

City of Oakland
Department of Transportation

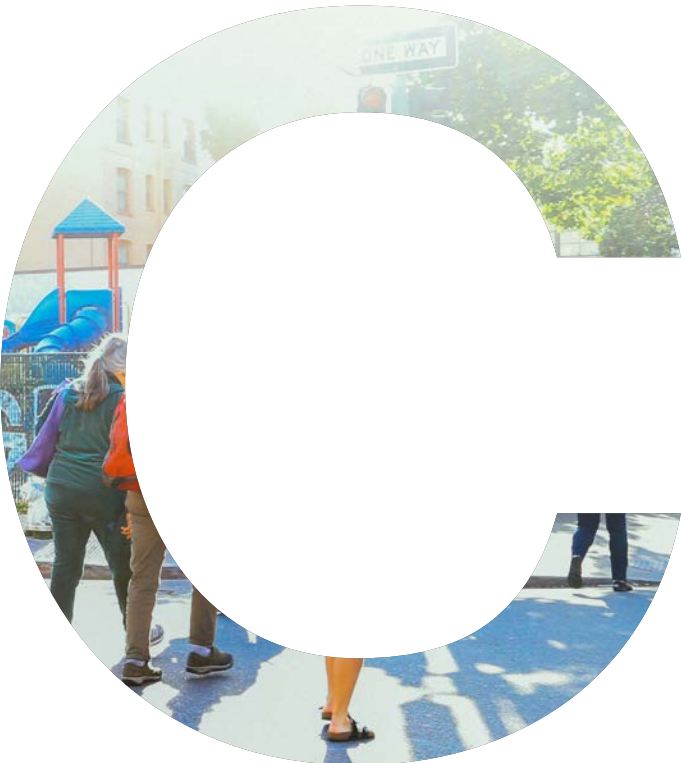
Appendix C

Oakland Walks! 2017 Draft Pedestrian Master Plan Update
Public Review Draft - April 6, 2017



City of
Oakland





Appendix C

Safety Toolkit

TREATMENT TOOLBOX

The pedestrian safety treatments are organized into the following three program areas:


- Signalized Intersections;
- Marked Uncontrolled Crosswalks at Two-Way Stop-Controlled Locations; and
- Marked Uncontrolled Crosswalks at Midblock Locations.








To apply this toolbox to corridors:







- Consider is the corridor over built from a vehicular capacity perspective? Could a road diet be implemented?
 - Road diets reduce the number of vehicle lanes a pedestrian has to cross and also consistently reduces vehicle speeds.
 - Reducing pedestrian exposure to vehicles and slowing vehicle speeds help lower the risk of pedestrian crashes.
- Identify intersections along the corridor that are higher risk (based on their physical characteristics and crash history) for pedestrian crashes.
 - Depending on the control at these intersections, see the treatments within the signalized intersection toolbox or treatments within the marked uncontrolled crosswalks at two-way stop controlled locations for potential improvements.
 - If there are a number of signalized intersections along the corridor, consider signal timing changes to coordinate the signals to encourage slower vehicle speeds (e.g., coordinate signals to encourage vehicle speeds of 13 mph).
- Identify midblock crossing locations – either existing marked uncontrolled midblock crossing locations or midblock locations that due to surrounding land uses are an attractive location for pedestrians to attempt to cross (e.g., midblock transit stops, commercial uses, schools, parks).
 - See the treatments within the marked uncontrolled crosswalks at midblock locations midblock section of the toolbox.

Table 1 summarizes the treatments provided in the toolbox by program area. Treatments marked with this symbol: ★ are treatments that may help with managing or slowing vehicle speeds. The toolbox provides more detail on each treatment type including planning level cost ranges or order of magnitude cost values, benefits and constraints, typical applications, and design considerations. Cost ranges were provided by City of Oakland staff unless otherwise noted. References containing additional guidance are provided for each treatment. The guidance in this toolbox should be used alongside the City of Oakland’s Crosswalk Policy guidance as well as the City’s Pedestrian Safety Guidance for Signalized Intersections Memorandum to identify the most appropriate treatment(s) at a particular location.

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MB-8	Implement a Road Diet (i.e., reduce the number of vehicle lanes) ★			



ADD EXCLUSIVE PEDESTRIAN PHASING

Cost Range: \$5,000 – 30,000 (per intersection installation)¹



Exclusive pedestrian phasing, sometimes referred to as a “pedestrian scramble,” stops all vehicular movement and allows pedestrians to cross in any direction (including diagonally).

Benefits

- Nearly eliminates all pedestrian-vehicle conflicts
- Allows pedestrians to cross in any direction
- Treatment is already established in the City of Oakland (8th and Webster)

Constraints

- May increase vehicle and/or pedestrian delay due to added phasing and increased cycle lengths
- Increased cycle lengths may encourage pedestrians crossing against the signal
- Additional educational and/or enforcement efforts may be required for consistent compliance.

Typical Applications

- Intersections with patterns of conflicts and/or collisions between crossing pedestrians and turning vehicles combined with high pedestrian crossing volumes.
- Central business district and other high pedestrian volume activity centers.

Design Considerations

- Speech walk messages used at intersections with exclusive pedestrian phasing shall be patterned after the model: “Walk sign is on for all crossings.”
- Locate the push button such that it is easily accessible by pedestrians, wheelchair users, and bicyclists.
- Treatment may result in longer cycle lengths at intersections with long diagonal crossing distances; this may increase total delay for pedestrians and motorists at the intersection.
- Impacts to transit operations should be considered.

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*
- *City of Oakland’s Pedestrian Safety Guidance for Signalized Intersections*

¹ The low end of the estimated cost range covers signal timing and reprogramming for the additional pedestrian phase while the high end of the estimated cost includes a new controller for the signal, additional pedestrian signal heads, and construction at the intersection.



RESTRICT RIGHT TURN ON RED

Magnitude Cost: \$500-\$5000 (per approach)²



Mounted signs eliminate the right of motorists to make a right turn at a red light. Can be used full-time or under restricted time intervals.

Benefits

- Reduces conflicts and collisions between motorists and pedestrians
- Reduces time motorists have to make a right turn
- Potential vehicle queuing
- Potential vehicle/transit delay

Constraints

Typical Applications

- Signalized intersections where right-turning movements interfere with crossing pedestrians and pedestrian crossing volumes are high. See below for restriction considerations.

Design Considerations

- Restrictions could be considered where:
 - There is inadequate sight distance for pedestrians and vehicles to see each other – inadequate sight distance means insufficient stopping sight distance for motorists and/or pedestrians do not have sufficient line of sight to judge a safe gap to cross based on prevailing vehicle speeds;
 - Geometric or operational characteristics may result in unexpected conflicts;
 - There is an exclusive pedestrian phase or an exclusive bicycle phase;
 - Heavy pedestrian volumes;
 - School or railroad crossings; and
 - Traffic signal with three or more phases.

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*

² The order of magnitude cost covers at the low end the purchase of a “No Right Turn on Red” sign and installation, while the high end costs represents the purchase and installation of a dynamic “No Right Turn on Red” sign.

Pedestrian Safety Solutions Toolbox

Signalized Intersections



PROTECTED RIGHT TURN PHASE

Magnitude Cost: \$3,000 – 5,000³

Protected right turn phases may be used where vehicle and pedestrian volumes are high to separate the two conflicting movements.



Benefits

- Reduces conflicts and collisions between right-turning motorists and pedestrians.

Constraints

- Increases pedestrian wait time at crossings
- Requires right-turn only lane.

Typical Applications

- Signalized intersections where high right-turning vehicle movements and high volumes of crossing pedestrians.
- Locations with a documented history of right-turning vehicle and pedestrian conflicts or collisions.

Design Considerations

- Protected right turn phases could be considered where:
 - There is inadequate sight distance for pedestrians and vehicles to see each other – inadequate sight distance means insufficient stopping sight distance for motorists and/or pedestrians do not have sufficient line of sight to judge a safe gap to cross based on prevailing vehicle speeds;
 - Geometric or operational characteristics may result in unexpected conflicts;
 - There are an unacceptable number of pedestrian conflicts with right-turn movements;
 - Heavy pedestrian volumes; and
 - Heavy right-turning vehicle volumes.

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*

³ The cost range covers retiming and reprogramming the signal and one or two additional signal heads.

Pedestrian Safety Solutions Toolbox

Signalized Intersections



MODIFY SIGNAL TIMING

Cost Range: \$1,000 – \$3,500 (per intersection)⁴



Adjusting existing signal timings to better accommodate pedestrians. This could include reducing the amount of vehicular green time to decrease pedestrian wait time at signals.

Benefits

- Provides additional crossing times and reducing wait times.
- Can be used to manage vehicle speeds along a corridor.

Constraints

- Improving conditions for one mode is often done at the expense of others (e.g. increased delay).

Typical Applications

- Signalized intersections where pedestrian cross times are inadequate for pedestrian volumes.
- Locations with a documented crash history of pedestrians frequently crossing against the signal.
- Along a corridor signal timing could be modified to help manage vehicle speeds – e.g., establishing progression for a vehicle speed of 13 mph.

Design Considerations

- Allow pedestrians sufficient time to cross the street, including seniors, children, and people with disabilities.
- A walking speed of 3.5 feet per second should be used to calculate the minimum pedestrian clearance interval (flashing red hand plus yellow and any all-red phases).
- Where pedestrians walk slower than 3.5 feet per second, or pedestrians who use wheelchairs routinely use the crosswalk, consider a walking speed of less than 3.5 feet per second.
- Provide a walk interval at least 7 seconds long to allow time for a pedestrian to leave the curb or shoulder before the clearance time begins.

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*
- *NACTO Urban Street Design Guide*

⁴ The cost range covers retiming and reprogramming a single intersection at the low end to more complex situations such as adjusting coordinated signals at the high end.



CONVERT PERMISSIVE PHASE TO PROTECTED OR PROTECTED/PERMISSIVE PHASING

Cost Range: \$3,000 - \$5,000⁵

Adjust signal phasing to allow left-turning vehicles a protected or protected/permissive left-turn phase instead of a permissive phase.



Benefits

- Reduce left-turning conflicts with pedestrians and vehicles
- Improve vehicle turning-related safety for pedestrians and improve safety for left-turning motorists.
- Improve left-turning operations

Constraints

- Less green time for through and right turn movements
- Less green time for pedestrian crossings

Typical Applications

- Signalized intersections where left-turning vehicle-pedestrian crashes are frequent.
- Signalized intersections where left-turning vehicles and pedestrians have frequent conflicts.

Design Considerations

- Consider protected or protected/permissive phasing at intersections with a history of left-turning collisions, where pedestrian-vehicle turning conflicts are high, and intersections with large skews.

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*
- *NCHRP Report 617: Accident Modification Factors for Traffic Engineering and ITS Improvements*
- *FHWA Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes*
- *NACTO Urban Street Design Guide*

⁵ The cost range covers retiming and reprogramming the signal and one or two additional signal heads.

Pedestrian Safety Solutions Toolbox

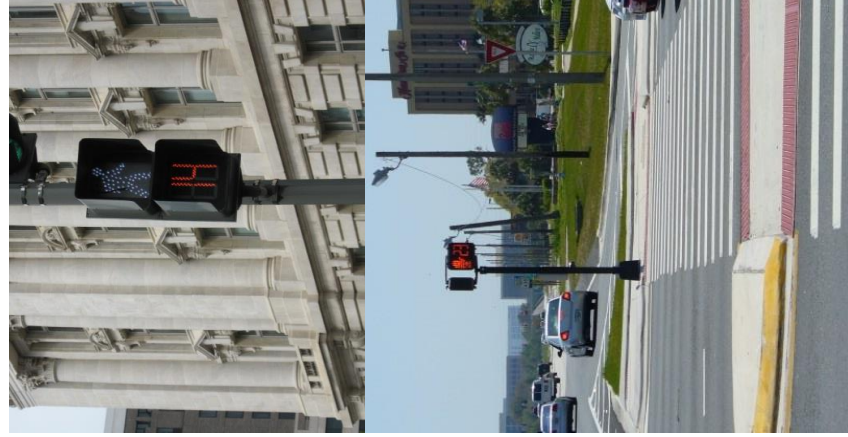
Signalized Intersections



INSTALL PEDESTRIAN COUNTDOWN TIMERS

Magnitude Cost: \$300 - \$1,000 (per device)⁶

Static Walk/Don't Walk pedestrian signals with countdown signal informing pedestrians of the time remaining to cross the street.



Benefits

- Fewer pedestrians cross the street late in the countdown as compared to signal heads with only the Flashing Don't Walk light

Constraints

- Typically a network-wide or subarea wide treatment to create consistency for road-users, but it expensive to implement throughout an area

Typical Applications

- Signalized intersections
- Particularly useful to pedestrians for longer distance crossings so pedestrians know how much time remains before signal changes
- May be useful where crash or conflict patterns indicate pedestrians cross frequently against the signal

Design Considerations

- Countdown pedestrian signals are particularly suitable for crosswalks where the pedestrian change interval is more than 7 seconds to inform pedestrians of the number of seconds remaining in interval.
- Where they are installed, push buttons to activate the pedestrian signal should be easily accessible by pedestrians, wheelchair users, and bicyclists for each crossing.

Additional Guidance

- California Manual on Uniform Traffic Control Devices*
- NACTO Urban Street Design Guide*

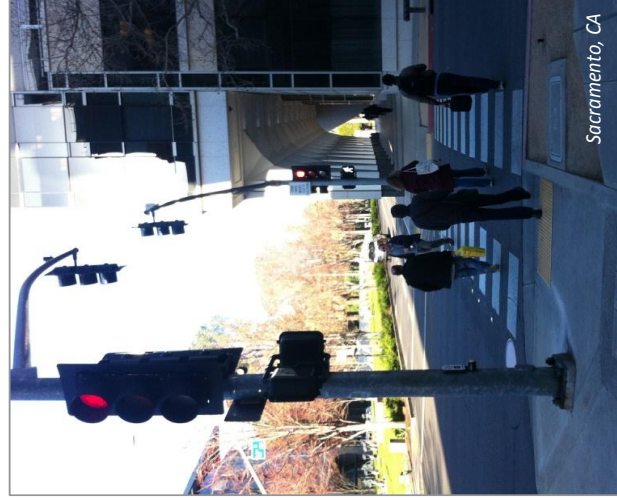
⁶ The cost range covers the device cost and additional installation.



IMPLEMENT LEADING PEDESTRIAN INTERVAL (LPI)

Cost Range: \$1,000 - \$2,000⁷

A leading pedestrian interval gives pedestrians a 2-5 second head start before the concurrent vehicle phase turns green to allow pedestrians to enter and occupy the crosswalk before turning vehicles get there.



Benefits

- Pedestrians are more visible in the crosswalk before vehicles start moving.
- Helps reduce conflicts with pedestrians and turning vehicles.
- Relatively low cost to implement

Constraints

- Reduces green time for vehicle movements.
- May add to delays at intersections operating near capacity.

Typical Applications

- Intersections where frequent turning vehicle movements make pedestrian crossing movements uncomfortable.
- Intersections with a documented history of turning movement-related vehicle-pedestrian crashes.

Design Considerations

- The leading pedestrian interval should give a minimum head start of 3-7 seconds depending on crossing distance.
- May be combined with a curb extension to improve visibility at high-conflict intersections.

Additional Guidance

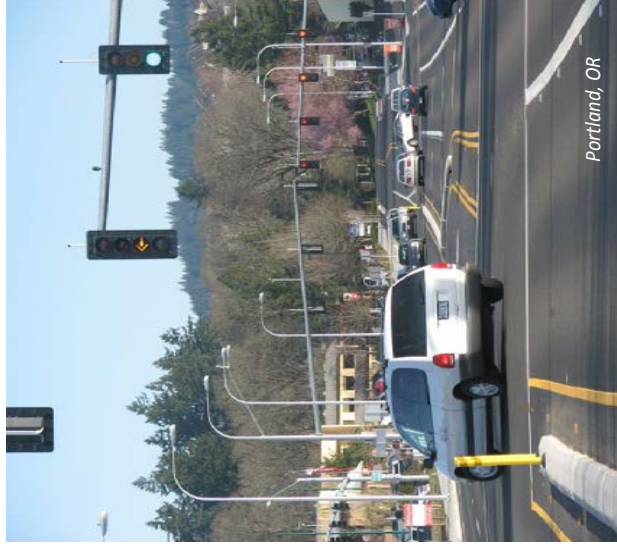
- *California Manual on Uniform Traffic Control Devices*
- *ITE Traffic Engineering Handbook*
- *ITE/FHWA Traffic Calming: State of the Practice*
- *NACTO Urban Street Design Guide*

⁷ The cost range covers reprogramming of a single crossing to reprogramming an entire intersection.



IMPLEMENT FLASHING YELLOW ARROW (FYA)

Cost Range: \$7,500⁸



A flashing yellow arrow with a leading pedestrian interval gives pedestrians a 2-5 second period when vehicles may turn if no conflicts are present but must yield to crossing pedestrians.

Benefits

- Intended to communicate to motorists that caution should be used in making maneuver and motorists must yield to oncoming vehicles and crossing pedestrians
- Relatively low cost to implement

Constraints

- Reduces green time for vehicle movements.
- May add to delays at intersections operating near capacity.
- Does not provide a protected head start for pedestrians

Typical Applications

- Intersections where frequent turning vehicle movements make pedestrian crossing movements uncomfortable.
- Intersections with a documented history of turning movement-related vehicle-pedestrian crashes.

Design Considerations

- The FYA leading pedestrian interval should give a minimum head start of 3-7 seconds depending on crossing distance.
- May be combined with a curb extension to improve visibility of and for pedestrians.

Additional Guidance

- California Manual on Uniform Traffic Control Devices*
- Improved Pedestrian Safety at Signalized Intersections Operating the Flashing Yellow Arrow*

⁸ The cost range covers a new controller or upgrade and replacement of the signal head and labor, per approach.



Marked Uncontrolled Crosswalks at Two-Way Stop-Controlled Locations

INSTALL RAISED INTERSECTION/PEDESTRIAN CROSSING ★

Cost Range: \$10,000 – \$50,000 (per crossing/intersection)⁹



A pedestrian crossing or intersection area raised vertically to give motorists and pedestrians a better view of the crossing area. A raised crosswalk is essentially a speed table marked and signed for pedestrian crossing.

Benefits

- Increases visibility of pedestrians by motorists
- Slows motorists' travel speeds

Constraints

- Can be difficult to navigate for large trucks and buses.
- May present drainage challenges
- Emergency response times may be increased

Typical Applications

- Two-lane roadways where pedestrians volumes are high (greater than 50 pedestrians per hour) and vehicle speed control is needed.
- Locations where low-volume streets intersect with high-volume streets or where a street changes its street type or functions.
- Locations where conflict and/or crash patterns reflect vehicle-pedestrian crashes due to unsafe speeds and failure to yield to pedestrians.



Design Considerations

- Locate raised intersection/crossings where vehicles have adequate stopping sight distance to see and slow. Consider nighttime visibility.
- Challenging locations for raised crosswalks include designated transit routes or at locations with steep grades or sharp curves.
- Raised crosswalks should be long enough to allow a passenger vehicle's front and rear wheels to be on top of the table at the same time. Average wheelbase for passenger vehicles is about 9 feet.¹⁰
- Consider drainage patterns resulting from installation and consider impacts on emergency response times.

Additional Guidance

- ITE/FHWA *Traffic Calming: State of the Practice*
- *California Manual on Uniform Traffic Control Devices*
- NACTO *Urban Street Design Guide*

⁹ The low end of the cost range represents the cost of implementing the treatment as part of a larger project while the high-end of the range represents the costs of the design and installation as a standalone project.

¹⁰ <http://www.nhtsa.gov/cars/rules/CAFE/NewPassengerCarFleet.htm>



Marked Uncontrolled Crosswalks at Two-Way Stop-Controlled Locations

INSTALL RAISED MEDIAN/REFUGE ISLANDS ★

Magnitude Cost: \$15,000 – 25,000 (per island)¹¹



Provides a raised refuge area in the median for pedestrians to stop while crossing the street. Can also help narrow roadway cross-section to slow vehicle speeds.

Benefits

- Creates possibility of two-stage crossings for pedestrians
- Can be used as a gateway to high pedestrian activity
- Can be used to help slow vehicle speeds

Constraints

- Must have at least 6 feet of space to accommodate wheelchairs; not all streets will have adequate space
- Physical barrier in the street

Typical Applications

- Intersections where:
 - pedestrians volumes are greater than 20 pedestrians per hour;
 - vehicle ADT volumes are greater than 12,000; and,
 - sufficient width to provide a refuge (minimum of 6 feet).
- Locations with a high frequency of pedestrian crashes.
- Locations with long blocks and vehicle speeds are higher than desired or posted.
- Multilane roadways with pedestrian crossing needs

Design Considerations

- Raised median/refuge island should be located in places where pedestrians commonly cross (e.g., transit stops, schools, etc.)
- Can be located at intersection crossings as well as midblock crossings

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*

¹¹ The low end of the cost range covers implementation while the high end includes design costs.



Marked Uncontrolled Crosswalks at Two-Way Stop-Controlled Locations

INSTALL IN-STREET “YIELD FOR PEDESTRIANS” SIGNS ★

Magnitude Cost: \$800 (per crossing)¹²



Signs placed in the middle of opposing travel lanes to increase driver awareness of pedestrians and the legal responsibility to yield right-of-way to pedestrians in the crosswalk.

Benefits

- Increases the number of motorists that yield to pedestrians in the crosswalk
- Reinforces the right of pedestrians in the travel-way

Constraints

- If used too often, motorists may ignore the signs
- Less effective on higher volume streets
- May require more maintenance than roadside signs.

Typical Applications

- Undivided two-lane road locations near schools and other pedestrian generators.
- In-street “Yield for Pedestrians” signs are commonly used in areas with lower vehicle volumes, low speeds (less than 35 mph), and poor yielding rates by motorists.
- Crash or conflict patterns resulting in vehicle-pedestrian crashes related to failure to yield by vehicles or unsafe speeds.

Design Considerations

- Per the *California MUTCD* (Section 2B.12), the in-street sign(s) should be placed in the roadway at the crosswalk location on the center line, lane line, or on a median island.
- Consider vehicle clearance widths for roadway design vehicles to avoid signs being hit.
- Use in-streets signs strategically, overuse will lead to lower compliance.

Additional Guidance

- California Manual on Uniform Traffic Control Devices*



¹² Cost range includes the cost of the sign and installation.



Marked Uncontrolled Crosswalks at Two-Way Stop-Controlled Locations

STRIPE ADVANCE STOP AND YIELD LINES

Magnitude Cost: \$1,000 (per crossing)¹³



R1-5

Advance stop and yield lines reduce vehicle encroachment into the crosswalk, improve drivers' view of pedestrians, and reduce multiple threat situations for pedestrians.

Benefits

- Increase pedestrian-motorist visibility at the crosswalk.
- Reduce multiple threat situations for pedestrians

Constraints

- May interfere with vehicle operations and contribute to queuing at congested locations.
- Potential sign clutter

Typical Applications

- At multilane locations where marked crosswalks are present and vehicular ADT is greater than 12,000 per day.
- At intersections where pedestrian volumes are greater than 20 per day and vehicular ADT is greater than 8,000 per day.
- At locations where vehicle encroachment into the crosswalk is common.
- In advance of Rectangular Rapid Flashing Beacons and Pedestrian Hybrid Beacons

Design Considerations

- Yield lines should be placed 4 to 50 feet in advance of controlled marked crosswalks based; distance is based on vehicle speeds, street width, on-street parking, nearby land uses, and demand for queuing space.
- Yield lines should be placed a minimum of 4 feet in advance of uncontrolled marked crosswalk locations.

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*

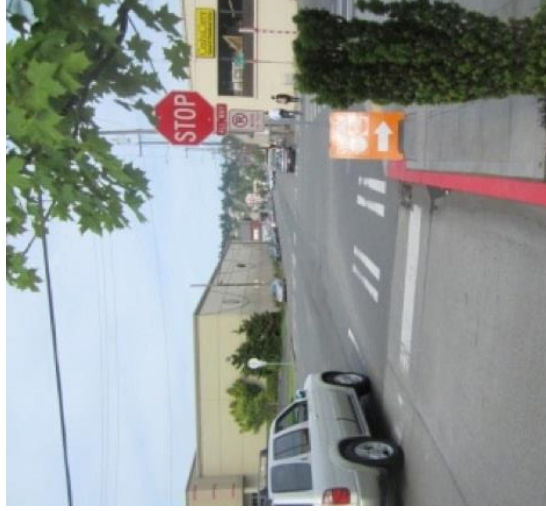
¹³ Cost includes striping, signs, and labor.



Marked Uncontrolled Crosswalks at Two-Way Stop-Controlled Locations

RESTRICT PARKING AT INTERSECTION APPROACHES

Magnitude Cost: \$600 (per approach)¹⁴



Red parking zones on the approaches to an intersection or crosswalk allow for improved sight distance between pedestrians waiting to cross or entering the crosswalk and approaching motorists.

Benefits

- Increase pedestrian-motorist visibility at the crosswalk.

Constraints

- Reduces available parking supply in area of restriction.

Typical Applications

- Locations where sight distance is currently limited and could be improved by removing parked vehicles.
- Locations with a history of frequent collisions or other documented safety concerns.

Design Considerations

- Each location should be evaluated to determine whether parking removal is appropriate.
- A minimum 10 foot red zone should be painted on all crosswalk approach legs.
- Longer red zones should be used at locations with a greater need for improved visibility due to unique sight distances, higher vehicle speeds, road geometry, or other conditions.

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*

¹⁴ Order of magnitude cost includes parking restriction sign, paint, and labor.



Marked Uncontrolled Crosswalks at Two-Way Stop-Controlled Locations

INSTALL PEDESTRIAN LIGHTING

Magnitude Cost: \$6,000 (per light)¹⁵



Denmark, Credit: Dan Burden

Pedestrian lighting may increase nighttime street visibility for pedestrians where existing illumination does not readily address crossing locations.

Benefits

- Increases visibility of pedestrians waiting to cross and in the crossing.

Constraints

- Potential to restrict and/or clutter sidewalk environment near the crosswalk.

Typical Applications

- Crossings or areas with high levels of nighttime pedestrian activity (e.g., greater than 20 pedestrians per hour).
- Locations with a high frequency of nighttime pedestrian crashes.
- Could also be considered for crossings with lower pedestrian volume activity if crossing conflict is severe or unexpected (e.g., pedestrian crossing location across a higher speed roadway).

Design Considerations

- Illumination could be used to contribute to the identity of a district or neighborhood and serve as a unifying element in the streetscape.
- Lighting should be scaled to the street and land use contexts to avoid light pollution/trespass and ensure a comfortable illumination quality for users.

Additional Guidance

- California Manual on Uniform Traffic Control Devices

¹⁵ Cost includes materials and labor per light.



Marked Uncontrolled Crosswalks at Two-Way Stop-Controlled Locations

REDUCE CORNER RADII

Cost Range: \$15,000 - \$60,000 (per corner)¹⁶



Reduces right-turning vehicle speeds at an intersection by forcing sharper turns. Reduced corner radii also shorten crossing distances for pedestrians.

Benefits

- Reduces right-turning vehicle speeds at the intersection.
- Reduces pedestrian exposure by reducing crossing distance.

Constraints

- Potential drainage changes needed in some retrofits.
- Less effective at reducing speeds before and after turns.

Typical Applications

- Intersections with average right-turn speeds above 15 miles per hour and where pedestrian volumes are greater than 20 pedestrians per hour.
- Intersections with a documented crash history of right-turning vehicle and pedestrian conflicts.

Design Considerations

- Corner curb radii should accommodate the roadway type's design vehicle turning movements.
- A smaller curb radius expands the pedestrian area and allows for better pedestrian ramp/crosswalk alignment.
- Minimize effective turning radius where possible.
- Consider existing drainage infrastructure needs for modifications.

Additional Guidance

- *California Manual for Uniform Traffic Control Devices*
- *NACTO Urban Street Design Guide*

¹⁶ Cost range depends on site conditions such as the need to relocate drainage or utilities as well as the need for surveying and/or design.

Pedestrian Safety Solutions Toolbox

Marked Uncontrolled Crosswalks at Midblock Locations



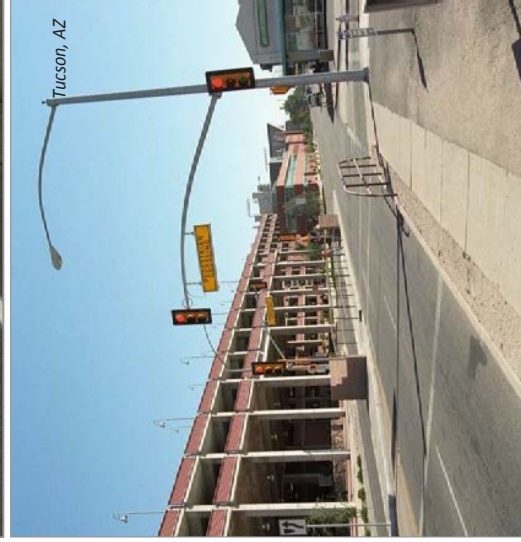
INSTALL PEDESTRIAN SIGNAL ★

Magnitude Cost: \$225,000 (per installation)

Provides pedestrians with a signal-controlled crossing at a midblock location or at a previously stop-controlled intersection where pedestrian volumes warrant full signalization. The signal remains green for the mainline traffic movement until actuated by a push button to call a red signal for traffic.



Beaverton, OR



Tucson, AZ

Benefits

- Has nearly 100 percent rate of motorist yielding behavior at crossing locations.
- Same appearance as standard traffic signal, so motorist understanding is high.

Constraints

- Must be activated by pedestrians.
- More costly than other crossing treatments.

Typical Applications

- Locations meeting traffic signal warrants for pedestrians as defined in the California MUTCD (Part 4).
- Locations where there are conflict or crash patterns between vehicle-pedestrians.
- Typical applications include:
 - Locations with four or more lanes and vehicle volumes greater than 15,000 per day
 - Locations with pedestrian volumes greater than 20 per hour and speed limits greater than 35 mph
 - At locations where multi-use paths intersect with roadways.

Design Considerations

- The push button to activate the pedestrian signal should be easily accessible by pedestrians, wheelchair users, and bicyclists (if applicable).

Additional Guidance

- *California Manual on Traffic Control Devices*
- *NACTO Urban Street Design Guide*
- *NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings*



Marked Uncontrolled Crosswalks at Midblock Locations

INSTALL PEDESTRIAN HYBRID BEACON (PHB) ★

Magnitude Cost: \$150,000 (per installation)¹⁷



Juneau, AK



Boise, ID

A pedestrian hybrid beacon is a pedestrian activated display that is unlit when not in use. It begins with a yellow light alerting drivers to slow, and then displays a solid red light requiring drivers to remain stopped while pedestrians cross the street. Finally, the beacon shifts to flashing red lights to indicate motorists may proceed after pedestrians have completed their crossing.

Benefits

- Higher rates of motorists yielding than crosswalks without PHB.
- Reduces pedestrian-involved crashes.
- Less delay to motor vehicle drivers than a signal.

Constraints

- Must be activated by pedestrians.
- More costly than other crossing treatments.
- Initially, may be unfamiliar to motorists.

Typical Applications

- Conditions consistent with the California MUTCD guidance.
- Typical locations include:
 - Locations with four or more lanes and vehicle volumes greater than 15,000 per day
 - Locations with pedestrian volumes greater than 20 per hour and speed limits greater than 35 mph
 - At locations where multi-use paths intersect with roadways.

Design Considerations

- The push button to activate the pedestrian hybrid beacon should be easily accessible by all users.

Additional Guidance

- *California Manual on Uniform Traffic Control Devices*
- *NACTO Urban Street Design Guide*
- *NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings*

¹⁷ Cost includes design, materials, and installation.

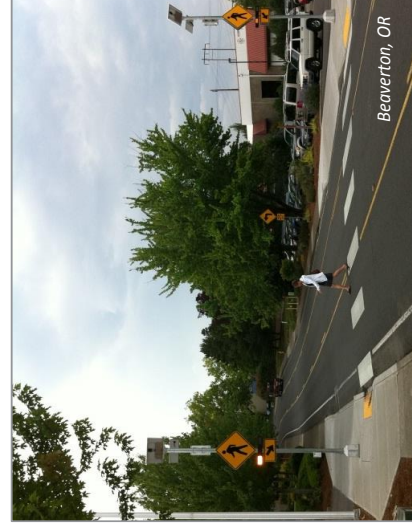
Pedestrian Safety Solutions Toolbox

Marked Uncontrolled Crosswalks at Midblock Locations



INSTALL RECTANGULAR RAPID FLASHING BEACON (RRFB) ★

Magnitude Cost: \$30,000 (per installation)



These crossing treatments include signs that have a pedestrian-activated “strobe-light” flashing pattern to attract motorists’ attention and provide awareness of pedestrians and/or bicyclists that are intending to cross the roadway.

Benefits

- Provides a visible warning to motorists at eye level.
- Increases motorists yielding behavior at crossing locations over round yellow flashing beacons (80 to 100 percent compliance).
- Allows motorists to proceed after yielding to pedestrians.

Constraints

- Flashing beacons must be activated by pedestrians.
- Motorists may not understand the flashing lights of the RRFB, so compliance may be lower than with a traffic signal.

Typical Applications

- Midblock crossings with pedestrian volumes of 20 or more pedestrians per hour and documented midblock crossing pedestrian collisions.
- Locations with:
 - three or more lanes and posted speeds of 30 mph or higher without a raised median.
 - three or more lanes and posted speeds of 40 mph with or without a raised median
- Locations where multi-use paths intersect with roadways.

Design Considerations

- The push button should be easily accessible by pedestrians, wheelchair users, and bicyclists (if applicable).
- Consider adding a push button in the median island for crossings of multi-lane facilities.
- Automated pedestrian detection may also be installed; it would increase cost of installation.

Additional Guidance

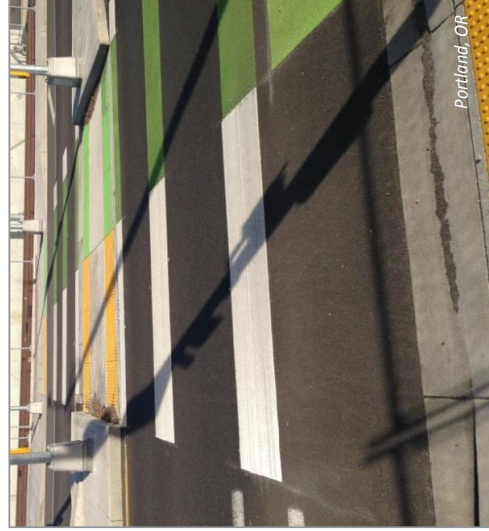
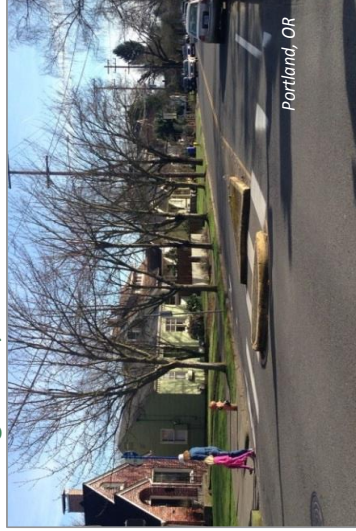
- *California Manual on Uniform Traffic Control Devices*
- NCHRP Report 562 *Improving Pedestrian Safety at Unsignalized Crossings*



Marked Uncontrolled Crosswalks at Midblock Locations

INSTALL CROSSING ISLAND (PEDESTRIAN REFUGE) ★

Magnitude Cost: \$15,000 – \$25,000 (per crossing island)¹⁸



Provides a raised refuge area in between opposing travel streams for pedestrians to stop while crossing the street. They can be used at intersections or mid-block crossings.

Benefits

- Reduces pedestrian exposure at marked and unmarked crosswalks.
- Requires shorter gaps in traffic to cross the street by allowing pedestrians to cross in two phases.
- Can help reduce vehicle speeds.

Constraints

- Streets with constrained right-of-way may not have sufficient width to allow for a crossing island.

Typical Applications

- Four or more lane roadways without a raised median where:
 - Posted speeds are 30 mph or less and vehicular ADT is between 9,000 and 12,000 per day.
 - Posted speeds are 35 mph and vehicular ADT is 9,000 per day or less.
- Often used in areas with high levels of vulnerable pedestrian users, such as near schools or senior centers/housing, or a demonstrated pedestrian crash history.

Design Considerations

- Must have at least 6 feet of clear width to accommodate people using wheelchairs.
- At crossing locations where bicyclists are anticipated, a width of 10 feet or greater is desirable to accommodate bicycles with trailers or groups of bicyclists.
- Can be applied in conjunction with other treatments.

Additional Guidance

- *California Manual for Uniform Traffic Control Devices*
- *NACTO Urban Streets Design Guide*
- *NCHRP Report 562 Improving Pedestrian Safety at Unsignalized Crossings*

¹⁸ Cost range varies from installation alone at the low end to design and installation at the high end.

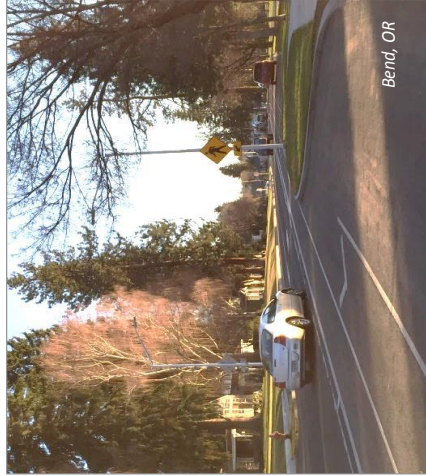
Pedestrian Safety Solutions Toolbox

Marked Uncontrolled Crosswalks at Midblock Locations



INSTALL CURB EXTENSIONS ★

Magnitude Cost: \$15,000 (per extension)¹⁹



An extension of the curb or the sidewalk into the street, usually at an intersection, that narrows the vehicle path, inhibits fast turns, and shortens the crossing distance for pedestrians.

Benefits

- Shortens crossing distances for pedestrians.
- Reduces motorist turning speeds.
- Increases visibility between motorists and pedestrians.
- Enables permanent parking
- Enables tree and landscape planting and water runoff treatment.

Constraints

- More easily implemented on streets with on-street parking.
- Physical barrier can be exposed to traffic.
- Greater cost and time to install than standard crosswalks.
- Can present turning radius problems to large vehicles.

Typical Applications

- Mid-block or intersection pedestrian crossings on streets with unrestricted on-street parking.
- Crossing locations with pedestrian collision history.
- Streets with on-street parking where:
 - pedestrian volumes ≥ 20 pedestrians per hour;
 - ADT ≥ 1,500 vehicles per day; and,
 - average right-turn speeds ≥ 15 mph.

Design Considerations

- Include a passage for bicycles to prevent conflicts with vehicles.
- Provide accessible curb ramps and detectable warnings.
- Include landscaping on the curb extension to differentiate the pedestrian travel path.

Additional Guidance

- *California Manual for Uniform Traffic Control Devices*
- *ITE/FHWA Traffic Calming: State of the Practice*
- *FHWA Designing Sidewalks and Trails for Access Part II*

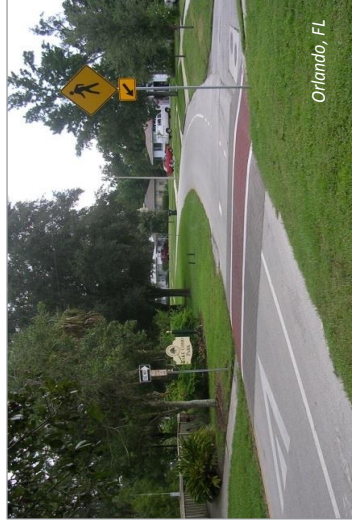
¹⁹ Costs will vary based on the length and drainage requirements.



Marked Uncontrolled Crosswalks at Midblock Locations

INSTALL RAISED PEDESTRIAN CROSSING

Magnitude Cost: \$10,000 – \$50,000 (per crossing)²⁰



Raised pedestrian crossings bring the level of the roadway even with the sidewalk, providing a level pedestrian path and requiring vehicles to slow. Raised crossings can be used at midblock crosswalks or intersections.

Benefits

- Increases visibility for pedestrians and motorists
- Slows motorists.

Constraints

- Can be difficult to navigate for large trucks, snow plows, and low ground clearance vehicles.

Typical Applications

- Raised crosswalks are typically provided at midblock crossings on two-lane roads where pedestrian volumes ≥ 50 pedestrians per hour and speed control is needed and there is a document history of pedestrian crossing-related collisions.
- Raised crosswalks may be provided at intersections where low-volume streets intersect with high-volume streets or where a roadway context changes (e.g. commercial to residential).

Design Considerations

- Raised crosswalks should be even with the sidewalk in height and at least as wide as the crossing or intersection.
- Provide detectable warnings for pedestrians where they cross from the sidewalk into the crossing area.
- Consider drainage needs and provide appropriate treatments.
- Use colored asphalt as opposed to brick or decorative surface materials to make the crossing smoother for those with mobility impairments.
- Raised crosswalks should not be used on transit routes or where there are steep grades or curves.

Additional Guidance

- *California Manual for Uniform Traffic Control Devices*
- *FHWA Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide*
- *NACTO Urban Street Design Guide*

²⁰ The cost range varies from inclusion as part of a larger project to the design and installation as a standalone project.

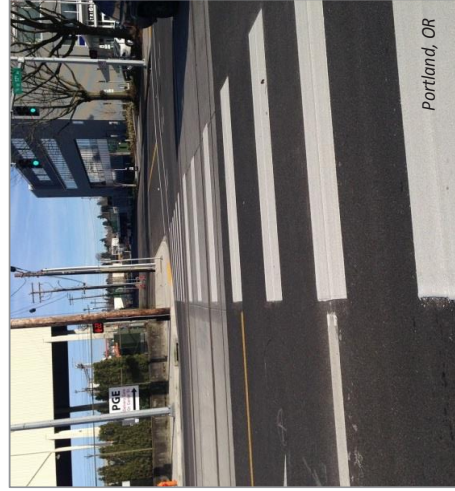
Pedestrian Safety Solutions Toolbox

Marked Uncontrolled Crosswalks at Midblock Locations



INSTALL HIGH VISIBILITY CROSSWALK

Magnitude Cost: \$2,500 (per crossing)²¹



High visibility crosswalks consist of reflective roadway markings and accompanying signage at intersections and priority pedestrian crossing locations.

Benefits

- Communicates potential for pedestrian crossings to motorists.
- Designates a preferred crossing location for pedestrians.
- Increases motorists' awareness of crossing pedestrians.

Constraints

- Can be more effective with other types of traffic control (signals, stop signs)²².
- Motorist compliance is lower than other midblock treatments.

Typical Applications

- Locations near schools, parks, hospitals, senior centers, or other pedestrian generators
- Peak hour pedestrian volumes are higher than 40 per hour and vehicle ADT is greater than 1,500 per day.
- Location is 300 feet or more from another crossing with documented history of pedestrian crossing collisions.

Design Considerations

- Striping can vary (continental, triple four, ladder, zebra, etc.)
- Minimum width is 6 feet, but wider crossings are preferred in areas with high number of pedestrians.
- Striped crosswalks alone should not be used where:
 - the speed limit exceeds 40 mph
 - the ADT is 12,000 or greater and there are four or more lanes without a raised median or crossing island
 - the ADT is 15,000 or greater and there are four or more lanes with a raised median or crossing island
- Ensure sufficient sight distance for vehicles and pedestrians
- In school zones, yellow striping should be used.

Additional Guidance

- *NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings*
- *California Manual on Uniform Traffic Control Devices*

²¹ Cost based on design, paint, and installation.

²² Fitzpatrick, K. et al, *NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings* (2006).



Marked Uncontrolled Crosswalks at Midblock Locations

IMPLEMENT A ROAD DIET OR ROAD RECONFIGURATION

Cost Range: \$30,000 - \$150,000 (per mile)²³



Orlando, FL



Oakland, CA

In a road diet project, a street's roadway space is reconfigured or restriped to reduce the number of vehicle lanes to prioritize speeds consistent with a pedestrian- and bicycle-oriented environment.

Benefits

- Decreases vehicle speeds
- Increases driver awareness of bicyclists and pedestrians
- Reallocates space for pedestrians and bicyclists
- Improves comfort level for pedestrians and bicyclists.

Constraints

- Can be more effective with other types of traffic control (signals, stop signs).
- At uncontrolled locations (midblock), motorist compliance is not as high as with other treatments.

Typical Applications

- Four or five lane undivided roadways with vehicular ADT of 20,000 or less, or peak hour directional volumes of 875 or less.
- Locations with a documented history of left-turning or speed-related collisions or conflicts with pedestrians.

Design Considerations

- Lane reconfiguration/road diet projects should have a traffic analysis conducted prior to implementation.
- The reconfiguration of the roadway space should be context sensitive, taking into account the operations, user needs, and land use context of the roadway.

Additional Guidance

- *NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings*
- *California Manual on Uniform Traffic Control Devices*
- *NACTO Urban Street Design Guide*

²³ Cost range covers the range from design and restriping only to more complicated projects involving planning, outreach, and more complex design.