City of Imperial Beach

Pedestrian Safety and Crosswalk Installation Policy

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City of Imperial Beach
Public Works Department
825 Imperial Beach Blvd.
Imperial Beach, CA 9193

GLOSSARY

Actuated Signal: A traffic signal or other indication where the phasing is controlled by the direct or indirect actions of the user such as push buttons, or video, inductive loop or other type of detection devices.

Advance Stop Line (ASL): A stop line at an intersection or mid-block crossing placed before a marked crosswalk.

Average Daily Traffic (ADT): The total bi-directional volume of traffic passing through a given point during a 24-hour period.

Approach: This is the portion of an intersection leg used by incoming traffic.

AASHTO: American Association of State Highway and Transportation Officials.

Bulbout: Another term for a curb extension, which protrudes into the street at an intersection or mid-block crossing to reduce the exposure for pedestrians and to reduce vehicular traffic speeds.

Controlled Location: Intersection or mid-block crossing location with a traffic signal or stop sign.

Channelization: This is the separation or regulation of conflicting traffic movements into definite paths of travel by use of pavement markings, raised islands or other suitable means to facilitate the safe and orderly conduct of vehicles and/or pedestrians.

Crosswalk: Portion of roadway where pedestrians are permitted to cross the street; may be marked or unmarked.

CTCDC: California Traffic Control Device Commission.

Curb Extension: See Bulbout.

Curb Radius: The radius of the circle joining the intersecting street curbs at a corner.

Curb Ramp: A combined ramp and landing that accomplishes a change in level at a curb. This element provides street and sidewalk access to pedestrians using wheelchairs.

Cycle Time: Time, in seconds, required for one complete sequence of signal indications for all movements at a given intersection.

Delay: This is the lost time (compared to free flow conditions) for vehicles, pedestrians or bicyclists.

Detectable Warning: A surface specified in the Americans with Disabilities Act Accessibility Guidelines, comprised of raised, truncated domes, used to inform pedestrians who are visually impaired, of road and rail vehicle crossings in the area immediately ahead.

85th Percentile Speed: The average speed at which 85 percent of drivers on a particular roadway are traveling.

Exclusive Pedestrian Phase: Signal phase during which only pedestrians are permitted to cross in an intersection and all vehicular signals display red.

FHWA: Federal Highway Administration.

Green Time: This is the length of a green indication for a particular traffic movement.

Island: A defined area between traffic lanes for control of vehicle movements and/or for pedestrian refuge.

Level of Service (LOS): This is a measure of the mobility characteristics of a transportation facility. Level of service for vehicles is determined by the delay or the volume/capacity ratio. Pedestrian and bicycle level of service can be quantitative or qualitative, using measures such as connectivity, comfort, accessibility and convenience.

Median: Portion of a divided highway or roadway separating the traveled ways for traffic moving in opposite directions. This may consist of a paved surface, unpaved surface, or raised island that can also serve as a refuge for pedestrians and other non-motorized roadway users.

Mid-block Crossing: A crossing point positioned between intersections rather than at an intersection.

Pedestrian: A person who travels on foot, or who uses assistive devices such as a wheelchair, for mobility.

Refuge Island: A median island that is designed to allow pedestrians to cross a street safely.

Scramble Phase: Pedestrians are permitted to cross in all directions at an intersection including diagonally, during an exclusive pedestrian signal phase.

Signal Cycle: One complete sequence of signal indications for all movements at a given intersection.

Signal Progression: Progressive movement of traffic (without stopping) at a planned speed, through signalized locations.

Sight Distance (SD): The length of roadway visible to the driver, bicyclist or pedestrian with an unobstructed line of sight.

Stopping Sight Distance: The distance traveled by a vehicle from the instant a driver of a vehicle sights an object necessitating a stop to where the vehicle is fully stopped, including the time needed to recognize the situation and apply the brakes.

Turning Radius: The minimum path of a turning vehicle at a corner. See also “curb radius.”

Traffic Calming Device: A physical measure used to divert or slow traffic.

Uncontrolled Location: Intersection or mid-block crossing without a traffic signal or stop sign.

Volume: The number of vehicles passing a given point during a specified period.

Warrants: Warrants are intended to provide guidance to the transportation professional in evaluating potential safety and operational benefits of installing improvements based on ‘average’ or ‘normal’ conditions. Warrants are not a substitute for engineering judgment. The fact that a warrant is met is not conclusive justification for the installations. Reliance exclusively on warrants may fail to provide adequate facilities for pedestrians, especially those with disabilities.

INTRODUCTION

This document provides guidelines for improving pedestrian safety and enhancing pedestrian circulation. It is intended to work in conjunction with the Neighborhood Traffic Management Program (NTMP) the City of Imperial Beach developed to create a process for implementing “traffic calming” measures to address safety concerns, traffic problems and quality-of-life issues related to speeding on neighborhood streets. A comprehensive pedestrian safety strategy contains a three-pronged approach of engineering, enforcement, and education programs. This document focuses on engineering elements, such as pedestrian crossing treatments and intersection design.

This document describes best practices related to numerous pedestrian treatments, including: pedestrian signals, pedestrian refuge islands, compact intersections, sidewalks, and crosswalks. It includes information about signalized and unsignalized locations, intersection design, and innovative treatments for at-grade crossings. It also includes recommendations for evaluating pedestrian safety as part of the development review process. This document is intended to serve as a reference guide for staff, citizens, and developers when determining the best engineering solutions to pedestrian safety concerns, particularly with regard to the location and design of crosswalks, pedestrian signals, and other elements of pedestrian safety.

Development of pedestrian safety guidelines will guide the City and developers in making decisions about where basic crosswalks (two stripes) can be marked; where crosswalks with special treatments, such as high visibility crosswalks, flashing beacons and other special features, should be employed; and where crosswalks will not be marked due to safety concerns resulting from volume, speed or sight distance issues. The Pedestrian Safety and Crosswalk Installation Policy also establish criteria for considering crosswalks at unsignalized or mid-block locations.

I. FUNCTION OF CROSSWALKS

Well-marked pedestrian crossings accomplish dual goals. They prepare drivers for the likelihood of encountering a pedestrian, and they create an atmosphere of walkability and accessibility for pedestrians. In California, it is legal for pedestrians to cross any street, except at unmarked locations between immediately adjacent signalized crossings or where crossing is expressly prohibited. Marked crossings reinforce the location and legitimacy of a crossing.

Why do cities mark crosswalks?

Crosswalk Function:

- Creating reasonable expectations where pedestrians may cross a roadway
- Predictability of pedestrian actions and movement
- Channelization of pedestrians to designated crossing locations

Advantages of marked crosswalks:

- Help pedestrians find their way across complex intersections
- Designate the shortest path
- Direct pedestrians to locations of best sight distance

Disadvantages of marked crosswalks:

- May create a “false sense of security” for pedestrians
- At uncontrolled locations on multi-lane streets with higher traffic volumes, may result in a greater number of pedestrian collisions if additional enhancements are not provided
- Maintenance is costly

In pedestrian-friendly cities, crossing locations are treated as essential links in the pedestrian network. At mid-block locations, pedestrians cannot cross legally without a marked crosswalk. When there are pedestrian generators in these locations, it may be appropriate to create safe, convenient crossing opportunities. Without mid-block crossing locations, pedestrians face the following three choices: detour to a controlled crossing location; detour to an intersection where it is legal to cross, even if not controlled; or cross illegally (jaywalk).

Steps in identifying candidate locations for crosswalks

The first step in identifying candidate crosswalk locations is to identify the places people would like to walk (pedestrian desire lines) which are affected by local land uses (homes, schools, parks, commercial establishments, etc.) and the location of transit stops. This information forms a basis for identifying pedestrian crossing improvement areas and prioritizing such improvements, thereby creating a convenient, connective and continuous walking environment.

The second step is identifying where it is safest for people to cross. Of all road users, pedestrians have the highest risk because they are the least protected. National statistics indicate that pedestrians represent 14 percent of all traffic incident fatalities while walking accounts for only three percent of total travel trips. Pedestrian collisions occur most often when a pedestrian is attempting to cross the street at an intersection or mid-block location.

Several major studies of pedestrian collision rates at marked and unmarked crosswalks have been conducted. In 2002, the Federal Highway Administration (FHWA) published a comprehensive report on the relative safety of marked and unmarked crossings. This document presents a variety of special treatment options to mitigate safety, visibility or operational concerns at specific locations. The flowchart on page 18 outlines the steps in identifying candidate locations for crosswalks based on the findings of the 2002 FHWA Study described on pages 6-8.

II. CROSSWALK SAFETY RESEARCH

A study by the City of San Diego in 1970 found that a higher rate of collisions involving pedestrians occurred at uncontrolled locations with marked crosswalks. However, the City of San Diego study, which was widely used by many other cities as a rationale for removing marked crosswalks at uncontrolled locations, fails to differentiate between different types of streets and crossing locations. A separate study conducted on California State highways reached similar conclusions in 1996, but this study was also limited in its applicability to City streets that typically have fewer lanes and carry less traffic volume than State highways.

More recent research conducted by the Federal Highway Administration (FHWA) in 2002 found that on two-lane roads, the presence of a marked crosswalk alone at an uncontrolled location was associated with no difference in pedestrian crash rate, compared to an unmarked crosswalk. On multilane roads with higher traffic volumes, having a marked crosswalk alone was associated with a higher pedestrian crash rate compared to an unmarked crosswalk. This research may be more relevant for developing a crosswalk policy for the City due to the City's varying street types.

The 2002 FHWA study of pedestrian collisions at marked and unmarked crosswalks is widely recognized as the best resource for determining appropriate locations for marked crosswalks at uncontrolled locations.

This study is used because:

- It is extensive - It examined motor vehicle/pedestrian collision rates at a large number of crossing locations not limited by roadway characteristics in 30 different cities

- It is thorough - The collision rates were broken down by roadway characteristics (two-lane and multi-lane roads with various speeds and traffic volumes) in order to give the clearest picture of pedestrian safety at each type of location

The authors of the study note that:

"When considering marked crosswalks at uncontrolled locations, the question should not simply be: 'Should I provide a marked crosswalk or not?' Instead, the question should be: 'Is this an appropriate tool for getting pedestrians across the street?' Regardless of whether marked crosswalks are used, there remains the fundamental obligation to get pedestrians safely across the street."

FHWA Study Summary (2002)

Study Objective: To compare pedestrian crash occurrence at marked versus unmarked crosswalks at uncontrolled intersections throughout the U.S.

Data:

- 1,000 marked and 1,000 unmarked crossings
- No school crossings
- Mid-block locations were included
- Crash history (5 years), pedestrian volumes, traffic volumes, number of lanes, speed limit
- 229 pedestrian accidents in the sample

Key findings:

a) 2-lane roads: No significant difference between marked and unmarked crosswalks
b) Multi-lane road with Average Daily Traffic (ADT) below 12,000: No significant difference between marked and unmarked crosswalks
c) Multi-lane road with ADT above 12,000 and no raised median: Marked crosswalks had significantly higher pedestrian crash rates than unmarked crosswalks
d) Multi-lane road with ADT above 15,000 and with raised median: Marked crosswalks had significantly higher pedestrian crash rates than unmarked crosswalks
e) Variables having no effect: Area type, mid-block versus intersection, speed limit, one-way versus two-way, crosswalk condition and marking pattern had no effect on the occurrence of pedestrian crashes
f) Multiple threat crashes: 17.6 percent of the crashes in marked crosswalks were multiple threat crashes (i.e. one vehicle stops for the pedestrian but the driver in the adjacent lane does not see the pedestrian). None occurred in unmarked crosswalks

The table on the following page summarizes the FHWA recommendations for installing marked crosswalks at uncontrolled locations, based on the findings of the 2002 study.

Table 1. 2002 FHWA recommendations for considering marked crosswalks and other needed pedestrian improvements at uncontrolled locations

	≤ 9,000 ADT			> 9,000 to ≥ 12,000 to			> 12,000 to ≤ 15,000 ADT			> 15,000 ADT		
	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph
2 lanes												
3 lanes												
++4 lanes Raised median[c]												
++4 lanes No median												

Key

Candidate sites for marked crosswalks. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk alone.

Probable candidate sites for marked crosswalks. Potential increase in pedestrian crash risk may occur if marked crosswalks are added without other pedestrian facility enhancements. These locations should be closely monitored and may be considered for enhancements as feasible.

Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.

a. These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.

b. Where the posted speed limit or 85th percentile speed exceeds 40 mph, marked crosswalks alone should not be used at uncontrolled locations.

c. The raised median or refuge island must be at least 4 ft. (1.2 m) wide and 6 ft. (1.8 m) long to adequately serve as a refuge area for pedestrians.

III. CONTROLLED LOCATIONS

Best Practices

The following is the recommended, or best practice, for pedestrian treatments in crosswalks at signalized intersections or stop-controlled approaches (i.e., vehicles stop at approach in question).

- **Mark crosswalks on all approaches** (i.e., legs of the intersection) using "Continental" crosswalk markings per California Standard Plans' "Continental" crosswalk design. In addition, at intersections where at least one crosswalk is uncontrolled but stop signs exist in advance of other warranted marked crosswalks, all crosswalks at the intersection shall consist of "Continental" markings. Where the accident data or observations of conflicts identify a crosswalk of particular concern, consider the special treatments identified below.

- **Special School Crosswalks** are marked crosswalks established adjacent to a school building or school grounds and must be painted yellow. Other established marked crosswalks may be painted yellow if the nearest point of the crosswalk is not more than 600 feet from a school building or grounds.

- **Pedestrian signals should be timed for a pedestrian travel speed of 4 feet per second[4].** If there are special land uses such as senior centers or schools within 100 feet of the intersection, slower walking speeds (3.5 feet per second) may be considered

The following two situations are exceptions to the policy of marking crosswalks on all approaches:

- **Crossing locations with heavy right- or left-turn volumes** that occur during the same signal phase as the conflicting pedestrian movement where protected signal phasing for the heavy movement or other solutions are infeasible[5]

- **Intersections with inadequate sight distance[6]** of pedestrians. Elimination of crosswalks in these instances should only occur after other solutions have been deemed infeasible

[4] The current standard of 4 feet per second is based on California Department of Transportation (Caltrans) Traffic Manual, 1996. 3.5 feet per second is recommended for pedestrian crossings by the U.S. Department of Transportation, Designing Sidewalks and Trails for Access, Part II: Best Practices Design Guide, 2001.
[5] Alternative pedestrian crossings should be identified and it may be necessary to install barrier treatments to reinforce that pedestrian should not cross at the location without a marked crosswalk.
[6] Unrestricted sight distance of pedestrians by motorists should be at least ten times the speed limit (for example, 250 feet for a street with a speed limit of 25 miles per hour).

Special Treatments

There are a number of innovative treatments for pedestrians at signalized intersections, mostly related to pedestrian signals. At locations with high pedestrian volumes and pedestrian-vehicle conflicts, the following measures are means to enhance the safety of pedestrian crossings:

<u>High numbers of turning vehicles</u>

- The **Animated Eye Light Emitting Diode (LED) Signal** is a tool for reminding pedestrians to watch for turning vehicles. It would normally be used at intersections with large numbers of turning vehicles (vehicles turning left or right into the crosswalk)

- **Early Release** or pedestrian lead-time, allows pedestrians to establish themselves in the crosswalk, reducing conflicts between pedestrians and turning vehicles

- **Special Pavement stencils** such as "Pedestrians Look Left" or "Watch Turning Vehicles" stencil are used to remind pedestrians to be watchful. These stencils, used in conjunction with special signage, significantly reduced the number of pedestrians not looking for threats at intersections.[7] Additionally, high-visibility crosswalks help channelize pedestrians

- Other special treatments include **"Yield to Pedestrians" signs**, and **reduced corner radii** to slow the speeds of right-turning vehicles. The curb radius should accommodate the expected amount and type of traffic for safe turning speeds. As the curb radius increases, incomplete stops become more frequent and drivers make turns at higher speeds.[8] Recommended ranges for curb radii are contained include: 15 feet for intersecting residential streets (local or collector), 20 feet to 30 feet for non-residential local and collector intersections. For arterial intersections, a curb radius of 30 feet would be required, except for industrial or truck route streets in which a 50-foot radius is required to accommodate a higher volume of truck turning movements

- Whenever possible, especially at locations adjacent to pedestrian generators, intersections should be designed without "free rights" for vehicles.

- **Pedestrian "scramble" phases**, so called because pedestrians have a walk signal in every direction while vehicles have a red light on all approaches. This treatment is appropriate in central business districts where pedestrian volumes are exceptionally high

- **"No Right Turn on Red" restrictions** for vehicles reduce pedestrian-vehicle conflicts at locations with high numbers of pedestrians, but makes vehicle circulation less convenient and may cause traffic diversions. This type of treatment needs to be considered on a case-by-case basis. Traffic signal service levels need to remain at acceptable levels

- **Advance stop lines or yield lines** are stop or yield bars placed four feet in advance of the crosswalk. Advance stop lines or yield bars should be considered based on pedestrian volumes, generators and safety concerns relevant to a specific crossing

[7] Van Houten, Ron et al, "Special Signs and Pavement Markings Improve Pedestrian Safety," ITE Journal, December 1996.
[8] Kulash, William M., Residential Streets, Urban Land Institute, 2001.

Wide intersections

- **Countdown signals** are useful at locations with crossing distances greater than 60 feet and pedestrian clearance intervals of greater than 15 seconds or a high pedestrian volume. At wide streets with long clearance intervals, the countdown signal effectively communicates the amount of time left to cross the street. At wide streets with medians, there should be adequate crossing time for the pedestrian to traverse the entire distance and countdown signals should be used as a default

- **Pedestrian Refuge Islands** should extend through the crosswalk, with a curb cut for wheelchair accessibility. Refuge islands should be clear of obstructions and have adequate drainage. They should be at least 12 feet long or the width of the crosswalk (whichever is greater) and 60 feet square. At actuated pedestrian signals, an accessible pedestrian push button should also be located in the median. Recommended refuge island widths are as follows:

Speed	**Minimum Width[9]**
25-30 mph	5 feet
30-35 mph	6 feet
35-45	8 feet

- Bulbouts are appropriate at locations with usable space next to the curb. Consider bulbouts at intersections of three or more lanes. Bulbouts should not extend further than six feet into the street adjacent to parallel parking, or 12 feet adjacent to diagonal parking. At locations with no on-street parking, bulbouts should not impede bicycle travel.

Pedestrian actuated signals

At pre-timed signals, pedestrians get the signal to walk on every crossing, in every signal cycle. However, many signals are not pre-timed, meaning vehicles activate them. These signals have pedestrian push-buttons, which pedestrians must push in order to get a walk signal and adequate time to cross the street.

- At locations where pedestrian activation is registered for greater than 75 percent of the peak hour signal cycles, signals could be set to accommodate pedestrian crossings in every peak period cycle

- At locations that are not on a direct path to a generator with low side street volumes, signals should be partially-actuated, meaning that pedestrians crossing the side streets get a WALK signal on every cycle, but pedestrians crossing the main street must use the pedestrian push button

- At locations that do not satisfy the location warrants above, where peak hour vehicle congestion and high vehicle volumes occur on all approaches, signals should be fully-actuated

When pedestrian push buttons are used, they should be well-marked, visible, and accessible to all pedestrians from a flat surface, consistent with recommendations from the U.S. Department of Transportation's Designing Sidewalks and Trails for Access.

[9] Where bikes are expected to use the crosswalk, medians should be at least six feet wide, the length of an average bike.

IV. UNCONTROLLED LOCATIONS

This section describes best practices for considering the installation of crosswalks at uncontrolled intersections and mid-block locations, safety considerations, and special treatments in locations where special consideration is recommended.

When to Install Crosswalks at Uncontrolled Intersections

The following is the recommended, or best practice, for pedestrian treatments at uncontrolled approaches to intersections that are not controlled by traffic signals or stop signs.[10]

Crossings should be marked where all of the following occur:

- Sufficient demand exists to justify the installation of a crosswalk (see Demand Considerations below)
- The location is 300 feet or more from a controlled crossing location
- The location has sufficient sight distance (sight distance in feet should be greater than 10 times the speed limit), and/or sight distance will be improved prior to crosswalk marking
- Safety considerations do not preclude a crosswalk (see page 13, Safety Considerations at Uncontrolled Locations)

Demand Considerations: Uncontrolled crossings should be identified as a candidate for marking if there is a demonstrated need for a crosswalk. Need can be demonstrated by:

- 20 pedestrians per hour during the peak hour or 60 pedestrians total for the highest consecutive four-hour period

or:

- The crossing is on a direct route to or from a pedestrian generator, such as a school, library, senior center, shopping center, park, or employment center

[10] The most common crosswalk of this type will be at intersections where a minor side street has a stop sign and a major street is uncontrolled.

When to Install Crosswalks at Mid-Block Locations

Mid-block crossings should be marked where the following occur:

- Sufficient demand exists to justify the installation of a crosswalk (see Demand Considerations below)
- The mid-block location is 300 feet or more from another crossing location
- The mid-block location has sufficient sight distance (sight distance in feet should be greater than 10 times the speed limit)
- Provision of a crossing would channelize potential jay-walkers to a suitable crossing location
- Safety considerations do not preclude a crosswalk (see below, Safety Considerations at Uncontrolled Locations)

Where mid-block crosswalks are installed, the default design should be the “triple four” or high-visibility pavement treatments. The installation of mid-block crosswalks requires approval of the City Council.

Demand Considerations: Candidate locations for marked pedestrian crossings at mid-block locations should meet one of the following criteria:

- 40 pedestrians during a one-hour period or 25/hour for four consecutive hours
- A pedestrian generator is less than 300 feet away at a location mid-way between signal or stop-controlled intersections, or there are significant pedestrian trip generators on both sides of the street

Safety Considerations at Uncontrolled Locations

The flowchart on page 18 and corresponding tables on pages 19 and 20 should be used to determine if special treatments are needed to ensure safe crossing at uncontrolled locations (see below for examples of special treatments). Where safety concerns would continue even with special treatments, pedestrian signal warrants, established in Caltrans’ Traffic Manual, should be tested to determine whether the crossing warrants a signal. In the event that a signal is determined to be inappropriate, the crosswalk should not be marked.

A crosswalk should not be installed if sight distance in feet is less than ten times the speed limit. For example, if an intersection has an approach speed of 25 miles per hour, the unrestricted view of pedestrians by motorists should be at least 250 feet.

Special Treatments for Uncontrolled Locations

Where marking a crosswalk is deemed appropriate at an uncontrolled crossing location on either a multi-lane street (three or more lanes) or on two-lane streets with ADT greater than 12,000 or where the posted speed limit exceeds 30 miles per hour then the crossing should be a high-visibility style.

High visibility crosswalks include textured pavement crosswalks and the “Continental” marked crosswalk. The use of textured crosswalks should be selective due to higher maintenance costs.

Additional special treatments can be considered at areas with heightened safety concerns. See pages 19 and 20 for guidance on choosing crosswalk treatments for different street types, with crosswalk treatments chosen from level one, two and three devices outlined below:

LEVEL ONE

- **High-Visibility Crosswalk Striping** – “Continental” crosswalk treatments provide heightened visibility over standard crosswalk marking per CA-MUTCD 3B.18. The “Continental” crosswalk shall consist of 24-inch-wide longitudinal white retro-reflective thermoplastic lines separated by a consistent 24" – 48" gap. In Imperial Beach, this gap shall typically be 36" as to best avoid vehicle wheel paths. The gap width shall be determined and confirmed by staff in the field.

- **High-Visibility Crosswalk Signage and Markings** – These treatments use advanced and at-crossing signage and advanced pavement markings to provide substantial visibility and warning at all crosswalks per CA-MUTCD Figure 3B.17, CA-MUTCD Section 7C.03, and Figure 7C-101. For non-school crosswalks, a combination of W11-2 and W16-9P signs with white “PED XING” pavement markings are to be used. For school crosswalks, a combination of SW24-2 and SW24-3 signs with yellow “SLOW SCHOOL ZONE XING” pavement markings are to be used.

- **Advanced Yield Lines and Yield Signage** – These treatments are to be used at all multi-lane approaches to crosswalks to provide substantial visibility and warning at all crosswalks and reduce likelihood of multiple-threat collisions pursuant to CA-MUTCD 3B-16 and 3B-17. The yield lines shall be installed per CA-MUTCD Figure 3B-16 standards at all multilane crosswalk approaches. All yield lines shall be accompanied by R1-5 or R1-5A sign per CA-MUTCD Figure 3B-17.

- **In-Street Pedestrian Crossing Signs** – These signs provide substantial visibility and warning and pedestrian right-of-way reminders at all crosswalk locations on low-speed two-lane roadways where risk of vehicular collisions with the sign is lowest. In-Street Pedestrian Crossing (R1-6) signs (CA-MUTCD Figure 2B-2) shall be placed in the roadway at the crossing location on the centerline, lane line, or median. The sign shall not be post-mounted on the left-hand or right-hand side of the roadway.

- **On-Street Parking Removal with Red Curb** – Per the FHWA Pedestrian Safety Guide and Countermeasure Selection System (Parking Restrictions at Crossing Locations), red curbing provides sight lines to pedestrians queuing to cross and improves their visibility to oncoming motorists. In locations where parking obstructs the sight lines between pedestrians and motorists, parking should be removed and at least 20 feet of red curb should be painted so approaching motorists can have a clear view of the pedestrian queue area.

- **Bulbouts (intersection crossing)** – Each corner of the intersection is extended into the intersection by approximately seven to eight feet to shorten the crossing distance for pedestrians and raise their visibility to motorists. Bulbouts also reduce speed of turning vehicles, encourage

pedestrians to cross at designated locations, and prevent vehicles from parking at corners. The FHWA Pedestrian Safety Guide and Countermeasure Selections System (Curb Extension) designates using bulbouts where it is desirable to shorten the crossing distance and increase visibility within the presence of a parking lane. Curb extensions should only be used where there is a parking lane and where transit and bicyclists would be traveling outside the curb edge for the length of the street. Care should be taken to ensure that street furniture and landscaping do not block motorists' views of pedestrians.

- **Bulbouts (mid-block crossing)** – Curbs are extended into the street by approximately seven to eight feet to shorten the crossing distance for pedestrians and raise their visibility to motorists. Bulbouts also reduce speed of turning vehicles, encourage pedestrians to cross at designated locations, and prevent vehicles from parking at corners. The FHWA Pedestrian Safety Guide and Countermeasure Selections System (Curb Extension) designates using bulbouts where it is desirable to shorten the crossing distance and increase visibility within the presence of a parking lane. Curb extensions should only be used where there is a parking lane and where transit and bicyclists would be traveling outside the curb edge for the length of the street. Care should be taken to ensure that street furniture and landscaping do not block motorists' views of pedestrians.

- **Tighten Curb Radius** – The FHWA Pedestrian Safety Guide and Countermeasure Selection System (Smaller Curb Radius) suggests tightening intersection curb radius' to decrease vehicle turning speed, increase sidewalk space and shorten pedestrian crossings. This treatment is appropriate on roadways with low truck turning volumes, where, traffic calming is a desired benefit, and where there is a history of right turn on red conflict. Radii may be increased to accommodate larger design vehicles. The proper radius design should accommodate public maintenance vehicles, school buses, and emergency vehicles and should take into account parking and bicycle lanes.

LEVEL TWO

- **Raised Median Pedestrian Refuge Island** - On multi-lane streets with ADT of less than 15,000 and 85th percentile speeds of less than 35 miles per hour, the FHWA research described earlier in this report concludes that provision of a median can address safety concerns. The median island minimizes pedestrian exposure during crossing by shortening the crossing distance and increasing the number of available gaps for crossing per the FHWA Pedestrian Safety Guide and Countermeasure Selection System (Crossing Island and Raised Medians). This installation is appropriate on multi-lane roadways with high pedestrian volume, high traffic volume, and intermediate or high travel speeds. The median should use a Type A ADA passageway and be a minimum of 6' wide (preferably 9') with median nose and adequate length to allow for anticipated number of pedestrians to queue safely. If the island is landscaped, the landscaping must not compromise the visibility of the pedestrians.

- **Staggered Pedestrian Crossing (Z-Crossing)** – The Z-Crossing is a pedestrian refuge that channels pedestrians to cross one half of the street; enter the island at one end; walk towards the flow of traffic; and exit at the other end to cross the second half of the street. This installation minimizes pedestrian exposure during crossing by shortening the crossing distance and increasing the number of available gaps for crossing per the FHWA Pedestrian Safety Guide and Countermeasure Selection System (Crossing Islands). It also forces pedestrians to turn in the median and face oncoming traffic before crossing the last segment. This installation can improve pedestrian safety on streets with ADTs between 12,000 and 45,000 and locations where pedestrians may be inattentive. Z-Crossings are typically used at midblock crosswalk locations and utilize detectable warnings and railings/barriers should be used to help realign pedestrians perpendicularly to the roadway before crossing. Best installation practices include advance yield markings (triangles 16 inches wide by 24 inches long separated by 9 inches located 30 to 50 feet in advance of the crossing), "Yield to Pedestrians" signage, and good visibility, especially at night.

- **Overhead Pedestrian Crossing Signs** – This signage increases visibility and provides a right-of-way reminder for motorists on a wide or busy street. In accordance with CA-MUTCD Section 2b.12, Figures R1-9 and R1-9a, the signage is appropriate at locations where street level signs are not effective or visible due to on-street parking, street trees, or other visual obstructions. An overhead pedestrian crossing sign installation can include various signs showing the universal pedestrian symbol, including both standard yellow, fluorescent yellow, and LED displays, and hangs from a mast arm that extends over the street. If used, the signage shall be placed over the roadway at the crosswalk location. It shall not be placed in advance of the crosswalk, nor should it be installed as an educational display that is not near any crosswalk.

- **Rectangular Rapid Flash Beacon (RRFB)** – These devices increase driver yielding rate at crosswalks through user-actuated LEDs that supplement warning signs at uncontrolled crossings in accordance with FHWA Pedestrian Safety Guide and Countermeasure selection System (Rectangular Rapid Flash Beacon). RRFBs should be used on multilane roadways with low yield rates but should be reserved for locations with significant pedestrian safety issues as over-use of RRFB treatments may diminish their effectiveness. RRFBs require installation of pedestrians push buttons or a pedestrian detection system for actuated control. Where possible, installation of solar-powered RRFBs should be pursued. Including RRFBs on a center island or median as well as the roadside can further increase driver yielding behavior, although with a lower marginal benefit than roadside beacons.

- **Street Lighting** – Street lighting can enhance the safety of all roadway users, while pedestrian-scale lighting improves nighttime security and enhances commercial districts. The FHWA Pedestrian Safety guide and Countermeasure Selection System (Lighting and Illumination) suggests utilizing street lighting in commercial areas with nighttime pedestrian activity. Streetlights can enhance the ambiance of the area and the visibility of pedestrians by motorists. Pedestrian walkways and crosswalks should be well lit uniformly by installing pedestrian-scale lighting on both sides of wide streets.

LEVEL THREE

- **High Intensity Activated Crosswalk (HAWK)** – These installations slow traffic speeds and reduce pedestrian-vehicle conflicts via an overhead pedestrian activated signal in accordance with CA-MUTCD Chapter 4F and FHWA Pedestrian Safety Guide and Countermeasure Selection System (Pedestrian Hybrid Beacon). These are best used at locations where pedestrians have difficulty finding gaps to cross a roadway, but a traditional traffic signal is not warranted. Installation requires a warrant analysis per CA-MUTCD Chapter 4F, and if warranted, the installation should include the beacons, stop lines, pedestrian signals and actuation equipment.

- **Pedestrian Traffic Signal** – These installations slow traffic speeds and reduce pedestrian-vehicle conflicts via an overhead pedestrian activated signal in accordance with CA-MUTCD Chapter 4C. These are best used at locations where pedestrians have difficulty finding gaps to cross a roadway and a traffic signal is warranted. Installation requires a warrant analysis per CA-MUTCD Chapter 4C, and if warranted, the signals should be countdown, accessible, with adequate crossing time programmed.

- **Pedestrian Overpass/Underpass** – This infrastructure provides complete separation of pedestrians from motor vehicle traffic per FHWA Pedestrian Safety Guide and Countermeasure Selection System (Pedestrian Overpasses/Underpasses). This remedy can link popular destinations that are separated by wide multilane roadways with higher speeds and high ADT. This treatment should be used sparingly and generally as a measure of last resort as pedestrians will not use them if a more direct route is available. Lighting, graffiti removal, and security are additional concerns with underpasses.

Other Uncontrolled Crosswalk Tools

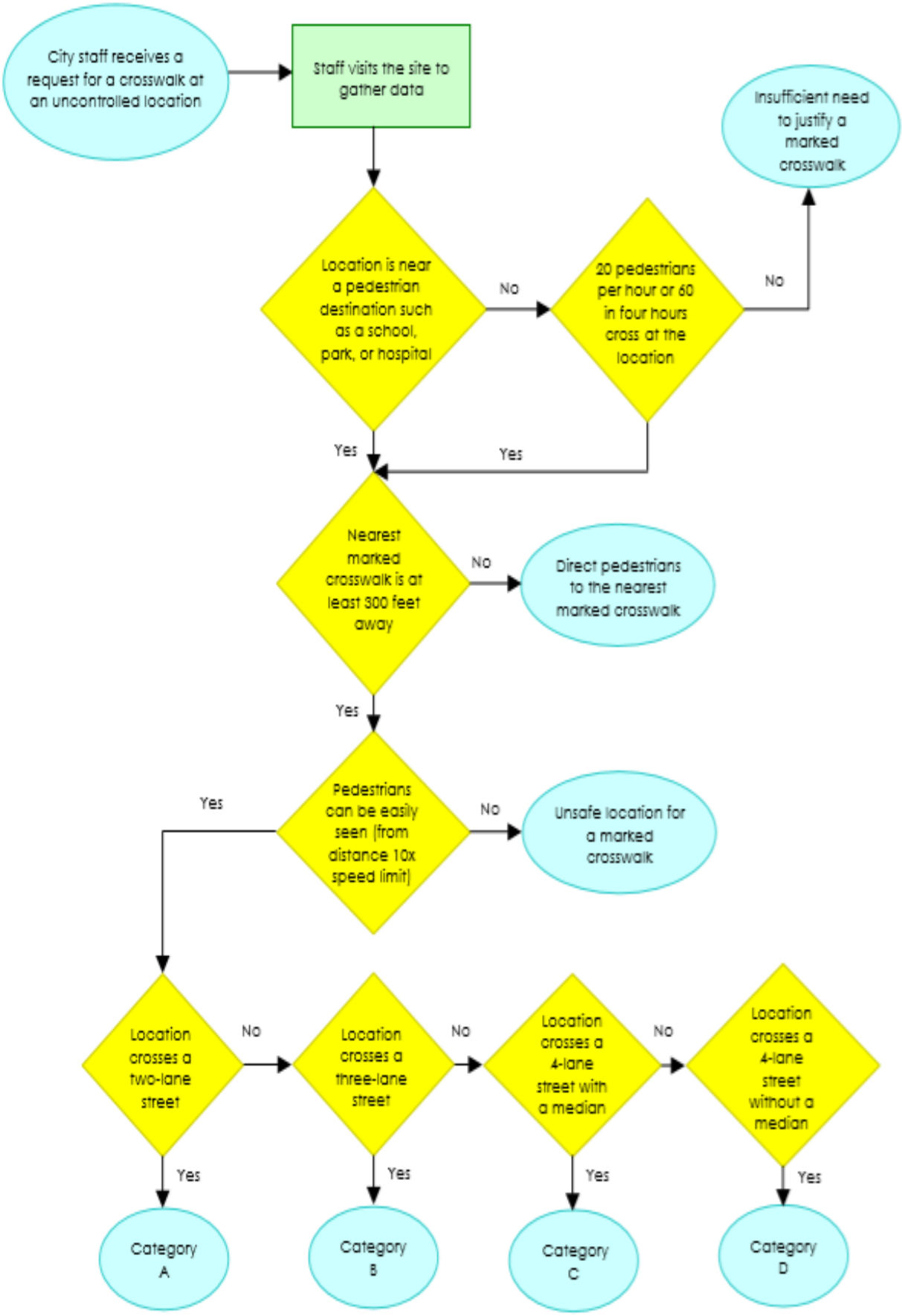
Ongoing and future research, as well as continued advancements in technology, will lead to the development and deployment of new tools to improve uncontrolled crosswalks. The City of Imperial will consider adding measures to its toolbox in the future.

As part of future roadway improvement projects, integration of uncontrolled crosswalk measures will be considered by the City, as appropriate. For example, curb extensions and refuge islands could be considered on major street reconstruction projects. Such measures could also be integrated into a “road diet” project where a four-lane roadway is converted to a three-lane roadway to enable center islands, bicycle lanes, and other considerations.

Choosing the Right Treatment for Crosswalks at Uncontrolled Locations

The flowchart on the following page and corresponding tables on pages 19 and 20 provide guidelines for choosing appropriate treatment options for pedestrian crossings at uncontrolled locations, based on number of travel lanes, average daily traffic (ADT) and other factors.

CROSSWALK PLACEMENT FLOWCHART FOR UNCONTROLLED LOCATIONS



The following charts summarize the type of crossing treatments appropriate for uncontrolled crossing locations within each category.

CATEGORY A: TWO LANE STREETS

NUMBER OF CARS (average daily traffic)	POSTED SPEED 30 miles per hour or less	35 miles per hour	40 miles per hour or more
9,000 cars or fewer per day	High visibility crosswalk	High visibility crosswalk	High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)
9,000-12,000 cars per day			
12,000-15,000 cars per day	High visibility crosswalk		
15,000 cars or more per day		High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)	Pedestrian signal or other Level 3 devices (See page 16)

CATEGORY B: THREE-LANE STREETS[12]

NUMBER OF CARS (average daily traffic)	POSTED SPEED 30 miles per hour or less	35 miles per hour	40 miles per hour or more
9,000 cars or fewer per day	High visibility crosswalk	High visibility crosswalk	High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)
9,000-12,000 cars per day		High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)	
12,000-15,000 cars per day	High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)		Pedestrian signal or other Level 3 devices (See page 16)
15,000 cars or more per day		Pedestrian signal or other Level 3 devices (See page 16)	

[12] Refers to streets with one lane in each direction and a center two-way left-turn lane

CATEGORY C: FOUR OR MORE LANES WITH A RAISED MEDIAN

NUMBER OF CARS (average daily traffic)	POSTED SPEED 30 miles per hour or less	35 miles per hour	40 miles per hour or more
9,000 cars or fewer per day	High visibility crosswalk	High visibility crosswalk	High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)
9,000-12,000 cars per day		High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)	Pedestrian signal or other Level 3 devices (See page 16)
12,000-15,000 cars per day	High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)		
15,000 cars or more per day	Pedestrian signal or other Level 3 devices (See page 16)	Pedestrian signal or other Level 3 devices (See page 16)	

CATEGORY D: FOUR OR MORE LANES WITHOUT A RAISED MEDIAN

NUMBER OF CARS (average daily traffic)	POSTED SPEED 30 miles per hour or less	35 miles per hour	40 miles per hour or more
9,000 cars or fewer per day	High visibility crosswalk	High visibility crosswalk plus a pedestrian refuge or other Level 1 device (see pages 14-15)	High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)
9,000-12,000 cars per day	High visibility crosswalk plus a pedestrian refuge or other Level 1 device (see pages 14-16)	High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)	Pedestrian signal or other Level 3 devices (See page 16)
12,000-15,000 cars per day	High visibility crosswalk plus a pedestrian refuge, overhead flashing beacons, or other Level 1 and 2 devices (see pages 14-16)		
15,000 cars or more per day	Pedestrian signal or other Level 3 devices (See page 16)	Pedestrian signal or other Level 3 devices (See page 16)	

V. INTERSECTION, SIDEWALK, AND CURB RAMP DESIGN

Intersections

"Never design more than you need" is the maxim underlying pedestrian-friendly intersections. Compact intersections, where pedestrian crossing distances are minimized and pedestrian visibility is enhanced, are the most accessible, safe, and effective for pedestrians. There are several elements to consider when evaluating an intersection for pedestrian friendliness:

- **Turning Radius:** Whenever possible, especially at locations adjacent to pedestrian generators, intersections should be designed with tight corner radii and without "free rights" for vehicles. Bulbouts can help retrofit existing intersections – reducing corner radii and crossing distances, and raising pedestrian visibility. The Metropolitan Transit System (MTS) should be consulted to determine the minimum turning radius to allow buses to make the turn.

- **Refuge Islands:** Where refuge islands are included, the tip of the island should extend through the crosswalk, with a curb cut for accessibility. Refuge islands should be clear of obstructions and have adequate drainage. They should be at least 12 feet long or the width of the crosswalk (whichever is greater) and 60 feet square. Recommended refuge island widths are as follows:

Speed	Minimum Width
25-30 mph	5 feet
30-35 mph	6 feet
35-45	8 feet

- **Signal Visibility:** Pedestrian signal heads should be located for maximum visibility.

- **Miscellaneous:** Signalized intersections should be well-lit, with pedestrian signals at each crosswalk.

Sidewalks

Sidewalks are the primary circulation routes for pedestrians. Pedestrian-friendly neighborhood street design improves the safety of the walking environment, fosters trips made on foot, and facilitates better access to transit service provided in the community. Key recommendations are summarized below.

- Install continuous sidewalks, separated from the roadway by a planter or park strip with a vertical curb along all new streets next to commercial or residential land uses. Recent research from the FHWA indicates that basic elements such as continuous, separated sidewalks may reduce "walking along roadway" pedestrian/vehicle crashes.[13]

Curb Ramps

The City maintains definitions and standards for curb ramp installation on City streets. Curb ramps provide street and sidewalk access to pedestrians using wheelchairs. The current standards require a single curb ramp at each corner. Dual ramps may be provided as right-of-way and crosswalks allow. Dual ramps are desirable to direct pedestrians to the correct alignment of the crosswalk, and where feasible, opposing curb ramps should align.

[13] McMahon, Patrick et al, "An Analysis of Factors Contributing to 'Walking Along Roadway' Crashes: Research Study and Guidelines for Sidewalks and Walkways," Report No. FHWA-RD-01-101.

VI. DEVELOPMENT REVIEW

Traffic Impact Studies and plan checks conducted by cities to review private development proposals have not traditionally incorporated measures of pedestrian safety or convenience. This report recommends that pedestrian safety impacts be evaluated during the development review process. The following are basic guidelines that could be included in Transportation Impact Studies:

- **Impact on the existing pedestrian system**
  Will the project change the width, routing, or conditions of an existing pedestrian facility?

- **Pedestrian travel patterns and access**
  Will the project alter existing pedestrian travel patterns and/or otherwise affect a pedestrian's ability to travel as directly as possible from origin to destination with no circuitous travel, due to any change to the sidewalk or pathway network?

- **Pedestrian circulation and access**
  Will the project reduce or restrict a pedestrian's access to any roadway or site, by decreasing safety, increasing the stress, or increasing the delay experienced by the pedestrian? This includes but is not limited to increasing the width of the road or reducing the width of the shoulder, bridge, overpass or underpass.[13]

- **Safety of Operations**
  Does the project meet or exceed accepted design standards and guidelines, as promulgated by responsible agencies such as the State of California or AASHTO? How will the project enhance and/or improve safety and connectivity for pedestrians?

- **Internal Pedestrian Circulation**
  Applicants should submit an internal pedestrian circulation plan (for all non-residential proposals) in order to facilitate the safest, smoothest transition from sidewalk or parking lot to building entrance. The circulation plan should include clearly marked walkways for pedestrians, delineated by textured or colored pavement or pavement stencils. In large parking lots, a continuous sidewalk should be provided in parking lot medians from the parking lot to a marked crossing to the building entrance. All new public buildings, meaning buildings that the public may use, such as shopping centers, should have at least one main entrance immediately adjacent to the sidewalk.

- **Access to Transit**
  MTS should be consulted during the development review process with regard to the location of transit stops and the installation of pedestrian paths and crossings to facilitate access to existing or new transit stops. Will the project restrict or enhance access to transit service currently provided or to future transit service planned?

[13] Pedestrians' stress levels can be quantitatively measured using Pedestrian Level of Service methodology. The PLOS is a spreadsheet with inputs for roadway width, traffic levels, posted speed, sidewalk width, and the presence and measurements of pedestrian buffers (including street trees).