

CHAPTER 4

BICYCLE FACILITY TOOLBOX

GOALS AND PRINCIPLES

PLANNING PRINCIPLES FOR URBAN BICYCLING NETWORKS

This chapter provides of an overview of the variety of tools to consider when designing streets to be welcoming and comfortable for people of all ages, abilities, and identities to bicycle.

Planning and designing for people who bicycle is similar to other transportation modes, where safety, travel demand, user delay, convenience, and economics are all taken into consideration.

KEY DESIGN PRINCIPLES

- + Bicycle travel on all streets should be direct, continuous, safe, and convenient.
- + Facility improvements will aim to accommodate people of all ages, abilities and identities.
- + All streets will be evaluated for how they can be improved for bicycling as they are constructed or reconstructed; improvements will be considered for all streets, whether or not they are specifically identified in the Network Vision.
- + Streets on the Bicycle Network Vision will be designed with respect to their role as designated in the Vision and in accordance with the Cycling Safety Ordinance.
- + Off-road facilities will be expanded and connected to existing networks within the city and region. Off-road facilities are desirable along high-speed and high-volume roadways, along rail corridors, and to provide access to parks and recreational areas. Note that many off-road facilities in the city are owned by other entities (e.g., the state Dept. of Conservation and Recreation) so coordination with others will be needed.

Although all roads - except for limited access highways - are bikeways, the type of facility will vary depending on the street type, usage, and conditions.

The City aims to create a high-comfort bicycle network using techniques such as separating people biking from motor vehicle traffic and reducing speed and volume where appropriate to create a comfortable shared environment for all users.

- + Local street improvements will be made to create Bicycle Priority Streets following the Network Vision and using a variety of treatments described in this chapter; the specific treatments used will be determined on a case-by-case basis.



Try it. Once you realize it is ok to bike, you'll do it. Go out and bike with your kids. With protected bike lanes in Cambridge it makes biking so much easier.

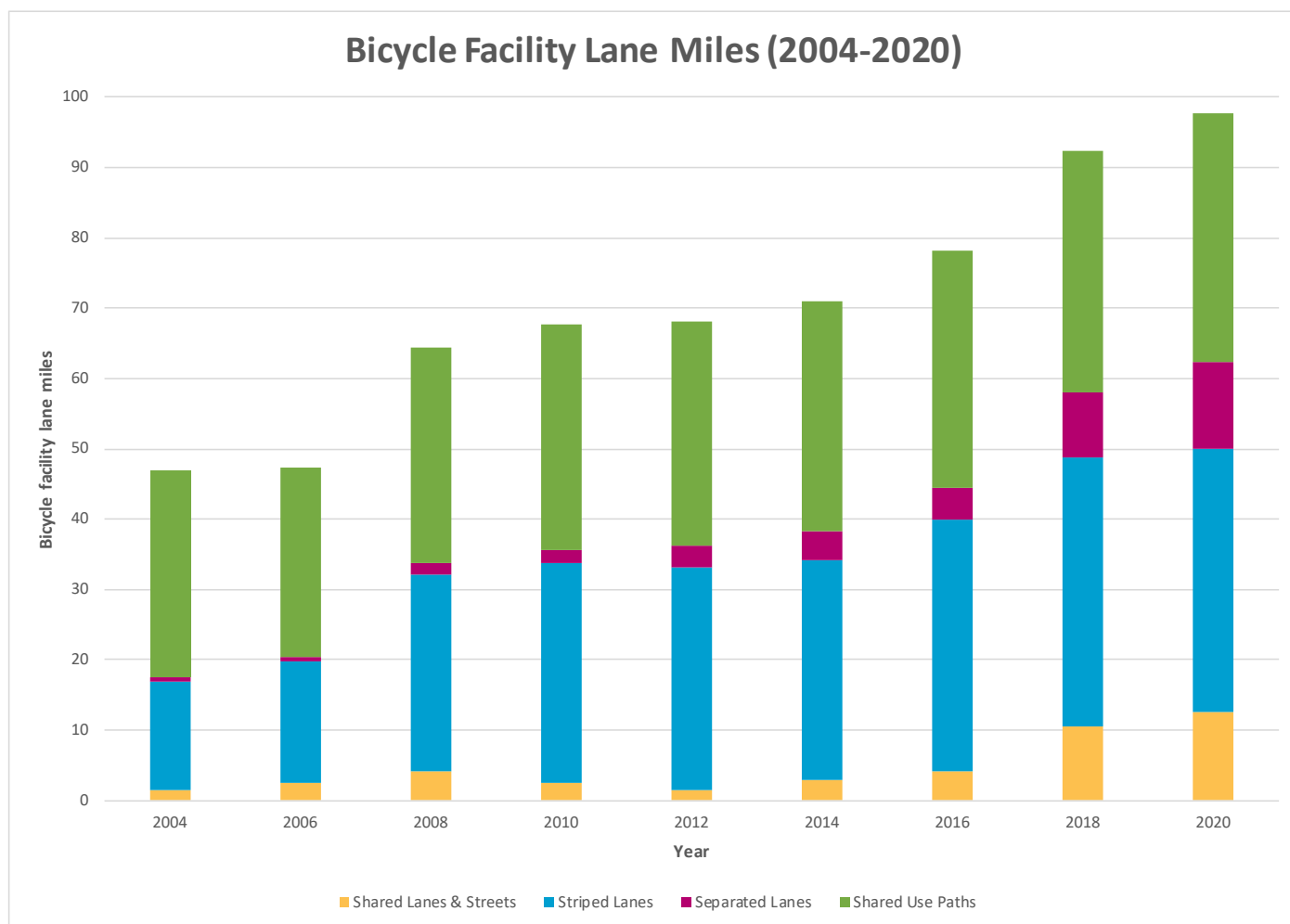
Melissa Dullea at Technology Square

BICYCLE FACILITY PLANNING AND TRACKING

Cambridge aims to improve its bicycle facilities each year through an ongoing planning and design process. A Bicycle Facility Map is used to track projects; once a project is designed or in an active design process, it is added as a “planned” facility, and the map is updated once or twice per year to document completed projects as “existing.” There is an additional, separate tracking system for the quick-build projects being implemented under the Cycling Safety Ordinance, and those projects will be added to the map as they are completed.

Bicycle Facility Type	Existing (Miles)	Planned (Miles)
Bike Path/Multi-Use Path	36.5	6.7
Conventional Bicycle Lanes	35.5	1.2
Separated Bicycle Lane	12.3	5.7
Buffered Bike Lane	1.9	0.4
Contra-flow Bicycle Lane	1.9	0.4
Shared Lanes	13.5	3.2
Shared Street	0.4	0
Total	100.5	17.0

A map of existing and planned bicycle facilities is included in the Appendix D.



IMPROVEMENT POLICIES

Bicycle facilities are considered at the inception of all Cambridge transportation projects and become incorporated into the design of each project. The [Five Year Plan for Sidewalk and Street Reconstruction](#) is the City's primary planning document for this important infrastructure work. City departments coordinate their work to ensure that all construction is reviewed in the design phase of every project to address the needs of bicycle transportation. Often these improvements can be made at a low cost, benefitting people who walk, bike and drive.

Separated bicycle lanes are also fast-tracked through quick-build projects, as mandated by the Cycling Safety Ordinance. These are implemented on streets identified for separation in the Bicycle Network Vision but are not scheduled for repaving or reconstruction. The implementation process and associated strategies for quick-build projects are outlined in Appendix H.

TECHNICAL REFERENCES FOR FACILITY DESIGN

Bicycle facility designs are developed using engineering judgment with reference to state of the art technical guidance, current research, best practices, and professional experience. National and international guides used include but are not limited to:

- + [NACTO Urban Bikeway Design Guide](#),
- + [NACTO Urban Street Design Guide](#),
- + [NACTO Designing for All Ages & Abilities](#),
- + [NACTO Transit Street Guide](#),
- + [CROW Design Manual for Bicycle Traffic](#),
- + [AASHTO Guide for the Development of Bicycle Facilities](#),
- + [AASHTO Guide for Geometric Design of Transit Facilities on Highways and Streets](#),
- + [MassDOT Separated Bike Lane Planning & Design Guide](#),
- + [FHWA Manual on Uniform Traffic Control Devices](#),
- + [FHWA Shared Use Path Guidance](#),
- + [FHWA Bikeway Selection Guide](#), and
- + [FHWA Separated Bike Lane Planning and Design Guide](#).

Cambridge has also developed reference materials for guidance, such as the [Cycle Tracks: A Technical Review of Safety, Design, and Research](#) (June 2014) and [Shared Bus/Bike Lanes Technical Memorandum](#) (August 2020). The City also has a robust [Traffic Calming Program](#) that incorporates designs to support bicycle travel, with particular attention to supportive design for streets identified as Bicycle Priority Streets in the Network Vision.



SEPARATED BIKE LANES

ONE-WAY SEPARATED BIKE LANES

Separated bicycle facilities are bicycle lanes that are vertically separated from motor vehicles and may be at sidewalk level or roadway level. For sidewalk level facilities, the furnishing zone may be between the separated bicycle lane and the motor vehicle travel lane, and/or pedestrian area to increase separation and comfort. For roadway level facilities, separation from motor vehicles may be achieved through delineator posts, parked vehicles, or concrete barriers. Benefits include clear separation between bicycle, pedestrian and motor vehicle operating space. This facility type is also known as a cycle track or protected bicycle lane.

Separated bike lanes have been shown to increase ridership on corridors where they are implemented, and to make bicycling more appealing to a wider range of people, especially those who express concerns about interacting with motor vehicle traffic. See Chapter 2 for details.

Design considerations:

- + Preferred facility for roadways with high vehicular volumes, significant bus routes or heavy vehicle use, higher speeds, and/or complex traffic patterns.
- + Bicycle lane may be elevated to sidewalk level or at roadway level.
- + Typically 5-7 feet wide plus 1-3 foot wide roadway buffer.
- + Operational requirements for street sweeping and snow plowing.
- + Bus stop operations, where applicable, including considering opportunities for constructing floating bus stops.



One of the most dangerous spots used to be around the crosswalk on Mass Ave at MIT in front of the School of Architecture ... until the city installed flex posts and more clearly marked the bike path. Since then, I have had no trouble in this crowded section of Mass Ave. These kinds of improvements, though not quite as secure as a bike path that is separated from cars through a raised lane, still make a huge difference. I'd now love to see more of this kind of solution all over the city!

– Greg, Mid-Cambridge

TWO-WAY SEPARATED BIKE LANES

Two-way separated bicycle facilities are physically separated bicycle lanes that allow bicycle movement in both directions on one side of the road. This facility dedicates and protects space for people biking and improves perceived comfort and safety.

Pairs of one-way separated bike lanes are generally preferred, but two-way facilities are sometimes desirable, such as when one side of the street has significantly fewer curb cuts and/or intersections than the other. They may also be considered where space constraints would preclude two one-way facilities but enable a two-way facility. They are also useful for one-way streets where two-way bicycle travel would provide better connectivity for people bicycling.

Design considerations:

- + Preferred along roadways with high vehicular volumes, and/or speeds, major bus routes or heavy vehicle use, and/or complex traffic patterns.
- + May improve connectivity for people biking when used on one-way streets.
- + Typically 8-14 feet wide plus a 1-3 foot wide roadway buffer.
- + Usually requires additional signing and marking at intersections; may require specialized signalization treatments.
- + Operational requirements for street sweeping and snow plowing.
- + Bus stop operations, where applicable, including considering opportunities for constructing floating bus stops.



QUICK-BUILD SEPARATED BIKE LANES

Quick-build separated bicycle lanes are vertically and/or horizontally separated bicycle lanes, typically at roadway level, which are established with materials requiring minimal or no construction.

These facilities are implemented in a shorter time frame than standard roadway reconstruction, sometimes in response to conditions of safety that require urgent action but also in order to enable the buildout of a bicycle network in a reasonable time frame. Quick-build separated bicycle lanes use materials such as pavement markings to delineate horizontal buffers, and flexible bollards, planter boxes, parked cars, or other elements to provide vertical barriers between people biking and moving motor vehicles. Quick-build separated bicycle lanes are often seen as interim facilities that allow cities to implement a more complete network until streets can be fully reconstructed. Because the materials are often non-permanent, cities have increased flexibility to test new layout options and adjust designs as necessary.



Design considerations:

- + Preferred facility for roadways with high vehicular volumes, speeds, and/or complex traffic patterns, where more permanent separation that requires construction will require a long time frame.
- + Typically 5-7 feet wide plus 2-3 foot wide roadway buffer. There must be a minimum of 7' between vertical objects, including curbs and flex posts, in order to allow for street cleaning and snow plow operations.
- + Roadway buffer should contain vertical elements such as flexposts, bollards, planters, parking stops, etc.
- + Vertical element can be chosen based on durability, maintenance considerations, and costs.
- + If adjacent to parked vehicles, buffer should be 3 feet wide to provide space for motorists to exit their vehicles and have space for door openings.
- + Accommodate bus stop operations, where applicable.

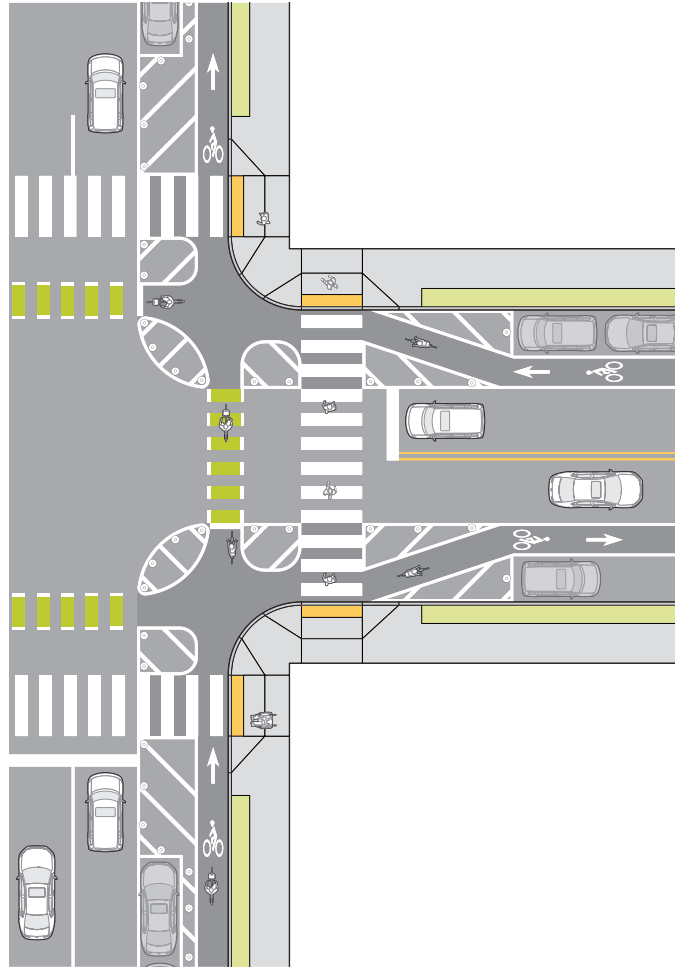
PROTECTED INTERSECTIONS

Protected intersections provide people bicycling with vertical and horizontal separation from motor vehicles at the intersection and provide separated space for queuing at signals. They may be designed for use with conventional bike lanes or separated bike lanes. Full-construction protected intersections use curbs and medians to provide separation between people biking and motor vehicle traffic.

Quick-build protected intersections are modified extensions of existing curblines that provide separation through an intersection without construction. These facilities are implemented on an accelerated schedule in response to conditions of safety or connectivity. Quick-build protected intersections use materials such as pavement markings to delineate horizontal buffers, and flexible bollards, planter boxes, or other elements to provide vertical barriers. They are generally considered interim facilities that are put in place until a street can be fully reconstructed, but can also be valuable in providing the flexibility to make design modifications as the facility is evaluated.

Design considerations:

- + Should be considered at large intersections with multiple travel lanes.
- + Quick-build materials, such as pavement markings and flexposts, can be used to outline a curb extension at intersection corners, reducing curb radii, and preventing vehicle encroachment.
- + Queuing space should be allocated for people biking to wait before proceeding through the intersection.
- + Consider operational requirements for street sweeping and snow plowing.



SHARED USE PATHS

A shared use path is defined as a trail permitting more than one type of user. Paths serve as part of the transportation circulation system and support multiple recreation opportunities, including walking, bicycling, and in-line skating. A shared use path is physically separated from motor vehicular traffic with an open space or barrier.

To improve the comfort and safety of path users, separation of people biking and people walking should be considered when volumes of users are high.



Design considerations:

- + Often located along active or abandoned rail corridors, utility easements, or along streams, rivers, or other linear features.
- + Cambridge's standard is 14 feet wide plus 2-3 foot buffers (narrower widths may be considered only where space constraints exist and may not be narrower than 10 feet plus buffers). Buffers must be level and safely traversable by people bicycling with no vertical obstructions.
- + May require specialized intersection treatments.
- + Must be ADA-compliant.
- + Provides low-stress, higher comfort connections for people walking and bicycling.
- + Separation of people walking and biking may be appropriate where there are more than 300 total users in the peak hour with more than 30% of the users being people walking.
- + Separation between people walking and biking can be achieved through pavement markings, contrasting pavement types, or physical separation (such as a grass buffer).
- + Consider using permeable asphalt; this not only has green infrastructure benefits but helps to minimize slippery conditions when wet or icy.
- + Ensure that paths are well-lit, for reasons of safety, equity and accessibility. Depending on the conditions, pedestrian-level lighting fixtures may be viable. Most lighting infrastructure enables varying lighting levels to adjust to local conditions or respond to environmental situations.

BICYCLE PRIORITY STREETS

Bicycle Priority Streets are roadways with low motorized traffic volumes and speeds that are designated and designed to give bicycle travel priority. Bicycle Priority Streets use signs, pavement markings, and speed and volume management measures to discourage through trips by motor vehicles. Bicycle Priority Streets can also include safe, convenient bicycle crossings of busy arterial streets. Bicycle Priority Streets often resemble what is also known as a bike boulevard, but may also include designated space for biking, such as bike lanes.

Achieving high comfort on a Bicycle Priority Street requires both low motor vehicle speeds and low motor vehicle volumes. Bicycle Priority Street implementation will aim to achieve the values identified in the table below. These thresholds are consistent with national best practices.

	Peak Hour Volume (VPH)	Average Daily Traffic (VPD)	Operating Speed (MPH)*
Ideal	≤150	≤1,000	≤20 mph
Preferred	≤300	≤2,000	≤20 mph
Maximum (without designated space)	≤450	≤3,000	≤25 mph
Maximum (with designated space)	≤450	≤6,500	≤25 mph

*85th Percentile Speed

To achieve and maintain high-comfort Bicycle Priority Streets, speed management treatments, volume management treatments, or designated space may be used. Effective speed management tools include neighborhood traffic circles, raised crosswalks/intersections, and one-lane pinch points. Tools to help achieve volume management include directional street management, median diverters, forced turn diverters, and diagonal diverters.

Bicycle lanes (including advisory bicycle lanes and contra-flow lanes) may be useful on Bicycle Priority Streets, particularly where speeds and/or volumes are higher than the preferred threshold values.

Design considerations:

- + May require speed management devices such as neighborhood traffic circles, raised crosswalks/intersections, or pinch points.
- + May require volume management devices such as diverters or directional street management.
- + May require delineated space for people biking such as bike lanes or contra-flow lanes.
- + May require wayfinding signage to direct people biking. Shared lane markings can be used as a wayfinding aid in this context.
- + Opportunity for plantings, rain gardens, and green infrastructure.



Credit: Alta

OTHER BICYCLE LANES

STANDARD BICYCLE LANES

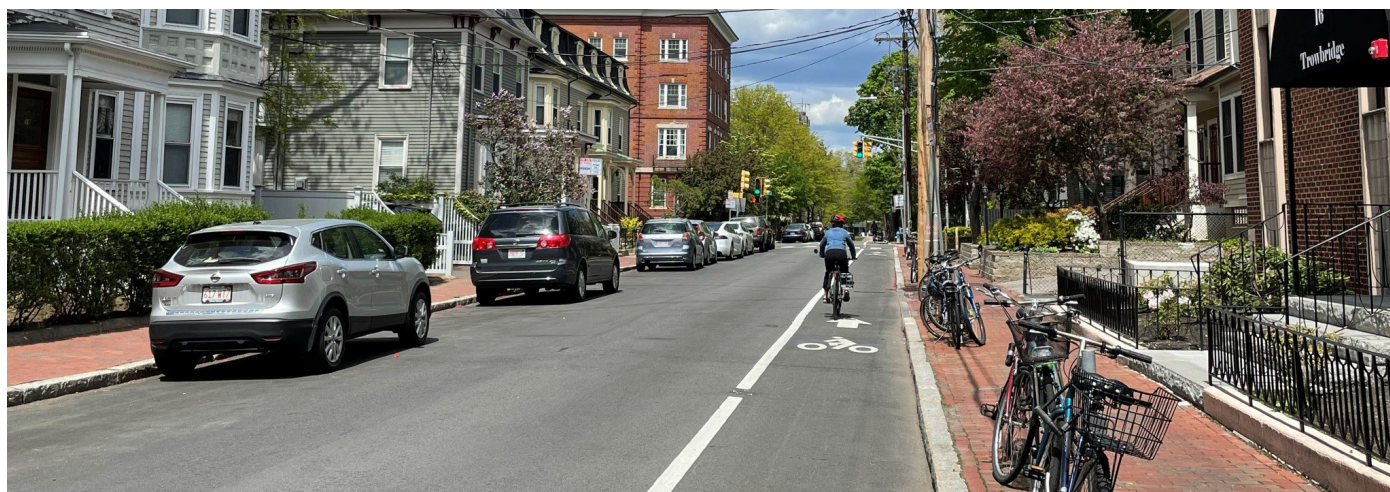
Bicycle lanes designate an exclusive lane for people biking through the use of pavement markings and signage. The bicycle lane is located adjacent to motor vehicle travel lanes and usually flows in the same direction as motor vehicle traffic (see Contra-flow Lanes for additional options). Bicycle lanes are typically on the right side of the street but placement on the left side may be considered in order to avoid conflicts or to enable connections under relevant circumstances. Benefits include providing clearly delineated space on the road for people biking and sending a message to other road users to expect people biking. When bike lanes are next to on-street parking without a buffer, there is the potential for “dooring” from drivers existing their vehicles without looking. A bicycle lane traveling along a curb may be a high comfort facility on some streets with low to moderate speeds and traffic volumes.

Design considerations:

- + Most appropriate for medium to low volume streets with vehicular speeds of 25 mph or less.
- + Typically 5-6 feet wide.
- + May require delineation at complex intersection or treatments to facilitate left turns.
- + Parking lanes should be marked to ensure vehicles park as close to the curb as possible.
- + Enforcement may be required to keep motorists from parking or stopping in the bicycle lane.

I especially appreciate the curbside designated bike lanes. They provide a sense of security on what would be otherwise very treacherous routes.

- Alyson, Riverside



BUFFERED BICYCLE LANES

Buffered bicycle lanes are conventional bicycle lanes with a designated buffer space separating the bicycle lane from the parking lane and/or the travel lane (a buffer against the parking lane is a higher priority). Benefits include reduced risk of “dooring” and greater space for people biking to maneuver.

For streets with no on-street parking, the buffer can be placed between the bike lane and the adjacent travel lane to provide additional separation from motorized traffic. A potential disadvantage of buffered bike lanes is that they are more liable to encroachment from people driving who illegally park their vehicles (personal, ride hail, delivery) in the bike lane, since the wider space makes drivers feel that they can park without impeding the flow of moving motor vehicle traffic.

Design Considerations:

- + Preferred treatment where separated bike lanes are not feasible on higher volume streets.
- + Provides further separation from parked vehicles and opening car doors, especially in areas with high parking turnover.
- + Typically a 5–6 foot wide bicycle lane and a minimum 3 foot wide buffer zone against parking.



LEFT-SIDE BICYCLE LANES

Left-side bicycle lanes are conventional bicycle lanes placed on the left side of one-way streets or two-way median divided streets. They are usually implemented where the majority of bicycle traffic is going straight or accessing streets or other connections on the left side. Benefits include avoidance of potential conflicts on the right side of the street, such as buses, opening car doors, and people accessing parked vehicles.

Design considerations:

- + Most appropriate for medium to low volume streets with vehicular speeds of less than 25 mph.
- + Typically 5-6 feet wide.
- + Avoids conflicts with parked vehicles and bus stops.
- + May require delineation at complex intersection or treatments to facilitate right turns.



ADVISORY BICYCLE LANES

An advisory bicycle lane is used on low-volume two-way streets that are too narrow to fit bicycle lanes and car travel lanes separately. An advisory bicycle lane is marked with a dashed line to the left, directing cars to travel outside the lane if possible. These markings give people biking a space to ride, but are also available to motorists if space is needed to pass oncoming traffic.

Design considerations:

- + Most appropriate for low volume and speed roadways without centerlines.
- + Central vehicle lane should be between 16 and 18 feet to allow most motorists to pass with minimal to no encroachment into the advisory lane, or between 10 and 13.5 feet to force yielding and encroachment.
- + The remaining width should be divided and delineated with a white dashed lane line on each side of the roadway, preferably 6-7 feet when adjacent to parking or 5-7 feet when adjacent to a curb.
- + May require education to instruct road users (people driving and bicycling) how to travel correctly on the corridor.



CONTRA-FLOW BICYCLE LANES

Contra-flow bicycle lanes are bicycle lanes designed to allow people bicycling to ride in the opposite direction of motor vehicle traffic. They convert a one-way street into a two-way street: one direction for motor vehicles and bicycles, and the other for bicycles only. Such facilities provide more direct connections for people bicycling and allow them to avoid streets that are less conducive for bicycling.

Separated bike lanes and buffered bike lanes can also be used to facilitate contra-flow bicycle movement.

Design considerations:

- + Preferred on the standard side of the roadway for the direction of travel.
- + Typical width matches concurrent-flow bike lanes.
- + May also be separated with flex posts or other separators.
- + May require additional pavement markings, signs, and traffic control devices at intersections.



CORRIDOR TREATMENTS

SHARED LANES

Shared lanes are facilities intended to be used by multiple types of users, such as people biking, driving, or taking transit. Shared lane markings (SLM) are road markings used to indicate a shared lane environment for people biking and driving. They reinforce the legitimacy of bicycle traffic on the street, recommend proper positioning for people biking, and may be configured to offer directional and wayfinding guidance.

Another type of shared lane is a shared bus/bike lane (SBBL). While generally meant for exclusive use by people traveling by bike and bus operations, the lanes are also often used by general motor vehicle traffic as a turn lane. Because of the nature of bus operations, as well as expectations regarding the purpose of a bus lane, there are heightened areas of concern regarding the safety and comfort in these types of lanes for people biking. In addition, given the nature of a shared lane with large vehicles, the SBBL is not a design that is considered to meet high-comfort criteria and therefore should generally not be thought of as part of an all ages, abilities, and identities network.

Design considerations (SLM):

- + Markings provided on roadways with speeds less than or equal to 25 mph, where there is no opportunity to install dedicated bicycle facilities.
- + Markings are typically positioned a minimum of 10 feet from the curb with on-street parking and 4 feet from curb without parking.
- + May be accompanied by “BIKES MAY USE FULL LANE” signs.

Design considerations (SBBL):

- + Recommended width of a full-time SBBL is 10-12 feet width.
- + Bicycle and bus traffic should not mix at high speeds.
- + SBBLs should only be used where buses will have operating speeds of 20 mph or less, and headways of 4 minutes or longer.
- + Separate bus and bicycle facilities are preferred over shared bus-bike lanes.
- + No vertical separation or significant pavement changes should be used between SBBLs and mixed-traffic lanes.
- + Corridors that are parallel and supplemental to higher-comfort bikeways are candidates for SBBLs.



SHARED STREETS

A shared street is one in which there is no vertical curbed delineation dividing the roadway and sidewalk (these streets are also known as “woonerfs” or “winkelerfs,” from the Dutch). The roadway and sidewalk surfaces are at the same level to create a continuous space. The space is shared between people driving, walking, and biking.

Design considerations:

- + Most appropriate for low volume and low speed roadways.
- + Ideally for roadways of 1,000 average daily motor vehicle traffic or less and speed limits of 10 mph.
- + May require coordination of loading activities for adjacent buildings.



SPEED MANAGEMENT - VERTICAL DEFLECTION

Vertical traffic calming treatments compel motorists to slow speeds and are commonly used on Bicycle Priority Streets. By lowering the speed differential between people biking and driving, safety and comfort are increased. Typical treatments in Cambridge include raised crosswalks or intersections.

Design considerations:

- + Raised crosswalks at intersections help to slow turning traffic at intersections.
- + Raised intersections and crosswalks are flush with the sidewalk.
- + Slopes should be designed per Cambridge standards.



SPEED MANAGEMENT - HORIZONTAL DEFLECTION

Horizontal traffic calming treatments may include one-lane pinch points or neighborhood traffic circles. Both can effectively slow and reduce motor vehicle traffic on Bicycle Priority Streets.

Pinch points consist of vertical objects on either side of the street to narrow the center of the lane such that oncoming drivers cannot pass through simultaneously and must yield. Neighborhood traffic circles are implemented at minor intersections to slow vehicles and potentially increase safety.

Curb extensions, bollards, flexposts, planters, and other materials can serve as the vertical elements that form the pinch point or the traffic circle.

Design considerations:

- + Pinch point widths need to be narrow enough so that drivers are not tempted to squeeze past each other but wide enough to enable emergency vehicles to pass through unimpeded. A space of 15 – 16 feet would typically achieve this goal.
- + Cut-through passageways should be provided to the outside of the pinch point to accommodate people biking; these should be carefully designed with maintenance requirements in mind. On very low volume streets, it may be acceptable to design a street without cut-throughs where people biking use the center travelway.
- + There should be approximately 15 feet of clearance around the traffic circle to provide emergency service access.



TRAFFIC VOLUME MANAGEMENT

Traffic volume management strategies are used to reduce traffic volumes on Bicycle Priority Streets and other intentionally low-traffic streets. They allow access by people driving, biking, and walking but facilitate continuous through-movement only for people biking and walking. Treatment types include:

- + **Median diverters** – This type restricts through vehicle movements on the Bicycle Priority Street and left turns from the cross street, but allows right turns to and from the cross street.
- + **Partial closures or forced turn diverters** – This type restricts through vehicle movements on the Bicycle Priority Street, as well as turns from the cross street.
- + **Diagonal diverters** – This type forces drivers to make right or left turns in certain directions, but allows bicycle and pedestrian traffic in all directions.
- + **One-way street segments that provide contra-flow bike lanes or permit two-way bicycle travel.** This can be the simplest implementation, requiring only signage.
- + **Diverters are designed to accommodate emergency vehicle access.**



Design Considerations

- + **Diverters shall provide bicycle access through a minimum 7-foot opening between vertical curbs in order to allow proper maintenance.**
- + **Closures and diverters should be clearly signed and marked to alert drivers to expect people biking emerging from or not turning at the feature.**
- + **Temporary materials may be used to test diversion impacts before permanent, curbed diverters are installed. However, 7 feet should be provided between vertical treatments to accommodate bike access and enable maintenance to be carried out.**
- + **Consultation with emergency services will be necessary.**
- + **Curb heights lower than 6 inches and/or beveled may be used on diverters and median barriers to allow emergency vehicles to mount and cross barriers.**



BICYCLE ROUTE WAYFINDING

A bicycle wayfinding system consists of signage and/or pavement markings to guide people biking to their destinations.

Design considerations:

- + Used to direct people biking to destinations along low-stress routes.
- + Indicates route direction, destination, and travel distance.
- + Relatively inexpensive to implement and maintain.



SIGNED CONTRA-FLOW STREETS

A signed bicycle contra-flow street is on a one-way street which is signed for two-way bicycle travel. Unstriped, signed bicycle contra-flow streets are roadways with low vehicular speeds and volumes that can assist people traveling by bike with making direct connections.

Design considerations:

- + Only compatible on low volume and low speed roadways.
- + May require additional considerations at intersections, including signs and markings.



LIGHTING

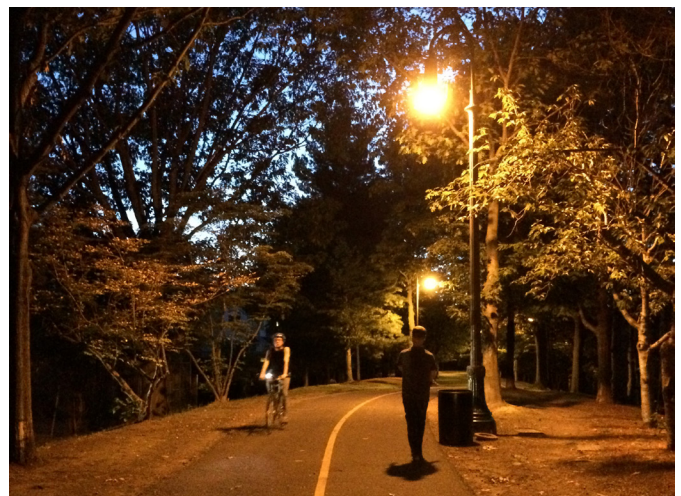
Adequate lighting is essential for safe nighttime travel for all road and path users. Good lighting on roads helps people driving, walking, and biking to see each other and potential hazards on the pavement. Nighttime lighting on shared use paths increases comfort and safety for people bicycling and walking, especially during the months when daylight hours are short and through areas that don't receive other light such as underpasses. Lighting is also a key element of ensuring more equitable access for all people. Visibility is particularly important for those with low vision and the ability to see pavement conditions is essential for wheelchair users. Some shared use paths are key parts of a transportation network for those who rely on walking or bicycling and do not have access to other means of transportation.

Installation of lighting along shared use paths should be continuous to avoid creating intermittently dark sections. To avoid creating a silhouetting effect, lighting should be placed to illuminate people crossing from the side instead of overhead.



Design considerations:

- + Conventional street lighting may adequately illuminate on-street bike facilities but should be evaluated. Adequate lighting at intersections is especially important. Attention should be given to light spacing and interference from trees and other obstructions to avoid the creation of dark spots.
- + Pedestrian-scale lighting also increases visibility of and for people bicycling. It is often used in commercial, mixed-use, and high-density residential neighborhoods. It is also used along shared-use paths and should be considered along sidewalk-level separated bike lanes.
- + The potential for light trespass should be considered in the selection of lighting components, especially in residential areas. Design elements such as shields help avoid light trespass. In addition, lighting levels can be adjusted during different times of the day. Research has shown that dawn and dusk are particularly risky for non-motorists in Cambridge and that lighting levels need to be kept higher throughout the city during those hours. Light levels may be modified in the late/overnight hours in residential districts.
- + LED lights, while more energy efficient, may provide less illumination on the ground than older sources if simply retrofitted, and therefore may need adjustment.



SPOT TREATMENTS

COLORED PAVEMENT MARKINGS

Colored pavement markings within a bicycle lane increase the visibility of the facility, identify potential areas of conflict, and reinforce priority to people biking in conflict areas.

Design considerations:

- + Preferred treatment at conflict locations such as driveways, intersections, turn lanes, etc.
- + Typically about the width of the bicycle lane.
- + May be solid or dashed and supplemented with bicycle symbols and white edge lines.
- + Material must be high friction surface to reduce skidding when pavement is wet.



BICYCLE BOXES

A bicycle box is an area at the head of a traffic lane at a signalized intersection. It provides people biking with a safe and visible way to get ahead of queuing traffic during the red signal phase. Bicycle boxes increase visibility of people biking, thereby mitigating conflicts with right-turning vehicles and reducing “right hook” crashes. They can also reduce signal delay for people biking. Bicycle boxes that extend across an entire intersection can also facilitate bicyclist left turn positioning during red lights, but the use of two-stage turn queue boxes are preferred for facilitating left turns, as they are more comfortable for users.

Design considerations:

- + Typically located between the stop line and the crosswalk.
- + Typically 10-16 feet in width.



TWO-STAGE TURN QUEUE BOXES

A two-stage turn queue box is a designated space for people biking to make a turn in two movements, located in front of the crosswalk on a perpendicular street at a signalized intersection. They are typically implemented to help people biking make left turns from right-side bicycle facilities, but could also be used to help people biking make right turns from left-side bike lanes.

To turn, people biking travel straight through the intersection during a green light, pull right and wait in the queue box. When the cross street receives a green light, the person biking proceeds straight through the intersection, completing the turn in two stages.

Design considerations:

- + Provides people biking a method to make turns from bicycle facilities.
- + Most important at high-volume signalized intersections where vehicular-style turns are difficult for people biking.
- + Typically located at signalized intersections in front of the crosswalks on a perpendicular street.
- + May require explanatory signage for users.



FLOATING BUS STOP

Floating bus stops can be used where bike lanes or separated bike lanes intersect transit stops. They provide accessible boarding and alighting spaces between travel lanes and bike lanes. This configuration reduces conflicts between people biking, transit vehicles, and people who are boarding, waiting to board, and alighting. In all cases, signs and markings should communicate that people walking have the right of way over people biking, and floating bus stops must comply with Americans with Disabilities Act (ADA) requirements.

Floating bus stops are preferred on streets with separated bike lanes adjacent to bus stops with high frequency bus service and/or high transit ridership. Operational constraints are considered, such as the distance bus drivers must traverse in order to reach the curb and downstream left turns in the bus route.



Design considerations:

- + A clear boarding and alighting area must be preserved. This may require slight realignment of the bike lane in advance of and beyond the stop.
- + At least one crosswalk across the bike lane connects the boarding and alighting area to the sidewalk. Two crosswalks are preferred to line up with both front and rear bus doors.
- + Shelters and other vertical objects that are 36 inches or higher are located a minimum of 6-12 inches from the bike lane edge.
- + Railings or planters (3 feet maximum height) may be located at the back of the platform for high ridership stops or along two-way separated bike lanes to channelize pedestrians to designated crossings. Ends of railings should be flared inward toward the bus stop and away from the bike lane for safety.
- + Where less than 8 feet of space is available, the bike lane may be tapered to create space for the bus stop. If the bike lane is narrowed to 4 feet (for a one-way bike lane), it is elevated to sidewalk level to minimize pedal strike risks on curbs. In the case of two-way facilities, the minimum width is 8 feet.
- + The bike lane may be elevated to sidewalk level to provide level pedestrian crossings. In these cases, bicycle transition ramps are located near crosswalks and outside of any lateral shifts of the bike lane.

BICYCLE SIGNALS

Bicycle signals are traffic signals intended for the exclusive use of bicycle traffic and facilitate people biking crossing at signalized intersections. They are typically used at complex intersections with unique bicycle traffic patterns that require additional control. Facilities they are applicable to include but are not limited to contra-flow bicycle lanes, separated bicycle lanes, protected bicycle lanes, and two-way separated bicycle lanes.

Design considerations:

- + Ability to provide an exclusive bicycle signal phase.
- + Ability to provide an advance start for cyclists at concurrent signals similar to a Leading Pedestrian Interval.



BICYCLE DETECTION

Bicycle detectors are installed at signalized intersections to allow traffic signals to detect the presence of people biking. Standard loop detectors may not detect people biking; therefore, bicycle detectors are recommended where needed.

Design considerations:

- + Required at locations where vehicle detection is installed and bicycle travel is permitted.
- + May be used to provide bicycle specific signal timings.
- + Typically, signage and pavement markings are used in addition to the bicycle detector.

