



Street Smarts Task Force Bicycle Facilities Toolbox



August 2007



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Prepared by
Eddie Church

Klotz Associates, Inc.
Barton Oaks Plaza
901 South Mopac Expressway, Bldg. V, Suite 220
Austin, Texas 78746



Klotz Associates, Inc.
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EXECUTIVE SUMMARY

The following is the “Bicycle Facilities Toolbox” report for the City of Austin - Street Smarts Task Force. This report provides a guide for various bike facility design elements that the Street Smarts Task Force may want to consider as they implement the goals of the *Austin Bicycle Plan*¹ and the Mayor's Fitness Council. Engineering design information, such as design standards and typical roadway details are also given. For this report, the 1999 *Guide for the Development of Bicycle Facilities*² published by the American Association of State Highway and Transportation Officials (AASHTO) and the 2006 *Texas Manual on Uniform Traffic Control Devices*³ (TMUTCD) published by the Texas Department of Transportation (TxDOT) were used as references. This report will help guide decisions involving bicycle facilities and provide the necessary information from which the task force members can choose when formulating recommendations for the city's bicycle plan.

Klotz Associates is providing this “Toolbox” to be used as an aid for making informed decisions about the standard AASHTO recommended bike facilities, as well as alternative bike facilities that are used in other “bicycle friendly” cities. Klotz Associates has attempted to provide the design elements and both the positive and negative aspects of these alternative facilities. The inclusion of these in this report should not be interpreted as a recommendation for any particular facility. Instead, their inclusion is simply a presentation of ideas to spur creative solutions for innovative transportation alternatives.



SECTION 1 INTRODUCTION

1.1 PURPOSE

The purpose of this manual is to provide City officials and the general public with information on bicycle (bike) facility design elements. This guide is intended to facilitate well-informed decision making, thus making bicycles a feasible and safe transportation alternative. The information provided in this manual is consistent with most highway engineering practices, as defined in the *AASHTO – guide for the development of bicycle facilities* (ed. 1999)² and the *Texas Manual on Uniform Traffic Control Devices* (ed. 2006)³. In addition to summarizing the design options discussed by AASHTO, information regarding innovative facilities and creative variations of standard practices from other cities and countries has been included.

1.2 DEFINITIONS

Below are some common definitions that will be discussed throughout this report. An easy to use reference chart is also included, as [Appendix A](#).

Bicycle Facility – A general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling². This includes roadway improvements for bicycle travel, bicycle parking facilities, etc.

Bicycle Lane – A portion of a roadway that has been designated by signing and pavement markings, for the exclusive use of bicycles².

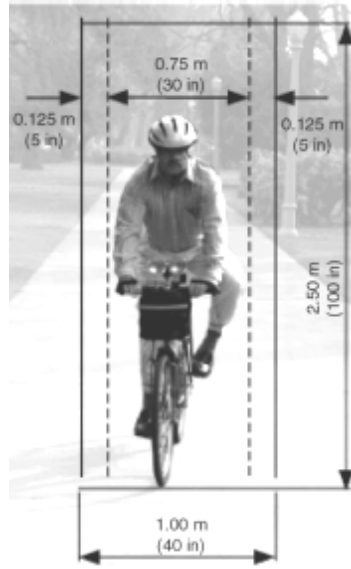
Bicycle Path (Shared-Use Path) – A bikeway separated from vehicular traffic by an open space or barrier; either within the highway right-of-way (ROW) or within an independent ROW. Shared use paths may also be used by pedestrians, skaters, wheelchair users, joggers and other non-motorized users².

Shared Roadway – A roadway that is open to both bicycle and motor vehicle travel. This may be an existing roadway with wide lanes or paved shoulders². A shared roadway may be signed as a route for bicyclists, if specific AASHTO criteria are met.

1.3 THE BICYCLE

An operating space of 4 feet is assumed as the minimum width for any facility designed for exclusive or preferential use by cyclists (Figure 1.1)².

(Figure 1.1 = Operating Space)²



The skill level, confidence and preferences of cyclists vary dramatically. Some bicycle riders are confident riding anywhere that they are legally allowed to operate, however most adult riders prefer to use roadways with a more comfortable amount of operating space or shared use paths that are separated from traffic. These adult riders will be classified as “type B”, as defined below. All categories of riders require smooth riding surfaces with bicycle-compatible roadway appurtenances, such as bicycle-safe drainage grates.

1.4 THE BICYCLE USER

A 1994 report by the Federal Highway Administration⁴ used the following general categories of bicycle user types (A, B and C) to assist designers in determining the impact of different facility types and roadway conditions on bicyclists (Pics 1.1 to 1.4):

A – Advanced or experienced riders generally use their bicycles as they would a motor vehicle. They are typically comfortable riding with motor traffic, but need sufficient operating space on the traveled way or the shoulder. The advanced riders are riding for convenience, speed and/or exercise.

B – Basic or less confident adult riders may also be using their bicycles for transportation purposes, but these riders prefer to avoid roads with fast or busy motor vehicle traffic. Basic riders are comfortable riding on neighborhood streets and shared use paths. These riders also prefer designated facilities, such as bike lanes or wide shoulder lanes on busier streets.

C – Children riding with or without their parents require access to key destinations, such as schools, recreational facilities and convenience stores. Residential streets with low traffic and links with shared use paths can accommodate children on their bicycles.

(Pics 1.1 to 1.4 = Typical Bicycle Users in Austin, TX)



(Church, Eddie)

1.5 TYPES OF FACILITIES

Planners and engineers should recognize that highway design choices will affect the level of use, the type of rider and the level of access. Bicycle facilities should be planned to provide connectivity and consistency for all users. For example, children using a path to get to school should not have to cross a major arterial roadway without intersection controls and bike lanes should not end abruptly at difficult intersections or busy stretches of road.

1.5.1 Shared Roadway

Shared roadways are the most common bicycle (bike) facility for intercity and recreational travel. Signing and/or striping may not be necessary, for these roads. Typically, cyclists use either a shoulder or wide curb lane. Wide curb lanes are common, along minor residential streets.

Signed shared roadways are simply shared roadway facilities that have been identified by signing. Bike routes listed in a city bike route map usually include this type of facility. A shared roadway bike facility should not be signed unless it meets specific criteria, as defined by AASHTO.

1.5.2 Bicycle Lanes

Bicycle (Bike) lanes are used to delineate available road space, for cyclists only. Bike lanes should be one-way facilities that carry bicycles in the same direction as motorists. If a roadway has curb and gutter or parking, the design criteria will vary.

1.5.3 Shared Use Paths

Shared use paths are facilities with an exclusive right-of-way (ROW) and with minimal cross flow by motor vehicles. These paths are often shared by cyclists, skaters and pedestrians. Depending on the usage and whether the path is one or two-directional, the recommended width varies.

1.6 INTERSECTIONS

Facilities should be selected so as to minimize the number of crossings. Intersections should also be improved to reduce the number of crossing conflicts.

The two most common crossing conflicts at intersections are:

1. Conflicts between motorists turning right and cyclists wanting to go straight.
2. Conflicts between motorists and cyclists that want to turn left.

Several intersection design options can be provided to help mediate these conflicts, such as signage alerting motorists of cyclists and clearly defined pavement markings. These pavement markings can include, but are not limited to, shared-lane arrows (“sharrows”) and “blue lanes”.

1.7 SIGNALS

The greatest risks to a cyclist at a signalized intersection are inadequate clearance interval and poor bicycle detection. An adequate clearance interval must be provided for cyclists that enter the intersection, at the end of the green light. This means that the yellow and all red time should be long enough for the average “B” bicycle user to get through the intersection and be clear of oncoming vehicles. AASHTO provides a design equation for this interval, but field observations should be undertaken to verify the actual minimum clearance interval.

Bicycle detection is important for a cyclist's safety and also for compliance with traffic law. Detection can be by either loop detectors within the pavement or by Video Image Vehicle Detection System (VIVDS) cameras mounted on the opposing signal arms. Detectors should be placed, according to the cyclist's expected path. Designating the optimum location for the bicycle to stop will also help with proper detection.

1.8 BICYCLE FRIENDLY COMMUNITIES

The "Bicycle Friendly Community"⁵ (BFC) campaign is sponsored by the League of American Bicyclists (LAB), which brings together more than 300,000 cyclists and 600 organizations⁶. This campaign is an awards program that recognizes municipalities that actively support bicycling, within the United States. A BFC provides safe accommodations for cycling and encourages its residents to bike for transportation and recreation. A committee reviews and scores the application and also consults with local cyclists in each community. An award of platinum, gold, silver or bronze status is designated for two years. In 2007, **Austin, Texas** was one of only twelve (12) cities awarded the silver status. Of the sixty-four (64) cities that have received a BFC status, only eight (8) cities have been awarded a status higher than silver. See **Appendix B**, for a complete Bicycle Friendly Community listing. The populations of each city have also been included, so cities with similar populations can be compared.

1.9 OTHER COUNTRIES

Amsterdam, Holland and Copenhagen, Denmark are arguably the most friendly bicycle cities in the world. A quarter of all transportation in Amsterdam takes place via bicycle⁷. This percentage rises to 40%, within the city center⁸. Amsterdam's number one problem is bicycle thefts. Current city policies include new measures designed to shift bike commuting into higher gear. This includes increased prison time for bike thieves and the construction of new parking facilities that can hold up to 10,000 bikes⁸. The bicycle parking facility shown below is located adjacent to the main train station, in Amsterdam (Pic 1.5).

(Pic 1.5 = Bicycle Parking in Amsterdam)⁹



(Carlin, Chance)

Copenhagen, Denmark is another European city where cycling is a strong part of the culture. Since 1995, bicycle traffic has risen by 41% and motor vehicle traffic has risen by only 18%. In 2003, 36% of the people rode bicycles to work while only 27% drove to work¹⁰.

(Pic 1.6 = Copenhagen, Denmark)¹¹



(Colville-Andersen)

(Pic 1.7 = Copenhagen, Denmark)⁸





SECTION 2 SHARED ROADWAYS

Shared roadways are the most commonly used bicycle (bike) facility for intercity and recreational travel. Shared roadway facilities include two options, paved shoulders (Pic 2.1) and wide curb lanes. Shared roadways can be signed, if the roadway is identified as a busy bicycle route.

(Pic 2.1 = RM 620 in Austin, TX)



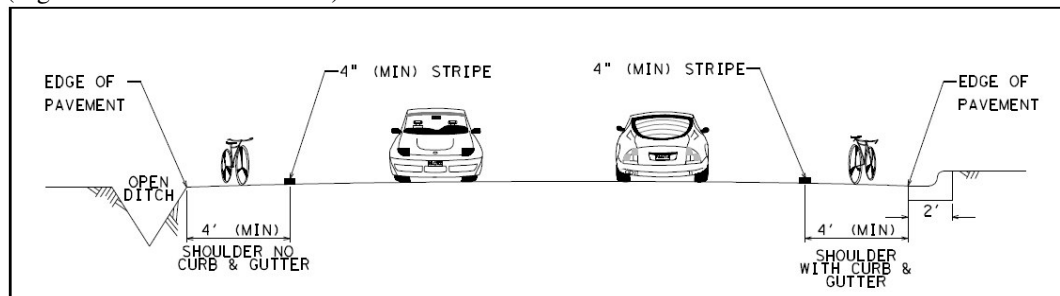
(Church, Eddie)

2.1 SHARED ROADWAYS

2.1.1 Paved Shoulders

AASHTO recommends that a shoulder intended for bicycle use have a minimum width of 4 feet and should also be separated from the travel lane by a 4 inch stripe (Figure 2.1). If the roadway has curb and gutter, this minimum width should not include the width of the gutter. A 5 foot wide shoulder is recommended when adjacent to guardrail, curb (Pic 2.2) or any other roadside barrier. AASHTO also recommends that wider shoulder widths are used when high bicycle traffic is expected or vehicle speeds exceed 50 mph.

(Figure 2.1 = Paved Shoulders)



(Klotz Associates, Inc.)

(Pic 2.2 = Spicewood Club Pkwy in Austin, TX)



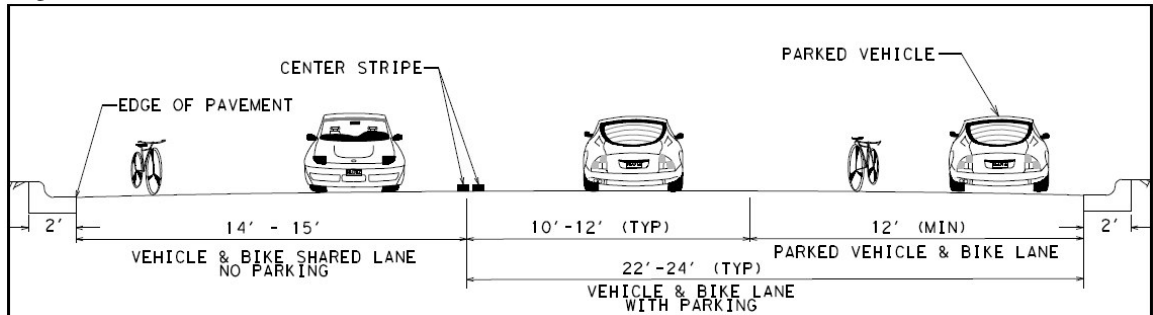
(Church, Eddie)

2.1.2 Wide Curb Lanes

A wide curb lane simply means that the outside travel lane is wider than 12 feet, in order to accommodate both motor vehicles and bicycles. AASHTO recommends a minimum of 14 feet of usable lane width, between the lane stripe and edge of pavement (Figure 2.2). The width of the gutter should not be included. AASHTO recommends increasing the lane width to 15 feet, where steep grades, drainage grates or roadside barriers exist.

When parking is allowed, a 22 foot to 24 foot lane should be provided. This includes a minimum of 12 feet for parked vehicles and bicyclists (Figure 2.2). In situations where the lane width is greater than 15 feet, consideration should be given to striping bike lanes or shoulders (Pic 2.3).

(Figure 2.2 = Wide Curb Lanes)



(Klotz Associates, Inc.)

(Pic 2.3 = Steiner Ranch Blvd. in Austin, TX)



(Church, Eddie)

2.1.3 Shared Roadway Concerns

On-street parking, pavement surface quality and drainage inlet grates are the three most common concerns for cyclists on shared roadway facilities. Cyclists must avoid open car doors, maneuvering vehicles and extended mirrors. A minimum of 12 feet should be provided to accommodate bicycles and parking for vehicles. Pavement surfaces should be smooth and uniform to provide a comfortable and safe ride for cyclists.

Wide cracks, raised asphalt edges, depressed drainage appurtenances and potholes can cause a cyclist to lose control. Bicycle-safe inlet grates are recommended, if roadway drainage features are required on bike routes. Inlet grates with slots parallel to the roadway can trap the wheel of a bicycle (Pic 2.4). Inlet grates should be replaced with bicycle safe grates that provide cross bars perpendicular with the roadway.

(Pic 2.4 = Inlet Grate with Parallel Slots)



(Church, Eddie)

2.2 SIGNED SHARED ROADWAY

2.2.1 Criteria

Signed shared roadways are simply shared roadway facilities that have been identified with signing (Pic 2.5). These are typically the bike routes that are listed in a city bike route map. Signing of a shared roadway indicates to cyclists that this route is bicycle friendly. A shared roadway bike facility should not be signed unless it meets the following criteria¹².

(Pic 2.5 = Signed Shared Roadway)²



1. The route provides connectivity and direct travel in bicycle-demand corridors.
2. The route connects discontinuous segments of shared use paths, bike lanes or other bike routes.
3. An effort has been made to adjust traffic control devices to give greater priority to cyclists on the route, as opposed to alternative streets.
4. Street parking has been removed or restricted.
5. A smooth surface has been provided.
6. Maintenance of the route will be sufficient to prevent accumulation of debris.
7. Wider curb lanes are provided compared to parallel roads.
8. Shoulder or curb lane widths generally meet or exceed width requirements.

2.2.2 Signing

The Manual on Uniform Traffic Control Devices (MUTCD)¹², Chapter 9 - Traffic Control for Bicycle Facilities, discusses how to properly stripe and sign bikeway facilities. This chapter also provides information on bicycle route guide signs. See the sample guide signs below.

(Figures 2.3 – 2.6)¹³



2.3 OTHER CITIES

West coast cities (BFC status) such as San Francisco (Gold), Portland (Gold), Seattle and the Los Angeles areas have taken the lead towards innovative ways to improve their respective bicycle plans. The implementation of shared-lane arrows (“sharrows”) and bicycle unique pavement markings (i.e. blue lanes and bike boxes) has started to make its way into other U.S. cities, such as New York City, NY, Tallahassee, FL, Cambridge, MA and Louisville, KY (Bronze).

2.3.1 Sharrows

The sharrow is a pavement marking which goes in the right-hand travel lane of a roadway. This tells both the motorists and the bicyclists that this lane is intended to be shared by both users.

The markings also have several other intentions, which include⁴⁰:

- Encourages cyclists to ride further towards the center of the lane and away from car doors.
- Encourages cyclists to ride on the street, as opposed to the sidewalk, and in the same direction as traffic.
- Also, makes motorists aware of cyclists' right to and presence in the lane.

Sharrows (Pics 2.6 & 2.7) were introduced in California, in 2004. A study conducted by the City of San Francisco shows that sharrows improved roadway positioning of both bicyclists and motorists, by providing space for cyclists well outside the dangerous "door zone"(Figure 2.7). The sharrows also caused drivers to give more clearance when passing. The sharrow also reduced wrong-way riding by bicyclists¹⁶.

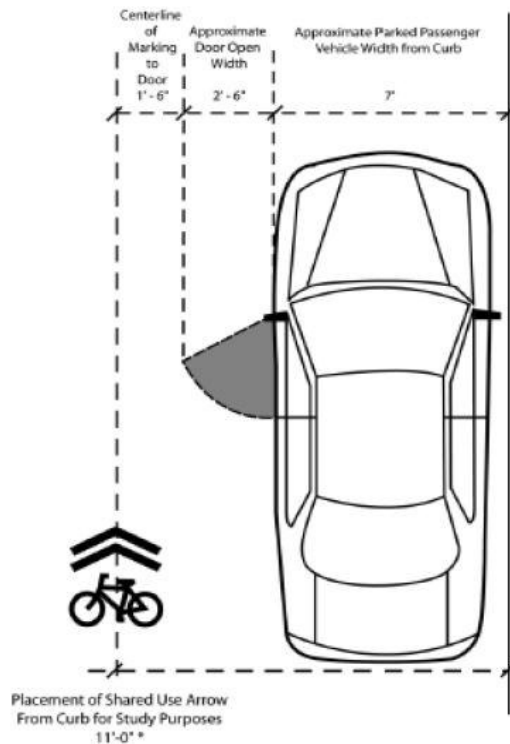
(Pic 2.6 = San Francisco, CA)¹⁴

(Pic 2.7 = Los Angeles, CA)¹⁵



(Born, Paul)

(Figure 2.7 = Sharrow Design Criteria)¹⁷



(Masoner, Richard)

At the 2007 meeting, the National Committee on Uniform Traffic Control Devices¹⁸ unanimously voted to endorse the shared lane marking (sharrow) and forwarded it to the Federal Highway Administration (FHWA) to be included in the next edition of the federal Manual on Uniform Traffic Control Devices (MUTCD)¹⁴. This publication is due to be published in 2009.

Until the revised MUTCD is released, cities wishing to use sharrows must make application to the FHWA for inclusion of sharrows into their bicycle plans. San Francisco, Los Angeles and other California cities obtained permission and have implemented the usage of sharrows already, via the California Department of Transportation¹⁹. Other cities, such as Portland, OR and Louisville, KY (Figure 2.8), made application to the FHWA to have sharrows approved as “experimental markings”²⁰.

(Figure 2.8 = Sharrow Sign in Louisville, KY)⁴⁰



For FHWA approval, a before-and-after study must be conducted and this data must be submitted. The application process for the City of Louisville included the following steps.

1. Obtain application from another city (i.e. Portland) that has already applied and customize their form.
2. Using video analysis, estimate the distance between the flow of bicycles and the motor vehicle traffic lane.
3. Using video analysis, estimate the minimum distance that vehicles come to bicycle traffic.
4. Document the number of wrong-way riding incidents, by bicycles.
5. Sample size must meet FHWA minimum requirement, for population.
6. A regression analysis of the data must be completed.

Louisville received permission from the Federal Highway Administration to experiment with the shared-lane marking or sharrow. The markings were first installed on the Clark Memorial Bridge and other metropolitan roads, in August of 2007.



SECTION 3 BICYCLE LANES

A bicycle (bike) lane is a striped lane on a roadway facility designated for bicycle use **only**. Bike lanes should be one-way facilities that carry bicycle traffic in the same direction as vehicular traffic, but not in the same space (Pic 3.1).

(Pic 3.1= Jollyville Rd. in Austin, TX)



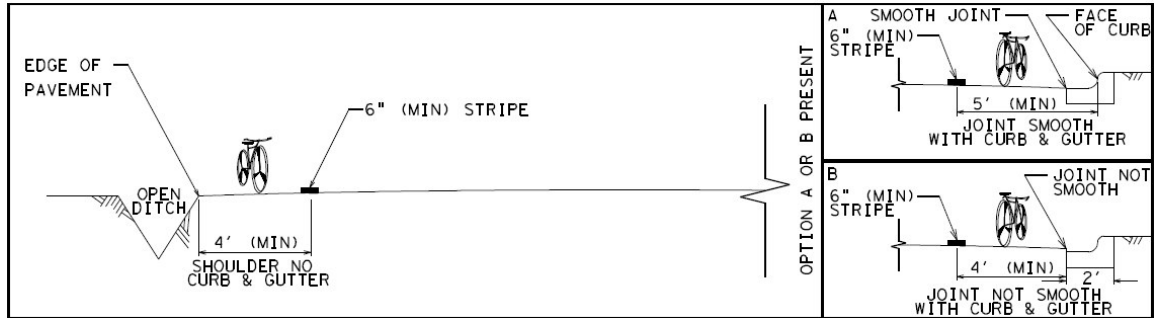
(Church, Eddie)

3.1 BIKE LANES

3.1.1 Bike Lane without Parking

AASHTO recommends that a bike lane be a minimum of 4 feet wide, along a roadway without curb and gutter. On a roadway with curb and gutter, a bike lane of 5 feet from face of curb to the bike lane stripe is recommended (Figure 3.1). A minimum of 3 feet of rideable surface should be provided when the longitudinal joint between the pavement and gutter is smooth (Pic 3.2). The rideable surface should be increased to 4 feet if this longitudinal joint is not smooth. A width of 5 feet or greater is recommended on roadways with substantial truck traffic or where vehicle speeds are greater than 50 mph.

(Figure 3.1 = Bike Lane without Parking)



(Klotz Associates, Inc.)

(Pic 3.2= Mesa Dr. in Austin, TX)

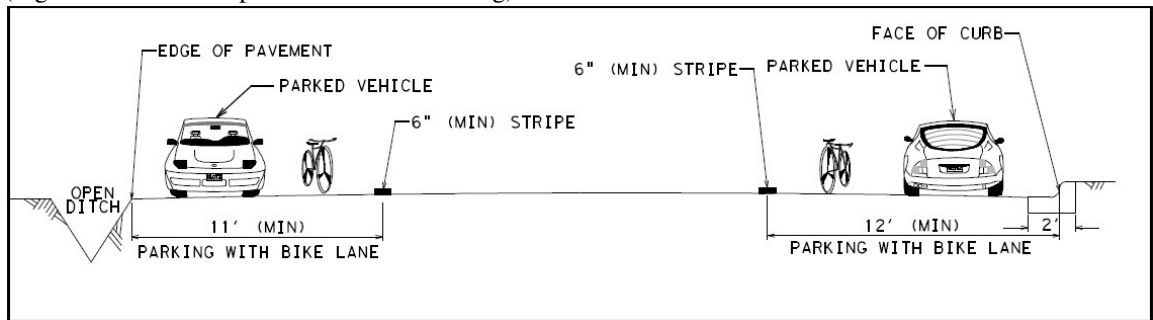


(Church, Eddie)

3.1.2 Bike Lane with Parking

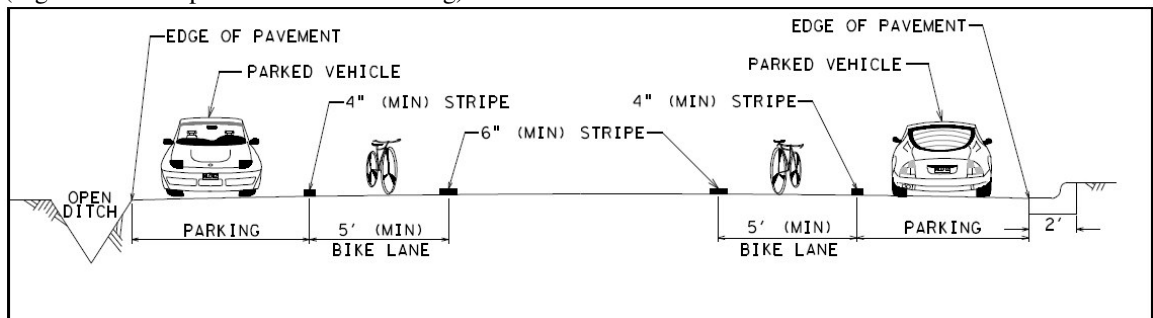
If the parking area is not striped, the shared area should be a minimum of 11 feet without curb and gutter and 12 feet with curb and gutter (Figure 3.2). If the parking area is striped then a minimum 5 foot wide bike lane should be provided, between the travel lane and parking area (Figure 3.3). In areas with a high volume of parking, an additional 1 to 2 feet is desirable. Shoal Creek Boulevard is an example of a shared bicycle and parking lane which is currently under review by the City of Austin Transportation Division (Pic 3.3).

(Figure 3.2 = Non-striped Bike Lane + Parking)



(Klotz Associates, Inc.)

(Figure 3.3 = Striped Bike Lane + Parking)



(Klotz Associates, Inc.)

(Pic 3.3 = Shoal Creek Blvd. in Austin, TX)



(Church, Eddie)

3.1.3 Bike Lane Concerns

Bike lanes share the same concerns as shared roadways: on-street parking (Pic 3.4), pavement surface quality and drainage inlet grates. Bicyclists must avoid open car doors, maneuvering vehicles and extended mirrors. The minimum lane widths should be provided to accommodate bicycles and parking for vehicles. Pavement surfaces should be smooth and uniform to provide a comfortable and safe ride for bicyclists.

Wide cracks, raised asphalt edges, depressed drainage appurtenances and potholes can cause a cyclist to lose control. Bicycle-safe inlet grates are recommended, if roadway drainage features are required on bike routes. Inlet grates with slots parallel to the roadway can trap the wheel of a bicycle. Inlet grates should be replaced with bicycle safe grates that provide cross bars perpendicular with the roadway.

(Pic 3.4 = Mesa Dr. in Austin, TX)



(Church, Eddie)

3.2 OTHER CITIES

3.2.1 Reconfigure Existing Lanes

In Sacramento, CA, existing road lanes have been reconfigured to accommodate the addition of bike lanes (Pic 3.5). Streets that once had narrow vehicle lanes can be reconfigured via a “road diet”, to create bike lanes on both sides. The Sacramento one-way street in Picture 3.5 illustrates the traffic-calming benefit of bike lanes. This street once had three narrow vehicle lanes prior to the “road diet” reconfiguration to create bike lanes on both sides. In addition to improving safety for cyclists, this dual-lane treatment has calmed traffic, pleasing neighborhood residents²¹.

(Pic 3.5 = Road Diet in Sacramento, CA)²¹



A typical road diet technique is to reduce the number of lanes on a roadway cross-section. One of the most common applications of a road diet is to convert a 4-lane section (Pic 3.6) with two travel lanes in each direction, into a 3-lane section with one travel lane in each direction plus two-way turn lane in the middle (Pic 3.7). In addition to improving safety for cyclists, this type of reconfiguration can also calm traffic²².

Typical lane diet techniques include narrowing vehicle lanes and also left-turn lanes. The resulting space created by reducing lane widths can be applied to bike lanes or wider shoulders. This gives added sight lines, turning radius and other benefits to all vehicles. Lane diets should fall within the AASHTO recommended lane width range. Road diets typically occur on roadways with 8,000 to 19,000 vehicles per day²². At 20,000 vehicles per day the diet is called a "super road diet." These diets range from 19,000 on up to about 23,000 vehicles per day²². The super diet can be implemented by replacing signals with roundabouts and other means to keep traffic moving smoothly and uniformly.

(Pic 3.6 = 4 Lanes, before Road Diet)²³



(Pic 3.7 = 3 Lanes + Bike Lanes, after Road Diet)²³



3.2.2 Blue Lanes

Blue bicycle lanes are being used in other cities, such as Portland, Oregon (Gold), Seattle, Washington and Copenhagen, Denmark. A blue lane is a colored bicycle lane used to promote bicycle awareness at motor vehicle-bicycle conflict areas, such as near a highway on-ramp or where traffic merges. Since 1997, the City of Portland has employed and evaluated blue lanes in ten locations. They found that more motorists yielded, more cyclists used the bike lanes, and both groups believed that blue lanes helped to promote safety³⁴. The study from the City of Portland shows the following statistics³⁵:

Observed action	Before blue paint	With blue paint
Bicyclist looked back	43.2%	25.9%
Bicyclist slowed or stopped	11%	4%
Bicyclist yielded	28.3%	8%
Bicyclist used turn signal	11%	5%
Motorist slowed or stopped	70.8%	86.7%
Motorist yielded	71.7%	92%
Motorist used turn signal	83.8%	63%

The above statistics reflect that more motorists tend to yield or stop after a bike lane has been painted blue. However, the first four statistics show a decrease in precautionary measures by cyclists. Both the positive and negative aspects of blue lanes have been presented, in this section. The interpretation of these statistics and other facts that have been presented may vary between individuals, so caution must be taken when applying this information towards different scenarios.

There are standards governing the use of traffic control devices (i.e. signs, stripes, and signals), so that traffic controls throughout the U.S. are uniform as possible. These standards are set forth in the Manual on Uniform Traffic Control Devices (MUTCD)¹². The MUTCD does not provide for the use of colored markings to delineate bike lanes, but the blue lanes in Portland were implemented via a partnership between the University of North Carolina Highway Safety Research Center and the Federal Highway Administration³⁶. See the pictures below, from various locations in Portland, Oregon (Pics 3.8 to 3.12).

(Pics 3.8 to 3.12 = Blue Lanes in Portland, Oregon)³⁶





3.2.3 Bike Boxes

A bike box is a designated area at the head of a traffic lane that allows cyclists a safe and visible way to get to the head of a traffic queue, at a signalized intersection. The actual box is designated by two pavement markings called stop bars, approximately 12 to 14 feet apart³⁹. The motor vehicle is required to stop at the first stop bar, so cyclists can cue in the designated box. A bike lane located on the right side of the right-lane is provided for bicycles, so bicycles can pass vehicles in order to enter the bike box easily and safely. The bike box extends at a right-angle from the bicycle lane across a lane or lanes of traffic.

Several European cities, Eugene, Oregon (Silver), Cambridge, Massachusetts (Pic 3.13) and Portland (Pic 3.14) have implemented bike boxes into their bicycle plans. Bicycle boxes promote safety, by making cyclists more visible and also eliminating conflicts for vehicles that are turning across a cyclist's path³⁴. Bike boxes have limited situations in which they can be used safely. The application of bike boxes should be thoroughly evaluated, before being implemented at any intersection. Intersections have many design variables that must be considered; therefore each intersection should be evaluated on a case-by-case scenario. Bike boxes are best used at a split-phased (one direction at a time) signalized intersection on a two lane roadway.

(Pic 3.13 = Bike Box in Cambridge, MA)³⁸



(Allen, John S.)

(Pic 3.14 = Bike Box in Portland, OR)³⁷



(Boulanger, Todd)

3.3 OTHER COUNTRIES

Amsterdam, Holland has 249 miles (400 Km) of dedicated bike lanes and paths²⁴. They run along the right sides of streets and typically feature white lines and bike symbols painted on the roadway or on a reddish-colored path. Amsterdam has many signs and signals designed especially for cyclists. Some important ones include:

- [Bike Traffic Lights](#): Signal lights shine red, yellow and green in the shape of a bicycle, at most major intersections. The button shown below (Pic 3.15) activates the special bike traffic light (Pic 3.16) to turn from red to green. City transportation trams and other vehicles have their own lights that don't always correspond with the bike lights. If a bike light does not exist, then the vehicle traffic lights are to be used by both bicycles and motor vehicles.

(Pic 3.15 & 3.16 = Activation & Signal in Amsterdam)²⁵



(McAllister, Shannon)



(McAllister, Shannon)

- [Designated Bike Path/Route](#): A round sign with a blue background and white bicycle indicates a bike lane or route (Pic 3.17).

(Pic 3.17 = Route Sign in Amsterdam)²⁶



(McAllister, Shannon)



SECTION 4

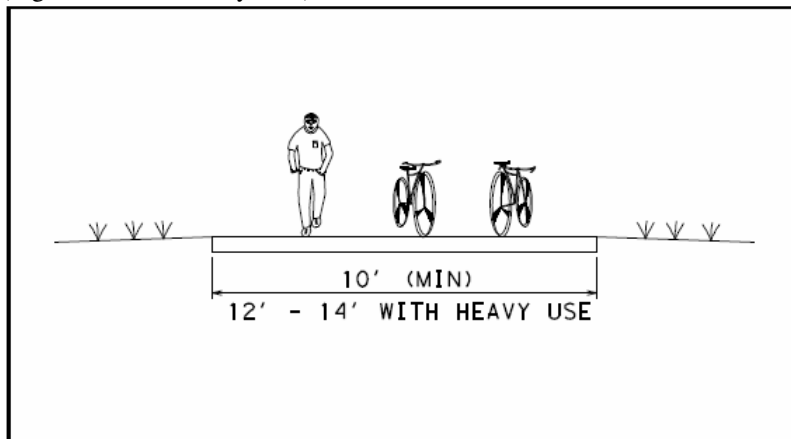
SHARED-USE PATH

Shared use path bicycle (bike) facilities are located on **exclusive right-of-way** (ROW) and with minimal cross flow by motor vehicles. These paths are often shared by cyclists, skaters and pedestrians.

4.1 SHARED USE PATH

4.1.1 TWO-WAY USE

(Figure 4.1 = Two-way Path)



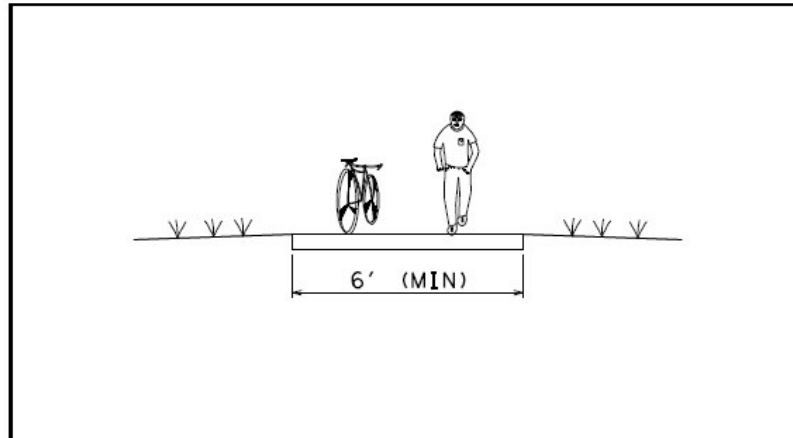
(Klotz Associates, Inc.)

Shared use paths should not be used as a replacement to on-road facilities, but rather to supplement on-road bike routes. On a typical shared use path a 10 foot wide path is recommended. Paths with heavy use should be increased to 12 or 14 feet wide (Figure 4.1) Shared use paths are typically not recommended adjacent to a roadway for the following reasons.

- Unless physically separated from the roadway by a median or a concrete barrier, one direction of bicycle traffic would be riding against the motor vehicle traffic.
- When the path ends, bicyclists will tend to continue to travel on the wrong side of the street.
- At intersections, vehicle traffic will not notice bicyclists approaching from the right.
- Bicyclists riding against vehicle traffic cannot read the roadway signs.

4.1.2 ONE-WAY USE

(Figure 4.2 = One-way Path)

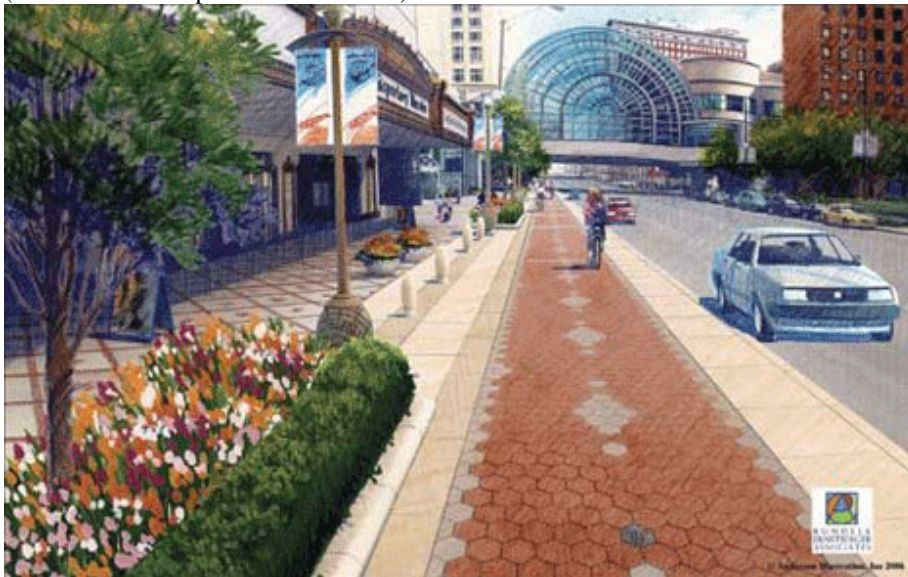


(Klotz Associates, Inc.)

A one-directional path should be a minimum of 6' wide, however they are not typically recommended because of the difficulty in enforcing one-way progression (Figure 4.2).

4.2 OTHER CITIES

(Pic 4.1 = Indianapolis Cultural Trail)²⁷



The city of Indianapolis, Indiana started construction of the Indianapolis Cultural Trail, in the spring of 2007²⁷ (Pic 4.1). This multi-use facility will accommodate bicycles and pedestrians, to encourage more human-powered movement through the city. This trail

will allow pedestrians to have their own right-of-way through the city center with access to many of the city's arts, retail, sporting, and cultural institutions. Five downtown cultural districts will be connected by the Indianapolis Cultural Trail. It will also connect with the Monon Trail (Pic 4.2), allowing visitors to easily access the Broad Ripple Village from downtown. Plans for the trail include transforming whole lanes of existing traffic in some places into wide, open spaces for bikes and people²⁸.

(Pic 4.2 = Monon Trail in Indianapolis, IN)²⁹



In 2005, the Monon Trail was used more than 1.2 million times (Pic 4.3), making this urban greenway perhaps one of the busiest in the nation³⁰. Originally built in 1847, the rail-trail pioneered in Indiana an already nation-wide vision: converting railways to greenways for recreation and commuter use. The Monon links commercial districts, schools, parks, the state fairgrounds and a dozen residential neighborhoods.

(Pic 4.3 = Monon Trail in Indianapolis, IN)²⁹





SECTION 5 INTERSECTIONS & SIGNALS

5.1 INTERSECTIONS

5.1.1 Roadway Intersections

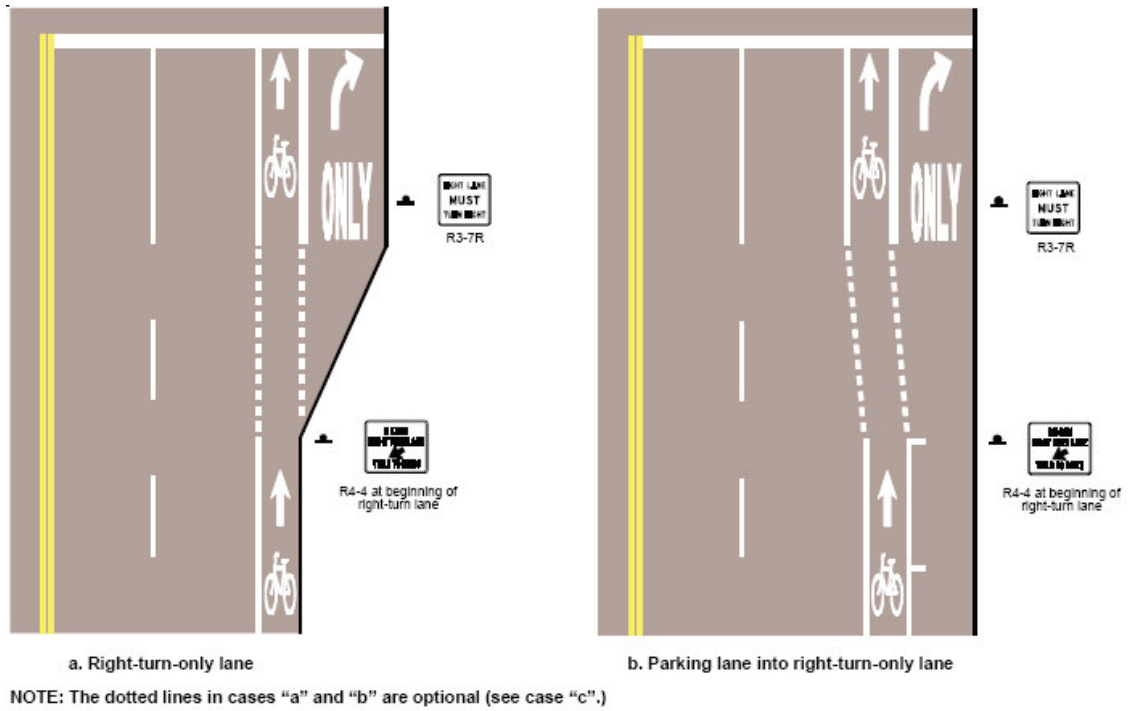
A common conflict at intersections is between vehicles turning right and cyclists wanting to go straight (Pic 5.1). It is possible to reduce conflicts, by merging bicyclists and right turning vehicles before the intersection (Pics 5.2 & 5.3). Below are several options to help minimize conflicts (Figures 5.1 – 5.4).

(Pic 5.1 = Far west Blvd. in Austin, TX)



(Church, Eddie)

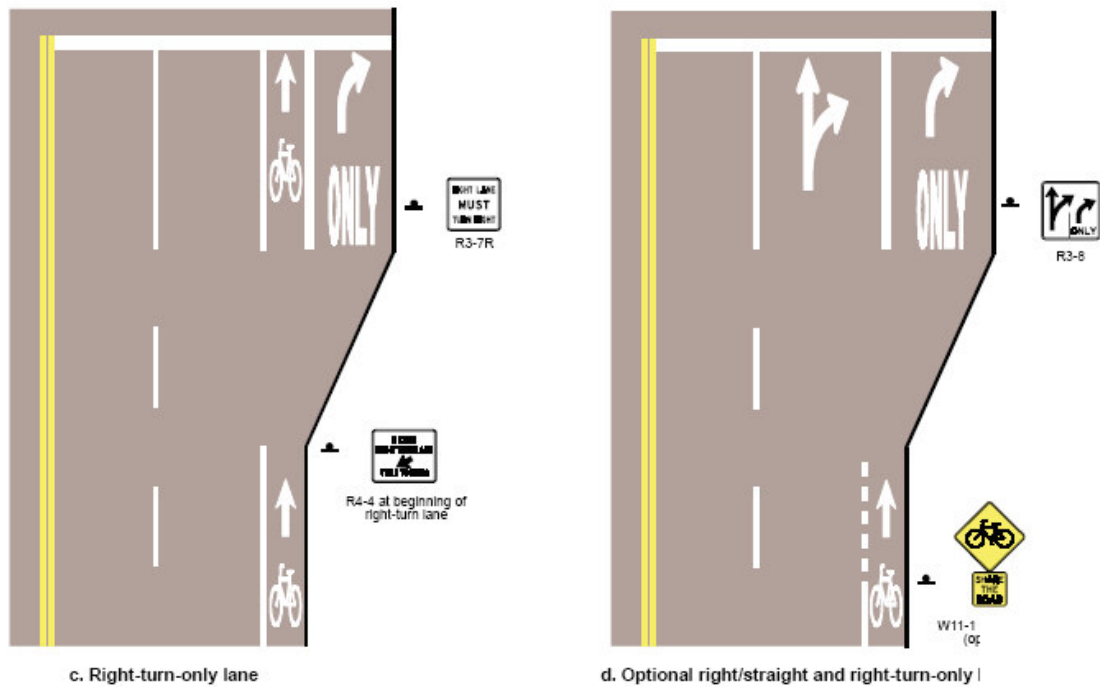
(Figure 5.1 & 5.2 = Right Turn Conflicts)²



(Pic 5.2 & 5.3 = Rock Harbor Dr. @ RM 620 in Austin, TX)

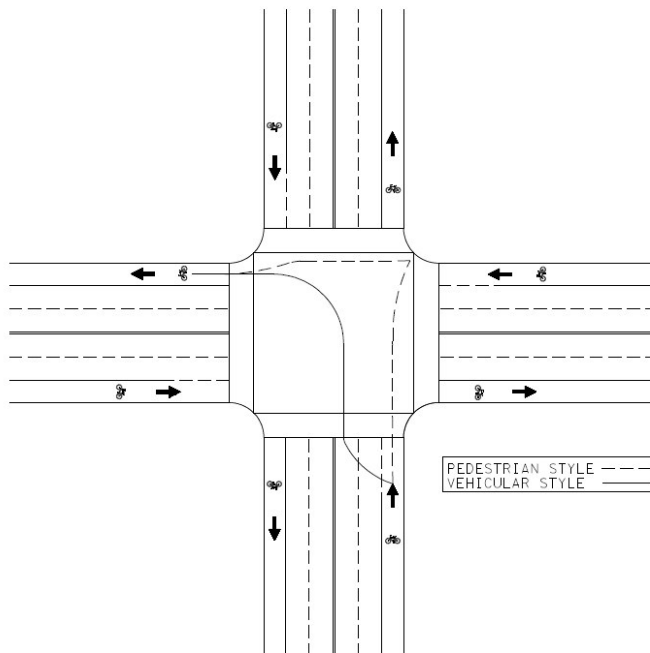


(Figure 5.3 & 5.4 = more Right Turn Conflicts)²



Another conflict for vehicles and bicyclists at intersections is left turns. Bicyclists have two options when making a left turn at an intersection. These options include a “vehicular style” left turn or a “pedestrian style” left turn (Figure 5.5).

(Figure 5.5 = Left-turn Conflicts)²

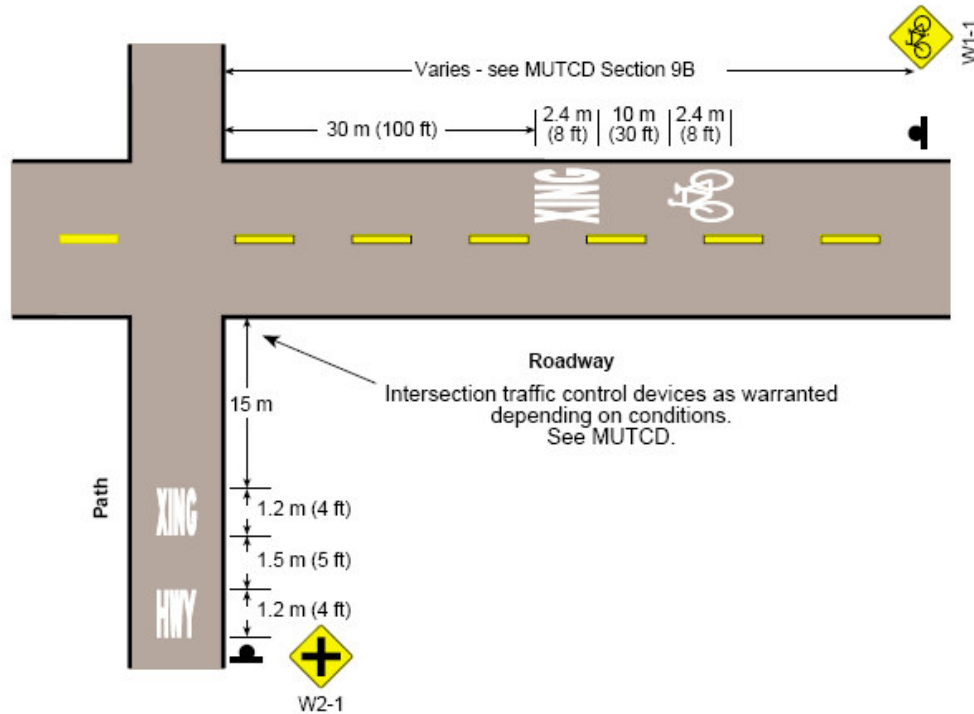


5.1.2 Path-Roadway Intersections

There are three types of path-roadway intersections: midblock, adjacent path and complex. Midblock and adjacent path are shown below.

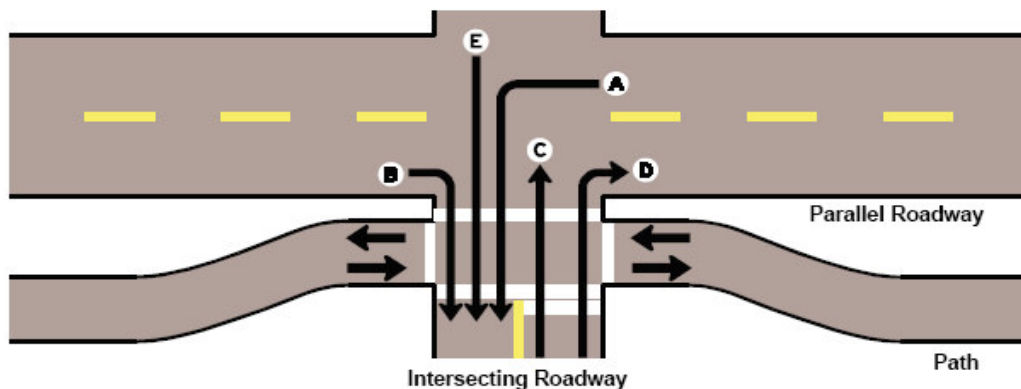
Midblock Intersection – The MUTCD³ provides guidance for properly signing and striping of midblock intersections.

(Figure 5.6 = Midblock Intersection)²



Adjacent Path Intersection – Adjacent path intersections create many conflict points between motorist and bicyclist. Careful consideration to permitted movements is important when designing this type intersection.

(Figure 5.7 = Adjacent Path Intersection)²



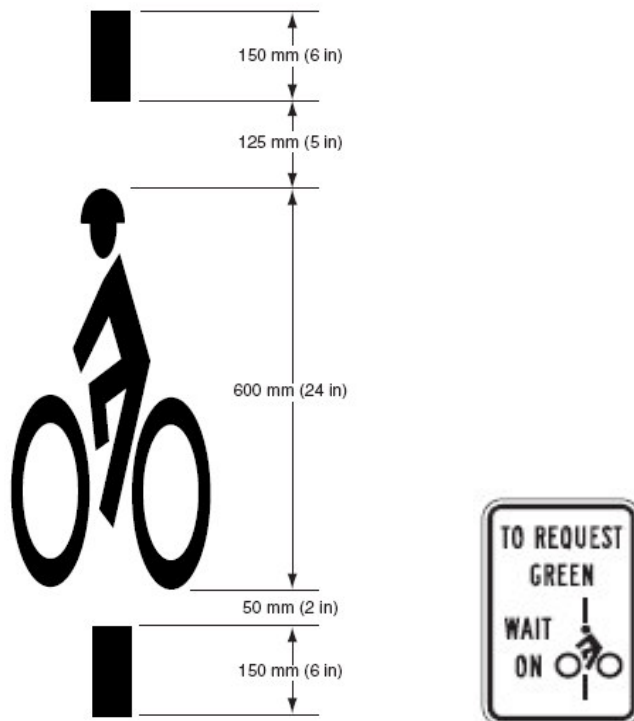
Complex Intersection – Complex intersections must be considered on a case by case basis.

5.2 SIGNALS

The two primary concerns that cyclists have at signalized intersections include insufficient clearance interval and poor bicycle detection. An adequate clearance interval should be provided for cyclists that enter the intersection at the end of the green light. This means that the yellow and all red time should be long enough for the average “B” bicycle user to get through the intersection and be clear of oncoming vehicles. AASHTO provides an equation that can be used to determine the amount of yellow time plus all red time necessary. However, field observations should be undertaken to verify the minimum clearance interval.

Bicycle detection is important for a cyclist’s safety and for compliance with traffic laws. Detection can be by either loop detectors within the pavement or by Video Image Vehicle Detection System (VIVDS) cameras mounted on the opposing signal arms. Detectors should be placed in the cyclist’s expected path. Specific signing and pavement markings can aid in directing bicyclists to the optimum location for detection. The symbol below (Figure 5.8) can be placed at the location for a bike loop detector or the best area for Video Image Vehicle Detection Systems (VIVDS) detection. This will inform the cyclist of the optimum location to activate the “green cycle”.

(Figure 5.8 & 5.9 = Bicycle Loop Marking & Sign)¹²



Standard loop detectors will detect cyclists, but the sensitivity must be adjusted so that bicycles are detected and the loops must be placed in a location where a cyclist's movements can be detected. Detection using loop detectors does not depend on the presence of conductive metals as commonly thought. Instead, most in-pavement loop detectors commonly used today are inductive loops, which are triggered by a break in the magnetic field³¹.

5.3 OTHER CITIES

A bicycle signal provides a separate signal to direct bike traffic through an intersection. Red, amber, and green bicycle lights are installed in addition to the standard red, amber and green ball and arrow indications. In California, bikes have the same rights and responsibilities as motor vehicles in most situations.

Consequently, the City of Davis changed its municipal code to clarify that at intersections with bicycle signals (Pic 5.4), bicycles should only obey the bicycle signals³². The City of Davis has also implemented the following bicycle safety measures: installation of bicycle signal heads that include advance signing warning users that bicycle signals are in use at the intersection ahead, and a “NO RIGHT TURN ON RED” changeable sign prohibiting motor vehicles from conflicting with bike and pedestrian traffic during the bike phase. Having separate bicycle signals has the following advantages³²:

- Separates conflicting movements.
- Provides cyclists with priority movement at an intersection.
- Protects cyclists in the intersection, which may improve real and perceived safety at high conflict areas.
- Improves flow of all types of traffic through the intersection.
- Alternates right-of-way between different road users.

(Pic 5.4 = Bicycle Signals in California)³²





APPENDIX A

BIKE FACILITIES REFERENCE CHART

FACILITY TYPE	FACILITY DESCRIPTION	COMMENTS	MINIMUM WIDTH ² (LF)	RECOMMENDED WIDTH ² (LF)	Pavement Markings	Signs
Shared Roadway	Paved Shoulder	No curb & gutter (C&G).	4	4 +	Separated from traffic by 4 inch stripe.	Bicycle route signs can be posted, if AASHTO criteria are met.
Shared Roadway	Paved Shoulder	Next to C&G, guardrail, etc. Do not include gutter width.	5	5 +	Separated from traffic by 4 inch stripe.	Bicycle route signs can be posted, if AASHTO criteria are met.
Shared Roadway	Paved Shoulder	If next to 50+ mph traffic, wider shoulders recommended.	5	5 +	Separated from traffic by 4 inch stripe.	Bicycle route signs can be posted, if AASHTO criteria are met.
Shared Roadway	Wide Curb Lane	Vehicles & bikes in same lane. C&G width not to be included.	12	14	If wider than 15 feet, striped bike lanes should be considered.	Bicycle route signs can be posted, if AASHTO criteria are met.
Shared Roadway	Wide Curb Lane	When steep grades, drainage grates or barriers exist.	12	15	If wider than 15 feet, striped bike lanes should be considered.	Bicycle route signs can be posted, if AASHTO criteria are met.
Shared Roadway	Wide Curb Lane	Includes minimum of 12 feet for parked vehicles and bicyclists.	22	24	If wider than 15 feet, striped bike lanes should be considered.	Bicycle route signs can be posted, if AASHTO criteria are met.
Bike Lane	Without Parking	No C&G.	4	5 +	Separated from traffic by 6 inch stripe.	See MUTCD ³ , chapter 9.
Bike Lane	Without Parking	Next to C&G, guardrail, etc. Do not include gutter width.	3	5 +	Separated from traffic by 6 inch stripe.	See MUTCD ³ , chapter 9.
Bike Lane	With Striped Parking	If next to 50+ mph traffic, an additional 1 to 2 feet is recommended.	5	7	Striped bike lane between vehicle traffic and parking lane.	See MUTCD ³ , chapter 9.
Bike Lane	With Non-Striped Parking	No C&G.	11	13	If high volume of parking, add 1 to 2 feet.	See MUTCD ³ , chapter 9.
Bike Lane	With Non-Striped Parking	Next to C&G.	12	14	If high volume of parking, add 1 to 2 feet.	See MUTCD ³ , for intersection crossings.
Shared Use Path	Two-Way Use	Not recommended, if adjacent to existing roadways.	10	12 +	Can have center line striping and direction markings.	See MUTCD ³ , for intersection crossings.

(AASHTO)



APPENDIX B

2007 BICYCLE FRIENDLY COMMUNITIES

	2007 POPULATION³³		2007 POPULATION³³
<u>Platinum (1)</u>		<u>Bronze (cont.)</u>	
Davis, California	65,384	Boca Raton, Florida	79,059
		Brentwood, California	39,996
<u>Gold (7)</u>		Brunswick, Maine	14,708
Boulder, Colorado	92,193	Burlington, Vermont	37,884
Corvallis, Oregon	50,776	Carmel, Indiana	45,040
Madison, Wisconsin	219,506	Carrboro, North Carolina	16,230
Palo Alto, California	57,738	Cary, North Carolina	102,482
Portland, Oregon	545,132	Chandler, Arizona	221,625
San Francisco, California	764,167	Chattanooga, Tennessee	154,589
Tucson, Arizona	521,615	Denver, Colorado	558,246
		Flagstaff, Arizona	59,726
<u>Silver (12)</u>		Gilbert, Arizona	157,616
Austin, Texas	669,131	LaCrosse, Wisconsin	50,543
Bellingham, Washington	71,868	Lawrence, Kansas	82,906
Chicago, Illinois	2,850,878	Longmont, Colorado	81,238
Eugene, Oregon	143,466	Louisville, Kentucky	246,076
Folsom, California	65,836	Mesa, Arizona	438,150
Fort Collins, Colorado	126,953	Milwaukee, Wisconsin	583,571
Gainesville, Florida	95,036	Mountain View, California	69,901
Jackson, Wyoming	8,626	Orlando, Florida	201,413
San Luis Obispo, California	45,314	Park City, Utah	8,133
Santa Barbara, California	91,049	Presidio of San Francisco, CA	36,224
Scottsdale, Arizona	221,493	Redmond, Washington	47,567
Tempe, Arizona	157,381	Roswell, Georgia	75,721
		Sacramento, California	456,545
<u>Bronze (44)</u>		Salt Lake City, Utah	179,748
Ada County, Idaho	336,193	St. Petersburg, Florida	249,547
Albuquerque, New Mexico	481,387	San Jose, California	915,872
Ann Arbor, Michigan	115,135	Schaumburg, Illinois	73,980
Arlington, Virginia	191,072	Shawnee, Kansas	56,328
Ashland, Oregon	20,710	South Lake Tahoe, California	23,737
Auburn, Alabama	48,259	South Sioux City, Nebraska	12,029
Beaverton, Oregon	80,895	Sunnyvale, California	129,441
Bend, Oregon	63,768	Vancouver, Washington	153,954
Bloomington, Indiana	69,070	Washington, DC	557,598

(Bicycle Friendly Community Campaign)



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