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Appendix D: Curb Return Radii Design Guidelines

I. Overview and Purpose

The intent of the curb return radii design guidelines is to establish a procedure that allows flexibility in designing curb radii to reflect conditions of specific locations, while assuring that the *result will yield the smallest radii that are feasible* to accommodate the specified design vehicle.

The primary reason for minimizing curb radii is to help provide shorter crossings for pedestrians. In general, the distance a pedestrian must cross to reach the opposite curb will decrease as the curb radius decreases. Similarly, the larger the radius, the greater the distance the pedestrian has to traverse and the more the pedestrian is potentially out of the line-of-sight of the driver. Smaller radii can also serve as a traffic calming design feature, requiring vehicles to turn at slower speeds, depending on the width of the street.

Smaller curb radii, therefore, serve to:

- Minimize the (unprotected) distance pedestrians need to cross,
- Allow for better alignment of the crosswalk with the connecting sidewalks (i.e., provide a continuous path of travel),
- Assure adequate space at the corner for proper placement and alignment of ADA-compliant curb ramps (typically, one per each direction of travel is desired),
- Moderate the speeds of turning vehicles,
- Improve visibility of drivers and pedestrians,
- Result in improved compliance with “No Turn On Red” regulations.

While the overall intent is to keep radii small and improve pedestrian crossings, curb radii will be designed to accommodate the expected type and volume of vehicle turning at the intersection. Properly designed curb radii will provide sufficient space for the expected vehicles to maneuver through their turns safely, while minimizing conflicts between cars, trucks, buses, bicyclists and pedestrians. The design should also take into account the typology of the two intersecting streets, the level of pedestrian activity expected, the location of crosswalks, curb ramps, presence or absence of bike lanes, pedestrian refuge islands, curb extensions, bus stops and on-street parking, and whether the intersection is signalized or unsignalized.

II. Design Criteria

The following guidelines are to be used to determine the curb radii at any given intersection. For the purposes of this process, the AASHTO Green Book’s “crawl speeds” are assumed for the turning speeds of vehicles.



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It is important to note that, as with any document of this nature, these guidelines are intended to provide guidance and direction when designing streets and should be flexible to account for the specific traffic, vehicle and roadway conditions at any given location, and be sensitive to any unique or unusual situations. Sound engineering and planning judgment shall be used to produce designs in keeping with the context of the adjacent land uses and surrounding street network.

Approach

The approach outlined in this section is different for **Local** and **Non-Local** streets, given the different nature and context of each of these typologies. The discussion on **Non-Local** streets is presented first as this is typically the more complex of the two street types.

a) Non-Local Streets

Determination of Appropriate Design Vehicle

The appropriate curb radii to be used at the intersection of two non-local streets is initially based on the type and frequency of vehicle (the “design vehicle”) expected to traverse the intersection under normal conditions. While often not readily available, this information can be determined by a variety of methods, such as field observations, vehicle classification counts, and assumptions and projections based on future land uses.

In the absence of specific information regarding the types and numbers of vehicles expected, Table 1 shall be used to select the appropriate design vehicle:

Table 1 – Design Vehicle for Non-Local Street Intersections

	Local	Main	Avenue	Boulevard	Parkway
Local	See Table4	Pass. Veh.	School Bus	SU-30	B-40
Main	-	SU-30	SU-30	B-40	B-40
Avenue	-	-	B-40	B-40	WB-50
Boulevard	-	-	-	WB-50	WB-50
Parkway	-	-	-	-	WB-62

Potential Encroachment for Turning Vehicles

Once a design vehicle is selected, the designer must make assumptions regarding the potential encroachment into various travel lanes on the receiving street. These assumptions relate to the ability of the design vehicle to turn from one street into the available traffic lanes on the receiving street. The possible encroachment is based on a number of factors, including the street typology, the number and width of traffic lanes, available sight distance, the speed and volume of vehicles on each



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street and the presence or absence of onstreet parking. As a result, different curb radii may be designed for each corner of an intersection.

While it is acknowledged that occasional encroachment by larger vehicles into adjacent or opposing lanes of traffic will occur, the goal is to minimize as much as possible conflicts between vehicles, pedestrians, bicyclists, and other users of the street, while providing the minimum curb radii appropriate for the given situation.

Tables 2 and 3 are to be used as a guide to determine the potential/possible encroachment for vehicles turning at signalized and unsignalized intersections, given the factors described above. **Figure 1** graphically illustrates the various encroachment scenarios (“cases” shown in **Tables 2 and 3**) that may be used for the design vehicle in determining the appropriate curb radii.

Table 2 – Allowable Encroachment for Signalized Intersections

From\To*	Local	Main	Avenue	Boulevard	Parkway
Local	Table 4	Case B	Case B	Case B	Case B
Main	Case D	Case C	Case B**	Case B	Case B
Avenue	Case D	Case C	Case B**	Case B	Case B
Boulevard	Case C	Case C	Case B**	Case B	Case B
Parkway	Case C	Case C	Case B**	Case B	Case B

Table 3 – Allowable Encroachment for Unsignalized Intersections

From\To*	Local	Main	Avenue	Boulevard	Parkway
Local	Table 4	Case C	Case A	Case A	-
Main	Case D	Case C	-	-	-
Avenue	Case D	-	-	-	-
Boulevard	Case D	-	-	-	-
Parkway	-	-	-	-	-

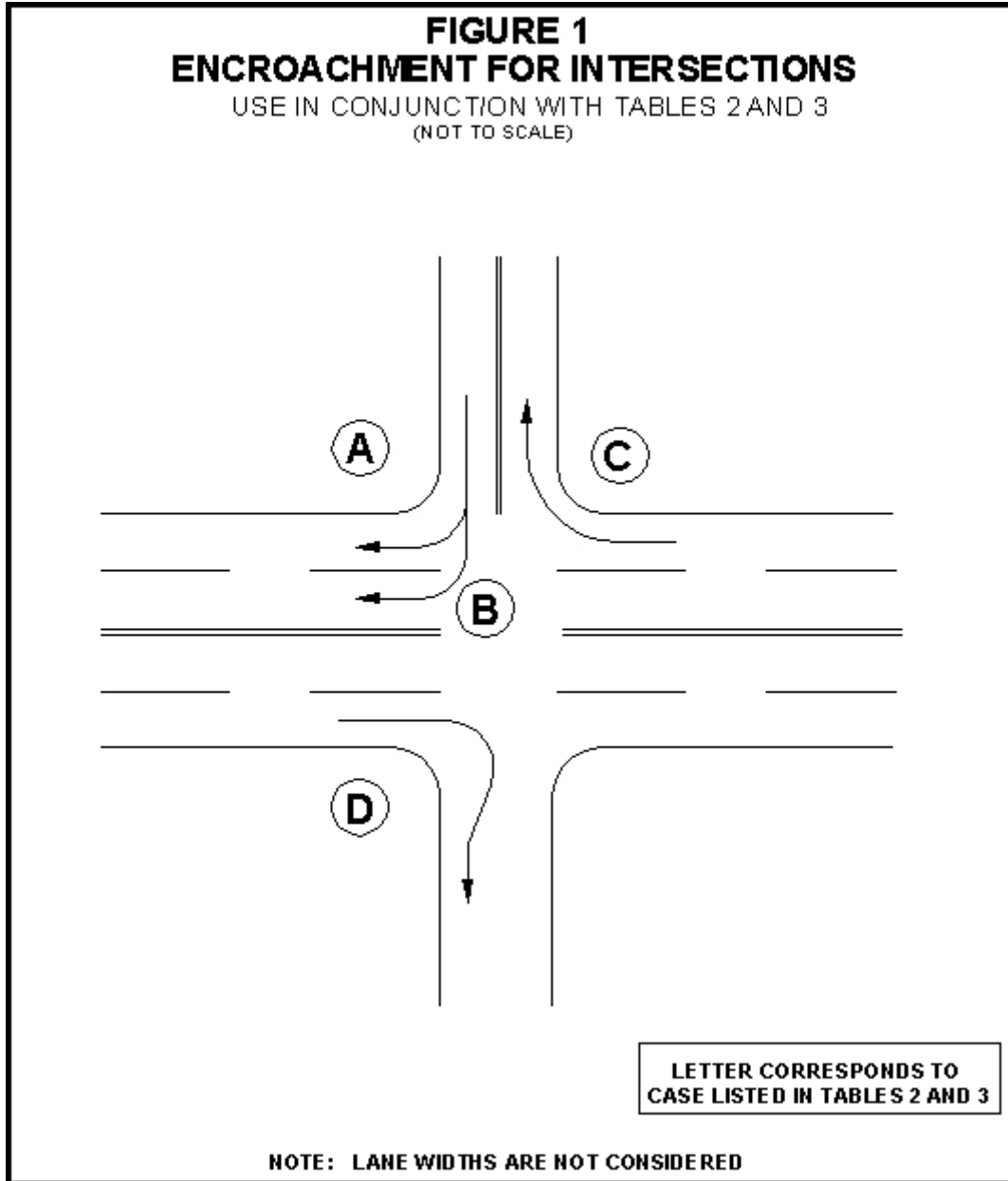
*The column along the left side of the table indicates the street *from* which the vehicle is turning; the headings indicate the *receiving* street.

**Case B should be assumed, unless the Avenue only has one receiving lane, whereupon Case A should be assumed.

The possible encroachment is intended to be more flexible at signalized intersections (i.e., resulting in smaller radii), since it is assumed that a) larger vehicles can wait for a green signal to assure adequate space to safely complete their turn, and b) a higher level of pedestrian activity is expected or desired.



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b) Local Streets

As stated previously, determination of the appropriate curb radii is based on many factors. In the case of *Local Streets*, curb-to-curb width must also be considered. In most cases, the width of the street is the critical factor in determining the necessary curb radii for *Local Streets*.

While *Local Streets* are typically narrower than *Non-Local Streets*, there is also more flexibility in applying the design vehicle encroachment guidelines, since it is generally assumed that the full width of available pavement can be used to “receive” the turning vehicle. This, of course, must take into account the traffic volumes, function, adjacent land uses and specific conditions of the street being designed.

Table 4 indicates the curb radii to be used for the intersections of *Local Streets*. Again, while the goal is to provide the smallest radii possible, the design should be tested to be sure it can adequately accommodate the *expected* typical design vehicle, based on the specific traffic and roadway conditions of the project area.

Table 4 - Curb Radii for Local Street Intersections

From\To	R/Narrow	R/Medium	R/Wide	C/Narrow	C/Wide	Industrial
R/Narrow	35					
R/Medium	20	15				
R/Wide	15	15	10			
C/Narrow	20	15	25	35		
C/Wide	15	15	15	30	10	
Industrial	30	25	15	40	25	50

R = Residential
C = Commercial

III. Other Factors Affecting Curb Radii

As previously stated, the determination of the appropriate curb radii for any given location is influenced by many different and varied factors. For the purpose of achieving the goals of Charlotte’s *Urban Street Design Guidelines*, the overwhelming consideration for most street types is for safety, including providing safer and shorter pedestrian crossings.

While minimizing the curb radii is the desired outcome, other factors must be evaluated to assure that the design is adequate before a final determination can be made.

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Additional factors to consider include:

- *The overall street pattern* – depending on the size and layout of the adjacent street system, it may be appropriate to design smaller radii at most intersections (e.g. along a *Main Street*), while accommodating larger vehicles at fewer select locations along designated routes.
- *The presence of a bike lane* – the additional width created by a bike lane makes the effective curb radius larger. Therefore, the actual curb radius can usually be smaller when a bike lane exists.
- *The presence of a raised median or pedestrian refuge island* - may require larger radii to prevent vehicles from encroaching onto the median. Alternatively, particularly for “gateway” medians on Local Streets, medians may have aprons to allow larger vehicles to turn without damaging landscaping or curbs.
- *Skewed or oddly shaped intersections* - may dictate larger or smaller radii than the guidelines would otherwise indicate.
- *Lane configuration or traffic flow* – intersections of one-way streets, locations where certain movements are prohibited (left or right turns), or streets with uneven numbers of lanes (two in one direction, one in the other) will also affect the design of curb radii.
- *Onstreet Parking* – the presence or absence of onstreet parking will directly affect the curb radii required to accommodate the design vehicle. **Table 5** may be used where *permanent full-time* onstreet parking is allowed and accommodated on *both streets* at an intersection.

Table 5 – Curb Radii with Permanent Full-time Onstreet Parking*

From\To	Local	Main	Avenue	Boulevard	Parkway
Local	15	20	25	30	-
Main	20	20	25	30	-
Avenue	25	25	25	30	-
Boulevard	30	30	30	35	-
Parkway	-	-	-	-	-

* *This table should not be used where parking is either part-time only or occurs infrequently.*