traffic lane. This provides space for maintenance crews to pull over and repair or reposition the barrier without blocking a lane of traffic.

WSDOT Design Manual 710-5 (5) states: "Avoid installing deflecting barriers in medians that provide less than 8 feet from the edge of the traveled way to the face of the barrier."

WSDOT Design Manual 710.07 (3) states: "Whenever site conditions permit, provide at least 14 feet of clearance from the adjacent lane edge to the cable barrier."

Examples of other strategies WSDOT used to reduce the risk of crossover collisions (continued)

SR 101 Morse Creek in Port Angeles

Comprehensive efforts to enhance safety on SR 101 between Sequim and Port Angeles began in 2005, when nine highway fatalities occurred during a five month period. The two-lane highway dips, curves and crosses a narrow bridge at Morse Creek. There also have been a significant number of head-on collisions involving inebriated drivers in this area. Local community members originally requested concrete barrier, but the cost far exceeded available funding and concrete median barrier would have unacceptably narrowed the driving lanes. Instead, WSDOT engineers added wide centerline striping and rumble strips, reduced the speed limit from 50 mph to 45 mph around the curves, and put in warning signs with flashing yellow lights and rumble strips across the lanes to warn drivers of the curve ahead. WSDOT does not yet have safety data because this $40,000 project was completed just recently. Anecdotal information indicates that the changes are enhancing safety.

SR 18 in south King County

In 1994, WSDOT started a $600+ million project to transform SR 18 from a rural two-lane highway to a modern four-lane divided freeway connecting I-5 and I-90. This work has been done in segments starting in Auburn. Major portions of the overall projects have already have been completed along the 28-mile highway. Other elements of this massive undertaking included widening the highway and shoulders, adding barrier, bridges and interchanges. WSDOT achieved a major safety milestone when construction crews eliminated the last stoplight on SR 18 last year. The upgrades have cut the number of injury collisions to less than half, despite significant traffic increases.

Types of cable median barrier

There are two types of cable barrier: low-tension and high-tension. The WSDOT Design Manual 710.07 indicates: “For new installations, the high-tension cable barriers are the first choice.” This is because high-tension cable barrier requires less deflection distance, which means that it can be placed closer to traffic. In addition, it is easier to maintain than low-tension cable barrier.

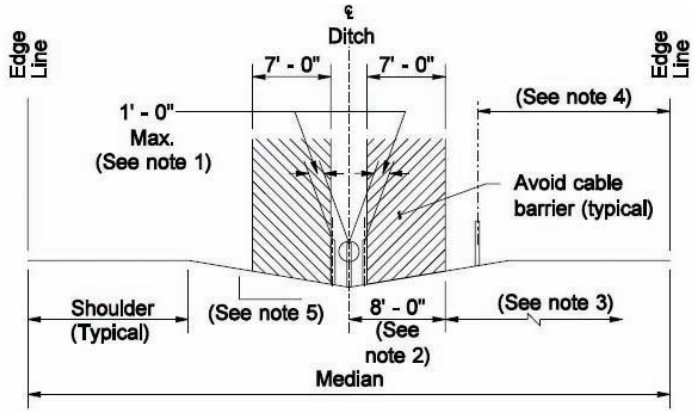
Median slope

The placement of cable median barrier on slopes can affect its performance. When placed on steep slopes, vehicles may be able to go over the barrier. When placed near the bottom of a ditch, recent experience and research has shown that vehicles can nose under the barrier. See Chapter 3 page 41 and Chapter 5, page 66.

Most barriers must be constructed on relatively level ground.

Cable barrier is thought to be an exception to that. It has been tested and its performance accepted on slopes up to 6:1. WSDOT’s Design Manual 710.07 (3) states: “Do not place this barrier [cable] on a side slope steeper than 6H:1V”, and provides a figure showing engineers where cable median barrier can be installed on slopes. However, this report suggests that more research is needed.

Figure 4.2
WSDOT Design Manual placement criteria



Notes:
(1) Cable barrier may be installed in the center of the ditch. The cable barrier may be offset from the ditch centerline a maximum of 1 foot in either direction.
(2) Avoid installing cable barrier within a 1 foot to 8 foot offset from the ditch centerline.
(3) Cable barrier may be installed a distance of 8 feet or greater from the ditch centerline.
(4) Depending on the system used and post spacing, this distance varies from 6 feet 8 inches to 12 feet.
(5) Applies to slopes between 6H:1V to 10H:1V.

Slopes beyond the barrier can be greater than 6:1 without affecting the barrier’s effectiveness. Where slopes are 10H:1V or flatter, the WSDOT Design Manual 710.05 (5) states “At these locations, position the barrier as close to the center as possible so that the recovery distance can be maximized for both directions.”

Drainage

Barrier can affect highway drainage. If not properly addressed, drainage problems can create ponds and puddles on a high-speed roadway. Guardrail and cable median barrier do not block water from draining off the highway. Concrete barriers block water and channel it. As a result WSDOT often must install drains to collect the stormwater. Treatment requirements may apply to the stormwater drainage system.

In addition, if WSDOT must flatten the median slope to install median barriers, the shallower ditch in the median may not be adequate to collect the stormwater accumulations. An enclosed drainage system may be necessary.

The WSDOT Design Manual 710.05 encourages engineers to consider drainage when selecting barrier types.

Environment

Grading slopes in a median can affect the natural environment. Grading can increase the amount of impervious surface, which could trigger a WSDOT requirement to collect and treat stormwater. In some instances, medians have been considered wetlands. WSDOT must consider carefully the environmental affects of installing guardrail or cable barrier posts, or grading for concrete barrier and possible environmental documentation and permit requirements.

Emergency response

Median barriers can hinder emergency response. For example, if the barrier is positioned close to one side of a highway, there may not be enough room for emergency vehicles to get around stopped traffic in the roadway en-route to an emergency scene.

Snow and ice operations

WSDOT maintenance crews often use snow plows to push snow and ice off of highways into piles on the roadside. Traffic barriers placed close to highway lanes can reduce the amount of space available to store piles of snow.

Barriers also can catch snow and create snow drifts. Cable median barrier's open design is less likely to catch snow. WSDOT's Design Manual 710.05 directs engineers to consider snow removal and drifting.

Barrier repair and maintenance

Typically, cable barrier repairs are quicker and less costly than repairs to guardrail or concrete barrier. However, guard rail and concrete barriers are less likely to require repair from minor collisions because they are more durable.

All types of barrier require regular maintenance. Cable barrier and guard rail require more intensive routine maintenance than concrete barrier. For example, crews must trim brush and weeds away from guard rail and cable barrier and must check cable barrier tension regularly.

Anytime maintenance workers are in a highway median they are exposed to nearby traffic, increasing their risk of injury. Increasing the time they spend in the median increases their risk. In addition, WSDOT often needs to restrict or redirect traffic during maintenance work to help keep workers and drivers safe. This can cause traffic delays, inconvenience drivers and increase the risk of collisions.

Cost

Median barrier cost, both initial and long term, is a consideration. When different barriers are suitable for a location, engineers are encouraged to stretch limited funding by selecting the most cost effective barrier option.

Installation costs per mile, including engineering, sales tax and associated materials and work, total $200,000 to $425,000 for cable barrier, $450,000 to $2.25 million for guardrail and $650,000 to $2.7 million for concrete barrier. Grading to flatten slopes pushes costs to the higher end of the range. Grading is required much less frequently for cable barrier than for concrete barrier and guardrail.

Routine repair costs for concrete barrier are low, and in many cases negligible. Cable barrier annual repair costs are approximately $2,600 per mile. Figure 4.3 shows a comparison of the maintenance costs for the low-tension and high-tension cable median barrier systems. Based on this data, repairs to high-tension cable median barrier cost slightly less, and the number of hours required to complete the repairs are 16 percent less than low-tension barrier.

Figure 4.3

Repair costs for low- and high-tension cable median barrier

	Number of repairs	Costs per repair			Posts replaced per repair			Staff hours per repair		
		Average	High	Low	Average	High	Low	Average	High	Low
Low-tension cable barrier	72	$838	$3,538	$156	5.6	22	1	14.0	57	3
High-tension cable barrier	147	$777	$3,550	$97	6.7	34	1	11.7	71	2
All cable barrier	219	$797			6.3			12.5		