

1201.01	General	1270.06	Emergency Escape Ramps
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## 1270.01 General

Auxiliary lanes are used to comply with capacity demand; maintain lane balance; accommodate speed change, weaving, and maneuvering for entering and exiting traffic; and encourage carpools, vanpools, and the use of transit.

For signing and delineation of auxiliary lanes, see the [Standard Plans](#), the [Traffic Manual](#), and the [MUTCD](#). Contact the region Traffic Engineer for guidance.

Although slow-vehicle turnouts, shoulder driving for slow vehicles, and chain-up areas are not auxiliary lanes, they are covered in this chapter because they perform a similar function.

For additional information, see the following chapters:

Chapter	Subject
<a href="#">1103</a>	Design controls, including speed
<a href="#">1230</a>	<u>Geometric cross section components</u>
<a href="#">1310</a>	Turn lanes
<a href="#">1310</a>	Speed change lanes at intersections
<a href="#">1360</a>	Collector-distributor roads
<a href="#">1360</a>	Weaving lanes
<a href="#">1410</a>	High-occupancy vehicle lanes

## 1270.02 Climbing Lanes

### 1270.02(1) General

Climbing lanes (see Exhibit 1270-1) are normally associated with truck traffic, but they may also be considered in recreational or other areas that are subject to slow-moving traffic. Climbing lanes are designed independently for each direction of travel.

### 1270.02(2) Climbing Lane Warrants

Generally, climbing lanes are provided when two warrants—speed reduction and level of service—are met. Either warrant may be waived if, for example, slow-moving traffic is causing an identified collision trend or congestion that could be corrected by the addition of a climbing lane. However, under most conditions, climbing lanes are built when both warrants are met.

#### 1270.02(2)(a) Warrant No. 1: Speed Reduction

Exhibit 1270-2a shows how the percent and length of grade affect vehicle speeds. The data is based on a typical commercial truck.

The maximum entrance speed, shown in the graphs, is 60 mph. This is the maximum value regardless of the posted speed of the highway. When the posted speed is above 60 mph, use 60 mph in place of the posted speed. Examine the profile at least  $\frac{1}{4}$  mile preceding the grade to obtain a reasonable approach speed.

If a vertical curve makes up part of the length of grade, approximate the equivalent uniform grade length.

Whenever the gradient causes a 10 mph speed reduction below the posted speed limit for a typical truck for either two-lane or multilane highways, the speed reduction warrant is met (see Exhibit 1270-2b).

### 1270.02(2)(b) Warrant No. 2: Level of Service (LOS)

The level of service warrant for two-lane highways is met when the upgrade traffic volume exceeds 200 vehicles per hour and the upgrade truck volume exceeds 20 vehicles per hour. On multilane highways, a climbing lane is warranted when a capacity analysis shows the need for more lanes on an upgrade than on a downgrade carrying the same traffic volume.

#### Exhibit 1270-1 Climbing Lane Example



### 1270.02(3) Climbing Lane Design

When a climbing lane is justified, design it in accordance with Exhibit 1270-3. Provide signing and delineation to identify the presence of the auxiliary lane. Begin climbing lanes at the point where the speed reduction warrant is met and end them where the warrant ends for multilane highways and 300 feet beyond for two-lane highways. Consider extending the auxiliary lane over the crest to improve vehicle acceleration and sight distance.

Design climbing lane width equal to that of the adjoining through lane and at the same cross slope as the adjoining lanes. Whenever possible, maintain a shoulder width equal to the adjacent roadway segments (preserve shoulder width continuity). On two-way two-lane highways, the shoulder may be reduced to 4 feet. If the shoulder width is reduced to 4 feet document the reasoning for the decision in the design parameter sheets. If the shoulder width is reduced to less than 4 feet, a design analysis is required.

Exhibit 1270-2a Speed Reduction Warrant: Performance for Trucks

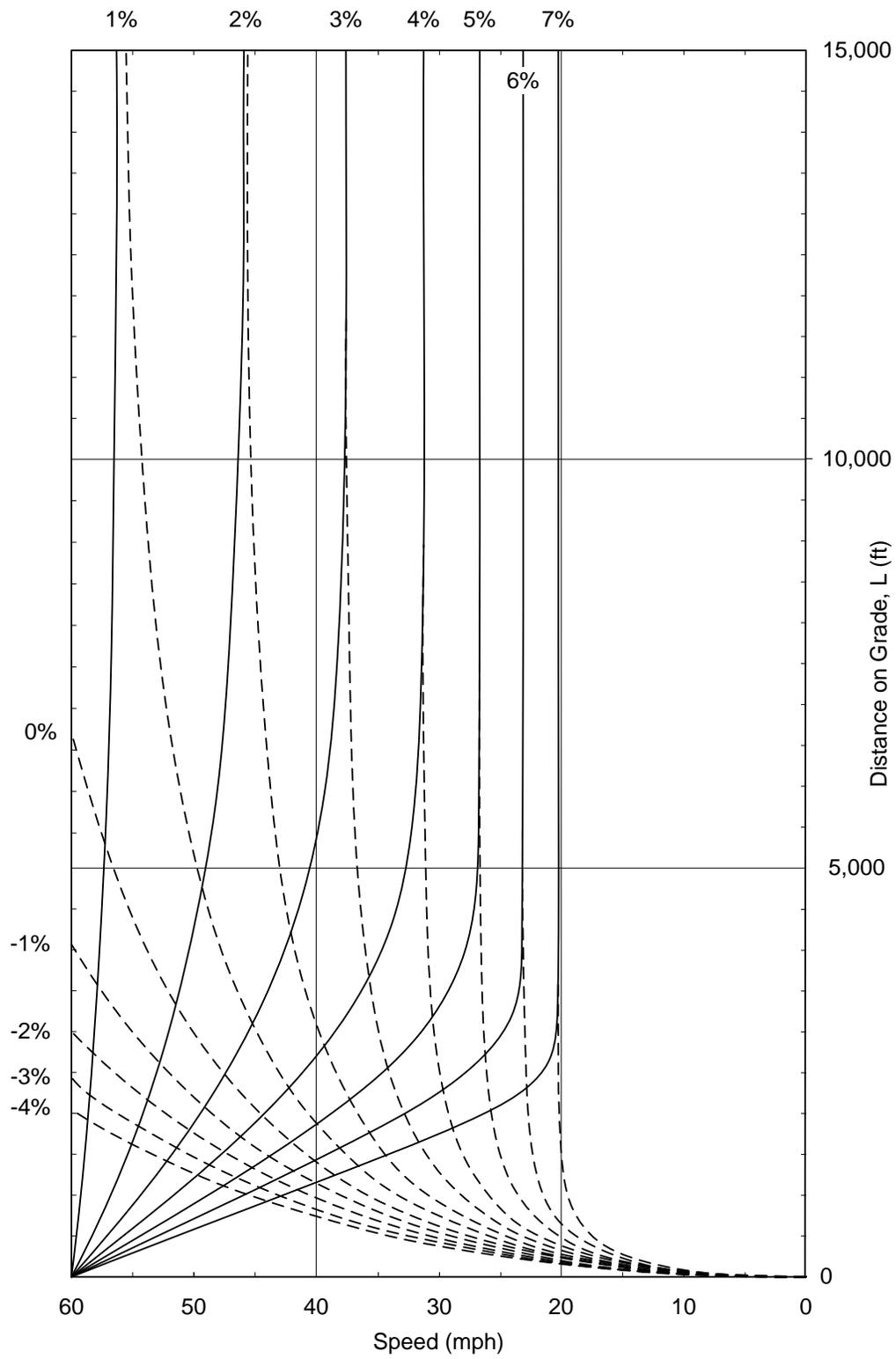
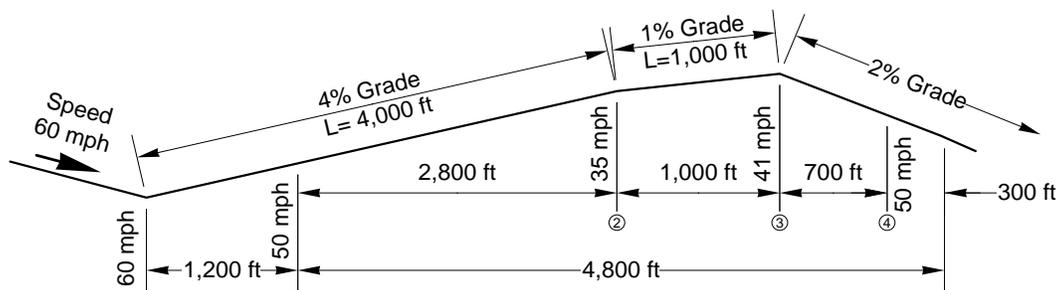
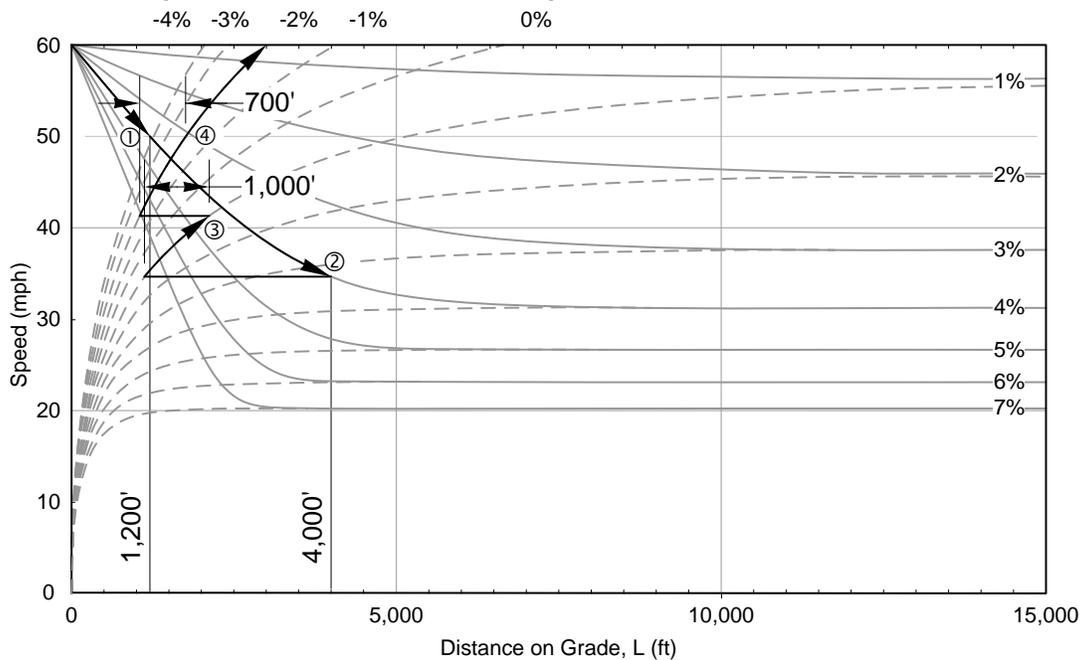


Exhibit 1270-2b Speed Reduction Warrant Example



**Given:**

A two-lane highway meeting the level of service warrant, with the above profile, and a 60 mph posted speed.

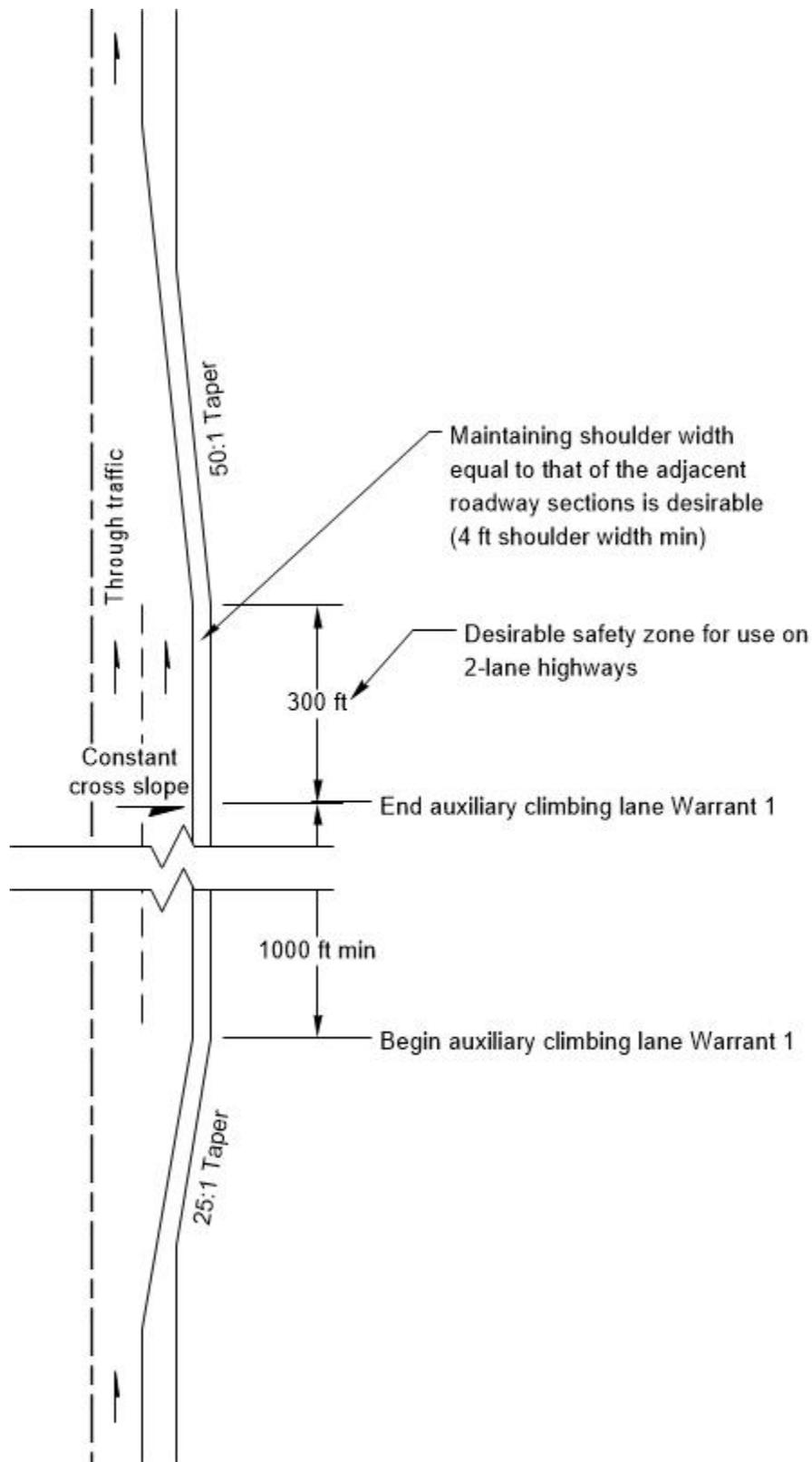
**Determine:**

Is the climbing lane warranted? If so, what is its length?

**Solution:**

1. Follow the 4% grade deceleration curve from a speed of 60 mph to a speed of 50 mph at 1,200 ft. The speed reduction warrant is met and a climbing lane is needed.
2. Continue on the 4% grade deceleration curve to 4,000 ft. Note that the speed at the end of the 4% grade is 35 mph.
3. Follow the 1% grade acceleration curve from a speed of 35 mph for 1,000 ft. Note that the speed at the end of the 1% grade is 41 mph.
4. Follow the -2% grade acceleration curve from a speed of 41 mph to a speed of 50 mph, ending the speed reduction warrant. Note that the distance is 700 ft.
5. The total auxiliary lane length is  $(4,000-1,200)+1,000+700+300=4,800$  feet. 300 ft is added to the speed reduction warrant for a two-lane highway (see 1270.02(3) and Exhibit 1270-3).

Exhibit 1270-3 Auxiliary Climbing Lane



## 1270.03 Passing Lanes

### 1270.03(1) *Passing Lane Benefits*

A passing lane (see Exhibit 1270-4) is an auxiliary lane provided in one or both directions of travel on a two-lane highway to improve passing opportunities. They may be intermittent or continuous passing lanes in level or rolling terrain and short four-lane sections. The objectives of passing lanes are to:

- Improve overall traffic operations on two-lane highways by breaking up traffic platoons and reducing delays caused by inadequate passing opportunities over substantial lengths of highway.
- Increase average travel speed within the passing lane itself; the speed benefits of passing lanes continue downstream of the lane. Passing lanes typically reduce the percent time spent following within the passing lane itself. These “percent time spent following” benefits can continue for some distance downstream of the passing lane.
- Improve safety by providing assured passing opportunities without the need for the passing driver to use the opposing traffic lane. Safety evaluations have shown that passing lanes and short four-lane sections reduce collision rates and severity.

### 1270.03(2) *Passing Lane Length*

Design passing lanes long enough to provide a reduction in traffic platooning. To maximize the traffic operational efficiency of a passing lane in level or rolling terrain, its length can vary from 0.5 mile to 2.0 miles depending on the directional flow rate, as shown in Exhibit 1270-5. Passing lanes longer than 2 miles can cause the driver to lose the sense that the highway is a two-lane facility. However, these lengths may vary for other reasons such as addressing safety-related issues. Passing lanes longer than 2.0 miles or shorter than 0.5 miles in length may be used depending on the identified need or other operational considerations within the design. Lengths shown do not include passing lane tapers at the beginning or end of the passing lane.

#### Exhibit 1270-4 Passing Lane Example



**Exhibit 1270-5 Length of Passing Lanes**

Directional Flow Rate (pc/h)	Passing Lane Length (mi)
100	≤0.50
200	>0.50-0.75
400	>0.75-1.00
≥700	>1.00-2.00
Source: Transportation Research Board, Highway Capacity Manual, 2000	

For assistance in developing a passing lane length, see the following website for an example of a self-modeling spreadsheet. This spreadsheet develops passing lane lengths based primarily on vehicle speed differentials and is to be used in conjunction with traffic modeling efforts. Contact the Headquarters Design Office for assistance ([www.wsdot.wa.gov/design/policy/default.htm](http://www.wsdot.wa.gov/design/policy/default.htm)).

**1270.03(3) Passing Lane Location**

A number of factors are considered when selecting an appropriate location for a passing lane, including the following:

- Locate passing lanes where decision sight distance (see [Chapter 1260](#)) at the lane decrease tapers can be provided.
- Provide stopping sight distance continuously along the roadway
- Avoid locating passing lanes near high-volume intersections, existing structures, railroad crossings, areas of dense development, and two-way left-turn lanes.
- Locate passing lanes where they appear logical to the driver.
- Carefully consider highway sections with low-speed curves (curves with superelevation less than required for the design speed) before installing a passing lane, since they may not be suitable for passing. For information on superelevation, see [Chapter 1250](#).
- Avoid other physical constraints, such as bridges and culverts, if they restrict the provision of a continuous shoulder.
- Consider the number, type, and location of intersections and road approaches.
- Consider grades when choosing the side on which to install the passing lane. Uphill grades are preferred but not mandatory.
- Preference for passing is normally given to the traffic departing a developed area such as a small town.

**1270.03(3)(a) Traffic Operational Considerations**

When passing lanes are provided at an isolated location, their typical objective is to reduce delays at a specific bottleneck; for example, climbing lanes (see 1270.02). The location of the passing lane is dictated by the needs of the specific traffic operational problem encountered.

When passing lanes are provided to improve traffic operations over a length of road, there is flexibility in the choice of passing lane locations to maximize their operational effectiveness and minimize construction costs.

If delay problems on an upgrade are severe, the upgrade will usually be the preferred location for a passing lane.

Passing lanes at upgrades begin before speeds are reduced to unacceptable levels and, where possible, continue over the crest of the grade so that slower vehicles can regain some speed before merging.

### **1270.03(3)(b) Construction Cost Considerations**

The cost of constructing a passing lane can vary substantially, depending on terrain, highway structures, shoulders, and adjacent development. Thus, the choice of a suitable location for a passing lane may be critical to its cost-effectiveness.

Generally, passing lanes in level and rolling terrain can be placed where they are least expensive to construct, avoiding locations with high cuts and fills and existing structures that would be expensive to widen.

### **1270.03(3)(c) Intersection-Related Considerations**

Consider a corridor evaluation of potential passing lane locations for each direction, avoiding placement of passing lanes near intersections. Avoid or minimize turning movements on a road section where passing is encouraged.

Low-volume intersections and driveways are allowed within passing lanes, but not within the taper transition areas.

Where the presence of higher-volume intersections and driveways cannot be avoided, consider including provisions for turning vehicles, such as left-turn lanes.

Provide right- and left-turn lanes in passing lane sections where they would be provided on a conventional two-lane highway.

Left turns within the first 1,000 feet of a passing lane are undesirable. Strategies to address the turning movement could include left-turn lanes, right-in/right-out access, beginning the passing lane after the entrance, and so on.

### **1270.03(4) Passing Lane Design**

Where a passing lane is planned, evaluate several possible configurations (see 1270.03(4)(a)) that are consistent with the corridor and fit within the constraints of the specific location.

The recommended minimum transition distance between passing lanes in opposing directions is 500 feet for “tail-to-tail” and 1,500 feet for “head-to-head” (see Exhibit 1270-7).

Some separation between lanes in opposite directions of travel is desirable; however, passing lanes can operate effectively with no separation. In either situation, address pavement markings and centerline rumble strips as appropriate.

It is desirable to channelize the beginning of a passing lane to move traffic to the right lane in order to promote prompt usage of the right lane by platoon leaders and maximize passing lane efficiency.

Widening symmetrically to maintain the roadway crown at the centerline is preferred, including in continuous passing lane configurations. However, the roadway crown may be placed in other locations as deemed appropriate. Considerations for crown locations might include: costs, constructability, right of way, environmentally sensitive roadsides, or other factors.

### **1270.03(4)(a) Alternative Configurations**

Where a passing lane will be provided, evaluate the configurations shown in Exhibit 1270-6. In the exhibit, general passing lane configurations and their typical applications are described in the following:

#### **a. Isolated Passing Lane – Exhibit 1270-6 (a)**

- Two-lane highway with passing lane provided at a spot location to dissipate queues.
- For isolated grades, consider climbing lanes (see 1270.02).

#### **b. Intermittent Passing Lanes, Separated – Exhibit 1270-6 (b)**

- Often pairs are used at regular intervals along a two-lane highway.
- Frequency of passing lanes depends on desired level of service.
- The spacing between passing lanes and between pairs may be adjusted to fit the conditions along the route (see 1270.03(3)).

#### **c. Continuous Passing Lanes – Exhibit 1270-6 (c)**

- Use only when constraints do not allow for the use of other configurations. The use of this configuration requires concurrence from the region Traffic Engineer. (See Exhibit 1270-7 for additional information regarding buffer areas.)
- Appropriate for two-lane roadways carrying relatively high traffic volumes where nearly continuous passing lanes are needed to achieve the desired level of service.
- Particularly appropriate over an extended section of roadway where a wide pavement is already available.
- May be used as an interim stage for an ultimate four-lane highway.

#### **d. Short Four-Lane Section – Exhibit 1270-6 (d)**

- Sufficient length for adjoining passing lanes is not available.
- Particularly appropriate where the ultimate design for the highway is four lanes.

#### **e. Intermittent Three-Lane Passing Lanes – Exhibit 1270-6 (e)**

- Does not require the slow vehicle to change lanes to allow passing.
- Requires the widening to transition from one side of the existing roadway to the other.
- Eliminates the head-to-head tapers.

### 1270.03(4)(b) Geometric Aspects

Carefully design transitions between passing lanes in opposing directions. Intersections, bridges, other structures, two-way left-turn lanes, painted medians, or similar elements can be used to provide a buffer area between opposing passing lanes. The length of the buffer area between adjoining passing lanes depends on the configuration (see Exhibit 1270-7).

Exhibit 1270-6 illustrates five passing lane design configurations. Part (c) illustrates a continuous three-lane section with alternating passing lanes. Consider a four-lane cross section when volume demand exceeds the capacity of a continuous three-lane roadway.

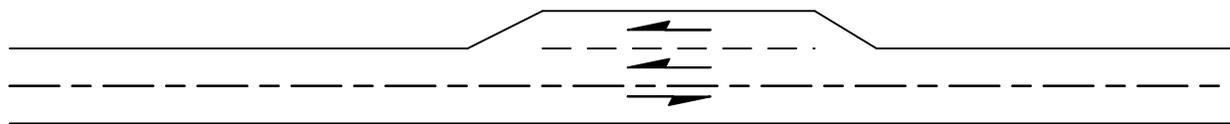
Exhibit 1270-8 illustrates taper rates, cross slopes, and section lengths for three and four-lane passing sections. Where practicable provide shoulder width in a passing lane section equal to the shoulder width on the adjacent segments of a two-lane highway. However, the shoulder may be reduced to 4 feet. If the shoulder width is reduced to 4 feet, document the reason for the decision on the design parameter sheets. If the shoulder width is reduced to less than 4 feet, a design analysis is required. See Chapter 1600 for shoulder rumble strip criteria and considerations.

Where practicable, design the passing lane width the same as the lane width on the adjacent segments of the two-lane highway.

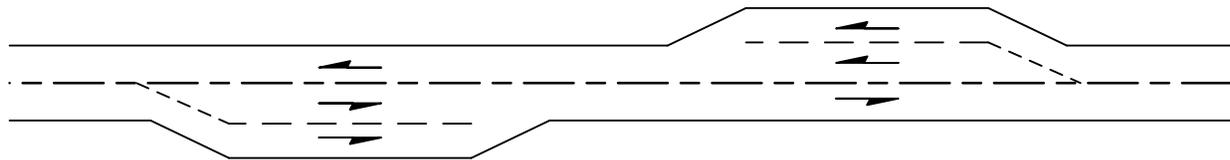
Provide a 25:1 or flatter taper rate to increase the width for a passing lane. When all traffic is directed to the right lane at the beginning of the passing lane, provide a taper rate of the posted speed:1. Provide a posted speed:1 taper rate for the merging taper at the end of a passing lane. (Refer to the Lane Transitions section in [Chapter 1210](#) for additional information on taper rates.) Consider a wide shoulder at the lane drop taper to provide a recovery area for drivers who encounter a merging conflict.

Provide signing and delineation to identify the presence of an auxiliary passing lane. Refer to the [Standard Plans](#), the [Traffic Manual](#), and the [MUTCD](#) for passing lane signing and marking guidance.

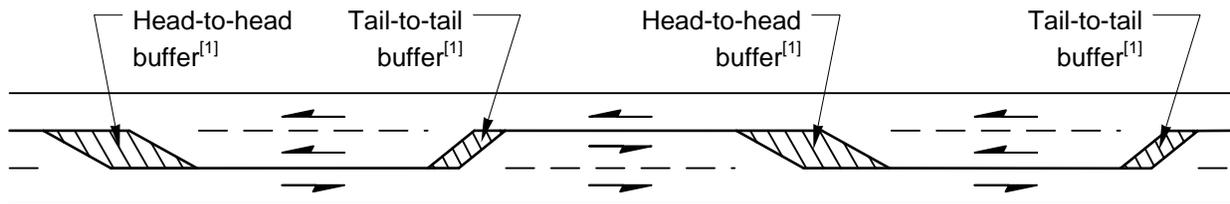
## Exhibit 1270-6 Passing Lane Configurations



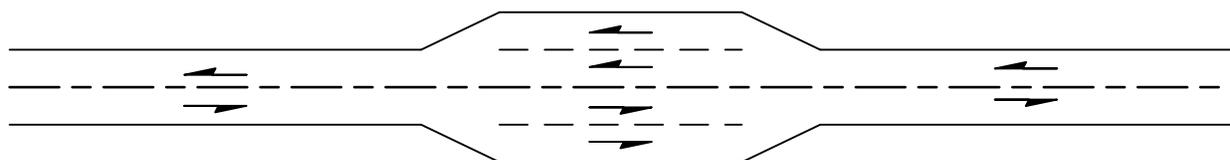
(a) Isolated Passing Lane



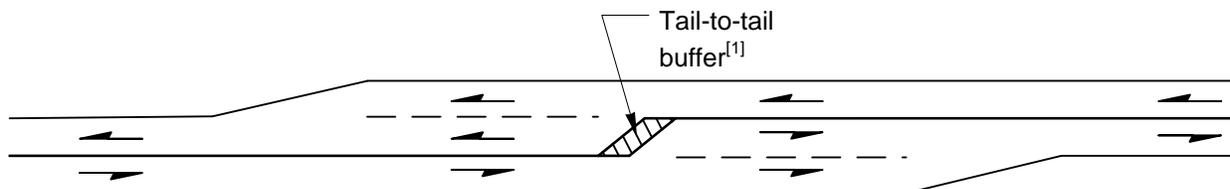
(b) Intermittent Passing Lane



(c) Continuous Three-Lane Section



(d) Short Four-Lane Section

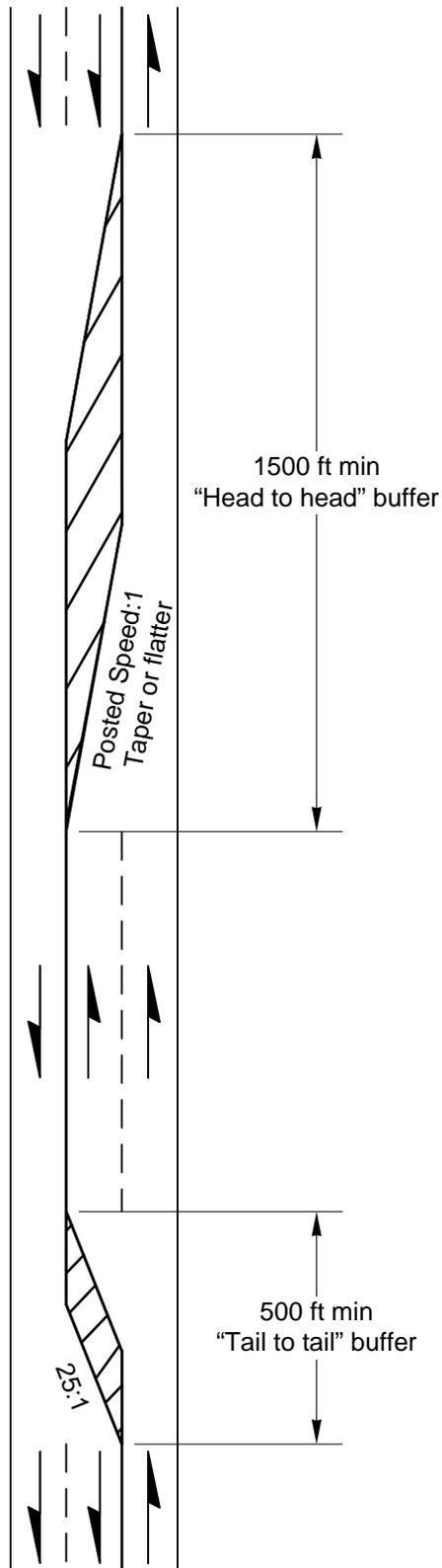


(e) Intermittent Three-Lane Passing Lanes

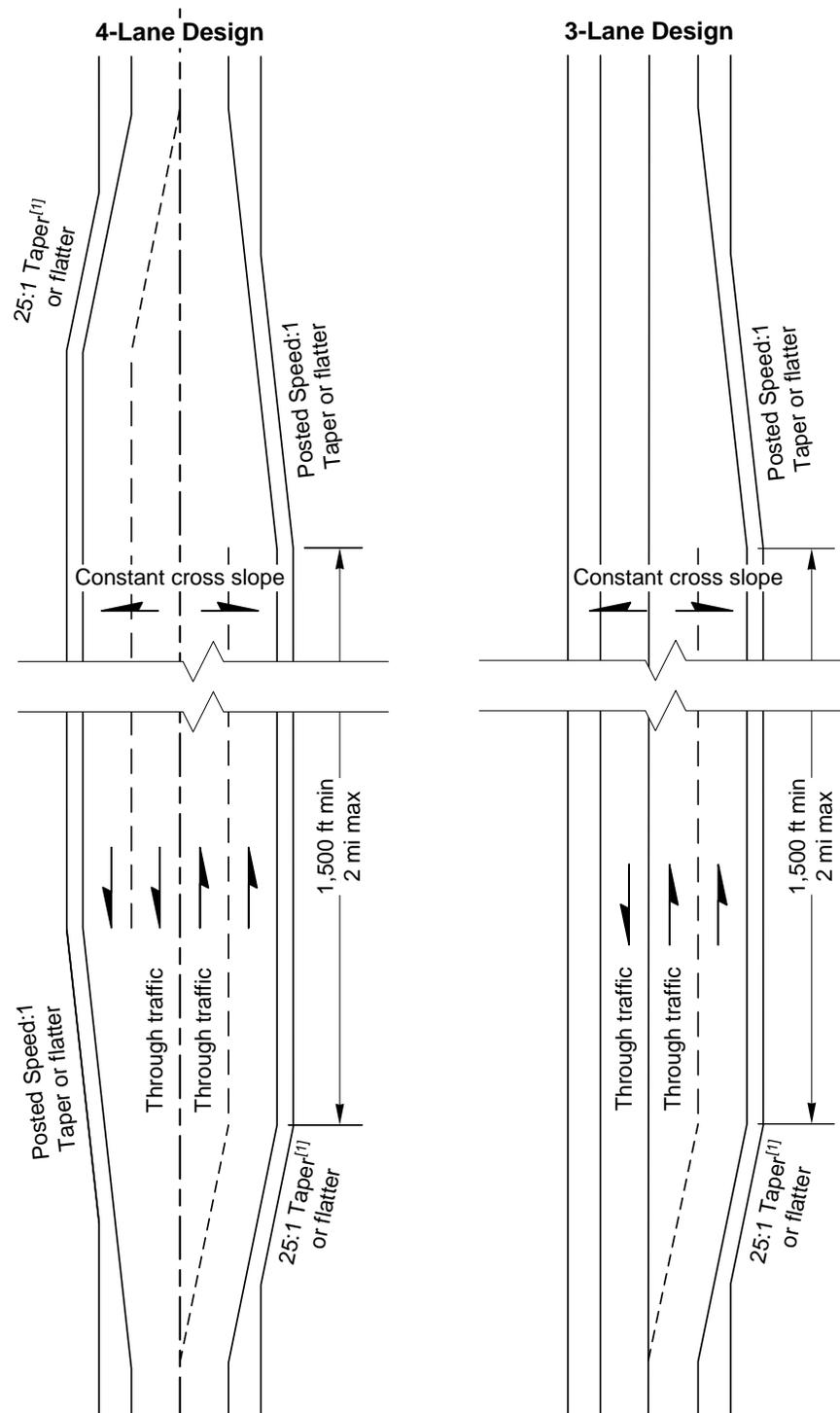
**Note:**

[1] See Exhibit 1270-7 for buffer design.

Exhibit 1270-7 Buffer Between Opposing Passing Lanes



## Exhibit 1270-8 Auxiliary Passing Lane

**Notes:**

- [1] Provide a posted speed:1 taper when all traffic is directed to the right lane at the beginning of the passing lane.
- [2] Where practicable provide the same lane and shoulder widths in the passing section as on adjacent segments. See 1270.03(4)(b).

## 1270.04 Slow-Moving Vehicle Turnouts

### 1270.04(1) General

[RCW 46.61.427](#) states:

*On a two-lane highway where passing is unsafe ... a slow-moving vehicle, behind which five or more vehicles are formed in a line, shall turn off the roadway wherever sufficient area for a safe turn-out exists, in order to permit the vehicles following to proceed...*

A slow-moving vehicle turnout is not an auxiliary lane. Its purpose is to provide sufficient room for a slow-moving vehicle to pull out of through traffic and stop if necessary, allow vehicles to pass, and then return to the through lane. Generally, a slow-moving vehicle turnout is provided on existing roadways where passing opportunities are limited, where slow-moving vehicles such as trucks and recreational vehicles are predominant, and where the cost to provide a full auxiliary lane would be prohibitive.

### 1270.04(2) Design

Base the design of a slow-moving vehicle turnout primarily on sound engineering judgment. Designs may vary from one location to another. Provide a length between 100 and 1,320 feet, excluding tapers. Select a width adequate for the vehicle type expected to use the turn-out, between 8 to 12 feet in width. Surface the turnouts with a stable, unyielding material (such as BST or HMA) with adequate structural strength to support the heavier traffic.

To improve the ability of a vehicle to safely reenter through traffic, locate slow-moving vehicle turnouts where adequate sight distance is available. The minimum design range for slow-vehicle turnouts may be where at least design stopping sight distance is available. See [Chapter 1260](#).

Sign slow-moving vehicle turnouts to identify their presence. For guidance, see the Standard Plans, the Traffic Manual, and the MUTCD.

## 1270.05 Shoulder Driving for Slow Vehicles

### 1270.05(1) General

Use of a shoulder driving section is an alternative means to meet the performance objectives provided by climbing or passing lanes.

Review the following when considering a shoulder driving section:

- Horizontal and vertical alignment
- Character of traffic
- Presence of bicycles
- Road approaches and intersections
- Clear zone (see [Chapter 1600](#))

### 1270.05(2) Design

When designing a shoulder for shoulder driving, locate where full design stopping sight distance (speed/path/direction decision sight distance is desirable) and a minimum length of 600 feet are available. Where practicable, avoid sharp horizontal curves. When barriers or other roadside objects are present, the minimum width is 12 feet. The shoulder width depends on the vehicles that will be using the shoulder. Where trucks will be the primary vehicle using the shoulder, use a 12-foot width; when passenger cars are the primary vehicle, a 10-foot width may be used.

Shoulder driving and bicycles are not compatible. When the route has been identified as a local, state, or regional significant bike route, shoulder driving for slow vehicles is undesirable. Reconstruct the shoulders to provide adequate structural strength for the anticipated traffic. Select locations where the side slope meets the criteria of [Chapter 1239](#). When providing a transition at the end of a shoulder driving section, use a 50:1 taper.

Signing for shoulder driving is required (see the Standard Plans, the Traffic Manual, and the MUTCD). Install guideposts when shoulder driving is to be permitted at night.

### 1270.06 Emergency Escape Ramps

#### 1270.06(1) General

Consider an emergency escape ramp (see Exhibit 1270-9) whenever a long, steep downgrade is encountered. In this situation, the possibility exists of a truck losing its brakes and going out of control at a high speed. Consult local maintenance personnel and check [crash data](#) to determine whether or not an escape ramp is justified.

#### Exhibit 1270-9 Emergency Escape Ramp Example



## 1270.06(2) Design

### 1270.06(2)(a) Types

Escape ramps include the following types:

- Gravity escape ramps are ascending grade ramps paralleling the traveled way. They are commonly built on old roadways. Their long length and steep grade can present the driver with control problems, not only in stopping, but with rollback after stopping. Gravity escape ramps are the least desirable design.
- Sand pile escape ramps are piles of loose, dry sand dumped at the ramp site, usually not more than 400 feet in length. The deceleration is usually high and the sand can be affected by weather conditions; therefore, they are less desirable than arrester beds. However, where space is limited, they may be suitable.
- Arrester beds are parallel ramps filled with smooth, free-draining gravel. They stop the out-of-control vehicle by increasing the rolling resistance and are the most desirable design. Arrester beds are commonly built on an upgrade to add the benefit of gravity to the rolling resistance. However, successful arrester beds have been built on a level or descending grade.
- The Dagnet Vehicle Arresting Barrier consists of chain link or fiber net that is attached to energy-absorbing units. (See [Chapter 1610](#) for additional information.)

### 1270.06(2)(b) Locations

The location of an escape ramp depends on terrain, length of grade, sight distance, and roadway geometrics. Desirable locations include before a critical curve, near the bottom of a grade, or before a stop. It is desirable that the ramp leave the roadway on a tangent at least 3 miles from the beginning of the downgrade.

### 1270.06(2)(c) Lengths

The length of an escape ramp depends on speed, grade, and type of design used. The minimum length is 200 feet. Calculate the stopping length using the equation in Exhibit 1270-10.

#### Exhibit 1270-10 Emergency Escape Ramp Length

$L = \frac{V^2}{0.3(R \pm G)}$
<p><b>Where:</b></p> <p><math>L</math> = Stopping distance (ft)</p> <p><math>V</math> = Entering speed (mph)</p> <p><math>R</math> = Rolling resistance (see <a href="#">Exhibit 1270-11</a>)</p> <p><math>G</math> = Grade of the escape ramp (%)</p>

Speeds of out-of-control trucks rarely exceed 90 mph; therefore, the desirable entering speed is 90 mph. Other entry speeds may be used when justification and the method used to determine the speed are documented.

**Exhibit 1270-11 Rolling Resistance (R)**

<b>Material</b>	<b>R</b>
Roadway	1
Loose crushed aggregate	5
Loose non-crushed gravel	10
Sand	15
Pea gravel	25

**1270.06(2)(d) Widths**

The width of each escape ramp depends on the needs of the individual situation. It is desirable for the ramp to be wide enough to accommodate more than one vehicle. The desirable width of an escape ramp to accommodate two out-of-control vehicles is 40 feet and the minimum width is 26 feet.

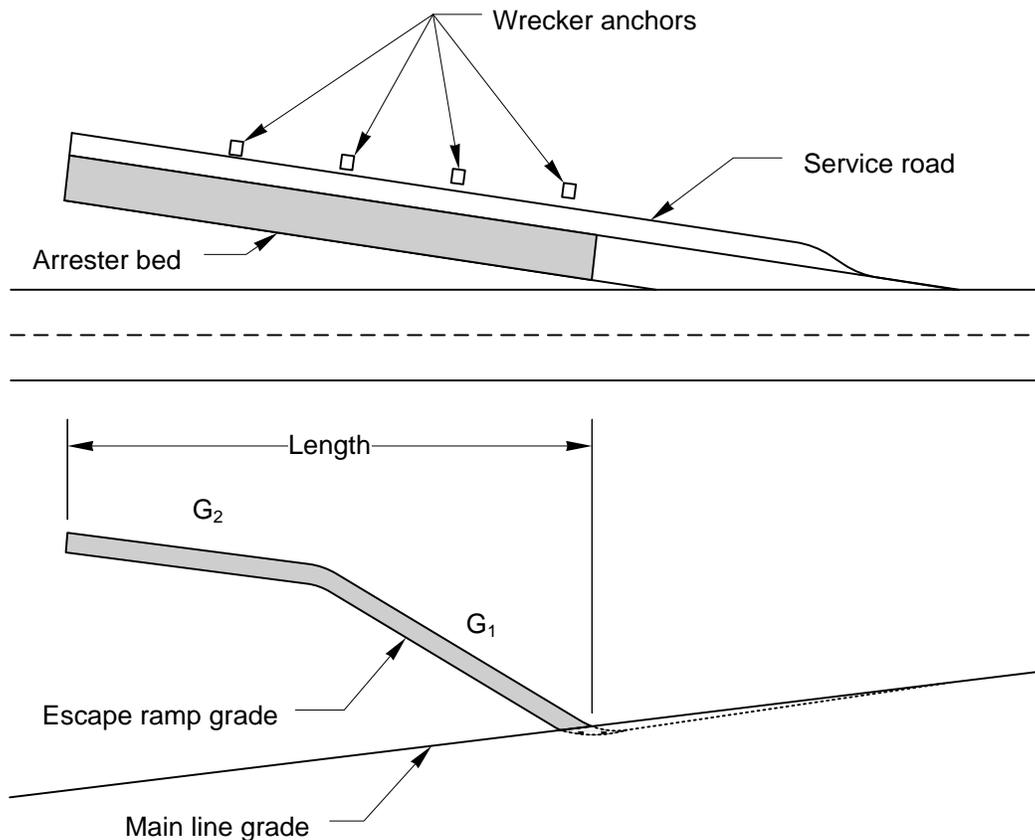
The following items are additional considerations in the design of emergency escape ramps:

- If possible, at or near the summit, provide a pull-off brake check area. Also, include in this area informative signing about the upcoming escape ramp.
- Free-draining, smooth, non-crushed gravel is desirable for an arrester bed. To assist in smooth deceleration of the vehicle, taper the depth of the bed from 3 inches at the entry to a full depth of 18 to 30 inches in not less than 100 feet.
- Mark and sign in advance of the ramp. Discourage normal traffic from using or parking in the ramp. Sign escape ramps in accordance with the guidance contained in the MUTCD for runaway truck ramps.
- Provide drainage adequate to prevent the bed from freezing or compacting.
- Consider including an impact attenuator at the end of the ramp if space is limited.
- A surfaced service road adjacent to the arrester bed is needed for wreckers and maintenance vehicles to remove vehicles and make repairs to the arrester bed. Anchors are desirable at 300-foot intervals to secure the wrecker when removing vehicles from the bed.

Typical examples of arrester beds are shown in Exhibits 1270-9 and 1270-12.

Include justification, all calculations, and any other design considerations in the emergency escape ramp documentation.

**Exhibit 1270-12 Typical Emergency Escape Ramp**



**1270.07 Chain-Up and Chain-Off Areas**

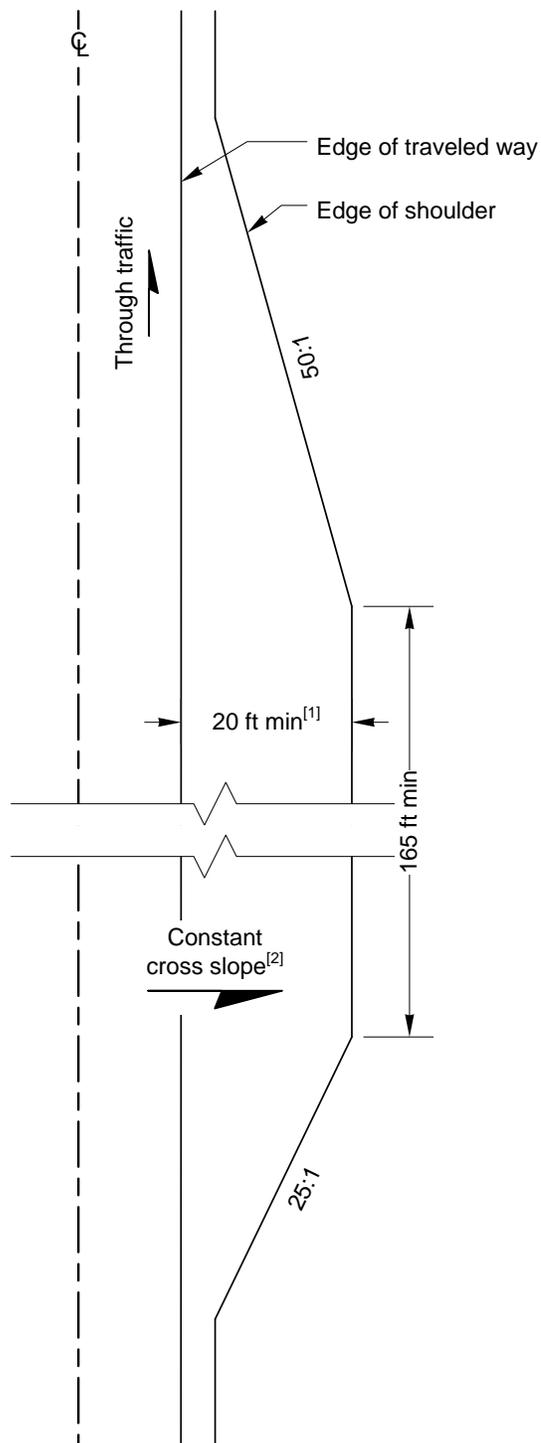
Provide chain-up areas to allow chains to be put on vehicles out of the through lanes at locations where traffic enters chain enforcement areas. Provide chain-off areas to remove chains out of the through lanes for traffic leaving chain enforcement areas.

Chain-up or chain-off areas are widened shoulders, designed as shown in Exhibit 1270-13. Locate chain-up and chain-off areas where the grade is 6% or less and desirably on a tangent section.

Consider illumination for chain-up and chain-off areas on multilane highways. When deciding whether or not to install illumination, consider traffic volumes during the hours of darkness and the availability of power.

The wide shoulders at chain-up and chain-off areas may encourage parking. When parking is undesirable, consider parking restrictions.

## Exhibit 1270-13 Chain-Up/Chain-Off Area

**Notes:**

- [1] Where traffic volumes are low and trucks are not a concern, the width may be reduced to 10 ft min, with 15 ft desirable.
- [2] 2% desirable. (See [Chapter 1250](#) for traveled way cross slope.)

## 1270.08 Documentation

Refer to [Chapter 300](#) for design documentation requirements.

## 1270.09 References

### 1270.09(1) *Federal/State Laws and Codes*

[Revised Code of Washington \(RCW\) 46.61](#), Rules of the road

### 1270.09(2) *Design Guidance*

[Manual on Uniform Traffic Control Devices for Streets and Highways](#), USDOT, FHWA; as adopted and modified by [Chapter 468-95 WAC](#) "Manual on uniform traffic control devices for streets and highways" (MUTCD)

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

[Traffic Manual](#), M 51 02, WSDOT

### 1270.09(3) *Supporting Information*

[A Policy on Geometric Design of Highways and Streets \(Green Book\)](#), AASHTO, current edition

[Emergency Escape Ramps for Runaway Heavy Vehicles](#), FHWA-T5-79-201, March 1978

[Highway Capacity Manual](#), latest edition, Transportation Research Board, National Research Council

[Truck Escape Ramps](#), NCHRP Synthesis 178, Transportation Research Board