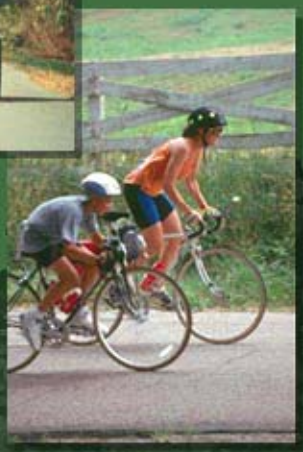
Frederick County Department of Parks and Recreation

FREDERICK COUNTY
PARKLANDS



BIKEWAY AND TRAIL
Design Standards
AND
Planning Guidelines

Adopted
July 2003

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FREDERICK COUNTY PARKLANDS

BIKEWAY AND TRAIL

Design Standards

AND

Planning Guidelines

As adopted by the Parks and Recreation Commission of Frederick County, Maryland

July 9, 2003

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As adopted by the Board of County Commissioners of Frederick County, Maryland

July 22, 2003

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BACKGROUND INFORMATION

Introduction
Purpose
Goals
History
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Resources

Introduction

Surveys conducted throughout the country indicate that trails are in high demand nationwide and are being heavily used for both recreation and transportation purposes. Trails are seeing immense popularity because they offer many benefits and are commonly seen as enhancing the quality of life for the surrounding communities which they serve. Aside from being a recreational amenity, trails offer the following benefits:

- Trails promote health and fitness by providing people the opportunity for active recreation in a variety of ways.
- Trails offer viable and safe transportation alternatives by connecting residential areas, recreational areas, commercial areas, employment centers and schools.
- Trails support the protection and preservation of natural resources and allow users to experience scenic natural environments within and through established greenway corridors.
- Trails promote economic development, specifically at trailhead locations, and may spur other benefits such as increase in property values and attraction of businesses.
- Trails increase user safety by offering dedicated travel routes for pedestrians, bicyclists, skaters and equestrians.

Recognizing these benefts and with a desire to promote recreational trail use to both residents and visitors, the Board of County Commissioners of Frederick County, Maryland adopted the *Frederick County Bikeways and Trails Plan* in December of 1999 as a first formal effort in identifying a comprehensive countywide network of bikeways and trails. The adopted plan reflects the county's vision statement:

> *Frederick County will be a place where bicycling and walking are viable modes of travel for recreation and transportation purposes. A network of bikeways and multi-use trails will provide safe and convenient connections between the County's municipalities and would provide access to recreational, historical/cultural, commercial, and employment areas.*

Purpose

The implementation of a countywide trail system requires consistency of design and quality. Trail users throughout Frederick County should expect safe, user-friendly and accessible trail facilities that provide quality environments and experiences that are inclusive of all people. In an effort to encourage design consistency, this document establishes a framework of design standards, planning guidelines, policies and recommendations for future implementation of off-street natural surface trails and multi-use trails within Frederick County's proposed network of future parklands and trail corridors. The guidelines set forth in this document are based on current recognized standards and recommendations by national transportation and recreation agencies and are designed to serve as a prelude to more detailed trails planning efforts.

Goals

The *Frederick County Parklands Bikeway and Trail Design Standards and Planning Guidelines* are established to help accomplish the following goals:

- Promote consistency of standards and guidelines for county parklands along proposed corridors specified in the *Frederick County Bikeways and Trails Plan.*
- Create a framework for future trail planning by a variety of agencies, jurisdictions and developments.
- Increase user safety, comfort and convenience by recommending appropriate design considerations for pathways, signage, facilities, landscaping, etc.
- Promote universal access to users with a broad range of skill levels and abilities, including children, older adults and people with disabilities.
- Recognize a variety of trail users including pedestrians, cyclists, in-line skaters and equestrians.
- Minimize impact to sensitive natural resources including wetlands, slopes, soils, and cultural resources.
- Support the Maryland Department of Transportation *Twenty Year Bicycle and Pedestrian Access Master Plan* as an outgrowth of the state's "Smart Growth" policies.
- Follow current recognized design guidelines being used with success nationwide.
- Increase the ease of long-term trail and facility maintenance by recommending the use of high-quality materials and promoting quality construction practices.

History

Federal

In 1991, federal transportation legislation was passed, creating the *Intermodal Surface Transportation Efficiency Act (ISTEA)*, which helped to increase the amount of federal funding available for trail projects throughout the country. Seven years later, the *Transportation Equity Act for the 21st Century (TEA 21)* expanded the provisions for non-traditional transportation projects such as bicycle and pedestrian facilities, specifially those facilities that provide off-road connections between residential areas, employment areas, schools and public transit facilities. It also requested that States begin to develop their own bicycle and pedestrian plans to encourage statewide promotion of multi-modal transportation. The following Federal programs are funded through TEA 21 and promote the development of off-street trail facilities:

- *Transportation Enhancement Program*
- *Recreational Trails Program*
- *Congestion Mitigation and Air Quality Improvement Program (CMAQ)*
- *National Scenic Byways Program*
- *Job Access and Reserve Commute Grants*
- *Transit Enhancement Activity Program*

State

Established in 1969 under the Department of Natural Resources*, Program Open Space* is a nationally recognized program providing dedicated funds for Maryland's state and local parks and conservation areas. The program symbolizes Maryland's long term commitment to conserving its natural resources and has been the primary source of state funding for trail projects.

The *Maryland Greenways Commision,* established by Executive Order in 1990, works closely with the Department of Natural Resources and the Maryland Department of Planning to track and promote greenway conservation activities in Maryland. Greenways are protected areas of linear open space, roughly established along natural corridors such as stream valleys and ridgelines, or human landscape features such as former railroad corridors and highway corridors. The Commission's goal is to create a statewide greenways infrastructure by protecting and connecting important natural corridors throughout the state, many of which provide people with trail access to outdoor recreation and enjoyment.

In response to increased public interest in bicycle and pedestrian travel, the State of Maryland, in 2000, adopted House Bill 1147, *Bicycle and Pedestrian Access 2001,* which seeks to improve bicycle and pedestrian facilities for the citizens of Maryland. The law, which supports the State's "Smart Growth" initiatives, mandated the development of a twenty-year bicycle and pedestrian master plan which would identify greenways and long distance routes that facilitate multi-modal transportation across the state. It also directs resources to both existing and new bicycle and pedestrian programs.

The Maryland Department of Transportation's *Twenty Year Bicycle and Pedestrian Access Master Plan*, issued in October 2002, states that Maryland is striving to be the best State in the nation for bicycling and walking and identifies the following vision statement to describe what it means to be the "best":

> *Maryland will be a place where people have the safe and convenient option of walking and bicycling for transportation, recreation, and health. Our transportation system will be designed to encourage walking and bicycling, and will provide a seamless, balanced and barrier-free network for all.*

County

Although Frederick County has been a popular location for recreational road cycling for people from across the State and the surrounding four-state region, there had never been a formal effort to identify, develop and promote a network of bikeways and trails in the County until several years ago. In 1999, the Board of Commissioners of Frederick County adopted the *Frederick County Bikeways and Trails Plan*, which identified strategies related to planning, facilities, education and promotion, and identified a proposed countywide network of both on-street and off-street bike routes and trail corridors, as depicted in the *Frederick County Bikeways and Trails Plan* map (see Appendix A). The plan indicated that the County did not have any current design standards but that it would pursue the development of design standards, planning guidelines and recommendations in order to promote consistency of design and quality.

Proposed Trail Corridors

As Maryland's largest county, Frederick County has several large parcels of established open space that provide a spectacular framework for the proposed bikeways and trails corridors. They include the Catoctin Mountain Park, Cunningham Falls State Park, Gambrill State Park, Sugarloaf Mountain, Monocacy River Corridor, Monocacy Natural Resource Area, the Frederick Municipal Forest, Monocacy National Battlefield Park, and the C&O Canal National Historic Park. Many of these areas offer unique natural experiences and provide connections between communities and recreational, historic and cultural resources throughout the county.

The Proposed Corridors for Future Parkland's Off-Street Bikeways and Trails map (see Appendix B) depicts a proposed network of trail corridors throughout the county, as identified in the *Frederick County Bikeways and Trails Plan*. The designated routes and recommended connection points are intended to be conceptual in nature and do not detail specific alignments, trail use, trail surface and other detailed design issues. The actual alignments of trails and detailed planning efforts within these corridors will be determined as specific trail projects are proposed and implemented within future parkland dedicated to the County specifically for trail construction.

Resources

Many national and state agencies have set forth exemplary design guidelines, standards and recommendations for bikeways and trails. The *Frederick County Parklands Bikeway and Trail Design Standards and Planning Guidelines* has relied heavily on these invaluable resources, adapting them to suit the unique conditions of Frederick County, and in some cases pulling text directly from the established and proven resources. Future trail implementors, such as architects, engineers, developers and land planners are strongly encouraged to consult these documents. The major sources include the following documents:

Guide for the Development of Bicycle Facilities, American Association of State Highway and Transportation Officials (AASHTO): 1999.

Twenty Year Bicycle and Pedestrian Access Master Plan, Maryland Department of Transportation (MDOT): 2002.

Maryland Atlas of Greenways, Water Trails and Green Infrastructure, Maryland Greenways Commission: 2000.

Frederick County Bikeways and Trails Plan, Frederick County Department of Planning and Zoning: 1999.

Manual on Uniform Traffic Control Devices (MUTCD), U.S. Department of Transportation, Federal Highway Administration: 2000.

Designing Sidewalks and Trails for Access: Part I of II: Review of Existing Guidelines and Practices, Federal Highway Administration (FHWA): 1999.

Designing Sidewalks and Trails for Access: Part II of II: Best Practices Design Guide, Federal Highway Administration (FHWA): 2001.

Accessibility Guidelines for Outdoor Developed Areas, Americans with Disabilities Act Accessible Guidelines (ADAAG): 1999 (Final Report).

National Bicycle and Walking Study, Current Planning Guidelines and Design Standards Being Used by State and Local Agencies for Bicycle and Pedestrian Facilities, Federal Highway Administration (FHWA): 1992.

Conflicts on Multiple-Use Trails, Synthesis of the Literature and State of the Practice, Federal Highway Administration (FHWA): 1994.

Oregon's Bicycle and Pedestrian Plan, Oregon Department of Transportation: 1995.

Iowa Trails 2000, Iowa Department of Transportation: 2000.

National Bicycle and Walking Study, Federal Highway Administration: 1992.

Frederick County Zoning Ordinance. Adopted and amended by the Frederick County Board of County Commissioners, Administered by the Frederick County Planning and Zoning Department.

Soil Survey of Frederick County Maryland. United States Department of Agriculture, Natural Resources Conservation Service in cooperation with Board of County Commissioners of Frederick County, Catoctin Soil Conservation District, Frederick Soil Conservation District, and Maryland Agricultural Experiment Station (University of Maryland): 2002.

2000 Maryland Stormwater Design Manual Volumes I & II. Center for Watershed Protection, Maryland Department of the Environment, Water Management Administration: 2000.

Maryland Department of Transportation State Highway Administration Standard Specifications for Construction and Materials. January 2001.

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SENSITIVE TRAIL LOCATIONS

Soils
Wetlands
Floodplains
Natural and Cultural Resources

The following information is provided to assist the trail designer in creating a trail that is sensitive to the natural features of the site. These areas require special consideration to properly retain and enhance their natural characteristics. A trail that considers the existing soil properties improves stability, safety, and long-term maintenance. Wetland and floodplain areas significantly enhance the trail user's experience by preserving the natural environment. Historic and cultural sites add variety and education to the experience. The information in this section highlights the major considerations regarding natural and cultural features, but will require further research once the variables have been determined for each specific site.

Soils

Soil conditions affecting trail design and implementation are to be examined on a case by case basis. The *Frederick County Parklands Bikeway and Trail Design Standards and Planning Guidelines* includes a graphic plan of the current General Soil Map for Frederick County, Maryland (see Appendix C). The map and the *Soil Survey of Frederick County, Maryland* were compiled by the United States Department of Agriculture and the Natural Resources Conservation Service in cooperation with the Board of County Commissioners of Frederick County, the Catoctin Soil Conservation District, the Frederick Soil Conservation District, and the Maryland Agricultural Experiment Station. The *Soil Survey* was adopted by the Board of County Commissioners on November 19, 2002. The map delineates 11 general soil map units across the county.

The following is a brief description of each unit condensed from the *Soil Survey of Frederick County, Maryland*. The slopes in the *Soil Survey* are divided in the following categories:

Nearly level ….....0 to 3 percent
Gently sloping..... .....3 to 8 percent
Strongly sloping.....8 to 15 percent
Moderately steep.....15 to 25 percent
Steep.....25 to 45 percent

Highfield-Ravenrock
These are gently sloping to steep, very deep, well drained soils. They occur in the region of the Blue Ridge that lies between South and Catoctin Mountains and in scattered areas near Sugarloaf Mountain. Slopes range from 3 to 65 percent but are commonly less than 25 percent. Highfield soils have a gravelly subsoil. Ravenrock soils have a wet substratum and a gravelly loamy subsoil.

Bagtown-Stumptown-Edgemont
These are gently sloping to very steep, moderately deep and very deep, well drained and moderately well drained soils. They occur on the mountain ridges and backslopes of Catoctin and South Mountain. Slopes range from 0 to 65 percent but are commonly less than 45 percent. Bagtown soils are well drained and have a seasonal high water table between depths of 3.5 and 5 feet. They are very deep and have a loamy subsoil. Stumptown soils are moderately deep, are well drained, and have a very loamy subsoil. In areas of Stumptown soils, as much as 15 percent of the soil surface is covered with stones and boulders. Edgemont soils are very deep, are well drained, and have a gravelly loamy subsoil.

Myersville-Catoctin-Mt. Zion
These are nearly level to steep, moderately deep and very deep, well drained and moderately well drained soils. They occur on summits, backslopes, footslopes, and in drainageways of the Blue Ridge between South and Catoctin Mountains. Slopes range from 0 to 45 percent. Myersville soils are very deep, are well drained, and have a loamy subsoil. Catoctin soils are moderately deep, well drained, and have a gravelly loamy subsoil. Mt. Zion soils are very deep and moderately well drained.

Trego-Foxville-Thurmont
These are nearly level to moderately steep, very deep, well drained to somewhat poorly drained soils. They occur on the lower mountain backslopes and footslopes of South and Catoctin Mountains in the Blue Ridge region. Slopes range from 0 to 15 percent but are commonly less than 15 percent. Trego soils are moderately well drained and have a seasonal high water table between depths of 1.5 and 3.5 feet, and have a gravelly loamy subsoil. Foxville soils are somewhat poorly drained and have a loamy subsoil. Thurmont soils are well drained and have a loamy subsoil.

Mt. Airy-Glenelg-Blocktown
These are nearly level to very steep, shallow, moderately deep, and very deep, well drained soils. This map unit occurs on ridges and side slopes of highly dissected landforms of the eastern Piedmont Plateau. Slopes range from 0 to 65 percent but are commonly less than 50 percent. Mt. Airy soils are moderately deep and have a very channery loamy subsoil. Glenelg soils are very deep and have a loamy subsoil. Blocktown soils are shallow and have a very channery loamy subsoil.

Penn-Klinesville-Reaville
These are nearly level to steep, moderately well drained and well drained, shallow and moderately deep soils. They occur on the part of the Frederick Valley known as the Triassic Basin. Slopes range from 0 to 65 percent but are commonly less than 30 percent. Penn soils are moderately deep, well drained, and have a very channery loamy subsoil. Klinesville soils are shallow and have a very channery loamy subsoil. Reaville soils are moderately well drained and have a silty suboil.

Duffield-Hagerstown-Ryder
These are nearly level to steep, moderately deep to very deep well drained soils. This map unit occurs in the Frederick Valley from about 1 mile west of the city of Frederick to the Araby Ridge in the east and at the Potomac River as a narrow band that widens to the northeast as far as Woodsboro. Slopes range from 0 to 25 percent. Duffield soils are very deep and have a loamy subsoil. Hagerstown soils are very deep and have a clayey subsoil. Ryder soils are moderately deep and have a loamy subsoil.

Linganore-Hyattstown-Conestoga
These are nearly level to steep, shallow, moderately deep, and very deep, well drained soils. They occur in the area that is centered around Urbana and runs from the southwest, at the Montgomery County line, to the northeast near Clemsonville. Slopes range from 3 to 65 percent. Linganore soils are moderately deep and have a very channery loamy subsoil. Hyattstown soils

are shallow and have a very channery loamy subsoil. Conestoga soils are very deep and have a loamy subsoil.

Cardiff-Whiteford
These are nearly level to steep, moderately deep and deep, well drained soils. They occur on a narrow ridge known as the Araby Ridge that runs from Woodsboro in the north to the Potomac River in the south. Slopes range from 3 to 65 percent but are commonly less than 40 percent. Cardiff soils are moderately deep and have an extremely channery loamy subsoil. Some areas of these soils have as much as 10 percent of the surface covered with flagstones. Whiteford soils are deep and have a loamy suboil.

Codorus-Hatboro-Combs
These are nearly level and gently sloping, very deep, well drained, moderately well drained, and poorly drained soils. They are located around perennial streams and major rivers. Codorus soils are moderately well drained and have a loamy substratum. Hatboro soils are poorly drained and have a loamy substratum. They are in backwater and depressional areas. Combs soils are well drained and formed in areas that have been built up from sedimentation and that flood less frequently. Approximately 12 percent of this map unit, or 3,000 acres, is water, dominantly major waterways, including the Potomac and Monocacy Rivers.

Rowland-Bermudian-Bowmansville
These are nearly level, very deep, well drained, moderately well drained, and poorly drained soils. They are located along perennial streams in the part of the Frederick Valley known as the Triassic Basin. Rowland soils are moderately well drained and have a stratified subsoil that is part loamy and part sandy and gravelly. Bermudian soils are well drained. They are loamy or sandy in the subsoil below a depth of 40 inches. Bowmansville soils are poorly drained and have a dominantly loamy subsoil. Approximately 18 percent of this map unit, or 1,645 acres, is water, mainly major streams.

The general soil map and descriptions are a guide for the trail designer to alert them to the general soil conditions to be encountered. Further detailed information can be obtained from the *Soil Survey of Frederick County, Maryland.*

It is a standard requirement for soil types to be delineated on development plans that are submitted to Frederick County for review and approval. This, in conjunction with these guidelines, will highlight soils that may need additional consideration for trail design due to factors such as high water table, slope, stones, soil erodability, etc.

The general soil information included in the *Frederick County Parklands Bikeway and Trail Design Standards and Planning Guidelines* inform the designer of the need for more soil condition research. Some sites may require geotechnical engineering investigation to determine the extent of the soil in relation to the trail and to develop recommendations for trail construction in problem areas. It is the developer's responsibility to perform compaction testing and geotechnical studies, as necessary, and to implement the recommendations for trail construction.

The following chart is a guide to soil characteristics for the General Soil Map (see Appendix C). It specifically relates soil suitability to paths and trails. This information has been condensed from the *Soil Survey of Frederick County, Maryland*. More detailed information can be obtained from the *Soil Survey*. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation.

Soil Name	Rating Class (with limiting features for paths and trails)
Highfield	Somewhat limited to very limited depending on slope, Too stony
Ravenrock	Very limited, Too stony
Bagtown	Very limited, Too stony, Content of large stones.
Stumptown	Somewhat limited to very limited depending on slope, Content of large stones
Edgemont	Not limited to very limited depending on slope, Too stony.
Myersville	Not limited
Catoctin	Not limited to very limited depending on slope and stones
Mt. Zion	Not limited
Penn	Not limited
Klinesville	Not limited to very limited depending on slope
Reaville	Very limited, Depth to saturated zone, Ponding
Duffield	Not limited
Hagerstown	Not limited
Ryder	Not limited
Linganore	Not limited to somewhat limited depending on slope
Hyattstown	Not limited to very limited depending on slope
Conestoga	Not limited
Trego	Not limited
Foxville	Very limited, Too stony, Content of large stones, Depth to saturated zone
Thurmont	Not limited
Mt. Airy	Not limited to very limited depending on slope
Glenelg	Not limited
Blocktown	Not limited to very limited depending on slope
Cardiff	Not limited to very limited depending on slope
Whiteford	Not limited

Soil Name (cont.)	Rating Class (with limiting features for paths and trails) (cont.)
Codorus	Not limited
Hatboro	Very limited, Depth to saturated zone, Ponding
Combs	Not limited
Rowland	Not limited
Bermudian	Not limited
Bowmansville	Somewhat limited, Depth to saturated zone

Wetlands

The impact of wetlands on trail design also necessitates special consideration. Wetland areas in Maryland are under the jurisdiction of the Army Corps of Engineers and the Maryland Department of the Environment. Any trail development impact on wetland areas must be reviewed and approved by the federal, state and local agencies. It is incumbent upon the design team to determine if there is potential impact to a wetland area. Wetlands are identified by type of vegetation, presence of water, and soil conditions. When wetlands are impacted by trail location a certified wetland delineator must determine the location of the wetland in accordance with MDE requirements. A plan and report will be filed with MDE for review and approval of the trail impact.

The National Wetlands Inventory maps are a good source to determine the presence of potential wetland areas. These maps were prepared by the U.S. Department of the Interior, Fish and Wildlife Service. They show potential wetland areas on U.S. Geological Survey maps at a scale of one inch equals 2,000 feet. The maps were prepared by analysis of aerial photographs, therefore, an on-the-ground analysis of the site is necessary to determine the actual presence and extent of wetlands. The maps can be viewed at the Frederick County Department of Planning and Zoning or by contacting the U.S. Department of the Interior.

The general recommendation is to create as little impact on the wetlands as possible. If a trail cannot be designed around the wetland area then the trail crossing should occur at a narrow section where there will be less disturbance to the wetland. When it is necessary to cross the wetland, a raised boardwalk design should be considered. This has several advantages for trail design. A raised boardwalk makes the trail less susceptible to water table fluctuations, protecting it from the deteriorating effects of the water, and it makes the trail more useable during inclement weather when a groundsurface trail would be covered with water. A boardwalk trail also has less impact on wetlands, since there is no structural fill required for this type of trail (refer to the section on “Grade-Separated Crossings” for more information regarding boardwalks).

If the wetland crossing is larger or deeper than a boardwalk can safely negotiate, then a bridge structure should be considered (refer to the section on “Grade-Separated Crossings” for for information regarding bridges).

Floodplains

Floodplains are an important consideration in the design of bike paths and trails. Many of the proposed trails in the county are near floodplains and stream corridors which present both negative and positive influences to trail design. A floodplain curtails the use of a trail when it is inundated by water and can increase trail maintenance with mud, debris or washout during a flood occurrence. Conversely, trails are well suited to stream corridors for several reasons. Flood damage to a trail is minor compared to above ground structures, loodplains are usually left in a natural vegetative state, which provides an enhanced environment for trail users, and a large variety of plants and animals congregate along stream corridors because of the availability of water, food and habitat.

For design purposes it is recommended that trails near floodplains and stream corridors be located outside and parallel to the "stream buffer", which Frederick County defines as a 50 foot setback from the bank of any perennial or intermittent stream. This will be discussed in greater detail below. Trails should avoid this area when possible or create as little disturbance as possible. Stream crossings by trails should be kept to a minimum.

At the same time, trail development can be designed to enhance the floodplain environment. One technique is to create forestation planting projects along the trail. State or county funding may be available for forestation from the Fee-in-Lieu-of planting account. This encourages reforestation of open space areas within the floodplain and stream corridor. These are high priority areas for forestation, because the forest provides benefits of slowing floodwater and filtering overland flow of sediment and pollutants before they reach the stream. Tree plantings for forestation projects should not be closer than ten feet to the trail surface. This distance discourages tree roots cracking and uplifting the pavement surface, and allows for lateral branch growth that will not interfere with the vertical clearance required for trail users.

Other techniques to enhance stream corridors are to plant native grasses along the trail, or a mixture of grasses and native shrubs. These provide similar filtration benefits to forestation and offer a planting option for situations where forestation is not practical. The grasses and shrubs must be adapted to thrive in the soil and water conditions of the floodplain. Appropriate varieties can be found in the 2000 Maryland Stormwater Design Manual Volumes I & II, Appendix A, Landscaping plant lists.

Any trail development within the floodplain or stream buffer will be strictly controlled by federal, state and county agencies and will require extensive review. The 100 year floodplain area must be delineated on development plans submitted to review agencies. Floodplain areas are depicted on maps produced by the Federal Emergency Management Agency (FEMA) and titled *Flood Insurance Rate Map Frederick County, Maryland*. This series of maps covers the county, and depicts the 100 year flood boundary. The maps can be viewed at the County Department of Planning and Zoning or purchased from FEMA.

Frederick County addresses floodplain districts in detail in Section 1-19-326 and 327 of the County Zoning Ordinance. Currently, these sections of the ordinances state that a minimum setback of 25 feet shall be provided from all floodplain boundaries, or 50 feet from the bank of any perennial or intermittent stream, whichever is greater (see Figure 1). The 50 foot setback is

required by the county as a "stream buffer" when a stream does does not have a floodplain delineated on the FEMA map. All development plans shall have floodplain boundaries and 100 year water surface elevations, where applicable, delineated on the plan in accordance with the ordinance. Please note that the county Zoning Ordinance (2003) is currently in a review and update process that may affect these setbacks and regulations. Any stream buffer or floodplain activities must obtain all federal, state, and local permits.

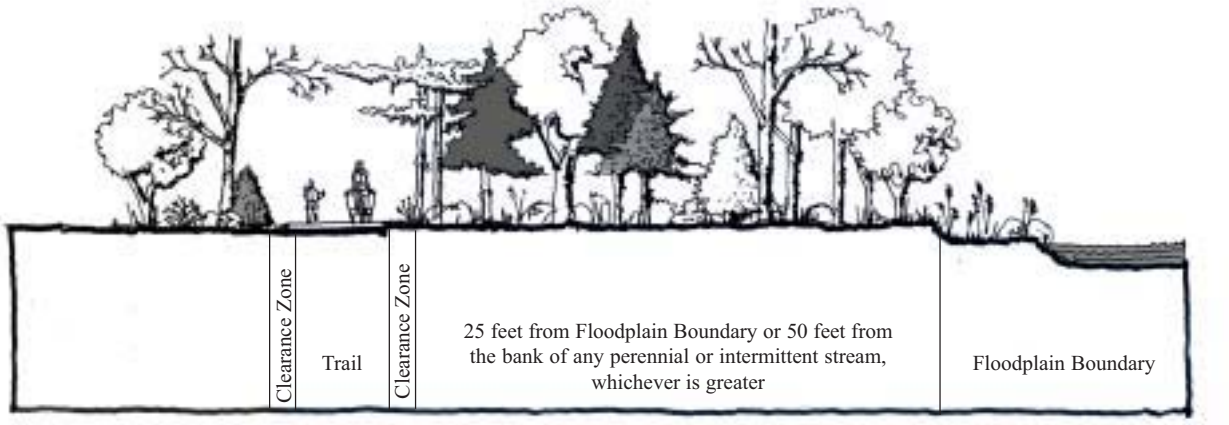

Figure 1 *Typical Cross-Section of Trail Near Floodplains*

The following information from the Zoning Ordinance should be considered for potential impact on the design of trails and trailhead facilities. Section 1-19-327 (c) of the ordinance states that within the FEMA annual or wetland area floodplain no land development, including parking lots, fill or excavation operations will be permitted. However, open shelters, pole type structures, fences and recreational uses not contained in a building are exempt from these provisions, upon obtaining a zoning certificate for construction.

In May of 1990 the Monocacy Scenic River Advisory Board established a river corridor overlay boundary for the Monocacy River. This boundary is 500 feet from the center of the river to each side. The purpose is to conserve river related resources and land features within the corridor. This boundary does not restrict the placement of trails within the overlay area.

Since many trails may be located along the floodplain, it is important to design for their impact. Drainage is the primary consideration. Trail layout and grading should be performed to maintain and encourage the natural drainage pattern when possible. Trails that counteract the natural drainage flow will usually become the new water channel. They offer the path of least resistance to water, which will encourage erosion, surface saturation, and frequent inundation. These factors will decrease the trail access for all users.

A two percent cross slope simplifies drainage and surface construction. An even cross slope surface will prevent water ponding and ice formation. Erosion can be reduced by maintaining the natural groundcover or seeding, mulching and sodding adjacent erodible areas. Drainage swales or mounds can be utilized to channel water away from the trail. Culverts may be necessary to move the water from one side of the trail to the other.

The following is a list of the floodplain soils in Frederick County. If any of these occur on a project, trail design and construction should account for the limitations these soils present. This list was adopted by the Board of County Commissioners on November 19, 2002.

Map Symbol	**Soil Name**
AfB	Adamstown-Funkstown complex
BfA	Bermudian silt loam
BmA	Bowmansville-Rowland silt loams
BmB	Bowmansville-Rowland complex
CgA	Codorus-Hatboro silt loams
CmA	Combs fine sandy loam
CnA	Combs silt loam
FoB	Foxville cobbly silt loam
FxA	Foxville-Hatboro soils
GvA	Glenville-Codorus complex
GvB	Glenville-Codorus complex
HdA	Hatboro-Codorus silt loams
LaB	Lantz-Rohrersville silt loams
LsA	Lindside silt loam
MaA	Melvin-Lindside silt loams
MoB	Mt. Zion-Codorus complex
RoB	Rohrersville-Lantz silt loams
RwA	Rowland silt loam
TxB	Trego-Foxville complex
WhB	Wheeling gravelly loam
WtB	Wiltshire-Funkstown complex

Natural and Cultural Resources

Incorporating natural and cultural resources in trail designs will significantly enhance the user's experience. Trails can provide an educational opportunity to learn about the natural environment, history and culture of the inhabitants. Natural resources include wetlands, floodplains, stream corridors, woodlands, steep slopes, soils, geologic features, plant and animal habitat, and scenic natural environments. Cultural resources include historic sites, archaeological sites, and recreational sites comprising county and municipal parks, state and national parks, and battlefields.

Natural and cultural resource areas require special consideration for trail design. The trail needs to provide a unique experience for the user, without compromising the resource that is being displayed. Trail design relating to soils, wetlands, floodplains and streams is discussed in previous sections of this manual.

Natural and cultural resources of plant/animal habitat or historic/archaeological sites can provide an educational experience for the trail user. These trails should have appropriate signage or interpretive brochures to identify features and provide information about the resource. In some instances, it is beneficial to create an interpretive trail if there are numerous points of interest in one location (refer to the section on "Support Services" for more information on interpretive facilities).

Trails through natural and cultural resources need to be sensitive to the particular feature. They should be designed with minimal impact to the environment, while still enhancing the user's experience. Opportunities should be provided for multiple sensory experience that will be available to people with different abilities. These features may include signs with large print, Braille, audio information, three-dimensional maps, and tactile surfaces. Trails that highlight natural and cultural resources add an extra dimension of interest for the trail user.

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DESIGN STANDARDS FOR DIFFERENT USE-MODES

Definitions
Natural Surface Trails
Improved SurfaceTrails

Definitions

Alignment: Refers to the horizontal curvature of the trail.

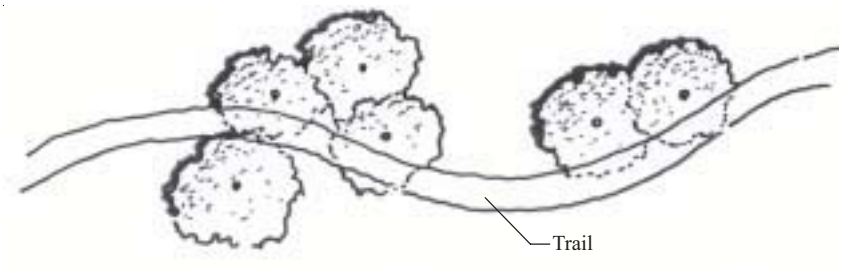


Figure 2 *Trail Alignment*

Basic Cyclist: Casual and/or novice cyclist that includes less experienced adults and children who are not comfortable riding in trafic.

Bikeway: Any path, trail or way which in some manner is specifically designed as being open to bicycle travel.

Clear Trail Width: Refers to the width of the traveled part of the trail that is free of protruding objects and obstacles, such as trees and overgrown vegetation.

Clear Zones: Refers to the area on each side of the trail between the traveled surface and any obstructions, such as trees, walls, or fences.

Cross Slope: The slope measured perpendicular to the direction of travel.

Drainage: Refers to techniques used to move and keep water off the trail and trail embankment.

Edge Protection: Edge protection is a physical barrier along the edge of the trail that serves to protect the user from potential hazardous conditions. Hazardous conditions include steep slopes, bodies of water, poisonous plants, etc. The protection can be a small 3 inch curb made of wood, stone, asphalt or concrete, or it can be a 42 inch high railing of sturdy construction. Dense landscaping can also be used for edge protection. The recommended type of edge protection varies with the individual trail and trail user.

Multi-Use Trails: These trails are designed to accommodate several different users, including walkers, joggers, bicyclists, equestrians, and in-line skaters and would have an improved surface of concrete, asphalt, crushed stone, compacted dirt or grass.

Single Track

The single track multi-use trail is the simplest type of trail facility and is planned to accommodate all desired use modes (see Figure 3). However, it is important to control the uses that take place, as incompatible user modes will cause serious conflict on a relatively narrow trail.

General Design Guidelines

Design guidelines for single tracks are simple. Of the user modes planned, the most stringent guidelines shall apply. If pedestrians are one of the user modes anticipated to use the trail, then the guidelines should meet the needs of older adults and people with disabilities.

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

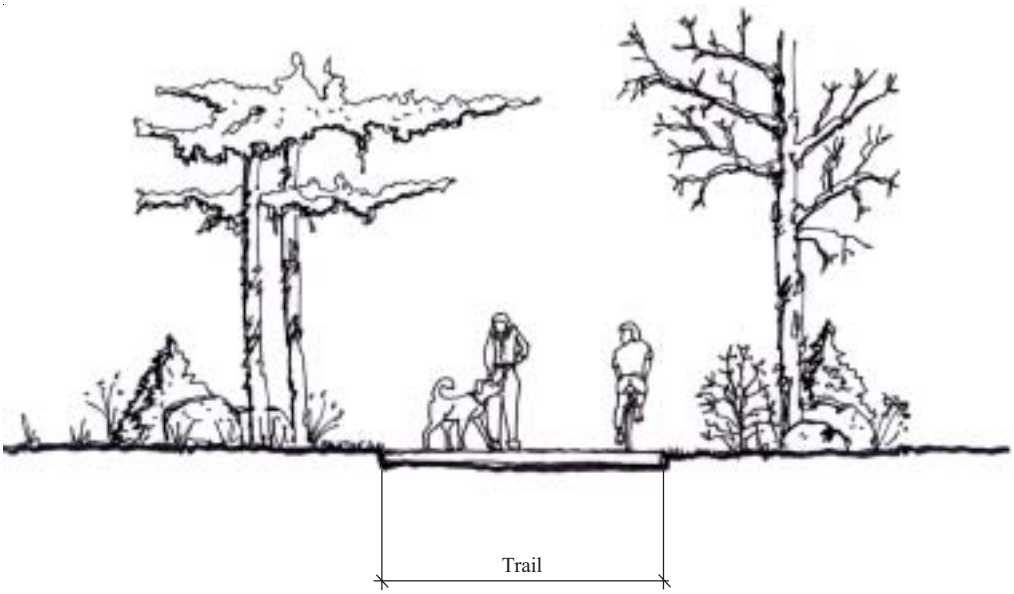


Figure 3 *Multi-Use Trail, Single Track*

Double Track

Double track trails are used when incompatible use modes coexist in the same corridor. They accommodate a variety of modes on two or more different trails, with each trail tailored to the unique needs of the use mode (see Figures 4 and 5).

General Design Guidelines

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

If there is enough right-of-way that is mostly cleared, a corridor with two parallel trails can be considered to provide greater separation of the various use modes. This type of trail would be especially useful where equestrians are permitted. The primary trail could accommodate pedestrians, bicyclists and skaters, while the second trail could accommodate equestrians or mountain bike riders. The second trail could have a wider grass shoulder of 4-6 feet rather than the minimum 2-4 feet or it could be separated from the primary trail by a buffer strip of vegetation.

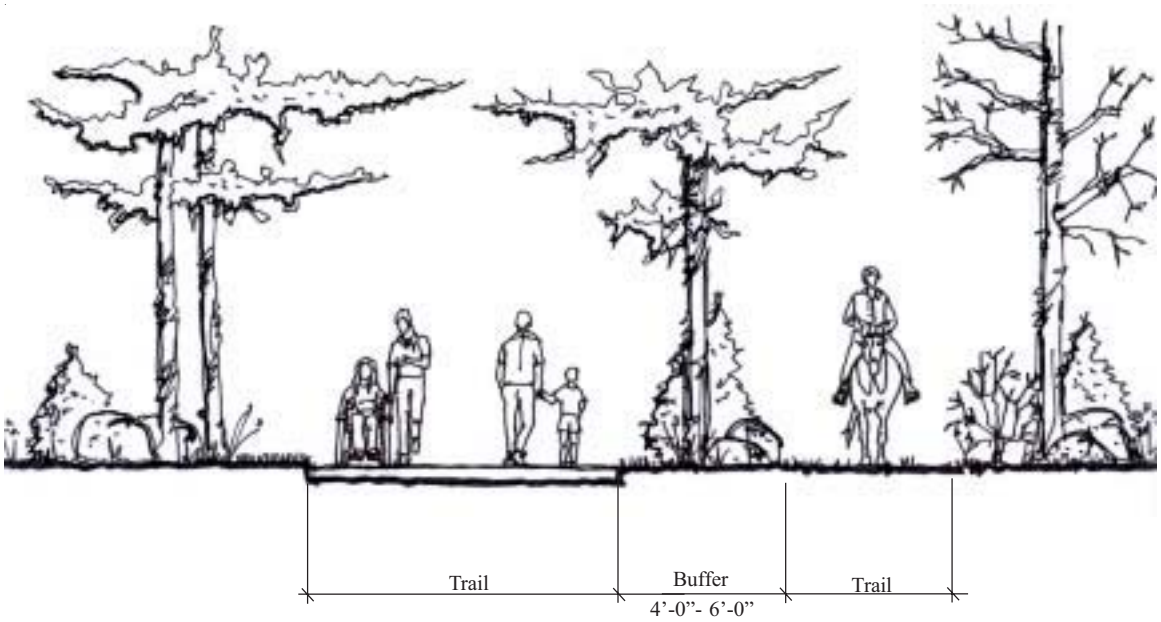


Figure 4 *Multi-Use Trail, Double Track with Vegetation Buffer*

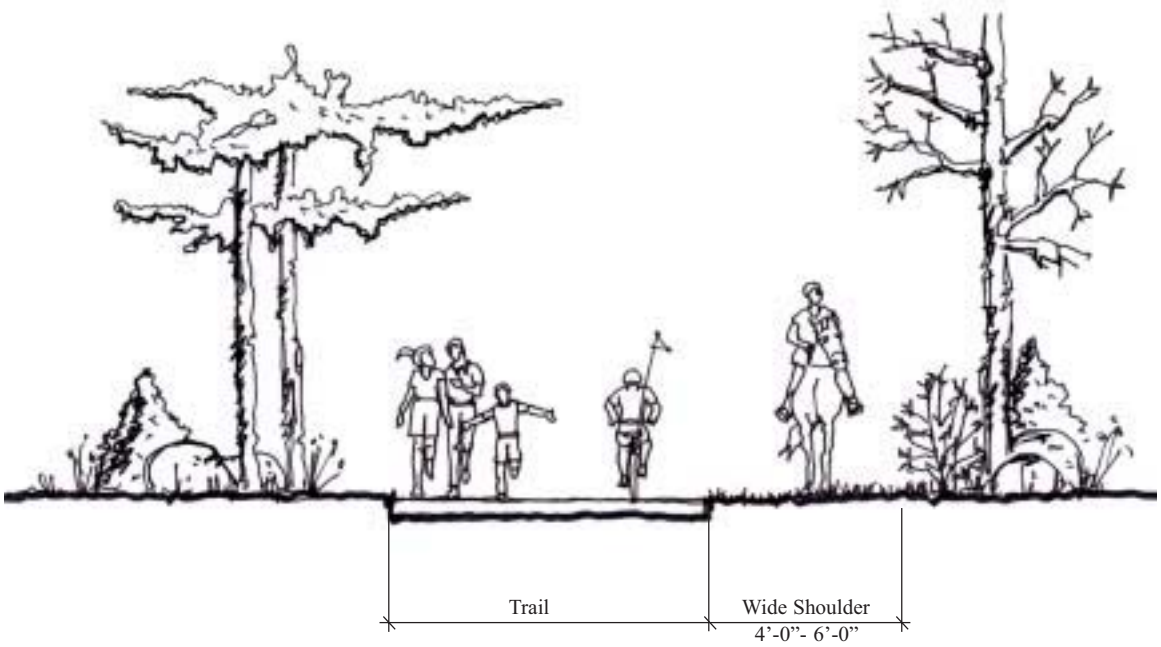


Figure 5 *Multi-Use Trail, Double Track with Wide Shoulder*

Natural Surface Trails: These trails are designed to accommodate hikers, mountain bikers, or equestrians and would typically be paths without an improved surface.

Profile: Refers to the vertical curvature of the trail.

Figure 6 *Trail Profile*

Right-of-Way: A general term, as pertaining to this document, denoting land, property or interest therein, usually in a strip, acquired for or devoted to transportation purposes.

Surface: Refers to the type of material on the traveled part of the trail, such as asphalt, concrete, stone dust, granular, dirt, grass, or alternative. Surface quality is affected by tread obstacles, such as rocks, and any openings such as gaps and grates located within the trail surface.

Trail surface and cross-section, including materials and thicknesses, shall be based on site specific conditions. Each trail design must be certified by a geotechnical engineer and must be reviewed and approved by applicable federal, state, county and local agencies.

Asphalt

Figure 7 *Typical Asphalt Paving Section*
(Exact dimensions to be determined)

Note: Surface Asphalt Mix must be a virgin asphalt mix containing no Recycled Asphalt Paving (RAP). Base and binder asphalt mixes may contain Recycled Asphalt Paving (RAP) to extent allowed by Maryland State Highway Administration approved mix design.

Concrete

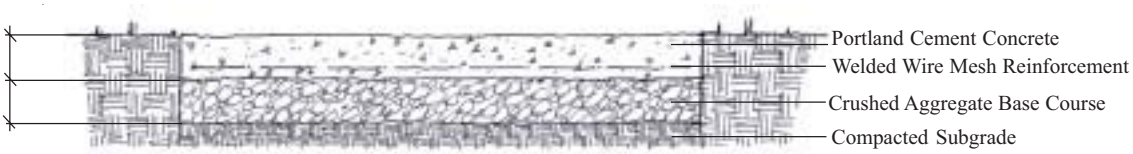


Figure 8 *Typical Concrete Paving Section*
(Exact dimensions to be determined)

Note: Concrete to be scribed in lengths equal to the width of the walk, up to 8 feet, and broom finished. Expansion joints to be spaced every 20 feet.

Stone Dust

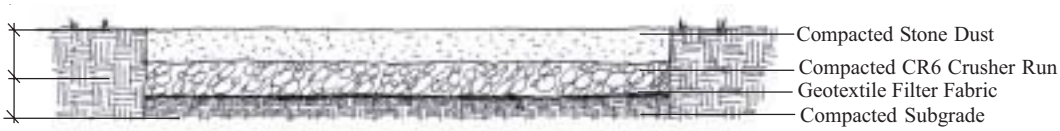


Figure 9 *Typical Stone Dust Section*
(Exact dimensions to be determined)

Swale: A linear depression or shallow ditch, usually parallel to the trail, designed to divert surface water away from the trail to prevent erosion. Swales should be designed so that no undue obstacle or hazard is created for the trail user.

Switchback: A trail that ascends a steep incline by taking a winding course to reduce the grade of the path.

Vertical Clearances: Refers to the height above the trail which is free from protruding objects and overhead obstructions, such as tree branches and bridges.

California Bearing Ratio (CBR): A soil strength measurement, which can be converted to the Modulus of Soil Resilience for the purpose of calculating pavement materials/layer thicknesses to be adequate for a specific set of site-specific characteristics (traffic volume/composition, weather, service life, reliability, etc.)

Natural Surface Trails

Hiking Trails

Width and Clearances
Hiking trails should have a clear width of 6 feet to allow room for passing and walking two abreast. A minimum width of 4 feet should only be used when site specific conditions do not allow for the preferred width. Trails through vegetation need regular maintenance to provide sufficient clearance. At a minimum a hiking trail should be cleared one foot beyond the width of the trail and to a height of 8 feet. This clearance may need to be increased to allow for vegetative growth between maintenance periods and to account for snow depth if the trail is used by cross country skiers (see Figure 10).

Surface and Drainage
The trail surface should maintain a natural surface wherever possible but should be firm enough to resist deformation when a person walks across it. It should be made of material that maintains a consistent stability over long periods of use (see Table 1). The surface needs to provide sufficient traction for walking. The cross slope should be 2% minimum and 5% maximum to provide drainage of surface water.

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

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

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

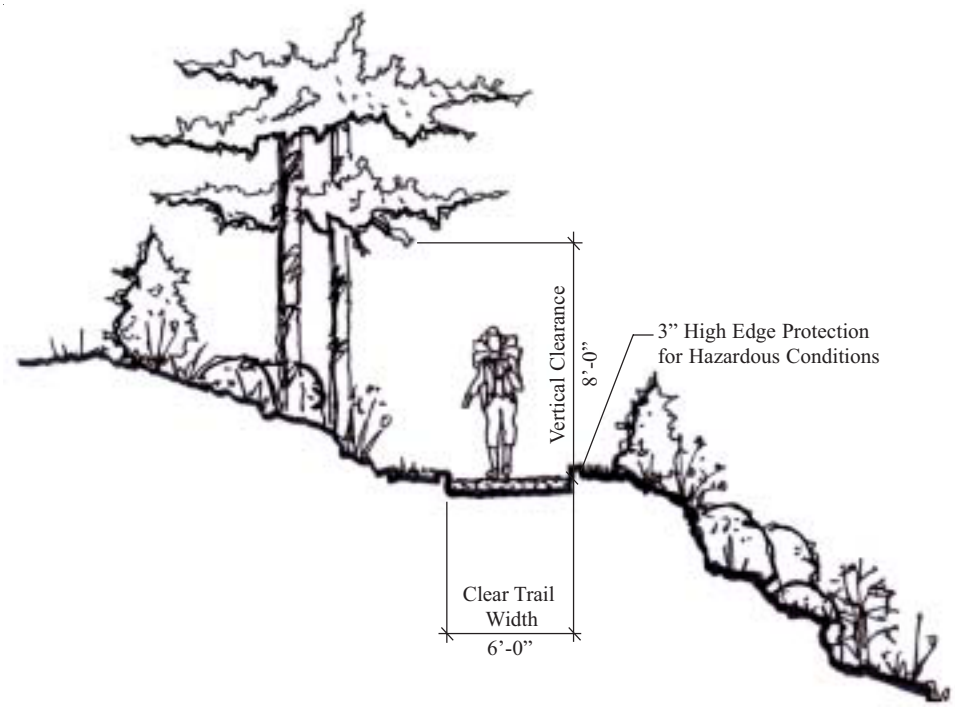


Figure 10 *Hiking Trail Clearances*

Mountain Bike Trails

Width and Clearance
Mountain bike trails should have a clear width of 6 feet for maneuverability and passing. A minimum width of 4 feet should only be used when site specific conditions do not allow the preferred width. The clearance should be a minimum of 2 feet on each side of the trail, with a vertical clearance of 8 feet (see Figure 11).

Surface and Drainage
The trail surface should maintain a natural surface wherever possible but should be firm enough to resist deformation. It should be made of material that maintains a consistent stability over long periods of use (see Table 1). The surface needs to provide sufficient traction for biking. The cross slope should be 2% minimum and 5% maximum to provide drainage of surface water.

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

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

Edge Protection
Edge protection is a physical barrier along the edge of the trail designed to protect the user from an adjacent hazardous condition. Edge protection for bicyclists needs to be 42 inches high *(Designing Sidewalks and Trails for Access, Part II of II, 15.7)*. The extra height prevents the cyclist from flipping forward over an obstacle. Low edges or curbs are not used on mountain bike trails, and would be a detriment to the cyclist.

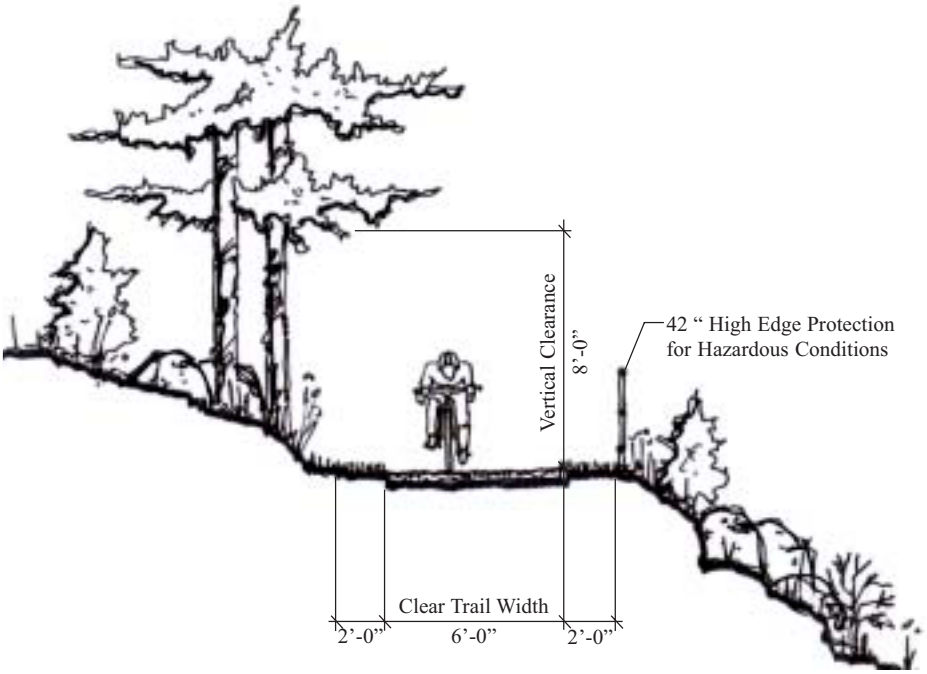


Figure 11 *Mountain Bike Trail Clearances*

Equestrian Trails

Width and Clearances
Equestrian trails should have a clear width of 10 feet for passing and two way use. A minimum width of 8 feet should only be used when site specific conditions do not allow the preferred width. Clearance for vegetation and obstructions should be a minimum of 2 feet beyond each side of the trail. Vertical clearance should be 10 feet minimum (see Figure 12). This may need to be increased to allow for vegetative growth between maintenance periods and to account for snow depth if the trail is used in the winter.

Surface and Drainage
Equestrian trails are typically natural surface trails. They can be maintained in a grass or dirt condition. Compacted stone dust may be used to assist areas with poor drainage. Low areas that collect surface water should be drained by grading or culverts. The trail can deteriorate quickly if used in a wet condition. A minimum 2% cross slope is recommended for drainage. The surface should be kept free of rocks and debris greater than 1½ inches in diameter.

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

Alignment and Profile
Equestrian trails should generally follow the alignment of the existing topography. Steep sections of trail should use switchbacks to alleviate the grade.

Edge Protection
Low edges should not be used on equestrian trails, since they create a tripping hazard for the horse. Protection from steep slopes or hazardous areas can be accommodated by dense landscaping or sturdy railing 42 inches in height.

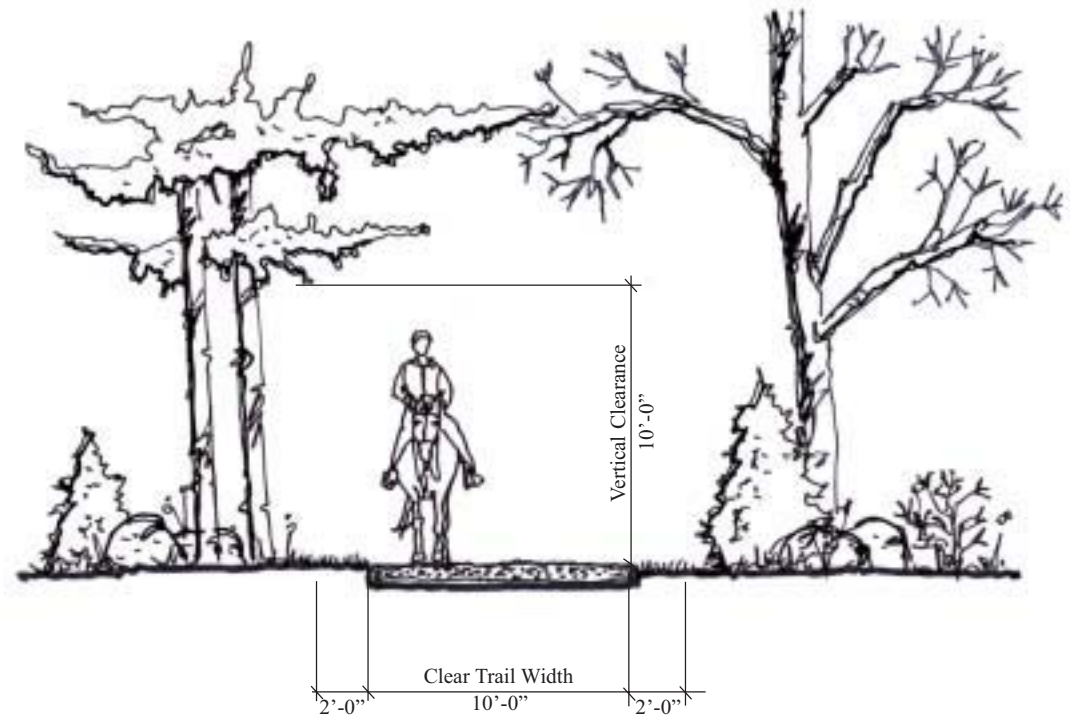


Figure 12 *Equestrian Trail Clearances*

Improved SurfaceTrails

Pedestrian Trails

Width and Clearance
Pedestrian trails should have a clear width of 6 feet to allow room for passing, walking two abreast, or for devices such as strollers and wheelchairs. A minimum width of 5 feet should only be used when site specific conditions do not allow the preferred width. Trails passing through vegetation need regular maintenance to provide sufficient clearance. At a minimum, a pedestrian trail should be cleared 2 feet beyond the width of the trail and to a height of 8 feet. The clearance may need to be increased to allow for vegetative growth between maintenance periods and to account for snow depth if the trail is used by cross country skiers or other winter users (see Figure 13).

Surface and Drainage
The trail surface should be firm enough to resist deformation when a person walks or wheels across it. Site specific studies and an improved surface will be required where varying trail usage warrants (see Table 1). An improved surface should be made of material that maintains consistent stability over long periods of use, such as concrete, asphalt or compacted stone dust. The surface needs to provide sufficient traction for walking, wheelchairs and crutches.

The cross slope should be 2% to provide drainage of surface water and conform to ADA regulations.

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

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

Edge protection
The edge on a pedestrian trail should be a minimum of 3 inches high. Bridges and boardwalks require a 42 inch high rail for pedestrians (*Designing Sidewalks and Trails for Access, Part II of II, 15.7).* Landscaping can be used to enhance the protection on steep slopes.

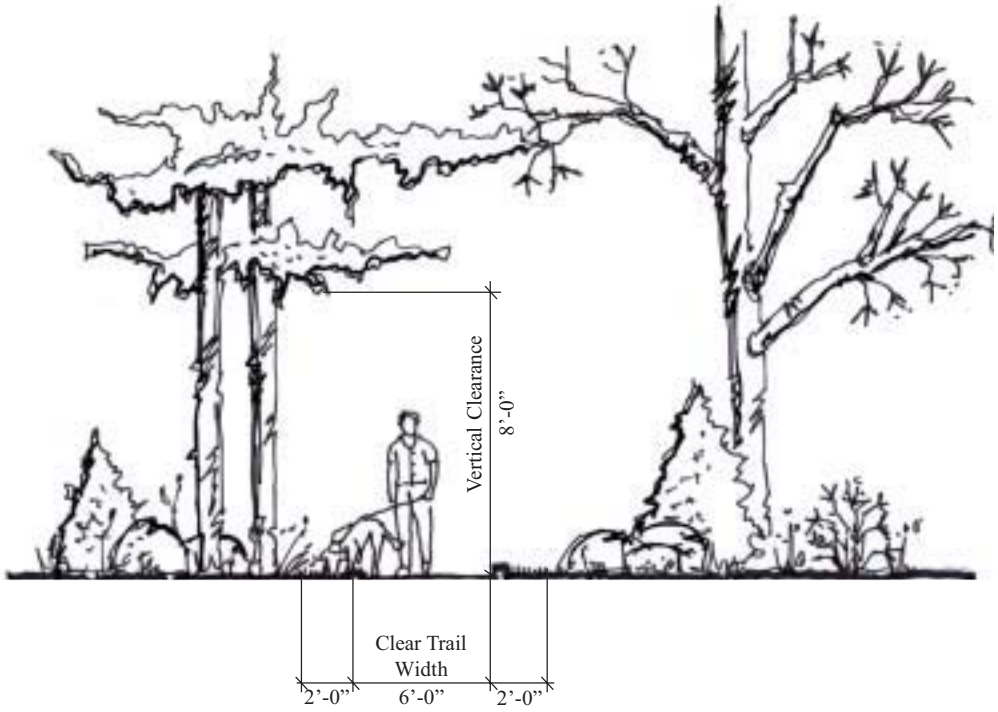


Figure 13 *Pedestrian Trail Clearances*

Bicycling and In-Line Skating Trails

Width and Clearance
These trails should have a clear width of 12 feet. A minimum width of 10 feet should only be used when site specific conditions do not allow the preferred width. A minimum clearance of 2 feet is required on each side of the trail. The clearance includes a 2 foot shoulder graded to a maximum slope of 1:6. The vertical clearance is a minimum of 8 feet (see Figure 14).

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

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

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

Design Speed	Minimum Radius
12 mph	36 feet
20 mph	100 feet
25 mph	156 feet

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

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

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

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

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

Bike trails must be designed with adequate stopping and sight distances to allow the cyclist to see and react to unexpected situations. The stopping distance of a bicycle is a function of the rider's perception and reaction time, the speed of the bicycle, the coefficient of friction between the tires and the pavement, and the braking ability of the bicycle. The following information and figures have been developed by AASHTO to assist the bike trail designer. Figure 15 indicates the minimum stopping sight distance for various speeds and grades based on a perception and brake reaction time of 2.5 seconds and a coefficient of friction of 0.25 to account for wet weather and poor braking of many bicycles. For two way trails, the sight distance in the descending direction will control the design.

Table 2 is used to select the minimum length of vertical curve to provide stopping sight distance at various speeds on crest vertical curves. The eye height is assumed to be 4 ½ feet and the object height is assumed to be 0 inches.

Table 3 and Figure 16 shows the minimum clearance to be used for sight obstructions for horizontal curves. Bicyclists frequently ride side by side or near the middle of the trail. For this reason lateral clearances on horizontal curves should be calculated based on the sum of the stopping sight distances for cyclists traveling in opposite directions around the curve. Where this is not possible the path can be widened through the curve, install a yellow centerline stripe, a "Curve Ahead" warning sign, or a combination of these.

Edge Protection

Low forms of edge protection are not recommended for bicycle traffic. If edge protection is needed it should be 42 inch high railing or landscaping (*Designing Sidewalks and Trails for Access, Part II of II, 15.7)*. The extra height prevents the cyclist from flipping forward over the rail. Bridges and boardwalks require a 42 inch high rail for cyclists. Landscaping can be used to enhance the protection from adjacent hazards.

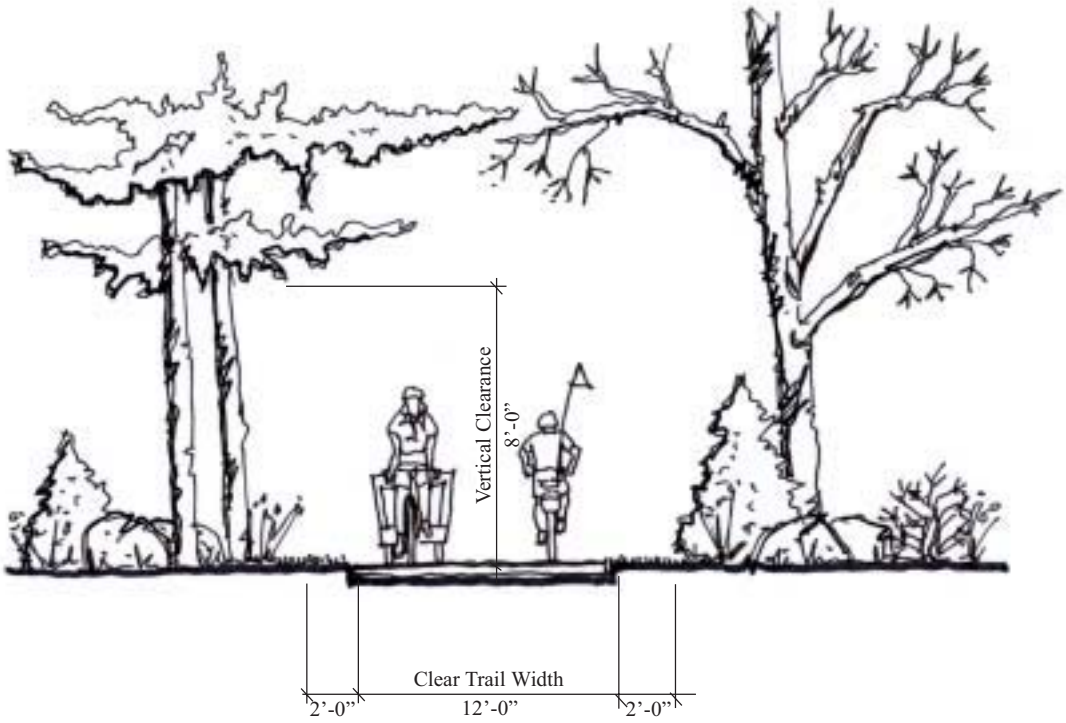
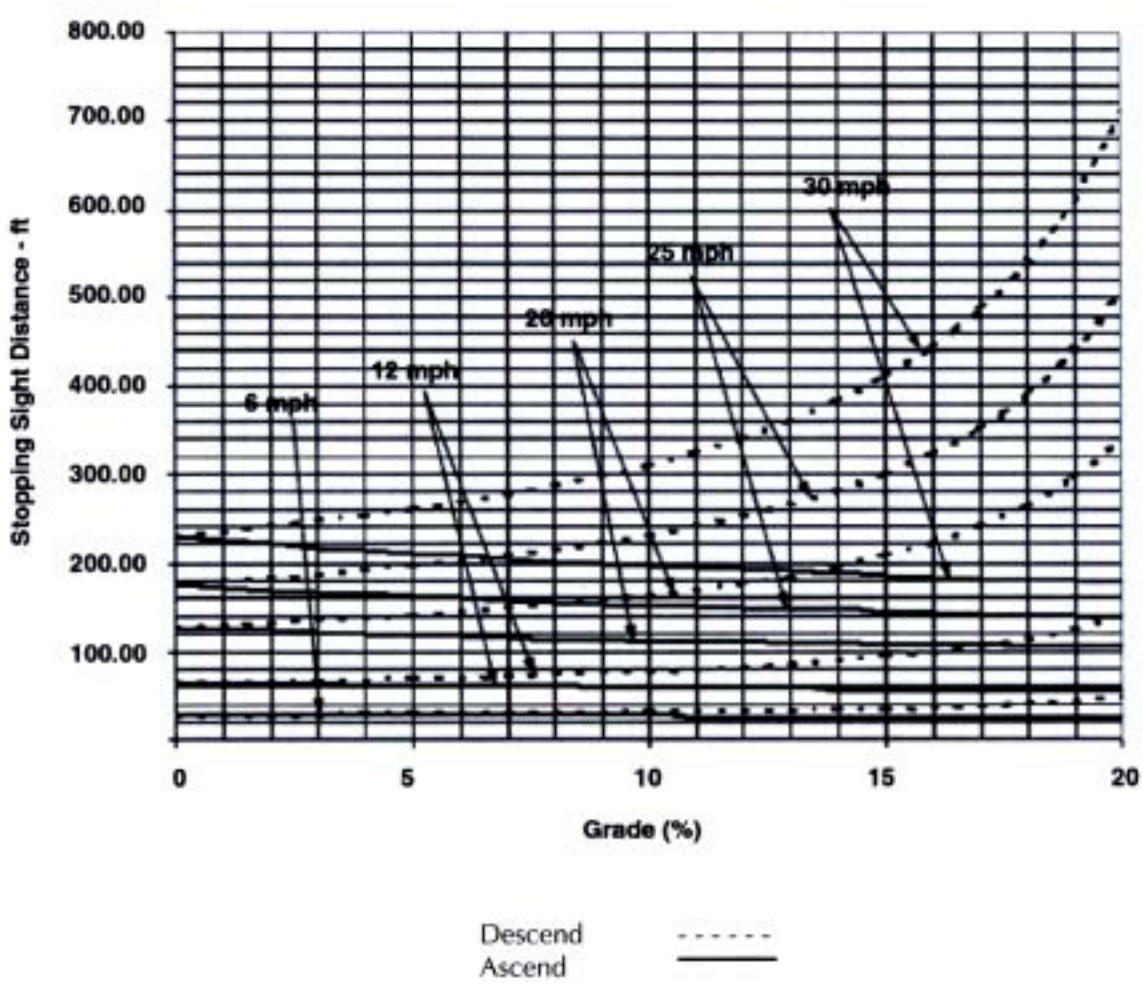


Figure 14 *Bicycle and In-Line Skating Trail Clearances*

FIRMNESS, STABILITY, AND SLIP RESISTANCE
FOR A VARIETY OF COMMON TRAIL SURFACING MATERIALS*
Table 1

SURFACE MATERIAL	FIRMNESS	STABILITY	SLIP RESISTANCE**
Asphalt	firm	stable	slip resistant
Concrete	firm	stable	slip resistant***
Soil with Stabilizer	firm	stable	slip resistant
Packed Soil without Stabilizer	firm	stable	not slip resistant
Soil with High Organic Content	soft	unstable	not slip resistant
Crushed Rock (3/4" minus) with Stabilizer	firm	stable	slip resistant
Crushed Rock without Stabilizer	firm	stable	not slip resistant
Wood Planks	firm	stable	slip resistant
Engineered Wood Fibers that comply with ASTM F1951	moderately firm	moderately stable	not slip resistant
Grass or Vegetation Ground Cover	moderately firm	moderately stable	not slip resistant
Engineered Wood Fibers that do not comply with ASTM F1951	soft	unstable	not slip resistant
Wood Chips (bark, cedar, generic)	moderately firm to soft	moderately stable to unstable	not slip resistant
Pea Gravel or 1 1/2" Minus Aggregate	soft	unstable	not slip resistant
Sand	soft	unstable	not slip resistant

* Taken directly from *Designing Sidewalks and Trails for Access, Part II of II, Table 15-1.*
** Dry Conditions
*** A broom finish significantly improves the slip resistance of concrete.



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

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

Figure 15 *Minimum Stopping Distance vs. Grades for Various Speeds*
(Taken directly from *Guide for the Development of Bicycle Facilities (AASHTO)* Figure 19)

MINIMUM LENGTH OF CREST VERTICAL CURVE (L) BASED ON STOPPING DISTANCE*

Table 2

A	S = Stopping Sight Distance (ft)														
(%)	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
2												30	70	110	150
3								20	60	100	140	180	220	260	300
4						15	55	95	135	175	215	256	300	348	400
5					20	60	100	140	180	222	269	320	376	436	500
6				10	50	90	130	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	177	278	400	544	711	900	1111	1344	1600	1878	2178	2500

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

when $S < L$ $L = \frac{AS^2}{900}$

Height of cyclist's eye – 4 1/2 ft
Height of object – 0 ft

Shaded area represents S = L

L = Minimum Length of Vertical Curve (ft)
A = Algebraic Grade Difference (%)
S = Stopping Sight Distance (ft)

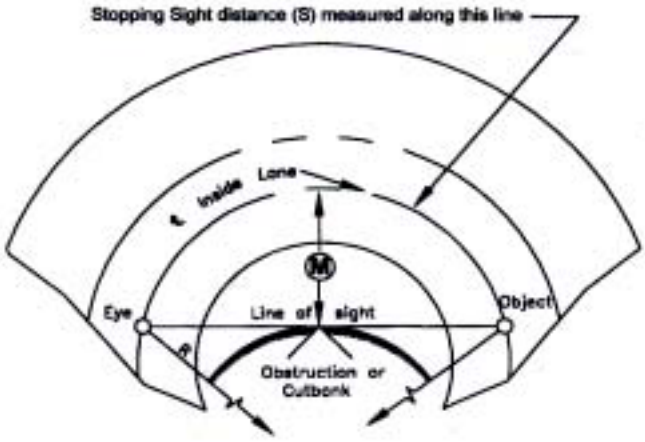
Minimum Length of Vertical Curve = 3 ft.

*Taken directly from *Guide for the Development of Bicycle Facilities (AASHTO)* Table 3. English Units.

MINIMUM LATERAL CLEARANCE (M) FOR HORIZONTAL CURVES*
Table 3

R (ft)	S = Stopping Sight Distance (ft)														
	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
25	2.0	7.6	15.9												
50	1.0	3.9	8.7	15.2	23.0	31.9	41.5								
75	0.7	2.7	5.9	10.4	16.1	22.8	30.4	38.8	47.8	57.4	67.2				
95	0.5	2.1	4.7	8.3	12.9	18.3	24.7	31.8	39.5	48.0	56.9	66.3	75.9	85.8	
125	0.4	1.6	3.6	6.3	9.9	14.1	19.1	24.7	31.0	37.9	45.4	53.3	61.7	70.6	79.7
155	0.3	1.3	2.9	5.1	8.0	11.5	15.5	20.2	25.4	31.2	37.4	44.2	51.4	59.1	67.1
175	0.3	1.1	2.6	4.6	7.1	10.2	13.8	18.0	22.6	27.8	33.5	39.6	46.1	53.1	60.5
200	0.3	1.0	2.2	4.0	6.2	8.9	12.1	15.8	19.9	24.5	29.5	34.9	40.8	47.0	53.7
225	0.2	0.9	2.0	3.5	5.5	8.0	10.8	14.1	17.8	21.9	26.4	31.3	36.5	42.2	48.2
250	0.2	0.8	1.8	3.2	5.0	7.2	9.7	12.7	16.0	19.7	23.8	28.3	33.1	38.2	43.7
275	0.2	0.7	1.6	2.9	4.5	6.5	8.9	11.6	14.6	18.0	21.7	25.8	30.2	34.9	39.9
300	0.2	0.7	1.5	2.7	4.2	6.0	8.1	10.6	13.4	16.5	19.9	23.7	27.7	32.1	36.7
350	0.1	0.6	1.3	2.3	3.6	5.1	7.0	9.1	11.5	14.2	17.1	20.4	23.9	27.6	31.7
390	0.1	0.5	1.2	2.1	3.2	4.6	6.3	8.2	10.3	12.8	15.4	18.3	21.5	24.9	28.5
500	0.1	0.4	0.9	1.6	2.5	3.6	4.9	6.4	8.1	10.0	12.1	14.3	16.8	19.5	22.3
565		0.4	0.8	1.4	2.2	3.2	4.3	5.7	7.2	8.8	10.7	12.7	14.9	17.3	19.8
600		0.3	0.8	1.3	2.1	3.0	4.1	5.3	6.7	8.3	10.1	12.0	14.0	16.3	18.7
700		0.3	0.6	1.1	1.8	2.6	3.5	4.6	5.8	7.1	8.6	10.3	12.0	14.0	16.0
800		0.3	0.6	1.0	1.6	2.2	3.1	4.0	5.1	6.2	7.6	9.0	10.5	12.2	14.0
900		0.2	0.5	0.9	1.4	2.0	2.7	3.6	4.5	5.6	6.7	8.0	9.4	10.9	12.5
1000		0.2	0.5	0.8	1.3	1.8	2.4	3.2	4.0	5.0	6.0	7.2	8.4	9.8	11.2

*Taken directly from *Guide for the Development of Bicycle Facilities (AASHTO)* Table 4. English Units.



Angle is expressed in degrees

$$M = R\left[1-\cos\left(\frac{28.655}{R}\right)\right]$$

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

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

Line of sight is 700 mm above centerline of inside lane at point of obstruction.

For English Units:

S = Stopping Sight Distance (ft)

R = Radius of centerline of lane (ft)

M = Distance from centerline of lane to obstruction (ft)

Figure 16 *Minimum Lateral Clearance (M) for Horizontal Curves*
(Taken directly from *Guide for the Development of Bicycle Facilities (AASHTO)* Table 4, cont.)

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DESIGN STANDARDS AT CROSSINGS

At-Grade Crossings
Grade-Separated Crossings

At-Grade Crossings

Road Crossing

Trail intersections with roads present the greatest safety concerns due to traffic volume and speeds. The following standards need to be considered for all road crossings. All intersections shall be in accordance with AASHTO.

- The trail should intersect at 90 degrees or as close to this as possible (see Figure 17).
- The trail width may need to be increased near the intersection to reduce conflicts among the users, such as stopping and grouping of cyclists.
- The trail should meet the road at the same elevation, with sufficient landing areas for the user.
- Good sight distance needs to be assured for motorists and trail users (see Figures 15 & 16 to compute sight distances).
- Signage is to be provided to warn road and trail users of the intersection.
- A visible crosswalk should be delineated at the intersection in accordance with the *Manual of Uniform Traffic Control Devices*, produced by the Federal Highway Administration.
- Curb ramps and detectable warnings may be necessary in certain situations. Intersection lighting may be needed to add to the safety of the crossing.
- Higher volume streets, such as arterials and collectors, may warrant a grade separated crossing.

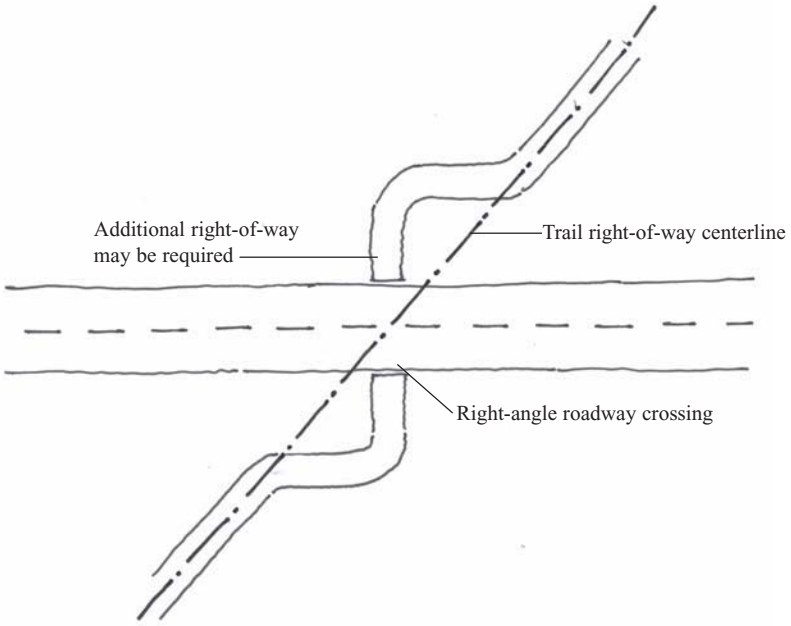


Figure 17 *Typical Redesign of a Diagonal Road Crossing*

The following definitions have been compiled from the Frederick County Streets and Roads Design Manual:

Arterial Roads (high traffic volume)
Arterials provide the primary access to the interstate freeway system and provide inter county access through rural areas. Efficient movement is the primary function of arterials, therefore access and frontage is limited to high volume generators of vehicle trips.

Collector Streets (moderate traffic volume)
Collectors primarily provide intra county access. They are designed to connect residential and employment areas. Rural collectors provide access to smaller communities, and commercial/industrial collectors access traffic from urban areas.

Residential Streets (low traffic volume)
Residential streets carry a lower volume of traffic at slower speeds and provide a safe and desirable environment for a residential neighborhood. They often provide on-street parking and through traffic within a neighborhood. Most single family homes will front and have access on these streets.

Rural Roads (lowest traffic volume)
Rural roads provide access between small communities, farms and rural residences. Older roads are often substandard in width, shoulders, sight distance or other design features. They are characterized by low traffic volume and slower speeds.

Railroad Crossing
Railroad crossings pose unique hazards particularly for the wheeled trail user. The wheel of the train requires a 2 inch wide gap (flangeway gap) parallel to each rail. This gap is a potential hazard for cyclists, in-line skaters and wheelchair users. The following recommendations, adapted from *Designing Sidewalks and Trails for Access, Part II of II*, should be considered in designing the railroad crossing:

- The trail approach and crossing should be as nearly 90 degrees as possible (see Figure 18).
- The trail crossing should be raised to the same level as the top of the rails. A surface material such as textured rubber railroad crossing pads provides a stable surface with good traction.
- The crossing approach should be ramped with minimal grades. Provide a flat area for 5 feet on either side of the track, free of obstacles, with a firm, stable surface.
- The trail should be hardened or stabilized for a sufficient distance so debris is not carried onto the track. A specific distance has not been established for this stabilized surface, however 20 feet from each rail is a recommended minimum.
- Signs and warning devices should be used to alert the train and trail user of the crossing.
- These devices should accommodate users with various types of impairment. Warning gates may be necessary in some situations.

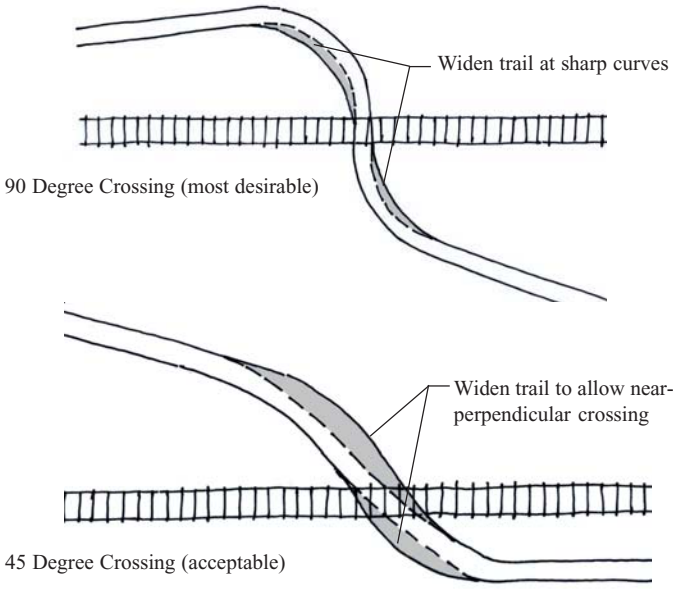


Figure 18 *Railroad Crossing Layouts*

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

- Cross as nearly to 90 degrees as possible.
- Cross at a similar elevation with level landing areas on each side of the crossing.
- Provide a stable surface with good traction in varying weather conditions. Since farm lanes are used by heavy equipment a stable surface is an important criteria. An extra depth of crusher run base with well compacted stone dust surface may provide a suitable solution.
- Maintenance of these crossings is important to prevent deterioration from use and adverse weather.
- Provide signs to alert the user to the crossing.

Other Trail Crossing (with different user modes)
Intersections of two trails present situations that can be alleviated by the following six means:

- Crossings should be offset to create three way intersections instead of four way.
- The trails should intersect at 90 degree angles.
- The trails should have minimum grade approaches with stable, smooth surfaces.
- Signs should be provided to indicate direction, distance and user right of way.
- Signage needs to be in a format applicable to the impairment of the potential user.
- Provide good sight distance and visibility for safety and security (see Figures 15 & 16 to compute sight distances).

Stream Crossing
Stream crossings by a trail should be kept to a minimum. When streams must be crossed there are several methods to consider. Smaller streams may be crossed by a single culvert, a series of side by side culverts, or a bridge, and larger stream crossings should be accommodated by a bridge (refer to the section on "Grade-Separated Crossings" for information regarding bridges). Culverts for smaller streams may be designed using one of the following options:

- Aluminized corrugated metal pipe, Type II
- Schedule 40 PVC pipe
- Concrete culvert
- Bottomless arch pipe
- Smooth bore, high density polyethylene pipe, per AASHTO
- Or acceptable Frederick County Department of Public Works design

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

Grade-Separated Crossings

One of the great advantages of bikeways and trails along former railroad corridors is that they often have grade-separated crossings with the highway system, as well as bridges that carry them over rivers and streams. Only a few of the proposed trail corridors within the Frederick County Parklands have this asset. Therefore, structures of all kinds, such as tunnels, bridges and boardwalks will be required to carry trail users under or over obstacles encountered along each trail. Underpass or overpass crossings are more expensive than at-grade crossings and therefore should only be utilized where user safety justifies the added expense.

Roadway Underpass (Tunnels)
Roadway underpasses are generally less expensive than overpasses and require less change in grade. However, underpasses may present security problems due to reduced visibility and drainage problems, both of which can be expensive to fix. The following factors are important to consider when designing roadway underpasses:

- Provide good sight distance and visibility for safety and security (see Figures 15 &16 to compute sight distances).
- Make the trail wide enough for two-way use, including 2 feet of clear width on either side.
- Maintain the minimum width through the structure.
- Provide adequate lighting and ventilation.
- Minimize approach grades.
- Provide signs to alert users to the crossing.

- Utilize barriers or landscaping to encourage the user to stay on the trail.
- Provide sufficient horizontal and vertical clearances (see Figure 19). Additional vertical height may be necessary to enhance user comfort, depending on site specific conditions.
- Provide centerline striping.

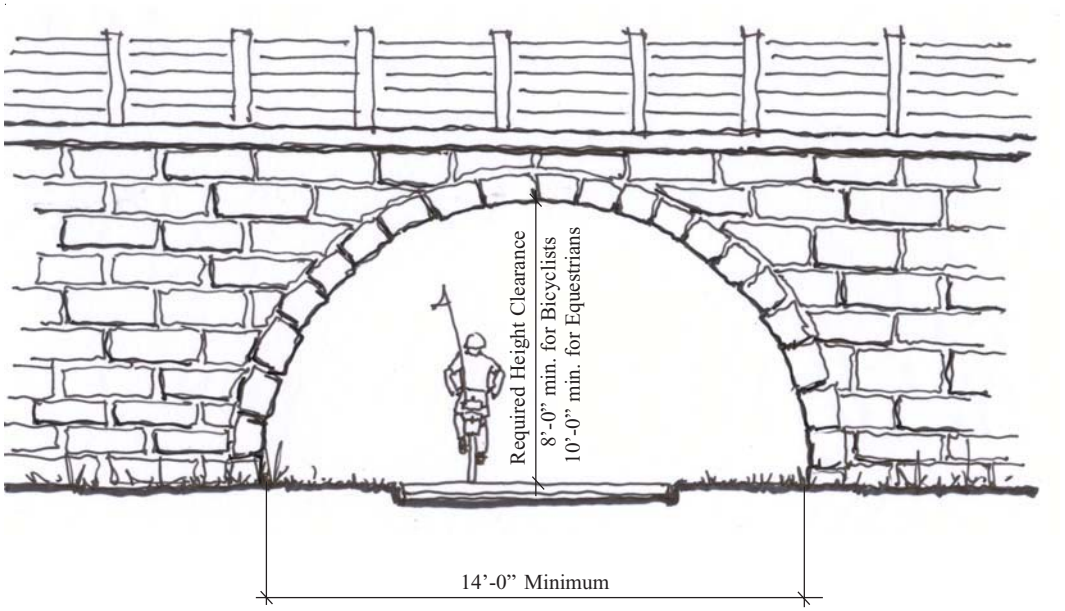


Figure 19 *Roadway Underpass Dimensions*

Roadway Overpass (Bridges)

Roadway overpasses are more open and present fewer security problems. However, they are generally more expensive, as they require much longer approaches to achieve the minimum 17 feet of vertical clearance from a roadway. The following factors are important to consider when designing roadway overpasses:

- Provide good sight distance and visibility for safety and security (see Figures 15 &16 to compute sight distances).
- Make the trail wide enough for two-way use, including 2 feet of clear width on either side.
- Provide sufficient horizontal clearances and required loading capacity for maintenance and emergency vehicles.
- Bridges should maintain a flat (not arched) surface.
- Minimize approach grades.
- Provide signs to alert users to the crossing.
- Utilize barriers or landscaping to encourage the user to stay on the trail.

- In order to prevent any objects from falling or being thrown onto the roadway below, provide 6 foot high fencing on both sides or a fully enclosed cage that maintains the recommended vertical clearances.
- Provide centerline striping.
- Provide adequate lighting, if necessary.

Trail implementors are strongly encouraged to use fully engineered, pre-fabricated, clear span bridges of welded steel construction, as described below.

Other Independent Trail Bridges

In addition to traversing roadways and highways, bridges are common trail structures used to cross other trail barriers, such as creeks, rivers and ravines.

Although bridges are designed to fulfill a practical role, with safety as the ultimate purpose, trail implementors are encouraged to incorporate bridge solutions that reflect the unique character of each trail and its surroundings, with minimal environmental impact. The *Frederick County Parkland Bikeway and Trail Design Standards and Planning Guidelines* strongly recommends the use of fully engineered, pre-fabricated, clear span bridges of welded steel construction for all required bridge structures, including roadways. These bridge solutions are widely recognized in the bridge industry and have been used successfully on trail projects throughout the country. They are safe, durable, economically priced and come in a variety of designs and spanning capabilities. The following specifications should be considered as minimum standards for the design and construction of each bridge, in addition to the design considerations for roadway overpasses (see above):

- Bridges must be designed by a licensed and registered engineer in the State of Maryland.
- Bridges for pedestrians and/or bicycle traffic shall be designed for a live load of 85 PSF.
- Where bicycle or pedestrian bridges are expected to be used by maintenance vehicles, special design consideration should be made for these loads.
- Bridges shall be designed to withstand wind loads.
- Bridges shall be designed to accommodate temperature differentials and maximum deflection allowances.
- Bridge materials shall be of unpainted weathering steel or painted steel with either wood decking or a poured concrete floor.
- All structural members shall have a minimum thickness of material of at least 3/16".
- Bridge fabricators must be certified by the American Institute of Steel Construction and have the personnel, organization, experience, capability, and commitment to produce a safe and quality product.
- Workmanship, fabrication, and shop connections shall be in accordance with American Association of State Highway and Transportation Officials Specifications (AASHTO).
- Provide all railings, toe plates and fencing, as required per all applicable codes.
- Provide quality design and workmanship with a minimum of a 10-year warranty against defects in materials and workmanship.

Boardwalks over Wetlands

In general, bikeways and trails should avoid swamps, marshes and other wetland areas whenever possible. Ocassionally, however, for unique interpretive or educational prurposes, a trail may cross a wetland. In such cases, elevated boardwalks are especially useful to allow trail users to experience the natural environment without negatively affecting the area (see figure 20). The boardwalk crossing should provide the same conditions and ease of use as the trail approaching the bridge.

- These crossings should be level with the trail surface and at least as wide as the approaching trail. Allow extra width on shared-use crossings (2 feet on each side) for passing or maneuvering.
- When handrails are required they should be 42 inches above the trail.
- Provide side barrier at trail level to prevent wheels and runners from dropping off the boardwalk.
- Visibility needs to be adequate for the approach and signs should be utilized to alert the user (see Figures 15 &16 to compute sight distances).
- Boardwalks must be designed by a licensed and registered engineer in the State of Maryland.

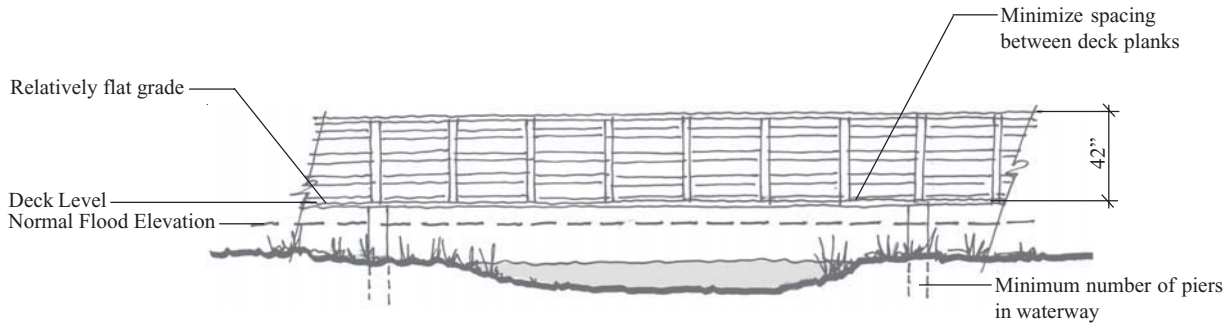


Figure 20 *Wetland Boardwalk*

SUPPORT SERVICES

Trailheads and Access Points
Connection to Public Transit
Rest Areas
Interpretive Facilities
Lighting
Fencing
Landscaping
Bollards, Gates and Medians

Support Services

When planning and designing trail projects, support services, such as trailheads and access points, connections to public transit systems, rest areas and interpretive facilities are often overlooked. These important amenities are an integral part of the trail experience and should be incorporated into the early planning stages and final design of each trail. In addition, the need for special lighting, fencing, and landscaping needs to be addressed.

The following sections have relied heavily on The Iowa Department of Transportation's Iowa Plan 2000, adapting it to suit the unique conditions of Frederick County and in some cases pulling text directly from the established resource.

Trailheads and Access Points

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

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

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

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

Connection to Public Transit

In order to meet the long-term transportation needs of Frederick County and promote the State's "Smart Growth" principles of reducing auto dependency, maximizing community cohesion, and making the most effective use of community resources and infrastructure, every effort needs to be made to develop intermodal connections throughout the County and the surrounding region. This includes bikeways and trails.

The development of bikeways and trails is intended for recreational AND transportation uses, and is therefore, most effective when it is connected to existing regional public transit systems, such as buses, trains and park-and-ride lots. This connection enables those people who by choice or by circumstance do not have access to a private automobile. It also allows people to take advantage of a wider range of transportation options, including walking and bicycling, and provides them with a potentially seamless transfer between travel modes.

The proposed trail corridors for the Frederick County Parklands (see Appendix B) have been developed to allow for and encourage intermodal connections with the Frederick County TransIT bus service, MARC train service and various park-and-ride lots throughout the County, all of which are working to promote "Smart Growth" principles. In fact, TransIT has recently purchased several bike racks to install on "Connector Route" buses which operate in and around Frederick City and urbanized areas of Frederick County. As future bikeways and trails develop throughout the County, trail planners and designers are strongly encouraged to contact the appropriate transportation agencies to work toward this notion of connectivity. Each trail must be evaluated on an individual basis and take into account the following recommendations:

- Provide locations of connection that are safe, obvious and convenient.
- Provide locations that are readily accessible by pedestrians.
- Provide secure bicycle parking at each location.

Rest Areas

Rest areas are generally small, level places located along a trail that provide users the oppportunity to move off the main traveled path to stop and gain relief from demanding grade or cross slope conditions. Periodic rest areas are beneficial to all trail users, but are particularly crucial for people with mobility impairments. Rest areas are most effective when placed at points of interest or scenic lookouts.

The design and placement of rest areas will vary for each trail, depending on the terrain and intended use. Therefore, the specific design of each rest area should be considered individually. The following guidelines set forth some general recommendations regarding rest areas along trails:

- Trail rest areas should at least include a seating area and a place to park the trail vehicle (bicycle, horse, etc.). They may also include drinking fountains, restroom facilities, signage and emergency phone service when deemed necessary. Rest areas on equestrian trails should include hitching posts.

- Trail rest areas should be located approximately every half-hour of travel time. The distance between rest areas is dictated by the use modes on the trail.
- Trail rest areas should be located after any prolonged uphill slope, especially for bicycle and walking trails.
- The surface of rest areas should be firm and stable
- Grades should not exceed 5% and cross slopes on paved surfaces should not exceed 2% and cross slopes on non-paved surfaces should not exceed 5%.

Interpretive Facilities

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

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

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

Lighting

Fixed source lighting improves visibility and safety at trailheads, access points and intersections for night use, and is critical for lighting tunnels and underpasses, when nighttime security could be an issue.

- The AASHTO Guide recommends using average maintained horizontal illumination levels of 5 lux (.5 footcandles) to 22 lux (2 footcandles), depending on the location.
- Where special security problems exist, higher illumination levels may be considered.
- Lighting poles should meet the recommended horizontal and vertical clearances.
- Selection of lighting fixtures to be determined according to site specific needs.
- Luminaires and poles should be at a scale appropriate for trail users.

Fencing
Appropriate fencing should be incorporated into each trail design, as necessary, to deter trespassing onto adjoining properties, as well as provide a safety buffer at dangerous locations along a trail. The following are minimum standards:

- Minimum fencing requirements shall be a two to three split-rail fence.
- Material of fencing to be dictated by surrounding neighborhood and site specific needs.
- Fences and railings shall be a minimum height of 42 inches.

Landscaping
Landscaping can be designed to provide numerous benefits for the trail environment. The trail designer needs to consider the existing landscape, as well as proposed landscaping during the initial phase of trail design.

The existing landscape should be preserved and incorporated into the design. Wetland and floodplain areas typically include native plant material that is adapted to the local soil and water conditions. It is cost effective to maintain these plants in their natural condition and allow them to filter sediment and pollution from the water runoff. Areas to be maintained in an existing tall grass condition should be mowed only once or twice a year. This infrequent mowing schedule reduces trail maintenance, creates better plant cover for water absorption and filtration, and increases flower and seed production for beneficial insects, birds, and wildlife. When a new trail is built through these areas, tall grasses may be a good option to promote erosion control and related benefits. It is recommended to seed the disturbed area with a natural seed mix to encourage re-establishment of the tall grass cover. Seed mix recommendations and installation guidelines can be found in the Maryland State Highway Administration Standard Specifications for Construction and Materials manual. Other planting options along streams include forestation planting or a mixture of shrubs and grasses. These options are discussed in the "Floodplains" section of this manual.

Existing native plants should be maintained as a buffer between parallel trails. This buffer is most desirable between parallel bike and equestrian trails. The buffer separation prevents alarming the horses with bicycle traffic to which they are unaccustomed. Care needs to be taken during the trail construction process to protect the existing vegetation. It is recommended that the area to be protected be fenced with the appropriate type of temporary construction fencing to prevent mechanical damage to the vegetation and prevent soil compaction around the root zone. It may be necessary to selectively prune or thin the vegetation to obtain trail clearances and remove trees in poor health that may fall on the trail. Trees that are too close to the trail surface may need to be removed if they are considered a collision hazard for errant bicyclists.

Existing native vegetation should be retained along the trail when it serves as a buffer to screen adjacent land uses. For example, screening the trail from adjacent residential areas is desirable for both homeowners and trail users. Screening from industrial uses or objectionable views also enhances the trail experience.

Proposed landscaping can be designed to improve sections of the trail that may not have sufficient natural buffer. Trailhead facilities and rest stops can benefit from an overhead tree canopy to provide shade relief from the summer sun. Low level landscaping can enhance the look of the facilities and screen objectionable views. The landscape can also be designed to identify the facility as part of the trail system. This is accomplished by using similar plant material at the trailhead and various points along the trail. This will assist the user to recognize features related to the trail and give advance warning that they are approaching a trail feature. Landscape design consideration must be given to maintain appropriate safe sight distance, and to provide sufficient visibility to maintain security.

Proposed landscaping can be designed to provide edge protection along steep slopes and other trail hazards. The landscaping should be sufficiently dense to act as a visual warning and to restrict trail user movement through the barrier. The landscape edge protection needs to be 3 feet high minimum for pedestrian trails and 42 inches high minimum for bike trails. Plant spacing varies with the species but will generally fall within the range of 3 to 5 feet on center. Native species should be encouraged when their characteristics fulfill the design objectives. The following is a partial list of plant material that is suitable for creating edge protection along the trail. There are other species and varieties whose characteristics are appropriate for this use. Refer to the Maryland Native Plant Society for a listing of plant material.

Evergreen Shrubs

- Abelia “Edward Goucher”, Abelia grandiflora
- Berberis julianae, Berberis julianae “Nana”
- Ilex crenata “Compacta”, Ilex crenata “Green Lustre”
- Ilex glabra “Nigra”, Ilex glabra “Shamrock”
- Juniperus chinensis “Kallays Compacta”, Juniperus chinensis “Pfitzeriana Compacta”
- Taxus media “Densiformis”, Taxus cuspidata “Intermedia”
- Viburnum x pragense, Viburum rhytidophyllum

Deciduous Shrubs

- Euonymus alatus, Euonymus alatus “Compacta”
- Spiraea nipponica “Snowmound”, Spiraea vanhouttei

Proposed landscaping should be designed to accommodate the vertical and horizontal clearances necessary for the trail user. The plant material should not create excessive fruit or flower litter that would pose a hazard on the trail.

Bollards, Gates and Medians

Certain road crossing or intersection situations may create a need to limit vehicular access to the trail. Bollards and gates are possible solutions to restrict motor vehicles. Bollards can effectively restrict vehicles from the trail and still allow pedestrians and bicyclists to pass through. It is important to design highly visible bollards so they do not present a collision hazard to bicyclists. Low level landscaping, 6" to 12" in height, can enhance visibility and create a low buffer around the bollard. Gates will completely restrict trail access because they stop vehicular, pedestrian and bicycle traffic. The gate opening and closure times are regulated by the Parks and Recreation Department.

Another method to limit trail use is to divide the trail entrance into two sections with a median or small island. The median should be wide enough to plant low shrubs to discourage vehicle traffic and provide visibility for bicyclists. The landscaping creates a "soft" barrier should the cyclist inadvertently enter the median. It also allows maintenance vehicles to straddle the median for trail access.

SIGNAGE AND MARKING

Types of Signs
Placement of Signs
Design of Signs
Markings and Striping
Marking and Signs at Intersections

Signage and Marking

Designed to increase the safety and comfort of trail users, adequate signing and marking are essential on any trail or trail system and should be incorporated into all Frederick County Parkland bikeways and trails. Signs communicate important information about the trail to the user, such as navigational and educational information, cautionary warnings of potential trail hazards, and regulatory uses. The Federal Highway Administration's *Manual on Uniform Traffic Control Devices (MUTCD) 2000* is a valuable resource that provides information on standard signage and pavement markings, and should be consulted by the trail designer.

Types of Signs

Informational Signs

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

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

Directional Signs

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

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

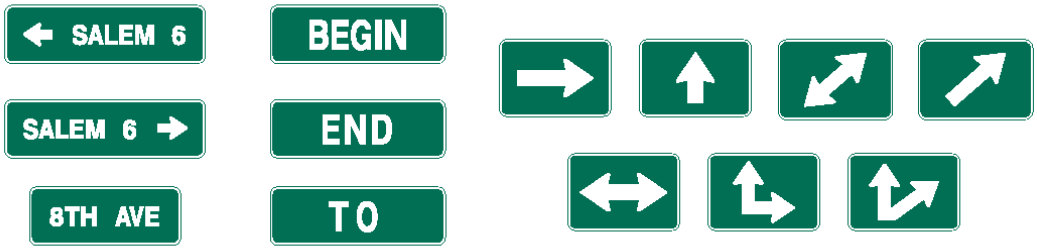


Figure 21 *Examples of Directional Signs*

Interpretive Signs
Interpretive signs are used to offer educational information on the trail environment. They include, but are not limited to, the following:

- Natural resources
- Cultural resources
- Historic resources
- Other educational resources

arning Signs
Warning signs are used to alert trail users to potentially hazardous or unexpected conditions. These signs should be used in advance of the condition. They include, but are not limited to, the following:

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

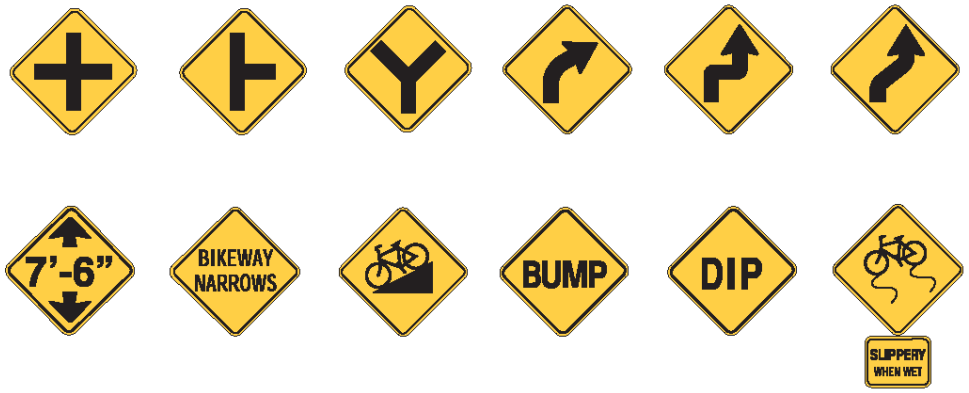


Figure 22 *Examples of Warning Signs*

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

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

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

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

Figure 23 *Examples of Regulatory Signs*

Placement of Signs

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

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

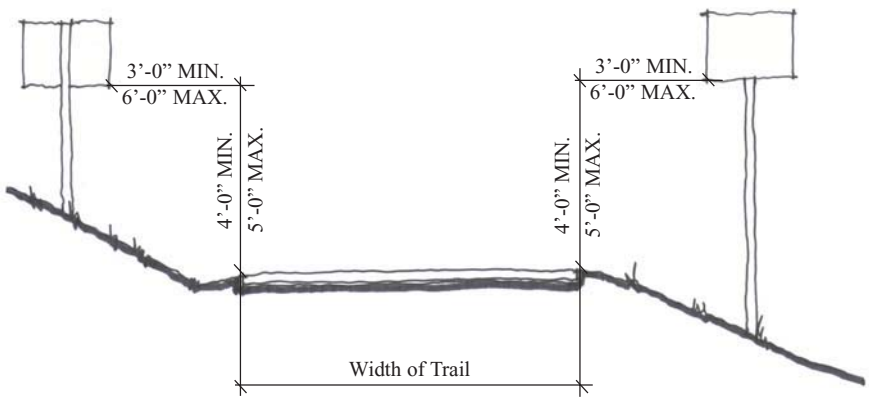


Figure 24 *Placement of Signs*
(adapted from MUTCD 2000, Section 9B.01)

Design of Signs (taken directly from MUTCD 2000, Section 9B.02)
Signs must be uniform and consistent for them to command the respect of trail users and should follow established sign design principles for ease of reading and comprehension.

- Signs shall be standard in material, shape, legend, color and font.
- All signs shall be retroreflective.
- Consider pictoral and symbol signs in place of verbal warnings.
- The sign sizes for multi-use trails shall be those shown in MUTCD 2000 Table 9B-1 (see Table 4).

SIGN SIZES FOR MULTI USE TRAILS*
Table 4

Sign	MUTCD Code	Minimum Sign Size	
		Millimeters	Inches
Stop	R1-1	450 x 450	18 x 18
Yield	R1-2	600 x 600 x 600	24 x 24 x 24
Bicycle Lane	R3-16,16a,17,17a	600 x 750	24 x 30
Movement Restriction	R4-1, 2, 3, 7	300 x 450	12 x 18
Begin Right Turn Lane Yield to Bikes	R4-4	900 x 750	36 x 30
No Motor Vehicles	R5-3	600 x 600	24 x 24
Bicycle Prohibition	R5-6	600 x 600	24 x 24
No Parking Bike Lane	R7-9, 9a	300 x 450	12 x 18
Pedestrians Prohibited	R9-3a	450 x 450	18 x 18
Bicycle Regulatory	R9-5, 6	300 x 450	12 x 18
Shared-Use Path Restriction	R9-7	300 x 450	12 x 18
Railroad Crossbuck	R15-1	600 x 112	24 x 4.5
Turn and Curve Warning	W1-1,2,3,4,5	450 x 450	18 x 18
Arrow Warning	W1-6, 7	600 x 300	24 x 12
Intersection Warning	W2-1,2,3,4,5	450 x 450	18 x 18
Stop, Yield, Signal Ahead	W3-1a,2a,3	450 x 450	18 x 18
Road Narrows	W5-2a	450 x 450	18 x 18
Bikeway Narrows	W5-4	450 x 450	18 x 18
Hill Sign	W7-5	450 x 450	18 x 18
Bump or Dip	W8-1,2	450 x 450	18 x 18
Bicycle Surface Condition	W8-10	450 x 450	18 x 18
Advance Grade Crossing	W10-1	450 dia.	18 dia.
Bicycle Crossing	W11-1	450 x 450	18 x 18
Low Clearance	W12-2	450 x 450	18 x 18
Share the Road Plaque	W16-1	600 x 750	24 x 30
Supplemental Bike Route Plaque	D1-1	600 x 150	24 x 6
Bicycle Parking	D4-3	300 x 450	12 x 18
Bike Route	D11-1	600 x 450	24 x 18
Bicycle Route Marker	M1-8	300 x 450	12 x 18
Bicycle Route Marker	M1-9	450 x 600	18 x 24
Supplemental Bicycle Route Guide	M4-11, 12, 13	300 x 100	12 x 4
Route Marker Supplemental Plaques	M7-1, 2, 3, 4, 5, 6, 7	300 x 225	12 x 9

*Taken directly from *Traffic Controls for Bicycle Facilities (MUTCD 2000),* Table 9b-1.

Trailhead Signs

Informational signs should be provided at each trailhead and major access point to convey accurate and detailed information about existing trail conditions and available facilities. This type of sign allows users to accurately assess whether or not a trail meets their personal level of safety, comfort and access. The following information should be conveyed on the sign:

- Trail name
- Frederick County Parkland Bikeways and Trails Logo (see below)
- Brief description of trail
- Permitted users (may vary depending on season)
- Trail map
- Milage to points of interest
- Trail length
- Elevation change over the total trail length and maximum elevation obtained
- Average running grade and maximum grades that will be encountered
- Average and maximum cross slopes
- Average tread width and minimum clear width
- Type of surface
- Size, location and frequency of obstacles

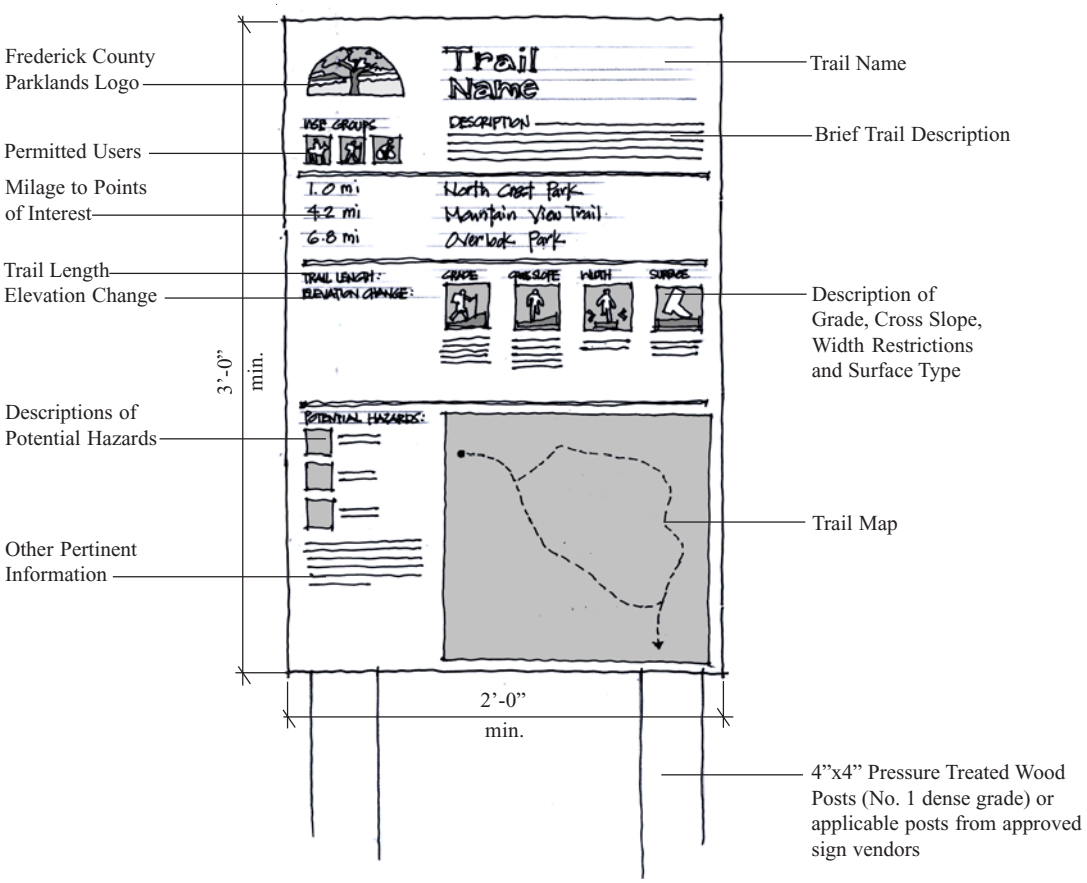


Figure 25 *Sketched Example of Trailhead Sign*

The Frederick County Bike ay and Trail Signs
To establish a unique identification, all trails within the Frederick County Parkland trail system must have a Frederick County Parkland Bikeways and Trails sign, complete with logo, to be placed at each trailhead, access point, and trail locations where trails cross into the County from other counties or states. The logo will be provided by the Frederick County Department of Parks and Recreation.

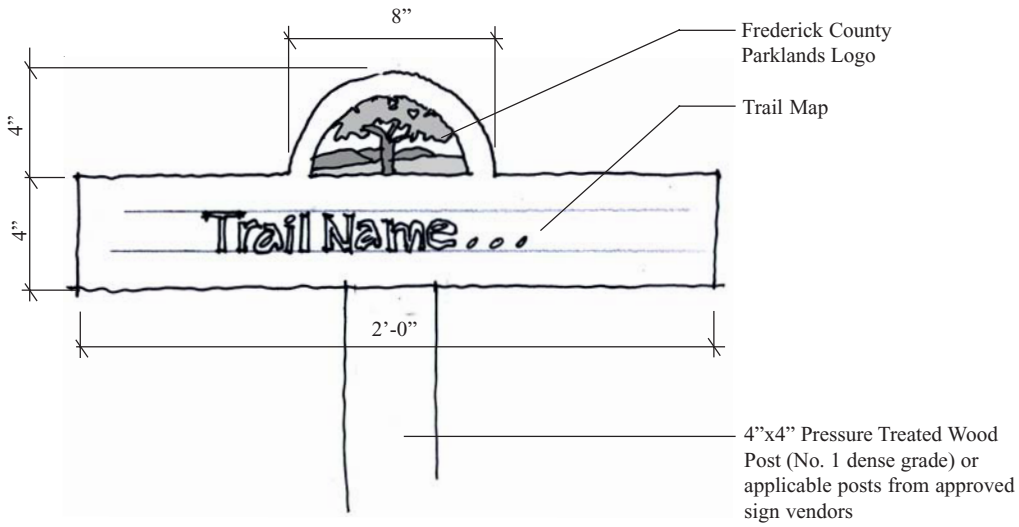


Figure 26 *Sketched Example of Trail Sign*

- Signs shall be made of anodized aluminum plates with black or colored text and images etched into surface, as required.
- Materials and hardware shall conform to design standards of highway signs.
- Lettering size of trail names shall be at least 2 inches and all other text shall not be smaller than one half inch.
- All fonts should be Gothic C, the standard highway font.
- Always use international symbols.

Markings and Striping
Marking and striping indicate the separation of lanes on multi-use trails.

- A solid white line is recommended for separation of pedestrian traffic and bicycle/in-line skating traffic and a dashed yellow line is recommended when adequate sight distance exists (see Figure 27).
- Solid white lines along the edge of trails are recommended where nighttime riding is expected.
- A solid yellow center line is recommended where trails are busy, where sight lines are restricted and on unlighted trails where night time riding is expected.
- Markings should be retroreflective.
- Consideration should be given to selecting pavement marking materials that will minimize loss of traction for bicycles in wet conditions.

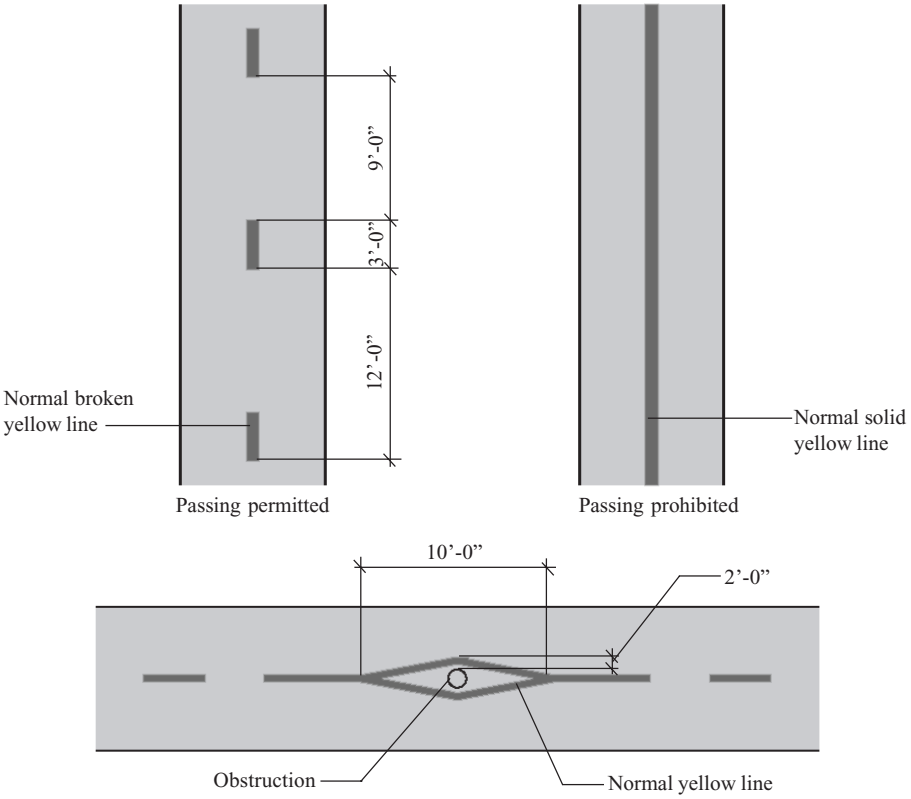


Figure 27 *Centerline Markings for Multi-Use Trails*

Marking and Signs at Intersections (taken directly from MUTCD 2000, Section 9C.01)

- Pavement marking and signs at intersections should tell trail users to cross at clearly defined locations and indicate that crossing traffic is to be expected.
- Similar devices to those used on roadways (stop and yield sign, stop bars, etc.) should be used on trails as appropriate.
- The AASHTO Guide notes that in addition to traditional warning signs in advance of intersections, motorists can be alerted to the presence of a trail crossing through flashing warning lights and striped or colored pavement crosswalks.

TRAIL ACCESSIBILITY

Trail Accessibility

The Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Areas, under the supervision of the United States Architectural and Transportation Barriers Compliance Board, issued a Final Report in 1999 discussing accessibility guidelines for trails. The proposed guidelines, currently being reviewed by several independent federal agencies, will soon be adopted by the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and will affect all trail planners and designers.

The guidelines apply to those multi-use trails designed and constructed for pedestrian use and are not applicable to natural surface trails which are primarily designed and constructed for recreational use by mountain bikers and equestrians, even if pedestrians may occasionally use the same trails. However, because everyone should have the opportunity to experience and enjoy the natural environment, the guidelines do attempt to balance the conflict between accessibility and the uniqueness of the outdoor experience by recommending that a percentage of each natural surface trail be accessible.

All newly designed and constructed multi-use pedestrian trails, or portions of existing trails connecting to accessible trailheads within the Frederick County Parkland system, shall be designed to accommodate the accessibility needs of all designated users. In addition to the guidelines described above, trail implementors are strongly encouraged to consult *Designing Sidewalks and Trails for Access: Part II of II: Best Practices Design Guide.*

As described in the Final Report of the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Areas, an accessible pedestrian trail would meet the following minimum technical provisions:

Surface
The trail surface shall be firm and stable.

Clear Tread idth
The clear tread width of the trail shall be 36 inches minimum.

Openings
Openings in trail surfaces shall be a size that does not permit passage of a 1/2 inch diameter sphere. Elongated openings shall be placed so that the long dimension is perpendicular or diagonal to the dominant direction of travel.

Protruding Objects
Protruding objects on trails shall comply with ADAAG 4.4.1 and shall have 80 inches minimum clear head room.

Tread Obstacles
Where tread obstacles exist, they shall not exceed 2 inches high maximum (up to 3 inches high where running and cross slopes are 5% or less).

Passing Space
Where clear tread width of a trail is less than 60 inches, passing spaces shall be provided at intervals of 1,000 feet maximum.

Cross Slope
The cross slope shall not exceed 1:20 (5%) maximum.

Running Slope
Running slope (trail grade) of trail segments shall comply with one or more of the following provisions. No more than 30 percent of the total trail length shall exceed a running slope of 1:12 (8.33%):

- 1:20 (5%) or less for any distance
- Up to 1:12 (8.33%) for 200 feet maximum with rest areas no more than 200 feet apart
- Up to 1:10 (10%) for 30 feet maximum with rest areas no more than 30 feet apart
- Up to 1:8 (12.5 %) for 10 feet maximum with rest areas no more than 10 feet apart

Rest Areas
Rest areas shall be 60 inches minimum in length, shall have a width at least as wide as the widest portion of the trail segment leading to the rest area, and have a slope not exceeding 1:20 (5%) in any direction.

Edge Protection
Where edge protection is provided along a trail, the edge protection shall have a height of 3 inches minimum.

Signs
Provide signs at trailheads and access points with accurate and detailed information about existing path conditions and available facilities. Sign information shall include total distance of the accessible segment, information about potential obstacles, surface type, grade, cross-slope, and other trail features, allowing users to accurately assess whether or not a trail meets their personal level of safety, comfort and access. Such information reduces the liklihood that a trail user will become stranded or endangered and can improve safety and visitor enjoyment. Trail users with visual impairments benefit from signs with large lettering, Braille panels, raised lettering, or audio boxes that play recorded trail information at the push of a button.

While the proposed guidelines address exceptions where trail designers may not be able to achieve accessibility, they strongly encourage access to the greatest extent possible. Departure from specific guidelines is permitted for any portion of the trail where strict compliance would:

- Cause substantial harm to cultural, historic or natural features or characteristics;
- Substantially alter the nature of the setting or the purpose;
- Require construction methods or materials that are prohibited by Federal, State or Local regulations;
- Not be feasible due to terrain or the prevailing construction practices.

In addition to the trail itself, it is critical that built facilities, such as parking lots, restrooms, picnic facilities and drinking fountains at the trailhead and along the trail, be accessible. ADAAG provides detailed scoping requirements for all built facilities along an accessible route. The trail designer should consult these quidelines, some of which are highlighted below:

Parking

The number of accessible parking spaces and required dimensions shall comply with ADAAG 4.1.2(5) and 4.6.

Total Parking In Lot	Required Minimum Number of Accessible Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2 percent of total
over 1000	20 plus 1 for each 100

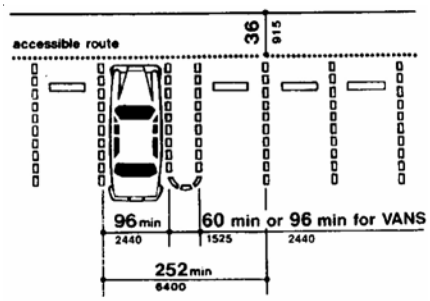


Fig. 9
Dimensions of Parking Spaces

Figure 28 *Accessible Parking Spaces and Required Dimensions*

Restrooms

All restrooms at trailheads and along the trail shall comply with ADAAG 4.16.

Picnic Tables and Benches
Picnic Tables, Benches and Trash/Recycling Containers shall comply with Sections 16.5, 16.8 and 16.12 of the Final Rule of the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Areas.

Drinking Fountains
All drinking fountains shall comply with ADAAG 4.15.

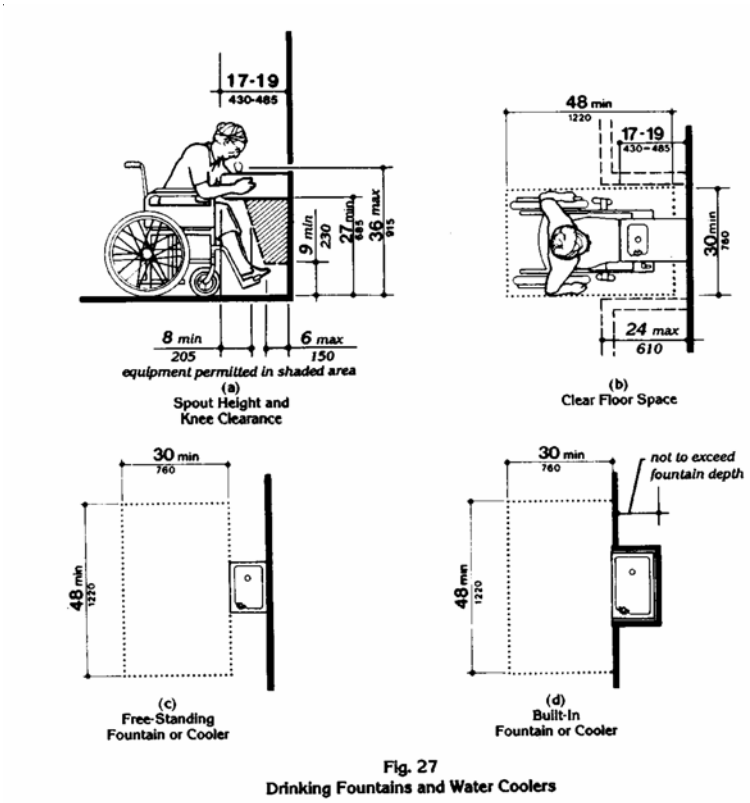


Figure 29 *Accessible Drinking Fountain Dimensions*

Ramps and Handrails
Any part of an accessible route requiring a ramp or handrails shall comply with ADAAG 4.8.

MAINTENANCE

Maintenance

Bikeway and trail maintenance keeps trails at or near constructed or intended conditions. Regular maintenance protects the investment of public funds, while enhancing user safety, protecting resources and providing continued access to the public. Poorly maintained trails and facilities become unusable and a legal liability.

A maintenance program, developed by the Frederick County Department of Parks and Recreation should be established and adopted by the operating agencies responsible for trail maintenance in order to preserve the trails and facilities, to insure the safety and comfort of trail users, and to maintain a harmonious relationship with adjacent property owners. This would include numerous efforts ranging from mowing and snow removal to replacement of damaged benches and signs to surface repair and reconstruction of the trail.

Every trail should be inspected and evaluated on a regular schedule in order to identify the need for minor or major maintenance repairs. Different types of trails will differ greatly in their maintenance requirements. However, all trails will require a variety of preventative and corrective activities throughout their lives to insure that they remain safe, accessible and in good condition.

The following recommended maintenance schedule is taken directly from the Iowa Department of Transportation's Trails Plan 2000 and outlines some general guidelines for maintenance activities and the frequency at which they should be performed. The outline provides a general approach to maintaining all types of trails. However, the agency responsible for each trail's operation and maintenance (Municipalities, Developers, Home Owner's Associations, Volunteers, etc.) will know best when certain maintenance activities should be performed.

Recommended Maintenance Schedule

Frequency	Maintenance Activity
As Needed	• Sign replacement • Map or signage updates • Sweeping and brush removal • Trash removal and litter clean-up • Repair or replace trail support amenities such as parking lots, benches, restrooms, etc. • Clearing of vegetation for adequate sight distances • Repair flood damage, such as silt clean-up, culvert clean out, etc. • Patching and minor re-grading • Repaint or repair trash receptacles, benches, signs, and other trail amenities, if necessary
Seasonal	• Mowing • Leaf blowing • Snow plowing or grooming • Planting, pruning and beautification

	• Culvert clean-out • Installation or removal of seasonal signage
Yearly	• Surface evaluation to determine needed patching, re-grading or installation of waterbars (see definition below) • Evaluate structural integrity of human-built trail features, such as bridges, retaining walls, steps, railings, etc. • Evaluate support services to determine need for repair or replacement • Repaint or repair trash receptacles, benches, signs, and other trail amenities
5-Year	• Sealcoat asphalt trails
10-Year	• Resurface, re-grade and re-stripe trail
20-Year	• Replace or reconstruct trail

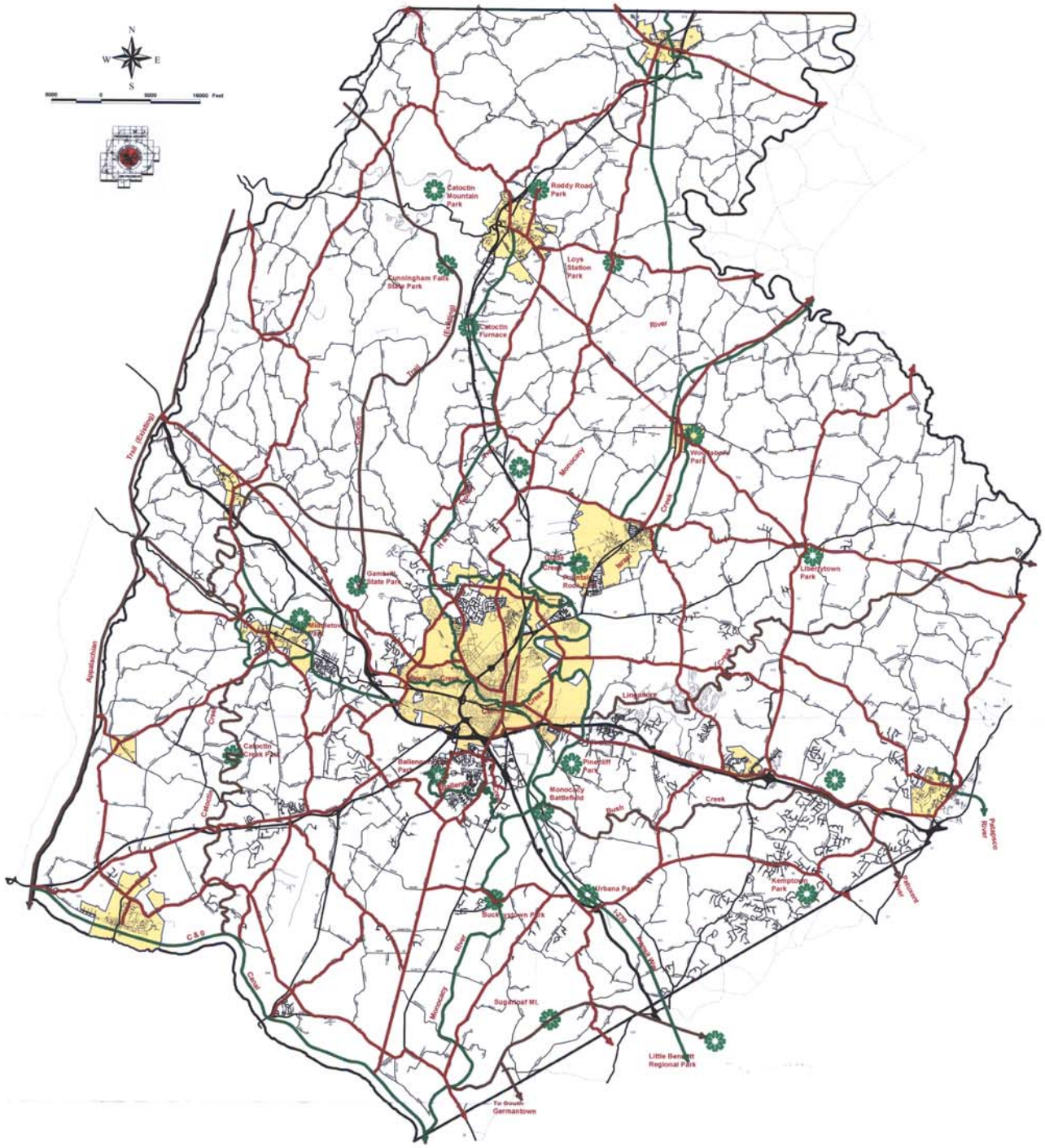
Trail users are often the first to experience trail deficiencies and identify needed repairs. Therefore, trail operators are strongly encouraged to establish a spot-improvement program. This program enables trail users to bring deficiencies and problems to the attention of the operating agency in a quick and efficient manner by having pre-addressed, postage-paid postcards available to the public, as well as appropriate telephone numbers posted along the trail. A timely response from the agency will help to insure safe and accessible trail conditions.

Definition:

aterbar: A waterbar is a drainage structure that is built across the width of the trail to direct water to the edge of the trail. It is used as a temporary solution to control drainage on steeper slopes. The use of waterbars is an indication that proper drainage was not accomplished with the original trail design and installation. Waterbars are typically made of wood, logs or stone. They are raised as much as 6 inches above the trail to intercept and direct the water runoff. The rigid waterbars should only be used on non-handicap accessible trails. Flexible waterbars are made of a rubber material imbedded in concrete in the trail. These can be run over by bicycles, wheel chairs, strollers, or other wheeled vehicles. It is preferable to control drainage without the use of waterbars. They create additional maintenance, trap sediment on the uphill side of the bar, and present hazards to the trail user.

APPENDIX

A. Map of Frederick County Bike ays and Trails Plan
B. Map of Proposed Corridors for Future Parklands
Off Street Bike ays and Trails
C. General Soils Map Frederick County, Maryland



On - Street Bikeways
Multi - Use Trails
Natural Surface Trails
Selected Parks

Prepared By:
Frederick County Planning Dept. GIS
Winchester Hall
12 East Church Street
Frederick MD 21701

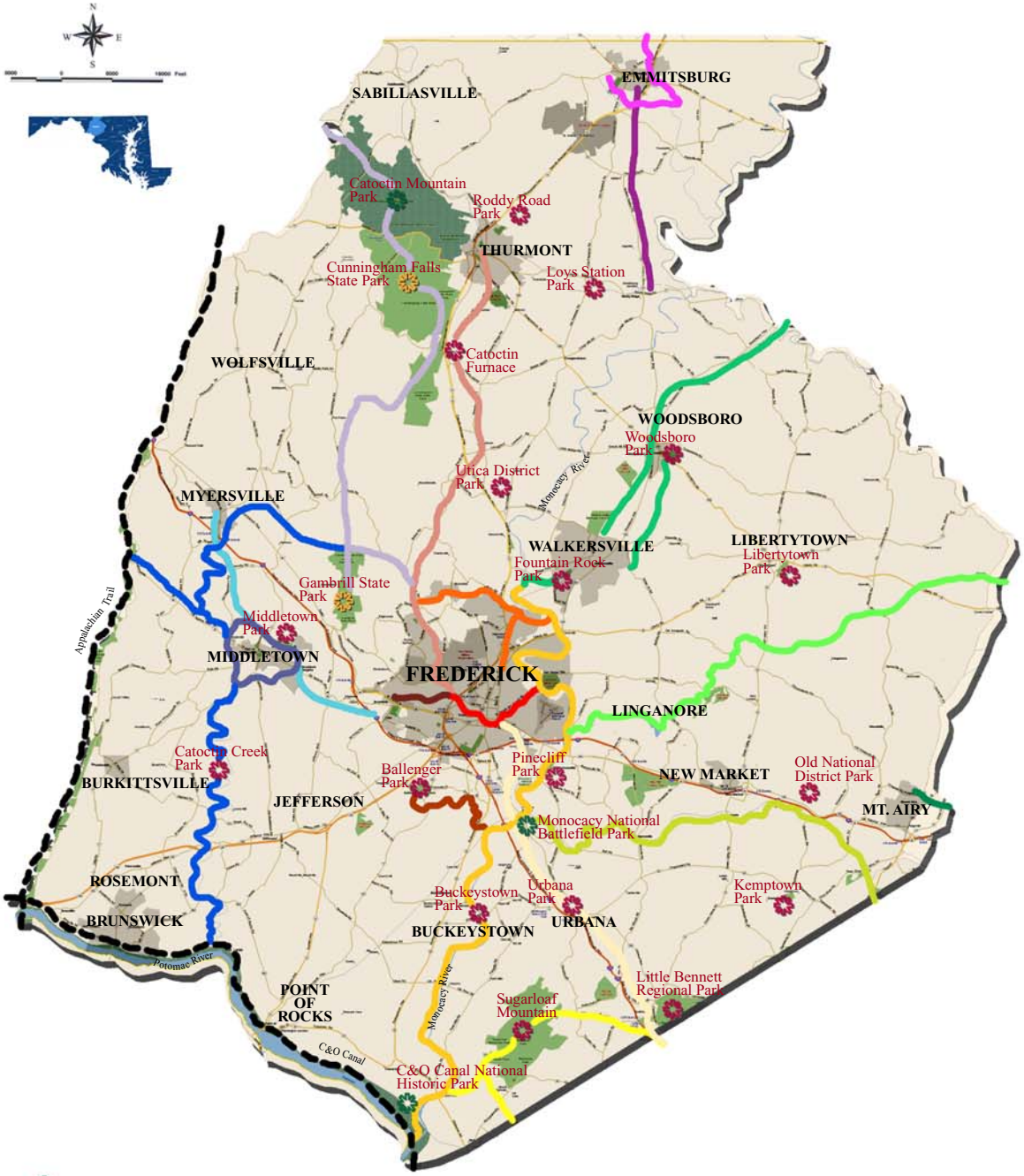
NOTE

This map is a planning tool and not a trail guide. The proposed off-street trail corridors indicate desire lines and should not be considered specific trail alignments. These corridors will undergo further study to determine the nature and location of the trail. Designation as an on-street bikeway does not imply that the road is currently improved as a bikeway. Improvements for bikeway facilities would be completed as part of roadway widening and other improvement projects.

For further information please contact the Frederick County Planning Department at (301) 694-1144.

Frederick County Bikeways and Trails Plan

Adopted December 16, 1999



National Park
State Park
County Park

H&F Trolley Trail
Ballenger Creek Trail
Rock Creek Trail
Carroll Creek Trail
Tuscarora Creek Trail
Monocacy River Geenway
Sugarloaf-Little Bennett Trail
I-270 Transitway
Bush Creek Trail
Linganore Creek Trail
B&O Trail
Walkersville-Woodsboro Corridor
Middletown-Myersville Trolley Trail
Middletown Greenway
Catoctin Creek Trail
Catoctin Trail Extensions
Emmitsburg Railroad Trail
Emmitsburg Greenway and Trail
Existing C&O Canal and Appalachian Trails

PROPOSED CORRIDORS FOR FUTURE PARKLANDS OFF-STREET BIKEWAYS AND TRAILS FREDERICK COUNTY, MARYLAND

(As identified in the Frederick County Bikeways and Trails Plan)

Note: The trail corridors depicted on this map are intended to be conceptual in nature and do not indicate specific trail alignments, trail use, trail surface and other detailed design issues.

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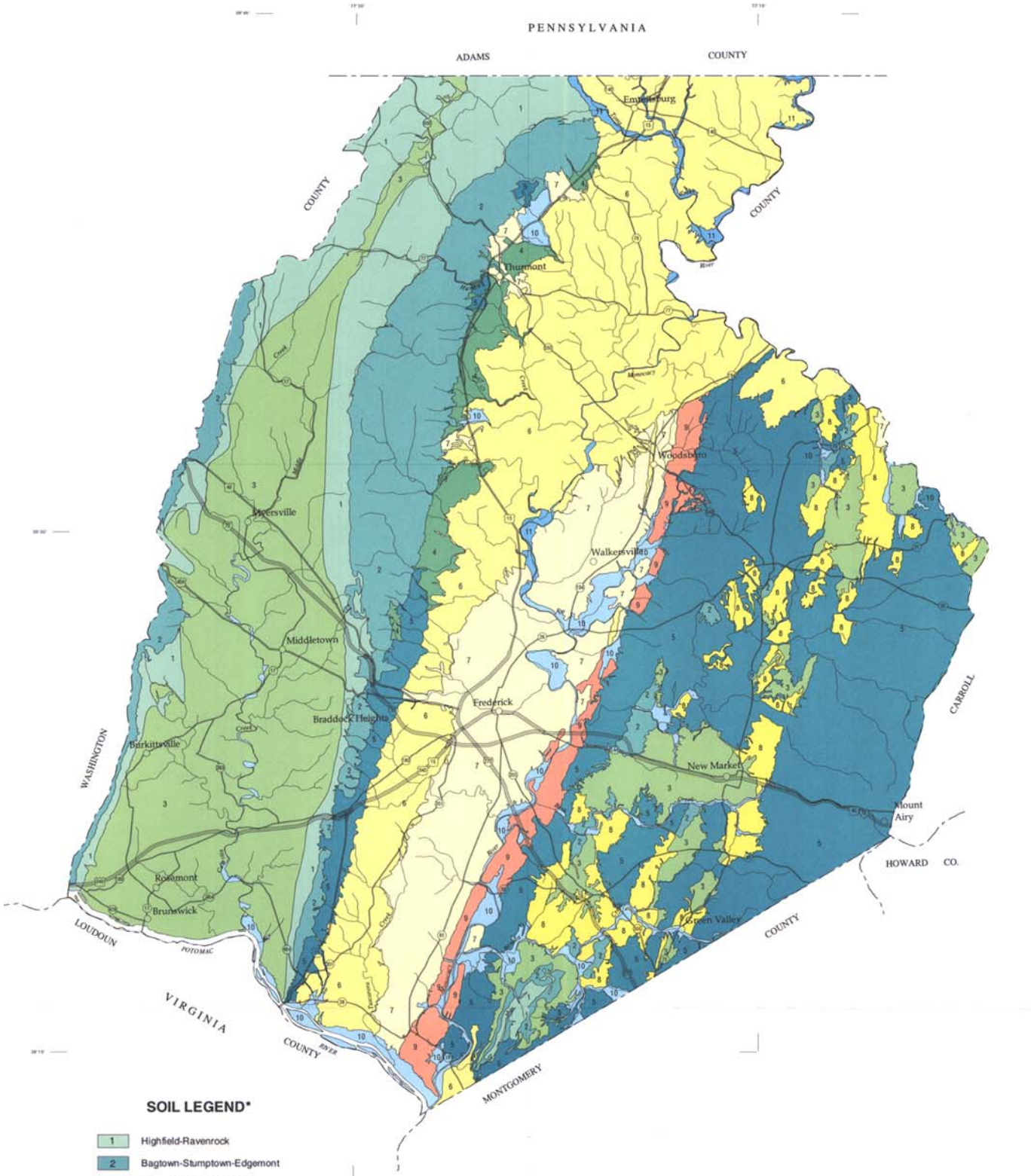

SOIL LEGEND*

1	Highfield-Ravenrock
2	Bagtown-Stumptown-Edgemont
3	Myersville-Catoctin-Mt. Zion
4	Trego-Foxville-Thurmont
5	Mt. Airy-Glenelg-Blocktown
6	Penn-Klinesville-Reaville
7	Duffield-Hagerstown-Ryder
8	Linganore-Hyattstown-Conestoga
9	Cardiff-Whiteford
10	Codorus-Hatboro-Combs
11	Rowland-Bermudian-Bowmansville

*The units on this legend are described in the text under the heading "General Soil Map Units."

Compiled 2001

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
BOARD OF COUNTY COMMISSIONERS OF FREDERICK COUNTY
CATOCTIN SOIL CONSERVATION DISTRICT
FREDERICK SOIL CONSERVATION DISTRICT
MARYLAND AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
FREDERICK COUNTY, MARYLAND

Scale 1:126720

MILES

KILOMETERS