SECTION A-5-BICYCLE FACILITY GUIDELINES

INTRODUCTION

These guidelines consist of six sections:

A. INTRODUCTION
B. DOT POLICY ON PARTICIPATION IN THE DEVELOPMENT OF BICYCLE FACILITIES
C. SELECTING ROADWAY DESIGN TREATMENTS TO ACCOMMODATE BICYCLES; this report contains recommendations for bikeway design
D. VDOT/AASHTO DESIGN GUIDELINES; these include bicycle path design guidelines and minimum bikeway design guidelines
E. AASHTO APPROVED INTERSTATE BICYCLE ROUTES
F. RESOURCES (followed by conversions from Imperial units to metric units)

The Transportation and Mobility* Planning Division will recommend to the road designer the inclusion of a bikeway on a particular project. Discussion will take place at the scoping meeting concerning the expected type of bicyclist that will use the facility and the type of facility to be designed. The district, locality, Transportation and Mobility Planning Division and other interested parties will provide input. Types of bicyclist include Group A, advanced; Group B, basic; and Group C, children. AASHTO designates bicycle facility types as Shared Roadway (No Bikeway Designation), Signed Shared Roadway, Bike Lane or Bicycle Lane and Shared Use Path. Individuals involved in the planning and design of bicycle facilities should be familiar with and refer to the latest Guide for the Development of Bicycle Facilities published by the American Association of State Highway and Transportation Officials. At the printing of these VDOT guidelines the date of the AASHTO Guide was 1999.

In rural and some urban sections of highway with scattered development, it is recommended that the facility be designed for Group A bicyclists. In developed areas near parks, schools, recreation areas, etc., it is recommended that the facility be designed for Group B, C bicyclists. Separate bike paths are recommended in areas where bicyclists are expected to be children, pre-teen or casual recreation riders.

Guidelines in SELECTING ROADWAY DESIGN TREATMENTS TO ACCOMMODATE BICYCLES are recommended as bikeway design criteria, but in no case will a bikeway be designed with criteria less than those contained in the VDOT/AASHTO DESIGN GUIDELINES. Bicycle facility design guidelines are available only in the VDOT/AASHTO DESIGN GUIDELINES section. One set of pertinent plans, profiles and typical sections on appropriate projects are to be provided to the Location and Design Bicycle Facilities Coordinator prior to Preliminary Engineering, Field Inspection and after related comments are received at public information meetings.

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* Rev. 7/07

The procedure for planning and designing a bicycle facility is:
1. Select the type of bicyclist; A, B or C or a combination of these.
2. Select the roadway design treatment or type of facility.
3. Design the facility in accordance with the VDOT Guidelines: FHWA and AASHTO

VDOT POLICY TO IMPROVE BICYCLE AND PEDESTRIAN ACCESS

The Commonwealth Transportation Board (CTB) approved a new policy aimed at providing bicyclists and pedestrians greater access to safe transportation on roadways across the state. The policy became effect upon its adoption by the Board on March 18, 2004, and will apply to projects that reach the scoping phase after its adoption. This policy shall supersede all current department policies and procedures related to bicycle and pedestrian accommodations.

Highlights from the policy include:

- A framework through which VDOT will accommodate bicyclists and pedestrians, including pedestrians with disabilities, along with motorized transportation modes in the planning, funding, design, construction, operation, and maintenance of Virginia's transportation network to achieve a safe, effective, and balanced multimodal transportation system.

- Sidewalks, bike lanes, shared-use paths or other accommodations will be considered in the design of all new highway and major reconstruction projects, depending on safety issues and the need.

Project Managers should be familiar with the policy prior to starting the Project Development Process. The entire policy can be obtained at http://www.virginiadot.org/programs/resources/bike_ped_policy.pdf

The following are a few excerpts from the policy:

The Virginia Department of Transportation (VDOT) will initiate all highway construction projects with the presumption that the projects shall accommodate bicycling and walking. VDOT will provide the leadership to implement this policy. During the decision process, the project manager and local representatives will, based on the factors listed in the policy, develop a recommendation on how and whether to accommodate bicyclists and pedestrians in a construction project prior to the public hearing. VDOT will promote the inclusion of bicycle and pedestrian accommodations in transportation planning activities at local, regional, and statewide levels. There are exceptions to the provision of accommodations.

Bicycle and pedestrian accommodations can be developed through projects that are independent of highway construction either within the highway right-of-way or on an independent right-of-way. Highway construction funds can be used to build bicycle and pedestrian accommodations either concurrently with highway construction projects or as independent transportation projects. Both types of bicycle and pedestrian accommodation projects will be funded in the same manner as other highway construction projects for each system (i.e., interstate, primary, secondary, or urban.

VDOT will work with localities to select and design accommodations, taking into consideration community needs, safety, and unique environmental and aesthetic characteristics as they relate to specific projects. The selection of the specific accommodations to be used for a project will be based on the application of appropriate planning design, and engineering principles. The accommodations will be designed and built, or installed, using guidance from VDOT and AASHTO publications, the MUTCD, and the Americans with Disabilities Act accessibility Guidelines (ADAAG). Methods for providing flexibility within safe design parameters, such as context sensitive solutions and design, will be considered.

During the preparations of an environmental impact statement (EIS), VDOT will consider the current and anticipated future use of the affected facilities by bicyclists and pedestrians, the potential impacts of the alternatives on bicycle and pedestrian travel, and proposed measures, if any, to avoid or reduce adverse impacts to the use of these facilities by bicyclists and pedestrians.

During project design VDOT will coordinate with the Virginia Department of Rail and Public Transportation (VDRPT) to address bicyclist and pedestrian access to existing and planned transit connections.

Requests for exceptions to design criteria must be submitted in accordance with VDOT's design exception review process. The approval of exceptions will be decided by the Federal Highway Administration or VDOT's Chief Engineer.

VDOT will ensure that accommodations for bicycling and walking are built in accordance with design plans and VDOT's construction standards and specifications.

BICYCLE ACCESS FACILITIES

VDOT may participate in the development of bicycle access facilities to serve public recreational areas and historic sites based on the current Recreational Access Fund Policy.

EXISTING ROADS

In some instances, for route continuity, bicycle facilities may be routed over existing facilities which are not planned for expansion. In these cases, the facilities are an operational feature and usually result in the identification of a bike lane, restriction of parking, or some other physical modification to accommodate bicycle travel. It is necessary for the State* Transportation and Mobility Planning Administrator to coordinate with the District Administrator, the Regional Traffic Engineer, and appropriate Divisions in the Central Office to assure agreement on the method of treatment for a bikeway over an existing route. All the conditions of VDOT Bicycle Facility Participation Guidelines and VDOT Funding Guidelines need to be met except the bicycle facility is not required to be constructed concurrently with a highway construction project. VDOT's financial participation and funding will be the same as specified in VDOT Funding Guidelines.

MAJOR DEVELOPMENTS AND SITE PLANS

When bicycle facilities are considered as part of the total development of a property where the road system will be maintained in the future by VDOT and the local government requires bikeways in new developments, the following conditions must be satisfied:

- The bicycle element of the entire plan for the development must be reviewed and approved by the local government prior to final approval by the State Transportation and Mobility Planning Administrator. Appropriate review must be made, and communication regarding the resolution of bicycle facility systems must be carried on between the Residency Administrator, Regional Traffic Engineer, and the State Transportation and Mobility Planning Administrator.

- Along any roadways identified in the site plan, which will be maintained in the future by VDOT, a bike path may be incorporated into the development parallel to but off of the right of way dedicated for street purposes. The maintenance and the responsibility for operating the bike path would fall on the owner, which would be the locality, the developer, or other entity with the responsibility of maintenance of the common land of the development and not the responsibility of VDOT. The bike path right of way will be exclusive of the road right of way; thus, future changes and/or modifications in the bike path would not be the responsibility of VDOT.

- Bikeways within the VDOT right of way shall be designed to meet AASHTO and VDOT guidelines.

For major developments and site plans where the road system will not be maintained in the future by VDOT, all bicycle facility connections to VDOT maintained facilities shall be subject to review and approval by the District Administrator.

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* Rev. 7/07

SELECTING ROADWAY DESIGN TREATMENTS TO ACCOMMODATE BICYCLES

Choosing the appropriate facility type is important. No one type of bicycle facility or highway design suits every bicyclist. Within any given transportation corridor, bicyclists may be provided with more than one option to meet the travel and access needs of all potential users.

The choice of highway design will affect the level of use, the types of user that can be expected to use any given road, and the level of access and mobility that is afforded bicyclists. For example, a four-lane divided highway with 12-foot travel lanes, no shoulder and a 55 mph speed limit will attract only the most confident of riders. The same road with a 5-foot shoulder or bike lane might provide sufficient "comfortable operating space" for many more adult riders, but would still not be comfortable for children or less confident adults. This latter group might only be accommodated through an alternative route using neighborhood streets linked by short sections of shared use path. If such an alternative route is provided and the four-lane road has a continuous paved shoulder, most experienced and many casual adult riders will continue to use the shoulder for the sake of speed and convenience.

Facilities for bicyclists should also be planned to provide continuity and consistency for all users. Children using a path to get to school should not have to cross a major arterial without some intersection controls, and shoulders and bike lanes should not end abruptly and unannounced at a difficult intersection or busy stretch of highway.

The selection of a bicycle facility type is dependent on many factors, including the ability of the users, specific corridor conditions and facility cost. AASHTO designates bicycle facility types as Shared Roadway (No Bikeway Designation), Signed Shared Roadway, Bike Lane or Bicycle Lane and Shared Use Path. The following are explanations of when each of these facilities may be appropriate. Design parameters for these four types are discussed later in this publication.

- Shared Roadway (No Bikeway Designation) - Most bicycle travel in the United States now occurs on streets and highways without bikeway designations. In some instances, a community's existing street system may be fully adequate for efficient bicycle travel and signing and striping for bicycle use may be unnecessary. In other cases, some streets and highways may be unsuitable for bicycle travel at present, and it would be inappropriate to encourage bicycle travel by designating the routes as bikeways. Finally, some routes may not be considered high bicycle demand corridors, and it would be inappropriate to designate them as bikeways regardless of roadway conditions (e.g., minor residential streets).

- Some rural highways are used by touring bicyclists for inner city and recreational travel. In most cases, such routes should only be designated as bikeways where there is a need for enhanced continuity with other bicycle routes. However, the development and maintenance of 4-foot paved shoulders with a 4-inch edge stripe can significantly improve the safety and convenience of bicyclists and motorists along such routes.

- Signed Shared Roadway - Signed-shared roadways are designated by bike route signs, and serve either to provide continuity to other bicycle facilities (usually Bike Lanes) or designate preferred routes through high-demand corridors.

- Bike Lane or Bicycle lane - Bike lanes are established with appropriate pavement markings and signing along streets in corridors where there is significant bicycle demand and where there are distinct needs that can be served by them. The purpose should be to improve conditions for bicyclists on the streets. Bike lanes are intended to delineate the right of way assigned to bicyclists and motorists and to provide for more predictable movements by each. Bike lanes also help to increase the total capacities of highways carrying mixed bicycle and motor vehicle traffic.

- Shared Use Path - Generally, shared use paths should be used to serve corridors not served by streets and highways or where wide utility or former railroad right-of-way exists, permitting such facilities to be constructed away from the influence of parallel streets. Shared use paths should offer opportunities not provided by the road system. They can provide a recreational opportunity or, in some instances, can serve as direct commute routes if cross flow by motor vehicles and pedestrians is minimized.

The tables in this section contain roadway design treatments and widths to accommodate bicycles found in the Federal Highway Administration Report "Selecting Roadway Design Treatments to Accommodate Bicycles", Publication Number FHWA-RD-92-073 January 1994. The controlling feature in the design of every bicycle facility is its location, whether it is on the roadway or on an independent alignment. The FHWA Report describes five basic types of facilities to accommodate bicyclists. The Shared Lane or Wide Outside Lane types may be appropriate designs for AASHTO's Shared Roadway (No Bikeway Designation) or Signed Shared Roadway types. The shoulder types may be appropriate designs for AASHTO's Shared Roadway (No Bikeway Designation). The Separate Bike Path correlates to AASHTO's Shared Use Path. The following are FHWA definitions of their five types of bicycle facilities:

- Shared Lane - Shared motor vehicle/bicycle use of a "standard" width travel lane.

- Wide Outside Lane (or wide curb lane) - An outside travel lane with a width of at least 14 feet.

- Bike Lane - A portion of the roadway designated by striping, signing, and/or pavement markings for preferential or exclusive use of bicycles. On urban projects the bike lane width is the distance from the face of the curb to the bike lane stripe. For VDOT projects, the bike lane stripe will lie 4 feet minimum from the edge of a gutter pan and 5 feet minimum from the face of curb without gutter pan*.

- Shoulder - A paved portion of the roadway to the right of the edge stripe on which bicyclists may ride. These areas are not marked or signed as 'bike lanes'.

* Rev. 7/07

- Separate Bike Path - A facility physically separated from the roadway and intended for bicycle use.

The FHWA publication categorizes bicyclists into three groups. Group A are advanced bicyclists with experience who can operate under most traffic conditions. Group B are basic bicyclists who are casual or new adult and teenage riders with less confidence of their ability to operate in traffic without special provisions for bicycles. Group C, children, are pre-teen riders whose roadway use is initially monitored by parents.

Tables A-5-1 through A-5-6 indicates the appropriate design treatments given various sets of traffic operations and design factors. The design treatments are considered "desirable widths" by the FHWA. There are three basic types of roadway sections for bicycles; urban without parking, urban with parking, and rural. Controlled-access freeways are considered a special case and are not addressed by the tables.

Roadway improvements such as bicycle facilities depend on the roadway's design. Bicycle paths located on independent alignment depend on many factors, including the performance capabilities of the bicyclist and the bicycle. The following tables do not include any specific recommendations for separate bike paths and their design standards are addressed under VDOT/AASHTO Design Guidelines for Shared Use Paths.

average motor vehicle operating speed	average annual daily traffic (AADT) volume											
	less than 2,000				2,000-10,000				over 10,000			
	adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance	
		truck,bus,rv				truck,bus,rv				truck,bus,rv		
less than 30 mph	sl 12	sl 12	wc 14	wc 14	sl 12	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14
30-40 mph	wc 14	wc 14	wc 15	wc 15	wc 14	wc 15	wc 15	wc 15	wc 14	wc 15	wc 15	wc 15
41-50 mph	wc 15	wc 15	wc 15	wc 15	wc 15	wc 15	sh 6	sh 6	wc 15	wc 15	sh 6	sh 6
over 50 mph	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6

TABLE A-5-1

GROUP A BICYCLISTS, URBAN SECTION, NO PARKING

(widths are in feet)

For Table A-5-1: wc and sl widths represent “usable widths” of outer lanes, measured from lane stripe to edge of gutter pan, rather than to the face of curb. If no gutter pan is provided, add 1 ft. Minimum for shy distance from the face of curb.

Key: wc = wide curb lane; sh = shoulder; sl = shared lane; bl = bike lane; na = not applicable; truck, buses, and/or recreation vehicles (approximately 30 per hour or more)

average motor vehicle operating speed	average annual daily traffic (AADT) volume											
	less than 2,000				2,000-10,000				over 10,000			
	adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance	
		truck,bus,rv				truck,bus,rv				truck,bus,rv		
less than 30 mph	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 15	wc 15	wc 14
30-40 mph	wc 14	wc 14	wc 15	wc 15	wc 14	wc 15	wc 15	wc 15	wc 14	wc 15	wc 15	wc 15
41-50 mph	wc 15	wc 15	wc 15	wc 15	wc 15	wc 16	wc 16	wc 16	wc 15	wc 15	wc 16	wc 16
over 50 mph	na	na	na	na	na	na	na	na	na	na	na	na

TABLE A-5-2

GROUP A BICYCLISTS, URBAN SECTION, WITH PARKING

(widths are in feet)

For Table A-5-2: wc widths represent “usable widths” of outer travel lanes, measured from the left edge of the parking space (8 to 10 ft. minimum from the curb face) to the left stripe of the travel lane.

Source: FHWA’s “Selecting Roadway Design Treatments to Accommodate Bicycles” dated 1994.

average motor vehicle operating speed	average annual daily traffic (AADT) volume											
	less than 2,000				2,000-10,000				over 10,000			
	adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance	
		truck,bus,rv				truck,bus,rv				truck,bus,rv		
less than 30 mph	sl 12	sl 12	wc 14	wc 14	sl 12	wc 14	wc 14	wc 14	wc 14	wc 14	sh 4	sh 4
30-40 mph	wc 14	wc 14	sh 4	sh 4	wc 14	wc 15	sh 4	sh 4	sh 4	sh 4	sh 4	sh 4
41-50 mph	sh 4	sh 4	sh 4	sh 4	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6
over 50 mph	sh 4	sh 6	sh 6	sh 4	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6

TABLE A-5-3

GROUP A BICYCLISTS, RURAL SECTION

(widths are in feet)

For Table A-5-3: wc and sl widths represent “usable widths” of outer lanes, measured from lane stripe to edge of the pavement if a smooth, firm, level shoulder is adjacent. If rough or dropped pavement edges or a soft shoulder exists, add 1 ft. minimum for shy distance from the edge of the pavement.

Key: wc = wide curb lane; sh = shoulder; sl = shared lane; bl = bike lane; na = not applicable; truck, buses, and/or recreation vehicles (approximately 30 per hour or more)

average motor vehicle operating speed	average annual daily traffic (AADT) volume											
	less than 2,000				2,000-10,000				over 10,000			
	adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance	
		truck,bus,rv				truck,bus,rv				truck,bus,rv		
less than 30 mph	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	bl 5	bl 5	bl 5	bl 5
30-40 mph	bl 5	bl 5	bl 5	bl 5	bl 5	bl 6	bl 6	bl 5	bl 5	bl 6	bl 6	bl 5
41-50 mph	bl 5	bl 5	bl 5	bl 5	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6
over 50 mph	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6

TABLE A-5-4

GROUP B/C BICYCLISTS, URBAN SECTION, NO PARKING

(widths are in feet)

For Table A-5-4: wc widths represent “usable widths” of outer lanes, measured from lane stripe to edge of gutter pan, rather than to the face of curb. If no gutter pan is provided, add 1 ft. minimum for shy distance from the face of curb. bl widths represent the minimum width from the curb face. For VDOT projects, the bike lane stripe will lie 4 feet minimum from the edge of the gutter pan. The bike lane stripe will lie 5 feet minimum from the face of curb.

Source: FHWA’s “Selecting Roadway Design Treatments to Accommodate Bicycles” dated 1994.

average motor vehicle operating speed	average annual daily traffic (AADT) volume											
	less than 2,000				2,000-10,000				over 10,000			
	adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance	
		truck,bus,rv				truck,bus,rv				truck,bus,rv		
less than 30 mph	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	wc 14	bl 5	bl 5	bl 5	bl 5
30-40 mph	bl 5	bl 5	bl 5	bl 5	bl 5	bl 6	bl 6	bl 5	bl 6	bl 6	bl 6	bl 6
41-50 mph	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6	bl 6
over 50 mph	na	na	na	na	na	na	na	na	na	na	na	na

TABLE A-5-5

GROUP B/C BICYCLISTS, URBAN SECTION, WITH PARKING

(widths are in feet

For Table A-5-5: wc and sl widths represent “usable widths” of outer lanes, measured from the left edge of the parking space (8 to 10 ft. minimum from the curb face) to the left stripe of the travel lane.

Key: wc = wide curb lane; sh = shoulder; sl = shared lane; bl = bike lane; na = not applicable; truck, buses. And/or recreation vehicles (approximately 30 per hour or more)

average motor vehicle operating speed	average annual daily traffic (AADT) volume											
	less than 2,000				2,000-10,000				over 10,000			
	adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance		adequate sight distance		inadequate sight distance	
		truck,bus,rv				truck,bus,rv				truck,bus,rv		
less than 30 mph	sh 4	sh 4	sh 4	sh 4	sh 4	sh 4	sh 4	sh 4	sh 4	sh 4	sh 4	sh 4
30-40 mph	sh 4	sh 4	sh 4	sh 4	sh 4	sh 6	sh 6	sh 4	sh 6	sh 6	sh 6	sh 6
41-50 mph	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6	sh 6
over 50 mph	sh 6	sh 6	sh 6	sh 6	sh 8	sh 8	sh 8	sh 8	sh 8	sh 8	sh 8	sh 8

TABLE A-5-6

GROUP B/C BICYCLISTS, RURAL SECTION

(widths are in feet)

Source: FHWA's "Selecting Roadway Design Treatments to Accommodate Bicycles" dated 1994

VDOT/AASHTO DESIGN GUIDELINES

The following design guidelines are to assist in the design of bicycle facilities and have been obtained from AASHTO's 1999 "Guide for the Development of Bicycle Facilities" and in combination with VDOT Policy. Only key information from AASHTO's Guide are contained in this VDOT publication. Individuals involved in the planning and design of bicycle facilities should be familiar with and refer to the latest AASHTO Guide for additional information. AASHTO criteria will be considered as "minimum criteria" by designers. These design guidelines consider four types of bicycle facilities: Shared Roadway (No Bikeway Designation), Signed Shared Roadway, Bike Lane or Bicycle Lane and Shared Use Path.

When bicycle facilities are proposed, the roadway conditions will be examined for potential problems specific to bicyclists. Safe drainage grates and railroad crossings, smooth pavements, and signals responsive to bicycles will be provided where warranted. Drainage grate inlets and utility covers in particular are potential problems to bicyclists and should be located in a manner which will minimize severe and/or frequent maneuvering by the bicyclist. When a new roadway is designed, all such grates and covers should be out of the bicyclists' expected path.

SHARED ROADWAYS

The most critical variable affecting the ability of a roadway to accommodate bicycle traffic is width. Adequate width may be achieved by providing paved shoulders or wide outside lanes.

- Paved Shoulders

  Paved shoulders should be at least 4 feet wide to accommodate bicycle travel. However, where 4 foot widths cannot be provided, any additional shoulder width is better than none at all. A shoulder width of 5 feet is recommended from the face of guardrail, curb or other roadside barriers. It is desirable to increase the width of shoulders where higher bicycle usage is expected. Additional shoulder width is also desirable if motor vehicle speeds exceed 50 mph, or the percentage of trucks, buses, and recreational vehicles is high, or if static obstructions exist at the right side of the roadway.

  On rural and urban collector and local roads and streets, provide minimum 4 foot wide paved shoulders when:

  a) Design Year ADT > 2000 VPD, with $\geq$ 5% total truck and bus usage

  or

  b) The route is an AASHTO Approved Interstate Bicycle Route or designated as a bicycle route on a Locality's Thoroughfare Plan and the graded shoulder width is 6 feet or greater.

  For the above situations, the remainder of the shoulder will be topsoil and seeded.

AASHTO's recommendations for shoulder width (as described in *A Policy on Geometric Design of Highways and Streets)* are the best guide for bicycles as well, since wider shoulders are recommended on heavily traveled and high-speed roads and those carrying large numbers of trucks. In order to be usable by bicyclists, the shoulder must be paved.

Rumble strips or raised pavement markers, where installed to discourage or warn motorists they are driving on the shoulder, are not recommended where shoulders are used by bicyclists unless there is a minimum clear path of 1 foot from the rumble strip to the traveled way, 4 feet from the rumble strip to the outside edge of paved shoulder, or 5 feet to adjacent guardrail, curb or other obstacle. If existing conditions preclude achieving the minimum desirable clearance, the width of the rumble strip may be decreased or other appropriate alternative solutions should be considered. VDOT's policy is to not install pavement markers along the outside edge line of a travelway.

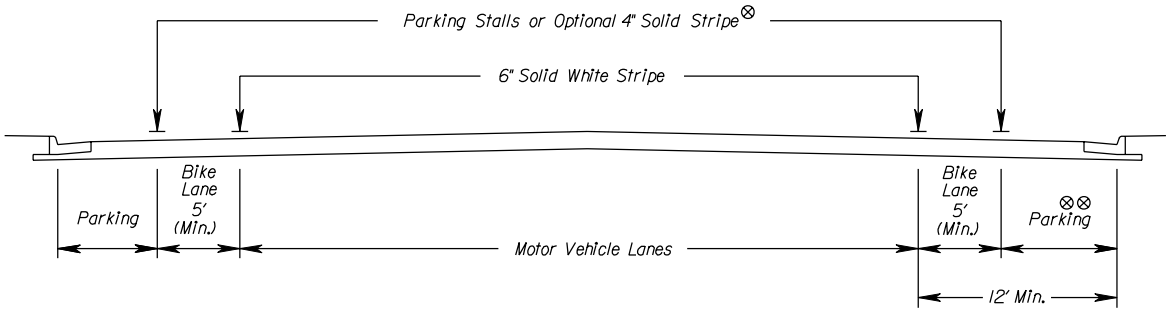
- Wide Outside Lanes

  Wide outside lanes for bicycle use are usually preferred where shoulders are not provided, such as in restrictive urban areas. On highway sections without designated bikeways, an outside or curb lane wider than 12 feet can better accommodate both bicycles and motor vehicles in the same lane and thus is beneficial to both bicyclists and motorists.

  In general 14 feet of usable lane width is the recommended width for shared use in a wide outside lane. Usable width normally would be from edge stripe to lane stripe or from the longitudinal joint of the gutter pan to lane stripe (the gutter pan should not be included as usable width). On stretches of roadway with steep grades where bicyclists need more maneuvering space, the wide outside lane should be slightly wider where practicable (15 feet is preferred). The 15 foot width may also be necessary in areas where drainage grates, raised reflectors on the right-hand side of the road, or on-street parking effectively reduce the usable width. With these exceptions in mind, widths greater than 14 feet that extend continuously along a stretch of roadway may encourage the undesirable operation of two motor vehicles in one lane, especially in urban areas, and therefore are not recommended. In situations where more than 15 feet of pavement width exists, consideration should be given to striping bike lanes or shoulders.

- On-Street Parking

  When there is on-street parking on urban roadways, the bicycle riding location is in the area between parked cars and moving motor vehicles. 12 feet of combined bicycle travel and parking width should be the minimum considered for this type of shared use. Striping should be provided to delineate the parking stalls. (See Figure A-5-1 Section 1).

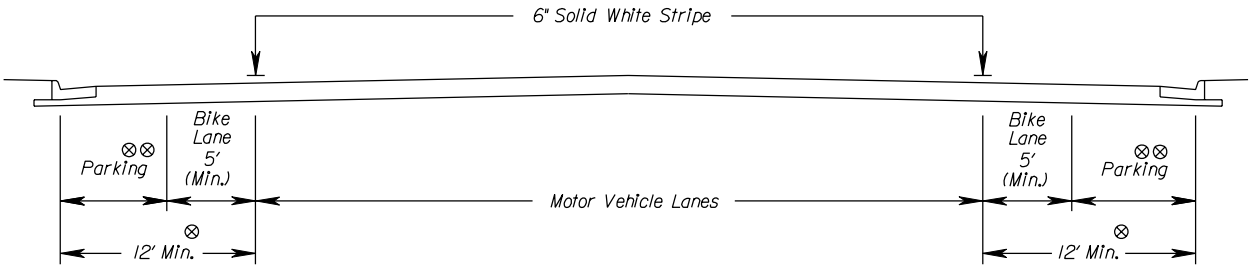


(1) BIKE LANES WITH ON-STREET PARKING

⊗The optional solid white stripe may be advisable where stalls are unnecessary (because parking is light) but there is concern that motorists may misconstrue the bike lane to be a traffic lane.

⊗⊗7' for Residential Street and 8' Commercial and mix use.*

* Rev. 7/07



⊗13 feet is recommended where there is substantial parking or turn over of parked cars is high (e.g. commercial areas).

⊗⊗7 feet for Residential Streets and 8 feet for Commercial and mix use Streets.*

(2) PARKING PERMITTED WITHOUT PARKING STRIPE OR STALL

(Bike lane not designated or marked)

FIGURE A-5-1

SIGNED SHARED ROADWAYS

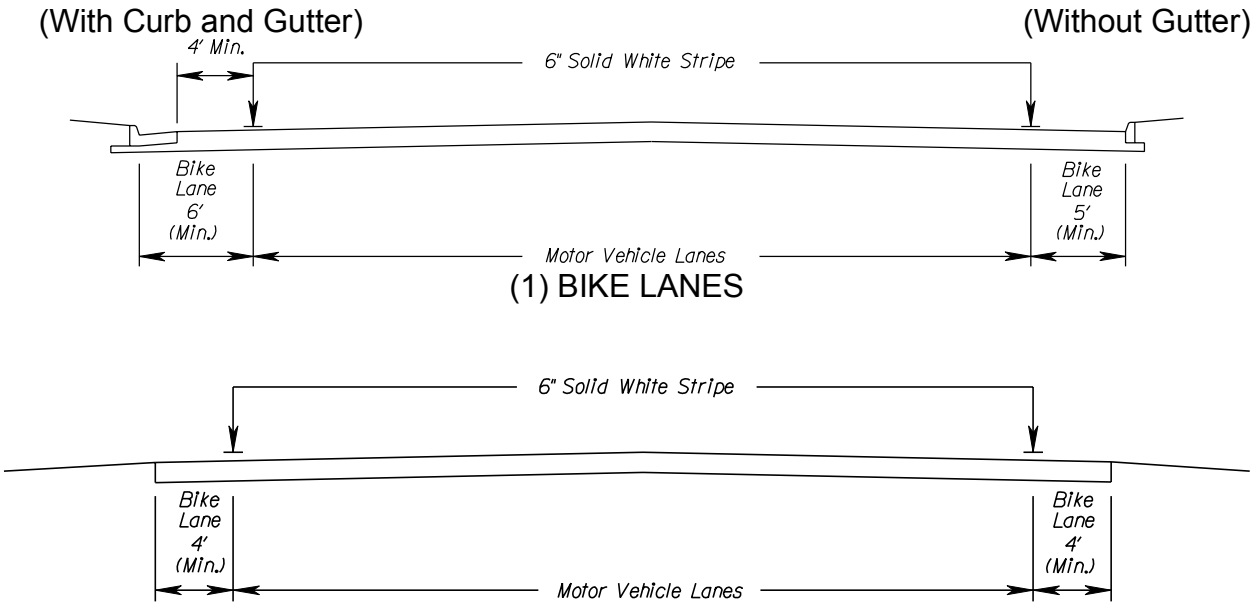
The distinction between shared roadways and signed shared roadways is that signed are those that have been identified by signing as preferred bike routes.

BIKE LANES

Bike lanes are incorporated into a roadway design when it is desirable to delineate available road space for use by bicyclists and motorists. Delineating bike lanes is not recommended within a required paved shoulder area. Urban settings will typically use a bike lane to accommodate bicyclists (See Figure A-5-2, (1)). Rural areas will normally make use of a 4' minimum paved shoulder to accommodate bicyclists (See Figure A-5-2, (2)). Drainage grates, railroad crossings, traffic control devices, etc must be evaluated and modified if necessary for bicycle use.

Bike lanes should be one-way facilities and carry bike traffic in the same direction as adjacent motor vehicle traffic. Two-way bike lanes on one side of the roadway are not recommended when they result in bicycle riding against the flow of motor vehicle traffic. In general, on one-way streets, a bike lane should be placed only on the right side of the street.

* Rev. 7/07



TYPICAL BIKE LANE CROSS SECTIONS

FIGURE A-5-2

- Bike Lane Widths

  The recommended width of a bike lane is 5 feet from the face of a curb to the bike lane stripe on roadways without a gutter pan. The recommended width of a bike lane is 4 feet from the edge of pavement to the bike lane stripe on curb and gutter roadways. Greater bike lane widths are desirable where substantial truck traffic is present, or where motor vehicle speeds exceed 50 mph. Where vehicle traffic volume is high or substantial truck, bus or recreational vehicle traffic is present or speeds warrant, 6 feet minimum is appropriate to the bike lane stripe from the face of curb. Figure A-5-2, Section (1), depicts a bike lane along the outer portion of an urban curbed street where parking is prohibited.

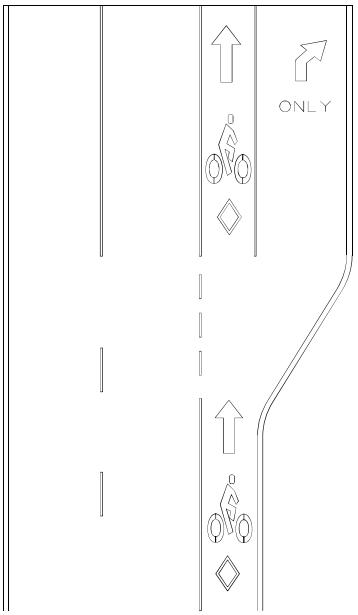
  Bicyclists tend to ride a distance of 32 to 40 inches from a curb face and it is important that the surface in this area be smooth and free of structures. Drain inlets and utility covers that extend into this area may cause bicyclists to swerve, and have the effect of reducing the usable width of the lane. Where these structures exist, the bike lane width may need to be adjusted accordingly.

  If parking is permitted, as in Figure A-5-1, Section (1), the bike lane should be placed between the parking area and the travel lane and have a minimum width of 5 feet. Bike lanes should never be placed between the parking lane and curb line.

* Rev. 7/07

- Bike Lanes and Turning Lanes

  Bike lanes complicate bicycle and motor vehicle turning movements at intersections. It is preferable to continue the same width of bike lane through the intersection. Locations where a bike lane approaches an intersection (4 feet from the edge of pavement on a curb and gutter roadway), the 4 foot wide section should continue parallel to the left of a right turn lane.



RIGHT TURN ONLY LANE

FIGURE A-5-3

- Bicycle Lanes Approaching Right-Turn-Only Lanes

  NOTES: For other intersection situations see the AASHTO Guide for the Development of Bicycle Facilities. For current typical bicycle lane pavement markings see VDOT Road and Bridge Standards or current insertable sheets.

  Figure A-5-3 presents a treatment for pavement markings where a bike lane approaches a motorist right-turn-only lane. The design of bike lanes should include appropriate signing at intersections to warn of conflicts. The approach shoulder width should be provided through the intersection, where feasible, to accommodate right turning bicyclists or bicyclists who prefer to use crosswalks to negotiate the intersection.

SHARED USE PATHS

Shared use paths are facilities on exclusive right-of-way and with minimal cross flow by motor vehicles. Users are non-motorized and may include bicyclists, inline skaters, roller skaters, wheelchair users (both non-motorized and motorized) and pedestrians including walkers, runners, and people with baby strollers and people waking dogs. Shared use paths are most commonly designed for two-way travel, and the following guidance assumes a two-way facility is planned unless otherwise stated. When paths are planned, it is desirable to provide paths on both sides of the roadway to decrease the likelihood of children crossing the road. Pavement design for shared use paths are recommended by the Materials Division.

- Separation Between Shared Use Paths and Roadways

  When two-way 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 5 feet, a suitable physical barrier is recommended. For curb and/or curb and gutter streets, the shared use path shall be a minimum of 5.5 feet from the face of the curb[*]. Consideration should be given to future signs or mailboxes, which may require additional clearance. 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 inches on structures), 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 should be designed to not be a hazard to motorists or bicyclist.

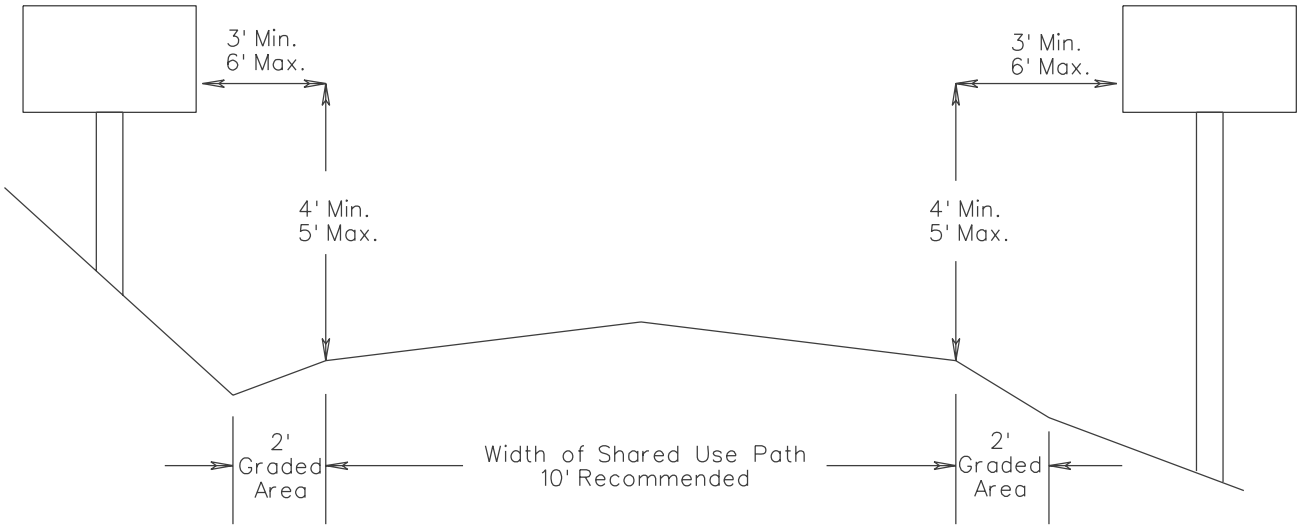
- Width and Clearance

  The paved width and the operating width required for a shared use path are primary design considerations. Under most conditions, a recommended paved width for a two-directional shared use path is 10 feet. In rare instances, a reduced width of 8 feet can be adequate. This reduced width should be used only where the following condition prevail

  (1) bicycle traffic is expected to be low, even on peak days or during peak hours
  (2) pedestrian use of the facility is not expected to be more than occasional
  (3) there will be good horizontal and vertical alignment providing safe and frequent passing opportunities

[*] Rev. 7/08

(4) during normal maintenance activities the path will not be subjected to maintenance vehicle loading conditions that would cause pavement edge damage. Under certain conditions it may be necessary or desirable to increase the width of a shared use path to 12 feet, or even 14 feet, due to substantial use by bicycles, joggers, skaters and pedestrians, use by large maintenance vehicles, and steep grades.



CROSS SECTION OF TWO-WAY SHARED USE PATH ON SEPARATED RIGHT OF WAY

FIGURE A-5-4

The minimum width of a one-directional shared use path is 6 feet. A one-way path would rarely be designed and only in a special situation. It should be recognized that one-way paths often would be used as two-way facilities unless effective measures are taken to assure one-way operation. Without such enforcement, it should be assumed that shared use paths would be used as two-way facilities by both pedestrians and bicyclists and designed accordingly.

A minimum 2 foot wide graded area should be maintained adjacent to both sides of the path. A minimum 3 foot clearance should be maintained from the edge of the path to signs, trees, poles, walls, fences, guardrail, or other lateral obstructions. Where the path is adjacent to canals, ditches or slopes steeper than 1:3, a wider separation should be considered. A minimum 5 foot separation from the edge of the path pavement to the top of slope is required. Depending on the height of embankment and condition at the bottom, a physical barrier, such as dense shrubbery, railing or chain link fence, may need to be provided*.

* Rev. 7/08

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 and emergency vehicles. In undercrossings and tunnels, 10 feet is required for adequate vertical shy distance*.

Where a slope of 1:2 or greater exist within 5 feet of a path and the fill is greater than 10 feet, a physical barrier such as dense shrubbery, railing or chain link fence should be provided along the top of slope. Other situations may also dictate a physical barrier, such as the height of embankment and condition at the bottom.

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 and emergency vehicles. In under crossings and tunnels, 10 feet is desirable for adequate vertical shy distance.

- Design Speed

  Shared use paths should be designed for a selected speed that is at least as high as the preferred speed of the faster bicyclists. In general, a minimum design speed 20 mph should be used. When a downgrade exceeds 4 percent, or where strong prevailing tailwinds exist, a design speed of 30 mph or more is advisable.

- Horizontal Alignment

  Most shared use paths built in the United States must also meet the requirements of the Americans with Disabilities Act, ADA guidelines require that cross slopes not exceed 2% to 3% to avoid the severe difficulties that greater cross slopes can create for people using wheelchairs. Thus, for most shared use paths, the maximum superelevation rate will be 3%. When transitioning a 3% superelevation, a minimum 25 foot transition distance should be provided between the end and beginning of consecutive and Reversing horizontal curves.

  The coefficient of friction depends upon speed; surface type, roughness, and condition; tire type and condition; and whether the surface is wet or dry. Extrapolating from values used in highway design, design friction factors for paved shared use paths can be assumed to vary from 0.31 at 12 mph to 0.21 at 30 mph.

  Based upon various design speeds of 12 to 30 mph and a desirable maximum lean angle of 15°, minimum radii of curvature for Paved Shared Use Paths can be selected from Table A-5-7:

Design Speed (V) (mph)	Minimum Radius ® (feet)
12	36
20	100
25	156
30	225

Minimum Radii for Paved Shared Use PATHS BASED ON 15° LEAN ANGLE

TABLE A-5-7

* Rev. 7/08

- Grade

Grades on shared use paths should be kept to a minimum, especially on long inclines. Grades greater than 5 percent are undesirable because the ascents are difficult for many bicyclists to climb and the descents cause some bicyclists to exceed the speeds at which they are competent or comfortable. On some shared use paths, where terrain dictates, designers may need to exceed the 5% grade recommended for bicycles for some short sections. For a general guide maximum grade lengths where the grade must exceed 5% see Table A-5-8.

5 to 6%	**For up to 800 feet**
7%	For up to 400 feet
8%	For up to 300 feet
9%	For up to 200 feet
10%	For up to 100 feet
11+%	For up to 50 feet

Source: AASHTO – Guide For The Development Of Bicycle Facilities.*

MAXIMUM GRADE LENGTHS

TABLE A-5-8

* Rev. 1/07

- Sight Distance

The following charts indicate the minimum stopping sight distance for various design speeds and grades based on a total perception and 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 shared use paths, the sight distance in the descending direction, that is, where "G" is negative, will control the design.

Sight Distance Descending Grade (ft/ft)

	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
6 mph	27	27	27	27	28	28	28	29	29	30	30	31	31	32	33	34	35	37	39	42	46
12 mph	63	64	65	66	67	68	69	71	72	74	76	78	81	84	88	92	97	104	113	124	140
20 mph	127	129	131	134	137	140	144	147	152	157	162	169	176	185	195	207	222	240	264	296	340
25 mph	175	179	182	186	191	196	201	207	214	222	231	241	252	265	281	300	323	352	389	439	508
30 mph	230	235	241	246	253	260	268	277	287	298	310	324	341	360	383	410	443	485	539	610	710

MINIMUM STOPPING SIGHT DISTANCE (FT.) DESCENDING GRADE

TABLE A-5-9

Sight Distance Ascending Grade (ft/ft)

	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%
6 mph	27	27	26	26	26	26	26	26	26	26	25	25	25	25	25	25	25	25	25	25	25
12 mph	63	63	62	61	61	60	60	59	59	58	58	57	57	57	56	56	56	55	55	55	55
20 mph	127	125	123	121	119	118	116	115	114	113	111	110	109	108	108	107	106	105	104	104	103
25 mph	175	172	169	166	164	161	159	157	155	153	151	150	148	147	145	144	143	141	140	139	138
30 mph	230	225	221	217	214	210	207	204	201	198	196	193	191	189	187	185	183	182	180	178	177

MINIMUM STOPPING SIGHT DISTANCE (FT.) ASCENDING GRADE

TABLE A-5-10

$$S = \frac{V^2}{30 (f \pm G)} + 3.67\ V$$

Where: S = stopping sight distance (feet)
V = velocity (mph)
F = coefficient of friction (use 0.25)
G = grade (ft/ft) (rise/run)

Source: AASHTO – Guide For The Development Of Bicycle Facilities.*

* Rev. 1/07

Table A-5-11 indicates the minimum length of vertical curve necessary to provide minimum stopping sight distance at various speeds on crest vertical curves. The eye height of the bicyclist is assumed to be 4.5 feet and the object height is assumed to be 0 inches to recognize that impediments to bicycle travel exist at pavement level.

A	"S" = Stoppping Sight Distance (feet)														
(%)	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	171	216	267	323	384	451	523	600
7				31	71	111	152	199	252	311	376	448	526	610	700
8			8	48	88	128	174	228	288	356	430	512	601	697	800
9			20	60	100	144	196	256	324	400	484	576	676	784	900
10			30	70	111	160	218	284	360	444	538	640	751	871	1000
11			38	78	122	176	240	313	396	489	592	704	826	958	1100
12		5	45	85	133	192	261	341	432	533	645	768	901	1045	1200
13		11	51	92	144	208	283	370	468	578	699	832	976	1132	1300
14		16	56	100	156	224	305	398	504	622	753	896	1052	1220	1400
15		20	60	107	167	240	327	427	540	667	807	960	1127	1307	1500
16		24	64	114	178	256	348	455	576	711	860	1024	1202	1394	1600
17		27	68	121	189	272	370	484	612	756	914	1088	1277	1481	1700
18		30	72	128	200	288	392	512	648	800	968	1152	1352	1568	1800
19		33	76	135	211	304	414	540	684	844	1022	1216	1427	1655	1900
20		35	80	142	222	320	436	569	720	889	1076	1280	1502	1742	2000
21		37	84	149	233	336	457	597	756	933	1129	1344	1577	1829	2100
22		39	88	156	244	352	479	626	792	978	1183	1408	1652	1916	2200
23		41	92	164	256	368	501	654	828	1022	1237	1472	1728	2004	2300
24	3	43	96	171	267	384	523	683	864	1067	1291	1536	1803	2091	2400
25	4	44	100	178	278	400	544	711	900	1111	1344	1600	1878	2178	2500

Source: AASHTO – Guide For The Development Of Bicycle Facilities.*

Heavy line represents S = L

when S > L $L = 2S - \frac{900}{A}$

when S < L $L = AS^2/900$

Height of cyclist eye – 4.5 feet

Height of object – 0 feet

L = Minimum Length of Vertical Curve (feet)

A = Algebraic Grade Difference (%)

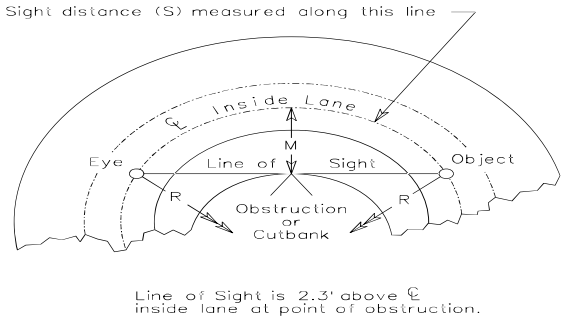
S = Stopping Sight Distance (feet)

Minimum Length of Vertical Curve = 3 feet

MINIMUM LENGTH OF CREST VERTICAL CURVE (L) BASED ON STOPPING SIGHT DISTANCE TABLE A-5-11

* Rev. 1/07

Figure A-5-5 and Table A-5-12 indicate the minimum clearance that should be used to line of sight obstructions for horizontal curves. The lateral clearance is obtained from the stopping sight distance and the proposed horizontal radius of curvature. The stopping sight distance is obtained from Table A-5-9 and Table A-5-10.



S = Sight distance in feet.

R = Radius of ℄ inside lane in feet.

M = Distance from ℄ inside lane in feet.

Angle is expressed in degrees

$$M = R\left[1-\cos\left(\frac{28.65\ S}{R}\right)\right]$$

$$S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R-M}{R}\right)\right]$$

Formula applies only when S is equal to or less than length of curve.

Formula applies only when S is equal to or less than length of curve.
Line of sight is 2.3 feet above centerline of inside lane at point of obstruction.

FIGURE A-5-5

R	"S" = Stopping Sight Distance (feet)														
(feet)	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	53.5	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		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

Source: AASHTO – Guide For The Development of Bicycle Facilities.*

MINIMUM LATERAL CLEARANCE FOR HORIZONTAL CURVES - TABLE A-5-12

* Rev. 1/07

Bicyclists frequently ride side-by-side on shared use paths, and on narrow paths bicyclists have a tendency to ride near the middle of the path. For these reasons, and because of the higher potential for bicycle crashes, 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 line stripe, installing a "Curve Ahead" warning sign in accordance with the MUTCD, or some combination of these alternatives.

- Path-Roadway Intersections

Intersections between paths and roadways are often the most critical issue in shared use path design. Due to the potential conflicts at these junctions, careful design is of paramount importance to the safety of path users and motorists. Solutions are provided in the AASHTO guide and should be considered as guidelines, and not as absolutes. Each intersection is unique, and will require sound engineering judgment on the part of the designer as to the appropriate solution. Shared use paths should cross roadways as close to an intersecting road as practical, however, in no case should the crossing be closer than 4 feet from the edge of the parallel travelway. As the Path approaches the crossing it should be aligned with the destination of the crossing on the other side of the road. Curb cuts should be appropriately aligned and be the same width as the path. The crossing should also be perpendicular (or nearly so) to the road being crossed. Normally, two curb cuts are recommended at each corner where a path crosses an intersection. Sight distance should be evaluated and sound engineering judgment must be used in locating crossings. There may be situations, such as low traffic volumes where the crossing should be located further from the intersection.

When a shared use trail intersects a road, with no sidewalk, the trail should slope to a relatively level (1%$\pm$ slope) area at the road elevation and the curb opening should be the same width as the trail. This layout would be similar to the Typical Alternate Plan seen in VDOT's CG-12 Standard. The level area should be of exposed aggregate. If a sidewalk exists along the road, then the sidewalk must also slope to the same relatively level area at the road elevation.

When a paved shared use path or trail crosses a gravel road or drive, the road or drive should be paved a minimum of 3 feet, on each side of the path or trail.

- Signing and Marking

Adequate signing and marking are essential on shared use paths, especially to alert bicyclists to potential conflicts and to convey regulatory messages to both bicyclists and motorists at highway intersections. In addition, guide signing, such as to indicate directions, destinations, distances, route numbers and names of crossing streets, should be used in the same manner as they are used on highways. In general, uniform application of traffic control devices, as described in the MUTCD, provides minimum traffic control measures which should be applied.

- Pavement Structure

Hard, all weather pavement surfaces are preferred over those of crushed aggregate, sand, clay, or stabilized earth since these materials provide a much lower level of service and require higher maintenance.

- Structures

On new structures, the minimum clear width should be the same as the approach paved shared use path, plus the minimum 2 foot wide clear areas on both sides of the path. Carrying the clear areas across the structures provides a minimum horizontal shy distance from the railing or barrier and it provides needed maneuvering space to avoid conflicts with pedestrians and other bicyclists who are stopped on the bridge. The typical section, including the shared use path and the 2 foot wide clear areas, may be modified by the State Structure and Bridge Engineer because of expected low bicycle volume, budget considerations, or other reasons. Railings, fences, or barriers on both sides of a path on a structure shall be a minimum of 54 inches (4.5 feet) high. In situations where the structure crosses a high speed or high volume road and objects are subject to being thrown (dangerously) off the structure, it maybe desirable to totally enclose the path with fencing. Totally enclosing a path may also be desirable in other areas such as a waterway crossing.

- Drainage

The recommended minimum pavement cross slope of 2 percent adequately provides for drainage. Sloping in one direction instead of crowning is preferred and usually simplifies the drainage and surface construction. A smooth surface is essential to prevent water ponding and ice formation. On unpaved shared use paths, particular attention should be paid to drainage to avoid erosion.

- Lighting

Lighting for shared use paths is important and should be considered where night usage is expected, such as paths serving college students or commuters, and at highway intersections. Lighting should also be considered through underpasses or tunnels, and when nighttime security could be an issue.

- Restriction of Motor Vehicle Traffic

Shared use paths may need some form of physical barrier at highway intersections to prevent unauthorized motor vehicles from using the facilities. Provisions can be made for a lockable, removable (or reclining) barrier post to permit entrance by authorized vehicles.

- Railroad Crossings

Railroad-highway grade crossings should 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. Consideration should be given to the crossing surface materials and to the flangeway depth and width.

- Bicycle Facilities Through Interchange Areas

Turning roadways provided for interchange ramp ingress and egress often require bicyclists to perform merging, weaving or crossing maneuvers with other vehicles. These conflict points are made challenging when a wide disparity in speed exists between traffic on the ramp and bicycle traffic crossing the ramp, and when grade separations create significant profile gradients. If a bike lane or route must traverse an interchange area, these intersection or conflict points should be designed to limit the conflict areas or to eliminate unnecessary uncontrolled ramp connections to urban roadways.

AASHTO APPROVED INTERSTATE BICYCLE ROUTES

VDOT provides signing along the designated AASHTO approved Interstate Bicycle Routes. Figure A-5-6 shows the corridors for Interstate Bicycle Routes 1 and 76 and the counties the routes pass through. The individual county maps provide detailed location information. County maps are to be checked by the plan designer to determine if their project is on a designated Interstate Bicycle Route. All proposed projects involving major construction or redevelopment along designated Interstate Bicycle Routes are to provide the necessary design features to facilitate bicycle travel in accordance with the parameters established in these guidelines.

RESOURCES

It should be understood that this Guide is not all inclusive. The publications listed below will provide additional information to be used in the design of bicycle facilities.

"Guide for the Development of Bicycle Facilities." AASHTO

"Manual on Uniform Traffic Control Devices." Federal Highway Administration

"Selecting Roadway Design Treatments to Accommodate Bicycles." Federal Highway Administration

"A Virginia Guide for Bicycle Facility Planning." Virginia Department of Transportation

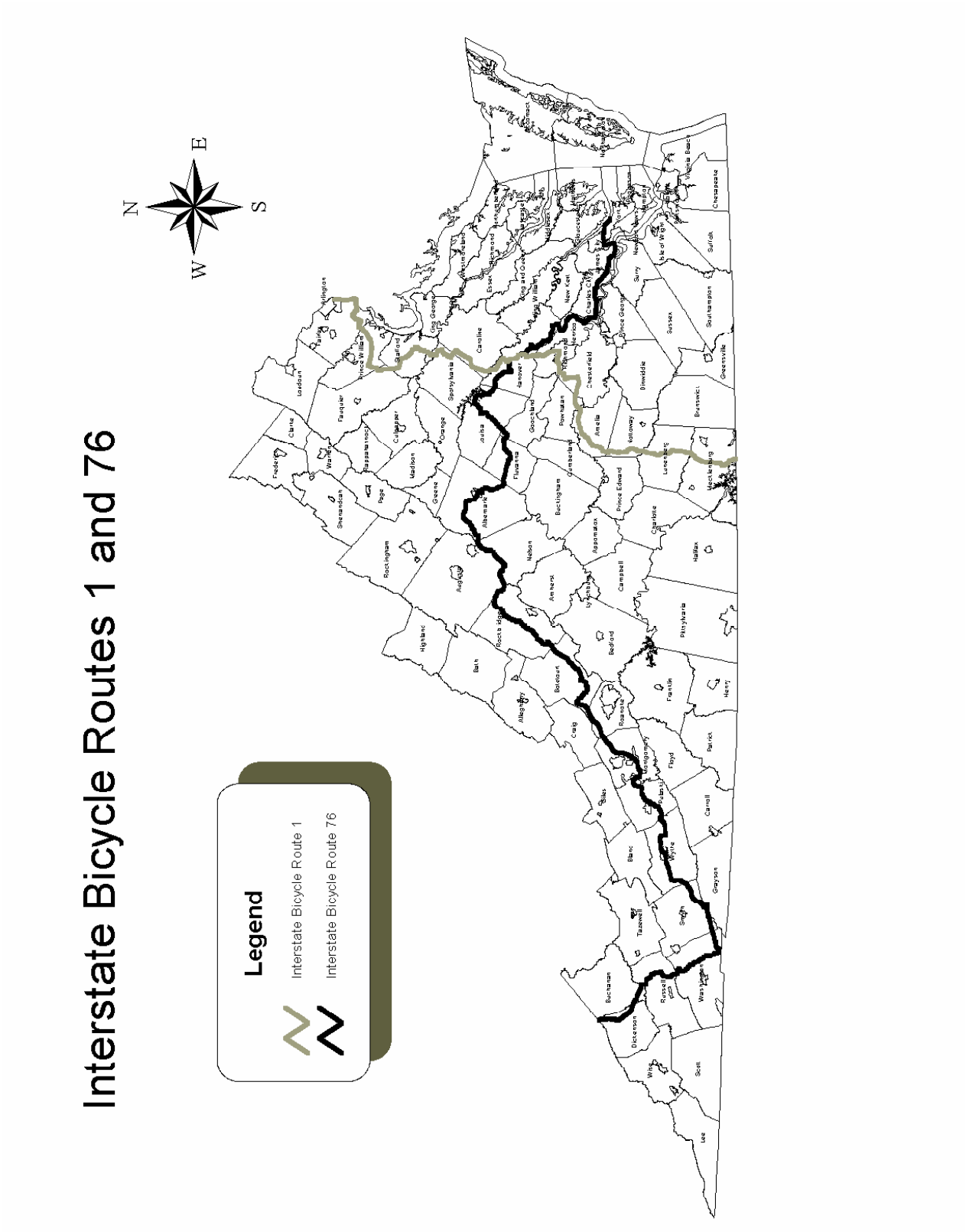

Interstate Bicycle Routes 1 and 76
N
E
S
W
Legend
Interstate Bicycle Route 1
Interstate Bicycle Route 76

FIGURE A-5-6

feet	meters		mph	km/h		inches	mm
1	0.3		12	20		4	100
2	0.6		20	30		6	150
3	0.9		25	40			
4	1.2		30	50			
5	1.5		50	80			
6	1.8		55	85			
7	2.1					inches	meters
8	2.4					32	0.8
9	2.7					40	1.0
10	3.0					42	1.1
11	3.4						
12	3.6						
13	3.9						
14	4.2						
15	4.5						
16	4.9						

CONVERSIONS FROM IMPERIAL UNITS TO METRIC UNITS
(for bicycle guidelines)

TO CONVERT	MULTIPLY BY	TO OBTAIN
feet	0.3048	meters
mph	1.6093	km/h
inches	0.0254	meters
inches	25.4	mm

1 foot = 0.3048 meter
1 mph = 1.6093 km/h
1 inch = 0.0254 meter
1 inch = 25.4 mm

CONVERSION FACTORS FOR DIMENSIONS OR SPEEDS NOT SHOWN ABOVE :

TABLE A-5-13