

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 and abilities to bicycle.

Planning and designing for bicyclists is similar to other transportation modes in which safety, travel demand, user delay, convenience, and economics are all taken into consideration. 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 low-stress bicycle network using techniques such as separating bicyclists from motor vehicle traffic and reducing speed and volume where appropriate to create a comfortable shared environment for all users.

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 and abilities.**
- + **Bicycle facilities with a high level of comfort should be provided on major streets, using tools as described in this chapter such as separated bicycle facilities and buffered bike lanes.**
- + **Off-road facilities will be expanded and connected to existing networks within the city and region. Off-road facilities are desirable on high-speed and high volume roadways, along rail corridors, and to provide access to parks and recreational areas.**
- + **Local street improvements will be made on a case-by-case basis using a variety of treatments described in this chapter, such as bicycle lanes and traffic calming.**

BICYCLE FACILITY PLANNING AND TRACKING

Cambridge aims to improve its bicycle facilities each year through an ongoing planning and design process. Existing and planned facilities, as of August 2015, include:

Bicycle Facility Type	Existing (Miles)	Planned (Miles)
Conventional Bicycle Lanes	19	2.5
Off-Road Paths	16	4
Shared Lane Markings	1	2.3
Contra-flow Bicycle Lanes	0.25	n/a
Shared Street	0.25	n/a
Separated Bicycle Lanes	2	1.7

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

IMPROVEMENT POLICIES

Bicycle facilities are considered at the inception of all Cambridge transportation projects and become

incorporated into the design of each project. 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 alike.

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 the **NACTO Urban Bikeway Design Guide**, **CROW Design Manual for Bicycle Traffic**, **AASHTO Guide for the Development of Bicycle Facilities**, **Manual on Uniform Traffic Control Devices**, **FHWA Shared Use Path Guidance**, 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).



SEPARATED BICYCLE FACILITIES

Separated bicycle facilities are vertically separated bicycle lanes that 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. Benefits include clear separation between bicycle, pedestrian and motor vehicle operating space. This facility type is also known as cycle tracks or protected bicycle lanes.

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 bicyclists, especially those identified as “interested but concerned.” See Chapter 2 for details.



Design considerations:

- + Preferred facility for roadways with high vehicular volumes, 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.
- + May require specialized intersection treatments.
- + Potential parking impacts to maintain sight lines.
- + Operational requirements for street sweeping and snow plowing.
- + Bus stop operations, where applicable.
- + For additional design guidance, refer to [Cambridge's Cycle Tracks: A Technical Review of Safety, Design, and Research](#), [NACTO Urban Bikeway Design Guide](#) and [FHWA Separated Bike Lane Planning and Design Guide](#).



TWO-WAY SEPARATED BICYCLE FACILITIES

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 bicyclists and improves perceived comfort and safety. A two-way facility usually requires less space than two one-way facilities, and can make maintenance easier.

Design considerations:

- + Preferred along roadways with high vehicular volumes, speeds, and/or complex traffic patterns.
- + May improve connectivity for bicyclists when used on one-way streets.
- + Typically **8-14 feet wide plus a 1-3 foot wide roadway buffer**.
- + May require specialized intersection treatments.

- + Potential parking impacts to maintain sight lines.
- + Operational requirements for street sweeping and snow plowing.
- + Bus stop operations, where applicable.
- + For additional design guidance, refer to [Cambridge's Cycle Tracks: A Technical Review of Safety, Design, and Research](#), [NACTO Urban Bikeway Design Guide](#) and [FHWA Separated Bike Lane Planning and Design Guide](#).



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.



Design considerations:

- + Often located along active or abandoned rail corridors, utility easements, or along streams, rivers, or other linear features.
- + Typically 10-14 feet wide.
- + May require specialized intersection treatments.
- + Must be ADA-compliant.
- + Provides low-stress, higher comfort bicycle and pedestrian connections.
- + For additional design guidance, refer to **AASHTO Guide for the Development of Bicycle Facilities**.



BICYCLE LANES

Bicycle lanes designate an exclusive lane for bicyclists through the use of pavement markings and signage. The bicycle lane is located adjacent to motor vehicle travel lanes and flows in the same direction as motor vehicle traffic. Bicycle lanes are typically on the right side of the street. Benefits include providing clearly delineated space on the road for bicyclists and sending a message to other road users to expect bicyclists.



Design considerations:

- + Most appropriate for medium to low volume streets with vehicular speeds of 30 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.
- + For additional design guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**, **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.

BUFFERED BICYCLE LANES

Buffered bicycle lanes are conventional bicycle lanes with a designated buffer space separating the bicycle lane from the parking lane. Benefits include reduced risk of “dooring” and greater space for bicyclists 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 double-parked motor vehicles or delivery vehicles.

Design considerations:

- + Preferred treatment where separated bike lanes are not feasible.
- + Provides further separation from parked vehicles and opening car doors, especially in areas with high parking turnover.
- + Typically 5 feet wide bicycle lane and a minimum of 2 feet wide buffer zone.
- + For additional design guidance, refer to **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.



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 30 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.
- + For additional design guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**, **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.



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 dotted line to the left, directing cars to travel outside the lane if possible. These markings give bicyclists 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.
- + Typically 5-7 feet wide and delineated with a white dotted lane line.
- + May require education to instruct bicyclists and motorists how to use correctly.



CONTRA-FLOW BICYCLE LANES

Contra-flow bicycle lanes are bicycle lanes designed to allow bicyclists 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 bicyclists and allow them to avoid streets that are less conducive for bicycling.

Design considerations:

- + Preferred on the standard side of the roadway for the direction of travel.
- + Typically 5-6 feet wide.
- + May require additional pavement markings, signs, and traffic control devices at intersections.
- + For additional design guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**, **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.



SIGNED CONTRA-FLOW STREETS

A signed bicycle contra-flow is on a one-way residential 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 bicyclists with making direct connections.

Design considerations:

- + Preferred on low volume and low speed roadways.
- + May require additional considerations at intersections, including signs and markings.
- + For additional design guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**.



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. This facility type is also known as a bicycle boulevard.



Design considerations:

- + Preferred on low volume and speed roadways that discourage speeding and cut-through vehicular traffic.
- + May require traffic calming devices such as speed tables, traffic circles, diverters, or chicanes.
- + May require wayfinding signage to direct bicyclists.
- + Opportunity for plantings, rain gardens, and green infrastructure.
- + For additional design guidance, refer to [NACTO Urban Bikeway Design Guide](#) and [AASHTO Guide for the Development of Bicycle Facilities](#).



SHARED STREETS

A shared street is one in which there is no vertical curbed delineation dividing the roadway and sidewalk. The roadway and sidewalk surfaces are at the same level to create a continuous space. The space is shared between motorists, pedestrians, and bicyclists.

Design considerations:

- + Most appropriate for low volume and low speed roadways.
- + Ideally for roadways of **3,000 average daily traffic** or less and speeds at or under **20 mph**.
- + May require coordination of loading activities for adjacent buildings.
- + For additional design guidance, refer to **NACTO Urban Street Design Guide**.



SHARED LANE MARKINGS

Shared lane markings (SLM) are road markings used to indicate a shared lane environment for bicyclists and motorists. They reinforce the legitimacy of bicycle traffic on the street, recommend proper bicyclist positioning, and may be configured to offer directional and wayfinding guidance.

Design considerations:

- + Markings provided on roadways with speeds **less than 30 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.
- + For additional design guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**, **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.



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 bicyclists 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.
- + For additional design guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**, **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.



BICYCLE BOXES

A bicycle box is an area at the head of a traffic lane at a signalized intersection. It provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase. Bicycle boxes increase visibility of bicyclists and reduce signal delay for bicyclists. Bicycle boxes that extend across an entire intersection can also facilitate bicyclist left turn positioning during red lights.

Design considerations:

- + Typically located between the stop line and the crosswalk.
- + Typically 10-16 feet in width.
- + For additional design guidance, refer to [NACTO Urban Bikeway Design Guide](#) and [AASHTO Guide for the Development of Bicycle Facilities](#).



BICYCLE ROUTE WAYFINDING

A bicycle wayfinding system consists of signing and/or pavement markings to guide bicyclists to their destinations.

Design considerations:

- + Used to direct bicyclists to destinations along low-stress routes
- + Indicates route direction, destination, and travel distance.
- + Relatively inexpensive to implement and maintain.
- + For additional guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**, **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.



TWO-STAGE TURN QUEUE BOXES

A two-stage turn queue box is a designated space for bicyclists 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 bicyclists make left turns from right-side bike lanes, but could also be used to help bicyclists make right turns from left-side bike lanes.

To turn, bicyclists 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 bicyclist proceeds straight through the intersection, completing the turn in two stages.

Design considerations:

- + Provides bicyclists a method to make turns from bicycle facilities.
- + Most important at high-volume signalized intersections where vehicular-style turns are difficult for bicyclists.
- + Typically located at signalized intersections in front of the crosswalks on a perpendicular street.
- + May require explanatory signage for users.
- + For additional design guidance, refer to **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.



BICYCLE SIGNALS

Bicycle signals are traffic signals intended for the exclusive use of bicycle traffic and facilitate bicyclists 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.
- + May require education for motorists.
- + For additional design guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**, **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.



BICYCLE DETECTION

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

Design considerations:

- + Required at locations where vehicle detection is installed and bicyclist 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.
- + For additional design guidance, refer to **FHWA Manual on Uniform Traffic Control Devices**, **NACTO Urban Bikeway Design Guide** and **AASHTO Guide for the Development of Bicycle Facilities**.

