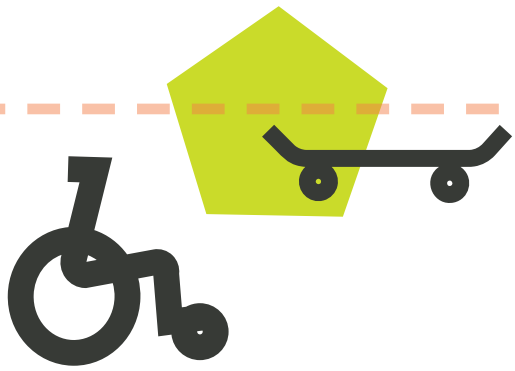




City of Santa Cruz Active Transportation Plan Update Appendix E: Treatment Toolkit

APRIL 2026



Appendix E: Treatment Toolkit

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Introduction

This toolkit's purpose is to supplement the Active Transportation Plan (ATP) and provide best practice guidance to engineers, planners, and community members. This Toolkit introduces bicycle and pedestrian facility treatments, providing an overview, engineering guidance, and additional contextual considerations for each treatment. The Toolkit is not comprehensive or intended to take the place of design standards prepared by local agencies, Caltrans, or any other entity.

The content in this Toolkit aligns with the following goals and strategies:

- Build and maintain comprehensive bicycle and pedestrian networks.
- Enhance safety and security for active transportation users.
- Continue progress and investments in active transportation.

Relationship with the Neighborhood Traffic Calming Toolkit

This toolkit complements the City of Santa Cruz's existing [Neighborhood Traffic Calming Toolkit](#), completed in January 2024. The Traffic Calming Toolkit focuses on treatments intended to reduce vehicular speeds or volumes along neighborhood streets. Because traffic calming benefits pedestrian and bicyclist safety, all but one of the treatments (Full Closures/Cul-De-Sacs) included in the Traffic Calming Toolkit can also be found in this ATP Toolkit. The guidance and considerations associated with the treatments common to both documents are consistent.

Crossings

What are Crossings?

Crossings are critical pieces of active transportation networks. Even where linear facilities, like sidewalks, are safe and comfortable for people walking, the presence of uncomfortable street crossings creates barriers. In Santa Cruz from 2020-2024, 37% of pedestrian-involved serious and fatal injury crashes occurred at intersections, with the other 63% taking place midblock. For minor injury crashes involving pedestrians, a slightly higher percentage (43%) of crashes took place at intersections and 57% took place midblock. A majority of fatal and serious injury crashes and minor injury crashes occurred midblock, where drivers travel faster and may not expect pedestrians. This may indicate long gaps between crosswalks, encouraging pedestrians to cross midblock so as not to have to travel out of their way to reach a safe crossing.

CROSSWALK MARKINGS

Legal crosswalks exist at all locations where sidewalks meet the roadway, regardless of whether pavement markings are present. Drivers are legally required to yield to pedestrians at intersections, even when there are no pavement markings. Providing marked crosswalks communicates to drivers that pedestrians may be present and helps guide pedestrians to locations where they should cross the street. In addition to pavement markings, crosswalks may include signals/beacons, warning signs, and raised platforms.

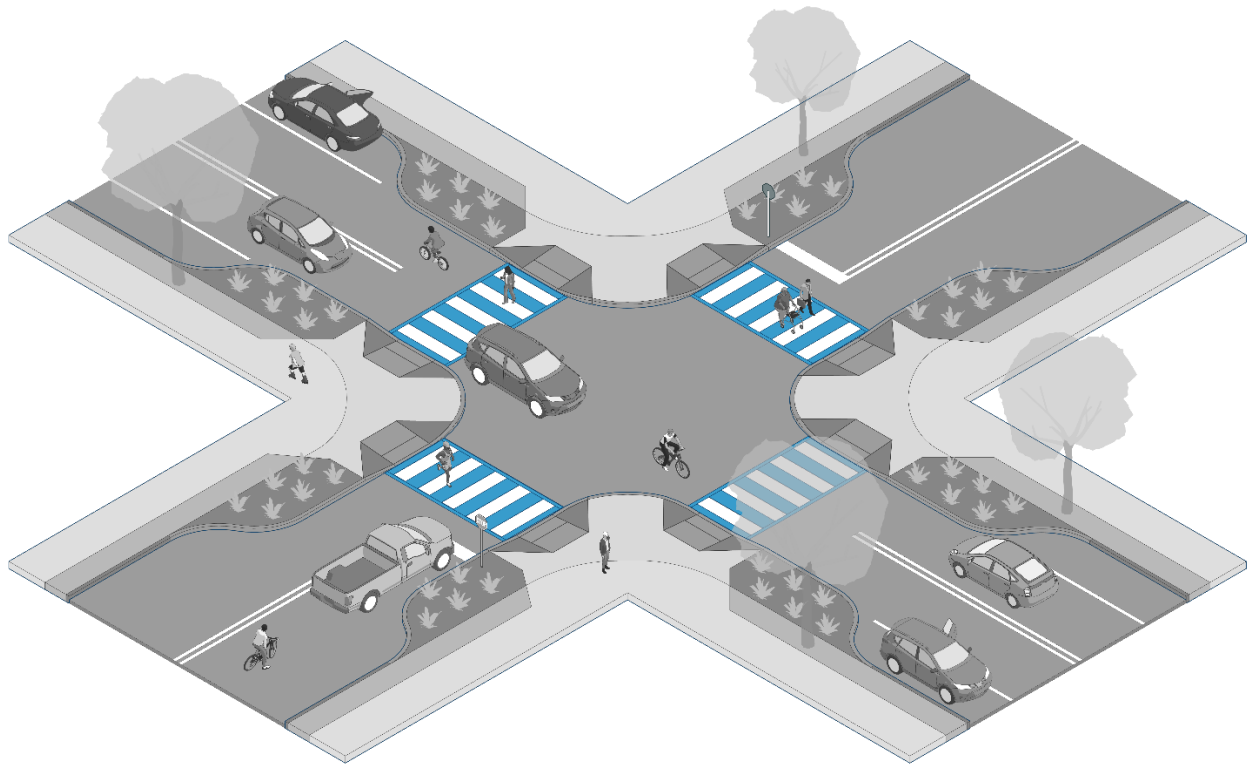


Figure 1: Marked crosswalks

Guidance

- Crosswalks should be marked on all legs of signalized intersections, in school zones, and across streets with more than minimal levels of traffic.
- Spacing targets for crosswalks, depending on context are as follows:
 - Urban core/downtown area: 200-300 feet; consider midblock crosswalks where block length exceeds 400 feet
 - Arterials and collectors outside of the urban core/downtown area: 600 feet maximum; consider midblock crosswalks where block length exceeds 800 feet, especially where pedestrian generators exist.
- Marked crosswalks should be oriented perpendicular to streets, minimizing crossing distances and therefore limiting the time that pedestrians are exposed.
- Marked crosswalks should be at least 10 feet wide or the width of the approaching sidewalk if it is greater.
- Crosswalks within 600 feet of school grounds must be painted yellow.

Crossing Treatments to Improve Visibility

Considerations

- There are many different styles of marked crosswalk striping and some are more effective than others. High-visibility crosswalks with striping parallel to the direction of travel for drivers are more visible to drivers, and are recommended in all cases, especially near schools. The graphic above shows continental striping, but other types of high-visibility striping exist.
- Raised crossings can calm traffic and increase the visibility of pedestrians. (See following section on “Raised Crosswalks” for more details.)
- Include crosswalks at transit stops, where a multi-use trail intersects with an arterial or collector, and where a sidewalk ends on one side of an arterial or collector and continues onto the other side.
- In areas of heavy pedestrian volumes (such as transit station areas, school zones, and main streets), marked crosswalks can be up to 25 feet wide.
- Crosswalks may need to be restriped after pavement work.

SIGNAGE AND PAVEMENT MARKINGS

Regulatory and warning signage, along with pavement markings like yield teeth and advance stop bars, alert drivers to the presence of pedestrian crossings. Signage and pavement markings can improve driver yielding behavior and improve pedestrian safety. Common high visibility treatments include advance warning signs, in-street pedestrian crossing signs, advance stop bars, and yield teeth.



Figure 2: Yield teeth

Guidance

- Yield teeth should be installed in advance of marked crosswalks at uncontrolled intersections or midblock crossings to indicate where drivers are required to yield to pedestrians. Yield teeth should be placed about 20 to 50 feet ahead of the marked crossing.
- Advance stop bars should be used at signalized and stop-controlled intersections to reduce vehicle encroachment into crosswalks and should be placed no less than 4 feet before the crosswalk begins and no more than 30 feet from the edge of marked crosswalks.
- In-street pedestrian crossing signs may be used at uncontrolled crossings on lower-speed or roadways with high pedestrian volumes where there are concerns over driver yielding behavior.
- Pedestrian crossing advance warning signage should be installed ahead of midblock crossings, uncontrolled crossings, or where there is limited sight distance on the approach to the crossing.

Considerations

- Pavement marking and signage visibility enhancements are most needed where drivers regularly fail to yield pedestrians or at locations with high pedestrian volumes, like crossings near schools or major destinations.

RECTANGULAR RAPID FLASHING BEACONS

Rectangular Rapid Flash Beacons (RRFBs) can be implemented to improve yielding compliance at uncontrolled, multi-lane crossings, as well as single-lane crossings where there is a history of collisions or low yielding compliance. RRFBs combine a pedestrian crossing sign with a bright flashing beacon that is activated only when a pedestrian is present and pushes the button to activate.



Figure 3: Rectangular rapid flashing beacon

Guidance

- RRFBs can be used when a signal is not warranted at an unsignalized crossing. They are not permitted at intersections with signals or STOP signs.

Considerations

- RRFBs are considerably less expensive to install than mast arm-mounted signals. They can also be installed with solar power panels to eliminate the need for an external power source.
- RRFBs should be limited to locations with critical safety concerns and should not be installed in locations with sight-distance constraints that limit the driver's ability to view pedestrians on the approach to the crosswalk.
- RRFBs should be used in conjunction with advance stop or yield bars and signs.
- RRFBs are usually implemented at high-volume pedestrian crossings but may also be considered for school zones, priority bicycle route crossings, or mid-block locations where bike facilities cross roads.
- RRFBs may be installed at roundabout crossings.

PEDESTRIAN HYBRID BEACON (PHB)

Pedestrian hybrid beacons (PHBs), including the High-intensity Activated Crosswalk Beacon (HAWK), are a type of hybrid signal intended to allow pedestrians and bicyclists to stop traffic to cross high-volume arterial streets. This type of signal may be used in lieu of a full signal that meets any of the traffic signal control warrants in the MUTCD. PHBs are designed to prevent “double-threat” crashes, where one driver stops in a multi-lane road, but the second driver hits the pedestrian or bicyclist, by providing a legally binding signal.



Figure 4: Pedestrian hybrid beacon

Guidance

- This type of device should be considered for all arterial crossings in a bicycle network and for path crossings if other engineering measures are found inadequate to create safe crossings.
- The MUTCD recommends minimum volumes of 20 pedestrians or bicyclists an hour for major arterial crossings (volumes exceeding 2,000 vehicles/hour).
- PHBs may also be used at locations which do not meet traffic signal warrants but where assistance is needed for pedestrians or bicyclists to cross a high-volume street.

Considerations

- While this type of device is intended for pedestrians, it would be beneficial to retrofit it for bicyclists as the City of Portland, Oregon has, using bicycle detection and bicycle signal heads on major cycling networks. Depending upon the detection design, the agency implementing these devices may have the option to provide different clearance intervals for bicyclists and pedestrians. The provision of bicycle signal heads would require permission to experiment from FHWA.

LIGHTING

Pedestrian-scale lighting illuminates sidewalks and crossings at night or low-light conditions using light fixtures that are shorter than roadway-scale light fixtures.



Figure 5: Pedestrian scale lighting

Guidance

- Provide at crossing approaches at controlled and uncontrolled intersections.
- Provide along sidewalks, especially along arterials and near schools, parks, commercial and recreation centers, major transit stops and stations

Considerations

- Illuminate key aspects of the roadway such as user conflict areas, intersections, and complex roadway conditions.
- Install lighting in advance of mid-block crossings and intersections to illuminate the front of a crossing pedestrian.
- Illuminate locations with known pedestrian safety and/or security issues such as bridges, underpasses, and tunnels.
- Ensure that street features such as trees, signs, or other obstructions do not block the light from reaching the roadway/pedestrian facilities.

CORNERS AND CURB RADII

Pedestrian safety and comfort is enhanced by smaller curb radii, which shorten crossing distances for pedestrians and reduce vehicle turning speeds. However, streets must accommodate large turning vehicles, including school buses and transit vehicles, which require larger turning radii. One of the most challenging aspects of intersection design is to determine methods of accommodating large vehicles while keeping intersections as compact as possible. This requires engineering judgment, as each intersection is unique in terms of the number of travel lanes, presence of a median, and other features that fundamentally impact corner design.

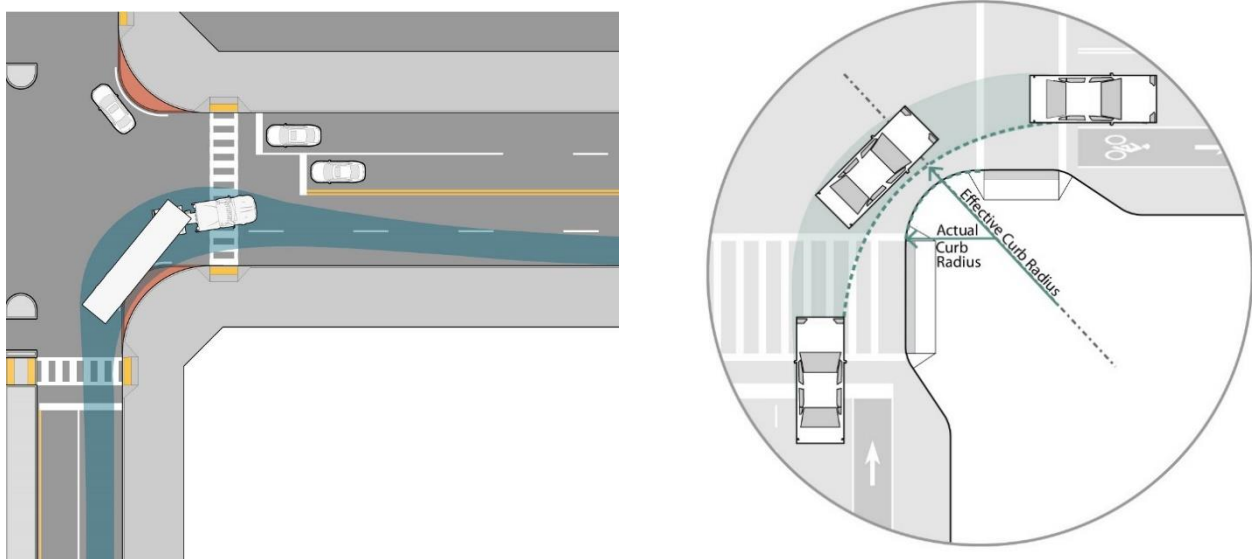


Figure 6: Mountable apron and effective turn radius

Guidance

- Curb radii should be designed to accommodate the intended design vehicle, or the most frequent user of a given street, turning using one approach lane and one receiving lane, as well as the intended control vehicle, or an infrequent larger vehicle, turning using multiple lane spaces.
- In urban areas, standard curb radii are 10-15 feet; in urban areas with trucks and buses, standard curb radii are 20-30 feet; along arterials that accommodate trucks and buses outside of urban areas, standard curb radii are 25-30 feet.

Considerations

- The design and control vehicle are context-dependent. Common design vehicles include a DL-27 for local streets, SU-30 for downtown and commercial streets, and BU-40 for designated bus routes. Control vehicles are often larger trucks like a WB-50.
- At signalized intersections, corner design should assume that a large vehicle will use the entire width of the receiving lanes on the intersecting street.
- Depending on an agency's encroachment policy, it may be possible to allow a large turning vehicle to encroach on the adjacent travel lane on the departure side (on multi-lane roads) to make the turn.
- Mountable truck aprons can be implemented to deter design vehicles from making higher-speed turns, while accommodating control vehicles without encroachment or off-tracking into pedestrian areas. Mountable truck aprons should be visually distinct from the adjacent travel lane and sidewalk.

CURB EXTENSIONS

Curb extensions, also known as neckdowns, bulb-outs, or bump-outs, are created by extending the sidewalk at corners or mid-block. In addition to shortening crossing distances, curb extensions can be used to change the geometry of intersections resulting in smaller corner radii and slowing turning motor vehicles.

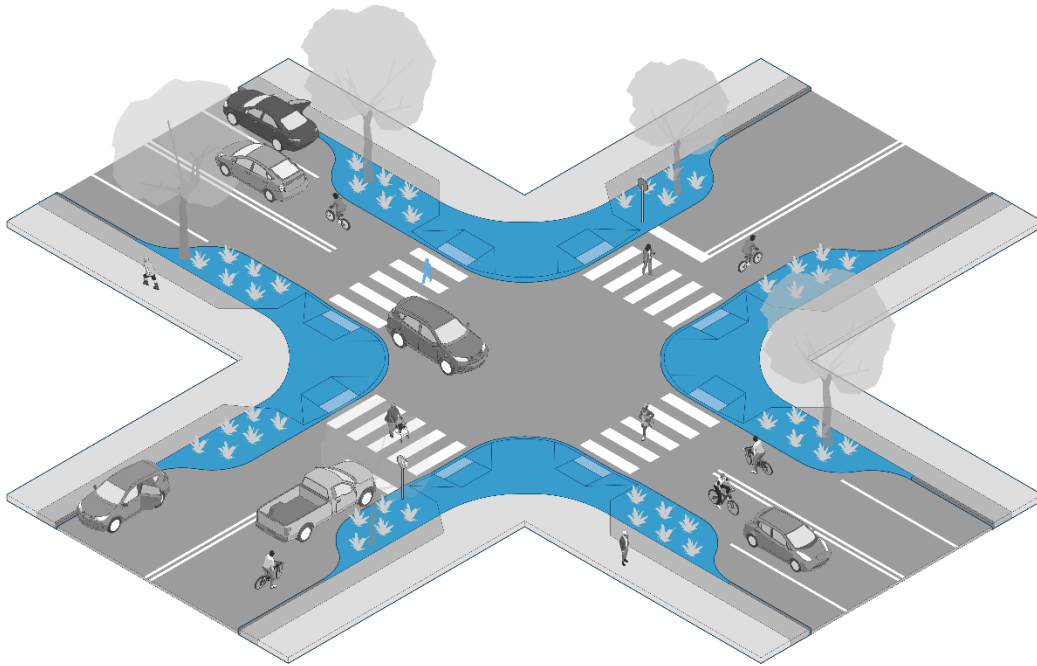


Figure 7: Curb extensions

Guidance

- Curb extensions should be considered where parking is present or where motor vehicle traffic deflection is provided through other curbside uses such as bicycle share stations or parklets. They cannot be installed where the curbside lane is a motor vehicle travel lane or bike lane
- Curb extensions are particularly valuable in locations with high volumes of pedestrian traffic, near schools, at unsignalized pedestrian crossings, or where there are demonstrated pedestrian safety issues.
- Consider using lower-cost, temporary materials like paint and flex posts first to ensure community buy-in before installing costlier curbs.

Considerations

- The turning needs of emergency, transit, and other large vehicles must be considered in curb extension design.
- Care should be taken to maintain direct routes across intersections by aligning pedestrian desire lines on either side of the sidewalk. Curb extensions often make this possible as they provide extra space for grade transitions.
- Consider providing a 20-foot long curb extension to restrict parking within 20 feet of an intersection to enhance visibility.

Crossing Treatments to Slow Vehicle Speeds

- When curb extensions conflict with turning movements, reducing the width and/or length of the curb extension should be prioritized over elimination.
- Emergency access is often improved through the use of curb extensions because intersections are kept clear of parked cars.
- Curb extensions may require the loss of some existing on-street parking.
- Ensure sufficient clearance for a vector truck to access catch basins.

SLOW TURN WEDGES

Slow turn wedges use markings, rubberized speed bumps, and potentially flexible plastic posts to buffer pedestrians from traffic and shrink the area where they could get hit by a car. They provide a benefit and function similar to tighter curb radii and curb extensions, but with low-cost and temporary materials. Wedges discourage drivers from cutting corners and instead encourage drivers to follow the proper path when making turns.



Figure 8: Slow turn wedge on an arterial in Oakland, CA

Guidance

- A wedge installation typically consists of modular, rubberized speed bumps bolted or otherwise adhered to the roadway surface and is combined with pavement markings that delineate a vehicle's turning path.
- Flexible plastic posts may be included to reinforce the edges of the wedge space, or as alternatives to the speed bumps.
- The effective turning radius established by the wedge should allow a passenger vehicle to take the turn without encroaching on the wedge or the paths of conflicting vehicular movements.
- Arterials, collectors, and local roads are all suitable candidates for this treatment.

Considerations

- The rubber wedges should be mountable, allowing emergency, transit, and other large vehicles to drive over them if necessary.
- Design adjustments may be necessary near bus stops.

PEDESTRIAN REFUGE ISLAND / MEDIANS

Pedestrian refuge islands are raised islands that provide a pedestrian refuge and allow pedestrians to cross one direction of motor vehicle traffic at a time. They can be located at intersections or mid-block.

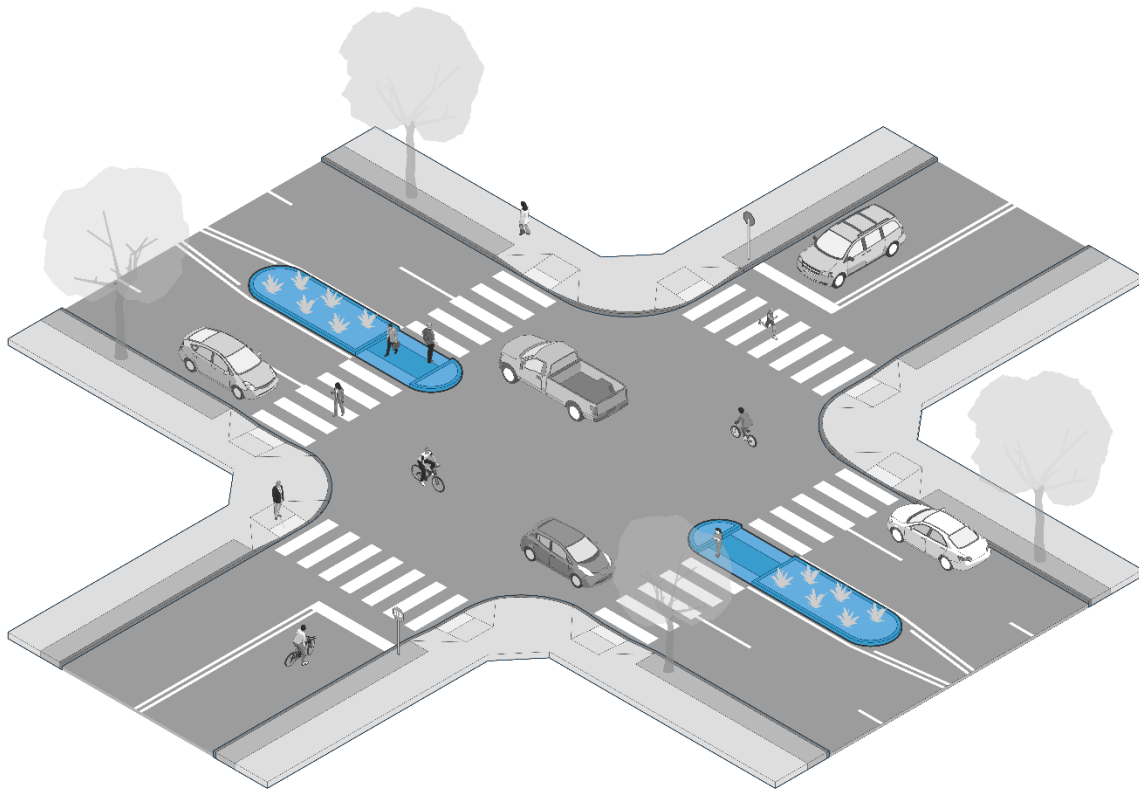


Figure 9: Pedestrian refuge islands

Guidance

- Pedestrian refuge islands must be at least 6 feet in width to integrate detectable warning surfaces and be considered a true pedestrian refuge island.
- There are two primary types of pedestrian refuge islands:
 - The first provides a cut-through of the island, keeping pedestrians at street-grade.
 - The second type ramps pedestrians up above street grade and may present challenges to constructing accessible curb ramps unless they are more than 17-feet wide (accommodating for ramp width and landing area).
- Pedestrian refuge islands should always be considered on collector or arterial roadways with moderate-to-high traffic speeds and volumes and multiple lanes, as well as where crossing distances are greater than 50 feet.

Considerations

- Pedestrian refuge islands can be coupled with other traffic calming features, such as partial diverters and curb extensions at mid-block and intersection locations.

Crossing Treatments to Slow Vehicle Speeds

- At mid-block crossings where width is available, islands should be designed with a stagger, or in a “Z” pattern, encouraging pedestrians within the median to face oncoming traffic before crossing.
- Should a midblock crossing be provided along a multilane arterial, a raised median or crossing island and supplementary traffic control devices are desirable. (See next section for guidance on installing raised crossings.)
- On a local road with relatively low traffic speeds and volumes, placing a raised median or crossing island might be done for aesthetic considerations or special pedestrian crossing characteristics and volumes.
- Refuge islands may require widths of 8 feet or greater in locations where significant pedestrian or bicycle volumes are present/expected, or to accommodate cargo bikes & wheelchairs more effectively.
- May be implemented as a quick build treatment through use of temporary materials.
- Pedestrian refuge islands might result in a loss of some existing on-street parking and an increase in maintenance obligations with landscaping and sweeping.

RAISED CROSSINGS

Raised crosswalks are used for traffic calming and to improve motorist yielding to people walking, rolling and biking at intersections and midblock crossings. In this design, crosswalks are elevated to reduce or eliminate the transition from the sidewalk to the street crossing. Transition aprons on each approach to the raised crossing are marked with pavement markings to alert drivers of the grade change.

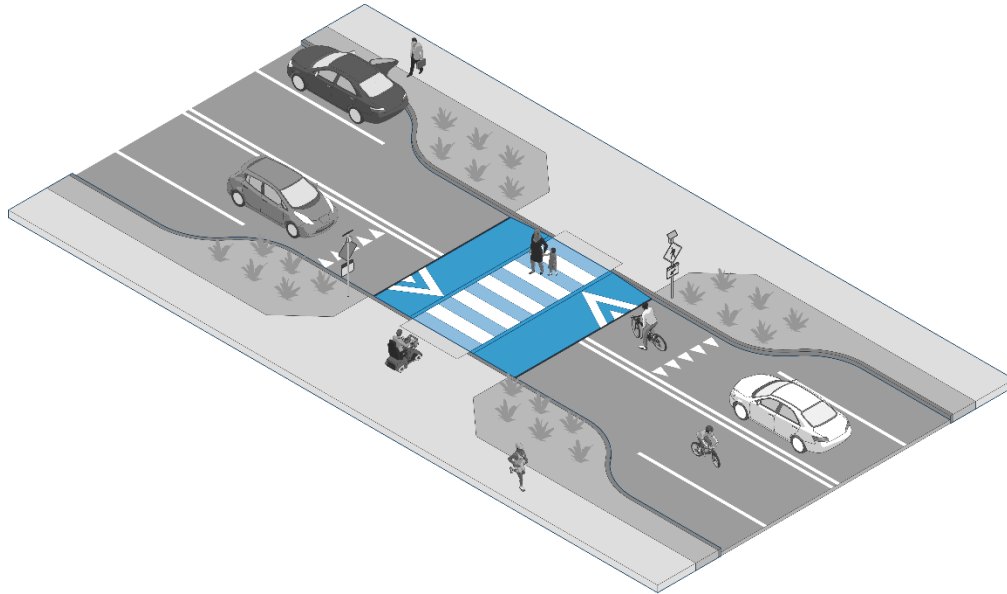


Figure 10: Raised crossing

Guidance

- Ensure a raised crosswalk is at least as wide as the connecting sidewalk or path of travel.
- Provide detectable warning surfaces at the edge of the sidewalk to indicate to pedestrians that they are exiting the sidewalk and entering the street. Ensure that raised crossing meets accessible slope requirements.
- On-street parking and loading must be restricted 20 feet before the marked crosswalk to provide adequate sight distance between people crossing and people driving.
- Yield lines (“shark teeth”) should be located 20 to 50 feet from the edge of the crosswalk.
- Include warning pavement markings for drivers on transition aprons and “Raised Crosswalk” signs at the crossing. Transition aprons should be 5 to 8% (relative to the street) on streets, and 5 to 15% (relative to the driveway/alley) on driveways and alleys.

Considerations

- Raised crosswalks may be beneficial at:
 - Unsignalized collector and local street crossings.
 - Crossings of driveways and alleys.
 - Crossings of channelized right turn lanes and roundabouts.

Crossing Treatments to Slow Vehicle Speeds

- Intersections where a large corner radius is required to accommodate large vehicles.
- Use trail-level and sidewalk-level bikeway crossings and locations where increased visibility, priority or accessibility for people walking, riding bicycles or using dockless mobility vehicles is desired or needed, including school zones and at crossings of multi-use paths.
- Raised crossings may be used as midblock crossings with the appropriate infrastructure, such as rectangular rapid flashing beacons (RRFBs), pedestrian hybrid beacons (PHB)s, median refuges, warning signage, and other elements as appropriate.
- Raised crosswalks are not appropriate on streets with steep roadway grades higher than 8%.
- Ensure that drainage and maintenance needs are accounted for in raised crossing design.
- Ensure design is compatible with EMS access.

Neighborhood Connectors

What are Neighborhood Connectors?

Neighborhood Connectors, sometimes referred to as bicycle boulevards, are local streets with low speeds and low traffic volumes that are designed to create a safe, comfortable environment for people biking. These often also improve conditions for pedestrians and other vulnerable road users. These conditions are achieved through the use of design treatments like traffic calming, signage and markings, improved street crossings, and access management. The goal is a route where people biking can comfortably bike in the street with vehicular traffic.



Figure 11: Neighborhood Connector with sharrows and a traffic circle

TRAFFIC CIRCLES

Traffic circles are raised islands, placed in intersections, around which traffic circulates. Stop signs or yield signs can be used as traffic controls at the approaches of the traffic circle. Circles prevent drivers from speeding through intersections by impeding the straight-through movement and forcing drivers to slow down to yield.



Figure 12: Traffic Circle at King Street and Ladera Drive, Santa Cruz

Guidance

- Unlike roundabouts, traffic circles are intended for the intersections of low-volume streets, commonly in residential neighborhoods. Therefore, deflection on approach legs is typically not used since vehicle speeds should already be 25 mph or less.
- Pavement markings should indicate priority for pedestrians at crossings and provide wayfinding guidance for bicyclists.
- The traffic circle's diameter should be great enough to establish horizontal deflection for vehicles travelling through the intersection, thereby achieving the intended traffic calming intent.
- Avoid use of traffic circles on streets with higher volumes of bus, freight, or emergency service activity.
- Mountable traffic circles, or mountable aprons on the perimeter of the circle, may be necessary to accommodate occasional emergency vehicles or large but infrequent design vehicles.
- Landscaping in the center of the circle should only be considered if there is sufficient space after accommodating emergency vehicle access.

Considerations

- Traffic circles can be very effective in moderating speeds and improving safety.
- Any landscaping in the circle requires regular maintenance or properly scaled plantings to avoid hinderances to visibility.
- Traffic circles must be designed so that the circulating traffic does not encroach on crosswalks.
- Depending upon the size of the intersection and circle, trucks may be permitted to turn left in front of the circle.

SPEED HUMPS

Speed humps are rounded raised areas placed across the road. They can be designed with cut-outs so that emergency vehicles and bicycles can pass through unhindered.



Figure 13: Speed humps on King Street, Santa Cruz

Guidance

- They are typically 3 to 3.5 inches high, typically parabolic in shape, and have a design speed of 15 to 20 MPH.
- A series of speed humps are often needed to retain slower speeds over a longer distance.
- Speed humps are typically not used on transit routes due to their effect on transit operations and passenger comfort.
- To effectively control vehicle speeds, space 250 to 300 feet apart.

Considerations

- Speed humps are intended for lower-speed, lower-volume streets, such as local, residential roads and local collectors, and typically not used on arterials or major collectors.
- The impact on emergency vehicles and transit operations should be evaluated.
- Speed humps may impact typical maintenance programmed for the street, e.g., sweeping, underground utility access, and resurfacing.
- Some neighbors may notice increased noise from vehicles passing over the humps.
- Speed humps can also add discomfort for bicyclists if cut-outs are not provided.
- If speed humps are used as a standalone traffic calming measure and without a spacing appropriate for the street's context, drivers might be able to accelerate through intersections or between the humps.

CHICANES

Chicanes slow traffic by creating a serpentine travel path by alternating street features from one side of the street to the other. Chicanes can be designed to integrate stormwater drainage catchments, street tree planting, benches, bicycle parking, and other amenities.

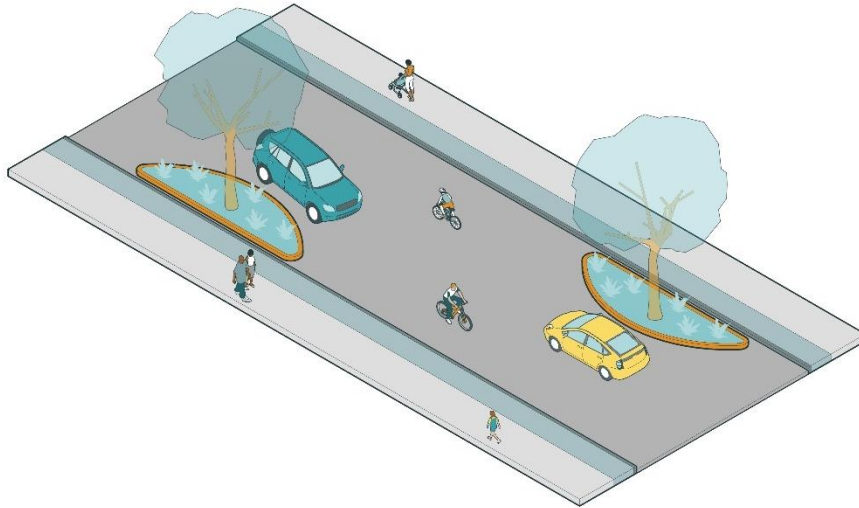


Figure 14: Midblock chicanes

Guidance

- Use chicanes on low-volume, local streets. Engineering judgment should be used to determine when the need is met for this treatment.
- Chicanes must meet requirements for horizontal tapers per the CA MUTCD.
- Avoid use of chicanes on streets with higher volumes of bus, freight, or emergency service activity. Use mountable curbs to accommodate larger motor vehicles while maintaining tight turn radii to slow people driving.
- Use vertical elements like plantings in combination with chicanes to warn drivers of traffic pattern.

Considerations

- Use for stormwater infiltration with bioretention areas or appropriately sized tree filter boxes.
- Consult with fire department to ensure that designs minimize impacts to emergency services.
- To maintain existing drainage patterns, consider relocating catch basins to one side of the chicane island.

PINCHPOINTS

Pinchpoints, also known as chokers, are curb extensions located directly across from each other that narrow a street. Pinchpoints leave the street cross section with two lanes that are narrower than the normal cross section and alert drivers to changing conditions on a roadway (e.g., lower speed limits or higher than usual pedestrian volumes). As such, they are beneficial as gateway treatments.



Figure 15: Pinchpoints

Guidance

- Pinchpoints can be used on arterials, collectors, and local streets.
- The narrowed curb-to-curb width should remain wide enough that two opposing passenger vehicles can pass side-by-side, albeit with drivers experiencing some discomfort if not travelling at a reduced speed.
- Designers might need to assume encroachment over the center line by emergency or transit vehicles, and thereby also yielding from oncoming drivers.

Considerations

- Since they lack vertical deflection, pinch points are a good traffic calming treatment on streets with regular emergency and transit vehicle operations.
- Where there is a bike lane, the pinchpoint should replace an existing parking space and the bike lane should be maintained, as shown in Figure 14. A neighborhood connector (shared road) is best for pairing with pinchpoints to minimize impacts to bike facilities.
- Pinchpoints result in the loss of on-street parking, if present.
- As with curb extensions, the impact on stormwater flow and the collection of debris should be considered during evaluation. Additional maintenance may be required.
- Pinchpoints may serve as gateway treatments as they visually indicate a change from a higher speed or volume roadway to a lower speed or volume roadway.

SPEED LIMIT REDUCTION

Speed limit reduction is the lowering of the posted speed limit on a road. Reduced speeds lead to safer, more comfortable roadway conditions for people walking, rolling, and biking. Speed limit reductions may be paired with other traffic calming treatments that alter the geometry of the road, leading drivers to naturally reduce their speed.



Figure 16: Reduced speed limit in Boulder paired with curb extensions at a midblock crossing

Guidance

- Speed limit reductions are not always an option as they often require an Engineering and Traffic Survey or certain state law allowances, such as through AB 43 in California.

Considerations

- Posted speed limit signs alone do little to influence driver behavior. Wide lanes or long straight sections of roadway can encourage higher speeds regardless of posted speed limit. Modifying roadway context and geometric design are essential to achieving speed reduction.

PARTIAL TRAFFIC DIVERTER

Partial traffic diverters are sections of curb built into a travel lane at an intersection to restrict through traffic along a street. These force vehicles to take an alternative route while allowing people walking or biking to continue unimpeded. Diverters promote slower traffic, reduce cut-through traffic, and reinforce slower, livable streets that promote the walking and biking.

There are various kinds of diverters that can be built, and like several other treatments, they can be built temporarily using flex posts and pavement markings or permanently using curbs and landscaping.

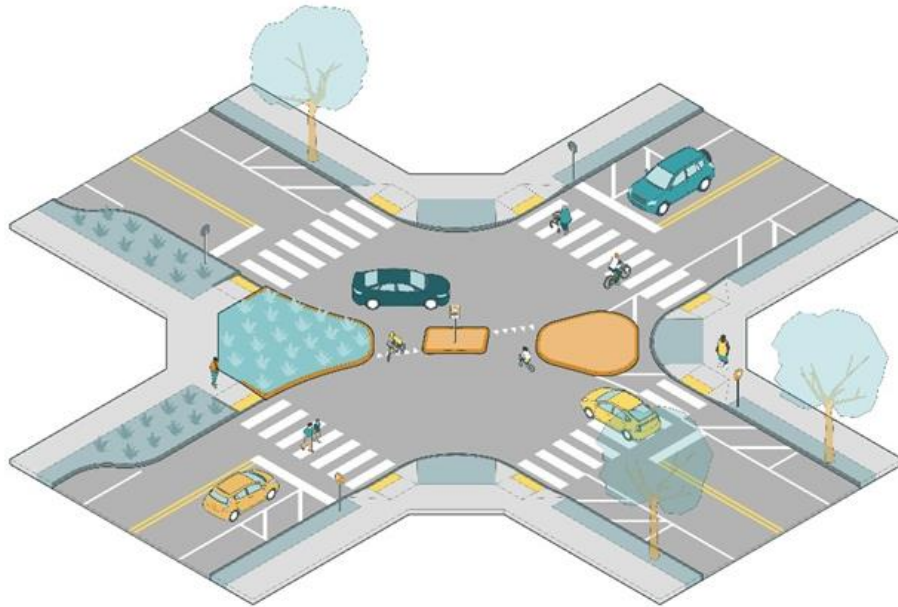


Figure 17: Diagonal traffic diverter at intersection.

Guidance

- Apply only at intersections where traffic can be shifted to adjacent streets without creating other safety or operational issues.
- Design diverters so that people walking, biking, and rolling can continue through the intersection unimpeded.
- Confirm that the design's geometry provides adequate space for turning vehicles, especially for larger vehicles like buses and trucks where applicable.

Considerations

- Coordinate with emergency response agencies and transit agencies and where needed, consider employing mountable elements to maintain emergency vehicle and bus access.
- If the route's problem is primarily speed related, diverters may need to be paired with other traffic calming devices.
- Where traffic volumes may remain high even with the implementation of a diverter, a bikeway with more separation may be more appropriate than additional diversion.

HALF CLOSURE (FORCED TURN)

Half closures are created by installing a curb extension, coupled with paint and signage, to force vehicles traveling along the street to turn, restricting through-travel along the street for motorists. They also prevent vehicles from turning onto a street while maintaining space for two-way bicycle travel. This effectively turns the end of a two-way street into a one-way for vehicles. Half closures are best paired with neighborhood connector bike facilities.



Figure 18: Half Closure

Guidance

- To mitigate conflicts with turning vehicles, the design should provide a bike lane with a bicycle box or two-stage bicycle turn box to allow bicyclists to position themselves in front of stopped vehicles.

Considerations

- At arterial crossings where it is not desirable to install a pedestrian hybrid beacon or full traffic signal, consider restricting left turns from the minor street. This forces motorists to turn right from the minor street onto the arterial, minimizing potential conflicts with bicyclists.

TURN RESTRICTIONS

Turn restrictions prohibit selected turning movements at intersections to reduce cut-through traffic and volumes. Unlike traffic diverters, these allow through traffic to continue along the street and instead limit traffic volumes through prevention of turning movements. This can be implemented through signage and pavement markings, but use of physical elements that prevent these movements can help ensure compliance.

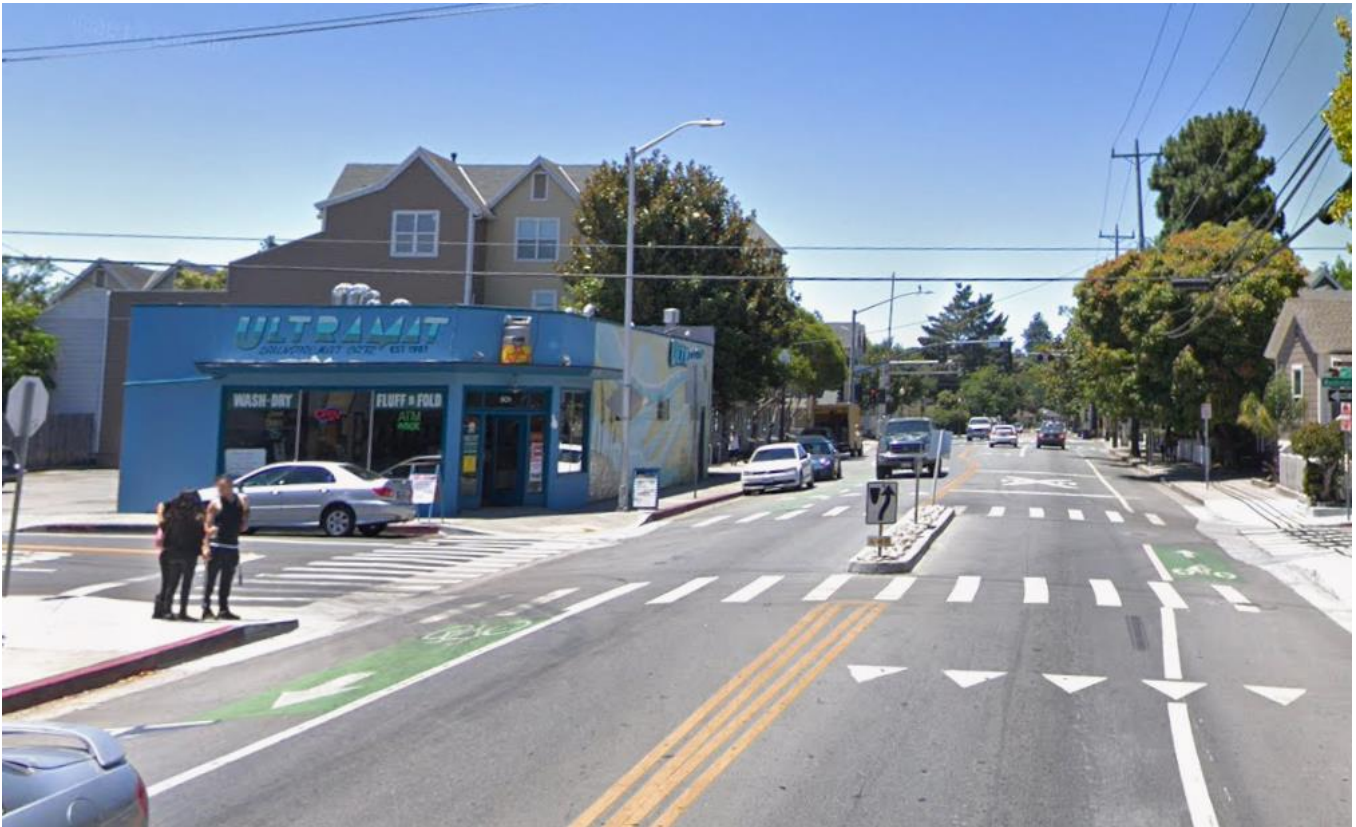


Figure 19: Left turns from Laurel Street onto Washington Street in Santa Cruz are prohibited with a median divider

Guidance

- Use turn restrictions at intersections where cut-through traffic is entering the local street from higher-volume streets.
- Install clear regulatory signage and pavement markings; consider supplemental physical elements, such as curbs, islands, or delineators where compliance is critical.
- Ensure that any restriction maintains access for bicyclists and pedestrians and does not create visibility or safety issues at the intersection.

Considerations

- Local residents may need to reroute to access their homes, depending on which turning movements are restricted.
- Restricting turns will deflect traffic to other nearby locations; this redistribution should be evaluated when selecting where and how to implement restrictions.
- Physical elements can improve compliance but may require coordination with emergency services and local access needs.

Separated Bike Lanes

What are Separated Bike Lanes?

Separated bike lanes are a dedicated bikeway facility type that combines the user experience of a shared-use path with the on-street infrastructure of a conventional bike lane. They are physically separated from motor vehicle traffic with a barrier and are distinct from the sidewalk. Separated bike lanes can be constructed at sidewalk grade, roadway grade, or an intermediate level between the sidewalk and street. Separated bike lanes can also be designed to serve one-way or two-way bicyclist traffic.

HEIGHT

Sidewalk Level

Sidewalk level separated bike lanes are bikeways built at sidewalk elevation that provide dedicated space for bicyclists. They can offer a high-comfort environment for people biking due to vertical separation from vehicular traffic. As these are constructed at the same level as sidewalks, they depend on clear, intentional separation so people walking and biking don't unintentionally mix.

Guidance

- Provide careful separation between the bike lane and sidewalk using street trees, landscaping, or tactile surfaces that people with vision disabilities can detect underfoot or by cane.
- Use visual contrast between the bike lane and sidewalk surface to reinforce where different users belong.
- Where the bike lane shifts between street level and sidewalk level at intersections and other mixing zones, provide a bicycle transition ramp.

Considerations

- Sidewalk level bike lanes with frequent intersections and driveways may require many transitions, which can affect constructability and comfort for users.

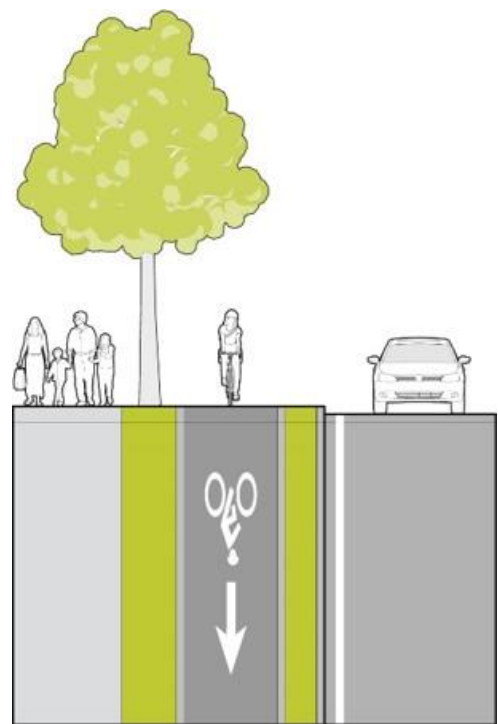


Figure 20: Sidewalk level bike lane

Separated Bike Lanes

Intermediate

Intermediate level bike lanes are located at an elevation between the sidewalk and adjacent street level. They provide many of the safety and comfort benefits of sidewalk and street-level separated bike lanes, but require smaller transitions when changing elevation to and from street or sidewalk levels. This can simplify design at intersections for elements including curb ramps and refuge islands.

Guidance

- A 2-to-3-inch curb reveal provides enough tactile separation for pedestrians without creating a trip hazard or pedal-strike issue. Using beveled curbs can maintain that vertical cue while supporting accessibility and maintenance vehicles.
- Use intermediate-level bike lanes where smoother elevation transitions are desired to simplify intersection design and improve accessibility.

Considerations

- Intermediate-level bike lanes offer many of the safety and comfort advantages of sidewalk-level or street-level separated lanes while requiring less complex elevation transitions.
- Maintenance of intermediate-level bike lanes should be included as part of the roadway maintenance (not part of sidewalk maintenance).

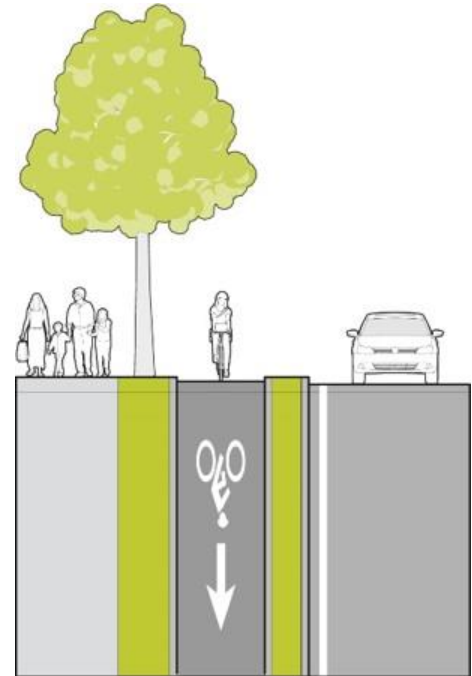


Figure 21: Intermediate level bike lane

Street Level

Street level separated bike lanes are common in retrofit situations where a separated bike lane is incorporated into the existing cross section of the street. They are also used for new construction where there is a desire to provide significant delineation between sidewalks and the bicycle facility to reduce pedestrian encroachment in the bike lane.

Separated Bike Lanes

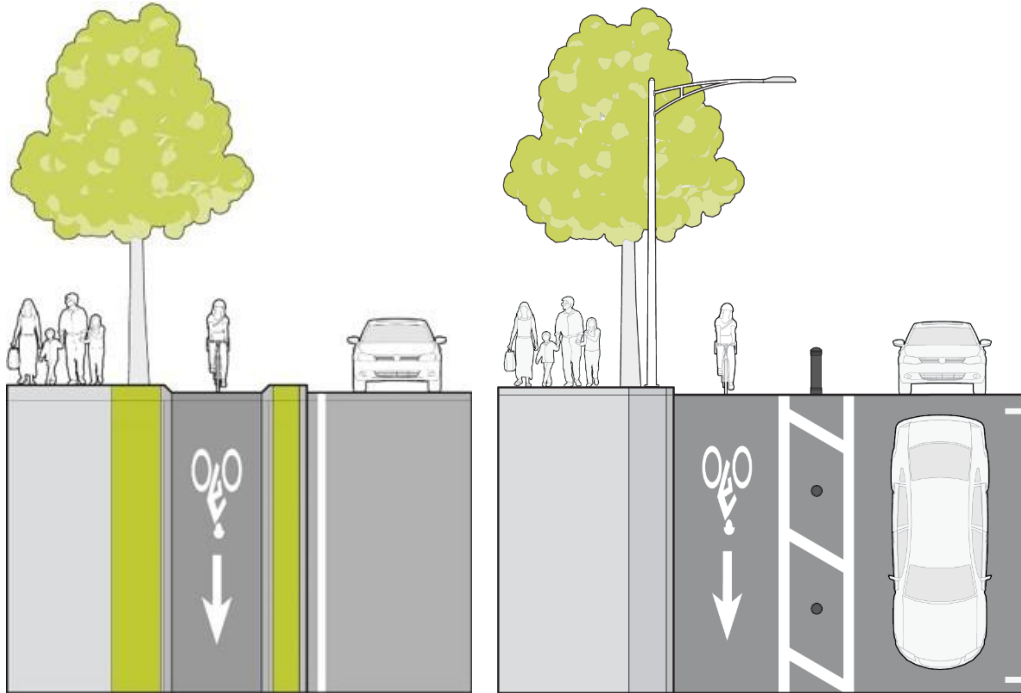


Figure 22: Street level bike lanes separated by curb (left) or flex posts (right).

Guidance

- Street-level separated bike lanes are best to place on corridors where the facility can fit within the existing curb-to-curb width.
- Where on-street parking or loading zones are present, be sure the design is compatible with accessibility requirements for pedestrians.
- Street-level separated bike lanes require 9 feet of space between the curb and the barrier to allow space for street sweeping.

Considerations

- Street-level separated bike lanes are well-suited to retrofit projects because they can be incorporated into the existing cross section and may minimize the need to relocate or reconfigure drainage infrastructure.
- They may be implemented as part of new construction when a corridor is being redesigned and there is a desire to clearly separate pedestrian and bicycle area.
- As these are located at the same level as vehicle traffic, ensuring there are sufficient barriers to prevent vehicle encroachment is critical for safety.
- Ensure sufficient road clearance for EMS access.

CONFIGURATIONS

One-way

One-way separated bike lanes operate in the same direction as adjacent vehicular traffic. They are typically provided on both sides of a two-way street, or on one side of a one-way street. This configuration aligns bicyclist travel direction with driver expectations and is often more straightforward to operate at intersections than a two-way bike lane.

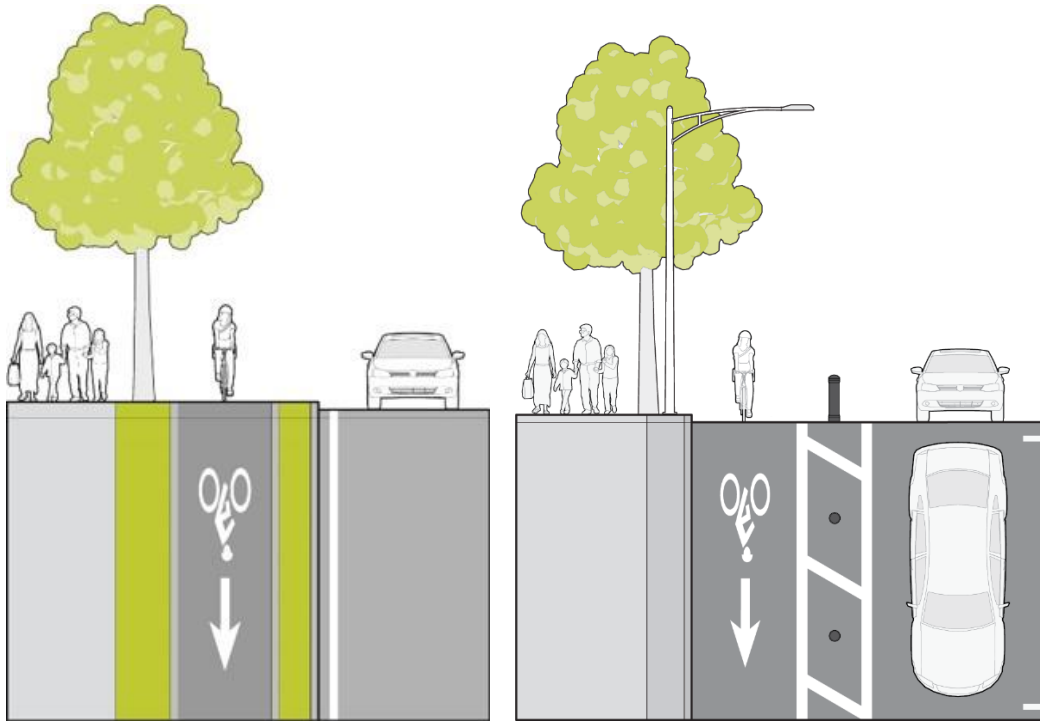


Figure 23: One-way bike lanes

Guidance

- Generally, one-way bike lanes should be used as the default configuration as they align closer with driver expectations, improving safety.

Considerations

- Crash risk is generally lower because drivers expect bicyclists to be traveling in the same direction as adjacent vehicular traffic.
- One-way SBLs are easier to integrate operationally, especially at intersections as they do not require additional bike signal phases.

Separated Bike Lanes

Two-way

Two-way separated bike lanes carry bicycle traffic in both directions on one side of the street. This design creates counterflow bicycle travel, where some bicyclists travel opposite the adjacent vehicular traffic. This can improve access to destinations if they are concentrated along one side of the corridor but requires careful design at intersections and extra signal phases to manage conflicts.



Figure 24: Two-way, separated bike lanes along Beach Street in Santa Cruz

Guidance

- Two-way separated bike lanes are useful on one-way streets, allowing bicyclists to travel in both directions to reach destinations on the corridor.
- They may be considered on streets that have a lot of driveways and intersections on one side of the street, but not the other, as conflict points can be limited.
- As they are positioned on one side of the street, two-way separated bike lanes are useful in situations where destinations are concentrated on one side.

Considerations

- Intersection design is essential: because bicyclists travel opposite the direction drivers typically expect, motorists may not look toward the counterflow direction when turning, increasing the potential for conflicts if design and visibility are not carefully addressed.
- Counterflow bicycle movements can require extra signal phases and careful intersection design. These should be considered holistically in coordinated signal corridors as this design can increase overall cycle length.
- These added needs at intersections should be weighted when considering implementation.

TYPES OF SEPARATION

Flex Posts

Flexible delineator posts (flex posts) are commonly used to provide the physical separation between bike lanes and adjacent vehicular travel lanes. Relative to other types of separation, flex posts are inexpensive and quick to install, making them ideal for pilot projects and corridors awaiting reconstruction. These generally require higher levels of maintenance.



Figure 25: A bicyclist uses a flex post-separated bike lane in San Francisco.

Guidance

- Where space allows and next to on-street parking, buffers should be 3 feet wide.
- Next to travel lanes, the width of flex post buffers can be as narrow as 2 feet, meaning they can fit in constrained corridors, but this limits the protection they offer.
- Flex posts require close spacing (10 to 20 feet on center) to discourage motor vehicle encroachment into the bicycle facility.

Considerations

- The main challenge with using flex posts is maintenance. Posts will frequently get knocked down, eroding protection and perceived quality.

Separated Bike Lanes

- Due to maintenance needs, flex posts are good short-term solution, but not necessarily a fiscally sustainable one.

Bollards

Rigid bollards are more durable and permanent than flex posts, offering more sustainability in the long term. Depending on the type of bollard used, they can be easy to replace, adjust or remove. Due to their larger size and stronger base when compared to flex posts, they provide more comfort than a flex post.



Figure 26: Bicyclists use a bollard-separated bike lane.

Guidance

- Bollards are narrow in width, allowing them to fit on constrained corridors.
- As with flex posts, bollards require close spacing to discourage or prevent motor vehicle encroachment depending on the circumstances.

Considerations

- Despite being more durable than flex posts, bollards are still susceptible to damage and may need frequent maintenance.
- Bollards may be an intermediate measure used for separation prior to investing in concrete separation.

Separated Bike Lanes

Rubber Curbs

Rubber curbs are a hybrid option that provide a low barrier between the bike lane and the vehicular lanes on a roadway. They sit directly on the pavement and are anchored with bolts, making them relatively easy to install, remove, or adjust. On their own, they provide physical separation and a visual edge to the bike lane. When paired with flex posts, they increase visibility and level of separation.



Figure 27: A bicyclist travels along a two-way, flex-post separated bikeway.

Guidance

- Rubber curbs are especially useful in situations where cities want slightly more permanent quick-build facilities without committing to implementing a full concrete curb.
- Their narrow width makes rubber curbs suitable for corridors with constrained widths.

Considerations

- Durability remains a limitation, as the bolts used to secure these curbs may loosen overtime requiring periodic maintenance. This should be factored into implementation plans.
- Similar to flex posts and bollards, these curbs are generally low risk to drivers if struck.

Concrete Curbs

Concrete curbs are among the most durable and permanent separation options. Once they are poured, they effectively become part of the street, creating continuous vertical separation between the bike lane and adjacent motor vehicle traffic. Installation can be costly and disruptive, since it often requires excavation and repaving. They are best implemented during full roadway reconstruction.

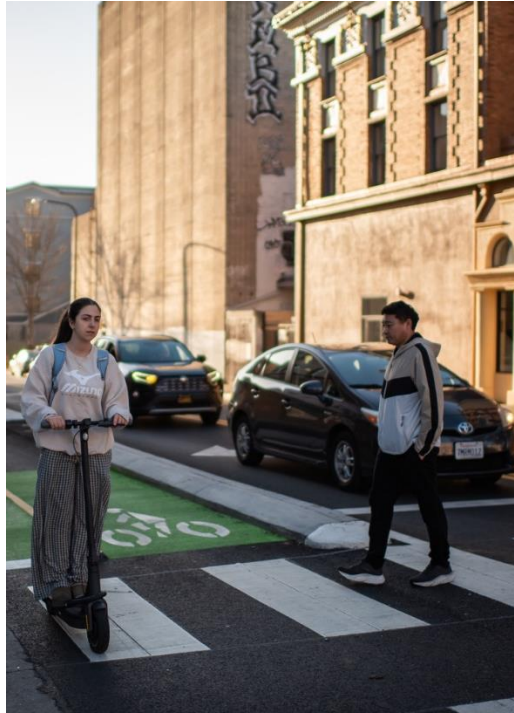


Figure 28: A person on a scooter uses a two-way, curb-separated bikeway.

Guidance

- Concrete curbs are recommended where more physical separation from vehicular traffic is needed, for example on roadways with higher posted speeds (≥ 30 mph) or higher traffic volumes ($\geq 6,500$ AADT).
- Concrete curbs are typically 6 inches tall with a beveled curb on the bikeway side.
- These may be installed as continuous curbs or with gaps for drainage and access as needed.
- Width of the separated bike lane must be sufficient to accommodate a sweeper.

Considerations

- Once installed, they require reconstruction to move or modify, which may limit flexibility in the future. Consider using lower-cost, temporary materials like flex posts or bollards first to test operational changes before installing curb protection.
- Due to high installation costs, they are best suited for where the city is repaving the street anyway.

PROTECTED INTERSECTIONS

Protected intersections incorporate separated bike lanes into their design and separate the pedestrian crossing of the bike lane from the pedestrian crossing of the vehicle traffic lane, thereby minimizing conflicts between modes and improving visibility for all users. In addition to providing dedicated space for bicycles, they shorten the pedestrian crossing distance and reduce the curb radii, effectively slowing the speeds of turning vehicles.

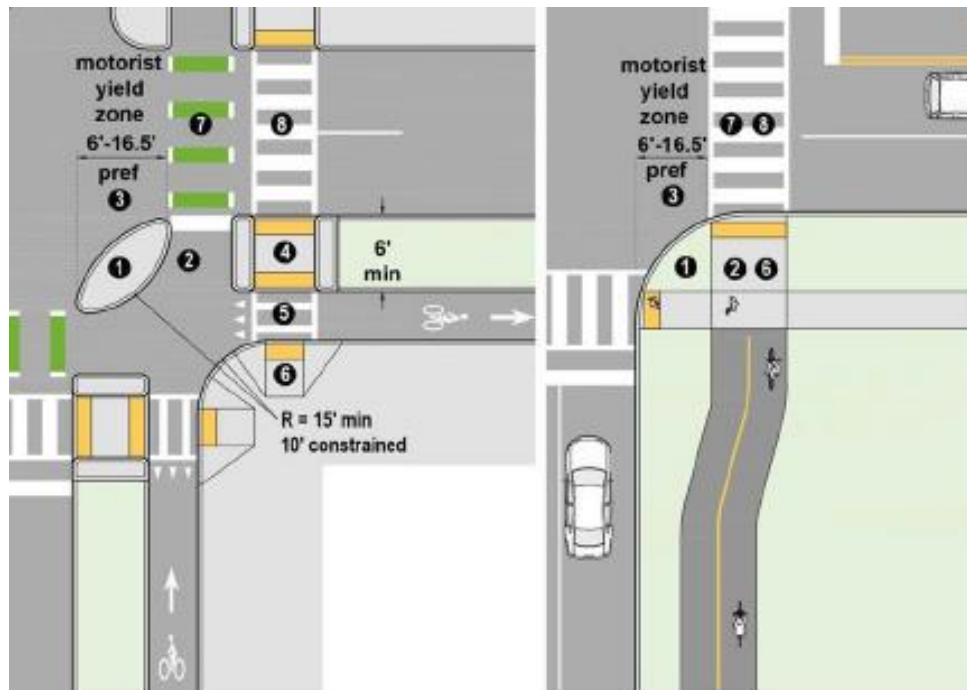


Figure 29: Key elements of a protected intersection

Guidance

- Protected intersections have eight key elements, as noted in the above graphic:
 1. Corner island
 2. Forward bicycle queuing area
 3. Motorist yielding zone
 4. Pedestrian refuge island
 5. Pedestrian crossing of the separated bike lane
 6. Pedestrian curb ramp
 7. Bicycle crossing of travel lanes
 8. Pedestrian crossing of travel lanes

Considerations

- At major intersections where space is available, protected intersection designs are preferred because they are intuitive and comfortable, provide clear right-of-way assignment, promote predictability of movement, and allow eye contact between motorists, bicyclists, and pedestrians.
- Where two-way separated bike lanes are installed on one side of the street, the contra-flow direction of bicycle travel introduces an unexpected movement at the intersection and requires more complex signal operations.

DESIGN, MAINTENANCE, AND EMERGENCY RESPONSE CONSIDERATIONS

The ongoing maintenance of bicycle facilities is equally as important as the initial designs in determining their day-to-day utility and long-term success. Therefore, when designing bicycle facilities it is critical to keep maintenance in mind. To accommodate street sweepers, facilities must meet or exceed the minimum width required for them to operate. When designing separated bike lanes, they should always meet these minimum widths required for maintenance to ensure they can be kept up and continue to accomplish their purpose in the long term. If this is not treated as a design criterion and the facility does not meet the required minimum widths, ongoing manual cleaning and upkeep should be expected. Coordination with operations teams should happen early and often to ensure that ongoing maintenance of facilities is planned and implemented.

Additionally, drainage, vegetation upkeep, and delineator replacement should be considered early on in the process and not after the design of a facility. Budget for replacement materials should be included in planning of project costs. This ensures that maintenance considerations are not afterthoughts, leading to poor upkeep and degradation of the facility over time. As mentioned previously, flexible delineator posts have low durability and will require frequent maintenance. This should be considered and accounted for early to set expectations for the long-term cost of maintenance of the facility.

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