Chapter 1231 Geometric Cross Section – Highways

1231.01 General

Geometric cross sections for state highways are governed by the need to balance performance metrics, the context, and selected design controls. The objective is to optimize the use of available public space while avoiding an unreasonable investment in right of way acquisition.

The term "highways" refers to all WSDOT roadways, including freeways; however, note that freeways have their own geometric cross section guidance. This chapter is not intended for freeway design. See Chapter 1232 for freeways.

1231.02 Design Up

Unless otherwise specified, use the "design up" method described in Chapter 1106 to choose a design element width when a range of widths is given in this chapter.

1231.03 Common Elements

The geometric cross sections shown in this chapter have many elements that are also common to facilities addressed in other chapters. The following chapters contain guidance related to these common geometric cross section elements:

• Vehicle Lanes	Section 1231.04 (below)
• Shoulders, side slopes & ditches	Section 1239.02
• Curbs	Section 1239.05
• Lateral clearance to curb or barrier	Section 1239.06
• Medians	Section 1239.08
• Parking & streetside (behind the curb) elements	Chapter 1238
• Cross slope and superelevation	Chapter 1250
• Pedestrian elements	Chapter 1510
• Bicycle elements	Chapter 1520
• Pedestrian and bicycle shared elements	Chapter 1515

1231.04 Cross Section Elements

1231.04(1) Vehicle Lanes

There are many types of lanes that may exist in a cross section, and each has its own purpose and sizing needs. General-purpose traffic lanes need to accommodate a variety of vehicle types including buses, freight vehicles, personal automotive vehicles, and bicycles. The target speed, modal priority, balance of performance needs, and transportation context are all considerations when determining size, type, and number of lanes.

1231.04(1)(a) Through Lanes

Through lanes are the most common lane type. All highways have at least one lane in each direction to provide unimpeded traffic flow from Point A to Point B. Lane width ranges for highways are listed in Exhibit 1231-1.

Exhibit 1231-1 Lane Widths for Highways

Speed	Highway Type	Lane Width Range [1][2]
≥ 50 mph	Freeway (incl. Interstate)	See Chapter 1232
	Other Highway	11' - 12'
40 & 45 mph	All	11' - 12'
≤ 35 mph	All	10' - 12'

Notes:

[1] The width shown is exclusive of the gutter if the gutter is a color that contrasts with the roadway.
[2] See Chapter 1430 for part time shoulders and Chapter 1440 for metered shoulders.

Established or common practices can be useful in determining and documenting lane width selection where a range of width values is provided. A brief list of these practices and some of their benefits is provided in Exhibit 1231-1. Engage subject matter experts in traffic operations, multimodal planning, and maintenance to establish and document the mode, function, performance, and tradeoffs involved (see DM Chapter 1106) prior to making the decision.

Lane Width Considerations	
General	Roadways on curves, see Chapter 1240 Turning Roadway Widths
	Narrower lanes may be used as part of a speed reduction strategy
	Two-lane, two-way rural highways: 12 ft lanes provide clearance between large vehicles traveling in opposing directions. Especially beneficial when high volumes or high truck percentages expected.
	On multilane facilities with width constraints, utilizing narrower inside lanes may permit wider outside lanes for bicycles, freight, and transit.
	Reduced lane widths allow more lanes to be provided in areas with constraints and allow shorter pedestrian crossing times because of reduced crossing distances.
≥ 40 mph	12 ft lanes provide increased benefit on free-flowing principal arterials with posted speeds of ≥ 50 mph.
	12 ft lanes provide increased benefit where there are higher truck volumes, especially for facilities with posted speeds of ≥ 40 mph.
	Safety and mobility performance difference between 11 ft and 12 ft lanes can be negligible. Work with the Region Transportation Operation Office to evaluate performance differences for the subject roadway
≤ 35 mph	11 ft lanes are common on urban arterials
	Lane widths of 10 ft may be appropriate in constrained areas with low truck and bus volume
	In pedestrian oriented sections, 10 ft lanes can be beneficial in minimizing crossing distance

1231.04(1)(b) Turn Lanes

Dedicated turn lanes are separated from the through lanes and provide storage for turning vehicles waiting for a signal or gap in opposing traffic. There are a number of different types of turn lanes which are discussed in detail in Chapter 1310. Turn lanes are useful when addressing the mobility and accessibility performance of motorized and bicycle modes. Traffic analysis determines the type, storage length, and number of turn lanes that are needed to achieve the balance of multimodal performance needs.

Turn lanes present potential conflicts, particularly with bicyclists and pedestrians. See Chapter 1510 and Chapter 1520 for additional discussion on ways to mitigate for these conflicts.

1231.04(1)(c) Transit-Only Lanes

Transit-only lanes are ideal for improving transit mobility performance and segregating heavily used or complex intermodal connections. There are many different ways to configure these within a geometric cross section. Some configurations are limited due to passenger loading needs for both the transit vehicle type and the stop locations. Develop widths for transit-only lanes with the partnering transit agency. See Chapter 1730 for additional information on Transit Facility considerations.

1231.04(1)(d) Auxiliary lanes

Auxiliary lanes enhance mobility performance for motor vehicles. See Chapter 1270 for design guidance and a detailed discussion on the types of auxiliary lanes.

1231.04(1)(e) Managed and Shared Lanes

There are many different types of managed and shared lanes. Some examples include:

- High occupancy vehicle (HOV) lanes (see Chapter 1410)
- Express toll lanes (ETL) (discuss with Tolling Division and see Chapter 1410)
- Part-time shoulder
- Metered shoulder
- Bicycle shared lane (see Chapter 1520)
- Business access and transit (BAT) lane (see Exhibit 1400-1)

1231.05 Bicycle and Pedestrian Elements

Bicycle and pedestrian elements include sidewalks, buffers, bicycle lanes and shared-use-paths. Note that shoulders designed to accommodate bicycles or pedestrians are not considered bicycle lanes. See Chapter 1510 and Chapter 1520 for information on the design of pedestrian and bicycle facilities.

1231.06 Designing Cross Sections

Select a cross section configuration that is based on the design elements and dimensions included in the project's preferred alternative (Chapter 1104, Chapter 1105, Chapter 1106), and the applicable design controls (Chapter 1103), and in the case of Complete Streets, including the required level of traffic stress (see Chapter 1510 and Chapter 1520). Where a range of values is provided for a cross section element, either in the examples below or in the applicable chapter in this manual, use the "mode, function, performance" approach to select and document the appropriate dimensions (see Chapter 1106).

1231.07 Cross Section Examples

The cross-section examples in this section are organized by modal priority based on the following primary modes:

Motor Vehicles, including freight

Bicycles

Pedestrians

Transit

The cross-section examples shown in Exhibit 1231-2 through Exhibit 1231-7 depict various combinations of elements that may be included in a cross section. The examples are intended to stimulate designer creativity and awareness of modal accommodations and are not intended to be standard cross sections to be reproduced for a given modal priority. It is expected that innovative project alternatives will result in diverse configurations that best balance baseline and contextual needs (see Chapter 1101).

The intention in providing these examples is to depict combinations of elements that may be included in a cross section depending on modal priority and Level of Traffic Stress needs. These examples are not standards, but instead are intended to be a starting point in the design process, demonstrating noteworthy practices in how to accommodate a given modal priority. Note that the dimensions shown in the examples represent design policy (except where noted as optional), and decisions to depart from the value or range shown for a particular element (based on the function described for it) requires a Design Analysis (see Section 300.03(2)(a).

Refer to the specific chapters referenced in the examples for more information about the configuration of individual elements, combinations of elements, and their required dimensions (or range of dimensions).

Maintaining the continuity of a roadway is an important consideration, particularly for limited access and other high-speed highways. However, it is also appropriate to change continuity as context changes in order to influence driver behavior. When designing intentional changes to the continuity of the roadway cross section, consider what is needed to enable the transition. Speed changes from ≥ 50 mph to speeds of ≤ 35 mph will need to transition the cross section over a distance utilizing a speed transition segment (see Chapter 1103).

1231.07(1) Auto-and Freight Oriented Cross Sections

Exhibit 1231-3 shows examples of motorized vehicle-oriented designs. Motorized vehicles come in a variety of types which are operated on many vehicle lanes and parking areas. The performance needs of freight and other automotive vehicle types are often similar. However, certain truck vehicle types may require additional turning roadway width for off-tracking (see Chapter 1240), or at other locations a truck climbing lane may be needed to facilitate mobility performance (see Chapter 1270).

Generally, lane width within suburban and urban contexts is less critical for mobility and safety performance than in rural and high-speed contexts. Within urban areas, placement of and sizing for loading areas within the parking areas can depend on the freight vehicle type.

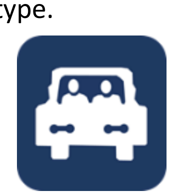
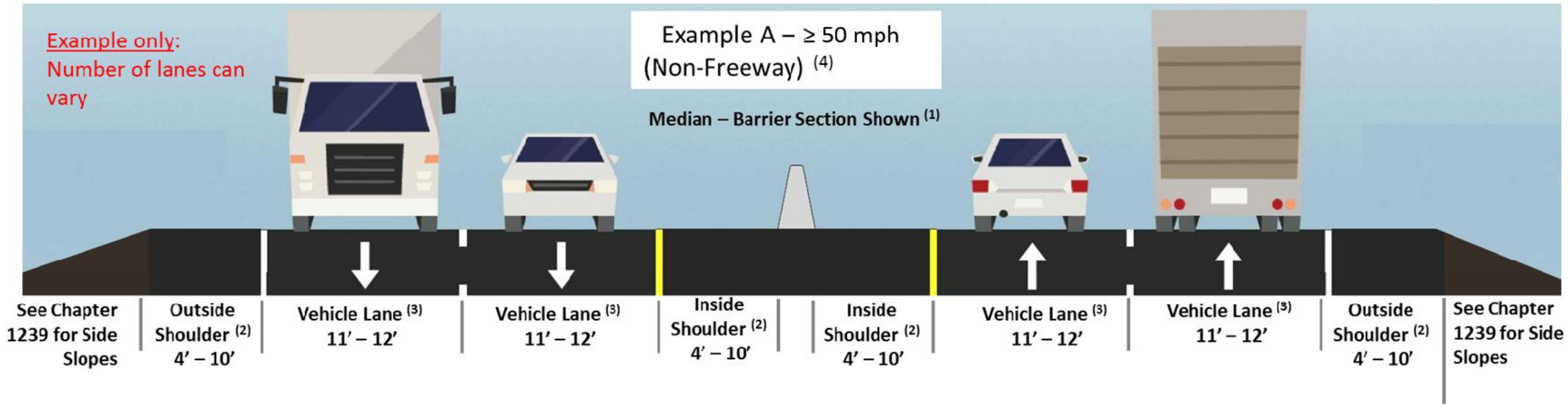
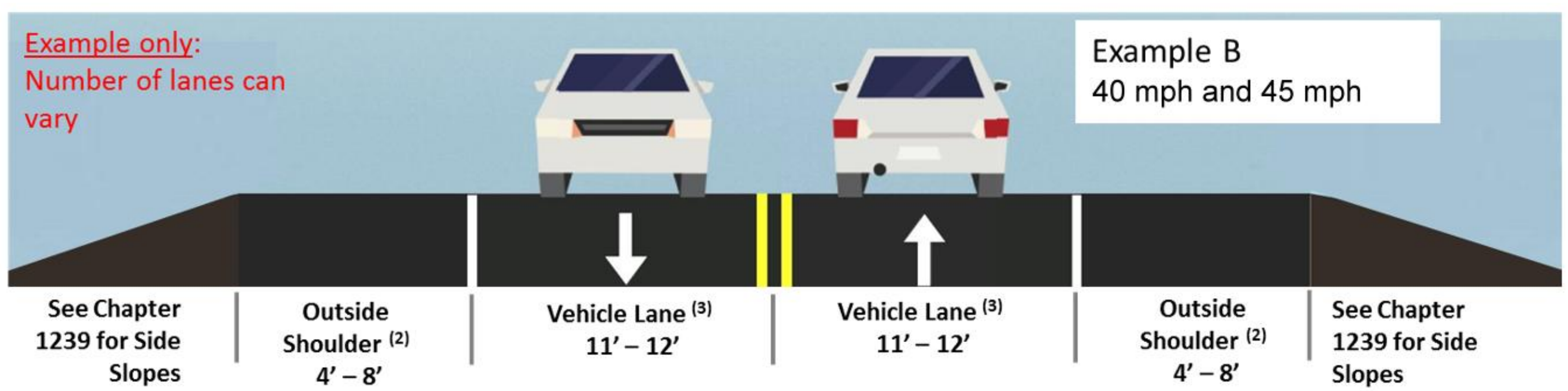
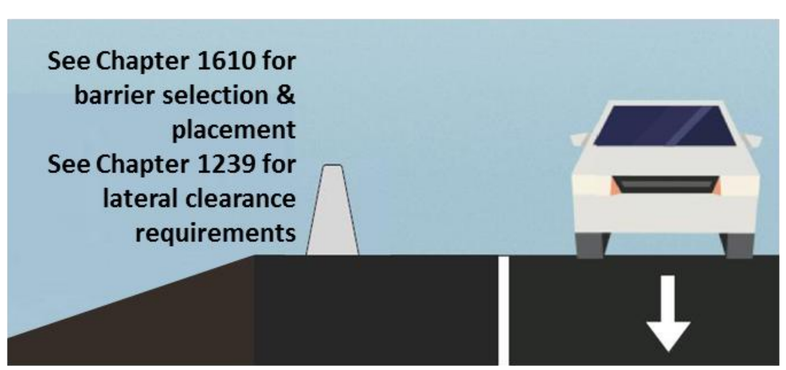


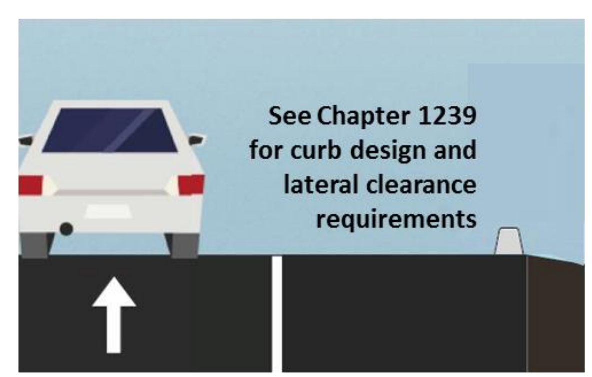
Exhibit 1231-2 Motor Vehicle Oriented Cross Sections







Barrier Present



Curb Present

Notes:

[1] Overall median width and design will vary. Some median designs include barrier and some do not. See Chapters 1239 and 1600.

[2] See Chapter 1239 for guidance on choosing a dimension from the range given.

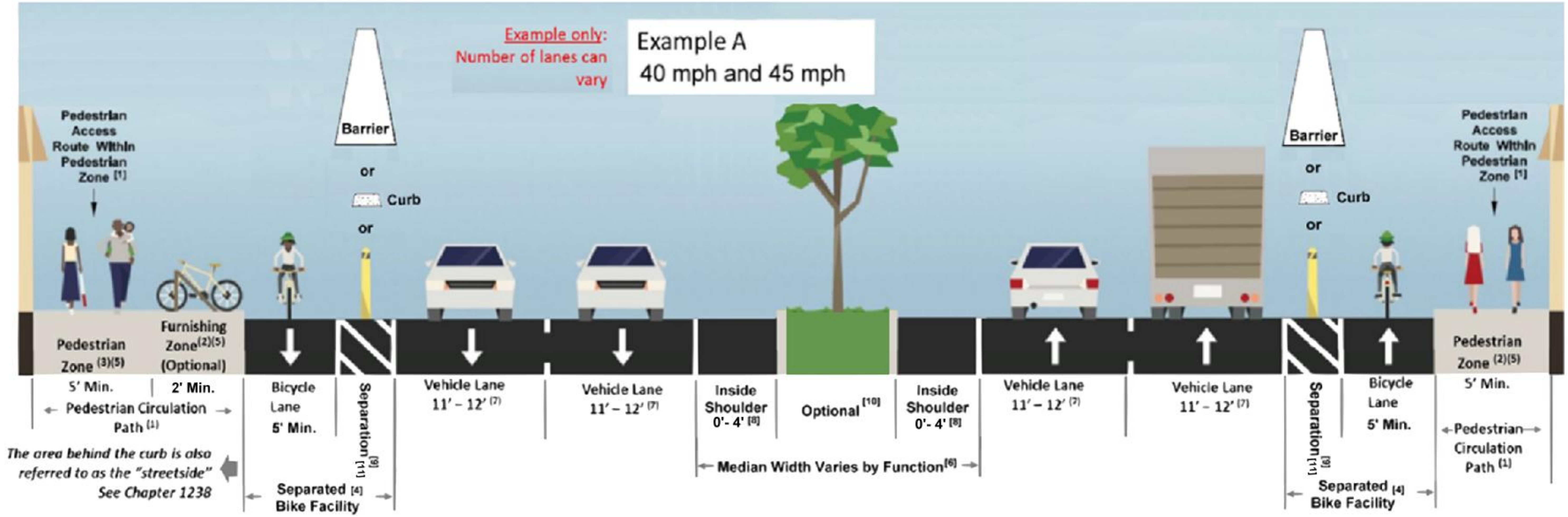
[3] See 1231.04 for guidance on choosing a dimension from the range given. See Chapter 1410 for guidance on HOV facilities.

[4] See Chapter 1232 to see if your roadway meets the definition of a freeway.

1231.07(2) Cross Sections Featuring Bicycle Facilities

Exhibit 1231-3 Example A features bicycle facilities in location with posted speeds of 40 mph or 45 mph. Bike Lane location within the cross section depends largely on how cyclists will interact with the land use and potential modal conflicts. Locating directional bike lanes on the outside of the motor vehicle lanes can improve accessibility for bicyclists. If cyclist mobility performance is a primary concern or intermodal conflicts (such as transit stop locations) are present, locating a two-way bike facility on one side of the roadway may be more appropriate. Whether or not a bike lane buffer is needed depends mostly on the target speed and average daily traffic (ADT) of the facility; the intent of bike buffers or seporated bike facilities is to address safety performance for cyclists. Buffers and other means of modal segregation also benefit motor vehicle drivers and bicyclists by delineating allocated spaces. Both roadway bike lane configurations and bike facility selection are discussed in more detail in Chapter 1520.

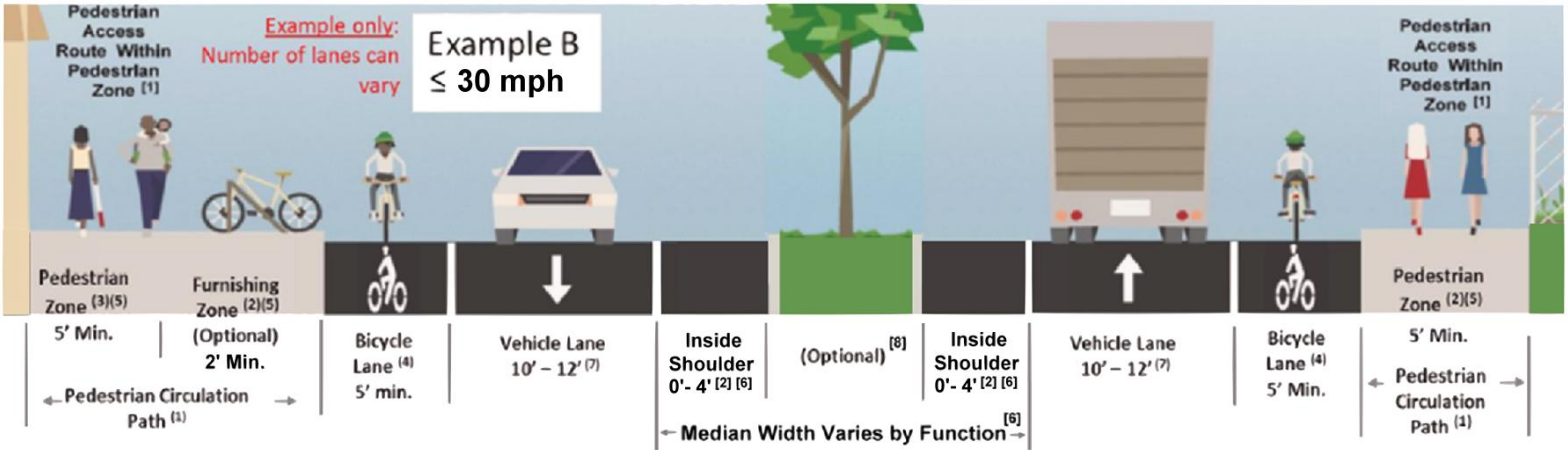
Exhibit 1231-3 Cross Sections Featuring Bicycle Facilities



Notes:

[1] See Chapter 1510
[2] Minimum width specified is exclusive of the curb width. See Section 1510.07
[3] If no furnishing zone is provided, minimum width is exclusive of the curb width.
[4] See Chapter 1520 for bike facility options.
[5] See Section 1238.03(3)
[6] Median width and design will vary by function. See Section 1239.08.
[7] See Section 1231.04 for guidance on choosing a dimension from the range given.
[8] See Sections 1239.05, 1239.06, and 1239.08
[9] Width 2' Minimum. 3' Minimum next to parked vehicles. When using curb or barrier (See Section 1520.03(2)(c)) and contact your ASDE details.
[10]Raised Island Shown. See Exhibit 1231-2 for Striped Median option.
[11]Match vertical element (tubular marker, curb, or Barrier) with path type, roadway AADT, and roadway speed. See Section 1510.02(5) for pedestrian facilities, Section 1520.03(2)(c) for separated bike lane, and 1515.04 for shared-use path.

Exhibit 1231-4 Cross Sections Featuring Bicycle Facilities



Notes:

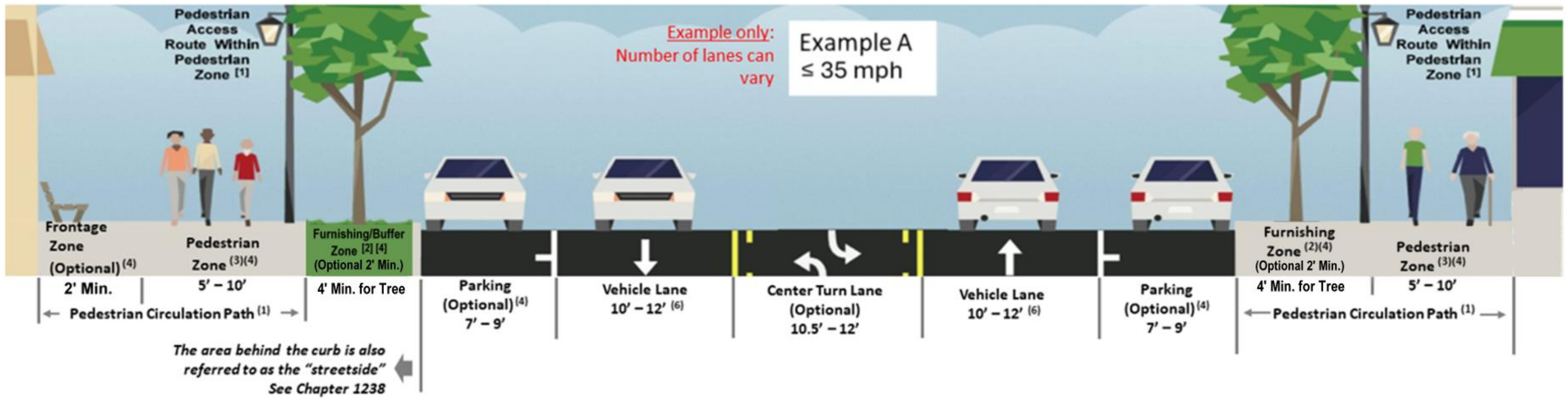
[1] See Sections 1510.06 and 1510.07
[2] Minimum width specified is exclusive of the curb width. See Section 1510.07.
[3] If no furnishing zone is provided, minimum width is exclusive of the curb width.
[4] See Section 1520.03 for bike facility options
[5] See Section 1238.02
[6] Overall median width and design will vary. See Section 1239.08(2).
[7] See Section 1231.04 for guidance on choosing a dimension from the range given.
[8] Raised Island Shown. See Exhibit 1231-2 for Striped Median option.

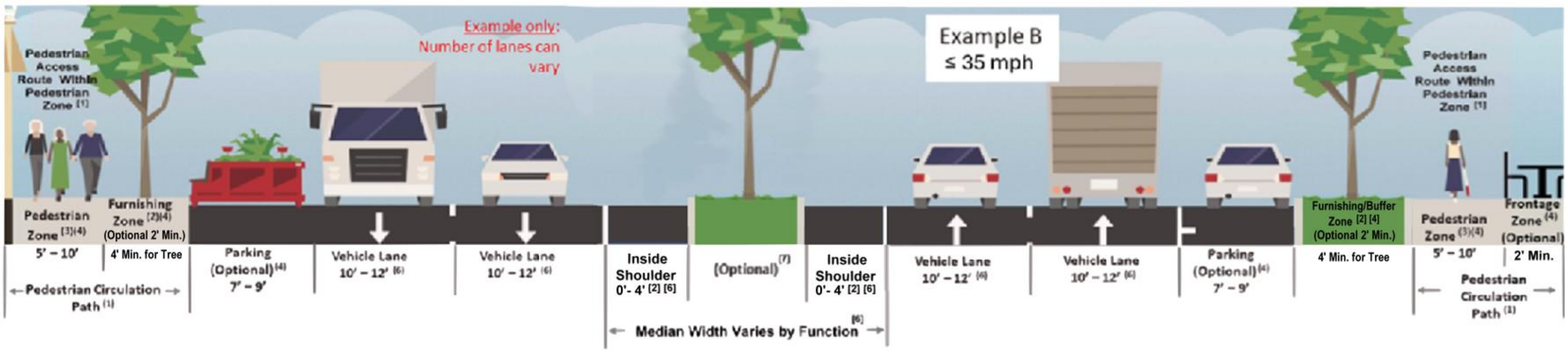
1231.07(3) Cross Sections Featuring Pedestrian Facilities

Exhibit 1231-5 shows cross-section examples featuring pedestrian facilities. The pedestrian mode is a vital transportation mode since, for most people, nearly every trip at least begins and ends by walking or rolling. Roadway facilities prioritized for pedestrians emphasize streetside elements. See Chapter 1238 for guidance regarding streetside elements.

The objective is to achieve the Pedestrian Circulation Path (PCP) necessary to support mobility, socioeconomic, and accessibility needs and provide access to intermodal connections. The configuration and dimension of streetside elements varies significantly depending on the performance needs being addressed. See Chapter 1510 for additional pedestrian design requirements and considerations.

Exhibit 1231-5 Cross Sections Featuring Pedestrian Facilities





Notes:

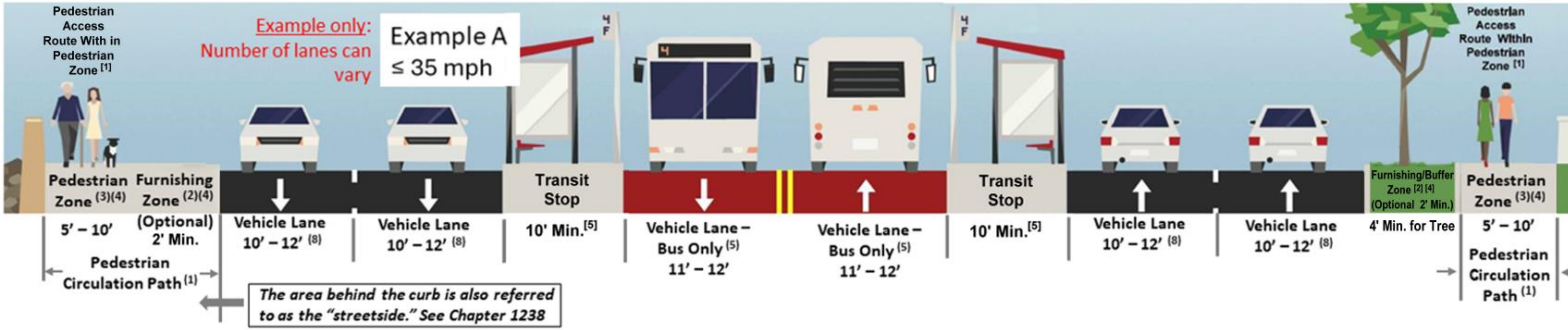
[1] see Chapter 1510.
[2] minimum width specified is exclusive of curb width.
[3] If no furnishing zone is provided, minimum width is exclusive of the curb width.
[4] see Chapter 1238.
[5] overall median width and design will vary. See Chapter 1239.
[6] see Section 1231.04 for guidance on choosing a dimension from the range given.
[7] raise island shown. See Exhibit 1231-2 for striped median option.

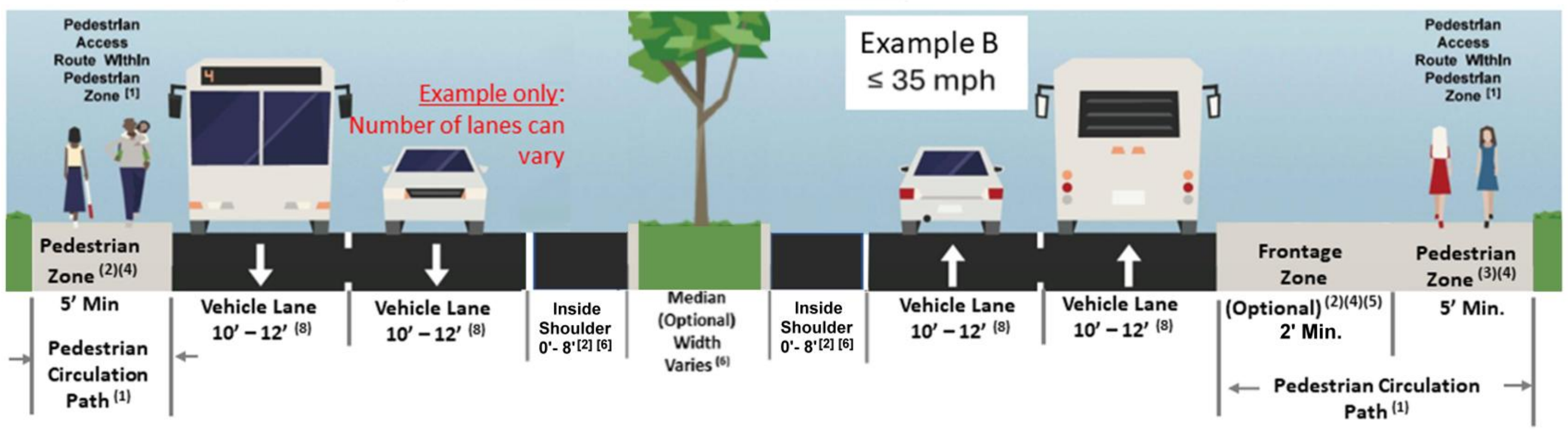
1231.07(4) Cross Sections Featuring Transit Facilities

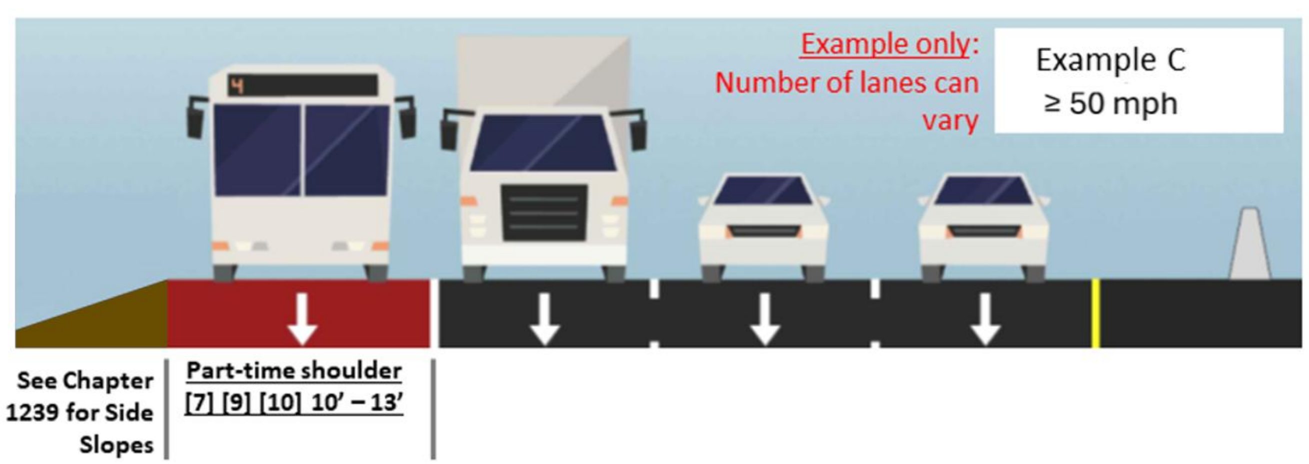
Exhibit 1231-6 provides examples of different potential configurations oriented for the transit mode. Work with the transit provider to determine their ability to operate within a given cross-sectional arrangement. In general, transit configurations can be positioned toward the side or center of a roadway. Both side and center configurations can be implemented with medians or outer separations to improve safety performance for intermodal connections, or mobility performance for the transit service.

Exhibit 1231-6 Example A shows a central configuration for transit service that provides a separated bus-only lane. Other transit vehicle types may require different widths and may also require other median cross section configurations for passenger loading. Exhibit 1231-6 Example B shows a side configuration where transit vehicles occupy the outside lane. This example can also be configured as business access and transit [BAT] lanes. Note the importance of streetside elements to assist with intermodal connections. Exhibit 1231-6 Example C is an example of a type of special use lane for high-speed routes that are routinely congested. In this example, the shoulder allows the restricted use for buses.

Exhibit 1231-6 Cross Sections Featuring Transit Facilities







Notes:

[1] See Chapter 1510.
[2] Minimum width specified is exclusive of the curb width.
[3] If no furnishing zone is provided, minimum width is exclusive of the curb width.
[4] See Chapter 1238.
[5] Verify width needs with transit provider, including lift extension needs. See Chapter 1510 for Pedestrian Access Route requirements, which may be affected by presence of a shelter. See Chapter 1730 Transit Facilities.
[6] Median width and design will vary. See Chapter 1239.
[7] See Chapter 1239 and Chapter 1730. Verify width needs with transit provider as appropriate. Requires a Design Analysis.
[8] See Section 1231.04 for guidance on choosing a dimension from the range given.
[9] See Chapter 1239 for guidance on choosing a dimension from the range given.
[10]Outside shoulder alignment shown. Inside shoulder can be used for part-time shoulder.

1231.07(5) Example Cross-Sections – Complete Streets

Complete street configurations attempt to balance the performance needs of all users, regardless of age, ability, or mode. The general intent is to provide context-appropriate designs that enable safe access for all design users. It is always important to consider modal connectivity and conflicts that may occur with complete street configurations, particularly at intersections and/or transit stop locations.

There are different potential configurations for complete streets, such as:

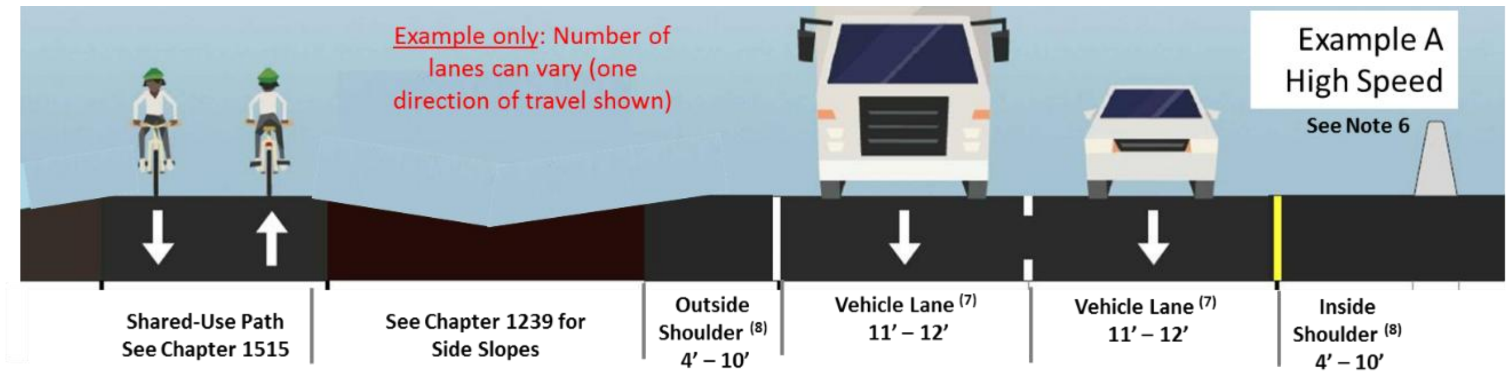
- A rural two-lane highway with an adjacent shared-use path.
- An urban highway or street with vehicle lanes, bike lanes, bus lanes, and sidewalks.
- An urban highway that undergoes a roadway section reallocation (see Section 1231.08) including installation of additional pedestrian crossings.

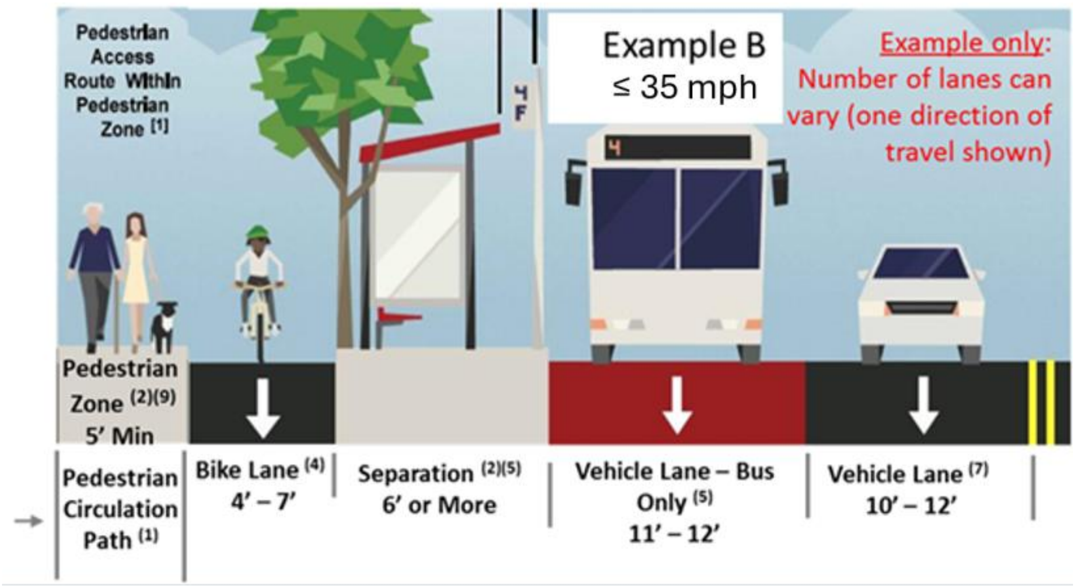
The two ≤ 35 mph examples in Exhibit 1231-7 illustrate roadway cross sections that:

Separate access lanes from through traffic lanes using curbed islands.

- Reduce conflicts between pedestrian, bike, transit, and auto modes by separating them.
- Provide transit stops integrated with raised islands.
- May result in improved operations for all modes.

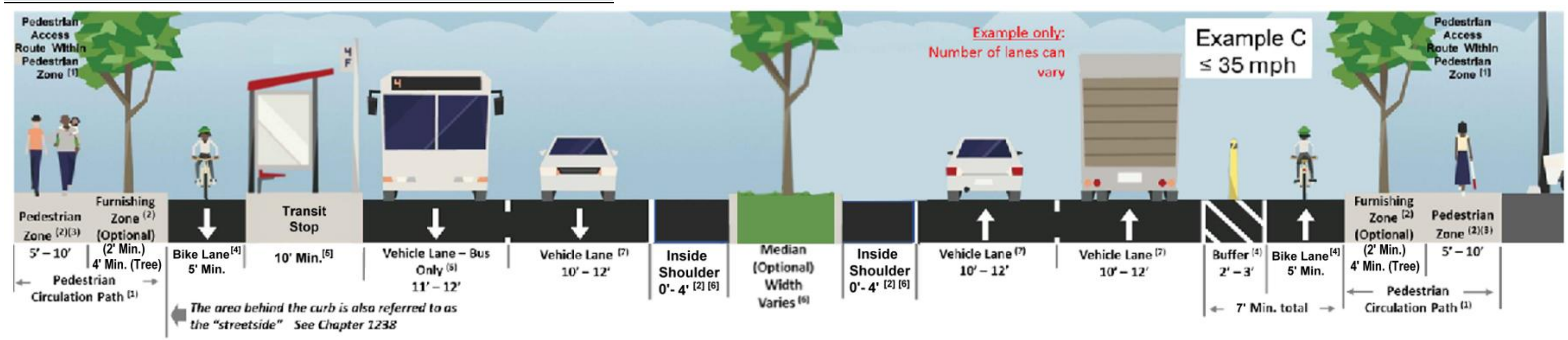
Exhibit 1231-7 Complete Streets Cross Sections





Notes:

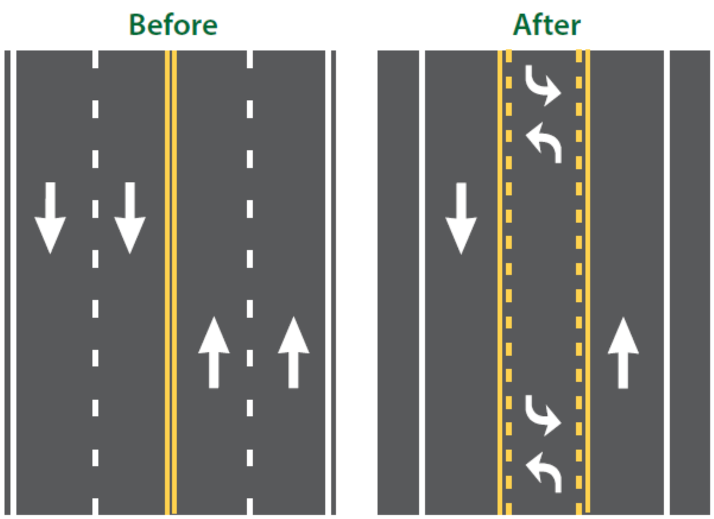
[1] See Chapter 1510
[2] See Chapter 1238
[3] If no furnishing zone is provided, minimum width is exclusive of the curb width.
[4] See Chapter 1520 for bike facility options.
[5] Verify width needs with transit provider. See Chapter 1730.
[6] Overall median width and design will vary. See Chapter 1239.
[7] See Section 1231.04 for guidance on choosing a dimension from the range given.
[8] See Chapter 1239 for guidance on choosing a dimension from the range given.
[9] Minimum width specified is exclusive of the curb width.



1231.08 Roadway Section Reallocation

Roadway section reallocation (also known as road diets or road buffets) change the channelization and roadway features of an existing roadway to improve multimodal performance. At intersections and access points, a reallocation can improve sight distances, may improve access management along the road, and in some cases may also improve mobility performance for motorists.

A common example is converting four-lane undivided highways to three lanes with the center lane for left turning movements and the remaining outside space repurposed for bicyclists or other functions. The center lane can consist of a two-way left-turn lane (TWLTL) or can be dedicated for directional left turns either by paint or other median treatments. The choice of how to configure the center lane depends largely on balancing the resulting safety and accessibility performance of different modes and land uses. (See Chapter 540 for additional restrictions on the use of TWLTLs)



Typical Road Diet Basic Design from FHWA Road Diet Informational Guide

Refer to “Guidebook for Roadway Cross Section Reallocation” (NCHRP 1036) for more information about developing reallocation alternatives, analyzing tradeoffs, and identifying a preferred alternative. The Region Traffic Engineer must approve reallocation applications on state highways.

Retrofit options refer to the application of lower-cost treatments that utilize paint and other delineation devices rather than hardscape features. See Chapter 1238 for more information on retrofit options such as relocating the curb, parklets and plazas.

1231.09 References

1231.09(1) Design Guidance

Highway Runoff Manual, M 31-16, WSDOT

Local Agency Guidelines (LAG), M 36-63, WSDOT

Plans Preparation Manual, M 22-31, WSDOT

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

Standard Specifications for Road, Bridge, and Municipal Construction, M 41-10, WSDOT

1231.09(2) Supporting Information

FHWA Road Diet Informational Guide, FHWA, 2014

Road Diet Informational Guide - Safety | Federal Highway Administration (dot.gov)

Understanding Flexibility in Transportation Design – Washington, WA-RD 638.1, Washington State Department of Transportation, 2005

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Urban Bikeway Design Guide, National Association of City Transportation Officials, New York, NY, 2012 revised 2013

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Designing Walkable Thoroughfares: A Context Sensitive Approach, Institute of Transportation Engineers, Washington D.C., 2010.

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Guide for Geometric Design of Transit Facilities on Highways and Streets, AASHTO, Washington, D.C., 2011

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

A Policy on Design Standards Interstate System, AASHTO, 2005

https://www.dot.state.al.us/publications/Design/pdf/DesignStandardsInterstateSystem.pdf

NCHRP Synthesis 443 – Practical Highway Design Solutions, Transportation Research Board, Washington D.C., 2013

www.trb.org/Main/Blurbs/168619.aspx

NCHRP Report 785 – Performance-Based Analysis of Geometric Design of Highways and Streets, Transportation Research Board, Washington D.C., 2014

www.trb.org/Main/Blurbs/171431.aspx

NCHRP Report 783 – Evaluation of the 13 Controlling Criteria for Geometric Design, Transportation Research Board, Washington D.C., 2014

www.trb.org/Main/Blurbs/171358.aspx

NCHRP Report 505 – Review of Truck Characteristics as Factors in Roadway Design, Transportation Research Board, Washington D.C., 2003

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NCHRP Report 1036 – *Guidebook for Roadway Cross Section Reallocation*, Transportation Research Board, Washington D.C., 2022

Roadway Cross-Section Reallocation: A Guide | The National Academies Press