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THE CITY OF COLUMBUS
ANDREW J. GINTHER, MAYOR

DEPARTMENT OF PUBLIC SERVICE

DESIGN MEMO 7.04

To: Designers, Contractors, and City Departments

Date: March 21, 2025

Subject: Modern Roundabout Design

Category: Intersections

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1 Purpose

This design memo provides guidance for Roundabout design as a crash severity reducing and congestion relief measure for intersection application. A roundabout is a circular intersection traffic control device with the following characteristics:

- Traffic flows counterclockwise around a center island.
- Entering traffic yields to circulating traffic.
- Channelized approaches deflect traffic into a proper entry path.
- Appropriate geometric curvature and curbs control the speed of vehicles.

1.1 Terms and Definitions

- **Accessible Pedestrian Crossings** – Pedestrian crossings provided at roundabouts must be usable by all pedestrians, including the visually impaired, wheelchairs, strollers and pedestrians walking bicycles.
- **Bicycle Path Diversion** – Bicycle treatments at roundabouts provide bicyclists the option of traveling through the roundabout either by riding in the travel lane as a vehicle, or by exiting the roadway and, if available, using a shared-use path, depending on the bicyclist's preference and/or level of comfort.
- **Capacity** – The maximum hourly flow rate at which persons or vehicles reasonably can be expected to traverse a point, e.g., intersection, or uniform segment of a lane or roadway during a given period under prevailing roadway, traffic, and control conditions.
- **Central Island** – The raised area in the center of a roundabout, around which traffic circulates. The central island is typically circular in shape but can be modified to accommodate alternative lane configurations, e.g., exclusive lefts with spiral-shaped central islands, and truck turning movements.
- **Circulatory Roadway** –The travel way portion of the roundabout used by vehicles to travel in a counterclockwise fashion around the central island. The minimum width is generally equal to the widest roundabout entry.
- **Detectable Warning Strip**: Placed perpendicular to the travel way in pedestrian crossing ramps and on refuge splitter islands.
- **External Truck Apron**: May be necessary at outside curb radii to accommodate the excess swept path of larger design vehicles. Stepped curb height is normally 4-inches. Concrete surface to be the same as the truck apron in depth and color. External Truck Aprons should not pass through crosswalks.
- **Entry Radius**: The smallest curb radius, on the right-hand side of the travel way, before or at the yield line. It is not the same as entry path radius or deflection.
- **Entry Width**: Width at the roundabout entrance, measured perpendicular to curb face. Must be sized to accommodate design vehicle, yet not be overly wide at single-lane roundabouts.
- **Exit Width**: Width at the roundabout exit, measured to curb face. Exit width should be as wide as the circulatory roadway then tapered downstream.
- **Flare Length:** The distance over which the approach widens to from a normal lane width to the entry width is the flare length. It affects roundabout capacity and can be used effectively to add capacity to convert a single lane approach to a multilane entry.
- **Inscribed Circle Diameter (ICD)**: Measure of the outer diameter of a roundabout or its overall 'footprint', usually measured between the face of opposing splitter islands. Its size is a function of entry and exit lanes, alignment of approaches and angle between approach legs. It is also governed by the size of design vehicle, and property constraints, especially with compact single lane roundabouts.
- **Landscape Buffer:** Placed between the curb and sidewalk to separate vehicular and pedestrian traffic and to help direct pedestrians to cross only at the designated crossing locations and to provide space for sign placement. Landscaping can improve intersection aesthetics and contribute

to traffic calming, provided it is placed outside or below the required intersection and stopping sight limits. The buffer must be detectable by people of all mobilities.

- **Landscaped Central Island**: A central non-traversable area, usually mounded and landscaped. Sightlines must be maintained around the outside but blocked through the middle using the height of mounding, often 3-ft. to 6-ft., with landscaping.
- **Pedestrian Crossing**: In most cases it is a two-stage crossing using the splitter island width as a refuge. The proximity is normally one to two car lengths (25 ft to 40 ft on exits if staggered) upstream of the yield line and distal from the exit splitter island bullnose.
- **Sidewalk / Shared-Use Path:** It is common to provide a shared-use path at the perimeter of the roundabout to provide both pedestrians and bicyclists off-road accommodation. Standard sidewalks are provided in lieu of a shared-use path when bicycle traffic is expected to use the roadway through the roundabout.
- **Splitter Island**: Separates opposing entering and exiting movements. Using a right-hand curvature it directs drivers to circulate counterclockwise and provides refuge area for pedestrians when it is at least 6-ft. wide where pedestrians cross.
- **Spiral (spiral lane transition)**: A spiral is a geometric feature of the truck apron needed for some multilane roundabout configurations with exclusive left-turn lanes. The spiral transitions left-turning vehicles from the inside to the outside circulating lane to allow vehicles to exit without changing lanes within the circulatory roadway (not to be confused with a highway curve spiral).
- **Truck Apron**: A traversable area for trucks necessary for single-lane roundabouts to avoid a very wide circulatory road or small central island.

1 Applicability

The City will consider roundabouts as the preferred option of traffic control where a new intersection is planned, or an existing intersection has safety and/or congestion that necessitates a future traffic signal or all-way stop. An alternatives analysis (potentially including other intersection control types, such as signals and stop signs, or other alternatives) shall be conducted at all intersections where a roundabout is being considered. The alternatives analysis shall include a detailed traffic operations analysis and shall consider City costs (e.g., right-of-way, construction, and maintenance) and public costs (e.g., delay, safety, social costs of crashes and the environment.) The alternatives analysis should be the decision-making tool used to determine whether or not a roundabout will be constructed. Final discretion for all intersection control decisions rests with the Division of Traffic Management Administrator.

The following guidelines on intersection control selection shall be applied:

- In existing developed areas, a roundabout should be examined where: a traffic control change is justified by an engineering study; when capital improvements are being considered; or, when safety or capacity issues have been identified. The use of roundabouts in these circumstances will be at the discretion of the Division of Traffic Management Administrator.
- When a roadway project includes reconstructing an existing intersection or constructing new intersections, a roundabout alternative is to be analyzed to determine if it is a feasible solution based on site constraints, including right-of-way (ROW) impacts, environmental factors, and other design constraints.
- When the analysis shows that a roundabout is a feasible alternative, a roundabout should be considered the preferred alternative due to the proven substantial safety benefits and other operational benefits.
- Roundabouts may not be feasible for these following reasons including but not limited to:
    - On steep grades or where sight distance obstructions exist;

- In close proximity to traffic signals;
- Where unreasonable right-of-way impacts or impacts to historical assets are evident;
- Environmental factors;
- Near railway crossings;
- Within an existing traffic signal coordinated network, or;
- Other space and design constraints.

1.1 Background

A roundabout is a circular intersection traffic control device with the following characteristics:

- Traffic flows counterclockwise around a center island.
- Entering traffic yields to circulating traffic.
- Channelized approaches deflect traffic into a proper entry path.
- Appropriate geometric curvature and curbs control the speed of vehicles.

Categories of roundabouts include mini-roundabouts, single lane layouts and multilane designs. The differences are mainly in circle size, with minis being the most compact while the largest circles, multilane designs, have at least two circulating lanes and multilane approaches or exits. Mini roundabouts have traversable central islands while multilane roundabouts have large central island areas suitable for landscaping and place-making.

Roundabouts are a Proven Safety Countermeasure[1] because they can substantially reduce crashes that result in serious injury or death. Roundabouts can:

- Improve safety
- Promote lower speeds and traffic calming
- Reduce conflict points
- Lead to improved operational performance
- Meet a wide range of traffic conditions because they are versatile in size, shape, and design.

Roundabouts are the preferred safety alternative for a wide range of intersections. The most common justification for a roundabout is safety. This is because roundabouts only have 8 potential conflict points vs. 32 at a traditional intersection. Studies by the Federal Highway Administration (FHWA) show that roundabouts reduce serious injury and deadly crashes by nearly 90% where two-way stop and signal-controlled intersections are converted to roundabouts[1].

Replacement of signalized intersections with roundabouts has been found to reduce vehicle emissions and fuel consumption by 30% or more. This is due to the reduction in idle time by vehicles waiting for the light to change. Although they may not be appropriate in all circumstances, they should be considered as an alternative for all proposed new intersections, particularly those with major road volumes with less than 90 percent of the total entering volume. The safety benefits of crash reduction and crash severity reduction translate into lower life-cycle costs of roundabouts.

Roundabouts are designed to be safer and more efficient than a traditional intersection. The geometry creates a low speed (20-30mph) environment inside the circulatory roadway, as well as at the entry and

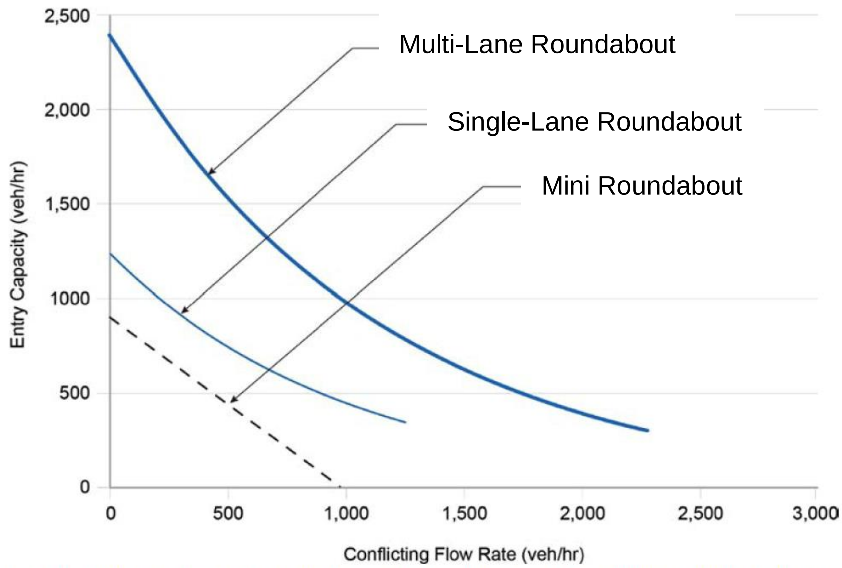
[1] https://highways.dot.gov/safety/proven-safety-countermeasures/roundabouts

exit locations. The geometry also prevents high angle crashes such as right-angle and left turn angle crashes. Lower angle, low speed crashes tend to be less severe than higher angle, high speed crashes.

2 Site Selection

2.1 Planning Level Practical Sizing

Where existing or projected turning movement data are available at the planning level, designers can estimate the required lane configuration of a roundabout. Each approach leg of the roundabout is evaluated individually to determine the number of entering lanes required on the basis of the entering and conflicting flow. **Figure 1** presents a simplified diagram that evaluates a roundabout one entry at a time. It uses the sum of entering flow for a given (y-values) entry plus the conflicting flow passing that same entry (x-values), as a planning guide on the type of roundabout and number of lanes that may be needed for any given entry.



NOTE: Practical capacity is assumed to be 90 percent of maximum capacity. Conclusions not valid at planning level for conflicting flow rates above 1,250 veh/hr for a single-lane circulatory roadway and 2,300 veh/hr for a two-lane circulatory roadway. Values beyond these practical limits may be possible, but further analysis is recommended. SOURCE: Derived from HCM (*1*) and Lochrane et al. (*9*).

Figure 1 - Planning-level practical entry capacity estimates using peak hour volumes for a given entry (Source: NCHRP 1043, "Roundabout Design Guide", Exhibit 8.5)

Rules of lane continuity at any intersection also applies to roundabouts. When two through lanes are required on any entry, there should be two corresponding circulating lanes and two exit lanes. Where exclusive left-turn or right-turn lanes are used, lane continuity rules still apply but alternative lane configurations should also be considered. For multilane roundabout lane configuration alternatives see **Section 4.3**.

Use the most recent version of HCM for the capacity analysis of a roundabout. The roundabout operational analysis shall account for possible phasing of capacity expansion, whereby an interim scheme may be established if the analysis reveals that single lane entries are adequate for a period of up to ten years. Traffic analysis results shall be submitted with the concept design including opening year, opening plus 10 years, & design year volumes, % trucks & turning movements on all approaches by movement. Overbuilding roundabout capacity has been shown to contribute to higher crash incidence.

3 Geometric Design Considerations for all Roundabouts

The City of Columbus has adopted the *NCHRP Report 1043, Guide for Roundabouts*, as the City's roundabout design guide. However, design criteria listed in this Design Memo and expressed preferences takes precedence over NCHRP Report 1043 guidance.

In addition to the geometric design diagrams provided in the following sections, the City expresses the following general design considerations for all roundabouts.

3.1.1 Non-Circular Shaped Roundabouts

Noncircular (oval, peanut, etc.) roundabouts should only be used when justified by right-of-way constraints and/or intersection skew angle. The reason for non-circular shape should be documented at the concept design stage.

3.1.2 Curbing and Splitter Islands

Curb and/ or Curb and Gutter shall be provided on the outside of the circulatory roadway and on all approaches a minimum distance equal to the length of the splitter island to help approaching drivers recognize the need to reduce their speed, prevent corner-cutting, and to confine vehicles to the intended design path. Curb and/or curb and gutter shall be provided for a minimum distance of 50-ft. past the edge of the circulatory roadway on the exit leg.

Splitter islands shall extend a minimum of 50-ft. from the edge of the inscribed circle. The desirable length of a splitter island is 100-ft. for urban design (30mph to 35mph) and 150-ft. to 200-ft. for rural or suburban conditions (>45mph)

The exit curb radii are usually larger than the entry radii in order to minimize the likelihood of congestion and crashes at the exits. This, however, is balanced by the need to maintain slow speeds through the pedestrian crossing on exit. The exit design is also influenced by the design environment (urban vs. rural), pedestrian demand, the design vehicle, and physical constraints. Roundabout exits in areas with pedestrian accommodations should be designed to provide adequate sight distance and control speeds.

Typical cross-sections for grading conditions of single lane and multilane layouts involve tipping the plane of the circle. This can improve the 'fit' of the grading design and reduce drainage and/or right-of-way constraints, which reduces construction impacts and costs. **Figure 2** illustrates the City's preferences for tipping circles on a plane. For large vehicle stability the low side of a tipped circle should have a cross-slope of 2% or less. Mini roundabout can also have a tipped circle, but the central island is still fully traversable.

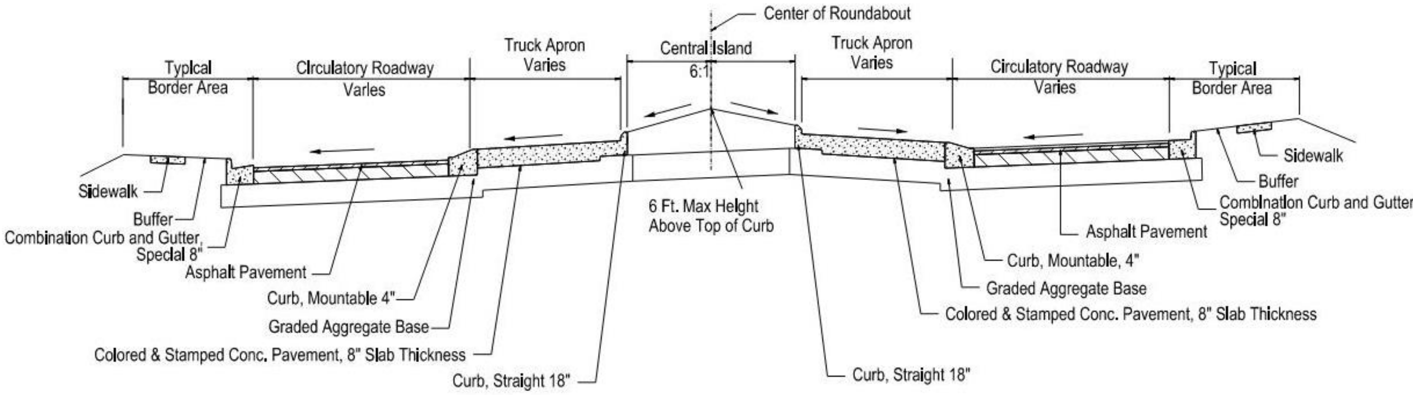


Figure 2 – Circulatory Roadway Typical Section (Tipped Circle)

3.1.3 Vertical and Grading Design Best Practices

For constructability and grade control, setting up additional alignments and profiles of the edge of pavement produces optimal grade control for retrofit designs. Developing a grading surface that closely follows existing topography or the natural grade of the intersection often results in tipping the circle. Tipping the circle, as **Figure 2** shows, requires gradual transition from sloping in on the high side to sloping out on the low side. The preferred maximum cross-slope of the low side should be 2-percent to prevent truck roll-overs.

Additional considerations for the proper accommodation of oversize/overweight vehicles (OSOWs) may be needed for vertical clearance checks of lowboys and other vehicles that have a reduced vertical envelope. In rare cases, the height of the center island truck apron and the circulatory grade may need to factor into the check vehicle vertical clearance. For additional guidance, see NCHRP Report 1043 Chapter 11.

3.1.4 Large and Oversize Truck Considerations

City of Columbus Design Memo 9.04 Turning Radii applies to roundabout design. In addition, for low clearance vehicles vertical clearance checks are recommended. A 3D analysis considers the ground clearance component of the 2D swept path. Usually, ground clearance is only a concern for lowboy (“gooseneck”-style trailer) vehicles. A typical lowboy-style vehicle will have a ground clearance of 6-inches. Analyzing the vehicle clearance assuming 5-inches is appropriate.

External Truck Aprons may be used where it can be shown that entry or exit widths become excessive, e.g., greater than 18ft. for a single lane roundabout, to accommodate the City design vehicle (WB-62). When a raised outside truck apron is designed for roundabouts, it must not overlap the pedestrian crossing ramp. The crossing may be shifted outside the overlapping swept path or the alignment of entry and exit travel way may be reconfigured to increase the angle between legs.

When a flush painted external truck apron is designed for roundabouts the pedestrian access route (sidewalk) through the flush painted outside truck apron shall be broken and the high visibility crosswalk pavement markings shall extend through the flush painted outside truck apron to the curb ramp as shown in **Figure 3**. The curb ramp and detectable warning surface shall be placed at the outside curb line.

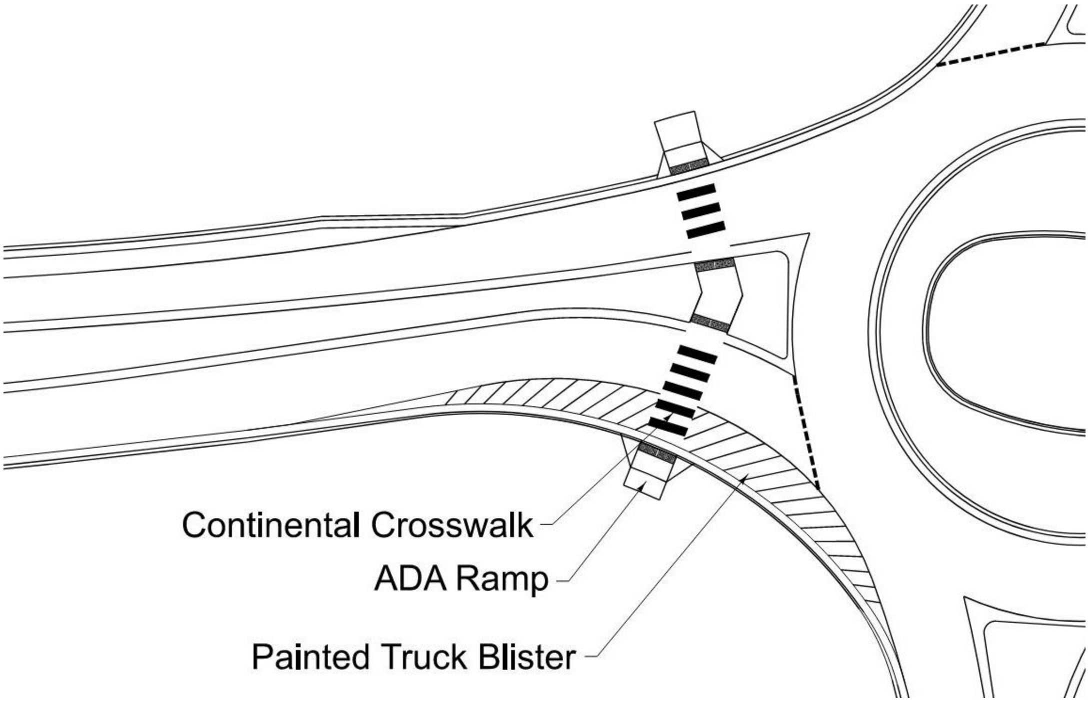


Figure 3 – Flush Painted Outside Truck Apron

3.1.5 High-speed approaches

High-speed approaches shall apply NCHRP 1043, Exhibit 10.110 except in the approach zone upstream of the transition or deceleration zone, apply AASHTO Table 3-9, Minimum Radii for Design Superelevation Rates for curved approaches curves. Superelevation can be transitioned from high speed AASHTO Table 3-9 criteria to low speed AASHTO table 3-13 using the minimum length of run-off per AASHTO equation 3-2.

3.1.6 Bicycle and Pedestrian Accommodations at Roundabouts

For bicyclists, safety and usability of roundabouts depends upon provision of crossing and approach or departure ramp design with the roundabout design (See Section 10.4, NCHRP 1043). Since typical on-road bicyclists travel is between 12 and 20 mph, roundabouts that are designed to constrain vehicle speeds to similar values will minimize the relative speeds between bicyclists and motorists, and thereby improve the safety and usability for bicyclists.

Single-lane roundabouts are much easier for bicyclists than multi-lane roundabouts since they do not require bicyclists to change lanes to make left-turn movements or otherwise select the appropriate lane for their direction of travel. At multilane roundabouts bike diversion and re-entry ramps are required per Section 10.4.5 Design for Bicyclists and Pedestrians Using Shared-Use Paths, NCHRP 1043. Bike Diversion and re-entry ramps are preferred at single lane roundabouts on an existing bike route. If there is no existing bike route, bicyclists can be assumed to share the circulatory roadway with vehicles in single lane roundabouts.

Exhibit 10.29, NCHRP 1043 illustrates staggered crosswalks at multilane roundabout exits. The separation distance from the exit bullnose should be less than 50ft. A splitter island must be wide enough to contain the staggered refuge area with sufficient lateral clearance of 2ft. to curb face.

The City of Columbus follows the U.S. Access Board PROWAG, (September 2023) and permits the use of RRFBs in lieu of PHBs at the discretion of the City Traffic Engineer. If there are no existing pedestrian facilities at an intersection the crosswalks should be built to allow for future connection as area sidewalks are added.

4 Categories of Roundabouts and Design Parameters

Categories of roundabouts include mini-roundabouts, single lane and multilane configurations. The differences are mainly in circle size, with minis being the most compact while the largest circles, multilane designs, have at least two circulating lanes and multilane approaches or exits. Mini roundabouts have traversable central islands while multilane roundabouts have large central island areas suitable for landscaping and place-making. This section presents each category of roundabout and the associated geometric design parameters.

4.1 Mini Roundabouts

Mini-Roundabouts, with traversable central islands are applicable in urban environments with speeds less than or equal to 30 mph. Placement of mini roundabouts in higher speed environments is feasible, but approach splitter islands must provide the compensating speed reduction that the circle size cannot afford. Longer raised splitter islands (>100-ft.) with reverse curvature, curbs, and other features (e.g., advance signing, pavement markings, reflecting delineators, or illumination) are applicable in locations with approach speeds 35 mph and greater.

Mini-roundabouts have a raised fully traversable central island. A mini-roundabout can be a low-cost alternative to all-way stop control for improving intersection capacity and safety without the need for acquiring additional right of way. The suitability of a mini roundabout depends on:

1) Traffic Volumes < 15,000 ADT (summation of ADT for each roadway or total ADT entering the intersection)
2) Truck Volumes < 5%

4.1.1 Physical Characteristics

Mini-roundabouts are typically defined by an inscribed circle diameter (ICD) of between 60 to 100 feet. The fully traversable central island and splitter islands allow larger vehicles to pass over the central island making left turns. Details of a mini-roundabout can be seen in **Figure 4**. This standard for mini-roundabouts is intended to be used where circulatory roadway paving is asphalt or concrete and approach speeds are 35 mph or less.

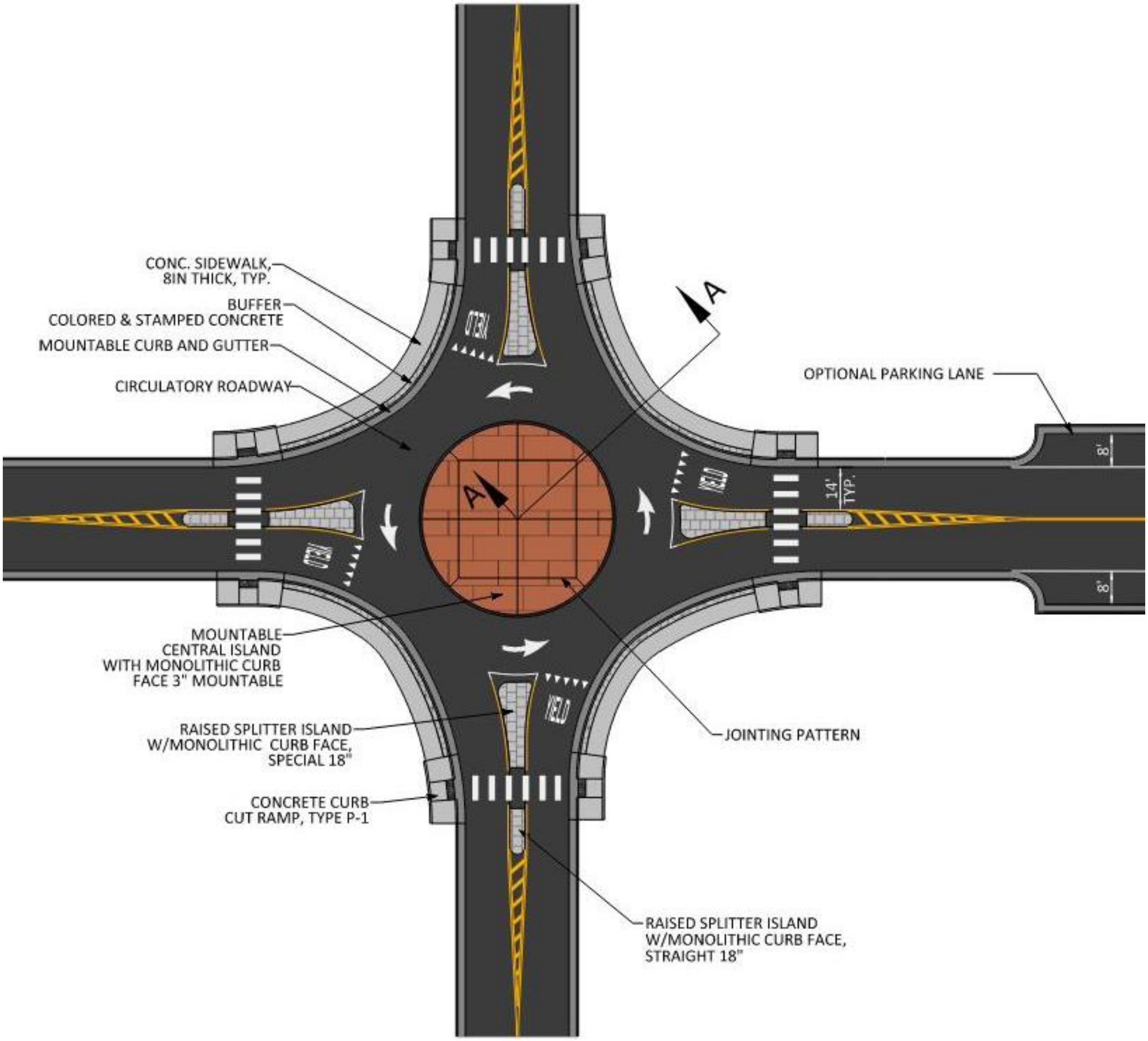


Figure 4 – Mini Roundabout: Geometric Design (See Figure 5 for Section A-A)

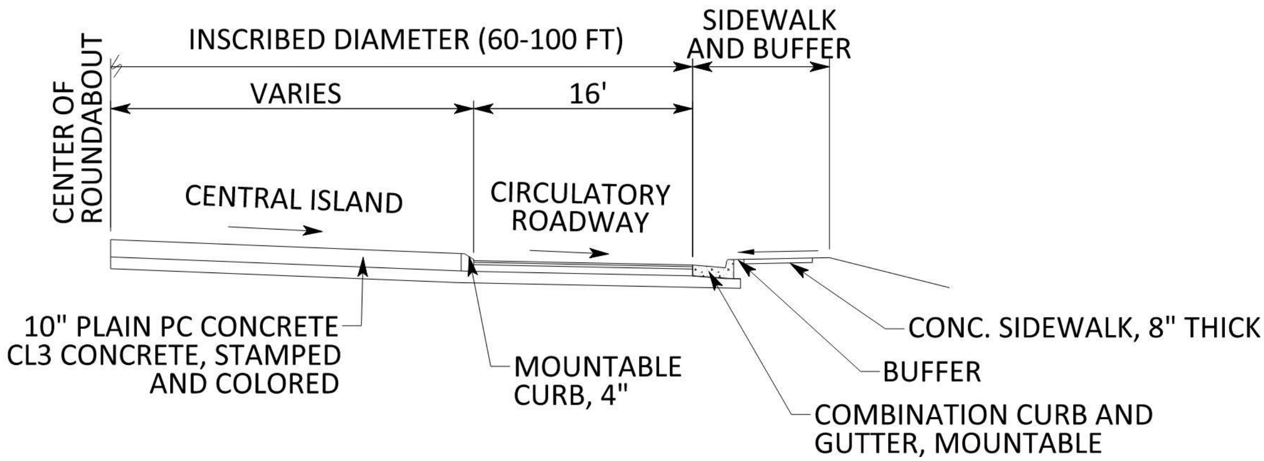


Figure 5 – Mini Roundabout: Typical Cross-section

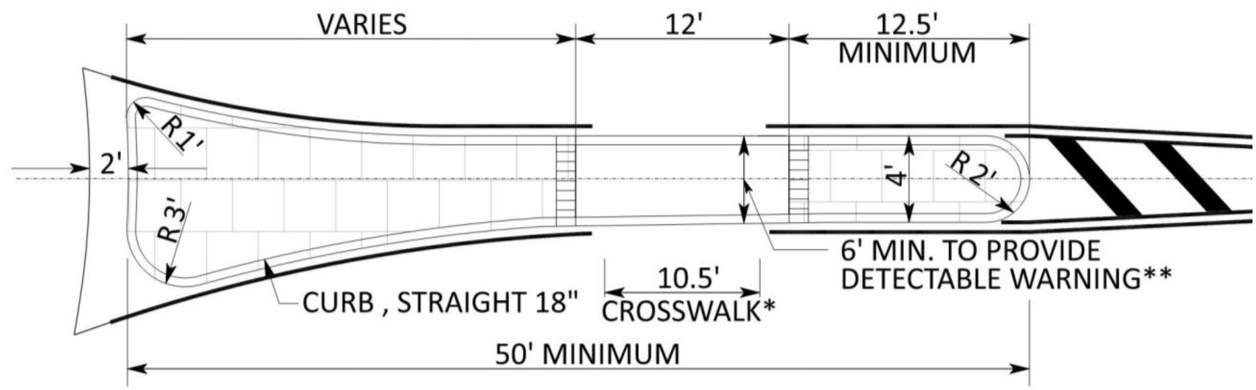


Figure 6 – Mini Roundabout: Splitter Island Parameters

Due to the smaller circle size, geometric entry path deflection at mini-roundabouts is more challenging, therefore, approach curvature typically governs entry speed, along with left offset of alignment for improved entry path deflection. This can be achieved through approach curvature (chicanes) and/or longer splitter islands. These features also contribute to recognition of the roundabout ahead so that drivers may decelerate in advance of the entry point. The majority of traffic should be able to pass through the mini-roundabout while staying within the circulatory roadway.

4.1.2 Signing and Marking – Mini-Roundabouts

Figure 7 shows the City's required placement of signs and pavement markings for the mini-roundabout.

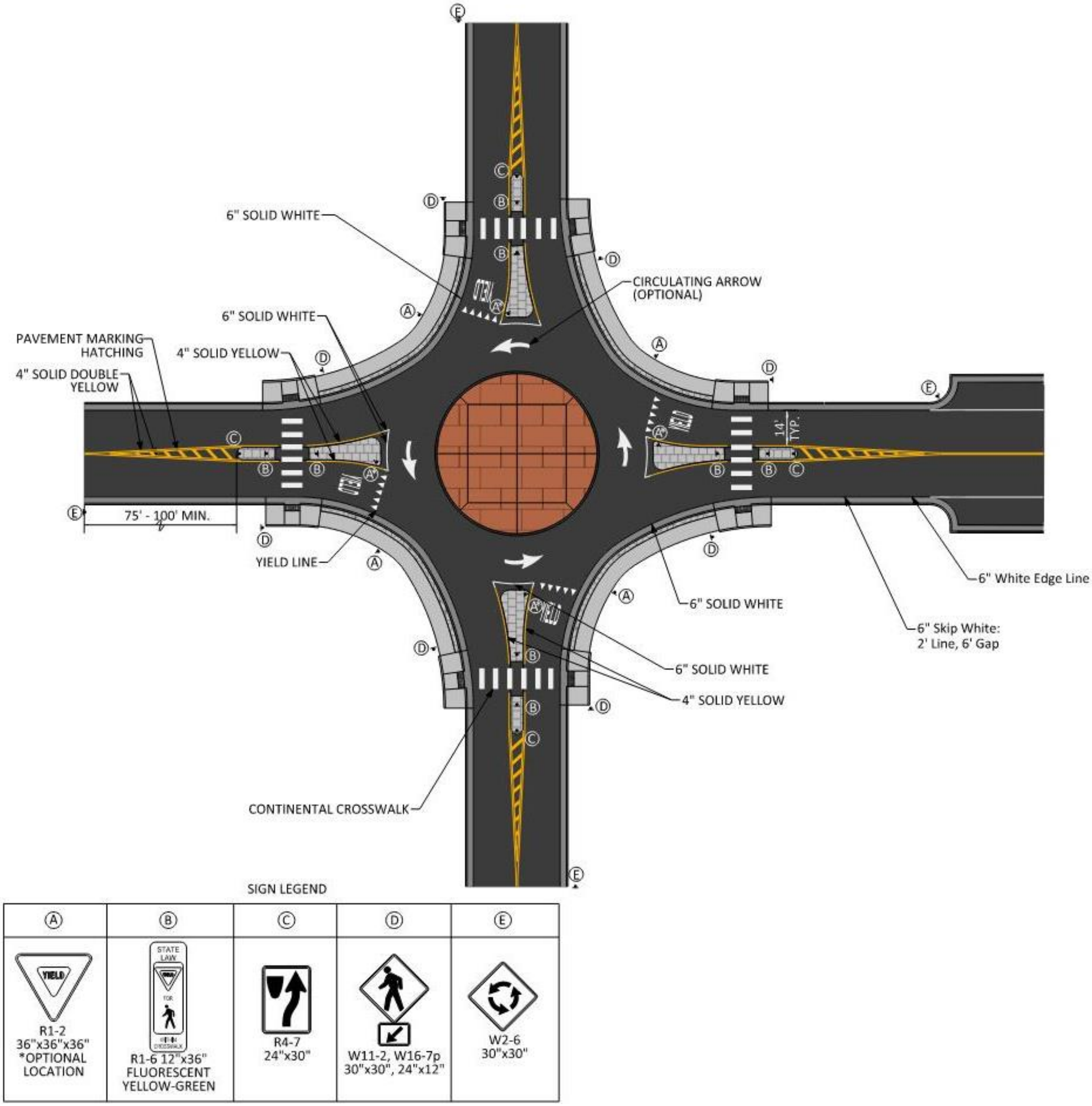


Figure 7 – Mini Roundabout: Signing and Marking

4.2 Single-Lane Roundabouts

Single-Lane Roundabouts have single-lane entry at all legs and one circulating lane. Single-lane roundabouts can include right-turn bypass lanes. Although they may be compact with a very small raised central island, they are distinguished from mini roundabouts by their non-traversable central island and larger inscribed circle diameter, typically within the range of 110 to 140 feet. The geometric design features include raised, curbed splitter islands with appropriate entry path deflection, a raised non-traversable central island, crosswalks, and a truck apron vertically separated from the circulatory roadway by a mountable curb. **Figure 8** illustrates the City's specifications and preferences regarding geometric design for a single-lane roundabout. Additionally, single lane roundabouts require traffic control devices that can be found on **Figure 10.**

The design of a single lane roundabout should have enough entry path deflection (geometric speed control) to create balanced speeds through the roundabout. The use of left offset of the approach alignment contirbutes to reduced speeds in advance of the entry line; this is especially important for compact roundabouts.

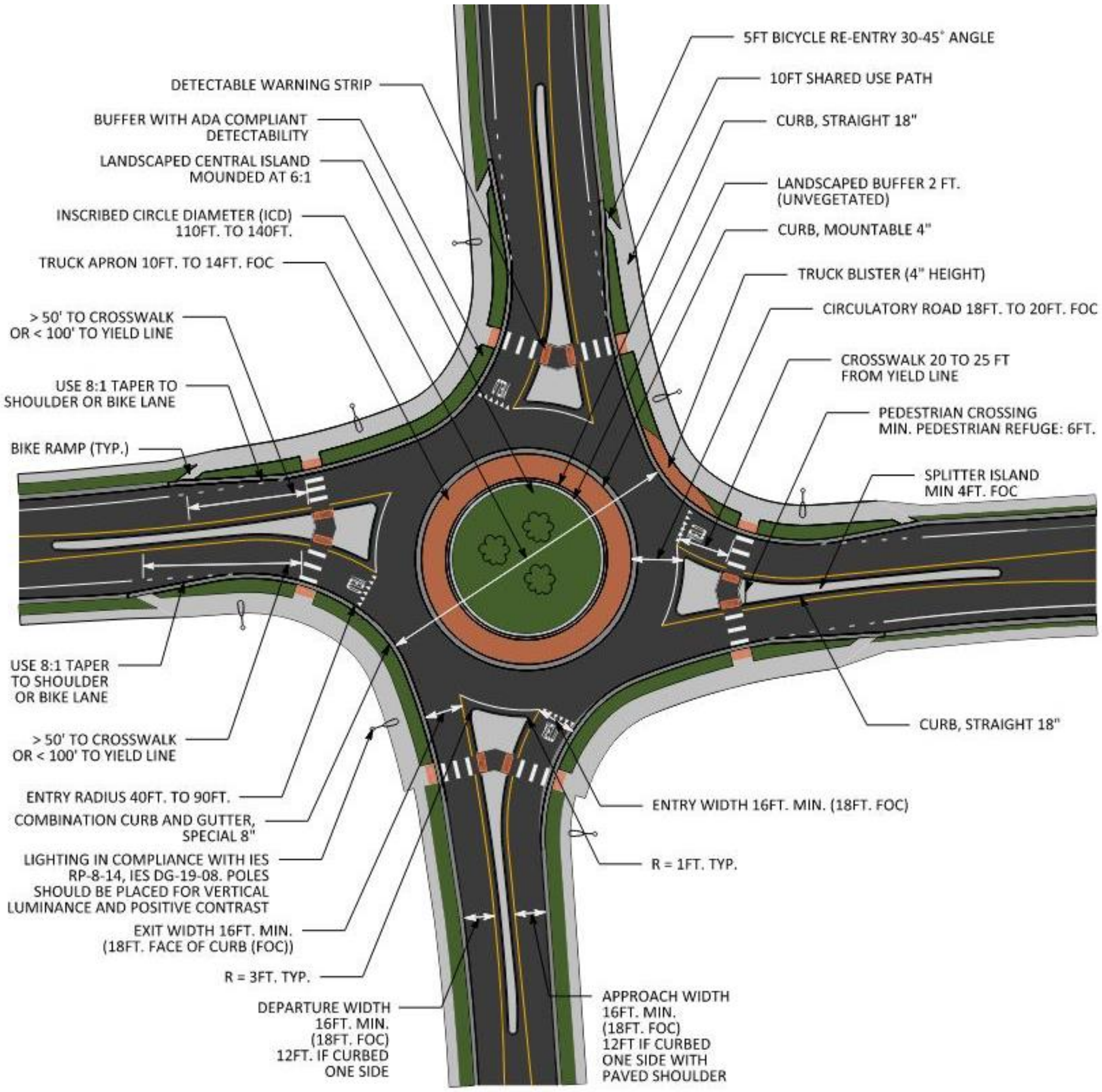


Figure 8 - Single Lane Roundabout: Physical Characteristics

A typical splitter island detail is show in **Figure 9**. The noses of the splitter island should be sloped to allow for any unintended vehicle over tracking. The surface of the median as well as the pedestrian crossing should be sloped to promote drainage as shown in Section A-A in **Figure 9**. This detail applies to Single Lane roundabouts as well as Multi Lane roundabouts.

NOTES:

1. TROWEL ISLAND NOSE TO A SMOOTH FINISH.
2. TRUNCATED DOMES IN DETECTABLE WARNING FIELD ALIGNED IN A ROW AND PARALLEL TO THE CROSSWALK.
3. JOINT SPACING TO BE DETERMINED IN FIELD.

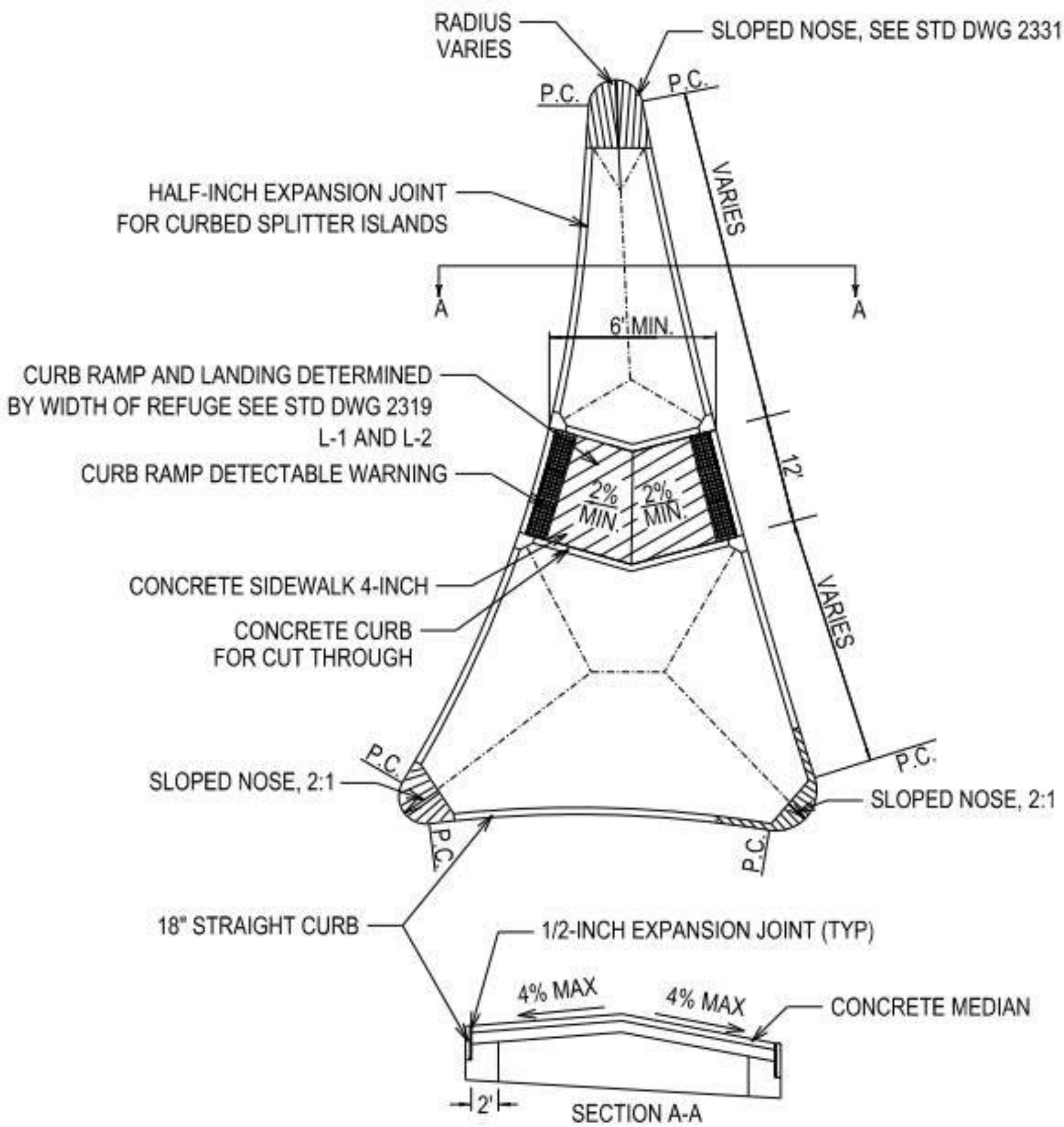


Figure 9 – Single Lane and Multi Lane Roundabout: Monolithic or Curbed Splitter Island Details

The choice between monolithic or curbed splitter islands shall be subject to the City’s approval.

4.2.1 Signing and Marking – Single Lane Roundabouts

Signs shall be mounted outside any areas traversable by vehicles. **Figure 10** displays signage for one approach of a typical single lane roundabout. Other approaches should be treated similarly.

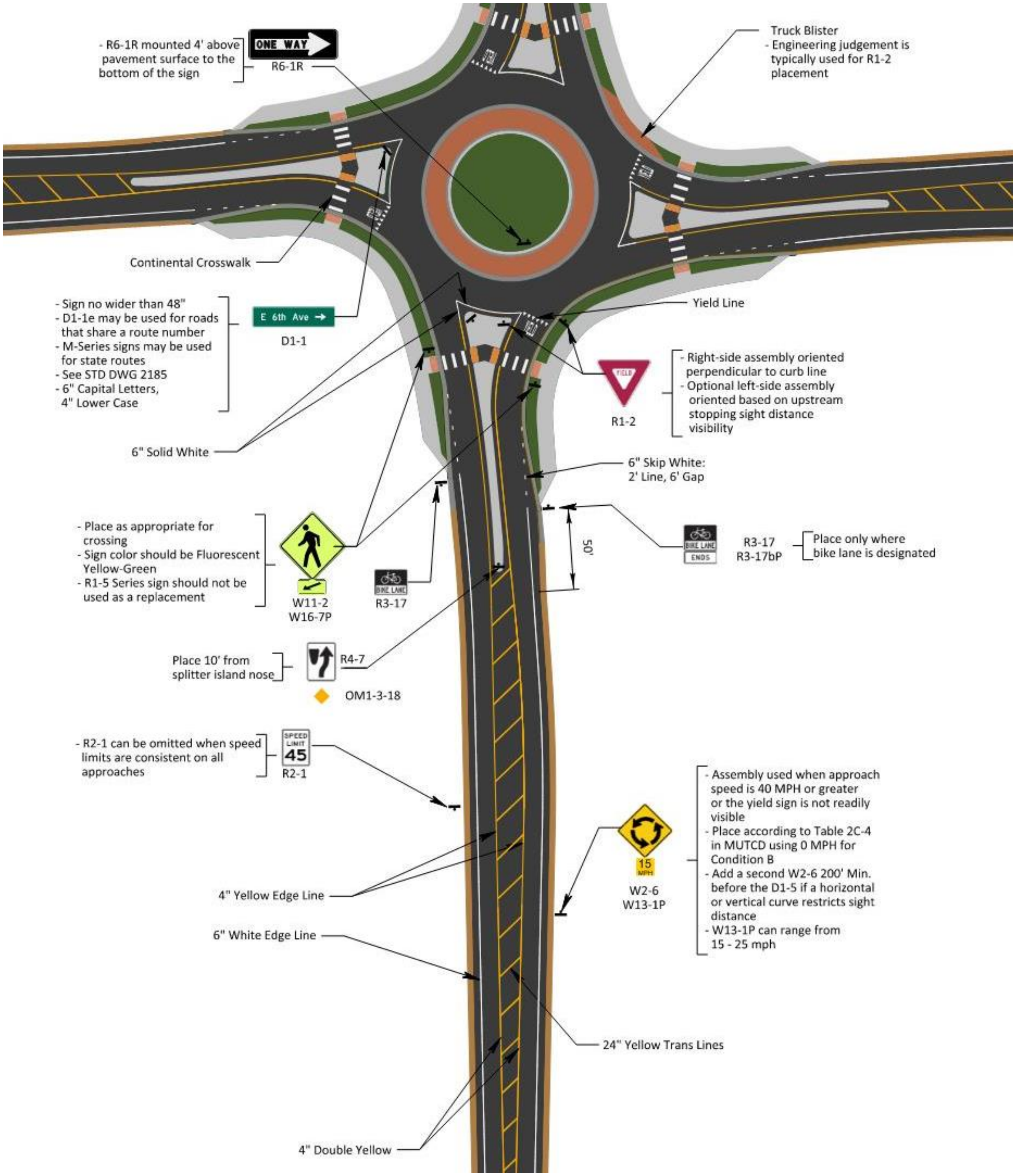


Figure 10 –Single-Lane Roundabout: Signing and Marking

4.3 Multi-Lane Roundabouts

Multi-Lane Roundabouts have at least one entry with two or more lanes and two or more corresponding circulating lanes. In some cases, the roundabout may have a different number of lanes on one or more approaches (e.g., two-lane entries on the major street and one-lane entries on the minor street). Multilane roundabouts may have single lane approaches that flare from one to two or more lanes. **Figure 11** illustrates alternative lane configurations for two-lane entries. The choice of lane configuration depends on the proportion of turning movements and their directions. The optimal two-lane configuration will have the least number of conflict points between entering and circulating traffic. Therefore, the lane configuration consisting of Left-Thru, Right-Only is optimal for safety while the other lane configuration versions may provide improved capacity but with measurable safety trade-off.

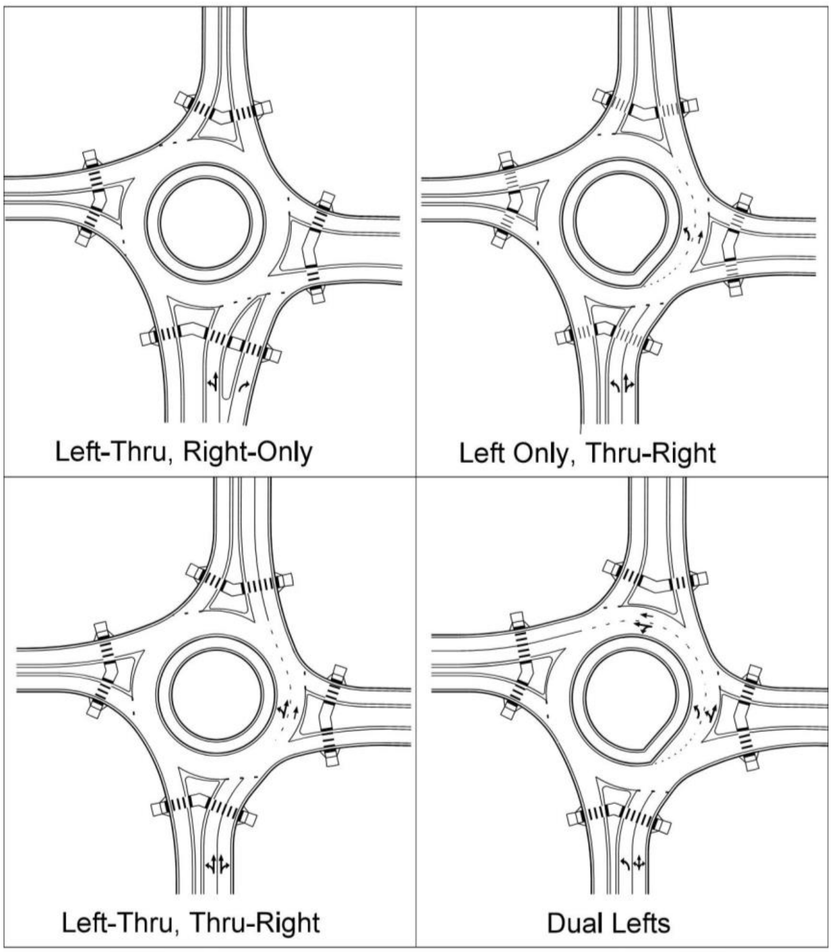


Figure 11 - Lane Configuration Options for Two lane Entry

4.3.1 Expandable Design

Driver decisions are more complex for multi-lane roundabouts. These decisions include choosing the

correct lane when entering, lateral positioning while circulating and correct lane for exiting. If a multilane roundabout design is warranted at build year plus ten (10) years, then a single lane roundabout or expandable roundabout may be used for the initial ten years. Alternatively, it can be designed as a multi-lane roundabout, but striped and signed as a single-lane roundabout when initially opened to traffic. Interim and ultimate lane configuration roundabout analysis may result in a preferred method of using future expandable design. The City's preference is for use of curbing, rather than striping the expandable design.

4.3.2 Lane Discipline in Multilane Roundabouts

Multilane roundabouts also accommodate passenger cars and buses traveling side by side. The circulatory roadway lane widths are usually 12-ft. to 14-ft. wide to accommodate school and transit buses staying in lane. Large trucks do not need to travel in-lane in multilane roundabouts; moreover, when designs are enlarged for large trucks in lane, this has been shown to decrease safety for all users. The geometric design features are illustrated on **Figure 12.** When possible, restrict the use of full multilane designs by use of exclusive left-turn lanes and single lane exits. In such cases, raised truck apron curbs are required for spiral designs. Additionally, multi-lane roundabouts require traffic control devices that can be found on **Figure 16**.

4.3.3 Geometric Parameters – Multilane Roundabouts

The design of a multi-lane roundabout should have adequate geometric speed control to create balanced speeds through the roundabout. The use of left offset approach alignment contributes to reduced speeds in advance of the roundabout entry.

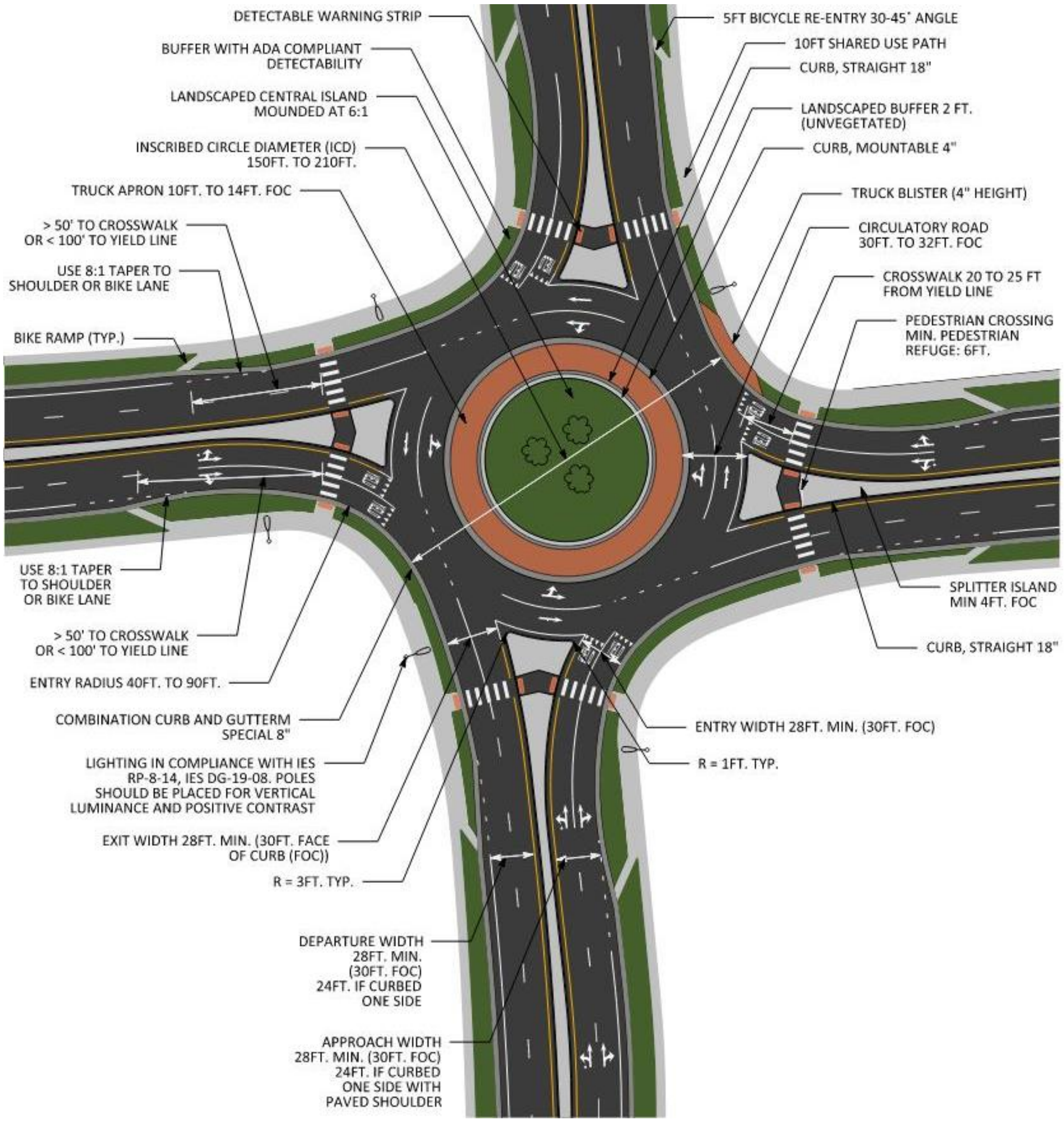


Figure 12 – Multi-Lane Roundabout: Physical Characteristics

4.3.4 Multilane Entry Design

Two passenger cars entering simultaneously shall have natural paths that keep the vehicles in lane. When the entry lanes of a multilane roundabout are not aligned correctly, overlap of vehicle paths can occur. This could result in reduced entry capacity and sideswipe conflicts from drivers not maintaining the correct lane upon entering or exiting the roundabout. **Figure 13** shows the appropriate entry and exit lane alignment to minimize path overlap.

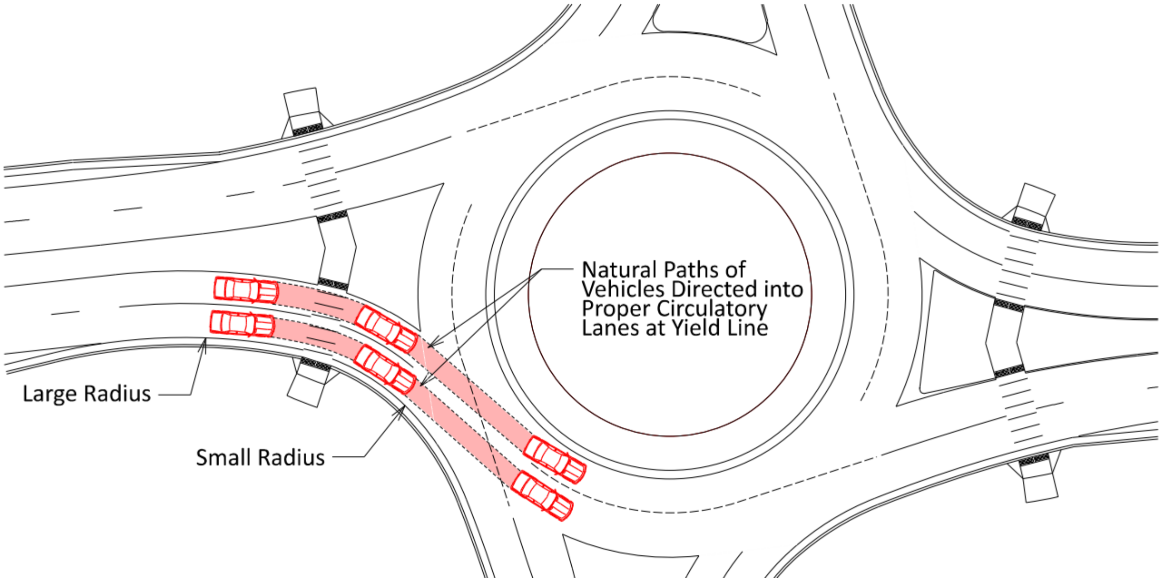


Figure 13 – Entry Design to Minimize Path Overlap

Figure 14 provides the linework checks to verify the development of natural parallel entry and exit paths. The blue line is an extension of the splitter island curve. When the curve enters the circle at an offset of 5ft. to the central island edge of pavement then path overlap is generally avoided. Checking for overlapping entry paths requires measurement of the tangents between reversing curves. The entry to circulating tangent should measure between 30 ft. and 50ft. The exit tangent should measure between 40ft. and 60ft.

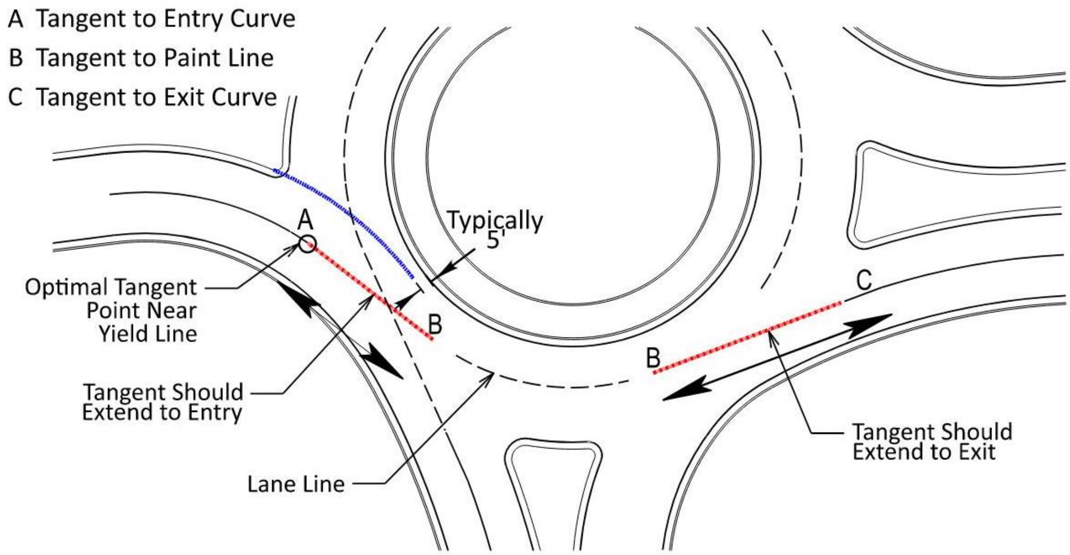


Figure 14 – Method for Checking Path Overlap

4.3.5 Multilane Spiral Design

Spiral (spiral lane transition) is a geometric feature of the truck apron needed for some multilane roundabout configurations with exclusive left-turn lanes. The spiral transitions left-turning vehicles from the inside to the outside circulating lane to allow vehicles to exit without changing lanes within the circulatory roadway (not to be confused with a highway curve spiral). Spiral circulatory geometry is commonly used when a dedicated left-turn lane is implemented at a multilane roundabout. **Figure 15** shows an example of a spiraled movement. Spirals can also be applied for any 2x1 lane configuration roundabout where the single circulating lane spirals to the portion of the roundabout where a resulting two lanes are located within the circulatory. Benefits of using spirals in roundabouts consist of:

- Guiding the circulating vehicle to the outer lane of the two-lane circulatory.
- Where adjacent driveways are located close to the roundabout, or a heavy right turn movement is common at the adjacent downstream intersection.
- Reduces the size of the conflict zone, the area where entering vehicles interact with circulating/conflicting vehicles.
- Reinforce yield behavior for the outer lane entering driver that is yielding at the two-lane entry because the spiral makes it more apparent that the circulating vehicle will cross the entry path of this entering lane.

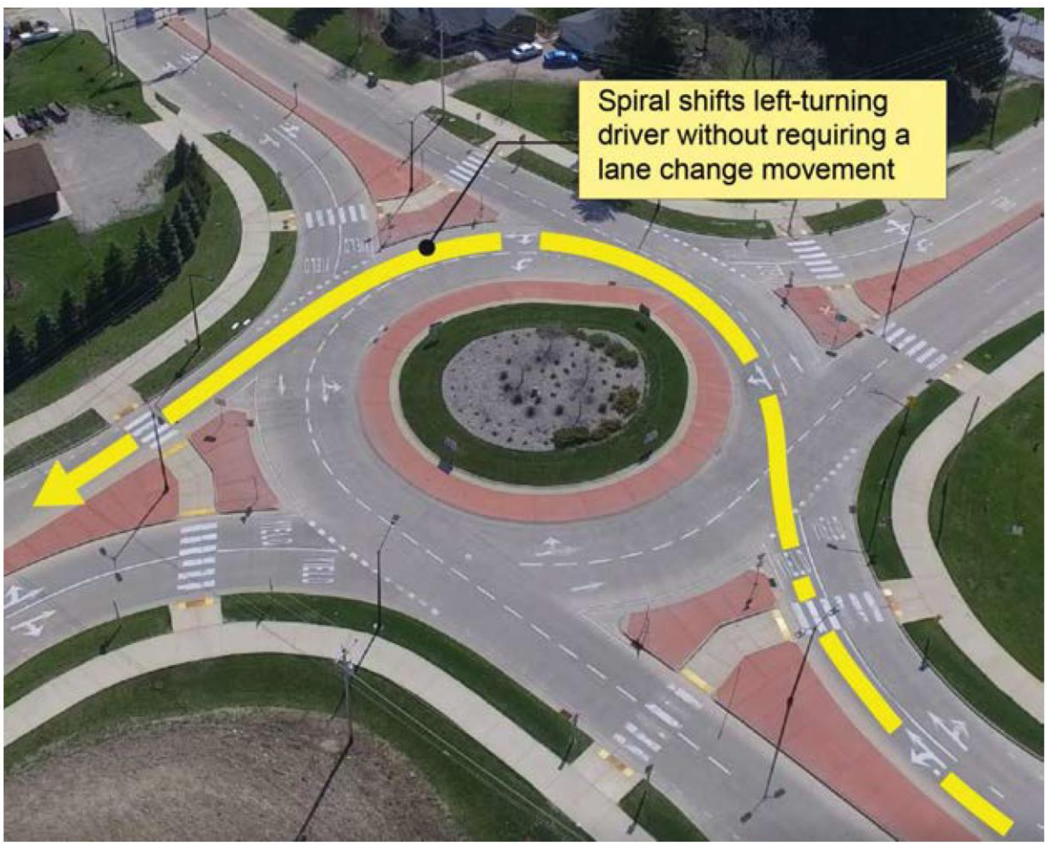


Figure 15 - Spiral Design Example (Source: NCHRP 1043 and Wisconsin DOT)

4.3.6 Signing and Marking – Multilane Roundabouts

Signs shall be mounted outside any areas traversable by vehicles. **Figure 16** displays signage for one approach of a typical single lane roundabout. Other approaches should be treated similarly.

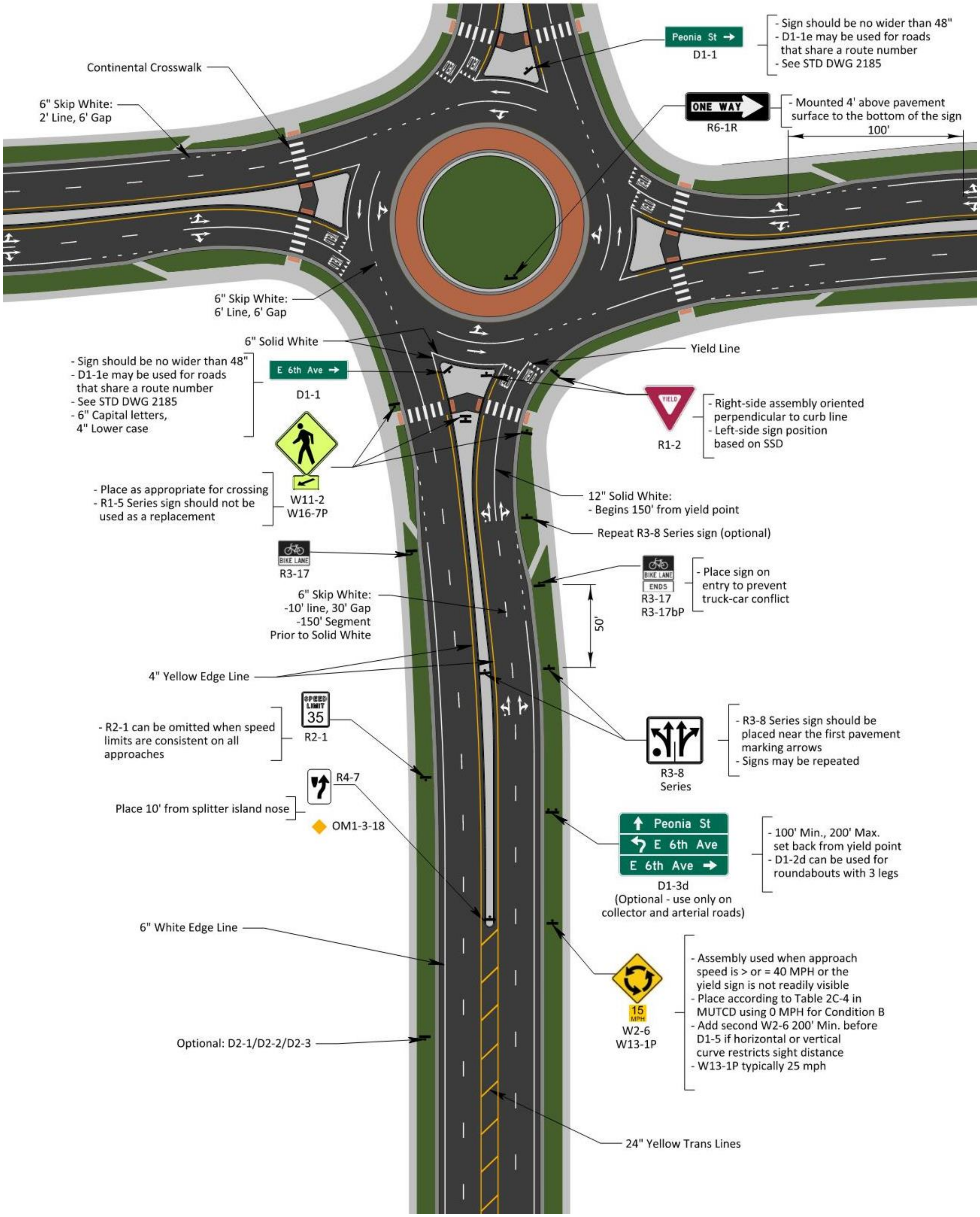


Figure 16 – Multi-Lane Roundabout: Signing and Marking

5 Geometric Design Criteria and Approval Process

Prior to commencing the conceptual design phase of any roundabout project, a Roundabout Scope Parameters and Design Criteria Table is required to be submitted to the City, along with the conceptual design submittal package. The table will be provided in excel format by the City to be filled out. An example of the roundabout scope parameters is provided in **Table 1** below. The scope parameters and design criteria must be reviewed and approved by the City, prior to advancing a concept design or submitting any design plans for review.

Table 1 – Roundabout Parameters

General Requirements

Design Vehicle	See Design Memo 9.04 Turning Radii Section 4.1.1
Check Vehicle	See Design Memo 9.04 Turning Radii Section 4.1.4
Approach/Departure Lane width	Minimum 16' when curb is on both sides
Longitudinal Grades	Minimum 0.5% - Maximum 5.0%
Cross Slope	Minimum 1.0% - Maximum 3.0%
View Angle (sight to left)	Minimum 75 degrees
Tangent between approach curves	Minimum 50'

Type Specific Requirements

Design Criteria	**Mini**	**Single**	**Multi**
Inscribed Circle Diameter (ICD)	80' - 100'	110' - 140'	150' - 210'
Entry Design Speed, preferred	<25mph	< 25 MPH	< 28 MPH
Entry Width	16'-21'	16' - 21'	28' - 32'
Entry Radius	50'-75'	50' - 100'	
Entry tangency (path overlap check)	N/A		26' - 50'
Exit Width	16'-21'	18' - 20'	28' - 32'
Exit Radius	50'-100'	200' - 800'	
Exit tangency (path overlap check)	N/A		Minimum 26'
Circulatory Roadway Width	Based on School Bus Swept Path	17' - 20'	28' - 32'
Truck Apron Width	N/A	10' - 14'	
Truck Apron Height	4"		
Truck Apron Slope	Minimum 1%		
Splitter Island Length, ≤ 35 MPH	Minimum 50'		
Splitter Island Length, > 35 MPH and ≤ 45 MPH	min. 50'	Minimum 100'	
Splitter Island Length, > 45 MPH*	min. 100'	Minimum 200'	
Distance from ICD to Crosswalk	25' at Entry, 40' Max at Exit		
Splitter Island Crossing Accommodation*	Flush	Refuge Island	Raised Crosswalk / RRFB*

Diameters are provided for general guidance. Site constraints, site context, and differing design and accommodation vehicles may result in roundabout ICDs outside of the limits shown herein. When pedestrian facilities are present, select values on the lower end of the provided range. A separate operational analysis should accompany the design to confirm lane configurations and capacity needs for the proposed roundabout design.

6 Design Performance Checks and Approval Process

A roundabout design submittal package of Design Performance Checks as detailed in the following sections is required for geometric concept design validation with the submission of the preliminary alignment or ahead of any plan submission when a preliminary alignment is not required.

An example of a typical design performance checks submittal can be found at the end of this design memo, in **Appendix A**. The design performance checks package approval is required before preliminary design commences and again at subsequent project stages if changes to the horizontal geometric design take place after concept design is approved. The geometric design check specifications and requirements are documented in the following sections.

6.1 Overview and Horizontal Design

A dimensioned general layout drawing showing:

- Inscribed circle diameter, circulatory roadway width, entry and exit widths, splitter island lengths lengths/raised/flush, truck apron widths including these features:
    - Pedestrian crossing locations/width, composition, raised/flush, markings.
    - Bicycle lane/approach & termination point.
    - A typical cross-section of the circle central island (mounded), apron, roadway and apron composition, width, slope and curb standard
- Pavement markings (directional arrows, yield lines, edge lines, etc.)
- Intersection Lighting pole locations (preferred)
- Signing (one sign string including guide signs and overhead lane designation signs on multilane roundabouts)
- Location of nearest development entrances to outer inscribed diameter and nature of land use
- Proximity of roundabout to traffic signal or other intersections
- Path overlap tangents and lengths

6.2 Geometric Design Speed Diagrams

Geometric design speed diagrams for each approach, entry, circulating and exit are required. Roundabouts shall be designed to promote geometric speed control per theoretical fastest path speeds in accordance with NCHRP 1043, Section 9.4. Left offset of the approach alignment increases the space for the approach curve to be well-developed for entry speed reduction. Geometric entry speeds (R1), measured according to NCHRP 1043 shall be less than 25mph along the fastest through movement path for single lane roundabouts and less than 28mph for the fastest through path for multilane roundabout entries.

Approach roadway design speeds and fastest theoretical paths to be shown and fast path radii to be annotated on the design checks submittal diagrams. Guidance on developing fast paths for Mini and Single Lane Roundabouts, can be found on **Figure 18**. Guidance on developing fastest paths for Multi-Lane Roundabouts, can be found on **Figure 19.**

Geometric entry path deflection is best represented by a continuous spline (a curve with constantly changing radii) because this most closely approximates how a vehicle traces its fastest path through a roundabout. A spline also allows analysts to draw the smoothest, most natural vehicular path. It is drawn from a starting point approximately 165 ft in advance of the entry line, with an offset of 5 ft from curbs, 5 ft from a centerline, and 3 ft from other pavement markings (such as a painted median or two-way left-turn lane), these are shown in **Figure 17**. The critical entry path radius, referred to as R1, occurs over the spline for 65 ft to 80 ft, near the yield point, where the tightest radius exists.

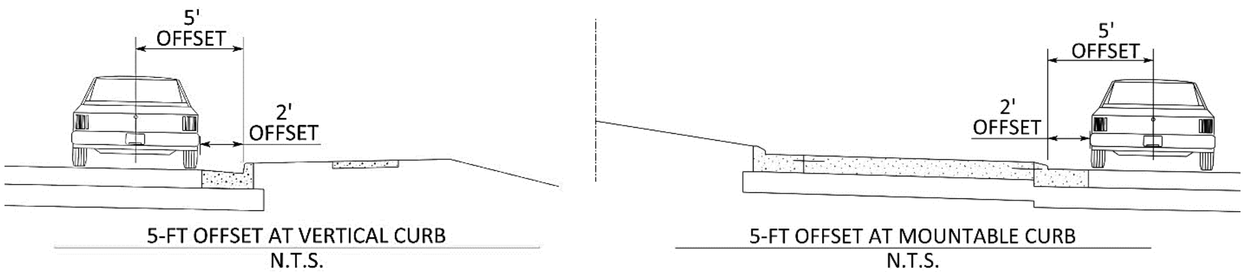


Figure 17 – Offsets from Curbs

In most cases, speed control on entry is the most important fastest path criteria for all roundabout configurations. In addition, if a location has a significant pedestrian count (greater than 25 pedestrians per hour), steps should be taken to facilitate lower vehicle speeds at all pedestrian conflict areas (including exit speeds from the roundabout). when checking exit speeds, both the predictive method (based on the R3 exit path radius) and NCHRP 1043 equation 9.7 (which accounts for acceleration from R2 to R3) should be checked.

R1, R2, and R3 paths should follow a natural spline. Geometric entry speed is usually governed by R1 radius but may be governed by R5 radius in some cases. On designs that cannot achieve deflection using central island and approach alignment offset to the left of center-line, add reverse curves on the approach splitter island, separated by a short tangent 50ft to 100ft. Approach curve radii to be sized using AASHTO Table 3-13, low speed urban design to avoid needing superelevation. **Table 2** outlines the recommended radii for roundabouts. Use NCHRP 1043, Section 9.4.3 for estimating predicted speeds associated fast path radii. The Radius values in the table, when applied with normal cross-slope, are associated with geometric design speeds of 22 mph to 28mph, as the desirable 'fastest-path' values for single lane and multilane roundabouts respectively.

Table 2 – Recommended Radii for Fastest Paths

Splined Fast Path Radius	Recommended Radius for Mini-Roundabout (FT)	Recommended Radius for Single-Lane Roundabout (FT)	Recommended Radius for Multi-Lane Roundabout
R1 Entry	100 to 165	120 to 165	175 to 220
R2 Circulating	70 to 100	70 to 120	70 to 170
R3 Exit	90 to 150	120 to 300*	120 to 300*
R4 Left-Turn	Central Island Radius +5 FT	Truck Apron Radius +5 FT	Truck Apron Radius +5 FT
R5 Right-Turn	50 to 90	70 to 100	70 to 170

*Where pedestrian use of an exit crosswalk is frequent (greater than 25 pedestrians per hour), adjust exit radii to reduce the R3 to less than 200 feet, except on multilane designs.

6.2.1 Mini and Single-Lane Roundabout Geometric Speed Checks

Figure 18 shows the fast path and R-value measurements for a single-lane and mini roundabout.

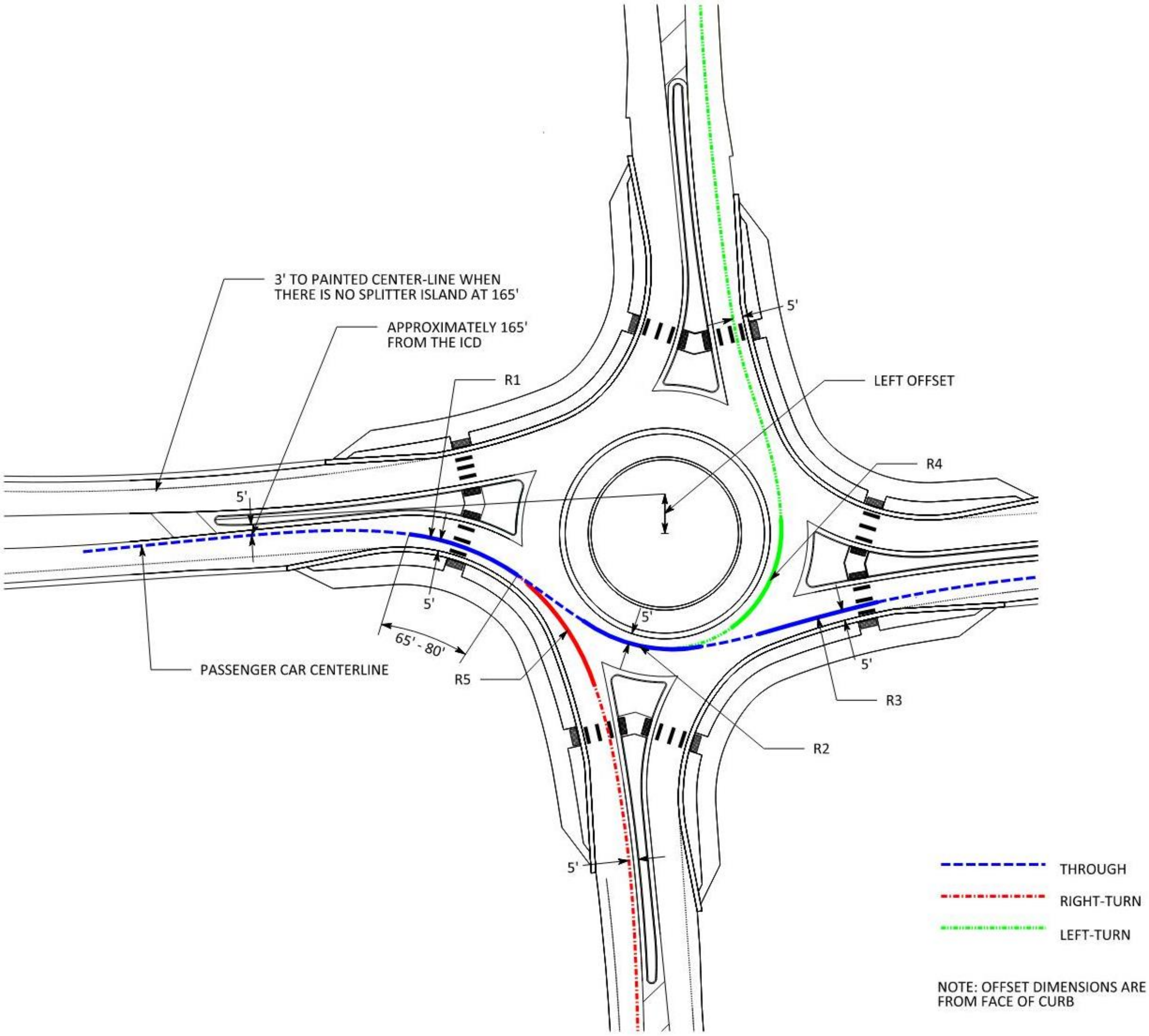


Figure 18 – Mini and Single-Lane Roundabout: Geometric Design Speeds

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6.2.2 Multi-Lane Roundabout Geometric Speed Checks

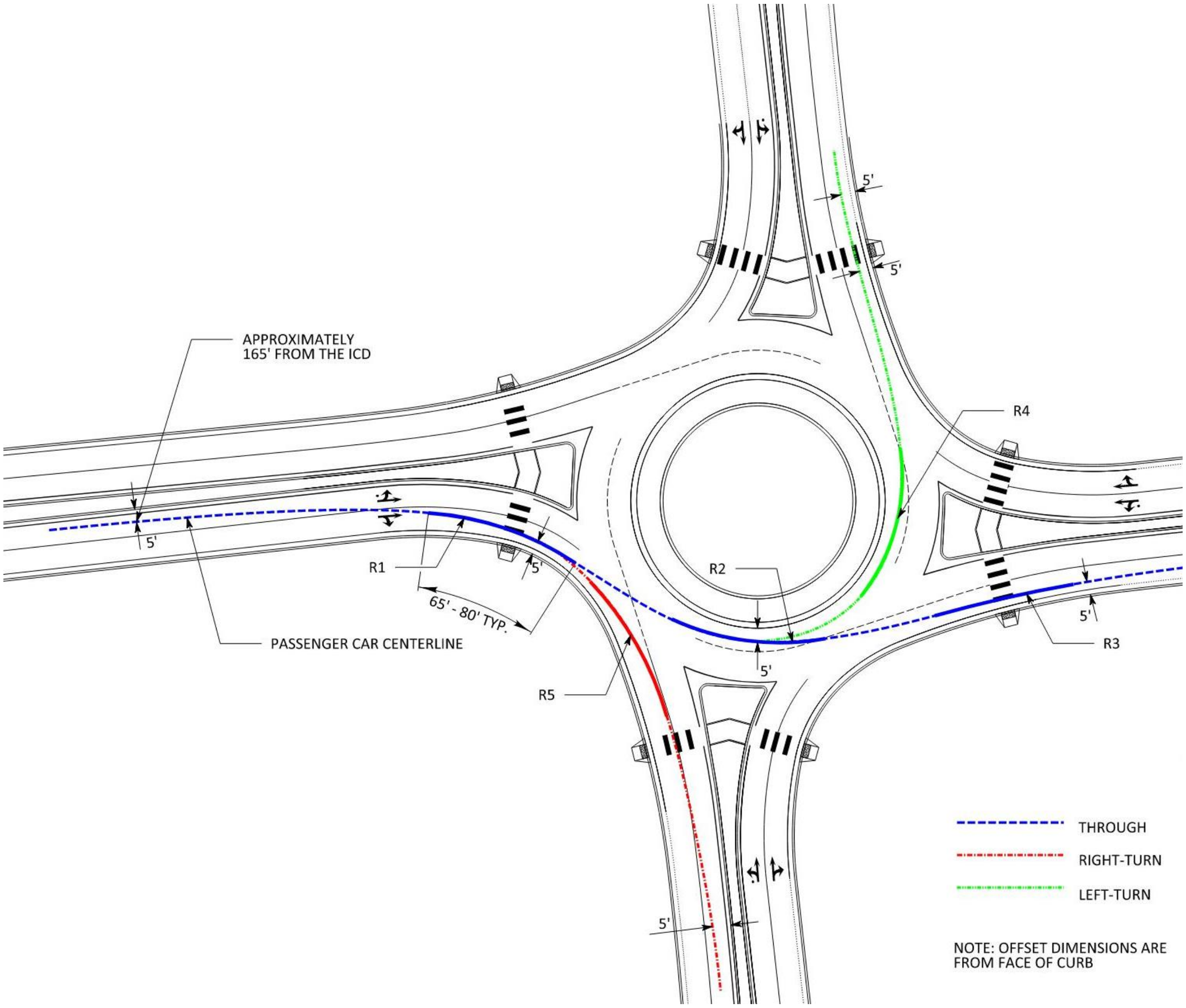

Figure 19 - Multi-Lane Roundabout: Geometric Design Speeds

6.3 Truck Swept-Path Diagrams

The following guidance applies to roundabouts in addition to Design Memo 9.04 Turning Radii. Truck swept-path diagrams shall be developed using AutoTURN® or similar software with depiction of the design and check vehicle(s) are required for all the turning movements to validate the width of lanes and the circulatory roadway, e.g., BUS-40 or CITY BUS. Validate the width of the central island truck apron and entry and exit widths using 1ft. from face of curb as the shy distance to vehicle wheels. The truck cab of a design vehicle should stay on pavement when running swept-path analysis, with all tires maintaining 1ft. from face of curb. Vehicles, such as busses and fire trucks, should not mount the central island truck apron.

6.3.1 Mini Roundabout Large Vehicle Checks

The smaller ICD of the mini roundabout restricts their usage dependent on the chosen design vehicle. Guidance on the minimum ICD allowed for certain vehicles to make a left-turn or U-turn is presented in **Table 3**. These values are generally for guidance and do not supersede the requirements of Design Memo 9.04 Turning Radii. Additionally, splitter islands should be mountable as needed based on the swept paths of the chosen design vehicle.

Table 3 - Mini-Roundabout ICD Requirements for Vehicle U-turns and Left-Turns (LT)

Inscribed Circle Diameter	Design Vehicles Accommodations			
	SU-30	BUS-40 (City Bus)	Fire Truck	WB-62
60	LT-Only	No	LT-Only	No
65	LT-Only	LT-Only	LT-Only	No
70	LT-Only	LT-Only	Yes	No
80	LT-Only	LT-Only	Yes	LT-Only
90	Yes	Yes	Yes	Yes
100	Yes	Yes	Yes	Yes

An example of a truck movement (SU-30) through a mini-roundabout has been provided in **Figure 20**. As shown by the blue shading, in a mini-roundabout the central island may be fully traversable as necessary for truck movements. Mini-roundabouts require larger trucks and buses to traverse the central island depending on the size of the circle and the configuration of the truck.

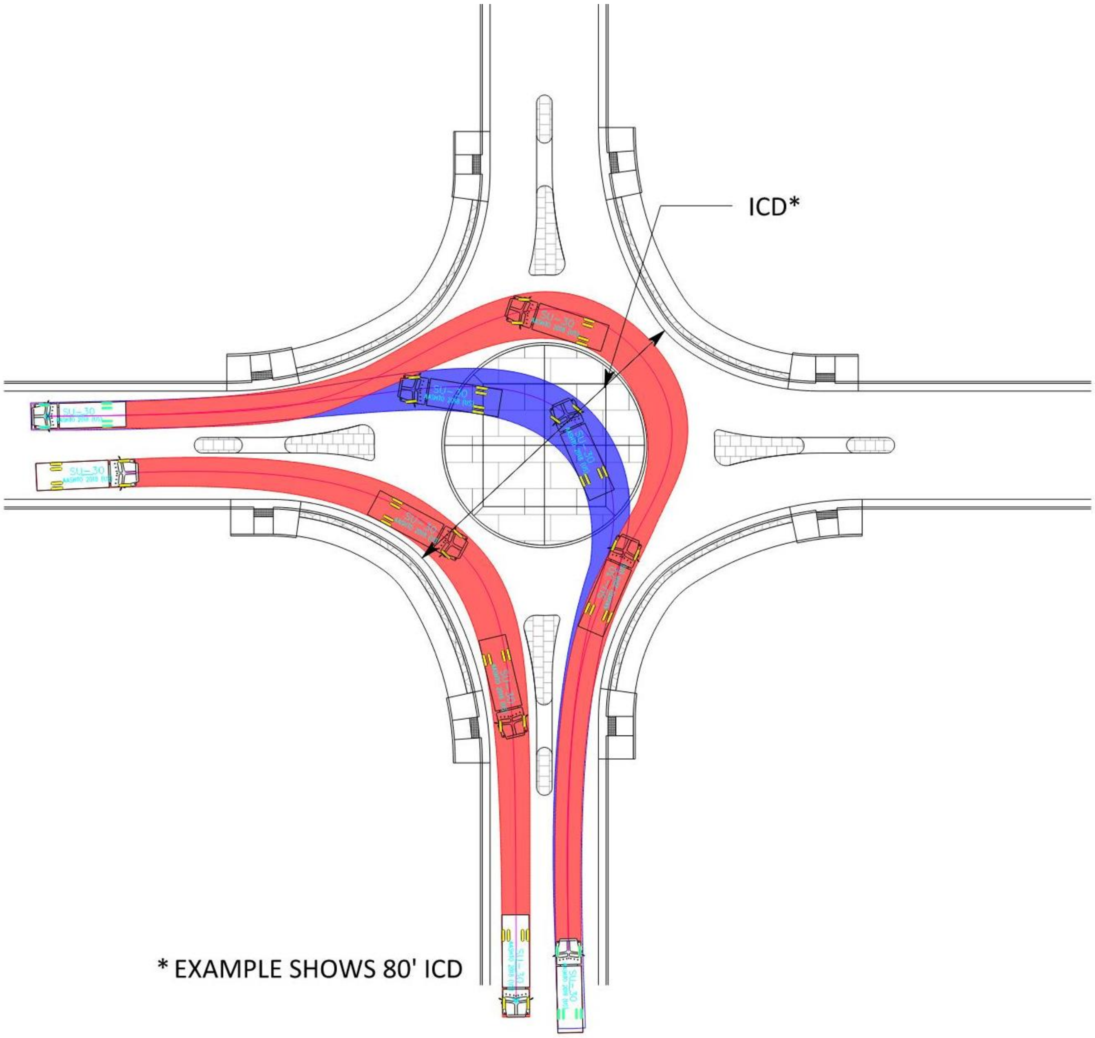

Figure 20 – Mini Roundabout: Truck Swept Paths (SU-30)

6.3.2 Single-Lane Roundabout Vehicle Checks

Larger trucks may need to use the truck apron as an overrun area while making through and left turning movements; right turning trucks are not to use the truck apron. Where entry, exit, or circulating width become excessive for right turns, consider using an outer edge external truck apron. The external truck apron should not pass through crosswalks. In addition to the requirements of Design Memo 9.04 Turning Radii, minimum right-turn radii for chosen design vehicles are presented in **Table 4.**

Table 4 – Minimum Right Turn Radii for Design Vehicles

Minimum Right Turn Radius	
SU-30	30 FT
BUS-40	25 FT
DL-27 & Fire Truck	16 FT
WB-62, WB-67	Determined by AutoTURN®

Figure 21 presents an example of a left and right turning movement through a single-lane roundabout. D1 is a measurement from the edge of pavement of the width of the circulating lane. D2 is a measurement from the face of curb of the circulating lane plus the truck apron. Recommended values of D1 and D2 are presented in **Table 5**.

Table 5 – Left Turning Width Recommended for Single-Lane Roundabouts
('D1' and 'D2' in feet – See Truck Swept Path Figure 19)

Inscribed Circle Diameter	Design Vehicle			
	D1 (EOP)		D2 (FOC)	
	SU-30	BUS-40	WB-62	WB-67
110	14*	15	32	39
120	14*	15	30	36
130	14*	14	27	33
140	14*	14	26	30

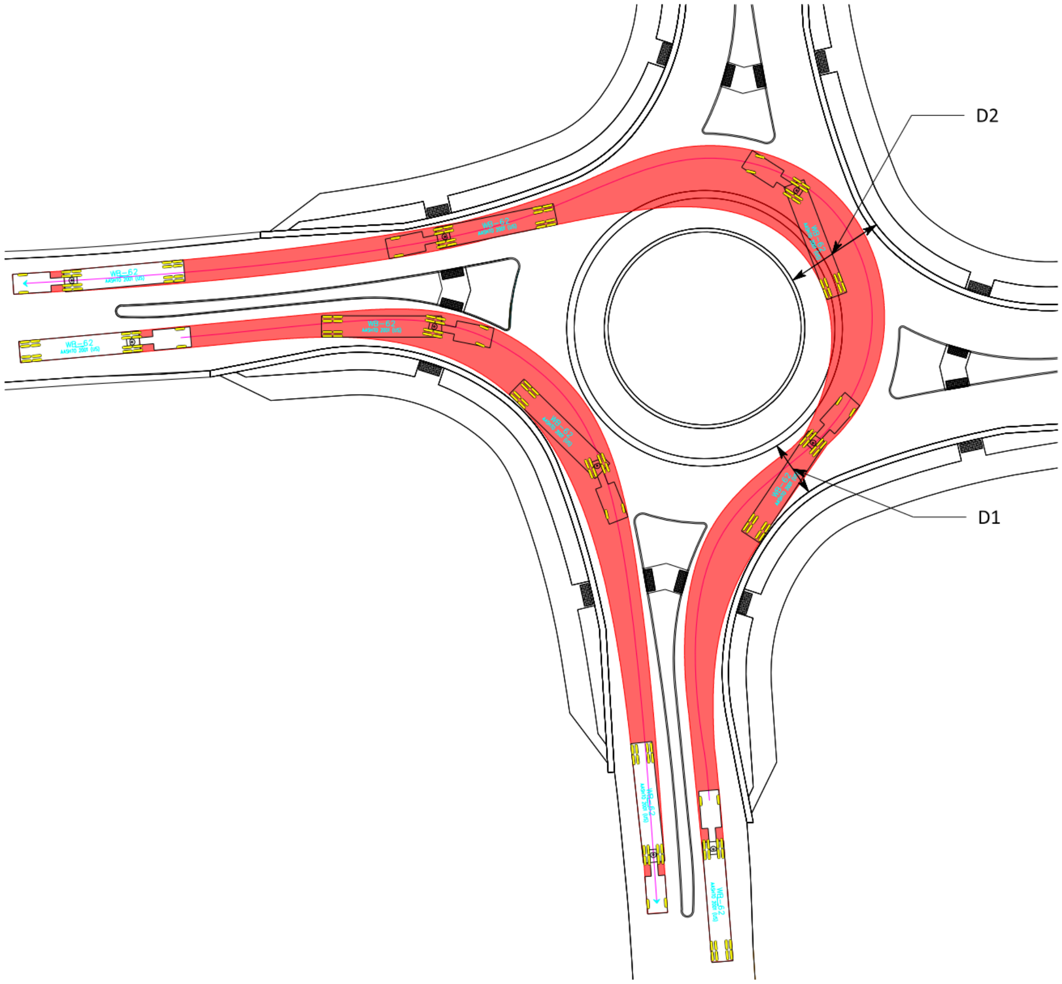

Figure 21 – Single-Lane Roundabout: Truck Swept Paths (WB-62)

6.3.3 Multi-Lane Roundabout Vehicle Checks

Multilane roundabout design vehicles considerations need to consider the swept paths on entry, on exit and in the circulatory roadway. The design vehicle may straddle lanes whereby the design vehicle is assumed to use the entire curb-to-curb width for entering, circulating and exiting as needed. **Figure 22** shows example thru and turning movements for a multi-lane roundabout. The following are design vehicle and check vehicle requirements:

- CITY BUS-40, and fire rescue truck are to track in lane on approach entry, circulating, and exiting. The circulatory roadway must accommodate a passenger car and bus in-lane (side-by-side) (see NCHRP 1043 Exhibit 10-39).
- WB-50, WB-62, WB-67 may use the central island truck apron for over tracking on left turning movements.
- Right turning trucks are not to use the truck apron. Where entry, exit, or circulating widths become excessive for right turns, consider using an external truck apron. External truck aprons should not pass through crosswalks.

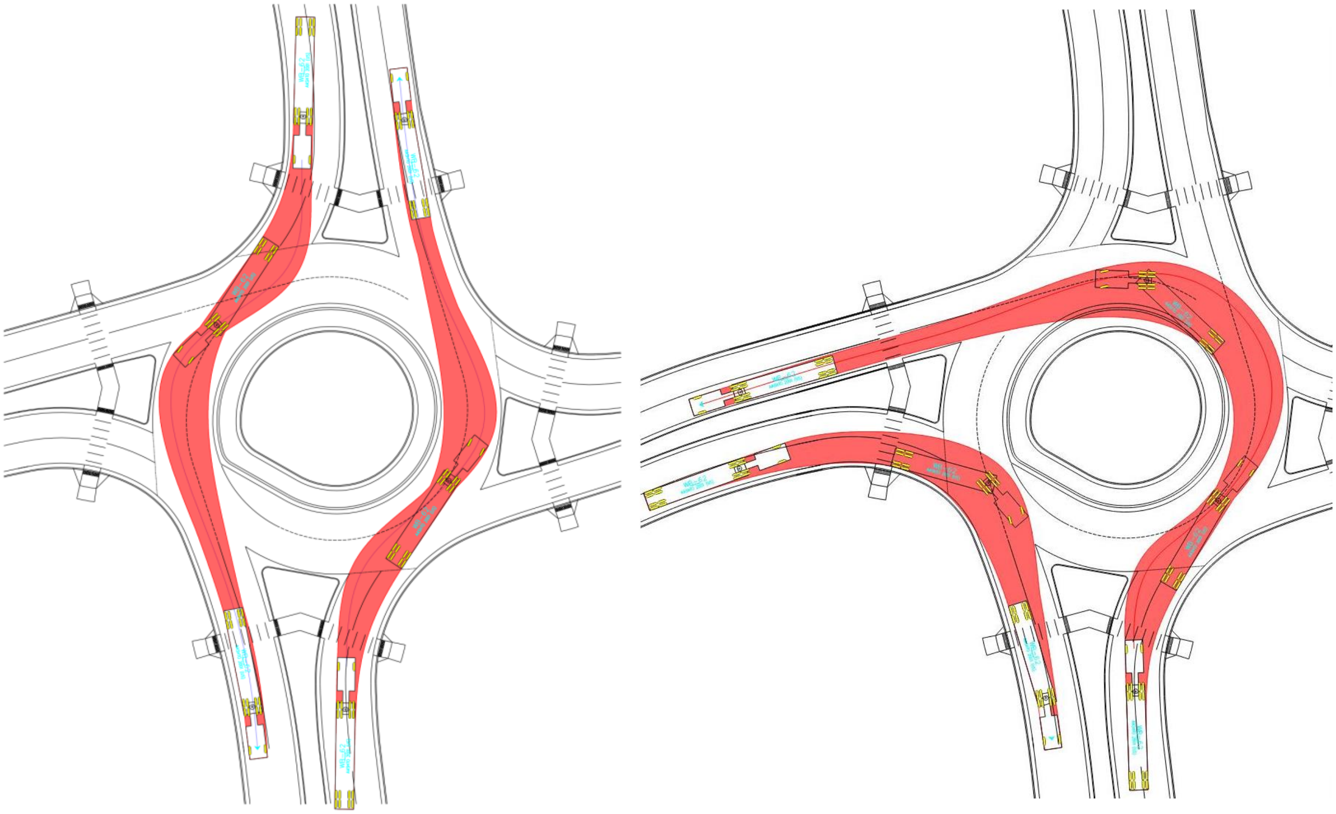

Figure 22 – Multi-Lane: Truck Swept Paths (WB-62)

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6.4 Stopping sight, Intersection Sight and View Angle Diagrams

Stopping sight distance, intersection sight distance, and view angle diagrams accounting for horizontal and vertical approach grades shall be checked for all roundabouts. Sight distances must account for height of eye and heights of objects; this is for the purpose of user safety and to establish limits to planting scheme/landscaping for mounded central island and splitter islands. For additional information refer to NCHRP 1043, Section 9.5.

6.4.1 Stopping Sight Distance

Stopping sight distances shall be calculated based on approach speed and AASHTO Chapter 3.2 Sight Distance. The approach stopping sight distance (**Figure 23**) should be drawn from the yield line or the crosswalk as applicable.

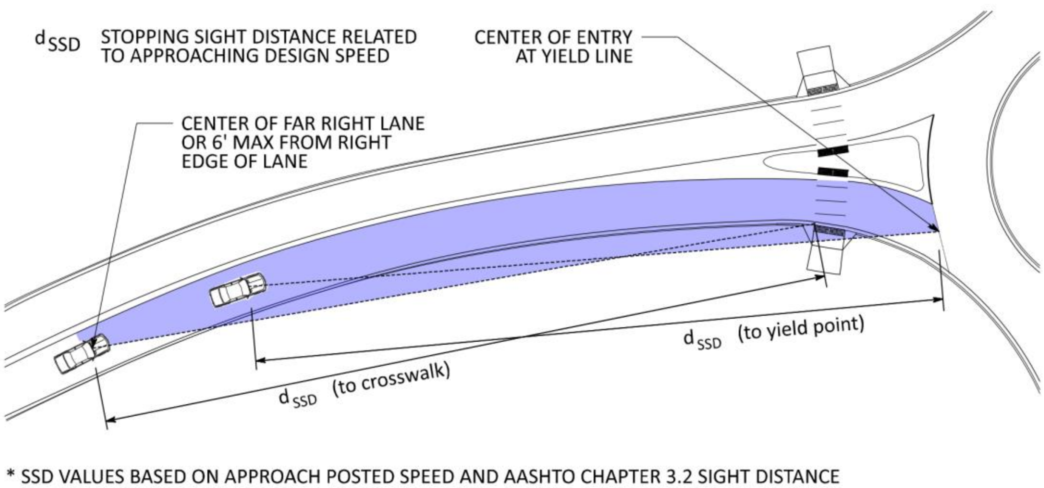


Figure 23 – Approach Stopping Sight Distance

Stopping sight distance to the downstream crosswalk shall be calculated using the measured speed for the right turn (R5) along the right turn fast path. This is shown in **Figure 24.** Stopping sight distance should be checked from the downstream crosswalk along the thru fast path to ensure that a vehicle making the through movement can see a pedestrian crossing and vice versa. This check should use the R1 entering speed.

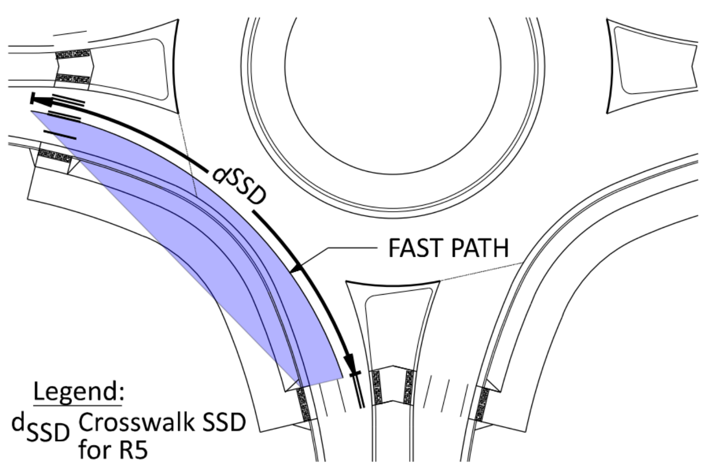
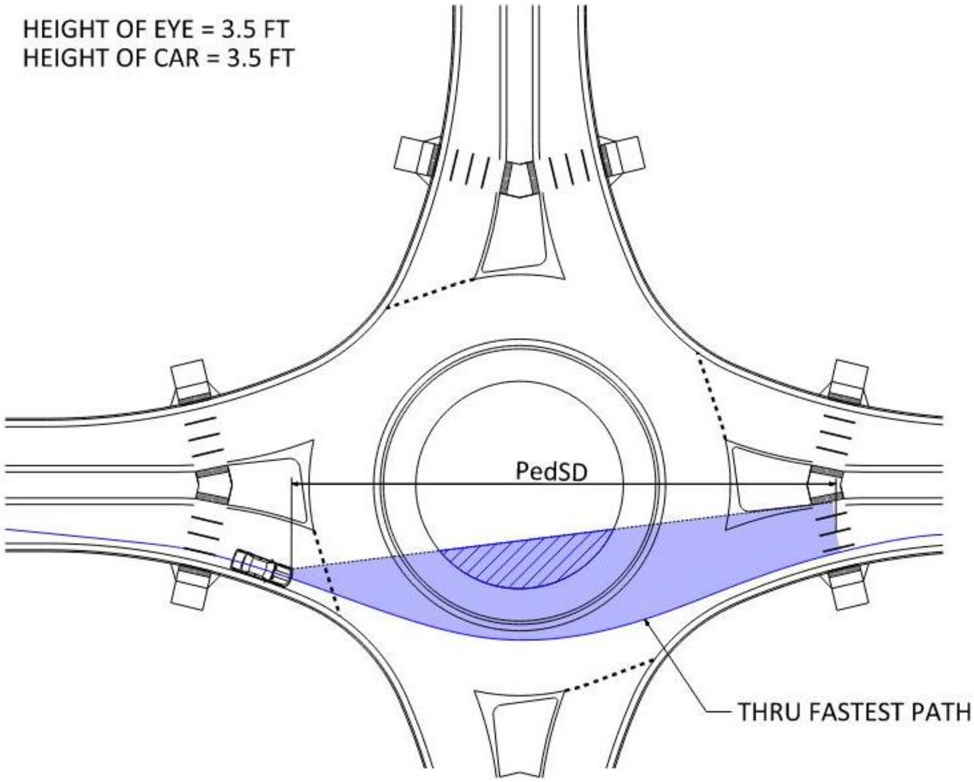


Figure 24 – Stopping Sight Distance to the Downstream Crosswalk

Figure 25 illustrates the required sight distance check to ensure that a pedestrian can see a driver entering the roundabout, making a through movement and driving a fastest-path alignment through the roundabout. Providing the minimum sight distance allows the pedestrian to cross at normal walking speeds with adequate time to clear the crosswalk before the advancing vehicle arrives.



NOTE:
- PEDESTRIAN SIGHT DISTANCE TO BE CACULATED USING THE EQUATION BELOW AND MEASURED ALONG THE THRU FAST PATH.
- VERTICAL CHECKS ARE TO USE A EYE HEIGHT OF 3.5 FT. AND A CAR HEIGHT OF 3.5 FT.

$$PedSD = 1.47S\left(\frac{L}{S_P} + t_s\right)$$

Where:

PedSD = Pedestrian Crossing Sight Distance (ft)

S = Design Speed (mph)

L = Crossing Distance (ft)

S_P = Average Pedestrian Walking Speed (ft/s), default = 3.5 ft/s

t_s = Pedestrian Start-Up and End Clearance Time (s), default = 3.0s

SOURCE: GDOT PEDESTRIAN STREETSCAPE GUIDE, UPDATE 1.2 (2021)

LEGEND

SIGHT ENVELOPE

LIMITED PLANTING HEIGHT AREA

Figure 25 – Pedestrian Stopping Sight Distance to Exiting Crosswalk

Circulating stopping sight distance can be used to determine which areas within the central island require low lying landscaping and which areas do not have limitations on planting heights. The circulating stopping sight distance is calculated using the R2 circulating speed and follows a path that is a 3-ft. offset from the edge of pavement of the circulating roadway or 5 feet from the face of curb, seen in **Figure 26** . This shape can then be rotated around the circle.

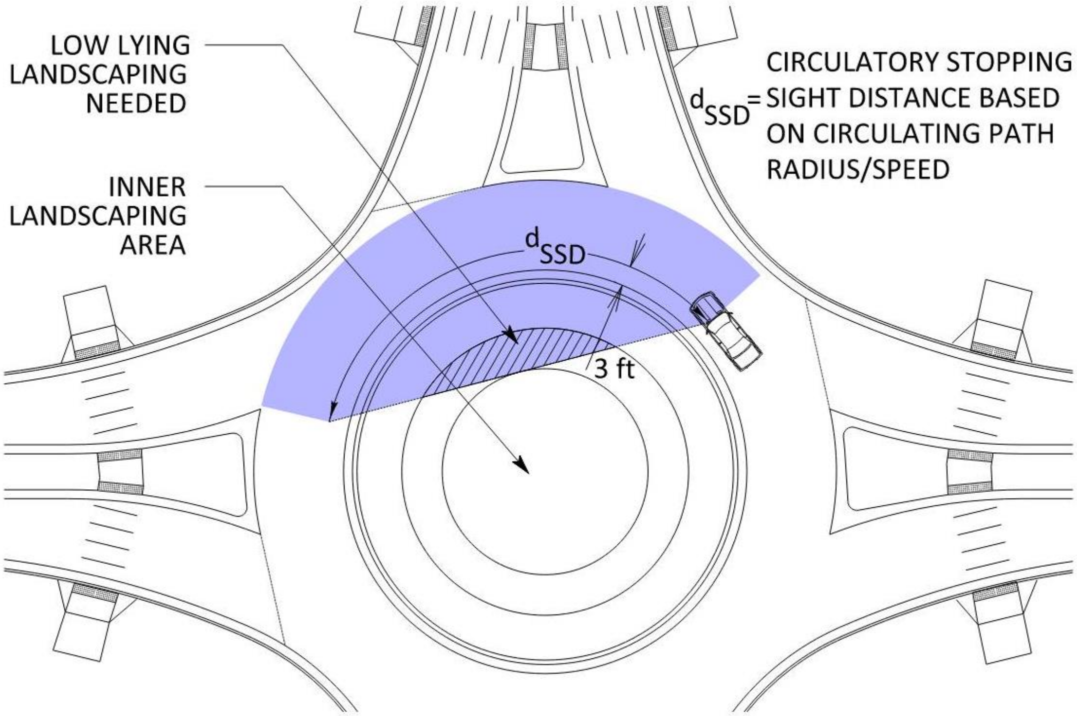


Figure 26 – Circulating Stopping Sight Distance

Vertical sight distance checks shall be performed and submitted, using a driver eye height of 3.5 feet and an object height of 2 feet. An example of this is shown in **Figure 27**

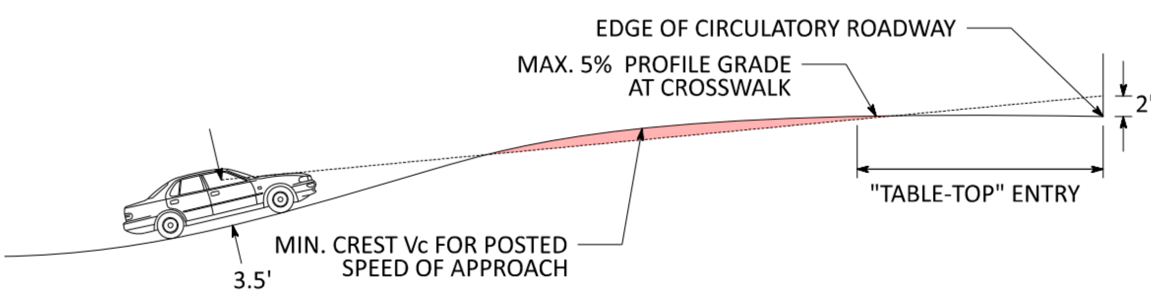


Figure 27 – Vertical Sight Distance

6.4.2 Intersection Sight Distance

The intersection sight distance shall be checked by offsetting the yield line of the entering approach and the upstream approach by 50 feet. In addition, the circulating intersection sight distance should be checked as shown in **Figure 28**.

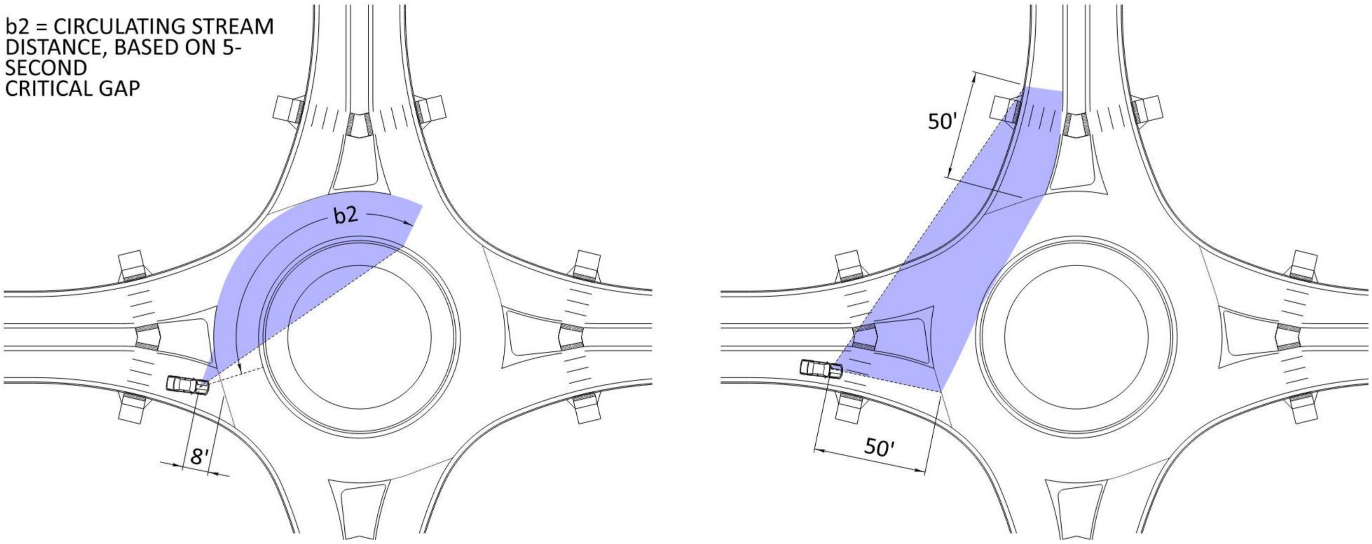


Figure 28 – Intersection Sight Distance

6.4.3 Entering Vehicle Sight Angle

The view angle of the entering vehicle is checked to ensure that a driver at the yield line, turning their head no more than 105 degrees, can see any oncoming entering or circulating vehicles. **Figure 29** illustrates the vehicle positions to check sight to the left.

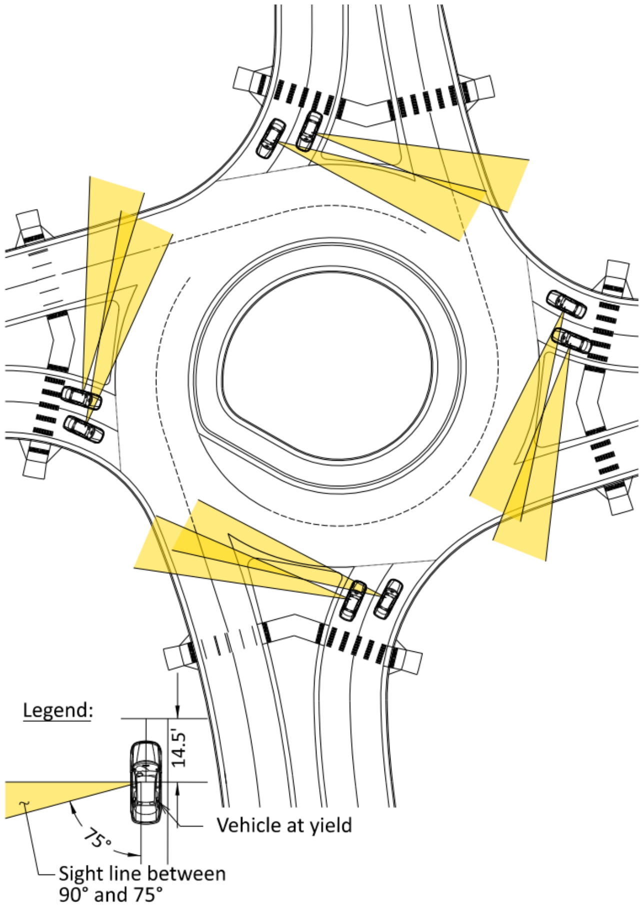


Figure 29 – Entering Vehicle Sight Angle