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Development of Guidelines for Bicycle Use of Controlled Access Facilities in Virginia

**VDOT Statewide Bicycle and Pedestrian Advisory Committee
Fall Working Group Meeting
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BACKGROUND

- The Commonwealth Transportation Board (CTB) adopted the *Policy for Integrating Bicycle and Pedestrian Accommodations* in 2004.
- This policy was designed to ensure that bicycle and pedestrian needs are accommodated through VDOT's construction, operations, and maintenance programs.
- **Problem:** VDOT lacks objective criteria for recommending prohibition of bicycle use of state controlled access facilities.



PURPOSE AND SCOPE

- **Purpose is** to develop a guide to help VDOT determine when the permission of bicycles on right shoulders of controlled access facilities in Virginia is appropriate from a safety standpoint.
- **Scope is limited** to bicycle use on state controlled access highways.
 - Scope does not include interstate highways or roads in incorporated cities or towns.
 - Scope does not address secondary roads.



CLIENT

- CTB Bicycle/Pedestrian Policy Implementation Team
 - directed by the *former* Secretary of Transportation and the *former* VDOT Commissioner
 - sought guidance for bicycle use of controlled access facilities.
- For this project, the client's interests were represented by the steering committee (next slide)



STEERING COMMITTEE

Current members

- Robin Grier (Chair), TMPD CO
- George Rogerson, L&D CO
- Michael Grey, Salem District
- Cindy Engelhart, Planning NOVA District
- David Dorfman, Civilian Bicyclist

Former members

- Fatemeh Allahdoust, Planning NOVA District
- Jake Hembolt, *formerly* TMPD CO
- Mike Sawyer, *formerly* TED CO
- Travis Bridewell, *formerly* Richmond District



METHOD

1. Data Collection: prohibition status, crashes, geometry (e.g., paved right shoulder width), traffic volume, and posted speed limit
2. Literature Review: federal and states guides and manuals
3. Database Development: primary highways only
4. Analysis: comparative analysis of review results, crash risk analysis, and stopping sight distance analysis
5. Guide Development
 - 1) Start from two relevant tables in FHWA's 1994 report, "Selecting Roadway Design Treatments to Accommodate Bicycles"
 - 2) Modify the tables through 9-step procedure devised based on analysis results
 - 3) Add other considerations (e.g., civil rights consideration)



PROPOSED GUIDE (1)

A GUIDE FOR PERMITTING BICYCLE USE OF RIGHT SHOULDERS ON CONTROLLED ACCESS FACILITIES IN VIRGINIA

This document shall serve as a guide not a warrant or requirement and is not for designing facilities for bicycle accommodation. This Guide is applicable only for controlled access highways in Virginia without street parking. In general, facilities meeting the conditions described below should permit bicycles on right shoulders.



PROPOSED GUIDE (2)

- The right shoulder shall meet the following width criteria:

Minimum Widths of Paved Right Shoulder for Bicycle Use

Posted Speed Limit* (miles per hour)	Average Annual Daily Traffic Volume (AADT) (vehicles per day)	
	< 2,000	≥ 2,000
45	3 ft	4 ft
50	4.5 ft	
55	5.5 ft	
60	6.5 ft	
65	7 ft	

*Speed data should be collected if there is evidence that the operating speed is higher than the posted speed limit.



PROPOSED GUIDE (3)

- When it is determined that a highway segment currently permitting access to bicyclists does not satisfy the conditions in the Guide, the existing permission shall not be removed when doing so would violate a person's rights under the Americans with Disabilities Act (ADA).

The Guide and the report are currently under review. Thus, they are subject to change.



QUESTIONS?



APPENDIX



9 Steps of Developing Minimum Shoulder Widths ①

Step 1: Start with Tables in FHWA's Bike Facility Design Guide

The tables for Group A bicyclists in urban sections without street parking and in rural section in FHWA's Bike Design Guide (1994) were adopted as the initial shoulder width tables. Speed categories below 45 mph were eliminated.

Table B-1. Minimum Widths of Wide Curb or Shoulder for Group A Bicyclists in Urban Section Without Street Parking (feet)

Average operating speed	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv				Truck, bus, rv				Truck, bus, rv			
45-50 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
>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

Note: wc=wide curb and sh=shoulder

Table B-2. Minimum Widths of a Shoulder for Group A Bicyclists in Rural Section (feet)

Average operating speed	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv				Truck, bus, rv				Truck, bus, rv			
45-50 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
>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

Note: sh=shoulder



9 Steps of Developing Minimum Shoulder Widths ②

Step 2: Convert Wide Curb Widths to Comparable Shoulder Widths

comparable shoulder width = wide curb width – typical lane width (12 feet)

Table B-3. Minimum Widths of a Shoulder for Group A Bicyclists in Urban Section Without Street Parking (feet)

Average operating speed	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv	
45-50 mph	sh 3	sh 3	sh 3	sh 3	sh 3	sh 3	sh 6	sh 6	sh 3	sh 3	sh 6	sh 6
>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

Note: sh=shoulder



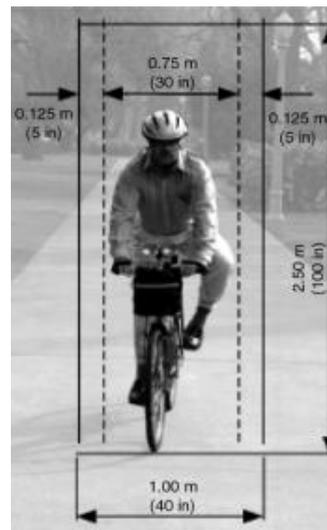
9 Steps of Developing Minimum Shoulder Widths ③

Step 3: Modify Minimum Design Widths Suitable for Permission Guide

The following considerations are made:

- The physical width of the bicyclist is 2.5 feet (i.e., 30 inches) (AASHTO, 1999).
- Tables B-1 and B-2 (thus, also Table B-3) were developed to aid in the design of bicycle facilities while the goal of this study is to develop guidance on conditions permitting bicyclists on shoulders. Guidance for determining use of a facility is typically less stringent than guidance for the design of facility.
- Based on input from engineers, it was determined that a minimum shoulder width of the design value minus 2 feet was sufficient for allowing bicycle use of shoulders, with a minimum shoulder width of 2.5 feet.

modified shoulder width = $\max[(\text{minimum design shoulder width} - 2 \text{ feet}), 2.5 \text{ feet}]$



9 Steps of Developing Minimum Shoulder Widths ④

Step 3: Modify Minimum Design Widths Suitable for Permission Guide

modified shoulder width = max[(minimum design shoulder width–2 feet), 2.5 feet]

Table B-4. Minimum Widths of Shoulder for Group A Bicyclists in Urban Section Without Street Parking (feet)

Average operating speed	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv	
45-50 mph	2.5	2.5	2.5	2.5	2.5	2.5	4	4	2.5	2.5	4	4
>50 mph	4	4	4	4	4	4	4	4	4	4	4	4

Table B-5. Minimum Widths of Shoulder for Group A Bicyclists in Rural Section (feet)

Average operating speed	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv	
45-50 mph	2.5	2.5	2.5	2.5	4	4	4	4	4	4	4	4
>50 mph	2.5	4	4	2.5	4	4	4	4	4	4	4	4



9 Steps of Developing Minimum Shoulder Widths ⑤

Step 4: Compare Minimum Widths for Urban and Rural Sections and Select Larger of Two Widths

Since there was no difference between urban and rural segments in the analysis of run-off-right crashes, combining minimum widths for urban and rural sections is suggested. A larger width between the two tables is adopted for each cell to create a new table as follows:

combined shoulder width = max(width in Table B-4, width in Table B-5)

Table B-6. Minimum Widths of Shoulder for Group A Bicyclists (feet)

Average operating speed	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv	
45-50 mph	2.5	2.5	2.5	2.5	4	4	4	4	4	4	4	4
>50 mph	4	4	4	4	4	4	4	4	4	4	4	4



9 Steps of Developing Minimum Shoulder Widths ⑥

Step 5: Calculate Minimum Shoulder Widths Maintaining Safe Separation Distance Due to Wind

The following conditions are considered:

- Width of a truck=8.5 feet (102 inches) (FHWA, 2004)
- Essential operating space of a bicyclist=3.3 feet (40 inches) (AASHTO, 1999)
- Width of the outside lane=12 feet

The following assumptions are made:

- An operating space of an 8.5-foot wide truck is 10 feet, 1 foot away from each end of a 12-foot lane.
- A bicyclist operates 1.65 feet from the edge of the pavement (1.65 feet is a half of the essential operating space [3.3 feet] of a bicyclist).

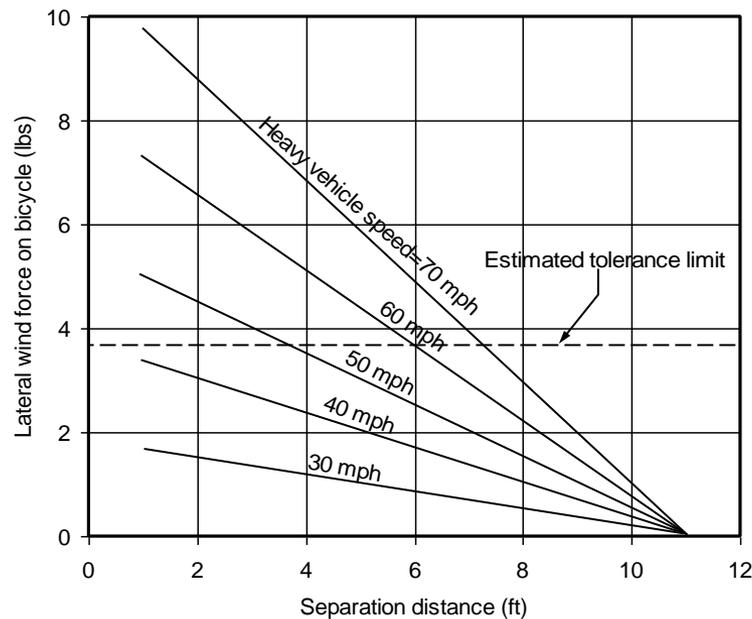


9 Steps of Developing Minimum Shoulder Widths ⑦

Step 5: Calculate Minimum Shoulder Widths Maintaining Safe Separation Distance Due to Wind

Safe separation distances to address wind force caused by passing trucks are found from Figure 2, Aerodynamic forces caused by heavy vehicles passing bicycles (FHWA, 1977). The safe separation distances corresponding to different speeds are found as below;

- 2.5 feet at 45 mph
- 3.75 feet at 50 mph
- 5 feet at 55 mph
- 6 feet at 60 mph
- 6.5 feet at 65 mph



Source: A Bikeway Criteria Digest (FHWA, 1977)

Figure 2. Aerodynamic forces caused by heavy vehicles passing bicycles

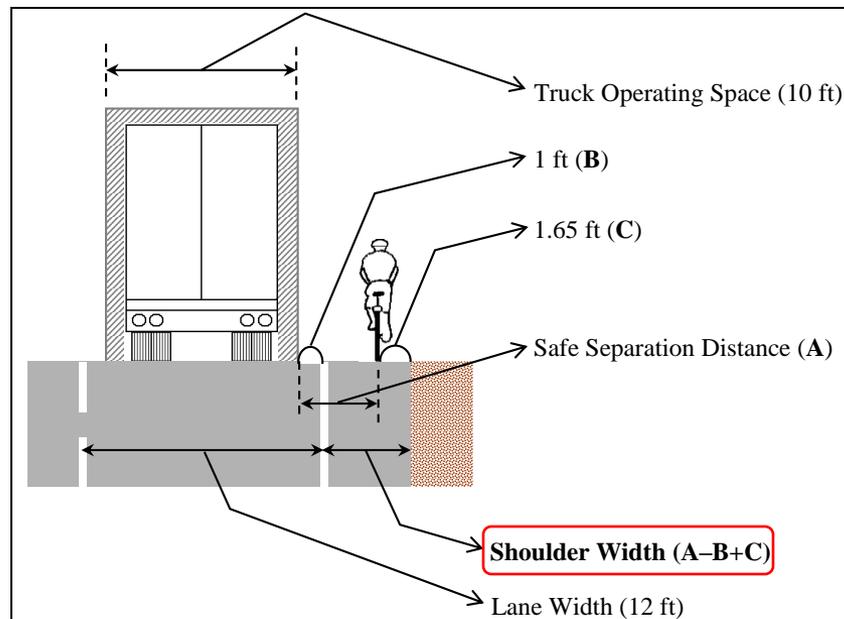


9 Steps of Developing Minimum Shoulder Widths ⑧

Step 5: Calculate Minimum Shoulder Widths Maintaining Safe Separation Distance Due to Wind

Minimum shoulder widths required to maintain the safe separation distances while considering other relevant conditions and assumptions are calculated as follow:

minimum shoulder width for safe separation = safe separation distance (A) – space between the right line of the lane and the right limit of a typical vehicle operating space (B) + space between a bicyclist and the edge of an pavement (C)



9 Steps of Developing Minimum Shoulder Widths ⑨

Step 5: Calculate Minimum Shoulder Widths Maintaining Safe Separation Distance Due to Wind

The calculated minimum shoulder widths for safe separation are:

- 3.15 feet (2.5'–1.0'+1.65') at 45 mph
- 4.40 feet (3.75'–1.0'+1.65') at 50 mph
- 5.65 feet (5.0'–1.0'+1.65') at 55 mph
- 6.65 feet (6.0'–1.0'+1.65') at 60 mph
- 7.15 feet (6.5'–1.0'+1.65') at 65 mph

Table B-7. Minimum Widths of Shoulder for Safe Separation Due to Wind (feet)

Average operating speed	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv			Truck, bus, rv			Truck, bus, rv			Truck, bus, rv		
45 mph	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15	3.15
46-50 mph	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
51-55 mph	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65
56-60 mph	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65
61-65 mph	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15



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Step 6: Compare Tables B-6 and B-7 Generated in Steps 4 and 5

In order to satisfy all the conditions and assumptions considered through Step 5, the larger of the two values (Tables B-6 vs. B-7) is adopted:

combined shoulder width = max(width in Table B-6, width in Table B-7)

Table B-8. Minimum Widths of Shoulder for Bicyclists (feet)

Average operating speed	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv	
45 mph	3.15	3.15	3.15	3.15	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
46-50 mph	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
51-55 mph	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65
56-60 mph	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65
61-65 mph	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15



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Step 7: Use Posted Speed Limits

For practical use of the table, a posted speed limit is recommended for use in place of the average operating speed because operating speed data are typically unavailable for highway segments. However, when operating speeds are thought to be higher than the posted speed limit, speed data should be collected and an average operating speed should be used in place of the posted speed limit.

Table B-9. Minimum Widths of Shoulder for Bicyclists (feet)

Posted speed limit	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–10,000				>10,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv	
45 mph	3.15	3.15	3.15	3.15	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
50 mph	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
55 mph	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65
60 mph	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65
65 mph	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15



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Step 8: Round Values for Practical Use

For practical use of the table, values in Table B-9 are rounded so that widths are based on 0.5 feet increments. All values are rounded to the nearest 0.5 ft.

Table B-10. Minimum Widths of Shoulder for Bicyclists (feet)

Posted speed limit	Average annual daily traffic volume (AADT) (vehicles per day)											
	<2,000				2,000–12,000				>12,000			
	Stopping sight distance				Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv		Truck, bus, rv	
45 mph	3	3	3	3	4	4	4	4	4	4	4	4
50 mph	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
55 mph	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
60 mph	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
65 mph	7	7	7	7	7	7	7	7	7	7	7	7



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Step 9: Combine Two Higher Volume Categories

All the widths for two higher AADT categories, 2,000-10,000 and >10,000, are identical. Thus, for simplicity, the two categories are combined so that the final table has two volume categories, <2,000 and ≥2,000.

Table B-11. Minimum Widths of Shoulder for Bicyclists (feet)

Posted speed limit	Average annual daily traffic volume (AADT) (vehicles per day)							
	<2,000				≥2,000			
	Stopping sight distance				Stopping sight distance			
	Adequate		Inadequate		Adequate		Inadequate	
	Truck, bus, rv			Truck, bus, rv			Truck, bus, rv	
45 mph	3	3	3	3	4	4	4	4
50 mph	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
55 mph	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
60 mph	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
65 mph	7	7	7	7	7	7	7	7

Table B-12. Minimum Widths of Shoulder for Bicyclists

Posted speed limit	Average annual daily traffic volume (AADT) (vehicles per day)	
	<2,000	≥2,000
45 mph	3 ft	4 ft
50 mph	4.5 ft	
55 mph	5.5 ft	
60 mph	6.5 ft	
65 mph	7 ft	

