Crosswalk Policy Guidelines

Prepared for:
City of Salinas

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FEHR PEERS

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1. INTRODUCTION

The City of Salinas initiated development of these Crosswalk Policy Guidelines to prescribe a formal and transparent process for marked crosswalk implementation. The City regularly receives requests to install marked crosswalks from residents, businesses, and institutions. However, designing a safe roadway crossing for pedestrians is a complex process; the installation of crosswalk striping alone does not necessarily constitute a safe pedestrian crossing.

The Crosswalk Policy Guidelines are aimed at improving pedestrian safety and enhancing pedestrian mobility. 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 the function of crosswalks and their legal context in the California Vehicle Code. It discusses the advantages and disadvantages of marked crosswalks and summarizes research in the United States focused on pedestrian safety and crosswalks. It provides a summary of best practices related to numerous pedestrian treatments, including geometric, signage and striping, and signal hardware or operational measure treatments.

The purpose of this document is to enable the City to respond to crosswalk requests in a manner that improves pedestrian accessibility and maintains public safety. It provides information to be used when making decisions about where standard crosswalks (two, parallel white 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.

This report was produced in cooperation with the City of Salinas. The suggestions presented in this report are based on local knowledge, data analysis, and discussions with the City of Salinas. These suggestions, which reflect general knowledge of best practices in pedestrian design and safety, are intended to guide City staff in making decisions for future safety improvement projects in the City, and they may not incorporate all factors that may be relevant to the pedestrian safety issues in the City. Final implementation of these guidelines will at all times involve engineering judgment.

2. BACKGROUND AND CONTEXT

The City of Salinas has several planning-level documents that provide the primary policy context for this *Crosswalk Policy*. These documents provide policy support for pedestrian-friendly land uses, built environment characteristics, and design standards in Salinas. This chapter provides a summary of the City's relevant plans and polices that address pedestrian safety, including the *General Plan* and *Pedestrian Plan*.

POLICY CONTEXT

GENERAL PLAN

The City's current *General Plan* (September 2002) includes several elements that address the pedestrian environment and safety, including the housing element, conservation/open space element, community design element, and circulation element. The *General Plan* used new urbanism principles to guide the future transportation and land use development in the City. The following goals and policies provide support for pedestrian-friendly design within Salinas:

- Community Design Element, Goal 3: Create a community that promotes a pedestrian-friendly, livable environment.
  - Policy CD-3.1: Create and preserve the distinct, identifiable neighborhoods that have traditional neighborhood development (TND) characteristics. Specifically, each neighborhood should have the following characteristics:
    - An approximately 5-minute walk from perimeter to center;
    - Housing densities should increase from perimeter to center (i.e., neighborhoods should be more densely populated at the center);
    - The neighborhood center should be the location of retail space, office space, and upper story residential above commercial and office space;
    - A civic or public space such as a plaza or park should be at the neighborhood center;
    - Small parks should be distributed throughout the neighborhood;
    - Schools should lie within the neighborhood and be easily accessible and within walking distance;

        - When not adjacent to agricultural operations, which may require a variety of buffering techniques, the neighborhood edge should be bordered by either a natural corridor or the edge of an adjacent neighborhood across a pedestrian-friendly boulevard; and
        - Front yard setbacks should decrease from the neighborhood edge to neighborhood center.
    - Policy CD-3.6: Provide and maintain a pedestrian-friendly atmosphere by encouraging "pedestrian zones" with increased landscaping, use of traffic-calming techniques on local streets, adequate separation of automobile traffic, and the inclusion of amenities such as lighted crosswalks and increased lighting along sidewalks.
    - Policy CD-3.8: Promote the use of alternative modes of transportation, including bus, rail, bicycling, and walking.
- Circulation Element, Goal C-5: Provide safe routes to school, work, shopping, and recreation for pedestrians.
    - Policy C-5.1: Increase availability of safe and well-maintained sidewalks in all areas of the City.
    - Policy C-5.2: Encourage all new bus stops and changes in existing bus stops to take pedestrian access into consideration.
    - Policy C-5.3: Ensure that all pedestrian route improvements meet with ADA standards for accessibility.
    - Policy C-5.4: Encourage parking lot designs that promote pedestrian access and safety.
    - Policy C-5.5: Improve the walking environment by providing safe and attractive sidewalks, cut-throughs, and walkways, for both recreational and commuting purposes.
- Housing
    - Policy H-1.10: Promote the development of neighborhoods, or sub-communities, designed to encourage pedestrian and mass transit by offering employment or services for the daily needs of residents, while reducing the need for autos.
- Conservation/Open Space
    - Policy COS-6.4: Support alternative modes of transportation, such as walking, biking, and public transit, and develop bike- and pedestrian-friendly neighborhoods to reduce emissions associated with automobile use.
    - Policy COS-7.12: Link activity centers, recreational opportunities, transit nodes, and other services to the integrated trails network.

PEDESTRIAN PLAN

The City of Salinas' *Pedestrian Plan* was adopted in May 2004 to support the principles and policies of the City's *General Plan*. The *Pedestrian Plan* includes goals and strategies to increase walking in the City in support of health, transportation, quality of life/social, economic, and environmental benefits. The plan specifically outlines these goals:

1. Promote the development and design of pedestrian facilities that are convenient, safe, attractive, comfortable, interesting, and interconnected to provide continuity of travel
2. Reduce the number of pedestrian-related accidents in Salinas
3. Condition New Development to install appropriate streets, sidewalks, pedestrian access ramps, traffic calming measures, lighting, and related facilities to encourage walking
4. Develop a Traffic Calming Policy to address vehicular speeds in residential and commercial areas
5. Develop a Suggested Routes to School Program for all elementary schools in Salinas
6. Educate the general public to increase the number of overall walking trips within Salinas
7. Identify needs of walking districts or areas to increase walking trips

The *Pedestrian Plan* includes strong policy support, as well as a project list for infrastructure upgrades and ongoing programs to encourage walking in the City. Appendix A of the Plan also includes a Pedestrian Facilities Toolbox, with design guidance for some pedestrian facilities and treatments, such as sidewalks/walkways, curb ramps, crosswalks, transit stops, driveways, curb radii, and roadway lighting.

The Plan's guidance for marked crosswalks has a three-pronged approach as follows:

- Accessibility – The crosswalk be located for convenient pedestrian access, preferably at controlled intersections (signals, all-way stops, etc.).
- Design – The design, use, and installation of crosswalks shall conform to the Caltrans Traffic Manual and Federal Manual of Uniform Traffic Control Devices (MUTCD), most recent edition.1
- Safety – Crosswalk markings must be placed to include a ramp so that a wheelchair does not have to leave the crosswalk to access the ramp.

[1] As of April 2013, the most recent editions include the California Manual of Uniform Traffic Control Devices (2012), based on the Federal Highways Administration (FHWA) Manual of Uniform Traffic Control Devices (2009).

EXISTING MARKED CROSSWALK INVENTORY

An up-to-date inventory of existing pedestrian facilities is an important and efficient approach to identify gaps and deficiencies in the existing pedestrian network. The City maintains this inventory in a computer aided drafting (CAD) database, and applies it to citywide Suggested Routes to Schools maps for distribution to local schools in the City. This section summarizes the existing marked crosswalk inventory within Salinas, current as of April 2013. **Figure 1** presents a map of the City of Salinas.

Appendix A presents a Citywide map showing existing marked crosswalks in the City, with a note if they are located at a stop-sign or traffic signal, in a school zone, or have been upgraded with other enhancements. Twenty-eight (28) enhanced crosswalks are currently marked in Salinas, generally at uncontrolled locations near schools, such as El Gablan Elementary, on Linwood Drive at Sequoia Street as shown in the photo below. These crossings are enhanced with high visibility, continental style markings with alternating white and fluorescent yellow-green blocks, which is an application unique to Salinas, and "LOOK" stencils at each corner encouraging pedestrians to look both ways before crossing.

Figure 1: City of Salinas Map

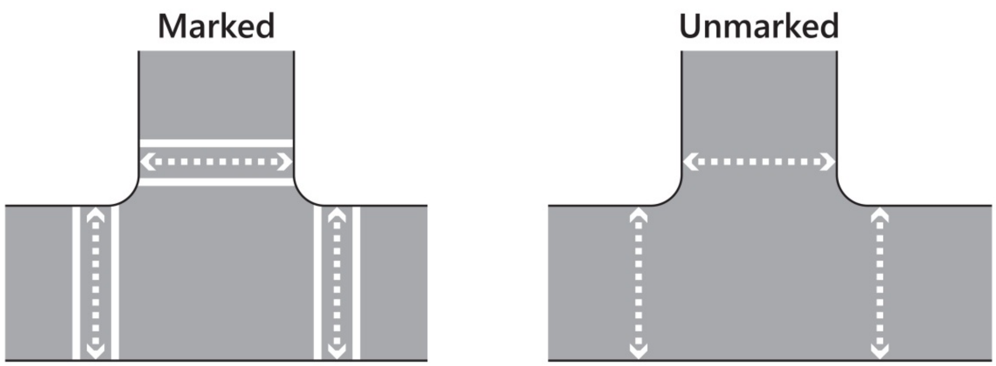
3. CROSSWALK FUNDAMENTALS

Pedestrian crossing and right-of-way laws vary state to state, and are often a source of driver or pedestrian uncertainty and confusion for when crossing is legal. This section outlines the types of crosswalks, where crossing the street is legal in California, and the steps the City should take in identifying locations for marked crosswalks.

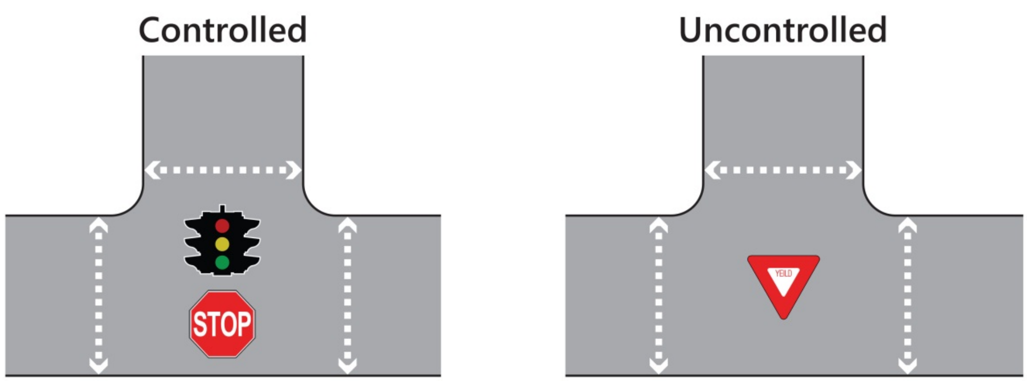
TYPES OF CROSSWALKS

Crosswalks are primarily classified by three characteristics:

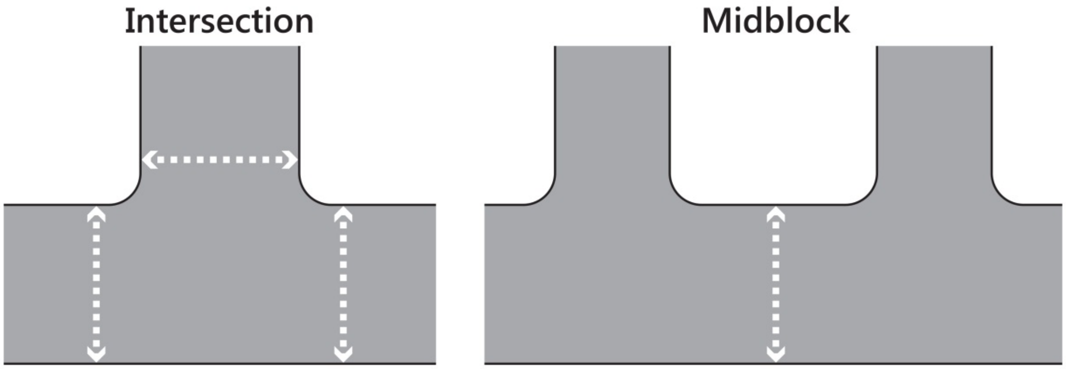
1) Whether they are <u>marked</u> (demarcated with striping on the street) or <u>unmarked</u> (no striping)



2) Whether they are <u>controlled</u> (by a traffic signal or stop-sign) or <u>uncontrolled</u> (with no intersection control)



3) Whether they are located at an intersection (where two streets meet) or mid-block (between intersections)



The following section outlines where crossing the street is legal in California. Based on pedestrian safety and crosswalk marking research, some types of crosswalks are safer than others (e.g., generally marked, controlled crosswalks at an intersection have lower risk of pedestrian collisions than a mid-block, uncontrolled crosswalk). A summary of relevant pedestrian safety research is provided in **Chapter 4**. **Chapters 4** and **5** in this document provide guidance on why, where, and how to treat crosswalks at uncontrolled and controlled locations, respectively, based on this research.

WHERE IS CROSSING THE STREET LEGAL?

In California, a legal crosswalk exists where a sidewalk meets a street, regardless of whether the crosswalk is marked (i.e., with or without striping to denote the crosswalk). Pedestrians may legally cross any street, except at unmarked locations between immediately adjacent signalized crossings, or where crossing is expressly prohibited. Marked crosswalks reinforce the location and legitimacy of a pedestrian crossing.

These legal statues are contained in the California Vehicle Code (CVC) as follows:

- Section 275 defines a legal crosswalk as:
  - That portion of a roadway included within the prolongation or connection of the boundary lines of sidewalks at intersections where the intersecting roadways meet at approximately right angles, except the prolongation of such lines from an alley across a street.
  - Any portion of a roadway distinctly indicated for pedestrian crossing by lines or other markings on the surface (such as a marked midblock crossing).
- Section 21950 describes right-of-way at a crosswalk:

    - The driver of a marked vehicle shall yield the right-of-way to a pedestrian crossing the roadway within any marked crosswalk or within any unmarked crosswalk at an intersection.
- Section 21955 describes where pedestrians may *not* cross a street:
    - Between adjacent intersections controlled by traffic control signal devices or by police officers, pedestrians shall not cross the roadway at any place except in a crosswalk.

WHY DO CITIES MARK CROSSWALKS?

Sidewalks and crosswalks are essential links within a pedestrian network. Whether commuting, running an errand, exercising, or wandering, pedestrians will need safe and convenient crossing opportunities to reach their destinations. A marked crosswalk has three (3) primary functions:

1) To create reasonable expectations where pedestrians may cross a roadway
2) To improve predictability of pedestrian actions and movement
3) To channel pedestrians to designated crossing locations (often selected for their optimal sight distance)

Advantages of Marked Crosswalks

Marked crosswalks offer the following advantages:

- They help pedestrians find their way across complex intersections
- They can designate the shortest path
- They can direct pedestrians to locations of best sight distance
- They assure pedestrians of their legal right to cross a roadway at an intersection or mid-block crossing

This last bullet point is important. The *California Vehicle Code* gives the right-of-way to pedestrians at any marked or unmarked crosswalk (as noted above), although the law is not always obeyed by road users, including both drivers and pedestrians. Drivers often fail to yield the right-of-way without the visual cue of a marked crosswalk. Pedestrians also do not always know the right-of-way law, and will either wait for a gap in traffic, or assert their right-of-way by stepping in to the roadway. Strategies for this challenge are discussed in the Education and Enforcement section of this document, **Chapter 6**.

STEPS TO IDENTIFY CANDIDATE LOCATIONS FOR MARKED CROSSWALKS

Identifying candidate locations for marked crosswalks involves two steps.

The first step is to locate the places people would like to cross the street. These locations are called *pedestrian desire lines*, which represent the most desirable, and typically most direct, places that people want to cross a street. Pedestrian desire lines are influenced by elements of the roadway network, such as transit stops, and nearby land uses (homes, schools, parks, trails, commercial centers, etc.). This information provides a basis for identifying pedestrian crossing improvement areas and prioritizing such improvements, thereby creating a convenient, connected, and continuous walking environment.

The second step in identifying candidate locations for marked crosswalks is to identify where people can cross safely. The primary consideration in this step is adequate stopping sight distance. Of all road users, pedestrians have the highest risk of injury in a collision because they are the least protected. The crosswalk safety treatment toolboxes in **Chapters 4** and **5** provide numerous options for enhancing pedestrian safety at uncontrolled and controlled crossings, respectively, with treatment selection based on the overall context of the crosswalk – including surrounding land uses, roadway characteristics, and user characteristics.

WHEN TO INSTALL MARKED CROSSWALKS

Once candidate locations are identified, an engineering evaluation should be conducted to determine if a marked crosswalk should be installed at an uncontrolled or mid-block location, and if so, what visibility enhancements should be included in the design. Crossings should be marked where all of the following occur:

- Sufficient demand exists to justify the installation of a crosswalk
- Sufficient sight distance as measured by stopping sight distance calculations exists and/or sight distance will be improved prior to crosswalk marking
- Safety considerations do not preclude a crosswalk

Figures 2 and **3** describe the overall procedures from the moment City staff receives a request for a new marked crosswalk (or considers removing an existing marked crosswalk) to the installation of the treatment. As described, the first steps to determine the appropriate location and treatment for the crosswalk include a staff field visit.

Figure 2: Marked Crosswalk Placement Flowchart

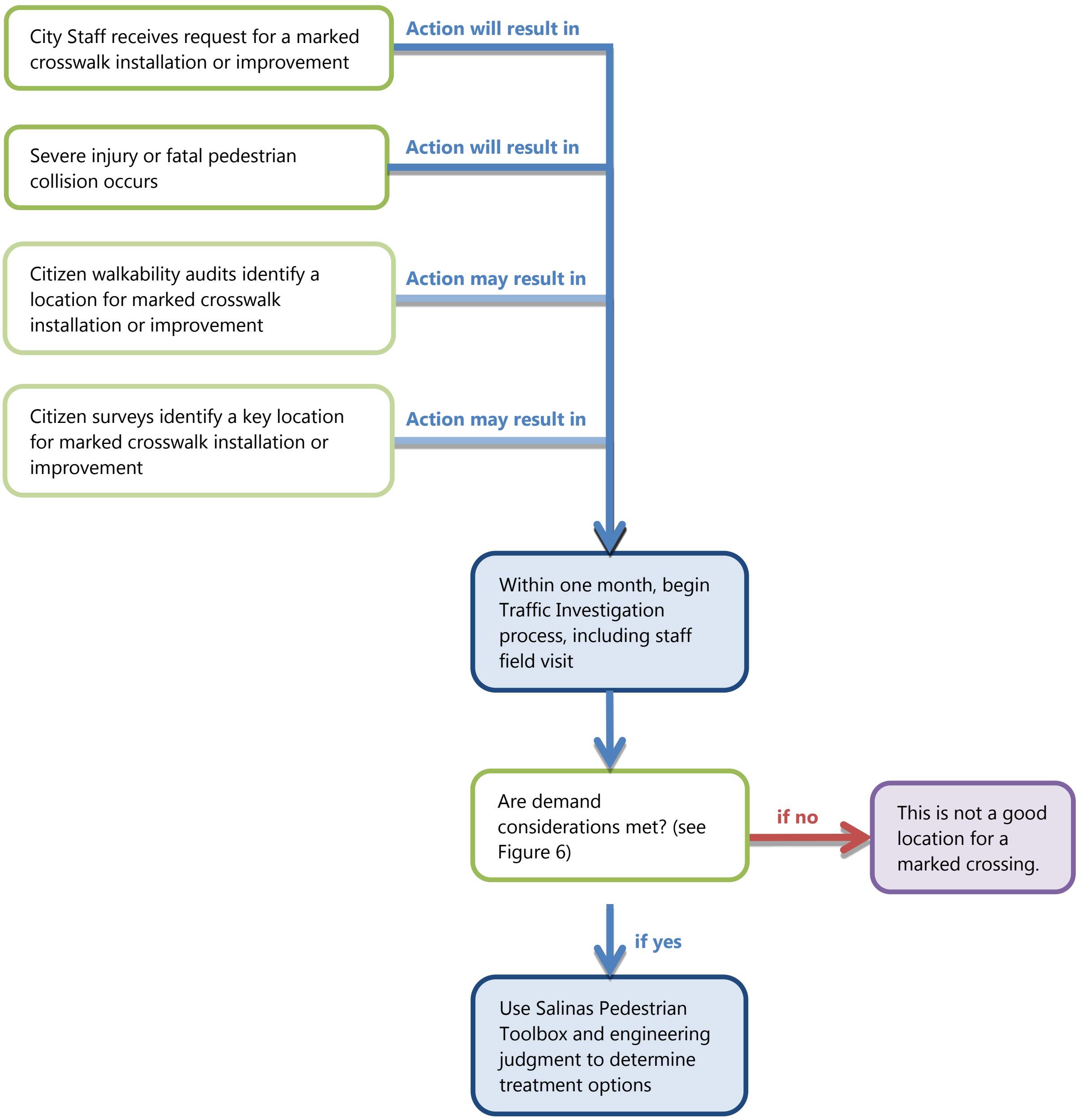
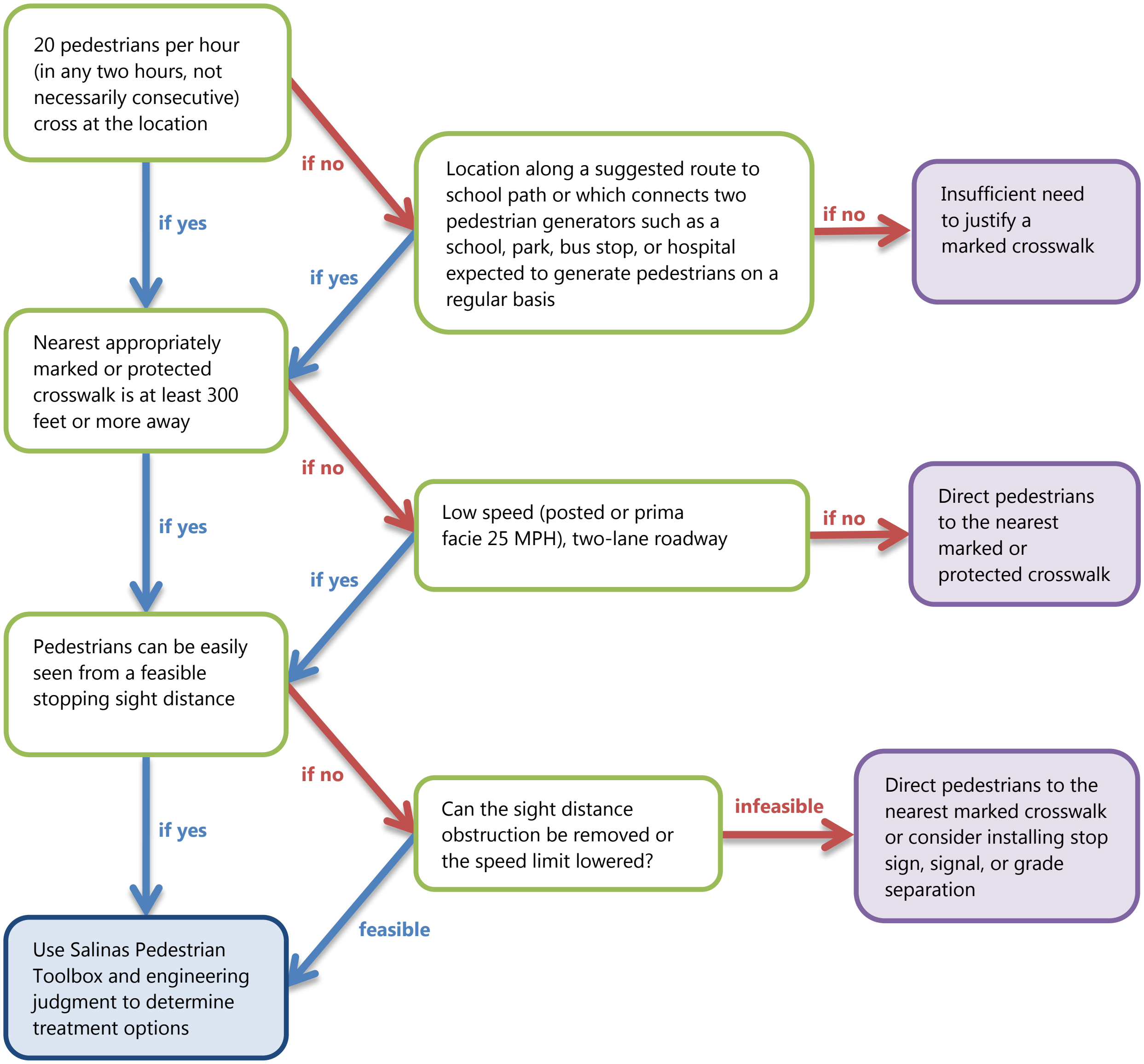


Figure 3: Feasibility Analysis for Treatments at Uncontrolled Locations



Note: Where no engineering action is recommended in Chart 2, consider applicable education and enforcement efforts.

4. UNCONTROLLED CROSSING ENHANCEMENT TOOLBOX

This section presents best practices for the installation of marked crosswalks at uncontrolled intersections and mid-block locations. Uncontrolled crossings require additional consideration during planning and design since traffic signals and stop signs are not provided to require motorists to stop – they must recognize the pedestrian and yield accordingly. Thus, providing appropriate enhancements to improve the visibility and safety of pedestrians crossing the street at an uncontrolled location is critical.

CROSSWALK SAFETY RESEARCH

Several studies of pedestrian safety at uncontrolled crossings have been completed, from which conflicting research had emerged in the past. Studies conducted in San Diego in the 1970s showed that pedestrian collision risk at marked, uncontrolled crosswalks was greater than at unmarked crossings. This led many cities to remove marked crosswalks, as they were suspected of providing a false sense of security that drivers would yield to pedestrians in the crosswalk. However, a more recent study[2] by the Federal Highway Administration (FHWA) comprehensively reviewed crossing safety at 1,000 marked and 1,000 matching unmarked crosswalks in 30 U.S. cities, controlling for site context factors. The study concluded that site factors related to pedestrian-involved collisions included pedestrian average daily traffic (ADT), vehicle ADT, number of lanes, median type, and the region of the U.S. At uncontrolled locations on two-lane roads and multi-lane roads with ADT below 12,000 vehicles, FHWA found that the presence of a marked crosswalk alone, compared with an unmarked crosswalk, made no statistically significant difference in the pedestrian crash rate. However, on multi-lane roads with an ADT of greater than 12,000 vehicles (without a raised median) and 15,000 vehicles (with a raised median) the presence of a marked crosswalk

Mid-Block Crossings

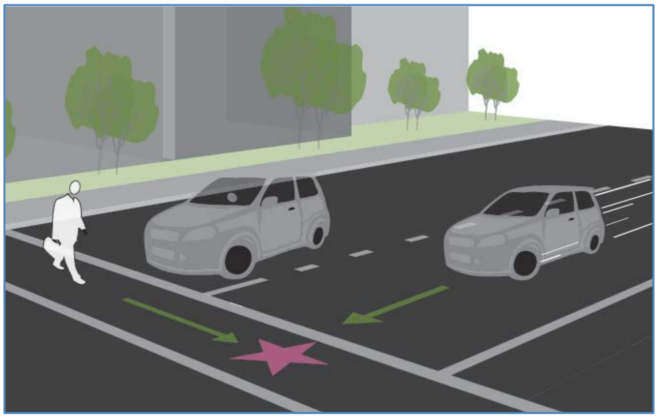
Crosswalks can be marked at intersections and mid-block points. Mid-block crossings play an important role for pedestrian access; without mid-block crossing locations, pedestrians may face the undesirable choice to detour to a controlled crossing location, detour to an intersection where crossing is legal even if not controlled, or cross illegally (if the midblock crossing is between two signalized intersections). Where signals are spaced far apart (generally more than 600-800 feet), pedestrians may have to detour several minutes to a controlled crossing location. Pedestrians are more likely to wait for a gap in traffic and cross at an unmarked location, rather than travel a distance out of their way to find a marked crosswalk. Mid-block crossings also offer an important safety consideration: fewer potential conflict points between pedestrians and motorists.

[2] Zeeger, C., J. Stewart, and H. Huang. *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*. Publication FHWA-RD-01-142, FHWA, U.S. Department of Transportation, 2001.

without other improvements was associated with a statistically significant higher rate of pedestrian collisions compared to sites with an unmarked crosswalk.

The results of the study should not encourage city officials to simply remove (or fail to install) marked crosswalks. Rather, the report suggested adding crosswalk enhancements to the marked crosswalks to balance mobility needs with safety needs. These improvements include providing raised medians on multi-lane roads, installing traffic and pedestrian signals where warranted, adding curb extensions, providing adequate lighting, and designing intersections with tighter turn radii.

In the FHWA study, about 70 percent of the pedestrian crashes occurred at marked crosswalks on multi-lane roads. Of the pedestrian crashes at marked crosswalks, 17.6 percent were classified as multiple-threat collisions. Multiple-threat collisions occur as one car slows down to allow pedestrians to cross, but a second car approaching from behind in the adjacent lane may not see the pedestrian, as illustrated in the image to the right. The slowing vehicle blocks the sight line of both the pedestrian and the second motorist, leading to the pedestrian-vehicle collision. Multi-lane roadways are therefore not well-served by unmarked or marked crosswalks alone. At these sites, the study concluded, engineers should consider countermeasures that provide additional safety to pedestrians and alert motorists to upcoming crosswalks. These countermeasures include advanced yield lines with corresponding signs informing motorists where to yield. Other more substantial measures may also be considered, such as signalization, illumination, or raised medians. The summary in **Table 1** below shows when marking a crosswalk only should not be considered.



Multiple threat conflicts on multi-lane roadways occur where a vehicle yielding to a pedestrian inhibits sight lines to another oncoming vehicle.

Table 1. Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT >9000 to 12,000			Vehicle ADT >12,000 - 15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multi-Lane (4 or More Lanes) With Raised Median***	C	C	P	C	P	N	P	P	N	N	N	N
Multi-Lane (4 or More Lanes) Without Raised Median	C	P	N	P	P	N	N	N	N	N	N	N

* 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.**

** Where the speed limit exceeds 40 mi/h (64.4 km/h) marked crosswalks alone should not be used at unsignalized locations.

C = **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.

P = **Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements.** These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = **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.**

*** The raised median or crossing 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 in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

With these studies as a backdrop, the remainder of this chapter outlines a decision making process to identify appropriate treatments and presents a variety of treatment options to mitigate safety, visibility, or operational concerns at specific locations.

TREATMENT SELECTION

At uncontrolled locations, a marked crosswalk with striping only may not provide adequate visibility to the pedestrian crossing, especially at high volume, high speed, or multi-lane crossings. Enhancements should be considered for installation to supplement crosswalk striping. Appropriate treatments should be identified based on:

- Site characteristics: presence of pedestrian desire lines, available sight distance and visibility, lighting
- Geometric configuration of the roadway: number of vehicle travel lanes and presence of curb extensions or median refuge islands
- Travel data: 85th percentile speeds, posted speed limits, and average daily traffic (ADT) volumes.

Marked crosswalks alone <u>should not</u> be installed on multi-lane streets (two or more lanes per direction; three or more lanes total) under the following conditions[3]:

- Speeds of greater than 40 miles per hour
- Average daily traffic volumes (ADT) greater than 12,000 without a raised median or pedestrian refuge island
- Average daily traffic volumes (ADT) greater than 15,000 with a raised median or pedestrian refuge island

Locations with speeds and ADT volumes below these thresholds may also warrant enhancements. The Uncontrolled Treatment Toolbox outlines considerations for the use of enhancements in various contexts as summarized in **Table 2**. This Toolbox may be used to identify potential treatments at a candidate uncontrolled crosswalk location based on the results of **Figures 2** and **3** in Chapter 3.

A calculation of Pedestrian Level of Service forms the basis for the treatment identification. Pedestrian Level of Service is the average delay experienced by pedestrians as they are waiting to cross the street. Expected motorist compliance is another other key variable for treatment identification. Compliance is based on field observations and engineering judgment. It is meant to reflect typical motorist responses to pedestrians attempting to cross the street. If drivers are likely to stop for a pedestrian, the compliance is rated "high." If drivers rarely stop for pedestrians, compliance is "low." The compliance rate should be assumed to be low for all locations where the speed limit is greater than 30 MPH. **Table 2** summarizes the appropriate treatments based on level of enhancement needed (with the most significant enhancement required with the worst LOS and compliance rates).

[3] California MUTCD, Section 3B. 18.

TABLE 2:
APPLICATION OF ENHANCED TREATMENTS FOR UNCONTROLLED LOCATIONS

Pedestrian Level of Service	Expected Motorist Compliance		
	Low (or Speed >30 mph)	**Moderate**	**High**
LOS A-D (average delay up to 30 seconds)	***LEVEL 3*** 2 lane road: In-pavement flashers, overhead flashing beacons Multi-lane road: RRFB *Plus LEVELS 1 and 2*	***LEVEL 2*** Curb Extensions, Bus Bulb, Reduced Curb Radii, Staggered Pedestrian Refuge *Plus LEVEL 1*	***LEVEL 1*** High Visibility Crosswalk Markings, Advanced Yield Lines, Advance Signage
LOS E-F (average delay greater than 30 seconds)	***LEVEL 4*** Pedestrian Hybrid Beacon, RRFB, or Direct Pedestrians to Nearest Safe Crossing *Plus LEVELS 1 and 2*	***LEVEL 3*** 2 lane road: In-pavement flashers, overhead flashing beacons Multi-lane road: RRFB *Plus LEVELS 1 and 2*	***LEVEL 2*** Curb Extensions, Reduced Curb Radii, Staggered Pedestrian Refuge *Plus LEVEL 1*

Notes: A pedestrian refuge island (median) is recommended for consideration in all scenarios with more than 2 lanes of traffic.

Level 1 represents a minor intervention, appropriate for situations with lower speeds and traffic volumes and high driver yielding rates. Higher levels represent more significant interventions, as may be needed on higher speed or volume roadways, wider roadways, and roadways where motorists are less likely to yield to pedestrians. Treatments may be combined with higher level treatments added to lower level treatments (i.e., flashing beacons with curb extensions). Additional funding sources should be identified as needed for these enhancements. Failing to provide an enhanced crosswalk and/or removing a marked crosswalk should be an option of last resort.

Application of **Table 2** is operationalized by the **XWalk+ Tool** that accompanies this policy. The Tool is embedded in an Excel platform and was developed to guide the user through application of the methods and processes summarized in this document. It should not replace understanding of local context or application of engineering judgment, but may be used to supplement this document.

TREATMENT OPTIONS

The following tables described preferred pedestrian safety treatments for uncontrolled locations with different roadway characteristics:

- Table 3: Geometric Treatments
- Table 4: Striping and Signage
- Table 5: Signal Hardware and Operational Measures

Within each table, devices are categorized in three levels based on the level of safety concern they are meant to address: Level 1 (all cases), Level 2 (enhancements), and Level 3 (advanced enhancements). Categories of improvements are cumulative; for example, a Level 2 device should also include appropriate Level 1 devices.

TABLE 3:
UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS

Treatment	Description	Level	Estimated Cost
6-1. Fewer Travel Lanes ("Road Diet")  *Image Source: Fehr & Peers*	Fewer travel lanes decrease roadway width and crosswalk length, reduce speeds, reduce left-turn and rear-end collisions, and often eliminate the multiple-threat collision. It takes an average pedestrian almost four seconds to cross each additional travel lane. Therefore, reducing the number of travel lanes minimizes the amount of time that pedestrians are in the crosswalk. More travel lanes than necessary can also increase vehicle travel speeds; research has shown that the severity of pedestrian collisions increases with vehicle travel speed. Where fewer travel lanes are not possible, travel lanes can be narrowed to as little as nine feet, especially left- and right-turn pockets.	**Level 1**	$20/LF[4]
6-2. Removal of Sight-Distance Obstructions  *Image Source: Fehr & Peers*	If objects impede sight-distance, this may result in an unsafe condition where motorists and pedestrians are unable to see each other. Items such as parked cards, signage, landscaping, fencing, and street furniture should be placed in a location that will not obstruct sight distance.	**Level 1**	$150/EA[5]

[4] Cost includes removal of existing pavement markings and repainting. Assumes existing curbs are to remain as is.

[5] Item removed is anticipated to be no larger than a sign and post.

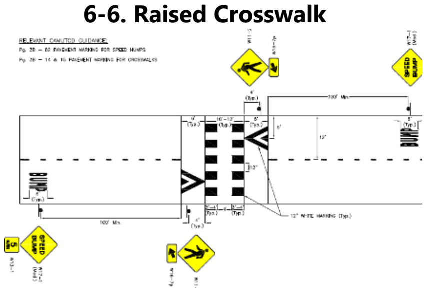
TABLE 3:
UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS

Treatment	Description	Level	Estimated Cost
6-3. Pedestrian Refuge Island  *Image Source: Fehr & Peers*	Raised islands are placed in the center of the roadway separating opposing lanes of traffic with cutouts or ramps for accessibility along the pedestrian path. Median refuge islands are recommended where right-of-way allows and conditions warrant. Studies show medians are one of the most important safety enhancements available for crosswalks. They simplify complicated multi-lane crossings by breaking the crossings/conflicts into two stages.	**Level 1**	$130/LF[6]
6-4. Curb Extensions  *Image Source: Fehr & Peers*	Curb extensions extend the curb and sidewalks further into the roadway, shortening the length of the crosswalk. They act as a traffic calming device by narrowing the effective width of the roadway and slowing turning speeds. Because they extend into the roadway, often past parallel-parked vehicles, they improve visibility for pedestrians. The also provide space for street furniture, landscaping, bicycle parking, and signs and signal poles. Curb extensions can be constructed with reduced curb radii and to accommodate ADA improvements, such as directional curb ramps.	**Level 1**	$140/LF[7]

[6] Cost includes new curb and concrete barrier. Assumes a 6 foot median.

[7] Cost includes removal of existing curb, new curb, new sidewalk, and new bollards. Cost does not include curb ramps.

TABLE 3:
UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS

Treatment	Description	Level	Estimated Cost
6-5. Split Pedestrian Crossover (SPXO)  *Image Source: Fehr & Peers*	This measure is similar to traditional median refuge islands; the difference is that the crosswalks in the roadway are staggered such that a pedestrian crosses half of the street and then walks toward traffic to reach the second half of the crosswalk. This measure must be designed for accessibility by including rails and truncated domes to direct sight-impaired pedestrians along the path of travel.	**Level 1** Note: see Table 11 for a Pedestrian Signal	$130/LF[8]
6-6. Raised Crosswalk  *Image Source: Fehr & Peers*	Raised crosswalks are speed tables (flat-topped speed humps) outfitted with crosswalk markings and signage, providing pedestrians with a level street crossing. By raising the level of the crossing, vehicles drive more slowly through the crosswalk and pedestrians are more visible to approaching motorists.	**Level 2**	$4,000/EA
6-7. Pedestrian Overpass/Underpass  *Image Source: Fehr & Peers*	This measure consists of a pedestrian or pedestrian/bicycle overpass or underpass of a roadway. It provides complete separation from motor vehicle traffic, normally where no other pedestrian facility is available, and connects off-road trails and paths across major barriers. Overpasses and underpasses should be used as a measure of last resort because of their cost and barriers to their effective/efficient use, with topographical and desire line considerations influencing their design. Personal security concerns must also be addressed in the design of these facilities.	**Level 3**	$150/SF

Source: Fehr & Peers, 2013.

[8] Same materials as 6-3

TABLE 4:
UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE

Treatment	Description	Level	Estimated Cost
7-1. High Visibility Markings  *Image Source: Fehr & Peers*	All uncontrolled marked crosswalks should feature high-visibility markings. Various striping patterns are available. The City of Salinas has recently installed white and fluorescent yellow green continental style markings. Triple four striping, as shown in the photo to the left, is recommended for use in future installations.	**Level 1**	$6/Ft
7-2. Advanced Yield Line  *Image Source: Fehr & Peers*	Advanced yield lines, often referred to as "sharks teeth", should be striped at all marked, uncontrolled crosswalks on multi-lane roadways. They should be placed 20-30 feet in front of the crosswalk. Their intention is to identify where vehicles should stop when yielding to a pedestrian to maintain adequate sight lines.	**Level 1**	$100/EA

TABLE 4:
UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE

Treatment	Description	Level	Estimated Cost
7-3. Advanced Warning Signs  *Image Source: Fehr & Peers*	High-visibility yellow or fluorescent-yellow-green (FYG) signs are posted at crossings to increase the visibility of a pedestrian crossing.	**Level 1**	$1,000/EA
7-4. In-Street Pedestrian Crossing Sign  *Image Source: FHWA*	This measure involves posting regulatory pedestrian signage on lane edge lines and/or road centerlines. The in-street pedestrian crossing sign may be used to remind road users of laws regarding right-of-way at an uncontrolled pedestrian crossing. They can be installed on medians and may also be temporary signs, placed by school crossing guards during school hours.	**Level 1**	$400/EA

Source: Fehr & Peers, 2013.

TABLE 5:
UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS

Treatment	Description	Level	Estimated Cost
8-1. Pedestrian-Scale Lighting  *Image source: www.ci.mil.wi.us*	Pedestrian-scale lighting improves visibility along a pedestrian's path and across driveways. It also improves visibility at pedestrian/vehicle conflict points in crosswalks.	**Level 1**	$10,000/EA[9]
8-2. Flashing Beacon  *Image Source: Fehr & Peers*	Flashing amber lights are installed on overhead or post-mounted signs, in advance of the crosswalk or at the crosswalk's entrance. Full-time flashing beacons are not recommended; flashing beacons are most effective when they are activated by the crosswalk user (they should rest on dark). By resting on dark, they can also be solar powered.	**Level 2**	$50,000/EA

[9] Cost assumes light every 100 feet

TABLE 5:
UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS

Treatment	Description	Level	Estimated Cost
8-3. Rectangular Rapid Flashing Beacon (RRFB)  *Image Source: Fehr & Peers*	The RRFB is an enhancement of the flashing beacon that replaced the traditional slow flashing incandescent lamps with rapid flashing LED lamps. The RRFB may be push-button activated or activated with passive detection. This treatment was approved for use in California via Interim Approval IA-11-83 in 2011. Any installations should be reported to Caltrans for documentation, but do not require pre-approval for experimentation.	**Level 2**	$25,000/EA
8-4. Pedestrian Hybrid Beacon (PHB)  *Image Source: FHWA*	The PHB is a pedestrian-activated beacon that is a combination of a beacon flasher and a traffic control signal. When actuated, the PHB displays a yellow (warning) indication followed by a solid red indication. During the pedestrian clearance interval, the driver sees a flashing red "wig-wag" pattern until the clearance interval has ended and the beacon goes dark. The device is included in the 2012 California MUTCD for use at midblock locations.[10]	**Level 3**	$50,000/EA
8-5. Pedestrian Signal  *Image Source: Fehr & Peers*	A pedestrian signal is a conventional traffic control device with warrants for use based on the MUTCD. The pedestrian warrants were revised with the 2009 Federal and 2012 California MUTCD.	**Level 4**	$100,000/EA

Source: Fehr & Peers, 2013.

[10] Use of the device at side-street stop control locations currently requires separate permission from the CTCDC (though this is under review).

5. CONTROLLED CROSSWALK TREATMENT TOOLBOX

Controlled crosswalks are located at stop-controlled or signalized intersections. Generally, these crossings do not need enhancements beyond standard crosswalk markings (two parallel lines), as the traffic signal or stop-sign controls allocation of right-of-way. However, in some cases, such as in the Downtown, at skewed intersections, or near schools, the City may consider providing enhanced crossings to create a sense of place or improved aesthetics, or to improve visibility. This chapter presents preferred and enhanced measures for pedestrian treatments at controlled locations to:

- Improve the visibility of pedestrians to motorists and vice-versa
- Communicate to motorists and pedestrians who has the right-of-way
- Accommodate vulnerable populations such as the disabled, children, and the elderly
- Reduce conflicts between pedestrians and vehicles
- Reduce vehicular speeds at locations with potential pedestrian conflicts

All treatments identified in this chapter are required or allowed by the standards and specifications in the *California Manual on Uniform Traffic Control Devices* (CA MUTCD).

PREFERRED CROSSING TREATMENTS

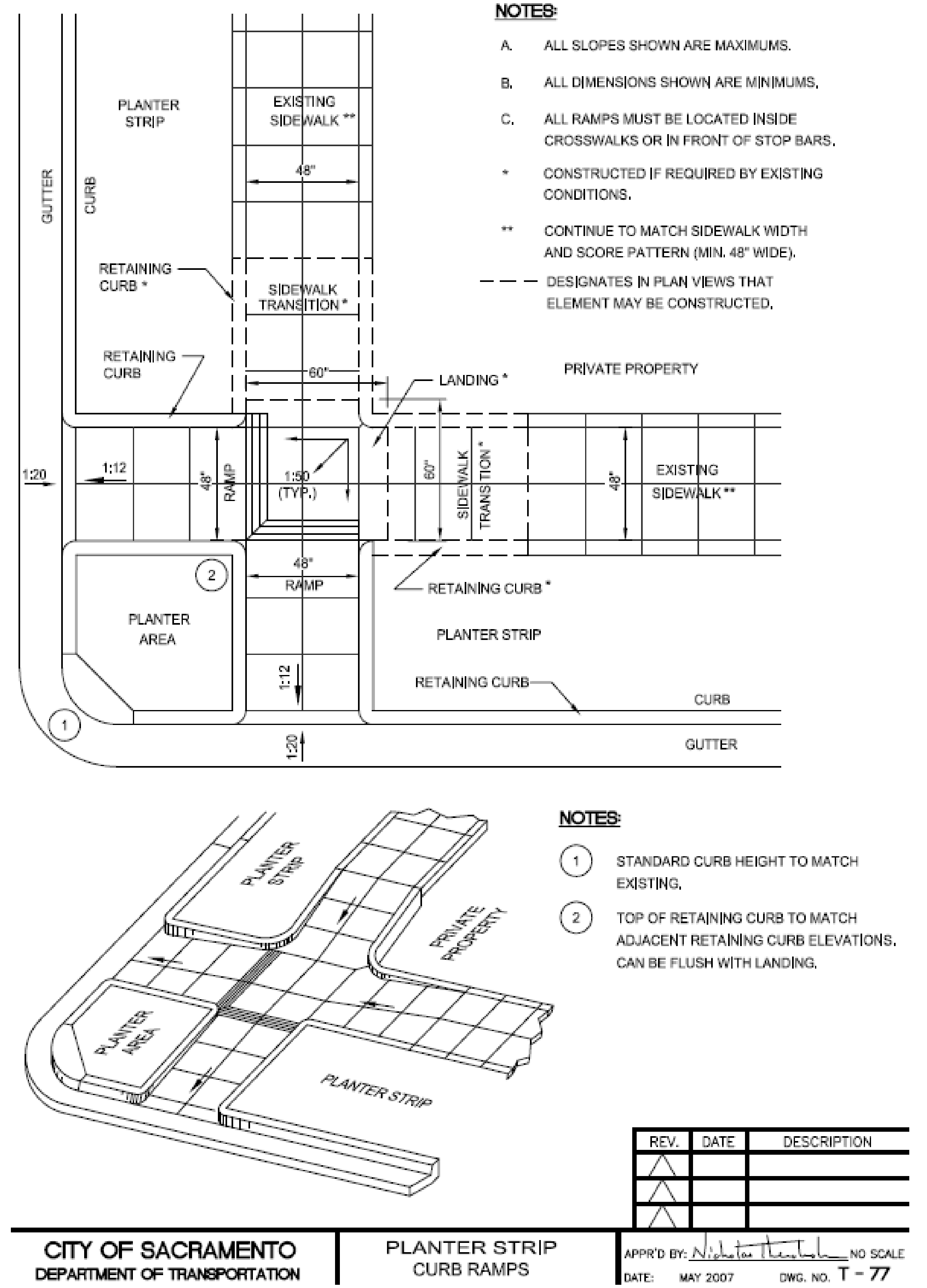
Preferred crossing treatments are identified as the basic pedestrian crossing improvements to be provided at all stop-controlled and signalized intersections. New controlled intersections should be designed with these treatments included; existing controlled intersections that require retrofits may be prioritized and upgraded as City funds become available. These treatments are based on recommended best practices in pedestrian safety:[11]

- Mark crosswalks on all legs of the intersection that serve a key desire line
- Provide advanced stop bars in advance of each crosswalk
- Minimize the number of vehicle traffic lanes pedestrians must cross
- Provide median refuge islands and thumbnails, as width and path of turn maneuvers allow
- Remove sight-distance obstructions
- Provide directional curb ramps for each crosswalk (e.g., two per corner) The Standard Drawings for the City of Sacramento include best practices for directional curb ramp design (see drawing T-

[11] See America Walks *Signalized Intersection Enhancements that Benefit Pedestrians* http://americawalks.org/wp-content/upload/America-Walks-Signalized-Intersection-Enhancement-Report-Updated-8.16.2012.pdf (2012).

77 in Transportation document at: http://portal.cityofsacramento.org/Utilities/Resources/Specs-and-Drawings)

- Eliminate free right-turn slip lanes, where feasible, and mitigate for pedestrian safety where they remain
- Locate bus stops on the far-side of the intersection (or in front of mid-block crossings)
- Minimize cycle lengths
- Reduce prevalence or eliminate permitted signal phasing where pedestrian crossings exist
- Provide pedestrian signal heads for all crossings at signalized intersections
- Provide adequate pedestrian clearance intervals (crossing time) at signalized intersections



Source: Standard drawings for the City of Sacramento Department of Transportation, 2007 (http://portal.cityofsacramento.org/Utilities/Resources/Specs-and-Drawings)

ENHANCED CROSSING TREATMENTS

At high volume pedestrian crossing locations or other areas designated by the City as pedestrian zones, the City may provide additional crosswalk enhancements at controlled intersections. These treatments provide improve drivers' awareness of pedestrians by slowing traffic through geometric changes, providing signal timing or phasing modifications, or enhancing striping or signing to improve visibility.

The following tables describe the preferred and optional enhanced pedestrian safety treatments that may be used at the City's discretion for controlled locations:

- Table 6: Geometric Treatments
- Table 7: Striping and Signage
- Table 8: Signal Hardware and Operational Measures

TABLE 6:
CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS

Treatment	Description	Level	Cost
9-1. Fewer Travel Lanes ("Road Diet")  *Image Source: Fehr & Peers*	Fewer travel lanes decrease roadway width and crosswalk length, reduce speeds, reduce left-turn and rear-end collisions, and often eliminate the multiple-threat collision. An average pedestrian takes almost four seconds to cross each additional travel lane. Therefore, reducing the number of travel lanes minimizes the amount of time that pedestrians are in the crosswalk. More travel lanes than necessary can also increase vehicle travel speeds; research has shown that the severity of pedestrian collisions increases with vehicle travel speed. Where fewer travel lanes are not possible, travel lanes can be narrowed to as little as nine feet, especially left- and right-turn pockets.	Preferred	$20/LF[12]
9-2. Pedestrian Refuge Island with "Thumbnail"  *Image Source: Fehr & Peers*	Median pedestrian islands provide a refuge for pedestrians to stand if they do not have sufficient time to cross a street. They can be enhanced with median pedestrian push buttons at signalized crossings. Median islands can be installed throughout a corridor or only at specific crosswalks.	Preferred	$130/LF[13]

[12] Cost includes removal of existing pavement markings and repainting. Assumes existing curbs are to remain as is.

[13] Cost assumes 6 foot median and includes new curb and concrete barrier.

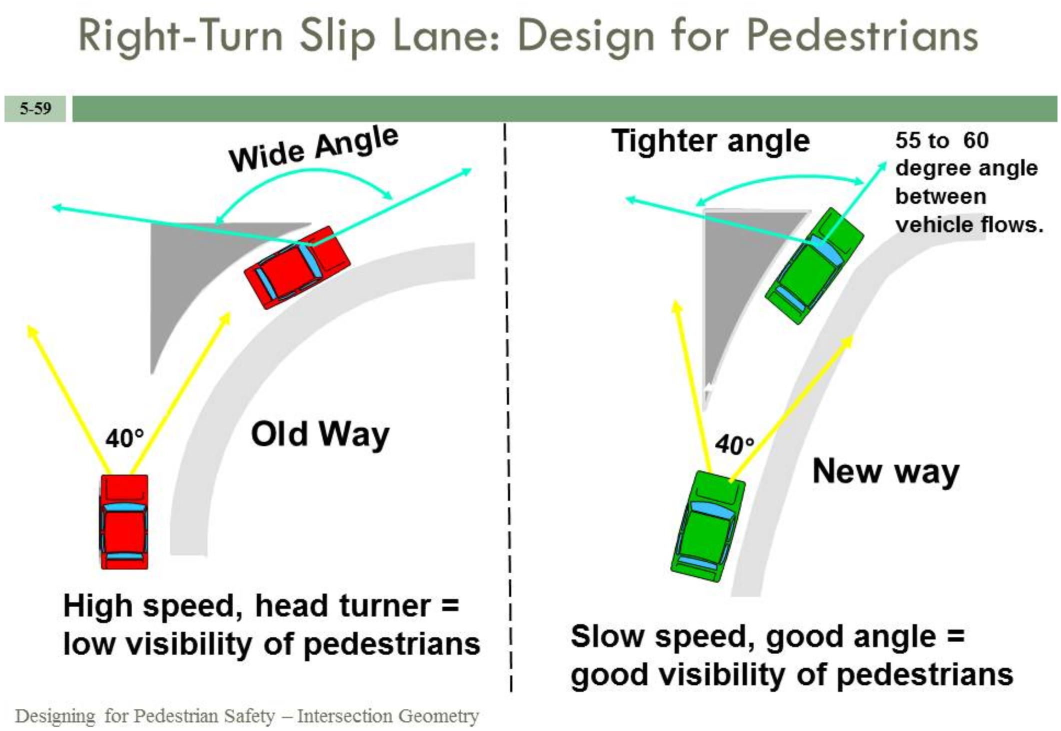
TABLE 6:
CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS

Treatment	Description	Level	Cost
9-3. Removal of Sight-Distance Obstructions  *Image Source: Fehr & Peers*	If objects impede sight-distance, an unsafe condition may arise where motorists and pedestrians are unable to see each other. Items such as parked cards, signage, landscaping, fencing, and street furniture should be placed in a location that will not obstruct sight-distance.	Preferred	$150/EA[14]
9-4. Directional Curb Ramps with Truncated Domes  *Image Source: Fehr & Peers*	Curb ramps offer wheelchair access to/from the sidewalk and crosswalk. Truncated domes, or tactile strips, warn blind pedestrians that they are about to enter a crosswalk. The best practice for curb ramps is to install two per corner so that each ramp points directly into the crosswalk and to the curb ramp at the other side of the street. Corner bulbouts can be used to increase the amount of space available for directional curb ramps.	Preferred	$4,000/ea

[14] Item removed is anticipated to be no larger than a sign and post

TABLE 6:
CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS

Treatment	Description	Level	Cost
9-5. Right-Turn Lane Design  *Image Source: Fehr & Peers*	Free right-turns allow vehicles to turn right at high speeds. Since the vehicles are not typically controlled by the traffic signal in this circumstance, crosswalks across the turn lanes are usually uncontrolled crosswalks. Controlled right-turn movements are preferable for pedestrians because they require a vehicle to stop on red before turning right. Where "pork-chop" islands that channelize right-turns are necessary to provide acceptable turning radii, raised crosswalks are a pedestrian enhancement. Other options include signalizing the crossing (especially if it is multi-lane) and designing the "pork-chop" for slower speeds and better visibility of pedestrians.	Preferred	$25,000/EA[15]



Source: FHWA

[15] Cost to remove assuming no electrical costs

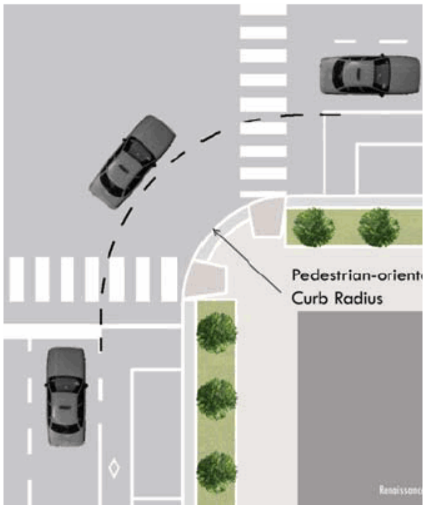
TABLE 6:
CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS

Treatment	Description	Level	Cost
9-6. Far-Side Bus Stops  *Image Source: Fehr & Peers*	Far-side bus stops allow pedestrians to cross behind the bus, improving pedestrian visibility. Far side bus stops also enhance transit operations by providing a guaranteed merging opportunity for buses. Exceptions for far-side bus stops include considerations for bus routing, sufficient sidewalk area, and conflicts with parking, land uses, or driveways.	Preferred	$1,000/EA[16]
9-7. Curb Extensions  *Image Source: Fehr & Peers*	Curb extensions extend the curb and sidewalks farther into the roadway, shortening the length of the crosswalk. They act as a traffic calming device by narrowing the effective width of the roadway and slowing turning speeds. Because they extend into the roadway, often past parallel-parked vehicles, they improve visibility for pedestrians. The also provide space for street furniture, landscaping, bicycle parking, and signs and signal poles. Curb extensions can be constructed to accommodate ADA improvements, such as directional curb ramps.	Enhanced	$140/LF[17]

[16] Cost assumes no sidewalk or paving work

[17] Cost includes removal of existing curb, new bollards, curb, and sidewalk. Cost does not include curb ramps.

TABLE 6:
CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS

Treatment	Description	Level	Cost
9-8. Reduced Turn Radius  *Image Source: AARP*	Vehicles travel faster through turns with a large radius. Reducing the radius of a corner is an effective way of reducing vehicle speeds. In suburban environments, turn radii generally do not need to exceed 30 feet. In urban environments turn radii can be 10 feet or less, especially where the meeting of one-way streets prohibits turning movements. Where on-street parking is permitted and/or bicycle lanes are present on one or both streets, consideration for further reductions of radii should occur acknowledging that the effective radius is increased with on-street parking. Corner curb radii on multi-lane streets should acknowledge that trucks turning right can turn into two lanes.	Enhanced	$175/LF[18]

Source: Fehr & Peers, 2013

[18] Cost includes removal of existing curb, new bollards, curb, and sidewalk. Cost does not include curb ramps.

TABLE 7:
CONTROLLED INTERSECTIONS: STRIPING AND SIGNAGE

Treatment	Description	Level	Cost
10-1. Marked Crosswalks  *Image Source: Google Maps*	Marking a crosswalk across all approaches of an intersection improves pedestrian accessibility. At a four-way intersection, a closed crosswalk forces pedestrians to cross via three crosswalks instead of one. Crosswalks on all approaches can often be accommodated without a significant impact to traffic signal operations.	Preferred	$15/LF[19]
10-2. Advanced Stop Bar  *Image Source: Fehr & Peers*	Advanced stop bars are placed five to seven feet in front of crosswalks. They keep vehicles from encroaching into the crosswalk when stopped at a red signal or stop sign.	Preferred	$7.50/LF

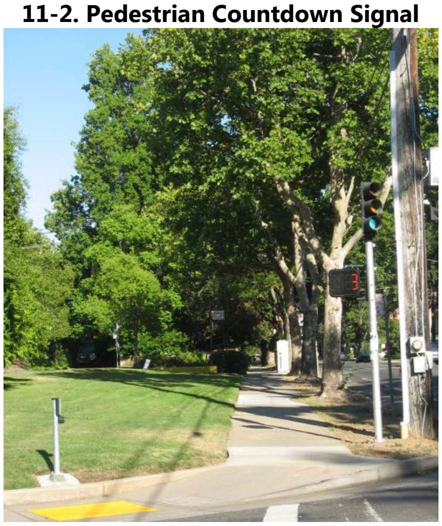
[19] Cost includes both lines of crossing.

TABLE 7:
CONTROLLED INTERSECTIONS: STRIPING AND SIGNAGE

Treatment	Description	Level	Cost
10-3. High Visibility Markings  *Image Source: Fehr & Peers*	High-visibility crosswalks at controlled locations are appropriate in areas with high pedestrian volumes, at crosswalks with skewed geometries, or near sensitive land uses (such as schools).	Enhanced	$6/Ft
10-4. Textured Pavement or Colored Crosswalks  *Image Source: Fehr & Peers*	Textured pavement can be used in crosswalks or in intersections as an aesthetic enhancement. Because of its texture, it may also calm traffic by slowing vehicles before they cross an intersection. It can also make crosswalks more visible. Textured pavement can be made of brick or, alternatively, both concrete and asphalt can be stamped to look like brick or stone. At controlled locations, standard crosswalk striping should be provided in addition to the textured pavement. A smooth, non-slip surface is preferable.	Enhanced	$15/SF

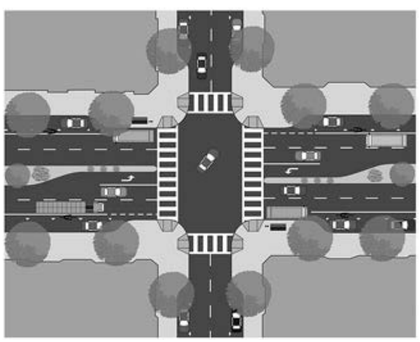
Source: Fehr & Peers, 2013

TABLE 8:
CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES

Treatment	Description	Level	Cost
11-1. Adequate Crossing Times  *Image Source: Fehr & Peers*	The 2012 California MUTCD requires a walking speed of 3.5 feet per second be assumed to determine crossing times as a default minimum (4.0 feet per second was previously the guidance). A speed slower than 3.5 feet per second can be used where slower pedestrians routinely use the crosswalk, such as locations near schools, hospitals, or senior centers.	Preferred	N/A[20]
11-2. Pedestrian Countdown Signal  *Image Source: Fehr & Peers*	Pedestrian countdown signals give pedestrians "Walk" and "Don't Walk" signals with a second-by-second countdown for each phase. Research suggests that pedestrians are more likely to obey the "Don't Walk" signal when delivered using a countdown signal. The device has been shown to enhance safety for all road users. The 2012 California MUTCD requires that all new pedestrian signals be countdown signals.	Preferred	$500/EA

[20] No construction costs associated with measure. Only preparation and implementation costs

TABLE 8:
CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES

Treatment	Description	Level	Cost
11-3. Pedestrian Signals and Push Buttons  *Image Source: Fehr & Peers*	Mounting push buttons for different crosswalks on one pole can be confusing for blind pedestrians. Push buttons should be separated by ten feet and placed within five feet of each curb ramp, one per crosswalk. At long crosswalks (≥60 feet) with a median refuge island, push buttons can be placed in the median for pedestrians who may not be able to cross the entire crosswalk in one cycle length. In areas with high pedestrian volumes, eliminating pedestrian push buttons and providing a pedestrian phase in every cycle, can enhance walkability (and signal compliance).	Preferred	$1,000/EA[21]
11-4. Short Cycle Lengths  *Image Source: Institute of Transportation Engineers*	Long cycle lengths at signalized intersections result in long pedestrian wait times to cross a street. By shortening an intersection's cycle length, pedestrians do not have to wait as long to cross after pushing the button to request a "Walk" signal.	Preferred	N/A[22]

[21] Cost includes pole

[22] No construction costs associated with measure. Only preparation and implementation costs

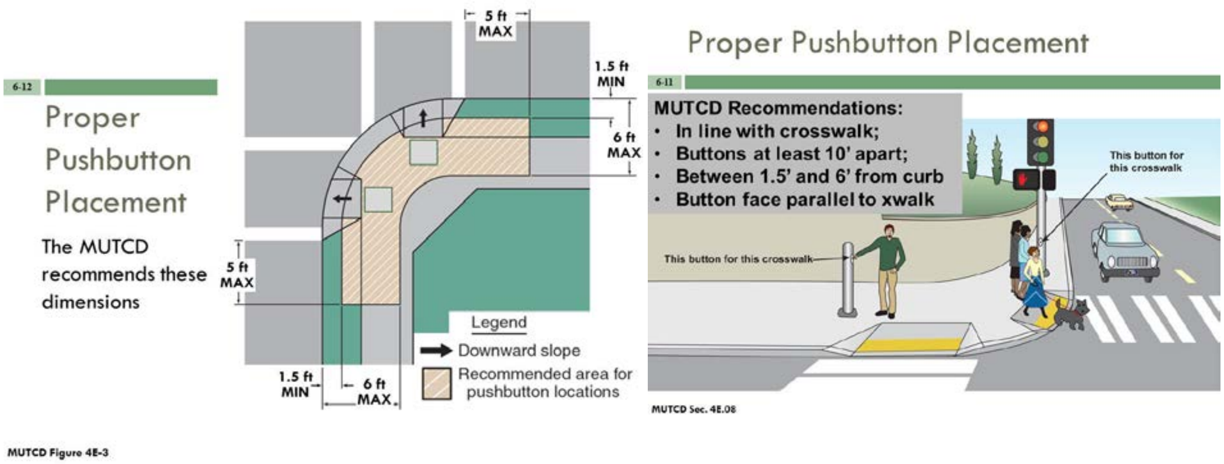
TABLE 8:
CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES

Treatment	Description	Level	Cost
11-5. Protected Left-Turns  *Image Source: Fehr & Peers*	Where permitted left-turns are allowed, denoted by a "Left Turn Yield on Green" sign, left-turning vehicles can conflict with pedestrians in the crosswalk. By making the left-turn protected, so that it is allowed only with a green arrow, the "Walk" signal at a crosswalk occurs at the same time that through- and right-turning vehicles in the same direction receive a green light. This reduces the risk of left-turning vehicle conflicts with the opposing crosswalk; since left-turns typically occur at a higher speed than right-turns, collisions of increased severity can be avoided by protecting left-turns.	Preferred	$20,000-50,000/EA[23]
11-6. Accessible Pedestrian Signals  *Image Source: Fehr & Peers*	Accessible pedestrian signals (APS) and detectors provide information, such as "Walk" indications and direction of crossing, in non-visual formats to improve accessibility for blind pedestrians. Audible options for accessible pedestrian signals include audible tones and speech messages. Vibrotactile push-buttons are effective options that alleviate the impacts of noise created by audible pedestrian signals. They are also accessible to deaf pedestrians. APS should always be provided when two push buttons are located on one pole and where persons with disabilities are expected frequently at a crossing. At other locations, APS is currently a best practice, but is expected to become a requirement when the proposed rulemaking of the *Public Rights of Way Accessibility Guidelines* (PROWAG) is finalized.	Enhanced	$2,500/EA

[23] Assumes left turn lane is existing, so no roadway work is necessary. Only signal work.

TABLE 8:
CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES

Treatment	Description	Level	Cost



Source: FHWA

11-7. Pedestrian Recall  *Image Source: Fehr & Peers*	Pedestrian recall gives pedestrians a "Walk" signal at every cycle. No push-button or detection is necessary since a "Walk" signal will always be given. Pedestrian recalls are useful in areas with high levels of pedestrian activity. They demonstrate that an intersection is meant to serve both vehicles and pedestrians. In general, pedestrian recall should be used if pedestrians actuate a "Walk" signal 75 percent of the time during three or more hours per day. Recall can be used 24-hours a day or during peak hours for pedestrians (in which case push buttons should continue to be provided).	Enhanced	N/A[24]

[24] No construction costs associated with measure. Only preparation and implementation costs

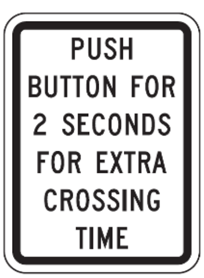
TABLE 8:
CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES

Treatment	Description	Level	Cost
11-8. No Right Turn on Red  *Image Source: FHWA*	When attempting to turn right on red, motorists must look left to see if the road is clear; motorists often do not look right before turning and may not see pedestrians to their right. Restricting right turns on red can reduce conflicts between vehicles and pedestrians. "Blank out" turn restriction signs (see 11-9 below) are more effective than conventional "No Right Turn on Red" signs. "No Right Turn on Red" signs that specify time-of-day restrictions or "When Pedestrians are Present" are confusing to motorists and are often disregarded.	Enhanced	$1,500/EA[25]
11-9. Blank-Out Turn Restriction LED Sign  *Image Source: Fehr & Peers*	The ubiquity of conventional turn restriction signs, usually for no right turn on red, contributes to their disregard by motorists. Blank out turn restriction signs activate only when the specified movement is prohibited. The LED sign is also very visible.	Enhanced	$2,000[26]

[25] Cost includes 2 signs: one on mast arm and other on pole nearby

[26] Cost includes installation

TABLE 8:
CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES

Treatment	Description	Level	Cost
11-10. Animated Eyes  *Image Source: Fehr & Peers*	Animated eyes pedestrian signals feature eyes that move from side to side when a "Walk" signal is given. The signals remind pedestrians to look for turning vehicles before proceeding into the crosswalk. Research has indicated that animated eyes pedestrian signals reduce conflicts between vehicles and pedestrians. Source: http://www.cers-safety.com/pedestriansignals.pdf	Enhanced	$2,000[27]
11-11. Leading Pedestrian Interval (LPI)  *Image Source: Fehr & Peers*	A leading pedestrian interval (LPI) advances the "Walk" signal for a few seconds while through-vehicles continue to receive a red indication. By allowing pedestrians to get a head start into the crosswalk, it can reduce conflicts between pedestrians and turning vehicles. The 2012 California MUTCD recommends that LPIs be at least three seconds in duration. Right-turn on red restrictions may be needed with LPIs are installed in locations with lower pedestrian volumes.	Enhanced	No construction costs only preparation and implementation costs
11-12. Push Button for Extended Crossing Time  *Image Source: FHWA*	Some pedestrians may need extra time to safely cross a street. Traffic signals can be retrofitted to provide pedestrians with increased crossing time by extending the duration of a pushbutton press.	Enhanced	$1,000/EA[28]

Source: Fehr & Peers, 2013.

[27] Cost includes installation

[28] Cost includes pole

6. EDUCATION, ENFORCEMENT, AND ENCOURAGEMENT PROGRAMS

The prior chapters in this policy describe engineering treatments to improve pedestrian safety and enhance walkability. Engineering, however, is only one aspect of a comprehensive pedestrian safety strategy. Education, enforcement, and encouragement, are also crucial, as outlined in the City's *Pedestrian Master Plan*. This section presents best practices for education, encouragement, and enforcement components of pedestrian safety programs that may be considered to supplement the *Crosswalk Policy Guidelines*.

EDUCATION

The following is a list of pedestrian safety practices for educating pedestrians and motorists about safe and lawful behavior:

- Website – provide informational materials relating to pedestrian safety
- Videos – post information such as public service announcements to the City's website
- Community outreach events – provide opportunities for pedestrian education such as Mayor's night out events
- Pamphlets – make informational materials available through the City
- Student group involvement – promote pedestrian safety by involving and educating student groups
- Street/Bus Stop/School Banners – place advertisements in high activity pedestrian areas
- Yard Signs – communicate roadway conditions to motorists and pedestrians
- Strategic partnerships – partner with groups such as American Association of Retired Persons (AARP) to promote pedestrian safety
- Local media campaigns – involve local media in pedestrian safety campaigns
- Classroom curricula – collaborate with local school districts to develop pedestrian safety curricula for schools
- Structured skills practice – develop a program that trains pedestrians in safe behavior
- Games, coloring books, etc. – develop or provide fun and educational materials for children

ENFORCEMENT

The following is a list of pedestrian safety practices for enforcing pedestrian and vehicular right-of-way laws:

- Officer training courses – provides law enforcement with full understanding of pedestrian laws and safety practices
- Traffic complaint hotline – provides a method for citizens to alert the City when a public facility is of concern, such as inoperable traffic signal
- Community enforcement – provides a mechanism for community members to help enforce traffic laws, such as a radar gun checkout program
- Adult school crossing guards – provides a trained adult to help pedestrians cross the street
- Pedestrian decoys – target enforcement activities with a staged pedestrian or motorist, targeting motorists or pedestrians who do not comply with traffic laws
- Partnership with media, stakeholders, and City departments – involve various stakeholders in pedestrian education campaigns and efforts

ENCOURAGEMENT

The following is a list of pedestrian safety practices that encourage pedestrians and motorists to engage in safe and lawful behavior:

- Wayfinding – install signage directing pedestrians to designated routes and destinations
- Walking school buses/Walking Wednesdays –organize activities by schools and/or parents that have students walk to school in groups on selected days
- Community walking audits – lead or support community members on walk around an area noting positive practices and areas for improvement
- Silver sneaker awards – distribute awards encouraging physical activity among seniors
- Incentives/contests – reward those who walk or demonstrate safe walking habits
- Peer-to-peer education – develop program to educate pedestrians through interaction with peers trained in pedestrian safety

APPENDIX A:

CITYWIDE CROSSWALK INVENTORY

APPENDIX B:

PEDESTRIAN LEVEL OF SERVICE CALCULATIONS

The pedestrian delay calculations included in the Crosswalk Tool rely on the methodology recommended in NCRHP Report 562 (http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf). A full discussion of this methodology is found in Appendix A of the NCHRP report. The key equations in the tool include:

TABLE 9:
PEDESTRIAN LOS CALCULATIONS

Road Characteristics	Description
Speed on the major street (mph)	Use the major road posted or statutory speed limit for the facilities or, if available, the 85th percentile speed.
Pedestrian **crossing distance** (ft)	Pedestrian crossing distance represents the distance that a pedestrian would need to cross before reaching either the far curb or a median refuge island. The distance would be between the near and far curbs if a painted or raised median refuge island is not present, or to the median refuge island if the island is present. Note if a parking stall is present, its width should be included in the crossing distance measurement. Crossing distance rather than number of lanes was selected for the procedure so that the extra time needed by a pedestrian to cross bike lanes, two-way left-turn lanes, wide lanes, etc. could be considered.
Counts	**Description**
Peak-hour **pedestrian volume** crossing major roadway (ped/h)	Pedestrian volume is the number of pedestrians crossing the major roadway in a peak hour. The count includes all pedestrian crossings of the major roadway at the location.
Major road peak hour **vehicle volume** (veh/h)	Vehicle volume represents the number of vehicles and bicycles on both approaches of the major road during a peak hour. If a painted or raised median refuge island is present of sufficient size to store pedestrians (minimum of 6 ft [1.8 m] wide), then consider the volume on each approach individually. In the signal warrant calculations, use the volume on both approaches (Vmaj-s). For the delay calculations, the volume (Vmaj-d) would reflect either both approaches if a refuge island is not present or each approach individually if a refuge island is present.
Local Parameters	**Description**
Motorist **compliance** for region (high or low)	Compliance reflects the typical behavior of motorists for the site. If motorists tend to stop for a pedestrian attempting to cross at an uncontrolled location, then compliance is "high." If motorists rarely stop for a crossing pedestrian, then compliance is "low."
Pedestrian **walking speed** (ft/s)	Walking speed represents the speed of the crossing pedestrians. Recent research has suggested walking speeds of 3.5 ft/s (1.1 m/s) for the general population and 3.0 ft/s (0.9 m/s) for the older population. If calculating for a site, determine the 15th percentile value of those using the crossing.
Pedestrian **start-up** time and end clearance time (s)	Start-up time is used in the calculation of the critical gap. A value of 3 s is suggested in the Highway Capacity Manual.

TABLE 9:
PEDESTRIAN LOS CALCULATIONS

Calculations	Description
Signal warrant check (ped/hr)	Regression equations were determined for the plots shown in the 2012 CA MUTCD Figures 4C-7 and 4C-8. These equations can calculate the minimum number of pedestrians crossing the major road needed to meet the signal warrant based on the major road volume. The recommendation made in 2006 to the National Committee on Uniform Traffic Control Devices is that the vehicles signal warrants values for crossing two lanes be used as the pedestrian signal warrant values. Both the peak vehicle hour and the peak pedestrian hour may need to be checked.
HAWK warrant check	Regression equations were determined for the plots shown in the 2012 CA MUTCD Figures 4F-1 and 4F-2. These equations can calculate the minimum number of pedestrians crossing the major road needed to meet the HAWK signal warrant based on the major road volume.
Critical gap (s), tc	Critical gap is the time in seconds below which a pedestrian will not attempt to begin crossing the street. For a single pedestrian, critical gap (tc) can be computed using Equation 18-17 of the 2000 Highway Capacity Manual. The equation includes consideration of the pedestrian walking speed (Sp), crossing distance (L), and start-up and end clearance times (ts). tc = (L/Sp) + ts
Major road flow rate (veh/s), v	Flow rate is a measure of the number of vehicles per second (v). For high-speed conditions, the number of vehicles is adjusted by dividing by 0.7. Flow rate is determined by: Low speed: v = Vmaj-p/3600 high speed: v = (Vmaj-p/0.7)/3600 It is based on the major road volume (Vmaj-d), which is the total of both approaches (or the approach being crossed if median refuge island is present) during the peak hour (veh/h).
Average pedestrian delay (s/person), dp	The 2000 Highway Capacity Manual includes Equation 18-21 that can be used to determine the average delay per pedestrian at an unsignalized intersection crossing (s/person). dp = (1/v)*(EXP(v*tc)-(v*tc-1)). It depends upon critical gap (tc), the vehicular flow rate of the crossing (v), and the mean vehicle headway.
Total pedestrian delay (ped-h)	Total pedestrian delay (Dp) uses the average pedestrian delay (dp) and multiplies that value by the number of pedestrians (Vp) to determine the total pedestrian delay for the approach. Dp = (dp × Vp)/3,600

Source: NCHRP Report 562, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf

APPENDIX C:
PEDESTRIAN COLLISION ANALYSIS

PEDESTRIAN COLLISION ANALYSIS

Vehicle-pedestrian collision data is one source of information to identify pedestrian safety "hotspots". Collision data was obtained from the California Highway Patrol Statewide Integrated Traffic Records System (SWITRS) for the City of Salinas between January 2005 and December 2010, the five (5) most recent years of available data at the time this report was authored.

The locations of pedestrian collisions were mapped to illustrate the pedestrian-vehicle collisions throughout Salinas. A total of 363 vehicle-pedestrian collisions occurred in Salinas between 2005 and 2010. **Figure 4** shows the number and location of collisions at intersections throughout Salinas from 2005-2010. **Table 10** lists the locations with the highest number of vehicle-pedestrian collisions Citywide. As shown, the intersection of N. Sanborn Road and Garner Avenue has the most frequent pedestrian collisions, with 14 occurring between 2005 and 2010.[29]

TABLE 10:
TOP PEDESTRIAN-VEHICLE COLLISION LOCATIONS, SALINAS, 2005-2010

Intersection	Number of Collisions	Intersection	Number of Collisions
N. Sanborn Road and Garner Avenue	14	Lincoln Avenue and Central Avenue	4
Salinas Street and W. Alisal Street	7	Geil Street and S. Main Street	4
N. Main Street and E. Laurel Drive	6	N. Main Street and Lamar Street	4
Williams Road and Bardin Road	5	Alisal Street and Wood Street	4
Harden Parkway and N. Main Street	5	E. Alisal Street and N. Madeira Avenue	4
E. Alisal Street and Sanborn Street	5	E. Market Street and Carr Avenue	4
E. Bernal Drive and N. Main Street	4	N. Sanborn Road and Freedom Parkway	4

Source: SWITRS, 2005-2010.Fehr & Peers, 2013.
Notes: This list is based on number of collisions and does not adjust for vehicle or pedestrian volumes (exposure). Collisions occurring 25 feet or closer to an intersection were assigned to the nearest intersection.

[29] The City recently received a Highway Safety Improvement Program (HSIP) grant to provide intersection safety improvements along the Sanborn Road Corridor that includes pedestrian benefits. (countdown signals/eliminates permitted left turns).

Figure 4: Salinas Pedestrian-Vehicle Collisions, 2005-2010

Figure 5 shows the higher severity pedestrian-vehicle collisions, including those with pedestrian injuries and fatalities, and **Table 11** lists the locations with the highest number of fatalities and injuries. Similar to Table 1, N. Sanborn Road and Garner Avenue has the highest frequency of pedestrian-vehicle collisions, with 14 injuries and two fatalities occurring between 2005 and 2010.

TABLE 11:
TOP PEDESTRIAN-VEHICLE COLLISIONS LOCATIONS, INJURY OR FATALITY, 2005-2010

Intersection	Number of Injuries (Fatalities)	Intersection	Number of Injuries (Fatalities)
N. Sanborn Road and Garner Avenue	14 (2)	E. Alisal Street and N. Pearl Street	4 (0)
N. Main Street and E. Laurel Drive	7 (0)	Freedom Parkway and N. Sanborn Road	4 (0)
Salinas Street and W. Alisal Street	7 (0)	E. Laurel Drive and Towt Street	4 (0)
E. Alisal Street and N. Sanborn Road	6 (0)	W. Alisal Street and Lincoln Avenue	4 (0)
Williams Road and Bardin Road	6 (0)	S. Main Street and Geil Street	4 (0)
Harden Parkway and N. Main Street	5 (0)	N. Main Street and Lamar Street	4 (0)
Alisal Street and Wood Street	4 (0)	N. Main Street and Bernal Drive	4 (1)
E. Alisal Street and N. Madeira Avenue	4 (0)	E. Alvin Drive and McKinnon Street	4 (0)

Source: SWITRS, 2005-2010.Fehr & Peers, 2013.
Notes: This list is based on number of collisions and does not adjust for vehicle or pedestrian volumes (exposure).
Collisions occurring 25 feet or closer to an intersection were assigned to the nearest intersection.

Figure 5: Salinas Pedestrian-Vehicle Collisions Resulting in Injuries and/or Fatalities, 2005-2010

Primary Collision Factor

Table 12 lists the most common primary collisions factors (PCFs) for pedestrian-vehicle collisions in Salinas. The top three PCFs were pedestrian right-of-way violation (wherein the motorist is at fault), pedestrian violation (wherein the pedestrian is at fault), and unsafe speed (wherein the vehicle's speed is the primary cause of the collision). In total, motorists are at fault for over 50 percent of pedestrian collisions. Pedestrian violations account for approximately one-third of collision factors.

TABLE 12:
PRIMARY COLLISION FACTORS (PCFS) FOR PEDESTRIAN-VEHICLE COLLISIONS IN SALINAS, 2005-2010

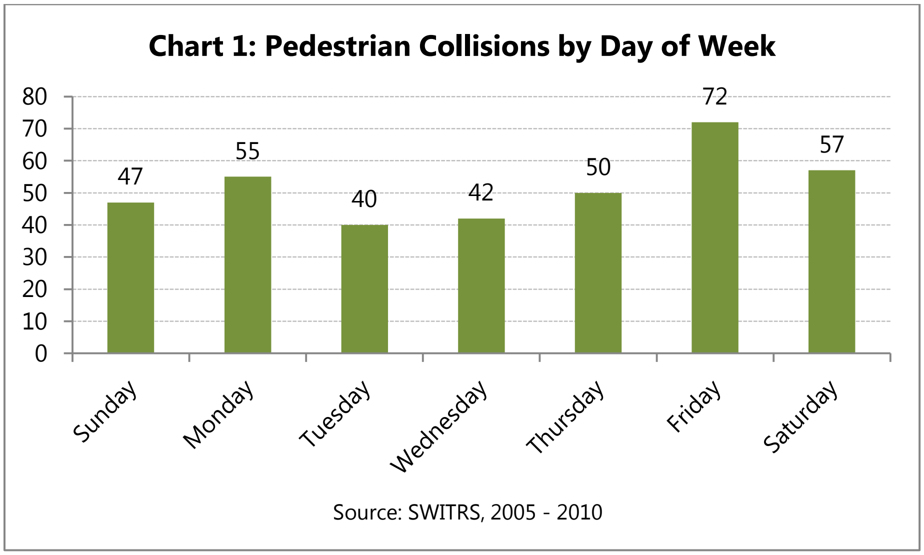
Primary Collision Factor	% of Total
Pedestrian Right-of-Way	36.4%
Pedestrian Violation	34.4%
Not Stated	5.2%
Unsafe Speed	4.4%
Unsafe Starting or Backing	3.0%
Traffic Signals and Signs	2.8%
Unknown	2.8%
Improper Turning	2.5%
Driving or Bicycling Under the Influence of Alcohol or Drug	2.2%
Automobile Right-of-Way	1.7%
Improper Passing	1.1%
Other Improper Driving	1.1%
Wrong Side of Road	0.8%
Other Hazardous Violation	0.8%
Unsafe Lane Change	0.6%

Source: SWITRS 2005-2010, Fehr & Peers, 2013

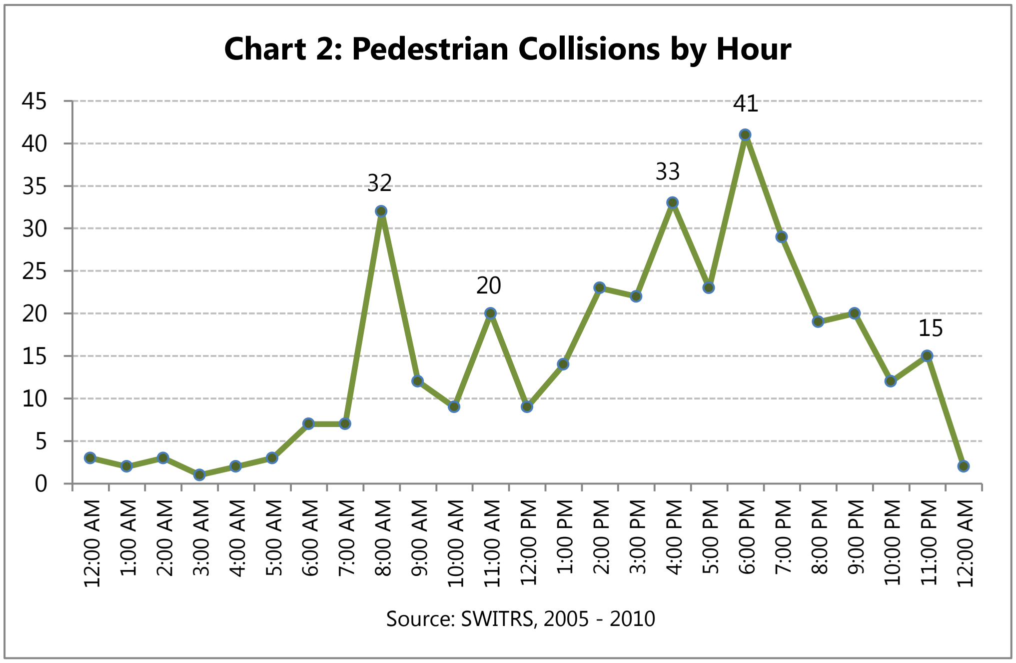
Day of the Week

The following statistics and charts show the number of pedestrian collisions that occur by day of the week and hour of the day. Between 2005 and 2010, collisions occurred most frequently on Fridays and

Saturdays, with 72 and 57 collisions, respectively. Monday had the third highest number of pedestrian collisions (55).



Pedestrian collisions occur in a pattern similar to typical morning and evening commute peak hours: between 2005 and 2010, 32 pedestrian collisions occurred in the 8:00 am hour, and 41 collisions in the 6:00 pm hour.



Weather Conditions

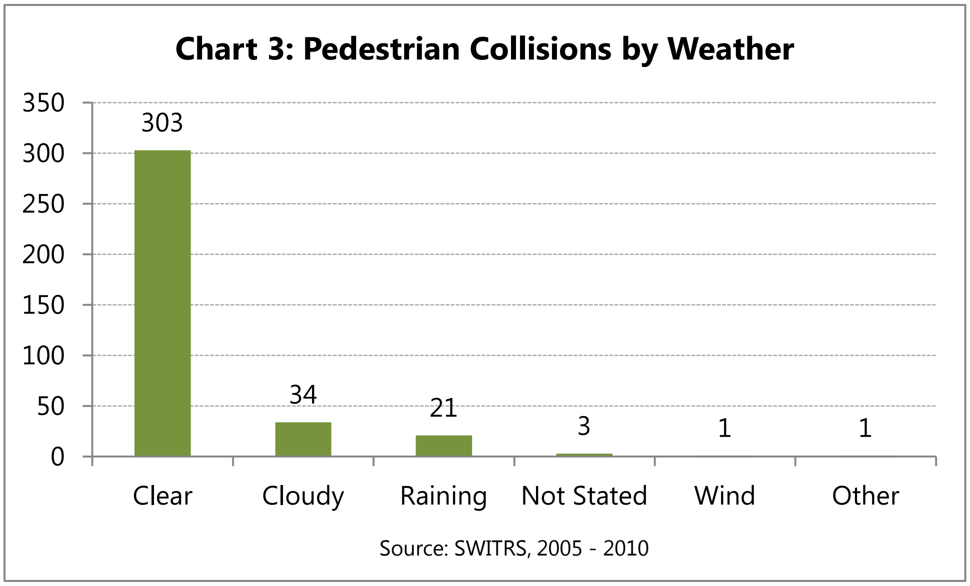


Chart 3 displays the weather conditions during pedestrian collisions in Salinas. The majority of pedestrian collisions took place when the weather was clear, which indicates that in 80% of collisions, weather was likely not a factor in condition of the roadway; however, sun glare may have contributed to some of these collisions. The weather was cloudy in 34 of the collisions and raining in 21. Wind was noted in one (1) collision, "Other" in one (1) collision, and in three (3) reports weather was not reported.

Age Statistics

TABLE 13:
AGE RANGES FOR PEDESTRIAN-VEHICLE COLLISIONS IN SALINAS, 2005-2010

Age Range	% of Total
0-15	28%
16-30	29%
31-45	18%
46-60	17%
61+	9%

Source: SWITRS 2005-2010, Fehr & Peers, 2013

Table 13 provides a summary of pedestrian age data for collisions in Salinas. The ages are grouped in five categories: ages 0-15, ages 15-30, ages 31-45, ages 46-60, and ages 61 and above. The greatest proportion of collisions involved the age group 16-30, which accounted for 29 percent of the collisions, followed closely by the age group 0-15, which accounted for 28 percent of pedestrian collisions. Together, pedestrians under 30 years of age account for over half of the pedestrians involved in collisions.

Near Schools

The frequency of pedestrian-vehicle collisions was also reviewed for school-age children (five years old through 18 years old) within ¼-mile of schools. **Figure 6** shows the locations of these pedestrian-vehicle collisions. In total, 33 collisions occurred that meet these criteria, or approximately 10 percent of the total pedestrian-vehicle collisions occurring Citywide.

SUMMARY

While walking accounts for only a small percentage of trips,[30] according to the National Highway Traffic Safety Administration (NHTSA), pedestrian fatalities represented 13 percent of total fatalities in traffic crashes in 2010 ("Traffic Safety Facts: 2010 Data," 2012). This implies that pedestrians are over represented in collisions compared to the number of trips made by walking. Pedestrian collisions are also known to be underreported, since those collisions with no injury or fatality often go without a police report and are, thus, not added to the City or SWITRS databases for analysis.

Collision data for the City of Salinas was obtained from the California Highway Patrol Statewide Integrated Traffic Records System (SWITRS) between January 2005 and December 2010, the five (5) most recent years of available data at the time this report was authored. Based on this data, 363 vehicle-pedestrian collisions occurred in Salinas between 2005 and 2010. The most common primary collision factors included pedestrian right-of-way violation (wherein the vehicle is at fault), pedestrian violation (wherein the pedestrian is at fault), and unsafe speed (wherein the vehicle's speed is the primary cause of the collision). Weekends (Fridays through Sundays) had higher collision frequency, on average, than weekdays; however, collision frequency tended to follow peak vehicle commute times – 8:00 am, 4:00 pm, and 6:00 pm have the highest number of pedestrian collisions.

Age is also an important variable in understanding collision frequency, as 57 percent of pedestrian collisions involved pedestrians under the age of 30. This indicates that safe routes to school education, enforcement, and engineering efforts should be a priority for the City.

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[30] According to the 2010 American Community Survey 3-Year Estimates, the walking mode for work trips in the United States is 2.8 percent.

Figure 6: Pedestrian-Vehicle Collisions for School-Age Children Occurring within ¼-Mile of Schools