JEFFERSON COUNTY TRAILS & GREENWAYS IMPLEMENTATION GUIDELINES

ODOT PID #99937

Dated: March 15, 2017

Brooke Hancock Jefferson
Metropolitan Planning Commission (BHJ-MPC)
124 North 4th Street, 2nd Floor
Steubenville, Ohio 43952-2132
(740) 282-3685

Ohio Department of Transportation
District 11
2201 Reiser Avenue
New Philadelphia, Ohio 44663
(330) 339-6633

Production of this document paid for by funds from the
U.S. Federal Highway Administration and Ohio Toll Revenue Credits.

Prepared For:

Brooke-Hancock-Jefferson Metropolitan Planning Commission
The Metropolitan Planning Organization for
Weirton-Steubenville, WV-OH Metropolitan Area
124 North Fourth Street, 2nd Floor
Steubenville, OH 43952

740/282-3685
304/797-9666
740/282-1821 FAX

Email: mikepap@bhjmpc.org Website: www.bhjmpc.org

TABLE OF CONTENTS

PREFACE

This document was prepared in March 2017 in part for the Ohio Department of Transportation (ODOT) JEF-BHJ 2016 BIKE/PED GUIDELINES, PID 99937 Project.

Prepared For:

Brooke Hancock Jefferson
Metropolitan Planning Commission
124 North 4th Street, 2nd Floor
Steubenville, Ohio 43952-2132
(740) 282-3685

Ohio Department of Transportation
District 11
2201 Reiser Avenue
New Philadelphia, Ohio 44663
(330) 339-6633

Prepared By:

ADR & Associates, Ltd.
88 West Church Street
Newark, Ohio 43055
(740) 345-1921

EXECUTIVE SUMMARY

This document was prepared on behalf of the Brooke Hancock Jefferson Metropolitan Planning Commission (BHJ-MPC) in conjunction with the Ohio Department of Transportation District 11 (ODOT D-11) via ODOT project JEF - BHJ 2016 Bike / Ped Guidelines, PID 99937 to provide implementation guidelines for trails, greenways, and bicycle routes in Jefferson County Ohio. There is a need for general guidelines for use by public agencies in Jefferson County to provide continuity on path development within the County.

The information presented in this document has been gathered from various sources including: A Policy on Geometric Design of Highways and Streets by the American Association of State Highway and Transportation Officials (AASHTO) Green Book, AASHTO Guide for the Development of Bicycle Facilities, the Federal Highway Administration (FHWA), Departments of Transportation, Federal and the Ohio Manual of Uniform Traffic Control Devices (OMUTCD), various communities and metropolitan planning organizations.

Safe convenient modes of travel for pedestrians, bicyclists, and motorists are expected, needed and planned in Jefferson County. The roadways which area also used as designated bikeways should be made more bicycle compatible. Bicycle compatible roadways have design features which allow a competent bicyclist to safely share the roadway with motor vehicles. Denying bicycle access and accommodations on the designated bike routes is incompatible with the goal of providing safe convenient modes of travel for bicyclists and vehicles using the routes.

The trails and greenways (bike path) implementation guidelines are intended for planning purposes only. They should be used to help scope projects for preliminary and detailed design project development.

The implementation guidelines provide recommended bicycle accommodations for designated bike routes. The bicycle implementation and design guidelines for roadways target Group A bicyclists, the most experienced cyclists. Many of the proposed preferred or ultimate bicycle accommodations will also serve Group B bicyclists, the average rider. Group C bicyclists, primarily children and beginners, and/or pedestrians are also addressed in this document. The three levels or groups of bicyclists are based on the Federal Highway Administration (FHWA) system of designating levels of bicycle ability for design purposes.

CHAPTER 1 – INTRODUCTION & PLANNING

INTRODUCTION

The purpose of this document is to provide implementation guidelines for trails and greenways, including bike routes in Jefferson County Ohio. The Trails and Greenways Design Guidelines described in this document present a comprehensive approach to designing new and modified streets and highways within the BHJ-MPC's area of influence to accommodate bicyclists. These guidelines will allow the BHJ-MPC, Jefferson County, and Local Jurisdictions to provide comfortable travel for pedestrian, bicyclists and motorists.

These implementation guidelines are sponsored by the Brooke Hancock Jefferson Metropolitan Planning Commission (BHJ-MPC) in conjunction with the Ohio Department of Transportation (ODOT).

Safe convenient modes of travel for pedestrians, bicyclists, and motorists are expected and needed. People are reluctant to ride bicycles in the absence of accommodations for bicyclists. Designated bikeways, bike lanes and separated bike paths, or multi-use trails, enhance the comfort level of people to use a bicycle.

This document is neither a textbook nor a substitute for engineering knowledge, experience, or judgment. It is intended to provide uniform procedures for implementing design decisions, assure quality and continuity in design of bike routes, trails, and greenways in Jefferson County Ohio, and assure compliance with relevant criteria. Although this document may be considered a primary source of reference by personnel involved in the design of the designated bike routes, it must be recognized that the practices suggested may be inappropriate for some portions of the bike routes, trails, and greenways due to fiscal limitations or other reasons.

The appropriate design of trails, greenways, and bicycle facilities enhances the enjoyment, safety, and comfort of bicyclists and other users. These guidelines are intended to supplement engineering judgement and existing local, state, and federal guidelines and not replace them. Consideration must be given to design standards adopted by city, county, or other local governments when designing facilities under their jurisdiction.

GUIDELINE USERS

The Jefferson County Trails and Greenways vision will be planned, designed, and implemented by the State of Ohio, Jefferson County agencies, local governments, and trail groups. The usefulness of these design guidelines, therefore, extends far beyond the Brooke-Hancock-Jefferson County Metropolitan Planning Commission. The following groups are likely to use the Jefferson County Trails and Greenways design guidelines:

- Policy-makers at various levels will use the design guidelines to plan for future trail development, especially relating to right-of-way or easement acquisition and corridor preservation.
- Trail planners, both public entities and private consultants, will use the design guidelines to make recommendations for roadway crossings, possible corridors, accommodation of various user modes, and other issues.
- Trail designers, including private consultants, will use the design guidelines in the construction documentation process when dealing with trail alignment, profile, width, cross-section, and surface.
- Concept/application reviewers will use the design guidelines to evaluate the trail for funding. As stated above, deviation from the design guidelines is possible, but priority may be given to trails that follow the design goals of the statewide system.
- Trail maintenance and operations agencies/ organizations will use the guidelines in the day-to-day operation of the trail by maintaining appropriate clear zones, surface condition, and access points.

PLANNING PRINCIPLES FOR TRAILS, GREENWAYS, & BIKEWAYS

Trail, greenway, and bikeway planning occurs on all scales from a single development project all the way to comprehensive neighborhood, district, city, county, and regional projects.

Though each bikeway plan has unique goals and circumstances, and cyclists differ in skill and purpose, there are key planning principles that consider the fundamental needs of all bicyclists. These principles can be widely applied to guide bikeway planning efforts.

Safety:

Providing designated space for bicyclists and minimizing conflicts with motor vehicles are critical elements to developing a safe bicycle network. Other important safety considerations include traffic volume, vehicular speed, stopping sight distance, pavement condition, and intersection treatments.

Convenience:

Bike routes should be continuous and link to other bikeways to provide direct and seamless travel. Gaps in the network, lengthy detours, frequent stops, and physical barriers such as highway and stream crossings can be discouraging for cyclists.

Regional Corridors:

Long-distance bikeways can provide continuous travel throughout the region. Because they require continuous right-of-way, regional corridors are often found along roadways and utility easements and may not provide direct access to destinations alone. As a result, creating connections between regional corridors, the on-street bikeway network, and key destinations is a critical strategy for improving non-motorized travel in the region.

Transportation Investment Optimization:

Roadway construction, widening, and maintenance projects can provide opportunities to add bicycle and pedestrian accommodations. By incorporating the needs of bicyclists and pedestrians in initial project design, roadway projects can improve safety and mobility for all users in a cost-effective manner.

Access:

By connecting destinations throughout residential, commercial, and recreational areas, bikeways can serve as key transportation routes.

Comfort:

Smooth pavement, designated operating space, lighting, landscaping, and directional signage improve the sense of comfort for cyclists. Additional amenities such as drinking fountains, restrooms, and shaded seating areas are welcome additions on routes where cyclists may be traveling longer distances.

Special Districts

Areas within the region can be identified as pedestrian and bicyclist special districts, areas in which automobile access is greatly restricted. The special district will be conducive to walking and bicycling based on demographic and physical characteristics. Improvements in special districts focus on improving circulation for pedestrians and bicyclists by providing a connected network of local bikeways and pedestrian improvements.

Livable Centers:

Livable Centers are destinations with a mix of land uses allowing people to live, work, and play with less reliance on their motorized vehicles. By concentrating a variety of activities together in a small area, cyclists are able to conveniently access multiple destinations with short trips. Safe connections to surrounding areas, secure bicycle parking, and shower facilities are key elements for accommodating cyclists in Livable Centers.

Goals:

As with all planning processes, bikeway planning starts with identifying what the community or neighborhood wants to achieve. Goals guide the overall planning and implementation process and help ensure that the community understands the intended outcome of the planning effort.

Existing Conditions:

An inventory of existing conditions provides critical information that will be used to identify recommendations and improvements, including the examination of elements such as existing bike routes, vehicular traffic counts, pedestrian and bicyclist counts, roadway conditions, vehicular speeds, signalized intersections, existing traffic generators, and planned transportation improvements.

Public Involvement:

As with all planning efforts, the public should be engaged in bikeway planning to ensure that the needs and desires of the community are met. Local cycling clubs, advocacy organizations, and neighborhood groups can identify existing issues as well as provide guidance on preferred cycling routes.

Destinations:

Understanding where people want to go is an important starting point. Destinations such as employment centers, schools, parks, civic buildings, transit stops, and retail centers should be identified as priorities for providing safe bicycle access.

Barriers and Constraints:

Bikeway planning rarely begins with a clean slate. As a result, the successful implementation of a bikeway plan requires a keen understanding of barriers and constraints. Barriers can be physical, such as a freeway or stream crossing, and can also include things like right-of-way availability, funding, or community opposition.

Route Selection:

Determining goals, evaluating existing conditions, identifying destinations, and overcoming barriers can lead to the selection of routes that are safe, convenient, accessible, and comfortable. Proposed routes should be verified through field work to evaluate suitability.

Implementation:

An implementation strategy prioritizes improvements, establishes estimated time lines, and identifies funding resources and assigned agencies responsible for the implementation.

Evaluation:

Regular evaluation helps determine whether the planning goals are being achieved and whether there are additional issues that need to be addressed. Evaluation also provides an opportunity for the community to celebrate progress.

Routine Accommodation:

Bicycle facilities, including bicycle parking, should be routinely considered and included in all capital and maintenance projects to provide "complete streets", as feasible.

Protecting the Environment:

Encouraging bicycling reduces automobile usage and its harmful effects on the environment.

GOALS

The Jefferson County Trails and Greenway Implementation Guidelines are established to help accomplish the following goals:

- Support and promote consistency of standards and guidelines for county trails and greenways along proposed corridors specified in the ***Jefferson County Trails and Greenway Plan*** dated October 2012.
- Create a framework for future trail planning by a variety of agencies, jurisdictions and developments within Jefferson County.
- Increase user safety, comfort and convenience by recommending appropriate design considerations for pathways, signage, facilities, landscaping, etc.
    - o Increase user safety by recommending appropriate trail widths, sight lines, clear zones, and other design considerations.
    - o Increase user comfort by recommending trail widths, rest areas, trail surfaces and other elements that contribute to a positive user experience.
- Promote universal access to users with a broad range of skill levels and abilities, including children, older adults and people with disabilities.
- Recognize a variety of trail users including pedestrians, cyclists, in-line skaters and equestrians.
- Ensure compatibility with roads and highways by setting forth specific guidelines for trail facilities within highway rights-of-way.
- Minimize impact to sensitive natural resources including wetlands, slopes, soils, and cultural resources by setting forth recommendations for trail location and mitigation strategies.
- Ensure the long-term viability of trails by recommending good planning and design practices.

BICYCLIST ABILITY LEVELS

The bicycle implementation guidelines are based on the Federal Highway Administration (FHWA) system of designating three levels of bicycle ability for design purposes.

The three FHWA levels are:

Group A – Advanced Bicyclists
Group B – Basic Bicyclists
Group C – Children Bicyclists

Each group is defined as:

Group A – Advanced Bicyclists

Advanced bicyclists are experienced cyclists who can ride under most traffic conditions. They 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 and shared roadways with motorists over separated bicycle facilities such as shared use paths.

Like motorists, Group A bicyclists prefer quick, direct access to destinations with a minimum of stops. Often, these conditions are found only on collectors and arterials, and most bicyclists found on these roads are Group A. These cyclists prefer to have sufficient roadway space to eliminate the need for either themselves or a passing motor vehicle to shift position. They desire to operate at maximum speed with minimum delays.

Group B – Basic Bicyclists

Basic bicyclists are casual or new adult and teenage riders who are less confident in their ability to operate in traffic without special provisions for bicycles. Group B cyclists consist of commuter, recreational, and utilitarian bicyclists. Most people fall into this category. Some will improve to Group A over time. Group B cyclists prefer comfortable access to destinations on bike-friendly roads, on separate bike paths, or on well-defined bike lanes or shoulders along arterials and collectors.

Group C – Children Bicyclists

Children bicyclists are pre-teen riders whose bicycling activity is initially monitored by their parents. Their bicycling requires access from residential areas to schools, recreation facilities, and shopping, on quiet residential streets or well-defined bicycle facilities. Before age 10, bike-riding choices are extremely limited and parental supervision is extremely important. While sidewalks are the best choices for such young riders, sidewalks have many problems if promoted for bicycle use by Groups A and B. The following are preferred for Group C cyclists:

- Access to key destinations surrounding residential areas, including schools, recreation facilities, shopping, or other residential areas.
- Residential streets with low motor vehicle speed limits and volumes.
- Well-defined separation of bicycles and motor vehicles on arterial and collector streets or separate bike paths.

DEVELOPING A BICYCLE NETWORK PLAN

The following discussion details a planning process intended to identify a network of routes where special bicycle facility treatments should be employed to meet the needs of bicyclists.

Many model planning processes could be used to select routes and design facility treatments to accommodate bicyclists. Chapter 1 of the AASHTO Guide contains several suggestions for establishing a bicycle planning program. The following process is but one example. It consists of six steps:

STEP 1	Establish performance criteria for the bicycle network.
STEP 2	Inventory the existing bicycle facility and roadway system.
STEP 3	Identify bicycle travel desire lines and corridors.
STEP 4	Evaluate and select specific route alternatives.
STEP 5	Select appropriate design treatments.
STEP 6	Evaluate the finished plan against the established performance criteria.

Step 1 - Establish Performance Criteria for the Bicycle Network:

Performance criteria define the important qualitative and quantitative variables to be considered in determining the desirability and effectiveness of a bicycle facility network. These can include:

Accessibility: This is measured by the distance a bicycle facility is from a specified trip origin or destination, the ease by which this distance can be traveled by bicycle, and the extent to which all likely origins and destinations are served. Some urban communities have adopted a criterion of having a bicycle facility within 1 mi of every residence. More importantly, no residential area or high priority destination (school, shopping center, business center, or park) should be denied reasonable access by bicycle.

Directness: Studies have shown that most bicyclists will not use even the best bicycle facility if it greatly increases the travel distance or trip time over that provided by less desirable alternatives. Therefore, even for Group B/C bicyclists, routes should still be reasonably direct. The ratio of directness to comfort as well as perceived safety involved in this tradeoff will vary depending on the characteristics of the bicycle facility (how desirable is it?), its more direct alternatives (how unpleasant are they?), and the typical user's needs (in a hurry?, business or pleasure trip?).

Continuity: The proposed network should have as few missing links as possible. If gaps exist, they should not include traffic environments that are unpleasant or threatening to Group B/C riders, such as high-volume or high-speed motor vehicle traffic with narrow outside lanes.

Route Attractiveness: This can encompass such factors as separation from motor traffic, visual aesthetics, and the real or perceived threat to personal safety along the facility.

Low Conflict: The route should present few conflicts between bicyclists and motor vehicle operators.

Cost: This would include the cost to both establish and maintain the system.

Ease of Implementation: The ease or difficulty in implementing proposed changes depends on available space and existing traffic operations and patterns.

Step 2 - Inventory Existing System:

Both the existing roadway system and any existing bicycle facilities should be inventoried and evaluated. The condition, location, and level of use of existing bicycle facilities should be recorded to determine if they warrant incorporation into the proposed new network or if they should be removed. If existing bicycle facilities are to be used as the nucleus of a new or expanded network, the inventory should note which improvements to the existing portions of the network may be required to bring the entire new network up to uniform design and operations standards.

A simple inventory of the roadway system could be based on a map of the annual average daily traffic (AADT) counts on each road segment within a community or region. A more complex inventory could include factors such as the number of traffic lanes, the width of the outside lane, the posted speed limit or actual average operating speed, the pavement condition, and certain geometric and other factors (e.g., the frequency of commercial driveways, grades, and railroad crossings).

Step 3 - Identify Bicycle Travel Corridors:

Predicting bicycle travel corridors for a community is not the same as identifying the routes that bicyclists currently use. Instead, travel corridors can be thought of as "desire lines" connecting neighborhoods that generate bicycling trips with other zones that attract a significant number of bicycling trips.

For motor vehicle traffic, most peak morning trips are made between residential neighborhoods and employment centers. In the evening peak, the opposite is true. In the evening or on weekends, the pattern of trip generation is much more dispersed as people travel to shopping centers, parks, and the homes of friends or relatives.

Estimating these trip flows for an entire city can be a complex, time-consuming effort requiring significant amounts of raw data and sophisticated computer models. Fortunately, transportation planning for bicycles is much simpler. Unlike traditional transportation planning that attempts to predict travel demands between future zones on as-yet-unbuilt streets and highways, bicycle planning attempts to provide for bicycle use based on existing land uses assuming that the present impediments to bicycle use are removed. These desire lines are, in fact, well represented by the traffic flow on the existing system of streets and highways.

The underlying assumption is that people on bicycles want to go to the same places as do people in cars (within the constraints imposed by distance), and the existing system of streets and highways reflects the existing travel demands of the community. Furthermore, most adults have a mental map of their community based on their experience as motor vehicle operators. Thus, they tend to orient themselves by the location of major streets and highways.

Therefore, a good way to estimate desire lines for bicyclists and to project bicycle trips is based on the existing pattern of motor vehicle flows. The simplest way to do this is to multiply the AADT of each segment of the road system by the bicycle mode split (the percentage of all trips that are made by bicycle) for the community or region. The census will provide bicycle mode splits for census tracts and entire communities. Mode split estimates of total trips by bicycle in American cities have ranged between 3 and 11 percent.

Again, it is important to note that the resulting map may not be a representation of where cyclists are now, but is instead a reflection of where bicyclists wish to go. The actual travel patterns of cyclists are heavily influenced by their perception of the bicycling environment they face. Uncomfortable or threatening bicycling conditions will cause these bicyclists to alter route choice from their most preferred alignment, choose a different travel mode, or not make the trip at all. Thus, the task of the transportation planner for bicycling is to ask, "Where are the bicyclists now?" and "Where would they be if they could go where they preferred?"

Although this use of existing traffic flows is a useful overall predictor of bicyclists' desire lines, a few special situations may require adjustments to the corridor map:

- Schools, especially colleges and universities, can generate a disproportionately large share of bicycle trips. This is especially true for campuses where motor vehicle parking is limited.
- Parks, beaches, libraries, greenways, rivers and lakesides, scenic roads, and other recreational facilities attract a proportionately higher percentage of bicycle trips.

Step 4 - Evaluate and Select Specific Route Alternatives:

The corridor identification procedure identifies desire lines for bicycle travel between various locations. The next step is to select specific routes within these corridors that can be designed or adapted to accommodate group bicyclists and provide access to and from these locations. The aim is to identify the routes that best meet the performance criteria established in the first step of this planning process.

Typically, this step and the selection of appropriate design treatments are highly interactive processes. The practicality of adapting a particular route to accommodate bicyclists may vary widely depending upon the type of design treatment selected. For example, a less direct route may become the best option if comparatively few, inexpensive, and easily implemented design improvements are required.

Therefore, steps 4 and 5 should be approached as an iterative loop in which both route selection and design treatment are considered together to achieve a network that is highly advantageous to the user, is affordable, has few negative impacts on neighbors and other nonusers, and can be readily implemented.

In summary, the selection of a specific route alternative is a function of several factors, including:

- The degree to which a specific route meets the needs of the anticipated users as opposed to other route options.
- The possible cost and extent of construction required to implement the proposed bicycle facility treatment.
- The comparative ease of implementing the proposed design treatment. For example, one option may entail the often unpopular decision to alter or eliminate on-street parking while another does not.
- The opportunity to implement the proposed design treatment in conjunction with a planned highway construction or reconstruction project.

A more inclusive list of factors to be considered in the selection of a specific route is presented in the AASHTO Guide for the Development of Bicycle Facilities.

Step 5 - Select Appropriate Design Treatments:

The principal variables affecting the applicability of a design treatment are:

- The design bicyclist. Is the proposed route projected to be used primarily by Group A bicyclists, or is it intended to also serve as part of a network of routes for Group B/C bicyclists?
- The type of roadway project involved on the selected route. Is the roadway scheduled for construction or reconstruction, or will the incorporation of design improvements be retrofitted into existing geometrics or right-of-way widths?
- Traffic operations factors. The most significant traffic operations factors for determining the appropriateness of various design treatments are:
    - Traffic volume
    - Average motor vehicle operating speeds
    - Traffic mix
    - On-street parking
    - Stopping Sight distance
    - Number of access points i.e. intersections and driveways

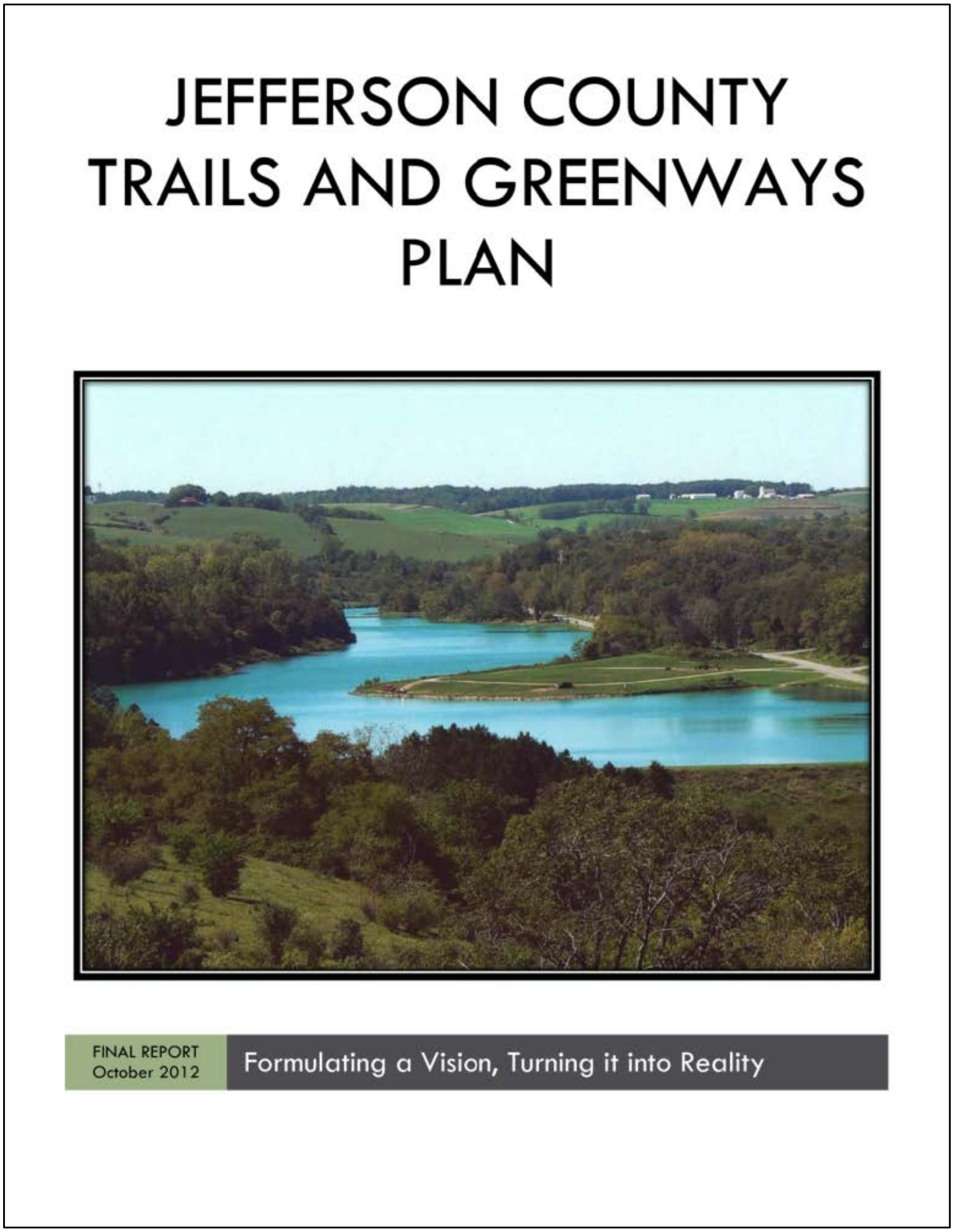
Step 6 - Evaluate the Finished Network Plan Using the Established Performance Criteria:

Will the proposed network meet the criteria established at the start of the planning process? If it does not meet most of these criteria, or inadequately meets a few critical goals, either the proposal will require further work, or the performance criteria must be modified. In the latter case, the planning process as a whole should be reviewed to determine if previously discarded routes should be reconsidered. They may now be more preferred options in light of the newly modified criteria.

This reality check is important. Many well-considered proposals fail when it is determined that the finished product no longer meets its established objectives.

PROPOSED TRAIL CORRIDORS

The proposed bikeway and trail corridors for future off-street bikeways and trails are depicted in the **Jefferson County Trails and Greenway Plan**. The designated routes and recommended connection points are intended to be conceptual in nature and do not detail specific alignments, trail use, trail surface and other detailed design issues. The actual alignments of trails and detailed planning efforts within these corridors will be determined as specific trail projects are proposed and implemented.


JEFFERSON COUNTY
TRAILS AND GREENWAYS
PLAN

FINAL REPORT
October 2012

Formulating a Vision, Turning it into Reality

TRAIL NAMING

Naming trails in Jefferson County may seem quite simple. However, some names, such as "Mud Slinger Trail", could imply improper use of the trail resource, poor environmental conditions, or access to a dangerous area. To avoid these situations, following some simple guidelines may help.

- Avoid naming trails after people.
- Avoid names that describe adverse conditions or improper use of the resource.
- Do not use a name that may be disrespectful to any cultural or ethnic group.
- Names that imply a destination or end point such as "Overlook Trail" or "Waterfall Trail" may be appropriate but don't use these types of names if the feature is an attractive nuisance or does not have appropriate viewing facilities.
- Names that have historic meaning are often used as long as there is no implication of an attractive nuisance or damage to cultural or archaeological resources.
- Trail names can be colors as long as the trail markers are coordinated to match the name. Don't name a trail the "Blue Trail" and then mark it with a different colored trail marker.
- Trail names that describe a natural feature may be used. Names such as "Ridge Trail", "Rim Trail" and "Valley Trail" are appropriate.

CHAPTER 2 – TYPES OF PATHWAYS & TRAILS

BIKEWAY FACILITIES

A bikeway network will be comprised of several primary bikeway facility types, none of which provide a one-size-fits-all solution. Different bikeway types are favored by different cyclists, and each performs best in certain contexts. The bikeway types defined hereon should be used as building blocks in the bikeway network, working together to provide safe and comfortable operating space for cyclists in a variety of settings.

Five basic types of facilities are used to accommodate bicyclists:

- Shared lane: shared motor vehicle/bicycle use of a "standard"-width travel lane.
- Wide outside lane: an outside travel lane with a width of at least 14 feet.
- Shared paved shoulder: a paved portion of the roadway to the right of the edge stripe designed to serve bicyclists.
- BIKE LANE: There are three basic types of bike lanes.
    - Standard Bike lane: a portion of the roadway located adjacent to the traveled way of motor vehicles that is designated by striping, signing, and/or pavement markings for preferential or exclusive use of bicycles.
    - Buffered Bike lane: a portion of the roadway separated or buffered from the traveled way of motor vehicles that is designated by striping, signing, and/or pavement markings for exclusive use of bicycles.
    - Cycle Tract: a portion of the roadway designated for exclusive use of bicycles. A cycle tract separates bicyclists from motor vehicles with a physical space or barrier.
- Separate bike path: a facility physically separated from the roadway and intended for bicycle use. A separate bike path facility type includes dedicated bicycle paths, shared-use paths and multi-use path or trail facilities that allow bicycles.

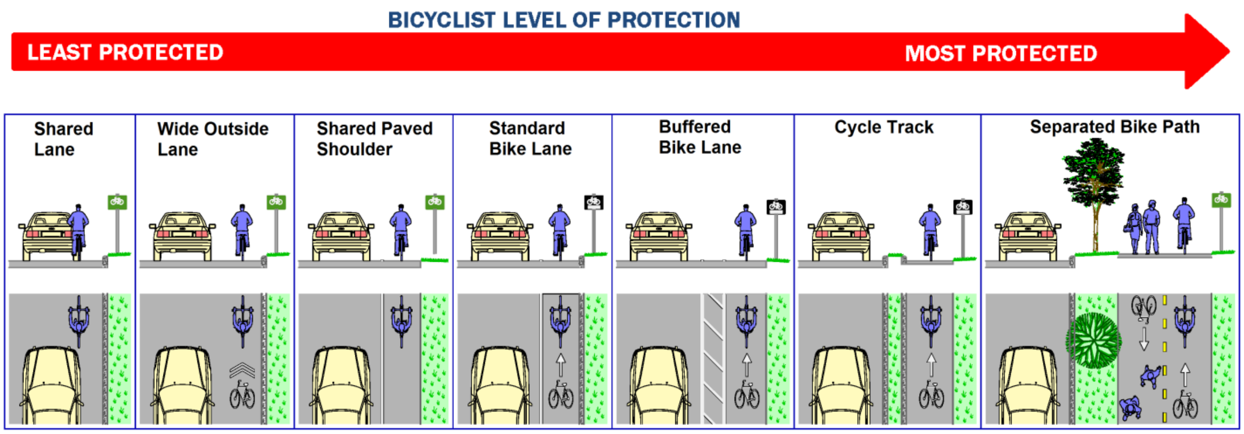
An important consideration regarding the five types of facilities designs is whether or not they should be designated, by pavement markings and/or signs, as bicycle facilities. Bicyclists prefer designated facilities for bicycle use. Therefore, when bike lanes or shoulders are provided to serve bicyclists, some designation should be included.

When design treatments are provided primarily to serve Group A riders, designation is optional. In some cases, it may be more desirable not to designate the facility for bicycle use. For instance, if bicycle use is permitted on the shoulder of a controlled access freeway, it is usually not appropriate to designate this roadway as a bicycle facility unless this route serves as the only link between two points.

Another consideration involves minor or marginal roadway improvements for bicyclists, such as providing a narrow (less than 4 feet) shoulder. This can significantly improve riding conditions for Group A bicyclists and should be considered if no better treatment is possible. However, this shoulder width is less than the minimum called for in virtually all design specifications and therefore should not be designated as a bicycle facility. Where a paved shoulder is intended to be designated as a "bicycle facility", it is essential the design conform to the State standard or AASHTO guidelines.

Bicycle Level of Treatment Considerations

The following graphic illustrates 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 or roadway. In some corridors, it may be desirable to construct facilities to a higher level of treatment than those recommended in relevant planning documents in order to enhance 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.



BICYCLE LEVEL OF TREATMENTS

SHARED LANES (SHARED ROADWAY)

Shared lanes are streets and highways or roadways with no special provision for bicyclists. Shared lanes typically feature 12-feet lane widths or less with no shoulders, allowing cars to safely pass bicyclists only by crossing the center line or moving into another traffic lane.

In residential areas with low motor vehicle traffic volumes and average motor vehicle speeds of less than 30 mph, this should present no problem for Group A riders, and will normally be adequate for Group B/C bicyclists to use as well if the lane width is at least 12 feet. Where the existing lane width is less than 12 feet, additional lane width or lower operating speed is advisable.

With higher speeds and traffic volumes, shared lanes become less attractive routes, especially to Group B/C riders. As the AASHTO Guide for the Development of Bicycle Facilities notes, however:

> *"To varying extents bicycles will be ridden on all highways where they are permitted. All new highways, except those where bicyclists will be legally prohibited, should be designed and constructed under the assumption that they will be used by bicyclists. Bicycle safe design practices should be followed to avoid the necessity for costly subsequent improvements."*

The AASHTO Guide identifies other actions by which bicycle use of shared roadways, regardless of lane widths or type of user, can be improved. Bicycle-safe drainage grates, smooth pavement, bicycle-safe railroad crossings, and traffic signals that respond to bicycles are all listed as examples.

Shared lanes do not usually require any special signing for bicyclists. Exceptions to this include situations when:

- Specific destinations or potential alternate routes for bicyclists need to be shown.
- A short gap exists between special bicycle facilities, such as between two trails, and bicyclists require signing to lead them to the next facility.

Signage and pavement markings are used to indicate a shared lane. The shared signed roadway which shared lanes is usually signed with a "Share The Road" warning sign. It is a standard bicycle warning sign with a "Share The Road" sign under the warning sign.

The advantages of a shared signed roadway include:

- Few or no modifications to existing roadways create a cost-effective project.
- Roadway debris is swept to the curb by motor vehicle movement, keeping the lane clear for cyclists.

Considerations for a shared signed roadway include:

- Motorists and cyclists must share the lane, which can be uncomfortable for some motorists and less-experienced cyclists.
- Wide lanes may inadvertently encourage faster vehicle speeds.

Designated Shared Roadway or Signed Bicycle Route

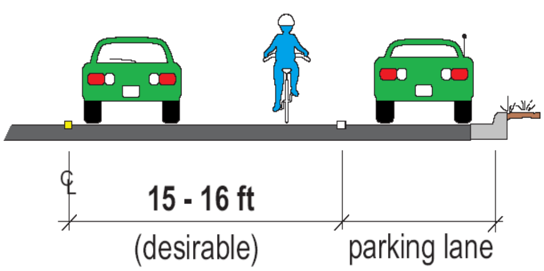
A designated shared roadway is identified by signage as a preferred route for bicycle use. These are typically identified for advanced or experienced (Group A) bicyclists. However, basic (Group B) bicycle riders will be interested in riding on bikeways which are designated facilities that encourage bicycle use. A signed bicycle route is typically designated along more lightly traveled residential or secondary roads and is indicated by signs with or without a specific route number. This type of facility should have appropriate directional and informational markers. Signed bicycle routes are designated by the jurisdiction having authority over the roadways included in the bicycle route system. Bicycle routes are often utilized to direct bicyclists to less-congested roadways that may follow the same general corridor as more heavily traveled arterial highways.

WIDE CURB LANES OR WIDE OUTSIDE LANES

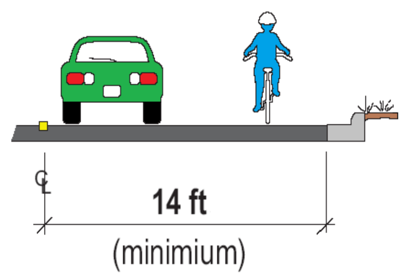
Shared roadways, with or without multiple lanes, often have a curb lane that is wider than other travel lanes to accommodate shared bicycle and vehicular traffic traveling side by side. This is called a wide curb lane or wide outside lane.

Wide curb lanes, or wide outside lanes, can be defined as right-most through traffic lanes that are substantially wider than 12 feet. The pavement width on signed shared roadway needs to have, as a minimum, a sufficient width of smoothly paved surface to permit the shared use of the roadway by bicycles and motor vehicles.

Most practitioners agree that 14 feet, usually measured from the lane stripe to the edge of the gutter pan rather than the curb face, is the minimum width necessary to allow a bicyclist and motorist to share the same lane without coming into conflict, changing lanes, or potentially reducing the motor vehicle capacity of the lane. Where traffic speeds exceed 40 mph, and when annual average daily traffic exceeds 10,000, 15 feet wide or 16 feet wide lanes are considered desirable.



WIDE OUTSIDE LANE
WITH PARKING LANE



WIDE OUTSIDE LANE
NO PARKING

Wide curb lanes have three widely accepted advantages. They can:

- Accommodate shared bicycle/motor vehicle use without reducing the roadway capacity for motor vehicle traffic.
- Minimize both the real and perceived operating conflicts between bicycles and motor vehicles.
- Increase the roadway capacity by the number of bicyclists capable of being accommodated.

Many other benefits are claimed for wide outside lanes ranging from assisting turning vehicles in entering the roadway without encroaching into another lane to better accommodating buses and other wider vehicles.

Wide outside lanes require the least amount of additional maintenance of the different facilities. The sweeping effect of passing motor vehicles and routine highway maintenance is usually enough to keep the lane free of debris and in good condition for bicycling.

Wide outside lanes are especially valuable for, and often favored by, Group A riders who are not easily intimidated by high traffic volumes and speeds. These riders do not require a designated space in which to ride or designation of the street as a bike route. The same is not true for Group B/C riders. Except on residential or low-volume streets, wide outside lanes are not generally sufficient to provide the degree of comfort and safety required by less skilled bicyclists or children and will do little to encourage them to ride.

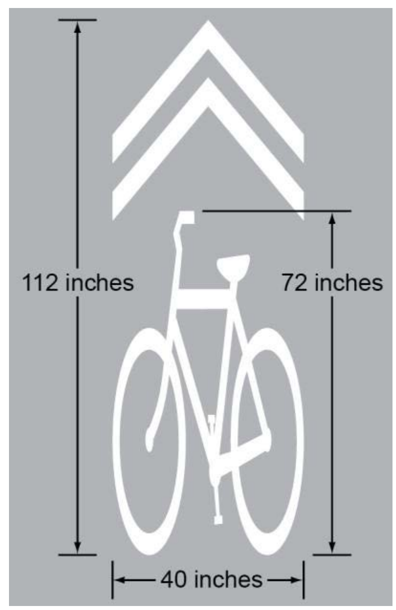
Wide curb lanes will be most applicable in urban areas on major streets where Group A riders will likely be operating. If no alternative route exists for Group B/C riders, a bike lane or shared paved shoulder should typically be used.

Shared Lane Pavement Markings (OMUTCD 9C.07)

Shared lane pavement markings enhance the visibility of bicycles along collector and minor arterial roadways. Shared use markings are intended to help bicyclists position themselves in lanes too narrow for a motor vehicle and a bicycle to travel side by side within the same traffic lane, to encourage safe passing of bicyclists by motorists, to reduce the chance of a bicyclist's impacting the open door of a parked vehicle in a shared lane with on-street parallel parking, to alert road users of the lateral location bicyclists may occupy, and to reduce wrong-way bicycling. The treatment is used when there is not enough space for bike lanes.

Sharrow

A sharrow is a common shared lane pavement marking used to indicate a shared lane. The marking, which includes a bicycle with a double chevron symbol, guides cyclists to ride in the correct direction and encourages proper positioning on the roadway away from parked cars and gutters. Sharrows provide a visible reminder that the lane is intended to be shared by motorists and cyclists.



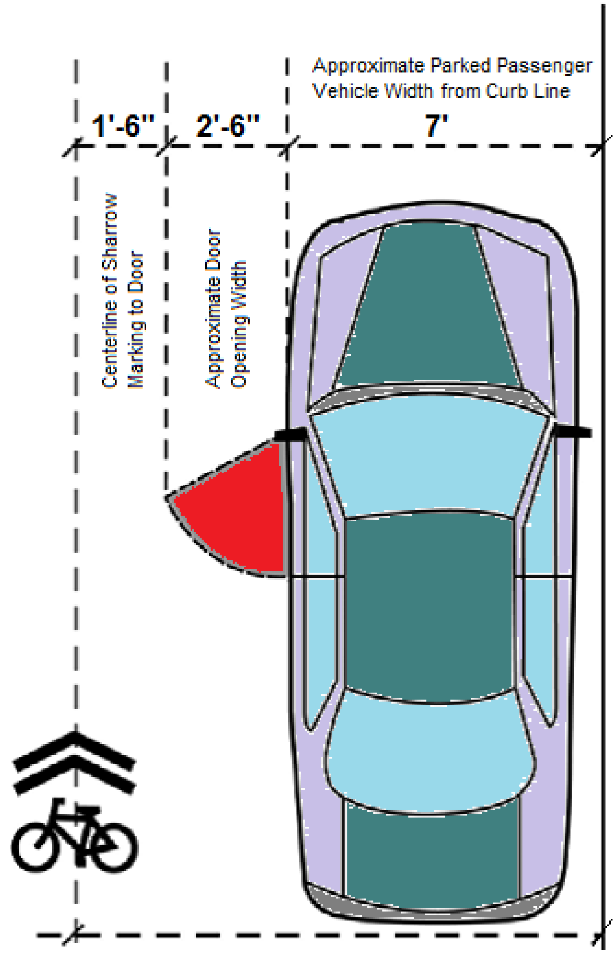
Shared Lane Marking
OMUTCD Figure 9C-9

<u>Advantages:</u>

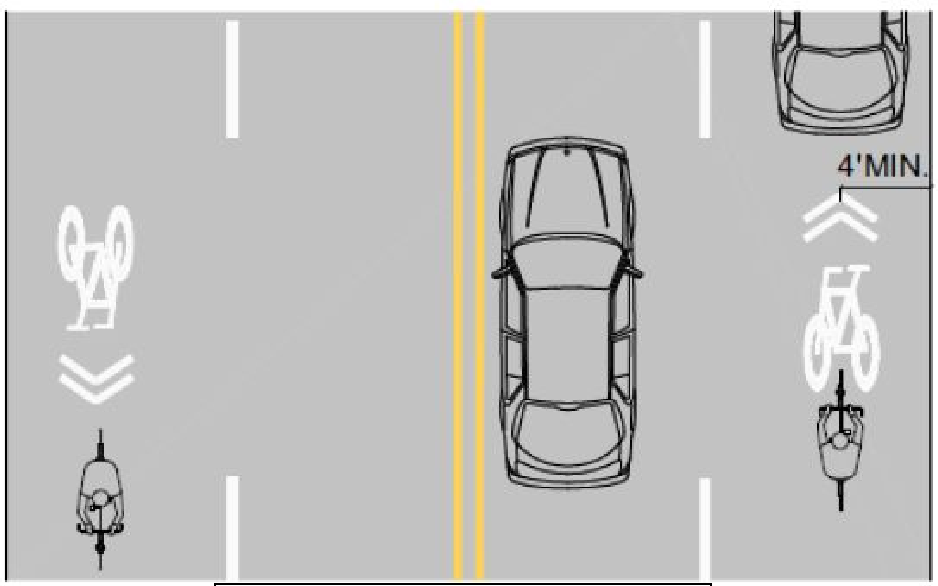
- Assist bicyclists with lateral positioning in a shared lane with on-street parallel parking in order to reduce the chance of a bicyclist's impacting the open door of a parked vehicle,
- Assist bicyclists with lateral positioning in lanes that are too narrow for a motor vehicle and a bicycle to travel side by side within the same traffic lane,
- Alert road users of the lateral location bicyclists are likely to occupy within the traveled way,
- Encourage safe passing of bicyclists by motorists, and Reduce the incidence of wrong-way bicycling.

Guidance:

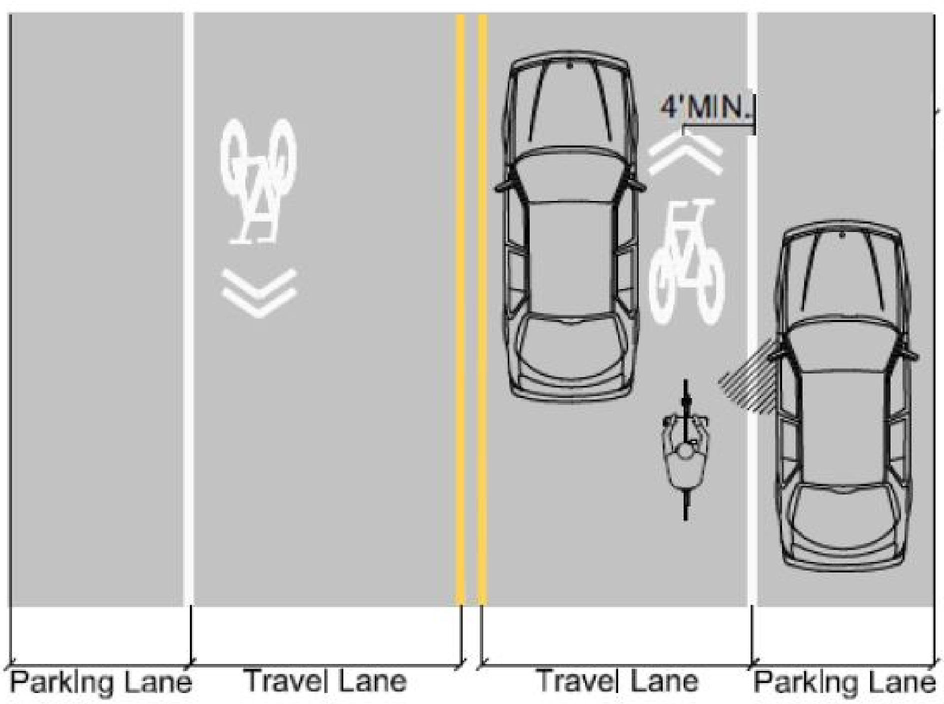
- Sharrows are not to be used on shoulders or in designated bike lanes.
- Sharrows with signage should be implemented on corridors with speed limits at or below 35 mph.
- Sharrows should be placed at 11 feet or greater from the face of curb to avoid the door zone when there is street side parking.
- Sharrows should be used in combination with informational and wayfinding signage, "share the road" signage, or bike route signage to deliver a clear message to both bicyclists and motorists.
- Sharrows should be placed immediately after an intersection and spaced at intervals not greater than 250 feet thereafter (2 markings on a short block, 3 on a long block).
- If used on a street without on-street parking that has an outside travel lane that is less than 14 feet wide, the centers of the Sharrows should be at least 4 feet from the face of the curb, or from the edge of the pavement where there is no curb.



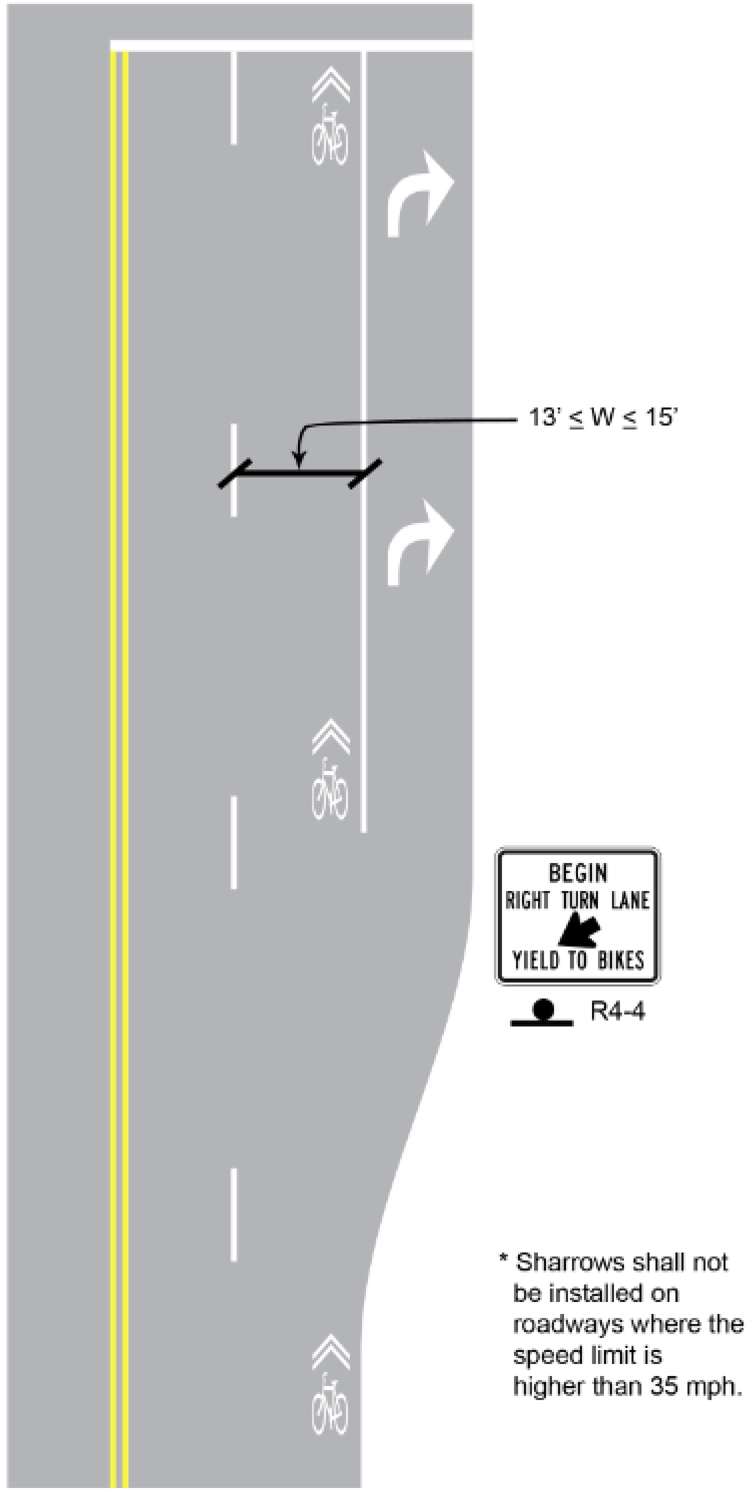
A "BICYCLE MAY USE FULL LANE" sign may be used in addition to or instead of the Shared Lane Marking to inform road users that bicyclists might occupy the travel lane.



SHARROW PLACEMENT
WITHOUT PARKING



SHARROW PLACEMENT
WITH PARKING



SHARROW PLACEMENT

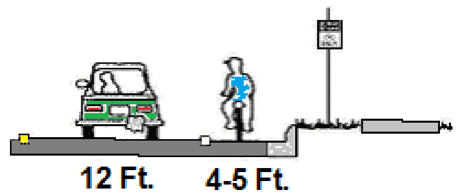
INTERSECTION APPROACHES

BIKE LANES

A bike lane is a portion of a roadway which is designated by striping, signage, and pavement markings for the preferential or exclusive use by bicyclists. Bike lanes are distinguished from other traffic lanes with special signage and pavement markings. Bicyclists benefit by having a lane that is separate from motor vehicle traffic.

Bike lanes should be used on streets that have higher speeds and/or traffic volumes. Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions and facilitate predictable behavior and movements between bicyclists and motorists. A bike lane is distinguished from a cycle track in that it has no physical barrier (bollards, medians, raised curbs, etc.) that restricts the encroachment of motorized traffic.

Conventional bike lanes run curbside when no parking is present, adjacent to parked cars on the right-hand side of the street or on the left-hand side of the street in specific situations. Bike lanes should always be one-way facilities carrying traffic in the same direction as adjacent motor vehicle traffic, and that they should not be placed between parking spaces and the curb. Bike lanes typically run in the same direction of traffic, though they may be configured in the contra-flow direction on low-traffic corridors necessary for the connectivity of a particular bicycle route.



The configuration of a bike lane requires a thorough consideration of existing traffic levels and behaviors, adequate safety buffers to protect bicyclists from parked and moving vehicles, and enforcement to prohibit motorized vehicle encroachment and double-parking. Bike Lanes may be distinguished using color, lane markings, signage, and intersection treatments.

Bike lane stripes are intended to promote the orderly flow of traffic, by establishing specific lines of demarcation between areas reserved for bicycles and lanes to be occupied by motor vehicles. This effect is supported by bike lane signs and pavement markings. Bike lane stripes can increase bicyclists' confidence that motorists will not stray into their path of travel if they remain in the bike lane. Likewise, with more certainty as to where bicyclists will be, passing motorists are less apt to swerve towards opposing traffic in making certain they will not hit bicyclists.

Bike lanes have a strong channelizing effect on motor vehicles and bicycles. The impact of marked bike lanes is particularly important for Group B/C riders. The lanes offer a designated and visible space for bicyclists and can be a significant factor in route choice.

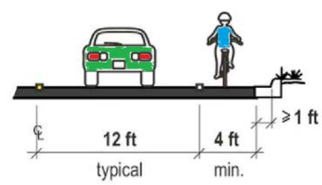
Use of bike lanes does require an additional commitment to maintenance. Bike lanes must be kept free of debris and loose gravel to remain useful and safe, which may require routine sweeping beyond that necessary for streets with no bike lanes. As motor vehicles are not allowed in the lanes, they cannot sweep the debris aside as they do in ordinary 12 feet traffic lanes. The bike lane stripes themselves must be maintained on a regular basis.

Other important issues include the presence of on-street parking and the number and complexity of intersections. Parking movements and car doors opening have the potential to cause crashes, so bike lanes should be designed to minimize these conflicts.

For example, on streets with parking lanes:

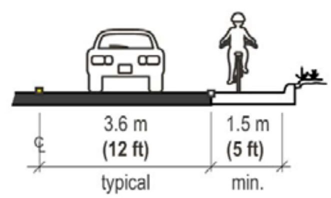
- Bike lanes should be at least 5 feet wide, at least 4 feet of which should lay to the left of the gutter pan seam.
- Bike lanes should be placed between the outer motor vehicle lane and the parking lane.
- Both sides of the bike lane should be marked. The right-hand marking will demarcate where motor vehicles should park and will allow sufficient clearance for a bicyclist to avoid car doors that are opening.
- Bike lanes are not advisable where angled parking is present.

Bicycle lanes can complicate turning movements at intersections if they encourage bicyclists to keep right and motorists to keep left, regardless of their turning intentions. Some jurisdictions have addressed this issue by ending bike lanes in advance of intersections, or by striping the lane with a broken, rather than a solid, white line in advance of the intersection to encourage merging.



NO PARKING
WITH STANDARD
GUTTER PAN

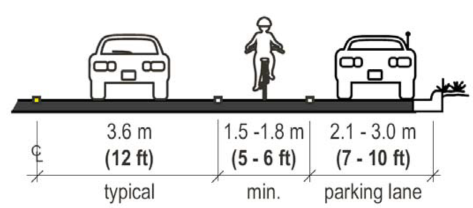
Bike lanes have wide applicability, especially for Group B/C riders in urban areas. When average daily traffic flows exceed 10,000 or average motor vehicle speeds exceed 30 mph, 5 feet bike lanes will attract and serve Group B/C riders better than wide outside lanes or other design treatments.



NO PARKING
WITH NO GUTTER SEAM
IN BIKE LANE

Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions and facilitate predictable behavior and movements between bicyclists and motorists.

The configuration of a bike lane requires a thorough consideration of existing traffic levels and behaviors, adequate safety buffers to protect bicyclists from parked and moving vehicles, and enforcement to prohibit motorized vehicle encroachment and double-parking. Bike Lanes may be distinguished using color, lane markings, signage, and intersection treatments.



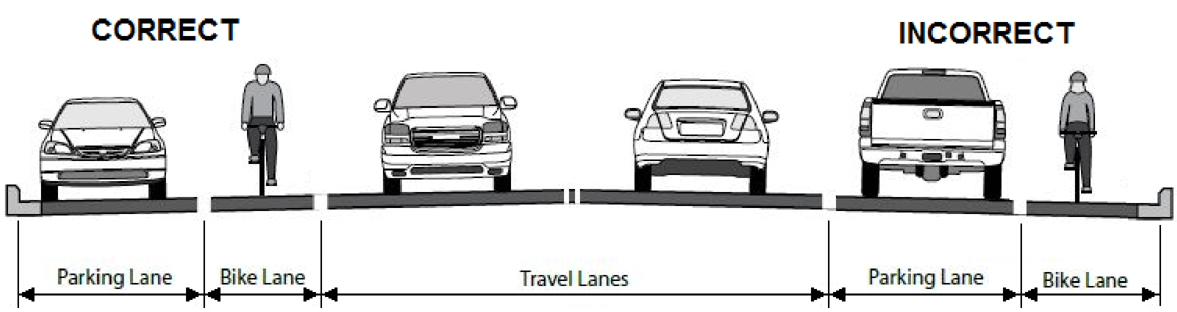
WITH ON STREET
PARKING ALLOWED

The dimensions of a bike lane are recommended to have a width of 5 to 6 feet preferred (4 to 5 feet minimum) with a vehicular travel width of 11 to 12 feet. Bike lanes should be 6 feet wide when adjacent to a 7 feet wide parking lane. The 4 feet minimum width should be considered only for street retrofits without parking lanes and no other reasonable option.

All bike lanes need to have a minimum 2.5 feet of clear surface to safely navigate alongside gutter pans, drainage grates and other surface obstructions. While a gutter pan may be considered a part of a bike lane if there is no pavement edge drop, it should not be considered as a clear surface for the bike lane. A curbside bike lane is recommended to include at least 5 feet of space outside of a gutter pan to allow for snow storage.

Considerations for a bike lane include:

- Bike lanes must be clear of hazards such as parked cars, sewer grates, road seams, and debris.
- Changing roadway conditions and contexts can pose design challenges when right-of-way is limited.
- Periodic street-cleaning is needed to remove collected debris.
- While the bicycle lane has been shown to increase overall predictability of traffic flow, the bicycle lane can erroneously increase a cyclist's confidence that motorists will not stray into his path of travel.
- Bicycle lanes must be clearly marked for one-way travel, with designated facilities provided on both sides of a street or roadway.
- Special consideration must be given to the treatment of bicycle lanes at major intersections. Bike lanes tend to complicate left turn movements for bicyclists at intersections. It is also difficult for bicyclists continuing straight while motor vehicular traffic is turning right.
- Sufficient width from the face of the curb should be provided so bicyclists can avoid conflicts with motorists while not having to travel too close to the curb.
- Two-way bicycle lanes located on one side of a roadway is not generally recommended. Per AASHTO, "Bicycle lanes should be one-way facilities and carry bicycle traffic in the same direction as adjacent motor vehicle traffic. Two-way bicycle lanes on one side of the roadway are not recommended when they result in bicycles riding against the flow of motor vehicle traffic. Wrong way riding is a major cause of bicycle crashes and violates the rules of the road stated in the Uniform Vehicle Code."
- Bicycle lanes placed between the curb and on-street parking are not generally recommended. Per AASHTO, "Bicycle lanes should always be placed between the parking lane and the motor vehicle lanes. Bicycle lanes should never be placed between the parking lane and the curb lane. This can create obstacles for bicyclists from opening car doors and poor visibility at intersections and driveways, and they prohibit bicyclists from making turns."



Retrofit Guidelines for Bicycle Lanes

Retrofitting existing streets and roadways in urbanized area to accommodate bicycles are needed because the population densities and land uses that support bicycling are most often found in urbanized areas. Existing roadways without bicycle lanes or additional operating width will often act as barriers for bicycle travel throughout the region.

Local jurisdictions should be engaged to help determine which portions of a roadway need to meet the AASHTO minimum lane widths and which can be made less without significantly affecting the safety or operation of the roadway for shared bicycle and motor vehicle use. An experienced traffic engineer should be engaged to review each deviation from the minimum required lane widths for acceptability, which may in some cases, requires a traffic study to be performed.

To retrofit a street or roadway with on-street parking to accommodate bicycles the need for on-street parking should be evaluated. A roadway's primary function is to move goods and people and not to store stationary vehicles. In some cases, parking may only be needed on one side to accommodate residences and/or businesses. Parking can sometimes be narrowed to 7 feet adjacent to a bicycle lane and especially in areas where traffic calming is being considered.

In situations where there are four lanes of traffic consisting of two lanes in each direction and there are a significant number of left-turn movements a road diet may be feasible to add bicycle lanes. The road diet will consist of re-striping the pavement for a continuous left-turn lane, two travel lanes, and two bicycle lanes.

Existing pavement can sometimes be retrofitted to include bicycle lanes if the older existing pavement markings can be removed and replaced to establish better use of existing pavement width to accommodate bicyclists and motorized vehicles.

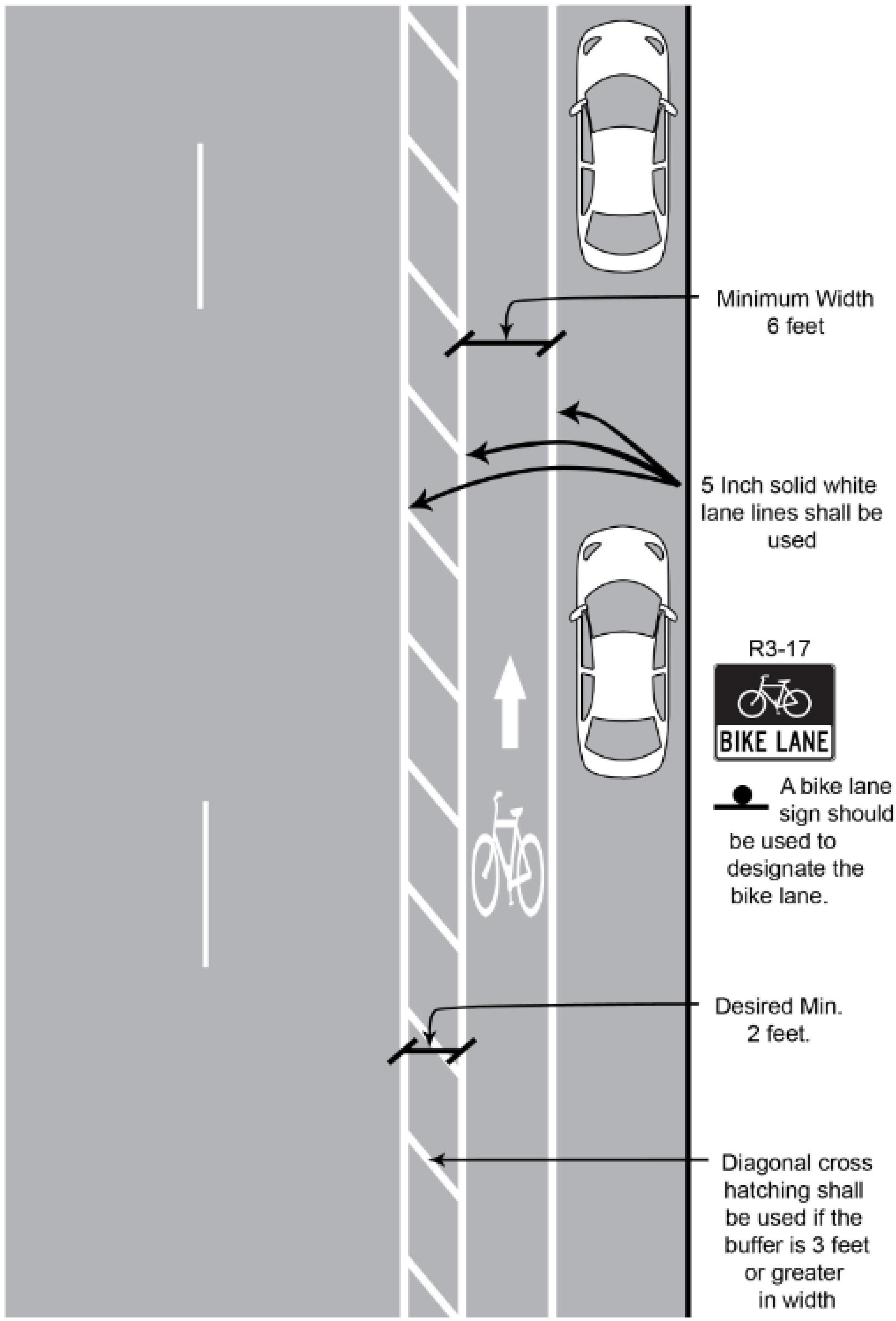
Retrofitting existing roadways and streets to include bicycle lanes can often be accomplished as the total pavement width stays the same or is wider. Adding bicycle lanes can enhance safety as: motor vehicle lanes are offset away from curbs and obstacles, travel lanes are bettered defined, parking is removed, turning radii is increased at intersections and driveways, and sight distances are improved.

Guidance for retrofitting streets includes:

- Evaluate the existing street space for modifications that provide space for bicycle lanes. Modifications to consider include:
    - Widening existing pavement and moving curbs outward.
    - Narrowing and removing existing lanes.
    - Narrowing medians.
    - Reduce planter strip widths.
- Analyze the effect of street modifications for bike lanes.
    - Pedestrian needs such as sidewalk widths, buffer widths, crossing widths and median widths.
    - Traffic volume, roadway capacity and traffic speed.
    - On-street parking demand and turnover.
    - Large truck and bus traffic.
    - Street/roadway curvature and alignment

Buffered Bicycle Lane

Buffered Bike Lanes are conventional bicycle lanes paired with a designated buffer space separating the bicycle lane from the adjacent motorized vehicle travel and/or parking lane. Support and guidance for buffered bike lanes is provided in the OMUTCD in its guidelines for buffered preferential lanes and NACTO Urban Bikeway Design Guide, Second Edition.



The advantages of a buffered bike lane include:

- Provides greater shy distance between motor vehicles and bicyclists.
- Provides space for bicyclists to pass another bicyclist without encroaching into the adjacent motor vehicle travel lane.
- Provides a greater space for bicycling without making the bike lane appear so wide that it might be mistaken for a travel lane or a parking lane.
- Appeals to a wider cross-section of bicycle users.
- Encourages bicycling by contributing to the perception of safety among users of the bicycle network

Considerations for a buffered bike lane include:

- Buffer striping may require additional maintenance when compared to a conventional bicycle lane.
- Buffered bike lanes should be maintained free of potholes, broken glass, and other debris.
- If trenching is to be done in the bicycle lane, the entire bicycle lane should be trenched so that there is not an uneven surface or longitudinal joints.

Uphill Bicycle Climbing Lane

Uphill bike lanes (also known as "climbing lanes") enable motorists to safely pass slower-speed bicyclists, thereby improving conditions for both travel modes. Uphill bike lanes should be 6-7 feet wide (wider lanes are preferred because extra maneuvering room on steep grades can benefit bicyclists). They can be combined with Shared Lane Markings for downhill bicyclists who can more closely match prevailing traffic speeds.

An uphill cycle climbing lane is typically placed on retrofit projects as newly constructed roads should provide adequate space for bicycle lanes in both directions of travel. Accommodating an uphill bicycle lane often includes delineating on-street parking (if provided), narrowing travel lanes and/or shifting the centerline if necessary.

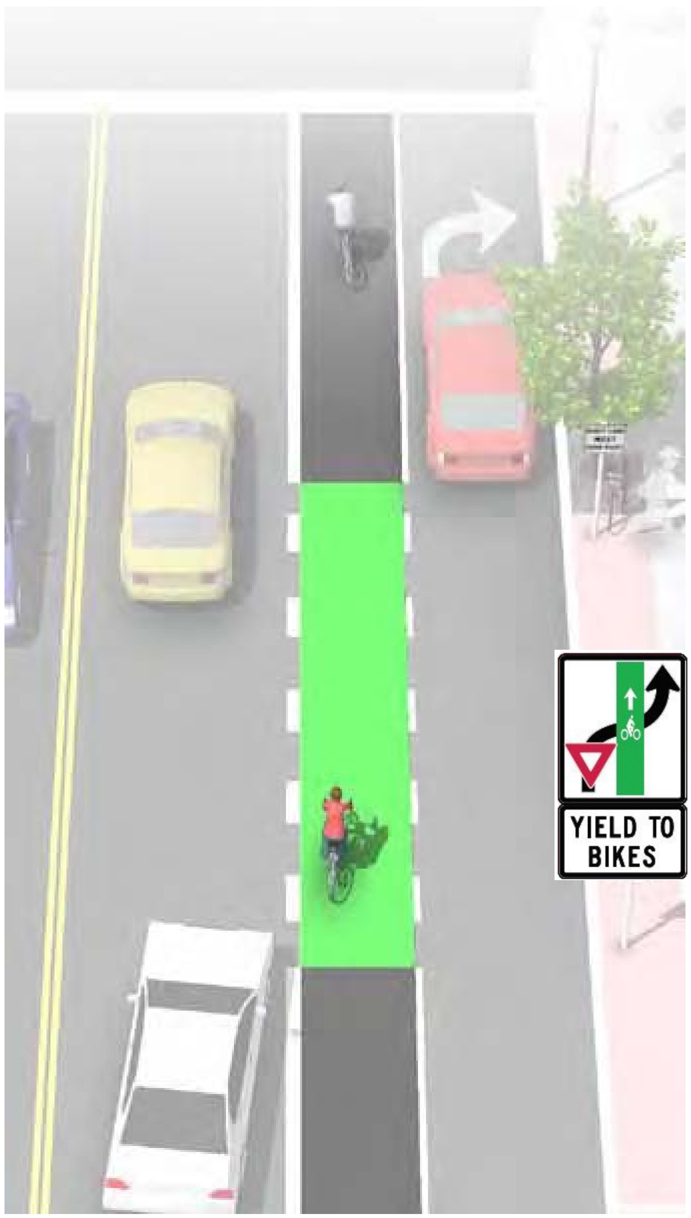
Colored Bike Lanes in Conflict Areas

Colored pavement within a bicycle lane increases the visibility of the facility and reinforces priority of bicyclists in conflict areas.

Evaluations found that significantly more motorists yielded to bicyclists and slowed or stopped before entering the conflict area after the application of the colored pavement when compared with an uncolored treatment.

Guidance:

- The colored surface should be skid resistant and retro-reflective.
- A "Yield to Bikes" sign should be used at intersections or driveway crossings to reinforce that bicyclist have the right-of-way in colored bike lane areas.



CYCLE TRACKS

A cycle track is an exclusive bicycle 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. In situations where on-street parking is allowed, cycle tracks are located to the curb-side of the parking (in contrast to bike lanes).

Cycle tracks may be one-way or two-way, and may be at street level, sidewalk level or at an

intermediate level. If at sidewalk level, a curb or median separates them from motor traffic, while different pavement color/texture separates the cycle track from the sidewalk. If at street level, they can be separated from motor traffic by raised medians, on-street parking or bollards.

A two-way cycle track is desirable when more destinations are on one side of a street (therefore preventing additional crossings), if the facility connects to a path or other bicycle facility on one side of the street, or if there is not enough room for a cycle track on both sides of the road.

By separating bicyclists from motor traffic, cycle tracks can offer a higher level of comfort than bike lanes and are attractive to a wider spectrum of the public.

Intersections and approaches must be carefully designed to promote safety and facilitate left-turns from the right side of the street.

Cycle track protection is provided through physical barriers and can include bollards, parking, a planter strip, an extruded curb, or on-street parking. Cycle tracks using these protection elements typically share the same elevation as adjacent travel lanes.

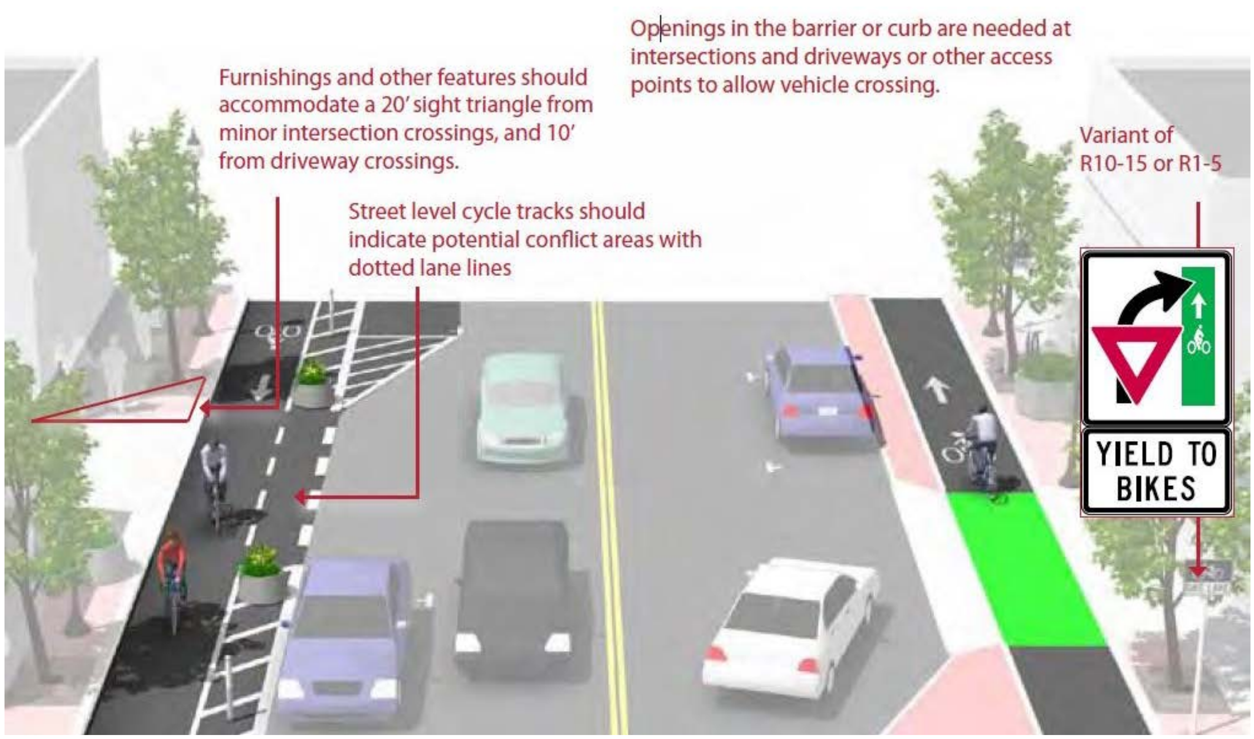
Raised cycle tracks may be at the level of the adjacent sidewalk or set at an intermediate level between the roadway and sidewalk to separate the cycle track from the pedestrian area.

Cycle tracks should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles. Cycle tracks located on one-way streets have fewer potential conflict areas than those on two-way streets.

Sidewalks or other pedestrian facilities should not be narrowed to accommodate the cycle track as pedestrians will likely walk on the cycle track if sidewalk capacity is reduced. Visual and physical cues (e.g., pavement markings & signage) should be used to make it clear where bicyclists and pedestrians should be travelling. If possible, separate the cycle track and pedestrian zone with a furnishing zone.

Cycle Tracks at Driveways and Minor Street Crossings

The added separation provided by cycle tracks creates additional considerations at intersections that should be addressed. At driveways and crossings of minor streets a smaller fraction of automobiles will cross the cycle track. Bicyclists should not be expected to stop at these minor intersections if the major street does not stop.



At driveways and minor street crossing locations, bicyclist visibility is important, as a buffer of parked cars or vegetation can reduce the visibility of a bicyclist traveling in the cycle track. Markings and signage should be present that make it easy to understand where bicyclists and pedestrians should be travelling. Access management should be used to reduce the number of crossings of driveways on a cycle track. Driveway consolidations and restrictions on motorized traffic movements reduce the potential for conflict.

Guidance:

- If the cycle track is raised, maintain the height of the cycle track through the crossing, requiring automobiles to cross over.
- Remove parking 30 feet prior the intersection.
- Use colored pavement markings and/or shared lane markings through the conflict area.
- Place warning signage to identify the crossing.

Cycle Tracks at Major Street Crossings

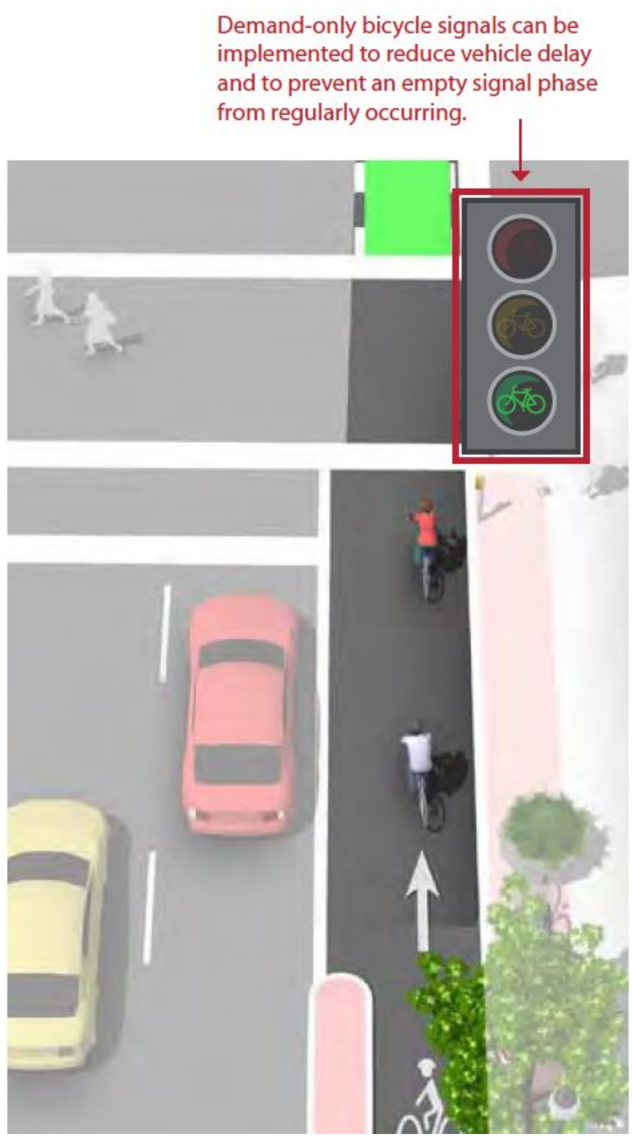
Cycle tracks approaching major intersections must minimize and mitigate potential conflicts and provide connections to intersecting facility types. Cycle track crossings of signalized intersections can also be accomplished through the use of a bicycle signal phase which reduces conflicts with motor vehicles by separating bicycle movements from any conflicting motor vehicle movements.

Signalization utilizing a bicycle signal head can also be set to provide cycle track users a green phase in advance of vehicle phases. The length of the signal phase will depend on the width of the intersection.

The same conflicts exist at non-signalized intersections. Warning signs, special markings and the removal of on-street parking in advance of the intersection can raise visibility and awareness of bicyclists.

Guidance:

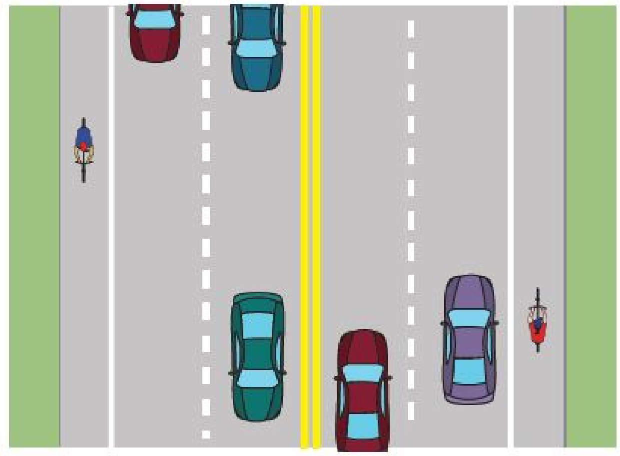
- Drop cycle track buffer and transition to bike lane 16' in advance of the intersection.
- Remove parking 16' -50' in advance of the buffer termination.
- Use a bike box or advanced stop line treatment to place bicyclists in front of traffic.
- Use colored pavement markings through the conflict area.
- Provide for left-turning movements with two-stage turn boxes.
- Consider using a protected phase bicycle signal to isolate conflicts between bicyclists and motor vehicle traffic.
- In constrained conditions with right turn only lanes, consider transitioning to a shared bike lane/turn lane.



SHARED SHOULDERS

AASHTO's "A Policy on the Geometric Design of Highways and Streets" defines a shoulder as:

> *… the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use and for lateral support of the subbase, base and surface courses.*



Shoulders are also useful as places for bicyclists to ride. AASHTO and many States explicitly recognize that adding or improving shoulders is often the best way to accommodate bicyclists—especially in rural areas.

Shoulders should be a minimum of 4 feet wide when designed to accommodate bicycle travel. While Group A (and even some Group B/C cyclists) will benefit from shoulder widths as narrow as 1 or 2 feet, these facilities should not be signed for bicyclists if they fail to meet prevailing State and/or AASHTO guidelines.

As traffic speeds increase, traffic mix includes heavier vehicles and trucks, and traffic volumes rise, added width is desirable. For example, once vehicle speeds exceed 40 mph and AADT is 2,000 or more, shoulder widths should usually be increased to 6 feet.

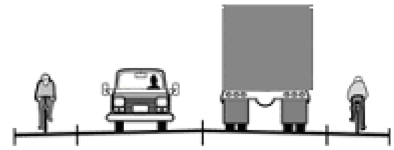
In urban areas, wide curb lanes are usually preferable to shoulders for Group A riders and bike lanes are usually preferable for Group B/C riders. One exception will be on high-speed urban arterials (more than 50 mph) where 6 feet shoulders will serve Group A riders better than wide curb lanes. Bike lanes, if used along these routes, should also be at least 6 feet wide.

Bicyclists will use shoulders where they are paved and maintained to the same surface standard as regular travel lanes. Where shoulders are designated as bicycle facilities, it is essential to keep them in good repair and free of debris, which often means a regular inspection and maintenance program.

Other surface irregularities, such as rumble strips, textured paving, and raised lane markers and reflectors, should be avoided on routes explicitly intended for bicyclists as they can cause falls or force bicyclists to ride in the traffic lane. Where the use of rumble strips is necessary, they should be located so as to leave a portion of the shoulder free for bicyclists.

Additional attention should be given to accommodating bicycle use on controlled access freeway shoulders where such use provides the only crossing of a river, lake, freeway, or other barrier.

Signed Shoulder Bicycle Route



A signed shoulder bicycle route is the portion of the roadway that is contiguous with the traveled way and includes the pavement shoulder. This area is often used for the accommodation of stopped vehicles and for emergency use. In Ohio, bicyclists are permitted to ride on the roadway's shoulder of non-freeways, and the shoulders may be signed as bicycle routes.

Highway shoulders better allow motor vehicles and bicyclist to coexist. Paved shoulders allow for bicycles to be separated from traffic using an edge line, but some corridors allow off-street parking. Shoulders will accommodate stalled vehicles and allow for safer traffic enforcement. Many bridges have paved shoulders with parking restricted.

Most paved shoulders are not signed and are located in rural and suburban locations. Some urban roadways have been treated with an edge line to achieve the same benefits of a paved shoulder. In urban areas a paved shoulder should not be substituted for a bike lane.

The dimensions of a signed shoulder bicycle route are recommended to have a preferred width of 6 to 8 feet (4 to 6 feet minimum) with a vehicular travel width of 11 to 12 feet.

The advantages of a signed shoulder bicycle route include:

- Improves safety for motorists while also providing space for cyclists.
- Accommodates cyclists in rural areas.
- Beneficial to provide a motorist breakdown area and traffic maintenance during construction or during an emergency.

Considerations for a signed shoulder bicycle route include:

- Vehicular speed and sight-distance must be considered.
- Paved shoulders should be included on both sides of the roadway.
- Rumble strips used to warn motorists often interfere with operating space for cyclists unless properly designed.
- Regular maintenance and debris removal is essential if paved shoulders are to be useful to bicyclists.
- A signed shoulder bicycle route should be signed to prohibit parking especially in urban areas.

A signed shoulder bicycle route may be used on roadways with:

- Designated bicycle routes and/or popular bicycling roadways.
- ADT's that typically exceed 2000 ADT.
- Average vehicle speeds that exceed 35 mph.

Design Considerations:

- Signed shoulders should be at least 4 feet in width.
- Signed shoulders should be at located 5 feet from the face of the guardrail, curb, or other roadside barriers.

- Signed shoulders should be 8 feet wide if motor vehicle speeds exceed 50 mph or if the percentage of trucks, buses and/or recreational vehicles is high.
- Shoulders should be wider where higher volumes of bicyclists are expected.

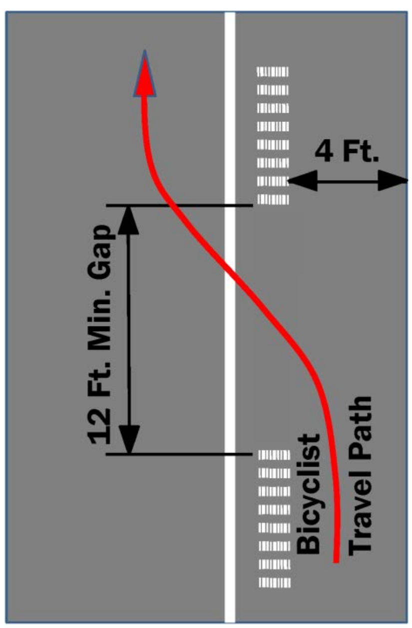
Rumble Strips

Rumble strips provide positive guidance for motorists on roadways. However, they present a difficult obstruction and potential hazard to bicyclists. Use of rumble strips should be avoided or designed to be more compatible for bicyclists.

Based on the Ohio Department of Transportation Location and Design Manual, Volume One Section 605.1.6 Bicycle Considerations: "Rumble strips generally should not be used on the shoulders of roadways designated as bicycle routes or having substantial volumes of bicycle traffic, unless the shoulder is wide enough to accommodate the rumble strips and still provide a minimum clear path of 4 feet from the rumble strip to the outside edge of the paved shoulder or 5 feet to adjacent guardrail, curb or other obstacle.

In areas designated as bicycle routes or having substantial volumes of bicycle traffic, the rumble strip pattern should not be continuous but should consist of an alternating pattern of gaps and strips, each 10 feet in length. Also, gaps should be provided in the rumble strip pattern ahead of intersections, crosswalks, driveway openings, and at other locations where bicyclists are likely to cross the shoulder."

According to AASHTO; "Frequent gaps should be provided to allow bicyclists to escape the shoulder to avoid blockages or to turn left. Gaps should be a minimum of 12 feet and spaced every 40 to 60 feet."



AASHTO Guidance

TYPES OF SEPARATE BIKE PATHS

Separate bike paths are also known as "multi-use trails" or "greenways," even though they are slightly different facilities. A trail typically runs along an independent right of way such as an abandoned railroad corridor, and a greenway is a park-type corridor of land that may or may not incorporate a trail within its boundaries.

Two-way bike paths should be at least 10 feet wide. Where possible, especially if bicycle or pedestrian traffic is expected to be high, paths should be a minimum of 12 feet wide. Given the variety of users of most bike paths, 8 feet widths will generally not be adequate. However, under the following conditions an 8 ft. path is acceptable according to the AASHTO Design Guide, Section 5.2.1:

- Bicycle traffic is expected to be low, even on peak days or during peak hours
- Pedestrian use of the facility is not expected to be more than occasional
- Horizontal and vertical alignments provide safe and frequent passing opportunities
- The path will not be regularly subjected to maintenance vehicle loading conditions that would cause pavement edge damage

One-way bike paths have a limited application as without strict enforcement, they will be used as two-way facilities. If they are provided, however, they should be at least 5 feet wide.

Bike paths are a valuable addition to the highway system and to the range of facilities available to planners and engineers seeking to improve conditions for all categories of bicyclist. They can serve both a transportation and recreation function and have proven to be significant generators of bicycle use. Both Group A and Group B/C riders (as well as other non-motorized users) can benefit from the absence of motor vehicle traffic on these paths.

Bike paths are not inherently more dangerous than other bicycle facilities if they are well designed, thoughtfully applied, and adequately maintained. For example, paths should not have their continuity destroyed by frequent motor vehicle cross flows and intersections with highways. These increase potential conflicts and are likely to make the route less popular with riders seeking to maintain momentum, particularly Group A.

Where adequate, uninterrupted right of way is available, separate bike paths can be used to good effect in providing long, continuous routes for commuting or recreation trips, access to destinations not otherwise available to bicyclists, and as cut-through between buildings and other breaks in the street network.

The implementation of a countywide trails and greenway system requires consistency of design and quality. Trail users throughout Jefferson County should expect safe, user-friendly and accessible trail facilities that provide quality environments and experiences that are inclusive of all people.

In an effort to encourage design consistency, this document establishes a framework of design standards, planning guidelines, policies and recommendations for future implementation of off-street natural surface trails and multi-use trails within Jefferson County's proposed network of future parklands and trail corridors.

The guidelines set forth in this document are based on current recognized standards and recommendations by national, state, and municipal transportation and recreation agencies and are designed to serve as a prelude to more detailed trails planning efforts.

SHARED-USE, SIDEPATH, OR MULTI-USE TRAIL

Multi-use trails are physically separated from motor vehicle traffic, except at road crossings. Trails are usually built either within an independent right-of-way (such as a utility corridor or abandoned railway), or along easements across private lands. Multi-Use trails accommodate a variety of users – including pedestrians, bicyclists, and other user groups – for both recreation and transportation purposes. Except for low volume, short segments, paved trails should be 10 feet wide. AASHTO provides extensive trail design guidelines – with road intersections being of particular importance.

A shared-use path is physically separated from motorized vehicular traffic by an open space or barrier and either within the roadway right-of-way or within an independent right-of-way. Shared use paths may also be used by pedestrians, skaters, wheelchair users, joggers, and other non-motorized users. A separate shared-use path provides transportation links, recreation areas, and outdoor fitness opportunities for a variety of users, including bicyclists and pedestrians. While the separation from motor vehicles provided by shared-use paths reduces the risk of some crash types, careful design is required to ensure safe roadway and driveway crossings and safe interactions among the different path users.

Physically separated facilities such as sidepaths or shared-use paths for pedestrians and bicyclists are a great way to encourage more walking and bicycling. Shared-use paths provide off-road connections that can be used for recreation and commuting. These paths are often found along waterways, abandoned or active railroad and utility rights-of-way, limited access highways, or within parks and open space areas.

Along high-speed, high-volume roads, sidepaths might be safer and more desirable than sidewalks or bike lanes. Sidepaths might also be used when existing roads provide the only rights-of-way available. Paths immediately adjacent to roadways may cross numerous intersecting roads and driveways that create hazards and other problems for path users. Creating safe and accessible intersections between paths and the road network is one of the most challenging and critical aspects of design.

Shared-use paths tend to attract bicyclists with a wide range of skill levels, including young children. A path, even if designed primarily as a bicycle facility, also likely will attract a mix of other users including pedestrians, in-line skaters and others, depending on location and access. Special care must therefore be taken in the planning and design of such paths to provide a satisfactory experience for bicyclists, and safe sharing of the facility with a variety of users of differing speeds and abilities.

Good planning and design of shared-use paths is crucial to provide for safe use, to maximize long-term benefits, and reduce future maintenance problems (such as erosion, water or edge deterioration). Pathways will never replace the road network for connecting to destinations, and some cyclists will prefer the road network for most riding due to the more direct route and fewer conflicts with slower path users.

A good process that incorporates input from future users and property owners may be the most important element to realizing a path that will maximize recreational and travel benefits and minimize potential problems. Good initial design is also crucial for minimizing future maintenance costs and problems. The process should engage the community so that the facility that is ultimately designed fits with local needs and with the local cultural, natural, and built environments.

The advantages of a shared use path include:

- A sense of safety and comfort given to less experienced cyclists and children.
- Can provide long distance travel along continuous corridors such as stream and former rail lines.
- Can serve as recreational amenities, especially when adjacent to natural features.

Considerations for a shared use path include:

- Direct access to destinations may be limited.
- Shared spaces with pedestrians can be difficult to navigate. All users should be encouraged to stay right. An exception may be paths along waterways or other features that capture the attention of pedestrians. In these instances, markings and/or signage may be used to encourage pedestrians to stay on the side of the path closest to the attraction to reduce conflicts associated with pedestrians crossing the pathway.
- Shared use paths are not recommended along roadways with frequent driveway or intersection crossings.
- Since nearly all shared use paths are used by pedestrians, they need to meet the accessibility requirements of the Americans with Disabilities Act (ADA).
- In areas with extremely heavy pathway volume, it may be necessary to segregate pedestrians from wheeled users.
- At intersections with roadways, paths should be signed, marked, and/or designed to discourage or prevent unauthorized motorized access. Bollards have been used by many path owners to prevent unauthorized vehicle access.
- Limited access highways often require fencing or other forms of controlling access. Shared-use paths constructed within these corridors, likely require fencing.

The design of a multi-use path or trail should account for a degree of incompatibility between bicyclists and pedestrians. The degree of incompatibility between bicyclists and pedestrians is a function of density, speed congestion and the presence of crossing and turning opportunities. The more pedestrian traffic a trail receives, the less suitable it will be for bicycle traffic. In most situations, a multi-use trail with significant pedestrian traffic should not be designated as a bicycle facility.

Linear trails though greenbelts may have lower pedestrian densities in areas away from entry points and significant pedestrian attractors such as picnic areas and playgrounds. The lower pedestrian areas may suffice for multi-use if sufficient width is provided and adequate sight distances and clearances are maintained.

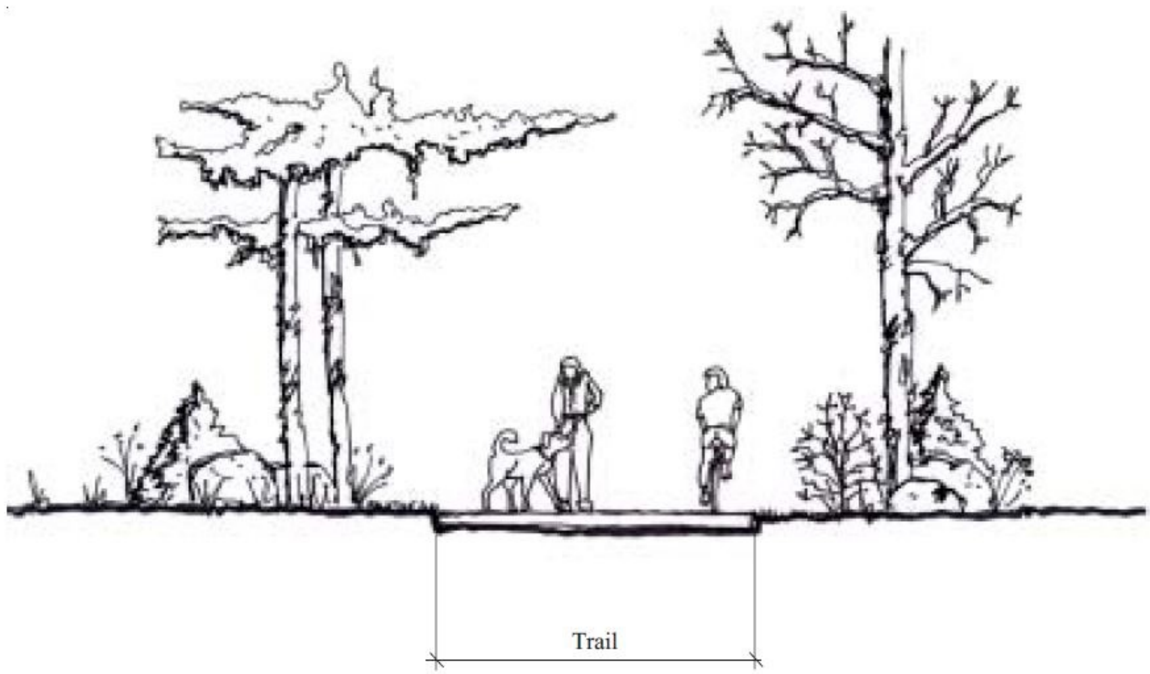
If higher pedestrian volumes are expected on a multi-use trail, as in the case in urban areas, consideration should be given to providing a separate pedestrian trail adjacent to, but separate from, the bicycle trail. In some cases, a simple stripe between the pedestrian and bicycle area may suffice. In other cases, providing a physical barrier and/or unpaved shoulder between the pedestrian and bicycle area may be necessary.

In areas with considerable congestion and diffuse patterns of pedestrian cross traffic, including pedestrians crossing in many places and at many angles, it may be more appropriate to direct bicycle traffic around the congested area and discourage fast bicycling within the congested area.

MULTI-USE TRAIL, SINGLE TRACK

The single track multi-use trail is the simplest type of trail facility and is planned to accommodate all desired use modes. However, it is important to control the uses that take place, as incompatible user modes will cause serious conflict on a relatively narrow trail.

Design guidelines for single tracks are simple. Of the user modes planned, the most



Multi-Use Trail, Single Track

stringent guidelines shall apply. If pedestrians are one of the user modes anticipated to use the trail, then the guidelines should meet the needs of older adults and people with disabilities.

Whether equestrians can be accommodated on this type of trail should be determined on a case by case basis. In rural areas which would not experience heavy bicycle and pedestrian traffic, a single track trail could safely accommodate equestrians.

Using a single path trail for bicycles and horses is not recommended because horses startle easily and may kick out suddenly if they perceive a bicyclist as a danger. A separate path for horses that is shielded by a visual barrier or has adequate separation from the bicycle path is recommended.

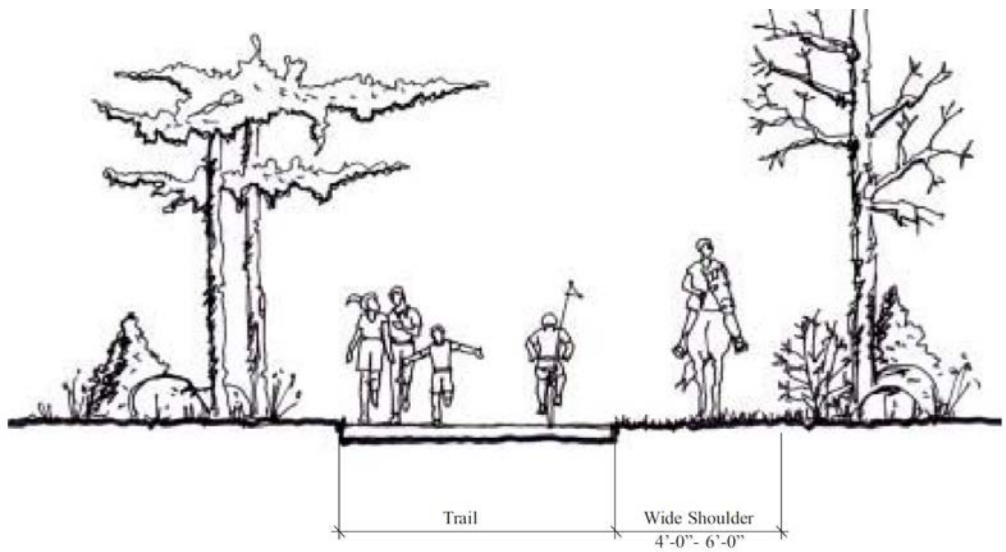
DOUBLE PATH TRAILS

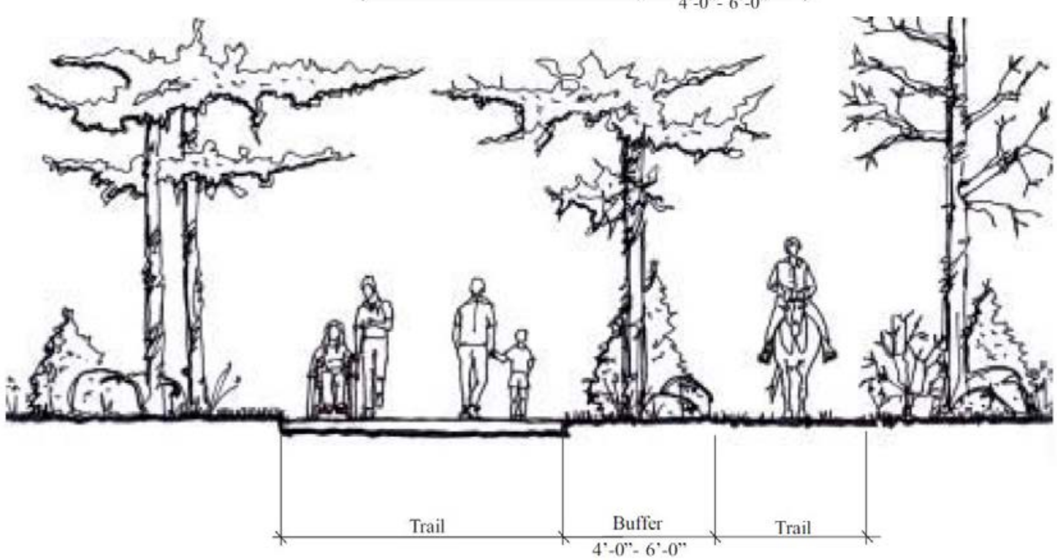
A double path trail is recommended to be used when incompatible use modes coexist in the same corridor. They accommodate a variety of modes on two or more different trails, with each trail tailored to the unique needs of the use mode.

When designing a double path corridor, there are two factors to consider, the design of each pathway and the separation of the various trails. Similar to the single path trail, the design of each pathway should follow the most stringent guidelines based on the user modes that it will accommodate.

If there is enough right-of-way that is mostly cleared, a corridor with two parallel trails can be considered to provide greater separation of the various use modes.

A double path trail will be especially useful where equestrians are permitted. The primary trail could accommodate pedestrians, bicyclists and skaters, while the second trail could accommodate equestrians or mountain bike riders. The second trail could have a wider grass shoulder of 4-6 feet rather than the minimum 2-4 feet or it could be separated from the primary trail by a buffer strip of vegetation.





BICYCLING & IN-LINE SKATING TRAILS

Following is an overview of bicycle and in-line skating trails. More detailed information will be presented in other sections of this document.

WIDTH AND CLEARANCE: These trails should have a clear width of 12 feet. A minimum width of 10 feet should only be used when site specific conditions do not allow the preferred width. A minimum clearance of 2 feet is required on each side of the trail. The clearance includes a 2 foot shoulder graded to a maximum slope of 1:6. The vertical clearance is a minimum of 8 feet.

Surface and Drainage: These will be hard surface trails comprised of asphalt or concrete. The cross slope should be 2% for drainage and accessibility.

When a trail is constructed on the side of a hill, it may be necessary to build a swale on the uphill side of the trail. The swale will intercept the surface drainage of water from the hill and prevent erosion of the trail. When necessary, a catch basin and culvert would be required to direct the water under the trail.

Alignment and Profile: Cycling and skating trails require gentler grade transitions due to higher travel speeds. The horizontal alignment of bicycle trails is derived from a combination of several factors. It is computed with the super-elevation of the trail surface (its cross slope as a percentage), the coefficient of friction between the tires and the surface, the lean angle and the speed of the bicycle. The Guide for the Development of Bicycle Facilities prepared by AASHTO lists the recommended minimum radii for a lean angle of 15 degrees (the casual cyclist) at various design speeds. In general, a design speed of 20 mph can be used. It is unlikely that the casual cyclist would travel faster than this on a mixed use trail.

Curve radii smaller than recommended may be used due to narrow right of way, topography, or other considerations. Standard curve warning signs and pavement markings should be installed in accordance with the Ohio Manual of Uniform Traffic Control Devices (OMUCTD). The adverse effect of sharper curves can be partially offset by widening the pavement in the affected area.

Vertical grades on shared use trails should be a maximum of 5% when possible. Grades greater than 5% makes a long ascent difficult to climb, and may encourage speeds on the descent that exceed the safety capability of the rider. Designers may need to exceed the 5% grade for short distances, due to topography or other limiting factors. As a general guide, the grades and lengths are recommended by AASHTO.

The following options are offered by AASHTO to mitigate excessive grades:

- On longer grades, an additional 4 to 6 feet of trail width will permit slower cyclists to dismount and walk.
- Provide signage to alert cyclists to the maximum percent of grade.
- Provide recommended descent speed signage.
- Exceed minimum stopping sight distances.
- Exceed minimum horizontal clearances, recovery areas or protective railing.
- Use a wider path width (4 to 6 feet) and switchbacks to contain the speed of descending cyclists.

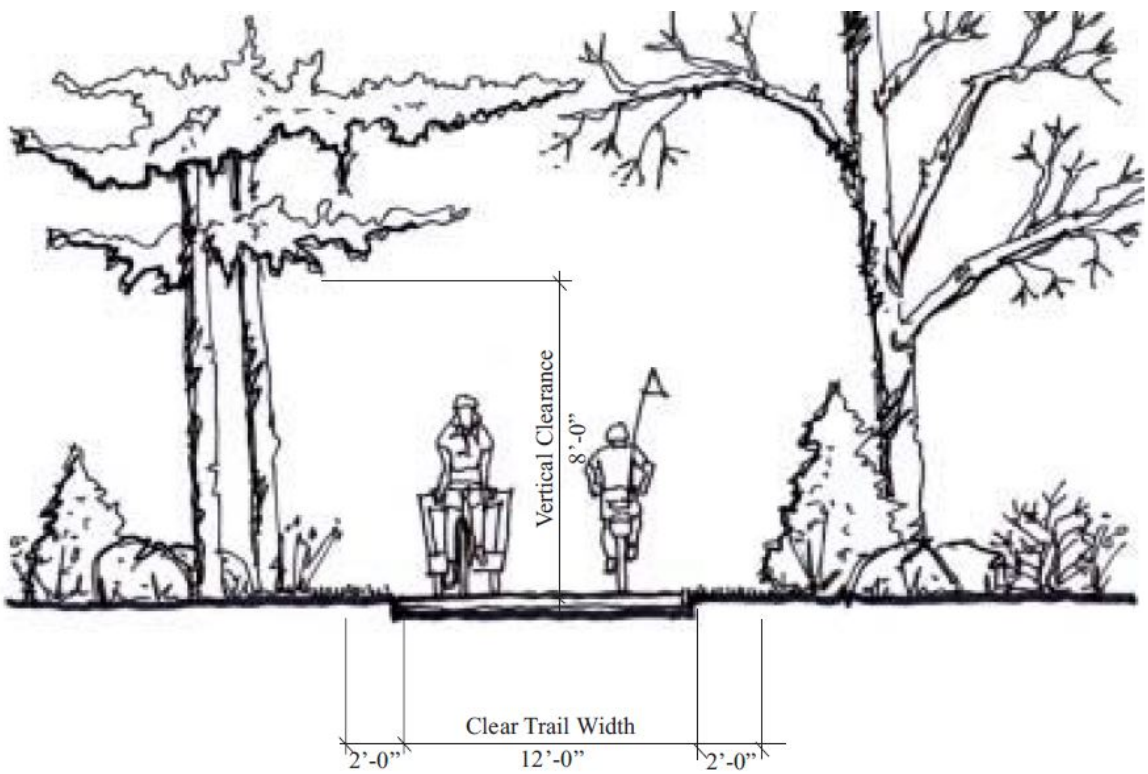
bicycle trails must be designed with adequate stopping and sight distances to allow the cyclist to see and react to unexpected situations. The stopping distance of a bicycle is a function of the rider's perception and reaction time, the speed of the bicycle, the coefficient of friction between the tires and the pavement, and the braking ability of the bicycle. AASHTO developed information and figures to assist the bicycle trail designer.

AASHTO's minimum stopping sight distance for various speeds and grades is based on a perception and brake reaction time of 2.5 seconds and a coefficient of friction of 0.25 to account for wet weather and poor braking of many bicycles. For two way trails, the sight distance in the descending direction will control the design.

AASHTO provides the minimum length of vertical curve to provide stopping sight distance at various speeds on crest vertical curves. The eye height is assumed to be 4 ½ feet and the object height is assumed to be 0 inches.

AASHTO shows the minimum clearance to be used for sight obstructions for horizontal curves. Bicyclists frequently ride side by side or near the middle of the trail. For this reason lateral clearances on horizontal curves should be calculated based on the sum of the stopping sight distances for cyclists traveling in opposite directions around the curve. Where this is not possible the path can be widened through the curve, install a yellow centerline stripe, a "Curve Ahead" warning sign, or a combination of these.

Edge Protection: Low forms of edge protection are not recommended for bicycle traffic. If edge protection is needed it should be 42 inch high railing or landscaping. The extra height prevents the cyclist from flipping forward over the rail. Bridges and boardwalks require a 42 inch high rail for cyclists. Landscaping can be used to enhance the protection from adjacent hazards.



PEDESTRIAN TRAILS

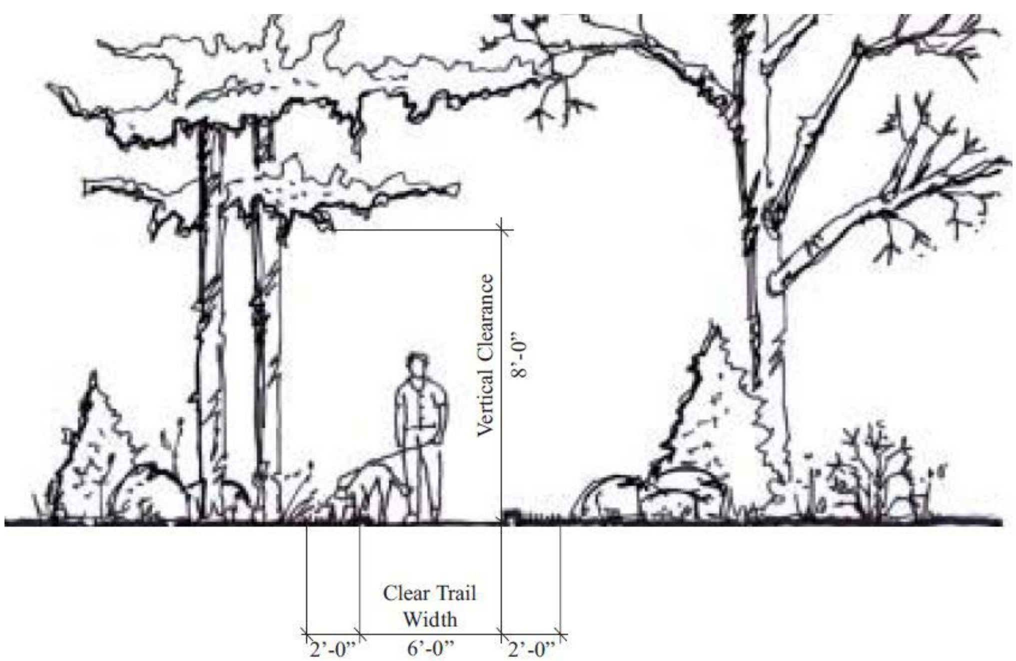
Width and Clearance: Pedestrian trails should have a clear width of 6 feet to allow room for passing, walking two abreast, or for devices such as strollers and wheelchairs. A minimum width of 5 feet should only be used when site specific conditions do not allow the preferred width. Trails passing through vegetation need regular maintenance to provide sufficient clearance. At a minimum, a pedestrian trail should be cleared 2 feet beyond the width of the trail and to a height of 8 feet. The clearance may need to be increased to allow for vegetative growth between maintenance periods and to account for snow depth if the trail is used by cross country skiers or other winter users.

Surface and Drainage: The trail surface should be firm enough to resist deformation when a person walks or wheels across it. Site specific studies and an improved surface will be required where varying trail usage warrants. An improved surface should be made of material that maintains consistent stability over long periods of use, such as concrete, asphalt or compacted stone dust. The surface needs to provide sufficient traction for walking, wheelchairs and crutches. The cross slope should be 2% to provide drainage of surface water and conform to ADA regulations.

When a trail is constructed on the side of a hill, it may be necessary to build a swale on the uphill side of the trail. The swale will intercept the surface drainage of water from the hill and prevent erosion of the trail. When necessary, a catch basin and culvert would be required to direct the water under the trail.

Alignment and Profile: Pedestrian trail profiles are not as critical as other trails, due to the slow speed of travel. Consideration should be given to wheelchair users, where gradual transitions between grades are desirable. Long slopes and switchbacks should have level landing areas for rest stops with benches, in conformance with accessibility regulations.

Edge protection: The edge on a pedestrian trail should be a minimum of 3 inches high. Bridges and boardwalks require a 42 inch high rail for pedestrians. Landscaping can be used to enhance the protection on steep slopes.



HIKING TRAILS

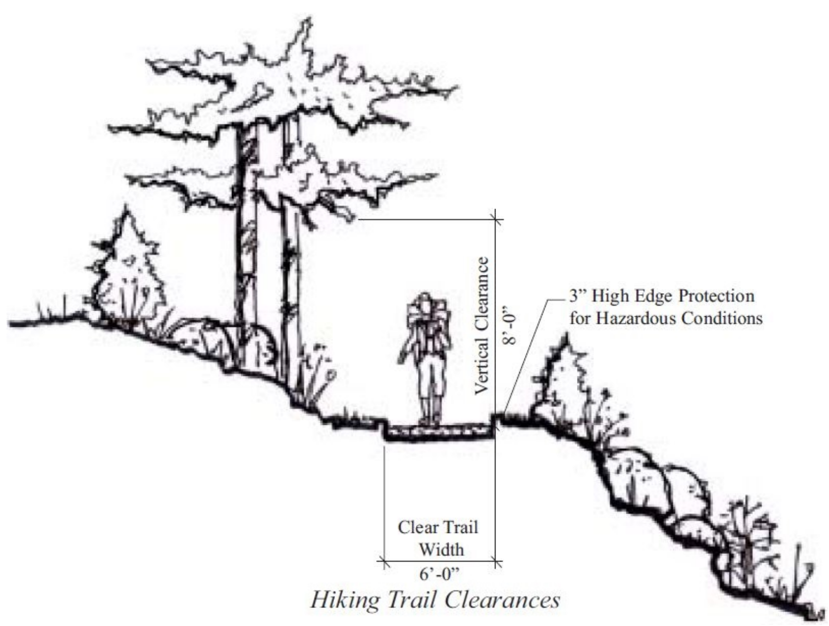
Hiking trails are typically natural surface trails designed to accommodate hikers, mountain bikers, or equestrians and would typically be paths without an improved surface.

Width and Clearances: Hiking trails should have a clear width of 6 feet to allow room for passing and walking two abreast. A minimum width of 4 feet should only be used when site specific conditions do not allow for the preferred width. Trails passing through vegetation need regular maintenance to provide sufficient clearance. At a minimum, a hiking trail should be cleared one foot beyond the width of the trail and to a height of 8 feet. This clearance may need to be increased to allow for vegetative growth between maintenance periods and to account for snow depth if the trail is used by cross country skiers.

Surface and Drainage: The trail surface should maintain a natural surface wherever possible but should be firm enough to resist deformation when a person walks across it. It should be made of material that maintains a consistent stability over long periods of use. The surface needs to provide sufficient traction for walking. The cross slope should be 2% minimum and 5% maximum to provide drainage of surface water. When a trail is constructed on the side of a hill, it may be necessary to build a swale on the uphill side of the trail. The swale will intercept the surface drainage of water from the hill and prevent erosion of the trail. When necessary, a catch basin and culvert would be required to direct the water under the trail.

Alignment and Profile: Hiking trail profiles are not as critical as other trails, due to the slow speed of travel. The hiking trail should follow the existing topography when possible. Long slopes and switchbacks should have level landing areas for rest stops.

Edge protection: Edge protection is helpful to protect trail users from an adjacent steep slope or hazardous situation. It serves as a low barrier between the user and the surrounding conditions. On pedestrian trails the low barrier is a small curb, usually made of wood, concrete, or asphalt, that is a minimum of 3 inches high. The curb edge is more readily detected by people with vision impairment. The 3 inch height is also sufficient for wheelchair users. Bridges and boardwalks require a 36 inch high rail for pedestrians as well as a 3 inch high edge protection. Landscaping can be used to enhance the protection from steep slopes or other hazards.



Hiking Trail Clearances

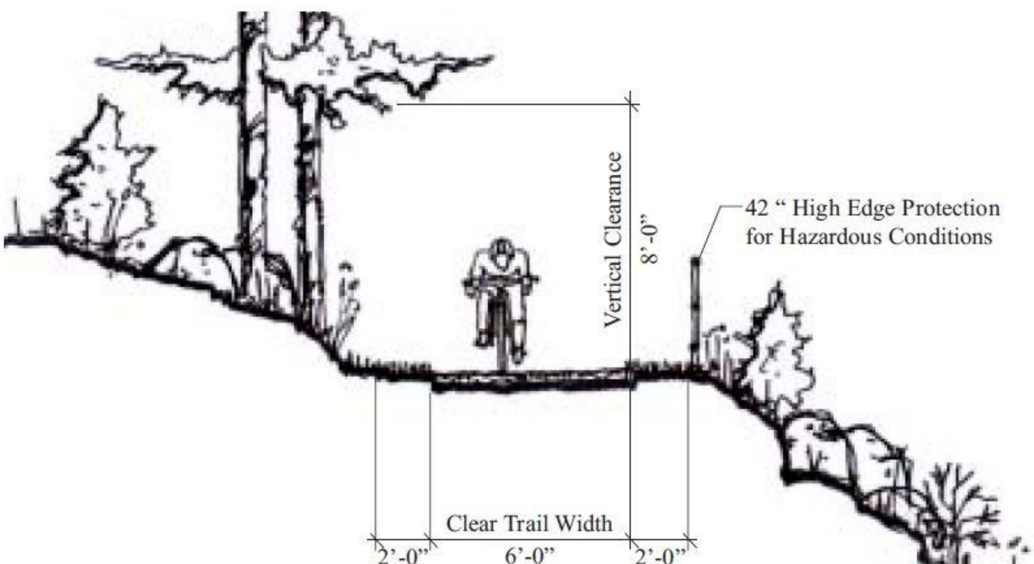
MOUNTAIN BIKE TRAILS

Width and Clearance: Mountain bike trails should have a clear width of 6 feet for maneuverability and passing. A minimum width of 4 feet should only be used when site specific conditions do not allow the preferred width. The clearance should be a minimum of 2 feet on each side of the trail, with a vertical clearance of 8 feet.

Surface and Drainage: The trail surface should maintain a natural surface wherever possible but should be firm enough to resist deformation. It should be made of material that maintains a consistent stability over long periods of use. The surface needs to provide sufficient traction for biking. The cross slope should be 2% minimum and 5% maximum to provide drainage of surface water. When a trail is constructed on the side of a hill, it may be necessary to build a swale on the uphill side of the trail. The swale will intercept the surface drainage of water from the hill and prevent erosion of the trail. When necessary, a catch basin and culvert would be required to direct the water under the trail.

Alignment and Profile: Mountain bike trails typically follow the existing contour of the land. However, because these standards are geared toward basic cyclists, site specific consideration must be given to avoid abrupt grade changes in the vertical profile. Horizontal curves are not typically a problem for mountain bikes due to the slower travel speed. The lower gear ratios that permit mountain biking can accommodate switchback turns, if necessary, for steep slopes. A variety of trail terrain is part of the challenge and appeal of mountain biking. Extra clearance width should be provided at curves for sufficient sight distance and safety. There are no minimum standards for clearance in these situations. However, in heavy vegetative growth, near a curve, the recommended clearance is 4 feet on each side of the trail, which is double the 2 foot standard clearance.

Edge Protection: Edge protection is a physical barrier along the edge of the trail designed to protect the user from an adjacent hazardous condition. Edge protection for bicyclists needs to be 42 inches high. The extra height prevents the cyclist from flipping forward over an obstacle. Low edges or curbs are not used on mountain bike trails, and would be a detriment to the cyclist.



Mountain Bike Trail Clearances

SIDEWALKS (Not recommended as a bikeway facility):

Sidewalks typically have the following characteristics that make them not suitable for bicycling because of the following:

- Sidewalks are designed primarily for walking pedestrian speed and maneuverability.
- Bicycle use of sidewalks is prohibited by local ordinance in some areas.
- Sidewalk geometrics are not intended to safely accommodate bicycles.
- Sidewalks typically contain sign posts, parking meters, hydrants, benches, trees and other fixed objects.
- Direct access from doorways, gates and parked cars causes conflicts with bicycling
- Sidewalks may have frequent intersections with driveways, alleys, roadways and other sidewalks.
- Joints in concrete sidewalks create an uneven riding surface.

Designating a sidewalk as a shared facility for bicycle travel is not recommended. Developing extremely wide sidewalks does not necessarily increase safety, because wide sidewalks may encourage higher-speed bicycle use and thus increased potential for conflicts with pedestrians. It is usually inappropriate to sign sidewalks that do not meet AASHTO shared-use path design criteria as bicycle routes. However, short segments of sidewalk may be signed for bicycle use if users are appropriately warned of substandard conditions, but this should be considered only under limited circumstances where there are no better alternatives, such as:

- Sidewalk segments can provide bikeway continuity along high-speed or heavily traveled roadways that offer inadequate space for bicyclists on the roadway.
- On long, narrow bridges, ramps should be installed at the sidewalk approaches to allow bicycle traffic to enter from the sidewalk as well as the roadway. If approach bikeways are two-way, sidewalk facilities also should be two-way.

In residential areas, sidewalk bicycle riding by young children is common. With lower bicycle speeds and lower cross-street auto speeds, potential conflicts are lessened, but not eliminated. Nevertheless, this type of sidewalk bicycle use is accepted.

ACCESSIBLE TRAIL DESIGN

“Accessibility” or “universal access” shall be considered a best practice in the decision-making processes, including planning, design, construction, and management of the trail network. Universal access includes design strategies that provide trail access to those with and without disabilities including families, seniors, and people with mobility impairments. At a minimum, current state and federal regulations concerning the Americans with Disabilities Act (ADA) shall be applied to provide access to a wide range of user capabilities as required by law.

SHARED-USE PATHS ON NEW ALIGNMENTS

A path that follows a stream or river, a property line, a sewer line, or crosses open fields is a path on a new alignment. New alignments have no base materials in place to pre-determine a path's location; therefore, all decisions as to the best location for the facility must be made before and during design. New alignments are the most costly type of shared-use paths, for more environmental and survey work, design decisions, and construction material are needed.

RAILS TO TRAILS

A "rail to trail" is the conversion of a disused railway into a multi-use path, typically for walking, cycling and sometimes horse riding. The characteristics of abandoned railways—flat, long, frequently running through historical areas—are appealing for various developments. Many rail trails are long-distance trails.

Rail-trails are built on well-graded base materials originally put into place for tracks and ties and railroad operation. The right-of-way is rarely wide enough to build a two way street, but is just enough to build a two way shared-use path. Generally, the culverts, bridges, and base materials are still in place. Corridor length is usually measured in miles, rather than feet, and often allows a connection to a nearby community. The railroad alignment is not dependent upon roadways; thus, railroads go through field and forest and can provide a close-to-wilderness experience. As the land is already disturbed, railroad corridors may need fewer environmental studies.

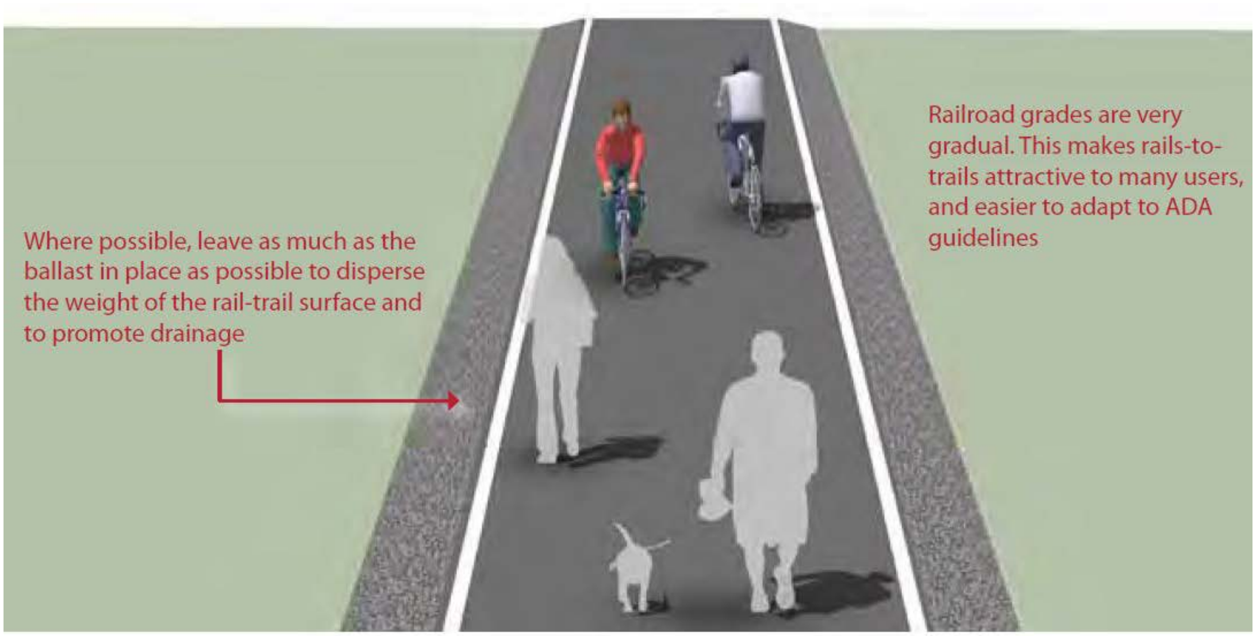
Rail to Trail Conversion Considerations

Rail to trail conversions can be complex for legal, social, and economic reasons. Railroads were often built with a mix of purchased land, government land grants, and easements. The land deeds can be over a hundred years old, land grants might be conditional upon continuous operation of the line, and easements may have expired. Railroad property rights have often been poorly defined and sporadically enforced, with neighboring property owners intentionally or accidentally using land they do not own. Such encroachers often later oppose a rail to trail conversion. Even residents who are not encroaching on railway lands may oppose conversion on the grounds of increased traffic in the area and the possibility of a decline in personal security. Because linear corridors of land are only valuable if they are intact, special laws regulate the abandonment of a railroad corridor. In the United States, the Surface Transportation Board (STB) regulates railroads, and can allow a corridor to be "rail banked" or placed on hold for possible conversion back to active status when or if future need demands. There are several cases in which trails convert back to active railroads.

It is important to understand that a rail line is abandoned when the railroad has applied to the STB for abandonment authorization, the STB has issued an order authorizing an abandonment of the line, and the railroad has notified the STB that is has consummated the abandonment authorization.

It is often impractical and costly to add material to existing railroad bed fill slopes. This results in trails that meet minimum path widths, but often lack preferred shoulder and lateral clearance widths.

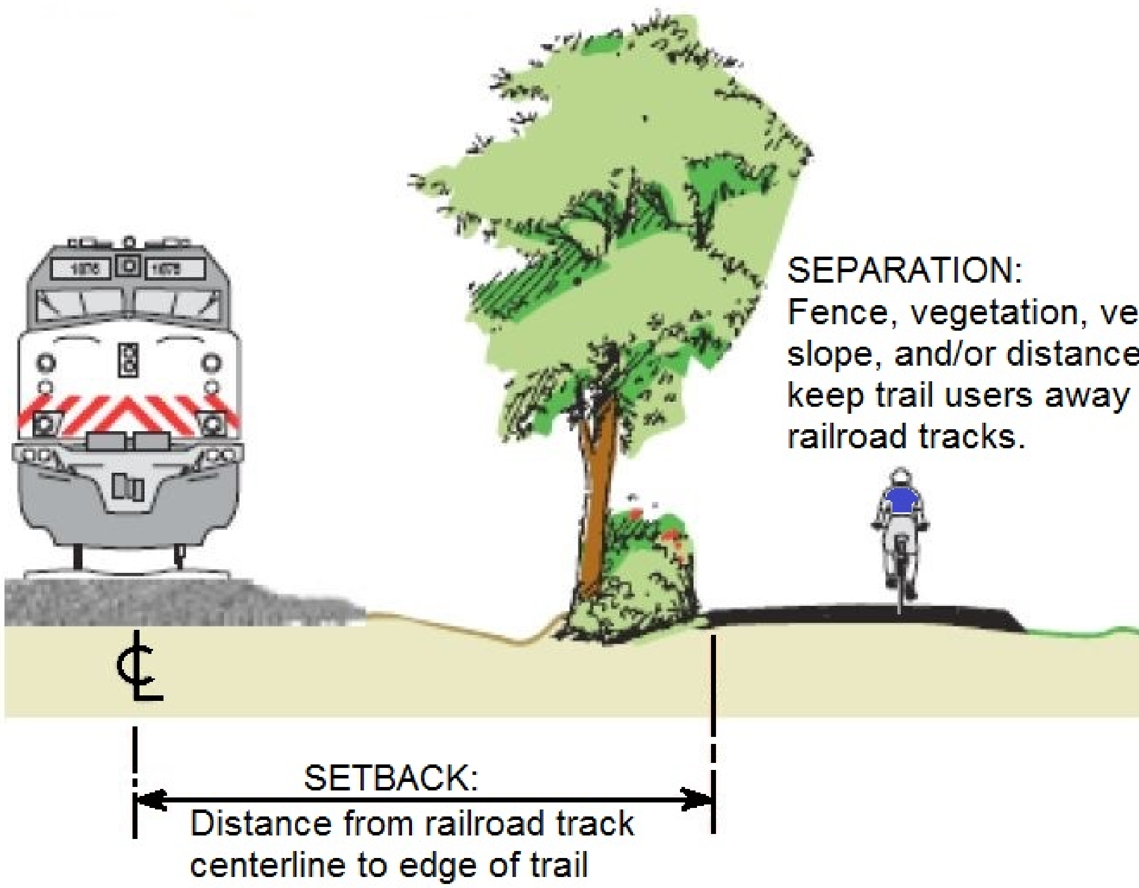
Rail-to-trails can involve many challenges including the acquisition of the right of way, cleanup and removal of toxic substances, and rehabilitation of tunnels, trestles and culverts. A structural engineer should evaluate existing railroad bridges for structural integrity to ensure they are capable of carrying the appropriate design loads. Where trails will be located on abandoned railroad corridors, the trail owner should assume the responsibilities previously held by the railroad, such as drainage, weed and litter control, and fencing.



TRAILS ADJACENT TO RAILROADS (RAIL WITH TRAILS)

"Rails with Trails" is a name given to multi-use trails along rail lines that remain active. Rails with Trails make efficient use of rail corridors by providing more transportation choices and recreation opportunities for the public. Rails with trails offer similar benefits to trail users and the general community as other types of trails provide that they are safely developed and designed.

Rails with Trails are usually constructed on railroad property thereby requiring extensive coordination with railroad and considerable expense. Railroad owners may be highly concerned with potential increased liability due to the construction of a rail with trail facility. There may be some constraints that could impact the feasibility of rail-with-trail projects. In some cases, space needs to be preserved for future planned freight, transit or commuter rail service. In other cases, limited right-of-way width, inadequate setbacks, concerns about safety/trespassing, and numerous mid-block crossings may affect a project's feasibility.

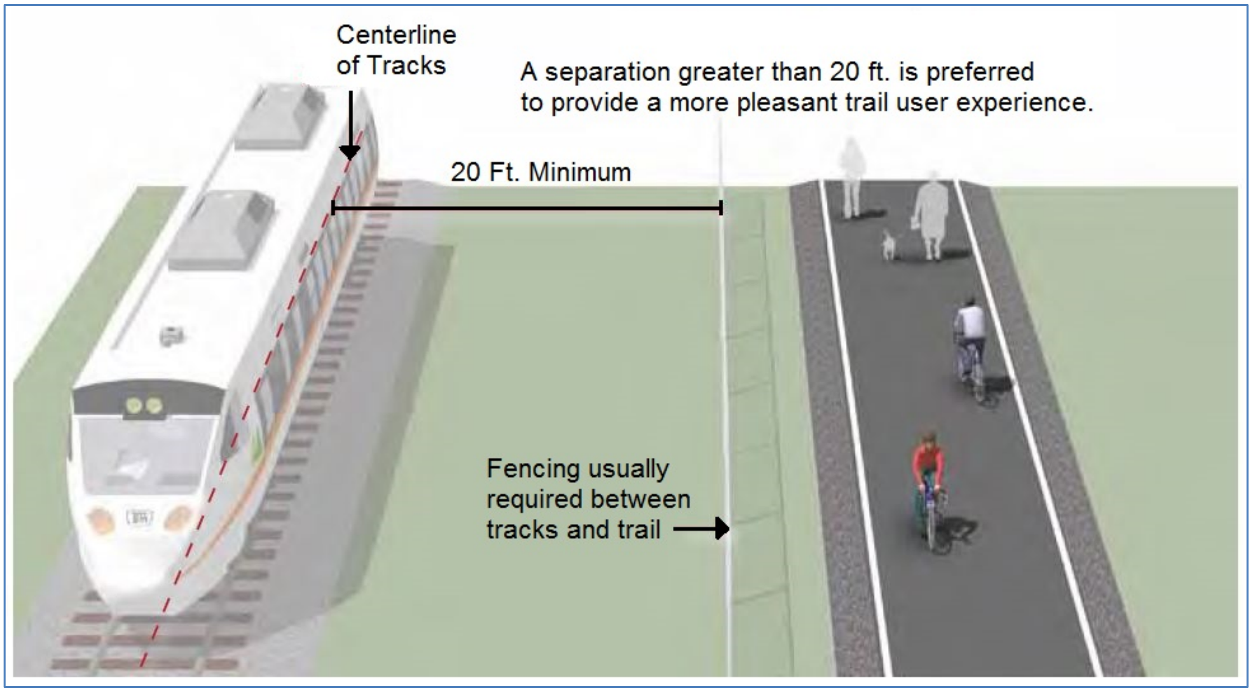


Another determining factor may be corridor ownership. Trails proposed for privately owned property will have to comply with the railroad's own standards. Trail planners need to be aware that the risk of injury should a train derail will be high, even for slow-moving trains. Discussions about liability assignment need to factor this into consideration.

When determining the minimum setback for a trail, factors to consider include train speed and frequency, maintenance needs, applicable state standards, separation techniques, historical problems, track curvature, topography, and engineering judgment.

In the case of high speed freight or transit lines, trails must be located as far from the tracks as possible and are infeasible if adequate setbacks and separation cannot be achieved.

At an absolute minimum, trail users must be kept outside the "dynamic envelope" of the track – that is, the space needed for the train to operate. The railroad dynamic envelope is the clearance required for the train and its cargo overhead due to any combination of loading, lateral motion, or suspension failure. It includes the area swept by a turning train.



Rails with Trails are recommended to be designed with a separation of 33 feet preferred and 25 feet minimum between the active rail centerline and the edge of trail. A barrier between the rail and trail is recommended and it will also need to be at least 25 feet from the rail. The barriers can be fences, ditches, vegetation, railing, etc. Individual railroads may have their own clearance requirements.

Most railroad companies require trails to provide fencing. Some railroad companies specify a requirement of 6 feet high fencing, no matter what the setback distance is. Fencing may not be required where a significant deterrent to trespass is provided or exists. Examples include water bodies, severe grade differentials, or dense vegetation. Other barrier types such as vegetation, ditches, or berms are often used to provide separation, especially where a trail is located farther than 25 feet from the edge of the trail to the centerline of the closest track, or where the vertical separation is greater than 10 feet. In constrained areas, using a combination of separation techniques may allow narrower acceptable setback distances.

UTILITY CORRIDORS

Continuous utility corridors can be good opportunities for trail implementation in rural areas. Utility corridors, typically overhead electric or telephone lines, offer linear rights-of-way that often see little active use. Many of the issues for utility corridors are the same as those for adjacent farmland. It is important to recognize that the best utility corridors are those that are owned outright by the utility company, as opposed to corridors that hold easements over agricultural land. Coordination with the utility is crucial to the implementation of this type of trail. The following guidelines apply to trail facilities in utility corridors.

- Work with adjacent landowners from the beginning of the trail planning process.
- Locate trail so that impact to utility poles and other above-ground elements is minimized.
- The trail owner may need to assist the utility in providing fencing or barricades to protect above-ground utility structures, such as towers, and control boxes.
- An agreement between the trail owner and the utility will be required to address trail restoration and cost responsibility for trail damage due to utility maintenance.

SIDEPATHS

Sidepaths are built parallel to roadways in the usual location for sidewalks, but differ from sidewalks in that they are 10 feet wide, designed for shared use, and require a barrier or 5-foot minimum or greater separation from the edge of traveled way. They are called "sidepaths" because local laws often prohibit bicycle use on "sidewalks," and they are proliferating because the right-of-way is in public ownership.

Sidepaths are a new design not covered in the American Association of State Highway and Transportation Officials (AASHTO), Guide for the Development of Bicycle Facilities; however, many of the concerns made about sidewalks in the guide apply equally to sidepaths. The Ohio Department of Transportation (ODOT) is in agreement with all of these concerns and does not recommend sidewalk or sidepath construction.

ODOT recognizes that sidepaths will continue to be built regardless of their recommendation, and therefore suggests the following:

- Involve safety and enforcement personnel in the planning of the sidepath to select acceptable traffic signal timing and signs.
- Develop rules that will make fault easy to determine should there be a crash.
- A program for local residents would be a good follow up, with emphasis placed on what is expected from drivers and path users, and what they can expect from each other at intersections.

According to the AASHTO guide, when two-way shared-use paths are located immediately adjacent to a roadway (a sidepath), some operational problems are likely to occur. In some cases, paths along highways for short sections are permissible, given an appropriate level of separation between facilities.

Some problems with paths located immediately adjacent to roadways are:

- Unless separated, sidepaths require one direction of bicycle traffic to ride against motor vehicle traffic, contrary to normal rules of the road.
- When the path ends, bicyclists going against traffic will tend to continue to travel on the wrong side of the street. Likewise, bicyclists approaching a shared-use path often travel on the wrong side of the street in getting to the path. Wrong-way travel by bicyclists is a major cause of bicycle/automobile crashes and should be discouraged at every opportunity.
- At intersections, motorists entering or crossing the roadway often will not notice bicyclists approaching from their right, as they are not expecting contraflow vehicles. Motorists turning to exit the roadway may likewise fail to notice the bicyclist. Even bicyclists coming from the left often go unnoticed, especially when sight distances are limited.

- Signs posted for roadway users are backwards for contra-flow bicycle traffic; therefore these cyclists are unable to read the information without stopping and turning around.
- When the available right-of-way is too narrow to accommodate all highway and shared-use path features, it may be prudent to consider a reduction of the existing or proposed widths of the various highway and bikeway cross sectional elements (i.e., lane and shoulder widths, etc.). However, any reduction to less than AASHTO Green Book design criteria must be supported by a documented engineering analysis.

- Many bicyclists will use the roadway instead of the shared-use path because they have found the roadway to be more convenient, better maintained, or safer. Bicyclists using the roadway may be harassed by some motorists who feel that in all cases bicyclists should be on the adjacent path.
- Although the shared-use paths should be given the same priority through intersections as the parallel highway, motorists falsely expect bicyclists to stop or yield at all cross-streets and driveways. Efforts to require or encourage bicyclists to yield or stop at each cross-street and driveway are inappropriate and frequently ignored by bicyclists.
- Stopped cross-street motor vehicle traffic or vehicles exiting side streets or driveways may block the path crossing.
- Because of the proximity of motor vehicle traffic to opposing bicycle traffic, barriers are often necessary to keep motor vehicles out of shared-use paths and bicyclists out of traffic lanes. These barriers can represent an obstruction to bicyclists and motorists, can complicate maintenance of the facility, and can cause other problems as well.

For the above reasons and depending upon traffic conditions, other types of bikeways are likely to be better suited to accommodate bicycle traffic along highway corridors. Shared-use paths should not be considered a substitute for street improvements even when the path is located adjacent to the highway, because many bicyclists will find it less convenient to ride on these paths compared with the streets, particularly for utility trips.

When shared-use paths are located adjacent to a roadway, wide separation between a shared-use path and the adjacent highway is desirable to demonstrate to both the bicyclist and the motorist that the path functions as an independent facility for bicyclists and others. When this is not possible and the distance between the edge of the shoulder and the shared-use path is less than five feet, a suitable physical barrier is recommended. Such barriers serve both to prevent path users from making unwanted movements between the path and the highway shoulder and to reinforce the concept that the path is an independent facility. Where used, the barrier should be a minimum of 42 inches high (54 inch preferred) to prevent bicyclists from toppling over it. A barrier between a shared-use path and adjacent highway should not impair sight distance at intersections, and the shoulder designed to not be a hazard to errant motorists.

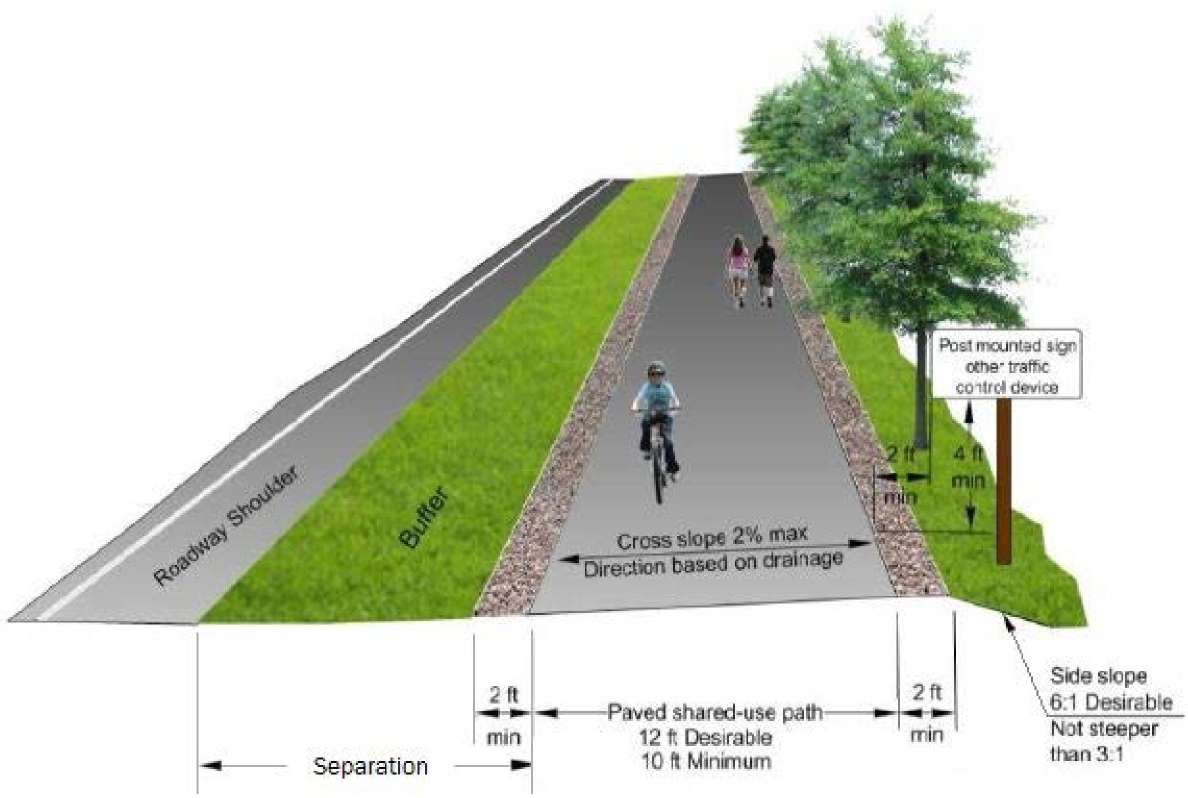
SEPARATION BETWEEN PATH & ROAD

The absolute minimum separation per the AASHTO Bike Guide is 5 feet from the edge of path to the edge of pavement traveled way. However, the following minimum separation guidance is recommended for the stated conditions which are greater than the said absolute minimum.

TWO-WAY SHARED-USE PATH, ADJACENT TO ROADWAY, NON-CURB SECTION

Non-Curb Section:

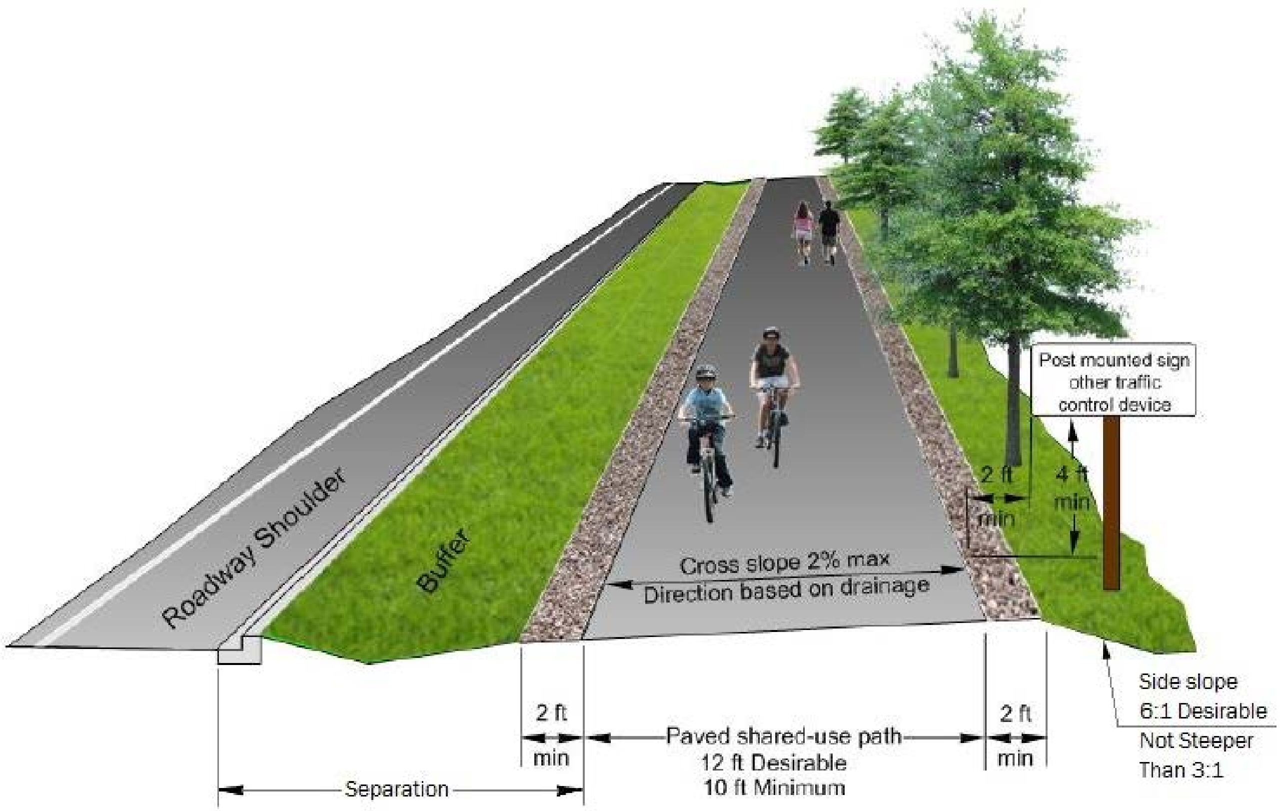
- Speed Limit Less Than or Equal 45 mph =20 Feet Desirable
- Speed Limit Less Than or Equal 45 mph =10 Feet Minimum
- Speed Limit Greater Than or Equal 50 mph = 24 to 35 Feet
- If Roadway Clear Zone is Greater, Must Use This Distance



TWO-WAY SHARED-USE PATH, ADJACENT TO ROADWAY, CURB SECTION

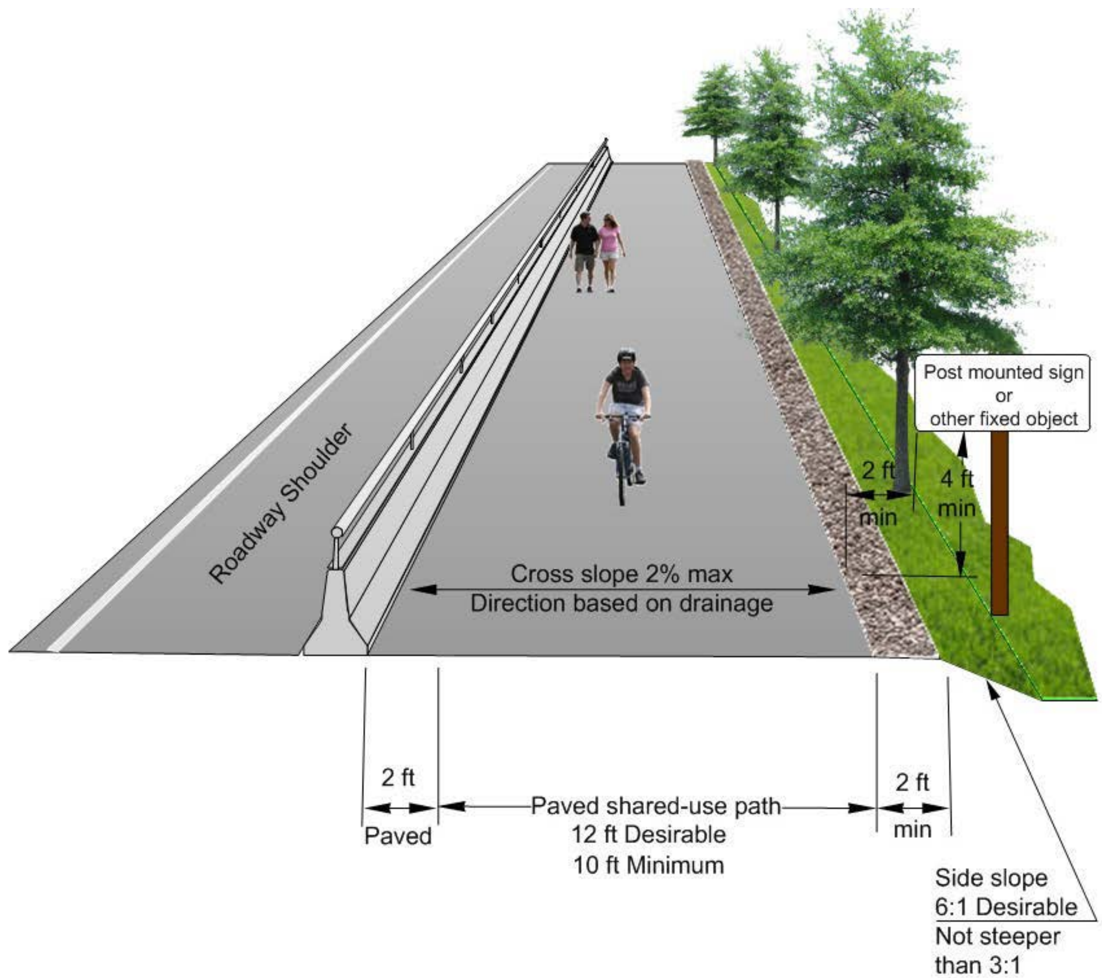
<u>Curb Section (From Back of Curb to Edge of Path):</u>

- Speed Limit Less Than or Equal 30 mph = 3 Feet with Parking
- Speed Limit Less Than or Equal 30 mph = 5 Feet Minimum
- Speed Limit 35 or 40 mph = 5 Feet Minimum
- Speed Limit Greater Than 45 mph = 10 Feet Minimum
- If Roadway Clear Zone is Greater, Must Use the Clear Zone Distance



TWO-WAY SHARED-USE PATH, ADJACENT TO ROADWAY, (>35 MPH)

When a separation greater than 5 feet can't be obtained for a two-way shared-use path located adjacent to a roadway with a speed limit greater than 35 mph, provide a barrier separation between the roadway and the path.



CHAPTER 3 - WAYFINDING

BIKEWAY SIGNAGE AND PAVEMENT MARKINGS

The use of appropriate signs and pavement markings will improve the safety and general public acceptance of bicycles on public roadways. Regulatory and warning signs will alert bicyclists to potential conflicts and convey regulatory messages to both bicyclists and motorists at highway intersections. Consult the Ohio Manual of Uniform Traffic Control Devices (OMUTCD) for the latest and most complete set of specifications for bicycle-related signs and markings. Bicyclist traffic control devices need to adhere to the following five basic requirements to perform their intended function:

- Fulfill a need.
- Command attention.
- Convey a clear, simple meaning.
- Command respect of road users.
- Give adequate time for proper response.

The local design, placement, operation, maintenance and uniformity of bicycle traffic control devices must be consistent with the OMUTCD recommended standards. Uniformity of design includes shape, color, symbols, wording, lettering, reflectivity, and sizes.

Regulatory signs give notice of traffic laws or regulations that bicyclists and motorists must follow. Examples include signs for bicycle lane designation, no parking signs, stop signs and yield signs.

The *Ohio Manual of Uniform Traffic Control Devices (OMUTCD), 2012 Edition, Part 9, Traffic Control for Bicycle Facilities,* currently offers the regulatory, warning and guide signs and plaques for bicycle facilities. The Part 9 section of the OMUTCD is included in the appendix.

A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes. A wayfinding system should be limited specifically to a designated bicycle network. A regional bicycle wayfinding system will direct bicyclists to major destinations.

BICYCLE WAYFINDING SIGNAGE

Wayfinding 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.

Wayfinding signage can direct users to differing types of destinations including:

- Other bicycle routes
- Recreational facilities and/or parks
- Scenic overlooks or other point of interest
- Transportation facilities
- Governmental, educational and other institutional facilities.

A wayfinding signage system will provide the following benefits:

- Visually indicates to motorists that they are driving along a bicycle route and should use caution.
- Identifies the best routes to significant destinations.
- Brands a bicycle route.
- Familiarizes users with the bikeway system.
- Encourages bicycling for infrequent users.
- Provides guidance to bicyclist to better estimate travel distance and time.

Wayfinding signage best practices include signage that is:

- Consistent
- Clear
- Legible
- Safe
- Intuitive
- Useful
- Safe
- Bicycle, pedestrian and/or motorist appropriate

Bicycle compatible roadways usually do not require regulatory, guide or informational signing in excess of that necessary for motorists, i.e., exclusively for bicyclists. In certain situations, however, additional signing may be needed to advise both motorists and bicyclists of the shared use of the roadway, including travel lane.

WAYFINDING SIGNAGE NETWORKS

A wayfinding signage network utilizes a route numbering system. Route numbering systems are more intuitive for bicycles with a map or access to a directory. Bicycle route map signs should be periodically placed along bicycle routes to provide additional wayfinding benefits to users.

WAYFINDING SIGNAGE SEQUENCING

Wayfinding signage sequencing provides guidance on marking of designated bicycle routes that is consistent with existing standards and guidance of the OMUTCD. Guidance is provided for signage of junctions, advance route turns, destinations, confirmations, reassurance and distance.

- Junction signage is placed in advance of intersections with other designated routes.
- Advance route turn signage is placed in advance of intersections where a turn must be made to remain on the indicated route or join an intersecting route.
- Destination signage supplies information concerning destinations that may be reached by way of designated or undesignated routes.
- Directional signage at intersections indicate turns or to affirm through movement along a continuing route, the beginning of a new route, or intersection with a different route.
- Confirming signage is placed shortly after intersections to identify routes have continued on different parting legs of an intersection.
- Distance signage is placed after junctions of designated routes, or when leaving incorporated or named built-up areas, to show distances to destinations of interest to bicyclists.
- Reassurance signage is placed at appropriate intervals between intersections in urban areas and along routes outside of built up or incorporated areas.

WAYFINDING DESTINATIONS

For the purposes of developing wayfinding signage, destinations are to be identified, classified and prioritized for inclusion on wayfinding signage. Destinations should be identified based on their relative importance throughout the area. General guidance for wayfinding destinations include:

- Destinations are shown in the top down order of distance from the signage position.
- Primary or major destinations should be shown up to five miles away. Examples include:
    - Downtown areas or specific neighborhoods
    - Other cities, villages or governmental jurisdictions (Township, County, Etc.)
    - Major landmarks (Ohio River Bridge)
- Secondary or regional destinations should be shown up to two miles away. Examples include:
    - Access to other transit systems
    - Other bicycle routes or travel ways
    - Trial head, trail terminus, or other access points.
- Tertiary or neighborhood/local destinations should be shown up to one mile away. Examples include places more local in nature such as:
    - Parks & recreational facilities
    - Scenic overlooks
    - Historic sites
    - Libraries

WAYFINDING SIGNAGE GENERAL GUIDANCE

Bicycle wayfinding signage may have jurisdictional logos and/or QR codes. They should not have any private logos, website addresses, or private business names unless they are a major generator of bicycle traffic.

Destination Signage Guidelines

A maximum of three (3) destinations are usually included with a bicycle route wayfinding sign. The destination signage is grouped by direction with the nearest destination first. If additional destinations are desired to be shown or multiple decisions signs needed, then multiple signs should be placed within 25 to 50 feet of each other.

Wayfinding Signage Font

The uniformity, legibility and adherence to existing standards dictate appropriate wayfinding signage. The wayfinding signage font is recommended to be "Highway Gothic" font.

Wayfinding Signage Travel Times

When travel times are included on bicycle wayfinding signage it is recommended at a 10 mph bicycle speed be used for travel time calculations.

Wayfinding Signage Lateral Placement

Wayfinding signage is to be mounted and placed in accordance with the current edition of the Ohio Manual for Uniform Traffic Control Devices (OMUTCD). This includes mounting height and lateral placement from the edge of path or roadway.

In general, regulatory and warning signs are a higher priority than wayfinding signs. Care should be taken to not obscure priority information. This includes providing a typical spacing of no less than 75 feet between signs along off-street pathways. This distance is based on travel speeds and thus is generally greater for on-street systems.

Wayfinding Sign Maintenance

Maintenance needs for bicycle wayfinding signs are similar to other signs, and will need periodic replacement due to wear. The responsible jurisdiction should maintain comprehensive inventories of the location and age of bicycle wayfinding signs to allow incorporation of bicycle wayfinding signs into any asset management activities.

WAYFINDING SIGNAGE TYPES

Generally there are three types of wayfinding signage:

- Confirmation signs
- Turn signs
- Decision signs

CONFIRMATION SIGNS

Confirmation signs inform bicyclists that they are on a designated bikeway and make motorist aware of the bicycle route. Confirmation signage may include distance or time information to designations. They are placed every one-quarter to one-half mile on off-street and rural roadway facilities. There are placed every two to three blocks along urban street facilities. They should be placed soon (within 150 feet) after turns and after major street intersections to confirm the destination route. There should be located within 30 feet after a turn on urban streets. They are often used in conjunction with confirmation pavement markings.

TURN SIGNS

Turn signs inform a bicyclist where a bikeway turns from one street or bikeway to another street or bikeway. They may be used with or without pavement markings. They usually include directional arrows and show destinations.

DECISION SIGNS

Decision signs mark the junction of two or more bikeways. They inform the bicyclist of the designated bicycle route to access key destinations. They may show destinations, arrows, distances and/or travel times. They are placed on the approach side of intersections in advance of a junction with another route. They may also be placed along a route to indicate a nearby destination.

OTHER BICYCLE SIGNAGE

In addition to bicycle wayfinding signing, there are other useful bicycle signing:

- Bicycle warning signs
- Bicycle regulatory signs
- Bicycle mile marker signs

Bicycle Warning and Regulatory Signs:

While some guide signs are variations of standard sign treatments, recommendations for the use of regulatory and warning signs should be followed as established in OMUTCD. Regulatory signs give notice of traffic laws or regulations that bicyclists and motorists must follow. Examples include signs for bicycle lane designation, "Bikes May Use Full Lane" signage, no parking signs, stop signs and yield signs.

Warning signs call attention to conditions on, or adjacent to, a bikeway that is potentially hazardous to users. The use of warning signs, which are typically yellow in color, should be kept to a minimum to maximize their effectiveness. Bicycle warning signs should be used whenever there is a need to warn motorists and bicycles to share the road or of an upcoming hazard. Examples of hazards include sharp curves, narrow lanes, merges of bikeway and vehicular traffic, etc. Warning signs should be posted at least 50 feet ahead of the hazard.

One warning sign being used is the "Share the Road" sign. This sub plate (W16-1), when combined with the standard W11-1 warning sign is intended to increase bicyclists' visibility. As a warning sign, "Share the Road" signs alert motorist of the presence of bicycle traffic. This sign is not intended to designate a bicycle route. They are typically used on roadways where bicycle traffic is common. The sign is also intended to remind bicyclist to ride in a manner that does not impede motorized traffic. Its intention is not to encourage inexperienced bicyclists to ride on the roadway as a preferred route. This sign is especially useful in cities and towns where there are large numbers of bicyclists riding on streets that may be unsuitable for designation as preferred bicycle routes due to factors such as narrow lanes, high-speed motor vehicle traffic or high traffic volumes.

BICYCLE MILE MARKER SIGNS

Shared use paths should include mile markers that indicate direction or distance to the trail terminus, a trailhead or other access point. Mile markers are also helpful when providing locational information to maintenance crews or for emergency response. Mile markers are typically good locations to also post signs with phone number or e-mail addresses where someone can report any maintenance, security or safety issues along the path. Mile markers include the system brand mark, distance in whole number miles or decimal miles when less than one mile, and may include path name and jurisdiction.

The path or route name and jurisdiction may be included. They should be placed every ¼ to ½ mile along the network. Point zero should begin at the southern and westernmost terminus points of a route of path. On shared use paths, mile markers may be installed on one side of the pathway, back-to-back.

PRIMARY PATHWAY IDENTITY SIGN

Primary pathway identification signs are oriented and scaled for vehicle drivers and serve as the initial welcome and identification of primary pathway access points. Signs include the system brand mark, pathway name, and local jurisdiction identity/logo.

SECONDARY PATHWAY IDENTITY SIGN

Function and Content: Secondary pathway identity signs are oriented and scaled for pedestrian and bicycle network users and serve as the initial welcome and identification of secondary pathway access points. Signs include the system brand mark, pathway name and local jurisdiction identity/logo.

SYSTEM IDENTIFIERS

System identifiers present opportunities to add the system brand mark or logo to existing features to expand visibility at an affordable rate. Identifiers may include vinyl wraps, adhesive graphics, sign toppers, and pavement markings with system name or brand mark. Refer to JEFFERSON COUNTY TRAILS & GREENWAYS SIGNAGE section for more detailed information on the system identifier for the Jefferson County Trails & Greenways System.

INFORMATION KIOSK

Kiosks provide a clearing house of information at a more detailed level than other elements. Kiosks include orientation map graphics indicating the on-street and off-street route and connections, major geographic features, destinations rules and responsibilities, emergency and pathway manager contact information and jurisdiction logo.

Potential locations for kiosks include key destinations in each jurisdiction.

The design guidelines for kiosks will vary per each jurisdiction's design preferences and existing standards. However, it is recommended that the participating cities use similar guidelines to create consistency across jurisdictions and brand the Jefferson County bicycle network. Kiosks should provide the following information:

- A map of key destinations in each municipality or jurisdiction
- A map of the bicycle network in the municipality or jurisdiction
- A map of the entire regional bicycle network
- The bicycle network logo
- "You-are-here" indications.

Recommended supplemental resources

for the kiosks include:

- Bicycle parking information
- Fold-up bicycle maps of the bicycle network
- Information regarding bicycle related activities in the area
- bicycle safety information and other bicycle resources

JEFFERSON COUNTY U.S. & STATE BIKE ROUTE SIGNAGE

Bicycle Route Signage is often used along bike routes where it is not appropriate or possible to add bicycle lanes. Bike Route Signage is used to bridge bikeway gaps and to provide bicyclists with basic information about where to ride. Bike routes should be placed along local, collector, and minor arterial routes that are relatively flat, provide direct access to neighborhood destinations, have minimal conflicts with larger vehicles (trucks and buses), and are located on corridors with safe volumes and speeds.

There are portions of one United States Bike Route and two proposed Ohio State Bike Routes located in Jefferson County. The designated bike routes are:

United States Bike Route 50 (USBR-50)

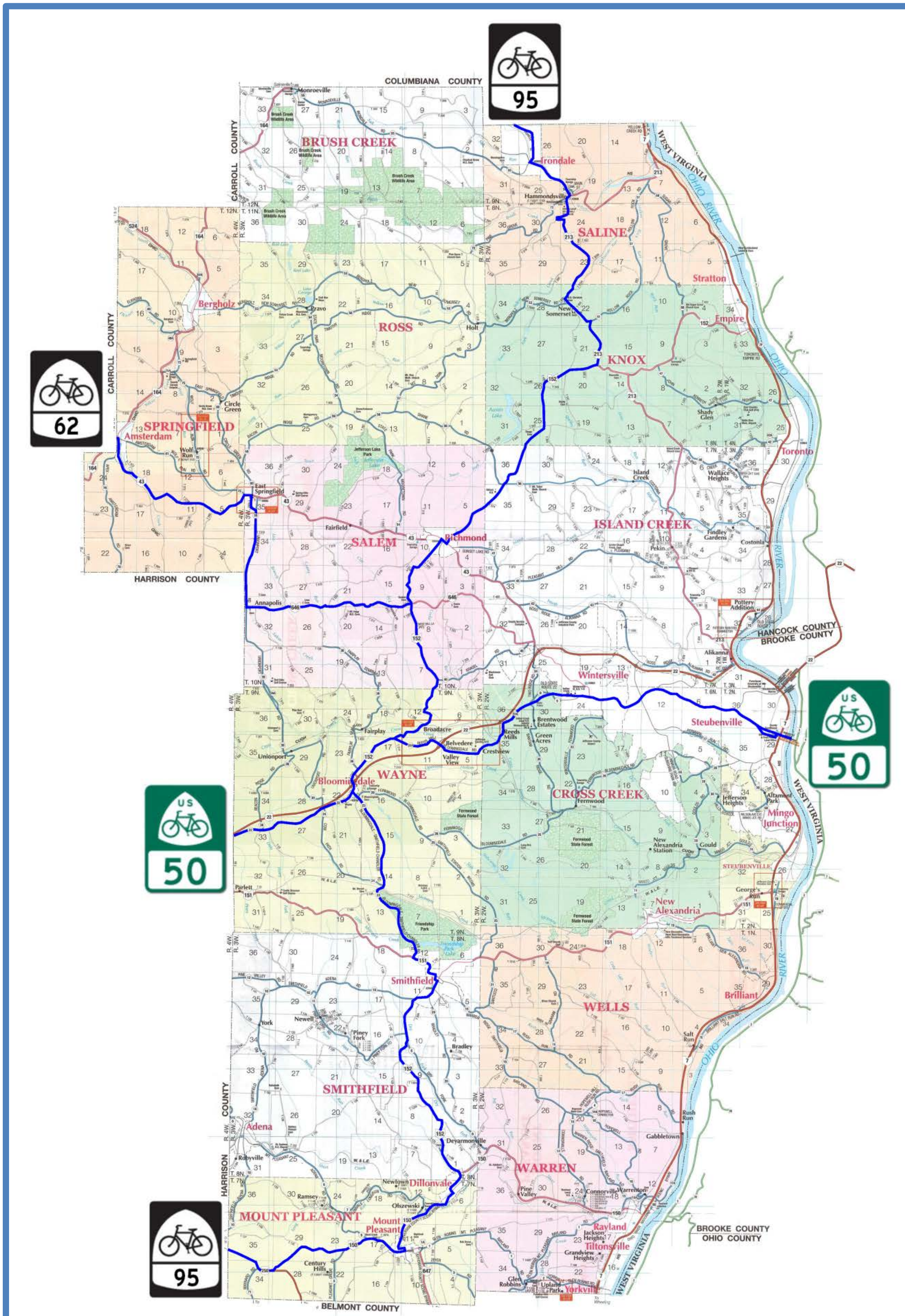
State Bike Route 95 (SBR-95)

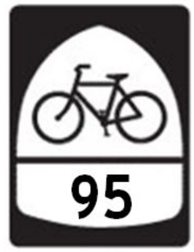
State Bike Route 62 (SBR-62)

The identified bike routes are as established or proposed by the Brooke Hancock Jefferson Metropolitan Planning Commission (BHJ-MPC) in conjunction with the Ohio Department of Transportation (ODOT) and others.

Local bike routes and multi-use paths should take into account, traveling with or connecting to, the designed U.S. and State Bike Routes during the planning and design of proposed bike routes.

U.S. & PROPOSED STATE BIKE ROUTE LOCATION MAP





STATE BIKE ROUTE SIGNAGE (SBR-62 & SBR-95)

Bicycle Route Sign (OMUTCD 9B.21, Sign M1-9)

Based on the OMUTCD, ODOT and the BHJ-MPC recommend a Bicycle Route Marker (M1-9) for use where it is desired to establish a unique identification through route designation of a state bicycle route.

The State Bicycle Route (M1-9) sign shall contain the assigned State route designation and shall have a black legend and border with a retroreflective white background. The sign shall be placed at intervals frequent enough to keep bicyclists informed of changes in route direction and to remind motorists of the presence of bicyclists.

U. S. BIKE ROUTE 50 (USBR-50) ROUTE SIGNAGE

The Ohio Department of Transportation (ODOT) has adopted and posted USBR-50 signs along the U.S. Bike Route per ODOT project USBR50-SIGN-FY2015 PID 98733. The project installed bike route signs in counties across Ohio.

The USBR-50 is signed using a M1-9 (ALTERNATIVE) sign also known as a M1-9A sign. The signs are mounted at a 7 feet mounting height on ODOT No. 2 support posts.

When needed, alternate route plaques, M4-1 signs, are placed above the M1-9A signs. Directional arrows or M6 signs are placed below the M1-9A signs.

M4-1

M6-1

M6-2

M6-3

U. S. BIKE ROUTE 50 (USBR-50) ROUTE SIGN M1-9A (ALTERNATIVE)

M1-9 (Alternate)
U. S. Bicycle Route (Alternate)

A	B	C	D	E	F	G	H	J	K	L	M	N
12	18	0.5	1.5	1.25	1.25 E	0.75	4.5	1	4 D	1.5	9	1.5
18	24	0.75	1.5	1.75	1.5 E	1	6	1.25	6 D	2	12	3

P	Q	R	S	T	U	V	W
9.296	6	1.263	1.388	0.25	0.375	1	1.5
11.895	8.5	1.528	1.653	0.313	0.437	0.75	1.5

★ See page 6-7 for symbol design.

★★ Optically space numerals about vertical centerline.

COLORS: LEGEND — GREEN (RETROREFLECTIVE)
INNER BACKGROUND — WHITE (RETROREFLECTIVE)
OUTER BACKGROUND — GREEN (RETROREFLECTIVE)

IA-15-1

JEFFERSON COUNTY TRAILS & GREENWAYS SIGNAGE

To establish a unique identification, all trails within the Jefferson County Trails and Greenways system should have a Jefferson County Trails and Greenway sign, complete with logo, to be placed at each trailhead, access point, and trail locations where trails cross into the County from other counties or states. The logo artwork will be provided by the Brooke-Hancock-Jefferson Metropolitan Planning Commission, committee approval is required.

Due to the multiplicity of jurisdictions that may be responsible for bikeway implementation within Jefferson County, it would be difficult to coordinate a logical and meaningful numbering system across the region that could evolve and expand with new opportunities for bicycle facility construction. For this reason, and because the OMUTCD allows for variance in sign design where messages other than those provided in the OMUTCD are needed, the regional signage system is proposed.

The Jefferson County Trails and Greenways signage should be placed along bike routes, trails and greenways whenever sponsors of the Jefferson County Trails & Greenways are involved or part of the Jefferson County Trails and Greenways system. This sign is a primary and secondary pathway identity sign used as a system brand mark to identify bikeways, trails and greenways that are part of the Jefferson County system of pathways. This sign should be scaled up to be viewable by motorists when using along streets and highways. This sign should be used in conjunction with pathway names and/or local jurisdictional identify signs or logos.

Contact the Brooke Hancock Jefferson Metropolitan Planning Commission (BHJ-MPC) for more information about the use of the “Jefferson County Trails & Greenways” plaque.

BIKE LANE AND ROAD SIGNS & PLAQUES (OMUTCD 9B.04)

The BIKE LANE (R3-17) sign and the R3-17aP and R3-17bP plaques (OMUTCD Figure 9B-2) shall be used only in conjunction with marked bicycle lanes as described in OMUTCD Section 9C.04.

If used, Bike Lane signs and plaques should be used in advance of the upstream end of the bicycle lane, at the downstream end of the bicycle lane, and at periodic intervals along the bicycle lane as determined by engineering judgment based on prevailing speed of bicycle and other traffic, block length, distances from adjacent intersections, and other considerations.

R3-17

R3-17aP

R3-17bP

BICYCLE MAY USE FULL LANE SIGN (OMUTCD 9B.06)

Sign R4-11

The purpose of the BICYCLES MAY USE FULL LANE signage is to inform roadway users that bicycle may occupy the travel lane when the existing travel lane is too narrow to safely allow the sharing with motorized vehicles. The primary advantage of the BICYCLES MAY USE FULL LANE signage is that it clearly conveys the message that bicycles may exercise their statutory right to take the full lane when necessary. Sometimes it is difficult for a bicyclist to assess whether or not they may use the full lane. On the other hand, an argument can be made to limit the installation of this type of signage to prevent confusion, to reduce sign clutter, and to convey a statute that bicyclists should already be familiar with. Where there is not enough room for a motorist to safely pass a bicyclist the use of the BICYCLES MAY USE FULL LANE signage should be considered.

Ohio Revised Code (ORC) Section 4511.55 addresses operating bicycles and motorcycles on a roadway. Generally, a bicyclist is required to ride as near to the right side of the roadway as possible, unless it is unsafe or impractical to do so. The BICYCLES MAY USE FULL LANE (OMUTCD R4-11) sign is a regulatory sign intended to advise motorists and bicyclists that bicycle traffic may be expected to move to the center of the travel lane in order to increase its visibility or avoid roadway obstacles in certain situations. These conditions include:

- Steep descending grades where bicycle traffic may be operating at higher speeds and requires additional maneuvering room to shy away from pavement edge conditions.
- Steep ascending grades, especially where there is no paved shoulder or the shared lane is not adequately wide; bicycle traffic may require additional maneuvering room to maintain balance at slow operating speeds.
- High volume urban conditions especially those with travel lanes less than the recommended width for lane sharing.
- Shared lanes in areas of limited sight distance.
- Situations where bicycle compatible shared lanes or demarcated shoulders or marked bike lanes are dropped or end, and bicycle and motor vehicle traffic must begin to share the travel lane.

<u>Guidance:</u>

Use of the BICYCLES MAY USE FULL LANE (R4-11) sign should be based on engineering judgment. The Bicycles MAY USE FULL LANE sign may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicyclists are present and where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side.

The BICYCLES MAY USE FULL LANE sign may be used in locations where it is important to inform road users that bicyclists might occupy the travel lane.

A Shared Lane Marking that may be used in addition to or instead of the BICYCLES MAY USE FULL LANE sign to inform road users that bicyclists might occupy the travel lane. When the BICYCLES MAY USE FULL LANE sign is used, the start and end of the section determined to warrant the signing should be marked with BEGIN (R3-9cP) and END (R3-9dP) plaques.

BICYCLE SHARE THE ROAD PLAQUE (OMUTCD 2C.60, 9B.19)

BICYCLES SHARE THE ROAD (OMUTCD W16-1P) Sign with (OMUTCD W11-1) Sign

Sign W16-1P

The BICYCLES SHARE THE ROAD (OMUTCD W16-1P) assembly is used to alert motorists of the presence of bicyclists in locations where bicyclists are forced to leave a shoulder, bicycle lane, or other bikeway and use the motor vehicle lanes because of either an obstruction or the end of the bikeway. The sign assembly is also intended to remind motorists and bicyclists that the roadway is to be shared between various modes of travel. In situations where there is a need to warn motorists to watch for bicyclists traveling along the highway, the SHARE THE ROAD (OMUTCD W16-1P) plaque should be used in conjunction with the (OMUTCD W11-1) sign.

A fluorescent yellow-green background color may be used for this sign or plaque. The background color of the plaque should match the color of the warning sign that is supplements.

The SHARE THE ROAD signage is recommended to be used under the following conditions:

- Shared lanes with relatively high posted travel speeds of 40 mph or greater.
- Other situations where it is determined advisable to alert motorists of the likely presence of bicycle traffic, and to alert all traffic of the need to share available roadway space.
- Where the rightmost travel lane is less than 15 feet wide, and there is insufficient shoulder width or the shoulder is otherwise un-rideable.
- Where there are obstacles (i.e. trees, traffic barrier, bridge piers, etc.) that impinge on an otherwise rideable shoulder.

In general, SHARE THE ROAD signs should not be used in locations with good bicycling conditions, such as roadways with low traffic volumes or roads with wide paved shoulders or bicycle lanes. SHARE THE ROAD signs should not be used in combination with:

- Sharrows,
- BICYCLES MAY USE FULL LANE (R4-11) sign,
- Bicycle Route signs
- Or other signs that already warn or advise motorists of bicycle use.

TRAILHEADS & ACCESS POINTS

Trailheads refer specifically to the primary means of accessing a trail, typically at the terminus points of each trail. They may include parking lots, restrooms, picnic facilities and other recreational amenities. Access points, on the other hand, refer to minor connections between the trail and nearby residential communities, recreational parks and roadways.

When developing both trailheads and access points, the designer should recognize that people with disabilities and a wide range of skill levels will participate in trail activities. Therefore, an accessible pathway should be developed that connects the public right-of-way and the public transit system to trailheads and access points. It is also crucial that all built facilities, such as parking lots, restrooms, picnic facilities and drinking fountains at the trailhead and along the trail, comply with Americans with Disabilities Act (ADA) accessibility guidelines, also known as ADAAG.

The following guidelines will assist the trail designer in the development and placement of trailheads and access points. Nevertheless, each project must be evaluated on a case-by-case basis:

- Trailheads should be placed at each terminus of a trail corridor, and any place where a large concentration of trail users is expected, such as at towns or major parks along the trail.
- An ADA accessible pathway should be developed that connects parking and other ADA accessible elements to the trailhead.
- Trailheads should include parking, benches, bicycle racks, signage, hitching posts (for equestrian trails), trash receptacles and a trail map, but may also include restrooms, picnic facilities, drinking fountains, water troughs, air filling station, bicycle repair station, emergency phone service and other necessary amenities.
- Trailheads associated with equestrian trails should provide parking and turn-around space for trailers.
- Trailhead facilities located adjacent to or within residential neighborhoods should be designed to ensure compatibility with the surrounding neighborhood.
- Trail access points should be placed wherever trail access is expected, such as at adjacent communities, schools, commercial areas, and parks.
- Trail access points should include signage identifying the trail and may include a map and drinking fountain. Limited parking may also be included, but because trail access points are designed to give access from local amenities to the trail, it may be unnecessary.

TRAILHEAD ACCESSIBILITY

Trailheads are required to have access routes complying with the American with Disabilities Act (ADA) accessibility guidelines (ADAAG) that are located between parking, path, and trailhead areas.

Slopes:

- Longitudinal Slope = Less than 5 %
- Cross Slope = Less than 2%

Parking:

- At Least 1 Van ADA Accessible Space For Every 6 Car ADA Accessible Spaces
- 1 Car ADA Accessible Space Per 25 Spaces (Up to 100, See ADAAG for Over 100)
- ADA Access Aisle = 5 Feet Wide
- Van ADA Access Space = 11 Feet Wide
- Car ADA Access Space = 8 Feet Wide

TRAILHEAD SIGNS

Provide signs at trailheads and access points with accurate and detailed information about existing path conditions and available facilities. People should have information about trails, including length, grade, and so forth, so that they can make their own decisions about which trail is appropriate for the amount of time they have available, the people in their group, and the type of hike they are interested in pursuing. Therefore, when information signs are provided at trailheads for newly constructed or altered trails, they should include at the following information:

- Trail name
- Trail logo
- Trails and Greenways logo
- Symbols showing allowable uses of the trail
- Length of the trail
- Type of surface on the trail (type, firmness and stability)
- Typical and minimum trail tread width
- Typical and maximum trail grade
- Typical and maximum trail cross slope
- Height of any major obstacles, such as boulders, in the trail tread, and other known trail hazards
- A statement that reflects the condition of the trail when it was constructed or assessed, including the construction or assessment date
- Map of the trail; either a trail-specific map or a park/vicinity map with the trail highlighted. A standard trail map comprises approximately half of the trailhead sign. Copies can also be printed on paper for patron use.

Trail users with visual impairments benefit from signs with large lettering, Braille panels, raised lettering, or audio boxes that play recorded trail information at the push of a button.

The requirement for posting the construction and trail assessment date is because natural catastrophes (i.e. tree blowdowns, flooding, etc.) can make trails temporarily inaccessible until maintenance crews can clear the obstruction. If the date is posted, people will be able to evaluate the likelihood that the trail remains in the posted condition. For instance, people may know that a major storm has occurred since the conditions were posted or may estimate the likelihood that vegetation may have overgrown the trail since the condition was evaluated.

Where more extensive trail information, such as an aerial map of the trail and related facilities, is provided, identify the location of specific trail features and obstacles that do not comply with standard technical requirements and include a profile of the trail grade.

If materials, such as maps, brochures, and so forth, need to be obtained from or filled out at a sign or kiosk, design the sign or kiosk to display the materials within the standard reach ranges of a person in a wheelchair.

EXAMPLE TRAILHEAD AND TRAIL SIGNS

Trailhead Entrance Signs

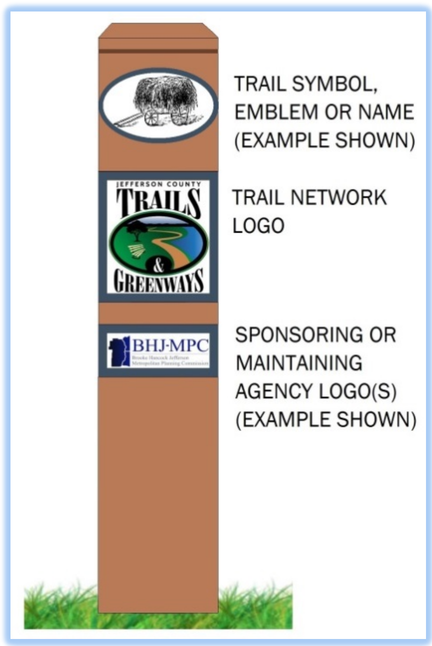
A trailhead entrance sign is typically located at the entrance or gateway to a trailhead facility. It is usually located to be visible from a public roadway. The trailhead entrance sign will show the trailhead facility name and/or associated trail names. Additionally they will identify sponsor, funding, and maintaining agencies.

Trailhead Signs

Trailhead signs are used to provide trail-specific information at the trailhead of each trail.

Trail Signs

Trail signs are used to provide information and symbols for trail users to find their way and to better understand the area.



TRAIL TYPE SIGNAGE

There are a variety of uses for trails and the type of signage for a specific trail is often dependent on what the trail is designed for. The trails framework categorizes trails by designed use, the use by which trails are most often identified. The designed use standard is the intended use that requires the highest level of development. Although numerous uses of a trail may be allowed, only one use is identified as the designed use with the exception of greenway trails, which are designed for multiple uses.

Accessible trails are ADA accessible pedestrian trails (greenway trails, short distance hiking trails, and interpretive trails) that are additionally designed to meet ADAAG standards to accommodate persons with disabilities.

Signage guidelines for all highway uses are provided in the Ohio Manual on Uniform Traffic Control Devices (OMUTCD). Specifically, Section 9 of the OMUTCD addresses Traffic Controls for Bicycle Facilities. Signage along public roads is usually managed by either the Ohio Department of Transportation (ODOT) or the local or county highway department.

Greenway trails. User education about standards of behavior is encouraged through the use of trailhead signage. Greenway trails are often marked at regular intervals with distance markers, which show the mileage point from one end of the trail. Distance markers may include an official symbol for the trail and usually no other route markers are needed; however, directional, regulatory, and cautionary signs are all typically used along greenway trails.

Hiking trails are designed specifically for foot travel. Backcountry foot trails are typically designed to be the least intrusive type of trail upon the natural environment and therefore often have the fewest and simplest signs. Along many backcountry hiking trails, blazes or markers are the only type of signage used, other than directional signs at trail junctions. For marking and signing designated long distance trails, follow the guidelines approved by the managing agency or trail organization for each specific trail.

Mountain bike trails are typically designed for low-impact use and can range from general use to challenging. In addition to markers and regulatory signage that keep bikers on the designated trail route, mountain bike trails may also include signs that rate the trail's level of difficulty.

Cross-country ski trails Although it is possible for cross country skiers to use many different types of trails, those trails designed as ski trails should be designated and signed as such and may include signs that rate the trail's level of difficulty. Cross-country ski trails should be marked so that travelers unfamiliar with the trails can follow them during poor weather conditions, when there are no tracks to follow and when the lighting is poor.

Interpretive trails are pedestrian trails designed for interpreting natural or cultural features in the landscape. **Nature trails** are interpretive trails designed to educate users about natural features, natural history, or wildlife along the trail. **Fitness trails** are designed with specific features that can be used to increase the physical fitness of persons using the trail. Other interpretive trails are designed to educate users about cultural history along the trail. Interpretive trails are posted with distinctive interpretive signage and often with directional and regulatory signs as well. Fitness trail signs are similar to other interpretive trail signs, but they guide users in interpreting special fitness features of the trail.

TRAIL SYMBOLS

The following recreation symbols should be used on trailhead signs, at trail junctions and road crossings, and on maps to indicate permitted uses of the trail. In addition, trail difficulty rating symbols can be used on mountain bike and cross country ski trails that have been rated for level of difficulty. Except for difficulty rating symbols, colors can be modified to coordinate with trail markings.

Symbol	Use
	**Hiking** (pedestrian)
	**Snowmobiling**
	**Equestrian** (horse trail)
	**Bicycling**
	**Mountain Biking**
	**Cross-Country Skiing**
	**Interpretive** (cultural history or nature trail)
	**Fitness**

Symbol	Use
	**Accessible** (must conform to specific standards)
	**Inline Skating** (roller blading)
	**Skateboarding**
	**Snowshoeing**
	**Easiest** (green)
	**More Difficult** (blue)
	**Most Difficult** (black)

TRAIL DIFFICULTY RATINGS

Mountain bike and cross-country ski trails can be rated to signify their comparative level of difficulty. Difficulty ratings are based on the degree of challenge a trail presents to an average user's physical ability and skill by using trail condition and route location factors such as alignment, steepness of grades, gain and loss of elevation, and natural barriers that must be crossed. It should be noted that conditions are subject to change due to weather and other factors. Standard guidelines and symbols used for rating trails are outlined below.

Mountain Bikes

Easy (green): Appropriate for all users. Trail follows obvious, well-marked trails and roads. Grades are gentle, tread is firm and stable, and only minor obstacles may be encountered.

More Difficult (blue): Appropriate for users of intermediate to advanced ability. Trail may have steeper terrain, narrower trail, variable tread, and some unavoidable obstacles.

Most Difficult (black): Advanced to expert. Trail requires great physical ability and navigational skill. Trail is where terrain is steep. Trail may be narrow with unavoidable obstacles and much variability in tread.

Cross-Country Skiing

Easy (green): Skiers need only basic knowledge and limited experience in the diagonal stride, snowplowing, and side stepping. Trail may have short downhill and uphill stretches.

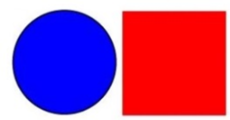
More Difficult (blue): Skiers must be able to ski variably steeper terrain requiring turning, snowplowing, herringboning, and diagonal stride.

Most Difficult (black): Skiers must be experienced. Terrain is frequently extreme. Turns are often sharp and linked together with no room to snowplow or herringbone.

TRAIL MARKERS & BLAZES


The most basic trail signs are those that identify the trail. These signs may provide the name of the trail, mark the route of the trail, or include simple information, such as difficulty rating, mileage point, and symbols that show allowable uses of the trail. Where directional signs are used, identification of the trail is often incorporated into the directional sign.

Waymarks are small, simple signs that mark the route of the trail and reassure trail users that they are on the trail. Trails can be marked in many ways. Blazes can be painted on trees, stakes, or other objects, posts can be set into the ground, markers can be nailed to trees or posts, or cairns (piles of rocks) can be carefully erected. Regardless of the method used or type of trail being marked, each specific trail should be marked clearly and consistently and the marking should conform to a standard color, shape, and size. Where trail conditions prevent the use of the standard marker, an alternative can be used.

The preferred method of marking trails is to use colored plastic or metal markers nailed to trees or posts. Plastic markers are less expensive but may not last as long as metal markers. Markers of various colors, shapes, and sizes are useful for distinguishing between multiple trails and between different types of trails. However, it should be noted that a large number of people are unable to distinguish between different colors; therefore, trail intersections should be well-labeled using different symbols or text (on markers or signs) to signify different trails. Markers with arrows may be used to indicate major changes in direction along a trail.

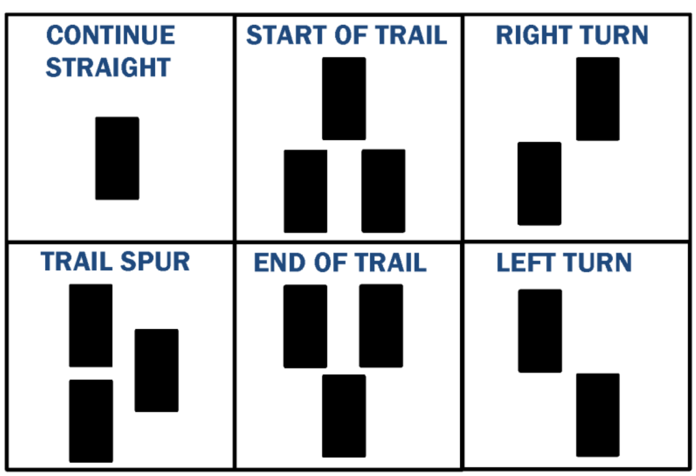
Distance markers may be used to show the mileage from either end of the trail or from a designated trailhead. These types of markers, typically used along greenway trails, can be very useful in emergency situations and for maintenance purposes. They are often placed every quarter mile, although placement at tenth-mile intervals may be preferable. Use of distance markers is encouraged along all trails and should include a unique identifier, such as the trail name. Where distance markers are used, other methods of marking the trail are usually unnecessary. Distance markers are often imbedded in a post that is placed into the ground alongside the trail using vandal-resistant hardware. Alternatively, distance markers can be metal or plastic markers nailed to trees or attached to posts; however, these types of specialized markers are prone to theft. Whichever method is used, the design of distance markers should be consistent along the entire length of the trail on which they are placed.

On long distance trails, it is not cost effective or desirable to use official trail markers as the sole method of marking a trail. Other less costly, less visually obtrusive, and more vandal-resistant methods should be used between widely-spaced markers. The preferred method is to use paint blazes, typically vertical rectangles painted on trees, posts, and other objects along the trail. The typical standard size for trail blazes is 2"x6". Acceptable blaze sizes along trails are 2"x3", 2"x4", and 2"x6"; however the size of blazes must remain consistent along each particular trail. To maintain continuity along designated long distance trails, follow the marking guidelines approved by the managing agency or trail organization for each specific trail.

Trail markings should be visible, yet unobtrusive, balanced according to the characteristics of the trail. In addition to indicating the trail route and reassuring users that they are on the trail, markers can also serve to influence the path taken by trail users, thereby helping to avoid trampling of fragile trailside vegetation and to prevent erosion.

General guidelines to use when marking trails:

- Use aluminum nails for attaching markers. Aluminum resists corrosion better than other metals and will not damage a saw when a future cut is made across a hidden nail.
- When driving nails into trees, be sure to leave a sufficient length protruding (approximately ½ inch) to allow for future tree growth. An exception can be made in areas of frequent vandalism or theft.
- Place waymarks at eye level of the user, when possible. Eye level will be different depending on the type of trail user and amount of snow cover. (Waymarks should be placed higher on horse and cross country ski trails.)
- Be sure to mark trails in both directions, first from one direction and then from the opposite direction, in order to gain each perspective. It may not be appropriate to simply put markers on opposite sides of the same tree.
- Trails need to be continuously marked, including when they follow roads. Mark trails such that the next waymark is clearly visible from the previous one. However, avoid placing waymarks so that more than one is readily obvious from the previous. One well-placed blaze or marker is better than several poorly placed blazes or markers.
- Be sure to keep vegetation pruned from in front of waymarks at all times, sufficiently allowing for summer growth.
- Painted blazes should have sharp corners and straight edges so that they are easily distinguished from natural objects when viewed from a distance. Blazes are best painted on trees larger than 3" in diameter with thick, darker bark that has been scraped smooth before painting.
- A double blaze, one above the other, signifies a sharp turn in the trail. Double blazes may be offset to signify the direction of the turn such that signifies a right turn and signifies a left turn. Other blaze configurations are included below.



TRAIL SIGN INFORMATION

The basis for producing trail signage is to provide information to trail users. It is appropriate to provide more information about a trail than simply marking a line on a map. It is therefore important to first fully understand what information is desired and to review the information to present to be sure it is helpful and appropriate for each specific trail. Providing accurate, objective information about actual trail conditions will allow people to assess their own interests, experience, and skills in order to determine whether a particular trail is appropriate or is sufficiently accessible to them.

This section is meant to provide information to assist managers in producing signage and printed material. This information may not apply to all trails or all uses and should only be used in trail brochures or posted on kiosks as desired. ***It is important to not overwhelm trail users with too much information.***

A variety of information formats may be used to convey trail information. Consideration should be given to providing written information in alternative formats such as Braille, large print, multiple languages, or an audible format. For example, the text of a trailhead sign could be made available on audiocassette or using a digital voice recorder. In addition, simplified text and reliance on universal symbols would provide information to individuals with limited reading abilities or limited understanding of the English language.

TRAIL SIGN FACE DESIGN

An effectively designed sign face is clear, concise, simple, and legible with well-spaced typography and plenty of space in the margin. Text for signs should be left-justified and use both capital and small-case lettering (except for wooden directional signs, which use all capital lettering). Universal symbols should be used when possible. The following fonts are preferred for trail signs, with the exception of wooden directional signs and interpretive signs:

Gatineau Souvenir Helvetica

The chart below is a guide to determining the minimum letter size based on the desired maximum distance at which a proposed sign is to be viewed. A research ophthalmologist working with the U.S. Army Corps of Engineers established a viewing distance of 28 feet per inch of letter height for Helvetica Medium font and a visual acuity of 20/40.

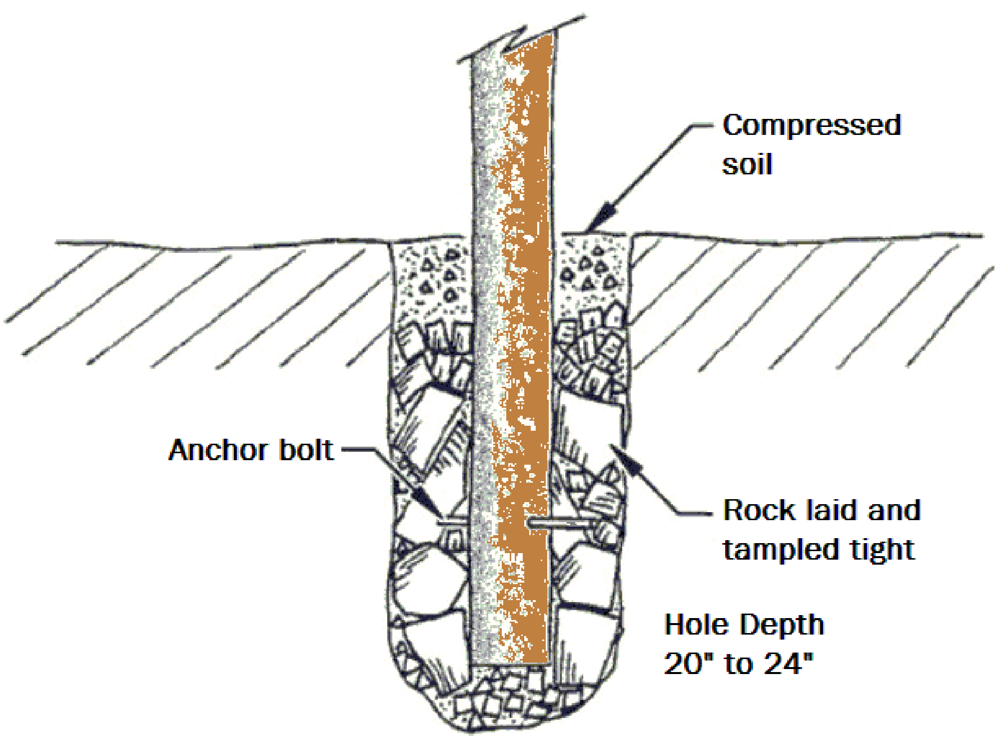
VIEWING DISTANCE (FEET)	CAPITAL LETTER HEIGHT (INCHES)
0-20	0.75
21-27	1
28-41	1.5
42-55	2
56-83	3
84-111	4

PMS 1615

Standard colors are white lettering on a brown background. Paint should be high-quality (two part epoxy will not fade) and compatible with the surface it is used on, as well as compatible with any preservatives used on wooden surfaces. Reflective paint, which may be desirable for high visibility in the dark, is available in Pantone Matching System (PMS) 1615, a shade of brown that is similar to that used on highway signs. PMS 1615 is suggested as the standard background color for trail signs (PMS 1615 color sample shown may not be exact).

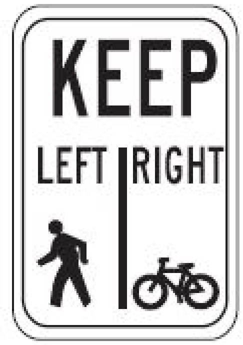
Signs needing their own support should be installed using one or two 4”x4” posts eight feet long placed approximately 24” into the ground with a theft-resistant anchor bolt. Posts of brown or gray recycled composite material are best for more developed areas (dark brown is suggested as the standard). A single wooden signpost may be used in primitive areas (cedar is best). Postholes should be filled with either concrete or rocks and covered with compressed soil. The sign should be attached to the post using theft-resistant, corrosion resistant hardware such that the top of the sign is level and even with the tops of the signposts.

SIGNPOST INSTALLATION



SHARED-USE PATH SIGNAGE

Signage increases safety and comfort on trails. The inclusion of signage on trails is an important amenity not to be overlooked. However, the overuse of signs is not recommended. Signs may assist in the navigation of a trail or trail system, warn of approaching roadway crossings, regulate trail use, and/or interpret natural features.



Signs must be uniform and consistent for them to command the respect of trail users and should follow established sign design principles for ease of reading and comprehension.

- Signs shall be standard in material, shape, legend, color and font.
- All signs shall be retroreflective.
- Consider pictorial and symbol signs in place of verbal warnings.
- The sign sizes for multi-use trails shall be those shown in OMUTCD.

The Ohio Manual on Uniform Traffic Control Devices (OMUTCD) is an invaluable reference for standard signage. Whereas this document is generally geared for roadway use, many of the signs may be adapted for trail use. In addition, the signs listed in the OMUTCD are an industry standard and can be easily fabricated. Following are the basic types of signs:

- Directional signs give street names, trail names, direction arrows, mileage to points of interest, and other navigational information.
- Cautionary signs warn of upcoming roadway crossings, steep grades, blind curves, and other potential trail hazards.
- Regulatory signs tell the "rules of the trail" by prohibiting certain uses or controlling direction of travel.
- Interpretive signs offer educational information on the trail environment.
- Objective signs provide information about the actual trail conditions, including grade, cross slope, surface, clear trail width and obstacle height. This allows users to make more informed decisions about which trails best meet their trail needs and abilities. For example, a wheelchair user may be able to travel over very steep grades provided the trail is at least 36 inches wide. Learning this information at the trailhead will help this user avoid the potential frustration of having to turn back if the trail becomes too narrow.

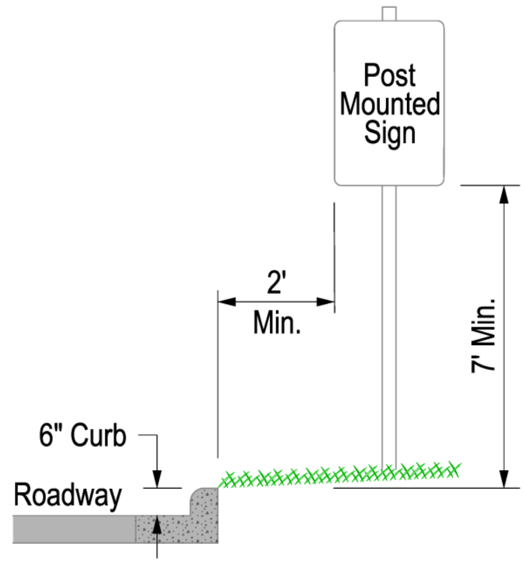
Other regulatory, cautionary, and directional signs should be placed as needed. The inclusion of signage in a trail project should be planned from the outset, but each project is vastly different, and signage should be considered on a case-by-case basis. The following guidelines relate to the general placement and design of trail signage.

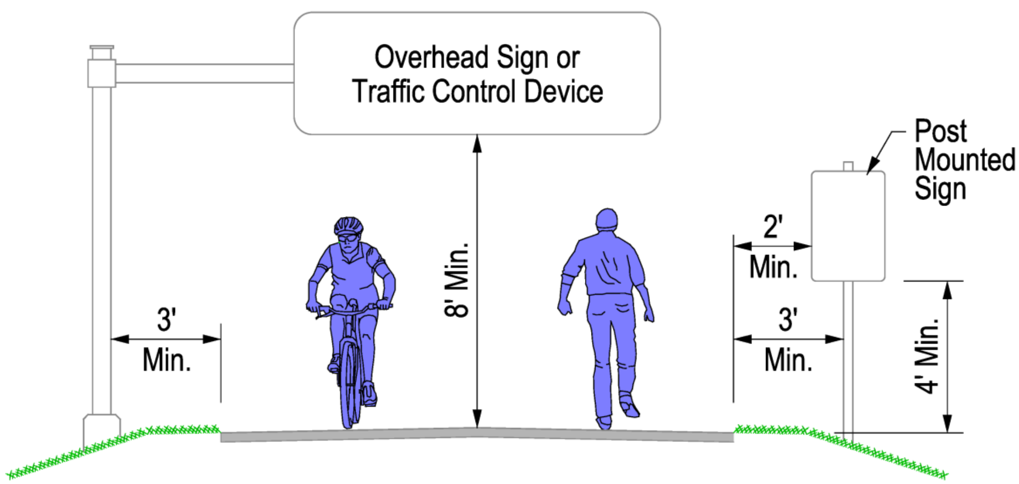
- Signs should be placed where they will be clearly visible. Placement is dependent on the sight lines (relative to user speed) of each trail.
- Signs should be placed at a constant distance from the trail edge.
- Lettering less than two inches in height is not recommended for directional signs.
- Text should be avoided on regulatory or cautionary signs wherever possible.
- Multiple signs may be mounted on the same post, but the primary message should be in the top position on the post.

SHARED-USE PATH SIGNAGE PLACEMENT

The placement of signs along each trail will vary greatly, depending on the intended use of the trail, and should comply with the following standards:

- Lateral sign clearance shall be a minimum of 2 feet (3 feet preferred) and a maximum of 6 feet from the near edge of the sign to the near edge of the path.
- Mounting height for pavement mounted signs shall be a minimum of 7 feet measured from the bottom edge of the sign to the near edge of the path surface.
- Mounting height for ground mounted signs shall be a minimum of 4 feet and a maximum of 5 feet, measured from the bottom edge of the sign to the near edge of the path surface.
- When overhead signs are used, the clearance from the bottom edge of the sign to the path surface directly under the sign shall be a minimum of 8 feet.
- Placement of signs to be reviewed during trail design review phase.

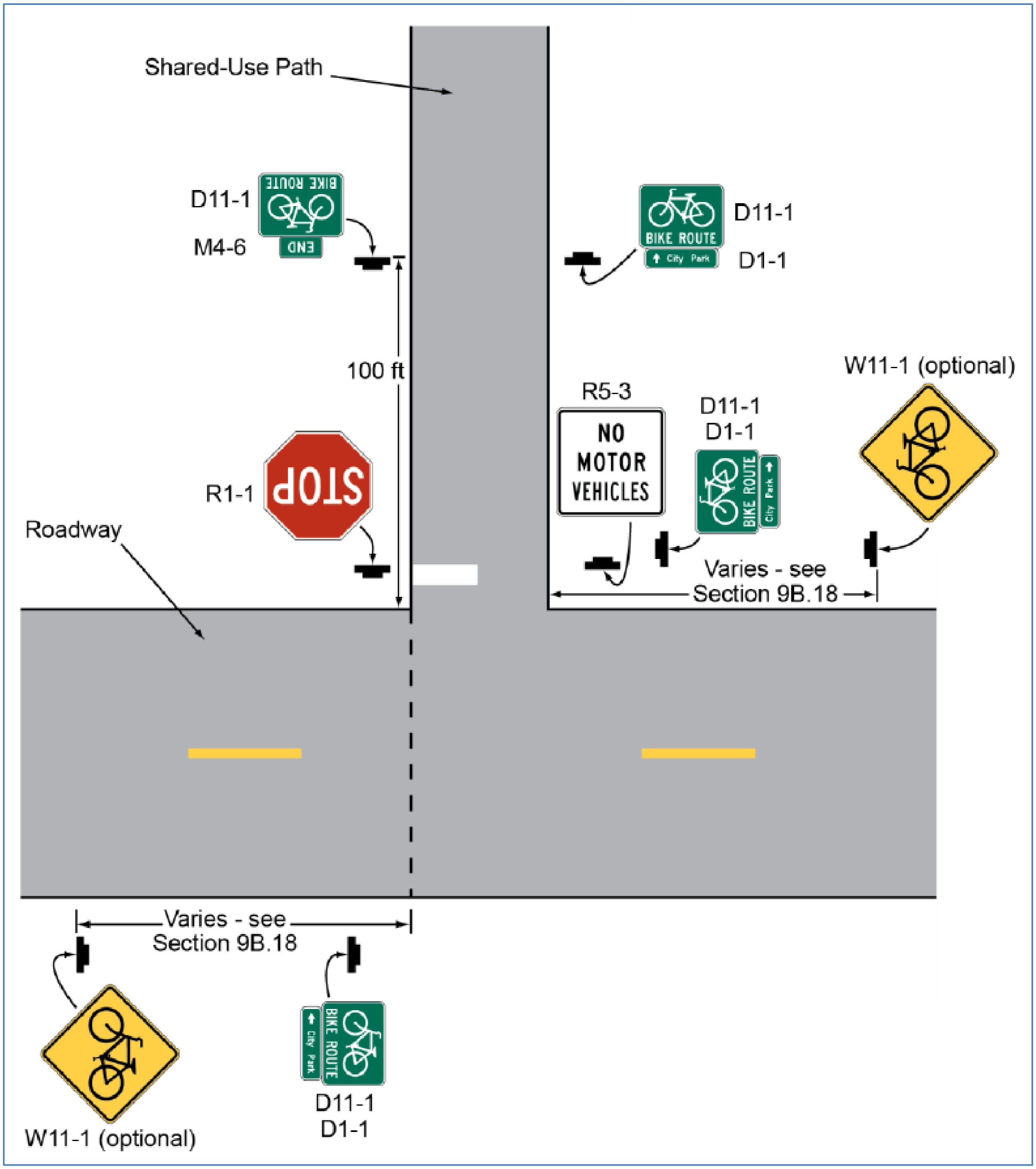




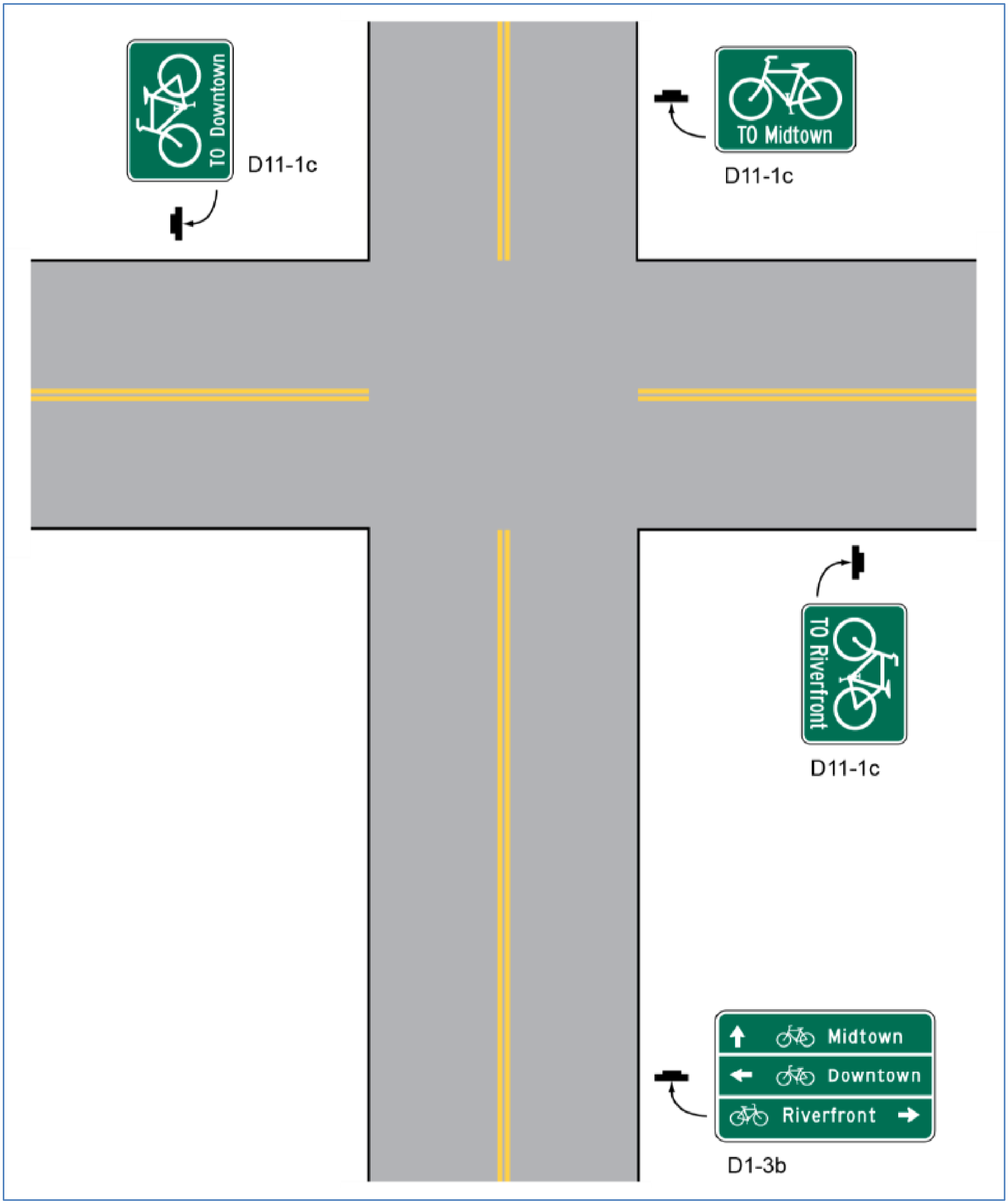
Ohio Department of Transportation Standard Construction Drawings (ODOT SCD)

- TC-42.10 Typical Guide Sign Placement
- TC-42.20 Typical Flat Sheet Sign Placement

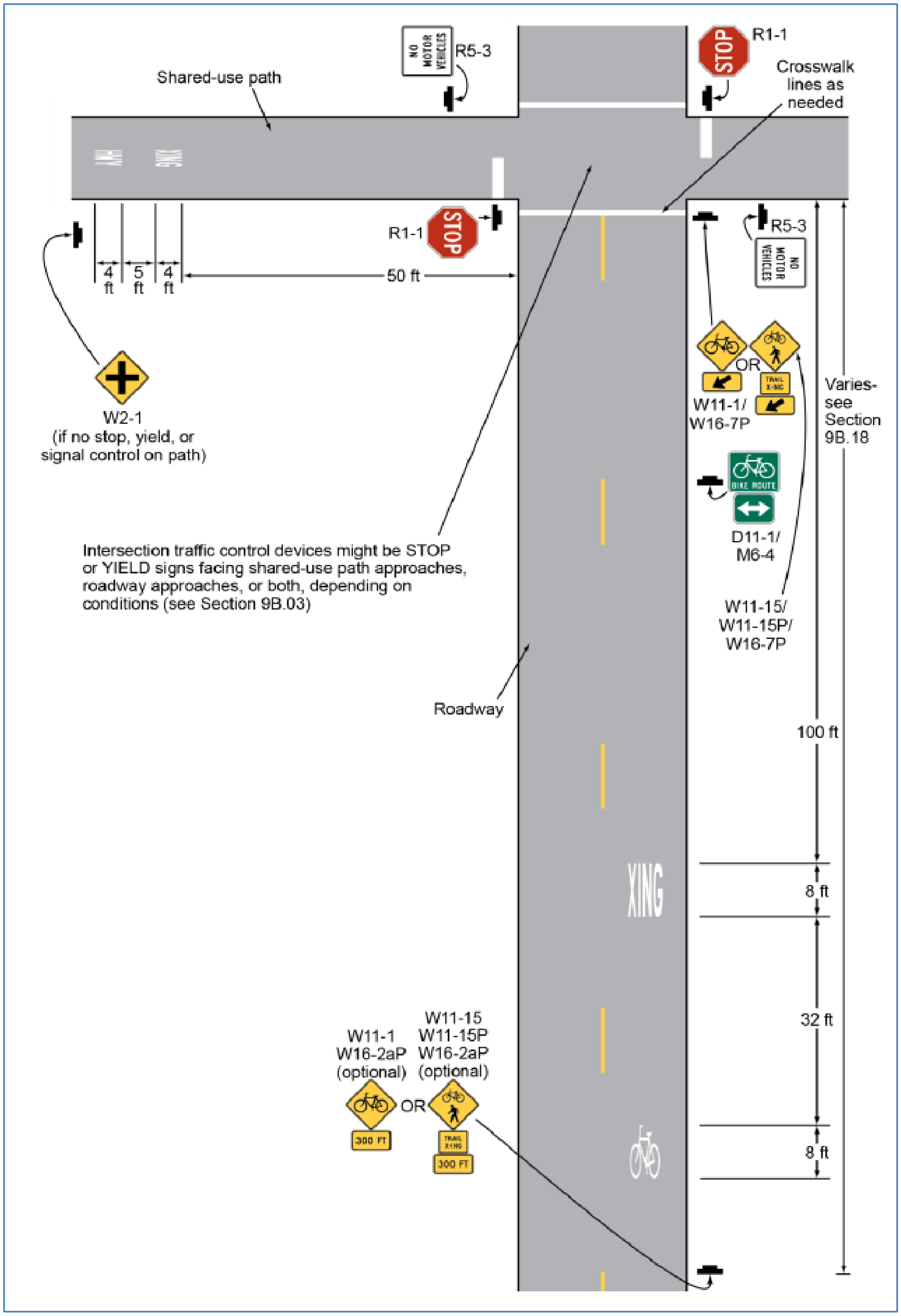
EXAMPLE OF PATH TERMINUS SIGNAGE
(OMUTCD Figure 9B-5)



EXAMPLE OF BICYCLE GUIDE SIGNING
(OMUTCD Figure 9B-6)

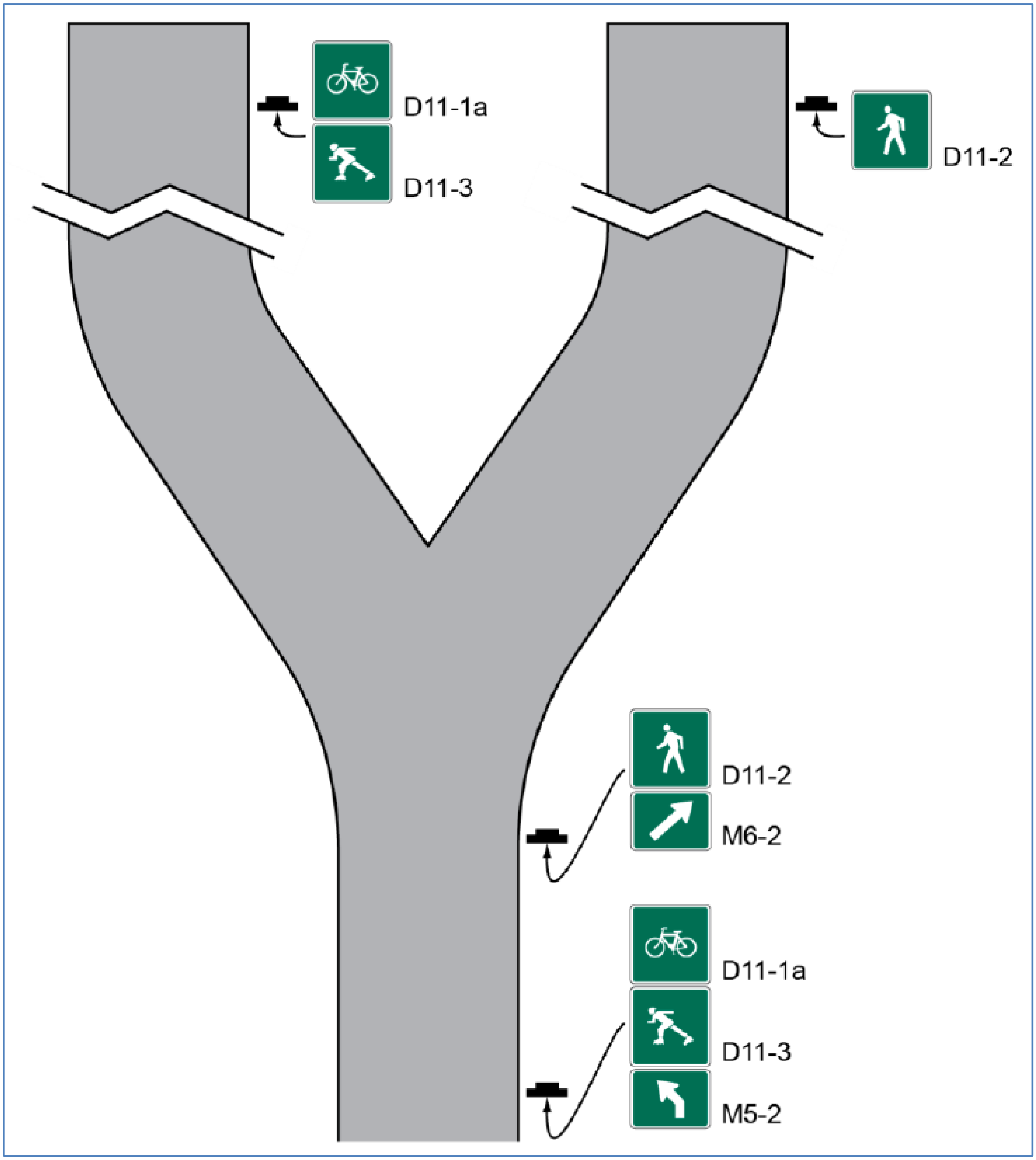


**EXAMPLE OF SHARED PATH CROSSING
SIGNING AND MARKINGS**
(OMUTCD Figure 9B-7)



EXAMPLE OF SHARED-USE PATH MODE SIGNAGE

(OMUTCD Figure 9B-8)



INFORMATIONAL SIGNS

Informational signs are used to direct and guide users along trails in the most simple and direct manner possible. Signs include, but are not limited to, the following:

- Identification of trailheads and access points
- Identification of cross streets
- Trail maps
- Descriptions of surface type, grade, cross-slope and other trail features

REGULATORY & WARNING SIGNAGE

Some regulatory signs convey information about park and trail regulations and others serve as traffic control devices. To present a positive tone and to reduce over-signing, regulatory signs should emphasize allowable uses and, where possible, use symbols instead of text. In problem areas, prohibited uses can be shown as symbols with a slash across them. Regulation signs should be placed on trailhead kiosks; other regulatory signs should only be used along trails as necessary. Boundary signs are placed along boundaries, both to mark the boundary and to provide regulatory information to trail users entering or leaving the trail.

Some warning signs point out potentially hazardous conditions along the trail, such as road crossings, narrow bridges, barriers, surface changes, sharp turns, and steep drops. They should generally be posted in advance of the specific area or site of concern. Other cautionary signs provide important information for the safety and well-being of visitors. These informational signs should be limited to trail information kiosks.

Be especially conscious of the potential for too many regulatory and warning signs and try to keep trailhead kiosks aesthetically pleasing by designing and arranging signs in a harmonious fashion. Having an excessive number of signs may result in signs losing their effectiveness as they compete for the attention of trail users. Excessive signing can be as detrimental as inadequate signing.

Standard traffic control signs should only be used when necessary, mainly along greenway trails with a high level of use. It is unnecessary to use full-size highway signs on trails. Refer to Part 9: Traffic Controls for Bicycle Facilities of the OMUTCD which addresses both signs and pavement markings.

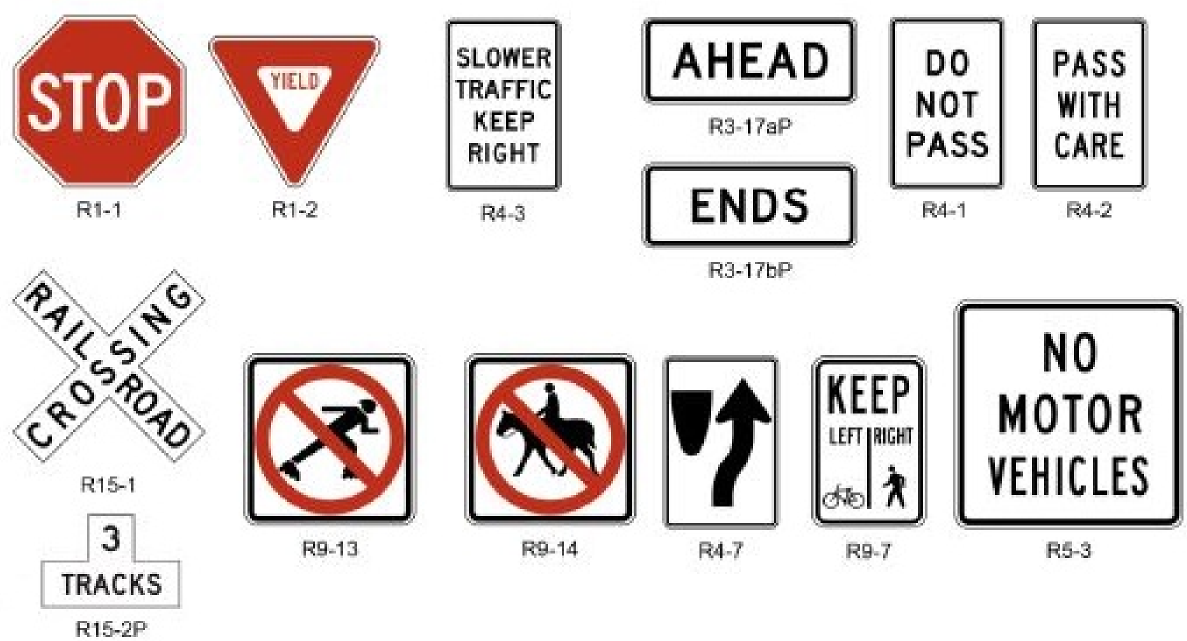
REGULATORY SIGNS

Regulatory signs are used to inform trail users of the "rules of the trail", as well as selected traffic laws and regulations. They include, but are not limited to, the following:

- Appropriate user modes for each trail (may change depending on season)
- Bike speeds
- Controlling direction of travel
- Stop and Yield Signs

STOP signs shall be installed on shared-use paths at points where bicyclists and other users are required to stop.

YIELD signs shall be installed on shared-use paths at points where bicyclists and other users have an adequate view of conflicting traffic as they approach the sign, and where trail users are required to yield the right-of-way to the conflicting traffic.

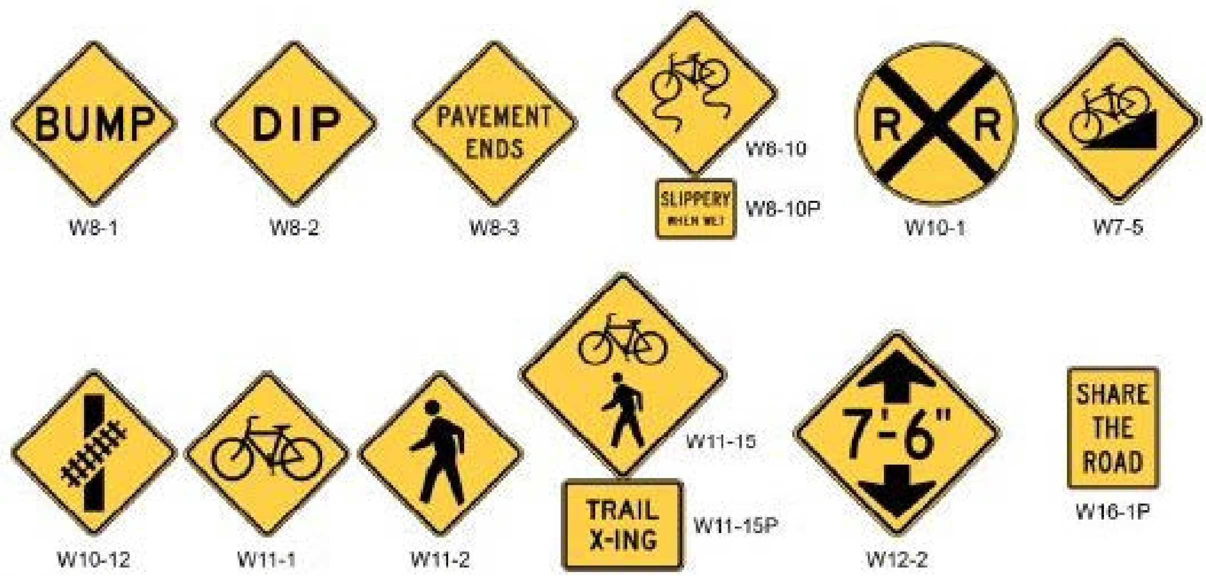


WARNING SIGNS

Warning signs are used to alert trail users to potentially hazardous or unexpected conditions, or where trail conditions could cause the rider to lose control (e.g., slick pavement or bridge decks, wet trail surfaces or rough surfaces). These signs should be used in advance of the condition. They include, but are not limited to, the following:

- Upcoming roadway, railroad or trail intersections
- Blind curves
- Steep grade
- Height and width constraints
- Trail conditions

Following are examples selected from the OMUTCD, 2012 Edition, Figure 9B-3, Warning Sign and Plaques for Bicycle Facilities:

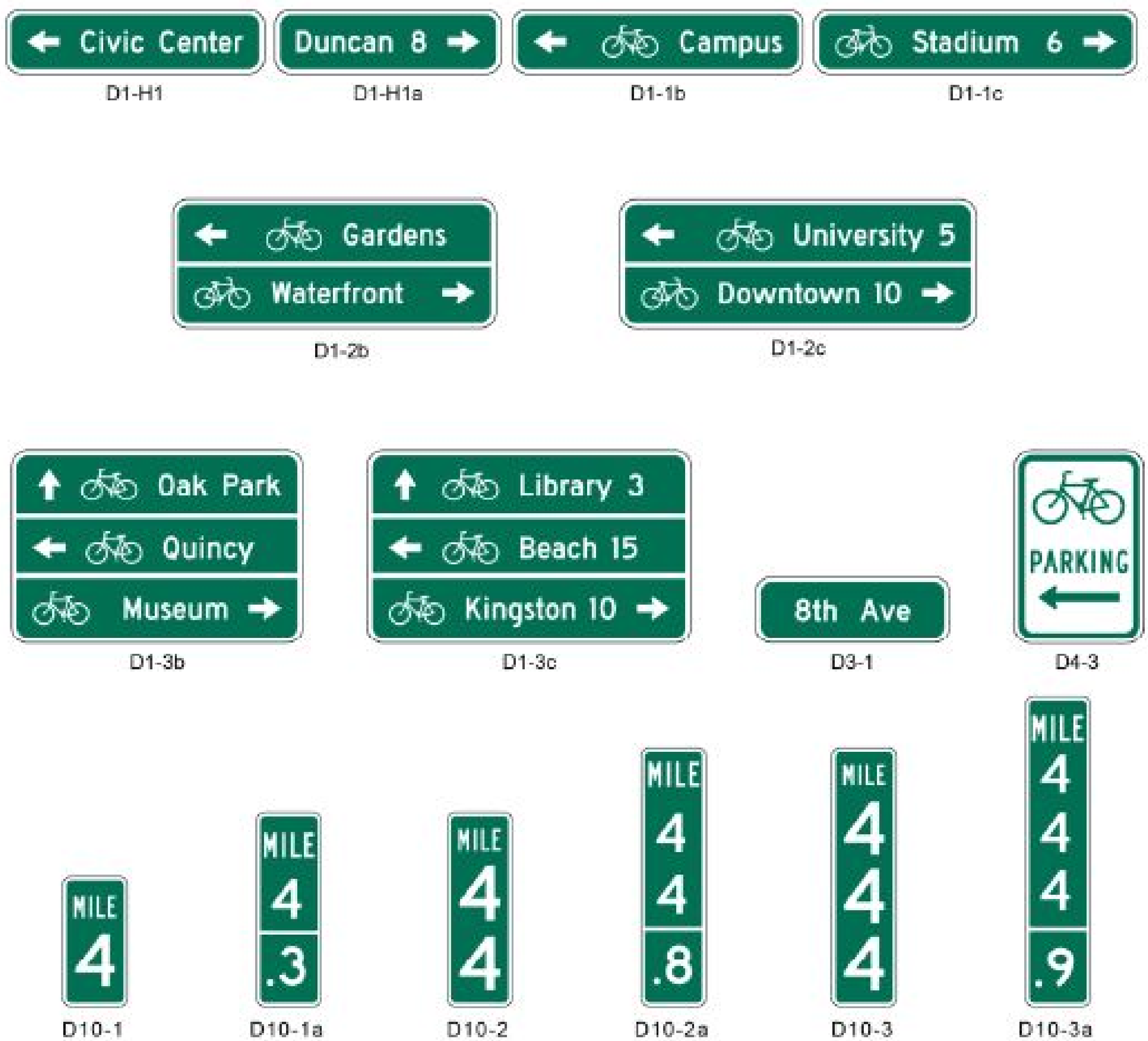


DIRECTIONAL SIGNS

Directional signs or Guide signs are used to inform trail users where they are along the trail and the distance to destinations and points of interest. They include, but are not limited to, the following:

- Street names
- Trail names
- Direction arrows
- Mile markers to be posted every mile
- Mileage to points of interest

Following are examples selected from the OMUTCD, 2012 Edition, Figure 9B-4, Guide Sign and Plaques for Bicycle Facilities:



INTERPRETIVE FACILITIES

Interpretive facilities allow the trail user to gain an understanding of the unique environment through which they travel, and therefore should be incorporated into the overall planning and design of each trail. Each trail's interpretive program will be different, based on its location, potential interpretive resources along the trail, and the use of the trail. Interpretive Facilities throughout Jefferson County could highlight various aspects of the landscape, native plants and animals, geologic history and cultural history. Trail planners and designers should incorporate any and all of these unique environmental resources into the trail experience.

The following guidelines offer general suggestions on interpretive facilities. However, each interpretive program must be evaluated on an individual basis:

- Interpretive facilities should include signage with ample graphics, to engage users of all ages. They may also include any of the rest area facilities listed above.
- Consideration should be given to providing interpretive information in a format that is accessible to people with vision impairments and people with limited English skills. This may include providing objects that can be examined or manipulated, or providing audio information in addition to written information.

Interpretive facilities should be placed wherever there is a significant cultural, historic, or natural resource to be displayed.

INTERPRETIVE SIGNS

Interpretive signs point out features of interest along the trail and educate trail users about those features, which can be natural, cultural, historical, or recreational. Interpretive signs can also direct users to avoid impacting ecologically sensitive areas and educate recreational users about the environment, thereby creating a new purpose for recreational trails. The completion of a trails plan prior to producing interpretive signs will accelerate the design process. Interpretive signs are a great medium that can reach a wide audience with minimal effort. Interpretive signage provides a variety of functions:

- Interpretive signs illuminate the power of place. Clear educational messages and content inform the public of each site's historic significance.
- Interpretive panels do more than provide just dates and facts. They also inspire a feeling of stewardship in site visitors, strengthening awareness of cultural and natural resources.
- Thoughtful and well-designed signage programs demonstrate community pride in local heritage.
- Interpretive signage is self-sufficient: it provides a high-quality interpretive experience without the requirements of staff or facilities to maintain.
- They are a consistent message available to many visitors at one time, can be viewed at the visitors' convenience, and are available 24 hours a day.
- Interpretive signage enhances visitor perceptions of a site, city, or region. By drawing attention to an area's unique history and identity, tourists better appreciate the story of a new place. Captivating interpretive signs and exhibits can become destinations in their own right.

Interpretive signs are not ideal in every situation. They are vulnerable to damage by weather, wildlife, and vandalism. They are also non-personal and may draw attention as a fragile resource that could be damaged by visitors.

Before researching, drafting the text, or designing a sign, the need for the interpretive sign must be determined. Answer the following questions:

- Is there something that needs explaining?
- Will something be missed without interpretation?
- Is a sign the appropriate form of interpretation?
- Will the sign help prevent damage to the site?
- Will enough visitors see the sign to make it cost effective?
- Who is the target audience of the sign?
- Will the signs damage the site?

There are three different types of interpretive signs. Ask yourself if you want your sign to inform, educate, or entertain the audience. What are your objectives?

- What do you want the audience to know and learn?
- What do you want the audience to do?
- How do you want the audience to feel?

Interpretive signs differ from historical markers. Historical markers are more informative rather than interpretive.

Other considerations for interpretive signs include:

- Text:
  - Must be an appropriate reading level--usually between a 7th and 9^{th} grade level.
  - Use short sentences and paragraphs. Keep text blocks short.
  - Avoid using jargon or technical terms.
  - Use upper and lower case text, not just uppercase.
  - Should be vivid language using active verbs.
  - Do not overload the reader with information.
- Design and layout:
  - Do not crowd text and graphics.
  - Avoid distractions such as busy backgrounds, illegible type, too dark or bright colors, etc.
  - Use colors and images that attract audience.
  - Limit colors to dominate, subordinate, and accent colors.
  - Use type styles and sizes that are easy to read. Do not use more than three different types.
  - Serif fonts can be easier to read, especially in longer text blocks.
  - Mount at appropriate height and angle for comfortable viewing. Keep in mind those with disabilities.
- Answer the following questions to determine the best location for a sign:
  - What is the relationship between the sign and the subject it is interpreting?
  - What is the potential for vandalism?
  - How accessible is the sign, particularly for those with disabilities?
  - Where is the location that gets the most traffic?
  - Who will maintain the sign?
  - Would the property owner be willing to place the sign at the desired location?

PAVEMENT MARKINGS

Pavement markings provide wayfinding and will alert bicyclists to potential conflicts and convey regulatory messages to bother bicyclists and motorists at highway intersections.

SHARED-USE PATH PAVEMENT MARKINGS

Painted markings may be used on paved trail surfaces; however, they should be used sparingly and only to supplement signage in critical areas, not as the only method of alerting trail users or motorists. Pavement markings can become worn and covered with leaves, dirt, or snow.

Pavement markings on multi-use paths are intended to channelize path users to reduce the risk of collisions and to warn them of obstacles or other hazards. Yellow should be used when separating opposing traffic and white for same direction traffic.

At a minimum, a yellow center line (or combined advance warning striping and center line if a bollard, lean rail, or median obstruction is present) 150 feet long should be painted on the approach to the intersection. This warns path users of the impending intersection and channelizes users to help avoid conflicts when negotiating the roadway intersection.

As specified in the OMUTCD, the regulatory pavement marking STOP may be used in conjunction with a stop bar and sign. This may be particularly appropriate for a path because of bicyclists' typical head-down position, though the center line as noted above should be adequate advance warning to stimulate search behavior.

If the path is marked with separate pedestrian and bicyclist areas, these may be continued up to the intersection or else merged at least 164 feet in advance of the intersection.

Where they are kept separated, a divided crosswalk is a concept that can be used to help channelize the user groups within the intersection.

All path pavement markings, including roadway crosswalks, must be highly visible, skid resistant, and durable. Thermoplastic should not be used for longitudinal striping along the path because the raised surface is a hazard to bicyclists and skaters. Its use for transverse striping is a tripping hazard to skaters.

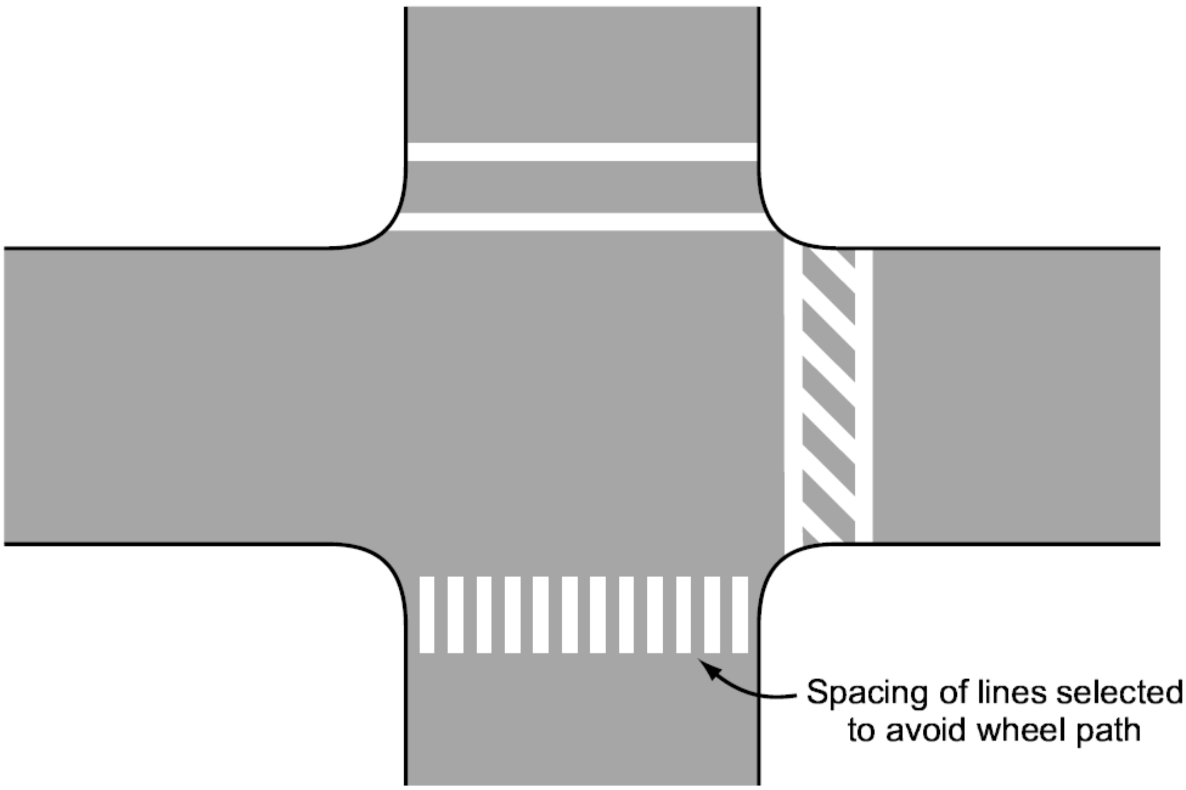
Specific design and application recommendations for pavement markings on bicycle paths are included in Part 9 of the OMUTCD. These recommendations include white lane lines, word messages, and bicycle symbols.

CROSSWALK STRIPING

Bicyclists and motorists are often confused by who has to yield the right-of-way at the intersection of a path and a street or highway. Painted crosswalk markings give pedestrians the right-of-way when crossing a road. High visibility marked crosswalks are recommended at all uncontrolled path-roadway intersections. On roadways with low traffic volumes and speeds where sight distances are adequate, the marked crosswalk should be sufficient to address pedestrian safety.

A path that uses a crosswalk for a street crossing, but is also posted with stop or yield signs for bicyclists, operates differently for bicyclists than a crosswalk at a traditional intersection. At traditional intersections, bicyclists approaching the crosswalks on sidewalks are not bound by stop and yield signs being used for the adjacent roadway, but have the same rights to the crosswalk as a pedestrian as long as they are walking or riding a bicycle in a manner which is consistent with the safe use of the crosswalk by pedestrians.

The OMUTCD provides guidelines for crosswalk placement. It is recommended that all path crossings have crosswalk markings. There is no conclusive evidence that a particular design will provide safer conditions.

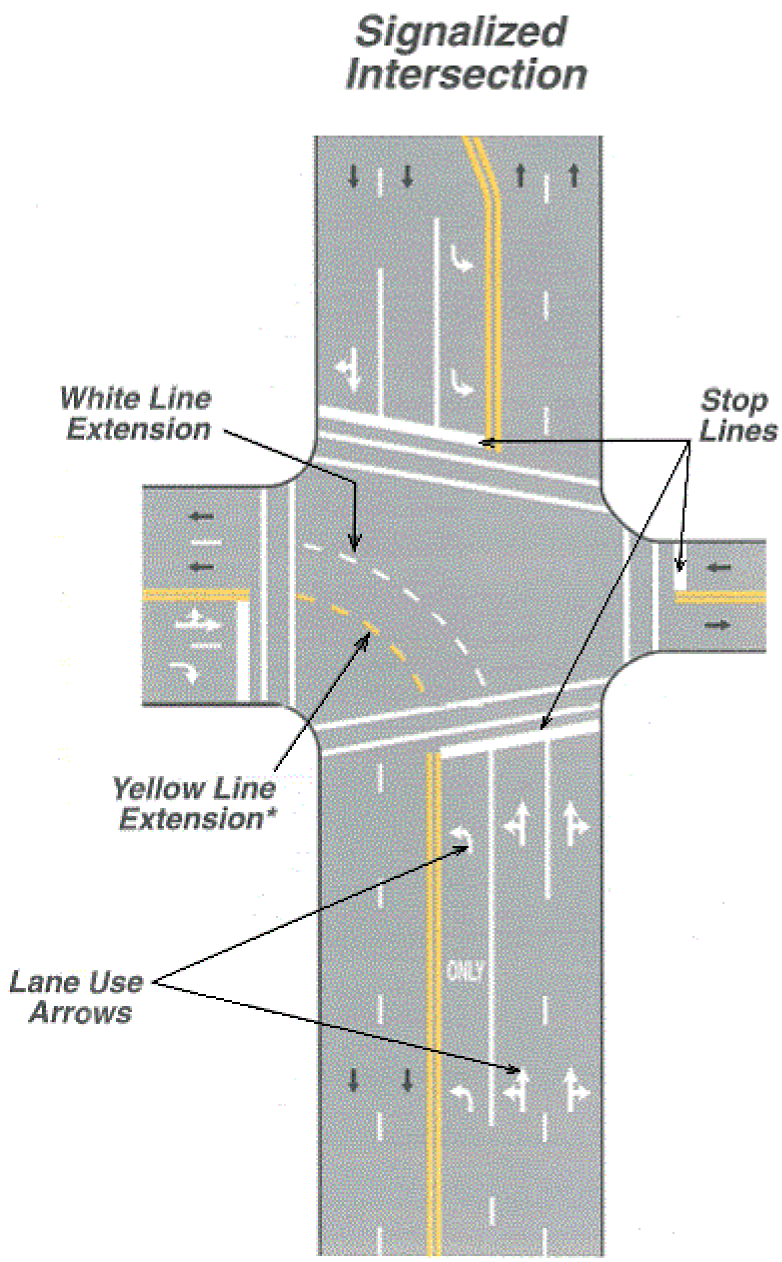


Consider that more paint may provide more protection. Although it has not been substantiated, it may be that the greater the amount of paint, the greater the perceived protection on the part of the pedestrian and the stronger the message to motorists of the presence and influence of pedestrians. Thus, it may be applicable for future use to install the heavier paint “ladder” pattern on lower speed and volume roads and the minimal paint “dashed” pattern on higher speed and volume roads.

STOP LINE MARKINGS

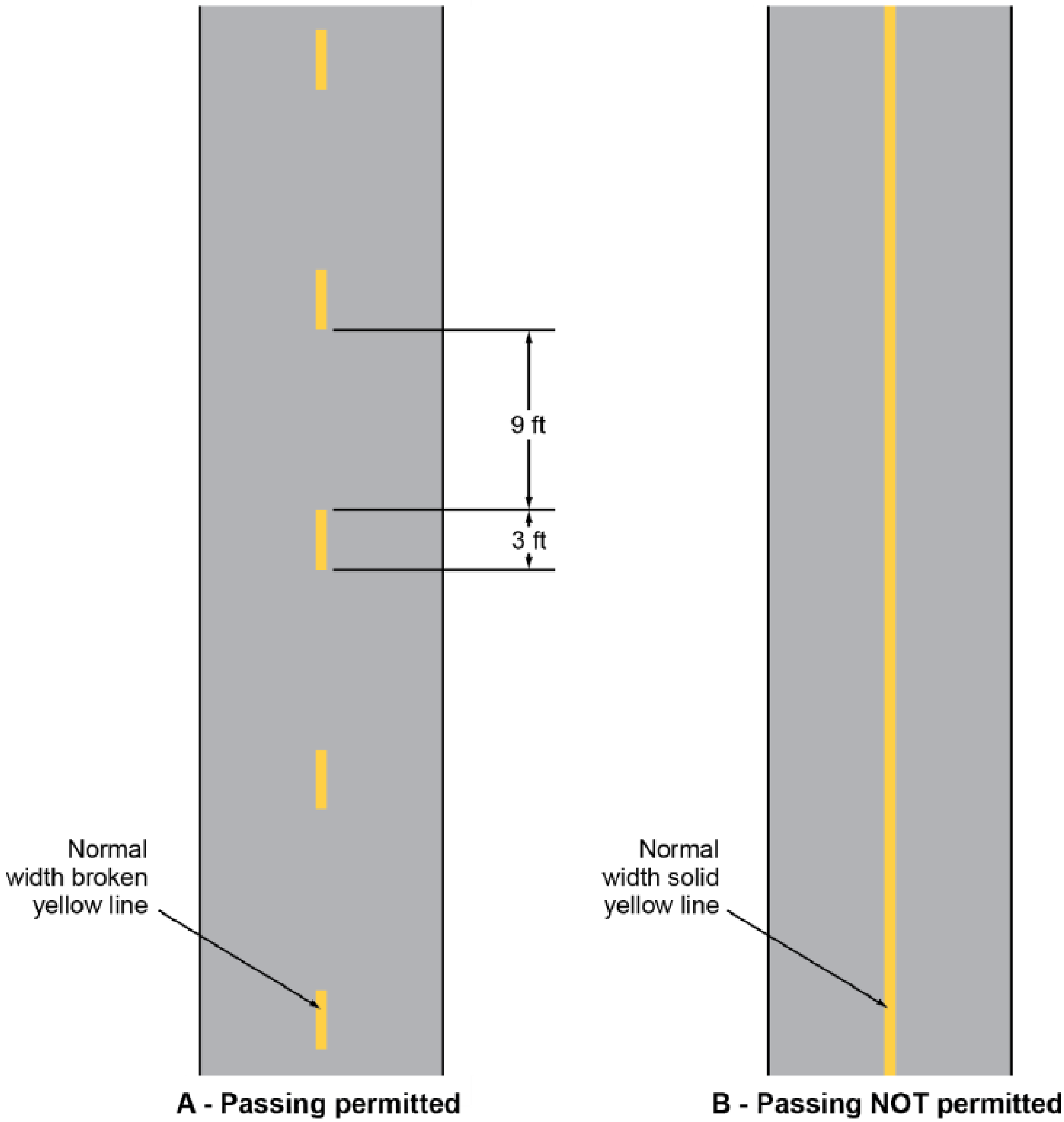
Stop lines are solid transverse white lines, normally 12 - 24 inches wide. They are used to indicate to motorists the optimal stopping point and may be helpful in preventing encroachment into crosswalks. However, stop lines are not necessary at most marked crosswalks, and the use of a wider crosswalk may be useful in lieu of a stop line.

When used, they should be installed 4 feet in advance of the crosswalk, although some jurisdictions have used them further in advance in an attempt to improve visibility and lessen the chance of a “multiple threat” type collision. With the stop line setback, the bicyclist – in the same position – and the moving motorist have an unobstructed view of each other.



Centerline Markings

Longitudinal pavement markings shall be used to define bicycle lanes according to the OMUTCD. A 4-inch wide yellow center line stripe can be used to separate opposite directions of travel—broken where sight distance permits passing and solid elsewhere. This practice can be especially beneficial with heavy bicycle volumes, on curves with restricted sight distance, and on unlighted paths where nighttime riding is anticipated.



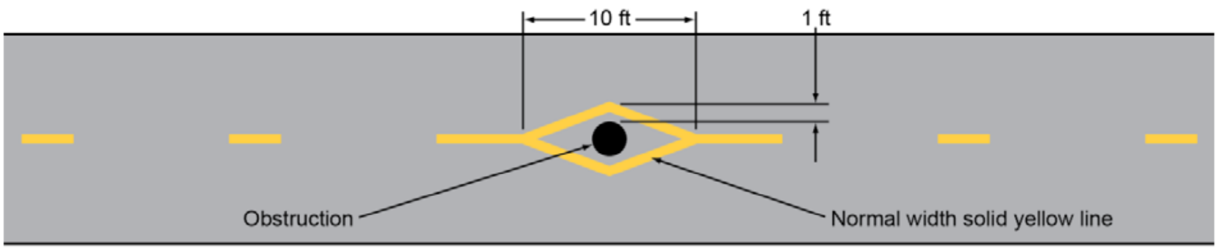
EDGE LINE PAVEMENT MARKINGS

While usually optional, white edge lines are beneficial where evening or night riding is expected. Even though bicycles are not equipped with strong headlights, the added visibility of retroreflective pavement markings can help the rider to navigate.

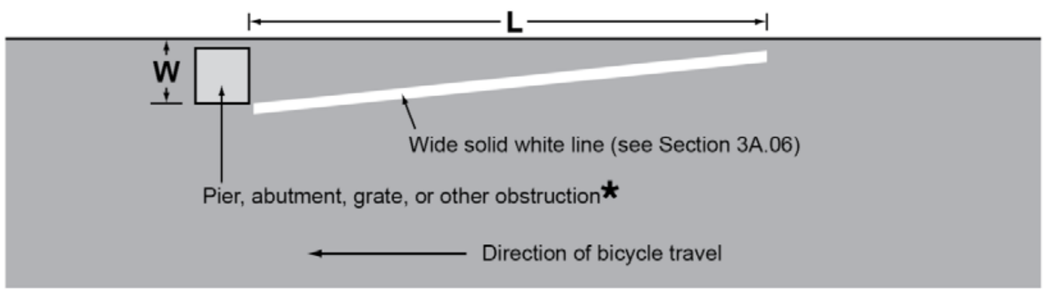
OBSTRUCTION MARKINGS

Where an obstacle, storm drain, or intake in the roadway cannot be avoided or modified for safe bicycle travel, the special pavement markings illustrated below, known as obstruction markings, can be used effectively.

The following is extracted from the OMUTCD Figure 9C-8.



A - Obstruction within the path



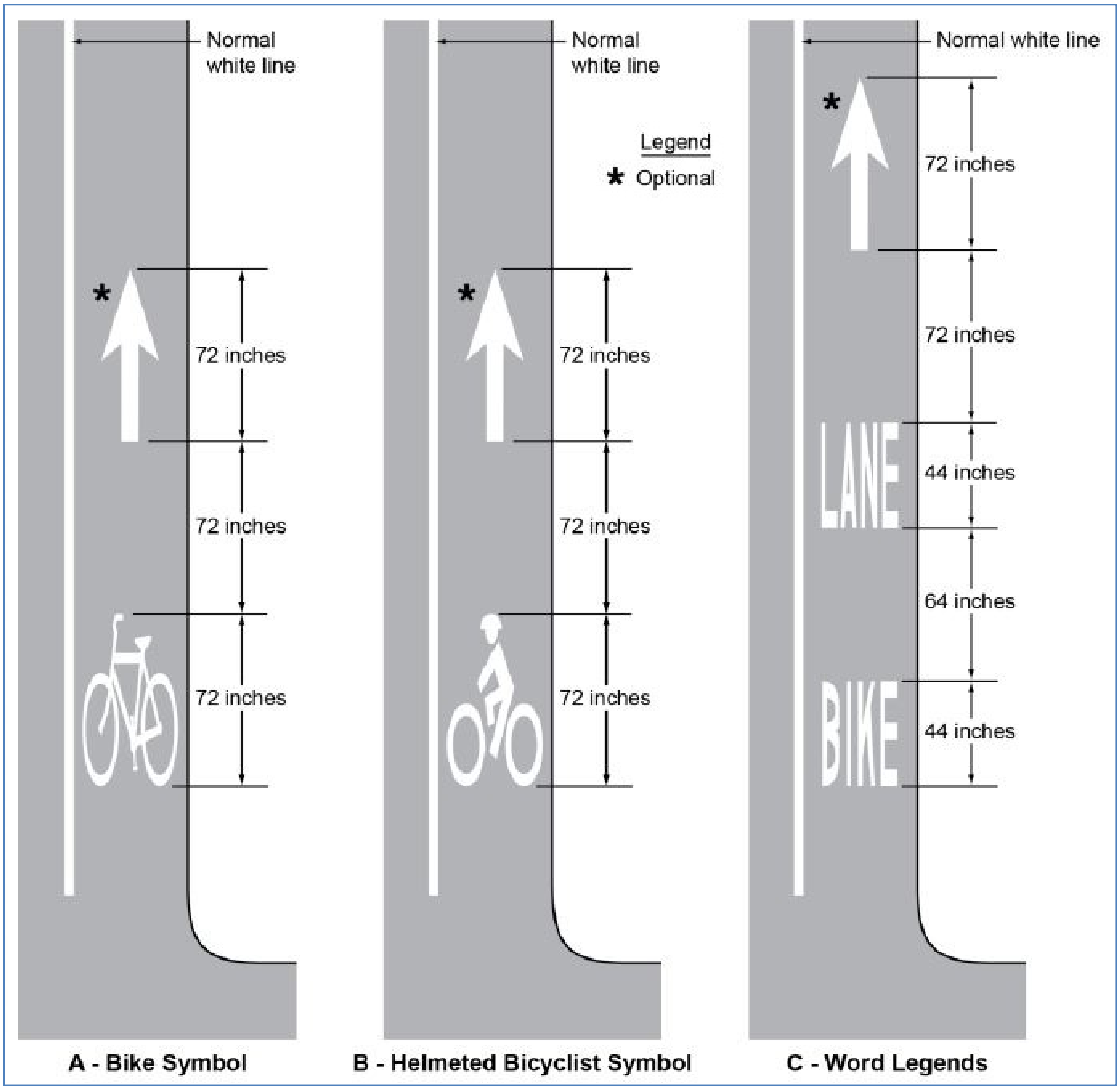
B - Obstruction at edge of path or roadway

L = WS, where W is the offset in feet and S is bicycle approach speed in mph

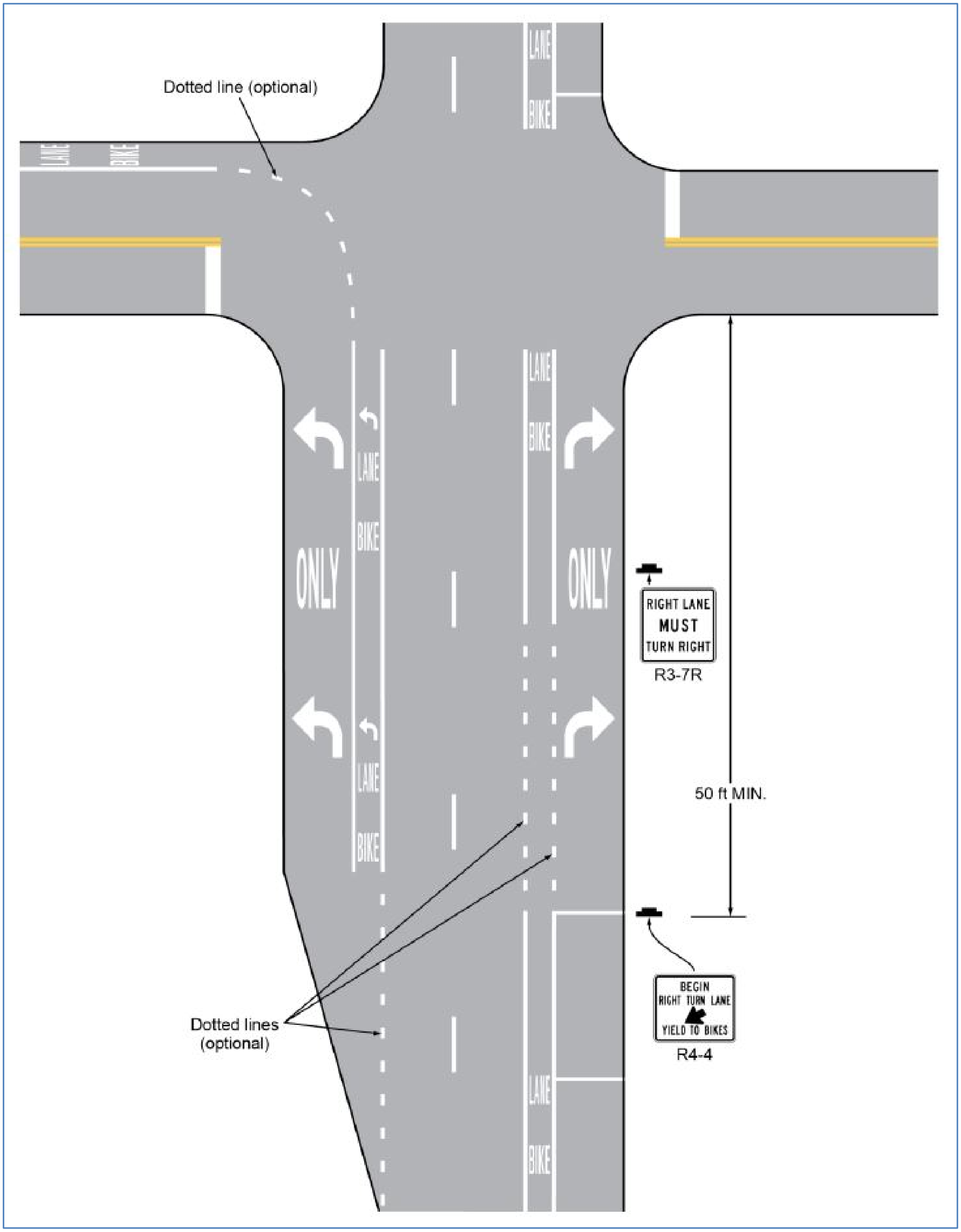
* Provide an additional foot of offset for a raised obstruction and use the formula
L = (W+1) S for the taper length

MARKINGS FOR BICYCLE LANES

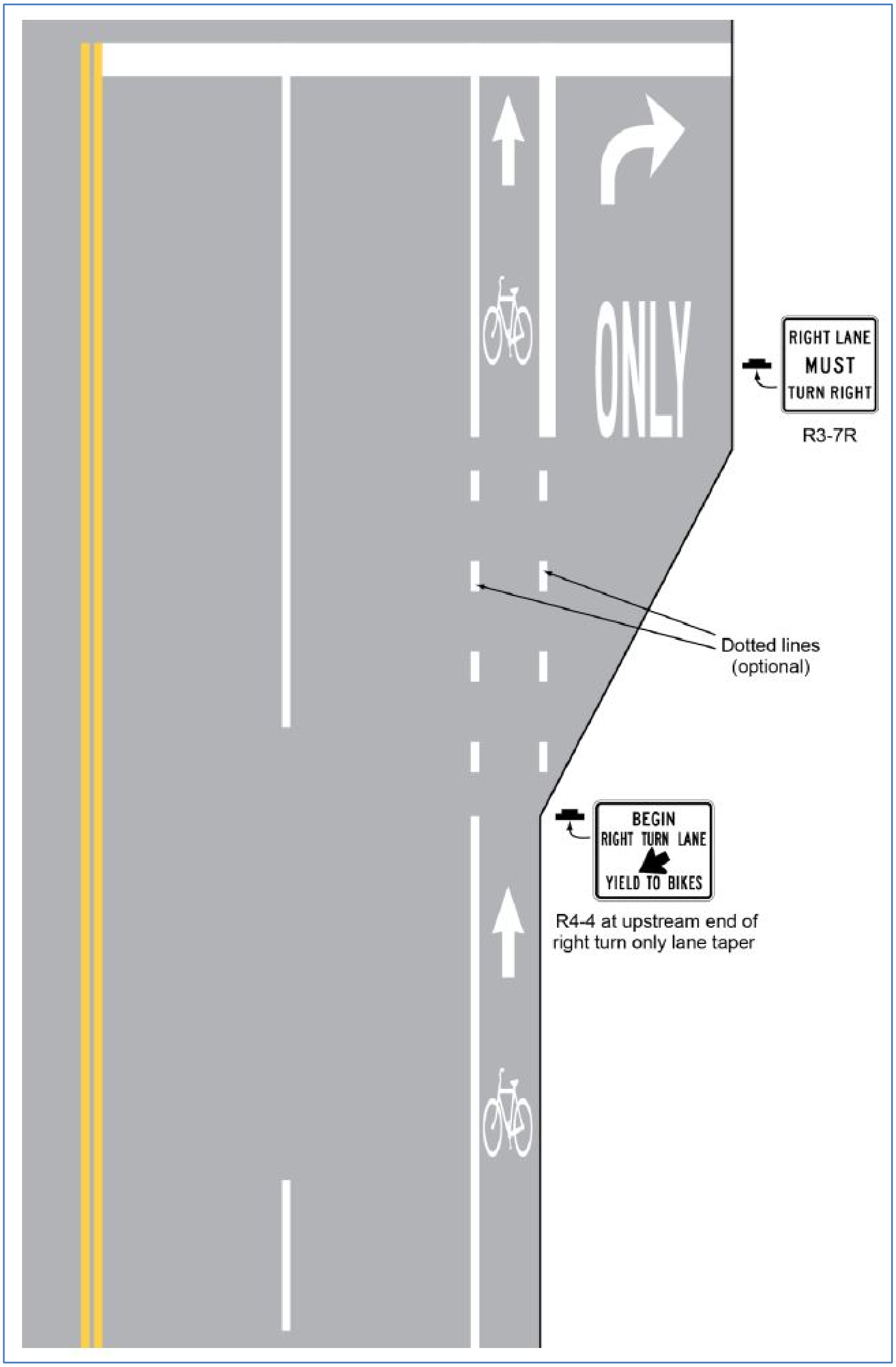
EXAMPLE OF WORD, SYMBOL & ARROW PAVEMENT MARKINGS FOR BICYCLE LANES
(OMUTCD Figure 9C-3)



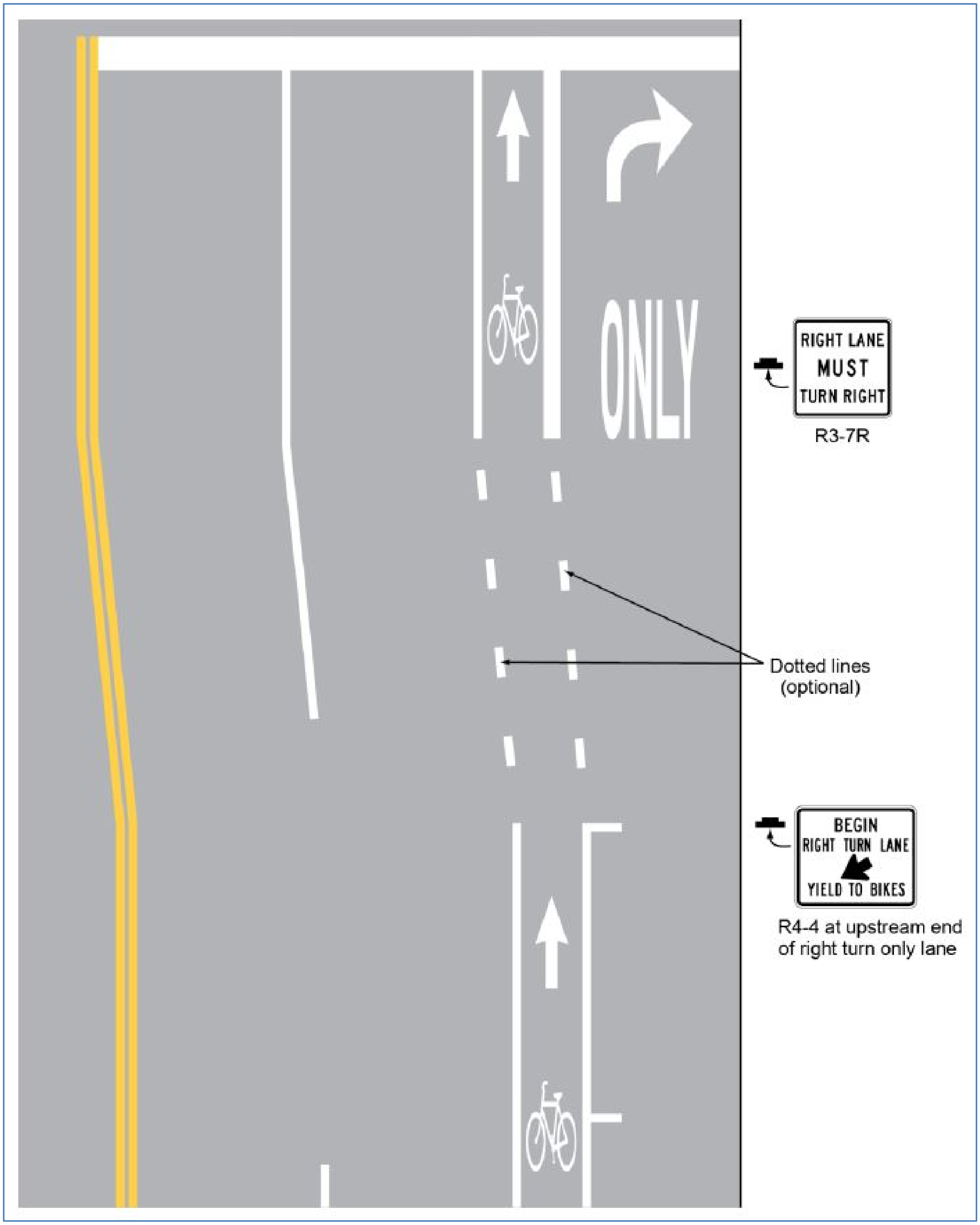
EXAMPLE OF INTERSECTION PAVEMENT MARKINGS FOR BICYCLE LANES
(OMUTCD Figure 9C-1)



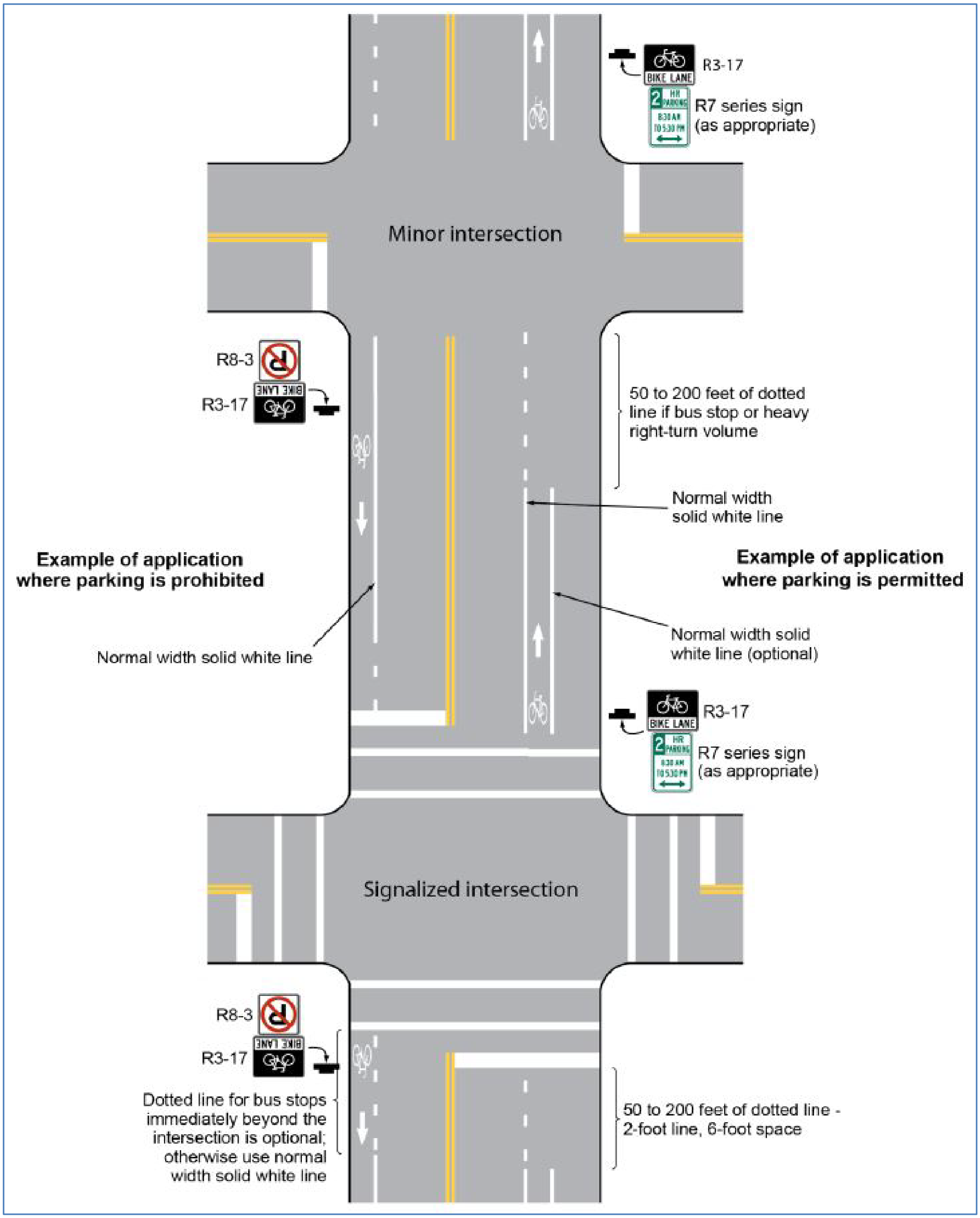
EXAMPLE OF INTERSECTION PAVEMENT MARKINGS FOR BICYCLE LANES
RIGHT TURN ONLY LANE (OMUTCD Figure 9C-4)



EXAMPLE OF INTERSECTION PAVEMENT MARKINGS FOR BICYCLE LANES
PARKING LANE INTO RIGHT TURN ONLY LANE (OMUTCD Figure 9C-5)



EXAMPLE OF INTERSECTION PAVEMENT MARKINGS FOR BICYCLE LANES ON A TWO-WAY STREET (OMUTCD Figure 9C-6)



CHAPTER 4 – ROAD DIETS & CYCLIST ACCOMMODATIONS

ROAD DIETS

Many roads are striped for multiple lanes in each direction, but not all of them require the extra lanes from a traffic volume standpoint. Sometimes the volumes on the road have decreased; in other cases, spare capacity was built in for anticipated conditions that never materialized. A Road Diet involves reallocating the existing roadway cross section to accommodate bike lanes, pedestrian facilities (walks and/or refuge islands), transit stops and or parking by reducing the number and/or width of motorized vehicle lanes. A Road Diet is generally described as "removing travel lanes from a roadway and utilizing the space for other uses and travel modes." Reducing the number of lanes can then be considered as a traffic calming measure. In many cases, the excess pavement can then be converted to more useful amenities such as shoulder areas, bicycle lanes, and dedicated left or right turn lanes.

Road Diets are recommended where the costs of acquiring right-of-way to provide separate accommodations for each mode of travel are cost-prohibitive, innovative or multi-use facilities within the existing right-of-way that accommodate both pedestrians and bicyclists may be considered, if appropriate for the roadway and its context.

A Road Diet can be a low-cost safety solution, particularly in cases where only pavement marking modifications are required to make the traffic control change. In other cases, the Road Diet may be planned in conjunction with reconstruction or simple overlay projects, and the change in cross section allocation can be incorporated at no additional cost.

Geometric and operational design features should be considered during the design of a Road Diet. Intersection turn lanes, traffic volume, signing, pavement markings, driveway density, transit routes and stops, and pedestrian and bicyclist facilities should be carefully considered and appropriately applied during the reconfiguration for appropriate Road Diet implementation. As with any roadway treatment, determining whether a Road Diet is the most appropriate alternative in a given situation requires data analysis and engineering judgment.

Whenever multilane roadways are scheduled for maintenance or reconstruction, the number of vehicular traffic lanes needed in each direction should be reviewed. In some cases, needed capacity improvements are identified which require widening the pavement to avoid congestion. However, on many roads, there is an opportunity to shift the use of available pavement width from vehicular travel lanes to auxiliary features such as turning lanes, bicycle lanes, or shoulders that increase the range of potential road uses. In the more developed areas where pedestrians would be regularly expected, search for opportunities to make the roadway more pedestrian friendly, such as the installation of curb extensions (or "bump-outs") and/or pedestrian shelter medians.

All of the following characteristics should be met for the location to be a candidate for multilane conversion:

- Having more than one travel lane in one or both directions
- Peak traffic volume for the multilane section can be accommodated by one travel lane
- The capacity of intersections are not compromised by the reduction in travel lanes

- Minimal impacts to existing parking where it is needed (some designs require eliminating parking near intersections)
- Provide proper lane continuity and adequate transition areas (or "lane drops")

In addition, potential safety benefits are considered. However, since the benefits extend beyond safety, a conversion can be done even if crash history is already low.

Road Diets may improve the operational efficiency of signalized and unsignalized intersections in a corridor. Operational improvements are typically seen when high ADTs and high left-turn percentages are present on the primary and cross-street. Typically Road Diets are shown to have reduced delays and reduced queues in these situations.

There are cases where a Road Diet may not be the appropriate solution. These cases include scenarios where the Road Diet will not improve the operational efficiency of the corridor or corridors where at-grade rail crossing or other conditions, such as a high frequency of bus stops may create queues that require a long time to dissipate. If an adequate transition cannot be designed for the Road Diet, it should be reconsidered, as this may cause an increase in crashes, and outweigh any derived benefit along the corridor. If left-turn lanes already exist on the corridor, even in limited locations at major intersections, the introduction of a Road Diet would .adversely impact capacity and safety benefits may not be realized.

Road Diets only address the specific crash types identified in the safety performance section. These crashes include rear end and sideswipes that result from an inside through lane that is blocked by left-turning traffic and left-turn angle crashes that result from offset left-turn lanes. If these crash types do not exist, a safety benefit would not be realized.

ROAD DIET ANALYSIS CHECKLIST

The following checklist is provided in order to allow for a systematic consideration of the various elements to be evaluated and considered prior to a Road Diet implementation. The checklist identifies analysis to be completed and data to be collected that may be used to assist in evaluating the Road Diet conversion for a specific section of roadway. Where applicable the guidance in this document may be used to address many of these issues.

Checklist for Road Diet Implementation Considerations:

- Operational aspects
  - Travel times
  - Intersection delays
  - Travel speeds
  - Minor street operations
  - Railroad crossings
- Safety aspects
  - Angle crashes
  - Left turn crashes
  - Rear end crashes
  - Pedestrian safety

  - Bicyclist safety
- Multimodal operations
  - Public transportation
  - Bicycle
  - Pedestrian
- Access management
- Livability
- Operational consistency
- Transition design
- Cross section elements o Number of lanes
  - Bicycle lanes
  - Parking
  - Sidewalks
  - Buffers

ROAD DIET INFORMATION GUIDE

Consult the FHWA Safety Program Road Diet Informational Guide for more planning and design guidance for Road Diets.

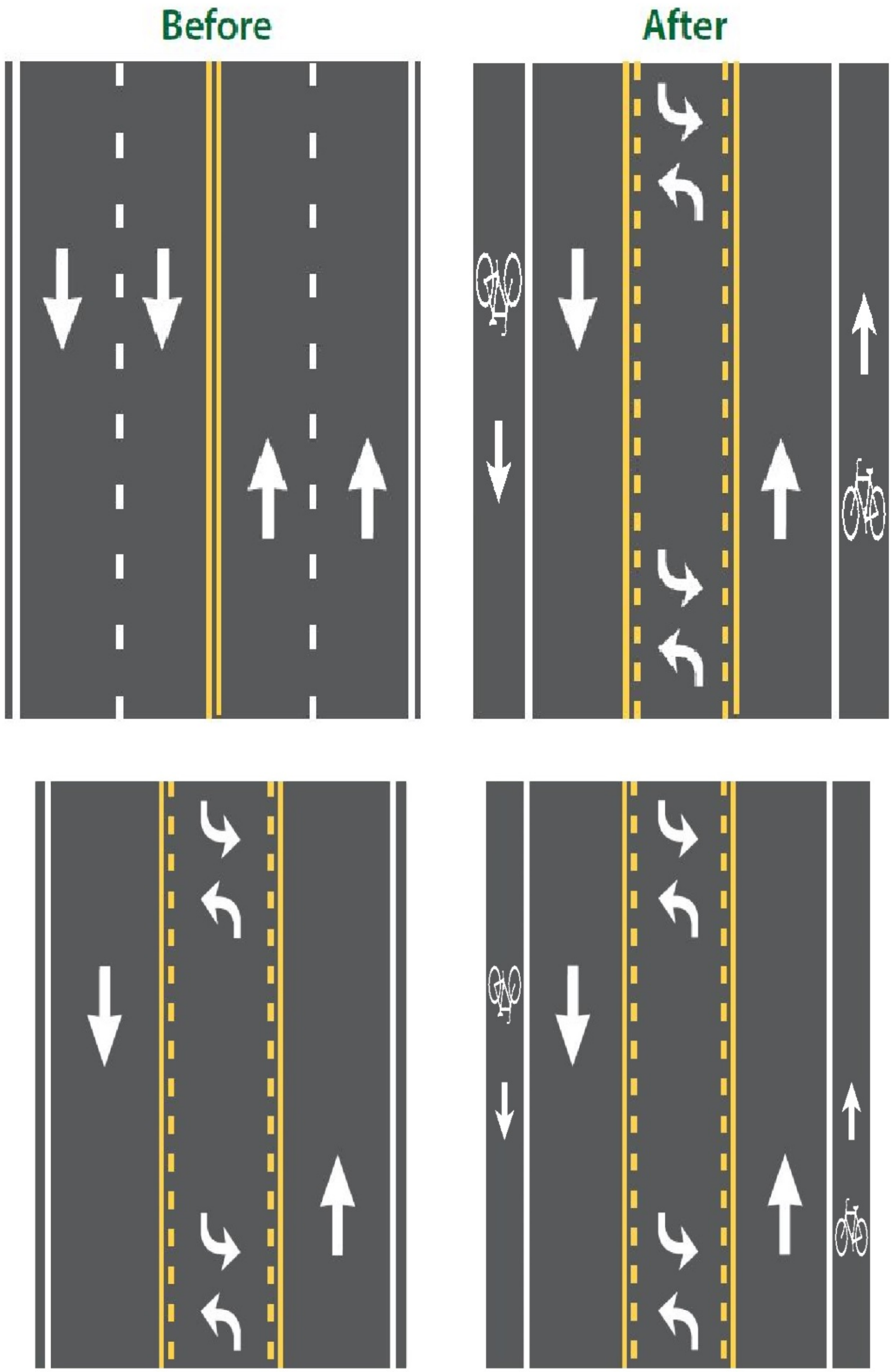
ROAD DIET TRANSITIONING

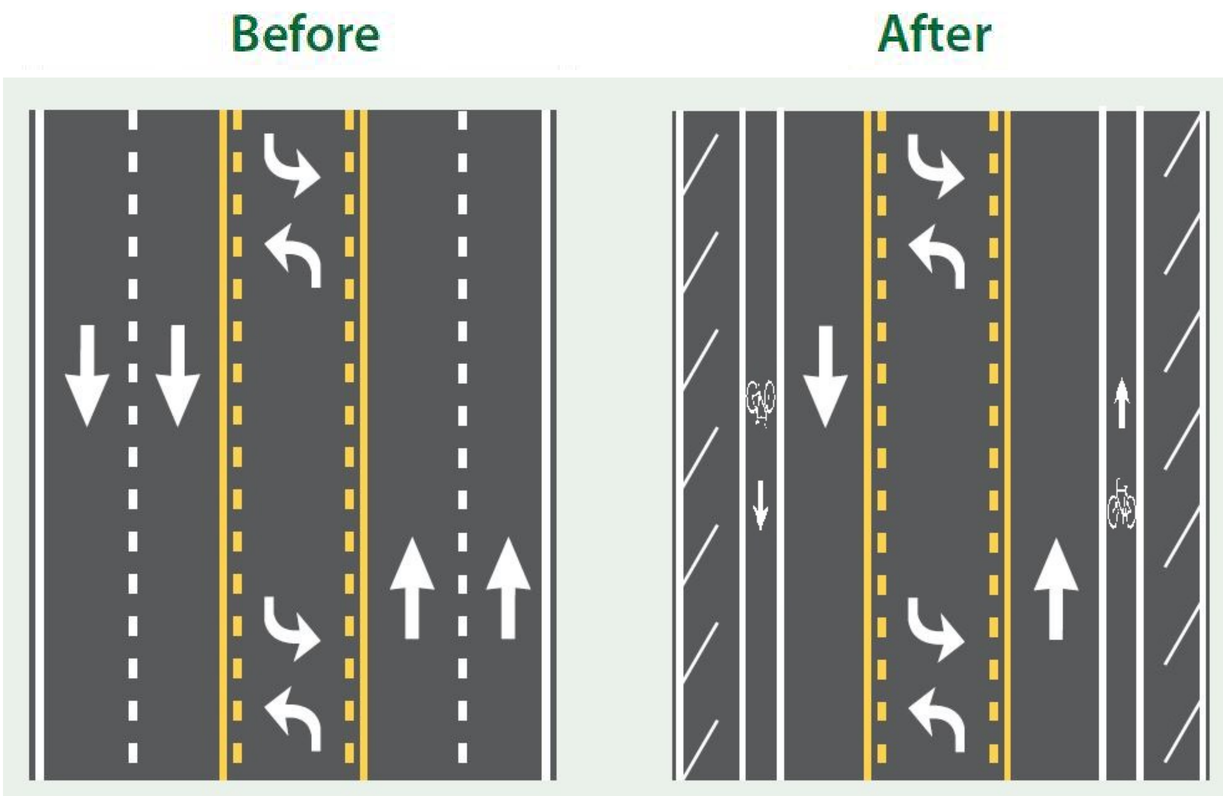
One of the primary considerations in the design of a Road Diet is the transition from a four-lane cross section to a three-lane cross section. This transition can serve as a capacity and safety concern if not designed properly. Ideally, a Road Diet would replace the entire four-lane section of roadway eliminating the need for a transition. However, if necessary the transition can be placed at either a major intersection or midblock.

If transitioning at a major intersection, the entering through lane should be dropped as a turn lane serving a significant volume of traffic, such as a heavy right turn movement. Dropping the lane as a right or left-turn lane for a minimal volume may be counterproductive as the weaving and merging operations associated with the lane drop occur simultaneously with the increased demands of the intersection.

A proper transition may also take place midblock on the roadway. When placing the transition midblock, it should occur away from intersections and/or high volume access points that would place stopped turning traffic in the through lanes of the merging traffic.

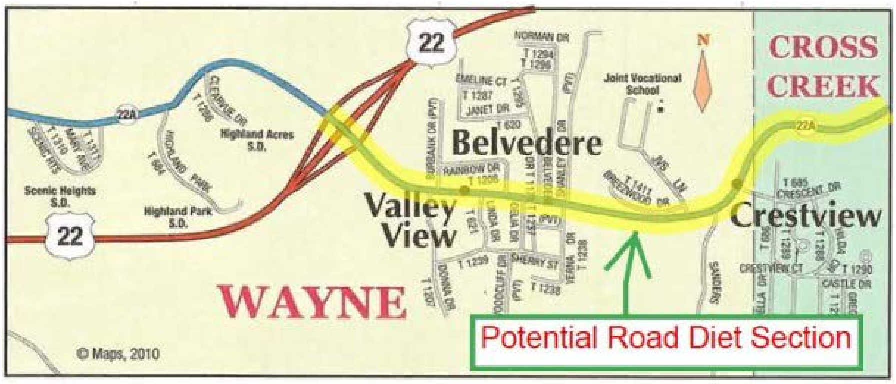
If not designed properly, these transitions can significantly increase crashes removing any safety benefit of the Road Diet. All transitions should follow AASHTO"s Policy on Geometric Design for Highways and Streets and the OMUTCD guidance for the reduction of through lanes.

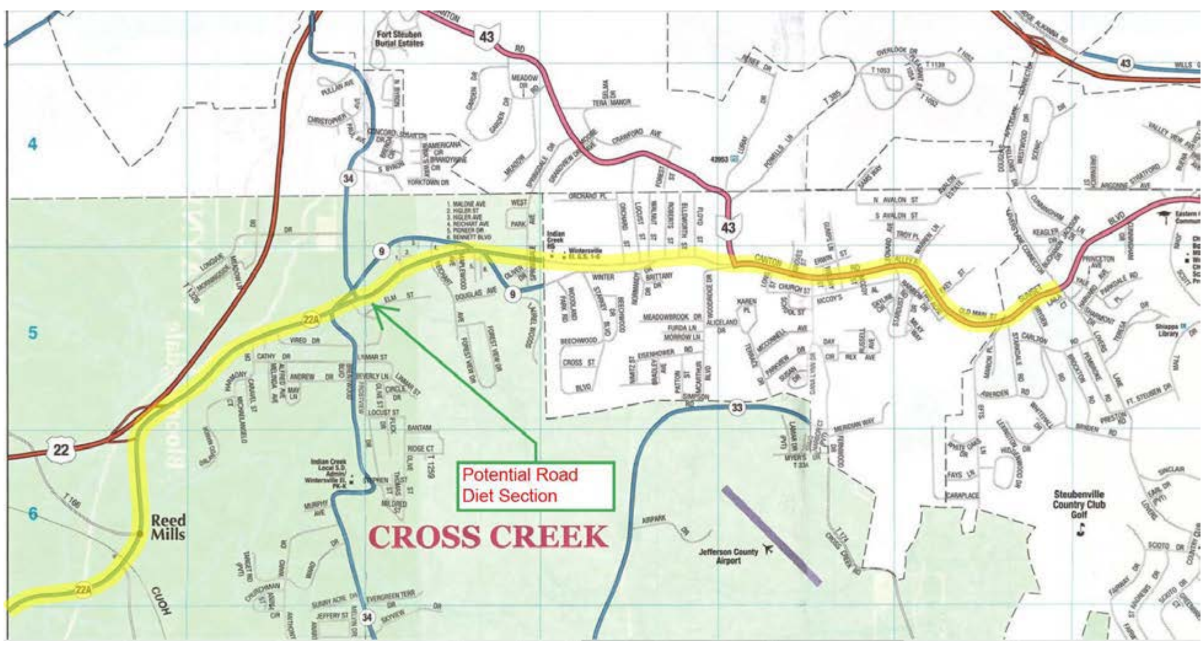

Before
After

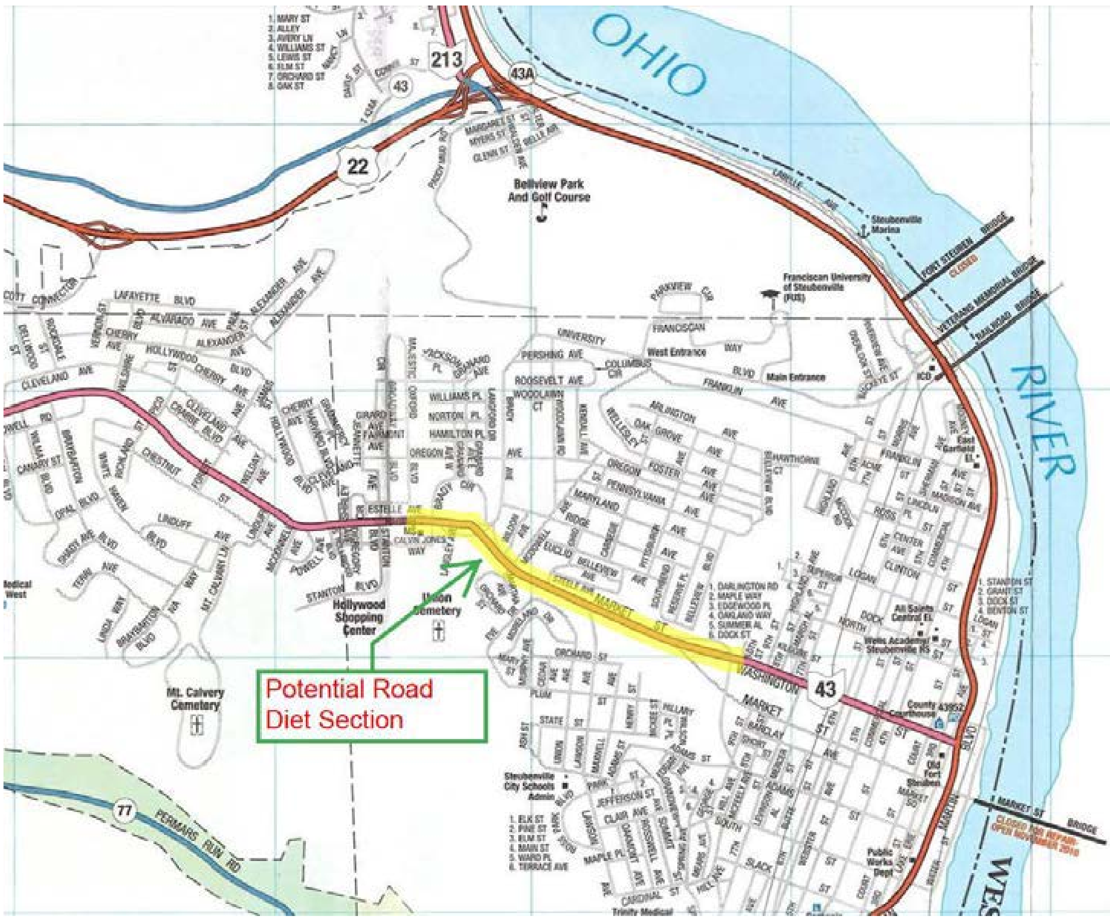

Before
After

MAPS OF POTENTIAL MULTILANE CONVERSIONS OR "ROAD DIETS"

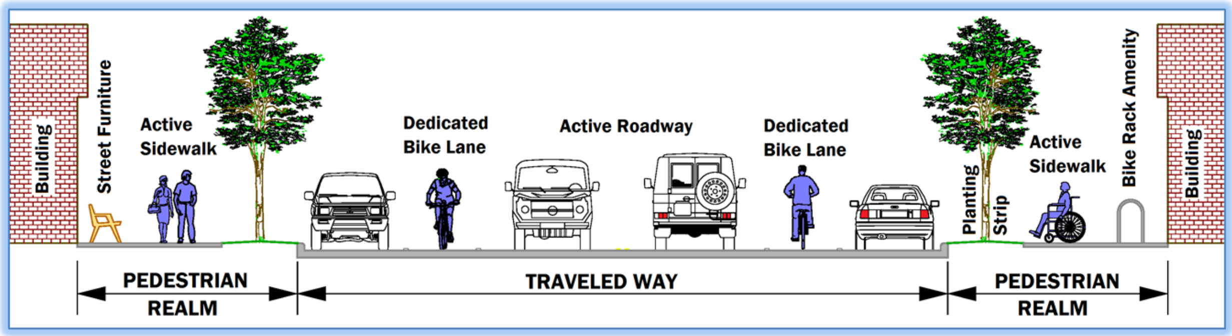
The maps below show locations in Jefferson County that have been identified as future conversion candidates. Conversions are usually done when the road is next repaved, due to the amount of striping changes that are involved.






OHIO
RIVER
213
43A
43
22
77
Bellview Park
And Golf Course
Franciscan University
of Steubenville
(FUS)
Hollywood
Shopping
Center
Mt. Calvery
Cemetery
Potential Road
Diet Section

COMPLETE STREETS



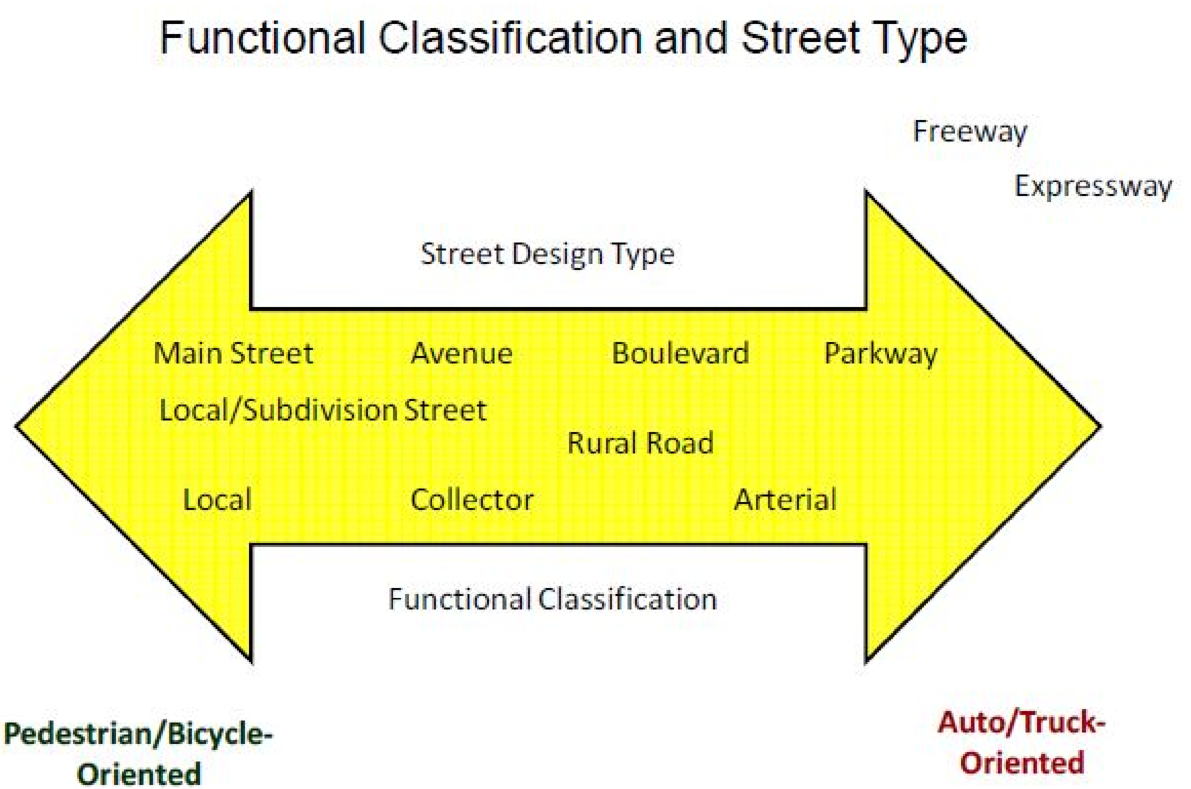
"Complete Streets" is a design principle by which all roadway users – motorists, bicyclists, pedestrians, etc. – can safely move along and across a street. Complete Streets are consistent with Context Sensitive Solutions. Generally, new standards are not needed to provide complete streets. The AASHTO Green Book already allows designs consistent with Complete Streets.

Complete streets will affect all streets noting that interstates, freeways and expressways are not considered streets. However, where streets intersect other roadway facilities that are not streets, the intersections should meet the complete street design principle.

Proponents of Complete Streets believe that they improve safety, lower transportation costs, provide transportation alternatives, encourage health through walking and biking, stimulate local economies, create a sense of place, improve social interaction, and generally improve adjacent property values. A Federal Highway Administration (FHWA) safety review found that designing the street with pedestrians in mind—sidewalks, raised medians, turning access controls, better bus stop placement, better lighting, traffic calming measures, and treatments for disabled travelers—all improve pedestrian, bicyclist and motorist safety.

An important component of Complete Streets is also providing connectivity regardless of the mode of transportation. Connectivity will provide more direct routes for pedestrians, bicyclists, motorists and transit thereby providing shorter travel distances, reduced vehicle miles traveled, less traffic congestion on arterials and collectors, greater emergency vehicle access with less response time, easier maintenance and improved services.

ACCOMMODATING BICYCLISTS ON ROADWAYS



Roadways used for designated bikeways should be made bicycle compatible. Bicycle compatible roadways have design features which allow a competent bicyclist to safely share the roadway with motor vehicles. The bicycle implementation and design guidelines for street and highways generally target Group A bicyclists. Many of the proposed roadway bicycle accommodations will also serve Group B bicyclists. Other routes and accommodations should be provided for Group C bicyclists and/or pedestrians.

Compatible roadway design guidelines differ based on traffic volumes, speeds and environmental setting. Dedicated space for bicyclists is preferred along higher volume and higher speed roadways.

Bicycle Compatible Roadway Additional Benefits:

Bicycle compatible roadways offer additional benefits to highway users such as:

- Greater offset to fixed objects
- Additional space for disabled vehicles
- Greater recovery zone for errant motorists
- Additional space for bus pull-overs at transit stops
- Better stability of roadway pavement structure
- Additional gutter drainage capacity during rainstorms
- Space for pedestrian travel, especially during snowstorms
- Greater area for temporary snow storage
- Reduction or elimination of drop-off at edge of pavement

BIKEWAY FACILITY TREATMENT SELECTION PREPARATION

To determine the appropriate highway design treatment to accommodate bicyclists, several factors associated with the specific route or project must be assessed:

- What types of bicyclists is the route most likely to serve?
- What type of roadway project is involved (new construction, reconstruction, or retrofit)?
- What are the current and anticipated traffic operations and design characteristics of the route that will affect the choice of a bicycle design treatment?

The recommended design treatments for bikeways are most easily implemented when new construction or reconstruction is planned. It is a relatively straightforward process to adopt the specified design treatment for bicycles at the project planning stage.

When implementation involves retrofitting an existing roadway to accommodate bicycle use, the project can be more complex. Existing streets built with a curb and gutter section will often be viewed as having a fixed width and improvements will likely be limited to "moving paint," that is, restriping the existing lanes.

When working with existing streets and highways, planners should investigate the opportunity to make at least minor or marginal improvements. However, where the need is to serve Group B/C bicyclists, it is essential to commit the resources necessary to provide facilities that meet the recommended design treatments. Only then can routes and facilities be designated for bicyclists and provide the desired access to the community.

BICYCLE FACILITY DESIGN FACTORS

Six major bicycle facility design factors have emerged among transportation planners and engineers working with bicycle facilities on the traffic operations and design factors having the greatest effect on bicycle use. Each of these factors is discussed below along with the ranges of values used to differentiate levels of need.

The six major factors are as follows:

- <u>Traffic volume:</u> Higher motor vehicle traffic volumes represent greater potential risk for bicyclists and the more frequent overtaking situations are less comfortable for Group B/C bicyclists unless special design treatments are provided. The following three ranges of AADT for used for consideration of traffic volume risk:
    - Under 2,000 AADT.
    - 2,000 to 10,000 AADT.
    - Over 10,000 AADT.

- Average motor vehicle operating speed: The average operating speed is more important than the posted speed limit, and better reflects local conditions. Again, motor vehicle speed can have a negative impact on risk and comfort unless mitigated by special design treatments. Four ranges of average speeds are used:

  - Less than 30 mph.
  - 30 to 40 mph.
  - 41 to 50 mph.
  - Over 50 mph.

- Traffic mix: The regular presence of trucks, buses, and/or recreation vehicles (i.e., approximately 30 per hour or more) can increase risk and have a negative impact on comfort for bicyclists. At high speeds, the wind blast from such vehicles can create a serious risk of falls. Even at lower operating speeds, shared lane use is less compatible. All types of bicyclists prefer extra roadway width to accommodate greater separation from such vehicles. Many bicyclists will choose a different route or not ride at all where there is a regular presence of such traffic unless they are able to remove themselves several feet from these motor vehicles. Different design treatments and widths are recommended depending on whether or not the volume of truck, bus, and/or recreational vehicles is likely to have a negative impact on bicycle use.

- On-street parking: The presence of on-street parking increases the width needed in the adjacent travel lane or bike lane to accommodate bicycles. This is primarily a concern associated with streets and highways built with an urban section.

- Sight distance: "Inadequate sight distance" relates to situations where bicycles are being overtaken by motor vehicles and where the sight distance is likely less than that needed for a motor vehicle operator to either change lane positions or slow to the bicyclist's speed. This problem is primarily associated with rural highways, although some urban streets have sight distance problems due to poor design and/or sight obstructions.

- Number of intersections: Intersections pose special challenges to bicycle and motor vehicle operators, especially when bike lanes or separate bike paths are introduced. The AASHTO Guide and various State design manuals include general guidelines for intersection treatments.
  The number and/or frequency of intersections should be considered when assessing the use of bike lanes. There is some evidence to suggest that the disruption in traffic operations associated with bike lanes is temporary. Over time, both bicyclists and motorists adapt to the new traffic patterns, learning to look for each other and effect merges prior to intersections.

RETROFITTING EXISTING HIGHWAYS

According to the FHWA and many state and local jurisdictions, bicycle lanes are the preferred bicycle facility in urban environments. Paved shoulders are appropriate in rural areas and wide curb lanes are appropriate in areas where there is not enough room to accommodate bicycle lanes or where traffic conditions call for the experienced traffic bicyclist.

There may be instances or locations where it is not feasible to fully implement guidelines pertaining to the provision of adequate pavement space for shared use due to environmental constraints or unavoidable obstacles. In such cases, warning signs and/or pavement striping should be employed to alert bicyclists and motorists of the obstruction, alert motorists and bicyclists of the need to share available pavement space, identify alternate routes (if they exist), or otherwise mitigate the obstruction.

On stretches of roadway where it is not possible to provide recommended shoulder or lane widths to accommodate shared use, conditions for bicycle traffic can be improved by:

- Striping wider outside lanes and narrower interior lanes;
- Providing a limited paved shoulder area by striping a narrow travel lane. This tends to slow motor vehicle operating speeds and establish a space (with attendant psychological benefits) for bicycle operation;
- Providing as little as 2 feet of usable riding surface to the right of the edge stripe. While this will not meet the design specifications necessary for a designated bicycle facility, it can provide an improved operating environment for both bicyclists and motor vehicles and will reduce the impact of bicycles on highway capacity. This and other marginal roadway improvements should be considered when the opportunity arises and there is no other option—such as wider shoulders, a bike lane, or wide curb lane—because of lack of space.

Where narrow bridges create a constriction, “move over” zebra striping should be used to shift traffic away from the parapet and provide space for bicycle traffic.

Other possible strategies may be employed as appropriate. These include:

- elimination of parking or restricting it to one side of the roadway
- reduction of travel lanes from two in each direction to one in each direction plus center turn lane and shoulders
- reduction of the number of travel lanes in each direction, and the inclusion or reestablishment of paved shoulders

Depending on these factors, priority is given for any recommended improvements, and specific facility types are suggested.

Some improvements can be opportunistic – to be done when the road is being expanded or redesigned. This significantly reduces costs. Higher-priority projects should be more proactive as part of a dedicated capital improvement program. These include roads:

- Scoring poor or very poor bicycle suitability ratings for both the roadway and the sidewalk/sidepath, if it exists
- Providing unique access (no alternatives) to significant destinations.

CHAPTER 5 – BICYCLE ROUTE SUITABILITY DETERMINATION

INTRODUCTION

Bicycle suitability criteria can be used by engineers, planners, and decision-makers to evaluate the "bicycle-friendliness" of roadways, both from the perspective of the bicyclist and the motorist.

Specifically, the bicycle suitability ratings of roadways can be used in several ways:

- Prioritize bicycle improvement projects for constrained financial resources;
- Identify gaps or deficiencies in a regional or intercity bicycle network;
- Evaluate roadway conditions for use by bicycle commuters and recreational cyclists;
- Estimate the effects of improvements;
- Compare existing and proposed bicycle facilities against each other and to other geographic features or attributes.

Bicycle suitability criteria should be simple to use and understand for technical and non-technical audiences while addressing basic elements that affect bicycle suitability. Simple criteria will aid in implementation and use of the bicycle suitability criteria. Additional complexities and/or refinements based on agency user or bicyclist input can be added at a later date.

BICYCLE ROUTE SUITABILITY RATINGS

Bicycle route suitability ratings for roadways and streets are based on a variety of existing roadway conditions and features such as posted speed limits, shoulder width, shoulder striping, terrain, pavement quality, safety/comfort level, motorized traffic volume and the existence of sewer grates, as documented based on a roadway survey and analyses.

The definitions below outline the typical conditions for each suitability definition at the time of the rating. The ratings are subjective and the actual conditions may vary. Separation from vehicles is defined as a shoulder, shoulder stripe, a similar type of buffer area, a designated bike lane, or an unusually wide travel lane.

Superior or Excellent:

The route is highly recommended for bicycle commuting. Low vehicular traffic and little interaction between bicyclists and motor vehicles are anticipated. The route has slow moving traffic and some separation between the bicyclists and motor vehicles.

Good:

The route is recommended for bicycle commuting. There is slightly more vehicular traffic and slightly higher level of interaction between bicyclists and motor vehicles than roads rated "Excellent". There is some separation between bicyclists and motor vehicles, with the motor vehicles typically moving faster than on "Excellent" rated roads.

Fair:

The route is acceptable for bicycle commuting. The route is moderately traveled with some possible interaction between bicyclists and motor vehicles. There is a higher volume of traffic with some separation between the bicyclists and motor vehicles. The route has motor vehicles traveling at slower speeds, or roads with lower volumes of traffic and little to no separation between bicyclists and motor vehicles.

Poor:

The route is only marginally suitable for bicycle commuting. The route is heavily traveled with some interaction between bicyclists and motor vehicles. The route has little to no separation between the bicyclists and motor vehicles. The motor vehicles move at faster speeds than roads rated "Average". The roadways may have some pavement in poor condition and/or rough terrain.

Very Poor:

The route is not suitable for bicycle commuting. The bicycles will need to interact with motor vehicles. The route is heavily traveled with fast moving traffic with little to no separation between the bicyclist and motor vehicle traffic. The route will have rough riding conditions for commuting bicyclists that include steep slopes, poor pavement conditions, high motorized traffic volumes, etc.

Prohibited:

Bicycles are not allowed on these types of facilities. These facilities are either full access controlled (freeways and interchanges) or may be partial access control.

RURAL HIGHWAY SUITABILITY FOR BICYCLES

The following chart rates a rural highway’s suitability for bicycle travel. In addition to rating existing rural highways, it can be used as a planning tool during the design of road projects. This rural highway suitability for bicycles measure closely resembles other national measures of road suitability. It is based on three variables:

- Traffic speed – measured by the posted speed limit.
- Traffic volume – measured by ADT (Average Daily Traffic) per lane.
- Width of outside lane – measured by the lane width, plus any paved shoulder width (free of rumble strips) less than 4 feet.

The chart details three levels of suitability. The colors are related to suitability level by:

Color	Code	Suitability
Green	H	High suitability
Blue	M	Medium suitability
Yellow	L	Low suitability
Red	N	Not suitable (poor)

<table>
<tr><th>SPEED LIMIT</th><th>VERY LOW
ADT/LANE
(<500)</th><th>LOW
ADT/LANE
(500-1249)</th><th>MEDIUM
ADT/LANE
(1250-5000)</th><th>HIGH
ADT/LANE
(>5000)</th></tr>
<tr><td rowspan="2"><=30 mph</td><td rowspan="2">All Widths = H</td><td rowspan="2">All Widths = H</td><td>>=12’ = H</td><td>>=12’ = M</td></tr>
<tr><td><12’ = M</td><td><12’ = L</td></tr>
<tr><td rowspan="2">35 – 40 mph</td><td rowspan="2">All Widths = H</td><td>>=12’ = H</td><td>>=12’ = M</td><td>>=12’ = L</td></tr>
<tr><td><12’ = L</td><td><12’ = L</td><td><12’ = N</td></tr>
<tr><td rowspan="3">45 – 50 mph</td><td>>=12’ = H</td><td>>=14’ = H</td><td>>=14’ = M</td><td>>=14’ = L</td></tr>
<tr><td rowspan="2"><12’ = M</td><td>12’-13’ = M</td><td>13’ = L</td><td rowspan="2"><14’ = N</td></tr>
<tr><td><12’ = L</td><td><13’ = N</td></tr>
<tr><td rowspan="3">55 mph</td><td>>=12’ = H</td><td>>=14’ = H</td><td>>=14’ = L</td><td rowspan="3">Not recommended without paved shoulders</td></tr>
<tr><td rowspan="2"><12’ = M</td><td>12’-13’ = M</td><td rowspan="2"><14’ = N</td></tr>
<tr><td><12’ = L</td></tr>
</table>

Any paved shoulder width less than 4 feet is added to the lane width. Rural highways with paved shoulders with width of 4 feet or more are specially marked as bike lanes or shared-use paved shoulders.

COMMUTER BICYCLE ROUTE SUITABILITY

COMMUTER BICYCLE ROUTE SUITABILITY CONSIDERATIONS

The following should be considered when determining the suitability of a route for bicyclists.

- At grade rail-road crossings - Rough and uneven railroad crossings and those that are set at an acute angle to the roadway and are obstacles to bicyclists.
- Bridge Crossings - Surface conditions on bridges and inadequate space to accommodate motor vehicles and bicycles can cause problems for cyclists and pedestrians.
- Manhole and Utility Covers – Recessed manholes covers that create obstacles to cyclists. These sometime appear after roadway resurfacing when a manhole is not raised to the new surface level.
- Bicycle-Safe Drainage Grates - Some types of drainage grates can trap a bicycle wheel and cause a crash, particularly those with bars that are parallel to the direction of travel and with wide openings between the bars.
- Absolute Distance – a bicyclist needs the energy to travel the required distance.
- Route Quality – The intrinsic safety of the route.
- Vertical Alignment – Long and steep grades require additional energy input compared to flat terrain.
- Sharp Turns and Stops – Stopping and braking impose a loss of energy, which has to be regenerated by a bicyclist.

COMMUTER BICYCLE ROUTE SUITABILITY CRITERIA

Bicycle suitability criteria are somewhat analogous to the level of service (LOS) criteria established in the Highway Capacity Manual (HCM), which engineers and planners commonly use to evaluate the quality of traffic flow on highways and streets. These suitability criteria, like the LOS criteria, can be used to evaluate existing conditions and identify facility improvement needs. Bicycle suitability criteria also can be used to determine those streets or highways that are most amenable to bicycle travel. Bicyclists typically prefer to use streets with low traffic volumes, low vehicle speeds, and wide curb lanes, bicycle lanes, or shoulders. A number of other factors can be used to determine those roadways most suitable for bicycle use.

There are three distinct types of bicycle suitability criteria:

Stress Levels: Stress levels are simple evaluation criteria based upon curb lane vehicle speeds, curb lane vehicle volumes, and curb lane widths. Bicycle stress levels are easy to calculate because there are only three input variables, but they do not incorporate other factors hypothesized to affect bicycle suitability.

Roadway Condition Index: The roadway condition index or suitability-based level of service includes criteria based on traffic volumes, curb lane width, speed limit, pavement factors and location factors. Bicycle planners will typically use these types of criteria in urban areas where data can be economically collected for roadways under study.

Capacity-Based Level of Service: Capacity-based level of service is volume-based or similar procedures that have been adapted from capacity analysis common in the Highway Capacity Manual. Capacity-based bicycle suitability procedures appear to be ill-suited for most bicycle planning and suitability assessment needs.

COMMUTER BICYCLE ROUTE SUITABILITY CRITERIA SIGNIFICANCE

The following characteristics are recommended to represent bicycle suitability on roadways by order of significance.

- Shoulder width (or travel lane width where no shoulder is present);
- Average daily traffic (ADT) volume per lane;
- Speed limit (as a surrogate for average vehicle operating speed); and,
- Shoulder (or travel lane) pavement conditions.

COMMUTER BICYCLE ROUTE SUITABILITY SCORE

The following bicycle suitability score and criteria are oriented toward intermediate or experienced bicyclists who are familiar with the rules of the road and effective bicycling.

$$\textit{Bicycle Suitability Score, } S_{Bicycle} = S_{Width} + S_{Traffic} + S_{Speed} + S_{Pavement}$$

Where;

$S_{Bicycle}$ is the bicycle suitability score

S_{Width} is the factor score for shoulder or travel lane width

$S_{Traffic}$ is the factor score for traffic volume

S_{Speed} is the factor score for speed limit

$S_{Pavement}$ is the factor score for shoulder or travel lane pavement conditions

SUITABILITY FACTOR		VALUE RANGE	FACTOR SCORE
S_{Width}	Shoulder Width [Curb Lane Width]	6 Ft. or Greater [15 Ft. or Greater]	2
		2 Ft. to 4 Ft. [12 Ft. to 14 Ft.]	0
		No Shoulder [Less than 12 Ft.]	-2
$S_{Traffic}$	Traffic Volumes ADT per Lane	Less than 1,000	2
		1,000 to 1,999	1
		2,000 to 4,999	0
		5,000 to 9,999	-1
		10,000 or Greater	-2
S_{Speed}	Posted Speed Limit (or Average Vehicle Speed)	35 mph and under	2
		40 or 45 mph	1
		50 or 55 mph	0
		60 or 65 mph	-1
		70 mph or greater	-2
$S_{Pavement}$	Shoulder/Travel Lane Pavement Surface Quality	New or Very Good Condition	2
		Good Condition	0
		Poor to Very Poor Condition	-2

The value ranges in the above table were selected such that each suitability factor has three (or five) possible ranges. The middle range for each suitability factor was set such that it corresponded to minimum desirable bicycling conditions, as indicated by current federal guidance in designating bicycle routes. The high suitability score range was set such that it corresponds to desirable bicycling conditions, whereas the low suitability score range was set to correspond to less than desirable bicycling conditions.

COMMUTER BICYCLE ROUTE SUITABILITY SCORE INTERPRETATION

A single numerical suitability score (bicycle suitability score) can be obtained by summing the score for each factor. With this equation, it is assumed that each suitability factor is weighted equally (i.e., no factor is more important than the other in determining overall roadway suitability). Equal weighting of each factor was selected for simplicity. Agency user or bicyclist input could lead to later refinements, such as differential weighting by factor.

Interpretations of bicycle suitability score values are contained in the following table.

Bicycle Suitability Score Range	Interpretation
6 to 8	All four suitability factors have **greater than minimum** desirable values. The physical characteristics of the roadway are most likely desirable by intermediate to experienced bicyclists.
-1 to 5	At least three of the four suitability factors have minimum desirable or greater than minimum desirable values. One suitability factor may have less than desirable values. The physical characteristics of the roadway could be desirable by intermediate to experienced bicyclists.
-2 to -5	At least two of the four suitability factors have less than minimum desirable values. One or two of the suitability factors may have minimum desirable values. The physical characteristics of the roadway may not be desirable by intermediate to experienced bicyclists.
-6 to -8	All four of the suitability factors have **less than minimum** desirable values. The physical characteristics of the roadway are most likely undesirable by intermediate to experienced bicyclists.

BICYCLE ROUTE SEGMENT SUITABILITY RATING

The following table identifies the rating corresponding to the Bicycle Suitability Score from the Bicycle Route Suitability Form.

SCORE	RATING	RATING DESCRIPTION
<3.00	SUPERIOR or EXCELLENT	Conducive to bicycle use. Minor improvements, if any are needed.
3.00 TO 3.99	GOOD	Accommodates most cyclists. Minor improvements may improve to superior rating.
4.00 TO 4.99	FAIR	Usable by many cyclists but poses significant hazards. Improvements, such as shoulders or lanes, are probably needed.
5.00 TO 6.99	POOR	Usable by some cyclists but poses significant hazards. Improvements, such as shoulders or lanes, are probably needed.
>=7.00	VERY POOR	Substandard conditions combined with heavy traffic create significant hazards. Improvements are needed.

Note that the ratings and weighting of the criteria factors are subjective but based on generally excepted practice. Factors affecting the rating are dependent on the skill levels of the bicyclists.

BICYCLE ROUTE SEGMENT SUITABILITY FORM

The following form may be used to analyze suitability for individual roadway segments.

BICYCLE ROUTE SEGMENT SUITABILITY FORM

Date:	Comments/Suggested Improvements:
Data Collector Name:	
Segment ID; Number or Name:	
Locations; Boundary Roads/Streets:	

A) General Road Factors	Measures
1) Annual Average Daily Traffic (AADT)	
2) Total Number of Through Lanes	
3) Speed (mph)	
4) Outside Lane Width (e.g. 11.5')	
5) Bike Lane or Paved Shoulder Width (e.g. 4.5') (Note~a Marked Bike Lane)	

Record these measures in the formula below

B) Pavement Factors	Score
1) (Circle one pavement description) Very Good = 0.25 Good = 0.75 Fair = 1.50 Poor = 2.25 Very Poor = 3.75	(Record score)
2) Presence of Curb Y N	Yes = 0.25
3) Rough RR Crossing Y N	Yes = 050
4) Storm Drain Grate Y N	Yes = 0.75
TOTAL Scores *Record score in formula below*	

C) Location Factors	Yes/No (circle)	Score for "Yes"
1) Angle Parking	Y N	0.75
2) Parallel Parking	Y N	0.50
3) Right-Only Turn Lanes	Y N	0.25
4) Center (Both) Turn Lane	Y N	-0.25
5) Physical Median	Y N	-0.50
6) Paved Shoulder	Y N	-0.75
7) Marked Bike Lane	Y N	-1.00
8) Severe Grades	Y N	0.50
9) Moderate Grades	Y N	0.25
10) Frequent Curves	Y N	0.25
11) Restricted Sight Distance	Y N	0.50
12) Numerous Driveways	Y N	0.50
13) Numerous Intersections	Y N	0.75
14) Difficult Intersections	Y N	1.00
15) Industrial Land Use	Y N	0.50
16) Commercial Land Use	Y N	0.25
17) Sidewalk Only One Side	Y N	0.25
18) Sidewalks Do Not Exist	Y N	0.50
TOTAL all "YES" points *Record score in formula below*		

$$\frac{\text{AADT}}{\boxed{}\ \text{X}\ 2500} + \frac{\text{Speed}}{35} + \frac{14 - \text{Outside Lane Width} - \text{Bike Lane or Paved Shoulder Width}}{2} + \text{Pavement Factors} + \text{Location Factors} = \text{Bicycle Suitability Score}$$

No. of through lanes

SIDEPATH SUITABILITY ALGORITHM

The following algorithm rates the suitability of a sidewalk or sidepath as a bicycle facility. (A sidepath is a trail parallel to, but separated from, a roadway) In addition to rating existing sidepaths, it can be used to plan safety improvements for new or existing sidepaths. This algorithm was developed using design issues described in the "AASHTO Guide for the Development of Bicycle Facilities."

The factors considered are: intersection traffic, continuity, curb cuts, pedestrian use, crosswalks, and path/road separation at intersections. For a particular segment, add the following terms:

<u>Intersection Traffic Score:</u>

The volume and speed of motor vehicular traffic – especially turning traffic – directly affect the risk of collision. Determine the intersection traffic score *X* from the following:

*X = [R+(2*A)+(4*B)] / M * [Spd*Vol];*

Where:
R = Number of residential intersections (driveways) on the segment,
A = Number of minor commercial intersections and streets (<1000 ADT),
B = Number of major commercial intersections and streets (>1000 ADT),
M = Length of segment in miles
Spd = Speed limit factor, for the parallel street:
    0-30 mph = 1,
    35-40 mph = 2,
    45+ mph = 3.

Vol = Traffic volume factor, parallel street:
    <2,000 ADT = 1;
    2,000-10,000 = 2;
    >10,000 = 3.

Add the following number of points for the intersection traffic score *X*.

X	Points
0	0
1-40	1
41-80	2
81-120	3
121-160	4
161-200	5
201-240	6
>240	7

<u>Continuity:</u>

Discontinuities (major gaps, or sidepath ends) may force cyclists to ride through grass, etc., and enter the roadway awkwardly. Cyclists will often avoid sidepaths with these gaps.

Add 4 points if major discontinuities exist.

Curb cuts:

Uncut curbs compromise cyclist movement and attention at intersections.

Add 3 points if any intersections are lacking curb cuts.

Pedestrian use:

Sidewalks and sidepaths are used by both bicyclists and pedestrians. Insufficient width increases user conflict. (However, extra width encourages higher cyclist speeds, which becomes a problem at incorrectly-designed intersections.) Add points according to the following chart:

Low (rare) ped use	Medium (sometimes) ped use	High (often) ped use
<= 5' - 1 point	<=5' - 2 points	<=5' - 4 points
> 5' - 0 points	6-7' - 1 point	6-7' - 2 points
	>=8' - 0 points	>=8' - 1 point

Crosswalks:

Visible crosswalks can help make motorists more aware of non-motorized traffic. Sometimes two parallel painted stripes are sufficient. At busier intersections, "ladder" or "zebra" crosswalks and other techniques enhance visibility.

Add 2 points if there are no crosswalks.
Add 1 point if there are some crosswalk markings, but more visibility is warranted for that intersection type.
Add 0 points for appropriately marked crossings. Take the worst-case crossing for the segment.

Intersection sidepath/road separation:

AASHTO recommends that sidepaths be brought closer to the parallel road at intersections, so motorists more easily see and consider bicyclists during their approaches. The vehicular stop line should be in back of the sidepath crossing – cyclists must not weave through stopped traffic when crossing.

Add 5 points if the crossing goes through stopped traffic.
Add 3 points if the crossing is not brought "close enough" to the parallel road.
Add 1 point when the crossing is brought close to the road.
Add 0 points for paved shoulders and bike lane crossings. Take the worst-case crossing for the segment.

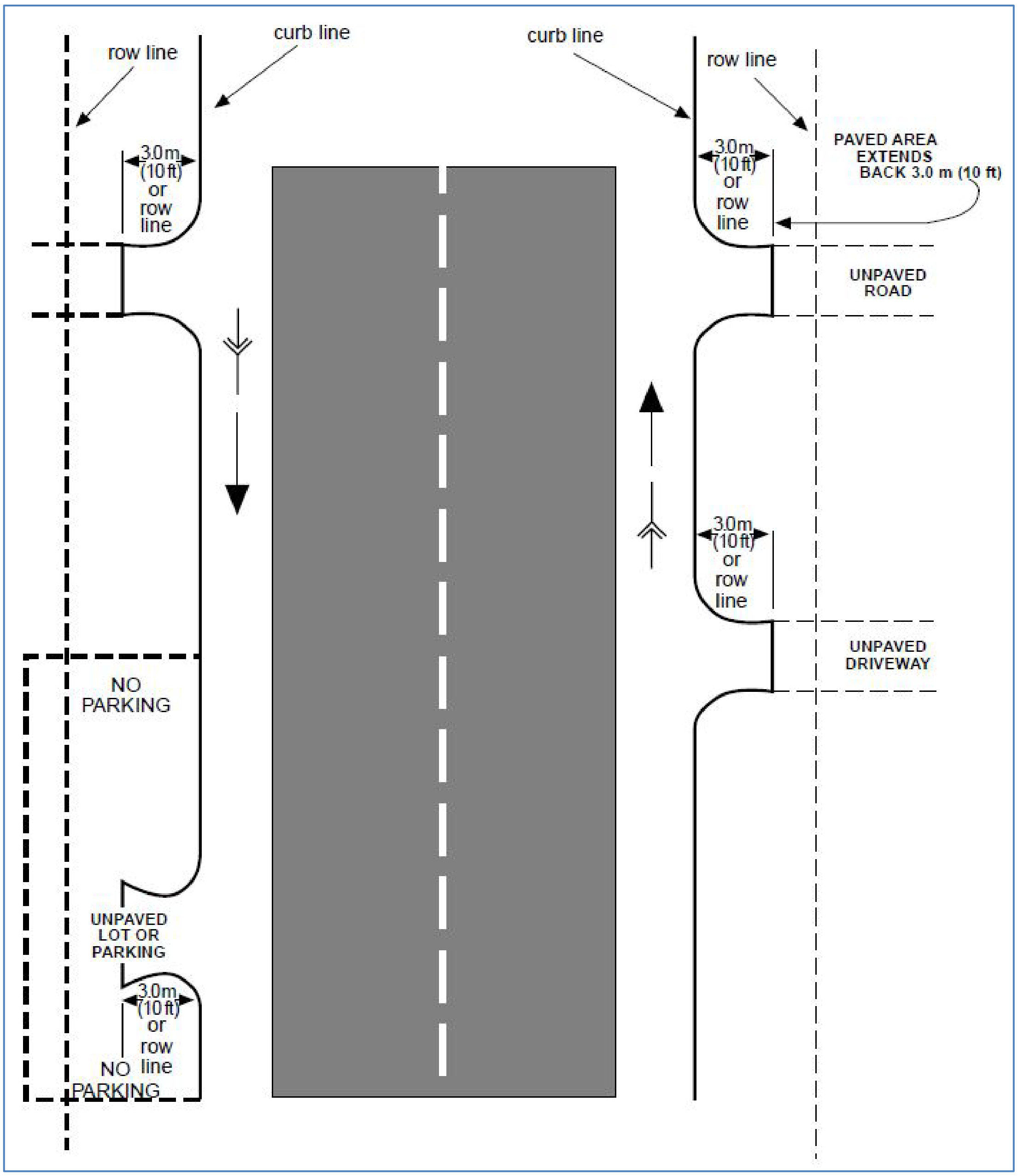
Add together all the points for the sidepath suitability score. Ranges of suitability are:

Suitability Score	Suitability
<= 7	High suitability
8-9	Medium suitability
10-11	Low suitability
>= 12	Not suitable (poor)

CHAPTER 6 – INTERSECTIONS

INTERSECTING DRIVEWAYS & UNPAVED ROADWAY DESIGN FOR BICYCLES

Sand, gravel and other debris in the bicyclist's path present a potential hazard. In order to minimize the possibility of debris from being drawn onto the pavement surface from unpaved intersecting roadways and driveways, during new construction, reconstruction and resurfacings, all unimproved intersecting streets and driveways should be paved back to the right-of-way line or a distance of 10 feet. Similarly, where curb cuts permit access to roadways from abutting unpaved parking lots, a paved apron should be paved back to the right-of-way line or 10 feet from the curb line. These practices will lessen the need for maintenance debris removal. The placement of the paved back area or apron should be the responsibility of those requesting permits for access via curb cuts from driveways and parking lots onto the highway system.



AT-GRADE INTERSECTION DESIGN FOR BICYCLES

The design of at-grade intersections requires strict conformance with standard practice, combined with the experience and creativity of the designer in selecting and applying the most appropriate treatment to accommodate each traffic movement. Uniformity is an important ingredient of intersection design because it is essential that all road users encounter familiar conditions at each intersection. Uniform standards and principles also serve to promote intersection treatments that have proven successful and have been accepted by transportation professionals and road users.

On the other hand, each intersection may have unique features that distinguish it in some way from other intersections. In addition, there are legitimate differences in local preferences that have created a set of equally acceptable alternatives for some treatments. This creates a tradeoff between uniformity and flexibility. Clearly, the most appropriate design policy is one that sets forth the standards and principles that must be observed and provides some latitude for choice in areas where choice can be offered.

The purpose of this section is to identify the mandatory requirements and to provide guidelines for choice where alternatives exist. The mandatory requirements are collected from several sources that represent a combination of material from authoritative references and research reports.

The guidelines presented are based on the premise that the design of an intersection must conform in all respects to the provisions of the Ohio statutes and rules, plus all authoritative references that have been adopted as standards by the Ohio Department of Transportation and local jurisdictions.

At-grade intersection design for bicycles should be such that it provides:

- Safe and convenient operation for all road users, including cyclists and pedestrians;
- Proper accessibility for pedestrians with special needs;
- Adequate capacity for peak-hour demand on all movements;
- Adequate maneuvering space for design vehicles;
- Resolution of conflicts between competing movements;
- Reasonable delineation of vehicle paths;
- Adequate visibility of conflicting traffic;
- Storage for normal queuing of vehicles;
- Appropriate access management application;
- Minimum delay and disutility to all road users;
- Proper drainage of storm water;
- Accommodation for all utilities, both above and below the ground;
- Necessary regulatory, warning and informational messages for all road users;
- Suitable advance warning of all hazards;
- Uniformity of treatment with similar locations.

Basic Elements:

The functional area on the approach to an intersection or driveway consists of three basic elements:

- Perception reaction distance
- Maneuver distance
- Queue storage distance

Perception reaction distance is the length traveled in the amount of time it takes to react and start breaking, typically 2.5 seconds. The maneuver distance includes the length needed for both braking and lane changing when there is a left or right turning lane. In the absence of turn lanes, the maneuver distance is the distance to brake to a comfortable stop. Queue storage distance is the distance from the centerline of the intersection to the end of traffic during peak-hour demand.

INTERSECTION CHARACTERISTICS

The characteristics of an intersection include a set of factors that are involved in some way in the intersection design process. Some characteristics act as controls, while others are the result of design decisions.

RESOLUTION OF CONFLICTS BETWEEN COMPETING MOVEMENTS

In the interest of safety, the conflict between two competing traffic movements must be resolved by a traffic control discipline that gives one movement priority over the other. When some movements are heavy, the priority must be assigned, alternated or distributed in some manner or at least one of the movements will fail.

THE NATURE OF INTERSECTION CONFLICTS

Most conflicts at intersections occur when two vehicles compete with each other for right-of-way. It is, however, important to recognize the conflicts that occur between two different types of road users. Inter-user conflicts may be characterized as:

- Vehicle-pedestrian conflicts: Right-of-way needs to be assigned to pedestrians crossing in crosswalks. Pedestrians crossing outside of crosswalks must yield to vehicles. Most pedestrian activity at intersections will be in crosswalks.
- Vehicle-bicycle conflicts: The bicycle should be considered to be a vehicle. In the traveled roadway, a bicycle is always considered as a vehicle. In crosswalks, the cyclist is treated as a pedestrian with respect to a motorized vehicle. Accommodations for bicycles at intersections should treat bicycles like pedestrians when in crosswalks.
- Bicycle-pedestrian conflicts: Because they assume the identity of a vehicle, bicycles on roadways are subject to the same rules indicated above for vehicle-pedestrian conflicts. When bicycles are on pedestrian facilities such as sidewalks, crosswalks, etc. they are required to yield to pedestrians.

Research has shown that the majority of bicycle/motor vehicle crashes occur at intersections. When using shared paths, the cyclist will still need to cross busy arterial streets, usually at signalized intersections. Special loop detectors (which can detect bicycles) as well as bicycle-oriented signal call buttons can facilitate the crossing. Bicycle routes typically used by younger children need to provide protected signalization for crossing arterial streets, both at intersections and at other locations where crossings are needed.

The following guidance is recommended for planning shared-use paths. However, the function of the crossings should also be considered as residential crossings typically produce fewer conflicts than a commercial crossing.

NUMBER OF CROSSINGS PER MILE OF PATH	DESIGN CONSIDERATION
0	IDEAL for safe pathway
1 to 4	Use SPECIAL CARE to treat the conflicts
5 to 8	Proceed with EXTREME CAUTION. Consider substituting with on-street bicycle lanes.
>8	DANGEROUS CONDITION. Substitute with on-street bicycle lanes or other treatment.

Grade-separated crossings are an alternative to protected at-grade crossings. Such crossings tend to be very expensive, which limits where they can be considered to only a few high priority locations. Neither bike overpasses nor underpasses work well near intersections. The crossing length is longer and the opportunity does not exist to adjust the road grade to shorten the slopes of the crossing. Also, the transitions between on-street lanes and the separate crossing path create the possibility of unsafe movements. Underpasses can prompt personal safety concerns if their required length is too great and/or visibility through the underpass is limited.

Intersections between paths and roadways are often the most critical issue in shared-use path design. Bike paths are not inherently more dangerous than other bicycle facilities if they are well designed, thoughtfully applied, and adequately maintained.

Paths should not have their continuity destroyed by frequent motor vehicle cross flows and intersections with highways. Due to the potential conflicts at these intersections, careful design is of paramount importance to the safety of path users and motorists alike.

High speed, wide radius intersection designs may enhance safety for motor vehicles by minimizing speed differentials between entering and exiting vehicles and through vehicles. However, these designs exacerbate speed differential problems faced by bicyclists travelling along the right side of a highway and encourage drivers to fail to yield the right-of-way to bicyclists. As a result, where wide radius curb returns are being considered, specific measures should be employed to ensure that the movement of bicyclists along the highway will be visible to motorists and to provide bicyclists with a safe area to operate. One method to accomplish this would be to stripe (dash) a bicycle lane through the intersection area. In this event, SHARE THE ROAD (OMUTCD W16-1P) signs should be posted in advance of the intersection to alert existing traffic, and yield to bicyclist signs should be posted on the approach to the intersection. In general, however, curb radii should be limited to distances which communicate to the motorist that the motorist must yield the right-of-way to bicyclists traveling along the roadway or to pedestrians walking along the sidewalk or roadway margin.

RECOMMENDED BIKEWAY INTERSECTION TREATMENT

A recommended treatment for path/roadway intersections is chose based on roadway speed and ADT, according to two different classes of crossing safety; “good” or “satisfactory.” Choose the “good” crossing treatment if the path is used for trips to school, if a large number of users are children, seniors, or disabled people, or if the crossing point is heavily used at times of peak bicycle and pedestrian use. Also, choose the “good” crossing treatment if the roadway cross section is large or the bikeway is part of a main bike route, or if future land development is likely to result in a significant increase of bicycle traffic or motor vehicle traffic. The following table lists guidelines for intersection treatment recommendations; however, each intersection is unique and will require sound engineering judgment on a case by case basis.

Motor Vehicle Speed	ADT	Bikeway Intersection Treatment
>50 mph	Any	Grade Separated (Good)
		Traffic Signal and 40 mph Speed Zone (Satisfactory)
45 mph	Any	Grade Separated (Good)
		Traffic Signals (Satisfactory)
40 mph	>7000	Grade Separated (Good)
		Traffic Signals (Satisfactory)
	<7000	Traffic Signals (Good)
		Crosswalk + Median Refuge Island (Satisfactory)
30 mph	>9000	Grade Separated (Good)
		Traffic Signals (Satisfactory)
	5000 to 9000	Traffic Signals (Good)
		Crosswalk + Median Refuge Island (Satisfactory)
	<5000	Crosswalk + Median Refuge Island (Good)
		Crosswalk (Satisfactory)

Consider the following when using the above table to select an intersection treatment:

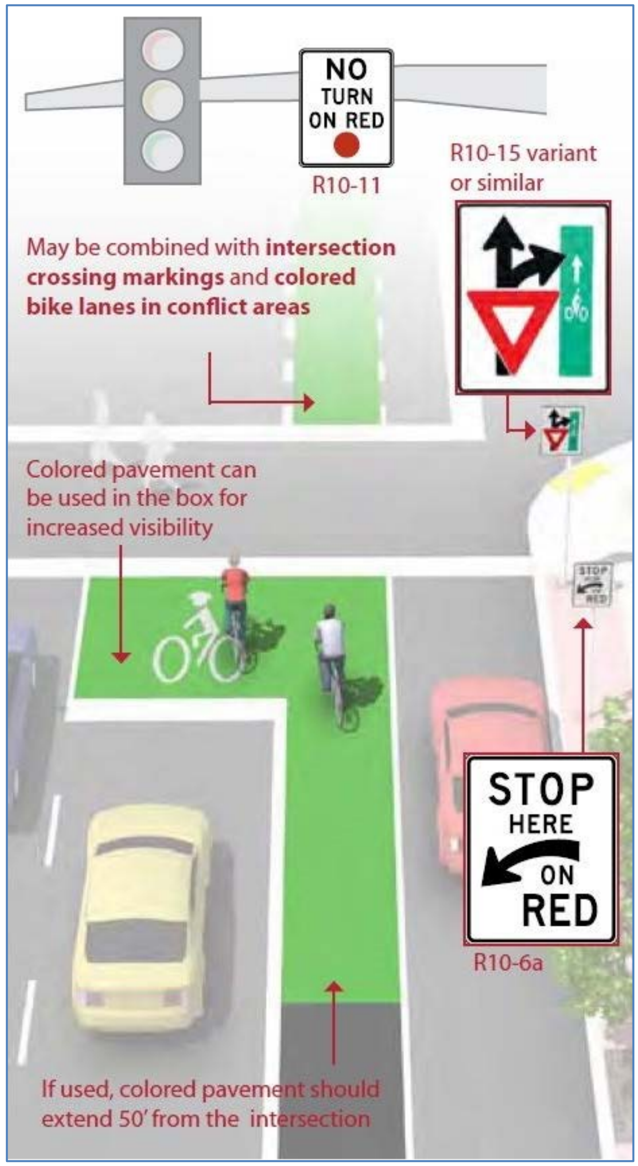
- The type of crossing used for bicycle/pedestrian traffic at an intersection between a main road and secondary road is usually the same as for the main road.
- If the number of lanes to be crossed is greater than 3 in each direction, or the total intersection width is greater than 75 feet, the intersection should have a pedestrian refuge or median island. Where bicyclists or pedestrians often wait at islands, a push button or bicycle-sensitive traffic detection device is desirable.
- At large intersections of very busy roads, rely on grade separation of pedestrian and bicycle traffic from both main and secondary roads, rather than signal controls
- If the speed limit along a section of road without traffic signals is greater than 40 mph and it is not practical to provide a grade-separated crossing, reducing the speed limit to 40 mph before the crossing, along with attention to signage and lighting, may be satisfactory.
- When choosing a location for a grade-separated crossing, pay special attention to ensure that ramp grades are minimized and that the location fits in well with the rest of the path network.

- At interchanges for motor vehicles, pedestrians and bicyclists may cross ramp terminals along minor roads and at diamond interchanges at grade; however, intersections with high volume of motorized traffic should be signalized.
- For crossing of a shared-use path with a low-ADT roadway, the following crossing treatments may be considered:
    - Bikeway crossing signs on roadway, with stop signs on shared-use path
    - Bikeway crossing signs on roadway plus user-actuated warning signals, with stop signs on shared-use path
    - Painted crosswalk markings may be used

BIKE BOXES

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

Bike boxes should be placed only at signalized intersections, and right turns on red shall be prohibited for motor vehicles. Bike boxes should be used in locations that have a large volume of bicyclists and are best utilized in central areas where traffic is usually moving more slowly. Prohibiting right turns on red improves safety for bicyclists yet does not significantly impede motor vehicle travel.

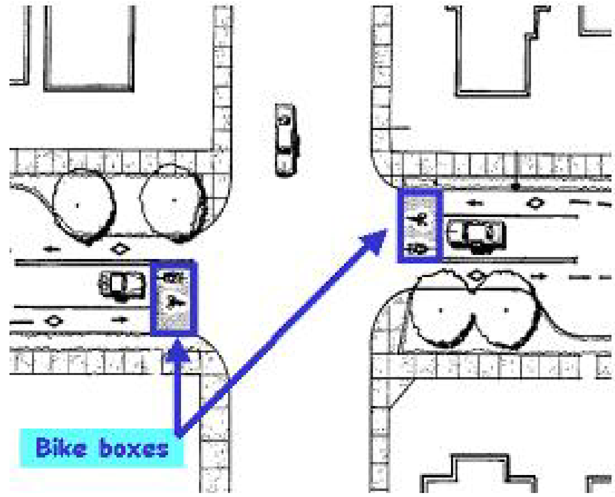


Guidance:

- 14' minimum depth
- A "No Turn on Red" sign shall be installed overhead to prevent vehicles from entering the Bike Box.
- A "Stop Here on Red" sign should be post-mounted at the stop line to reinforce observance of the stop line.
- A "Yield to Bikes" sign should be post-mounted in advance of and in conjunction with an egress lane to reinforce that bicyclists have the right-of-way going through the intersection.
- An ingress lane should be used to provide access to the box.

ADVANCE BIKE BOX

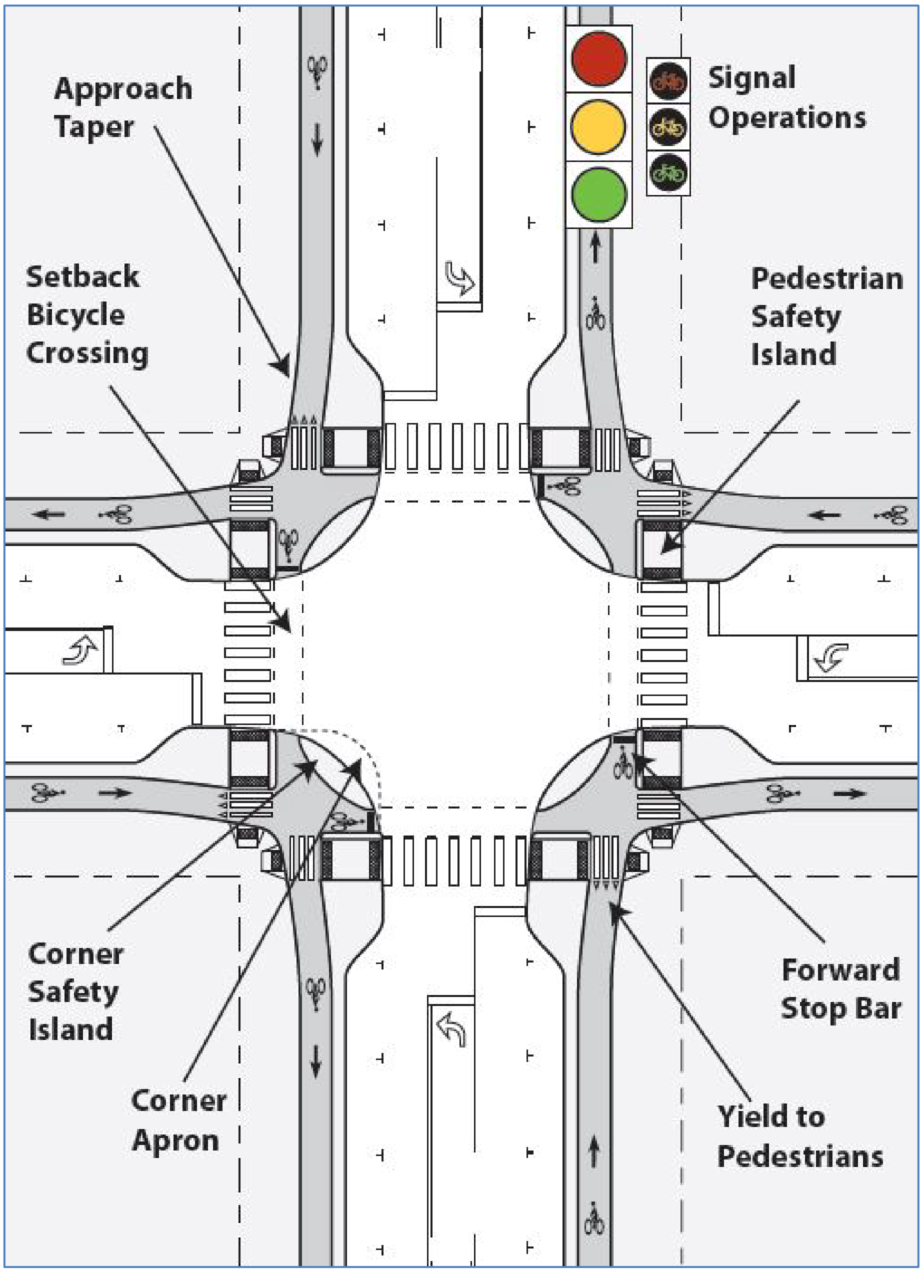
The objectives of the advance bicycle box are to improve the visibility of cyclists at intersections and to enable them to correctly position themselves for turning movements during the red signal phase by allowing them to proceed to the front of the queue.

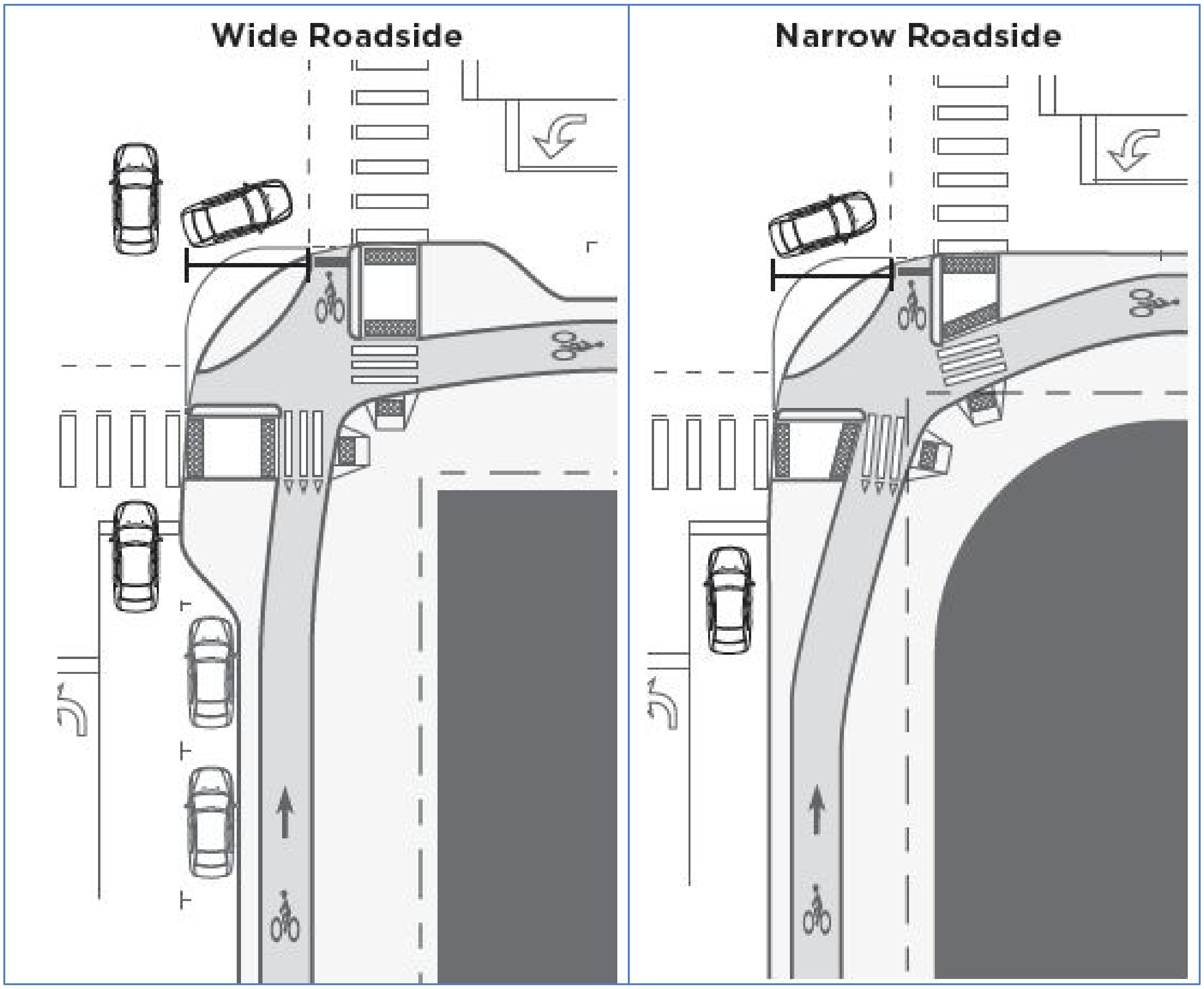


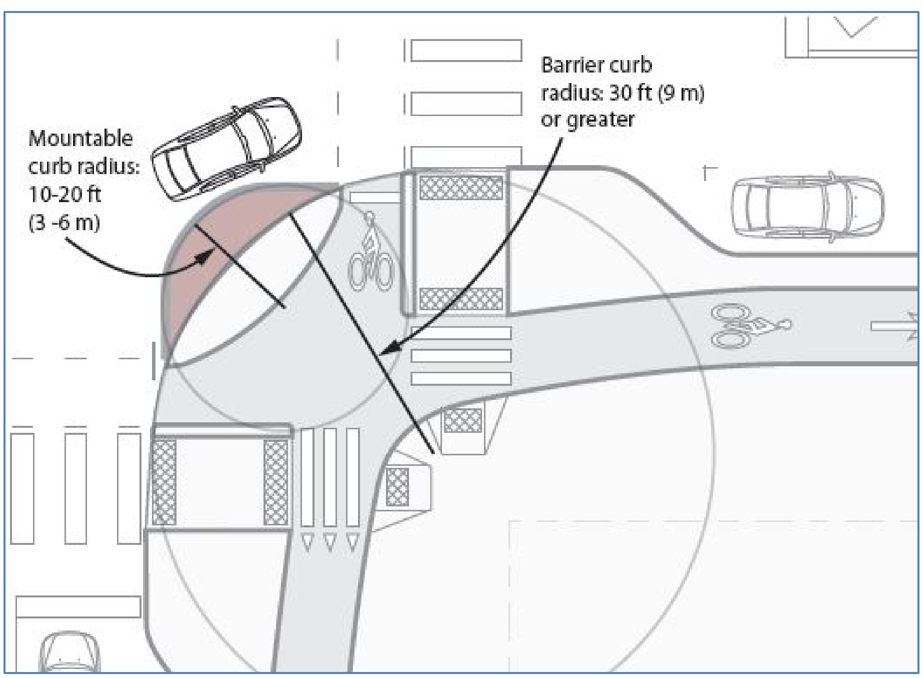
A bicycle lane leading up to a bicycle "reservoir" is located between the motor vehicle stop line and the crosswalk. The bicycle box should be 12 to 14 feet deep. If it is shallower, bicyclists tend to feel intimidated by the motor vehicles, and if it is deeper, motorists tend to encroach. To increase its effectiveness, a bicycle stencil should be placed in the bicycle box and a contrasting surface color is strongly recommended for the reservoir and the approach bicycle lane. Instructional signs and separate cyclist signal heads can be installed in conjunction with the bicycle box. This treatment may be used at intersections with high motor vehicle and bicycle ADTs, frequent turning conflicts, and intersections with a high percentage of turning movements by both cyclists and motorists.

BICYCLE PROTECTED INTERSECTION CONCEPT

Information extracted from *"Evolution of the Protected Intersection"*, Dec. 2015, prepared by Alta Planning + Design Protected intersections use a variety of design elements to create safe, comfortable conditions for bicyclists. While not all of these elements are required in all situations, they make up the typical protected intersection experience. Corner safety islands have multiple roles: offering a protected place for bicyclists to queue when crossing and turning and managing the speed of turning vehicles when permitted turn conflicts are allowed. Special attention should be paid to the amount of deflection required for both pedestrians and bicyclists in advance of the intersection.



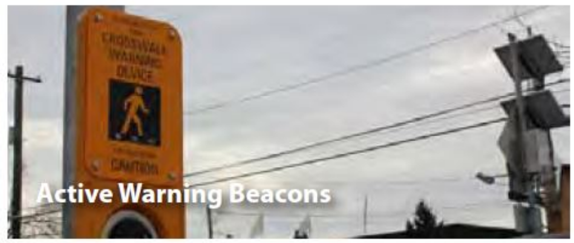

Wide Roadside
Narrow Roadside


Mountable curb radius: 10-20 ft (3 -6 m)
Barrier curb radius: 30 ft (9 m) or greater

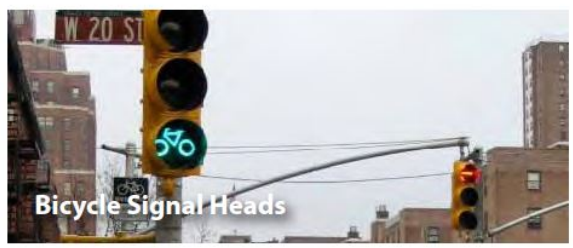
BICYCLE SIGNALIZATION, DETECTORS, & ACTUATION

Bicycle signals and beacons facilitate bicyclist crossings of roadways. Bicycle signals make crossing intersections safer for bicyclists by clarifying when to enter an intersection and by restricting conflicting vehicle movements. Bicycle signals are traditional three lens signal heads with green, yellow and red bicycle stenciled lenses that can be employed at standard signalized intersections and hybrid beacon crossings. Flashing amber warning beacons can be utilized at unsignalized intersection crossings. Push buttons, signage, and pavement markings may be used to supplement these facilities for both bicyclists and motorists.


Bicycle Detection and Actuation


Active Warning Beacons


Hybrid Beacons (HAWK)



Bicycle Signal Heads

Determining which type of signal or beacon to use for a particular intersection depends on a variety of factors. These include speed limits, Average Daily Traffic (ADT), anticipated bicycle crossing traffic, and the configuration of planned or existing bicycle facilities. Signals may be necessary as part of the construction of a protected bicycle facility such as a cycle track with potential turning conflicts, or to decrease vehicle or pedestrian conflicts at major crossings. An intersection with bicycle signals may reduce stress and delays for a crossing bicyclist, and discourage illegal and unsafe crossing maneuvers.

Proper bicycle detection should meet two primary criteria: accurately detects bicyclists and provides clear guidance to bicyclists on how to actuate detection (e.g., what button to push, where to stand). Bicycle loops and other detection mechanisms can also provide bicyclists with an extended green time before the light turns yellow so that bicyclists of all abilities can reach the far side of the intersection.

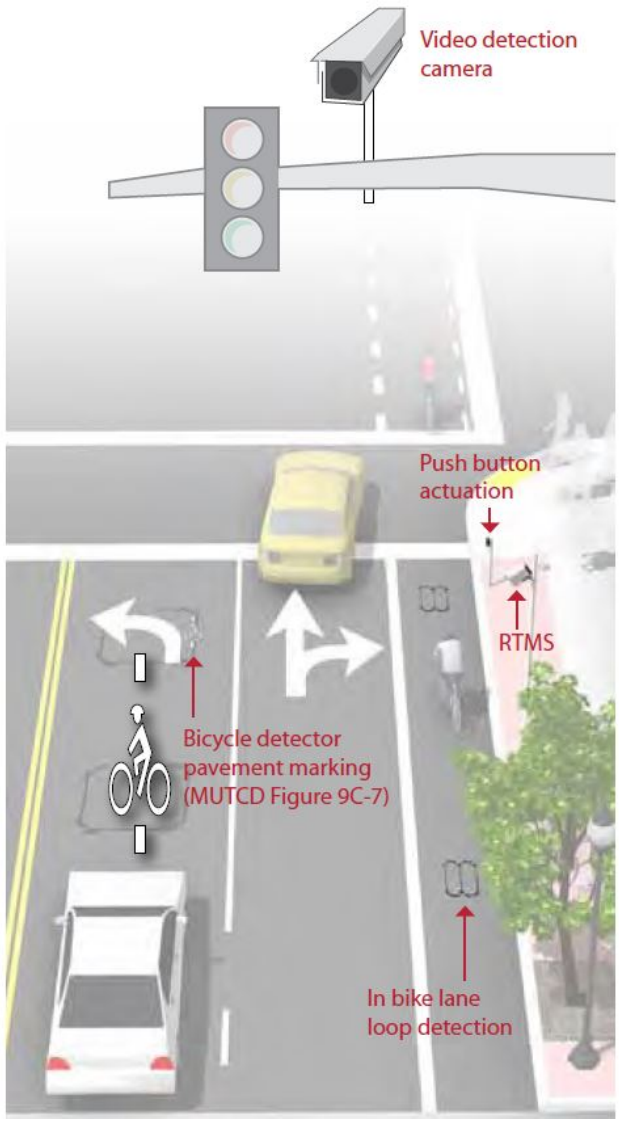
Signal detection and actuation for bicyclists should be maintained with other traffic signal detection and roadway pavement markings.

AASHTO discusses clearance intervals for traffic signal timing, and states that traffic-actuated signals should be sensitive to bicycles.

When a bicycle approaches an intersection, there are several means of detecting and facilitating its movements. Most of the innovations are passive detection devices such as loop detectors and infrared or video detection systems. Other methods are activated, such as the bicycle push-button, similar to that used by pedestrians.

Traffic-actuated signals should accommodate bicycle traffic. Detectors for traffic-activated signals should be sensitive to bicycles and should be located in the bicyclist's expected path. Examples of successful installations of bicycle sensitive signal detectors are the quadrupole loop, the diagonal quadrupole loop and the standard loop.

Stenciling should direct cyclists to the point where their bicycle will set-off detectors. For the sake of riders who have vehicles with insufficient amounts of iron to be detected, and to add redundancy in the event of failure of the bicycle sensitive loop detectors, pedestrian push buttons should be provided at all signalized intersections and mounted in a location which permits their activation by a bicyclist without dismounting. Where left turn lanes are provided and only protected left turns are allowed, bicycle sensitive loop detectors should be installed in the left turn lane or a pedestrian style push button should be provided that is accessible to a bicyclist in the turn lane to permit activation of the left turn phase.



EXISTING TRAFFIC SIGNAL DETECTION

Fine-tuning existing traffic detection systems may also improve bicycling conditions. Signal timing should include a minimum green time that allows bicyclists to remount their bicycles and travel across the intersection, and a yellow/red time that provides a safe bicycle clearance interval. Generally, 2 to 3 seconds added to the minimum automobile green time is appropriate; a yellow interval of 3.0 to 6.0 seconds offers sufficient time for a cyclist to come to a complete stop or enter the intersection legally; and an all-red clearance interval greater than 2.0 seconds is needed to clear bicycles from most intersections.

BICYCLE SIGNAL HEADS

A bicycle signal is an electrically powered traffic control device that should only be used in combination with an existing conventional or hybrid signal. Bicycle signals are typically used to improve identified safety or operational problems involving bicycle facilities. Bicycle signal heads may be installed at signalized intersections to indicate bicycle signal phases and other bicycle-specific timing strategies. Bicycle signals can be actuated with bicycle sensitive loop detectors, video detection, or push buttons.

In the United States, bicycle signal heads typically use standard three-lens signal heads in green, yellow, and red. Bicycle signals are typically used to provide guidance for bicyclists at intersections where they may have different needs from other road users (e.g., bicycle-only movements, or leading bicycle intervals).

Specific locations where bicycle signals have had a demonstrated positive effect include:

- Those with high volume of bicyclists at peak hours
- Those with high numbers of bicycle with motor vehicle crashes, especially those caused by turning vehicle movements
- At T-intersections with major bicycle movement along the top of the "T"
- At the confluence of an off-street bicycle path and a roadway intersection
- Where separated bicycle paths run parallel to arterial streets

Local municipal code should be checked or modified to clarify that at intersections with bicycle signals, bicyclists should only obey the bicycle signal heads. For improved visibility, smaller (4 inch lens) near-sided bicycle signals should be considered to supplement far-side signals.

Bicycle signal heads require the same maintenance as standard traffic signal heads, such as replacing bulbs and responding to power outages.

At signalized intersections where bicycle traffic exists or is anticipated (i.e. it is designated in a bicycle route plan as an existing or proposed bicycle facility), consideration should be given to bicyclists in the timing of the traffic signal.

The 2012 AASHTO Guide for the Development of Bicycle Facilities, fourth edition, provides guidance on how to determine the clearance interval needed to accommodate bicyclists.

BICYCLE SIGNALIZATION

The objective of providing bicycle signalization is to separate conflicting movements and facilitate the flow of all types of traffic. There are three types of intersections where they are used:

- Type A, at tee intersections with high bicycle traffic along the top of the tee;
- Type B, at the confluence of an off-street bicycle path with an intersection;
- Type C, where separated bicycle paths run parallel to arterial streets.

Traffic signals should be considered for signal phasing that provides for a minimum bicycle green time of 12 seconds and a maximum green time of 25 seconds. Additionally, a two-second all red-interval should be provided at the end of this phase as opposed to only one second at the end of other phases. Pedestrian cycle times are five seconds of walk and 18 seconds of pedestrian clearance. Other treatments included with the installation of the bicycle signal heads include advance-sign warning (BICYCLE SIGNAL AHEAD). The phasing plan prohibits motorists from conflicting with bicycle and pedestrian traffic.

ACTIVE WARNING BEACONS

Active warning beacons are user actuated illuminated devices designed to increase motor vehicle yielding compliance at crossings of multi lane or high volume roadways.

Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or Rectangular Rapid Flash Beacons (RRFB).

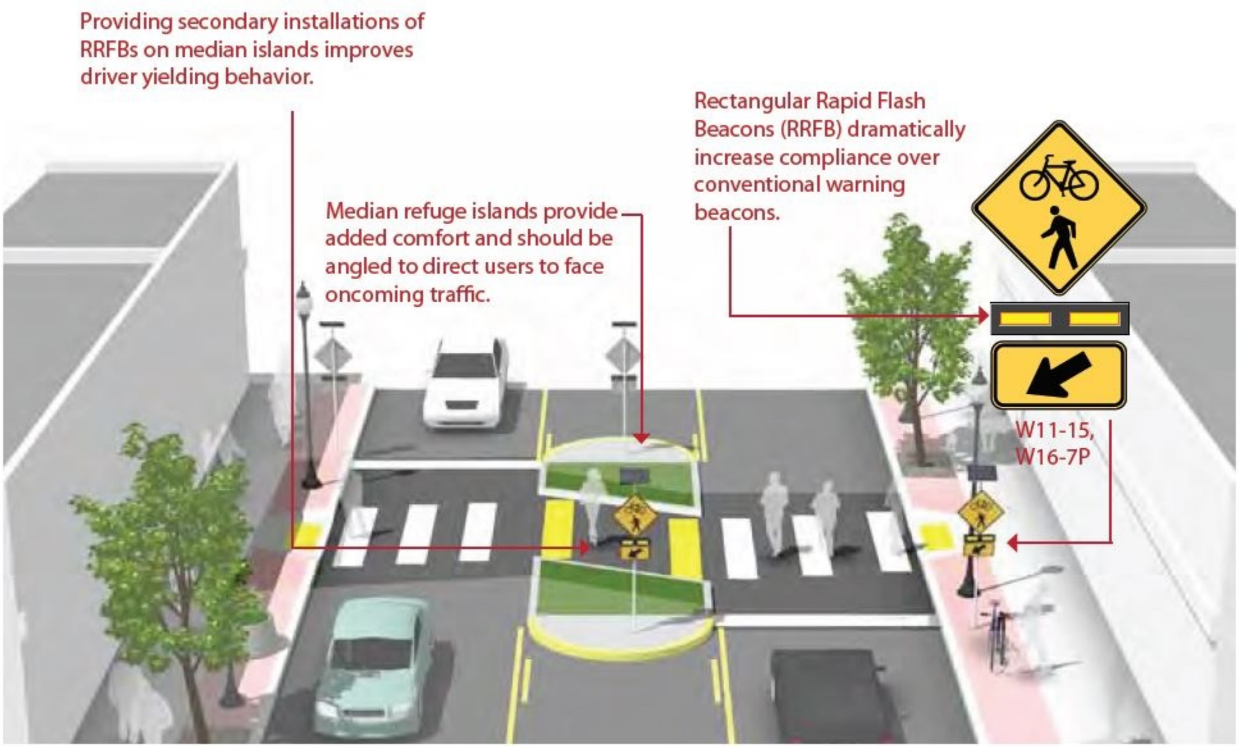
Guidance:

- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs or traffic signals.
- Warning beacons shall initiate operation based on pedestrian or bicyclist actuation and shall cease operation at a predetermined time after actuation or, with passive detection, after the pedestrian or bicyclist clears the crosswalk.
- If roadway constraints preclude a median refuge island, a Hybrid Beacon ("HAWK") signal should be considered after careful coordination with ODOT. A HAWK signal could be incorporated at either mid-block or shared-use path crossings.

Rectangular Rapid Flash Beacons (RRFB) have the highest compliance of all the warning beacon enhancement options.

A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88 percent. Additional studies over long term installations show little to no decrease in yielding behavior over time.

A HAWK signal could be incorporated at either mid-block or shared-use path crossings. Depending on power supply, maintenance can be minimal. If solar power is used, RRFBs can run for years without issue.



BICYCLE PUSH BUTTON/BAR ACTIVATION

The bicyclist activates the signal by pushing a bar or button similar to those used for pedestrians, but the button is installed in a location convenient for bicyclists and the signal timing is set appropriately for bicyclists. The sign plate located above the push button/pad/bar indicates that it is not for the use of pedestrians. The larger the surface of the button, the easier it is for cyclists to use, thus a push pad is preferential to a push button, and a push bar is preferential to a push pad, as it can be actuated without removing one's hands from the handlebars.

Push buttons are appropriate when other methods of detection are not feasible, particularly at narrow tunnels or where multi-use paths cross signalized intersections. Advantages of the push button are that it is typically less expensive than other means of detection, and it allows for different signal timing for different user needs.

Advantages:

- Allows separate signal timings for different user needs.
- Less expensive than other detection treatments.

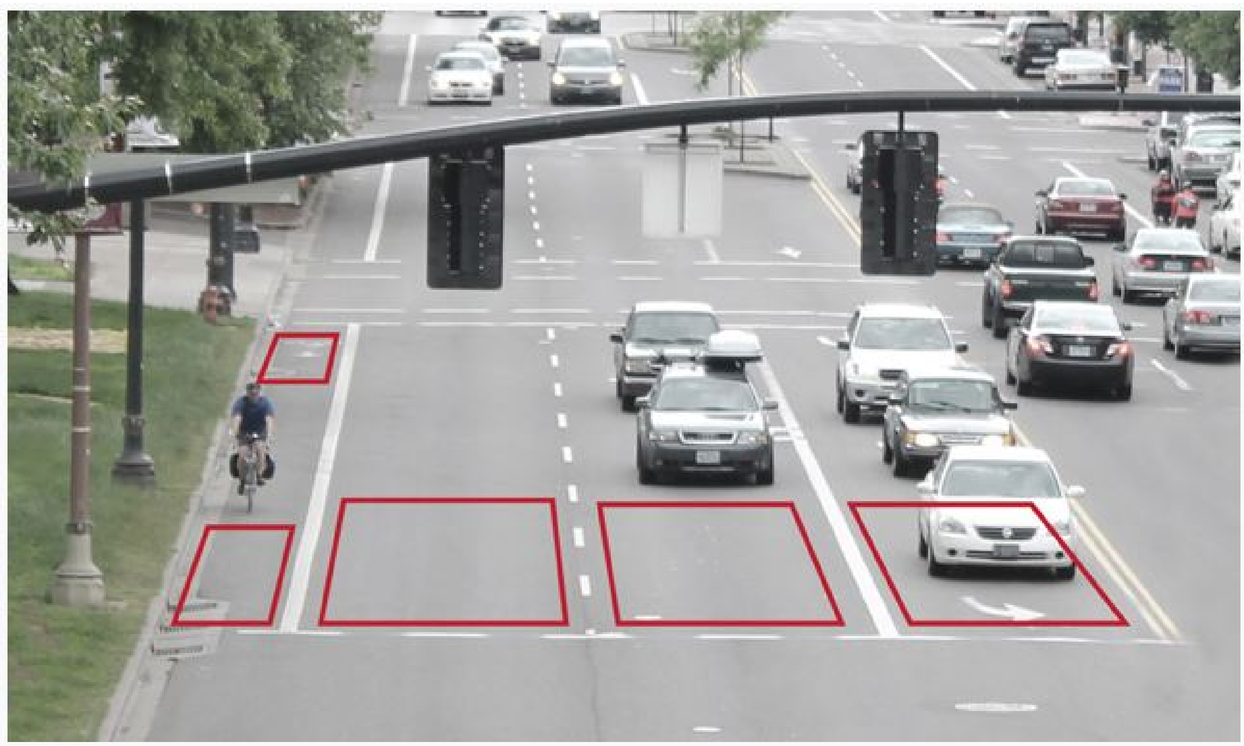
Considerations:

- Location of push button does not, in most cases, allow the bicyclist to prepare appropriately for through or left turning maneuvers at the intersection.
- A push button forces the bicyclist to stop completely to actuate the signal.

BICYCLE-ACTIVATED LOOP DETECTORS

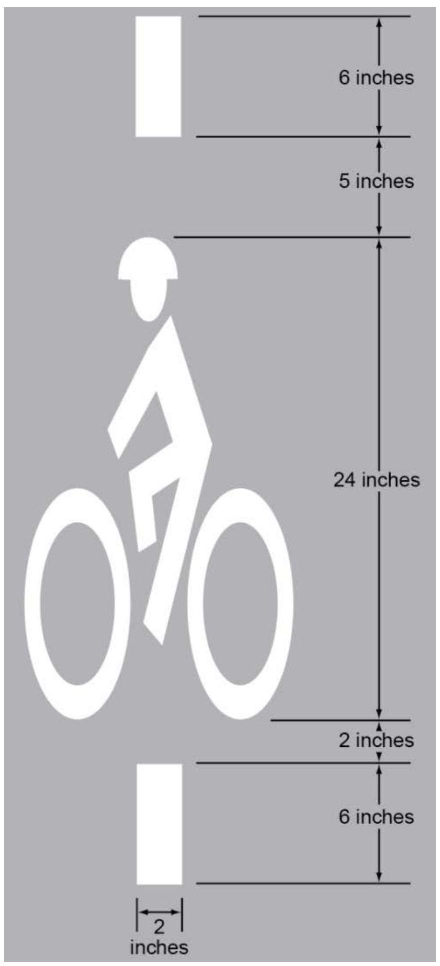
Bicycle-activated loop detectors are installed within the roadway to allow the presence of a bicycle to trigger a change in the traffic signal. This allows the bicyclist to stay within the lane of travel without having to maneuver to the side of the road to trigger a push button.

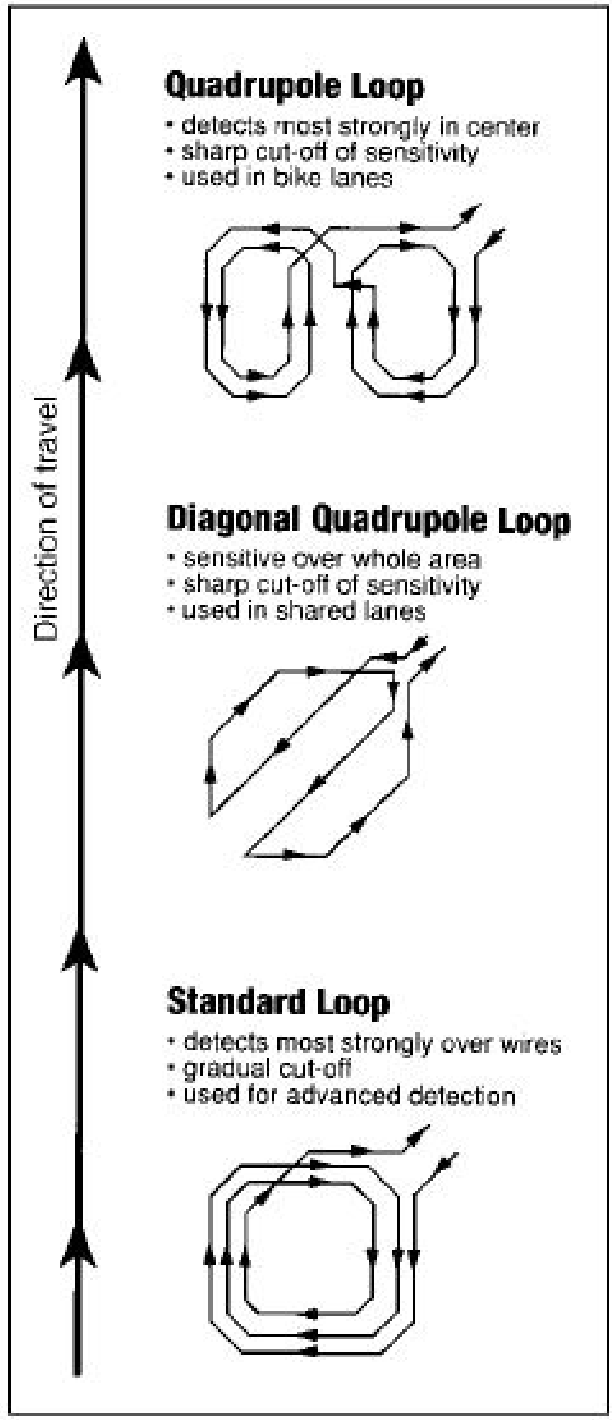
Loops that are sensitive enough to detect bicycles should be supplemented with pavement markings to instruct bicyclists how to trip them.



As new signals are installed or major updates occur at existing signalized locations, bicycle loop detectors should be installed on the bikeway system for all movements that do not recall an automatic green light. It is suggested that loop detectors be installed in the approach bike lane 100 feet in advance of the intersection as well as at the intersection itself. The upstream loop should not be used when it would be triggered by right-turning vehicles. When the upstream loop is triggered, the green time should be extended for the cyclist to reach the loop at the stop bar, at which point the signal should allow the cyclist to clear the intersection. The time that a bicycle needs to cross an intersection is longer than the time needed for vehicles, but shorter than the time needed for pedestrians. The AASHTO Guide for the Development of Bicycle Facilities includes detailed equations for bicycle signal timing. In general, while the normal yellow interval is usually adequate for bicycles, an adjustment to the minimum green should be considered.

Stencils indicating the loop detector should be marked on the roadway at the intersection where a bicyclist may not be positioned correctly over a loop. The figure at the bottom of this page shows the appropriate location and use of loop detector stencils at intersections.





VIDEO DETECTION SYSTEMS

Video detection systems use digital image processing to detect a change in the image at a location. These systems can be calibrated to detect bicycles. Video camera system costs range from $20,000 to $25,000 per intersection.

Video detection systems are used to activate treatments such as signal timing specifically needed to assist bicyclists to cross at signalized intersections. This system is useful at signalized intersections where there are dedicated bicycle lanes. The video system uses detectors drawn in video images to sense the presence of bicycles in bicycle lanes at signalized intersections.

Video Detection System Advantages:

- Special signal timing can be activated to allow bicyclists sufficient time to cross the intersection. This treatment enhances safety for this mode of transportation.
- It will detect bicycles that do not contain iron, unlike loop detectors.
- It is not affected by asphalt work and may be used to help direct traffic during construction.

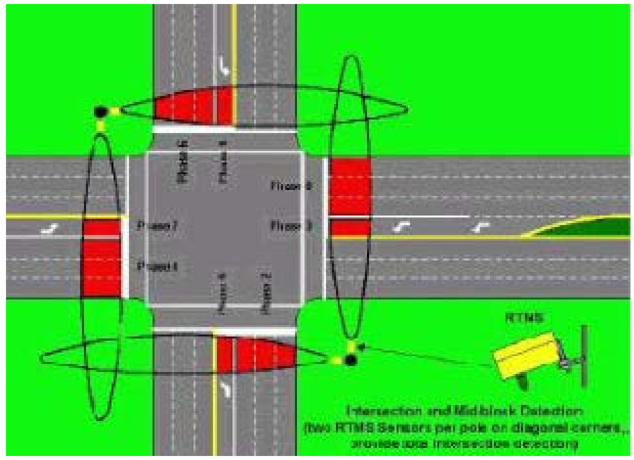
Video Detection System Considerations:

- Longer phases needed for bicyclists may disrupt signal progression if cycle lengths are based on shorter phases.
- Since bicyclists do not always stop in the same place while waiting to cross a street, cameras may either falsely detect a bicyclist or may not detect a bicyclist that is present, in both cases causing unnecessary delay for road users.
- Weather conditions such as thick fog and blinding sunlight can reduce the effectiveness of the camera.

REMOTE TRAFFIC MICROWAVE SENSOR DETECTION (RTMS)

A Remote Traffic Microwave Sensor (RTMS) is a detection system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method marks the detected object with a time code to determine its distance from the sensor. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection.

RTMS uses microwave sensors to detect bicycles at signalized intersections using frequency modulated continuous wave radio signals that detect objects in the roadway. This method can detect slow moving or stopped vehicles unlike Doppler.



It is also marked with a time code, which gives information on how far away the object is. This technology can also be used to count vehicles. Many new systems have storage and data download capabilities to remote locations.

RTMS Advantages:

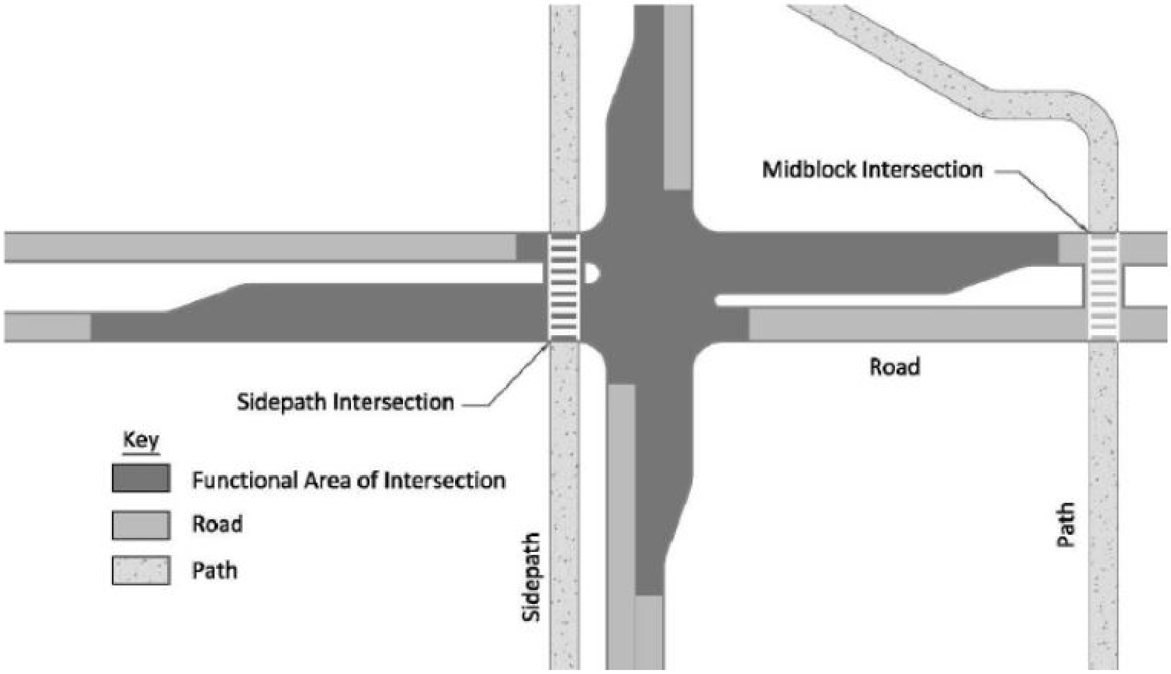
- RTMS can detect slow moving or stopped objects.
- RTMS is not affected by extremes in light or temperature, weather conditions such as fog that may obstruct video cameras, or road/utility work.
- RTMS can detect bicycles that do not contain iron.
- The waves refract around large vehicles so smaller vehicles are still “visible.”

RTMS Considerations:

- Microwave systems are more expensive than standard loops.
- According to Electronic Integrated Systems, Inc. (EIS), RTMS has never been deployed for the sole purpose of detecting bicycles.
- It may have trouble detecting smaller objects, including young children, or young children on bicycles.

CHAPTER 7 – CROSSINGS

ROADWAY CROSSINGS



Designing crossings between a pathway and a roadway involves a number of variables, including anticipated mix and volume of path users, the speed and volume of motor vehicle traffic on the roadway being crossed, the configuration of the road, the amount of sight distance that can be achieved at the crossing location, and other factors. Geometric design features and traffic controls must be used in combination to achieve safe and efficient accommodations for all users.

The design approach for the intersection of a shared use path with a roadway is similar to the design approach used for the intersection of two roadways in the following ways:

- The intersection should be conspicuous to both road users and path users.
- The sight lines should be maintained to meet the requirements of the traffic control provided.
- The intersections and approaches should be on relatively flat grades.
- The intersections should be as close to a right angle as possible, given the existing conditions.
- The least traffic control that is effective should be selected.

Shared use path crossings come in many configurations, with many variables: the number of roadway lanes to be crossed, divided or undivided roadways, number of approach legs, traffic speeds, traffic volumes, and traffic controls that range from uncontrolled to yield, stop or signal controlled. Each intersection is unique and requires engineering judgment to determine the appropriate intersection treatment. The safe and convenient passage of all modes through the intersection is the primary design objective.

Regardless of whether a pathway crosses a roadway at an existing roadway intersection, or at a new midblock location, the principles that apply to general pedestrian safety at crossings (controlled and uncontrolled) are transferable to pathway intersection design.

When trails cross roadways at intersections, the trail should generally be assigned the same traffic control as the parallel roadway (i.e., if the adjacent roadway has a green signal, the trail should also have a green/walk signal or if the parallel roadway is assigned the right-of-way with a stop or yield sign for the intersecting street, the path should also be given priority). At signalized intersections, if the parallel roadway has signals that are set to recall to green for every cycle, the pedestrian signal heads for the trail should generally be set to recall to "WALK". Countdown pedestrian signals should be installed at all signalized trail crossings as signal heads are replaced. As required by the Ohio Manual of Uniform Traffic Control Devices (OMUTCD), the walk signal for any trail shall not conflict with a protected left- or right-turn interval.

Consideration should be given to providing a leading pedestrian interval at trail crossings (i.e., three seconds of green/walk signal time are given to trail users before any potentially-conflicting motor vehicle movements are given a green signal). This allows pedestrians and bicyclists to have a head start into the roadway to become more visible to turning traffic.

Where the signals for the parallel roadway are actuated, the trail crossing will also need to be actuated. For trail crossings, the minimum WALK interval may be 9-12 seconds to accommodate increased flow. The USE PED SIGNAL sign may be used at trail crossings at signalized intersections. Pedestrian pushbuttons should be located within easy reach of both pedestrians and bicyclists, who should not have to dismount to reach the pushbutton.

An advance loop detector within 100 feet of the intersection should be considered, so bicyclists can approach the intersection slowly but without having to stop.

If trails cross at intersections with all way stops, stop signs should be placed at each trail approach. Consideration should be given to removing stop signs for the trail and the parallel roadway leaving the intersection two-way stop controlled for the intersecting roadway. An engineering study should be conducted before removing or adding any stop signs. At intersections with STOP signs controlling only one of the approaches, the trail should be assigned the same right-of-way as the parallel street. Stop signs should not be placed on the trail approaches to the intersecting roadway if the parallel street has no stop signs. If the two streets have the same roadway classification, and the stop signs face the intersecting street that is parallel to the trail, consideration should be given to reversing the stop sign placement, giving the right-of-way to the trail and the parallel street. An engineering study should be conducted before reversing the stop sign placement.

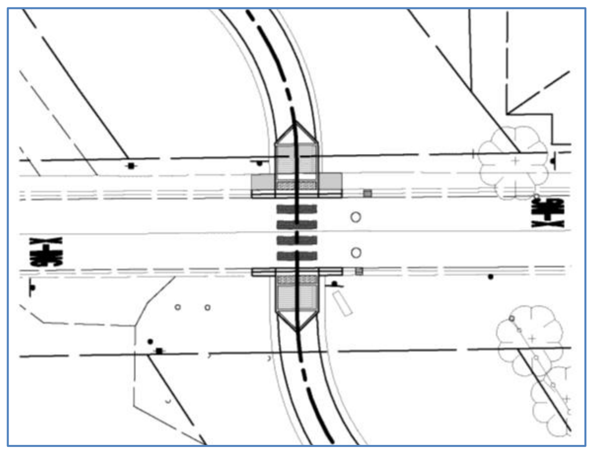
The decision of whether to use a traffic signal at a trail midblock crossing should be primarily based on the latest version of the OMUTCD Pedestrian Signal Warrants.

At trail midblock crossings, all trail users (including bicyclists) should be included in calculating the "pedestrian volume" for the warrant procedure. When a trail crossing meets the warrants, there may be other reasons why a signal is not necessary at the crossing. Where a decision has been made not to install a traffic signal at a mid-block trail crossing, STOP signs should be used to assign the right-of-way to the trail or the roadway. These signs are intended to remind cyclists and pedestrians to stop and look before crossing because although these locations are marked crosswalks, trail users should exercise caution before crossing. To minimize driver confusion, these stop signs should be installed such that they are not visible by drivers on the intersecting street. If the signs are visible to drivers, it may lead them to interpret that they have the right-of-way and do not need to stop for trail users.

The assignment of priority at a shared-use path/roadway intersection should be assigned with consideration of the following:

- The relative importance of the trail and the roadway.
- The relative volumes of trail and roadway traffic.
- The relative speeds of trail and roadway users.

TRAIL MIDBLOCK CROSSINGS



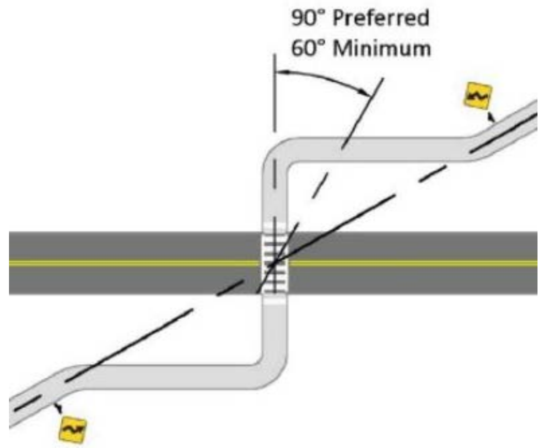
Trail midblock crossings are the most straight forward type of the three configurations. Midblock crossings should be far enough away from existing intersections between roadways to be clearly separate from the activity that occurs as motorists approach these intersections (such as merging movements, acceleration & deceleration or preparations to enter turn lanes). There are many other variables to consider when designing this type of intersection, including right-of-way assignment, traffic control devices, sight distance for bicyclists and motor vehicle operators, refuge island use, access control, and pavement marking.

The following should be considered for trail midblock crossings:

- The path should intersect the road at a 90 degree crossing angle when possible.
- The path width should be increased at intersections to reduce user conflicts, such as stopping and grouping of cyclists.
- The trail should meet the road at the same elevation with sufficient landing areas for the user.
- Roadway signage should be provided to alert motorists of the crossing in accordance with the OMUTCD.
- The crosswalk needs to be visible to increase awareness. The visible crosswalk should be delineated in accordance with the OMUTCD.
- Detectable warnings should be provided at all crossings.
- The intersection should be signed to indicate whether a path user or the motorist has the right of way at the crossing.
- Intersection lighting may be needed to add to the safety of the crossing.
- Higher volume streets, such as arterials and collectors, may warrant a grade separated crossing.
- Engineering judgement and warrants in the OMUTCD are to be used to decide if signalization is required.

CROSSING ANGLES

It is preferable for the shared-use path crossing to intersect the roadway at an angle as close to perpendicular as practical, so as to minimize the exposure of the crossing path users and maximize sight lines. A crossing skewed at 30 degrees is twice as long as a perpendicular crossing, doubling the exposure of path users to approaching vehicles, and increasing delays for motorists who must wait for path users to cross. Retrofitting skewed path crossings can reduce the roadway exposure for path users. If the preferred 90 degree crossing angle is not practical, a minimum 60 degree crossing angle may be acceptable to minimize adverse impacts and to minimize right-of-way requirements.



CROSSWALK WIDTH

A crosswalk is usually marked the same width as the shared-use path leading to it but never less than 6 feet wide. General guidance on crosswalk marking is provided in the OMUTCD.

CROSSWALK MEDIANS

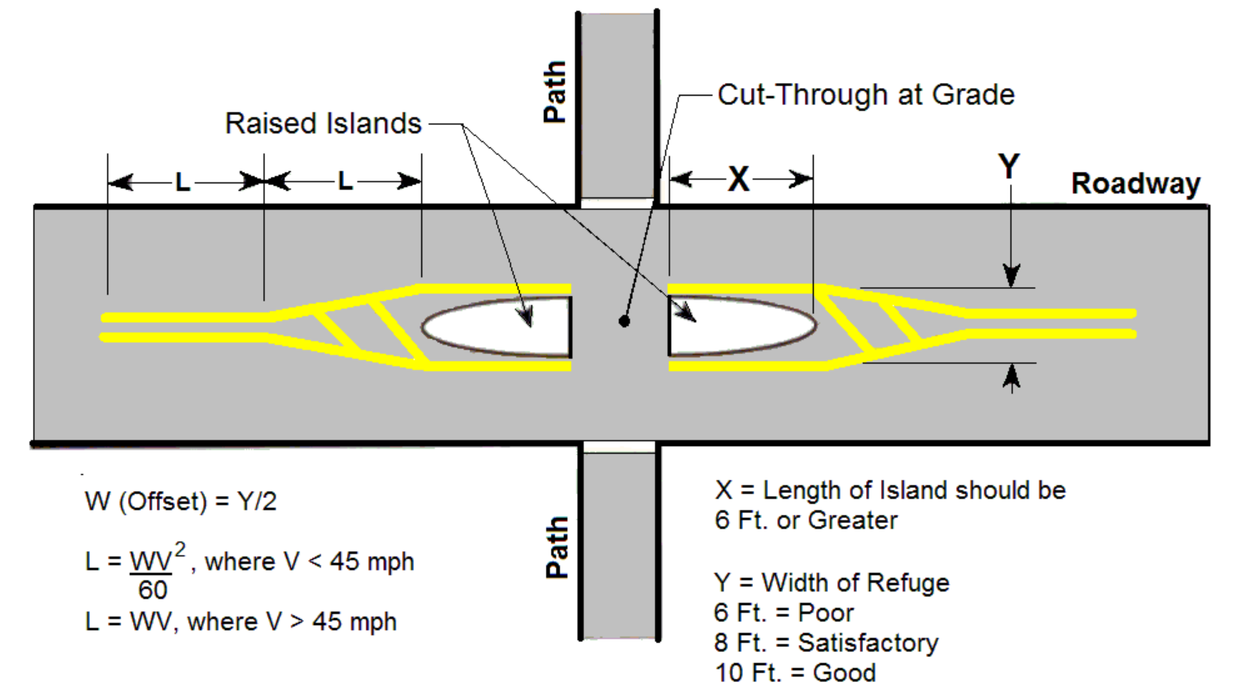
A crosswalk median separates conflicts in time and place. The pedestrian faced with one or more lanes of traffic in each direction must determine a safe gap in two, four, or even six lanes at a time. This is a complex task requiring accurate decisions. Younger and older pedestrians have reduced gap acceptance skills compared with pedestrians in other age groups. Pedestrians also typically have poor gap assessment skills at night. Many may predict that a car is 200 away when, in fact, it is only 100 feet away, far too close to attempt a crossing.

Medians allow for more frequent gaps. Not only do medians separate conflicts, but they also create the potential for acceptable gaps. On a standard–width, four–lane roadway with a center left–turn lane 64 feet wide, with five 12 feet lanes plus two 24 inch gutter pans, it takes an average pedestrian traveling 4 feet/sec nearly 16 seconds to cross. Finding a safe 16–second gap in four moving lanes of traffic may be difficult or impossible. In any event, an attempt to cross may require a wait of 3–5 minutes. Faced with such a substantial delay, many pedestrians select a less adequate gap, run across the roadway, or stand in the center left–turn lane in hope of an additional gap. If a raised median is placed in the center, the pedestrian now crosses 26 feet instead. This requires two 8–second gaps. These shorter gaps come more frequently. Based on traffic volume and the platooning effects from downstream signalization, the pedestrian may be able to find an acceptable gap in a minute or less.

REFUGE ISLAND

A refuge island should be considered if any of the following apply:

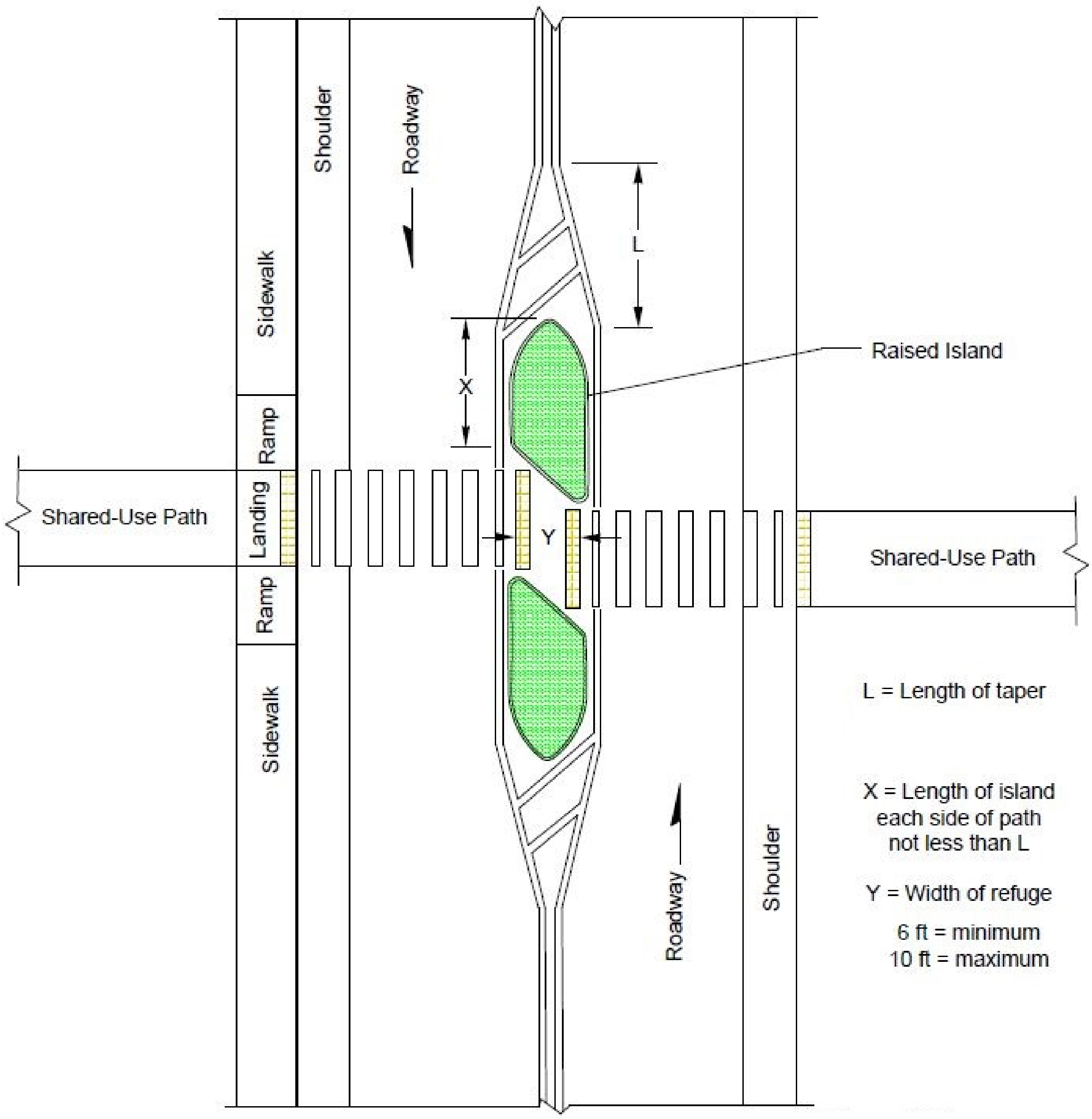
- A high roadway traffic volume or speed creates unacceptable conditions for the path user;
- The roadway is wider than 75 feet, or a pedestrian walking at 2.5 feet/sec. cannot completely cross the street during the green traffic-signal phase;
- A mid-block shared-use-path crossing or a path-roadway intersection is located where there are limited gaps in traffic (based on gap study);
- The crossing will be used by a number of people who cross relatively slowly, such as the elderly schoolchildren, persons with disabilities, etc.



REFUGE LAYOUT AREA

MEDIAN REFUGE CROSSWALK OFFSET

A midblock crossing with a median refuge allows the pedestrian to look for gaps in only one direction at a time. Offsetting the crosswalk at the median in the direction that a pedestrian needs to look encourages the pedestrian to stop and look in the correct direction. A midblock crossing without a median refuge requires the pedestrian to look for gaps in both directions as once.

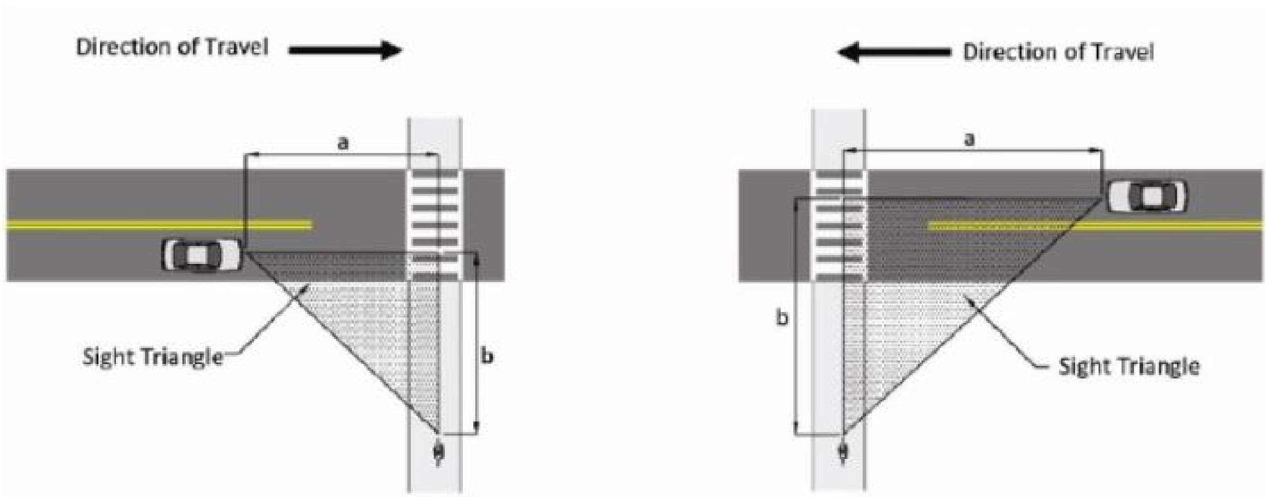


CROSSING APPROACH SIGHT TRIANGLES

APPROACH SIGHT TRIANGLES (PATH – ROADWAY)

Approach sight triangles needed for yield control depend on the design speeds of both the path and the roadway. If yield control is to be used for either the roadway approach or the path approach, available sight distance should be adequate for a traveler on either approach to slow, stop, and avoid a traveler on the other approach.

The roadway leg of the sight triangle is based on the bicyclist's ability to reach and cross the roadway if they don't see a potentially conflicting vehicle approaching on the roadway, and have just passed the point where they can execute a stop without entering the intersection.

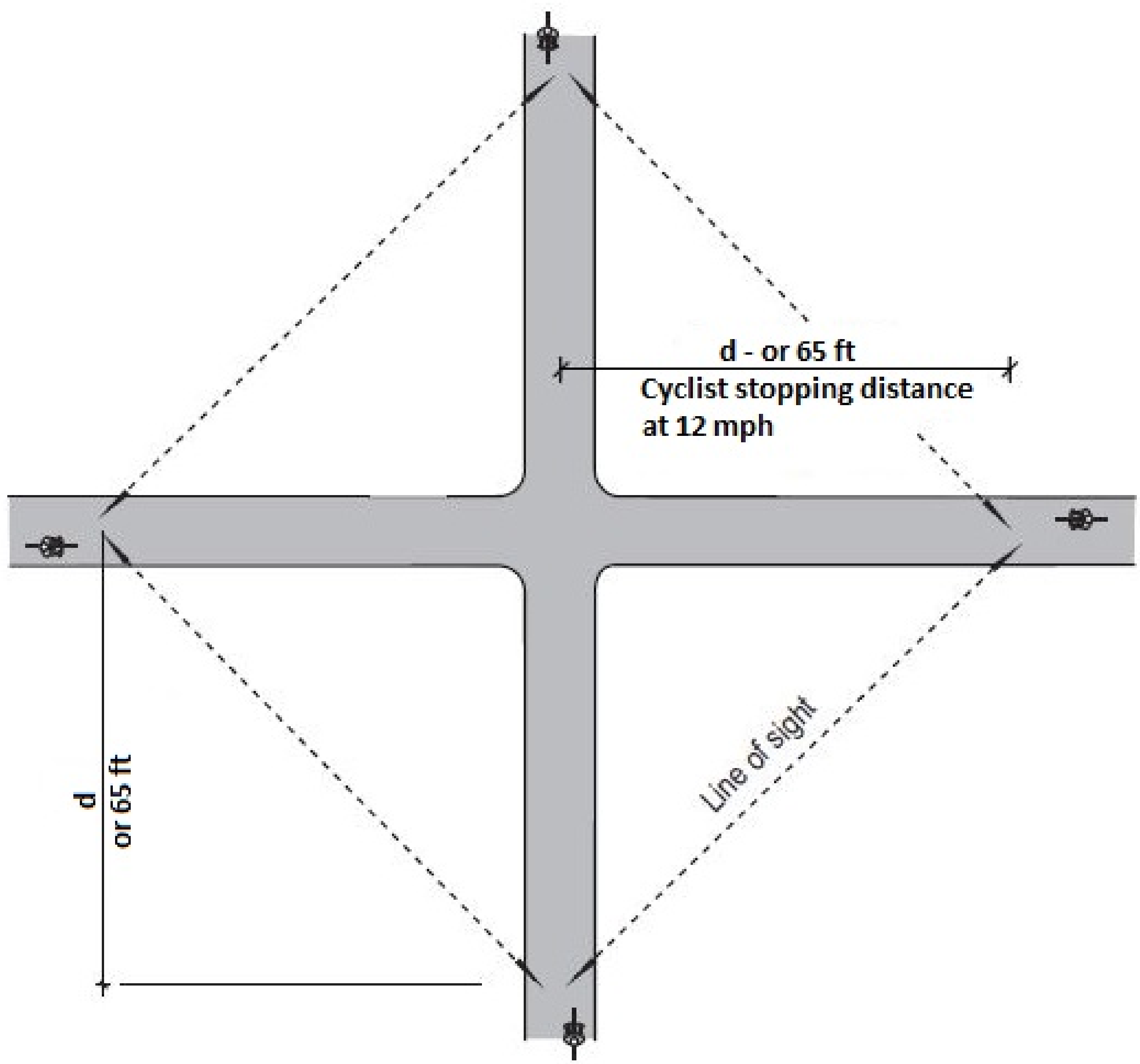


For approach sight triangle criteria, refer to AASHTO (American Association of State Highway and Transportation Officials), Guide for the Development of Bicycle Facilities 4Th Edition, (Washington, D.C.: AASHTO, 2012).

APPROACH SIGHT TRIANGLES (PATH – PATH)

Bicyclists tend to slow their speeds as they approach intersections, thus a design speed for path intersections of 12 mph is acceptable. The minimum intersection radius along paths should be 10 to 20 feet, depending on the maintenance equipment used and the overall widths of the paths.

Intersections between two shared-use paths do not usually include a stop sign. Bicyclists must rely on sufficient sight-distance at path/path intersections to see other users with sufficient reaction time to avoid a collision. The following illustrates how the line of sight relates to stopping sight distance “d” at path/path intersections.



(a) FOUR-WAY PATH INTERSECTION

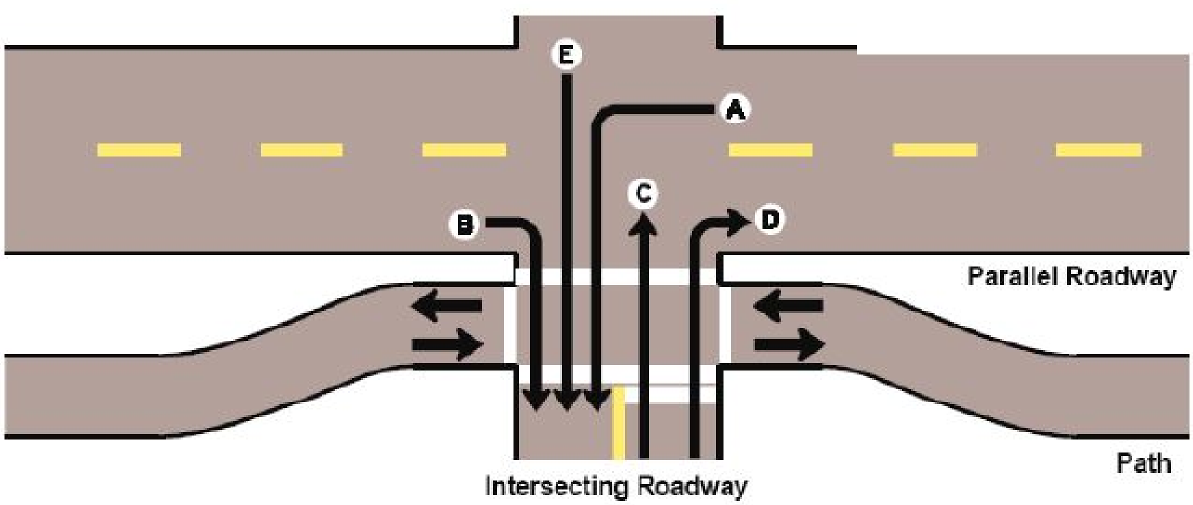
Acceptable design stopping sight distance may vary depending upon design speed, approach grade and user mix as described in the following paragraphs:

- Where a path is used for trips to school, or if a large number of users will be children, seniors or disabled people, or if the intersection is heavily used in general, design the lines of sight to allow a stopping sight distance of 65 feet, and limit downhill grades to 2 percent or less on the paths approaching the intersection. Under these conditions, braking will be smooth and path safety will be good.
- Under many conditions, where the user mix does not include those listed above, sight lines allowing a stopping sight distance of 50 feet will be satisfactory, with downhill grades less than 4 percent on paths approaching the intersection, but bicyclists may have to brake sharply to avoid collisions.
- Under restrictive conditions, where topography or other features are beyond the control of the designer, sight lines allowing at least 33 feet stopping sight distance may be used with signage and pavement markings warning bicyclists to slow before the intersection. Where downhill grades exceed 4 percent on paths approaching the intersection, stopping sight lines should be increased and signage and pavement markings used to warn bicyclists of the approaching intersection.

If practical, increase the stopping sight-distance where there is a downhill approach to an intersection. When the grade of a path is greater than 4 percent at the approach to a path/path intersection, increase the sight distance by 15 to 35 feet, depending on the grades and length of the gradient. If the path slopes steeply toward a 4-legged intersection, consider dividing the crossing point into two T-intersections.

Adjacent Path Crossing:

Adjacent path crossings occurs where a path crosses a roadway at an existing intersection between two roadways, whether it is a T-intersection (including driveways) or a simple four-legged intersection. It is preferable that this type of crossing be carefully integrated close to the intersection so as to allow motorists and path users alike to recognize each other as intersection traffic. With this configuration, the path user is faced with potential conflicts with motor vehicles turning left (A) and right (B) from the parallel roadway, and on the crossed roadway (C, D, and E).

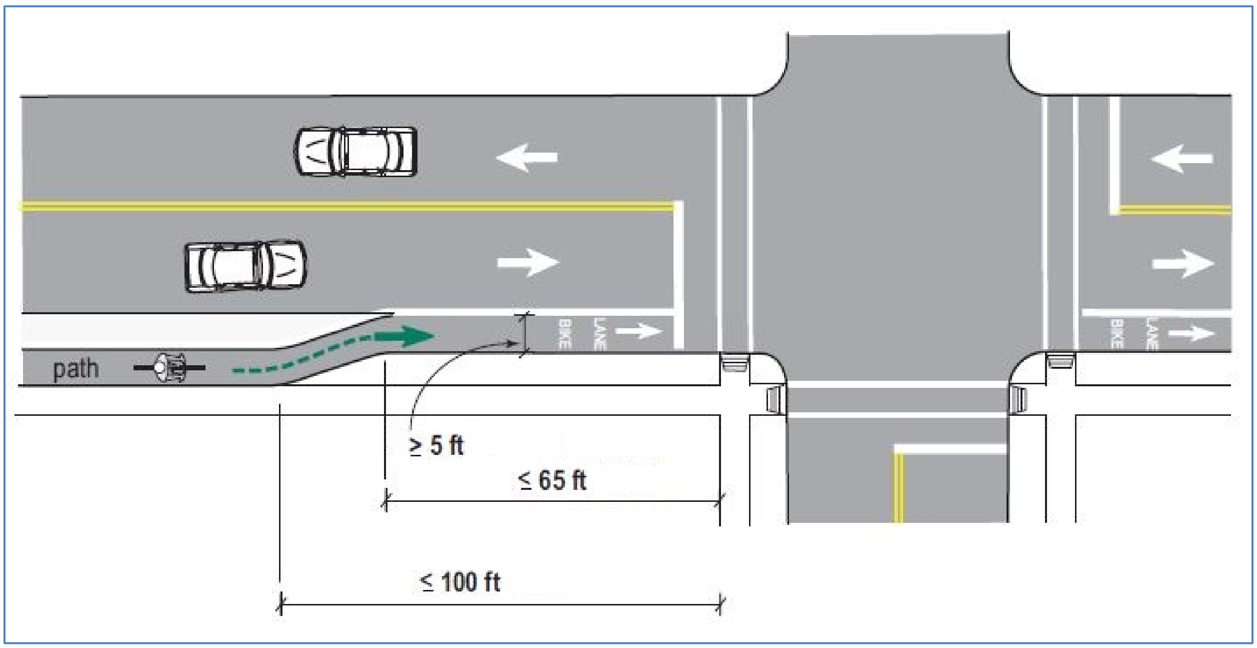


The major road may be either the parallel or crossed roadway. Right-of-way assignment, traffic control devices, and separation distance between the roadway and path are also important variables which greatly affect the design of this intersection. Further complicating the situation is the possibility of the conflicts being unexpected by both path users and motorists. Clear sight lines across corners are especially important.

In a Type A turning movement, it may be advisable to prohibit permissive left turns on a high-volume parallel roadway and high-use path crossings. For turning movement Type B, as small as practical corner turning radius may be required to reduce the speeds of motor vehicles. For type C and D movements, it may be advisable to prohibit right-turns-on red and place a stop bar in advance of the path crossing. To account for vehicle movement E, it may require an all-red phase to protect the path users.

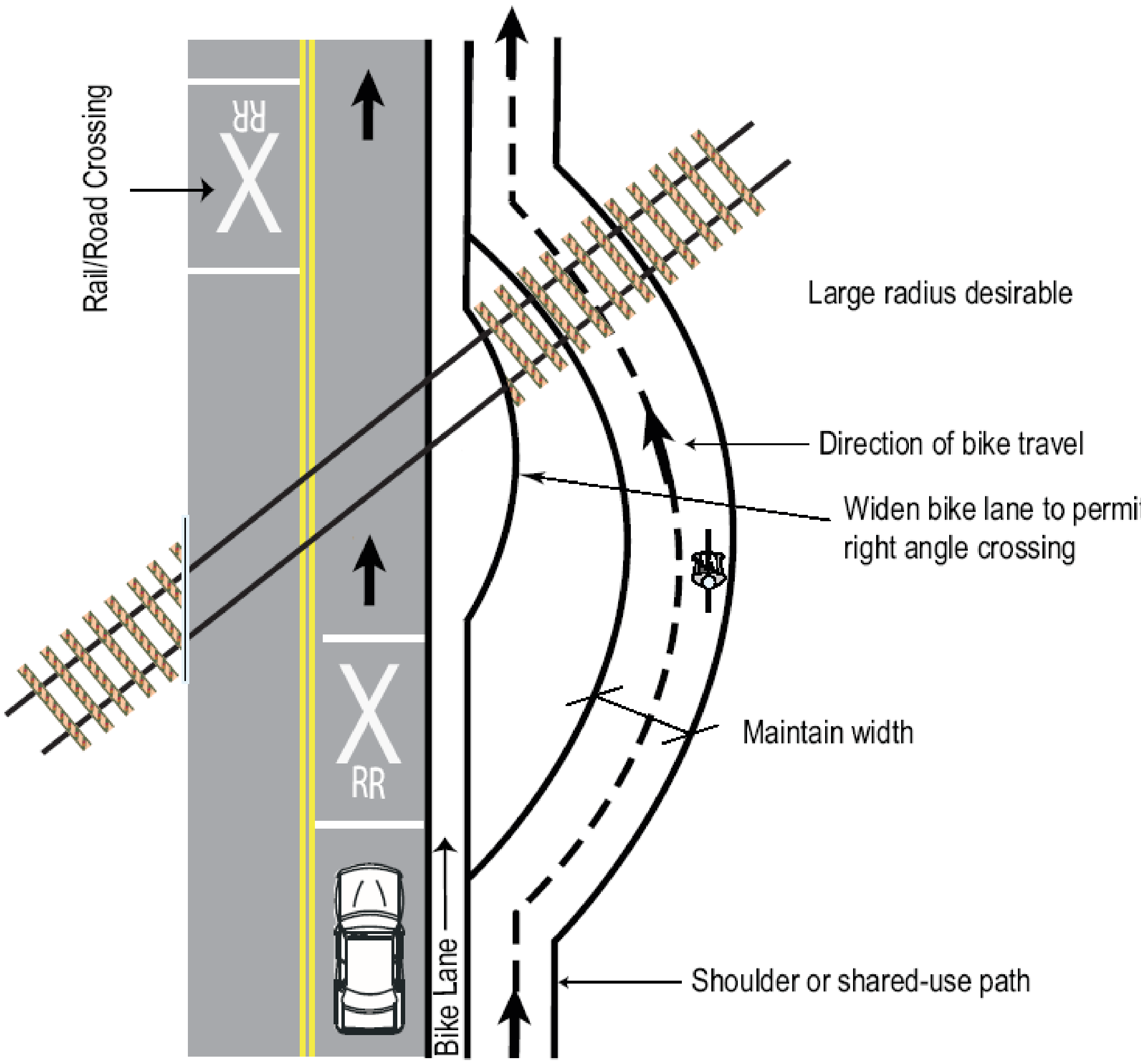
One-Way Path at Signalized Intersections:

One-way paths have the advantage of increased visibility and safety at signalized intersections. Where there are substantial numbers of right-turning motorists and through bicyclists, the one-way path intersection design should be considered. End the one-way path 65 to 100 feet before the intersection and let bicyclists continue on a bicycle lane in the roadway.



CROSSING RAILROADS AT-GRADE

Bicyclists require a smooth riding surface and adequate warning devices at all at-grade railroad crossings. It is important that the railroad crossing be designed to allow bicycles to safely cross the tracks as close to 90 degrees to the tracks as possible. This minimizes the possibility of a bicyclist's wheels being trapped in the rail flangeway, causing loss of control. Where this is not feasible, the shoulder (or wide outside lane) should be widened, or "blistered out" to permit bicyclists to cross at the tracks at a right angle.

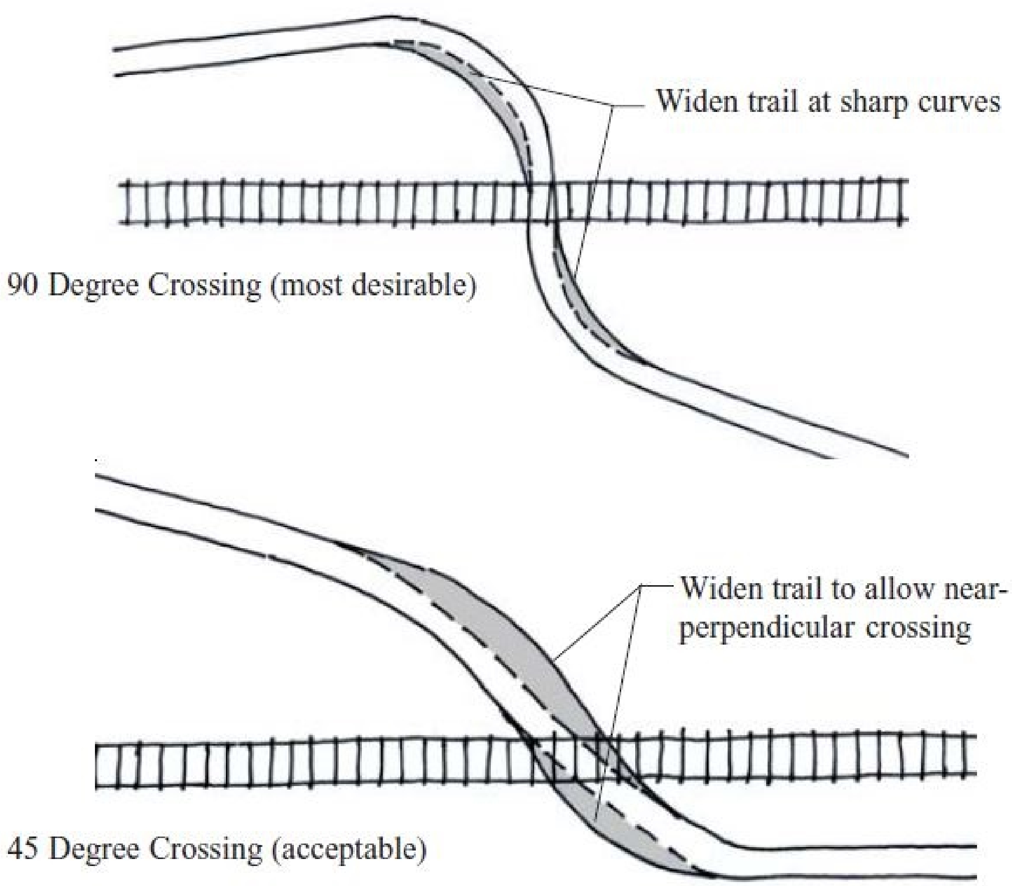


Concrete or rubberized crossings are recommended for crossings along bicycle routes to minimize the possibility of a bicycle tire getting stuck. Pavement surface adjacent to the rail should be at the same elevation as the rail. Pavement should be maintained so that ridge build-up does not occur next to the rails. Other options to provide a smooth grade crossing include: removal of abandoned tracks; use of compressible flangeway fillers, timber plank crossings, or rubber grade crossing systems. These improvements should be included in any project which offers the opportunity to do so.

Railroad tracks usually require careful attention from a cyclist due to the rough pavement surface usually surrounding a grade crossing, the gaps between the pavement and track, and the slippery surface of the steel track itself. When the track crosses the road at anything other than a right angle, the hazard is multiplied, as the flange opening of the crossing can easily “capture” the front wheel of the bicycle resulting in an immediate crash. This situation also applies to expansion joints on roadway/path bridges.

Bicyclists will often adjust their paths of travel to cross such tracks at right angles. However, when there is a lack of adequate shoulder space to accommodate this maneuver, a bicyclist may well complete the maneuver in the path of oncoming or following traffic.

When it is not possible to cross at 90 degrees, the path should be widened (at least as wide as the approach bikeway) to allow the bicyclist to cross as close to 90 degrees as possible. Special construction and materials should be considered to keep the flangeway (open space next to the rail) depth and width to a minimum. Pavement should be maintained so ridge buildup does not occur next to the rails. Timber plank crossings may be used, but tend to be slippery when wet.



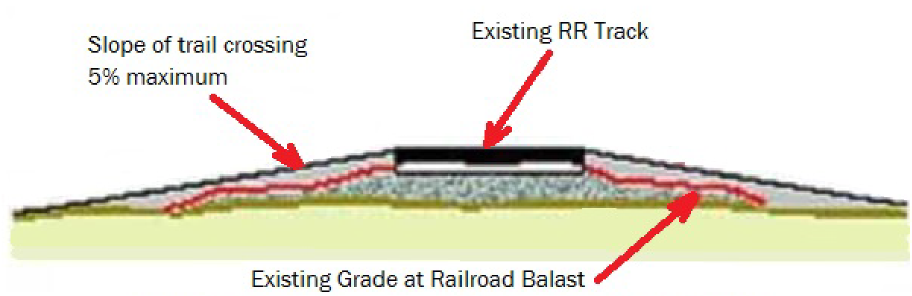
Railroad Crossing Layouts

The angle of crossing is a critical issue, particularly for bicyclists and people with disabilities. The AASHTO Bike Guide makes the following statement with respect to the crossing angle of a bikeway at a railroad track: "Railroad-highway grade crossings should ideally be at a right angle to the rails. The greater the crossing deviates from this ideal crossing angle, the greater is the potential for a bicyclist's front wheel to be trapped in the flangeway, causing loss of steering control. If the crossing angle is less than approximately 45 degrees, an additional paved shoulder of sufficient width should be provided to permit the bicyclist to cross the track at a safer angle, preferably perpendicularly."

Flangeway is the term used for the space between the rail and the pavement edge. The standard flangeway width for commuter and transit railroad crossings is 2.5 inches and 3 inches for freight railroads. These widths are greater than many bicycle tires and wheelchair casters. For this reason, acute angle crossings are not recommended. Also, according to the AASHTO Bike Guide, where active warning devices are not used to indicate an approaching train, the trail should cross the railroad at or nearly at right angles and where the track is straight. Where the track is not straight (e.g., on a curve), complications exist: sight distance is restricted and the rails may be at different levels.

Appropriate signs and pavement markings should be installed to inform and warn bicyclists at all at-grade railroad crossings. Installing signs and signals with bells should be considered at a path crossing.

The AASHTO Bike Guide and ADA accessibility guidelines specify grade requirements for shared use paths. Trail grades over 5 percent are allowed for short distances in specific circumstances. Grades over five percent are not recommended for crossing approaches. In general, the trail approach should be at the same elevation as the track. Steep grades on either side of the track can cause bicyclists to lose control, may distract trail users from the conditions at the crossing, and may block sight lines.



APPROACH GRADE AT AT-GRADE RAILROAD CROSSINGS

Existing at-grade railroad crossings typically have some sort of passive warning devices -- railroad "crossbucks" or railroad crossing signs. A railroad crossbuck and warning signage is needed in accordance with the OMUTCD is required at all railroad crossings. Some at-grade crossings may have a stop sign at the crossbuck or signal and gate arms are often installed at busier intersections. All grade-separated railroad crossings should be wide enough to allow for a bicycle facility along a street right-of-way.

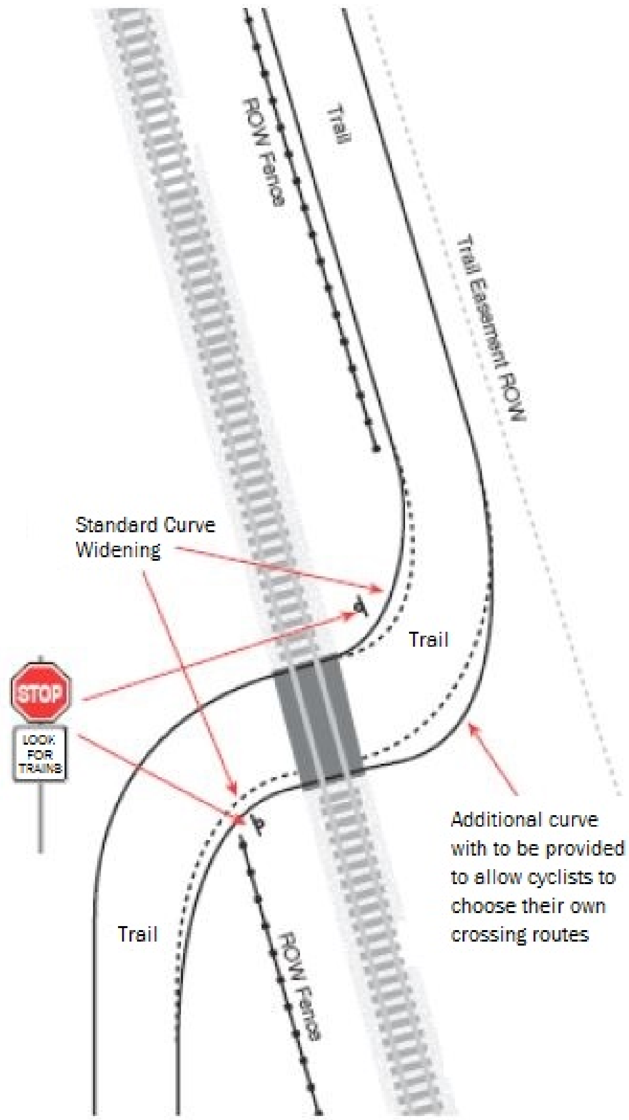
RAILROAD SEPARATION

Most railroad companies require trails to provide fencing. Some railroad companies specify a requirement of 6 feet high fencing, no matter what the setback distance is. Fencing may not be required where a significant deterrent to trespass is provided or exists. Examples include water bodies, severe grade differentials, or dense vegetation. Other barrier types such as vegetation, ditches, or berms are often used to provide separation, especially where a trail is located farther than 25 feet from the edge of the trail to the centerline of the closest track, or where the vertical separation is greater than 10 feet. In constrained areas, using a combination of separation techniques may allow narrower acceptable setback distances.

ADJACENT TRAIL RAILROAD CROSSINGS

Trail-rail grade crossings should reduce illegal track crossings by channelizing users to safer crossing areas. Crossings must not be located where trains may be regularly stopped, since this would encourage trail users to cross between or under railroad cars -- an extremely dangerous and unacceptable movement. Crossings should not be located on railroad curves where sight lines are poor. When new at-grade crossings are not permitted, the crossing design will need to channelize users to cross the tracks at roadway locations or develop a grade-separated crossing.

Adequate sight distance is particularly important at trail-rail intersections that do not have active warning devices such as flashing lights or automatic gates. Bicyclists, pedestrians, and other trail users should be given sufficient time to detect the presence of an approaching train and either stop or clear the intersection before the train arrives.



OTHER TRAIL CROSSING SITUATIONS

CROSSING DRIVEWAYS

At unpaved highway or driveway crossings of shared-use paths, the highway or driveway should be paved a minimum of 10 feet on each side of the crossing to reduce the amount of gravel being scattered along the path by motor vehicles. The pavement structure at the crossing should be adequate to sustain the expected loading at that location. In areas where climates are extreme, the effects of freeze-thaw cycles should be anticipated.

AGRICULTURAL CROSSINGS

Agricultural crossings present a frequent trail crossing situation. These would generally be described as a trail intersection with a gravel or dirt farm lane. Both gravel and dirt present potentially unstable conditions, particularly for the wheeled trail user. The following recommendations should be considered in designing these crossings:

- Cross as nearly to 90 degrees as possible.
- Cross at a similar elevation with level landing areas on each side of the crossing.
- Provide a stable surface with good traction in varying weather conditions. Since farm lanes are used by heavy equipment a stable surface is an important criterion.
- Maintenance of these crossings is important to prevent deterioration from use and adverse weather.
- Provide signs to alert the user to the crossing.

TRAILS ADJACENT TO FARMLAND

While productive agricultural land can be a scenic amenity for trail users, it is important to understand the value of that land to its owner. For trails that pass adjacent to active agricultural land, especially on abandoned railroad corridors, it is important to communicate with adjacent landowners during the trail planning process. Landowners' issues may include the need for trail crossings for farm machinery or animals, liability concerns, and concerns about vandalism and littering. The following guidelines describe methods for increasing a trail's compatibility with farmland.

- Work with adjacent landowners from the beginning of the trail planning process.
- Where necessary, provide agricultural access across the trail for adjacent landowners.
- Where necessary, install a vegetative buffer or fence between the trail and adjacent property.
- Respect local setback requirements for adjacent commercial, industrial, and residential property.

TRAILS CROSSING TRAILS

Intersections of two trails present situations that can be alleviated by the following means:

- Crossings should be offset to create three-way intersections instead of four-way.
- The trails should intersect at 90 degree angles.
- The trails should have minimum grade approaches with stable, smooth surfaces.
- Signs should be provided to indicate direction, distance and user right of way.
- Signage needs to be in a format applicable to the impairment of the potential user.
- Provide good sight distance and visibility for safety and security.

CROSSING STREAMS

Stream crossings by a trail should be kept to a minimum. When streams must be crossed there are several methods to consider. Smaller streams may be crossed by a single culvert, a series of side by side culverts, or a bridge and larger stream crossings should be accommodated by a bridge.

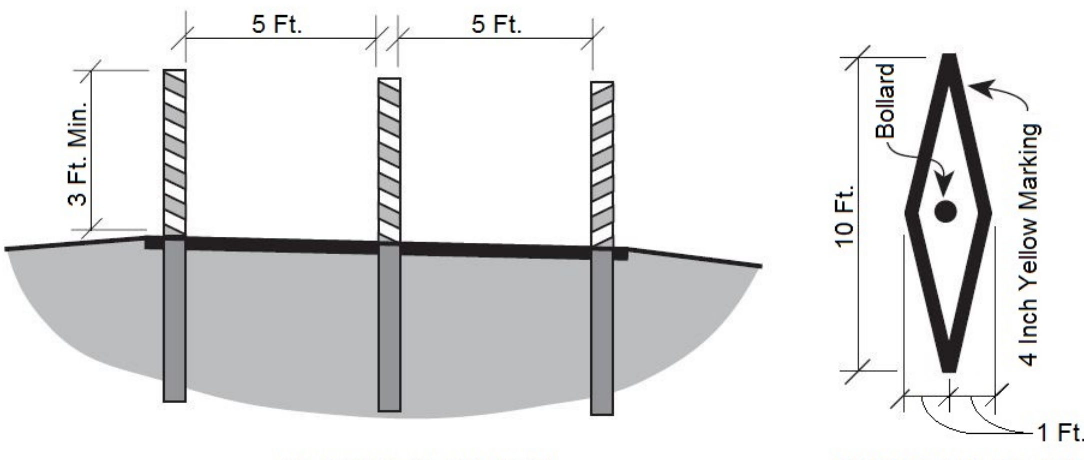
Durability and maintenance costs are factors to be weighed with each culvert option. Consideration should also be given to accommodate the passage of fish through the culvert. Blockage of fish routes is detrimental to their feeding, mating and protective habitat. Stream crossings must be designed per current county, state and federal regulations. The design will be reviewed and approved by the pertinent agencies prior to release of construction permits.

TRAFFIC BARRIERS FOR TRAILS

Bicycle paths often need some form of physical barrier at highway intersections to prevent unauthorized motor vehicles from using the facilities. At the same time, the traffic barrier should be designed to minimize the danger it poses for bicyclists and to allow the passage of emergency or maintenance vehicles. For this reason, proper materials, adequate design, good visibility, and appropriate location are critical. While it is possible to restrict automobile and truck access, eliminating motorcycle access is very difficult. Barriers that can keep motorcycles out may make bicycle access difficult and potentially dangerous as well. At entrances to private driveways, motor vehicle barriers are less important than they are at highways. However, if a particular driveway is found to be a significant entry point for motorists, barriers should be considered there as well.

Lockable, removable bollards at path entrances will allow entry of authorized vehicles. Bollards should be at least 3 feet high, permanently reflectorized for nighttime visibility and painted a bright color for improved daytime visibility. Their surface should be smooth and free of protrusions to prevent snagging a bicyclist's clothing or equipment.

To allow appropriate clearances, a 5 feet spacing between bollards should be used. Wider spacing can allow entry to motor vehicles, while narrower spacing might prevent entry by adult tricycles and bicycles with trailers or present a hazard for less proficient bicyclists. On a 10 feet path, the paving should be flared slightly and one bollard located near both edge and one bollard in the middle. A wider path will require more bollards, again spaced at 5 feet.

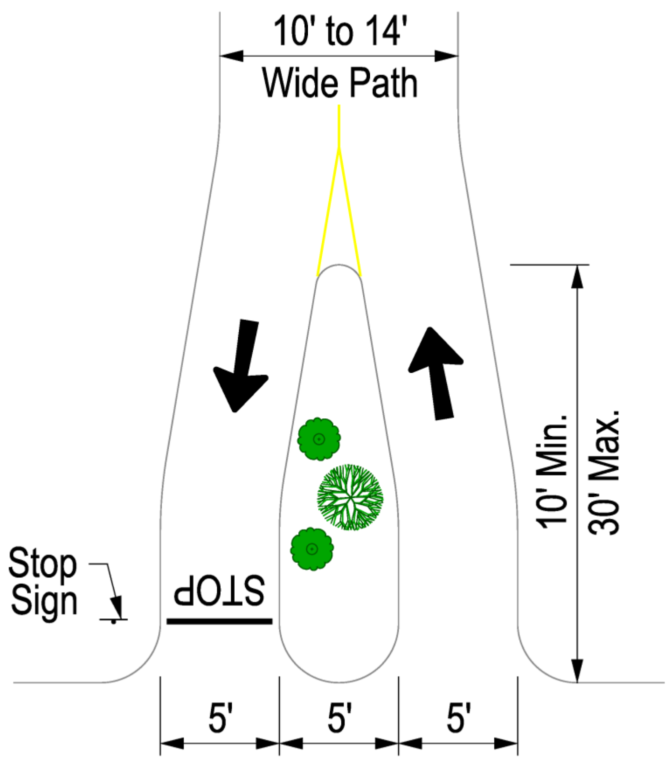


Reflectorized bollards used to keep motor vehicles off bicycle paths with pavement markings.

The barrier should be installed in a highly visible location with adequate sight distance from either direction. Lighting may be considered if the location has inadequate street lighting to illuminate the barrier. Marking an envelope around the barrier is recommended. If sight distance is limited, special advance warning signs or painted pavement markings should be provided. It is best to locate the barrier 30 feet from the intersection to allow bicyclists to pay full attention to traffic once they reach the crossing and to remove the barrier from the motorist's clear recovery zone.

An alternative method of restricting entry of motor vehicles is to split the entry way for the last 10 feet or 30 feet before the intersection into two 5 feet sections that enter the intersection approximately 5 feet apart. The sections may be separated and surrounded by low landscaping. Emergency vehicles can still enter if necessary by straddling the landscaping. The higher maintenance costs associated with landscaping should be acknowledged, however, before this alternative method is selected.

Whether the bollard or split entry method is used, pavement markings and signing may be used to warn bicyclists and direct them in the appropriate direction.



Supplemental considerations when designing bicycle path barriers (posts or bollards):

- At a minimum, provide stopping sight distance to bollards. An ideal location for bollard placement is in a relatively straight area of the path where the bollards placement has adequate stopping sight distance. Do not place bollards in difficult-to-see locations (for example, immediately upon entering a tunnel).
- For cases where multiple bollards are used longitudinally along the path, locate them at least 20 feet apart, with the first bollard in line from each direction having stopping sight distance.
- Use a contrasting striping pattern on the bollard.
- Use reflective materials on the bollard, such as a band at the top and at the base.
- Design all bollards along a corridor to be uniform in appearance. Frequent cyclists can become familiar with the bollards and recognize them easily.
- Provide pavement markings in accordance with standard design practices and the OMUTCD at all bollards on paved paths.
- Use removable bollards to permit access by emergency and service vehicles.
- Non-removable bollards may be used where access is not needed.
- Bollards placed near roadways need to be breakable or placed beyond clear zone. The may also need to be breakable for emergency vehicles.

MOPEDS

It is undesirable to mix mopeds and bicycles on the same facility because of the higher operating speeds of mopeds, the additional maneuvering requirements of mopeds, and the increased frequency of passing maneuvers. The design guidelines for bicycles facilities are inadequate for moped use.

NEIGHBORHOOD ACCESSWAYS

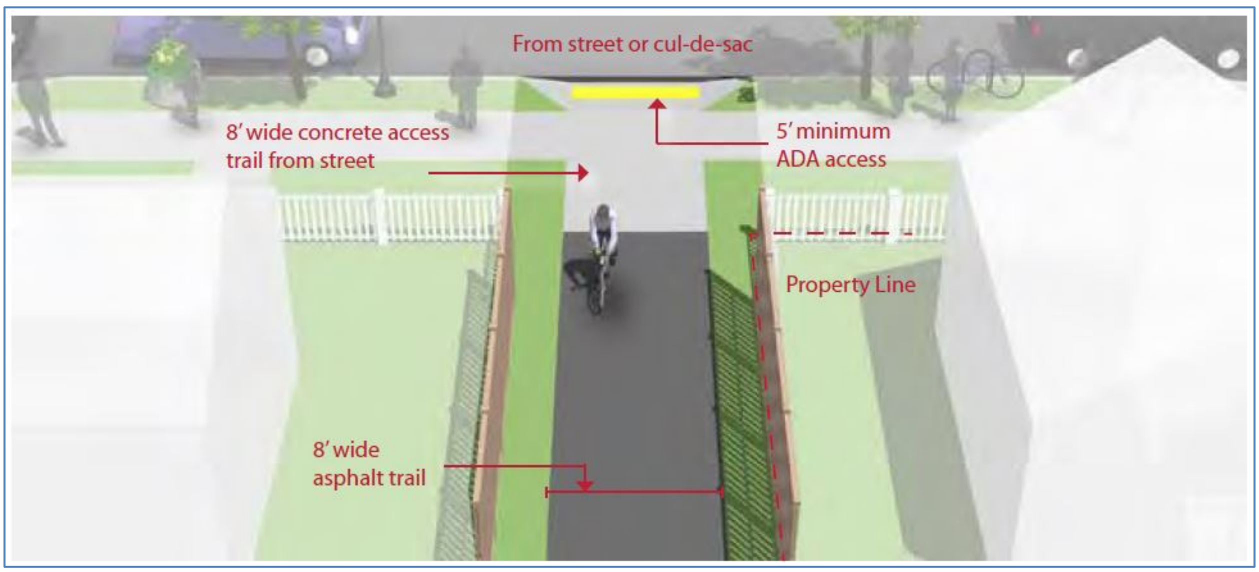
Neighborhood accessways provide residential areas with direct bicycle and pedestrian access to parks, trails, greenspaces, and other recreational areas. They most often serve as small trail connections to and from the larger trail network, typically having their own rights-of-way and easements. Additionally, these smaller trails can be used to provide bicycle and pedestrian connections between dead-end streets, cul-de-sacs, and access to nearby destinations not provided by the street network.

The following is recommended for neighborhood accessways:

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

Neighborhood accessways should be designed into new subdivisions at every opportunity and should be required by County or municipal subdivision regulations.

For existing subdivisions, neighborhood and homeowner association groups are encouraged to identify locations where such connects would be desirable. Nearby residents and adjacent property owners should be invited to provide landscape design input.



CHAPTER 8 – ENGINEERING DESIGN CRITERIA

DESIGN GUIDELINES FOR SHARED-USE PATHS

The purpose of these guidelines is to provide best practices for shared-use paths in facility planning and design that planners, engineers and designers should explore and consider when designing safe and functional facilities for their communities. These best practices are a compilation of shared-use path guidelines and standards from bicycle-friendly communities elsewhere; they are encouraged to be used locally where engineering judgment is applied.

Shared-use paths are a component of the Complete Streets concept, a component of the multi-modal transportation system and a valuable element of the bicycle transportation network. They serve a transportation and recreational function and have proven to be significant generators of bicycle use. Shared-use paths provide continuous routes for commuting or recreational trips, access to destinations not otherwise available to bicyclists, and provide connections where there are breaks in the street network. Shared-use paths are facilities on exclusive rights-of-way and with minimal cross-flow by motor vehicles. These facilities are most commonly designed for two-way travel and the guidance herein assumes a two-way facility unless otherwise stated.

There are some similarities between the design criteria for shared-use paths and highways (e.g., horizontal alignment, sight distance requirements, signing and markings). On the other hand, some criteria (e.g., horizontal and vertical clearance requirements, grades and pavement structure) are dictated by operating characteristics of bicycles that are substantially different from those of motor vehicles. The design of a shared-use path should take into account the likely speed of users, the ability of bicyclists to turn corners without falling over, skidding, or hitting their pedal on the ground as they lean over.

Shared-use paths are sometimes referred to as trails; however, in some other states and jurisdictions, the term trail means an unimproved recreational facility. Because of this distinction, shared use paths or "paths" will be used throughout this document as reference to this type of bikeway. However, since this document is a compilation of other agencies' guidelines and standards, the sources cited and quoted may use "paths" or "trails" interchangably.

The basic types of shared-use paths are: new alignments; rail-trails; rails-with-trails; and sidepaths. In actual use, these paths are interchangeably called bikeways, bike paths, paths, trails, rail-trails, bike-hike trails, bike/pedestrian ways, multiuse paths/trails, or greenways. Users of shared-use paths are nonmotorized and may include but are not limited to bicyclists, in-line skaters, roller skaters, wheelchair users (both motorized and non-motorized) and pedestrians, including walkers, runners, people with baby strollers, people walking dogs, etc. While many treatments represented here will also serve pedestrians, this document primarily focuses on shared-use paths as a facility for bicycle use.

Shared-use paths should be thought of as a complementary system of off-road transportation routes for bicyclists that serve as a necessary extension to the roadway network. Shared-use paths should not be used to preclude on-road use of bike lanes, wide outside lanes, paved shoulders and bicycle routes any more than freeways should be used to preclude a motorist's use of county roads, city streets or the state route network.

BICYCLE FACILITY TREATMENT DESIGN GUIDELINES

The bicycle facility implementation guidelines provided herein are intended to be applicable to the roadways that are designated to be part of designated bicycle routes. The designation of a roadway as a bikeway or bicycle route represents a proactive policy designed to encourage bicycling.

Designated roadways are roads on which bicycle use is anticipated and invited through the use of lane markings, signage, maps or tour guides. Designated bicycle facilities provide greater safety for less experienced or less confident riders. Designated roadways are located where encouragement of bicycle use is desired, based on consideration of traffic conditions, pavement width and geometrics, and appropriateness and directness of the particular route.

A roadway that is designated to be a bike route by signage is a preferred route for bicycle use. These are typically identified for advanced or experienced (Group A) bicyclists. However, basic bicycle riders will be interested in riding on bikeways which are designated facilities that encourage bicycle use. Thus, designated bike routes should be designed and developed to accommodate Group B users as much as practical.

Guidelines for selecting the appropriate design treatment are based on the principle variables affecting the applicability of a design treatment. The principle variables are the design bicyclist, the type of roadway project involved on the designated route, and the traffic operation factors. More information about the applicable factors can be found in the FHWA publication FHWA-RD-92-073 and current edition of the American Association of State Highway and Transportation Officials' Guide to the Development of Bicycle Facilities (AASHTO Guide).

The technical basis for the bicycle accommodations recommendations are based on the following:

<u>AASHTO Guide</u>

The 2012 Guide for the Development of Bicycle Facilities by the American Association of State Highway and Transportation Officials (AASHTO) forms the technical basis for the recommendations. All of the engineering design details should be taken from the AASHTO guide. The guidelines described by AASHTO are generally recognized by the industry – and the court system – as the standard for bicycle facility design.

<u>Ohio Manual for Uniform Traffic Control Devices (OMUTCD)</u>

The OMUTCD provides design guidance and examples.

BICYCLE DESIGN VEHICLE

The purpose of this bicycle design vehicle 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.

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

The bicycle is distinct from all other modes of transportation by being the smallest and lightest vehicle. To ensure the safety and comfort of bicyclists, the size of the vehicle must be taken into account, along with the amount of lateral and vertical clearance needed by a moving bicyclist.

All bicycles share certain standardized characteristics. The handlebars are the widest part of a bicycle. On a mountain bike or adult tricycle, the handlebars may be as much as 28 inches wide; on touring or city bicycles they typically are 16 to 24 inches wide. The minimum width that a stationary bicycle occupies is 24 inches. The height at the handlebars and saddle, for all but the child bicycles, range from 3 to 3.6 feet. This height is important in determining the placement of a rub rail. Refer to railing design criteria for rub rail requirements.

The tires on most bicycles range in width from ¾ of an inch to 2 inches with a contact surface of around 1/10 of an inch and wider. They often provide little traction. If the pavement is covered with sand or leaves or is wet, the bicycle has even less traction and needs more room to brake. This is one of several factors to consider when designing curves. The wheels on most bicycles range in diameter from 24 to 28 inches.

A bicyclist's design vertical height is 100 inches. Even a tall individual will not reach this height when seated on a bicycle, but it is essential to allow extra clearance for bicyclists pedaling upright or passing under an overpass. Bicyclists can and often do get up out of the saddle and stand on their pedals to accelerate and to increase their power climbing hills. Signage above a bicyclist should also allow for at least this amount of vertical clearance.

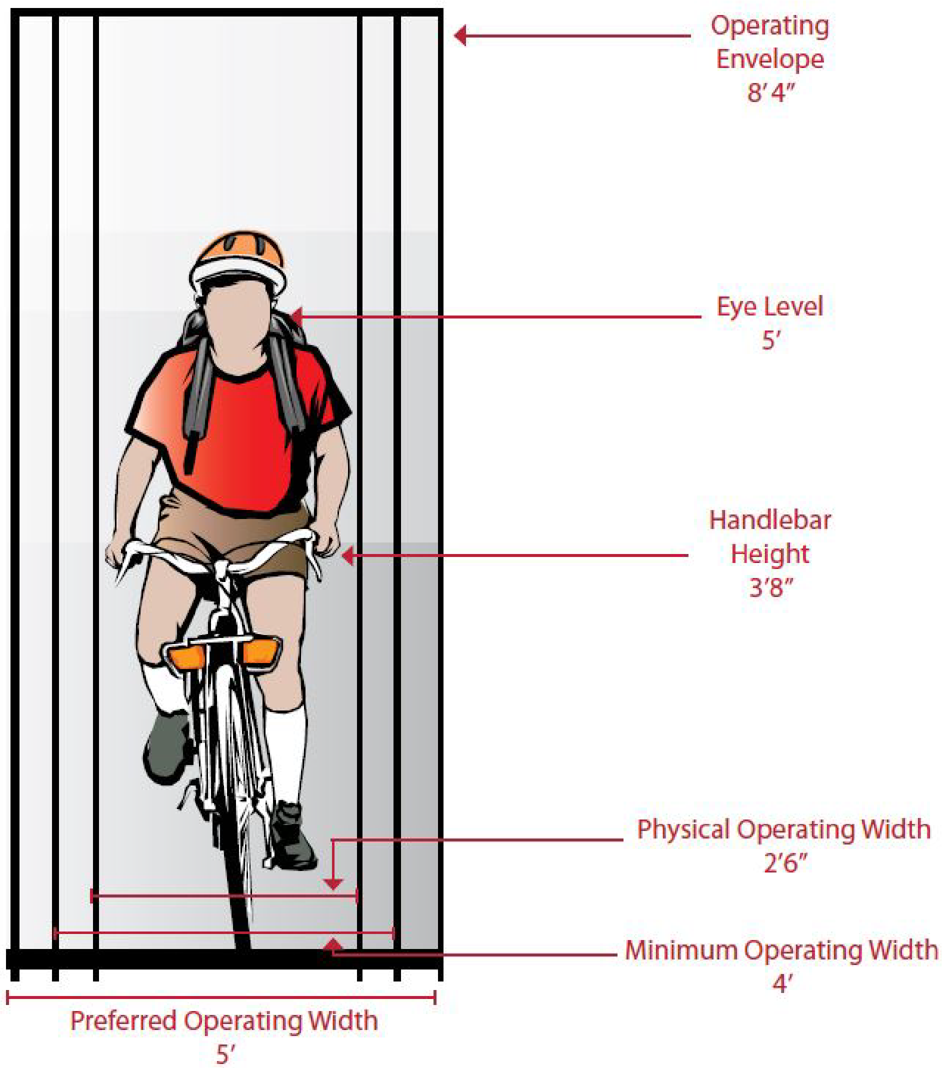
Under normal conditions, a moving bicyclist needs a corridor at least 40 inches wide in order to maintain balance when riding at low speeds or against crosswinds. To ride comfortably and avoid fixed objects (sidewalks, shrubs, potholes, signs, signals, etc.) and other users such as pedestrians and wheelchairs, a bicyclist needs an additional 10 inches of clearance on each side, bringing the basic width of a one-way corridor to 5 feet.

In enclosed areas, a space 10 feet wide is desirable for two opposing bicyclists to comfortably pass each other and react to unexpected maneuvers of other riders. An 8-foot wide facility is too narrow for two opposing bicyclists to comfortably pass each other.

Children, who weave more when riding than adults, need room to maneuver and could potentially crash when passing.

In an open area, bicyclists require less space. Open areas afford bicyclists more space for unexpected maneuvers. However, guidelines for federally funded paths require 10 feet with 2-foot shoulders on each side.

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

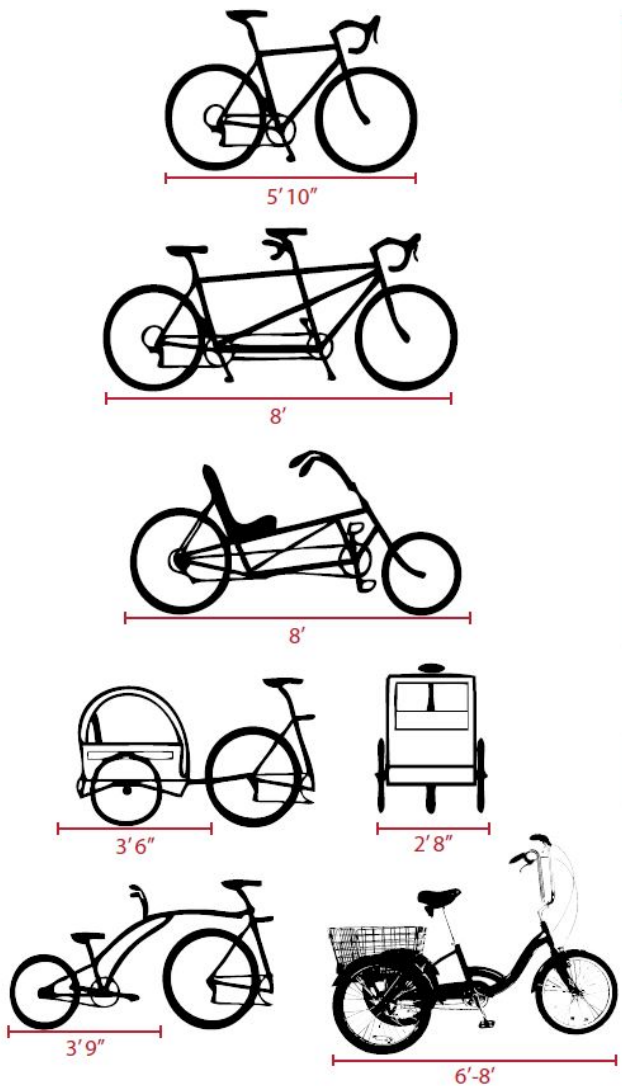


Standard Bicycle Rider Dimensions

Source: AASHTO Guide for the Development of Bicycle Facilities

BICYCLE DESIGN VEHICLE – TYPICAL DIMENSIONS

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



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
Adult Tricycle	Physical length	6 ft to 8 ft
	Physical width	2 ft 8in to 3 ft

Bicycle Typical Dimensions

Source: AASHTO Guide for the Development of Bicycle Facilities
Note: AASHTO does not provide typical dimensions for tricycles.

BICYCLE DESIGN VEHICLE –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 following table provides typical bicyclist speeds for a variety of conditions. Tandem bicycles and bicyclists with trailers have typical speeds equal to or less than upright adult bicyclists.

Bicycle Type	Feature	Typical Speed
Upright Adult Bicyclist	Paved level Surface	15 mph
	Crossing Intersections	10 mph
	Downhill	30 mph
	Uphill	5 – 12 mph
Recumbent Bicyclist	Paved Level Surface	18 mph

BICYCLE DESIGN VEHICLE – STABILITY

- Bicycles derive stability from the angular momentum of spinning wheels—at low speed a bicycle is less stable and requires greater skill to maintain control;
- Cross winds and motor vehicle wind blast negatively affect stability.

BICYCLE DESIGN VEHICLE – STEERING

- It takes about 1.5 seconds to set up for a turn;
- Bicycles steer more slowly when loaded.

BICYCLE DESIGN VEHICLE – SURFACE CONDITIONS EFFECTS

- Tires contact the ground with as little as two dimes of surface area;
- Bicycles provide little shock absorption;
- Loose materials and slick surfaces (steel, thermoplastic, paint, oil, moisture) can cause slippage;
- Longitudinal seams of > ¼ inch and other surface irregularities impact control.

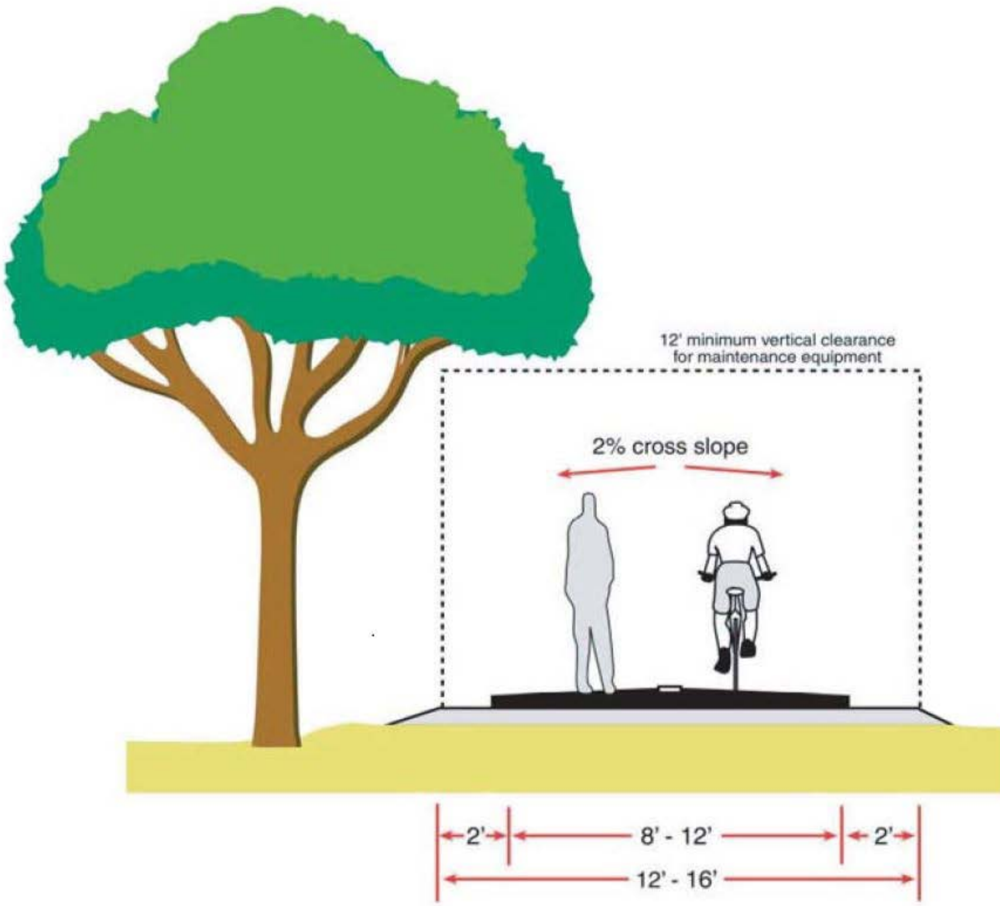
BICYCLE DESIGN VEHICLE – BRAKING

- Deceleration:
  - Maximum ~16 feet/s^2
  - Typical ~ 4 - 8 feet/s^2
- Perception-reaction time 2.5 s;
- Allow additional 1.0 - 3.0 seconds for surprised condition reaction time.

BICYCLE DESIGN VEHICLE – VISIBILITY

- Viewing object height ~ 4 inches
- Bicycles are very narrow relative to other vehicles;
- Bicyclists' curbside position on the roadway places them out of motorists' expected viewing area;
- Motorists tend to look for other motor vehicles to the exclusion of bicyclists which are much less numerous;
- Bicycles are especially difficult to detect under low light conditions.

PATH DESIGN GUIDANCE



GEOMETRICS FOR BIKE PATHS

All bike path geometric design criteria shall conform to AASHTO Guide for the Development of Bicycle Facilities, 4th Edition 2012

BIKEPATH DESIGN SPEED

The speed that a bicyclist travels is dependent on several factors, including the type and condition of the bicycle, the purpose of the trip, the condition and location of the bicycle path, the presence of other traffic, the speed and direction of the wind and the physical condition of the bicyclist.

Bicycle paths should be designed for a selected speed that is at least as high as the preferred speed of the faster bicyclists. However, paths should not be designed to encourage speed.

AASHTO has a number of tables and equations to help designers meet the tolerances of a bicyclist based on the following key numbers: In general, a minimum design speed of **20 mph** should be used; however, when the grade exceeds four (4) percent for descending grades greater than 500 feet, or where strong prevailing tailwinds exist, a design speed of **30 mph** is advisable. On unpaved paths, where bicyclists tend to ride slower, a lower design speed of **15 mph** can be used. The Ohio Department of Transportation Locations and Design Manual Volume One Section 702.2.3 provides guidance showing that a design speed of **18 mph** is generally sufficient for relatively flat grades of 2 percent or less. Speed bumps or similar surface obstructions, intended to slow down bicyclists in advance of intersections, should not be used. They may divert a rider’s attention from traffic or catch a pedal causing the cyclist to fall.

Since bicycles have a higher tendency to skid on unpaved surfaces, horizontal curvature design should take into account lower coefficients of friction. With the growing popularity of mountain bicycles, provision of unpaved trails is likely to increase. However, little research has been done on the phenomenon. Quite possibly, speeds on some types of unpaved trails will equal or exceed those on paved trails, especially where there are significant grades. The engineer should exercise proper care when dealing with this new area of design.

REDUCED DESIGN SPEEDS:

There is growing concern that the 20 mph design speed prescribed by AASHTO may create too great of an operating speed differential between families riding and high speed bicyclists. It may be that different types of paths require different design speeds. Urban paths used by school children may have a lower requirement than rural paths with a large percentage of high speed cyclists. Bicyclist speeds can be reduced using signage and path design characteristics that discourage excessive speeds. The design characteristics may include tight turns, intersections, short downhill grades, rougher trail surface and markings.

Intersection approaches may be another location which would benefit from a low design speed. Reducing the speed of path users approaching intersections could allow for the replacement of some STOP signs with YIELD signs. Unless the speed reduction is obvious, posting of the recommended speed and changed condition is essential (see the Ohio Manual for Uniform Traffic Control Devices (OMUTCD)). Since most bicycles don't have speedometers, signing is limited in its effectiveness. Any designs using low design speeds should be evaluated for safety and effectiveness.

Trails which will be predominantly used for commuting to school probably do not need to be designed for 20 mph. Mixing the school children with the high speed bicyclist would create a hazardous situation.

PAVEMENT DESIGN FOR BIKE PATHS

PAVEMENT SURFACE FOR BIKE PATHS

Bicycles require a smooth riding surface without obstructions or pavement irregularities because of their narrow, high pressure tires, and lack of suspension. On roadways with rough surfaces and hazards, a bicyclist will ride as close to the smooth wheel track in the travel lane as possible. These conditions will affect the level of service of the roadway.

Bicycle traffic is more sensitive to pavement irregularities than is motor vehicle traffic. During construction, appurtenances should not be left projecting above the pavement surface. Repeated resurfacings without adjusting the utility cover neck flange or drainage grate frames results in the covers being sunken below the pavement surface, a hazardous condition to bicycle traffic which bicyclists refer to as "black holes." Therefore, utility covers and drainage grates should be adjusted to fit flush with the roadway surface in all new construction, reconstruction and resurfacing projects.

> A hard surface, such as cement or asphalt, will generally see cyclists operating at a faster speed than a soft surface, but may not be as popular with joggers and is more expensive to install.
>
> A soft surface trail will discourage or prevent in-line skating but may enable horse-back riders to share the trail and is less expensive to install. Factors such as weather conditions and soil types can affect the choice of asphalt, concrete, or crushed rock.

Generally, bituminous concrete (asphalt) pavement surface is preferred over concrete for bike paths. To construct and maintain a smooth riding surface on shared-use paths, path pavements should be machine-laid. Soil sterilant should be used where necessary to prevent vegetation from erupting through the pavement.

<u>Flexible Pavement</u>

Hot Mix Asphalt (HMA) pavements (known as flexible pavements) have proven to give a smooth, flexible, long-lasting surface preferred by the outdoor enthusiast for recreational purposes and for use as a means of transportation and links to public transportation centers. HMA is the most common surface for bicycle paths.

<u>Rigid Pavement</u>

Portland Cement Concrete Pavements (PCCP), known as rigid pavement, has proven to be more durable over the long term than HMA. The use of concrete surfacing for paths has proven to be the most suitable for long-term use. Using modern construction practices, concrete provides a smooth ride with low maintenance costs. Concrete paths can be placed with a slip-form paver. The surface must be cross-broomed. Concrete paths cost more to build than HMA paths, yet do not become brittle, cracked and rough with age, or deformed by roots and weeds as with asphalt.

On Portland cement concrete pavements, transverse joints should be saw-cut to control cracking. The crack-control joints should be saw-cut, not troweled. Normally these joints should be spaced at twice the pavement width; i.e., 10 feet wide equals 20 feet of space. On the other hand, skid resistance qualities should not be sacrificed for the sake of smoothness. Broom finish or burlap drag concrete surfaces are preferred over trowel finishes, for example.

Subgrade

Off-street paths should be designed with sufficient surfacing structural depth for the subgrade soil type to support maintenance and emergency vehicles. Very poor subgrade (wet and/or poor material) should be removed and replaced with appropriate material, or the subgrade should be treated with lime, cement, geotextile fabric or geogrid.

Highway Shoulders

Where highway shoulders are employed to provide the pavement width necessary to accommodate bicycle traffic, the pavement surface should be as smooth as the adjacent travel lane. Bituminous concrete is preferred over concrete where shoulders are employed. The outside pavement area (where bicycle traffic normally operates) should be finished free of longitudinal seams. On Portland cement concrete, pavement transverse expansion joints should be sawcut.

In areas where bituminous shoulders are added to existing pavement, or pavement is widened, existing pavement should be sawcut and the outer edge removed to produce a tight longitudinal joint. The pavement section at the sawcut should match the existing section to minimize wear and joint opening.

RAISED ROADWAY REFLECTORS

Raised roadway reflectors provide substantial benefits in areas of poor visibility. However, when used on the edge line they are a surface irregularity which can be hazardous to bicycle traffic. Therefore, raised reflectors should only be used along interior lane lines or center lines, not edge lines.

PATH STRUCTURAL SECTION

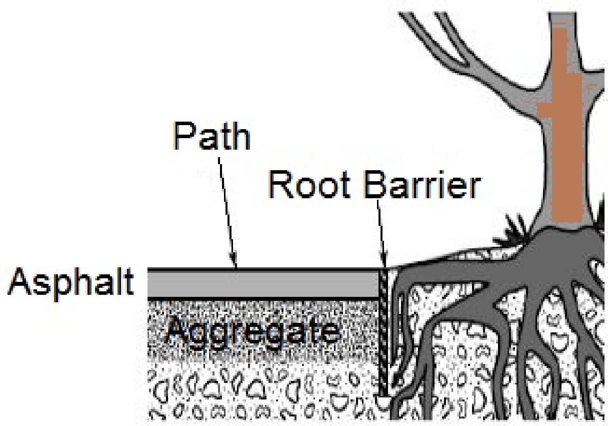
Design the pavement structural section of a shared-use path in the same manner as a highway, considering the quality of the subgrade and the anticipated loads on the path. Design loads are normally as required for maintenance and emergency vehicles. An experienced local pavement design engineer should be consulted to determine the design thickness for the trail pavement based on the anticipated uses, loading conditions, drainage, and soils information.

To design a bikepath pavement the type and strength of the native soil and drainage conditions needs to be determined. An investigation of the soils should be performed to evaluate the subgrade, load support capabilities, surface water, and groundwater conditions. In some areas, the swell potential of the native soils must be addressed. The soil investigation should be performed with test locations at appropriate intervals to account for the varying soil conditions that may be encountered.

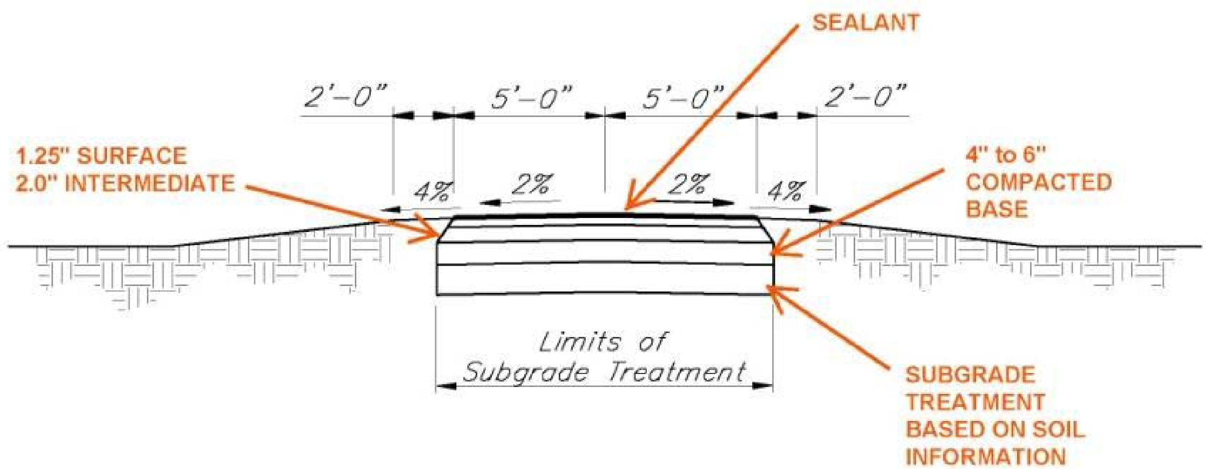
Where a path is planned within a corridor that was allowed to grow wild, the soil under the path and shoulder must be dug up and plant roots disturbed thoroughly (clearing and grubbing), or the soil sterilized, so that plants will not grow and pop through the asphalt. When greenery is making its way up through the new asphalt, little volcanoes are formed. The greenery on the pavement surface looks soft, but in actuality, the ride is very rough due to the little volcanoes that hardened around the vegetation.

All vegetation, including roots, must be removed in the preparation of the subgrade. Special care is needed to control new growth, such as the use of soil sterilant or lime treatment of the subgrade. Plants that can cause other problems should be controlled, such as those with thorns that can puncture bicycle tires.

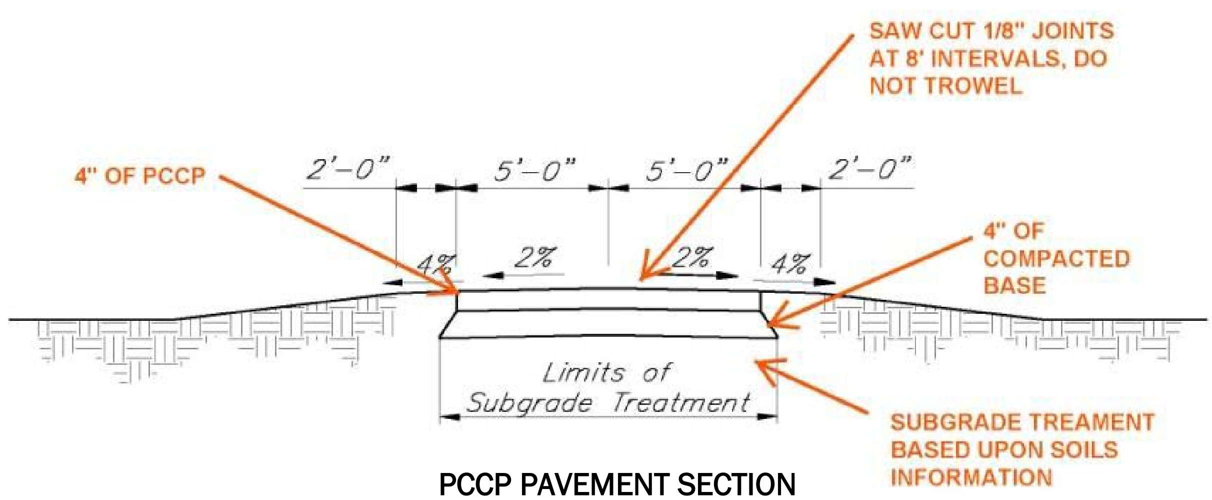
Paths built in wooded areas present special problems. The roots of shrubs and trees can pierce through the surface and cause it to bubble up and break apart. Preventive methods include removal of vegetation, realignment of the path away from trees, and placement of root barriers along the edge of the path. An effective barrier is created with a 12” deep metal shield; greater depth is required for some trees such as cottonwoods.



The following are the minimum recommended pavement sections for HMA and PCCP. The pavement section can be modified but any modification should be designed by a registered professional engineer and based on a subsurface geotechnical investigation.



HMA PAVEMENT SECTION



PCCP PAVEMENT SECTION

PATH DRAINAGE

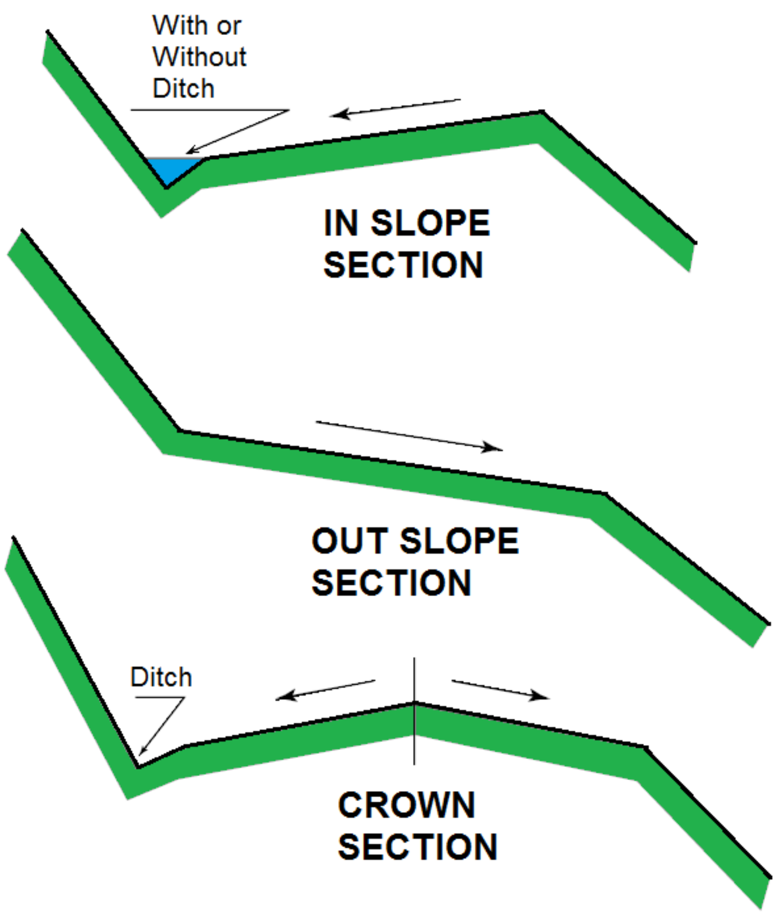
It is very important that bicycle trails are well drained. Standing water on the trail will adversely affect the trail surface and decrease the life and quality of the trail. Poor drainage can ruin a good trail.

The AASHTO guide recommends a cross slope of 2 percent for drainage. The need to make trails ADA accessible to people using wheelchairs argues against a cross slope greater than 2 percent.

Other considerations to ensure adequate drainage include:

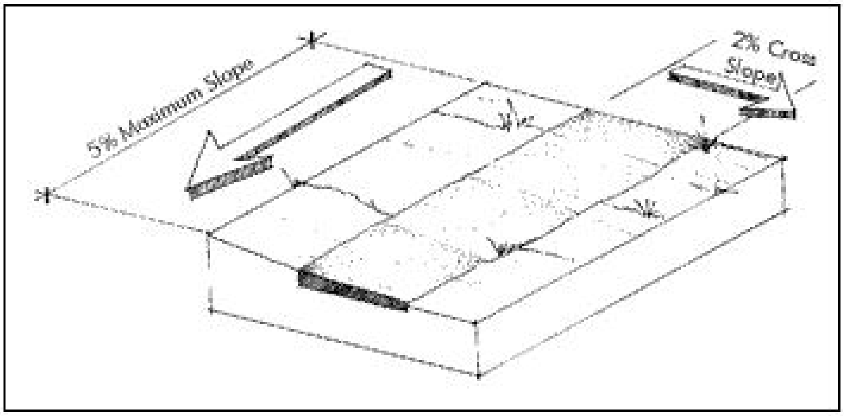
- Slope the trail in one direction rather than having a crown in the middle of the trail.
- Ensure a smooth surface to prevent ponding and ice formation.
- Place a ditch on the upside of a trail constructed on the side of a hill.
- Place drainage grates, utility covers, etc. out of the travel path of bicyclists.
- Preserve natural ground cover adjacent to the trail to inhibit erosion.
- Disturbed areas should be seeded and mulched or sodded to prevent erosion.
- Culverts may be necessary to move water under the trail.

On curves, the cross slope should direct runoff to the inside, providing a slight amount of super elevation. Sloping on one direction usually simplifies longitudinal drainage design and surface construction.



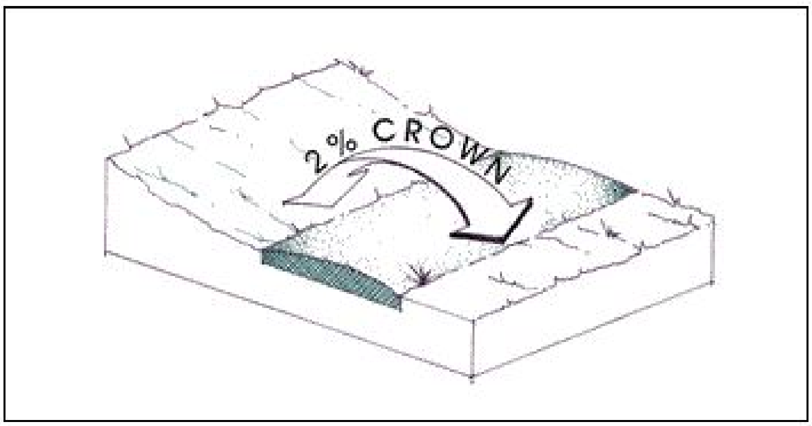
TRAIL CROSS SLOPE:

Bicycle trails should not exceed a uniform cross slope of 2 percent.



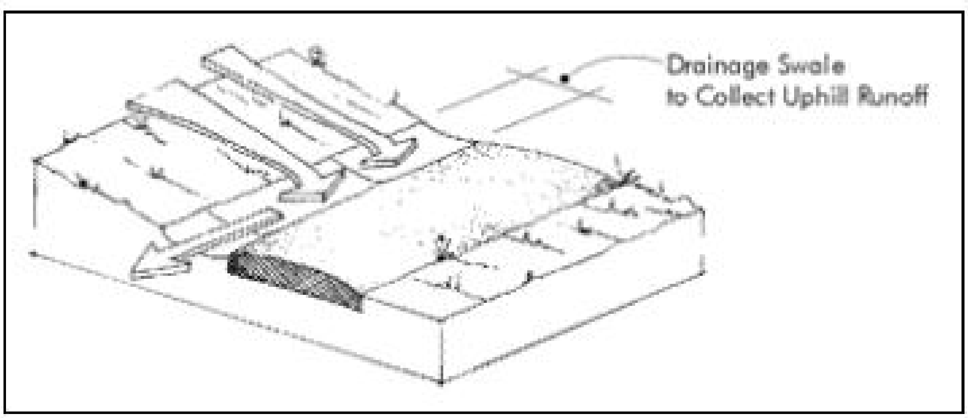
CROWNING OF TRAIL SURFACE:

Crowning of the trail at 2 to 3 percent is acceptable, but may be more difficult and costly to construct.



TRAIL WITH DRAINAGE SWALE:

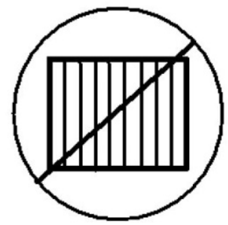
Where a trail is benched into a slope, a swale on the uphill side should be considered to catch water before it crosses the trail.



DRAINAGE STRUCTURES

Stormwater drainage facilities and structures are usually located along the edge of roadway where they often present conflicts with bicyclists. Careful consideration should be given to the location and design of drainage facilities on bicycle compatible roadways. The sizing of drainage structures, culverts, and ditches should be determined by an experienced hydraulic engineer.

DRAINAGE INLETS & GRATES



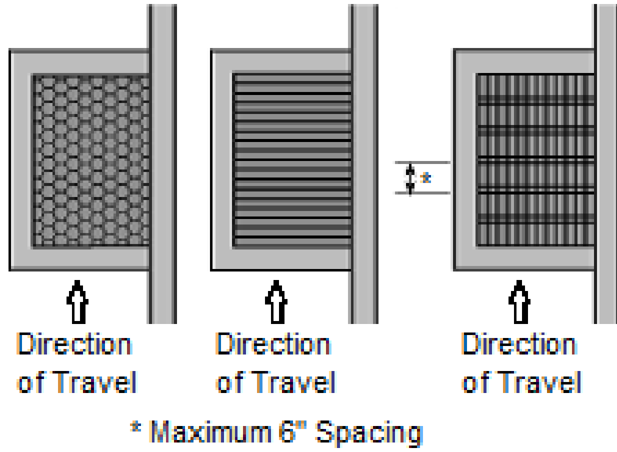
All drainage grate inlets pose some hazard to bicycle traffic. The greatest hazard comes from stream flow drainage grates which can trap the front wheel of a bicycle and cause the cyclist to lose steering control or have the narrow bicycle wheels drop into the grate. Another hazard is caused by bicyclists swerving into the lane of traffic to avoid drainage grates, manhole covers or valve boxes.

Example of bicycle unsafe grate with openings parallel to direction of travel

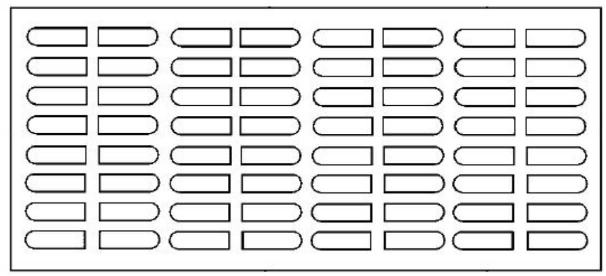
Example of grate that will not catch a bicyclist's wheel.

A bicycle safe drainage grate with acceptable hydraulic characteristics should be used in all normal applications and should be installed flush with the final pavement. Where additional drainage inlet capacity is required because of excessive gutter flow or grade (greater than 2 percent), double inlets should be considered. Depressed grates and stream flow grates should not be used except in unique or unusual situations which require its use and only outside the lane sharing area. Depressed grates should only be installed on shoulders that are 6 feet wide or greater and only where necessary. Where projects offer the possibility for replacement of stream flow grates located in the bicycle lane sharing area, these grates should be replaced with the bicycle safe grate.

When roads or intersections are widened, new bicycle safe drainage grates should be installed at a proper location at the outside of the roadway, and existing grates and inlet boxes should be properly retired and removed, and the roadway reconstructed. Drainage grate extensions, the installation of steel or iron cover plates or other "quick fix" methods which allow for the retention of the subsurface drain inlet are unacceptable measures since they will create a safety hazard in the portion of the roadway where bicyclists operate.



Bicycle safe drainage inlet grates shall have openings sufficiently narrow and short to prevent bicycle tires from dropping into the grates, regardless of the direction of bicycle travel. Where it is not immediately feasible to replace existing grates with standard grates designed for bicycles, 1 in by ¼ inch steel cross straps should be welded to the grates at a spacing of 4 inches to reduce the size of the openings.

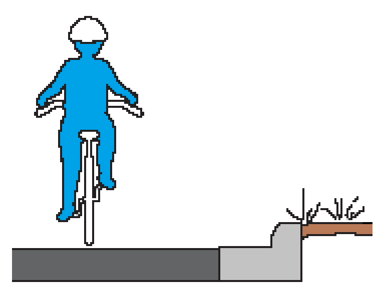


MANHOLES & COVERS

Manholes and covers should be located outside of the lane sharing area for bicycles wherever possible. Utility fixtures located within the bicycle lane sharing area or any travel lane used by bicycle traffic should be eliminated or relocated. Where these fixtures cannot be avoided the pavement surface should be made flush with the particular facility.

COMBINATION CURB & GUTTER

The gutter pan on a combination curb and gutter greatly reduces space available for bicyclists. The width of the gutter pan should not be used when calculating the width of pavement necessary for shared use by bicyclists, but can be used for clearance from the curb. On steep grades, the gutter should be set back an additional one foot to allow space to avoid high speed crashes caused by the longitudinal joint between the gutter pan and pavement.

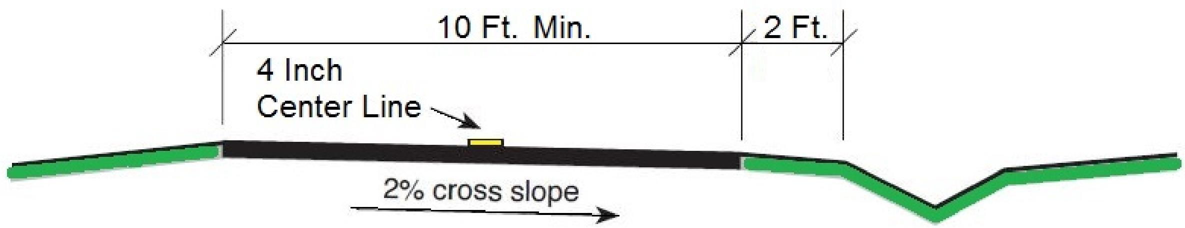


PATH CROSS SLOPE

The maximum cross slope on a paved shared-use path is to be 2%. The cross slope of the shoulders can be no steeper than 6H:1V. To accommodate drainage, the entire section, including shoulders, should transition through curves. It is desirable to design the pivot point on the outside edge of one side of the shoulder or the other to avoid a pavement crown.

It is recommended that cross slopes be designed to be less than the allowed maximum to account for some tolerance in construction. For example, design for a 1.6% cross slope (rather than the 2% maximum).

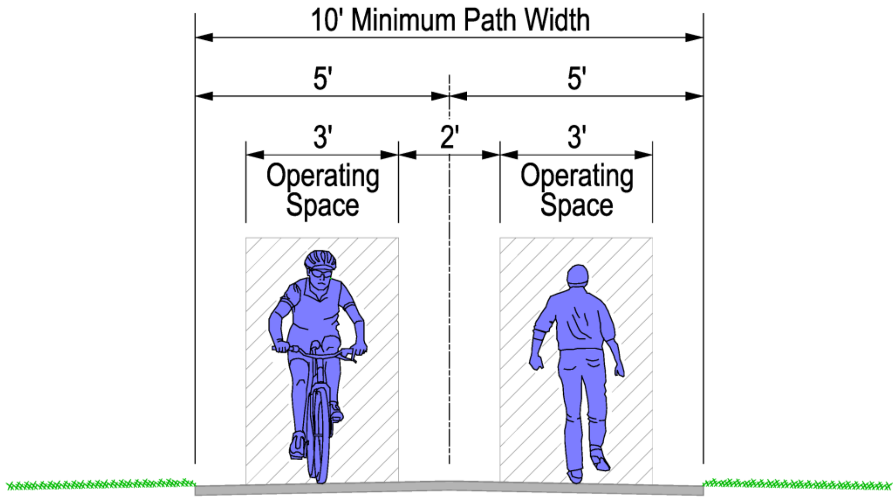
The pavement surface should be sloped to one side which is desirable and usually simplifies drainage design and surface construction. Generally, surface drainage from the path is dissipated as it flows down the side slope.



TYPICAL BICYCLE PATH CROSS SECTION

PATH PAVED WIDTH

The paved width and the operating width required for a bicycle path are primary design considerations. Under most conditions, the minimum paved width for a two-directional bicycle path is 10 feet. Wider widths (12 to 14 feet) are applicable to areas with high use and/or a wider variety of user groups.

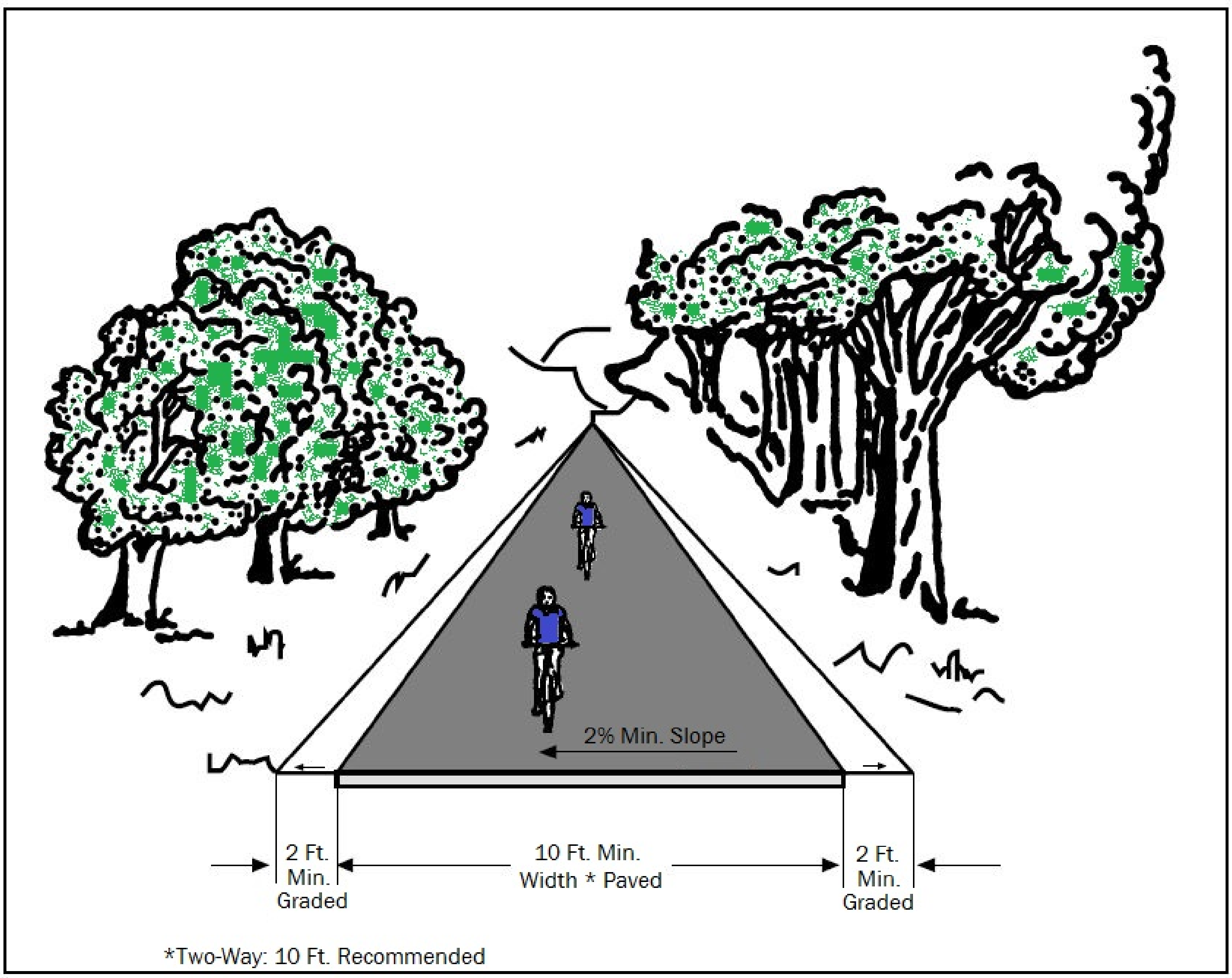


Paths narrower than 10 feet are not recommended as they do not permit safe and frequent passing opportunities where there is high bicycle use, especially where pedestrian use is frequent. Also, a narrow path is subject to pavement edge damage from maintenance vehicle loading conditions. (A segment of path less than 10 feet wide may be acceptable or necessary for short distances, such as when passing between buildings or utility poles that cannot be moved, or when crossing bridges that cannot be modified, or unusual items such as above-ground pipes to underground storage tanks. These should be treated on a case-by-case basis and signed in accordance with the OMUTCD.)

In many cases, it may be desirable to increase the width of a bicycle path to 12 feet. For example, wider paths may be needed in cases involving substantial bicycle volume, probable shared use with joggers and other pedestrians, use by large maintenance vehicles, steep grades and locations where bicyclists are likely to ride two abreast. One-way bicycle paths often will be used as two-way facilities unless effective measures are taken to assure one-way operation. For this reason, one-way paths are not recommended.

In some instances, a minimum of 8 feet wide bicycle path can be adequate. This minimum should be used only where the following conditions prevail:

- Bicycle traffic is expected to be low, even on peak days or during peak hours.
- Pedestrian use of the facility is not expected to be more than occasional.
- There will be good horizontal and vertical alignment providing safe and frequent passing opportunities.
- The path will not be subjected to maintenance vehicle loading conditions that would cause pavement edge damage.
- Reduced widths are acceptable on linkage paths. Because of their short length, they seldom allow bicyclists to operate at full speed, and because of low traffic volumes they seldom result in conflicts. However, whenever possible, linkage paths should comply with the minimum width standards.



HORIZONTAL ALIGNMENT AND SUPERELEVATION

Superelevation (transverse sloping of path down toward the inside of the curve) of 2 percent to 3 percent should be provided on most curves. For most conditions, the minimum super-elevation rate of 2 percent will be adequate. The ADA allows a maximum super-elevation rate of 3 percent for accessibility. When transitioning a 3 percent super-elevation, a minimum 25 feet transition tangent distance should be provided between the end and beginning of consecutive and reversing horizontal curves. A cross slope of 2 percent is recommended for drainage on tangent (straight) sections of a shared-use path.

The minimum radius of horizontal curvature depends on design speed, rate of super-elevation, coefficient of friction and the allowable lean angle of the bicyclist. By ignoring the coefficient of friction and the super-elevation rate, the equation shown can be used to find the approximate bicyclist lean angle for a given curve radius and bicyclist speed. The desirable minimum radius of horizontal curvature for varied design speeds, based on a 15 degree lean angle, is provided in the following Table.

Desirable Minimum Radius of Horizontal Curvature for Paved Shared-Use Paths (Based on a 15 degree lean angle)

Design Speed (V) (mph)	Radius (R) (ft.)
12	36
15	56
20	100
25	156
30	225

A lean angle of 20 degrees is considered maximum for average bicyclists, and the pedal may strike the ground at a lean angle of approximately 25 degrees. When the lean angle approaches 20 degrees, the minimum radius of curvature negotiable by a bicycle is a function of the super-elevation rate, the coefficient of friction between the bicycle tires and the path surface, and the speed of the bicycle. For this situation, the minimum design radius of curvature can be determined from the equation shown.

For English Units:

$$\theta = \mathrm{Tan}^{-1}\left(\frac{0.067\,V^2}{R}\right)$$

Where:
R = Radius of curvature (ft)
V = Design speed (mph)
θ = Lean angle from the vertical (degrees)

Coefficient of friction factors used for design should be selected based upon the point at which centrifugal force causes the bicyclist to recognize a feeling of discomfort and instinctively act to avoid higher speed. The coefficient of friction depends on speed, surface type, roughness and condition of pavement, tire type and condition, and whether the surface is wet or dry. Although no data exists for unpaved surfaces, it is suggested that friction factors be reduced by 50 percent to allow a sufficient margin of safety.

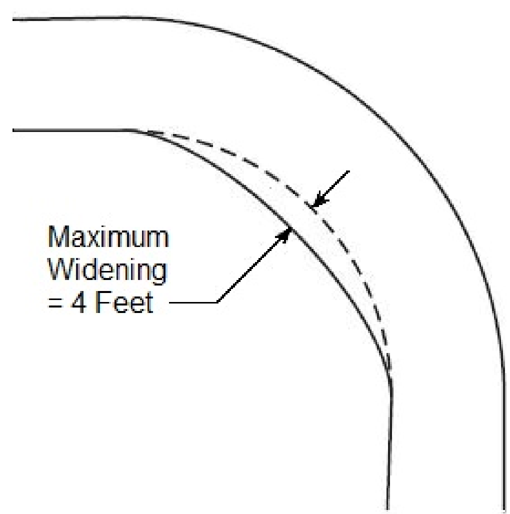
The minimum radius of horizontal curvature, based upon a 2 percent super-elevation rate and a 20 percent lean angle, is shown in the following Table. Extra paved width should be provided for curves designed for a 20 degree lean angle, because the bicyclist will require more space while leaning on the curve. When a curve radius smaller than shown in the following Table is used (because of limited right of way or other considerations) standard curve warning signs and supplemental pavement markings may be needed. The negative effects of a sharper curve can also be partially offset by widening the pavement through the curve.

Desirable Minimum Radius of Horizontal Curvature for Paved Shared-Use Paths (Based on a 20 degree lean angle)		
Design Speed (V) (mph)	Coefficient of Friction (f)	Minimum Radius (R) (ft.)
12	0.31	30
15	0.29	48
20	0.28	90
25	0.25	155
30	0.21	260

Occasionally, designers are tempted to add curves for the purpose of controlling bicyclist speed or to provide some variation in the path alignment. While sometimes successful, this approach may lead bicyclists to cut corners when the resulting alignment appears either arbitrary or unsafe at typical approach speeds. Further, if the curve has a significantly lower design speed than the connecting trail, cyclists may misjudge the appropriate approach speed and leave the trail.

When substandard radius curves must be used on bicycle paths because of right-of-way, topographical or other considerations, standard curve warning signs and supplemental pavement markings, such as a solid yellow center line, should be installed in accordance with the OMUTCD.

The negative effects of substandard curves can also be partially offset by widening the pavement through the curves. The additional pavement may be added on either the inside or outside of the curve.



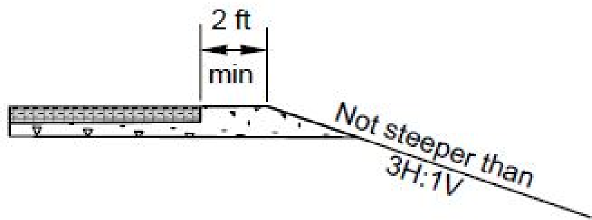
Curve widening may partially offset the effects of substandard curves.

PATH SHOULDERS AND SIDE SLOPES

Side slopes along shared-use paths are an important design feature.

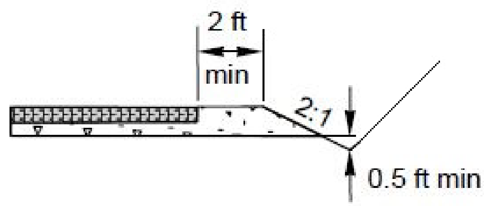
Ideally, a graded shoulder width at least 3 to 5 feet wide with a maximum cross slope of 6:1 should be provided on each side of the pathway where practical.

At a minimum, a 2 foot graded areas with a maximum slope of 6:1 should be provided for clearance from lateral obstructions such as bushes, large rocks, bridge piers, abutments and poles.

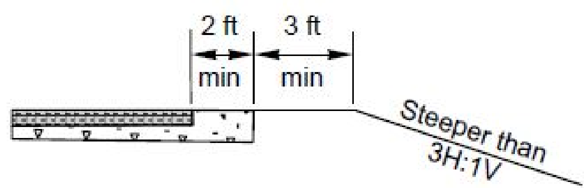


The minimum graded shoulder width is 2 feet for a side fore slope not steeper than 3H:1V.

Where a path is constrained against an embankment and the path is in a cut section, the minimum graded shoulder width is 2 feet for a maximum 2:1 fore slope not steeper than 2H:1V with less than a 4 feet drop.



The minimum graded shoulder width should be widened to 5 feet or more for steeper fill slopes to provide clear space (recover area) between the path and the top of the slope break point. As an alternative to providing a wider graded shoulder, vegetation can be used as a buffer on the slope. A natural or physical barrier can also be used.



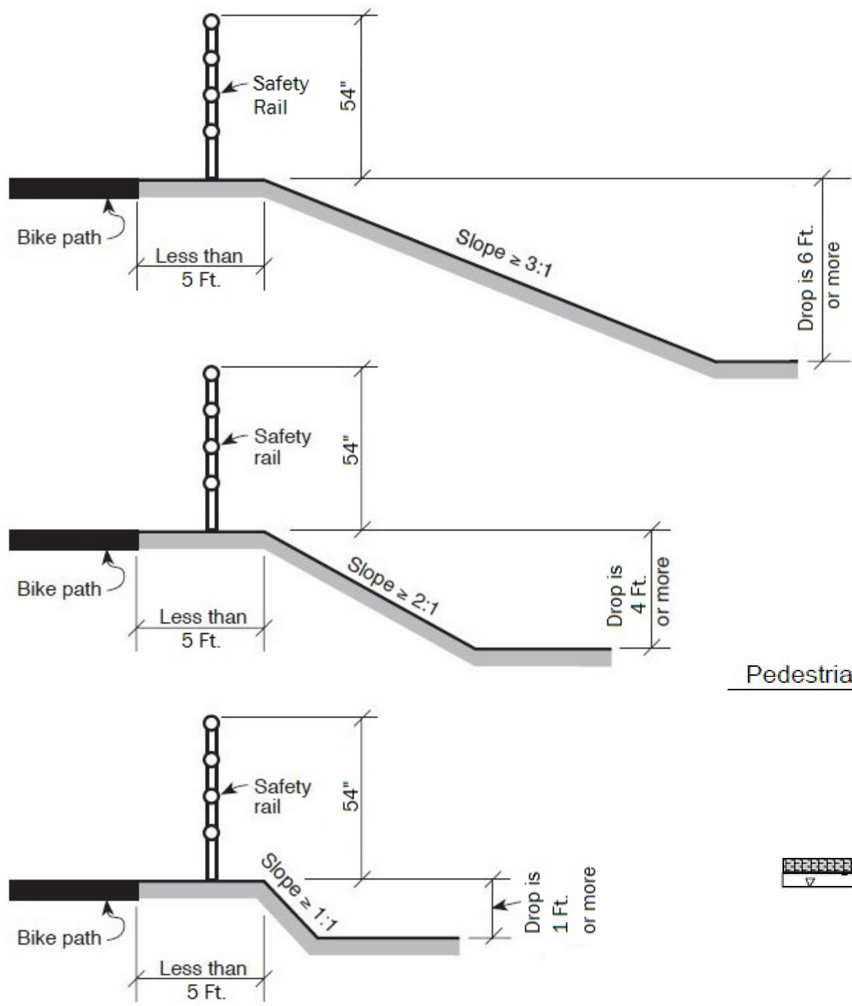
For shared-use paths with side slopes steeper than 3H:1V, or where obstacles or waterways may exist, evaluate the potential risk and provide mitigation such as:

- A minimum 5-foot separation from the edge of the pavement to the embankment edge. This can be accomplished by providing a 5-foot shoulder and is the preferred mitigation where possible.
- A natural barrier such as dense shrubbery on the side slopes.
- A physical barrier, such as pedestrian rail.
- Where a shared-use path is adjacent to a vertical drop of 2 feet 6 inches or more, a pedestrian rail is needed.
- If the vertical drop is less than 2 feet 6 inches, a pedestrian rail, chain link fence, or 4-inch curb at the edge of the shared-use path may be installed to delineate the edge.
- Where a shared-use path is constructed on the side of a hill, drainage facilities may need to be considered.

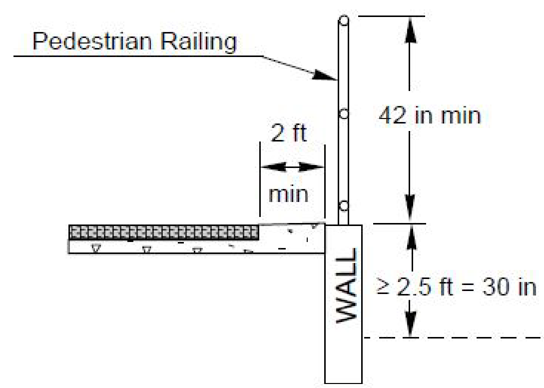
Where a recovery area (distance between the edge of the path pavement and the top of the slope) is less than 5 feet, physical barriers or safety rails are recommended in the following situations.

- Slope 3:1 or greater, with a drop of 6 feet or greater;
- Slope 3:1 or greater, adjacent to a parallel body of water or other substantial object;
- Slopes 2:1 or greater, with a drop of 4 feet or greater;
- Slopes 1:1 or greater, with a drop of 1 foot or greater.

The barrier or rail should begin prior to, and extend beyond the area of need. The lateral offset should be at least 1 foot from the edge of path. The ends of the barrier should be flared away from the path edge.



BICYCLE SAFETY RAIL AND SLOPE LOCATION



GRADES

The grade that a bicyclist can be expected to negotiate depends on the length of the grade, wind velocity, and surface condition. Generally speaking, the amount of energy required to use a bicycle route will affect the usage of the route, and bicyclists will tend to avoid routes that have steep hills. Some bicyclists will find themselves walking on long, steep uphill grades. On downhill grades, bicyclists may exceed the speed at which they can safely control their bicycles. Therefore, grades should be kept to a minimum, even at the expense of providing added curvature or travel distance, within the practical limits for the site.

The maximum grade recommended for shared-use paths is 5 percent and sustained grades should be limited to 3 percent, as much as practical. However, steeper grades are allowable.

Grades on paths parallel to a roadway should be equal to or flatter than the roadway grade, with grades of 5 percent or less preferred. Grades in excess of 8.3 percent (12:1) exceed ADA Accessibility Guidelines for pedestrian facilities and should be avoided on shared-use paths unless significant physical constraints exist.

The AASHTO Guide for the Development of Bicycle Facilities acknowledges that on recreational routes, designers may need to exceed a 5 percent grade for short sections. It recommends several methods to mitigate excessive grades:

- Eliminate hazards to the bicyclists and pedestrians near the end of a ramp
- Warn bicyclists and pedestrians with signage ahead of steep downgrade hazards
- Provide signage stating recommended descent speed
- Exceed minimum stopping sight-distances
- When practical, widen the path by 4 to 6 feet to provide space for slower speed bicyclists to dismount and walk
- Provide a series of short switchbacks near the top to contain the speed of descending bicyclists.

For paths with crushed aggregate surfaces, grades less than 3 percent are preferred due to the risk of skidding, as well as for erosion control. A paved section is recommended to allow for stopping ahead of an intersection at the bottom of an unpaved downgrade section. Path surfaces should be paved for the distance that grades exceed 3 percent, if practical.

The maximum recommended values for grade restrictions and grade lengths are shown in the following Table.

Recommended Grade Restrictions for Paved Paths

Grade Value (%)	Maximum Length of Grade Segment (Feet)
5 to 7	800
7 to 8	400
8 to 9	300
Greater Than or Equal to 9	200

SIGHT DISTANCE

A bicycle path should be designed with adequate stopping sight distances to provide bicyclists with an opportunity to see and react to the unexpected. The distance required to bring a bicycle to a full controlled stop is a function of the bicyclist's perception and brake reaction time, the initial speed of the bicycle, the coefficient of friction between the tires and the pavement, and the braking ability of the bicycle.

STOPPING SIGHT DISTANCE

The minimum stopping sight distance for various design speeds and grades are based on a total perception and a brake reaction time of 2.5 seconds and a coefficient of friction of 0.25 to account for the poor wet weather braking characteristics of many bicycles. For two-way bicycle paths, the sight distance in the descending direction will control the design.

$$S = \frac{V^2}{30(f \pm G)} + 3.67V$$

Where: S = Stopping sight distance - ft
V = Velocity - mph
f = Coefficient of friction (use 0.25)
G = Grade - rise/run

Stopping sight distances on bicycle paths.

VERTICAL CURVE LENGTH

A minimum length of vertical curve is necessary to provide minimum stopping sight distance at various speeds on crests. The eye height of the bicyclist is assumed to be 4.5 feet and the object height is assumed to be zero to recognize that hazards to bicycle travel exist at pavement level.

$$L = 2S - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A} \quad \text{When } S > L$$

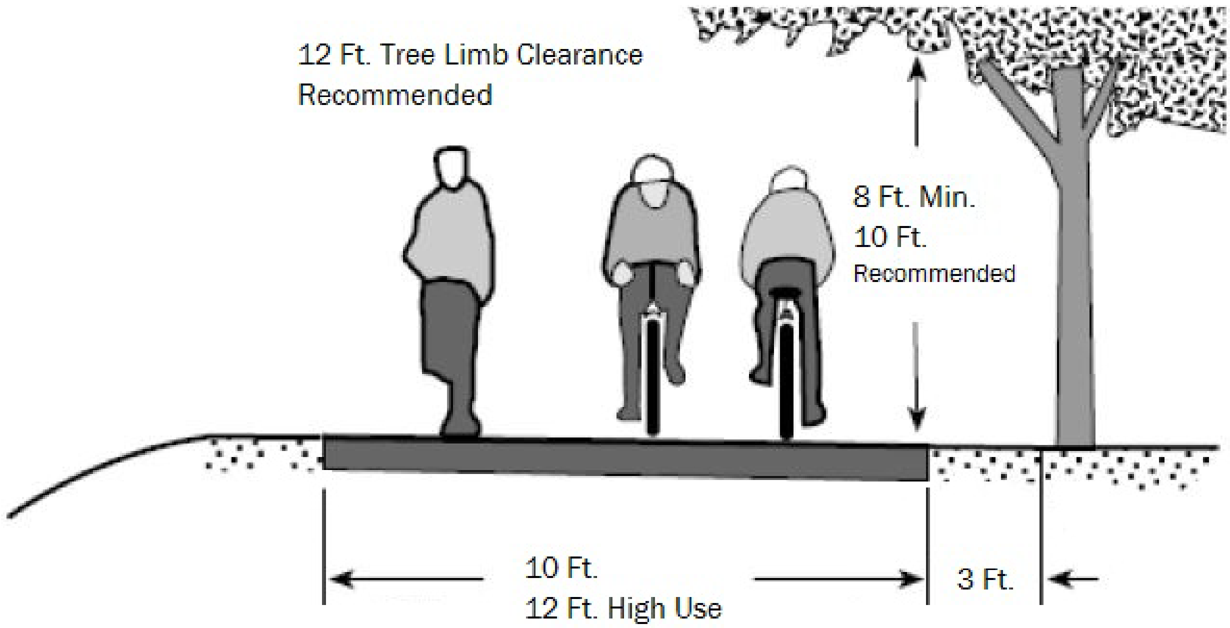
$$L = \frac{AS^2}{100(\sqrt{2h_1} + \sqrt{2h_2})^2} \quad \text{When } S < L$$

$$L_{MIN} = 2V$$

S = Stopping sight distance m (ft.)
A = Algebraic difference in grade
h_1 = Eye height of bicyclist 1.35 m (4.5 ft)
h_2 = Height of object 0 m (0 ft)
L = Minimum vertical curve length m (ft)

Sight distances for crest vertical curves on bicycle paths.

PATH CLEARANCES



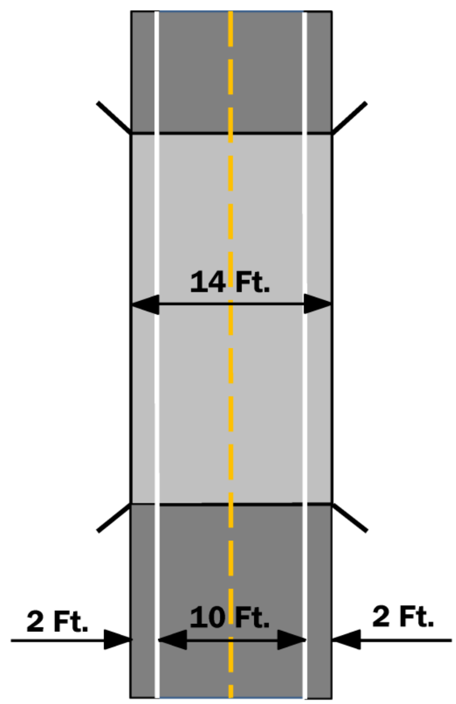
HORIZONTAL CLEARANCES

A minimum 2 feet wide graded area should be maintained adjacent to both sides of the pavement. However, 3 feet or more is desirable to provide clearance from trees, abutments, piers, polls, walls, fences, box culverts, guardrails or other lateral obstructions. A wider graded area on either side of the bicycle path can serve as a separate jogging path. If adequate clearance cannot be maintained between the path and vertical barriers or other features causing bikeway constriction, a warning sign should be used in advance of the hazard with an object marker at the location of the hazard. A hazard warning sign treatment should only be used where unavoidable and is by no means a substitute for a good design.

On new structures, the minimum clear width should be the same as the approach width of the path. The desirable clear width should include a minimum 2-foot wide clear area.

Carrying the clear areas across the structures provides a minimum horizontal shy distance from the railing or barrier and needed maneuvering space to avoid conflicts with others who are stopped on the bridge. Access by emergency and maintenance vehicles should be considered in establishing the design clearances of structures on shared-use paths.

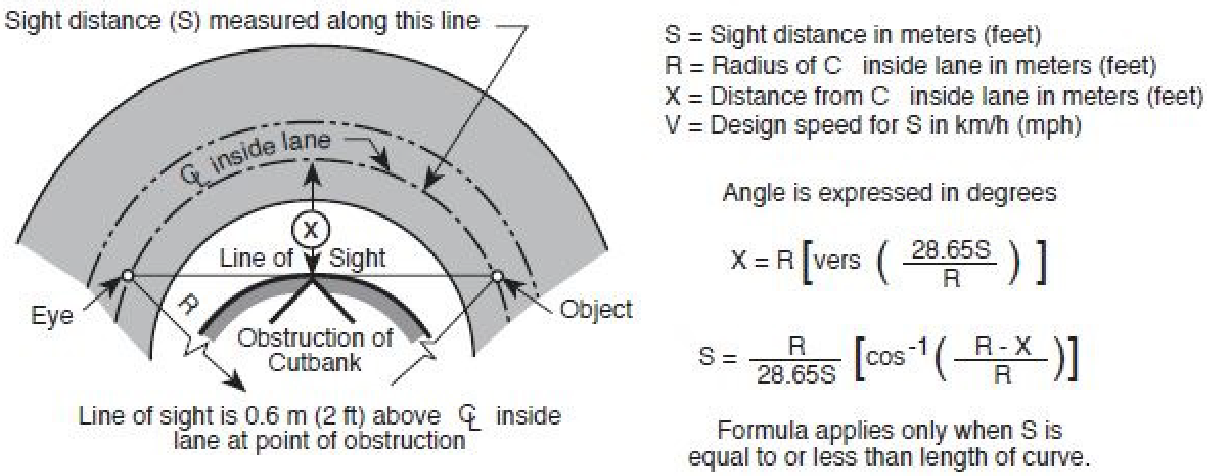
A wide separation between a bicycle path and canals, ditches or other significant depressions is essential for safety. A minimum of 5 feet of separation from the edge of the bike path pavement to the top of the slope is desirable. If this is not possible, a physical barrier such as dense shrubbery or a chain link fence should be provided.



A wide separation between a bicycle path and any nearby highway is desirable to confirm to both the bicyclist and the motorist that the bicycle path functions as an independent facility for bicycles. When this is not possible and the distance between the edge of the roadway and the bicycle path is less than 5 feet then a suitable positive barrier should be provided. Such dividers serve to prevent bicyclists from making unwanted movements between the path and the highway shoulder and to reinforce the concept that the bicycle path is an independent facility. Where used, the divider should be a minimum of 54 inches high, to prevent bicyclists from toppling over it. Such a situation should be treated as a special case and appropriate roadside design and warning measures taken. Where the path approaches crossing roadways or driveways, the barrier should be modified as necessary to enhance visibility between bicyclists and motorists. For additional information concerning railing and protective barrier heights refer to the “PATH RAILING” section of this document.

LATERAL HORIZONTAL CLEARANCE ON CURVES

There is a minimum clearance that should be used to determine the line-of-sight obstructions for horizontal curves. The desired lateral clearance is obtained by entering the stopping sight distance and the proposed horizontal radius of curvature in the following formulae.



Lateral clearance on horizontal curves on bicycle paths.

Bicyclists frequently ride abreast of each other on bicycle paths, and on narrow bicycle paths, bicyclists have a tendency to ride near the middle of the path. For these reasons, and because of the serious consequences of a head-on bicycle accident, lateral clearances on horizontal curves should be calculated based on the sum of the stopping sight distances for bicyclists traveling in opposite directions around the curve. Where this is not possible or feasible, consideration should be given to widening the path through the curve, installing a yellow center stripe, installing a curve ahead warning sign, in accordance with the OMUTCD, or some combination of these alternatives.

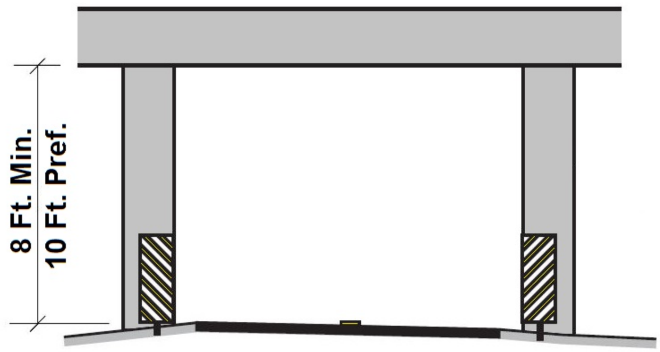
NARROWING PATHS

PATH NARROWS (W5-4a) may be installed on bicycle facilities shared-use paths to warn bicyclists of conditions not readily apparent.

In practice, shared use paths are the only bikeway type on which the W5-4a is used. Use on other types of bikeways would be inappropriate or confusing. For example, where a bicycle lane narrows and minimum width cannot be maintained, jurisdictions generally end the lane or discontinue designation

VERTICAL CLEARANCE TO OBSTRUCTIONS

The vertical clearance to obstructions should be a minimum of 8 feet. However, vertical clearance may need to be greater to permit passage of maintenance vehicles and, in under crossings and tunnels, a clearance of 10 feet is desirable and may be needed for adequate vertical shy distance.



BICYCLE PATH WITH OVERHEAD AND ADJACENT OBSTRUCTIONS

Vertical clearance on shared-use path bridges may be dictated by occasional motor vehicles using the path. Where practical, a vertical clearance of 10 feet is desirable for adequate vertical shy distance. Bridge designs to support maintenance and emergency vehicles should accommodate medium-sized vehicles. Barriers to prevent motor vehicle crossings and alternate access could be provided to keep bridge costs affordable.

Vertical clearance if recommended to be 12 feet under tree limbs since they often sag during certain environmental conditions.

TUNNELS & UNDERCROSSINGS

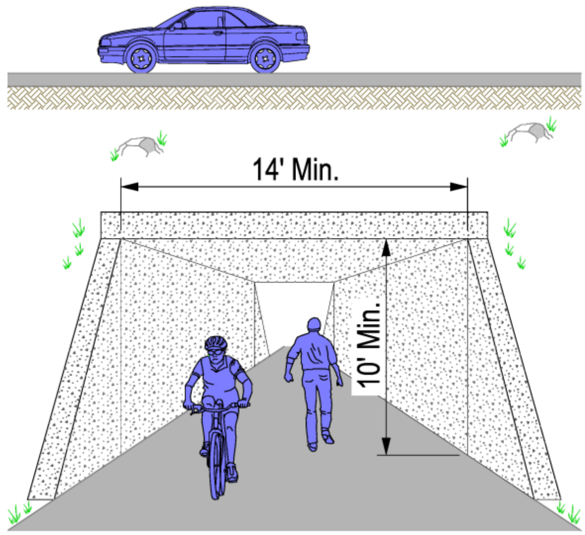
TUNNELS

Tunnels are often considered less successful than bridges for reasons of security, confinement, drainage and other factors. The problems associated with tunnels can often be mitigated in large part by splitting the elevation change with the roadway to be crossed, submerging the tunnel half way and raising the roadway the other half. If a multi-lane highway is being crossed, a skylight can be used to flood the tunnel with light at midsection.

There is an entire profession dedicated to the design, physics, construction and rehabilitation of tunnels. Most tunnel engineering firms work on rail, road or water tunnel projects, but an increasing number work on non-motorized tunnels. Just like tunnels for motorists, building or rebuilding tunnels for bicyclists and pedestrians include ensuring proper drainage or waterproofing, preventing rock falls and ensuring overall structural stability.

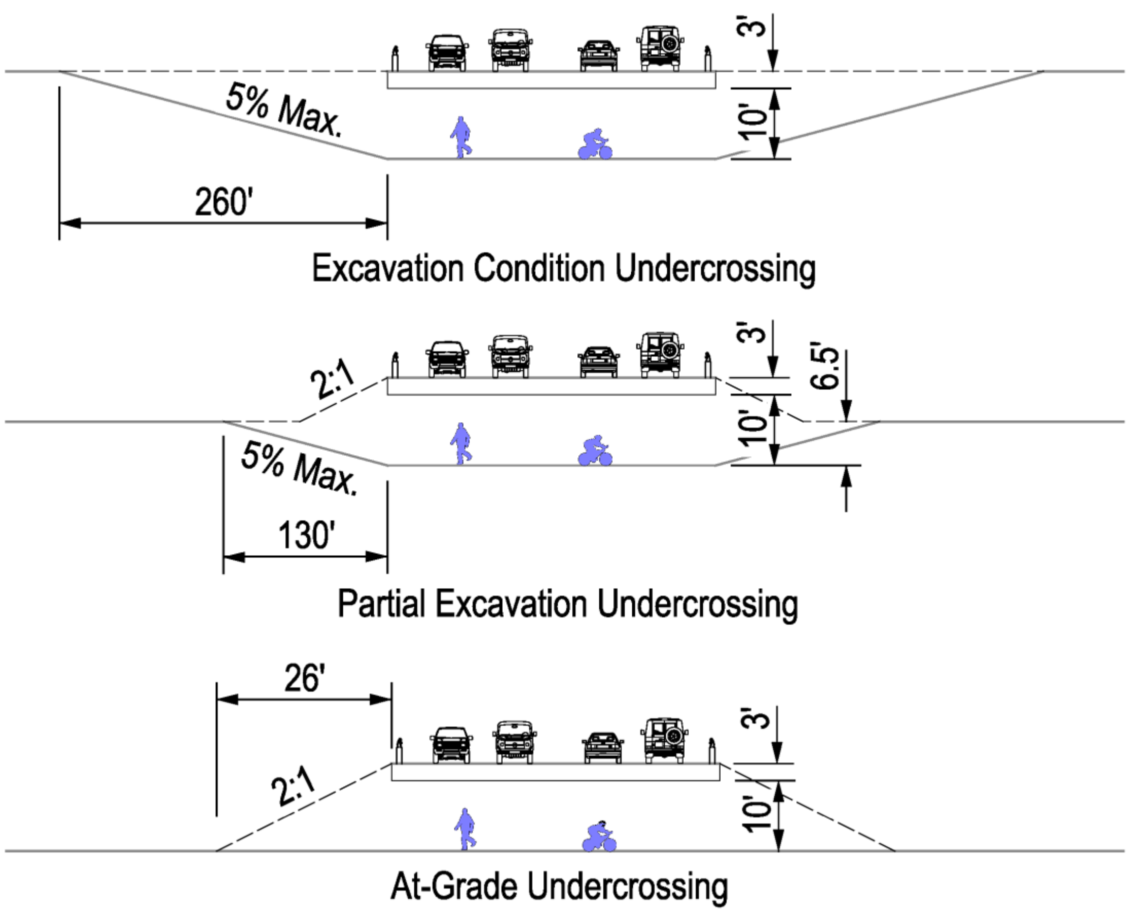
UNDERCROSSINGS

The preferred grade separation is the undercrossing because it allows shorter and flatter approaches than an overcrossing. Close attention to the design is needed because of the bicyclist's tendency towards excessive speed in an effort to contend with the adverse ascending grade. Therefore, approaches should be kept to no more than 5 percent grade. The roadway should be raised so that the upper portion of the bicycle tunnel is above the elevation of the surrounding terrain. This design approach usually allows relatively short approaches of modest grade, thus moderating the tendency to excessive speed in the tunnel. In addition, this design feature may allow drainage to be accomplished by gravity.



Undercrossing Dimensions

Undercrossings shall be fully lighted for safety. Finally, visibility into and through a raised tunnel enhances the sense of safety compared to a deeper structure with less visibility.

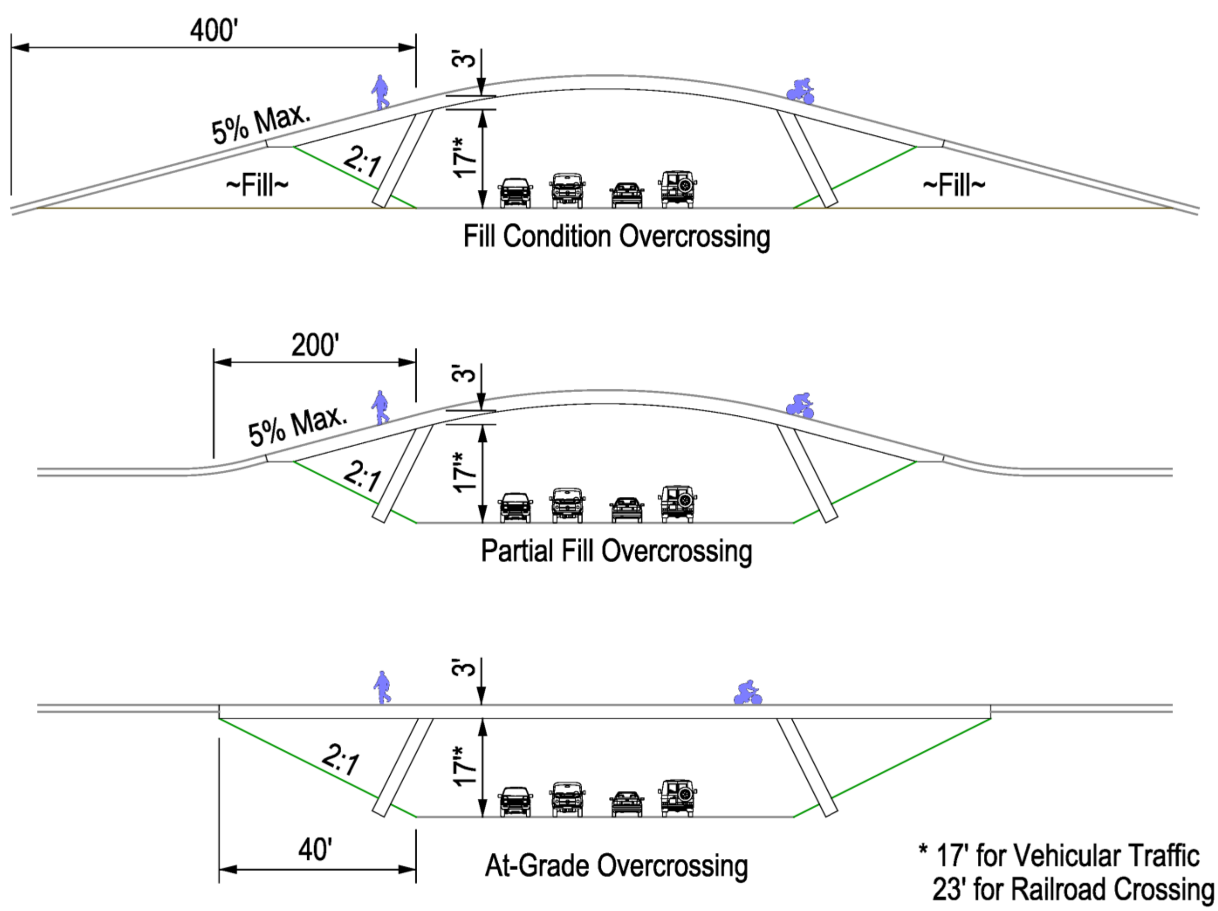


OVERCROSSINGS

Roadway overpasses are more open and present fewer security problems. However, they are generally more expensive, as they require much longer approaches to achieve the minimum 17 feet of vertical clearance from a roadway.

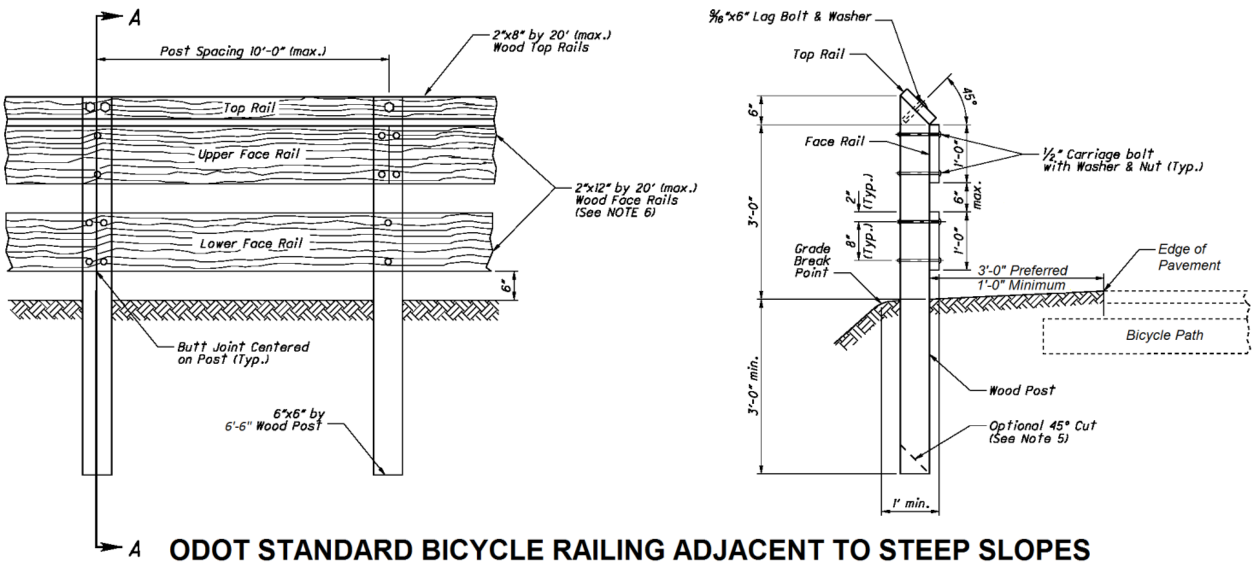
The following factors are important to consider when designing roadway overpasses:

- Due to concerns of personal safety, overcrossings are generally a preferred alternative to undercrossings where roadway curb-to-curb width exceeds about 90 feet. Steep grades should be moderated as much as possible so that ridership is not unduly discouraged.
- Grades exceeding 4 percent for downhill travel do not, by themselves, create a safety problem, provided that safety criteria derived from the 30 mph design speed are followed. For ascending cyclists, a combination of length and grade should be selected that carefully balances the two as necessitated by the total climb required. Short, steep grades less than 5 percent are preferable to modest grades of 2 to 4 percent, if those modest grades must persist for distances significantly in excess of 500 feet.
- In order to prevent any objects from falling or being thrown onto the roadway below, provide 6 foot high fencing on both sides of the overpass, or a fully enclosed cage that maintains the recommended vertical clearances.



PATH RAILING

The primary purpose of a bicycle rail is to protect bicyclists from a hazard on the other side. The rail height to keep a bicyclist from falling over it will depend on site-specific conditions including speed of travel, direction of travel relative to the railing and the angle of the collision between the biker and the rail. Also, the type of bicycle and the height of the bicyclist will affect the center of gravity and therefore the rail height necessary to prevent vaulting or falling over the railing. Higher railings are needed on curves where cyclists can attain higher speeds over locations where cyclists are traveling parallel to the rail and will not be traveling fast. Another consideration is the degree of hazard faced when falling over the edge, e.g., a precipitous drop versus falling onto a grassy slope.



ODOT STANDARD BICYCLE RAILING ADJACENT TO STEEP SLOPES

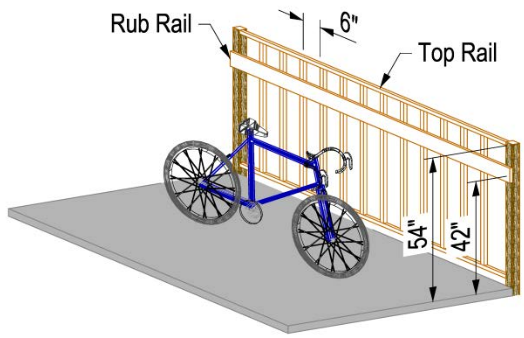
A 42-inch bicycle rail is recommended for locations where the combination of high speeds and high impact angles are not likely. For site conditions where this combination is likely, a minimum height of 48 inches is recommended. A rail height of 48 inches should be considered at locations where bicyclists should be protected from a severe hazard, such as:

- On the outside edge of a highway bridge.
- Between a bike path and travel lanes on a highway bridge where the biker may fall into the path of vehicular traffic (as opposed to a shoulder).
- A bikeway bridge with a drop of 2 feet or greater.
- Along a pathway where the railing protects from cliff, water body or other such hazard

Railing 54 inches high is recommended at locations where bicyclists should be protected from a severe hazard and have a potential to vault over the railing as a result of a high speed angular collision, e.g.:

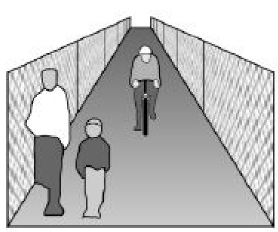
- Where the radius of curvature is not adequate for the design speed or attained speed and falling over the rail would subject biker to a severe hazard.
- Where sight distance is inadequate and a biker could take evasive action and collide with a railing at a sharp angle.
- At the end of a long descent where speeds of bicyclists are higher.

Railings, fences or barriers on both sides of a path on a structure should be at least 54 inches high per AASHTO bridge design manual, and where they are higher than 42 inches a rub rail should be provided at the approximate handlebar height of 42 inches, according to AASHTO.



According to the Ohio Department of Transportation (ODOT), a smooth rub rail should be attached to the barriers at handlebar height of 42 inches (3.5 feet) high. A smooth wide rub rail should be installed to at a height between 36 inches to 44 inches to reduce likelihood that a bicyclist's handlebar will be caught by the railing. The opening between horizontal or vertical members on railings should be small enough that a six (6) inch sphere cannot pass through them in the lower 27 inches. For the portion of the railing that is higher than 27 inches, openings may be spaced such that an eight (8) inch sphere cannot pass through them. This is done to prevent children from falling through the openings.

There is a slight difference between AASHTO and some other communities or agencies with respect to recommended heights. Some others recommend the bicycle railing should be 54 inches (4.5 feet) high, but all agree on the required rub rail height. A minimum of 48 inches (4 feet) high railing should be used on bridges and bridge approaches were high-speed, steep angle impacts between a bicyclist and railing may occur if not otherwise specified by the governing jurisdiction.



"Cattle- chute" effect

Care must also be taken to avoid a "cattle chute" effect by placing a high chain-link or other fence on each side of a path. Where this situation is needed or unavoidable, gaps should be placed along the fence. It is not desirable to place the pathway in a narrow corridor between two fences for long distances as this creates personal security issues, prevents users who may need help from being seen, prevents path users from leaving the path in an emergency, and impedes emergency response.

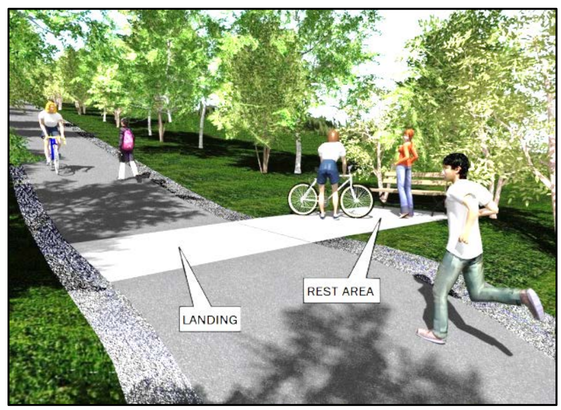
GRADE SLOPE MITIGATION

The following is guidance to mitigate steep grades:

- On Longer Grades Widen Pavement Width by 4-6 Feet to allow slower speed bicyclists to dismount and walk;
- Eliminate hazards to the path user near the end of a steep downgrade or ramp;
- Warn the path user by means of signage ahead of a steep downgrade hazard;
- Provide signage stating the recommended descent speed;
- Exceed the minimum stopping sight distance; or
- Provide a series of short switchbacks near the top of a descent to contain the speed of a descending bicyclist, or consider a portion of 10 to 20 ft. length with a 1 to 2% grade at the point of direction change on the switchbacks to provide a resting area for the path user.
- Provide small resting areas to break up a longer grade.

SHARED-USE PATH LANDING & REST AREA

Although optional, rest areas may be provided adjacent to the shared-use path outside of the path travelled way. When used, the requirements for rest areas include:



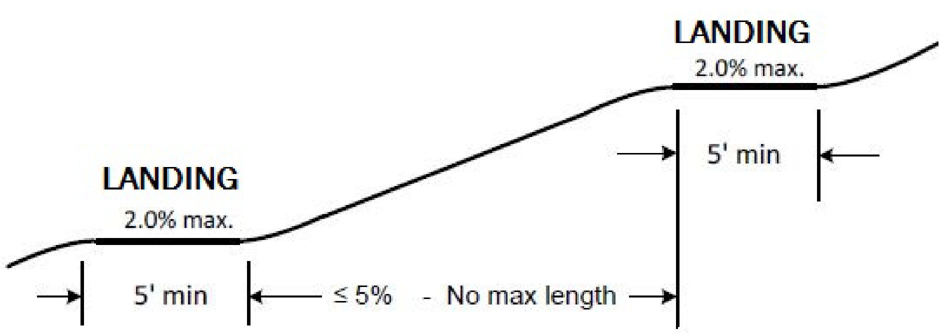
- The maximum rest area running slope and cross slopes are 2%.
- The minimum size is to be 5 feet by 5 feet.
- If features such as benches are provided, they must meet ADA requirements.

Shared-use path landings are desirable on extended grades. They provide users a level place to rest on extended grades.

Design landings to:

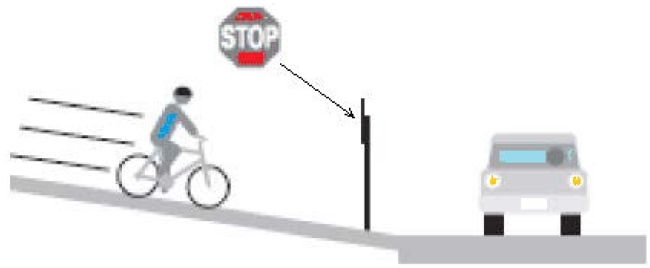
- Permit users to stop periodically and rest.
- Not exceed maximum running slopes and cross slopes of 2%.
- Be in line and as wide as the shared-use path. Landings are to be at least 5 feet long.
- Avoid abrupt grade changes or angle points. Design transitions to landings using vertical curves.

An alternative to using landings along the pathway is to provide a short sidepath to a rest area. The sidepath rest areas should be as close to the main pathway as possible yet allow the transition of running slope to rest area cross slope.



PATH TERMINATION

When shared-use paths terminate at existing roads, it is important to integrate the path into the existing system of roadways. Care should be taken to properly design the terminals to transition the traffic into safe merging or diverging situations. Appropriate signing is necessary to warn and direct both bicyclists and motorists regarding these transition areas.



Care must be taken so wrong-way riding is discouraged. The Florida DOT recommends the following guidelines when designing path termini:

- Analyze the tasks of both path users (bicyclists, skaters, and pedestrians) and motorists, and study the discrepancies between planned for and actual behavior. The design should take into account path user desire lines.
- Terminate the path at the lowest point of the street hierarchy as possible. It is generally better to end on a minor residential street than on a principal arterial if the choice exists. Path users can then work their way up the street hierarchy to their destination or their highest point of comfort.
- Provide sidewalks along the intersecting road for pedestrians, and recognize that some bicyclists may also use these, whether specifically intended for bicyclists or not. Sidewalks may be carefully designed to accommodate bicyclists in limited and special circumstances.
- Include positive guidance such as signs, pavement markings, and channelization to induce bicyclists to ride on the proper side of the road, with traffic.
- Provide educational materials for bicyclists, skaters, and pedestrians.
- If the path is terminated on a one-way street, consider a contra-flow bicycle lane to enhance bicycle transportation opportunities, and to accommodate inevitable would-be wrong-way riders.
- Restrict parking near the path terminus, as would be done for a street or driveway junction.
- A path-roadway terminus can be an excellent location to implement motor vehicle traffic-calming measures.
- Where the path ends at a busy midblock location, consider a jug-handle design to assist left-turning road bicyclists in making a right-angle crossing to access the path.

ADA ACCESSIBLE TRAILS

In order to provide adequate information about an existing trail or trail segment so that persons with disabilities can easily understand the difficulties they will encounter before setting out on that particular trail, it is necessary to evaluate the trail by conducting a trail assessment. 'Accessible' is a term used to describe a facility or trail that can be approached, entered, and used by persons with disabilities and that complies with standards established under the Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA). If a particular trail doesn't meet those standards, the information obtained during a trail assessment is still useful for individuals to determine whether or not that trail is appropriate for them. Objective information about the trail conditions will enhance the accessibility, safety, and satisfaction of all trail users, both with and without disabilities. All trails, but especially pedestrian trails should be evaluated to determine the following, when practicable:

- Length of trail or trail segment
- Surface type, firmness, and stability
- Typical and minimum tread width
- Typical and maximum running slope
- Typical and maximum cross slope
- Length of trail segments meeting accessible standards (in linear feet)
- Location of the first point of exception to accessible standards
- Tread obstacles that limit accessibility
- Elevation (trailhead, maximum, and minimum)
- Total elevation change

In addition to physical design standards, accessible trails also have official sign design standards. Accessible trail signs identifying trails and trail segments that have been officially assessed and designated as accessible to persons with disabilities shall be placed at the trailhead and at all designated access points. These signs shall display the official symbol designating that the trail or trail segment is accessible, and shall include the total distance of the accessible trail or trail segment and the distance to the location of the first point of exception to accessible standards. Marker posts may be used to display accessibility information at access points without trailhead signs. Decals are readily available to attach to flexible fiberglass marker posts. Where more extensive trail information is provided, the location of specific trail features and obstacles that do not comply with accessible standards should be identified. When available, the following additional information should be included on trailhead signs:

- Trail-specific trail symbol
- Running slope (average and maximum grade)
- Cross slope (average and maximum)
- Cumulative elevation change (gain and loss)
- Profile of the trail grade showing changes in surface type and accessibility
- Clear tread width (minimum and average)
- Tread obstacles (magnitude and frequency)
- Any major height obstacle, such as boulders, in the trail tread

CHAPTER 9 – ENVIRONMENTAL CONSIDERATIONS

"The below environmental process is provided as a guideline only and the user should consult and collaborate with the appropriate lead agency during the very early planning phases of a project to determine concerns and specific environmental requirements. The lead agency could be but is not limited to, Ohio Department of Transportation, Ohio Department of Natural Resources, Ohio Environmental Protection Agency, or the U.S. Army Corps of Engineers."

The National Environmental Policy Act (NEPA) of 1969 established environmental policies to ensure federal agencies assess and determine if an action will result in significant environmental impacts. The law requires all federal actions, permitting or funding, to seek a balance between engineering and environmental concerns. As a result, a multi-disciplinary approach is required in order to investigate an action's impact on both the human and natural environment. The goal is to ensure compliance with NEPA, as well as implementing federal regulations, while at the same time incorporating engineering requirements for the project. This approach includes the need to conduct appropriate environmental and technical studies, resource agency coordination, public involvement, and engineering analysis.

Bikeways not using federal funds still have to comply with federal and state laws, however the overall number of laws or regulations is not as extensive as it is under the NEPA process.

The *Environmental Guidelines* are divided into two sections:

- Bikeways with new right-of-ways or existing right-of-ways with significant disturbance.
- Bikeways within existing right-of-way and no new disturbance.

ENVIRONMENTAL FOR NEW RIGHT-OF-WAYS

The Environmental Guidelines are divided into three sub-sections:

- Environmental Documents;
- Guidelines for completing the environmental documentation for the preliminary engineering or planning phase;
- Guidelines for completing the environmental documentation for the final design, right-of-way, or construction phase.

ENVIRONMENTAL DOCUMENTS

Following is a summary of the different types of environmental laws and documents that can be required for federally and non-federally funded projects.

In the case of federally funded projects, it is anticipated that most local government projects will be classified as a Categorical Exclusions (CE), and some will also require the preparation of a 4(f) Evaluation because of the tendency to build bikeways in existing parks or other public lands. The federal sponsor will assist the local government in determining what environmental laws and documents are applicable to a project.

Non-federally funded projects are not covered by NEPA and therefore the documentation is significantly less and included below.

FEDERALLY FUNDED PROJECTS

All local government projects using federal funds must comply with the requirements of federal and state laws to ensure that the environment is protected. The major laws that must be complied with are:

- National Environmental Policy Act (NEPA): NEPA requires projects receiving federal funds to consider natural and socio-economic factors using a systematic, interdisciplinary approach before committing to a project. The process requires coordination with various environmental agencies to obtain information on cultural, socio-economic, and natural resources within the project area, documentation of any impacts upon those resources, and consideration of ways to avoid or minimize impacts as appropriate.
- Section 106 of the National Historic Preservation Act (NHPA): Section 106 requires projects receiving federal funds to consider the effect of the activity on significant historic structures and archeological resources.
- Section 4(f) of the Department of Transportation Act: Section 4(f) provides special protection for publicly-owned public parks, recreation areas, and wildlife and waterfowl refuges, or significant historic sites.
- Section 404 and 401 of the Clean Water Act (CWA): Section 404 and 401 of the CWA prohibits discharge of dredged or fill material into wetlands and waterways unless proven that steps have been taken to avoid and minimize wetland impacts where practicable, and unavoidable impacts are compensated through activities provided to restore or create wetlands.
- Section 7 of the Endangered Species Act (ESA): Section 7 of the ESA requires that federally assisted actions do not jeopardize the continued existence of any threatened or endangered (RTE) species or adversely modify the habitat of such species.
- Section 6(f) of the Land and Water Conservation Fund Act (LWCFA): Section 6(f) requires federally assisted actions that propose impacts, or the permanent conversion, of outdoor recreation property that was acquired or developed with LWCFA grant assistance be approved by the Department of the Interior's National Park Service. Impacts to Section 6(f) lands must be mitigated through replacement lands of equal value, location, and usefulness.
- Title VI of the Civil Rights Act and Executive Order 12898, Environmental Justice: Title VI ensures that no person on the grounds of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal funds. Executive Order 12898 requires agencies to identify and address, as appropriate, any disproportionally high and adverse human health or environmental effects of the project on minority populations and low-income populations.
- Farmland Protection Policy Act (FPPA): The FPPA is intended to minimize the impact federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It assures that, to the extent possible, federal programs are administered to be compatible with state, local units of government, and private programs and policies to protect farmland.

Compliance with the above referenced laws will be documented in the following:

CATEGORICAL EXCLUSION (CE)

CEs are defined as projects that do not result in significant environmental effects, and are therefore excluded from the requirements to prepare and Environmental Assessment (EA) and/or an Environmental Impact Statement (EIS). A project qualifies for a CE only if the proposed actions do not:

- Induce significant impacts to planned growth or land use for the area
- Require the relocation of significant numbers of people
- Have significant impact on any natural, cultural, recreational, historic or other resource
- Involve significant air, noise or water quality impacts
- Have significant impacts on travel patterns
- Either individually or cumulatively, have any significant environmental impacts

A typical CE is three to five pages in length, plus required attachments, i.e. ecological survey, including wetlands; cultural and historic investigations; and hazardous materials survey.

If the level of impacts exceed the threshold for a CE document then either an EA or an EIS will be required.

Because of the complexity and detail required, the local government should contact the federal sponsor for further information regarding any projects that require an EA or EIS.

Section 4(f) Evaluation

Section 4(f) Evaluations are used if a federally funded project "uses" a Section 4 (f) resource such as publicly-owned public parks, recreation areas, and wildlife or waterfowl refuges, or historic sites. Generally there are two types of Section 4(f) uses which require the preparation of a Section 4 (f) Evaluation:

- Fee-simple ROW
- Permanent and perpetual easements

The federal sponsor will assist the local government in determining when a Section 4(f) use occurs and appropriate level of Section 4(f) documentation required. Early identification of Section 4(f) uses will help the project stay on schedule, as Section 4(f) Evaluations can add several months to the approval process.

NON-FEDERALLY FUNDED PROJECTS

If federal funds will not be used, a local government must still comply with applicable state and federal laws, however the number of laws and documentation is significantly less. The most notable law for non-federal projects would be the above referenced Section 404 and 401 of the CWA, which regulates impacts to "waters of the US", including wetlands.

Depending on the environmental impact, documentation by the local government should include an environmental screening report that would document the following: an investigative site visit and secondary source literature reviews for cultural resources, ecological resources, FEMA mapped 100-year floodplains, and hazardous waste areas. The review typically does not include an ASTM Environmental (ESA) Phase I, II or a Phase I Archaeological Survey.

ENVIRONMENTAL DOCUMENTATION FOR PRELIMINARY ENGINEERING

Evidence of compliance consists of obtaining an approved document, referenced above, from the sponsoring federal agency if the Preliminary Engineering (PE) phase will be federally funded. The approved document is valid only for PE, which is generally defined as the level of design necessary to determine environmental impacts, minimization or mitigation of impacts, or to complete the environmental document required for the final design, ROW, or construction phase.

Studies that may need to be completed to support the above documentation and provide environmental compliance may include the following resources, with the appropriate state/federal resource agency listed:

- Ecological, including wetlands, streams, and waterways, scenic rivers, and threatened and endangered species
  - Ohio Department of Natural Resources (ODNR)
  - Ohio Environmental Protection Agency (OEPA)
  - U.S. Army Corps of Engineers (USACE)
  - U.S. Fish and Wildlife Service (USFWS)
  - National Park Service (NPS)

- Hazardous Materials, including gas stations, landfills, and industrial sites
  - OEPA
  - Bureau of Underground Storage Tanks Register (BUSTR)
  - U.S. Environmental Protection Agency (USEPA)

- Environmental Justice
  - FHWA
  - USEPA

- Cultural Resources, including historic bridges, archaeological sites, and historic buildings
  - Ohio Historic Preservation Office (OHPO)
  - Advisory Council on Historic Preservation (ACHP)

- Section 4(f) Properties, including parks, recreation areas, and wildlife/waterfowl Refuges
  - FHWA

- Section 6(f) Properties (Land & Water Conservation Fund)
  - ODNR-Real Estate and Land Management (REALM)
  - NPS

- Farmlands
  - Natural Resource Conservation Service (NRCS)

ENVIRONMENTAL DOCUMENTATION FOR FINAL DESIGN

Evidence of compliance consists of coordinating with the appropriate environmental agencies regarding the impacts of the project, or lack thereof, and obtaining an approved environmental document. The approved environmental document is required before the final design, ROW, property negotiation or acquisition, or construction phases of a project can begin. This document is separate from the document that is approved for the PE phase of a project.

> *Failure to obtain an approved document before starting any of these phases could result in the loss of federal funds.*
>
> *In order for final design to continue without interruption, the work required to obtain the approved document must be completed as early as possible in the design process*.

This is generally when enough work has been completed to determine the environmental impacts of a project.

If the local government intends to use federal funds for ROW activities, these activities (property negotiation or acquisition) cannot proceed until the environmental document has been approved. However, exceptions are allowed for situations that involve hardships and protective buys. It is acceptable for ROW activities such as title searches, preliminary map preparation and appraisals to be done concurrently within the NEPA process.

ENVIRONMENTAL FOR EXISTING RIGHT-OF-WAYS

Bikeways within existing right-of-way (ROWs) typically do not result in significant impacts to the human or natural environment; therefore no environmental documentation or further NEPA approval is required. This section of the Environmental Guidelines will give specific examples of proposed bikeway construction activities that are considered exempt and do not require environmental documentation and construction activities that may trigger NEPA approval and related environmental documentation. Specifically steps will be outlined to confirm proposed bikeways meet the exempt standards and will not need NEPA approval or environmental documentation.

Exempt and Non-Exempt Activities: If a project is exempt no further documentation or further NEPA approval is required. Generally the project meets the following:

- The intent of 23 CFR 771.117 (c); https://www.gpo.gov/fdsys/pkg/CFR-2011-title23-vol1/pdf/CFR-2011-title23-vol1-sec771-117.pdf
- Does not result in significant impacts to the human or natural environment
- Standard stand-alone transportation activities

The following projects or activities would be considered exempt and not require additional environmental consideration:

- Construction of bicycle lanes and pedestrian walkways, with no new disturbance, including:
    - Sidewalks, shared use paths, and facilities
    - Small passenger shelters
    - Alterations to facilities or vehicles for elderly and handicapped accessibility

- Guardrail installation and replacement including:
    - Median cable barriers, with no relocation of roadway ditches or back-slopes

- Replacement of existing or installation of new traffic signals, including:
    - Flashing beacons, RR warning devices, and Intelligent Transportation Systems with no likelihood of contaminated materials

- General pavement marking or "line painting"
- Herbicidal spraying
- Mowing or brush removal or trimming projects
- Installation or maintenance of signs, including
    - Pavement markings and raised pavement markers
    - Traffic calming activities
    - New or replacement fencing, with no likelihood of contaminated materials

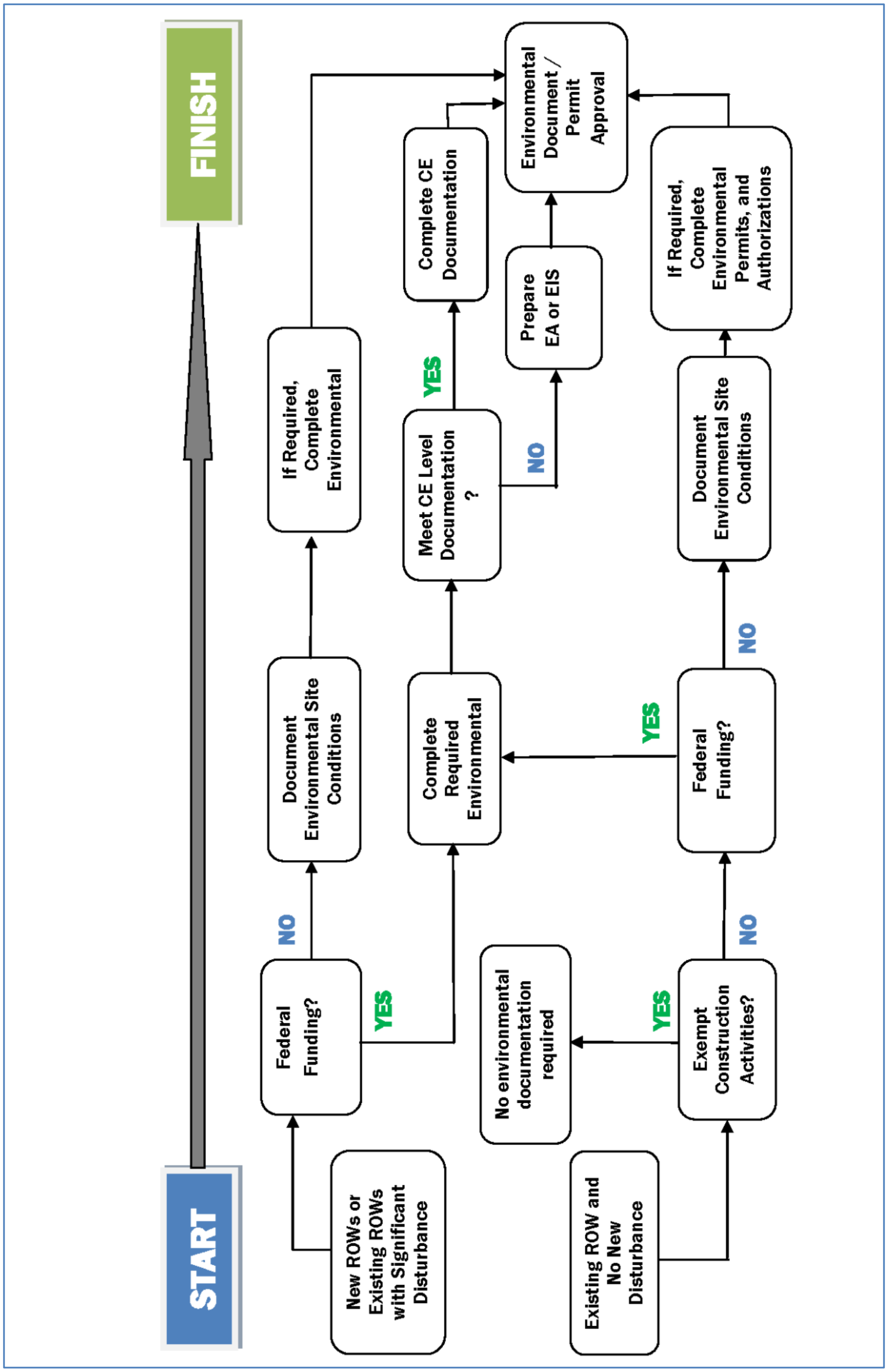
- Study or planning type projects
- Bridge projects that include:
    - Deck overlays and/or deck replacements
    - Superstructure replacement
    - Maintenance activities
    - Painting

- Maintenance, including:
    - Filling potholes
    - Crack sealing, mill, and resurfacing
    - Full pavement rehab
    - Joint grinding or milling and shoulder reconstruction
    - Minor slide stabilization or repair
    - Minor erosion control

- Projects or activities are NOT exempt when the following is present or will occur:
    - New ROW acquisition
    - Scenic River corridors
    - Section 404 or 401 federal Clean Water Act permits
    - State or federal threatened and endangered species
    - Wetlands
    - Historic properties or Historic Districts
    - Section 4(f)/6(f) properties
    - Substantial traffic disturbance
    - Public controversy

If any of the above, from the non-exempt list, will occur in the project area, additional environmental documentation will be needed, for federally funded and non-federally funded projects. Level of effort and documentation is dependent on resources proposed to be impacted and degree of impact. Because impacts to non-exempt resources are similar to, and may include ROW acquisition or expansion, the applicable laws, studies, and documentation have been outlined in the New Right-of-Ways section.

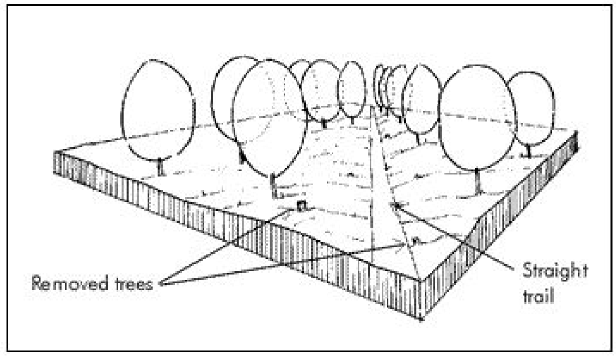
ENVIRONMENTAL DOCUMENTATION FLOWCHART

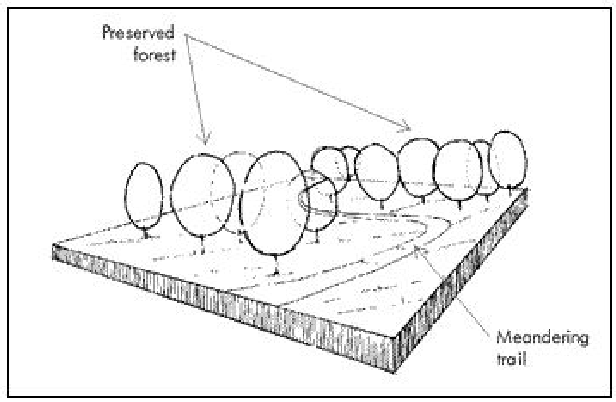


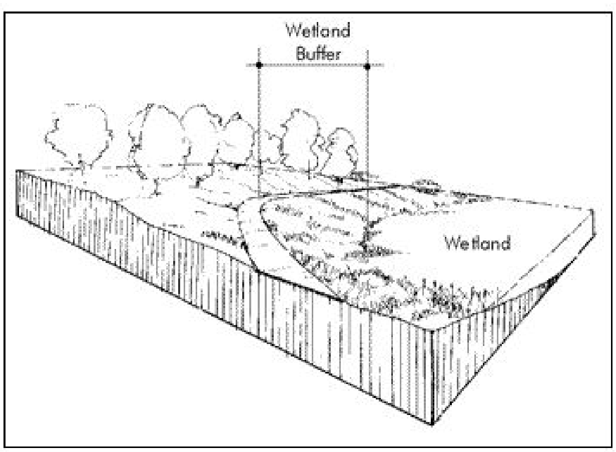
ENVIRONMENTALLY SENSITIVE CORRIDORS

A major desire of trail users is to be offered a scenic trail experience. In so doing, it is important that trails do not negatively impact the environment which they strive to showcase. The following guidelines describe how a trail's impact on natural and cultural resources could be reduced.

- Reduce grading on native grasslands and lakeshores.
- Avoid locating trails through wetlands. In cases where wetland crossings are necessary, a boardwalk or other structure may be used but would require a permit.
- Consider a buffer zone, planted with native vegetation, between trail and wetland, where possible.
- In forested areas and where possible, meander the trail to avoid the removal of trees.
- If avoiding trees is not practical, place the trail to minimize removal of trees. If possible, limit tree removal to those trees that have the least effect on the natural environment.
- Consult with the Ohio Department of Natural Resources if endangered or threatened plant or animal species may be present in the trail corridor.
- Adhere to all applicable environmental regulations and reviews.
- Avoid locating trails through known archaeological sites.
- Consult with Ohio State Historic Preservation Office if cultural or historic resources exist within the corridor.





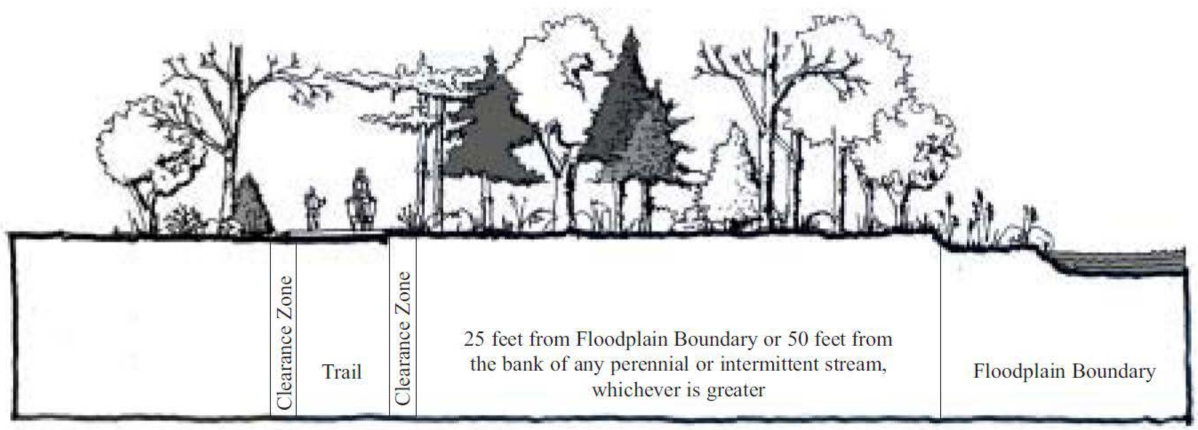


AVOIDANCE OF TREES (Above)

WETLAND BUFFER (Left)

FLOOD PLAINS

Floodplains are an important consideration in the design of bicycle paths and trails. Many of the proposed trails in the county may be near floodplains and stream corridors which present both negative and positive influences to trail design. A floodplain curtails the use of a trail when it is inundated by water and can increase trail maintenance with mud, debris or washout during a flood occurrence. Conversely, trails are well suited to stream corridors for several reasons. Flood damage to a trail is minor compared to above ground structures, Floodplains are usually left in a natural vegetative state, which provides an enhanced environment for trail users, and a large variety of plants and animals congregate along stream corridors because of the availability of water, food, and habitat.



For design purposes, it is recommended that trails near floodplains and stream corridors be located outside and parallel to the "stream buffer", which is recommended to have a 50 foot setback from the bank of any perennial or intermittent stream. Trails should avoid this area when possible or create as little disturbance as possible. Stream crossings by trails should be kept to a minimum.

Trail development can be designed to enhance the floodplain environment. One technique is to create forestation planting projects along the trail. This encourages reforestation of open space areas within the floodplain and stream corridor. These are high priority areas for forestation, because the forest provides benefits of slowing floodwater and filtering overland flow of sediment and pollutants before they reach the stream. Tree plantings for forestation projects should not be closer than ten feet to the trail surface. This distance discourages tree roots cracking and uplifting the pavement surface, and allows for lateral branch growth that will not interfere with the vertical clearance required for trail users. Other techniques to enhance stream corridors are to plant native grasses along the trail, or a mixture of grasses and native shrubs. These provide similar filtration benefits to forestation and offer a planting option for situations where forestation is not practical.

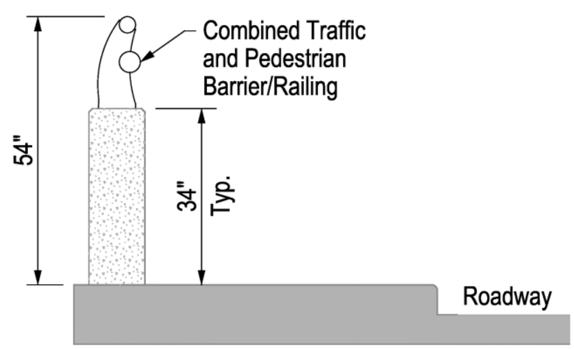
Any trail development within the floodplain or stream buffer will be strictly controlled by federal, state and county agencies and will require extensive review. The 100 year floodplain area must be delineated on development plans submitted to review agencies. Floodplain areas are depicted on maps produced by the Federal Emergency Management Agency (FEMA). Any stream buffer or floodplain activities must obtain all federal, state, and local permits.

CHAPTER 10 – BRIDGES

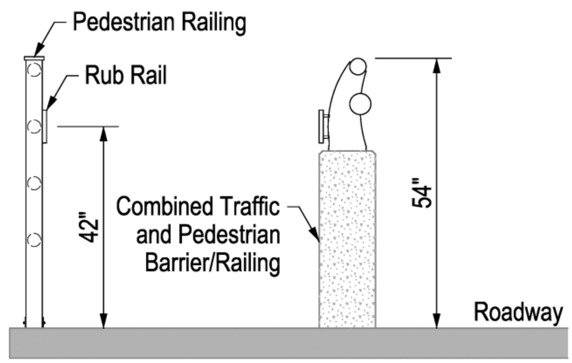
BRIDGE DESIGN FOR BICYCLES

Bridges serve an important function by providing bicycle access across barriers. However, some features found in bridges can be unsuitable where bicyclists are to be accommodated. The most common of these are curb-to-curb widths that are narrower than the approach roadways (especially where combined with relatively steep grades), open grated metal deck, low railings or parapets and certain types of expansion joints that can cause steering difficulties.

Sidewalks are generally not acceptable for bicycling. However, in a few limited situations, such as on long or narrow bridges, designation of the sidewalk as an alternate facility can be beneficial provided that curb cuts and appropriate signing are provided. Bridge railing or barrier curb parapets should have railings at least 4.5 feet) high.



LOW SPEED APPLICATION



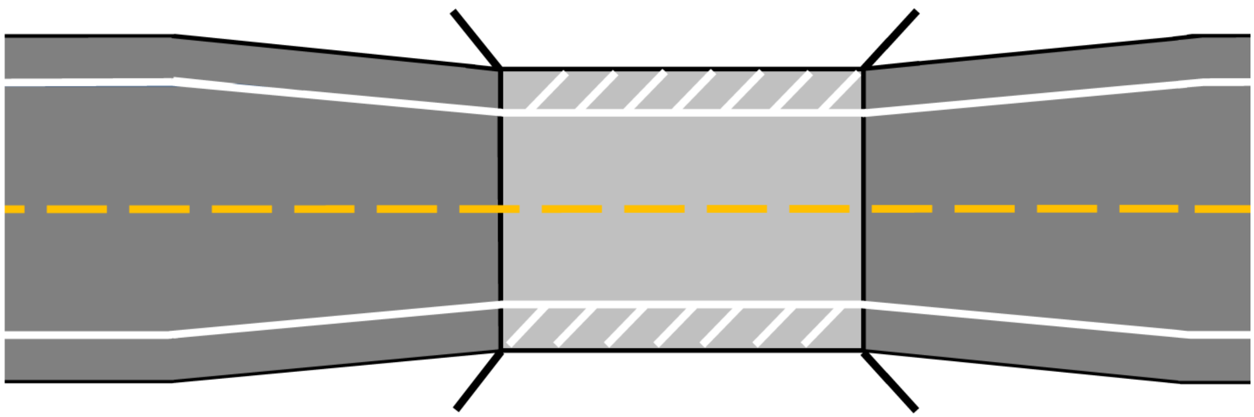
HIGH SPEED APPLICATION
(NON-FREEWAY PREFERRED)

TRANSITIONING AT BRIDGES AND STRUCTURES

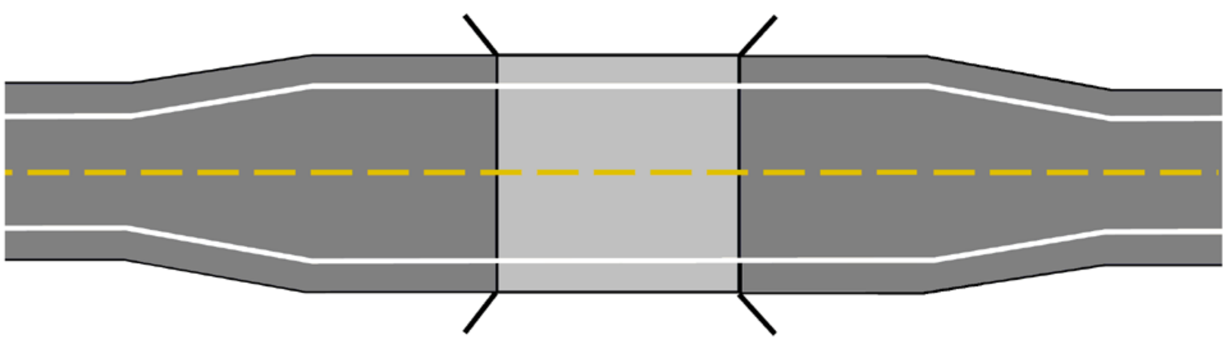
Abrupt changes in the pavement width of the right travel lane or shoulder should be discouraged. While skilled bicyclists will ride in a straight line by guiding off the lane stripe, many riders will unpredictably move right or left as the lane or shoulder widens or narrows.

Special transition problems frequently occur at bridges and structures, either when traffic lanes merge to cross a narrow bridge, or when a narrow roadway approaches a new, wider bridge. In the first situation, warning may be provided to both bicyclists and motorists by using the standard OMUTCD W5-2 "Narrow Bridge" sign in advance of any bridge or culvert having a roadway clearance less than the width of the approach pavement.

An additional treatment for unavoidable obstacles such as narrow bridges is to use zebra warning striping on the bridge shoulders. The stripes function to divert motor vehicle traffic away from the bridge parapet thus providing additional operating space on the right-hand side of the bridge for cyclists.



For the second situation, safe bicycle passage may be accommodated in the transition from a wide structure to a narrow roadway by continuing the extra operating width of the bridge shoulders or wide outside lanes for at least 100 feet on either side of the bridge. If entrance or exit ramps or intersections are present, the shoulder or wide curb lane treatment should continue at least as far as the ramps or intersection.



TRAIL BRIDGE DESIGN CRITERIA

An overpass, underpass, small bridge, drainage facility or facility on a highway bridge may be necessary to provide continuity to a bicycle path. On new structures, the minimum clear width should be the same as the approach paved bicycle path; and the desirable clear width should include the minimum 2 feet wide clear areas. Carrying the clear areas across the structures has two advantages. First, it provides a minimum horizontal shy distance from the railing or barrier, and second, it provides needed maneuvering space to avoid conflicts with pedestrians and other bicyclists who are stopped on the bridge. Access by emergency, patrol, and maintenance vehicles should be considered in establishing the design clearances of structures on bicycle paths. Similarly, vertical clearance may be dictated by occasional motor vehicles using the path. Where practical, a vertical clearance of 10 feet is desirable for adequate vertical shy distance.

Railings, fences, or barriers on both sides of a bicycle path structure should be a minimum of 54 inches (4.5 feet) high. A smooth rub rail should be attached to the barriers at handlebar height of 42 inches (3.5 feet).

Bridges designed exclusively for bicycle traffic may be designed for pedestrian live loadings. On all bridge decks, special care should be taken to ensure that bicycle safe expansion joints are used.

Where it is necessary to retrofit a bicycle path onto an existing highway bridge, several alternatives should be considered in light of what the geometrics of the bridge will allow.

One option is to carry the bicycle path across the bridge on one side. This should be done where:

- The bridge facility will connect to a bicycle path at both ends;
- Sufficient width exists on that side of the bridge or can be obtained by widening or restriping lanes; and
- Provisions are made to physically separate bicycle traffic from motor vehicle traffic as discussed above.

A second option is to provide either wide curb lanes or bicycle lanes over the bridge. This may be advisable where:

- The bicycle path transitions into bicycle lanes at one end of the bridge; and
- Sufficient width exists or can be obtained by widening or restriping.

A third option is to use existing sidewalks as one-way or two-way facilities. This may be advisable where:

- Conflicts between bicyclists and pedestrians will not exceed tolerable limits; and
- The existing sidewalks are adequately wide. Under certain conditions, the bicyclist may be required to dismount and cross the structure as a pedestrian.

Because of the large number of variables involved in retrofitting bicycle facilities onto existing bridges, compromises in desirable design criteria are often inevitable. Therefore, the width to be provided is best determined by the designer, on a case-by-case basis, after thoroughly considering all the variables.

PEDESTRIAN AND BIKEWAY BRIDGES LOADING REQUIREMENTS

Reference: Ohio Department of Transportation Bridge Design Manual Section 301.4.2 Pedestrian and Bikeway Bridges.

> Pedestrian and bicycle bridges shall be designed in accordance with the latest edition of the AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges; ODOT design guidelines; and this Manual. ODOT's most current design guidelines are available at ODOT'S Office of Local Projects website, www.dot.state.oh.us/local/.
>
> Where sidewalks, pedestrian, and/or bicycle bridges are intended to be used by maintenance and/or other incidental vehicles, an H15-44 vehicle, shall be included in the design loading. The H15-44 lane loading should not be considered. The vehicle live load shall not be placed in combination with the pedestrian live load and the dynamic load allowance need not be applied to the H15 vehicle.

BICYCLE BRIDGE DESIGN CRITERIA

Reference: Ohio Department of Transportation Bridge Design Manual Section 209.9 Bicycle Bridges.

> Reference should be made to ODOT's most current design guidelines and Section 300 of the Manual. The current design guidelines can be found on ODOT's Office of Local Projects web page, www.dot.state.oh.us/local/. For new structures generally the minimum bridge width should be the same as the width of the paved bicycle path and approach shoulders. A minimum transverse slope of 1/4 inch per foot [0.021] sloped in one direction should generally be used. Bicycle railings should be a minimum of 3'-6" high (to be acceptable to ODOT but not recommended for bicycle facilities). For the design of the railing refer to AASHTO LRFD Article 13.9. If an occasional maintenance vehicle is going to use the bridge, the railing should only be designed as a bicycle railing. The type of bridge deck joints used should be bicycle safe.
>
> If a timber deck is used, a 1.5 inch minimum thickness of Item 441, Asphalt Concrete Surface Course, Type 1, PG64-22, shall be applied in order to provide an abrasive skid resistant surface. Consult the Office of Structural Engineering for recommendations before specifying other alternative surfaces.

PEDESTRIAN BRIDGE DESIGN CRITERIA

Reference: Ohio Department of Transportation Bridge Design Manual Section 209.10 Pedestrian Bridges.

> Pedestrian facilities shall meet the grade and cross slope requirements specified in Volume One, Section 306.2.5 of the ODOT Location & Design Manual. For pedestrian bridges over highways an additional one foot of vertical clearance shall be provided. Refer to BDM Section 301.4.2 for additional design guidance.
>
> If a timber deck is used, a 1.5 inch minimum thickness of Item 441, Asphalt Concrete Surface Course, Type 1, PG64-22, shall be applied in order to provide an abrasive skid resistant surface. Other alternative surfaces may be used if approved by the Department.

SIDEWALKS ON BRIDGES DESIGN CRITERIA

Reference: Ohio Department of Transportation Bridge Design Manual Section 209.11 Sidewalks on Bridges.

> Sidewalks should be provided where significant pedestrian traffic is anticipated and/or the approach roadway has sidewalks or requires provisions for future sidewalks. Refer to Volume One, Section 306.4 of the ODOT Location & Design Manual for specific pedestrian traffic requirements. The width of the bridge sidewalk is generally the width of the approach sidewalk plus 12 inches [300 mm], with the widths typically between 5 and 6 feet [1500 and 1800 mm] wide.
>
> A 1/4 inch per foot [0.02] cross slope should be provided to drain the sidewalk towards the curb line. The sidewalk height shall be 8 inches [203 mm] on the bridge, tapering down to the approach curb height within the length of the approach slab.
>
> A detail of the standard curb (height, face slope, and corner rounding) should be given. Refer to Section 300 of this Manual for vandal protection fencing requirements.

EXISTING RAILROAD BRIDGES CONVERSIONS

Existing railroad bridges were designed for the heavy loads imposed by rail traffic. When a railroad is abandoned the existing railroad bridges often remain. This is because the cost for removing the bridge usually exceeds the bridge's scrap value. Unless the existing railroad bridge is deteriorated beyond the point that it can be economically repaired, it usually can be converted for pedestrian, bicycle, and equestrian use. It can also usually support maintenance vehicles and emergency vehicles.

Considerations for conversion of prior railroad bridges include:

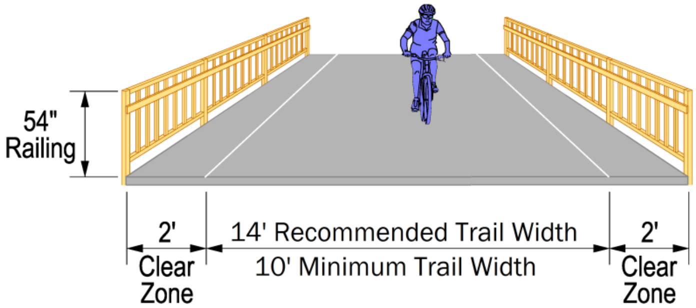
- Determine the bridge's historical significance. The State Historic Preservation Office (SHiPO) can assist with determining if a bridge is eligible for the National Register of Historic Places or has already be determined to be historic. An experienced professional engineer, architect, or historian (environmental scientist) can assess the structure's historical significance.
- Determine the bridges existing condition and suitability for modification. A professional engineer experienced in designing, inspecting and evaluating the condition of bridge structures should be engaged to determine the existing condition of the existing railroad bridge to be converted and evaluate the extent of any repairs and modifications needed to convert the bridge to trail use.

INDEPENDENT TRAIL BRIDGE DESIGN CRITERIA

In addition to traversing roadways and highways, bridges are common trail structures used to cross other trail barriers, such as creeks, rivers and ravines.

Although bridges are designed to fulfill a practical role, with safety as the ultimate purpose, trail planners and designers are encouraged to incorporate bridge solutions that reflect the unique character of each trail and its surroundings, with minimal environmental impact.

Fully engineered, pre-fabricated, clear span bridges of welded steel construction for all required bridge structures are recommended. These bridge solutions are widely recognized in the bridge industry and have been used successfully on trail projects throughout the country. They are safe, durable, economically priced and come in a variety of designs and spanning capabilities. The following specifications should be considered as minimum standards for the design and construction of each bridge, in addition to the design considerations for roadway overpasses:



- Bridges must be designed by a licensed and registered engineer in the State of Ohio.
- Bridges for pedestrians and/or bicycle traffic shall be designed for a minimum live load of 85 PSF and in accordance with the Ohio Department of Transportation Bridge Design Manual (BDM) Section 209.9 & 209.10.
- Where bicycle or pedestrian bridges are expected to be used by maintenance vehicles, special design consideration should be made for these loads.
- Bridges shall be designed to withstand wind loads.
- Bridges shall be designed to accommodate temperature differentials and maximum deflection allowances.
- Bridge materials shall be of unpainted weathering steel or painted steel with either wood decking or a poured concrete floor.
- All structural members shall have a minimum thickness of material of at least 3/16".
- Bridge fabricators must be certified by the American Institute of Steel Construction and have the personnel, organization, experience, capability, and commitment to produce a safe and quality product.
- Workmanship, fabrication, and shop connections shall be in accordance with American Association of State Highway and Transportation Officials Specifications (AASHTO).
- Provide all railings, toe plates and fencing, as required per all applicable codes.
- Provide quality design and workmanship with a minimum of a 10-year warranty against defects in materials and workmanship.

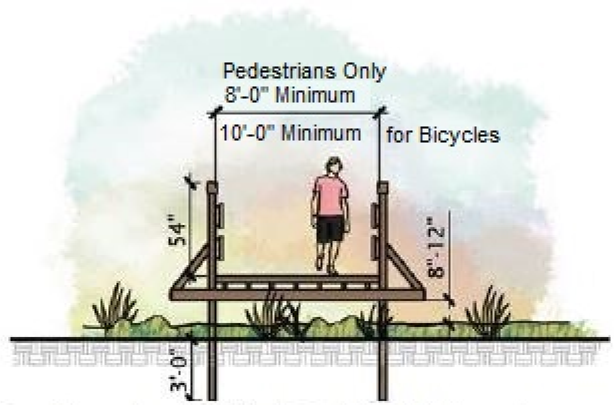
BOARDWALK DESIGN CRITERIA

Boardwalks are used to span unavoidable wet areas, sensitive resource areas, or depressions. Boardwalks should be considered where wetland and sensitive habitat areas are located. They also can be used to provide trail in areas where grading and filling might harm tree roots or create trail surfaces that wildlife such as amphibians will not cross.

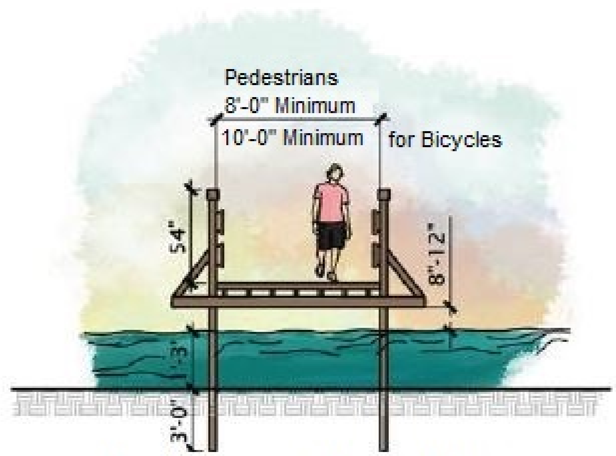
Footings vary depending on soil conditions. Plastic lumber is more expensive than wood but very long-lasting for deck boards. Its heavier weight can help avoid floating in sites that flood and the pronounced texture can reduce slippery surfaces.

Wood surfaces in shaded or moist sites may become slick or even grow moss. This can be managed by attaching half-inch (1/2”) hardware cloth (wire mesh), especially where boardwalks follow creek grade, and be attached with one-and-a-half-inch (1 ½”) heavy-duty staples approximately eight to twelve (8-12) inches apart. The upper side of the mesh should have wires perpendicular to the direction of travel. The ends of hardware cloth should be tucked between deck boards or lapped over the sides and stapled every four to six (4-6) inches. Paint with sand texture may also help, depending on site conditions. An annual cleaning (after autumn leaves fall) is recommended. A kick rail is particularly important along accessible trails where it helps people using canes or wheelchairs stay on the structure.

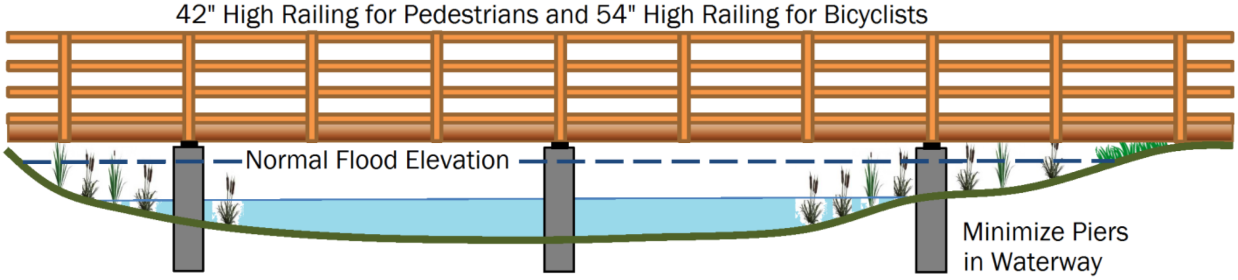
Boardwalks need to be designed by a licensed and registered engineer in the State of Ohio.



Boardwalk over Sensitive Habitat Area



Boardwalk over Shallow Water



WETLAND BOARDWALK

BOARDWALKS OVER WETLANDS

In general, bikeways and trails should avoid swamps, marshes and other wetland areas whenever possible. Occasionally, however, for unique interpretive or educational purposes, a trail may cross a wetland. In such cases, elevated boardwalks are especially useful to allow trail users to experience the natural environment without negatively affecting the area. The boardwalk crossing should provide the same conditions and ease of use as the trail approaching the bridge.

- These crossings should be level with the trail surface and at least as wide as the approaching trail. Allow extra width on shared-use crossings (2 feet on each side) for passing or maneuvering.
- When handrails for pedestrians are required they should be 42 inches above the trail. Handrails are in addition to 54” high railing required for bicyclists.
- Provide side barrier at trail level to prevent wheels and runners from dropping off the boardwalk.
- Visibility needs to be adequate for the approach and signs should be utilized to alert the user.
- Boardwalks must be designed by a licensed and registered engineer in the State of Ohio. All boardwalk designs must be permitted through the appropriate agencies when encroaching on environmentally sensitive areas.

BOARDWALK DESIGN LOADING CRITERIA

Boardwalks should be designed for live loads that meet State of Ohio and local building code requirements. There are applications where live loads need to be increased or decreased based on occupancy type (ex. Concert stage will require heavier live load and a ramp may allow a lighter design load). Depending on the application, boardwalks may need to be designed for pedestrian live loads, vehicular live loads and other types of loads such as wind, seismic, snow, equestrian, and flooding. Designs should be per the following:

TYPE OF APPLICATION	GOVERNING DESIGN CODE
Boardwalk, Swale Crossing, Multi-Use Path, Bike Trail, Elevated Greenway	AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges
Ramp, Deck, Observation Platform	International Building Code (IBC) or local building code.
Vehicular Bridge	AASHTO LRFD Bridge Design Specifications and ODOT Bridge Design Manual (BDM)

Following are several common boardwalk live load options for engineers to consider when designing a public or commercial boardwalk. A single vehicle shall be placed to produce the maximum load effects and shall not be placed in combinations with the pedestrian load. The dynamic load allowance need not be considered for this loading.

The AASHTO LRFD code requires that when the clearance width of a boardwalk is greater than 7'-0" but less than 10'-0", the design vehicular live load shall be H-5 Truck. It is also common for an agency or municipality to run pickup trucks or larger maintenance vehicles over the top of the boardwalk, thus validating the H-5 truck. The H-5 truck would be equivalent to a 10,000 lb. vehicle.

The AASHTO code requires that clearances greater than 10'-0" shall be designed for a vehicular live load of H-10 (20,000 lb.)

BOARDWALK DESIGN VEHICLES

Maintenance Vehicle: Parks and recreation maintenance crews often need to access their boardwalks with small vehicles. There small vehicles typically weigh 5,000 lbs. with 2,500 lbs. per axle with a 96" wheel base.

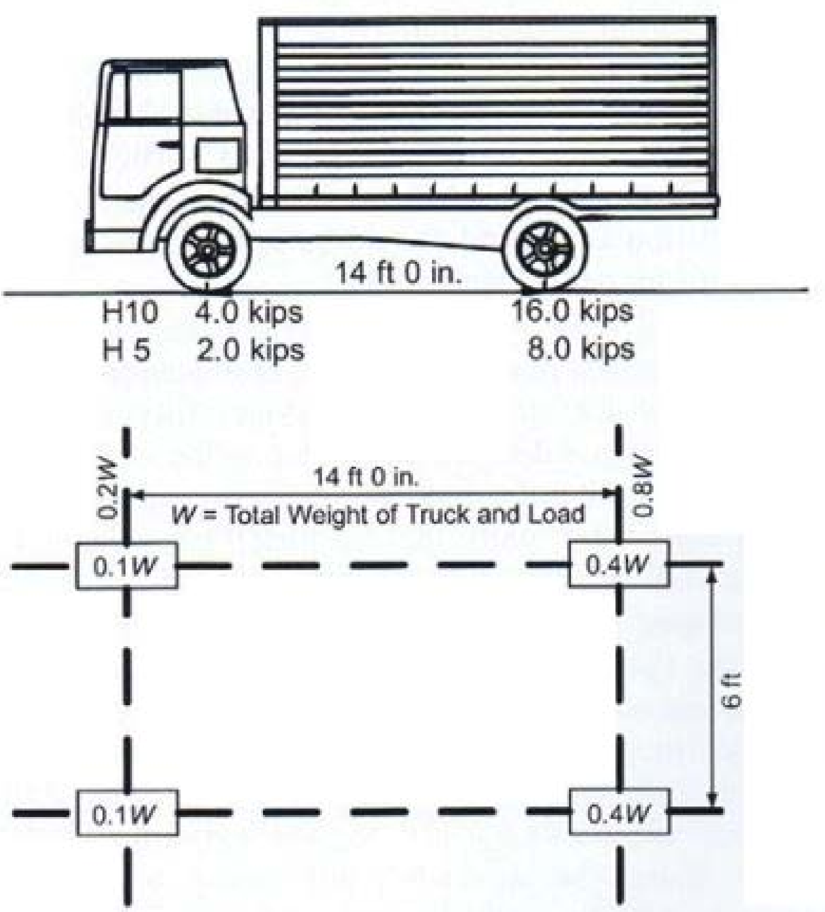
H-5 Truck (10,000 lbs. vehicle): AASHTO H-5 vehicle weighing 10,000 lbs. with 8,000 lbs. & 2,000 lbs. axles with a 14' wheel base and 72" width between wheels.

Emergency Vehicle (15,000 lbs. vehicle): The next level of design should be for an ambulance or emergency vehicle which has been described as a 15,000 lb. vehicle.

H-10 Truck (20,000 lbs. vehicle): AASHTO H-10 vehicle weighing 20,000 lbs. with 16,000 lbs. & 4,000 lbs. axles with a 14' wheel base and 72" width between wheels.

Design Vehicle

Clear Deck Width	Design Vehicle
7 to 10 ft	H5
Over 10 ft	H10



TRAIL BRIDGE CLASSIFICATIONS & INSPECTIONS

A trail bridge is a trail structure, including supports, erected over a depression or obstruction such as water, roadway, trail or railway that provides a continuous pathway and has a deck for carrying traffic or other loads.

Trail bridges are divided into three classifications for inspection purposes: Complex Trail Bridges; Major Trail Bridges; and Minor Trail Bridges

Each trail bridge classification is defined in more detail below.

Complex Trail Bridges

Complex trail bridges include all trusses, suspension, multiple-span, and non-timber/log trail bridges with a span greater than 20 feet and a vertical distance greater than 5 feet. Major Trail Bridges which develop significant structural defects and/or load limitations would be moved to the complex trail bridge classification. Minor trail bridges, determined to have increased complexity or user safety concerns, could be classified as complex trail bridges. An example of this might be a short concrete bridge (less than 20 feet) located over a deep gorge.

Major Trail Bridges

Major trail bridges include all single-span timber/log trail bridges with a span greater than 20 feet and a vertical distance greater than 5 feet. Minor trail bridges, determined to have increased complexity or user safety concerns, could be classified as complex trail bridges. An example of this might be a short timber bridge (less than 20 feet) located over a deep gorge.

Minor Trail Bridges

Minor trail bridges include all trail bridges that do not meet the definition of a complex or major trail bridge, and that have a span less than 20 feet or a vertical distance less than 5 feet. Minor trail bridges do not include boardwalks, puncheon, and similar trail structures.

Trail Structures

Trail structures include constructed features on a trail such as puncheon, boardwalk, retaining walls, water bars, etc.

Other Trail Structures

This includes structures such as fishing docks, viewing platforms, etc. that are frequently located on or adjacent to a trail. These features are often engineered similarly to a bridge, and often involve moderate-to-high risk to users in the event of structural failure. They do not meet the definition of a continuous pathway, however, and are often considered destination points instead.

INSPECTIONS

Trail bridges and structures requires a periodic technical inspection by an Ohio registered professional engineer prequalified and experienced in performing bridge inspections in the Stage of Ohio. Bridges should be inspected yearly and all structures every five (5) years.

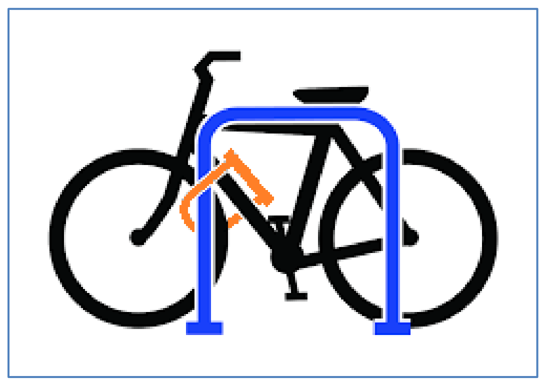
CHAPTER 11 – BICYCLE PARKING AND STORAGE

BICYCLE PARKING

Every bicycle trip has two main components: the route selected by the bicyclist and the "end-of-trip" facilities at the destinations, such as safe and secure bicycle parking. This section provides guidance on the provision and placement of safe, secure, and convenient bicycle parking facilities.

As the Jefferson County bicycle network grows, so will the population that chooses to ride a bicycle. The availability of secure and convenient parking is critical to bicyclists. The availability of short and long-term bicycle parking at key destinations such as parks, schools, community facilities, transit stations, and municipal centers is a vital part of a complete bicycle network.

Bicycle racks and bicycle lockers are the basic equipment types. Different designs and manufacturers are readily available. Bicycle racks generally meet short-term parking needs. They are convenient for brief stops at shopping centers, libraries, post offices and other locations and are simple to use.



Bicycle lockers are suited for locations that must accommodate long term bicycle storage needs such as at transit centers, park and ride lots, schools, employment centers and multifamily residential developments. They are typically used by commuters and offer secure storage space and protection for accessories. Lockers usually require a rental or lease program and/or key distribution system and must be monitored and maintained. Locker designs include options for double-sided access with interior partitions and can be purchased in different type groupings and numbers of units.

In some cases, a combination of both lockers for long-term storage and racks for quick, easy access should be provided at the same location to meet the needs of different types of users.

Short-term bicycle parking facilities, generally bicycle racks, should be highly visible and easily accessible and should be provided at entrances to destinations like libraries, downtown commercial areas, post offices, parks and other public spaces. Wherever possible, bicycle racks should be located under a shelter.

BICYCLE PARKING DESIGN GUIDELINES

- Place short-term bicycle parking as close to the building entrance as possible. This increases security and makes bicycle riding a visible travel option to bicyclists and non-bicyclists. Avoid placing short-term bicycle parking in an out-of-the-way place. Avoid placing screening or landscaping around short-term bicycle parking. Hiding bicycle parking increases theft.
- Make bicycle parking visible to bicyclists, building security, foot traffic, and anyone approaching the building. Making bicycle parking visible to foot traffic reduces the incidents of theft and vandalism.
- Provide lighting for bicycle parking areas if needed. Motorists as well as bicyclists prefer to park in a well-lit place and it's a theft deterrent.
- Install parking devices which support the frame of the bicycle, not just the wheel. Poorly designed bicycle parking devices bend the wheel and damage the bicycle.
- Install parking devices which accept a variety of locks. It's discouraging for a bicyclist to ride to a rack and be unable to lock to it.
- Make the parking facility simple. Many racks designed for short-term bicycle parking are too complex. Inverted-U's are simple, relatively vandal and maintenance proof, and accept a variety of locks. Grid-style racks can damage wheels and are not recommended.
- A bicycle rack needs to provide two points of contact to secure a bicycle.
- Keep the bicycle's parking area clean. Bicyclists don't feel unkempt parking areas are secure. Plan for regular maintenance.

NOT-RECOMMENDED BICYCLE RACK

- Provide cover from the elements. Bicyclists don't want to sit on a wet seat or leave their bicycle out in the rain to rust.
- Develop a bicycle locker rental program that is low cost and convenient to encourage use by bicycle commuters.
- Avoid posting "No Bike Parking" signage. If bicycles are being parked outside of the bicycle parking area, something is wrong with your bicycle parking. If signage is to be provided, place a sign indicating the location of bicycle parking.
- Avoid placing bicycle parking where irrigation systems coat the bicycles with water.
- Avoid installing lockers, or other bicycle racks, which could be used for anything other than bicycle storage. Coin-operated lockers can create maintenance and operation issues.
- Avoid installing bicycle parking devices which can be tripped over and could be a hazard to pedestrians and visible impaired.
- Two points of contact are preferred for securing bicycles to a rack.

BICYCLE RACKS

Inverted-U Bicycle Rack (Recommended)

An inverted-U bicycle rack is typically 36” high and constructed of 2 3/8” galvanized pipe. The inverted-U bicycle rack is recommended because it provides good support to the bicycle, and users are able to lock both the wheels and frame of the bicycle to the rack. The rack has no sharp edges or moving parts and is virtually maintenance free.

Multiple Loop Bicycle Rack or Ribbon Bicycle Rack

Multiple loop bicycle racks or ribbon bicycle racks are sometimes used. However, ribbon style bicycle racks limit the ability to secure a bicycle using two points of contact without severely reducing the capacity of the rack. Multiple inverted-U bicycle racks should be used instead of ribbon racks.

Public Bicycle Corrals (On-Street Bicycle Parking)

Bicycle Corrals are an on-street bicycle parking facility that can accommodate up to 16 bicycles in the same area as a single vehicle parking space. They work best where sidewalks are too narrow to accommodate bicycle racks and in areas with both high levels of people bicycling and demand for bicycle parking. When placed near street corners, a Corral also increases visibility and creates an additional buffer between people walking and people driving.

BICYCLE RACK MATERIALS

Stainless steel: Requires no coating and is attractive and virtually maintenance-free, but it is typically the most expensive material.

Vinyl coating: Can be somewhat more expensive than other options, but is one of the best when aesthetics and durability are considered. Vinyl requires minimal maintenance. Vinyl coatings are the most user-friendly of all the **options** because they will not scratch bicycles the way harder coatings will.

Powder coating: An excellent option because it allows all of the same color options as paint, but is very durable. Powder coating is usually the same cost as galvanized.

Galvanized coatings: Durable and much less expensive than stainless steel, but galvanized racks are not typically considered as attractive as other options.

Paint: Economical, but is not as durable as the other options.

This is a major issue where metal surfaces are subjected to alternating cycles of heavy rain in the winter months and heat in the summer.

Stock: Whenever possible, racks should be constructed from square metal stock, since round stock may be vulnerable to pipe cutters.

PUBLIC BICYCLE RACK LOCATION GUIDANCE

Public bicycle racks should be placed in public right-of-way and placed to comply with ADA requirements. The bicycle racks should be placed to avoid conflicts with pedestrians and parked vehicles. A recommended place for public bicycle racks is near the curb and away from building entrance ways, crosswalks, bus stops and loading zones.

In order to accommodate a range of bicycle styles and sizes, racks must be installed to allow sufficient space between bicycles and between racks.

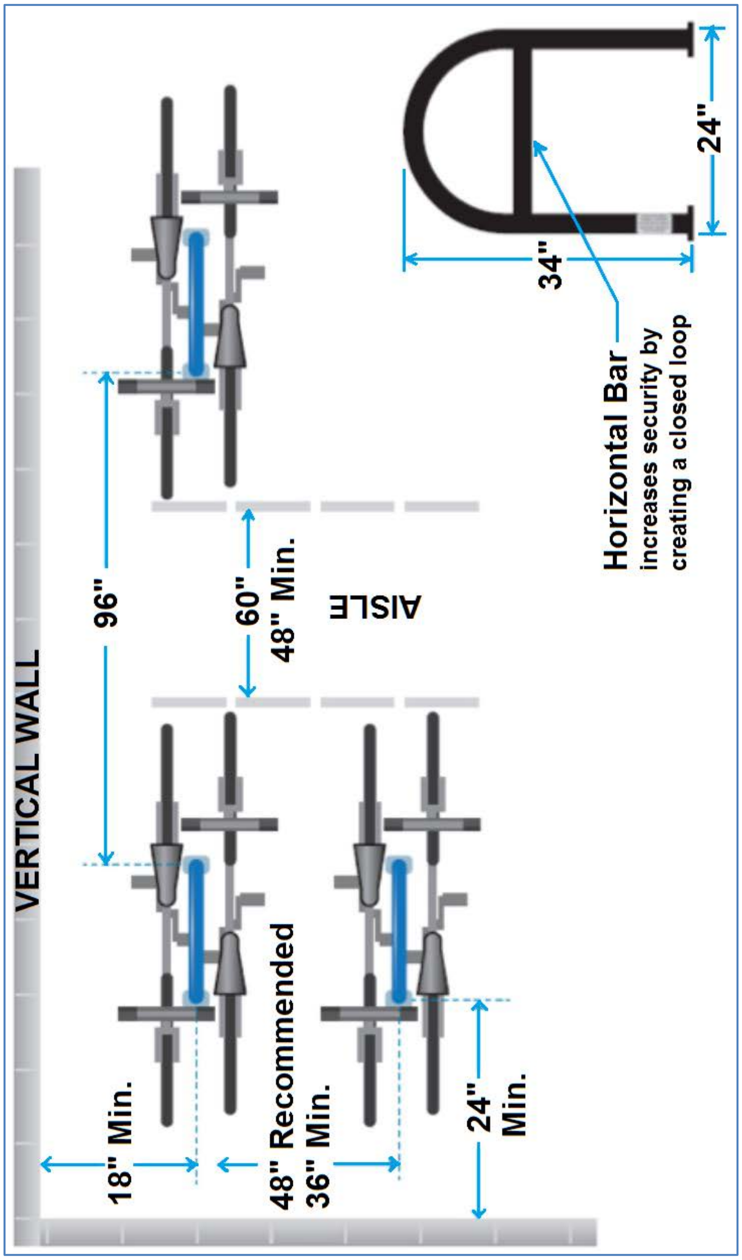
If there are two or more rack spaces (also known as “elements”) in a single rack, there must be a minimum of 36 inches (48 inches recommended) center to center between bicycle racks when bicycles are locked side to side; otherwise, the handlebars of one bicycle can prevent another bicycle from parking in the adjacent space.

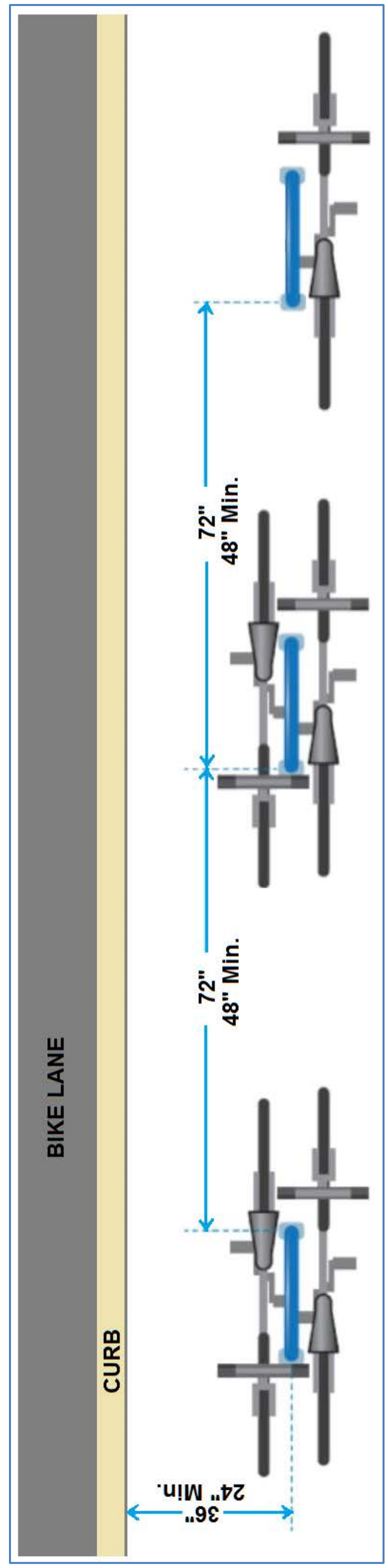
In addition to optimizing space by situating adjacent bicycles a sufficient distance apart, bicycle racks must be installed to allow sufficient space for bicyclists and their bicycles to move about between racks. In most cases, a standard bicycle footprint is six feet long. Aisles between rows of racks must be a minimum of four feet wide.

For security, bicycle racks should always be installed in concrete. If concrete is infeasible, asphalt is acceptable on rare occasions. Soil is never acceptable. There are two primary types of bicycle rack installation: surface mount and cast in place. Either is acceptable, but for certain rack models, only one installation type will work.

Surface mount is appropriate where racks are being installed onto an existing concrete slab. Anti-tampering bolts and other hardware should be used to prevent theft of the whole rack. If an asphalt substrate is all that is available, concrete footings should be poured.

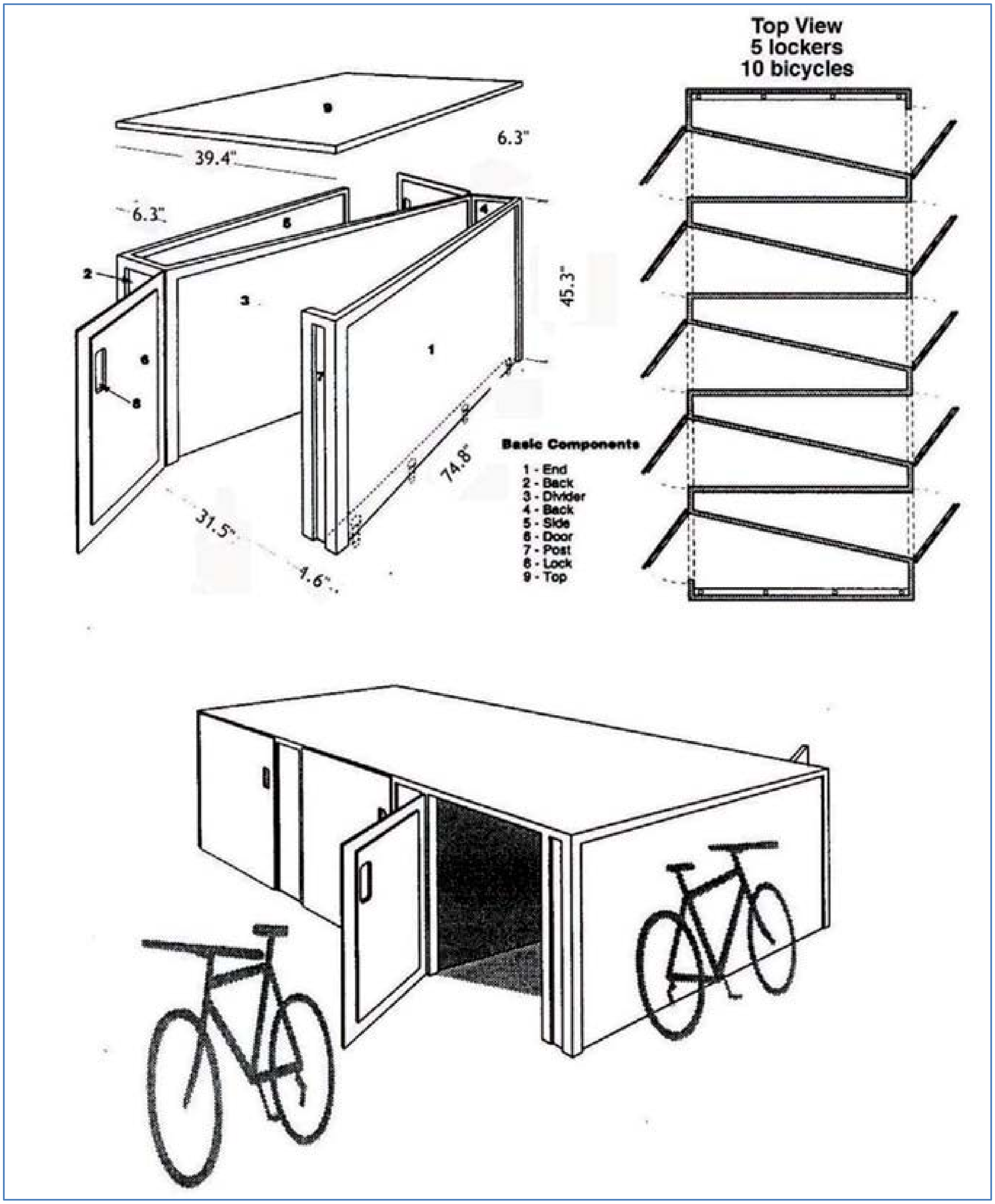
Cast-in-place is the best option for security purposes, but may be impossible if the rack installation location already has a slab poured or if the chosen rack type does not provide a cast-in-place option. Cast-in-place installation is appropriate for either asphalt or concrete.


VERTICAL WALL
96"
60"
48" Min.
AISLE
Horizontal Bar
increases security by
creating a closed loop
34"
24"
18" Min.
48" Recommended
36" Min.
24"
Min.


BIKE LANE
CURB
72"
48" Min.
72"
48" Min.
36"
24" Min.

BICYCLE STORAGE

Bicycle Lockers are covered storage units that can be locked individually, providing secure parking for one bicycle. Bicycle Cages are secure areas with limited-access doors. Occasionally, they are attended. Each of these means is designed to provide bicyclists with a high level of security so they feel comfortable leaving their bicycles for long periods of time. They are appropriate for employees of large buildings and at transit stations. Lockers provide a secure place for bicyclists to store their helmets or other riding gear. Showers are important for bicycle commuters with a rigorous commute and/or formal office attire.



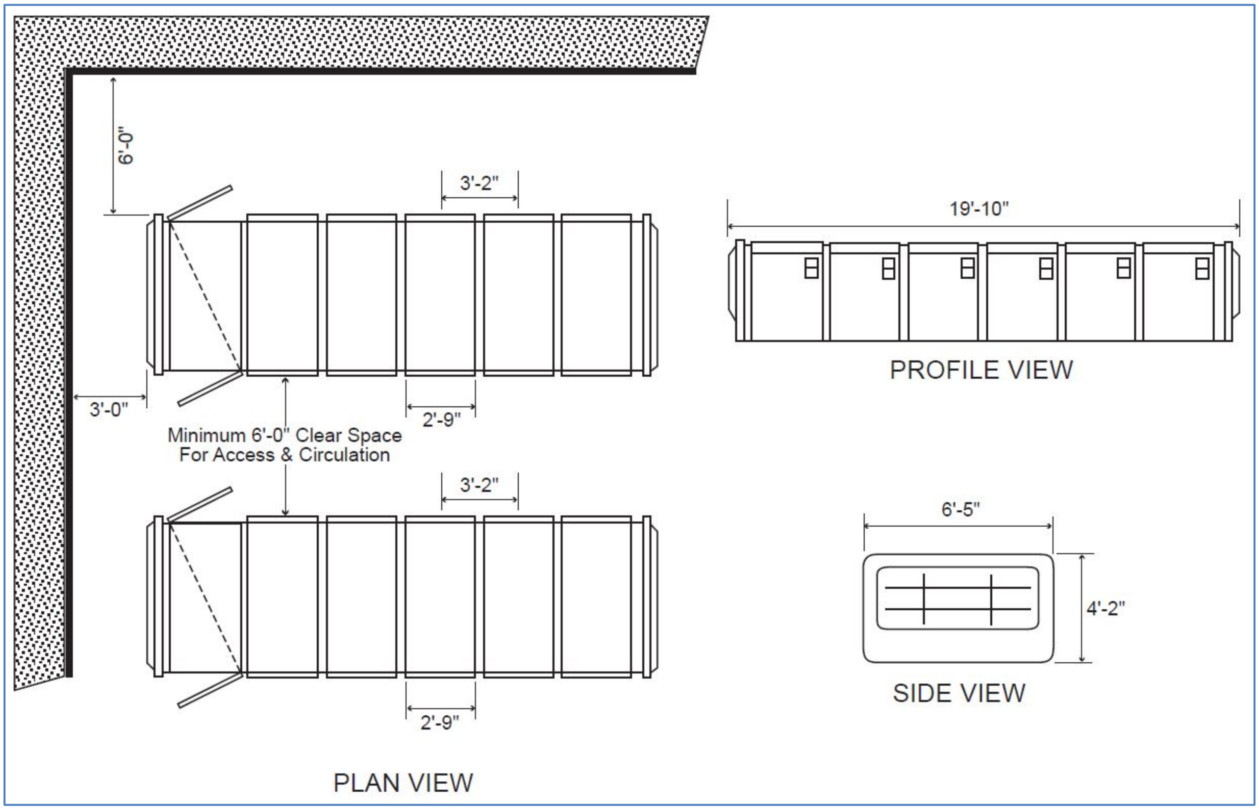
Long-term bicycle facilities such as bicycle lockers should be located in secure, easily monitored locations. At transit centers lockers should be placed near boarding locations and be separated from motor vehicle parking areas. Lockers at employment centers should be located near building entrances. In all cases, access to bicycle lockers should be convenient but must not interfere with pedestrian flow or traffic.

BICYCLE LOCKER MATERIALS

Stainless steel: The best material because it is the strongest and most durable, it reflects sunlight well, and requires the least amount of maintenance because it never needs painting.

Powder coated steel: The second best option. Although not as durable as stainless steel, powder coated steel is available in a broad range of colors (though dark colors should be avoided due to heat absorption in the summer) and will last many years.

Composite materials: Composite materials such as resin-based materials, chip-board, and particle board should be avoided. These materials photo-oxidize and break down quickly, and are not as secure as steel lockers.



BICYCLE ELECTRONIC LOCKERS

Electronic bicycle lockers provide secure individualized parking that can be accessed with an electronic card. Unlike standard key lockers which provide one key for one renter, a single e-locker can be rented by multiple cyclists each week by using smart card technology.

MULTIMODAL CENTERS & BICYCLE STATIONS

Unstaffed bicycle stations are shared access storage areas in which registered cyclists lock their own bicycles. Cyclists gain access to these facilities by registering for a key or key code. Security can be bolstered with surveillance cameras, human monitoring, visual transparency (such as wrought iron fencing), and by locating them in areas with plenty of pedestrian activity. (Note: Cameras are only recommended in conjunction with human monitoring and action; otherwise, they do not deter vandalism or theft.)

Also known as valet bicycle parking, staffed bicycle parking facilities offer a high level of security and often provide repair and retail services to generate revenue to offset staffing costs and to provide additional services for users. Bicycles parked in staffed facilities are typically not locked if they are checked in and out by the staff person. Staffing costs make such facilities more expensive to operate than other types of parking, so hours of operation can be limited. Cyclists who need to retrieve a parked bicycle after hours must make prior arrangements with the staff operator. Arrangements may include securing the user's bicycle to an outdoor rack of locker at the time the staffed facility closes thereby allowing the bicycle user to retrieve their bicycle afterhours. Staffed bicycle parking facilities that are subsidized typically offer free parking. These facilities have typically struggled to mature into self-sustainable operations.

Other services or amenities sometimes offered at attended bicycle parking facilities include: bicycle repairs, bicycle and electric car sharing, bicycle rental, bicycle maintenance classes, restroom, locker room and shower, tools and repair stands, bicycle tours, and a café.

Determining the best type of bicycle parking to augment lower-security bicycle racks requires consideration of a number of factors:

- Bicyclists' usage patterns and potential demand: Considerations include how many spaces are needed and the duration and frequency of parking.
- Available space or facilities: Is there enough space to install bicycle lockers or would a bicycle shed or bicycle station, which provide the same amount of parking in a smaller footprint, suffice? Is there an existing structure that could be used to house the shared bicycle parking?
- Resources for parking administration: Who will manage the bicycle parking on a day-to-day basis? Who will respond to customer issues?
- Outside capital funding to construct bicycle parking facilities is much easier to come by than securing ongoing operations funding.

BICYCLE PROVISIONS ON BUSES

Provisions for bicycles on buses can include racks on buses or on-board areas on buses. Guidelines for considering such programs and facilities depend on service area characteristics and equipment types. In urban areas, high transit ridership and limited space on trains often limits the carrying capacity for bicycles. However, there are locations with service area characteristics that are favorable for such programs. These include transit systems with off-peak, reverse commuters where adequate space for bicycles is available; destinations and routes associated with recreation areas, shore areas, hotels and tourism where demand is higher; colleges and university settings; and air quality attainment areas which often can qualify for funding for such projects.

CHAPTER 12 - AMENITIES

FENCING

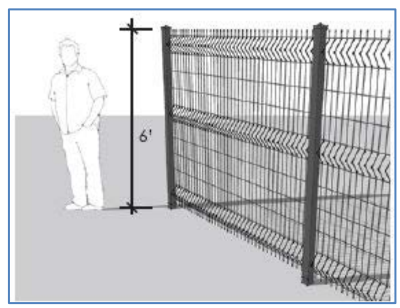
Fencing along a trail will vary depending on the location and agreements between adjacent landowners and the trail owner. The use of fencing along a trail corridor should be used conservatively to maintain the open feel and views of the environment as well as to maintain neighborhood connectivity. Fencing will typically be used for safety, security, trespass prevention, environmental impacts and privacy.

Where right-of-way permits, a landscaped buffer should be provided instead of fencing. Fences can be costly if installed unnecessarily and the long-term maintenance adds to long-term budget impacts. The fence designs proposed for the trail corridor are standards that can be applied to several scenarios. Efforts should be made to preserve and encourage neighborhood connectivity.

Fences will be used when required by either by the trail owner or the adjacent landowner. When a fence is required, it will be located at the right-of-way edge or a minimum of two (2) feet with three (3) feet recommended from the outermost edge of the trail surface.

The specific location of, and the type of, the trail fence will be determined at the time of the preliminary design and finalized in the construction documents for each implementation phase of a trail project. Where authorized private farm crossings exist or are planned, the implementing entity, with trail owner approval, and the adjacent landowner will mutually determine the most appropriate method of a secured gated treatment or open fence segments for farm vehicular access and/or public access to public lands, should they be deemed necessary.

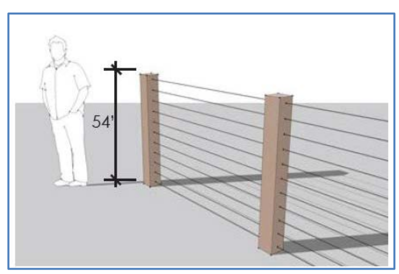
WIRE SECURITY FENCE



Where the upmost security is necessary, a 72 inch (6 feet) high woven-wire fence with metal posts is recommended. This fence type provides a high level of trespass prevention and security. This fence also provides an opportunity for screening with vine plantings to soften the look of the fence and could provide additional protection from train blown dust and debris. Consider using wire security fence in in the following areas:

- Urban and industrial areas
- Rail track and trail separator (where high number of illegal crossings are expected) Reference Section: ***TRAILS ADJACENT TO RAILROADS (RAIL WITH TRAILS)***
- Safety and security need
- Agricultural land boundaries

SMOOTH WIRE FENCE

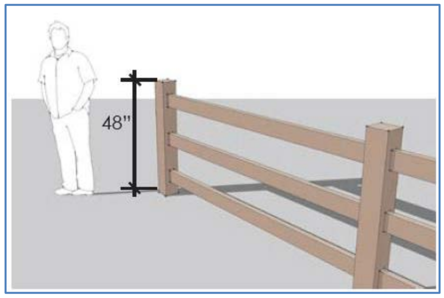


Smooth wire fencing is 54 inches (4.5 feet) high, includes ten (10) wire strands, and has a wood, concrete or metal post. This fence type reduces trespassing and provides open visibility of the surrounding landscape. Consider using smooth wire fence in in the following areas:

- Rural and urban areas
- Agricultural land boundaries
- Rail track and trail separator
- Scenic areas and open space
- Environmentally sensitive sites

SPLIT RAIL FENCE

Split-rail fencing is 48 inches (4 feet) high and includes three or four rails. This fence type provides a low level prevention of trespassing; some open visibility, boundary delineation, and emulates a parkland character. Consider using split rail fence in in the following areas:

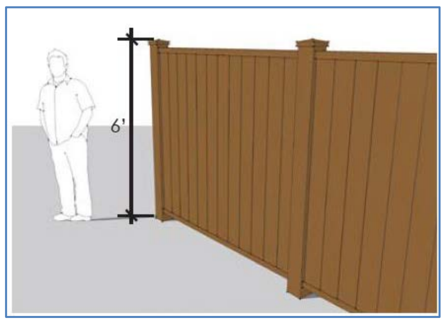


- Urban areas and rural residential
- Open space and park lands

In urban areas, a fence may be used to separate the trail from adjacent property. The design and use of this fence is subject to the discretion of each implementing entity. The style of the fence in urban areas shall reflect the design character established by local design plans. Fencing types may include wood, wood substitute, stone and wrought iron, wrought iron or other suitable materials excluding chain link materials. Concrete may be stamped/formed and painted to look like wood.

PRIVACY FENCE

A 72 inch (6 feet) high privacy fence with posts should be provided where enhanced privacy is necessary. This fence type provides some level of trespassing prevention, security, and privacy for adjacent landowners. This fence also provides an opportunity for screening with vine plantings. Using concrete components increases the life of the fence and reduces the long-term maintenance cost. Consider using privacy fence in in the following areas:

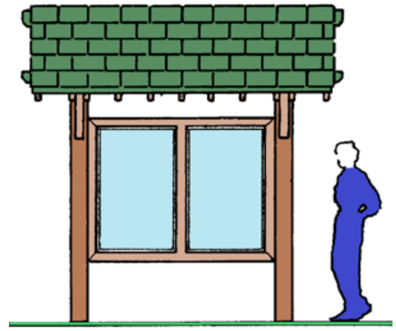


- Urban and industrial areas
- Residential areas
- Safety and security need

OTHER FENCE

Other barrier types between the trail and private property may be used such as ditches, berms, and/or vegetation. Recommended vegetation types should be low-water, low-maintenance varieties. Ditch or berm gradients should not exceed two to one (2:1) slopes or be greater than ten (10) feet in depth or height.

KIOSKS



Trail information kiosks provide a central location, typically near trailheads or adjacent to parking areas, to welcome visitors to one or more trails and to prevent sign clutter by consolidating visitor information in one place. If there is only a single trail in the area, the kiosk may be located at the trailhead and include the trailhead sign. All kiosks should display an overall park map showing facilities and trails, either as part of the trailhead sign or displayed separately. A map of a large park could be displayed across one entire side of the kiosk. The trail information kiosk may also include brochures and maps, provide a location for a trail register, and provide additional information such as trail conditions and amenities, trail etiquette, area characteristics, local history, trail organizations, degree of accessibility, rules and regulations, interpretive programs, and upcoming events. Emergency contact information should be clearly posted on kiosks and should include police contact information.

Interpretive kiosks are used to educate visitors about natural, cultural, historical, or recreational features of a park or trail. An interpretive trail may have a series of kiosks at intervals along the trail. For other trails, there may be only a single interpretive kiosk at or near the trailhead.

Design specifications for two types of kiosks are recommended. One design includes a single panel on each side of the kiosk and the other design is for duplicate panels on each side. Although kiosk designs should accommodate 32”x48” panels, the size and style of the kiosk can vary depending on what is needed for each specific site. For example, a bulletin board could be included for patrons to post temporary notices, or a single large panel could accommodate several smaller signs. Be sure that the kiosk is designed to accommodate the needs of its intended location.

KIOSK DESIGN GUIDANCE

A kiosk refers to the superstructure, the skeleton on which the information is wrapped. Panel refers to designed and fabricated materials mounted to the kiosk. Bulletin board refers to any plywood or corkboard facade built onto the kiosk that is secured using a framed, hinged cover of transparent material (like Plexiglas, Lexan, or glass).

The initial planning elements to consider for kiosks include:

- Audience
- Location
- Thematic Focus
- Partnerships
- Budgeting

Audience:

Potential audience groups include:

- Hikers (thru hikers, section hikers, day hikers),
- Tourists to community, visiting for other opportunities, and
- Locals who may or may not be aware or inspired by the trail system.

While the kiosk offers the opportunity to speak to an array of audiences, the message on any one panel is clearest when directed to one intended audience. The opportunity presented with a kiosk is to quickly answer a trail user's questions. This means assessing what they know when they arrive, what they don't know, and what their interest is in the information presented.

If goal of the kiosk is to reach seasoned trail visitors as well as to expose new people to the trail, a second side should be added to the kiosk. This will allow the kiosk to engage both audiences without cluttering the panel or confusing the audience.

Location:

Identifying the right location for a kiosk will ensure its use and value. There are multiple considerations when assessing a location for a kiosk such as follows:

- What is the primary course of arrival of visitors to the community?
- Consider visitation patterns. What is the first destination for the visitor upon reaching the community? Where will they go first?
- Does it make sense to position the sign nearest to the side of the community that visitors will enter and depart from to reach the trail?
- Is the kiosk location walkable? What is it like getting there by foot? What is it like connecting to the rest of the community from the kiosk, on foot?
- Standing at the kiosk, could a visitor view a map that corresponds to the physical space around the visitor, or would the map reference community details or the trail not viewable from this location?
- Is there enough space for multiple people to stand and view the kiosk at the kiosk's location?
- Would the kiosk or sign location harmonize with the resource rather than conflict with the resource?

Seek recommendations from the target audience and residents of the community to narrow the options for the potential placement of the kiosk.

Themes:

Kiosks should offer a welcome and an orientation including answering the question (“Where am I?”). The kiosk may share a brief description about a community’s present or past. Some thematic ideas to consider for a kiosk include the following:

Present:

- Trail Neighbors: Helping the community and commitment to the trail
- Explore the trail: Local points of interest and recommended hike(s)
- Recreation: Nearby activities
- Natural Heritage: Geology, landforms of interest, natural flora and fauna

Past:

- Conservation Heritage that include efforts to preserve lands, water, cultural resources
- Community: Then & Now
- Cultural Heritage of the community and/or its landscape: role in American history, industrial heritage, agricultural heritage, transportation heritage
- Emerging Frontier – ancients, expansion/settlers, landscape
- Identify a relevant theme to each potential site, or select a universal theme for any site selected.

Partnerships:

A kiosk offers the potential to recognize the input and accrues value from a number of partners working together to plan, develop, fund and maintain a trail. Funding partners may include the financial support of grant makers, donors and others.

Note: If the site for the kiosk is located on land owned by a state or federal agency, there may be alternate specific design guidelines that must be followed. For example, federal partners restrict the listing of specific business names but permit icons representing kinds of services found nearby.

Budget:

There are a number of considerations that impact the cost of a kiosk. There is the time spent planning to establish the scope of work, the necessary time required to research and write content, select a designer, identify relevant images, work with the panel vendor, and identify and manage any project volunteers.

Expenses may include:

- Purchase of the rights to relevant images or illustrations
- Graphic design services
- Panel fabrication, plus tax and shipping
- Installation, both labor and materials
- Residual financial commitments after installation to maintain the kiosk, including future maintenance and/or replacement

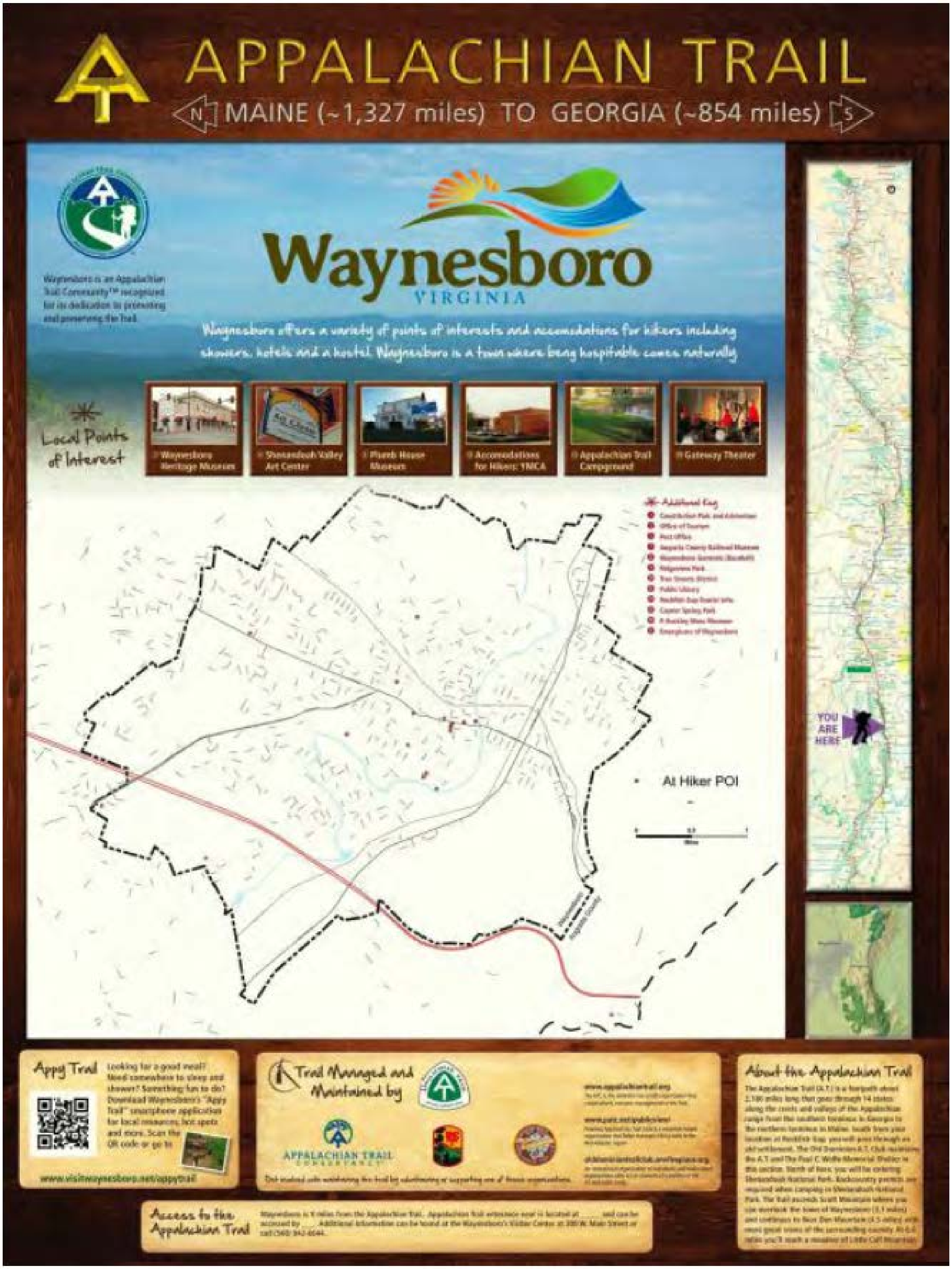
Panel Construction Material:

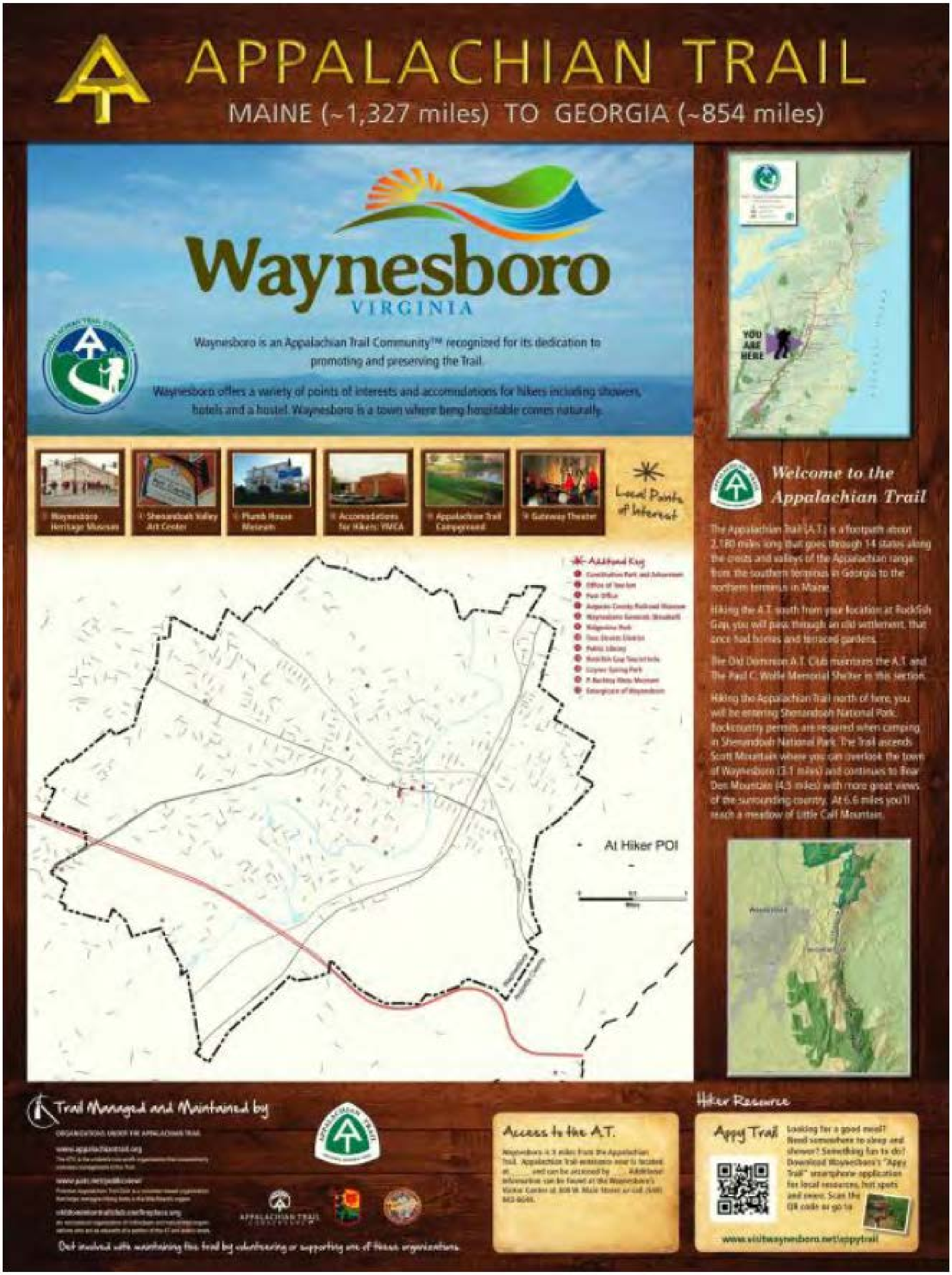
Kiosks and fabricated panels placed outdoors are exposed to the elements. By being aware of the sign location, planners, designers and fabricators of the panels can chose the right blend of materials for the project and set appropriate expectations for its lifespan and scheduled replacement.

UV light can fade panels and vandals can damage them; luckily, production processes have improved the UV resistance and durability of modern panels. Nevertheless, take note of the direction your sign will face and the degree to which it is exposed to sunlight. A south-facing sign will fade more readily than others, but may serve as an asset when planning the orientation of an included map.

PANEL FABRICATION PROCESS	DESCRIPTION
Fused Polycarbonate: Vinyl inkjet printing fused between two sheets of polycarbonate	UV resistant Excellent color transmission Vandal resistant Damage to surface can often be cleaned or buffed 30% recycled materials ¼, ½-inch thickness available
High Pressure Laminate: Inkjet printed paper and melamine sheets compressed with high pressure and heat. As the melamine resin melts, print is absorbed to consolidate product into single solid plastic piece	Excellent image quality 30% recycled materials
Sintra: Moderately expanded closed-cell polyvinyl chloride (PVC) extruded to a solid sheet with low gloss, matte finish	Lightweight and rigid Moisture and UV resistant
Vinyl	Very good image quality Easy to mount Easier to damage
Matte Paper Printed, laminated	Fades fastest Least water resistant Easier to damage

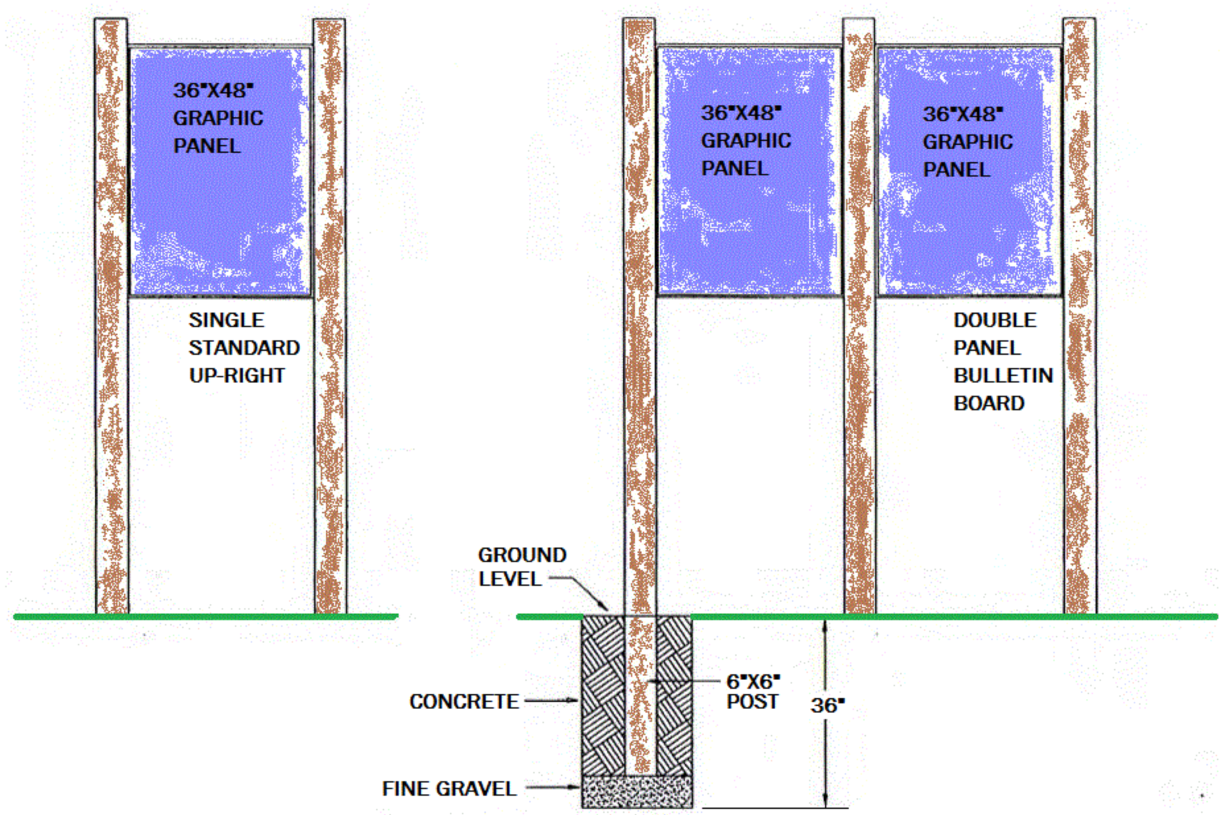
EXAMPLE KIOSK PANEL CONTENT: (Source: AT Community Kiosks Design Guide)


APPALACHIAN TRAIL
N MAINE (~1,327 miles) TO GEORGIA (~854 miles) S
Waynesboro
VIRGINIA
Waynesboro offers a variety of points of interests and accomodations for hikers including showers, hotels and a hostel. Waynesboro is a town where being hospitable comes naturally.
Local Points of Interest
Waynesboro Heritage Museum
Shenandoah Valley Art Center
Plumb House Museum
Accomodations for Hikers: YMCA
Appalachian Trail Campground
Gateway Theater
Additional Key
At Hiker POI
YOU ARE HERE
Appy Trail
Looking for a good meal? Need somewhere to sleep and shower? Something fun to do? Download Waynesboro's "Appy Trail" smartphone application for local resources, hot spots and more. Scan the QR code or go to
www.visitwaynesboro.net/appytrail
Trail Managed and Maintained by
APPALACHIAN TRAIL CONSERVANCY
www.appalachiantrail.org
About the Appalachian Trail
Access to the Appalachian Trail


APPALACHIAN TRAIL
MAINE (~1,327 miles) TO GEORGIA (~854 miles)
Waynesboro
VIRGINIA
Waynesboro is an Appalachian Trail Community™ recognized for its dedication to promoting and preserving the Trail.
Waynesboro offers a variety of points of interests and accommodations for hikers including showers, hotels and a hostel. Waynesboro is a town where being hospitable comes naturally.
Local Points of Interest
Welcome to the Appalachian Trail
AT Hiker POI
Trail Managed and Maintained by
Access to the A.T.
Hiker Resource
Appy Trail
www.visitwaynesboro.net/appytrail

Elements of a Kiosk Panel:

The elements of a kiosk panel include graphics and images, accompanying text, and a map. The following outlines any required elements, technological enhancements to consider, and provides guidelines for creating consistency through the use of color and text. It helps plan and define the specific information that should be included on a kiosk panel map.



LOGO USAGE:

A basic kiosk will include: the community logo or the designated municipality's logo. A visual description of the cooperative management system should include the logos of the sponsoring agencies and the local, federal or state land-managing partner(s) closest to the community. The Jefferson County Trails and Greenways logo should be used on facilities that are part of the Jefferson County Trails and Greenways system. Other logos that may be appropriate include partnerships with the state or county, tourism agency, or funders of the sign or trail project.

TEXT:

The size of font determines its readability. Increasing font size will increase the readability of the content. As a general rule, headers may be as large as 120 points, text may be as large as 32 points, and a section header may be 60 points. The designer should consider setting a standard at 30 point size for main text, 108 points for titles and 22 points for captions. Block quotes can be variable depending on size/space availability. Black ink should be considered for designs since it last longer and requires a minimum text size allowance of 16 points.

The National Park Service Harpers Ferry Center offers these best practices for increasing the legibility and comprehension of a kiosk in its "Wayside Exhibit Design". The best practices include:

- Increase line spacing (leading) above font point size. Recommendations for ratio are found in the Wayside Exhibit Typographic Standards.
- Line length for blocks of text should be set between 6 – 12 words.
- Align text flush left with a jagged right edge.
- Avoid hyphenation.
- Use a single space between sentences.
- Utilize Em-dashes (—) in sentences to offset phrases rather than single or double hyphens. Em-dashes should also be used for indicated time frame (e.g. 5:00 p.m.—6:00 p.m.)
- Use no more than two fonts in one sign.

KIOSK MAP:

Maps included on a kiosk need to orient the visitor to their location in relation to the trail and the community. If the trail does not pass through the community, two separate maps is the preferred method to meet both objectives. What the target audience needs to know will determine for each panel what information is displayed on the map(s). The following are recommended best practices for planning a map based on Wayside Map Standards, National Park Service, 2005, Harpers Ferry Center Media Services. The intent of the NPS Wayside Map Standards is to establish a common language with maps. The map standards should serve as a guide to mapping and not as a hard and fast set of rules.

- The **"YOU ARE HERE"** feature is the most important part of a map.
- Features and labels on maps should be consistent with language used on other area maps and guidebooks.
- Always ensure that intersections of trails or roads intersect (touch) on the map.
- As a general rule, wayside maps work better when they are oriented in the same direction as the viewer, but there are exceptions.

TAKE AWAY MAPS:

A kiosk may have take-away maps or brochures in addition to the panel map.

NAMING FEATURES:

Listing business names offers a more personalized approach. It may be more helpful for hikers to see names because they may be planning to visit specific places based on information in their guides. For instance, names would readily differentiate a hostel from a hotel, but icons might confuse one bed with another.

One consideration for proper names is that it may be a means of raising money for the project. These are suggestions on how a community wishing to support their kiosk can offset some costs. Listing business names may provide a source of revenue for the ongoing maintenance of the sign. If you want to promote the whole town, include all relevant businesses and bold face the financial supporters. This tiered support will likely garner more enthusiastic support from the community.

Icons:

Icons should be used to represent businesses on maps and kiosk panels. They have the added benefit of not highlighting any particular business. Icons create equanimity for hiker services. They don't create "favorites". Icons also increase the longevity of the map since they withstand businesses changing ownership or changing names. The drawback to icons is that they are less personal than identify the name of businesses.

One suggestion for the map is to include a directory that has the names and phone numbers of businesses, so that visitors can readily verify the hours or vacancy of a business.

Content Considerations:

- Keep it brief. Make it easy to read. Write to a basic reading level. Use an active voice. Simplify the message to make understanding it easy, and make sure the content is relevant.
- As a rule, avoid acronyms, adverbs, contractions, clichés, and colloquialisms. When possible also avoid the universal symbol for "No!" (The red circle with the slash through it).
- The design should attract attention.
- Paragraphs or blocks of text should be no longer than 4 – 6 sentences.
- Each segment should not be longer than 100-150 words. Limit the word count for the entire panel to 200 words.

Panel Design:

The elements of a panel include graphics and images, accompanying text, and a map. They should coalesce to provide a common look between designated communities and agencies. Key visual elements will help achieve this goal and a template should be made available for use by communities.

Required design elements:

- Header: The header should have the trail name.
- Cooperative Management Infographic: *Who manages the trail?* This is a visual description of the cooperative management system. It includes the logos of the Jefferson County Trails and Greenways, and the local, state or federal land-managing partner(s) closest to the community. This element should be designed to easily enable sign designers to swap partner logos and their respective basic information and contact information.

Recommended design elements:

- Trail Map: A trail map is recommended that shows the encompassing length of the trail such that it conveys the magnitude of the entire trail. The intent is for the visitor to assess their location in relation to the scale of the whole trail, connecting them with something much larger that the short hike they may take.
- Overview Map: An overview map of the entire trail or trail system.
- Community Map and/or Community Name
- Theme, Headline & Copy
- Local Points of Interest
- Quick Response (QR) Code

Technology Enhancements:

Quick Response (QR) codes are an optional element to a kiosk panel design. Since not all visitors will have smart phones, be discerning about the information posted on the land page as well as what information is found via the provided link. QR codes are typically used for:

- Optionally used for community events
- Mobile visitors center for downloadable map and resources
- Additional interpretive information not on the sign such as natural or cultural history

GUIDELINES FOR SELECTING KIOSK IMAGES AND GRAPHICS

The images selected for use in a panel should capture the imagination of visitors. They should be visually compelling and help "tell the story" of the community or the trail. Once the panel's focus is decided upon, images and graphics need to be selected for the designer to consider and work with to create a visually compelling design. They may be illustrations or photographs, and may be current or historical. For potential images, determine the quality of the original digital image or scanned image.

Follow recommendations from the graphic designer on the resolution quality and file format needed for the designers work. If selecting historic photos, be sure they are scanned at a high resolution. Members of the community or local hiking club may be amateur or professional photographers willing to contribute photos for the panel; they may also sell the rights to use the image. For the use of any images, secure permission to use the images from the owner. If people are in the images, it is recommended to also have a photo release signed by them as well.

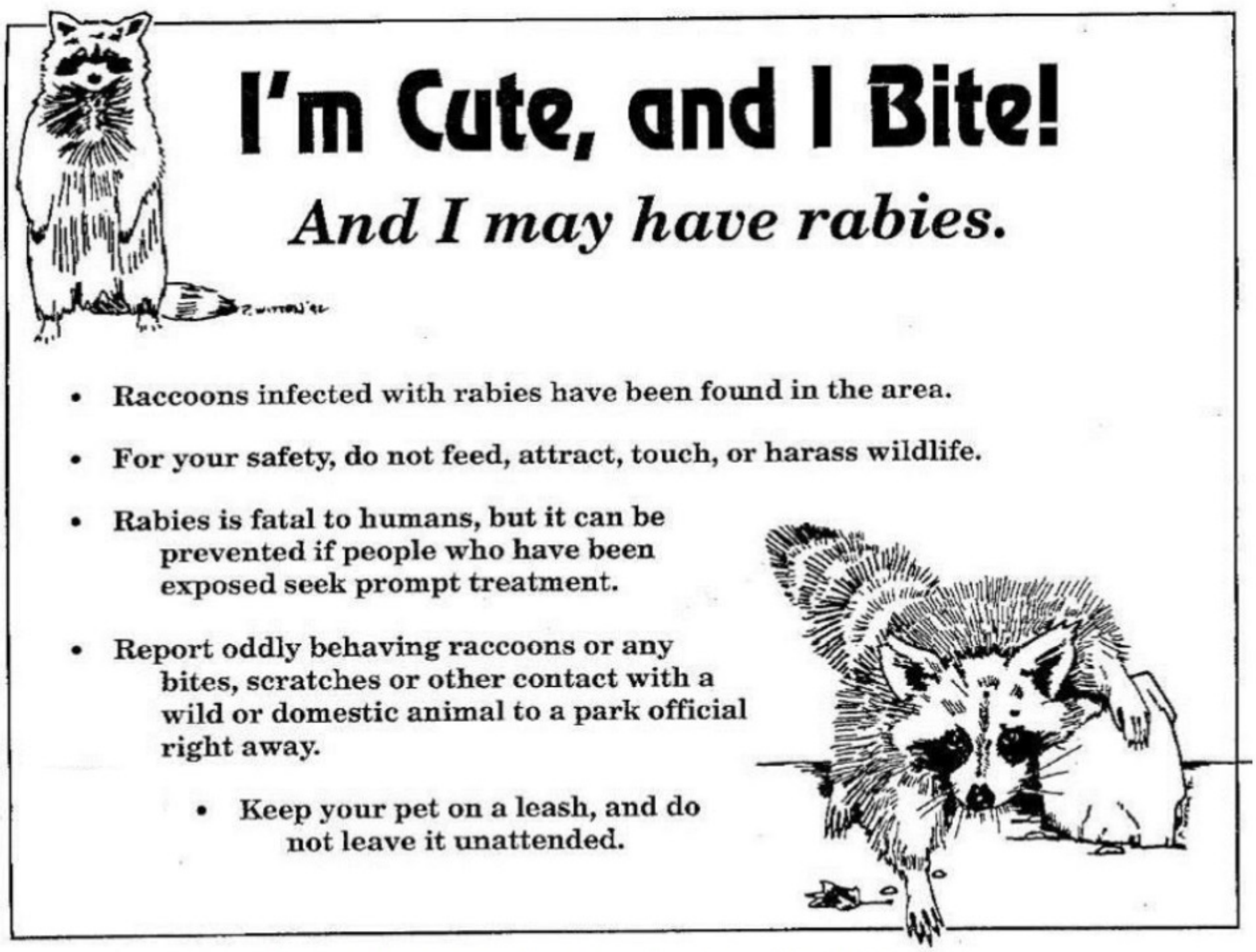
Dynamic Content

A kiosk should have a bulletin board to provide dynamic "changeable" content. It is important that the bulletin board or other dynamic content is kept up to date for the benefit of trail users. Relevant information to the dynamic content portion might include:

- Alerts relevant to hikers
- Relocations
- Special events within the community
- Upcoming volunteer opportunities
- Community volunteers and services
- Regulations & Safety information
- Other suggestions

At the discretion of the maintaining agency, all or part of the optional bulletin board component of the kiosk may be dedicated to school students. School students using the trail as a basis for learning may have interest in helping to maintain a portion of the community kiosk as part of the service-learning component of their curriculum.

Example Kiosk Sign



Example of a cautionary sign for a kiosk (above)

Supplemental Information

A tri-fold brochure offers a portable way for visitors to take the information with them. It may provide more in-depth information about planning a day hike, accessing the trail, and "Leave No Trace" ethics. It can be used to generate membership for the local trail club, or recruit people for volunteer opportunities. Tri-fold brochures are much easier to revise than panels. Brochures are also an alternative to the dynamic component of a kiosk, providing information on community events, activities, or new services.

To create a brochure, follow the guidelines for sign text – keep it clear, brief and simple. Be aware that a brochure may end up as litter or used for unintended purposes, and be ready to adapt, if necessary. Brochures should be biodegradable.

Kiosk Maintenance

Regular kiosk maintenance should be part of any trail plan. Kiosks are highly visible and their maintenance or lack of maintenance leaves the visitor with a positive or negative impression about the trail and the park. A well maintained kiosk conveys a sense of pride and reduces vandalism. A poorly maintained kiosk may contribute to disorientation of trail users and a diminished visitor experience. It is important to repair or replace damaged signs promptly.

When a kiosk is observed to have been weathered, deteriorated or destroyed, the reasons for the condition should be considered. For kiosks damaged by the weather, the kiosk should be modified to use stronger and more durable materials, design modifications, and/or relocation of the kiosk to a location less exposed to adverse weather conditions. For kiosks damaged by water or decay, consider applying a sealer or preservative or replacing the sign with a more water-resistant material. Be sure to assure the treatments are compatible with the color, aesthetics, and environmentally sustainable practices.

The following kiosk maintenance guidelines are recommended:

- Maintain a record of the kiosk including type of kiosk, location, displays, etc. Photos of the installed kiosk should be maintained in the records to assist with restoration of the kiosk and/or its displays.
- The kiosk should be inspected regularly after each winter season for damage and deterioration. The displays should be inspected for weathering and visibility.
- Loose, missing or damaged components should be repaired or replaced as soon as they are discovered.
- Leaning or loose kiosks should be up righted and secured immediately.
- Clear vegetation from around the signs to maintain visibility.
- Review kiosk signage and display content to ensure relevance and accuracy.

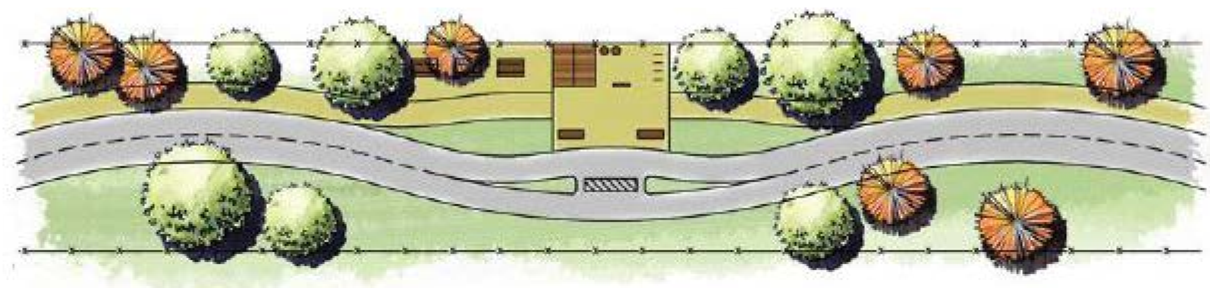
SHELTERS, REST AREAS, & COMFORT STATIONS

Support facilities on bicycle paths are improvements that promote bicycle use. On long, uninterrupted bicycle paths amenities should include minor and major comfort stops. Minor facilities may include shade shelters or informational maps. Major facilities should provide restrooms, water or other conveniences. Shelters at minor facilities can include roofed structures with protected seats. They should be set back from bicycle path traffic, located away from obstructions that can obscure visibility and cause safety concerns, and positioned to ensure protection from prevailing winds.

Facilities should be considered at access points of the bicycle path that help link the path to communities and surrounding land uses and destinations such as transit centers, parks, and parking areas. Full-service shelters and rest areas should meet local design and ADA standards relating to water and sewage utility connections and restroom accessibility.

Water services can include drinking fountains designed with spigots to fill water bottles.

TRAIL REST STOPS OR REST AREA

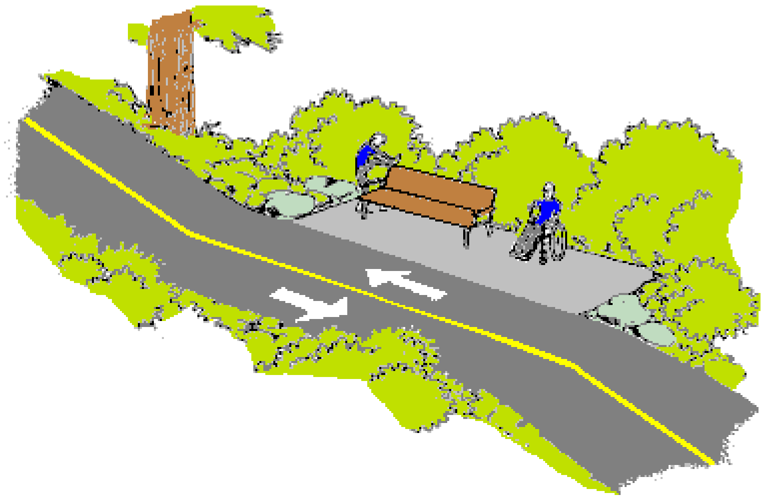


A trail rest stop or trail rest area is a designated place to stop along a trail and may consist of a concrete pad, a bench, bicycle rack, trash receptacle secured by tamper proof bolts and a covered shelter. Rest areas are defined as level portions of a trail wide enough to provide wheelchair users and others a place to rest and gain relief from prevailing grade and cross-slope demands. Users can benefit from rest stops on steep or very exposed trails to pause from their exertions and enjoy the environment.

Rest areas generally occur every mile and are located with consideration given to existing grade, shade, existing vegetation, views, environmental conditions and security. Rest areas are most effective when placed at intermediate points, scenic lookouts, or near trail amenities.

Landscaping and a roof structure should be proposed at rest areas where existing vegetation and shade does not exist. Landscaping with low shrubs and groundcovers and a minimum of one shade tree in proximity to the rest area is recommended where existing shade trees are not present.

Depending on the site conditions where the rest stop is located, a slab on grade or a wood deck option with a hand rail is advisable. The slab on grade option should be used where slopes are not severe and where extensive fill will not be required. Where slopes are steep and or where filling cannot be accomplished due to environmental and/or drainage reasons, a deck structure made of pressure treated and recycled lumber should be used. In the event that a deck structure is used, a concrete abutment may be required to be constructed adjacent to the trail to attach the wood structure and decking.

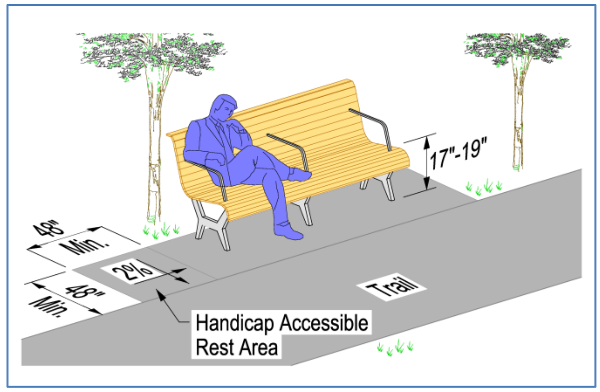


Periodic rest areas are beneficial for all shared-use path and trail users, particularly for people with mobility impairments that expend more effort to walk than other pedestrians. Rest areas are especially crucial when grade or cross slope demands increase. The frequency of rest areas should vary depending on the terrain and intended use. For example, heavily used shared-use paths and trails should have more frequent opportunities for rest. Rest areas provide an opportunity for users to move off the trail, instead of remaining on the trail to stop and rest. If a rest area is only provided on one side of the trail, it should be on the uphill side. Having separate rest areas on both sides of the trail is preferred when there is a higher volume or higher traffic speed. This reduces trail users from having to cross in front of other trail users moving in the opposite direction.

A rest area will have many of the same characteristics as a rest interval. However the additional space allows for more amenities. In general, rest areas should have the following design characteristics:

- Grades that do not exceed 5 percent;
- Cross slopes on paved surfaces that do not exceed 2 percent and cross slopes on non-paved surfaces that do not exceed 5 percent;
- A firm and stable surface;
- A width equal to or greater than the width of the trail segment leading to and from the rest area;
- A minimum length of 60 in;
- A minimal change of grade and cross slope on the segment connecting the rest area with the main pathway; and
- Accessible designs for amenities such as benches, where provided.

BENCHES



Benches can be particularly important for people with disabilities, who may have difficulty getting up from a seated position on the ground. Some benches should have backrests to provide support when resting, and at least one armrest to provide support as the user resumes a standing position. Accessible seating should provide the same benefits as seating for users without disabilities. For example, providing a wheelchair space facing away from the intended view would not be appropriate.

Benches provided along trails should meet the following requirements. Ensure that the front edge of the bench seat is 17 to 19 inches above the ground. When more than one bench is provided in a common area such as a scenic overlook, at least half of the benches must have back support that runs the full length of the bench

Provide one armrest on at least half of the benches with back support. Consider the visitors who will use a particular area when deciding where to locate an armrest. For people who have difficulty standing up from a seated position, having an armrest can be helpful. However, armrests on both ends of the bench could prevent a person using a wheelchair from being able to transfer onto the bench. A compromise design is a bench with back support and one armrest placed in the middle of the bench. Another option is to place a single armrest on the end of the bench farthest from the clear ground space.

All parts of the bench must be able to withstand 250 pounds applied vertically or horizontally at any point of the seat, fastener, mounting device, or supporting structure.

Provide a clear ground space that is 36 by 48 inches adjacent to one end of each bench. Do not allow this clear space to overlap the outdoor recreation access route or trail, so that using the bench or clear space doesn't limit travel past the bench and vice versa. Locate the clear space to provide shoulder alignment between a person sitting on the bench and a person seated in a wheelchair occupying the clear space, so that transfers to the bench are convenient and conversations between people on the bench and beside it are comfortable.

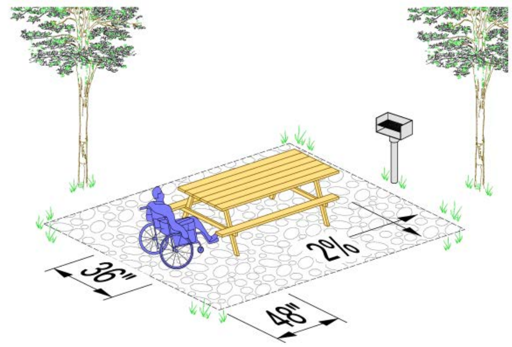
Do not allow the slope of the clear floor or ground space to exceed 1:48 (2 percent) in any direction, except if the surface isn't paved or built with boards. The slope may be up to 1:33 (3 percent) when needed for proper drainage. The surface must be firm and stable and made from a material that is appropriate to the setting and level of development.

When the above recommendations and requirements can’t be realistically achieved due to site constraints or the nature of the facility, they should be implemented to the maximum extent practical.

PICNICKING FACILITIES

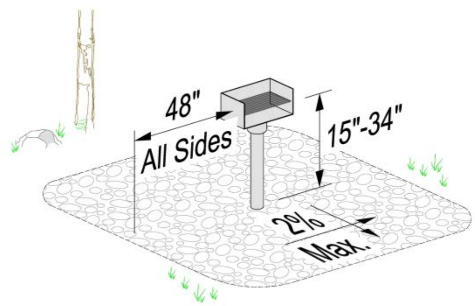
Picnic sites should include a picnic table and a pedestal grill. The use area should be sloped 1.5 percent maximum to drain. Picnic sites shall meet or exceed the minimum accessibility requirements.

Picnic Tables



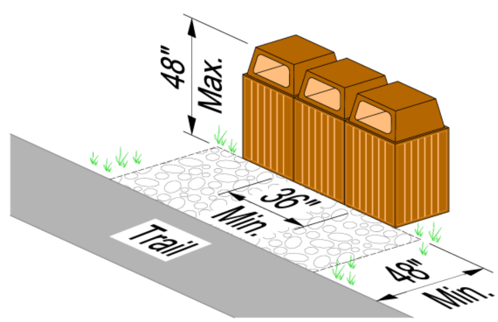
The table should be of heavy-duty construction. The recommended minimum length is 8 feet and shall meet accessibility requirements and standards. It is recommended that a variety of wheelchair-seating locations be provided (e.g. end, center, or side access) and that the edges of the bench seats be painted on either side of the wheelchair-seating location to alert persons with visual impairments that no bench seat is present in the space. Accessible picnic tables shall provide one wheelchair space for each 24 linear feet of usable table surface perimeter. For longest life and least maintenance, it is recommended that tables be constructed of concrete or metal and light in color.

Pedestal Grill



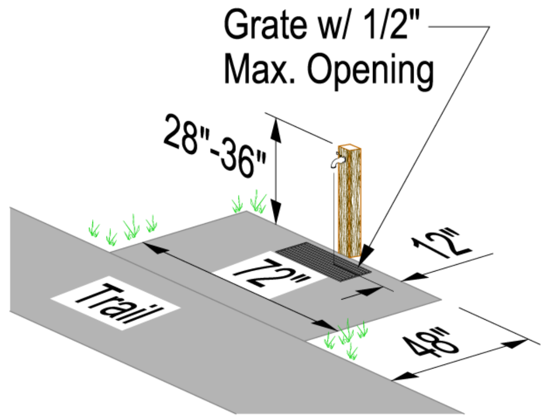
The grill should be located at the edge of the use area and downwind from the table. The grill should be installed to avoid any fire hazard. It is recommended that the cooking surface of the pedestal grill be large enough that a camp stove could be set upon it and be stable. The grill should be installed so that the cooking surface is at a maximum height of 34 inches above the use area surface.

Trash Receptacles



Trash receptacles need to meet accessible standards when on accessible areas. The accessible receptacles shall have a minimum clear space of 36 inches by 48 inches positioned for forward approach to the receptacle opening, or 30 inches by 60 inches positioned for a parallel approach to the receptacle opening. The surface of the clear space shall be firm and stable. (A stable surface remains unchanged by applied force so that when the force is removed, the surface returns to its original condition. A firm surface resists deformation by indentation.)

Accessible Water Hydrants & Spigots



Hydrants and spigots, other than water utility hookups (included below), that are located along an accessible trail, shall have a 48-inch by 72-inch minimum accessible clear space centered on the water hydrant, with the long side of the space adjoining or overlapping clear ground space. Locate the space so that the water spout is 11 inches minimum and 12 inches maximum from the rear center of the long side of the space. The spout shall be located between 28 inches and 36 inches above the ground surface. The splash basin must have a level accessible surface. If a grate is used, the openings in the grate shall not allow the passage of a 0.5-inch-diameter sphere or dowel rod and the openings shall be placed perpendicular to the dominant direction of travel. If the surface is concrete, asphalt, or boards, the clear ground space slope shall be no more than 2 percent in any direction throughout the entire surface area. If the surface is a material other than concrete, asphalt, or boards, then the clear ground space slope is allowed to increase up to 3 percent in any direction if needed for drainage (but not for other reasons). In all cases, the clear space shall be firm and stable. (A stable surface remains unchanged by applied force so that when the force is removed, the surface returns to its original condition. A firm surface resists deformation by indentation.)

LIGHTING

Lighting encourages pedestrian and bicyclist use by increasing visibility, comfort, and perceived safety. Appropriate quality and placement of lighting can enhance an environment in addition to increasing comfort and safety.

Fixed source lighting reduces conflicts along paths and at intersections. In addition, lighting allows the bicyclists to see the bicycle path direction, surface conditions and obstacles. Lighting for bicycle paths should be provided where considerable riding is expected at night, such as bicycle paths serving college students or commuters, where there is insufficient available light from the surrounding area, and at highway intersections, especially if there are post barriers that the cyclist must avoid. While bicycles may be required to have headlights after dark, the low level of lighting required by law won't necessarily light a bicyclist's path sufficiently to see and avoid obstacles. Each lighting situation is unique and must be dealt with on a case-by-case basis.

The AASHTO Guide recommends using average maintained illumination levels of between 5 (0.5 foot candles) and 22 lux (2 foot candles), and some state DOTs such as the Florida DOT recommends 25 as the average initial lux. Where special security problems exist, higher illumination levels may be considered such as 53 lux for long underpasses. The following design standards should be used:

Illumination Level (Average Initial lux) = 25*
Uniformity Ratio (Avg. /Min.) = 4:1 or less
Uniformity Ratio (Max. /Min.) = 10:1 or less
* AASHTO recommends 5-22 lux depending on location

Light poles should be 12 feet to 15 feet high and must meet the recommended horizontal and vertical clearances. Luminaires and poles should be at a scale appropriate for a pedestrian or bicycle path. Vandal resistant lighting fixtures are recommended in all locations. Mercury vapor or metal halide lamination is preferred for pedestrian level lighting. However, modern LED lighting offers a cost-effective alternative.

Underpasses and tunnels may need additional lighting, except where there is a completely open view into the tunnel from the surrounding area. Even in the day time, tunnels may need lighting for both visibility and security. On bright sunny days, bicyclist entering a dark underpass may be momentarily blinded and unable to see potential hazards and therefore the tunnel may need lighting to navigate safely.

Lighting should be placed wherever there is signage and accessible electricity. This is particularly important for warning signs. All intersections should be lit far enough back from the intersection in order to allow the bicyclist and motorist enough time to see the intersection and act appropriately. The effect of incidental lighting on the path and on cyclists also needs to be considered. When a path parallels a road the lights of oncoming traffic will shine directly on bicyclists cause momentary blindness that is dangerous on a curving path or in the face of oncoming bicycle traffic. In this case, low-level path lighting is recommended. The designer should keep in mind that in certain areas lighting is prone to high levels of vandalism.

LANDSCAPING

Landscaping can be designed to provide numerous benefits for the trail environment. The trail designer needs to consider the existing landscape, as well as proposed landscaping during the initial phase of trail design.

The existing landscape should be preserved and incorporated into the design. Wetland and floodplain areas typically include native plant material that is adapted to the local soil and water conditions. It is cost effective to maintain these plants in their natural condition and allow them to filter sediment and pollution from the water runoff. Areas to be maintained in an existing tall grass condition should be mowed only once or twice a year. This infrequent mowing schedule reduces trail maintenance, creates better plant cover for water absorption and filtration, and increases flower and seed production for beneficial insects, birds, and wildlife. When a new trail is built through these areas, tall grasses may be a good option to promote erosion control and related benefits. It is recommended to seed the disturbed area with a natural seed mix to encourage re-establishment of the tall grass cover. Seed mix recommendations and installation guidelines can be found in the Ohio Department of Transportation Construction and Materials Specifications. Other planting options along streams include forestation planting or a mixture of shrubs and grasses.

Existing native plants should be maintained as a buffer between parallel trails. This buffer is most desirable between parallel bicycle and equestrian trails. The buffer separation prevents alarming the horses with bicycle traffic to which they are unaccustomed. Care needs to be taken during the trail construction process to protect the existing vegetation. It is recommended that the area to be protected be fenced with the appropriate type of temporary construction fencing to prevent mechanical damage to the vegetation and prevent soil compaction around the root zone. It may be necessary to selectively prune or thin the vegetation to obtain trail clearances and remove trees in poor health that may fall on the trail. Trees that are too close to the trail surface may need to be removed if they are considered a collision hazard for errant bicyclists.

Existing native vegetation should be retained along the trail when it serves as a buffer to screen adjacent land uses. For example, screening the trail from adjacent residential areas is desirable for both homeowners and trail users. Screening from industrial uses or objectionable views also enhances the trail experience.

Proposed landscaping can be designed to improve sections of the trail that may not have sufficient natural buffer. Trailhead facilities and rest stops can benefit from an overhead tree canopy to provide shade relief from the summer sun. Low level landscaping can enhance the look of the facilities and screen objectionable views. The landscape can also be designed to identify the facility as part of the trail system. This is accomplished by using similar plant material at the trailhead and various points along the trail. This will assist the user to recognize features related to the trail and give advance warning that they are approaching a trail feature. Landscape design consideration must be given to maintain appropriate safe sight distance, and to provide sufficient visibility to maintain security.

Proposed landscaping can be designed to provide edge protection along steep slopes and other trail hazards. The landscaping should be sufficiently dense to act as a visual warning and to restrict trail user movement through the barrier. The landscape edge protection needs to be 3 feet high minimum for pedestrian trails and 42 inches high minimum for bicycle trails. Plant spacing varies with the species but will generally fall within the range of 3 to 5 feet on center. Native species should be encouraged when their characteristics fulfill the design objectives.

The following is a partial list of plant material that is suitable for creating edge protection along the trail. There are other species and varieties whose characteristics are appropriate for this use.

Evergreen Shrubs

- Abelia, Abelia grandiflora “Edward Goucher”
- Berberis julianae, Berberis julianae “Nana”
- Ilex crenata “Compacta”, Ilex crenata “Green Lustre”
- Ilex glabra “Nigra”, Ilex glabra “Shamrock”
- Juniperus chinensis “Kallays Compacta”, Juniperus chinensis “Pfitzeriana Compacta”
- Taxus media “Densiformis”, Taxus cuspidata “Intermedia”
- Viburnum x pragense, Viburum rhytidophyllum

Deciduous Shrubs

- Euonymus alatus, Euonymus alatus “Compacta”
- Spiraea nipponica, Spiraea vanhouttei “Snowmound”

Proposed landscaping should be designed to accommodate the vertical and horizontal clearances necessary for the trail user. The plant material should not create excessive fruit or flower litter that would pose a hazard on the trail.

CHAPTER 13 - MAINTENANCE

BICYCLE FACILITY OPERATION & MAINTENANCE

The condition of the roadway surface is an important element in both bicycle safety and level of service. In general, due to their high pressure, narrow profile tires, lack of suspension, and need to maintain balance, bicycles require a higher standard of road maintenance than motor vehicles. Potholes, bumps, seams, and debris (which can be of minor annoyance or no consequence whatever to motor vehicles) are potential hazards to bicycle traffic as these obstacles can cause loss of control of the bicycle, or cause the bicyclist to risk conflict with motor vehicle traffic by swerving to avoid the obstacle.

For the above-mentioned reason, the roadway surface on which bicycles normally operate should be maintained free of potholes, bumps, corrugations, seams, unraveled pavement edges, gravel, glass fragments, and any other debris or obstacles that mar a smooth riding surface. The area involved includes the right portion of the outside travel lane plus any additional space. Typically, this portion of the roadway gets less attention as maintenance efforts are concentrated on the portion of the roadway used by motor vehicles.

Maintenance repairs in this area should be carried out with the needs of the bicycle in mind; i.e., they should be done in a workmanlike fashion with particular attention to providing a smooth pavement surface.

The following actions are recommended by the AASHTO Guide for the Development of Bicycle Facilities as requirements in the operation and maintenance of bicycle facilities.

- Create a smooth surface free of potholes and debris.
- Eliminate drop-offs from pavement edges.
- Inspect pavement conditions - do not allow unraveled pavement edges.
- Inspect signs - making certain that signs do not intrude into bicycle travel space.
- Control growth of trees, shrubs, and vegetation.
- Supply trash and recycling receptacles and be sure they are regularly emptied.
- Mow areas in the vicinity of bicycle paths.
- Plow snow - do not use deicing agents.
- Enforce and prevent unauthorized motor vehicles from using the path.
- Maintain bicycle and shoulder lane striping and markings.
- Establish an agency responsible for the control, maintenance, and policing of bicycle facilities.

Maintenance of roadways to accommodate bicycle traffic does not usually require changes in the types of maintenance activities that are carried out; rather it requires changes in the focus of maintenance practices. Where possible, maintenance, repair and litter removal activities should be shifted to include and not ignore roadway margins and shoulders.

The use of a shared lane will limit the amount of grit and debris that collects in the bicycle operating (lane sharing) area, as motor vehicle traffic will "sweep" this area clean. When shoulders are assumed to be the appropriate area for bicycle operation, it is essential to regularly sweep the shoulder area. All shoulders should be swept at least monthly. On highways where gravel or other debris can be anticipated to accumulate, more frequent sweeping will be required. This will be especially important on highways carrying a large number of gravel, construction or trash hauling vehicles.

GENERAL MAINTENANCE

Bikeway and trail maintenance keeps trails at or near constructed or intended conditions. Regular maintenance protects the investment of public funds, while enhancing user safety, protecting resources and providing continued access to the public. Trails and facilities become unusable and a legal liability when poorly maintained.

A maintenance program should be established and adopted by the operating agencies responsible for trail maintenance in order to preserve the trails and facilities, to insure the safety and comfort of trail users, and to maintain a harmonious relationship with adjacent property owners. This would include numerous efforts ranging from mowing and snow removal to replacement of damaged benches and signs to surface repair and reconstruction of the trail.

Every trail should be inspected and evaluated on a regular schedule in order to identify the need for minor or major maintenance repairs. Different types of trails will differ greatly in their maintenance requirements. However, all trails will require a variety of preventative and corrective activities throughout their lives to insure that they remain safe, accessible and in good condition.

The following recommended maintenance schedule outlines some general guidelines for maintenance activities and the frequency at which they should be performed. The outline provides a general approach to maintaining all types of trails. However, the agency responsible for each trail's operation and maintenance (Municipalities, Developers, Home Owner's Associations, Volunteers, etc.) will know best when certain maintenance activities should be performed.

RECOMMENDED MAINTENANCE SCHEDULE

As Needed, Maintenance Activity Frequency

- Sign replacement
- Map or signage updates
- Sweeping and brush removal
- Trash removal and litter clean-up
- Repair or replace trail support amenities such as parking lots, benches, restrooms, etc.
- Clearing of vegetation for adequate sight distances
- Repair flood damage, such as silt clean-up, culvert clean out, etc.
- Patching and minor re-grading
- Repaint or repair trash receptacles, benches, signs, and other trail amenities, if necessary

Seasonal, Maintenance Activity Frequency

- Mowing
- Leaf blowing

- Snow plowing or grooming
- Planting, pruning and beautification
- Culvert cleanout
- Installation or removal of seasonal signage

Yearly, Maintenance Activity Frequency

- Surface evaluation to determine needed patching, re-grading or installation of waterbars
- Evaluate structural integrity of human-built trail features, such as bridges, retaining walls, steps, railings, etc.
- Evaluate support services to determine need for repair or replacement
- Repaint or repair trash receptacles, benches, signs, and other trail amenities

5-Year, Maintenance Activity Frequency

- Comprehensive trail inspection.
- Sealcoat asphalt trails

10-Year, Maintenance Activity Frequency

- Resurface, re-grade and re-stripe trail.

20-Year, Maintenance Activity Frequency

- Replace or reconstruct trail.

Trail users are often the first to experience trail deficiencies and identify needed repairs. Therefore, trail operators are strongly encouraged to establish a spot-improvement program. This program enables trail users to bring deficiencies and problems to the attention of the operating agency in a quick and efficient manner by having pre-addressed, postage-paid postcards available to the public, as well as appropriate telephone numbers posted along the trail. A timely response from the agency will help to insure safe and accessible trail conditions.

SIGN MAINTENANCE

Regular maintenance of signage should be part of any trail plan. Signs are highly visible and their maintenance or lack of maintenance leaves the visitor with a positive or negative impression about the trail and the park. Well-maintained signs convey a sense of pride and reduce vandalism while poorly maintained signs may contribute to a diminished visitor experience, including disorientation of trail users.

The following guidelines are recommended:

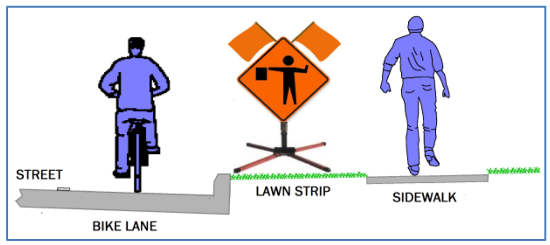
- Maintain a record of all signage, including location, type of sign, and photo.
- Inspect signs regularly, especially after each winter season, for weathering and visibility.
- Repair or replace damaged or missing signs as soon as possible.
- Secure loose or tilting signs in an upright position.
- Clear vegetation from around signs to maintain visibility.
- For signs mounted on living trees, loosen fasteners as necessary to accommodate growth of the tree.
- Review signage content to ensure continued relevance and accuracy.
- Obsolete, damaged, or surplus signs should be reused or recycled whenever possible.

When signs have been weathered or otherwise damaged or destroyed, consider the reasons for the damage. If the sign was eaten by wildlife, consider less palatable materials. If weather or natural events damaged the sign, consider stronger materials, a different location, or a different system for mounting the signs. If the sign is damaged by water or decay, consider applying a sealer or preservative (assuring compatibility with color, aesthetics, and environmentally sustainable practices) or replacing the sign with a more water-resistant material.

CONSTRUCTION ZONES (WORK ZONES)

This section describes work zone conditions that can cause safety concerns for bicyclists. Offered are recommended practices and descriptions of effective strategies and techniques that can be used to mitigate work zone safety concerns.

Construction zones can account for an inordinate amount of the safety and liability problems. This is unfortunate and unnecessary because preparing a detour plan can ensure public safety and minimizes disruption where possible. Hazards to bicyclists may include: signs, equipment, or debris in the bikeway, blocked access without advance warning, rough pavement or gravel without advance warning, poor pavement transitions, especially when parallel to the line of travel (e.g.: metal plate edges or pavement removal/resurface areas which are not tapered). To address these hazards, it is suggested that detour signs be posted to direct bicyclists to an alternate route. Warning signs alert riders to construction or rough surfaces and debris should be removed regularly.

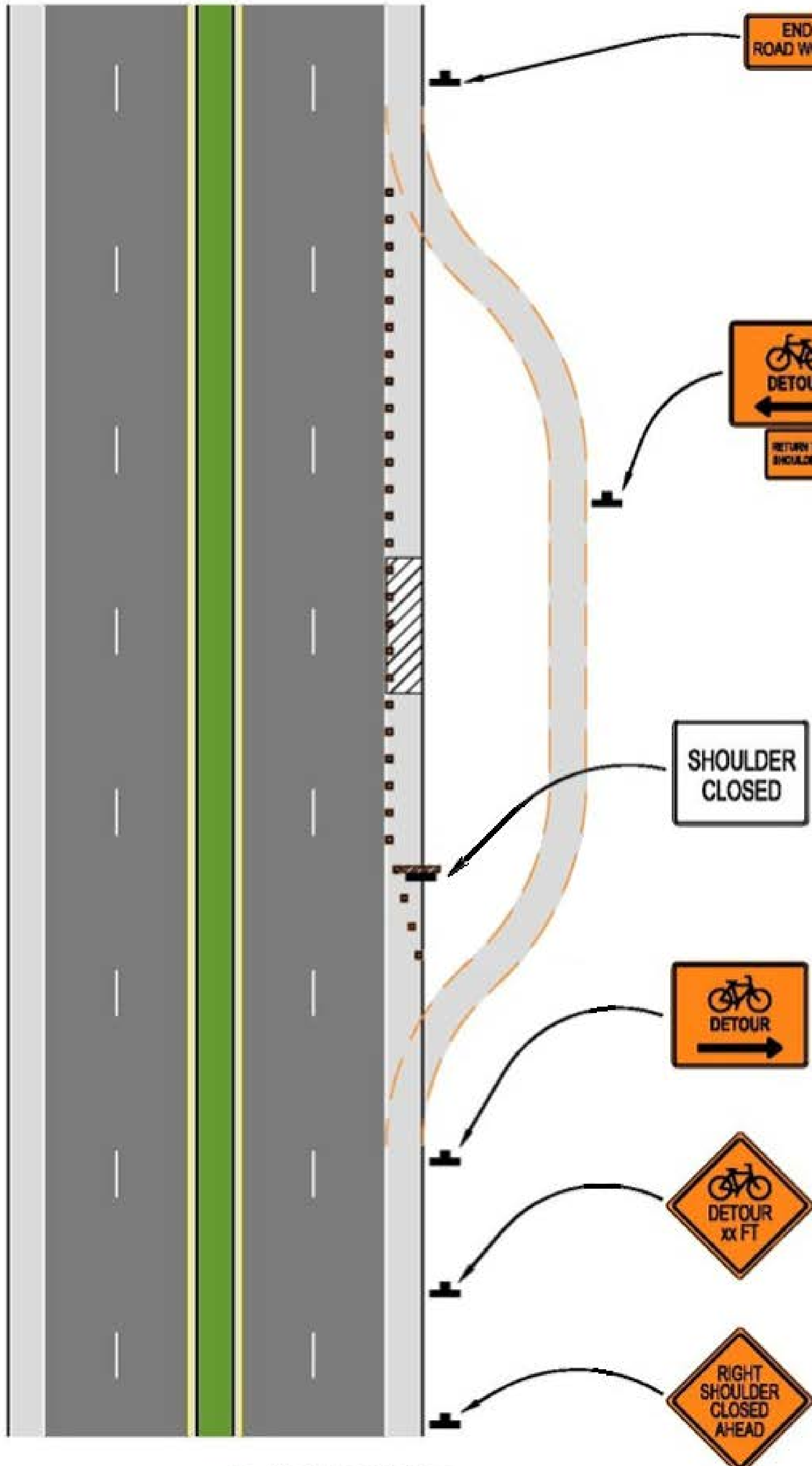


Hazards should be mitigated on all roads to be used by bicyclists. As stated in AASHTO, "The majority of bicycling will take place on ordinary roads with no dedicated space for bicyclists. Bicyclists can be expected to ride on almost all road ways." Therefore, hazard removal should occur on all roadways except for freeways where bicycle travel is prohibited by law.

BICYCLE ACCOMMODATION IN WORK ZONES

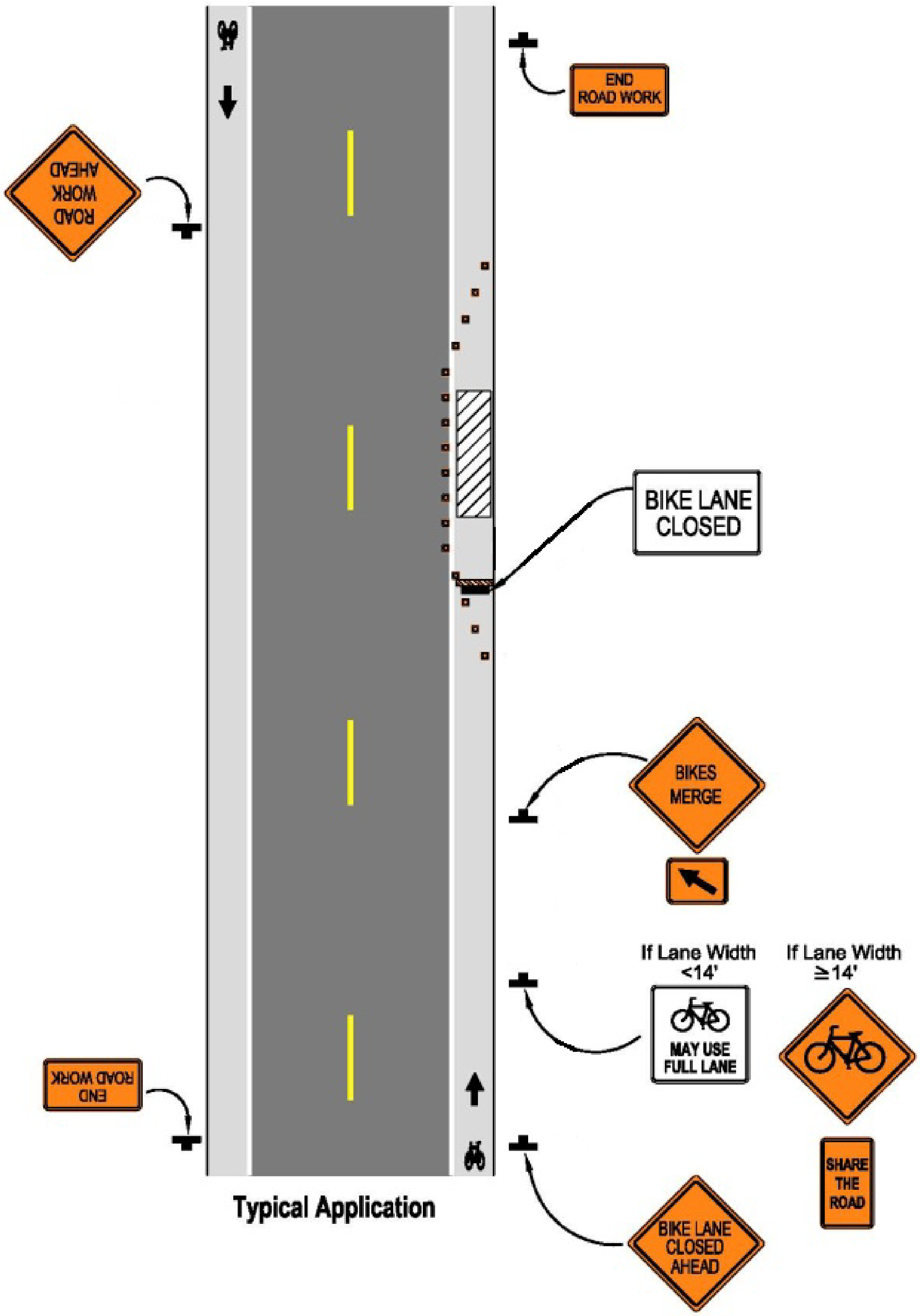
- Existing paths of travel for bicycles (bike lane/usable shoulder) should be maintained during construction at all times. This may require the temporary realignment and/or relocation of a bike lane or usable shoulder.
- Every effort should be made to avoid using bicycle lanes for construction staging areas.
- Where bicycle lanes are not present or cannot be maintained, provide for a shared vehicle lane as wide as physically feasible.
- Where bicycles are directed to share a travel lanes, the merge point should be easy to navigate and obvious for both motorists and bicyclists.
- Bicyclists should not be directed onto sidewalks with pedestrians unless there are no reasonable alternatives.
- Bicycle lanes should be comprised of a smooth, hard travel surface. Loose gravel, compacted aggregate, sand, mud and standing water should be avoided.
- Maintain adequate drainage during construction to avoid pooling on shoulders and in bike lanes.

Paved Shoulder Closure with Bicycle Detour onto Path

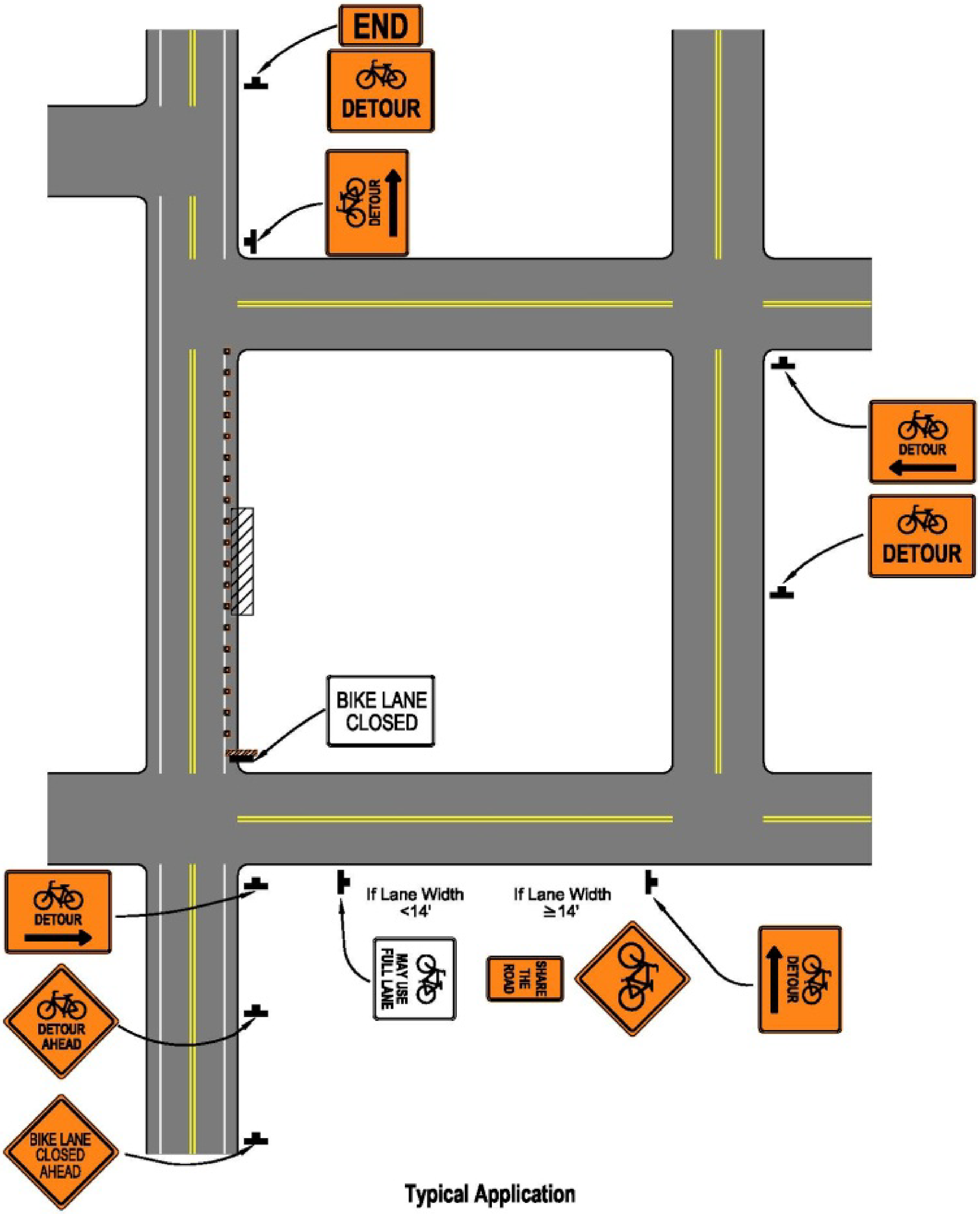


Typical Application

Bicycle Lane Closure without Detour

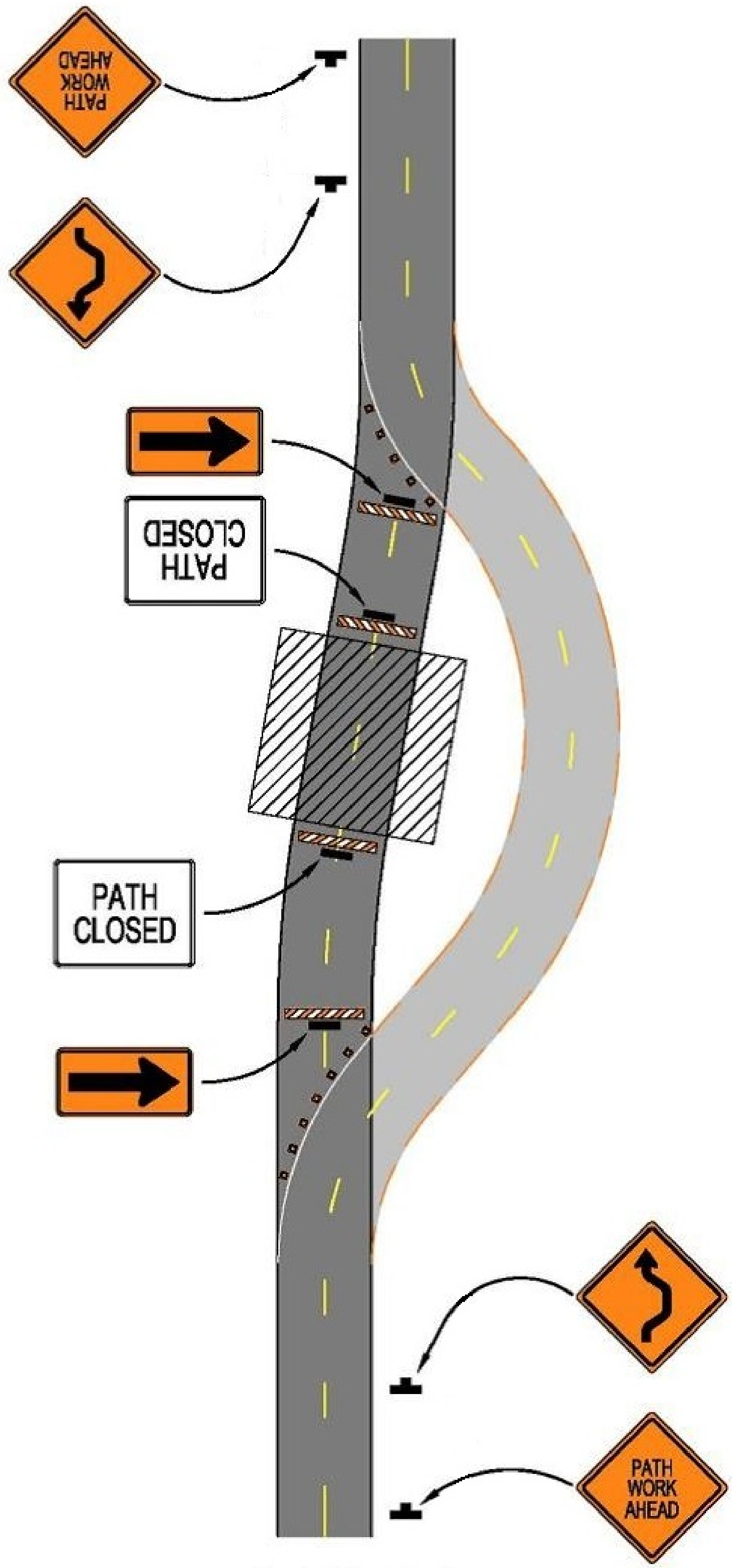


Typical Application



Typical Application

Temporary Path Detour for Shared-Use Path



Typical Application

DEFINITIONS

Alignment: The horizontal curvature of the trail.

Arterial: Roadways with high traffic volumes and are frequently the route of choice for intercity buses and trucks.

Basic Cyclist: Casual and/or novice cyclist that includes less experienced adults and children who are not comfortable riding in traffic.

Bicycle: A vehicle with two or more wheels that is built to be propelled by human power through a belt, chain or gears (whether or not it has an auxiliary motor). For the purposes of this manual 'bike', 'bicycle' and 'cycle' mean the same thing.

Bicycle Facility: A public facility especially constructed for bicycle traffic. This term has broad use and can refer to any part of a bicycle route, bicycle path, bicycle lane, associated signage or parking equipment.

Bicycle Lane: A marked lane, or the part of a marked lane beginning at a bicycle lane sign applying to the lane; and ending at the nearest of the following:

(a) an end bicycle lane sign applying to the lane;

(b) an intersection (unless the lane is at the unbroken side of the continuing road at a T - intersection or continued across the intersection by broken lines); or

(c) if the road ends at a dead end - the end of the road.

Bicycle Suitability: Bicycle suitability is the perceived comfort and safety of a linear section of a bikeway that includes streets and shared-use paths.

Bicycle Friendliness: Bicycle friendliness includes the general perceptions about all aspects of bicycle travel, including bikeability, laws and policies to promote biking, education efforts to encourage biking, and general acceptance of bicycling throughout the region.

Bikeability: Bikeability is the perceived comfort, safety and convenience of an entire bikeway network to access important destinations throughout the region.

Bikeway: Any path, trail or way which in some manner is specifically designed as being open to bicycle travel. Bikeway is a generic term for any road, street, path, etc. which in some manner is specifically designed for bicycle travel, regardless of whether the facility is designated for preferential or exclusive use by bicyclists or is shared with other transportation modes.

Bollard: Post used to restrict motor vehicle use of space dedicated to bicyclists and/or pedestrians.

Clearance Interval: The length of time that the DON'T WALK indication is flashing on a pedestrian signal indication.

Clear Trail Width: The width of the traveled part of the trail that is free of protruding objects and obstacles, such as trees and overgrown vegetation.

Clear Zones: The area on each side of the trail between the traveled surface and any obstructions, such as trees, walls, or fences.

Collectors: Roads that provide a more balanced blend of mobility and access.

Cross Slope: The slope measured perpendicular to the direction of travel.

Crosswalk: Any portion of a roadway at an intersection or elsewhere that is distinctly indicated for pedestrian crossing. Where there are no pavement markings, there is a crosswalk at each leg of every intersection, defined by law as the prolongation or connection of the lateral lines of the sidewalks.

Curb Ramp: A combined ramp and landing to accomplish a change of level at a curb in order to provide access to pedestrians using wheelchairs.

Drainage: The techniques used to move and keep water off the trail and trail embankment.

Edge Protection: Edge protection is a physical barrier along the edge of the trail that serves to protect the user from potential hazardous conditions. Hazardous conditions include steep slopes, bodies of water, poisonous plants, etc. The protection can be a small 3 inch curb made of wood, stone, asphalt or concrete, or it can be a 42 inch high railing of sturdy construction. Dense landscaping can also be used for edge protection. The recommended type of edge protection varies with the individual trail and trail user.

Grade Separation: Vertical separation of travelways through use of a bridge or tunnel so that traffic conflicts are minimized.

Greenway: A greenway is a linear open space corridor managed for recreation, conservation, and/or transportation. A greenway does not necessarily imply inclusion of a recreational trail. In fact, greenways can sometimes simply be a strip of preserved forest or vegetation along a stream, ridge, or other natural feature. Some may be located along a man-made corridor, such as railroad or utility rights-of-way, or along a highway or road corridor. For the purposes of this document, greenways refer to open space corridors with a recreational trail, multi-use path, or trail, and/or bikeway.

Guide Sign: A sign that shows route designations, destinations, directions, distances, services, points of interest, or other geographical, recreational, or cultural information.

HCM: Highway Capacity Manual

Highway: A general term for denoting a public way for purposes of travel by vehicular travel, including the entire area within the right-of-way.

Intersection: The area embraced within the prolongation or connection of the lateral curb lines, or if none, the lateral boundary lines of the roadways of two highways that join one another at, or approximately at, right angles, or the area within which vehicles traveling on different highways that join at any other angle might come into conflict.

Island: A defined area between traffic lanes for control of vehicular movements and/or for pedestrian refuge. It includes all end protection and approach treatments. Within an intersection area, a median or an outer separation is considered to be an island.

Level of Service (LOS): Term for the measurement of how well traffic “flows” through a roadway system or how well an intersection functions.

Loop Detector: A device placed under the pavement at intersections to detect a vehicle or bicycle and subsequently trigger a signal to turn green.

Median: Area in the center of the roadway that separates directional traffic; may provide a striped crossing and halfway point for pedestrians (also can be effective traffic calming design). Medians may be level with the surrounding roadway or "raised" using curb and/or gutter. Medians may include landscaping, concrete, paint/striping or any combination thereof.

Multi-Use, Shared-Use Trails or Paths: These trails, or paths, are designed to accommodate several different users, including walkers, joggers, bicyclists, equestrians, and in-line skaters and would have an improved surface of concrete, asphalt, crushed stone, compacted dirt or grass. Multi-Use or shared-use trails or paths are physically located separate from roadways and are used for walking, biking, in-line skating, etc.

Natural Surface Trails: These trails are designed to accommodate hikers, mountain bikers, or equestrians and would typically be paths without an improved surface.

OMUTCD: The Ohio Manual on Uniform Traffic Control Devices.

Paved Shoulder: A paved shoulder is the edge of the roadway beyond the outer stripe edge that provides a place for people riding bicycles. It only functions well for bicyclists if it is wide enough (4-5 feet), free of debris, and does not contain rumble strips or other obstructions.

Pavement Marking: An assortment of markings on the surface of the pavement that provide directions to motorists and other road users as to the proper use of the road.

Pedestrian: A person afoot; a person operating a pushcart; a person riding on, or pulling a coaster wagon, sled, scooter, tricycle, bicycle with wheels less than 14 inches in diameter, or a similar conveyance; a person on roller skates, skateboard, wheelchair or a baby in a carriage.

Profile: The vertical curvature or vertical alignment of the trail.

Refuge Islands: Corner raised triangles or medians, used by pedestrians and bicyclists at intersections or mid-block crossings for assistance with crossing wide streets, especially where motor vehicle right turn lanes exist.

Right-of-Way (R/W): A general term denoting land devoted to transportation purposes. The land may be owned outright by the agency responsible for the roadway or the agency may have a perpetual easement to use it for transportation purposes.

Right-of-Way (Assignment)**:** The permitting of vehicles and/or pedestrians to proceed in a lawful manner in preference to other vehicles or pedestrians by the display of sign or signal indications.

Rumble Strip: A feature that is installed to alert road users to unusual traffic conditions. Longitudinal rows of rumble strips may be placed along the centerlines and/or shoulder edge-lines of highways to alert drivers that they are straying outside the appropriate lane. Transverse rows of rumble strips may be placed on the roadway surface in the travel lane(s) to alert motorists of upcoming significant speed changes.

Shared Roadway: A roadway where bicyclists and motor vehicles share the same space with no striped bike lane.

Shared-Use Path: Facilities physically separated from motor vehicle traffic by an open space or barrier, either within the highway right-of-way or within an independent right-of-way. Shared use paths may be used by a mix of non-motorized users such as bicyclists, walkers, runners, wheel chair users and skaters.

Sidepath: A shared use path located immediately adjacent and parallel to a roadway.

Sidewalk: An improved facility intended to provide for pedestrian movement, usually but not always, located in the public right-of-way adjacent to a roadway. Sidewalks are typically constructed of concrete.

Sight Distance: The distance a person can see along an unobstructed line of sight.

Superelevation: The cross-slope of the pavement used to compensate for the effect of centrifugal force on horizontal curves.

Targeted Bicyclist: The bicycle suitability analysis and the rating criteria are designed for the experienced adult riders. The suitability analysis is not intended for children, inexperience riders, or riders who are not comfortable riding in roadway travel lanes.

Traffic Control Devices: Signs, signals or other fixtures, whether permanent or temporary, placed on or adjacent to a traveled way by authority of a public body having jurisdiction to regulate, warn, or guide traffic.

Traffic Volume: The number of vehicles that pass a specific point in a specific amount of time (hour, day, year).

Trails and Greenways: Trails and greenways provide connections between points of interest in addition to being a recreational amenity to cyclists and pedestrians.

Trail Surface: Refers to the type of surface on the traveled part of the trail, such as asphalt, concrete, granular, or alternative. Surface quality is affected by tread obstacles, such as roots or rocks, and by any openings such as gaps and grates located within the trail surface.

Traveled Way: The portion of the roadway for the movement of vehicles, exclusive of shoulders and bicycle lanes.

Vertical Clearance: The height above the trail which is free from protruding objects and overhead obstructions, such as tree branches or bridges.

Waterbar: A drainage structure that is built across the width of the trail to direct water to the edge of the trail. It is used as a temporary solution to control drainage on steeper slopes. The use of waterbars is an indication that proper drainage was not accomplished with the original trail design and installation. Waterbars are typically made of wood, logs or stone. They are raised as much as 6 inches above the trail to intercept and direct the water runoff. It is preferable to control drainage without the use of waterbars. They create additional maintenance, trap sediment on the uphill side of the bar, and present hazards to the trail user.

Wide Curb Lane: A 14 foot (or greater) wide outside lane adjacent to the curb of a roadway that provides space for bicyclists to ride to the right of motor vehicles. Also referred to as a “wide outside lane”. If adjacent to parking, 22 foot wide pavement may also be considered a wide curb lane.

REFERENCE SOURCES & RESOURCES

The criterion included in this document has been developed from information obtained from the following resources:

1) AASHTO (American Association of State Highway and Transportation Officials), Guide for the Development of Bicycle Facilities 4Th Edition, (Washington, D.C.: AASHTO, 2012)
https://bookstore.transportation.org/item_details.aspx?ID=1943

2) AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, July 2004
https://bookstore.transportation.org/collection_detail.aspx?ID=131&gclid=CNzomMHGmdACFRCqaQod71UIrw

3) AASHTO - A Policy on Geometric Design of Highways and Streets 6Th Edition (2011 Green Book)
https://bookstore.transportation.org/Item_details.aspx?id=1917

4) AASHTO - Roadside Design Guide, 4Th Edition (2011)
https://bookstore.transportation.org/collection_detail.aspx?ID=105&gclid=CIbgzf7XmdACFQYGaQodhNcPRg

5) Ohio Department of Transportation (ODOT) Location and Design Manual, Volume 1, 2016
- Section 308 On Road Bicycle Guidelines
- Section 700 Multi-Modal
- Section 905.2, Figure 904-2, Urban Landscaping Typical Curbed Section 45 MPH or Less

https://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Pages/locationanddesignmanuals.aspx

6) Ohio Department of Transportation (ODOT), 2014, Bikeway Pavement Marking Details, Plan Insert Sheet
https://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/PISs/Documents/0207000_07-18-2014.pdf

7) Ohio Department of Transportation (ODOT), Standard Construction Drawing, 2014, Bikeway Railing, RM-5.2
http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Archive%20Roadway%20Standard%20Construction%20Drawings/RM-5.2%20Bikeway%20Railing%202003-2014.pdf

8) Ohio Manual of Uniform Traffic Control Devices (OMUTCD), 2012 Edition, Part 9, Traffic Control for Bicycle Facilities
http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/OhioMUTCD/Documents/2012_Part09_011312_Final_bookmarked.pdf

9) National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide, Second Edition, 2016
http://nacto.org/publication/urban-bikeway-design-guide/

10) Federal Highway Administration (FHWA) Safety Program – Road Diet Information Guide (2014) FHWA-SA-14-028
http://safety.fhwa.dot.gov/road_diets/info_guide/rdig.pdf

11) FHWA – Evaluation of Lane Reduction "Road Diet" Measures and Their Effects on Crashes and Injuries, FHWA-HRT-04-082
http://www.fhwa.dot.gov/publications/research/safety/humanfac/04082/04082.pdf

12) FHWA Implementing Bicycle Improvements at the Local Level, Publication No. FHWA-98-105, 1998
http://www.fhwa.dot.gov/publications/research/safety/98105/98105.pdf

13) FHWA – Selecting Roadway Design Treatments to Accommodate Bicycles (1994) FHWA-RD-92-073
http://safety.fhwa.dot.gov/ped_bike/docs/select.pdf

14) United States Access Board Guidelines and Standards
https://www.access-board.gov/guidelines-and-standards

15) Shared-Use Paths Best Practices for Bikes & Pilot Treatments, September 2006, Mid-Ohio Regional Planning Commission, 285 East Main Street, Columbus, Ohio 43215
http://www.morpc.org/trans/BikePedSharedUsePathBestPractices.pdf

16) Jefferson County Trails & Greenways Implementation Guidelines, 2016, Brooke Hancock Jefferson County Metropolitan Planning Commission
http://www.bhjmpc.org/wp-content/uploads/2015/05/Jeff-Co-TG-Plan-FINAL-20150526.pdf

17) Highway Capacity Manual, Fifth Edition, HCM 2010, Transportation Research Board

18) Public Right of Way Accessibility Guidelines (PROWAG)
http://www.access-board.gov/prowac/nprm.htm

19) A Guideline for the Design and Construction of HMA Pavement for Trails and Paths, National Asphalt Pavement Association, Information Series 129, 2002
http://driveasphalt.org/assets/content/resources/IS129_HMA_Pavements_for_Trails_and_Paths.pdf

20) Shared-Use Paths Best Practices for Bikes & Pilot Treatments, September 2006, Mid-Ohio Regional Planning Commission, 285 East Main Street, Columbus, Ohio 43215
http://www.morpc.org/trans/BikePedSharedUsePathBestPractices.pdf

21) Bikeway and Trail Design Standards and Planning Guidelines, 2003, Frederick County Parklands, Frederick County Department of Parks and Recreation
http://www.recreater.com/DocumentCenter/View/297

22) Update to Regional Bicycle and Pedestrian Facility Guidelines – Region of Portland, ME, 2013, Portland Area Comprehensive Transportation System

23) Outdoor Developed Areas Accessibility Guidelines (ODAAG) of 2012. http://www.fs.fed.us/t-d/pubs/htmlpubs/htm12232806/page01.htm

The U.S. Access Board developed ODAAG as a component of ADA/ABAAG. It contains accessibility guidelines for outdoor developed recreation areas and trails that are federally funded. Federal agencies may develop and use their own guidelines only if they are an equal or higher standard.

24) ADA Standards for Accessible Design (ADASAD) of 2010.

The U.S. Department of Justice adopted the ADA portion of ADA/ABAAG for use by State and local government entities and private entities open to the public. ADASAD is effective as of March 15, 2012.

25) Americans with Disabilities Act Accessibility Guidelines (ADAAG)—1991 to 2010.

ADAAG explains how to apply the Americans with Disabilities Act (ADA) of 1990 in the built environment. These guidelines apply to services provided by State and local governments, and public accommodations.

26) Wayside Exhibit Typographic Standards, National Park Service, 2010, Harpers Ferry Center Media Services.
https://www.nps.gov/hfc/pdf/waysides/type-standards.pdf

The Typographic Standards are one of many tools used to create a consistent recognizable format for organizing and presenting information to the public. These standards along with National Park Service identity standards, editorial standards, map standards, consistent work processes, and maintenance programs help keep costs down and visitor interest in the wayside media at a high level.

27) Wayside Map Standards, National Park Service, 2005, Harpers Ferry Center Media Services.
https://www.nps.gov/hfc/pdf/waysides/map-standards.pdf

The intent of the NPS Wayside Map Standards is to establish a common language with maps. The map standards should serve as a guide to mapping and not as a hard and fest set of rules.

28) AASHTO (American Association of State Highway and Transportation Officials), LRFD Guide Specifications for the Design of Pedestrian Bridges, (Washington, D.C.: AASHTO)
https://bookstore.transportation.org

SUITABILITY REFERENCES

Bicycle Level of Service (BLOS): Landis, Bruce, "Real-Time Human Perceptions: Toward a Bicycle Level of Service, "Transportation Research Record 1578 (Washington DC, Transportation Research Board, 1997).

Bicycle Compatibility Index (BCI): "Development of the Bicycle Compatibility Index: A Level of Service Concept, Final Report," FHWA-RD-98-072 (1998).

"Development of the Bicycle Compatibility Index: A Level of Service Concept, Implementation Manual," FHWA-RD-98-095 (1998).

Pedestrian Level of Service: Landis, Bruce W., et al. "Modeling the Roadside Walking Environment: A Pedestrian Level of Service." Transportation Research Record 1773. (Washington, DC, Transportation Research Board, 2001).

W.C Wilkinson and others, "Selecting Roadway Design Treatments to Accommodate Bicycles," FHWA Report No. FHWA-RD-82-073 (Washington, D.C.: U.S. DOT, FHWA, 1994)

American Association of State Highway and Transportation Officials, Guide for the Development of Bicycle Facilities (Washington, D.C.: AASHTO, 2012).

U.S. Department of Transportation, Manual on Uniform Traffic Control Devices (Washington, D.C.: U.S. DOT, 1988)

Shared-Use Path Level of Service Calculator, A User's Guide, U.S. Department of Transportation Report No. FHWA-HRT-05-138 July 2006.

Highway Capacity Manual, Fifth Edition, HCM 2010, Transportation Research Board

Pedestrian & Bicycle Level of Service, Methodology for Crossings at Signalized Intersections, Feb. 2007, Charlotte Department of Transportation

Bicycle Suitability Criteria for State Roadways in Texas, June 1997, Sponsored by the Texas Department of Transportation

INDEX

APPENDIX

- Ohio Manual of Uniform Traffic Control Devices (OMUTCD), 2014, Part 9, Traffic Control for Bicycle Facilities

- Ohio Department of Transportation (ODOT) Location and Design Manual, Volume 1, 2016, Section 308 OnRoad Bicycle Guidelines

- Ohio Department of Transportation (ODOT) Location and Design Manual, Volume 1, 2016, Section 700 Multi-Modal

- Ohio Department of Transportation (ODOT) Location and Design Manual, Volume 1, 2016, Section 905.2, Figure 904-2, Urban Landscaping Typical Curbed Section 45 MPH or Less

- Ohio Department of Transportation (ODOT), 2014, Bikeway Pavement Marking Details, Plan Insert Sheet

- Ohio Department of Transportation (ODOT), Standard Construction Drawing, 2014, Bikeway Railing, RM-5.2

- National Park Service, Harpers Ferry Medial Services, 2005, Standard Map Elements for Maps on Wayside Exhibits and Signs

PART 9. TRAFFIC CONTROLS FOR BICYCLE FACILITIES

CHAPTER 9A. GENERAL

Section 9A.01 Requirements for Bicyclist Traffic Control Devices

Support:

01 General information and definitions concerning traffic control devices are found in Part 1.

Section 9A.02 Scope

Support:

01 Part 9 covers signs, pavement markings, and highway traffic signals specifically related to bicycle operation on both roadways and shared-use paths.

Guidance:

02 *Parts 1, 2, 3, and 4 should be reviewed for general provisions, signs, pavement markings, and signals.*

Standard:

03 **The absence of a marked bicycle lane or any of the other traffic control devices discussed in this Chapter on a particular roadway shall not be construed to mean that bicyclists are not permitted to travel on that roadway.**

Section 9A.03 Definitions Relating to Bicycles

Support:

01 Definitions and acronyms pertaining to Part 9 are provided in Sections 1A.13 and 1A.14.

Section 9A.04 Maintenance

Guidance:

01 *All signs, signals, and markings, including those on bicycle facilities, should be properly maintained to command respect from both the motorist and the bicyclist. When installing signs and markings on bicycle facilities, an agency should be designated to maintain these devices.*

Section 9A.05 Relation to Other Documents

Support:

01 "The Uniform Vehicle Code and Model Traffic Ordinance" published by the National Committee on Uniform Traffic Laws and Ordinances and the Ohio Revised Code (see Section 1A.11) have provisions for bicycles and are the basis for the traffic control devices included in this Manual.

02 Informational documents used during the development of the signing and marking recommendations in Part 9 include the following:

A. "Guide for Development of Bicycle Facilities," which is available from the American Association of State Highway and Transportation Officials (see the Preface for the address); and
B. State and local government design guides.

03 Other publications that relate to the application of traffic control devices in general are listed in Section 1A.11.

Section 9A.06 Placement Authority

Support:

01 Section 1A.08 contains information regarding placement authority for traffic control devices.

Section 9A.07 Meaning of Standard, Guidance, Option, and Support

Support:

01 Paragraph 1 of Section 1A.13 contains information regarding the meaning of the headings Standard, Guidance, Option, and Support, and the use of the words "shall," "should," and "may."

Section 9A.08 Colors

Support:

01 Section 1A.12 contains information regarding the color codes.

CHAPTER 9B. SIGNS

Section 9B.01 Application and Placement of Signs

Standard:

01 **Bicycle signs shall be standard in shape, legend, and color.**

02 **All signs shall be retro reflectorized for use on bikeways, including shared-use paths and bicycle lane facilities.**

03 **Where signs serve both bicyclists and other road users, vertical mounting height and lateral placement shall be as provided in Part 2.**

04 **Where used on a shared-use path, no portion of a sign or its support shall be placed less than 2 feet laterally from, or less than 8 feet vertically over the entire width of the shared-use path (see Figure 9B-1).**

05 **Mounting height for post-mounted signs on shared-use paths shall be a minimum of 4 feet, measured vertically from the bottom of the sign to the elevation of the near edge of the path surface (see Figure 9B-1).**

Guidance:

06 *Signs for the exclusive use of bicyclists should be located so that other road users are not confused by them.*

07 *The clearance for overhead signs on shared-use paths should be adjusted when appropriate to accommodate path users requiring more clearance, such as equestrians, or typical maintenance or emergency vehicles.*

Section 9B.02 Design of Bicycle Signs

Standard:

01 **If the sign or plaque applies to motorists and bicyclists, then the size shall be as shown for conventional roads in Tables 2B-1, 2C-2, 2D-1, 2H-1 or 8B-1.**

02 **The minimum sign and plaque sizes for shared-use paths shall be those shown in Table 9B-1, and shall be used only for signs and plaques installed specifically for bicycle traffic applications. The minimum sign and plaque sizes for bicycle facilities shall not be used for signs or plaques that are placed in a location that would have any application to other vehicles.**

Option:

03 Larger size signs and plaques may be used on bicycle facilities when appropriate (see Section 2A.11).

Guidance:

04 *Except for size, the design of signs and plaques for bicycle facilities should be identical to that provided in this Manual for signs and plaques for streets and highways.*

Support:

05 Uniformity in design of bicycle signs and plaques includes shape, color, symbols, arrows, wording, lettering, and illumination or retroreflectorization.

Section 9B.03 STOP and YIELD Signs (R1-1, R1-2)

Standard:

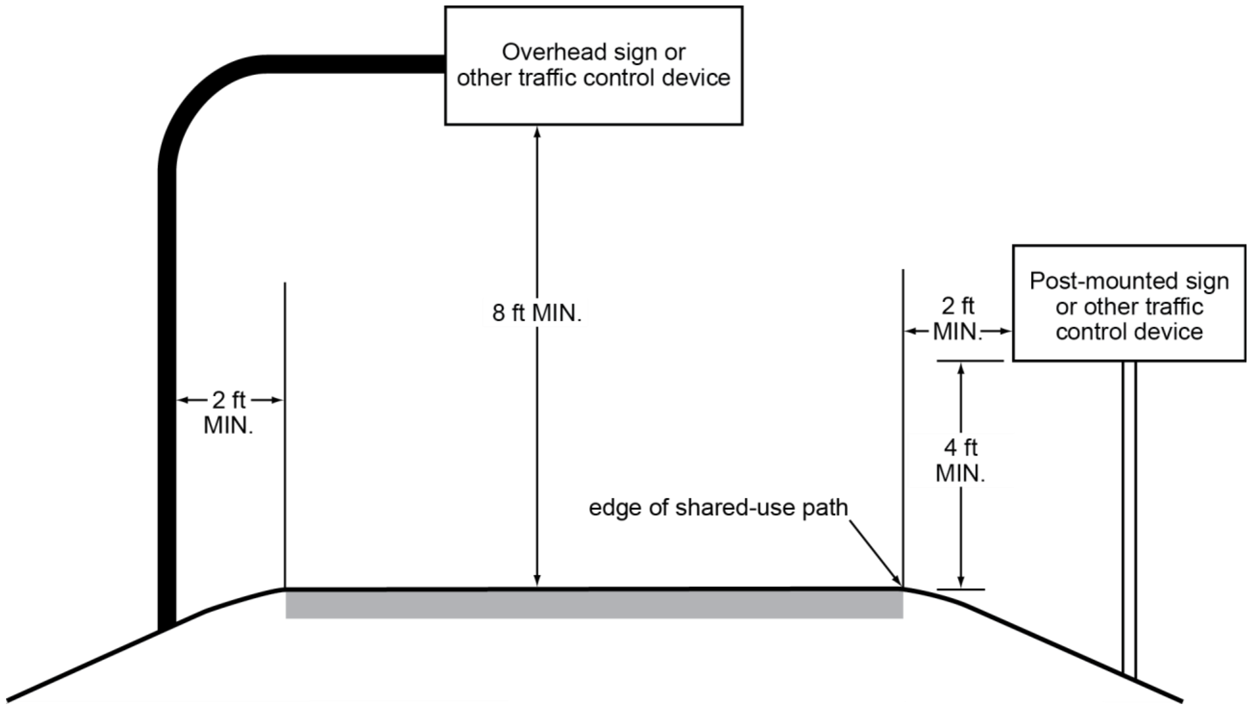
01 **STOP (R1-1) signs (see Figure 9B-2) shall be installed on shared-use paths at points where bicyclists are required to stop.**

02 **YIELD (R1-2) signs (see Figure 9B-2) shall be installed on shared-use paths at points where bicyclists have an adequate view of conflicting traffic as they approach the sign, and where bicyclists are required to yield the right-of-way to that conflicting traffic.**

Option:

03 A 30 x 30 inch STOP sign or a 36 x 36 x 36 inch YIELD sign may be used on shared-use paths for added emphasis.

Figure 9B-1. Sign Placement on Shared-Use Paths



Guidance:

04 *Where conditions require path users, but not roadway users, to stop or yield, the STOP sign or YIELD sign should be placed or shielded so that it is not readily visible to road users.*

05 *When placement of STOP or YIELD signs is considered, priority at a shared-use path/roadway intersection should be assigned with consideration of the following:*

A. Relative speeds of shared-use path and roadway users;
B. Relative volumes of shared-use path and roadway traffic; and
C. Relative importance of shared-use path and roadway.

06 *Speed should not be the sole factor used to determine priority, as it is sometimes appropriate to give priority to a high-volume shared-use path crossing a low-volume street, or to a regional shared-use path crossing a minor collector street.*

07 *When priority is assigned, the least restrictive control that is appropriate should be placed on the lower priority approaches. STOP signs should not be used where YIELD signs would be acceptable.*

Section 9B.04 Bike Lane Signs and Plaques (R3-17, R3-17a, R3-17bP)

Standard:

01 **The BIKE LANE (R3-17) sign and the R3-17aP and R3-17bP plaques (see Figure 9B-2) shall be used only in conjunction with marked bicycle lanes as described in Section 9C.04.**

Guidance:

02 *If used, Bike Lane signs and plaques should be used in advance of the upstream end of the bicycle lane, at the downstream end of the bicycle lane, and at periodic intervals along the bicycle lane as determined by engineering judgment based on prevailing speed of bicycle and other traffic, block length, distances from adjacent intersections, and other considerations.*

Table 9B-1. Bicycle Facility Sign and Plaque Minimum Sizes[1, 2] (Sheet 1 of 2)

Sign or Plaque	Sign Designation	Section	Shared-Use Path	Roadway
STOP	R1-1	2B.05, 9B.03	18 x 18	—
YIELD	R1-2	2B.08, 9B.03	18 x 18 x 18	—
BIKE LANE	R3-17	9B.04	—	24 x 18
Bike Lane (plaques)	R3-17aP, 17bP	9B.04	—	24 x 8
Movement Restriction	R4-1, 2, 3, 7	2B.28, 29, 30, 32; 9B.14	12 x 18	—
BEGIN RIGHT TURN LANE YIELD TO BIKES	R4-4	9B.05	—	36 x 30
Bicycles MAY USE FULL LANE	R4-11	9B.06	—	30 x 30
Bicycle WRONG WAY	R5-1b	9B.07	12 x 18	
NO MOTOR VEHICLES	R5-3	9B.08	24 x 24	—
No Bicycles	R5-6	9B.09	24 x 24	—
No Parking BIKE LANE	R7-9, 9a	9B.10	—	12 x 18
No Pedestrians	R9-3	9B.09	18 x 18	—
RIDE WITH TRAFFIC (plaque)	R9-3cP	9B.07	12 x 12	
Bicycle Regulatory	R9-5, 6	9B.11	12 x 18	
Shared-Use Path Restriction	R9-7	9B.12	12 x 18	—
No Skaters	R9-13	9B.09	18 x 18	—
No Equestrians	R9-14	9B.09	18 x 18	—
Push Button For Green Light	R10-4	9B.11	9 x 12	—
Bicycle Signal Actuation	R10-22	9B.13	12 x 18	
Bike Push Button For Green Light	R10-24	9B.11	9 x 15	
Push Button To Turn On Warning Lights	R10-25	9B.11	9 x 12	—
Bike Push Button For Green Light (arrow)	R10-26	9B.11	9 x 15	
Grade Crossing (Crossbuck)	R15-1	8B.03, 9B.14	24 x 4.5	—
Number of Tracks (plaque)	R15-2P	8B.03, 9B.14	13.5 x 9	—
LOOK	R15-8	8B.17, 9B.14	18 x 9	—
Turn and Curve Warning	W1-1, 2, 3, 4, 5	2C.07, 9B.15	18 x 18	—
Arrow Warning	W1-6, 7	2C.12, 2C.47, 9B.15	24 x 12	—
Intersection Warning	W2-1, 2, 3, 4, 5	2C.46, 9B.16	18 x 18	—
Stop, Yield, Signal Ahead	W3-1, 2, 3	2C.36, 9B.19	18 x 18	—
NARROW BRIDGE	W5-2	9C.20, 9B.19	18 x 18	—
PATH NARROWS	W5-4a	9B.19	18 x 18	—
Hill (Bicycle)	W7-5	9B.19	18 x 18	30 x 30
BUMP or DIP	W8-1, 2	2C.28, 9B.17	18 x 18	—
PAVEMENT ENDS	W8-3	2C.30, 9B.17	18 x 18	—
Bicycle Surface Condition	W8-10	9B.17	18 x 18	30 x 30
SLIPPERY WHEN WET (plaque)	W8-10P	9B.17	12 x 9	
Grade Crossing Advance Warning	W10-1	8B.06, 9B.19	24 Dia.	—
NO TRAIN HORN (plaque)	W10-9P	8B.21, 9B.19	18 x 12	—
Skewed Crossing	W10-12	8B.25, 9B.19	18 x 18	—

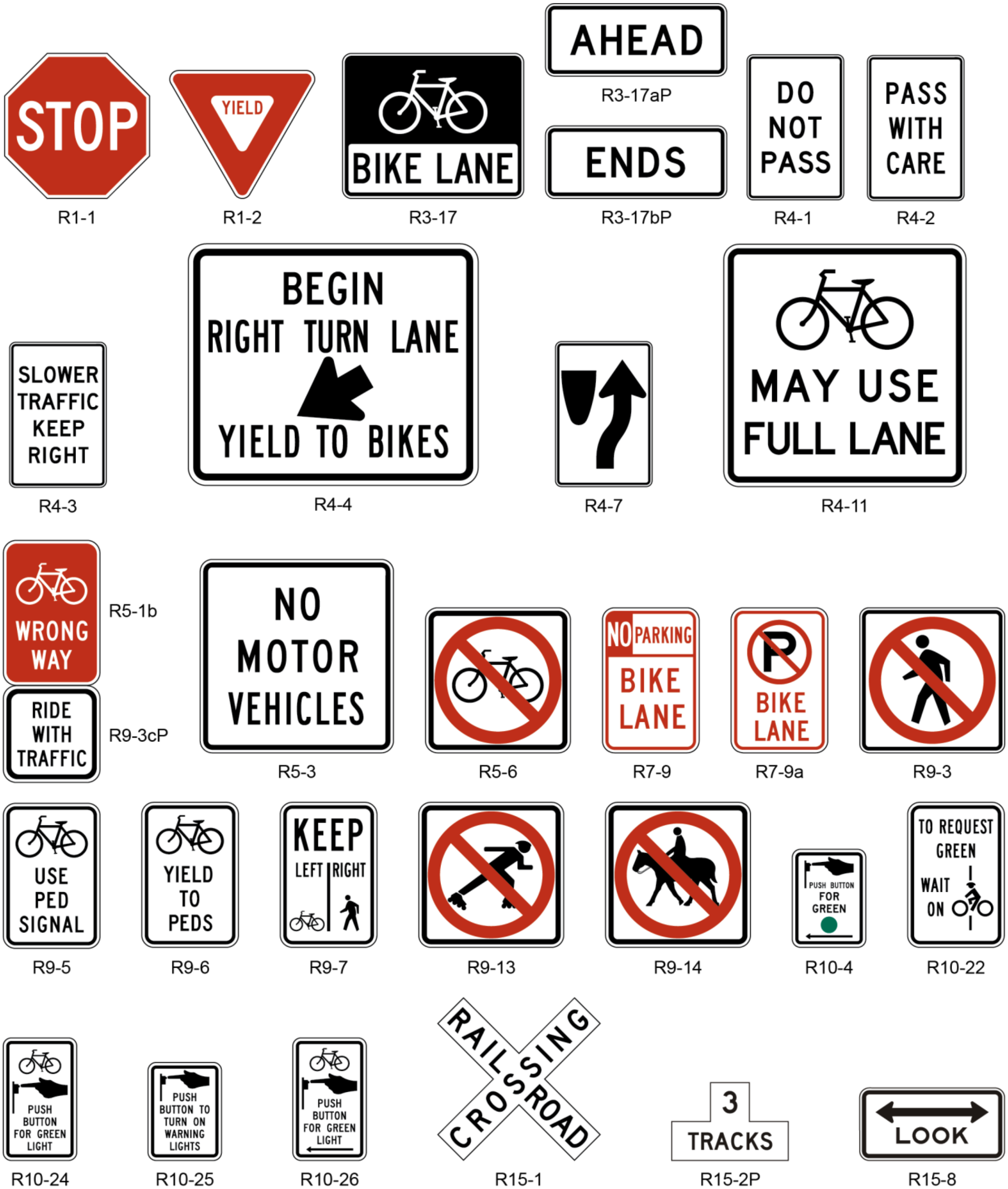
Table 9B-1. Bicycle Facility Sign and Plaque Minimum Sizes[1, 2] (Sheet 2 of 2)

Sign or Plaque	Sign Destination	Section	Shared-Use Path	Roadway
Bicycle Warning	W11-1	9B.18	18 x 18	—
Pedestrian Crossing	W11-2	2C.50, 9B.19	18 x 18	—
Combination Bike and Ped Crossing	W11-15	9B.18	18 x 18	—
TRAIL X-ING (plaque)	W11-15P	9B.18	18 x 12	—
Low Clearance	W12-2	2C.27, 9B.19	18 x 18	—
Playground	W15-1	2C.51, 9B.19	18 x 18	—
SHARE THE ROAD (plaque)	W16-1P	2C.60, 9B.19	—	—
XX FEET (plaque)	W16-2P	2C.55, 9B.18	18 x 12	—
XX FT (plaque)	W16-2aP	2C.55, 9B.18	18 x 9	—
Diagonal Arrow (plaque)	W16-7P	9B.18	—	—
AHEAD (plaque)	W16-9P	9B.18	—	—
Destination (1 line)	D1-H1, H1a	2D.37, 9B.20	varies x 6	—
Bicycle Destination (1 line)	D1-1b, 1c	9B.20	varies x 6	
Bicycle Destination (2 lines)	D1-2b, 2c	9B.20	varies x 12	
Bicycle Destination (3 lines)	D1-3b, 3c	9B.20	varies x 18	
Street Name	D3-1	2D.43, 9B.20	varies x 6	—
Bicycle Parking Area	D4-3	9B.23	12 x 18	
Reference Location (1-digit)	D10-1	2H.02, 9B.24	6 x 12	—
Intermediate Reference Location (1-digit)	D10-1a	2H.02, 9B.24	6 x 18	—
Reference Location (2-digit)	D10-2	2H.02, 9B.24	6 x 18	—
Intermediate Reference Location (2-digit)	D10-2a	2H.02, 9B.24	6 x 24	—
Reference Location (3-digit)	D10-3	2H.02, 9B.24	6 x 24	—
Intermediate Reference Location (3-digit)	D10-3a	2H.02, 9B.24	6 x 30	—
Bike Route	D11-1, 1c	9B.20	24 x 18	24 x 18
Bicycles Permitted	D11-1a	9B.25	18 x 18	—
BIKE ROUTE (plaque)	D11-1bP	9B.25	18 x 6	—
Pedestrians Permitted	D11-2	9B.25	18 x 18	—
Skaters Permitted	D11-3	9B.25	18 x 18	—
Equestrians Permitted	D11-4	9B.25	18 x 18	—
Bicycle Route	M1-8, 8a	9B.21	12 x 18	18 x 24
U.S. Bicycle Route	M1-9	9B.21	12 x 18	18 x 24
Bicycle Route Auxiliary Signs	M2-1; M3-1,2,3,4; M4-1,1a,2,3,5,6,7,7a,8,14	9B.22	12 x 6	
Bicycle Route Arrow Signs	M5-1,2; M6-1,2,3,4,5,6,7	9B.22	12 x 9	
Type 3 Object Markers	OM-3L, C, R	2C.63, 9B.26	6 x 18	—

Notes:

1. a.) Larger signs may be used when appropriate;
   b.) Dimensions are shown in inches as width x height.
2. If the sign or plaque applies to motorists and bicyclists, then the size shall be as shown for conventional roads in Tables 2B-1, 2C-2, 2D-1, 2H-1 or 8B-1.

Figure 9B-2. Regulatory Signs and Plaques for Bicycle Facilities



Section 9B.05 BEGIN RIGHT TURN LANE YIELD TO BIKES Sign (R4-4)

Option:

01 Where motor vehicles entering an exclusive right-turn lane must weave across bicycle traffic in bicycle lanes, the BEGIN RIGHT TURN LANE YIELD TO BIKES (R4-4) sign (see Figure 9B-2) may be used to inform both the motorist and the bicyclist of this weaving maneuver (see Figures 9C-1, 9C-4, and 9C-5).

Guidance:

02 *The R4-4 sign should not be used when bicyclists need to move left because of a right-turn lane drop situation.*

Section 9B.06 Bicycles MAY USE FULL LANE Sign (R4-11)

Support:

01 ORC Section 4511.55 addresses operating bicycles and motorcycles on a roadway (see Appendix B). Generally, a bicyclist is required to ride as near to the right side of the roadway as possible, unless it is unsafe or impractical to do so.

Guidance:

02 *Use of the Bicycles MAY USE FULL LANE (R4-11) sign should be based on engineering judgment.*

Option:

03 The Bicycles MAY USE FULL LANE sign (see Figure 9B-2) may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicyclists are present and where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side.

04 The Bicycles MAY USE FULL LANE sign may be used in locations where it is important to inform road users that bicyclists might occupy the travel lane.

05 Section 9C.07 describes a Shared Lane Marking that may be used in addition to or instead of the Bicycles MAY USE FULL LANE sign to inform road users that bicyclists might occupy the travel lane.

Guidance:

06 *When the Bicycles MAY USE FULL LANE sign is used, the start and end of the section determined to warrant the signing should be marked with BEGIN (R3-9cP) and END (R3-9dP) plaques.*

Section 9B.07 Bicycle WRONG WAY Sign and RIDE WITH TRAFFIC Plaque (R5-1b, R9-3cP)

Option:

01 The Bicycle WRONG WAY (R5-1b) sign and RIDE WITH TRAFFIC (R9-3c) plaque (see Figure 9B-2) may be placed facing wrong-way bicycle traffic, such as on the left side of a roadway.

02 This sign and plaque may be mounted back-to-back with other signs to minimize visibility to other traffic.

Guidance:

03 *The RIDE WITH TRAFFIC plaque should be used only in conjunction with the Bicycle WRONG WAY sign, and should be mounted directly below the Bicycle WRONG WAY sign.*

Section 9B.08 NO MOTOR VEHICLES Sign (R5-3)

Option:

01 The NO MOTOR VEHICLES (R5-3) sign (see Figure 9B-2) may be installed at the entrance to a shared-use path.

Section 9B.09 Selective Exclusion Signs

Option:

01 Selective Exclusion signs (see Figure 9B-2) may be installed at the entrance to a roadway or facility to notify road or facility users that designated types of traffic are excluded from using the roadway or facility.

Standard:

02 **If used, Selective Exclusion signs shall clearly indicate the type of traffic that is excluded.**

Support:

03 Typical exclusion messages include:

A. No Bicycles (R5-6),
B. No Pedestrians (R9-3),
C. No Skaters (R9-13), and
D. No Equestrians (R9-14)

Option:

04 When used on a sidewalk, the No Bicycles (R5-6) sign may be 18 x 18 inches.

05 Where bicyclists, pedestrians, and motor-driven cycles are all prohibited, it may be more desirable to use the R5-10a word message sign that is described in Section 2B.39.

Section 9B.10 No Parking BIKE LANE Signs (R7-9, R7-9a)

Standard:

01 **If the installation of signs is necessary to restrict parking, standing, or stopping in a bicycle lane, appropriate signs as described in Sections 2B.46 through 2B.48, or the No Parking BIKE LANE (R7-9 or R7-9a) signs (see Figure 9B-2) shall be installed.**

Section 9B.11 Bicycle Regulatory Signs (R9-5, R9-6, R10-4, R10-24, R10-25, R10-26)

Option:

01 The R9-5 sign (see Figure 9B-2) may be used where the crossing of a street by bicyclists is controlled by pedestrian signal indications.

02 Where it is not intended for bicyclists to be controlled by pedestrian signal indications, the R10-4, R10-24, or R10-26 sign (see Figure 9B-2 and Section 2B.52) may be used.

Guidance:

03 *If used, the R9-5, R10-4, R10-24, or R10-26 signs should be installed near the edge of the sidewalk, in the vicinity of where bicyclists will be crossing the street.*

Option:

04 If bicyclists are crossing a roadway where In-Roadway Warning Lights (see Section 4N.02) or other warning lights or beacons have been provided, the R10-25 sign (see Figure 9B-2) may be used.

05 The R9-6 sign (see Figure 9B-2) may be used where a bicyclist is required to cross or share a facility used by pedestrians and is required to yield to the pedestrians.

Section 9B.12 Shared-Use Path Restriction Sign (R9-7)

Option:

01 The Shared-Use Path Restriction (R9-7) sign (see Figure 9B-2) may be installed to supplement a solid white pavement marking line (see Section 9C.03) on facilities that are to be shared by pedestrians and bicyclists in order to provide a separate designated pavement area for each mode of travel. The symbols may be switched as appropriate.

Guidance:

02 *If two-way operation is permitted on the facility for pedestrians and/or bicyclists, the designated pavement area that is provided for each two-way mode of travel should be wide enough to accommodate both directions of travel for that mode.*

Section 9B.13 Bicycle Signal Actuation Sign (R10-22)

Option:

01 The Bicycle Signal Actuation (R10-22) sign (see Figure 9B-2) may be installed at signalized intersections where markings are used to indicate the location where a bicyclist is to be positioned to actuate the signal (see Section 9C.05).

Guidance:

02 *If the Bicycle Signal Actuation sign is installed, it should be placed at the roadside adjacent to the marking to emphasize the connection between the marking and the sign.*

Section 9B.14 Other Regulatory Signs

Option:

01 Other regulatory signs described in Chapter 2B may be installed on bicycle facilities as appropriate.

Section 9B.15 Turn or Curve Warning Signs (W1 Series)

Guidance:

01 *To warn bicyclists of unexpected changes in shared-use path direction, appropriate turn or curve (W1-1 through W1-7) signs (see Figure 9B-3) should be used.*

02 *The W1-1 through W1-5 signs should be installed at least 50 feet in advance of the beginning of the change of alignment.*

Section 9B.16 Intersection Warning Signs (W2 Series)

Option:

01 Intersection Warning (W2-1 through W2-5) signs (see Figure 9B-3) may be used on a roadway, street, or shared-use path in advance of an intersection to indicate the presence of an intersection and the possibility of turning or entering traffic.

Guidance:

02 *When engineering judgment determines that the visibility of the intersection is limited on the shared-use path approach, Intersection Warning signs should be used.*

03 *Intersection Warning signs should not be used where the shared-use path approach to the intersection is controlled by a STOP sign, YIELD sign, or a traffic control signal.*

Section 9B.17 Bicycle Surface Condition Warning Sign (W8-10)

Option:

01 The Bicycle Surface Condition Warning (W8-10) sign (see Figure 9B-3) may be installed where roadway or shared-use path conditions could cause a bicyclist to lose control of the bicycle.

02 Signs warning of other conditions that might be of concern to bicyclists, including BUMP (W8-1), DIP (W8-2), PAVEMENT ENDS (W8-3), and any other word message that describes conditions that are of concern to bicyclists, may also be used.

03 A supplemental plaque may be used to clarify the specific type of surface condition.

Section 9B.18 Bicycle Warning and Combined Bicycle/Pedestrian Signs (W11-1, W11-15)

Support:

01 The Bicycle Warning (W11-1) sign (see Figure 9B-3) alerts the road user to unexpected entries into the roadway by bicyclists, and other crossing activities that might cause conflicts. These conflicts might be relatively confined, or might occur randomly over a segment of roadway.

Option:

02 The combined Bicycle/Pedestrian (W11-15) sign (see Figure 9B-3) may be used where both bicyclists and pedestrians might be crossing the roadway, such as at an intersection with a shared-use path. A TRAIL X-ING (W11-15P supplemental plaque (see Figure 9B-3) may be mounted below the W11-15 sign.

03 A supplemental plaque with the legend AHEAD or XX FEET may be used with the Bicycle Warning or combined Bicycle/Pedestrian sign.

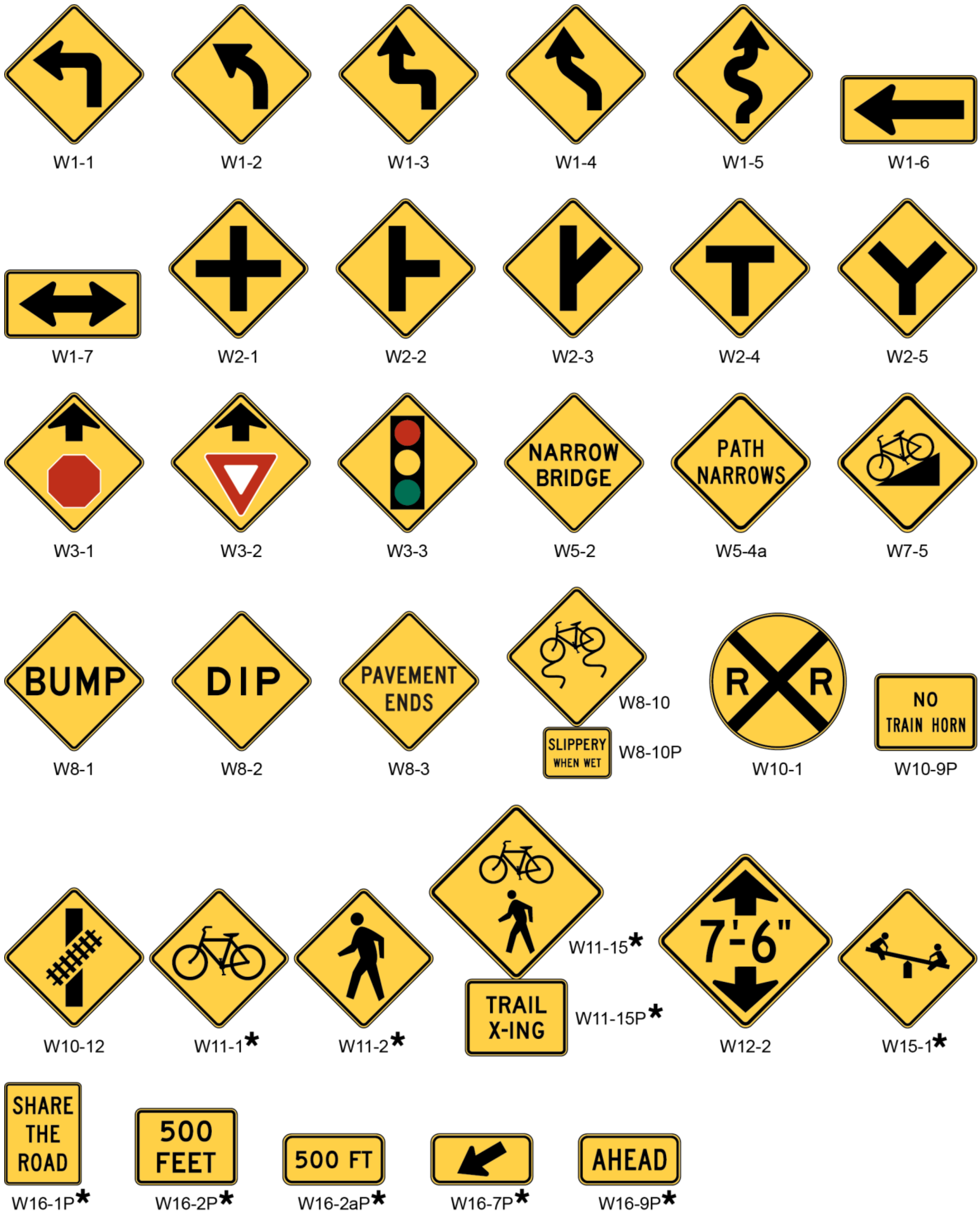
Guidance:

04 *If used in advance of a specific crossing point, the Bicycle Warning or combined Bicycle/Pedestrian sign should be placed at a distance in advance of the crossing location that conforms with the guidance given in Table 2C-4.*

Standard:

05 **Bicycle Warning and combined Bicycle/Pedestrian signs, when used at the location of the crossing, shall be supplemented with a diagonal downward pointing arrow (W16-7p) plaque (see Figure 9B-3) to show the location of the crossing.**

Figure 9B-3. Warning Signs and Plaques for Bicycle Facilities



* A fluorescent yellow-green background color may be used for this sign or plaque. The background color of the plaque should match the color of the warning sign that it supplements.

Option:

06 A fluorescent yellow-green background color with a black legend and border may be used for Bicycle Warning and combined Bicycle/Pedestrian signs and supplemental plaques.

Guidance:

07 *When the fluorescent yellow-green background color is used, a systematic approach featuring one background color within a zone or area should be used. The mixing of standard yellow and fluorescent yellow-green backgrounds within a zone or area should be avoided.*

Section 9B.19 Other Bicycle Warning Signs

Option:

01 Other bicycle warning signs (see Figure 9B-3) such as PATH NARROWS (W5-4a) and Hill (W7-5) may be installed on shared-use paths to warn bicyclists of conditions not readily apparent.

02 In situations where there is a need to warn motorists to watch for bicyclists traveling along the highway, the SHARE THE ROAD (W16-1) plaque (see Figure 9B-3) may be used in conjunction with the W11-1 sign.

Guidance:

03 *If used, other advance bicycle warning signs should be installed at least 50 feet in advance of the beginning of the condition.*

04 *Where temporary traffic control zones are present on bikeways, appropriate signs from Part 6 should be used.*

Option:

05 Other warning signs described in Chapter 2C may be installed on bicycle facilities as appropriate.

Section 9B.20 Bicycle Guide Signs (D1-1b, D1-1c, D1-2b, D1-2c, D1-3b, D1-3c, D11-1, D11-1c)

Option:

01 Bike Route Guide (D11-1) signs (see Figure 9B-4) may be provided along designated bicycle routes, to inform bicyclists of bicycle route direction changes and to confirm route direction, distance, and destination.

02 If used, Bike Route Guide signs may be repeated at regular intervals so that bicyclists entering from side streets will have an opportunity to know that they are on a bicycle route. Similar guide signing may be used for shared roadways with intermediate signs placed for bicyclist guidance.

03 Alternative Bike Route Guide (D11-1c) signs may be used to provide information on route direction, destination, and/or route name in place of the “BIKE ROUTE” wording on the D11-1 sign (see Figures 9B-4 and 9B-6).

04 Destination (D1-H1, D1-H1a) signs, Street Name (D3-1) signs, or Bicycle Destination (D1-1b, D1-1c, D1-2b, D1-2c, D1-3b, D1-3c) signs (see Figure 9B-4) may be installed to provide direction, destination, and distance information as needed for bicycle travel. If several destinations are to be shown at a single location, they may be placed on a single sign with an arrow (and the distance, if desired) for each name. If more than one destination lies in the same direction, a single arrow may be used for the destinations.

Guidance:

05 *Adequate separation should be made between any destination or group of destinations in one direction and those in other directions by suitable design of the arrow, spacing of lines of legend, heavy lines entirely across the sign, or separate signs.*

Standard:

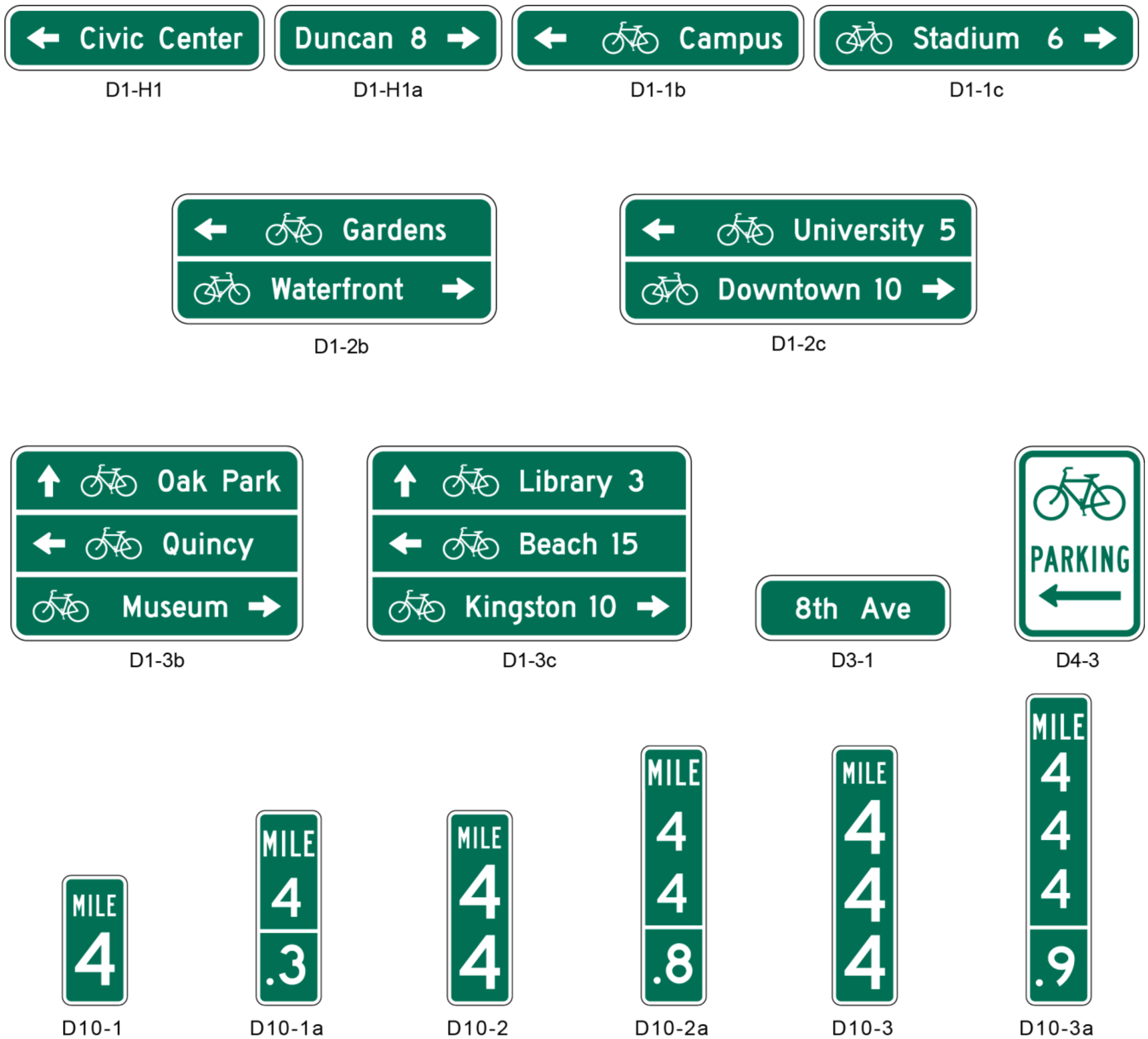
06 **An arrow pointing to the right, if used, shall be at the extreme right-hand side of the sign. An arrow pointing left or up, if used, shall be at the extreme left-hand side of the sign. The distance numerals, if used, shall be placed to the right of the destination names.**

07 **On Bicycle Destination signs, a bicycle symbol shall be placed next to each destination or group of destinations. If an arrow is at the extreme left, the bicycle symbol shall be placed to the right of the respective arrow.**

Guidance:

08 *Unless a sloping arrow will convey a clearer indication of the direction to be followed, the directional arrows should be horizontal or vertical.*

Figure 9B-4. Guide Signs and Plaques for Bicycle Facilities (Sheet 1 of 2)



09 *The bicycle symbol should be to the left of the destination legend.*

10 *If several individual name signs are assembled into a group, all signs in the assembly should have the same horizontal width.*

11 *Because of their smaller size, Bicycle Destination signs should not be used as a substitute for vehicular destination signs when the message is also intended to be seen by motorists.*

Support:

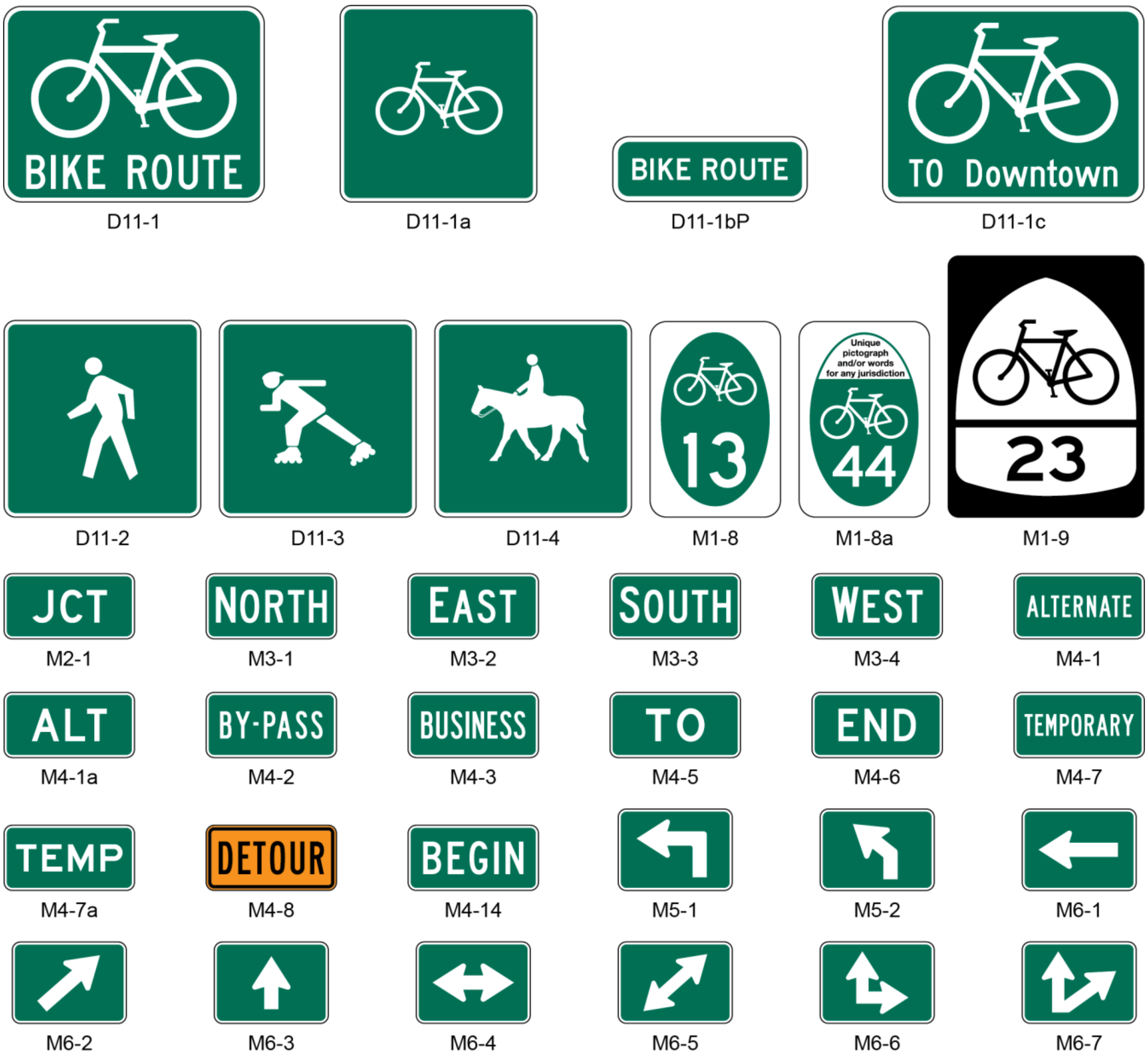
12 Figure 9B-5 shows an example of the signing for the beginning and end of a designated bicycle route on a shared-use path. Figure 9B-6 shows an example of signing for an on-roadway bicycle route. Figure 9B-7 shows examples of signing and markings for a shared-use path crossing.

Section 9B.21 Bicycle Route Signs (M1-8, M1-8a, M1-9)

Option:

01 To establish a unique identification (route designation) for a State or local bicycle route, the Bicycle Route (M1-8, M1-8a) sign (see Figure 9B-4) may be used.

Figure 9B-4. Guide Signs and Plaques for Bicycle Facilities (Sheet 2 of 2)



Standard:

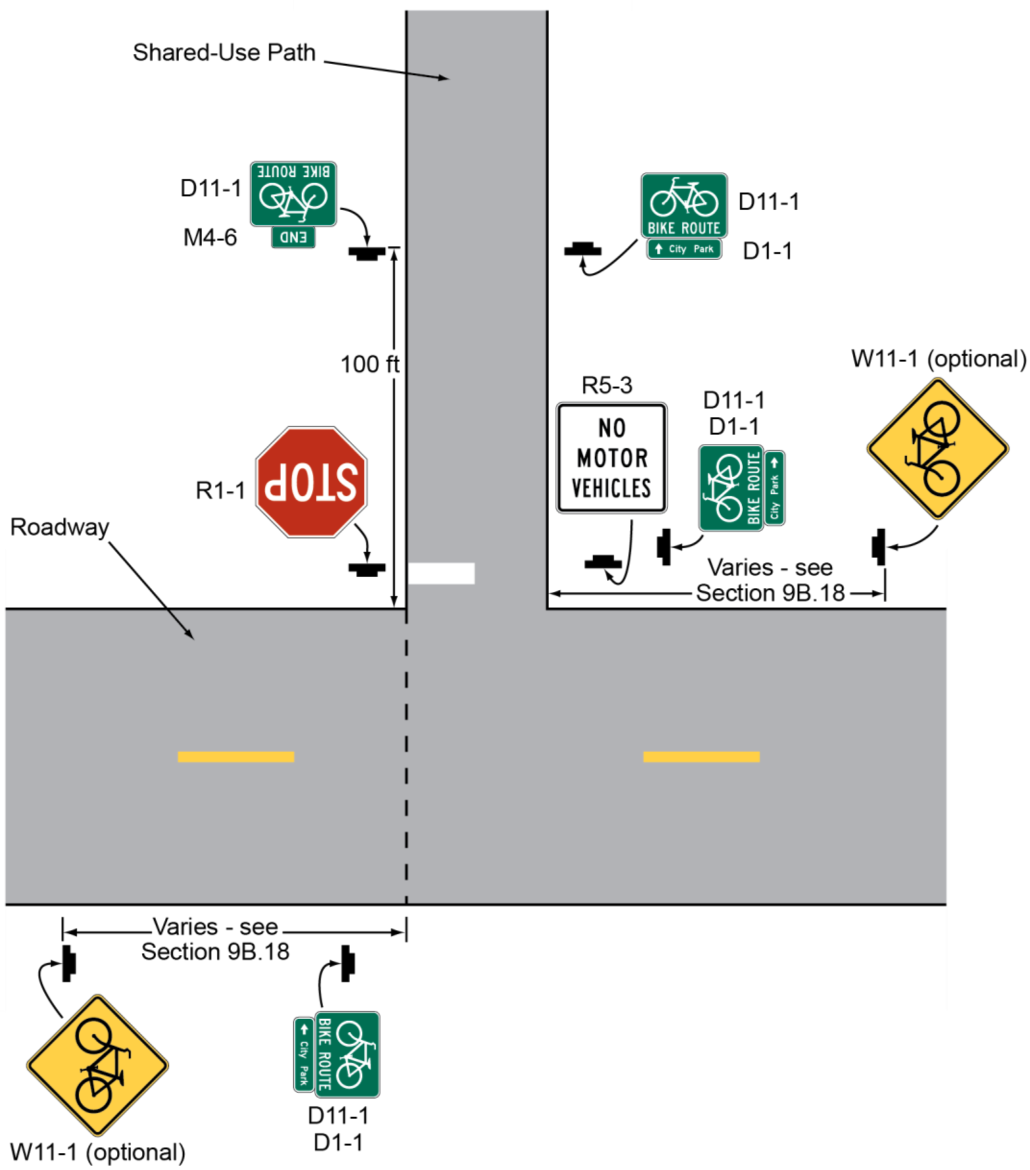
02 **The Bicycle Route (M1-8) sign shall contain a route designation and shall have a green background with a retroreflectorized white legend and border. The Bicycle Route (M1-8a) sign shall contain the same information as the M1-8 sign and in addition shall include a pictograph or words that are associated with the route or with the agency that has jurisdiction over the route.**

Guidance:

03 *Bicycle routes, which might be a combination of various types of bikeways, should establish a continuous routing.*

04 *Where a designated bicycle route extends through two or more States, a coordinated submittal by the affected States for an assignment of a U.S. Bicycle Route number designation should be sent to the American Association of State Highway and Transportation Officials (see the Preface for the address).*

Figure 9B-5. Example of Signing for the Beginning and End of a Designated Bicycle Route on a Shared-Use Path



Standard:

05 **The U.S. Bicycle Route (M1-9) sign (see Figure 9B-4) shall contain the route designation as assigned by AASHTO and shall have a black legend and border with a retroreflectorized white background.**

Guidance:

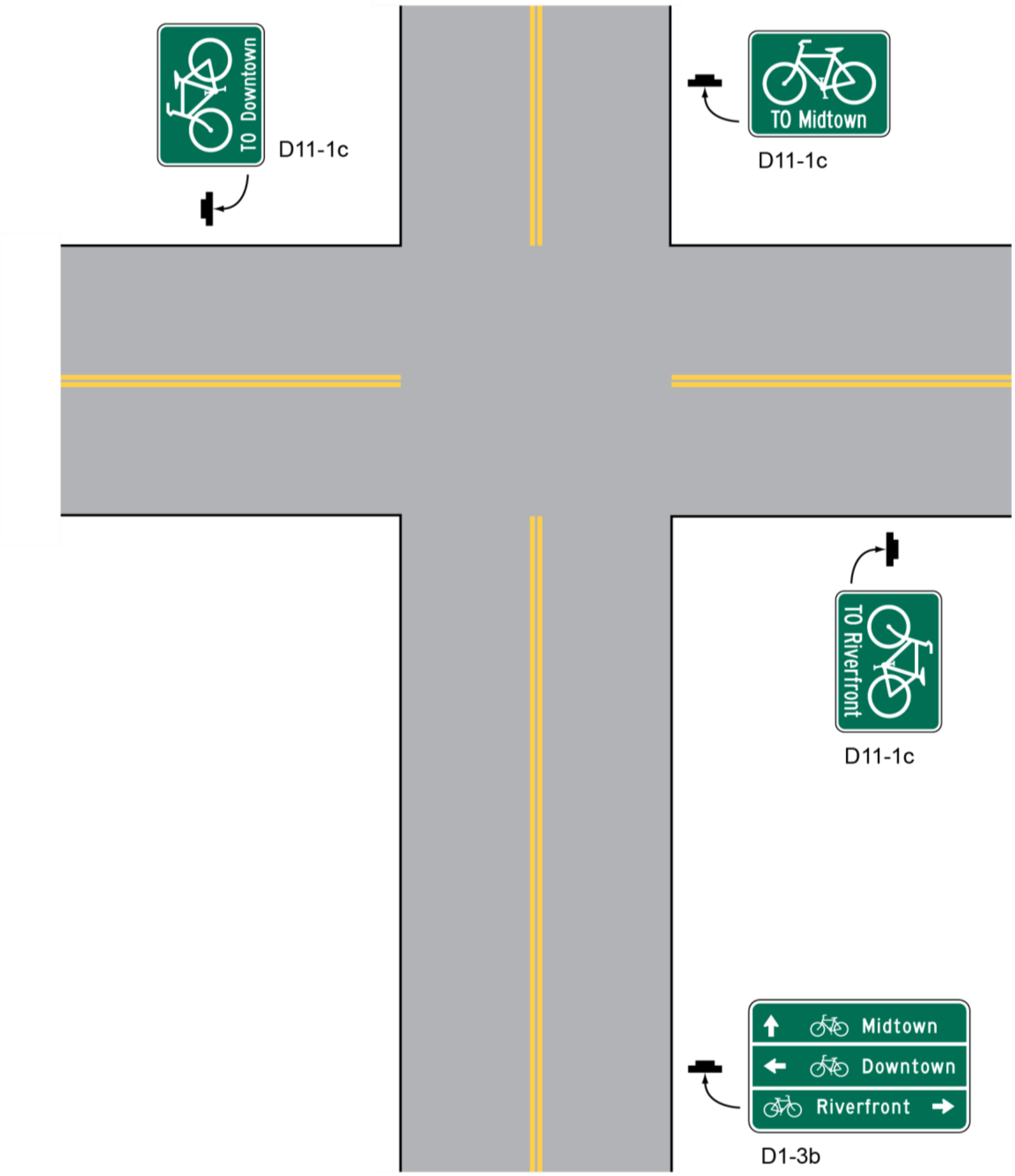
06 *If used, the Bicycle Route or U.S. Bicycle Route signs should be placed at intervals frequent enough to keep bicyclists informed of changes in route direction and to remind motorists of the presence of bicyclists.*

Option:

07 Bicycle Route or U.S. Bicycle Route signs may be installed on shared roadways or on shared-use paths to provide guidance for bicyclists.

08 The Bicycle Route Guide (D11-1) sign (see Figure 9B-4) may be installed where no unique designation of routes is desired.

Figure 9B-6. Example of Bicycle Guide Signing



Section 9B.22 <u>Bicycle Route Sign Auxiliary Plaques</u>

Option:

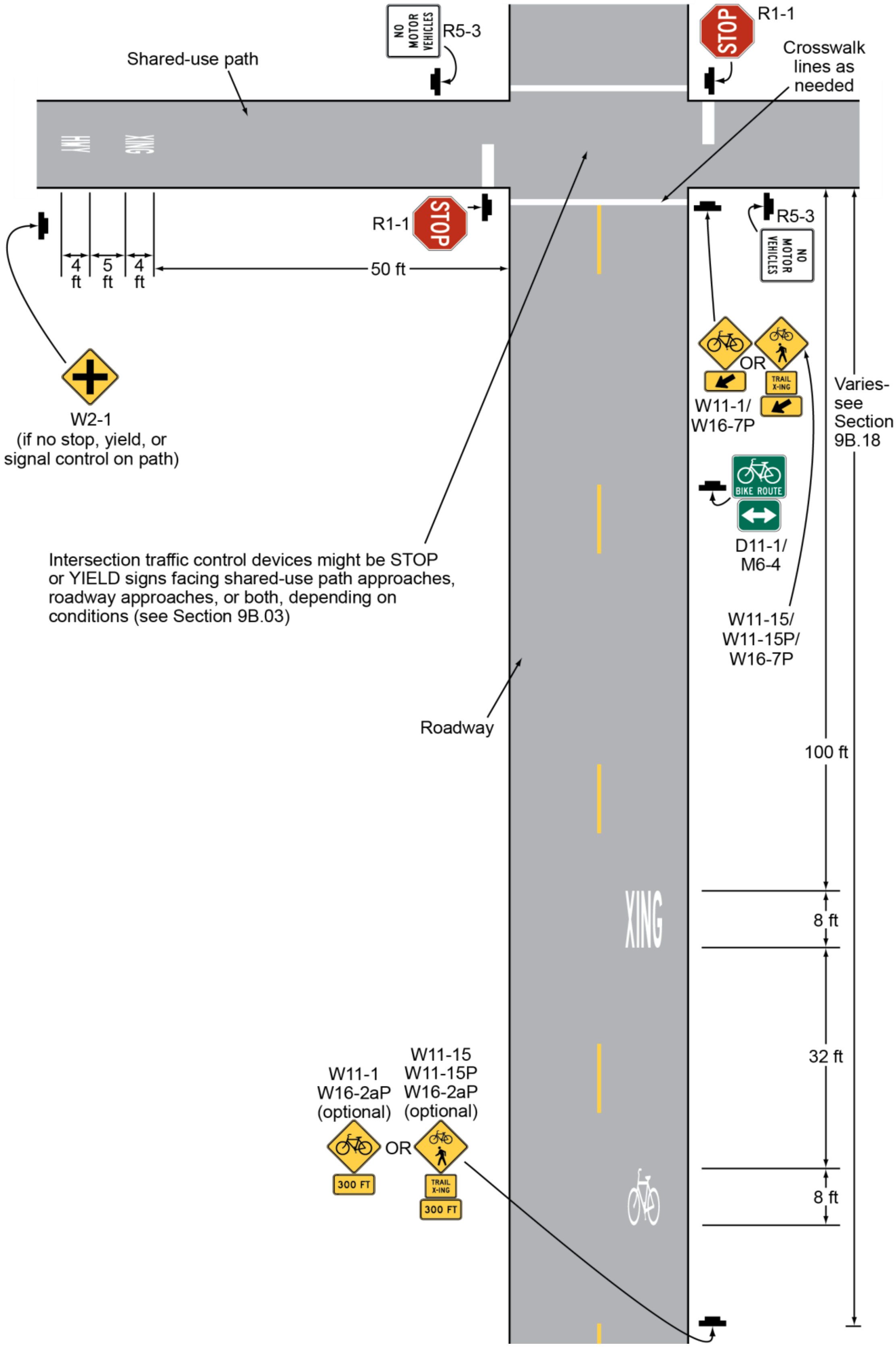
01 Auxiliary plaques may be used in conjunction with Bike Route Guide signs, Bicycle Route signs, or U.S. Bicycle Route signs as needed.

Guidance:

02 *If used, Junction (M2-1), Cardinal Direction (M3 series), and Alternative Route (M4 series) auxiliary plaques (see Figure 9B-4) should be mounted above the appropriate Bike Route Guide signs, Bicycle Route signs, or U.S. Bicycle Route signs.*

03 *If used, Advance Turn Arrow (M5 series) and Directional Arrow (M6 series) auxiliary plaques (see Figure 9B-4) should be mounted below the appropriate Bike Route Guide sign, Bicycle Route sign, or U.S. Bicycle Route sign.*

Figure 9B-7. Examples of Signing and Markings for a Shared-Use Path Crossing



04 *Except for the M4-8 plaque, all route sign auxiliary plaques should match the color combination of the route sign that they supplement.*

05 *Route Sign auxiliary plaques carrying word legends that are used on bicycle routes should have a minimum size of 12 x 6 inches. Route sign auxiliary plaques carrying arrow symbols that are used on bicycle routes should have a minimum size of 12 x 9 inches.*

Option:

06 With route signs of larger sizes, auxiliary plaques may be suitably enlarged, but not such that they exceed the width of the route sign.

07 A route sign and any auxiliary plaques used with it may be combined on a single sign.

08 Destination (D1-1b and D1-1c) signs (see Figure 9B-4) may be mounted below Bike Route Guide signs, Bicycle Route signs, or U.S. Bicycle Route signs to furnish additional information, such as directional changes in the route, or intermittent distance and destination information.

Section 9B.23 Bicycle Parking Area Sign (D4-3)

Option:

01 The Bicycle Parking Area (D4-3) sign (see Figure 9B-4) may be installed where it is desirable to show the direction to a designated bicycle parking area. The arrow may be reversed as appropriate.

Standard:

02 **The legend and border of the Bicycle Parking Area sign shall be green on a retroreflectorized white background.**

Section 9B.24 Reference Location Signs (D10-1 through D10-3) and Intermediate Reference Location Signs (D10-1a through D10-3a)

Support:

01 There are two types of reference location signs:

A. Reference Location (D10-1, 2, and 3) signs show an integer distance point along a shared-use path; and

B. Intermediate Reference Location (D10-1a, 2a, and 3a) signs also show a decimal between integer distance points along a shared-use path.

Option:

02 Reference Location (D10-1 to D10-3) signs (see Figure 9B-4) may be installed along any section of a shared-use path to assist users in estimating their progress, to provide a means for identifying the location of emergency incidents and crashes, and to aid in maintenance and servicing.

03 To augment the reference location sign system, Intermediate Reference Location (D10-1a to D10-3a) signs (see Figure 9B-4), which show the tenth of a mile with a decimal point, may be installed at one tenth of a mile intervals, or at some other regular spacing.

Standard:

04 **If Intermediate Reference Location (D10-1a to D10-3a) signs are used to augment the reference location sign system, the reference location sign at the integer mile point shall display a decimal point and a zero numeral.**

05 **If placed on shared-use paths, reference location signs shall contain 4.5-inch white numerals on a green background that is at least 6 inches wide with a white border. The signs shall contain the word MILE in 2.25-inch white letters.**

06 **Reference location signs shall have a minimum mounting height of 2 feet, measured vertically from the bottom of the sign to the elevation of the near edge of the shared-use path, and shall not be governed by the mounting height requirements prescribed in Section 9B.01.**

Option:

07 Reference location signs may be installed on one side of the shared-use path only and may be installed back-to-back.

08 If a reference location sign cannot be installed in the correct location, it may be moved in either direction as much as 50 feet.

Guidance:

09 *If a reference location sign cannot be placed within 50 feet of the correct location, it should be omitted.*

10 *Zero distance should begin at the south and west terminus points of shared-use paths.*

Support:

11 Section 2H.05 contains additional information regarding reference location signs.

Section 9B.25 Mode-Specific Guide Signs for Shared-Use Paths (D11-1a, D11-2, D11-3, D11-4)

Option:

01 Where separate pathways are provided for different types of users, Mode-Specific Guide (D11-1a, D11-2, D11-3, D11-4) signs (see Figure 9B-4) may be used to guide different types of users to the traveled way that is intended for their respective modes.

02 Mode-Specific Guide signs may be installed at the entrance to shared-use paths where the signed mode(s) are permitted or encouraged, and periodically along these facilities as needed.

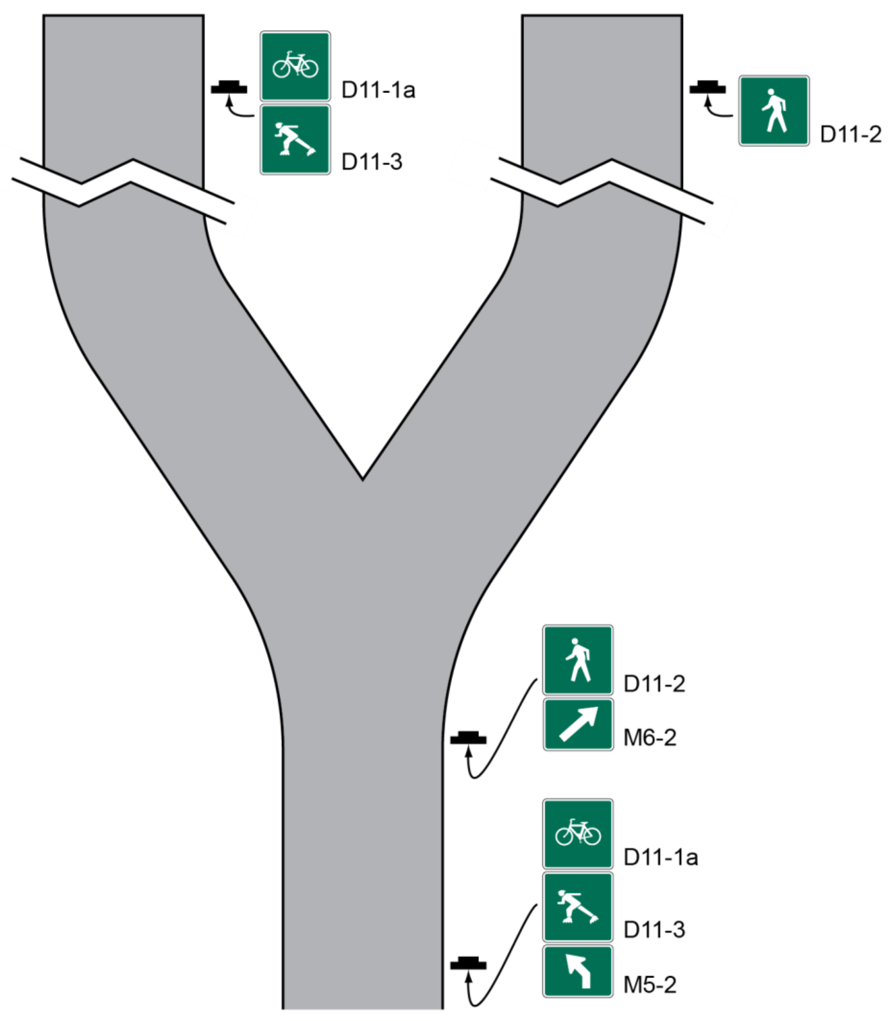
03 The Bicycles Permitted (D11-1a) sign, when combined with the BIKE ROUTE supplemental plaque (D11-1bP), may be substituted for the D11-1 Bicycle Route Guide sign on paths and shared roadways.

04 When some, but not all, non-motorized user types are encouraged or permitted on a shared-use path, Mode-Specific Guide signs may be placed in combination with each other, and in combination with signs (see Section 9B.09) that prohibit travel by particular modes.

Support:

05 Figure 9B-8 shows an example of signing where separate pathways are provided for different non-motorized user types.

Figure 9B-8. Example of Mode-Specific Guide Signing on a Shared-Use Path



Section 9B.26 Object Markers

Option:

01 Fixed objects adjacent to shared-use paths may be marked with Type 1, Type 2, or Type 3 object markers such as those described in Section 2C.63 and shown in Figure 2C-13. If the object marker is not intended to also be seen by motorists, a smaller version of the Type 3 object marker may be used (see Table 9B-1).

Standard:

02 **Obstructions in the traveled way of a shared-use path shall be marked with retroreflectorized material or appropriate object markers.**

03 **All object markers shall be retroreflective.**

04 **On Type 3 object markers, the alternating black and retroreflective yellow stripes shall be sloped down at an angle of 45 degrees toward the side on which traffic is to pass the obstruction.**

CHAPTER 9C. MARKINGS

Section 9C.01 Functions of Markings

Support:

01 Markings indicate the separation of the lanes for road users, assist the bicyclist by indicating assigned travel paths, indicate correct position for traffic control signal actuation, and provide advance information for turning and crossing maneuvers.

Section 9C.02 General Principles

Guidance:

01 *Bikeway design guides (see Section 9A.05) should be used when designing markings for bicycle facilities.*

Standard:

02 **Markings used on bikeways shall be retroreflectorized.**

Guidance:

03 *Pavement marking word messages, symbols, and/or arrows should be used in bikeways where appropriate. Consideration should be given to selecting pavement marking materials that will minimize loss of traction for bicycles under wet conditions.*

Standard:

04 **The colors, width of lines, patterns of lines, symbols, and arrows used for marking bicycle facilities shall be as defined in Sections 3A.05, 3A.06, and 3B.20.**

Support:

05 Figures 9B-7 and 9C-1 through 9C-9 show examples of the application of lines, word messages, symbols, and arrows on designated bikeways.

Option:

06 A dotted line may be used to define a specific path for a bicyclist crossing an intersection (see Figure 9C-1) as described in Sections 3A.06 and 3B.08.

Section 9C.03 Marking Patterns and Colors on Shared-Use Paths

Option:

01 Where shared-use paths are of sufficient width to designate two minimum width lanes, a solid yellow line may be used to separate the two directions of travel where passing is not permitted, and a broken yellow line may be used where passing is permitted (see Figure 9C-2).

Guidance:

02 *Broken lines used on shared-use paths should have the usual 1-to-3 segment-to-gap ratio. A nominal 3 foot segment with a 9 foot gap should be used.*

03 *If conditions make it desirable to separate two directions of travel on shared-use paths at particular locations, a solid yellow line should be used to indicate no passing and no traveling to the left of the line.*

04 *Markings as shown in Figure 9C-8 should be used at the location of obstructions in the center of the path, including vertical elements intended to physically prevent unauthorized motor vehicles from entering the path.*

Option:

05 A solid white line may be used on shared-use paths to separate different types of users. The R9-7 sign (see Section 9B.12) may be used to supplement the solid white line.

06 Smaller size letters and symbols may be used on shared-use paths. Where arrows are needed on shared-use paths, half-size layouts of the arrows may be used (see Section 3B.20).

Section 9C.04 Markings For Bicycle Lanes

Support:

01 Pavement markings designate that portion of the roadway for preferential use by bicyclists. Markings inform all road users of the restricted nature of the bicycle lane.

Figure 9C-1. Example of Intersection Pavement Markings—Designated Bicycle Lane with Left-Turn Area, Heavy Turn Volumes, Parking, One-Way Traffic, or Divided Highway

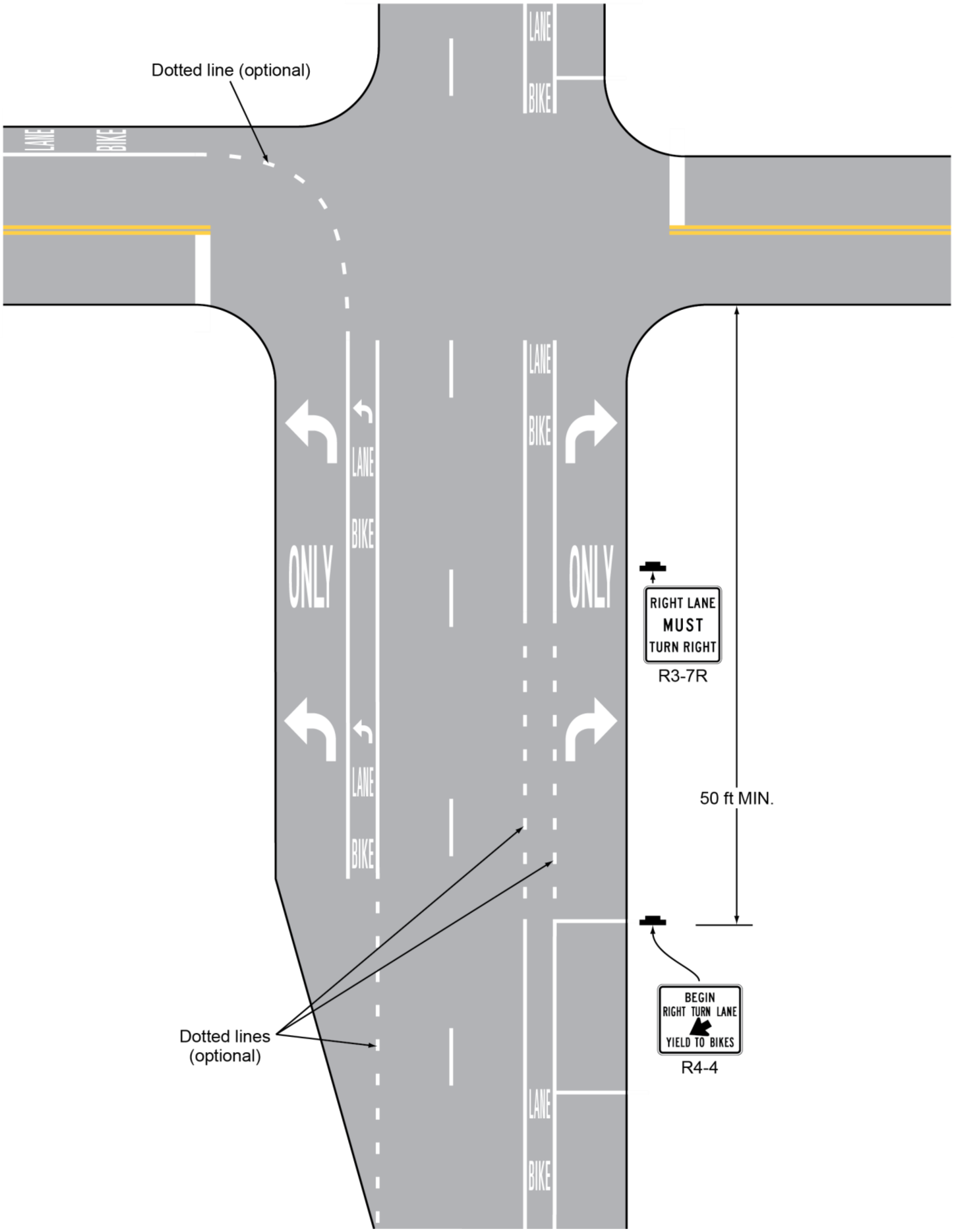
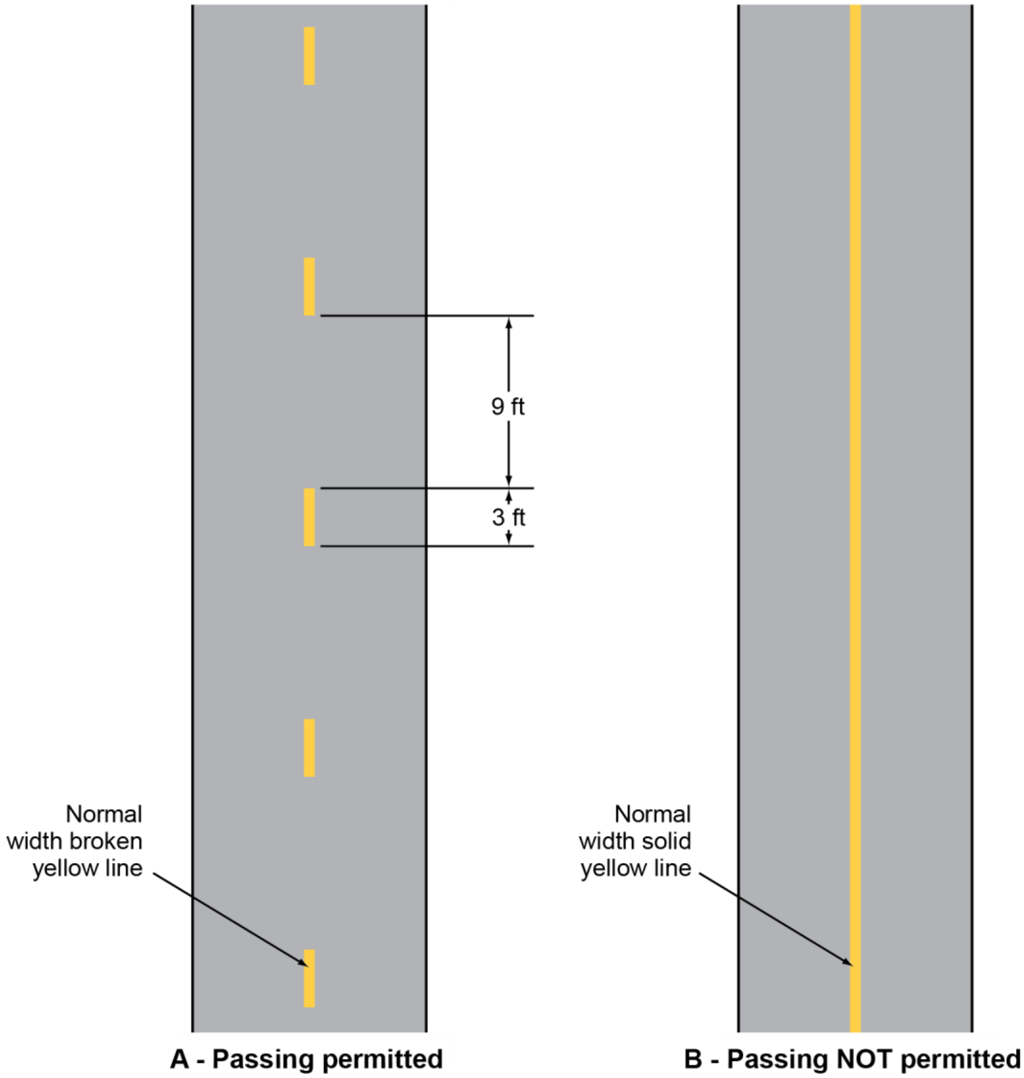


Figure 9C-2. Examples of Center Line Markings for Shared-Use Paths



Standard:

02 **Longitudinal pavement markings shall be used to define bicycle lanes.**

Guidance:

03 *If used, bicycle lane word, symbol, and/or arrow markings (see Figure 9C-3) should be placed at the beginning of a bicycle lane and at periodic intervals along the bicycle lane based on engineering judgment.*

Standard:

04 **If the bicycle lane symbol marking is used in conjunction with other word or symbol messages, it shall precede them.**

Option:

05 If the word, symbol, and/or arrow pavement markings shown in Figure 9C-3 are used, Bike Lane signs (see Section 9B.04) may also be used, but to avoid overuse of the signs not necessarily adjacent to every set of pavement markings.

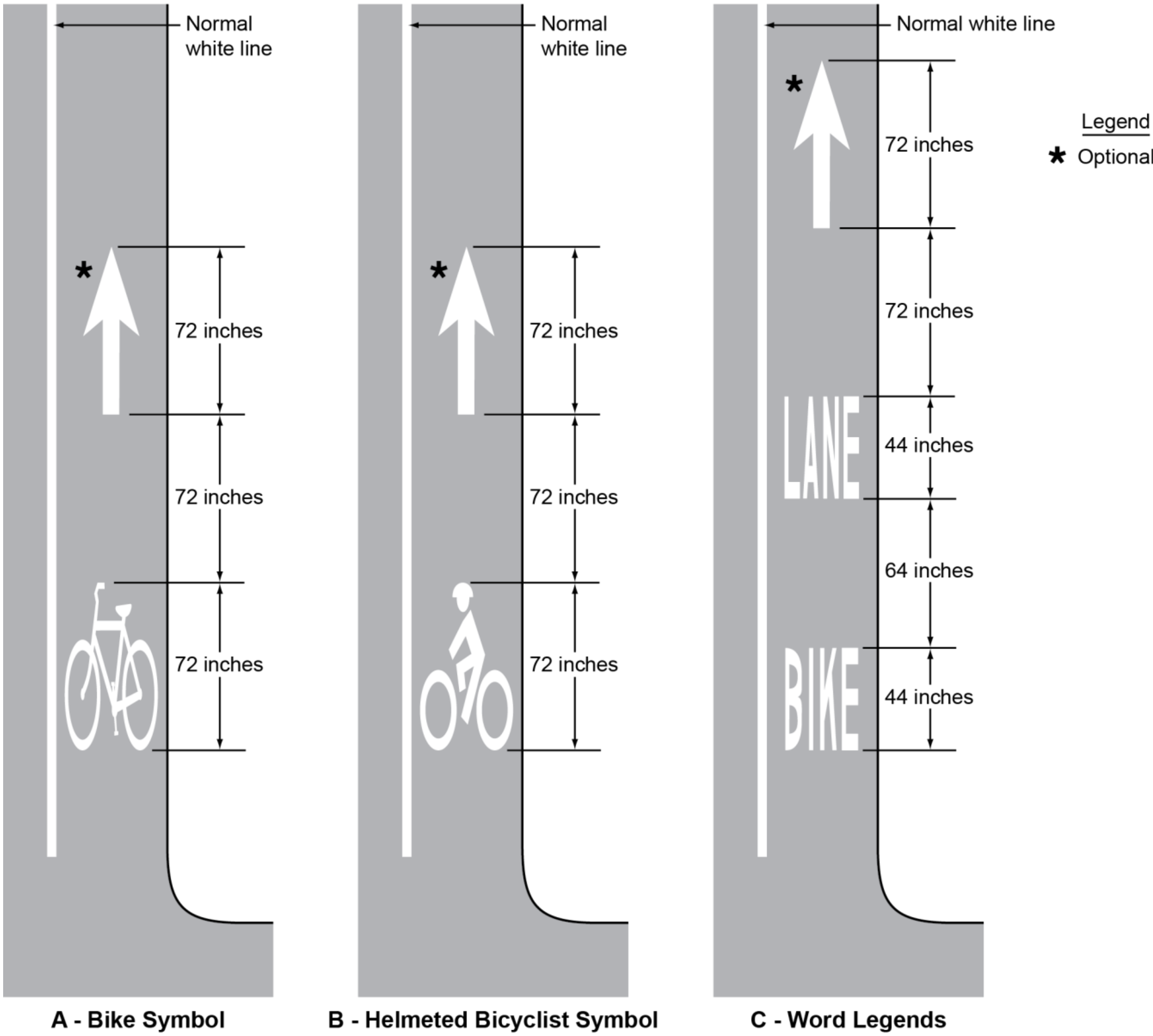
Standard:

06 **A through bicycle lane shall not be positioned to the right of a right turn only lane or to the left of a left turn only lane.**

Support:

07 A bicyclist continuing straight through an intersection from the right of a right turn lane or from the left

Figure 9C-3. Word, Symbol, and Arrow Pavement Markings for Bicycle Lanes



of a left-turn lane would be inconsistent with normal traffic behavior and would violate the expectations of right-or left-turning motorists.

Guidance:

08 *When the right through lane is dropped to become a right turn only lane, the bicycle lane markings should stop at least 100 feet before the beginning of the right-turn lane. Through bicycle lane markings should resume to the left of the right turn only lane.*

09 *An optional through-right turn lane next to a right turn only lane should not be used where there is a through bicycle lane. If a capacity analysis indicates the need for an optional through-right turn lane, the bicycle lane should be discontinued at the intersection approach.*

10 *Posts or raised pavement markers should not be used to separate bicycle lanes from adjacent travel lanes.*

Support:

11 Using raised devices creates a collision potential for bicyclists by placing fixed objects immediately adjacent to the travel path of the bicyclist. In addition, raised devices can prevent vehicles turning right from merging with the bicycle lane, which is the preferred method for making the right turn. Raised devices used to define a bicycle lane can also cause problems in cleaning and maintaining the bicycle lane.

Standard:

12 **Bicycle lanes shall not be provided on the circular roadway of a roundabout.**

Guidance:

13 *Bicycle lane markings should stop at least 100 feet before the crosswalk, or if no crosswalk is provided, at least 100 feet before the yield line, or if no yield line is provided, then at least 100 feet before the edge of the circulatory roadway.*

Support:

14 Examples of bicycle lane markings at right-turn lanes are shown in Figures 9C-1, 9C-4, and 9C-5. Examples of pavement markings for bicycle lanes on a two-way street are shown in Figure 9C-6. Pavement word message, symbol, and arrow markings for bicycle lanes are shown in Figure 9C-3.

Section 9C.05 Bicycle Detector Symbol

Option:

01 A symbol (see Figure 9C-7) may be placed on the pavement indicating the optimum position for a bicyclist to actuate the signal.

02 An R10-22 sign (see Section 9B.13 and Figure 9B-2) may be installed to supplement the pavement marking.

Section 9C.06 Pavement Markings for Obstructions

Guidance:

01 *In roadway situations where it is not practical to eliminate a drain grate or other roadway obstruction that is inappropriate for bicycle travel, white markings applied as shown in Figure 9C-8 should be used to guide bicyclists around the condition.*

Section 9C.07 Shared Lane Marking

Option:

01 The Shared Lane Marking shown in Figure 9C-9 may be used to:

A. Assist bicyclists with lateral positioning in a shared lane with on-street parallel parking in order to reduce the chance of a bicyclist's impacting the open door of a parked vehicle,
B. Assist bicyclists with lateral positioning in lanes that are too narrow for a motor vehicle and a bicycle to travel side by side within the same traffic lane,
C. Alert road users of the lateral location bicyclists are likely to occupy within the traveled way,
D. Encourage safe passing of bicyclists by motorists, and
E. Reduce the incidence of wrong-way bicycling.

Guidance:

02 *The Shared Lane Marking should not be placed on roadways that have a speed limit above 35 mph.*

Standard:

03 **Shared Lane Markings shall not be used on shoulders or in designated bicycle lanes.**

Guidance:

04 *If used in a shared lane with on-street parallel parking, Shared Lane Markings should be placed so that the centers of the markings are at least 11 feet from the face of the curb, or from the edge of the pavement where there is no curb.*

05 *If used on a street without on-street parking that has an outside travel lane that is less than 14 feet wide, the centers of the Shared Lane Markings should be at least 4 feet from the face of the curb, or from the edge of the pavement where there is no curb.*

06 *If used, the Shared Lane Marking should be placed immediately after an intersection and spaced at intervals not greater than 250 feet thereafter.*

Option:

07 Section 9B.06 describes a Bicycles MAY USE FULL LANE sign that may be used in addition to or instead of the Shared Lane Marking to inform road users that bicyclists might occupy the travel lane.

Figure 9C-4. Example of Bicycle Lane Treatment at a Right Turn Only Lane

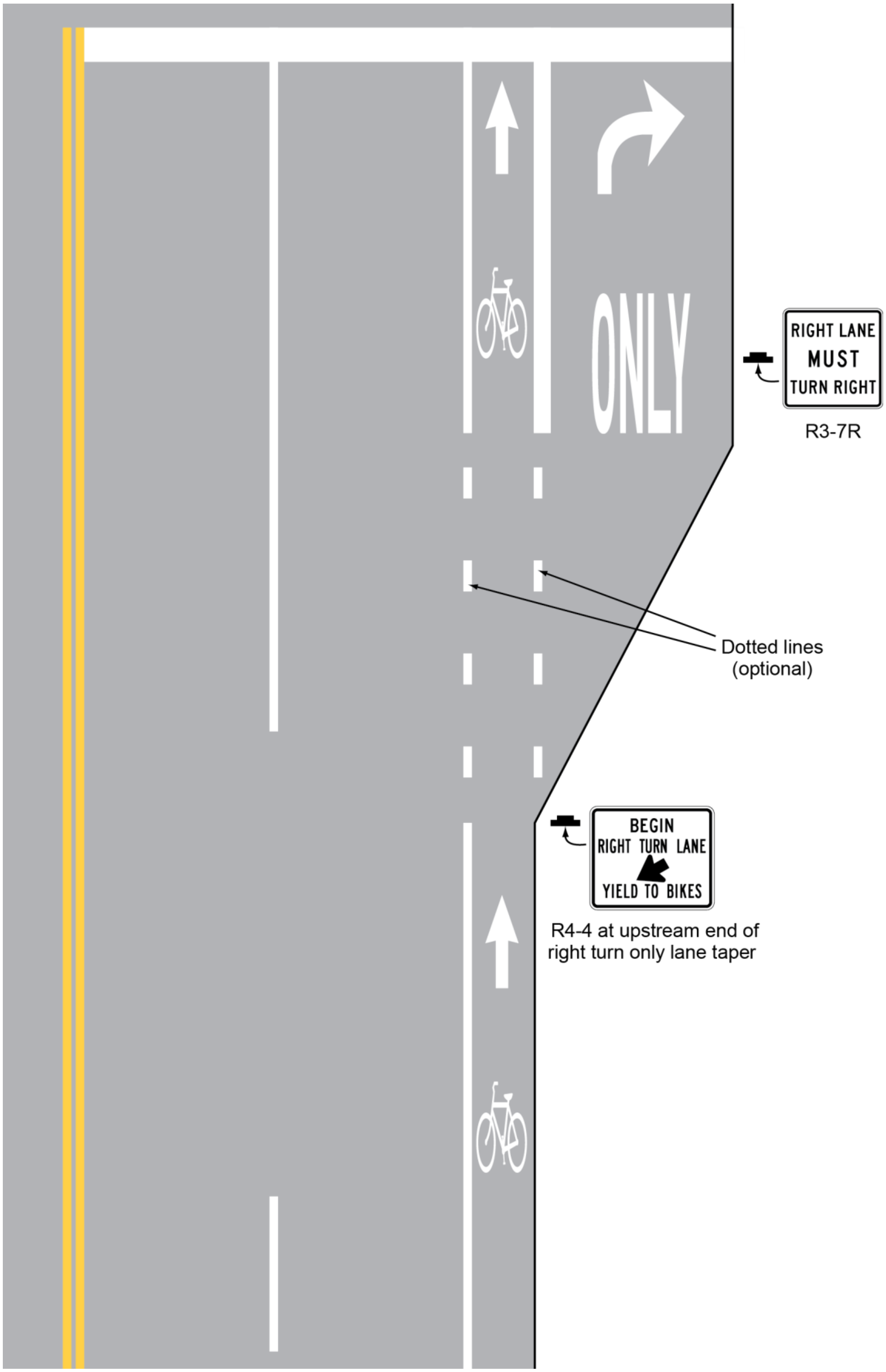


Figure 9C-5. Example of Bicycle Lane Treatment at Parking Lane into a Right Turn Only Lane

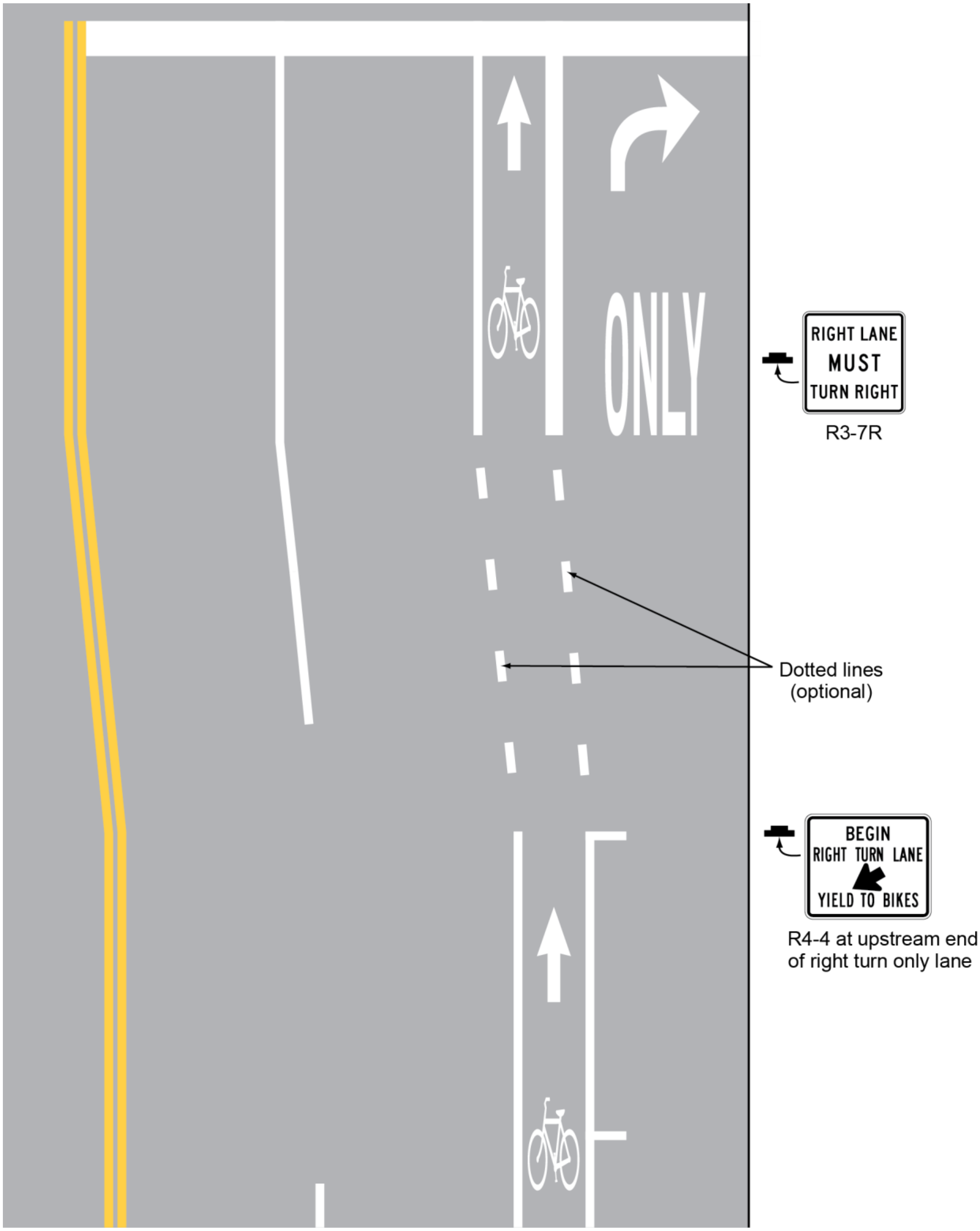


Figure 9C-6. Example of Pavement Markings for Bicycle Lanes on a Two-Way Street

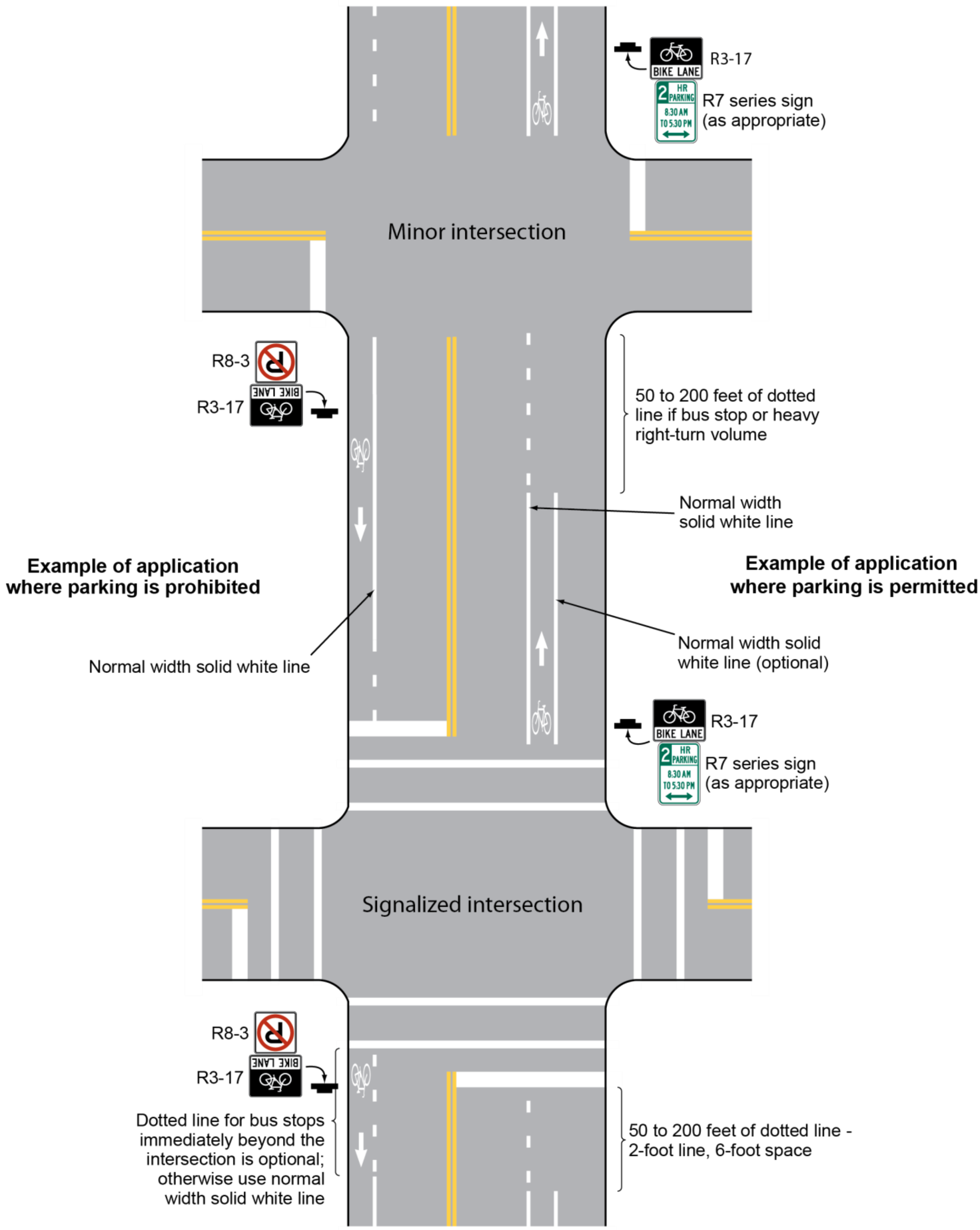


Figure 9C-7. Bicycle Detector Pavement Marking

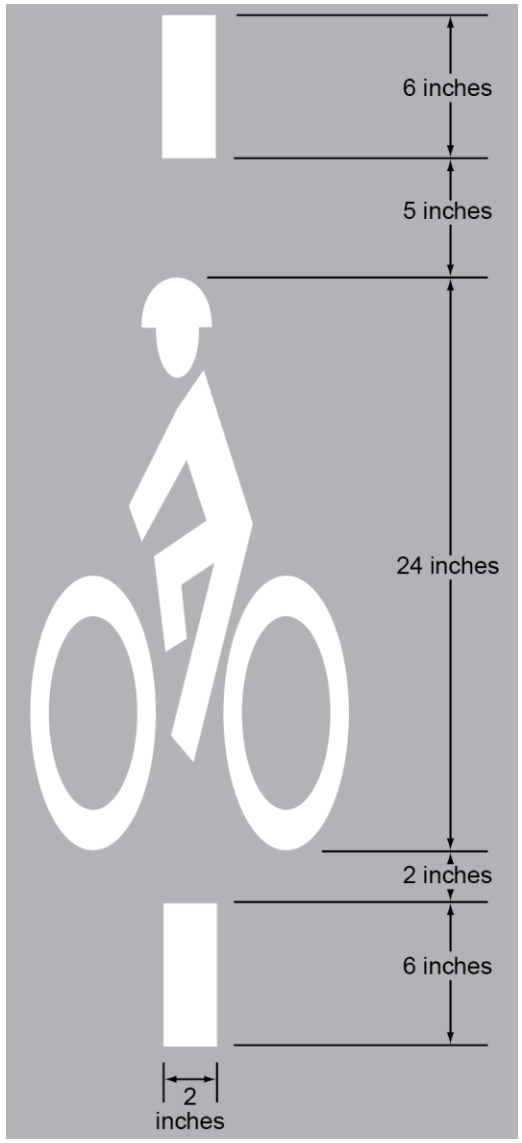
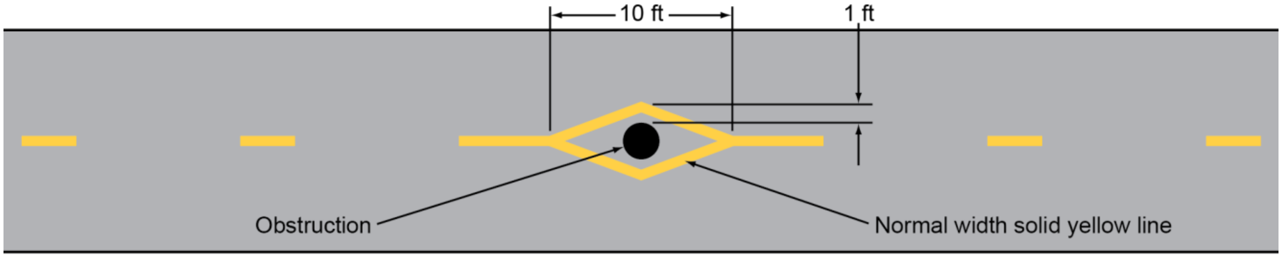
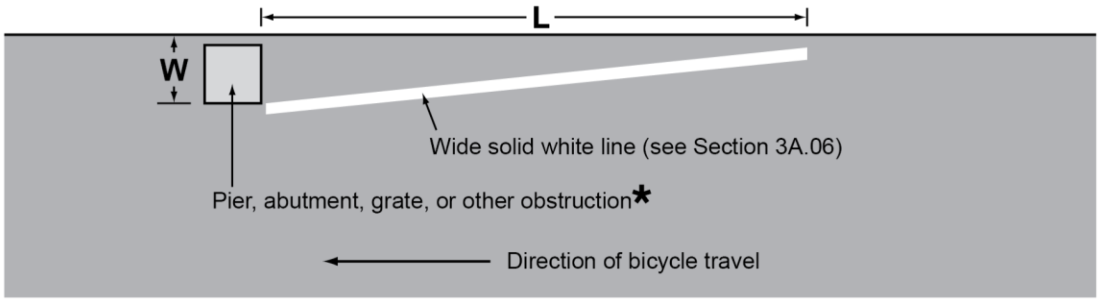


Figure 9C-8. Examples of Obstruction Pavement Markings



A - Obstruction within the path

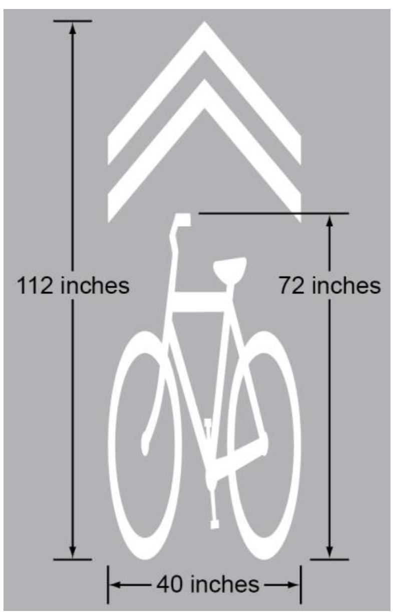


B - Obstruction at edge of path or roadway

L = WS, where W is the offset in feet and S is bicycle approach speed in mph

* Provide an additional foot of offset for a raised obstruction and use the formula L = (W+1) S for the taper length

Figure 9C-9. Shared Lane Marking



CHAPTER 9D. SIGNALS

Section 9D.01 <u>Application</u>

Support:

01 Part 4 contains information regarding signal warrants and other requirements relating to signal installations.

Option:

02 For purposes of signal warrant evaluation, bicyclists may be counted as either vehicles or pedestrians.

Section 9D.02 <u>Signal Operations for Bicycles</u>

Standard:

01 **At installations where visibility-limited signal faces are used, signal faces shall be adjusted so bicyclists for whom the indications are intended can see the signal indications. If the visibility-limited signal faces cannot be aimed to serve the bicyclist, then separate signal faces shall be provided for the bicyclist.**

02 **On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists.**

Intentionally blank.

308 On-Road Bicycle Facilities

308.1 General

This section provides an overview of designs that facilitate safe, efficient and convenient travel for bicyclists on roadways. Bicyclists often have to share these roadways with motorized vehicles as they travel.

308.2 Design

Generally, the basic geometric design guidelines for motor vehicles will result in a facility that will provide a safe accommodation for on-street bicyclists. If properly designed for motor vehicles, roadway design elements such as stopping sight distance, horizontal and vertical alignment, grades and cross slopes will meet or exceed the minimum design standards applicable to bicyclists. See AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition for additional information regarding the design of On-Road Bicycle Facilities.

308.3 Shared Lanes

Bicycles may be operated on all roadways except where prohibited by statute or regulation. Shared lanes where bicyclists and motor vehicles share the same travel lanes exist everywhere; on local neighborhood streets, on city streets, and urban, suburban and rural highways. There are no bicycle-specific designs or dimensions for shared lanes or roadways, but various design features can make shared lanes more compatible with bicycling, such as adequate sight distance and roadway designs that encourage lower speeds.

308.3.1 Shared Lanes on Major Roadways (Wide Curb/Outside Lanes)

Motor vehicles will begin encroaching at least part way into the next lane for lane widths of 13 ft. or less to pass a bicyclist. Lane widths of 14 ft. or greater will allow motorists to pass bicyclists without encroaching into the adjacent lane. For additional information on shared lane widths see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

308.4 Paved Shoulders

Bicyclist accommodations on roadways with higher speeds or traffic volumes can be greatly improved by adding, improving or expanding paved shoulders.

Paved shoulders are different from bicycle lanes, in that at intersection approaches paved shoulders are placed to the right of the right-turn lanes and bike lanes are placed on the left side of right-turn lanes since they are intended to serve the through movements by bicyclists. Through moving bicyclists should normally be to the left of right-turning motor vehicles to avoid conflicts. On roadways with paved shoulders that approach right-turn lanes, some jurisdictions introduce a bike lane only at the intersections, and then transition back to a paved shoulder. For more information on paved shoulders see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

For uncurbed roadways with no vertical obstructions immediately adjacent to the roadway, paved shoulders should be at least 4 ft. wide to accommodate bicycle travel. A shoulder width of at least 5 ft. is recommended from the face of any vertical obstruction such as guardrail, curb, or other roadside barrier since bicyclists generally shy away from a vertical face. It is desirable to increase the width of shoulders where any of the following conditions exist: high bicycle usage is expected, motor vehicle speeds exceed 50 mph, use by heavy trucks, buses, or recreational vehicles is considerable or static obstructions exist at the right side of the roadway.

On two-way roads it is preferable to provide paved shoulders on both sides; however, in constrained locations where pavement width is limited, it may be preferable to provide a wider shoulder on only one side of the roadway, rather than to provide a narrow shoulder on both sides. This approach may prove beneficial in the following situations:

> On uphill roadway sections, a shoulder may be provided to give slow-moving bicyclists additional maneuvering space, thereby reducing conflicts with faster moving motor vehicle traffic.
>
> On roadway sections with vertical or horizontal curves that limit sight distance, it can be helpful to provide shoulders over the crest and on the downgrade of a vertical curve, and on the inside of a horizontal curve.

For more information on paved shoulders see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

308.5 Bicycle Lanes

308.5.1 General Considerations

Bicycle lanes are one-way facilities designated for preferential use by bicyclists that typically carry bicycle traffic in the same direction as adjacent motor vehicle traffic. Bike lanes are the appropriate and preferred bicycle facility for thoroughfares in both urban and suburban areas. Where there is a high potential for bicycle use, bike lanes may be provided on rural roadways near urban areas. Paved shoulders may be designated as bike lanes by installing bike lane symbol markings.

308.5.2 Bicycle Lanes on Two-Way Streets

Bike lanes should be provided on both sides of two-way streets since a bike lane provided on only one side may invite wrong-way use. For additional information on bicycle lanes on two-way streets see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

308.5.3 Bicycle Lanes on One-Way Streets

On one-way streets the bike lane should be on the right-hand side of the roadway. If there are a significant number of left turning bicyclists or if a left-side bike lane decreases conflicts resulting from heavy bus traffic, heavy right-turn movements (including double right-turn lanes), deliveries, or on-street parking a bike lane may be placed on the left side of the roadway.

Bike lanes should typically be provided on both streets of a one-way couplet in order to provide facilities in both directions and discourage wrong-way riding. If width constraints or other conditions make it impractical to provide bike lanes on both streets, shared-lane markings should be considered on the constrained street. This provides a more complete network and encourages bicyclists to travel with the flow of the other traffic.

308.5.4 Bicycle Lane Widths

Bicycle lane widths should be determined based on the speed, volume, and type of vehicles in adjacent lanes since these factors significantly affect bicyclists' comfort and desire for lateral separation from other vehicles. Also, the appropriate width should take into account design features at the right edge of the bicycle lane, such as the curb, gutter, on-street parking lane, guardrail or other roadside barrier.

The preferred operating bicycle lane width is 5 ft. Wider bicycle lanes may be desirable under the following conditions:

- Adjacent to a parking lane (7 ft.) with a high turnover (such as those servicing restaurants, shops, or entertainment venues), a wider bicycle lane (6-7 ft.) provides more operating space for bicyclists to ride out of the area of opening vehicle doors.

- In areas with high bicycle use and without on-street parking, a bicycle lane width of 6 to 8 ft. makes it possible for bicyclists to ride side-by-side or pass each other without leaving the lane.

- On high-speed (greater than 45 mph) and high-volume roadways, or where there is a substantial volume of heavy vehicles, a wide bicycle lane provides additional lateral separation between motor vehicles and bicycles to minimize wind blast and other effects.

The minimum width of a bicycle lane is 4 ft. for roadways with no curb and gutter and no on-street parking. For roadways where the bike lane is immediately adjacent to the curb, guardrails or other vertical surface, the minimum bike lane width is 5 ft., measured from the face of a curb or vertical surface to the center of the bike lane line. There are two exceptions to this:

- In locations with higher motor-vehicle speeds where a 2-ft. wide gutter is used, the preferred bike lane width is 6 ft., inclusive of the gutter.

- On extremely constrained, low-speed roadways with curbs but no gutter, where the preferred bike lane width cannot be achieved despite narrowing all other travel lanes to their minimum widths, a 4-ft. wide bike lane can be used.

For additional information or design considerations concerning bicycle lanes widths see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

308.5.5 Bicycle Lanes and On-Street Parking

Where on-street parking is permitted, the bike lane should be located between the parking lane and the travel lane. The recommended bike lane width in these locations is 6 ft. and the minimum width is 5 ft.

Bike lanes should not be placed between the parking lane and the curb. Such placement reduces visibility at driveways and intersections, increases conflicts with opening car doors, complicates maintenance, and prevents bike lane users from making convenient left turns.

Parallel Parking

Where bike lanes are installed adjacent to parallel parking, the recommended width of a marked parking lane is 8 ft., and the minimum width is 7 ft. Where parallel parking is permitted but a parking lane line or stall markings are not utilized, the recommended width of the shared bicycle and parking lane is 13 ft. If parking usage is low and turnover is infrequent a minimum width of 12 ft. may be satisfactory.

Diagonal Parking

Bike lanes should normally not be placed adjacent to conventional front-in diagonal parking, since drivers backing out of parking spaces have poor visibility of bicyclists in the bike lane.

The use of back-in diagonal parking can help mitigate the conflicts normally associated with bike lanes adjacent to angled parking. For additional information on the benefits of back-in diagonal parking see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

308.5.6 Bicycle Lanes at Intersections

Intersections and driveways present the increased likelihood for conflicts between bicyclists and motor vehicles.

For additional information regarding turning considerations for bicycle lanes see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

308.6 Retrofitting Bicycle Facilities on Existing Streets and Highways

Existing streets and highways can be retrofitted to improve bicycle accommodations by either widening the roadway or by reconfiguring the existing roadway. Paved shoulders can be added to improve mobility and comfort for bicyclists and reduce bicycle related crashes on busier or higher-speed rural roads. It may be possible to accommodate bike lanes on urban (curbed) roadways by reconfiguring travel lanes or make other adjustments that better accommodate bicyclists where reconfiguration of the lanes is not practical.

When retrofitting roads for bicycle facilities, the width guidelines for bike lanes and paved shoulders (see Sections 308.4 and 308.5.4) should be applied. For additional information on retrofitting bicycle facilities on existing streets and highways see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

Retrofitting bicycle facilities on bridges presents special challenges because it may be impractical to widen an existing bridge. The guidance in Section 308.6.2 for retrofitting bicycle facilities without roadway widening is applicable to existing bridges. Further guidance on accommodating bicyclists on bridges is presented in Section 308.8.2.

308.6.1 Retrofitting Bicycle Facilities by Widening the Roadway

Where right-of-way is adequate, or where additional right-of-way can be obtained, roads can be widened to provide wide outside lanes, paved shoulders, or bike lanes. Widening must be weighed against the possibility that vehicle speeds will increase, which may adversely impact bicyclists and pedestrians.

308.6.2 Retrofitting Bicycle Facilities without Roadway Widening

In many areas, especially built-out urban and suburban areas, physical widening is impractical, and bicycle facility retrofits have to be done within the existing paved width. There are three methods of modifying the allocation of roadway space to improve bicyclist accommodation:

1. Reduce or reallocate the width used by travel lanes.
2. Reduce the number of travel lanes.

3. Reconfigure or reduce on-street parking.

In most cases, travel lane widths can be reduced without any significant changes in levels of service for motorists. Before travel lane widths are reduced, an operational study should be performed to evaluate the impact of a specific lane configuration. One benefit is that bicycle LOS will be improved. Creating shoulders or bike lanes on roadways can improve pedestrian conditions as well by providing a buffer between the sidewalk and the roadway.

Reducing Travel Lane Width

In some cases, the width needed for bike lanes or paved shoulders can be obtained by narrowing travel lanes. Lane widths on many roads are greater than the minimum values shown in ***Figures 301-2a and 301-4a*** and, depending on condition, may be candidates for narrowing.

For additional information concerning the reduction of the travel lane widths see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

Reducing the Number of Travel Lanes

One method that can be used to integrate bike lanes on existing roadways is reducing the number of travel lanes which is often referred to as a "road diet". This strategy can be used on streets with excess capacity (more travel lanes than needed to accommodate the existing or projected traffic volumes), especially between intersections.

A traffic study should be conducted to evaluate potential reductions in crash frequency and severity, to evaluate motor vehicle capacity and level of service, to evaluate bicycle LOS, and to identify appropriate signalization modifications and lane assignment at intersections before implementing a road diet.

Road diets have many benefits, often reducing crashes; improving operations; and improving livability for pedestrians, bicyclists, adjacent residents, businesses, and motorists.

For additional information concerning the reduction in the number of travel lanes see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

Reconfiguring or Reducing On-Street Parking

For additional information concerning reconfiguring or reducing on-street parking see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

308.8 Other Roadway Design Considerations

Bicycle travel should be safely accommodated at railroad crossings, drainage grates, bridges, viaducts, tunnels, traffic signals, interchanges and roundabouts. For additional information concerning these design features see AASHTO's Guide for the Development of Bicycle Facilities 2012 Fourth Edition.

700 Multi-Modal Considerations

Table of Contents

702 Shared Use Paths

702.1 General

Shared use paths are multi-use paths designed primarily for use by bicyclists and pedestrians, including those with disabilities, for transportation and recreation purposes. Shared use paths are physically separated from motor vehicle traffic by an open space or barrier. The following sections are based on the AASHTO Guide for the Development of Bicycle Facilities Fourth Edition, the Manual of Uniform Traffic Control (MUTCD), and the FHWA document, Shared Use Path Level of Service Calculator.

702.1.1 Accessibility Requirements for Shared Use Paths

Due to the fact that nearly all shared use paths are used by pedestrians, they fall under the accessibility requirements of the Americans with Disabilities Act (ADA). Paths in the public right of way that function as sidewalks should be designed in accordance with the proposed Public Rights of Way Accessibility Guidelines (PROWAG), or subsequent guidance that may supersede PROWAG in the future.
Shared use paths built in independent right of way should meet the draft accessibility guidelines in the Advance Notice of Proposed Rulemaking (ANPRM) on Accessibility Guidelines for Shared Use Paths or any subsequent rulemaking that supersedes the ANPRM.

702.2 Elements of Design

The first step in designing a shared use path is determining the design users. Due to the large percentage of adult bicyclists, they are the basis for most of the design recommendations.

702.2.1 Width and Clearance

The next step in designing a shared use path is determining the cross section. The width of the shared use path should be sufficient to serve the expected volume of users with a facility consistent with guidance for safe operation. The minimum paved width for a two-directional shared use path is 10 feet.

Typically, widths range from 10’ to 14’, with wider widths applicable to areas with high use and/ or a wider variety of user groups. The FHWA document, Shared Use Path Level of Service Calculator can be used in determining the appropriate width of a pathway. Wider paths are advisable in the following situations

- When there is a significant use by inline skaters, adult tricycles, children, or other users that need more operating width;
- Where the path is used by larger maintenance vehicles;
- On steep grades to provide additional passing area; or
- Through curves to provide more operating space.

Ideally, a graded shoulder width at least 3 to 5 feet wide with a maximum cross slope of 6:1 should be provided on each side of the pathway. At a minimum, a 2 foot graded area with a maximum slope of 6:1 should be provided for clearance from lateral obstructions such as bushes, large rocks, bridge piers, abutments, and poles. See Figure 701-1E for a typical cross section of a two-way shared use path. Where paths are adjacent to parallel bodies of water or downward slopes of 3:1 or steeper, a wider separation should be considered. A 5 ft. separation from the edge of path pavement to the top of the slope is desirable. Depending on the height of the embankment and condition at the bottom, a physical barrier, such as dense shrubbery, railing or fencing may be needed. Where a recovery area (distance between the edge of the path pavement and the top of the slope) is less than 5 feet, physical barriers or rails are recommended in the following situations (see Figure 701-2).

- Slope 3:1 or greater, with a drop of 6’ or greater;
- Slope 3:1 or greater, adjacent to a parallel body of water or other substantial object;
- Slope 2:1 or greater, with a drop of 4’ or greater
- Slopes 1:1 or greater, with a drop of 1’ or greater.

The barrier or rail should begin prior to, and extend beyond the area of need. The lateral offset of the barrier should be at least 1’ from the edge of path. The ends of the barrier should be flared away from the path edge.
It is not desirable to place the pathway in a narrow corridor between two fences for long distances, as this creates personal security issues, prevents users who need help from being seen, prevents path users from leaving the path in an emergency, and impedes emergency response.
Objects shall not overhang or protrude into any portion of a shared use path at or below 8’ measured from the finish surface. In some situations, a vertical clearance greater than 8’ may be needed to permit passage of maintenance and emergency vehicles.

702.2.2 Shared Use Paths Adjacent to Roadways (Sidepaths)

While it is generally preferable to select path alignments in independent rights-of-way, there are situations where existing roads provide the only corridors available. Sidepaths are specific type of shared use path that run adjacent to the roadway, where right-of-way and other physical constraints dictate. Sidepaths may be considered in addition to on-road bicycle facilities. A sidepath should satisfy the same design criteria as shared use paths in independent right-of-way.
Utilizing or providing a sidewalk as a two-way shared use path is undesirable.
Paths can function along highways for short sections, or for longer sections where there are few street and/or driveway crossings, given appropriate separation between facilities and attention to reducing crashes at junctions. Two-way sidepaths can create operational concerns. These conflicts include:

1. At intersections and driveways, motorists entering or crossing the roadway often will not notice bicyclists approaching from their right, as they do not expect wheeled traffic from this direction. Motorists turning from the roadway onto the cross street may likewise fail to notice bicyclists traveling the opposite direction from the norm.
2. Bicyclists traveling on sidepaths are apt to cross intersections and driveways at unexpected speeds (speeds that are significantly faster than pedestrian speeds). This may increase the likelihood of crashes, especially where sight distance is limited.

3. Motorists waiting to enter the roadway from a driveway or side street may block the sidepath crossing, as drivers pull forward to get an unobstructed view of traffic.
4. Attempts to require bicyclists to yield or stop at each cross street or driveway are inappropriate and are typically not effective.
5. When the sidepath ends, bicyclists traveling in the direction opposed to roadway traffic may continue on the wrong side of the roadway. Similarly, bicyclists approaching a path may travel on the wrong side of the roadway to access the path. Wrong-way travel by bicyclists is a common factor in bicycle-automobile crashes.
6. Depending upon the bicyclist's specific origin and destination, a two-way sidepath on one side of the road may need additional road crossings (and therefore increase exposure); however the sidepath may also reduce the number of road crossings for some bicyclists.
7. Signs posted for roadway users are backwards for contra-flow riders, who cannot see the sign information. The same applies to traffic signal faces that are not oriented to contra-flow users.
8. Because of the proximity of roadway traffic to opposing path traffic, barriers or railings are sometimes needed to keep traffic on the roadway or path from inappropriately encountering each other. These barriers can represent an obstruction to bicyclists and motorists, impair visibility between road and path users, and can complicate path maintenance.
9. Sidepath width is sometimes constrained by fixed objects (such as utility poles, trash can, mailboxes, etc.)
10. Some bicyclists will use the roadway instead of the sidepath because of the operational issues described above. Bicyclists using the roadway may be harassed by motorists who believe bicyclists should use the sidepath.
11. Bicyclists using a sidepath can only make a pedestrian-style left turn, which generally involves yielding to cross traffic twice instead of only once, and thus induces unnecessary delay.
12. Bicyclists on the sidepath, even those going in the same direction, are not within the normal scanning area of drivers turning right or left from the adjacent roadway into a side road or driveway.
13. Even if the number of intersections and driveway crossings is reduced, bicycle-motor vehicle crashes may still occur at the remaining crossings located along the sidepath.
14. Traffic control devices such as signs and markings have not been shown effective at changing road or path user behavior at sidepath intersections or reducing crashes and conflicts.

For these reasons, sidepaths should not be used.

Guidelines for Sidepaths

Although paths in independent rights-of-way are preferred, sidepaths may be considered where one or more of the following conditions exist:

- The adjacent roadway has relatively high-volume and high-speed motor vehicle traffic that might discourage many bicyclists from riding on the roadway, potentially increasing sidewalk riding, and there are no practical alternatives for either improving the roadway or accommodating bicyclists on nearby parallel streets.
- The sidepath is used for a short distance to provide continuity between sections of path in independent rights-of-way, or to connect local streets that are used as bicycle routes.
- The sidepath can be built with few roadway and driveway crossings.

- The sidepath can be terminated at each end onto streets that accommodate bicyclists, onto another path, or in a location that is otherwise bicycle compatible.

In some situations, it may be better to place one-way sidepaths on both sides of the street or highway. Clear directional information is needed if this design is used. This design can reduce some of the concerns associated with a two-way sidepath at driveways and intersections.
A wide separation should be provided between a two-way sidepath and the adjacent roadway. The minimum recommended distance between a path and the roadway curb or edge of travelled way (where there is no curb) is 5 ft. Where a paved shoulder is present, the separation distance begins at the outside edge of shoulder. Where the separation is less than 5 feet, a physical barrier or railing should be provided between the path and the roadway. Such barriers or railings serve to prevent path users from making undesirable or unintended movements from the path to the roadway and to reinforce the concept that the path is an independent facility. The barrier or railing need not be of a size and strength to redirect an errant motorist toward the roadway, unless other conditions indicate the need for a crashworthy barrier. Barriers or railings at the outside of a structure or a steep fill embankment should be a minimum of 42 in. high. Barrier at other locations that serve only to separate the area for motor vehicles from the sidepath should generally have a minimum height equivalent to the height of a standard guardrail.

702.2.3 Design Speed

The next step in shared use path design is to determine the design speed. For most paths in relatively flat areas (grades less than 2 percent), a design speed of 18 mph is generally sufficient, except on inclines where higher speeds can occur.

702.2.4 Horizontal Alignment

After determining the design speed of the shared use path, the horizontal and vertical alignment of the shared use path should be designed. The minimum radius of horizontal curvature for bicyclists can be calculated using two different methods. One method uses "lean angle", and the other method uses superelevation and coefficient of friction. In general, the lean angle method should be used in design. The table below shows minimum radii of curvature for a paved path using a 20-degree lean angle. See the AASHTO Guide for the Development of Bicycle Facilities 2012 Edition for information on calculating the minimum radius based superelevation and coefficient of friction.

US Customary	
Design Speed (mph)	Minimum Radius (ft)
12	27
14	36
16	47
18	60
20	74
25	115
30	166

Minimum Radii for Horizontal Curve on Paved Shared Use Path at a 20-degree Lean Angle

702.2.5 Cross Slope

Shared use paths should have a maximum cross slope of 2 percent, to accommodate people with disabilities

702.2.6 Grade

The maximum grade of a shared use path contained within the roadway right of way shall not exceed the general grade established for the adjacent roadway. Where the shared use path is not contained within the roadway right of way, the maximum grade of the shared shall be 5 per cent.

702.2.7 Stopping Sight Distance

To provide path users with opportunities to see and react to unexpected conditions, shared use paths should be designed with adequate stopping sight distances.

For a crest vertical curve, the height of eye is assumed to be 4.5 ft. and the object height is assumed to be 0 in. to recognize that impediments to bicycle travel exists at pavement level. Figure 701-3E can be used to select the minimum length of vertical curve needed to provide minimum stopping sight distances at various speeds on crest vertical curves.

Figure 701-4 illustrates the horizontal sight distance for a shared use path. The lateral clearance (horizontal sight line offset) is obtained using the table from Figure 701-5 and the proposed horizontal radius of curvature.

Path users typically travel side-by-side on shared use paths. On narrow paths, bicyclists tend to ride near the middle of the path. Lateral clearances on horizontal curves should be calculated based on the sum of the stopping sight distances for path users travelling in opposite directions around the curve.

702.2.8 Surface Structure

The surfaces of shared use paths should be firm, stable, and slip resistant and shall comply with R302.7 of the PROWAG.

Vertical alignment shall be generally planar within shared use path (including curb ramp runs, turning spaces, and gutter areas within shared use path) and surfaces at other elements. Grade breaks shall be flush. Where shared use paths cross rails at grade, the shared use path shall be level and flush with the top of rail at the outer edges of the rails, and the surface between the rails shall be aligned with the top rail.

It is important to maintain a smooth riding surface on shared use paths. Vertical surface discontinuities shall be 0.5 in. maximum. Vertical surface discontinuities between 0.25 in. and 0.5 in. shall be beveled with a slope not steeper than 50 percent. The bevel shall be applied across the entire vertical surface discontinuity.

Utility covers and bicycle compatible grates should be flush with the surface of the pavement on all sides. Horizontal openings in gratings and joints shall not permit passage of a sphere more than 0.5 in. in diameter. Elongated openings in gratings shall be placed so that the long dimension is perpendicular to the dominant direction of travel. Railroad crossings should be smooth and be designed at an angle between 60 and 90 degrees to the direction of travel in order to minimize the possibility of falls.

Flangeway gaps at pedestrian at-grade crossings shall be 2.5 in. maximum on non-freight rail track and 3 in. maximum on freight rail track.

702.2.9 Bridges and Underpasses

The receiving clear width on the end of a bridge (from inside of rail or barrier to inside of opposite rail or barrier) should allow 2 ft. of clearance on each side of the shared use path but under constrained conditions may taper to the shared use path width.

Carrying the clear areas across the structures has two advantages. First, the clear width provides a minimum horizontal shy distance from the railing or barrier, and second, it provides needed maneuvering space to avoid conflicts with pedestrians or bicyclists who have stopped on the bridge.

Protective railings, fences, or barriers on either side of a shared use path on a stand-alone structure should be a minimum of 42 in. high. There are some locations where a 48 in. high railing should be considered in order to prevent bicyclists from falling over the railing during a crash. This includes bridges or bridge approaches where high-speed, steep angle impacts between a bicyclists and a railing may

occur, such as at a curve at the foot of a long descending grade where the curve radius is less than appropriate for the design speed or anticipated speed.
Openings between horizontal or vertical members on railings should be small enough that a 6 in. sphere cannot pass through them in the lower 27 in. For the portion of railing that is higher than 27 in., openings may be spaced such that an 8 in. sphere cannot pass through them. This is done to prevent children from falling through the openings. Where a bicyclist's handlebar may come into contact with a railing or barrier, a smooth wide rubrail may be installed at a height of about 36 in. to 44 in. to reduce the likelihood that bicyclist's handlebar will be caught by the railing.
The structural design of shared use path bridges should be designed in accordance with the AASHTO LRFD Bridge Design Specifications for Design of Pedestrian Bridges.

702.3 Shared Use Path Intersection Design

Shared use path intersection can be at a "new" mid-block location or a sidepath at an existing intersection of two roadways. Both intersection designs should consider the variable speed between the vehicles and path users, the available intersection sight distance and the traffic volumes. The objectives of both designs are

- Alert the motorists and path users to the crossing
- Communicate who has the obligation to yield to whom
- Enable the motorists and/ or path users to fulfill their obligations

Illumination of the path/ roadway intersection should be considered, especially on unlit paths.
Curb ramps with detectable warnings should be provided at intersections. The curb ramps and detectable warnings should extend the full width of the shared use path.

702.3.1 Design of Mid-Block Crossings

It is preferable for mid-block crossings to intersect the roadway at a 90° angle to minimize the crossing distance and to maximize the intersection sight distance.
Shared use paths are unique in terms of assignment of the right of way, due to the legal responsibility to drivers to yield to pedestrians in crosswalks. Bicyclists approach the intersection at a far greater speed than pedestrians. A stop or yield sign is need to remind the bicyclists who has the legal right of way at crossings.
The least restrictive form of intersection control should be used at shared use path intersections. A common misconception is the routine installation of stop control for the pathway. Per the MUTCD, Stop signs should not be used where Yield signs would be acceptable." Sight triangles should be used in selecting the appropriate control (see Figures 701-6 & 701-7).
Additional traffic control, such as a signal or active warning device, may be needed due to the traffic volumes, vehicular speed or roadway geometry.

702.3.2 Sidepath Intersection Design

The potential issues with sidepaths are discussed in section 702.2.2, but there are times when they are unavoidable. The following design measures may reduce crashes:

- Reduce the driveway density.
- Reduce the speeds of both the path user and the motorists. Tighter corner radii, median refuge islands, and no free flow right turns are several examples.
- Improve visibility. Keep approaches to intersections and major driveways clear of obstructions such as parked vehicles, landscaping elements and traffic control devices.

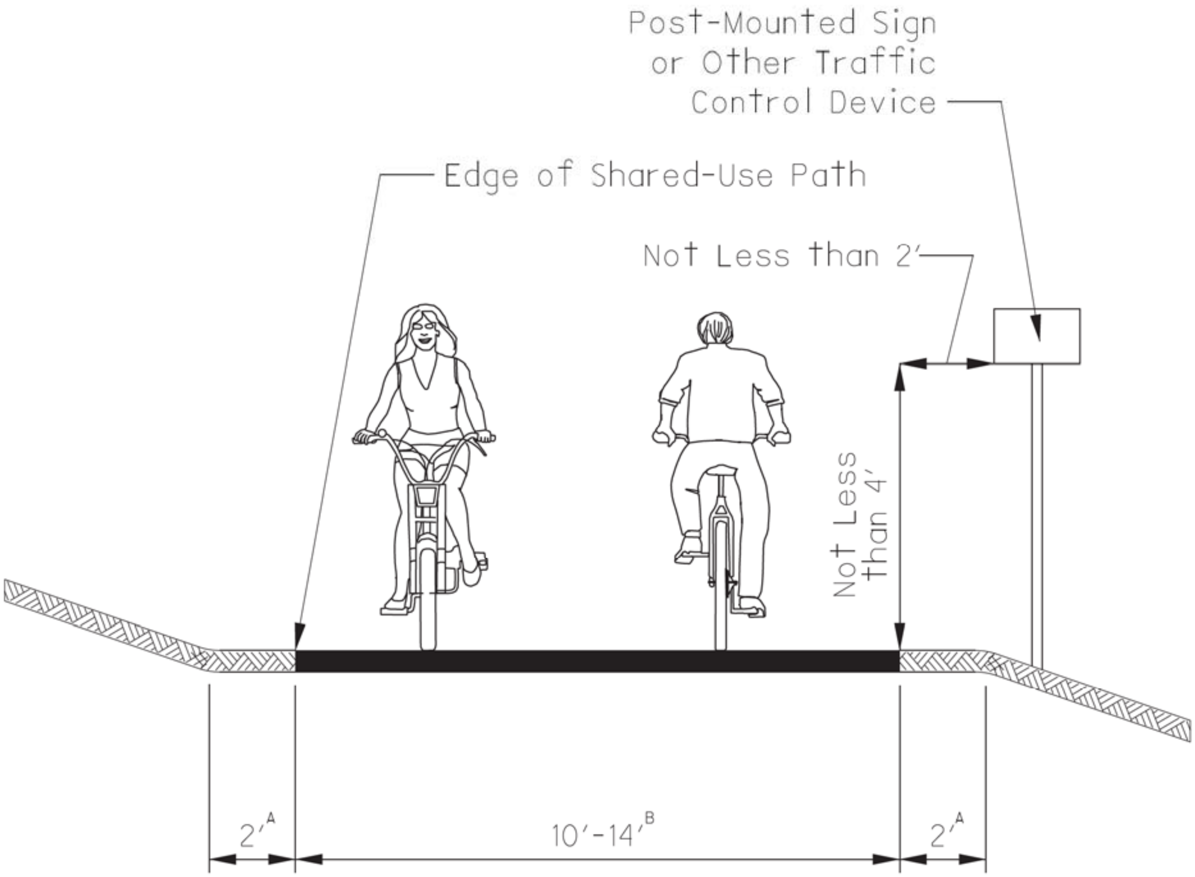
At signalized intersections, the following design measures should be considered

- Prohibit right turn on red.

- Provide a leading pedestrian interval or if the volumes on the path are high, then consider an exclusive phase.
- Allow turning movements on fully protected phases only.

700 Multi-Modal Considerations

TYPICAL CROSS SECTION OF TWO-WAY, SHARED USE PATH ON INDEPENDENT RIGHT-OF-WAY	701-1E
	REFERENCE SECTIONS 702.2.1

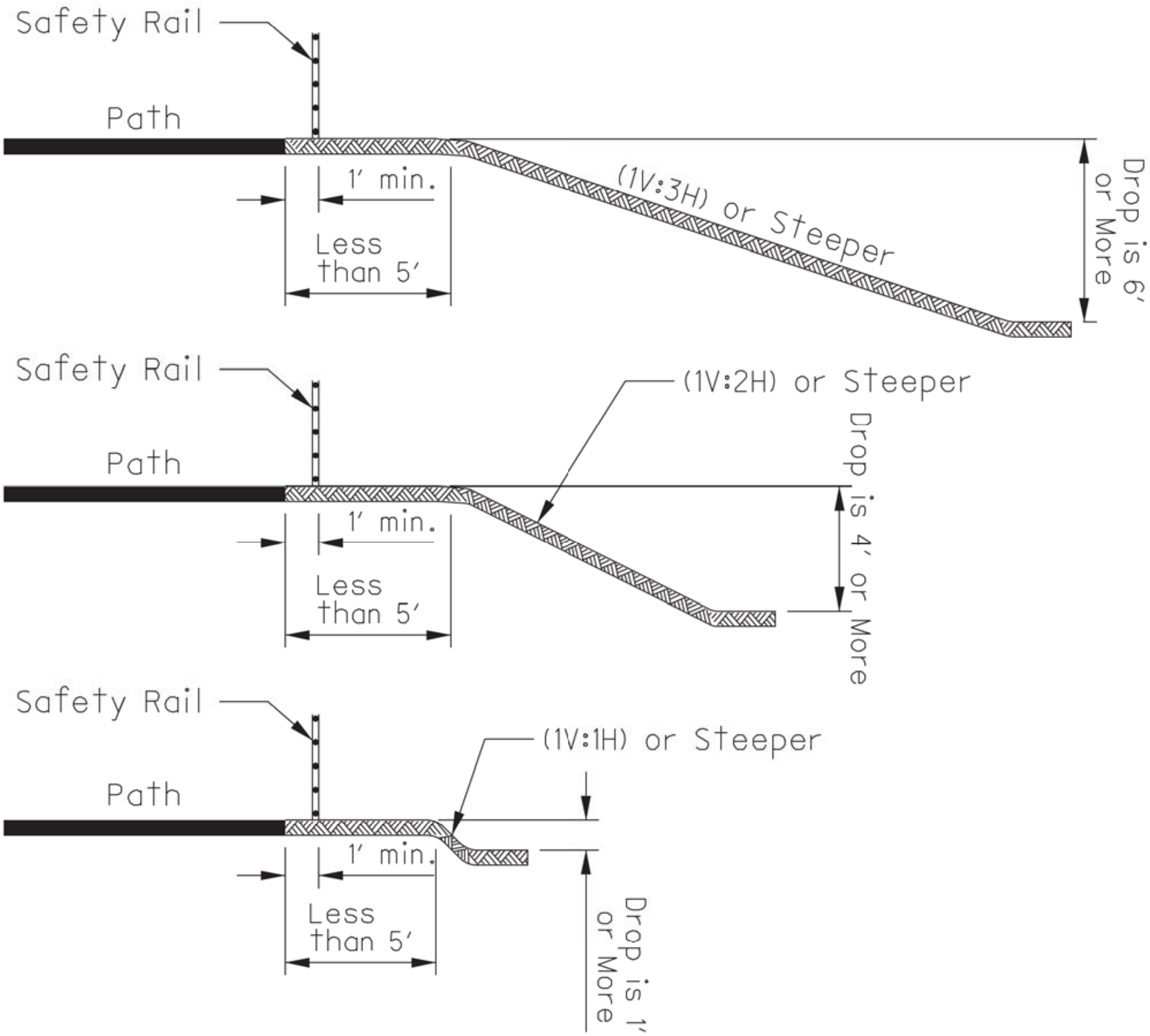


Notes:

A (1V:6H) Maximum Slope (typ.)

B More if necessary to meet anticipated volumes and mix of users, per the FHWA *Shared Use Path Level of Service Calculator*

SAFETY RAIL BETWEEN PATH AND ADJACENT SLOPE	701-2E
	REFERENCE SECTIONS 702.2.1



MINIMUM LENGTH OF CREST VERTICAL CURVE BASED ON STOPPING SIGHT DISTANCE

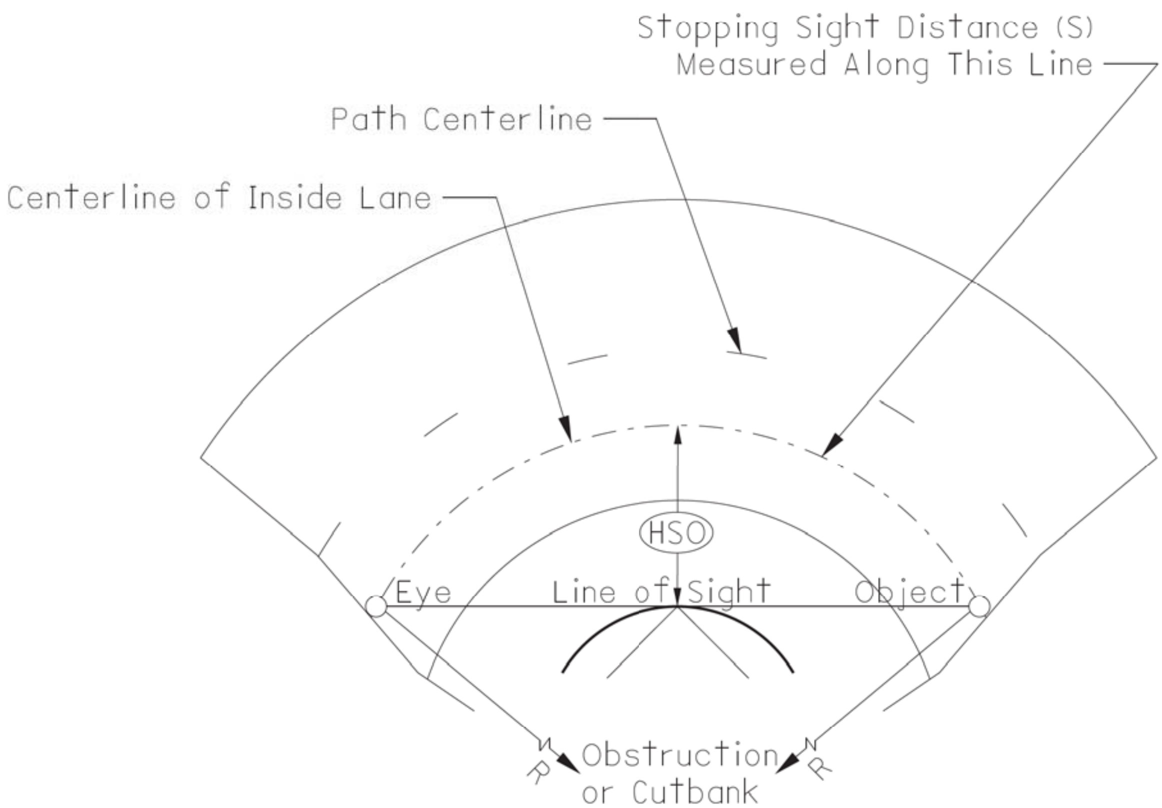
701-3

REFERENCE SECTIONS
309.2.7

A	S = Stopping Sight Distance (ft)														
(%)	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
2												30	70	110	150
3								20	60	100	140	180	220	260	300
4						15	55	95	135	175	215	256	300	348	400
5					20	60	100	140	180	222	269	320	376	436	500
6				10	50	90	130	170	210	267	323	384	451	523	600
7				31	71	111	151	191	231	311	376	448	526	610	700
8			8	48	88	128	168	208	248	356	430	512	601	697	800
9			20	60	100	140	180	220	260	400	484	576	676	784	900
10			30	70	110	150	190	230	270	444	538	640	751	871	1000
11			38	78	118	158	198	238	278	489	592	704	826	958	1100
12		5	45	85	125	165	205	245	285	533	645	768	901	1045	1200
13		11	51	91	131	171	211	251	291	578	699	832	976	1132	1300
14		16	56	96	136	176	216	256	296	622	753	896	1052	1220	1400
15		20	60	100	140	180	220	260	300	667	807	960	1127	1307	1500
16		24	64	104	144	184	224	264	304	711	860	1024	1202	1394	1600
17		27	67	107	147	187	227	267	307	756	914	1088	1277	1481	1700
18		30	70	110	150	190	230	270	310	800	968	1152	1352	1568	1800
19		33	73	113	153	193	233	273	313	844	1022	1216	1427	1655	1900
20		35	75	115	155	195	235	275	315	889	1076	1280	1502	1742	2000
21		37	77	117	157	197	237	277	317	933	1129	1344	1577	1829	2100
22		39	79	119	159	199	239	279	319	978	1183	1408	1652	1916	2200
23		41	81	121	161	201	241	281	321	1022	1237	1472	1728	2004	2300
24	3	43	83	123	163	203	243	283	323	1067	1291	1536	1803	2091	2400
25	4	44	84	124	164	204	244	284	324	1111	1344	1600	1878	2178	2500

Shaded Area Represents S>L
Minimum Length of Vertical Curve = 3'

DIAGRAM ILLUSTRATING COMPONENTS FOR DETERMINING HORIZONTAL SIGHT DISTANCE	701-4
	REFERENCE SECTIONS 309.2.7



$$HSO = R\left[1-\cos\left(\frac{28.65S}{R}\right)\right]$$

$$S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R-HSO}{R}\right)\right]$$

Where:

S = Stopping Sight Distance (ft)

R = Radius of Centerline of Lane (ft)

HSO = Horizontal Sightline Offset, Distance from Centerline of Lane to Obstruction (ft)

Note: - Angle is Expressed in Degrees
- Line of Sight is 2.3′ above Centerline of Inside Lane at Point of Obstruction

MINIMUM LATERAL CLEARANCE (HORIZONTAL SIGHTLINE OFFSET OR HSO) FOR HORIZONTAL CURVES

701-5

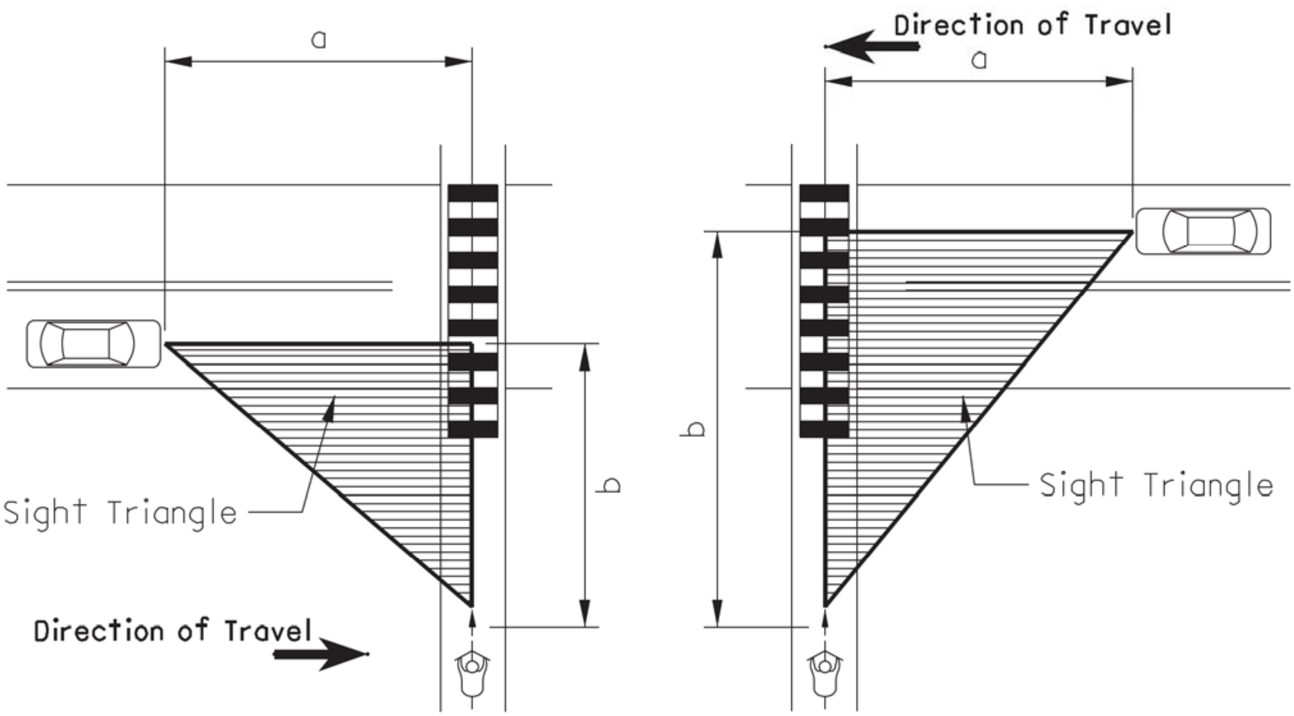
REFERENCE SECTIONS 702.2.7

S = Stopping Sight Distance (ft)															
R (ft)	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
25	2.0	7.6	15.9												
50	1.0	3.9	8.7	15.2	23.0	31.9	41.5								
75	0.7	2.7	5.9	10.4	16.1	22.8	30.4	38.8	47.8	57.4	67.2				
95	0.5	2.1	4.7	8.3	12.9	18.3	24.7	31.8	39.5	48.0	56.9	66.3	75.9	85.8	
125	0.4	1.6	3.6	6.3	9.9	14.1	19.1	24.7	31.0	37.9	45.4	53.3	61.7	70.6	79.7
155	0.3	1.3	2.9	5.1	8.0	11.5	15.5	20.2	25.4	31.2	37.4	44.2	51.4	59.1	67.1
175	0.3	1.1	2.6	4.6	7.1	10.2	13.8	18.0	22.6	27.8	33.5	39.6	46.1	53.1	60.5
200	0.3	1.0	2.2	4.0	6.2	8.9	12.1	15.8	19.9	24.5	29.5	34.9	40.8	47.0	53.7
225	0.2	0.9	2.0	3.5	5.5	8.0	10.8	14.1	17.8	21.9	26.4	31.3	36.5	42.2	48.2
250	0.2	0.8	1.8	3.2	5.0	7.2	9.7	12.7	16.0	19.7	23.8	28.3	33.1	38.2	43.7
275	0.2	0.7	1.6	2.9	4.5	6.5	8.9	11.6	14.6	18.0	21.7	25.8	30.2	34.9	39.9
300	0.2	0.7	1.5	2.7	4.2	6.0	8.1	10.6	13.4	16.5	19.9	23.7	27.7	32.1	36.7
350	0.1	0.6	1.3	2.3	3.6	5.1	7.0	9.1	11.5	14.2	17.1	20.4	23.9	27.6	31.7
390	0.1	0.5	1.2	2.1	3.2	4.6	6.3	8.2	10.3	12.8	15.4	18.3	21.5	24.9	28.5
500	0.1	0.4	0.9	1.6	2.5	3.6	4.9	6.4	8.1	10.0	12.1	14.3	16.8	19.5	22.3
565		0.4	0.8	1.4	2.2	3.2	4.3	5.7	7.2	8.8	10.7	12.7	14.9	17.3	19.8
600		0.3	0.8	1.3	2.1	3.0	4.1	5.3	6.7	8.3	10.1	12.0	14.0	16.3	18.7
700		0.3	0.6	1.1	1.8	2.6	3.5	4.6	5.8	7.1	8.6	10.3	12.0	14.0	16.0
800		0.3	0.6	1.0	1.6	2.2	3.1	4.0	5.1	6.2	7.6	9.0	10.5	12.2	14.0
900		0.2	0.5	0.9	1.4	2.0	2.7	3.6	4.5	5.6	6.7	8.0	9.4	10.9	12.5
1000		0.2	0.5	0.8	1.3	1.8	2.4	3.2	4.0	5.0	6.0	7.2	8.4	9.8	11.2

STOPPING SIGHT DISTANCE	701-6
	REFERENCE SECTIONS 702.2.7, 702.3

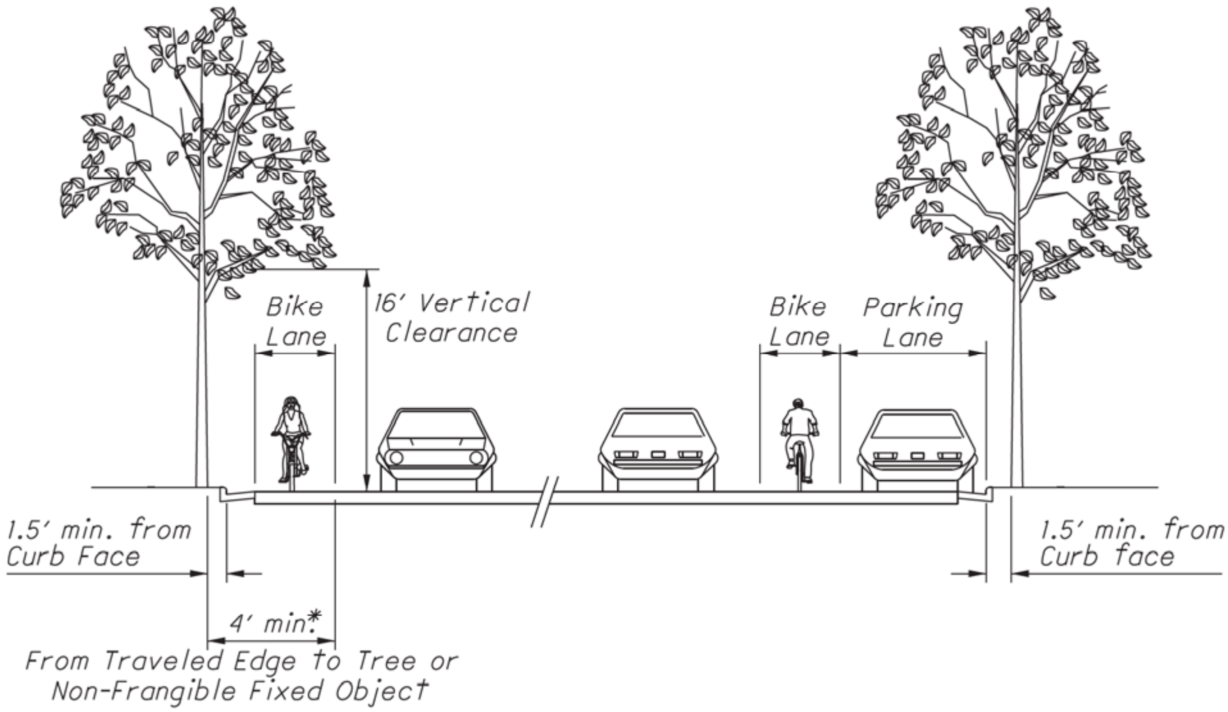
Bicycle Design Speed (mph)	Stopping Sight Distance (Design Values)						
	No Grade Adjustment	% Down Grade			% Up Grade		
		3	6	9	3	6	9
8	43	46	51	60	41	40	38
10	58	63	71	85	55	52	51
12	75	81	93	113	70	66	64
14	93	102	117	145	86	82	78
16	113	125	145	181	104	98	93
18	134	150	175	221	123	116	110
20	157	176	207	264	144	135	127
25	222	253	301	390	202	187	176
30	298	341	411	539	268	247	231

# YIELD SIGHT TRIANGLES	701-7
	REFERENCE SECTIONS 702.3

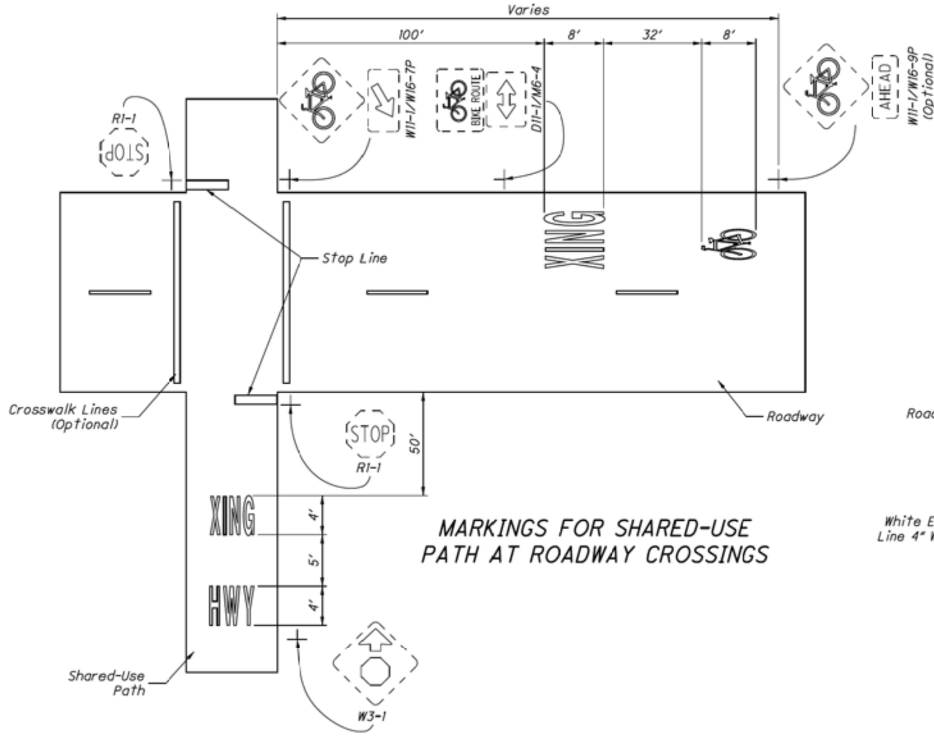


Length of Roadway Leg of Sight Triangle		
$t_a = \dfrac{S}{1.47V_{path}}$ $t_g = t_a + \dfrac{w+L_a}{0.278V_{path}}$ $a = 1.47V_{road}t_g$		
where:		
t_g	=	travel time to reach and clear the road (s)
a	=	length of leg sight triangle along the roadway approach (ft)
t_a	=	travel time to reach the road from the decision point for a path user that doesn't stop (s)
w	=	width of the intersection to be crossed (ft)
L_a	=	design speed of the path (mph)
V_{path}	=	typical bicycle length = 6 ft
V_{road}	=	design speed of the road (mph)
S	=	stopping sight distance for the path user traveling at design speed (ft)

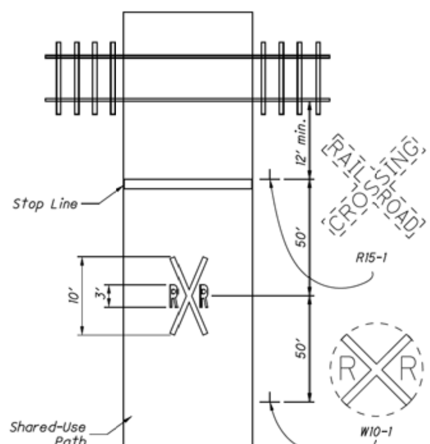
URBAN LANDSCAPING TYPICAL CURBED SECTION 45 MPH OR LESS	904-2
	REFERENCE SECTIONS 905.2



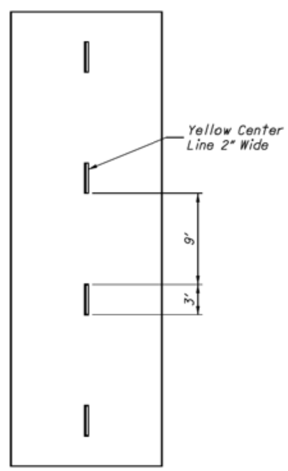
CURBED SECTION
WITH BIKE LANES OR ON STREET PARKING



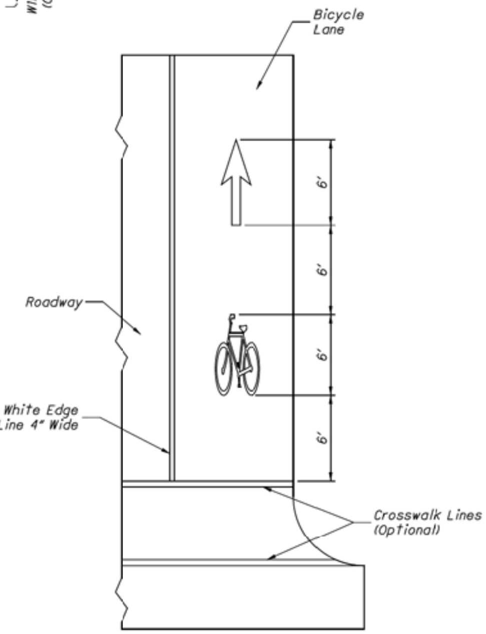
MARKINGS FOR SHARED-USE PATH AT ROADWAY CROSSINGS



MARKINGS FOR SHARED-USE PATH AT RAILROAD CROSSINGS



CENTER LINE MARKINGS FOR SHARED-USE PATH

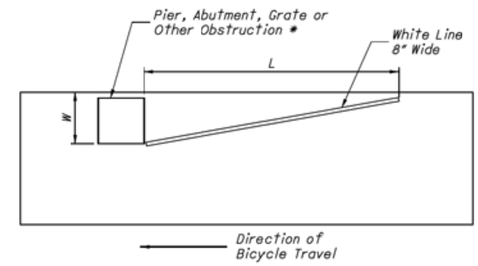


MARKINGS FOR BICYCLE LANE

(See Note 4)

NOTES:

1. Edge lines are optional on the shared-use path. If used, the edge line should be 2" wide.
2. Center line is optional on the shared-use path.
3. Arrows, words and symbol markings are optional on the shared-use path.
4. Green colored pavement may be used for bike lanes if called for in the plans.

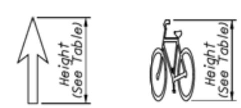


TYPICAL MARKINGS AROUND AN OBSTRUCTION

L (ft) = WS

W - Width in feet
S - Bicycle Approach Speed in Miles per Hour

* Provide an Additional Foot of Offset for a Raised Obstruction and Use the Formula L=(W+1)S for the Taper Length.



FACILITY TYPE	HEIGHT	STRAIGHT ARROW	BIKE SYMBOL	HWY	XING	RXR SYMBOL
	Feet	AREA (SQUARE FEET)				
SHARED-USE PATH	4	4	3	5	6	----
	10	----	----	----	----	16
BICYCLE LANE	6	6	5	----	16	----
ROADWAY- URBAN	6	5	5	----	16	----
ROADWAY- RURAL	8	7	7	----	21	----

THIS DRAWING REPLACES PIS 207000 DATED 01-18-2013.

OFFICE OF ROADWAY ENGINEERING

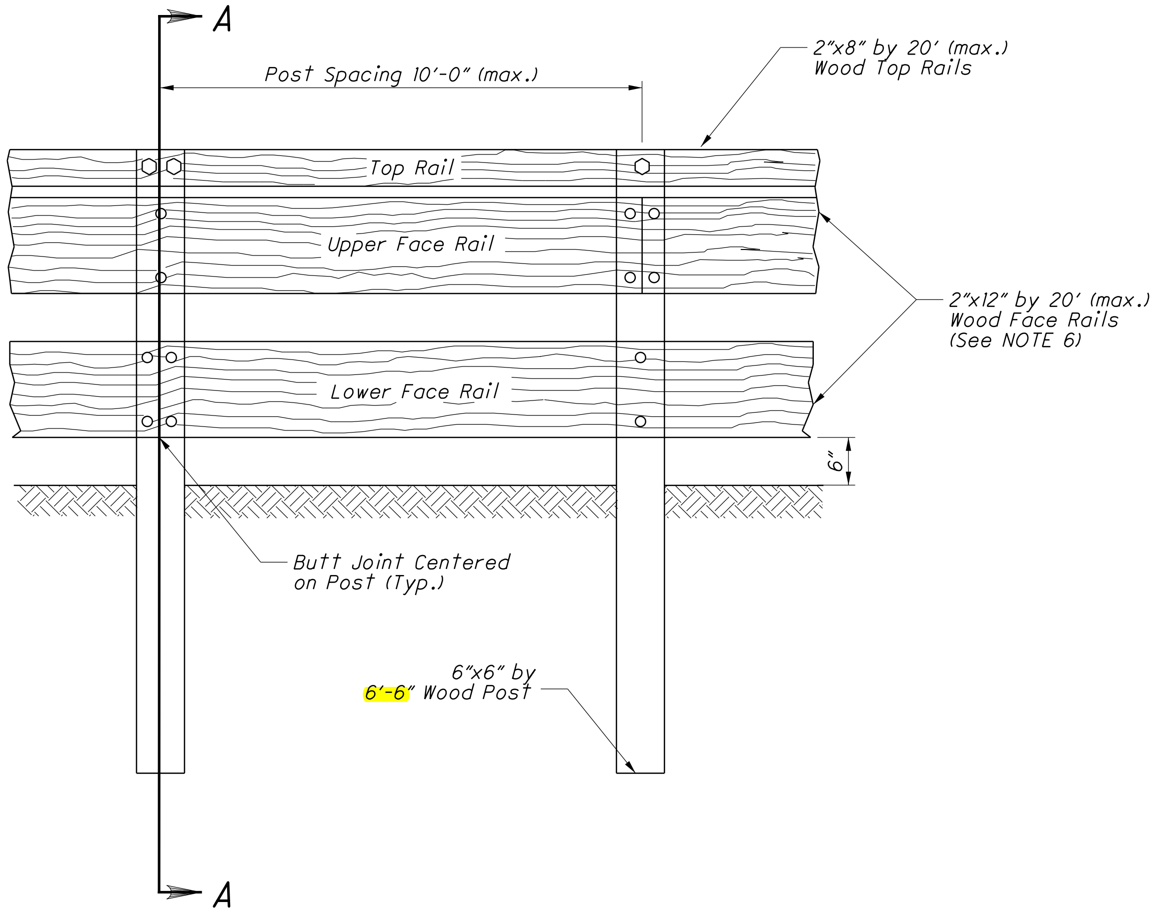
DESIGNED | REVIEWED | REVISION DATE 07-18-2014 | CHECKED | PIS NUMBER 207000

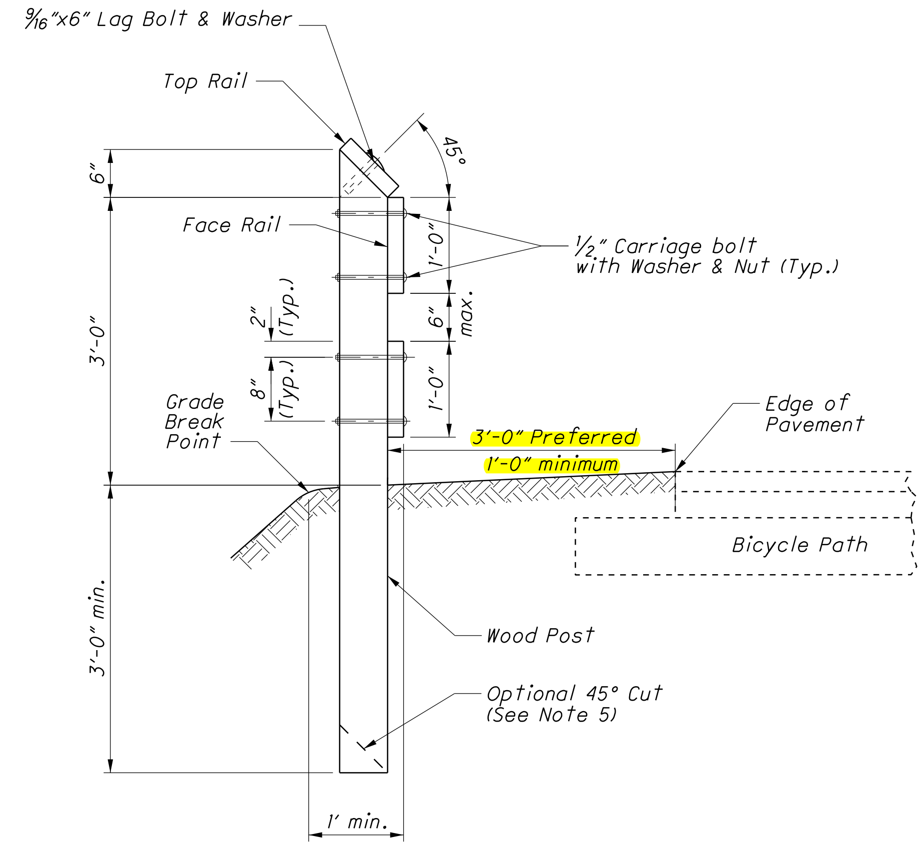
PLAN INSERT SHEET

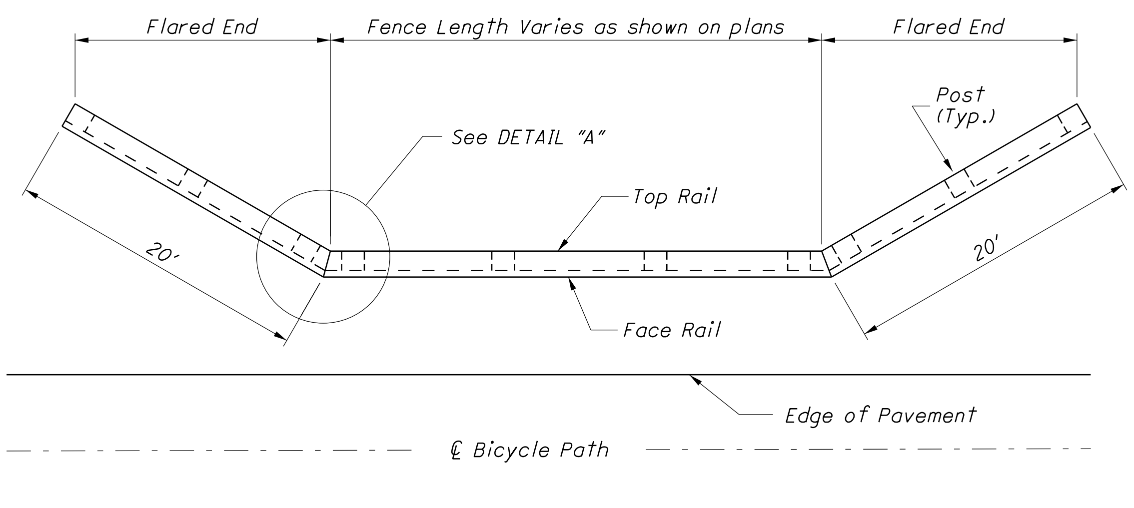
BIKEWAY PAVEMENT MARKING DETAILS

PIS 207000

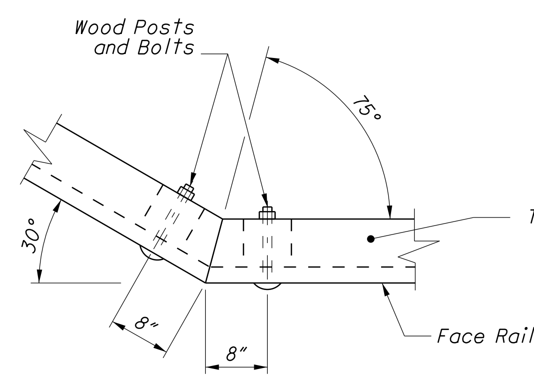
1/1







PLAN VIEW



Lag Bolts in Top Rail are not shown for clarity.

DETAIL "A"

NOTES

1) CCA treat all wood members as specified in CMS 712.06.

2) Galvanize all bolts, washers, and nuts as specified in CMS 711.02 and 711.10. Counterbore face of rails to provide flush bolt heads.

3) Provide a wood railing that is smooth and splinter free.

4) Where less than 1'-0" of graded shoulder width (10:1 or flatter) extends beyond the edge of the face rail, use longer posts so that a minimum 5'-0" embedment depth is provided.

5) The bottom end of the 6"x6" posts may be cut to a 45° point.

6) Stagger butt ends of the top rail and the lower face rail (on alternate posts). Center all butt end joints on the posts.

7) Include the cost of furnishing and placing all posts, rails, and hardware in the unit price bid for Item 607 - Fence, Misc.: Wood Fence.

THIS DRAWING REPLACES RM-5.2 DATED 1-21-11

STATE OF OHIO DEPARTMENT OF TRANSPORTATION

ADMINISTRATOR

1-17-2014
DATE

STDS. ENGINEER
M. Ruppe

OFFICE OF ROADWAY ENGINEERING

STANDARD ROADWAY CONSTRUCTION DRAWING

BIKEWAY RAILING

SCD NUMBER
RM-5.2

1/1

Standard Map Elements
for Maps on Wayside Exhibits and Signs

Harpers Ferry Center
Media Services

National Park Service
U.S. Department of the Interior

Original page dimensions are 22 inches x 34 inches

Linework

Line specifications are intended as a guide for parkwide maps and maps which show large areas. Linework may vary with focus, size, and scale of map. Relationships between line specifications should remain similar.

Limited access highway	8 point line, prints 50% black
Primary road	4 point line, prints 50% black
Secondary road	2 point line, prints 50% black
Unpaved road	2 point line, prints 50% black; 12 point dash, 5 point gap
4-wheel-drive trail	2 point line, prints 50% black; 5 point dash, 5 point gap
Street grid	2 point line, prints white
Limited access highway interchange	12 point square; 2 point outline prints 50% black, interior prints white
Parking area	50% black shape
Overlook	Half-circle abutting road or trail
Overpass	Two ticks parallel to upper road; 2 point line, prints 100% black
Locked gate	2 point line, prints 100% black
Distance indicator (0.5 mi 0.8 km)	12 point Frutiger 55 Roman
Drainage	6 point line, prints 65% cyan or Pantone 298
Intermittent drainage	6 point line, prints 65% cyan or Pantone 298; round caps, 18 point dash, 8 point gap, 1 point dash, 8 point gap, 1 point dash, 8 point gap
Waterfall	three parallel 1 point ticks, prints 65% cyan or Pantone 298
Marsh pattern	prints 65% cyan or Pantone 298
Spring	prints 65% cyan or Pantone 298
Dam	2 point tick across drainage, prints 100% black
Ford	parallel 2 point ticks across drainage, prints 100% black
Lock	2 point chevron, pointing upstream, prints 100% black
River milepost (55)	solid 9 point locator dot with 18 point Frutiger 55 numeral
Ferry route	3 point line, prints 100% cyan or highlight blue; 7 point dash, 5 point gap
Red starboard day marker	triangle prints highlight red
Green port day marker	square prints highlight green
Red starboard channel buoy	symbol prints highlight red
Tour route	color line (replaces road) with optional directional arrow alongside; prints highlight color
Trail	5 point line, prints highlight color; 0.5 point dash, 8 point gap
Bike trail	5 point line, prints highlight color; 0.5 point dash, 8 point gap with positive bike pictograph
Steep trail	2 point chevron, pointing uphill; prints 100% black
National scenic trail	3 point line, prints highlight green; 7 point dash, 5 point gap
Railroad	1 point line with 15 point dashed line overprinting; 1 point dash, 28 point gap prints 50% black
Battle	1 point line with highlight yellow fill

Area Colors

Color specifications are only a general guide. Colors may vary with focus, size, and scale and final production method of the map. Each color is specified as both for four color process and flat color.

Park area

- prints 10% cyan and 15% yellow or 40% of Pantone 358
- prints 25% cyan and 35% yellow or Pantone 358
- prints 40% cyan and 50% yellow or Pantone 359
- prints 60% cyan and 80% yellow or Pantone 360

Non-subject area

- prints 5% yellow and 5% black
- prints 8% cyan, 5% magenta and 10% yellow or 70% of Pantone 454
- prints 5% cyan, 7% magenta and 18% yellow or 80% of Pantone 468
- prints 7% cyan, 7% magenta and 5% yellow or 8% of Pantone 518
- prints 7% magenta and 11% yellow or 60% of Pantone 475
- prints 6% cyan, 10% magenta and 10% yellow or 90% of Pantone 482

Open water area

- prints 15% cyan or 50% of Pantone 290
- prints 25% cyan and 5% magenta or Pantone 290
- prints 50% cyan and 10% magenta or Pantone 291

Built-up area

- prints 10% yellow or Pantone 607
- prints 20% yellow or 65% of Pantone 608
- prints 30% yellow or Pantone 608

Indian Reservation

- prints 5% cyan, 5% magenta, and 8% yellow

State Park or other natural area

- prints 10% cyan and 30% yellow or Pantone 365
- prints 30% cyan and 60% yellow or Pantone 367

Highlight Colors for Lines and Locators

- prints 40% Magenta + 100% Yellow or Pantone Orange 021
- prints 100% Yellow or Pantone Process Yellow
- prints 56% Cyan + 100% Yellow or Pantone 376
- prints 100% Cyan + 100% Yellow or Pantone 354
- prints 100% Cyan + 100% Magenta or Pantone Violet
- prints 100% Cyan + 43% Magenta or Pantone 300
- prints 100% Cyan or Pantone Process Blue
- prints 15% Cyan + 40% Magenta or Pantone 251
- prints 100% Magenta or Pantone Process Magenta
- prints 100% Magenta + 100% Yellow or Pantone Red 032

Standard Map Elements
for Maps on Wayside Exhibits and Signs

Harpers Ferry Center
Media Services

National Park Service
U.S. Department of the Interior

Original page dimensions are 22 inches x 34 inches

NPS Pictographs

All pictographs used on the map must be identified in the map legend. Pictographs should be limited to no more than six per map. Any map feature which appears only once or twice should be labeled rather than using a pictograph.

Pictograph box: 0.375"
Label in legend: 18 point Frutiger 55 Roman with 18 point leading. Align the centerline of the cap height to the centerline of the symbol.

- Airport
- Amphitheater
- Boat launch
- Boat tour
- Bike trail
- Campground
- Canoe access
- Crosscountry ski trail
- Downhill skiing
- Drinking water
- Fishing
- Food service
- 4-wheel-drive trail
- Gas station
- Hiking trail
- Horse trail
- Interpretive trail
- Lodging
- Marina
- Medical facility
- Parking
- Picnic area
- Post office
- Ranger station
- RV camping
- Restrooms
- Sailing
- Sanitary disposal station
- Scuba diving
- Shelter
- Showers
- Snowmobile trail
- Stable
- Store
- Swimming
- Telephone
- Tour bus
- Trail bike trail
- Visitor information
- Wheelchair-accessible

Permit — When a permit is required for feature identified by a symbol, add the word **"Permit"** in 11 point Frutiger 65 Bold.

Use positive form of camping and picnic table pictographs to refer to a particular point. Use positive symbols in conjunction with the trail or route line. Do not use with a locator dot.

- Airfield
- Cannon
- Campsite
- Picnic table
- 4-wheel-drive (trail)
- Canoe access
- Trail bike (trail)
- Crosscountry ski (trail)
- Horse (trail)
- Bike (trail)
- Snowmobile (trail)
- Fire tower
- Lighthouse

Sample map legend

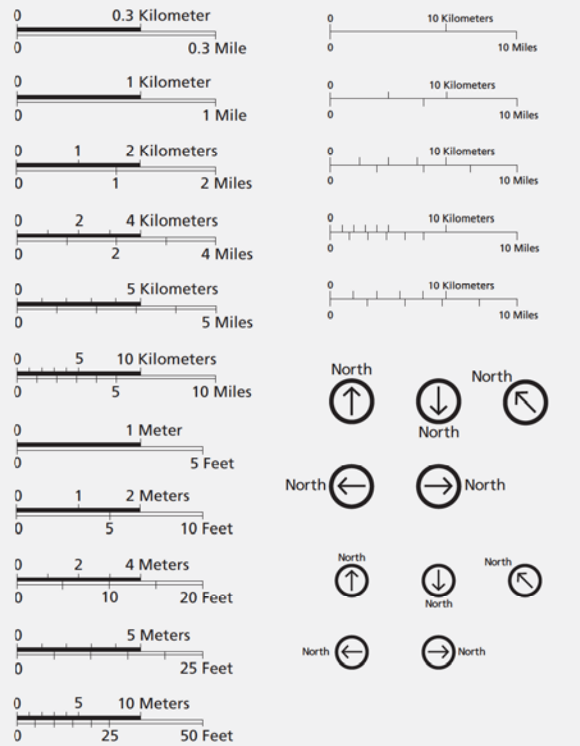
All pictographs used on the map must be identified in the map legend. Include any lines, symbols, or colors which are not labeled directly on the map. Labels are 10 point Frutiger 55 Roman with 18 point leading. Align the centerline of the cap height to the centerline of the symbol or legend box.

- Wilderness
- Public land
- Private land within park
- Parking
- Restrooms
- Picnic area

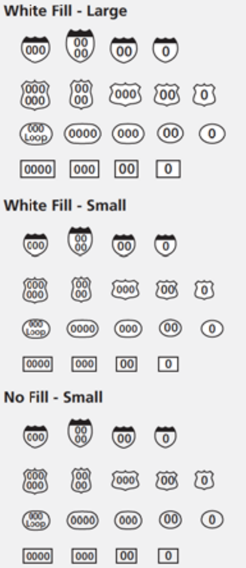
Scales and North Arrows

Scales shown actual size. Adjust the length as necessary to match map scale but do not exceed five inches.

Labels: large size: 18 point Frutiger 55 Roman.
small size: 12 point Frutiger 55 Roman.



Road Shields



Directional Notes
Type is 14 point Frutiger 56 Italic

To Leesburg and (00)
To (00) and Frederick
To Rohrersville 00mi 00km
To (00) and Shepherdstown
To Purcellville and (00)

Directional Arrows

You Are Here

Type is 24 point Frutiger 75 Bold caps/lower case printing white in solid black box. Black box is 2.25" wide by 0.375" high. Use 12 point locator dot. First

You Are Here

You Are Here

You Are Here

You Are Here

Tour Stops

Type is 14 point Frutiger 65 Bold

0 1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25

0 1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25

Locator Symbols

- Town circles
- 9 point
- 12 point
- 16 point
- 9 point
- 12 point
- 16 point

Use locator dots for points of interest and natural features. Use locator squares for structures.

Location