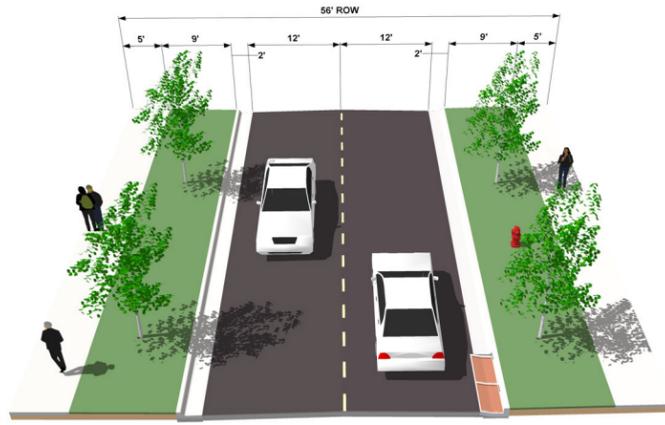
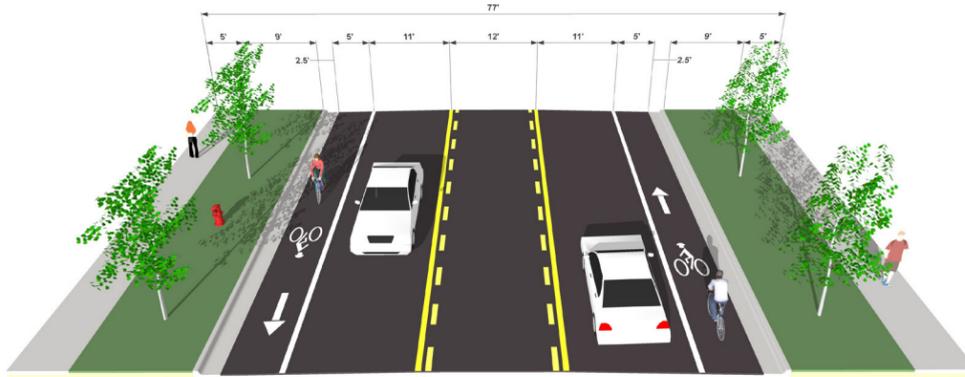


Appendix A:
Recommended Cross-Sections

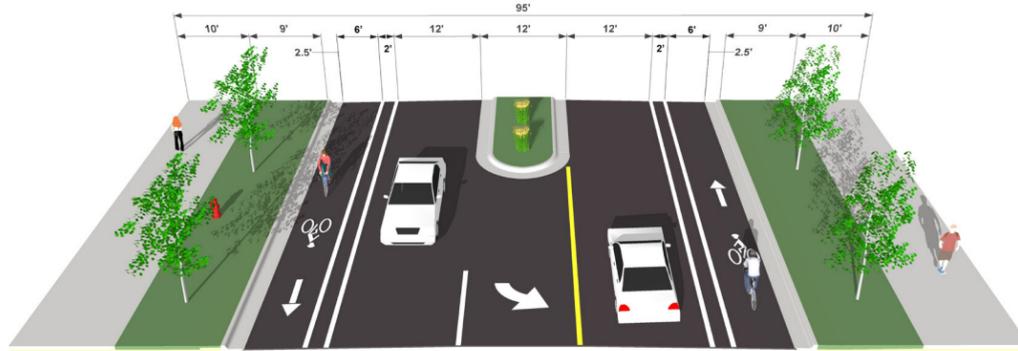
Local Street



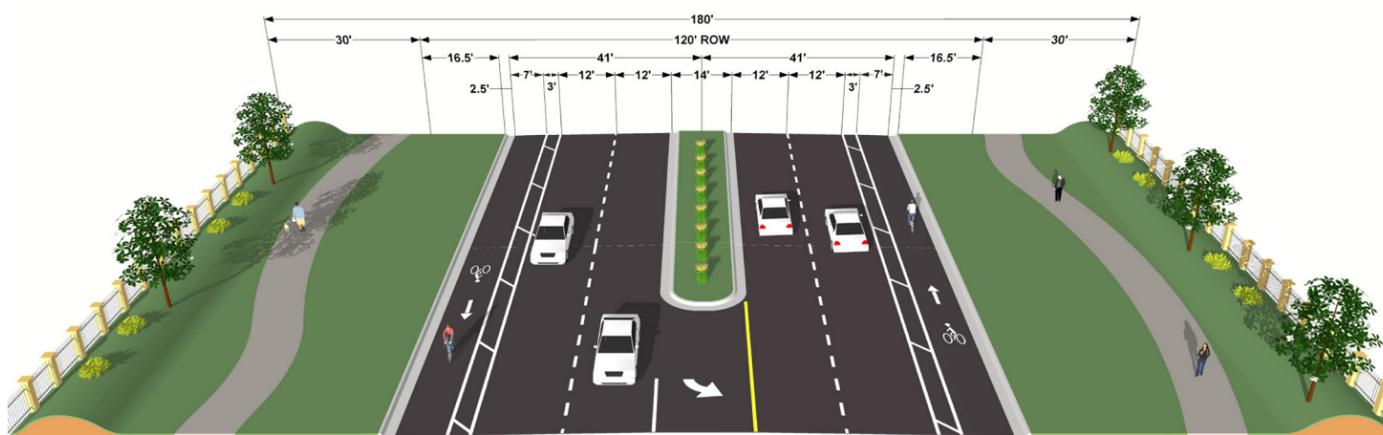
Collector



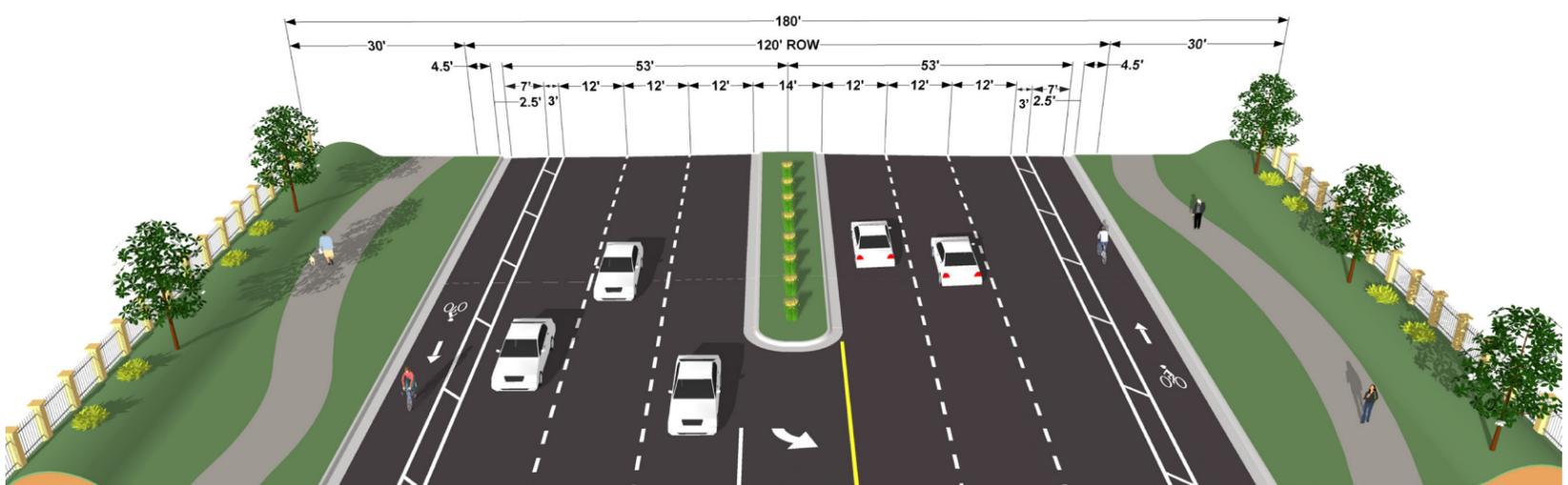
Minor Arterial



Major Arterial



Principal Arterial



Appendix B:
Bicycle Parking Best Practices

Bicycle Parking Best Practices

Bicycle parking is an important end-of-trip facility for those riding bicycles for any purpose, allowing secure storage of bicycles and comfortable access to destinations. The purpose of this documents is to provide Saratoga Springs with best practices in developing a bicycle parking ordinance.

There are many alternatives in how to approach bicycle parking. To develop best practices the Association for Pedestrian and Bicycle Professionals' (APBP) Bicycle Parking Guidelines Manual (2nd Edition) was reviewed as well as code language and design standards from nearby communities like Lindon, Lehi, Orem, South Salt Lake. Portland Oregon, often cited as one of the most bicycle friendly communities in the nation, was also consulted.

Provide Short and Long-term Bicycle Parking

Providing parking for both short-term users and long-term users is important component in providing adequate bicycle parking for different types of users. Short-term parking in the form of bicycle racks provide a convenient and semi-secure location for visitors who will only be parking for a few hours or less. This encourages bicycle use for utilitarian trips. Long-term parking, in the form of bicycle lockers or indoor bike rooms, provide additional security and protection from weather. This is provided to serve employees and residents who will be parking their bicycles for longer than just a few hours. Providing long-term parking can encourage bicycle use for commute trips.



Short-term parking is typically provided at most land uses, while long-term parking is often required only for multi-family developments and larger employers. For example, in Portland, no long-term bicycle parking is required on a site where there is less than 2,500 square feet of gross building area. As another example, Lehi only requires offices with more than 250 automobile parking stalls to provide long-term bicycle parking storage. Other office users are encouraged to provide long-term bicycle parking, but it is not a requirement. As an incentive, Lehi also offers parking vehicles parking reduction of one vehicle stall for every two indoor bicycle parking stalls up to a 10% reduction in required vehicle stalls.



Provide an Adequate Amount of Parking for Appropriate Land Uses

Adequate bicycle parking should be provided at most land uses. However, determining the appropriate amount of bicycle parking is a key concern in developing a code. Providing too little will reduce the likelihood of encouraging bicycle use and frustrate users. Providing too much would add additional costs to development with little benefit.

Some cities have elected to use vehicular parking to determine bicycle parking requirements. In this case the total amount is based on a percentage of the total number of required vehicular stalls. As an example, Lehi sets the number of required bicycle stalls at five percent of the total required number of vehicular parking stalls, with a minimum 2 stalls. This applies to all land use types.

The APBP Bicycle Parking Guidelines Manual sets its recommendations based on a bicycle mode share goal of five percent, bicycle ownership rates, and U.S. Green Building Council’s Leadership in Energy Development and Environmental Design (LEED) credit levels for alternative transportation. Different rates are applied based on land use. However, rather than listing out every possible land use, uses are grouped together (see Table 1).

Table 1: Example APBP Bicycle Parking Requirement Recommendations

Type of Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
Single Family Homes	No spaces required	No spaces required
Multifamily dwelling		
a. With a private garage	No spaces required	0.10 spaces for each bedroom Minimum of 2 spaces
b. Without a private garage for each unit	0.5 spaces for each bedroom. Minimum of 2 spaces	0.10 spaces for each bedroom. Minimum of 2 spaces
c. Senior Housing	0.5 spaces for each bedroom. Minimum of 2 spaces.	0.10 spaces for each bedroom. Minimum of 2 spaces
Non-assembly cultural (Library, Government Building, etc.)	1.5 spaces for every 10 employees. Minimum of 2 spaces.	1 space for each 8,000 sqft of floor area. Minimum of 2 spaces
Assembly (church, theaters, etc.)	1.5 spaces for every 20 employees. Minimum of 2 spaces.	Spaces for 5% of maximum daily attendance
Health care/hospitals	1.5 spaces for every 20 employees. Minimum of 2 spaces.	1 space for each 20,000 sqft of floor area. Minimum of 2 spaces
Education		
Day-care for 15 or more children	1.5 spaces for each 20 employees or one for each 50,000 sqft of floor area, whichever is greater. Minimum of 2 spaces.	1 space for each 20 students of planned capacity. Minimum of 2 spaces
Nursery schools, kindergartens, and elementary schools (1-3)	1.5 spaces for each 10 employees. Minimum of 2 spaces.	1.5 space for each 20 students of planned capacity. Minimum of 2 spaces
Elementary (4-6), junior high, and high schools	1.5 spaces for each 10 employees plus 1.5 spaces for each 20 students of planned capacity. Minimum of 2 spaces.	1.5 space for each 20 students of planned capacity. Minimum of 2 spaces
Colleges and universities	1.5 spaces for each 10 employees plus 1 space for each	1.5 spaces for each 10 employees plus 1.5 spaces for

Type of Activity	Long-term Bicycle Parking Requirement	Short-term Bicycle Parking Requirement
	10 students of planned capacity; or 1 space for each 20,000 sqft of floor area, whichever is greater.	each 20 students of planned capacity. Minimum of 2 spaces.
<i>Rail/bus terminals and stations/airports</i>	Spaces for 7% of projected a.m. peak period daily ridership	Spaces for 2% of a.m. peak period daily ridership.
<i>Retail (general food sales or groceries)</i>	1 space for each 10,000 sqft. of floor area. Minimum of 2 spaces.	1 space for each 2,000 sqft. of floor area. Minimum of 2 spaces.
<i>General retail</i>	1 space for each 10,000 sqft. of floor area. Minimum of 2 spaces.	1 space for each 5,000 sqft. of floor area. Minimum of 2 spaces.
<i>Office</i>	1.5 spaces for each 10,000 sqft. of floor area. Minimum of 2 spaces.	1 space for each 20,000 sqft. of floor area. Minimum of 2 spaces.
<i>Auto Related</i>	1 space for each 10,000 sqft. of floor area. Minimum of 2 spaces.	1 space for each 20,000 sqft. of floor area. Minimum of 2 spaces.
<i>Off-street parking lots and garages available to the general public</i>	1 space for each 20 automobile spaces. Minimum of 2 spaces.	Minimum of 6 spaces of 1 per 10 auto spaces.
<i>Manufacturing and production</i>	1 space for each 12,000 sqft of floor area. Minimum of 2 spaces	Number of spaces to be prescribed by the Planning Director. Consider minimum of 2 spaces at each public building entrance.

Parking Location

Short-term bicycle parking should be easy to locate and close to destination entrances. Making bicycle parking highly visible not only helps to encourage bicycle use, but also makes it more secure by ensuring more “eyes on the street”. Distances in the codes reviewed vary between fifty to a hundred feet from building entrances. When possible, short-term parking should also be located in areas that are protected from weather under existing structures.



Long-term bicycle parking should be easy to locate through the use of signage, but should have controlled access. As an example, to provide security, long-term bicycle Portland requires that long-term bicycle parking must be in at least one of the following locations:

- (1) In a locked room;
- (2) In an area that is enclosed by a fence with a locked gate. The fence must be either 8 feet high, or be floor-to-ceiling;
- (3) Within view of an attendant or security guard;
- (4) Within 100 feet of an attendant or security guard;
- (5) In an area that is monitored by a security camera; or
- (6) In an area that is visible from employee work areas.



Secured to Hard Surface

Short-term bicycle parking should be secured to a hard surface to enhance security and reduce the risk of theft. Hard surfaces also make it easier and more convenient for users to access bicycle parking. This can include concrete or asphalt surfaces.



Design

The design of bicycle spacing should focus on making parking as easy and convenient as possible for all users. To accommodate a conventional bicycle the following layout design is recommended.

- A bicycle parking space is the space that one bicycle typically occupies (e.g. a U-shaped bicycle rack has two bicycle parking spaces, one on either side of the rack).
- Each required bicycle parking space should be at least 2.5 feet in width (5 feet between parallel racks) by 6 feet in length to allow sufficient space between parked bicycles.
- The rack supports the bicycle frame at two contact points on the frame and allows the bicycle frame and one wheel to be locked to a bicycle rack with a high security, U-shaped shackle lock if both wheels are left on the bicycle.
- A bicycle six feet long can be securely held with its frame supported so that the bicycle cannot be pushed or fall in a manner that will damage the wheels or components.
- The rack should be securely anchored.
- Each bicycle parking space should be accessible without moving another bicycle.
- There should be an aisle **at least** 4 feet wide behind all required bicycle parking to allow room for bicycle maneuvering.
- The area devoted to bicycle parking should be a hard surface.
- Racks should be located with **at least** 30 inches clearance in all directions from any obstruction, including but not limited to other racks, walls, and landscaping. Large retail uses such as supermarkets and grocery stores should be encouraged to locate racks with a 36 inch clearance

in all directions from any vertical obstruction, including but not limited to other racks, walls, and landscaping.

In developing appropriate dimensions, the city should also consider alternative bicycle types that often have different design considerations. Accommodating tandem, recumbent, folding bicycles, adult tricycles, and cargo bicycles should be considered in determining appropriate bicycle parking design. However, this should also be weighed against the additional space and costs of accommodating non-conventional bicycles. The codes that were reviewed did not include designs specifically focused on accommodating different types of bicycles. However, certain land uses like senior living centers and grocery stores may benefit from having different design requirements.



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Appendix C:
Bike Facility Decision Matrix

BICYCLE FACILITY CONTEXTUAL GUIDANCE

AVERAGE ANNUAL DAILY TRAFFIC (1,000 veh/day or 100 veh/peak hr)

FACILITY TYPE

NEIGHBORHOOD BIKEWAY

Comfortable and attractive bicycling environment without utilizing physical separation; typically employs techniques to prioritize bicycling.

ADVISORY BIKE LANE

Bicycle priority areas delineated by dotted white lines, separated from a narrow automobile travel area.

BIKE LANE

Exclusive space for bicyclists through the use of pavement markings and signage (without buffers or barriers).

BUFFERED BIKE LANE

Traditional bike lane separated by painted buffer to vehicle travel lanes and/or parking lanes.

PROTECTED BIKE LANE

Physically separated bikeway. Could be one or two way and protected by a variety of techniques

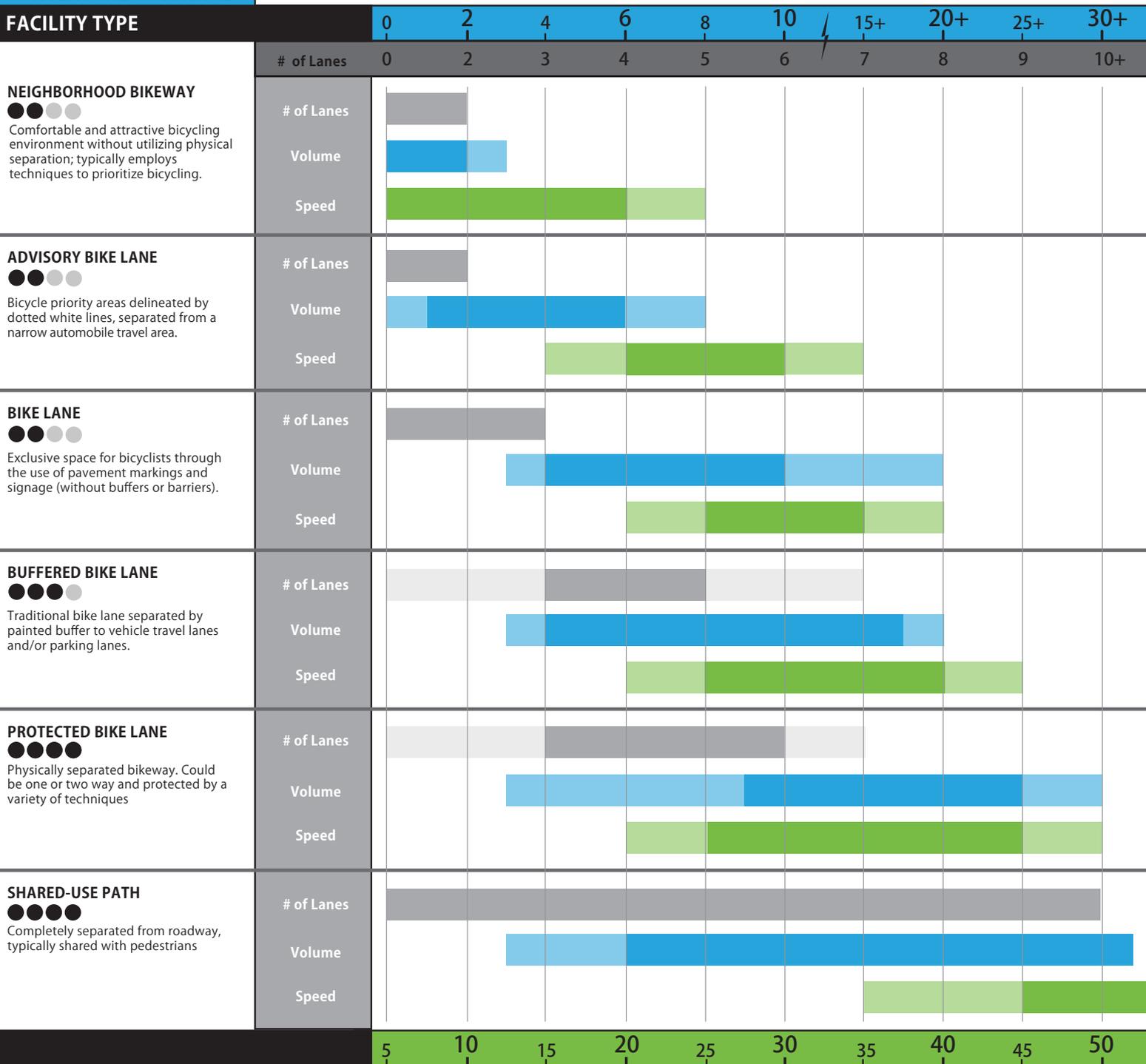
SHARED-USE PATH

Completely separated from roadway, typically shared with pedestrians

LEGEND

SEPARATION	
●●●●	Minimal Separation
●●●●●	Moderate Separation
●●●●●●	Good Separation
●●●●●●●	High Separation

min	LANES	max
min	VOLUME	max
min	SPEED	max
Acceptable	Desired	Acceptable



POSTED TRAVEL SPEED (mph)

Appendix D:

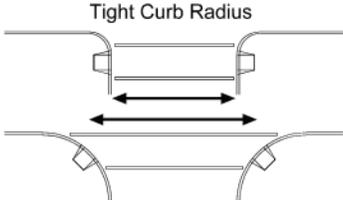
Bicycle and Pedestrian Facility Toolbox

Bicycle and Pedestrian Facility Toolbox

Pedestrian Crossing Treatments

Tool	Description	Benefits	Consideration
<p>Marked Crosswalk</p>  <p><i>Image source: www.walkinginfo.org/pedsafe/</i></p>	<p>Provide designated pedestrian crossings at:</p> <ul style="list-style-type: none"> • Pedestrian generators • Crossings with significant pedestrian volumes (at least 15 per hour) • Crossings with high vehicle-pedestrian collisions 	<p>Signal a clear “channel” for pedestrian pathways to both pedestrians and vehicles</p>	<p>Marked crosswalks alone should not be installed on multi-lane roads with more than about 10,000 vehicles/ day.</p>
<p>High-Visibility Signs and Markings</p> 	<p>Includes a family of crosswalk striping styles such as the “ladder” and the “continental”</p> <p>High-visibility colored signs are posted at crossings to increase driver awareness of the pedestrian crossing</p>	<p>Increase driver awareness of unexpected condition or location where drivers need to exercise a higher level of caution based on potential conflicts with more vulnerable road users</p>	<p>Beneficial in areas where drivers might not expect a pedestrian crossing or where a higher level of driver attention is required due to potential pedestrian and bicycle conflicts</p>
<p>Advanced Yield Lines</p>  <p><i>Image source: www.saferoutesinfo.org</i></p>	<p>Standard white yield limit lines are placed in advance of marked, uncontrolled crosswalks.</p>	<p>Increases the pedestrian’s visibility to motorists</p> <p>Reduces the number of vehicles encroaching on the crosswalk</p> <p>Indicates to drivers where to stop</p>	<p>Useful in areas where pedestrian visibility is low and in areas with aggressive drivers</p> <p>Addresses the multiple-threat collision on multi-lane roads.</p>

Pedestrian Crossing Treatments

Tool	Description	Benefits	Consideration
<p>In-Street Pedestrian Crossing Signs</p>  <p><i>Image source: http://mutcd.fhwa.dot.gov</i></p>	<p>Regulatory pedestrian signage posted on lane edge lines and road centerlines</p> <p>May be used to remind road users of laws regarding right of way at an unsignalized pedestrian crossing</p>	<p>Highly visible to motorists and has a positive impact on pedestrian safety at crosswalks</p> <p>Good driver compliance with yielding to pedestrians though compliance decreases on multi-lane roadways</p>	<p>Mid-block crosswalks</p> <p>Unsignalized intersections</p> <p>Low-speed areas</p> <p>Two-lane roadways</p> <p>May need to be removed in winter in snowy climates</p>
<p>Curb Extension/ Bulb Outs</p> 	<p>Traffic-calming measure meant to slow traffic and increase driver awareness</p> <p>Consists of an extension of the curb into the street, making the pedestrian space (sidewalk) wider</p>	<p>Narrows the distance that a pedestrian has to cross and decreases pedestrian exposure time</p> <p>Increases the sidewalk space on the corners.</p> <p>Improves pedestrian visibility</p> <p>Lowers vehicle turning speeds</p> <p>Provides opportunity to store and treat storm water runoff</p>	<p>Suitable along most roadways and intersections so long as a parking lane shadows the curb extension</p> <p>Need to consider impact on transit service and could provide extended curb extension that extends length of bus stop so long as there is another travel lane to bypass the stopped bus</p> <p>Need to consider larger vehicle turning paths</p>
<p>Reduced Curb Radii</p>  <p><i>Image Source: www.ci.austin.tx.us</i></p>	<p>The radius of a curb is reduced requiring motorists to make a tighter turn</p>	<p>Narrow the distance pedestrians have to cross</p> <p>Reduce traffic speeds and increase driver awareness (like curb extensions)</p>	<p>Beneficial on streets with high pedestrian activity, on-street parking, and no curb-edge transit service</p> <p>More suitable for wider roadways and roadways with low volumes of heavy truck traffic</p>

Pedestrian Crossing Treatments

Tool	Description	Benefits	Consideration
<p>Raised Crosswalks</p> 	<p>Marked crosswalks that are raised to act simultaneously as a traffic calming device</p>	<p>Provide superior safety advantage to pedestrians with demonstrated increased yielding by drivers</p>	<p>Appropriate on streets with moderate traffic</p> <p>Particularly effective where heavily used trails cross a road</p>
<p>Median Pedestrian Island</p>  <p><i>Image source: http://thegoodcity.wordpress.com/category/transportation/</i></p>	<p>Raised islands are placed in the center of a roadway, separating opposing lanes of traffic with cutouts for accessibility along the pedestrian path, providing a refuge for people crossing</p>	<p>This measure allows pedestrians to focus on each direction of traffic separately, and the refuge provides pedestrians with a better view of oncoming traffic as well as allowing drivers to see pedestrians more easily. It can also split up a multi-lane road and act as a supplement to additional pedestrian tools.</p>	<p>Recommended for multi-lane roads wide enough to accommodate an ADA-accessible median</p>
<p>Staggered Median Pedestrian Island</p>  <p><i>Image source: www.pedbikeimages.org/</i></p>	<p>Crosswalks in the roadway are staggered such that a pedestrian crosses half the street and then must walk <i>towards</i> traffic to reach the second half of the crosswalk</p> <p>Must be designed for accessibility by including rails and truncated domes to direct sight-impaired pedestrians along the path of travel.</p>	<p>Increase in the concentration of pedestrians at a crossing and the provision of better traffic views for pedestrians</p> <p>Motorists are better able to see pedestrians as they walk through the staggered refuge.</p>	<p>Best used on multi-lane roads with obstructed pedestrian visibility or with off-set intersections</p> <p>Must be designed for accessibility by including rails and truncated domes to direct sight-impaired pedestrians along the path of travel</p>

Pedestrian Crossing Treatments

Tool	Description	Benefits	Consideration
<p>In-Roadway Warning Lights</p>  <p><i>Image Source: www.tfhr.gov/</i></p>	<p>Both sides of a crosswalk are lined with pavement markers, often containing an amber LED strobe light</p> <p>Lights may be push-button activated or activated through passive pedestrian detection</p>	<p>Provides a dynamic visual cue</p> <p>Increase effectiveness in low light conditions</p>	<p>Best in locations with low bicycle ridership, as the raised markers present a hazard to bicyclists</p> <p>May not be appropriate in areas with accumulating snow due to decreased visibility of lights</p> <p>Not as effective in locations with bright sunlight</p>
<p>Overhead Flashing Beacons</p>  <p><i>Image source: tti.tamu.edu</i></p>	<p>Flashing amber lights installed on overhead signs in advance of the crosswalk or at the crosswalk</p>	<p>Blinking lights during pedestrian crossing times increase the number of drivers yielding for pedestrians and reduce pedestrian-vehicle conflicts</p> <p>May also improve conditions on multi-lane roadways.</p>	<p>Best used in places where motorists cannot see a traditional sign due to topography or other barriers</p>
<p>Rapid Flash Beacons</p>  <p><i>Image source: mutcd.fhwa.dot.gov</i></p>	<p>Replace the traditional slow flashing incandescent lamps with rapid flashing LED lamps</p> <p>The beacons may be push-button activated or activated with pedestrian detection</p>	<p>Very effective as measured by increased driver yielding compliance (65-80% compliance)</p> <p>Solar panels reduce energy costs associated with the device</p> <p>Wireless capabilities reduces installation cost</p>	<p>Appropriate for single and multi-lane roadways</p> <p>Effectiveness decreases as the number of travel lanes increases</p>

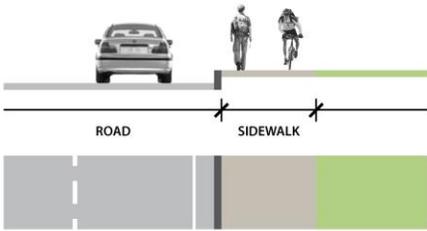
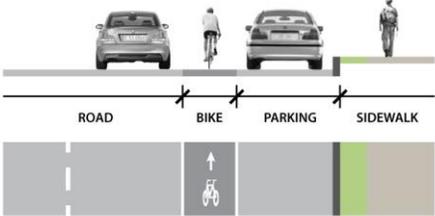
Pedestrian Crossing Treatments

Tool	Description	Benefits	Consideration
<p>Pedestrian Hybrid Beacon</p> 	<p>Pedestrian-actuated beacon that is a combination of a beacon flasher and a traffic control signal</p> <p>When actuated, the beacon displays a yellow (warning) indication followed by a solid red light</p> <p>During pedestrian clearance, the driver sees a flashing red “wig-wag” pattern until the clearance interval has ended and the signal goes dark</p>	<p>Reduces pedestrian-vehicle conflicts and increases driver compliance with yielding to pedestrians (80-90% compliance)</p> <p>Reduces vehicle delay when compared to standard pedestrian traffic signal</p>	<p>Useful in areas where it is difficult for pedestrians to find gaps in automobile traffic to cross safely, but where normal signal warrants are not satisfied</p> <p>Based on higher cost, most appropriate for higher speed multi-lane roadways.</p>
<p>Pedestrian Countdown Signals</p>  <p><i>Image source: www.livablestreets.com</i></p>	<p>Pedestrian signal head that displays the amount of time remaining during the pedestrian clearance interval</p>	<p>Reduces pedestrian-vehicle conflicts and slows traffic speeds</p> <p>Studies have shown it reduces pedestrian versus vehicular crashes by 25%</p>	<p>Required by the MUTCD for all signalized intersections</p> <p>With pedestrian signal heads</p>

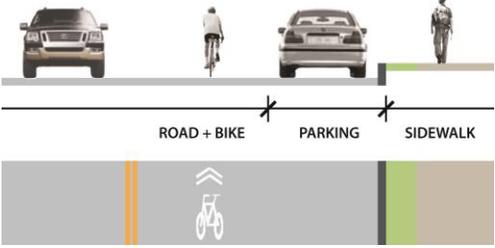
Pedestrian Corridor Treatments

Tool	Description	Benefits	Consideration
<p>Sidewalks</p> 	<p>All-weather walking surface outside the travel way</p>	<p>Provides pedestrians a safer and more enjoyable location to walk along a roadway</p>	<p>Should be consider along all corridors</p>
<p>Corridor Lighting</p>  <p><small>Peter Lagerwey</small></p> <p><i>Image source: www.pedbikeimages.org/</i></p>	<p>Roadway and pedestrian sidewalk lighting to improve driver visibility of pedestrians during low light conditions</p>	<p>Improves driver visibility of pedestrians and provides them more time to react to a potential conflict</p>	<p>Should be considered along all corridors</p>
<p>Landscape Buffer</p> 	<p>Providing a 5-12' landscaping strip between the edge of roadway and the pedestrian path</p>	<p>Improves pedestrian walking environment by providing buffer between moving traffic and sidewalk</p> <p>Provides area to install street furniture and utilities to help maintain a clear pedestrian walkway</p> <p>Provides an area to store and treat storm water run-off</p>	<p>Should be considered on most corridors where right-of-way width permits</p>

Bicycle Facility Treatments

Tool	Description	Benefits	Consideration
<p>Sidewalk Bikes Permitted</p>  <p>The diagram shows a cross-section of a street. On the left is a 'ROAD' with a car. To the right of the road is a 'SIDEWALK' with a person walking and a person riding a bicycle. A vertical line separates the road from the sidewalk. Below the diagram is a color-coded pavement layout: a grey road with a dashed white line, a grey sidewalk, and a green area representing the bicycle lane on the sidewalk.</p>	<p>Designed for bicycle usage to avoid conflicts between single direction motor vehicle traffic</p>	<p>Sidewalks will include additional signage, ground markings, and special curb cuts to facilitate bicycle travel</p> <p>Physical separation between wheeled and non-wheeled users is recommended to minimize potential conflicts between users</p>	<p>Interim solutions that connect two green facilities together</p> <p>Should be used only when there is no immediate solution to resolve a connection between two green facilities</p>
<p>Buffered or Protected Bike Lane</p>  <p>A photograph of a city street with a green-painted bike lane. A white SUV is parked in a space between the bike lane and the travel lane. A fire hydrant is visible on the sidewalk. The background shows modern city buildings.</p>	<p>Created by painting a flush buffer zone between a bike lane and the adjacent travel lane</p> <p>Buffers may also be provided between bike lanes and parking lanes to demarcate the door zone and discourage bicyclists from riding closely next to parked vehicles</p> <p>Buffer zones may be more permanent through the use of concrete barriers, parking, planters, or differences in elevation</p>	<p>Provides a warning for motorists and bicyclists that the street is multi-purpose</p> <p>Buffered bike lanes increase the riding comfort for bicyclists as they increase separation from vehicular traffic and/or parked vehicles</p>	<p>Should be considered at locations where there is excess pavement width or where increased separation is desired</p>
<p>Bicycle Lane</p>  <p>The diagram shows a cross-section of a street with a dedicated bicycle lane. From left to right: a 'ROAD' with a car, a 'BIKE' lane with a bicycle icon and an arrow pointing forward, a 'PARKING' area with a car, and a 'SIDEWALK' with a person walking. Below the diagram is a color-coded pavement layout: a grey road with a dashed white line, a grey area with a white bicycle icon and arrow, a grey parking area, and a green sidewalk.</p>	<p>Portion of the roadway designated for preferential use by bicyclists</p> <p>One-way facilities that typically carry bicycle traffic in the same direction as adjacent motor vehicle traffic on the right side of the roadway</p>	<p>Provide dedicated space from vehicular traffic</p> <p>Reduce stress caused by acceleration and operating speed differentials between bicyclists and motorists</p>	<p>Desirable on collectors and some arterials where traffic volumes and speeds are higher</p> <p>Typically installed by reallocating existing street space by narrowing existing lanes, removing travel lanes or parking lanes, and/or reconfiguring parking lanes</p>

Bicycle Facility Treatments

Tool	Description	Benefits	Consideration
<p>Bicycle Boulevard</p>  <p><i>Image source: www.pedbikeimages.org/</i></p>	<p>Low traffic volume and low speed streets that are designated to give cyclists the priority.</p> <p>Use signs, pavement markings, and traffic calming measures to discourage through trips by motor vehicles and provide cyclists with enhanced crossing of arterial streets.</p>	<p>Provide cyclists of all abilities with low stress route</p> <p>Enhanced safety due to reduced exposure to moving traffic</p> <p>Provide enhanced wayfinding</p>	<p>Installed on streets with less than 3000 ADT and travel speeds below 25 mph</p> <p>Install traffic calming to reduce travel speeds or traffic volumes</p> <p>Coordinate with emergency responders on impacts to their response time</p>
<p>Marked Shared Lane (Sharrow)</p> 	<p>Marking alerts road users to the lateral position bicyclists are likely to occupy within the traveled way to be most visible to drivers and to help avoid conflicts with parked cars</p>	<p>Provide guidance to bicyclists and motorists in situations where separate bicycle facilities are not provided</p> <p>Encourage safer passing practices (including changing lanes, if necessary)</p>	<p>Installed where there is insufficient space to allocate to a dedicated bicycle facility in the right most through travel lane</p> <p>Generally used on collector streets where a more comfortable bicycle facility cannot be provided due to right-of-way constraints</p>
<p>Advisory Bike Lane</p>  <p><i>Image source: Minneapolis Dept. of Public Works</i></p>	<p>Uses dashed lane line to distinguish bike lane and allow for drivers to encroach into the bike lane when cyclists are not present to avoid an oncoming vehicle in the opposite direction</p>	<p>Brings greater awareness to the roadway as shared space</p> <p>Encourages slower vehicular travel speeds and reduces cut through traffic</p>	<p>Generally used on streets too narrow for traditional bike lanes and lower volume streets</p> <p>Do not impact usable roadway width</p>

Bicycle Facility Treatments

Tool	Description	Benefits	Consideration
<p>Grade Separated Crossing</p>  <p><i>Image source: omahamidcenturymodern.blogspot.com</i></p>	<p>Pedestrian-only overpass or underpass over a roadway or topographical barrier</p> <p>Provides complete separation of pedestrians from motor vehicle traffic, normally where no other pedestrian facility is available</p>	<p>Allow for the uninterrupted flow of pedestrian movement separate from vehicular traffic</p> <p>Reduces energy expenditure for cyclists by spanning existing topography</p>	<p>Most feasible and appropriate in extreme cases where pedestrians must cross roadways such as freeways and high-speed, high-volume arterials</p> <p>This measure should be considered only with further study due to the cost implications</p>
<p>Back-in Angle Parking</p>  <p><i>Image source: www.pedbikeimages.org/</i></p>	<p>Reorients traditional head-in parking to allow drivers to back into a diagonal parking space</p>	<p>Improves driver visibility of approaching traffic and cyclists</p> <p>Improves vehicle passenger safety, especially for children, as open doors of the vehicle block pedestrian access to the travel lane and guide pedestrians to the sidewalk</p> <p>Eases loading of cargo into trunk of vehicle</p>	<p>Highly recommended in locations where diagonal parking is adjacent to bike lane</p> <p>Avoid installing near locations where vehicle overhang could cause damage or danger pedestrians on the sidewalk</p> <p>Sometimes can require outreach to drivers to educate them on the change in parking orientation</p>

Bicycle Parking & Maintenance

Tool	Description	Benefits	Consideration
<p>Bike Rack</p> 	<p>Bicycle racks are devices to which bicycles may be securely attached. The rack itself should be securely attached to the ground or a stationary object such as a building. Weather protection may also be provided in the form of a cover or shield. Bike racks are appropriate for short-term use.</p>	<p>Provides bicyclists with short-term parking</p> <p>Encourages bicycle use</p>	<p>Possible risk of bicycle theft or vandalism</p> <p>If racks are not covered, bicycles may be exposed to the elements</p>
<p>Bicycle Locker</p> 	<p>A locker or box in which a single bicycle can be placed and locked. Lockers may either be available on a first-come-first-served basis and/or for a fee. Users can reserve lockers for several months at a time for an established fee, or can rent as needed on a short-term basis.</p>	<p>Good for long-term use</p> <p>Encourages bicycle use</p> <p>Prevents theft and vandalism</p> <p>Typically provides protection from the elements</p>	<p>More expensive than bike racks</p> <p>Potential to be misused such as for storage of things besides bicycles</p>
<p>Bicycle Repair Stands</p> 	<p>Do-it-yourself bicycle repair stands offer an air pump and basic tools to make minor bicycle repairs.</p>	<p>Encourages bicycle use by removing concerns related to common maintenance and repair issues.</p>	<p>Repair stands should be located near short-term and long-term bicycle parking.</p>

Bicycle Facility Intersection Treatments

Tool	Description	Benefits	Consideration
<p>Enhanced Intersection Markings</p>  <p><i>Image source: NACTO</i></p>	<p>Consists of using colored pavement markings or additional bike symbols within the intersection to increase the visibility of cyclists to drivers, identify areas of potential conflict, and provide guidance to cyclists on their intended alignment through the intersection.</p>	<p>Increases visibility of cyclists</p> <p>Raises driver and cyclists awareness of conflict areas</p> <p>Increases driver yielding behavior</p> <p>Increases cyclists comfort level</p>	<p>Should be used reluctantly in area where there is potential for conflict between cyclists and drivers</p> <p>Typical application locations include across wide intersections and driveways and along enhanced bikeway facilities</p>
<p>Bicycle Box</p> 	<p>A bicycle box is a marked on-street waiting area designed to improve cyclist visibility when stopped. There are two types of bicycle boxes: two-point left turn and advanced stop line.</p>	<p>Cyclists are more visible to automobiles and not forced to wait within traffic</p> <p>Cyclists may be allowed to travel in directions that automobiles are not</p>	<p>Drivers and other cyclists may not be aware of how bike boxes function</p> <p>The two-point left may take more time to cross the intersection</p> <p>Traffic level of service may be affected by advanced stop line bike boxes</p>
<p>Bicycle Detection Loop</p> 	<p>Embedded loop detector in roadway surface detects a bicycle</p>	<p>Decreases delay for cyclists at signalized intersection</p> <p>Encourages cyclists to wait for signal indication</p>	<p>Should be considered in locations where there is a high number of cyclists or low number of vehicles that would activate the signal</p>

Bicycle Facility Intersection Treatments

Tool	Description	Benefits	Consideration
<p>Bicycle Signal</p> 	<p>Signals dictate traffic behaviors and patterns. Bicycle signals give priority phasing for bicycle crossing. They can also inform cyclists and drivers about the interaction between bicycles and traffic.</p>	<p>Improves safety by allowing cyclists to cross intersection without interacting with automobiles</p> <p>Traffic signals are understood by cyclists and drivers</p> <p>Opportunity to combine phasing with crosswalks</p>	<p>Added cost</p> <p>Possible negative impacts to intersection level of service</p>

Signalized Intersection Treatments

Tool	Description	Benefits	Consideration
<p>Leading Pedestrian/Bicycle Intervals</p> 	<p>Traffic signal timing that provides pedestrians/bicyclists with a few second head start prior to motor vehicles on the parallel roadway being given the green light</p>	<p>Increases pedestrian visibility for turning vehicles and driver yielding compliance for pedestrians</p> <p>Helps reduce conflicts between turning vehicles and pedestrians</p>	<p>Can be applied at most signalized intersections especially where there is a high number of turning vehicles and pedestrians conflicts</p>
<p>Protected Left Turn Phasing</p> 	<p>Traffic signal phasing that only allows left turning vehicles to enter the intersection</p>	<p>Eliminates conflicts between left turning vehicles and pedestrians which is one of the most common type of crash involving a pedestrian and vehicle</p>	<p>Used primarily on higher volume roadways where the left turning vehicle must cross multiple approach lanes and there is no left turn storage issues</p>
<p>No Turn on Red (signs)</p> 	<p>Posting regulatory signs that restrict vehicles from turning on red signal indications</p>	<p>Eliminates potential conflicts between turning vehicles and pedestrians or bicyclists that might be crossing during the conflicting traffic signal phase.</p>	<p>Should be considered in most urban locations where there are a high number of pedestrians</p> <p>Turn restriction can be limited to certain hours when pedestrians are most likely to be present at the intersection</p>
<p>Retiming Clearance Intervals</p>	<p>Modifying the pedestrian clearance intervals at</p>	<p>Increases the comfort level for all pedestrians</p>	<p>Should be considered around schools and senior centers where</p>

	<p>signalized intersections to provide adequate time for a pedestrian to cross the intersection at a slower walking speed that 3.5 ft/s</p>	<p>and reduces the need to rush to cross the street</p>	<p>pedestrians with slower walking speeds are anticipated</p>
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Bicycle Corridor Signing Treatments

Tool	Description	Benefits	Consideration
<p>Way-finding signs</p> <p><i>Image source: NACTO</i></p>	<p>Posting a series of pedestrian and bicycle way-finding signs that orient pedestrians to walking and biking destinations along a corridor</p>	<p>Encourages more walking and bike trips by providing people with a reference point to a destination</p>	<p>Applied in locations where there are pedestrian and bicycle destination or attractors</p> <p>Should be located in areas where will not obstruct the pedestrian walkway or create sign clutter</p> <p>Should be scaled to be legible for appropriate user</p> <p>Should not be used to promote private businesses</p>
<p>Stop Sign Reorientation</p> <p>Turning stop signs to favor through movements on bike blvd.</p>	<p>Reorientating two-way stop controlled approaches to provide bike boulevard approaches with the right-of-way at the intersection</p>	<p>Reduces delay and energy expenditure for cyclists and thereby encourages more cyclists to use the street</p>	<p>Should perform stop warrants analysis prior to removing</p> <p>Repeal existing city ordinances prior to implementation</p> <p>May need to provide additional traffic calming on bike boulevard to discourage additional cut-through traffic and higher travel speeds</p> <p>Should evaluate traffic operation impacts on stop controlled approaches</p>

Traffic Calming Treatments

Tool	Description	Benefits	Consideration
<p>Median Barriers</p>  <p><i>Image source: http://streetswiki.wikispaces.com/Traffic+Diverters</i></p>	<p>Islands located along the centerline of a street and continuing through an intersection so as to block through movement at a cross street.</p>	<p>Can improve safety by prohibiting dangerous turning movements</p> <p>Can reduce traffic volumes on a cut-through route that crosses a major street</p>	<p>Good for local street connections to main streets where through traffic along the continuing local street is a problem and main streets where left-turns to and/or from the side street are unsafe.</p> <p>Require available street width on the major street</p>
<p>Speed Humps (Sinusoidal)</p> 	<p>Rounded, raised areas placed across the roadway. They are generally as wide as the lane or roadway and are 10 to 14 feet long (in the direction of travel).</p>	<p>Relatively inexpensive</p> <p>Relatively easy for bicycles to cross</p> <p>Effective in slowing speeds</p>	<p>Good for locations where very low speeds are desired and reasonable, and where noise and fumes are not a major concern.</p> <p>Commonly applied in residential areas with low traffic volumes.</p> <p>Smoother than traditional speed humps</p>
<p>Speed Lumps/Speed Cushions</p>  <p><i>Image source www.mesaaz.gov/speed/speedFAQ.aspx</i></p>	<p>Several small speed humps installed in a series across a roadway with spaces in between them.</p>	<p>Allow larger vehicles, especially fire trucks, to straddle them without slowing down</p> <p>Bicyclists may pass between speed cushions</p>	<p>Cushions should be clearly marked for visibility.</p>

Traffic Calming Treatments

Tool	Description	Benefits	Consideration
<p>Speed Tables</p> 	<p>Flat-topped speed humps often constructed with brick or other textured materials on the flat section. Their long flat designs allow higher speeds than Speed Humps. Textured materials improve the appearance of speed tables, and draw attention to them.</p>	<p>Smoother for large vehicles</p>	<p>Good for locations where low speeds are desired but a somewhat smooth ride is needed for larger vehicles.</p>
<p>Raised Crosswalks</p> 	<p>Speed Tables outfitted with crosswalk markings and signage to facilitate pedestrian crossings, providing pedestrians with a level street crossing. Also, by raising the level of the crossing, pedestrians are more visible to approaching motorists.</p>	<p>Provide safer crossing for pedestrians Channelize pedestrians to an attractive crossing</p>	<p>Good for locations where vehicle speeds are excessive and pedestrian volumes are high. Impacts on drainage need to be considered.</p>
<p>Raised Intersections</p>  <p><i>Image source: www/transitutopia.blogspot.com</i></p>	<p>Flat raised areas covering an entire intersection, with ramps on all approaches and often textured materials. The raised intersection makes crosswalks more visible by motorists and perceived as "pedestrian territory".</p>	<p>Increases awareness of pedestrians May be used as a neighborhood gateway feature Calm two streets at once</p>	<p>Good for intersections with substantial pedestrian activity.</p>

Traffic Calming Treatments

Tool	Description	Benefits	Consideration
<p>Traffic Circles</p> 	<p>Traffic circles are small roundabouts, with raised islands. Traffic circulates around the central island.</p>	<p>Can reduce crash frequency and severity</p> <p>Can have positive aesthetic value</p> <p>Placed at an intersection, they can calm two streets at once</p>	<p>Good for calming residential or local intersections, where large vehicles are not a major concern but speeds, volumes, and safety are problems.</p> <p>May require elimination of some on-street parking</p> <p>Island landscaping must be maintained</p>
<p>Mini Roundabouts</p> 	<p>Operate in the same manner as larger roundabouts, with yield control on all entries and counterclockwise circulation around a mountable (traversable) central island.</p>	<p>Can often be developed to fit within existing right-of-way constraints.</p> <p>May provide less delay for a critical movement or for an overall intersection in comparison to other intersection alternatives.</p> <p>Do not allow opportunities for landscaping in the central island. As with comparably sized traditional intersections, landscaping opportunities are limited to the periphery of the intersection.</p>	<p>Most effective in lower speed environments in which all approaching roadways have posted speed of 30 mph or less</p> <p>Generally not recommended for intersections with more than four legs.</p>
<p>Center Island Narrowings</p>  <p><i>Image source: www.encinoparkhoa.org</i></p>	<p>An island located along the centerline of a street that narrows the travel lanes. They are often landscaped to increase visibility and provide a visual amenity. If fitted with a gap to allow pedestrians to walk through at a crosswalk, they then called "pedestrian refuges."</p>	<p>Increase pedestrian safety</p> <p>Can have positive aesthetic value</p>	<p>Ideal for entrances to residential areas, and wide streets where pedestrians need to cross.</p>

Traffic Calming Treatments

Tool	Description	Benefits	Consideration
<p>Choker/Neckdowns</p>  <p><i>Image source: www.pedbikeimages.org/</i></p>	<p>Curb extensions at midblock locations that narrow a street.</p> <p>Can be designed to restrict traffic to a single lane or accommodate two traffic lanes</p>	<p>Easily negotiable by large vehicles</p> <p>Can have positive aesthetic value</p> <p>Shortens pedestrian crossing distance</p>	<p>Good for areas with substantial speed problems and no on-street parking shortage.</p>
<p>Center Island Narrowings</p>  <p><i>http://www.encinoparkhoa.org</i></p>	<p>An island located along the centerline of a street that narrows the travel lanes. They are often landscaped to increase visibility and provide a visual amenity. If Fitted with a gap to allow pedestrians to walk through at a crosswalk, they then called "pedestrian refuges."</p>	<p>Increase pedestrian safety</p> <p>Can have positive aesthetic value</p>	<p>Ideal for entrances to residential areas, and wide streets where pedestrians need to cross.</p>
<p>Detached Curb Extensions</p> 	<p>Bulb outs that are separated from the curb.</p>	<p>Allow original curb and gutter to drain excess stormwater, but provide benefits of bulb outs.</p> <p>Can be hardscaped or landscaped, including LID.</p>	<p>Not accessible without a cover to bridge the gutter.</p>

Appendix E:
Crosswalk Decision Matrix

**PEDESTRIAN CROSSING
CONTEXTUAL GUIDANCE**
At unsignalized locations

Local Streets
≤30 mph

Collector Streets
25-45 mph

Arterial Streets / Parkway
45+ mph

FACILITY TYPE	Local Streets		Collector Streets			Arterial Streets / Parkway				
	2 lane		2 lane	2 lane with median refuge		4 lane	4 lane with median refuge	5 lane	6 lane	6 lane with median refuge
Crosswalk Only (high visibility)	✓		EJ	EJ		X	X	X	X	X
Crosswalk with warning signage and yield lines	EJ		✓	✓		X	X	X	X	X
Active Warning Beacon (RRFB)	X		✓	✓		X	✓	X	X	X
Hybrid Beacon	X		EJ	EJ		✓	✓	✓	✓	✓
Full Traffic Signal	X		EJ	EJ		✓	✓	✓	✓	✓
Grade separation	X		EJ	EJ		EJ	EJ	EJ	✓	✓

LEGEND	
Most Desirable	✓
Engineering Judgement	EJ
Not Recommended	X

Appendix F:
Separated Bikeways at Intersections
Guidance

Separated Bikeways at Intersections

Intersections are junctions at which different modes of transportation meet and facilities overlap. An intersection facilitates the interchange between bicyclists, motorists, pedestrians and other modes in order to advance traffic flow in a safe and efficient manner. Designs for intersections with bicycle facilities should reduce conflict between bicyclists (and other vulnerable road users) and vehicles by heightening the level of visibility, denoting clear right-of-way and facilitating eye contact and awareness with other modes. Intersection treatments can improve both queuing and merging maneuvers for bicyclists, and are often coordinated with timed or specialized signals.

The configuration of a safe intersection for bicyclists may include elements such as color, signage, medians, signal detection and pavement markings. Intersection design should take into consideration existing and anticipated bicyclist, pedestrian and motorist movements. In all cases, the degree of mixing or separation between bicyclists and other modes is intended to reduce the risk of crashes and increase bicyclist comfort. The level of treatment required for bicyclists at an intersection will depend on the bicycle facility type used, whether bicycle facilities are intersecting, and the adjacent street function and land use.



Bike Lanes at Right Turn Only Lanes

Description

The appropriate treatment at right-turn lanes is to place the bike lane between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to use a shared bike lane/turn lane.

The design (right) illustrates a through bike lane, with signage indicating that motorists should yield to bicyclists through the conflict area.

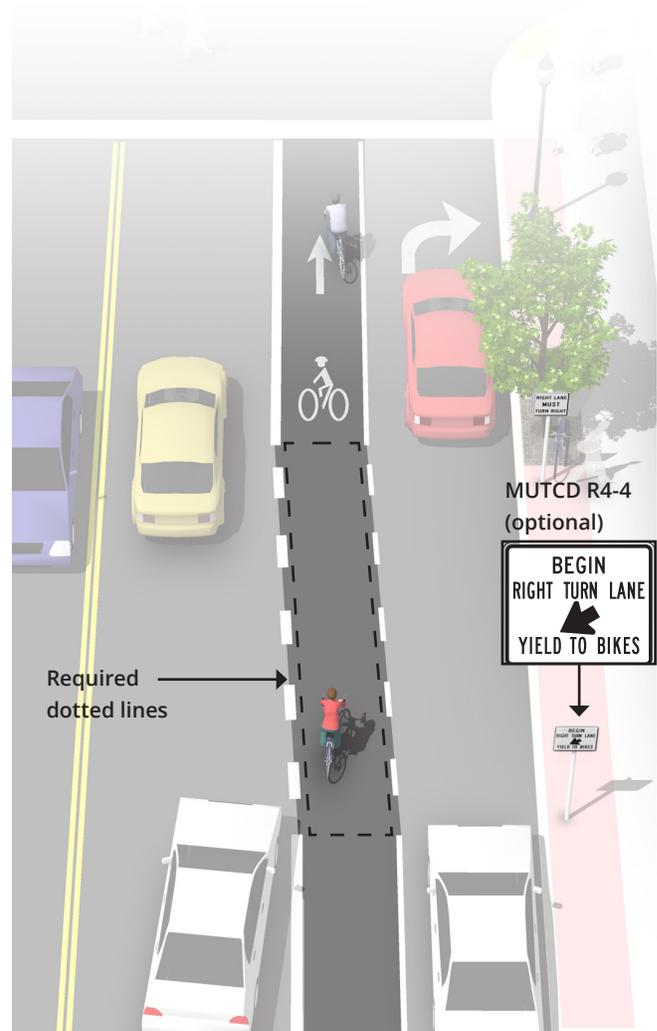
Guidance

At auxiliary right turn only lanes (add lane):

- Continue existing bike lane width; 5' min.
- Use signage to indicate that motorists should yield to bicyclists through the merge area.
- Keep merge area as straight as possible to not add confusion about right of way to motorists. If a buffered bike lane is approaching an intersection the bike lane may need to be shifted to the left side of the buffer to create a straight merge area.

Where a through lane becomes a right turn only lane:

- Do not define a dotted line merging path for bicyclists.
- Drop the bicycle lane in advance of the merge area.
- Use shared lane markings to indicate shared-use of the lane in the merging zone.



Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*, 2012.
FHWA. *Manual on Uniform Traffic Control Devices*, 2009.
NACTO. *Urban Bikeway Design Guide*, 2012.

Combined Bike Lane / Turn Lane

Description

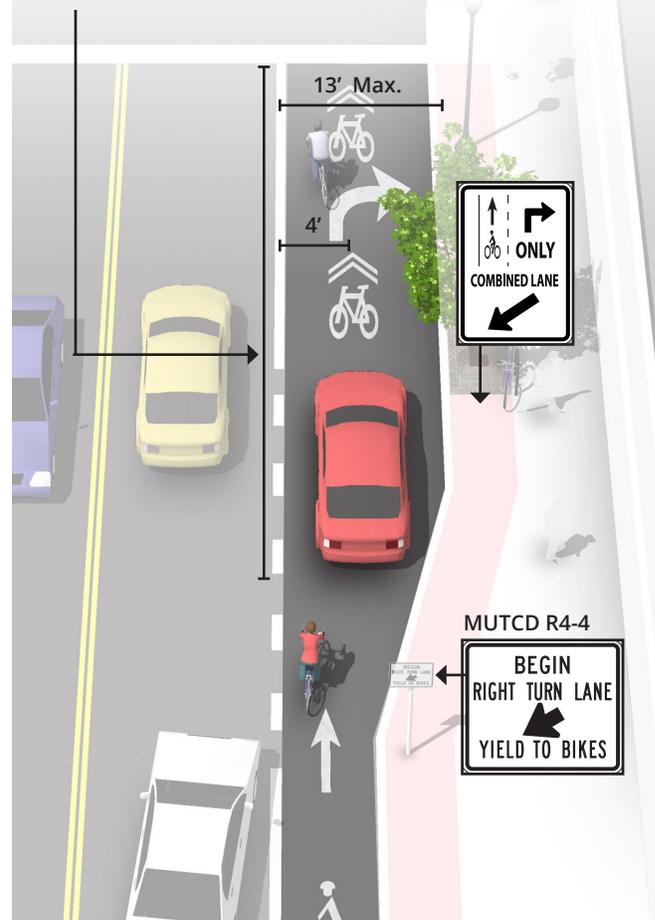
The combined bike lane/turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. Shared lane markings indicate proper bicyclist position within the lane. This treatment includes signage advising motorists and bicyclists of proper positioning within the lane.

This treatment is recommended at intersections lacking sufficient space to accommodate both a standard through bike lane and right turn lane.

Guidance

- Maximum shared turn lane width is 13 feet; narrower is preferable. If turn lane is greater than 14', provide a dedicated through bicycle lane, see page 11.
- Center shared lane markings 4' from the left edge of the combined turn lane
- Bike lane pocket should have a minimum width of 4 feet with 5 feet preferred.
- A "Right Turn Only" sign with an "Except Bicycles" plaque should be included to make it legal for through bicyclists to use a right turn lane.
- Entrance taper of 1:7 should accommodate 20 mph entry
- Storage length should be less than 100'

Short turn lanes encourage slower motor vehicle speeds



Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*, 2012.
FHWA. *Manual on Uniform Traffic Control Devices*, 2009.
NACTO. *Urban Bikeway Design Guide*, 2012.

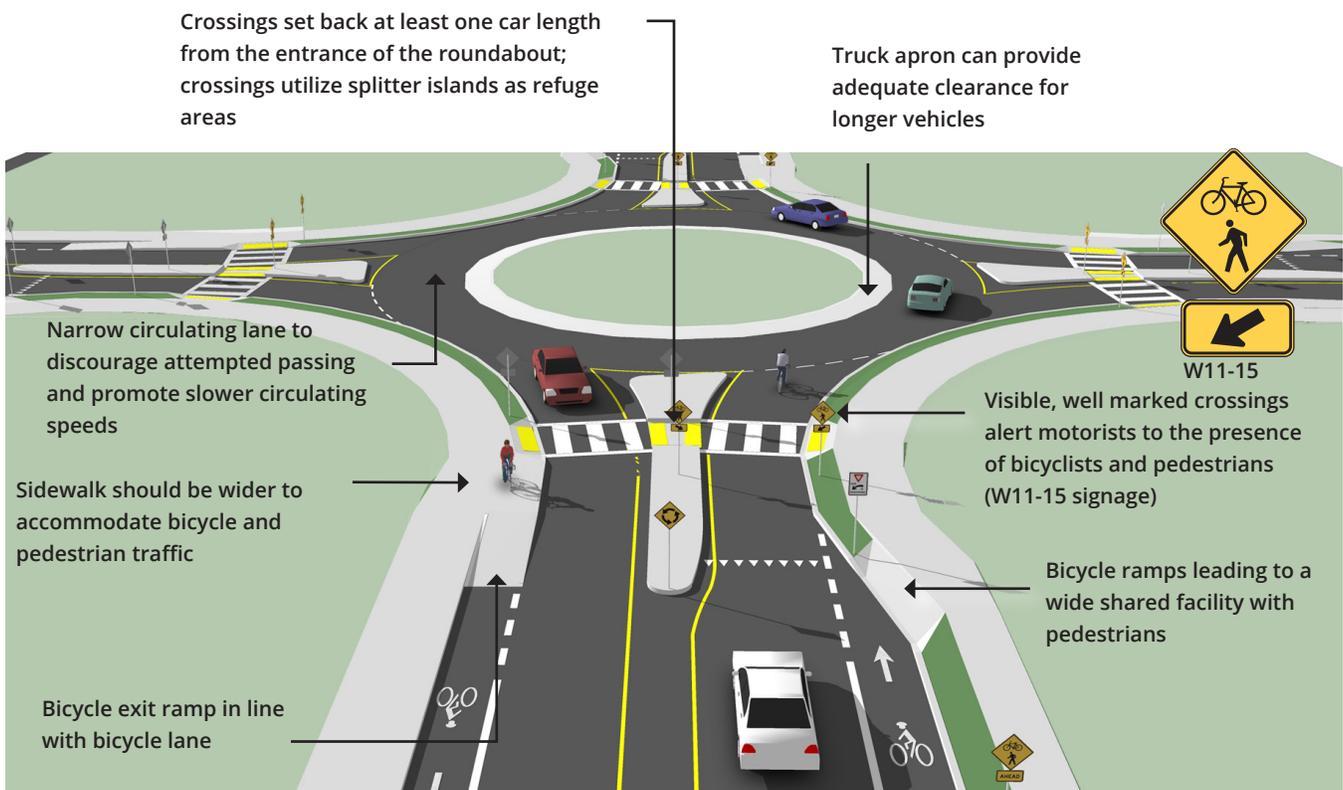
Single Lane Roundabouts

Description

In single lane roundabouts it is important to indicate to motorists, bicyclists and pedestrians the right-of-way rules and correct way for them to circulate, using appropriately designed signage, pavement markings, and geometric design elements.

Guidance

- 25 mph maximum circulating design speed.
- Design approaches/exits to the lowest speeds possible.
- Encourage bicyclists navigating the roundabout like motor vehicles to “take the lane.”
- Maximize yielding rate of motorists to pedestrians and bicyclists at crosswalks.
- Provide separated facilities for bicyclists who prefer not to navigate the roundabout on the roadway.



Discussion

Research indicates that while single-lane roundabouts may benefit bicyclists and pedestrians by slowing traffic, multi-lane roundabouts may present greater challenges and significantly increase safety problems for these users.

Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*, 2012.
FHWA. *Manual on Uniform Traffic Control Devices*, 2009.
TRB. *Roundabouts: An Informational Guide, Second Edition*. NCHRP 672, 2010.

Materials and Maintenance

Signage and striping require routine maintenance.

Bicycle Detection and Actuation

Description

Bicycle detection at signals promotes safe and legal bicycling behavior by reducing the probability that people riding bicycles will not be detected.

Guidance

Provide one of the following types of bicycle detection systems at all proposed signals. Include MUTCD Figure 9C-7 to orient bicyclists to proper positioning to facilitate detection.

Loop Detectors

Bicycle-activated loop detectors are installed within the roadway to allow the presence of a bicycle to trigger a change in the traffic signal.

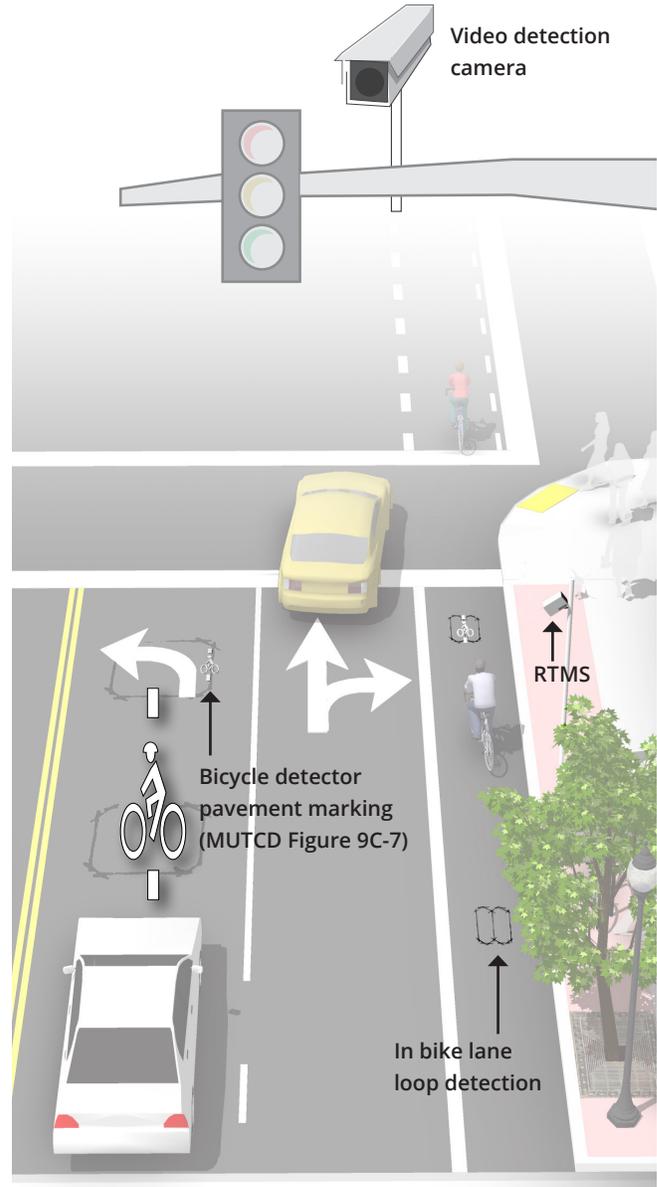
Loops that are sensitive enough to detect bicycles should be supplemented with pavement markings to instruct bicyclists how to trip them.

Video Detection Cameras

Video detection systems use digital image processing to detect a change in the image at a location.

Remote Traffic Microwave Sensor Detection (RTMS)

RTMS is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method marks the detected object with a time code to determine its distance from the sensor. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection.



Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*, 2012.
FHWA. *Manual on Uniform Traffic Control Devices*, 2009.
NACTO. *Urban Bikeway Design Guide*, 2012.

Materials and Maintenance

Signal detection and actuation for bicyclists should be maintained with other traffic signal detection and roadway pavement markings.

Two-Stage Turn Queue Boxes

Description

Two-stage turn queue boxes offer bicyclists a safe way to make left turns at multi-lane signalized intersections from a physically separated or conventional bike lane.

Additionally, bicyclists in protected (or separated) bike lanes are often unable to merge into traffic to turn left due to physical separation, making the provision of two-stage left turn boxes critical.

Guidance

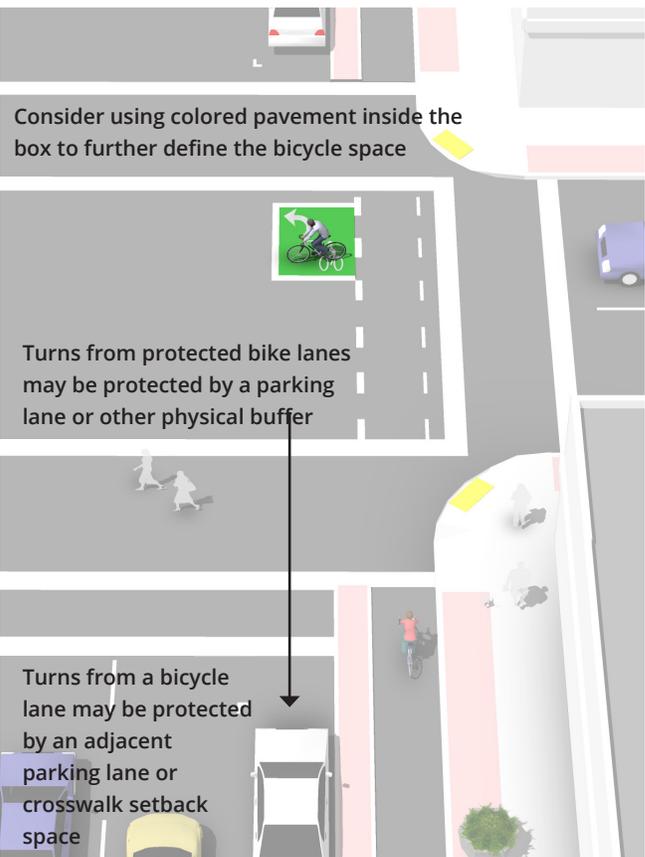
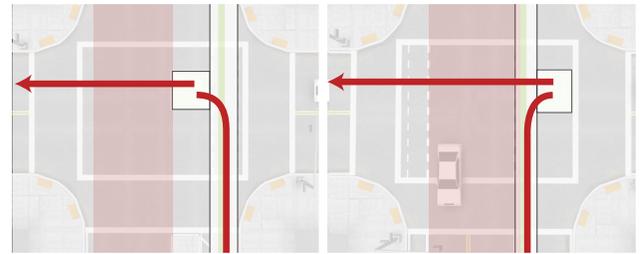
- The queue box shall be placed in a protected area. Typically this is within an on-street parking lane or protected bike lane buffer area.
- 8 foot x 6 foot preferred dimensions of bicycle storage area (6 foot x 3 foot minimum).
- Bicycle stencil and turn arrow pavement markings are used to indicate proper bicycle direction and positioning.
- This design formalizes a maneuver called a “box turn” or “pedestrian style turn”.
- Two-stage turn queue boxes reduce conflicts in multiple ways; from keeping bicyclists from queuing in a bike lane or crosswalk and by separating turning bicyclists from through bicyclists.
- Bicyclist capacity of a two-stage turn queue box is influenced by physical dimension (how many bicyclists it can contain) and signal phasing (how frequently the box clears).
- Consider providing a “No Turn on Red” (MUTCD R10-11) on the cross street to prevent motor vehicles from entering the turn box.

Discussion

Two-stage turn queue boxes are considered experimental by FHWA. While two stage turns may increase bicyclist comfort in many locations, this configuration will typically result in higher average signal delay for bicyclists due to the need to receive two separate green signal indications (one for the through street, followed by one for the cross street) before proceeding.

Protected bike lane turn box protected by physical buffer:

Bike lane turn box protected by parking lane:



Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*, 2012.

Materials and Maintenance

Paint or other marking materials can wear more quickly in high traffic areas or in winter climates. Costs will vary due to the type of paint used and the size of the two-stage turn box. Typical costs are \$11.50 per square foot.