

3. Project Design

Section at a Glance

- *Background*
- *Frequently Asked Design Questions*
- *Design Resources*

Background

This section addresses basic questions and provides general resources for both paved and unpaved trail design. The design goals for any project should be to create safe, enjoyable and accessible* facilities that minimize impact to the

environment. Achieving these multiple goals will require incorporating information from many sources.

➔ For a listing of key references, see *Design Resources* at the end of this section.

It is important during design to review all pertinent standards and guidelines and utilize all applicable data to incorporate safety measures and user enjoyment in facility design. Bear in mind that development of your project may require the services of a licensed professional such as a landscape architect or engineer. In the end, the types of facilities proposed for your project will determine your design needs. The facilities may include:

- Paved trails and paths
- Unpaved trails
- Canoe launches and fishing docks
- Restrooms and drinking water facilities
- Informational and interpretive kiosks and signage
- Picnic areas
- Visitor centers
- Bridges and boardwalks

Be aware that there may be specific design requirements if you are funding the construction of your project through a grant program. Certain state and federal programs require adherence to specific design criteria. Contact the program or contract manager for the particular funding source you are applying for to determine if any requirements exist.

Consider the potential impact of the project to the natural environment. Minimize impacts to environmentally sensitive areas by avoiding them. If your project is part of a larger ecological greenway, balance recreational and interpretive opportunities with protection of the greenway's environmental assets. As with design requirements, some funding programs may require environmental review of proposed projects and may also

* Americans with Disabilities Act (ADA) accessibility requirements are explained in the U.S. Department of Transportation two-part document, *Designing Sidewalks and Trails for Access*. For further information regarding ADA requirements as they relate to trail design in Florida, please contact Alexandra Weiss of OGT at 850-245-2052.

require that any necessary environmental permits be in place prior to project construction. Consult with a biologist or other appropriate specialist to evaluate the most ecologically sensitive alignment for your project. As discussed in *Section 1, Planning Greenways and Trails*, thorough planning will help set the stage for good design and will ensure the protection of environmental resources.

Frequently Asked Design Questions

The Office of Greenways & Trails receives many questions regarding project design. The following answers are intended to address some of the most frequently asked questions. Many of the answers provided here are drawn from the publications listed under *Design Resources* at the end of this section.

➔ If you have any questions that are not specifically addressed here, please consult the *Design Resources* listed at the end of this section or contact your OGT regional coordinator for further guidance. OGT regions and planner contact information can be found at <http://www.dep.state.fl.us/gwt/contacts/pdf/ogtregions.pdf>.

Q. What is the appropriate width for a trail corridor?

Corridor width may vary. Depending on available space, a narrow section of corridor may allow little or no buffer between trails when there are multiple trail types in one corridor. Correspondingly, a wider section of the same corridor may allow substantial buffers and total separation of trail types. For paved trails, the “minimum optimum” corridor width is 36 to 56 feet (**Figure 1**), which is calculated as follows:

- 12 to 18 feet – paved trail surface width, varies by project; plus,
- 10 feet for clear zones – 2 foot wide at-grade shoulders at each edge of the pavement to provide trail goers a surface change rather than a drop if they stray off the paved surface, with an additional 3 foot clear zone beyond the 2 foot at grade shoulder to reduce conflicts if a trail user uses the at-grade shoulder; plus,
- 10 to 20 feet for buffers - 5 to 10 foot vegetative buffers outside the clear zones to provide room for a shaded canopy to remain or grow; plus,

For unpaved trails, the minimum “optimum corridor” width is 22 to 48 feet (figures extrapolated from the *Florida Greenways and Trails System Design Guidelines for Unpaved and Paddling Trails, Appendix E*):

- 4 to 8 feet - unpaved trail surface width, varies by project; plus,
- 8 to 20 feet or more for buffers – separates user groups such as equestrian, hikers and bicyclists, and provides room for a shaded canopy to remain or grow on both sides of the cleared paths.

These numbers represent minimum “optimum corridor” widths. Specific physical conditions, including bridges, ridges, narrow sections of corridor and other constricted areas such as trailheads and road crossings, may require shared use of a single, more narrow path.

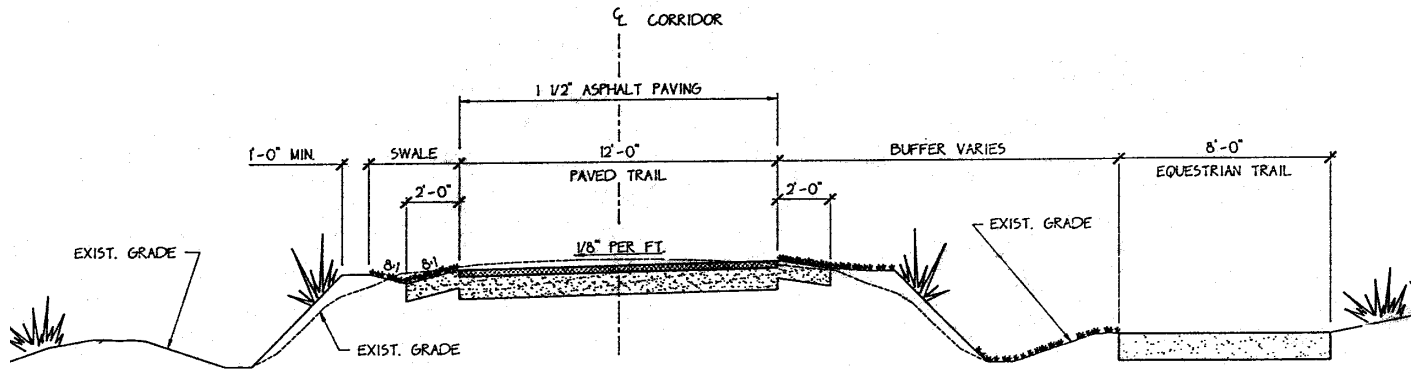


Figure 1. Typical Paved Trail Corridor Section
(Source: Office of Greenways and Trails)

Q. What is the best pavement width for a trail?

The recommended minimum recreational paved trail width is 12 feet for trails expected to receive more than occasional mixed-use (bicycles, pedestrians and skaters). Your designs should reflect careful attention to safety, user enjoyment and preventing user conflict, especially when planning for a paved trail that may receive substantial mixed-use.

Q. Why not opt for a narrower width so our paving funds will go further?

If space restrictions due to corridor width are a consideration, 10 feet may be acceptable. However, whenever there is more than occasional shared use, 12-foot widths are safer and more enjoyable. Consider the following:

Groups of two or more recreational bicyclists generally ride in tandem. Bicyclists use a minimum of 2 feet of trail width per bicycle and maintain a minimum comfort zone of 2 feet from any obstacle (each other, the edge of the pavement, or other trail users). Therefore, one direction of comfortable tandem bicycle riding requires a minimum width of 10 feet. Correspondingly, two-way single-file bicycle traffic requires a minimum width of 10 feet to recreate comfortably.

Again, for substantial mixed-use a minimum paved width of 12 feet is recommended.

Q. *What about roadway intersections along paved trails?*

Use Florida Department of Transportation (FDOT) approved designs for roadway crossing signs and pavement markings. Design crossings that reflect design specifications for curves, grades and steep shoulders. Refer to FDOT publications listed under *Design Resources* at the end of this section.

STOP signs should not necessarily be used at every trail intersection. Nor should the intersecting roadway always be given priority over the trail. The *Manual on Uniform Traffic Control Devices (MUTCD)* should be consulted when signing and striping trail-
roadway intersections. This document can be downloaded from the web at <http://mutcd.fhwa.dot.gov/>.

Q. *What if our trail intersects a roadway at a severe angle?*

If your trail does not cross a roadway at or close to a ninety-degree angle you have a skewed crossing. Skewed crossings increase the distance a trail user is in the roadway. Skewed crossings also cause the trail user to turn their back to one direction of oncoming vehicular traffic. The combined effects are an increase in the time spent in the roadway and greatly diminished view in one direction.

Skewed crossings can be corrected by using a jug-handle shaped trail approach that brings trail users up to and across the intersection at a right angle (**Figure 2**).

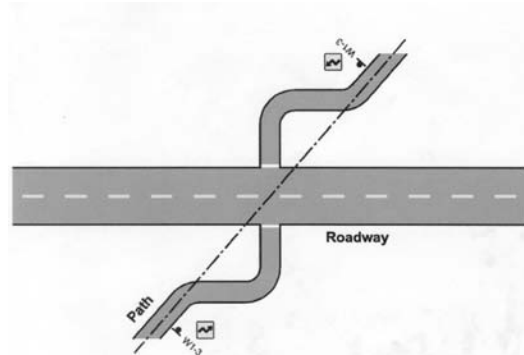


Figure 2. Typical Redesign of Diagonal Road Crossing

(Source: *Guide for the Development of Bicycle Facilities*)

Q. *What can we do to keep motorized vehicles off our paved trail?*

Design your trail to keep the average automobile driver from mistaking your trail for a road. Experience has demonstrated that no trail can be built to be completely secure from illegal motorized use. Thanks to traditional enforcement techniques, illegal trail use by motorized drivers has never been an ongoing problem.

Only on rare occasions will you encounter motorized drivers that are intent on breaking the law. Since criminals do not like witnesses, almost every instance of joy-riding or

illegal dumping occurs before a trail is built and open to the public or at night when the trail is closed.

Your goal is to design road intersections that are unmistakably closed to motorized use. This is best accomplished through designs that reduce potential conflicts for the trail user. Remember to keep your trail free of man-made obstacles. Whenever possible, install all guard rails, traffic bollards and signs outside of the clear zone, which extends three to 6 feet from the edge of the asphalt trail surface (American Association of State and Highway Transportation Officials).

Many excellent designs have proven successful in deterring unauthorized vehicles from entering the trail. The two most common treatments are the single bollard system and the median system, which are explained below.

Q. What is the single bollard system?

The single bollard system uses one 4-inch by 4-inch or larger post strategically anchored in the center of the trail surface as you approach the road crossing. The bollard should be located on the trailside of the boundary line for the roadway right-of-way. Each individual bollard placed across the trail surface or within the clear zone at the edge of the paved trail surface creates a permanent conflict zone. Numbers of trail user crashes with bollards are directly related to the number of conflict zones.

If bollards are used they should be placed far enough from the road intersection to allow trail users to successfully negotiate one conflict area (the bollard) before entering the next conflict area (the intersection) while constantly monitoring any oncoming trail traffic. If a bicyclist or other trail user does make contact with a bollard, the distance between the bollard and the roadway becomes the trail user's recovery area. Therefore, it is recommended that bollards be setback as much as 50 feet from the roadway.

Q. What is the median system?

A median system (**Figure 3**) uses a low, mountable curb that separates the directional flow of the trail as trail users approach the intersection. Raised medians alert trail users to the upcoming intersection and separate the trail's directional traffic flow throughout the conflict zone. The conflict zone we refer to in this case is the interaction between both directions of trail



Figure 3. Raised Median Intersection
(Courtesy of Seminole County)

users, the raised median and the road crossing.

The raised median creates two narrow paths where the trail intersects the roadway and the average automobile driver will not mistake the two separated narrow paths for a roadway. Authorized trail access for service vehicles, law enforcement and emergency vehicles is maintained by slowly driving over or around the raised median.

The median system uses a mountable curb to gradually separate the directional flow of the trail by at least 2 feet before intersecting the roadway. Mountable curbs begin at the same grade as the trail surface and gradually rise four to six inches in the direction of the center of the median. Sod, wildflowers or other low vegetative cover can be planted within the median. Please note that it is best to use native or noninvasive plants for medians and buffers. For more information about native plants, visit <http://ifasbooks.ifas.ufl.edu/c-103-invasive-and-non-native-plants.aspx>

Q. What are the relative benefits of the bollard and median systems for preventing unauthorized motorized vehicle use on paved trails?

The main benefit of the bollard system is lower construction cost. The main benefits of the median system are the trail's low probability of being mistaken as a roadway, the absence of problems associated with bollards (such as crashes and vandalism) and aesthetics.

Q. Are there standards for signs at road intersections?

For unpaved trails, depending on the site distance, use levels and other specific characteristics, minimal signage may be adequate for both the roadway and the trail. If there will not be vehicular conflicts between right-of-ways (no intersecting paved bicycle right-of-way), roadway signage can be limited to FDOT approved caution signs to alert motorized vehicles of the existence of a pedestrian crossing.

In general, paved trail signage should follow the standards set forth in the *Manual on Uniform Traffic Control Devices (MUTCD)*. This document can be downloaded from the web at <http://mutcd.fhwa.dot.gov/>.

Q. How do we select an unpaved trail alignment that accommodates various uses?

As noted at the beginning of this section, consider the alignment that results in the least environmental impact, particularly when providing biking and equestrian uses. Buffers between hiking, mountain biking and equestrian trails are also important to

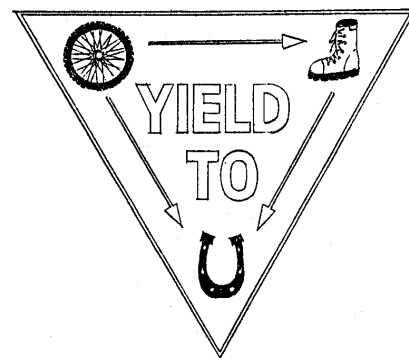


Figure 4. Sample Yield Sign
(Source: *Trails for the Twenty-First Century*)

consider. Use signs, kiosks and brochures to stress trail etiquette. Be sure trail signs clearly indicate which user groups have the right to be on a shared use trail. Remember the yield triangle: bicyclists yield to hikers and horses, hikers yield to horses (**Figure 4**).

Q. Are there standards for marking unpaved trails?

Many types of markers are used to identify hiking, equestrian, bicycle and paddling trails. Collectively these markers are referred to as reassurance markers.

Reassurance markers come in various forms:

- Cut or painted blazes on trees;
- Wood, plastic, or metal marker tags;
- Marker posts;
- Signs; and
- Cairns (mounds of stones).

These markers are used to help travelers identify the trail corridor when the trail tread or path is indistinct or confused by multiple trails.

Trail marking procedures vary by agency and type of trail. Trail goers use the management entity's trail map or a trailhead kiosk to identify the trail-marking plan for a specific trail. Many sites have multiple trails; each trail should be marked with its own blaze color or reassurance marker. There are not state or national standards for color schemes. It is helpful to use different symbols or numbers on maps of trails that are marked by different colors so that black and white copies will make sense.

For hiking trails in Florida, standardization leans towards the following:

Primary Trails -

Orange blazes are generally used for primary hiking trails, especially on the Florida National Scenic Trail.

Secondary Trails -

Blue blazes are generally used for secondary side or connecting hiking trails.

Change in Direction -

Double blazes of the same color indicate the trail is departing from an obvious path.

When double blazes are offset, the highest blaze indicates the new direction.

Common Tread -

Use double markers when two separate trails share a common tread. If a yellow trail and a green trail share a common tread for any distance, use yellow and green trail markers side by side until the trails depart the common path.

→ For more information regarding trail marking, see *Appendix E, Florida Greenways and Trails System Design Guidelines for Unpaved and Paddling Trails* at: <http://www.dep.state.fl.us/gwt/community/refguide/pdf/appende.pdf>

Q. Are there special requirements for paddling trails, boardwalks over navigable waters or in-water signage?

Yes. Paddling trails, boardwalks over navigable waters, and in-water informational signage must comply with US Coast Guard, US Army Corps of Engineers and Florida Fish and Wildlife Conservation Commission (FWC) regulations. For permit information, contact:

FWC, Division of Law Enforcement
Boating Safety and Water Management Office
620 South Meridian Street, Tallahassee, FL 32399-1600
Phone: (850) 410-0656 ext. 17169
Web: <http://myfwc.com/boating/>

→ For more information regarding paddling trails, see *Appendix E, Florida Greenways and Trails System Design Guidelines for Unpaved and Paddling Trails*.

Q. What about mixed-use bridges?

Both required and suggested design criteria exist for individual bridge applications. For example, be sure to adhere to all applicable ADA standards and check with FDOT for emergency vehicle design load requirements for your particular application. For mixed-use with equestrians refer to *Appendix E, Florida Greenways and Trails System Design Guidelines for Unpaved and Paddling Trails*. For equestrian use, it is recommended that the bridge deck be constructed with a non-skid surface such as crushed shell, wood, rubber mat or textured concrete (consult area equestrians for preferences). There should be no reduction in unpaved tread width or paved surface width as the trail approaches and crosses the bridge.

Q. Which state office is the best source of information for paved trail design?

The Florida Department of Transportation (FDOT) and the Florida Department of Environmental Protection (FDEP) are charged with combining forces to provide a statewide, integrated system of bicycle and pedestrian ways. Section 335.065 (3), Florida Statutes, states:

The department [FDOT], in cooperation with the Department of Environmental Protection, shall establish a statewide, integrated system of bicycle and pedestrian ways in such a manner as to take full advantage of any such ways that are maintained by any governmental entity. For the purposes of this section, bicycle facilities may be established as part of or separate from the actual roadway and may utilize existing road rights-of-way or other rights-of-way or easements acquired for public use.

Both FDOT and the Office of Greenways and Trails can provide general information regarding paved trail design. However, because bicycles are considered vehicles and a person riding a bicycle on a road has “all of the rights and all of the duties applicable to the driver of any other vehicle” (Section 316.2065, Florida Statutes), FDOT is the primary agency in Florida responsible for design of bicycle facilities. It is important to follow FDOT roadway signage and pavement marking requirements when designing paved trails that will accommodate bicycles. Land managers may also chose to adopt additional criteria regarding paved trail design.

For more information about FDOT design standards, guidance, and related resources, contact:

Florida Department of Transportation Safety Office

605 Suwannee St., MS 53

Tallahassee, FL 32399

Phone: (850) 245-1500

Web: http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.shtm

Design Resources

The following is a listing of key resources that provide information regarding guidelines, standards and design. Many of these resources will point you to other important sources of information. Where possible, we have noted whether the resource is available on the web.

Designing Sidewalks and Trails for Access, U.S. Department of Transportation

This is a two-phase project focused on how sidewalks and trails should be developed to promote pedestrian access for all users, including people with disabilities. Part I is a review of existing guidelines and practices. Part II is a best practices design guide for planners, designers, and transportation engineers.

➔ Designing Sidewalks and Trails for Access may be downloaded for more information visit:

- [Memorandum](#) (November 20, 2001) - explains the responsibilities of the USDOT in implementing the Americans with Disabilities Act (ADA).
<http://www.fhwa.dot.gov/environment/bikeped/tranmemo.htm>.

- [Part 1](http://www.fhwa.dot.gov/environment/sidewalks/index.htm) - provides a review of the State of the Practice in accommodating people with disabilities.
<http://www.fhwa.dot.gov/environment/sidewalks/index.htm>
- [Part 2](http://www.fhwa.dot.gov/environment/sidewalk2/index.htm) - provides recommended design criteria for accessible transportation facilities.
<http://www.fhwa.dot.gov/environment/sidewalk2/index.htm>
- [Errata Sheet](http://www.fhwa.dot.gov/environment/bikeped/errata.htm) - provides technical corrections to the recommended designs proposed in Part 2.
<http://www.fhwa.dot.gov/environment/bikeped/errata.htm>

Designing Trail Intersections, FDOT

A guidance document addressing some of the issues associated with path/roadway intersections.

➔ This publication can be downloaded from FDOT. For more information, visit http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/TRAILINT.PDF and http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/APPEND.PDF

Designing Trail Termini, FDOT

Another guidance document addressing some of the issues associated with distribution of trail traffic at their termini.

➔ This publication can be downloaded from FDOT. For more information visit http://www.dot.state.fl.us/safety/ped_bike/handbooks_and_research/termini.pdf

Florida Bicycle Facilities Planning and Design Handbook, FDOT

This document is a handbook, which means it provides information above and beyond design requirements. It does not create standards but does quote them. When AASHTO, FHWA, or FDOT release new standards, the handbook is updated accordingly.

➔ This publication can be downloaded from FDOT. For more information, visit http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.shtm#Florida%20Ped%20Handbook

Florida Greenways and Trails System Design Guidelines for Unpaved and Paddling Trails, Florida Recreational Trails Council

Developed by the Florida Recreational Trails Council in 1998, this resource provides minimum design guidelines for unpaved non-motorized trails to accommodate hiking, jogging, bicycling, horseback riding, paddling or multiple uses in Florida.

➔The complete guidelines are available in *Appendix E* of this document (available for download at <http://www.dep.state.fl.us/gwt/community/refguide/pdf/appende.pdf>).

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

As its introduction explains, “this guide provides information to help accommodate bicycle traffic in most riding environments. It is not intended to set forth strict standards, but, rather, to present sound guidelines that will be valuable in attaining good design... However, in some sections of the guide, design criteria include suggested minimum guidelines. These are recommended only where further deviation from desirable values could result in unacceptable safety compromises.”

It is a guide, not a manual. However, it is widely accepted as the best engineering practice of the day by designers.

The *AASHTO Guide* contains shared use path geometric design criteria such as width, horizontal and vertical alignment, horizontal and vertical clearance, sight distances and grades. The criteria in the *AASHTO Guide* form the foundation of Florida’s design standards.

➔The *AASHTO Guide* can be ordered in both book and CD-ROM format. To order call 1-800-231-3475 or visit https://bookstore.transportation.org/item_details.aspx?ID=104

Guide for the Planning, Design, and Operation of Pedestrian Facilities (AASHTO Guide), American Association of State Highway and Transportation Officials (AASHTO)

This guide focuses on identifying effective measures for accommodating pedestrians.

➔The *AASHTO Guide* can be ordered in both book and CD-ROM format. To order call 1-800-231-3475 or visit https://bookstore.transportation.org/collection_detail.aspx?ID=39

Florida Pedestrian Facilities Planning and Design Handbook

This handbook, produced for FDOT by the University of North Carolina's Highway Safety Research Center (HSRC), discusses design processes and principles of designing trail/roadway intersections. It includes information on providing for pedestrians with disabilities, intersection design, traffic calming, school access, regulating traffic and site design.

➔ This document can be downloaded from the web. Visit http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.shtm#Florida%20Ped%20Handbook.

Manual on Uniform Traffic Control Devices (MUTCD), U.S. Department of Transportation

The *MUTCD* is adopted in 23 CFR 655.603 “as the national standard for all traffic control devices installed on any street, highway, or bikeway open to public travel” (Section 1A.07).

Standards for signage and markings that may be used on shared-use paths are included in Chapter 9. Guidance on the assignment of priority at a shared-use path/roadway intersection is provided in Section 9B.03.

A key principle of traffic design, as important for paved paths as for roadways, is that a “standard device used where it is not appropriate is as objectionable as a nonstandard device; in fact, this might be worse, because such misuse might result in disrespect at those locations where the device is needed and appropriate” (s. 1A.06).

The *MUTCD* has been adopted by FDOT as a state rule to satisfy the requirement of Section 316.0745, F.S., that “The Department of Transportation shall adopt a uniform system of traffic control devices for use on the streets and highways of the state.” It should be noted that streets are defined as “the entire width between the boundary lines of every way or place of whatever nature when any part thereof is open to the use of the public for purposes of vehicular traffic” and bicycles are legally vehicles.

➔ This document can be downloaded from the web. Visit <http://mutcd.fhwa.dot.gov/>.

Manual of Uniform Minimum Standards for the Design, Construction and Maintenance for Streets and Highways (“The Florida Greenbook”), FDOT

This document provides the “minimum standards and criteria for the design...of all public streets, ... sidewalks, ...bicycle ways...used by the public for vehicular or pedestrian traffic” (section 336.045, (1) F.S.).

➔ This publication can be downloaded from FDOT. For more information, visit <http://www.dot.state.fl.us/rddesign/FloridaGreenbook/FGB.shtm>.

Park Guidelines for Off Highway Vehicles, National Off-Highway Vehicle Conservation Council (Fogg, G.E.)

This book is a resource guide to assist in the planning, development, enhancement and operation of off-highway vehicle (OHV) recreation facilities.

➔ To order, call the NOHVCC home office at 800-348-6487 or by email at trailhead@nohvcc.org or by visiting their website at <http://www.nohvcc.org/> .

➔ The report is also available from the **National Recreation and Park Association** at www.nrpa.org, click on NRPA Store, and look for Park Planning Guidelines for Off-Highway Vehicles.

Plans Preparation Manual, FDOT

This document describes design standards for FDOT projects on state highway systems, including (in Chapter 8) those for shared use paths.

➔ This publication can be downloaded from FDOT. For more information, visit <http://www.dot.state.fl.us/rddesign/PPMManual/PPM.htm>

Design Standards, FDOT

This site contains all available electronic versions of the FDOT Design Standards. This includes all applicable FDOT Interim Standards and Design Standards Modifications.

➔ This publication can be downloaded from FDOT. For more information, visit <http://www.dot.state.fl.us/rddesign/DesignStandards/Standards.shtm>.

Rails-with-Trails: Lessons Learned, U.S. Department of Transportation

This report examines safety, design and liability issues associated with the development of shared use paths and other trails within or adjacent to active railroad transit rights-of-way.

➔ Additional information regarding this report may be downloaded from the U.S. Department of Transportation Federal Highway Administration, visit <http://www.fhwa.dot.gov/environment/rectrails/rwt/toc.htm>.

Trails Construction and Maintenance Notebook, USDA Forest Service/DOT Federal Highway Administration

Basic trail construction and maintenance information, in an easy to use handbook format.

➔ This publication can be ordered from FHWA. For more information, visit <http://www.fhwa.dot.gov/environment/rectrails/trailpub.shtm>.

Trails for the Twenty-First Century, Rails-to-Trails Conservancy (Flink, C.A.; Olka, K. & Searns, R.M.)

This manual provides planning, design and management guidance for multi-use trails.

➔ This publication can be ordered from the American Trails Bookstore. For more information, visit <http://americantrailsstore.org/books.html>.

Trail Solutions: IMBA's Guide to Building Sweet Singletrack

This manual provides guidance for the design, construction and maintenance of singletrack mountain bicycling trails.

➔ This publication can be ordered from the American Trails Bookstore. For more information, visit http://www.americantrailsstore.org/items/imba_ts.html

Managing Mountain Biking: IMBA's Guide to Providing Great Riding

This manual offers best practices for planning, designing, building, and managing successful and sustainable trail networks and park parks

➔ This publication can be ordered from the American Trails Bookstore. For more information, visit http://americantrailsstore.org/items/imba_mmb.html