NORRIS LAKE AREA

Trail Sustainability & Connectivity Study

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THE BIG PICTURE

The Norris Lake Area Trail Sustainability and Connectivity Study, herein noted as the Study, evaluates current conditions of existing trails and identifies opportunities to enhance user experiences through strategic recommendations. This report is a result of steering committee and stakeholder engagement, field observation, and research on best practices from across the state and the country. Information provided is a resource for local parks and communities as they explore the benefits associated with developing a sustainable and connected regional trail system.

THE BIG PICTURE

As a regional destination nestled in the Appalachian Mountains of in Eastern Tennessee, the Norris Lake Area benefits from natural and man-made features that provide recreational opportunities for a broad variety of users. With a rich history that is intertwined with the emergence of the Tennessee Valley Authority (TVA) and the development of Norris Dam along the Clinch River, the area has much to learn, discover, and explore. The area is home to multiple recreation destinations that include:

- Norris Dam State Park
- Norris Watershed
- Loyston Point
- Big Ridge State Park

These recreational areas combined with local destinations such as the City of Norris, marinas, Anderson County Park, and many others are assets for community members and anchors for tourism. Activities such as bicycling (mountain and on-street), hiking, camping, horseback riding, boating, and many more can currently be enjoyed throughout the area by users of varying ages and abilities.

Existing recreational assets lay the foundation for the developing of the Study. The streets and trails throughout the area provide access to natural features, such as Norris Reservoir, along with cultural and historical resources that are part of its legacy. Central to this study is establishing a vision for comprehensive connectivity within and between recreational destinations. Increased connectivity provides choices for mobility between locations and allows the family camping to leave the car at the campsite and explore nearby restaurants or marinas on bicycles, the hiker to experience a variety of loops in a State Park, or a mountain biker to safely link multiple trail systems with a stop in the City of Norris for a lunch break. The purpose of this study is to provide a path forward for each recreational destination to enhance the user experience by linking surrounding recreational and local destinations and making strategic modifications to relieve the burden of trail maintenance and implement trails that are designed to be sustainable. Furthermore, the vision of this plan is to elevate the Norris Lake Area with additional recreational attractions to that benefit public health and local economies.

This Guide Includes:

» CASE STUDIES that highlight how trail development and connectivity can achieve the goals of public health, economic development, and marketing

» INVENTORY AND ANALYSIS of existing trails and street networks to assess conditions and identify barriers for enhanced connectivity

» RECOMMENDED STRATEGIES to link recreational and local destinations to one another, specific future opportunities for each recreational destination, and program, policy, and funding resources

» TRAIL AND NETWORK DESIGN GUIDANCE as a resource for the entire region to use when developing and maintaining sustainable trails for a variety of users

Recreational opportunities in the Norris Lake Area should strive for sustainability and comprehensive connectivity—achieving goals related to public health, economic development, and marketing for tourism—to provide the ability for residents and visitors of all ages and abilities to explore and enjoy the region's many assets safely and conveniently.

CONNECTED RECREATION DESTINATIONS: WHY CARE?

Regional Goals

MARKETING & BRANDING

The Outdoor Industry Association estimates just over 80% of consumer spending in the outdoor industry, nearly $525 billion, is travel-related.[1] Consumer spending on outdoor recreation is nearly twice as large as spending on pharmaceuticals, motor vehicles/parts, gasoline/fuel, and household utilities.[1] Growth in mountain biking and bicycling, in particular, has been steady over the past decade; mountain biking participation alone grew from 6.7 million people in 2006 to 8.3 million people in 2015.[2] Outdoor enthusiasts are known to travel for recreational trips. Data collected by Singletracks.com found that mountain bikers take two riding-focused trips each year and traveled an average distance of just over 550 miles from home.[3] Marketing and branding the diverse outdoor recreation opportunities in the Norris Lake Area will be key to area's success in attracting visitors and reaping economic benefits from tourism. In addition, marketing and branding can also increase the area's draw for future residents, from retirees to young families who want to enjoy the outdoors.

HEALTH

The World Health Organization has identified inactivity is one of the leading health risk factors around the world.[4] People who walk or bicycle, whether for recreation or transportation, have improved cardiovascular fitness, with a lessened risk of coronary heart disease by nearly 50%.[5,6] Walking and bicycling are low impact activities, meaning they place less stress on joints that other aerobic activities. Lastly, trails and separated bikeways provide an attractive, safe, and accessible low- or no-cost place to walk, hike, jog, or bicycle. This gives people of all ages an opportunity to incorporate exercise into their daily routines.

ECONOMIC DEVELOPMENT

There is no question that countless communities across America have experienced significant economic growth from a result of trail, greenway, and bikeway infrastructure. Increasing land values around trails and walkable areas show that people desire to live closer to active transportation and recreation facilities; people, including those that do not bike or walk for trips often, are willing to make investments in places with better transportation choices and robust recreation options. A study of 11 cities around the US found that bicycle and pedestrian projects created 50% more jobs than vehicle-centric roadway projects.[7] In addition, investment in greenway and trail infrastructure has contributed to the revitalization of communities and contributed millions of dollars in direct economic impact.[8,9]

CASE STUDIES

Within Appalachia and other rural areas, there are examples of communities similar to the Norris Lake Area with successful regional bike networks. Links for each case are available on page 10.

Coös County, New Hampshire

SUMMARY

Located at the northern extent of the Appalachian Mountains, Coös County is home to thousands of acres of public land and a dense cluster of off-road trails. While there are many existing businesses in the outdoor industry in the area, until recently, they operated independently of each other. In an effort to grow trail-based tourism without risking environmental degradation, businesses and organizations in Coös County are currently implementing a regional plan to increase quality of visits to the area through longer stays and more local spending options rather than increased number of visitors.

RELEVANCE

- **Marketing:** The project includes a push for developing and publishing online trail map information as part of larger marketing campaign.
- **Economic:** The project seeks to retain maximum amount of tourism dollars within the local economy through strategic development of small businesses to fill gaps in the local supply chain and includes tourism-based workforce development. This "value-chain" strategy ensures economic opportunities are appropriate for the region.
- **Health:** The project is increasing access to bicycles for local youth through a program at a newly established bike shop.

KEYS TO SUCCESS

- **Collective mentality:** The value-chain model relies heavily on partnerships through regional marketing, development of small businesses that complement each other, and training locals for tourism-based jobs such as outdoor guides. New amenities that serve tourists are also available as added assets to the local community.
- **Find a Niche:** By working with an economist, project organizers are identifying niche economic opportunities. A revised marketing strategy also highlights authentic experiences unique to the region.

IMAGE 1. Crystal Bridges Trail in Northwest Arkansas

Northwest Arkansas Trails

LOCATION

Washington and Benton counties, including the cities of Fayetteville, Springdale, Bentonville, and Rogers.

SUMMARY

With more than 200 miles of trails and bikeways, Northwest Arkansas offers urban and backcountry bicycling options for outdoor enthusiasts. While many of the individual trails are internationally recognized, the connectivity of the network also makes walking and bicycling safer and more convenient transportation options.

RELEVANCE

- **Marketing:** In addition to significant marketing of the region's trail network, a diverse group of stakeholders representing numerous jurisdictions established a long-range plan to guide development of the regional trail network.
- **Economic:** A 2018 study attributed bicycling with $137 million in annual economic benefits to the region with bicycle tourists spending $25 million at local businesses each year.
- **Health:** Between 2015 and 2017, annual bicyclist counts increased 24% across the entire trail network with average weekday bicycle rates up by 32%, indicating local use of the trail system. The League of American

Bicyclists now ranks Northwest Arkansas as a Silver-level Bicycle Friendly Community.

KEYS TO SUCCESS

- **Connect Destinations:** The trail system connects facilities to each other and to major destinations within the region, making Northwest Arkansas an ideal place for single- or multi-day bike tourism vacations.
- **Plan and Evaluate:** Projects identified in adopted plans are more competitive for grant funding. Setting goals and evaluating progress based on performance measures, allows Northwest Arkansas to demonstrate the impact of initial efforts and make data-driven decisions about future investments. For example, data shows soft-surface mountain bike trails are a significant driver of tourism.

Calhoun County Mountain Biking Trails

LOCATION

Calhoun County, Alabama

SUMMARY

Nested in the foothills of the Appalachian Mountains, Calhoun County has over 35 miles of existing mountain biking trails, 25 of which comprise the Coldwater Mountain Bike Trail in Anniston, Alabama. The Coldwater Mountain Bike Trail is a Silver-level IMBA Ride Center on 4,000 acres that offers plenty of variety and potential for loop combinations. In addition, the area is home to the recently opened McClellan Bike Trail, the first specialty design National Interscholastic Cycling Association (NICA) trail in the state of Alabama.

RELEVANCE

- **Marketing:** Calhoun County is home to the state's biggest bicycling event of the year, the Alabama Cycling Classic. The event also often kicks off the Professional Road Tour, providing a national platform to showcase the area's trail systems.
- **Economic:** In 2012, an Economic Impact Analysis was conducted for the Coldwater Mountain Bike Trail to assess its economic potential. The results predicted that 10% of mountain bikers using the trails would be out-of-town visitors who would need to stay overnight and 90% would be area residents or day-trippers. The study predicted mountain bikers would contribute between $2 and $6 million to the

local economy, particularly to restaurants, accommodations, and retail stores. A more recent study by the Alabama Tourism Department found that travelers spent $80 million in Calhoun County in 2016.

- **Health:** The region's focus on eco-tourism broadly, and building mountain biking and hiking trails in particular, provide opportunities for residents and tourists to stay active.

KEYS TO SUCCESS

- **Building a Culture of Bicycling:** In collaboration with local partners, the County hosts multiple cycling events each year, including the Alabama Cycling Classic, the Cheaha Challenge & Ladiga Cruise, the Coldwater Fat Tire Fest, and the Iron Mountain Challenge. In addition, the Northeast Alabama Bicycle Association (NEABA), a non-profit organization created to promote cycling in the Northeast Alabama area, hosts a variety of weekly rides.
- **Leveraging Experts:** NEABA partners with IMBA Trail Solutions, IMBA's professional trailbuilding and consulting branch, to work nearly year-round to evolve and expand the Coldwater Mountain Bike Trail system.

South Knoxville Urban Wilderness

LOCATION

Knoxville, Tennessee

IMAGE 2. Girl Scouts hiking the Urban Wilderness trails

SUMMARY

Located less than 2.5 miles south of downtown, Knoxville's Urban Wilderness boasts more than 50 miles of connected trails and greenways. The trail system winds through 1,000 acres of mature forests, farmland, and areas with unique geology to connect seven distinct recreational areas. It also provides access to rock climbing, water-based recreation, and trails specifically designed for mountain biking. Amenities such as water bottle refill stations, restrooms, and ample wayfinding help provide a high-quality user experience.

RELEVANCE

- **Economic:** A 2015 study estimated the economic impacts of the Urban Wilderness on the three counties around Knoxville will total $241,498 due to increased state and local sales tax revenue. This estimate is expected to increase as the trail system gains popularity, as data on the impact of mountain bike races in Oregon suggests the potential for significant increase from special events that may take place on the Urban Wilderness trail system in the future.

- **Marketing**: The same study analyzed economic impact of bicycling on trail systems by type. The Norris Lake Area aligns with the study's definition of a regional destination - a trail system located in a rural area with majority non-local users and fewer total users than a national destination. The study found, by comparison, regional destinations are used less frequently but generate more total daily expenditures from bicycle-related activities than the other trail system types with nearly $145 of expenditures per day. This underscores the economic impact of marketing trail systems in rural areas to populations able to access the trails as part of a one-day trip.

KEYS TO SUCCESS

- **Appeal to Multiple Interests:** The South Knoxville Urban Wilderness is far more than a trail system for just walking and bicycling. Linking environmental, cultural, and commercial destinations means the trail system attracts a range of users and creates more economic opportunities for businesses to support these diverse users. On top of this, a variety of facilities ranging in difficulty from easy to extreme accommodates users of all abilities.

- **Connect Commercial with Recreational:** The trail system traverses city, county, state, non-profit, and private lands. Easements across these properties make it possible for the trail system to connect commercial areas to a dense web of recreational areas. Researchers analyzing the economic potential of the South Knoxville Urban Wilderness note this as a key to success as the economic impact of trail systems with connections to commercial areas tend to have a greater economic impact.

Rocky Knob Mountain Bike Park

LOCATION

Boone, North Carolina

SUMMARY

Rocky Knob is a 185-acre mountain biking park with 8 miles of single-track trail split into four skill-level areas plus a pump-track. Feasibility studies began in 2009 and trail building followed quickly in 2011. Since opening, the park has received national attention.

RELEVANCE

- **Marketing:** The park, which is free for all users, was developed by Watauga County and Watauga County Tourism Development Authority. Marketing is funded through revenue generated by occupancy tax, which is largely driven by tourism.

- **Economic:** Rocky Knob made Boone a regional destination for family-friendly mountain biking. Research shows the park generates approximately $2.7 million in annual economic benefits for the area.

- **Health:** The park combines mountain biking with other outdoor

IMAGE 3. Rocky Knob Mountain Bike Park

recreation through provision of other amenities such as a playground, picnic areas, and three shelters. All trails are multi-use for hiking and biking with an average slope of 5%, making the park more suitable for a wider range of users with varying levels of ability.

KEYS TO SUCCESS

- **Built-in Options:** Routes include spur trails with technical features as well as bailout connectors. The trail rating system is nested with all four skill-level areas further broken down by difficulty for an improved user experience.
- **Leverage Local Momentum:** Rocky Knob utilized land owned by the County, volunteers for trail construction, and combined funding from local organizations with tax revenue and grants. Work parties occur multiple times per year through partnership between the County and two local bike organizations. The park also serves as a learning laboratory for courses at nearby Appalachian State University.

The Duluth Traverse Trail System

LOCATION

Duluth, Minnesota

SUMMARY

Duluth is Minnesota's outdoor recreation epicenter and envisions becoming a premier national trail destination for a variety of trail user types. The Duluth Traverse Trail system contains:

- a 40-mile two-way single-track green level beginner trail that traverses Duluth and connects neighborhoods and people to green spaces and parks (Gold Level IMBA Ride Center);
- five Trail Centers, areas of concentrated routes providing multiple options for a variety of skill levels, with over 70 miles of concentrated clusters of multi-use, single track trails with a range of skill levels and variety of terrain all connected to the Traverse Spine;
- skills areas which provide obstacles and features targeting beginners to advanced riders; and
- short trail segments within City limits, called Neighborhood Connections, that connect Duluth's neighborhoods directly to the Traverse System.

RELEVANCE

- **Marketing:** The City of Duluth has partnered with a local community nonprofit, Cyclists of Gitchee Gumee Shores (COGGS), who support the trails through advocacy and marketing efforts. COGGS hosts

an annual Duluth Traverse Gala, the Duluth Enduro Ride Series, and the Kraus-Anderson Bike Duluth Festival. In addition, The Duluth Experience is a local travel agency that markets the area and provides tour packages. Lastly, the City maintains an online map of trails and a COGGS maintains a "status feed" with the most up-to-date information on trail closures.

- **Economic:** A 2017 Economic Impact Study of the Duluth Traverse Trail system found that 75% of mountain bikers that use the trail— somewhere between 34,000 and 45,000 riders annually—are not Duluth residents. Two-thirds of those visitors make overnight trips when they visit. This study also found that the non-local visitors to the trail system contribute between $25.8 to $34.4 million every year to the Duluth economy.

- **Health:** A collaborative partnership with the Statewide Health Improvement Program (SHIP), Healthy Duluth, St. Louis County Public Health, Duluth YMCA, and over a dozen other organizations assesses and works to address community health issues through built environment chances to encourage active living, improve residents' access to healthy food, and creating a diverse community-wide transportation system.

KEYS TO SUCCESS

- **Strategic Partnerships:** The City jointly builds and maintains trails with COGGS, as well as utilizing the organization for grant writing, fundraising, and marketing efforts. As an advocacy group, COGGS can support the City by promoting and supporting specific policy initiatives that benefit the mountain biking community.
- **Community Engagement:** Continual community engagement is key to understand the evolving needs of residents and visitors and how their user experience can be enhanced. In their last planning effort, the City of Duluth and COGGS held over 50 meetings with a diverse array of stakeholders, including user-specific groups (e.g., bikers, hikers, skiers) and other groups that could play a role in furthering the success of the Duluth Traverse (e.g., local businesses, property owners). They also asked specific youth-focused questions to better understand how the unique priorities of young mountain bikers.

Buckeye Lake, Ohio

LOCATION

Licking, Perry, and Fairfield counties.

SUMMARY

Located 30-minutes from Columbus and surrounded by farms, Buckeye Lake is dotted with residential villages, parkland, and marinas. The region is strategically building a bicycle and pedestrian network in conjunction with commercial development nodes to create a more connected, vibrant lake community.

RELEVANCE

- **Marketing:** Since 2017, the annual Tour de Buckeye Lake event lures bicyclists to the region for a one-of-a-kind experience that combines bicycling with pontoon boat rides across the lake. More than 500 bicyclists participated in 2019. The event helps draw attention to the region's many recreational opportunities and all proceeds fund future trail development.
- **Health:** Regional trail advocates worked closely with the Ohio Department of Natural Resources to design and build a multi-use trail along the lake's dam when structural failure required rehabilitation of the dam.

KEYS TO SUCCESS

- **Leverage Non-Profits:** Organizers established several non-profit organizations to provide platforms for planning, fundraising, and executing the region's vision for Buckeye Lake to become a major, year-round tourist destination. With 50-60 regular volunteers, Bike Buckeye Lake spearheads trail development and operates the annual bike race. Buckeye Lake Region Community Foundation conducts fundraising from private donors and administers grant requests. Buckeye Lake Region Corporation receives funding from the Community Foundation and helps coordinate collaborative efforts across the tri-county area. Through work groups such as the Land, Lake and Leisure Uses Task Force, the Buckeye Lake Region Corporation secures the funding and partnerships necessary to carry out the region's long-range vision. Collectively, these organizations can mobilize resources quickly and strategically.
- **Cultivate a Culture of Bicycling:** As of 2019, Bike Buckeye Lake has donated 400 bikes, helmets and locks to local youth in need as part of group's annual bike giveaway.

IMAGE 4. Pontoon shuttle service during Tour de Buckeye Lake

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BUCKEYE LAKE, OHIO

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INVENTORY & ANALYSIS

The Norris Lake Area in Eastern Tennessee contains thousands of acres of parks and protected land managed by local, state, and federal agencies. Within the study area, there are four major recreation destinations, all of which include trail systems: Norris Dam State Park, Loyston Point, Big Ridge State Park, and Norris Watershed.

This section reviews existing conditions of trails in each park with a focus on trails that provide opportunity for bicycling, hiking, horseback riding or a combination of uses. The assessment also considers on-street connections between the parks. Critical gaps in the study area's nonmotorized network are identified along with opportunities for improved connections.

TRAIL ASSESSMENT

The project team assessed trails within the study area using a combination of GIS analysis and field observation to identify the unique features and needs of each recreation destination. Information from stakeholder interviews and steering committee meetings guided the assessment.

Assessment Factors

The chart below highlights the rationale for the individual trail assessment factors.

TABLE 1. Assessment Factors

FACTOR	RATIONALE
Trail Network	
Total Trails	Provides information on capacity
Trail Miles	Provides information on capacity and length of time to explore the entire trail system
Interconnectivity	
Trail Connectivity	Trail systems with several stand-alone trails provide fewer options than systems with clusters of connected trails. Trail clusters can also facilitate maintenance and emergency services.
Trail Density from Trailheads	Provides information about access to trails for park visitors, maintenance, and emergency services as well as potential needs for wayfinding and parking
Trail Design	
Single-track vs. Double-track	Provides information on capacity, target user groups, and maintenance.
Surface	Provides information on accessibility, maintenance, erosion, and target user groups
Permitted Use	Related to potential user conflicts, wayfinding, maintenance, and co-requisite amenities

TABLE 1. Assessment Factors Continued

FACTOR	RATIONALE
Geophysical	
Trails by Slope Class	Steep slopes are associated with potential erosion, increased maintenance burden, and reduced accessibility for users of various abilities.
<5%	• Considered accessible regardless of length • Supports diverse users with various abilities • Minimizes risk of erosion
5-9.9%	• Supports most hikers; limits braking for biking • 10% is maximum average slope for sustainable trail design
10-14.9%	• Appropriate for short segments with erosion control • Provides moderate to difficult hiking experience, and more difficult mountain biking experience
15-19.9%	• Occasionally appropriate for short segments with erosion control
20%+	• Potentially appropriate for short segments with significant erosion control • 33% or 3:1 is considered the maximum slope for avoiding most erosion issues • Creates extremely difficult experience for hiking and mountain biking
Trails in the Floodplain	Indicates potential risk of erosion, trail damage, or seasonal closures. Trail segments in the floodplain may warrant realignment.
Blueline Stream Crossings	Indicates potential risk of erosion, environmental degradation, or seasonal closures. Blueline stream crossings may require altered trail design or realignment.
Natural Heritage Element Occurrence Conflicts	Identifies areas of conflict between trails and environmentally sensitive areas containing species with high ecological value.
Cultural Resources	Provides information about potential trail users and marketing.

Priority Trail Identification Process

During stakeholder interviews, some property managers identified trails they consider priority trails due to higher level of concern regarding user conflicts, maintenance, or other sustainability issues. These priority trails warranted additional analysis.

Norris Dam State Park Priority Trails

- Lakeview Trail (previously named Storybrook Trail)
- Marine Railway Trail
- High Point Spur Trail

Norris Watershed Priority Trails

- Ridgecrest Trail
- Longmire Trail
- Reservoir Hill Trail

Findings by Major Recreation Destination

The trail assessment highlights the fact that the Norris Lake Area is rich with off-road trails offering recreation opportunities for hiking, mountain biking, and horseback riding. The following are a few key findings from the trail assessment.

REGIONAL

- While most trails allow multiple users, few are intentionally designed to support the individual and collective needs of these user groups. Loyston Point contains the only trails intentionally designed to support mountain biking.
- Overall, the trail systems have a high rate of internal connectivity with most trails connected to other trails and trailheads providing access to a trail cluster. There are existing trail connections between Norris Dam State Park and Norris Watershed, which also connects to the City of Norris. Big Ridge State Park has longer distances between trail connections.

NORRIS DAM STATE PARK

- Existing trails allow for users to explore much of the park.
- Trail connections are difficult in some locations and more interconnectivity would benefit all user types.

NORRIS WATERSHED

- Trails users include hikers, mountain bikers, and horseback riders.
- Multiple existing trails are along fall lines, causing increased erosion and ongoing maintenance burdens in addition to safety issues.

LOYSTON POINT

- Sustainable design principles were used to develop Loyston Point trails.
- Trail maintenance is minimal and user volumes are high.

BIG RIDGE STATE PARK

- Hiker only trails provide a limited view of all that Big Ridge State Park has to offer.
- Future trails could allow for more discovery and a diversity of users.

Norris Dam State Park (4,038 acres)

Norris Dam State Park is managed by Tennessee State Parks and the Tennessee Department of Environment and Conservation.

Bisected by Norris Dam and Norris Lake, the Park is comprised of two discrete areas with separate trail systems. Most trails on the west side of the Park are multi-use for hiking and bicycling. The east side of the Park allows horseback riding on certain multi-use trails. During stakeholder interviews, local land managers noted the need to re-route problematic sections of trail. A large part of the Park's budget is used to maintain existing facilities including many cultural and historical resources.


TABLE 2. Norris Dam State Park Trail Statistics

FACTOR	RESULTS
Trail Network	
Total Trails	18 trails
Trail Miles	27.93 miles of trail
Trail Design	
Single-track	18.9 miles (67.79% of total)
Double-track	9.0 miles (32.21% of total)
Surface	data unavailable
Permitted Use	
Hiking	3.04 miles (10.88% of total)
Hiking & Biking	13.32 miles (47.70% of total)
Hiking, Biking, & Equestrian	11.57 miles (41.42% of total)
Geophysical	
Trails by Slope Class	
<5%	15.22miles (54.57% of total)
5-9.9%	5.55 miles (19.9% of total)
10-14.9%	3.52 miles (12.62% of total)
15-19.9%	1.76 miles (6.29% of total)
20% +	1.69 miles (6.06% of total)
Trails in the Floodplain	0.84 miles (3.02% of total)
Blueline Streams	15 crossings and several trail segments parallel to streams
Natural Heritage Conflicts	None
Cultural Resources	• Norris Dam, Lenoir Museum, historic grist mill and barn, historic cabins • Visitors center, cabins, campsites, shelters

FIGURE 1. Trail Interconnectivity at Norris Dam State Park

There are three distinct trail clusters within the Park, two in the west and one in the east. In the west, in one cluster trail users can access 13.32 miles of trail. This cluster is served by eight trailheads. The other cluster on the west side of the Park is off Village Green Drive, connects users with 1.34 miles of trail, and is served by three trailheads. The cluster on the east side of the Park provides access to 12.85 miles of trail and contains nine trailheads. Tennis Court Trail is the only isolated trail in the Park. It has two trailheads. Overall, most trails in the Park (98.50%) are connected to at least one other trail.
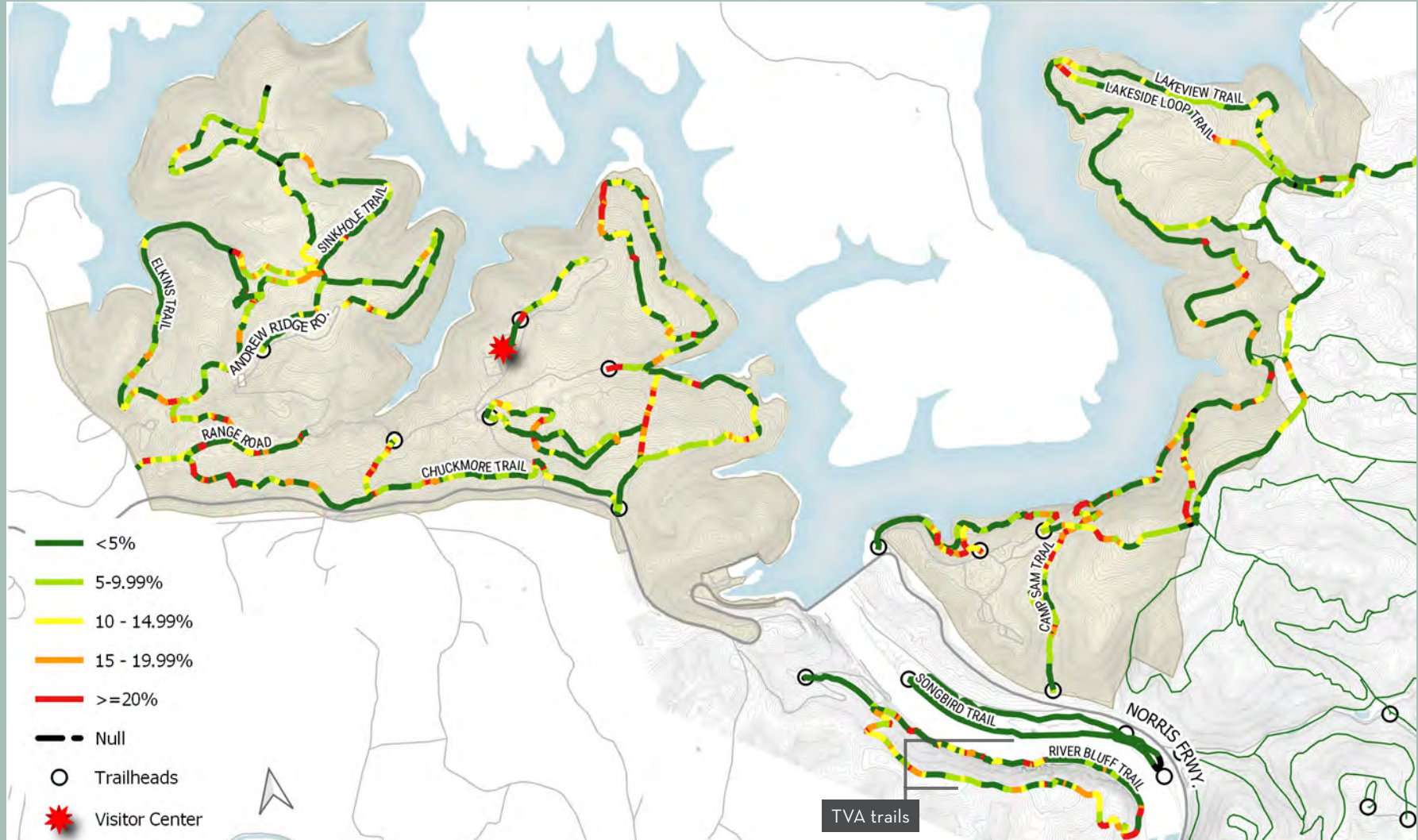
FIGURE 2. Trail Steepness at Norris Dam State Park

With over half of all trail miles with slopes less than 5%, Norris Dam State Park has several options for entry-level hiking experiences. Many of the shoreline trails have the most gentle slopes such as Lakeside Trail, Lakeview Trail, and Songbird Trail (on TVA property). Routes with the highest proportion of steep trail (greater than 15% slope) include Highpoint Spur Trail, Christmas Fern Trail, and Harmon Trail.

Norris Watershed (2,300 acres)

This recreation area is managed by the Town of Norris.

Norris Watershed shares a boundary with both Norris Dam State Park and the Town of Norris. The majority of trails are open for hiking, mountain biking, and equestrian use. Motor vehicles are permitted on two trails during part of the year. Norris Watershed also allows limited deer hunting by permit only and includes the only public shooting range in Tennessee. The Watershed is open for day-use only.

TABLE 3. Norris Watershed Trail Statistics

| FACTOR	RESULTS
Trail Network	
Total Trails	34 trails
Trail Miles	32.9 miles of trail
Trail Design	
Single-track	16.7 miles (50.76% of total)
Double-track	8.4 miles (25.53% of total)
Surface	• Natural surface woods vehicle trail: 7.6 miles (23.10%) • ADA-accessible: 0.2 miles (0.61%)
Permitted Use	
Hiking	11.7 miles (35.56% of total)
Hiking, Biking, & Equestrian	13.6 miles (41.34% of total)
All Users & Motor Vehicles	Seasonally: 7.6 miles (23.10% of total)
Geophysical	
Trails by Slope Class	
<5%	15.98 miles (50.74% of total)
5-9.9%	6.89 miles (21.89% of total)
10-14.9%	4.01 miles (12.74% of total)
15-19.9%	2.59 miles (8.22% of total)
20% +	1.44 miles (4.56% of total)
Trails in the Floodplain	0.1 miles (0.19% of total)
Blueline Streams	34 crossings
Natural Heritage Conflicts	1
Cultural Resources	• One historic site
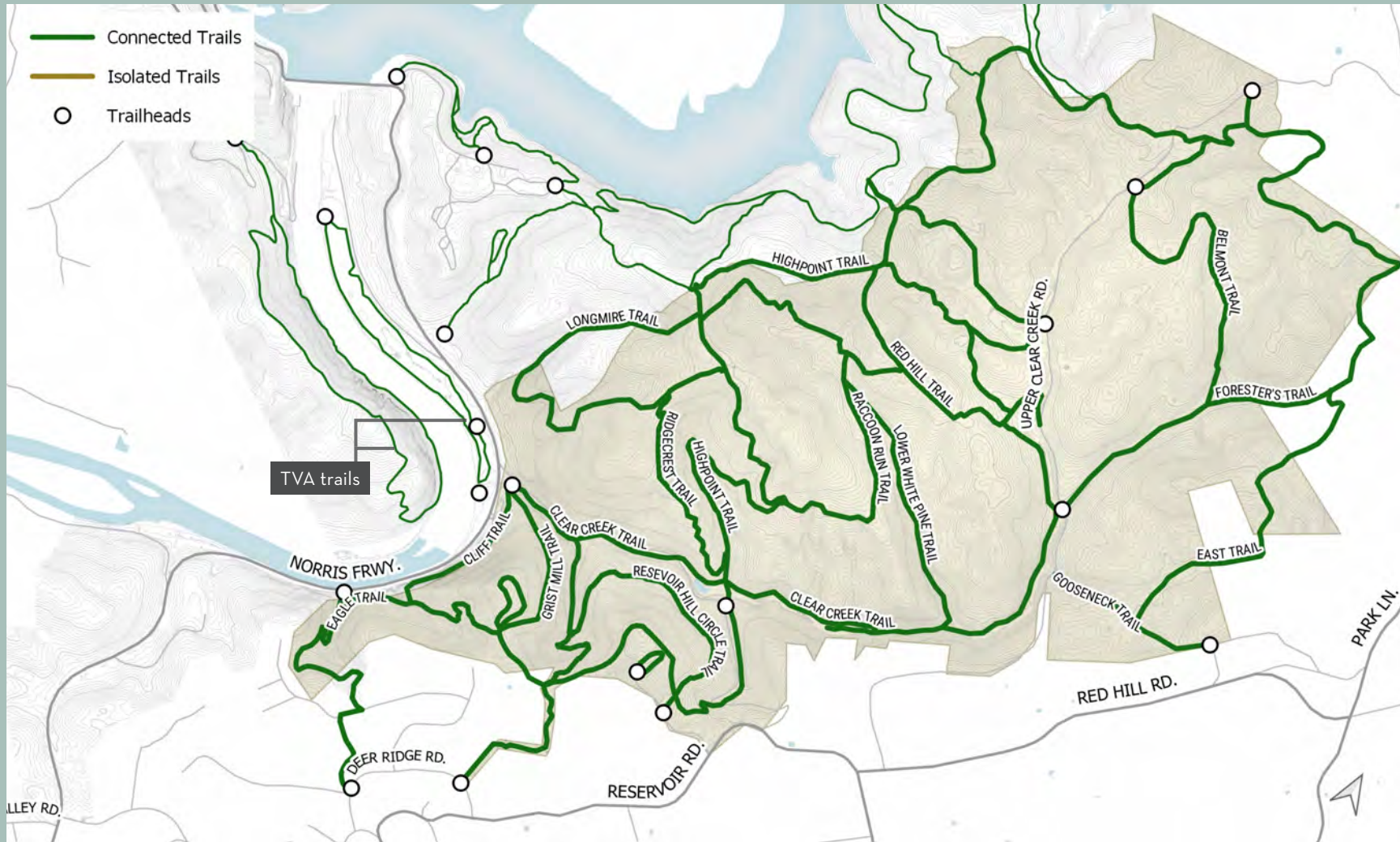
FIGURE 3. Trail Interconnectivity at Norris Watershed

Within the Watershed, 27.4 miles of trail are connected to one another. This cluster of trails is also connected to 12.5 miles of trail on the east side of Norris Dam State Park and, by way of those trails, the 0.3 miles of Camp Sam Trail that is on Watershed property. River Bluff and Songbird trails are isolated, meaning they are not connected to any other trails.

Legend:
- <5%
- 5-9.99%
- 10 - 14.99%
- 15 - 19.99%
- >=20%
- Null
- O Trailheads

TVA trails

Carson Brewer Trail
(ADA accessible)

LONGMIRE TRAIL · HIGHPOINT TRAIL · BELMONT TRAIL · RED HILL TRAIL · UPPER CLEAR CREEK RD. · FORESTER'S TRAIL · RIDGECREST TRAIL · HIGHPOINT TRAIL · RACCOON RUN TRAIL · LOWER WHITE PINE TRAIL · CLIFF TRAIL · CLEAR CREEK TRAIL · GRIST MILL TRAIL · RESERVOIR HILL CIRCLE TRAIL · CLEAR CREEK TRAIL · EAST TRAIL · GOOSENECK TRAIL · EAGLE TRAIL · NORRIS FRWY. · DEER RIDGE RD. · RESERVOIR RD. · RED HILL RD. · PARK LN. · VALLEY RD.
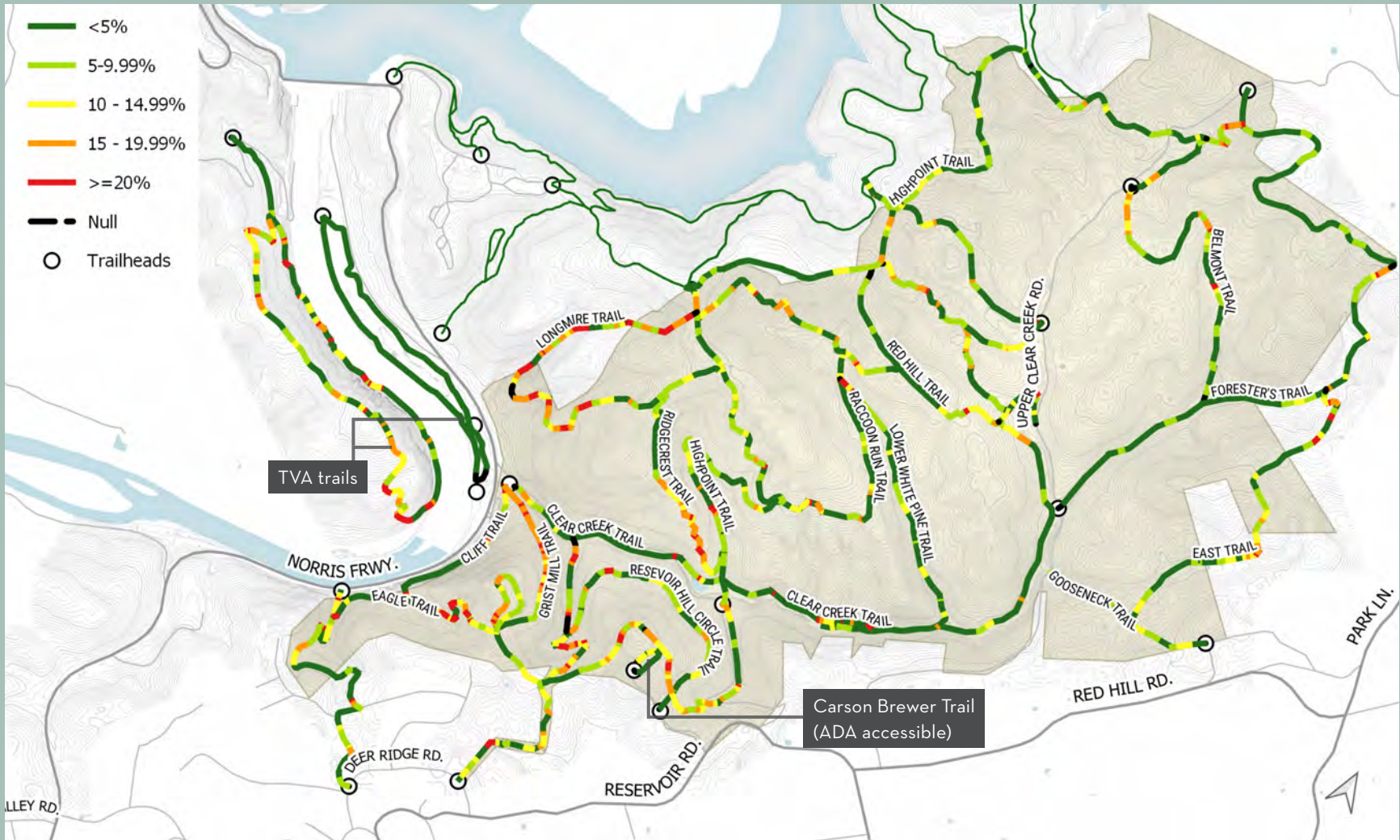
FIGURE 4. Trail Steepness at Norris Watershed

Compared to the adjacent Norris Dam State Park, Norris Watershed offers a slightly more strenuous trail experience. A majority of trail miles are less than 5% slope and many of the more gently sloped trails are located near Upper Clear Creek Road. Yet, there are trails with very steep sections. Nearly 60% of Grist Mill Trail and 50% of Longmire Trail have steep slopes (over 15%). Other routes with high proportions of steep trail include Ridgecrest Trail, Reservoir Hill Trail, Freeway Trail, and Hwy 441 Access Trail.

Loyston Point (1,500 acres)

This recreation area is owned and operated by TVA.

The most recently developed recreation area in the region, Loyston Point features a network of multi-use trails specifically designed to accommodate mountain biking. Almost all trails are open to biking and hiking with the exception of Hemlock Bluff Trail, which is for foot traffic only

Lessons learned from mountain bike use and trail design at Loyston Point serve as a model for future trail development in the study area.

TABLE 4. Loyston Point Trail Statistics

FACTOR	RESULTS
Trail Network	
Total Trails	5 trails and 2 trail connectors
Trail Miles	17.7 miles of trail
Trail Design	
Single-track	15.2 miles (85.88% of total)
Double-track	2.5 miles (14.12% of total)
Surface	Majority natural surface (specific data unavailable)
Permitted Use	
Hiking	2.5 miles (14.12% of total)
Hiking & Biking	15.2 miles (85.88% of total)
Geophysical	
Trails by Slope Class	
<5%	11.8 miles (66.50% of total)
5-9.9%	4.0 miles (22.85% of total)
10-14.9%	1.3 miles (7.33% of total)
15-19.9%	0.4 miles (2.17% of total)
20% +	0.16 miles (0.90% of total)
Trails in the Floodplain	0.47 miles (2.66% of total)
Blueline Streams	6 crossings
Natural Heritage Conflicts	None
Cultural Resources	Nearby campground and canteen

FIGURE 5. Trail Interconnectivity at Loyston Point

All 17.7 miles of trail within Loyston Point are connected to one another and can be accessed through a single trailhead.

FIGURE 6. Trail Steepness at Loyston Point

Unlike the other trail systems in the Norris Lake Area, nearly all the trails in Loyston Point have gentle slopes. Nearly 90% of the trail system has less than 10% slope. This makes the trail system supportive of many users with various levels of ability. There are a few steep sections on Hemlock Bluff Trail and Clinch Trail.

Big Ridge State Park (3,687 acres)

Tennessee State Parks and the Tennessee Department of Environment and Conservation manage Big Ridge State Park.

Big Ridge State Park is a beautiful property currently best viewed from the water. Located on Big Ridge Embayment, the park has over 35 miles of untouched shoreline. Big Ridge has the least amount of developed trails in the region and trail use is limited to hiking.

Several hiking trails currently exist around the visitor's center and the Big Ridge Embayment; however, few trails traverse the remainder of the park's land area. Of the existing trails, many are heavily used family hiking trails. Potential improvement projects identified during stakeholder interviews include building new trails, converting existing trails to multi-use trails to allow mountain biking, establishing a backcountry campsite, and increasing access to the lake.

TABLE 5. Big Ridge State Park Trail Statistics

FACTOR	*RESULTS*
Trail Network	
Total Trails	11 trails
Trail Miles	12.43 miles of trail
Trail Design	
Single-track	data unavailable
Double-track	data unavailable
Surface	Majority natural surface (specific data unavailable)
Permitted Use	
Hiking	12.43 miles (100% of total)
Geophysical	
Trails by Slope Class	
<5%	7.1 miles (56.89% of total)
5-9.9%	2.0 miles (16.08% of total)
10-14.9%	1.2 miles (9.91% of total)
15-19.9%	1.0 miles (8.12% of total)
20% +	1.1 miles (8.80% of total)
Trails in the Floodplain	1.19 miles (9.60% of total)
Blueline Streams	25 crossings and several trail segments parallel to streams
Natural Heritage Conflicts	None
Cultural Resources	• Historic assembly hall, grist mill, and cemetery • Visitors center, cabins, campsites, shelters

FIGURE 7. Trail Interconnectivity at Big Ridge State Park

There is one cluster with 11.86 miles of connected trail within the Park. Ten trailheads serve this cluster. Two trails, Fisherman's Trail and Ole Mill Trail, are isolated. Each of these trails has a separate trailhead. Most trails (95.37%) within the Park are part of the connected trail cluster.

FIGURE 8. Trail Steepness at Big Ridge State Park

In terms of slope of existing trails, Big Ridge State Park is somewhat similar to Norris Watershed as both parks have the same proportion of trail miles with slopes than 10%. Big Ridge State Park has a higher proportion of very steep trail (>20%). Routes with the highest proportion of steep trail include Meditation Point Trail, Indian Rock Trail, and Big Valley Trail.

TRAIL ACCESS AND PARKING

Convenient access is important to establishing a network of trails that are a destination for local and regional users. Existing trail users often drive to parking areas that are either connected to or in close proximity of a trailhead. While driving may be the most common manner to access trails, several trailheads within the Watershed Area and a few within Norris Dam State Park are within two miles of the City of Norris. Short distances between municipalities and trailheads provide opportunities to access the trails by bicycle or on foot. Table 7, on page 28, identifies three access categories:

- Trailheads – locations where users can access existing trails and in many cases are locations where trails intersect with local roadways;
- Trailhead Parking – locations where users can access existing trails that also have designated space for vehicle parking; and
- Non-Trailhead Parking – designated space for vehicular parking that are in close proximity to trailheads but do not offer direct access to trails from the parking area.

Location of each access category along with two-mile and five-mile buffers around nearby municipalities—Norris, Rocky Top, and Maynardville—are illustrated in Figure 9 on the following page. There are several trail access and parking locations within the buffers shown (Table 6). As the trail system adds to the appeal of the Norris Lake Area, the number of parking spaces/locations along with convenient access by modes other than a personal vehicle should be explored.

TABLE 6. Trail Access and Parking Near Municipalities

MUNICIPALITY	TRAIL ACCESS/PARKING LOCATIONS	
	Within 2 Miles	Within 5 Miles
Norris	8	28
Rocky Top	0	19
Maynardville	0	0

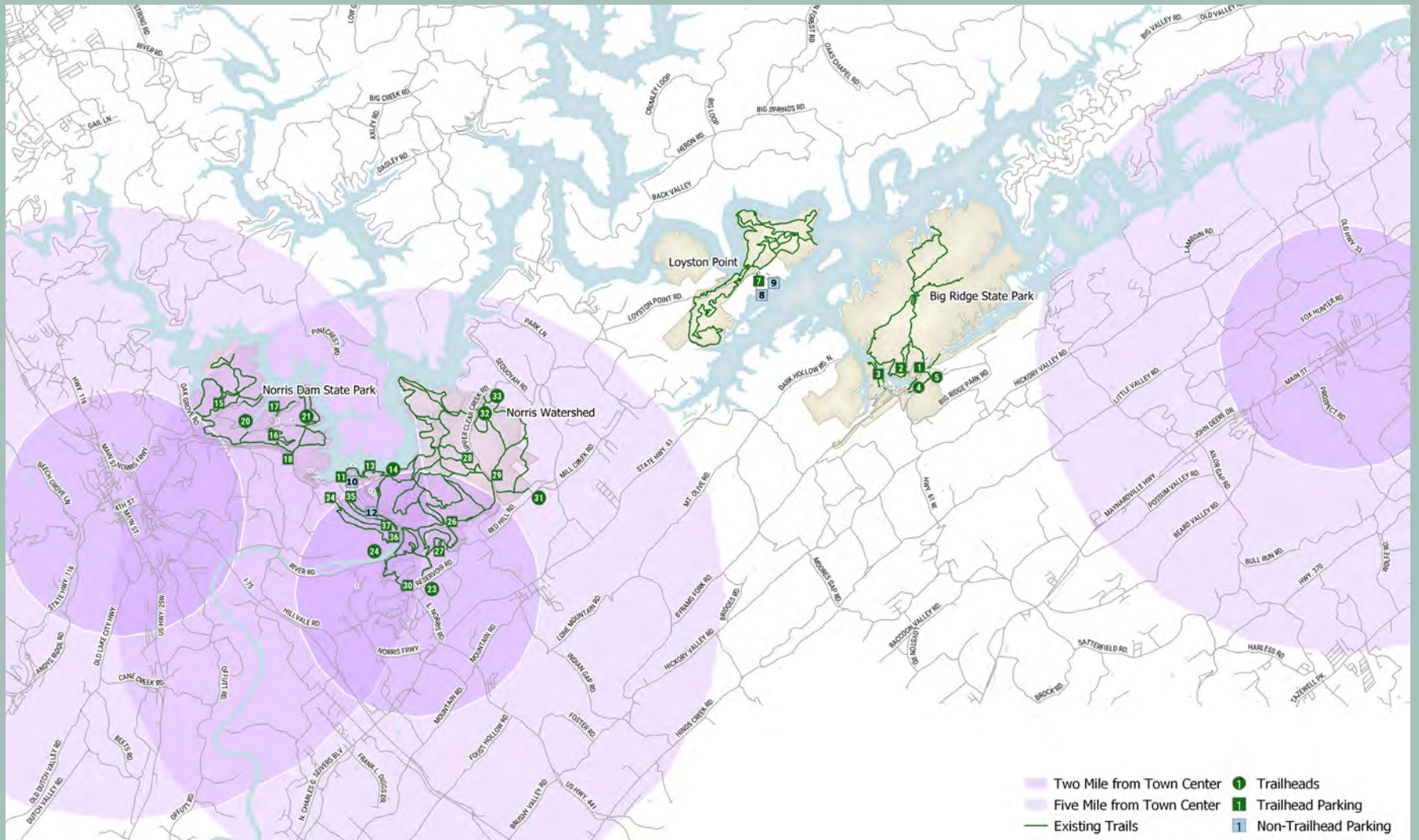**IMAGE 5. Parking at Hickory Star Marina looking across the bay to Big Ridge State Park**

FIGURE 9. Trail Parking in the Norris Lake Area
Trails are commonly accessed by driving; however, trailheads are in close proximity of nearby communities and can be reached by hiking or biking.

TABLE 7. Trail Access and Parking Inventory

MAP ID	ACCESS CATEGORY	APPROXIMATE PARKING STALLS
Big Ridge State Park		
1	Trailhead Parking	18
2	Trailhead Parking	6
3	Trailhead Parking	45
4	Trailhead	N/A
5	Trailhead	N/A
6	Non-Trailhead Parking	16
Loyston Point		
7	Trailhead Parking	53
8	Non-Trailhead Parking	10
9	Non-Trailhead Parking	70
Norris Dam State Park		
10	Non-Trailhead Parking	35
11	Trailhead Parking	9
12	Non-Trailhead Parking (Horses)	15
13	Trailhead Parking	12
14	Trailhead	N/A
15	Trailhead Parking	10
16	Trailhead Parking	9
17	Trailhead Parking	5
18	Trailhead Parking	6
19	Non-Trailhead Parking	15
20	Trailhead	N/A
21	Trailhead	N/A

MAP ID	ACCESS CATEGORY	APPROXIMATE PARKING STALLS
Norris Watershed		
22	Trailhead	N/A
23	Trailhead	N/A
24	Trailhead	N/A
25	Trailhead	N/A
26	Trailhead Parking	5
27	Trailhead Parking	20
28	Trailhead Parking	8
29	Trailhead Parking	5
30	Trailhead Parking	22
31	Trailhead	N/A
32	Trailhead	N/A
33	Trailhead	N/A
Tennessee Valley Authority (TVA)		
34	Trailhead Parking	6
35	Trailhead Parking	25
36	Trailhead Parking	30
37	Trailhead Parking	30

WAYFINDING ASSESSMENT

Wayfinding and signage are a key element that define user experience on trail systems and on bicycle or hiking routes between trail systems. Wayfinding can help new trail users orient themselves to the overall park system. It also contributes to user safety by clearly designating allowed users, informing users where they are along the trail, and guiding them to entrance and exit points. Between trail systems, wayfinding ensures that new visitors know how to reach their destination and welcomes long-time residents and visitors by creating a sense of place. Understanding the state of existing wayfinding within each park system, and between the parks, can help establish actionable steps forward towards more cohesive wayfinding that enhances the overall user experience.

Existing Wayfinding

Big Ridge State Park

- Brown signage and white lettering
- Provide mileage distances
- Color coded tags

Loyston Point

- White and black icons for trail name, trail direction, and allowed user types
- Large kiosk with park information and trail maps

Norris Watershed

- Wood signs carved with trail names
- Some color tags on trees
- No mileage information provided

Norris Dam State Park

- Red and white plastic signs with trail names and direction
- Wooden signs with green lettering that have trail name and distance
- Trailheads with park maps and information on trail mileage and park hours

Between Park Wayfinding

- Minimal signage to park systems
- Follows traditional roadway signage designs

Conclusion

Park systems throughout the Norris Lake Area contain similar wayfinding elements with unique designs. Best practices, such as adding blazes with color coding for different trails, including mileage on wayfinding, and adding maps and visitor information to major trailheads can be applied from one park system to another. Not only will this contribute to a better user experience within a singular park system, but it will also foster a cohesive experience shared in recreational areas throughout the Norris Lake area.

There is currently limited wayfinding elements, beyond traditional roadway signage, between the parks in the Norris Lake Area. Adding signage directing people to the parks, and to any bikeway routes between the parks, will add to the region's sense of place, increase safety for people bicycling, and make the overall experience of traveling between the parks more convenient and straightforward. Additional wayfinding and signage that reflects the brand of the region will add to the visitor experience and contribute to the sense of place for current residents of the Norris Lake Area.

ROAD NETWORK ASSESSMENT

Although the four parks are within close geographic proximity to each other, topography and the rural road network create a challenge for people seeking to bicycle between destinations. Norris Lake separates Big Ridge State Park and Loyston Point by less than a mile, yet the on-road route totals 14.7 miles. Likewise, the west and east sides of Norris Dam State Park are only a quarter of a mile apart by water.

During interviews, stakeholders identified the lack of connectivity between the region's recreation destinations and to nearby towns. The majority of roads in the study area lack bicycle and pedestrian facilities. Although there are nearly 31 miles of signed bicycle routes in the study area, representatives from the Tennessee Department of Transportation (TDOT) noted it is not advisable to bicycle on some of these signed routes while other, more bike-friendly road segments are not designated as bicycle routes. TDOT also monitors several routes that provide access to the area's recreation destinations. TDOT restripes roads and installs signage and guardrails based on the findings of these safety audits.

Level of Traffic Stress

This study utilizes the Level of Traffic Stress (LTS) method, developed by the Mineta Transportation Institute.[1] The analysis quantifies bicyclists' experience using a given segment of road based on the road's characteristics.

Assessment Factors

Factors that affect LTS include speed, the road's geometry, daily traffic conditions, and the level of separation of existing bicycle facilities from traffic. Four classifications were used to describe the greater Norris Lake Area's existing LTS, with LTS 1 indicating the most comfortable riding environments, and LTS 4 indicating the least comfortable riding environments.

LTS was determined based on datasets provided by TDOT, as well as a desktop survey of speed limits in the study area. These data included speed limits, functional classification, and roadway ownership (e.g., is the road a part of the TDOT system or not). Traffic volume data was only available for a few roads and, therefore, was not included in the analysis. Overall, traffic volume was assumed to be heavier on roads owned by TDOT (i.e., "on system" roads) as they tend to be more direct, higher speed routes for longer-distance travel.

A score of LTS 1 is assigned to roads that are appropriate for most children; the level of attention required from cyclists is minimal, making it safe for all levels of cyclists. These roads are characterized by lower traffic speeds (25 miles per hour or less) and a "local" functional class designation. Multiuse paths, trails, and greenways are also assigned LTS 1.

The next level, LTS 2, is given to local roads that still have slower traffic speeds (30 miles per hour or less for on-system roads and 35 miles per hour or less for off-system roads). Collector or arterial roads can also be LTS if they have low traffic speeds (less than 25 miles per hour for on-system roads and less than 30 miles per hour for off-system roads). These conditions are suitable for the mainstream adult population; while these roads require more attention from the riders than LTS 1, they are still appropriate for most rider skill levels.

Corridors that are well suited for enthusiastic riders confident in their abilities are classified as LTS 3. On-system local roads with a speed limit of 35 miles per hour or off-system local roads with speeds less than 40 miles per hour can be classified as LTS 3. Collector or arterial roads that have speeds less than 30 miles per hour for on-system roads or 40 miles per hour for off-system roads are also given LTS 3 classification.

The LTS 4 category roads are those that are only fitting for the most advanced levels of cyclists—those who can be classified as "strong and fearless" riders. The minimum speed limits for this category vary depending on functional classification and road ownership. On-system roads will be assigned an LTS 4 if they are local roads with speeds 40 miles per hour or greater or collector/arterial roads with speeds 35 miles per hour or greater. Off-system roads will be assigned an LTS 4 if they are local roads with speeds 45 miles per hour or greater or collector/arterial roads with speeds 40 miles per hour or greater.

Limitations

The LTS does not capture all road attributes that may influence how comfortable an individual feels while bicycling on any given road. The mountainous terrain and winding roads characteristic to the eastern Tennessee region can pose additional challenges for bicyclists through limited sight lines and arduous hills to climb. While some people who bicycle in the Norris Lake Area may be comfortable riding in these conditions to get to and from the region's destinations, many are not. A well-connected bikeway network between the region's park systems that is designed for people of all ages and abilities will allow bicycling to be a safer, more comfortable, and more convenient choice.

TABLE 8. Level of Traffic Stress Scoring Criteria

| SCORE	QUALITATIVE ASSESSMENT	QUANTITATIVE ASSESSMENT
LTS 1	Level of stress tolerable by most children, requiring minimal attention of cyclists	• Greenways and trails • Low speed (25 mph or less) local roads
LTS 2	Appropriate riding conditions for the mainstream adult population	On-System Roads: • Low speeds (30 mph or less) on-system local roads • 25 mph or less on on-system collectors/arterials Off-System Roads: • Lower-speeds (35 miles per hour or less) on off-system local roads • Low speeds (30 mph or less) on off-system collector or arterial roads
LTS 3	Well-suited for the enthusiastic rider that is confident in his/her riding abilities, but still prefers separated facilities	On-System Roads: • 35 mph on on-system local roads • 30 mph or less on on-system collectors/arterials Off-System Roads: • 40 miles per hour on off-system local roads • 35 mph on off-system collector or arterial roads
LTS 4	Only tolerated by riders who may be classified as "strong and fearless"	On-System Roads: • 40 mph or greater local roads • 35 mph or greater collectors/arterials Off-System Roads: • 45 miles per hour or greater local roads • 40 miles per hour or greater collector and arterial roads
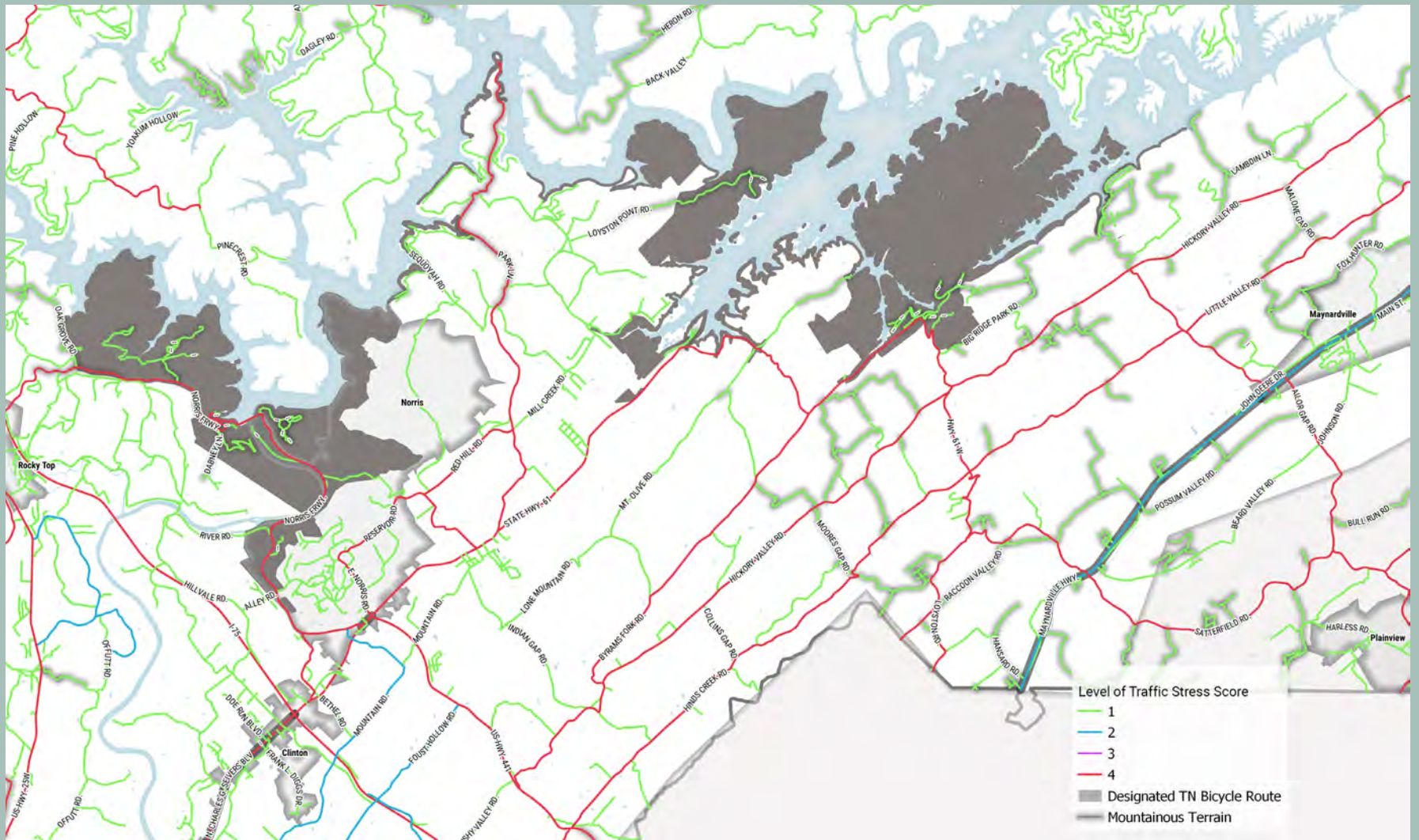
FIGURE 10. Level of Traffic Stress of the Norris Lake Area
Each street in the study area is assigned a level of traffic stress based on the scoring criteria. Most streets scored either as LTS 1 (highest comfort) or LTS 4 (lowest comfort).

LTS Results

As illustrated in Figure 9, many of the roads in the Norris Lake Area are either low-stress (LTS 1) or high-stress LTS (4). Most of the LTS 1 routes are local and collector roads that connect residential areas to major thoroughfares, while LTS 4 routes are more direct, higher-capacity arterial roads and interstates that provide more direct and efficient connections to regional destinations. This makes sense considering the LTS Scoring Criteria drew heavily on functional class and speed limit.

The abundance of low-stress bicycle options in the Norris Lake Area is encouraging when considering options for future bikeway facilities appropriate for people of all ages and abilities; however, the presence of a single well-designed, high-comfort facility will do little to increase connectivity between local destinations and community resources. A thoughtfully planned bicycle network is necessary to enable people to seamlessly reach destinations, whether bicycling for recreation or as a mode of transportation. Utilizing arterial roads that provide the most direct access to destinations is often necessary when creating an efficient bikeway network that is as convenient as possible. Considerations of each road's level of traffic stress will be pertinent when selecting which bikeway facility types comprise the network.

Not all members of the community will choose to ride a bicycle from where they live to the park or another community destination, but a bikeway network should be provided for those that do make this choice and for those who have no choice. Nearly 6% of households in Anderson, Campbell, and Union counties do not have access to a personal vehicle.[2] While that is slightly lower than the national average and vehicle ownership statistics in more urban areas, those who do rely on walking, biking, or transit to reach community resources should be able to do so safely. In addition, effective bicycle networks often lead to more people bicycling by creating routes that are efficient, seamless, and easy to use.

It is critical to reiterate that LTS does not take into consideration roadway geometry (other than width), terrain, and sightlines. These factors can only be analyzed through desktop review and field verification.

Critical Network Gaps

Identification of critical gaps in the pedestrian and bicycle network relied on GIS analysis and field observation. Stakeholder interviews provided insight on the types of places that need focused access improvements. The assessment highlights critical gaps near key destinations with emphasis on gaps located along routes serving multiple destinations.

Low-Stress Bicycle and Pedestrian Network Gaps

There are currently no on-street bicycle facilities in the area, apart from TDOT designated bicycle routes, and these routes do not promise an experience where people on bikes are separated from vehicular traffic or feel a healthy level of comfort. For this reason, many bicycle routes are not utilized by less-experienced and less-confident bicyclists and may not sufficiently serve the needs of all people on bikes in the community. The designated bicycle route along state highway 61, for example, received an LTS 4 score, likely because it has higher traffic volumes traveling along it at higher speeds. State routes 171 and 144, which have similar roadway characteristics to highway 61, were also categorized as LTS 4. This route provides a direct connection between the City of Norris, the City of Clinton, the Norris Watershed, and Big Ridge State Park. The development of a more comfortable user experience could encourage more people of all levels to bike along this corridor to reach these destinations.

Specific analysis of the completeness and quality of the area's sidewalk network was not conducted as a part of this study and may warrant further examination when considering pedestrian connectivity within municipalities and between local destinations. However, stakeholder interviews highlighted crossing Norris Dam as a key challenge for pedestrians, particularly in moving between the western and eastern sides of Norris Dam State Park. The Dam does have sidewalk, but it is narrow and does not provide a physical barrier between cars driving and people walking across the Dam.

Opportunities for Better Connections

Connecting people to the places they live, work, and play—restaurants, businesses, work, home, school, parks, marinas, etc.—is key to positioning the Norris Lake Area as a place of choice for visitors and potential residents, while also increasing the quality of life of existing community members. While the study area's topography, sightlines, and roadway geometry pose challenges to creating high-comfort bicycle and pedestrian facilities, there are key locations that, with focused attention, can transform the experience for people walking and bicycling in the Norris Lake Area.

Key Intersections

- TN Hwy 61 @ Bryams Farm Road (near entrance of Big Ridge State Park)
- TN Hwy 61 @ Park Lane
- TN Hwy 61 @ Mountain Road and Lambdin Road
- TN Hwy 61 @ US 441 Norris Freeway (both intersections)
- TN Hwy 61 @ Hillvale Road
- US 441 Norris Freeway @ River Road (on route to Loyston Point)
- Mill Creek Road @ Ridge Circle Road Curve on incline at intersection
- US 441 Norris Freeway at@ Lower Clear Creek Road (on route between Norris Watershed and Norris Dam)

Potential Conflict Points

- US 441 crossing Norris Dam
- Lower Clear Creek at Red Hill Trail (in Norris Watershed)
- Reservoir Road, Red Hill Road and Lambdin Road intersection

Sources

1. Mekuria, M.C., P.G. Furth,and H. Nixon. Low-Stress Bicycling and Network Connectivity. MTI Report 11-19. Mineta Transportation Institute, San Jose State University, San Jose, CA, 2012.

2. American Community Survey. Household Tenure by Vehicles Available 5-Year Estimates. 2018.

RECOMMENDED STRATEGIES

Establishing a system of sustainable and connected trails is process that includes implementation of trail projects, community programs, and user friendly policies.

Recommendations in this study are intended to help identify next steps, key partnerships, and funding opportunities that will leverage local assets and guide future investment.

REGIONAL CONNECTIVITY

The following pages illustrate proposed routes for the Norris Lake Area's bikeway network. Roadway ownership, potential challenges (e.g., terrain, sightlines, right-of-way), and suggested facility types are provided for each route.

Regardless of the project, collaboration with the agencies that own and maintain the roads—whether TDOT, county, or municipal partners—will be crucial for success. Coordination will be key for future funding of projects along TDOT roadways, particularly as these heavily traveled arterials often necessitate facilities that provide more separation for bicyclists (which are usually more costly). Traffic calming measures may be more appropriate for local roads under county and city ownership. Though these measures can range in costs, keeping partners informed and involved in the planning and design process will better situate the bikeway network to become a reality.

The Federal Highway Association has identified seven key principles for bikeway network design:

- **Safety** – the frequency and severity of crashes are minimized and conflicts with motor vehicles are limited
- **Comfort** – conditions do not deter bicycling due to stress, anxiety, or concerns over safety
- **Connectivity** – all destinations can be accessed using the bicycling network and there are no gaps or missing links
- **Directness** – bicycling distances and trip times are minimized
- **Cohesion** – distances between parallel and intersecting bicycle routes are minimized
- **Attractiveness** – routes direct bicyclists through lively areas and personal safety is prioritized
- **Unbroken Flow** – stops, such as long waits at traffic lights, are limited and street lighting is consistent

While the unique topography and rural character of the Norris Lake Area provides an environment quite dissimilar from urban bikeway networks, these principles should be considered in the local context when determining the appropriate routing and facility types for the bikeway network. Chapter 5 provides more detailed information related to bikeway facility selection and design guidance.

In addition, establishing a bikeway network that serves a variety of rider types—from fearless road warriors to families taking a relaxing weekend ride—means more than lines on a map. Experiential aspects of the bicycle trip itself (e.g., wayfinding, design elements) and upon arriving at the destination (e.g., amenities such as bike parking, visitor center to learn about trails and programming) are equally important. The Policy & Programming section later in this chapter recommends strategies to enhance the user experience of bicyclists, as well as hikers and other visitors to the Norris Lake Area.
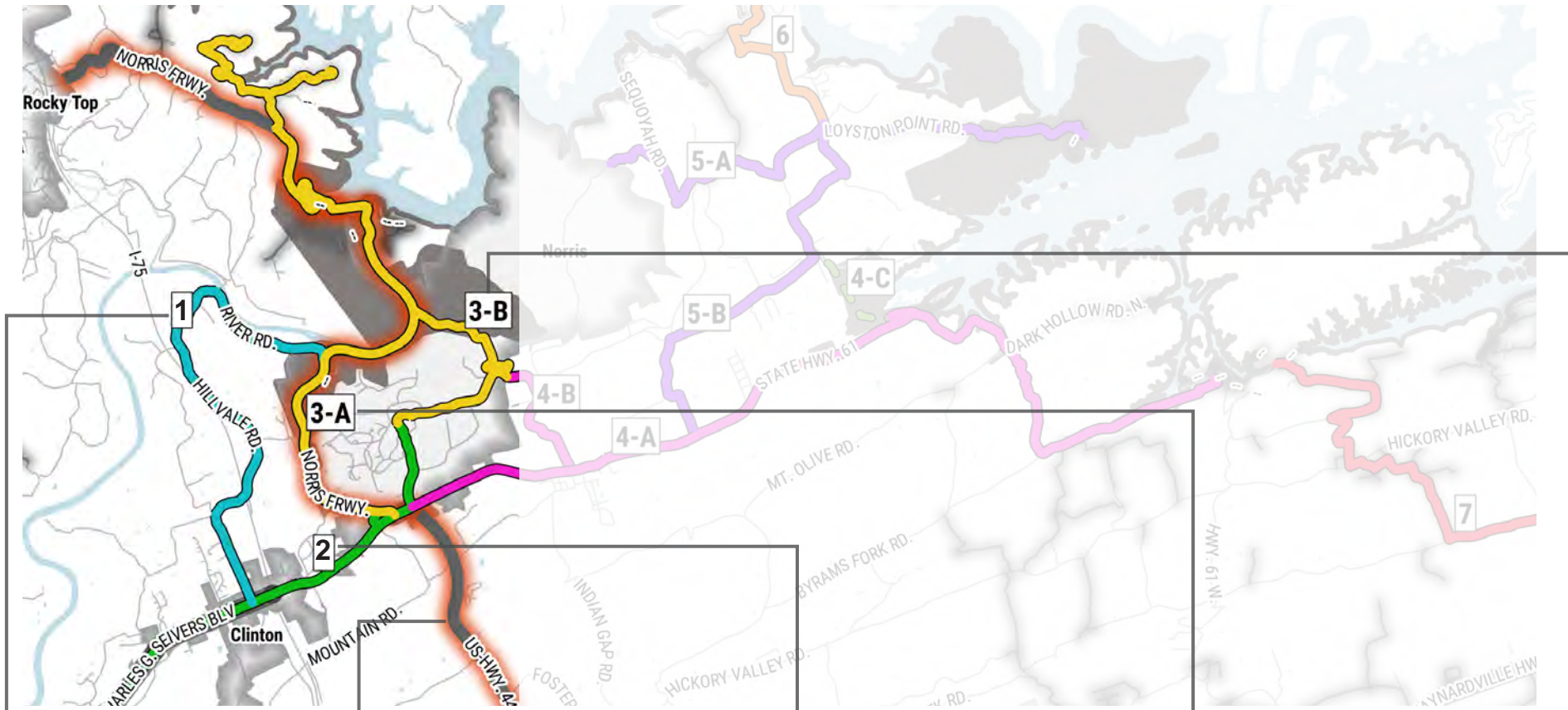
» ROUTE 1

Traverses the existing designated bicycle route along Highway 61.

- Connects the Cities of Norris and Clinton.

- Primarily owned and maintained by TDOT.

- Existing right-of-way and wide shoulders to allow for facility improvements

- A physically separated facility is need for user comfort.

» SCENIC BYWAY

Scenic highway that is a primary connection to Norris Dam State Park.

- Scenic connection from the interstate to Norris Dam State Park.

- Primarily owned and maintained by TDOT.

- Recommended scenic byway designation.

» ROUTE 2

Scenic rolling hill and river route connection.

- Connects interstate commerce to the City of Norris, the Norris Watershed, and Norris Dam State Park.

- Primarily owned and maintained by Anderson County.

- Limited to a signed route due to existing topography and lack of right-of-way.

» ROUTE 3-A

Primary Norris Dam State Park connection.

- Scenic connection from the interstate to Norris Dam State Park.

- Primarily owned and maintained by TDOT.

- Limited to a signed route due to existing topography and lack of right-of-way.

- Needs sightline improvements and shoulders added where able in curve sections.

- A speed limit reduction is encouraged.

» ROUTE 3-B

Primary Norris Dam State Park connection.

- Connects the City of Norris to the Norris Watershed and Norris Dam State Park.

- Primarily owned and maintained by the City of Norris.

- Some existing sidewalk present.

- Limited to a signed route due to existing topography and lack of right-of-way.
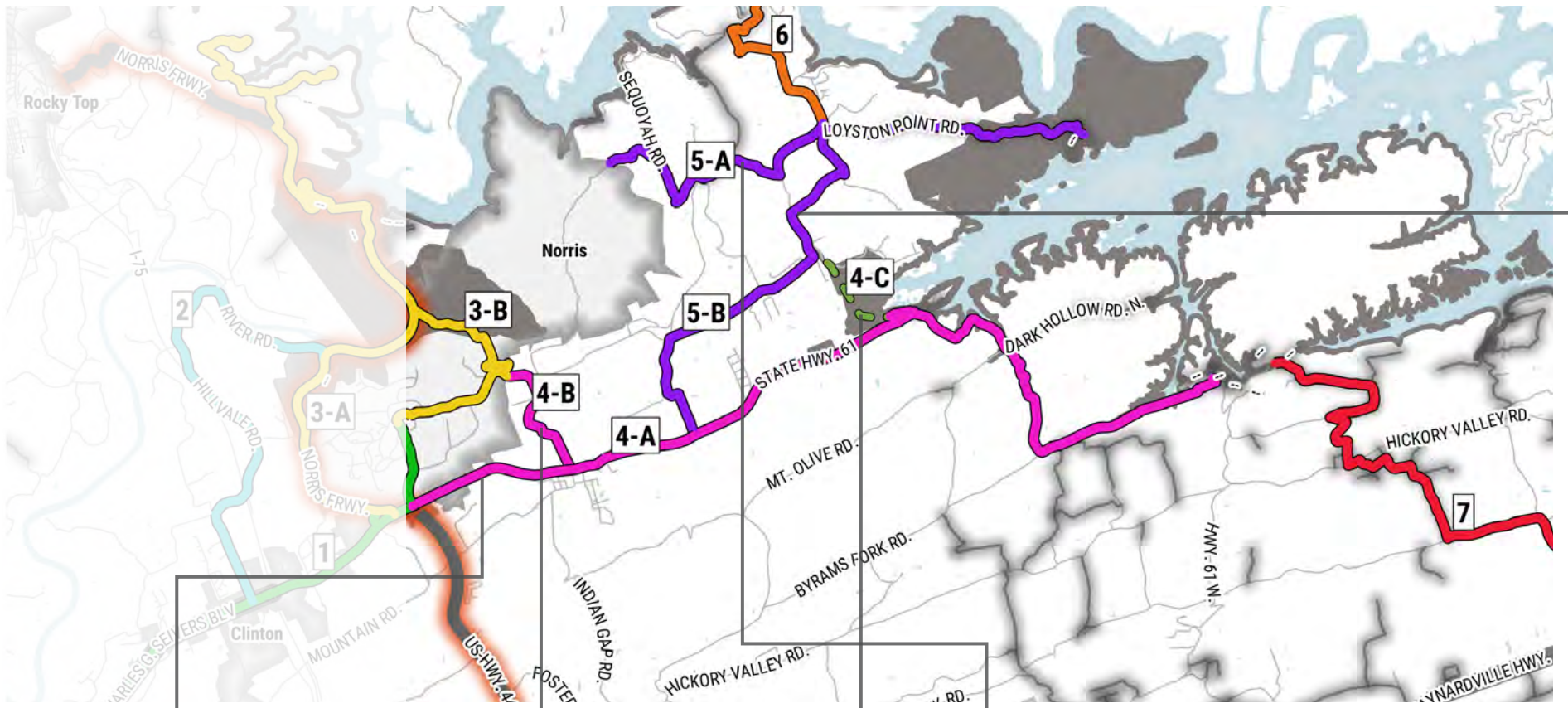
ROUTE 4-A
Big Ridge Connector.

- Connects the City of Norris to Big Ridge State Park.
- Primarily owned and maintained by TDOT.
- Existing right-of-way and wide shoulders to allow for facility improvements.
- Current signed bicycle route.
- Significant sightline and shoulder improvements are desired between Dark Hollow Drive and Byrams Fork Road.

ROUTE 4-B
Big Ridge Connector spur.

- Connects the City of Norris and Norris Watershed to the Big Ridge connector.
- Primarily owned and maintained by Anderson County.
- Limited to a signed route due to existing topography and lack of right-of-way.

ROUTE 4-C
Big Ridge - Loyston greenway connector spur.

- Connects the Big Ridge State Park to Loyston Point.
- Land is primarily owned and maintained by TVA.
- Greenway can be natural surface or hard surface.

ROUTE 5-A
Norris Watershed to Loyston Point Connector.

- Connects the Norris Watershed to Loyston Point.
- Primarily owned and maintained by either Anderson or Union County.
- Limited to a signed route due to existing topography and lack of right-of-way.
- Significant sightline and shoulder improvements are desired.

ROUTE 5-B
Loyston Point to Big Ridge Connector spur.

- Connects Loyston Point to signed route on Highway 61.
- Primarily owned and maintained by either Anderson or Union County.
- Limited to a signed route due to existing topography and lack of right-of-way.
- Some significant sightline and shoulder improvements are desired.
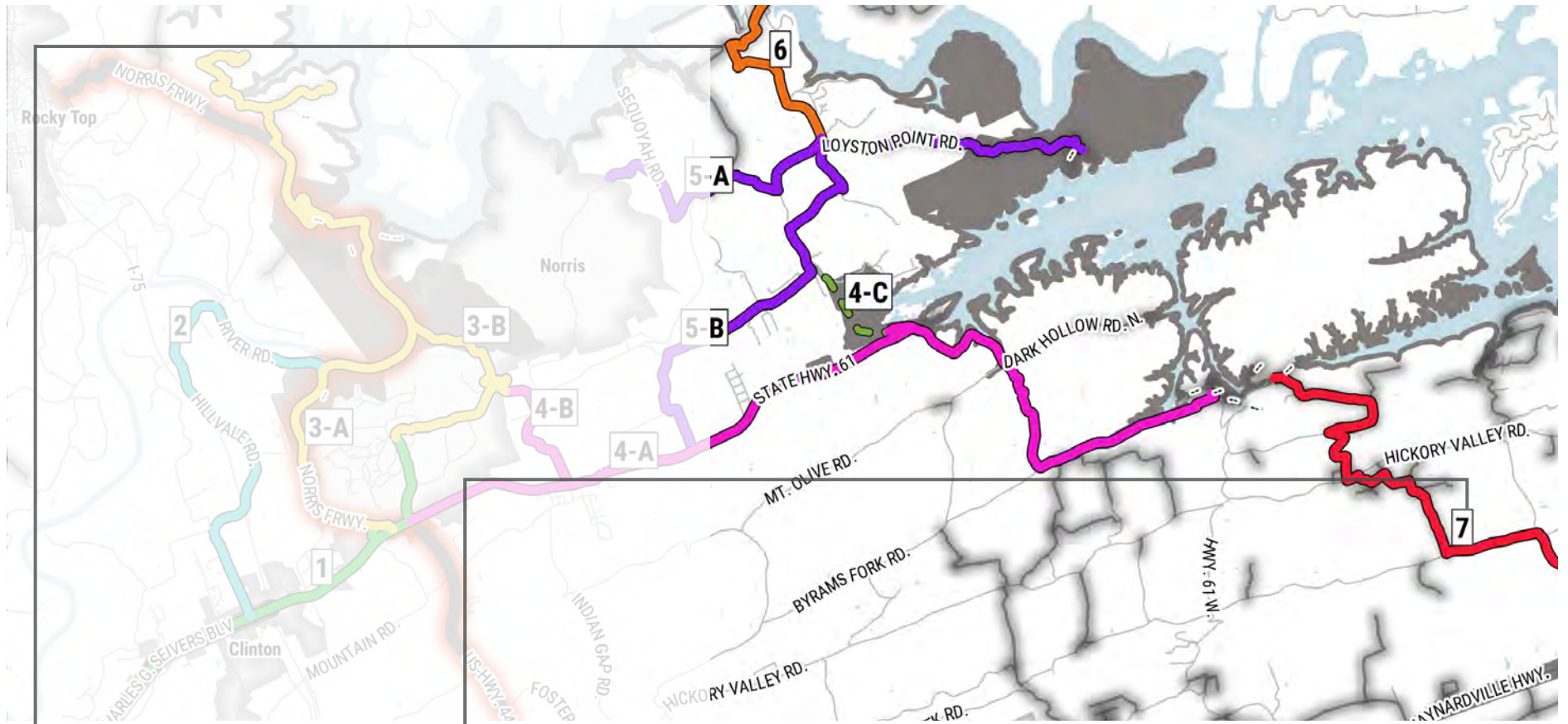
» ROUTE 6

Anderson County Park Connector.

- Connects Anderson County Park to Loyston Point and the Norris Watershed.

- Primarily owned and maintained by Anderson County.

- Limited to a signed route due to existing topography and lack of right-of-way.

- Significant sightline and shoulder improvements are desired.

» ROUTE 7

Maynardville Connector.

- Connects Big Ridge State Park to Maynardville.

- Primarily owned and maintained by Union County with some TDOT and Maynardville owned.

- Limited to a signed route due to existing topography and lack of right-of-way.

- Significant sightline and shoulder improvements are desired.

TABLE 9. Recommended Regional Routes, Facility Type, and Limitations

ROUTE	ROADWAY	LTS SCORE	SPEED LIMITS	FUNCTIONAL CLASS	OTHER LIMITATIONS	RECOMMENDED FACILITY TYPE
1	• Highway 61 • Norris Freeway (US 441) • E. Norris Road	• 4 • 4 • 4	• 45-55 • 40-55 • 30	• Principal Arterial/Major Collector • Major Collector • Minor Collector	• N/A	Separated facility (e.g., shared use path)
2	• Hillvale Road • River Road	• 1 • 1	• 30-35 • 30	• Local • Local	• Topography • Right-of-way	Signed route
3-A	• Norris Freeway (US 441) • Village Green Drive • Andrews Ridge Road	• 4 • 1 • 1	• 30-50 • 15-30 • 15-30	• Major Collector • Local • Local	• Topography • Right-of-way • High speeds	Signed route and speed limit reduction
3-B	• West Circle Road • Reservoir Road • Lower Clear Creek Road • Norris Freeway (US 441) • Village Green Drive • Andrews Ridge Road	• 4 • 4 • 1 • 4 • 1 • 1	• 20 • 20-30 • 15-20 • 30-45 • 15-30 • 15-30	• Minor Collector • Minor Collector • Local • Major Collector • Local • Local	• Topography • Right-of-way	Signed route
4-A	• Highway 61	• 4	• 30-55	• Major Collector	• N/A	Separated facility (e.g., shared use path)
4-B	• Lower Clear Creek Road • Reservoir Road • Lambdin Road • Highway 61	• 1 • 4 • 4 • 4	• 20 • 30-40 • 40 • 30-55	• Local • Minor Collector • Minor Collector • Major Collector	• Topography • Right-of-way	Signed route
4-C	• No existing roadway	• N/A	• N/A	• N/A	• N/A	Greenway (paved or unpaved)
5-A	• Upper Clear Creek Road • Sequoyah Road • Park Lane • Forgety Road • Mill Creek Road • Ridge Circle Road • Loyston Point Road	• 1 • 1 • 4 • 1 • 1 • 1 • 1	• 30 • 25 • 35 • no data • 30 • no data • no data	• Local • Local • Minor Collector • Local • Local • Local • Local	• Topography • Right-of-way	Signed route

TABLE 7. Recommended Regional Routes, Facility Type, and Limitations Continued

ROUTE	ROADWAY	LTS SCORE	SPEED LIMITS	FUNCTIONAL CLASS	OTHER LIMITATIONS	RECOMMENDED FACILITY TYPE
5-B	• Nig Longmire Road • Park Lane • Mill Creek Road • Ridge Circle Road • Loyston Point Road	• 1 • 4 • 1 • 1 • 1	• no data • 35 • 30 • 25 • no data	• Local • Minor Collector • Local • Local • Local	• Topography • Right-of-way	Signed route
6	• Ridge Circle Road • Park Lane	• 1 • 4	• 30 • 35	• Local • Minor Collector	• Topography • Right-of-way	Signed route
7	• Big Ridge Park Road • Grissom Road • Hickory Valley Road • Hickory Drive • Guyton Drive • Beeler Road • Ousley Gap Road • Hinds Creek Road • Hickory Star Road • Heiskell Road • John Deere Drive • Maynardville Highway • Main Street	• 1 • 1 • 4 • 1 • 1 • 1 • 1 • 4 • 4 • 1 • 1 • 2 • 1	• 15 • no data • 45 • no data • no data • no data • no data • 35 • 45 • no data • 30 • 45 • no data	• Local • Local • Major Collector • Local • Local • Local • Local • Minor Collector • Major Collector • Local • Local • Minor Arterial • Local	• Topography • Right-of-way	Signed route

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TRAIL IMPLEMENTATION

Trail construction options range from full professional design-build to volunteer construction of professionally designed trail. Trail implementation decisions depend on multiple factors including budget, timeline, quality, preciseness, and availability of volunteers. While engaging volunteers can help garner interest and sense of ownership in the trail system, there is a risk of volunteer burnout and reduced quality. Linear foot cost estimates vary widely depending on materials and professional services. Volunteer labor drastically reduces cost of construction but is less reliable. In-kind donations of materials such as lumber, mulch, and crushed stone can also help to reduce costs.

DISCLAIMER

All trail alignments are conceptual and lengths are approximate. The opinion of probable costs in this section are order-of-magnitude estimates made for budget purposes only. Estimates shall be reviewed, revised, and adjusted accordingly at program verification/schematic design phases. For each fiscal year after the publication of this document, 2020, estimator should add 5% to the unit cost of each item.

Designer/Builder	Strengths	Weaknesses
PROFESSIONAL DESIGN-BUILD » Cost estimate: $4-$16 per linear foot	» Quickest completion rate » Generally higher quality; work covered by insurance and licenses » Single point of contact (generally)	» Most expensive
HYBRID: PROFESSIONAL DESIGN AND MECHANIZED BUILD WITH VOLUNTEER FINISH » Cost estimate: $3-8 per linear foot	» More affordable than full professional build » Fairly quick completion rate » Volunteer training creates skilled base of volunteers for future projects » Entails community buy-in	» Not always quick; relies on consistent volunteer availability » Volunteer burnout possible » Lower quality outcome possible
PROFESSIONAL DESIGN AND OVERSIGHT OF VOLUNTEER BUILD » Cost estimate: $0.50-1.50 per linear foot	» Most affordable up-front labor costs » Volunteer training creates skilled base of volunteers for future projects » Entails community buy-in	» Slowest completion rate; relies on consistent volunteer availability » Volunteer burnout possible » Lower quality finish

TRAIL RECOMMENDATIONS

The trail assessment conducted within each recreation destination provided a foundation for developing recommendations. Along with input from the project steering committee, the project team reviewed topography to understand ongoing maintenance issues and possible safety concerns. The following recommendations highlight how removing trail segments, re-routing trails, or adding new trails offers value to each park and its users. All trail alignments are conceptual and additional field review is necessary prior to implementation.

Recommendations for each park identify specific goals that may be accomplished and trail user groups that may benefit.

Trail Recommendation for all Parks

PARTNER WITH LOCAL ORGANIZATIONS/CLUBS to provide routine and volunteer maintenance within the trail system. This will support all trail users and contribute to marketing efforts within the Norris Lake Area.

Regional Goals

- **MARKETING & BRANDING**
- **HEALTH**
- **ECONOMIC DEVELOPMENT**

Trail User Groups

- Hikers, Walkers, & Joggers
- Persons with disabilities
- Bicyclists
- Mountain bikers
- Equestrians
- Emergency & Maintenance Personnel

Norris Dam State Park

Spanning both sides of the dam, Norris Dam State Park provides trails with lakeshore and hilltop views. Development of many existing trails occurred along or provided connections to homestead roads, which creates opportunities for new trails as well as re-routing or removing existing trails to increase connectivity within the park.

Recommended changes include interconnected loops and a commitment to sustainable trail alignment and development. In total, the additional **11.4 miles** of new trail would increase total trail miles by **41%**.

Critical to the recommendations is a clear understanding that developing more trails does not result in more maintenance, and that sustainable design can ultimately reduce the burden of maintenance while providing more opportunities for hikers and mountain bikers.

Recommendation	Regional Goals Met	Trail Users Supported
» **REMOVE TRAILS** that are difficult to maintain and have unsustainable design including portions of Rock Creek, Highpoint, and Lakeside Loop trails		
» **RE-ROUTE TRAILS** to increase safety and convenience of popular trails while reducing ongoing maintenance issues. Re-routes recommended include but are not limited to sections of Chuckmore, High Point Spur, Marine Railway, and Lakeside Loop trails.		
» **NEW TRAILS** will enhance user experience and allow for park exploration along with interconnected loops offering short and long outings for varying abilities		
» **MARKET THE TRAIL SYSTEM** as a local and regional amenity, emphasizing the historical character and how both the park and its trails offer something for people with a range of abilities and interests		

FIGURE 11. Trail Recommendations at Norris Dam State Park

Legend:
- Maintain Existing Trail
- Remove Existing Trail
- Build New Trail
- Potential Water Taxi
- ○ Trailheads
- ✹ Visitor Center
- ⬠ Cabins
- ▲ Campsites

Sequoyah Marina

LAKEVIEW TRAIL
LAKESIDE LOOP TRAIL

SINKHOLE TRAIL

ELKINS TRAIL

RANGE ROAD

CHUCKMORE TRAIL

Cove Creek Wildlife Management Area

Norris Dam Marina

CAMP SAM TRAIL

SONGBIRD TRAIL

RIVER BLUFF TRAIL

NORRIS FRWY.

» ENHANCE

New route offers views of Norris Lake with technical mountain biking features in rocky areas

» RE-ROUTE

Many trails have steep sections that warrant alternate routes, especially the Chuckmore Trail & Lakeside Loop

» ENHANCE

Trail connecting the west side of the Park to Norris Dam and US 441

» CONNECT

A water taxi between the adjacent marinas would offer a safe connection across the park

FIGURE 12. Detailed Trail Recommendations at Norris Dam State Park

Sequoyah Marina

Cove Creek Wildlife Management Area

Norris Dam Marina

Legend:
- Maintain Existing Trail
- Remove Existing Trail
- Potential Water Taxi
- ○ Trailheads
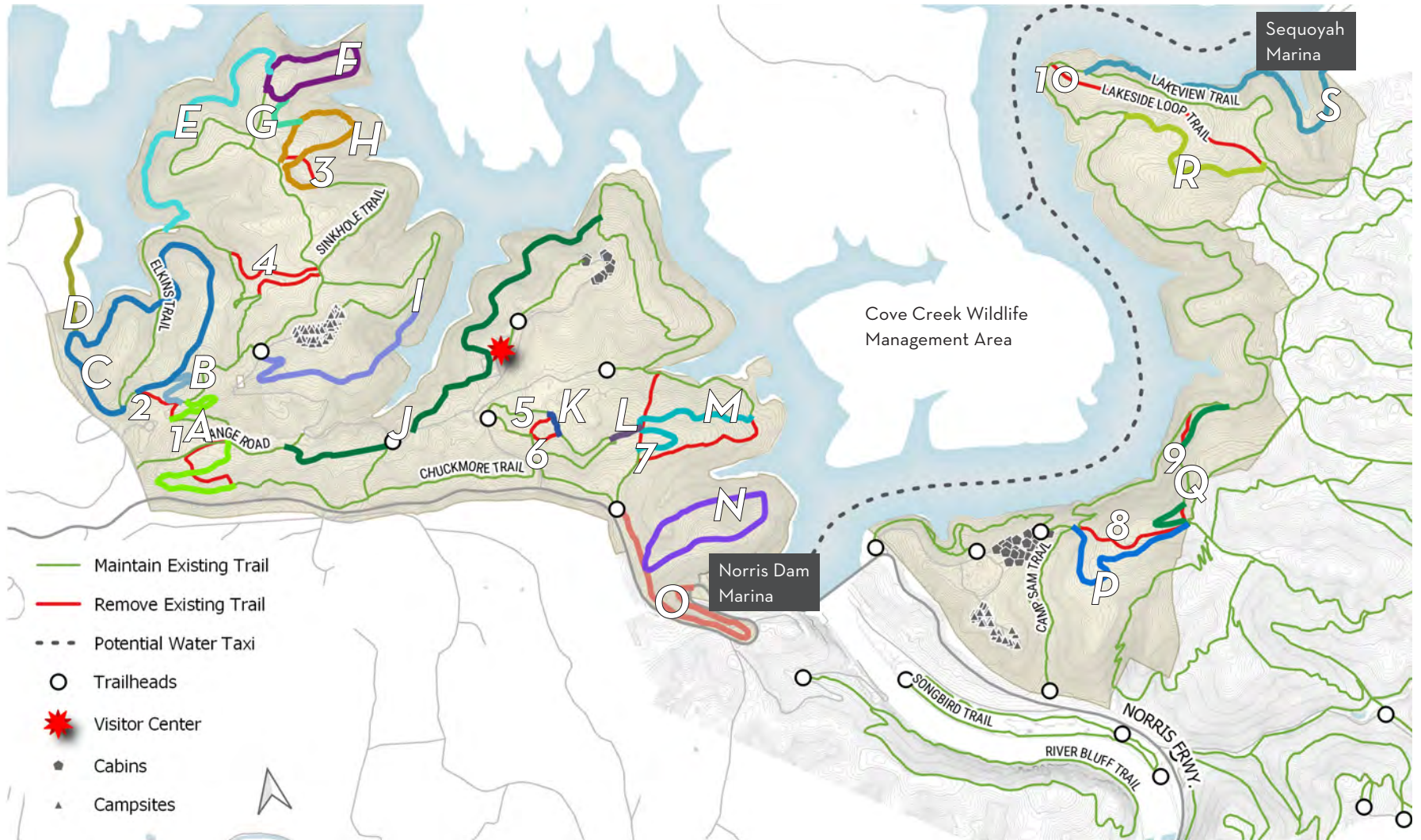- ✹ Visitor Center
- ⬠ Cabins
- ▲ Campsites

TABLE 10. Detailed Trail Recommendations at Norris Dam State Park

TRAIL I.D.	ACTION	TRAIL TYPE	LENGTH	COST ESTIMATE	ADDITIONAL INFORMATION
1	Remove/Re-route	Singletrack	0.47 miles	N/A	• Steep sections of Chuckmore Trail
2	Remove/Re-route	Singletrack	0.16 miles	N/A	• Steep section of Elkins Trail
3	Remove/Re-route	Singletrack	0.18 miles	N/A	• Sinkhole Trail
4	Remove/Close	Singletrack	0.65 miles	N/A	• Rock Creek Trail
5	Remove/Re-route	Singletrack	0.11 miles	N/A	• Fitness Trail
6	Remove/Re-route	Singletrack	0.11 miles	N/A	• Harmon Trail
7	Remove/Re-route	Singletrack	0.79 miles	N/A	• Marine Railway Trail
8	Remove/Re-route	Singletrack	0.42 miles	N/A	• Highpoint Trail
9	Remove/Re-route	Singletrack	0.19 miles	N/A	• Highpoint Spur Trail/Lakeview Trail
10	Remove/Re-route	Singletrack	0.84 miles	N/A	• Steep sections of Lakeside Loop Trail
A	Build	Singletrack	0.61 miles	$1,610-51,533	• Replaces steep section of Chuckmore Trail
B	Build	Singletrack	0.52	$1,426-45,619	• Replaces steep section of Elkins Trail
C	Build	Singletrack	1.84 miles	$4,858-155,443	• Trail overlooking Norris Lake with technical, rocky features
D	Build	Singletrack	0.42 miles	$ 1,109-35,482	• Spur trail connecting to TVA boat ramp and parking lot
E	Build	Singletrack	1.21 miles	$3,194-102,221	• Creates multiple loop options
F	Build	Singletrack	0.84 miles	$2,218-70,963	• Planned trail with trail grant
G	Build	Singletrack	0.2 miles	$528-16,896	• Connector between Sinkhole Trail and new trail
H	Build	Singletrack	0.85 miles	$2,244-71,808	• Replaces section of Sinkhole Trail
I	Build	Singletrack	0.93 miles	$2,455-78,566	• Expands Hootin Holler Trail; connects to trailhead and parking
J	Build	Singletrack	1.7 miles	$4,488-143,616	• Connects multiple trails and to pool parking lot; closes a loop
K	Build	Singletrack	0.08 miles	$211-6,758	• Combines Fitness and Harmon Trails; replaces steep sections
L	Build	Singletrack	0.1 miles	$264-8,448	• Connects Harmon Trail (and parking) to Marine Railway Trail
M	Build	Singletrack	0.73 miles	$1,927-61,670	• Replaces sections of Marine Railway Trail
N	Build	Singletrack	1.09 miles	$2,878-92,083	• Trail overlooks Norris Lake and Norris Dam
O	Build	Singletrack	1.08 miles	$2,851-91,238	• Connects westside of Park to marina and Norris Dam
P	Build	Singletrack	0.24 miles	$1,848-59,136	• Replaces section of Highpoint Trail
Q	Build	Singletrack	0.46 miles	$1,214-38,861	• Replaces sections of Highpoint Spur Trail/Lakeview Trail
R	Build	Singletrack	0.72 miles	$1,901-60,826	• Replaces steep sections of Lakeside Loop Trail
S	Build	Singletrack	1.23 miles	$3,247-103,910	• Connects to Sequoyah Marina

Norris Watershed

The Watershed recreational area outside of the City of Norris offers a range of experiences for users including horseback riding, which is not allowed on trails in other recreational areas in the region. While consideration of water quality is essential to any trail modifications or changes within the region, this is especially true within the Watershed area. Existing trails within the Norris Watershed are conveniently accessed from the City of Norris and from the east side of Norris Dam State Park.

Recommendations for strategic re-routes can accomplish more sustainable development that protects water quality and can reduce ongoing maintenance costs, time, and funding.

Recommendation	Regional Goals Met	Trail Users Supported
STRATEGIC RE-ROUTES remove trail that exists along fall-lines and provide a safer and more enjoyable experience for all users.	📢 ➕	🚶‍🦮 🚴
EVALUATE ACCESS AND PARKING to determine any barriers to trail users. As the Watershed becomes more of a destination, more capacity will be necessary to accommodate people traveling.	📢 🔗$	🚴 🚶‍🦮 🐎
MARKET THE TRAIL SYSTEM as a local and regional amenity, emphasizing the ecological character and how both the park and its trails offer something for people with a range of abilities and interests	📢 ➕ 🔗$	🚴 🚶‍🦮 ♿ 🐎 🧰
SUSTAINABLE TRAILS FOR ALL USERS can reduce maintenance that may result for any one user group. If trails are re-routed, trail signage and width should be considered to reduce conflicts between users and provide additional access for emergency responders.	📢 ➕ 🔗$	🚴 🚶‍🦮 🐎 🧰

FIGURE 13. Trail Recommendations at Norris Watershed

Maintain Existing Trail
Remove Existing Trail
Build New Trail
Plan New Trail
○ Trailheads

HIGHPOINT TRAIL
BELMONT TRAIL
LONGMIRE TRAIL
RED HILL TRAIL
UPPER CLEAR CREEK RD.
FORESTER'S TRAIL
RIDGECREST TRAIL
HIGHPOINT TRAIL
RACCOON RUN TRAIL
CLIFF TRAIL
GRIST MILL TRAIL
CLEAR CREEK TRAIL
RESEVOIR HILL CIRCLE TRAIL
EAST TRAIL
NORRIS FRWY.
EAGLE TRAIL
CLEAR CREEK TRAIL
LOWER WHITE PINE TRAIL
GOOSENECK TRAIL
PARK LN.
RED HILL RD.
DEER RIDGE RD.
RESERVOIR RD.
ALLEY RD.
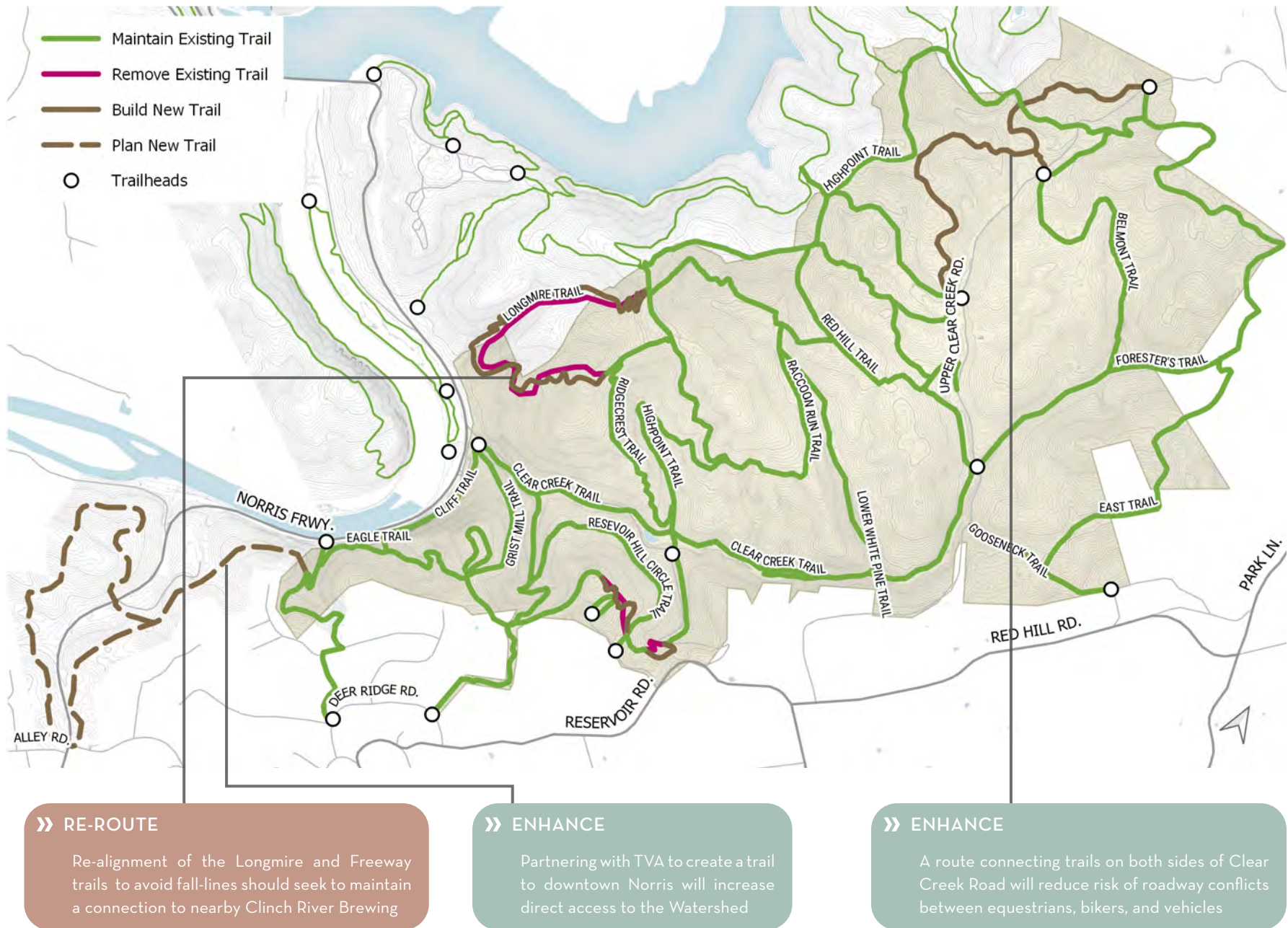
» RE-ROUTE

Re-alignment of the Longmire and Freeway trails to avoid fall-lines should seek to maintain a connection to nearby Clinch River Brewing

» ENHANCE

Partnering with TVA to create a trail to downtown Norris will increase direct access to the Watershed

» ENHANCE

A route connecting trails on both sides of Clear Creek Road will reduce risk of roadway conflicts between equestrians, bikers, and vehicles

FIGURE 14. Detailed Trail Recommendations at Norris Watershed

FIGURE 14. Detailed Trail Recommendations at Norris Watershed
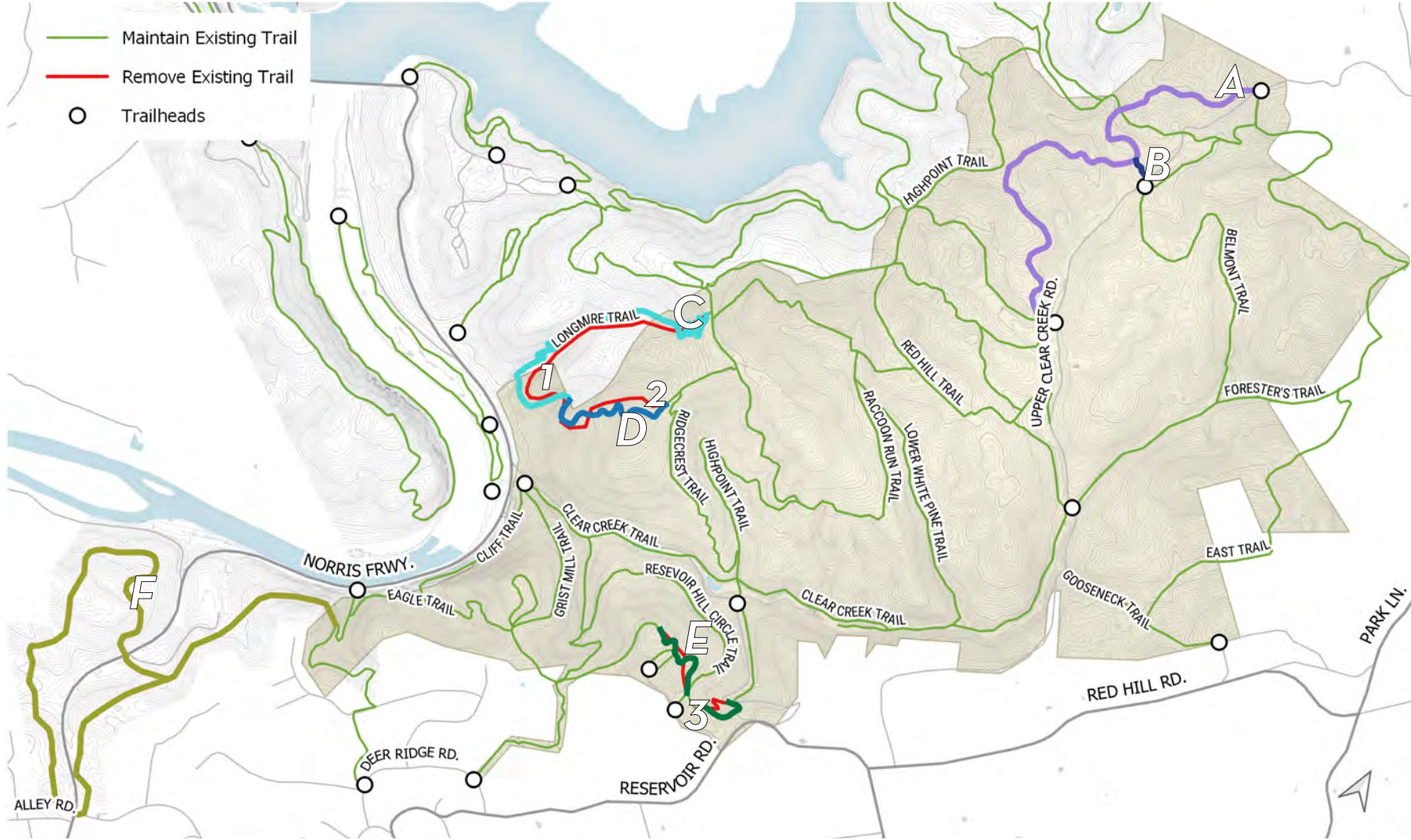
TABLE 11. Detailed Trail Recommendations at Norris Watershed

TRAIL I.D.	ACTION	TRAIL TYPE	LENGTH	COST ESTIMATE	ADDITIONAL INFORMATION
1	Remove/Re-route	Singletrack	0.64 miles	N/A	• Steep sections of Longmire Trail
2	Remove/Re-route	Singletrack	0.59 miles	N/A	• Steep sections of Freeway Trail
3	Remove/Re-route	Singletrack	0.22 miles	N/A	• Steep sections of Reservoir Hill Trail
A	Build	Singletrack	1.79 miles	$4,726-151,219	• Connects to trails on both sides of Upper Clear Creek Rd.
B	Build	Singletrack	0.09 miles	$238-7,603	• Spur trail connecting to Belmont Trail
C	Build	Singletrack	1.24 miles	$3,274-104,755	• Replaces steep sections of Longmire Trail
D	Build	Singletrack	0.47 miles	$1,241-39,706	• Replaces steep sections of Freeway Trail
E	Build	Singletrack	0.47 miles	$ 1,241-39,706	• Replaces sections of Reservoir Hill Trail
F	Build	Singletrack	2.97 miles	$7,841-250,906	• Connects Eagle Trail to Town of Norris (via TVA property)

Loyston Point

The Loyston Point trail system is in excellent condition for hiking and mountain biking. As the premier mountain biking destination in Eastern Tennessee, the success of sustainable trail design at Loyston is evident in how well the trails are holding up to this high demand. In particular, trail-related programming will provide additional marketing and economic development opportunities for the region.

Recommendations include constructing **6.23 miles** of new trail, which would increase total trail miles by **35%**.

Recommendation	Regional Goals Met	Trail Users Supported
» NEW TRAIL on the adjacent TVA-owned land will better balance demand from trail users across the park. The trail totals 5 miles and will showcase more shoreline views.	📢 🚴$	🚴 🚶🐕
» SERVE AS A LEARNING LABORATORY for the region by hosting special events for mountain biking such as trail design workshops, equipment/gear demonstrations, learn-to-ride classes, etc. • PeopleForBikes offers a short-term electric mountain bike (eMTB) loan program in addition to other resources for land managers[1]	📢 ➕ 🚴$	🚴
» IDENTIFY POTENTIAL SITES FOR WATER-BASED TRANSPORT to facilitate future development of water-taxi or similar service by a local marina or outfitter to a scenic and safe route between parks	📢 ➕ 🚴$	🚴 🚶🐕 🧰

FIGURE 15. Trail Recommendations at Loyston Point

Legend:
- Maintain Existing Trail
- Build New Trail
- Potential Water Taxi
- ○ Trailheads

Map labels: LOYSTON LOOP TRAIL, HEMLOCK BLUFF TRAIL, CLINCH TRAIL, POINT 19 TRAIL, MILL CREEK LOOP TRAIL, LOYSTON POINT RD., MCAFEE LN.
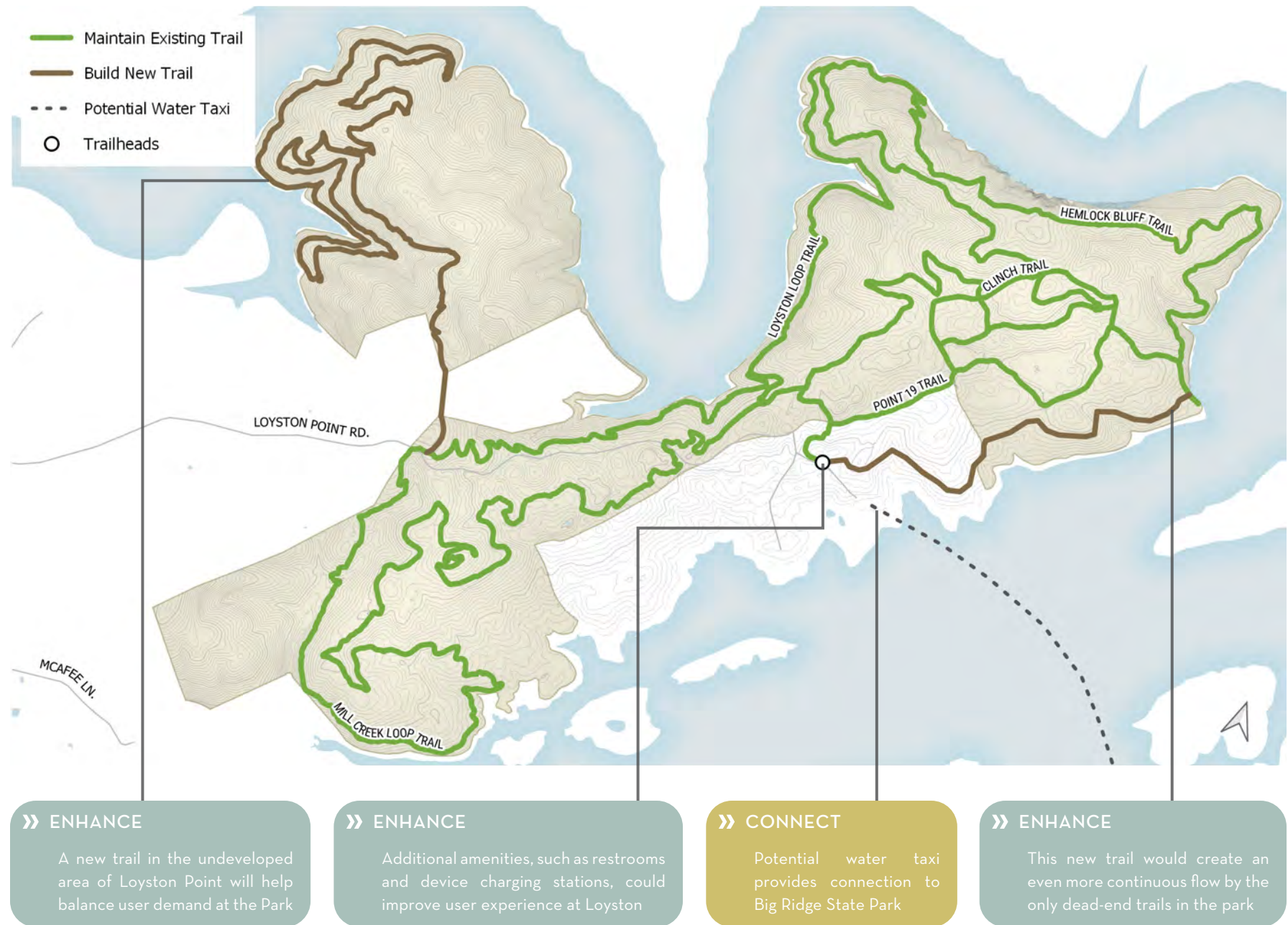
》ENHANCE
A new trail in the undeveloped area of Loyston Point will help balance user demand at the Park

》ENHANCE
Additional amenities, such as restrooms and device charging stations, could improve user experience at Loyston

》CONNECT
Potential water taxi provides connection to Big Ridge State Park

》ENHANCE
This new trail would create an even more continuous flow by the only dead-end trails in the park

FIGURE 16. Detailed Trail Recommendations at Loyston Point

Legend:
- Maintain Existing Trail
- Potential Water Taxi
- Trailheads

HEMLOCK BLUFF TRAIL

CLINCH TRAIL

LOYSTON LOOP TRAIL

POINT 19 TRAIL

LOYSTON POINT RD.

MCAFEE LN.

MILL CREEK LOOP TRAIL

A

B

C

D
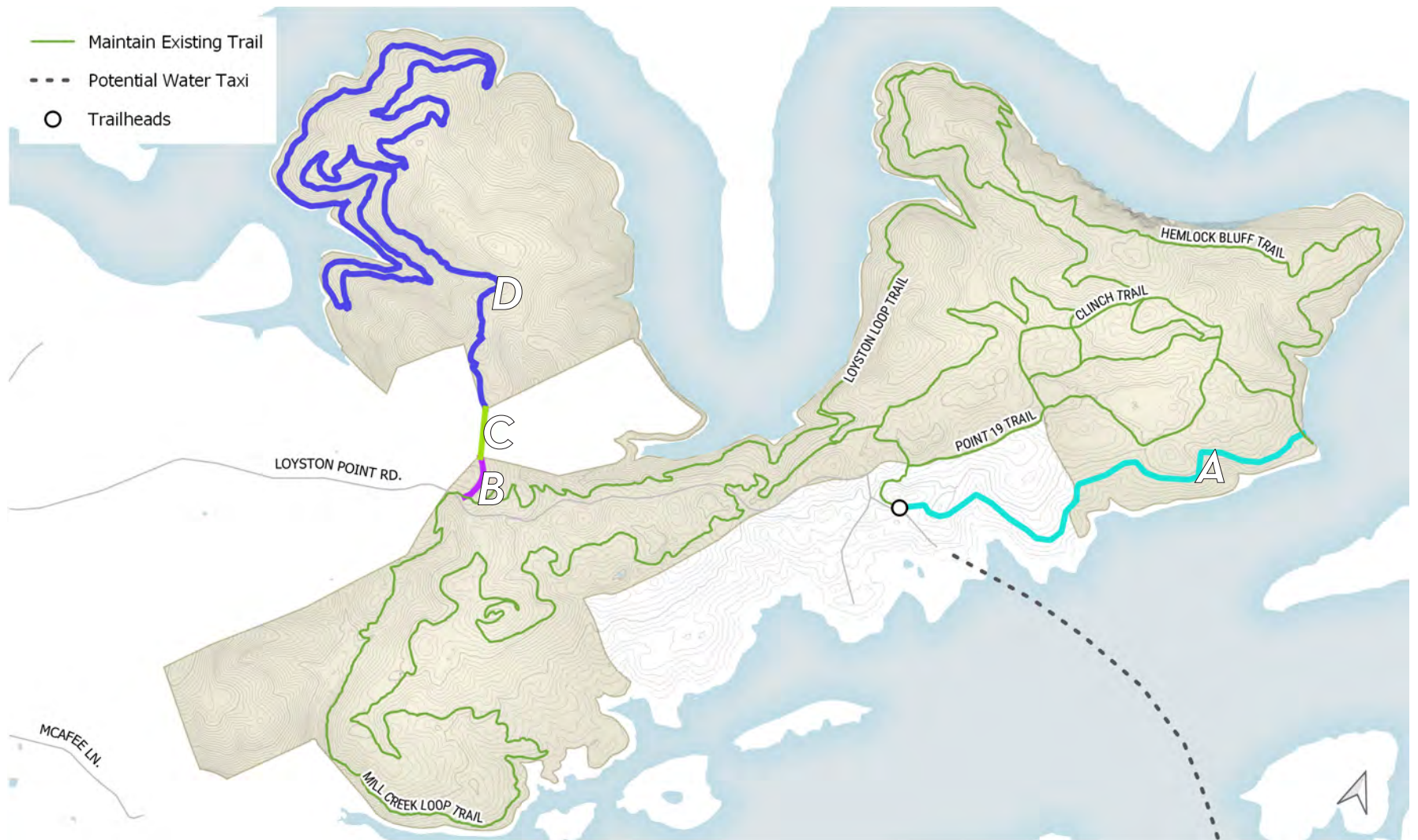
TABLE 12. Detailed Trail Recommendations at Loyston Point

TRAIL I.D.	ACTION	TRAIL TYPE	LENGTH	COST ESTIMATE	ADDITIONAL INFORMATION
A	Build	Singletrack	1.28 miles	$3,379-108,134	• Connects to Point 19 Trail to Loyston Loop Trail and trailhead
B	Build	Singletrack	0.12 miles	$317-10,138	• New connector trail
C	Build	Access Road	0.12 miles	$12,672-19,008	• Gravel road for trail access to proposed new trail
D	Build	Singletrack	4.95 miles	$13,068-418,176	• New stand-alone trail

Big Ridge State Park

With a desire to increase family friendly trails and attract new users, recommendations for Big Ridge include creation of several new trails and park features. In total, **36.28 miles** of new trail will increase the park's trail system by **287%** while highlighting the pristine shoreline of Norris Lake.

New routes that support multiple user groups (hikers, bicyclists, and mountain bikers) will quickly make Big Ridge a more prominent destination in the Norris Lake Area. Improved connectivity throughout the park will offer a greater number of unique experiences for visitors while facilitating maintenance and emergency management. Re-routing problematic sections of trail and creating a new access road/trail will also help relieve maintenance burdens.

Recommendation	Regional Goals Met			Trail Users Supported		
» **EPIC PERIMETER TRAIL** following the shoreline will capitalize on the expansive views of Big Ridge Lake. The proposed trail totals 22.4 miles and helps unify the park.	📣	➕	💲	🚵	🚶🐕	🧰
» **SHORTER LOOPS** and spurs will connect beginners to the perimeter for custom length trips without backtracking. This allows users to experience more of the park.	📣	➕	💲	🚵	🚶🐕	🚲
» **ACCESS ROAD** alongside existing trails through the center of the Park will improve emergency response and facilitate maintenance		➕				🧰
» **PUMP TRACK** situated on the large, open land area near the park entrance will provide space for beginners to gain skills and experts to hone their technique. Pump tracks also serve as entertainment amenity.	📣	➕	💲	🚵		
» **REMOTE CAMP SITES** will complement the new perimeter trail and provide stunning views for overnight trips	📣		💲	🚵	🚶🐕	🚲

FIGURE 17. Trail Recommendations at Big Ridge State Park

Legend:
- Maintain Existing Trail
- Remove Existing Trail
- Build New Trail
- (PT) Pump Track
- Potential Water Taxi
- ○ Trailheads
- ✦ Visitor Center
- ⬠ Cabins
- ▲ Campsites

HWY. 61 W.

BIG RIDGE PARK RD.

HICKORY STAR RD.

Hickory Star Marina

» RE-ROUTE
Route changes on Dark Hollow Trail and Lake Trail to avoid persistent maintenance issues

» ENHANCE
New access road alongside Valley and Dark Hollow Trails for emergency response and maintenance

» ENHANCE
New perimeter trail offers multi-day backpacking and improves trail connectivity

» CONNECT
Potential water taxi offers connection to Loyston Point and nearby Hickory Star Marina

FIGURE 18. Detailed Trail Recommendations at Big Ridge State Park

FIGURE 18. Detailed Trail Recommendations at Big Ridge State Park

TABLE 13. Detailed Trail Recommendations at Big Ridge State Park

TRAIL I.D.	ACTION	TRAIL TYPE	LENGTH	COST ESTIMATE	ADDITIONAL INFORMATION
1	Remove/Re-route	Singletrack	0.19 miles	N/A	• Lake Trail
2	Remove/Re-route	Singletrack	0.4 miles	N/A	• Steep sections of Dark Hollow Trail
A	Build	Singletrack	0.6 miles	$1,584-50,688	• Connects to campground
B	Build	Singletrack	0.19 miles	$502-16,051	• Replaces sections of Lake Trail
C	Build	Singletrack	0.04 miles	$106-3,379	• Connects Lake Trail to
D	Build	Singletrack	0.35 miles	$924-29,568	• Replaces steep sections of Dark Hollow Trail
E	Build	Singletrack	20.84 miles	$ 55,018-1.76M	• Perimeter lakeshore trail
F	Build	Singletrack	1.98 miles	$5,227-167,270	• Creates loop option off perimeter trail
G	Build	Singletrack	2.77 miles	$7,313-234,010	• Connects perimeter loop to interior trails
H	Build	Singletrack	0.39 miles	$1,030-32,947	• Connects perimeter loop to interior trails
I	Build	Singletrack	0.42 miles	$1,109-35,482	• Creates loop option off perimeter trail
J	Build	Singletrack	1.74 miles	$4,594-146,995	• Connects perimeter loop to interior trails
K	Build	Singletrack	0.35 miles	$924-29,568	• Creates loop option
L	Build	Access Road	2.94 miles	$310,464-465,696	• Provides service and emergency access to the interior and to the perimeter trail on far opposite side of the Park
M	Build	Singletrack	0.7 miles	$1,848-59,136	• Offers more direct connection from Big Ridge Embayment crossing to interior trails; creates loop options
N	Build	Singletrack	0.3 miles	$792-25,344	• Creates loop option
O	Build	Singletrack	2.01 miles	$5,306-169,805	• Connects to Hickory Star Marina
P	Build	Singletrack	3.6 miles	$9,504-304,128	• Provides new trail for nearby campground

POTENTIAL FUNDING

A variety of potential funding sources are available to help make the recommendations provided in this study a reality. The following sources include public (federal, state, and regional) and private funding opportunities.

LOCAL PARKS AND RECREATION FUND

Overview: The Local Parks and Recreation Fund (LPRF) program provides state funding for the purchase of land for parks, natural areas, greenways and the purchase of land for recreational facilities. Funds also may be used for trail development and capital projects in parks, natural areas and greenways. The Tennessee Department of Environment & Conservation's Recreation Educational Services arm administers the LPRF grants. These grants are a 50% match. For the 2018 LPRF Grant Application Cycle, the grant application minimum request was $25,000 ($50,000 total project) and the grant application maximum request $500,000 ($1,000,000 total project). Applications are accepted every other year.

Relevance: This grant could be used to support land acquisition for bikeways, greenways, or other trail facilities connecting parks and town centers. Alternatively, these funds could be leveraged to build trails or other capital projects (e.g., signage, visitor center, amenities) in the parks.

More Info: https://www.tn.gov/environment/about-tdec/grants/grants-recreation-grants/grants-local-parks-and-recreation-fund-lprf-grants.html

BLUECROSS BLUESHIELD OF TENNESSEE FOUNDATION

Overview: The BlueCross BlueShield of Tennessee Foundation is a private, charitable foundation with a focus on creating active, healthy spaces across Tennessee that connect people and foster a sense of community. Recently, they started funding BlueCross BlueShield of Tennessee Healthy Places, active outdoor spaces for communities to share and play together.

Relevance: The BlueCross Healthy Place Program works with government entities and non-profit organizations to create and revitalize public spaces. Healthy places funded through this program must be free and open to the public and agree to exclusive BlueCross Healthy Place branding, naming, and signage rights. Up to $7.5 million dollars in awards are granted each year. Grants applications are accepted annually in August. Park facility improvements, a new visitor center, bike-friendly amenities in town centers (e.g., bike parking), or segments of the bikeway network connecting town centers and parks would likely be eligible for BlueCross Healthy Place funding and designation.

More Info: https://www.bcbst.com/about/in-the-community/healthy-places/

MULTIMODAL ACCESS GRANT

Overview: TDOT's Multimodal Access Grant is a state-funded program created to support the transportation needs of pedestrians, bicyclists, and transit users through infrastructure projects that address existing gaps along state routes. Multimodal Access Grant projects are state-funded at 95 percent with a 5 percent local match. State match amount will not exceed $950,000.

Relevance: This funding could be leveraged for bikeway projects that increase connectivity between town centers. This grant funding is required to be located along a state route, so only projects that upgrade or fill gaps in existing bicycle and/or pedestrian facilities along state routes should apply. When applying, emphasis should be placed on the transportation component of the bikeways and how they increase connectivity between town centers, increasing access to community resources and providing alternative transportation modes.

More Info: https://www.tn.gov/tdot/multimodal-transportation-resources/multimodal-access-grant.html

THE APPALACHIAN REGIONAL COMMISSION

Overview: The Appalachian Regional Commission (ARC) is a regional economic development agency that provides technical and financial assistance to 420 counties throughout Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia. ARC funds a variety of development projects that pertain to one or more of the following goals: economic development, workforce development, critical infrastructure, leveraging natural and cultural heritage, and strengthening leadership and community capacity.

Relevance: The ARC has a history of funding projects related to transportation, trail development, tourism studies, master plans, and revitalization efforts. In fiscal year (FY) 2019, ARC funded 11 bike/hike trail planning and design with an average of approximately $224,000 per project. Campbell County and Union Counties are eligible for a 70% match as the ARC considers both counties to be "At-Risk" of being economically distressed, while Anderson County is eligible for the standard 50% match. ARC also regularly works with the TVA. A bikeway network connecting parks and town centers within the Norris Lake Area would likely align closely with the ARC's asset-based economic development grants as the bikeway network would leverage cultural, natural, and structural assets unique to Appalachia.

More Info: https://www.arc.gov/index.asp

IMBA TRAIL ACCELERATORS GRANTS

Overview: The International Mountain Biking Association (IMBA) administers grants to provide communities a jump-start to building trails. A Trail Accelerator grant offers awardees professional trail planning and consultation services to launch their trail development efforts, which can often leverage additional investment from local, regional, and national partners. Grants typically range from $5,000-$30,000 and they require a one-to-one match. Applicants can be local, municipal, state, or federal government agencies and 501(c)3 nonprofits that actively manage parks and trails.

Relevance: Parks within the Norris Lake Area that aspire to build expand mountain biking or multiuse trails should consider this funding source. Projects that leverage the community's cultural assets and historical heritage, increase community access to mountain biking, and promote community development, volunteer recruitment, new rider development, youth riding, and engaging marginalized community members are particularly well-suited for this grant program.

More Info: https://www.imba.com/trails-for-all/trail-accelerator-grants

THE CONSERVATION ALLIANCE GRANTS

Overview: The Conservation Alliance seeks to protect threatened wild places throughout North America for their habitat and recreational values. Grants of up to $50,000 are awarded to registered 501(c)(3) organizations whose project meets the following criteria: 1) secures lasting and quantifiable protection of a specific wild land or waterway; 2) engages citizens through grassroots action in support of conservation effort; 3) has a clear recreational benefit; and 4) has a good chance of success within four years.

Relevance: Nonprofit partners of parks and municipalities are eligible for grant funding. Prior to applying, the nonprofit must first be nominated by a Conservation Alliance member company. Strategic partnership and communication will be key in working with nonprofit partners and Conservation Alliance member companies to pursue this funding source.

More Info: https://www.conservationalliance.com/grants/

PEOPLEFORBIKES COMMUNITY GRANT PROGRAM

Overview: This program provides funding for projects that build momentum for bicycling in communities across the U.S. These projects include bike paths and rail trails, mountain bike trails, bike parks, BMX facilities, and large-scale bicycle advocacy initiatives. Grants of up to $10,000 are awarded to non-profit organizations and local governments and have totaled more than $3.5 million since 1999. This program is funded by PeopleForBike's partners in the bicycle industry, including the following companies: Batch, Cannondale, Giant, Niner, Shimano, Trek, and Vaast.

Relevance: Bicycle facility projects, whether for mountain or road bicyclists, in the Norris Lake Area would be most appropriate for this funding source. Grants from this program could be combined with other funding sources.

More Info: https://peopleforbikes.org/our-work/community-grants/

RECREATIONAL TRAILS PROGRAM

Overview: The Recreational Trails Program (RTP) is a federal funded, state administered grant program. RTP provides grant funding for land acquisition for trails, trails maintenance and restoration/rehabilitation, trail construction, and trail head support facilities. All grant projects must be on publicly owned land. Awards are made to local, state, and federal governments to develop trails and trail facilities. The Tennessee Department of Environment and Conservation accepts applications every year. The grant covers 80% of the project cost and requires a 20% match.

Relevance: New trail development and maintenance of existing trails within parks are well-suited for this funding source. Trail amenities, signage, and wayfinding, and trailhead facilities are other projects that could pursue RTP grants. Any future greenway trails planned as connections between town centers and the parks are also candidates for this funding program.

More Info: https://www.tn.gov/environment/about-tdec/grants/grants-recreation-grants/grants-recreation-educational-trail-program.html

BETTER UTILIZING INVESTMENTS TO LEVERAGE DEVELOPMENT TRANSPORTATION GRANTS

Overview: Better Utilizing Investments to Leverage Development (BUILD) Transportation grants are nationally competitive grants for capital investments on surface transportation projects that achieve a significant impact for a local or metropolitan area. A total of $1 billion has been allocated to BUILD Grants in 2020, which the U.S. Department of Transportation (USDOT) aims to benefit a greater number of projects located in rural areas.

Relevance: States are eligible to receive up to $100 million in BUILD Grants. The BUILD program enables USDOT to use a rigorous merit-based process to select projects with exceptional benefits, explore ways to deliver projects faster and save on construction costs, and make needed investments in national infrastructure. This is a highly competitive program. In 2019, USDOT received nearly 670 applications, with over ten times the available funding being requested; only 55 applicants received awards. Bicycle infrastructure projects that contribute to a network connecting town centers and parks would align with BUILD grant goals.

More Info: https://www.transportation.gov/BUILDgrants

COMMUNITY FACILITIES
GRANT PROGRAM

Overview: The Community Facilities grant is a program made available through USDA Rural Development that funds the purchasing, construction, and/or improvement of essential community facilities (e.g., health care facilities, public facilities, community support services, public safety services, educational services, utility services, local food systems) in rural areas. Funding is available as grants, low interest direct loans, or a combination of the two. Eligible areas include cities and towns with 20,000 residents or fewer according to the latest U.S. Census Data. The match portion is dependent on census tracts and the eligible amounts are at the discretion of the Rural Development Office.

Relevance: This funding source could support infrastructure investments in bicycle connections and place-making that provide obvious community benefit while also boosting recreational tourism for rural communities in the Norris Lake Area. Street improvements are provided as an example of essential community facilities. Bikeway facilities increase safety and provide alternative transportation options, providing a necessary service for residents while making the area more attractive to visitors.

More Info: https://www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program/tn

TRANSPORTATION
ALTERNATIVES PROGRAM

Overview: The Fixing America's Surface Transportation (FAST) Act replaced the Transportation Alternatives Program (TAP) with a set-aside of Surface Transportation Block Grant Program funding for transportation alternatives. These set-aside funds include all projects and activities that were previously eligible under TAP, encompassing a variety of smaller-scale transportation projects such as pedestrian and bicycle facilities, recreational trails, Safe Routes to School projects, community improvements such as historic preservation and vegetation management, and environmental mitigation related to stormwater and habitat connectivity. For projects funded under this program, the federal share is 80% and a 20% match is required from the eligible project sponsor.

Relevance: More than $317 million in grants from this program have been distributed through TDOT. The money has gone to 267 communities across the Volunteer State to build sidewalks, bike and pedestrian trails and to renovate historic train depots and other transportation-related structures. For the Norris Lake Area, this funding source could assist in developing a bikeway network that connects town centers with parks and their trail systems.

More Info: https://www.tn.gov/tdot/program-development-and-administration-home/local-programs/tap.html

CONGESTION MITIGATION AND AIR QUALITY IMPROVEMENT PROGRAM

Overview: The federal Congestion Mitigation and Air Quality Improvement (CMAQ) program provides dedicated federal funding to state Departments of Transportation for projects that improve air quality and reduce congestion. The CMAQ program improves air quality by funding transportation projects and programs that reduce air emissions from cars, trucks and buses (mobile sources) in air quality non-attainment and maintenance areas, which are the only areas eligible for CMAQ funding.

Relevance: Bicycle and pedestrian facilities and programs are eligible for CMAQ funding. Bikeway projects providing alternative transportation options and increasing connectivity between town centers and parks would be candidates for this funding source. In the Norris Lake Area, only Anderson County is designated as an air-quality non-attainment or maintenance area; therefore, only projects located in Anderson County are eligible.

More Info: https://www.tn.gov/tdot/long-range-planning-home/air-quality-planning/cmaq-funding.html

POLICY & PROGRAMMING

Beyond the trails: what do active transportation enthusiasts expect?

Visitors and residents who enjoy the abundance of natural assets in the Norris Lake Area are seeking experiences that will provide lasting memories and an escape from the busy pace of everyday life. These experiences should engage people in a personal way and provide an overall positive user experience. Active recreational enthusiasts want experiences that:

- Connect them with nature,
- Provide an escape from society,
- Are fun and challenging,
- Support outdoor exercise,
- Include a variety of opportunities,
- Connect to other trails and routes that create a range of possibilities,
- Provide a sense of belonging, and/or
- Integrate convenient facilities that make the user's experience complete.

A high-quality recreation destination designed to encourage tourism, while also catering to local residents, should be supported by infrastructure, policies, and programming that makes it easy to enjoy the various trail systems. The following pages provide a variety of policy and programming options for the Norris Lake Area.

IMAGE 6. Food from Clinch River Brewing[2]

Policy Recommendations

DEVELOP DECISION-MAKING TOOLS

- **Collect regular data on trail users.** Understanding where people are coming from, why they are visiting (e.g., mountain biking, hiking, fishing, boating), and how their overall experience will help in evaluating the infrastructure, programming, and policy recommendations in this guide. Consistent evaluation and data collection for the trail systems within each network will support future planning efforts.
- **Use geographic information system (GIS) or global positioning system (GPS)** to inventory and monitor trails, as well as develop maps for assessment and marketing purposes. Ensure that field staff and volunteers are trained in the proper use of these technologies.
- **Prioritize operations and maintenance.** Developing plans that estimate the cost of managing and maintaining trail systems can assist in future planning, design, and construction efforts. In addition, strategies to mitigate user conflicts and sustainability concerns should be outlined. Action plans developed should identify funding approaches and strategies for short- and long-term investments in the trail systems, bikeway connections to the park, and other projects.
- **Set goals and monitor progress.**

PLAN FOR REGIONAL AND LOCAL TRAIL CONNECTIVITY

- **Continue strengthening regional partnerships** to collaborate on inter-jurisdictional trails and bikeways. These opportunities can be explored in-depth during trail and bikeway planning and design processes but should be ongoing.

ENCOURAGE PRIVATE INVOLVEMENT IN TRAIL EFFORTS AND COMMUNITY STEWARDSHIP OF TRAILS

- **Review state park policies** to determine how tour operators, outfitters, bicycle shop owners, and private or nonprofit organizations can be involved in supporting trail development, maintenance, and programming. Consider establishing partnerships with local governments, non-profits, and community groups, including but not limited to: Clinch Valley Trail Alliance, Friends of Norris Dam State Park, Adventure Anderson County, Norris Lake Project Team, Appalachian Mountain Bike Club, Knoxville Track Club, and Campbell County Chapter of Friends of Norris Lake Watershed.
- **Establish roles and responsibilities** for partners.
- Consider adopting policies that **encourage owners of property adjacent to parks to become a partner** in trail development and maintenance. Landowners who provide easements to trail-developing organizations could be given liability protection in the case that trail users are injured on their land. This ensures protection for individuals or organizations that are willing to provide multimodal connections and close gaps in systems.

PRIORITIZE MULTIMODAL CONNECTIVITY BETWEEN THE RECREATION DESTINATIONS

- Providing safe and convenient ways for people to get from where they live or are staying to their recreation destinations is a vital aspect of the overall aspect of the resident and visitor experience in the Norris Lake Area. Whether biking, hiking, or driving, people should be able to get where they need and want to go throughout the area seamlessly. **Future planning efforts,** including the parks' operations, maintenance, and business plans, **should include connectivity between the park systems.**

PRIORITIZE COHESIVE SIGNAGE AND WAYFINDING THROUGHOUT THE REGION

- Whether for first-time visitors or regular users, **proper signage can contribute to a quality user experience**, increase safety (particularly when connecting between parks), and establish expectations by making trail etiquette clear. Trail signage on trails, at trail intersections, at trailheads, and street navigation between state parks systems and local municipalities can contribute to a seamless experience for trail users in reaching and using the parks.
- **Incorporate branding** into wayfinding elements, particularly those connecting the park systems to one another.
- **Provide a visitor information center** to serve as a gateway to the area's recreational and heritage trails and learning about the region's culture and history. This should be located in area where visitors can secure gear and supplies, enjoy a meal, have repairs made, or arrange overnight accommodations. Materials and amenities may include brochures, maps, guidebooks, electronic kiosks with videos and maps, souvenirs, snacks, rental bicycles, visitor surveys, and public restrooms. Staff (paid or volunteer) can provide planning assistance.

USE THE REGION'S APPALACHIAN ROOTS TO ENHANCE THE AREA'S SENSE OF PLACE

- **Connect park and trail users to local sites** that reflect the character of the region.
- **Ensure tourism stakeholders are involved** with other regional leaders in transportation and recreational planning initiatives.

FOSTER A BICYCLE-FRIENDLY ENVIRONMENT

- **Make bicycle parking easily available and accessible** in communities near the park systems.
- **Encourage restaurants to adopt bicycle-friendly practices**, such as posting menus outside the building so that bicyclists or hikers can easily see them from the sidewalk or making sealable take-out containers available for easier takeout orders not being transported in a vehicle.
- **Work with local businesses to make sure that some basic biking and hiking gear is available for sale near the parks.** This should include mechanical items such as spare tubes, tools, protective gear, some basic bike parts and tools, rain gear, packs, and other wearables. In addition, having a small fleet of entry-level mountain bikes available for rent would meet the needs of casual mountain bikers and other visitors packing light.
- Work with local outfitters and businesses to **consider providing paid shuttle services for trail users.**
- **Have stations where people can wash off their bikes** after a day of muddy riding.

BUILD THE FRAMEWORK FOR A ROBUST ECOTOURISM INDUSTRY

- Continue to **explore alternative creative funding solutions** to achieve community solutions and work with local governments, where appropriate, to secure dedicated funding that could be reinvested for tourism marketing and development purposes. Garnering widespread support from tourism stakeholders and an advocacy effort of the industry will be important in influencing government leaders. For tourism development, the **formation of a tourism development fund** at local level could be explored.
- **Explore the development of tourism business assistance programs,** such as incubators, through local governments, small business administrations, and economic development departments, as appropriate, to seek support and assistance for tourism businesses.
- **Encourage the establishment of tourism-based businesses.** A bike shop, in particular, could serve as a hub for the local bicycling scene, visitors, and bike tourism, as they are staffed by riders that know the trails and can provide visitors with the information they need. They also offer visiting bikers the option of professional repairs and servicing while they are on vacation. They can provide a social connection for riders by organizing group rides, and training sessions. Many are also involved in sponsoring local mountain biking events.
- **Apply to the Appalachian Gateway Communities Initiative (AGCI)** to assess the area's tourism strengths and develop an action plan to boost tourism to the Norris Lake Area.
- Build and market the **Clinch Valley as a bicycle destination**. Beyond the parks detailed in this study, the Clinch Valley also includes Anderson County Park, Aspire Park, Haw Ridge, Windrock, and the Black Oak Ridge Conservation Easement on the Department of Energy Reservation. Together, these parks can establish the larger region as a bicycle destination and draw tourism from across the state and throughout the region.

OVERVIEW OF IMBA RIDE CENTER DESIGNATIONS

IMBA Ride Centers are extensive trail networks that provide mountain biking experiences for a range of users and abilities in vibrant communities of all sizes with strong bicycle-friendly culture. The following is an overview of the criteria and a brief review of how the Norris Lake Area may be evaluated. Information in this section is a not a comprehensive evaluation based upon all of the IMBA criteria or including all of the existing conditions with the Norris Lake Area. Implementing trail, policy, and program recommendations in this study will further align the Norris Lake Area with the Ride Center designation criteria established by IMBA.

Relevance to the Norris Lake Area

The IMBA Ride Center designation includes a variety of key characteristics that are an excellent guide for developing facilities and services that attract and support mountain bikers. The Norris Lake Area already has many attributes required for Ride Center Designation; however there are key components the region must address. This presents and opportunity to collaborate across agencies and jurisdictions within the Norris Lake Area. Many of the recommendations for trails, policies, and programs in this study align with the IMBA Ride Center designation criteria summarized below.

Criteria

The following are the key criteria by which applications for IMBA Ride Center designation are evaluated:

- Singletrack Mountain Bike Trail Within 30 Minutes Travel Time
- Trail Variety
- Support Services
- Community Involvement
- Data Capture and Evaluation

How the Norris Lake Area Stacks Up

SINGLETRACK MOUNTAIN BIKE TRAIL WITHIN 30 MINUTES

The 30 minute travel time as defined by Google Maps would not include many of the Norris Dam area trails that are gravel roads or double track. Downtown Clinton was used as the point of origin purely for geographic reasons. Mileage is approximate.

LOCATION	TRAVEL TIME FROM CLINTON	EXISTING TRAIL MILES
Loyston Point	24 minutes	13 miles
Big Ridge State Park	25 minutes	0 miles
Norris Dam State Park	18 minutes	15 miles
Aspire Park	2 minutes	18 miles
Haw Ridge	14 minutes	25 miles
Windrock Bike Park	28 minutes	15 miles
Sharps Ridge	28 minutes	7 miles

TRAIL VARIETY

The Norris Lake Area has a great variety of trails. From Windrock's double black downhill runs to Loyston's novice friendly trails there is something for everyone. There is a need for additional entry level trails outside of Loyston Point to offer greater access for beginners.

SUPPORT SERVICES

1) Bike shop with quality rentals

- Currently there are no bike shops in the area other than Oak Ridge Bike Center. There are no bike rentals except for downhill rentals at Windrock.

2) Mountain Bike Guide Services including shuttle service

- Unavailable

3) Lodging

- Bike-friendly Hotels/Motels with wash stations, bike lockers or allow bikes in rooms:
    - Exit 122 has many options. Cove Lake and Emory Road have many options. Norris and Big Ridge have cabins.
- Camping with RV hookups:
    - Norris Dam State Park, Big Ridge State Park, Loyston Point, Cove Lake State Park, Windrock and KOA at Raccoon Valley
- Primitive Camping:
    - Many options around Norris Lake

4) Food: There is a variety of food retail outlets including breweries with craft beer, such as the Clinch River Brewery and The Pearl at Aspire Park.

- Sweet Cafe, Archer's Food Center, VEGA Cafe & Smokehaus

5) Airport

- McGee Tyson

6) Medical/EMS Services

7) Quality Signage

8) Trailhead Amenities

- Parking, bathrooms, potable water, quality signage

9) Trailhead Access by Bicycle

- Available for Norris Dam State Park and Loyston Point

10) Shuttle/uplift services

- Available only at Windrock

11) Three+ Days of Riding

- A week's worth is readily available

12) Long Distance Adventures

11) Backcountry Experience

COMMUNITY INVOLVEMENT

1) Mountain Bike Clubs

- CVTA, AMBC, Friends of Norris Dam, Friends of Big Ridge, etc

2) Group Rides (regularly scheduled group rides)

3) Mountain Bike Related events (festivals , rides, races, etc)

4) Community Support

5) Land Manager Support

DATA CAPTURE AND EVALUATION

1) Trail Counters

2) User Surveys

3) Annual Reports

Programming Recommendations

LEVERAGE LOCAL AND REGIONAL APPALACHIAN CULTURE IN PROGRAMMING

- **Develop historical trail routes, themes, and resources.** Identify historical and cultural routes located within the Norris Lake Area and locate facilities that provide for a trail experience along these routes. Identifying and listing these routes will provide for additional funding opportunities by external stakeholders, and opportunities for the area to increase tourism.

- **Create experiential recreation activities that link natural and cultural history.** Visitors of varied backgrounds and interests are increasingly seeking "experiential tourism" which allows them to touch, smell, taste and feel the uniqueness of a place. This might include a "living history hike" for families that recreates early TVA settlement life. Historical buildings, such as the Rice Grist Mill and the Museum of Appalachia, can be great backgrounds for demonstrations of traditional local activities.

- **Offer more local products (e.g., food, arts and crafts) in park gift shops and visitor centers.** Build on the experiential aspect of visiting the Norris Lake Area by offering locally grown and crafted products that reflect the authentic natural, cultural and agricultural heritage of the area.

- **Showcase the region's history and heritage through events and festivals,** including signature music festivals, as well as personifying the culture of the region through visual and craft arts and culinary experiences. Use events to extend visitor seasons and further leverage the fall visitor season with events featuring fall foliage and Appalachian music and arts. Encourage athletic races/competitions (in applicable areas), which fit well with the terrain, character and tourism offerings.

- **Develop culinary trails,** including breweries, wineries, distilleries, and agritourism, which tie in other visitor themes, including music and arts.

EXPLORE BOAT-BASED CONNECTIVITY OPTIONS

- To supplement on-road multimodal connectivity between park systems, **consider establishing a boat shuttle service** between the parks, and between the western and eastern sides of Norris Dam State Park or Loyston Point and Big Ridge State Park. This could be developed in partnership with the local outfitters and marinas.

LEVERAGE VOLUNTEER GROUPS AND COMMUNITY SUPPORT

- **Consider implementing an Adopt-A-Trail Program** to support the park systems in the maintenance, management, and ongoing operations of the existing trail system. Funds collected from this program shall be exclusively available to the park systems for programming, maintenance, management, and other activities directly related to the trail system.

CATER TO A VARIETY OF TOURISTS

- **Create and package experiences** for visitors who see trip planning as a barrier and value local support and assistance in tailoring their experience. Consider a variety of package types to attract tourists with differing interests (e.g., mountain biking, hiking, family-oriented, culture-focused, etc.). Communities may choose to establish packages locally or through working with external travel specialists that provide outdoor experiences. Local businesses can be a partner in packaging opportunities by including accommodation-based packages or providing services as a part of a package (e.g., bike rental or shuttle service). Marketing local business could generate revenue to pay for staffing or other updates.
- **Provide guided services** that use local mountain bikers or hikers and local knowledge to enhance the visitor experience. Customized tours, from hourly to full-day guided tours can give visitors the opportunity to experience the best a community has to offer in a short space of time. The Norris Lake Area is also home to incredible biodiversity boasting lush spring ephemerals, pawpaw groves that ripen in late summer, and species unique to the hollers of the area. In particular, birding is increasingly popular recreation activity for people of all ages. Local guides with intimate knowledge of the area's ecology are best for helping visitors experience the area's seasonal highlights and can help ensure environmentally sensitive areas are respected.

STRENGTHEN RESIDENT AWARENESS OF ATTRACTIONS IN THE AREA

- **Hold special days for locals** (e.g., "community day" or "hometown day") to encourage invite residents to come to local attractions. For attractions with fees, consider waiving or reducing the fee for the day. These events can support local businesses that take part, strengthen residents' pride for their community, and makes them better spokespeople for the area's attractions.

BOOST EDUCATIONAL PROGRAMMING

- **Develop consistent ethics messaging for trail users** to foster responsible trail stewardship among visitors and residents and incorporate this messaging into trail-related communications. Develop messaging that appeals specifically to youth and those new to using trails. Consider adopting the Leave No Trace Outdoor Ethics, the Tread Lightly! Inc., Guide to Responsible Mountain Biking programs, and/or the International Mountain Bicycling Association's Rules of the Trail.
- **Develop interpretation and information along trail routes,** emphasizing the relationship between resource protection and responsible trail stewardship.
- **Pursue relationships with trail interest groups,** such as mountain bike manufacturers, retailers, service providers, outfitters, and communities of bicyclists and hikers who either belong to formal organizations, or are casual users, to enhance education and information opportunities.
- **Plan rides or hikes** with park staff, volunteers, and members of the outdoor recreation community to learn more about the resources available and/or discuss issues along the trail. These could be completely educational, or the park could also use these opportunities to gain feedback from trail users. Volunteer trail work rides and hikes can also be planned to encourage active participation in trail management efforts.

- **Conduct a market assessment and routine user surveys.**
  - **Assess the existing market**. Information about current visitors is crucial to understanding effectiveness of existing marketing efforts and capturing similar visitors in the same geographic areas. This information may help develop a base of annual or repeat visitors, who are often the type of tourists that are also interested in the community's wellbeing.
  - **Consider what type of trail users the area will attract**. This will depend on a number of factors, including but not limited to:
    - The types of trails in your community and how they are promoted them to visitors.
    - How your community is positioned with other nearby communities (e.g. working together to promote a regional product/experience).
    - The range of bike-friendly accommodation options.
    - Access to the community from major centers.
    - Access from within the community to the trails.
    - Supporting infrastructure and amenities for bikers.
    - Availability of mountain bike services such as guides and bike camps.
    - Other things to do that complement the bike experience: activities and attractions, culture and arts.
- **Work towards national trail recognition.** Whether through IMBA Ride Center designation or nominating trails to mountain biking or hiking publications that run "outstanding trails" competitions, building the area's stature and profile in the marketplace brings not only creditability to a community, but also serves as a valuable marketing tactic.
- **Partner with targeted media sources** to advertise the Norris Lake Area to outdoor enthusiasts. Outdoor and recreational media options include:
  - **Websites** can be a cost-effective and quick method to reach a broad network of potential visitors. Another option is partnering with organizations to write reviews about or include the area in an article.
  - **Social networking sites, blogs, and forums** offer an excellent opportunity to connect with other mountain bikers, hikers, and outdoor enthusiasts and receive feedback about their experiences first-hand. Partnerships with influencers to write articles about or review the area's trails is an option, as well as more traditional advertising.
  - **Traditional print advertising and articles in outdoor publications** can be more expensive but can reach an audience untapped through online efforts.
  - A list of potential media partners is provided on the following page
- **Create a brand for the region** and consistently use the brand when developing promotional materials. Develop "Why Norris Lake?" promotional documents targeted to specific user groups that highlight the opportunities and amenities the area has to offer—existing trails and opportunities for various skill levels, great dining venues, and places to stay—all conveniently located near other major trail systems and outdoor attractions. This package should include printed flyers and brochures that can be made available at outfitters, bike shops, races, and other recreational events around the region—particularly those within close proximity to the Norris Lake Area. The region (inside and outside of Eastern Tennessee) already has a flourishing selection of bike shops and outfitters shown in Table 14. Reaching out to these locations will spur interest in individuals and groups already rooted in the industry and with heightened motivation to explore new trails.
- **Establish a strong online presence.** Centralize information and tourism resources on a single website that contains information about all of the trails, and other recreational opportunities, in the area, as well as links to each park system's website. The website should be comprehensive and all necessary trip-planning details to potential visitors and includes a web-based system for responding to inquiries in a timely manner. A point-person should be dedicated to maintaining webpages, posting regularly, and answering any questions received through these platforms. Brainstorm creative partnerships and/or applying for grants to create a brief and exciting promotional video focused on outdoor recreation opportunities in the Norris Lake Area.

Potential Media Partners

- The Outdoor Project (digital and social media)
- Blue Ridge Outdoors (print, digital, and social media)
- Appalachian Magazine (print, digital, and social media)
- Global Mountain Bike Network (YouTube)
- FreeHub Magazine (print, digital, and social media)
- Tennessee Wildlife Resources Agency's TN Outdoor Journal series (TV, YouTube, and social media)
- Matador Network (digital and social media)
- Adventure Outdoors Magazine (digital and social media)
- Tennessee Vacation (digital and social media)
- Roots Rated (digital and social media)
- PinkBike (digital and social media)

Sources

1. https://peopleforbikes.org/our-work/e-bikes/for-land-managers/

2. https://www.visitknoxville.com/listings/clinch-river-brewing/1817/

TABLE 14. Regional Outfitters and Bike Shops

LOCATION	OUTFITTER/BIKE SHOP
Knoxville, TN	• Biketopia • Outdoor Knoxville Adventure Center • Greenlee's Bicycle Shoppe • Tennessee Valley Bicycles • Runners Market • Bearden Bike & Trail • Bike Zoo • Harper's Bike Shop • West Bikes • River Sports Outfitters • Fountain City Pedaler • Echelon Bikes • Cedar Bluff Cycles
Oak Ridge, TN	• Oak Ridge Bicycle Center
Maryville, TN	• Cycleology Bikes • River John Outfitters • Little River Trading Company
Asheville, NC	• Motion Makers Bicycle Shop • Black Dome Mountain Sports • Frugal Backpacker
Townsend, TN	• Little River Outfitters
Hot Springs, NC	• Bluff Mountain Outfitters
Black Mountain, NC	• Take A Hike Outfitters
Johnson City, TN	• The Bike Shop
Crossville, TN	• Hurricane Cycles
Sparta, TN	• The Town Hall Bicycle Shop
Seiverville, TN	• Off The Chain Cycles • GSM Outfitters LLC
Kingsport, TN	• Larry's Cycle Shop • Reedy Creek Bicycles
Gatlinburg, TN	• Day Hiker
Erwin, TN	• Erwin Outdoor Supply
Bryson City, NC	• Bryson City Outdoors
Pigeon Forge, TN	• Hikey Mikey

COUNTY ACTION PLANS

Collectively, the regional and County-specific action plans detailed over the following pages will build the Norris Lake Area as a regional outdoor recreation destination by leveraging the area's rich character and heritage.

Strategies are provided for the region as a whole and for Anderson, Campbell, and Union counties specifically. Lastly, decision-making criteria for catalyst and ongoing funding priorities is outlined.

REGIONAL ACTION PLAN

STRATEGIC ACTION ITEMS

Establish a steering committee comprised of key regional partners to carry this study's recommendations into reality is central to success. This committee should formalize the roles and responsibilities of each partnering organization, as well as monitor regional progress toward plan recommendations and celebrate achievements.

The steering committee should work together to accomplish the following regional actions:

- **Conduct a market assessment and routine surveys** of park users and regional tourists. Use this information to prioritize regional and community-specific investments. Data from these analyses can also be used to strengthen future grant applications.

- **Establish cohesive branding** for the Norris Lake Area Trail System and **create a plan for disseminating branding to outdoor recreational partners** in the region who create promotional materials for their services (e.g., marinas, private campgrounds, tour guides, hotels).

- **Develop "Why Norris Lake?" promotional documents** targeted to specific user groups that highlight the opportunities and amenities the area has to offer—existing trails and opportunities for various skill levels, lake adventures, great dining venues, and places to stay—all conveniently located near other major trail systems and outdoor attractions. This package should include printed flyers and brochures that can be made available at outfitters, bike shops, races, and other recreational events around the region—particularly those within close proximity to the Norris Lake Area. The region (inside and outside of Eastern Tennessee) already has a flourishing selection of bike shops and outfitters. Reaching out to these retailers will spur interest in individuals and groups already rooted in the industry and with heightened motivation to explore new trails.

- **Establish a strong online presence by centralizing information and tourism resources on a single website** that contains information about all of the trails, and other recreational opportunities, in the area, as well as links to each park system's website. **A point-person should be dedicated** to maintaining webpages, highlighting events in the area, posting regularly, and answering any questions received through these platforms.

- **Partner with media sources** to advertise the Norris Lake Area to outdoor enthusiasts.

- Brainstorm creative partnerships and/or apply for grants to **create a brief and exciting promotional video** focused on outdoor recreation opportunities in the Norris Lake Area.

- **Incorporate branding into uniform wayfinding design and standards** to be adopted by local municipalities.

- Include **promotion and marketing of entrepreneurial businesses** related to trails in marketing materials.

- **Decide on the most appropriate location for a regional visitor center** or tourism hub. If multiple visitor centers will be established, the group should decide how they will supplement one another.

- **Collaborate on grant applications.** For each application, decide which partner(s) will be responsible for submitting. In addition, establish roles for other partner organizations to support grant application development.

- Utilizing existing trail and recommended on-street connections, **identify a route that links Norris Dam State Park to Loyston Point** and connects all three counties with a signed bicycle route.

- **Prioritize funding a multimodal trail** that connects communities throughout the region and can leverage TDOT support.

- **Commit to celebrating new trails** throughout the region regardless of geographic location or jurisdiction..

ANDERSON COUNTY ACTION PLAN

STRATEGIC ACTION ITEMS

- **Allocate catalyst funding** for new sidewalk connections to trailheads in the Watershed area and the implementation of bicycle parking at county parks and trailhead locations. **Commit annual funding to trail connectivity and amenities such as small grant program for businesses installing trail user amenities** (i.e., bicycle parking, water filling stations, bicycle repair stations). Annual funding could also be used to acquire easements for off-street trail connections within the County. It could also assist trail-oriented entrepreneurial businesses such as bike rentals, water taxis services between parks, or outdoor recreation retail/service shops.

- **Decide which departments should be represented on the regional steering committee** that will guide recommendations in this study to implementation.

- **Establish which department will be responsible for the operations and maintenance of bicycle facilities within the County.** This may be dependent on which entity owns the roadway. Collaboration with TDOT and municipalities within the County will be key to a well-maintained regional bikeway network.

- **Build the framework to make data-driven decisions** about mobility for people walking and bicycling. Use state tools to annually monitor and assess pedestrian- and bicycle-related crashes. Invest in the use of GIS, or other geospatial analysis systems, and train the appropriate staff on their use. Incorporate survey questions about trail use, bicycling, and walking into local planning efforts around transportation, recreation, tourism, or economic development.

- **Continue existing or develop new events and festivals that showcase the County's history and heritage.** Use events to further leverage the fall visitor season with events featuring fall foliage and Appalachian music and arts. Encourage athletic races/competitions (in applicable areas).

- **Continue strengthening regional partnerships** to collaborate on inter-jurisdictional trails, bikeways, and outdoor recreational programming efforts. Consider establishing partnerships with non-profits and community groups in the County, including but not limited to the key stakeholders highlighted on this page.

- **Explore the formation of tourism development fund** for projects in the County.

- Work with municipalities, small business administrations, and economic development departments to **develop tourism business assistance programs** (such as incubators) to support and assist tourism businesses.

- Have the Anderson County Planning Commission **formally adopt the bikeway routes recommended in this study.**

- **Add an exemption to Article III.A.14.E of the Subdivision Requirements** that allows land dedications for greenways or bikeways adopted by the Anderson County Planning Commission to exceed 10% of land area.

- **Consider requiring dedication or reservation of adopted bikeway alignments in new developments and along major roadways.** Consider providing a **fee-in-lieu option** for developers; this funding can go towards future bikeway development and maintenance. Also, consider providing **incentives** for developers to dedicate land.

- **Develop and adopt a County policy that encourages owners of property adjacent to parks to become a partner in trail development and maintenance.** Landowners who provide easements to trail-developing organizations could be given liability protection in the case that trail users are injured on their land. This ensures protection for individuals or organizations that are willing to provide multimodal connections and close gaps in systems.

- **Encourage municipalities in the County to adopt bicycle-friendly policies,** such as bicycle parking requirements and standards in local zoning codes.

- **Commit to celebrating strategic first wins with a public event.**

- **Develop action items businesses in the County can take to advance the region's position as a premier outdoor recreation destination.** Example action items include:
  - Posting menus outside the building or on windows so that bicyclists or hikers can easily see them from the sidewalk.
  - Making sealable take-out containers available for easier takeout orders not being transported in a vehicle.
  - Selling basic biking and hiking gear, such as spare tubes, basic bike parts and tools, rain gear, packs and other wearables, and first aid kits.
  - Establishing paid shuttle services for trail users.
  - Providing stations where people can wash off their bikes after a day of muddy riding.
  - Provide boot cleaning stations outside restaurants and stores to encourage hikers to explore the community.

- **Explore a boat shuttle** from Sequoyah Marina and Norris Dam to Cove Creek Wildlife Management Area.

CAMPBELL COUNTY ACTION PLAN

STRATEGIC ACTION ITEMS

- **Allocate catalyst funding** for new sidewalk connections to trailheads in the Norris Dam State Park and the implementation of bicycle parking at local marinas and trailhead locations. **Commit to annual funding to trail connectivity and amenities** such as small grant program for businesses installing trail user amenities (i.e., bicycle parking, water filling stations, bicycle repair stations). Annual funding could also be used to acquire easements for off-street trail connections within the County. Annual funding could also assist trail-oriented entrepreneurial businesses such as bike rentals, water taxis services between parks, or outdoor recreation retail/service shops.

- **Decide which departments should be represented on the regional steering committee** that will guide recommendations in this plan to implementation.

- **Establish which department will be responsible for the operations and maintenance of bicycle facilities within the County.** This may be dependent on which entity owns the roadway. Collaboration with TDOT and municipalities within the County will be key to a well-maintained regional bikeway network.

- **Build the framework to make data-driven decisions** about mobility for people walking and bicycling. Use state tools to annually monitor and assess pedestrian- and bicycle-related crashes. Invest in the use of GIS, or other geospatial analysis systems, and train the appropriate staff on their use. Incorporate survey questions about tail use, bicycling, and walking into local planning efforts around transportation, recreation, tourism, or economic development.

- **Continue existing or develop new events and festivals that showcase the County's history and heritage.** Use events to extend visitor seasons and further leverage the fall visitor season with events featuring fall foliage and Appalachian music and arts. Encourage athletic races/competitions (in applicable areas), which fit well with the terrain, character and tourism offerings.

- **Continue strengthening regional partnerships** to collaborate on inter-jurisdictional trails, bikeways, and outdoor recreational programming efforts. Consider establishing partnerships with non-profits and community groups in the County, including but not limited to the key stakeholders highlighted on this page.

- **Explore the formation of tourism development fund** for projects in the County.

- Work with local municipalities, small business administrations, and economic development departments to **develop tourism business assistance programs** (such as incubators) to support and assist tourism businesses.

- **Develop and adopt a County policy that encourages owners of property adjacent to parks to become a partner in trail development and maintenance.** Landowners who provide easements to trail-developing organizations could be given liability protection in the case that trail users are injured on their land. This ensures protection for individuals or organizations that are willing to provide multimodal connections and close gaps in systems.

- **Encourage municipalities in the County to adopt bicycle-friendly policies,** such as bicycle parking requirements and standards in local zoning codes.

- **Commit to celebrating strategic first wins with a public event.**

- **Develop action items businesses in the County can take to advance the region's position as a premier outdoor recreation destination.** Example action items include:
  - Posting menus outside the building or on windows so that bicyclists or hikers can easily see them from the sidewalk.
  - Making sealable take-out containers available for easier takeout orders not being transported in a vehicle.
  - Selling basic biking and hiking gear, such as spare tubes, basic bike parts and tools, rain gear, packs and other wearables, and first aid kits.
  - Establishing paid shuttle services for trail users.
  - Providing stations where people can wash off their bikes after a day of muddy riding.
  - Provide boot cleaning stations outside restaurants and stores to encourage hikers to explore the community.

- **Explore a boat shuttle** from Sequoyah Marina and Norris Dam to Cove Creek Wildlife Management Area.

UNION COUNTY ACTION PLAN

STRATEGIC ACTION ITEMS TO

- **Commit to annual funding to trail connectivity and amenities such as small grant program for businesses installing trail user amenities** (i.e., bicycle parking, water filling stations, bicycle repair stations). Annual funding could also be used to acquire easements for off-street trail connections within the County. Annual funding could also assist trail-oriented entrepreneurial businesses such as bike rentals, water taxis services between parks, or outdoor recreation retail/service shops.

- **Decide which departments should be represented on the regional steering committee** that will guide recommendations in this plan to implementation.

- **Establish which department will be responsible for the operations and maintenance of bicycle facilities within the County.** This may be dependent on which entity owns the roadway. Collaboration with TDOT and municipalities within the County will be key to a well-maintained regional bikeway network.

- **Build the framework to make data-driven decisions** about mobility for people walking and bicycling. Use state tools to annually monitor and assess pedestrian- and bicycle-related crashes. Invest in the use of GIS, or other geospatial analysis systems, and train the appropriate staff on their use. Incorporate survey questions about trail use, bicycling, and walking into local planning efforts around transportation, recreation, tourism, or economic development.

- **Continue existing or develop new events and festivals that showcase the County's history and heritage.** Use events to extend visitor seasons and further leverage the fall visitor season with events featuring fall foliage and Appalachian music and arts. Encourage athletic races/competitions (in applicable areas), which fit well with the terrain, character and tourism offerings.

- **Continue strengthening regional partnerships** to collaborate on inter-jurisdictional trails, bikeways, and outdoor recreational programming efforts. Consider establishing partnerships with non-profits and community groups in the County, including but not limited to the key stakeholders highlighted on this page.

- **Explore the formation of tourism development fund** for projects in the County.

- Work with local municipalities, small business administrations, and economic development departments to **develop tourism business assistance programs** (such as incubators) to support and assist tourism businesses.

- Have the Union County Commission **formally adopt the bikeway routes recommended in this study.**

- **Consider requiring dedication or reservation of adopted bikeway alignments in new developments and along major roadways.** Consider providing a **fee-in-lieu option** for developers; this funding can go towards future bikeway development and maintenance. Also, consider providing **incentives** for developers to dedicate land.

- **Develop and adopt a County policy that encourages owners of property adjacent to parks to become a partner in trail development and maintenance.** Landowners who provide easements to trail-developing organizations could be given liability protection in the case that trail users are injured on their land. This ensures protection for individuals or organizations that are willing to provide multimodal connections and close gaps in systems.

- **Encourage municipalities in the County to adopt bicycle-friendly policies,** such as bicycle parking requirements and standards in local zoning codes.

- **Commit to celebrating strategic first wins with a public event.**

- **Develop action items businesses in the County can take to advance the region's position as a premier outdoor recreation destination.** Example action items include:
    - Posting menus outside the building or on windows so bicyclists or hikers can easily see them from the sidewalk.
    - Making sealable take-out containers available for easier takeout orders not being transported in a vehicle.
    - Selling basic biking and hiking gear, such as spare tubes, basic bike parts and tools, rain gear, packs and other wearables, and first aid kits.
    - Establishing paid shuttle services for trail users.
    - Providing stations where people can wash off their bikes after a day of muddy riding.
    - Provide boot cleaning stations outside restaurants and stores to encourage hikers to explore the community.

KEY STAKEHOLDERS

REGIONAL

- Anderson County
- Campbell County
- Union County
- Tennessee Valley Authority
- Big Ridge State Park
- Norris Dam State Park
- The City of Norris
- The City of Clinton
- The City of Maynardville
- The City of Rocky Top
- Tennessee River Valley
- Geotourism
- Middle East Tennessee Tourism Council
- Clinch Valley Trail Alliance
- Appalachian Mountain Bike Club
- Friends of Norris Dam State Park
- Norris Lake Project Team
- TDOT

WITHIN ANDERSON COUNTY

- Norris Lake Community Foundation
- Anderson County Highway Department
- Anderson County Office of Planning and Development
- Anderson County Parks and Recreation Department
- Adventure Anderson County
- City of Norris
- City of Clinton
- City of Oak Ridge
- City of Rocky Top
- Town of Oliver Springs
- Norris Dam State Park
- Manhattan Project National Historical Park
- North Cumberland Wildlife Management Area
- Keep Anderson County Beautiful
- Keep Norris Beautiful
- Boy and Girl Scout Troops
- The Norris Lake Project
- Tennessee Citizens for Wilderness Planning
- Friends of Norris Dam State Park
- Tennessee Valley Authority
- TDOT
- Sequoyah Marina
- Stardust Marina
- Trout Unlimited - Norris Chapter

WITHIN CAMPBELL COUNTY

- Campbell County Environmental Services Department
- Campbell County Parks & Recreation Department
- Campbell County Road Superintendent
- Campbell Enhancement Fund
- City of Jellico
- City of LaFollette
- City of Rocky Top
- Town of Caryville
- Town of Jacksboro
- Norris Dam State Park
- Indian Mountain State Park
- Cove Lake State Park
- Cove Creek Wildlife Management Area
- North Cumberland Wildlife Management Area
- Cumberland Trail State Park
- Chuck Swan State Forest
- The Norris Lake Project
- Campbell County Chapter of Friends of Norris Lake Watershed
- Friends of Norris Dam State Park
- Tennessee Valley Authority
- TDOT
- Flat Hollow Marina & Resort
- Indian River Marina
- Norris Dam Marina
- Powell Valley Resort
- Shanghai Resort
- Springs Dock & Resort
- Twin Cove Resort & Spa
- Whitman Hollow Marina
- Mountain Lake Marina & Campground

WITHIN UNION COUNTY

- Union County Road Superintendent
- Union County Community Foundation
- Union County Chamber of Commerce
- City of Luttrell
- City of Plainview
- City of Maynardville
- Big Ridge State Park
- Chuck Swan State Forest
- The Norris Lake Project
- Tennessee Valley Authority
- Beach Island Resort & Marina
- Blue Springs Hollow Boat Dock
- Hickory Star Resort & Marina
- TDOT
- Lakeview Marina
- Waterside Marina

DECISION-MAKING CRITERIA FOR PRIORITIZING PROJECTS & PROGRAMS

When prioritizing projects for funding catalyst or ongoing projects, the following criteria should be considered. These criteria can be quantified based on what criteria each decision-making entity—whether at the municipal, County, or regional level—finds appropriate. Scores can be weighted to reflect criteria that are more important than others. Criteria selected for the prioritization of one-time funding for catalyst projects vs. ongoing funding for strategic regional investments may differ.

Catalyst funding is one-time support for projects or programs. This funding source often supports large-scale infrastructure projects that have a high return on investment (e.g., building bikeways, re-routing trails, creating a visitor center).

Ongoing funding is continued support for projects or programs. This funding source often contributes to the ongoing operations and maintenance of infrastructure (trails, bikeways, visitor centers, etc.) or continuing programming (e.g., website, marketing efforts).

POTENTIAL PRIORITIZATION CRITERIA

For each of the following categories, ask "will the project or program...?"

MARKETING

- Increase tourism visits and length of stays
- Leverage existing assets
- Reach potential visitors to the region
- Enhance the visitor/trail user experience

ECONOMIC DEVELOPMENT

- Increase jobs
- Strengthen the local economy
- Attract and retain business

COMMUNITY HEALTH & QUALITY OF LIFE

- Provide more opportunities for active living for people of all ages and abilities
- Increase the education, knowledge, and/or skills of residents
- Provide environmental benefits
- Increase safety

NETWORK COMPLETENESS (TRAIL OR ON-ROAD SYSTEMS)

- Provide an essential link in the proposed network (i.e., without this link the system could not be completed)
- Be important as a 'standalone' project
- Be a long-term element and potential future link in the system
- Sustain the system in the long-term

CONNECTIVITY & ACCESSIBILITY

- Increase mobility options between key regional destinations
- Increase access to key community destinations (e.g., schools, employment, retail or commercial areas, parks or recreational areas, residential neighborhoods)

REACH

- Benefit the entire region
- Benefit a target area within the region
- Contribute to regional goals

EASE OF IMPLEMENTATION

- Feasible
- Be ready for implementation or have the potential for advancement
- Have full agency and public support
- Require additional staff and resources

COST

- Contribute to lowered maintenance costs
- Reach the widest range of people per unit cost required for policy/ program development (for non-capital projects)
- Realize multiple benefits
- Leverage public resources
- Be a good fit with goals of high priority funding opportunities
- Have a high return on investment

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5

TRAIL & NETWORK DESIGN GUIDANCE

This chapter presents design recommendations for off-road trails and roadway connected network facilities that are appropriate for the region. The variety of off-road trails will increase accessibility and comfort for people who use the region's recreation areas. Roadway facilities will also serve park-goers by increasing connectivity between the recreation areas while benefiting residents who bike and walk.

Much of this chapter is dedicated to specific trail design recommendations, construction standards, and trail types to ensure minimal maintenance and the best user experience. This guide is intended for use by trail practitioners, maintenance personnel, and regional stakeholders. The guidance illustrates how to design sustainable trails that follow contours instead of fall-lines, and effectively encourage users to remain on-trail, minimizing maintenance and reconstruction needs and costs.

SUSTAINABLE TRAILS

What are sustainable trails?

- Trails that use low-impact surface materials and locally available materials where possible
- Trail alignments that minimize disturbance to the land and adjacent natural systems, such as waterways
- Trails that require a minimal amount of routine and remedial maintenance
- Trails that minimize use of carbon-intensive materials such as concrete

Key Tenets:

- Sustainable trails serve different user groups, including walkers, hikers, joggers, mountain bikers, ATV drivers, and horseback riders.
- Designing and building sustainable trails that can serve each group requires an understanding of each group's needs.
- The key principles of designing, building, and maintaining sustainable trails are similar for each of these user groups.
- Trail systems that have consistent maintenance methodologies, strategies, and equipment across the trail types.

TRAIL TYPES

The following are the five proposed trail typologies and user groups in the Norris Lake Region:

SHARED-USE PAVED TRAILS

- Sidepaths included

SINGLETRACK TRAILS

- Beginner through Extremely Difficult
- Soft-surface sidepaths included

BIKE-OPTIMIZED TRAILS

- Beginner through Extremely Difficult

ACCESSIBLE TRAILS

ACCESS TRAILS OR ROADS

- For Emergency or mainline users
- May overlap with Shared-Use Paved Trails or Accessible Trails

Trail User Groups

Hikers, Walkers, & Joggers

Persons with disabilities

Bicyclists

Mountain bikers

Equestrians

ATV users

First Responders & Maintenance Personnel

Applying Trail Typologies

A specific trail type is proposed according to its surrounding environment, target user, location, whether it is for safety along roadways, or to enhance user experience. Depending on the existing soil types, the trail soil typical sections illustrated may be substituted for natural material as applicable.

For several of the trail types, multiple user groups are possible. By grouping the natural surface trails to potentially fit into IMBA's Ride Center criteria, there will be flexibility if pursuing a designation. Clear wayfinding will be essential to maintaining a cohesive system and one that can accommodate the various user groups.

Singletrack trails will be most often preferred or shared use with potential equestrian, mountain biking and hiking usage. There are many sub-types for the singletrack and bike optimized such as Gravity Specific trails, flow trails, pump tracks, and uphill or downhill only. In addition, singletrack and bike optimized may have a directional bike with a multi-directional hike designation. In some cases, specific designation will be for the purposes of IMBA's Ride Center scoring.

TRAIL ACCESS

Emergency

Typically called fire roads or access roads, emergency access should be considered for the existing trail system and future trail construction. Where feasible, emergency access will reduce difficulty with rescues and the number of helicopter or boat extractions needed.

The base guidelines for emergency routes to be established are as follows:

- Establishing minimum distances for egress, search & recovery
  - These can be based on approximate rescue times, jurisdictions, and grade difference between lake and emergency route
- Access route standards
  - Establish widths, grades, materials for existing and anticipated future vehicles/equipment
- Helicopter landing pad distribution or spacing
  - For each access route, establish a landing pad location spacing

These guidelines should be coordinated with the appropriate stakeholders prior to access route layout and design.

Central Trail Spine or Mainline

In addition to the function of emergency access, providing such trails can serve as a central trail mainline. The benefits include:

- Improved maintenance access to loop trails
- Beginner, user-friendly, increase attraction to system –
  - Can be arranged like double-track to facilitate side-by-side riding
  - Offers bailout points for beginners to try more difficult runs

- Offers bailout points for more advanced users in case of severe weather, minor injury, fatigue, etc.

Design features

- Materials, grades, widths – see trail use and typical sections for proposed details
- Shelters – minimum spacing 2 miles, to serve for rest or meet-up points
- Bike repair stations – at every shelter
- Other potential amenities include – toilets, water fountains, bicycle wash-down stations, trash and recycling receptacles

When allocating space for the mainline, future amenities should be allowed for in the design as trail usage changes or funds become available. Refer to the typical sections below for additional designs of these trails.

TRAIL DESIGN GUIDELINES

Trails are the primary way in which people experience nature in the Norris Lake Area. Natural surface trails that are carefully and sustainability sited promote an enjoyable user experience and minimize future maintenance requirements. These design guidelines specify how trails and supporting facilities should be designed and constructed and have been compiled considering best practices. The following guidelines are design parameters for creating sustainable trails and determining proposed typical trail sections for each trail type.

The International Mountain Bicycling Association (IMBA) is a recognized leader in trail guidance, stewardship, investment, and authority for systems across the United States. Trails and trail systems that have followed IMBA guidelines have been built across the country and internationally, and have proven to be sustainable. By following the guidelines in this document and IMBA best practices, proposed future trails will adhere to the most up to date sustainable guidelines at the time of their design and construction. The goal of this approach is for a collective benefit to users and communities, with more trail systems adhering to IMBA Trail Ratings, guidance and facility designs.

Trail Widths

Trail tread widths are the physical space required for different trail users and are the basis for defining typical trail sections. The following figures illustrate typical users and arrangements for passing or side-by-side operation.

- Hiking or jogging
- Equestrian use
- Mountain biking – downhill, uphill, and cross country
- Emergency or Mainline Access

Trail tread widths, user types, and IMBA trail designations are the central design criteria for establishing the typical sections and proposed characteristics for the Norris Lake Area.

TYPICAL SECTIONS

The following pages contain typical sections for trail and on-road network facilities appropriate for the Norris Lake Area. A variety of trail widths are appropriate for many of the off-road facilities, while roadway facilities require specific widths throughout the length of the corridor to reduce risk of conflicts with motor vehicles.

Trails

Multipurpose Natural Trails

Multipurpose natural trails accommodate all types of non-motorized trail users (most commonly hikers, bicyclists, and equestrians).

MULTIPURPOSE NATURAL TRAILS	
Sub-Types	Edge protected
Surface Material (Typical)	Crushed stone; compacted earth
Running Slope	• 5% maximum (any distance); 8.33% (max per accessibility guidance) • If trail is within the roadway right-of-way, can match the road's running slope
Appropriate Characteristics	Cross slope below 2%, 2" maximum height tread obstacles
Inappropriate Characteristics	Any characteristics that compromise the accessible requirements noted above
Management Considerations	Typically managed as shared use
Preferred Easement Width	50' (20' minimum)
Average Construction Cost	$3-10/LF

FIGURE 19. Multipurpose Natural Trail Section

| NATURAL AREA | MAINTENANCE STRIP (5') | SHARED USE PATH NATURAL SURFACE (10'-12') | MAINTENANCE STRIP (5') | NATURAL AREA |

20'-22' ROW (PROPOSED)
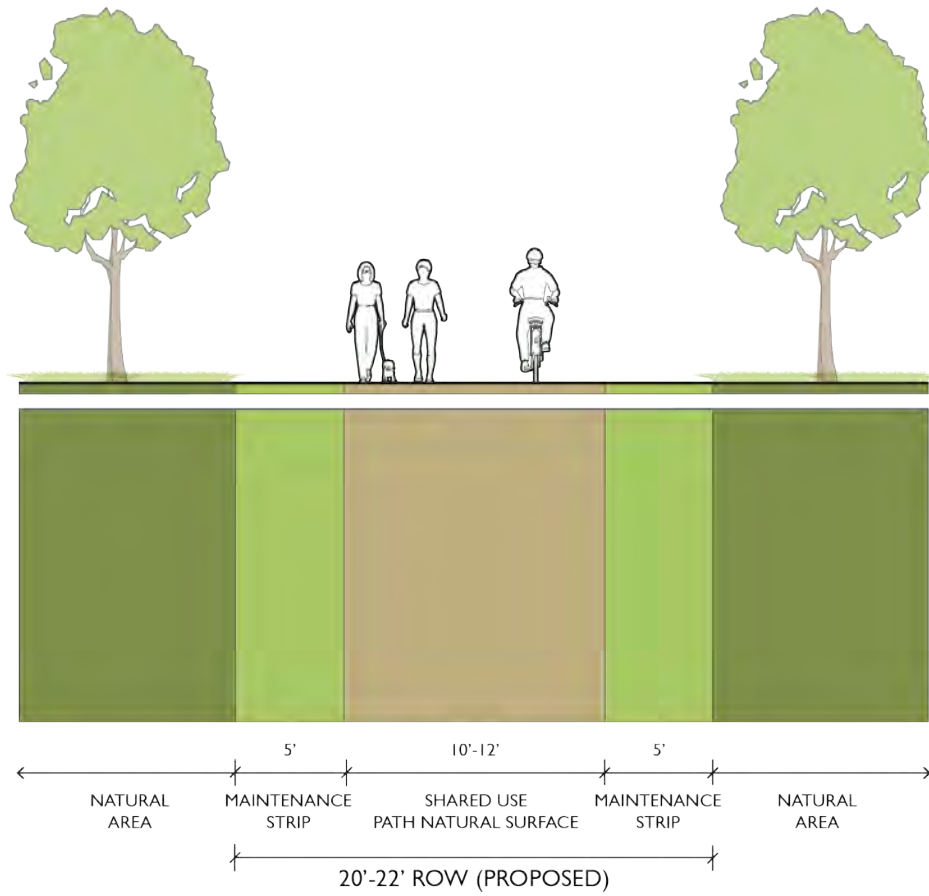
Singletrack Trails

Singletrack trails are constructed to facilitate access to hikers, bikers, and trail runners.
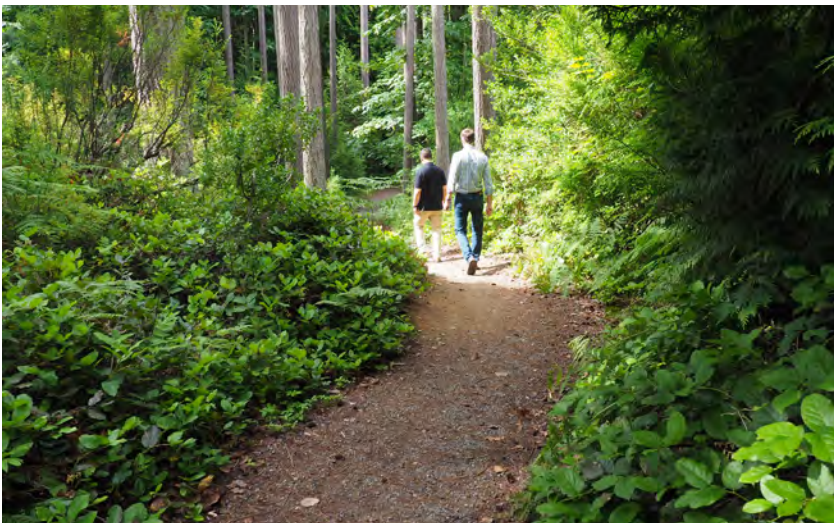
SINGLETRACK TRAILS	
Sub-Types	• Easier, more difficult, very difficult, extremely difficult • Uphill only, downhill only, gravity oriented, hike optimized, or uphill bike/multi-directional hike trails
Surface Material (Typical)	Natural surface
Running Slope	Can be routed with steeper running slopes up to 15% (depending on local soil conditions) Refer to Key Trail Design Principles
Appropriate Characteristics	Small berms, rollers, slow-speed technical features, clear sightlines on faster segments of trail
Inappropriate Characteristics	Large berms, jumps, drops, high-speed features
Management Considerations	May be designed as a single use or preferred use trail; when bicyclists are permitted, direction of travel may be specified
Preferred Easement Width	50' (10' minimum) - If Applicable
Average Construction Cost	$4-16/LF

FIGURE 20. Singletrack Trail Section

CLEAR ZONE

10'

1' VARIES 1'

NATURAL AREA

NATURAL SURFACE

NATURAL AREA

WIDTH VARIES BASED ON DESIRED TRAIL DIFFICULTY AND RANGES FROM 6'' TO 72'' OR MORE. REFER TO IMBA TRAIL DIFFICULTY RATING SYSTEM
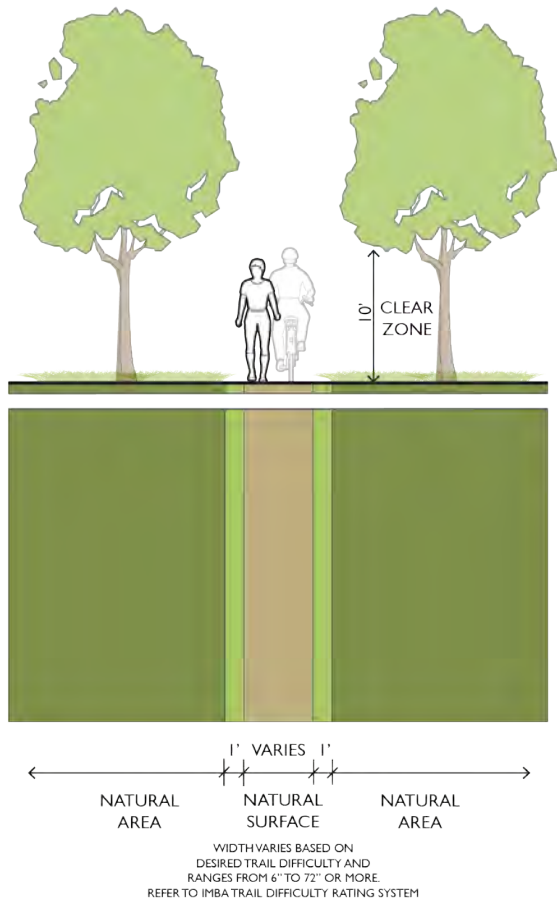
Bike Optimized Trails

Bike optimized trails are constructed to enhance the experience and efficiency of riding a bicycle.

BIKE OPTIMIZED TRAILS	
Sub-Types	• Easier, more difficult, very difficult, extremely difficult • Uphill only, downhill only, gravity oriented
Surface Material (Typical)	Natural surface
Running Slope	• 6-8% or less (up to 15% for short segments 50-100') Refer to Key Trail Design Principles. • Uphill bicycles: overall running slope of 10% or less (up to 15% for short segments)
Appropriate Characteristics	Larger berms and/or high speed features, jumps, drops, elevated structures, and other technical features suited to bicyclists
Inappropriate Characteristics	Mandatory advanced features without "ride-arounds"
Management Considerations	Direction of travel is commonly specified; may also be preferred use or single use
Preferred Easement Width	50' (10' minimum) - If Applicable
Average Construction Cost	$5-15/LF

FIGURE 21. Bike Optimized Trail Section

10' CLEAR ZONE

VARIES
1'   1'

NATURAL AREA   NATURAL AREA   NATURAL AREA

WIDTH VARIES BASED ON
DESIRED TRAIL DIFFICULTY
AND RANGES FROM 6" TO 72" OR MORE.
REFER TO IMBA TRAIL DIFFICULTY RATING SYSTEM
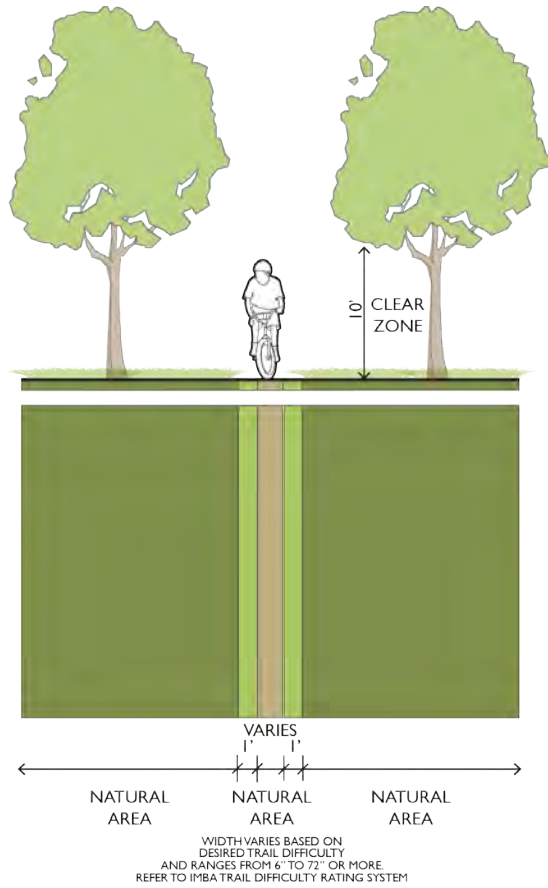
Accessible Trails

Accessible trails comply with the ADAAG's regulations for "Accessible Trails"

ACCESSIBLE TRAILS	
Sub-Types	N/A
Surface Material (Typical)	Concrete, asphalt, compacted natural surface, decomposed granite, or crusher fines
Running Slope	• Running slope of 1:20 (any distance) • 1:12 (max 200') • 1:10 (max 30') • 1:8 (max 10')
Appropriate Characteristics	Cross slope below 5%, 2" maximum height tread obstacles, passing space every 1000' where tread is less than 60"
Inappropriate Characteristics	Any characteristics that compromise the accessible requirements noted above
Management Considerations	Typically managed as shared use
Preferred Easement Width	50' (15' minimum)
Average Construction Cost	N/A

FIGURE 22. Accessible Trail Section

NATURAL AREA

MAINTENANCE STRIP — 5'

VARIES
TRAIL WIDTH IS 36"
MIN. 60" OR MORE
PREFERRED — 5'

MAINTENANCE STRIP — 5'

NATURAL AREA

20'-22' ROW (PROPOSED)
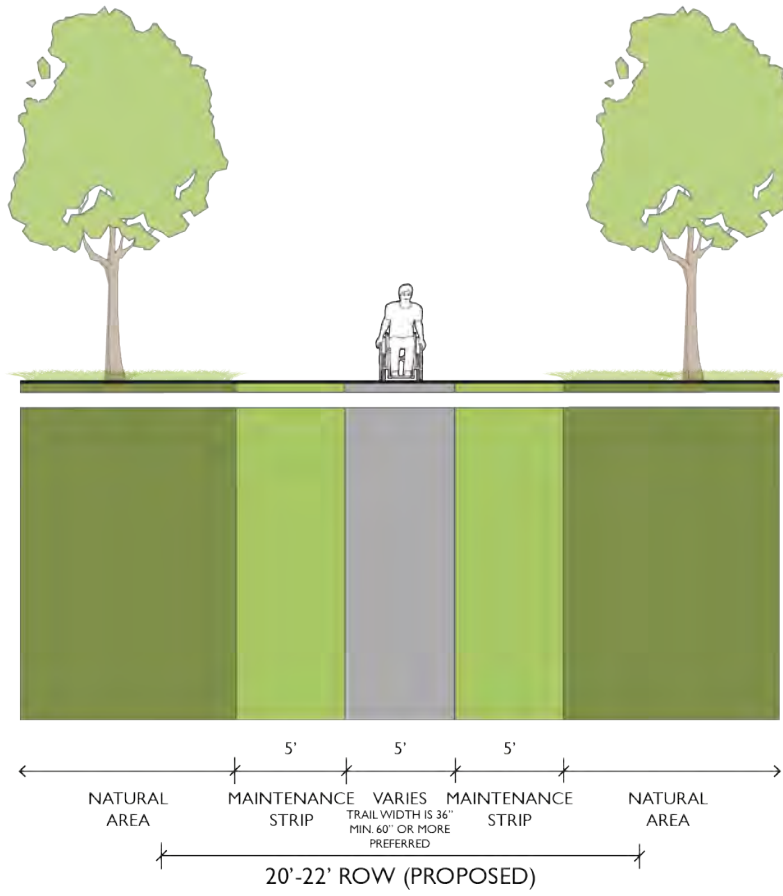
IMAGE 7. Accessible trail in the Pacific Northwest[2]

Service Trails or Roads

Service access roads may facilitate trail user circulation, however ultimately exist to facilitate access to infrastructure or other destinations

SERVICE TRAILS & ROADS	
Sub-Types	N/A
Surface Material (Typical)	Natural surface, concrete, or asphalt
Running Slope	Usually predetermined by existing route
Appropriate Characteristics	Varies by purpose, but typically constructed to accommodate periodic motorized access
Inappropriate Characteristics	Any trail features that would interfere with the utilitarian purpose of the service road and prevent access to the associated infrastructure
Management Considerations	Typically managed as shared use and includes maintenance and emergency access
Preferred Easement Width	30' (15' minimum)
Average Construction Cost	$20-30/LF

FIGURE 23. Service Trails or Roads

5'	8'-10'	5'
NATURAL AREA	MAINTENANCE STRIP	SHARED USE PATH NATURAL SURFACE	MAINTENANCE STRIP	NATURAL AREA

20'-22' ROW (PROPOSED)
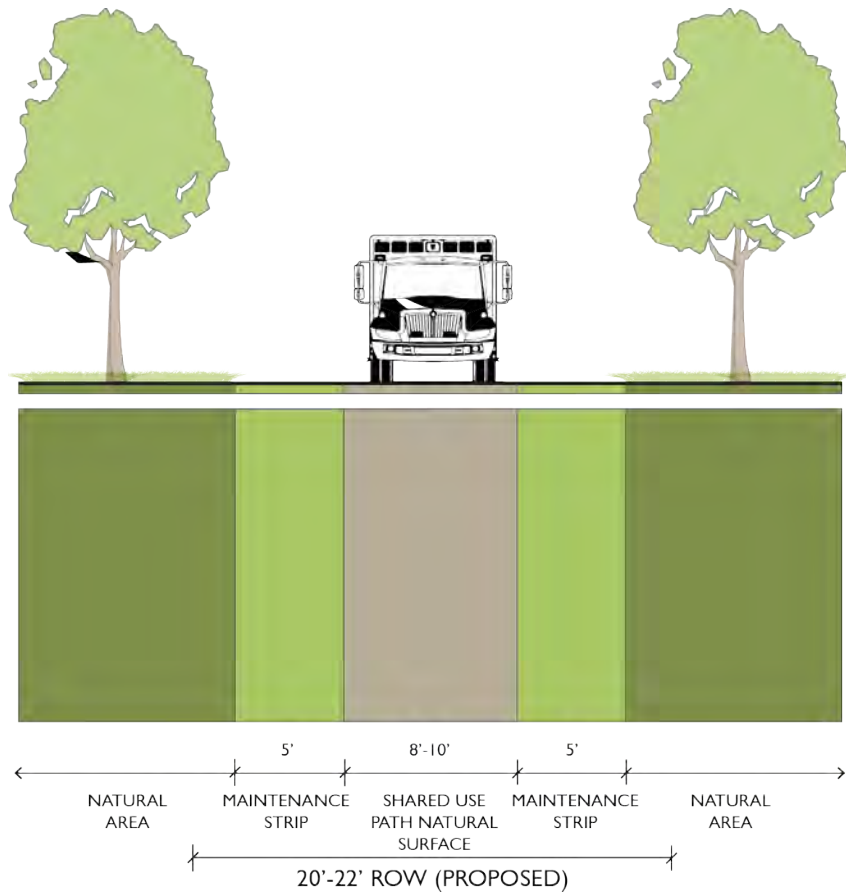
Roadway Connected Network Facilities

Bike Lanes & Buffered Bike Lanes

Bike lanes provide dedicated space for bicyclists traveling, typically in the same direction as motor vehicles. Buffered bike lanes are similar with an additional space for more separation from traffic. This buffer may be painted or have delineators to further emphasize the bike lane.

BIKE LANES & BUFFERED BIKE LANES	
Sub-Types	Buffered Bike Lane, Sidewalks are encouraged
Surface Material (Typical)	Asphalt
Running Slope	Must follow and maintain roadway grade
Appropriate Characteristics	4' minimum width, standard DOT striping with signage, and free of debris and obstructions
Inappropriate Characteristics	N/A
Management Considerations	Sweeping and debris removal
Preferred Easement Width	26.5'
Average Construction Cost	• Bike Lane: $10/LF • Buffered Bike Lane: $15/LF

FIGURE 24. Bike Lane Section

VARIES	5'	3'	5'	11'
LANDSCAPE	SIDEWALK	LAND-SCAPE	BIKE LANE	TRAVEL LANE

24.5' ROW (PROPSED
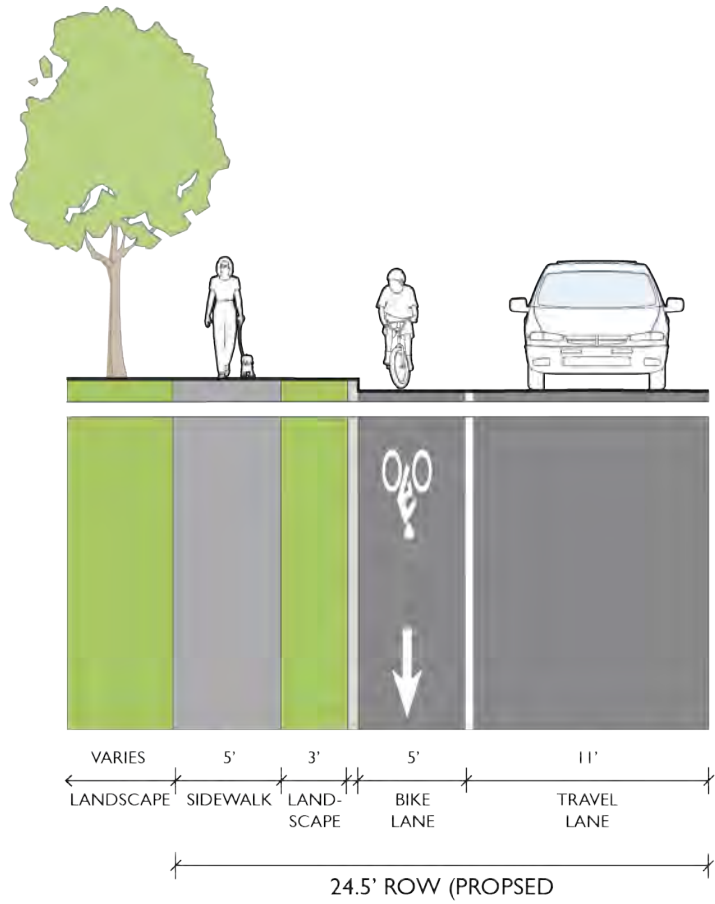
FIGURE 25. Bike Lane with Buffer Section

VARIES	5'	3'	5'	2'	11'
LANDSCAPE	SIDEWALK	LAND-SCAPE	BIKE LANE		TRAVEL LANE

26.5' ROW (PROPOSED)
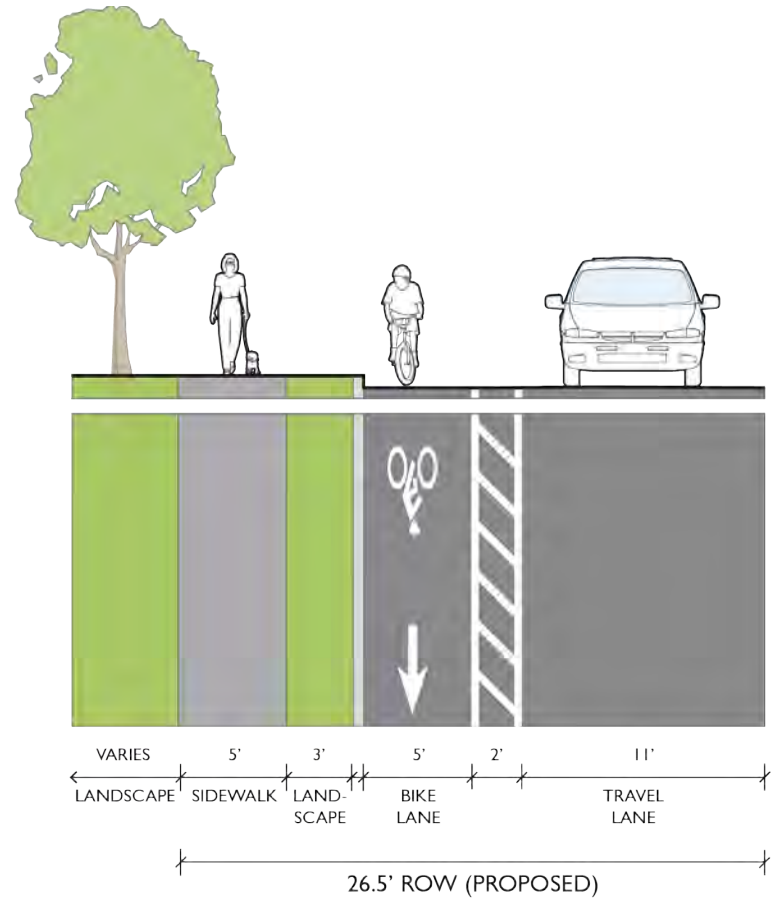
Shared Use Paths

Shared use paths accommodate all types of non-motorized users (most commonly people who walk, bicycle, wheel, or use assistive devices).

SHARED USE PATHS	
Sub-Types	Sidepath, Greenway
Surface Material (Typical)	Asphalt
Running Slope	Must follow and maintain roadway grade
Appropriate Characteristics	12' minimum width, standard DOT striping with signage, and free of debris and obstructions
Inappropriate Characteristics	N/A
Management Considerations	Sweeping and debris removal
Preferred Easement Width	27.5'
Average Construction Cost	$185/LF

FIGURE 26. Shared Use Path Section

VARIES | 12' | 4' | 11'

LANDSCAPE | SHARED USE PATH TWO WAY TRAVEL | LANDSCAPE BUFFER | TRAVEL LANE

27.5' ROW (PROPOSED)
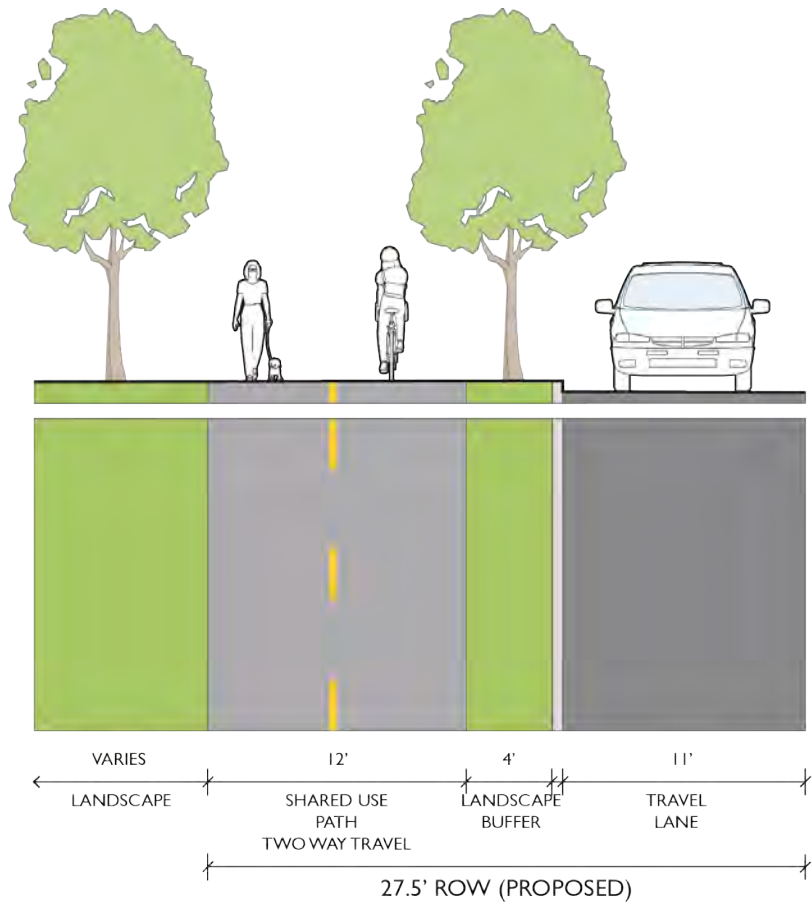
Signed Bike Routes

Signed bike routes are typically roadway facilities that are appropriate for more advanced bicyclists who are comfortable riding in mixed traffic with motor vehicles. In rural areas, many signed bicycle routes are roads with higher posted speed limits, however roads with lower speeds, less traffic, and wider shoulders are more comfortable for users. These routes have additional signage to provide wayfinding specifically for bicyclists.

SIGNED BIKE ROUTES	
Sub-Types	Neighborhood Greenway
Surface Material (Typical)	Asphalt
Running Slope	Must follow and maintain roadway grade
Appropriate Characteristics	Share the roadway signage, DOT symbols, free of debris and obstructions, and improved sightlines
Inappropriate Characteristics	N/A
Management Considerations	Sweeping and debris removal
Preferred Easement Width	22.5'
Average Construction Cost	$2/LF

FIGURE 27. Signed Bike Route Section

VARIES | 5' | 3' | 14'
LANDSCAPE | SIDEWALK | LAND-SCAPE | TRAVEL LANE

22.5' ROW (PROPSED)

SIGNED AND MARKED
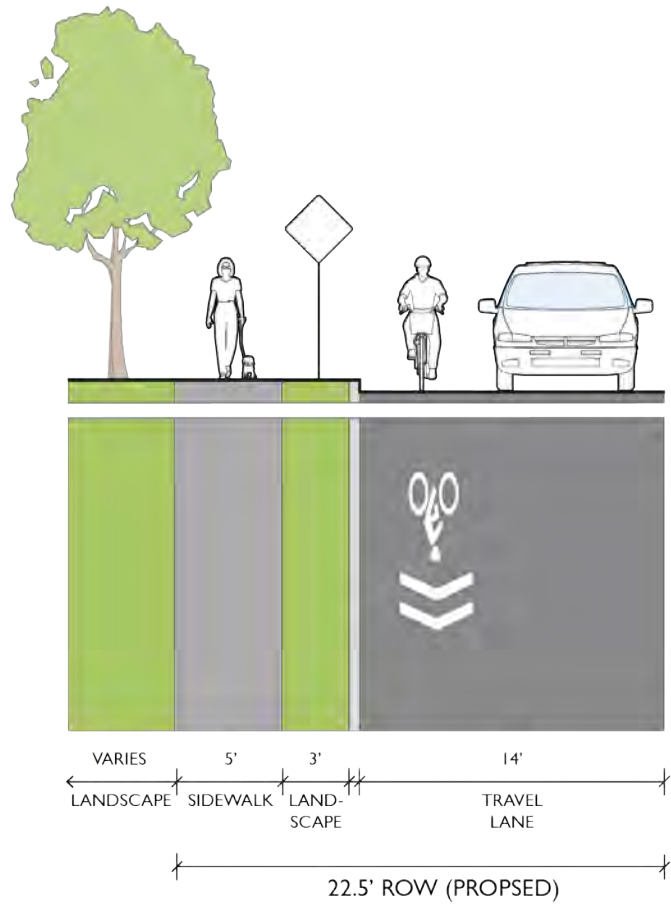
Clear Zones

The Trail Planning, Design, and Development Guidelines detail clearance zones for natural surface trails. For paved trails and access routes, the latest guidance from MUTCD and AASHTO should apply.

The following parameters are specific to natural surface trails:

- Vertical clear height above ground level
  - Clearance to overhead obstructions should be 10 feet minimum for non-equestrian trails and 12 feet minimum for equestrian trails
- Horizontal clear zones / maintenance strips
  - Generous clearance
  - Tight clearance
  - Clearance on side slopes
  - Long vertical features
  - Reducing habitat fragmentation
  - Reducing splash erosion

Trail Treads – Natural Forces

Three central forces act upon all-natural surface trail treads: compaction, displacement, and erosion.

Compaction

Compaction, when caused by trail use, is a primarily downward force that compacts the tread. The compacted tread usually becomes lower than the surrounding ground level.

Displacement

Displacement is a sideways force from friction and impact of feet, tires, and hooves. With displacement some material remains in the tread and the rest is push out of the tread resulting in a lower trail surface relative to the adjacent ground.

FIGURE 28. Trail Compaction and Displacement

Tread material displaced in trailbed

Displaced tread material outside trail exacerbates the height difference between tread and surrounding ground

Trail use causes compaction and displacement of tread material in all directions
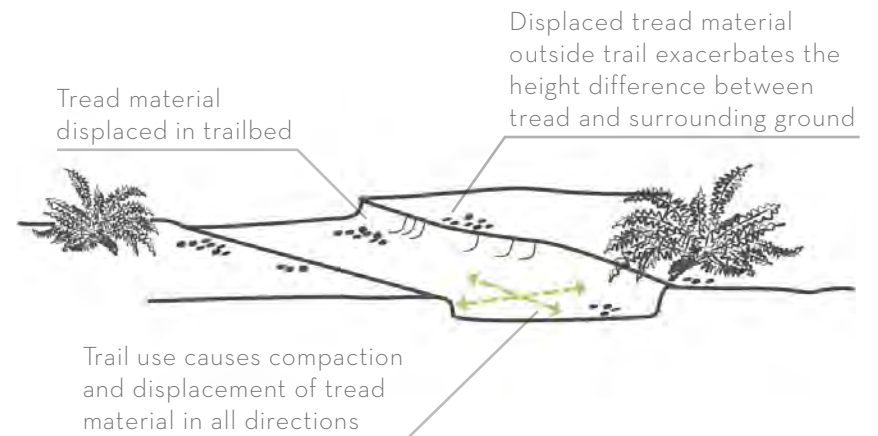
Erosion

Erosion on trails is the wearing of materials by water or wind. Proper construction, material quality, and compaction from use helps prevent erosion through hardening the trail tread. To be sustainable, the trail needs to be able to accommodate any type of runoff event, even major storm events. Trails constructed and designed based on this sustainable trail guidance should have reduced erosion impacts and wear compared to typical design.

When utilized correctly, rolling grade can avoid common erosion issues and reduce the overall risk factors. Small-scale erosion is something that can be managed through routine maintenance, but it is important to minimize the frequency in a larger or dispersed trail network.

The main principals to avoid erosion are:

- Limiting the size of the tread watershed
- Limiting the tread grade
- Following the key design guidelines

FIGURE 29. Erosion Risks

Limited vegetation in the trail watershed does not absorb and slow down runoff, increasing the risk of instant inundation of downstream tread.

Larger watersheds cause more runoff than smaller watersheds, which receive less rain.

Tread watershed boundaries

Fall line

Poorly draining soils such as clay absorb less rainfall, yielding more runoff in the watershed

Potential tread crest breaches pose risk of runoff flowing down trail and combining with next watershed.

Steep tread grades are more prone to erosion. Erosion mitigation not possible for very steep slopes.

Loose tread material are less resistant to displacement and erosion.

Longer segments in watershed accumulate more water and with enough water will erode despite gentle slopes.

Limited tree cover over the trail exposes tread to rainfall and splash erosion, which is particularly damaging on steep sections of trail.

Material Considerations

Local soil types and surficial geology can necessitate lower running slopes, higher cross slopes, and other alterations to the design standards. Soil compaction and susceptibility to compaction, displacement, wetting and erosion should always be carefully evaluated prior to final alignment and construction of any trail segment. In some cases, the presence of shale layers or other challenging rock types may necessitate substantial adjustments to the trail alignments. Grade control is extremely important for trail sustainability in rocky areas, and maximum grades should be kept slightly lower than those shown in the trail design guidelines. Compacted soil and decomposed granite are both low-impact materials suitable for most non-bicycle trails and decomposed granite or crusher fines are the preferred surface for trails with high activity, paved trail shoulders, and equestrian use.

NATIVE SOILS AND ROCKY MATERIALS

Natural surface trails are pathways composed of compacted native soil or gravel. They can be designed and managed to service a wide variety of users or a select few. The ideal soil type is typically a loam and since the materials used are local or on-site offer a low-cost surface with lower maintenance costs long-term.

MULCH

Mulch is a soft trail surface, typically cheaper than loose gravel or aggregate but more costly to maintain. Mulch decomposes and has a higher rate of erosion or washing out in larger storm events. Poorly draining mulch trails will result in a bad user experience and is generally not ideal for high pedestrian traffic.

AGGREGATE

Aggregate or crushed stone is durable and can complement the aesthetic of the natural landscape. Most trail users can be accommodated with proper gradation and compaction. Crushed stone can be made of nearly any type of rock and therefore is one of the most accessible trail surface types.

ASPHALT

Asphalt is the most common for bike paths and shared use paved trails. It can be popular with users for its smooth, continuous surface and has

the benefit of lower cost, but requires more upkeep than concrete. As a flexible pavement, asphalt can also be considered for installing a paved trail on grades steeper than 3%. If constructed properly on suitable sub-grade, asphalt has a life span of about half that of concrete, or 10 to 15 years.

CONCRETE

Concrete is proven to be the most durable for bike paths and paved trails over time and the experience can be improved by using sawcut joints in place of troweled joints. Concrete is a more carbon-intensive material, but typically requires less maintenance.
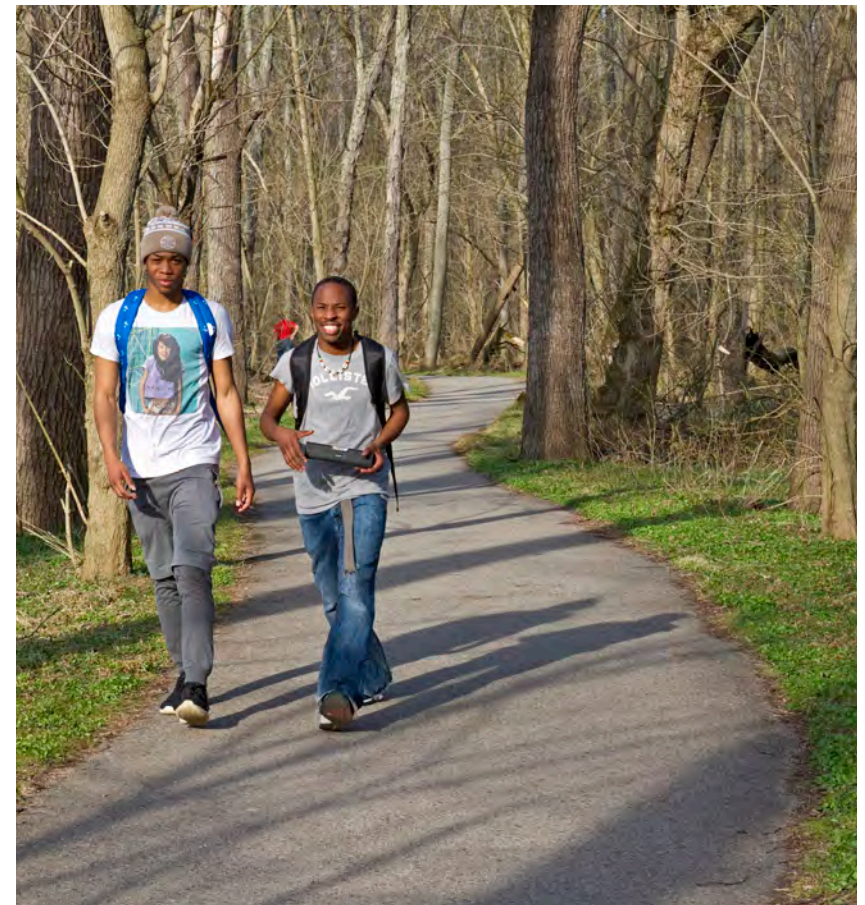
BOARDWALK

Boardwalks are elevated structures that allow trail users to cross wetlands and other types of marshy land. Wood is the most common type of boardwalk decking material, but alternative materials include composite boards and concrete decking. Boardwalk foundation systems also vary depending on geotechnical conditions. Options include timber (pressure treated piles), steel, concrete, and composite. Composite lumber typically costs more than wood but its durability can make it more cost-effective over the life of the structure, particularly if there is equestrian use.

BRIDGES

Bridges create opportunities for overlooks, habitat protection, trail connections, and provide access. Wood trail bridges can provide cost-effective minor drainage crossings while supporting route character. Since wood's life span is limited, composite lumber may be considered as an alternative deck material, especially if equestrian use is anticipated. Long span wood construction requires similar abutments and supports as steel bridges. Prefab steel truss bridges are commonly used for long span crossings. Additional design considerations for prefab steel truss bridges included finishes such as weathered steel, paint or galvanizing and deck options such as cast-in-place reinforced concrete, precast planks, open grating or composite or wood decking.

Alignment and Layout

There are six key guidelines of sustainable trails including the five essential elements of sustainable trails as outlined in the International Mountain Bicycling Association's (IMBA) publication "Trail Solutions." These guidelines should be referenced when investigating or making modifications to existing trails and for maintenance procedures.

FOLLOW NATURAL TOPOGRAPHY

Minimizing disturbance to existing soil, trees and side slopes will be critical to long-term sustainability and help maintain the natural feel a trail. Following natural topography also helps minimize changes to drainage catchments and retaining slope stability.
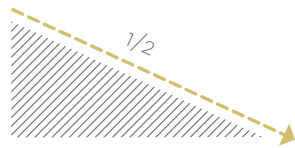
HALF RULE

The half rule guidance is a trail's grade shouldn't exceed half the grade of the hillside or side slope that the trail traverses. Trails that exceed half the grade are considered "fall line" trails and drainage crossing will follow the trail rather than crossing it, creating a high probability for erosion.

10% AVERAGE GRADE

An average trail grade of 10 percent or less is considered sustainable. This doesn't mean that all trails should be kept under 10 percent, but the trail builder will need to limit the length of sections that exceed 10 percent. Maintaining 10 percent average is greatly beneficial as it applies to most soil types, allows design flexibility, helps future reroutes, accommodates undulations, aids planning, and minimizes user-caused erosion.
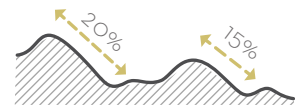
MAXIMUM SUSTAINABLE GRADE

The maximum grade is the steepest portion of a trail that is more than approximately 10 feet in length. It's critical to determine what the maximum allowable trail grade will be prior to beginning construction. Several factors should be considered when determining the maximum sustainable trail grade which include: half rule, soil types, annual rainfall amount, grade reversals, type of users, number of users, and difficulty level
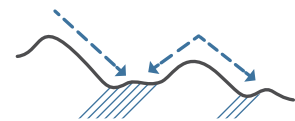
GRADE REVERSALS AND ROLLING GRADE

A grade reversal is a point where an ascending trail changes direction subtly for 10 to 50 linear feet before ascending again. This change in grade allows for water to exit the trail. Rolling contour trails gently undulate while traversing side slopes to divide trails into distinct trail watersheds. Trail watersheds limit the amount of drainage flowing across a trail
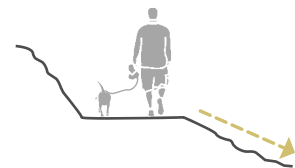
OUTSLOPE

Outslope allow water to sheet flow off the trail instead of channeling down its center. Paired with grade reversals, an outslope can help trails endure with minimal maintenance and reduce long term erosion or effects from drainage issues.

Alignment Considerations

Tread crests, dips, climbs, and waterbars are techniques to efficiently achieve the rolling grade design. Trail turns and switchbacks are techniques to meet grade related guidelines.

FIGURE 30. Rolling Grade Trail Design Best Practices

Drainage crossings require tread dip regardless of size or emphemerality to avoid water flow down the trail.

Tread dips at low points facilitate drainage to prevent mud puddles.

Harden tread when rolling trail and/or native soils do no mitigate erosion.

Tread crests provide high points needed to divide the trail into watersheds to disperse drainage.

Edge buffers such as berms or shoulders defines the trail, increasing awareness of edge on steeper slopes.

IMAGE 8. Rolling grade trail design in Loyston Point

TRAIL DESIGN ELEMENTS

Waterbars

Rigid waterbars use stone or timbers to reinforce the top of the crest against displacement. In some cases, the waterbar serves as an actual "dam" for water. Due to the reduced need for a fill material, waterbars are often easier to form than filled crests on hiking and equestrian trail segments steeper than about 9 percent and less than 18 percent. Stone waterbars use closely fitted stones to minimize gaps. Although labor intensive to build, stone waterbars are rustically attractive trail structures. Where on-site stone is not available, 8-inch-round pressure-treated timber can be used. Untreated peeled logs can also be used where a more rustic appearance is desired, although these will need to be replaced every few years. As with any filled crests, rigid waterbars can be breached if the bar itself is breached or if sediment reaches the top of the crest. Generally, rigid waterbars should be used only on nonmotorized trails. Motorized users tend to go around rigid waterbars, defeating their purpose. Rigid waterbars are hazards for snowmobiles and groomers. The following graphic illustrates common placement of a rigid waterbar.

Note that waterbars are only intended for use on hiking trails.

IMAGE 9. Waterbar on hiking trail[2]

Trail Turns

Most contour or rolling grade trails require direction changes or turns to change elevation at a sustainable grade or to meet the key guidelines described above. The main turns are climbing turns, switchbacks and insloped turns.

For trails allowing mountain bikes, berms are recommended at each turn where downhill movement is allowed for insloped turns and switchbacks. Berms improve comfort and safety for bikes. The trail width should be increased at berms where equestrian usage is allowed to avoid frequent displacement of the berm by hooves. For such trails, berms should not be included in the recommended widths.

Climbing Turns

Climbing turns help trail users to gain elevation at a consistent and sustainable grade. There is no constructed platform or landing, and users will be climbing directly in the fall line for a short segment. Therefore, climbing turns should be free-flowing and gentle, and are not suitable for sideslope grades steeper than 7 %.

TYPICAL PLACEMENT

- Climbing turns can located on shallow slopes at or below 7%.

TYPICAL CONSTRUCTION

- Climbing turn radii should be kept as wide as possible, ideally 20' or more.
- Upper and lower legs of the turn are joined by a short section of trail that lies in the fall line. Armoring can be used to reduce maintenance on the fall line section of trail.
- Grade reversals should be located above and below the turn.

FIGURE 31. Climbing Turn

Natural or placed barrier

Side slope: 7% maximum

Outslope: 5%

Apex of turn aligns with fall line
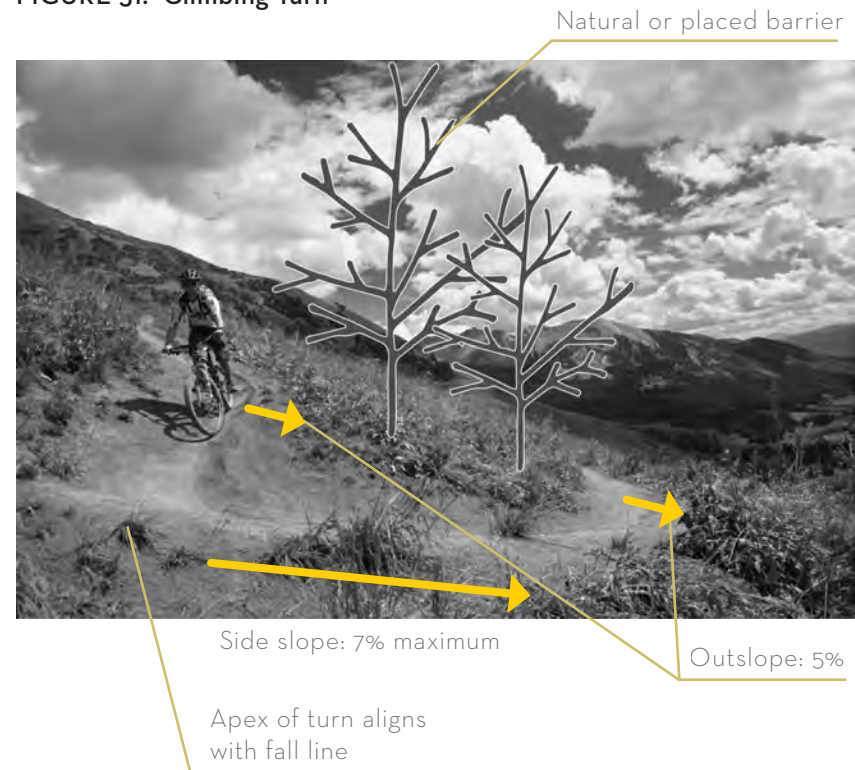
Switchbacks

Switchbacks allow direction reversal with a constructed landing and are more durable on steep slopes than climbing turns. IMBA recommends a version called the rolling crown switchback which are carefully engineered for effective drainage.

TYPICAL PLACEMENT

- Switchbacks should be placed on the flattest slope possible – gentle knobs or other natural platforms are good places to locate switchbacks.
- Stagger switchbacks to avoid short cutting.

TYPICAL CONSTRUCTION

- Turn should be placed on a near level platform that is slightly crowned.
- The turning platform should have a minimum 6' radius.
- Approaches should follow the contour and include grade reversals in advance of the turning platform
- Grade reversals should be located above and below the turn
- Approaches should be designed to control trail user speeds into the turning platform to reduce braking and maintenance.
- Material excavated from the top leg can be used to build up the bottom leg.
- Excavated material forming the turning platform and lower leg should be held in place with a retaining wall

FIGURE 32. Rolled Crown Switchback

Water drains out back of landing

Insloped tread approaching landing

Side slope: 10% or more

Crowned landing sloped 5% in all directions

Natural or placed barrier

Retaining wall

Outsloped tread following landing

Insloped Turns

Insloped turns are best for mountain bike trails to improve trail flow and add an element of fun by creating a banked or bermed turn. These turns can limit skidding and trail widening while providing a sustainable feature with close attention to drainage flows.

TYPICAL PLACEMENT

- In-sloped turns should be considered for any location where slowing is likely needed to allow a trail user to negotiate a turn
- Insloped turns work best on sideslopes up to 25%

TYPICAL CONSTRUCTION

- Approaches should follow the contour and include grade reversals in advance of the turn.
- The approach above the turn should be kept at a relatively gentle grade (5-8%) to keep speeds in check prior to the turn.
- The approach below the turn should be brief but steep (around 15%).
- Keep the radius of the in-slope turn between 10 to 15 feet.
- Position the turn around a natural feature such as a boulder or tree to prevent short-cutting of the turn.
- Keep sightlines clear since trail users will be capable of navigating these turns at higher speeds.
- Tread dip after turn allows trapped water to escape

FIGURE 33. Insloped Turn

Backslope blended with insloped tread

Side slope: <25% preferred

Natural or placed barrier

Insloped tread through turn
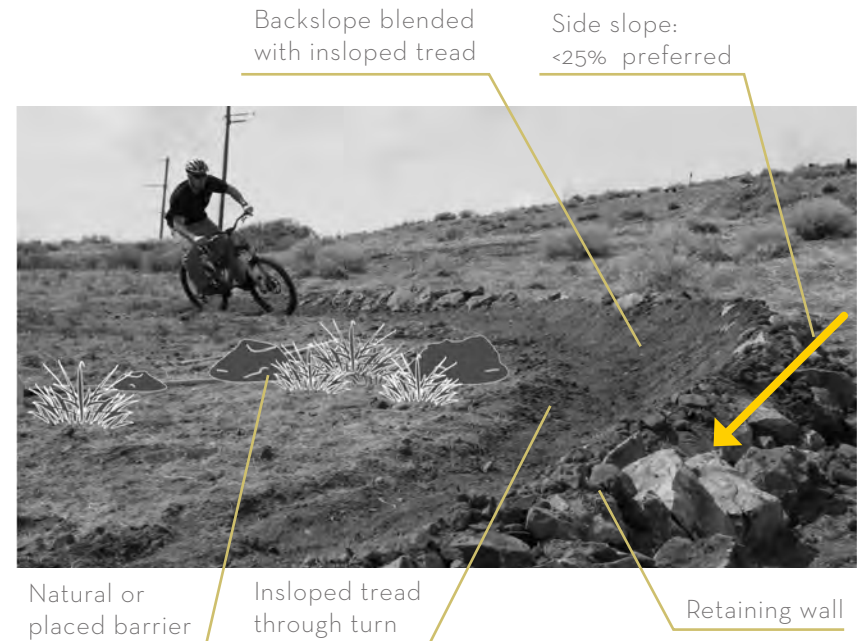
Retaining wall

IMAGE 10. Trail with a series of insloped turns[3]

Retaining Walls

Retaining walls can be used for a variety of purposes: to support turns or turning platforms on switchbacks, secure trails on rough terrain, and to support partial benches. The height of the retaining wall will dictate whether they can be done in-house or if outside expertise and calculations are needed.

Stone retaining walls allow trails to be built where they normally would not be, or to improve otherwise unsustainable conditions or design. The typical stone wall process is:

- Begin by cutting a footing off the trail edge so the finished wall will be off the trail tread
- Daylight the footing for drainage
- Stack larger stones intermingled with medium stones near the foundation and fill voids with smaller stones. More contact between stones means more friction and a better built wall.
- Stagger joints vertically and horizontally
- Materials excavated can be used as backfill

IMBA best practices should be consulted before making any retaining wall decisions. For walls along accessible trails or shared use paved trails, geotechnical and structural engineers are typically needed for the design to ensure quality, safety, and proper liability.

Drainage

Drainage is a crucial component to sustainable trails and can be divided into crossings, conveyance, and green infrastructure design. Major factors for drainage control include annual rainfall amounts, peak drainage flow depths, and how high water levels encroach on the land during 10, 20, and 100-year storms. Drainage structures may require review and permitting from agencies such as Tennessee Department of Transportation (TDOT), U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and Tennessee Wildlife Resources Agency

Crossings

Following the key principals should help establish key locations where creeks, intermittent streams or drainage channels, or groundwater surcharge need closer drainage attention. For crossings, typical solutions include direct crossing, trail hardening, culverts, or bridges.

Direct crossings are a continuation of the trail through the flow area. They can be utilized for drainages where flows are spread out and clearly intermittent and the facility is low-use.

For sustainable trails, trail hardening is preferred unless there are high water velocities or flow depths exceed 3 feet during high flows. Trail hardening, it is often essential to have an armored turn-down area

with a design that doesn't allow erosion of the base layer underneath the hardened features. Hardened crossings are most appropriate for drainages that experience seasonal, slow moving water that would otherwise erode a trail.

Culverts are most appropriate for flow areas with periodic flows in narrow, defined channels where ramping up to the crossing is not necessary. For culverts it is important to confirm that there are not significant peak flows. Culverts should be designed to TDOT standards when applicable and armored around the inlet and outlet to ensure they are long-lasting and avoid subsurface erosion.

Some regional trail networks are using low-cost recycled material bridges, log bridges are an example of a cheaper solution. For minimal maintenance, prefabricated bridges are a good solution if the budget permits. Bridges or boardwalks are the preferred crossing strategy for locations with flowing or continuously present water. Deck widths should match or exceed the trail width.

Conveyance

If the trail is designed in accordance with the key principals, conveyance shouldn't be a frequent concern. Often in retrofit situations, channel and hardening improvements are necessary to avoid having to re-grade or re-align long segments of trail. Channels should be properly sized to reduce ongoing erosion maintenance.

Low-impact (Green Infrastructure) Design

Low-impact stormwater design is most important at paved trails or at trailheads where there is an increase in impervious area. Green infrastructure can reduce peak flows, increase infiltration, and help reduce cross drainage structure sizes along paved trails. Most important it will help improve water quality. In rural or remote areas properly designed grass channels are a proven cost-effective approach.

Armoring or Hardening

Armoring is a method of using large rocks or stones to harden a trail and prevent erosion. Armoring for user-based erosion is much different than water-caused erosion. Additional measures should be taken in designs for armoring at drainage crossings, specifically the inclusion of turn-downs and grout stabilization.

Armoring for user-based erosion should be done in compliance with IMBA's Trail Solutions Specifications. Armored drainage crossings as mentioned above, are cost-effective solution for users to pass through while minimizing erosion. The crossings do not interfere with movement of water, sediment, aquatic life or woody debris when properly construction. It will be important to introduce consistent armoring details for use in the trail systems to ensure they are long-lasting, maintain a natural look, and don't significantly increase maintenance burdens.

PERFORMANCE SPECIFICATIONS

Design and Construction

For both bike park and trail network construction, design plans typically rely on performance specifications to set expectations and guidelines. Performance specifications help ensure consistency for maintenance, trail construction, and trail experience. For higher impact users such as mountain bikers, equestrians, maintenance vehicles, and ATVs, specifications should be adjusted for the use with the most surface impact.

A base set of specifications to be expanded or modified by trail type are as follows:

- All trail construction shall comply with the specifications, drawings, requirements and design intent prescribed in the construction and contract documents. Additional resources include IMBA's Trail Solutions (2004) and Managing Mountain Biking (2007). Modifications shall be approved by owner's representative.
- Completed products shall reflect professional workmanship in appearance, quality, and attention to detail. Trails and features shall be well integrated into the site, aesthetically pleasing in appearance, and well-shaped, crafted, and finished according to commonly accepted best practices for high quality trails. Work must be completed to the satisfaction of the owner's representative.
- Trail contractor shall leave trails and the adjacent area in a finished and natural-looking condition and minimize disturbance to permanent existing vegetation to the extent possible in coordination with general contractor, topsoil spreading, irrigation, and landscape installation.
- All excavated material generated during trail construction must be used in the trail or dispersed and blended into a surrounding terrain or removed. No piles of excavated material greater than 6 inches deep shall be left behind.
- The trail contractor shall be responsible for fine grading and positive drainage away from all trails and trail features. No impoundments nor ponding of surface water shall be allowed.
- Test Riding: Trail Contractor shall thoroughly test ride all trails and trail features by bike or typical user type. For bike trails, test ride to be with appropriate expert rider, to ensure the specified riding experience, design, flow, rhythm, character, difficulty, and specifications are met. Testing shall be performed during the trail alignment and trail feature location process, as well as during construction and following construction, to the extent possible and in consultation with owner's representative. Trails and features shall be modified and corrected as necessary until performance specifications are met.

Accessible Trails

Accessibility on trails ensures that access is provided for all trail users with special attention for users with mobility, auditory, visual, respiratory, and other impairments. Creating a truly accessible trail means thought is given to the construction, interpretive resources, and other components. Advances in technology have spurred developments in accessibility policy, especially regarding the implementation of Other Power-Driven Mobility Device (OPDMD) policies and providing trails with specific treatments where high populations of people living with disabilities may reside. Additional information can be found on the US Access Board website. In some instances, jurisdictions have adopted a policy to create trails that will serve as many users as possible, depending on the context, terrain, and other variables.

The United States Access Board has approved American with Disabilities Act Accessibility Guidelines (ADAAG) for trails and outdoor recreational access routes. Constructing trails may have limitations that make meeting ADAAG and AASHTO guidelines difficult and sometimes prohibitive. Prohibitive impacts include harm to significant cultural or natural resources; a significant change in the intended purpose of the greenway trail; requirements of construction methods that are against federal, state, or local regulations; or terrain characteristics that prevent compliance.

Guidance

- Provide a hardened, firm, and stable surface
- Clear tread width recommendations: 36 inch minimum
- Openings less than 1/2 inch
- Tread obstacles: 2 inches high maximum (up to 3 inches high where running and cross slopes are 5 percent or less)

LONGITUDINAL SLOPE

- Five percent or less for any distance
- Up to 8.33 percent for 200 feet max with resting intervals no less than 5 feet long and equal to the width of the trail at both ends
- Up to 10 percent for 30 feet max with resting intervals no less than 5 feet long and equal to the width of the trail at both ends.
- Up to 12.5 percent for 10 feet max with resting intervals no less than five feet long and equal to the width of the trail at both ends.

CROSS SLOPE

- 5% maximum

RESTING INTERVALS

- If resting intervals are not located within the trail tread, adjacent resting interval clear widths must be 3 feet minimum.

PASSING SPACE

- Provided at least every 1,000 feet where trail width is less than 60 inches

EDGE PROTECTION

- Provided on trails to increase safety. When provided, it should be at least 75 mm (3 inches) high since a lower surface might not be obvious or detectable to people with limited vision who use canes.

SIGNAGE

- Shall be provided indicating the length of the accessible greenway trail segment
- Trailhead signage: should provide accessibility information, such as trail gradient/profile, distances, tread conditions, location of drinking fountains, and rest stops.

DETECTABLE PAVEMENT

- Changes at curb ramp approaches should be placed at the top of ramps before entering roadways.

TRAILHEAD PARKING

- One accessible parking space per every 25 vehicle spaces at trailheads.

GROUND HEIGHT

- Trail amenities, drinking fountains, and pedestrian-actuated push buttons should be placed no higher than 4 feet off the ground.

Under the definitions of the Federal Accessibility Guidelines, there are three types of accessible routes;

- Access routes relate to the built environment where all routes need to meet accessibility requirements
- Outdoor recreation access routes relate to facilities in the outdoor environment where reasonable access is required
- Accessible trail relates to a natural trail that is designated as suitable for all levels of ability and consistent with conditions that have been set forth by the federal guidelines.

The Outdoor Developed Areas Draft Final Rule by the United States Access Board has defined four conditions that would allow for departure from the technical provisions in the guidelines. These conditions include;

- Where compliance would cause substantial harm to cultural, historic, religious or significant natural features or characteristics.
- Where compliance would substantially alter the nature of the setting or the purpose of the facility or portion of the facility.
- Where compliance would require construction methods or materials that are prohibited by federal regulations or statutes.
- Where compliance would not be feasible due to terrain or prevailing construction practices.

While this document provides a framework, new accessible trail construction should be verified with the latest and relevant pedestrian accessibility guidelines. ADA Part 35.104 and 35.130 detail power driven mobility device regulations and general prohibitions against discrimination for such devices.

Trail Signage and Access Control

Trail signage and access control are an essential component to sustainable trails to help maintain correct usage across different trail type and ensure safe experiences for users.

Trail Signage

Types of signs include:

- Regulatory / warning signs
- Difficulty level signs
- Interpretive and educational trail signs
- Community Wayfinding
    - Directional signs and route guides
    - Trailhead / orientation signs

REGULATORY/WARNING SIGNS

Regulatory and warning signage must conform to the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) and the AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities.

Regulatory signs should state route usage rules and regulations associated and identify the managing agency, organization or group

where applicable. The route regulations message should promote both user safety and enjoyment. It is important to post route use regulations at key access points such as staging areas and trailheads, along with the use of maps and informational materials. Route signage should also be coordinated with County and adjacent city networks.

Typical route regulation signs include:

- Route identification and confirmation
- Guidance and distance to trail destinations and key points of interest
- Safety features and user safety
- Warnings or known hazards
- Hours of use
- Pedestrian, bicycle, equestrian, ATV, and vehicular control
- Dog leash requirements, no smoking allowed, and alcohol requirements
- Notice of restrictions where use control is needed
- Protection of resources

DIFFICULTY LEVEL SIGNS

Trail signage indicating the level of difficulty should follow IMBA method to ensure consistency across the system and to other similar destinations. The IMBA method is being used by the most prominent mountain bike trail systems in the country. Their rating system is used to categorize the relative technical difficulty of recreation trails. IMBA's rating system can:

- Help trail users make informed decisions
- Encourage visitors to use trails that match their skill level
- Manage risk and minimize injuries
- Improve the outdoor experience for a wide variety of visitors
- Aid in the planning of trail and trail systems

Note this rating system is comparable to the International Trail Marking System used for ski trails throughout the world. This system is most applicable to mountain bikers but is also useful to hikers and equestrians. As noted in the following figure, tread width, tread surface, trail grade (maximum and average) and natural obstacles and technical trail features are the most important criteria to consider in the rating process.

IMBA has the following guidelines for ratings and the Trail Solutions Guide should be consulted for more detail:

- Rate Technical Challenge Only
- Collect Trail Measurements
- Include Difficulty and Trail Length on Signs and Maps
- Evaluate Difficulty Relative to Local Trails
- Use Good Judgment
- Consider Other Trail Qualities
- Use Common Sense and Seek Input

FIGURE 34. IMBA Trail Difficulty Rating System[4]

	EASIEST WHITE CIRCLE	EASY GREEN CIRCLE	MORE DIFFICULT BLUE SQUARE	VERY DIFFICULT BLACK DIAMOND	EXTREMELY DIFFICULT DBL. BLACK DIAMOND
TRAIL WIDTH	72" (1,800 mm) or more	36" (900 mm) or more	24" (600 mm) or more	12" (300 mm) or more	6" (150 mm) or more
TREAD SURFACE	Hardened or surfaced	Firm and stable	Mostly stable with some variability	Widely variable	Widely variable and unpredictable
AVERAGE TRAIL GRADE	Less than 5%	5% or less	10% or less	15% or less	20% or more
MAXIMUM TRAIL GRADE	Max 10%	Max 15%	Max 15% or greater	Max 15% or greater	Max 15% or greater
NATURAL OBSTACLES AND TECHNICAL TRAIL FEATURES (TTF)	None	Unavoidable obstacles 2" (50 mm) tall or less Avoidable obstacles may be present Unavoidable bridges 36" (900 mm) or wider	Unavoidable obstacles 8" (200 mm) tall or less Avoidable obstacles may be present Unavoidable bridges 24" (600 mm) or wider TTF's 24" (600 mm) high or less, width of deck is greater than 1/2 the height	Unavoidable obstacles 15" (380 mm) tall or less Avoidable obstacles may be present May include loose rocks Unavoidable bridges 24" (600 mm) or wider TTF's 48" (1,200 mm) high or less, width of deck is less than 1/2 the height Short sections may exceed criteria	Unavoidable obstacles 15" (380 mm) tall or less Avoidable obstacles may be present May include loose rocks Unavoidable bridges 24" (600 mm) or narrower TTF's 48" (1,200 mm) high or greater, width of deck is unpredictable Many sections may exceed criteria

Community Wayfinding

Comprehensive and innovative map, marking, and signing systems (collectively "wayfinding") helps to make trail networks more accessible, desirable, and memorable. Wayfinding branding offers an opportunity to create a unique theme and identity for signage and other trail support facilities. An overarching signage and directional system for the Norris Lake trails system will help users find their way to, from, and along trails. A good wayfinding plan requires an accurate understanding of the regional trail system: its routes, trail types, jurisdictions, destinations, origins, users, and the needs and abilities of those who maintain, manage, and provide emergency services for the trail.

The benefits of a region-wide wayfinding system include:

- Improved awareness of the trail networks
- Enhanced legibility for the public to find and follow the trail
- A greater sense of security and comfort
- Increased numbers of bicycle and walking trips for transportation and recreation
- Better agency and inter-agency planning, coordination and management

The five main principles are:

- Cohesion
- Connect Places
- Identity
- Predictability
- Keep it Simple

Wayfinding Elements

DIRECTION OR GUIDE SIGNS

Direction signs provide directional and distance information to major destinations and trail amenities. Direction signs contain the local trail name in the header plaque and list destinations. They should be placed along trails to indicate upcoming destinations and junctures.

CONFIRMATION MARKERS OR SIGNS

Confirmation markers provide in route reassurance of trail identity and inform users they are on a designated trail system route. They can include the system brand and trail name. The confirmation markers also provide space for supplemental directional arrows, use icons, and can double as mile markers.

TURN SIGNS

Turn signs inform riders about an upcoming intersection. They contain the destination or alternate route name and an arrow. They should be placed along trails shortly before trail junctures. Utilized off-route, they can help get cyclists to the trails.

FIGURE 35. Turn signs

PAVEMENT MARKINGS

Pavement markings are a cost effective and low-profile way to supplement or replace aspects of confirmation markers, mile markers, direction signs, and turn signs. They may also include interpretive elements, such as callouts to views or points of interest.

GATEWAY MONUMENT SIGNS

Gateway signs serve as trail landmarks placed at with major trail access points. They enhance the visibility of the trail network for both current and prospective users. The trail name is the focus of the sign content and is supported with local destinations that can be reached along that trail.

MILE MARKERS

Trail or mile markers provide users the visual assurance that they are on a specific route and can double as distance markers on a regular interval at least once per mile or every half mile. Distance markers can also be useful for both user and first responder orientation. They allow users to track how far they have traveled and help people put their location in context by matching the marker to a map. Most trail users identify strongly with distance from home, distance from their favorite place, or simply with knowing a certain location based on its relationship to a mile point.

FIGURE 36. Monument sign

FIGURE 37. Mile markers

INTERPRETIVE SIGNS

Interpretive signs provide information at key natural, historic, or cultural sites along trails. They are typically larger signs angled towards a point of interest. They typically include large graphic material.

TRAILHEAD KIOSKS

Kiosks provide visitors with information to orient themselves, learn of site opportunities, rules and regulations, hours of operation, and local events such as volunteer activities for the trail system. The design style should coordinate with the character and branding for the overall sign system. The kiosks should be readily identifiable as an information source and provide elements such as bulletin boards, regional maps, rules and regulations and accessibility advisories.

IMAGE 11. Trailhead at Loyston Point

Design

A thoughtful wayfinding design aesthetic can help reinforce the identity and character of a trail network. Though the signage elements have different scales and dimensions, they should be instantly recognizable as part of the same wayfinding family. This is achieved through a uniform design style, including graphics and icons, colors, fonts, materials, shapes, and proportions.

This document provides high level guidelines, but the next steps are to develop a conceptual wayfinding design. Following the concept design, additional levels of input and outreach are required to develop a final design.

On-Road Sign Placement

Sign placement should typically be outside of sight distance triangles and meet AASHTO and MUTCD guidelines for each facility type.

Wayfinding guide sign mounting height and vertical clearance requirements vary by location (see Figure 7 14-8). The minimum height, measured vertically from the bottom of the lowest sign on the assembly to the near edge of pavement or top of curb are as follows:

- Rural Areas – 5 ft minimum
- Urban Areas* – 7 ft minimum
- Shared Use Path – 4 ft minimum

*or where pedestrian traffic or parking is likely

Sign placement and mounting height must meet pedestrian accessibility requirements. This is particularly important in urban areas where multiple sign panels are mounted on the same post and may be in close proximity to pedestrian clear zones. See the proposed PROWAG and MUTCD Section 2A.18 for more information.

The MUTCD requires post-mounted signs on-street to be crashworthy if within the clear zone. The lateral offset, measured horizontally from the edge of curb to the left edge of the largest sign panel on an assembly, are as follows:

- Rural Areas – 12 ft minimum
- Urban Areas* – 2 ft minimum
- Shared Use Path – 2 ft minimum

*or where pedestrian traffic is likely

See MUTCD Section 2A.19 for more details. Per MUTCD, bicycle wayfinding signs should not be mounted overhead.

To allow adequate advance notice of left turns, decision or turn signs should be placed at a distance before the intersection that is based on the number of turn lanes the bicyclist needs to merge across to make a legal left turn.

- Zero-lane merge: 25 ft
- One-lane merge: 100 ft
- Two-lane merge: 200 ft

Access Control

Access Control refers to physical barriers such as bollards, gates, or landscape medians that control use of trails. In some situations, it is necessary to control public vehicle access through the use of:

- Bollards
- Fencing & Gates
- Bollard alternatives – landscape medians

When feasible, landscape medians or other bollard alternatives are preferred for user comfort and providing all ages and abilities facility access. Where fencing and gates are needed, they can help reinforce the desired trail theme and brand. Decorative fencing can add visual interest to a trail or trailhead and could be used as gateway elements or adjacent to neighborhoods to help establish the trail as a unique and memorable place.

Lighting

Lighting allows specific areas to be used at night and provides safety for trail users. Lighting should be considered at trailheads, staging areas, and on-street crossings. In some cases, lighting may be helpful for the hours around dusk and controlled with timers. Lighting should not be considered where nighttime use is not expected, next to sensitive wildlife habitat areas, or adjacent to residential neighborhoods near trail systems.

Matching the complimenting light fixtures style and types with other site furnishings will strengthen the overall aesthetic of the trail system staging areas. Light output color should be considered, since consistent color illumination will visually enhance and link the staging areas at night. All light sources should provide a similar warm white color light. Solar powered light fixtures should be utilized where feasible for new installations or for retrofit projects.

Crime Prevention Through Environmental Design (CPTED) principles, specifically the role of lighting, should be considered for trailheads, street crossings and in evaluating the overall trail system.

TRAIL BUILDING

Steps for developing trails:

CONFIRM THE PROPERTY

Confirm property limits, environmental conditions, and flood boundaries. Consider where users should be allowed and where use is prohibited, such as environmentally sensitive areas.

PREPARE THE CONSTRUCTION PLAN

Create a critical path analysis of construction to avoid bottlenecks and slow downs as trail construction is heavily weather-dependent. Partner with local organizations and businesses to coordinate in-kind donations of labor and materials.

CONFIRM TRAIL USERS & FEATURES

Identify current and target trail users to determine necessary trail typologies and trail features. Ability, age, and intended activity all relate to network layout and trail construction. Consider conflicts between user groups.

CONSTRUCT TRAIL(S)

Clear the corridor based on requirements for intended trail users. Cut trail benches - full or half bench (see following page for details) and turns to navigate topography while avoiding excessively steep trail. Minimize environmental impact through construction.

LAYOUT THE TRAIL

Identify control points - both as places users are encouraged to access and places they are not. Design trail system based on stacking loops that follow the natural contours. Ensure trails offer a variety of open, flowing segments and tight, more technical sections.

INSTALL SIGNAGE

Use signs to reinforce control points. Develop messaging based on intended users and related interests; coordinate with interpretative exhibits. On multi-use trails, provide graphic explanation of trail etiquette including yielding. Consider mile markers to assist with emergency response.

FLAG THE CORRIDOR

Walk the exact alignment of the proposed trail (in both directions) and flag the corridor as well as any obstacles to remain in the trail. Use flags to provide guidance for the construction crew.

FORMALIZE MANAGEMENT & MAINTENANCE

Coordinate with agencies and organizations to ensure seasonal and annual maintenance of trails. Identify trails and locations within the trail system in need of more regular maintenance.

Trail Construction

Natural surface trails meet the recreational demands of hikers, mountain bikers, equestrians, and other non-motorized recreational trail users. Proper trail construction is important to reduce ongoing maintenance costs as well as to ensure that the trail is both usable and enjoyable for intended user groups.

New trails should be constructed using a "full bench cut" in which the entire trail tread is built on solid ground. A "partial bench cut" which is similar to "cut and fill" will only be utilized if a full bench cut is not feasible due to rock outcrops, slabs, or other natural features. A partial bench cut uses loose fill dirt to construct a portion of the trail treads. Fill dirt tends to loosen over time and can then wash and erode. This issue is minimized when constructing a full bench cut. The trail bed will be shaped to leave an even, compacted, uniform surface free of indentations or protruding roots and stumps. The grading of the trail tread, back slope, and drainage features will be finished to a smooth, stable surface. Any excess or disturbed soil outside the trail tread is evenly distributed and covered with leaves, organic debris, and other natural materials to aid in aesthetics and sedimentation and erosion control.

FIGURE 39. Full Bench Construction

Round critical point

Shoulder Width

Tread Width

Place excavated material evenly away from trail

-5% to 5%

FIGURE 38. Partial Bench Construction

Shoulder Width

Tread Width

Round critical point

Place excavated material evenly away from trail

Retaining wall backfilled with appropriate material
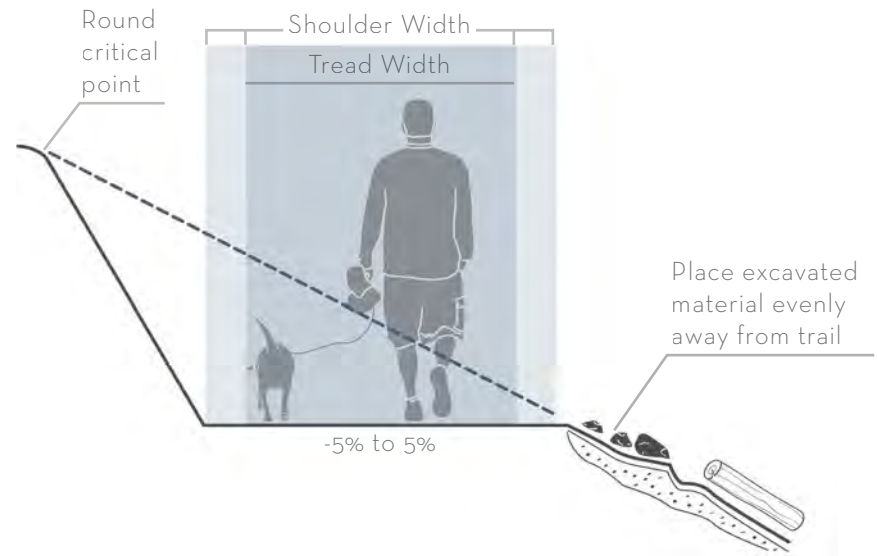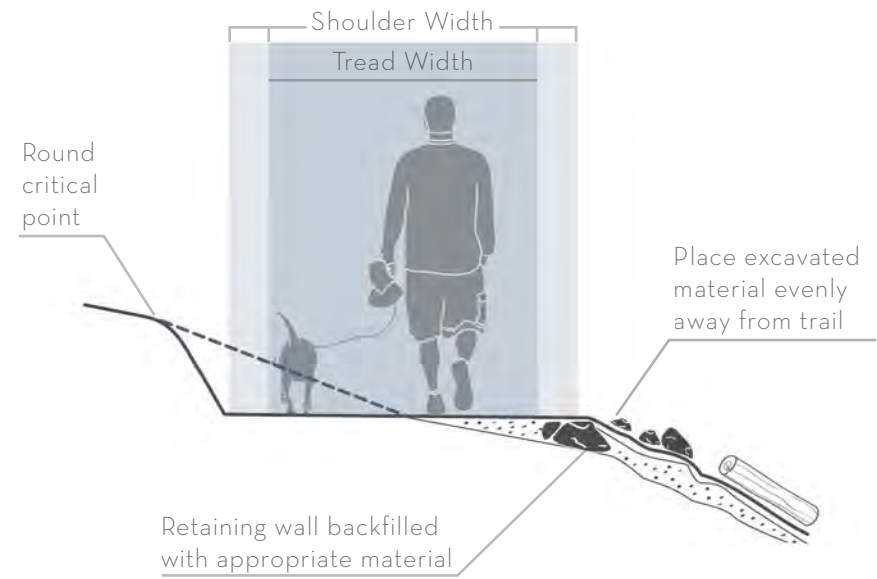
TRAIL CONSTRUCTION METHODS

How a trail is constructed (mechanized or by hand) influences the finished product. However, the two methods should not be conflated with a desired result. Rather than rely on an implementation method, a proposed trail should be described using the following performance/design standards:

- Impacts (visual, soil and plant disturbance)
- Tread width
- Tread texture
- Tread shaping (in/out-slope, berms, lips/landings)
- Clearing limits
- Sinuosity/meander
- Drainage features (spacing and amplitude of grade reversals)
- Angle of repose of the back-slope
- Maximum height of tread obstacles

It is then up to the contractor to select the most cost-effective method to build the trail in conformance with the performance standards. For example, a narrow, rugged trail in the backcountry will likely be built by hand whereas a 48"-wide, smooth trail in the front-country will likely be built using mechanized equipment. Even with performance standards it is good practice to mandate maximum equipment size so that unqualified contractors don't bid on a project expecting to use equipment that is better suited for road building than trail construction.

Other factors besides access and physical characteristics may influence the chosen trail construction method. Schedule and availability of volunteers may also impact trail construction methods.

IMBA's Trail Solutions Specifications should be consulted for key construction steps for turns, retaining walls, drainage crossings, armoring, and wetlands.

Tools and Equipment

The recommended tools and equipment vary by trail type, location, and who is doing the construction. Several resources for tool and equipment selection include the following:

- IMBA's Trail Solutions handbook
- Professional Trail Builders Association website (https://www.trailbuilders.org)
- American Trails website (https://www.americantrails.org/)
- U.S. Forest Service Trail Management Tools (https://www.fs.usda.gov/managing-land/trails/trail-management-tools)

Since the type and technological development in machinery such as mini-dozers and mini-excavators is continually evolving, we recommend consulting other organizations such as the Northwest Arkansas Trailblazers or trail specific contractors that are building many miles of trail each year. It could be very useful for the purposes of both new construction and maintenance.

Hand Tools

For manual, complicated trail maintenance the most common tools include:

CLEARING TOOLS

- Weed Cutter
- Machete
- Swedish Safety Brush Axe
- Brush Hook
- Loppers (Pruning Shears)

SAWING AND CHOPPING TOOLS

- Bow Saw
- Razor-Tooth Saw
- Folding Saw
- Pole Saw with Pole Pruner
- Axe

GRUBBING AND RAKING TOOLS

- Mattock
- Hoes (Grub Hoe/Adze Hoe/Hazel Hoe
- Pick
- Fire Rake

DIGGING AND TAMPING TOOLS

- Digging-Tamping Bar
- Pole-Hole Digger

POUNDING AND HAMMERING TOOLS

- Single Jackhammer
- Star Drill

LIFTING AND HAULING TOOLS

- Timber Carrier (Log Carrier)
- Peavey and Cant Hook
- Griphoist
- Come Along
- Rigging (Block and Table)
- Wheelbarrow
- Canvas Bags
- YAK Trailer or Beast of Burden (BOB)

BARK PEELING TOOLS

- Spud (Bark Spud)
- Drawknife
- Adze

Mechanized Tools

Mechanized tools allow for more rapid construction and maintenance. With advances in technology, machines have become more accessible and a reduced footprint even in more extreme terrain. The most common tools include:

WALK-BEHIND EARTHMOVERS

- Compact utility loaders

RIDE-ON EARTH MOVERS

- Mini-Dozers

Excavators

CHOOSING THE RIGHT MACHINE

In many cases, there isn't a wrong answer to tool choice but there are some key factors to consider as outlined in the Trail Solutions Specifications.

- Is hand labor available?
- How steep is the sideslope?
- How is the traction?
- What is the desired trail width?
- Are there rocks and roots?
- Is there a thick organic layer?

IMAGE 12. Mechanized trail construction[5]

TRAIL MAINTENANCE

Maintenance refers to the routine and remedial tasks performed to ensure that trails are kept in safe and usable condition for users over the short-term and long-term life of the trail. Effective maintenance begins with proper planning, design, and construction. A comprehensive trail maintenance plan should include all known and anticipated routine and remedial tasks required to provide a safe and positive user experience. The plan should identify personnel and equipment costs needed for each task. Quick and timely responses to maintenance issues by trail managers can help build the public's confidence that the network of trails in the Norris Lake Area will result in a positive user experience.

FIGURE 40. Trail Maintenance Decision-Making Flow Chart

Assessments	Elements	Findings	Decisions
National Environmental Policy Act	Visitor Use	Conditions do not exceed resources, safety standards, and visitor capacity.	**Full Operations:** Trails remain open. Management and restoration as needed.
Trail Condition Assessment & Inventory	Erosion	Conditions annually exceed resources, safety standards, and visitor capacity for a short period or season.	**Temporary/Seasonal Closure:** Trail use limited. Repair and restoration of closed areas.
Trail Carrying Capacity Guide	Mud	Conditions annually exceed resources, safety standards, and visitor capacity.	**Permanent Closure:** Trail realignment considered. Restoration and management plan developed for closed areas.
Trail Counts & Intercept Surveys	Ecological Sensitivity		
	Trail Facilities and Amenities		
	Cultural Resources		

NEPA Review: roadway projects

Receive Notice to Proceed for NEPA from TDOT Local Programs Development Office	**TDOT Local Programs Development Office coordinates with reviewing agencies**	**Engineering must pass environmental clearance by TDOT and reviewing agencies**	**Submit project to State Historical Preservation Office, which may trigger further review**	**Receive clearances from reviewing agencies and complete project engineering**

NEPA Review: off-road trail projects involving federal agencies (project lead, permits, funding)

Determine NEPA requirements for reviewing agencies.	**Determine likelihood of environmental impact, and if impact is an approved categorical exclusion.**	**If impacts are uncertain, develop Environmental Assessment (EA). Reassess significance of environmental impacts.**	**If significant impacts likely, prepare Environmental Impact Statement (EIS). Identify preferred alternative.**	**Record decision, which is not restricted to the environmentally preferable option. Monitor, if applicable.**

*A proposal to change NEPA was active at the time of printing

Guiding Principles of Sustainable Trail Maintenance

The collective network of trails in the Norris Lake Area should be viewed as a public resource that will help establish East Tennessee as a regional recreation destination. The most important factor for developing sustainable trails is to plan, design and construct the trail with a clear understanding of the desired user groups and a thorough understanding of trail building techniques that minimize adverse impacts. The following guiding principles, organized around key themes, will help trail managers maintain and preserve a world-class system.

Prioritize Public Safety and Liability

- The most important goal of a trail maintenance program is to provide a safe, comfortable, and attractive trail experience.
- Establish written protocols for trail inspection, maintenance, and reporting.

Provide a High-Quality User Experience

- Provide a high-quality experience for a variety of trail users of all ages and abilities.
- Where possible, weave the unique historic, cultural, and recreational aspects of a community into the trail experience.

Cultivate Partnerships

- Encourage cooperative partnerships with volunteer organizations, adjacent landowners, local communities, and other government agencies.
- Keep the lines of communication open especially for adjacent residents and businesses.
- Conduct periodic community meetings to discuss and address concerns.
- Leverage public-private partnerships to assist with funding and maintenance.
- Creatively use social media to engage the community and seek volunteers (i.e., Facebook, MTB Project, etc.)

Generally, maintenance is completed by trail managers or planners. Maintenance and inspection practice will vary depending on the facility being maintained. The following guidance is specific to the trails within the Norris Lake region and should cover the range of trail uses.

Maintenance tasks can be designated as routine or remedial. Routine tasks take place on a regular basis whether daily, monthly, seasonally, or less frequently. The more rigorously the routine trail maintenance

schedule is followed, the less likely remedial maintenance issues will occur. Remedial maintenance responds to a specific unplanned activity such as repairing a broken fence or removing a fallen tree limb. Trail maintenance supported by an inspection program is also important for risk management. When a maintenance issue occurs on a trail, it is important to address the issue and document having done so. If it cannot be immediately addressed, it is important to document steps taken so as to minimize liability.

Routine Maintenance Operations

Routine maintenance refers to the regularly scheduled maintenance activities that help trail managers:

- Provide a safe environment for trail users
- Reduce long-term costs by addressing minor maintenance needs before they grow into major issues
- Create predictability for users and volunteers.

A routine maintenance regimen can include litter pick-up, trash and debris removal, weed and dust control, trail sweeping, sign replacement, tree and shrub trimming, and other regularly scheduled activities. Routine maintenance may also include minor repairs and replacements such as fixing cracks and potholes or repairing a broken hand railing.

Routine trail inspections are an important element to a trail maintenance program. Inspections allow for the documentation of issues and provides a baseline for determining future maintenance costs. Inspections can also help track maintenance response rates, which can lead to a more efficient maintenance system.

The type of facility, concentration of users, seasonal impacts, and vegetation growth rate will impact routine maintenance schedules. Some maintenance activities may need to occur weekly, while other activities are only necessary on a monthly, seasonal, or annual basis.

The frequency of required maintenance tasks should be established as new facilities are implemented and should be reviewed and updated annually to reflect any changes in usage, safety issues, etc. Trail managers can use methods such as pedestrian and bicycle counts, sketch plan analysis methods for estimating pedestrian and bicycle demand, public survey results, and public meeting comments to determine which resources are the most heavily used and may require the most attention.

Often it can be very helpful to have a system in place for trail users to provide input, feedback, or report issues with trails. Social media platforms can be one way for trail users to flag maintenance issues.

Facility Maintenance

Basic housekeeping of trail facilities will ensure that the network is clean and functional and will also improve the life of each facility. Clearing trails of trash, glass, branches and other forms of debris improves safety for users and maintains facility aesthetics. Swiftly responding to graffiti will help discourage the broken window effect, where signs of neglect can encourage further vandalism. Volunteer efforts should be utilized where practicable in the performance of this maintenance task. Typical facility maintenance items are:

- Sweeping/blowing
- Trash and debris removal
- Graffiti removal
- Preventative maintenance for paved trails

IMAGE 14. Gravel on trail[6]

Vegetation Management

Vegetation encroaching onto (or under) trail facilities can impede trail users and reduce visibility. For paved trail surfaces, roots should be controlled to prevent surface defects that lead to hazardous conditions. Adequate clearances and sight distances should be maintained. Trail users should be visible to approaching motorists in locations where

this is possible. Overgrown shrubs and low-hanging branches can also obscure wayfinding signs.

When conducting vegetation management, trail managers should pay close attention to the important role that vegetation plays in facility character as well as user experience. Routine trimming, mowing, and pruning of vegetation can contribute to trail aesthetics and user safety, but an overly aggressive approach can degrade the natural features that attract users in the first place.

IMAGE 15. Multi-use trail in Northwest Arkansas[7]

IMAGE 16. Overgrown grass on trail[8]

TYPICAL VEGETATION MANAGEMENT TASKS INCLUDE:

- Tree and shrub trimming and pruning
- Mowing of vegetation
- Invasive species control
- Mulching and edging

- Root pruning or removal
- Weed suppression
- Leaf litter removal from drainage facilities

TABLE 15. Routine Maintenance Operations

ISSUE	FREQUENCY (BY TRAIL TYPE)					RECOMMENDATIONS
	Shared Use Trails	Accessible Trails	On-Road Facilities	Bike Optimized Trails	Singletrack Trails	
Facility Maintenance						
Sweeping/ Blowing	Weekly	Weekly	Bi-weekly	Quarterly	Quarterly	• Hard surface trails can be swept by machine. • Spot sweeping of some trail areas may be swept by hand or blowers. • For unpaved facilities, remove loose rocks. • For on-road facilities, coordination with local agencies may be required.
Trash Removal	Bi-weekly	Bi-weekly	Bi-weekly	Quarterly	Quarterly	• Includes removal of ground debris and emptying of litter and/or recycling cans. • Consider using volunteers for this task.
Vegetation Management						
Tree / Shrub Trimming and Pruning	Spring and Fall; and as needed to maintain clear zones					• Trim vegetation that encroaches on vertical and horizontal clear zones to maintain user safety. Remove low-hanging limbs. • Maintain proper sight distances at trail intersections and around curves. • Ensure vegetation is not blocking signage.
Mowing	Bi-weekly during Spring, Summer and Fall.					• Mow vegetation along trail corridors where appropriate to maintain minimum horizontal clear zones. • For on-road facilities, coordination with local agencies may be required.
Weed Control	One time each during Spring, Summer and Fall					• Cut or spray weeds encroaching on/growing through the trail with approved herbicide by licensed applicator. Cutting is preferred whenever possible, and is the only acceptable method in ecologically sensitive areas.
Invasive Species Control	One time each during Spring, Summer and Fall					• Manually remove or spot spray invasive species that harm local ecosystems. Pest management plans should be developed and enacted to protect and preserve areas of special value, such as wetlands, riparian buffers, etc.

Remedial Maintenance Operations

Remedial maintenance responds to specific unplanned tasks. Remedial maintenance activities can range from minor items, such as removing fallen tree limbs to correcting significant defects in the network. Remedial maintenance also includes the repairing, replacing or restoring major components that have been destroyed, damaged, or significantly deteriorated from normal usage and old age. Some items may occur on a five- to ten-year cycle such as repainting, seal coating asphalt pavement or replacing signage. Major reconstruction items will occur over a longer period or after an event such as a flood. Examples of major remedial issues include stabilization of a severely eroded hillside, repaving a trail surface or a street used for biking, or replacing a footbridge. Remedial maintenance should be part of a long-term capital improvement plan.

The following tasks should be performed on an as needed basis to keep network facilities in good, usable condition. The table below depicts the average life of each facility type, as well as general ancillary facilities, with normal wear and tear. The repair or replacement of existing facilities should be reflected in a projected budget for future maintenance costs.

LONGEVITY OF FACILITIES	
Mulch	2-3 years
Granular Stone/ Natural Surface	7-10 years
Asphalt	7-15 years
Concrete	20 + years
Boardwalk	20 + years
Bridge/Underpass/Tunnel	100 + years

Establishing a Priority Process for Remedial Maintenance

Major maintenance needs will need to be prioritized to determine which needs are addressed first. While a robust routine maintenance program will reduce major needs, some remedial work will be necessary. Trail managers should consider establishing a maintenance prioritization process to determine which needs are addressed first. When prioritizing tasks, trail managers should evaluate the underlying issues behind the maintenance need. For example, a major repair on a little-used section of trail may not be as high a priority as a less expensive project on a more heavily used trail segment. Once maintenance issues and needs are prioritized, they can be translated into a list of projects for construction.

TABLE 16. Priority Maintenance Lists - Hypothetical Example

TRAIL SEGMENT	DESCRIPTION	UNDERLYING ISSUES/RATIONALE
Priority Issues		
Singletrack Loop A	Trail wash-out	• User safety • Environmental degradation
Shared Use Path B	Undercut trail	• User safety
Priority Needs		
Side Path - Mile Marker 53	Resurfacing needed on heavily used trail	• User safety • Accessibility
Shared Use Path C	Wayfinding signage needs cleaning	• Trail experience • User safety
Locations to Monitor		
Singletrack Loop B	Faster than normal weed growth from heavy rainfall	• User safety • Environmental degradation
Bike Lane - Mile Marker 34	Pavement marking is fading	• User safety
Access Road	Gravel showing signs of rutting	• User safety • Trail experience
Construction Projects		
Side Path - Mile Marker 53	Resurfacing needed on heavily used trail	• Funding available • High volume of users
Singletrack Loop A	Trail wash-out	• Trail segment closed until repair can be made

Facility Repair / Replacement

All trail facilities will require repair or replacement at one time or another. Facility repairs can include relatively minor items, such as signage cleaning and repainting benches, to major items, such as structural repairs to bridges and boardwalks and trail widening projects.

In some situations, existing trails to be converted to a different use or needing repair, it will be necessary to decommission, realign, or reconstruct a trail with adherence to the guidance in this document.

The time between observation and repair/replacement will depend on whether the needed repair is deemed a hazard, to what degree the needed repair will affect the safety of the user, and whether the needed repair can be performed by an in-house maintenance crew or if it is so extensive that the needed repair must be done by outside entities or replaced completely. For further guidance, refer to the Trail Maintenance Table (Table 17 on pages 141-142).

Habitat Enhancement or Control

Habitat enhancement and control can improve aesthetics, help prevent erosion, and provide for wildlife habitat. Habitat control involves mitigation of damage caused by wildlife.

- Plant vegetation, such as trees and shrubs
- Take preventative measures to protect landscape features from wildlife, such as installing fencing around sensitive or newly planted plant materials
- Apply herbicide to eliminate any problem plant species, such as poison ivy or kudzu, etc.
- Apply herbicide to maintain facility edges and prevent encroaching vegetation, such as along trails and sidewalks
- Deter interaction between facility users and facility inhabitants, such as feeding the wildlife, etc.

IMAGE 18. Schuylkill River cleanup[9]

IMAGE 19. Schuylkill River cleanup[10]

Widening

For high-volume routes, trails with a change in use, or adding an emergency access route, widening may be needed as part of the remedial maintenance. Widening should be done in accordance with the guidelines in this document. Close attention should be paid to avoid settlement, compaction or surface variance between the existing and new sections of trail.

Drainage Upgrades or Replacement

For retrofit, upgrades, or trail replacement, drainage features previously mentioned such as culverts, hardening, or bridges should be considered. For most maintenance solutions, there are two low-cost drainage improvements that can be utilized: knicks and rolling grade dips.

KNICKS

Knicks are effectively out-sloped drain features. Knicks can be utilized to redirect water off poorly drained sections of existing trails on gentle slopes often regardless of the cause of the issue.

- Typical Placement
  - Knicks are normally located on gradual segments of existing trail where puddling occurs.
  - Knicks should be located adjacent to and lower than the trail so that the knick will have a place to drain.
- Typical Construction
  - Knicks should be constructed as semi-circular depressions, about 10-feet in diameter, that direct water to the outside of the trail.
  - Knicks should be constructed with a max 15% outslope

ROLLING GRADE DIPS

Rolling grade dips are useful in draining water from a trail whose slope is too steep to be drained by a knick alone. Rolling grade dips are preferred over waterbars which require frequent maintenance and compromise the trail user experience. Rolling grade dips require cohesive soils so they may not apply to some of the project area.

- Typical Placement
  - Rolling grade dips are typically located at sections of trail where water flows down the trail rather than across it.
- Typical Construction
  - A rolling grade dip features a knick followed by a crest and a long, gentle ramp hindering water from flowing down the trail
  - Ramps and crests should be thoroughly compacted and consolidated to resist the velocity of water running down the trail
  - Typically, soil excavated from the knick can be used to construct the crest.

IMAGE 20. Rolling grade dip[11]

Maintenance Practices

The following is a list of best practices for common routine and remedial maintenance. For busier networks trail users are invaluable for notification of issues or areas in need of repair.

Routine Trail Inspections

- The best trail maintenance programs inspect and respond to maintenance issues at the same time
- Requires planning and equipment, such as paint, saws, weed killer, graffiti removal supplies, trash bags, etc.

Routine Maintenance Practices

See Table 17 on the following pages for best practices pertaining to routine maintenance operations.

TABLE 17. Remedial Maintenance Operations

ISSUE	FREQUENCY (BY TRAIL TYPE)					RECOMMENDATIONS
	Shared Use Trails	Accessible Trails	On-Road Facilities	Bike Optimized Trails	Singletrack Trails	
Facility Repair/Replacement						
Structures						
Bridges / Underpasses / Tunnels	Annual inspection by licensed engineer					• Repair as needed • Expected lifespan of 50-100 yrs
Boardwalks	Annual inspection by licensed engineer					• Repair as needed • Expected lifespan of 20+ yrs
Amenities (benches, litter receptacles, waysides, restrooms)	Annually or as needed					• Repair and repaint benches, litter receptacles and other facilities. Remove graffiti as soon as possible. Ensure restrooms are in good working order. Inspection should be done on a regular basis to discourage the broken windows effect.
Signage	Annually or as needed					• Ensure signs are clean and in good repair
Drainage & Erosion Control						
Regrading (knicks & rolling dips)	N/A	N/A	N/A	As needed		• Regrading may be necessary to prevent or eliminate low spots and resolve other drainage issues. Consider the use of knicks and rolling grade dips to resolve most drainage-related issues.
Washouts	As needed; inspect facilities after storm and flood event					• Identify extent of repairs, risk of environmental degradation, and volume of trail users. Refer to the Trail Maintenance Decision Making Flow Chart and Priority Matrix.
Trail Widening	Inspect annually					• May be necessary if evidence exists that trail users are using clear zones due to high volume of users. Consider user types, ecological impacts of trail widening and adjust facility design accordingly.
Habitat Enhancement						
Plant or replace vegetation	Annually					• Trees, shrubs and groundcover plantings should be part of the annual budget, as properly-designed plantings can help control erosion, enhance the wildlife habitat through native plantings, and contribute to a trail facility's character.
Weed suppression and invasive species control	As needed to ensure user safety					• Cut or spray weeds that encroach on trail facilities outside of the regular maintenance periods. This may be necessary during especially wet growing seasons or if regular weed control maintenance practices are not followed.

TABLE 17. Remedial Maintenance Operations Continued

ISSUE	FREQUENCY (BY TRAIL TYPE)					RECOMMENDATIONS
	Shared Use Trails	Accessible Trails	On-Road Facilities	Bike Optimized Trails	Singletrack Trails	
Pavement Preservation						
Surface treatments	Every 3-5 years			N/A	N/A	• Treatments for asphalt surfaces include fog seal, chip seal, microsurfacing. Consider trade-offs between durability of treatment, curing time, and initial cost vs. maintenance costs.
Crack treatments	Within first 5 years of construction, then as-needed after			N/A	N/A	• Necessary to prevent moisture infiltration, which can accelerate pavement distress.
Pothole & depression repair	Seasonally or annually					• For paved asphalt facilities, consider trade-offs of hot-mix vs. cold-mix asphalt patching. Generally hot-mix patches are more durable.
Resurfacing	Every 10-20 years			N/A	N/A	• Appropriate when asphalt trail has reached the end of its useful life. Methods include asphalt overlay over the existing surface, mill and overlay which removes existing asphalt prior to application of a new layer. Take care to ensure resurfacing maintains the originally designed slopes and grades and that it is flush around surface utilities such as gutters, manholes, inlet grates, etc. .
Pavement Markings						
Paint	Lifespan of approx. 3-24 months depending on environmental factors and trail usage.			N/A	N/A	• Generally least expensive to install but also less durable than other materials. Very sensitive to high humidity.
Epoxy Paint	Lifespan of approx. 24-48 months depending on environmental factors and trail usage.			N/A	N/A	• More durable than latex paint but also more expensive to install. Requires specialized equipment to ensure proper blending of its bonding components.
Thermoplastic	Lifespan of approx. 48-72 months depending on environmental factors and trail usage.			N/A	N/A	• Durable; ideal for high traffic areas. More expensive than paint and epoxy paint.
Preformed Tape	Lifespan of approx. 36-96 months depending on environmental factors and trail usage.			N/A	N/A	• Most durable option and also most expensive to install. Can be used for lane lines, legends, symbols.

Typical Maintenance Costs

The chart to the right is a planning level estimate of annual maintenance costs for the various types based on the sample checklists.

ACTIVITY	SUB-TYPE	DISCUSSION	PLANNING-LEVEL COST
Annual Maintenance	Sustainability-Built Trails	Costs increase slightly for backcountry trail because of the time associated with mobilizing personnel, equipment and materials into remote areas	4% of total construction costs
	Unsustainable Legacy Trails	Difficult to estimate, each trail would have to be evaluated individually.	Requires individual evaluation
Weed Control	N/A	Aggressive control and containment of weeds to current extent will keep future costs low; public education at trailheads can help reduce weed dispersal along trails.	$1,500 per trail system mile
Trails Management	N/A	Develop a position for a ranger(s) to monitor and manage activities within the Norris Lake Area. Includes salary, benefits, fuel, equipment maintenance, and cell phone.	$81,500 / year (one position)

Trail Specifications and References

The following resources are supplemental guidance for designing and constructing sustainable trails:

- IMBA Trail Solutions Specifications
- IMBA Guide to Providing Great Riding
- MN DNR Trail Planning, Design, and Development Guidelines
- Bureau of Land Management Guidelines for a Quality Trail Experience

As a means of consistency and basis for the trail system these references should be used in design, construction, and maintenance when practicable.

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