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The Eastern Goochland Greenway

Connecting Goochland's Past, Present and Future

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The Eastern Goochland Greenway
Connecting Goochland's Past, Present, and Future

Prepared for
Virginia Department of Conservation & Recreation

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Introduction

Project Purpose

The Eastern Goochland Greenway Plan proposes a shared-use trail that is nested within the Virginia Department of Conservation and Recreation's (DCR) conceptualization of a statewide trail system called the James River Heritage Trail (JRHT). The JRHT includes shared use bicycle and pedestrian facilities as well as water trail access points that would connect pre-existing trail systems to new proposed trails that are parallel with and in close proximity to Virginia's James River corridor and all of the natural, cultural, and historic resource opportunities that the surrounding areas offer. Specifically, the Eastern Goochland Greenway aims to serve two major purposes:

- Safely and sustainably connect the natural, cultural, and historic resources along the River Road West (Virginia State Route 6) and James River corridors in eastern Goochland County through providing a shared use trail for recreational enthusiasts, casual users, and commuters alike.
- Contribute to ancillary benefits related to human health, economic impact, and environmental health that shared use recreational trails can provide.

The proposed trail will span approximately 16.58 miles along the River Road West (Virginia State Route 6) corridor, a Virginia Byway, with its eastern terminus near the County's eastern border shared with Henrico County at West Creek Parkway, the entrance to West Creek Business Park, and its western terminus located at Goochland Courthouse Village within the census-designated place and county seat of Goochland, specifically connecting to existing bicycle and pedestrian infrastructure at Goochland High School and Middle School (Figure 1). The County's explicit desire for this project is expressed in the *2040 Major Thoroughfare Plan*, in which the recommended thoroughfare improvement is listed to "Construct [a] multimodal facility" from "River Road West (Virginia State Route 6) to Henrico County Line". This facility will additionally support Goochland's *2035 Comprehensive Plan* objective of "providing multi-modal facilities such as sidewalks, shared-use paths, and bikeways". Additionally, the Eastern Goochland Greenway has the potential to connect to the larger trail systems throughout the JRHT corridor, such as the Virginia Capital Trail running from Williamsburg west to Richmond, aiding in the creation of a statewide trail system.

The statewide JRHT route, with a western terminus at the headwaters of the James River in the Allegheny Mountains and an eastern terminus where the river empties into the Chesapeake Bay at Hampton Roads, offers a variety of recreational opportunities from water sports like kayaking and fishing to terrestrial activities like cycling and hiking. Additionally, the JRHT provides access to cultural assets such as proprietors of Virginia's booming craft alcohol industry and is rich in historical significance in the form of Virginia Landmarks Register, National Register of Historic Places, National Park Service, and National Historic Landmarks sites. Goochland County is no exception to these notions, providing a wealth of natural, cultural, and historic assets throughout the County and particularly along its southern border defined by the James River. This plan first discerns the locations of the natural, cultural, and historic resources along the route as well as which areas have or are lacking sustainable trail elements, trail-oriented development, and public services related to safe, sustainable shared use trails. Next, it seeks to determine where the most suitable locations to support the addition of these missing components are. Then, the plan uses a sustainability rating system to determine what the level of sustainability of the trail could be if plan recommendations are implemented.

Introduction

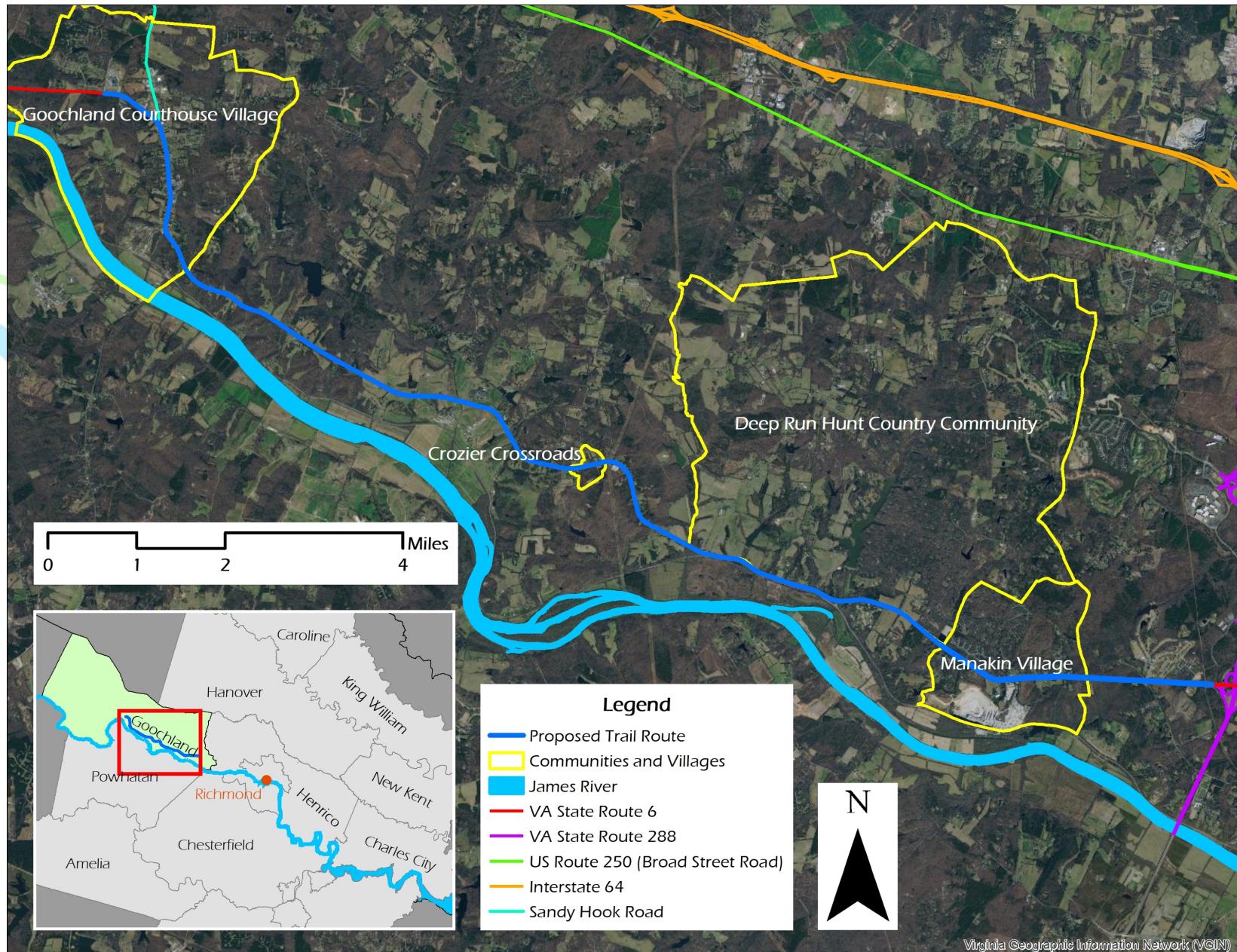


Figure 1. Eastern Goochland Greenway Study Area Map (Goochland County GIS Department, 2019).

Introduction

Client Description

The primary client for the Eastern Goochland Greenway plan is the Virginia Department of Conservation and Recreation (DCR), headquartered in Richmond, Virginia. Representing the DCR is Jennifer Wampler, the agency's Trails Coordinator. The DCR has conceptualized the creation of the statewide James River Heritage Trail, a braided trail network that follows the James River from the foothills of the Allegheny Mountains to the Chesapeake Bay. Trail segments follow the old Kanawha Canal towpath, park trails, scenic riverside roadways, and urban riverfront trails deep into the commonwealth (VA Department of Conservation and Recreation, n.d.). The roughly 17-mile Eastern Goochland Greenway will be a trail segment nested within the larger James River Heritage Trail.

Plan Outline

The Eastern Goochland Greenway Plan starts by providing necessary foundational information regarding Goochland County and the specific study area's existing conditions. This section covers background information, includes a robust discussion of the communities in which the proposed trail route passes through, and ends with future projections of population and employment trends. Next, a literature review of the existing knowledge about research around the topics relevant to the plan is carried out to identify themes that support the rationale for carrying out the plan, as well as identify gaps in the literature in which the plan attempts to address. Then, the plan's approach regarding the methods for conducting the necessary research in order to generate plan recommendations is discussed. Finally, the plan examines a variety of recommendations offered to carry out the development of the trail and create a safe, sustainable shared use trail providing Goochlanders, Virginians, and tourists alike with all the benefits the Eastern Goochland Greenway can offer.

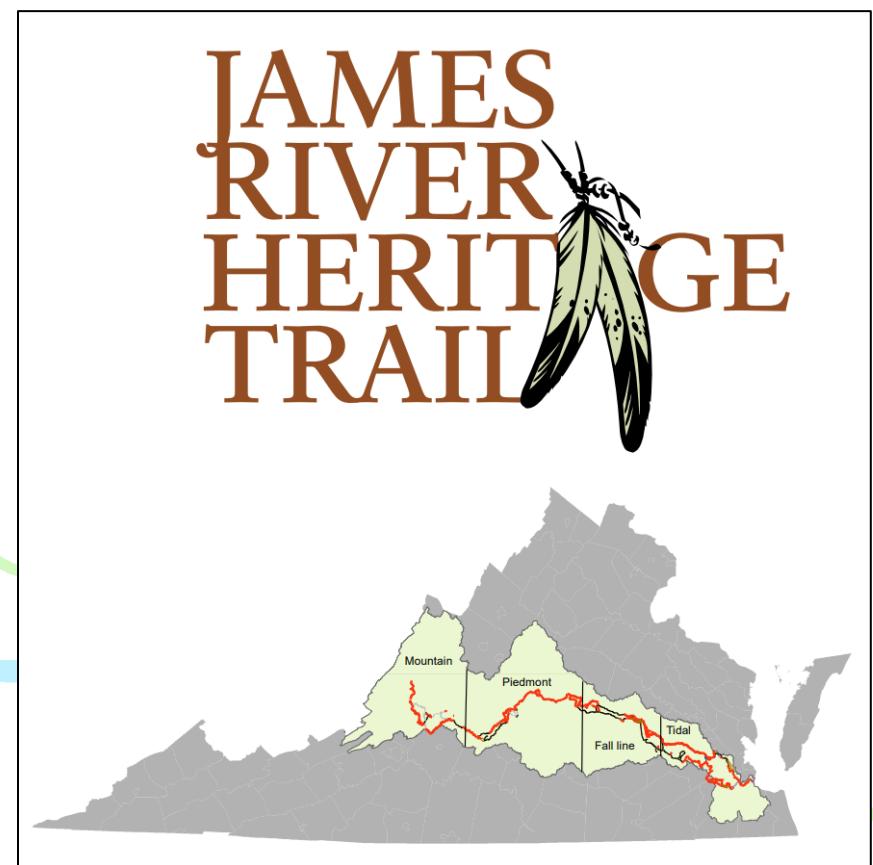


Figure 2. DCR Logo and James River Heritage Trail (VA Department of Conservation & Recreation, 2011).

Background

Plan Context

Goochland County is a rural locality situated in central Virginia on the western edge of the growing Richmond, Virginia Metropolitan Statistical Area (MSA) and is approximately 25 miles southeast of the City of Charlottesville. Goochland has an exurban and rural setting and is immediately west of the heavily populated, sprawling, and suburban Henrico County, which surrounds the City of Richmond. Tuckahoe Creek acts as the eastern boundary with Henrico County, and Goochland abuts Louisa and Hanover Counties to the north and Fluvanna County to the west. The James River flows along the County's southern border and separates it from Powhatan, Cumberland, and Chesterfield Counties to the south. Interstate 64 traverses the northern part of the County from east-to-west, and four interstate interchanges are located within the County along this route (Figure 1). U.S. Route 250 passes through the County close to and parallel with Interstate 64, and Virginia State Route 6 (River Road West) runs east-to-west in the southern part of the County (Figure 1). Virginia State Route 288, which serves as a western segment of the outer circumferential highway/expressway system for the Richmond region, crosses the eastern part of the County (Figure 1). Goochland is home to West Creek Business Park, a 3,500-acre, campus-style business park which serves as the principal economic driver for the County. Major employers in West Creek include Capital One, CarMax, the Virginia Farm Bureau, and Performance Food Group. Luck Stone Corporation operates facilities countywide, including its corporate headquarters near West Creek (Goochland County, 2015).

Although its residents value the County's rural character and strive to keep it intact, the Greater Richmond Region's exploding population growth and sprawling development patterns are increasingly encroaching further into Goochland along major regional corridors. These notions have influenced Goochland's planners' creation and update of several new and pre-existing countywide plans to prepare for the County's continued future growth. In order to proactively guide Goochland's expected future population growth and associated physical development demand, a variety of innovative planning strategies can be considered and implemented to accommodate these projections. Specifically, Goochland's *2040 Major Thoroughfare Plan* identifies and elaborates upon the County's aspiration for achieving an improved multimodal transportation network in a number of key areas and crucial corridors (Goochland County, 2018). Because of the County's immediate proximity to the James River, the DCR also has interests in creating multimodal trail networks in Goochland County as well.

Background

Goochland County is roughly 289 square miles (184,960 acres) in area and the 2017 population was 22,457 (Goochland County, 2015, 2018). Much of the County's development is concentrated with developed land making up approximately 22% of the total land area and the rural land use designation making up 64% of all County land, resulting in a development footprint of 1.84 acres per resident (The Center for Urban and Regional Analysis, 2017).

Examining the land uses within the River Road West corridor and the Eastern Goochland Greenway study area reveals similar patterns. As reflected in the County zoning map, the land uses around the majority of the trail route, particularly the middle portion, are largely agricultural, aiding in the scenic beauty of rural Goochland that trail users could experience (Figure 3). Contrastingly, the land uses within the study area's two termini exhibit more business and residential uses, suitable for the potential of these development nodes to contribute to many different trail aspects (Figures 5 and 6). A number of different villages and communities are intersected by the proposed trail route, discussed next.

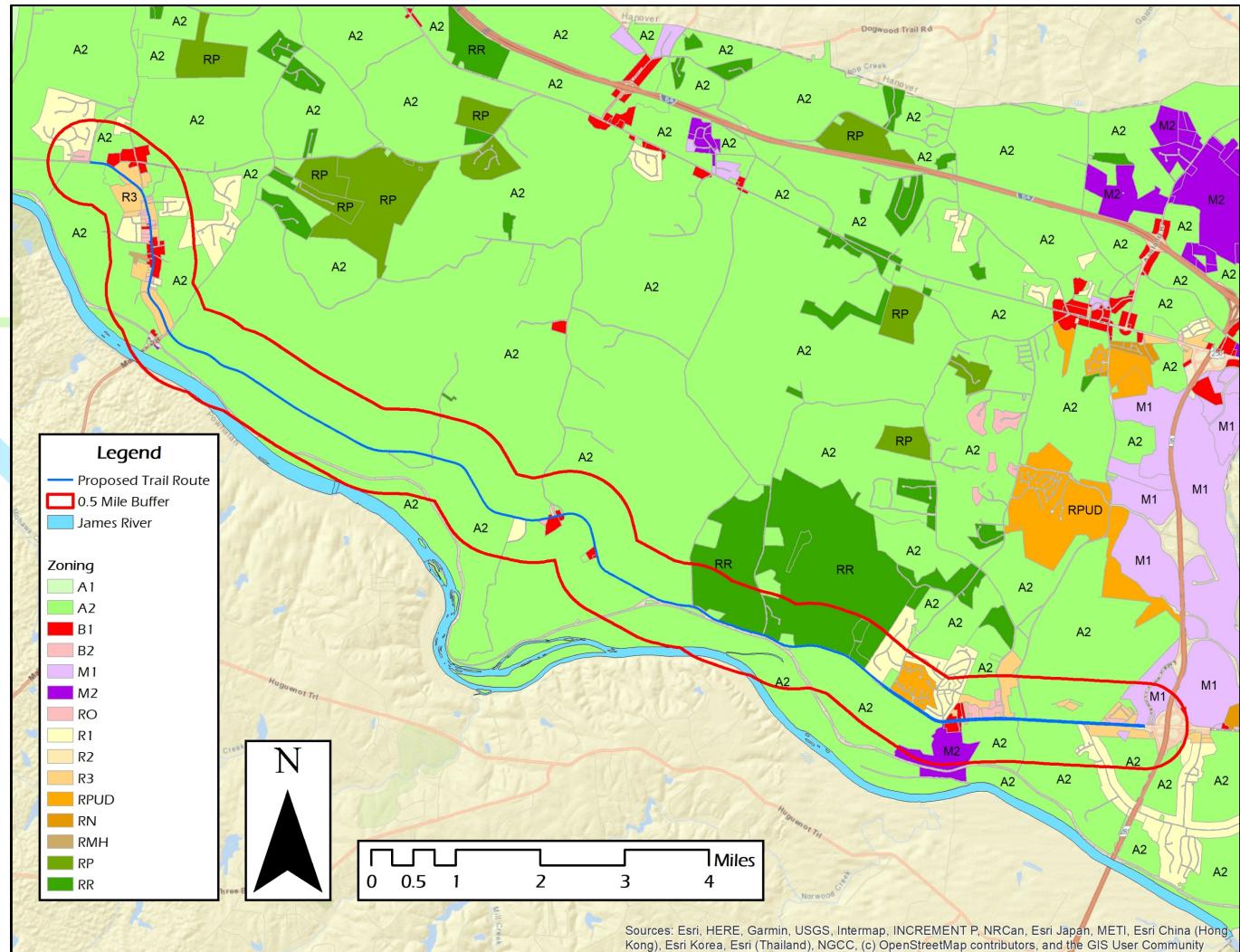


Figure 3. Study Area Zoning Map (Goochland County GIS Department, 2019).

Background

Villages & Communities

The River Road West corridor in which the proposed trail will be located is situated in the southeastern portion of Goochland County and parallels the James River. Following a relatively linear path for the most part, the study area passes through the major village of Goochland Courthouse, the emerging major village of Manakin, the rural crossroads of Crozier, and the Deep Run Hunt Country Community (Goochland County, 2015). These villages and communities vary in size, design, and a variety of other characteristics, detailed below.

Goochland Courthouse

Goochland Courthouse, the only major village within the study area and the western terminus of the proposed trail, is the historical and institutional center of government and public services for the County. This village serves as the County's civic center with the courthouse, municipal building, library, the County's only middle school and high school, community shopping centers, the YMCA, Reynolds Community College, and residential areas located here. In Goochland, major villages like Goochland Courthouse have existing utility services and/or plans to expand utility services in the future. These areas are identified as "designated growth areas" where new development should be encouraged and concentrated. Currently, Goochland Courthouse is one of only three major villages and service districts in the County that offers public water and sewer services, so it is expected to be a primary location for future development.



Figure 4. Goochland County Courthouse (Goochland County, 2020).

Background

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Land use designations along the River Road West corridor in this village are almost entirely business and residential uses, with agricultural uses becoming more prevalent moving away from the corridor towards the peripheral areas (Figure 5). Pedestrian traffic is common and encouraged within Goochland Courthouse because of existing pedestrian infrastructure such as light-pole lined sidewalks along River Road West and additional pedestrian and cyclist infrastructure connecting to Goochland High School and Middle School. Furthermore, this corridor is within the Courthouse Design Overlay District, which is one of a number of County overlay areas applied to selected entrance corridors and village centers in order to conserve elements of the County's scenic beauty and to preserve and protect these areas (Goochland County, 2019).

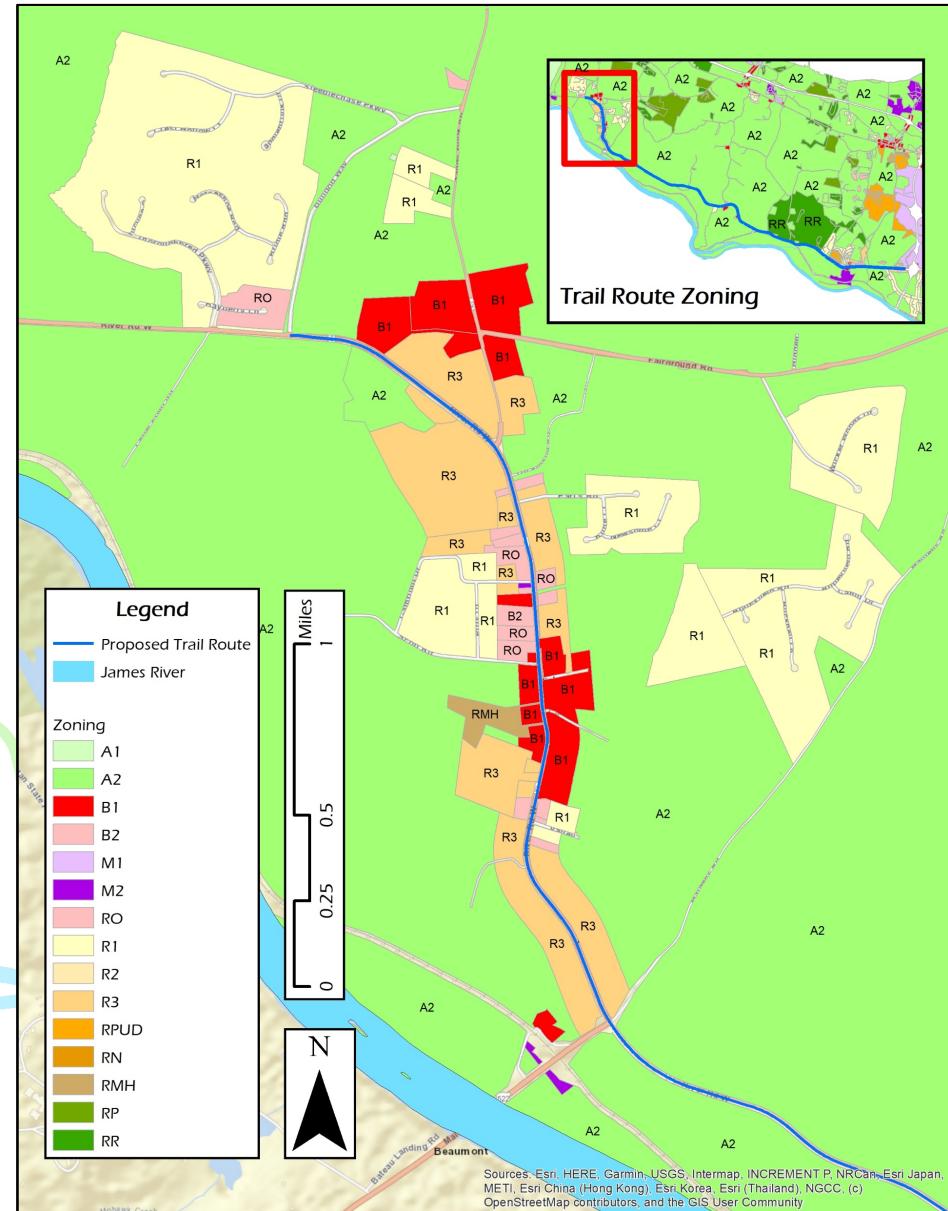


Figure 5. Western Terminus Zoning Map
(Goochland County GIS Department, 2019).

Background

Manakin

The village of Manakin close to the proposed trail's eastern terminus has a likelihood of having access to public water and sewer within the next twenty years, so is considered an emerging major village by Goochland County (Goochland County, 2015). Land use designations along the River Road West corridor in this area are largely business and residential on the northern side of the roadway and agricultural and industrial on the southern side, including the large Luck Stone Boscobel Quarry along the James River (Figure 6).

Additionally, the eastern terminus of the proposed trail route connects to the West Creek Business Park, an established business park totaling over 3,500 acres of land with approximately 800 acres developed, 1,700 acres undeveloped, and 650 acres preserved in a flood plain (West Creek Business Park, n.d.). The business park employs more than 10,000 people and is home to a number of large regional and even national businesses such as Capital One, CarMax, Virginia Farm Bureau, Hospital Corporation of America (HCA), Performance Food Group, and the Federal Reserve Bank of Richmond (West Creek Business Park, n.d.). Zoned for hospitality, light industrial, medical office, multi-family, office, and retail and with ample water and sewer capacity for future growth, the West Creek Business Park is a quickly growing regional attraction that provides much potential for the context of the Eastern Goochland Greenway Plan.

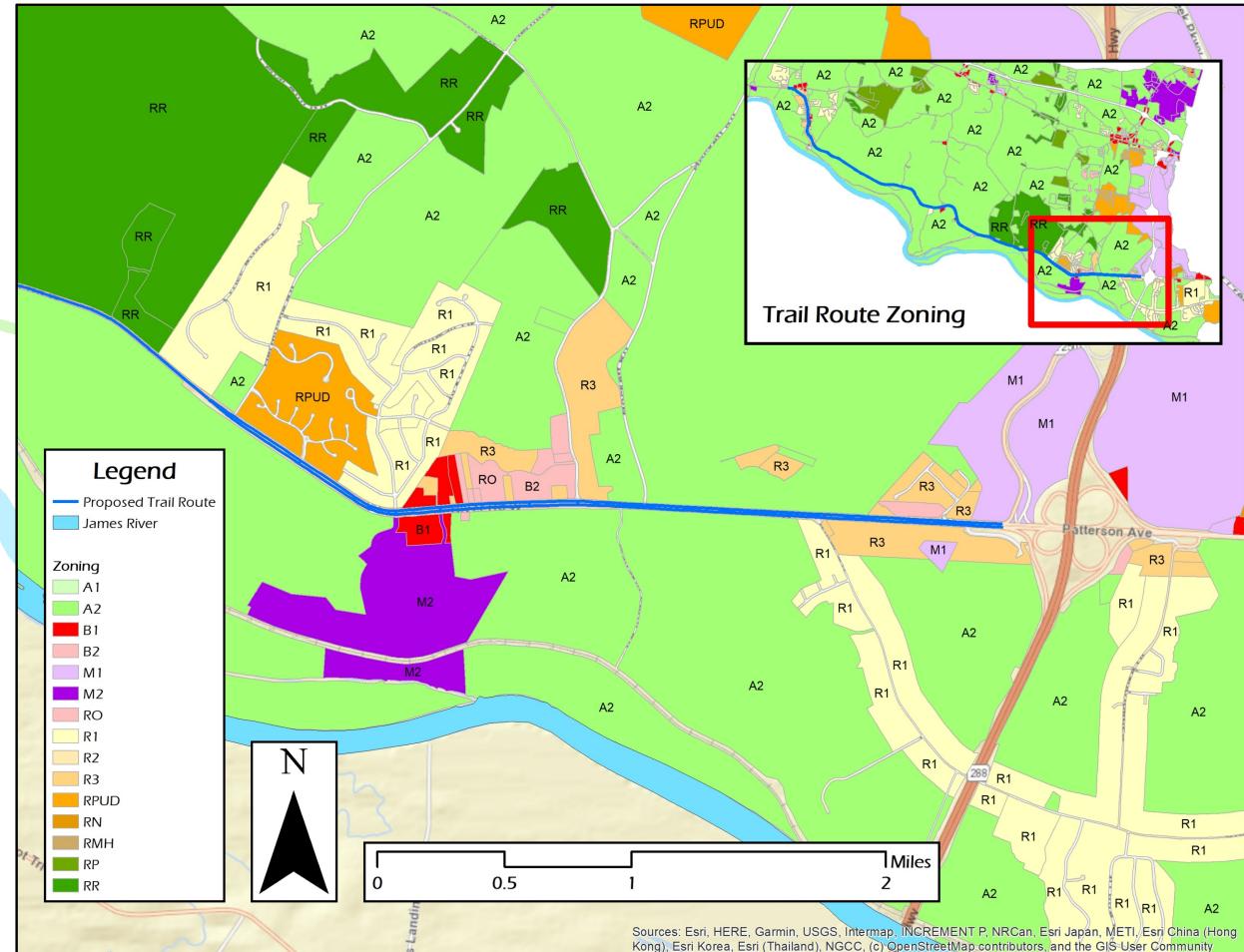


Figure 6. Eastern Terminus Zoning Map (Goochland County GIS Department, 2019).

Background

Deep Run Hunt Club & Crozier

Considering the villages and communities that are situated in between the developed termini areas of the trail route, the trail passes through the Deep Run Hunt Club Community and the rural crossroads of Crozier. The Deep Run Hunt Country Community is located along the northern side of the River Road West corridor and shares a southwestern boundary with Manakin. The area is known for its equestrian activities and is home to the Deep Run Hunt Club, numerous horse farms, and equestrian schools. The character of the area is large lot single-family residences, horse farms, equestrian trails, and semi-public facilities centered on recreational activities (Goochland County, 2015). Lastly, the rural crossroads of Crozier is the smallest community that the study area intersects. Rural crossroads are an important part of the County's heritage but are not necessarily areas where the County wishes to encourage development. These small districts once served as the commercial and social centers of their surrounding areas and still maintain their rural character and function as viable centers of activity (Goochland County, 2015).



Figure 7. Crozier, Virginia along River Road West in Goochland County (Wikimedia Commons, 2018).

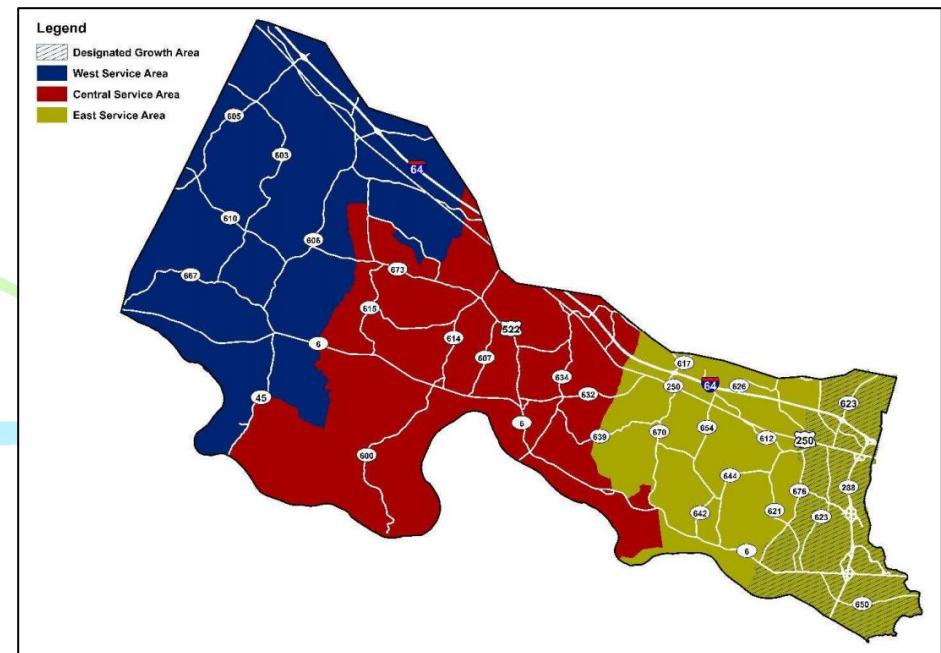
Background

FUTURE PROJECTIONS

The population and employment trends in Goochland are projected to nearly double by 2040, especially in the County's East Service Area, one of two service areas that the proposed Eastern Goochland Greenway will travel through (Table 1). Population is expected to grow by 163% and employment by 71% in the Eastern Service Area while population is expected to grow by 28% and employment by 156% in the Central Service Area, the other service area in which the proposed trail route passes through (Table 1). In considering these projected trends, it is important for Goochland County to preemptively prepare for the increased physical development and infrastructural enhancements that will be required to accommodate this growth. Because of this notion, the opportunity arises to target the aspiration for creating a "complete local transportation system includ[ing] bikeways, sidewalks, and other pathways" outlined in the *Goochland 2035 Comprehensive Plan* in concert with the objective of developing a multimodal facility along River Road outlined in the *2040 Major Thoroughfare Plan* (Goochland County, 2015, 2018).

Table 1. Goochland County Socioeconomic Projections
(Goochland County, 2018).

Socioeconomic Data	2017	2040	Percent Change
Population			
West Service Area	4,038	4,925	22%
Central Service Area	7,184	9,164	28%
East Service Area	11,235	29,571	163%
Total	22,457	43,660	94%
Employment			
West Service Area	704	1,472	109%
Central Service Area	1,795	4,598	156%
East Service Area	13,115	22,420	71%
Total	15,614	28,490	82%



Background

Trail Assets

One of the primary objectives of the Eastern Goochland Greenway plan is to connect the River Road West and James River corridors' natural, cultural, and historic resources and provide enhanced access for commuters, recreational enthusiasts, and casual users alike to visit and interact with these sites.

Preliminary research involved with identifying the locations of these sites was aided by data provided by the plan's client, particularly concerning sites of historic significance, as well as an additional identification process. All sites are within a maximum distance of 2 miles of River Road West although the majority of sites are much closer, keeping in mind that on average it takes approximately six minutes or less to travel one mile by bicycle for the average user. Table 2 lists the names of the identified natural, cultural, and historic resources – referred to as trail assets – along the route, their corresponding numbers on the map, and their asset type classification. On the following page, Figure 9 shows a map of the sites in relation to the trail route, the James River, and the Fire-Rescue Stations along the route. The assets are color coded in Table 2 to correspond with the asset types in Figure 9.

Table 2. Trail Assets

Number	Name	Asset Type
1	Thomas Jefferson Boyhood Home (Historic), Tuckahoe (NRHP Listing), Tuckahoe Plantation (Current Name), Tuckahoe Plantation House (Historic)	Historic
2	Powell's Tavern (Historic/Current)	Historic
3	Hardywood Park Craft Brewery - West Creek	Cultural
4	Kindred Spirit Brewing	Cultural
5	Edwin Joseph DuVal House (Historic/Location), Oak Grove (Historic/Current)	Historic
6	Ben Dover (Historic), Ben Dover Farm (Historic)	Historic
7	Rochambeau (Current), Rochambeau Farm (NRHP Listing)	Historic
8	Brookview Farm (Current), Dover Slave Quarter (NRHP Listing), Dover Slave Quarter Complex (Historic)	Historic
9	First Union Colored School (Historic/Current), Rosenwald (Descriptive)	Historic
10	Tanglewood (Tavern, Inn, Ordinary) (Historic), Tanglewood Ordinary (Historic/Current)	Historic/Cultural
11	Kameschatka (Historic), Lightfoot's Beaverdam Plantation (Historic) (also known as Mount Bernard Complex)	Historic
12	T. Brady Saunders Boy Scout Camp	Natural/Cultural
13	Courthouse Creek Cider	Cultural
14	James River Park	Natural
15	Tucker Park at Maidens Crossing	Natural
16	Brightly (Historic/Current)	Historic
17	Goochland County Historical Society	Historic
18	Goochland County Court Square Historic District (Historic/Current)	Historic
19	Goochland County Administration Complex	Cultural
20	Goochland Farmers Market - Courthouse	Cultural
21	Hidden Rock Park	Natural
22	Goochland Elementary School	Cultural
23	Goochland Middle School and Goochland High School	Cultural
24	Lock-Keeper's House (NRHP Listing), The Lock-Keeper's House (Historic/Current)	Historic
25	Powhatan State Park	Natural
26	Goochland Branch Library	Cultural
27	Goochland Family YMCA	Cultural
28	Reynolds Community College	Cultural
29	Leakes Mill Park	Natural

Background

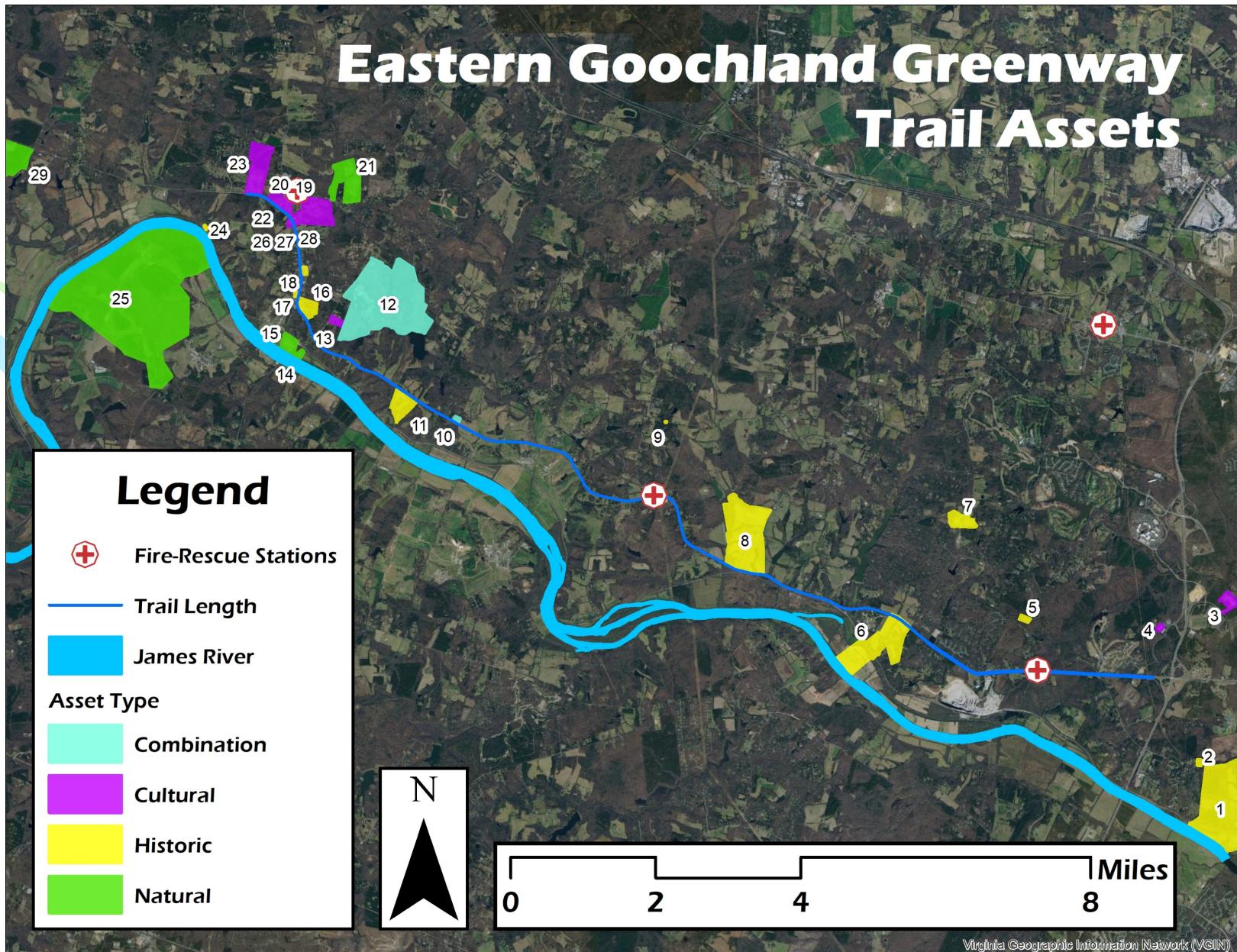


Figure 9. Trail Assets Map (Goochland County GIS Department, 2019).

Background

Existing Knowledge

Communities of all sizes are increasingly investing in bicycle and pedestrian infrastructure, with these trends reshaping destinations across the globe (Urban Land Institute, 2016). In the United States, localities and even entire states can implement trail systems to support a number of beneficial processes regarding topics such as human health, economic impact, and environmental health. In order to better comprehend the current state of knowledge relevant to the subject of shared use trail development as it pertains to the Eastern Goochland Greenway, a review of the existing literature on this topic was necessary. This literature review sought to identify the current state of knowledge regarding sustainable, shared use trail development, determine any potential gaps in the literature, and set the context of further research necessary for the Eastern Goochland Greenway.

After analyzing the contemporary literature regarding trail development, four overarching themes emerged as central to the current state of knowledge on this topic and most relevant for this plan. These themes bring up questions that are sought to be answered through the literature review process, and the answers to these questions serve as a basis of knowledge that will inform the development of successive portions of the plan. The following themes were identified:



Sustainable trail development

Shared use trails support current economic, environmental, and social needs without compromising the ability for future generations to meet these needs.



Human health

Shared use trails offer a number of beneficial opportunities to support human health.

Information uncovered in the literature review supplies the plan with foundational knowledge with which to determine the accompanying methodology utilized to generate recommendations. In addition to a number of peer-reviewed articles and academic studies, the literature review was also informed by higher-level institutional reports, such as the Federal Highway Administration's *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts* report. These reports provide a basis for determining the best practices in trail development that will be echoed throughout the other thematic areas of the literature review. Best practices for sustainable trail development are discussed first, as this portion of the research informs the successive themes identified further in this review.



Economic impact

Shared use trails can have large, advantageous impacts on local and regional economies.



Environmental health

Shared use trails foster a connection with the environment and can encourage conservation efforts and crucial ecological processes.

Background

Sustainable trail development

The first step in considering trail development is understanding the current methods and best practices for creating these networks. Specifically regarding the rural character inherent of the study area in Goochland County and the accompanying source of pride this provides for the local population extending from their rustic identity, a review of the literature sought to uncover best practices in trail development that could be applied to match the characteristics of the communities in which the trail route is located. The topical areas of best practices covered by this review are the physical characteristics of sustainable trails, performance measures and rating systems that enhance the planning, construction, and use of trails, and considerations of sustainability in trail development. A number of studies, in concert with contemporary reports produced by the Federal Highway Administration, provide the foundational understanding of how to implement best practices when designing trails, particularly those that exist in rural communities.

The *Small Town and Rural Multimodal Networks* report provides a wealth of information regarding best practices for the physical specifications of rural trail development. Particularly relevant to this project are this report's guidelines for physically separated facilities, the ideal form of bicycle and pedestrian facility for this plan due to considerations such as the chance for fewer conflicts with motor vehicles (Federal Highway Administration, 2016). Figure 10 displays a diagram of the ideal trail type for the Eastern Goochland Greenway. Especially considering the detailed physical aspects of model trail design in rural communities, this 2016 report provides recommendations regarding specific geometric design aspects such as pathway widths, roadway separation widths, and landscape recommendations, as well as other elements regarding markings and signage, intersection design, and accessibility considerations (Federal Highway Administration, 2016). Although this report is extremely detailed and helpful in a specific design capacity, it is also useful to examine higher-level best practices that help produce sustainable trail systems.

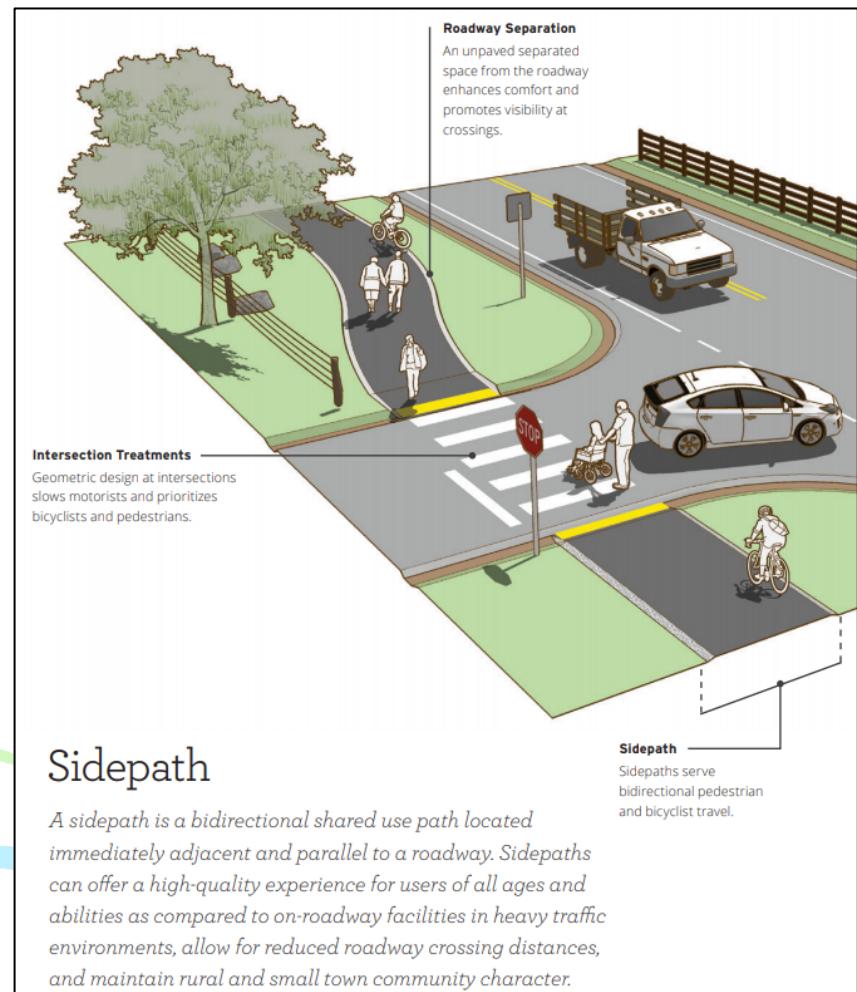
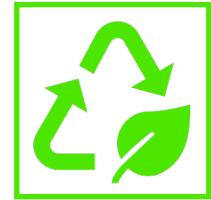


Figure 10. Sidepath Diagram
(Federal Highway Administration, 2016).

Background



Performance measures and rating systems are increasingly being implemented to quantify the level of sustainability in a variety of physical development processes (Oswald Beiler & Lintz, 2016). Specifically targeting shared use trails, the GreenPaths Rating System was created with the goal of measuring the sustainability of shared use trail development including the planning, design, and construction processes. This rating system is supported by the five different categories seen below (Table 3) A total of 47 credits, or sustainability indicators, are used to gauge sustainability in the development process (Table 3). The 47 credits are each weighted to total 182 achievable points and an accompanying scale discerns the certification level of the trail, which ranges from not certified, certified, silver, gold, and up to platinum based on the percentage of total points achieved (Oswald Beiler & Lintz, 2016). The credits are weighted using a decision analysis method called the analytic hierarchy process (AHP), which uses a pairwise comparison survey that compares each individual category and subcategory (credit) (Oswald Beiler, & Waksmunski, 2015). The credits and categories are compared on the standard AHP scale of 1 (*equal importance*) through 9 (*extreme importance*) based on their importance toward the goal of developing a sustainable shared-use path (Oswald Beiler, & Waksmunski, 2015).

Table 3. *GreenPaths Rating System Sustainability Indicators (Oswald Beiler, & Waksmunski, 2015).*

Planning and Location	Green Construction	Infrastructure and Amenities	Continuing Practices	Project Specific
Project Goals	Waste Management Strategy	Historical Outreach	Seasonal Maintenance	Innovation
Context Sensitive Solutions	Minimize Site Disturbance	Wildlife Protection	Waste Management Plan	Sustainability Expert
Lifecycle Cost Analysis	Recycled Materials	Rest Areas	Recycling Facilities	
Local, Diverse Project Team	Regional Materials	Restroom Accessibility	Waste Facilities	
Repurposed Land Use	Trail Mix Material	Green Restrooms	Art Connection	
Agricultural Land and Wetland Conservation	Permeable Surface	Hydration Stations	Public Outreach	
Scenic, Historic, and Cultural Enhancement	Cool Surface	Trailhead Lighting	Shared-Use Path Watch Program	
Compact Development	Stormwater Management	Path and Intersection Lighting		
Mixed Land Uses	Site Vegetation	Energy Efficient Lighting		
Diverse Communities	Protection from Steep Slopes and Waterways	Bicycle Parking		
Access Points		Bicycle Friendly Attractions		
Multimodal Connectivity		Trailhead Surveillance		
ADA Accessibility		Emergency Call Boxes		
		Locational Signage		
		Multimodal Intersection Safety		

Background



Reflecting on the three pillars of sustainability of society, economy, and the environment, referred to as the “triple bottom line”, the study above concluded that the GreenPaths Rating System is a highly useful method of integrating sustainable features and practices in the planning, design, and construction phases of shared-use trails. Furthermore, there is an enhanced value of applying the rating system earlier in the development process in order to increase the likelihood of integrating more opportunities for sustainable practices and features (Oswald Beiler & Lintz, 2016).

Other studies have utilized performance measures and rating systems to evaluate entire trail system plans at a higher level than single trail segments. A case study by Lindsey assessed the sustainability of the greenway system in Indianapolis, Indiana. This study defines Greenways as “linear open spaces or parks along rivers, ridgelines, or historic infrastructure corridors such as canals or railroads that connect people with places and provide opportunities for recreation, conservation, and economic development” (Lindsey, 2003). Through the evaluation process, the study applied the six principles of sustainability defined by Berke and Conroy (2000) of harmony with nature, livable built environment, place-based economy, equity, polluters pay, and responsible regionalism. The study analyzed the Indianapolis Greenways Plan and sought to link indicators of the six identified principles of sustainability to the goals and objectives outlined in the plan. Additionally, the study integrated the use of resident surveys in order to discern perceptions and use patterns of trail neighbors and visiting users. The framework utilized in this study benefits the knowledge base of this topic by providing an example and method of how current trail plans can be evaluated through the identification of sustainability indicators in order to gauge the level of sustainable practices integrated into their design (Lindsey, 2003).

Sustainability has increasingly become a central focus of planning, and planners exploring the sustainability of the outcomes of local planning initiatives will experience the advantageous effects of the integration and evaluation of sustainable practices into their plans (Lindsey, 2003). Particularly regarding plans involved with shared use trail development and multimodal transportation and recreation networks, assessing sustainability objectives at every level of the development process, from planning all the way through construction, will serve to benefit trail systems with sustainability goals by providing opportunities for enhanced social equity, improved environmental quality, and positive economic impact. These sustainability themes are further expanded upon in other supporting literature targeting trail development and human health, economic impact, and environmental health discussed next.

Background

Human health

As the U.S. population grapples with issues of obesity, diabetes, and other health concerns related to a sedentary lifestyle, health professionals have increasingly placed greater significance on creating recreational infrastructure to increase physical activity. Recreational hiking, biking, and running trails offer an effective means of encouraging healthy lifestyles through promoting exercise, physical recreation, and active transportation (Courtenay & Lookingbill, 2014). The most common use of trails is for fitness and recreation, and activity levels have been shown to increase in communities with trails that are primarily used for physical fitness (Corning et al., 2012). Additionally, outdoor experiences also support mental health through reduced stress and crime rates, greater community support systems, opportunities for psychological relaxation and renewal, and improved mental focus (Courtenay & Lookingbill, 2014). A 2005 cost-benefit analysis estimated that for every \$1.00 investment in trail development, a \$2.94 return in direct medical benefits occurs (Courtenay & Lookingbill, 2014).

Additionally, new ideas around the concept of “active transportation” have added recent considerations to the literature regarding the relationship of trails to human health. In recent years, investments in infrastructure that accommodates users who walk and ride bicycles have begun to influence how communities are shaped. Sometimes called “nonmotorized transportation,” active transportation involves human-powered activity, primarily walking and bicycling (Urban Land Institute, 2016). Not only does encouraging active transportation support the advantageous health benefits discussed above, it’s also a catalyst for a variety of economic benefits. For example, active transportation on trail systems has the ability to reduce transportation costs and increase property values for parcels close to these trails (Courtenay & Lookingbill, 2014). The economic impacts of sustainable trail development are further discussed next.



Figure 11. South Lake Tahoe, CA SR-28 Shared Use Path (Federal Highway Administration, 2016).

Background

Economic impact



Recreational trails benefit their communities by furnishing a place for local people to use and enjoy and by attracting tourists who spend money in the local economy (Bowker, Bergstrom, & Gill, 2007). In particular, bike-friendly cities and towns are increasingly finding that bicycle facilities boost the tourism economy and encourage extended stays and return visits. For example, a University of Wisconsin-Madison study estimated that bike tourism contributes \$1.5 billion to the state's economy every year (Urban Land Institute, 2016). Communities that invest in bike trails and other active transportation infrastructure are finding that these facilities encourage visitors to stay longer, spend more money, and come back more often (Urban Land Institute, 2016).

Specifically considering the economic impact of recreational multimodal trails in the state of Virginia, a study carried out by Bowker et al. estimated the net economic value to trail users and the local economic impact of the Virginia Creeper Rail Trail (VCRT) in the highly rural southwestern region of the state. The VCRT is a 34-mile long trail running through Grayson and Washington Counties, both in Virginia. Following an abandoned rail line, the trail's management is a unique agreement in which half of the corridor is owned and managed by the federal government and half is privately owned and managed by local governments. This study was novel in its approach because unlike most of the previous literature that only considered the direct economic effects of tourist spending, Bowker et al. goes beyond this by estimating not only the direct effects of trail-related spending, but also the indirect and induced economic effects of this spending as well.

The monetary valuation results from this study suggest that the trail is a highly valuable asset to the people who enjoy using it and to local businesses who benefit from trail-related tourist expenditures (Bowker et al., 2007). The study reports on two economic elements of the VCRT. The first, net economic value, measures the benefits to users themselves of recreating on the VCRT. Individual net economic value for recreation access to the VCRT was estimated at \$23 to \$38 per person per trip, while aggregate net economic value of the VCRT to users was estimated at \$2.3 million to \$3.9 million. On the other hand, economic impacts measure the commercial benefits to local communities of VCRT tourist spending. Annually, VCRT tourists spend around \$1.2 million directly within the two counties that the trail runs through. This tourist spending in the local economy generates around \$1.6 million in total economic activity (Bowker et al., 2007). Furthermore, it is also important to note that when disaggregated by the length of stay of the user, it was found that day users spend an average of \$12 per person per trip and overnight users spend \$87. Economic development is frequently a key concern of local governments, particularly in rural areas where job opportunities and income may be lacking. This study's results point to the fact that trail-related expenditures by VCRT tourists are relatively high, and the "new money" brought in by them stimulates even more economic growth and increases overall wealth in the economy (Bowker et al., 2007).

Background



Comparing the VCRT to a case study outside of Virginia, the results are similar. A study completed by Pollock et al. analyzed the economic impact of paddler recreation in six different communities along the Northern Forest Canoe Trail running through New York, Vermont, Quebec, New Hampshire, and Maine. Albeit much larger than the Virginia Creeper Rail Trail and of a different recreation focus (paddle sports rather than bicycling and pedestrian use), this study found that economic impacts were still relatively large. The average paddler group reported spending \$343 to \$416 within 25 miles of the waterway during the duration of their trip, or \$39 per person per day, with non-local (or tourist) groups spending even more than that. Additionally, this study found that overnight visitors outspend day users by a ratio of 10:1 (Pollock et al., 2012).

In considering the findings of various studies focused on the economic impact of recreational multimodal trails, a number of overarching themes are important to note. First, the inextricable link between positive human health benefits and the economic impacts generated by sustainable trail development provide planning departments with ammunition in regard to targeting the negative health consequences of sedentary lifestyles and encouraging economic stimulation, particularly in rural localities. Next, there is a high value in overnight tourist spending centered around these trails. Localities looking for the most lucrative economic benefits when considering the development of shared use trails should consider the value in accommodating overnight users as well as day-trippers.



Figure 12. Biking on the Virginia Creeper Trail (Virginia is For Lovers, 2020).

Background

Environmental health



Conservation and recreation planning share many common goals, including the desire to increase landscape connectivity, or the degree to which the landscape can facilitate or impede ecological movement among resource patches (Taylor et al. 1993). However, trail networks typically develop independent of ecological corridors, with sole focus on human activities while at the same time ignoring the potential to align conservation values within these trails. Because funding for conservation and recreation development is often limited, multi-purpose trails located strategically in unison with conservation opportunities provide a chance for integrated recreation and conservation planning, potentially leading to an abundant return on investments (Courtenay & Lookingbill, 2014). The traditional model of conservation planning has been to separate and exclude humans from ecologically important areas. However, isolating people from conservation activities can be counterproductive. Combining recreation planning with conservation goals and activities can increase community awareness of and ownership in environmental conservation, thus having the potential to form a conservation ethos in users (Courtenay & Lookingbill, 2014).

When considering some of the overlapping objectives of recreational trail networks and ecological corridors, the notion of Green Infrastructure (GI) comes to mind. As broadly defined by Benedict and McMahon (2001) and Troulas et al. (2007), “GI consists of interconnected networks of core (large, intact areas of natural habitat) and corridor (smaller, connecting bridges of habitat) green spaces that help to enhance ecosystem services and conserve ecological processes.” Examples of ecosystem services that GI can enhance are water filtration, stormwater control, and air quality purification. Examples of critical ecological processes that GI can support are species migration, dispersal, and recolonization (Courtenay & Lookingbill, 2014). Integrating the common goals of recreation and conservation within the trail development process can provide a host of benefits to localities.

Many opportunities exist to support environmental conservation within the realm of sustainable trail development. Conservation and environmental protection efforts can be ingeniously woven into trail plans because both of these practices share common objectives with recreation planning, such as preserving land either for recreational human activities or natural processes as well as enhancing landscape connectivity. Planners would benefit by combining recreation plans for shared use trails with conservation plans as a means to catalyze an environmental ethos in their communities. This can promote a stronger sense of responsibility for the environment and the crucial services it provides, as well as maximize economic returns and foster sustainable development practices.

Background

Through reviewing the literature relevant to the development of shared use trails, four primary themes were identified; best practices for sustainable trails, impacts for human health, opportunities for economic impact, and impacts for environmental health. The studies reviewed provided insights into the contemporary thinking on these topics, as well as put forth recommendations for the best means of achieving the most desirable qualities of these themes through planning, and specifically planning for trails. In summary, the knowledge postulated in these studies helps inform the goals of this research by providing guidance for opportunities to enhance human health, achieve positive economic impact, and support environmental conservation through the development of safe, sustainable, multimodal recreation and transportation trails.

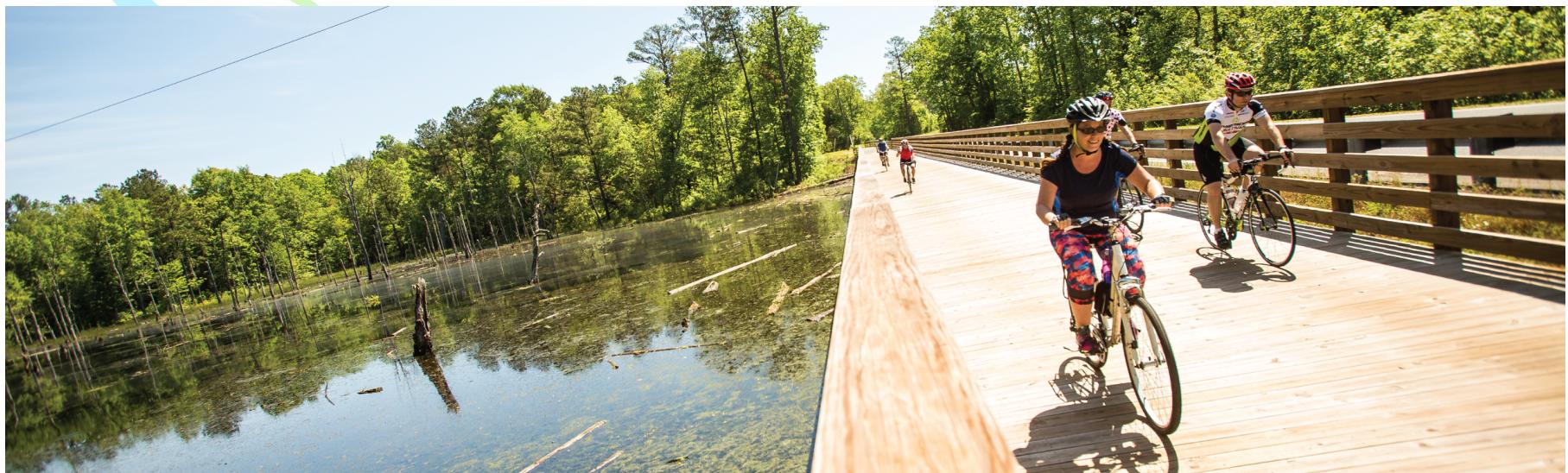


Figure 13. Biking on the Virginia Capital Trail (Virginia Capital Trail Foundation, 2020).

Approach

Methodology

In order to provide recommendations for the most suitable location and sustainable creation of the Eastern Goochland Greenway, a variety of types of information were gathered for analysis. Different key characteristics of the potential route provide the basis for discerning where it can be most suitably located and how it can be sustainably developed, while at the same time connecting identified natural, cultural, and historic resources located along the route in order to provide users with the best possible access to these assets. A major type of information that was identified initially was the locations of natural, cultural, and historic resources along the route such as natural resources and green spaces like parks, campgrounds, and James River access points, cultural assets such as public service buildings and breweries and wineries, and historic resources that can come in the form of museums and National Register of Historic Places sites - all referred to as *trail assets*. Connecting these assets is a prime objective of this plan.

Other existing information types initially identified were the locations of current and planned development nodes that can be connected along the route as well as utilized for their existing trail infrastructure, such as new residential projects near West Creek Business Park and existing pedestrian and cyclist infrastructure present along River Road West in Goochland Courthouse. These development nodes were also considered for their potential for improvement in order to accommodate trail users and the associated development necessary to attract them to visit the trail, such as local businesses like lodging opportunities and restaurants. Next, the locations of public services related to safe and successful shared use trail systems were determined. Key public services that are vital to the potential of this multimodal network are emergency services and their accessibility to the potential trail and existing infrastructure.

Inherent in the nature of the research process for the Eastern Goochland Greenway are a variety of geographic data that were mapped using geographic information system (GIS) software. Through this mapping process, several spatial analyses were performed regarding the research questions discussed next. Relevant geographic data were mapped using the ArcGIS family of software, particularly ArcMap version 10.7.



Figure 14. Active Transportation (Pittsford Town Supervisor Bill Smith, 2020).

Approach

Stakeholder Engagement

Stakeholder outreach was conducted to inform the plan. Outreach focused on cyclists, for this group is both an expert on and a potential future user of the trail. It was determined that reaching out and speaking to cyclists who have ridden this route would serve to provide the plan with knowledge of the challenges of using the route in its existing form, as well as uncover some of the most crucial elements of a shared use trail that attract these users to utilize trail resources.

The Richmond Area Bicycling Association (RABA) offers regularly scheduled and impromptu rides, a monthly newsletter, and meetings featuring presenters speaking on topics of interest to the club, among other things (Richmond Area Bicycle Association, 2020). This group organizes rides in Goochland County that partially take place on River Road West, so the stakeholder engagement process involved reaching out to members for the purpose of conducting expert interviews. The following RABA member positions responded to inquiries about this plan and conducted expert interviews with the researcher.

- Ride Director (Weekly Road Rides), Previous President (1/17/2020)
- Ride Director (Monthly Road Rides), Past President (1/21/2020)
- Safety Chair (1/23/2020)

Through discussion, a number of questions were posed to elicit user perceptions of cycling in this area and the potential the Eastern Goochland Greenway has to serve users in the best ways. Interviewees were asked about the current usage trends of cyclists in eastern Goochland County, as well as RABA's organized group rides that occur on River Road West. Further, interviewees were questioned about their personal experiences riding along River Road West. The discussion involved discerning important elements for cyclists regarding connections to the identified trail assets as well as ideal safety features and amenities these cyclists deem most important for their rides. Next, active transportation and commuting by bicycle in the Richmond region was discussed., as well as the Virginia Capital Trail's impact on the cycling community.

Approach

The following three research questions were posed in order to carry out the research necessary to arrive at the plan's final recommendations:

Question Which areas are lacking sustainable trail elements, trail-oriented development, and/or public services and what are the most suitable locations to support the addition of these missing components?

Question II What is the most suitable location for the alignment of the trail?

Question III What is the level of sustainability for the current state of the potential trail, and what could the level of sustainability be if recommendations were carried out?

Figure 15. Plan Research Questions.

Approach

Research Question #1

Which areas are lacking sustainable trail elements, trail-oriented development, and/or public services and what are the most suitable locations to support the addition of these missing components?

In order to discern which areas along the proposed route are lacking sustainable trail elements, trail-oriented development, and/or public services, the route was first separated into a number of unique geographic segments. These segments were determined by considerations of logical geographic breaks along the route, roadway characteristics, the geography of Goochland County, the presence and lack of assets, development, and public services, and an orientation towards segments that were somewhat similar in length so as to make the disaggregated evaluation process more uniform and manageable. This segmentation method also plays a role in final project recommendations by providing a framework to determine which phases may be more practical for earlier development and which phases may need additional resources and time to construct.

In regard to the necessary data sources required for analysis, the most up-to-date GIS (Geographic Information System) data was obtained through special permission directly from Goochland County, as well as from the Virginia Department of Conservation and Recreation and the Virginia Department of Transportation. Further in situ observational field data was collected by the researcher to confirm that GIS data matched the existing conditions on the ground, as well as to provide a general knowledge of the proposed route through the corridor.

After the proposed trail route was separated into unique segments, analysis was performed on geographic information regarding existing assets, development, and public services. A combination of GIS data, a variety of existing plans produced by Goochland County and Henrico County, and additional outside research were utilized to facilitate this analysis. Next, the research process moved to determining where these elements for the potential route may be deficient. The GreenPaths Rating System provides guidance for locating specific trail elements, such as recommendations as to the frequency with which certain trail elements like trail heads and restroom facilitates should be located in order to achieve a desired level of sustainability according to GreenPaths' certification index. Although a lack of these assets, development, and services signifies that certain locations may not be auspicious to support this trail, they also serve as opportunities for new development of trail-supporting elements along the corridor.

As a means to organize this information, an Assets/Liabilities Analysis was performed and a corresponding matrix was generated for the trail phases in order to discern their key characteristics that can attract users to the trail, as well as opportunities they each have for improvement. This analysis goes into detail regarding the assets and liabilities of each phase and displays relevant geographic information using a series of maps.

Approach

Research Question #2

What is the most suitable location for the alignment of the trail?

Discerning the most appropriate alignment of the Eastern Goochland Greenway takes into account much of the information uncovered in the preceding research question regarding the presence and lack of sustainable trail elements, trail-oriented development, and/or public services along the route. Additionally, it also considers the accessibility and concentration of trail assets that line both the north and south sides of River Road West, as well as roadway characteristics such as speed limit and right-of-way. All of these factors were analyzed for each segment in order to discern the most suitable and above all, safest alignment of the trail for users along the River Road West corridor.



Figure 16. Tanglewood Ordinary (Aynsley Fisher, 2010).

Approach

Research Question #3

What is the level of sustainability for the current state of the potential trail, and what could the level of sustainability be if recommendations were carried out?

Next, the unique trail segments were analyzed in a pre-evaluation for their level of sustainability using the GreenPaths Rating System, a sustainability rating system for the design and construction of shared-use paths implemented in order to promote environmental, social, and economic benefits through the trail development process (Oswald Beiler & Waksmunski, 2015). The 47 sustainability indicators, or credits, used to measure the level of sustainability in the development of shared-use paths within the GreenPaths Rating System serve as ideal elements to integrate into the trail. Along with the pre-evaluation of the potential trail in its current state, the trail was again evaluated in a post-evaluation after recommendations were uncovered in the research process and considered for integration into the trail.

The GreenPaths Rating System draws on the theoretical framework of sustainability within the planning field, particularly the notion that sustainable cities and ideas of green urbanism have emerged as compelling models for translating broad sustainability goals and aspirations into tangible physical and social outcomes (Beatley, 2012). However, the broader, long-term sustainability framework can also be reconciled with the local, short-term implications of livability. The notion of livability stems from the idea that environmental, economic, and equity issues must be considered at a narrower spatial scale relevant to individual people, households, neighborhoods, and communities in geographically smaller areas (Gough, 2015). Considering Gough's notion that livability interventions represent the incremental steps that collectively increase the potential for longer-term strides towards sustainability, the Eastern Goochland Greenway can be seen as an example of a livability intervention that seeks to pave the way towards a future orientation towards sustainable communities in Goochland County.

Oswald Beiler and Waksmunski (2015) developed the GreenPaths Rating System in order to measure the sustainability of the development of shared use trails, including the planning, design, construction, and maintenance processes. GreenPaths provides a holistic view of the environmental, economic, and social impacts of the development process using performance measures. The performance measures (also referred to as credits) can be applied to various projects in order to determine the level of sustainability implemented in their development (Oswald Beiler and Lintz, 2016). According to Oswald Beiler and Waksmunski, the credits for GreenPaths are either achieved (full points awarded) or not achieved (no points awarded), and it is recommended that GreenPaths be applied toward the entire facility where possible in order to provide a more comprehensive and holistic rating for the facility. However, the unique aspects of the relatively long expanses of trail in this plan lend themselves to a more detailed analysis through the application of GreenPaths to each distinct trail phase, so GreenPaths was used to evaluate each unique trail phase in the pre-evaluation process.

The trail segments then underwent the same GreenPaths evaluation after plan recommendations were uncovered, through a post-evaluation process. After this post-evaluation was completed, the results were then compared with the pre-evaluation results to discern the improvement in sustainability and accompanying accreditation that is possible through the implementation of project recommendations.

Research Findings

Stakeholder Engagement

Through interviews with local cyclists who have ridden the proposed trail route along the roadside of River Road West, a number of important themes were elicited from interviewees that show what potential trail users are most concerned about in regards to the potential of this shared use trail facility and that have direct implications for generating recommendations for the Eastern Goochland Greenway. It is important to discuss these themes first, as they will constantly be brought up again throughout successive portions of the research findings section and be carried into the recommendations. The following three themes were central to the conversations had with expert stakeholders.

Safety/"Somewhere to go"

The most common topic discussed in the interview process was user safety. As the cycling route exists in its current form along the roadway, there is much concern for the safety of cyclists here. Additionally, cyclists already use West Creek for its well-lit, well-paved, 3-mile loop, but tend to be an annoyance to businesses whose parking lots are often filled without express permission. There is also an issue with cyclists getting ticketed in the past by law enforcement for petty traffic infractions in an attempt to discourage their use of these roads (Bloom, 2011).

Economic Impact/Tourism

In responding to questions about how the Virginia Capital Trail (VCT) impacted the cycling community, each individual interviewee mentioned not only how cyclists benefit from the VCT, but also the economic impacts it had for regional tourism and especially businesses along the route, noting how a barbecue restaurant along the VCT was previously on the brink of closing and is now enjoying much success as a favorite stop for cyclists.

Transportation Potential

Two of the interviewees stated that at one point they both used VA State Route 6, or Patterson Avenue (River Road West in Goochland) for commuting from Henrico's West End into the City of Richmond. These discussions alluded to the notion that that cyclists who ride for commuting purposes are willing to cycle longer distances if there is a safe route to use.

"Now, Route 6 as it is currently designed and used is extremely dangerous to ride on because it follows the East-West direction. It follows the sun. Drivers coming in - depending on the time of the day - have the sun in their eyes. Going in straight lines, it's very difficult to see a bicyclist. If you're going eastward in the morning, dangerous. If you're going westward in the evening, dangerous. Then you add the hill and the fact that it is a relatively straight road, high speed, and coming over the crest of the hill, you don't see a bicyclist. Instant death."

"It's not great there either (West Creek), nowhere to park to ride your bike. Who wants to do a six mile loop all day long? People use it to train and get used to it. And, you know, I see this trail as being hugely beneficial...Now you have a place to go. People ride for fitness and for transportation, and they (bikes) keep them going from Point A to Point B. If we have nowhere to go or we don't have a place to get to that place that we can ride safely, then we have a problem. Or, the bicycle is not used well, or people are forced to use roadways, existing roadways that are very dangerous."

"In the US, when people think of bikes, everyone thinks of kids. Anywhere else in the world, it's a mode of transportation."

"The types of things that really help it get used more is if there are restrooms, occasionally, if there's some place to use a restroom along the route. Parents want to take their kids out bicycling, or just on longer rides, and it's nice to have a place, relatively clean and safe, where you can use a restroom."

Research Findings

Research Question #1

Which areas are lacking sustainable trail elements, trail-oriented development, and/or public services and what are the most suitable locations to support the addition of these missing components?

Trail Segmentation Process

The first step of the research process was to disaggregate the entire length of the Eastern Goochland Greenway into a number of unique trail segments. This process took into consideration a number of relevant elements of the trail route, such as roadway characteristics, the concentration of trail assets, the geography of Goochland County, and an orientation towards segments that were somewhat similar in distance so as to make the disaggregated evaluation process more manageable. This analysis resulted in the separation of the trail route into four unique segments, each ranging in size from 2.7 miles (Goochland Courthouse) to 5 miles (Maidens) in length. Figure 17 shows the separated segments along with the trail assets and the three Fire-Rescue stations along the route.

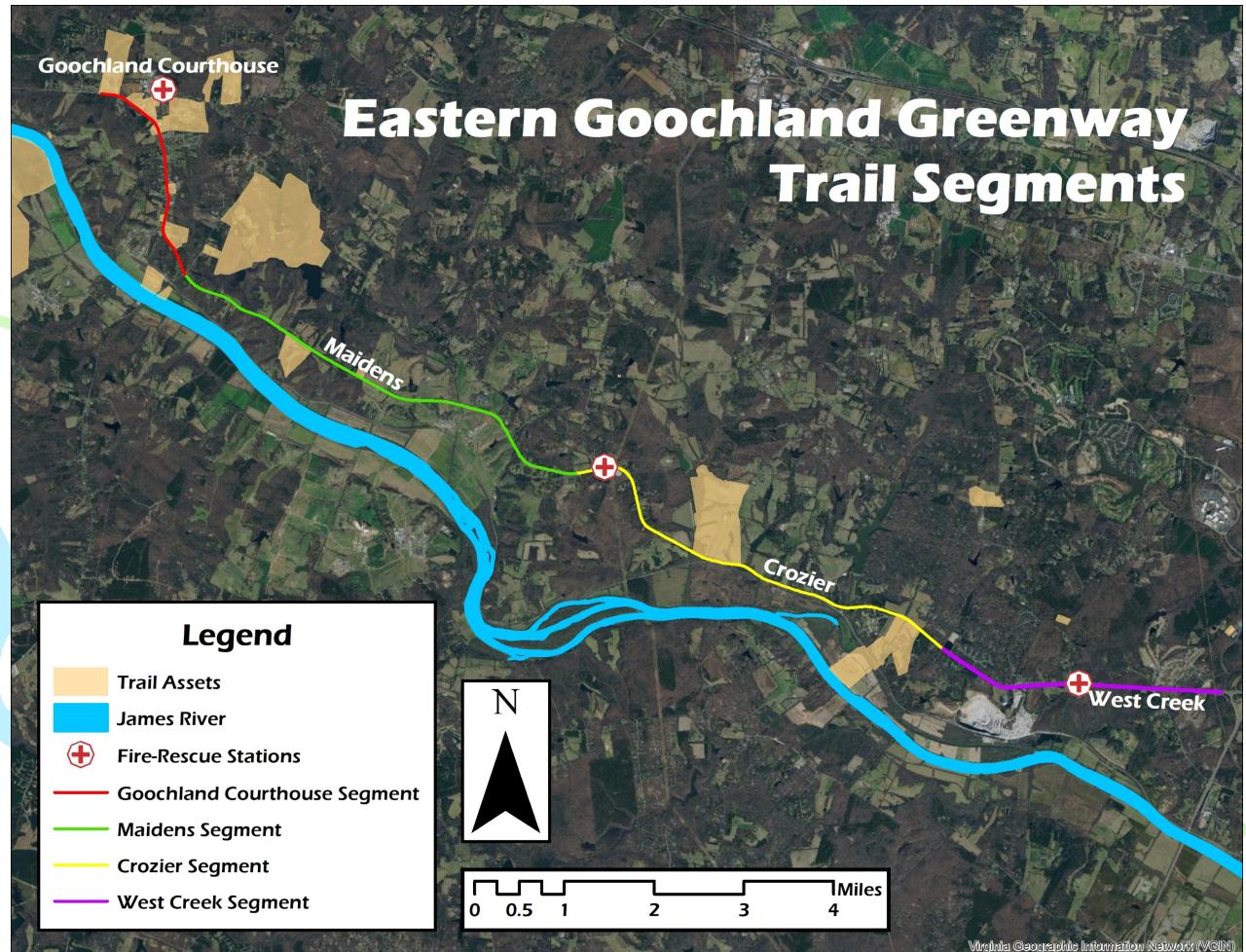


Figure 17. Eastern Goochland Greenway Trail Segments Map (Goochland County GIS Department, 2019).

Research Findings

Goochland Courthouse Segment

The geographic analysis process first evaluated the Goochland Courthouse segment, the shortest segment at 2.7 miles in length. First, it is useful to recall that this trail segment scored the highest on the preliminary GreenPaths Rating System pre-evaluation with a score of 40 points or 22% of possible points. A major reason that this segment scored more points than the Maidens or Crozier segments is that it contains a variety of land uses in close proximity to the trail route, falling under GreenPaths credit PL-9: Mixed Land Uses (Appendix A). This notion is also important because it shows a valuable connection between residential, business, and agricultural land uses in this area.

Another important characteristic of this trail segment is the presence of existing pedestrian infrastructure along both sides of River Road West in some capacity, with roughly 1.5 miles of sidewalk on the eastern side. Coupled with this existing infrastructure is a slower speed limit than any other trail segment, ranging from 35 miles per hour for much of this stretch to 45 miles per hour at the entrance and exit of the village. Additionally, this segment is within close proximity to a majority of the identified trail assets along the route, with 17 of 29 assets located within one mile of the corridor. Because a high concentration of the County's public services are provided in this village, such as those within the Goochland Administration Building and Goochland High School and Middle School, this trail segment is one of the most auspicious for supporting trail activities.

Another unique feature of this trail segment is the opportunity to provide water access in the form of a non-motorized boat ramp and fishing opportunities along 1,200 feet of the James River at the 36-acre Tucker Park at Maidens Crossing on the southern side of the roadway (trail assets #14 and #15 in Figure 18) (Goochland County, 2020). This notion is important to consider in terms of the potential of the JRHT to have a water trail component in this area.

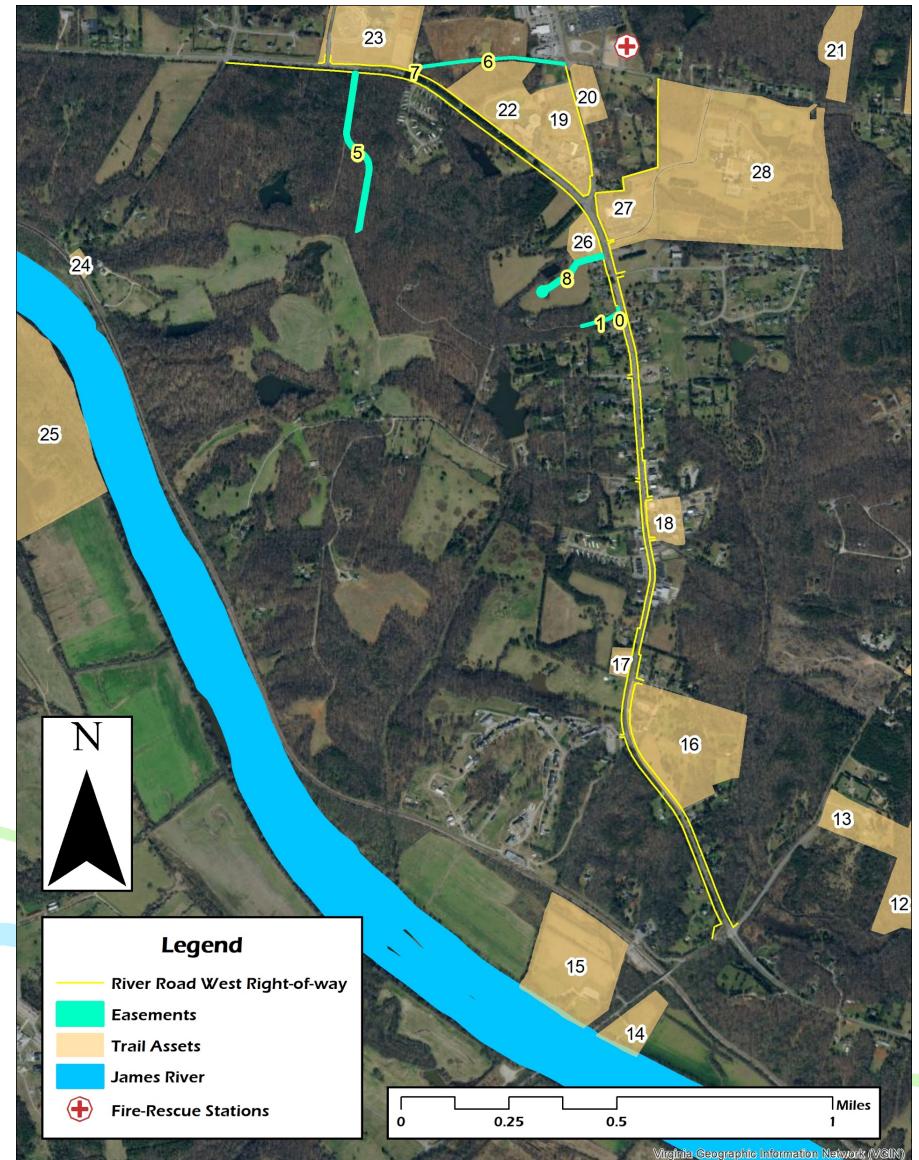


Figure 18. Goochland Courthouse Segment Map
(Goochland County GIS Department, 2019).

Research Findings

Maidens Segment

At five miles in length, the Maidens segment is the longest portion of the Eastern Goochland Greenway and is largely bounded by private landowners and agricultural land uses. This is also the only trail segment without a Fire-Rescue Station located along the route. In addition, the speed limit along this segment is very high at 55 miles per hour and drops to 45 miles per hour at the unincorporated community of Maidens. However, this trail segment has the second highest concentration of trail assets, with 9 of 29 trail assets within a mile of the trail route. In particular, this segment also provides James River access at Tucker Park at Maidens Crossing, as does the Goochland Courthouse segment (assets #14 and #15 in Figure 19). The easements immediately along this segment were not of particular interest in terms of assets or liabilities. However, there is one easement within a close proximity to this trail segment and with road connectivity that has the opportunity to provide James River access, discussed next.

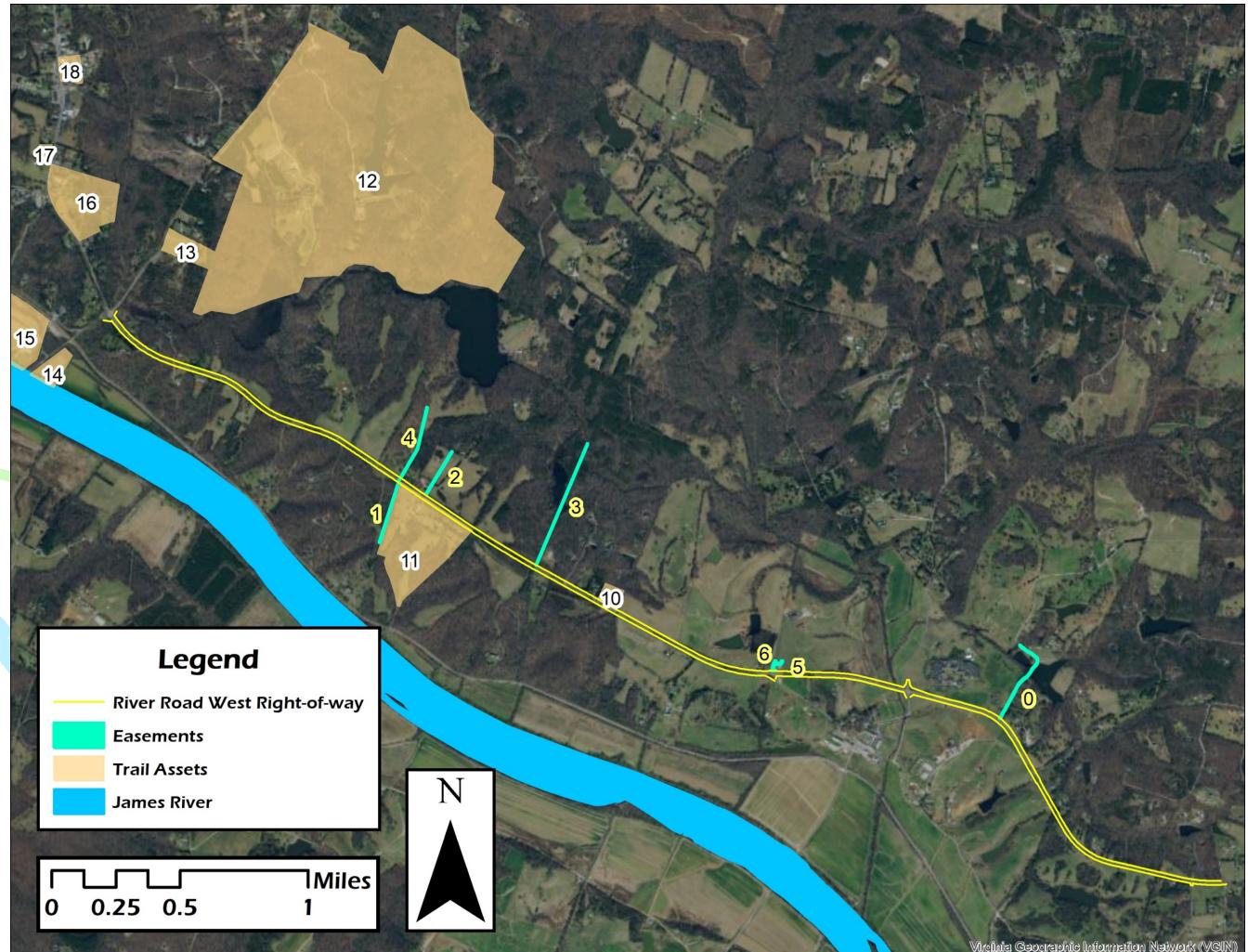


Figure 19. Maidens Segment Map (Goochland County GIS Department, 2019).

Research Findings

Lee Road Easement

Less than two miles south of the River Road West corridor on the southern side of the road, a small easement sits at the end of Lee Road, labeled “1” on the accompanying map. The easement connects Lee Road to the James River and is situated over an existing CSX railroad right-of-way area.

This easement is also identified in Goochland County’s *2010-2015 Parks and Recreation Master Plan*. Under the section titled “Recommended Access Points in Goochland Co.” a small discussion identifies this easement as a potential access point to the James River (Goochland County, 2011). The Parks and Recreation Master Plan goes on to suggest that a possible road crossing over the railroad right-of-way could provide access to two large, forested islands and several small islands located in the area (Goochland County, 2011).

Unfortunately, there is no mention of this easement serving as a water access point in the most recent, updated version of this document, the *Goochland Parks, Recreation & Facilities Master Plan 2016-2020*. Another easement in close proximity to the one at the end of Lee Road can provide access to the river and is discussed next as it falls under the purview of the Crozier segment.

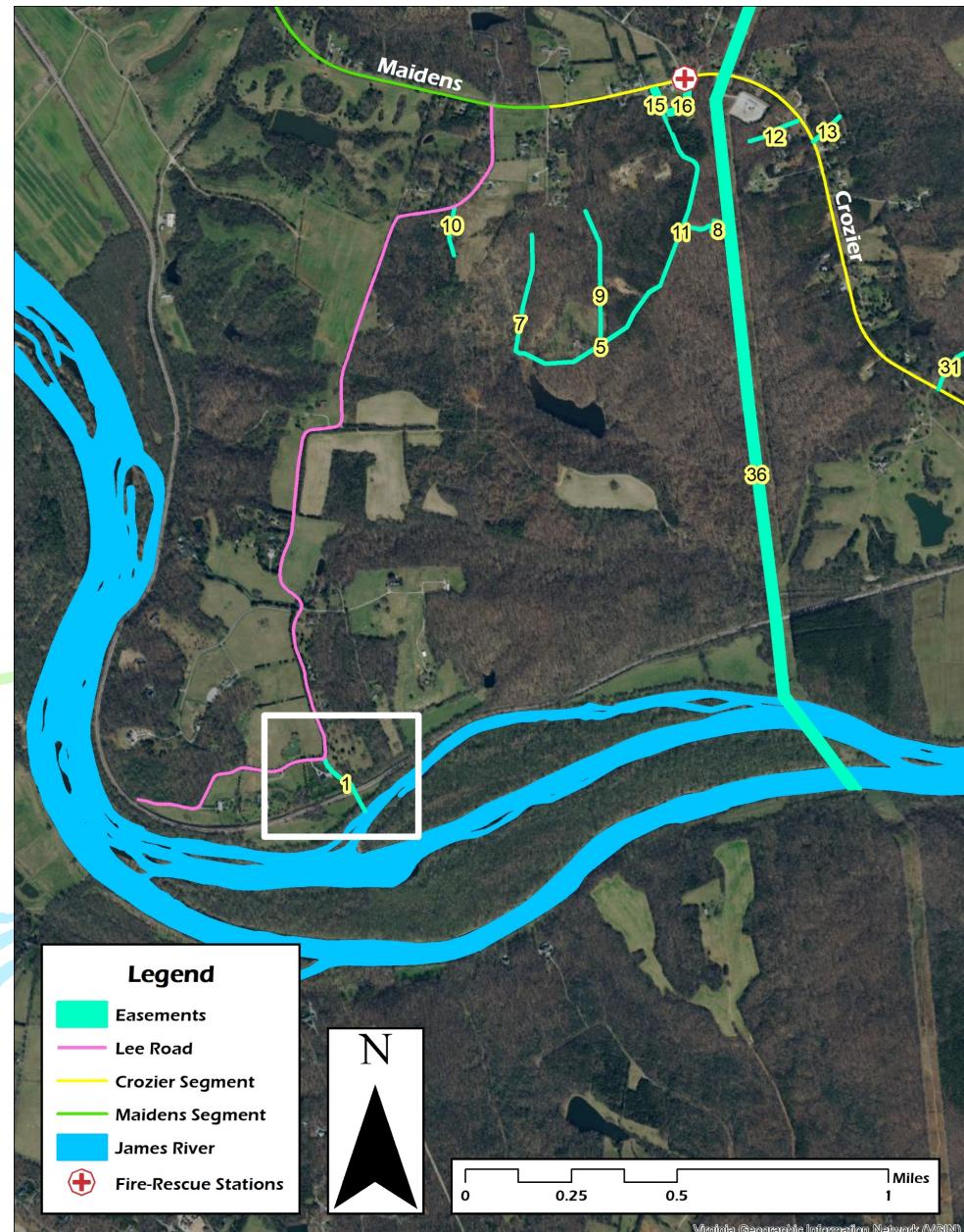


Figure 20. Lee Road Easement Map (Goochland County GIS Department, 2019).

Research Findings

Crozier Segment

Similar to the Maidens segment, the Crozier segment of the Eastern Goochland Greenway is a largely rural expanse of the trail route bordered by many private landowners. Near the center of this segment, the parcel boundaries bordering River Road West are much further apart because the CSX railroad comes to immediately border and “share” a right-of-way area with the roadway, possibly providing extra space for the shared use trail. Unfortunately, only 2 of 29 trail assets are within a mile of the trail route and the speed limit is mostly 55 miles per hour, dropping to 45 miles per hour at Crozier Crossroads. However, this segment also presents a number of unique opportunities for connections to nature and the James River. First, the easement labeled “12” is a 120 foot Dominion Power transmission line easement that has the potential to act as a linear park or greenway connection and provide water access to the James River.

Four parcels covering over 470 acres accessible by easements labeled “5” and “8” are a part of the James River Mitigation Landbank, a landbank approved in 1998 to sell 208 wetland and over 16,000 stream mitigation credits to offset development impacts (Falling Springs LLC, 2020). Although this landbank is set aside for developers to purchase wetlands and stream credits in order to offset the impacts their development practices may have on these fragile but essential ecosystems in other locations, opportunities may exist to use these easements to provide access to the James River for Eastern Goochland Greenway users.

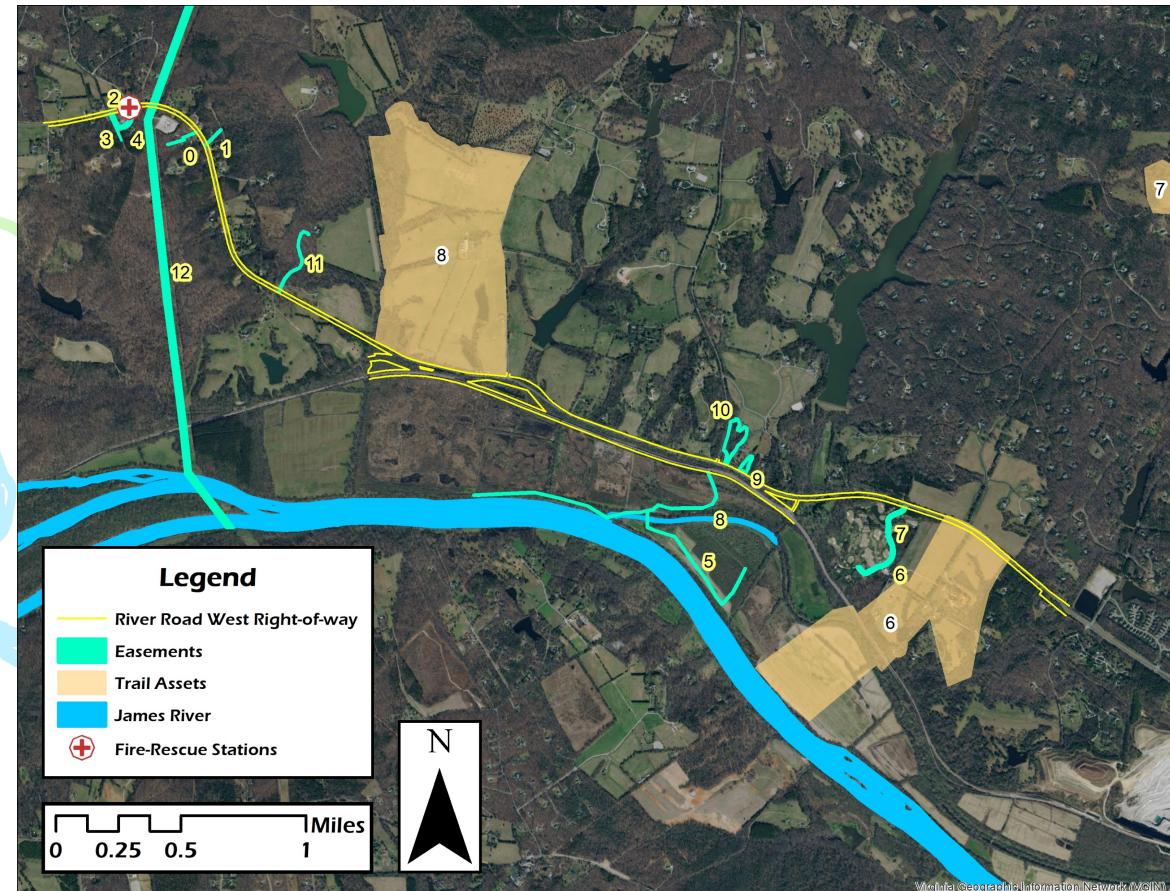


Figure 21. Crozier Segment Map (Goochland County GIS Department, 2019).

Research Findings

West Creek Segment

The West Creek segment of the Eastern Goochland Greenway has many valuable characteristics that make it a favorable portion of this shared use trail system. Drawing on the results of the expert interviews conducted during the stakeholder engagement process, the cyclists interviewed stated that West Creek is already utilized by cyclists to train for events and simply for recreational purposes. Additionally, background research identified West Creek as a growing regional attraction with regional and national office headquarters, hospitality and lodging, residential opportunities, and retail and entertainment opportunities with ample water and sewer capacity for future growth because it is within Goochland County's Tuckahoe Creek Service District. Because of the County's rural identity, Goochland states that service districts are intended to spur business, commercial, and industrial growth, as well as economic development within the district, increase property values for the district landowners, and protect the health and safety of the residents in the district (Goochland County, 2020).

The West Creek segment also has advantageous road characteristics regarding right-of-way and user safety. In its current form, it operates as a four-lane divided highway with a grass covered median separating the eastbound and westbound lanes of River Road West. This notion lends to a wider right-of-way area, referenced by a user in a stakeholder interview who stated they felt comfortable riding along the roadway in this area in its current form because the presence of two lanes allows vehicles to pass cyclists. The major liability of this stretch of roadway is the high 55 mile per hour speed limit. Additionally, only 3 of 29 trail assets are located within a mile of this segment. However, the West Creek segment also provides connections to two planned trail systems as well as a more conceptual cultural trail, discussed next.

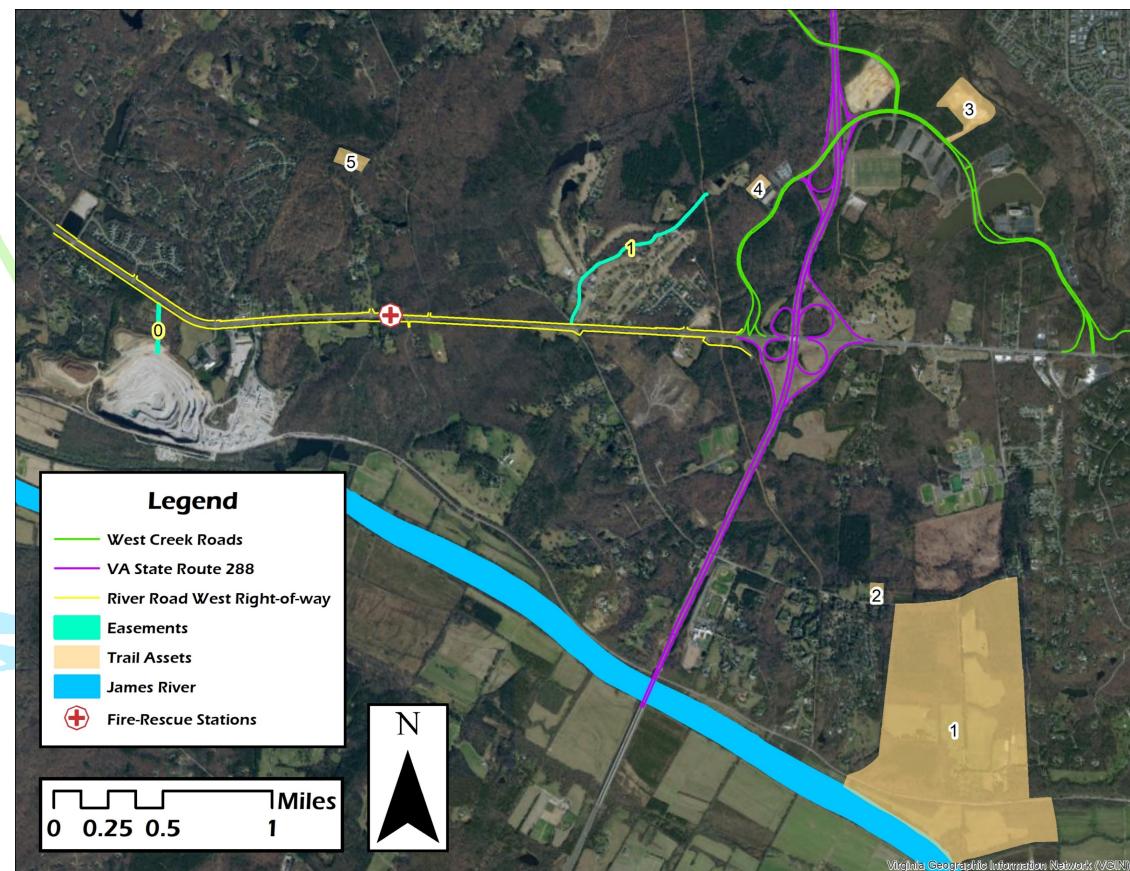


Figure 22. West Creek Segment Map (Goochland County GIS Department, 2019).

Research Findings

West Creek Segment Trail Connections

West Creek is not only a growing regional attraction but is also situated alongside a valuable wetland habitat at Tuckahoe Creek. Considering what public space already exists here, neighboring Henrico County operates Tuckahoe Creek Park just over its border with Goochland County, with Tuckahoe Creek generally acting as the border between the two localities. Tuckahoe Creek Park features an ADA accessible boardwalk system that provides people of all abilities community access to Tuckahoe Creek where visitors can enjoy walking, fishing, and scenic overlooks (Henrico County Recreation & Parks, 2020). Figure 23 shows an image of Tuckahoe Creek Park and Figure 24 shows Henrico County's May 2014 Tuckahoe Creek Park Master Plan Map.

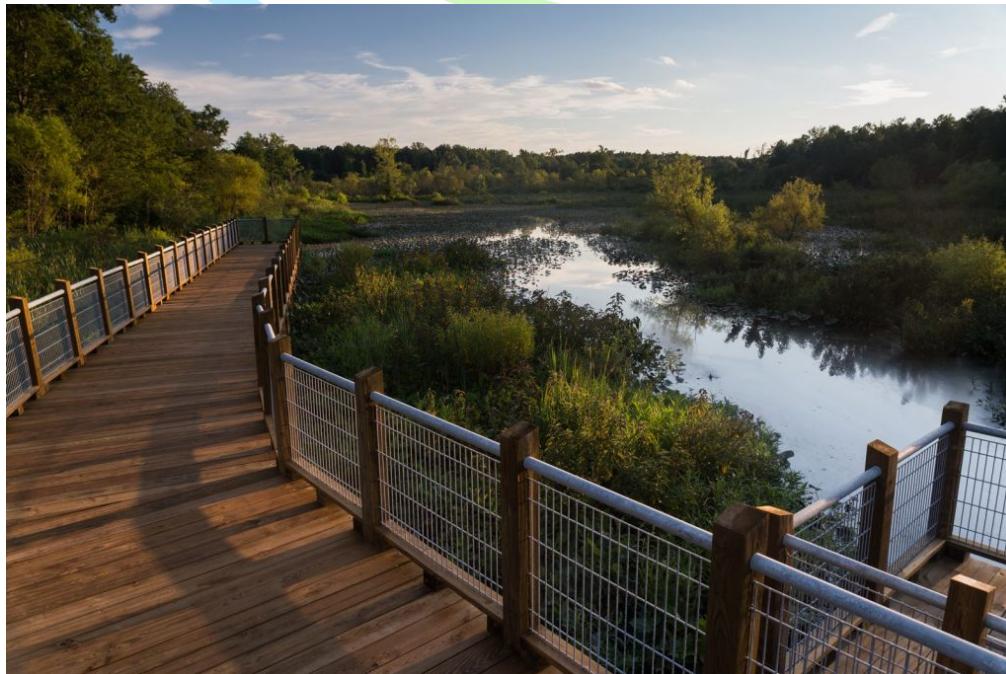


Figure 23. Tuckahoe Creek Park (Henrico County, 2020).

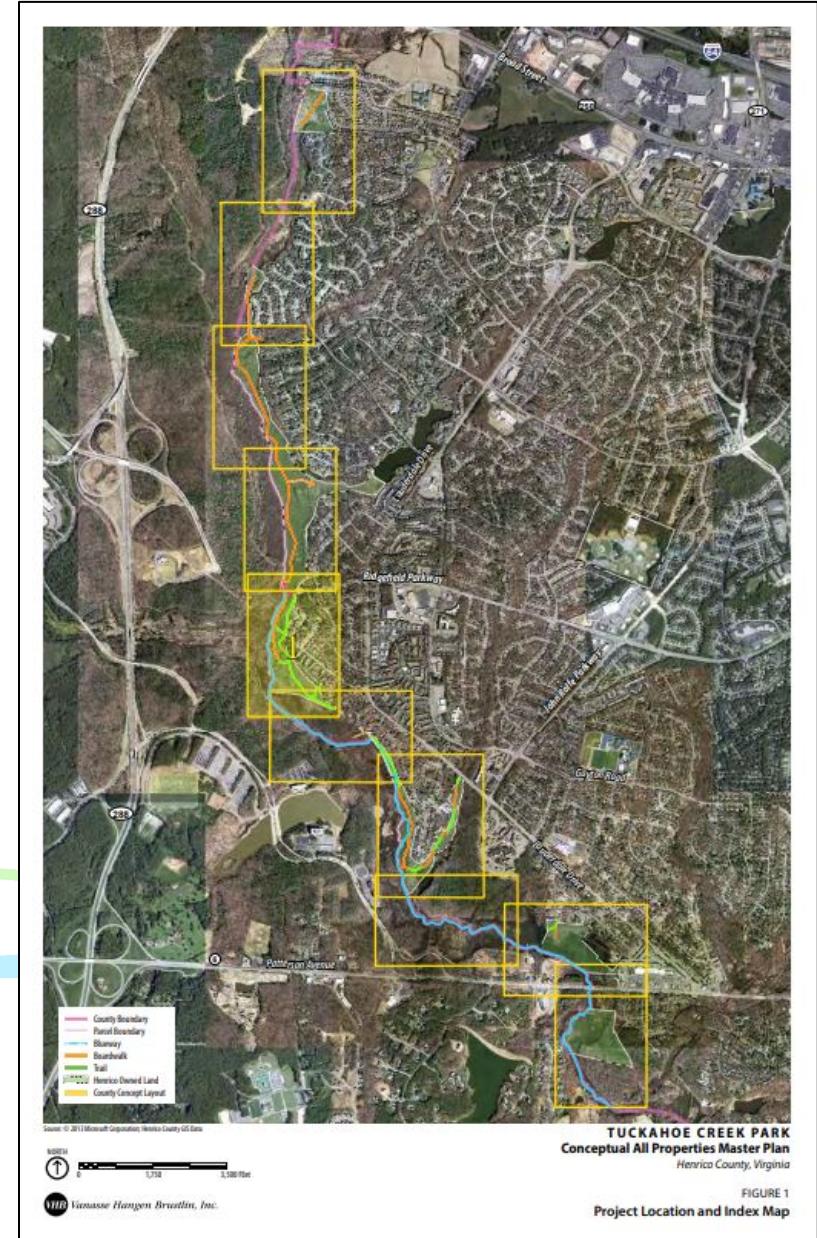


Figure 24. Tuckahoe Creek Park Master Plan Map (Henrico County Recreation & Parks, 2014).

Research Findings

Furthermore, Goochland County has plans to construct a 10 foot wide multi-use path approximately 8,600 feet in length linking the Virginia Farm Bureau office to the West Creek Emergency Center within an existing 30 foot wide county utility easement (Tom Coleman, 2017) (Figure 26). Called West Creek Trail, it would also connect to trail asset #3, Hardywood Park Craft Brewery - West Creek (Figure 25). Furthermore, trail assets #3 (Hardywood) and #4 (Kindred Spirit Brewing) are both breweries that are part of the Richmond West Craft Alcohol Trail (Richmond West Craft Alcohol Trail, 2020). This is one segment of the larger, planned West Creek Trails shared use trail system utilizing the County's existing public utilities maintenance easements that will traverse approximately 6.5 miles from Broad Street Road (U.S. Route 250) to River Road West (VA State Route 6) upon completion (Figure 26).



Figure 25. Hardywood Park Craft Brewery
West Creek (EventZingo, 2020).

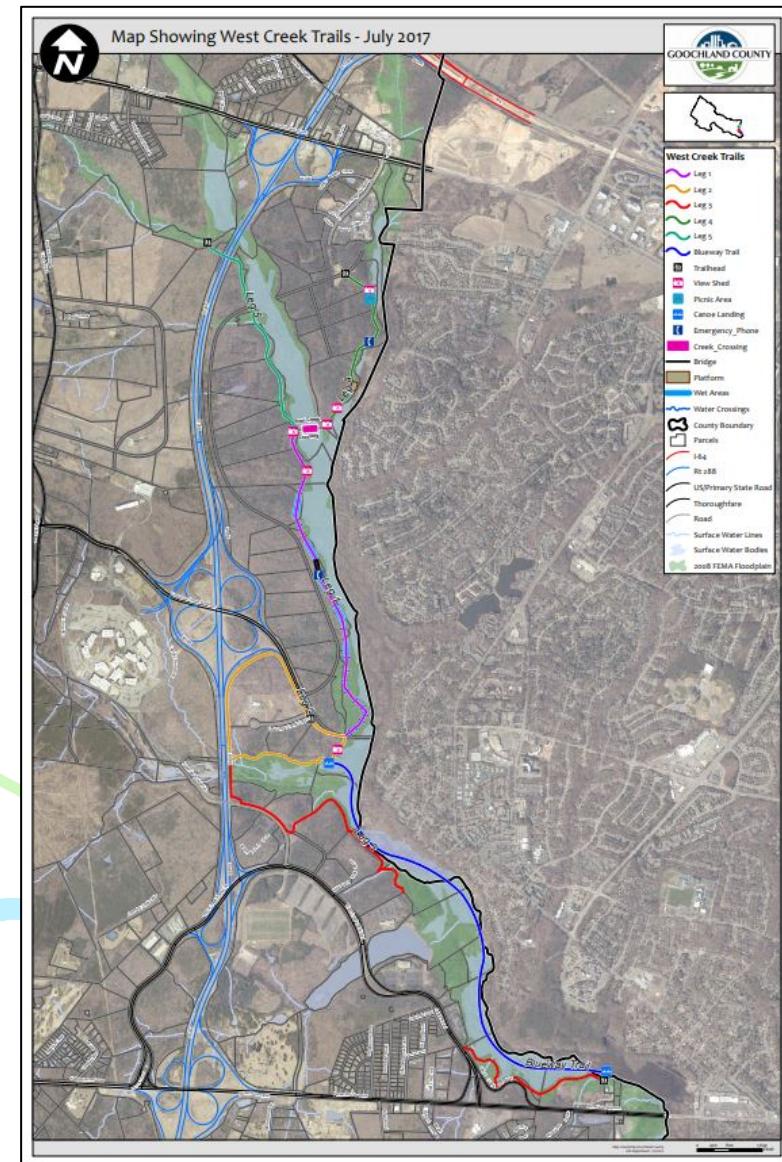


Figure 26. West Creek Trails Map
(Goochland County, 2017).

Research Findings

Assets & Liabilities Analysis

In order to organize the information collected through this portion of the research process, an Assets and Liabilities matrix was generated for the unique trail segments in order to discern their key characteristics that can attract users to the trail, as well as opportunities they each have for improvement.

Table 4. Assets & Liabilities Matrix.

Trail Phase	Length	Assets	Liabilities
Goochland Courthouse Segment	2.71 miles	<ul style="list-style-type: none"> - Existing pedestrian infrastructure - Sidewalks and street lights along Route 6 from Goochland YMCA to Parrish Ford (Approximately 1 mile in length on the eastern side of road) - Existing pedestrian infrastructure - Sidewalks, street lights, and benches from Exxon gas station to Courthouse Village shopping center, as well as along Goochland Care's property (Approximately 0.3 miles in length on the western side of the road) - Existing pedestrian infrastructure - 5 foot sidewalk from Goochland High School to Goochland Administration Building (Approximately 0.75 miles in length on the northern side of road) - Low speed limit - 35 mph (45 mph at entrance and exit at Goochland County Administration Building and Maidens) - James River access - Tucker Park at Maidens Crossing - Dog park - Tucker Park Dog Park - Trail assets - 17 of 29 assets within 1 mile of the trail route - Transportation connection to schools - 3 public schools and Reynolds Community College located along route - Emergency services - Close proximity to Fire-Rescue Station 5 - Development connection - Courthouse Village (employment, residential, retail, civic services, recreational) - Trail connection - Courthouse Creek Greenway (Proposed): Bikeway/pedestrian trail along Courthouse Creek that would connect Tucker Park at Maidens Crossing to Hidden Rock Park. 	<ul style="list-style-type: none"> - Unsafe connection to James River access - Maidens Road to Tucker Park (55 mph and no infrastructure)
Maidens Segment	5.07 miles	<ul style="list-style-type: none"> - James River access - Tucker Park at Maidens Crossing - James River access - Easement at the end of Lee Road - Trail assets - 9 of 29 assets within 1 mile of trail route 	<ul style="list-style-type: none"> - High speed limit - 55 mph (45 mph at Maidens) - Unsafe connection to James River access - Maidens Road to Tucker Park (55 mph and no infrastructure) - Emergency services lacking - No Fire-Rescue Station along this longest segment of the trail route
Crozier Segment	4.86 miles	<ul style="list-style-type: none"> - Emergency services - Fire-Rescue Station 2 along this segment - James River access - Crozier Crossroads electric utility easement - James River access - James River Mitigation Landbank and associated easements 	<ul style="list-style-type: none"> - High speed limit - 55 mph (45 mph at Crozier Crossroads) - Lacking trail assets - 2 of 29 assets within 1 mile of the trail route
West Creek Segment	3.94 miles	<ul style="list-style-type: none"> - Emergency services - Fire-Rescue Station 1 along this segment - Road safety - Separated 4 lane highway is safer than 2 lane highway along rest of route - Development connection - West Creek Business Park (employment, residential, entertainment, retail, hospitality/lodging, medical services) - Trail connection - Goochland County's West Creek Trail (proposed) - Trail connection - Henrico's Tuckahoe Creek Park (proposed expansion) - Current cyclist use - Cyclists ride 3-mile loop in West Creek 	<ul style="list-style-type: none"> - High speed limit - 55 mph - Lacking trail assets - 3 of 29 assets within 1 mile of the trail route

Research Findings

Research Question #2

What is the most suitable location for the alignment of the trail?

Alignment Analysis

An important element of the research process relevant not only to the physical alignment of the Eastern Goochland Greenway but also for the purpose of evaluation through the GreenPaths Rating System is the corresponding road right-of-way areas for each trail segment. In the most ideal scenario, the Eastern Goochland Greenway would be sited entirely in the River Road West right-of-way area in order to produce the most minimal disturbance to land owners along the route. Additionally, the notion of locating a shared use trail in a right-of-way area falls under the GreenPaths credit PL-5: Repurposed Land Use (Appendix A). In order to discern these right-of-way areas, a number of resources were sought out in an attempt to receive access to any pre-existing right-of-way information sources. Goochland County parcel boundary lines for parcels bordering River Road West were utilized to create map layers of parcel boundary borders along the entirety of the trail route. Goochland County's GIS Analyst stated that although this may not provide a completely accurate picture of how wide the right-of-way areas stretch across the River Road West roadway, they can provide a consistent idea of how much room there might be for the Eastern Goochland Greenway.

For the Goochland Courthouse Segment and western terminus of the trail, the ideal alignment is on the northern or eastern side of River Road West because there is already roughly 1.5 miles of existing sidewalk infrastructure out of 2.71 miles of trail route on this side of the roadway. Although the right-of-way area seems limited on both sides of the roadway in this segment, there is a much higher concentration of trail assets on the northern or eastern side of the road here too (Figure 18 on page 30). As the trail route moves to the Maidens Segment, James River access is provided on the southern side of the roadway at Tucker Park at Maidens Crossing (Trail Asset #15). Furthermore, additional river access can be provided on the southern side of the roadway through conversion of the Lee Road Easement (Easement #1 in Figure 20 on page 32) into a public water access point. The only challenge of the Maidens Segment aligning on the southern side is that the trail's only mid-point restaurant and historic site, Tanglewood Ordinary (Trail Asset #10), is on the northern side of the roadway. Although there is less development in this segment, the right-of-way area can still be best described as limited. Next, the Crozier Segment lends itself to an alignment on the southern side on the road because Easements #12, #8, and #5 in Figure 21 on page 33 all have the potential to provide public river access on the southern side of River Road West. Additionally, a unique opportunity may exist to utilize the railroad right-of-way in this segment as it abuts and combines with the road right-of-way to the south, producing the widest right-of-way area of the trail route. Finally, the West Creek Segment and eastern terminus of the trail would benefit from an alignment on the northern side of the road for several reasons. First, the entrance to West Creek Business Park is on this side of the road. Additionally, Luck Stone's Boscobel Quarry and the frequency of large trucks entering and leaving this site make the southern side of the roadway a dangerous option for trail users (Figure 22 on page 34).. Because River Road West is a four-lane divided highway in this segment, there is more right-of-way width here.

Research Findings

Research Question #3

What is the level of sustainability for the current state of the potential trail, and what could the level of sustainability be if recommendations were carried out?

GreenPaths Rating System Pre-Evaluation

After dividing the trail into its unique segments and evaluating their assets and liabilities, the next step in the research process was to evaluate these segments in their current form using the GreenPaths Rating System. It is important to note that because a shared use trail does not currently follow River Road West, yet cyclists still ride along this route, the actual roadway was considered to be the trail space being assessed for the pre-evaluation process. Additionally, the majority of GreenPaths credits were obviously not applicable to River Road West in its current form, so in order to distinguish between those credits which do not apply to the “roadway trail” and those credits that could apply, the pre-evaluation designated “N/A” to the credits that were not applicable and a score of “0” to those that did apply but were not achieved. The credits that were achieved were awarded the full amount of points that is designated under the corresponding GreenPaths AHP weights.

As the table of pre-evaluation results shows, none of the four segments were able to achieve GreenPaths certification, although the Goochland Courthouse and West Creek segments came close (Table 6). The Goochland Courthouse segment and West Creek segment both scored 40 out of 182 possible points (22%), closely approaching the threshold for the “Certified” designation of at least 66 out of 182 possible points (36%) (Tables 5 and 6). Furthermore, the Maidens and Crozier segments both scored 30 out of 182 possible points (16%). Because the GreenPaths Rating System is a tool used to evaluate the design and construction of shared use paths and not roadway paths, the results of the pre-evaluation of trail segments that were considered to be a part of the River Road West roadway for the purposes of this analysis showed higher scores than initially anticipated. The GreenPaths pre-evaluation points toward the Goochland Courthouse segment and the West Creek segment being more opportune for the development of the Eastern Goochland Greenway in terms of the sustainability indicators the segments were evaluated under. These segments have a head start in regard to creating a sustainable shared use trail along this route.

Table 5. GreenPaths Rating System Certification Levels
(Oswald Beiler, & Waksmunski, 2015).

Certification Level	Points Required
Certified (36-45%)	66-82
Silver (46-54%)	83-99
Gold (55-72%)	100-132
Platinum (73-100%)	133-182

Table 6. GreenPaths Rating System Pre-Evaluation Results

Trail Segments			
Goochland Courthouse	Maidens	Crozier	West Creek
40 (22%)	30 (16%)	30 (16%)	40 (22%)

Recommendations

Upon considering the findings uncovered in the research process, the following set of recommendations in the forms of goals, objectives, and actions as well as an implementation timetable were generated in order to guide the achievement of the objectives of the Eastern Goochland Greenway Plan. It is important to note that certain actions correspond to GreenPaths Rating System credits, which are identified in parenthesis following the given action. The full list of GreenPaths Rating Systems credit points, descriptions, and measurements is included in Appendix A. Furthermore, if all the recommendations corresponding to the GreenPaths Rating System sustainability indicators are carried out, there is potential for the Eastern Goochland Greenway to be awarded 90 additional points on the GreenPaths certification scale, resulting in the whole trail earning a total of anywhere from 120 to 130 points. This would give the trail the certification level of “Gold”, and these notions can be utilized in advocating for the approval of the Eastern Goochland Greenway Plan.

Goal 1: Advocate for the trail and seek out funding opportunities for its development.

Objective 1.1: Promote awareness and advocacy for the trail.

Action 1.1.1: Build support among local and state policymakers by producing information resources (online, through brochures, etc.) about the trail and distributing these resources to those who might have vested interest in the trail and could support its development and funding.

Action 1.1.2: Develop a James River Heritage Trail advocacy group within the Department of Conservation and Recreation to provide trail expertise, raise public awareness, and seek out funding and contribution opportunities to enhance and promote the development of the trail.

Action 1.1.3: Increase public awareness of sustainable trail activities by incorporating a public education program and community events into the trail by holding at least five events (running/bicycle races, nature walks, festivals, craft shows, etc.) a year on the trail or in collaboration with the trail (CP-6).

Action 1.1.4: Encourage trail-oriented development and active transportation by producing information resources (online, through brochures, etc.) about these topics and distributing these resources to local developers and businesses.

Recommendations

Objective 1.2: Partner with local businesses and trail assets to foster support of the trail.

Action 1.2.1: Promote bicycling by providing secure bicycle racks in view of the front entrance at retail, business, and school locations along the trail for at least 50% of all land uses within 1/4 mile of the trail (IA-11).

Action 1.2.2: Encourage local businesses and trail assets to support the installation of user amenities like benches, water fountains, fix-it stations, and refuse/recycling receptacles on their property by developing and distributing information resources (online, through brochures, etc.) regarding economic impacts of shared use trails.

Objective 1.3: Seek out funding opportunities for the trail.

Action 1.3.1: Seek out funding opportunities for the physical construction of the trail and its amenities from grants and the state and federal governments.

Action 1.3.2: Solicit private support for the construction of trail user amenities through developing a sponsorship program in which donors can sponsor trail amenities.

Action 1.3.3: Host semi-annual fundraising events (running/bicycle races, etc.) on the trail to raise money for its annual budget.

Recommendations

Goal 2: Implement sustainable design, construction, and maintenance practices in the development of the trail.

Objective 2.1: Apply sustainable design practices to the development of the trail.

Action 2.1.1: Perform a hydrologic evaluation documenting stormwater management strategies and natural measures for stormwater controls that allow infiltration along the entire length of the trail in order to improve the quality and reduce the quantity of runoff (GC-8).

Action 2.1.2: Select and document a plant mix to include small, medium, and large sized noninvasive, low maintenance, and drought-resistant vegetation planted along the length of the trail in order to Increase biodiversity (GC-9).

Action 2.1.3: Reduce environmental impacts of restrooms with energy efficient electrical fixtures and low flow plumbing fixtures in permanent facilities and eco-friendly portable facilities by documenting fixture (lighting, faucet, toilet, hand dryer, etc.) choices and portable facility choices showing improved energy efficiency and environmental friendliness compared to normal practices (IA-5).

Action 2.1.4: Minimize energy consumption through the use of renewable energy sources (solar, wind, etc.) and energy efficient lighting such as LED light bulbs for all light fixtures associated with the trail (IA-9).

Action 2.1.5: Promote the arts and the community by incorporating locally produced artwork into the trail through displaying artwork with local connections, at minimum, every 3 miles along the trail. Local connections can include: the artist currently resides or previously resided within 25 miles of the trail, the art is focused on a subject within 25 miles of the project, or materials originated within 25 miles of the project (CP-5).

Recommendations

Objective 2.2: Utilize sustainable construction practices in the development of the trail.

Action 2.2.1: Minimize the construction material taken to a landfill by developing a documented plan showing a reduction in the types and amount of waste directed to a landfill compared to common practices prior to construction (GC-1).

Action 2.2.2: Limit the extraction of virgin materials through the use of recycled materials for at least 25% of project construction material by weight (GC-3).

Action 2.2.3: Reduce transportation impacts and support local economies through the utilization of regional materials by using 50% of project material by weight originating within 50 miles of the project location and 75% originating within 100 miles of the project location (GC-4).

Action 2.2.4: Combat the heat island effect and reduce stormwater runoff temperature by constructing at least 50% of the trail using cool surface materials and techniques (GC-7).

Objective 2.3: Implement sustainable maintenance practices in trail upkeep.

Action 2.3.1: Ensure proper trail maintenance by documenting a management plan for maintenance (litter removal, tree trimming/removal, leaf removal, snow removal, debris removal, mowing, vegetation upkeep, signage placement/replacement, bridge and crossing maintenance and inspection, drainage inspection, facility upkeep, and as needed patching and resurfacing of pavement) and determining responsible parties and frequency of maintenance (CP-1).

Action 2.3.2: Support proper refuse and recycling management by documenting a plan for garbage and recycling pickup and disposal, and determining responsible parties and frequency of collection from facilities provided along the length of the trail (CP-2).

Action 2.3.3: Reduce solid waste production from trail users and allow users to dispose of recyclables and trash generated while using the trail by providing periodically spaced recycling facilities and trash receptacles along the trail at minimum, every $\frac{1}{2}$ mile (CP-3 & CP-4).

Recommendations

Goal 3: Provide frequent, safe, and inclusive access to the trail and its amenities.

Objective 3.1: Adhere to and document ADA accessibility guidelines in trail design, amenity design, and access facility design.

Action 3.1.1: Incorporate an absolute minimum trail width of 8 feet (PL-13).

Action 3.1.2: Design the trail so that its grade is equal to the general grade established for the adjacent street (River Road West) and includes a maximum grade of 5% at street crossings (PL-13).

Action 3.1.3: Ensure all amenities adhere to ADA accessibility guidelines (PL-13).

Action 3.1.4: Provide access to the trail through periodically spaced trailheads every 5 miles with vehicular parking in addition to frequent, safe, easy, and public access points every $\frac{1}{2}$ mile (PL-11).

Objective 3.2: Equip the trail with user amenities.

Action 3.2.1: Include stopping points for trail users through periodically spaced rest areas that include an area to pull off of the trail every $\frac{1}{2}$ mile and benches at every mile (IA-3).

Action 3.2.2: Provide permanent restroom facilities at all trailheads and portable restroom facilities so that no point on the trail is more than 3 miles away from a restroom facility (IA-4).

Action 3.2.3: Ensure adequate hydration for trail users by providing water fountains that are accessible for humans and pets every 3 miles along the trail (IA-6).

Action 3.2.4: Support bicycling on the trail by providing a secure bicycle rack at all designated trailheads and ensure adequate storage capacity based on projected usage (IA-10).

Action 3.2.5: Provide trail users with a sense of location and distance traveled through signage (mile markers, street labels, and nearby attractions) with mile markers provided at minimum every $\frac{1}{2}$ mile, street labels at all road crossings, and additional signage directing users to nearby attractions (IA-14).

Action 3.2.6: Where possible, utilize easements along the James River to adapt into public water access points.

Recommendations

Objective 3.3: Incorporate safety features along the trail.

Action 3.3.1: Equip all trailheads with lighting fixtures to illuminate the parking area and provide adequate lighting along undeveloped/remote sections of the trail and at all road or railroad crossings by illuminating the trail to safe levels as per AASHTO (2005) Roadway Lighting Design Guide (IA-7 and IA-8).

Action 3.3.2: Use video surveillance at all trailheads that provides views of all vehicular and bicycle parking (IA-12).

Action 3.3.3: Locate emergency call boxes every $\frac{1}{2}$ mile in areas where adjacent properties are spaced every 200 yards or more along the trail (IA-13).

Action 3.3.4: Provide cautionary crossing signs on the road and trail at all intersections, proper yield signs, and crosswalks at all road crossings (IA-15).

Action 3.3.5: Increase trail safety through creating an organized trail watch program consisting of responsible parties who ride the length of the trail to monitor safety and maintenance concerns, whether through a volunteer ambassador program or relying on local law enforcement (CP-7).

Implementation

Implementation

Implementation

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Appendix A

Appendix A. GreenPaths Rating System Credit Descriptions.

Category	ID	Name	Points	Description of Goal	Measurement
Planning and Location	PL-1	Project Goals	5	Identify opportunities for sustainable development through clearly defined project goals and objectives.	Prior to shared-use path development, determine and document the environmental, economic, and social goals and objectives of the project as well as preliminary methods to achieve these goals.
Planning and Location	PL-2	Context Sensitive Solutions	8	Identify and address the needs and concerns of stakeholders and community members by holding public meetings throughout the planning process.	Hold at least 2 public meetings throughout the planning process, a meeting before the preliminary designs are determined and a meeting before the final alternative is selected. Document the meeting agendas and any public input.
Planning and Location	PL-3	Lifecycle cost analysis	4	Complete a life cycle cost analysis based on the projected life of the path and provide justification for the costs with evidence of the community and user benefits.	Perform and document lifecycle cost analyses for the surface material and stormwater management choices including why each alternative was chosen. Additionally, perform and document a lifecycle cost analysis for the entire project including economic opportunities from the project and community and user costs and benefits.
Planning and Location	PL-4	Local, diverse project team	4	Promote the local economy by employing local firms and workers with a variety of backgrounds to complete the project.	Contract design and construction firms with office locations no more than 50 miles from the project location. Employ at least 50% of the project team and construction workers living within 25 miles of the project location and 90% within 50 miles. Employ a primary design team with backgrounds in at least three different disciplines.
Planning and Location	PL-5	Repurposed Land Use	10	Limit the development effects of the path by redeveloping an existing right of way for the project such as converting an abandoned rail line to a trail path.	Develop the shared-use path entirely within or alongside an existing right of way: abandoned rail lines, active rail lines, roads, rivers, canals, transit lines, utility lines, etc. (Wetmore 2013).
Planning and Location	PL-6	Agricultural Land and Wetland Conservation	7	Limit the development effects and preserve resources by avoiding construction on prime agricultural land or wetlands.	Pathway construction avoids land previously designated as agricultural or wetland.
Planning and Location	PL-7	Scenic, Historic, and Cultural Enhancement	7	Enhance the community by means of project placement along significant scenic, historic, or cultural sites.	Establish the path so that at least one point per 10 miles is located within one mile (bicycle compatibility LOS \geq C) of a site on the National Register of Historic Places (National Park Service 2013), a State Park, or a local significant historic or cultural site.
Planning and Location	PL-8	Compact Development	8	Maximize the number of potential path users by establishing the path and or trailheads in a high density area.	Establish the path in an area with a residential density of at least 10 dwelling units per acre within 1/4 mile of the path for 50% of the path.
Planning and Location	PL-9	Mixed Land Uses	10	Ensure path users have access to destinations for work, education, retail, recreation, etc. along the pathway.	Provide access to at least 3 different land uses (residential developments, commercial centers, industrial parks, educational centers, recreational parks, etc.) within 1/4 mile of the path for each mile of the path.

Category	ID	Name	Points	Description of Goal	Measurement
Planning and Location	PL-10	Diverse Communities	5	Maximize the accessibility of the path to mixed income/diverse communities.	Provide access within 1/4 mile to a classified Environmental Justice (FHWA 2014) area as designated by the local Metropolitan Planning Organization or Rural Planning Organization.
Planning and Location	PL-11	Access points	6	Provide access to the path with periodically spaced trailheads with vehicular parking in addition to frequent, safe, easy and public access points.	Place designated trailheads, at minimum, one for every 5 miles. Place additional public access points no more than 1/2 mile apart.
Planning and Location	PL-12	Multimodal Connectivity	7	Increase transportation access options by providing connections to other sustainable transportation modes (bus, rail, ferry, etc.) from the path and/or trailhead.	Provide access to at least one bus stop within 1/4 mile from the path for every mile of the path and/or one rail or ferry stop within 1 mile (bicycle compatibility LOS $\geq C$) from the path for every 5 miles of the path.
Planning and Location	PL-13	ADA accessibility	8	Provide access for all users by adhering to ADA accessibility guidelines in path design (width, grade, trailhead access, etc.), amenity design (benches, water fountains, restrooms, etc.), as well as the design of all access facilities connected to the path.	Document ADA accessibility (United States Access Board 2013) measures for path design, amenity design and access points.
Green Construction	GC-1	Waste management strategy	1	Minimize the construction material taken to a landfill through a documented waste management strategy developed prior to construction.	Prior to construction, develop a documented plan showing a reduction in the types and amount of waste directed to a landfill compared to common practices.
Green Construction	GC-2	Minimize site disturbance	2	Minimize site disruption and reduce impacts from material transport by matching existing grades as closely as possible and balancing the total amounts of cut and fill.	Match the existing grade for 50% of the path length. Perform excavation so that difference between cut and fill is less than 10% of the average total volume moved, as described in Greenroads (Univ. of Washington and CH2M Hill, Inc. 2011).
Green Construction	GC-3	Recycled materials	2	Minimize the extraction of virgin materials through the use of recycled materials.	Use recycled materials for at least 25% of project construction material by weight.
Green Construction	GC-4	Regional materials	2	Minimize transportation impacts and support local economies through the use of regional materials.	Use at least 50% of project material by weight, originating within 50 miles of the project location and 75% originating within 100 miles of the project location.
Green Construction	GC-5	Trail mix material	2	Improve the quality and reduce the quantity of stormwater and increase pedestrian comfort by using a crushed aggregate surface material for, at minimum, a portion of the path.	Construct at least 50% of the path length of a softer surface such as crushed stone.

Category	ID	Name	Points	Description of Goal	Measurement
Green Construction	GC-6	Permeable surface	2	Improve the quality and reduce the quantity of stormwater by using permeable pavement on any paved portions of the path, intersection crossings, and trailheads.	Construct at least 50% of the path surface (asphalt, concrete, etc.) using permeable surface materials and techniques.
Green Construction	GC-7	Cool surface	1	Reduce the heat island effect and reduce stormwater runoff temperature through the use of cool pavement or surface techniques.	Construct at least 50% of the path using cool surface materials and techniques.
Green Construction	GC-8	Stormwater management	4	Improve the quality and reduce the quantity of stormwater by means of natural stormwater management facilities that allow infiltration.	Perform a hydrologic evaluation documenting the stormwater management strategy and natural measures for stormwater control along the entire length of the path.
Green Construction	GC-9	Site vegetation	3	Increase biodiversity through a diverse mix of different sized, low maintenance, and native plant species.	Select and document a plant mix to include small, medium, and large sized, noninvasive, and drought-resistant vegetation planted along the length of the path.
Green Construction	GC-10	Protection from steep slopes and waterways	2	Protect path users from steep slopes or waterways along the path with fencing or guiderails.	Install fences along portions of the path with downward slopes greater than 1:3 with a 5 foot vertical drop and along waterways to avoid safety hazards.
Infrastructure and Amenities	IA-1	Historical Outreach	1	Increase public knowledge of the history of the shared-use path right-of-way with informative signage along the path.	Include signage at trailheads about the history of the path and signage at any historic or cultural sites along the path.
Infrastructure and Amenities	IA-2	Wildlife protection	2	Encourage wildlife diversity on the path by providing habitats for wildlife and educational material for path users.	Incorporate one wildlife habitat per mile that has been certified by the National Wildlife Federation (National Wildlife Federation 2013) as well as educational signage at trailheads and at least every 3 miles at habitats along the path.
Infrastructure and Amenities	IA-3	Rest areas	2	Provide stopping points for path users through periodically spaced rest areas with benches along the path.	Incorporate rest areas that include an area to pull off of the path every 1/2 mile and benches at every mile.
Infrastructure and Amenities	IA-4	Restroom accessibility	3	Provide restroom access along the path with permanent facilities at trailheads and permanent or portable facilities periodically spaced along the path.	Provide permanent restroom facilities at all trailheads. Additionally, provide portable facilities so no point on the path is more than 3 miles away from a facility.

Category	ID	Name	Points	Description of Goal	Measurement
Infrastructure and Amenities	IA-5	Green restrooms	2	Reduce environmental impacts of restrooms with energy efficient electrical fixtures and low flow plumbing fixtures in permanent facilities and ecofriendly portable facilities.	Document fixture (lighting, faucet, toilet, hand dryer, etc.) choices and portable facility choices showing improved energy efficiency and environmental friendliness compared to normal practices.
Infrastructure and Amenities	IA-6	Hydration stations	2	Ensure adequate hydration for path users with periodically spaced, human and pet accessible water fountains.	Provide water fountains that are accessible for humans and pets, at minimum, every 3 miles along the path.
Infrastructure and Amenities	IA-7	Trailhead lighting	3	Increase path safety through adequate lighting at path trail heads.	Equip all path trailheads with lighting fixtures to illuminate the parking area to safe levels as per AASHTO (2005) Roadway Lighting Design Guide.
Infrastructure and Amenities	IA-8	Path and intersection lighting	3	Increase path safety through adequate lighting along undeveloped/remote sections and at all road or railroad crossings along the path.	Illuminate all portions of the path to a safe level as per AASHTO (2005) Roadway Lighting Design Guide. This may require lighting fixtures in remote sections of the path and lighting at road or railroad crossings.
Infrastructure and Amenities	IA-9	Energy efficient lighting	2	Reduce energy consumption through the use of renewable energy sources and energy efficient lighting.	Use LED light bulbs and renewable energy sources (solar, wind, etc.) for all light fixtures associated with the path.
Infrastructure and Amenities	IA-10	Bicycle parking	3	Promote bicycling through secure bicycle racks at all path trailheads.	Provide a secure bicycle rack at all designated trailheads and provide adequate storage capacity based projected usage.
Infrastructure and Amenities	IA-11	Bicycle friendly attractions	2	Promote bicycling through secure bicycle racks in view of the front door at retail, business, school, and transit locations along the path.	Include bicycle racks in view of the front entrance of the building, if applicable, for at least 50% of all land uses (excluding low density residential) within 1/4 mile of the path.
Infrastructure and Amenities	IA-12	Trailhead surveillance	1	Increase path safety with video surveillance at path trail heads.	Use video surveillance at all trailheads, providing views of all vehicular and bicycle parking. Surveillance footage should be accessible for at least 2 weeks from when it was filmed.
Infrastructure and Amenities	IA-13	Emergency call boxes	2	Increase path safety with emergency call boxes periodically spaced along remote path areas.	Provide emergency call boxes spaced, at minimum, every 1/2 mile in areas where adjacent properties are spaced every 200 yards or more along the path.

Category	ID	Name	Points	Description of Goal	Measurement
Infrastructure and Amenities	IA-14	Locational signage	3	Provide path users with a sense of location and distance traveled through signage (mile markers, street labels, and nearby attractions).	Provide mile markers, at minimum, every 1/2 mile and street labels at all road crossings. Include additional signage directing users to nearby attractions.
Infrastructure and Amenities	IA-15	Multimodal intersection safety	5	Ensure safe intersections at road or railroad crossings with cautionary measures including signage and crosswalks.	Provide cautionary crossing signs on the road and path at all intersections in addition to proper yield signs. Also provide crosswalks at all road crossings.
Continuing Practices	CP-1	Seasonal maintenance	6	Ensure proper path maintenance with a management plan for seasonal maintenance (vegetation upkeep, leaf removal, snow removal).	Document a plan determining responsible parties and frequency of maintenance for vegetation upkeep, leaf removal, snow removal, and path condition maintenance.
Continuing Practices	CP-2	Waste management plan	6	Ensure proper path maintenance with a management plan for garbage and recycling pickup and disposal.	Document a plan determining responsible parties and frequency of garbage and recycling collection and disposal from provided facilities and along the length of the path.
Continuing Practices	CP-3	Recycling facilities	3	Reduce solid waste production from shared-use path users by providing recycling facilities along the path.	Place recycling receptacles, at minimum, every 1/2 mile.
Continuing Practices	CP-4	Waste facilities	5	Allow path users to dispose of trash generated while using the path with periodically spaced trash receptacles.	Place waste receptacles, at minimum, every 1/2 mile.
Continuing Practices	CP-5	Art connection	2	Promote the arts and the community by incorporating locally produced artwork into the path project.	Display artwork with local connections, at minimum, every 3 miles along the path. Local connections can include: the artist currently resides or previously resided within 25 miles of the path, the art is focused on a subject within 25 miles of the project, or materials originated within 25 miles of the project.
Continuing Practices	CP-6	Public outreach	4	Increase public awareness of sustainable activities by incorporating a public education program and community events into the path project.	Hold at least 5 events (running/bicycle races, nature walks, festivals, craft shows, etc.) a year on the path or in collaboration with the path.
Continuing Practices	CP-7	Shared-use path watch program	4	Increase path safety through an organized path watch program.	Document an organized path watch program with responsible parties covering the length of the path.
Project Specific	PS-1	Innovation	4	Increase project sustainability by allowing project stakeholders to develop and implement innovative project specific credits.	Document project specific credits including an explanation of how the credit helps to achieve sustainability.
Project Specific	PS-2	Sustainability expert	2	Increase project sustainability with a team member accredited in LEED, Envision, etc. and/or with previous experience in Greenroads, GreenLITES, STARS, ILAST, LEED ND, Envision, INVEST, or another sustainable transportation rating system.	Provide proof of at least one team member's sustainability accreditation or evidence of previous experience with a sustainability rating system.

Appendix B

Appendix B. GreenPaths Rating System Pre-Evaluation Results.

Credit	Title	Points Possible	Trail Segments			
			Goochland Courthouse	Maidens	Crozier	West Creek
PL-1	Project goals	5	5	5	5	5
PL-2	Context sensitive solutions	8	0	0	0	0
PL-3	Lifecycle cost analysis	4	0	0	0	0
PL-4	Local, diverse project team	4	0	0	0	0
PL-5	Repurposed land use	10	10	10	10	10
PL-6	Agricultural land and wetland conservation	7	7	7	7	7
PL-7	Scenic, historic, and cultural enhancement	7	7	7	7	7
PL-8	Compact development	8	0	0	0	0
PL-9	Mixed land uses	10	10	0	0	10
PL-10	Diverse communities	5	0	0	0	0
PL-11	Access points	6	0	0	0	0
PL-12	Multimodal connectivity	7	0	0	0	0
PL-13	ADA accessibility	8	0	0	0	0
GC-1	Waste management strategy	1	0	0	0	0
GC-2	Minimize site disturbance	2	0	0	0	0
GC-3	Recycled materials	2	0	0	0	0
GC-4	Regional materials	2	0	0	0	0
GC-5	Trail mix material	2	0	0	0	0
GC-6	Permeable surface	2	0	0	0	0
GC-7	Cool surface	1	0	0	0	0
GC-8	Stormwater management	4	0	0	0	0
GC-9	Site vegetation	3	0	0	0	0
GC-10	Protection from steep slopes and waterways	2	0	0	0	0

Credit	Title	Points Possible	Trail Segments			
			Goochland Courthouse	Maidens	Crozier	West Creek
IA-1	Historical outreach	1	1	1	1	1
IA-2	Wildlife protection	2	0	0	0	0
IA-3	Rest areas	2	0	0	0	0
IA-4	Restroom accessibility	3	0	0	0	0
IA-5	Green restrooms	2	0	0	0	0
IA-6	Hydration stations	2	0	0	0	0
IA-7	Trailhead lighting	3	0	0	0	0
IA-8	Path and intersection lighting	3	0	0	0	0
IA-9	Energy efficient lighting	2	0	0	0	0
IA-10	Bicycle parking	3	0	0	0	0
IA-11	Bicycle friendly attractions	2	0	0	0	0
IA-12	Trailhead surveillance	1	0	0	0	0
IA-13	Emergency call boxes	2	0	0	0	0
IA-14	Locational signage	3	0	0	0	0
IA-15	Multimodal intersection safety	5	0	0	0	0
CP-1	Seasonal maintenance	6	0	0	0	0
CP-2	Waste management plan	6	0	0	0	0
CP-3	Recycling facilities	3	0	0	0	0
CP-4	Waste facilities	5	0	0	0	0
CP-5	Art connection	2	0	0	0	0
CP-6	Public outreach	4	0	0	0	0
CP-7	Shared-use path watch program	4	0	0	0	0
PS-1	Innovation	4	0	0	0	0
PS-2	Sustainability expert	2	0	0	0	0
Total Points		182	40 (22%)	30 (16%)	30 (16%)	40 (22%)