



**CLARK COUNTY**  
WASHINGTON  

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**PUBLIC WORKS**






# CLARK COUNTY TRAFFIC MANUAL



INTEROFFICE MEMORANDUM

Transportation Division

Clark County, Washington  
Department of Public Works

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DATE: June 6, 2019  
SUBJECT: Traffic Manual

The Clark County Traffic Engineering Section has prepared this *Traffic Manual* based on national best practices, research from accredited publications by NCHRP, TRB and ITE etc., in consultation with other agencies such as Federal Highway Administration, Washington Department of Transportation, Oregon Department of Transportation, sound engineering judgement and input from field maintenance staff and crew chiefs. It does not supersede the *Manual on Uniform Traffic Control Devices* (MUTCD) or any other established Federal, State or local guidelines, but rather provides clarification for unique situations.

This manual provides guidelines regarding the application of traffic control devices in Clark County. Engineers are still required to make an assessment based on individual field conditions and make recommendations accordingly, but conformance to the methodology and guidelines described in this manual is essential. The purpose of this manual is to attain uniformity in the application of traffic control devices thereby enhancing the safety and operations along County roadways.

This traffic manual concentrates on:

- Clark County traffic engineering guidelines and practices on design, placement and implementation of signing, striping, and pavement markings.
- Provides clarification on the application of the MUTCD, Federal, State and local guidelines and standards regarding traffic control devices in the public right-of-way.
- Temporary traffic control guidelines, not addressed in the MUTCD, for bicyclists and pedestrians.
- Collection and documentation of field data.
- Protocols and procedures for regulatory changes to traffic control such as speed limit, parking prohibition, limitation to certain class of vehicles on a roadway, etc.

In addition, the *School Zone Traffic Control Policy* and *Pedestrian Crossing Treatment Policy*, prepared by Clark County Traffic Engineering section, are companion documents to this traffic manual that provide detailed traffic control treatment guidelines on the subject.



## Table of Contents

|                                                         |    |
|---------------------------------------------------------|----|
| Chapter 1 – General Information.....                    | 1  |
| Chapter 2 – Sight Distance.....                         | 3  |
| Stopping Sight Distance .....                           | 3  |
| Intersection Sight Distance .....                       | 4  |
| Chapter 3 – Signs.....                                  | 5  |
| Sign Installation.....                                  | 5  |
| Regulatory Signs.....                                   | 6  |
| STOP Signs.....                                         | 6  |
| Speed Limit Signs .....                                 | 7  |
| No Parking Signs.....                                   | 9  |
| End County Road Signs .....                             | 12 |
| Barricades .....                                        | 13 |
| Warning Signs.....                                      | 14 |
| Horizontal Alignment Signs.....                         | 14 |
| Narrow Road Signs.....                                  | 21 |
| DEAD END/NO OUTLET Signs.....                           | 21 |
| Stop Ahead Signs.....                                   | 22 |
| Signal Ahead Signs .....                                | 23 |
| Intersection Warning Signs .....                        | 23 |
| Deer Crossing Signs.....                                | 23 |
| Equestrian Crossing Signs .....                         | 24 |
| Object Markers .....                                    | 24 |
| Chapter 4 – Markings.....                               | 25 |
| Striping .....                                          | 25 |
| Centerline and Edge Lines.....                          | 25 |
| No-Passing Zones.....                                   | 28 |
| Drop Lane Lines.....                                    | 35 |
| Pavement Markings .....                                 | 35 |
| Stop Lines.....                                         | 35 |
| Raised Pavement Markers (RPMs).....                     | 36 |
| Chapter 5 – Traffic Control for Bicycle Facilities..... | 38 |
| Bicycle Lane Width.....                                 | 38 |
| Bicycle Lane Symbol.....                                | 39 |
| BIKE LANE Sign .....                                    | 39 |
| Green Bike Lane .....                                   | 39 |
| Signage for Bicyclists Sharing the Road.....            | 40 |
| Bicycle Temporary Traffic Control.....                  | 41 |

Chapter 6 – Traffic Control for School Areas ..... 45

    School Bus Stop Location ..... 45

    School Bus Stop Ahead Sign ..... 45

    School Bus Turnaround Sign ..... 46

Chapter 7 – Sweeping Curves ..... 47

**List of Tables**

Table 1. Publication Descriptions..... 2

Table 2. Stopping Sight Distance..... 3

Table 3. Sign Letter Height Calculation ..... 6

Table 4. STOP Sign Sizes ..... 7

Table 5. Speed Limit Sign Sizes ..... 8

Table 6. Parking Restrictions Based on Roadway Width ..... 10

Table 7. Horizontal Alignment Sign Selection (MUTCD Table 2C-5) ..... 15

Table 8. Supplemental Curve Warning Signing based on Speed Differential ..... 15

Table 9. Guidelines for Advance Placement of Warning Signs (Modified MUTCD Table 2C-4)..... 20

Table 10. Typical Spacing of Chevron Alignment Signs on Horizontal Curves (MUTCD Table 2C-6) ..... 20

Table 11. STOP Sign Visibility and STOP AHEAD Sign Placement..... 22

Table 12. Guidelines for Striping of County Roads ..... 26

Table 13. Minimum Passing & No-Passing Zone Lengths ..... 28

Table 14. Minimum Criteria for No-Passing Zones ..... 30

Table 15. Drop Lane Line Distances ..... 35

Table 16. RPM Spacing on Curves..... 36

Table 17. Signage for Bicyclists Sharing the Road..... 41

Table 18. Sweeping Curve Scenarios ..... 47

Table 19. Signing and Striping Components for Sweeping Curves ..... 48

## List of Figures

|                                                                                |    |
|--------------------------------------------------------------------------------|----|
| Figure 1. Hierarchy for Publications.....                                      | 1  |
| Figure 2. Stopping Sight Distance .....                                        | 3  |
| Figure 3. No Parking on Both Sides.....                                        | 10 |
| Figure 4. No Parking in Hammerhead.....                                        | 12 |
| Figure 5. Curve Warning Signing based on Speed Differential .....              | 17 |
| Figure 6. Curve Warning Signing for Winding Roads .....                        | 18 |
| Figure 7. Curve Warning Signing for Reverse Curve and Single Curve .....       | 19 |
| Figure 8. No-Passing Zone Striping Examples .....                              | 29 |
| Figure 9. No-Passing Zone – Lane Reduction & Addition Transition .....         | 31 |
| Figure 10. No-Passing Zone – Uncontrolled & Stop Controlled Intersections..... | 32 |
| Figure 11. No-Passing Zone – Signalized Intersection & Railroad Crossing.....  | 33 |
| Figure 12. No-Passing Zone – Horizontal & Vertical Curves .....                | 34 |
| Figure 13. Construction Sign Placement.....                                    | 43 |
| Figure 14. Sweeping Curve Scenarios A & B .....                                | 49 |
| Figure 15. Sweeping Curve Scenarios C & D .....                                | 50 |

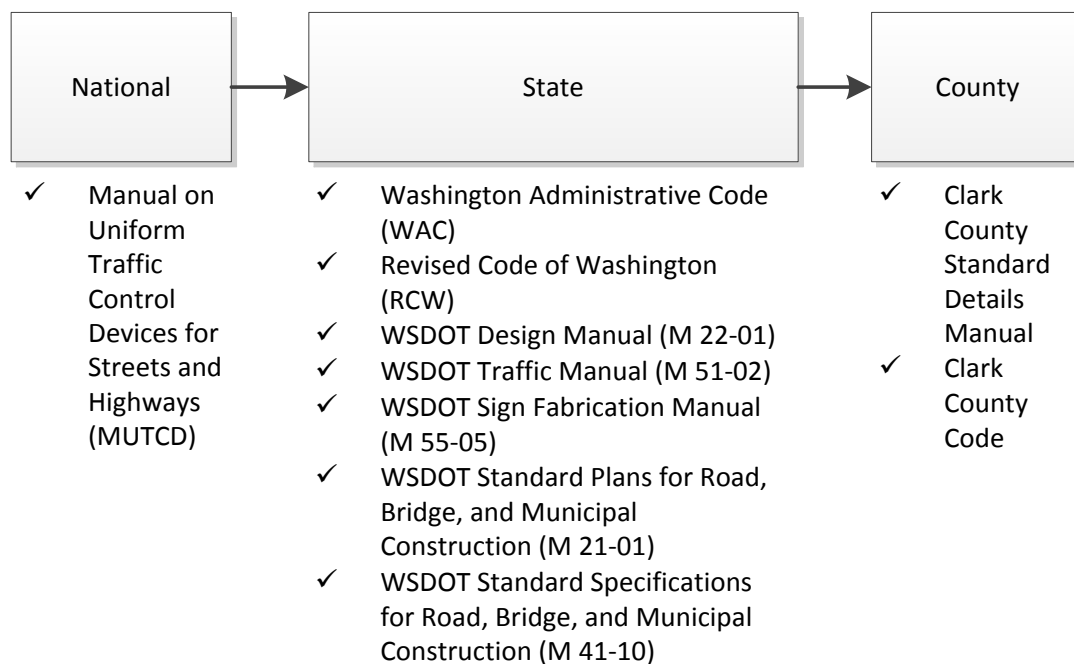




## Chapter 1 – General Information

The Clark County Traffic Manual documents the traffic engineering and operations policies and guidelines followed by Clark County. The manual covers policies and guidelines that are not universally documented as standard practices and also provides details on the implementation of traffic control devices.

The Traffic Manual follows this order: national guidance, statewide guidance where specifics have been established by the state of Washington, and Clark County code and standard details. Figure 1 shows the priority of the national, state, and county publications with which the Clark County Traffic Manual is in compliance.



**Figure 1. Hierarchy for Publications**

These publications are described in Table 1. Note that in compiling this manual additional accredited publications (such as Institute of Traffic Engineers [ITE], Transportation Research Board [TRB], National Cooperative Highway Research Program [NCHRP], and American Association of State Highway and Transportation Officials [AASHTO]) were used as resources to compile this Traffic Manual. However, these are not listed. The table covers only the publications related to compliance with national, state and countywide guidance and standards.

Table 1. Publication Descriptions

| Publication                                                                          | Level    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Manual on Uniform Traffic Control Devices (MUTCD)                                    | National | Sets standards and guidelines for traffic control devices along facilities open to public travel. Published by the Federal Highway Administration (FHWA) under Title 23 - Code of Federal Regulations (CFR), Part 655, Subpart F, and applies national laws. Emphasizes the importance of uniformity by providing standards and guidance on many aspects of traffic control, ranging from sign sizes, color, location, mounting height, and retroreflectivity to where traffic signals and other traffic control devices are recommended. Also presents examples of traffic control layouts, with recommended signing and pavement markings. |
| Washington Administrative Code (WAC)                                                 | State    | Amends the MUTCD to comply with laws and policies specific to the Revised Code of Washington.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Revised Code of Washington (RCW)                                                     |          | Compilation of the current laws in the state of Washington. Title 46 relates to motor vehicle laws, and Title 61 is specific to rules of the road.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| WSDOT Design Manual (M 22-01)                                                        |          | Provides policies, procedures, and methods for developing and documenting the design of transportation facilities in Washington State.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| WSDOT Traffic Manual (M 51-02)                                                       |          | Provides guidelines and procedures for the use and implementation of traffic control devices in Washington State.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| WSDOT Sign Fabrication Manual (M 55-05)                                              |          | Implements the guidelines for traffic signs from the MUTCD and FHWA's "Standard Highway Signs" with Washington State's modifications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| WSDOT Standard Plans for Road, Bridge, and Municipal Construction (M 21-01)          |          | Provides standard drawings showing fabrication, installation and construction methods in Washington.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| WSDOT Standard Specifications for Road, Bridge, and Municipal Construction (M 41-10) |          | Provides language used for the written agreement between WSDOT and the Contractor for work delivered to the public by WSDOT. Has been developed and refined over the years through the delivery of countless projects.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Clark County Standard Details Manual                                                 | County   | Provides standard details showing fabrication, installation and construction methods in Clark County.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Clark County Code                                                                    |          | A codification of the general ordinances of Clark County. Title 40.350 is specific to transportation and circulation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

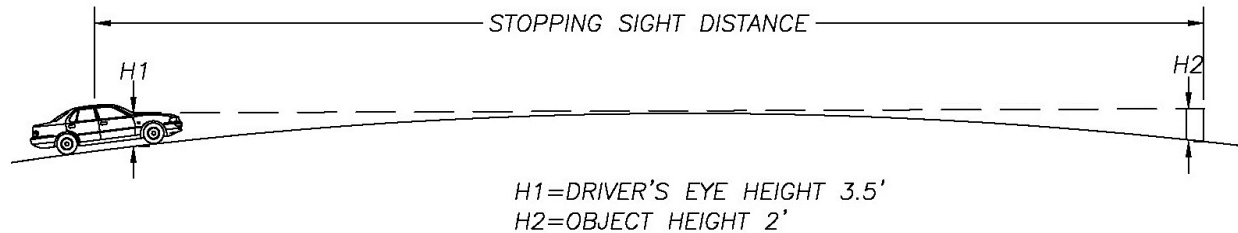
The policies and guidelines described in the body of the Clark County Traffic Manual are supplemented by materials in the appendices. Throughout the text, the appendices are referenced as needed for relevant field procedures and worksheets.

## Chapter 2 – Sight Distance

Sight distance is defined as the length of roadway visible to the driver. Clark County Code sets specific standards and guidance for different types of sight distance. This section describes two types—stopping sight distance and intersection sight distance.

### Stopping Sight Distance

Stopping sight distance is the distance needed for a driver to see an object on the roadway and to bring his or her vehicle to a safe stop prior to colliding with the object. Stopping sight distance is calculated for an assumed standard object height and driver’s eye height. It varies based on the vehicle’s speed according to the industry wide standard from “A Policy on Geometric Design of Highways and Streets.”<sup>1</sup> The calculation also includes the time for the driver to perceive the object, to react, and to respond to the potential hazard. Figure 2 illustrates the dimensional parameters for estimating stopping sight distance.



**Figure 2. Stopping Sight Distance**

Clark County Code has a standard for stopping sight distance,<sup>2</sup> as shown in Table 2. The values in the code assume a level roadway and need to be adjusted for roadway grade where applicable.

**Table 2. Stopping Sight Distance**

| Speed (mph) | Stopping Sight Distance (ft) |
|-------------|------------------------------|
| 25          | 155                          |
| 30          | 200                          |
| 35          | 250                          |
| 40          | 305                          |
| 45          | 360                          |
| 50          | 425                          |

Note: Clark County Code Table 40.350.030-7. Stopping Sight Distance

<sup>1</sup> A Policy on Geometric Design of Highways and Streets, AASHTO, 2018

<sup>2</sup> Clark County Code 40.350.030(B)(8)(a)

## Intersection Sight Distance

Intersection sight distance is the distance needed for a driver to have an unobstructed view of the side streets and any approaching vehicles prior to entering the intersection. Sufficient intersection sight distance allows the driver enough time to make a decision and proceed into the intersection. Sight triangles are the areas that should remain clear of objects to provide the driver continuous and unobstructed visibility. The dimensions of the sight triangles depend on the roadway speed and type of intersection traffic control, as described below:

- **Uncontrolled** sight triangles need to be at least 100 feet by 100 feet per Clark County Code, but may be reduced to 80 feet by 80 feet for corner lots in an urban residential subdivision.<sup>3</sup>
- **Yield controlled** sight triangles vary based on the major road speed.<sup>4</sup> Drivers approaching a YIELD sign on the minor road are permitted to enter or cross the major road without stopping, provided there are no conflicting vehicles on the major road.
- **Stop controlled** sight triangles vary based on the major road speed.<sup>4</sup> Drivers approaching a STOP sign on the minor approach must stop before entering or crossing the major road. The minor street driver must have adequate visibility along the major street to execute subsequent movement. Clark County Code has a modified standard for intersection sight distance at stop controlled intersections.<sup>5</sup> This standard is a simplified version of AASHTO's intersection sight distance. It multiplies the posted speed (in miles per hour) by a factor of 10. See Appendix B for the worksheet for intersection sight distance measurements.

*\*See Clark County Standard Details Manual for details regarding intersection sight distance and graphical illustrations.*

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<sup>3</sup> Clark County Code 40.350.030(B)(8)(c)

<sup>4</sup> A Policy on Geometric Design of Highways and Streets, AASHTO, 2018

<sup>5</sup> Clark County Code 40.350.030(B)(8)(b)

## Chapter 3 – Signs

### Sign Installation

Traffic signs are used to convey a specific message to drivers on the roadway. The MUTCD is the federally recognized source for policies, standards, and guidance regarding sign installation. Traffic signs should be installed only where warranted by facts and justified by engineering studies. Two of the compelling reasons that excessive signs are not recommended are driver distraction and inattention. Drivers can process only a certain amount of information at one time; therefore, careful consideration must be given in determining which signs should be installed to ensure safe operation of the roadway. Excessive and/or unwarranted signs diminish the significance and may even remove the validity from critical and important traffic control signs, making it difficult for the driver to react to critical signs and thereby reducing overall compliance and deteriorating traffic safety and operations.

According to the MUTCD, traffic signs are classified in three distinct categories:<sup>6</sup>

- **Regulatory:** provide notice of traffic laws or regulations
- **Warning:** provide notice of a situation that might not be readily apparent
- **Guide:** show route designations, destinations, directions, distances, services, points of interest, and other geographical, recreational, or cultural information

Signs should be used where appropriate to mitigate safety concerns and/or operational issues and to clarify situations that are not self-evident to the driver. The decision to use a particular device at a specific location should be based on an engineering study or engineering judgment.

The placement of a sign where it is not appropriate or justified is as objectionable as a substandard or obsolete sign. Therefore, all signs that were required by uncommon circumstances or temporary restrictions should always be removed or covered when such conditions cease to exist.

### Sign Spacing

Studies indicate that on average drivers are able to comprehend three words per second, after the initial perception reaction time of two seconds. Unique messages require more perception time; symbol signs take less perception time than word signs. To the extent feasible, signs must be spaced properly to allow the drivers to see, process and react prior to seeing the next sign. Therefore, regular traffic control signs should preferably be spaced at a minimum of four seconds apart, as calculated by the posted speed of the roadway. Under constrained conditions, spacing may be reduced to three seconds.

For example, for a roadway that is posted at 35 miles per hour, the minimum sign spacing would be 200 feet. The sign-spacing criteria is a general guideline and does not apply to special circumstances and signing for horizontal curves.

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<sup>6</sup> Per 2009 MUTCD Section 2A.05

### Sign Letter Height

Regulatory and warning traffic signs generally have fixed dimensions. However, special signs and those used during construction should follow Washington Department of Transportation (WSDOT) guidelines for letter height.<sup>7</sup>

The calculation is as follows:  $Letter\ Height = \left(\frac{N}{3} + 2\right) * f$

N = Number of words in the message

f = Legibility factor<sup>8</sup> (see Table 3)

**Table 3. Sign Letter Height Calculation**

| Speed Limit or 85 <sup>th</sup> Percentile Speed |                 | Legibility Factor (f) |
|--------------------------------------------------|-----------------|-----------------------|
| Miles per hour                                   | Feet per second |                       |
| 25                                               | 37              | 1.2                   |
| 30                                               | 44              | 1.5                   |
| 35                                               | 51              | 1.7                   |
| 40                                               | 59              | 2.0                   |
| 45                                               | 66              | 2.2                   |
| 50                                               | 73              | 2.4                   |

The following example applies the formula and calculates the letter height:

Message = “No Left Turn 4:00 PM to 6:00 PM”, N = 8 words

The roadway speed is 35 miles per hour, which yields a legibility factor (f) of 1.7.

$Letter\ Height = \left(\frac{8}{3} + 2\right) * 1.7 = 7.9\ inches$ , **use an 8 inch letter height**

### Regulatory Signs

Regulatory signs give notice of traffic laws or regulations and are discussed in Chapter 2B of the 2009 MUTCD. Clark County has specific guidelines for several regulatory signs, including these:

- STOP Signs
- Speed Limit Signs
- No Parking Signs
- End County Road Signs
- Barricades

#### STOP Signs

The use of STOP signs on minor-street approaches should be considered according to the conditions from the MUTCD Section 2B. Table 4 lists the STOP sign sizes for use on county roadways. The STOP sign

<sup>7</sup> The guidelines are based on needing one inch of visibility per 30 feet.

<sup>8</sup> Legibility factor is found by dividing the vehicle speed in feet per seconds by 30.

size is based on the number of lanes and speed for the minor approach that is controlled by the STOP sign and the main approach that is uncontrolled.

**Table 4. STOP Sign Sizes**

| Stop Controlled (Minor) Approach |                   | Uncontrolled (Main) Approach |                   | Sign Size |
|----------------------------------|-------------------|------------------------------|-------------------|-----------|
| Number of Lanes                  | Speed Limit (mph) | Number of Lanes              | Speed Limit (mph) |           |
| Single                           | ≤ 30              | Single                       | Any               | 30"       |
|                                  |                   | Multi-lane                   | ≤ 40              | 30"       |
|                                  |                   |                              | ≥ 45              | 36"       |
| Single                           | ≥ 35              | Any                          | Any               | 36"       |
| Multi-lane*                      | Any               | Any                          | Any               | 36"       |

\*Exclusive left or right turn lanes are considered to be multi-lane

The sign size may be increased by the engineer if there is poor sign visibility, a lack of compliance, crash history, or other justifiable field conditions. The STOP sign shall be Type XI sheeting with a protective overlay film. Where there is a pattern of drivers running the STOP sign, placement of a supplementary STOP on the left-hand side of the roadway or in the median should be considered as it has been shown to reduce crashes.

See Chapter 4 for guidance on the installation of stop lines.

### Speed Limit Signs

Guidelines related to speed limits are provided in the Washington Administrative Code,<sup>9</sup> which states that Speed Limit signs shall display the speed limits that are established by statute, ordinance or regulation. The establishment of new or the revision of existing regulatory speed limits on public roadways must go through the county's legislative body for approval.

The protocol for establishing new or revising existing regulatory speed limits on county roadways involves the following steps:

1. Upon receiving requests from the public or observation from Clark County staff, traffic engineer(s) drive the corridor to make a preliminary assessment. Possible locations to re-evaluate regulatory speeds may also include corridors that undergo significant land use, geometric, physical characteristic or traffic condition changes. The regulatory speed assessment should be based on the following roadway elements:
  - Highway: Geometric and physical conditions such as lane width, horizontal and vertical curves, pavement condition, shoulder, sight distance
  - Traffic: 85th percentile speed, pace, mean speed, mode, vehicle mix, crash history
  - Roadside culture: Access density, pedestrian environment, urban/rural, residential/commercial

<sup>9</sup> WAC 468-95-045

2. Upon concurrence from traffic engineer, a study needs to be conducted as the base line for recommending regulatory speed limit. The most common method is a speed study, but other approaches occasionally are used, such as expert system approach, speed optimization, and safe system approach (school or park zone speed).
3. The engineer reviews the results of the speed study and recommends a regulatory speed. The report should include a narrative with crash history, roadway data, roadside culture, terrain, speed data, etc. The recommendation should also account for system speed optimization and network speed.
4. The speed study should include the speed data and the vicinity map.
5. A staff report recommending the revision in regulatory speed should be prepared.
6. An ordinance establishing new regulatory speed should be prepared for the legislative body's approval.

Changes to multiple corridors may be combined in one staff report and ordinance. A speed study for each individual location shall be documented, prepared, and filed with the ordinance.

Where speed limit signs are used, signs should be placed according to the following guidance:

- For speed changes that occur midblock, the maximum offset for Speed Limit signs, in either direction, shall not be more than 50 feet from the point of speed change.
- Speed limit signs should not be placed in between a horizontal alignment warning sign and the end of the curve or turn, where the advisory speed conflicts with the regulatory speed.
- Placement of speed limit signs should be avoided within school speed zones.
- On a multi-lane highway, a supplemental speed limit sign should be installed in the median where possible.
- Speed limit signs should be installed when there is a change in speed limit. It should generally be installed after every major intersection of collectors and higher functional classification and signalized intersections.
- Speed limit signs for local access residential subdivision streets are generally installed only once at entry points to the residential street network from a higher speed roadway (except for school zones).
- The terminal point of a regulatory speed limit to basic speed is designated by an "End X Speed Limit" sign (see R2-101 custom sign, 24"x36").



R2-101

Table 5 lists the speed limit sign sizes for use on Clark County roadways. The signs sizes may be increased or decreased by the engineer based on field conditions and traffic operations consideration. Poor sign visibility, lack of compliance, crash history, or other field conditions may dictate the use of a larger sign size.

**Table 5. Speed Limit Sign Sizes**

| Number of Lanes | Speed Limit (mph) | Sign Size |
|-----------------|-------------------|-----------|
| Single          | All speeds        | 24" X 30" |
| Multi-lane      | ≤ 45              | 30" X 36" |
| Multi-lane      | 50                | 36" X 48" |



### No Parking Signs

As a general rule, no parking signs should be spaced such that a driver parked anywhere can see and recognize at least one parking prohibition sign. The standard sign size is 12" x 18" (R7-2 Mod), and the signs should be installed between 30 and 45 degrees to the roadway alignment. The county's standard no parking sign uses a symbol instead of text because symbol signs can typically be recognized and understood from about twice the distance as a word sign. A parking prohibition zone would typically be indicated by signs at the start and end points and possibly at intermediate locations. If a sign is used with an arrow at one end, the no parking zone should be closed with an opposing arrow at the other end of the zone.



R7-2 Mod

The standard spacing for no parking signs is 250 feet.<sup>10</sup> Sign spacing can be increased or decreased based on the following conditions and engineering judgment:

- Decrease sign spacing if there is excessive visual noise, if the sign uses text instead of the no parking symbol, if compliance is in doubt, and/or if sign visibility is an issue.
- Increase sign spacing if the sign is installed perpendicular to the roadway facing the traffic, the sign is oversized, and/or the driver has no choice but to drive or walk past one or more clearly visible no parking signs.

At locations where the intent is to restrict parking in the vicinity of an intersection, an option would be to install a modified version of R7-1 (12" x 18") sign that states no parking here to corner with an arrow. This option is permitted in Section 2B-47 of the 2009 MUTCD and would eliminate the need for a second sign enclosing the parking prohibition zone. The maximum distance from the intersection radius return where the use of sign would be permitted is 200 feet. The parking prohibition sign(s) should be rotated 45 degrees in the direction the parking is restricted or 30 degrees if parking is prohibited in both directions.



R7-1 Mod

Where parking is to be restricted along the entire pavement, the preferred method of signing is to post no parking signs on both sides of the street. However, right-of-way or other constraints may make posting signs on both sides of the street unfeasible. On residential streets or two-lane roads without center median, it is permissible to install no parking signs on one side of the street with a both sides plaque. If two no parking signs are installed on the same post, restricting parking on both sides, the sign installation angles should be 45 degrees facing the opposing direction of traffic. In this case, it is permissible to increase the spacing between the sign posts to 350 feet provided at least one sign is visible to the driver within the parking restriction zone at all times, as shown in Figure 3.

<sup>10</sup> Spacing is based on field experience and other agency practice; there is no guidance provided by MUTCD or WSDOT.

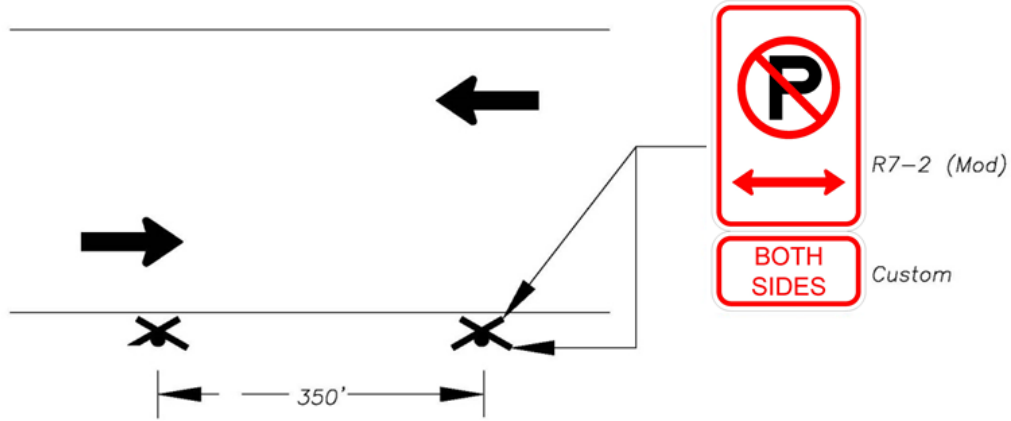


Figure 3. No Parking on Both Sides

**Parking Restrictions based on Roadway Width**

Parking may be restricted on one or both sides of the roadway based on the roadway width. In accordance with the Washington Administrative Code and Clark County Code,<sup>11,12</sup> parking restrictions that apply for specific roadway widths are shown in Table 6.

Table 6. Parking Restrictions Based on Roadway Width

| Roadway Width (W)  | Parking Restrictions based on Roadway Width (if any) |
|--------------------|------------------------------------------------------|
| $W \leq 20$ feet   | No parking on either side of the roadway             |
| $20 < W < 28$ feet | Parking on one side of the roadway                   |
| $W \geq 28$ feet   | None                                                 |

For partial-width roads that are less than 24 feet wide, parking shall be prohibited per Clark County Code.<sup>13</sup>

**Truck Parking Restrictions**

Trucks are not allowed to park on streets adjacent to a residential zone per Clark County Code 10.10. If necessary, signs restricting truck parking on such streets may be installed, using R7-107 Mod (12"x18").



<sup>11</sup> WAC 308-330-265 (11)

<sup>12</sup> Clark County Code 10.02.022, adopts WAC 308-330-265 with one amendment to (13)

<sup>13</sup> Clark County Code 40.350.030(B)(5)(a)(5)

### *Parking Restrictions based on Curvilinear Streets*

Most local access streets in unincorporated Clark County are 28 feet wide or less. To control speeds through residential neighborhoods, and in some cases to optimize the use of available land, it is a common practice to design curvilinear streets in the subdivision layout. Some bends in the street layout form right-angle bends. Because a bend in the roadway alignment does not constitute an intersection, it is legal to park vehicles within the bend area of the street. This practice has been an ongoing operational issue for larger vehicles, such as a school bus, to navigate through the bend alignment if vehicles are parked on both sides of a 28-foot-wide street. Depending on the degree of bend, through passage of larger (especially emergency) vehicles may be impeded when vehicles are parked on both sides.

Therefore, all residential street layouts with bends in the corridor, where the deflection angle is greater than or equal to 45 degrees, must demonstrate the following:

- A school bus (S-BUS-40) must be able to safely navigate the bend in the road with vehicles parked on both sides of the street.
- The assumed parking width should be eight feet from the face of the curb.
- The vehicle turning template needs to account for off-tracking and swept path of the design vehicle.
- There shall be a minimum of one foot of clearance between the body of the school bus and the parked vehicles.
- Parking shall be removed either on one or both sides of the street to accommodate the above traffic operations condition.

### *Parking Restrictions in Cul-de-sacs*

Cul-de-sacs are constructed with the purpose of allowing service vehicles, specifically fire engines, to turn around after providing service. A cul-de-sac is not required to be constructed if the length of the dead end street is 150 feet or less per Clark County Code,<sup>14</sup> because fire engines can extend their hose to a length of 150 feet. Therefore, parking should be prohibited within any cul-de-sac with length greater than 150 feet. At the discretion of the engineer, parking may be prohibited in any cul-de-sac based on traffic safety and operation considerations.

### *Parking Restrictions in Hammerheads*

Hammerheads, like cul-de-sacs are constructed with the purpose of allowing service vehicles, specifically fire engines, to turn around after providing service. The hammerhead design does not allow vehicles to turn around if there are vehicles parked within the county's standard hammerhead. For this reason, parking should be prohibited in the entire hammerhead and on one side of the approaching roadway for 60 feet, as shown in Figure 4.

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<sup>14</sup> Clark County Code 40.350.030-12(c)

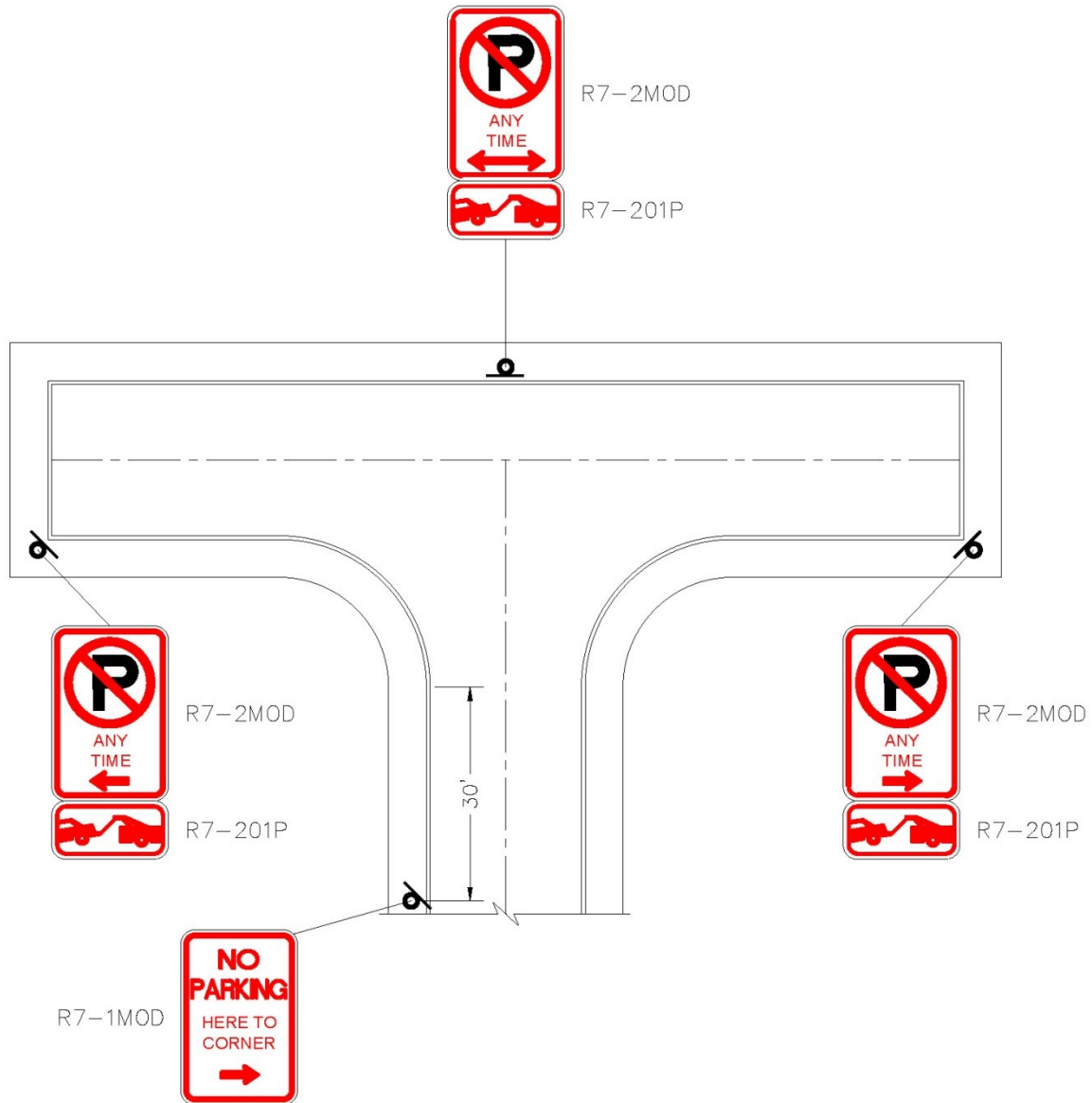


Figure 4. No Parking in Hammerhead

**End County Road Signs**

End County Road signs (see I2-703 custom sign, 36"x30") should be placed where a county road terminates but the roadway continues as privately owned.



I2-703

## Barricades

Barricades can be used to indicate the end of a roadway or sidewalk. The term, barricade, is derived from the French word *barrique*, which is any object or structure that creates a barrier or obstacle to control, block passage, or force the flow of traffic in the desired direction. Clark County typically uses Type III barricades at the end of the roadway and Type II at the end of the sidewalk. Where both types of barricade are needed at the same location, a Type III barricade may be extended to indicate the end of sidewalk in addition to the roadway.

### End of Road – Type III

The use of a Type III barricade is recommended in the following situations:

- To designate the end of pavement or travel way where a greater target value is desired as compared to an object marker
- To alert the road user of the roadway terminus, usually on a corridor with a posted speed of 35 mph and above
- To protect workers, prevent vehicles from encountering hazard or any other object beyond the end of the travel way
- To prevent trespassing beyond the end of pavement

*\*See Clark County Standard Details Manual for details regarding Type III barricades.*

In situations where a barricade is not necessary based on the above criteria, Type 4 object markers may be used instead (see section in Warning Signs).

Other methods to indicate the end of a road include a properly designed chain across the pavement, a gate, breakaway bollards, or emergency access bollards, as approved by the engineer.

### End of Sidewalk – Type II

The standard treatment for denoting the end of a sidewalk is a Type II barricade. However, this is not always the optimum treatment. Sometimes these barricades force pedestrians to walk in the vehicle travel way to get around the barricade or the barricade obstructs the line of sight. Therefore, if a non-hazardous flat shoulder or reasonable surface beyond the end of sidewalk is available for use by most pedestrians, a temporary transition should be installed.

*\*See Clark County Standard Details Manual for details regarding Type II barricades.*

For private development and capital projects, the civil designer should consult with the traffic engineer to determine the appropriate treatment at the end of the sidewalk. Pedestrian safety, pedestrian route continuity, and American with Disabilities Act (ADA) requirements should be considered in selecting the appropriate treatment. Based on field conditions, the construction engineer may also recommend alternate treatment at the end of sidewalk. The ultimate responsibility for determining and specifying an end-of-sidewalk treatment will rest with the civil designer.

## Warning Signs

Warning signs give notice of a situation that might not be readily apparent and are discussed in Chapter 2C of the 2009 MUTCD. Clark County has specific guidelines for several warning signs, including the following:

- Horizontal Alignment Signs
- Narrow Road Signs
- DEAD END/NO OUTLET Signs
- Stop Ahead Signs
- Signal Ahead Signs
- Intersection Warning Signs
- Deer Crossing Signs
- Equestrian Crossing Signs
- Object Markers

### Horizontal Alignment Signs

To reduce run-off-the-road crashes, the MUTCD provides guidance regarding horizontal alignment signs, as shown in Table 7. The recommendations are based on the speed differential, which is defined as the difference between the speed limit and the advisory speed. Clark County guidelines follows the MUTCD but provide more detailed criteria for the circumstances under which each horizontal alignment sign should be installed.

Warning signs are important traffic control devices for enhancing traffic safety and require care and prudence in the choice of installation. The level of signing and striping should be proportional to the degree of threat posed to the traffic because of the curvilinear alignment. Vehicles tend to lose control and run off the road where drivers encounter unexpected changes in alignment or are driving too fast for the conditions. Excessive signage leads to sign pollution and diminishes the importance and effectiveness of warning signs at high risk locations.

**Table 7. Horizontal Alignment Sign Selection (MUTCD Table 2C-5)**

| Type of Horizontal Alignment Sign                                                                                                                                                  | Difference Between Speed Limit and Advisory Speed |             |          |          |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-------------|----------|----------|----------|
|                                                                                                                                                                                    | 5 mph                                             | 10 mph      | 15 mph   | 20 mph   | ≥ 25 mph |
| Turn (W1-1), Curve (W1-2), Reverse Curve (W1-4), Winding Road (W1-5), and Combination Horizontal Alignment/Intersection (W10-1) (see Section 2C.07 to determine which sign to use) | Recommended                                       | Required    | Required | Required | Required |
| Advisory Speed Plaque (W13-1P)                                                                                                                                                     | Recommended                                       | Required    | Required | Required | Required |
| Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)                                                                                                                            | Optional                                          | Recommended | Required | Required | Required |

**Note:** Required means that the sign and/or plaque shall be used, recommended means that the sign and/or plaque should be used, and optional means that the sign and/or plaque may be used. See MUTCD Section 2C.06 for roads with ADT < 1,000.

**Supplemental Curve Warning Signing Based on Speed Differential**

The speed differential at curves should be estimated based on operational speed or running speed just prior to the curve and the advisory speed for the curve. Appendix A provides typical acceleration distances to determine the operational speed in between curves, as well as the county’s field procedure for ball banking, to determine the appropriate advisory speed for the curve.

The recommendations for supplemental curve warning signing based on the speed differential are summarized in Table 8.

**Table 8. Supplemental Curve Warning Signing based on Speed Differential**

| Speed Differential (Operational Speed - Curve Advisory Speed) | Supplemental Curve Warning Signs                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 mph                                                        | Supplemental warning signs are not required.                                                                                                                                                                                                                                                                                      |
| 15 mph                                                        | Supplemental warning signs, in the form of a large arrow or a series of chevrons, are required in addition to the standard advisory sign.                                                                                                                                                                                         |
| 20 mph                                                        | Supplemental warning signs are required and a curve advisory plaque should be considered below the large arrow or series of chevrons.                                                                                                                                                                                             |
| ≥ 25 mph                                                      | In addition to the recommendations for the scenario with a speed differential of 20 mph, there are various options that can be considered. The options include any combination of the following: install a combination horizontal alignment/advisory speed sign, use of oversized sign(s), and/or use of a higher sign face type. |

The scenarios shown in Figure 5 present a general guideline for installing warning signs and traffic control devices for a single horizontal curve encountered on a roadway alignment. This guideline is generally meant for non-continuous curves (curves separated by more than 600 feet) or curves signed separately. Assessment of field conditions and engineering judgment should be exercised at every location to determine the proper traffic control device. Crash history, pavement grades, drop-off, presence of other hazards, driver expectations, or field conditions may require installation of additional traffic control devices or provision of other treatments.

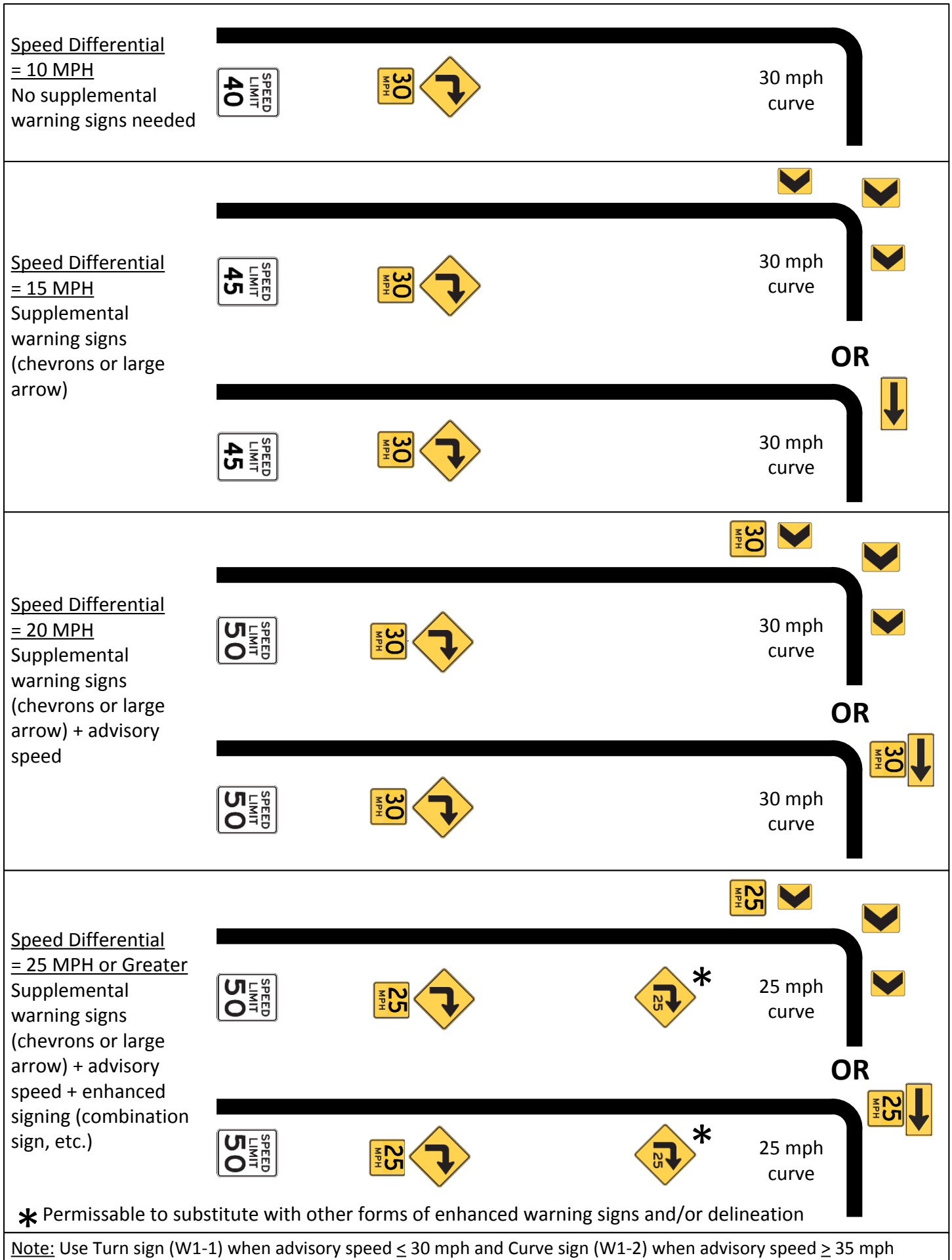
#### **Curve Warning Signing for Winding Roads**

For a series of at least three curves separated by tangent distances of less than 600 feet, the winding road sign should be used. A supplemental plaque may be used with a winding road sign, such as NEXT 1/2 MILE. The slowest safe advisory speed in the series of curves shall be used as the advisory speed plaque for the winding road warning sign. If the difference in safe advisory speeds between the curves in the series is extreme, then the engineer may consider signing the curves separately by using a combination of single curve, reverse curve, and/or winding road signs.

The scenarios in Figure 6 for winding roads and Figure 7 for a reverse curve followed by a single curve present a general guideline for installing warning signs and traffic control devices for a series of horizontal curves encountered on a roadway alignment. For determination of the speed differential, the operational speed just prior to the curve should be assessed for field conditions, and proximity and sharpness of the previous curve. These factors will affect the approach speed of the driver, and in turn how the next curve should be treated. The typical acceleration distances provided in Appendix A can be used to determine the operational speed in between curves.



Figure 5. Curve Warning Signing based on Speed Differential

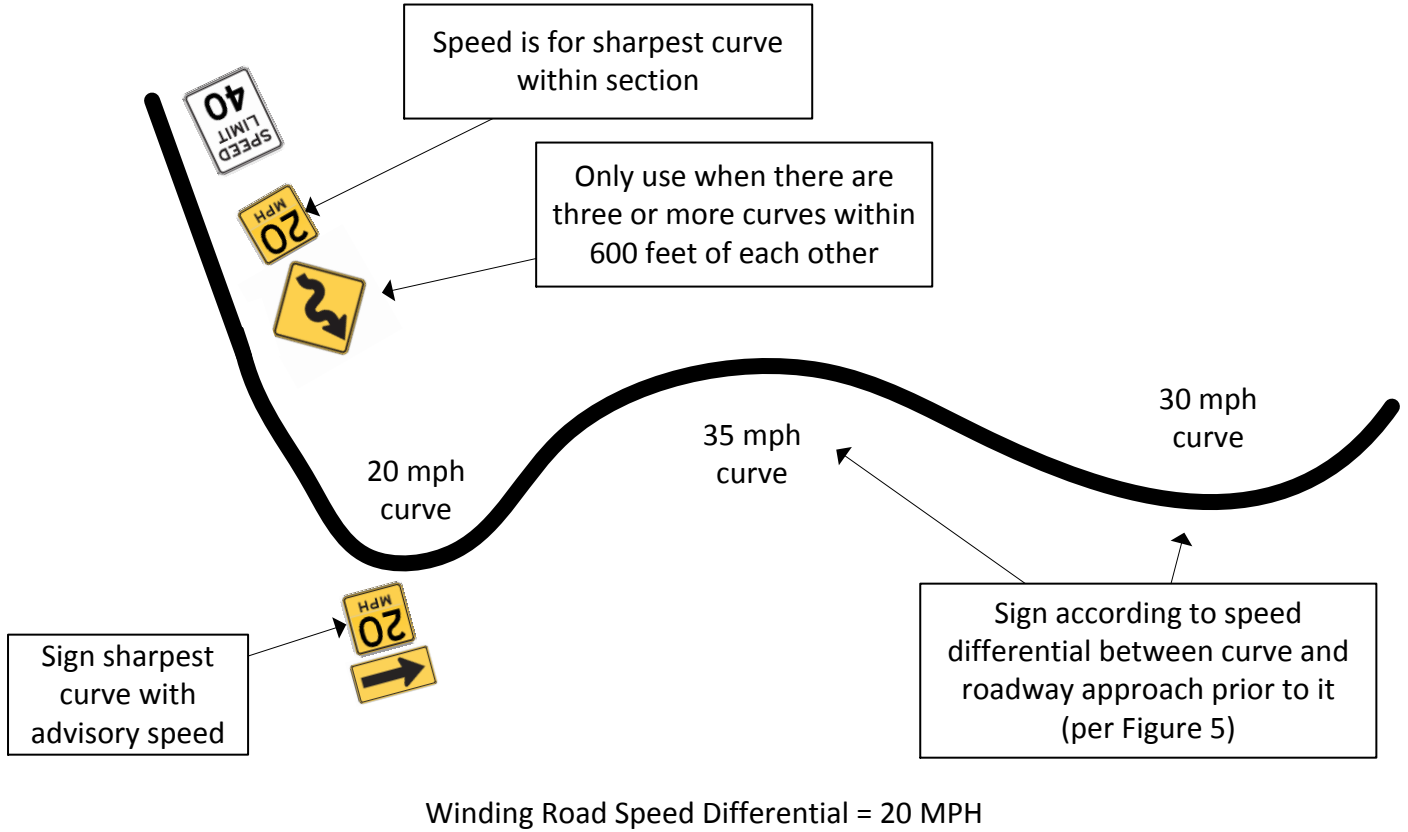


\* Permissible to substitute with other forms of enhanced warning signs and/or delineation

Note: Use Turn sign (W1-1) when advisory speed  $\leq$  30 mph and Curve sign (W1-2) when advisory speed  $\geq$  35 mph

Figure 6. Curve Warning Signing for Winding Roads

Winding Road Example #1



Winding Road Example #2

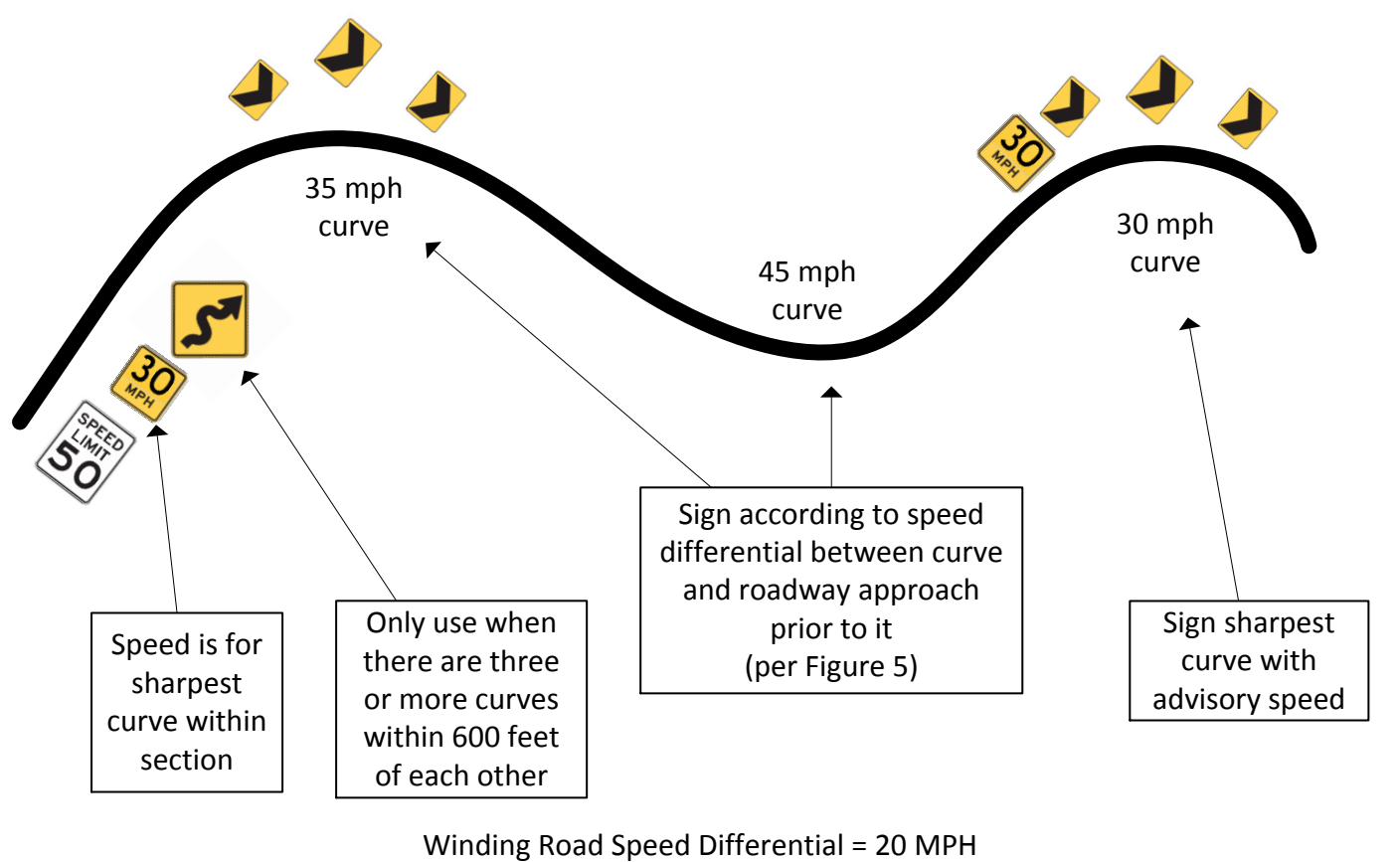
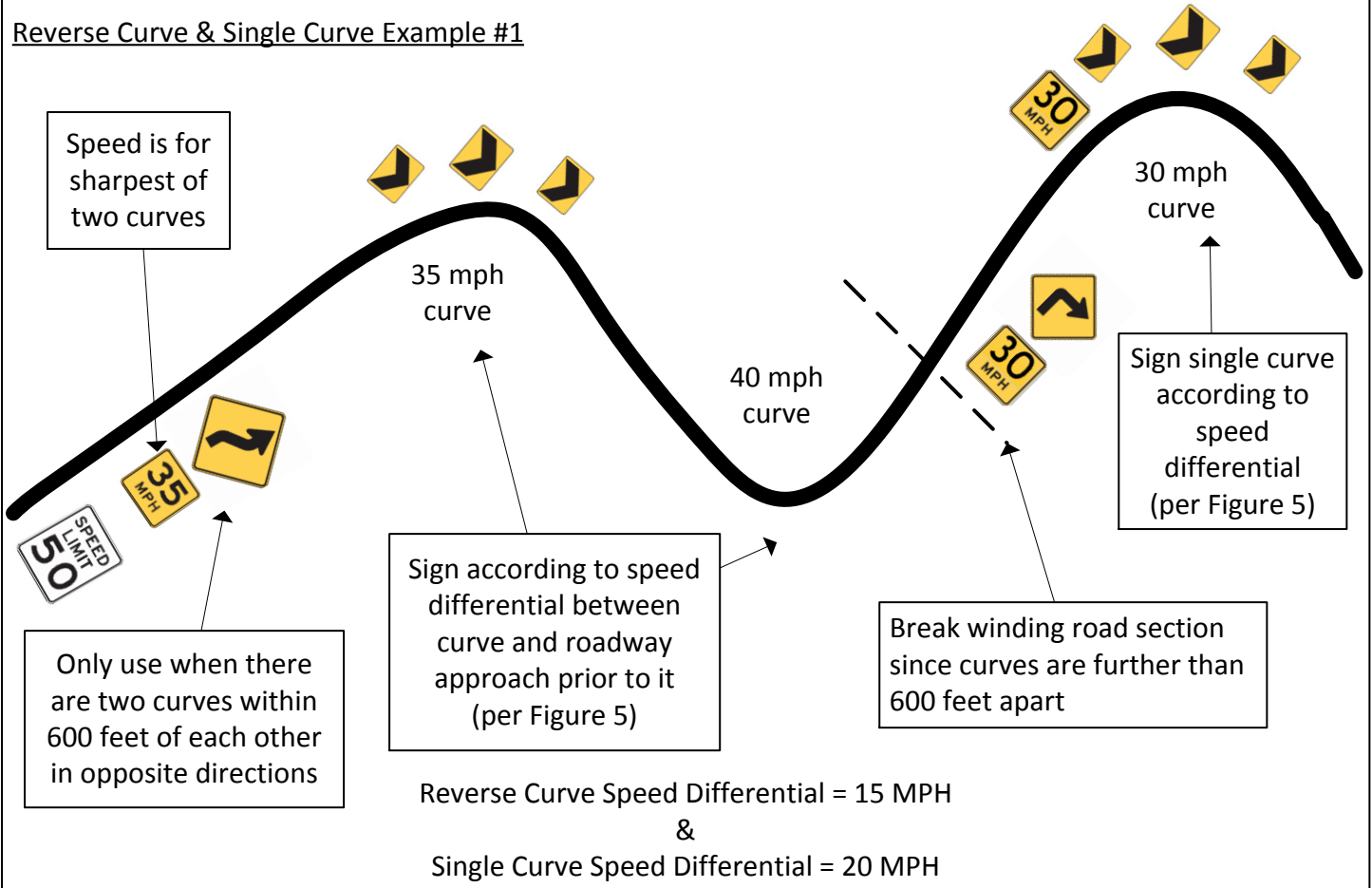
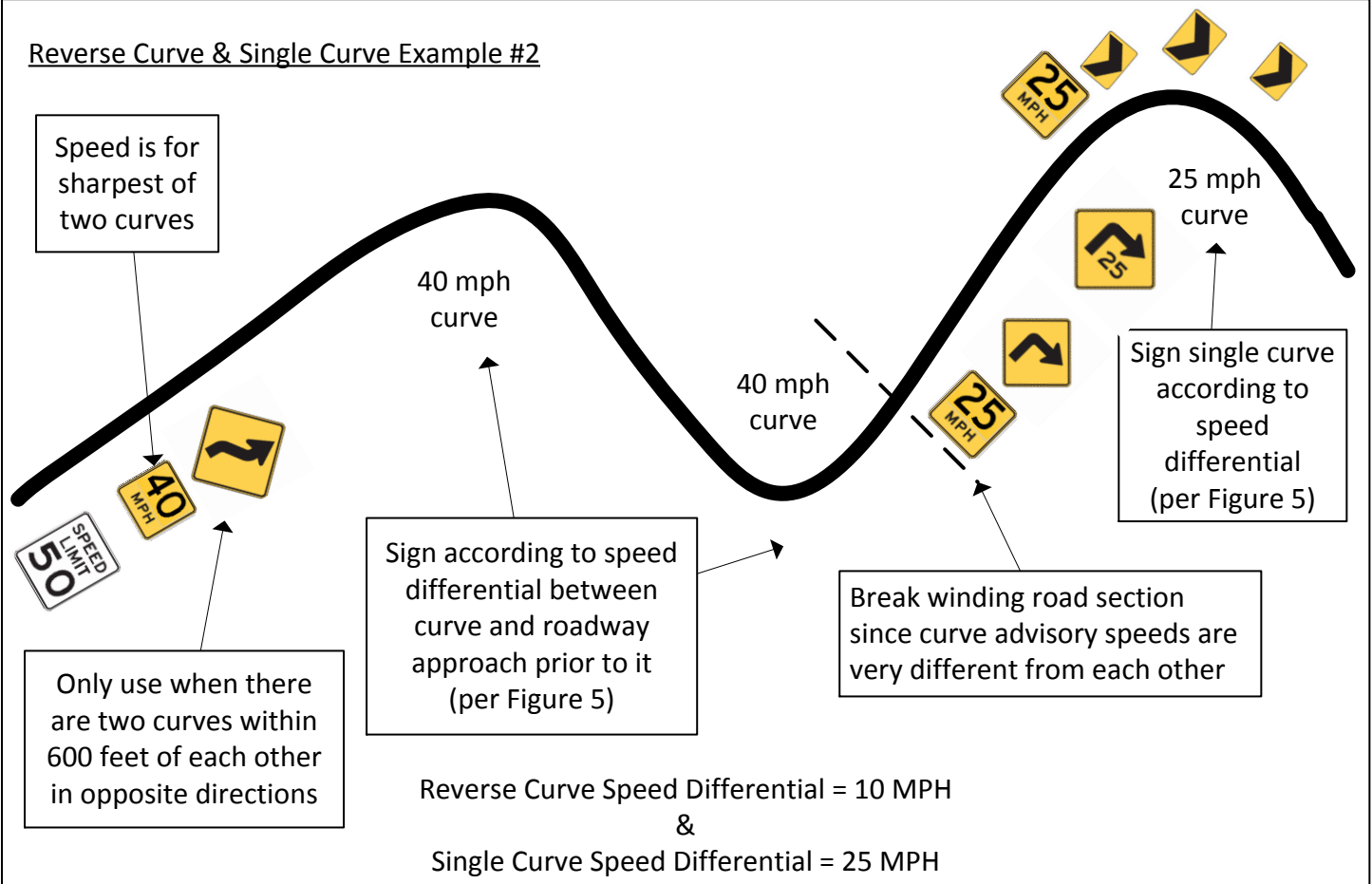


Figure 7. Curve Warning Signing for Reverse Curve & Single Curve

Reverse Curve & Single Curve Example #1



Reverse Curve & Single Curve Example #2



## Sign Placement

The following are guidelines for placement of curve warning signs. Sign placement should consider sign visibility and proximity to other signs. Curve warning signs are spaced according to the speed, as shown in Table 9. The advance sign placement distance is the minimum but could be increased based on a variety of field conditions such as sign visibility to the approaching driver and proximity to other signs.

**Table 9. Guidelines for Advance Placement of Warning Signs (Modified MUTCD Table 2C-4)**

| Posted or 85 <sup>th</sup><br>Percentile<br>Approach Speed<br>(mph) | Advance Placement Distance (feet)                                              |     |     |     |
|---------------------------------------------------------------------|--------------------------------------------------------------------------------|-----|-----|-----|
|                                                                     | Condition B: Deceleration to the listed advisory speed (mph) for the condition |     |     |     |
|                                                                     | 10                                                                             | 20  | 30  | 40  |
| 35 - 40                                                             | 150                                                                            | 150 | 150 | -   |
| 45                                                                  | 150                                                                            | 150 | 150 | 150 |
| 50                                                                  | 200                                                                            | 175 | 150 | 150 |

Where supplemental warning signs are required based on the speed differential, a large arrow sign or chevron alignment signs may be used. A large arrow sign is typically selected for sharper radius curves. In some situations both large arrow and chevron alignment signs may be used on the same curve to address safety and traffic operational concerns. Additionally, large arrow or chevron alignment signs may sometimes be appropriate even if the supplemental curve warning signs are not warranted based on the speed differential. For an example, a combination of a horizontal and vertical curve might create a blind curve or there could be other safety concerns such as a major drop-off in the vicinity of a horizontal curve.

Large arrow signs are placed on the outside of the turn or curve in line with the headlight of the approaching traffic to guide traffic through the change in the horizontal alignment. Selecting the optimal sign placement is best done in the field.

Chevron alignment signs are placed on the outside of the turn or curve to guide traffic. Chevron alignment signs are spaced according to the advisory speed and/or curve radius, as shown in Table 10, based on MUTCD guidance. If the sign spacing based on the curve radius yields a closer spacing as compared to the spacing based upon the advisory speed, the more conservative value should be used. Chevron alignment signs start at the point of curve (PC) of the curve and end at the curve point of tangent (PT). The sign placement is to ensure that at least two chevron signs are visible to the approaching driver through the entire curve.

**Table 10. Typical Spacing of Chevron Alignment Signs on Horizontal Curves (MUTCD Table 2C-6)**

| Advisory Speed (mph) | Curve Radius (feet) | Sign Spacing (feet) |
|----------------------|---------------------|---------------------|
| ≤ 15                 | < 200               | 40                  |
| 20 – 30              | 200 – 400           | 80                  |
| 35 – 45              | 401 – 700           | 120                 |
| 50 – 60              | 701 – 1,250         | 160                 |
| > 60                 | > 1,250             | 200                 |

### Narrow Road Signs

A narrow road sign (W5-2a) may be used at the beginning of a narrow unimproved corridor with an average daily volume of less than 600 vehicles per day. Corridors with pavement width between 16 and 18 feet and minimal shoulder may qualify for a narrow road sign with an accompanying advisory speed plaque. The advisory speed for the narrow road would be based upon the judgement and recommendation of the reviewing traffic engineer evaluating the safe operational speed of the corridor.



W5-2a

### DEAD END/NO OUTLET Signs

A street with a terminal at one end is defined as a dead end street. As a general rule, to provide navigational guidance to drivers, a warning sign should be installed at the entrance for all dead end streets. However, the DEAD END or NO OUTLET sign may not be necessary where the terminal status of the road is clearly apparent to the driver.

The following guidelines apply regarding the installation of a DEAD END sign at the entrance of the street (if these conditions are met, no additional signs are necessary):

- A DEAD END sign should be installed on all new dead end roads longer than 250 feet or where the status of the road is not readily apparent to the driver on the through street.
- A DEAD END sign should be considered on existing dead end roads longer than 350 feet or where the terminal status of the road is not readily apparent to the driver on the through street.
- The DEAD END sign should be installed at a location easily observed by the driver on the main street prior to committing the vehicle to the terminal street.
- To enhance early detection of the terminal street, preference should be given to installing a rectangular DEAD END sign (W14-1a) on top of the street name signs.
- Depending upon field conditions and practicality, consideration may be given to installing a DEAD END sign (W14-1) at the back of a STOP sign or on the departure side of the terminal street.

The following guidelines apply regarding the installation of a NO OUTLET sign at the entrance of the street (if these conditions are met, no additional signs are necessary):

- A NO OUTLET sign shall be installed for a street network that has only one point of ingress/ egress.
- To enhance early detection of the closed street network, preference should be given to installing a rectangular NO OUTLET sign (W14-2a) on top of street name signs.
- Depending upon the field conditions and practicality, consideration may be given to installing a NO OUTLET sign (W14-2) at the back of STOP sign or on the departure side of the terminal street.

### Stop Ahead Signs

The installation and placement of a supplemental Stop Ahead warning sign are based on federal guidelines.<sup>15</sup> When a Stop Ahead sign is used, it should match the STOP sign size. The Stop Ahead sign must be visible from 180 feet, the sign may be moved further back from the standard distances if the sign is not visible from 180 feet.

The sign should be considered under the following circumstances:

- If visibility of the STOP sign is less than the required STOP sign visibility distance from Table 11.
- If the intersection is a high crash location due to low compliance of the stop control.
- If the stop control is at an unexpected location such as at an intersection after a long stretch of uncontrolled traffic flow.
- If the STOP sign controls a rural classified roadway.
- If environmental factors like fog or glare prevent the approaching driver from clearly comprehending the traffic control in time to take decisive action.
- If the corridor speed limit is 45 mph and above.

The visibility required for a STOP sign is based on decision sight distance.<sup>16</sup> The STOP sign should be visible and free of obstructions such as tree branches, vegetation, other signs, etc. Its required minimum visibility distance for various speeds is listed in Table 11.

Where warranted, the Stop Ahead sign should be placed at the distance shown in Table 11, which is a calculated minimum distance from the back of the STOP sign. The placement of the Stop Ahead sign is based on selecting the greater of the following distances measured from the STOP sign:

- Required STOP sign visibility distance minus 180 feet (based on the assumption that the sign is visible to the approaching driver from a distance of 180 feet).
- 3.5 seconds of vehicle travel time.
- Minimum distance of 150 feet.

**Table 11. STOP Sign Visibility and STOP AHEAD Sign Placement**

| Posted Speed (mph) | Required STOP Sign Visibility Distance (feet) <sup>17</sup> | Stop Ahead Sign Placement Distance (feet) |
|--------------------|-------------------------------------------------------------|-------------------------------------------|
| 25                 | 180                                                         | 150                                       |
| 30                 | 220                                                         | 155                                       |
| 35                 | 275                                                         | 180                                       |
| 40                 | 330                                                         | 210                                       |
| 45                 | 395                                                         | 235                                       |
| 50                 | 465                                                         | 285                                       |

<sup>15</sup> MUTCD and AASHTO's "A Policy on Geometric Design of Highways and Streets"

<sup>16</sup> Column 0 of Table 2C-4 from FHWA's "Manual on Uniform Traffic Control Devices", 2009

<sup>17</sup> Column A of Table 3-3 Decision Sight Distance from AASHTO's "A Policy on Geometric Design of Highways and Streets", 2018

For the majority of the speeds, the distance that dictates is the 3.5 seconds of vehicle travel time.

### Signal Ahead Signs

Advance traffic control of a Signal Ahead sign with a street name plaque should be installed in advance of all traffic signals. The engineer has the option of omitting the Signal Ahead sign on a local access road approach to a signalized intersection. Advance sign placement is generally based on MUTCD 2C-4 but modified to accommodate other factors such as length of turn lanes, number of through lanes and traffic volume.

The advance street name plaque (W16-8) is typically placed below the signal ahead sign, however if the plaque is significantly wider than the signal ahead sign, then the plaque may be installed above the signal ahead sign.



W3-3 & W16-8p

### Intersection Warning Signs

Intersection warning signs are typically installed when the intersection approach is uncontrolled. Advance sign placement is generally based on MUTCD 2C-4 but modified to accommodate other factors such as length of turn lanes, number of through lanes and traffic volume. Intersection warning signs should be installed if any of the following conditions are met:

- Side street is a collector or above
- Sight distance issue
- Intersection is hidden
- Crash history

The advance street name plaque (W16-8) is typically placed below the intersection warning sign, however if the plaque is significantly wider than the intersection warning sign, then the plaque may be installed above the intersection warning sign.

### Deer Crossing Signs

The MUTCD provides guidance for Deer Crossing signs (W11-3).<sup>18</sup> Prudence is recommended when authorizing installation of such a sign. The following is the Clark County criteria for consideration of a Deer Crossing sign:

- At least five documented deer/vehicle collisions per mile per year for at least two years over the past 10 years.
- At least 10 carcass counts per mile per year for at least three years over the past 10 years, which does not mean documented vehicle/deer crashes.
- Based on field knowledge, maintenance activity and input from maintenance staff.
- For a longer corridor stretch, it is permissible to install a plaque such as Next 2 Miles (W16-4P) below the Deer Crossing sign (W11-3).

<sup>18</sup> 2009 MUTCD Section 2C.41

The sign should be reviewed for continued necessity every 10 years and should be considered for removal if either of the following conditions are met:

- The deer/vehicle collision incidents listed in previous bullets 1 and 2 drop to half or less **OR**
- Maintenance staff recommends removal of the sign based on field knowledge.

### Equestrian Crossing Signs

Clark County, Washington has one of the highest densities of per capita horse ownership in the nation. As such, the County receives requests for equestrian crossing signs. Per Section 2C.50 of the 2009 MUTCD, the crossing signs may be installed where there are unexpected entries of horses in the roadway. The County will consider the installation of equestrian crossing warning signs where certain conditions are met. In order for the crossing to be eligible for the signs, a critical crossing threshold would need to be met, similar to criteria for pedestrian crossings.

1. The signs would be installed for public trail crossings where riders are expected to use the trail for horse ridership.
2. The signs would be installed for a licensed stable where:
  - a) The stable has a minimum capacity for 15 horses, and
  - b) The facility boards horses for horse keeping, and
  - c) The facility trains horses and riders, and
  - d) The horse owners cross the roadway to either ride along County roadway or access the facility or the horses cross the roadway to transfer between adjacent facilities, and
  - e) The crossing meets minimum stopping sight distance.

If installed, the crossing would be signed with an equestrian crossing sign (W11-7) with a downward arrow plaque (W16-7p) at the crossing location and an advance equestrian crossing sign (W11-7) paired with an ahead plaque (W16-9p).

### Object Markers

Type 3 object markers, such as OM3-L or OM3-R, are used to mark obstructions adjacent to or within the roadway. They are most commonly used to mark bridge ends or utility poles, but they may also be used to delineate the edge of pavement for half-width road improvements (especially for short sections). The suitable mounting height for Type 3 object markers in most circumstances is four feet.<sup>19</sup>

Type 4 object markers, such as OM4-1, OM4-2 or OM4-3, are used to mark the end of roadway, when a barricade is not being used (see Regulatory Signs section). When Type 4 object markers are used to denote the end of a roadway, the minimum mounting height shall be four feet.

<sup>19</sup> MUTCD 2009, Section 2C.63



## Chapter 4 – Markings

Markings on roadways provide guidance and information for the road user according to Chapter 3A of the 2009 MUTCD. Clark County has specific guidelines for striping, pavement markings, and raised pavement markers.

### Striping

Clark County has specific guidelines for the following types of roadway striping:

- Centerline and Edge Lines
- No-Passing Zones
- Drop Lane Lines

#### Centerline and Edge Lines

The guidelines for striping centerlines and edge lines on county roads are summarized in Table 12. The guidelines describe the conditions under which centerline and/or edge lines should be installed, based on functional classification, roadway width, volume, speed, and other considerations. Roadway width is defined as the width from one edge of pavement to the other edge. Typically, edge lines are striped with equal shoulder width on either side of the roadway and should generally be considered only in the absence of curb, gutter and/or sidewalk. The Clark County policy meets the Washington requirements for edge lines per the Washington Administrative Code.<sup>20</sup>

Existing centerline and/or edge line striping will continue to be maintained on facilities that do not qualify for centerline and/or edge line striping according to the current guidelines until the pavement is resurfaced.

With written justification by a traffic engineer, centerline, edge line, and/or raised pavement markers may be installed to address safety and/or traffic operational concerns along corridors not meeting the striping guidelines.

If a rural major or rural minor collector qualifies for centerline and/or edge line striping, the striping should be continued to a logical end point and even if the route continuity is a lower volume road and/or an unclassified road that generally does not qualify for centerline and/or edge line striping. If the facility narrows beyond the point where the roadway qualifies for striping, the maintenance staff should contact traffic engineering staff for direction.

*\*See Clark County Standard Details Manual for details regarding centerline and edge line striping.*

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<sup>20</sup> WAC 468-95-190 Edge lines shall be on paved rural arterials with a traveled way or 20 feet or more in width and an average daily traffic (ADT) of 6,000 or greater vehicles per day

**Table 12. Guidelines for Striping of County Roads**

| Functional Classification                             | Roadway Width (ft) | Centerline Striping                                                                                                            | Edge Line Striping                                                                                                                                                                                                                                                                                                                                                                                     | Notes                                                                                                                             |
|-------------------------------------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| <b>Urban major and minor arterials and collectors</b> |                    |                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                   |
| Urban Arterial                                        | < 18               | No                                                                                                                             | Yes                                                                                                                                                                                                                                                                                                                                                                                                    | When width is 16-18 feet, only install centerline striping to improve safety and traffic operations <sup>1</sup> .                |
|                                                       | 18 – 20            | Conditional, if:<br>- Improves traffic operations <sup>1</sup> <u>OR</u><br>- ADT > 2,000 <u>OR</u><br>- Posted speed > 30 MPH | Yes                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                   |
|                                                       | ≥ 20               | Yes                                                                                                                            | Yes                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                   |
| Urban Collector                                       | < 18               | No                                                                                                                             | No                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                   |
|                                                       | 18 – 20            | Conditional, if:<br>- Improves traffic operations <sup>1</sup> <u>OR</u><br>- ADT > 2,000 <u>OR</u><br>- Posted speed > 25 MPH | No (unless an engineer determines there is a unique situation that justifies it)                                                                                                                                                                                                                                                                                                                       |                                                                                                                                   |
|                                                       | ≥ 20               | Yes                                                                                                                            | Conditional, if:<br>- Improves traffic operations <sup>2</sup> <u>OR</u> to provide shoulder for bikes or pedestrians                                                                                                                                                                                                                                                                                  | Minimum travel lane width is 10 feet. Centerline may be offset to provide shoulder on one side of the road for pedestrians/bikes. |
| <b>Rural major and minor collectors</b>               |                    |                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                   |
| Rural Collector                                       | ≤ 16               | No                                                                                                                             | Conditional, if:<br>- < 3 feet recovery area shoulders and ≥ 4 feet drop adjacent to the recovery area <u>OR</u><br>- Winding road terrain with advisory curves speed of 25 MPH or less <u>OR</u><br>- 5 or more preventable, run off the road crashes/mile in the past 3 years <u>OR</u><br>- Other factors such as ADT, school bus routes, grades, vertical curves, and other fixed roadside objects | The road should be signed “SINGLE LANE ROAD - xx FEET” if the driveable shoulder is less than 2 feet on either side.              |
|                                                       | 16 – 18            | No                                                                                                                             | Conditional, if:<br>- Significant portion of corridor is next to a hazard <sup>3</sup> warranting barrier protection <u>OR</u> ADT > 1,200                                                                                                                                                                                                                                                             |                                                                                                                                   |
|                                                       | 18 – 20            | Conditional, if:<br>- Improves traffic operations <sup>1</sup> <u>OR</u><br>ADT > 1,500                                        | Yes                                                                                                                                                                                                                                                                                                                                                                                                    | Edge line striping may be omitted if ADT < 600.                                                                                   |

| Functional Classification                                                      | Roadway Width (ft) | Centerline Striping                                                                             | Edge Line Striping                                                 | Notes                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rural Collector                                                                | 20 – 26            | Yes                                                                                             | Yes                                                                | Centerline and/or edge line striping may be omitted if ADT < 600.                                                                                                                                                                                                                                           |
|                                                                                | ≥ 26               | Yes                                                                                             | Yes                                                                | Centerline and/or edge line striping may be omitted if ADT < 600.<br>Where a pedestrian path does not exist, travel lanes should be 11 feet with equal shoulder on both sides <sup>4</sup> . Wider travel lanes may be used for heavy vehicle traffic or if adequate shoulder for pedestrians is available. |
| <b>Unclassified roadways including neighborhood collectors and circulators</b> |                    |                                                                                                 |                                                                    |                                                                                                                                                                                                                                                                                                             |
| Local Urban                                                                    | < 20               | No                                                                                              | No                                                                 |                                                                                                                                                                                                                                                                                                             |
|                                                                                | 20 – 24            | Conditional, if:<br>- Roadway is classified/ functions like a neighborhood collector/circulator | No                                                                 |                                                                                                                                                                                                                                                                                                             |
|                                                                                | ≥ 24               | Conditional, if:<br>- Roadway is classified/ functions like a neighborhood collector/circulator | Conditional, if:<br>- To provide shoulder for bikes or pedestrians |                                                                                                                                                                                                                                                                                                             |
| Local Rural                                                                    | < 20               | No                                                                                              | No                                                                 |                                                                                                                                                                                                                                                                                                             |
|                                                                                | 20 – 26            | Conditional, if:<br>- ADT > 1,500                                                               | No                                                                 | The engineer may use RPM’s instead of a centerline at specific locations, such as curves.<br>If edge line striping is used, minimum travel lane width should be 11 feet.                                                                                                                                    |
|                                                                                | ≥ 26               | Conditional, if:<br>- ADT > 1,500                                                               | Conditional, if:<br>- To provide shoulder for bikes or pedestrians |                                                                                                                                                                                                                                                                                                             |

**Notes:**

1. Factors such as ADT, vertical and horizontal alignments to designate passing/no passing zones would be a key factor in determining the striping of centerlines.
2. Prevents crashes, prevents run-off-the road, serve as a traffic calming tool, etc.
3. Has less than a foot of recoverable shoulder followed by significant drop-off and/or fixed objects too close to the travelled way.
4. Equal shoulders are suggested since at least some paved shoulder at the edge increases the traffic safety, especially at curves. The presence of paved shoulders also helps save the edge of pavement from disintegrating, especially where there is large percentage of heavy vehicles. All shoulders may be moved to one side of the road if there is substantial pedestrian traffic.

### No-Passing Zones

The following passing and no-passing zone standards for two- and three-lane roadways are largely based on the publications, “A Policy on Geometric Design of Highway and Streets” and “NCHRP Report 605.”<sup>21,22</sup> The passing sight distance,<sup>23</sup> minimum passing zone length,<sup>24</sup> and minimum no-passing zone length all vary by the posted speed of the roadway, as shown in Table 13. The engineer should exercise judgment, due diligence, and discretion in applying these values and base the passing zone striping on actual field conditions and traffic operations.

**Table 13. Minimum Passing & No-Passing Zone Lengths**

| Posted Speed (MPH) | Passing Sight Distance (Feet) <sup>23</sup> | Minimum Passing Zone Length (Feet) <sup>24</sup> | Minimum No-Passing Zone Length (Feet) |
|--------------------|---------------------------------------------|--------------------------------------------------|---------------------------------------|
| 25                 | 450                                         | 475                                              | 275                                   |
| 30                 | 500                                         | 550                                              | 325                                   |
| 35                 | 550                                         | 650                                              | 375                                   |
| 40                 | 600                                         | 750                                              | 400                                   |
| 45                 | 700                                         | 800                                              | 400                                   |
| 50                 | 800                                         | 800                                              | 400                                   |

Passing zones on a two-lane highway should be established at reasonable intervals and placement should consider traffic volume, vehicle classification, and level of service. In situations where there are long intervals between passing zones, the engineer may authorize a passing zone less than the minimum acceptable passing zone length, in order to provide a passing opportunity. For example, on a two mile long corridor that is 50 MPH without any opportunity for a driver to pass, it may make sense to add a passing zone that is 600 feet long, even though that is less than the minimum of 800 feet. Additionally, to accommodate a passing zone, the minimum no-passing zone length could be reduced by up to half the stated value from Table 13 (column 4) on a case-by-case basis and following engineering judgment.

Figure 8 shows examples of how to layout striping for passing and no-passing zones for three scenarios: (1) the passing zone needs to be closed out and changed to no-passing, (2) the no-passing zone needs to be extended, and (3) the no-passing zone needs to be reduced to accommodate a passing opportunity.

<sup>21</sup> AASHTO, A Policy on Geometric Design of Highway and Streets, 2018

<sup>22</sup> NCHRP Report 605, Passing Sight Distance Criteria, 2008

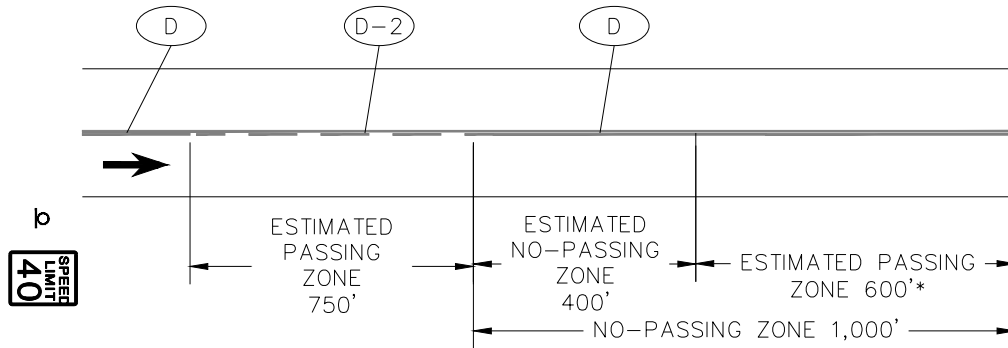
<sup>23</sup> Table 3-4. A Policy on Geometric Design of Highways and Streets (AASHTO)- 2018 Edition

<sup>24</sup> Table 3-5. A Policy on Geometric Design of Highways and Streets (AASHTO)- 2018 Edition

Figure 8. No-Passing Zone Striping Examples

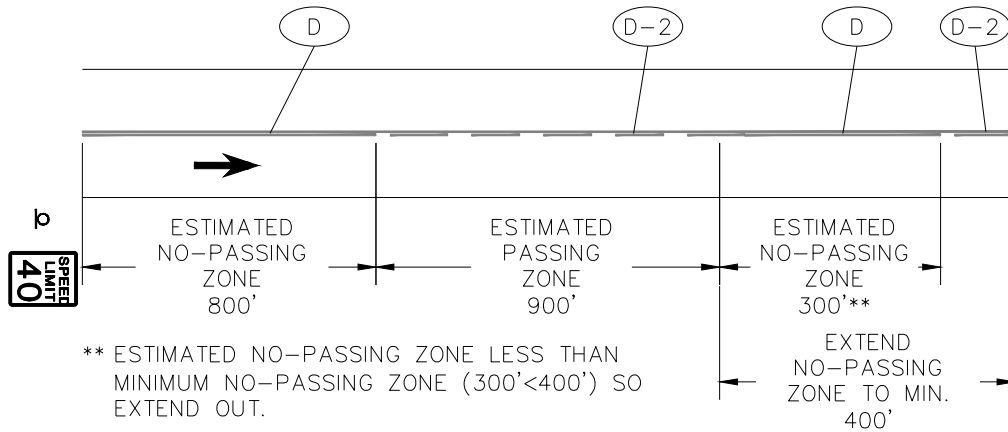
| Posted Speed (MPH) | Minimum Passing Zone Length (Feet) | Minimum No-Passing Zone Length (Feet) |
|--------------------|------------------------------------|---------------------------------------|
| 40                 | 750                                | 400                                   |

Example #1



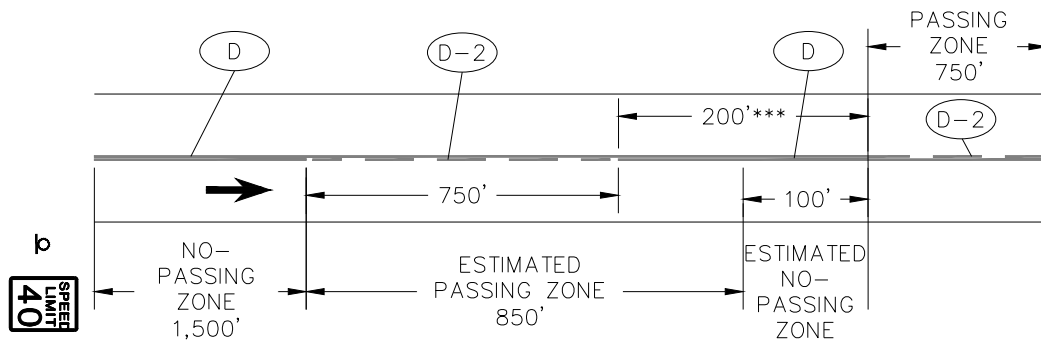
\* ESTIMATED PASSING ZONE LESS THAN MINIMUM PASSING ZONE (600' < 750') SO CLOSE OUT AS NO-PASSING ZONE.

Example #2



\*\* ESTIMATED NO-PASSING ZONE LESS THAN MINIMUM NO-PASSING ZONE (300' < 400') SO EXTEND OUT.

Example #3



\*\*\* THE RECOMMENDED MINIMUM NO-PASSING ZONE LENGTH MAY BE REDUCED UP TO HALF TO ACCOMMODATE A PASSING ZONE WHERE THE IMPLEMENTATION OF THE MINIMUM NO-PASSING ZONE LENGTH MAY RESULT IN CONTINUOUS NON-AVAILABILITY OF A PASSING ZONE. USE ENGINEER'S DISCRETION.

Table 14 lists common roadway features and the minimum criteria for no-passing zone lengths as well as a reference to the accompanying figure for each roadway feature.

**Table 14. Minimum Criteria for No-Passing Zones**

| Roadway Feature                                       | Minimum Criteria for No-Passing Zone Length                                                                                                                          | Figure # with Further Detail |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Lane Reduction Transition                             | Minimum No-Passing Zone Length beyond the end of taper                                                                                                               | Figure 9                     |
| Lane Addition Transition                              | Passing Zone Length prior to the start of taper                                                                                                                      | Figure 9                     |
| Signalized Intersection                               | 200 Feet <sup>1</sup>                                                                                                                                                | Figure 11                    |
| Stop Controlled Intersection (same for Yield Control) | Stopping Sight Distance <sup>1</sup>                                                                                                                                 | Figure 10                    |
| Uncontrolled Intersection                             | 100 feet                                                                                                                                                             | Figure 10                    |
| Railroad Crossing                                     | Stopping Sight Distance                                                                                                                                              | Figure 11                    |
| Horizontal Curve                                      | <u>No obstruction</u> : 200 feet beyond the Point of Tangent (PT) <sup>25</sup><br><u>With an obstruction</u> : Varies depending on line of sight around obstruction | Figure 12                    |
| Vertical Curve                                        | Passing Sight Distance                                                                                                                                               | Figure 12                    |
| Obstruction in Center of the Roadway                  | Based on taper length (L)                                                                                                                                            | Per 2009 MUTCD Figure 3B-15  |
| Intersection Left Turn Lane                           | 2L prior to the start of turn lane taper                                                                                                                             | Per MUTCD                    |

<sup>1</sup>Could be reduced to a minimum of 100 feet

No-passing zones shall be established because of a lack of minimum line of sight and particularly considered at the following locations:

- High activity school zones, high pedestrian crossing locations, and areas with frequent driveways, where passing would create potential conflict
- Segments with heavy traffic volumes and a high percentage of trucks where opportunities for passing are limited

Roadway segments should be marked as no-passing if engineering judgment indicates potential or demonstrated traffic safety or operational issues associated with passing or if better passing zone opportunities are available in the near vicinity.

*\*See Clark County Standard Details Manual for details regarding different types of centerlines, including double yellow centerline, no-pass line, and skip centerline.*

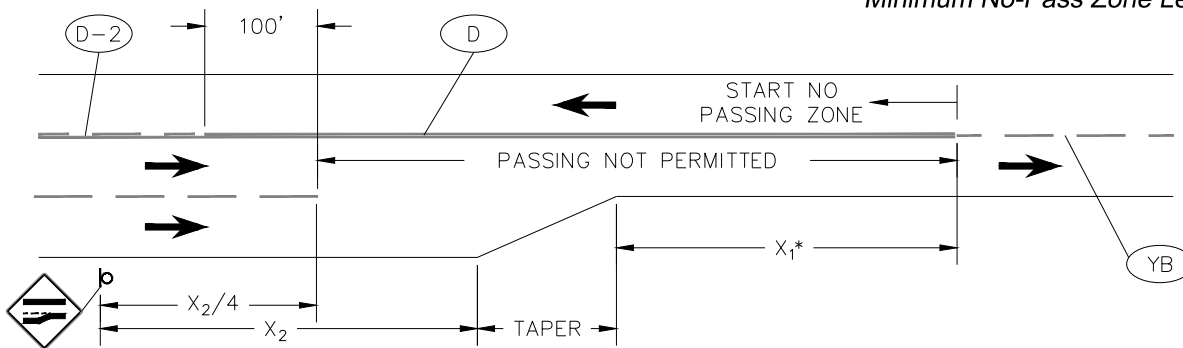
<sup>25</sup> With engineering judgement, for sweeping curves with a large radius and clear line of sight, the curve may be considered for a passing zone

Figure 9. No-Passing Zone Lane Reduction & Addition Transition

No-Passing Zone Lane Reduction Transition

| Posted Speed (MPH) | $X_1^*$ (Feet) | $X_2$ (Feet) |
|--------------------|----------------|--------------|
| 25                 | 275            | 325          |
| 30                 | 325            | 460          |
| 35                 | 375            | 565          |
| 40                 | 400            | 670          |
| 45                 | 400            | 775          |
| 50                 | 400            | 885          |

\* Minimum No-Pass Zone Length



No-Passing Zone Lane Addition Transition

| Posted Speed (MPH) | $X^*$ (Feet) |
|--------------------|--------------|
| 25                 | 475          |
| 30                 | 550          |
| 35                 | 650          |
| 40                 | 750          |
| 45-50              | 800          |

\* Minimum Passing Zone Length

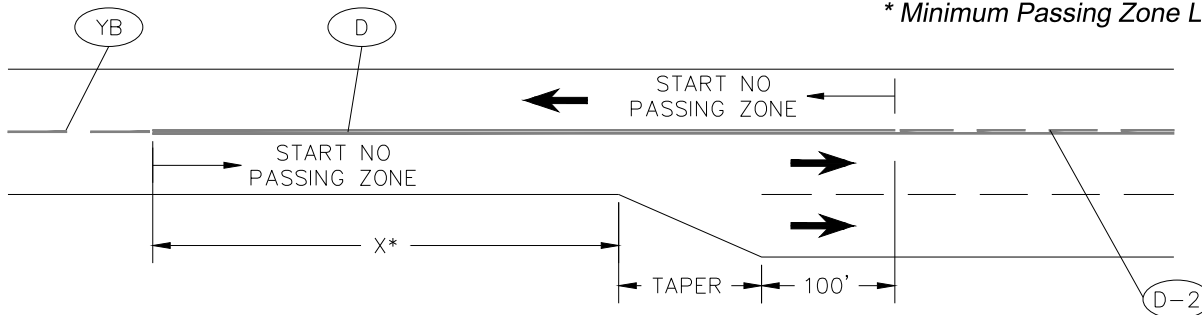
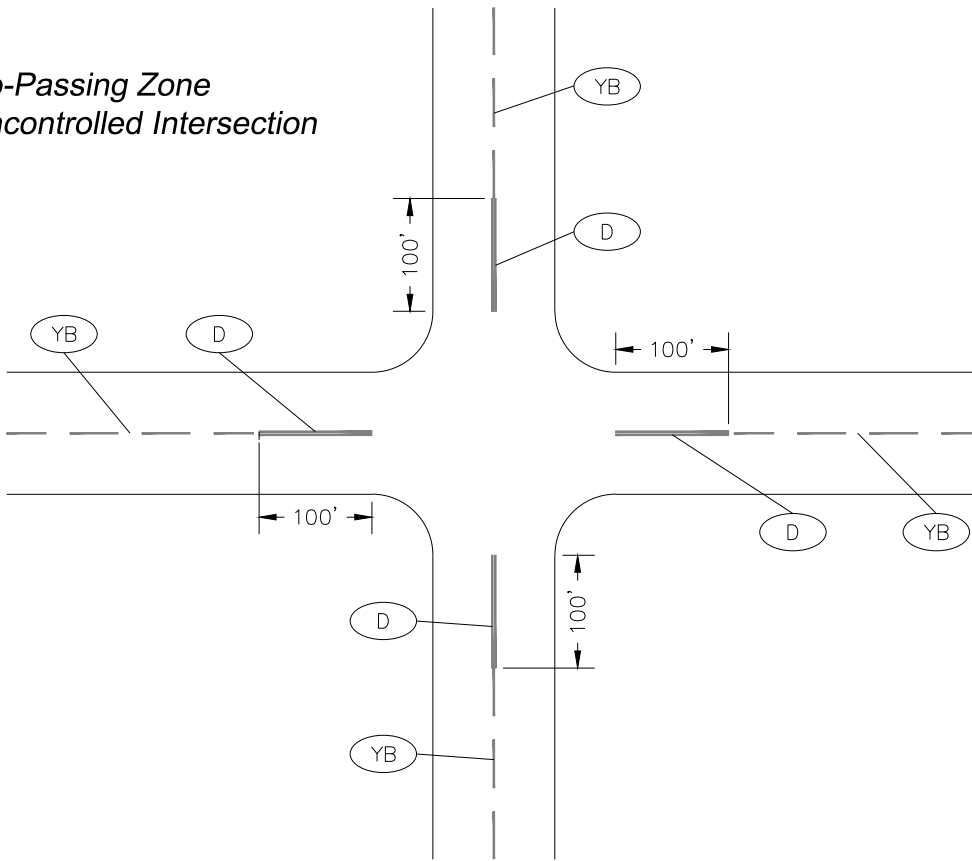
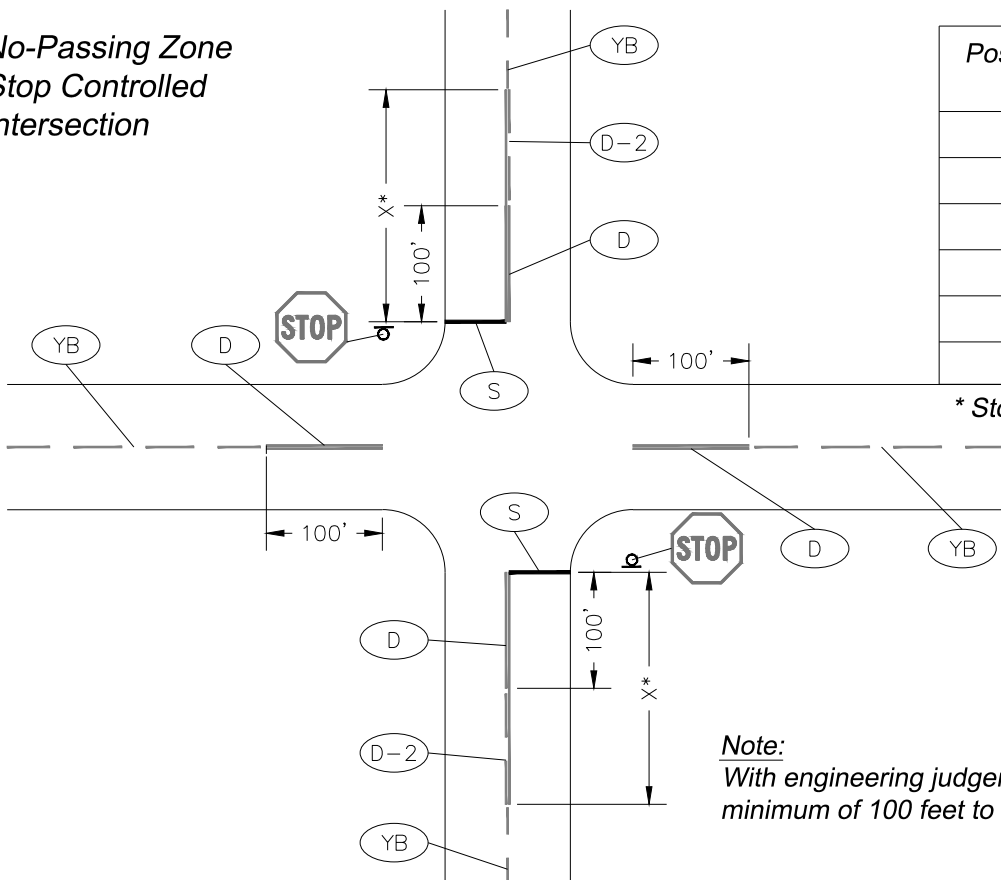


Figure 10. No-Passing Zone Uncontrolled & Stop Controlled Intersections

No-Passing Zone  
Uncontrolled Intersection



No-Passing Zone  
Stop Controlled Intersection



| Posted Speed (MPH) | X* (Feet) |
|--------------------|-----------|
| 25                 | 150       |
| 30                 | 200       |
| 35                 | 250       |
| 40                 | 325       |
| 45                 | 400       |
| 50                 | 475       |

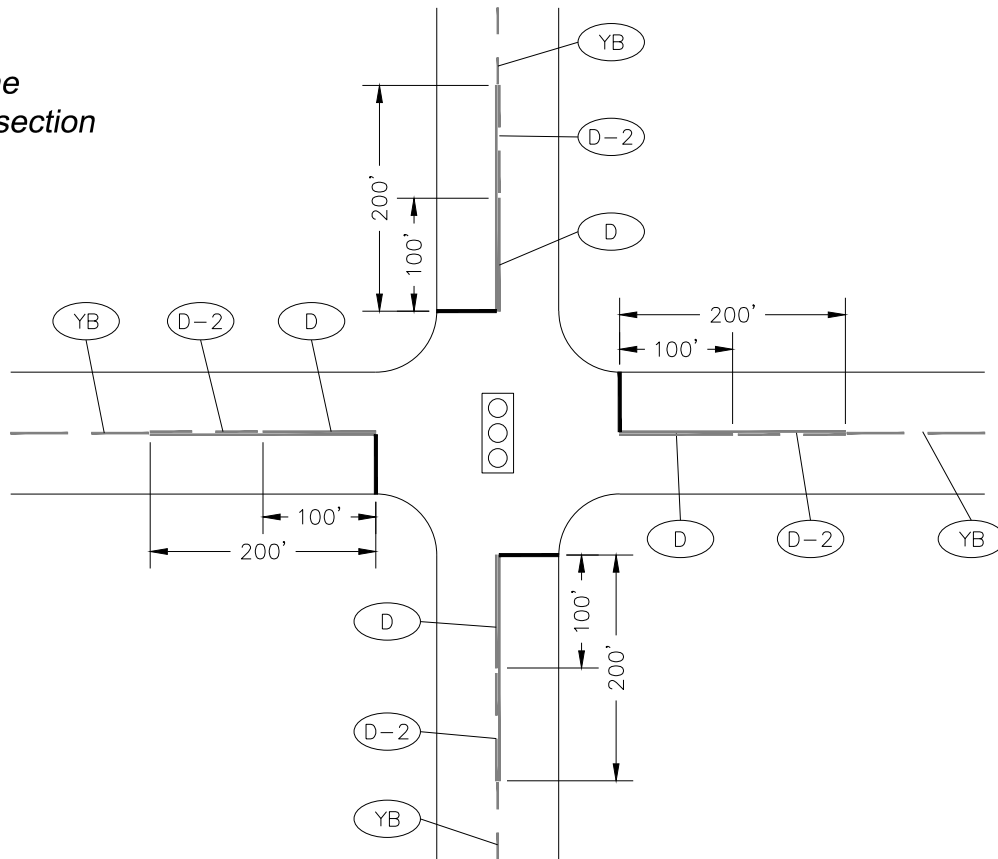
\* Stopping Sight Distance

**Note:**  
With engineering judgement, X may be reduced to a minimum of 100 feet to accommodate a passing zone.



Figure 11. No-Passing Zone Signalized Intersection & Railroad Crossing

No-Passing Zone  
Signalized Intersection



No-Passing Zone  
Railroad Crossing

| Posted Speed (MPH) | X* (Feet) |
|--------------------|-----------|
| 25                 | 150       |
| 30                 | 200       |
| 35                 | 250       |
| 40                 | 325       |
| 45                 | 400       |
| 50                 | 475       |

\* Stopping Sight Distance

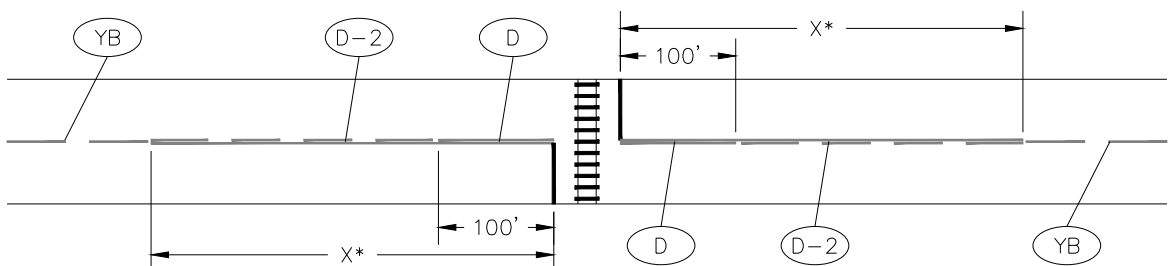
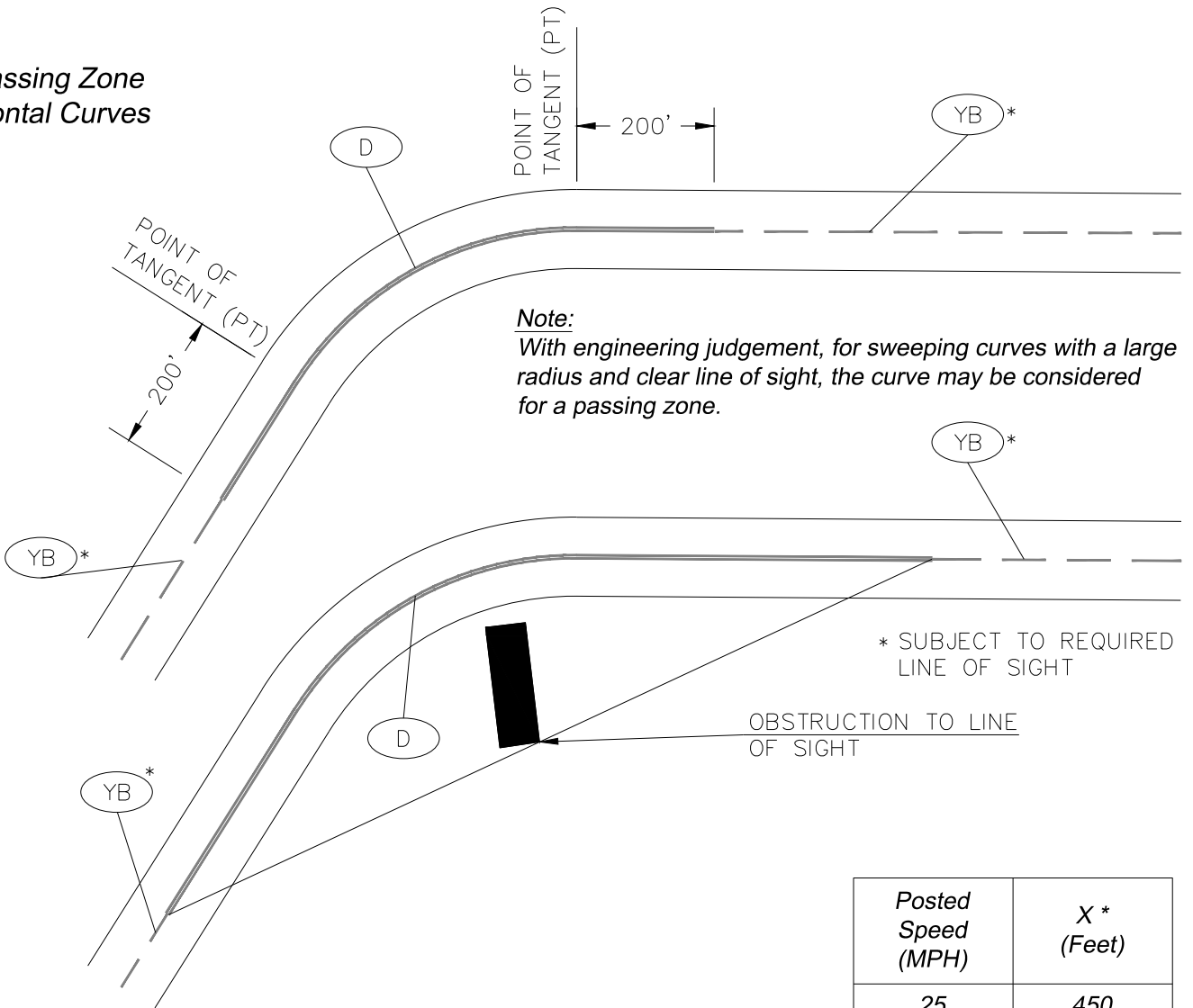


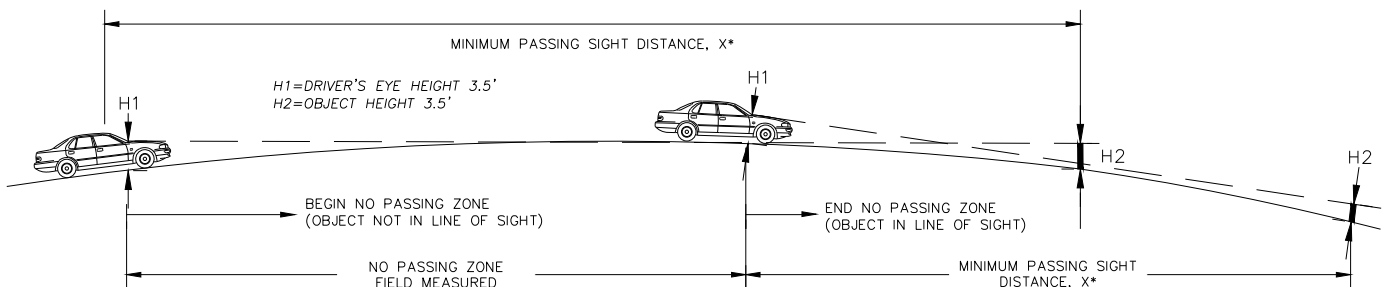
Figure 12. No-Passing Zone Horizontal & Vertical Curves

No-Passing Zone  
Horizontal Curves



| Posted Speed (MPH) | X* (Feet) |
|--------------------|-----------|
| 25                 | 450       |
| 30                 | 500       |
| 35                 | 550       |
| 40                 | 600       |
| 45                 | 700       |
| 50                 | 800       |

No-Passing Zone  
Vertical Curves



### Drop Lane Lines

Drop lane line striping shall be used in advance of a wide line to distinguish a lane drop from an intersection through lane, according to the MUTCD. The standard distance for the drop lane line striping, shown in Table 15, is measured from the start of the turn lane or wide line. The distance is modified to a minimum of 600 feet where a bicycle lane is present to ensure adequate sign spacing for the required additional bicycle related signs.

**Table 15. Drop Lane Line Distances**

| Posted or 85 <sup>th</sup> Percentile Speed (mph) | Drop Lane Line Distance (feet) measured from start of turn lane |                   |
|---------------------------------------------------|-----------------------------------------------------------------|-------------------|
|                                                   | Without Bicycle Lane <sup>26</sup>                              | With Bicycle Lane |
| 25                                                | 325                                                             | 600               |
| 30                                                | 460                                                             | 600               |
| 35                                                | 565                                                             | 600               |
| 40                                                | 670                                                             | 670               |
| 45                                                | 775                                                             | 775               |
| 50                                                | 885                                                             | 885               |

*\*See Clark County Standard Details Manual for guidance on drop lane line striping and pavement markings with bicycle lanes.*

### Pavement Markings

Clark County has specific guidelines for stop line pavement markings.

#### Stop Lines

Stop lines can legally be installed only where the traffic control device requires vehicles to stop. Stop lines at railroad crossings are the exception, and drivers are not required to stop. Clark County normally installs stop lines only at signalized intersections, all-way stop controlled intersections, Pedestrian Hybrid Beacons (PHB), flashing beacons, and railroad crossings.

Clark County generally does not install stop lines at two-way stop controlled intersections except as a tool for traffic operations mitigation, under the following conditions:

- The intersection is a high crash location due to lower compliance of the stop control.
- The stop control is at an unexpected location such as at an intersection after a long stretch of uncontrolled traffic flow.
- The driver needs positive guidance regarding stopping position of the vehicle as a mitigation for inadequate sight distance.
- The driver needs guidance regarding stopping position of the vehicle to accommodate turning vehicles at an intersection.
- The driver needs positive guidance regarding stopping position of the vehicle for pedestrian (marked or unmarked) crosswalk.

<sup>26</sup>From MUTCD 2009 Table 2C-4 Column for Condition A

- The driver needs supplemental information indicating which legs of the intersection are required to come to a complete stop.

*\*See Clark County Standard Details Manual for details regarding stop line pavement markings.*

### Raised Pavement Markers (RPMs)

Raised pavement markers (RPMs) are used with roadway striping to provide additional delineation. RPMs can be particularly helpful to provide guidance around horizontal curves. The following are guidelines for RPM spacing, consistent with WSDOT and Federal Highway Administration (FHWA)<sup>27</sup>:

- Install 2YY RPMs at 80-foot intervals on tangent sections of the roadway.
- Install 2YY RPMs at 40-foot intervals on roadway with alignment radius of 500 - 2,000 feet.
- For alignment radius sharper than 500 feet, follow engineer's guidance to suit field conditions.

The winding alignment on many rural roads, coupled with a lack of illumination, contributes to a large number of run-off-road crashes during nighttime conditions. RPMs continue to provide guidance regarding roadway alignment under wet weather conditions and where the retroreflectivity of centerline striping has diminished. Closely spaced RPMs under appropriate conditions also prevent head-on collisions and run-off-road crashes.

Closely spaced RPMs are supplemental to curve warning signs and can provide an additional alert for a fast-approaching driver to a changing condition ahead. Closely spaced RPMs at the start of a sharp curve better define the start point as well as the centerline of the alignment and alert the driver of a necessary speed differential ahead to safely negotiate the curve. It also discourages the driver from encroaching into the opposing lane. Table 16 provides guidelines for RPM spacing on curves with a default approach speed of 50 mph, but engineering judgment must be used to adjust the approach speed to the curve based on conditions.

**Table 16. RPM Spacing on Curves**

| Curve Advisory Speed (mph) | Speed Differential (mph) | 2YY RPM Spacing (feet) | Tangent Length Beyond the Curve (feet) |
|----------------------------|--------------------------|------------------------|----------------------------------------|
| 45                         | 5                        | 80 <sup>1,2</sup>      | -                                      |
| 35-40                      | 10 to 15                 | 40 <sup>2</sup>        | 250                                    |
| 20-30                      | 20 to 30                 | 20 <sup>2</sup>        | 200                                    |
| 15 ≤                       | 35 ≥                     | 10                     | 200                                    |

**Notes:**

<sup>1</sup> For advisory speed 5 MPH less than the posted/operating speed no reduction in RPM spacing would be necessary.

<sup>2</sup> The recommendations in this memo are meant to better identify the start of a sharp curve. Closer RPM spacing per the FHWA publication, FHWA-RD-97-152 will govern for curves with sharp radius.

Specific situations should be evaluated individually and engineering judgment used to adjust the recommended RPM spacing as needed. For example, at high crash or severe hazard locations, it may be appropriate to have a higher density of RPMs and/or to install RPMs for longer distances on the tangent

<sup>27</sup> FHWA, RPM Spacing in Traffic Zones, FHWA-RD-97-152

to the curve. Conversely, if the road alignment is continuously winding, the driver does not have the opportunity to pick up speed. In this case, there is no need to install closely spaced RPMs since very little speed differential exists, and the RPMs are primarily meant to alert a high speed approaching driver of changing conditions. Sharp curves with a higher super elevation can also be candidates for closely spaced RPMs. RPM spacing through the curve should generally be maintained the same way as approach spacing.

*\*See Clark County Standard Details Manual for details regarding RPM's, they are included in many of the longitudinal markings (or striping).*

## Chapter 5 – Traffic Control for Bicycle Facilities

The Clark County Standard Details Manual includes signing and striping layouts for various bicycle lane scenarios at intersections. The following items are discussed in further detail below:

- Bicycle Lane Width
- Bicycle Lane Symbol
- BIKE LANE Sign
- Green Bike Lane
- Signage for Bicyclists Sharing the Road
- Bicycle Temporary Traffic Control

### Bicycle Lane Width

According to Clark County standards,<sup>28</sup> the bicycle lane width is six feet. This width is measured from the center of the lane line to the face of the curb. Under constrained conditions for a curbed section of roadway, the minimum width of a bicycle lane can be four feet where no hazard is present. Under constrained conditions for an uncurbed section of roadway, a paved shoulder may be considered suitable for bicyclists. The minimum shoulder width for a paved shoulder to accommodate bicyclists is 3.5 feet where no hazard is present. A hazard is defined as:

- Vertical drop-off of greater than four inches adjacent to pavement edge.
- Negative shoulder slope steeper than 6:1.
- Fixed objects within two feet of the pavement edge.

If bicycle lanes are narrower than five feet, appropriate mitigation measures shall be instituted and shall include, but not be limited to, ensuring that stormwater manhole covers and inlets are bicycle friendly and remove any hazard that may reduce the usable width of the bicycle lane.

Where required as part of the road standard or other adopted plan, the bicycle lane facility shall not be eliminated or compromised at the expense of accommodating other modes. However, for environmental, topographic, or other non-mitigatable constraints, when compromising the bicycle lane standard becomes unavoidable, a design variance shall be required.

Any deviation from the Clark County road standard, adopted plans, WSDOT, and/or federal standards shall be required to follow the appropriate variance process. The variance document shall clearly state the reasons and justification for the variance from the standard as well as the mitigation implemented. For partially improved roadway sections, the document must indicate that the variance granted is temporary and shall sunset with full improvement of the roadway section.

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<sup>28</sup> Clark County Code, Table 40.350.030-2

## Bicycle Lane Symbol

The bicycle lane symbol pavement marking should be used at the beginning of a bicycle lane and at periodic intervals along the bicycle lane.<sup>29</sup> The county recommends installing the bicycle lane symbol pavement marking at all of the following locations:

- At the start of bicycle lane
- Every 750 feet (for continuous bicycle lane without intersections in between)
- On the far side of major cross streets

*\*See Clark County Standard Details Manual for details regarding bicycle symbol pavement markings.*

## BIKE LANE Sign

The BIKE LANE sign (R3-17) and plaques (R3-17a and R3-17b) should be used in advance of the upstream end of the bicycle lane, at the downstream end of the bicycle lane, and at periodic intervals along the bicycle lane as determined by engineering judgment and based on prevailing speed of bicycle and other traffic, block length, distances from adjacent intersections, and other considerations.

## Green Bike Lane

The FHWA has issued an interim approval for the use of green-colored pavement in marked bicycle lanes and in extensions of bicycle lanes through intersections and other traffic conflict areas.<sup>30</sup> This should be used only where the path of bicyclists crosses the motor vehicle path, there is a heavy conflict between motor vehicles and bicycles, and when other road users should yield to bicyclists. Colored pavement by definition is a traffic control device that must demonstrate a need before it is used.

Green color in a bicycle lane should only be used if either of the following conditions exists:

- A traffic conflict area exists at one of the following locations:
  - Bicycle lane crosses a heavily used right turn lane.
  - Traffic in a channelized right turn lane crosses a bicycle lane.
- A need for this treatment is demonstrated by either of the following:
  - History of three or more motor vehicle-bicycle crashes exists at or adjacent to the traffic conflict area over the most recent three-year period.
  - Documented conflicts (failure of the motor vehicle to yield to the bicyclist) between cyclists and motor vehicles at an average rate of two per peak hour during the hours listed below. Documentation shall include observations from a minimum of two separate data collection periods, conducted on different days in a one month period, and at least one weekday and one weekend count period during peak bicycle travel times of at least two hours in duration. Peak bicycle travel times vary by surrounding land use but are typically these hours:

<sup>29</sup> MUTCD 2009

<sup>30</sup> Federal Highway Administration (FHWA) Interim Approval (IA-14 dated April 15, 2011)

- Weekday, 11:00 AM to 1:00 PM
- Weekday, 5:00 PM to 7:00 PM
- Saturday, 8:00 AM to 2:00 PM

Colored pavement shall not replace or be used in lieu of required markings for bicycle lanes as defined in the MUTCD and/or the Clark County Standard Details Manual but shall supplement such markings.

*\*See Clark County Standard Details Manual for details regarding green bike lane layouts.*

Materials permitted to color the bike lane green shall fall within the color parameters defined by the FHWA interim approval. During the first three years of the installation, the county shall annually review crash reports in conflict area to assess if the colored pavement is improving safety.

### Signage for Bicyclists Sharing the Road

A shared lane where bicycles share the facility with motor vehicle traffic on collector or arterial roadways is not an adopted Clark County standard. Where connections must be established between bike facilities, a shared use facility with motor vehicles may be acceptable subject to certain conditions. To qualify as a shared lane, the minimum outside lane width should be at least 14 feet. Signs should be considered for installation at locations that meet at least one or more of the following criteria:

- After a bike lane ends and bicyclists and motorists enter a shared lane situation in a moderate to heavily used bicycle corridor
- On stretches of road that are used to connect two sections of a bike facility separated by a reasonable distance
- On roadway sections with a significant history of bicycle crashes
- Where a conflict or courtesy problem between bikes and motor vehicles has been documented
- Where motorists and bicyclists have reduced sight distance

Where shared lane signing is being considered, the following three signs or sign assemblies can be used:

- Share the Road sign assembly (W11-1 and W16-1)<sup>31</sup>
- Bicycles May Use Full Lane sign (R4-11)<sup>32</sup>
- Bikes on Road sign assembly (W11-1 and W11-101)<sup>33</sup>

The scenarios for the appropriate use of each sign or sign assembly are presented in Table 17 and are based on posted speed, lane width, and whether the location is an intersection or roadway segment.



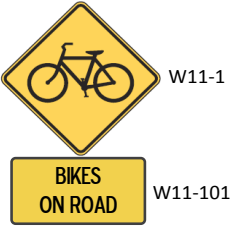
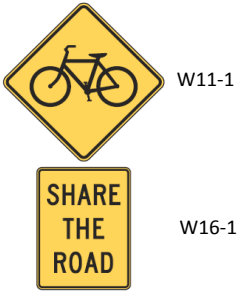
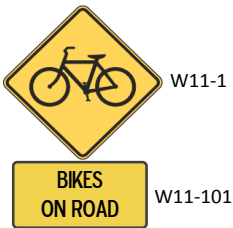
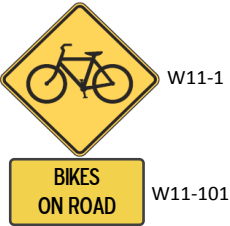
<sup>31</sup> AASHTO Guide for Development of Bicycle Facilities, Chapter 4.3.2, 2012

<sup>32</sup> Narrow is defined as less than 12 feet by the TRB Highway Capacity Manual, which means this width assumes that no lane sharing occurs between a bicycle and a vehicle because they cannot travel safely side by side within the same lane.

<sup>33</sup> Bikes on Road sign (W11-101) as specified in the WSDOT Sign Fabrication Manual is to be used in conjunction with the Bicycle Warning sign (W11-1) per WSDOT Traffic Manual



**Table 17. Signage for Bicyclists Sharing the Road**

| Posted Speed (MPH) | Intersection*                                                                                                                         |                                                                                                                                     | Roadway Segment                                                                                                                         |                                                                                                                                       |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
|                    | Right turn lane width < 12 feet                                                                                                       | Right turn lane width ≥ 12 feet                                                                                                     | Curb lane width < 14 feet                                                                                                               | Curb lane width ≥ 14 feet                                                                                                             |
| 25                 | Bicycles May Use Full Lane sign<br><br>R4-11         | Share the Road sign assembly<br><br>W11-1<br>W16-1 | Bikes on Road sign assembly<br><br>W11-1<br>W11-101   | Share the Road sign assembly<br><br>W11-1<br>W16-1 |
| 30                 |                                                                                                                                       |                                                                                                                                     |                                                                                                                                         |                                                                                                                                       |
| 35                 |                                                                                                                                       |                                                                                                                                     |                                                                                                                                         |                                                                                                                                       |
| 40                 |                                                                                                                                       |                                                                                                                                     |                                                                                                                                         |                                                                                                                                       |
| 45                 | Bikes on Road sign assembly<br><br>W11-1<br>W11-101 |                                                                                                                                     | Bikes on Road sign assembly<br><br>W11-1<br>W11-101 |                                                                                                                                       |

**Notes:**

\*Within 300 feet (measured from back of stop bar) approaching a public road intersection

\*\*Curb lane volume must be less than 3,500 vehicles per day to use the Bicycles May Use Full Lane sign or Share the Road sign assembly; if the volume exceeds 3,500 vehicles per day, use Bikes on Road sign instead.

*\*See Clark County Standard Details Manual for details regarding shared use lane layouts.*

**Bicycle Temporary Traffic Control**

Bicyclists may legally use both the roadway and sidewalk,<sup>34</sup> and they need to be considered under both conditions. Where work encroaches upon a bicycle lane or a shared lane used by bicyclists, an accessible, safe, and clearly defined route shall be provided and maximum effort made to provide a convenient bicycle way separate from active work areas. The contractor shall not force a bicyclist into an unsafe condition as part of traffic control. Bicycle lanes and other identified bicycle routes shall be kept free of obstructions. If it is not feasible during construction to provide bicyclists with facilities comparable to pre-construction conditions, bicycle detours shall be considered.

<sup>34</sup> RCW 46.61.755

A bicycle lane closure requires the same type of signage and traffic control as a motor vehicle lane closure. The proposal to close a bicycle lane shall demonstrate that impacts cannot be reasonably avoided through any of the following options:

- Utilization of alternative construction methods.
- The facility cannot be reasonably relocated through reassignment of motor vehicle lanes or other existing facilities.
- The duration and extent of impacts has been minimized.
- An adequate detour has been provided.

The contractor shall seek to safely accommodate bicycles through the work area to the extent possible. The contractor shall notify the roadway user far enough in advance with signage that the bicycle lane is closed so cyclists can modify their route where necessary.

### **Work Area Accommodation**

The contractor shall accommodate bicyclists in work areas as follows:

- The contractor shall provide safe and protected bicycle access into, through and out of the work area, including proper channelization and signage.
- Bicycles should be separated from motor vehicle traffic wherever possible.
- The method for providing safe accommodations for bicyclists should be prioritized as follows:
  1. Provide a temporary bicycle lane on the same roadway past the work zone by shifting and narrowing the adjacent traffic lanes. The minimum lane width for bicycle travel shall be four feet.
  2. Provide a shared travel lane by merging bicyclists with adjacent motor vehicle traffic (only for speeds up to 35 mph or curb lane volume less than 3,500 vehicles per day).
  3. Direct bicyclists onto a shared path with pedestrians.
  4. Provide a bicycle detour route.
- The contractor shall ensure construction equipment, including signs and barricades, do not obstruct the bicycle travel way (see Figure 13 for further detail on construction sign placement).
- Where steel plates are necessary on the bicycle travel way, the contractor shall follow the requirements for open trenches within the traveled way or auxiliary lane and shall have a steel plate placed and anchored over them. Plates shall be textured to provide a non-skid surface in dry and wet conditions acceptable to the engineer. All plates shall be highlighted with paint at the edges and an advance warning sign shall be used to identify the presence of the plate. A wedge of suitable material shall be placed for a smooth transition between the pavement and the steel plate.
- Where exposed utility manholes or lids are present, the contractor shall ensure minimal exposure to traffic with tapered asphalt mix or equivalent along all sides to minimize the hazard, and utility manholes or lids will be painted or delineated.
- Where roadway grinding occurs as part of a pavement rehabilitation project or where construction debris or gravel may jeopardize the safety of bicyclists, the contractor shall ensure the roadway surfaces are frequently cleaned or swept to minimize exposure to bicyclists.

- For pavement or utility replacement projects, the contractor shall avoid or minimize asphalt or concrete seam exposures (especially longitudinal seam formation) to bicyclists.
- For motor vehicle lanes which continue through the work area, the contractor shall provide advance warning to bicyclists and motorists of any transition into and out of the travel lanes, and allow sufficient lane width to accommodate both.
- For motor vehicles lanes which continue through the work area, the Contractor shall consider motor vehicle travel speed, grade, pavement condition, length of work area, lighting, sight distance, lane width and length of work zone to determine the appropriate traffic control options for bicycles.
- The contractor will provide advance notice to bicyclists regarding alternate routes where bicycling through the work area cannot be safely accommodated.

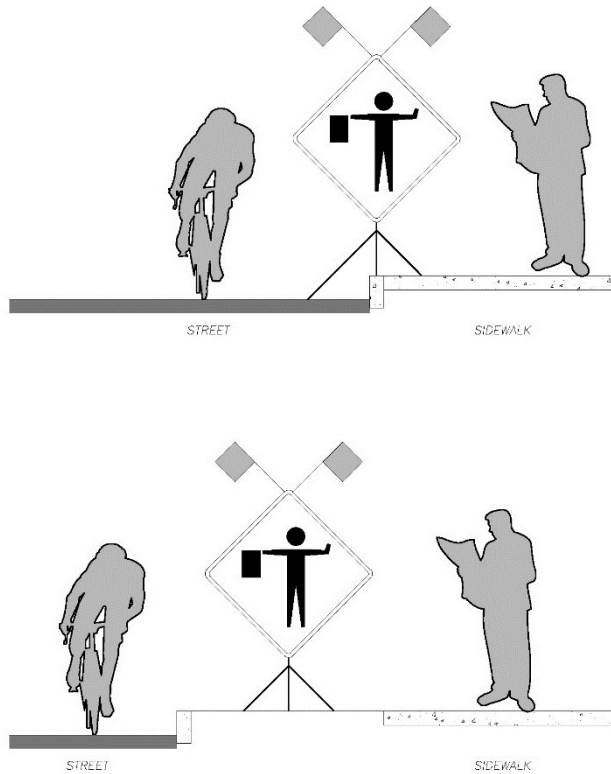


Figure 13. Construction Sign Placement

### Bicycle Facility Closures, Detours and Alternate Routes

If the engineer determines that temporarily closing a bicycle facility within the work area is required for the safety of bicyclists, traffic control design considerations must be addressed as they would be for a motor vehicle lane closure. The contractor shall include a bicycle facility closure and detour plan in the proposed traffic control plan for review and approval by the engineer before closing a bicycle facility. Approved signs, markings, and traffic control shall be used where a detour is required.

Determination to close a bicycle facility and to provide a well-signed detour route will include consideration of the needs of all bicyclists who use the bicycle facility under normal conditions, including daily commuters, recreational, and novice bicyclists. The conditions to be considered to close a bicycle facility and provide an alternate route include the following:

- Removal or reduction of existing motor vehicle and/or bicycle lanes through the work area and the ability to effectively transition bicyclists into and out of motor vehicle traffic
- Motor vehicle and bicycle travel speeds
- Bicycle activity
- Grades

- Significant amount or frequency of pavement grindings, potholes, or utility lids
- Length and duration of work area
- Lighting and sight distance

The engineer may determine that bicycle safety is adequate to maintain bicycle access through the work area but may still require additional bicycle alternate routes.

The following shall be considered in the development of a bicycle detour or alternate route:

- The bicycle detour or alternate route should parallel the existing bicycle facility impacted by the work area and minimize detour distance to the extent possible.
- The bicycle detour or alternate route shall be maintained and regularly monitored (clear of debris and signs maintained) during the course of construction.
- Necessary signage shall be used in advance of each approach to the bicycle detour or alternate route, and shall be posted at least five days in advance of the closure.
- Where a significant change in bicycle volumes on a detour or alternate route is expected, warning signage for bicyclists and motor vehicles shall be considered.

*\*See Clark County's Traffic Control Library for details regarding bicycle traffic control, available upon request.*

## Chapter 6 – Traffic Control for School Areas

The “Clark County School Zone Traffic Control Policy” provides clear guidance on the implementation of traffic control in school zones and areas.<sup>35</sup> The policy covers appropriate use of traffic control devices under various sets of conditions and provides guidelines on school crosswalks, reduced school speed zones, school areas, and active school zone (flasher) traffic control. Additionally, the policy includes standards for signing, striping, and illumination.

The items related to signs for school bus stops and turnarounds are not covered in the School Zone Traffic Control Policy, but are instead included in the Traffic Manual, as listed below:

- School Bus Stop Location
- School Bus Stop Ahead Sign
- School Bus Turnaround Sign

### School Bus Stop Location

State law and engineering guidelines require school bus stops at a location that is clearly visible to approaching traffic from a distance of at least 500 feet unless the stop is situated at a safe location away from the travel lane.<sup>36</sup>

Assuming state mandated sight distance cannot be met, every effort should be made to locate the school bus stop to meet the minimum line of sight requirements to protect the safety of the students boarding or de-boarding the school bus. The school bus flashing light, which has an object height of eight feet above the pavement, should be visible to the approaching driver from a minimum of 300 feet, unless the location meets the safe stopping sight criteria for a child crossing the road.<sup>37</sup> The field procedure for confirming the school bus stop eligibility is included in Appendix A.

Clark County does not condone the placement of a bus stop location that does not meet the minimum requirements set forth in footnote 37 below.

### School Bus Stop Ahead Sign

On roadways with more than two travel lanes or on a divided highway, traffic from the opposing direction is not required to stop. Consequently, the visibility of the school bus does not need to be verified for the direction in which traffic is not required to stop.<sup>38</sup>

All school bus stop ahead sign (S3-1) requests need to come directly from the respective school district to the county. The request process is as follows:

<sup>35</sup> Clark County School Zone Traffic Control Policy, December 2016

<sup>36</sup> WAC 392-145-011

<sup>37</sup> 300 feet is based on panic deceleration rate of 20 ft/sec<sup>2</sup>. Stopping sight distance is based on a comfortable deceleration rate of 11.2 ft/sec<sup>2</sup>. According to NCHRP 400, the 15<sup>th</sup> percentile deceleration rate is 21.6 ft/sec<sup>2</sup> for dry pavement and 18.5 ft/sec<sup>2</sup> for wet pavement. Perception reaction time is 2 secs and approach speed is 50 mph.

<sup>38</sup> RCW 46.61.370

1. With exceptions because of mitigating circumstances, the school districts will have the opportunity to send in requests—mid-January (start of winter session) and late August (start of fall session)—for any locations they believe have an issue with visibility of a stopped school bus to approaching traffic from either travel direction.
2. Prior to sending the request for a school bus stop ahead sign, the school district will make a preliminary assessment of the visibility and safety of the bus stop location.
3. If the preliminary evaluation does not indicate 500 feet of visibility to the stop location,<sup>39</sup> or is deemed unsafe by the school district for any reason, the school district will attempt to relocate the school bus stop to a safer location or make an alternate arrangement if possible.
4. If the relocation of the stop is not possible, the school district will request Clark County to further evaluate the bus stop location(s) and installation of a school bus stop ahead sign.
5. Along with the request for evaluation of a new stop location(s), the school districts should also notify Public Works about any stop locations with school bus stop ahead signs that are no longer active school bus stops. Public Works will consider removing or covering the sign.
6. In the school bus stop ahead sign request, the school district needs to provide the following:
  - The address/location for each school bus stop to be evaluated
  - The pick-up and drop-off direction for the school bus
  - The pick-up and drop-off timing
  - If children need to cross the street during pick up time

A school bus stop ahead sign should only be installed by Public Works after verification by engineering staff. If a warning sign is warranted, it would need to be installed at the distance provided in the MUTCD.<sup>40</sup> The field staff collecting the data would determine the location for the warning sign.

The maximum distance that the sign can be placed is 150% of the value stated in the MUTCD. This maximum distance is used only with factors such as driveways, intersection location, visibility obstruction due to vegetation, or close proximity to other signs. If the proposed sign location is not clearly legible from a distance of at least 250 feet, the placement of the school bus stop ahead sign should be moved further back accordingly. The warning sign should be installed only in the direction of restricted visibility.

### School Bus Turnaround Sign

If the minimum available line of sight to the school bus turnaround is less than prescribed by the MUTCD plus 100 feet,<sup>40</sup> a school bus turnaround sign may be installed per state law.<sup>41</sup> The county follows WSDOT and uses their version of the school bus turnaround sign (S3-201) from the WSDOT Sign Fabrication Manual instead of the MUTCD version (S3-2). The procedure for measuring line of sight and sign placement is the same as the school bus stop ahead sign (as described in Appendix A).

<sup>39</sup> If the school bus stop location does not meet the 500 feet visibility requirement, the school district will advise if the children can wait in a holding area for the school bus to arrive before crossing the street.

<sup>40</sup> MUTCD 2009, Table 2C-4, value from Column 0

<sup>41</sup> WAC 468-95-329

## Chapter 7 – Sweeping Curves

Intersections with sweeping curves or intersections, where the major movement is not through traffic for any of the cross streets, require special traffic control. These situations are typically encountered in rural areas. Traffic operations and safety can become problematic with sweeping curves, especially where the curve can be taken at a higher speed or where the traffic control, such as a STOP sign, violates driver expectation. Traffic engineering principles dictate that the right-of-way should be assigned to the major traffic movement. The MUTCD recommends, as the preferred traffic control for the major movement, the use of a STOP sign with an EXCEPT RIGHT TURN plaque below it.<sup>42</sup> The signing and striping components for intersections with a sweeping curve are described in further detail in Table 19.

This traffic manual provides guidance for four sweeping curve scenarios. The salient features of the traffic control guideline are that the major movement is indicated by the double yellow centerline and wide dotted extension line and the only approach with all movements completely stopped is designated with a stop line. This arrangement clearly communicates to the side street driver the direction of major traffic flow. Furthermore, on high speed approaches with a sweeping curve, the driver is given advance warning regarding the traffic control at the intersection. Table 18 summarizes the traffic control features for the four sweeping curve scenarios and provides reference to the accompanying figure.

**Table 18. Sweeping Curve Scenarios**

| Scenario | Number of Legs | Description of Traffic Control Features                                                                                                                                                                                                                  | Figure Number |
|----------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| A        | 4              | Major movement through sweeping curve includes: stop ahead, curve warning sign(s) with large arrows, stop control except for right turn, double yellow centerline, and wide dotted extension line. Minor approaches are stop controlled with stop lines. | Figure 14     |
| B        | 3              | Same as Scenario A except there is one minor road approach instead of two.                                                                                                                                                                               | Figure 14     |
| C        | 3              | Same as Scenario B with the addition of oncoming traffic does not have a stop plaque with the stop sign for the minor approach.                                                                                                                          | Figure 15     |
| D        | 4              | For urban local access roads with posted speeds of 30 mph or less, double yellow centerline and curve warning signs can be omitted.                                                                                                                      | Figure 15     |

The traffic control features for the scenarios described above are a general guideline and may be modified by the engineer according to actual field conditions and traffic operations. The traffic control could be implemented in these situations:

- Seventy percent of the approaching traffic at the intersection is across two of the approaches of the intersection that are perpendicular to each other.
- Two of the approaches of the intersection that are perpendicular to each other belong to the roadway with major classification and engineering judgment supports this traffic control.

<sup>42</sup> Manual on Uniform Traffic Control Devices, 2009

Table 19. Signing and Striping Components for Sweeping Curves



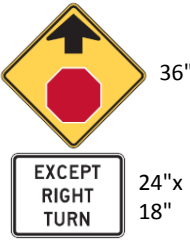

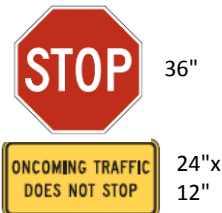
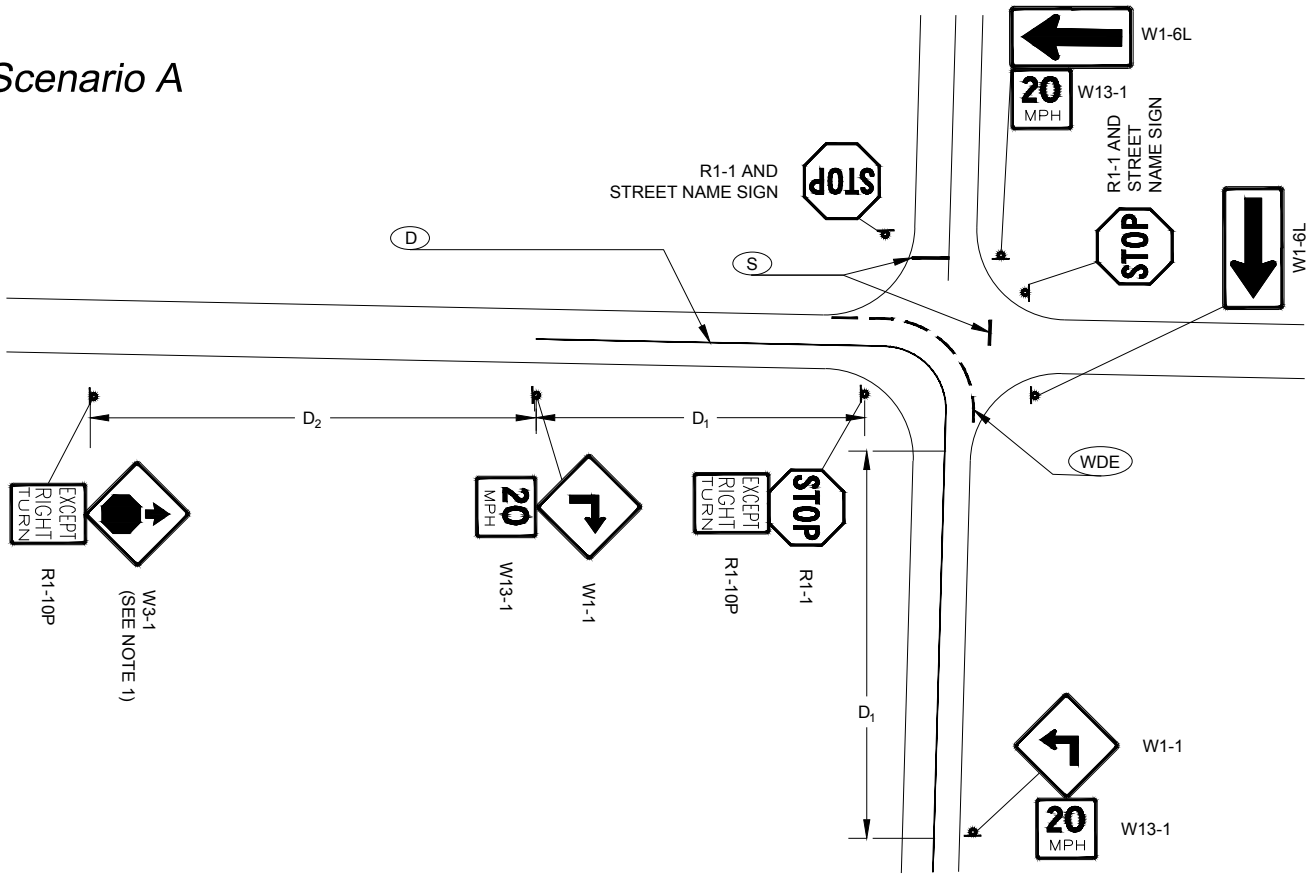
| Signing/Striping Component                                                                                                                                                                          | Typical Use                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------|-----|-----|----|---------------------------------------------|----|-----|----|-----|----|-----|----|-----|-------|-----|-----|-----|---|----|-----|-----|-----|-----|----|-----|-----|-----|-----|
| <p>Curve warning sign with an advisory speed plaque</p> <p>W1-1 &amp; W13-1</p>  <p>30"</p> <p>24"</p>             | <ul style="list-style-type: none"> <li>Advisory speed determined by ball bank speed test (per Appendix A)</li> <li>Sign placement, D<sub>1</sub>, from the beginning of the curve</li> <li>See Chapter 3 Warning Signs Section for additional information</li> </ul> <table border="1" data-bbox="625 255 1399 489"> <thead> <tr> <th rowspan="2">Posted Speed (mph)</th> <th colspan="4">D<sub>1</sub>, Curve Warning Sign Placement Distance (ft)</th> </tr> <tr> <th colspan="4">Deceleration to listed advisory speed (mph)</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>20</td> <td>30</td> <td>40</td> <td></td> </tr> <tr> <td>35-40</td> <td>150</td> <td>150</td> <td>150</td> <td>-</td> </tr> <tr> <td>45</td> <td>150</td> <td>150</td> <td>150</td> <td>150</td> </tr> <tr> <td>50</td> <td>200</td> <td>175</td> <td>150</td> <td>150</td> </tr> </tbody> </table>                                    | Posted Speed (mph) | D <sub>1</sub> , Curve Warning Sign Placement Distance (ft) |     |     |    | Deceleration to listed advisory speed (mph) |    |     |    | 10  | 20 | 30  | 40 |     | 35-40 | 150 | 150 | 150 | - | 45 | 150 | 150 | 150 | 150 | 50 | 200 | 175 | 150 | 150 |
| Posted Speed (mph)                                                                                                                                                                                  | D <sub>1</sub> , Curve Warning Sign Placement Distance (ft)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
|                                                                                                                                                                                                     | Deceleration to listed advisory speed (mph)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 10                                                                                                                                                                                                  | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 30                 | 40                                                          |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 35-40                                                                                                                                                                                               | 150                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 150                | 150                                                         | -   |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 45                                                                                                                                                                                                  | 150                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 150                | 150                                                         | 150 |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 50                                                                                                                                                                                                  | 200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 175                | 150                                                         | 150 |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| <p>Large arrow sign</p> <p>W1-6L</p>  <p>48"x 24"</p>                                                              | <ul style="list-style-type: none"> <li>Guides the major movement around the curve</li> <li>Use when recommended based on speed differential between intersection approach and curve advisory speed</li> <li>See Chapter 3 Warning Signs Section for additional information</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| <p>Stop Ahead sign with an except right turn plaque</p> <p>W3-1 &amp; R1-10P</p>  <p>36"</p> <p>24"x 18"</p>      | <ul style="list-style-type: none"> <li>Provides advanced notification to approaching drivers regarding the traffic control at the intersection to help avoid confusion or surprises at the intersection and minimizes potential rear end crashes</li> <li>Sign placement, D<sub>2</sub>, from STOP sign or from curve warning sign, when applicable</li> <li>Only needed when the approach speed to the sweeping curve ≥ 40 MPH or when the STOP sign is not visible per Table 11</li> </ul> <table border="1" data-bbox="625 861 1425 1138"> <thead> <tr> <th>Posted Speed (mph)</th> <th>D<sub>2</sub>, Stop Ahead Sign Placement Distance (ft)</th> </tr> </thead> <tbody> <tr> <td>25</td> <td>150</td> </tr> <tr> <td>30</td> <td>155</td> </tr> <tr> <td>35</td> <td>180</td> </tr> <tr> <td>40</td> <td>210</td> </tr> <tr> <td>45</td> <td>235</td> </tr> <tr> <td>50</td> <td>290</td> </tr> </tbody> </table> | Posted Speed (mph) | D <sub>2</sub> , Stop Ahead Sign Placement Distance (ft)    | 25  | 150 | 30 | 155                                         | 35 | 180 | 40 | 210 | 45 | 235 | 50 | 290 |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| Posted Speed (mph)                                                                                                                                                                                  | D <sub>2</sub> , Stop Ahead Sign Placement Distance (ft)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 25                                                                                                                                                                                                  | 150                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 30                                                                                                                                                                                                  | 155                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 35                                                                                                                                                                                                  | 180                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 40                                                                                                                                                                                                  | 210                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 45                                                                                                                                                                                                  | 235                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| 50                                                                                                                                                                                                  | 290                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| <p>STOP sign with except right turn plaque</p> <p>R1-1 &amp; R1-10P</p>  <p>36"</p> <p>24"x 18"</p>              | <ul style="list-style-type: none"> <li>The plaque supplements the STOP sign and makes it clear that the driver is allowed to turn right without stopping.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| <p>STOP sign with oncoming traffic does not stop plaque</p> <p>R1-1 &amp; W4-4bP</p>  <p>36"</p> <p>24"x 12"</p> | <ul style="list-style-type: none"> <li>The plaque supplements the STOP sign and makes it clear to the minor street driver that the minor approach is the only traffic with a stop control.</li> <li>There are three options for the plaque depending on the roadway geometry, including the following: (1) oncoming traffic does not stop, (2) oncoming and traffic from right does not stop, (3) oncoming and traffic from left does not stop.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| <p>Stop line</p> <p>See Clark County Standard Detail T3.1</p>                                                                                                                                       | <ul style="list-style-type: none"> <li>Provides clear emphasis that the side street approaches are stop controlled.</li> <li>A STOP pavement marking (traffic letters) may be considered by the engineer if issues are reported or observed.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| <p>Double yellow centerline with 2YY raised pavement markers (RPM's)</p> <p>See Clark County Standard Detail T3.0</p>                                                                               | <ul style="list-style-type: none"> <li>Provides a clear indication of route continuity and assigned right-of-way for the major movement.</li> <li>The centerline should be striped through the intersection and should extend at least to the curve warning sign.</li> <li>RPM's alert approaching drivers during night time conditions and provide delineation if the striping fades.</li> <li>The RPM's should be placed at the spacing specified in Table 16.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                             |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |
| <p>Wide dotted extension line</p> <p>See Clark County Standard Detail T3.0</p>                                                                                                                      | <ul style="list-style-type: none"> <li>Supplements the driver information regarding the assigned right-of-way.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                    |                                                             |     |     |    |                                             |    |     |    |     |    |     |    |     |       |     |     |     |   |    |     |     |     |     |    |     |     |     |     |



Figure 14. Sweeping Curve Scenarios A & B

Scenario A



Scenario B

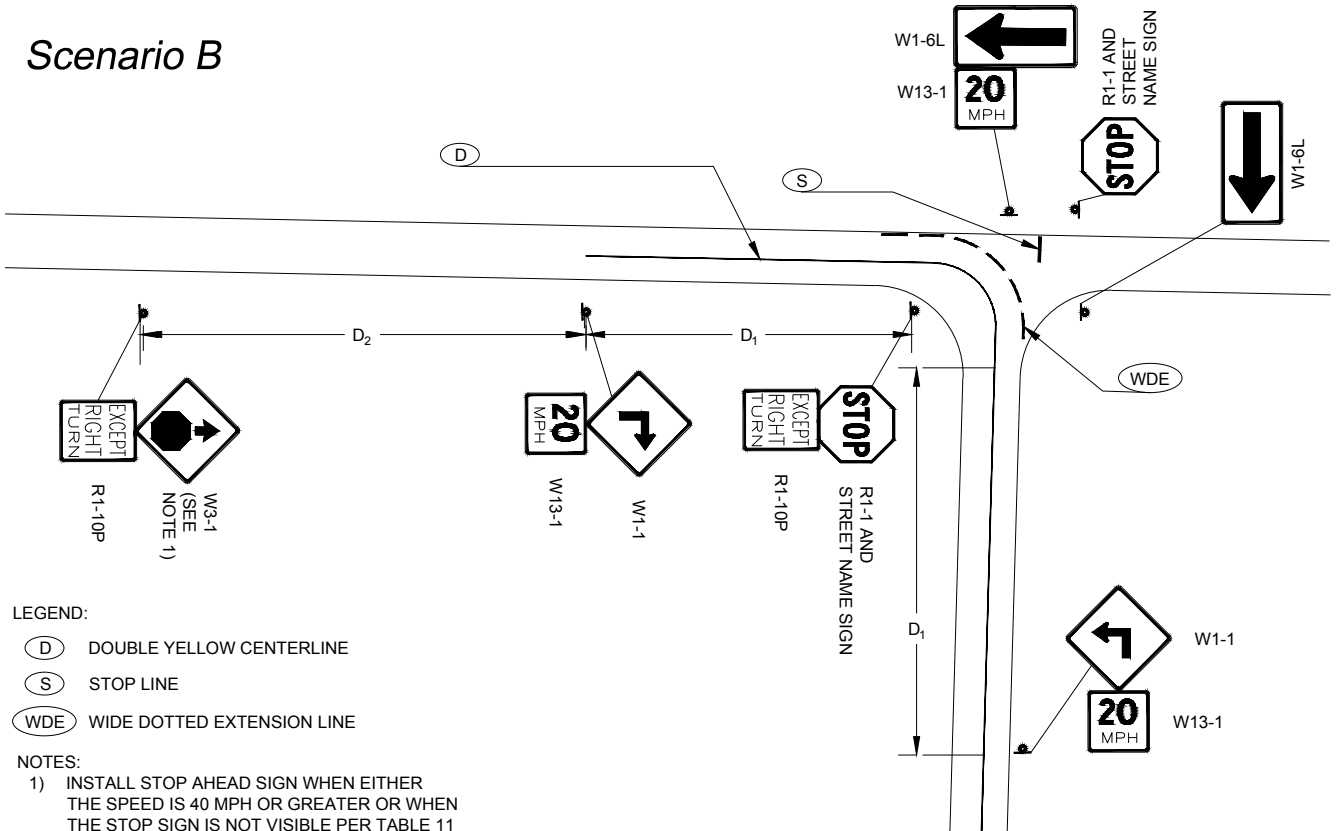
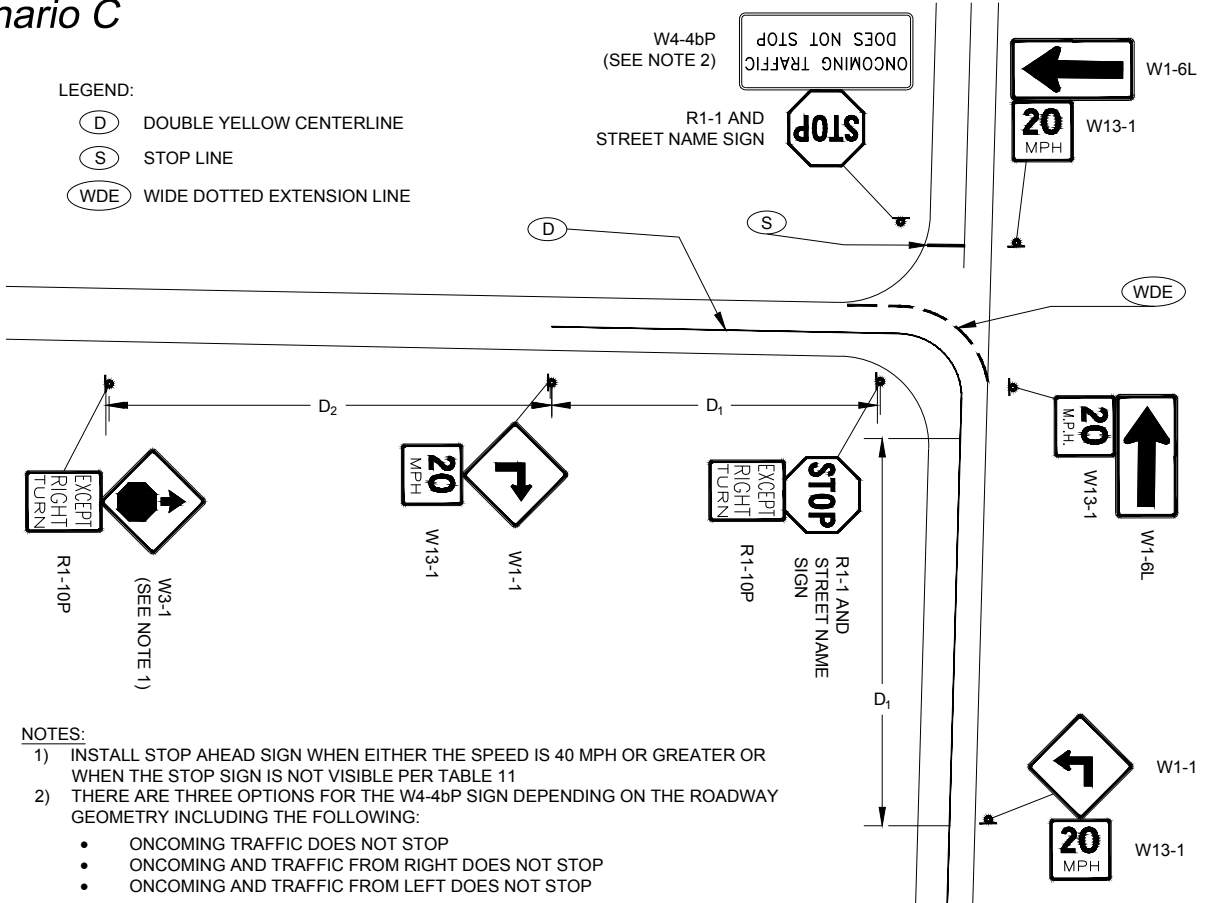


Figure 15. Sweeping Curve Scenarios C & D

Scenario C

LEGEND:

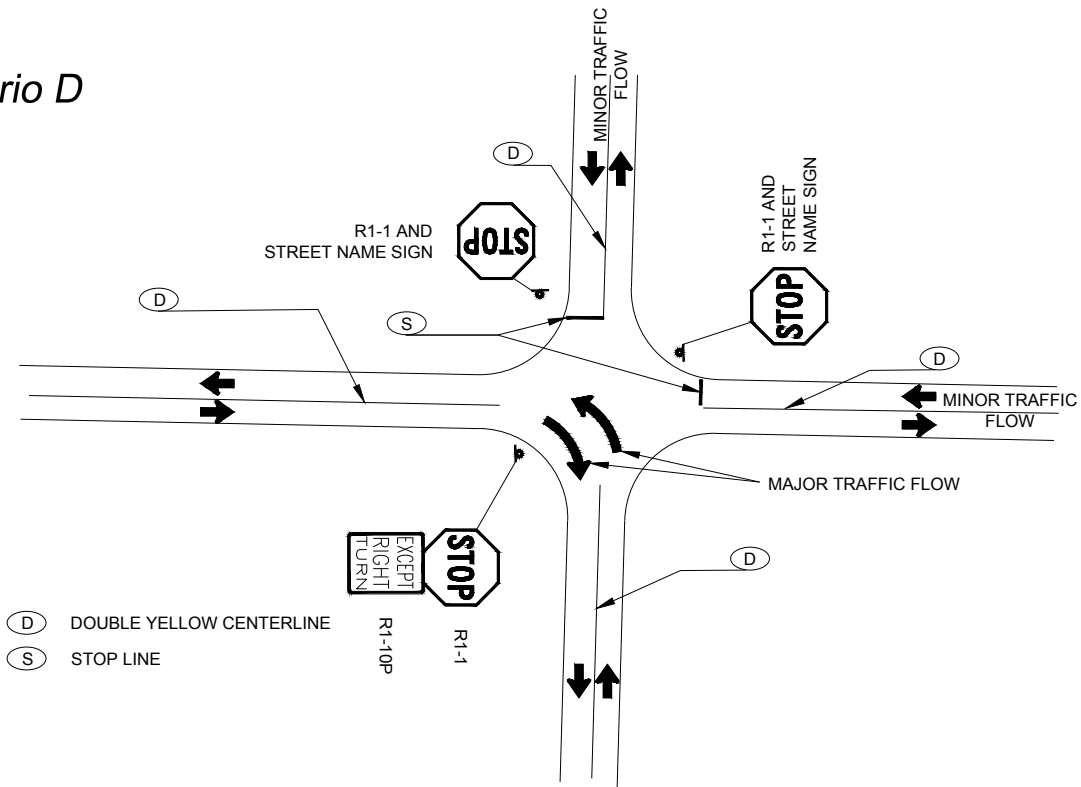
- (D) DOUBLE YELLOW CENTERLINE
- (S) STOP LINE
- (WDE) WIDE DOTTED EXTENSION LINE



NOTES:

- 1) INSTALL STOP AHEAD SIGN WHEN EITHER THE SPEED IS 40 MPH OR GREATER OR WHEN THE STOP SIGN IS NOT VISIBLE PER TABLE 11
- 2) THERE ARE THREE OPTIONS FOR THE W4-4bP SIGN DEPENDING ON THE ROADWAY GEOMETRY INCLUDING THE FOLLOWING:
  - ONCOMING TRAFFIC DOES NOT STOP
  - ONCOMING AND TRAFFIC FROM RIGHT DOES NOT STOP
  - ONCOMING AND TRAFFIC FROM LEFT DOES NOT STOP

Scenario D



- (D) DOUBLE YELLOW CENTERLINE
- (S) STOP LINE

# Appendices

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**Appendix A - Field Procedures**

**Appendix B - Worksheets**

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## Appendix A – Field Procedures

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## Field assessment method for confirming school bus stop sign eligibility

Field staff will need an 8-foot high flag and a DMI equipped vehicle. Staff needs to wear appropriate safety gear and the vehicle needs to be equipped with strobe lights.

The following data and information must be collected prior to the field visit:

- Assemble data for each individual stop provided by the school district.
- Look up the speed limit of the facility.
- Look up Table 2C-4 of the 2009 MUTCD for warning sign placement and County code for safe stopping sight distance.

The field data collection process consists of the following steps (requires two people):

1. At the designated school bus location, a staff member will hold a flag, eight feet high, measured from the pavement surface. The flag will be positioned approximately in the center of the near side lane.
2. The other staff member, driving a DMI equipped vehicle, will approach the school bus stop location at a relatively low speed and note the distance at which the flag is visible.
3. If the flag is visible at a distance of 500 feet or more, then no further action is necessary and the bus stop has adequate sight distance (for that particular direction of travel).
4. If the flag is visible at a distance less than 500 feet, the driver will note the obstructions in the line of sight and will note the effort it will take to remove them.
  - If the visibility of the flag is between 300 and 500 feet, the safety of the stop location would be deemed to be compromised. As a mitigation measure, the location would warrant a School Bus Stop Ahead (S3-1) sign assuming that the school district cannot relocate the bus stop to a safer location.
  - If the visibility of the flag is less than 300 feet and the speed is 35 MPH or less, then the Alternate Procedure as described below should be used. The speed<sup>1</sup> used for the analysis should be the lower of either the posted speed or the operational speed.
  - If the visibility of the flag is less than 300 feet and the speed is 40 MPH or greater, then it would be considered an unsafe school bus stop location. The speed<sup>1</sup> used for the analysis should be the lower of either the posted speed or the operational speed.
5. Repeat steps 2, 3 and 4 for the opposite direction.

### Alternate Procedure:

Field staff will need a 3.5-foot high flag and a DMI equipped vehicle. The alternate procedure is based on safe stopping sight distance using either the posted speed or the operational speed, whichever is the lower value. Suitable adjustment (based on AASHTO chart) would need

---

<sup>1</sup> Engineering judgement required

to be made in estimating the stopping sight distance calculation to account for the upgrade or downgrade terrain of the pavement.

For example, the engineer may use 30 mph as the analysis speed if the operational speed or advisory speed curve is 30 mph on a road with basic speed. For this procedure, the driver eye height is 3.5 feet<sup>2</sup> and the object height at the bus stop location is 3.5 feet (height of a child assumed to be four feet).

1. Use the same procedure described above with the 3.5-foot high flag instead of eight feet.
  - If the visibility of the flag is greater than safe stopping sight distance, the safety of the stop location would be deemed to be compromised. The location would warrant a School Bus Stop Ahead (S3-1) sign assuming that the school district cannot relocate the bus stop to a safer location.
  - If the visibility of the flag is less than safe stopping sight distance, then it would be considered an unsafe school bus stop location.

---

<sup>2</sup> The height of a child is chosen for alternate method because here is potential that a child might be crossing the street to get to the stop location before the school bus has arrived.

## **Methodology for assessing No-Pass Zones for a two-lane road**

Passing sight distance is the clear and unobstructed visibility of an opposing vehicle, on a two-lane road, available to the driver of an approaching vehicle while passing a slower moving vehicle ahead. An assumption in estimating passing zones is that the passing vehicle is travelling at least 12 mph faster than the slower moving vehicle. Engineering judgment and prudence should be exercised, in designating passing zones, in situations where the passing drivers may have to pass several vehicles in a queue or frequently pass long wheel-base tractor trailers.

The passing sight distance standards for Clark County are described in the Traffic Manual, which are based on the 2018 AASHTO's "A Policy on Geometric Design of Highways and Street" and "NCHRP Report 605".

Clark County utilizes two separate methodologies for evaluating the passing zones for two-lane roads; Method 1 utilizes computer software, while Method 2 is a manual method.

### **Method 1: Computer Software method of evaluating No-Passing Zones on a two-lane road**

The primary method of evaluating passing zones on a two-lane road is by estimating the available passing sight distance with software created by Clark County Public Works. This is achieved by creating a roadway centerline profile using LIDAR data where available. The LIDAR data is downloaded to AutoCAD Civil 3D, which provides profile elevations at preset station intervals. Clark County typically uses 25 foot increments as the station intervals. The profile data is transposed in the Clark County passing sight distance software. The analyst also identifies the locations (station data) in the input file; such as public road intersections, railroad crossing etc.; where passing is legally prohibited.

For example, the analyst would enter the limits of a public road intersection as station 9+25 to Station 10+00 as a No-Pass zone. This distance is defined as extending from the stop location to the next stop location. The software estimates the lengths of available passing zones when the centerline profile is downloaded in the software. The software automatically breaks the passing zone at NPZ locations identified by the analyst in the input file. The software also automatically closes out the passing zone where the length of passing zone is less than the minimum (close out distance) per the Traffic Manual.

An aerial map of the corridor with stationing is printed out, which forms the basis for creating a signing and striping plan. It is up to the analyst to manually extend the NPZ 100 feet beyond the public road intersection or other locations such as railroad crossings as appropriate. The analyst is also responsible for manually lengthening the No Pass Zone on the signing and striping plan sheet, where the calculation shows it to be less than the recommended minimum. The analyst

must also note the locations and manually adjust the NPZ for roadway features as noted in the Traffic Manual.

The default value for estimating the available passing zone that Clark County uses is 3.5 feet as the driver eye height and 3.5 feet as the target height of the approaching vehicle. The software produces an output for passing zones assuming a tangent section of the roadway. It does not have the ability to identify sight distance obstructions due to horizontal curves or other roadside obstructions. The No-Passing zone begins as soon as the 3.5 feet mark on the lead vehicles begins. The output provided by the software is the base result for the No-Passing zone. The software evaluating the roadway profile does take in to account the minimum lengths of pass and no-pass. The output must always be field verified for reasonableness. When in doubt, or in case of significant horizontal curves, the manual method must be deployed for the entire corridor. The engineer should always have plan sheets available while field verifying passing zones for reasonableness and should manually evaluate them when in doubt.

#### Method 2: Manual method of evaluating No-Passing zones on a two-lane road

If LIDAR data is not available, results of the software output need to be field verified, or in case of significant horizontal curvature, the manual method of establishing NPZ must be deployed. This method requires the use of two passenger vehicles equipped with distance measuring instruments (DMI). It is important that the DMI's for both vehicles are calibrated prior to assessing the NPZ. This method requires three personnel along with a set of cell phones or two 800 MHz radios. The lead vehicle is fitted with a target in the form of a red or yellow tape at 3.5 feet height. The lead vehicle starts from a designated marked location (typically an intersection) and drives a certain distance. For example for a 50 MPH road, the minimum passing sight distance required is 800 feet. Depending upon the skill and experience of the personnel, the first vehicle would stop at 900 to 1,000 feet providing an error buffer between 100 to 200 feet. The lead vehicle then resets the DMI to zero while the following vehicle positions itself at the starting position.

The driver in the lead vehicle calls out the distance every 100 feet while the driver in the following vehicle matches that distance on their own DMI. To minimize error and ensure accuracy, it is recommended that the both drivers drive at an agreed speed of either 15 or 20 MPH. The second personnel in the follow vehicle records the distances when the target on the lead vehicle disappears and reappears. The stationing of locations where passing would not be allowed such as public road intersections or railroad crossings are noted by the person in the follow vehicle. It is important to note that the lead vehicle must travel at least 1,000 feet beyond the end point ( for 50 MPH corridor) to complete the evaluation of Pass/ No Pass zones. It is helpful to have the stationing of public road intersection and other critical points noted



prior to the start of the run because it provides a mid-corridor start point in case of disruption and it also validates the accuracy of the DMI.

The run in the reverse direction can be completed in a similar fashion. Alternately, the DMI reading may be locked at the end of the run. The lead vehicle would stop 1,000 feet in front of the follow vehicle. The DMI would then run in the reverse direction. This would allow easier marking of the striping on the plan sheet.

The readings are then translated to a striping plan on plan sheets complete with an aerial background and stationing. Adjustments for pass/no pass zones are made for public road intersections and other locations where passing is prohibited. The analyst must manually adjust for NPZ for roadway features as described in the Traffic Manual in creating the striping plan.

It should be noted that the pass zone can be adjusted per the engineer's discretion by modifying values such as minimum passing/no pass zone lengths or by modifying NPZ at a stop controlled intersection, etc. Another example of engineer's discretion would be a vehicle approaching a tight curve in a high speed corridor. In this case, the vehicle in the opposing direction would not be travelling at a high speed and as such some adjustment regarding the passing sight distance may be made, if necessary. Such modification would be justifiable where there are limited numbers of passing zones and modifications of the values would create passing opportunities. Any deviations from the standard must be documented and filed with the passing zone striping plan sheets.

Lastly, the pass and no pass locations should be pre-marked in the field and reviewed by the engineer for reasonableness. An as-built striping plan should be prepared by the engineer stamping the plans and PDF and a paper copy stored.

## Methodology for determining curve warning signs

The County uses the Ball-Bank Indicator Method<sup>3</sup> to determine appropriate curve warning speeds. The Ball-Bank Indicator Method is conducted by field driving tests with the use of a ball-bank indicator and a speedometer. The ball-bank indicator has a curved glass tube filled with a liquid and a weighted ball that floats in the tube. The ball floats outward in the tube when the vehicle travels around a curve. The movement of the ball is measured in degrees of deflection, and this reading is indicative of the combined effect of super elevation, lateral (centripetal) acceleration, and vehicle body roll.

The MUTCD 2009 edition provides guidelines for the maximum deflection that does not cause “driver discomfort” at that curve speed. The deflections are compatible with the current AASHTO guidance and are based on the fact that drivers often exceed posted advisory curve speeds by 7 to 10 mph. The maximum deflections for the curve speed are:

- 16 degrees of ball-bank for speeds of 20 mph or less,
- 14 degrees of ball-bank for speeds of 25 to 30 mph, and
- 12 degrees of ball-bank for speeds of 35 mph and higher.

### Required:

- Two people
- Vehicle with speedometer
- Ball-bank indicator mounted in the vehicle (calibrated to a 0-degree reading when the vehicle is stopped on a level surface)
- Distance measuring instrument (DMI) set to a known reference point.

### Procedure:

- 1) One person drives the vehicle through the corridor at a constant speed following the curve alignment(s) as closely as possible. The driver must reach the test speed in advance of the beginning of the curve(s), and maintain a constant speed throughout the length of the curve(s). The second person records the deflection readings from the ball-bank indicator and the location for that driving speed (using Table 1).
- 2) If there are curves where the deflection is exceeded by the MUTCD criteria, then the speed of the vehicle is decreased by 5 mph and the test is repeated.
- 3) The vehicle speed is adjusted in 5 mph blocks until the reading is just below the acceptable maximum deflection. The curve advisory speed is set at the highest test speed that does not result in a ball-bank indicator reading greater than an acceptable level. For a reverse curve or winding road, the tightest curve in the series would govern the posted advisory speed plaque.
- 4) After the curve advisory speeds have been determined for each curve, then appropriate curve warning signs need to be determined per the Traffic Manual and recorded in Table 2. The signs are then field located, and adjusted as needed.

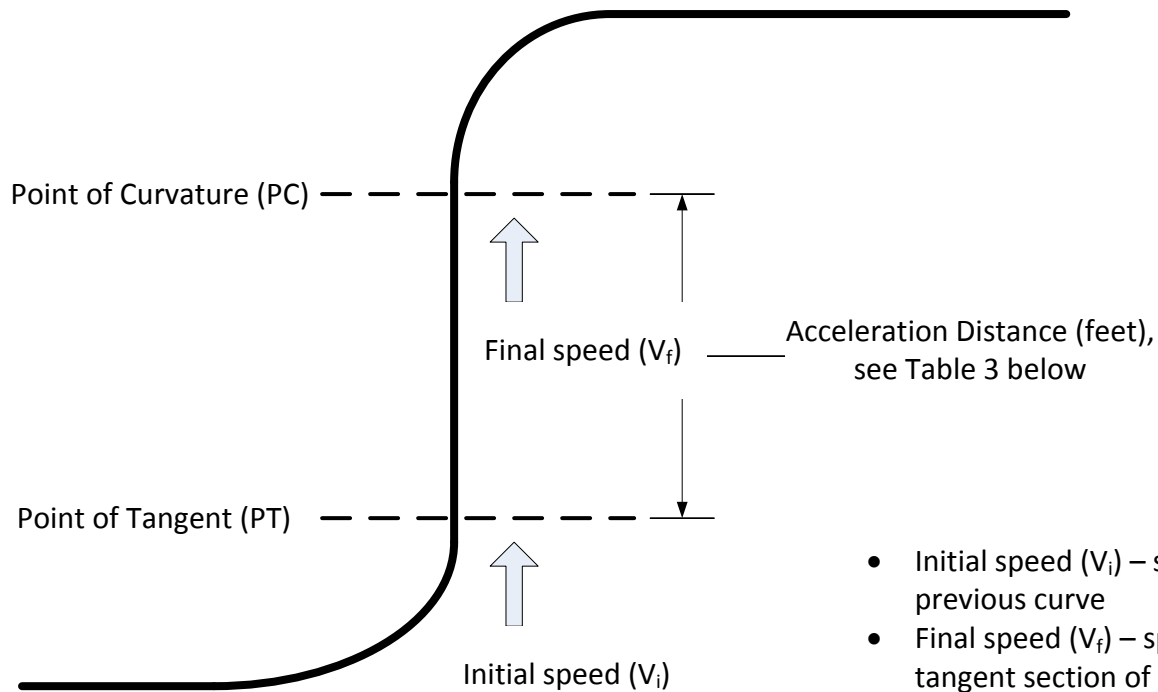
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<sup>3</sup> Approved method for establishing advisory speeds per FHWA Procedures for Setting Advisory Speeds on Curves, June 2011, Chapter 3





## Acceleration Distance Between Horizontal Curves



- Initial speed ( $V_i$ ) – speed after exiting previous curve
- Final speed ( $V_f$ ) – speed after the tangent section of roadway, before entering the next curve

**Table 3. Acceleration Distance Between Horizontal Curves (feet)**

|                            |    | Final speed, $V_f$ (mph) |     |     |     |     |     |
|----------------------------|----|--------------------------|-----|-----|-----|-----|-----|
|                            |    | 25                       | 30  | 35  | 40  | 45  | 50  |
| Initial speed, $V_i$ (mph) | 10 | 410                      | 480 | 565 | 710 | 820 | 940 |
|                            | 15 |                          | 450 | 535 | 680 | 790 | 910 |
|                            | 20 |                          |     | 490 | 635 | 745 | 865 |
|                            | 25 |                          |     |     | 605 | 725 | 860 |
|                            | 30 |                          |     |     |     | 645 | 780 |
|                            | 35 |                          |     |     |     |     | 690 |

### Notes:

- 1) The acceleration distance was calculated using the kinematic equation  $V_f^2 = V_i^2 + 2aS$
- 2) The acceleration rate used was  $4.2 \text{ ft/sec}^2$ , except for curves with a speed of 25 MPH or higher, where the acceleration rate was  $3.8 \text{ ft/sec}^2$
- 3) A distance of 275 feet for final speeds of 35 MPH and under or a distance of 325 feet for final speeds of 40 MPH and over was added to the distance needed to accelerate to account for a driver slowing down once they see the curve warning sign or supplemental signing
- 4) The acceleration distances provided are a general guideline. Judgement needs to be used to take into account field conditions such as grade, horizontal curve, presence of shoulder, embankment, or other traffic control devices.

## Appendix B – Worksheets

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## Worksheet for Intersection Sight Distance Measurements



Minor Street Name: \_\_\_\_\_

| Posted Speed<br>(mph) | Required Intersection<br>Sight Distance (feet) |
|-----------------------|------------------------------------------------|
| 20                    | 200                                            |
| 25                    | 250                                            |
| 30                    | 300                                            |
| 35                    | 350                                            |
| 40                    | 400                                            |
| 45                    | 450                                            |
| 50                    | 500                                            |

Major Street

Name: \_\_\_\_\_

Posted Speed: \_\_\_\_\_



| Minor Street Approach | Looking towards _____ leg of intersection | Distance from Edge of Travelled Way (feet) | Measured Intersection Sight Distance (feet) |  |
|-----------------------|-------------------------------------------|--------------------------------------------|---------------------------------------------|--|
|                       |                                           | 15                                         |                                             |  |
|                       |                                           | 12                                         |                                             |  |
|                       |                                           | 15                                         |                                             |  |
|                       |                                           | 12                                         |                                             |  |
|                       |                                           | 15                                         |                                             |  |
|                       |                                           | 12                                         |                                             |  |
|                       |                                           | 15                                         |                                             |  |
|                       |                                           | 12                                         |                                             |  |

Considerations for objects in the line of sight:

- Are obstructions removable?
- Are obstructions outside ROW?
- Can they be marked in the field?
- What's the potential mitigation?

