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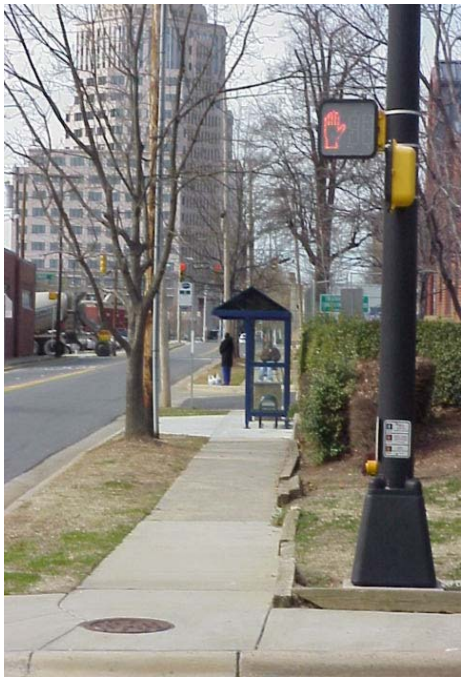
Connecting Charlotte

Charlotte Department of Transportation

PEDESTRIAN & BICYCLE LEVEL OF SERVICE

METHODOLOGY FOR CROSSINGS AT SIGNALIZED INTERSECTIONS

April 2005



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INTRODUCTION

The Charlotte Department of Transportation has developed the following methodology to assess the important design features that affect pedestrians and bicyclists crossing signalized intersections. Referred to as Level of Service (LOS), this methodology identifies and evaluates features according to their influence on the comfort and safety of pedestrians and bicyclists. Among the key features identified and rated are crossing distance, roadway space allocation (i.e., crosswalks, bike lanes), corner radius dimension and traffic signal characteristics.

This methodology can be used as a diagnostic tool to assess and improve pedestrian and bicyclist levels of comfort and safety by modifying design and operational features of intersections. The results can be compared with those for traffic levels of service of an intersection and weighed according to user priorities. This methodology is intended to be used to select design and operational features that can help achieve desired levels of service for pedestrians and bicyclists.

SIGNALIZED INTERSECTION FEATURES AND THEIR RELATIVE IMPORTANCE TO PEDESTRIAN LEVEL OF SERVICE (LOS)

The primary impediments to comfort and safety for pedestrians crossing at signalized intersections are crossing distance and conflicts with turning vehicles. Vehicle volumes and speeds are factors as well, but are tempered by the presence of the traffic signal, its phasing, and/or physical characteristics of the intersection. For example, tight corner radii can slow the speeds of right-turning vehicles, and right and left turn conflicts can be reduced or eliminated by signal phasing, all design factors affecting comfort and safety between pedestrians and vehicles. So although volumes and speeds are not explicitly addressed by this methodology, they are implicitly dealt with.

This approach for assessing pedestrian level of service, therefore, identifies those key elements or features of intersections that enhance or reduce comfort and safety, and then weighs them relative to one another by a point system. Points are assigned to physical and operational features of intersections according to how well they achieve these objectives. These important features are discussed below.

Rated Intersection Features

Crossing Distance (Table 1) – As previously mentioned, crossing distance is the primary crossing component or obstacle for pedestrians traveling across intersections and therefore receives the greatest weight in this methodology – accounting for more than half of all possible points. The less distance one has to walk to cross a street, the easier and more comfortable it is perceived to be. A crossing equivalent to two or three lanes, for example, rates a minimum LOS of C, exclusive of any other features. By contrast, a crossing of seven lanes or more falls in the LOS F range, exclusive of other features. For wide street crossings, where there is a greater probability that pedestrians might fail to make it across the entire roadway during a signal phase, level of service can be improved

noticeably if there is a median wide enough to serve as a refuge. Slip lanes and raised corner islands can also enhance pedestrian crossings by breaking long continuous distances into shorter, more manageable crossings. Crossing distance is determined based on the number of motor vehicle travel lanes that must be crossed to reach the far side of the intersection. Travel lanes are assumed to be within the range of 10 to 12' in width. If a lane(s) is much wider, one might consider the street crossing as wider than simply the number of delineated travel lanes.

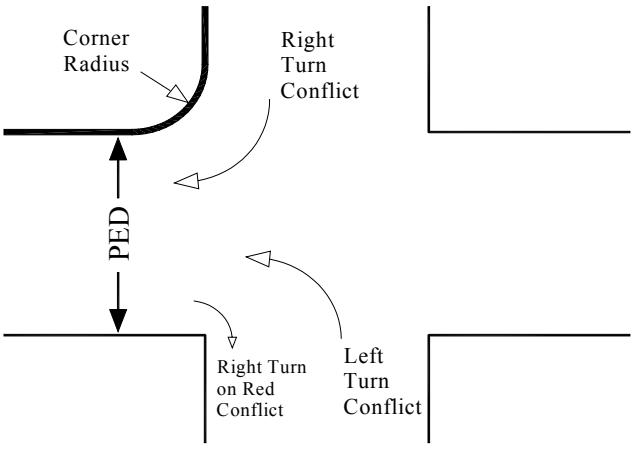
Signal Phasing & Timing (Tables 2 & 3) – This is the most intricate of the categories and accounts for over 25% of the total points. It is rated according to the type and level of crossing information provided to the pedestrian and whether the signal phasing minimizes, eliminates or exacerbates conflicts between pedestrians and turning vehicles (Figure 1).

The signal phasing feature that rates best for reducing left turn conflicts across the pedestrian path is the Protected Only phase (when turns occur on a green arrow only), provided there are signals that inform pedestrians when they can cross without a conflict with left turning vehicles. Protected turn phases (e.g., green arrow only, green arrow/green ball) without accompanying pedestrian signals expose pedestrians to greater risks by adding an extra phase to the signal cycle that may not be perceptible to pedestrians. This condition, which may entice pedestrians into the street while motorist are turning on the arrow and not expecting to encounter pedestrians crossing, is viewed negatively. Also considered an increased risk, and rated accordingly, are lane arrangements that allow multiple lanes of traffic to turn across pedestrian paths, unless the signal phasing reduces or eliminates the conflict.

As with left turn conflicts, right turn conflicts are assessed according to lane configuration and signal phasing. Points can only be achieved in this category if the pedestrian conflict with turning traffic is eliminated by the signal phasing. Points are taken away if either the signal phasing creates a conflict similar to that discussed above for left turn phasing (overlap) or multiple lanes of traffic are allowed to turn concurrent with pedestrian crossings. Otherwise, no points are awarded or subtracted.

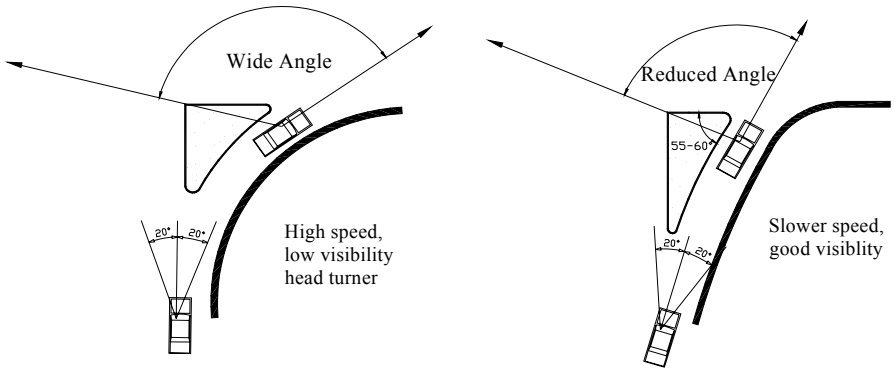
Points can also be attained by the use of pedestrian signals, provided vehicle conflicts are reduced and/or information is given by the signal that shows pedestrians how much time is available for them to cross the street (e.g., countdown signals). Additional points can be obtained within this subcategory by timing pedestrian phases for slower walk speeds, if countdown pedestrian signals are used. Pedestrian phase times based on slower walk speeds without countdown signals are not perceptible to pedestrians, and therefore do not receive extra points.

Figure 1. Pedestrian Crossing Conflicts



Corner Radius (Table 4) – Corner radius is rated according to its effect on right-turning vehicle speeds and any increased walking distance for pedestrians. The smaller the radius, the slower the turning speeds around it and the less additional distance to be walked. Radii of 20' or smaller rate best, while large radii (greater than 40') are considered detrimental enough to be assigned negative point values. If slip lanes or raised corner channel islands suitable in size to serve as pedestrian refuge are provided (Figure 2), then points are assigned according to the type of traffic control present (i.e., yield or signal control) and how this control manages the pedestrian-turning vehicle conflict. For simplicity, no distinction is made between corner radius and its effect on vehicle speeds for turns into a single lane or turns into multiple lanes. Also, the effect of intersection angle on vehicle speeds for a given radius is not directly incorporated. Corner radius ranks third for points among the rated intersection features.

Figure 2. Corner Channel Island Designs



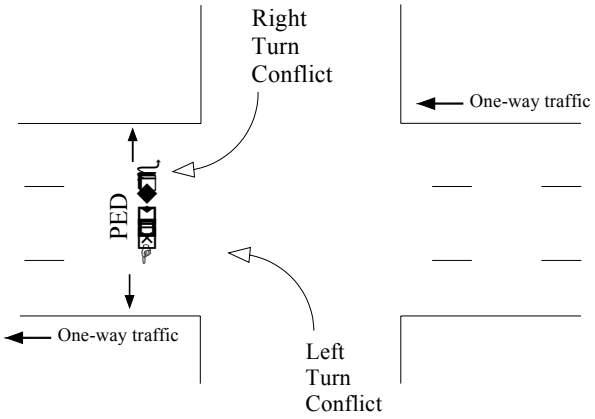
(A) Standard slip lane design (B) Modified slip lane design

Right-Turns-On-Red (Table 5) – There are differing views as to the safety benefits of prohibiting this movement. Since prohibiting right-turns-on-red eliminates a possible conflict between pedestrians and motorists, it was decided that it should be rated. The Right-Turns-On-Red and Crosswalk (below) features both account for about 5% of the possible points.

Crosswalk Treatment (Table 6) - The presence and design features of a crosswalk are both rated. Crosswalks help raise awareness to motorists of the possibility of pedestrians crossing the street. Enhanced crosswalks are viewed as being more visible and therefore somewhat better than simple transverse markings.

Adjustment for Traffic Flow Direction (Table 7) – This parameter accounts for the increased risk to pedestrians caused by their exposure to left and right turning traffic while crossing the departure leg of a one-way street that intersects a two-way street. With this scenario, pedestrians are exposed to left and right turning traffic for the entire crossing distance of the road, instead of just a portion (such as is the case for crossing a two-way street with traffic stopped on the approach lanes by the signal).

Figure 3. Adjustment for Traffic Flow Direction



SIGNALIZED INTERSECTION FEATURES AND THEIR RELATIVE IMPORTANCE TO BICYCLE LEVEL OF SERVICE (LOS)

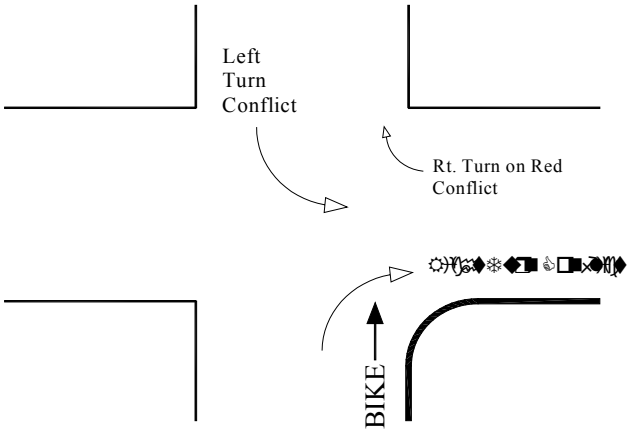
The major impediments to the comfort and safety of bicyclists are somewhat different than those for pedestrians. Traffic signal features and potential conflicts with turning vehicles are still prominent issues, but crossing distance is less important and is surpassed by the desire for physical space in the roadway (providing a separation from the automobile travel lanes). Since bicyclists share space with and travel alongside motor vehicles, the speed of traffic is also a factor.

As with the pedestrian level of service methodology, key elements or features of intersections that enhance or reduce comfort and safety are identified and assigned points according to how well they meet the objectives. These important features are discussed below.

Rated Intersection Features

Signal Phasing & Timing (Table 9) – Features that remove potential left turn conflicts from the path of bicyclists and features that place bicyclists before motorists (in time and space) are rated as desirable. Signal phasing and timing accounts for approximately 35% of the possible points.

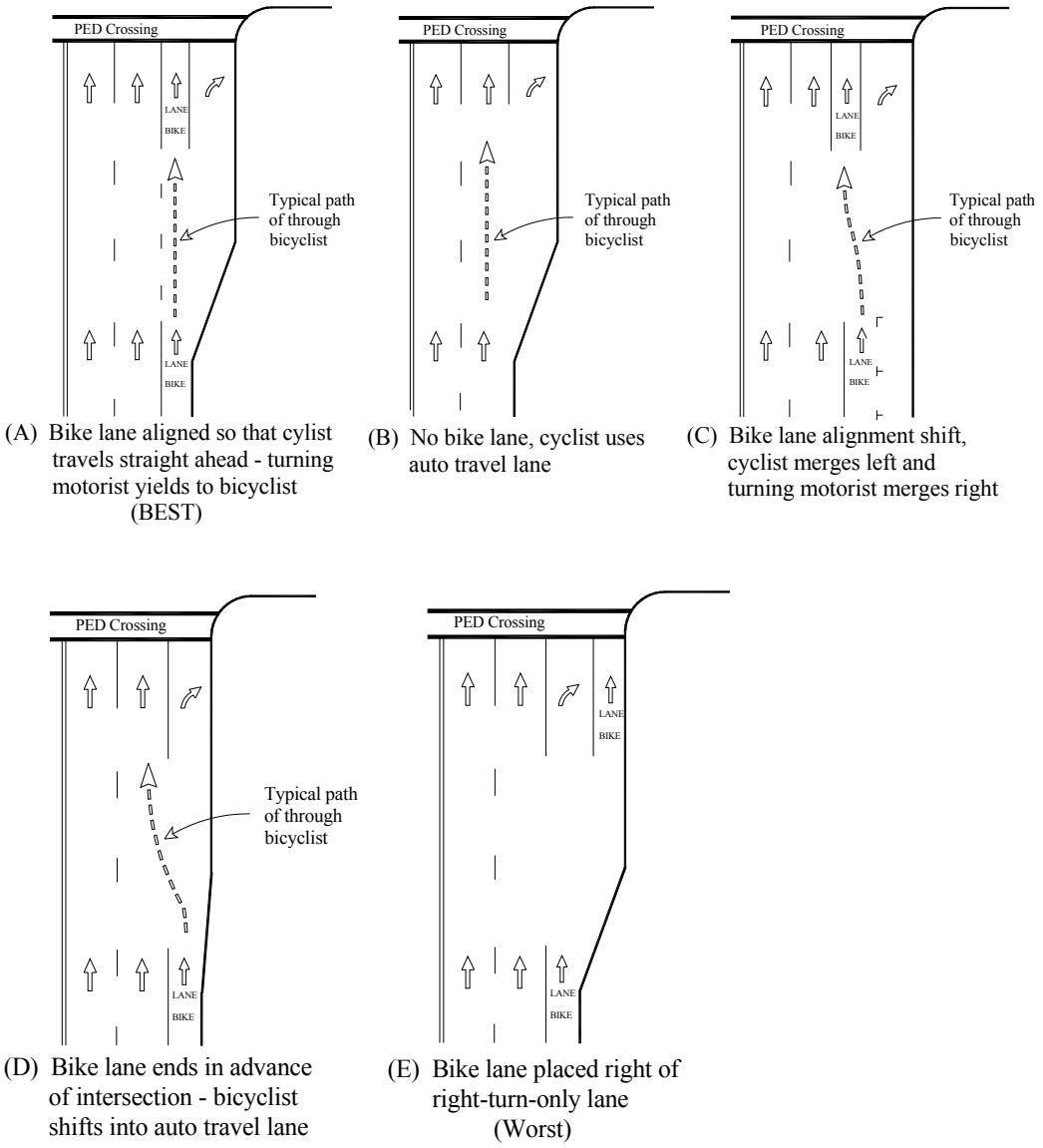
Figure 4. Bicycle Crossing Conflicts



Bikeway Space (Table 10) – Travel space, separate from the outside travel lane, is viewed as highly desirable. Marked bike lanes are the most preferred method of handling in-street bike operations. There is a difference of opinion among cyclists concerning the desirability of wide outside travel lanes (13' to 14') compared to standard width travel lanes (10' to 12'). Because wide outside travel lanes provide extra clearance between bicyclists and motorists, this methodology rates wide outside lanes as better than standard lanes. Ratings are assigned according to how space is allocated in advance of the intersection (approach leg), as well as to how it is allocated beyond the intersection (departure leg). This feature accounts for nearly 30% of the possible points.

Right Turn Traffic Conflict (Table 11) – This parameter addresses the potential conflict involving motorists turning right and bicyclists traveling straight ahead on an intersection approach. The preferred method of resolving this conflict is for bicyclists to 'take' the traffic lane if it is shared with traffic, or if there is a separate right turn lane, motorists should merge right in advance of the intersection while bicyclists travel straight-ahead. Points are awarded if there is no right turn conflict with motorists or if there is a bicycle lane that places bicyclists left of a right turn lane. Otherwise, points are either not awarded at all or they are taken away, depending on whether the bicyclist or motorist is required to merge.

Figure 5. Bike Treatments at a Right Turn Only Lane



Speed of Adjacent Traffic (Table 12) – As mentioned earlier, traffic speeds affect bicyclists' comfort and safety. The speed of traffic traveling adjacent to cyclists accounts for approximately 20% of all points. For simplicity, posted speed limit is used as the measure.

Right-Turns-On-Red (Table 13) - This condition creates another conflict between bicyclists and motorists. Bicyclists can easily blend into the background when a motorist is looking to turn right on red because motorists are often looking for larger motor vehicles (Figure 4).

Crossing Distance (Table 14) – Not as important for cyclists as for pedestrians, but the risk of exposure to motor vehicles approaching from the cross street, particularly as the street width increases, deserves rating.

Intersection Features Not Rated in the Pedestrian and Bicycle Methodologies

There are several other features not rated in these methodologies that also affect the comfort and safety of pedestrians and bicyclists. Among these features are sight lines, street lighting, pavement condition, signing, pedestrian and bike detection, curb extensions, and ADA features such as wheel chair ramps and accessible signals. To obtain meaningful results the authors chose to rate a relatively small number of features. It was quickly discovered that rating too many features diluted the results and tended to make features nearly indistinguishable in their importance relative to one another.

PEDESTRIAN AND BICYCLE LOS DETERMINATION

Level of service for an intersection crossing/approach is determined by adding points from Tables 1 through 7 (for Pedestrians) and points from Tables 9 through 14 (for Bicyclists). The accumulation of points is then compared to the points listed in Tables 8 (Pedestrians) and 15 (Bicyclists), which provides the threshold values for levels of service A through F. An overall intersection level of service for either pedestrian or bicycle features can also be determined by adding the total points from each crossing and dividing their sum by the number of intersection crossing legs (e. g., a three leg intersection's point totals would be divided by three). The higher the point total, the better the level of service.

SUMMARY

The level of service methodology presented in this report is intended to be used to assess the most crucial, especially safety related, factors affecting pedestrians' and bicyclists' crossing signalized intersections. It attempts to identify and compare those design elements that help make intersection crossings safer and pedestrians and bicyclists feel more comfortable. The methodology is not concerned with the quality of the environment away from the intersection crossing, so those elements that make an area more inviting and attractive to pedestrians and bicyclists, such as visual stimuli, convenience, security, and noise are not considered. For Charlotte, these other elements and their importance on creating a pedestrian and bicycle friendly environment are addressed through initiatives such as the new Street Design Guidelines, plans for livable centers and transit station areas.

The focus of this methodology is on those intersection features that reduce traffic conflicts, minimize crossing distances, slow down traffic speeds and raise user awareness. The methodology assumes that all rated features are adequately designed and implemented (e.g., signals are timed adequately and pedestrian signals are well placed), so that equivalent comparisons can be made between features. While important to the overall sense of safety and comfort, elements of risk (e.g., traffic volumes) are not

directly evaluated in the methodology since design features are the focus and design features can be used to mitigate the effects of risks. Furthermore, design features such as cross-section distance, number and type of travel lanes, and signal-phasing schemes do reflect varying traffic volumes.

This level of service methodology is expected to be applied in conjunction with the traditional level of service methodology for motor vehicles. The importance or relative weight given to each level of service (for motor vehicles, bicyclists or pedestrians) is expected to vary by intersection, depending on the planned function and context of each intersection.

PEDESTRIAN LEVEL OF SERVICE CALCULATION

TABLE 1. PEDESTRIAN LOS: Crossing Distance

Crossing distance is determined based on the total number of motor vehicle travel lanes that must be crossed to reach the opposite side of the street. The added effect of corner radii on crossing distance is addressed in parameter number 3 (Corner Radius). When the number of travel lanes crossed includes the crossing of corner refuge island lane(s), an adjustment to the points in the table below should be made. This adjustment is described just below the table.

	Points		
Travel Lanes Crossed	**No Median (or less than 4')**	**Median Refuge (4' to 6')**	**Median Refuge (6' or more)**
2 Lanes	**60**	**60**	**60**
3 Lanes	**55**	**55**	**55**
4 Lanes	**45**	**45**	**48**
5 Lanes	**34**	**36**	**40**
6 Lanes	**23**	**26**	**32**
7 Lanes	**12**	**15**	**24**
8 Lanes	**0**	**6**	**16**
9 Lanes	**-12**	**-4**	**8**
10 Lanes	**-24**	**-15**	**0**

Corner Refuge Island Adjustment:

Crossing of corner refuge island lanes is not weighed as heavily as crossing other travel lanes, and therefore the points assigned based on crossing distance in the table above should be adjusted. Six points are assigned for each refuge island lane crossed, and these points are then subtracted from the points assigned for the remaining number of travel lanes crossed.

Example 1. A crossing of 5 lanes (one of which is a refuge island lane) is adjusted as follows: 45 points (based on 4 lanes) - 6 points (for refuge island lane) = 39 points.

Example 2. A crossing of 5 lanes (two lanes which are corner refuge island lanes) is adjusted as follows: 55 points (based on 3 lanes) - 6 points - 6 points = 43 points.

Corner Refuge Island Adjustment

Example 1: 5 lane Crossing, with curbed slip lane island

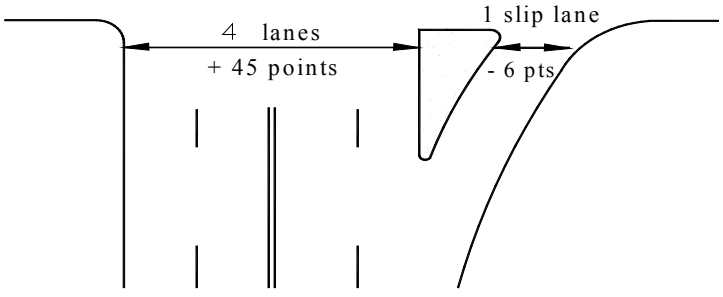


TABLE 2. PEDESTRIAN LOS: Signal Phasing Features

	Points
A. Left Turn Conflicts (Left Turns into Pedestrian Crossing Path) (See Figure 1, page 4)	
A1. Lefts on GREEN BALL Only (permissive phase - left turns unprotected) • From SINGLE lane, no pedestrian phase on conflicting crossing • From SINGLE lane, with pedestrian phase on conflicting crossing • From 2 or more lanes, no pedestrian phase on conflicting crossing • From 2 or more lanes, with pedestrian phase on conflicting crossing	**0** **4** **-10** **-5**
A2. Lefts on GREEN ARROW & GREEN BALL (protected/permissive phase) • From SINGLE lane, no pedestrian phase on conflicting crossing • From SINGLE lane, with pedestrian phase on conflicting crossing	**-5** **4**
A3. Lefts on GREEN ARROW Only (protected only phase) • From SINGLE lane, no pedestrian phase on conflicting crossing • From SINGLE lane, with pedestrian phase on conflicting crossing • From 2 or more lanes, no pedestrian phase on conflicting crossing • From 2 or more lanes, with pedestrian phase on conflicting crossing	**3** **12** **0** **12**
A4. No Left Turn Conflict (e.g., "T" intersections, one-way streets, exclusive pedestrian phase)	**15**
B. Right Turn Conflicts (Right Turns into Pedestrian Crossing Path) (See Figure 1, page 4)	
B1. Rights on GREEN BALL Only (permissive phase) • From SHARED Thru-Right lane, no pedestrian phase on conflicting crossing • From SHARED Thru-Right lane, with pedestrian phase at crossing • From SINGLE Right lane, no pedestrian phase on conflicting crossing • From SINGLE Right lane, with pedestrian phase on conflicting crossing • From 2 or more Right lanes, no pedestrian phase on conflicting crossing • From 2 or more Right lanes, with pedestrian phase on conflicting crossing	**0** **0** **0** **0** **-10** **-7**
B2. Rights on GREEN ARROW & GREEN BALL (overlap phase) • From RIGHT turn lane(s), no pedestrian phase on conflicting crossing • From RIGHT turn lane(s), with pedestrian phase (no conflict for duration of the Green Arrow)	**-7** **0**
B3. Rights on GREEN ARROW Only (protected phase) • From SINGLE Right lane, no pedestrian phase • From SINGLE Right lane, with pedestrian phase – turning traffic held for pedestrian movement, which eliminates turning/crossing conflict • From 2 or more Right lanes, no pedestrian phase • From 2 or more Right lanes, with pedestrian phase – turning traffic held for pedestrian movement, which eliminates turning/crossing conflict	**-10** **10** **-15** **10**
B4. No Right Turn Conflict (e.g., "T" intersections, one-way streets, exclusive pedestrian phase)	**15**

TABLE 3. PEDESTRIAN LOS: Signal Phasing & Timing Features

	Points
C. Pedestrian Phase Signal Display (if present)	
C1. UPRAISED HAND, WALKING PERSON display	**0**
C2. UPRAISED HAND, WALKING PERSON display – with LEADING pedestrian phase (pedestrians start crossing seconds before vehicles on the adjacent street)	**4**
C3. COUNTDOWN display (crossing time is shown)	
With pedestrian crossing time based on following walk speeds:	
> 3.5 ft/sec	**4**
≤ 3.5 ft/sec	**6**
C4. LEADING COUNTDOWN display (pedestrians start crossing seconds before vehicles on the adjacent street)	
With pedestrian crossing time based on following walk speeds:	
> 3.5 ft/sec	**6**
≤ 3.5 ft/sec	**8**

TABLE 4. PEDESTRIAN LOS: Corner Radius
(see Figure 1, page 4)

	Points
A. Radius ≤ to 20’	**10**
B. Radius > 20’ and ≤ 30’	**5**
C. Radius > 30’ and ≤ 40’	**0**
D. Radius > 40’ and ≤ 60’ (or Equivalent Compound Curve)	**-5**
E. Radius > 60’ (or Equivalent Compound Curve) – with radii this large, there is typically enough space to provide a raised pedestrian refuge island (~100 square feet or more in size).	
E1. NO CURBED corner CHANNEL ISLAND provided for pedestrian refuge	
E1a. Right turns can be made on GREEN BALL	**-10**
E1b. Right turns made on GREEN ARROW Only	**-3**
E2. STANDARD Slip Lane – with curbed island suitable for pedestrian refuge (see Figure 2A, page 4)	
E2a. Turning roadway uncontrolled (free flow right turns)	**-10**
E2b. Turning roadway (one lane) under yield control	**0**
E2c. Turning roadway (one lane) under GREEN ARROW Only signal control	**10**
E2d. Turning roadway (two lanes) under GREEN ARROW Only signal control	**10**
F. MODIFIED Slip Lane – with curbed island serving as pedestrian refuge (see Figure 2B, page 4)	
F1. Turning roadway (one lane) under yield control	**5**
F2. Turning roadway (one lane) under GREEN ARROW Only signal control	**10**
F3. Turning roadway (two lanes) under GREEN ARROW Only signal control	**10**
G. No Corner Radius (e.g., “T” intersection crossing with no right turn conflict)	**12**

TABLE 5. PEDESTRIAN LOS: Right-Turns-On-Red

	Points
Allowed	**0**
Prohibited (or no conflict because right turns are not permitted/possible)	**5**

Table 6. PEDESTRIAN LOS: Crosswalk Treatment

	Points
No designated crosswalk	**0**
Painted crosswalk	
- Transverse markings (marking perpendicular to traffic flow)	**3**
- Diagonal/Longitudinal LADDER type markings (parallel to traffic flow)	**5**
Textured/Colored	**5**

Table 7. PEDESTRIAN LOS: Adjustment for Traffic Flow Direction

	Points
Pedestrian Crossing of two-way street	**0**
Pedestrian Crossing of one-way streets (see Figure 3, page 5)	
A. Applies to the departure leg crossing of a one-way street with 3 or more lanes that intersects with a two-way street (with pedestrians exposed to both left & right turn vehicle conflicts for the *entire* crossing distance) and left turns occur on permitted phase (Green Ball).	**-10**
B. Applies to the departure leg crossing of a one-way street with 3 or more lanes that intersects with a two-way street (with pedestrians exposed to both left & right turn vehicle conflicts for the *entire* crossing distance), however, the left turn conflict is minimized by a Protected/Prohibited left turn phase (Green Arrow only) on adjacent street, and the pedestrian crossing is controlled by pedestrian signals	**-3**

TABLE 8. Point Totals and Corresponding PEDESTRIAN Level of Service

Points	LOS
93+	A
74 - 92	B
55 - 73	C
37 - 54	D
19 - 36	E
0 - 18	F

BICYCLE LEVEL OF SERVICE CALCULATION

TABLE 9. BICYCLE LOS: Signal Phasing & Timing Features

	Points
Bicycle Phase	
No leading bicycle phase	**0**
Leading bicycle phase (cyclists given green seconds before other traffic – requires bike signal display, bike lane & bike detection)	**12**
Signal Timing	
Minimum green & clearance (yellow) time based on automobile speeds	**0**
Minimum green & clearance (yellow) time based on bicycle speeds	**6**
Stop Bar Location	
Shared stop bar - automobiles & bikes stop at common point	**0**
Advanced stop bar or bike box – bikes stop closer to intersection than automobiles	**10**
Vehicular Left Turn Phase – turns opposing cyclists (see Figure 4, page 6)	
None	**0**
Leading Protected/Permissive	**6**
Protected/Prohibited	**12**
No Left Turn Conflict (e.g., "T" intersection, one-way streets)	**15**

TABLE 10. BICYCLE LOS: Bike Space within the Roadway

Approach Leg	Departure Leg	Points
Ride in Auto Travel Lane (12' wide or less)		
	Auto travel lane	**0**
	Widened outside lane	**5**
	Bike lane or shoulder (4' minimum)	**10**
Ride in Widened Outside Lane (travel in lane 13' to 14')		
	Auto travel lane	**5**
	Widened outside lane	**12**
	Bike lane or shoulder (4' minimum)	**25**
Ride in Bike Lane or Shoulder (4' minimum)		
	Auto travel lane	**10**
	Widened outside lane	**15**
	Bike lane or shoulder (4' minimum)	**30**

TABLE 11. BICYCLE LOS: Treatment of Right Turn Conflicts

	Points
No Right Turn Conflict (e.g., "T" intersection, one-way street)	**15**
No Separate Right Turn Lane	**0**
Separate Right Turn Lane (see Figure 5, page 7)	
With bike lane LEFT of right turn lane (cyclist travels straight ahead and motorist merges right) – see Figure 5A	**5**
No bike lane (cyclist travels straight ahead and motorist merges right) – see Figure 5B	**-5**
Curb lane drops as right turn lane, with bike lane left of turn lane (cyclist merges left) – see Figure 5C	**-10**
Curb lane drops as right turn lane, no bike lane at intersection (cyclist merges left) – see Figure 5D	**-15**
Bike lane RIGHT of right turn lane – see Figure 5E	**-25**

TABLE 12. BICYCLE LOS: Speed Limit of Adjacent Traffic

		Points
High Speed	(› 40 miles per hour)	**-15**
Moderate Speed	(30 – 35 miles per hour)	**0**
Low Speed	(‹ 30 miles per hour)	**20**

TABLE 13. BICYCLE LOS: Right-Turns-On-Red

	Points
Allowed	**0**
Prohibited (or no conflict because right turns are not permitted/possible)	**5**

TABLE 14. BICYCLE LOS: Intersection Crossing Distance

		Points
	≤ 3 motor vehicle travel lanes	**10**
	4 to 5 motor vehicle travel lanes	**5**
	≥ 6 travel motor vehicle lanes	**0**

TABLE 15. Point Totals and Corresponding BICYCLE Level of Service

Points	LOS
93+	A
74 - 92	B
55 - 73	C
37 - 54	D
19 - 36	E
0 - 18	F

Intersection Example # 1 of the Applied Methodologies

Application of the pedestrian and bicycle level of service methodologies for an example intersection is presented in Figures 1 and 2. The intersection evaluated is that of a one-way street (4th Street) and a two-way street (McDowell Street) in downtown Charlotte. The sample worksheets in figures 1 and 2 provide information on features relevant to the intersection.

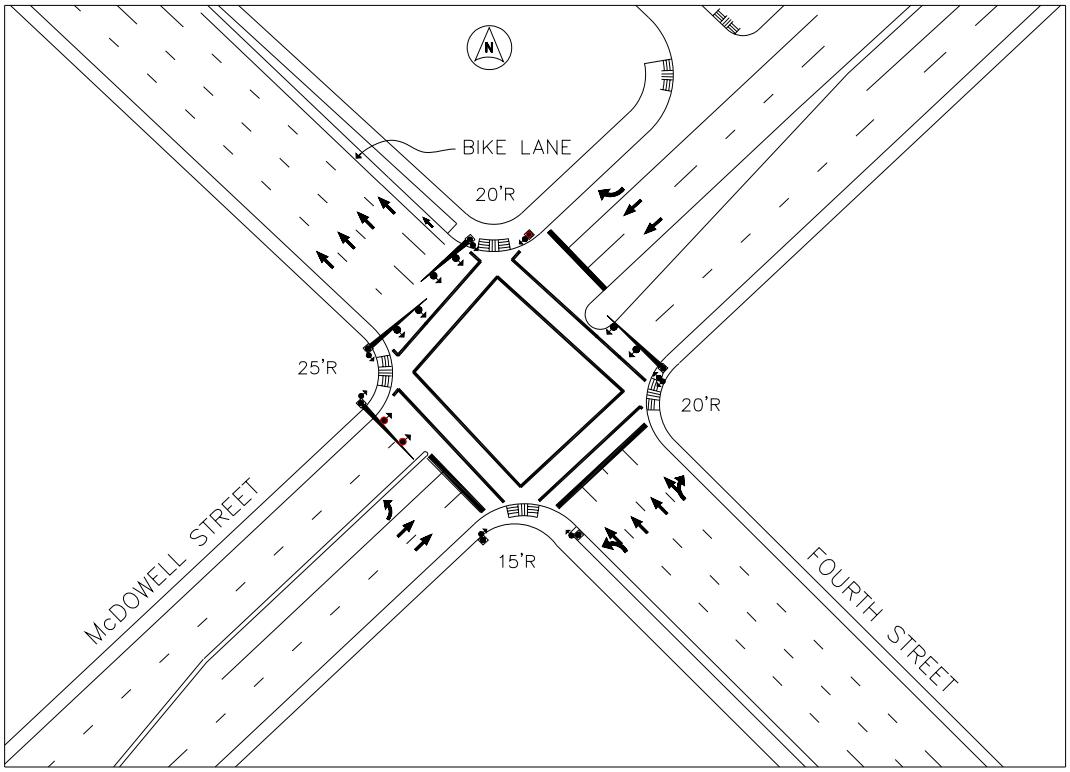


Figure 6. Example Intersection #1: Pedestrian LOS Calculation

Location: 4th Street & McDowell Street

	Crossing of Northbound Approach (McDowell St.)	Crossing of Westbound Approach (4th St.)	Crossing of Southbound Approach (McDowell St.)	Crossing of Eastbound Approach (4th St.)
Pedestrian Crossing Distance	5 Lanes (2' median)	4 Lanes	5 Lanes (10' median)	4 Lanes
Score	**34**	**45**	**40**	**45**
Corner Radius	25'	15'	20'	20'
Score	**5**	**10**	**10**	**10**
Signal Features				
Left Turn Conflict (left turns into pedestrian path)	Lefts on Green Ball Only, from a single lane – with pedestrian phase	No left turn conflict - (4th St. one-way)	No left turn conflict – (4th St. one-way)	Lefts on Green Arrow/Green Ball - with pedestrian phasing
Score	**4**	**15**	**15**	**4**
Right Turn Conflict (right turns into pedestrian path)	No right turn traffic conflict (4th St. one-way)	No right turn traffic conflict (4th St. one-way)	Right turns on Green Ball, from a shared thru-right lane - with pedestrian phase	Right turns on Green Ball, from separate right lane – with pedestrian phase
Score	**15**	**15**	**0**	**0**
Pedestrian Signal Display	Countdown display (4 ft/sec)	Countdown display (4 ft/sec)	Countdown display (4 ft/sec)	Countdown display (4 ft/sec)
Score	**4**	**4**	**4**	**4**
Right-Turns-On-Red	No conflict – (4th St. one-way)	Allowed	Not Allowed	No conflict – (4th St. one-way)
Score	**5**	**0**	**5**	**5**
Crosswalks	Painted Transverse (markings perpendicular to traffic flow)	Painted Transverse (markings perpendicular to traffic flow)	Painted Transverse (markings perpendicular to traffic flow)	Painted Transverse (markings perpendicular to traffic flow)
Score	**3**	**3**	**3**	**3**
Traffic Flow Direction	Two-way street	Multilane one-way street, no left and right turn conflicts	Two-way street	Departure leg crossing of one-way street (4 lanes) with left and right turn conflicts)
Score	**--**	**--**	**--**	**-10**
Approach Total	**70**	**92**	**77**	**61**
Approach LOS	**C**	**A**	**B**	**C**
Intersection AVG.	**75**			
INTERSECTION LOS	**B**			

Figure 7. Example Intersection #1: Bicycle LOS Calculation

Location: 4th Street & McDowell Street

	Northbound Approach (McDowell St.)	Eastbound Approach (4th St.)	Southbound Approach (McDowell St.)	Westbound Approach (4th St.)
Signal Phasing/Timing Features	No leading bicycle phase	*Not Applicable (One-way street)*	No leading bicycle phase	No leading bicycle phase
Bicycle Phase				
Score	**0**		**0**	**0**
Signal Timing	Based on automobile speeds		Based on automobile speeds	Based on automobile speeds
Score	**0**		**0**	**0**
Opposing Vehicular Left Turn Phases	No left turn conflict		Protected/Permissive	No left turn conflict
Score	**15**		**6**	**15**
Stop Bar Placement	Vehicles & bikes stop at same point		Vehicles & bikes stop at same point	Vehicles & bikes stop at same point
Score	**0**		**0**	**0**
Bikeway Space on Street	Auto Travel Lane to Auto Travel Lane: 12' outside lane		Auto Travel Lane to Auto Travel Lane: 12' outside lane	Auto Travel Lane to Bike Lane: 12' outside lane to 4' bike lane
Approach/Departure Leg				
Score	**0**		**0**	**10**
Right Turning Traffic Conflict	No right turn conflict (intersects with one-way street)		Separate right turn lane - no bike lane	Shared thru-right lane - no bike lane
Shared Traffic Lane/Separate Right Turn Traffic Lane				
Score	**15**		**-5**	**0**
Speed Limit of Intersection Approach	35 MPH		35 MPH	30 MPH
Score	**0**		**0**	**0**
Right-Turn-On-Red	Allowed		No right turn conflict (intersects with one-way street)	Allowed
Score	**0**		**5**	**0**
Intersection Crossing Distance	4 travel lanes		4 travel lanes	5 travel lanes
Score	**5**		**5**	**5**
Approach Total	**35**		**11**	**30**
Approach LOS	**E**		**F**	**E**
Intersection AVG.	**25**			
Intersection LOS	**E**			

Intersection Example # 2 of the Applied Methodologies

A second application of the pedestrian level of service methodology is presented in Figure 3. This example illustrates how the methodology should be applied for slip lane or channel island designs. The sample worksheet in figure 3 provides information on features relevant to the intersection.

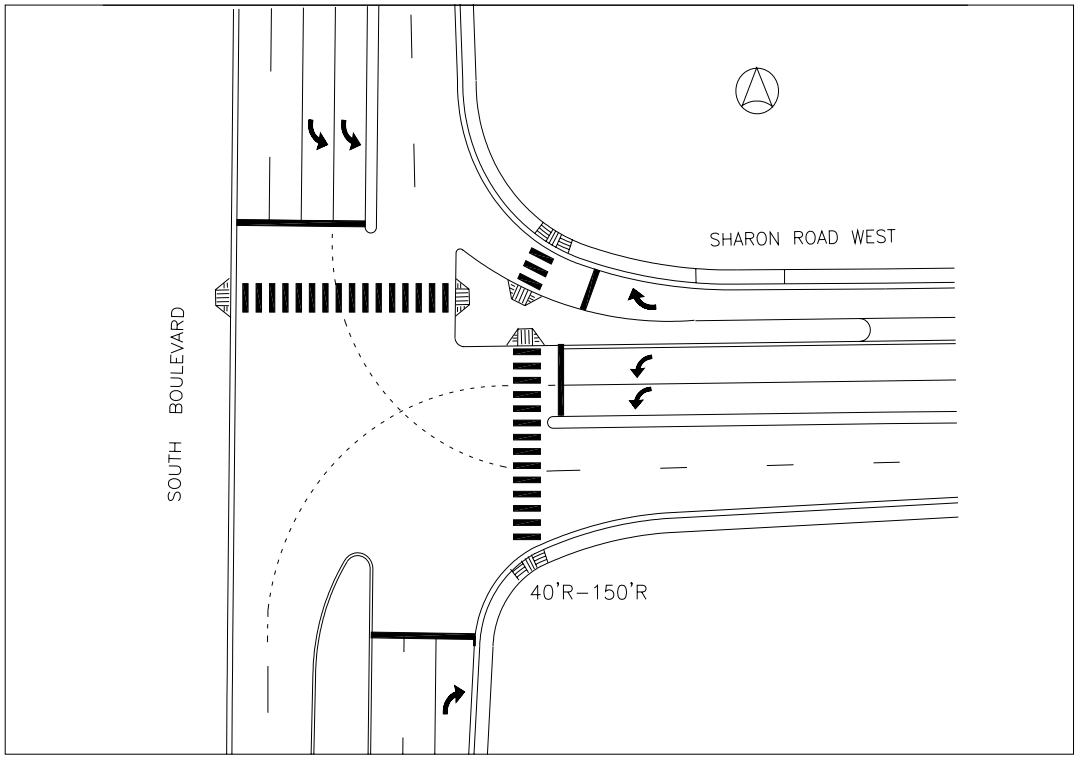


Figure 8. Example Intersection #2: Pedestrian LOS Calculation

Location: South Boulevard & Sharon Road West (Alternative Design)

	Crossing of Northbound Approach (South Boulevard.)	Crossing of Westbound Approach (Sharon West)	Crossing of Southbound Approach (South Boulevard.)	Crossing of Eastbound Approach (No Street Crossing)
Pedestrian Crossing Distance	5 Lanes (12' median)	5 Lanes Total 4 + 1 slip lane (4' median)	7 Lanes Total 6 + 1 slip lane (4' median)	----
Score	**40**	45 (for 4 lanes) – 6 (for slip lane)= **39**	26 (for 6 lanes) – 6 (for slip lane) = **20**	----
Corner Radius	T intersection: No conflicting right turns	40'-150' Compound curve equivalent to 50' radius	Slip Lane Island, traffic under Green Arrow signal control	----
Score	**12**	**-5**	**10**	
Signal Features				
Left Turn Conflict (left turns into pedestrian path)	Lefts on Green Arrow Only, from two lanes – no pedestrian phase	Lefts on Green Arrow Only, from two lanes – with pedestrian phase	No left turn conflict	----
Score	**0**	**12**	**15**	
Right Turn Conflict (right turns into pedestrian path)	No right turn traffic conflict	Right turns on Green Arrow /Green Ball, from separate right lane – with pedestrian phase	Rights on Green Arrow Only, from single lane, with pedestrian phase	----
Score	**15**	**0**	**10**	
Pedestrian Signal Display	No Pedestrian Signals	Countdown displays (3.5 ft/sec)	Countdown displays (3.5 ft/sec)	----
Score	**0**	**6**	**6**	
Right-Turns-On-Red	Allowed	Prohibited	No Turn Conflict	----
Score	**0**	**5**	**5**	
Crosswalks	No Designated Crossing	Painted Longitudinal Markings (Ladder Style)	Painted Longitudinal Markings (Ladder Style)	----
Score	**0**	**5**	**5**	
Traffic Flow Direction	Two-way street	Two-way street	Two-way street	
Score	--	--	--	---
Approach Total	**67**	**62**	**71**	---
Approach LOS	**C**	**C**	**C**	---
Intersection AVG.	**66**			
INTERSECTION LOS	**C**			