# Intersection Design Guidance (Right Turn Only)

## Purpose

The purpose of this document is to provide guidance on intersection design for designers and reviewers.

## Design Process

The following steps should be followed to properly design a proposed entrance or intersection improvement:

A. Pre-application meeting
   1. Determine entrance location(s)
   2. Define the design vehicle for entrance or offsite improvements based on the proposed use. Refer to Figure 2 for guidance choosing a design vehicle. The engineer assumes full responsibility for designing an entrance or intersection without first meeting with DelDOT to determine the required design vehicle.
   3. If the entrance or intersection will be unchannelized, utilize Figures 6 and 8 to determine the correct intersection corner/geometric design values.
   4. An entrance or intersection may need to be channelized. Refer to Figures 20, 21 and 22 for intersection corner design values. Reasons to consider channelizing include:
      i. Pedestrian crossing distance is a concern
      ii. Need for pedestrian refuge
      iii. Pedestrian signals to be installed at signalized entrances or intersections
      iv. Need to deter vehicular movements to or from an entrance
   5. Triangular channelized islands shall meet the requirements listed in Figures 26 and 27.
   6. Determine if lane encroachment is permitted on the approach and/or departure legs as shown in Figure 3.

B. Design
   1. List the design vehicle in the trip generation diagram
   2. Provide design vehicle turning movement diagrams with the initial plan submittal to verify that the minimum requirements for edges of traveled way for the design vehicle, drive aisle widths and channelizing islands sizes are met. If a signal is proposed at the intersection, then electronic files shall be forwarded to the Traffic Section to begin signal design only after these design features have been verified.
   3. If a turning software application is used to create the templates, a minimum 10 mph speed shall be used for the design vehicle.
   4. The design vehicle shall be properly positioned within the traffic lane at the beginning and end of the turn with a 2 foot offset from the edge of traveled way on the tangents. It is recommended to maintain the 2 foot offset of the design vehicle's inner wheel path throughout the most of the turn and with a clearance at no point less than 9 inches from the face of curb or edge of pavement if uncurbed as shown in Figure 1.

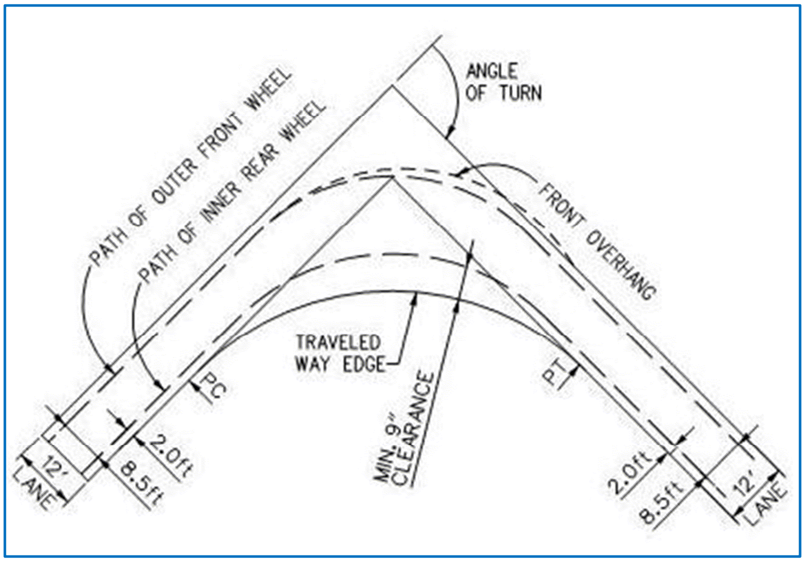



Figure 1

## Sample Design Vehicles Uses

Figure 2 provides suggestions for design vehicles to use for several commonly proposed development uses.

| Proposed Development Use | Design Vehicle* |
|---|---|
| Residential Subdivision | SU-30, WB-62** |
| Bank | SU-30 |
| Gas Station | WB-40, WB-50, or WB-62 |
| Big Box Store (e.g. Walmart, Lowes, Best Buy) | WB-67 |
| Restaurant (e.g. Applebee's, Chili's, Ruby Tuesday) | WB-62 |
| Fast Food | WB-40, WB-50, or WB-62 |
| Mid-size Retail/Grocery<br>(e.g. Dollar Store, Giant, Safeway) | WB-62 |
| Small Retail | SU-30, WB-40, or WB-50 |
| Pharmacy | WB-62 |
| Car Wash | SU-30 |
| School | SU-30, WB-62** |
| Intersections of State Maintained Roadways | WB-62 |

**Refer to Table 2-1 of AASHTO's* A Policy on Geometric Design of Highways and Streets, $6^{th}$ Edition, *for design vehicle dimensions.*

*** Encroachment into the opposing lane of the entrance drive may be permitted but not on curb or islands. Refer to Section 1 for additional guidance.*

Figure 2 – Design Vehicle Selection

## Right Turn Design

### 1. Intersection Corner Radii

The radii of an intersection's corners or the curves connecting the edges of pavement of the intersecting streets—are defined by either the curb (face or where asphalt pavement and edge of gutter meet), or, where there is no curb, by the edge of pavement. The intersection's corner radii are a key factor in the multimodal performance of the intersection. The corner radius affects the pedestrian crossing distance, the speed and travel path of turning vehicles, and the appearance of the intersection.

Excessively large pavement corner radii result in significant drawbacks in the operation of the street since pedestrian crossing distance increases with pavement corner radius. Further, the speed of turning motor vehicles making right turns is higher at corners with larger pavement corner radii. The compounded impact of these two measures—longer exposure of pedestrians to higher-speed turning vehicles—yields a significant deterioration in safety and quality of service to both pedestrians and bicyclists.

The underlying design control in establishing pavement corner radii is the need to have the design vehicle turn within the permitted degrees of encroachment into adjacent or opposing lanes. Figure 3 illustrates degrees of lane encroachment often considered acceptable based on the intersecting roadway types. These degrees of lane encroachment vary significantly according to roadway type, and balance the operational impacts to turning vehicles against the safety of all other users of the street. Although Figure 3 provides a starting point for planning and design, the designer must confirm the acceptable degree of lane encroachment during the project development process. It is acceptable for a design vehicle turning from a right turn lane to encroach onto the adjacent bike lane on the approach leg. Lane

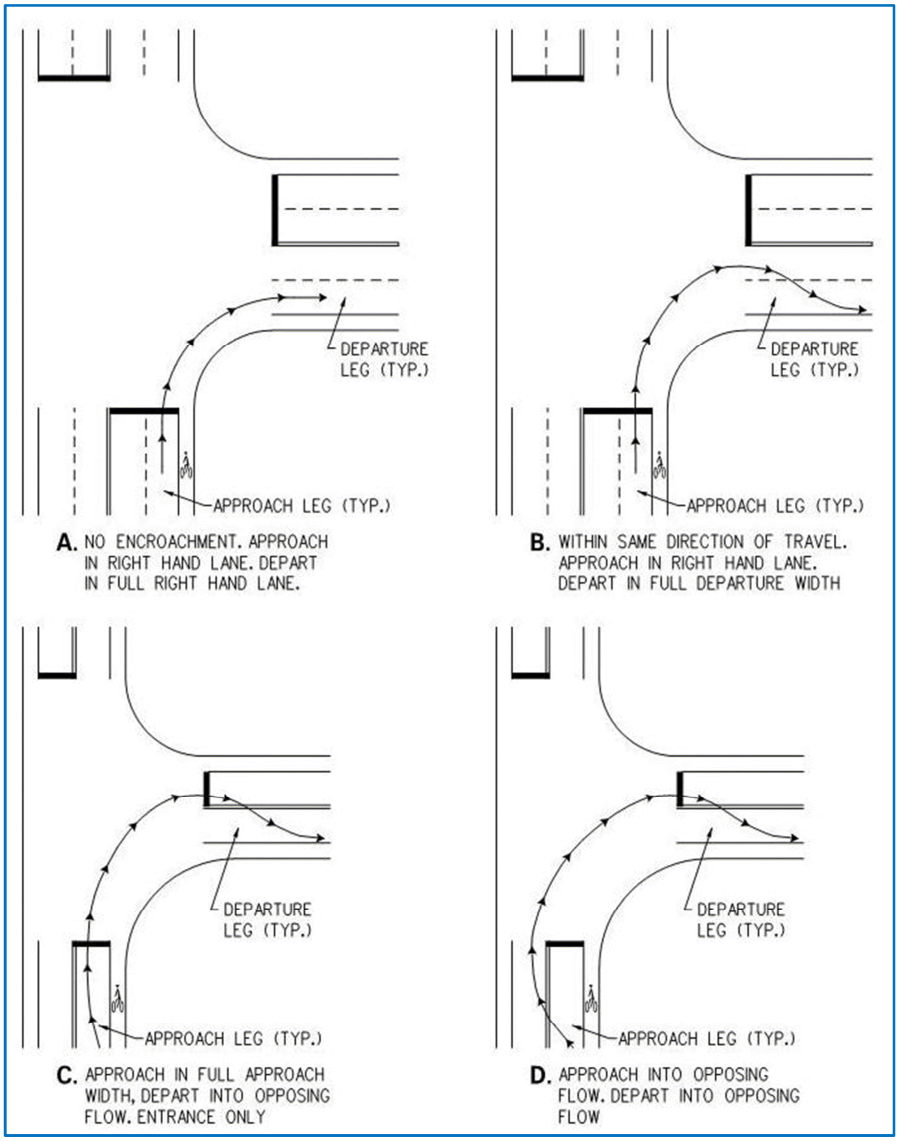



**Figure 3 – Typical Lane Encroachment by Design Vehicle**

encroachment in full departure width (not full approach width) as shown in Condition B may be permitted at signalized intersections where a gap is provided allowing the design vehicle turning onto a multi-lane roadway to utilize both travel lanes to make a right turn. Condition C may be acceptable for right turns into an entrance if design vehicle movements are expected during off-peak times. In nearly all cases, Condition D, in which the turning vehicle encroaches into opposing flow, should be avoided. Encroachment by the design vehicle on curbed channelized islands, outer curb line or beyond the edge of pavement (when no curb is present) is not permitted.

At the great majority of all intersections, whether curbed or otherwise, the pavement corner design is dictated by the right-turn movement. Left turns are seldom a critical factor in corner design, except at intersections of one-way streets, in which case their corner design is similar to that for right turns at intersections of two-way streets. The method for pavement corner design can vary as illustrated in Figure 4 and described below.

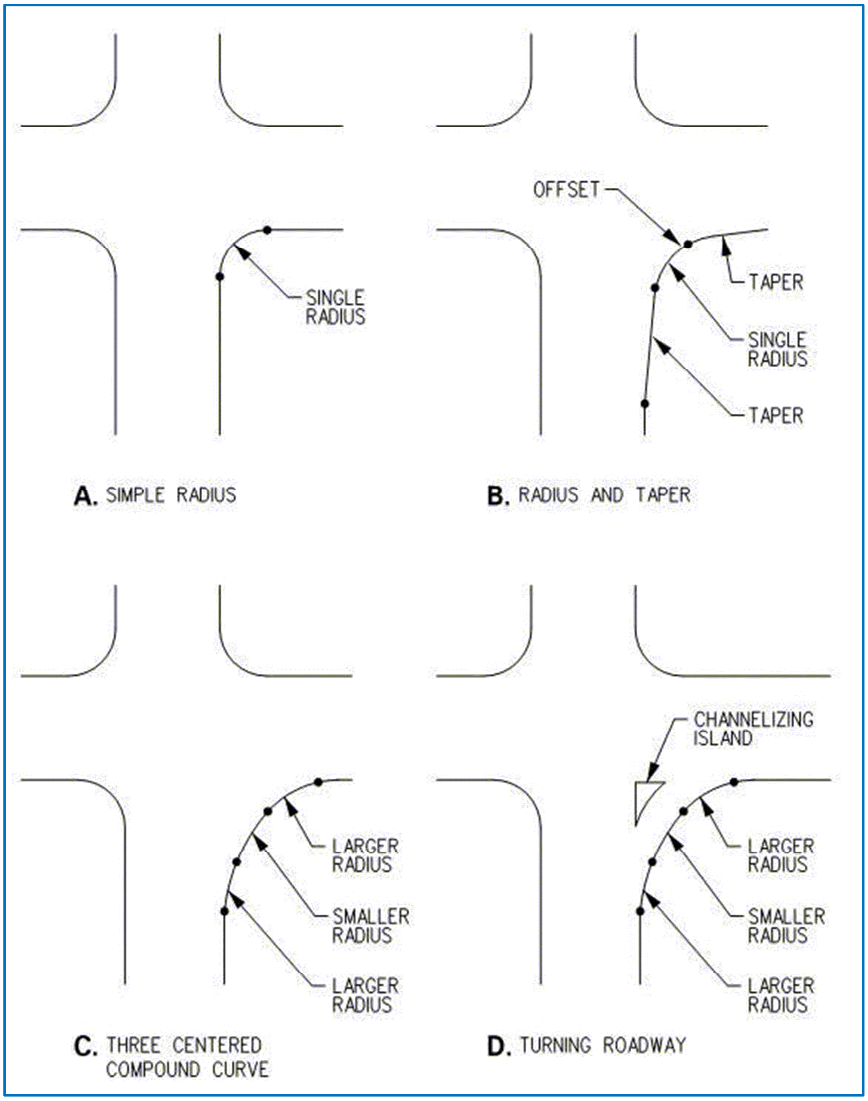



**Figure 4 – Methods for Pavement Corner Design**

## 2. Simple Curve Radius

A simple curb radius may be used right-angle (90 degree) turns on roadways at <u>unchannelized intersections</u> for passenger, single unit and small semitrailer design vehicles turning.

In many situations, the "effective" pavement width on approach and departure legs is greater than an 11 or 12 foot wide travel lane. This is the pavement width usable, by the design motor vehicle, under the permitted degree of lane encroachment. At a minimum, effective pavement width is always the right-hand lane and therefore usually at least 11-12 feet, on both the approach and departure legs. Where a shoulder is present, the shoulder (typically 5 to 8 feet) is added to the effective width on those legs (approach, departure or both), the effective width may increase to between 16 to 20 feet. In addition, the effective width may include encroachment into adjacent lanes of traffic. An example of this is a combination vehicle using an inside travel lane to make a right turn at a signalized intersection. Figure 5 shows Conditions A, B and C where the effective width may be utilized to design an intersection corner. An example using Condition B in the figure to determine the curve radius is a SU-30 vehicle turning right at a 90 degree intersection from a local road having an 11 foot travel lane and a 5 foot shoulder onto a collector road having a 12 foot travel lane and an 8 foot shoulder. Therefore, the effective approach leg width is 16 feet and the effective departure leg width is 20 feet. Figure 6 provides design values for various widths of approach and departure legs at unchannelized intersections.

For larger angles of turns and/or large design vehicles, simple curve radius with taper combinations or three centered compound curves should be considered.

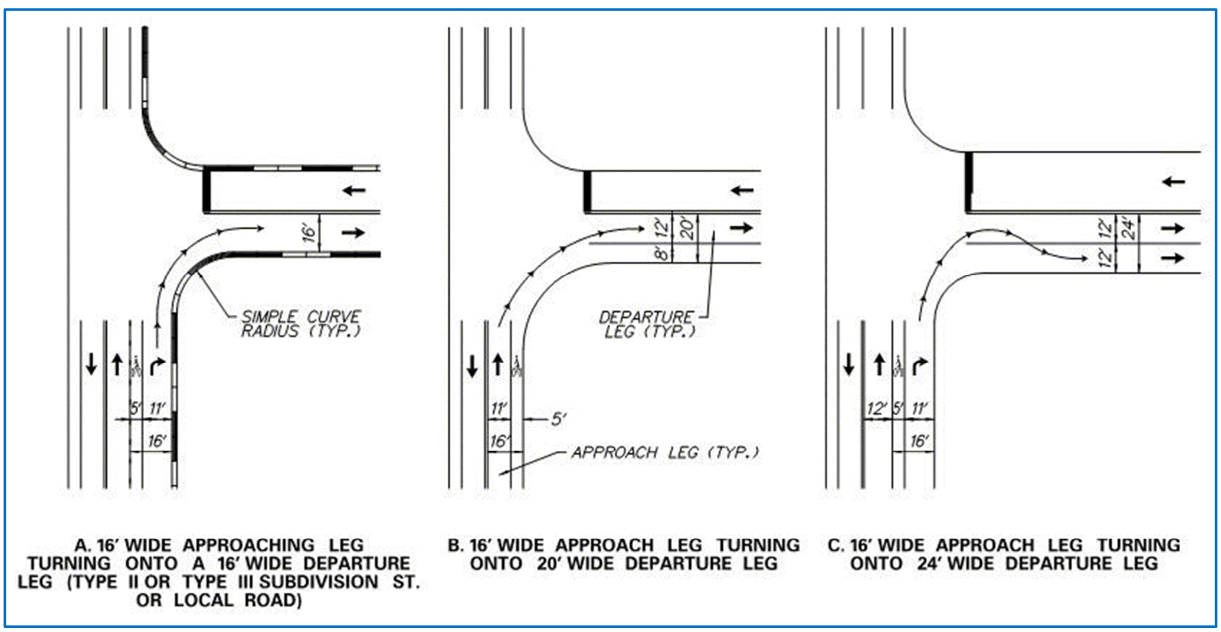



**Figure 5 – Effective Pavement Width Examples**

| Angle of Turn (Degrees) | Effective Width on Approach Leg (ft) | Effective Width on Departure Leg (ft) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Passenger Car (P) | | | Single Unit Truck (SU-30) | | | Tractor Trailer (WB-40) | | | |
| | | 12 | 16 | 20 | 12 | 16 | 20 | 12 | 16 | 20 | 24 |
| 75 | 12 | 35 | 20 | 15 | 55 | 50 | 35 | - | 60 | 40 | 35 |
| | 16 | 20 | 15 | 15 | 55 | 45 | 25 | 80 | 60 | 35 | 20 |
| | 20 | 20 | 15 | 15 | 50 | 35 | 15 | 75 | 50 | 20 | 15 |
| 90 | 12 | 30 | 20 | 15 | 50 | 40 | 30 | 80 | 60 | 35 | 30 |
| | 16 | 20 | 15 | 15 | 50 | 35 | 20 | 75 | 55 | 35 | 25 |
| | 20 | 15 | 15 | 15 | 45 | 30 | 15 | 65 | 50 | 25 | 15 |
| 105 | 12 | 20 | 20 | 15 | 50 | 40 | 30 | 65 | 50 | 35 | 30 |
| | 16 | 20 | 15 | 15 | 45 | 35 | 25 | 60 | 50 | 30 | 25 |
| | 20 | 15 | 15 | 15 | 40 | 25 | 15 | 55 | 45 | 25 | 20 |
| 120 | 12 | 20 | 15 | 15 | 45 | 40 | 30 | 60 | 50 | 35 | 30 |
| | 16 | 15 | 15 | 15 | 45 | 30 | 25 | 55 | 45 | 30 | 25 |
| | 20 | 15 | 15 | 15 | 40 | 25 | 20 | 55 | 40 | 25 | 20 |
| 150 | 12 | 20 | 15 | 15 | 40 | 30 | 30 | 45 | 40 | 30 | 30 |
| | 16 | 15 | 15 | 15 | 40 | 30 | 25 | 45 | 40 | 30 | 25 |
| | 20 | 15 | 15 | 15 | 35 | 25 | 25 | 40 | 35 | 25 | 20 |

Minimum 15 ft. radius used.

Source: Adapted from A Policy on Geometric Design of Highways and Streets, AASHTO, 2011, Chapter 9, Intersections

**Figure 6 - Simple Curve Radius with Effective Pavement Width**

Based on values provided in Figure 6, Figure 7 provides guidance on how to design a simple curve radius for a SU-30 design vehicle at an unchannelized intersection.

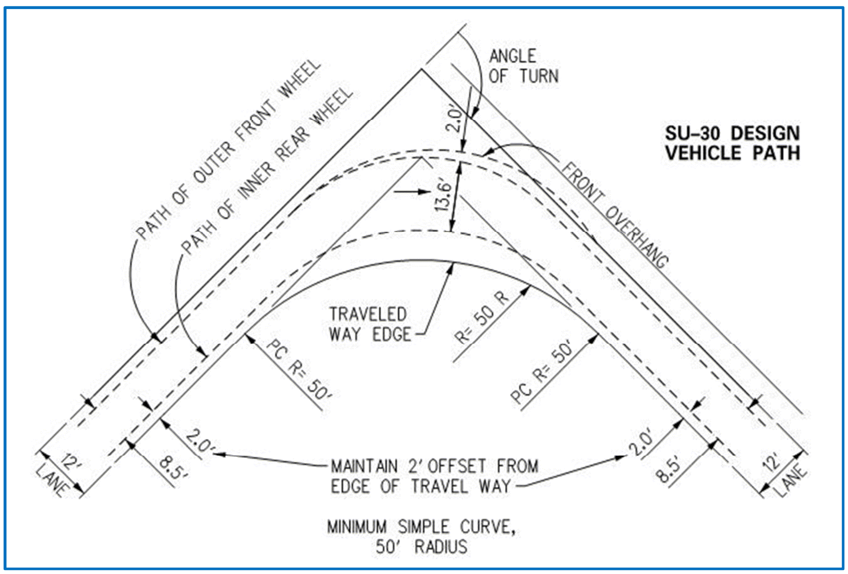



**Figure 7 - Simple Curve Radius Example for an SU-30**

## 1. Simple Curve Radius with Taper

The combination of a simple radius flanked by tapers can often fit the pavement edge more closely to the design vehicle than a simple radius (with no tapers). This closer fit can be important for large design vehicles where effective pavement width is small (due either to narrow pavement or need to avoid any lane encroachment), or where turning speeds greater than minimum are desired. Figure 8 summarizes design elements for curve/taper combinations at unchannelized intersections that permit various design motor vehicles to turn, without any lane encroachment, from a single approach lane into a single departure lane. Values provided are for design vehicles turning from a 12 foot wide approach leg onto a 12 wide foot departure leg. If the effective width of the approach leg and/or departure leg is greater than 12 feet, than the offset or taper length ratio may be reduced to optimize the corner design.

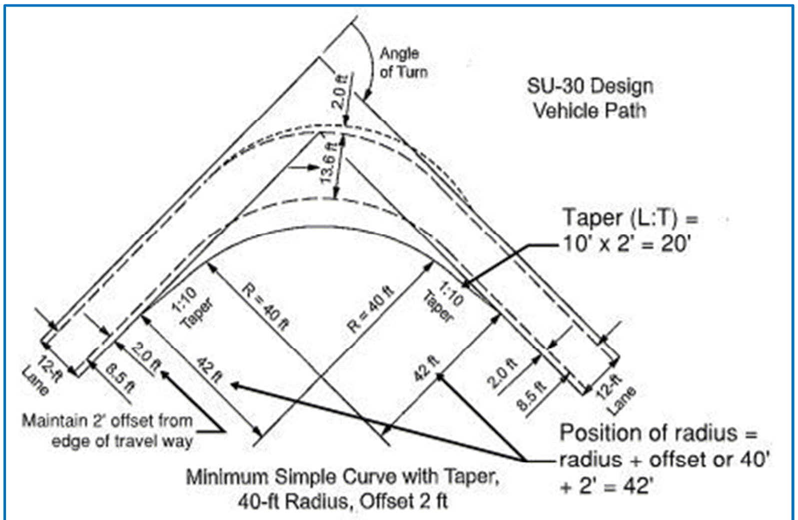
| Angle of Turn (Degrees) | Design Vehicle | Simple Curve Radius with Taper | | |
|---|---|---|---|---|
| | | Radius (ft) | Offset (ft) | Taper Length (L:T) |
| 75 | P | 25 | 2 | 10:1 |
| | SU-30 | 45 | 2 | 10:1 |
| | WB-40 | 60 | 2 | 15:1 |
| | WB-62 | 145 | 4 | 20:1 |
| 90 | P | 20 | 2.5 | 10:1 |
| | SU-30 | 40 | 2 | 10:1 |
| | WB-40 | 45 | 4 | 10:1 |
| | WB-62 | 120 | 4.5 | 30:1 |
| 105 | P | 20 | 2.5 | 10:1 |
| | SU-30 | 35 | 3 | 10:1 |
| | WB-40 | 40 | 4 | 10:1 |
| | WB-62 | 115 | 3 | 15:1 |
| 120 | P | 20 | 2 | 10:1 |
| | SU-30 | 30 | 3 | 10:1 |
| | WB-40 | 35 | 6 | 8:1 |
| | WB-62 | 100 | 5 | 15:1 |
| 150 | P | 18 | 2 | 10:1 |
| | SU-30 | 30 | 4 | 10:1 |
| | WB-40 | 60 | 6 | 8:1 |
| | WB-62 | 60 | 10 | 10:1 |

Source: Adapted from A Policy on Geometric Design of Highways and Streets, AASHTO, 2011, Chapter 9, Intersections

Figure 8 - Simple Curve Radius and Taper

Based on values provided in Figure 8, Figure 9 provides guidance how to design a simple curve radius with taper corner design for an SU-30 design vehicle at an unchannelized intersection.




Source: Adapted from A Policy on Geometric Design of Highways and Streets, AASHTO, 2011, Chapter 9, Intersections

Figure 9 - Simple Curve Radius with Taper Example for an SU-30

Laying out a simple curve radius with taper may be done in a few easy steps as outlined below:

A. Based on the angle of turn and design vehicle, select the appropriate radius, offset and taper length (length to offset ratio) from Figure 8.

B. To find the center of the radius, offset the radius plus the offset distance from the outside edge of the approach and departure legs. Draw a circle equal to the radius and snap the center to the point of intersection as shown in Figure 10.

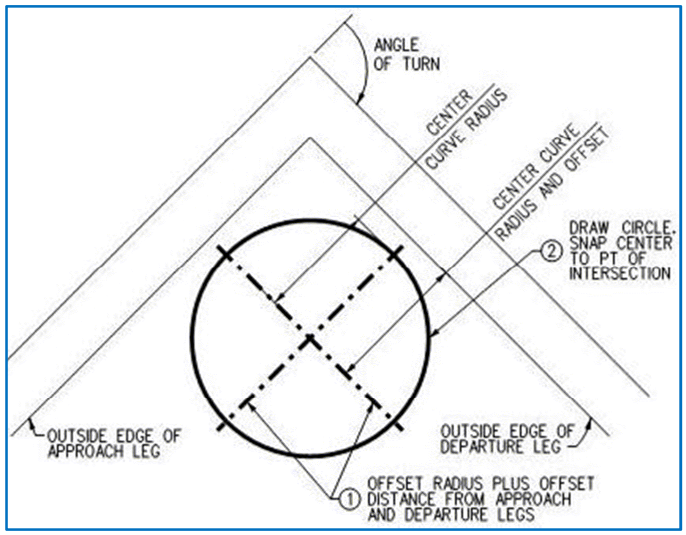



Figure 10 - Simple Curve with Taper Design

C. Draw a line from the center of the circle perpendicular to the approach and departure legs. Multiply the offset distance by the taper length. For example, if L:T is 20:1 and the offset is 4 feet, then the taper length equals 4' x 20 = 80'. Offset the distance calculated (i.e. 80') from the perpendicular lines as shown in Figure 11.

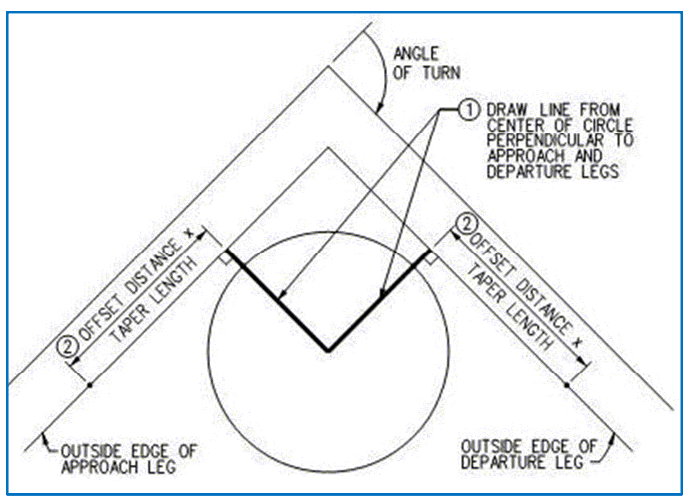



Figure 11 - Simple Curve with Taper Design

D. From the point where the offset intersects the outside edge of the approach and departure legs, draw a line back tangent to the circle as shown in Figure 12.

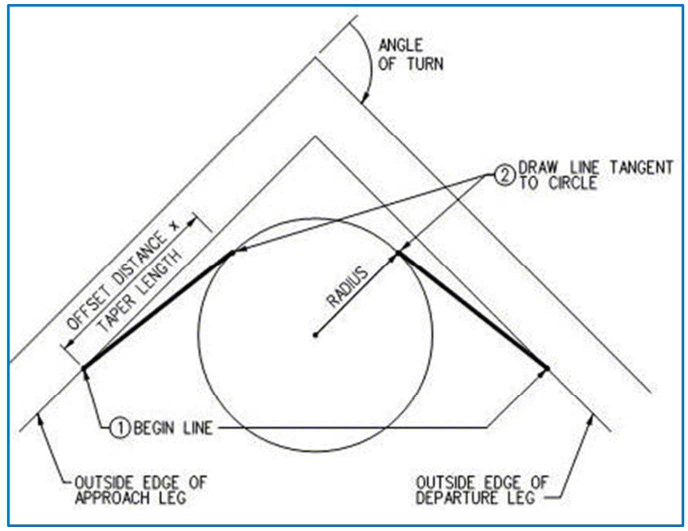



Figure 12 - Simple Curve with Taper Design

E. Trim the circle at the PC and PT as shown in Figure 13.

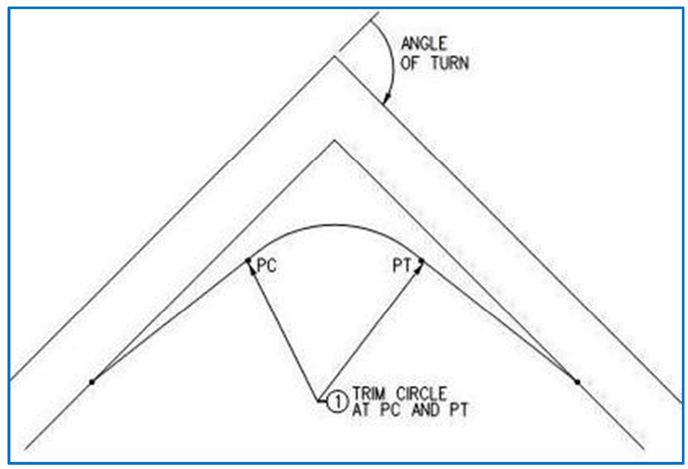



Figure 13 - Simple Curve with Taper Design

## 2. Three Centered Compound Curves

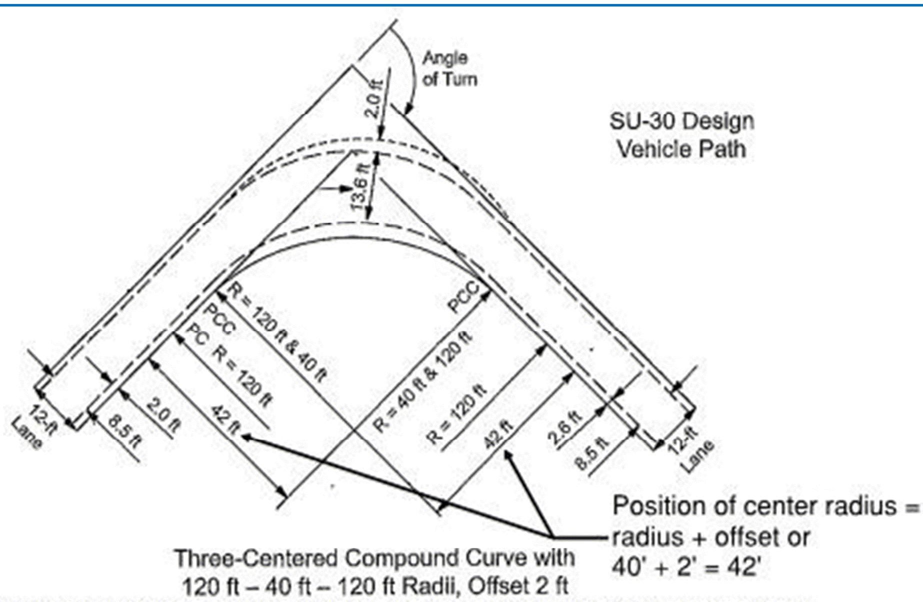
Figure 14 shows the minimum edge of traveled way design values for various uses using three centered compound curves at an <u>unchannelized intersection</u>, without any lane encroachment, from a single approach lane into a single departure lane. Values provided are for design vehicles turning from a 12 foot wide approach leg onto a 12 wide foot departure leg. If the effective width of the approach leg and/or departure leg is greater than 12 feet, than the radii and/or offset may be reduced to optimize the corner design.

Based on design values provided in Figure 14, Figure 15 provides guidance how to design a three centered compound curve corner design for a SU-30 design vehicle at an unchannelized intersection.

| Angle of Turn (Degrees) | Design Vehicle | Radius (R1-R2-R1, ft) | Offset (ft) |
|---|---|---|---|
| 75 | P | 100-25-100 | 2 |
| | SU-30 | 120-45-120 | 2 |
| | WB-40 | 120-45-120 | 5 |
| | WB-62 | 440-75-440 | 15 |
| 90 | P | 100-20-100 | 2.5 |
| | SU-30 | 120-40-120 | 2 |
| | WB-40 | 120-40-120 | 5 |
| | WB-62 | 400-70-400 | 10 |
| 105 | P | 100-20-100 | 2.5 |
| | SU-30 | 100-35-100 | 3 |
| | WB-40 | 100-35-100 | 5 |
| | WB-62 | 520-50-520 | 15 |
| 120 | P | 100-20-100 | 2 |
| | SU-30 | 100-30-100 | 3 |
| | WB-40 | 120-30-120 | 6 |
| | WB-62 | 520-70-520 | 10 |
| 150 | P | 75-20-75 | 2 |
| | SU-30 | 100-30-100 | 4 |
| | WB-40 | 100-30-100 | 6 |
| | WB-62 | 480-55-480 | 15 |

Source: Adapted from A Policy on Geometric Design of Highways and Streets, AASHTO, 2011, Chapter 9, Intersections

**Figure 14 - Three Centered Compound Curves**




Source: Adapted from A Policy on Geometric Design of Highways and Streets, AASHTO, 2011, Chapter 9, Intersections

**Figure 15 - Three Centered Compound Curve Example for an SU-30**

Laying out a three centered compound curve may be accomplished in a few steps as outlined below:

A. Based on the angle of turn and design vehicle, select the appropriate radii and offset from Figure 14.

B. To find the center of the center curve radius, offset the radius plus the offset distance from the outside edge of the approach and departure legs. Draw a circle equal to the radius and snap the center to the point of intersection as shown in Figure 16.

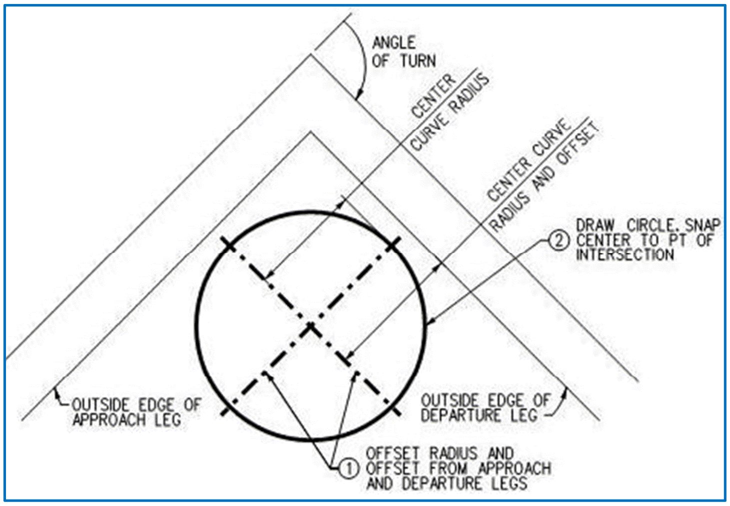



Figure 16 - Three Centered Compound Curve Design

C. Using the 'Place Arc' command and 'Tangent' snaps in AutoCad® or Microstation®, snap tangent to the departure leg and then snap tangent to the center circle as shown in Figure 17. Repeat steps to draw the arc on the approach leg.

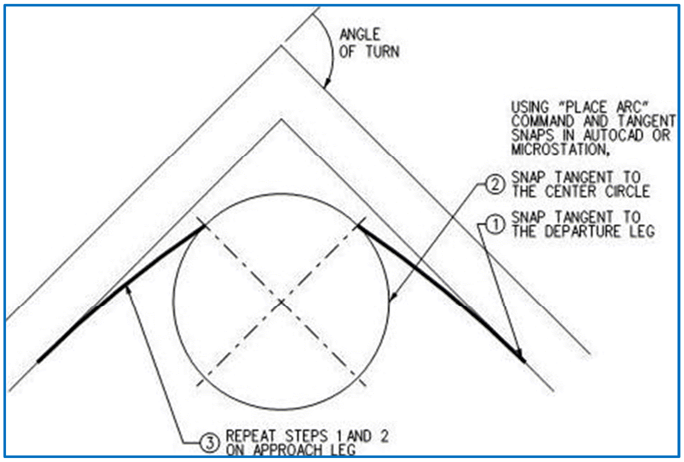



Figure 17 - Three Centered Compound Curve Design

D. Trim the center circle to the arcs as shown in Figure 18.

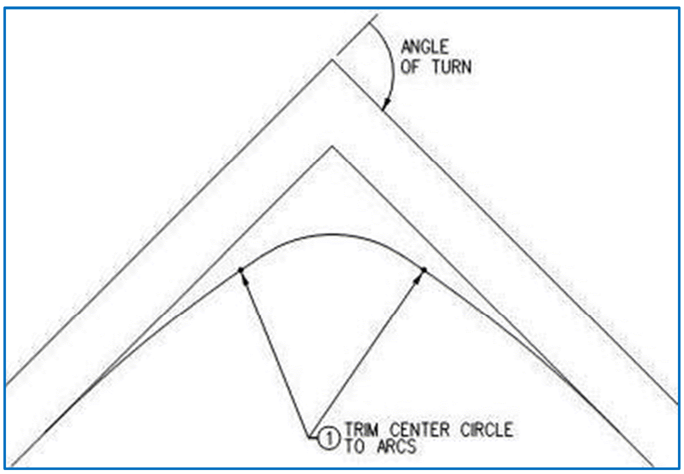



Figure 18 - Three Centered Compound Curve Design

### 3. Turning Roadways

A separate right-turn roadway, usually delineated by channelization islands and auxiliary lanes, may be appropriate where right-turn volumes are large, where lane encroachment by any motor vehicle type is unacceptable, where higher speed turns are desired, or where angle of turn is well above 90 degrees.

Three centered compound curves may be used on turning roadway for passenger vehicles and should be considered where SU and semitrailer combinations will be turning as shown in Figure 19.

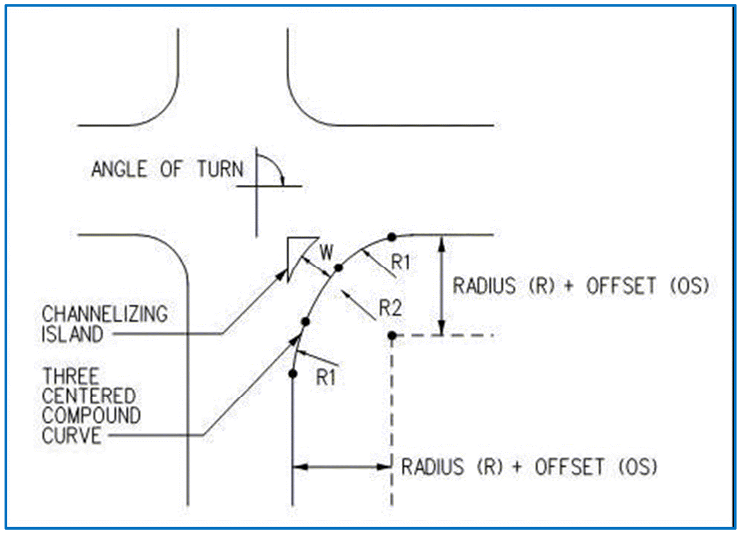



**Figure 19 - Turning Roadways and Islands**

Figure 7-6 of the *Road Design Manual* provides suggested simple curve radii and lane widths combinations for turning roadways based on several types of smaller design vehicle. Figure 20 shows a sample turning roadway design for passenger cars and occasional SU's for a right-in and right-out entrance using simple curve radii. Figure 21 shows a sample turning roadway design for bus and WB-40 design vehicles for a right-in and right-out entrance using simple curve radii. In all cases, the channelizing island should be checked to verify that it meets the minimum size requirements.

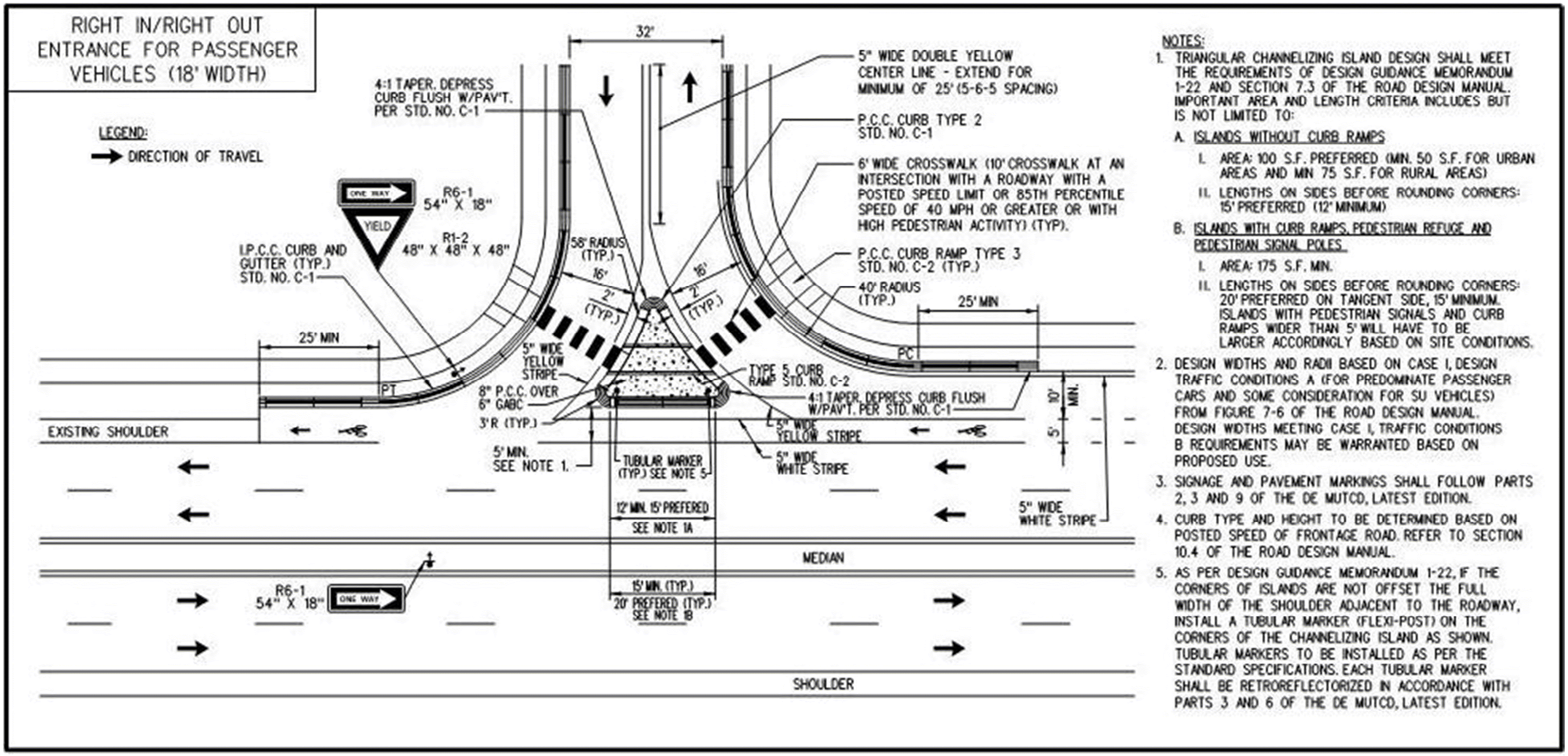



**Figure 20 – Sample Turning Roadway Design for Passenger Cars and Occasional SU's**

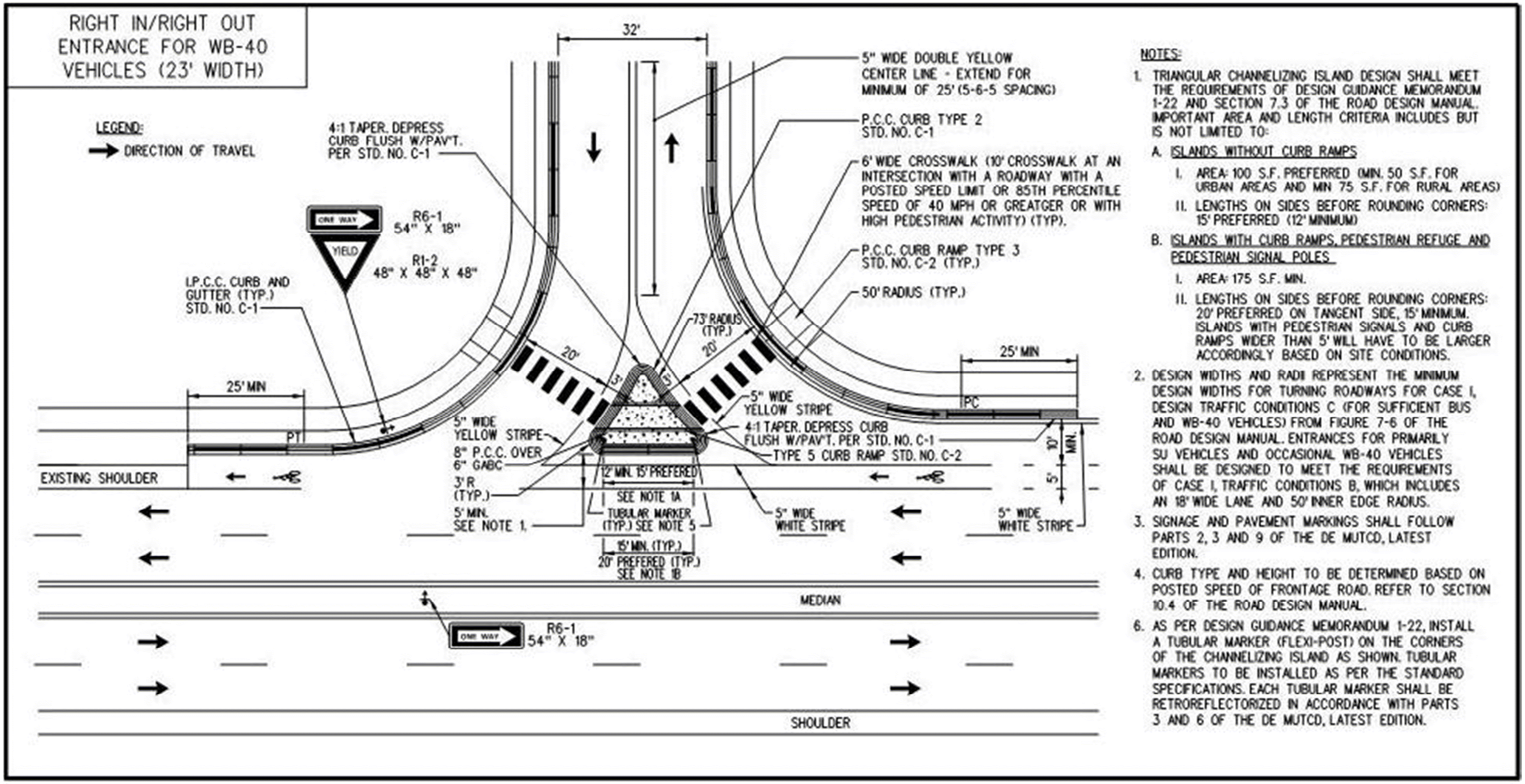



**Figure 21 – Sample Turning Roadway Design for WB-40's**

| Angle of Turn (Degrees) | Design Classification | Three Centered Compound Curve | | Width of Lane (ft) |
|---|---|---|---|---|
| | | Radii (R1-R2-R1, ft) | Offset (ft) | |
| 75 | A | 150-75-150 | 3.5 | 14 |
| | B | 150-75-150 | 5 | 18 |
| | C | 220-135-220 | 5 | 22 |
| 90 | A | 150-50-150 | 3 | 14 |
| | B | 150-50-150 | 11 | 21 |
| | C | 200-70-200 | 11 | 25 |
| 105 | A | 120-40-120 | 2 | 15 |
| | B | 150-35-150 | 11.5 | 29 |
| | C | 180-60-180 | 9.5 | 32 |
| 120 | A | 100-30-100 | 2.5 | 16 |
| | B | 150-30-150 | 10.5 | 33 |
| | C | 140-55-140 | 7 | 45 |
| 150 | A | 100-30-100 | 2.5 | 16 |
| | B | 150-30-150 | 9 | 42 |
| | C | 160-40-160 | 6 | 53 |

Appropriate design values for turning roadways using three centered compound curves turning from a 12 foot wide approach leg onto a 12 foot wide departure leg are provided in Figure 22. When the effective width of the approach and/or departure leg are wider than 12 feet, then it may be possible to use smaller curve radii and offset to design the turning roadway. The turning roadway lane widths may be reduced with pavement markings to channelize passenger cars and discourage the usage of the wider turning roadway as two turning lanes.

Design Classification:
A – Primarily passenger vehicles; permits occasional design single-unit trucks to turn with restricted clearances
B – Provides adequately for the SU-30 and SU-40 design vehicles; permits occasional WB-62 design vehicles to turn with slight encroachment on adjacent traffic lanes
C – Provides fully for the WB-62 design vehicle
Verify island size meets minimum preferred size of 100 $ft^2$ for curbed islands or 175 $ft^2$ for islands with curb ramps, pedestrian refuge and pedestrian signal poles. Refer to Figures 26 and 27.

Figure 22 - Turning Roadways

Figures 23, 24 and 25 show examples of minimum turning roadway designs for 90-degree right turn based on the design vehicle and its frequency of use. Figure 23 shows a minimum turning roadway using a three-centered curve with radii of 150, 50, and 150 ft with the middle curve being offset 3 ft from the tangent edged extended and a 14 ft lane width. This design not only permits passenger vehicles to turn at a speed of about 15 mph but also enables single-unit

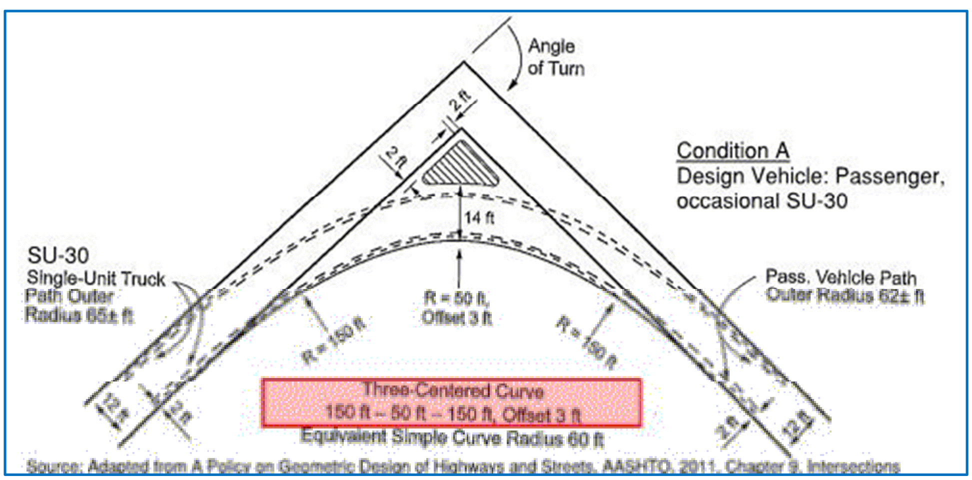



Figure 23 - Turning Roadway Design for Passenger Car and SU-30

truck designs vehicles to turn on a radius (right front wheel) of approximately 65 ft and still clear turning roadway by about 1 ft on each side.

By increasing the turning roadway width 2 ft and using the same combination of curves but with the middle curve being offset 7 ft from the tangent edges extended, a more desirable arrangement results as shown in Figure 24. This design enables the single unit truck design vehicles to use a 75 ft turning radius with adequate clearances and makes it possible for the WB-62 design vehicle to negotiate the turn with only slight encroachment on adjacent through-traffic lanes.

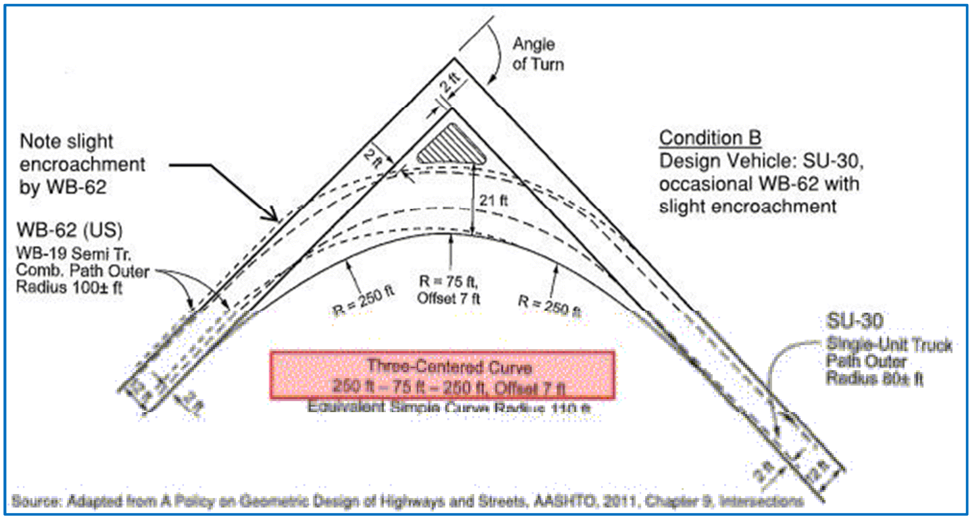



Figure 24 - Turning Roadway Design for SU-30 and Occasional WB-62

At locations where a significant number of semitrailer combinations, particularly the longer units, will be turning, the arrangements should be used as shown in Figure 25. This design, consisting of a minimum curve of 70 ft radius, an offset of 11 ft and terminal curves with radii of 200 ft generally provides for WB-62 design vehicle passing through a 25 ft turning roadway width and greatly benefits the operation of smaller vehicles.

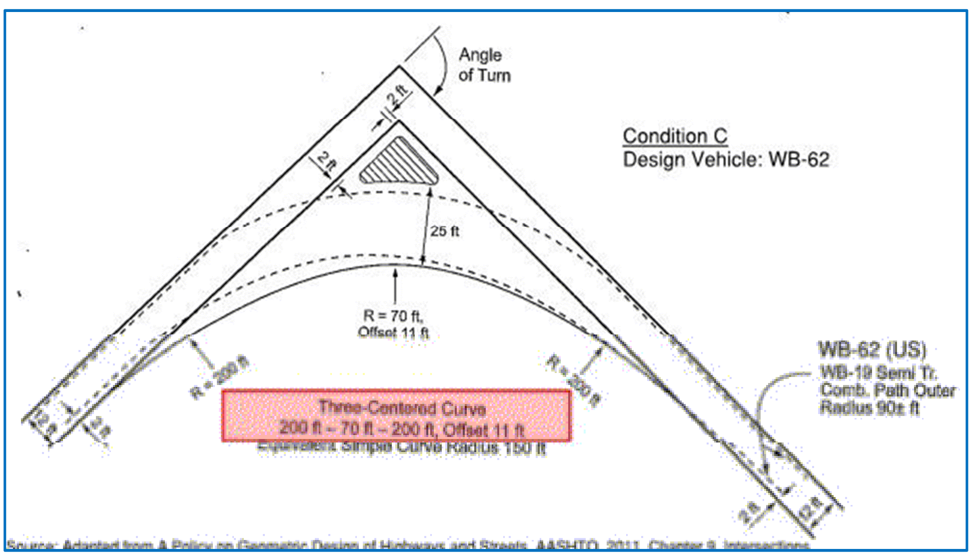
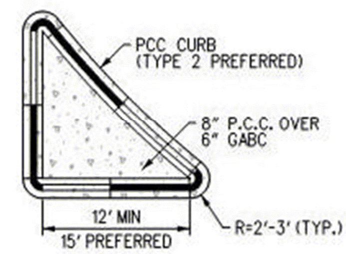



Figure 25 - Turning Roadway Design for WB-62

## 4. Channelizing Islands

An island's principle functions are to control and direct traffic movements, usually turning, dividing opposing and same direction traffic streams and to provide refuge for pedestrians and bicyclists. An island is a defined as an area between traffic lanes for control of vehicle movements and may be delineated by barrier curb (having a vertical rise greater than 6 inches), mountable curb (having a vertical rise 6 inches or less) or a pavement area marked by paint. P.C.C. curb, Type 2 is the preferred curb used to delineate an island. Islands should be sufficiently large to be visible to motorists and to accommodate pedestrian refuge and pedestrian signal poles where required. Figures 26 and 27 provide minimum and preferred island sizes as stated in Section 7.3.3 of the *Road Design Manual*.

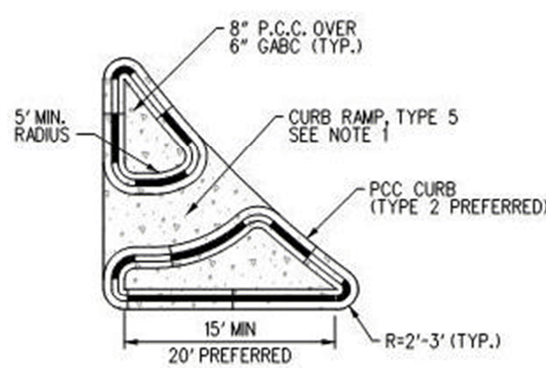



| LOCATION | MINIMUM ISLAND SIZE ($ft^2$) | PREFERRED ISLAND SIZE ($ft^2$) |
|---|---|---|
| URBAN | 50 | 100 |
| RURAL | 75 | 100 |

Figure 26 – Island Sizes for Non-Pedestrians

Design Guidance Memorandum 1-22 provides additional guidance related to an island's offset from the travel lane based on several conditions. Typically, the island is offset from the traveled way the full width of the shoulder or turn lane. This offset may be reduced to only five feet to accommodate bicycles (as shown in Figure 28) under the following conditions:

- Urban, suburban and developing areas where, due to queue lengths and congestion, there is a need to discourage traffic from using the shoulder to pass on the right.
- Commercial driveway entrances or streets leading up to an urban, suburban or developing intersection to prevent illegal shoulder traffic prior to the deceleration lane. Here, the island also offers protection to the vehicle entering the highway and prevents a car crossing the highway entering the business or side street from being involved in an angle crash.
- Crosswalks where pedestrian refuge and shortening the length of the crossing is needed, particularly where there is signalization.




| LOCATION | MINIMUM ISLAND SIZE ($ft^2$) | PREFERRED ISLAND SIZE ($ft^2$) |
|---|---|---|
| URBAN/RURAL | 175 | >175 |

1. REFER TO STD DETAIL NO. C-3, SHT. 3 OF 3 FOR CURB RAMP, TYPE 5 DETAIL.
2. ISLANDS WITH PEDESTRIAN SIGNALS AND CURB RAMPS WIDER THAN FIVE FEET SHALL BE LARGER THAN THE MINIMUM SIZES LISTED ABOVE.

Figure 27 – Island Sizes for Pedestrians

As stated in the AASHTO Green Book, "islands used for channelization should not interfere with or obstruct bicycle lanes at intersections." The offset for bicycles may be reduced to 4 feet at locations of high pedestrian use to minimize crossing time.

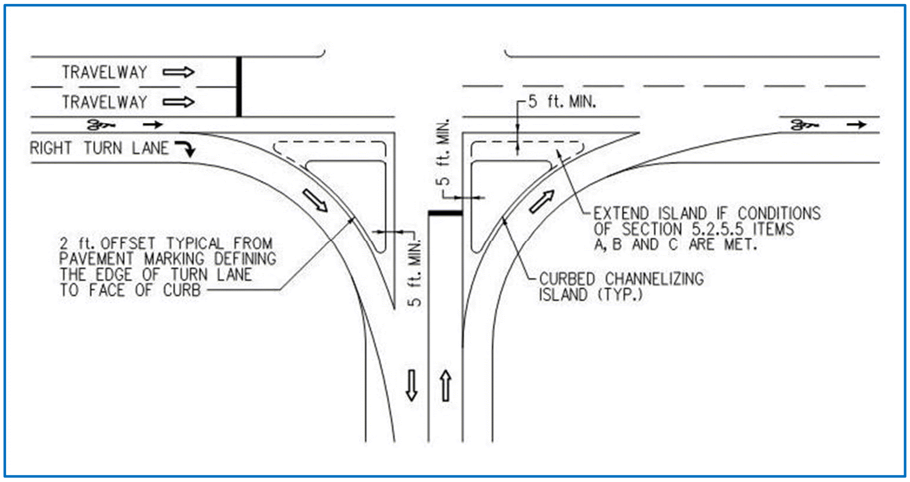



**Figure 28 - Triangular Island Offset**

No matter what the island configuration, positive drainage must be provided for the safety of vehicles and pedestrians, the corners of the island shall be flush with the pavement as per the Standard Specifications for snow plowing operations and the corners of islands not offset the full width of the shoulder adjacent to the roadway shall be delineated with flexible delineators as per the Standard Specifications. See Chapter 7 of the *Road Design Manual* for additional information.

Once the turning roadway is laid out and the triangular channelizing island is added including the previously described offset requirements, verify that the minimum island size listed in Figures 26 or 27 have been met. If the island size is not met using the recommended three centered compound curve radii from Figure 22, then the curve radii should be increased until the required minimum island size is achieved.

## Left Turn Design

A center or median left turn lane is an auxiliary lane usually located between two travel lanes to provide deceleration, storage and protection to left turning motorists. Without left turn lanes, operational and safety issues may occur on roadways with high opposing volumes to the turning vehicles and/or large turning volumes. If a median is provided, at width of 16 to 18 feet is acceptable to accommodate a single turn lane and four foot wide curbed divider typically consisting of back to back PCC curb, type 2.

### 5. Warrants and Lengths

DelDOT's auxiliary lane worksheet should be used to determine if a left turn lane is warranted. If required, the worksheet provides the recommended storage, deceleration and taper lengths. The typical entrance diagram provides additional guidance for pavement markings. Both the worksheet and diagram are available at http://www.deldot.gov/information/business/.

Median end treatment