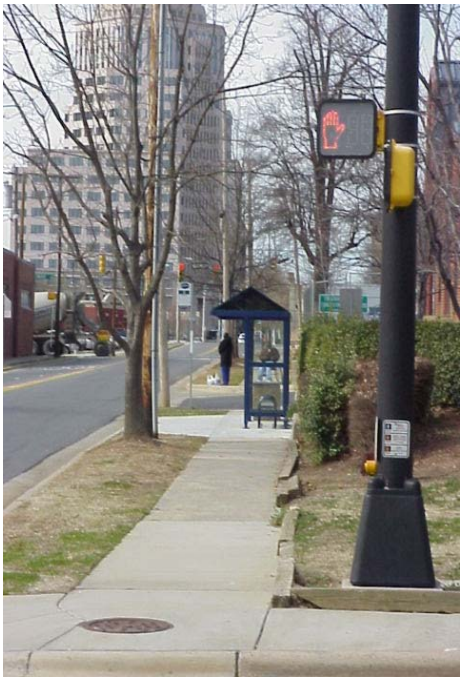
Connecting Charlotte

Charlotte Department of Transportation

PEDESTRIAN & BICYCLE LEVEL OF SERVICE

METHODOLOGY FOR CROSSINGS AT SIGNALIZED INTERSECTIONS

Updated February 2007



CONTENTS

Introduction …… p 3
Signal Features and Pedestrian Level of Service ……... p 3
Signal Features and Bicycle Level of Service …… p 6
Pedestrian and Bicycle Level of Service Determination …… p 9
Summary …… p 9
Pedestrian Level of Service Calculation Tables …… p 11
Bicycle Level of Service Calculation Tables …… p 16
Intersection Example #1 ……..…….. p 19
Intersection Example #2 ……..…….. p 22

TABLES AND FIGURES

Table 1 Pedestrian LOS: Crossing Distance ……. p 11
Table 2 Pedestrian LOS: Signal Phasing & Timing Features ……... p 12, 13
Table 3 Pedestrian LOS: Corner Radius ……... p 14
Table 4 Pedestrian LOS: Right Turns On Red ……. p 15
Table 5 Pedestrian LOS: Crosswalk Treatment …… p 15
Table 6 Pedestrian LOS: Adjustment for One-Way Street Crossings ….. p 15
Table 7 Point Totals and Corresponding Pedestrian Level of Service …. p 15

Table 8 Bicycle LOS: Bicycle Travel Way & Speed of Adjacent Traffic p 16, 17
Table 9 Bicycle LOS: Signal Features – Left Turns & Stop Bar Location p 17
Table 10 Bicycle LOS: Right Turn Traffic Conflict ……..……... p 18
Table 11 Bicycle LOS: Right Turns On Red ……. p 18
Table 12 Bicycle LOS: Intersection Crossing Distance ……. p 18
Table 13 Point Totals and Corresponding Bicycle Level of Service ……. p 18

Figure 1 Pedestrian Crossing Conflicts ……. p 5
Figure 2 Corner Channel Island Designs …….. p 5
Figure 3 Adjustment for One-Way Streets … …….. p 6
Figure 4 Bicycle Crossing Conflicts ……. p 7
Figure 5 Bike Treatments at Exclusive Right Turn Lanes ..…….. p 8
Figure 6 Example Intersection #1: Pedestrian LOS Calculation …….. p 20
Figure 7 Example Intersection #1: Bicycle LOS Calculation …….. p 21
Figure 8 Example Intersection #2: Pedestrian LOS Calculation ……. p 23

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. 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 B, exclusive of any other features. By contrast, a crossing of eight 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 14' 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. For example, the departure leg of an intersection is 20' wide and unmarked. In this case, the departure leg can be considered as two travel lanes to be crossed instead of one.

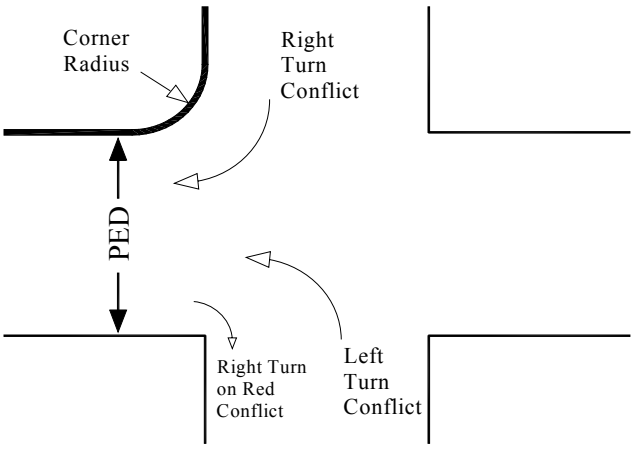
Signal Phasing & Timing (Table 2) – This is the most intricate of the design parameters and second most important in terms of points. It is rated according to the type and level of crossing information provided to the pedestrian and whether the signal phasing minimizes, eliminates or exacerbates conflicts 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.

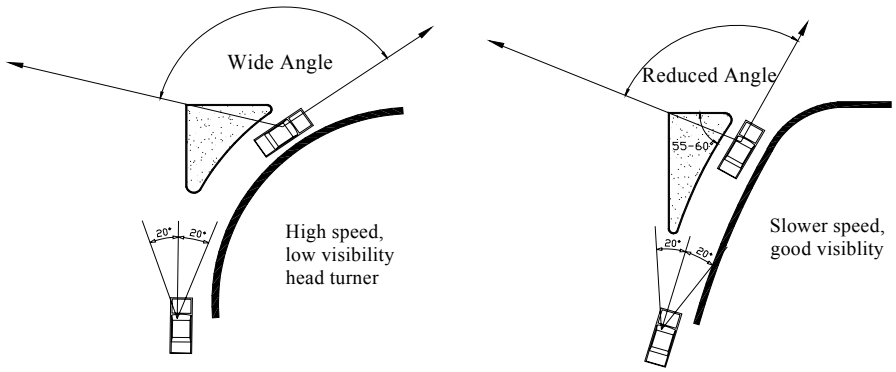
Points can also be attained by the use of pedestrian signals, provided vehicle conflicts are reduced and/or information is given by the signal that shows pedestrians how much time is available for them to cross the street (e.g., countdown signals). Additional points can be obtained within this subcategory 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 3) – 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



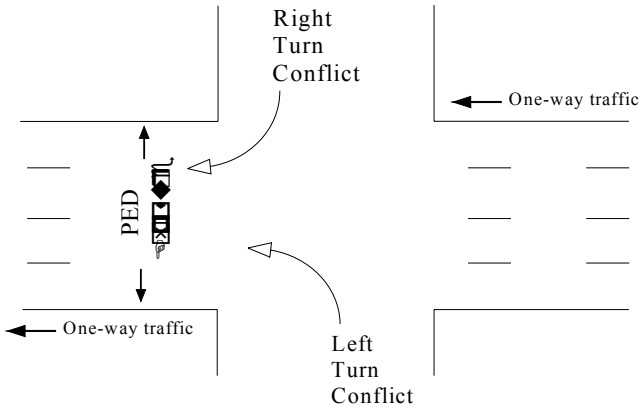
(A) Standard slip lane design (B) Modified slip lane design

Right Turns On Red (Table 4) – Prohibiting right-turns-on-red eliminates a possible conflict between pedestrians and motorists. The Right-Turns-On-Red and Crosswalk (below) features each account for about 5% of the possible points.

Crosswalk Treatment (Table 5) - The presence of and design features of crosswalks are both rated. Crosswalks help raise awareness to motorists of the possibility of pedestrians crossing the street. Enhanced crosswalks (e.g., textured/colored pavement or ladder style pavement markings) are more visible than simple transverse markings, and therefore are rated better.

Adjustment for One-Way Street Crossings (Table 6) – 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 One-Way Streets



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 apart from automobile traffic. Because bicyclists share space with and travel alongside motor vehicles, the speed of traffic is also a significant 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

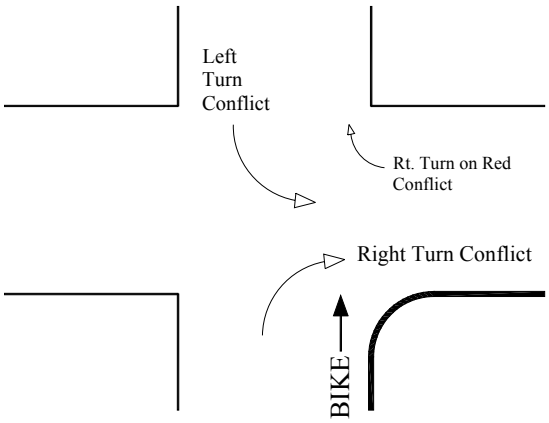
Bicycle Travel Way & Speed of Adjacent Traffic (Table 8) – Where bicyclists travel within the roadway and how fast motor vehicle traffic is moving next to them is the most important factor in accessing their comfort and safety.

For streets with moderate to high traffic speeds (30 mph or more), travel space beyond that provided for general traffic is highly desirable. This extra space may be in the form of separate bicycle lanes, or in the form of wide outside travel lanes (13' to 14'). Bicycle lanes rate best and are the preferred treatment. Conditions requiring bicyclists to share travel lanes with motorists rate poorly.

Bike lanes and wide outside lanes, on the other hand, do not provide as much benefit on low speed streets (less than 30 mph) because cyclists can better match the speed of adjacent traffic. Also, low speed streets generally carry low traffic volumes, which many cyclists prefer.

Signal Features – Left Turn Phasing & Stop Bar Location (Table 9) – Features that remove potential left turn conflicts from the path of bicyclists and features that place bicyclists before motorists (in space) are rated as desirable. Signal phasing and stop location rate as the second most important bicycle feature.

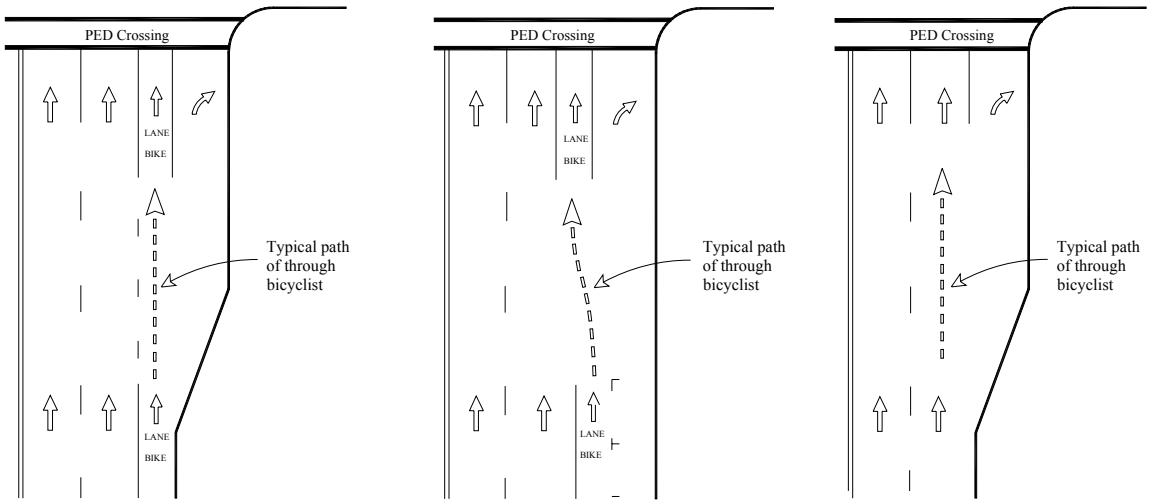
Figure 4. Bicycle Crossing Conflicts



Right Turn Traffic Conflict (Table 10) – 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 (Figure 5), 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.

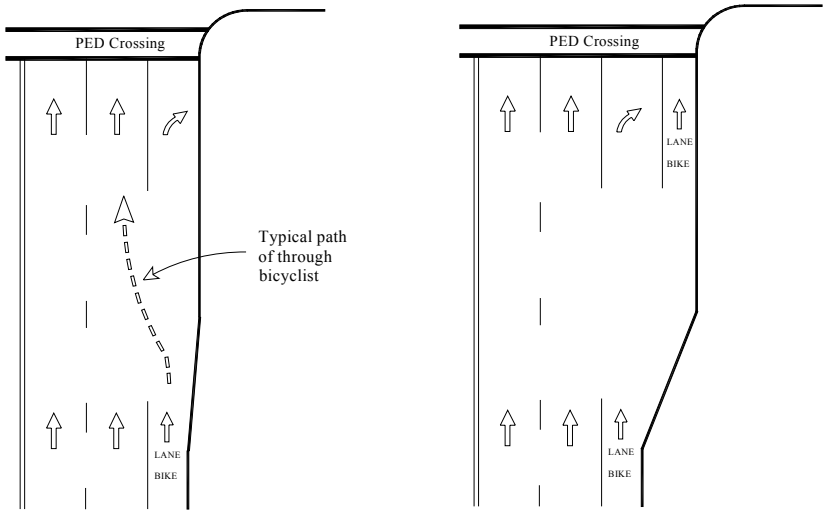
Figure 5. Bike Treatments at Exclusive Right Turn Lanes



(A) Straight alignment - Cyclists travel straight and turning motorists yield to cyclists (BEST CONDITION)

(B) Alignment shift - Cyclists merge left and turning motorists merge right

(C) No bike lane - Cyclists share lane with motorists



(D) Bike lane ends - cyclists shift into motor vehicle lane

(E) Bike lane right of turn lane (BAD CONDITION)

Right Turns On Red (Table 11) - 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 12) – Wide street crossings increase the risk of exposure to bicyclists from motor vehicle traffic on cross-streets. Signal clearance times (the yellow and all-red signal phase portions) are timed for motor vehicle speeds and not the slower speeds of bicyclists; therefore, the wider the intersection, the greater the likelihood that cyclists will still be crossing when right-of-way changes to the cross-street.

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 and should be considered in intersection design. 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.

PEDESTRIAN AND BICYCLE LOS DETERMINATION

Level of service for an intersection crossing/approach is determined by adding points from Tables 1 through 6 (for Pedestrians) and points from Tables 8 through 12 (for Bicyclists). The accumulation of points is then compared to the points listed in Tables 7 (Pedestrians) and 13 (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 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. These other elements and their importance on creating a pedestrian and bicycle friendly environment are addressed through initiatives such as the Urban Street Design Guidelines

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 typically 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.

The following pages provide additional detail of the pedestrian and bicycle level of service methodologies, along with example level of service calculations. As a companion piece to this document, Charlotte DOT has also developed an electronic spreadsheet that can be used to quickly calculate levels of service. The spreadsheet should be used when performing level of service calculations.

PEDESTRIAN LEVEL OF SERVICE CALCULATION

TABLE 1. PEDESTRIAN LOS: Crossing Distance

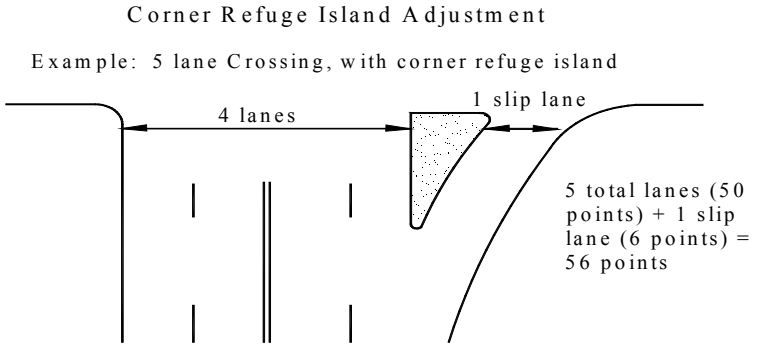
Crossing distance is determined based on the total number of motor vehicle travel lanes that must be crossed to reach the opposite side of the street. The added effect of corner radii on crossing distance is addressed in parameter number 3 (Corner Radius). When the number of travel lanes crossed includes 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		
Total Travel Lanes Crossed	**No Median Refuge (or less than 4')**	**Median Refuge (4' to 6')**	**Median Refuge (6' or more)**
2 Lanes	**80**	**80**	**80**
3 Lanes	**78**	**78**	**78**
4 Lanes	**65**	**65**	**68**
5 Lanes	**50**	**52**	**55**
6 Lanes	**37**	**40**	**44**
7 Lanes	**24**	**28**	**33**
8 Lanes	**8**	**12**	**20**
9 Lanes	**-5**	**0**	**10**
10 Lanes	**-15**	**-10**	**0**

Corner Refuge Island Adjustments:

- 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. Refuge lane points are added to the points assigned for the total crossing distance from Table 1 above.

  Example: A crossing of 5 lanes (one of which is a refuge island lane) is adjusted as follows: 50 points (based on 5 lanes crossed) + 6 points (for refuge island lane) = 56 points.



- Adjustments are also made based on how slip lane traffic is controlled at the intersection. If slip lane traffic is under signal control then 5 points are added to the crossing total. If traffic is under Yield control then 3 points are subtracted from the crossing total, and if traffic is uncontrolled (i.e., free flow) then 20 points are subtracted.

TABLE 2. PEDESTRIAN LOS: Signal Phasing & Timing Features

Pedestrian Crossing Conflicts

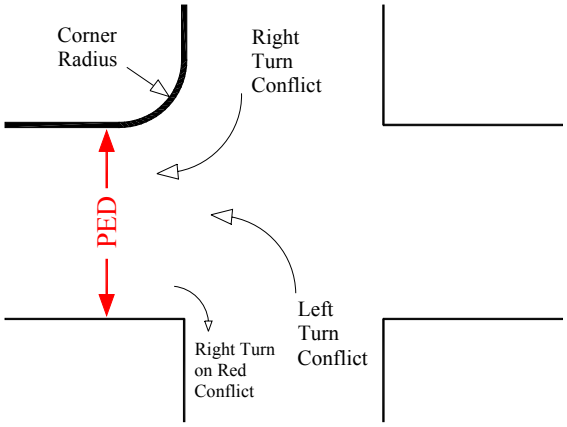


Table 2A **Left Turn Conflicts (Left Turns into Pedestrian Crossing Path)**	**Points**
A1. Lefts on GREEN BALL Only (permissive phase - left turns unprotected) • From SINGLE lane, no pedestrian phase on conflicting crossing • From SINGLE lane, with pedestrian phase on conflicting crossing • From 2 or more lanes, no pedestrian phase on conflicting crossing • From 2 or more lanes, with pedestrian phase on conflicting crossing	 **-5** **0** **-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** **0**
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	 **5** **15** **0** **15**
A4. No Left Turn Conflict (e.g., "T" intersections, one-way streets, exclusive pedestrian phase)	**15**

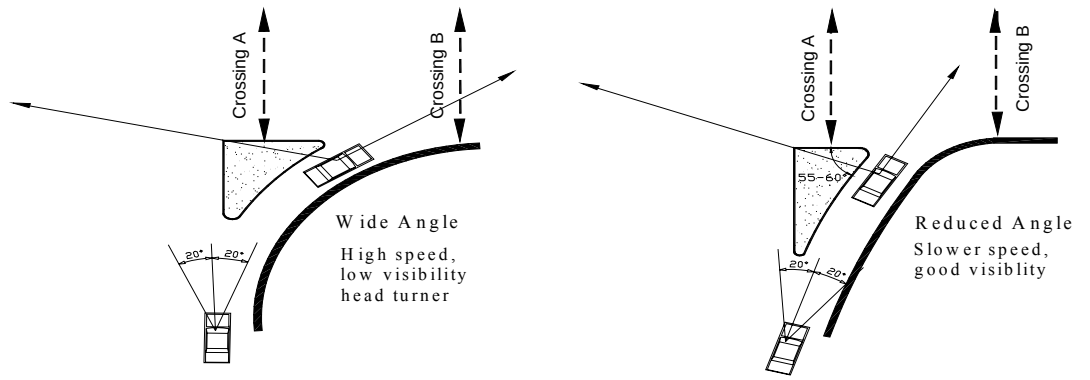
Table 2B **Right Turn Conflicts (Right Turns into Pedestrian Crossing Path)**	**Points**
B1. Rights on GREEN BALL Only (permissive phase)	
• From SHARED Thru-Right lane, no pedestrian phase on conflicting crossing	**0**
• From SHARED Thru-Right lane, with pedestrian phase at crossing	**0**
• From SINGLE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

TABLE 2C **Pedestrian Phase Signal Display**	
C1. No Pedestrian Phase	**-5**
C2. UPRAISED HAND, WALKING PERSON display	**0**
C3. UPRAISED HAND, WALKING PERSON display – with LEADING pedestrian phase (pedestrians start crossing seconds before vehicles on the adjacent street)	**4**
C4. COUNTDOWN display (crossing time is shown) With pedestrian crossing time based on following walk speeds:	
> 3.5 ft/sec	**5**
≤ 3.5 ft/sec	**8**
C5. 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 ≤ 3.5 ft/sec	 **8** **12**

TABLE 3. PEDESTRIAN LOS: Corner Radius

Standard Radius	**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)	**-10**
E. Radius > 60’ (or Equivalent Compound Curve)	**-15**



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

CHANNEL ISLAND (in lieu of standard radius)	
F. Painted Channel Island (no curb)	
- Right turns are uncontrolled (free flow)	**-20**
- Right turns made on Yield or Signal Control	**-10**
G. Curbed Channel Island (Figure A)	
- Right turns are uncontrolled (free flow)	**-20**
- Right turns on Yield, Green Ball or Green Arrow/Green Ball	
(& Pedestrian crossing at location B)	**-10**
(& Pedestrian crossing at location A)	**0**
- Right turns on Green Arrow Only	
(& Pedestrian crossing at location B)	**0**
(& Pedestrian crossing at location A)	**5**
H. Curbed Low Speed Design Slip Lane (Figure B)	
- Right turns on Yield, Green Ball or Green Arrow/Green Ball	
(& Pedestrian crossing at location B)	**0**
(& Pedestrian crossing at location A)	**5**
- Right turns on Green Arrow Only	
(& Pedestrian crossing at location B)	**5**
(& Pedestrian crossing at location A)	**10**

I. No Corner Radius (e.g., "T" intersection)	**10**

TABLE 4. PEDESTRIAN LOS: Right Turns On Red

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

Table 5. PEDESTRIAN LOS: Crosswalk Treatment

No designated crosswalk	**-5**
Painted crosswalk	
- Transverse markings (Type A)	**0**
- LADDER type markings (Type B)	**5**
Textured/Colored Pavement	**5**

Crosswalk Types

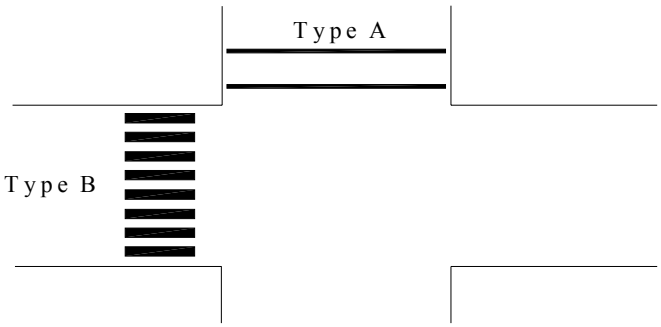


Table 6. PEDESTRIAN LOS: Adjustment for One-Way Street Crossings

Applies only to the departure leg of a one way street with 4 or more lanes that intersects a two-way street. (Figure 3, page 6)	
Conflicting left turns made on:	
• Green Ball Only (with or without pedestrian phase)	**-10**
• Green Arrow/Green Ball (with or without pedestrian phase)	**-10**
• Green Arrow Only (without pedestrian phase)	**-5**
• Green Arrow Only (with pedestrian phase)	**-2**
• Condition does not apply	**0**

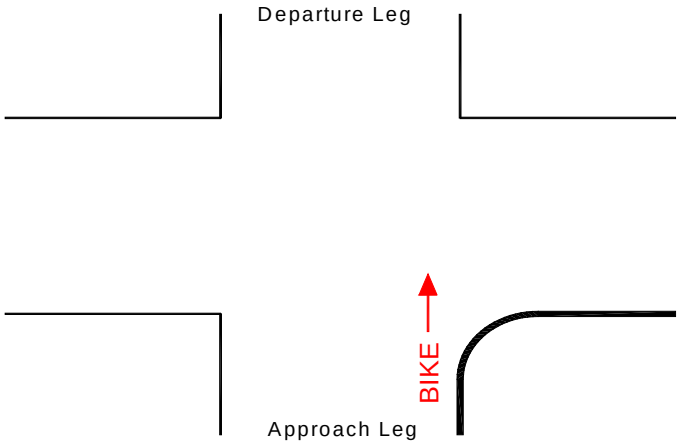
TABLE 7. Point Totals and Corresponding PEDESTRIAN Level of Service

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 8. BICYCLE LOS*:* Bicycle Travel Way & Speed of Adjacent Traffic



Bike Travels in: (Approach/Departure Legs)	Speed Limit	Points
• **Shared Auto Lane to Shared Auto Lane** (lanes ≤ 12' wide)	≥ 40 mph	5
	30 to 35 mph	30
	‹ 30 mph	50
• **Shared Auto Lane to Wide Curb Lane** (13' to 14' wide)	≥ 40 mph	20
	30 to 35 mph	40
	‹ 30 mph	55
• **Shared Auto Lane to Bike Lane**	≥ 40 mph	35
	30 to 35 mph	50
	‹ 30 mph	60
• **Shared Wide Curb Lane To Shared Auto Lane**	≥ 40 mph	15
	30 to 35 mph	35
	‹ 30 mph	50
• **Shared Wide Curb Lane to Wide Curb Lane** (13' to 14' wide)	≥ 40 mph	30
	30 to 35 mph	50

	‹ 30 mph	60
• **Shared Wide Curb Lane to Bike Lane**	≥ 40 mph	45
	30 to 35 mph	60
	‹ 30 mph	70

TABLE 8 (continued)

Bike Travels in: (Approach/Departure Legs)	Speed Limit	Points
• **Bike Lane to Shared Auto Lane** (lanes ≤ 12' wide)	≥ 40 mph	30
	30 to 35 mph	45
	‹ 30 mph	55
• **Bike Lane to Wide Curb Lane** (13' to 14' wide)	≥ 40 mph	40
	30 to 35 mph	55
	‹ 30 mph	65
• **Bike Lane to Bike Lane**	≥ 40 mph	60
	30 to 35 mph	70
	‹ 30 mph	80

TABLE 9. BICYCLE LOS: Signal Features – Left Turn Phasing & Stop Bar Location

Vehicular Left Turn Phase – turns opposing cyclists (Figure 4, page 7)	**Points**
Made on Green Ball Only	**0**
Made on Green Ball/Green Arrow	**5**
Made on Green Arrow Only	**15**
No Left Turn Conflict (e.g., "T" intersection, one-way streets)	**15**
Stop Bar Location	
Shared stop bar - automobiles & bikes stop at common point	**0**
Advanced stop bar – bikes stop closer to intersection than automobiles	**10**

Bicycle Crossing Conflicts

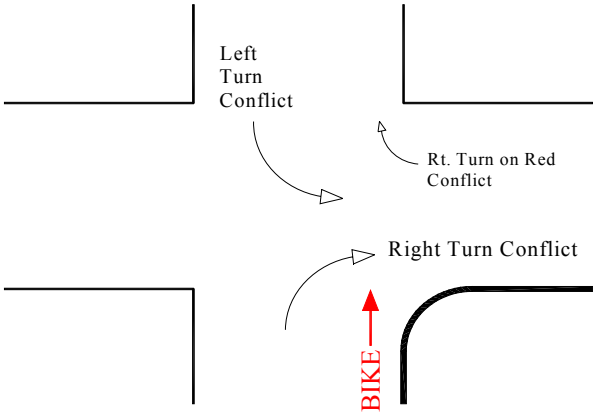


TABLE 10. BICYCLE LOS: Right Turn Traffic Conflict

	Points
No Right Turn Conflict (e.g., "T" intersection, one-way street)	**15**
No Separate Right Turn Lane (Bike in Shared Lane)	**0**
Separate Right Turn Lane (Figure 5, page 8)	
Bike lane LEFT of right turn lane (cyclist travels straight ahead and motorist merges right) – see Figure 5A	**10**
Curb lane drops as right turn lane, with bike lane left of turn lane (cyclist merges left, motorist merges right) – see Figure 5B	**5**
No bike lane (cyclist travels straight ahead and motorist merges right) – see Figure 5C	**0**
Curb lane drops as right turn lane, no bike lane at intersection (cyclist merges left, motorist merges right) – see Figure 5D	**0**
Bike lane RIGHT of right turn lane – see Figure 5E	**-20**

TABLE 11. BICYCLE LOS: Right Turns On Red

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

TABLE 12. BICYCLE LOS: Intersection Crossing Distance

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

TABLE 13. 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

Application of the pedestrian and bicycle level of service methodologies for an example intersection is presented in Figures 6 and 7. 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 6 and 7 provide information on features relevant to the intersection.

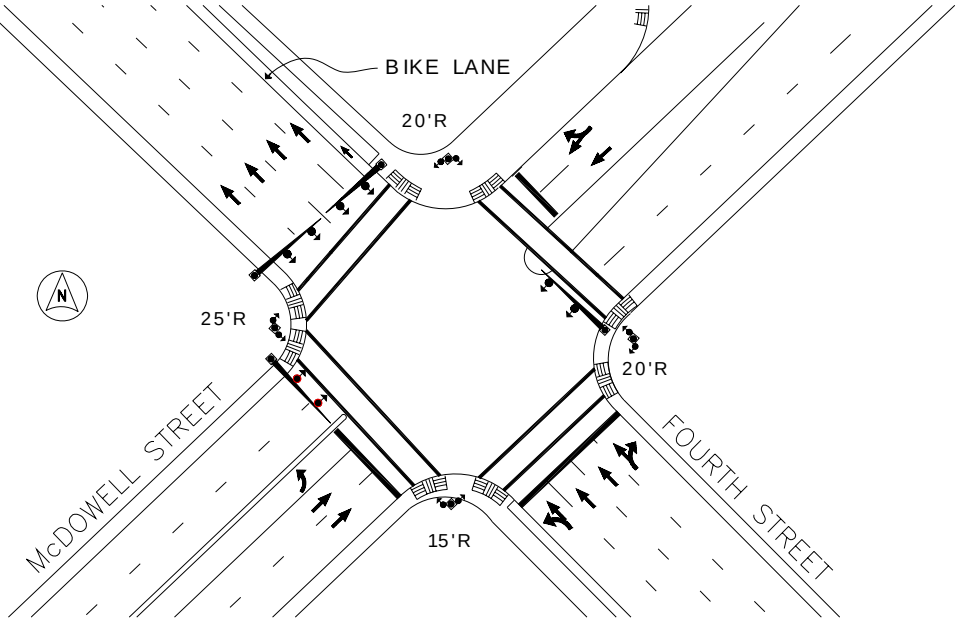


Figure 6. Example Intersection #1: Pedestrian LOS Calculation

Location: 4th Street & McDowell Street

	Crossing of Northbound Approach (McDowell St.)	Crossing of Southbound Approach (McDowell St.)	Crossing of Eastbound Approach (4th St.)	Crossing of Westbound Approach (4th St.)
Pedestrian Crossing Distance	5 Lanes (2' median)	4 Lanes (10' median refuge)	4 Lanes	4 Lanes
Score	**50**	**68**	**65**	**65**
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)	Lefts on Green Arrow/Green Ball - with pedestrian phasing	No Left Turn Conflict - (4th St. one-way)
Score	**0**	**15**	**0**	**15**
Right Turn Conflict (right turns into pedestrian path)	No Right Turn 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 a shared thru-right lane - with pedestrian phase	No Right Turn Conflict (4th St. one-way)
Score	**15**	**0**	**0**	**15**
Pedestrian Signal Display	Countdown Display (4 ft/sec)	Countdown Display (4 ft/sec)	Countdown Display (4 ft/sec)	Countdown Display (4 ft/sec)
Score	**5**	**5**	**5**	**5**

Corner Radius	25'	20’	20'	15'
Score	**5**	**10**	**10**	**10**
Right Turns on Red	No Conflict (4^{th} St. one-way)	Prohibited	No Conflict (4^{th} St. one-way)	Allowed
Score	**5**	**5**	**5**	**0**
Crosswalks	Textured/Colored	Textured/Colored	Textured/Colored	Textured/Colored
Score	**5**	**5**	**5**	**5**
Adjustment for One-Way Street Crossings	Two-Way Street (Not Applicable)	Two-Way Street (Not Applicable)	Departure Leg 4 Lanes Wide, with left and right turn conflicts	Multilane One-Way street, no left and right turn conflicts (Not Applicable)
Score	**--**	**--**	**-10**	**--**
Approach Total	**85**	**108**	**80**	**115**
Approach LOS	**B**	**A**	**B**	**A**
Intersection AVG.	**97**			
INTERSECTION LOS	**A**			

Figure 7. Example Intersection #1: Bicycle LOS Calculation

Location: 4^{th} Street & McDowell Street

	Northbound Approach (McDowell St.)	Southbound Approach (McDowell St.)	Eastbound Approach (4^{th} St.)	Westbound Approach (4^{th} St.)
Bike Travel Way & Speed of Adjacent Traffic	Shared 12’ Lane with Motor Vehicles 35 mph	Shared 12’ Lane with Motor Vehicles 35 mph	Does not Apply	Shared 12’ Lane Transitions to 4’ Bike Lane 35 mph
Score	**30**	**30**		**50**
Signal Features				
Opposing Vehicular Left Turn Phase	No Left Turn Conflict	Green Arrow & Green Ball		No Left Turn Conflict
Score	**15**	**5**		**15**
Stop Bar Location	Vehicles & Bikes Stop at Same Point	Vehicles & Bikes Stop at Same Point		Vehicles & Bikes Stop at Same Point
Score	**0**	**0**		**0**
Right Turning Traffic Conflict Shared Traffic Lane/Separate Right Turn Traffic Lane	No Right Turn Conflict	Shared Thru-Right lane - no bike lane		Shared Thru-Right Lane - no bike lane on approach

Score	**15**	**0**		**0**
Right Turns On Red	Allowed	No Conflict		Prohibited
Score	**0**	**5**		**5**
Intersection Crossing Distance	4 Travel Lanes	4 Travel Lanes		5 Travel Lanes
Score	**-5**	**-5**		**-5**
Approach Total	**55**	**35**		**65**
Approach LOS	**C-**	**E+**		**C**
Intersection AVG.	**52**			
Intersection LOS	**D+**			

Intersection Example # 2

A second application of the pedestrian level of service methodology is presented in Figure 8. This example illustrates how the methodology should be applied for slip lane or channel island designs. The sample worksheet in figure 8 provides information on features relevant to the intersection.

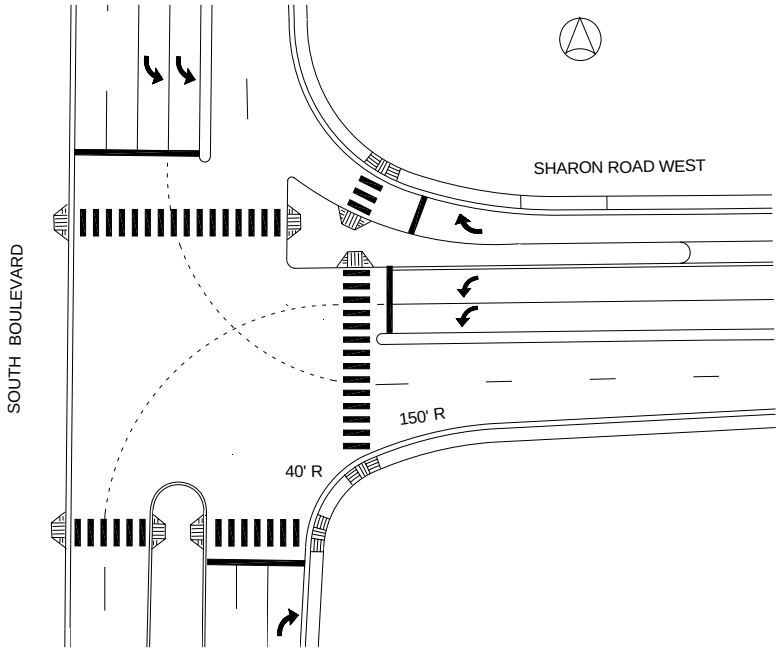


Figure 8. Example Intersection #2: Pedestrian LOS Calculation

Location: South Boulevard & Sharon Road West

	Crossing of Northbound Approach (South Blvd..)	Crossing of Southbound Approach (South Blvd.)		Crossing of Westbound Approach (Sharon Rd. West)
Pedestrian Crossing Distance	5 Lanes (12' median refuge)	7 Lanes 6+1 slip lane – under yield control (no median refuge)		5 Lanes 4+1 slip lane – under yield control (no median refuge)
Score	**55**	**27**		**53**
Signal Features				
Left Turn Conflict (left turns into pedestrian path)	Lefts on Green Arrow Only, from 2 lanes – with pedestrian phase	No Left Turn Conflict		Lefts on Green Arrow Only, from 2 lanes – with pedestrian phase
Score	**15**	**15**		**15**
Right Turn Conflict (right turns into pedestrian path)	No Right Turn Conflict	Cross to Corner Channel Island		Right Turns on Green Arrow/Green Ball, from single right turn lane
Score	**15**	**7**		**0**
Pedestrian Signal Display	Countdown Display	Countdown Display		Countdown Display (4 ft/sec)

	(4 ft/sec)	(4 ft/sec)		
Score	**5**	**5**		**5**
Corner Radius	None (T intersection)	Corner Slip Island (crossing point A)		Compound Curve (55' equivalent)
Score	**10**	**5**		**-10**
Right Turns on Red	Allowed	No Conflict		Slip Lane, right turns yield controlled
Score	**0**	**5**		**0**
Crosswalks	Ladder Style	Ladder Style		Ladder Style
Score	**5**	**5**		**5**
Adjustment for One-Way Street Crossings	Not Applicable	Not Applicable		Not Applicable
Score	**--**	**--**		**--**
Approach Total	**105**	**69**		**68**
Approach LOS	**A**	**C**		**C**
Intersection AVG.	**81**			
INTERSECTION LOS	**B**			