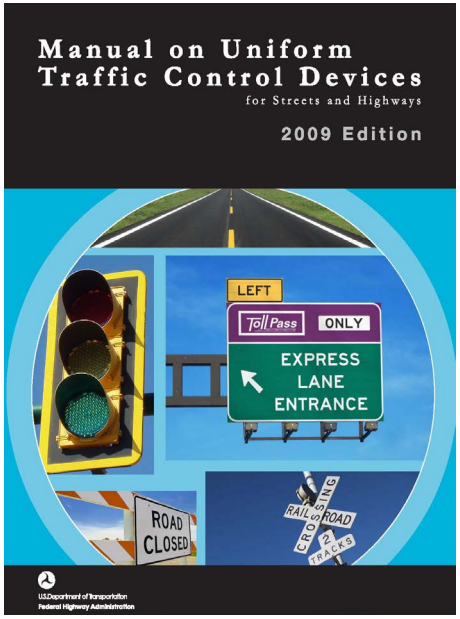
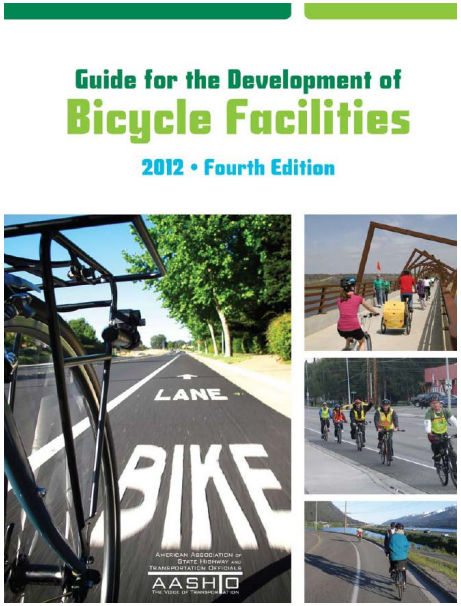
Appendix A: Design Guidelines

A safe, comfortable, and memorable trail experience begins with well-designed facilities. The Flyway Trail will utilize best practices in trail and bikeway design to create a world-class trail experience for people of all ages and abilities.





Design Guidelines

Introduction

Safe, accessible, and well-designed facilities are integral to the success of any trail or bikeway project. Agencies and organizations throughout the United States continue to explore and refine trail and bikeway design in order to enhance user comfort and safety, minimize conflict with motor vehicles and other trail users, and create a supportive and welcoming environment for bicycling, walking, and trail-related activities. This section of the study provides an overview of the current practice of trail and bikeway design, with a focus on best practices, practical applications, and context-sensitive considerations.

The section is divided into the following sections:

- Design standards, publications, and guidelines
- Trail user group definitions
- On-street bicycle facility selection and design guidelines
- General design practices for paved trails
- Trail management features
- Trail intersections
- Trail amenities
- Trail signage

Design Standards, Publications, and Guidelines

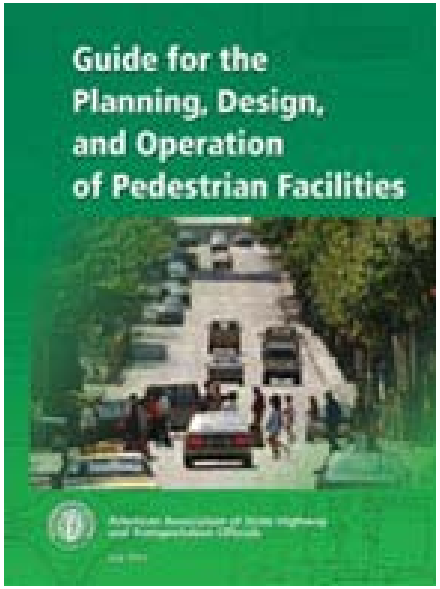
The guidelines recommended in this document are intended to assist city, county, and state officials in the selection and design of trails and their ancillary facilities. The standards draw together best practices by facility type from public agencies and municipalities nationwide. The following guides have been used to formulate standards and best practices for implementing trails in Buffalo County, Wisconsin.

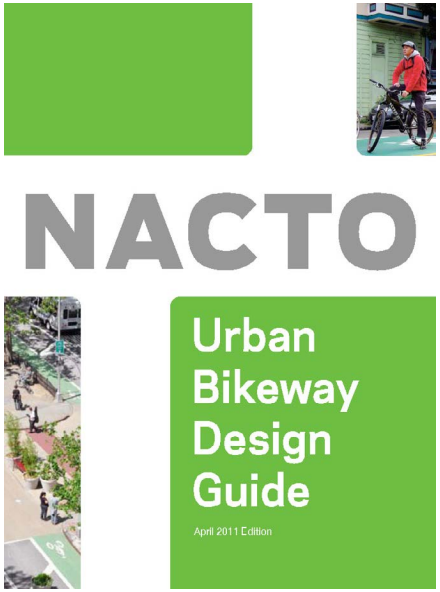
National Guidelines

The Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices* (MUTCD) (2009) defines the standards used by road engineers nationwide to install and maintain traffic control devices on all public streets, highways, trails, 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.

To further clarify the MUTCD, the FHWA created a table of contemporary bicycle facilities that lists various bicycle-related signs, markings, signals, and other treatments and identifies their official status with regard to FHWA acceptance (e.g., can be implemented, currently experimental).

Trail design treatments not explicitly covered by the MUTCD are often subject to experiments, interpretations, and official rulings by the FHWA. The MUTCD Official Rulings is an online resource that allows website visitors to obtain information about these





supplementary materials. Copies of various documents (such as incoming request letters, response letters from the FHWA, progress reports, and final reports) are available on this website: http://mutcd.fhwa.dot.gov/orsearch.asp.

American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities*, updated in June 2012, provides guidance on dimensions, use, and layout of specific bicycle facilities. The standards and guidelines presented by AASHTO provide basic information, such as minimum sidewalk widths, bicycle lane dimensions, detailed striping requirements, and recommended signage and pavement markings.

The National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide* (2013) is a modern publication of nationally recognized trail design standards and offers guidance on the current state of the practice designs. Based on current practices in the best cycling cities in the world, this invaluable resource offers substantive guidance for cities seeking to improve bicycle transportation in places where competing demands for the use of the right-of-way present unique challenges. All of the NACTO *Urban Bikeway Design Guide* treatments are in use in many cities around the US and internationally.

Offering similar guidance for pedestrian design, the 2004 AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities* provides comprehensive guidance on planning and designing for people on foot.

Meeting the requirements of the Americans with Disabilities Act (ADA) is an important part of any bicycle and pedestrian facility project. The United States Access Board's proposed 2011 *Public Rights-of-Way Accessibility Guidelines* (PROWAG), the 2009 ICC/ANSI A117.1, *Accessible and Usable Buildings and Facilities*, the 2010 ADA *Standards for Accessible Design*, and the 2013 ABA *Accessibility Guidelines for Outdoor Developed Areas* contain standards and guidance for the construction of accessible facilities. This includes requirements for sidewalk curb ramps, slope requirements, and pedestrian railings along stairs. Some of these treatments are not directly referenced in the current versions of the AASHTO Guide or the MUTCD, although many of the elements of these treatments are found within these documents. In all cases, engineering judgment is recommended to ensure that the application makes sense for the context of each treatment, given the many complexities of urban streets.

The US Department of Agriculture (USDA) Forest Service's *Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds* (2009) provides information for equestrian trail planning and design. Important considerations such as tread width, vertical and horizontal clearance, single versus dual tread design, barriers, landscaping, trailhead amenities, and user behavior and etiquette.

Crime Prevention Through Environmental Design (CPTED) is defined as a multi-disciplinary approach to deterring criminal behavior through environmental design. CPTED strategies rely upon the ability to influence offender decisions that precede criminal acts by affecting the built, social, and administrative environment. These principals should be applied to the Flyway Trail and other trails and bikeways in Buffalo County when feasible and where conflicts with existing local policies and ordinances do not exist.

State Guidelines

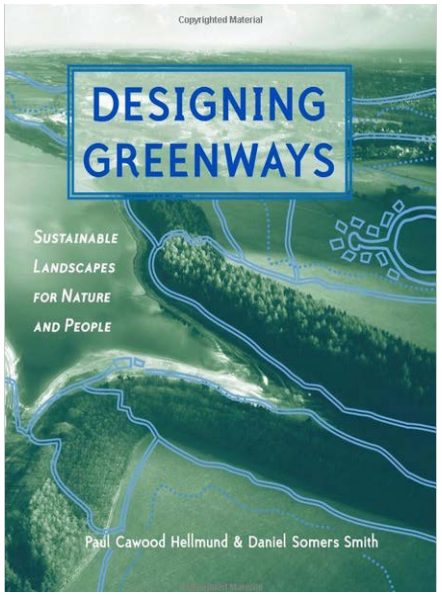
The Wisconsin Department of Transportation (WisDOT) policies and design guidance for bicycle, pedestrian and trail facilities continues to evolve in response to increased public desire for active transportation facilities and increased bicycle and pedestrian activity throughout the state. The State's commitment to bicycling and walking as viable and accessible transportation modes was strengthened in 2010 in concurrence with the United States Department of Transportation's (USDOT) ***Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations***, which states that every transportation department, including the USDOT itself, "has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and bicycling into their transportation systems." WisDOT policy requires all communities to incorporate bicycle and pedestrian facilities on federally and state-funded projects, allowing for exceptions in only five strict circumstances, including excessively disproportionate costs, constrained environments, and absence of need.

WisDOT's ***Bicycle Facilities Handbook*** (2004) and ***Facilities Development Manual*** (continually updated) provide in-depth information for complete streets principles and project development, bicycle network planning, and bicycle and pedestrian facility design. Each of these documents covers rural and urban contexts, and as such will be indispensable resources in the development of the Flyway Trail and its associated and ancillary facilities.

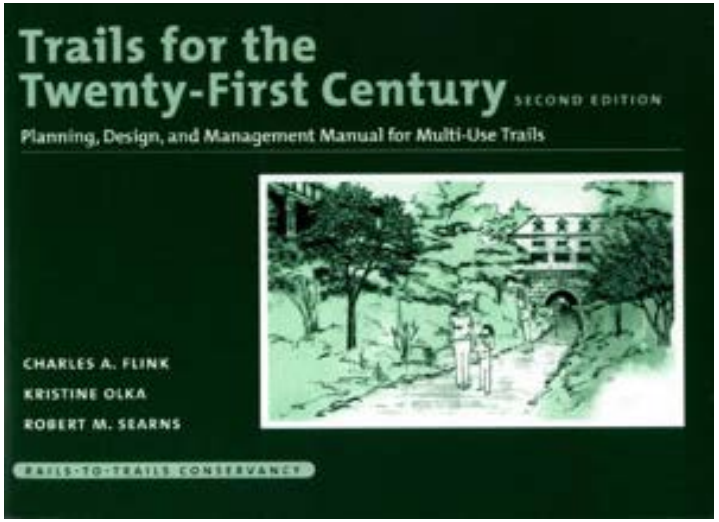
The ***Facilities Development Manual*** includes specific design criteria for the Great River Road (GRR), noting that "the special character of tourist traffic using the GRR warrants the use of modified design criteria for improvement projects on this road." The GRR should be designed "as a parkway including scenic overlooks, waysides, and special signing, and, where warranted, wider shoulders and shoulder pavement." Slower drivers, frequent pulling over on the shoulder, and high volumes of recreational vehicles and bicyclists during the tourist season are accommodated by a five-foot minimum paved shoulder width in areas with average daily traffic volumes exceeding 1,000.

Other Publications

Trails for the Twenty-First Century (2001). This book provides a comprehensive overview of trail planning, design, construction, and operations/maintenance. It summarizes steps necessary to complete a successful trail project using a systematic approach. Construction method best practices make recommendations for proper sub-grade preparation, sub-base material, and tread surface. Also included in the book are specific design guidelines regarding proper trail ancillary facilities and environmental considerations, land acquisition, management, and operations and maintenance of trails.



Designing Greenways (2006). This publication focuses on the holistic approach of greenways as ecological corridors. The book explains how greenway trails function ecologically and illustrates how to solve natural and social fragmentation. It is a practical guide for how planners, designers, and conservationists can implement solutions with consideration of land use and infrastructure issues.



User Group Definitions

Trails attract a variety of users with different needs and expectations. Important design characteristics for different users are width, surface material, sight distances, clearances, and trail amenities. The following sections provide the framework for incorporating standards and guidelines for trail design and planning.

Trail users include:

- Pedestrians—joggers, hikers, walkers, baby strollers, pet walkers, nature watchers
- Bicyclists—commuting, recreational, touring; different types of bicycles
- In-line skaters and skateboarders
- Wheelchair users and users of other mobility devices, such as Electronic Personal Mobility Devices (EPMD)

User Conflict

Multi-user conflict is an important safety issue in trail planning, design, and development. Typically these conflicts are caused by multiple user types traveling at different speeds. The combination heavy trail usage and insufficient widths may result in user conflicts. Other factors that can lead to user conflicts are poorly designed and engineered trail alignments, inadequate facility capacity, or inappropriate user behavior, such as pedestrians not staying to the right. Potential conflicts that exist between trail users are unique to the users themselves and indicated in the table below.

The most effective trail use management plan is a well-conceived safety program that provides the individual user with a Code of Conduct for the trail, sometimes called a Trail Ordinance. Several communities across the U.S. have adopted progressive trail ordinances for public use, including King County, Washington, and the East Bay Regional Park in Alameda and Contra Costa Counties, California.

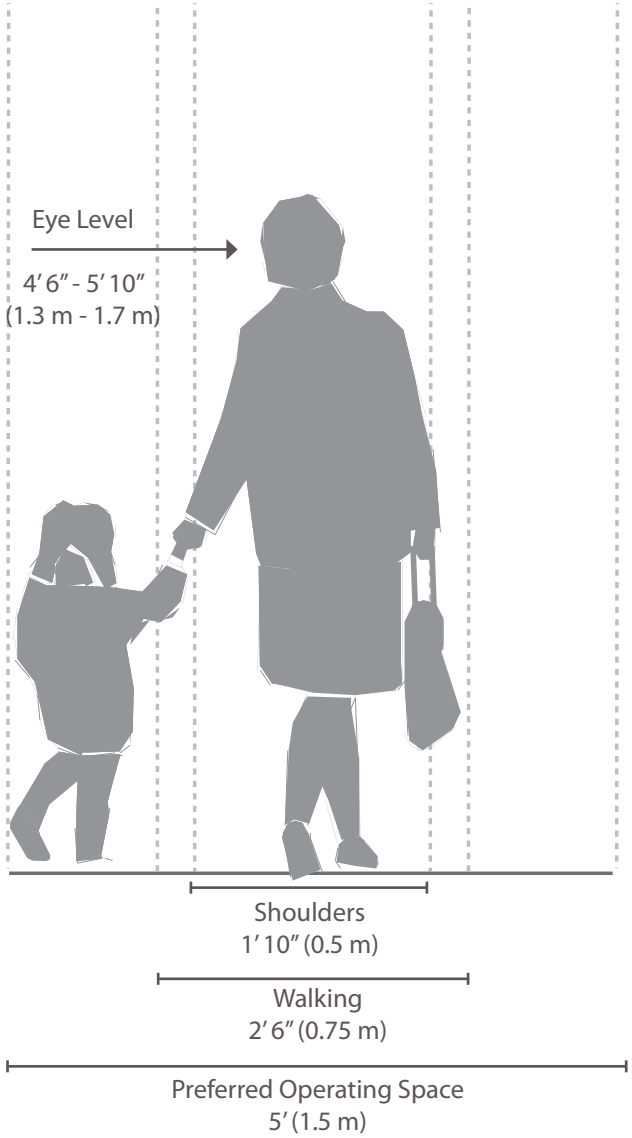
Potential Trail User Conflicts

USER TYPE	POTENTIAL CONFLICTS WITH OTHER USERS
PEDESTRIANS (includes any users on foot)	• Multiple pedestrians may walk more than two abreast, making it difficult for other users to pass • Children may veer into oncoming users on bicycles • Pet owners may not exercise on-leash etiquette • May not keep to the right, making it difficult for other users to pass
BICYCLISTS	• Have tendency to startle other users • May not obey posted speed limits • May frighten wildlife • May not exercise appropriate audible etiquette when passing
SKATERS	• Have tendency to startle other users • May not exercise appropriate audible etiquette when passing
WHEELCHAIR USERS	• May not keep to the right, making it difficult for other users to pass

Design Needs of Pedestrians

Pedestrians have a variety of characteristics and trails should accommodate a variety of needs, abilities, and possible impairments. Age is one major factor that affects pedestrians' physical characteristics, walking speed, and environmental perception. Children have low eye height and walk at slower speeds than adults. They also perceive the environment differently at various stages of their cognitive development. Older adults walk more slowly and may require assistive devices for walking stability, sight, and hearing. The table below summarizes common pedestrian characteristics for various age groups.

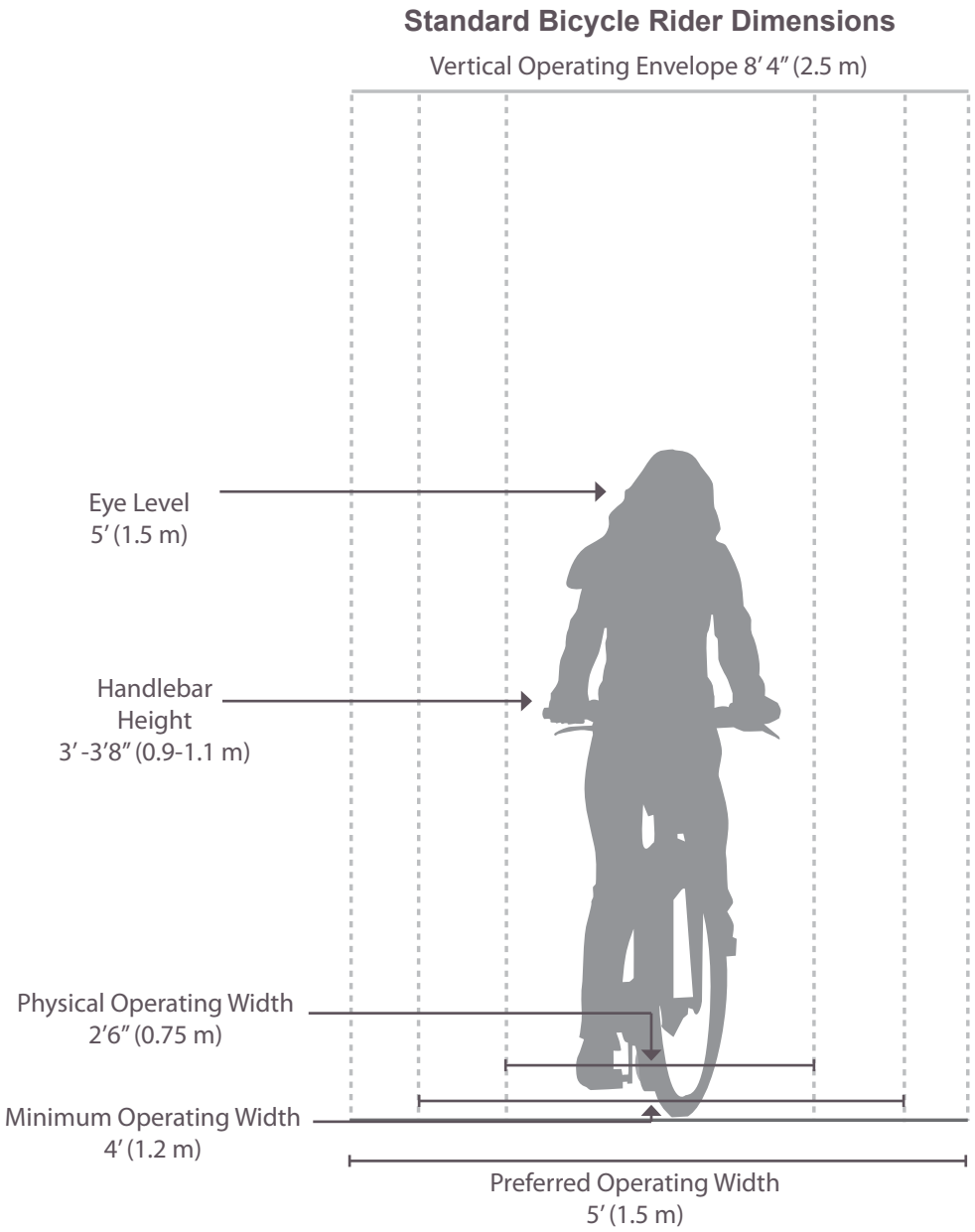
As a rule of thumb, the MUTCD recommends a normal walking speed of 3-1/2 feet per second when calculating the pedestrian clearance interval at traffic signals. The walking speed can drop to 3 feet per second for areas with older populations and persons with mobility impairments. While the type and degree of mobility impairment varies greatly across the population, the trail system should accommodate these users to the greatest reasonable extent at trail intersections, sharp turns, overpasses, and underpasses.



Pedestrian Characteristics by Age

Age	Characteristics
0-4	Learning to walk Requires constant adult supervision Developing peripheral vision and depth perception
5-8	Increasing independence, but still requires supervision Poor depth perception
9-13	Susceptible to "dart out" intersection dash Poor judgment Sense of invulnerability
14-18	Improved awareness of traffic environment Poor judgment
19-40	Active, fully aware of traffic environment
41-65	Slowing of reflexes
65+	Difficulty crossing street Vision loss Difficulty hearing vehicles approaching from behind

Source: AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities. 2004. Exhibit 2-1.



Source: AASHTO Guide for the Development of Bicycle Facilities, 3rd Edition. 2012.

Design Needs of Bicyclists

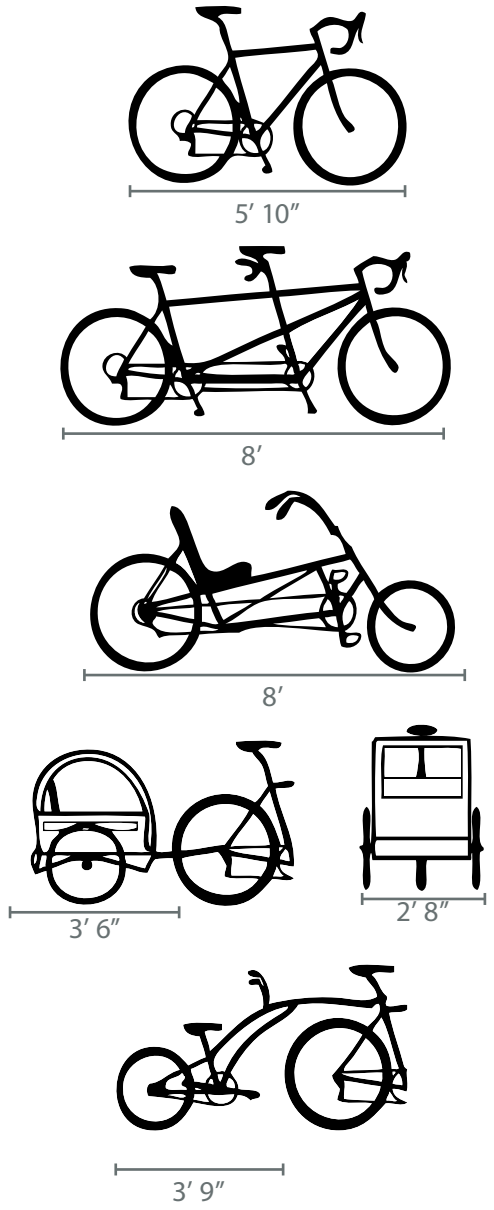
Similar to motor vehicles, bicyclists and their bicycles exist in a variety of sizes and configurations. These variations occur in the types of vehicle (such as a conventional bicycle, a recumbent bicycle, or a tricycle) and behavioral characteristics (such as the comfort level of the bicyclist). The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

The figure at left illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear, open space with no visual obstructions to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer 5 feet or more operating width, although 4 feet may be minimally acceptable.

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 Design Vehicle - Typical Dimensions

Bicycle Type	Feature	Typical Dimensions
Upright Adult Bicyclist	Physical width	2 ft 6 in
	Operating width (Minimum)	4 ft
	Operating width (Preferred)	5 ft
	Physical length	5 ft 10 in
	Physical height of handlebars	3 ft 8 in
	Operating height	8 ft 4 in
	Eye height	5 ft
	Vertical clearance to obstructions (tunnel height, lighting, etc)	10 ft
	Approximate center of gravity	2 ft 9 in - 3 ft 4 in
Recumbent Bicyclist	Physical length	8 ft
	Eye height	3 ft 10 in
Tandem Bicyclist	Physical length	8 ft
Bicyclist with child trailer	Physical length	10 ft
	Physical width	2 ft 8 in



Design Speed Expectations

The expected speed that different types of bicyclists can maintain under various conditions also influences the design of facilities such as shared-use paths. The table to the right provides typical bicyclist speeds for a variety of conditions.

Speed Expectations

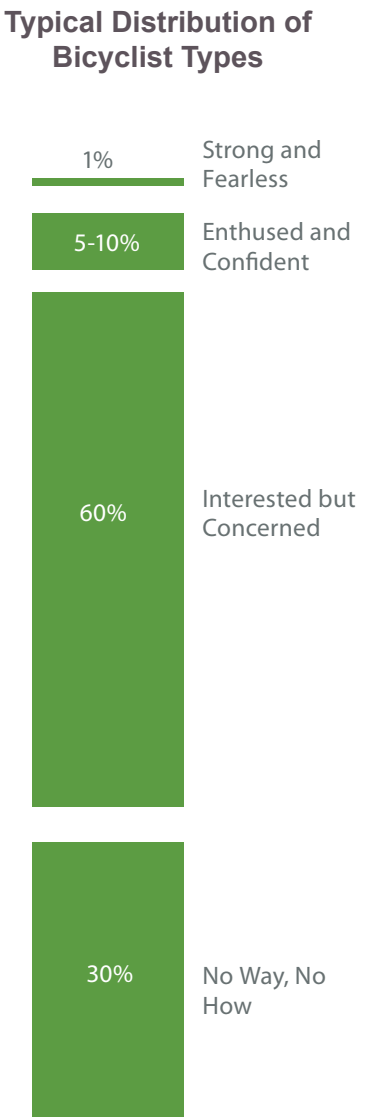
Bicycle Type	Feature	Typical Speed
Upright Adult Bicyclist	Paved level surfacing	8-15 mph
	Crossing Intersections	10 mph
	Downhill	20-30 mph
	Uphill	5 -12 mph
Recumbent Bicyclist	Paved level surfacing	11-18 mph

Skill Levels of Bicyclists

It is important to consider bicyclists of all skill levels when creating a non-motorized plan or project. Bicyclist skill level greatly influences expected speeds and behavior, both in separated bikeways and on shared roadways. Bicycle infrastructure should accommodate as many user types as possible, with decisions for separate or parallel facilities based on providing a comfortable experience for the greatest number of people.

The bicycle planning and engineering professions currently use several systems to classify the bicycling population, which can assist in understanding the characteristics and infrastructure preferences of different bicyclists. The most conventional framework classifies the "design cyclist" as Advanced, Basic, or Child[1]. A more detailed understanding of the US population as a whole is illustrated in the figure at left. Developed by planners in Portland, Oregon[2], and supported by data collected nationally since 2005, this classification provides the following alternative categories to address varying attitudes towards bicycling in the US:

- ***Strong and Fearless*** (approximately 1 percent of population): 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*** (5 to 10 percent of population): 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*** (approximately 60 percent of population): This user type comprises the bulk of the cycling population and represents bicyclists who typically only ride a bicycle on low-traffic streets or multi-use trails 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 and Confident" with encouragement, education, and experience.
- ***No Way, No How*** (approximately 30 percent of population): 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 never ride a bicycle other than on rare occasions or under special circumstances (e.g., in a park, with a child).



1 Selecting Roadway Design Treatments to Accommodate Bicycles. (1994). Publication No. FHWA-RD-92-073

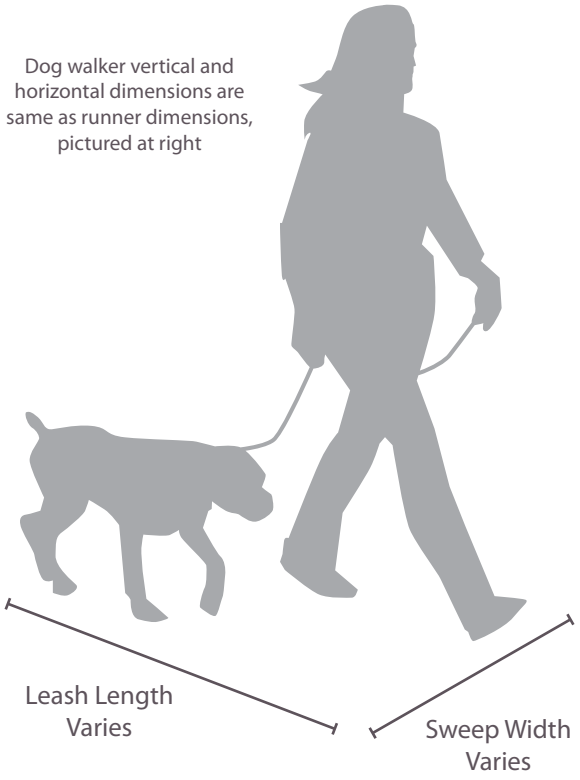
2 Four Types of Cyclists. (2009). Roger Geller, City of Portland Bureau of Transportation.

http://www.portlandonline.com/transportation/index.cfm?&a=237507

Design Needs of Dog Walkers

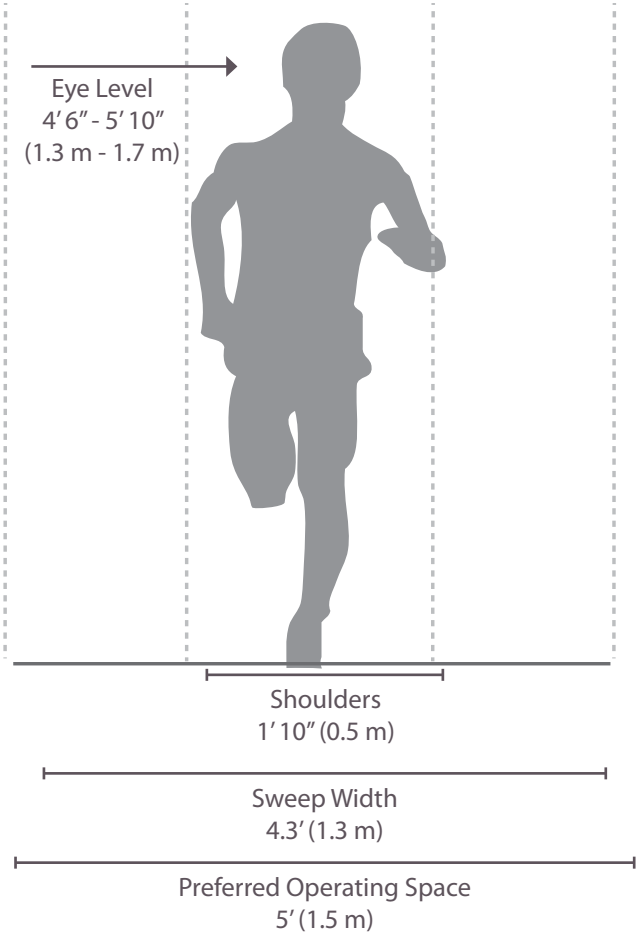
Dog walking is a common and anticipated use on trails. Dog sizes vary largely, as does leash length and walking style, leading to wide variation in possible design dimensions.

Trails designed to accommodate wheelchair users are likely to provide the necessary dimensions for the average dog walker. Amenities such as dog waste stations at trailheads enhance conditions for dog walkers.



Design Needs of Runners

Running is an important recreation and fitness activity commonly performed on trails. Many runners prefer softer surfaces (such as rubber, bare earth, or crushed rock) to reduce impact. Among hardened surfaces, asphalt is preferred over concrete because it is more forgiving on joints. Runners can change their speed and direction frequently.



Typical Speed

User	Typical Speed
Runner	6.2 mph

Source: FHWA. Characteristics of Emerging Road and Trail Users and Their Safety. (2004).

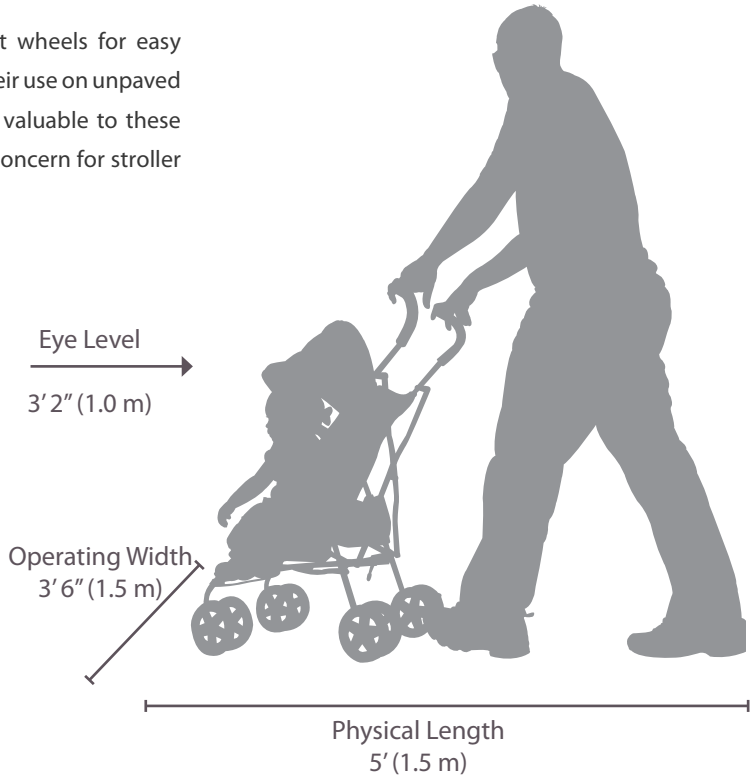
Design Needs of Strollers

Strollers are wheeled devices pushed by pedestrians to transport babies or small children. Stroller models vary greatly in their design and capacity. Some strollers are designed to accommodate a single child; others can carry three or more. Design needs of strollers depend on the wheel size, geometry, and ability of the adult who is pushing the stroller.

Strollers commonly have small pivoting front wheels for easy maneuverability, but these wheels may limit their use on unpaved surfaces or rough pavement. Curb ramps are valuable to these users. Lateral overturning is one main safety concern for stroller users.

Typical Speed

User	Typical Speed
Stroller	3.7 mph



Source: FHWA. (2004).

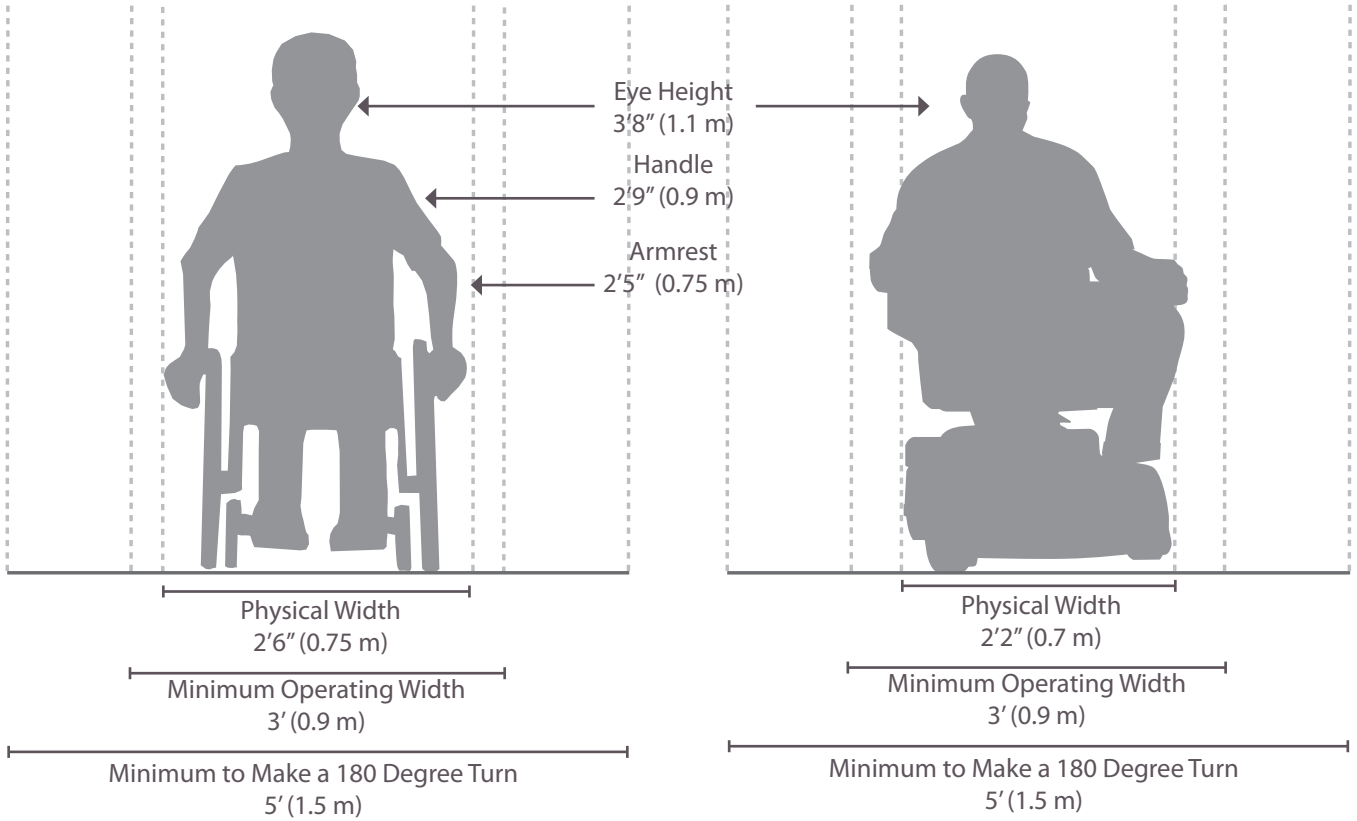
Design Needs of Mobility Assistance Device Users

As the American population ages, the number of people using mobility assistance devices (such as manual wheelchairs or powered wheelchairs) increases.

Manual wheelchairs are self-propelled devices. Users propel themselves using push rims attached to the rear wheels. Braking is done through resisting wheel movement with the hands or arm. Alternatively, a second individual can control the wheelchair using handles attached to the back of the chair.

Power wheelchairs use battery power to move the wheelchair. The size and weight of power wheelchairs limit their ability to negotiate obstacles without a ramp. Various control units are available that enable users to control the wheelchair movement, based on user ability (e.g., joystick control, breath controlled).

Maneuvering around a turn requires additional space for wheelchair devices. Providing adequate space for 180 degree turns at appropriate locations is an important element for accessible design.



Wheelchair User Typical Speed

User	Typical Speed
Manual Wheelchair	3.6 mph
Power Wheelchair	6.8 mph

Wheelchair User Design Considerations

Effect on Mobility	Design Solution
Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
Cross-slopes cause wheelchairs to veer downhill.	Cross-slopes of less than two percent.
Require wider path of travel.	Sufficient width and maneuvering space.

Source: FHWA. Characteristics of Emerging Road and Trail Users and Their Safety. (2004). USDOJ. 2010 ADA Standards for Accessible Design. (2010).

Design Needs of Skaters

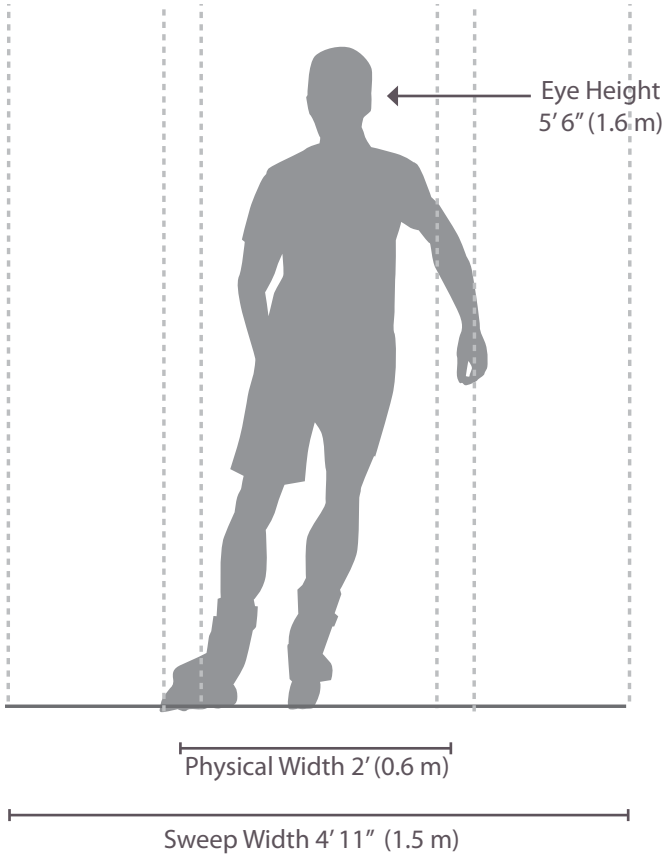
Inline skates are commonly used for recreational and transportation purposes. They typically have three to five wheels of 3 to 4 inches diameter, aligned in a straight line. Inline skate design allows for more efficient and high speed travel than quad wheel skates.

Operational characteristics vary by skill level of the operator. Novice skaters travel more slowly and have a narrower sweep width from advanced skaters. Novice users may also have trouble making sharp turns and stopping quickly, particularly on speed grades.

Inline skates are nearly impossible to use on unpaved surfaces and can be uncomfortable and difficult to operate on rough pavements, such as asphalt with large aggregate.

Typical Speed

User	Typical Speed
Inline Skates	9.9 mph



Source: FHWA. Characteristics of Emerging Road and Trail Users and Their Safety. (2004).

On-Street Bicycle Facility Selection and Design Guidelines

This section summarizes the bicycle facility selection typology developed for Flyway Trail. The specific facility type that should be provided depends on the surrounding environment (e.g., auto speed and volume, topography, and adjacent land use) and expected bicyclist needs (e.g. bicyclists commuting on a highway versus students riding to school on residential streets).

Facility Selection Guidelines

There are no hard and fast rules for determining the most appropriate type of bicycle facility for a particular location—roadway speeds, volumes, right-of-way width, presence of parking, adjacent land uses, and expected bicycle user types are all critical elements of this decision. Studies find that the most significant factors influencing bicycle use are motor vehicle traffic volumes and speeds. Additionally, most bicyclists prefer facilities separated from motor vehicle traffic or located on local roads with low motor vehicle traffic speeds and volumes. Because off-street pathways are physically separated from the roadway, they are perceived as safe and attractive routes for bicyclists who prefer to avoid motor vehicle traffic. Consistent use of treatments and application of bikeway facilities allow users to anticipate whether they would feel comfortable riding on a particular facility and plan their trips accordingly. This section provides guidance on various factors that affect the type of facilities that should be provided.

On-street bicycle facility design has grown significantly over time. The diversity of bikeway types provides communities with a comprehensive toolbox for bicycle network development. Shared facilities (shown in the column above) are best suited for low-volume, low-speed roadways, while separated facilities (shown in the column to the right) offer a safe and convenient facility along busier roadways.

Facility Classification

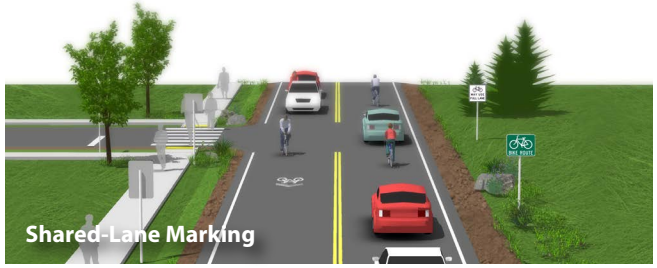
Consistent with bicycle facility classifications throughout the nation, these Bicycle Facility Design Guidelines identify the following classes of facilities by degree of separation from motor vehicle traffic.

Shared Roadways are bikeways where bicyclists and cars operate within the same travel lane, either side by side or in single file depending on roadway configuration. The most basic type of bikeway is a signed shared roadway. This facility provides continuity with other bicycle facilities (usually bike lanes) or designates preferred routes through high-demand corridors.

Shared Roadways may also be designated by pavement markings, signage, and other treatments including directional signage, traffic diverters, chicanes, chokers, and/or other traffic-calming devices to reduce vehicle speeds or volumes. Shared-lane markings are included in this class of treatments.

Separated Bikeways, such as bike lanes, use signage and striping to delineate the right-of-way assigned to bicyclists and motorists. Bike lanes encourage predictable movements by both bicyclists and motorists. Paved shoulders are also included in this classification.

Cycle Tracks are exclusive bike facilities that combine the user experience of a separated path with the on-street infrastructure of conventional bike lanes.



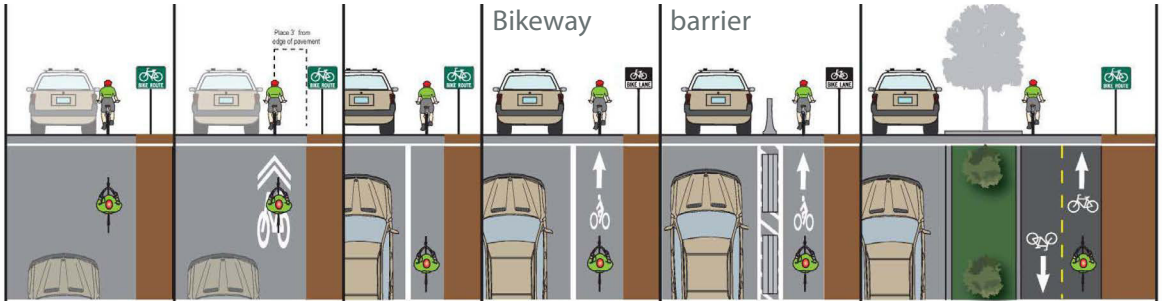
Facility Continua

The following continua illustrate the range of bicycle facilities applicable to various roadway environments, based on the roadway type and desired degree of separation. Engineering judgment, traffic studies, previous municipal planning efforts, community input, and local context should be used to refine criteria when developing bicycle facility recommendations for a particular street. In some corridors, it may be desirable to construct facilities to a higher level of treatment than those recommended in relevant planning documents. This approach enhances user safety and comfort. In other cases, existing and/or future motor vehicle speeds and volumes may not justify the recommended level of separation, and a less intensive treatment may be acceptable.

Least Protected → Most Protected

Arterial/Highway Bikeway Continuum (without curb and gutter)

Wide Outside Lane | Sharrow | Shoulder Bikeway | Wide Shoulder Bikeway | Cycle Track: protected with barrier | Shared Use Path

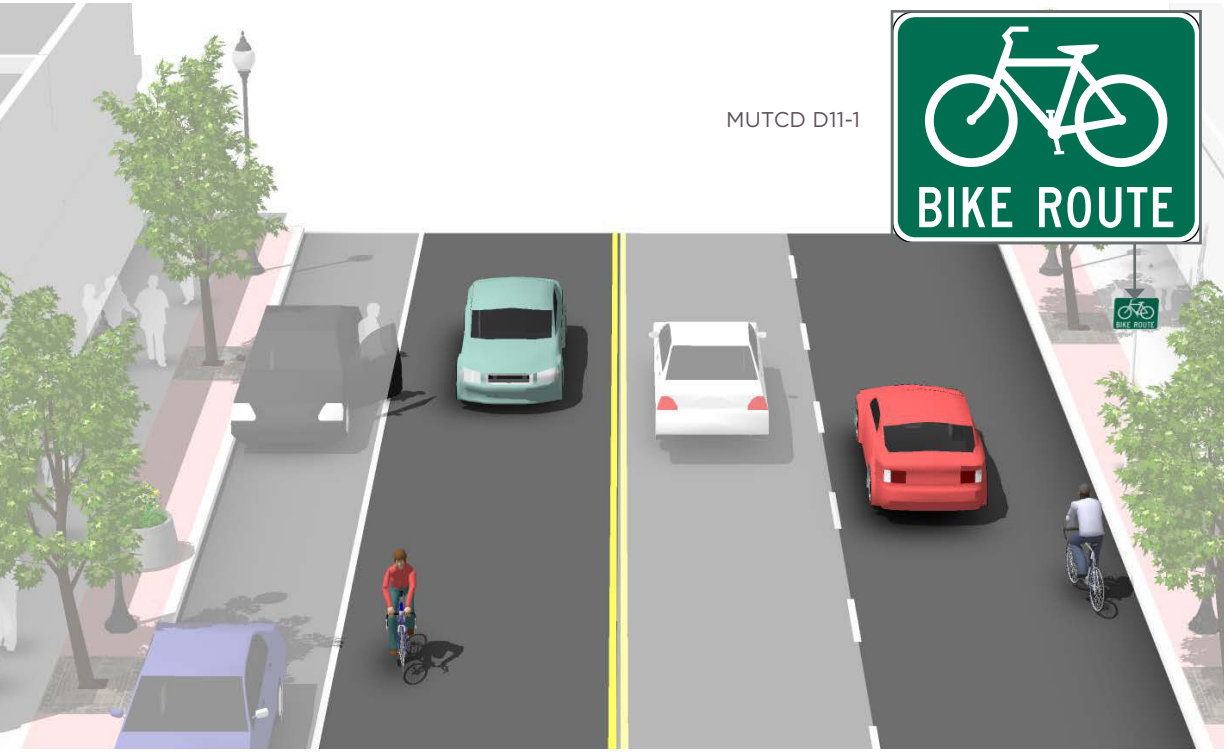


Arterial/Highway Bikeway Continuum (with curb and gutter)

Sharrow | Conventional Bicycle Lane | Buffered Bicycle Lane | Cycle Track: at-grade, protected with parking | Cycle Track: protected with barrier | Cycle Track: curb separated

Signed Shared Roadways

Signed shared roadways are facilities shared with motor vehicles. They are typically used on roads with low speeds and traffic volumes, however 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.



MUTCD D11-1

GUIDANCE

- Lane width varies depending on roadway configuration.
- Bicycle 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 a bicycle route
  - At major changes in direction or at intersections with other bicycle routes
  - At intervals along bicycle routes not to exceed 1/2 mile.

DISCUSSION

Signed 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 bicycle boulevard due to a lack of traffic calming, wayfinding, pavement markings, and other enhancements designed to provide a higher level of comfort for a broad spectrum of users.

MATERIALS AND MAINTENANCE

Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear.

Marked Shared Roadways

A marked shared roadway is a general purpose travel lane marked with shared lane markings (SLM) used to encourage bicycle travel and proper positioning within the lane. In constrained conditions, the SLMs are placed in the middle of the lane to discourage unsafe passing by motor vehicles. 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.

GUIDANCE

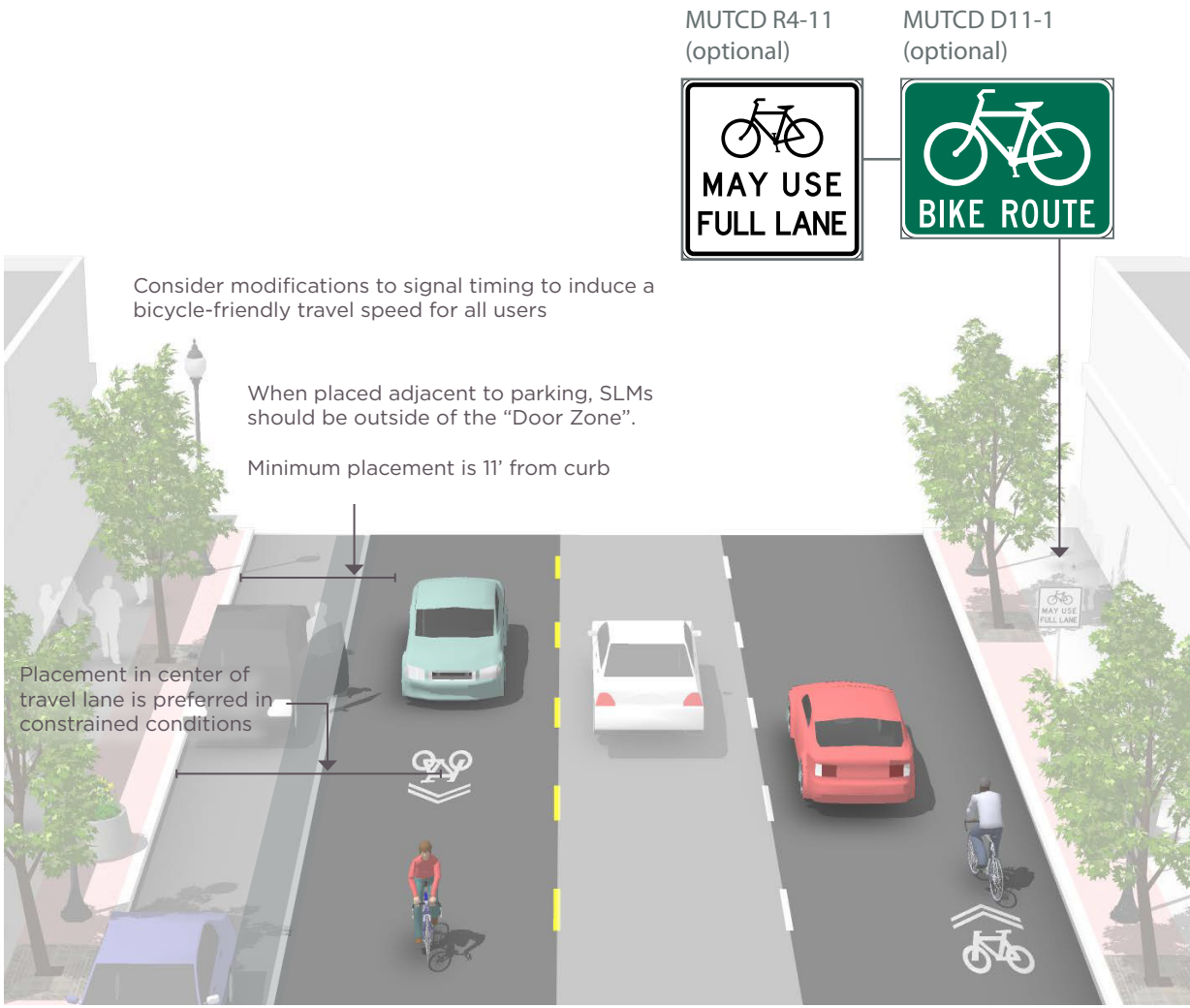
- Lane width varies depending on roadway configuration.
- Bicycle Route signage (D11-1) should be applied at intervals frequent enough to keep bicyclists informed of changes in route direction and to remind motorists of the presence of bicyclists. Commonly, this includes placement at:
  - Beginning or end of Bicycle Route
  - At major changes in direction or at intersections with other bicycle routes
  - At intervals along bicycle routes not to exceed 1/2 mile

DISCUSSION

Bike Lanes should be considered on roadways with outside travel lanes wider than 15 feet or where other lane narrowing or removal strategies may provide adequate road space. SLMs shall not be used on shoulders, in designated Bike Lanes, or to designate Bicycle Detection at signalized intersections (MUTCD 9C.07). This configuration differs from a Quiet Street due to a lack of traffic calming, wayfinding, and other enhancements designed to provide a higher level of comfort for a broad spectrum of users.

MATERIALS AND MAINTENANCE

Placing SLMs between vehicle tire tracks will increase the life of the markings and minimize the long-term cost of the treatment.



Bicycle Boulevards

Bicycle boulevards, also referred to as quiet streets or neighborhood greenways, are a special class of shared roadways designed for a broad spectrum of bicyclists. They are low-volume, low-speed local 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.

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

GUIDANCE

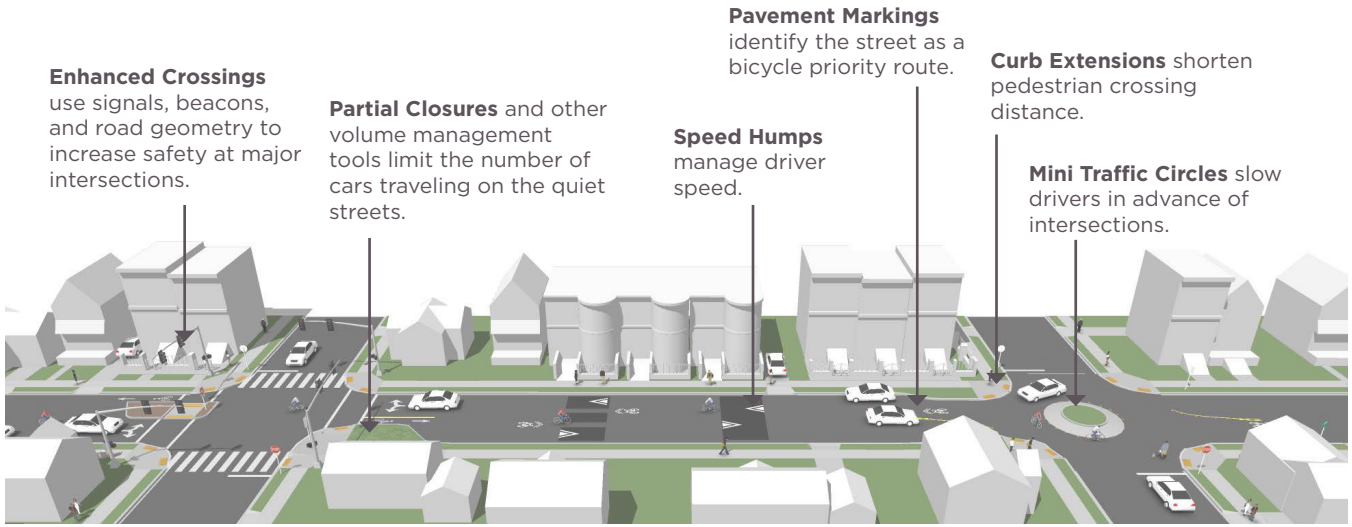
- Bicycle boulevards should have a maximum posted speed of 25 mph. Use traffic calming to maintain an eighty-fifth percentile speed below 22 mph.
- Implement volume control treatments based on the context of the bicycle boulevard, using engineering judgment. Target motor vehicle volumes range from 1,000 to 3,000 vehicles per day.
- Intersection crossings should be designed to enhance safety and minimize delay for bicyclists.

DISCUSSION

Bicycle boulevards 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.

MATERIALS AND MAINTENANCE

Vegetation should be regularly trimmed to maintain visibility and attractiveness.



Shoulder Bikeways

Typically found in less-dense areas, shoulder bikeways are paved roadways with striped shoulders (4 feet minimum) wide enough for bicycle travel. Shoulder bikeways often, but not always, include signage alerting motorists to expect bicycle travel along the roadway. 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. This type of treatment is not typical in urban areas and should only be used where constraints exist.

GUIDANCE

- 4 feet minimum when no curb and gutter is present.
- 5 feet minimum when adjacent to curb and gutter or 3 feet more than the gutter pan width if the gutter pan is wider than 2 feet.
- 5 feet minimum width on sections of the Great River Road with a minimum 1,000 ADT.
- 14-1/2 feet preferred from curb face to edge of bike lane. (12 foot minimum).
- 7 feet maximum width for use adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of bike lane.

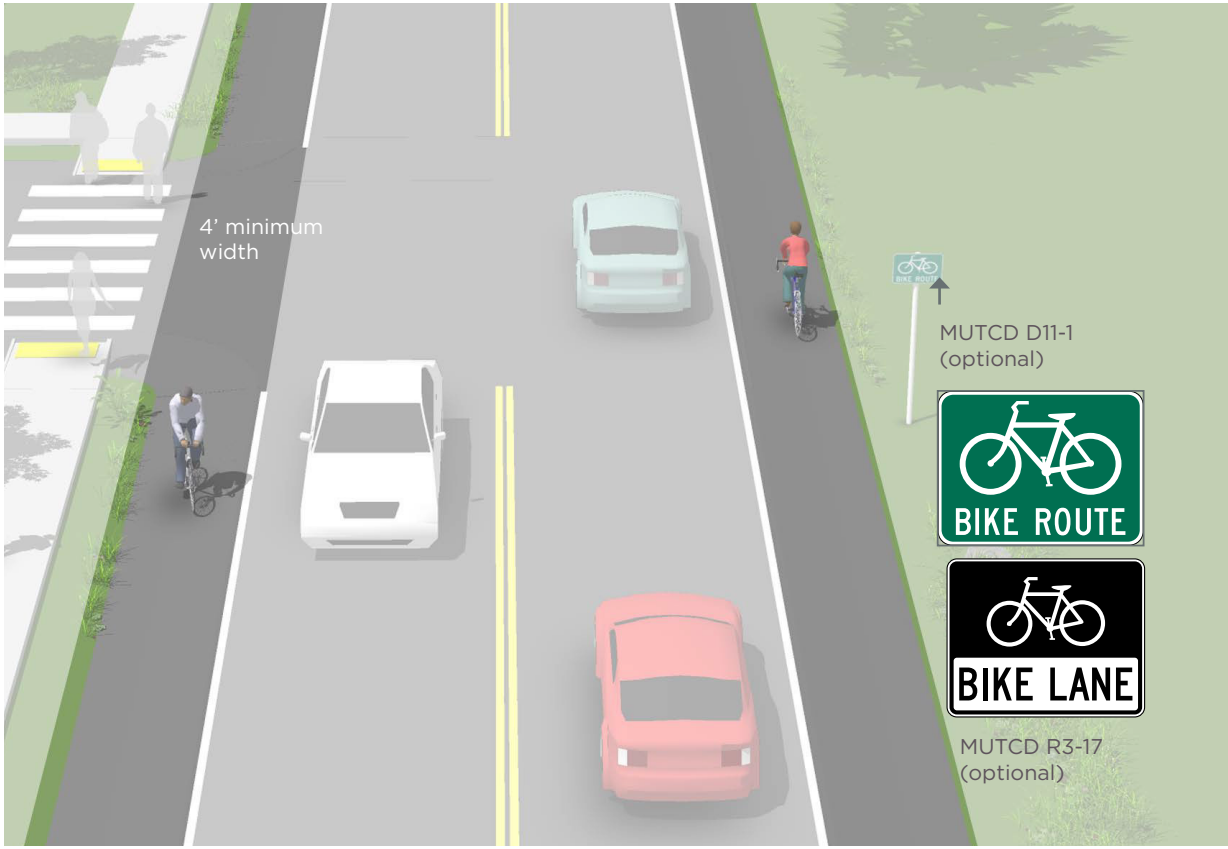
DISCUSSION

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 to 16 foot) outside travel lane. Consider configuring as a marked shared roadway in these locations.

Where feasible, roadway widening should be performed with pavement resurfacing jobs.

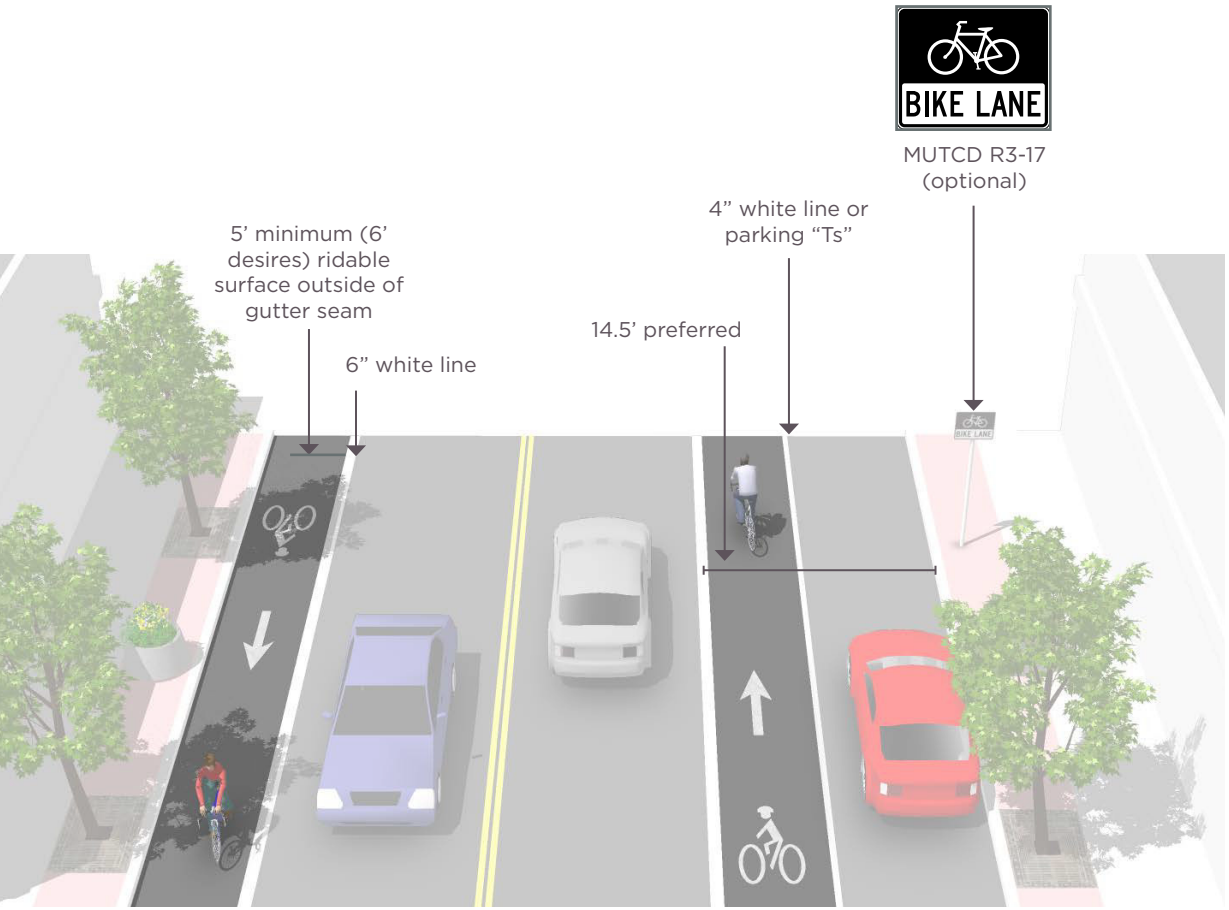
MATERIALS AND MAINTENANCE

Paint can wear more quickly in high-traffic areas or in winter climates. Shoulder bikeways should be cleared of snow through routine snow removal operations.



Bicycle Lanes

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is located 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.



Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped and signed bikeway than if they are expected to share a lane with vehicles.

GUIDANCE

- 4 feet minimum when no curb and gutter is present.
- 5 feet minimum when adjacent to curb and gutter or 3 feet more than the gutter pan width if the gutter pan is wider than 2 feet.
- 14-1/2 feet preferred from curb face to edge of bike lane. (12 feet minimum).
- 7 feet maximum width for use adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of bike lane.

DISCUSSION

Wider bicycle lanes are desirable in certain situations such as on higher-speed arterials (45 mph+) where use of a wider bicycle lane would increase separation between passing vehicles and bicyclists. Appropriate signing and stenciling is important with wide bicycle lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane. Consider Buffered Bicycle Lanes when further separation is desired.

MATERIALS AND MAINTENANCE

Paint can wear more quickly in high-traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

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. Buffered bike lanes are allowed as per MUTCD guidelines for buffered preferential lanes (section 3D-01).

Buffered bike lanes are designed to increase the space between the bike lane and the travel lane or parked cars. This treatment is appropriate for bike lanes on roadways with high motor vehicle traffic volumes and speed, adjacent to parking lanes, or a high volume of truck or oversized vehicle traffic.

GUIDANCE

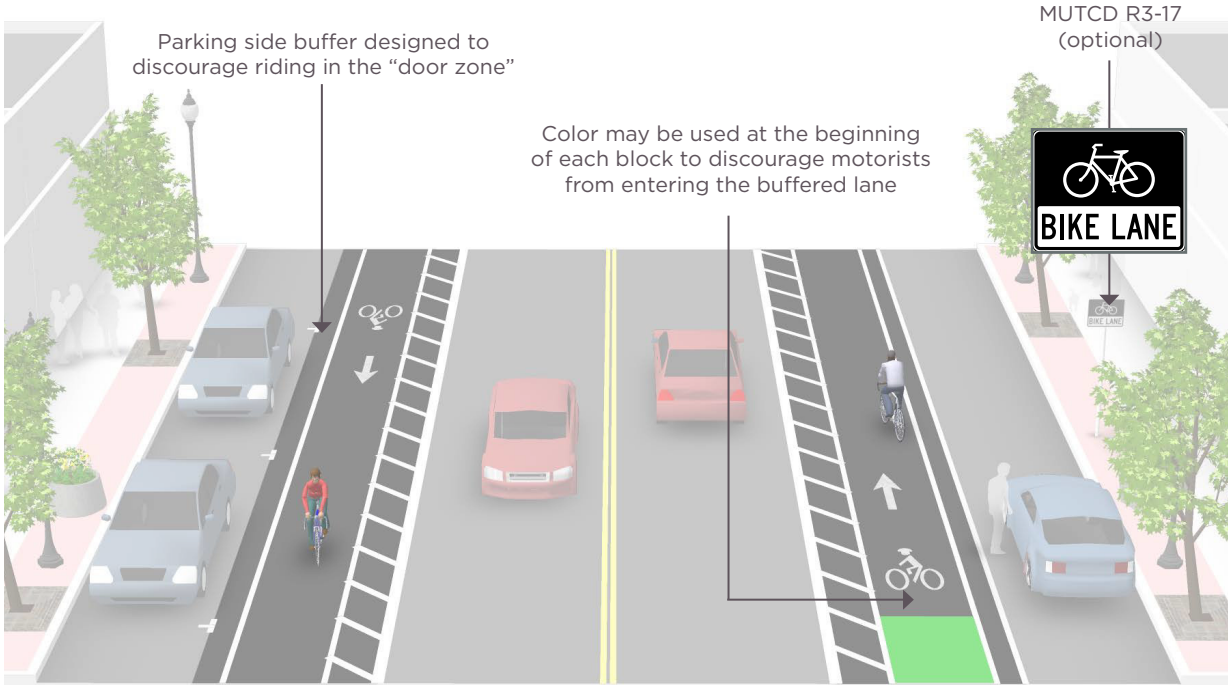
- Where bicyclist volumes are high or where bicyclist speed differentials are significant, the desired bicycle travel area width is 7 feet.
- Buffers should be at least 2 feet wide. If 3 feet or wider, mark with diagonal or chevron hatching. For clarity at driveways or minor street crossings, consider a dotted line or colored pavement for the inside buffer boundary where cars are expected to cross.

DISCUSSION

Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection. Commonly configured as a buffer between the bicycle lane and motor vehicle travel lane, a parking side buffer may also be provided to help bicyclists avoid the 'door zone' of parked cars.

MATERIALS AND MAINTENANCE

Paint can wear more quickly in high-traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.



Advisory Bike Lanes

Advisory bicycle lanes (also called dashed bicycle lanes)provide a bicycle-priority space on a two-lane street too narrow for conventional bicycle lanes. Similar in appearance to bicycle lanes, advisory bicycle lanes are distinct in that they are temporarily shared with motor vehicles during head-on approaching maneuvers and turning movements.

BENEFITS

- Creates priority for people bicycling in what would otherwise be a shared-roadway condition.
- Increases predictability and clarifies positioning between people bicycling and people driving.
- Encourages increased separation while passing.

TYPICAL APPLICATION

- This treatment may be most appropriate on roadways with low volumes if the road is straight with few bends, inclines or sightline obstructions.
- Motor vehicle traffic volumes are low-moderate (1,500-4,500 ADT). May function on streets with up to 6,000 ADT.
- Narrow two-lane streets where there is insufficient room for conventional bicycle lanes.
- Streets with a travel lane area of 20-30 feet. Streets with travel area wider than 30 feet can support conventional bike lanes.

Minneapolis, MN - This downtown street is too narrow for both conventional bicycle lanes and parking. Advisory bicycle lanes allow the road to continue to serve parking and motor vehicle access, while providing a prioritized space for people to ride.

Advisory Bike Lanes (Cont.)

DESIGN FEATURES

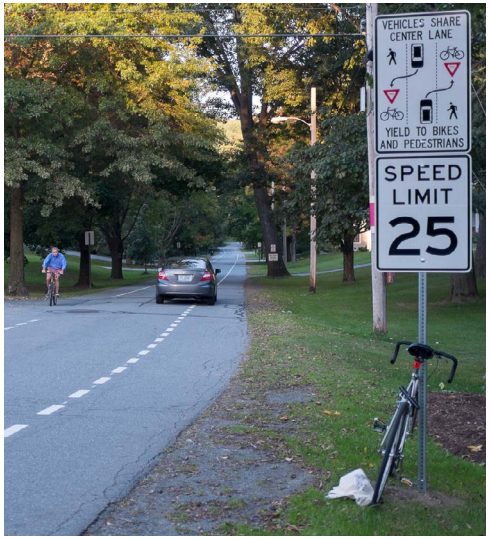
- No centerline on roadway to promote safe passing distances.
- Bicycle lane delineated with white broken line to permit encroachment when necessary.
- Advisory bicycle lane width of 5 to 7 ft.
- Bicycle lane markings should be used to clarify the designated use of the lane.
- Recommended two-way motor vehicle travel lane width of 16 ft. Some installations have worked with center lane as narrow as 10 ft.
- If a parking lane is present it should be highly utilized or feature frequent curb extensions to clearly define the edge of the travelled way. Parking is prohibited within the advisory bicycle lane.
- Two-Way Traffic warning sign (W6-3) may be used to clarify two-way operation of the road.

DISCUSSION

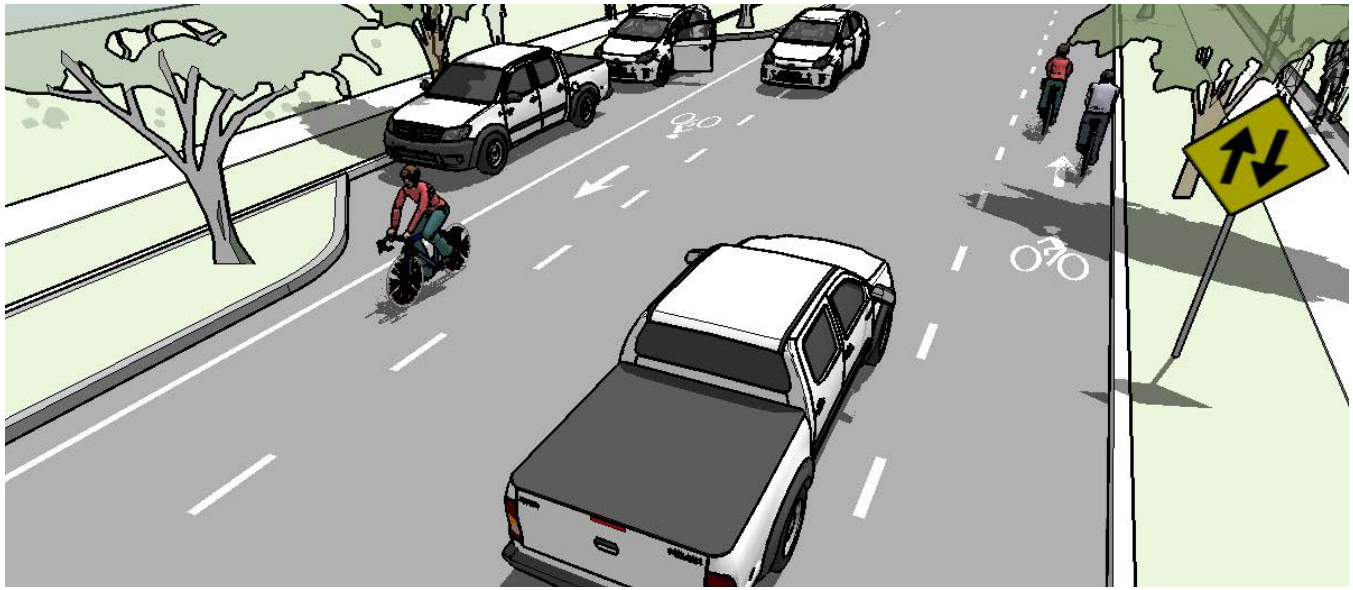
This treatment is considered experimental by FHWA and may require a Request to Experiment as described in section 1A.10 of the MUTCD. Specific design detail should conform to MUTCD and Ca-TCDC experimentation requirements.

Consider the use of colored pavement within the advisory bicycle lane area to discourage unnecessary encroachment by motorists or parked vehicles.

Advisory bicycle lanes may be appropriate on low volume streets in freight districts. Required passing widths for truck or emergency vehicles should be considered on routes where such vehicles are anticipated.



Hanover, NH - Advisory lanes used to provide a bicycling and walking space on a street without sidewalks or room for bicycle lanes.



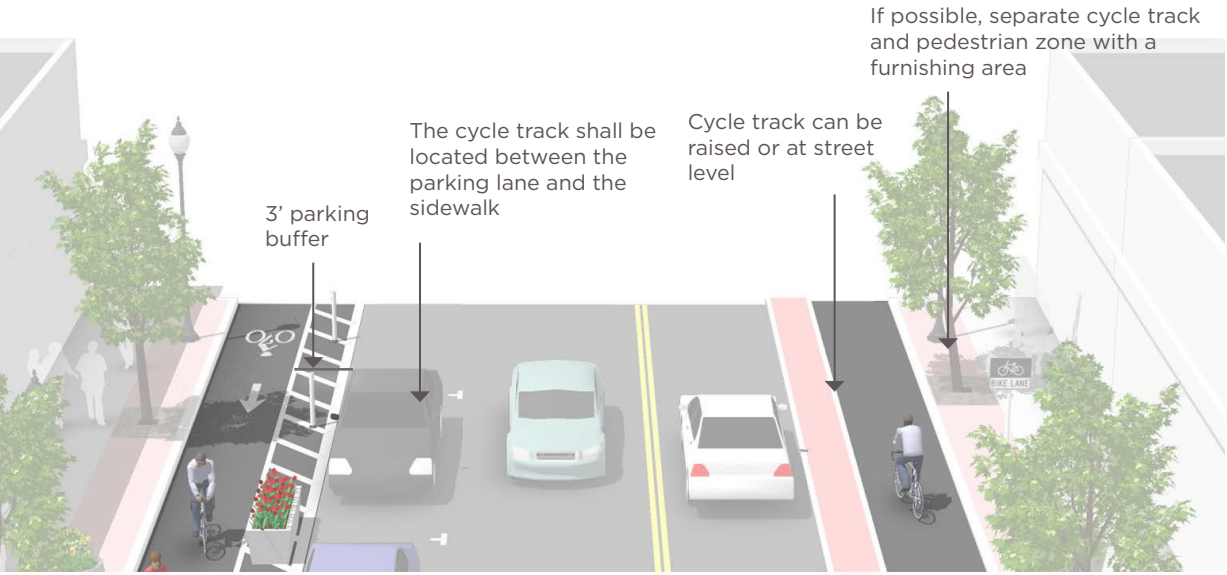
Cycle Tracks

A cycle track is an exclusive bike facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. A cycle track is physically separated from motor traffic and distinct from the sidewalk. Cycle tracks have different forms but all share common elements—they provide space that is intended to be exclusively or primarily used by bicycles and are separated from motor vehicle travel lanes, parking lanes, and sidewalks.

Raised cycle tracks may be at the level of the adjacent sidewalk or set at an intermediate level between the roadway and sidewalk to separate the cycle track from the pedestrian area.

GUIDANCE

- Cycle tracks should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles.



One-Way Cycle Tracks

- 7 feet recommended minimum to allow passing. 5-foot minimum width in constrained locations.

Two-Way Cycle Tracks

- Cycle tracks located on one-way streets have fewer potential conflict areas than those on two-way streets.
- 12 feet recommended minimum for two-way facility. 8-foot minimum width in constrained locations

DISCUSSION

Special consideration should be given at transit stops to manage bicycle and pedestrian interactions. Driveways and minor street crossings are unique challenges to cycle track design. Parking should be prohibited within 30 feet of the intersection to improve visibility. Color, yield markings, and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic. If configured as a raised cycle track, the crossing should be raised so that the sidewalk and cycle track maintain their elevation through the crossing.

MATERIALS AND MAINTENANCE

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.

General Design Practices for Paved Trails

The intent of trail construction is to make open space available without damaging the qualities of the natural environment that are most valued and appreciated. Surfacing should be selected to support projected intensities of use and to enable multiple uses. Surfacing should also account for site topography, surface drainage, frequency of flooding, construction cost, and maintenance concerns.

Key features include:

- Frequent access points from the local on-street transportation network
- Directional signs to direct users within the trail network
- A limited number of at-grade crossings with streets or driveways
- Easily accessible connections to destinations
- Facilities that safely accommodate multiple user types

Trail Surfacing Types

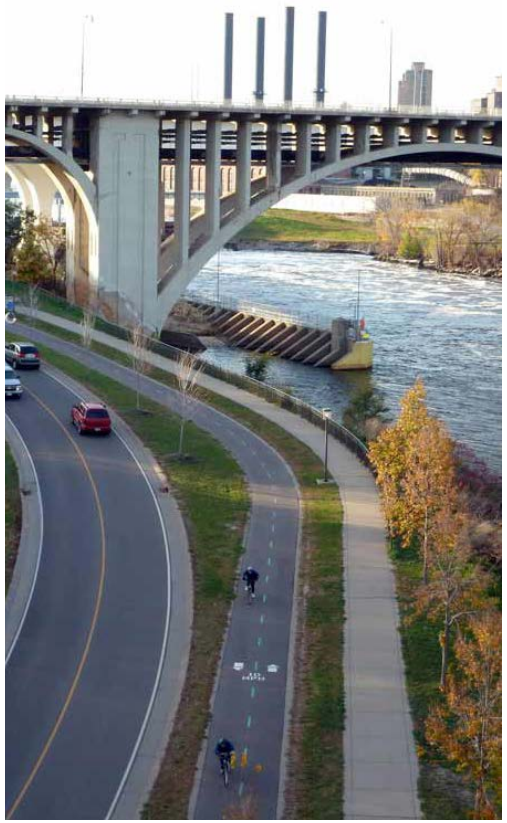
American Disabilities Act Accessibility Guidelines compliant trails require paved surfaces, in most instances for access and ease of use. In limited cases, packed gravel fines can be used, where there is little to no topography. However, packed surfaces require much more maintenance effort and cost over time and may not be desirable in the long term.

Asphalt trails offer substantial durability for the cost of installation and maintenance. Asphalt is popular with users for its smooth, continuous surface and has the benefit of lower cost but requires more upkeep than concrete. As a flexible pavement, asphalt can also be considered for installing a paved trail on grades steeper than 3 percent. If constructed properly on suitable sub-grade, asphalt has a life span of about half that of concrete, or 10 to 15 years.

When properly constructed and maintained on a regular basis, concrete can last 25 years or more. The high cost of concrete is often the most limiting factor since it is one of the most expensive surfaces to install. It is recommended that concrete be used for its superior durability and lower maintenance requirements in areas prone to frequent flooding, and for intensive urban applications.

Permeable paving is twice the cost of asphalt to install and is only recommended in very special trail applications under the following considerations:

- A maintenance schedule must be established for vacuuming debris after storm events (required to retain permeability).
- Only use permeable paving areas with proper drainage (not suitable in floodplain or areas with ponding or sedimentation).



Example of a separated track for pedestrians; along West River Parkway, Minneapolis; photo by Stuart Macdonald, 29 Oct 2010; courtesy of American Trails

When determining surface type for trails, consider topography, landscape position, underlying soils, and user needs. All surfaces have advantages and disadvantages, and each must be analyzed to determine which surface is appropriate in any given location.

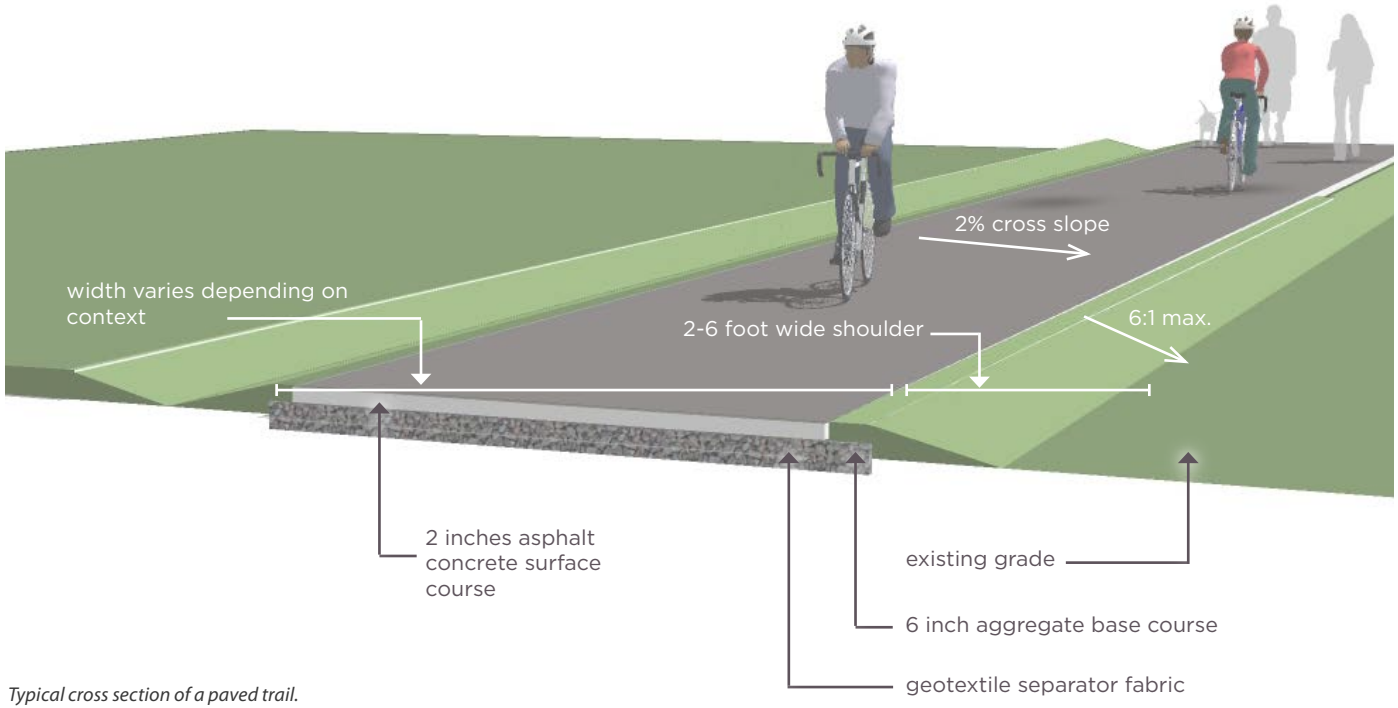
GUIDANCE

Width

- Nine feet is the absolute minimum width allowed for a shared use trail and is only recommended for low-volume Neighborhood Trails. AASHTO requirements for trails receiving federal funding is 10 feet minimum.
- Ten feet is recommended in most situations and is adequate for moderate to heavy use.
- Twelve feet (and in very heavy trail use, 14 feet or more) is recommended for situations with high concentrations of multiple users. A separate track (5 feet minimum) can be provided for pedestrian use where right-of-way permits.

Lateral Clearance

- A 2-foot minimum shoulder on both sides of the trail should be provided for all trails. Use 6 feet of shoulder in fill sections and 3 feet of shoulder in cut sections.
- The use of bollards is generally discouraged. 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 and spaced adequately. Consider alternative design elements to control trail entry.



Typical cross section of a paved trail.

Overhead Clearance

- Clearance to overhead obstructions should be 8 feet minimum, with 10 feet recommended.
- Convex mirrors should be provided at blind corners and at the approaches to underpasses with poor sight lines.

Striping

- Striping should be used on trails with anticipated heavy use or with high concentrations of multiple users.
- See the Pavement Markings guideline in this document for more information.

Surface Grade

- Trails should be designed to comply with ADAAG standards when possible (see Accessible Trail Design guideline section for more information).
- Provide a 2 percent cross slope from crown of trail in both directions to provide positive drainage off the trail as conditions allow.
- Provide a 48 inch safety rail for the following circumstances within 6 feet of the edge of pavement:
  - Slope is greater than or equal to 3:1 and drop of 6 feet
  - Slope is greater than or equal to 2:1 and drop of 4 feet
  - Slope is greater than or equal to 1:1 and drop of 1 foot

Materials

- Asphalt is a common surface for trails, offering substantial durability for the cost of installation and maintenance.
- It is recommended that concrete be used for its superior durability and lower maintenance requirements, specifically in areas prone to frequent flooding, since the hardness and jarring of this surface is not preferred by runners or cyclists. Saw-cut concrete joints rather than troweled improve user experience.
- Proper trail foundation will increase the longevity of the trail. Two inches of surfacing material over 6 inches of base course gravel over geotextile fabric is recommended.

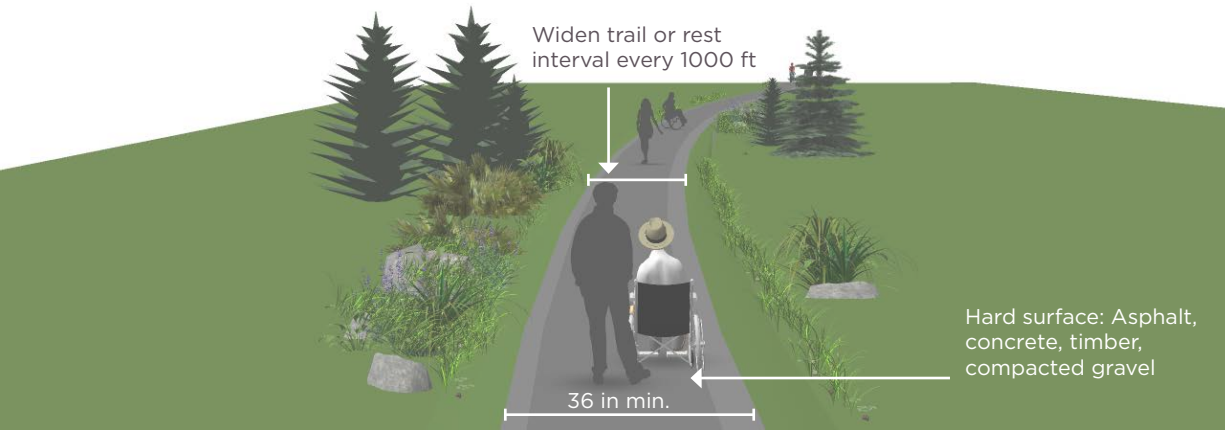
Swamp Rabbit Trail along the Reedy River in Greenville, NC

Accessible Trail Design

The United States Access Board has approved American with Disabilities Act Accessibility Guidelines (ADAAG) for trails and outdoor recreational access routes. Constructing trails may have limitations that make meeting ADAAG and AASHTO guidelines difficult and sometimes prohibitive. Prohibitive impacts include harm to significant cultural or natural resources; a significant change in the intended purpose of the trail; requirements of construction methods that are against federal, state, or local regulations; or terrain characteristics that prevent compliance.

GUIDANCE

- Surface: Hardened surface such as asphalt, concrete, timber, compacted gravel
- Clear tread width (pedestrian-only): 36 inches minimum for low-volume, pedestrian-only facilities
- Clear tread width (multi-use): 10 feet minimum
- Tread Obstacles: 2 inches high maximum (up to 3 inches high where running and cross slopes are 5 percent or less)



- Cross Slope: 5 percent maximum
- Longitudinal slope must meets one or more of the following:
  - Five percent or less for any distance
  - Up to 8.33 percent for 200 feet max with resting intervals no less than 5 feet long and equal to the width of the trail at both ends.
  - Up to 10 percent for 30 feet max with resting intervals no less than 5 feet long and equal to the width of the trail at both ends.
  - Up to 12.5 percent for 10 feet max with resting intervals no less than 5 feet long and equal to the width of the trail at both ends.
  - NOTE: If resting intervals are not located within the trail tread, adjacent resting interval clear widths must be 3 feet minimum.
- No more than 30 percent of the total trail length may exceed a running slope of 8.33 percent.
- Passing Space: provided at least every 1,000 feet where trail width is less than 60 inches.
- Signs: shall be provided indicating the length of the accessible trail segment.
- Detectable pavement changes at curb ramp approaches should be placed at the top of ramps before entering roadways.
- Trailhead signage should provide accessibility information, such as trail gradient/profile, distances, tread conditions, location of drinking fountains, and rest stops.
- Provide one accessible parking space per every 25 vehicle spaces at trailheads.
- Trail amenities, drinking fountains, and pedestrian-actuated push buttons should be placed no higher than 4 feet off the ground.

Crime Prevention Through Environmental Design (CPTED) Principles for Trails

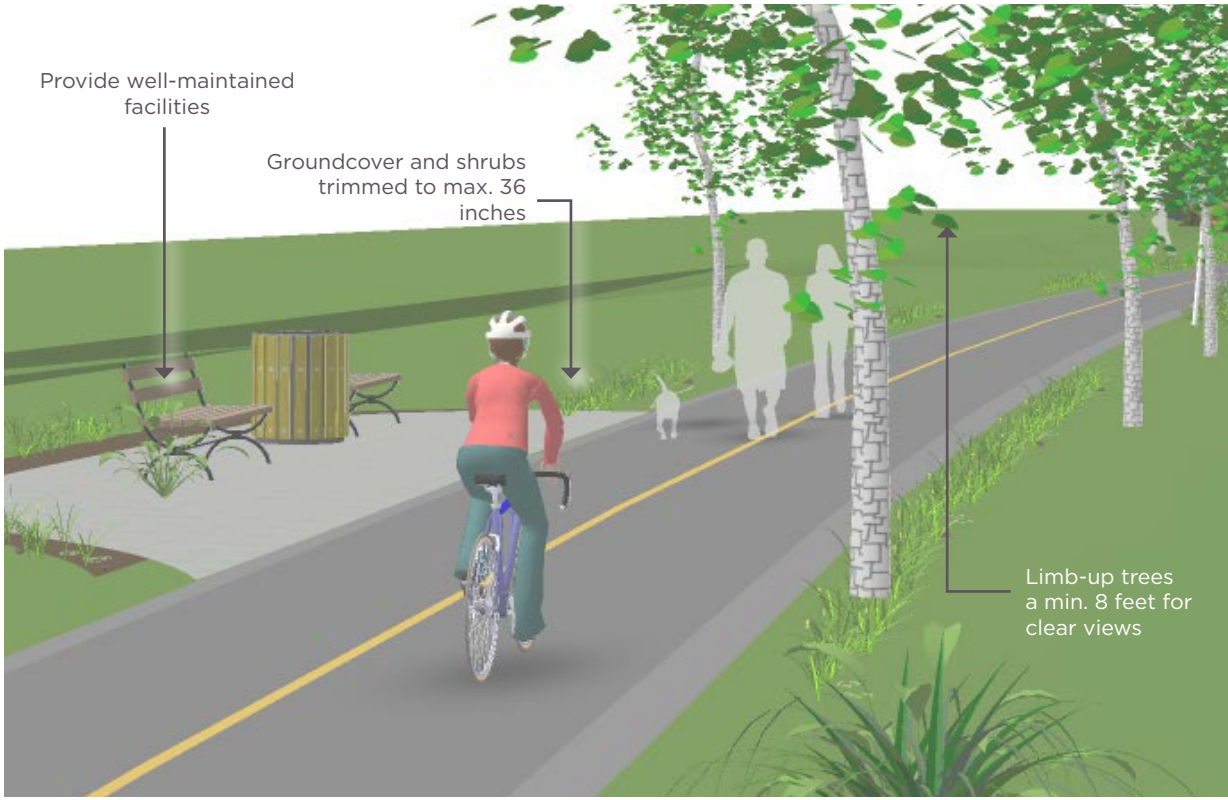
Personal safety, both real and perceived, heavily influences a trail user's decision to use a facility and a community's decision to embrace the trail system. Proper design must address both the perceived safety issues (i.e., feeling safe or fear of crime) and actual safety threats (i.e., infrastructure failure and criminal acts). CPTED is a proactive approach to deterring undesired behavior in neighborhoods and communities. When all spaces have a defined use and the use is clearly legible in the landscape, it is easier to identify undesired behavior.

- Principle #1: Natural Surveillance
- Principle #2: Natural Access Control
- Principle #3: Territorial Reinforcement
- Principle #4: Maintenance

Apply CPTED guidelines to trail facilities, management features, and amenities when appropriate.

GUIDANCE

- Where feasible, fencing installed along trails should not obstruct the view of trail users.
- Where the trail is fenced for long stretches, intermittent openings should be located to allow users to enter and exit the trail. Access points to the trail should be at locations with good visibility from the surrounding neighbors.
- Trail signage should include the contact number to report graffiti, suspicious behavior, and maintenance issues (e.g., "Immediately report any observed graffiti to 911").



- All groundcover and shrubs along trails should be trimmed to a maximum height of 36 inches above ground level.
- Trees should be limbed-up to provide a minimum of 8 feet of vertical clearance over the trail within the trail corridor.
- Tree canopies should not obstruct pathway illumination.
- Hostile native landscaping material (e.g., vegetation with thorns) can be used in strategic areas to discourage unauthorized use and eliminate entrapment areas.

- Add anti-graffiti application to retaining walls, where appropriate.
- Where lighting is installed on trails, the illumination should:
  - Be adequate to identify a face up to 20 yards away.
  - Have full cut-off fixtures to reduce light pollution.
  - Provide uniform coverage, eliminating dark pockets.
  - Provide good color rendition.
  - Not be obstructed by tree canopies.
- The use of metal halide or light emitting diode (LED) lamps are recommended, as they provide excellent color rendition. Color rendition is especially important when describing identifying features such as hair, clothing, and vehicle color. Light quality is as important as the quantity. Poor lighting, whether too bright or not bright enough, can diminish safety.
- Lighting should respond to the conditions of the site and meet the minimum standards set forth by the Illuminating Engineering Society of North America (IESNA).

Riparian Trails

Depending on the width of the floodplain area, riparian corridors often offer substantial recreational and open space preservation opportunities. These corridors include rivers and streams, drainage facilities, and wetlands (where environmentally feasible). All trails constructed within riparian corridors in the Flyway Trail study area should be studied for stormwater impacts, wildlife habitat impacts, and floodplain development impacts.

GUIDANCE

- Trails in riparian corridors should meet or exceed General Design Practices indicated previously due to their sensitive nature and generally poorly-drained and wet periods of the year.
- Confirm local and current watershed buffer rules to determine acceptable uses and buffer widths.
- All trails within floodplain areas will require adequate environmental permits from local floodplain administrators. Confirm current requirements with stormwater staff when designing riparian trails.

Routing and Alignment

- Where possible, trails should follow the contours.
- Avoid constructing trails along fall lines, which are prone to erosion and generally cannot be maintained over time.
- Trails through wetlands should be avoided if possible. If wetlands must be crossed, choose the narrowest point.
- Construction of trails immediately adjacent to or abutting streambanks should be avoided to the greatest degree possible. Construct all trails at the maximum distance from streams as is practical.
- Include consideration of stream restoration potential where feasible. Stream restoration projects commonly involve considerable reshaping of the floodplain to reduce bank angles and heights to allow the stream to access its floodplain.

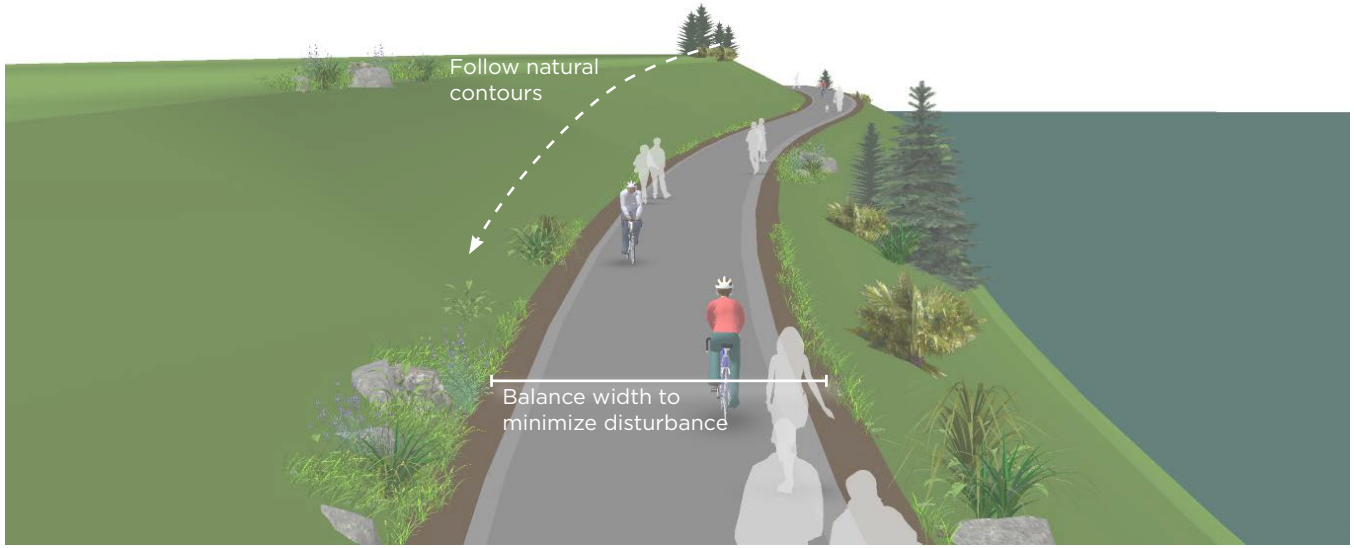
Access Points

- Any access point to the trail should be well-defined with appropriate signage designating the corridor as a shared-use trail and prohibiting motor vehicles.

- Design logical points of interest to avoid informal "social" trails that follow poorly executed routes and trample floodplain vegetation or sensitive areas.

Materials and Management

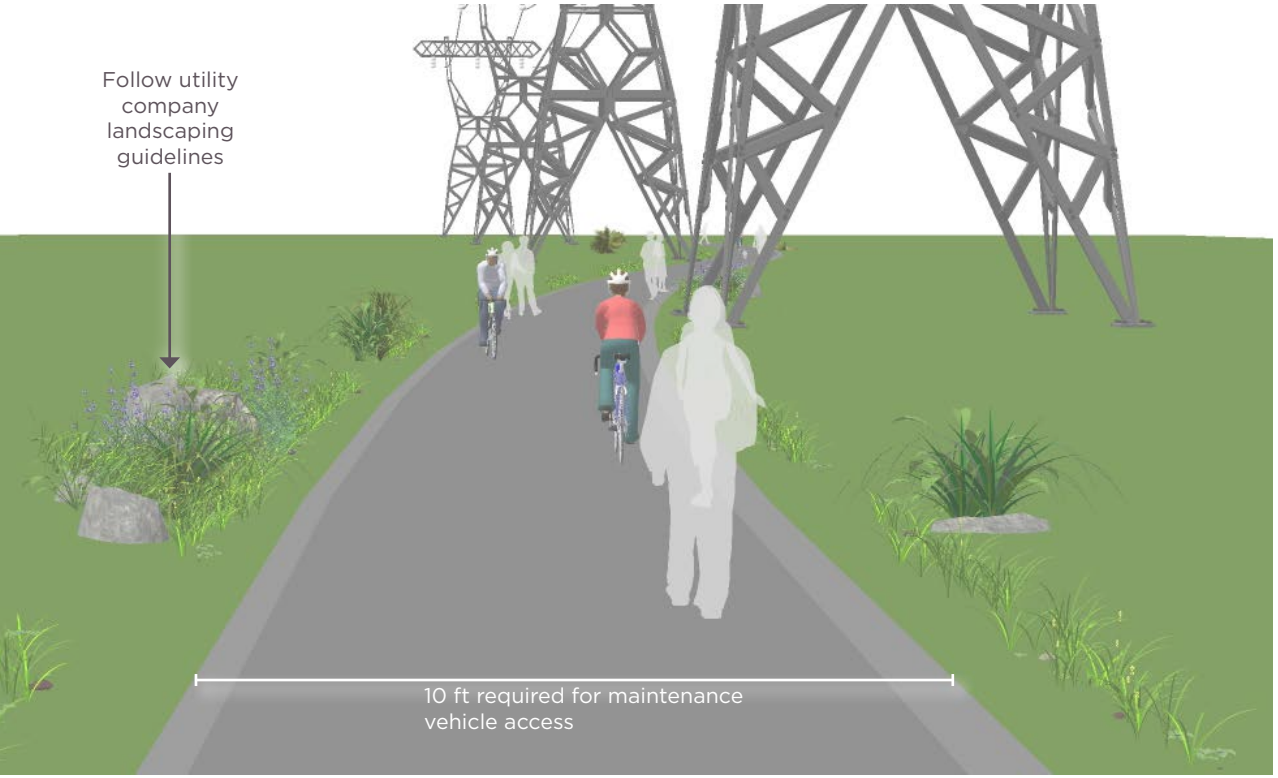
- Concrete is the recommended surface treatment for trails prone to flooding due to its superior durability and lower maintenance requirements.
- Permeable paving is not recommended in floodplain areas or areas without proper drainage. Sheet flow and sediment transport clogs pores and requires vacuuming after all storm events.
- Where wetlands are present, use elevated tread materials (such as timber boardwalk) to preserve these fragile ecosystems.
- Do not use gravel or crushed stone fines in riparian areas prone to flooding. These materials have very low cohesiveness and erode easily. They can also contribute to sediment in streams.
- Use natural dispersed infiltration systems such as vegetated swales to manage stormwater.



Typical cross section of a paved trail along a riparian corridor.

Trails in Utility Corridors

Existing man-made corridors may be able to simultaneously serve the needs of trail users. Underground utilities such as water, sewer, natural gas, or buried electric or optic lines can accommodate trails as well as above-ground utilities such as telephone, cable, or overhead electric. Utility companies benefit from this arrangement by having uninterrupted, easily accessible route to their utility service.



GUIDANCE

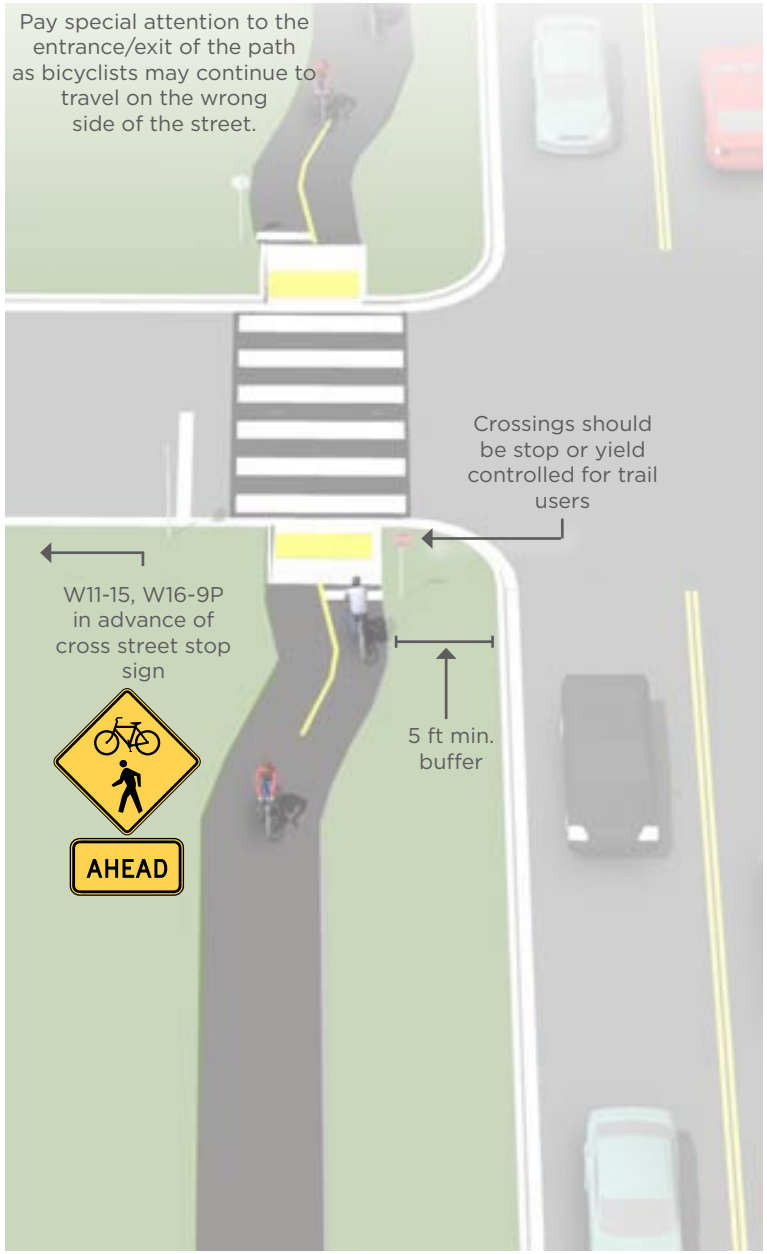
- Utility companies require specific design guidelines, routing and alignment, and landscaping limitations.
- Ten feet of width is required if motor vehicles will be accessing the trail for maintenance purposes.
- In sewer easements, the edge of trail should be at least 10 feet from manhole rims, where possible.
- All trails require acquisition of an easement from the current fee simple title owner of the land.
- Some utilities have trail width limitations within their rights-of-way. When designing trails in utility corridors, confirm current guidelines widths with each utility.
- In many cases, physical barriers are required at access points to deter motor vehicles. When used, barriers should be out of the path of travel and clear minimum openings should be maintained. Consider separate access point for motor vehicles.
- For electrical utility corridors, a minimum separation of 25 feet is required between the trail and any associated electrical equipment (such as guy wires, power poles, and towers).
- Culverts and vegetation must be installed per the utility's specifications.
- Structures are typically restricted within utility easements. Structures include signage, lighting, and benches.
- Review each utility's policy and construction specifications for repair, maintenance, access, and corridor maintenance requirements.
- User expectations will be similar to other trails. However trails in utility corridors may be restricted to the conditions listed above and closed at certain times when utility repairs are necessary.

Trails in Roadway Corridors

Sometimes referred to as "sidepaths," these trails provide more comfortable widths than sidewalks and can accommodate multiple users when designed adequately.

GUIDANCE

- This configuration works best along roadways with limited driveway crossings and with services primarily located on one side of the roadway, or along a riverfront or other natural feature. It is not recommended in areas with frequent driveways or cross streets.
- A minimum width of 10 feet is necessary for bicyclists to pass other users safely on sidepaths.
- A 5-foot wide or greater vegetated buffer between the sidepath and the roadway should be provided.
- At driveway entrances and other roadway crossings, appropriate regulatory and wayfinding signage and crossing treatments should be provided.
- Sidepath should be yield controlled, not stop controlled, at driveway crossings and low-volume street crossings.
- In some cases, sidepaths will transition to sidewalks or designated bicycle lanes. In the event that sidepaths merge onto streets, provide appropriate signage and pavement markings to help safe merging.
- Trails constructed within roadway ROW will likely require an encroachment permit from WisDOT. Check with WisDOT for ROW limitations regarding the following:
  - Structures, such as retaining walls and bridges
  - Clear recovery zone from the edge of a roadway travel land to the edge of a trail that is in ROW. Will depend on Average Daily Traffic (ADT)
  - Stormwater treatment and vegetation



Barrier-Separated Sidepaths

When space is constrained or improved user comfort is desired, shared use paths adjacent to roadways (sidepaths) may be barrier separated from the adjacent travel lanes.

Barriers, while needed in tight spaces, can narrow both roadway and path, create hazards, and should be used with caution and close attention to design.

GUIDANCE

- For use on streets with less than 5 feet of natural surface separation between the roadway and the sidepath. Paved shoulders should not be included in the separation distance measurement.
- For use on streets with high speeds (>45 mph) and/or high volumes of motor vehicles, where a robust form of physical separation is preferred.
- On streets lacking curb and gutter.
- Barriers should meet minimum height requirements of a standard guardrail (28 to 32 inches). On high speed highways (≥ 45 mph), a crash-worthy barrier should be used.
- Provide 2 feet of shy distance from the barrier to preserve preferred operating dimensions for bicyclists.
- When curbs are present in high speed conditions (> 40 mph), guardrails should be placed flush with the face of curb. Curb face should be 100 mm or shorter with a sloping face curb (AASHTO type C or G).
- In highly constrained conditions lacking room for a barrier, the path may be raised with a vertical curb, or striped with rumble strips.
- Barriers may be constructed of steel or timber.
- Guardrail need not be of size and strength to redirect vehicles, unless high speeds or other conditions indicate the need for crash worthy barrier.

Trails Accommodating Equestrian Use

Horse riding is a popular recreational activity in Buffalo County, and the accommodation of equestrian trail users along the Flyway Trail can diversify recreational activities along the study area corridor and support spending at local businesses in Buffalo County. While bicycling and equestrian use have been successfully integrated on many trails throughout the United States, additional design considerations are necessary to reduce conflict and support a positive experience for all users. General design principles to mitigate conflict include the maintenance of adequate sight lines, signing to clarify appropriate passing techniques and yielding responsibilities, and, in some cases, the provision of a separate bridle path.

Additionally, trail surface is an important factor dictating equestrian use. While most road and touring cyclists prefer the smooth surface of a paved trail, horses and mules prefer a soft surface. As such, many paved trails that lack wide shoulders or clearance are unsuitable for equestrian activity.

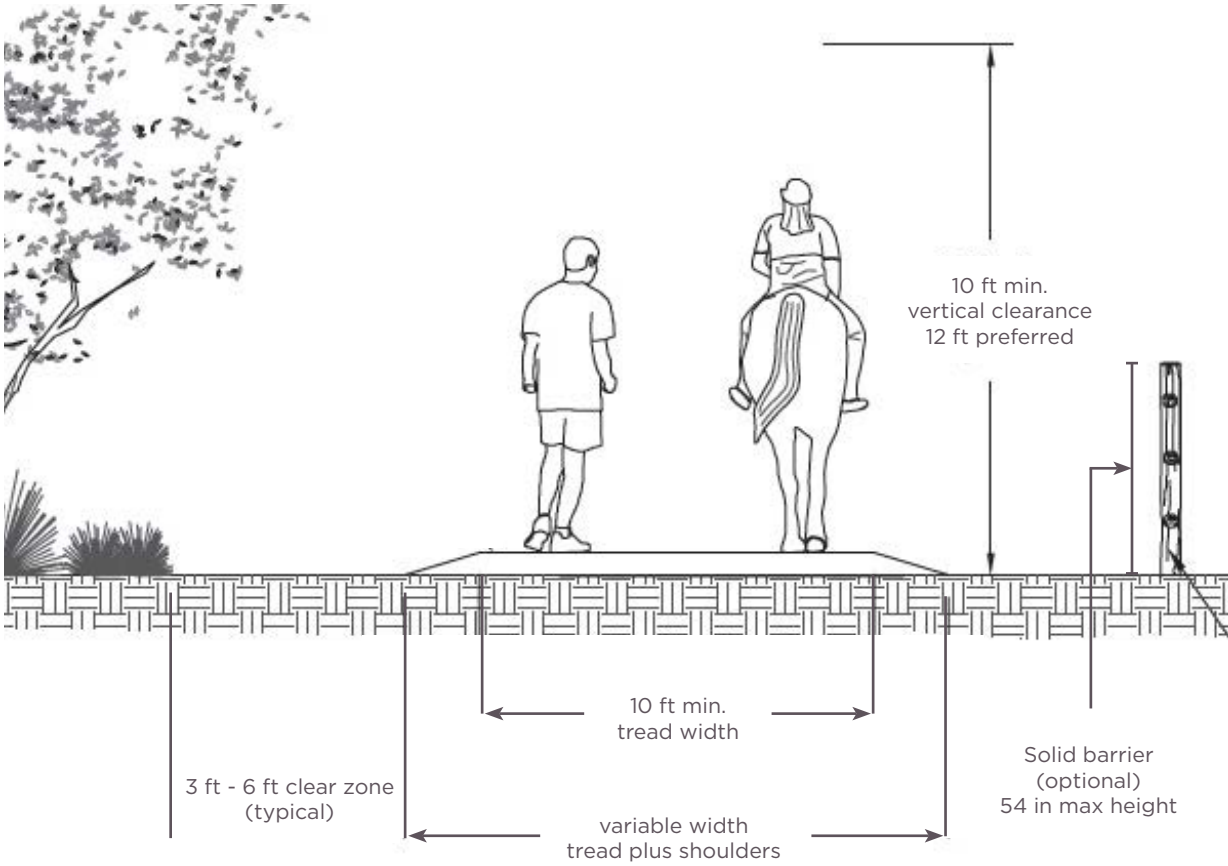
Shared-use paths that support equestrian activity can be divided into two categories: single-tread trails and dual-tread trails.

Single-Tread Trails

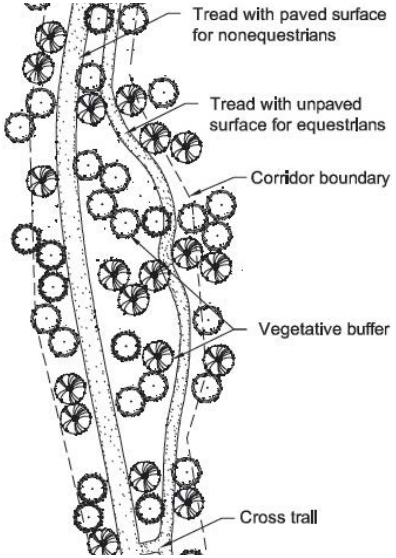
Single-tread trails allow all trail users to share the same space and are generally preferred where trail user volumes and potential conflicts are low. Single-tread trails are suitable for equestrian use and pedestrians but are not recommended for equestrian use and bicyclists.

GUIDANCE

- Minimum 10 foot width for shared single tread surface.
- Provide minimum 10 foot vertical clearance (12 foot clearance preferred).
- Fencing and other solid vertical barriers adjacent to the trail should be no more than 54 inches tall.
- Provide signage to impart proper passing techniques and yielding responsibilities.
- Provide 3 to 6 feet of clear zone between tread and adjacent vegetation and/or barrier.



Source: Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds



Vegetative buffers and a meandering bridlepath alignment can provide an attractive facility where moderate right-of-way is available. (Source: Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds)

Dual-Tread Trails

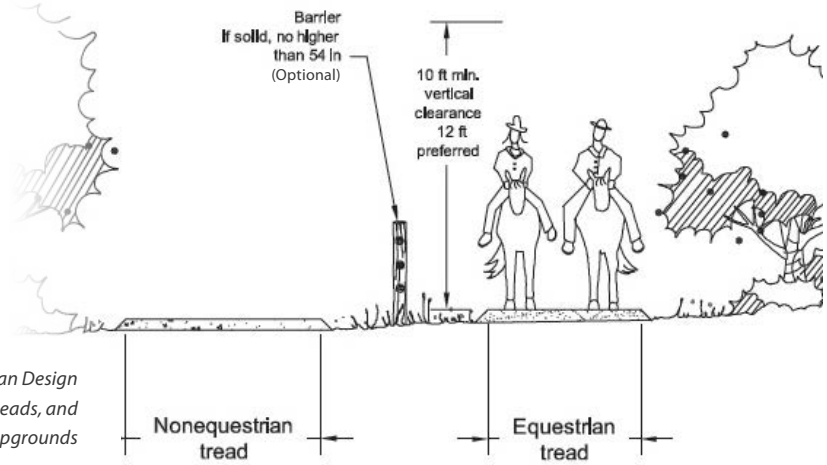
Dual-tread trails consist of two trail surfaces—one of bicyclists, and one for equestrian use—separated by landscaping and/or a vertical barrier. Dual-tread trails are preferred to single-tread trails when bicyclists are permitted to use the trail. Treads are typically separated by landscaping or a physical barrier such as a fence or wall. Vertical separation should still allow the horse and rider to see the adjacent trail and its users, thereby reducing the potential of startling the horse.

For constrained conditions in which there is not enough width to provide landscaping or vertical separation (with necessary clear zone), a 3 foot shoulder can provide separation between the treads and support various user types.

GUIDANCE

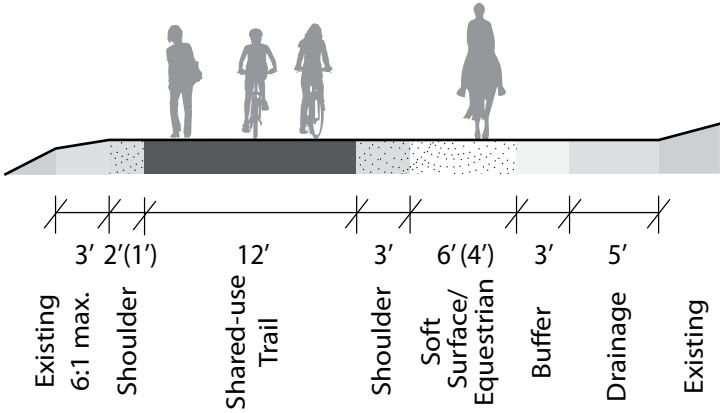
- Provide minimum 10 feet of vertical clearance (12 feet preferred).
- Fencing and other solid vertical barriers adjacent to the trail should be no more than 54 inches tall.
- Provide 3 to 6 feet of clear zone between tread and adjacent vegetation and/or barrier.

Typical Conditions



Source: Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds

Constrained Conditions



Trail Management Features

There are certain trail management needs that may be considered depending on the context. Some trails require management features to enhance user experience, provide privacy and security to adjacent property owners, or to sustain the life span of the trail.

Access Management

Trailheads

Trailheads provide essential access to a trail system and can include many amenities in one location: automobile parking, bicycle parking, comfort stations, drinking fountains, trash and recycle receptacles, dog waste stations, bicycle repair stations, and trail wayfinding and informational signage.

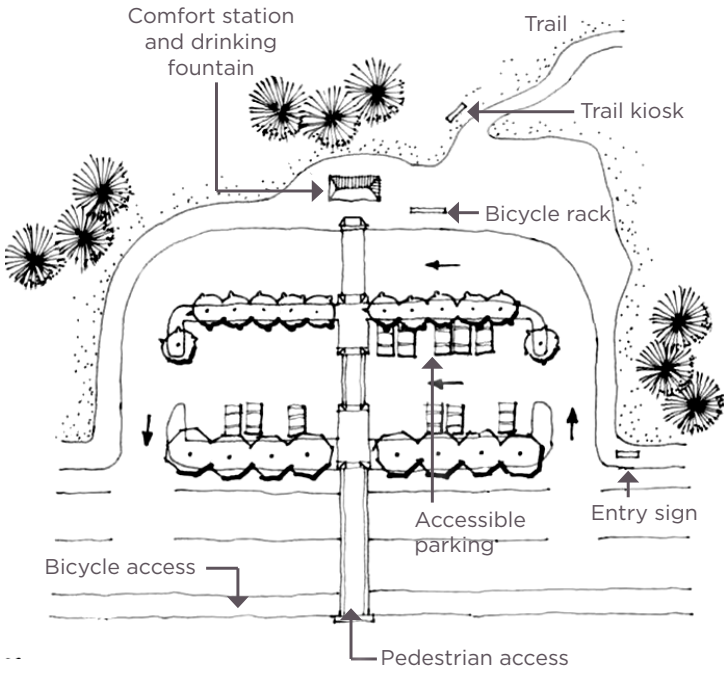
There is no prescription for the frequency of trailheads. Conduct user counts, vehicle counts, and surveys across the trail network at peak hours of use to determine parking demand. Consider locating trailheads with consideration to other available public facilities or through partnerships with owners of existing parking areas. When locating trailheads in or adjacent to neighborhoods streets, work with property owners to install "No Parking" signs if desired, and to minimize impacts during construction and daily use.

Major Trailheads

Major trailheads should be established near large residential developments, commercial developments, and transportation nodes, making them highly accessible to the surrounding community and to the trail system. A major trailhead could include all of the items mentioned previously plus additional facilities, such as shelters, picnic areas, and more extensive parking.

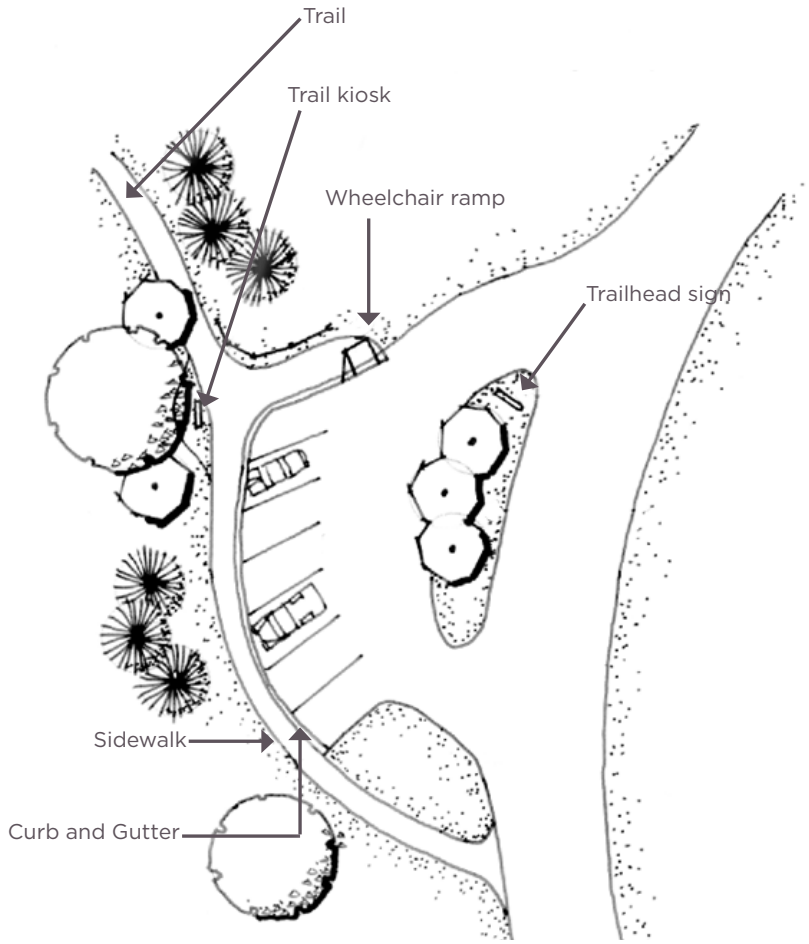
GUIDANCE

- Major trailheads can provide parking for ten to forty vehicles, depending on availability of land and anticipated level of use of the trail.
- Consider 300 to 350 square feet for each parking space.
- Major trailheads will typically have a large paved parking lot that accommodate passenger vehicles and large vehicles year round. Consider locating larger lots in existing disturbed areas to minimize environmental impacts.
- Major trailheads should provide emergency and maintenance vehicle access and turnaround.



Major Trailhead

- Place ADA accessible parking spaces near the site's accessible route, at a rate of one accessible space per twenty-five standard spaces. Parking spaces and access aisles should not exceed 2 percent slope in any direction.
- Parking lot surfaces should never exceed 5 percent slope in any direction.
- Where major trailheads are located near neighborhoods, provide user access from local streets crossing the trail. Where trails cross neighborhood streets, "No Parking" signs may be desirable to minimize impact on the neighborhood.
- Reduce the visual intrusion of large parking areas by using vegetative screening.
- Consider one-way vehicle circulation within parking areas to minimize road width.
- Refer to current setbacks and other requirements within local regulations.



Minor Trailhead

Minor Trailheads

Minor trailheads are trail access points with very minimal infrastructure. They can occur at parks and residential developments. Some minor trailheads could include a small parking lot for five to six passenger vehicles. In addition to vehicle parking, minor trailheads may include drinking fountains, benches, trash and recycling receptacles, an information kiosk, and signage about the trail network.

GUIDANCE

- Minor trailheads can provide parking for up to ten vehicles. The parking area may be asphalt or gravel, as long as ADA requirements are met.
- Minor trailheads should provide emergency and maintenance vehicle access.
- Minor trailheads should be ADA accessible and provide at least one accessible space near the accessible route.
- Provide adjacent wayfinding signage that directs trail users to minor trailheads.

Trail Edge Definition

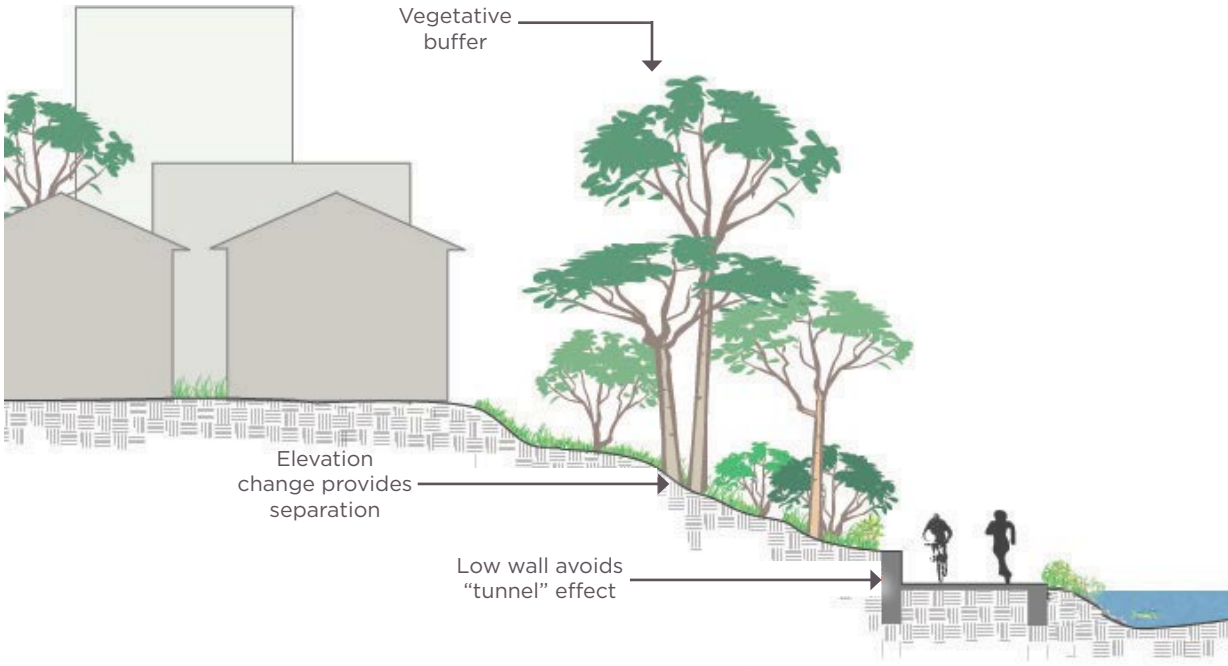
Vegetation, topography, ditches, fencing, railings, or walls may be used to clearly mark trail edges. Such features serve multiple purposes, including:

- Providing visual separation/privacy screens
- Delineating public space from private property adjacent to the trail
- Discouraging the development of unauthorized foot trails
- Separating users from hazardous drop-offs or adjacent non-compatible land use

Wildlife passage and safety for trail users are important factors in determining appropriate trail edge treatments. Although the public often perceives fencing as a means of providing safety by prevention of unwanted access, fencing that blocks visual access completely can have the opposite effect by impairing informal trail surveillance (see CPTED guidelines for more information).

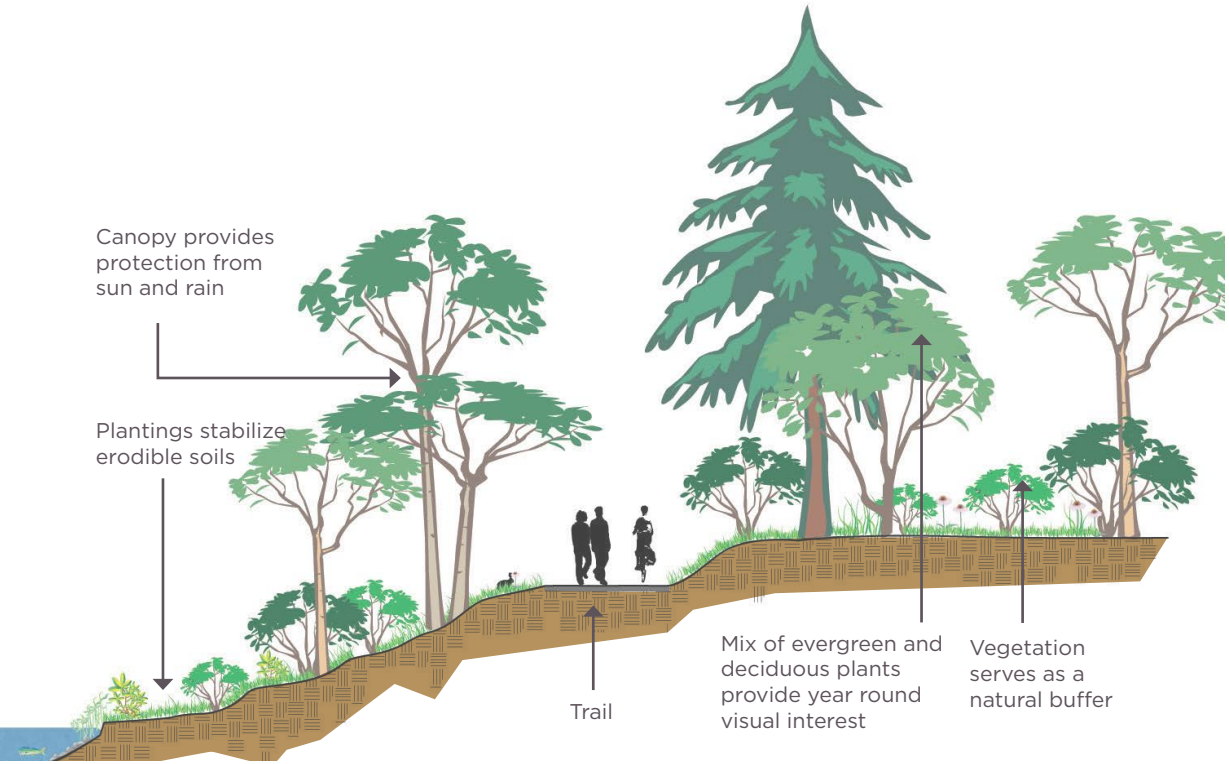
GUIDANCE

- If separation is desired purely for privacy reasons, native vegetation buffers or the use of topography are recommended where possible.
- For physical separation aimed at preventing trespassing or guarding against hazardous slopes, consider the use of topography, ditches, semi-transparent fencing or railings, and hostile vegetation.
- Fencing should strike a balance between adjacent residents' privacy and informal surveillance of the trail. Permeable fencing of 4 feet tall or less can provide a barrier sufficient to denote property boundaries or to deter most access. Opaque fencing or walls can degrade the experience of trail users, obscure views, and create a "tunnel" effect that creates the effect of users feeling "trapped."
- Railings on bridges, boardwalks, and at the edges of steep slopes should be provided. For more information, see the Fencing and Railings guideline.



Vegetative Screening

The presence or absence of vegetation and the type of vegetation present in a trail corridor affects habitat quality, the trail's effectiveness as a wildlife corridor, ecological sustainability, and the aesthetic experience for the trail user. Trails are more effective at providing wildlife habitat and corridors when they have native trees and shrubs present. Trees and shrubs can also shade users from sun and shelter users from rain. When possible, protecting, preserving, and maintaining existing native vegetation when constructing trails through riparian corridors is the first choice for creating separation between the trail and adjacent properties. Vegetative buffers create a natural privacy screen, provide habitat for wildlife, and stabilize erodible soils.



GUIDANCE

- In locations where trees and shrubs are lacking and can be planted, native species are the most ecologically sustainable choice. As a group, native species require less maintenance than horticultural plantings and often provide wildlife with a food source.
- To achieve an open line of sight, groundcover and shrub height should be a maximum of 24 inches above ground level.
- Topography and soil moisture regime largely determine where different plant species occur.
- Tree canopies should not obstruct trail illumination.
- Select and place trail vegetation to provide seasonal comfort: shade in the warmer months and sunlight in colder months.
- Select native landscaping material that can deter users from using unauthorized foot trails, access points, or exits (e.g., vegetation with thorns).
- Follow CPTED requirements.

Maintenance and Establishment

- Larger plants require more water to survive than seeds and smaller plants. Plant seeds and/or plants either right before or during the rainy season to take advantage of seasonal rainfall (spring and fall).
- Remove all competing invasive vegetation and or mulch regularly to conserve water.
- Trees should be trimmed to provide a minimum of 8 feet of vertical clearance within trail circulation.
- Fertilizing native plants is only necessary in extreme cases when the condition of the soil is in need of repair.

Shared-Use Path Entry Control

A variety of physical barriers and design strategies are employed to restrict motor vehicle access to trails. The most prevalent of these physical barriers is the bollard post. Despite its prevalence, the bollard presents numerous safety hazards to trail users. Common design characteristics leading to crash hazards include:

- Inconsistent and unpredictable placement and usage
- Broken fold-down posts often do not fold back up
- Removable posts often lack flush sleeves
- Removable posts often include chains to prevent theft
- Damaged and broken posts can protrude from the trail surface

For these reasons, bollards should be discouraged within the path of travel. Alternative design strategies to control shared-use path entry signage, landscaping, and curb cut design to reduce the likelihood of motor vehicle access. A three-step design process should begin with signage, then approach design, and finally barriers. Physical barriers should only be considered when other measures do not adequately control unauthorized vehicles or where the danger posed by unauthorized vehicles exceeds the safety risks to trail users by the barriers themselves.

GUIDANCE

- Install signs identifying path and prohibiting vehicle entry.
- "No Motor Vehicles" signage (MUTCD R5-3) may be used to reinforce access rules.
- Split tread into two sections in advance of the crossing to discourage motor vehicle access.
- Vertical curb cuts should be used to discourage motor vehicle access.
- Use barriers only if vehicle entry risks exceed barrier risks to trail users.
- Removable barriers should leave a flush surface.
- Barriers should be permanently reflective for nighttime visibility and bright in color for daytime visibility.
- Barriers should provide 5 feet clearance from face to face.
- If possible, provide separate access for authorized motor vehicles.
- Consider targeted surveillance and enforcement at specific intrusion locations.

Environmental Management:
Drainage and Erosion Control

Drainage and erosion control is necessary to maintain a stable trail system and low-maintenance facility. Excessive soil erosion near a trail is usually the result of water collecting and flowing along the trail edge or onto the surface with enough volume and velocity to carry away soil. This results in a degraded trail area and potential impacts to adjacent or downstream water resources. When managing stormwater along all trails, use dispersed infiltration systems such as vegetated swales, over engineered stormwater control structures such as storm drains, and catch basins for reduced maintenance and improved aesthetic.

GUIDANCE

Paved Surfaces:

- A 2 percent cross slope will resolve most drainage issues on a paved trail and should be used for both the tread and its shoulders. A maximum 1:6 slope is used for the shoulders, although 2 percent is preferred. For sections of cut where uphill water is collected in a ditch and directed to a catch basin, water should be directed under the trail in a drainage pipe of suitable dimensions.
- Following land contours helps reduce erosion problems, minimizes maintenance, and increases comfort levels..
- Provide low groundcover vegetation up to the edge of the trail to prevent erosion on shoulders.

Example of a silt sock controlling drainage along a riparian trail corridor

Natural Surfaces:

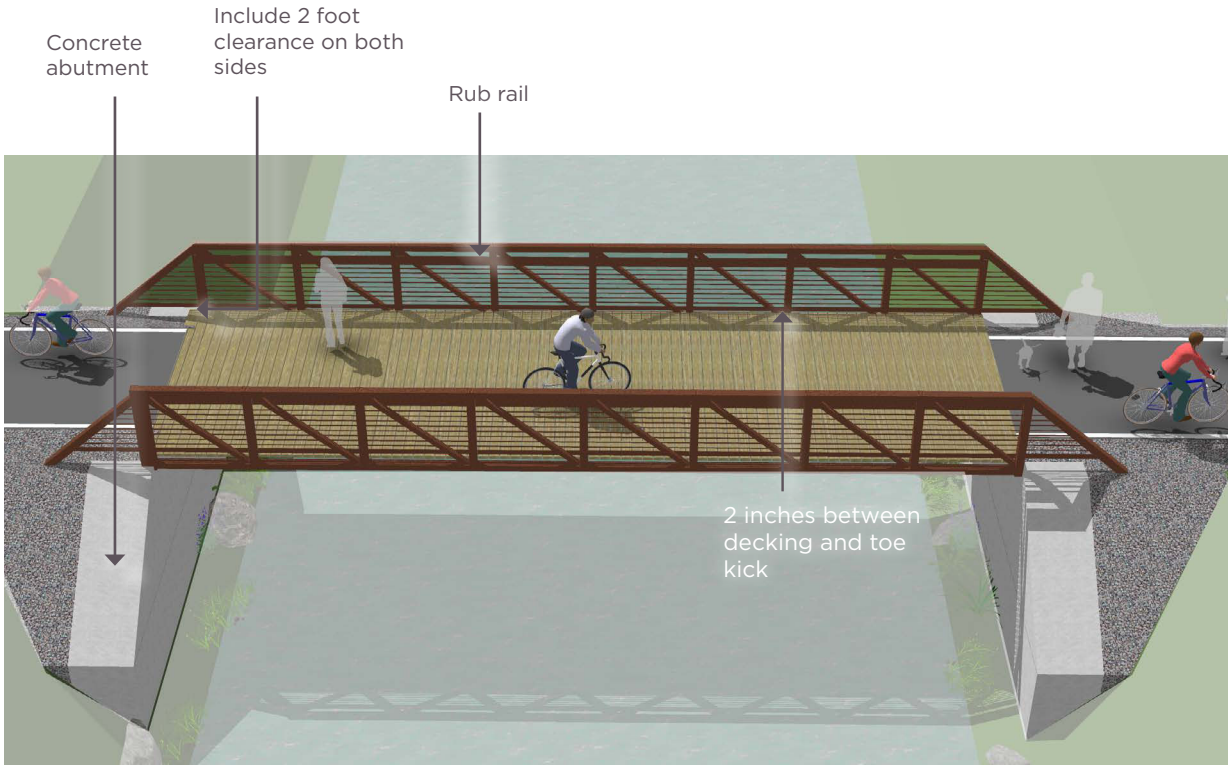
- Erosion will occur on natural surface trails. Natural surface trails should be designed to accommodate erosion by shaping the tread to limit how much erosion occurs and to maintain a stable walkway and tread. The goal is to outslope the trail so that water sheets across, instead of down, its tread.
- Contour trails are also outsloped 5 percent from the face of the ridge to aid in sheeting water off the trail during rain events. These trails disperse and shed water in a non-erosive manner.
- Avoid fall line trails when possible.
- Designing trails with rolling grades is the preferred way to build sustainable natural surface trails. “Rolling grade” describes the series of dips, crests, climbs, and drainage crossings linked in response to the existing landforms on the site to form a sustainable trail.
- Frequent grade reversals (grade dips, grade brakes, drain dips, or rolling dips) are a critical element for controlling erosion on sustainable trails. A general rule-of-thumb is to incorporate a grade reversal every 20 to 50 linear feet along the trail to divide the trail into smaller watersheds so the drainage characteristics from one section will not affect another section.

Boardwalks and Bridges

Boardwalks and bridges are structures that cross over sensitive natural or inundated areas while limiting the potential for environmental impact. They are typically used when crossing small creeks and wetlands. Boardwalks range in length and can span as little as 10 feet or stretch for longer distances depending on site conditions. Bridges are used where greater span lengths are required and when the objective is to reduce base flood elevations. Boardwalks are usually constructed of timber, concrete, or recycled plastic decking. Recycled systems such as Trex® are popular for their material durability; however, they have structural limitations. Modular concrete boardwalk systems are gaining popularity due to their low-impact installation methods and durability within wet areas. Permatrak™ is a system being used in some communities in the state and by the National Park Service.

GUIDANCE

- Boardwalk clear span width should be a minimum of 10 feet when no rail is used. A 12 foot width is preferred in areas with higher anticipated use and whenever railings are used.
- A 6 inch curb rail is recommended; however, a 42 inch guardrail is required at locations where there is a 30 inch or greater difference in the low water bridge elevation and the ground elevation below. Maximum opening between railing posts is 4 inches.
- Boardwalks should be designed to structurally support 5 tons of capacity.
- Evaluation of boardwalk footings should include uplift as well as loading consideration for flood events.
- Consult a structural engineer for member sizing and post footing design. The foundation normally consists of marine-grade timber posts or auger piers (screw anchors). Screw anchors provide greater support and durability.
- Give careful consideration to minimize slippery decking surfaces following storm events. A topcoat of non-skid paint, sandy compounds, or a light asphalt overlay can be effective on timber decking. Concrete is the most reliable non-skid surface.
- Local, state, and federal permits will be required where a boardwalk is located within wetlands. Any construction in wetlands is subject to regulations and should be avoided.

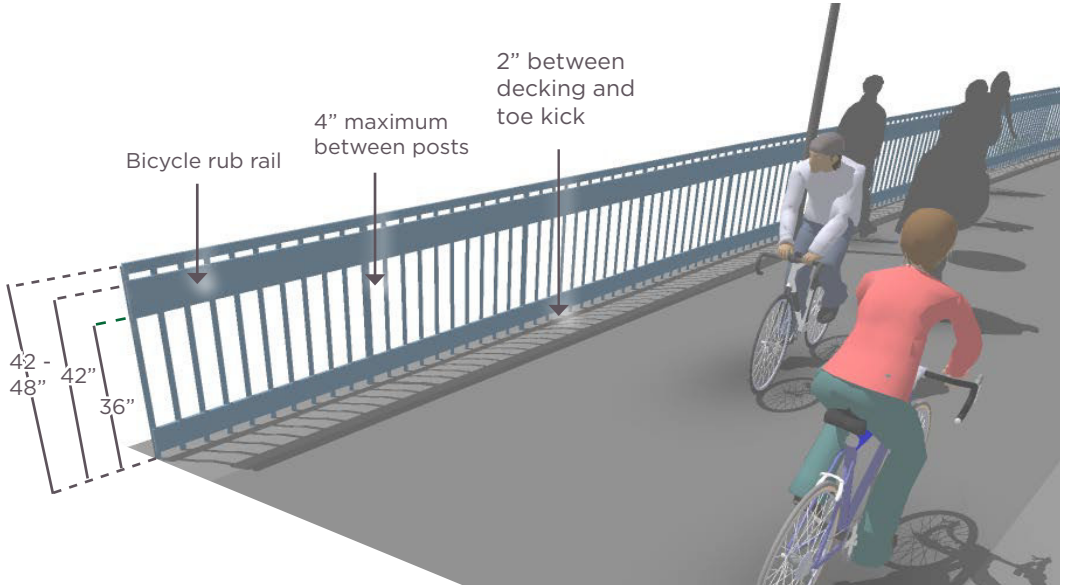


Safety Management: Fencing and Railings

Railing and fences are important features on bridges, some boardwalks, or in areas where there may be a hazardous drop-off or incompatible adjacent land uses.

GUIDANCE

- At a minimum, railings and fences should consist of a vertical top, bottom, and middle rail. Picket style fencing should be avoided as it presents a safety hazard for bicyclists.
- Railings should be at least 42 inches above the finished grade, and up to 48 inches where more hazardous conditions exist, such as a bridge over a highway.
- Openings between horizontal or vertical members on railings should be small enough that a 6 inch sphere cannot pass through in the lower 27 inches. For the portion of railing higher than 27 inches, openings may be spaced such that an 8 inch sphere cannot pass through.
- Use durable fencing and railing materials, such as vinyl or recycled plastic, for reduced maintenance and sustainability.
- The middle railing functions as a "rub rail" for bicyclists and should be located 33 to 36 inches above the finished grade.
- Local, state, and/or federal regulations and building codes should be consulted to determine when it is appropriate to install a railing and comply with current standards.



Trail Intersections

Overview

At-grade roadway crossings can create potential conflicts between trail users and motorists; however, well-designed crossings can mitigate many operational issues and provide a higher degree of safety and comfort for users. In most cases, at-grade trail crossings can be properly designed to provide a reasonable degree of safety and can meet existing traffic and safety standards. Generally speaking, trail facilities for bicyclists require additional considerations due to the higher travel speed of bicyclists versus other trail users.

Special consideration must be given when delineating at-grade trail crossings. The sign types, pavement markings, and treatments will vary based on the roadway type the trail crosses. Proper signage and pavement markings alerting trail users of at-grade crossings must also be utilized. Care must be taken not to place too many signs at crossings lest they begin to lose their visual impact. The appropriate department within the respective state, county, or local government entity should be consulted prior to design and installation of roadway crossing treatments.

At-grade roadway intersection

Reorient angled crossings to approach at 90 degrees

Trail roundabout

Intersections with Other Trails

At the intersection of two trails, users should be aware that they are approaching an intersection and of the potential for encountering different user types from a variety of directions. This can be achieved through a combination of regulatory and wayfinding signage and unobstructed sight lines.

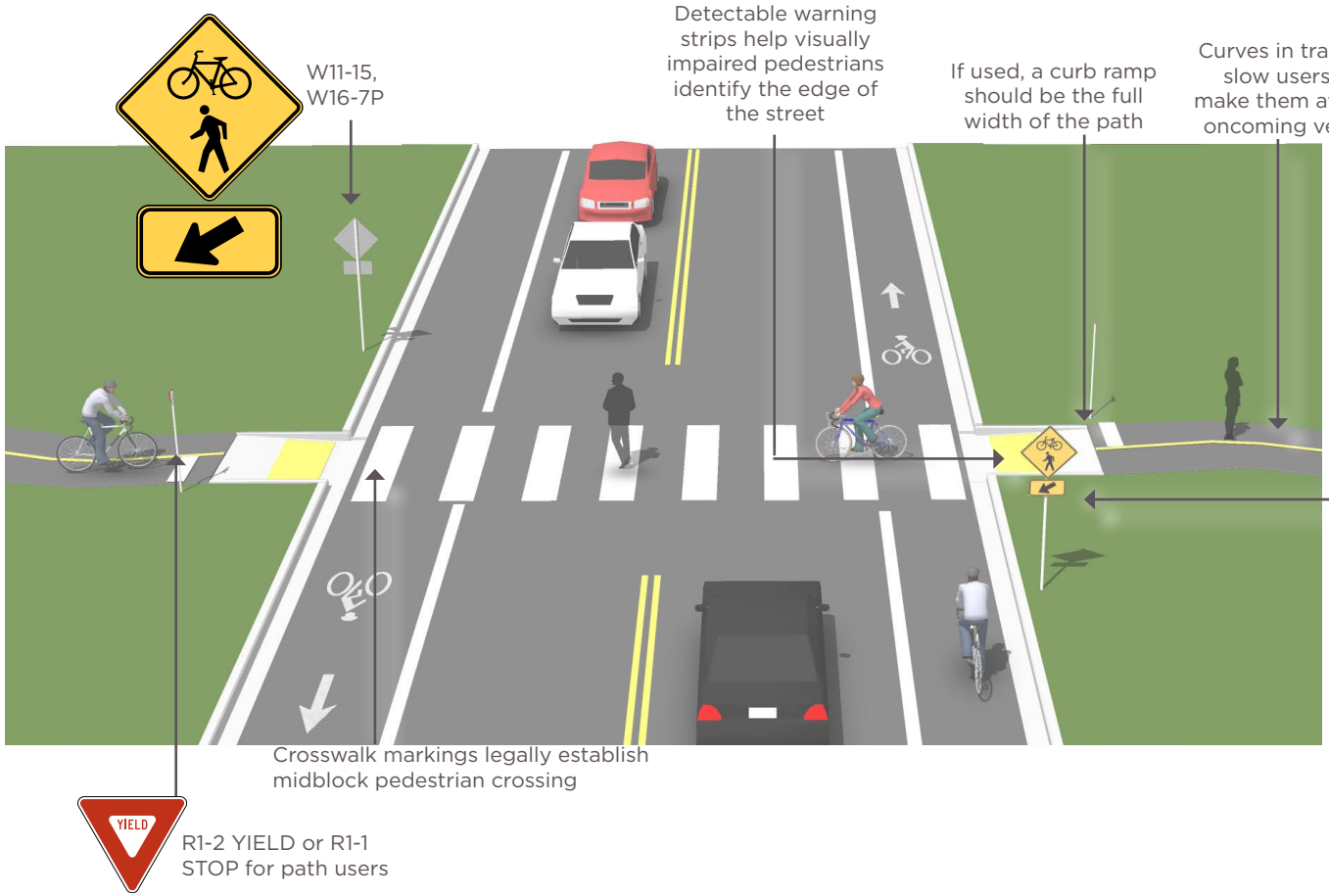
GUIDANCE

- Trails should be aligned to intersect at 90 degree angles when possible.
- Sight lines should be clear for all users, as determined by expected user speeds.
- Consider off-setting the trail intersection and creating two three-way intersections rather than one four-way intersection.
- A roundabout may be a viable design option to slow speeds and clarify expected operation.
- Include directional signage at intersections.
- If a roundabout design is used, consider the use of landscaping with low growing (no more than 24 inches high) and minimally spreading native shrubs and groundcover that require little maintenance and provide clear sight lines.
- Other material can be used within roundabouts such as boulders and public art to discourage shortcut paths through the central island as long as clear sight lines under 36 inches are maintained.

Marked/Unsignalized Crossings

A marked/unsignalized crossing typically consists of a marked crossing area, with 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, trail traffic, use patterns, vehicle speed, road type, road width, and other safety issues such as proximity to major attractions.

When space is available, using 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. Locate markings out of wheel tread when possible to minimize wear and maintenance costs.



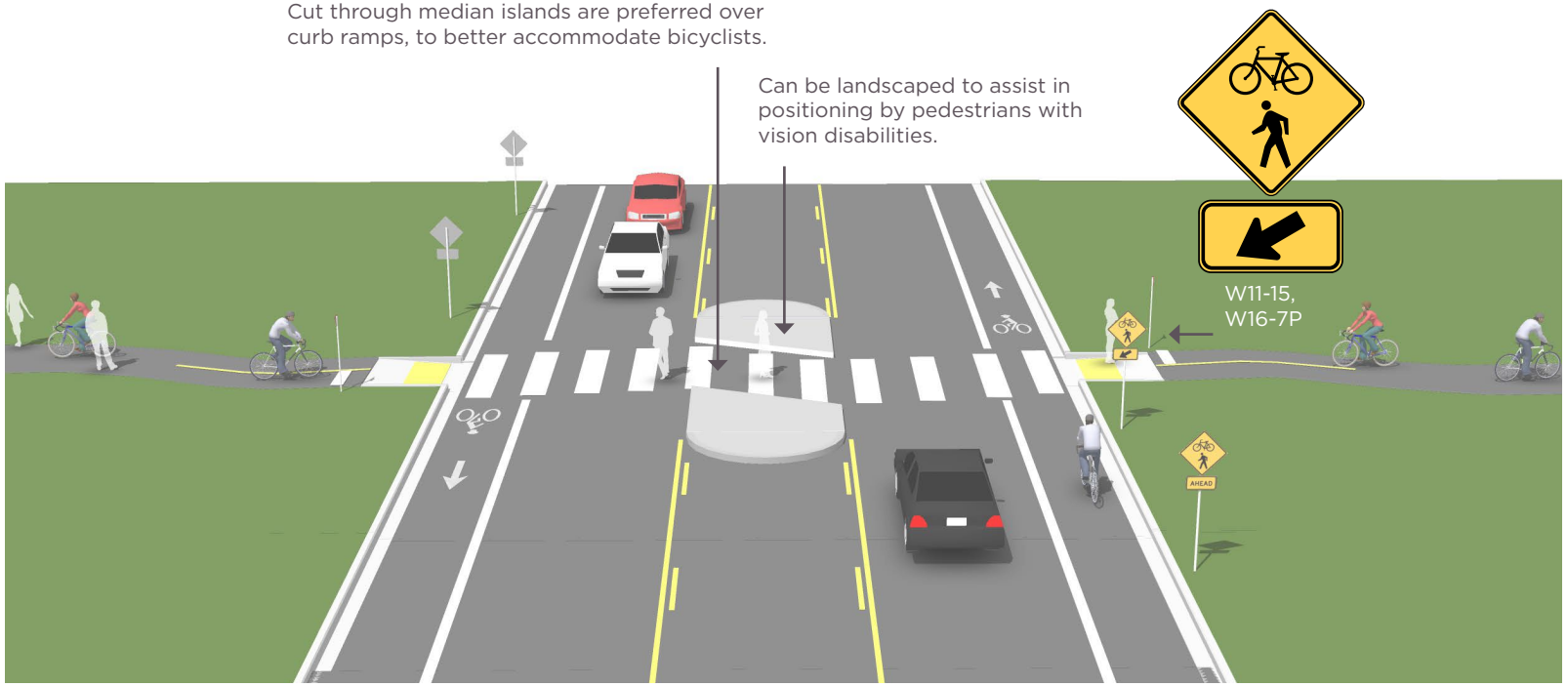
Optional Rectangular Rapid Flashing Beacon (RRFB) with push button activation and solar power

Median Refuge Islands

Median refuge islands are located at the mid-point of a marked crossing and help improve trail user safety by directing crossing in one direction of traffic at a time. Refuge islands minimize user exposure by shortening crossing distance and increasing the number of available gaps for crossing.

GUIDANCE

- Appropriate at signalized or unsignalized crosswalks.
- The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings.
- If a refuge island is landscaped, the landscaping should not compromise the visibility of trail users crossing in the crosswalk. Consider the use of landscaping with low growing, minimally spreading native shrubs and ground cover that require little maintenance and are no higher than 18 inches.
- Refuge islands may collect road debris and may require somewhat frequent maintenance.
- The approach nose should be highly visible.

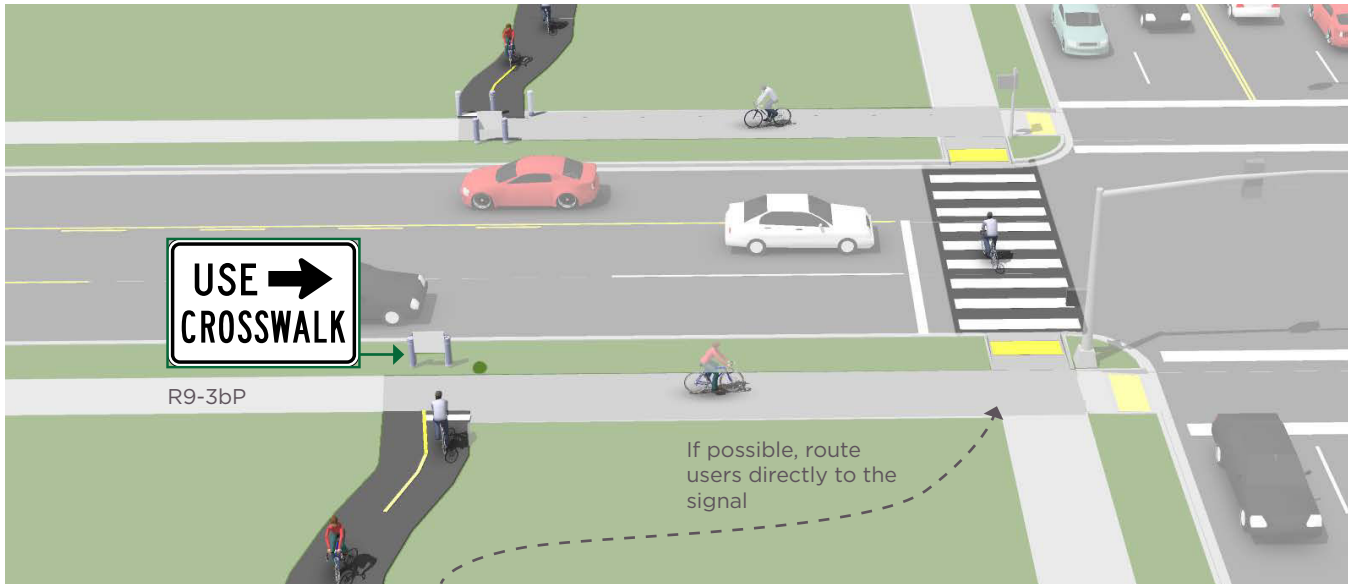


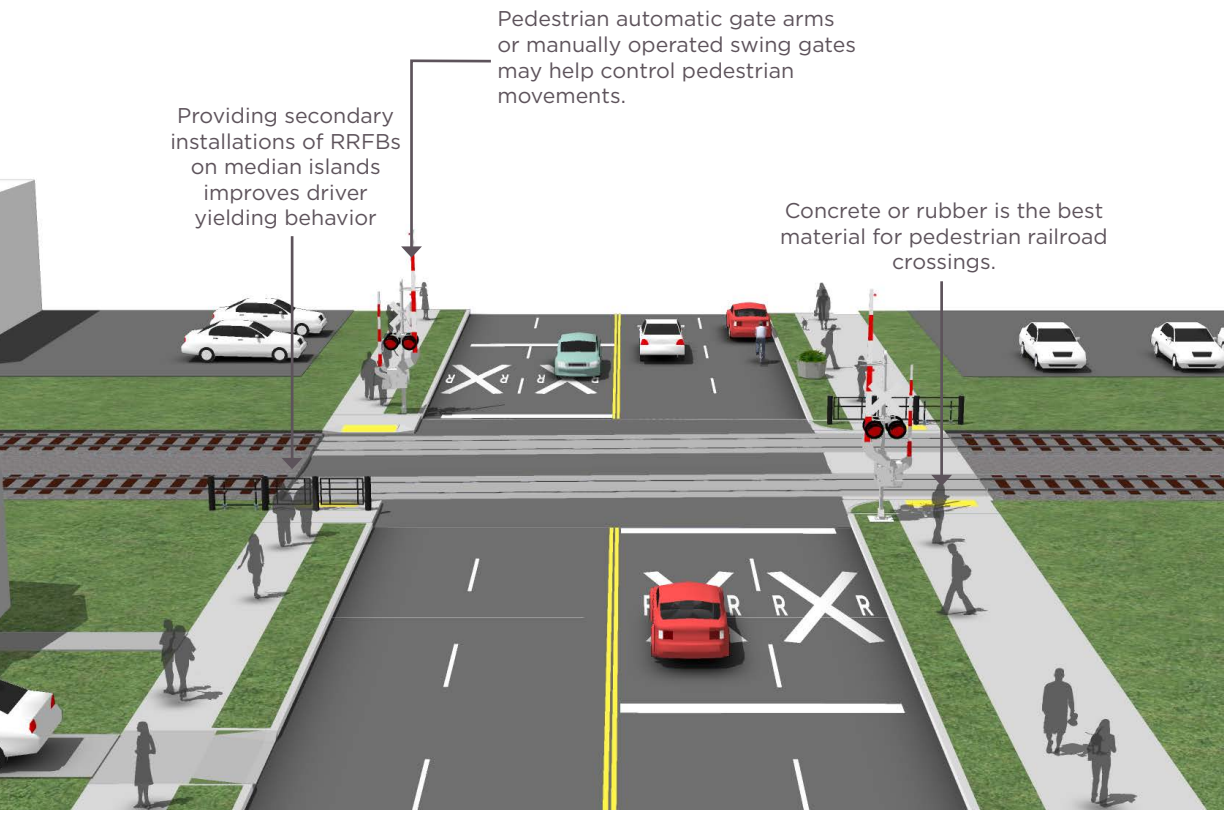
Signalized Crossings

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

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

If possible, route users to signalized crossing. If no crossings are in vicinity, use appropriate crossing treatment. Any signal or "hawk" specific to crossings has to be evaluated to have met FHWA warrants for the appropriate control device.





Pedestrian At-Grade Railroad Crossings

Locations where sidewalks must cross railroad tracks are problematic for pedestrians, particularly for those with mobility or vision impairments. Wheelchair and scooter casters can easily get caught in the flangeway gap, and slippery surfaces, degraded rough materials, or elevated track height can cause tripping hazards for all pedestrians. Angled track crossings also limit sight triangles, impacting the ability to see oncoming trains.

GUIDANCE

- Bells or other audible warning devices may be included in the flashing-light signal assembly to provide additional warning for pedestrians and bicyclists.
- Pedestrians need clear communication and warning to know that they may encounter a train and when a train is coming. Provide clear definition of safest crossing location.
- The crossing should be as close as practical to perpendicular with tracks. Ensure clear lines of sign and good visibility so that pedestrians can see approaching trains
- The crossing must be level and flush with the top of the rail at the outer edge and between the rails.
- Flangeway gaps should not exceed 2.5 in (3.0 in for tracks that carry freight.)

Crossing design and implementation is a collaboration between the railroad company and the highway agency. The railroad company is responsible for the crossbucks, flashing lights and gate mechanisms, and the highway agency is responsible for advance warning markings and signs. Warning devices should be recommended for each specific situation by a qualified engineer based on various factors including train frequency and speed, path and trail usage, and sight distances.

Trail Amenities

Overview

When designing functional, attractive, and inviting trails, the small details matter. Elements such as a lighting fixtures, public art, benches, and other amenities help create a unique identity for a trail. It is important that these details work together to create a complete experience for all users.

Amenity area with benches, bicycle parking, drinking fountains, and interpretive signage in Boulder, Colorado.

Trash and Recycling Receptacles

Trash and recycle receptacles provide for proper maintenance and appearance of trails. For recycling receptacles, signage should be provided indicating what recyclables are accepted. Consider including educational signage about the importance of recycling and the environmental benefits. Trash and recycling receptacles should be prioritized along more heavily used sections.

GUIDANCE

- Locate receptacles at each trailhead and each seating area (one per every one picnic table, one per every two benches).
- In areas with adequate sunlight, consider compacting receptacles for trash and recyclables that use smart technology (such as Big Belly®).
- Placement of other receptacles will depend upon the location of concessions, facilities and areas of group activities.
- Receptacles need to be accessible to maintenance personnel and trail users.
- Receptacles should be selected using the following criteria:
  - Expected trash/recycling amount
  - Maintenance and collection program requirements
  - Durability
  - Animal-proof
- Receptacles should be set back a minimum of 3 feet from the edge of the trail.

Comfort Stations

Comfort stations are one of the most critical building amenities because they need to be responsive to a wide range of human needs and abilities. Careful consideration should be given to a number of factors before locating comfort stations, including available land, size of trailhead, existing comfort station facilities, utility availability, and user need.

Prior to undertaking any comfort station building design, consultation with a structural and civil engineer, state building codes, health and safety codes, ADAAG and Public Rights-of-Way Accessibility Guidelines (PROWAG) standards, and local development codes is required. The space required for each comfort station building depends on the number of toilets to be provided.

Comfort stations require considerable maintenance and service. Access to these resources should be a strong consideration when planning for comfort station buildings.

Comfort Station

GUIDANCE

- Local, state, and federal codes take precedence for all comfort station facilities.
- Prioritize location of comfort stations at trailheads within existing parks and review gaps for placement at other trailheads or locations within the system.
- Comfort station structures should be located adjacent to vehicular access points for security, maintenance, and access to water and sewer (unless they are self-composting).
- Comfort stations should also make use of natural light and ventilation to the extent possible.
- Place bicycle parking close to comfort station structures so that bicyclists do not impede trail access. Inadequate bicycle parking encourages informal propping of bicycles at or against comfort station buildings.
- Provide comfort station facilities that are durable and resistant to vandalism.
- Always provide comfort station facilities outside of floodprone areas.
- Where other comfort station facilities are available within the park and trail system, use wayfinding signage along trails to direct users appropriately.
- Composting toilets should be considered in remote areas or where utility connections are unavailable.

Drinking Fountains

Drinking fountains provide opportunities for users to replenish fluids and potentially extend their trip. Access to City water service must be available. Review Regulatory Flood Protection Elevation prior to locating.

GUIDANCE

- Locate drinking fountains at least 5 feet from trail edge.
- Locate drinking fountains near comfort stations, at trailheads, parks, and other public gathering places along the trail.
- Standard and accessible fountains should be installed to accommodate all trail users.
- Consider grouping amenities together (seating, bicycle parking, drinking fountains, and bicycle repair stations) at a rest stop or comfort station.
- Drinking fountains should be placed on a well-drained surface (2 percent sloped concrete slab).
- Consider the use of durable and vandalism-resistant materials such as steel or stone.
- Drinking fountains must be ADAAG compliant; see Accessible Trail Design guideline for more information.

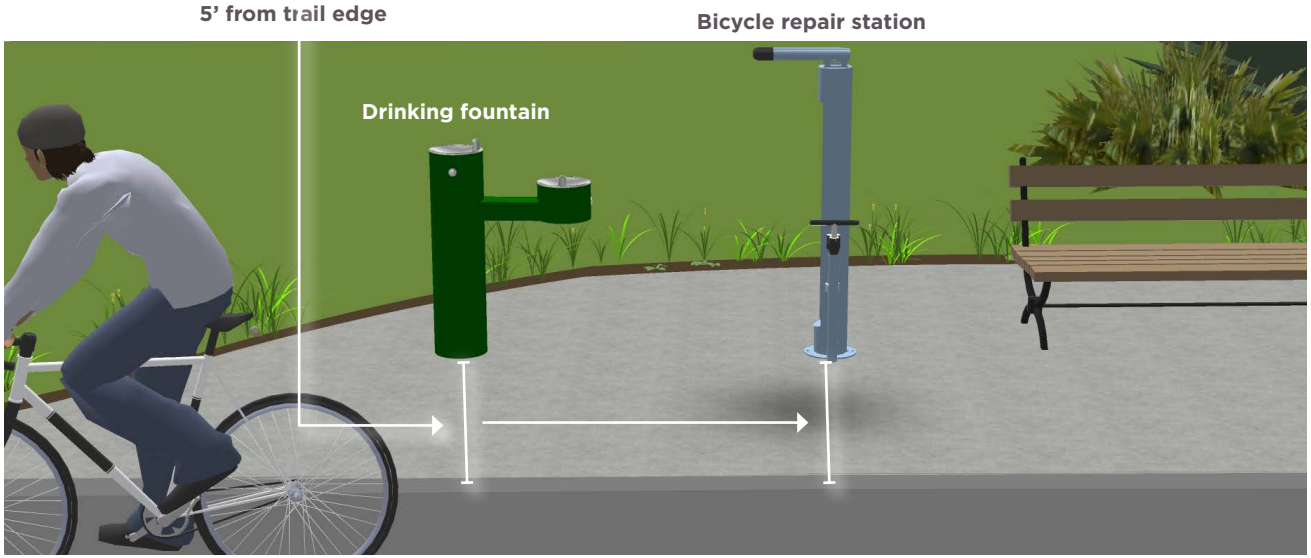
Bicycle Repair Stations

Bicycle repair stations are small kiosks designed to offer a complete set of tools necessary for routine bicycle maintenance.

Popular locations for placement include major or minor trailheads and rest stops trails.

GUIDANCE

- Bicycle repair station tools are secured by high security cables, but will still be an attractive target for theft. Proper placement of kiosks in areas of high activity is one key strategy to reduce potential vandalism.
- Consider grouping repair stations together with other amenities (seating, bicycle parking, and drinking fountains) at a rest stop.



Bicycle Parking

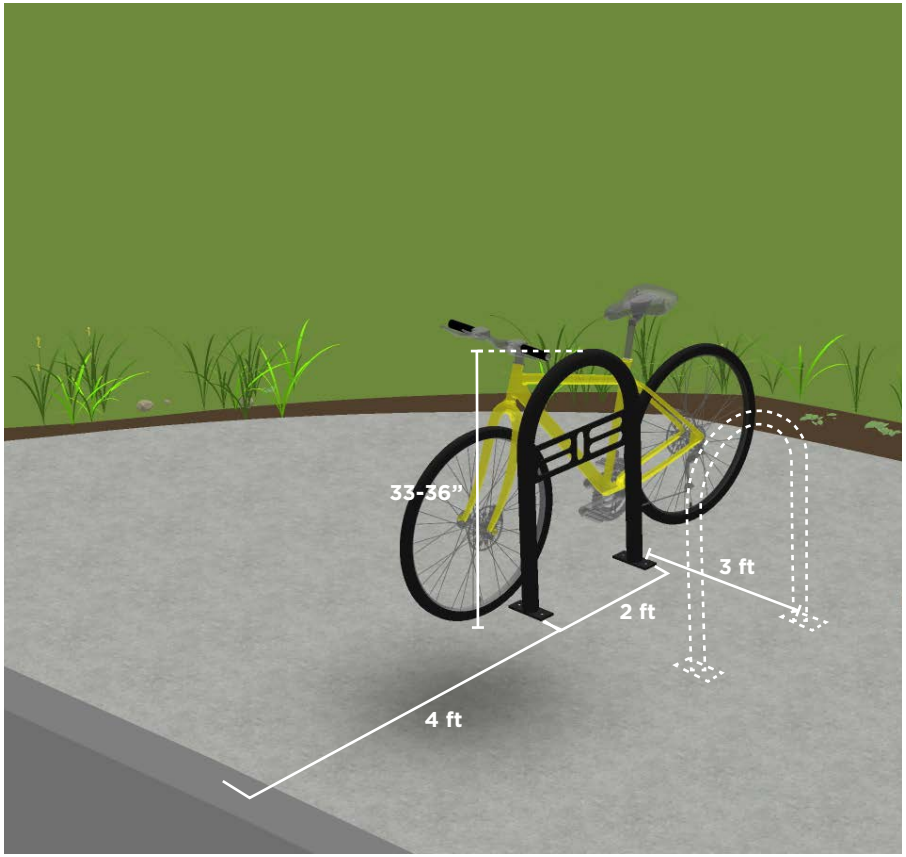
Bicycle parking should be as convenient as the majority of automobile parking and should be easily accessible from the associated trail. Entrances and exits should be designed to minimize conflict with trail user traffic patterns.

Bicycle parking should be located on a hardscape surface and not be located directly in front of other trail amenities. Ideal rack location should be parallel along the trail approach. Parking should be located no more than 25 feet from ingress/egress and at least 5 feet from the edge of trail to avoid traffic conflict. Location should be highly visible.

Consideration should be given to avoid emergency ingress/egress, service access, and vehicular conflict areas.

GUIDANCE

- Locate bicycle racks at comfort stations, select trailheads, points of interest, and rest stops.
- The bicycle rack should supports the bicycle in at least two places, preventing it from falling over.
- The bicycle rack should allow locking of the frame and one or both wheels with a U-lock.
- When installing racks on concrete surfaces, use 3/8 inch anchors to plate mount. Shim as necessary to ensure vertical placement.
- When installing racks on pavers or other non-stable surfaces, embed into base. Core holes no less than 3 inches in diameter and 10 inches deep.
- Ensure the rack is securely anchored to ground.
- Consider bicycle racks that resist cutting, rusting, bending, and deformation.



MUTCD D4-3

Signage may be desired to direct users to bicycle parking areas

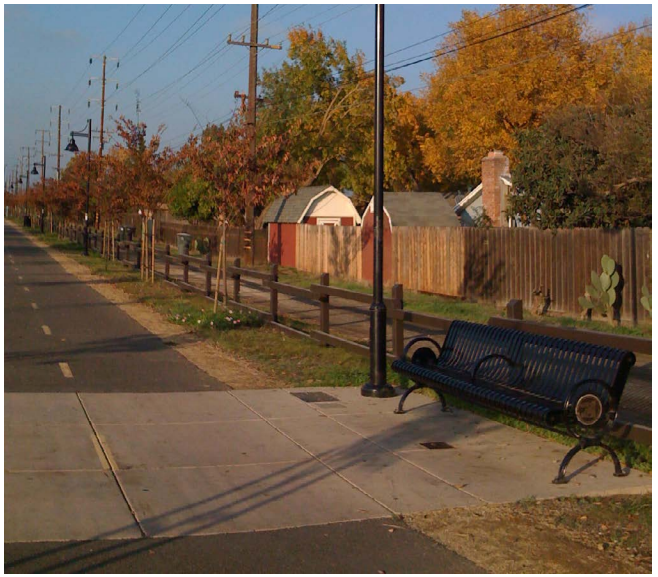
Seating

Seating along trails provides a place for users to rest, congregate, contemplate, or enjoy art, nature, and interpretive elements throughout a trail. Benches can be designed to create identity along the trail or be strictly utilitarian. Picnic tables provide places for trail users to congregate for meals or to relax.

GUIDANCE

- Locate benches and other site furniture a minimum of 3 feet from the edge of the trail.
- Locate benches along the trail where appropriate, or where there is a demand by users. Providing seating at one mile gaps is the goal. Seating within 1/2 mile of trailheads is recommended.
- Provide benches and picnic tables in areas that provide interesting views, are close to an interpretive element, and offer shade or shelter from seasonal winds.
- Drainage should slope away from the bench and the trail.
- Locate benches a minimum of 4 feet from comfort stations and drinking fountains and a minimum of 2 feet from trash and recycling receptacles, lighting poles, and sign posts.
- Wheelchair access should be possible at some picnic tables and alongside benches. Provide access with a hardened surface such as concrete or asphalt.
- Seating should be securely anchored to the ground. Consider durable materials or native materials such as boulders that are vandalism-resistant.

Trail-side seating in a rural context



Trail-side seating in a small town context

Public Art and Sculpture

Public art engages the community through artists' work and creates a memorable experience for trail users. Art and sculpture can create an identity for the trail and strengthen the emotional connection between the Flyway Trail and its users. Depending on the scale and form, it can become an "event" in itself and serve as a public attraction.

Public art can be aesthetic and/or functional, and double as sitting or congregational areas. Memorable installations can act as landmarks and serve as valuable wayfinding tools. Public art can be a device for telling a compelling and memorable story about the trail and area history.

GUIDANCE

- Artists can be commissioned to provide art at one or multiple locations along trails.
- When appropriate, artists could be engaged as part of the corridor planning and development process.
- Artists should be encouraged to produce artwork in a variety of materials for sites along the corridor.
- When appropriate, consider developing furnishings and amenities with artistic intent. Key locations such as turns or landscape changes could be areas to highlight through the inclusion of public art. Consider how to provide continuity between elements while maintaining the unique styles of multiple artists.
- Provide art displays on trails with anticipated high use and user exposure.
- Consider community-based art and temporary installations.

North Carolina Art Museum Park

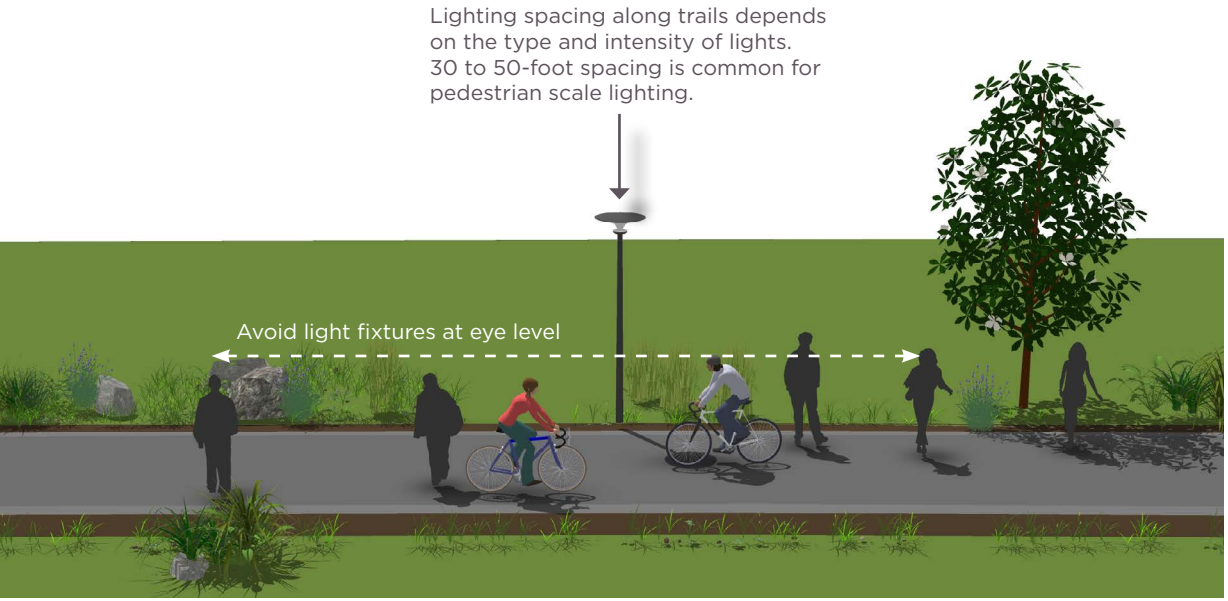
Temporary organic art sculpture

Solar Power with LED

Lighting

Lighting for trails should be analyzed on a case-by-case basis with full consideration of the maintenance commitment lighting requires. In general, lighting is not appropriate for trails in remote areas, trails with low use, or where there is little to no development.

Lighting can improve visibility along the trail and intersection crossings at night for commuters. If a trail is determined to be unlit and closes at sun down, extended hours for commuters should be considered, particularly during winter months when trips to and from work are often made before sunrise and after sunset. Lighting may also be necessary for day-time use in tunnels and underpasses.



GUIDANCE

- Recommended locations for lighting include the following:
  - Trailheads and parking areas
  - Comfort stations
  - Major trailhead intersections to use as a navigation aid
  - Entrances and exits of bridges and underpasses and in tunnels
  - Street crossings
- Low-cost light emitting diodes (LED) offer a wide range of light levels and can reduce long term utility costs.
- Design lighting levels appropriate to each situation.
- Trail lighting should be at pedestrian scale.
- Solar powered lighting is available where utility collection is difficult or when alternative energy sources are desired.
- Avoid light fixtures at eye level that could impair visibility.
- Limit direct glare or excessive illumination on to adjacent properties, streets, or sidewalks.
- Dependent upon trail hours, consider uses in urban and/or commercial land use areas.

Trail Signage

Signage Overview

A comprehensive system of signage ensures that information is provided regarding the safe and appropriate use of all facilities, both on-road and on shared-use paths. The bicycle network should be signed seamlessly with other alternative transportation routes, such as bicycle routes from neighboring jurisdictions, trails, historic and/or cultural walking tours, and wherever possible, local transit systems.

Signage includes post- or pole-mounted signs and pavement striping. Signage is further divided into information signs, directional/wayfinding signs, regulatory signs, and warning signs. Trail signage should conform to the Manual on Uniform Traffic Control Devices and the American Association of State Highway Transportation Official Guide for the Development of Bicycle Facilities.

Signage along the Missouri River Greenway in St. Louis County, Missouri

Bikeway Network Wayfinding Signage

The ability to navigate through a city is informed by landmarks, natural features, and other visual cues. Wayfinding signs indicate:

- Direction of travel
- Location of destinations
- Location of access points

These signs increase users' comfort and accessibility to the trail network. Wayfinding signage can serve many purposes including:

- Helping to familiarize users with the trail system.
- Helping users and emergency responders identify locations, in case of emergency on the trails.
- Helping users identify the best routes to destinations.
- Helping overcome a "barrier to entry" for people who do not use the trail system.
- Helps users find access points to the trail system.

Wayfinding signs also visually cue motorists that they are driving near a trail corridor and should use caution. Signs are typically placed at key locations leading to and along routes, including the intersection of multiple routes.

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

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.

Sign Types

A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes. There are three general types of wayfinding signs:

Confirmation Signs

Indicate to bicyclists that they are on a designated bikeway. Make motorists aware of the bicycle route. This signage can include destinations and distance/time but does not include arrows.

Turn Signs

Indicate where a bikeway turns from one street onto another street. This signage can be used with pavement markings, and does include destinations and arrows.

Decisions Signs

Mark the junction of two bikeways and informs bicyclists of the designated bike route to access key destinations. Destinations and arrows, distances and travel times are optional but recommended.

DISCUSSION

Section 1A.12 of the MUTCD establishes the general meaning for signage colors. 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.

ALTERNATIVE DESIGNS

A customized alternative design may be used to include pedestrian-oriented travel times, local town logos, and sponsorship branding.

Sign Placement

GUIDANCE

Signs are typically 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.

Decisions Signs

Near-side of intersections in advance of a junction with another bicycle route.

Along a route to indicate a nearby destination.

Confirmation Signs

Every 1/4 to 1/2 mile on off-street facilities and every two to three blocks along on-street bicycle facilities, unless another type of sign is used (e.g., within 150 feet 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

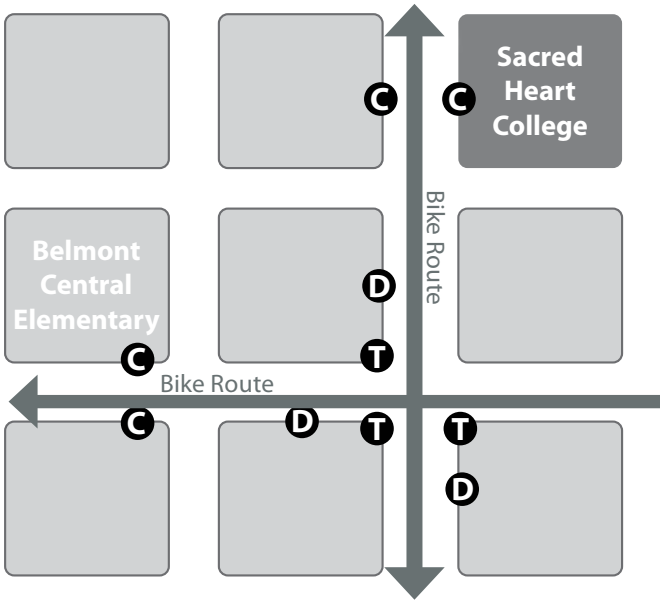
Near-side of intersections where bike routes turn (e.g., where the street ceases to be a bicycle route or does not go through). Pavement markings can also indicate the need to turn to the bicyclist.

DISCUSSION

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 five 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.

MATERIALS AND MAINTENANCE

Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear.



D Decision Sign

C Confirmation Sign

T Turn Sign

Regulatory Signs

Regulatory signs give a direction that must be obeyed and apply to intersection control, speed, vehicle movement, and parking. The examples below are types of regulatory signs that could be integrated into a signage program.

GUIDANCE

- Smaller scale signs or plaques may be used for trail applications.
- See the MUTCD 9B for a detailed list of regulatory sign application and guidance.

R1-1

R1-2

R5-3

R9-7

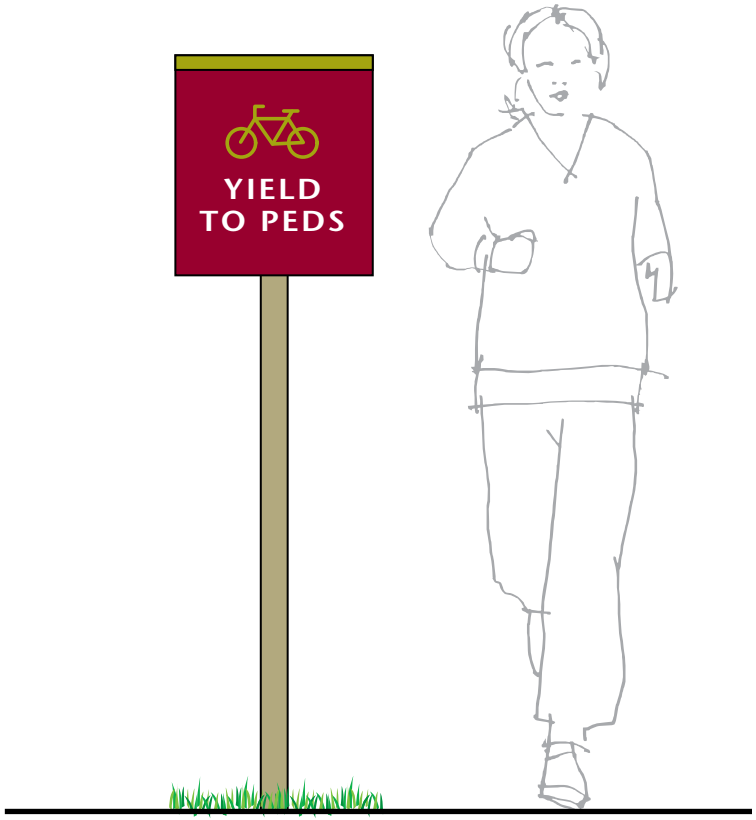
R15-8

Etiquette Signage

Informing trail users of acceptable etiquette is a common issue when multiple user types are anticipated. Yielding the right-of-way is a courtesy and yet a necessary part of a safe trail experience. The message must be clear and easy to understand. The most common trail etiquette systems involve yielding of bicyclists to pedestrians.

GUIDANCE

- Trail etiquette information should be posted at access points and periodically along the trail.

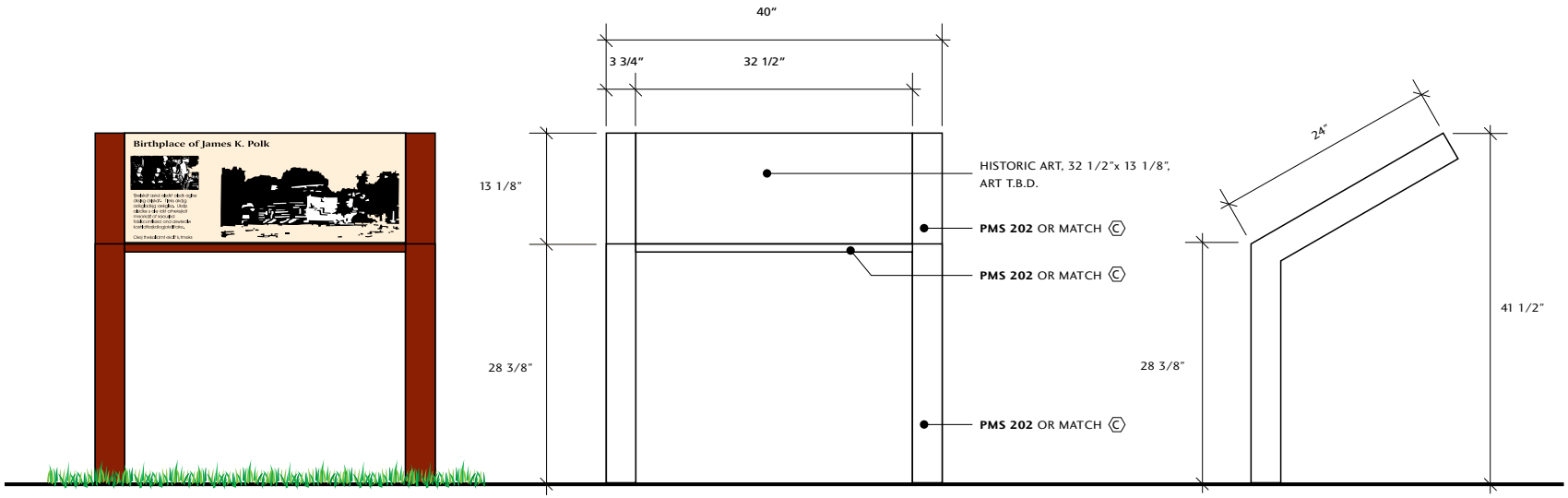


Interpretive Signage

Interpretive displays provide trail users with information about the surrounding environment or site, wildlife, vegetation, history, and the significance of cultural elements. Interpretive displays may also be combined with public art and sculpture opportunities along the trail.

GUIDANCE

- Consider the character of the trail and surrounding elements when designing these signs.
- Work with experts specific to the information you are conveying on the signs such as historians, ecologists, or artists.
- Separate interpretive signage panels from the main trail circulation so that users can stop and not impede traffic.
- Consider including interpretive signage at rest stops or areas of congregation.
- Panels must be ADA accessible.
- Consider use of technology for interpretation.



H INTERPRETIVE

SIDE ELEVATION

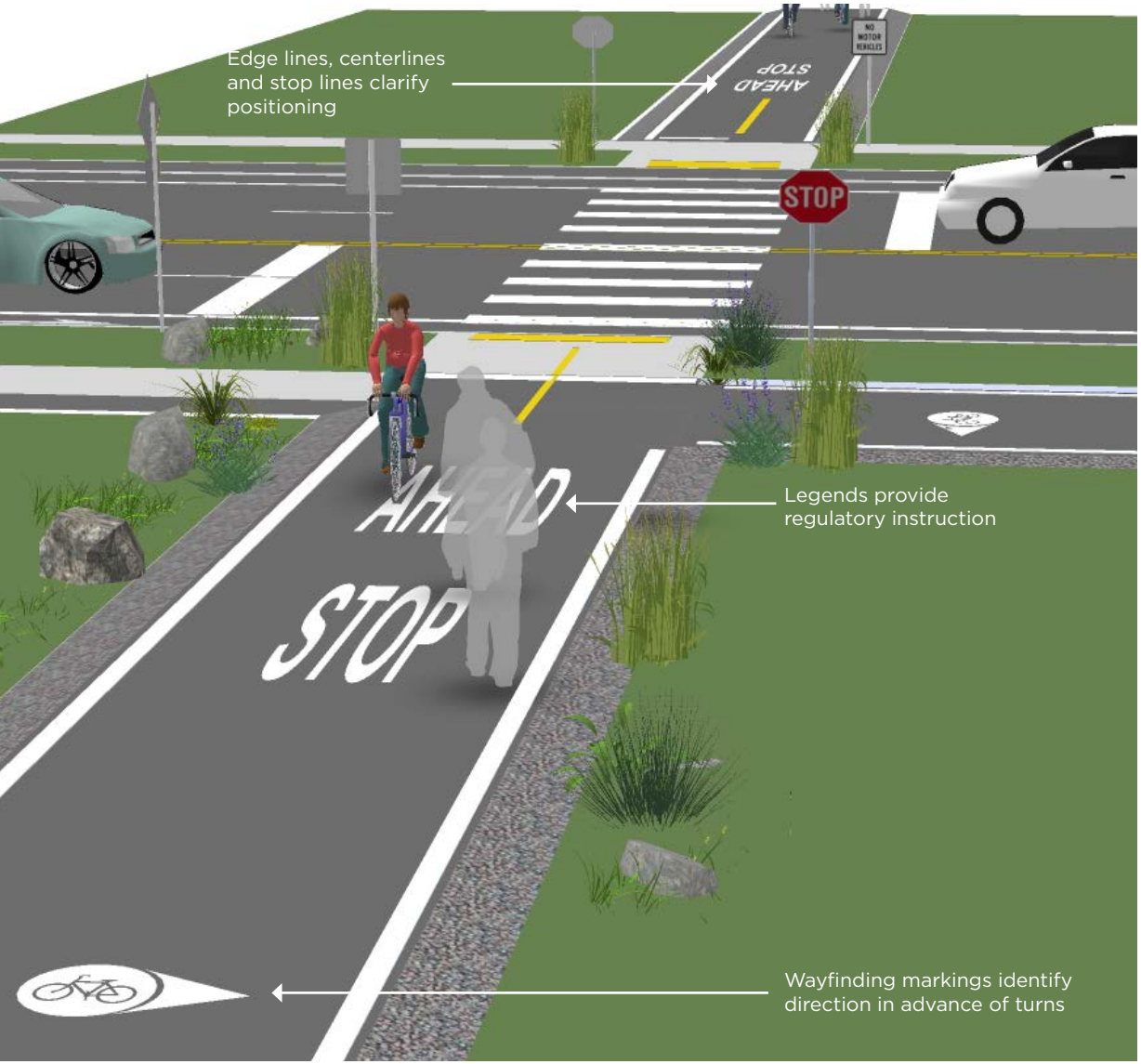
Informational Kiosks and Message Centers

Kiosks and message centers provide trails users with information to orient themselves, learn of areas of interest, read the rules and regulations of the trail system, and find the hours of operation.

GUIDANCE

- Install kiosks at each major and minor trailhead.
- Rules and regulations, and ADAAG accessibility advisories should be included on each kiosk.
- When locating kiosks next to parking facilities, set the units back far enough from traffic and protect the support posts or structure with appropriately sized barriers.
- Provide ADA access using established guidelines for visual height, clearance, and surface type where kiosks are located.
- Evaluate the use of emerging technology options for implementation of information and messages as part of the signage program.

Signage along the Silver Comet Trail



Pavement Markings

Pavement markings are commonly used to reinforce signs along a trail, but they should not be used to replace signs altogether. Center line striping is the most common form of pavement marking, but warning, regulatory, and directional messages can be used. Use pavement markings sparingly and only where necessary to attract additional attention to a possible problem area.

GUIDANCE

- Do not use pavement markings at critical stopping or turning points.
- High-visibility thermoplastic material is the most durable and visible. Use white or yellow.
- Pavement markings to consider include “Stop,” “Yield,” and “Slow.”
- Place messages at trail access points, prior to roadway intersections or bridges, or near intersections with converging trails.
- 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.
- Non-slip or non-skid pavement marking or striping materials should be used in all cases when trails are wet.
- Consider using at road intersections for road name identification.

alta
PLANNING + DESIGN