



Accommodating Pedestrians



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1 Introduction

The Rutgers Transportation Policy Institute (TPI) has been retained by the New Jersey Department of Transportation (NJDOT) to establish a Pedestrian and Bicycle Resource Project. The goal is to provide consistent vision and policy for application throughout the state to address the needs of pedestrians and bicyclists. To accomplish this TPI is in the process of establishing an Information Clearinghouse as well as gathering technical resources to make available for all levels of government throughout New Jersey. As part of the project TPI is also providing education and training through organization of workshops and conferences, and assistance in clarifying specific legal and technical issues concerning walking and bicycling.

This discussion paper focuses on issues regarding accommodation of pedestrians throughout the state. It is presented in two sections:

- Section 1: Provides a review of NJDOT guidelines, policies and other national and international guidelines relative to accommodating pedestrians based on road function, traffic volumes and speeds. This includes a review of the New Jersey Residential Site Improvement Standards (RSIS).
- Section 2: Presents recommendations to the New Jersey Pedestrian Guideline, New Jersey Roadway Design Manual (NJ RDM), Residential Site Improvement Standards (RSIS) and also the Manual on Uniform Traffic Control Devices (MUTCD) regarding the critical elements of an effective walking environment.

Guidance and direction for this research was provided by an Advisory Committee consisting of NJDOT, - county, - local - and consulting engineers. The Committee was appointed at the beginning of the project to review draft work products, provide assistance and contribute ideas from their own experience and expertise.

The purpose of this paper was not to rewrite the existing state pedestrian guidelines but rather to discover current lack of initiatives, guidance, and standards that, if identified

and addressed carefully, could contribute to the enhancement of accommodating pedestrians in New Jersey (and elsewhere). Making walking safer, more pleasant and attractive is essential to accomplish the statewide goal to reduce pedestrian deaths and injuries and reduce vehicle miles traveled.

2 Existing Conditions

Comparative Analysis of State and National Guidelines – State of the Practice

This section provides a review of guidelines and practices that influence and/ or are related to accommodating pedestrians in the state of New Jersey (and elsewhere). It includes a detailed analysis of existing planning, practice and design standards affecting pedestrians and suggests some of the most critical changes that could be made to improve the walking environment within the state. The single most important factor will be agreement among all state guidelines and standards to provide effective and clear guidance and confidence among communities, local officials, engineers and planners regarding the implementation, planning and design of pedestrian facilities.

2.1 Pedestrian Manual and AASHTO

The pedestrian manual was prepared for use as a guide in the integration of walking into the transportation system during the program and project development stages. The information contained in the manual was based on existing, widely accepted documents. The manual was intended to supplement the national guide of the American Association of State Highway Officials (AASHTO) for the Geometric Design of Streets and Highways and the New Jersey Department of Transportation Roadway Design Manual (RDM). AASHTO guidelines were reproduced wholly or in part in various sections of the manual. Where necessary, additional information has been provided to refine, but not change, the intent of information presented in the AASHTO guidelines.^{iv}

^{iv} Pedestrian Compatible Planning and Design Guidelines, New Jersey Department of Transportation, April 1996, p.i.

Although it outlines a wide range of possible facilities for accommodating pedestrians, the New Jersey pedestrian guideline in many instances does not provide sufficient detail for implementation. This is especially true concerning critical elements such as crosswalks, speed limits, pedestrian refugees, bus stops, etc. What is also problematic is that the mandatory standards for the design of New Jersey state roadways (*RDM*) and the pedestrian guidelines do not comply with each other. The *RDM* standards provide only minimal guidance for accommodating pedestrians; many of the general roadway standards are also rather pedestrian unfriendly, such as provisions for wide lanes and shoulders, wide turning radii etc. Most of these provisions focus on faster and more comfortable automobile movement.



Picture 2.1-1: Typical highway situation throughout New Jersey – no place to walk or cross the street although land use and bus stops indicate that pedestrians are commonly present.



Picture 2.1-2: Wide turning radii - with the primary purpose to accommodate trucks and buses - allows motorists to make a fast turn and as a result puts pedestrians at risk at this downtown intersection. New Brunswick, NJ.

If such conditions remain, especially in an urban context, providing or marking a crosswalk or implementing a sidewalk is not likely to significantly enhance conditions for pedestrians. Thus, important links between the pedestrian manual and the *RDM* need to be made to ensure a better balance among the various road users in the future.

The state's pedestrian guide recommends:

- Accommodating shared use by various modes, at a minimum;
- Encouraging pedestrian activity, especially in cities, towns, or village centers;

- Prioritizing pedestrian traffic over motor vehicle traffic in zones dedicated to pedestrian movement.

The New Jersey pedestrian guideline is most prescriptive in its treatment of sidewalks, regarding suggestions of how and when to implement them. Sidewalks are generally considered warranted whenever the roadside and land development conditions are such that pedestrians regularly move or will move along the highway. The guide further recommends sidewalks along any street or highway in developed areas having an AADT > 1,200 that is not provided with shoulders, even though pedestrian volumes may be light. Its four feet minimum sidewalk width recommendation complies with AASHTO and the state's RDM.



Picture 2.1-3: Adequate suburban sidewalk.



Picture 2.1-4: Attractive urban sidewalk.

In comparing the New Jersey guide with the Oregon Bicycle and Pedestrian guide, both consider wide paved shoulders adequate in rural areas on state highways. The New Jersey guide further finds paved shoulders adequate on all roadways within 5 miles of an urban area and only recommends separate paths (not immediately adjacent to the roadway) where sufficient shoulder width cannot be provided.

In contrast Oregon recognizes when population density and roadside activities are high, that state and county roads deserve special pedestrian considerations beyond shoulders even in rural areas. The Oregon Bicycle and Pedestrian Plan recommends treating suburban areas as urban. These are important distinctions between the Oregon and New Jersey Pedestrian guidelines since many state highways run through rural and

suburban towns and villages with high speed limits and no sidewalks provided, even though pedestrian and bicycle activity is or could be present. Thus, decisions to implement sidewalks and crosswalks should not be based primarily on vehicular volume and roadway classification but be based upon a much greater number of aspects that exist on or adjacent to a roadway.



Picture 2.1-5: No sidewalk or path – the people are required to skate and walk in the roadway.



Picture 2.1-6: No sidewalk - woman has to walk in roadway.

Another area to examine within the New Jersey guide is that in rural areas when pedestrian volumes are high and/ or groups of pedestrians typically travel together (as an example the guide mentions routes to school), paved shoulders greater than 4 feet wide are considered adequate. If there is a shoulder on a school route or any route commonly used by children (or other people), the space could easily be reallocated to provide sidewalks, preferably in conjunction with speed reducing measures especially at crossings. These measures would not just safely accommodate people walking, but also encourage children and others to walk again.

An additional caveat within the pedestrian guide is its suggestion that suburban areas will generally not reach the pedestrian volumes, which justify crosswalks. The guide recommends, in suburban areas, professional judgment must be applied to the pattern of existing and future land use to assess if these patterns, rather than volumes, should warrant a crosswalk. Leaving such decisions to the judgment of engineers makes crosswalk implementation an exception, not the common practice. Many times crosswalks and/ or improved safety at crossings in general is sacrificed to retain or

improve motor vehicle flow.

The New Jersey guide also does not normally recommend mid-block crossings if the location is within 400 feet of an intersection. It further states that, if the MUTCD warrants (see Section 2.1.3 p. 10) are met or if field studies warrant, a signalized pedestrian crossing may be desirable but first a refuge island or unsignalized crossing should be considered – 4 feet minimum, 6 feet desirable.

Given the importance of crosswalks for the safety and convenience of pedestrians and other road users, the standards as used in New Jersey provide some guidance but are lacking in detail (specifically detail that will lead to implementation) for engineers. In addition crosswalks are barely addressed within the RDM (engineers generally refer to the MUTCD) and surprisingly not addressed at all within the RSIS. This results in engineers using their own judgment to provide or include crossings in highway projects. As a consequence - and understandably - engineers may often hesitate to implement and/ or mark crosswalks.



Picture 2.1-7: Although mixed retail/ commercial land use, this state highway is poorly designed for pedestrians. Wide lanes and no place to cross. Red Bank, NJ.

2.2 Roadway Design Manual

The New Jersey Roadway Design Manual provides the mandatory roadway design standards for New Jersey state highways. Most of the RDM standards comply with the national policy on highway design practice, published by AASHTO. When standards differ, however, the RDM instructions govern in New Jersey (except on interstate highways). Interestingly, the review of both, AASHTO and the RDM concluded that New Jersey standards are sometimes greater than those provided by AASHTO (e.g. turning radius, lane widths). What this means is that the NJ standards for lane width and turning radii provide faster and more convenient vehicle flow and also commonly create much more difficult situations for pedestrians to negotiate. Furthermore, pedestrian (and bicycle) facilities are barely addressed within the manual thus highway engineers often do not consider these modes. For any future revisions of the RDM it will be important to 1) incorporate comprehensive design and implementation instructions for pedestrian (and bicycle) facilities, and 2) emphasize the negative and positive effects of various roadway designs on all road users.

The following section presents RDM standards that commonly seem to have negative impacts on safe and convenient provisions for pedestrians.

Rural vs. Urban

Although the RDM makes many urban/ rural differentiations, the general emphasis is to construct all “land service highways” equally. A major problem associated with this is that minimum shoulder width for all state highways does not change between urban and rural classifications (8 feet outside and 3 feet at medians for both - exceeding AASHTO values). In practice the same is true – “land service highways” commonly have (wide) shoulders, wide clear zones, no curbs and high speeds, all of which are generally not pedestrian-friendly design features and consume valuable space that could otherwise be used by non-motorized modes.

Corner and Curve Radius

Regarding the minimum turning path of design vehicles for minimum space and slow

speeds, AASHTO standards include tighter turning radii than the RDM does, as is shown in the tables below.

	Corner Radius (Intersection of two Local Streets)	
Design Vehicle	NJ RDM - m (ft)	AASHTO - m (ft)
Passenger vehicles	4.5 – 7.5 (15 - 25)	Same
Occasional bus or truck	> 9 (> 30)	Same
Frequent bus or truck	> 15 (> 50)	> 12 (> 40)

	Curve Radius for low speed urban streets	
Design Speed km/h (mph)	NJ RDM - m (ft)	AASHTO - m (ft)
30 (20)	20 (66)	Same
40 (25)	40 (131)	25 (82)
50 (31)	70 (230)	25 (82)
60 (37)	115 (377)	30 (98)

Tables 2.2-1 and 2: Corner and Curve Radius Comparison of NJ and AASHTO standards.

A pedestrian struck by a right-turning vehicle at an intersection is not an uncommon crash type. The faster a vehicle is making that turn the more likely it is that if there is a crash, it would have severe or even fatal results for the pedestrian. A wide corner radius allows vehicles to make such turn at high speed. Tightening turning radii will not just reduce turning speeds but also shorten crossing distance for pedestrians and enhance sight distance between pedestrians and motorists. However, a tighter corner radius increases the chances that large trucks or buses may ride over the curb and endanger the pedestrian. Thus, careful consideration should be given to the type of development and road users so that an appropriate roadway design and radius can be provided.

Locations with no curb extensions but parking or bicycle lane can have even tighter radii because they give vehicles more room to negotiate the turn. Some cities in the Northeast frequently have radii of 2 – 5 feet – much tighter than modern guidelines recommend – without suffering any detrimental effects. More typically, in new construction, the appropriate turning radius is about 15 feet and about 25 feet for arterial

streets with a substantial volume of turning buses and/ or trucks.^v

Lane Width

Regarding lane width the RDM also provides greater standards than AASHTO. The minimum lane width of a travel lane on a land service highway as per RDM is 11 feet (12 feet desirable; 12 – 16 feet for turn lanes) and as per AASHTO is only 10 feet (12 feet desirable, 10 – 16 feet for turn lanes). It is not uncommon, especially within New Jersey's more densely populated areas, that existing roadways have 10 feet (and sometimes even 9 feet) wide travel lanes without having any detrimental effect on motor vehicle travel.^{vi} Thus, the RDM should suggest that lane widths need not to be widened unless there is a demonstrated crash history that will be alleviated by the widening. Likewise, the widening must not create a new crash problem due to excessive speed etc. Instead of general widening - and depending on the land use conditions adjacent to the roadway - strong consideration should be given to the implementation of pedestrian and cycle facilities.

2.3 MUTCD Crosswalks and Signal Placement

The Manual on Uniform Traffic Control Devices (MUTCD) includes some rather ... “flux” recommendations concerning provisions for pedestrians especially regarding its crosswalk regulations and Signal Placement standards.

Crosswalks

As previously pointed out, crosswalks are one of the most critical issues regarding the accommodation of pedestrians, especially since a great amount of accidents occurs at crosswalk locations. This is not surprising since a majority of pedestrians will generally cross at crosswalks – thus, the probability of crashes increases compared to other locations. However, designating and leading pedestrians across a desired location

^v www.walkinginfo.com/de/roadway/curb/index.htm

^{vi} Compare: Transportation Research Records No. 1445 discussing safety effects of various lane and shoulder widths on low-volume roads; NHRP Report 362 analyzing safety effects of various roadway widths for low-traffic-volume roads; NCHRP Report 330 discussing the effective utilization of street width on urban arterials; NHTSA DOT HS 809 021 literature review on vehicle travel speeds and pedestrian injuries.

requires careful examination since providing no crossing is better than providing one that is unsafe.

Legal crosswalks exist at all public street intersections. This implies that a crosswalk exists even if it is not marked. But, the only way a crosswalk can exist at a mid-block location is if it is marked.

Cities throughout the US and the state tend to install marked crosswalks at signalized intersections, particularly in urban areas where there is considerable amount of pedestrian activity. Sometimes jurisdictions install marked crosswalks at school crossing locations where crossing guards are used and they are more likely to mark crosswalks at intersections controlled by a stop sign. At uncontrolled locations (e.g. not controlled by a traffic signal or stop sign) some agencies choose rarely, if ever, to install marked crosswalks, while others have installed marked crosswalks at selected pedestrian crossing locations, particularly in downtown areas. Sometimes selected crosswalks are supplemented with advance overhead or post-mounted pedestrian warning signs, flashing lights, "Stop For Pedestrian in Crosswalk" signs and/ or supplemented markings.

The warrants for a pedestrian crossing are guided by the MUTCD. Section 4C.05 "Pedestrian Volume" states that both of the following must be met: ≥ 100 pedestrians per hour for any four hours of an average day, or > 190 pedestrians during any one hour of the day; and < 60 gaps per hour in the traffic flow of sufficient length to cross the street. This warrant ignores the fact that current roadway design discourages people from walking even when there is a *potential* for moderate to high pedestrian volumes (e.g. in rural town centers, school areas, retail/ commercial establishments etc.).

It should be considered that the automobile's popularity did not precede the building of our roadways - the roadways were built first to accommodate and encourage people to travel to and from origins and destinations. Although the state DOT occasionally works with counties or municipalities to determine if the level of activity is sufficient, the guideline within the MUTCD should address and clarify the potentials.



Picture 2.3-1: Typical scenario ...



Picture 2.3-2: ... pedestrians stranded in traffic trying to cross the street.



Picture 2.3-3: Marked crosswalk with curb cuts - Audubon, NJ.



Picture 2.3-4: Marked crosswalk at unsignalized intersection with post-mounted pedestrian warning signs – New Paltz, NY.

Contributing to the crosswalk dilemma may be considerable controversial research regarding the safety effects of implementing marked crosswalks in certain locations. Some of this research is misleading, while some of it can be very helpful in identifying critical issues of pedestrian crossings. For example some safety research based on crash analysis has found that unmarked crosswalks in certain locations are safer than marked crosswalks. This can certainly be true in some locations, however, such statements often do not consider other reasons for example the fact that at risk people such as the elderly or children are more likely not to cross at unmarked locations. This issue is addressed in further detail within Section 3.1 beginning on page 17.

Signal Placement

Current signal placement standards for vehicular traffic at intersections, as outlined within the MUTCD, often seem to create safety hazards for pedestrians (and also drivers) at crossings/ intersections.

Everybody is aware of the problem – motor vehicles proceeding into the crosswalk rather than stopping in advance to let the pedestrian cross safely. The results:

- 1) The pedestrian either waits for the car to clear the crosswalk, thus possibly missing a green phase or hurrying across, or
- 2) the pedestrian starts crossing but is forced to walk around the nose of the car close to or into oncoming traffic (see pictures 2.3-5 and 6), or
- 3) the pedestrian has to zigzag their way around the rear of the stopped car(s).

Although state law requires motorists to yield to pedestrians in crosswalks, this law is typically ignored and generally not enforced. If signals were however placed in such a manner that the motorist would be forced to stop in advance of the crosswalk to see the signal, - which would be the case if signals were only provided on the near side of an intersection, - there would be no (real) need to enforce the law or rely on “good” behavior. However, the current signal placement standards as outlined within the MUTCD do not recognize this potential.

Besides minimum sight distance requirements, per MUTCD standards, at least one of two signals is to be placed within the primary cone of visibility, which encounters 20 degrees either side of straight ahead and within 40 to 150 feet from the stopping point (see Figure 2.3-1).

As a result, one signal at or near the far side of an intersection always becomes a requirement especially when stop lines are only placed 4 feet in advance of an intersection. With much further advanced stop lines (e.g. 15 – 30 feet as recommended within the stop line section), the primary cone of visibility would automatically move (closer) to the near side of an intersection.

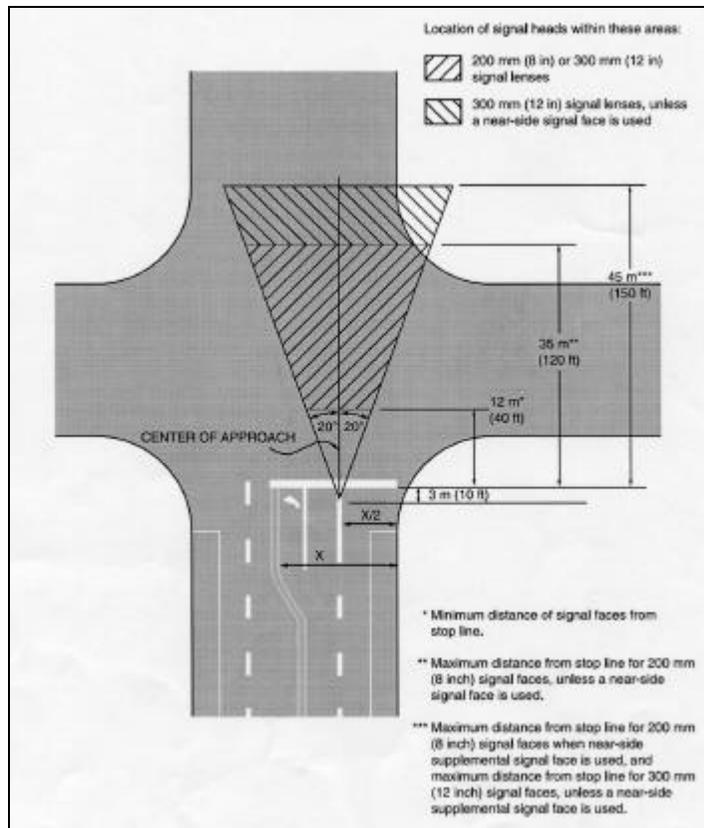


Figure 2.3-1: MUTCD Signal Placement Standard.

Interestingly, in several European countries (e.g. Austria, Germany), signals are only placed on the near side of an intersection (with few exceptions at very large-complex intersections). As in the U.S., signal placement standards in those countries are also based on signal visibility, which are very similar to the minimum sight distance standards as applied in the U.S. (The Austrian guide for example requires signals to be visible 75m in advance at a speed of 50km/h and 125m in advance at a speed of 70km/h). So whenever these minimum sight distance requirements can be achieved with a signal on the near side of an intersection, there are no additional requirements for a signal further into the intersection. For vehicles stopped at the stop line, near side signals (post-mounted and overhead) also allow for greatest visibility if placed at the appropriate height and location.

A closer look at signal placement leads one to wonder if the only benefit of far side signals may be to accommodate faulty drivers that proceeded beyond the point they were supposed to stop.



Pictures 2.3-5 and 6: A typical conflict – the motorist pulls into the crosswalk because the far side signal allows him/ her to do so – the pedestrians/ cyclist are forced to cross in or near the path of turning vehicles. New Brunswick, NJ.

Not providing signals beyond a certain point where drivers are supposed to stop could significantly enhance pedestrian safety and comfort at crossings especially in conjunction with RTOR prohibition and further recessed stop lines for example in downtown areas.



Picture 2.3-7: Near side signal only – motorists are naturally forced to stop at stop line because otherwise he/ she would not be able to see the signal. Germany.

Far side signals instead of enhancing safety seem to do exactly the opposite, allowing and maybe even encouraging drivers to proceed further into the intersection/ conflict

area. Additionally, far-side (especially overhead) signals make drivers look up and away from the people and oncoming traffic at ground level once at or within an intersection area. It could be beneficial to place signals in such way that drivers are looking at a lower angle to have pedestrians, cyclists and other vehicles more within their field of view. The issue should be further explored in terms of pedestrian, cyclists and drivers safety.

2.4 Residential Site Improvement Standards

The Residential Site Improvement Standards are uniform standards for how new housing developments would be built including standards for streets, parking and sidewalks. The last revised version of the standards was adopted in 1997 by the New Jersey Department of Community Affairs. A review of the standards concluded that there are gaps between the goals and objectives of the Residential Site Improvement Standards and the pedestrian guide.

Similar to the pedestrian guide, the RSIS generally require sidewalks in all new urban and suburban housing developments, and they do not require sidewalks in rural developments. The RSIS makes the requirement of sidewalks and graded areas primarily dependent on road classification (but also intensity of development) rather than existing and potential road users. The standard does not require sidewalks on rural roads and lanes with ADT < 500, again, not taking into consideration other road users or conditions outside of or in addition to traffic volume. The standard does however recommend (although not require) sidewalks when a development/ project is located within 2,500 feet of a train station, public or school bus route, recreational, business or retail use and where streets connect to existing streets with sidewalks. The standard allows waiving curbs when a community desires to preserve its rural character. Most significantly, the RSIS does not make any mention of providing safe crossings at appropriate locations. It appears that pedestrian accommodations are either an exception to the rule or left up to the discretion of the community or design engineer.

3 An Effective Walking Environment

This Section discusses crosswalk implementation in further detail as well as various other critical elements that make an effective walking environment. Guidance and recommendations for implementation is provided within this Section. A checklist of design and engineering issues that should be considered in the planning process for making an effective walking environment is provided in the Appendix.

Critical Elements

3.1 Crosswalks

As previously pointed out, many pedestrian crashes occur at crossings and as a result there may be hesitation to provide such crossings – often the best and safest solution seems to be to not provide any crossings at all – assuming this prevents people from crossing roadways where they are not wanted. It certainly is important to prevent people from crossing streets at highly undesirable and unsafe locations, however, a balanced approach needs to determine whether there is a potential of people regularly crossing the street e.g. due to adjacent land use conditions. Research and safety reports indicate that pedestrians try to find the shortest path between origins and destinations of their trip – given that pedestrians use their own powered energy – this is understandable. In many cases, 20-30 feet become crucial distances yet on paper (design plans) these distances often go unnoticed, particularly when the thrust of the plan is to move automobiles, not pedestrians. Every effort should be made to provide safe crossings wherever pedestrian activity exists or is anticipated and to provide such crossings within reasonable distance from each other to ensure minimum jaywalking.

A recently published Transportation Research Board (TRB) report^{vii} provided detailed analysis of the safety effects for pedestrians of marked vs. unmarked crosswalks at uncontrolled (unsignalized) locations. The purpose was to recommend improvements to the safety and access of pedestrians crossing the streets, as opposed to a rather

^{vii} Zegeer, C., Stewart, J., Huang, H., Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Analysis of Pedestrian Crashes in 30 Cities. Transportation Research Board Report, July 2000.

common practice of saying “no” to marking crosswalks. The research concluded that marked crosswalks are best used in combination with other treatments. Before removing a crosswalk or making a decision not to install a crosswalk at a given location, treatments to reduce motor vehicle speed (e.g. traffic calming measures), the number of lanes, and/ or other measures to facilitate pedestrian street crossings (e.g. traffic signals with pedestrian signals, raised medians) should be fully explored. The following section summarizes some of the most important safety issues found within the marked vs. unmarked crosswalk research. Consideration of these findings are the building blocks to improving the practice of implementing safer pedestrian crossings.

- A greater frequency of crashes occurs when pedestrian volumes are higher, traffic ADT is higher and number of travel lanes are higher (e.g. roads with three or more lanes have higher pedestrian crash rates than two-lane roads).
- Locations with a raised median (or raised crossing island) have significantly lower pedestrian crash rates at multi-lane sites with both, marked and unmarked crosswalks.
- On two-lane roadways there are no significant differences in pedestrian crashes for marked vs. unmarked crosswalk sites.
- On multi-lane roads (3+ lanes) with an ADT of 12,000 or less there are also no differences in pedestrian crash rates between marked vs. unmarked crosswalks.
- On multi-lane roads with an ADT above 12,000, either with or without a raised median, higher pedestrian crash rates at marked crosswalk sites occur.
- On multi-lane roads, more fatal plus A-injury^{viii} pedestrian crashes happen at marked crosswalks.
- On multi-lane roads, painted medians (not raised) provide no significant safety benefits to pedestrians compared to multi-lane roads with no median at all.
- At speed limits above 40mph, marked crosswalks are less safe than unmarked crosswalks.

In some situations (e.g. low-speed, two-lane streets in downtown areas), installation of a marked crosswalk may help consolidate multiple crossing points. Priority should be placed on providing marked crosswalks where the pedestrian crossing volume exceeds 20 per peak hour (or 15 or more of elderly or children). These are significantly lower and

more appropriate volumes than recommended within the MUTCD to warrant a crosswalk.

Factors not having significant effects on pedestrian crash rates include: area type (e.g. residential, CBD, location type (e.g. intersection vs. midblock), traffic operation (one-way or two-way), conditions of crosswalk marking (excellent, fair, poor) and crosswalk marking patterns (e.g. parallel lines, ladder type, zebra stripes – no mention of brick paved crosswalks).

Furthermore speed limits of 35mph and above can be associated with a greater percentage of fatal and A-type injuries compared to sites having lower speed limits.

On multi-lane undivided roads with traffic volumes of about 10,000 ADT and below, pedestrian crash rates are about the same at marked and unmarked crossings; for ADT above 10,000 pedestrian crash rates at marked crosswalks become increasingly worse as ADT increases. The crash rate at unmarked crossings increases only slightly as ADT increases (but still increases).

The greatest difference in pedestrian crash types between marked vs. unmarked crosswalks involves “multiple threat” crashes where a vehicle in one lane of a multi-lane road is stopping for a pedestrian to cross the street while the driver of an oncoming vehicle in an adjacent lane fails to stop and strikes a pedestrian.

The results from the Zegeer study suggest that wide, multi-lane streets are difficult for many pedestrians to cross, particularly if there is an insufficient number of adequate gaps in traffic due to heavy traffic volumes and high vehicle speeds.

Further, while marked crosswalks in themselves may not increase measurable unsafe pedestrian or motorist behavior as a different studies suggest, one possible explanation is that installing a marked crosswalk may increase the number of at-risk pedestrians (particularly children and the elderly) who choose to cross there instead of at the nearest signal-controlled crossing.

^{viii} A-injury refers to very serious injuries with permanent damages/ handicaps.

Motorists failing to yield represents a large percentage of pedestrian crashes at both, marked and unmarked crossings. This indicates a strong need for improved drivers (but also pedestrian) enforcement and education. A more pedestrian-friendly, driver-alerting roadway design by slowing speeds, providing raised medians, curb extensions, traffic calming measures, and others may help as well.



Picture 3.1-1: Crosswalk leading across multi-lane road to the train station – unsafe due to long distance, high speeds of traffic and no refuge for pedestrians. Bernardsville, NJ.



Picture 3.1-2: Mid-block crossing with curb extension to reduce crossing distance for pedestrians. Westminster, MD.



Picture 3.1-3: Raised Median and marked crosswalk, Albany, NY.

Interestingly, a separate analysis mentioned within the Zegeer study concluded that pedestrians aged 65 and over were over-represented in pedestrian crashes. Given an increasingly aging population due to the “Baby Boomers” this becomes an even more important issue than it already is. Another complementary study of pedestrian and motorists behavior and vehicle speed before and after crosswalk installation conducted at locations in NY, VT, MN, and CA, revealed that very few motorists stopped or yielded to pedestrians either before or after marked crosswalks were installed. Interestingly, after marked crosswalks were installed, there was an increase in pedestrian looking behavior (before stepping into the street). This tends to contradict the “false sense of security claims” attributed to marked crosswalks, since pedestrian behavior was found to have improved.

Summary – Where, When and How?

After careful analysis of the various issues associated with crosswalks, it can be concluded that:

- Deciding where to mark a crosswalk is only one consideration in finding solutions to improve pedestrian safety;
- Pedestrian crashes are relatively rare at uncontrolled pedestrian crossings in general, whether this depends on reasons beyond the amount of people or the low number of at-risk people actually crossing here is hard to determine;
- Marked crosswalks should not be installed **alone** on two-lane roads with an ADT above 12,000 or on multi-lane roads with an ADT above 9,000 (a raised median or signalized crossing could be possible solutions);
- At speed limits above 40mph greater treatments (e.g. traffic and pedestrian signals and/ or raised median) are also necessary;
- Crosswalks alone should also not be installed where limited sight distance, complex or confusing roadway design, sites with certain vehicle mixes (many heavy trucks), or other dangers exist, without first providing adequate design features and/ or traffic control devices;



Picture 3.1-4: Dangerous design and location of crosswalk due to limited sight distance. Although signage alerts motorists of an upcoming crosswalk, it is hidden behind the curve (and bushes). Motorists on this slip lane are looking for gaps to the left. They often turn and even accelerate without noticing pedestrians and cyclists trying to cross. In addition, people crossing cannot see approaching cars. New Brunswick, NJ.

- If nothing else is done beyond marking a crosswalk at uncontrolled locations, pedestrians will generally not experience increased safety conditions. Besides research conducted within the US, further research from Europe shows (p.16 of Zegeer report) the need for pedestrian improvements beyond uncontrolled crosswalks (pages 10,11 of Zegeer report).

A variety of facilities have been found to improve pedestrian safety and/ or ability to cross the street under various conditions (7-21 p. 17). Examples include:

- Raised medians or crossing islands on multi-lane roads;
- Traffic signals (with pedestrian signal) where warranted due to existing **and anticipated** volumes;
- Reducing crossing distance through curb extensions, raised pedestrian islands at intersections and reducing 4-lane undivided roads to two thru lanes with dual left-turn lane or left-turn bays (or two-way left-turn lane), sidewalks and bicycle facilities;

- Traffic calming measures to slow vehicle speeds and/ or reduce cut-through traffic where appropriate thru raised crossings (crosswalk or intersection), street narrowing (chicanes, “skinny streets”, neckdowns, etc), and traffic mini-circles or diagonal converters;
- Adequate lighting;
- Safer intersections (crossing islands, tighter turning radii);
- Narrower widths and/ or access management (consolidation of driveways);
- Pedestrian warning signs;
- Narrow streets to achieve desired speeds;
- Whenever a marked crosswalk is installed on an uncontrolled multi-lane road, advanced stop-lines should be considered (up to 30 feet in advance; see section on advanced stop lines);
- Elimination of parking on approaches to uncontrolled crosswalks;
- Railings in medians, which direct pedestrians to the right and increase their likelihood of looking for oncoming traffic.

Some of the treatments mentioned above require closer examination especially those not receiving adequate recognition within the state’s pedestrian guideline. The implementation of pedestrian improvements such as those identified above, have been known to increase pedestrian traffic.

3.2 Speed Limits – Slowing Traffic

Slowing down vehicular traffic in various appropriate locations is at least as important as providing safe crossings for creating safe and convenient walking environments. In general high speeds of traffic approaching a pedestrian crossing impedes the pedestrians while crossing (and on the sidewalk), thus decreasing the comfort level for pedestrians. In several European countries implementation of 30km/h (approx. 20mph) zones has become very common practice especially in residential areas. Many safety studies have affirmed that total number of accidents (not just where pedestrians were involved) are 1) reduced and 2) much less severe after introduction of such measure both, for the motorist and the pedestrian.



Picture 3.2-1: Cobblestone surface texture and tree planted islands to reduce motor vehicle speeds. Germany.



Picture 3.2-2: 30km/h (20mph) Zone. Denmark.

More important, at 20mph, significantly less accidents end fatal for pedestrians involved, whereas the common U.S. 25mph speed limit more likely ends fatal or severe for a pedestrian (especially since the exact speed limit is rarely obeyed and motorists tend to drive a couple of mph's faster). See Figure 3.2-1 below illustrating the speed-safety correlation.

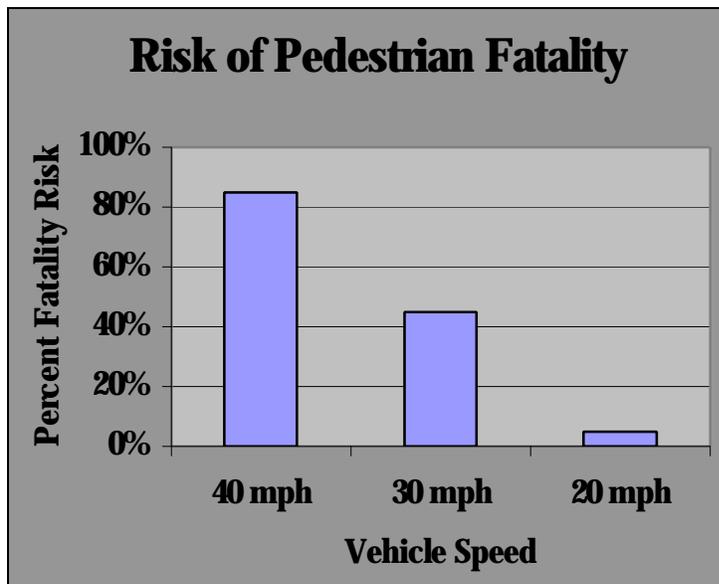


Figure 3.2-1: Risk of Pedestrian Fatality Relation to Motor Vehicle Speed. Data Source: NHTSA, USDOT, 1999.

Gut, Arguemente, Verkehr, Germany, 1991 states:

The slower speeds enforced by traffic calming mean fewer crashes. Those that do occur are less severe. Research on traffic impact severity shows that the impact of a vehicle moving at less than 20 mph does not usually inflict serious injury to the pedestrian. Crashes with impact speeds between 20-30 mph generally seriously injure a pedestrian, while injuries sustained by a pedestrian struck by a vehicle at over 35mph are severe, and frequently fatal.

Furthermore, safety research has proven that simply posting (speed limit or “yield to pedestrian”) signs is much less successful than the implementation of physical speed-reducing measures such as traffic calming features or designing the road to such desired speed.



Picture 3.2-3: A busy, pedestrian generating downtown, however, frequent crossings are missing for pedestrians to safely get to and from stores on each side of the roadway. Metuchen, NJ.



Picture 3.2-4: Traffic Calming
Source: Reid Ewing, Traffic Calming, State of the Practice, USDOT/ FHWA.

Finally, area wide measures have proven to be significantly more effective than spot improvements since it is easier to expect and adjust to these measures.^{ix} Accidents are usually more scattered throughout residential areas than they are in built-up areas,

^{ix} Hummel, T., Dutch Pedestrian Safety Research, Federal Highway Administration, FHWA-RD-99-092, December 1999.

therefore area wide measures rather than “black-spot” improvements are most important here. In built-up areas on the main roads, where most accidents generally occur, area wide, but also spot-improvements, often become necessary since some intersections are much more congested and hazardous for pedestrians and cyclists than others.

3.3 Medians

The NJ pedestrian guide recognizes that the delay in crossing the road without a median can be as much as ten times the delay incurred while crossing with a median. A median of at least 8 feet in width is recommended to be included on all new or reconstructed arterial and collector highways of four or more lanes to accommodate pedestrians in refuges. When widening a highway to four or more lanes it is recommended to incorporate a median of 4 feet minimum. As mentioned earlier within the discussion of marked vs. unmarked crosswalks at uncontrolled locations, medians (if painted/ striped and not raised) on multi-lane roads do not provide any significant safety benefits to pedestrians. In addition, the dimensions provided in the pedestrian guide should be revised considering that: a mother pushing a baby stroller; a person in a wheel-chair; and, somebody pushing a bike across a street, would all likely be exposed to motor vehicle traffic while waiting in the median.^x To safely accommodate these road users, a minimum of 6 feet or none should be recommended.



**Picture 3.3-1: Insufficient width of median refuge.
Burlington, VT.**



**Picture 3.3-2: Sufficient width of median refuge.
Germany.**

^x The average bicycle length is about 6 feet therefore a minimum median width of 6 feet is recommended herein.



**Picture 3.3-3: Sufficient refuge space?
New Brunswick, NJ.**



**Picture 3.3-4: Not during peak hour when many
commuters from New York City try to get across.
New Brunswick, NJ.**

More extensively used in Europe, but also found in some U.S. cities, - and considered beneficial to pedestrians, are railings in medians which direct pedestrians to the right and thus increase their likelihood of looking for oncoming traffic. Examples of such design are illustrated in the two graphics below (Figures 3.3-1 and 2). It should be noted that such railings should first – not be designed as to intimidate pedestrians and secondly – be of short distance not to create an unnecessary long detour for the pedestrian.

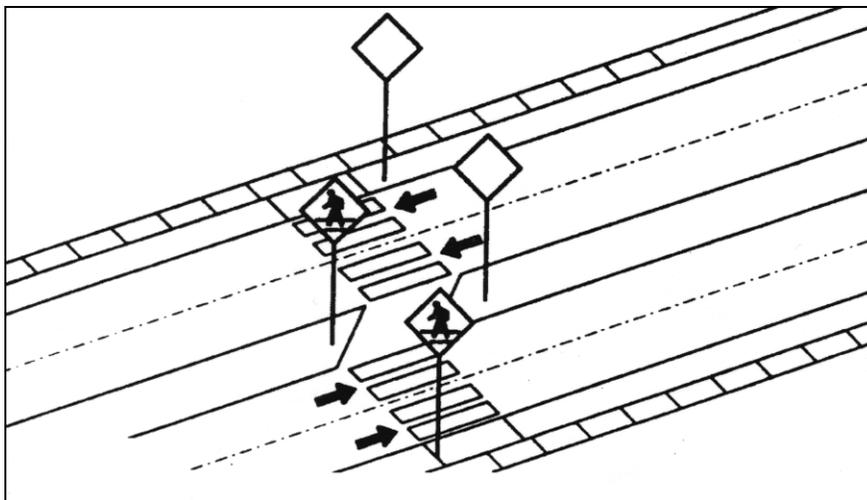


Figure 3.3-1: Unsignaled Mid-Block Crossing with Angled Center Refuge.

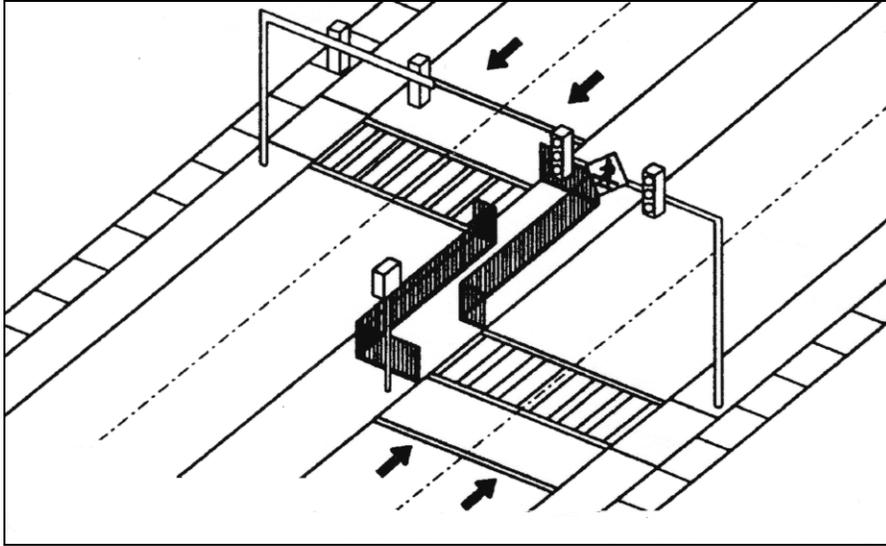


Figure 3.3-2: Signalized Mid-Block Crossing with Channelized Center Refuge.

Source: Washington State DOT

3.4 Traffic Signals

The New Jersey Pedestrian guide suggests that if the warrants as set out in the MUTCD Section 4C-5 are met or if field studies warrant, then a signalized pedestrian crossing may be desirable. However, it further states that consideration should first be given to provision of a refuge island and an unsignalized crossing. This recommendation lacks significant guidance for engineers to justify signals as emphasized within the earlier Section of this paper on crosswalks (Section 3.1.1) as well as in the following Section on refuge islands (Section 3.1.5). In addition as also mentioned previously, the MUTCD warrants do not encounter anticipated pedestrian volumes and thus, ignore the many locations in New Jersey that have the potential of becoming vital walking environments if safety and convenience were to be enhanced. Traffic signals (and speed reduction or other safety measures) should especially be considered for those situations that were identified as unsafe when only provided with a crosswalk (see Section 3.1.1).



Picture 3.4-1: A crosswalk, nice wide median and two-phase push-button signal with almost immediate response ensures a safe and convenient crossing for pedestrians (and cyclists). Germany.

3.5 Refuge Islands

Pedestrian refuge islands are recommended to be installed where continuous medians cannot be provided, speeds are generally less than 45mph, and pedestrian crossing volumes are in excess of 100 persons per day or where there has been a crash history. Refuge islands are beneficial in that they reduce total crossing distance for pedestrians, allow pedestrians to cross fewer lanes at a time and judge conflicts separately; and, they can create a refuge that slower pedestrians can wait for a break in the traffic stream. Islands are thus considered safe and convenient pedestrian facilities. However, the design/ placement of many refuge islands provided on New Jersey roadways can sometimes create hazardous conditions for pedestrians, particularly when insufficient stopping (sight) distance is provided for motor vehicles (and also the pedestrian).

In addition, on roadways with high volumes and speeds, traffic islands (or medians for mid-block crossings) **alone** are not sufficient safety devices for pedestrians. Particularly dangerous are free-right turn lanes (slip lanes) for motor vehicles with safety islands and no signals.

To a large extent pedestrian refuges have been provided in preference to other traffic calming and road safety measures because they are easy to install. They do not require Traffic Regulation Order, and there is no requirement to consult the public or others before installing them. They require less signing and are generally less controversial or

constrained by regulations than some of the other traffic calming devices (e.g. road humps). There seems to be a tendency, therefore, to install traffic islands and pedestrian refuges in response to perceived needs to do something.



Picture 3.5-1: Motorists commonly ignore pedestrian's right-of-way at this refuge island. If they are forced to stop, they generally do so within the crosswalk as shown in the picture. New Brunswick, NJ.

Many refuge islands in New Jersey are placed where cars exit or turn from a major highway onto a lower class road. Often these (meant to be) deceleration lanes (or slip lanes) approach the island with no speed reducing measures other than signs. Generally, vehicles approaching the cross road (and thus the island) are most concerned about traffic flow coming from the left trying to find a convenient gap to merge into the traffic flow. Such slip lanes often even encourage motorists to accelerate to fill the gap. As a result, pedestrians trying to cross to reach the island are not within their primary view and are exposed to serious threats. This issue has been subject to an increasing amount of safety research. One of the more effective design and placement alterations/ recommendations is illustrated in the graphic below. It shows that rather simple adjustments can make a big difference regarding safety for all road users.

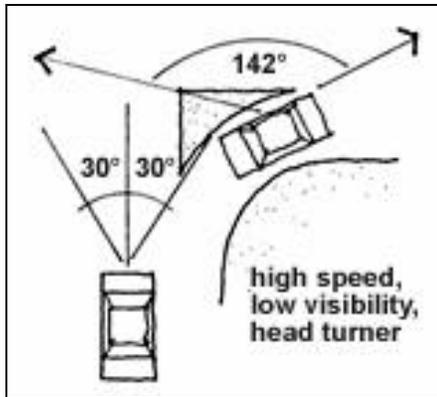


Figure 3.5-1: Current AASHTO Standard

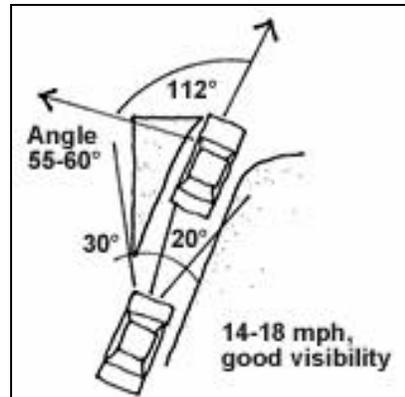


Figure 3.5-2: Recommended Design

Source: walkinginfo.com

In summary, studies have found/ concluded that pedestrian refuges assist pedestrians to cross roads more easily (if designed properly), with less delay and greater perceived safety. However, vehicle speeds are not necessarily reduced and pedestrian accidents may not be reduced if pedestrian activity increases.

3.6 Advanced Stop Lines

Stop lines/ bars are generally placed 4 feet in advance of and parallel to a crosswalk. This is common practice throughout New Jersey and follows the standard outlined within the MUTCD. It has been documented, however, that the use of further advanced stop bars encourages motorists to yield farther back from a crosswalk and thus increase safety for pedestrians at a crossing. When a motorists stops too close to the crosswalk (if at all) when yielding to pedestrians, the vehicle can obscure the view of drivers traveling in adjacent lanes that the pedestrian needs to cross. The greater distance a yielding vehicle stops behind a crosswalk, the farther away motorists and pedestrians in adjacent lanes can see each other and take appropriate action to avoid a crash. Another advantage of advanced stop lines is that they can help reduce the probability of “billiard ball” collisions that could result when another motorist has a rear-end crash with a motorist stopped for a pedestrian and push that vehicle into the pedestrian. According to Danish studies, 5m (approx. 15 feet) seems to be the best location for a stop line before a marked crossing, a distance equivalent to that adopted for recessed stop lines for motor vehicles used to protect cyclists at intersections in Denmark. Various other

studies have also affirmed that placing stop lines further in advance than the current 4 feet standard improves sight distance and thus safety for pedestrians crossing a roadway. Advanced stop-lines should be considered along with a sign such as “Stop here for Crosswalk” at each site. Data on vehicle/ pedestrian conflicts indicate that a sign alone (up to 30-50 feet before the crossing) can reduce conflicts but the combined approach of the advanced stop line and warning sign can result in an even more significant reduction of such crashes.^{xi}

Finally, advanced or recessed stop lines allow larger vehicles such as trucks and buses to turn without the need to widen lanes or turning radii at intersections which would result in an extension of the crossing distance for pedestrians (see Picture 3.6-2 below).



Picture 3.6-1: Recessed stop line also allows cyclists to get a head start before motor vehicles, thus making them more visible to motorists.



Picture 3.6-2: Recessed stop line allows bus to turn besides a very tight turning radius – New Brunswick, NJ.

Source: walkinginfo.org

3.7 Bus Stops

A major issue that has received little attention within any of the existing state guidelines is the location of bus stops in regard to pedestrian safety. Without guidance or justification, the New Jersey pedestrian guide recommends placing bus stops at the far side of an intersection. It is important to point out the various advantages and

^{xi} Van Houten, R. and Malenfant, J.E. L., Canadian Research on Pedestrian Safety, Federal Highway Administration publication # FHWA-RD-99-090, December 1999.

disadvantages of different bus stop locations to assist engineers, planners, bus service providers, etc. with their decision where to place a bus stop. Final decisions will always depend on several safety and operating elements that require on-site evaluation. The following is an attempt to provide the initial guidance, most of which was taken from a Transportation Research Board report providing guidelines for the Location and Design of Bus Stops^{xii}.

After ridership potential and bus stop spacing (not specifically addressed within this paper) most critical factors in bus stop placements are safety and avoidance of conflicts that would otherwise impede bus, car, or pedestrian flows. Principally bus stops should be placed in an area where typical improvements, such as bench or passenger shelter, can be accommodated in the public right-of-way. Besides that, determining the proper location of bus stops involves choosing among far-side, near-side, and midblock stops. The table below presents comparisons of the advantages and disadvantages of each bus stop type.

^{xii} Transportation Research Board report, Transit Cooperative Research Program, Report 19, Guidelines for the Location and Design of Bus Stops.

	Advantages	Disadvantages
Far Side Stop	<ul style="list-style-type: none"> ▪ Minimizes conflicts between right turning vehicles and buses; ▪ Provides additional right turn capacity by making curb lane available for traffic; ▪ Minimizes sight distance problems on approaches to intersection ▪ Encourages pedestrians to cross behind the bus; ▪ Allows buses to use the intersection to decelerate rather than decelerating already prior to the intersection (and thus slowing traffic); ▪ Results in bus drivers being able to take advantage of the gaps in traffic flow that are created at signalized intersections. 	<ul style="list-style-type: none"> ▪ May result in conflicts with right turning vehicles from cross streets. ▪ May result in the intersections being blocked during peak periods by stopping buses; ▪ May obscure sight distance for crossing vehicles; ▪ May increase sight distance problems for crossing pedestrians; ▪ Can cause a bus stop to stop far side after stopping for a red light, which interferes with both bus operations and all other traffic; ▪ May increase number of rear-end accidents since drivers do not expect buses to stop again after stopping at a red light; ▪ Could result in traffic queued into intersection when a bus is stopped in travel lane.
Near Side Stop	<ul style="list-style-type: none"> ▪ Minimizes interferences when traffic is heavy on the far side of an intersection; ▪ Allows passengers to access buses closest to crosswalk; ▪ Results in the width of the intersection being available for the driver to pull away from curb; ▪ Eliminates potential of double stopping; ▪ Allows passengers to board and alight while the bus is stopped at a red light; ▪ Provides driver with opportunity to look for oncoming traffic, including other buses with potential passengers. 	<ul style="list-style-type: none"> ▪ Increases conflicts with right turning vehicles on the road that the bus is stopped on; ▪ May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians; ▪ May cause sight distance to be obscured for cross vehicles stopped to the right of the bus; ▪ May block the through lane during peak period with queuing buses; ▪ Increases sight distance problems for crossing pedestrians.
Mid Block Stop	<ul style="list-style-type: none"> ▪ Minimizes sight distance problems for vehicles and pedestrians; ▪ May result in passenger waiting areas experiencing less pedestrian congestion. 	<ul style="list-style-type: none"> ▪ Requires additional distance for no-parking restrictions; ▪ Increases walking distance for patrons crossing at intersection. ▪ Encourages patrons to cross street at midblock (jaywalking).

Table 3.7-1: Comparative Analysis of Bus Stop Locations.

The most common type of bus stop provided throughout New Jersey is the curb-side bus stop, also considered on-street location. This is the simplest and most inexpensive design for a transit agency to install. Besides that, it provides easy access for bus

drivers and results in minimal delay to a bus. However, there are several disadvantages with this design and other options should also be considered especially to provide transit riders safe, comfortable and convenient access. These include different types of bus bay designs (general, open and queue jumper bus bays) and nubs.

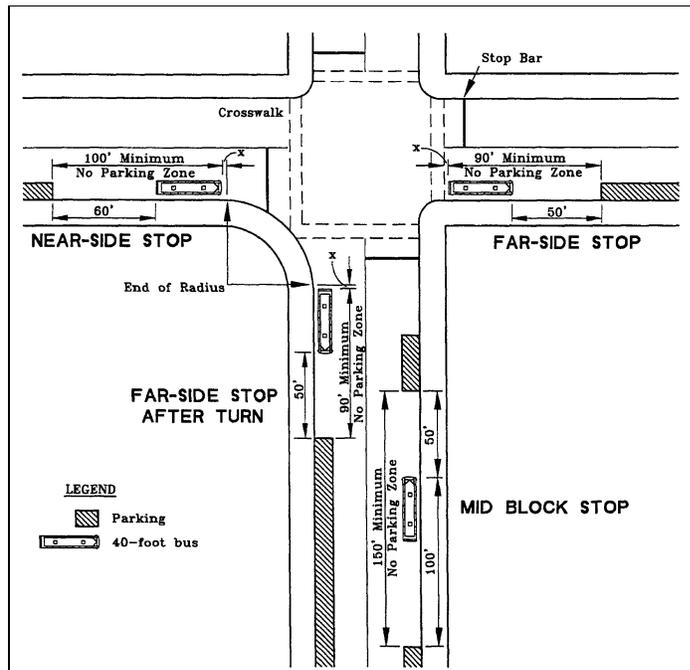


Figure 3.7-1: Typical Dimensions for On-Street Bus Stops^{xiii}

Source: NJ Transit

A bus bay (or turnout) allows through traffic to flow freely without obstruction of stopped buses. Bus bays should be considered when the following factors are present:

- Traffic in the curb lane exceeds 250 vehicles during the peak hour;
- Traffic speed is greater than 40mph;
- Bus volumes are 10 or more per peak hour on the roadway;
- Passenger volumes exceed 20 to 40 boardings an hour;
- Average peak-period dwell time exceeds 30 seconds per bus;
- Buses are expected to layover at the end of a trip;

^{xiii} It should be noted that various European guidelines, with regard to pedestrian and bicyclists safety at intersections, recommend to place bus stops at least 20m (approx. 60 feet) before an intersection since otherwise stopping buses will reduce cyclists and pedestrians safety and their visibility for other road users at the intersection.

- Potential for auto/ bus conflicts warrants separation of transit and passenger vehicles;
- History of repeated traffic and / or pedestrian accidents at stop location;
- Right-of-way width is adequate to construct a bay without adversely affecting sidewalk pedestrian movement;
- Sight distance (e.g. hills, curves) prevent traffic from stopping safely behind a stopped bus;
- A right-turn lane is used by buses as a queue jumper lane;
- Appropriate bus signal priority treatment exists at an intersection;
- Bus parking in the curb lane is prohibited, and
- Improvements, such as widening, are planned for a major roadway. (This provides the opportunity to include the bus bay as part of the reconstruction, resulting in a better-designed and less-costly bus bay.)

In conjunction with traffic signals, far-side bus bays are preferred since a far-side, curbside stop can cause vehicles stopping behind the bus to queue in the intersection. Important to note is that there is evidence that bus drivers will not use a bus bay when traffic volumes exceed 1,000 vehicles per hour per lane because the heavy volumes make it extremely difficult to maneuver a bus out of a midblock or near-side bay. These situations could be remedied by using acceleration bus lanes, signal priority, or far-side placements (signal creating gaps in traffic). Bus bays can also provide advantages to cyclists riding on-street especially on single-lane roadways since the cyclist is not forced into oncoming traffic when trying to pass a bus stopped on-street.

In an open bus bay design the bay is open to the upstream intersection. Besides the general bus bay advantages, with the open bus bay design the bus driver has the pavement width of the upstream cross street available to decelerate and to move the bus from the travel lane into the bay. Re-entry is more difficult than with the typical bus bay design. An important disadvantage is that the pedestrian crossing distance at an intersection increases by the width of the bay.

Another alternative is a partial open bus bay (with sidewalk extension) to reduce pedestrian crossing distance but still allow buses to use the intersection approach in entering the bay. This also prevents right-turning vehicles from using the bay for

acceleration movements.

Queue jumper bus bays provide priority treatment for buses along arterial streets by allowing the buses to bypass traffic queued at congested intersections. These bus stops consists of a near-side, right-turn lane and a far-side open bus bay allowing the buses to use the right-turn lane to bypass congestion and proceed through the intersection.

Nubs (also referred to as curb extensions and bus bulbs) are a section of sidewalk that extend from the curb of a parking lane to the edge of the through lane. Nubs have been used as traffic-calming techniques and as bus stops. Although they operate similar to curb-side bus stops, they offer additional areas for patrons to walk and wait for a bus and provide space for bus patron amenities such as shelters and benches.

Nubs should be considered at sites with the following characteristics:

- High pedestrian activity;
- Crowded sidewalks;
- Reduced pedestrian crossing distances, and
- Bus stops in travel lines.

Since nubs have particular application along streets with lower traffic speeds and/ or lower traffic volumes, additional speed reduction measures should be considered where pedestrian volumes are high and implementation of a nub seems appropriate. Collector streets in neighborhoods and designed pedestrian districts are considered good candidates for the nub design bus stop.

Far-side bus stops seem to encourage pedestrians/ patrons to cross the street from behind the bus, thus making them more visible to motorists approaching from behind the bus. As a result, far-side bus stops are considered to reduce accident risks. Bus bays (either far- or near-side) can also reduce the risk of pedestrians getting hit by approaching motorists since, given sufficient width of the bay, a pedestrian attempting to cross the street in front of a bus can still be within the bus bay area instead of stepping immediately into the travel lane, thus increasing visibility for both, the pedestrian and motorist. However, each type and placement of facility has its advantages and

disadvantages and each bus stop location and type should be evaluated individually (with site specific information) to decide the best and safest solution.

The problem of bus drivers discharging passengers along a route at various non-designated stops is generally an indication of insufficient bus stop locations. This will need to be carefully analyzed by the municipality in conjunction with the bus-operating agency. Although this problem may not always be avoidable, it certainly can be minimized by providing bus stops in the vicinity and close to locations where most people need to go/ come from. This can also have a very positive effect on ridership. Another approach to avoid the practice of bus drivers discharging passengers at non-bus stop locations could be passage of a local ordinance which would prohibit such practice and make the bus driver liable for any accident that happens to a patron discharged at a non-designated stop. Such an ordinance would most likely reduce the incidences of bus drivers stopping at any point on the route. Caution is advised with the interpretation of this recommendation; it is certainly not desirable to pass such ordinance before careful analysis of the existing conditions determining whether sufficient stops are provided within proximity to origins and destinations of patrons. Only when the practice of illegal discharging then continues should an ordinance be considered.

3.8 *Right-Turn-On-Red*

The New Jersey pedestrian guideline recommends prohibiting Right-Turn-On-Red where significant pedestrian activity is present and existing conditions warrant such a prohibition. Right-Turn-On-Red (RTOR) permission, which was introduced in the 1970's and has been found to sometimes have detrimental effects on pedestrians, including creating safety hazards. Therefore the practice deserves closer examination/ evaluation/ emphasis.

Concerns with prohibiting RTOR include that motorists are likely to disobey the regulation and/ or become aggravated if pedestrians are not present (e.g. at night or at locations with no pedestrian generators). A solution to this could be a partial (certain time of the day) restriction. A recent study conducted by the Insurance Institute for Highway Safety^{xiv}, which looked at 15 different intersections in Virginia found that at least

^{xiv} Status Report, Insurance Institute for Highway Safety, Vol. 36, No. 4, April 2001, p. 3.

time of day restrictions of RTOR have the potential to reduce crashes. Signs 'prohibiting RTOR from 7am to 7pm' increased the percentage of drivers who stopped at stop lines from 21 to 40 percent and reduced the number of drivers who turned right on red without stopping (32 to 13 percent). The number of pedestrians who yielded decreased slightly. At sites posted with signs 'prohibiting right on red when pedestrians are present', there was little change overall.

However, due to safety benefits to pedestrians, all-day RTOR restrictions should principally apply where and/ or when there are high (anticipated) all-day pedestrian volumes (e.g. downtown, near busy transit stops, etc.). This can be done either by posting a simple or more alerting sign.

A general problem with the RTOR is that while the law requires motorists to come to a full stop and yield to cross street traffic and pedestrians prior to turning, many motorists do not fully comply with the regulation. Motorists are often very intent on looking for traffic approaching on their left that they are not alert to pedestrians on their right. In addition motorists often pull into the crosswalk to wait for a gap in the traffic stream. A significant concern that is often raised when RTOR is prohibited is that this may lead to higher RTOG (Right-Turn-On-Green) conflicts when there are concurrent signals. Use of the leading pedestrian interval (LPI) can generally resolve this issue. However, when pedestrian volumes (or anticipated) are very high, exclusive pedestrian signals should be considered.^{xv}

4 Conclusion

It can be concluded that New Jersey's pedestrian guidelines are, in fact, very comprehensive and cover a great range of design and planning issues concerning the accommodation of pedestrians. However, the prevailing condition throughout most of the state is that pedestrians are accommodated on state and local roadways through (often just minimum width) sidewalk provisions, wide shoulders and crosswalk striping at intersections.

^{xv} www.Walkinginfo.org, Design and engineering: signals and signs: right turn on red.



Picture 4-1: Typical crosswalk condition – striped but hardly visible. Maplewood, NJ.



Picture 4-2: Typical sidewalk condition – minimum width and poorly maintained. Maplewood, NJ.

There are still only few examples where pedestrian activity has actually been progressively encouraged or where people on foot have been given priority before motor vehicle traffic.



Picture 4-3 and 4: Wide sidewalks, attractive storefronts and nice street furniture encourage people to walk.

One rather exceptional example in New Jersey can be found in downtown Red Bank, where sidewalks were widened, appropriate street trees and pedestrian-scaled street

lights implemented, bump-outs incorporated at selected intersections, several crosswalks have been brick paved, and benches and planters placed throughout downtown.



***Picture 4-5: Raised/ brick paved intersection and wide sidewalks, benches and other attractive street furniture create an inviting environment for walking.
Downtown Red Bank, NJ.***



***Picture 4-6: Bulb-outs reduce crossing distances for pedestrians.
Downtown Red Bank, NJ.***

Pedestrian activity has soared in Red Bank since these improvements were made. In South Orange a four-lane thoroughfare was reduced to one-way in each direction with center turn lanes at intersections, to gain greater sidewalk space. Crosswalks have been marked/ striped and bulb-outs implemented to reduce crossing distances.

These are examples of provisions that not only consider accommodating pedestrians but actually encourage (and to some extent prioritize) pedestrian activity where it seems appropriate. However, these are exceptions in NJ, even in downtown commercial and retail hubs, school areas and other pedestrian generating locations, pedestrians are rarely given appropriate considerations.



Picture 4-7: Main Street (before) with two lanes in each direction. South Orange, NJ.



Picture 4-8: Main Street (after) with one lane in each direction and center turning lanes, paved crosswalks and widened sidewalks. South Orange, NJ.



Picture 4-9: Main Street (after) – improved sidewalk and streetscape. South Orange, NJ.



Picture 4-10: Main Street (after) – improved aesthetics and lighting in alleys. South Orange, NJ.

Unfortunately crash statistics also don't speak in favor of pedestrian safety throughout the state. Although New Jersey - compared to other states - ranks fairly low regarding total traffic fatalities, one in every five people who are killed along roadways are not in vehicles but on foot. One might argue, given that New Jersey is the most densely populated state in the country, it is likely that more people walk (there are no statistics available on the actual amount of people walking) and thus, more people get killed. However, it is a fact that on New Jersey's roadways about 150 people on foot are killed each year and these are alerting and unacceptable numbers.^{xvi}

^{xvi} Traffic Safety Facts, *Pedestrians*, NHTSA, DOT HS 809 094.

It would be easy if the problem were just the existing guidelines. However, it is not that simple. The problem is a combination of several factors including: a lack of walking and bicycling promoting policies at all levels of government as these are healthy, - sustainable - and environmentally friendly modes of transportation; compliance among various state guidelines and standards; lack of (community and engineer) knowledge about existing pedestrian planning and design guidelines; lack of requirement and consideration of walking and bicycling within the initial scoping phase of transportation projects (often, at best, walking and bicycling is considered as an afterthought which creates controversies due to space- and funding problems); a lack of enforcement and education of the various road users; and finally, a lack of appreciation and acceptance of people walking among the general public.

People on foot are often considered a nuisance especially to fast and efficient automobile movement. Additionally, streets where people walk are often associated with higher crime rates (as walking and bicycling often occurs in lower-income neighborhoods where not everybody can afford owning a car) and noise; such generalizations have put pedestrians and cyclists in a negative light with the American public. Too little media attention is given to the benefits of these sustainable modes such as public health, safety, social encounter, and the feeling of independence that many people (especially children) experience when they walk to get to places.

Another issue worthy of discussion is that the roadway design manual, the RSIS and also most municipal master plans state that if a community wants to retain its rural character, they are not required to implement sidewalks. It seems odd that a sidewalk would make a place less rural. Thesauruses would define rural space as peaceful, idyllic, simple, natural – how have we come to accept the argument that walking would damage areas defined as such but accept that roads and cars contribute to retain these characters?

Thus, the recommendations made within this paper will only partially contribute to solving a problem that is much broader in scope. However, the recommendations are useful for future implementation. They provide a variety of choices to local officials, planners and engineers and should be considered for a consistent update of all roadway planning and design guidelines and standards.

One Last Thought

The Highway Classification System

Another principal problem contributing to the lack of recognition of pedestrian needs, but not addressed within this paper, may be the existing highway classification system, which in most localities in the US, including New Jersey, is based on the AASHTO method.

The highway classification system is the framework for describing the type of roadway that can be built as part of a given design code. The US and thus the state's system differentiate between arterial, collector, and local roadways and treats roadways in an urban downtown differently from highways in an open rural environment. A caveat in this method is that the distinction is made on the basis of area wide population density. In other words the system classifies roadways over a fairly wide geographic area and does not respond to localized changes such as that encountered in going from open fields to small villages. Thus, the context of an area/ roadway is ignored. As a comparison some European systems distinguish between a much larger number of roadway settings based on different criteria. Whereas the first criteria is often similar to AASHTO and distinguishes between rural and urban, they further ask whether the road is outside or within a built-up area. The second criteria considers the physical aspects of the setting: is the road framed by buildings. The third and most important criteria different from AASHTO in the European systems is the consideration of the non-vehicular uses of the roadway: is the roadway used largely for vehicular or pedestrian access, or does it serve the role as a public gathering place? The U.S. system does not contain the implicit understanding that roadways serve many functions beyond that of simply carrying vehicular traffic.

AASHTO fails to recognize clusters of development in a rural context such as village centers. These village centers however, are centers of activity in the rural communities as they encompass public facilities such as schools, churches, post offices, libraries and small commercial establishments. Thus often roads do not alter their design as they enter village centers. The roadway design does not lead the driver to adopt a driving behavior appropriate for a village center, where they might have to share the road with

pedestrians and cyclists. Often only a speed limit sign indicates the entrance to a village center. The absence of sidewalks, which are not required in rural design standards, often forces pedestrians to walk on the highway.

In recent years a shift in the provision of transportation infrastructure has taken place and context sensitive design has emerged as a new planning practice. Engineers for example have started to specify more moderate roadway and shoulder width, and to design for lower design speeds where appropriate, as for example a highway or state road that cuts through a village center. However, there are still many examples of local communities, which are unwilling to simply depend on the application of flexible design standards and often they are unaware of such practice. Sidewalks for example have still not become a standard in the highway layout in rural village centers, even in the vicinity of schools. The experiences of these communities emphasize the need to institutionalize the change.

In addition, other highway classification systems recognize that streets do not only serve transportation related functions. They are a place of commercial and social encounter; they are part of public realm and often serve social activity just as much as they serve automobile travel. Urban planners more and more embrace a perception of streets incorporating varied functions therefore functional classification should also incorporate non-transportation functions and facilitate suitable design.^{xvii}

^{xvii} Garrick, N.W. and Kuhnimhof, T., Street Design and Community Livability.

5 Appendix

Think Pedestrian Checklist

At some point everyone is a pedestrian, whether the walk is for fitness, to get places or between modes or places as for example we park our car and walk to a train station, or park our car and walk to the store. To make our experience as a pedestrian more pleasant and more safe it is important to consider what puts pedestrians at risk and how these risks can be resolved or at least minimized. The following list is intended to help as “think pedestrian”.

- Risks are greatest in urban areas where pedestrian activity tends to be higher and concentrated;
- Problems are especially severe in central city areas, where vehicle traffic is heavy and recreation space is limited;
- Sixty-eight percent of pedestrian deaths occur in urban settings (Note: most people walk here), although there is a higher ratio of deaths to injuries in rural areas because of higher impact speeds on rural roads;
- A substantial number of pedestrian injuries occur at intersections;
- A substantial number of urban pedestrian crashes involve turning vehicles, particularly left-turning vehicles;
- The majority of pedestrian crashes occur at locations other than intersections, where vehicle speeds are higher and drivers do not expect to have to stop. One common type of collision can be characterized as a dart-out because a pedestrian appears suddenly from the roadside allowing the driver little time to react. A good example is a child running out from between parked cars on a residential street;
- At impact speeds slower than 10-12 mph a car may (only) hit the upper leg and torso of a child, and the upper and lower leg of an adult; at higher speeds, pedestrians usually slide over the front edge of the hood before their upper bodies strike the vehicle;
- Allowing right turns on red has been shown to increase pedestrian collisions at intersections, especially in urban areas, so curbing this practice at least in areas of high pedestrian activity would likely reduce pedestrian collisions;

- Extending the time available for pedestrians, especially elderly ones, to cross with a green light can also improve pedestrian safety at signals;
- Special warning signs and pavement markings designed to encourage or prompt pedestrians to look for turning vehicles as they cross the street may help lower pedestrian collisions; an Institute study found the use of sign prompts and crosswalk warning messages increased the percentage of pedestrians looking for threats from turning vehicles and decreased the number of conflicts between them;
- One study found that providing pedestrians a three-second head start through the use of a leading pedestrian interval - a signal that allows pedestrians to begin crossing prior to the release of turning vehicles - reduces conflicts between pedestrians and turning vehicles as well as the incidence of pedestrians yielding the right-of-way to turning vehicles. Other Institute research found that moving painted stop lines farther back from crosswalks than the standard 4 feet resulted in a significant increase of drivers who stopped at least 4 feet from the crosswalks and a significant decrease in the percentage of drivers who stopped within the crosswalks;
- Speed limits should be strictly enforced in areas of pedestrian activity. The faster a vehicle is traveling, the less likely it is that a driver can stop in time to avoid hitting a pedestrian. When collisions do occur, the ratio of deaths to injuries is higher where speed limits are higher.
- Red light violations also need to be curbed.^{xviii}

^{xviii} http://www.iihs.org.safety_facts/fatality_facts/peds.html. Insurance Institute for Highway Safety, pp. 1-3, October 2000.

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Photo Resources

Voorhees Transportation Policy Institute Photo Collection

Michael King, Traffic Calmer and Architect

Dan Burden's Walkable Communities Slide Collection

Danish Collection of Cycle Concepts