



9. BIKEWAY DESIGN

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(Credit: Kimley-Horn and Associates, Inc.)



INTRODUCTION

Since the bicycle is a non-motorized vehicle, it is the cleanest and greenest form of vehicular transportation. The bicycle is human-powered. This simple fact should be integrated in concept throughout the essential principles, planning, design, and construction of bikeways.

Bicycle transportation is active transportation. Therefore, traveling by bicycle is not only environmentally-friendly, it promotes healthy living. Bicycle transportation helps individuals address many modern public health concerns including obesity, stress, and anxiety disorders.

Today, bicycling use is on the rise in the United States and crash rates have decreased over time through proven education, encouragement, and engineering techniques. However, bicyclists are still vulnerable road users who experience fatality rates significantly higher than the general mix of road users. According to research conducted by the Portland Bureau of Transportation, most bicyclists that use on-road bicycle facilities are classified as “strong and fearless” and are generally comfortable operating a bicycle intermixed with high traffic volumes and fast speeds. Most bicyclists prefer local streets with slow vehicular speeds, which tends to limit the number of destinations that they can comfortably reach given the current disconnected street network prevalent in most developed areas. Therefore, great progress is still ahead of us through creating truly bicycle-friendly infrastructure for all user types that enhances comfort, directness, accessibility, and safe traffic surroundings.

BICYCLING FOR ALL AGES AND REASONS

Bicycling occurs at all ages, in all places, among all income groups, and for all kinds of reasons. Apart from its use for daily, functional journeys, the bicycle also plays a major role in recreational activities. Recreational bicycling is not just for fun; recreational bicycling should be given a high priority for public health reasons.



*Bicyclist on A1A, Fort Lauderdale
(Credit: Luisa Fernanda Arbeláez)*



*Young bicyclists leaving school
(Credit: Kimley-Horn and Associates, Inc.)*



Bicycle facilities and attractive surroundings are essential for people on bicycling trips. If these bicycle facilities are close to home, they improve the livability and hence the quality of the living environment.

ESSENTIAL PRINCIPLES OF BIKEWAY DESIGN

The following principles inform the bikeway facility guidelines for Broward County and its local jurisdictions established in this chapter.

- Bicyclists should have safe, convenient, and comfortable access to all destinations.
- Every street is a bicycle street, regardless of whether a designated bicycle facility or bicycle route is present.
- Street design should accommodate all types, levels, and ages of bicyclists.
- Bicyclists should be separated from pedestrians, except under special circumstances such as shared-use pathways or shared-space streets.
- Bikeway facilities should take into account vehicle speeds and volumes, with
 - Shared use on low volume, low-speed roads.
 - Separation on higher volume, higher-speeds roads.
- Bikeway treatments should provide clear guidance to enhance safety for all users.
- Since most bicycle trips are short, a complete network of designated bikeways has a grid spacing of roughly ½ mile.



*Florida law requires 3 feet of passing separation
(Credit: Kimley-Horn and Associates, Inc.)*

PLANNING FOR A RANGE OF BIKEWAY USERS



*Plan bicycle facilities for various skill levels
(Credit: Dan Burden)*

Many early bikeway designs assumed that bicyclists resemble pedestrians in their behavior. This led to undesirable situations, including bicyclists being underserved by inadequate facilities, pedestrians resenting bicyclists in their space, and motorists being confused by bicyclists entering and leaving the traffic stream in unpredictable ways. Only under special circumstances (e.g., on shared-use paths less than 14 feet in width or shared-space streets) should bicyclists and pedestrians share the same space.



CHARACTERISTICS OF BICYCLISTS AND THE BICYCLE VEHICLE

As stated in Florida Statute 316.2065, bicyclists operate a vehicle and are legitimate road users. However, they are slower and less visible than motor vehicles.

Bicyclists should be the primary design parameter in bikeway facilities. Bicycling requires both the physical and mental capacities of the bicyclist. The physical capacity is required to initiate the vehicle's movement and to keep it moving. Mental capacity, both consciously and subconsciously, is required to ride the bicycle safely. Conscious mental capacity is required to operate the vehicle within traffic within traffic flow. Subconscious mental capacity is required to steer the bicycle, keep balance, and ride within a straight line.

"Inadequate cycling lanes and sidewalks. I can often get part-way, but certain key stretches remain dangerous and eliminate the whole route."

- Broward County Complete Streets (survey respondent)

In addition, the perceived dangers of bicycling tend to limit its ability to attract new riders as a transportation mode in many urban areas. The perceived dangers of bicycling on busy streets within the general public is one reason why enhanced bicycle facilities and going beyond the minimums will likely be necessary to attract a significant mode shift to bicycling.

BICYCLIST SKILL LEVEL

Bicyclist skill level also provides a wide variety of speeds and expected behaviors. Several systems of bicyclist classification are used within the bicycle planning and engineering professions. These classifications can be helpful in understanding the characteristics and infrastructure preferences of different cyclists. However, these classifications may change in type or proportion over time as infrastructure and culture evolve. Bicycle infrastructure should use planning and designing options, from shared roadways to separate facilities, to accommodate as many user types as possible and to provide a comfortable experience for the greatest number of cyclists.

A classification system developed by the City of Portland, Oregon, provides the following bicycle user types:

- Strong and Fearless. Bicyclists who will ride anywhere regardless of roadway conditions. These bicyclists can ride faster than other user types, prefer direct routes,



*Proficient bicycle riders
(Credit: Kimley-Horn and Associates, Inc.)*



and will typically choose roadways, even if shared with vehicles, over separate bicycle facilities such as shared-use paths. This bicyclist type comprises a very low percentage of the population.

- **Enthusied and Confident.** This group encompasses intermediate bicyclists who are mostly comfortable riding on all types of bicycle facilities but will usually prefer low traffic streets, bike lanes, or separate paths when available. They may deviate from a more direct route in favor of a preferred facility type. This group includes commuters, utilitarian cyclists, and recreational riders, and probably represents less than 10 percent of the population.
- **Interested but Concerned.** This user type makes up the bulk (likely between half and two-thirds) of the cycling or potential cycling population. They are cyclists who typically ride only on low traffic streets or paths under favorable conditions and weather. They perceive traffic and safety as significant barriers towards increased use of cycling. These cyclists may become “Enthusied and Confident” with encouragement, education, and experience.
- **No Way, No How.** People in this category are not cyclists; they perceive severe safety issues with riding in traffic and will never ride a bicycle in traffic under any circumstances. But some may eventually give cycling a second look and may progress to the user types above if better facilities are provided. This group likely comprises something between a quarter and a third of the population.



*Less-experienced bicycle riders prefer paths
(Credit: Kimley-Horn and Associates, Inc.)*

Of particular interest to the discussion of bicyclist skill level are children. Children riding on their own or with their parents may not travel as fast as their adult counterparts but still require access to key destinations in their community, such as schools, convenience stores, and recreational facilities. Residential streets with low motor vehicle speeds linked with shared-use paths and busier streets with well-defined pavement markings between bicycles and motor vehicles can accommodate children without encouraging them to ride in the travel lanes of major arterials.

BIKEWAY TYPES AND DESIGNS

A designated bikeway network provides a system of facilities that offers enhancement, guidance, and/or priority to bicyclists over other roadways in the network. However, it is



important to remember that all streets in an urbanized area should safely and comfortably accommodate bicyclists, regardless of whether the street is designated as a bikeway. Several general types of bikeways are listed in this section with no implied order of preference.

In Florida, local jurisdictions should follow minimum width and geometric criteria in the Florida Manual of Uniform Minimum Standards (Florida Greenbook), or follow proper procedures for exemptions and experiments. It should be noted that the Florida Greenbook contains *minimums*. Local jurisdictions should not interpret this to mean *exact dimension*. In many circumstances, exceeding these minimums provides for a more desirable bicycling environment.

It should be noted that many of the bikeway facility types and geometric criteria established in this manual that go beyond minimum standards found in the Florida Greenbook have been implemented and evaluated in other metropolitan areas, and found to be successful from a safety, mobility, and encouragement perspective. These bikeway facility types are found in several planning and engineering guidebooks such as the National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide* and the Institute of Transportation Engineers (ITE) *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*. In particular the NACTO *Urban Bikeway Design Guide* is intended to help practitioners make good decisions about urban bikeway design. The treatments outlined in the guide are based on real-world experience in some of the most bicycle friendly cities and have been selected for inclusion in the Guide because of their utility in helping local jurisdictions meet their goals related to bicycle transportation.

Many signs and pavement markings are available for use by planners and designers for bikeways as designated in the Federal Highway Administration (FHWA) *Manual on Uniform Traffic Control Devices* (MUTCD). Signs are referenced in this section by the acronym MUTCD and their MUTCD sign designation number for easy reference. Designers will find detailed design information including sign size and sign placement in the latest version of the MUTCD available online.

The Florida Department of Transportation (FDOT) provides designers with criteria for bicycle symbol markings and striping in *FDOT Standard Index 17347*. The *FDOT Plans Preparation Manual* (PPM) Chapter 8 provides guidance for bicycle facility design on the State Highway System (SHS).



*Bicycle lane pavement marking symbol
(Credit: Kimley-Horn and Associates, Inc.)*



BIKE LANES



*Bicyclist using a bike lane with an R3-17 sign
(Credit: Kimley-Horn and Associates, Inc.)*

A bike lane is that portion of the roadway that has been designated by striping and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes should also be signed with the MUTCD R3-17 sign. (Note: The MUTCD now considers the R3-17 sign optional. This should not be interpreted as “not required.” Instead, designers have flexibility for the use and spacing of the R3-17 sign. In general, most urban bike lanes should include R3-17 signs. Factors that should be present for not providing the R3-17 signs are in situations of extreme sign clutter, in downtown districts where the sign would block pedestrian clear width, and in situations where dense, natural landscaping would block the

visibility and effectiveness of the sign and would detract from the natural beauty of the landscape).

Advantages of Bike Lanes

- Bike lanes enable bicyclists to position themselves where they will be visible to motorists.
- Bike lanes facilitate predictable behavior and movements between bicyclists and motorists.
- Bike lanes encourage bicyclists to ride on the traveled way rather than the sidewalk.
- Bike lanes encourage bicyclists to ride in the direction of traffic.
- Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing road traffic conditions.
- Bike lanes enable bicyclists to ride at a constant speed (which minimizes energy loss), especially when traffic in the adjacent travel lanes speeds up or slows down (stop-and-go).

Motorists are prohibited from using bike lanes for driving and parking, but may use them for emergency avoidance maneuvers or breakdowns. Bike lanes are one-way facilities that carry bicycle traffic in the same direction as adjacent motor-vehicle traffic (one exception are contra-flow bike lanes, which are discussed later in this chapter).

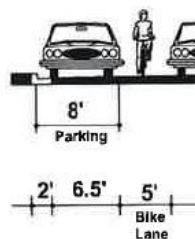
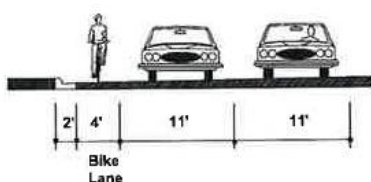


Bike lanes may also have enhanced treatments, which are also addressed in subsequent sub-sections of this chapter. In general, the information presented in the Bike Lanes sub-section of this chapter refers to conventional bike lanes most commonly found in engineering manuals and design criteria.

Bike lanes are appropriate on arterial boulevards, avenues, and collectors. Bike lanes may also be provided on rural roads where there is high bicycle use. Bike lanes are generally not recommended on local streets with relatively low traffic volumes and speeds, where a shared roadway is the appropriate facility. Although there is no exact criteria, NACTO guidance states that bike lanes are most helpful on streets with greater than 3,000 motor vehicle average daily traffic and streets with a posted speed limit of 25 MPH or higher. Bike lanes may be used on other streets where bicycle travel and demand is substantial, such as within parks. Where on-street parking is provided, bike lanes are generally striped on the left side of the parking lane.

The following geometric design criteria are established for bike lanes.

- Preferred bike lane width (rideable surface) – 6 feet; absolute minimum width – 4 feet (the preferred dimensions should be used unless other street elements have been reduced to their minimum dimensions)
- Absolute minimum bike lane width adjacent to on-street parking – 5 feet (unless there is a marked buffer between the bike lane and on-street parking; where on-street parking is permitted, delineating the bike lane with two stripes, one on the street side and one on the parking side, is preferable to a single stripe)
- The desirable bike lane width adjacent to a guardrail or other physical barrier is 2 feet wider than otherwise in order to provide a minimum shy distance from the barrier
- Gutter seams, drainage inlets, and utility covers should be flush with the pavement and oriented to prevent conflicts with bicycle tires.
- Streets with high volumes of traffic and/or higher speeds need wider bike lanes (6 feet to 8 feet) than those with less traffic or slow speeds.
- Bike lanes on one-way streets should generally be on the right side of the traveled way and should always be provided on both legs of a one-way couplet. The bike lane may be placed on the left of a one-way street if it decreases the number of conflicts (e.g., those caused by heavy bus traffic or parking) and if bicyclists can safely and conveniently transition in and out of the bike lane. If sufficient width exists, the bike lanes can be striped on both sides of a one-way street.



Bike lane width minimums

(Source: Broward County Final Report on Alternative Roadway Design Guidelines)



BUFFERED BIKE LANES

Buffered bike lanes are conventional bike lanes paired with a designated buffer space separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. A buffered bike lane is optional for all bike lane facilities per MUTCD guidance for buffered preferential lanes found in 2009 MUTCD Section 3D-01.

According to *Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track & SW Stark/Oak Street Buffered Bike Lanes* (Portland State University, Center for Transportation Studies, 2011), nine in ten bicyclists preferred a buffered bike lane to a conventional bike lane, seven in ten bicyclists indicated they would go out of their way to ride on a buffered bike lane over a conventional bike lane, and bicyclists indicate they feel lower risk of being “doored” in the buffered bike lanes when adjacent to on-street parking.

Buffered bike lanes provide the following advantages when compared to conventional bike lanes.

- Provides greater shy distance between bicyclists and motor vehicles.
- Provides space for faster moving bicyclists to pass slower moving bicyclists without having to encroach into the motor vehicle travel lane.
- Provides a greater space for bicycling without making the bike lane appear so wide that it might be mistaken for a travel lane or a parking lane.
- Appeals to a wider range of bicyclists and encourages bicycling.



Buffered bike lane

(Source: NACTO Urban Bikeway Design Guide)

Buffered bike lanes can be considered anywhere a standard bike lane is being considered. Although there is no standard criterion for when buffered bike lanes are required, in general buffered bike lanes should be provided on streets with high travel speeds, high volumes, high percentage of trucks or buses, and streets with extra space within the traveled way.

The buffer should be marked with a wide solid single white line along both edges of the buffer space. The buffer should be at least 2 feet in width, with diagonal hatching used if the buffer is 3 feet in width or greater. Consider dashing the inside buffer boundary where cars are expected to cross, such as adjacent to on-street parking. The combined width of the buffer and bike lane should be considered the “bike lane width”. Where buffers are used, bike lanes can be narrower because the shy distance function is assumed by the buffer. For example, a 4-foot bike lane and a 3-foot buffer could be provided adjacent to on-street parking since the “bike lane width” would be considered 7 feet. For a parking side buffer, parking T’s are acceptable to mark between a parking lane and the buffer.



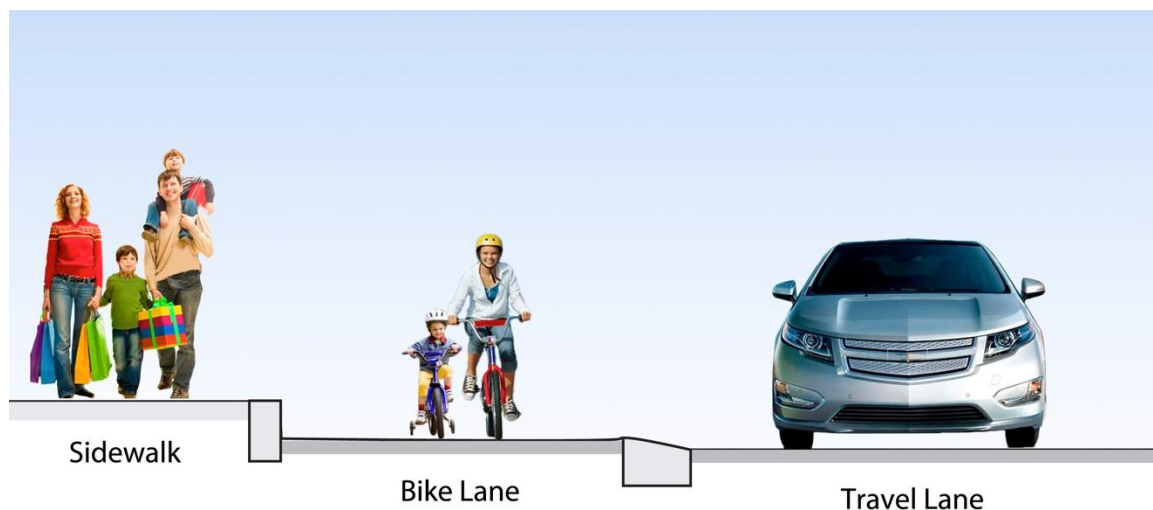
RAISED BIKE LANES

Bike lanes are typically an integral portion of the traveled way and are delineated from motor vehicle lanes with painted stripes. Although some bicyclists ride on these facilities comfortably, others prefer more separation. Raised bike lanes incorporate the convenience of riding on the street with some physical separation. This is accomplished by elevating the bicycle lane surface 2 to 4 inches above street level, while providing a traversable curb to separate the bikeway from the adjacent motor vehicle travel lane.

Advantages of Raised Bike Lanes

- Motorists know they are straying from the travel way when they feel the slight bump created by the traversable curb.
- The traversable curb allows motorists to make turns into and out of driveways.
- The traversable curb allows cyclists to enter or leave the bike lane (e.g., for turning left or overtaking another cyclist).
- The raised bike lane drains towards the centerline, leaving it clear of debris and puddles.
- Novice bicyclists are more likely to ride in the bike lane, leaving the sidewalk for pedestrians.

Raised bike lanes can be constructed at little additional expense for new roads. Retrofitting streets with raised bike lanes is more costly; it is best to integrate raised bike lanes into a larger project to remodel the street due to drainage reconstruction. Special maintenance procedures may be needed to keep raised bike lanes swept. There is no restriction on the use of raised bike lanes in FHWA guidance as long as an appropriately designed traversable curb is used and all other MUTCD guidance is followed.



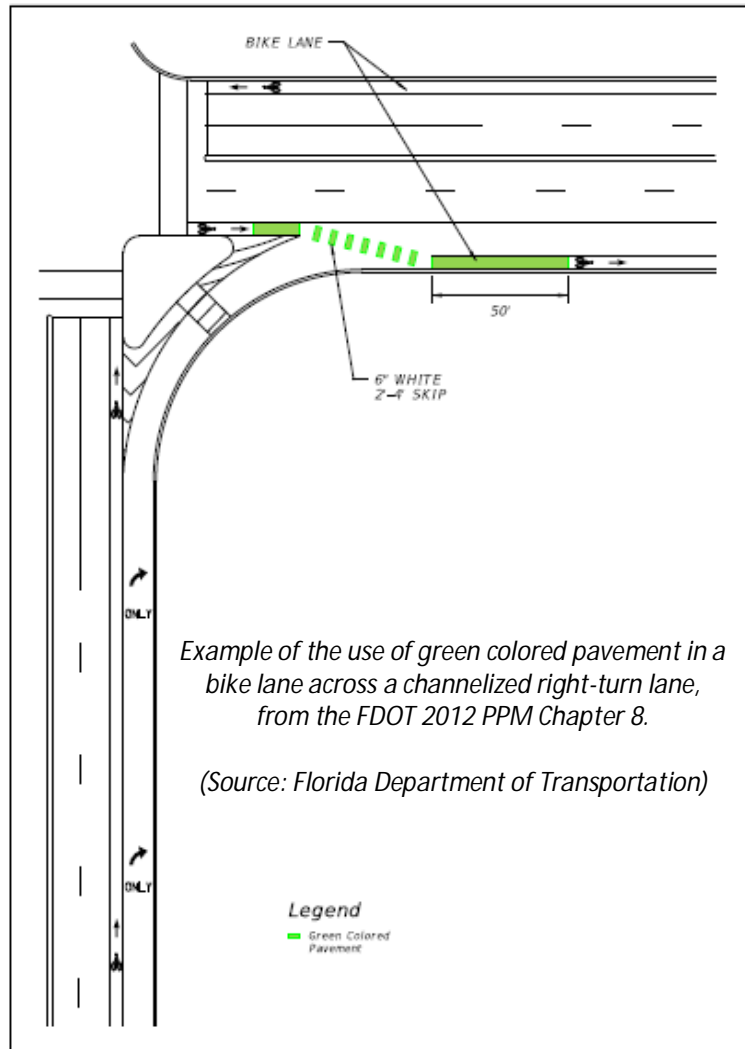
Raised bike lanes (Credit: Michele Weisbart)



GREEN BIKE LANES

The Federal Highway Administration (FHWA) has issued an Interim Approval (IA-14) for the optional use of green colored pavement in designated bike lanes and in extensions of designated bike lanes through intersections and other traffic conflict areas. Green colored pavement may be installed within bicycle lanes as a supplement to the other pavement markings that are required for the designation of a bicycle lane.

FDOT has requested and received approval from FHWA for the use of green colored pavement in locations consistent with the FHWA's Interim Approval memorandum for state roadways. According to FDOT, the effectiveness of green colored pavement for bike lanes is maximized if the treatment is used only where the path of bicyclists crosses the path of other road users and where road users should yield to bicyclists. A traffic conflict area may include locations where the bike lane crosses an exclusive right-turn lane, a channelized free-flow right-turn lane, an add lane situation, a drop lane situation, a path that crosses a high number of driveways, or adjacent to a dedicated bus bay. FDOT provides more information about the optional use of green colored pavement for bike lanes in the 2012 Plans Preparation Manual (PPM), Chapter 8.4.2.2.



It should be noted that use of colored pavement within a bicycle lane increases the visibility of the facility and reinforces priority to bicyclists in conflict areas.

While a variety of colored treatments have been used, the FHWA approval is for green as the preferred color for bicycle facilities of this type in areas where conflicts or shared use is intended. Maintenance of color and surface condition are considerations. Traditional traffic paints and coatings can become slippery. Long life colored asphalt surfaces with good wet skid resistance should be considered.



CONTRA-FLOW BIKE LANES

Contra-flow bike lanes are bike lanes designed to allow bicyclists to ride in the opposite direction of motor vehicle traffic. Contra-flow bike lanes convert a one-way traffic street into a two-way street for bicycles only (one direction for motor vehicles and bikes, and the other direction for motor vehicles).

Contra-flow bike lanes must be separated from the opposing direction of travel with double yellow center lane striping. Contra-flow bike lanes can be implemented at the present time without the need for experimentation if signs and pavement markings that are MUTCD-compliant are used.

Care must be exercised within the design process because the contra-flow design introduces new design challenges and may introduce new conflict points at intersections and driveways as motorists may not expect on-coming bicyclists. Intersection traffic controls including signal design modifications will be required to control the contra-flow bike lane.

Contra-flow bike lanes provide the following benefits.

- Provides a connectivity, accessibility, and travel time advantage for bicyclists on one-way streets.
- Reduces dangerous one-way bicycling by formalizing the contra-flow bicycle travel.
- Decreases sidewalk riding along one-way streets.



Contra-flow bike lane
(Source: NACTO Urban Bikeway Design Guide)

Typical Applications for Contra-Flow Bike Lanes

- Streets where bicyclists are already riding the wrong way.
- Streets where alternate routes require excessive out-of-direction travel.
- Streets where alternate routes include incomplete streets or uncomfortable streets for bicycling.
- Streets that could provide two-way connections between bicycle facilities.
- Streets that are low-speed and low-volume.
- Where space is provided, designated bike lanes should be provided on both sides. When there is no room for a with-flow bike lane, shared-lane markings (sharrows) should be used to guide with-flow bicyclists.
- If sufficient space exists, a buffered contra-flow bike lane design should be utilized.



SHARED BUS AND BIKE LANES

In most instances, bicycles and buses can share the available road space. On routes heavily traveled by both bicyclists and buses, separation can reduce conflicts (stopped buses hinder bicycle movement and slower moving bicycles hinder buses). Ideally, shared bus and bike lanes should be 13 feet to 15 feet wide to allow passing by both buses and bicyclists.

Separate bus lanes and bike lanes should be considered to reduce conflicts between passengers and bicyclists, with the bus lane at the curbside. Buses will be passing bicyclists on the right, but the fewer merging and turning movements reduce overall conflicts.

Shared bus and bike lanes should be considered on roadways where bus rapid transit (BRT) improvements are desired, such as dedicated bus lanes, but not enough space exists to provide a bus lane and a bike lane.



*Simulation of a shared bus and bike lane adjacent to on-street parking
(Source: San Diego Association of Governments)*



CYCLE TRACKS

Cycle tracks, also known as protected bike lanes, are specially designed bikeways separated from the parallel motor vehicle travel lanes by a protective barrier. The barrier may be a physical barrier, such as a concrete curb, a line of parked cars, or landscaping, or a physical buffer that motor vehicles cannot cross, which may include traffic separators or plastic delineators. Cycle tracks are effective in attracting users who are concerned about conflicts with motorized traffic. Cycle tracks can be well suited to downtown areas where they minimize traffic conflicts with pedestrians.



One-way cycle track (Credit: Dan Burden)

Streets selected for cycle tracks should have minimal pedestrian crossings and driveways. They should also have minimal loading/unloading activity and other street activity.

There is no MUTCD restriction on the use of cycle tracks if signs and pavement markings that are compliant with the MUTCD are used. Cycle tracks should be designed to minimize conflicts with street activities as well as with pedestrians and driveways. Cycle tracks can be provided on new facilities, but they require more width than other types of bikeways. They are best suited for existing streets where surplus width is available; the combined width of the cycle track and the barrier is more or less the width of a travel lane. The area to be used by bicycles should be designed with adequate width for street sweeping to ensure that debris will not accumulate. Cycle tracks tend to work most effectively where there are few uncontrolled crossing points with unexpected traffic conflicts.

Cycle track concerns include visibility, treatment at intersections, uncontrolled midblock driveways and crossings, wrong-way bicycle traffic, and difficulty accessing or exiting the facility at midblock locations. There is some controversy regarding the comparative safety of cycle tracks. Recent studies have concluded that cycle tracks are as safe as other treatments when high usage is expected and when measures such as separate signal phases for right-turning motor vehicle and through cyclists, and left-turning cyclists and through motor vehicles, are deployed to regulate crossing traffic. Cycle tracks may be one-way or two-way.

- One-way cycle tracks
- Two-way cycle tracks



In addition, cycle tracks may be at varying levels of vertical separation.

- At the street level
- At the sidewalk level (raised cycle track)
- At an intermediate level (raised cycle track)

Note that a one-way cycle track at an intermediate level separated from motor vehicles by a traversable curb is the same as a raised bike lane presented earlier in this section.

One-Way Cycle Tracks

- One-way protected cycle tracks are typically at street level and use a variety of methods for physical protection from motor vehicle traffic including curbs, medians, plastic traffic separators, and on-street parking.
- One-way protected cycle tracks, like conventional bike lanes, are essentially a type of preferential use lane as defined by the MUTCD in Section 2G.01.
- Like bike lanes, the desired width of a one-way protected cycle track at street level should be at least 6 feet. In areas of high bicycle volumes, the desired width should be greater. The design of the protective barrier or buffer should dictate the absolute minimum width. For example, if a flush striped buffer of 2 feet is provided between the cycle track and an adjacent on-street parking lane, then the minimum cycle track width could be as narrow as 4 feet, since the cycle track plus the buffer would create 6 feet of “bike lane width” space.



*One-way cycle track with on-street parking as the buffer from the motor vehicle travel lanes.
Note the use of “parking T’s” to designate the on-street parking spaces.
(Source: NACTO Urban Bikeway Design Guide)*



Two-Way Cycle Tracks

- Two-way cycle tracks are physically separated cycle tracks that allow bicycle movement in both directions on one side of the road.
- While sharing some of the same design characteristics as one-way cycle tracks, additional considerations at driveway and intersections are required.
- Two-way cycle tracks may be configured as a protected cycle track at street level with a barrier or on-street parking to provide separation. They may also be configured as a raised cycle track at sidewalk level or at an intermediate level to provide vertical separation from motor vehicle traffic.
- If at the sidewalk level, a curb or median separates the cycle track from motor vehicle traffic, while different pavement color or texture separates the cycle track from the sidewalk.
- One of the typical applications for a two-way cycle track is when there is not enough room for a one-way cycle track on both sides of the street.
- Another typical application is where considerably more (or all) destinations and/or bicycle demand is located on one side of the street.



*Two-way cycle track
(Credit: Kimley-Horn and Associates, Inc.)*

Raised Cycle Tracks

- Raised cycle tracks are one-way or two-way bicycle facilities that are vertically separated from motor vehicle traffic.
- Raised cycle tracks may be separated from motor vehicle traffic by a curb, or they may be separated by a furnishing zone or landscaping zone.
- At intersections, the raised cycle track can be dropped and merged onto the street, or it can be maintained at sidewalk level where bicyclists cross with pedestrians, possibly with a dedicated bicycle signal.
- When a one-way raised cycle track at an intermediate level separated from motor vehicles by a traversable curb is provided, this is the same as a raised bike lane presented earlier in this section.



SHARED USE PATHS

Shared use paths are facilities separated from motor vehicle traffic by an open space or barrier. Shared use paths can be either within a roadway right-of-way or within an independent right-of-way. Examples of independent rights-of-way that can include shared use paths include waterways, utility corridors, and rail lines. Bicyclists, pedestrians, joggers, and skaters often use shared use paths, such as canals. They are often elements of a community trail plan. Shared use paths may also be integrated into the street network with new subdivisions as described in Chapter 4, "Street Networks and Classifications."

Shared use paths provide the following advantages.

- Shared use paths are attractive to bicyclists who are uncomfortable riding or are unable to ride in mixed traffic.
- Shared use paths are often part of designated bike route systems.
- Shared use paths in independent rights-of-way can provide travel time savings for bicyclists by making connections that would otherwise be significantly longer through the roadway network.



*Example of a shared-use path: Pompano Airpark Path
 (Credit: Kimley-Horn and Associates, Inc.)*

The following geometric design criteria are established for shared use paths.

- Preferred shared use path width – 12 feet; absolute minimum path width – 8 feet (the preferred dimensions should be used unless right-of-way constraints dictate)
- A graded shoulder of 2 feet should be provided on each side of the shared use path.
- Wider pavement may be needed in high-use areas. Where significant numbers of pedestrians, bicyclists, skaters, and other users share the path, either wider pavement or separate walkways should be used to help to eliminate conflicts. A minimum width of 14 feet is typically recommended for separating users (two 4-foot lanes one in each direction for wheeled users, and a 6-foot space for pedestrians). Separation of modes on shared use paths can be implemented and signed with the MUTCD R9-7 sign.
- Shared use paths are not substitutes for on-road bicycle facilities. Many advanced bicyclists choose on-road bicycle facilities even when shared-use paths are provided within the same right-of-way.
- The intersections of shared-use paths with roads are of critical importance to the overall environment and safety experienced by users. Intersections should be designed with crossing safety treatments that assist path users to cross the road. Consistent with



FDOT PPM Chapter 8.3.2, curb ramps on shared-use paths should be the same width as the path itself to minimize conflicts between bicyclists and pedestrians. The trail crossing warning sign (MUTCD W11-15) should be used to warn motorists of the shared use path crossing location.



Examples of signage associated with shared-use paths
(Credits: Kimley-Horn and Associates, Inc.)



SHARED ROADWAYS

A shared roadway is a street in which bicyclists comfortably ride in the same travel lanes as other traffic because of the low-volume, low-speed characteristic of the roadway. Shared roadways as a bikeway type should not be confused with other shared situations, such as bicycle boulevards, shared lane markings (sharrows), or wide curb lanes, which are discussed later in this chapter.

A good example of shared roadways are most local residential neighborhood streets where motor vehicle traffic volume and traffic speeds are low enough that even novice bicyclists feel comfortable riding in the street.

Shared roadways are the most common bikeway type. There are no specific width standards for shared roadways. Most are fairly narrow; they are simply the streets as constructed. Under certain conditions, a narrow width may increase the viability of a shared roadway as a bikeway because it means that a motorist is forced to remain behind a bicyclist without attempting an overtaking maneuver if there is oncoming traffic. The suitability of a narrow lane or a wide lane for shared roadways is the subject of many factors, such as the intensity of bicycle traffic and the presence of on-street parking.

The suitability of a shared roadway decreases as motor vehicle traffic speeds and volumes increase. Many local streets carry excessive traffic volumes at speeds higher than they were designed to carry. These can function better as shared roadways if traffic speeds and volumes are reduced. For a local street to function acceptably for bicyclists as a shared roadway, traffic volumes should not be more than 3,000 to 5,000 vehicles per day, and speeds should be 25 mph or less. If traffic speeds and volumes exceed these thresholds, separated facilities (e.g., bike lanes) should be considered or traffic calming should be applied to reduce the vehicle speeds/volumes. Many traffic calming techniques can make these streets more amenable to bicycling while also solving other community goals related to livability.

Shared space streets are a type of shared roadway where speeds are very slow (rarely more than walking speed). Bicyclists, other wheeled users, motor vehicles, and pedestrians all share the same space. Shared space streets may support café seating, play areas, and other uses. More information on shared space streets can be found in Chapter 4, "Street Networks and Classifications," Chapter 5, "Traveled Way Design," Chapter 11, "Traffic Calming," and Chapter 13, "Re-Placing Streets."

Centerline Removal

On low-volume, low-speed streets with one travel lane in each direction, removal of the centerline is one strategy to facilitate passing of bicyclists by motor vehicles. Motorists may be unwilling to cross over a centerline to pass a bicyclist, resulting in instances where motorists feel like they are stuck behind a slower moving bicyclist and attempt to pass the bicyclist too closely. Bicyclists in these situations may feel pressured to ride to the extreme far right or in



the gutter to allow motorists to pass. Removal of the centerline opens the entire traveled way for passing, and allows bicyclists to position themselves at a safe and comfortable distance from the curb or roadside obstacles. Lack of centerlines is also a traffic calming technique, as drivers tend to drive slower without the visible separation from oncoming traffic.

The MUTCD mandates centerline stripes on urban streets with average daily traffic (ADT) of 6,000 or more; most neighborhood streets suitable for shared roadway bicycle facilities are well below that threshold and could be candidates for centerline removal.

ADVISORY BIKE LANES

In some cases, local governments may wish to stripe bike lanes on narrow local streets for which centerline removal is recommended or no centerline exists. If motor vehicles will need to encroach into the bike lane to pass oncoming vehicles, the bike lanes should be striped with white “skip stripes” instead of solid white edge striping. In this case, these dashed bike lanes are called advisory bike lanes. Motor vehicles should only enter the advisory bike lane for the purpose of going around an oncoming vehicle or to enter a parking stall (when applicable).

An example of an advisory bike lane has been implemented on East 14th Street in Minneapolis.

Advisory bike lanes are currently an experimental treatment for which FHWA experiments are in progress. Local jurisdictions wishing to implement advisory bike lanes should follow the FHWA experimentation process for new traffic control devices outlined in Chapter 1, “Introduction.”



Before (left) and after (right) views of the advisory bike lanes on East 14th Street in Minneapolis. The after condition aerial on the right shows the centerline removal and the placement of dashed advisory bike lanes. Note that the street still accommodates two-way traffic. Motorists only encroach into the advisory bike lanes when passing an oncoming vehicle or to access the on-street parking.

(Photo Source: Google Maps and Google Street View, Accessed June 19, 2012)



BICYCLE BOULEVARDS



*Bicycle boulevard: Portland, OR
(Credit: Ryan Snyder)*

A bicycle boulevard is an enhanced shared roadway; it is a local street that has been modified to prioritize through bicycle traffic but discourage through motor vehicle traffic. Bicycle boulevards can be thought of as bicycle arterials.

To create a bicycle boulevard, a local street is modified to function as a prioritized through street for bicyclists while maintaining local access for automobiles. This is done by adding traffic calming devices to reduce motor vehicle speeds and through trips, and installing traffic control devices that limit conflicts between motorists and bicyclists and give priority to through bicyclist movement.

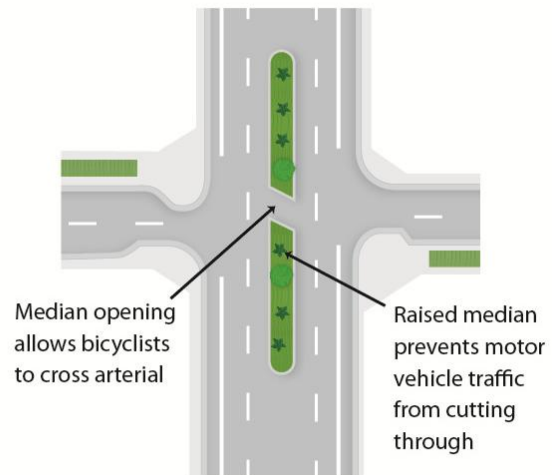
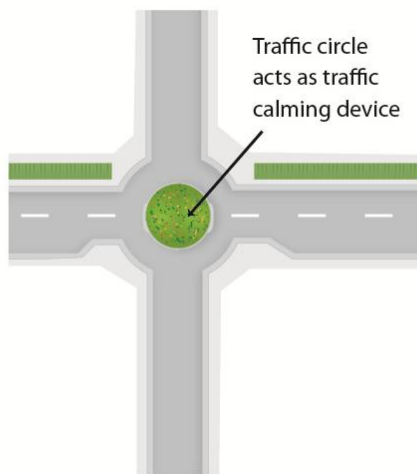
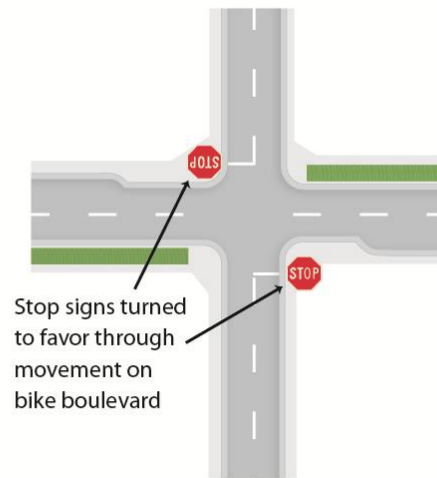
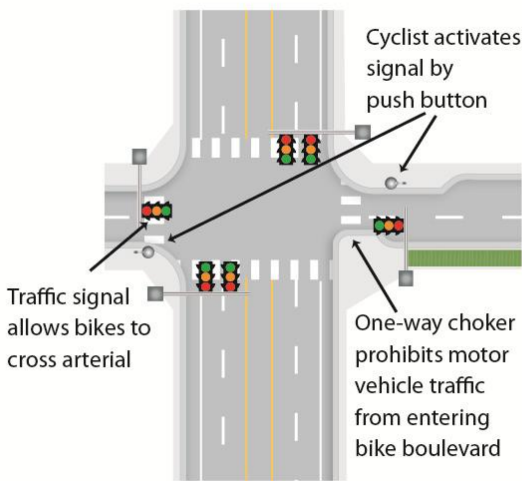
One key advantage of bicycle boulevards is that they attract bicyclists who do not feel comfortable on busy streets and prefer to ride on lower traffic streets. Bicycle travel on local streets is generally compatible with local land uses (e.g., residential and some retail). Residents who want slower traffic on neighborhood streets often like measures that support bicycle boulevards. By reducing traffic and improving crossings, bicycle boulevards also improve conditions for pedestrians. Successful bicycle boulevard implementation requires careful planning with residents and businesses to ensure acceptance.



*Traffic circles allow for landscaping opportunities
(Credit: Ryan Snyder)*

Elements of a Bicycle Boulevard

A successful bike boulevard includes the following design elements.



Components of bicycle boulevards (Credit: Michele Weisbart)

- Selecting a direct and continuous street, rather than a circuitous route that winds through neighborhoods. Bike boulevards work best on a street grid. If any traffic diversion will likely result from the bike boulevard, selecting streets that have parallel higher-level streets can prevent unpopular diversion to other residential streets.
- Placing motor vehicle traffic diverters at key intersections to reduce through motor vehicle traffic (diverters are designed to allow through bicyclist movement)
- Turning stop signs towards intersecting streets, so bicyclists can ride with few interruptions



- Replacing stop-controlled intersections with mini-circles and mini-roundabouts to reduce the number of stops cyclists have to make
- Placing traffic-calming devices to lower motor vehicle traffic speeds
- Placing wayfinding and other signs or markings to route cyclists to key destinations, to guide cyclists through difficult situations, and to alert motorists of the presence of bicyclists
- Where the bicycle boulevard crosses high-speed or high-volume streets, providing crossing improvements such as the following.
 - Signals, where a traffic study has shown that a signal will be safe and effective. To ensure that bicyclists can activate the signal, loop detection should be installed in the pavement where bicyclists ride.
 - Roundabouts where appropriate.
 - Median refuges wide enough to provide a refuge (8 feet minimum) and with an opening wide enough to allow bicyclists to pass through (approximately 6 feet). The design should allow bicyclists to see the travel lanes they must cross.

Bicycle boulevards in and of themselves are not traffic control devices, so there is no overall restriction on their use from the FHWA. Bicycle boulevards can be implemented at the present time without the need for experimentation if signs, pavement markings, and traffic control devices that are compliant with the MUTCD are used.



SHARED LANE MARKINGS (SHARROWS)

Shared-lane markings (also commonly called “sharrows”) may be used as an additional pavement marking treatment for shared roadways. Sharrows can serve a number of purposes.

- Sharrows remind bicyclists to ride farther from parked cars to prevent “dooring” collisions.
- Sharrows make motorists aware of the expectation to find bicycles sharing the travel lane.
- Sharrows recommend proper lateral spacing guidance for bicyclists.
- Sharrows show bicyclists the correct direction of travel.

The 2009 MUTCD outlines guidance for sharrows in Section 9C.07. In addition, FDOT Standard Index 17347 provides guidance for the geometric design criteria and spacing of sharrows. As shared lane markings are relatively new, guidance on application of sharrows will likely evolve. Shared lane markings should not be considered a substitute for bike lanes, cycle tracks, or other designated bicycle facilities where these types of facilities are otherwise warranted or space permits. Shared lane markings can be used as the standard element in the development of bicycle boulevards.

Shared lane markings may be accompanied by a “Bicycles May Use Full Lane” sign (MUTCD R4-11).

Placing the sharrow between vehicle tire tracks increases the life of the markings and decreases long-term maintenance costs.



*Sharrows pavement marking
(Credit: Kimley-Horn and Associates, Inc.)*



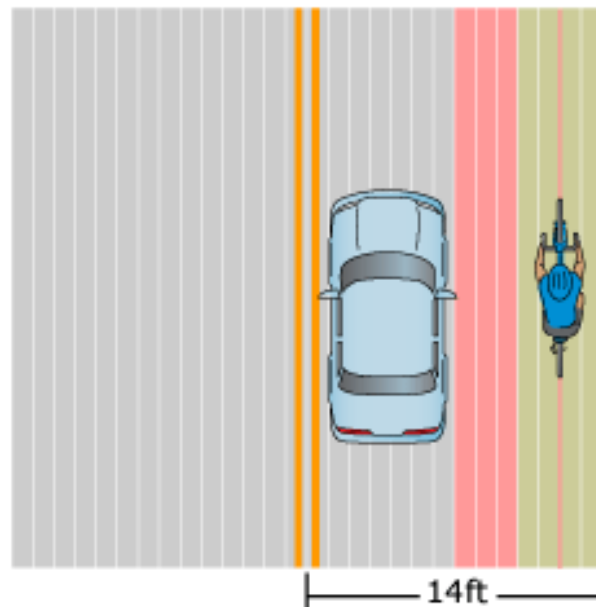
*MUTCD R4-11 sign
(Credit: Kimley-Horn and Associates, Inc.)*



WIDE OUTSIDE LANES

On streets where bike lanes would be more appropriate but with insufficient width for bike lanes, wide outside lanes may be provided. This situation may occur on resurfacing projects where there are physical constraints and all other options, such as narrowing travel lanes, have been pursued. Wide outside lanes are not particularly attractive to most bicyclists; they simply allow a motorized vehicle to pass bicyclists within a travel lane without encroaching into an adjacent lane, if bicyclists are riding far enough to the right.

Wide curb lanes may also encourage higher motor vehicle speed, which is contrary to the design principles of this manual. Wide lanes should never be used on local residential streets. A 14- to 15-foot wide lane allows a passenger car to pass a bicyclist in the same lane. The sharrow pavement marking may be considered for use at the appropriate lateral placement within a wide outside lane. However, a “Bicycles May Use Full Lane” sign (MUTCD R4-11) should never be used for a wide outside lane. Widths of 16 feet or greater encourage the undesirable operation of two motor vehicles in one lane. In this situation, a designated bike lane should be striped.



*Wide outside lane
(Credit: Florida Bicycle Association)*



UNDESIGNATED LANE (URBAN SHOULDER)

On streets where bike lanes would be more appropriate but with insufficient width for bike lanes, an undesignated lane (urban shoulder) may be provided as an alternative to the wide outside lane.

If provided, a minimum 3-foot wide smooth surface should be provided between the lip of the gutter pan and edge line stripe. This minimum width enables bicyclists to ride far enough from the curb to avoid debris and drainage grates and far enough from other vehicles to avoid conflicts. By riding away from the curb, bicyclists are more visible to motorists than when hugging the curb. Undesignated lanes have similar characteristics as wide outside lanes, but with the added benefit of an edge line striping between motor vehicles and bicyclists. However, it is likely that only the “strong and fearless” bicyclists feel comfortable in this undesignated space.



*Undesignated lane.
Note the corner radius striping, which allows bicycles to enter the
undesignated lane.
(Credit: Kimley-Horn and Associates, Inc.)*



PAVED SHOULDERS

Paved shoulders accommodate bicycle travel on rural highways and country roads by providing a suitable area for bicycling and reducing conflicts with faster moving motor vehicles. Paved shoulders are only a rural bicycle facility. Paved shoulders in urban areas are signed and marked as bike lanes. Paved shoulders have similar characteristics as bike lanes, but are not designated through pavement marking symbols and signage.

Paved shoulders are provided on rural highways for a variety of safety, operational, and maintenance reasons. When providing paved shoulders, bicycle use should be assumed.

- A preferred width of 6 feet is recommended. This allows a bicyclist to ride far enough from the edge of pavement to avoid debris and far enough from passing vehicles to avoid conflicts.
- On rural roads with prevailing speeds over 45 mph, 8 feet is preferred.
- An absolute minimum width of 4 feet for a paved shoulder bicycle facility may be used under constraints.
- When rumble strips are provided on the paved shoulder, care should be exercised to ensure at least a minimum rideable surface of 4 feet is provided to the outside of the rumble strip. When designed properly, rumble strips can be a benefit to bicyclists using a paved shoulder by notifying motorists when they begin to encroach upon the shoulder. Since rumble strips are approximately 1.5 feet wide, and are typically offset from the edge line striping by approximately 0.5 feet, a paved shoulder with a rumble strip must be a minimum of 6 feet in total width to accommodate bicyclists within the outer 4 feet.



*Paved shoulder with Share-the-Road sign assembly
(Credit: Kimley-Horn and Associates, Inc.)*



BIKE ROUTE WAYFINDING

A bicycle route wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bike routes. A bike route is a term used for planning purposes or to designate recommended bicycle transportation or recreation routes. A bike route is not a facility type. A bike route can be any bikeway type.

- Wayfinding signs are typically placed at decision points along bike routes.
- There are three general types of wayfinding signs.
 - Confirmation signs indicate to bicyclists that they are on a designated bikeway. Confirmation signs can include destinations and distance/time but do not include arrows. Confirmation signs have an added benefit of making motorists aware of the bicycle route.
 - Turn signs indicate where a bikeway turns from one street to another street. Turn signs include arrows, and may include destinations and distance/time. Turn signs should be placed on the near-side of intersections and may be supplemented with pavement markings.
 - Decision signs mark the junction of two or more bike routes. Decision signs inform bicyclists of the designated bike route to access key destinations. Decision signs include destinations and arrows. Distances and travel times are recommended but are optional.



*Bicycle route turn signage at a path entrance to Tradewinds Park
 (Credit: Kimley-Horn and Associates, Inc.)*



Numbered bicycle route signage at a turn location. Note that if the arrow turn plaque were removed, this would be a confirmation sign.

(Credit: Kimley-Horn and Associates, Inc.)



*Bicycle route destination signage at a decision point
 (Credit: Kimley-Horn and Associates, Inc.)*



INTEGRATING WITH THE STREET SYSTEM

Most bikeways are part of the street; therefore, well-connected street systems are very conducive to bicycling, especially those with a fine-meshed network of low-volume, low-speed streets suitable for shared roadways. In less well-connected street systems, where wide streets carry the bulk of traffic, bicyclists need supplementary facilities, such as short sections of paths and bridges, to connect otherwise unconnected streets.

There are no hard and fast rules for when a specific type of bikeway should be used, but some general principles guide selection. As a general rule, as traffic volumes and speeds increase, greater separation from motor vehicle traffic is desirable. Other factors to consider are user type (more children or recreational cyclists may warrant greater separation), adjacent land uses (multiple driveways may cause conflicts with shared-use paths), available right-of-way (separated facilities require greater width), and costs.

As a general rule, designated bicycle facilities (e.g., bike lanes and cycle tracks) should be provided on all major streets (avenues and boulevards), as these roads generally offer the greatest level of directness and connectivity in the network, and are typically where destinations are located. There are occasions when it is infeasible or impractical to provide bikeways on a busy street, or the street does not serve the mobility and access needs of bicyclists. The following guidelines should be used to determine if it is more appropriate to provide facilities on a parallel local street.

- Conditions exist such that it is not economically or environmentally feasible to provide adequate bicycle facilities on the street.
- The street does not provide adequate access to destination points within reasonable walking distances, or separated bikeways on the street would not be considered safe.
- The parallel route provides continuity and convenient access to destinations served by the street.
- Costs to improve the parallel route are no greater than costs to improve the street.
- If any of these factors are met, bicyclists may actually prefer the parallel local street facility in that it may offer a higher level of comfort (bicycle boulevards are based on this approach).

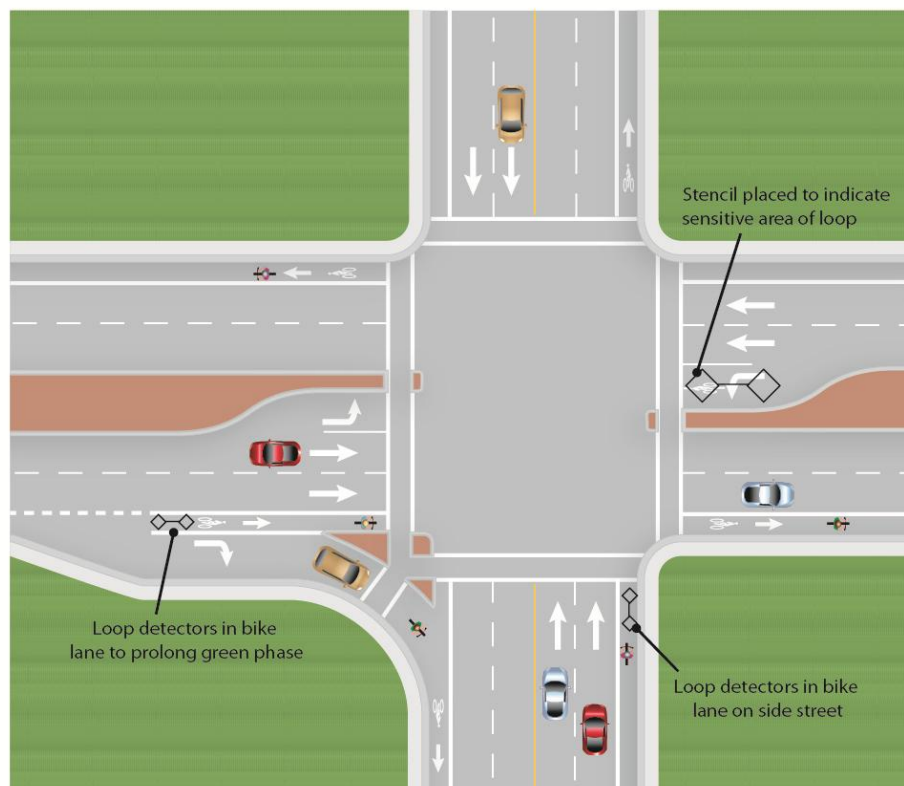
Off-street paths can also be used to provide transportation in corridors otherwise not served by the street system, such as along utility corridors and canals, through parks, on abandoned railroad tracks, or along active railroad rights-of-way. While paths offer the safety and scenic advantages of separation from traffic, they must also offer frequent connections to the street system and to destinations such as residential areas, employment sites, shopping, and schools. Street crossings must be well designed with measures such as signals or median refuge islands.



INTERSECTIONS

Intersections are junctions at which different modes of transportation meet and facilities overlap. A well-designed intersection facilitates the interchange between bicyclists, pedestrians, motorists, and transit so traffic flows in a safe and efficient manner. Designs for intersections with bicycle facilities should reduce conflicts between bicyclists (and other vulnerable road users) and vehicles by heightening visibility, denoting a clear right-of-way, and ensuring that the various users are aware of each other. Intersection treatments can resolve both queuing and merging maneuvers for bicyclists, and are often coordinated with timed or specialized signals.

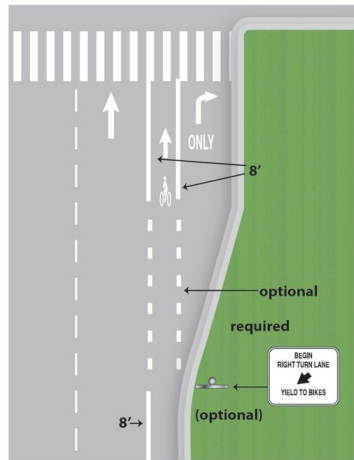
Chapter 6, "Intersection Design," provides general principles of geometric design; all these recommendations will benefit cyclists. The configuration of a safe intersection for bicyclists may include additional elements such as color, signs, medians, signal detection, and pavement markings. Intersection 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, the adjacent street function, and the adjacent land use.



Bikeway markings at intersections (Credit: Michele Weisbart)



BIKEWAY MARKINGS AT INTERSECTIONS



*Bike lane markings at intersections with right-turn lanes
(Credit: Michele Weisbart)*

Continuing marked bicycle facilities at intersections (up to the crosswalk) ensures that separation, guidance on proper positioning, and awareness by motorists are maintained through these potential conflict areas. The appropriate treatment for right-turn only lanes is to place a bike lane pocket (a.k.a. “keyhole lane”) between the right-turn lane and the rightmost through lane. The “Begin Right Turn Lane, Yield to Bikes” sign (MUTCD R4-4) sign may also be posted to indicate to motorists that they must yield to bicyclists crossing the taper of the right-turn only lane.

If a full bike lane pocket cannot be accommodated, a combined bicycle lane/right-turn lane can be installed that places a standard-width bike lane on the left side of a dedicated right-turn lane. A dashed strip delineates the space for bicyclists and motorists within the shared lane (this is another form of an “advisory bike lane” discussed earlier in the chapter). This treatment must include pavement markings and signs advising motorists and bicyclists of proper positioning within the lane. Regulatory signage should be provided stating that bicyclists are allowed to make a through movement from the right-turn lane.

Sharrows are another option for marking a bikeway through an intersection where a bike lane pocket cannot be accommodated.

BICYCLE SIGNAL HEADS



*Bicycle signal head:
Long Beach, CA
(Credit: Charlie Gandy)*

Bicycle signal heads may be installed at signalized intersections to improve identified safety or operational problems for bicyclists. Bicycle signal heads provide guidance for bicyclists at intersections where bicyclists have different needs from other road users (e.g., bicycle-only movements and leading bicycle intervals) or to indicate separate bicycle signal phases and other bicycle-specific timing strategies. A bicycle signal should only be used in combination with an existing conventional or hybrid beacon. In the United States, bicycle signal heads typically use standard three-lens signal heads in green, yellow, and red with a stencil of a bicycle. Bicycle signal heads are currently experimental; local jurisdictions that wish to implement bicycle signal heads should follow the FHWA experimentation procedures outlined in Chapter 1,

“Introduction.” Bicycle traffic signal phasing with circular indications are approved for use by FHWA if a “Bike Signal” sign is mounted adjacent to the signal face.



BICYCLE SIGNAL DETECTION

Bicycle detection is used at actuated traffic signals to alert the signal controller of bicycle crossing demand on a particular approach. Bicycle detection occurs either through the use of push buttons or by automated means (e.g., in-pavement loops, video, and microwave). Inductive loop vehicle detection at many signalized intersections is calibrated to the size or metallic mass of a vehicle, meaning that bicycles may often go undetected. The result is that bicyclists must either wait for a vehicle to arrive, dismount and push the pedestrian button (if available), or cross illegally. Loop sensitivity can be increased to detect bicycles.

Proper bicycle detection must accurately detect bicyclists (be sensitive to the mass and volume of a bicycle and its rider); and provide clear guidance to bicyclists on how to actuate detection (e.g., what button to push or where to stand).

Broward County Traffic Engineering Division (BCTED) is migrating toward video detection for traffic signals. BCTED staff has indicated that it is possible to set-up detection zones for bicyclists within the video detection system. Bicycle detection zones should be established as standard procedure for all transportation projects involving traffic signal work.



*Bicycle signal detection sign
(Credit: Toole Design Group)*

BICYCLE COUNTDOWNS (COUNTDOWN-TO-GREEN)

Near-side bicycle signals may incorporate a “countdown-to-green” display to provide information about how long until the green bicycle indication is shown, enabling riders to push off as soon as the light turns green, which improves visibility for bicyclists.

LEADING BICYCLE INTERVALS

Based on the Leading Pedestrian Interval, a Leading Bicycle Interval (LBI) can be implemented in conjunction with a bicycle signal head. Under an LBI, bicyclists are given a green signal while the vehicular traffic is held at all red for several seconds, providing a head start for bicyclists to advance through the intersection. This treatment is particularly effective in locations where bicyclists are required to make a challenging merge or lane change (e.g., to access a left turn pocket) shortly after the intersection, as the LBI would give them sufficient time to make the merge before being overtaken by vehicular traffic. LBIs also generally increase bicyclist visibility to motorists when passing through the intersection after a red light. This treatment can be used to enhance a bike box.



BIKE BOXES

A bike box is a designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to queue during the red signal phase and helps facilitate left-turn movements when the bike box extends across all of the through lanes. Bike boxes are accompanied by advanced stop lines for motor vehicles and no-turn-on-red restrictions. Appropriate locations include:

- At signalized intersections with high volumes of bicycles and/or motor vehicles, especially those with frequent bicyclist left-turns and/or motorist right-turns.
- Where there may be right or left-turning conflicts between bicyclists and motorists.
- Where there is a desire to better accommodate left-turning bicycle traffic.
- Where a left turn is required to follow a designated bike route or bicycle boulevard, to access a shared-use path, or when the bicycle lane moves to the left side of the street.
- When the dominant motor vehicle traffic flows right and bicycle traffic continues through (such as at a Y intersection or access ramp).



*Bicycle box: Portland, OR
(Credit: Ryan Snyder)*

Bike boxes are currently an experimental treatment for which FHWA experiments are in progress. Local jurisdictions wishing to implement bike boxes should follow the FHWA experimentation process for new traffic control devices outlined in Chapter 1, "Introduction."

TWO-STAGE TURN QUEUE BOXES

On right-side cycle tracks, bicyclists are often unable to merge into traffic to turn left due to physical separation. This makes the provision of two-stage left turns critical in ensuring these facilities are functional. The same principles for two-stage turns apply to both bike lanes and cycle tracks. 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.

Accommodating two-stage "delayed" left-turns via pavement markings and signal detection can be implemented at the present time according to FHWA guidance if signs and pavement markings that are compliant with the MUTCD are used.

BICYCLE PARKING

Secure bicycle parking at likely destinations is an integral part of a bikeway network. On-street bicycle parking should be accommodated within the furniture zone of a sidewalk in downtown districts and urban centers. Secure bicycle parking may also be accommodated within the frontage zone if it does not block doorways, windows, or building access. Bicycle parking should also be provided at bus stops. Bicycle thefts are common and lack of secure parking is often cited as a reason people hesitate to ride a bicycle. The same consideration should be given to bicyclists as to motorists, who expect convenient and secure parking at all destinations. Bicycle parking should be located in well-lit, secure locations close to the main entrance of a building, no further from the entrance than the closest automobile parking space. Bicycle parking should not interfere with pedestrian movement.



On-street bicycle parking in a building frontage zone near a decorative wall mural: Fort Lauderdale (Credit: Kimley-Horn and Associates, Inc.)

Bike racks along sidewalks should support the bicycle well (typically two points of contact with the frame), and make it easy to lock a U-shaped lock to the frame of the bike and the rack. Examples below show an “inverted U” rack and an art design rack that meet these functional criteria. Refer to the Association of Pedestrian and Bicycle Professionals (APBP) *Bike Parking Guidelines* for additional information.



Inverted U Bike Rack (Credit: Sky Yim)



Bicycle racks can double as public art: Los Angeles, CA (Credit: Sky Yim)



MAINTENANCE

Maintenance is a critical part of safe and comfortable bicycle access. Two areas that are of particular importance to bicyclists are pavement quality and drainage grates. Rough surfaces, potholes, and imperfections, such as joints, can cause a rider to lose control and fall. Care must be taken to ensure that drainage grates are bicycle-safe; otherwise a bicycle wheel may fall into the slots of the grate, causing the cyclist to fall. The grate and inlet box must be flush with the adjacent surface. Inlets should be raised after a pavement overlay to the new surface. If this is not possible or practical, the new pavement should taper into drainage inlets so the inlet edge is not abrupt.

The most effective way to avoid drainage-grate problems is to eliminate them entirely with the use of inlets in the curb face. This may require more grates to handle bypass flow, but is the most bicycle-friendly design.

LEGAL STATUS

As of the writing of the *Broward Complete Streets Guidelines*, a number of the designs discussed in this chapter, including advisory bike lanes, bike boxes, and bicycle signal heads, have not yet been adopted by the FHWA's MUTCD or AASHTO, and are therefore considered experimental treatments. However, these devices appear to be promising improvements in bicycle access and safety as they have been widely used in Europe and experimented with in several U.S. cities with positive results. All of the techniques and devices presented herein are discussed at length in the NACTO *Urban Bikeway Design Guide* and the reader is directed to consult the NACTO Guide for more detailed information including case studies and examples.

Every potential implementation condition is different and care must be exercised to follow sound planning and engineering principles for the use of these facilities. Any local jurisdiction wishing to use the treatments that do not specifically fall under MUTCD guidance should follow the appropriate experimental procedures as outlined by the FHWA's "Request for Experimentation" (RFE), which is summarized in Chapter 1, "Introduction."

IMPLEMENTATION

Implementation of a bikeway network often requires an implementation plan. Some bikeways, such as paths, bicycle boulevards, and other innovative techniques described in this guide, will require a capital improvement project process, including identifying funding, a public and environmental review process, and plan preparation. Other bikeway improvements piggy-back onto planned construction, such as resurfacing, reconstruction, or utility work.



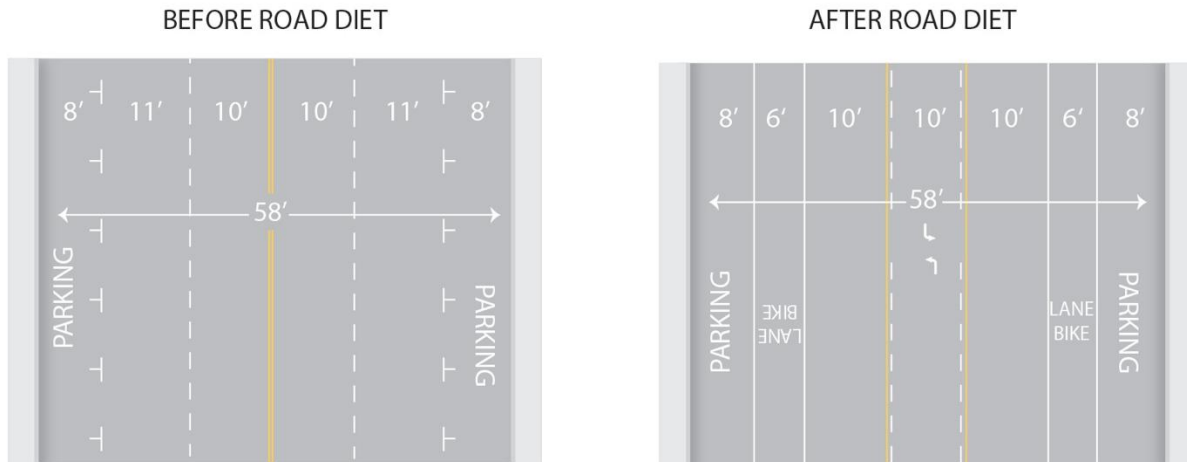
The majority of bikeway facilities are provided on streets in the form of shared roadways or bicycle lanes. Shared roadways usually require virtually no change to existing roadways, except for some directional signs, occasional markings, and minor changes in traffic control devices; removing unnecessary centerline stripes is a strategy that can be implemented after resurfacing projects. Striped bike lanes are implemented on existing roads through use of the strategies below.

RESURFACING

The cost of striping bicycle lanes is negligible when incorporated with resurfacing, as this avoids the high cost of stripe removal; the fresh pavement provides a blank slate. Jurisdictions will need to anticipate opportunities and synchronize restriping plans with repaving and reconstruction plans. If new pavement is not anticipated in the near future, grinding out the old lane lines can still provide bike lanes.

There are three basic techniques for accommodating bike facilities:

- Lane width narrowing. Where all existing or planned travel lanes must be retained, travel lanes can be narrowed to provide space for bike lanes. Recent studies have indicated that the use of 10-foot travel lanes does not result in decreased safety in comparison with wider lanes for vehicle speeds up to 35 mph. Eleven-foot lanes can be used satisfactorily at higher speeds especially where trucks and buses frequently use these streets. However, where a choice between a 6-foot bike lane and an 11-foot travel lane must be made, it is usually preferable to have the 6-foot bike lane. Parking lanes can also be narrowed to 7 feet to create space for bike lanes on slow-speed (generally 25 MPH or less) streets. More information on lane width narrowing is provided in Chapter 15, "Retrofitting Suburbia."
- Road diets. Reducing the number of travel lanes provides space for bicycle lanes. Many streets have more space for vehicular traffic than necessary. Some streets may require a traffic and/or environmental analysis to determine whether additional needs or impacts may be anticipated. The traditional road diet changes a four-lane undivided street to two travel lanes, a continuous left-turn lane (or median), and bike lanes. In other cases, a four-lane street can be reduced to a two-lane street without a center-turn lane if there are few left turns movements. One-way couplets are good lane-reduction candidates if they have more travel lanes in one direction than necessary for the traffic volumes. For example, a four-lane one-way street can be reduced to three lanes and a bike lane. Since only one bike lane is needed on a one-way street, removing a travel lane can free enough room for other features, such as on-street parking or wider sidewalks. Both legs of a couplet must be treated equally, so there is a bike lane in each direction. More information on road diets is provided in Chapter 15, "Retrofitting Suburbia."



Accommodating bicycle lanes with road diets (Credit: Michele Weisbart)

- **On-Street Parking Removal.** On-street parking is vital on certain streets (such as residential or traditional central business districts with little or no off-street parking); but other streets have allowable parking without a significant visible demand. In these cases, parking prohibition can be used to provide bike lanes with minimal public inconvenience. On-street parking removal should always be preceded by a district-wide parking study to ensure adequate shared parking is provided for local businesses and residences.

UTILITY WORK

Utility work often requires reconstructing the street surface to complete restoration work. This provides opportunities to implement bike lanes and more complex bikeways such as bike boulevards, cycle tracks, or paths. It is necessary to provide plans for proper implementation and design of bikeway facilities prior to the utility work. It is equally necessary to ensure that existing bikeways are replaced where they exist prior to utility construction.

REDEVELOPMENT

When streets are slated for reconstruction in conjunction with redevelopment, opportunities exist to integrate bicycle lanes or other facilities into the redevelopment plans.



PAVED SHOULDERS

Adding paved shoulders to existing roads can be quite expensive if done as stand-alone capital improvement projects, especially if swale lines have to be moved, or if open drains are changed to enclosed drains. But paved shoulders can be added at little extra cost if they are incorporated into projects that already disturb the area beyond the pavement, such as laying utility lines or drainage work.

ADDITIONAL RESOURCES

Federal Highway Administration (FHWA), *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), 2009 Edition.

National Association of City Transportation Officials (NACTO), *Urban Bikeway Design Guide*, 2011.

American Association of State Highway Transportation Officials (AASHTO), *Guide for the Development of Bicycle Facilities*, 2012.

Florida Department of Transportation (FDOT), *2012 Plans Preparation Manual*, Chapter 8.

Florida Department of Transportation (FDOT), *Standard Index 17347*.

Florida Department of Transportation (FDOT) *Manual of Uniform Minimum Standards for Design, Construction, and Maintenance for Streets and Highways* (The Florida Greenbook), 2011.

Association of Pedestrian and Bicycle Professionals (APBP), *Bike Parking Guidelines*, 2nd Edition.



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