VOLUME 3

DAVENPORT GO

a multi-modal enhancement plan

March 2019

VOLUME 2

MARKET FOR ACTIVE TRANSPORTATION

This chapter investigates the market for bicycling in Davenport - the number of potential cyclists and pedestrians and the preferences of that potential market. It draws heavily on new and recent census information, national trends, and the 350+ citizens who responded to the Davenport GO Multi-Modal Transportation Survey.

5

INTRODUCTION

Before building a major shopping center or apartment project, a developer usually commissions a market analysis, designed to determine whether enough people will shop or live there to support the effort and to define the features that will appeal to customers. Similarly, an active transportation master plan should also evaluate the size and character of the potential market. This helps assess the impact of a bicycle and pedestrian transportation program on factors such as motor vehicle traffic and emissions. It also helps us understand what the existing and potential bicycling community wants of the program, in turn increasing the chances that active modes can reach their potential for Davenport and the region.

This market study uses two major instruments:

- Estimates of existing and future pedestrian and bicycling demand: Using a demand model developed by Alta Planning & Design that is clear, straightforward, and easy to track for future measurement.
- The results of the Davenport GO: A Multi-Modal Transportation Plan. This survey was completed by 368 people, a very satisfactory participation rate for a community of this size, and provides valuable information about the city's potential active transportation community.

EXISTING ACTIVE TRANSPORTATION DEMAND

Tables 5.2 and 5.3 on the following pages use the Alta model to estimate existing and potential pedestrian and bicycle demand. Primary sources of information include the 2012-2016 average computations of the American Community Survey (ACS), developed by the Census Bureau, and 2010 Census data, Federal Department of Transportation, and the Safe Routes to School Program. The model makes certain assumptions about transportation choices of populations such as K-12 and college students. The sources of these assumptions are included in the table.

Davenport now has an estimated 56,366 daily pedestrian trips and about 4,987 daily bicycle trips for all purposes (including recreational activity). Walking has a 2.32 percent commuter mode share. Bicycling has a 0.42 percent commuter mode share. This contrasts with Minneapolis with a bicycling mode share of about 3.9 percent, one of the highest in the nation. Table 2.1 shows the mode share in a variety of other cities.

2030 Midpoint Demand

Tables 5.2 and5.3 provide both projections of trips made by pedestrians and bicyclists at 50 percent and 100 percent completion of the proposed system, based on a 20 year implementation schedule between now and 2040. At the mid-point, enough infrastructure has been put in place to have a significant impact on transportation choices. This midpoint model paints a picture of what Davenport's transportation could be 10-12 years from now with gradual implementation of an improved pedestrian and bicycle system. It assumes that:

- Walk-to-work commuters increase from about 2.32 percent to 3.25 percent of all workers, a very modest increase.
- Transit's share of the modal mix increases from 1.27 percent to a 3.25 percent as system and accessibility improvements continue to be made according to regional planning efforts.
- Bicycle commuting, encouraged by new infrastructure, could increase to about 1.2 percent by 2030.
- About 22.5 percent of K-8 students will walk to school, compared to an assumption of about 17 percent today. This is still far lower than the 60 percent of students who walked to school thirty years ago.

Applying these changes increases daily pedestrian trips from about 56,366 in 2016 to about 83,578 in 2030, almost doubling over the 12 year period. Bicycle trips could increase from about 4,987 to about 20,772 daily trips. These very attainable changes begin to have a real impact on the overall transportation picture in Davenport. This model assumes that by 2030, about 8% of work commuting trips will eventually be made by "active transportation" modes – transit, foot, and bicycle.

2040 Potential Demand

Tables 5.2 and 5.3 project full implementation in Davenport of the complete pedestrian and bikeway system, along with supporting education and encouragement programs. This projection assumes that the city will grow at an average annual rate of 0.30 percent during the next 20 years, the general growth rate forecasted in the Comprehensive Plan: Davenport + 2035. It also projects that active modes will claim a 10 percent mode share by 2040 and that 2 percent of Davenport's residents will cycle to work. The number of K-8 students walking to school will increase to 25 percent, still far below levels experienced thirty years ago.

All of the assumptions result in an increase of weekday pedestrian trips from 56,366 in 2016 to about 102,969; and an increase in weekday bicycle trips from about 4,987 in 2016 to about 28,196.

In addition to making a significant contribution to the carrying capacity of streets in Davenport, active transportation also can have significant health benefits. Assuming that the average bicycle trip is about two miles and the average pedestrian trip is 0.5 miles, the projected number of added trips made by active transportation adds 46,418 bicycle miles (or 3,868 hours at 12 mph) and 23,301 pedestrian miles (or 7,767 hours at 3 mph). The impact of this level of physical activity and calorie consumption can be highly beneficial to the city's residents.

It is also important to note that these projections do not include technological change that can make bicycling even more widespread. Many observers believe that the introduction of e-bikes, which use a small electric motor to assist pedal-driven bicycles, will broaden the appeal of bicycling for transportation. On-street infrastructure is particularly well-suited to accommodating these more capable vehicles.

Table 5.1: Comparative Cities' Mode Share

CITY	TOTAL COMMUTERS	WALK %	BIKE %
Davenport, IA	46,491	2.3	0.4
Omaha, NE	204,463	2.8	1.0
Cedar Falls, IA	21,886	9.9	0.9
Des Moines, IA	102,291	2.8	0.4
Dubuque, IA	28,631	4.9	0.4
Sioux City, IA	39,661	1.7	0.2
Duluth, MN	41,795	5.8	0.8
Edina, MN	22,150	1.5	0.7
Lee's Summit, MO	45,488	0.4	-
Lincoln, NE	141,747	2.8	1.7
Fargo, ND	65,138	3.5	0.7
Beaverton, OR	45,685	3.4	1.1
Gresham, OR	47,569	2.6	0.7
Sioux Falls, SD	89,272	2.1	0.4
Bellingham, WA	39,308	8.3	3.3
Cedar Rapids IA	65,912	2.9	1.8

Source: 2012-2016 American Community Survey

Table 5.2: Existing and Projected Pedestrian Trips, 2016-2040

PEDESTRIAN TRIPS	2016 BASE YEAR	2016 SHARE (%)	2020	2020 SHARE (%)	2030	2030 SHARE (%)	2040	2040 SHARE (%)	ASSUMPTIONS/SOURCES
Population	102,305		104,898		108,360		111,655		2016: ACS Base; 2016-2040 0.3% average annual growth rate from the Comprehensive Plan
Population 16 Years and Older	48,259	47.17%	49,482		51,115		52,670		2012-2016 ACS
Total Population Commuting to Work	46,491	45.44%	47,669		49,243		50,740		2012-2016 ACS
Walk to Work	1,062	2.28%	1,192	2.50%	1,600	3.25%	2,030	4.00%	Base year: 2012-2016 ACS
Work at Home Population 16+	1,786	3.70%	1,831	3.70%	1,891	3.70%	1,949	3.70%	2012-2016 ACS
Work at Home Pedestrian Trips	446	25%	458	25%	473	25%	487	25%	25% make one ped trip
Take Transit to Work	579	1.25%	1,192	2.50%	1,600	3.25%	2,030	4.00%	Base year: 2012-2016 ACS
Walk to Transit	444	75%	894	75%	1,200	75%	1,522	75%	75% walk to transit
School Population K-8	13,197	12.90%	13,531	12.90%	13,978	12.90%	14,403	12.90%	2012-2016 ACS
K-8 Pedestrian Trips	2,217	16.80%	2,706	20.00%	3,145	22.50%	3,601	25.00%	National Center for Safe Routes to School, 2013, 15.2% walk to/ 18.4% walk home from school
School Population 9-12	3,785	3.70%	3,881	3.70%	4,009	3.70%	4,131	3.70%	2012-2016 ACS
9-12 Pedestrian Trips	208	5.50%	233	6.00%	321	8.00%	413	10.00%	5.5% walk to school
College Aged Population	10,537	10.30%	10,804	10.3%	11,161	10.3%	11,500	10.3%	2012-2016 ACS (18-24 year olds)
College Aged Pedestrian Trips (not to work)	3,161	30.00%	3,781	35.00%	4,464	40.00%	5,750	50.00%	
Total Pedestrian Commuters	7,556		9,264		11,204		13,803		
Total Pedestrian Commuter Trips	15,112		18,528		22,407		27,606		2 trips for each commuter
Other Trips Ratio (commuter to non-commuter trips)	2.73		2.73		2.73		2.73		U.S. DOT, Federal Highway Administration, 2001 National Household Travel Survey, via Alta Planning & Design
Other Pedestrian Trips	41,254		50,580		61,171		75,364		Commuter Trips x Other Trips Ratio
Total Daily Pedestrian Trips	**56,366**		**69,108**		**83,578**		**102,969**		

Table 5.3: Existing and Projected Bicycle Trips, 2016-2040

PEDESTRIAN TRIPS	2016 BASE YEAR	2016 SHARE (%)	2020	2020 SHARE (%)	2030	2030 SHARE (%)	2040	2040 SHARE (%)	ASSUMPTIONS/SOURCES
Population	102,305		104,898		108,360		111,655		2016: ACS Base; 2016-2040 0.3% average annual growth rate from the Comprehensive Plan
Population 16 Years and Older	48,259	47.17%	49,482		51,115		52,670		2012-2016 ACS
Total Population Commuting to Work	46,491	45.44%	47,669		49,243		50,740		2012-2016 ACS
Bike to Work	195	0.42%	381	0.80%	591	1.20%	1,015	2.00%	Base year: 2012-2016 ACS
Work at Home Population 16+	1,786	3.70%	1,764	3.70%	1,822	3.70%	1,877	3.70%	2012-2016 ACS
Work at Home Bike Trips	89	5.00%	88	5.00%	91	5.00%	94	5.00%	5% make one bike trip
Take Transit to Work	592	1.27%	1,192	2.50%	1,600	3.25%	2,030	4.00%	Base year: 2012-2016 ACS
Bike to Transit	12	2.00%	24	2.00%	48	3.00%	81	4.00%	2% bike to transit
School Population K-8	13,197	12.90%	13,531	12.90%	13,978	12.90%	14,403	12.90%	2012-2016 ACS
K-8 Bike Trips	290	2.20%	406	3.0%	559	4%	720	5%	National Center for Safe Routes to School, 2013, 2.2% bike to school
School Population 9-12	3,785	3.70%	3,881	3.70%	4,009	3.70%	4,131	3.70%	2012-2016 ACS
9-12 Bike Trips	38	1.00%	58	1.5%	100	2.50%	145	3.5%	1.00% bike to school
College Aged Population	10,537	10.30%	10,804	10.30%	11,161	10.30%	11,500	10.30%	2012-2016 ACS (18-24 year olds)
College Aged Bike Trips (not to work)	44	10.00%	1,080	10.00%	1,395	12.50%	1,725	15.00%	
Total Bike Commuters	668		2,038		2,784		3,780		
Total Bike Commuter Trips	1,337		4,076		5,569		7,559		2 trips for each commuter
Other Trips Ratio (commuter to non-commuter trips)	2.73		2.73		2.73		2.73		U.S. DOT, Federal Highway Administration, 2001 National Household Travel Survey, via Alta Planning & Design
Other Bike Trips	3,650		11,127		15,203		20,637		Commuter Trips x Other Trips Ratio
Total Daily Bike Trips	**4,987**		**15,203**		**20,772**		**28,196**		

COMMUNITY ENGAGEMENT

One element of evaluating the market for active transportation involved hearing how people in the community are using the existing system, where the gaps are, and where future priorities may lie. These everyday users of the Davenport system provided valuable insight to develop a priority based active transportation system. Input was gathered several ways:

Field reconnaissance and stakeholder groups. These visits included initial field work on bicycle and interest/stakeholder group discussions, helping us become familiar with issues and the overall structure of Davenport neighborhoods and street system. During this process, we rode most of the city's candidate streets and compiled an extensive photographic inventory

Bicycle and Pedestrian Survey. This survey, explored the characteristics of Davenport citizens and other interested participants in walking and bicycling and measured their level of comfort with different types of facilities. The survey attracted 368 responses and produced information to help frame the direction of this plan.

Community Workshop. The community workshop was held in August 2017 to solicit input from stakeholders on the emerging bicycle network and facility concepts. Held at the Credit Island Pavilion, dozens of participants learned about the project and contributed their ideas.

Public Open House. A public open house event on February 19, 2018 at the Figge Art Museum provided extensive displays and a presentation of the plan's preliminary recommendations for review and comment. Comments were incorporated into revisions to the plan and the proposed network. Project website. A project website, provided updates, advertised meetings, and gathered input throughout the planning process.

Map my ride. An interactive map on the project website allowed people to click and draw areas in Davenport to identify community destinations, bicycling barriers, their current bike route, and their desired bike route.

Community survey. A community survey was launched at the beginning of the project and made available on-line. The survey presented questions on people's active transportation usage and comfort level in Davenport. Several preferred themes emerged that became incorporated into final system. The results of the survey are described in more detail on the following pages.

Community kick-off event. A community kick-off meeting took place in July 2017. The event introduced the project to engage people in discussions with other stakeholders.

Focus groups. Focus groups in July included open discussions with the Quad Cities Bicycle Club, the Bi-state Trails Committee, the school district, young professionals, and other stakeholders. The meetings included a full day of discussions about the issues and challenges facing active transportation users in Davenport to get an in-depth understanding of issues and opportunities.

Design studio. A multiple day design studio in August engaged residents, business owners, and other stakeholders directly in conceptual planning for new bicycle routes, existing route improvements, and connectivity throughout Davenport. Participants shared their ideas, issues, and concerns informally with the design team, helping define and test concepts. Open house event. A public open house occurred in February, 2018. The open house provided the public an opportunity to review and comment on a refined bicycle network plan and implementation strategies before further development and adoption.

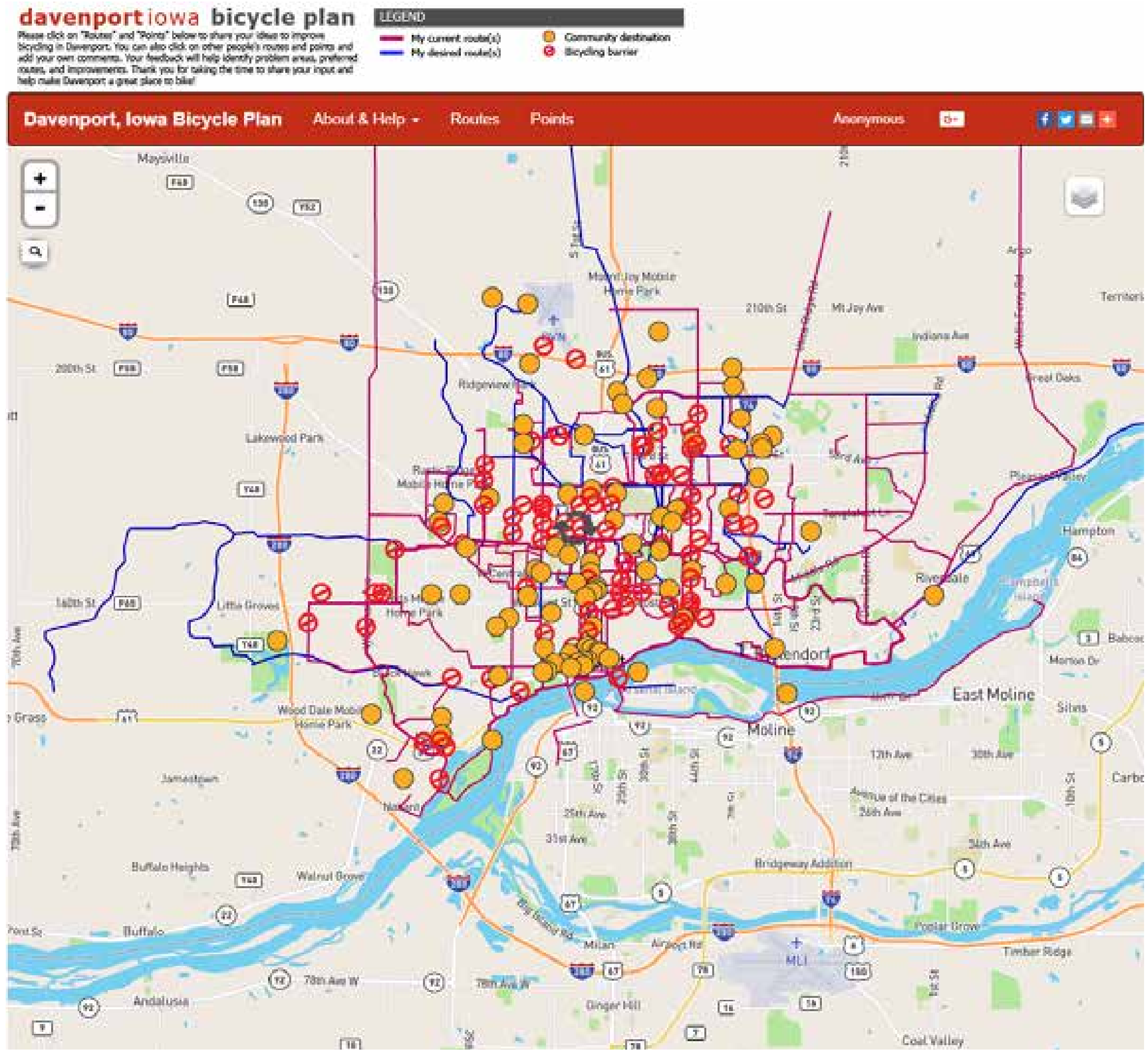
A steering committee consisting of city staff, bicycle groups, community members, and other stakeholders met regularly throughout the planning process and helped respond to ideas, provide further input, grant direction to the planning team.

MAP MY RIDE

Through the duration of the project a “Map My Ride” feature was available on the project website. Figure 5.1 shows the responses. The responses unveiled several themes:

- Many community destination are located downtown. Other destinations spread throughout the community relate to schools, parks, and recreation features such as community YMCA locations.
- There are desired routes to the north and west. Many of the desired routes are extension of existing trails or routes that could be completed with crossing improvements at various man made barriers.
- Noted barriers were widespread throughout the community. Most barriers related to pavement condition, intersection safety, and high traffic volumes. Areas of clustered barriers include:
    - › The southern most stretch of Jersey Ridge Road.
    - › Intersection of 46th Street and Eastern Avenue.
    - › Several areas on the Duck Creek path related to crossings, trail conditions, and other hazards.
- Many barriers were noted on respondents’ current route. Meaning there are not easier route options and they are forced to encounter these barriers each time they bike.

Figure 5.1: Map My Ride Responses



Source: Alta Planning + Design

DAVENPORT GO SURVEY

The community survey helps define the preferences and opinions of all people that may experience Davenport's active transportation system, whether a current user or prospective user. The responses provide important guidance for designing the network. While the survey gathered information about both bicyclists and pedestrians, most questions were geared toward bicyclists.

Respondent Characteristics

LIVE AND WORK

Respondents represent all parts of the community and region:

- About 40% of respondents live in northeast and southeast Davenport where a large portion of Davenport's population resides. Another 30% indicate they live in outside of Davenport (Bettendorf, Rock Island, etc.)
- Respondent's place of work is distributed well across the region. About 17% work in south central Davenport, the area including downtown, and about 16% work in northeast Davenport. Therefore, a multi-modal system that reaches all parts of the community is needed.

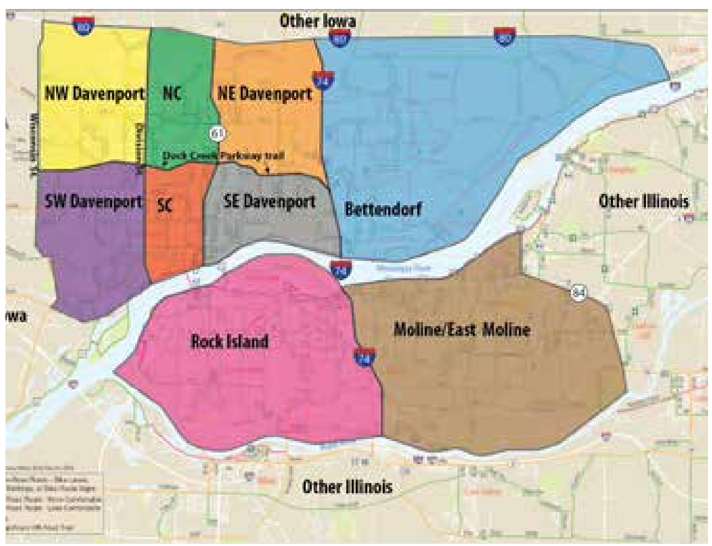


Figure 5.2: Survey Regions

BICYCLING AND WALKING HABITS

The existing active transportation habits in Davenport helps understand the frequency of facility use and provides one metric to evaluate improvements.

Pedestrian Characteristics

As a universal mode of transportation, walking is enjoyed by many residents in Davenport on a regular basis. Figure 5.3 shows 32% of participant-reported walking several times a week to every day. 29% reported walking once or twice a week. This is a high indication that residents will utilize any improvements to the pedestrian mobility system.

An overwhelming number of people reported regular exercise or workout as the primary reason for walking. Figure 5.4 shows over 30% reported walking for social visits and trips to parks or recreational facilities. 14-25% walk for family outings, shopping, routine errands and trips to library and museums. Less than 10% reported walking for work, school, and business-related activities. Overall, the main reason for walking in the community is recreational related.

Bicyclist Characteristics

The largest group of respondents were cyclists most interested in improved infrastructure. The two largest groups, 36% each, characterized themselves as believing new facilities will improve their experience and encourage more usage, and also concerned about the safety of riding in mixed automobile traffic.

Responses from regular cyclists (regular and frequent) account for 55% compared to 17% from infrequent riders (infrequent or very infrequent). The engagement from regular riders is a hopeful sign that any improvements to the system will see a high level of activity. This trend is illustrated in Figure 5.5.

Exercise is the main purpose for cycling for 80% of the respondents. Recreation-related purposes are most frequent reasons mentioned for bicycling in Figure 2.6. 30% of the respondents report bicycling to work, school, and family outings. A smaller but significant group use bicycles for shopping and going to meetings within the city.

Figure 5.3: Purposes of Walking

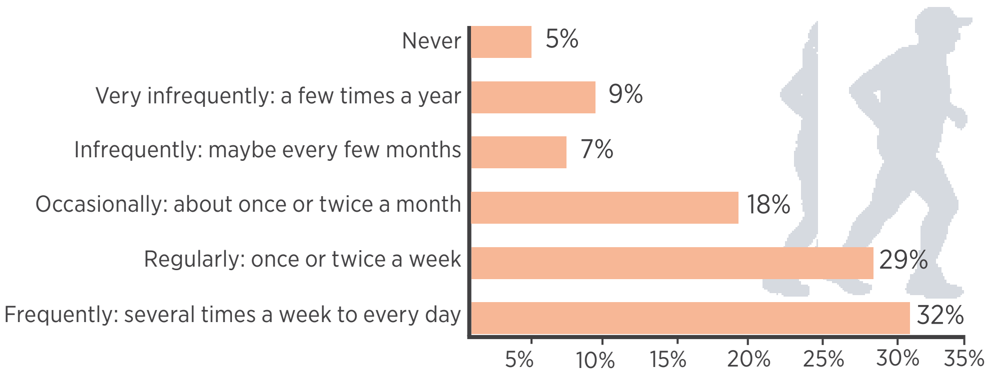
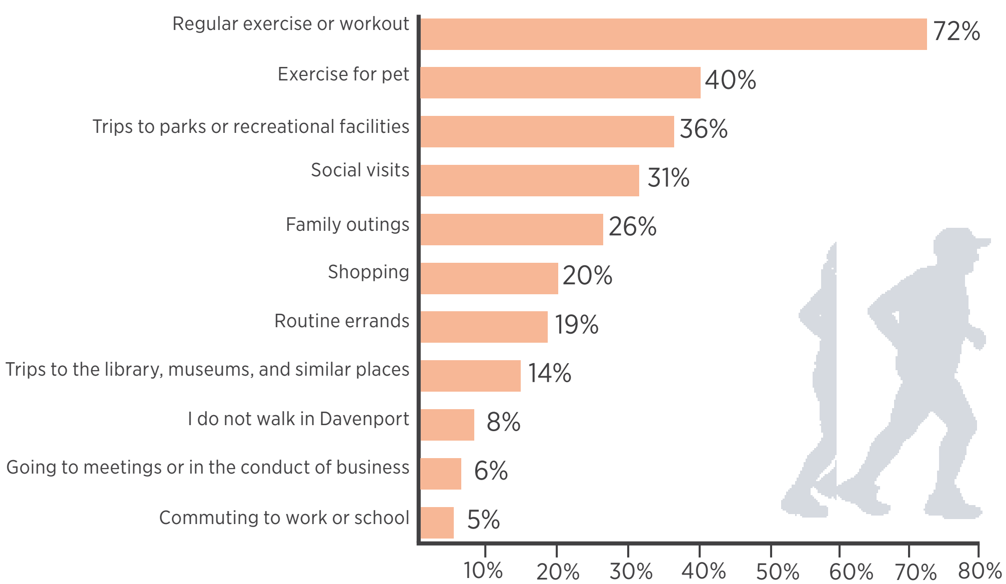


Figure 5.4: Frequency of Walking



Survey Conclusions

The survey provides many insights into the needs, deficiencies, and opportunities for the multi-modal network.

Community wide access. Respondents work across the region and find it important to have access to destinations spread throughout the community.

Strong bicycle presence. Many respondents identified as committed cyclists who ride frequently. However, a large majority ride for recreation purposes rather than a means of transportation. These groups would help advocate usage of new facilities and programming for others to follow.

Connectivity. Many of the top important destinations to reach in the community are schools and parks. These destinations should be safely accessible to all users and experience level.

Infrastructure diversity. The most comfortable bicycle environments for respondents are separated from traffic, including many infrastructure types not seen in Davenport. Respondents indicate a flexibility to tray new types of pedestrian and bicycle facilities in Davenport streets

Holistic improvement strategies. Respondents placed a high priority on both infrastructure improvements and supporting initiatives like safety programs. However, strategies that do not separate bicyclists from motorist, such as signage and shared lane markings, are not viewed as effective.

COMMITTED AND FEARLESS: I am a committed bicyclist who rides in mixed traffic on every street. I don't believe that any significant further action on bicycle facilities is necessary. ***2.56%***

COMMITTED URBAN CYCLIST: I am a committed bicyclist who rides in mixed traffic on most streets, but believes that new facilities like bike lanes, bike routes, and trails are needed to improve Davenport's biking environment for me and encourage other people to ride more often. ***36.22%***

INTERESTED AND CONCERNED: I am interested in bicycling and use low-traffic streets, but am concerned about the safety of riding in mixed automobile traffic. More trails and bike lanes and routes would increase the number of trips that I make by bicycle. ***36.86%***

RECREATIONAL TRAIL USER: I am a recreational or occasional bicyclist and ride primarily on trails. I would like to see more trails, but am unlikely to ride on city streets even with bike lanes. ***12.82%***

INTERESTED NON-RIDER: I do not ride a bicycle now, but might be interested if Davenport developed facilities that met my needs better or made me feel safer. ***5.13%***

NON-RIDER UNLIKELY TO RIDE: I do not ride a bicycle, and am unlikely ever to do so. ***6.41%***

Figure 5.5: Frequency of Cycling

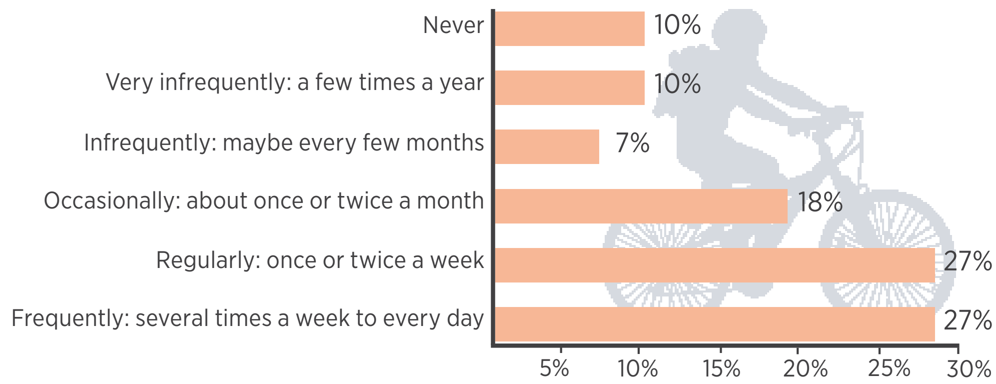
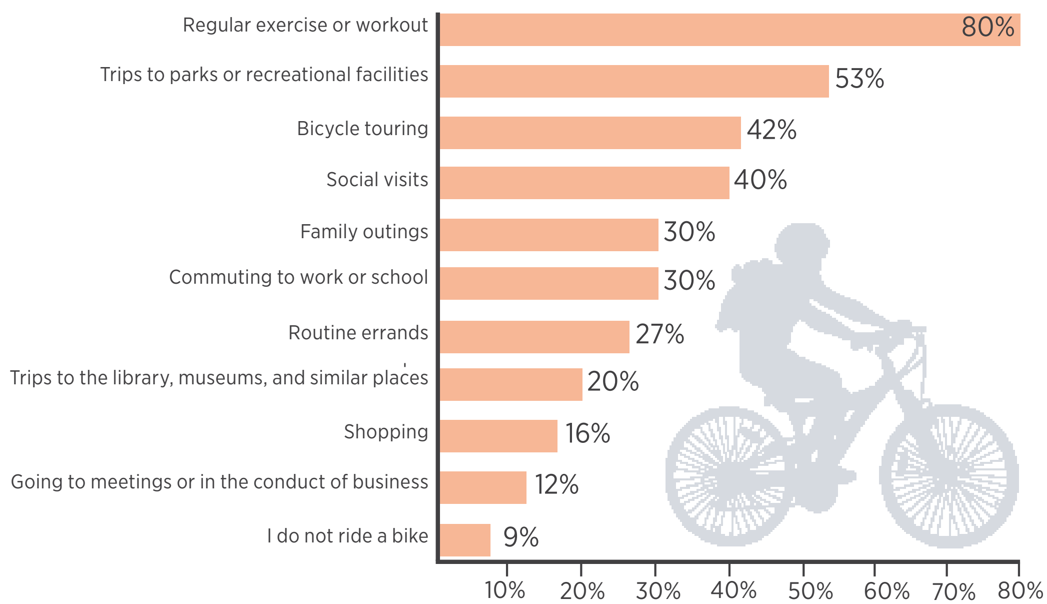


Figure 5.6: Purposes of Cycling



Trail Usage

Participants were asked how often they use major trails in the Davenport region, shown in Table 2.4. More than 50% reported using the Mississippi Riverfront and Duck Creek Parkway Trails on a regular basis. While, 23-31% regularly use the Great River Trail (Rock Island/Moline) and Veterans Memorial Parkway Trails. Less frequently used trails include the Sunderbrunch Park Trails, the 53rd Street Trail, and Hennepin Canal Trail (Moline).

Table 5.4: Frequency of Trail Usage

TRAIL	NEVER/VERY INFREQUENTLY	OCCASIONALLY	REGULARLY/ FREQUENT
Duck Creek Parkway Trail	16.5%	32.6%	50.0%
Mississippi Riverfront Parkway Trail	15.4%	33.0%	51.6%
Veterans Memorial Parkway Trail	30.9%	31.9%	23.1%
Sunderbrunch Park Trails	40.3%	38.0%	17.2%
53rd Street Trail	51.0%	21.6%	4.6%
Great River Trail (Rock Island/Moline)	31.9%	32.3%	31.3%
Hennepin Canal Trail (Moline)	55.2%	27.1%	5.6%

Figure 5.7: Importance of Various Destinations for Cycling

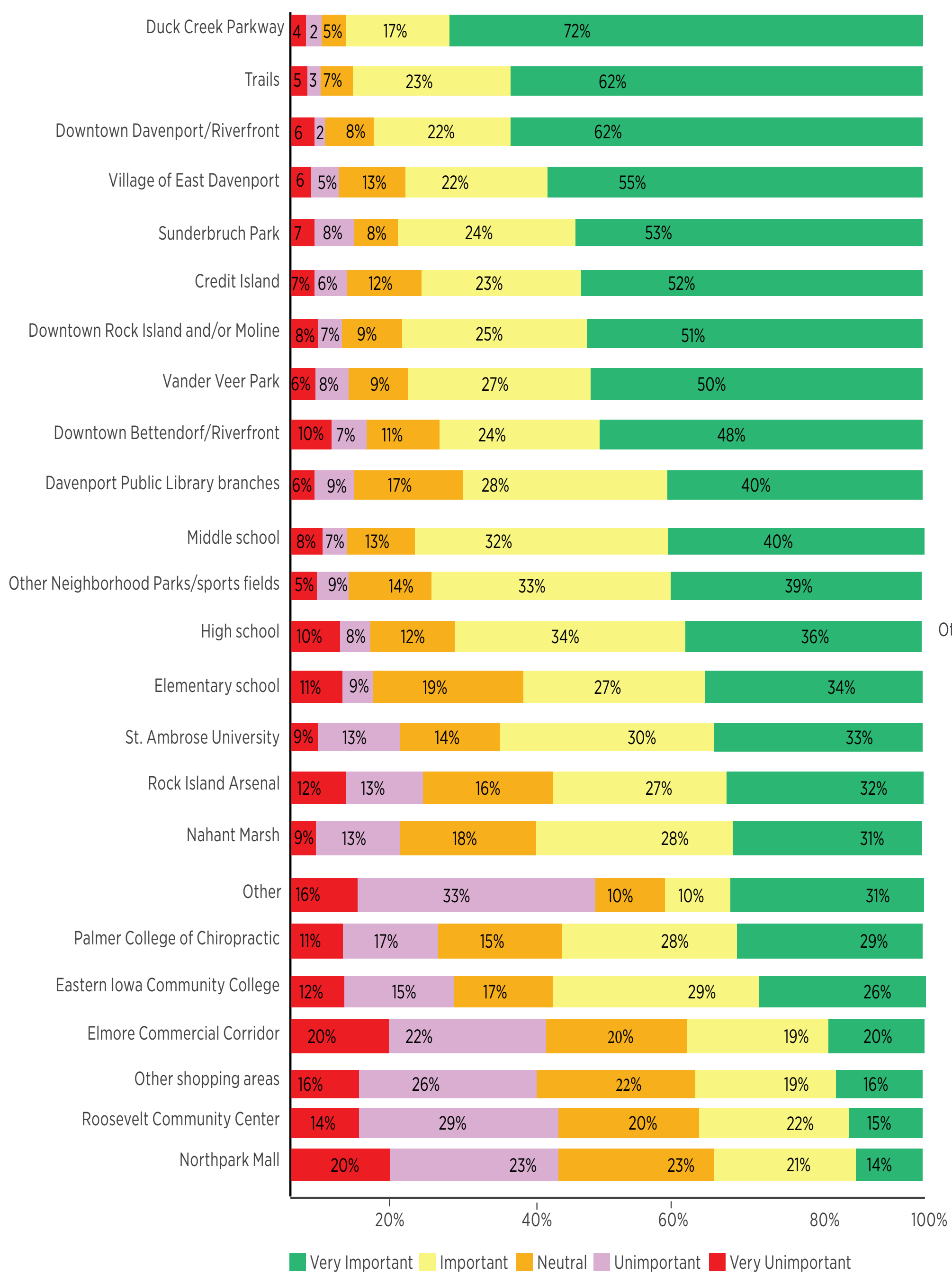
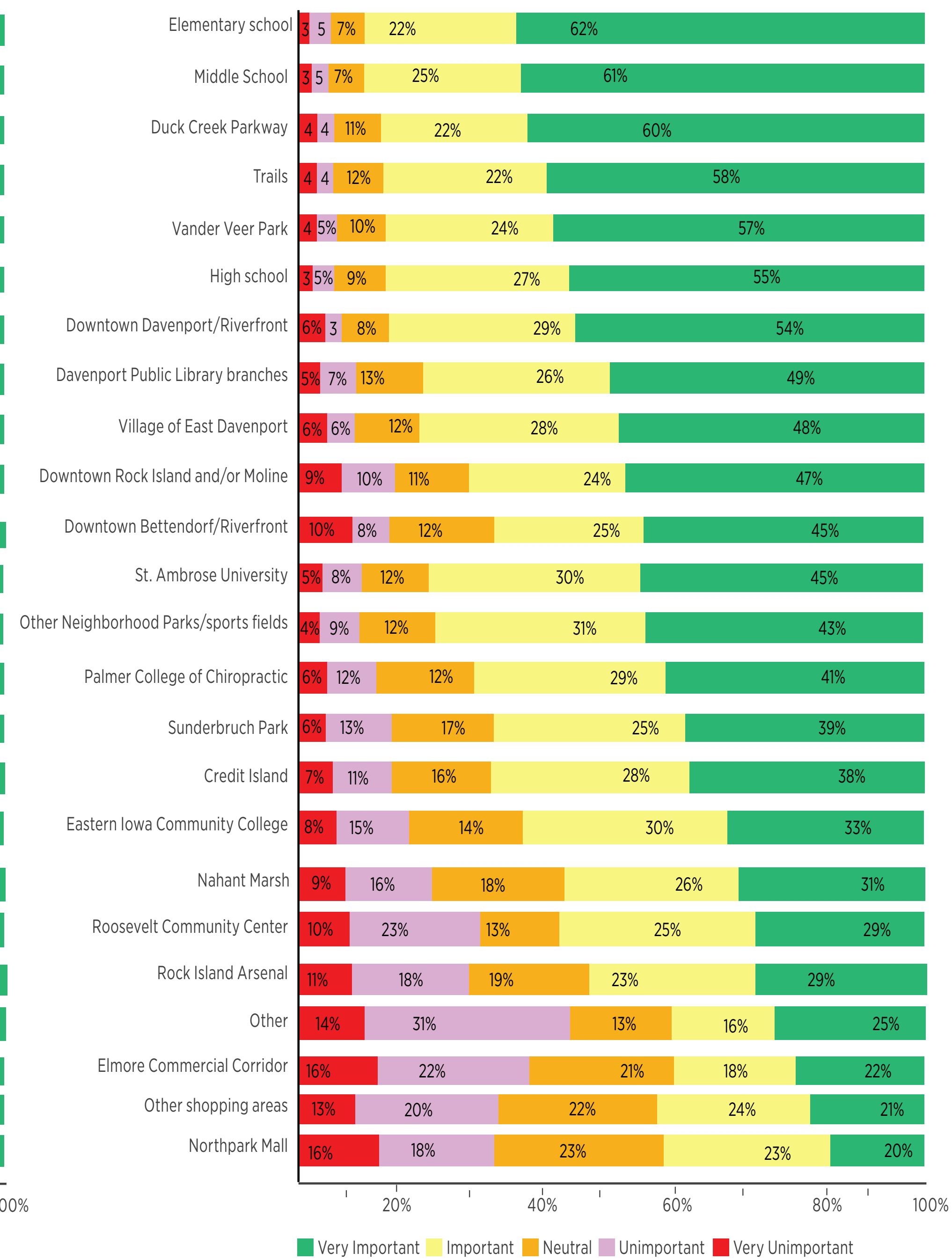


Figure 5.8: Importance of Various Destinations for Walking



Destinations

Improving and developing a safe non-motorized mobility network throughout Davenport requires knowledge of how residents perceive the importance of various locations for cycling and walking. The survey listed a number of different community destinations and asked respondents to rank them based on the level of importance to them for biking and walking access.

Figures 5.7 and 5.8, on the next page, describe the results, indicating the percentage of participants who considered good access very important to unimportant. These, in turn, suggest the places that the network should serve.

For good bicycle access, over 70% of the respondents ranked the following as important or very important:

- Trails
- Duck Creek Parkway
- Downtown Davenport/Riverfront
- Vander Veer Park,
- Downtown Rock Island and/or Moline
- Credit Island,
- Sunderbruch Park
- Village of East Davenport
- Other Neighborhood Parks or sports fields
- Middle school

For good walking access, over 80% of the respondents ranked the following as important or very important:

- Downtown Davenport/Riverfront,
- High school,
- Vander Veer Park,
- Trails,
- Duck Creek Parkway,
- Middle school, and
- Elementary school

Over 70% ranked the following as important or very important for good walking access:

- St.Ambrose University,
- Davenport Public Library branches,
- Other Neighborhood Parks or sports fields, and
- Downtown Bettendorf/Riverfront

Infrastructure Types

Much of the survey was designed to assess the comfort of current and prospective bicyclists with different types of bicycle environments. The survey asked participants to respond to a gallery of photographs of streets and facilities. Most of the images for evaluating streets were local to Davenport, while infrastructure solutions typically came from other cities. Respondents could choose from five ratings. Rating categories for the examples presented included:

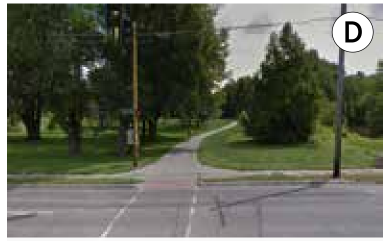
1. "This presents a very safe route that can be used by all people." (2X weighting factor)
2. "This is a comfortable cycling route for most users." (1.5X weighting factor)
3. "I am comfortable using this street myself, but do not advise it for inexperienced cyclists or younger riders." (No weighting factor)
4. "I am uncomfortable with this street, but might use it for very short distances." (No weighting factor)
5. "I am very uncomfortable riding here and would never ride on it." (No weighting factor)

The images to the right and on the following page groups images on the basis of the weighted score, calculated by applying the weighting factor to each category.

The **top-rated settings** include multi-use trails, four-lane divided with sidepath, enhanced sidepaths/widened sidewalks, barrier separated cycle tracks, multi-use neighborhood paths, and paths within a boulevard median. **Examples in Davenport include the path along Veterans Memorial Parkway and the Duck Creek Path.**

The **second highest-rated settings** include local streets, divided boulevards, neighborhood bike lanes, protected/green bike lanes, and bicycle boulevards. **Examples include 46th Street and Kirkwood Boulevard.**

Group 1: Generally seen as comfortable for all users



Multi-Use Trail

4-Lane Divided Side Path

Multi-Use Neighborhood Path

Enhanced Sidepath / Sidewalk

Barrier Separated Cycle Track

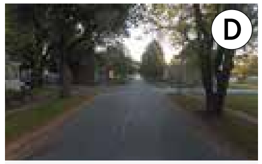
Path in Boulevard Median

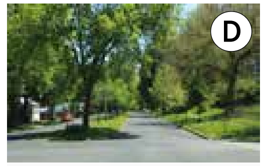
(D) Indicates Davenport Setting

The **third highest-rated settings** included the most variety. People like the idea of bicycling on these settings, but infrequent cyclists may hesitate to use. These included environments such as narrow striped shoulders, bike lanes in urban environments, arterials with paved shoulders, one-way local streets, and multi-lane arterials with separation/buffering from vehicles.

Also important were the lowest rated settings, which included multi-lane arterials with no buffering, urban minor arterials, and shared lane markings.

Group 2: Generally seen as comfortable for most users


Two-lane Local Street


Divided Boulevards


3-Lane, Bike Lanes, Non-Urban Environment


Protected Bike Lane, Bollards

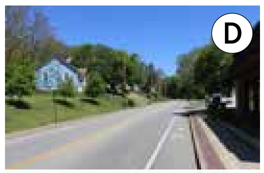

Green Protected Bike Lane

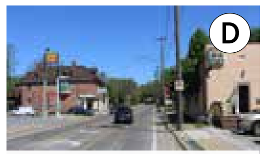

Bicycle Boulevard

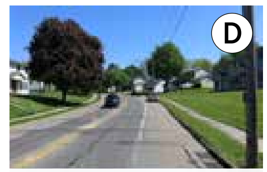

Bike Lane, Sidepath/Sidewalk


Green Bike Lane

Group 3: Generally seen as comfortable for most users, but somewhat more focused on experience

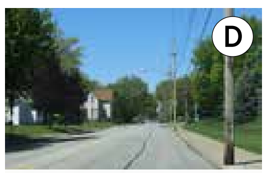

2 Lane Narrow Striped Shoulder

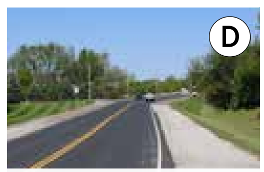

3-Lane, Bike Lanes, Urban Environment

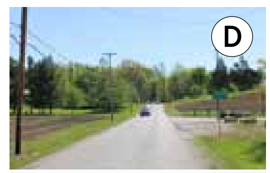

2-Lane Collector,Striped Pkg Lane

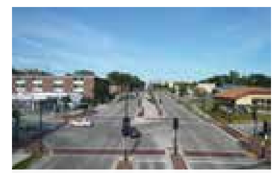

2-Lane Designated Bike Route

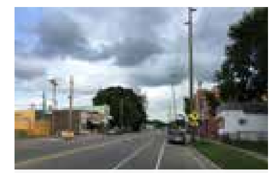

One-Way Local Street


2-Lane Collector


2-Lane Arterial, Paved Shoulders


2-Lane Rural Section


Major Arterial Complete Street


2-Lane Arterial, Bike Lanes

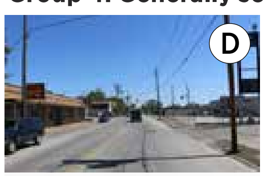

Hybrid Sharrow/Bike Lane

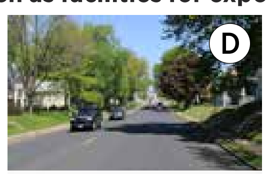

Green Bike Lane

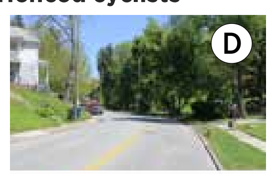

4 to3 Lane Conversion, Bike Lane


Center of Street Cycle Track

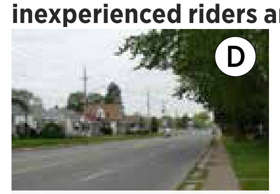
Group 4: Generally seen as facilities for experienced cyclists

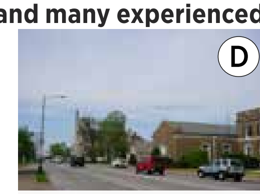

2-Lane Urban Minor Arterial


2-Lane Minor Arterial


2-Lane with Sharrows

Group 5: Generally seen as uncomfortable for inexperienced riders and many experienced cyclists


4-Lane Arterial


4-Lane One-Way Major Arterial

Strategies for Improvement

Respondents were asked to rank the effectiveness of various actions to improving bicycle trips in Davenport.

Over 70% believe the following would be effective or very effective:

- Better crossings/intersection control of major streets
- Protected bike lanes buffered from traffic
- More trail development
- Widened sidewalks or paths along major streets
- Better project design that encourages bicycle access
- A strong bicycle advocacy organization
- Bike safety activities designed for kids

Several of the highest ranking actions involve capital infrastructure investments. However, respondents also tended to feel the advocacy and education programs would also be effective to improve the bicycling environment in Davenport.

Table 5.5: Effectiveness of Various Actions

VERY EFFECTIVE OR EFFECTIVE OVER 70%	VERY EFFECTIVE OR EFFECTIVE 70-50%	VERY EFFECTIVE OR EFFECTIVE 50% OR LESS
Better crossings / intersection control of major streets	A system of designated on-street bicycle routes that lead to important destinations	Wayfinding and directional signs
Protected bike lanes buffered from traffic	Better pavement markings at intersections	Posting "Bicyclists May Use Full Lane" Signs
More trail development	Better sidewalk ramps at intersections	Shared lane markings
Widened sidewalks or paths along major streets	Count down crossing signals	A "bike station" with showers, repair, and bike parking facilities
Better project design that encourages bicycle access	More safe routes to school's projects and activities	A bike-sharing program
A strong bicycle advocacy organization	Enforcement of laws that protect vulnerable road users, such as minimum passing distance laws	
Bike safety activities designed for kids	Better motorist education programs	
	Improved bicycle safety and education activities	
	More special events, such as benefit rides	
	Challenges and promotions for bicycle commuters	
	More information about bicycling clubs, events, programs	
	More community bicycling events	

VOLUME 2

ACTIVE TRANSPORTATION BARRIERS

This chapter addresses various physical barriers to active transportation in the city. Its principal focuses are arterial streets and intersections that cross major routes in the proposed network. It presents a toolkit of solutions that can be adapted to the specific contexts found in Davenport.

6

Concord St intersection with Rockingham Road: a signalized intersection on a major pedestrian and bicycle route where pavement crossing markings would create a safer, more visible environment for active transportation.

BARRIERS IN THE NETWORK

Arterial streets, major intersections, steep grades, streams, railroads, and other natural and built barriers present significant obstacles to continuous bicycle and pedestrian route networks in Davenport and other major cities. Of these, major streets and intersections present the most persistent problems. Difficult crossings require a higher level of experience and comfort with traffic, reducing the number of people who are likely to walk or bike to various destinations. They create special problems for children, whose parents fear for their safety as they attempt to cross major traffic corridors; and people who require some additional time to cross.

To some degree, the network design presented in Chapter One inherently addresses barriers by planning routes that cross major corridors at signalized intersections, connect into bridge crossings of waterways, or avoid hills with grades beyond the capacity of all but the most capable climbers. But many barriers are unavoidable and busy streets always present challenges regardless of traffic control. This chapter identifies these challenge areas and presents concepts that can apply to specific circumstances. Chapter Two, presenting route details, provides more detailed design guidance and crossing concepts for some of the most challenging of these situations.

Major barriers to continuity in the Davenport network include the following:

- **Major multi-lane, high volume and speed arterials.** While major streets always present challenges, the Kimberly and Brady/Harrison corridors are especially difficult. Kimberly Road, a four-lane divided highway with a wide median and shoulders, is a formidable barrier because of its width and heavy high speed traffic. It presents an even greater obstacle as the section increases to six lanes plus turn lanes in the Northpark area between Brady and Welcome Way. Every major north-south route must cross Kimberly at some point. Brady, Harrison, and Welcome Way, as multi-lane and mostly one-way arterials, require people crossing at unsignalized intersections to find gaps in four lanes of continuous traffic, an extremely difficult task. Interstate 74 also has only two crossing s without interchanges at Veterans Memorial Parkway and the Duck Creek Trail.

- **Other major streets.** Other minor arterial and even collector corridors have operational characteristics that create significant barriers. Many of these streets (Locust, Jersey Ridge, Hickory Grove, Division) present traditional four-lane sections in a 40-foot street channel, requiring pedestrians and bicyclists to address two lanes in each direction without refuge. Other two-lane arterials (Eastern, Northwest) have continuous traffic flows with limited gaps for crossing.

- **Railroads.** Davenport's railroads are relatively low-speed, low-volume lines that present barriers more physical than operational. For example, the Canadian Pacific branch to Eldridge interrupts 46th Street, a principal east-west corridor in the proposed active network and an important gap in the city's street grid; and the north-south Iowa Interstate line limits east-west access between Locust and Central Park, including a potential connection of Lombard Street. The Iowa Interstate also parallels the Riverfront Trail. Connections to the trail generally cross the rails at right angles, but wet conditions or rough tracks can create hazards.

- **Offset intersections.** Several on-street routes cross busy streets at offset intersections. These include 14th and 15th Streets across Brady and Harrison and Forest Road across 46th Street and Locust Street.

These general barriers, combined with field inspection and analysis of several factors, including average daily traffic, width of corridors, observation of signal cycles, and other factors, led to a preliminary list of barrier points that are addressed in the route details. As part of the development of details in the next phase of this planning process. Map 6.1 categorizes and maps these points, and Table 6.1 lists them with their specific required conditions. Table 6.2 describes a toolbox of intersection and barrier improvements, including the types of intersection problems that they can address.

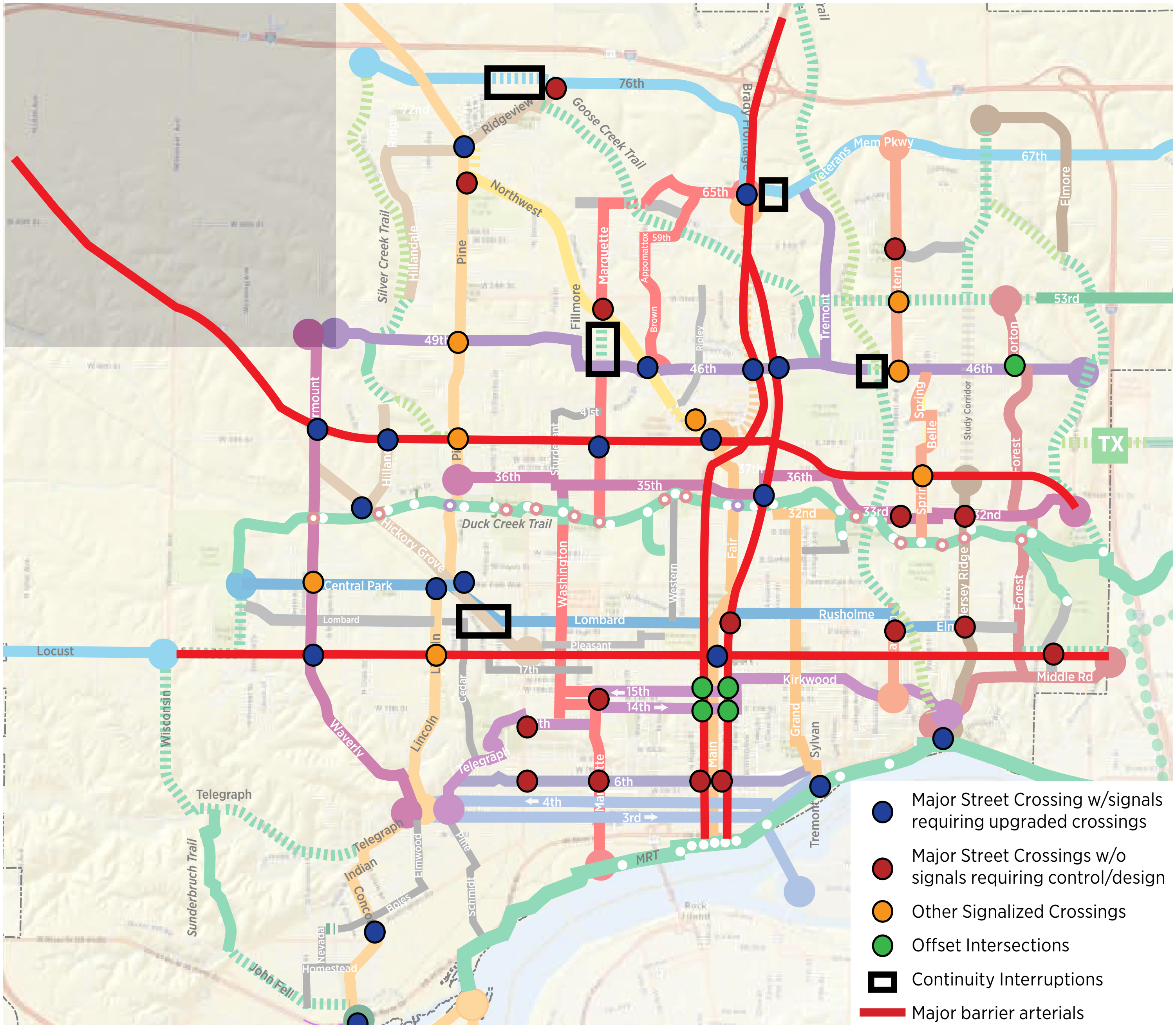
Subsequent illustrations show more detailed consideration of various potential solutions. Application of these to specific locations in Davenport will be determined by further engineering evaluation, including a traffic study where relevant.

Forest and Kimberly, an example of good design for pedestrians crossing a major arterial. Signals were added to this intersection with well-defined crosswalks and crossing refuge areas in the median.

Table 6.1: Barrier Categories

CONTEXT	CONDITION	EXAMPLE
Major street crossings with signals/crossing upgrades	Traffic signal control. Some cases are large intersections with poor definition of pedestrian and bicycle paths. Treatments include high visibility crosswalks, bicycle crossing markings, refuge medians	65th/Veterans Parkway and Brady Street, Main Street and Kimberly Road
Major street crossings without signals	Routes on secondary streets crossing arterials or major collectors without traffic control. Possible treatments include warning signage, high visibility pavement markings, flashing beacons, hybrid beacons, full pedestrian signals, refuge medians	Lombard at Brady, Elm at Jersey Ridge, 6th and Brady, 58th and Eastern
Other signalized crossings	Traffic signal control with good intersection and crossing design. Crosswalk visibility may be enhanced in some cases.	Kimberly and Forest, 49th and Pine
Offset intersections	Two legs of an intersection are offset from one another. Possible treatments include establishing one crossing point and using short sidepath segments to transition to single alignment; or use pavement markings to guide path through the intersection.	14th and 15th and Harrison, 46th and Forest Road
Continuity interruptions	Breaks in route continuity created by lack of railroad crossings, streams or gaps in streets. Treatments include alternate routes or reasonable diversions consistent with network standards; new bridges; or interim paths on proposed street links.	Marquette between Northwest Blvd and 46th; 46th between Tremont and Eastern

Map 6.1: Barrier Locations



PEDESTRIAN CROSSING CONTEXTUAL GUIDANCE
At unsignalized locations

FACILITY TYPE	Local Streets 15-25 mph: 2 lane	Local Streets 15-25 mph: 3 lane	Collector Streets 25-30 mph: 2 lane	Collector Streets 25-30 mph: 2 lane with median refuge	Collector Streets 25-30 mph: 3 lane	Arterial Streets 30-45 mph: 2 lane	Arterial Streets 30-45 mph: 2 lane with median refuge	Arterial Streets 30-45 mph: 3 lane	Arterial Streets 30-45 mph: 4 lane	Arterial Streets 30-45 mph: 4 lane with median refuge	Arterial Streets 30-45 mph: 5 lane	Arterial Streets 30-45 mph: 6 lane	Arterial Streets 30-45 mph: 6 lane with median refuge
1 Crosswalk Only (high visibility)	✓	✓	EJ	EJ	X	EJ	EJ	X	X	X	X	X	X
2 Crosswalk with warning signage and yield lines	EJ	✓	✓	✓	✓	EJ	EJ	EJ	X	X	X	X	X
3 Active Warning Beacon (RRFB)	X	EJ	✓	✓	✓	✓	✓	✓	X	✓	X	X	X
4 Hybrid Beacon	X	X	EJ	EJ	EJ	EJ	✓	✓	✓	✓	✓	✓	✓
5 Full Traffic Signal	X	X	EJ	EJ	EJ	EJ	EJ	EJ	✓	✓	✓	✓	✓
6 Grade separation	X	X	EJ	EJ	EJ	X	EJ	EJ	✓	✓	✓	✓	✓

LEGEND
- Most Desirable ✓
- Engineering Judgement EJ
- Not Recommended X

River Drive and Mound. Improved crossing markings and railroad warnings will link the Village of East Davenport routes to the riverfront more effectively.

Table 6.2: Barrier Crossing Techniques

TECHNIQUE	DESCRIPTION	POTENTIAL APPLICATION
Grade separation	Overpass or underpass that separates bike/ped traffic from crossing arterials	First Bridge, I-74 crossing connected to Tanglefoot Lane, Goose Creek Trail undercrossing
Pedestrian refuge median	Island in middle of a two-way street, allowing pedestrians and bicyclists to address crossing traffic in one direction at a time from a protected place.	Trail or route crossings of arterials and major collectors where turning movements are not necessary. Elm at Eastern, 14/15 and Marquette offset intersections, 12th and Division
High visibility crosswalks	Well-defined crosswalks, using durable reflective materials and typically using Continental or Zebra/Ladder crosswalk markings, Also includes green or chevron markings to guide bicycle path or lane across intersection.	Arterial street crossings with significant pedestrian and bicycle traffic. 14th and Harrison, Kimberly and Pine, 35th and Brady
Beacons: HAWKS (High Intensity Activated Crosswalk Beacon) and flashing beacons.	Pedestrian actuated signals. HAWK signals often used at midblock and for trail crossings and include flashing yellow and solid red stop sequence. Flashing beacons typically located at intersections and use flashing lights but no red signal. In January, 2018, one such beacon, Rectangular Rapid Flashing Beacons (RRFB's) were removed from MUTCD approval because of patent issue. These beacons appeared to be effective and their approval status should be monitored.	Trail crossings, other unsignalized crossings of major streets. Lombard and Brady,
Protected Intersection	New intersection design providing a protected, high visibility corner location for bicyclists and pedestrians.	Veterans and Brady, Main and Locust

Figure 6.1: Intersection Concepts, Neckdowns

Neckdowns

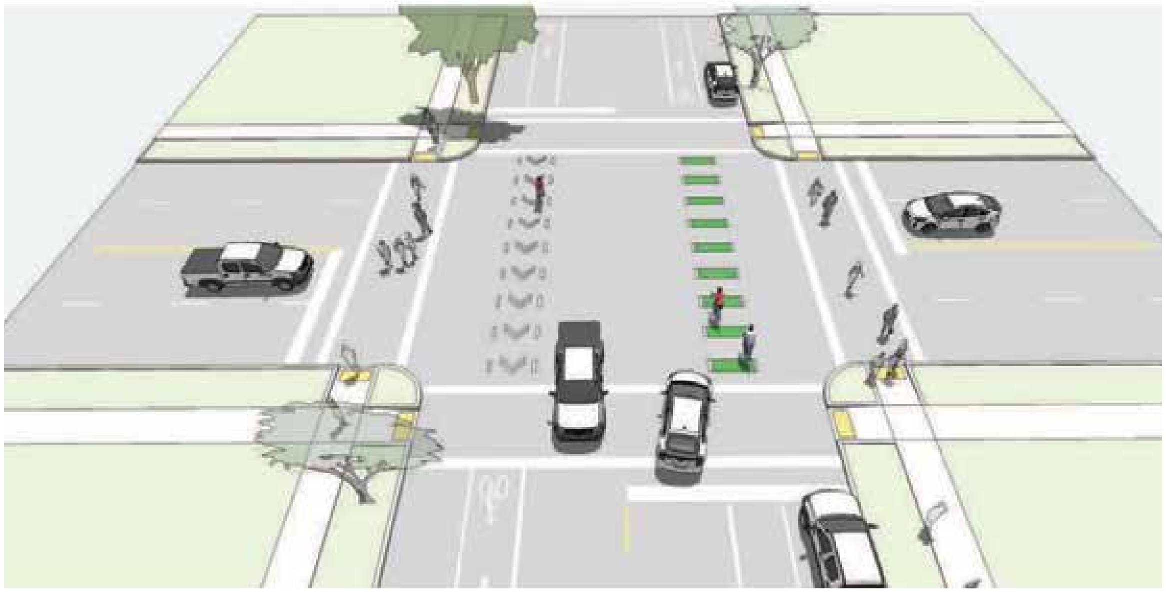
Context:
"Bicycle boulevards" – relatively low volume streets with good continuity

Technique:
Curb extensions that reduce the curb to curb width at an intersection to 22- to 24-feet. Especially appropriate in Davenport where many network streets are 32- to 36-feet wide.

Benefits

- Reduces average traffic speed.
- Reduces distance of pedestrian crossing
- Provides some protection for parked cars
- May provide opportunities for neighborhood plantings and beautification

Figure 6.2: Intersection Concepts: Pavement Markings



Intersection Pavement Markings

Context:
Crossings of major intersecting streets by on-street active network routes

Technique:
- High visibility crosswalks with pavement markings using various methods to define a bicycle track across an intersection
- May be used in combination with rapid rectangular flashing beacons or hybrid signals

Benefits
- Increases visibility of pedestrians and bicyclists
- Notifies motorists on intersecting major streets of presence of a significant number of active users

Figure 6.3: Intersection Concepts, Bike Boxes

Bike Box

Context:

Locations (often signalized intersections) where bike routes intersect or other locations that involve a significant number of left-turning movements for bicyclists otherwise traveling in a bike facility or "as far to the right as practicable."

Technique:

Painted area behind the stop bar defined for use by bicyclists

Benefits

- Reduces incidence of bicyclists turning left across traffic from the right-hand side of a road
- Reduces incidence of crashes at intersections

Figure 6.4: Intersection Concepts, Pedestrian Refuge Median

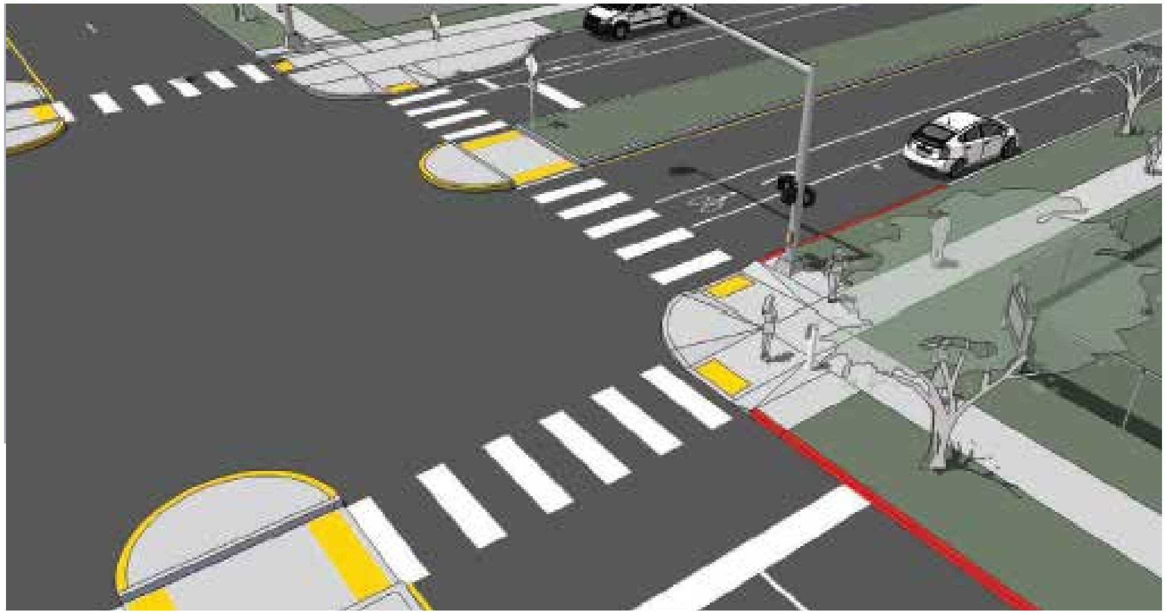
Pedestrian Refuge Median

Context:
Trail crossings of major streets
Bike/ped crossings of major streets where left-turns are not required

Technique:
• Refuge median in a two-way turn lane. Alternative is removal of parking from crossing area and diverging lanes slightly to provide space for the median
• High visibility crosswalks and pavement markings
• Used in conjunction with yellow caution signs.
• May include flashing beacons or HAWK protection

Benefits
• Increases visibility of pedestrians and bicyclists
• Notifies motorists on intersecting major streets of presence of a significant number of active users

Figure 6.5: Intersection Concepts, Reduced Curb Radius



Reduced curb radius. *The two tier mountable curb provides the benefits of a small curb radius but still provides the larger radius necessary for safe passage of trucks and other large vehicles.*

Reduced Curb Radius

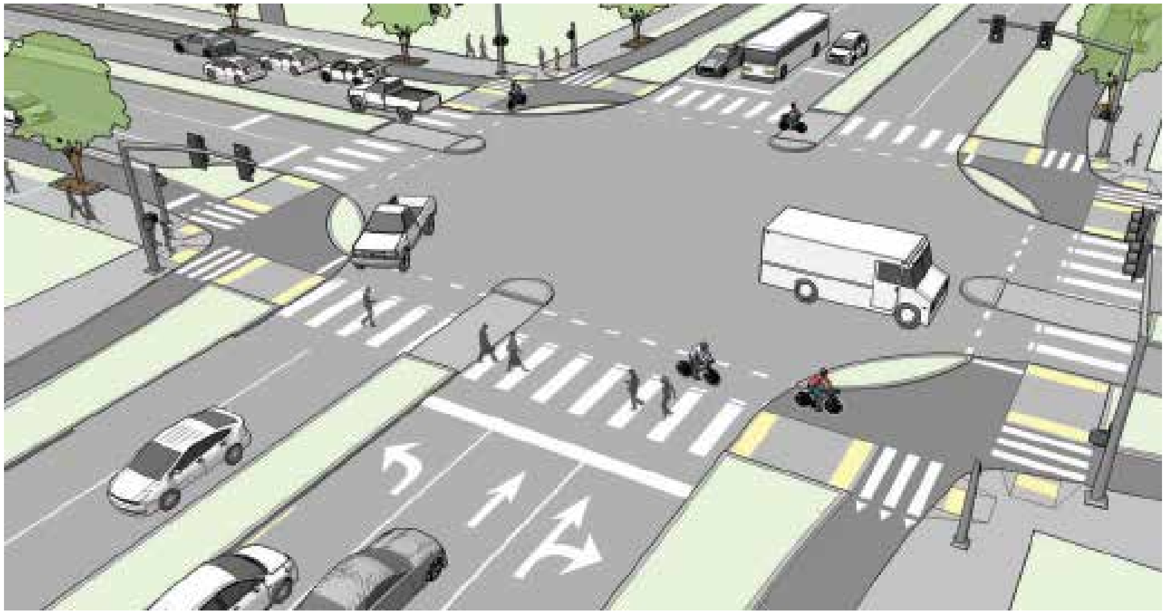
Context:
Urban street intersections along bicycle and pedestrian routes

Technique:
Reduce curb radius at intersections. Most appropriate at locations with few vehicles that require long radius turns such as local street intersections or intersections of local and collector streets

Benefits

- Requires drivers of right turning vehicles to slow as they make turns, increasing safety for users of sidepaths
- Reduces incidence of "right-hook" crashes.

Figure 6.6: Intersection Concepts, Protected Intersection



Top: Protected intersection in Salt Lake City. Above: Concept for an arterial crossing with bike lanes and paths in Wauwatosa, WI

Protected Intersections

Context:
Intersections of streets with sidepaths or trails with major arterials and wide highways

Technique:
• New intersection design in frequent use in Europe and beginning to be implemented in US, providing a visible, protected space for pedestrians and bicycles to cross wide and busy intersections.
• Protected space is separated from turning traffic by an island
• Requires a two-stage crossing for bicyclists turning left to an intersecting trail or major street

Benefits
• Increases visibility of pedestrians and bicyclists
• Reduces the perceptual width of large intersections
• Provides high visibility for vulnerable users, placing them in a setting where they are both protected and in a preferred position entering an intersection

Figure 6.7: Intersection Concepts, High Visibility Crosswalks

High visibility crosswalks on Wilshire Boulevard in Santa Monica, CA establish pedestrian visibility zones on a 6-lane arterial corridor.

High Visibility Crosswalks

Context:
Large street intersections that dominate pedestrian scale

Technique:
Develop crosswalks with sufficient width and marking density to establish crosswalk area as a highly visible pedestrian territory.

Benefits

- Provides enhanced intersection safety for pedestrians.
- Creates a scale of markings that is not overwhelmed by major multi-lane intersections

Clockwise from left: HAWK signal and crosswalks on Woodchuck Bicycle Boulevard in Wichita, KS; flashing beacon in Wauwatosa, WI; advance warning and beacon on Prairie Sunset Trail in Goddard, KS

Crossing Signs and Beacons

Context:
Crossings of major streets that do not warrant full signalization

Technique:
Variety of equipment types, based on traffic volume and street width, including waning signs, flashing beacons, and hybrid beacons (HAWK)

Benefits

- Advise motorists of the presence of pedestrians and bicyclists
- Range of applications to adapt to specific situation
- Less expensive or disruptive of traffic flow than full signalization

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DAVENPORTGO

VOLUME 3

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VOLUME 3

DESIGN GUIDELINES

The design guidelines serve as an inventory of bicycle and trail design treatments to provide a strong foundation for the development of the Davenport bicycle transportation network. These treatments and design guidelines are important because they represent the tools for creating a safe and accessible community.

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DESIGN GUIDELINES

The Design Guidelines serve as an inventory of bicycle and trail design treatments to provide a strong foundation for the development of the Davenport bicycle transportation network. These treatments and design guidelines are important because they represent the tools for creating a safe and accessible community. The guidelines are not, however, a substitute for a more thorough evaluation by a landscape architect or engineer upon implementation of facility improvements.

The Design Guidelines serve as an inventory of bicycle and trail design treatments to provide a strong foundation for the development of the Davenport bicycle transportation network.

National Guidance

The following standards and guidelines are referred to in this guide:

- The Federal Highway Administration's (FHWA) ***Manual on Uniform Traffic Control Devices (MUTCD)*** defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public traffic The MUTCD is the primary source for guidance on lane striping requirements, signal warrants, and recommended signage and pavement markings.
- American Association of State Highway and Transportation Officials (AASHTO) ***Guide for the Development of Bicycle Facilities (2012)*** provides guidance on dimensions, use, and layout of specific bicycle facilities.
- The National Association of City Transportation Officials' (NACTO) ***Urban Bikeway Design Guide (2012)*** is the newest publication of nationally recognized bikeway design standards, and offers guidance on the current state of the practice designs.
- The AASHTO A Policy on ***Geometric Design of Highways and Streets (2011)*** commonly referred to as the "Green Book," contains the current design research and practices for highway and street geometric design.

State Guidance

The Iowa Department of Transportation's (IDOT) Statewide Urban Design and Specifications (SUDAS) manual provides guidance for local agencies regarding bicycle and pedestrian facility design. Drawing heavily from the AASHTO publications, the SUDAS manual was updated for the 2018 construction season and includes new sections for bicycle facility design, particularly for buffered and separated bike lanes, that reference the NACTO ***Urban Bikeway Design Guide***.

Impact on Safety and Crashes

Bicycle facilities can have a significant influence on user safety. The Federal Highway Administration Crash Modification Factor Clearinghouse (http://www.cmfclearinghouse.org/) is a web-based database of Crash Modification Factors (CMF) to help transportation engineers identify the most appropriate countermeasure for their safety needs. Where available and appropriate, CMFs or similar study results are included for each treatment.

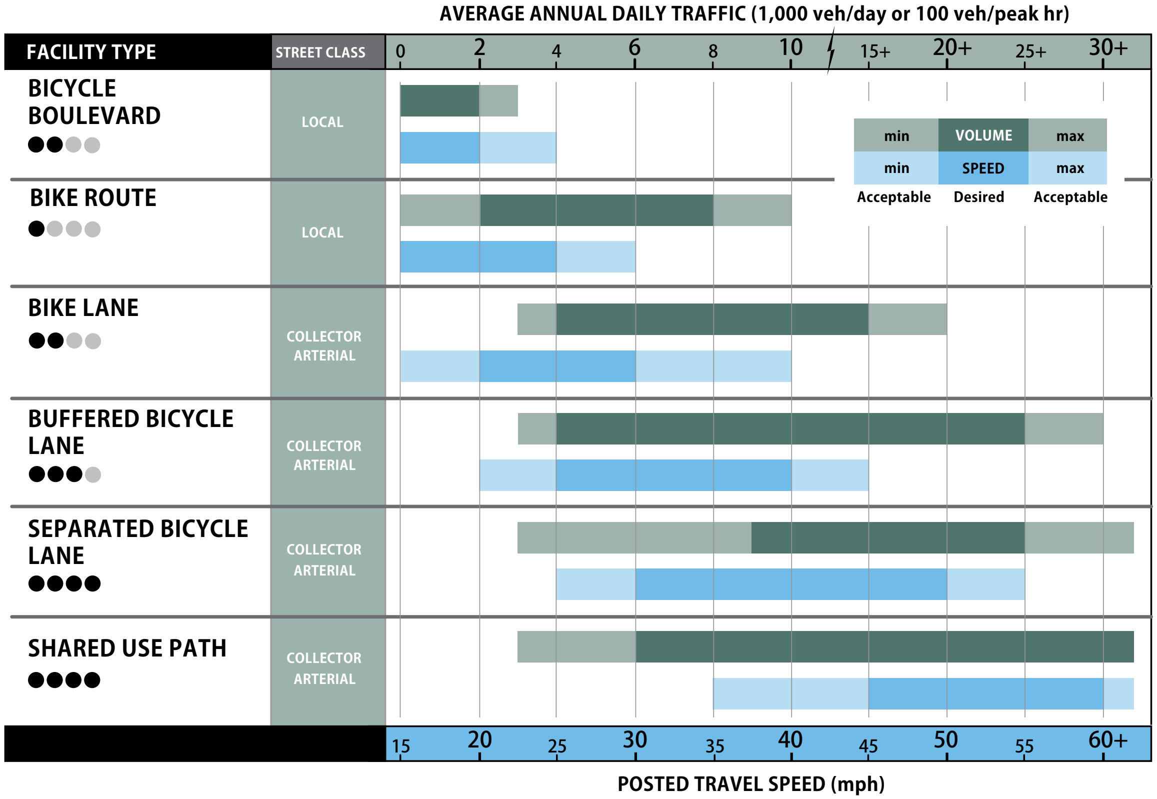
FACILITY SELECTION

Selecting the best bikeway facility type for a given roadway can be challenging, due to the range of factors that influence bicycle users' comfort and safety. There is a significant impact on cycling comfort when the speed differential between bicyclists and motor vehicle traffic is high and motor vehicle traffic volumes are high.

Facility Selection Table

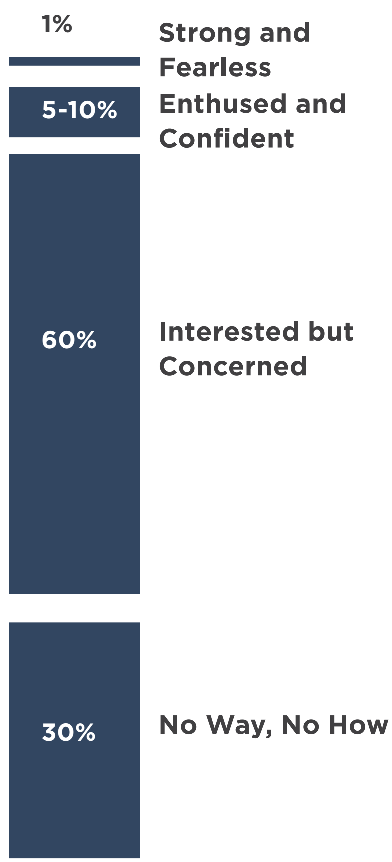
As a starting point to identify a preferred facility, the chart below can be used to determine the recommended type of bikeway to be provided in particular roadway speed and volume situations. To use this chart, identify the appropriate daily traffic volume and travel speed on or the existing or proposed roadway, and locate the facility types indicated by those key variables.

Other factors beyond speed and volume which affect facility selection include traffic mix of automobiles and heavy vehicles, the presence of on-street parking, intersection density, surrounding land use, and roadway sight distance. These factors are not included in the facility selection chart below, but should always be considered in the facility selection and design process.



BICYCLE USER TYPES

The current AASHTO Guide to the Development of Bicycle Facilities encourages designers to identify their rider type based on the trip purpose (Recreational vs Transportation) and on the level of comfort and skill of the rider (Causal vs Experienced). A user-type framework for understanding a potential rider's willingness to bike is illustrated in the figure below. Developed by planners in Portland, OR* and supported by research**, this classification identifies four distinct types of bicyclists.



Typical Distribution of Bicyclist Types

Strong and Fearless. Characterized by bicyclists that will typically ride anywhere regardless of roadway conditions or weather. These bicyclists can ride faster than other user types, prefer direct routes and will typically choose roadway connections -- even if shared with vehicles -- over separate bicycle facilities such as shared-use paths.

Enthused and Confident. This user group encompasses bicyclists who are fairly comfortable riding on all types of bikeways but usually choose low traffic streets or shared-use paths when available. These bicyclists may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of bicyclists such as commuters, recreationalists, racers and utilitarian bicyclists.

Interested but Concerned. This user type comprises the bulk of the cycling population and represents bicyclists who typically only ride a bicycle on low traffic streets or shared-use paths under favorable weather conditions. These bicyclists perceive significant barriers to their increased use of cycling, specifically traffic and other safety issues. These people may become "Enthused & Confident" with encouragement, education and experience. This segment of users will help increase demand for bicycle facilities.

No Way, No How. Persons in this category are not bicyclists, and perceive severe safety issues with riding in traffic. Some people in this group may eventually become more regular cyclists with time and education. A significant portion of these people will not ride a bicycle under any circumstances.

* Roger Geller, City of Portland Bureau of Transportation. Four Types of Cyclists. http://www.portlandonline.com/transportation/index.cfm?&a=237507. 2009.

** Dill, J., McNeil, N. Four Types of Cyclists? Testing a Typology to Better Understand Bicycling Behavior and Potential. 2012.

USER DESIGN DIMENSIONS

The purpose of this section is to provide the facility designer with an understanding of how bicyclists operate and how their bicycle influences that operation. Bicyclists, by nature, are much more affected by poor facility design, construction, and maintenance practices than motor vehicle drivers.

Bicyclists lack the protection from the elements and roadway hazards provided by an automobile's structure and safety features. By understanding the unique characteristics and needs of bicyclists, a facility designer can provide quality facilities and minimize user risk.

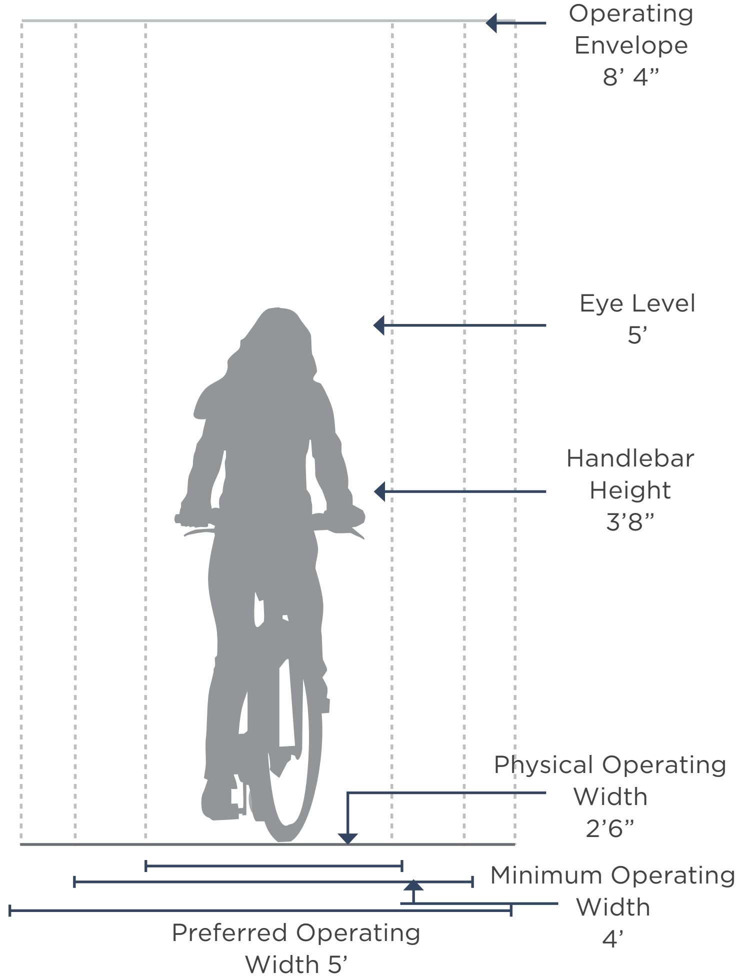
Bicycle as a Design Vehicle

Similar to motor vehicles, bicyclists and their bicycles exist in a variety of sizes and configurations. These variations occur in the types of vehicle (such as a conventional bicycle, a recumbent bicycle or a tricycle), and behavioral characteristics (such as the comfort level of the bicyclist). The design of a bikeway should consider reasonably expected bicycle types on the facility and utilize the appropriate dimensions.

The figure to the right illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear space to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer five ft or more operating width, although four ft may be minimally acceptable.

In addition to the design dimensions of a typical bicycle, there are many other commonly used pedal-driven cycles and accessories to consider when planning and designing bicycle facilities. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories. The figure to the left summarizes the typical dimensions for bicycle types.

Bicycle Rider - Typical Dimensions



SHARED ROADWAYS

On shared roadways, bicyclists and motor vehicles use the same roadway space. These facilities are typically used on roads with low speeds and traffic volumes, however they can be used on higher volume roads with wide outside lanes or shoulders. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

SIGNED & MARKED SHARED ROADWAYS


BICYCLE BOULEVARDS

SIGNED & MARKED SHARED ROADWAYS

Signed and marked shared roadways are facilities shared with motor vehicles. They are typically used on roads with low speeds and traffic volumes. These on-street bikeways incorporate shared lane markings in a general purpose travel lane and D11-1 bike route signs to identify the street as a bikeway and alert motorists to be aware of bicycle traffic. The shared lane markings (SLM) encourage bicycle travel and proper positioning within the lane. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

Typical Application

- Signed & Marked Shared Roadways serve either to provide continuity with other bicycle facilities (usually bike lanes) or to designate preferred routes through high-demand corridors.
- This configuration differs from a bike boulevard due to a lack of traffic calming and other enhancements designed to provide a higher level of comfort for a broad spectrum of users.
- In constrained conditions, the SLMs are placed in the middle of the lane. On a wide outside lane, the SLMs can be used to promote bicycle travel to the right of motor vehicles.
- In all conditions, SLMs should be placed outside of the door zone of parked cars.

Design Features

Route Signage

- Lane width varies depending on roadway configuration.

(A) Bike route signage (D11-1) should be applied at intervals frequent enough to keep bicyclists informed of changes in route direction and to remind motorists of the presence of bicyclists. Commonly, this includes placement at:

  › Beginning or end of Bicycle Route.

  › At major changes in direction or at intersections with other bicycle routes.

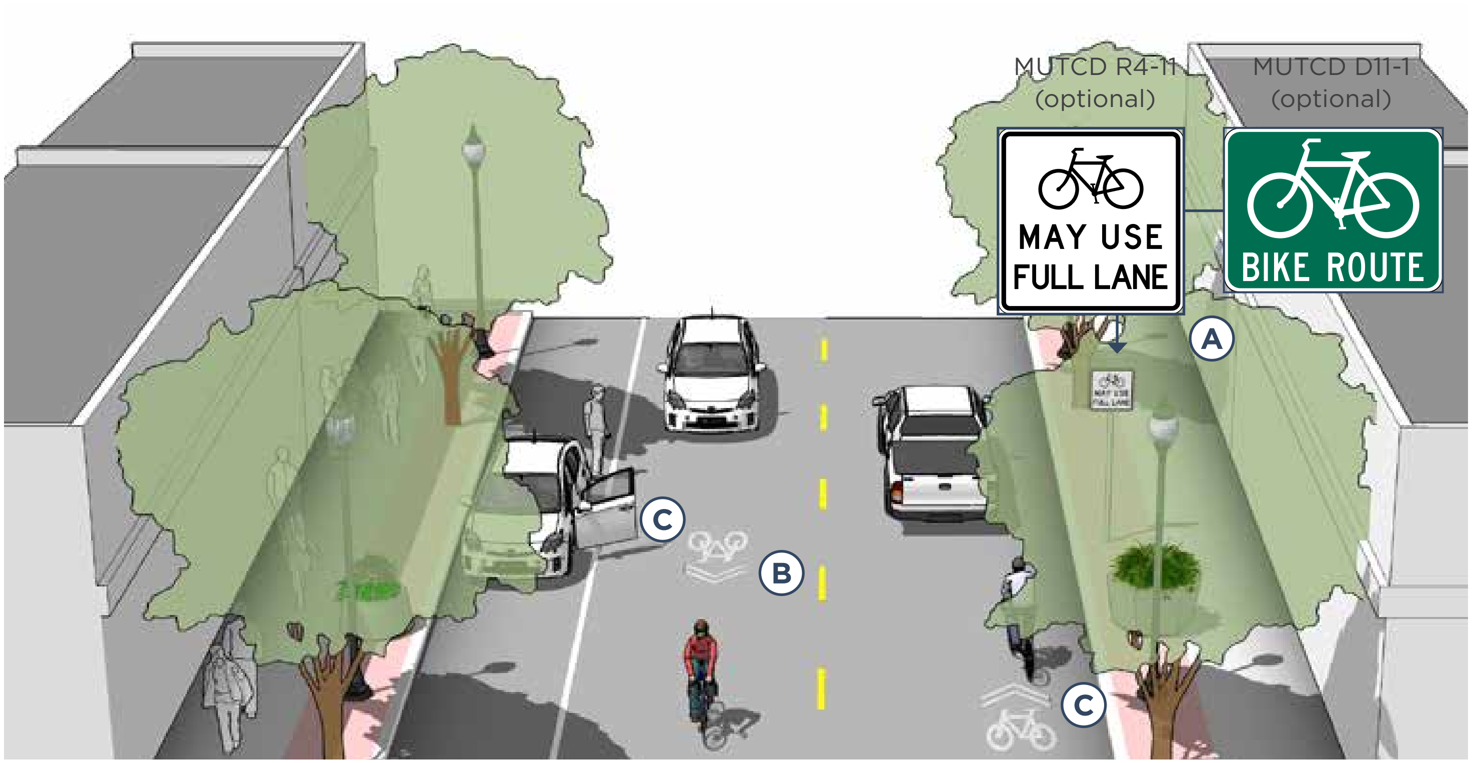
  › At intervals along bicycle routes not to exceed ½ mile.

Shared Lane Markings

- May be used on streets with a speed limit of 35 mph or under. Lower than 30 mph speed limit preferred.

(B) In constrained conditions, preferred placement is in the center of the travel lane to minimize wear and promote single file travel.

(C) Minimum placement of SLM marking centerline is 11 feet from edge of curb where on-street parking is present, 4 feet from edge of curb with no parking. If parking lane is wider than 7.5 feet, the SLM should be moved further out accordingly.



BICYCLE BOULEVARDS

Bicycle boulevards are low-volume, low-speed streets modified to enhance bicyclist comfort by using treatments such as signage, pavement markings, traffic calming and/or traffic reduction, and intersection modifications. These treatments allow through movements of bicyclists while discouraging similar through-trips by non-local motorized traffic.

Typical Application

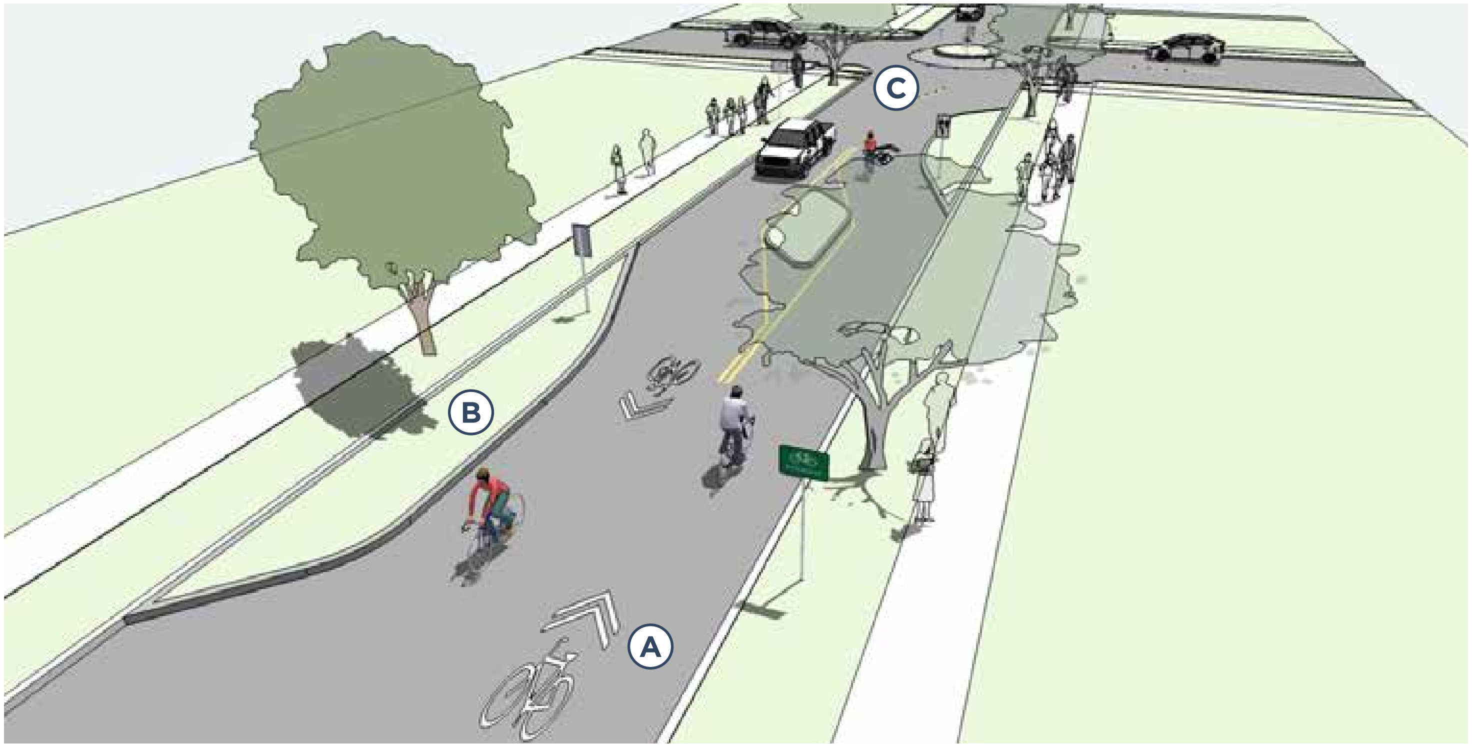
- Parallel with and in close proximity to major thoroughfares (1/4 mile or less).
- Follow a desire line for bicycle travel that is ideally long and relatively continuous (2-5 miles).
- Avoid alignments with excessive zigzag or circuitous routing. The bikeway should have less than 10 percent out of direction travel compared to shortest path of primary corridor.
- Streets with travel speeds at 25 mph or less and with traffic volumes of fewer than 3,000 vehicles per day.

Design Features

(A) Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard.

(B) Implement volume control treatments based on the context of the bicycle boulevard, using engineering judgment. Target motor vehicle volumes range from 1,000 to 3,000 vehicles per day.

(C) Intersection crossings should be designed to enhance safety and minimize delay for bicyclists.



Further Consideration

Bicycle boulevard retrofits to local streets are typically located on streets without existing signalized accommodation at crossings of collector and arterial roadways. Without treatments for bicyclists, these intersections can become major barriers along the bicycle boulevard and compromise safety.
Traffic calming can deter motorists from driving on a street. Anticipate and monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

Crash Reduction

In a comparison of vehicle/cyclist collision rates on traffic-calmed side streets signed and improved for cyclist use, compared to parallel and adjacent arterials with higher speeds and volumes, the bicycle boulevard as found to have a crash reduction factor of 63 percent, with rates two to eight times lower when controlling for volume (CMF ID: 3092).

Bicycle Boulevards

Bicycle boulevards are established on streets that improve connectivity to key destinations and provide a direct, low-stress route for bicyclists, with low motorized traffic volumes and speeds, designated and designed to give bicycle travel priority over other modes.

Traffic Calming

Streets along classified neighborhood bikeways may require additional traffic calming measures to discourage through trips by motor vehicles.

BICYCLE BOULEVARDS - VERTICAL TRAFFIC CALMING

Motor vehicle speeds affect the frequency at which automobiles pass bicyclists as well as the severity of crashes that can occur. Maintaining motor vehicle speeds closer to those of bicyclists' greatly improves bicyclists' comfort on a street. Slower vehicular speeds also improve motorists' ability to see and react to bicyclists and minimize conflicts at driveways and other turning locations.

Vertical speed control measures are composed of slight rises in the pavement, on which motorists and bicyclists must reduce speed to cross.

Guidance

- Bicycle boulevards should have a maximum posted speed of 25 mph. Use traffic calming to maintain an 85th percentile speed below 22 mph.
- Speed humps are raised areas usually placed in a series across both travel lanes. A 14' long hump reduces impacts to emergency vehicles. Speed humps can be challenging for bicyclists, gaps can be provided in the center or by the curb for bicyclists and to improve drainage. Speed humps can also be offset to accommodate emergency vehicles.
- Speed lumps or cushions have gaps to accommodate the wheel tracks of emergency vehicles.
- Speed tables are longer than speed humps and flat-topped. Raised crosswalks are speed tables that are marked and signed for a pedestrian crossing.
- For all vertical traffic calming, slopes should not exceed 1:10 or be less steep than 1:25. Tapers should be no greater than 1:6 to reduce the risk of bicyclists losing their balance. The vertical lip should be no more than a 1/4" high.

Speed Hump

Offset Speed Hump

Temporary Speed Cushion

Raised Crosswalk

BICYCLE BOULEVARDS - HORIZONTAL TRAFFIC CALMING

Horizontal traffic calming devices cause drivers to slow down by constricting the roadway space or by requiring careful maneuvering.

Such measures may reduce the design speed of a street, and can be used in conjunction with reduced speed limits to reinforce the expectation of lowered speeds.

Guidance

- Maintain a minimum clear width of 20 feet (or 28 feet with parking on both sides), with a constricted length of at least 20 feet in the direction of travel.
- Chicanes are a series of raised or delineated curb extensions, edge islands, or parking bays on alternating sides of a street forming an "S"-shaped curb, which reduce vehicle speeds by requiring motorists to shift laterally through narrowed travel lanes.
- Pinchpoints are curb extensions placed on both sides of the street, narrowing the travel lane and encouraging all road users to slow down. When placed at intersections, pinchpoints are known as chokers or neckdowns. They reduce curb radii and further lower motor vehicle speeds.
- Traffic circles are raised or delineated islands placed at intersections that reduce vehicle speeds by narrowing turning radii and the travel lane. Traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles like fire trucks or school buses.

Temporary Curb Extension

Chicane

Choker or Neckdown

Pinchpoint with Bicycle Access

BICYCLE BOULEVARDS - TRAFFIC DIVERSION

Motor vehicle traffic volumes affect the operation of a bicycle boulevard. Higher vehicle volumes reduce bicyclists' comfort and can result in more conflicts. Implement volume control treatments based on the context of the bicycle boulevard, using engineering judgment. Target motor vehicle volumes range from 1,000 to 3,000 vehicles per day, above which the route should be striped as a bike lane or considered a signed shared roadway.

Guidance

- Traffic diversion treatments reduce motor vehicle volumes by completely or partially restricting through traffic on a bicycle boulevard.
- Partial closures allow full bicycle passage while restricting vehicle access to one way traffic at that point.
- Diagonal diverters require all motor vehicle traffic to turn.
- Median diverters (see Major Intersection Treatments) restrict through motor vehicle movements while providing a refuge for bicyclists to cross in two stages.
- Street closures create a "T" that blocks motor vehicles from continuing on a bicycle boulevard, while bicycle travel can continue unimpeded. Full closures can accommodate emergency vehicles with the use of mountable curbs (maximum of six inches high).

Partial Closure

Diagonal Diverter

Median Diverter

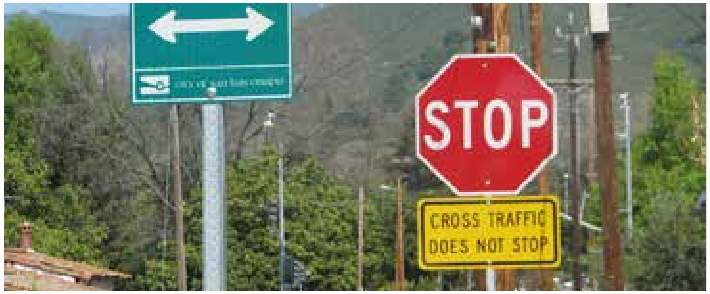
Full Closure

BICYCLE BOULEVARDS - MINOR INTERSECTIONS

Treatments at minor roadway intersections are designed to improve the visibility of a bicycle boulevard, raise awareness of motorists on the cross-street that they are likely to encounter bicyclists, and enhance safety for all road users.

Guidance

- On the bicycle boulevard, the majority of intersections with minor roadways should stop-control cross traffic to minimize bicyclist delay. This will maximize bicycling efficiency.
- Traffic circles are a type of horizontal traffic calming that can be used at minor street intersections. Traffic circles reduce conflict potential and severity while providing traffic calming to the corridor.
- If a stop sign is present on the bicycle boulevard, a second stop bar for bicyclists can be placed closer to the centerline of the cross street than the motorists' stop bar to increase the visibility of bicyclists waiting to cross the street.
- Curb extensions can be used to move bicyclists closer to the centerline to improve visibility and encourage motorists to let them cross.



Stop Signs on Cross-Street


Traffic Circles


Bicycle Forward Stop Bar


Curb Extension

BICYCLE BOULEVARDS - MAJOR INTERSECTIONS

The quality of treatments at major street crossings can significantly affect a bicyclist's choice to use a neighborhood greenway, as opposed to another road that provides a crossing treatment.

Guidance

- Bike boxes increase bicyclist visibility to motorists and reduce the danger of right "hooks" by providing a space for bicyclists to wait at signalized intersections.
- Median islands provided at uncontrolled intersections of neighborhood greenways and major streets allow bicyclists to cross one direction of traffic at a time as gaps in traffic occur.
- Hybrid beacons, active warning beacons and bicycle signals can facilitate bicyclists crossing a busy street on which cross-traffic does not stop.
- Select treatments based on engineering judgment; see National Cooperative Highway Research Program (NCHRP) Report # 562 Improving Pedestrian Safety at Unsignalized Crossings (2006) for guidance on appropriate use of crossing treatments. Treatments are designed to improve visibility and encourage motorists to stop for pedestrians; with engineering judgment many of the same treatments are appropriate for use along neighborhood greenways.

Bike Box

Median Island

Hybrid Beacon (HAWK

Active Flashing Beacon

BICYCLE BOULEVARDS - OFFSET INTERSECTIONS

Offset intersections can be challenging for bicyclists who are required to briefly travel along the busier cross street in order to continue along the neighborhood greenway.

Guidance

- Appropriate treatments depend on volume of traffic including turning volumes, traffic speeds and the type of bicyclist using the crossing.
- Contraflow bike lanes allow bicyclists to travel against the flow of traffic on a one-way street and can improve neighborhood greenway connectivity.
- Bicycle left-turn lanes can be painted where a neighborhood greenway is offset to the right on a street that has sufficient traffic gaps. Bicyclists cross one direction of traffic and wait in a protected space for a gap in the other direction. The bike turn pockets should be at least 4 feet wide, with a total of 11 feet for both turn pockets and center striping.
- Short bike lanes on the cross street assist with accessing a neighborhood greenway that jogs to the left. Crossing treatments should be provided on both sides to minimize wrong-way riding.
- A cycle track can be provided on one side of a busy street. Bicyclists enter the cycle track from the neighborhood greenway to reach the connecting segment of the neighborhood greenway. This maneuver may be signalized on one side.

Contraflow Bike Lane

Left Turn Bike Lanes

Short Bike Lanes on the Cross Street

Separated Bike Lane Connection

ON-STREET BIKEWAYS

Designated for bicycle travel, on-street bikeways are separated from vehicle travel lanes by striping, and can include pavement stencils and other treatments. On-street bikeways may be most appropriate on collector streets with single-lane of traffic in each direction where moderate traffic volumes and speeds are too high for shared-roadway use.

CONVENTIONAL BIKE LANES

PAVED SHOULDERS

BUFFERED BIKE LANES

ADVISORY BIKE LANES

UPHILL BIKE LANE / CLIMBING LANE

SHOULDER BIKEWAYS

Typically found in less-dense areas, shoulder bikeways are paved roadways with striped shoulders (4'+) wide enough for bicycle travel. Shoulder bikeways often, but not always, include signage alerting motorists to expect bicycle travel along the roadway.

Typical Application

- Located in more rural environments where there are no curbs or gutters.
- Suitable for roadways with higher speeds and lower bicycle volumes.
- Shoulder bikeways should be considered a temporary treatment, with full bike lanes planned for construction when the roadway is widened or completed with curb and gutter.

Design Features

(A) A minimum of 4 feet of ridable surface should be available for bicycle travel. (AASHTO 2012)

(B) Rumble strips are not recommended on shoulders used by bicyclists unless there is a minimum 4 foot clear path. 12 foot gaps every 40-60 feet should be provided to allow access as needed.

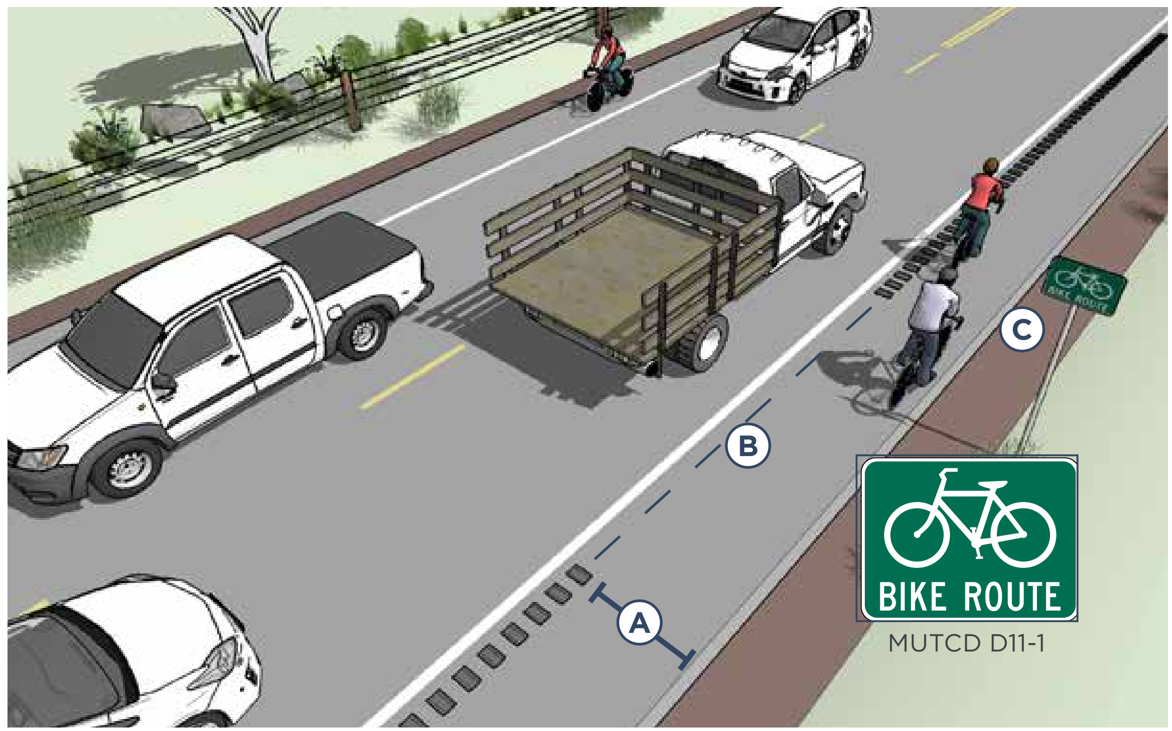
(C) Optional MUTCD D11-1 "Bike Route" wayfinding signage.

Further Consideration

- If it is not possible to meet minimum bicycle lane dimensions, a reduced width paved shoulder can still improve conditions for bicyclists on constrained roadways. In these situations, a minimum of 3 feet of operating space should be provided.
- A wide outside lane may be sufficient accommodation for bicyclists on streets with insufficient width for bike lanes but which do have space available to provide a wider (14'-16') outside travel lane. Consider configuring as a marked shared roadway in these locations.

Shoulder Bikeway

Shoulder bikeways provide benefits for bicycles, pedestrians, and motor vehicles.



ADVISORY BIKE LANES

Advisory bike lanes are a type of shared roadway that clarify operating positions for bicyclists and motorists to minimize conflicts and increase comfort. Similar in appearance to bike lanes, advisory bike lanes are distinct in that they are temporarily shared with motor vehicles during turning, approaching, and passing.

Typical Application

- Most appropriate on streets where motor vehicle traffic volumes are low-moderate (500-4,500 ADT), and where there is insufficient room for conventional bicycle lanes. Traffic speeds of 30 KPH to 60 KPH are possible with advisory bike lanes but caution should be used at higher speed levels, e.g. traffic calming, lower vehicular volumes, etc.
- If on-street parking is present, parking lanes should be highly utilized or occupied with curb extensions to separate the parking lane from the advisory bike lane.

Design Features

Ⓐ No centerline on roadway.

Ⓑ Advisory bike lane width of 5 - 7 ft.

Ⓒ Minimum center travel lane width of 8 - 20 ft.. When center travel lane width allows 2 vehicles to pass without use of bike lanes, additional traffic calming should be considered. Center travel lane widths which make it unclear whether two vehicles can pass without use of the bike lane should be avoided – use obviously narrow or obviously wide center travel lanes.

Crash Reduction

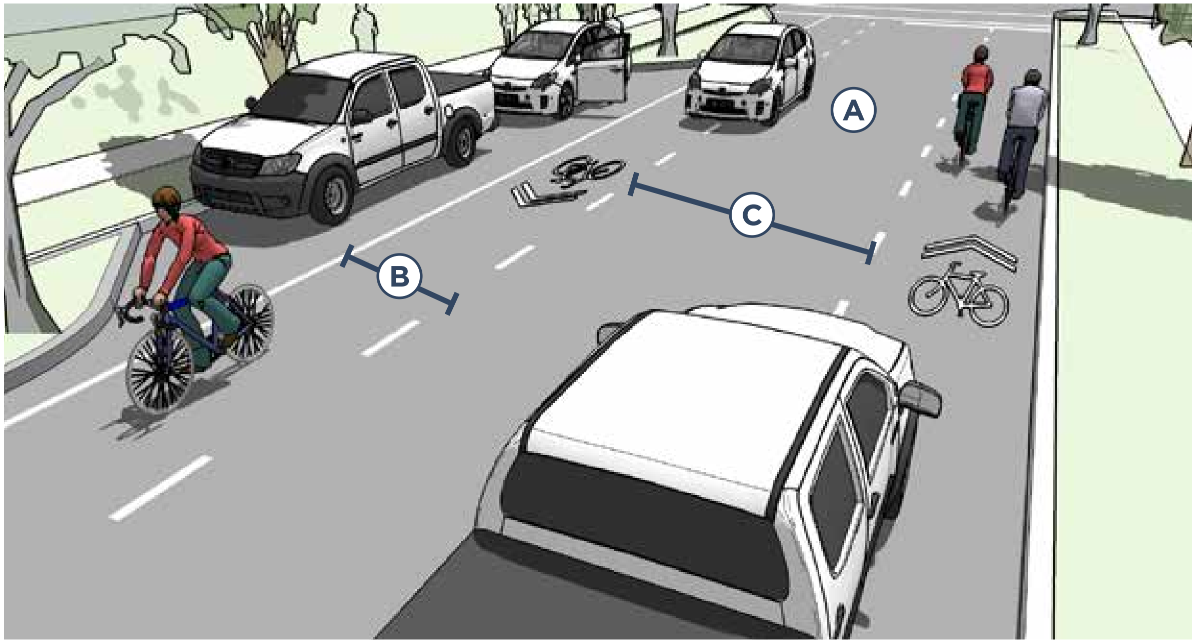
Short-term engineering evaluation studies have been performed on five US ABL installations. All have found the facilities to be safe and operating as intended. One English study found a reduction in accidents from 17 injury accidents a year to 11 (a 35% reduction) after removal of a centerline from a road in Wiltshire County.

Further Consideration

- Consider the use of colored pavement within the bike lanes to discourage unnecessary encroachment by motorists or parked vehicles.
- It is important to consider the needs of various road users when implementing an advisory bike lane. Required passing widths for truck or emergency vehicles should be considered on routes where such vehicles are anticipated.
- This treatment can be used on both urban and rural roads with appropriate speeds and volumes. Curves, hills, and dips should be assessed for sufficient sight distance to ensure safe operation.
- Channelizing islands may be useful in areas where drivers need to be encouraged to return to the center travel lane.

Advisory Bike Lane in Minnesota

Bike lane symbols and lane stripping tell motorists and cyclists where to position themselves.



CONVENTIONAL BIKE LANES

On-street bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signs. The bike lane is located directly adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge or parking lane.

Typical Application

- Bike lanes may be used on any street with adequate space, but are most effective on streets with moderate traffic volumes ≥ 6,000 ADT (≥ 3,000 preferred).
- Bike lanes are most appropriate on streets with moderate speeds ≥ 25 mph.
- Appropriate for skilled adult riders on most streets.
- May be appropriate for children when configured as 6+ ft wide lanes on lower-speed, lower-volume streets with one lane in each direction.

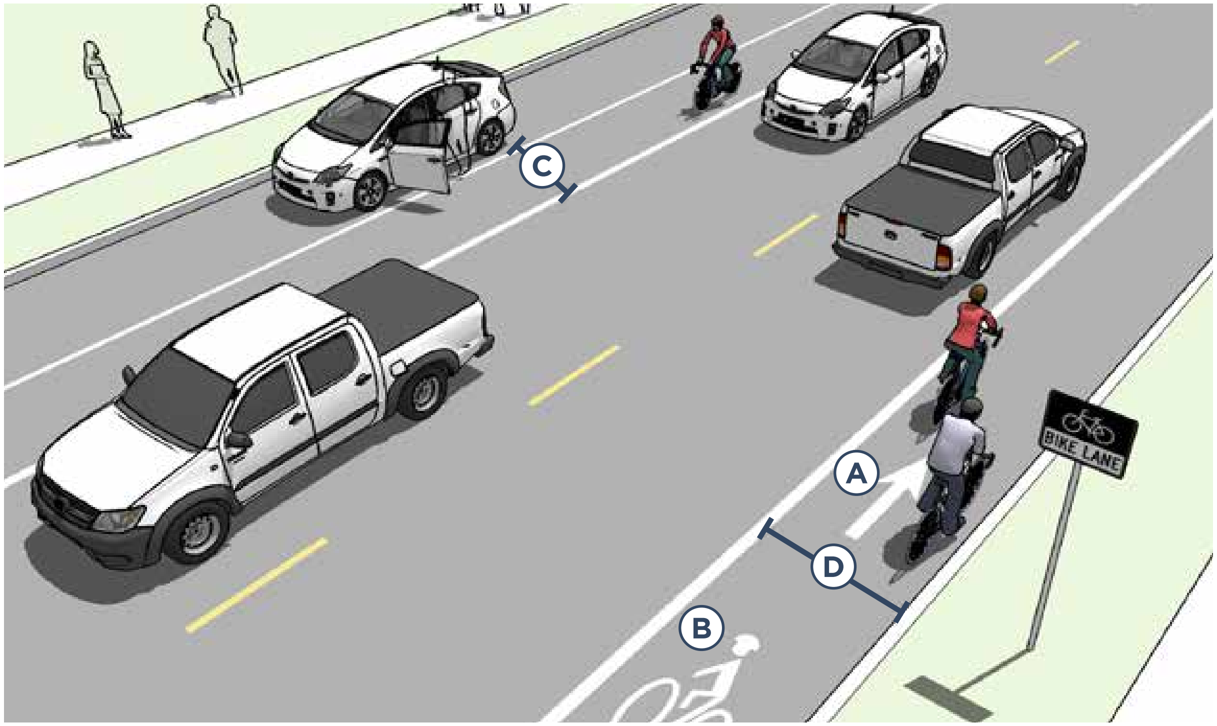
Design Features

(A) Mark inside line with 6" stripe. Mark 4" parking lane line or "Ts".[1]

(B) Include a bicycle lane marking (MUTCD Figure 9C-3) at the beginning of blocks and at regular intervals along the route (MUTCD 9C.04).

(C) 6 ft width preferred adjacent to on-street parking (5 ft min.).

(D) 5–6 ft preferred adjacent to curb and gutter (4 ft min.) or 4 ft more than the gutter pan width.



1 Studies have shown that marking the parking lane encourages people to park closer to the curb. FHWA. Bicycle Countermeasure Selection System. 2006.

Further Consideration

- On high speed streets (≥ 40 mph) the minimum bike lane should be 6 ft.
- On streets where bicyclists passing each other is to be expected, where high volumes of bicyclists are present, or where added comfort is desired, consider providing extra wide bike lanes up to 7 ft wide, or configure as a buffered bicycle lane.
- It may be desirable to reduce the width of general purpose travel lanes in order to add or widen bicycle lanes.
- On multi-lane and/or high speed streets, the most appropriate bicycle facility to provide for user comfort may be buffered bicycle lanes or physically separated bicycle lanes.

Manhole Covers

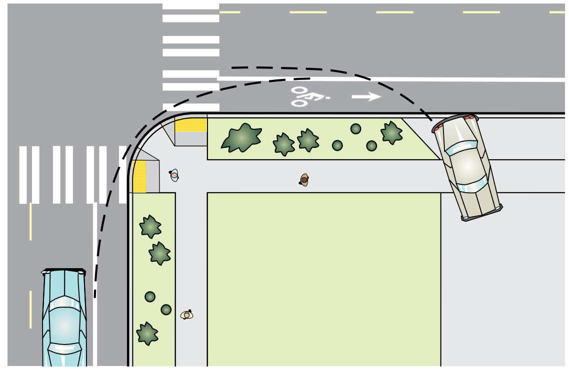
Manhole surfaces should be manufactured with a shallow surface texture in the form of a tight, nonlinear pattern.

Manholes, drainage grates, or other obstacles should be set flush with the paved roadway. Roadway surface inconsistencies pose a threat to safe riding conditions for bicyclists.

Crash Reduction

Before and after studies of bicycle lane installations show a wide range of crash reduction factors. Some studies show a crash reduction of 35 percent (CMF ID: 1719) for vehicle/bicycle collisions after bike lane installation.

Place Bike Lane Symbols to Reduce Wear



Bike lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed outside of the motor vehicle tread path in order to minimize wear from the motor vehicle path (NACTO 2012).

Conventional Lane

Bicycle lanes provide an exclusive space, but may be subject to unwanted encroachment by motor vehicles.

Conventional Bike Lane

Bike lane symbols and lane stripping tell motorists and cyclists where to position themselves.

BUFFERED BIKE LANES

Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.

Typical Application

- Anywhere a conventional bike lane is being considered.
- On streets with high speeds and high volumes or high truck volumes.
- On streets with extra lanes or lane width.
- Appropriate for skilled adult riders on most streets

Design Features

(A) The minimum bicycle travel area (not including buffer) is 5 ft wide.

(B) Buffers should be at least 2 ft wide. If buffer area is 4 ft or wider, white chevron or diagonal markings should be used.

- For clarity at driveways or minor street crossings, consider a dotted line.
- There is no standard for whether the buffer is configured on the parking side, the travel side, or a combination of both.

Further Consideration

- Color may be used within the lane to discourage motorists from entering the buffered lane.
- A study of buffered bicycle lanes found that, in order to make the facilities successful, there needs to also be driver education, improved signage and proper pavement markings.[1]
- On multi-lane streets with high vehicles speeds, the most appropriate bicycle facility to provide for user comfort may be physically separated bike lanes.

1 Monsere, C.; McNeil, N.; and Dill, J., "Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track and SW Stark/Oak Street Buffered Bike Lanes. Final Report" (2011).Urban Studies and Planning Faculty Publications and Presentations.

- NCHRP Report #766 recommends, when space in limited, installing a buffer space between the parking lane and bicycle lane where on-street parking is permitted rather than between the bicycle lane and vehicle travel lane.[2]

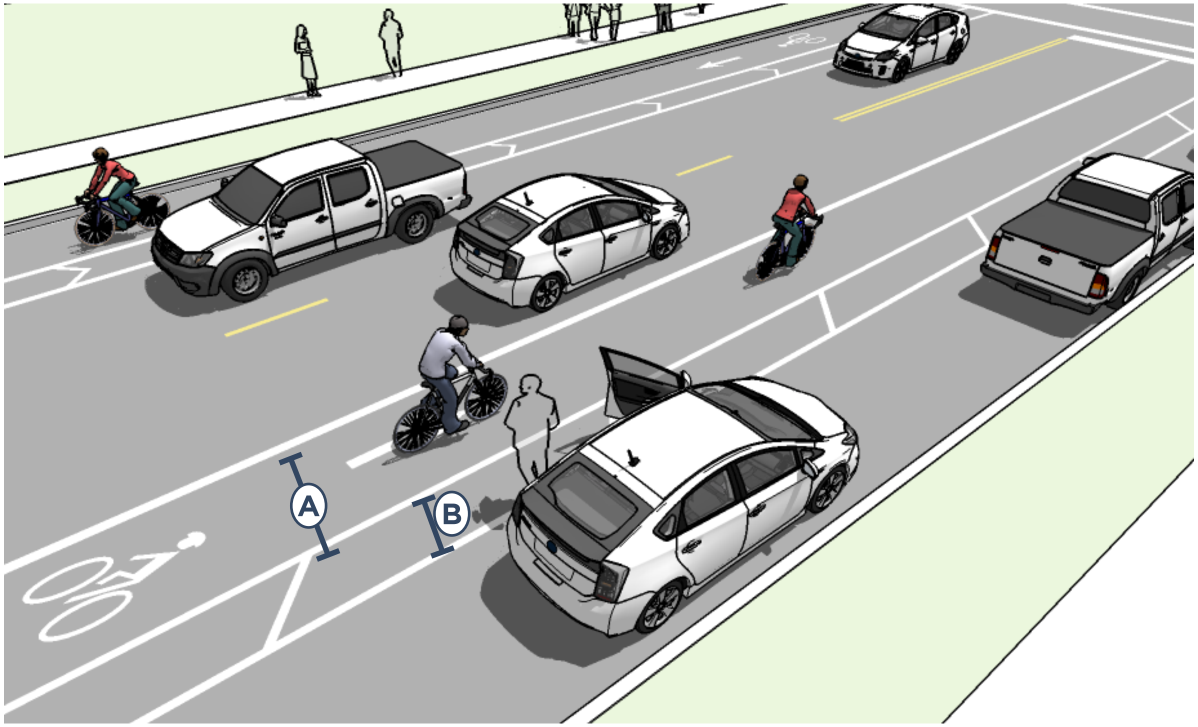
Crash Reduction

A before and after study of buffered bicycle lane installation in Portland, OR found an overwhelmingly positive response from bicyclists, with 89 percent of bicyclists feeling safer riding after installation and 91 percent expressing that the facility made bicycling easier.[3]

2 National Cooperative Highway Research Program. Report #766: Recommended Bicycle Lane Widths for Various Roadway Characteristics.
3 National Cooperative Highway Research Program. Report #766: Recommended Bicycle Lane Widths for Various Roadway Characteristics.

Buffered Bicycle Lane

Pavement markings delineate space for cyclists to ride in a comfortable facility.



UPHILL BIKE LANES (CLIMBING LANES)

Uphill bike lanes (also known as "climbing lanes") enable motorists to safely pass slower-speed bicyclists, thereby improving conditions for both travel modes.

Typical Application

- On shared roadways with a hill, where cyclists will be slowed by the uphill grade.
- Typically found on retrofit projects, as newly constructed roads should provide adequate space for bicycle lanes in both directions of travel.

Design Features

- (A) Uphill bike lanes should be 6-7 feet wide (wider lanes are preferred because extra maneuvering room on steep grades can benefit bicyclists).
- (B) Can be combined with shared lane markings for downhill bicyclists who can more closely match prevailing traffic speeds.

Further Consideration

- Accommodating an uphill bicycle lane often includes delineating on-street parking (if provided), narrowing travel lanes and/or shifting the centerline if necessary.
- A bike lane sign (MUTCD R3-17) may be used to increase visibility of the climbing lane.

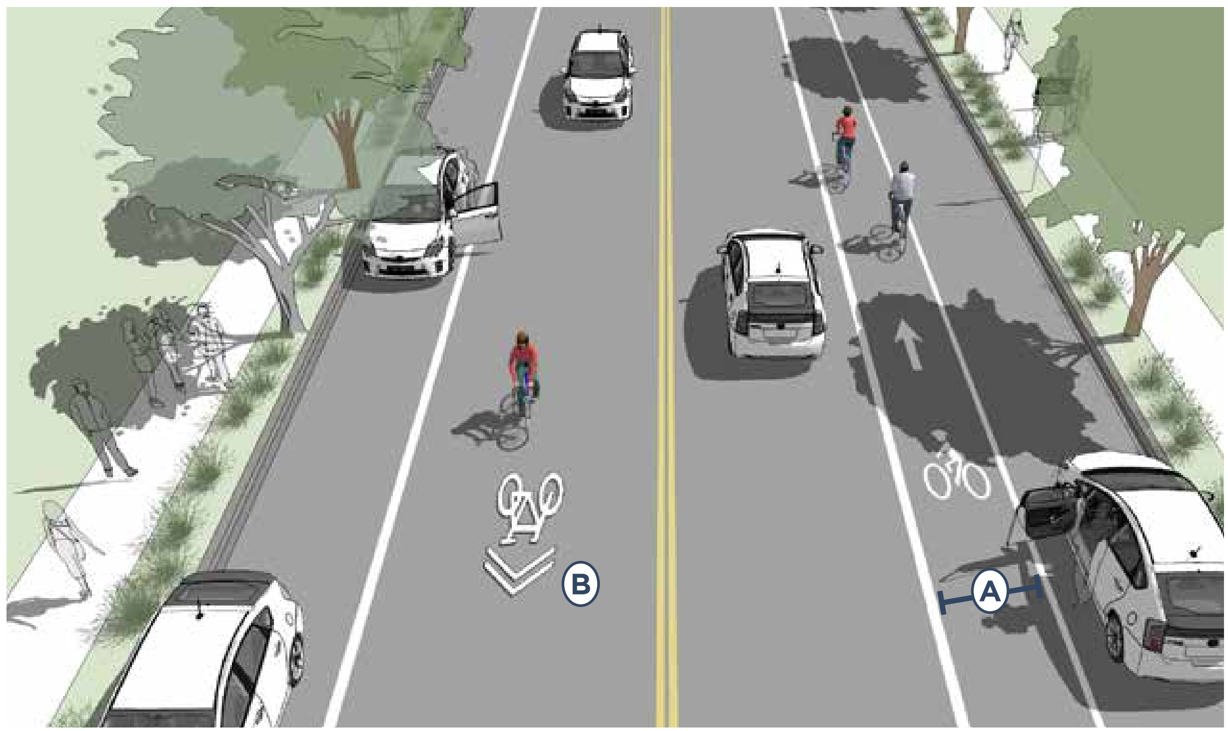
Crash Reduction

By separating vehicle and bicycle traffic, climbing lanes enable motorists to safely pass slower-speed bicyclists, thereby improving conditions for both travel modes.

Climbing Lane

A climbing lane is added on the uphill portion of the roadway.

A climbing lane, with bicycle pavement markings, safely positions cyclists for the uphill portion of the roadway.



PHYSICALLY SEPARATED BICYCLE LANES

A physically separated bicycle lane (SBL) is an exclusive bike facility that combines the user experience of a separated path with the on-street infrastructure of an on-street bike lane. A separated bicycle lane is physically separated from motor traffic by a vertical element and distinct from the sidewalk. In situations where on-street parking is allowed, separated bicycle lanes are located between the parking and the sidewalk.

ONE-WAY SEPARATED BIKE LANES

TWO-WAY SEPARATED BIKE LANES

SEPARATION METHODS

ONE-WAY SEPARATED BIKE LANES

When retrofitting separated bike lanes onto existing streets, a one-way street-level design may be most appropriate. This design provides protection through physical barriers and can include flexible delineators, curbs, on-street parking or other barriers. A street level separated bike lane shares the same elevation as adjacent travel lanes.

Typical Application

- Street retrofit projects with limited funds for relating curbs and drainage.
- Streets with high motor vehicle volumes and/or speeds and high bicycle volumes.
- Streets for which conflicts at intersections can be effectively mitigated using parking lane setbacks, bicycle markings through the intersection, and other signalized intersection treatments.
- Appropriate for most riders on most streets.

Design Features

(A) Pavement markings, symbols and/or arrow markings must be placed at the beginning of the separated bike lane and at intervals along the facility (MUTCD 9C.04).

(B) 7 ft width preferred (5 ft minimum).

(C) 3 ft minimum buffer width adjacent to parking. 18 inch minimum adjacent to travel lanes (NACTO, 2012). Channelizing devices should be placed in the buffer area.

- If buffer area is 4 ft or wider, white chevron or diagonal markings should be used.

Further Consideration

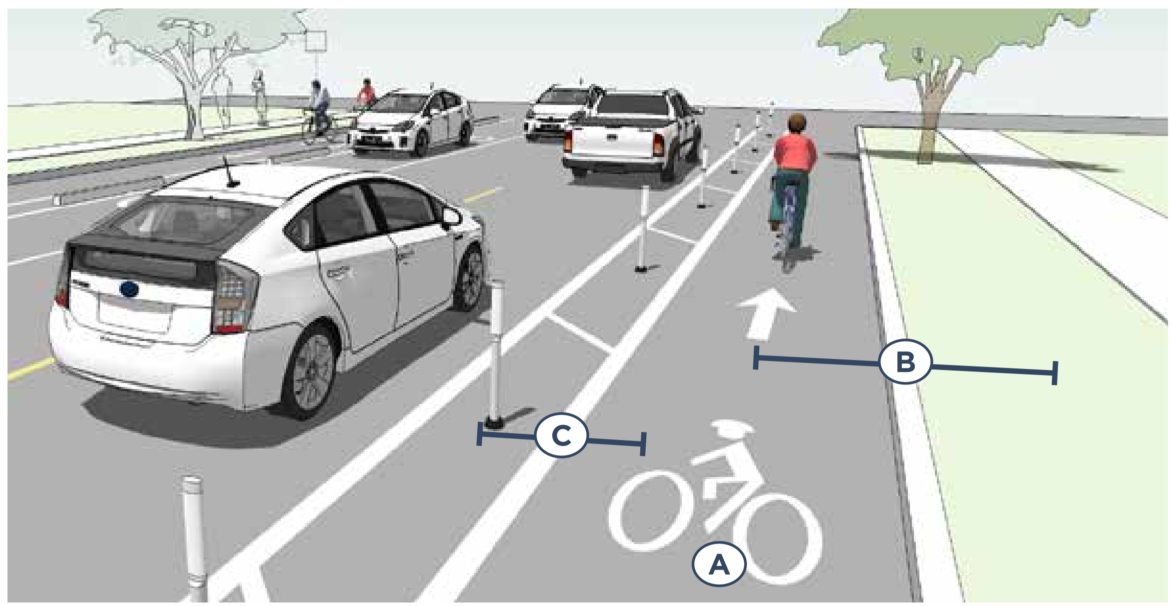
- Separated bike lane buffers and barriers are covered in the MUTCD as preferential lane markings (section 3D.01) and channelizing devices (section 3H.01). Curbs may be used as a channeling device, see the section on islands (section 3I.01).
- A retrofit separated bike lane has a relatively low implementation cost compared to road reconstruction by making use of existing pavement and drainage and by using parking lane as a barrier.
- Gutters, drainage outlets and utility covers should be designed and configured as not to impact bicycle travel.
- Special consideration should be given at transit stops to manage bicycle & pedestrian interactions.

Crash Reduction

A before and after study in Montreal of physically separated bicycle lanes shows that this type of facility can result in a crash reduction of 74 percent for collisions between bicyclists and vehicles. (CMF ID: 4097) In this study, there was a parking buffer between the bike facility and vehicle travel lanes. Other studies have found a range in crash reductions due to SBL, from 8 percent (CMF ID: 4094) to 94 percent (CMF ID: 4101).

Street Level Separated Bicycle Lanes

Street Level Separated Bicycle Lanes can be separated from the street with parking, planters, bollards, or other design elements.



TWO-WAY SEPARATED BIKE LANES

Two-Way Separated Bicycle Lanes are bicycle facilities that allow bicycle movement in both directions on one side of the road. Two-way separated bicycle lanes share some of the same design characteristics as one-way separated bicycle lanes, but may require additional considerations at driveway and side-street crossings.

Typical Application

- Works best on the left side of one-way streets.
- Streets with high motor vehicle volumes and/or speeds.
- Streets with high bicycle volumes.
- Streets with a high incidence of wrong-way bicycle riding.
- Streets with few conflicts such as driveways or cross-streets on one side of the street.
- Streets that connect to shared use paths.

Design Features

(A) 12 ft operating width preferred (10 ft minimum) width for two-way facility.

- In constrained an 8 ft minimum operating width may be considered.

(B) Adjacent to on-street parking a 3 ft minimum width channelized buffer or island shall be provided to accommodate opening doors (NACTO, 2012) (MUTCD 3H.01, 3I.01).

- A separation narrower than 5 ft may be permitted if a physical barrier is present (AASHTO, 2013).
- Additional signalization and signs may be necessary to manage conflicts.

Further Consideration

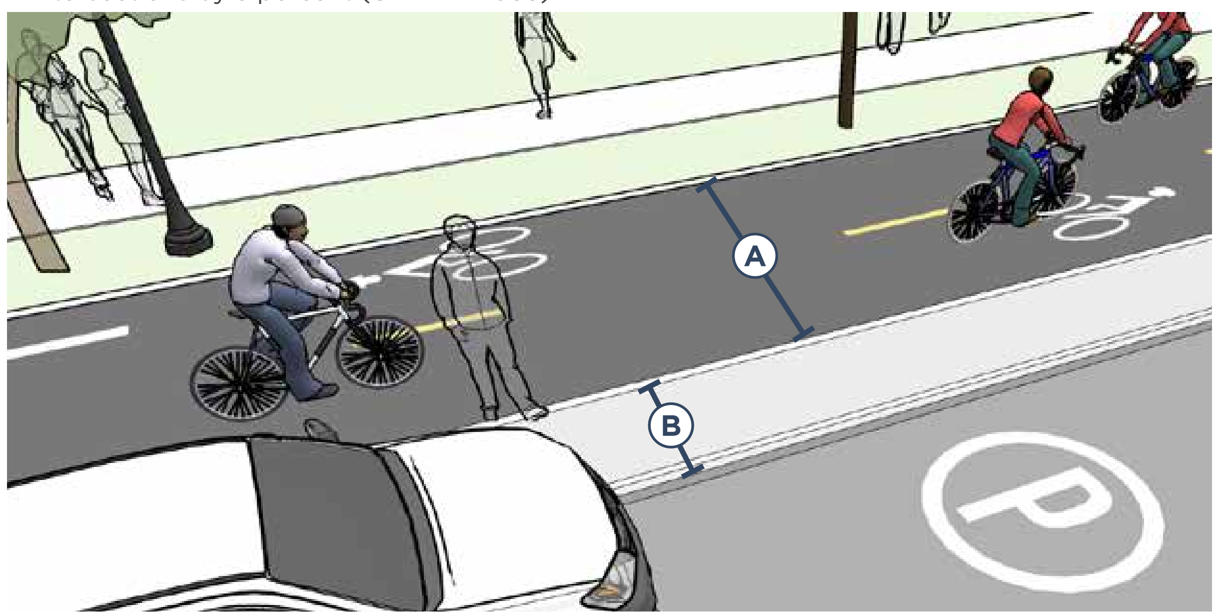
- On-street bike lane buffers and barriers are covered in the MUTCD as preferential lane markings (section 3D.01) and channelizing devices, including flexible delineators (section 3H.01). Curbs may be used as a channeling device, see the section on islands (section 3I.01).
- A two-way separated bike lane on one way street should be located on the left side.
- A two-way separated bike lane may be configured at street level or raised and separated with vertical separation from the adjacent travel lane.
- Two-way separated bike lanes should be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles.

Crash Reduction

A study of bicyclists in two-way separated facilities found that accident probability decreased by 45 percent at intersections where the separated facility approach was detected between 2-5 meters from the side of the main road and when bicyclists had crossing priority at intersections. (CMF ID: 3034) Installation of a two-way separated bike lane 0-2 meters from the side of the main road resulted in an increase in collisions at intersections by 3 percent (CMF ID: 4033).

Two-Way Separated Bicycle Lanes

A two-way facility can accommodate cyclists in two directions of travel.



SEPARATION METHODS

Separated bikeways may use a variety of vertical elements to physically separate the bikeway from adjacent travel lanes. Barriers may be robust constructed elements such as curbs, or may be more interim in nature, such as flexible delineator posts.

Typical Application

Appropriate barriers for retrofit projects:

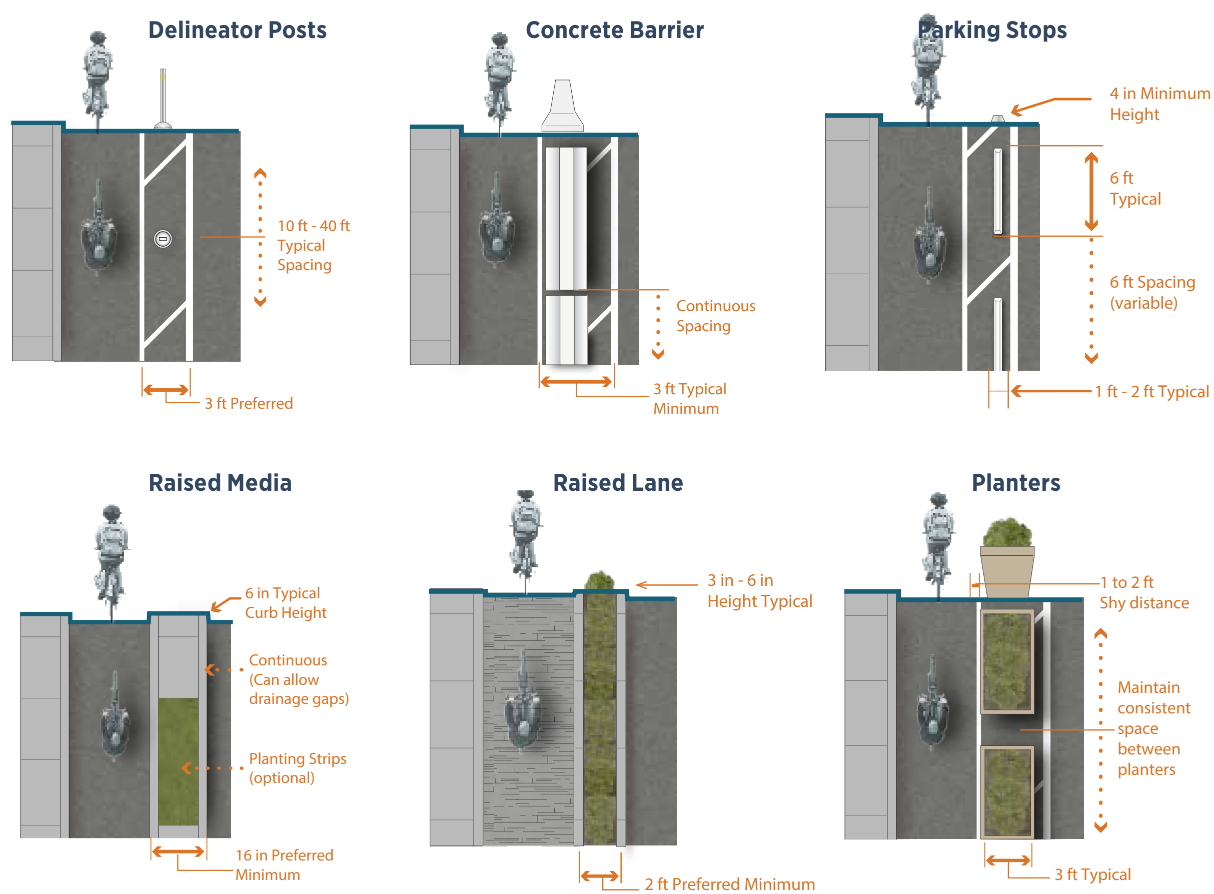
- Parked Cars
- Flexible delineators
- Bollards
- Planters
- Parking stops

Appropriate barriers for reconstruction projects:

- Curb separation
- Medians
- Landscaped Medians
- Raised separated bike lane with vertical or mountable curb
- Pedestrian Safety Islands

Design Features

- Maximize effective operating space by placing curbs or delineator posts as far from the through bikeway space as practicable.
- Allow for adequate shy distance of 1 to 2 ft from vertical elements to maximize useful space.
- When next to parking allow for 3 ft of space in the buffer space to allow for opening doors and passenger unloading.
- The presences of landscaping in medians, planters and safety islands increases comfort for users and enhances the streetscape environment.



Further Consideration

- Separated bikeway buffers and barriers are covered in the MUTCD as preferential lane markings (section 3D.01) and channelizing devices (section 3H.01). Curbs may be used as a channeling device, see the section on islands (section 3I.01).
- With new roadway construction a raised separated bikeway can be less expensive to construct than a wide or buffered bicycle lane because of shallower trenching and sub base requirements.
- Parking should be prohibited within 30 ft of the intersection to improve visibility.

Crash Reduction

A before and after study in Montreal of separated bikeways shows that this type of facility can result in a crash reduction of 74 percent for collisions between bicyclists and vehicles. (CMF ID: 4097) In this study, there was a parking buffer between the bike facility and vehicle travel lanes. Other studies have found a range in crash reductions due to SBL, from 8 percent (CMF ID: 4094) to 94 percent (CMF ID: 4101).

BIKEWAY SEPARATION METHODS

Raised separated bikeways are bicycle facilities that are vertically separated from motor vehicle traffic.

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Raised separated bikeways are bicycle facilities that are vertically separated from motor vehicle traffic.

BIKEWAY INTERSECTION TREATMENTS

Intersections are junctions at which different modes of transportation meet and facilities overlap. An intersection facilitates the interchange between bicyclists, motorists, pedestrians, and other modes in order to advance traffic flow in a safe and efficient manner. Designs for intersections with bicycle facilities should reduce conflict between bicyclists and motor vehicles by heightening the level of visibility, denoting clear right-of-way, and facilitating eye contact and awareness with other modes.


HYBRID BEACON FOR BIKE ROUTE CROSSING

BIKE LANES AT ADDED RIGHT TURN LANES

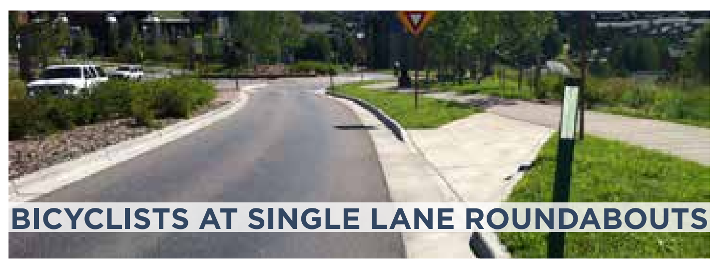

INTERSECTION CROSSING MARKINGS


COMBINED BIKE LANE/TURN LANE


BIKE BOX


TWO-STAGE TURN BOXES


COLORED BICYCLE LANES


BICYCLISTS AT SINGLE LANE ROUNDABOUTS

INTERSECTION CROSSING MARKINGS

Bicycle pavement markings through intersections guide bicyclists on a safe, direct path through the intersection and provide a clear boundary between the paths of through bicyclists and vehicles in the adjacent lane.

Typical Application

- Streets with conventional, buffered, or separated bike lanes.
- At direct paths through intersections.
- Streets with high volumes of adjacent traffic.
- Where potential conflicts exist between through bicyclist and adjacent traffic.

Design Features

- Intersection markings should be the same width and in line with leading bike lane.
- (A) Dotted lines should be a minimum of 6 inches wide and 4 ft long, spaced every 12 ft.
- All markings should be white, skid resistant and retro reflective (MUTCD 9C.02.02).
- (B) Green pavement markings may also be used.

Further Consideration

The National Committee on Uniform Traffic Control Devices has submitted a request to include additional options bicycle lane extensions through intersections as a part of future MUTCD updates.[1] Their proposal includes the following options for striping elements in the crossing:

- Bicycle lane markings
- Double chevron markings, indicating travel direction .
- Green colored pavement.

1 Letter to FHWA from the Bicycle Technical Committee for the MUTCD. Bicycle Lane Extensions through Intersections. June 2014.

Crash Reduction

A study on the safety effects of intersection crossing markings found a reduction in accidents by 10 percent and injuries by 19 percent.[2]

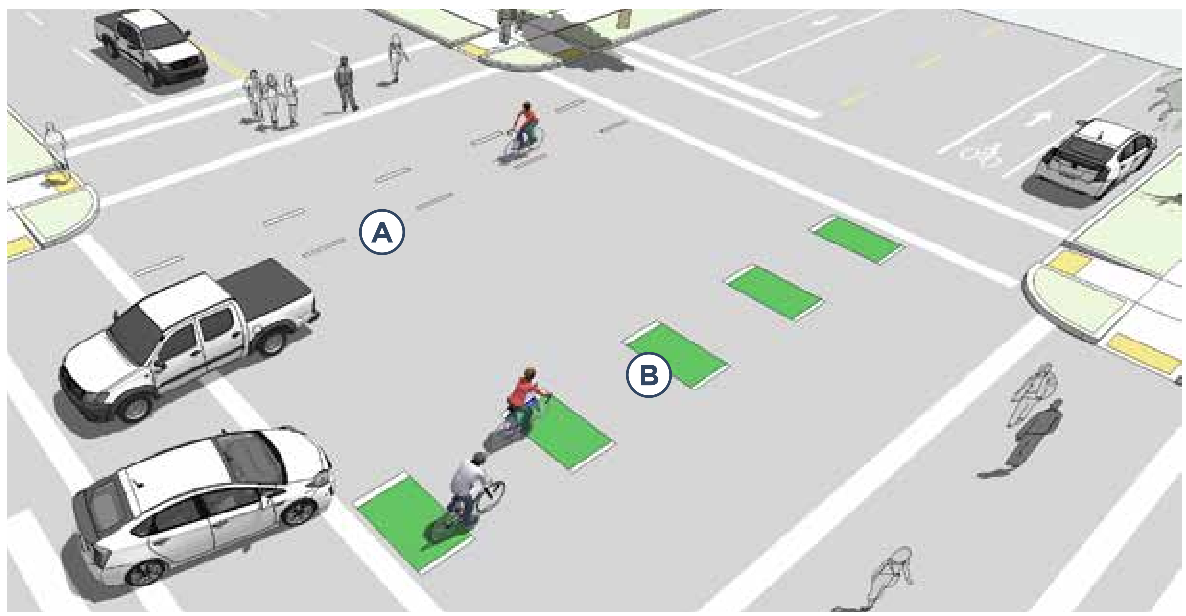
A study in Portland, OR found that significantly more motorists yielded to bicyclists after the colored pavement had been installed (92 percent in the after period versus 72 percent in the before period).[3]

2 Jensen, S.U. (2008). Safety effects of blue cycle crossings: A before-after study. Accident Analysis & Prevention, 40(2), 742-750.

3 Hunter, W.W. et al. (2000). Evaluation of Blue Bike-Lane Treatment in Portland, Oregon. Transportation Research Record, 1705, 107-115.

Intersection Crossing Markings

Intersection crossing markings can be used at signalized intersections or high volume minor street and driveway crossings, as illustrated above.



BIKE BOX

A bike box is a designated area located at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible space to get in front of queuing traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box. On a green signal, all bicyclists can quickly clear the intersection.

Typical Application

- Potential areas of conflict between bicyclists and turning vehicles, such as a right or left turn locations.
- Signalized intersections with high bicycle volumes.
- Signalized intersections with high vehicle volumes.

Design Features

(A) 14 ft minimum depth from back of crosswalk to motor vehicle stop bar (NACTO, 2012).

(B) A "No Turn on Red" (MUTCD R10-11) sign shall be installed overhead to prevent vehicles from entering the Bike Box. A "Stop Here on Red" (MUTCD R10-6) sign should be post mounted at the stop line to reinforce observance of the stop line.

(C) A 50 ft ingress lane should be used to provide access to the box.

- Use of green colored pavement is optional.

Further Consideration

- This treatment positions bicycles together and on a green signal, all bicyclists can quickly clear the intersection, minimizing conflict and delay to transit or other traffic.
- Pedestrians also benefit from bike boxes, as they experience reduced vehicle encroachment into the crosswalk.

Crash Reduction

A study of motorist/bicyclist conflicts at bike boxes indicate a 35 percent decrease in conflicts (CMF ID: 1718). A study done in Portland in 2010 found that 77 percent of bicyclists felt bicycling through intersections was safer with the bike boxes.[1]

1 Monsere, C. & Dill, J. (2010). Evaluation of Bike Boxes at Signalized Intersections. Final Draft. Oregon Transportation Research and education Consortium.

Bike Box

A bike box allows for cyclists to wait in front of queuing traffic, providing high visibility, and a head start over motor vehicle traffic.

COLORED MARKINGS IN CONFLICT ZONES

Colored pavement within a bicycle lane may be used to increase the visibility of the bicycle facility, raise awareness of the potential to encounter bicyclists and reinforce priority of bicyclists in conflict areas.

Typical Application

- Within a weaving or conflict area to identify the potential for bicyclist and motorist interactions and assert bicyclist priority.
- Across intersections, driveways and Stop or Yield-controlled cross-streets.

Design Features

(A) Typical white bike lanes (solid or dotted 6” stripe) are used to outline the green colored pavement.

(B) In weaving/turning conflict areas, preferred striping is dashed, to match the bicycle lane line extensions.

- The colored surface should be skid resistant and retro-reflective (MUTCD 9C.02.02).
- In exclusive use areas, such as bike boxes, color application should be solid green.

Further Consideration

- Green colored pavement shall be used in compliance with FHWA Interim Approval (FHWA IA-14.10).[1]
- While other colors have been used (red, blue, yellow), green is the recommended color in the US.
- The application of green colored pavement within bicycle lanes is an emerging practice. The guidance recommended here is based on best practices in cities around the county.

1 FHWA. Interim Approval for Optional Use of Green Colored Pavement for Bike Lanes (IA-14). 2011.

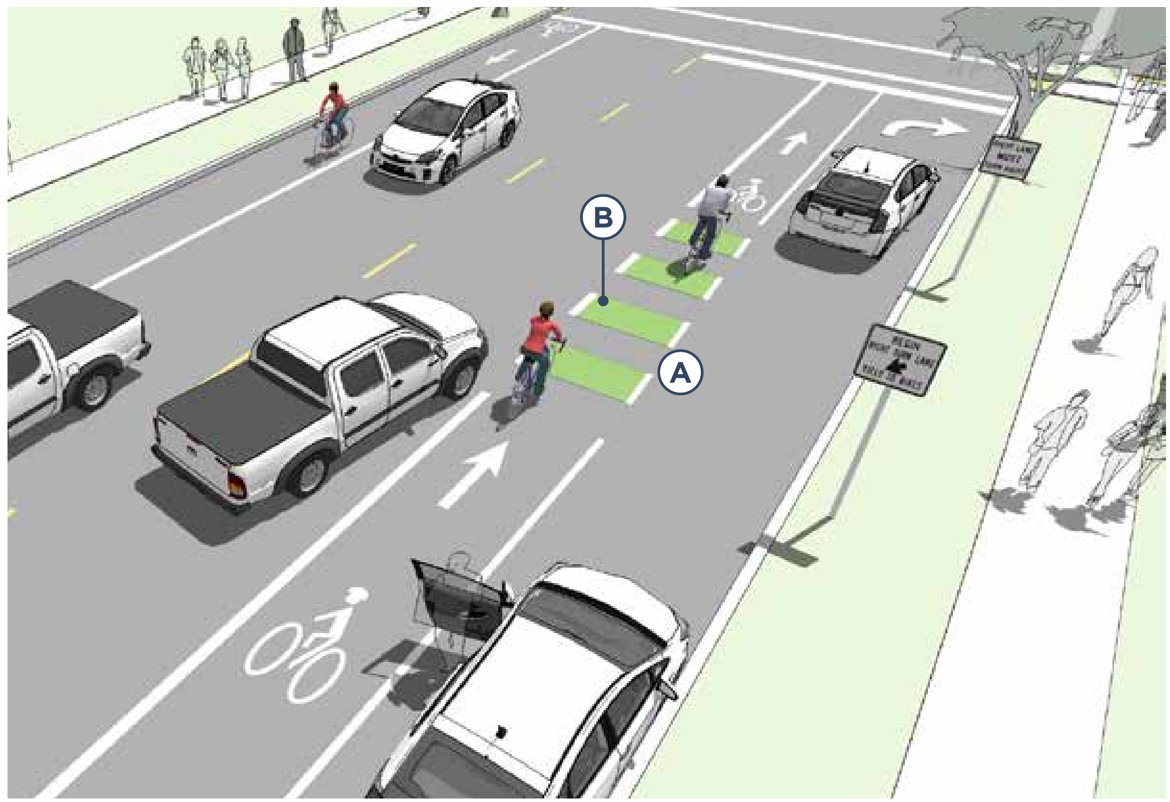
Crash Reduction

Before and after studies of colored bicycle lane installations have found a reduction in bicycle/vehicle collisions by 38 percent and a reduction in serious injuries and fatalities of bicyclists by 71 percent.[2] A study in Portland, OR found a 38 percent decrease in the rate of conflict between bicyclists and motorists after colored lanes were installed.[3]

2 Jensen, S.U., et. al., “The Marking of Bicycle Crossings at Signalized Intersections,” Nordic Road and Transport Research No. 1, 1997, pg. 27.
3 Hunter, W. W., et. al., Evaluation of the Blue Bike-Lane Treatment Used in Bicycle/Motor Vehicle Conflict Areas in Portland, Oregon, McLean, VA: FHWA, 2000, pg. 25.

Colored Bicycle Lane

A colored bicycle lane on Laurel Street in Santa Cruz, CA alerts users to potential merging in advance of an intersection. Photo by Richard Masoner via Flickr (CC BY-SA 2.0).



BIKE LANES AT ADDED RIGHT TURN LANES

The appropriate treatment at right turn only lanes is to introduce an added turn lane to the outside of the bicycle lane. The area where people driving must weave across the bicycle lane should be marked with dotted lines to identify the potential conflict areas. Signage should indicate that motorists must yield to bicyclists through the conflict area.

Typical Application

- Streets with right-turn lanes and right side bike lanes.
- Streets with left-turn lanes and left side bike lanes.

Design Features

(A) Mark inside line with 6" stripe.

(B) Continue existing bike lane width; standard width of 5 to 6 ft (4 ft in constrained locations).

(C) A "Begin Right Turn Lane Yield To Bikes" (MUTCD R4-4) signs indicates that motorists should yield to bicyclists through the conflict area.

- Consider using colored in the conflict areas to promote visibility of the dashed weaving area.

Further Consideration

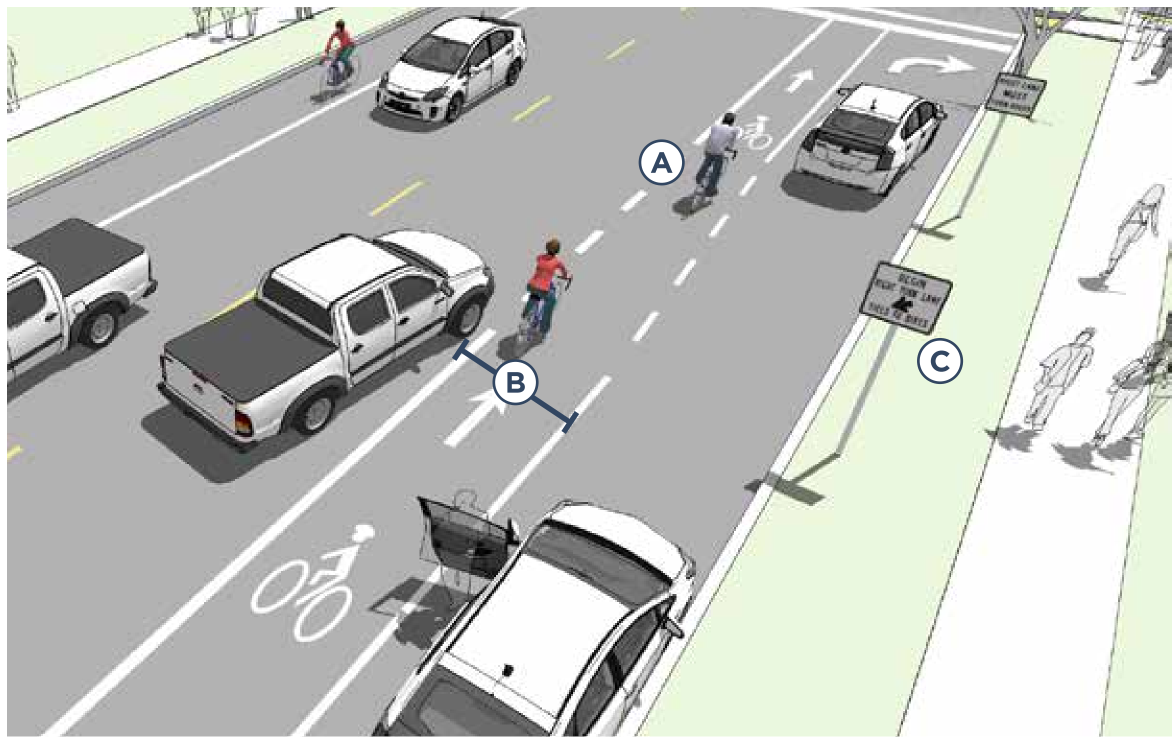
- The bicycle lane maintains a straight path, and drivers must weave across, providing clear right-of-way priority to bicyclists.
- Maintaining a straight bicycle path reinforces the priority of bicyclists over turning cars. Drivers must yield to bicyclists before crossing the bike lane to enter the turn only lane.
- Through lanes that become turn only lanes are difficult for bicyclists to navigate and should be avoided.
- The use of dual right-turn-only lanes should be avoided on streets with bike lanes (AASHTO, 2013). Where there are dual right-turn-only lanes, the bike lane should be placed to the left of both right-turn lanes, in the same manner as where there is just one right-turn-only lane.

Crash Reduction

Studies have shown a 3 percent decrease in crashes at signalized intersections with exclusive right turn lanes when compared to sharing the roadway with motor vehicles (CMF ID: 3257).

Through Bicycle Lane to the Left of a Right Turn Only Lane

Drivers wishing to enter the right turn lane must transition across the bicycle lane in advance of the turn.



COMBINED BIKE LANE/TURN LANE

Where there isn't room for a conventional bicycle lane and turn lane, combining them creates a shared lane where bicyclists can ride and turning motor vehicles yield to bicyclists. The combined lane places shared lane markings within a right turn only lane.

Typical Application

- Most appropriate in areas with lower posted speeds (30 MPH or less) and with lower traffic volumes (10,000 ADT or less).
- May not be appropriate for high speed arterials or intersections with long right turn lanes.
- May not be appropriate for intersections with large percentages of right-turning heavy vehicles.

Design Features

A Maximum shared turn lane width is 13 ft; narrower is preferable (NACTO, 2012).

B Shared Lane Markings should indicate preferred positioning of bicyclists within the combine lane.

C A "Right Lane Must Turn Right" (MUTCD R3-7R) sign with an "EXCEPT BIKES" plaque may be needed to permit through bicyclists to use a right turn lane.

D Use "Begin Right Turn Lane Yield To Bikes" signage (MUTCD R4-4) to indicate that motorists should yield to bicyclists through the conflict area.

Further Consideration

- Recommended at intersections lacking sufficient space to accommodate both a standard through bike lane and right turn lane.
- Not recommended at intersections with high peak motor vehicle right turn movements.
- Combined bike lane/turn lane creates safety and comfort benefits by negotiating conflicts upstream of the intersection area.

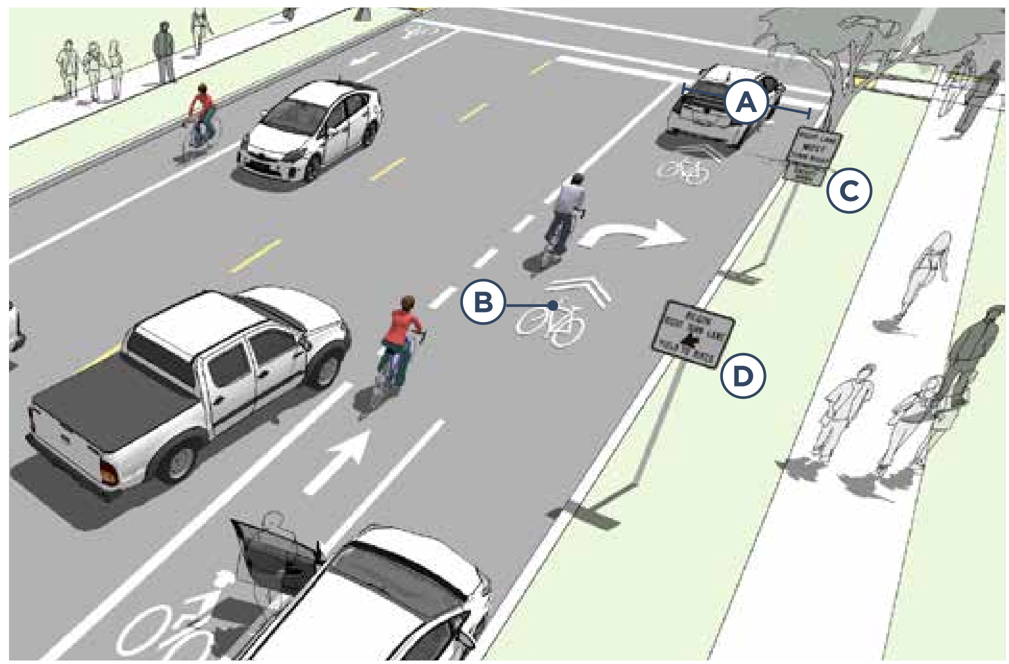
Crash Reduction

A survey in Eugene, OR found that more than 17 percent of the surveyed bicyclists using the combined turn lane felt that it was safer than the comparison location with a standard-width right-turn lane, and another 55 percent felt that the combined-lane site was no different safety-wise than the standard-width location.[1]

1 Hunter, W.W. (2000). Evaluation of a Combined Bicycle Lane/Right-Turn Lane in Eugene, Oregon. Publication No. FHWA-RD-00-151, Federal Highway Administration, Washington, DC.

Combined Bike Lane/Turn Lane (Billings, MT)

Shared lane markings and signs indicate that bicyclists should right in the left side of this right turn only lane.



TWO-STAGE TURN BOXES

Two- stage turn boxes offer bicyclists a safe way to make turns at multi-lane signalized intersections from a physically separated or conventional bike lane. On physically separated bike lanes, bicyclists are often unable to merge into traffic to turn due to physical separation, making the provision of two-stage turn boxes critical.

Typical Application

- Streets with high vehicle speeds and/or traffic volumes.
- At intersections locations of multi-lane roads with signalized intersections.
- At signalized intersections with a high number of bicyclists making a left turn from a right side facility.

Design Features

- The two-stage turn box shall be placed in a protected area. Typically this is within the shadow of an on-street parking lane or separated bike lane buffer area and should be placed in front of the crosswalk to avoid conflict with pedestrians.

(A) 8 ft x 6 ft preferred depth of bicycle storage area (6 ft x 3 ft minimum).

(B) Bicycle stencil and turn arrow pavement markings shall be used to indicate proper bicycle direction and positioning (NACTO, 2012).

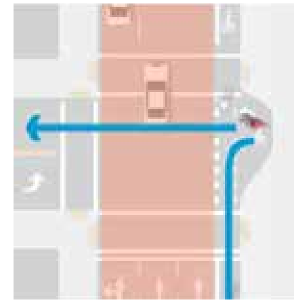
Further Consideration

- Consider providing a “No Turn on Red” (MUTCD R10-11) on the cross street to prevent motor vehicles from entering the turn box.
- This design formalizes a maneuver called a “box turn” or “pedestrian style turn.”
- Some two-stage turn box designs are considered experimental by FHWA.
- Design guidance for two-stage turns apply to both bike lanes and separated bike lanes.
- Two-stage turn boxes reduce conflicts in multiple ways; from keeping bicyclists from queuing in a bike lane or crosswalk and by separating turning bicyclists from through bicyclists.
- Bicyclist capacity of a two-stage turn box is influenced by physical dimension (how many bicyclists it can contain) and signal phasing (how frequently the box clears).

Crash Reduction

There are no Crash Modification Factors (CMFs) available for this treatment.

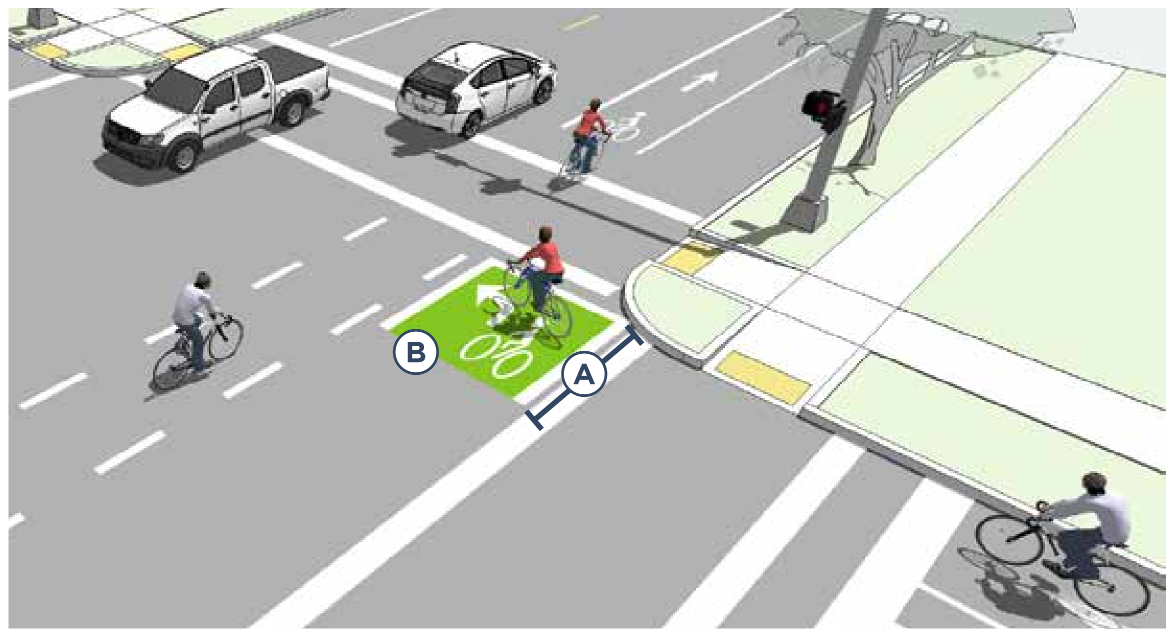
Jughandle Turn Box



This MUTCD compliant design carves a jughandle out of the sidewalk to provide space for waiting bicyclists.

Separated Bike Lane Turn Box

On separated bike lanes, the two-stage turn box can be located in the protected buffer/parking area.



BICYCLISTS AT SINGLE LANE ROUNDABOUTS

Roundabouts are circular intersection designed with yield control for all entering traffic, channelized approaches and geometry to induce desirable speeds. They are used as an alternative to intersection signalization.

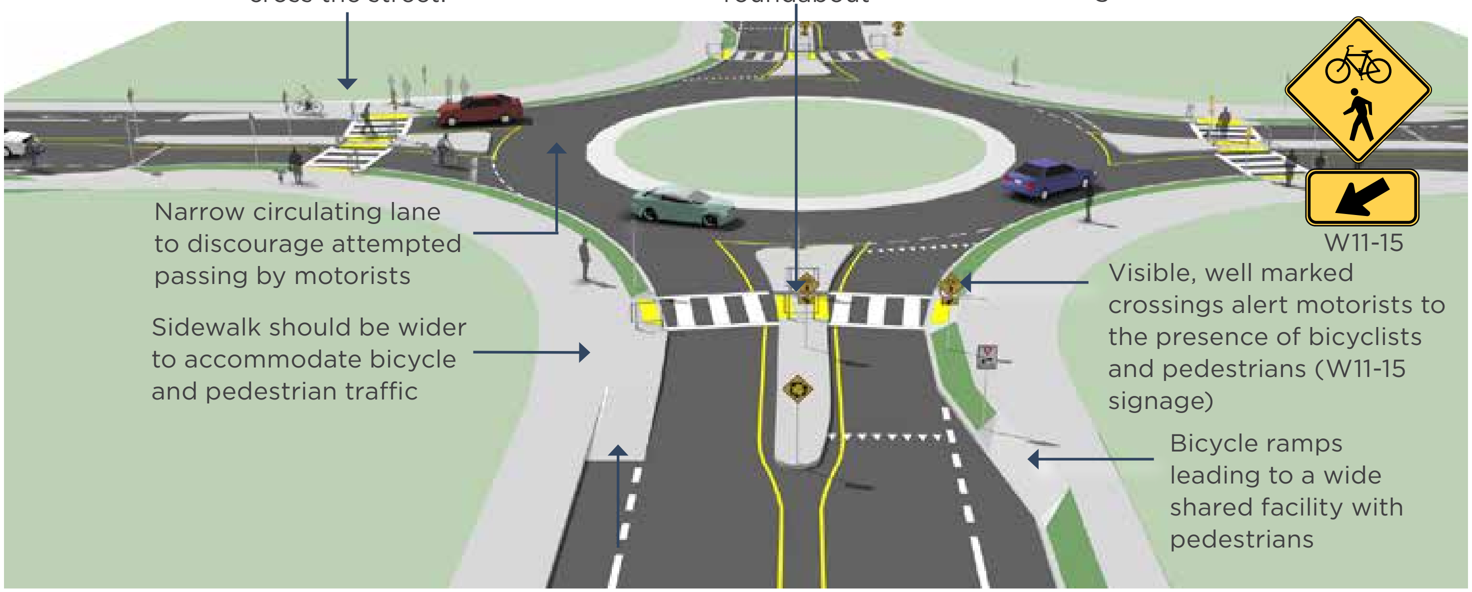
Typical Application

- On bicycle routes a roundabout or neighborhood traffic circle is preferable to stop control as bicyclists do not like to lose their momentum due to physical effort required. At intersections of multi-use paths, pedestrian and bicycle only roundabouts are an excellent form of non-motorized user traffic control.

Design Features

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

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



BIKEWAY AMENITIES

The ability to navigate through a city is informed by wayfinding signage and pavement markings, the availability of bicycle parking, and the provision of well-maintained bicycle facilities. Integrating bicycling and public transportation extends the catchment area for both modes and creates greater opportunity for active transportation.

BIKE PARKING

WAYFINDING SIGN TYPES

BIKEWAY MAINTENANCE

WAYFINDING SIGN PLACEMENT

BIKEWAY ACCESS TO TRANSIT

WAYFINDING SIGN TYPES

The ability to navigate through a city is informed by landmarks, natural features, and other visual cues. Signs throughout the city should indicate to bicyclists the direction of travel, the locations of destinations and the travel time/distance to those destinations. A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes.

Typical Application

- Wayfinding signs will increase users' comfort and accessibility to the bicycle network.
- Signage can serve both wayfinding and safety purposes including:
  - Helping to familiarize users with the network
  - Helping users identify the best routes to destinations
  - Addressing misperceptions of time and distance
  - Helping overcome a "barrier to entry" for people who are not frequent bicyclists (e.g., "interested but concerned" bicyclists)

Design Features

(A) Confirmation signs indicate to bicyclists that they are on a designated bikeway. Make motorists aware of the bicycle route. Can include destinations and distance/time but do not include arrows.

(B) Turn signs indicate where a bikeway turns from one street onto another street. These can be used with pavement markings and include destinations and arrows.

(C) Decisions signs indicate the junction of two or more bikeways and inform bicyclists of the designated bike route to access key destinations. These include destinations, arrows and distances. Travel times are optional but recommended.

Further Consideration

- Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes.
- Too many road signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists rather than per vehicle signage standards.
- A community-wide bicycle wayfinding signage plan would identify:
  - Sign locations
  - Sign type – what information should be included and design features
  - Destinations to be highlighted on each sign – key destinations for bicyclists
  - Approximate distance and travel time to each destination
- Green is the color used for directional guidance and is the most common color of bicycle wayfinding signage in the US, including those in the MUTCD.
- Check wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear and replace signage along the bikeway network as-needed.

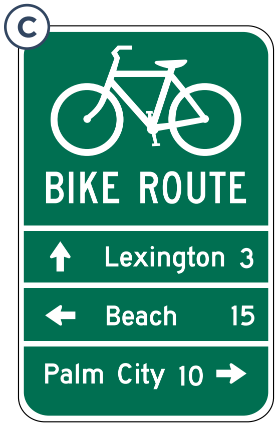
A

D11-1c

B

D1-1

C



D11-1/D1-3a

Crash Reduction

There is no evidence that wayfinding signs have any impact on crash reduction or user safety.

Community Logos on Signs

Wayfinding signs can include a local community identification logo, as this example from Oakland, CA.

Custom Street Signs (Berkeley, CA)

Custom street signs can also act as a type of confirmation sign, to let all users know the street is prioritized for bicyclists.

WAYFINDING SIGN PLACEMENT

Signs are placed at decision points along bicycle routes, typically at the intersection of two or more bikeways and at other key locations leading to and along bicycle routes.

Typical Application

Confirmation Signs

- Placed every ¼ to ½ mile on off-street facilities and every 2 to 3 blocks along on-street bicycle facilities, unless another type of sign is used (e.g., within 150 ft of a turn or decision sign).
- Should be placed soon after turns to confirm destination(s). Pavement markings can also act as confirmation that a bicyclist is on a preferred route.

Turn Signs

- Near-side of intersections where bike routes turn (e.g., where the street ceases to be a bicycle route or does not go through).
- Pavement markings can also indicate the need to turn.

Decision Signs

- Near-side of intersections in advance of a junction with another bicycle route.
- Along a route to indicate a nearby destination.

Design Features

- MUTCD guidelines should be followed for wayfinding sign placement, which includes mounting height and lateral placement from edge of path or roadway.
- Pavement markings can be used to reinforce routes and directional signage.

Further Consideration

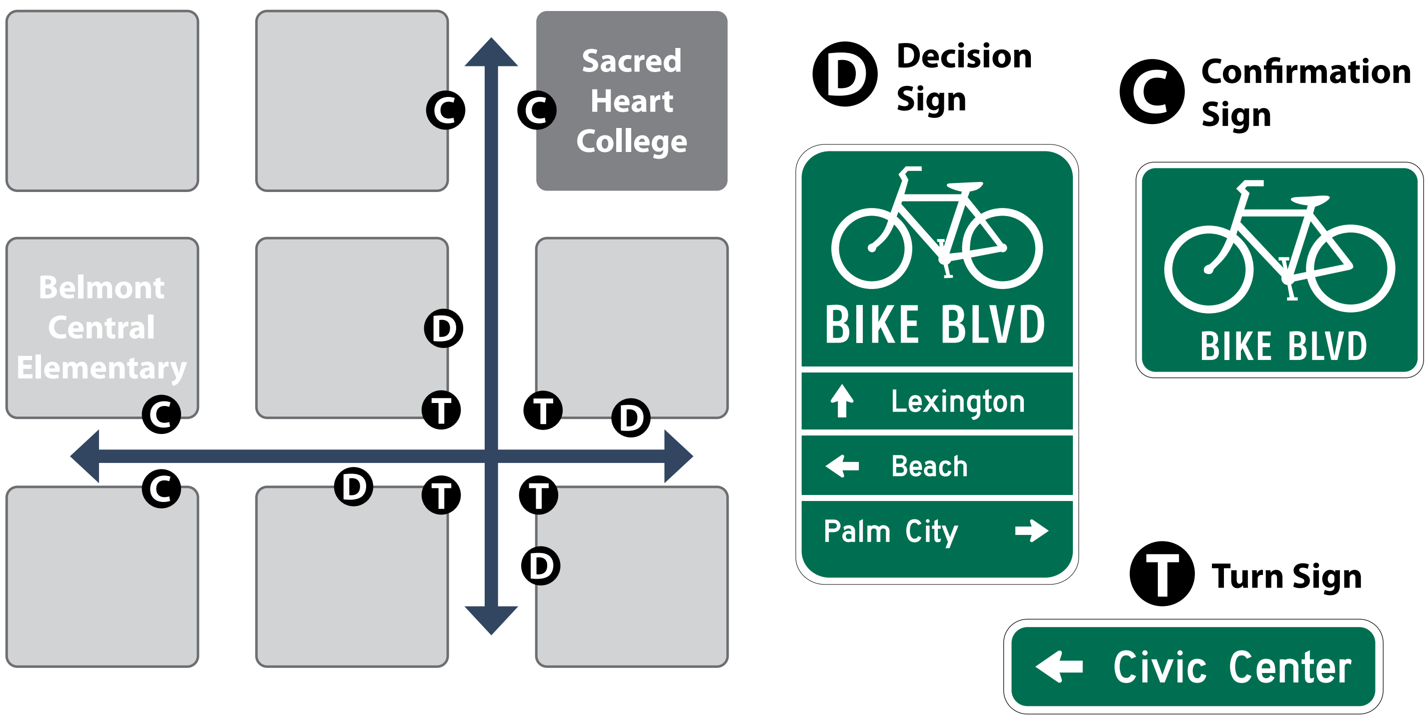
It can be useful to classify a list of destinations for inclusion on the signs based on their relative importance to users throughout the area. A particular destination's ranking in the hierarchy can be used to determine the physical distance from which the locations are signed. For example, primary destinations (such as the downtown area) may be included on signage up to 5 miles away. Secondary destinations (such as a transit station) may be included on signage up to two miles away. Tertiary destinations (such as a park) may be included on signage up to one mile away.

Crash Reduction

There is no evidence that wayfinding signs have any impact on crash reduction or user safety.

Wayfinding Pavement Markings

Some cities use pavement markings to indicate required turns or jogs along the bicycle route.



BIKE PARKING

Bicyclists expect a safe, convenient place to secure their bicycle when they reach their destination. This may be short-term parking of two hours or less, or long-term parking for employees, students, residents, and commuters.

Typical Application

- Bicycle parking facilities shall be located in highly visible well-lighted areas. In order to maximize security, whenever possible short-term bicycle parking facilities shall be located in areas highly visible from the street and from the interior of the building they serve (i.e., placed adjacent to windows).
- Bike racks provide short-term bicycle parking and is meant to accommodate visitors, customers, and others expected to depart within two hours. It should be an approved standard rack, appropriate location and placement, and weather protection.
- On-street bike corrals (also known as on-street bicycle parking) consist of bicycle racks grouped together in a common area within the street traditionally used for automobile parking. Bicycle corrals are reserved exclusively for bicycle parking and provide a relatively inexpensive solution to providing high-volume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces into on-street bicycle parking. Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces.

Design Features

- All bicycle facilities shall provide a minimum 4 ft aisle to allow for unobstructed access to the designated bicycle parking area.
- Bicycle parking facilities within auto parking facilities shall be protected from damage by cars by a physical barrier such as curbs, wheel stops, poles, bollards, or other similar features capable of preventing automobiles from entering the designated bicycle parking area.
- Bicycle parking facilities should be securely anchored so they cannot be easily removed and shall be of sufficient strength and design to resist vandalism and theft.

Bike Racks

(A) 2 ft minimum from the curb face to avoid 'dooring.'

(B) 4 ft between racks to provide maneuvering room.

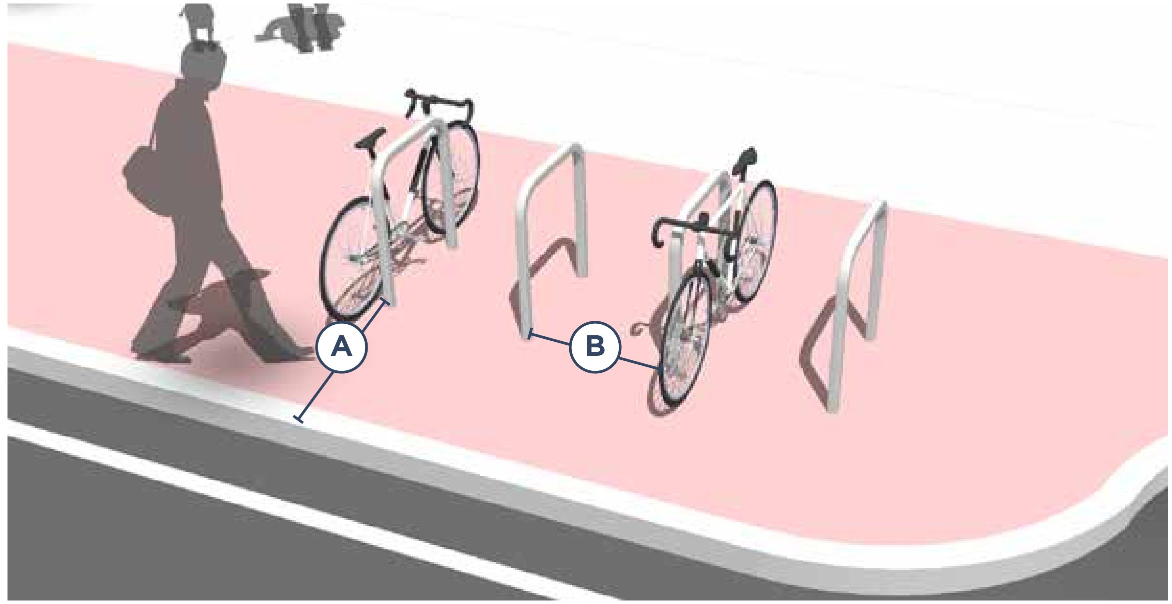
- Locate close to destinations; 50 ft maximum distance from main building entrance.
- Minimum clear distance of 6 ft should be provided between the bicycle rack and the property line.

Bike Corrals

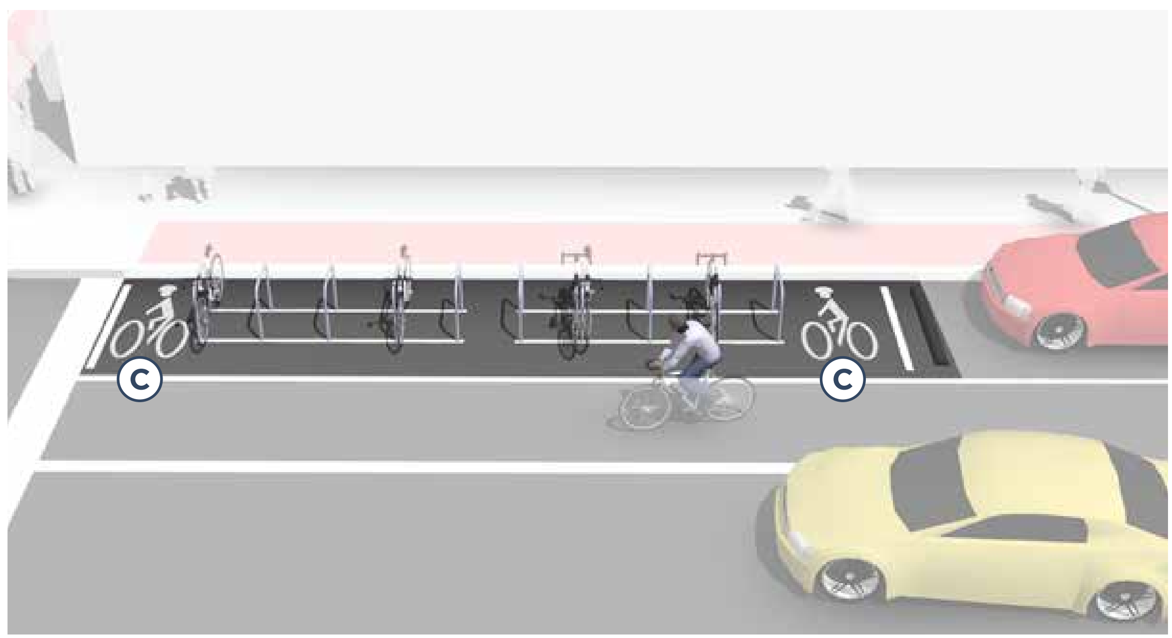
(C) Bicyclists should have an entrance width from the roadway of 5-6 ft for on-street corrals.

- Can be used with parallel or angled parking.
- Parking stalls adjacent to curb extensions are good candidates for on-street bicycle corrals since the concrete extension serves as delimitation on one side.
- Off-street bike corrals are appropriate where there is a wide sidewalk furnishing zone (7 ft or greater), or as part of a curb extension.

Perpendicular Bike Racks



Bike Corral



BIKEWAY MAINTENANCE

Regular bicycle facility maintenance includes sweeping, maintaining a smooth roadway, ensuring that the gutter-to-pavement transition remains relatively flush, and installing bicycle-friendly drainage grates. Pavement overlays are a good opportunity to improve bicycle facilities. The following recommendations provide a menu of options to consider to enhance a maintenance regimen.

Maintenance

(A) Sweeping

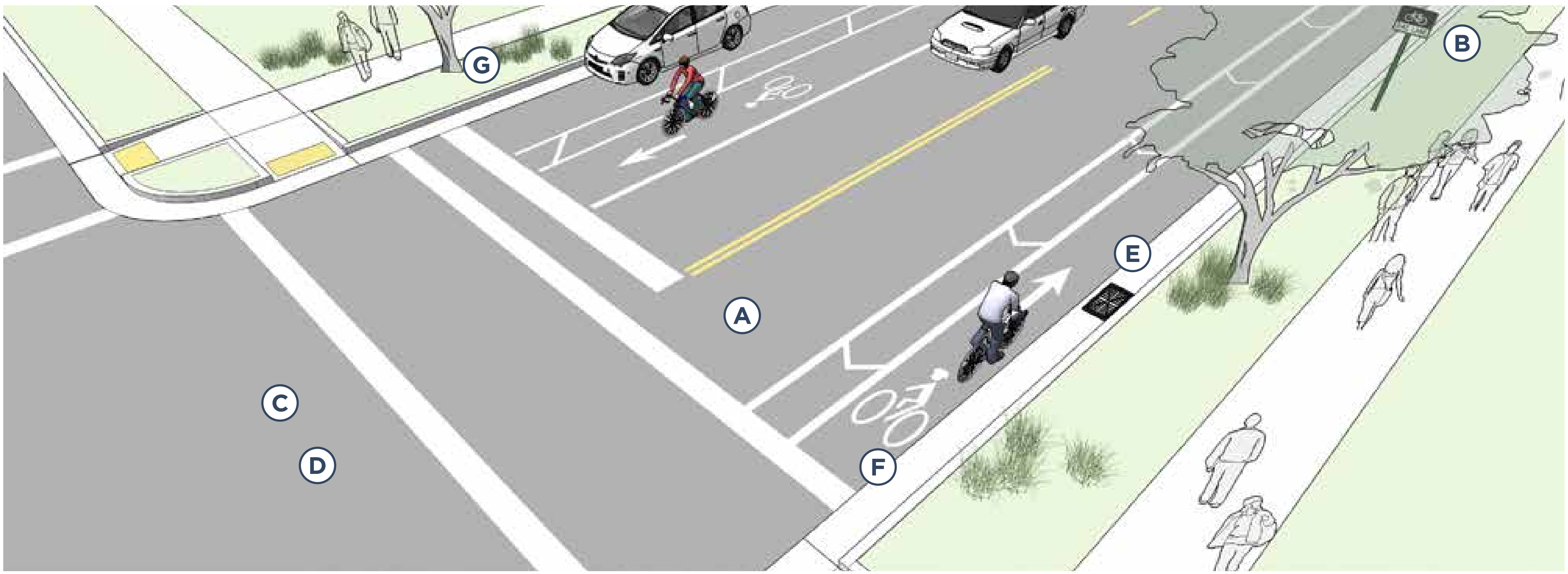
- Establish a seasonal sweeping schedule that prioritizes roadways with major bicycle routes.
- Sweep walkways and bikeways whenever there is an accumulation of debris on the facility.
- In curbed sections, sweepers should pick up debris; on open shoulders, debris can be swept onto gravel shoulders.

(B) Signage

- Check regulatory and wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear.
- Replace signage along the bikeway network as-needed.
- Perform a regularly-scheduled check on the status of signage with follow-up as necessary.
- Create a Maintenance Management Plan.

(C) Roadway Surface

- Maintain a smooth pothole-free surface.
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼".



- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings.
- Inspect the pavement 2 to 4 months after trenching construction activities are completed to ensure that excessive settlement has not occurred.

(D) Pavement Overlays

- Extend the overlay over the entire roadway surface to avoid leaving an abrupt edge.
- If the shoulder or bike lane pavement is of good quality, it may be appropriate to end the overlay at the shoulder or bike lane stripe provided no abrupt ridge remains.
- Ensure that inlet grates, manhole and valve covers are within ¼ inch of the finished pavement surface and are made or treated with slip resistant materials.

(E) Drainage Grates

- Require all new drainage grates be bicycle-friendly, including grates that have horizontal slats on them so that bicycle tires and assistive devices do not fall through the vertical slats.
- Create a program to inventory all existing drainage grates, and replace hazardous grates as necessary – temporary modifications such as installing rebar horizontally across the grate should not be an acceptable alternative to replacement.

(F) Gutter to Pavement Transition

- Ensure that gutter-to-pavement transitions have no more than a ¼" vertical transition.
- Examine pavement transitions during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets.

(G) Landscaping

- Ensure that shoulder plants do not hang into or impede passage along bikeways.
- After major damage incidents, remove fallen trees or other debris from bikeways as quickly as possible.

Maintenance Management Plan

- Provide fire and police departments with map of system, along with access points to gates/bollards.
- Enforce speed limits and other rules of the road.
- Enforce all trespassing laws for people attempting to enter adjacent private properties.

Table A.1: Recommended Walkway and Bikeway Maintenance Activities

ACTIVITY	SCHEDULING
Inspections	Seasonal – at beginning and end of Summer
Pavement sweeping/blowing	As needed, with higher frequency in the early Spring and Fall
Pavement sealing	5 - 15 years
Pothole repair	1 week – 1 month after report
Culvert and drainage grate inspection	Before Winter and after major storms
Pavement markings replacement	As needed
Signage replacement	As needed
Shoulder plant trimming (weeds, trees, brambles)	Twice a year; middle of growing season and early Fall
Tree and shrub plantings, trimming	1 – 3 years
Major damage response (washouts, fallen trees, flooding)	As soon as possible

BICYCLE ACCESS TO TRANSIT

Safe and easy access to transit stations and secure bicycle parking facilities is necessary to encourage commuters to access transit via bicycle. Bicycling to transit reduces the need to provide expensive and space consuming car parking spaces.

Design Features

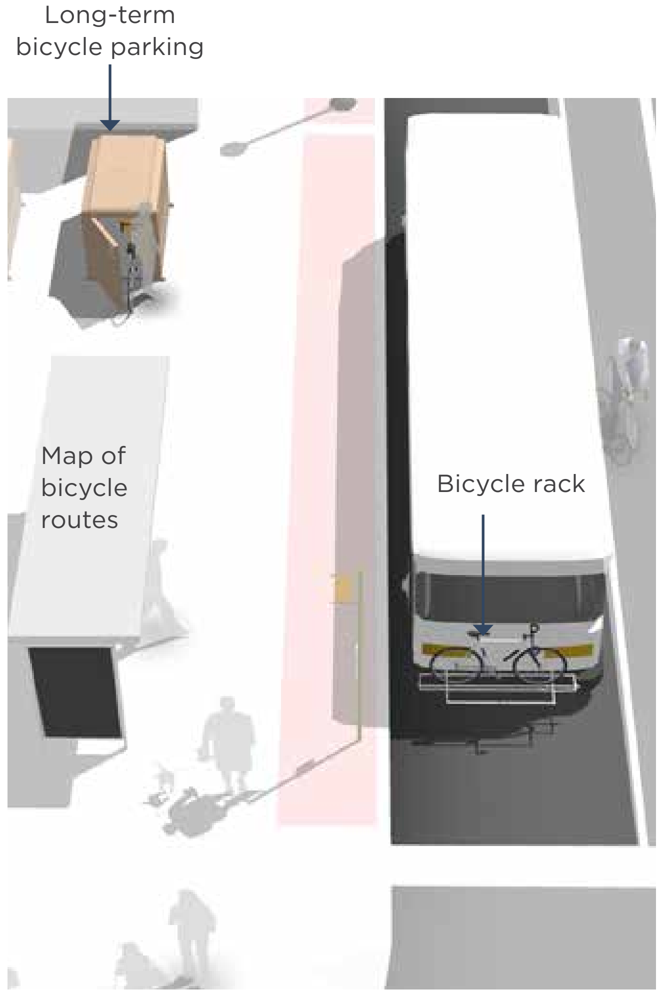
Many people who ride to a transit stop will want to bring their bicycle with them on the transit portion of their trip, so buses and other transit vehicles should be equipped accordingly.

Access

- Provide direct and convenient access to transit stations and stops from the bicycle and pedestrian networks.
- Provide maps at major stops and stations showing nearby bicycle routes.
- Provide wayfinding signage and pavement markings from the bicycle network to transit stations.
- Ensure that connecting bikeways offer proper bicycle actuation and detection.

Bicycle Parking

- The route from bicycle parking locations to station/ stop platforms should be well-lit and visible.
- Signing should note the location of bicycle parking, rules for use, and instructions as needed.
- Provide safe and secure long-term parking such as bicycle lockers at transit hubs. Parking should be easy to use and well maintained.



RETROFITTING STREETS

Retrofitting existing streets to add bikeways requires reallocating existing street width through striping modifications. The reallocation of space, through lane narrowing and lane reconfiguration, can provide enough space to add bicycle accommodations. Roadways can also be widened, when necessary, to provide additional space.


ROADWAY WIDENING


LANE NARROWING


LANE RECONFIGURATION


PARKING REDUCTION

ROADWAY WIDENING

Bike lanes can be accommodated on streets with excess right-of-way through shoulder widening. Although roadway widening incurs higher expenses compared with re-striping projects, bike lanes can be added to streets currently lacking curbs, gutters and sidewalks without the high costs of major infrastructure reconstruction.

Application

- Roadway widening is most appropriate on roads lacking curbs, gutters and sidewalks.
- If it is not possible to meet minimum bicycle lane dimensions, a reduced width paved shoulder can still improve conditions for bicyclists on constrained roadways. In these situations, a minimum of 3 feet of operating space should be provided.

Design Features

- Guidance on bicycle lanes applies to this treatment.
- (A) 4 foot minimum width when no curb and gutter is present.
- 6 foot width preferred.

LANE NARROWING

Lane narrowing utilizes roadway space that exceeds minimum standards to provide the needed space for bike lanes. Many roadways have existing travel lanes that are wider than those prescribed in local and national roadway design standards, or which are not marked.

Application

- On roadways with wide lane widths. Most standards allow for the use of 11 foot and sometimes 10 foot wide travel lanes to create space for bike lanes.
- Special consideration should be given to the amount of heavy vehicle traffic and horizontal curvature before the decision is made to narrow travel lanes. Center turn lanes can also be narrowed in some situations to free up pavement space for bike lanes.

Design Features

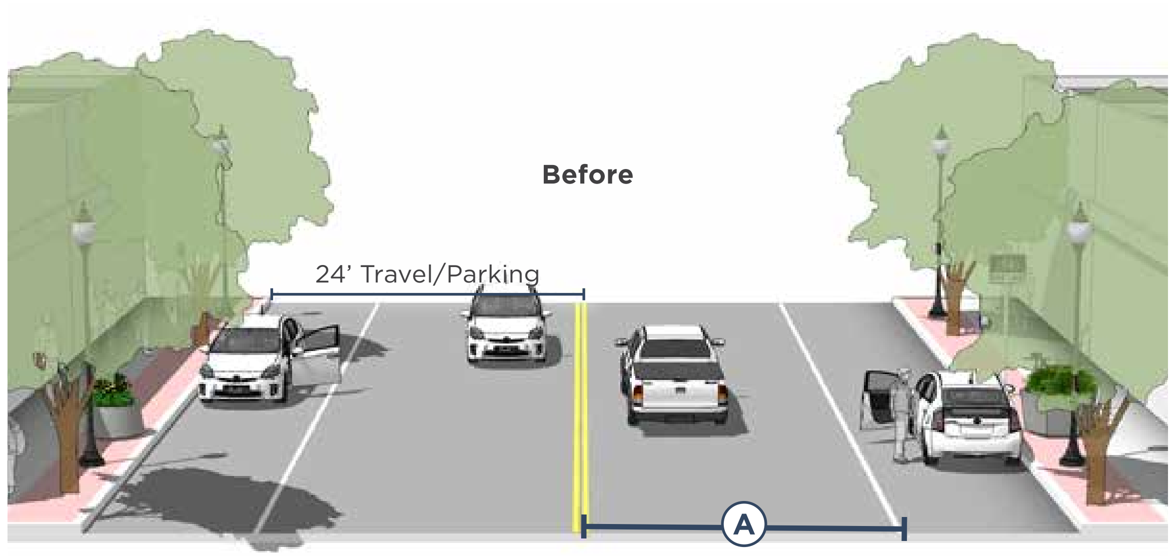
Vehicle lane width:

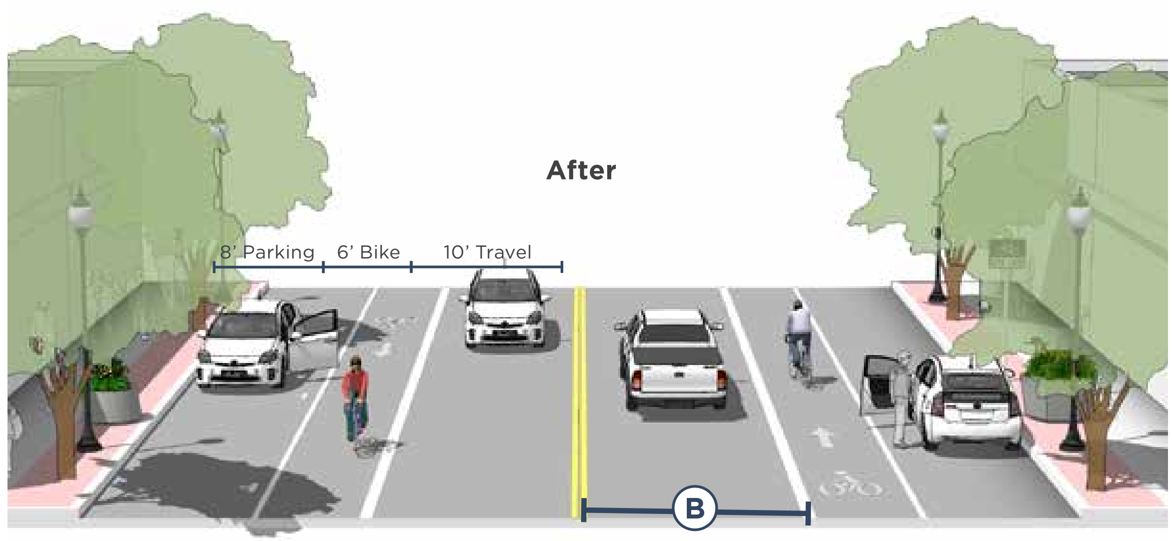
(A) Before: 10-15 feet

(B) After: 10-11 feet

Bicycle lane width:

- Guidance on bicycle lanes applies to this treatment.





LANE RECONFIGURATION

The removal of a single travel lane will generally provide sufficient space for bike lanes on both sides of a street. Streets with excess vehicle capacity provide opportunities for bike lane retrofit projects.

Application

Depending on a street's existing configuration, traffic operations, user needs and safety concerns, various lane reduction configurations may apply. For instance, a four-lane street (with two travel lanes in each direction) could be modified to provide one travel lane in each direction, a center turn lane, and bike lanes. Prior to implementing this measure, a traffic analysis should identify potential impacts.

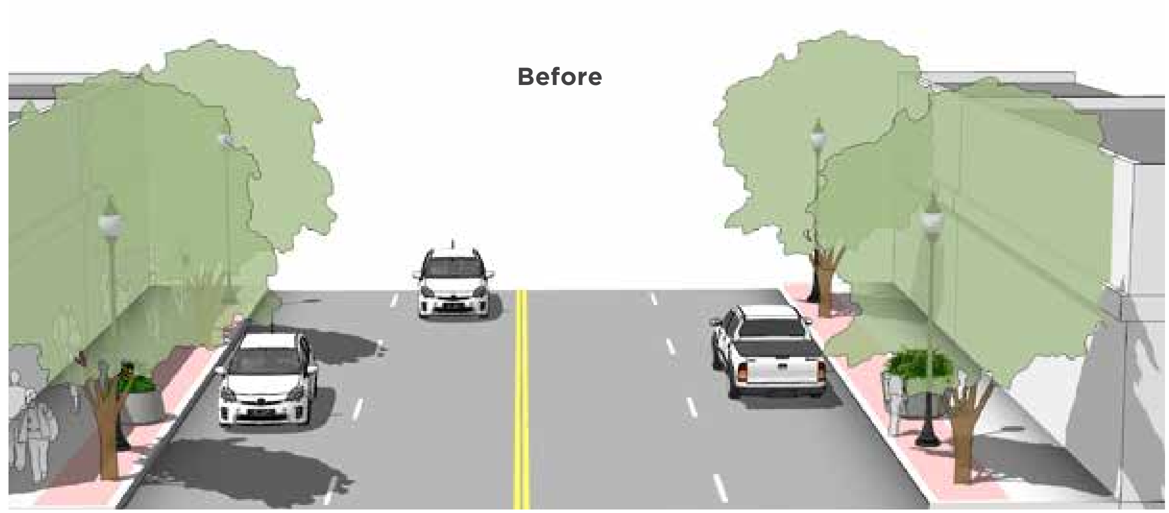
Design Features

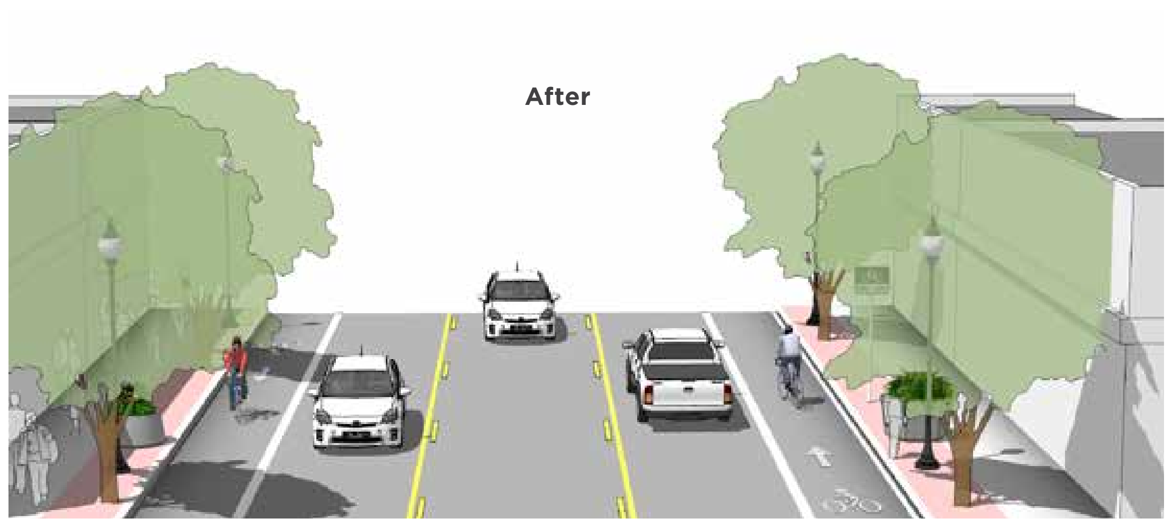
Vehicle lane width:

- Width depends on project. No narrowing may be needed if a lane is removed.

Bicycle lane width:

- Guidance on bicycle lanes applies to this treatment.





PARKING REDUCTION

Bike lanes can replace one or more on-street parking lanes on streets where excess parking exists and/or the importance of bike lanes outweighs parking needs. For example, parking may be needed on only one side of a street. Eliminating or reducing on-street parking also improves sight distance for bicyclists in bike lanes and for motorists on approaching side streets and driveways.

Application

Removing or reducing on-street parking to install bike lanes requires comprehensive outreach to the affected businesses and residents. Prior to reallocating on-street parking for other uses, a parking study should be performed to gauge demand and to evaluate impacts to people with disabilities.

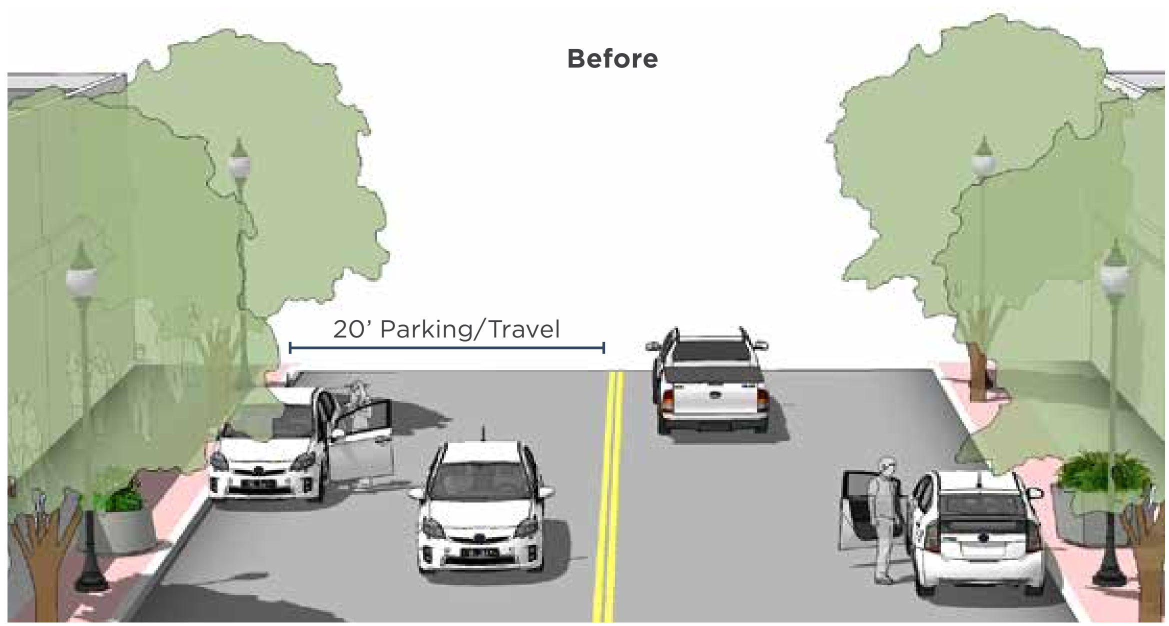
Design Features

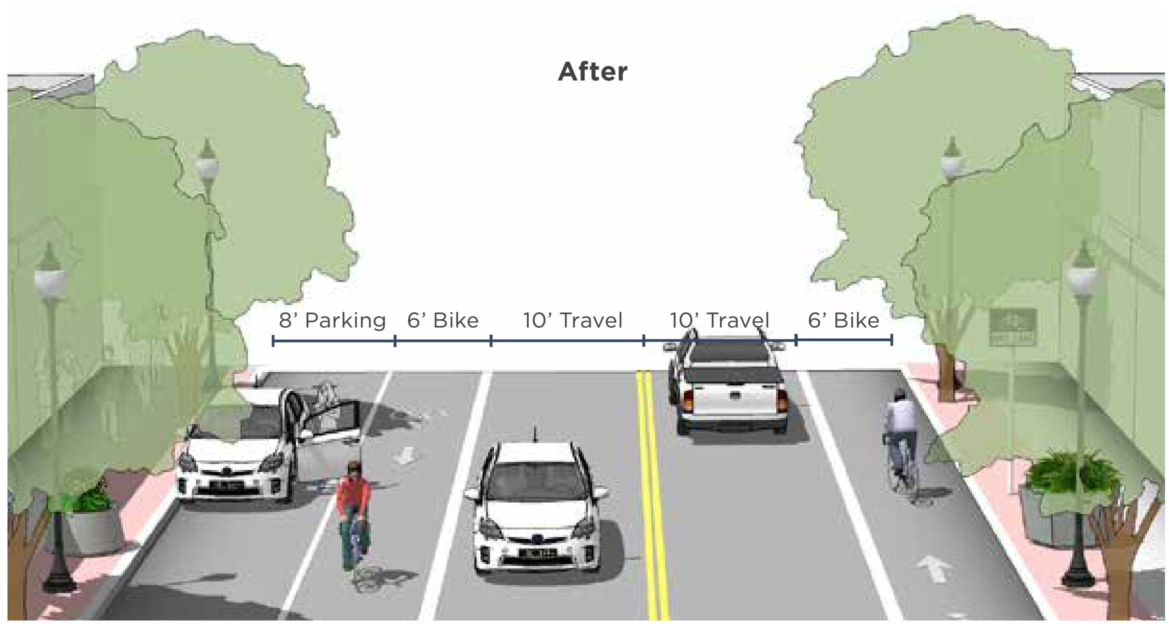
Vehicle lane width:

- Parking lane width depends on project. No travel lane narrowing may be required depending on the width of the parking lanes.

Bicycle lane width:

- Guidance on bicycle lanes applies to this treatment.





OFF-STREET FACILITIES

Off-street facilities provide places for walking and bicycling that are separated from motor vehicle traffic. These facilities are frequently found in parks, along rivers, beaches, and in greenbelts or utility corridors where there are few conflicts with motorized vehicles. Off-street facilities can also include amenities such as lighting, signage, and fencing.


RAIL-WITH-TRAIL


LOCAL NEIGHBORHOOD ACCESSWAYS


SHARED USE PATH


BOARDWALKS


SIDEPATH


TRAILHEADS

SHARED USE PATH

Shared use paths can provide a desirable facility, particularly for recreation, and users of all skill levels preferring separation from traffic. Bicycle paths should generally provide directional travel opportunities not provided by existing roadways.

Typical Application

- In abandoned rail corridors (commonly referred to as Rails-to-Trails or Rail-Trails.
- In active rail corridors, trails can be built adjacent to active railroads (referred to as Rails-with-Trails.
- In utility corridors, such as powerline and sewer.
- In waterway corridors, such as along canals, drainage ditches, rives and beaches.
- Along roadways.

Design Features

Width

- (A) 8 ft is the minimum allowed for a two-way bicycle path and is only recommended for low traffic situations.
- 10 ft is recommended in most situations and will be adequate for moderate to heavy use.
- 12 ft is recommended for heavy use situations with high concentrations of multiple users. A separate track (5' minimum) can be provided for pedestrian use.

Lateral Clearance

- (B) A 2 ft or greater shoulder on both sides of the path should be provided. An additional ft of lateral clearance (total of 3') is required by the MUTCD for the installation of signage or other furnishings.
- If bollards are used at intersections and access points, they should be colored brightly and/or supplemented with reflective materials to be visible at night.

Overhead Clearance

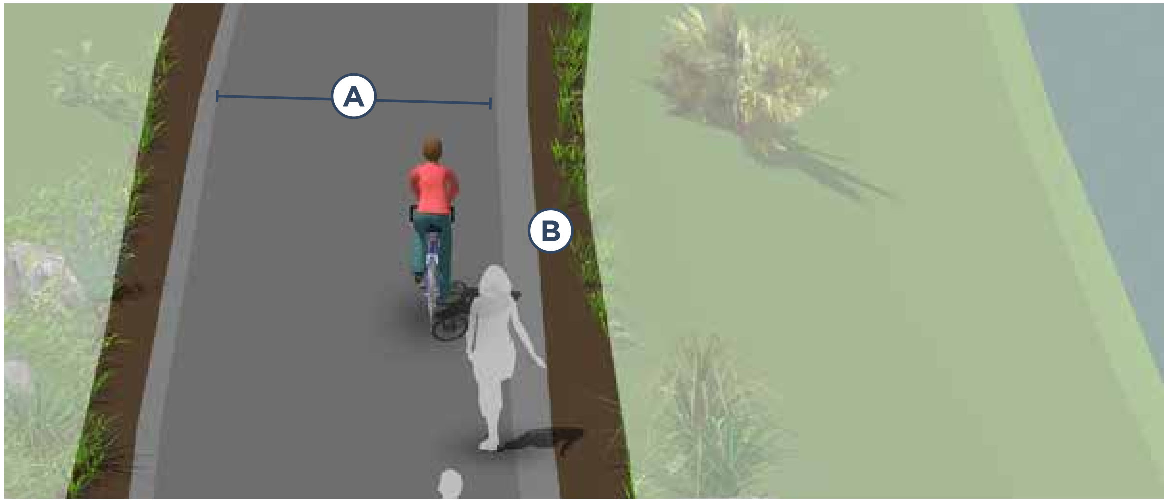
- Clearance to overhead obstructions should be 8 ft minimum, with 10 ft recommended.

Striping

- When striping is required, use a 4 inch dashed yellow centerline stripe with 4 inch solid white edge lines.
- Solid centerlines can be provided on tight or blind corners, and on the approaches to roadway crossings.

Further Consideration

The provision of a shared use path adjacent to a road is not a substitute for the provision of on-road accommodation such as paved shoulders or bike lanes, but may be considered in some locations in addition to on-road bicycle facilities.
To reduce potential conflicts in some situations, it may be better to place one-way sidepaths on both sides of the street.



Crash Reduction

Shared use paths reduce injury rates for cyclists, pedestrians, and other non-motorized modes by 60 percent compared with on street facilities.[1]

1Teschke, Kay. Route Infrastructure and the Risk of Injuries to Bicyclists. American Public Health Association. December 2012.

SIDEPATH

Sidepaths provide desirable facilities, particularly for recreation users of all skill levels that prefer separation from traffic. Sidepaths should provide directional travel opportunities not provided by existing roadways.

Typical Application

- Along Roadways

Design Features

- Guidance for sidepaths should follow that for general design practices of shared use paths.
- A high number of driveway crossings and intersections create potential conflicts with turning traffic. Consider alternatives on streets with a high frequency of intersections/heavily used driveways.
- Where a sidepath terminates special consideration should be given to transitions so as not to encourage unsafe wrong-way riding by bicyclists.

Further Consideration

- Crossing design should emphasize visibility of users and clarity of expected yielding behavior. Crossings may be STOP or YIELD controlled depending on sight lines and motor vehicle volumes and speeds.
- The provision of a shared use path adjacent to a road is not a substitute for the provision of on-road accommodation such as paved shoulders or bike lanes, but may be considered in some locations in addition to on-road bicycle facilities.
- To reduce potential conflicts, it may be better to place one-way sidepaths on both sides of the street.

Crash Reduction

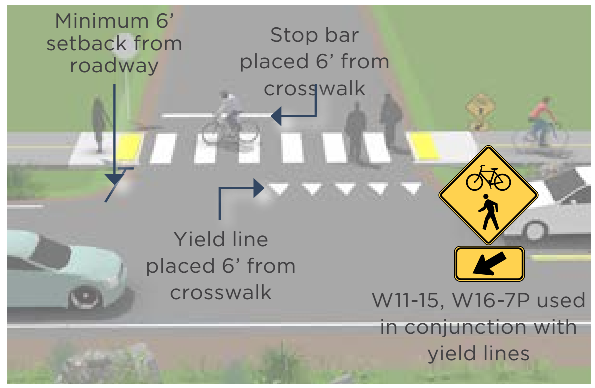
Sidepaths perform similarly to shared use paths, which reduce injury rates for all road users by 60 percent compared with on street facilities.[1]

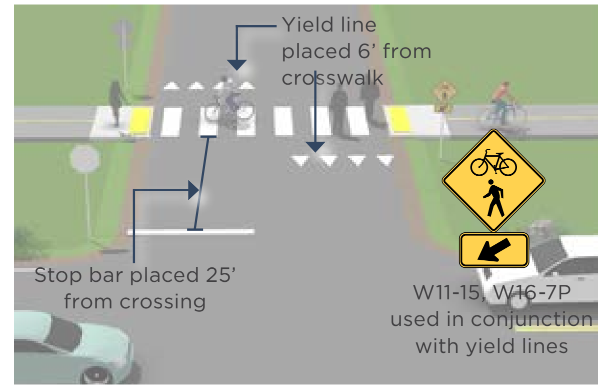
1Teschke, Kay. Route Infrastructure and the Risk of Injuries to Bicyclists. American Public Health Association. December 2012.

Crossing Approaches

Adjacent Crossing - A separation of 6 feet emphasizes the conspicuity of riders at the approach to the crossing.

Setback Crossing - A set back of 25 feet separates the path crossing from merging/turning movements that may be competing for a driver's attention.





RAIL-WITH-TRAIL

Rails-with-Trails projects typically consist of paths adjacent to active railroads. In some cases, space needs to be preserved for future planned freight, transit or commuter rail service. In other cases, limited right-of-way width, inadequate setbacks, concerns about safety/ trespassing, and numerous crossings may affect a project's feasibility.

Typical Application

- Along active railroad corridors.

Design Features

- Shared use paths in active rail corridors should meet or exceed general design standards. If additional width allows, wider paths, and landscaping are desirable.
- (A) Setback is based on space constraints, train frequency, train speed and physical separation. 10 - 25 ft setback from centerline of tracks to fencing is recommended.

Further Consideration

Separation (between path and railroad corridor) greater than 20' will result in a more pleasant trail user experience and should be pursued where possible. Railroads may require fencing with rail-with-trail projects. Concerns with trespassing and security can vary with the volume and speed of train traffic on the adjacent rail line and the setting of the shared use path, i.e. whether the section of track is in an urban or rural setting.

If required, fencing should be a minimum of 5 feet in height with higher fencing than usual next to sensitive areas such as switching yards. Whenever feasible, provide transparent fencing. Setbacks from the active rail line will vary depending on the speed and frequency of trains, and available right-of-way.

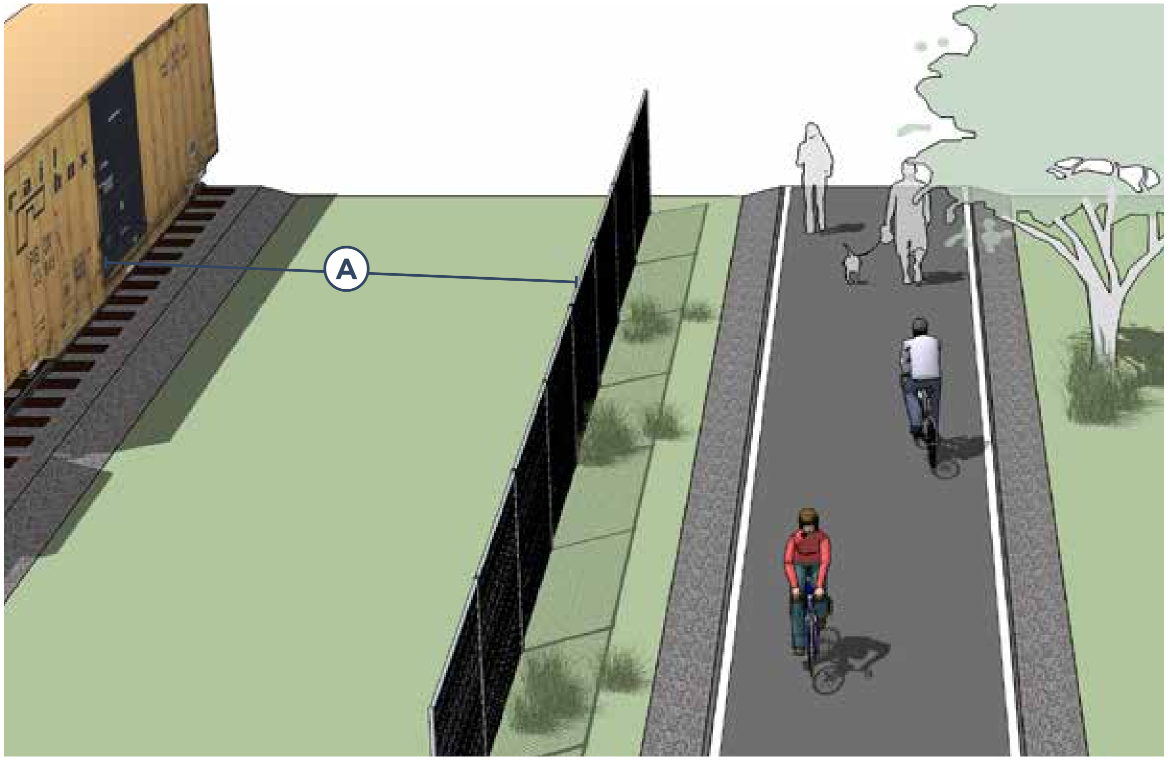
Crash Reduction

Shared use paths reduce injury rates for cyclists, pedestrians, and other non-motorized modes by 60 percent compared with on street facilities.[1]

1Teschke, Kay. Route Infrastructure and the Risk of Injuries to Bicyclists. American Public Health Association. December 2012.

Rail Trail

The Springwater Corridor in Portland, Oregon is an example of shared use path located adjacent to an active railroad corridor.



LOCAL NEIGHBORHOOD ACCESSWAYS

Neighborhood accessways provide residential areas with direct bicycle and pedestrian access to parks, trails, greenspaces, and other recreational areas. They most often serve as small trail connections to and from the larger trail network, typically having their own rights-of-way and easements.

Typical Application

- Neighborhood accessways should be designed into new subdivisions at every opportunity and should be required by City/County subdivision regulations.
- For existing subdivisions, neighborhood and homeowner association groups are encouraged to identify locations where such connects would be desirable. Nearby residents and adjacent property owners should be invited to provide landscape design input.

Design Features

- Neighborhood accessways should remain open to the public.
- Trail pavement shall be at least 8 ft wide to accommodate emergency and maintenance vehicles, meet ADA requirements and be considered suitable for multi-use.
- (A) Trail widths should be designed to be less than 8 ft wide only when necessary to protect large mature native trees over 18” in caliper, wetlands or other ecologically sensitive areas.
- Access trails should slightly meander whenever possible.

BOARDWALKS

Boardwalks are typically required when crossing wetlands or other sensitive natural areas. A number of low-impact support systems are also available that reduce the disturbance within wetland areas to the greatest extent possible.

Typical Application

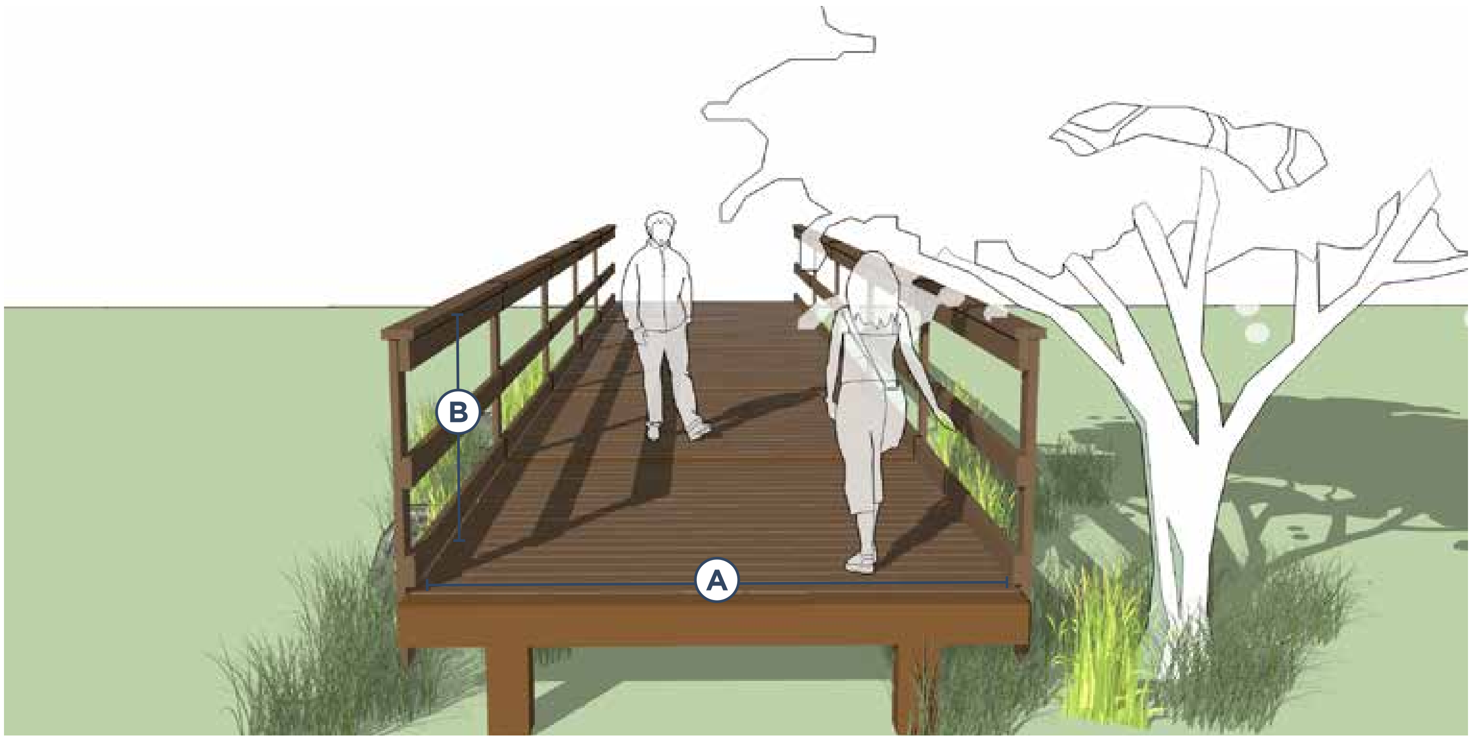
- Boardwalks are usually constructed of wooden planks or recycled material planks that form the top layer of the boardwalk. The recycled material has gained popularity in recent years since it lasts much longer than wood, especially in wet conditions.
- In general, building in wetlands is subject to regulations and should be avoided.

Design Features

(A) A boardwalk width should be a minimum of 10 ft when no rail is used. A 12 ft width is preferred in areas with average anticipated use and whenever rails are used.

(B) When the height of a boardwalk exceeds 30”, railings are required.

- If access by vehicles is desired, boardwalks should be designed to structurally support the weight of a small truck or a light-weight vehicle.



TRAILHEADS

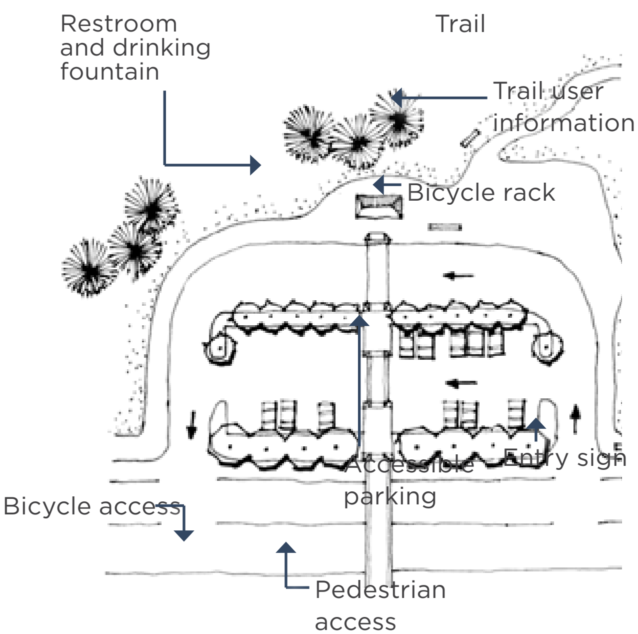
Good access to a path system is a key element for its success. Trailheads serve the local and regional population arriving to the path system by car, transit, bicycle or other modes. Trailheads provide essential access to the shared use path system and include amenities like parking for vehicles and bicycles, restrooms (at major trailheads), and posted maps.

Typical Application

- At major and minor trailheads.

Design Features

- Major trailheads should include automobile and bicycle parking, trail information (maps, user guidelines, wildlife information, etc.), garbage receptacles and restrooms.
- Minor trailheads can provide a subset of these amenities.

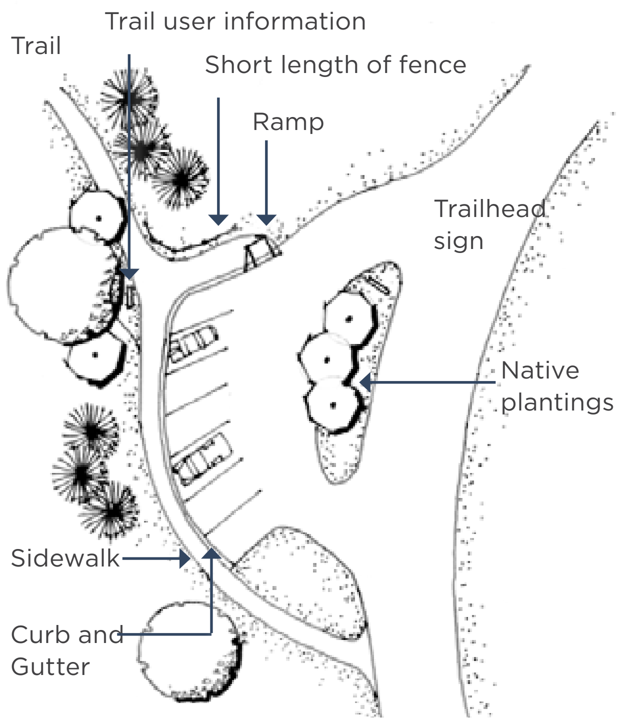


Major Trailhead

Further Considerations

Trailheads with a small motor vehicle parking area should additionally include bicycle parking and accessible parking.

Neighborhood access should be achieved from all local streets crossing the path. No parking needs to be provided, and in some situations "No Parking" signs will be desirable to minimize impact on the neighborhood. See Local Neighborhood Accessways for neighborhood connection guidance.



Minor Trailhead

Signage, including maps and other important information, educate visitors to a trail in Utah.

Signage, bike parking, trash cans, and bench seating provide a welcoming trailhead experience at Fanno Creek in Oregon.

STREET CROSSING TREATMENTS FOR OFF-STREET FACILITIES

Careful consideration should be given when designing and implementing trail intersection treatments, to ensure safe and convenient trail crossings for people walking and biking. Trail intersection treatments may be simple marked crosswalks on low volume, low speed roadways or may require more intensive treatments, such as signalization.


ACTIVE ENHANCED CROSSING


ROUTE USERS TO SIGNALIZED CROSSING


MARKED CROSSING


FULL TRAFFIC SIGNAL CROSSINGS


MEDIAN CROSSING


GRADE-SEPARATED CROSSINGS

MARKED CROSSING

A marked/unsignalized crossing typically consists of a marked crossing area, signage, and other markings to slow or stop traffic. The approach to designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, pathway traffic, use patterns, vehicle speed, road type, road width, and other safety issues such as proximity to major attractions.

Typical Application

Maximum Traffic Volumes

- ≤9,000-12,000 Average Daily Traffic (ADT) volume
- Maximum travel speed of 35 MPH

Minimum Sight Lines

- 25 MPH zone: 155 ft
- 35 MPH zone: 250 ft
- 45 MPH zone: 360 ft

Design Features

- On roadways with low to moderate traffic volumes (<12,000 ADT) and a need to control traffic speeds, a raised crosswalk may be the most appropriate crossing design to improve pedestrian visibility and safety.

MEDIAN CROSSING

On roadways with higher volumes, higher speeds and multi-lanes of vehicular traffic, a median crossing is preferred. A median refuge island can improve user safety by providing pedestrians and bicyclists space to perform the safe crossing of one side of the street at a time.

Typical Application

Maximum Traffic Volumes

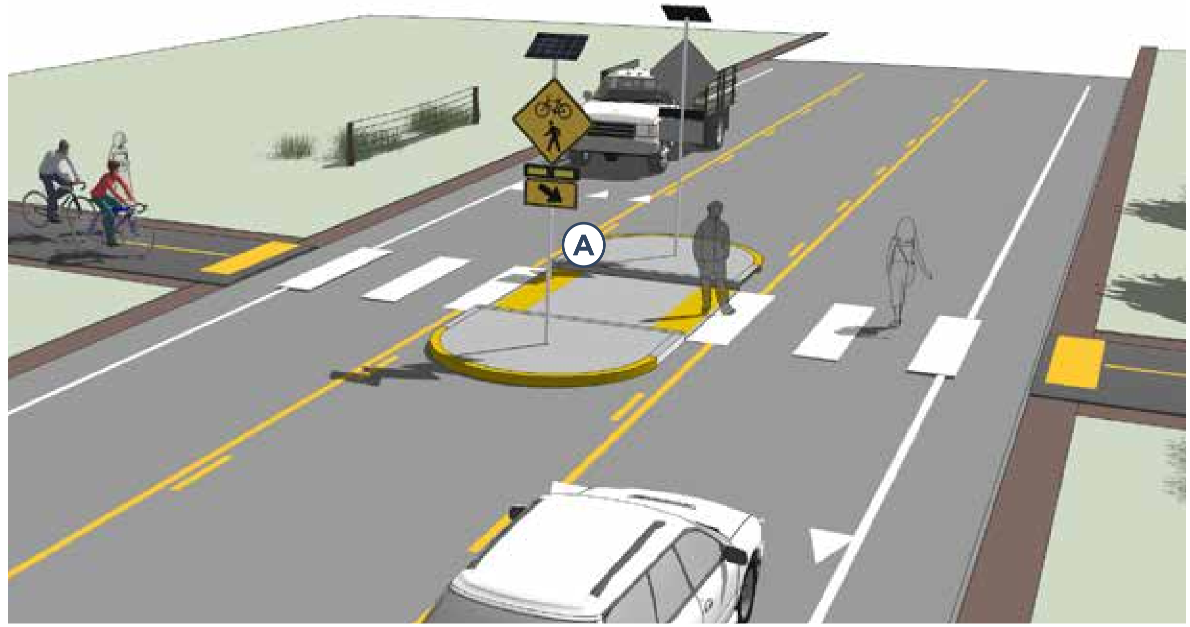
- Up to 15,000 ADT on two-lane roads, preferably with a median.
- Up to 12,000 ADT on four-lane roads with median.

Design Features

- Unsignalized crossings of multi-lane arterials over 15,000 ADT may be possible with features such as sufficient crossing gaps (more than 60 per hour), median refuges, and/or active warning devices like rectangular rapid flash beacons or in-pavement flashers, and excellent sight distance. For more information see the discussion of active enhanced crossings.

ENHANCED ACTIVE CROSSING

Active enhanced crossings are unsignalized crossings with additional treatments designed to increase motor vehicle yielding compliance on multi-lane or high volume roadways. These enhancements include pathway user or sensor actuated warning beacons, shown below, or Pedestrian Hybrid Beacons.



Typical Application

- Guidance for marked/unsignalized crossings applies.
- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals.
- Warning beacons shall initiate operation based on user actuation and shall cease operation at a predetermined time after the user actuation or, with passive detection, after the user clears the crosswalk.

Design Features

(A) Flashing beacons are user-actuated lights that supplement warning signs at unsignalized intersections or mid-block crossings.

- Pedestrian hybrid beacons provide a high level of comfort for crossing users through the use of a red-signal indication to stop conflicting motor vehicle traffic. Hybrid beacon installation faces only cross motor vehicle traffic, stays dark when inactive, and uses a unique 'wig-wag' signal phase to indicate activation. Vehicles have the option to proceed after stopping during the final flashing red phase, which can reduce motor vehicle delay when compared to a full signal installation.

ROUTE USERS TO SIGNALIZED CROSSING

Path crossings within approximately 400 ft of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection to avoid traffic operation problems when located so close to an existing signal.

Typical Application

- For this restriction to be effective, barriers and signing may be needed to direct path users to the signalized crossing. If no pedestrian crossing exists at the signal, modifications should be made.
- Path crossings should not be provided within approximately 400 ft of an existing signalized intersection. If possible, route path directly to the signal.

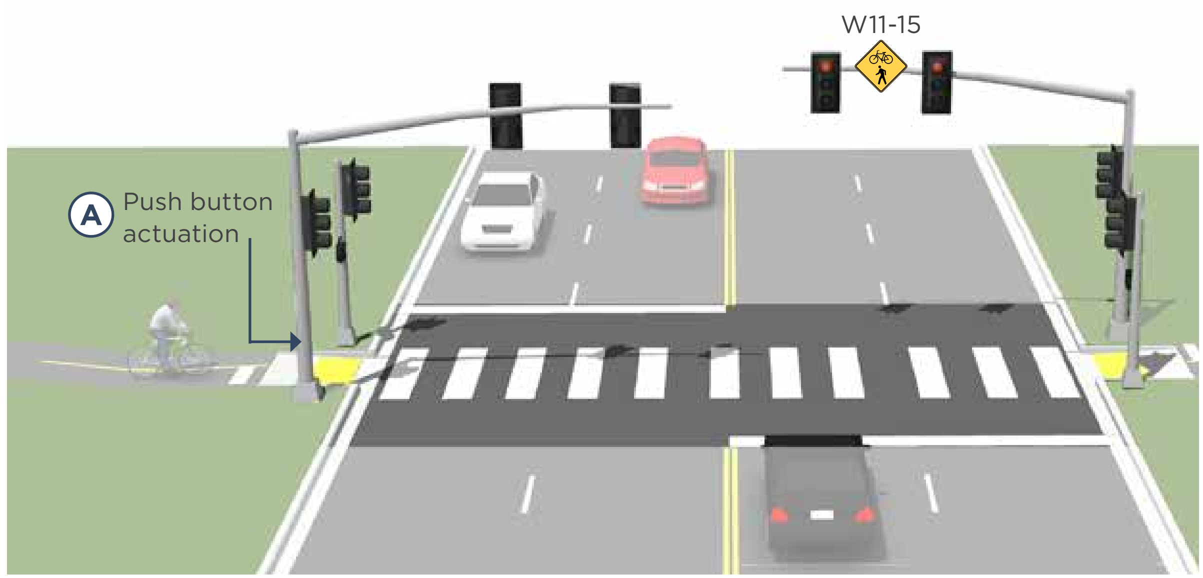
Design Features

- In the US, the minimum distance a marked crossing can be from an existing signalized intersection varies from approximately 250 to 660 ft.
- Engineering judgment and the context of the location should be taken into account when choosing the appropriate allowable setback. Pedestrians are particularly sensitive to out of direction travel and undesired mid-block crossing may become prevalent if the distance is too great.

FULL TRAFFIC SIGNAL CROSSING

Signalized crossings provide the most protection for crossing path users through the use of a red-signal indication to stop conflicting motor vehicle traffic.

A full traffic signal installation treats the path crossing as a conventional 4-way intersection and provides standard red-yellow-green traffic signal heads for all legs of the intersection.



Typical Application

Full traffic signal installations must meet MUTCD pedestrian, school or modified warrants. Additional guidance for signalized crossings:

- Located more than 300 feet from an existing signalized intersection.
- Roadway travel speeds of 40 MPH and above.
- Roadway ADT exceeds 15,000 vehicles.

Design Features

(A) Shared use path signals are normally activated by push buttons but may also be triggered by embedded loop, infrared, microwave or video detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street.

- Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity and safety.

GRADE-SEPARATED CROSSINGS

Grade-separated crossings provide critical non-motorized system links by joining areas separated by barriers such as railroads, waterways, and highway corridors. In most cases, these structures are built in response to user demand for safe crossings where they previously did not exist. There are no minimum roadway characteristics for considering grade separation.

Typical Application

- Where shared-use paths cross high-speed and high-volume roadways where an at-grade signalized crossing is not feasible or desired, or where crossing railways or waterways.
- Depending on the type of facility or the desired user group, grade separation may be considered in many types of projects.

Design Features

(A) Overcrossings should be at least 8 ft wide with 14 ft preferred and additional width provided at scenic viewpoints.

(B) Railing height must be a minimum of 42 inches for overcrossings.

(C) Undercrossings should be designed at minimum 10 ft height and 14 ft width, with greater widths preferred for lengths over 60 ft.

(D) Centerline stripe is recommended for grade-separated facility.