Chapter 2: Components of a Bicycle Facility Network

A well designed and executed alternative transportation network is comprised of many elements that combine to ensure a safe, efficient, and pleasant bicycling experience for residents and visitors to reach desired destinations. A bicyclist must feel safe in order to utilize a cycling network and they must have clear direction and system information. A well-utilized bicycle facility must be free of too many physical barriers, provide as much separation from motorists as possible, present a clear understanding of bicycling options, and lastly, to the best extent possible, be comprised of fairly continuous and direct routes.

Bicycle facilities must be designed and constructed to meet different physical and site characteristics and must consider multiple user types and comfort levels. Much information on the design specifications for signage, bike lanes, wide shoulders, walkways, and intersection crossing and other components of an alternative transportation system is available. Specific bicycle facility design is determined by State and local standards, most of which are based on design and construction standards set by the American Association of State Highway and Transportation Officials, AASHTO, and the Manual on Uniform Traffic Control Devices, MUTCD.

An overview of the components necessary to create a safe and effective bicycle network are presented below. The localities and partners within Region 2000 should look for opportunities to utilize all of these elements in various locations throughout the region. These components, along with the other transportation system elements which include transit and sidewalks, in combination with encouragement and enforcement programs, highlighted further in Chapter 4, must be combined to create a comprehensive bicycle transportation network.

Bicyclist Skill Levels

Potential users of the bicycle network are represented by a diverse range of physical characteristics, age, riding comfort, and skill level. In recognition of these differences in user characteristics, a rating system has been developed by the American Association of State Highway and Transportation Officials (AASHTO). Within this system bicyclists are defined by a three-category rating system used to represent the overall comfort and ability level of the cyclist. The rating system, or each of the three user types, is defined as:

- Group A – Advanced bicyclists are those cyclists who are comfortable riding a bicycle under most traffic conditions. These cyclists have a high comfort and expertise level. They operate their bicycles as transportation vehicles, tend to ride for convenience and speed, desire convenient and direct routes to destinations, and are generally comfortable on most roads riding with courteous and alert vehicular traffic.

- Group B –Basic bicyclists who are casual riders, or young adults with limited experience, or teenage riders that do not have the same level of confidence or comfort to operate in all traffic conditions as Group A cyclist might. These cyclists tend to look for lower vehicular traffic volume and speed routes and specialized bicycle facilities.

- Group C – Children and young teen riders whose roadway and facility use is generally monitored by an adult comprise this group. This group often moves more slowly and less directly than other groups, requires attentive traffic conditions, and where possible, should use off-road, specialized facilities to ensure safety.

Bicycle Facility Types

The following presents a description of the primary on-road bicycle accommodations. The following information is based on facility descriptions and visual examples presented in the AASTO *Guide for the Development of Bicycle Facilities*, VDOT *Virginia Bicycle Facility Resource Guide*, and the FHWA *Manual of Uniform Traffic Control Devices for Streets and Highways – 2009 Edition* (MUTCD).

Each of the following accommodations requires specific design and road conditions to facilitate safe use. Facility installation and design adjustments are often necessary and should be evaluated on a case-by-case basis under the direction of a qualified engineer and consultation with local planners. More detailed information on design features of these facility types is found in **Appendix A**.

Bicycle Lane

A bicycle lane is a portion of the roadway that is designated through striping, signing, and pavement markings for the preferential or exclusive use of bicycles. Bicycle lanes are located on both sides of the road (except along one way streets) and carry cyclists in the same direction as car travel. Bike lanes are established along roads where there is anticipated significant bicycle demand and generally where the average daily traffic (ADT) is 3000 or more. The minimum width for a bicycle lane is 4 feet, however 5- and 6-foot lanes are suggested for collector and arterial roads. The Virginia Bicycle Facility Resource Guide recommends the following bike lane minimum widths to meet specific road conditions:

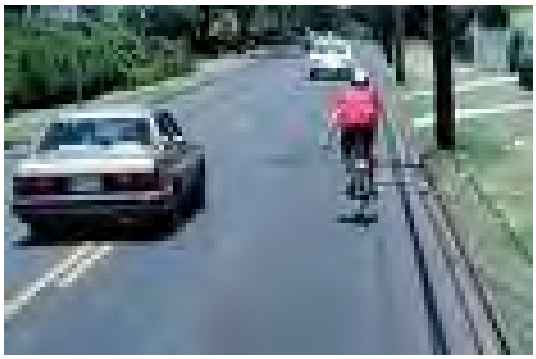
- 4 foot minimum on roadways with gutter pan and curb;
- 5 foot minimum where adjacent to barrier curb or other solid side obstruction;
- 5 foot minimum when adjacent to on-street parking; and
- 6 foot where substantial truck traffic is present or where motor speeds exceed 50 mph.

Shared Lane Markings or "Sharrows"

Shared lane markings or "Sharrows" provide an accommodation option along roadways where designated bicycle lanes are not an option due to design constraints. The use of Sharrows was approved within the 2009 MUTCD. Currently, within Virginia this practice has yet to be approved. Bicycle signage or Sharrows provide increased visibility and awareness for motorists to be aware of the likelihood of cyclists along the route. The use of signage or shared lane markings also serve to guide cyclist along designated bicycle routes. Design considerations:

- Generally for roads at 35 MPH or less;
- Should be marked approximately every 200' to 250'
- Along roads too narrow for bike lanes
- Used along roads with or without street parking

Wide Outside Lanes



Wide outside lanes refers to a share the road conditions along the through lane closest to the curb and gutter of a roadway that is a minimum of 14-feet wide thus providing width for motorist and bicyclists. This facility accommodation also provides motorist increased width and comfort to pass more safely. Some considerations, this accommodation does not provide motorist visual cue and the wider lane may encourage increased motorist speed.

Paved Shoulders

Improvement, through additional width, along the shoulder portion of the road can provide an effective share the road bicycle accommodation. In order to serve as a safe accommodation for cyclists however, they need to be smooth, well-maintained, and consist of a uniform surface. A shoulder width of 4 feet is recommended in most cases to provide cyclist comfort. There are however, certain instances where additional width may be advised:

- steep climbing slope – cyclists may need more width as they need additional width to move their bikes when traveling up hill;
- high bike usage is expected (along a primary route);
- motor vehicle speeds expected above 50 mph;
- where there is an anticipated high volume of trucks, buses, or other commercial vehicles.

It should be noted that while a 4 foot paved shoulder is recommended, a two foot minimum width paved shoulder is required in order for VDOT to consider the road as meeting minimum design paved shoulder bicycle accommodation criteria. Therefore, any additional width that can be provided will benefit a cyclist. Information provided through the *Bicycle and Pedestrian Information Center* notes that additional shoulder width has been shown to also benefit motorists on two-lane roads by reducing the incidence running off the paved surface and causing over-correcting and cross-over accidents. Further, increased width has also been shown to provide maintenance benefits due to increased road structure durability. Paved shoulders can often be accommodated through restriping of existing pavement or through addition during road maintenance schedules.

The paved shoulder bicycle accommodation is also a share the road accommodation type and should therefore include signage to alert motorists and guide bicyclists.

Wide outside lanes, paved shoulders and other on-road accommodations should include signage to alert motorist and guide bicyclists.

Multi-use Paths / Greenways

Multi-use paths, generally speaking, are off-road corridors separated from the road system by an open space or barrier. They are generally designed for multiple users which include pedestrians, cyclists, skaters, wheelchair users, joggers, and other non-motorist users. Multi-use paths should be designed for a minimum of 10 feet of width and constructed of a uniform and compactable surface that meets the specific surface needs of multiple users. Greenway refers to those multi-use trails that combine to create a longer distance continuous system, such as the James River Heritage Trail System.

Ancillary Facilities

In addition to specific on-road and off-road facilities such as sidewalks, there must be additional resources that expand the comfort and safety necessary to support the use of a bicycle as a transportation mode. Three of the most basic of these ancillary resources include signage, bicycle storage, and water availability.

Signage

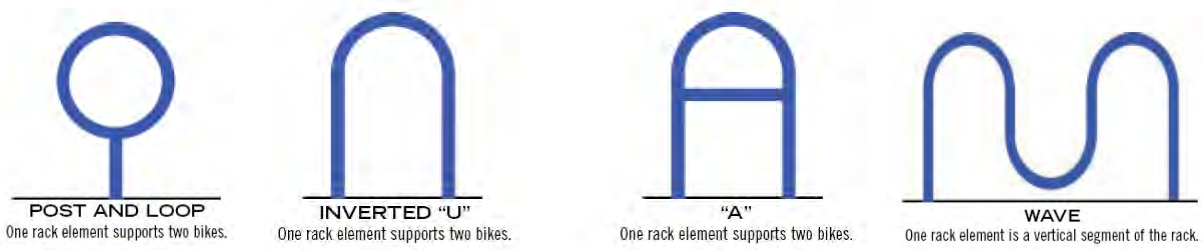
Signage is a vital component of a well designed and safe alternative transportation system. A comprehensive signage system ensures accurate information is provided to cyclist, pedestrians, and motorists regarding safe and proper use of facilities and directional and way finding information. As with all bicycle system components there are specific uses and design standards, provided through MUTCD, that dictate signage use. There are many bicycle signs and usage is determined by design considerations. More information on signage can be obtained through MUTCD.

Examples of warning and directional signage

Source: www.traffic**sign**.us/bike**sign**.html; a component of the FHWA's MUTCD webstite

Bicycle racks

In order to promote the use of bicycles as a viable transportation mode, bicyclists must be provided opportunities to store bicycles at community destination points, transit stops, and trail head locations. There are a number of bicycle rack designs available, simple designs that limit the possibility of bending of bicycle wheels and ease of use are preferred. Also, it is important to locate racks so they have space so as not hamper pedestrian flow, are located close to destination and/or building entrances, and are appropriately lighted and located with a clear view to ensure safety for the user. Below are examples of some commonly used bike rack systems.



Source: *Bicycle Parking Guidelines*, Association of Pedestrian and Bicycle Professionals, 2002, www.apbp.org.

Bicycle-Activated Detector Loops

Intersections along primary corridors can be adjusted to recognize bicycles, thus creating safer conditions for cyclist and motorist. Bicycle-activated loop detectors can be installed within the roadway allowing the weight of the bicycle to trigger a traffic signal change. Bicycle-loop intersections should include pavement marking to guide the cyclist to the location to trip the timed system.

Public water facilities

At primary system nodes, such as trail heads and primary recreation facilities, and common public facilities such as libraries and governmental offices, there should be clearly available and marked drinking fountains.

Other ancillary facilities that should be included within the overall system and should be expanded and built upon as the use and demand within a community increases include such items as bicycle lockers and air pumping facilities at key trail heads and transit stations.

Obstacles for Cyclist

Bicycle use on roads is an appropriate, expected, and legal transportation mode. The only exception is in specific locations where bicycle use is stated as illegal, these locations are in general along high-speed, limited-access highways. While almost any road may be used by cyclists for transportation purposes, there are a number of key obstacles that limit comfortable transportation use by most cyclists. Most of these obstacles are related to safety and cyclist vulnerability by traveling on the same grade surface as motorized vehicles.

Below is an overview of the more common obstacles faced by cyclists when traveling along the road system. Addressing solutions to elevate these conditions through design and education is crucial in creating an atmosphere that supports a safe and efficient bicycle transportation network. The most common obstacles faced by bicyclists include:

- Not enough separation from motorized vehicles/effective width available for bicyclists;
- Speed of traffic along road;
- Volume of vehicles along the road;
- Surface conditions of the pavement along the road;
- Existence of parking along the road; and
- Amount of large vehicles/trucks that travel along the road.
- Lack of motorist education on cyclist rights and practices

The difference in the physical characteristics and bicycle knowledge of potential cyclist, variation in facility condition, and cyclist obstacles highlight the need to implement the physical and programmatic solutions necessary to create a safe bicycle network.

Determining Facility Options

There are many parameters that must be factored when determining bicycle facility accommodation options available to create a safer and effective alternative transportation corridor.

Bicycle Level of Service and Bicycle Compatibility Index

Evaluation measures have been developed by transportation specialists to assist in determining cyclist comfort along specific conditions and methods to evaluate changes that would enhance comfort and safety. Two mathematical methods have been developed to assist in evaluating the Level of Service (LOS) of a particular road for its ability to accommodate on-road cycling along with current motorist use. These mathematical methods are the Bicycle Level of Service (BLOS) and Bicycle Compatibility Index (BCI). Both BCI and BLOS utilize a rating system from A to F , where A represents the highest level of bicycle accommodation and cyclist comfort descending to F, representing a high degree of cyclist discomfort.

Level of Service Evaluation Methods and Descriptions

Level of Service (LOS)	BLOS Score	Cyclist Comfort Description (BLOS)	Bicycle Compatibility Index (BCI) Range	BCI Level
A	< = 1.5	Excellent bicycle environment	< = 1.50	Extremely High
B	1.5 – 2.5	Good Bicycle Environment	1.51. – 2.30	Very High
C	2.5 – 3.5	Fair (acceptable to experienced cyclist and novice cyclist)	2.31 – 3.40	Moderately High
D	3.5 – 4.5	Poor environment (acceptable to experience bicyclists)	3.41 – 4.40	Moderately Low
E	4.5 – 5.5	Deficient environment (unacceptable to experienced and novice bicyclists)	4.4.1 – 5.30	Very Low
F	> 5.5	Unsafe environment (unsuitable for any bicycle travel)	> 5.30	Extremely Low

Source: City of Raleigh Bicycle Transportation Plan, 2009; Bikeway Plan for Roanoke Valley Area MPO, 2005

The Bicycle Level of Service (BLOS) Model represents an evaluation of physical features which are evaluated to establish a perceived comfort level and safety experience by a cyclist while taking into account the standard vehicular use of the road. As such, the BLOS considers the bicyclist experience quality given current road conditions. It is important to keep in mind that the BLOS evaluation method represents a perceived, therefore subjective, comfort level, and represented grades do not reflect safety, take into account accident data, include intersection evaluations along corridors, and are dependent on accuracy of data input. The BLOS model utilizes evaluation data which include:

- Motor vehicle traffic volume and speed
- Number of travel lanes
- Presence of on-street parking
- Presence and width of paved shoulder
- Pavement condition
- Percentage of heavy trucks.

The Bicycle Compatibility Index (BCI) Model is a mathematical equation that evaluates the capability of a road to accommodate both motorist and cyclist. This evaluation technique was developed by the Federal Highway Administration (FHWA) and includes evaluation parameters such as:

- Number of travel lanes
- Curb and shoulder width/availability

- Land use indicator (commercial/residential)
- Speed limit
- 85% of speed
- Average Annual Daily Travel and % of high volume/large trucks daily
- Parking information

Both the BCI and BLOS evaluation techniques are utilized by planners and engineers to assist in accommodation evaluations, planning, road and accommodation design evaluations, and route selection and suggestions. It is important to note, that while either a BLOS or BCI rating is a very valuable planning and evaluation tool, neither method is a guarantee of absolute on-road cyclist safety. However, these evaluation techniques are extremely valuable in their application to assist with accommodation planning.

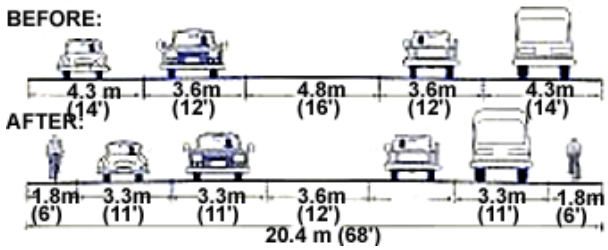
Strategies to Create Bicycle Facilities

There are a number of strategies that can be employed to create on-road accommodations. This section provides an overview of some of the more common road adjustments that can be made to create on-road facilities. It should be noted that with all accommodation methods, corresponding signage is required.

Road Restriping

Road restriping describes the process of adjusting current road travel width by restriping, or narrowing lane markings, without adjusting current road width to create a bicycle accommodation. Road restriping can be used to narrow the widths of travel lanes to create space for either a bicycle lane or wide outside lanes. AASHTO supports that travel lanes between 10 and 12 feet is adequate design standards for most urban collectors and urban arterials where there is good operating flow and low speed (45 MPH or less)(1). It should be noted that lane narrowing and reduction of lane width does require detailed design analysis by an engineer and is beyond this planning level. Further, along roads with higher traffic volumes and limited sight distance, wider lane width is warranted.

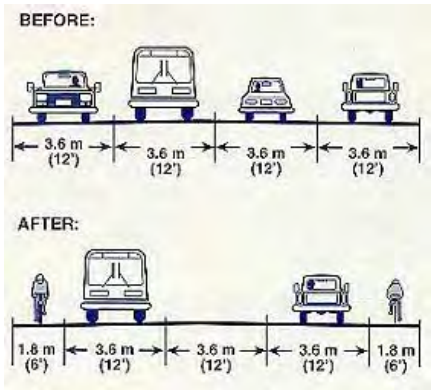
Source: FHWA



Reduced travel-lane width

Road restriping example - an existing five lane road with 12' lanes (total 60' of road width) could be adjusted to five 10' lanes and 5' bike lanes (total 60' of road width).

Source: FHWA



Travel lanes reduced from four to two, with center turn lane

Road Diet/Reduce Travel Lanes

A road diet refers to the process of reducing the number of travel lanes to create additional space for creation of road accommodation. The most common example is a reduction of a four-lane undivided to a one travel lane in each direction, with a center turn lane and two bike lanes. Road diets are good choices where the goal is to also create traffic calming along a roadway.

Considerations to road level of service are necessary for use of this accommodation.

Road Striping

Road striping refers to those roads that require only striping to create on-road accommodations. These accommodations may be either creation of a preferred bicycle lane or at a minimum, creation of additional shoulder space. No other adjustments are required along roads only requiring striping only.

Pavement Markings

Pavement marking with bicycle symbols placed within the roadway lane provides visual cues to both motorists and cyclists. Pavement markings indicate a share the lane condition and unlike bicycle lanes do not separate cyclists from motorists. Create an option where road condition does not allow for restriping or stripping accommodation strategies.

New Construction

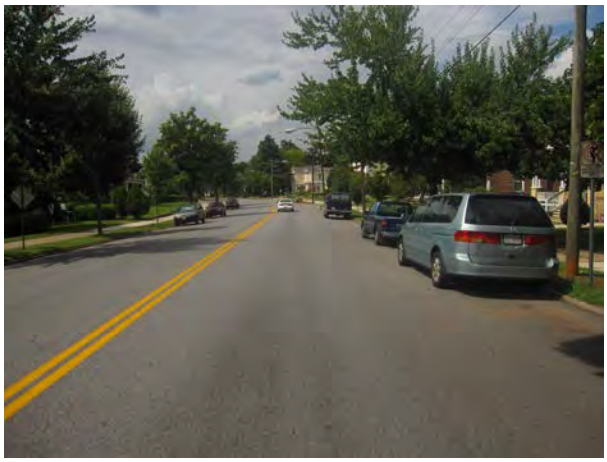
This method for creating on-road accommodations refers to adding additional pavement width to a roadway to accommodate inclusion of a bicycle facility. Coordination during roadway design or reconstruction schedules provides accommodation options. Where space is available along primary roads, opportunities for sidepaths can also be considered within the new construction.

Region 2000 Road Examples

The following local roads have been adjusted to give an example of bicycle accommodation strategies.

Memorial Avenue, Lynchburg

Restriping of Memorial Avenue to narrow existing turning lane to accommodate bicycle lanes.



Rivermont Avenue, Lynchburg

Striping along Rivermont Avenue to create bicycle lanes.