CHAPTER 3
Bikeway Facility Design Guidelines

Introduction

Bicycles are legally classified as vehicles by Maryland Vehicle Law and are allowed on most public roads in Montgomery County, with a few exceptions (freeways like I-495 and I-270). As such, all roadways should be designed with bicycle use in mind. In this plan, bikeways are designated on roadways where there is a particular need to provide a connection to a major destination. The appropriate bicycle facility for any given roadway, or segment of roadway, depends on the road's classification, pavement and right-of-way width, motor vehicle speeds and volumes, adjacent land uses and expected growth patterns, and other factors. Bikeway selection guidelines are covered in Chapter 2.

Bikeways can generally be divided into two broad categories:

1. On-street facilities generally consist of bike lanes, paved shoulders or shared roadways (with and without wide outside lanes; with or without signing).

2. Off-street facilities consist of hiker-biker trails in parks or shared use paths along roadways.

Shared use paths along roads are generally best used to supplement the on-street bikeway network in corridors not served by roadways and/or along utility, rail, or other linear corridors. However, the County already has an extensive network of shared use paths along roadways. This plan acknowledges these bikeways, and recommends additional shared use paths along county and state roads to supplement and make connections to the existing off-road shared use path network. Shared use paths can best be used to accommodate bicycles on high-speed roadways without driveways and with few intersections (e.g., Great Seneca Highway).

Purpose of Bikeway Design Guidelines

Including a chapter on bikeway design guidelines serves primarily three purposes:

- To ensure consistently designed facilities throughout the County
- To inform engineers and planners of effective bikeway designs and of potential design solutions to complex design problems
- To educate the public on safe and effective bikeway design so that they know what to expect to see on the ground when a bikeway is implemented

First and foremost, including bikeway design guidelines in this plan helps to ensure that bikeways are consistently designed and implemented througout the County. The guidelines establish a base of knowledge from which all interested parties can discuss and debate bikeway implementation. The design guidelines are also intended to serve as an aid to engineers, designers, planners and others in safely accommodating bicycle traffic in different riding environments and encouraging predictable bicycling behavior. Finally, the guidelines provide the public with an idea of what they can expect to see and experience when a bikeway is actually built or implemented.

The guidelines are based primarily on the 1999 Guide for the Development of Bicycle Facilities (AASHTO Guide, see Figure 3-1), published by the American Association of State Highway and Transportation Officials (AASHTO) and the Manual on Uniform Traffic Control Devices (MUTCD; see Figure 3-2), published by the U.S. Department of Transportation.

All bikeways built or implemented in the County will be expected to meet AASHTO and MUTCD standards whereever possible. The guidelines are consistent with the County's "Roadway Design Manual" published by

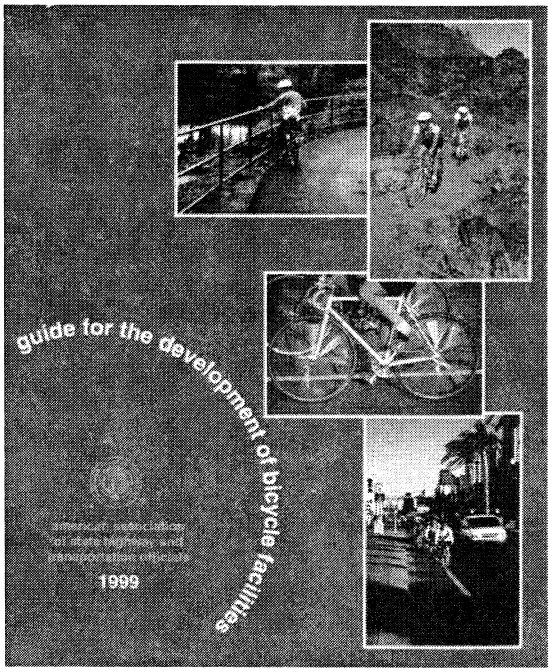

Figure 3-1.
AASHTO Guide For the Development of Bicycle Facilities

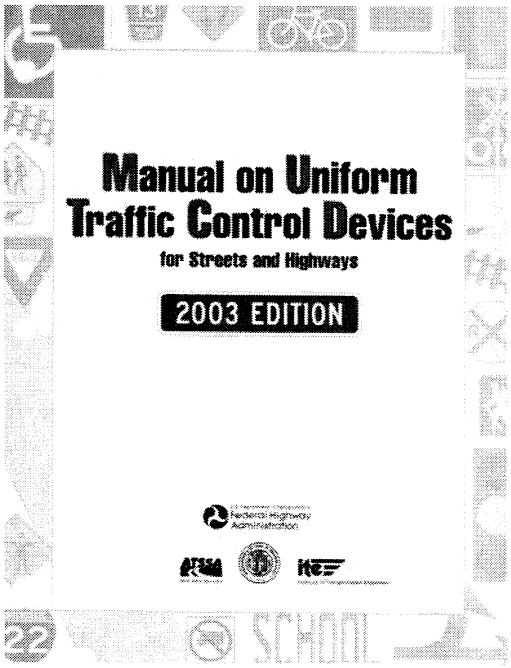

Figure 3-2.
Manual on Uniform Traffic Control Devices (MUTCD)

the County's Department of Public Works and Transportation. The plan borrows additional ideas and concepts from the Oregon Department of Transportation Bicycle and Pedestrian Plan.

The guidelines are a primer on bicycle facilities design along County roads. They are not a stand-alone document and do not necessarily address bikeways along State highways and State roads (see Appendix E for SHA policies governing bikeway design along State highways). These guidelines highlight important issues, but do not cover all of the design details that might be encountered in developing bicycle facilities. This section is not a complete reference, but rather serves as an overview of the possible solutions to problems designers are faced with when implementing bicycle facilities.

Detailed roadway engineering drawings are provided in the County's roadway design standards manual, updated periodically. Furthermore, designs for specific facilities are addressed during project planning (See chapter 4, Bikeway Implementation, for a description of County and state project planning processes). Where details are not covered in these guidelines or in the County's design manual, appropriate engineering principles and judgment should be applied during project planning to provide for the safety and convenience of bicyclists, pedestrians and motorists. Additionally, these guidelines will help with updating bikeway design aspects of the County's road code.

Goals of Bikeway Design Guidelines

- To design and construct bikeway facilities in the County consistent with the latest thinking in safe bikeway design, recognizing that many concepts presented in this chapter may become outdated over the life of the plan.

- To design and construct facilities that will encourage people to use them

Relation to County's Road Code

The County's Roadway Design Manual serves as the official County policy for roadway design. The Manual shows only cross-sections (not illustrations) of roads and shows engineering specifications for minimum widths for travel lanes, bike paths and landscape panels, etc. The Manual does not include specifications or illustrations for on-road bikeways or for intersection treatments. The bikeway design guidelines contained in this plan simply serve as an aid to engineers on possible ways to design on-road bicycle facilities, recognizing that specific design solutions are typically determined during facility planning.

The Design Bicyclist

Bicycles come in a variety of shapes and sizes and bicyclists come in a variety of skill levels. To effectively design bicycle facilities, the range of dimensions and characteristics of common commercially available bicycles and the physical details of the typical bicyclist (e.g., dimensions, speed) should be understood (see Figure 3-3).

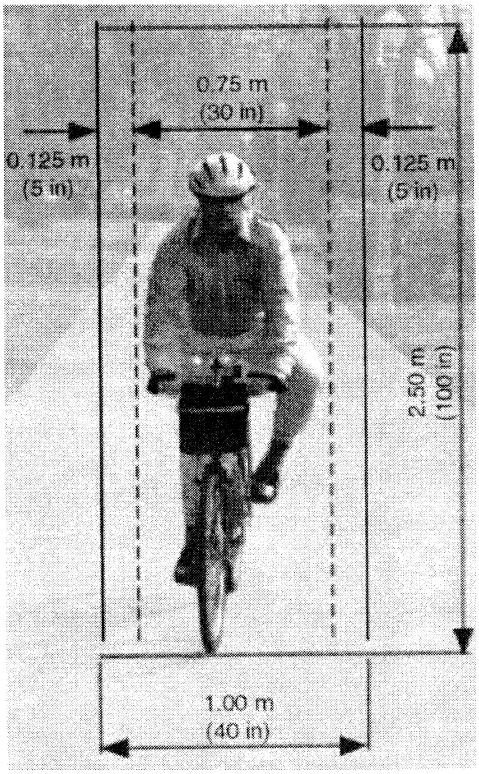

Figure 3-3. Bicycle operating space (Source: AASHTO Guide for the Development of Bicycle Facilities, 1999)

Bicyclists generally require three feet of operating width based solely on their profile. Due to steering wobble, bicyclists typically track over at least a 4-foot width. The necessary width is increased to 5 feet or greater for steep hill climbs and descents.

Types of Bikeways

The 2003 Maryland Vehicle Law defines a bikeway as: 1) any trail, path, part of a highway, surfaced or smooth shoulder, or sidewalk; or 2) any travelway specifically signed, marked or otherwise designated for bicycle travel. The basic design treatments used to accommodate bicycle travel on the road are: signed shared roadway; shoulder bikeway (signed or not); or bike lane. Another type of facility is located alongside a road but is separated from motor vehicle travel lanes: shared use path. More detailed descriptions of bikeway types with desirable applications for each can be found in Table 2-1.

Construction of a bicycle route or restriping a roadway with bicycle lanes has been shown to encourage the increased use of bicycles. However, it would be incorrect to say that bikeway facilities are inherently safer than roads without special bicycle-safe designs. Signage and marking can increase a user's level of confidence and provide a more defined, predictable road environment for both the motorist and the bicyclist, however, bikeways cannot ensure a reduced or eliminated risk of a possible accident. Accidents may be caused by many variables other than facility design, including poor judgment or behavior by the motorist, the bicyclist or a pedestrian.

Shared Use Paths

The County features an extensive network of existing and proposed roadside shared use paths as well as shared use paths along abandoned or future active transit-ways. In some cases, these bikeways serve as a primary bikeway, meaning the facility is the only existing or proposed bicycle accommodation for a particular segment of road. In other cases, the roadside shared use path supplements an existing or potential on-road bikeway, whether bike lanes, shared travel lane or wide shoulder. Roads with both off-road and on-road bicycle accommodation are said to have dual bikeways.

Shared Use Path - General Design Characteristics

- 8-12' concrete or asphalt path
- Located with the right-of-way (ROW) of a road or transitway
- Designed and constructed by, or under the supervision of, a transportation agency (SHA, MTA, DPWT) or municipal agency (Rockville or Gaithersburg)
- May be maintained and/or managed by DPWT or M-NCPPC
- Intended for off-road non-motorized transportation (biking and walking), but may be used for recreation (joggers, roller-bladers, etc.)
- Prohibit motorized vehicles (exceptions include electric wheelchairs and Segways)
- Should be designed and constructed to AASHTO and MUTCD standards, including appropriate informational, warning and regulatory signs.

Figure 3-4. Shared use path along a major road or highway
(Source: www.pedbikeimages.org/Dan Burden)

Examples of shared use paths in the County include: Falls Road, Greencastle Road, Robey Road, Great Seneca Highway, North Bethesda Trail, Norbeck Road extended.

Shared use paths should not be confused with sidewalks. Sidewalks are designed and intended for pedestrian travel and can be as narrow as 4' depending on the road classification. Sidewalks often include street furniture (benches, bus shelters, trash receptacles) and other characteristics that are intended to only enhance the pedestrian experience, and serve as dangerous obstacles to bicyclists.

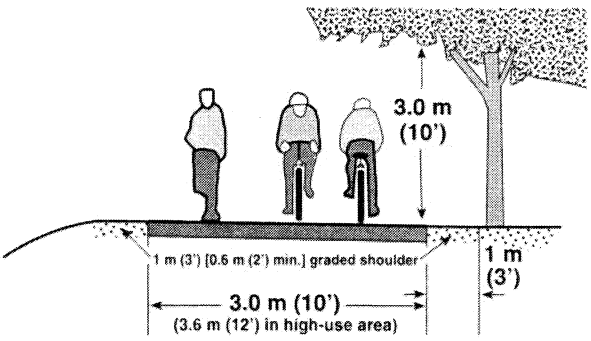

Figure 3-5. Cross section of a typical shared use path (Source: Oregon Department of Transportation)

Shared Use Path - Other Design Considerations

Pavement Width and Clearance Zones
AASHTO recommends a pavement width of at least 10 feet, but the County road standards currently recommend eight feet. This discrepancy needs to be reconciled. The 10-foot standard allows two bicyclists to pass each other with a one- or two-foot buffer and minimizes the need to leave the path. Ten feet is recommended by this plan and twelve feet is recommended for areas expecting intensive use. Widths less than 10 feet may be acceptable where right-of-way is limited or for locations with severe site constraints. These decisions can be made during project planning or during subdivision review.

Where possible, a three-foot wide graded horizontal clear zone should be provided and maintained on each side of the path. Every effort should be made not to install signs, posts, guardrails, fences, and telephone poles or other devices in this clear zone. In addition, the DPWT or municipal agency is responsible for maintaining any vegetation that may encroach into this clear space.

A 10-foot high vertical clearance should be provided and maintained. DPWT and/or municipal agencies are responsible for trimming overhanging tree branches.

Landscape Panel

AASHTO recommends a five-foot minimum buffer between the path edge and the curb. However, the County's roadway design manual requires a six-foot minimum width for the planting of trees. Because trees provide for a more pleasant riding environment and visual barrier to motorized traffic, a six-foot landscape panel width is recommended (the minimum acceptable for trees). Placing the trees in the center of a six foot panel would provide only a three-foot clear zone, therefore, a seven foot panel is desirable to provide the necessary clearance and also eliminate the path getting warped by driveways.

A barrier should be provided between paths and the roadway when the minimum width for a landscape panel is not possible. Such barriers also serve to prevent path users from making unwanted movements into the motor vehicle travel lanes and to reinforce the path as an independent travel corridor. The barrier should be at least 42 inches high to prevent bicyclists from toppling over it. This is not current design policy and the potential operational conflicts with motorized vehicles would need to be resolved.

Curb Ramps and Crosswalks

At all driveways and intersections for which a shared use path crosses, curb cuts and crosswalks should be eight-feet wide (as opposed to four or five for a typical sidewalk). Where a path is located adjacent to a sidewalk, crosswalks and curb ramps only should be provided for the path, but the ramp should be at least 8' wide.

Trail crossings at intersection

Intersections should be marked and signed in such a manner as to adequate notify motorists that bicycles may be present and may cross using the crosswalk, including the use of special pavement textures in crosswalks to create "crossbikes."

Signs For Bicyclists

Bicyclists need to be warned of possible conflicts with motor vehicles and with pedestrians. Therefore, all major, non-signalized intersections should be properly signed or marked to warn bicyclists to slow down or stop.

- Appropriate MUTCD-approved signs should be installed at periodic intervals along the path to remind bicyclists to yield to pedestrians and to notify users that the shared use path is a designated bike route.

- At signalized intersections, appropriate MUTCD-approved signs should be installed to warn bicyclists to stop and use the pedestrian signal to cross.

- Appropriate MUTCD-approved signs also should be installed at all major commercial driveways and locations where the path crosses a residential primary.

- Other appropriate MUTCD-approved signs may be suitable for minor residential or neighborhood roads. Signs and/or pavements markings are not necessary at all independent residential or commercial driveways that may cross the path.

Signs For Motorists (Driveways/Crosswalks)

Motorists need to be notified of the potential presence of bicyclists at intersections and locations where a path crosses a major commercial driveway or residential primary. Appropriate MUTCD-approved signs should be installed at these locations, facing the motorist crossing the path from the outside. Additionally, these signs should be accompanied by the diagonal downward pointing arrow to show the location of the crossing.

Lighting
If nighttime or twilight time use of the path is expected (i.e., used for commuting), adequate pedestrian-oriented lighting for the path should be provided. Types, locations, intervals and illumination levels can be determined during facility planning. Good lighting is especially needed at intersections. The latest recommendation of the Illuminating Engineering Society of North America (IESNA) should be followed. In addition, all lighting should conform to the County's Lighting policy.

Bike Lanes

Bike lanes provide a designated travel lane adjacent to other travel lanes for the preferential or exclusive use of bicycles. They are one-way facilities that carry bicycle traffic in the same direction as adjacent motor-vehicle traffic. Bike lanes should never be provided on only one side of a two-way street; this may cause confusion and encourage bicyclists to use the bike lanes as a two-way on-street bike path. Motorists are prohibited from using bike lanes for driving or parking, but may use them for emergency avoidance maneuvers or breakdowns.

Bike Lanes - General Design Characteristics

- 4'- 6' marked lane
- Delineated by 6" wide solid white line to separate it from motor vehicle travel lanes
- Identified by pavement markings (bike logo or bike lettering with arrow (see Figures 3-6 and 3-7)
- Designed and constructed to AASHTO and MUTCD standards, including appropriate informational, warning and regulatory signs.

Bike Lanes - Other Design Considerations

Width Standards
The AASHTO recommended minimum width of a bike lane for a closed section road is 1.8 m (5 ft), as measured from the center of stripe to the curb or edge of pavement. This width enables cyclists to ride far enough from the curb to avoid debris and drainage grates, yet far enough from passing vehicles to avoid conflicts. By riding away from the curb, cyclists are more visible to motorists than when hugging the curb. The minimum bike lane width is four feet on open shoulders and five feet from the face of a curb, guardrail or parked cars. A clear riding zone of four feet is desirable if there is a longitudinal joint between asphalt pavement and the gutter section. On roadways with flat grades, it may be preferable to integrate the bike lane and gutter to avoid a longitudinal joint in the bike lane.

Bike lanes wider than six feet may be desirable in areas of very high use, on high-speed roads where wider shoulders are warranted, or where they are shared with pedestrians. Care should be taken so they are not mistaken for a motor vehicle lane or parking area, with adequate marking or signing.

Pavement Markings and Signs
A bike lane should be marked with pavement stencils and a wide stripe. If parking is permitted, the bike lane should be placed between the parking lane and the travel lane, and have a minimum width of 1.5 m (5 ft). The official pavement stencil for all future or renovated bike lanes should be a bike logo or "bike lane" lettering and an arrow pointing bicyclists in the direction of traffic.

- Motorists should be alerted to presence of a bike lane using appropriate MUTCD-approved signs ("Bike Lane Ahead) at least 50 feet prior to the beginning of a bike lane, unless at an intersection where it should be placed within 25 feet of the intersection.
- Appropriate MUTCD-approved signs (Bike Lane Ends) should be placed where a bike lane suddenly terminates, whether at an intersection or middle of a road segment.
- Appropriate MUTCD-approved signs (Bicycle Right Lane Only) should be placed every 500 feet on both sides of the road.
- Appropriate MUTCD-approved signs (No Parking, Bike Lane) should be placed every 200 feet on both sides of the road to discourage illegal use of a bike lane by motorists.

- All signs should be installed within 3 feet of the curb or shoulder edge, and be no higher than 10 feet and no lower than 6 feet from the ground. Signs should be visible (unobstructed by poles, trees or bushes) from at least 25 feet away.

Extruded Curbs (Parking Curb Stops)
This plan recommends against the use of extruded curbs. Parking curb stops are often used throughout the U.S. to separate motor vehicle travel space from bicycle travel space. However, these create an undesirable condition; either the cyclist or motorist may hit the curb and lose control, with the motor vehicle crossing onto the bikeway or the cyclist falling onto the roadway. At night, the curbs cast shadows on the lane, reducing the bicyclist's visibility of the surface. Extruded curbs make bikeways difficult to maintain and tend to collect debris. They are often hit by motor vehicles, causing them to break up and scatter loose pieces onto the surface.

Reflectors & Raised Pavement Markers
Raised , reflective pavement devices are also often used throughout the U.S. to separate motor vehicle travel space from bicycle travel space. These can deflect a bicycle wheel, causing the cyclist to lose control and should not be used in the County.

Two-Way Bike Lane
This plan recommends against the use of two-way bike lanes. Two-way bike lanes essentially function as a shared use path located on-road, adjacent to motor vehicle travel. They create a dangerous condition for bicyclists and encourage illegal riding against traffic and should not be employed in the County.

Continuous Right-Turn Lanes
This configuration is difficult for cyclists; riding on the right puts them in conflict with right-turning cars, but riding on the left puts them in conflict with cars merging into and out of the right-turn lane. The best solution is to eliminate the continuous right-turn lane, consolidate accesses and create well-defined intersections wherever possible.

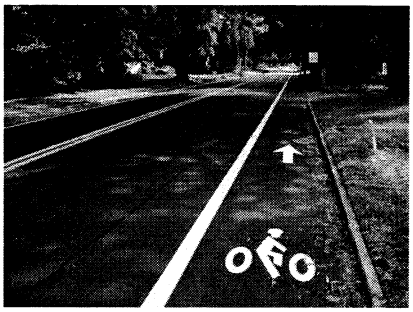

Figure 3-6. Example of a bike lane with logo and arrow.
(Source: www.pedbikeimages.org/Dan Burden)

Figure 3-7. Example of a bike lane in Honolulu, Hawaii with text and arrow.
(Source: www.pedbikeimages.org/Dan Burden)

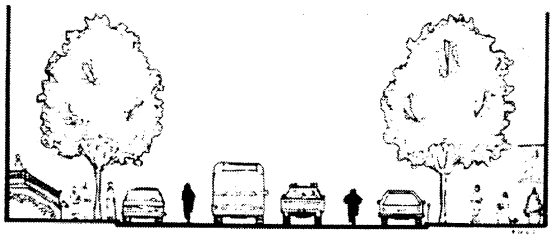

Figure 3-8. Cross-section of a bike lane between travel lanes and on-street parallel parking

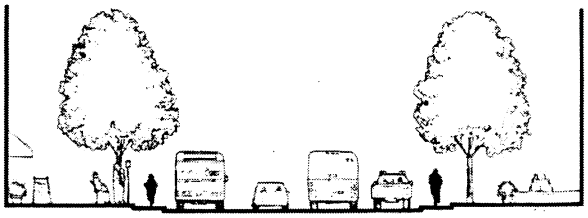

Figure 3-9. Cross-section of a bike lane between travel lanes and the curb

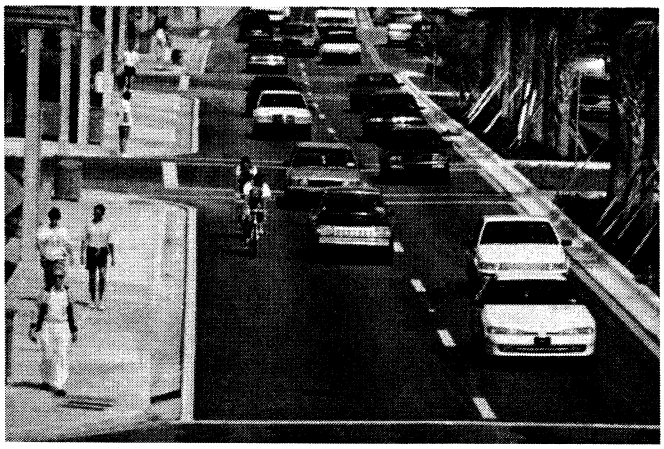

Figure 3-10. Example of a signed shared roadway, wide outside lane (Source: www.pedbikeimages.org/Dan Burden)

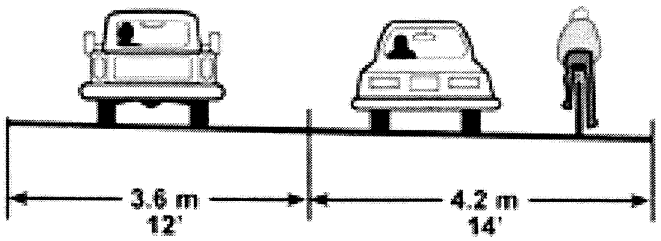

Figure 3-11. Cross-section of a wide curb lane (Source: Oregon Department of Transportation)

Bike Lanes at Intersections

Properly designing bike lanes at intersections and in locations with multiple turning movements is probably among the most difficult design issues. The AASHTO Guide provide practical, detailed guidance to designing and installing bike lanes at intersections, including proper design of pocket lanes.

Space Constraints

For roads with serious space limitations or right of way constraints, a 3-foot striped lane may suffice as an unofficial bike lane (SHA "bicycle areas"); these roads are classified under this plan as a shared roadway, not bike lanes, and do not have to be signed or marked.

Signed Shared Roadways
(Class III Bikeway)

The County features an extensive network of proposed signed shared roadways. Mile per mile, shared roadways are the most common bikeway type in the United States and the least complicated and least costly to implement.

To a varying extent, bicycles are used on most county roads and state highways, except where prohibited. In fact, a large percentage of bicycling takes place on shared roadways with no dedicated space for bicyclists. Local streets with low traffic volumes and speeds safely accommodate bicyclists (except young children) without any special treatments.

There are three general types of shared roadways as identified in this plan: 1) Wide Curb Lane; 2) Shoulder Bikeway; and 3) Local Street.

Wide Curb Lanes

A wide curb lane is typically implemented on a closed section (with curb) road. To be effective, a wide lane should be at least 4.2 m (14 ft) wide, but less than 4.8 m (16 ft). Usable width is normally measured from curb face to the center of the lane stripe, but adjustments need to be made for drainage grates, parking and the ridge between the pavement and gutter. Widths greater than 4.8 m (16 ft) encourage the undesirable operation of two motor vehicles in one lane. In this situation, an informal bike lane or shoulder bikeway should be striped. Wide curb lanes more than 14 feet wide should be striped to create an informal 3-4' bike lane. See Figures 3-10 and 3-11

Shoulder Bikeways

Paved shoulders provide suitable bicycling conditions for most riders. When providing paved shoulders for bicycle use, a minimum width of 1.8 m (6 ft) is desirable. See Figures 3-12 and 3-13. This allows a cyclist to ride far enough from the edge of pavement to avoid debris, yet far enough from passing vehicles to avoid conflicts. If there are physical width limitations, narrower shoulders may be suitable; the actual width would be determined by posted speed limits and traffic volumes.

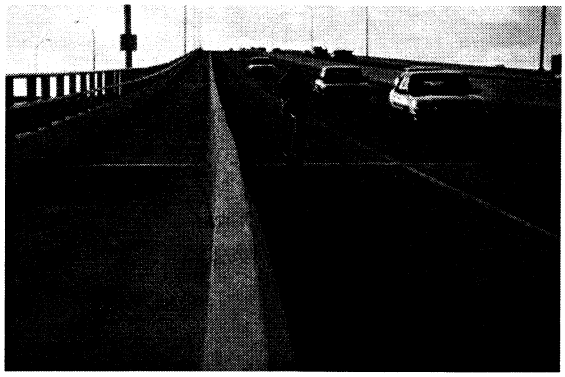

Figure 3-12. Shoulder bikeway on a bridge (Source: www.pedbikeimages.org/Dan Burden)

Local Street

There are no specific bicycle standards for most local signed shared roadways; they are simply the roads as constructed. Bicyclists truly share the road with motor vehicles. See Figure 3-14. However, it is important that shared roadways leading to key destinations be signed as a bike route, including arrow signs to help with navigation. All signed shared roadways should be signed as bike routes and include relevant accompanying directional, distance and informational signs.

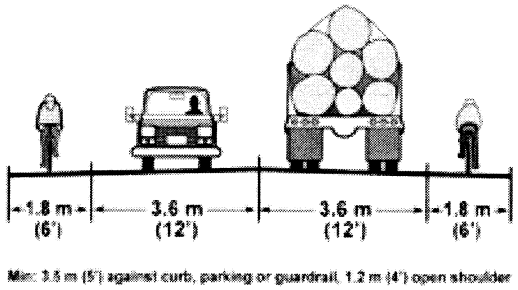

Figure 3-13. Cross-section of shoulder bikeway along two-lane open section road or highway (Source: Oregon Department of Transportation)

Other Design Considerations

All roads in Montgomery County should be designed to safely accommodate bicycling, regardless of whether the roads has been designated as a bikeway or has a shared use path alongside it. The design considerations below should be applied to all roadways in the county, regardless of designation as an official bikeway.

Drainage Grates

Drainage grates are potential obstructions to bicyclists. Grates with slots parallel to the travel lane are especially hazardous; the grate traps the front wheel and throws the bicyclist off the bicycle. Care should be taken to ensure that drainage grates are bicycle-safe, and that they have narrow slots perpendicular to or at a 45-degree angle to traffic. See Figure 3-15.

Railroad Crossings

Special care should be taken wherever a bikeway intersects railroad tracks. Refer to AASHTO Guide for details.

Figure 3-14. Bicyclist on a local street (Source: www.pedbikeimages.org/Dan Burden)

Sidewalk Ramps on Bridges

These can help cyclists if the bridge sidewalks are wide enough for bicycle use (minimum 1.2 m [4 ft]). They should be provided where motor vehicle traffic volumes and speeds are high, the bridge is fairly long and the outside traffic lanes or shoulders on the bridge are narrow. Sidewalk railings should be 42" high. See Figure 3-16.

Shared Use Paths on Bridges

Where a shared use path crosses a bridge, the path should have a railing on the traffic side and should be widened by two feet on each side to provide a shy distance from the rail and the bridge parapet (see AASHTO recommendations in Highway Safety Design and Operations Guide). Railings should be 42" high.

Rumble Strips

Rumble strips are provided to alert motorists that they are wandering off the travel lanes onto the shoulder. They are most common on long sections of straight freeways in rural settings, but are also used on sections of two-lane undivided highways. Bicyclists generally do not like them and the application of rumble strips should be limited along roads for which an on-road bikeway exists or is planned.

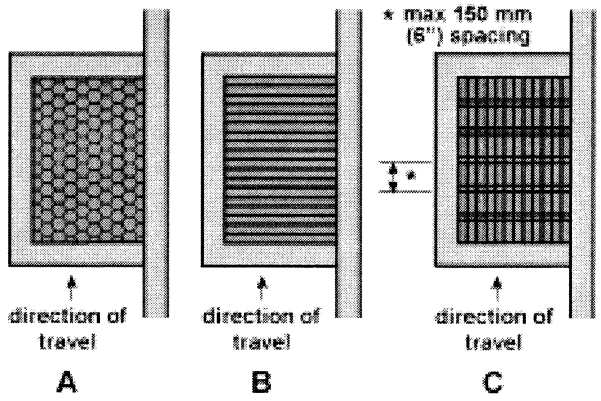

Figure 3-15. Sample designs of safe drainage grates (Source: Oregon Department of Transportation)

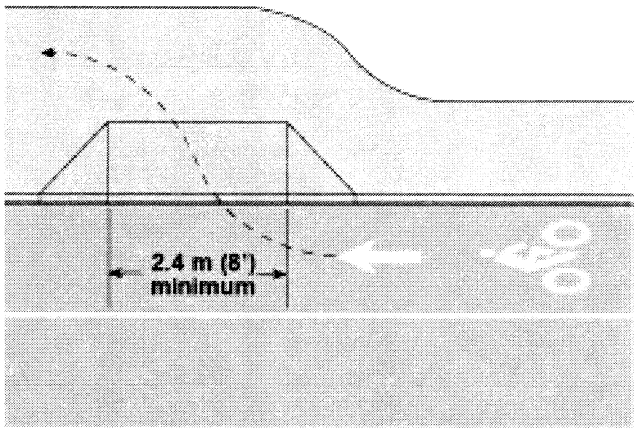

Figure 3-16. Aerial view of a curb cut for bridge (Source: Oregon Department of Transportation)