BBC RESEARCH & CONSULTING

Health, Social Equity, and Economic Impact of the Potomac Heritage National Scenic Trail in Northern Virginia

Northern Virginia Regional Commission

TECHNICAL DOCUMENTATION

nvrc Northern Virginia Regional Commission

NATIONAL PARK SERVICE

POTOMAC HERITAGE NATIONAL SCENIC TRAIL

Technical Documentation

November 15, 2021

Health, Social Equity, and Economic Impact of the Potomac Heritage National Scenic Trail in Northern Virginia

Prepared for

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INTRODUCTION

The Northern Virginia Regional Commission (NVRC) retained BBC Research & Consulting to analyze the health, social equity, and economic impacts of the Potomac Heritage National Scenic Trail (PHNST) in Northern Virginia.

Background

The braided network of trails comprising the PHNST spans close to 900 miles of multi-use trails across Virginia and three other states - the District of Columbia and three bordering states—Pennsylvania, Maryland, and Virginia—and provides access to numerous cultural, historic, and natural attractions including Mount Vernon, the National Mall, Harpers Ferry, Potomac River, and Chesapeake Bay. In Northern Virginia, the trail network spans 140 miles through the Town of Dumfries, the Town of Occoquan, the Town of Leesburg, the City of Alexandria and Counties of Loudoun, Fairfax, Arlington, and Prince William. The trail includes many elements of local, regional, state, and federal parks.[1]. The Northern Virginia sections of the trail are governed by multiple federal, state, and local entities. In order to coordinate among land managers, NVRC created a 2014 memorandum of understanding designed to promote and improve the network.[2] Figure D-1 provides a thumbnail map of the entire trail and Figure D-2 provides a map of the trail in Northern Virginia.

Trails not only provide a wide range of recreational values, services, and protection of specific natural and cultural features, but they also explicitly contribute to social and economic well-being. To assist the National Park Service, local governments, and other land management agencies, with the completion of the PHNST, NVRC, local, state, and federal partners will use this research to develop a deeper understanding about why the trail and its connections are valuable to Northern Virginia.

Objectives

The objective of this research was to assess the public health and community-related impacts associated with the use of the trail and provide recommendations to maximize those impacts and help justify the appropriate investment of resources in trail completion, infrastructure, and programming. Working closely with NVRC staff, BBC Research & Consulting (BBC) conducted a

[1] The trail includes portions of Great Falls Park, the George Washington Memorial Parkway, Historic Alexandria, the Mount Vernon Trail, Prince William Forest Park, Leesylvania State Park, Mason Neck State Park, the Washington and Old Dominion Trail, George Washington's Mount Vernon, Woodlawn & Frank Lloyd Wright's Pope-Leighey House, the Bureau of Land Management Meadowood Special Recreation Area, and the U.S. Fish and Wildlife Services Potomac River National Wildlife Refuge Complex.

[2] PHNST Memorandum of Understanding. https://www.novaregion.org/DocumentCenter/View/12700/Final-MOU-with-Maps-101620-sm-file?bidId= Accessed 9/15/2021

comprehensive assessment of the health, social equity, economic, and transportation impacts of the PHNST in Northern Virginia. This assessment included:

- Detailed information about the health impacts of the trail on local residents;
- The role of the trail in economic development in the region;
- An analysis of the equity of health, economic, and safety outcomes for residents along the trail; and
- A review of the transportation benefits provided by the trail.

This study will help NVRC better understand the impact of investments in the PHNST throughout the region and provide a benchmark for support of future program and capital spending. A key element of the study included the analysis of how closing gaps might increase the benefits of the trail. That analysis included two case studies for specific elements of the trail along with generalized information about closing all gaps along the trail in Northern Virginia.

Report Structure

Below, in the Executive Summary (starting on page 3), we provide an overview of the key results and recommendations from the study, a description of the methodology used to analyze the trail and benefits begins on page 5 with the detailed results beginning on page 16. BBC provides overall recommendations from the research starting on page 27. Appendix A includes the in-depth interview guide used for the research. Appendix B includes the survey instrument used to collect information from businesses as a part of the research. Appendix C includes the focus group report provided by Equitable Cities and the Virginia Department of Health.
Appendix D includes relevant maps of the trail and region.

EXECUTIVE SUMMARY

The PHNST in Northern Virginia provides numerous health, economic, and social benefits for the residents and businesses in the region. Quantifying these benefits requires understanding overall use of the trail along and how that use differs for different user groups.

BBC estimated the number of annual trips and annual miles traveled on the trail using information from NVRC, the Virginia Department of Transportation (VDOT), StreetLight, Strava, and local government pedestrian and bicycle counters. BBC augmented those data with qualitative research from interviews with local government officials, nongovernmental organization staff, and business representatives along the corridor. Based on the currently completed trail (excluding potential benefits from filling gaps along the route in Northern Virginia), key findings from the research include:

- **Trail Use.** In total, trail users walk 13.6 million miles and bike 45 million miles each year. On average this represents 100,000 miles of walking and 300,000 miles of biking for each mile of completed trail.
- **Health.** Regional residents see $349 million in annual benefits due to decreased mortality from the trail and $55 million annually in reduced healthcare costs.
- **Equity.** Benefits of the trail are not equally distributed. Users are more likely than regional residents to identify as white or black, while users are less likely than regional residents to identify as Hispanic. Areas along the trail with a higher concentration of socially vulnerable residents typically have fewer access points, more gaps (unfinished segments) in the trail, and more traffic safety issues than those neighborhoods with less socially disadvantaged residents.
- **Economic development.** The trail corridor boasts more than 250 restaurants and retail outlets representing more than $86 million in annual revenues. Many of these businesses serve trail users and some staff reported challenges for customers traveling between businesses and the trail. Each year, tourists (individuals using the trail who do not reside in Washington D.C., Virginia, or Maryland) take 680 thousand biking trips and 720 thousand walking trips along the trail. This equates to 5.4 million miles biked, and 2.1 million miles walked along the trail. On average, a tourist to the region spends more than $300 during their stay including $36 in local taxes.
- **Transportation.** Residents commute more than 6 million miles annually along the trail. If replaced with personal vehicles, this would result in an additional 2,500 metric tons of carbon dioxide equivalent (CO2e) in the region each year and a savings of more than $4 million in annually, $480 thousand in environmental and $3.7 million in personal vehicle costs.[3]

[3] Carbon dioxide equivalent or CO2e means the number of metric tons of CO2 emissions with the same global warming potential as one metric ton of another greenhouse gas and is calculated using Equation A-1 in 40 CFR Part 98. https://www3.epa.gov/carbon-footprint-calculator/tool/definitions/co2e.html

The study team also worked with NVRC staff and key stakeholders to develop recommendations for future infrastructure investment and trail programming including:

- **Design** – create spaces with good lighting, sight lines, and comfortable amenities;
- **Programming** – work with community organizations to activate the trail, understand the balance between recreation and transportation and increase programming for underserved population;
- **Communication** – help residents understand that the trail is for everyone;
- **Education** – help enforcement and local government understand the unique needs of the community;
- **Safety** – improve safety for trail users and for pedestrians and bicyclists along networks adjacent to the trail;
- **Data collection** – bolstering local government efforts to collect pedestrian and bicycle use data;
- **Outreach** – ensure broad input from all stakeholders regarding future infrastructure and amenity investments; and
- **Trail completion** – work with local governments to complete planned and temporary sections of the trail and complete routing the trail on currently unplanned segments Completing gaps will result in a variety of benefits for the region related to tourism, business development, and current disparities in trail infrastructure for underserved populations. For example, BBC estimates that completing the gaps would result in an additional $80 million in annual mortality benefits and $13 million in annual avoided health care costs.

METHODOLOGY

This section details the methodology used to estimate use of the PHNST by pedestrians and bicyclists and evaluate the economic, social, and health benefits of the trail.

Trail Use Data

Working with NVRC staff, BBC explored a variety of potential data sources for determining annual trail use. Below we provide a description of each data source included in the analysis.

StreetLight data. StreetLight is a subscription-based online application that provides estimates of vehicle, bike, and pedestrian trips that occur within a specified geographic area. BBC obtained access to Streetlight data for the region near the PHNST through NVRC and the Virginia Department of Transportation (VDOT).[4]

Streetlight gathers location records produced by cell phones, GPS devices, and other navigation tools in vehicles or carried by individuals as they travel through a region using highways, streets, bike paths, or sidewalks. Based on these data, StreetLight reports the purpose, distance, and time of trips as well as demographic information about the individuals taking each trip.

Using the online StreetLight tool, users can access a variety of data about the trips for a particular geographic area including:

- Average travel distances;
- Relative measures of trip volume;
- Average trip duration; and
- Demographic characteristics of trail users

For automobile traffic, StreetLight provides estimated vehicle counts and total trips. For pedestrian and bicycle trips, StreetLight provides relative indices of activity rather than actual counts of activity.

For travel on a given route, StreetLight allows users to create a virtual "gate" along roads and trails and will provide data regarding the trips starting, ending, or passing through the gate. StreetLight also allows users to create custom travel "line segments" and analyze the travel patterns of individuals passing through utilizing each line segment.

BBC created gates in the online StreetLight portal along all segments of PHNST in Northern Virginia. To ensure complete coverage, the maximum distance between any two gates included

[4] BBC accessed the StreetLight portal through https://insight.streetlightdata.com/login
Additional information about StreetLight data related to pedestrian and bicycles activity can be found here: https://www.streetlightdata.com/bike-pedestrian-traffic-analytics/ Accessed between June 11, 2021 and August 31, 2021. BBC provided the raw data files to NVRC.

in the analysis was two miles. Each gate analyzed in StreetLight is considered a separate geographic area. As a result, a trip that crosses through multiple gates would be counted at each gate crossing. To minimize double counting of trips, BBC also created line segments that passed through multiple gates in order to account for longer trips. For gates that intersected with a line segment, BBC adjusted the activity index by subtracting the index from the line segment from the index for each gate the segment passed through. Those adjusted gate indices, the indices from the line segments traversing multiple gates, and indices from gates that did not fall within a line segment were included in the final analysis of total activity along the trail. To obtain actual counts of trail activity, StreetLight also allows users to submit data from bicycle and pedestrian counters to calibrate the activity indices and analyze the number of trips and miles for a particular line segment or gate. During the study of PHNST, this feature was not working correctly. As a result, BBC worked with StreetLight representatives to understand the process used, and replicated the process results as described below in the model development section (starting on page 7).

BBC accessed Streetlight data for the region near the PHNST using the StreetLight portal, accessing data beginning in June 2021 through August 2021. Raw data downloaded from the StreetLight portal and used in BBC's analyses were provided to NVRC upon completion of the study.

Cell phone use and StreetLight data collection. BBC and NVRC were concerned about whether the reliance of StreetLight data on cell phone use, smartphone application use, and GPS device use might introduce bias in the analyses of trail users. According to research from the Pew Research Institute, 97 percent of all adults in the US report owning a cell phone and 85 percent report owning a smartphone.[5] There are some variations within different subsets of the US population. For example, among Black adults in the US, 99 percent reported owning a cell phone and 83 percent reported owning a smartphone. For White adults, 97 percent reported owning a cell phone and 85 percent reported owning a smartphone. These differences in cell phone and smartphone usage may result in the underreporting of low-income and minority users of the PHNST when using StreetLight data. The increase of cell phone and smartphone application across all segments of the population may reduce this bias in the future.

Strava Metro data. Strava is an internet-based application that allows users to track physical activity such as biking, running, and walking.[6] While the basic features of Strava are available to any user, the platform provides additional analysis for users who pay a subscription fee. Strava aggregates data collected from user activity and provides information on community-wide activity for local and state governments through the Strava Metro program. Strava provides access to Strava Metro for consultants, transportation planners, and engineers who are working directly with a local government entity. BBC worked with NVRC to obtain access to Strava Metro data for the PHNST. In contrast to the StreetLight data, Strava Metro provides actual counts of trail users in addition to information about average activity time and distance. Given the barrier

[5] Pew Research Center. Mobile Fact Sheet https://www.pewresearch.org/internet/fact-sheet/mobile/ Accessed 10/15/2021

[6] Strava is accessed at www.strava.com for users. Government organizations access Strava data through the Strava Metro Portal: https://metro.strava.com/ BBC accessed Strava Metro data for the study in August 2021.

to entry to using Strava (users are required to sign up for an account, use a phone or watch capable of tracking activity, and activate the app prior to engaging in physical activity), BBC only used Strava data when information from StreetLight and counters were not available or reliable.[7]

Walking and biking counters. NVRC staff worked with BBC to identify bicycle and pedestrian counters along the PHNST in Northern Virginia. Arlington County Department of Transportation (Arlington DOT) maintains the largest collection of counters in the region with more than 35 counters located along the County's network of pedestrian and bicycle infrastructure.[8] The County also collects data for three counters in the City of Alexandria. Some of those counters for the County have been operational for more than a decade, which is valuable for obtaining annual and seasonal average trail usage. BBC requested and obtained counter data from Arlington County Department of Transportation (DOT) for all Arlington DOT counters and the City of Alexandria counters along the PHNST, as well as for a few counters on major routes leading to the trail. These data included monthly usage for each counter across a three-year period from 2016 to 2018. Additionally, Arlington DOT conducted five weeks of data collection from August 30,2021 to October 3,2021 on three mobile counters north of the Francis Scott Key Bridge along the hiking paths of the George Washington National Memorial Parkway section of the PHNST. NVRC and BBC requested placement of these counters due to the unique, rural nature of the trail in this region and the relative dearth of counter data on this type of trail infrastructure. Using the monthly and annual data from the other counters and the five-week data, BBC performed a correlation analysis to estimate the annual usage for the three mobile counters. Figure D-3 provides a map of the City of Alexandria and Arlington DOT counters, and Figure D-4 presents a more detailed map of the locations of the three mobile counters.[9]

BBC also collected counter information maintained by Prince William County for three locations along the southern portion of the PHNST. BBC did not include those counters because they were unable to differentiate between individuals on bicycles, pedestrians, and horses.

Model development. Based on input from StreetLight staff, BBC created gates in the StreetLight application corresponding to each counter location along the trail where a local government provided usable pedestrian and bicycle count data. BBC submitted these data to StreetLight for calibration within the StreetLight online application. Due to technical issues, the calibration function of the StreetLight application was unable to produce results and BBC consulted StreetLight staff on how to manually calibrate the data model using a linear regression model.

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[7] BBC used StreetLight and modeled data for all pedestrian analyses as well as bicycle analyses in the central portion of the trail (from the Frances Scott Key Bridge to the southern end of Oronoco Bay Park). BBC used Strava Metro data for the northern and southern segments of the trail (See Figure D-5 for a map of the northern, central, and southern regions of the PHNST).

[8] Bike Arlington provides an online dashboard reporting counter information from the county: https://counters.bikearlington.com/?_ga=2.244153477.1690358997.1637610980-584225830.1637610980 Accessed October, 2021.

[9] For the purposes of analysis, BBC used data from the following counters in Figure D-3: 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 35, 36, 38, 40, 41, and the three mobile counters from Figure D-4.

Instead of using the online application, StreetLight staff recommended calibrating the index data by calculating the average annual daily traffic (AADT) count for each analyzed trail segment. Using the data from the permanent City of Alexandria and Arlington DOT counters along the PHNST, BBC calculated the annual average counts for each StreetLight index and converted them to AADT counts for both pedestrian and bicycle data. Using the data from the permanent Arlington DOT counters and the five weeks data of data collected from the three mobile counters, BBC estimated the average annual counts for the three mobile counters.

For the pedestrian analysis, BBC included counter data and StreetLight data from the calendar year 2018 which represented the most complete year of data unaffected by the pandemic. BBC used the counter locations from the Arlington DOT as well as the three mobile counters to model the entire trail (north, central, and southern sections). The resulting pedestrian use regression model fit the data well (R^2 of 0.81) for all portions of the trail meaning there was a strong correlation between the StreetLight index and actual activity count.

When analyzing the bicycle data, BBC also used data from 2018. Based on reviewing potential models for bicycling use, BBC determined it was most appropriate to model the central section of the trail (from the Frances Scott Key Bridge to the southern end of Oronoco Bay Park, see Figure D-5 for a map of the trail with sections identified for analysis) separately from the northern and southern sections of the trail. BBC used two different models because it appeared that the relationship between counter data and the StreetLight index was less reliable for the northern and southern portions of the trail. The model for the central section of the trail fit the StreetLight and counter data well, so BBC used that approach for that portion of the trail. The differences in trail use may account for the need to use different modeling approaches. For example, residents use the central section of trail more frequently and a larger share of the bicycle trips along that part of the trail are for transportation (as opposed to recreation).

BBC created a model for the central portion of the trail using StreetLight indices and data from the permanent counter locations (the three mobile counters only provided pedestrian counts) that fit the data well (R^2 of 0.63). For the northern and southern portions of the trail, BBC chose to use Strava Metro activity count data instead of counter data to model bicycle activity in those areas.

Caveats, limitations, and future adjustments. The overall estimates of trail use represent the best data available to NVRC and BBC at the time of the study. When presented with a choice regarding data use or modeling, BBC chose to employ the more conservative approach in estimating trail use and activity (e.g., when deciding between two sets of analyses, BBC chose the analysis which suggested lower levels of activity along the trail). Given the rapid advances in counter technology and StreetLight data, BBC recommends reviewing use data regularly and updating estimates once resident and visitor patterns settle after the pandemic.

BBC provided details about the modeling used to NVRC but did not publish the model results and specification as it likely is not useful for modeling trails other than the specific section of the PHNST analyzed in this project.

Health Benefits

BBC analyzed three components of economic, mortality, and morbidity impacts related to health and the use of the PHNST:

- The number and value of lives saved due to walking and biking by residents on the trail;
- The avoided health care costs due to moderate to vigorous activity by residents on the trail; and
- The avoided costs of pollution realized by residents commuting to work via walking and biking on the trail.

Mortality. Using BBC's modeled information on resident trail use and the World Health Organization's (WHO's) Health Economic Assessment Tool (HEAT), BBC estimated the existing health benefits of walking, bicycling, and running on the PHNST in Northern Virginia.[10] In addition to current estimates, BBC estimated the increased benefits derived from two gap closure case studies.

HEAT data allows calculations of the economic value of the reduction of mortality if a certain number of people walk or bike a given distance on most days. To complete the HEAT analysis, BBC used regional data to estimate existing and future PHNST use by area residents in terms of the average number of trips along the network per person per year, the average distance covered in trips along the trail, and the total number of individuals taking trips. In addition, we used a Virginia estimate of mortality rate (580.6 per 100,000 people) and economic value of a life in the region as calculated by the United States Department of Transportation (USDOT).[11,12]

HEAT estimates the risk of death for residents who exercise regularly from any cause (i.e., all-cause mortality) compared to the risk of death for people who do not exercise regularly. We applied the WHO's estimates of those risks to the amount of exercise reported in regional health metrics. After identifying reductions in all-cause mortality risk that a population might incur from specific levels of moderate to vigorous exercise, HEAT was used to compare the number of adults who would normally be expected to die in any given year to the number of adults who would be expected to die given if there were increased use of the PHNST in Northern Virginia from completing the gaps and improving equitable access. Finally, using HEAT, BBC estimated the discounted economic savings from estimated reductions in deaths over a year of trail use.

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[10] World Health Organization. Health economic assessment tool (HEAT) for cycling and walking. https://www.euro.who.int/en/health-topics/environment-and-health/Transport-and-health/activities/guidance-and-tools/health-economic-assessment-tool-heat-for-cycling-and-walking Accessed September 2021. BBC used the more generalized version of the HEAT model found here: http://heat3.heatwalkingcycling.org/

[11] National Institute on Minority Health and Health Disparities (NIH) Death Rates Table for Virginia https://hdpulse.nimhd.nih.gov/data/deathrates/index.php?stateFIPS=51&cod=247&race=00&sex=0&age=600&type=death&sortVariableName=name&sortOrder=asc Accessed September 2021.

[12] United States Department of Transportation. Departmental Guidance on Valuation of a Statistical Life in Economic Analysis. https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis 2020 value is $11.6 million

Morbidity. According to the United States Department of Health's Office of Disease Prevention and Health promotion, moderate to vigorous physical activity (defined as at least 30 minutes of activity five times a week), provides numerous health benefits for youth and adults including:

- Improved cognition, bone health, fitness, and heart health for youth and adults;
- Reduced rates of depression for youth and adults;
- Reduced rates of eight types of cancer in adults; and
- Reduced risk of all-cause mortality, heart disease, stroke, high blood pressure, and type 2 diabetes in adults;[13]

A 2012 study published in the Journal of the American Heart Association estimated the avoided healthcare costs of all these benefits for typical American residents.[14] BBC used data from the Kaiser Family Foundation to inflation adjust these costs to present day dollars and adjust for differences between national health care costs and Virginia costs.[15] The recommended number of trips per person is 5 trips a week, or 150 minutes each week. Based on annual trip data for biking and walking, BBC estimated the number of resident trips that met the 30-minute threshold, which was then converted to individuals by dividing that number of trips by five (to reach the recommended 150 minute/week threshold) and then dividing by 52 (to estimate the amount of activity that would be equivalent to the annual number of persons performing at least 150 minutes of exercise a week). Using this result, BBC estimated the current annual avoided health care costs provided by the PHNST in Northern Virginia.

Environmental. A research paper published in the Transportation Research Board journal provided the estimated public health and climate change costs associated with pollution produced by automobiles.[16] This study provided estimates for the Washington D.C. metro area in 2008 ($0.058/mile, which BBC inflated to $0.075/mile). BBC used this study's results to estimate the value of the avoided automobile commuting miles and avoided environment pollutants based on multiplying the avoided pollution costs by the number of miles commuted via walking and biking along the PHNST in Northern Virginia. For modeling the amount of pollution avoided,

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[13] U.S. Department of Health and Human Services. (2018). Physical Activity Guidelines for Americans, 2nd edition. Retrieved from https://health.gov/paguidelines/second-edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf

[14] Valero-Elizondo, J., Salami, J. A., Osondu, C. U., Ogunmoroti, O., Arrieta, A., Spatz, E. S., Younus, A., Rana, J. S., Virani, S. S., Blankstein, R., Blaha, M. J., Veledar, E., & Nasir, K. (2016). Economic Impact of Moderate-Vigorous Physical Activity Among Those With and Without Established Cardiovascular Disease: 2012 Medical Expenditure Panel Survey. Journal of the American Heart Association, 5(9), e003614. https://doi.org/10.1161/JAHA.116.003614

[15] Kaiser Family Foundation Health Care Expenditures per Capita by State of Residence. https://www.kff.org/other/state-indicator/health-spending-per-capita/

[16] Transportation Research Record: Journal of the Transportation Research Board, No. 2233, Transportation Research Board of the National Academies, Washington, D.C., 2011, pp. 120–127. DOI: 10.3141/2233-14

BBC relied on the United States Department of Transportation's 2020 estimates of vehicle emissions per mile.[17]

Caveats, limitations, and future considerations. BBC worked to find the most robust yet conservative estimates of health benefits from the rail. Future modeling may refine models such as the WHO's HEAT analysis and provide updated data on avoided healthcare and pollution costs. It is important to note that some transportation benefits were not included in the analysis (those for non-commute trips, which are indistinguishable from home-based recreation trips in StreetLight data). It is likely that pollution savings in the future may decrease with the increased electrification of the regional personal vehicle fleet.

Equity Analysis

BBC reviewed several different metrics for the equity analysis, including trail access, completion, and traffic crashes. Much of the analysis was based on the Center for Disease Control's (CDC) social vulnerability index (SVI).[18] BBC also collected qualitative information related to equity in trail use through in-depth interviews conducted by BBC staff and focus groups conducted by Equitable Cities in conjunction with the Virginia Department of Health.

CDC social vulnerability index. NVRC staff recommended using the CDC's SVI as a method to identify areas within the region with a greater share of underserved residents. Per NVRC's request, BBC used the 2018 SVI normalized to the Commonwealth of Virginia rather than the nationally normalized data. The SVI includes 15 variables across four separate socio-economic categories to determine the social vulnerability of a particular population. Those variables and categories include:[19]

- **Socioeconomic Status**
  - Below Poverty
  - Unemployed
  - Income
  - No High School Diploma
- **Household Composition & Disability**
  - Aged 65 or Older

[17] United States Department of Transportation Bureau of Transportation Statistics. https://www.bts.gov/content/estimated-national-average-vehicle-emissions-rates-vehicle-vehicle-type-using-gasoline-and Accessed October 2021

[18] Center for Disease Control/Agency for Toxic Substances and Disease Registry. CDC/ATSDR Social Vulnerability Index. https://www.atsdr.cdc.gov/placeandhealth/svi/index.html Accessed in September 2021. Additional documentation available: https://www.atsdr.cdc.gov/placeandhealth/svi/publications/publications_materials.html Accessed in October 2021.

[19] CDC SVI 2018 Documentation - https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/pdf/SVI2018Documentation-H.pdf accessed 10/22/2021

- Aged 17 or Younger
- Civilian with a Disability
- Single-Parent Households

- **Minority Status & Language**
  - Minority
  - Speaks English "Less than Well"

- **Housing Type & Transportation**
  - Multi-Unit Structures
  - Mobile Homes
  - Crowding
  - No Vehicle
  - Group Quarters

BBC used SVI data from NVRC's Geographic Information Systems (GIS) files for the Census tracts adjacent to the PHNST.[20]

NVRC PHNST database. BBC relied on NVRC GIS data for information about all physical characteristics of the trail including:

- Completed segments;
- Gaps with planned but unknown route alignments;
- Gaps with planned known route alignments;
- Trail head access points;
- Bus and rail stops; and
- Trail length.

VDOT crash data. Based on recommendations from NVRC staff, BBC used 2019 VDOT's GIS crash data to analyze fatal pedestrian and bicycle crashes near the PHNST.[21]

Demographic data. BBC used NVRC demographic data for the region in analyzing resident demographics. For trail user demographics, BBC relied on information from StreetLight developed from Census data, smartphone application information, and resident home locations. Each StreetLight analysis provides basic demographic data about users along with the overall

[20] NVRC ArcGIS Portal. https://data-nvrc.opendata.arcgis.com/ Accessed June 2021. S

[21] VDOT Crash Analysis Tool - https://www.virginiaroads.org/maps/1a96a2f31b4f4d77991471b6cabb38ba/about Accessed September 2021

pedestrian and bike use index. In order to develop trail-wide demographic estimates, BBC used a mile-weighted average of the demographic data provided by StreetLight for each gate and line segment analyzed.

BBC also examined data for the Census tracts within 1.5 miles of the trail using information from the CDC's SVI database.[22] While some of these demographic data are less specific than the data available from StreetLight or the region-wide census data, they provide useful context on the demographics of residents living close to the trail (for example, the Census tract data only reports "Minority residents" while regional data and StreetLight provide more detailed information on the race and ethnicity of residents).[23]

In-depth interviews. BBC conducted interviews with eight individuals regarding equitable access to the PHNST. Five individuals were staff of local or county governments and three individuals were representatives of non-governmental organizations working with underprivileged populations in the region. Each interview lasted between 10 and 60 minutes and were conducted by phone or video chat. Additional information about the interviews is included in the results section on page 21 and the interview guide is included in Appendix A.

Focus groups. After initial project discussions with NVRC staff and representatives of the Virginia Department of Health (VDH), it was determined that VDH would be willing to fund focus group research in support of the overall analysis of the PHNST. VDH contracted with Equitable Cities to conduct four focus groups with regional residents. These focus groups included ten individuals and half of those individuals identified as part of a racial minority group. Appendix B provides more detailed information about the focus group results.

Caveats, limitations, and future considerations. NVRC should consider updating the equity analyses as the CDC updates the SVI with more recent data. Additionally, as partners consider completing gaps along the trail, NVRC and its partners should consider how completing those gaps will impact vulnerable populations. Finally, NVRC should consider reviewing not only trail completion status, but the quality, safety, and availability of amenities of the trail and how those metrics correlate with the SVI of the adjacent neighborhoods.

[22] CDC/ATSDR SVI Data and Documentation Download. Accessed https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html in August 2021.

[23] CDC SVI 2018 Data Documentation. Accessed https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/pdf/SVI2018Documentation-H.pdf in August 2021

Economic Development Analysis

As shown by numerous studies, trails can play a key role in supporting local economies.[24] NVRC and BBC sought to analyze the impact of the trail on local businesses and tourism in the region.

Trail-facing businesses. BBC collected lists of businesses and organizations from a variety of sources including:

- The National Park Service (NPS);
- NVRC; and
- Hoovers Dun & Bradstreet.[25]

BBC merged these lists together and then removed duplicate information records to create a database of businesses in the region. Using mapping tools, BBC narrowed the list of businesses to restaurants and outdoor retailers within 1.5 miles of the trail. BBC created a business survey and invited businesses to participate via email. For those with email addresses that did not respond, BBC followed up with a phone call and letter asking for the businesses to complete the survey. BBC received five completed surveys and conducted two interviews with businesses in the region. Appendix A includes the survey instrument used for the business survey.

Revenue and employment data. BBC used revenue and employment data from Hoovers Dun & Bradstreet. These data typically represent a three-year average of sales and employment for an organization.

Out-of-region visitors. Using StreetLight data, BBC determined the proportion and number of trips and miles walked and biked for residents of Washington D.C., Virginia, Maryland, and states outside of those three jurisdictions. Using these data, BBC defined tourists (individuals visiting the region for recreation or business travel) as residents from outside of Washington D.C., Virginia, and Maryland. BBC derived the proportion of tourist trips and miles using weighted averages of those data from the individual StreetLight zones and segments compiled for the overall trail use analysis. BBC also researched the economic contribution of visitors to the D.C. region using information from Destination DC.[26] Destination DC reported that in 2019 visitors generated $331 per trip including $36 in local sales taxes.

Caveats, limitations, and future considerations. NVRC should consider updating the business analysis by conducting additional surveys and interviews with local businesses. When designing future trail segments or refurbishing existing sections of the trail, NVRC and partners should include businesses in outreach efforts. Finally, NVRC should consider working with

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[24] https://www.railstotrails.org/resourcehandler.ashx?id=4620

[25] Hoovers Dun & Bradstreet (D&B) is an international business list provider. More information is available here: https://www.dnb.com/business-directory.html and here: https://www.dnb.com/content/dam/english/dnb-solutions/DNB_Hoovers_Product_Brochure.pdf. BBC accessed D&B data for the Northern Virginia region between August 15, 2021, and September 1, 2021.

[26] https://washington-org.s3.amazonaws.com/s3fs-public/2019_washington_dc_visitor_statistics.pdf

organizations such as Destination DC to better understand visitor behavior and how the trail might further support the tourism economy in the region.

Transportation Analysis

BBC analyzed the transportation benefits of the PHNST in Northern Virginia by analyzing the proportion of commuting trips reported on the trail and analyzing bicycle and pedestrian traffic crashes in the trail corridor.

Commuting trips. BBC used StreetLight data to determine the proportion of trips used for commuting along the trail. For each gate and trail segment analyzed, StreetLight provides the proportion of trips that are home-to-work or work-to-home. BBC used a mile-weighted average across all segments analyzed to determine the total number of trips and miles commuted on the trail.

Crash analysis. BBC used information from 2019 VDOT crash data to analyze traffic crashes in the trail corridor.[27] BBC looked at fatal and serious-injury crashes in the corridor that involved pedestrians and bicycles.

Caveats, limitations, and future considerations. It is important to note that using the StreetLight commuting data underestimates the total transportation trips on the trail. StreetLight categorizes trips as "home-to-work or work-to-home," "home-to-other or other-to-home," and "not home-based." It is likely that some of the "home-to-other or other-to-home" trips are transportation related and some are recreational. Given the lack of additional information about these trips, BBC chose to exclude "home-to-other and other-to-home" trips from the transportation analysis. In future analyses, NVRC could work with StreetLight to better understand these types of trips.

Gap Analysis

BBC worked with NVRC to identify two gaps in the trail for analysis. One, a boardwalk along Neabsco Creek completed in June 2019, while the other was a planned expansion in the northern portion of the trail corridor near Broad Run and Goose Creek. The northern gap will provide access between the PHNST and the Washington & Old Dominion rail trail. BBC used StreetLight and Strava data to look at analyze the impact of closing these gaps. Appendix D provides maps of these gaps in Figures D-6 and D-7.

BBC also estimated the overall benefits of completing planned trail expansions in the corridor as well as gaps where there is currently no route specified. Those gap analyses relied on interpolation of the trail benefits based on the use of existing trail segments.

Geographic Analyses. Many of the analyses relied on overlaying data from NVRC's GIS database with the CDC's SVI information. Appendix D presents the maps used for those analyses.

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[27] VDOT Crash Analysis Tool - https://www.virginiaroads.org/maps/1a96a2f31b4f4d77991471b6cabb38ba/about Accessed September 2021

RESULTS

Using the methodology described above, BBC analyzed the health, social, business, and transportation benefits of activity along the trail. Below we describe results for each category along with the results of the analyses of the two case study gaps, and the overall gaps required to complete impacts trail in Northern Virginia.

Health Results

Bicycling and walking along the PHNST keeps residents active and decreases the prevalence of adverse health conditions such as heart disease, diabetes, and other chronic health conditions. Figure 1 presents the total health benefits of biking and walking on the PHNST in Northern Virginia. Health benefits from the PHNST contribute an estimated $404 million in total health benefits to the local economy, including $349 million in reduced mortality benefits identified using the WHO's HEAT model and $55 million dollars in estimated avoided health care costs. Commuting along the trail also reduces pollution produced by residents when compared with using a vehicle. Walking and bicycling commutes prevent 1.2 metric tons of nitrogen oxide (NOx) gases and 27 metric tons of carbon monoxide (CO) from reaching the region's air. Below, BBC provides more information about all three of those estimates.

Figure 1.
Morbidity and Avoided Healthcare Benefits

Transportation Mode	Annual Resident Miles	ANNUAL ECONOMIC BENEFITS		
		Mortality	Avoided Healthcare Costs	Total
Biking	30,000,000	$139,000,000	$23,000,000	$162,000,000
Walking	9,000,000	$210,000,000	$32,300,000	$242,300,000
Total	39,000,000	$349,000,000	$55,300,000	$404,300,000

Source: BBC Research & Consulting 2021 from WHO HEAT analysis data, StreetLight data, and Medical Panel Expenditure Survey.

Avoided health care costs associated with the PHNST. According to the U.S. Department of Health and Human Services, 150 minutes a week of regular, moderately intense physical activity provides health protection from many chronic health conditions, including heart disease, stroke, diabetes, and others.

Using those guidelines, BBC used Streetlight data to estimate the proportion of Northern Virginia residents whose walking or biking trips on the PHNST lasted more than 30 minutes. Based on this information, BBC estimates residents might see $55 million in annual benefits from avoided health care expenses. This annual savings represents more than $390,000 in annual avoided health care benefits per mile of trail each year.

Reduced mortality benefits. The HEAT tool allows local governments to estimate the annual number of lives saved in a region due to the health benefits of bicycling and the economic benefit

associated with that reduction in mortality. The analysis used Northern Virginia-specific data from Streetlight to analyze the existing health benefits from walking and biking on the PHNST.

Based on estimates from the HEAT model, the PHNST currently helps prevent about 32 deaths per year by providing protection from deaths associated with sedentary living (e.g., heart disease and diabetes).[28] Using an economic benchmark of $11 million per avoided fatality, the value of which is calculated regularly by the USDOT, the HEAT model suggests that there are $349 million in annual reduced mortality benefits.[29] This represents more than $2.4 million of annual mortality benefit per mile of trail annually.

Air pollution benefits. Residents commute more than 6 million miles annually. Replacing those commuting miles with personal vehicle miles would add substantial pollution to the regional environment including 27 metric tons of CO, 1.2 metric tons of NOx, and 2,587 metric tons of CO2e.[30]

Figure 2.
Air Pollution Benefits

Transportation Mode	Annual Commuting Miles	ANNUAL AVOIDED POLLUTION (Metric Tons)		
		CO	NOx	CO2e
Biking	4,600,000	19.1	0.9	1,831
Walking	1,900,000	7.9	0.4	756
Total	6,500,000	27.0	1.2	2,587

Source: BBC Research & Consulting 2021 from StreetLight data and Bureau of Transportation Vehicle Emission data.

[28] The World Health Organization's Health Economic Assessment Tool does not consider the negative health impacts of road traffic accidents involving bicyclists. For more information, please see pages 14-19 in the methodology and user guide. (http://www.euro.who.int/__data/assets/pdf_file/0010/256168/ECONOMIC-ASSESSMENT-OF-TRANSPORT-INFRASTRUCTURE-AND-POLICIES.pdf).

[29] This value is determined by carefully studying wages in occupations and industry that vary in terms of how dangerous they are to one's survival. A variety of studies over the past 30 years have examined labor markets to determine the premium people must be paid to take on greater personal risk in their work, and the results of these studies are extrapolated and combined by the USDOT to arrive at its estimate, which is known as the Value of a Statistical Life (VSL). HEAT discounts the VSL three percent per year because the model considers future health benefits less valuable than current health benefits.

[30] For reference, the C02e emissions are equivalent to the annual carbon footprint of about 1,000 US residents.

Equity Results

The substantial benefits realized by residents from the PHNST are not distributed equally among all residents in the region. As documented by many national organizations, minority residents, residents with disabilities, and older residents are often underserved by outdoor spaces.[31, 32, 33, 34, 35] BBC documented the use of the trail for different demographic groups as well as key trail attributes for types of Census tracts based on their SVI. As an addition to the project, the Virginia Department of Health contracted with Equitable Cities to conduct focus groups with residents to discuss barriers to trail access and use. BBC also conducted in-depth interviews with nongovernmental and local government staff to better understand the accessibility of the trail in Northern Virginia for diverse populations.

Demographics of trail use. As shown in Figure 3, the greatest share of trail users are white residents. There are more white and black trail users than their overall concentrations in Northern Virginia. Disparities between trail use and residents are most prominent for Asian, American Indian, and Hispanic residents.

Figure 3.
Demographics of Trail Users and Regional Residents

Category	NOVA Region 2020 Census	TRAIL USERS	
		Walking	Biking
Race			
American Indian	0.6%	0.4%	0.4%
Asian	16.6%	7.6%	6.7%
Black	11.8%	16.9%	15.8%
Native Hawaiian or Pacific Islander	0.1%	0.1%	0.1%
White	49.8%	67.0%	69.8%
Other/Multiple Races	21.1%	8.0%	7.2%
Ethnicity			
Hispanic	18.8%	11.8%	10.6%
Non-Hispanic	81.2%	88.2%	89.4%

Source: BBC Research & Consulting 2021 from American Community Survey and StreetLight data

[31] National Health Foundation. *Breaking Down the Lack of Diversity in Outdoor Spaces.* https://nationalhealthfoundation.org/breaking-down-lack-diversity-outdoor-spaces/

[32] American Hiking Society. *Racism in the Outdoors.* https://americanhiking.org/hiking-resources/racism-in-the-outdoors/

[33] Mills, James Edwards. National Geographic. *Here's how national parks are working to fight racism.* https://www.nationalgeographic.com/travel/national-parks/article/more-diversity-how-to-make-national-parks-anti-racist

[34] Hubbart, Sarah. National Environmental Education Foundation. *Increasing Accessibility Makes the Outdoors Open for All.* https://www.neefusa.org/health/outdoor-activity/increasing-accessibility-makes-outdoors-open-all

[35] Green, Jared L. Smart Cities. *What Do Seniors Need In Parks?* https://www.smartcitiesdive.com/ex/sustainablecitiescollective/what-do-seniors-need-parks/1070996/

Demographics of the Trail Corridor. Beyond analyzing the demographics of all residents in the region, BBC used data from the CDC's Census tract level SVI data to provide insight into residents living within 1.5 miles of the trail. These analyses do not include specific race and ethnic categories and provide information about broad age groups. Figure 4 provides the results of those analyses for the entire corridor and separately for the four types of SVI Census tracts. While most residents in the corridor are non-Minority (53.1%) it is important to note that the highest proportions of minority residents, residents living below the poverty line, and unemployed residents are found in the High and Moderately High SVI Census tracts. Low and Moderately Low SVI tracts report a higher proportion of residents over age 65.

Figure 4.
Trail Corridor Demographics

Type of Census Tract by Social Vulnerability Index	Demographic Category				
	Proportion minority (all groups except non-Hispanic White)	Proporiton of residents below poverty	Proportion over age 65	Proportion disabled	Proportion unemployed
All	**46.9%**	**6.5%**	**10.5%**	**6.7%**	**2.2%**
Low (0.00-0.25)	30.1%	3.0%	12.1%	5.7%	1.6%
Moderately Low (0.25-0.50)	43.9%	6.1%	10.8%	6.8%	2.1%
Moderately High (0.50-0.75)	67.4%	9.2%	8.2%	7.1%	2.8%
High (0.75-1.00)	74.9%	13.9%	8.0%	8.5%	3.3%

Source: BBC Research & Consulting 2021 from CDC SVI Census Tract data and American Community Survey 2014-2018 estimates.

Trail completion. Based on analysis of completed, planned, and temporary trail segments, moderately high and high socially vulnerable Census tracts are more frequently near planned and temporary segments. BBC also examined the prevalence of sections of unrouted gaps in the trail according to the SVI and found that moderately high socially vulnerable Census tracts were more likely to be near those gaps than other Census tracts. Figure 5 shows the results of those analyses. Figure D-2 provides a map of the PHNST trail identifying completed trail segments and gaps.

Figure 5.
Trail Completion Results

CDC Social Vulnerability Index	PROPORTION OF TRACTS				
	Adjacent to Trail	Near One or More Completed Segments	Near One or More Planned Segments	Near One or More Planned or Temporary Segments	Near One or More Unrouted Gaps
Low (0.00-0.25)	44%	86%	24%	24%	13%
Moderately Low (0.25-0.50)	31%	93%	29%	29%	9%
Moderately High (0.50-0.75)	15%	81%	63%	67%	22%
High (0.75-1.00)	11%	79%	47%	53%	11%

Source: BBC Research & Consulting 2021 from American Community Survey and StreetLight data.

According to Census tract data, tracts near trail gaps have a higher proportion of minority residents (49.1%) when compared to tracts without gaps (46.5%).

Trail access. Using data from NVRC, BBC analyzed the prevalence of access points to the trail (parking lots, trailheads, junctions with other trails) for each SVI classification. As shown in Figure 6, a lower proportion moderately high and high SVI tracts have trailhead (parking) access points when compared to low and moderately low SVI tracts. Figure D-8 provides a map of the PHNST with access points identified along the trail.

Figure 6.
Trailhead (parking) Access Results

CDC Social Vulnerability Index	PROPORTION OF TRACTS	
	With Access	Without Access
Low (0.00-0.25)	28%	72%
Moderately Low (0.25-0.50)	22%	78%
Moderately High (0.50-0.75)	19%	81%
High (0.75-1.00)	11%	89%

Source: BBC Research & Consulting 2021 from American Community Survey and StreetLight data.

Based Census tract data, tracts with access to the trail have a lower proportion of minority residents (42.7%) when compared to tracts without rail stops (48.3%).

BBC also examined access to transit stops along the corridor. As show in Figure 7, the distribution of bus stops across the region is uniform when considering the social vulnerability indices of Census tracts, but low and moderately low SVI tracts are more likely to have train stations. Figure D-9 provides a map of the PHNST corridor showing bus and rail stations within 1.5 miles of the trail.

Figure 7.
Transit Access Results

CDC Social Vulnerability Index	PROPORTION OF TRACTS			
	With Bus Access	Without Bus Access	With Rail Access	Without Rail Access
Low (0.00-0.25)	27%	73%	8%	92%
Moderately Low (0.25-0.50)	24%	76%	5%	95%
Moderately High (0.50-0.75)	30%	70%	4%	96%
High (0.75-1.00)	26%	74%	0%	100%

Source: BBC Research & Consulting 2021 from American Community Survey and StreetLight data.

According to Census tract data, tracts with rail stops have a slightly lower proportion of minority residents (45.6%) when compared to tracts without rail stops (47.0%). Minorities represent 48.9 percent of residents in tracts with bus stops and 46.2 percent of residents in tracts without bus stops.

Traffic crashes. Moderately high and high SVI Census tracts near the trail were more likely to have a fatal crash than low and moderately low SVI Census tracts. Those tracts also report more serious injury crashes involving pedestrians and bicycles. Figure 8 summarizes the results for fatal crashes. Figure D-10 provides a map of the PHNST corridor showing serious and fatal pedestrian and bicycle crashes within 1.5 miles of the trail.

Figure 8.
Fatal Crash Results

CDC Social Vulnerability Index	PROPORTION OF TRACTS	
	With Fatal Accidents	Without Fatal Accidents
Low (0.00-0.25)	15%	85%
Moderately Low (0.25-0.50)	22%	78%
Moderately High (0.50-0.75)	56%	44%
High (0.75-1.00)	42%	58%

Source: BBC Research & Consulting 2021 from VDOT data.

Qualitative research. Equitable Cities conducted four focus groups with residents of northern Virginia. Appendix C provides the full report from Equitable Cities and the Virginia Department of Health. Key findings from the focus groups include:

- Residents find the PHNST a safe and ideal place to interact with nature and exercise.
- There is a need for improved marketing and advertising of the trail.
- Participants cited lack of parking and clean, unlocked restrooms as the most important barriers to trail use.
- While most participants feel safe on the trail, some participants noted that they avoid using the trail at night and feel more comfortable using the trail with larger groups of people.
- Participants recommended that local agencies increase access to local neighborhoods.
- Increased programming, specifically targeted towards underserved populations, would help increase trail access.
- Minority residents stated that they feel more comfortable on the trail when they see people like themselves on the trail.

BBC conducted in-depth interviews with a mix of nongovernmental organization staff and local government representatives. Interviewees reported challenges for underrepresented residents related to safety in accessing and using the trail, comfort along the trail (including sight lines, restrooms, and seating areas), access to the trail, and input on trail design, routes, and maintenance. Based on that feedback, the interviewees suggested improving the following aspects of the trail:

- **Design** — interviewees recommend that local agencies create spaces with good lighting, sight lines, and comfortable amenities.

- **Programming** — Federal, state, and local agencies should work with community organizations to activate the trail and help educate residents and agency staff about the importance of balancing recreational and transportation uses along the trail.

- **Communication** — interviewees recommend improved signage and marketing for the trail. These messages should help educate residents about the way diverse groups may use the trail and reinforce that the trail is for everyone.

- **Education** — agencies at all levels should help trail enforcement personnel and local governments understand the unique needs of the underserved community along the trail and prioritize inclusive outreach techniques to ensure appropriate representation.

Economic Development Results

In many regions of the United States, trails support economic activity in the form of tourism, increased property values, and business growth.[36] BBC worked with NVRC and NPS staff to gather information about business activity along the trail along with estimates of use of the trail by tourists.

Trail-facing businesses. BBC worked with NVRC and stakeholders to gather information about businesses near the trail corridor. We augmented those data with business lists from Dun & Bradstreet (D&B), which is a national database of businesses that BBC has used extensively for research on regional and state businesses. D&B provided information on revenues, employment, and other business characteristics. BBC limited the businesses to restaurants and establishments in industries related to outdoor activities and used ZIP codes near the trail to select the relevant businesses. After gathering and cleaning those data, BBC limited the businesses to those within 1.5 miles of the trail using GIS analysis. Figure 9 provides key details related to the number of establishments and the revenues of trail-facing businesses. Figure D-11 provides a map of the trail-facing businesses in the corridor.

Figure 9.
Trail-facing Business Results

Business Type	Number of Establishments	Total Annual Revenue
Outdoor retail	16	$3,800,000
Restaurant	238	$83,000,000
Total	**254**	**$86,800,000**

Source: BBC Research & Consulting 2021 from Hoovers Dun & Bradstreet data.

Survey and interview results. BBC emailed an online survey to all businesses with an active email address and attempted to search for email addresses for the trail. BBC also called businesses with active email addresses to encourage them to respond to the survey and mailed

[36] Rails-to-Trails Conservancy. *From Trail Towns to TrOD: Trails and Economic Development.* https://www.railstotrails.org/resourcehandler.ashx?id=4620 Accessed October 2021

letters to all businesses on the list encouraging them to participate in the survey. Overall, BBC received five responses to the surveys and interviews. BBC also had conversations with staff at multiple businesses in the region. Given the number of responses to the survey and the information gathered from the conversations, BBC chose to analyze the survey as qualitative anecdotes. Key findings from this research indicate that:

- The trail serves as a "commuter highway" in certain areas for residents who walk and bike to work. This supports local bike shops and quick-serve restaurants.
- Access to the trail can prove challenging for businesses and organizations along the trail. Simple connections via sidewalks can be difficult to build due to configuration of storefronts (e.g., strip malls facing roads) and the cross-jurisdictional nature of the trail.
- Improving user comfort and adding amenities would support additional economic development along the trail. Business owners commented that certain portions of the trail could use surface refurbishment as well as benches, public restrooms, and picnic areas.
- The corridor represents a unique opportunity for bike and pedestrian trips in a more urban environment.

Tourists. BBC defined tourists in the region as individuals using the trail who reside outside of Virginia, Maryland, or Washington D.C. and developed those estimates using data from StreetLight. As shown in Figure 10, tourists account for 5.4 million miles of biking (12% of miles biked on the trail) and 2.1 million miles of walking (15% of miles walked) along the trail annually. In total, tourists take 1.4 million trips on the trail annually.

Figure 10.
Tourist Trail Use Results

Transportation Mode	Annual Trips by Out-of-region Visitors (thousands)	Annual Miles from Out-of-region Visitors (millions)
Biking	681	5.38
Walking	716	2.13
Total	**1,397**	**7.51**

Source: BBC Research & Consulting 2021 from StreetLight data.

According to research from Destination DC, the Washington D.C. advocacy organization for tourism, visitors to the D.C. area spend $331 each day including $36 in local tax receipts.[37] Attributing visitor expenditures directly to the trail would result in an overestimation of the contribution of the trail to the regional economy. Tourists on the trail likely visit the region due to a collection of numerous amenities in the area, including national parks, museums, family and

[37] Destination D.C. *2019 Visitor Statistics Washington, D.C.* https://washington-org.s3.amazonaws.com/s3fs-public/2019_washington_dc_visitor_statistics.pdf

friends, and natural attractions. The trail contributes to the visitor experience and based on discussions with local businesses, nonprofit representatives, and local government staff, completing the trail and improving the amenities along the trail would help increase tourism to the region.

Transportation Results

BBC analyzed the number of annual miles commuted along the trail, how those miles translate into avoided personal vehicle and pollution costs, and the safety of pedestrians and bicyclists along the trail corridor.

Commuting. Based on data from StreetLight, commuting accounts for 1.9 million miles of walking and 4.6 million miles of biking annually. The average mile of PHNST trail sees more than 45,000 miles of commuting each year.

Avoided costs. Using data from the Internal Revenue Service's estimates of per-mile personal vehicle ownership costs ($0.56 per mile in 2021[38]), and Transportation Research Board data from D.C. specific estimates for the cost of pollution, BBC estimated the trail provides more than $4 million in annual total avoided transportation costs (an average of more than $29,000 of avoided costs annually per mile of trail). Figure 11 provides details of these analyses.

Figure 11.
Trail Commuting Results

Transportation Mode	Annual Commuting Miles	ANNUAL AVOIDED COSTS		
		Environmental	Personal Vehicles	Total
Biking	4,600,000	$340,000	$2,600,000	$2,940,000
Walking	1,900,000	$140,000	$1,100,000	$1,240,000
Total	6,500,000	$480,000	$3,700,000	$4,180,000

Source: BBC Research & Consulting 2021 from StreetLight data, IRS personal vehicle cost data, and Transportation Research Board pollution cost data.

Figure 1.
Morbidity and Avoided Healthcare Benefits

Transportation Mode	Annual Resident Miles	ANNUAL ECONOMIC BENEFITS		
		Mortality	Avoided Healthcare Costs	Total
Biking	30,000,000	$139,000,000	$23,000,000	$162,000,000
Walking	9,000,000	$210,000,000	$32,300,000	$242,300,000
Total	39,000,000	$349,000,000	$55,300,000	$404,300,000

Source: BBC Research & Consulting 2021 from WHO HEAT analysis data, StreetLight data, and Medical Panel Expenditure Survey.

[38] United States Internal Revenue Service. Standard Mileage Rates for 2021 https://www.irs.gov/newsroom/irs-issues-standard-mileage-rates-for-2021 Accessed September 2021

Safety. During 2019, there were seven pedestrian and bike fatalities due to crashes in the trail corridor. Pedestrians and bicyclists were also involved in 208 serious injury crashes. BBC identified key areas along the corridor where crashes appear to be more prevalent including:

- Near Woodbridge in Prince William County;
- Along Interstate 95 and U.S. Route 1 near Dumfries; and
- Near Interstate 495 in Alexandria.

While none of these crashes occurred directly on the PHNST, this analysis underscores the importance of improving the network of infrastructure that facilitates resident access to the trail.

Gap Results

BBC analyzed the impacts of the recently completed Neabsco Creek Boardwalk along with project impacts for closing gaps in the trail near Broad Run and Goose Creek in Loudoun County. Based on estimates for use of existing trail segments, BBC also estimated the benefits the region might see if agencies complete all planned and temporary trails as well as fill those gaps where routes have not been determined.

Neabsco Creek. In June 2019, Prince William County opened the Neabsco Creek Boardwalk in Neabsco Regional Park. This 0.75-mile section of pedestrian-only trail cost around $4 million and saw more than 250,000 miles of pedestrian use during 2020. Figure D-6 provides a map of the boardwalk and its relative position along the trail. Use of this portion of trail exceeds the annual average for walking along all segments and contributes $1.5 million in annual avoided health care costs and $3.9 million in mortality benefits. Additionally, pedestrian segments near the boardwalk saw increased pedestrian use according to Strava data for the area. Estimates for these increases ranged from around an 80 percent increase to a 300 percent increase. It is likely that some of the increased use was due to the overall increase in recreational activity during the pandemic in 2020.

Figure 11.
Morbidity and Avoided Healthcare Benefits

Benefit Category	Value
Miles walked annually	250,000
Mortality benefits	$3,900,000
Avoided healthcare costs	$1,500,000

Source: BBC Research & Consulting 2021 from WHO HEAT analysis data, StreetLight data, and Medical Panel Expenditure Survey.

Broad Run and Goose Creek. BBC analyzed potential benefits from completing two gaps on the trail in Loudon County. The first segment would connect the PHNST to the Washington and Old Dominion trail along Broad Run while the second segment would connect the two trails along Goose Creek. In total, closing those two gaps would add six miles to the trail. Based on estimates of recently completed segments in the area, BBC analyzed the potential benefits to the region from construction of the two planned segments (see Figure D-7 for a map of the area and

its location relative to the PHNST in Northern Virginia). Upon completion of those segments, BBC estimates that residents would walk an additional 100,000 miles on the trail annually and bike between 300,000 and 1 million miles on the trail. As seen in Figure 12, this represents avoided health care costs of $300,000 - $500,000 annually and mortality benefits of $2.1 million - $7 million annually.

Figure 12.
Broad Run and Goose Creek Gap Completion Estimates

	RANGE OF RESULTS	
Estimated Annual Benefit	Walking	Biking
Miles	100,000	300,000 - 1,000,000
Mortality benefits	$1,500,000	$2,100,000 - $7,000,000
Avoided healthcare costs	$600,000	$300,000 - $500,000
Commuting miles	21,000	30,000 - 100,000
Avoided commuting costs	$13,500	$19,000 - $64,000

Source: BBC Research & Consulting 2021 from WHO HEAT analysis data, StreetLight data, and Medical Panel Expenditure Survey.

Planned and temporary gaps. Using data from NVRC's GIS database on the PHNST, BBC identified 21 miles in gaps along the trail. As shown in Figure 13, closing these gaps might result in an additional 1.3 million miles walked and 4.5 million miles biked on the trail. Those results translate to $7.9 million annually in avoided health care costs and $52 million in regional mortality benefits.

Figure 13.
Planned and Temporary Gap Completion Estimates

	ESTIMATED RESULT	
Estimated Annual Benefit	Walking	Biking
Miles	1,350,000	4,500,000
Mortality benefits	$20,850,000	$31,500,000
Avoided healthcare costs	$3,200,000	$4,700,000
Commuting miles	285,000	675,000
Avoided commuting costs	$186,000	$441,000

Source: BBC Research & Consulting 2021 from WHO HEAT analysis data, StreetLight data, and Medical Panel Expenditure Survey.

Unrouted gaps. Some gaps in the PHNST currently do not have a planned route. BBC worked with NVRC to estimate the potential trail length required to close these gaps (13.7 miles). As shown in Figure 14, closing those gaps might result in an additional 900,000 miles walked and 2.9 million miles biked on the trail. Those results translate to $5.2 million in avoided health care costs and $34.1 million in regional mortality benefits.

Figure 14.
Unrouted Completion Estimates

Estimated Annual Benefit	ESTIMATED RESULT	
	Walking	Biking
Miles	900,000	2,900,000
Mortality benefits	$13,600,000	$20,500,000
Avoided healthcare costs	$2,100,000	$3,100,000
Commuting miles	190,000	440,000
Avoided commuting costs	$120,000	$290,000

Source: BBC Research & Consulting 2021 from WHO HEAT analysis data, StreetLight data, and Medical Panel Expenditure Survey.

Recommendations

Based on BBC's research, NVRC should consider working with partner agencies on improving resident use of the trail in the following areas:

- **Programming targeted to encourage trail use by underserved residents.** Rather than creating new programs, NVRC and partner agencies should build on the efforts of local groups such as Outdoor Afro, Casa Chirilagua, and the Four Mile Run Conservancy.
- **Infrastructure improvements along the trail to improve safety and help residents feel comfortable using the trail.** These improvements might include additional restrooms, benches, lighting, and picnic areas. Partner agencies should also consider widening trails for increased use, improving sightlines along the trail, and adding signs for navigation.
- **Increasing safe access points and routes along the trail.** The equity analysis revealed gaps in access points along the trail in moderately high and high socially vulnerable Census tracts. Beyond direct links to the trail, improved pedestrian and bike infrastructure in the greater trail corridor would encourage addition use by residents. Our analyses noted challenges for pedestrian and bicycle crashes near Woodbridge and Dumfries in Prince William County and along Interstate 495 in Alexandria.
- **Standards, marketing and branding of the trail.** Given the multi-jurisdictional nature of the trail, some users noted that the trail lacks cohesive standards related to the type of infrastructure, amenities, and programming along the trail. While it is unrealistic to expect that the trail will develop in a uniform manner given federal, local, and regional restrictions, working to define a few standard trail typologies would help users understand infrastructure expectations for the various sections of the trail. Beyond infrastructure, some users noted that the trail might benefit from more uniform branding and marketing. These efforts would help residents understand the broad reach of the trail and give local agencies an opportunity to educate the community on the wide variety of uses and programming along the trail.
- **Inclusive input regarding trail investments.** As local agencies expand or refurbish sections of the trail, it is vital that all residents have the opportunity to influence the design of the trail, amenities included along the corridor, and programming expected for activation. Some residents suggested that past outreach has been more accessible for affluent and white community members.
- **Trail data collection.** The counter data provided for the trail was instrumental in developing the estimates of total trail use. NVRC should consider helping local, federal, and regional agencies learn from past counter installations and add counting infrastructure in areas of the trail such as Loudoun County and Prince William County.

- **Business development and outreach.** NVRC and local agencies should consider building relationships with businesses and organizations along the trail using the list gathered as a part of this research as a starting point. Encouraging businesses to cater to trail users and view the trail as a potential source of customers will help improve the economic development potential for the trail.

- **Trail completion.** NVRC should work with federal, state, regional, and local governments to complete planned and temporary sections of the trail and complete routing the trail on currently unplanned segments Completing gaps could result in an additional $80 million in annual mortality benefits and $13 million in annual avoided health care costs.

APPENDIX A.

In-Depth Interview Guide

APPENDIX A.
In-depth Interview Guide

This appendix includes the in-depth interview guide used for the analysis of the PHNST in Northern Virginia.

Interview Guide

Background

The following guide is for general direction only. Not every interview will include each area of questions, and there will likely be valuable types of discussions not specifically identified in the guide. The interviews will capture information related to key areas including:

- View of the Potomac Heritage National Scenic Trail (PHNST);
- Barriers to access to the trail;
- Trends in use observed by the organization over the past 5-10 years;
- Organizations or entities in the area that have successfully addressed equity in access to recreation and active transportation infrastructure;
- Population groups that are most disadvantaged in the region with respect to recreation and active transportation infrastructure;
- Suggestions for future outreach to disadvantaged communities in the region; and
- Recommendations for future infrastructure investments.

[BBC staff:] Please make sure that the interview log captures the following information, which can often be obtained prior to the interview:

- Interviewee name, organization, and role;
- Telephone number and e-mail address of interviewee;
- Interviewee's representative geographic area;
- The populations(s) that interviewee serves; and
- Date of interview.

Introduction

Hi, my name is *[NAME]* with BBC Research & Consulting. Thanks again for agreeing to talk with me today. As you know, we're conducting a comprehensive assessment of the Potomac Heritage National Scenic Trail in Northern Virginia. Our work is focusing on the health and economic impacts of the trail along with the disparities in use and access among the diverse groups of residents within Northern Virginia. Our work will inform NVRC's strategy for increasing access and use of the trail.

Based on our research and conversations with other community leaders, we understand that you work closely with the *[X]* community. Is that correct? Do you work with any other particular populations or communities?

Ok, and I understand you are a [*Role*] at [*Organization Name*]. Is that correct?

Great, we think your insights about this community/these communities will help us develop a clear and comprehensive understanding of issues relating to trail use and access in Northern Virginia.

Our conversation today is confidential. When we present any of your insights to NVRC, we'll remove any identifying information. I'd like to record our interview to make sure that I accurately capture your insights. Is that okay?

[IF YES, turn on recorder. IF NO, don't record the interview but do take thorough notes.]

A. Stakeholder Information

1. To begin, can you tell me a little about your role with [*organization name*]?
    a. *[IF NOT ALREADY ADDRESSED]* Does any of your work relate to recreation and trails in Northern Virginia? If so, tell me more about that.
    b. We're especially interested in your experiences with the *[X]* community. Would you share your history working with the *[X]* community? Where did your work start and how did you get where you are now?
        i. *[If needed]* Tell me more about the work you're currently doing to serve this community(s).

B. Trail Use in Northern Virginia

1. I'd like to talk about your impressions of trails in Northern Virginia.
    a. For starters, how has the trail system in Northern Virginia changed over time? In what ways?
    b. What are your thoughts on the biking and walking generally in Northern Virginia?

2. Now let's talk about trends in trail use among different communities in Northern Virginia.
    a. What communities or populations do you feel benefit the most from the trails?
    b. How about the *[X]* community? Can you talk about trends you seen in trail use among that community? *[Probe for info on trail use among community of expertise, if not already discussed in (a)]*
    c. Thinking about the *[X]* community, have you noticed any changes over time in terms of trail use or changes in how the community/communities views trails issues?
    d. What are the major barriers for *[X]* community to trail use?
3. Thinking about the future of trail use in Northern Virginia, do you have a prediction for what it will look like 5 years from now? 10 years from now? Do you foresee any changes in use in the future?
    a. What makes you say that?

C. Barriers and solutions

Now I want to switch gears to talk about possible solutions to address barriers to trail use in Northern Virginia.

1. Do you know of **existing** programs to help alleviate barriers to trail access in Northern Virginia?

[*IF YES*]: Of those, what strategies do you think are particularly effective? What makes you say that?

[PROBE FOR THESE IF THEY DO NOT COME UP]

a. Are there strategies that would be helpful that **aren't currently implemented?**

b. Is there/would there be support for these initiatives in *[community/communities of expertise]*? What makes you say that?

c. Are there particular strategies that you believe would address barrier in the *[X]* community?

    a. How should strategies be implemented in the *[X]* community? What group(s) do you think would be best positioned to provide those services? What are the nuances related to working with *[X]* that NVRC should consider in implementing new programs?

2. How important is trail use *to your organization/in the work that you do*?

[*IF LOW IMPORTANCE*] Is there anything that might change that? What would make this an important issue to your organization?

a. [*If the organization provides any services aiming to increase trail use*]

    i. Do you tend to focus more on infrastructure, programming, or outreach? Why?

b. *[If organization DOES NOT provide services]* Why not?

D. Priorities

1. What do you think is the *most pressing* issue related to increasing trail use in Northern Virginia?

2. Now thinking about strategies we discussed earlier what do you think NVRC's **role should be in** addressing trail use in Northern Virginia? What **particular services, resources, or initiatives related to increasing trail use** should the NVRC prioritizing? Are there **particular communities** NVRC should be prioritizing?

E. Concluding Questions

1. Do you have any other insights that you would like to share, particularly about the *[X]* community in Northern Virginia, in terms of trail issues?

2. Who else should we talk to in the region related to the *[X]* community or trail use in general?

Closing

Thank you very much for sharing your insights with me today! If you have any questions about our research or about your participation, feel free to contact me. Thanks again!

APPENDIX B.

Business Survey Instrument

APPENDIX B.
Business Survey Instrument

This appendix includes the business survey instrument used for the analysis of the PHNST in Northern Virginia.

Survey Instrument

Northern Virginia Regional Commission coordinates the Potomac Heritage National Scenic Trail (PHNST) in Northern Virginia under a cooperative agreement with the National Park Service (NPS). NVRC has worked in partnership with NPS on the trail since the 1990s. NVRC has selected BBC Research & Consulting to conduct a study of the equity, health, and economic benefits of the PHNST.

[INSERT NVRC AND BBC logos on survey intro page]

NVRC and BBC Research & Consulting are conducting a survey about businesses near the Potomac Heritage National Scenic Trail (PHNST) in the Northern Virginia region. The survey will augment additional research on the economic, health, and equity impacts of the PHNST in Northern Virginia.

The Potomac Heritage National Scenic Trail spans close to 900 miles. It is a braided trail network from the Laurel Hills Highlands Trail in western Pennsylvania to Virginia, ending at the mouth of the Potomac River.

The Trail network in Northern Virginia includes various hiking, hiking/equestrian and hiking/equestrian/bicycling facilities. Today the trail runs through Northern Virginia from southern Prince William County to the Town of Leesburg, which some smaller sections not complete. Existing segments include the 18-mile Mount Vernon Trail and the George Washington Memorial Parkway trail. Existing segments also run along the Potomac River through much of Fairfax County and Prince William County, as well as part of Loudoun County.

[INCLUDE MAP, potentially add list of parks and trail segments to augment this description – new maps will be posted on 8/17]

Thank you for your participation. Your information will be used to assess regional economic conditions that are connected to trail usage. Individual business data and answers will be kept private and strictly confidential

1. Please briefly describe the main line of business at your firm. What goods or services do you manufacture or sell?

2. Approximately what year was your firm established?

   (RECORD FOUR-DIGIT YEAR, e.g., '1977')

   9998=(DON'T KNOW)

   9999=(REFUSED)

   1=NUMERIC (1900-2021)

3. What ZIP code is your business located in?

   (RECORD EIGHT DIGIT ZIP CODE, e.g., 22206)

4. What county is your business located in?

   1=WRITTEN COUNTY NAME

5. How many full-time employees on average work for your business in Northern Virginia?

   9998=(DON'T KNOW)

   9999=(REFUSED)

   1=NUMERIC (0-5000)

6. How many part-time employees on average work for your business in Northern Virginia?

   9998=(DON'T KNOW)

   9999=(REFUSED)

   1=NUMERIC (0-5000)

7. Please select the category that best represents your company's annual revenue. If you don't know the answer to this question, please skip it.?

   1=Under $100,000

   2= $100,001 - $250,000

   3= $250,001 - $500,000

   4= $500,001 - $1million

   5=Greater than $1 million, but equal to or below $2.5 million

   6= Greater than $2.5 million, but equal to or below $5 million

   7= Greater than $5 million, but equal to or below $10 million

   8= Greater than $10 million

   98=(DON'T KNOW)

   99=(REFUSED)

8. Approximately what percentage of that gross revenue comes from client purchases from out-of-region or visitors?

   1=(ENTER %)

   98=(DON'T KNOW)

   99=(REFUSED)

9. Are you aware of the PHNST in Northern Virginia (segments of the trail include the Mount Vernon Trail, George Washington Memorial Pkwy Trail, Neabsco Creek, etc.)?

   1=YES

   2=NO – SKIP TO QUESTION 12

10. How would you describe your location relative to the trail?

    1=On or visible from the trail

    2=Visible from a trailhead or access point

    3=Within ¼ mile from the trail or trailhead

    4=More than ¼ mile from the trail or trailhead

    98=(DON'T KNOW)

11. Approximately what percentage of your company's gross revenue are related to users of the PHNST trail and its connecting trails?

    1=(ENTER %)

    98=(DON'T KNOW)

    99=(REFUSED)

12. Approximately what percentage of your company's gross revenue are related to individuals walking or biking to your location?

    1=(ENTER %)

    98=(DON'T KNOW)

13. 99=(REFUSED)Does your business provide outfitting or support services (e.g. bike or boat rental, bike repair, athletic apparel, fast food, shuttle service) for users of trails such as the PHNST?

    1=YES

    2=NO (Terminate)

    98=(DON'T KNOW) (Terminate)

    99=(REFUSED) (Terminate)

14. We're interested in any general insights you can offer on starting and expanding a business in the outfitting industry in Northern Virginia. Do you have any thoughts to offer on these topics?

    1=WRITTEN RESPONSE

    97=(NOTHING/NONE/NO COMMENTS)

    98=(DON'T KNOW)

    99=(REFUSED)

15. Finally, we're interested in whether your company has encountered any barriers or difficulties in Northern Virginia associated with starting and expanding a business in the outfitting industry. Do you have any thoughts to share on these topics?

    1=WRITTEN RESPONSE

    97=(NOTHING/NONE/NO COMMENTS)

    98=(DON'T KNOW)

    99=(REFUSED)

APPENDIX C.

Focus Group Report

The Potomac Heritage National Scenic Trail

Summary of Focus Group Findings – September 2021

Table of Contents

Introduction

The Northern Virginia Regional Commission (NVRC), in conjunction with the Virginia Department of Health (VDH), is seeking to learn community views on accessing and using the Potomac Heritage National Scenic Trail. As part of the effort, VDH requested technical assistance from Equitable Cities, LLC (Equitable Cities) to conduct focus groups with residents with plans for NVRC to incorporate the focus group findings into a study to develop a methodology to show the health, equity, transportation, and economic benefits of safe Potomac Heritage Trail completion in Northern Virginia which will be completed by the end of this year. Special focus was originally placed on hosting in-person sessions for Loudoun and Prince William Counties residents. Due to challenges with securing a space a host the focus group sessions and the need to be more socially distant due to the COVID-19 global pandemic, four virtual sessions were held via Zoom and eligibility for participation was broadened to include Fairfax County residents. Equitable Cities facilitated two focus groups with residents of Prince William County on September 18, 2021 and two focus groups with residents of Fairfax and Loudoun Counties on September 19, 2021. NVRC and VDH managed all aspects of the focus group process, including marketing, communications, and participant recruitment, whereas Equitable Cities developed the focus group script and provided a $50 e-gift card to each participant for participating in the focus groups. While 38 registered, there were a total of 10 focus group participants across all four focus groups. Of them, four as male and six identified as female. Half of the participants identified as part of a racial minority group, including Asian, Black, and Hispanic/Latino, and one person had a physical disability.

This report summarizes key findings from all four focus groups conducted in the September of 2021. It is anticipated that Northern Virginia Regional Commission will incorporate the focus group findings into a study to develop a methodology to show the health, equity, transportation, and economic benefits of a safe Potomac Heritage National Scenic Trail completion in Northern Virginia, which is to be completed later this year.

Focus Groups Findings

Participants' Familiarity, Use and Satisfaction with the Potomac Heritage National Scenic Trail

Most participants in the Prince William County and Fairfax/Loudoun County focus groups are familiar with the Potomac Heritage National Scenic Trail. The focus group participants were asked to share via a Zoom poll how familiar they were with the trail. Their options ranged from not all familiar to extremely familiar with the trail. Of the 10 participants that responded to the initial poll, only two participants were slightly familiar or not familiar at all with the trail due to being new to the area. Only one participant—a resident in the Fairfax/Loudoun County focus group—stated that he/she was extremely familiar with the trail. Most of the focus group participants were moderately satisfied with the trail and use it occasionality/sometimes.

Participants' Views on the Greatest Benefits of the Trail

Most participants in the Prince William County and Fairfax/Loudoun County focus groups view the Potomac Heritage National Scenic Trail as an ideal place to connect with nature and increase their and their family's overall physical activity and health, including mental health. The focus group participants were asked to select via a Zoom poll the greatest benefits of using the trail. Their options included social connections, exposure to nature, commuting or running errands, physical activity and health, economic group for communities, and reducing social isolation. Of the 10 participants that responded to the initial poll, the majority selected exposure to nature and physical activity and health as their top two choices. These participants indicated that they go on the trail to walk, to bike, to exercise, and to reconnect with nature to improve their mental health and connect with other people, including family members and friends. One participant also shared how important it is for his/her children to be able to spend time outdoors and for the family to be physically active.

Except for one individual, economic growth for communities and using the trail for commuting or running errands was not perceived as one of the greatest benefits of trail use. The one individual that did rank commuting or running errands highly was an avid cyclist who, before retirement, commuted daily to his job via bicycle on the Mount Vernon Trail.

Participants' Views on the Biggest Deterrents to Utilizing the Trail

The biggest deterrents to participants and their families using the trail include a lack of accommodations (i.e., parking and restrooms) particularly for seniors and persons with disabilities, accessible online information, and wayfinding signage along the trail. The focus group participants were asked to select via a Zoom poll the biggest deterrents to using the trail. Their options included safety concerns on the trail; safety concerns in route to the trail; connectivity of the trail to their home/work/other frequent destinations; lack of awareness of the trail; concerns of wildlife and animals along the trail; and lack of accommodations for people with disabilities, children, families, seniors, and the elderly. Of the 10 participants that responded to the initial poll, the majority expressed concerns regarding an overall lack of accommodations such as accessible parking and clean, unlocked restrooms. Participants were least concerned about connectivity to the trail via their home/work/other frequent destinations or safety concerns in route to the trail. In regard to personal safety concerns and crime, two female participants shared that they avoid being alone on the trail during early morning and late evening hours.

Participants in the Prince William County focus group expressed a slight concern for animals along the trail; however, other participants mentioned that they enjoyed encountering animals on the trail as they attempted to reconnect with nature and the outdoors. One participant did express, however, concern that it is not clear who to call if one sees a bear or another potentially dangerous animal on or near the trail.

Participants in both focus groups indicated that it is very difficult to find information about the trails online, and that wayfinding on the trail is almost nonexistent or difficult to locate, even for frequent trail users. As such, participants noted that there should be more accessible and up-to-date information online, and that at a minimum it should include information on trail access points, trail segment length/distance, and key destinations along the route, such as shopping, restrooms, parking, etc. One participant in the Prince William County focus group expressed giving up on trying to use the trail due to the overall lack of information regarding it and other trails in the area. This point was shared by those who had recently moved to their areas, stating that they would use the trail more often if they knew more about it.

Other deterring factors mentioned by participants in both focus groups included the lack of restrooms, parking, and connectivity to public transit, along with knowledge of where to get food and water. One participant who identified as a white disabled woman expressed that she is limited to specific parts of the trails that have parking and cannot venture out to different portions of it.

Of note, participants in both Prince William County and Fairfax/Loudoun County focus groups expressed that a contributing factor to using the trail is the well-maintained paved paths for biking.

Participants' Views of the Best Indicators of an Equitable Trail Network

Most participants in the Prince William County and Fairfax/Loudoun County focus groups view a) distribution of access points in communities, b) connectivity of the trail to key destinations, and c) presence of a distribution of trail amenities along the Potomac Heritage National Scenic Trail as the best indicators of an equitable trail network. The focus group participants were asked to select via a Zoom poll the best indicator of an equitable trail network. Their options included distribution of access points in communities; safety of routes to trail access points; connectivity of trail to destinations (shops, schools, businesses, residences, etc.); presence of and distribution of trail amenities throughout (benches, trash receptacles, lighting, etc.); safety of trail throughout network; and seeing others like themselves using the trail. Of the 10 participants that responded to the initial poll, the majority stated that the best indicators of an equitable trail network are a) distribution of access points in communities, b) connectivity of the trail to key destinations, and c) presence of a distribution of trail amenities along the Potomac Heritage National Scenic Trail as the best indicators of an equitable trail network

Participants in both focus groups shared that for the trail to be equitable and inclusive, all communities must have access to the trail and that everyone person using the trail regardless of their race/ethnicity, socioeconomic status, and/or physical ability or disability should have access to it. They stated that the trail must be connected to key destinations such as shops, schools, businesses, and residences, and that there must be a sufficient distribution of clean and accessible trail amenities throughout the network. Comparatively, with a few exceptions, participants were less concerned about the safety of routes to trail access points, safety of the trail throughout the network, and seeing others like themselves using the trail. It is important to

note however that most participants drove to the trail or had direct access to the trail from their homes.

A few minority participants, both men and women, did how important it is to see others like themselves using the trail. For example, while an East Asian male participant indicated that seeing someone like him on the trail is not his top priority, he did indicate that it is something that he pays close attention to. Similarly, an East Asian woman indicated that like seeing someone like her varies in importance depending on what is going on in the world. She mentioned 9/11 as a vivid and real example due to the discriminatory behavior she had witnessed and observed towards others that resembled her during that time. Of all the participants, the only participant to select "seeing others like you using the trail" as the number one indicator of equitable trail network was an African American female participant. She expressed that she is always conscious of potential issues she may face due to being a Black woman on trail that is mostly used by non-Black persons. On the other hand, White participants indicated that seeing someone like themselves on the trail was not as important to them since they are part of the racial majority utilizing the trail.

Participants' Views on COVID-19's Impact on Trail Use

Most participants in the Prince William County and Fairfax/Loudoun County focus groups witnessed an increase in trail use during the pandemic. Participants were asked to share to what degree has the Covid-19 pandemic impacted their use of the trail. Participants in both focus groups indicated that they saw an increase in trail use during the pandemic. Participants expressed that many people felt the urge to leave their homes, to be active, and to connect with nature and other people from a distance during the pandemic. They also noted that many of the places that they would normally visit were closed, so the trail network was the next best option.

Most focus group participants did not see an increase in their own activity due to their frequent use of the trail. However, the participants that were less familiar with the trail indicated that they did increase their use of the trail as time went on. One participant in the Prince William County focus group expressed that going on the trails and seeing people made him feel more optimistic about the state of the world. Another participant in the Fairfax/Loudoun County focus groups indicated that crowding on the trails was a concern, and that they had to find alternative routes to bicycle. This participant, a frequent bicycle user of the trail, expressed growing concerns over the lack of trail etiquette shown by new users of the trails, particularly pedestrians and families with children, who would not keep to the right side of the trail so that bicyclists could safely pass thus ensuring the safety of all users.

Participants' Negative Interactions with Law Enforcement and Other Trail Users

Most participants in the Prince William County and Fairfax/Loudoun County focus groups have not experienced or personally witnessed negative interactions from other trail users or law enforcement on the Potomac Heritage National Scenic Trail. Participants were asked to share in what ways do concerns of negative interaction (i.e., harassment, arrest, violent attacks)

with law enforcement or other trail users because of your race, gender, sex, disability status, or age impact their desire to utilize the Potomac Heritage National Scenic Trail. The overwhelming majority of participants stated that they had not experienced or personally witnessed negative interactions from other trail users or law enforcement on the trail. The only noted "negative" interaction was mentioned by a participant in the Fairfax/Loudoun County focus groups who stated that as a cyclist he sometimes encounters bad behaviors from people in cars and from other bicyclists enroute to the trail.

A Black female focus group participant expressed that she has not had any negative experience, but she frequently thinks about he she is being perceived as a Black woman on the trail. Women in both focus groups expressed that they have not had negative experiences. However, they are vigilant and have heard of other women being victims of theft, verbal and physical harassment, and indecent exposure, especially at night. The women stated that they feel safer using the trail at night when there is a male in the group or when they are with a larger group of women. These participants indicated that if they had a negative experience that it would deter them from using the trail moving forward. Lastly, an Asian male focus group participant indicated that while he has not had any negative experiences while using the trail, he did mention that he was more vigilant when attacks against Asian Americans were more prevalent.

Participant's Recommended Planning Strategies to Increase Trail Use

When it comes to planning strategies to increase use of the Potomac Heritage National Scenic Trail, participants recommended increased marketing and awareness of the trail, increased communication and wayfinding along the trail, and improved access and connectivity to surrounding neighborhoods and key destinations. Participants were asked to identify their top planning strategies to increase use of the Potomac Heritage National Scenic Trail. Their options included the following: improvements to amenities on the trail (e.g., lighting, places to sit, visibility on/off trail); improvements to ADA accommodations in route to the trail and along the trail; connecting access points to transportation infrastructure such as bike lanes, sidewalks, bus stops, train stations; improvements to signage/wayfinding for trail access points; improved pedestrian and bicyclist conditions near trail access points; and increased marketing of the trail in public announcements or community engagement.

Participants in both Prince William and Fairfax/Loudoun County focus groups indicated that many people and residents are unaware of the trail as well as how to access it safely by various modes. Participants expressed that increased marketing of the trail is needed, particularly the information shared on government websites and social media. Participants also discussed the need for accurate, up-to-date, and user-friendly online maps and information on trail access points, the locations of paved surfaces for bicycling, and surrounding amenities. One participant in the Prince William County focus group suggested to create a map like the one of the National Mall that is interactive and shares specific details about key locations and amenities.

However, participants were quick to highlight the disparities in internet access and literacy, particularly among racial minorities, low-income populations, and seniors. Participants note that people/residents may not be able to afford the internet; therefore, sending up-to-date printed maps and information on the trail to their homes would be more equitable. Another focus group participant mentioned that paper maps are easier to navigate than using a smartphone, particularly for seniors.

Equity in terms of access was also mentioned due to some parts of the trail not being accessible to public transit, which makes it inaccessible to those who do not own car. Participants indicated the need for clean accessible restrooms, parking, and trails with ADA accommodations for those with disabilities and the elderly. Lastly, a participant in the Fairfax/Loudoun County focus group also indicated that having a wide trail to allow for a variety of uses is important.

Participants in both focus groups also indicated the need for greater connectivity between the trail and adjacent neighborhoods and destinations. Participants expressed the need for wayfinding on paths so that people know the true length of the trail, and whether the trail has amenities such as restrooms, water, and food nearby. One participant in the Fairfax/Loudoun County focus group mentioned being at a "fork in the path and being unsure of which one to take." Lastly, the participants mentioned the connection between a trail and a restaurant in Fairfax to illustrate the need to connect more restaurants and other businesses to the trail as well as nature.

Participants in both groups mentioned issues concerning land use and trail development. Specifically, one participant in the Fairfax/Loudoun County focus group suggested that there should be zoning to ensure connectivity in communities that the trail goes through. This participant expressed that currently different residential developers constructing new communities create trails that do not connect to the existing trail network. He mentioned that connectivity is also negatively affected by homeowner associations denying public access to trails in their community.

Participant's Recommended Programming Strategies to Increase Trail Use

When it comes to programming strategies to increase use of the Potomac Heritage National Scenic Trail, participants recommended educational nature-inspired learnings, competitive walking, jogging, and cycling events, local active transportation groups, and trail ambassadors. Participants were asked to identify their top programming strategies to increase use of the Potomac Heritage National Scenic Trail. Their options included the following: neighborhood walking, jogging, and cycling groups; regular events (e.g., music, movies, and games) along the trail; Park Rx programming with doctors and healthcare workers; and community physical activity competitions with prizes.

Participants in both the Prince William County and Fairfax/Loudon County focus groups indicated the need for more programming and events via social media, newsletters, and improved government websites. Participants suggested programming that educates people on the local wildlife and nature, including the river and diverse trees present in the area. Participants

suggested creating races and other events to support charities, which they believe would enhance awareness of the trail to people outside the community and thus increase overall use of the trail.

Participants recommended the creation of a civic engagement board for continuous public feedback in communities of various socioeconomic status and having trail neighborhood ambassadors to answer questions to ensure trail safety, especially in the evening, which was suggested by Fairfax/Loudoun County participants.

Lastly, participants in the Prince William County focus group suggested creating neighborhood groups for jogging, walking, and cycling to increase trail use. Participants in the Fairfax/Loudoun County focus group conveyed that it has become apparent during the pandemic that many people do not know the rules of safe trail use so there is a need for more educational opportunities and programming. These focus group participants observed people gathering in the middle of trails, not allowing bicyclists to safely use the trail. Therefore, they suggested having scheduled bike rides to introduce the trail to people and how to use it in a safe manner.

Conclusion and Recommendations

The Potomac Heritage National Scenic Trail is viewed by focus group participants as a safe and ideal place for residents and visitors alike to connect with nature and improve their and their family's overall physical activity and health. To build upon the success and increased use of the existing trail network—particularly during the Covid-19 pandemic—as well as to build a more equitable and inclusive trail network moving forward, focus group participants recommended the following planning and programing strategies: increased marketing and awareness of the trail, particularly online; increased communication and wayfinding along the trail; improved access and connectivity to surrounding neighborhoods and key destinations; improved accommodations such as parking and restrooms; new educational nature-inspired learnings; competitive walking, jogging, and cycling events; formation and promotion of local and neighborhood active transportation groups; deployment and recruitment of trail ambassadors.

APPENDIX D.

Maps and Geographic Analyses

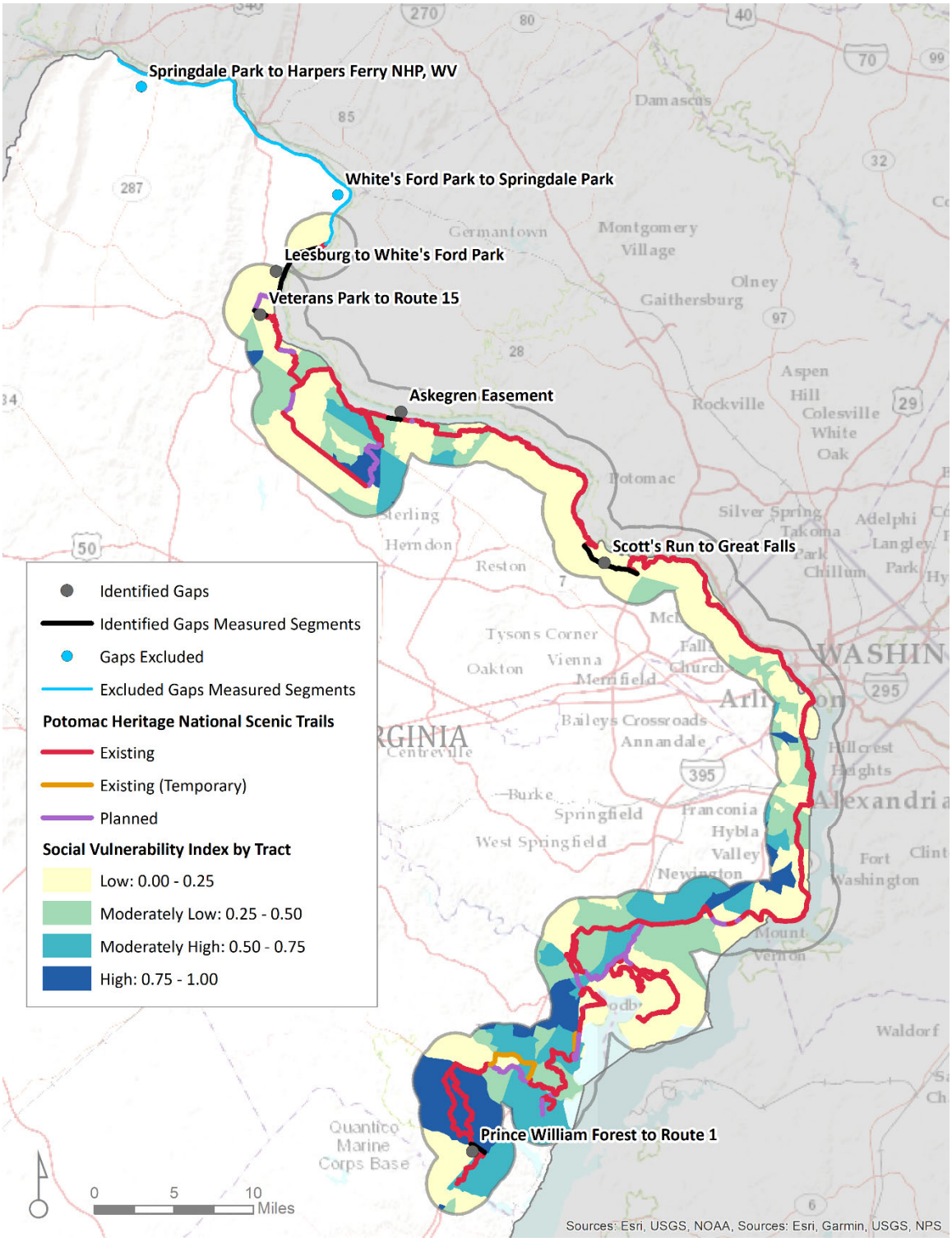
APPENDIX D.
Maps and Geographic Analyses

Below are maps used by the study team to analyze the benefits of the Potomac Heritage National Scenic Trail in Northern Virginia.

Figure D-1.
PHNST Thumbnail Map

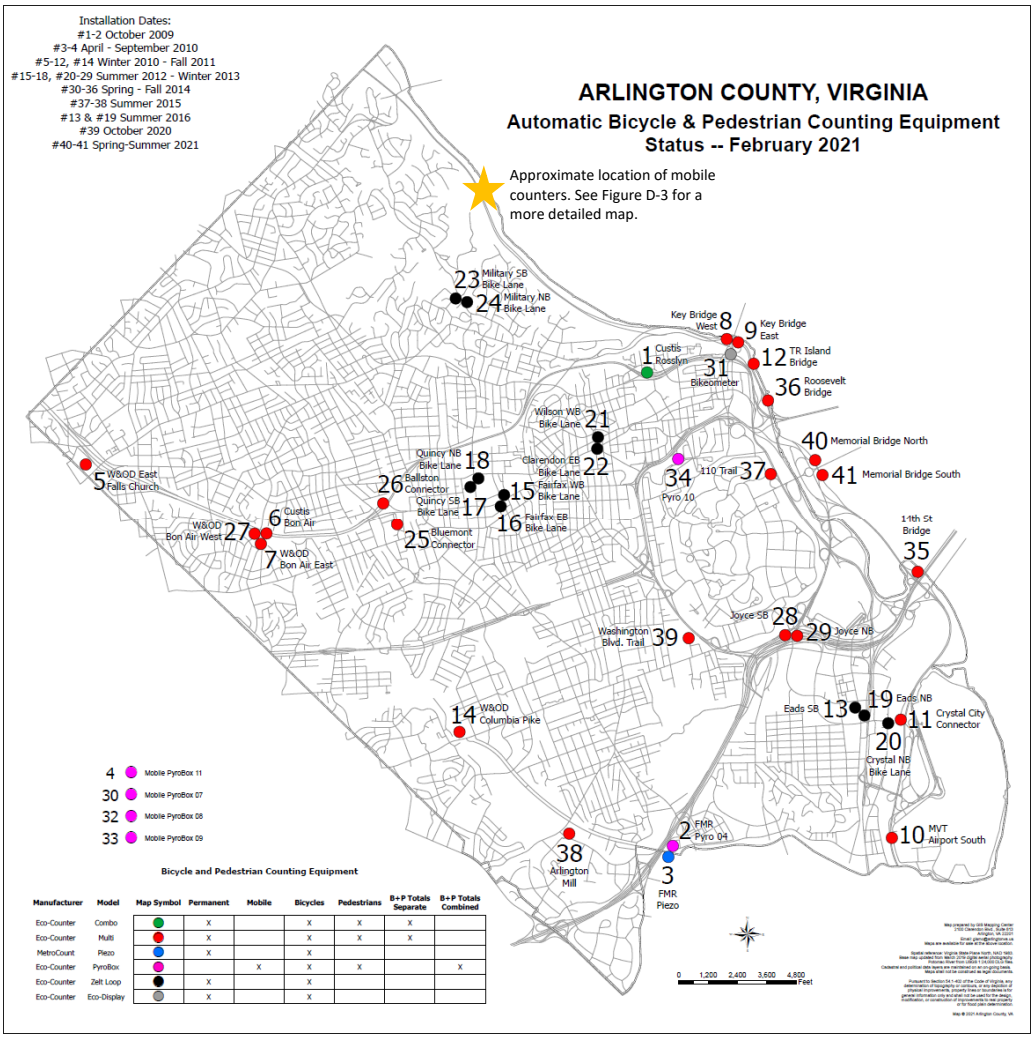
Source: National Park Service. Potomac Heritage National Scenic Trail Route Making & Graphic Identity Guide. 2015
http://npshistory.com/publications/pohe/route-marking-graphic-id-2015.pdf Accessed October 2021

Figure D-2.
PHNST in Northern Virginia with Gaps Identified



Source: BBC Research & Consulting from NVRC and CDC data..

Figure D-3.
Arlington County Counter Map



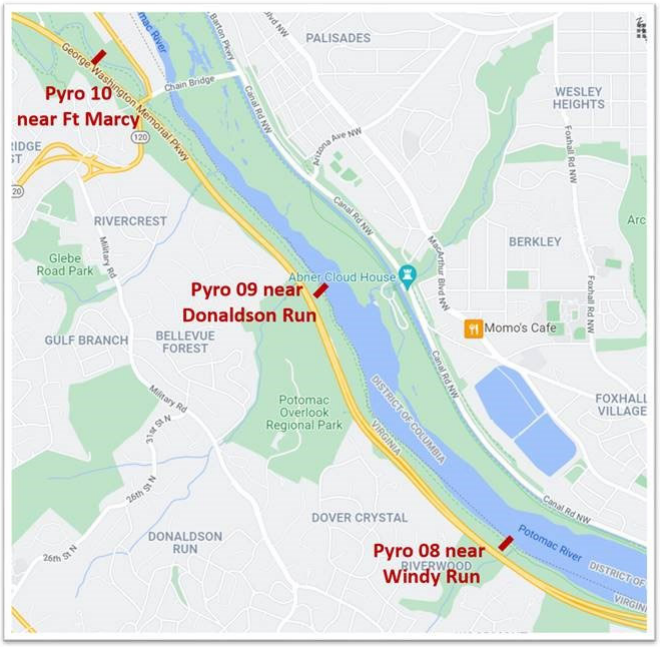
Bicycle and Pedestrian Counting Equipment

Manufacturer	Model	Map Symbol	Permanent	Mobile	Bicycles	Pedestrians	B+P Totals Separate	B+P Totals Combined
Eco-Counter	Combo		X		X	X	X	
Eco-Counter	Multi		X		X	X	X	
MetroCount	Piezo		X		X			
Eco-Counter	PyroBox			X	X	X		X
Eco-Counter	Zelt Loop		X		X			
Eco-Counter	Eco-Display		X		X			

Source: Arlington County Virginia, February 2021.

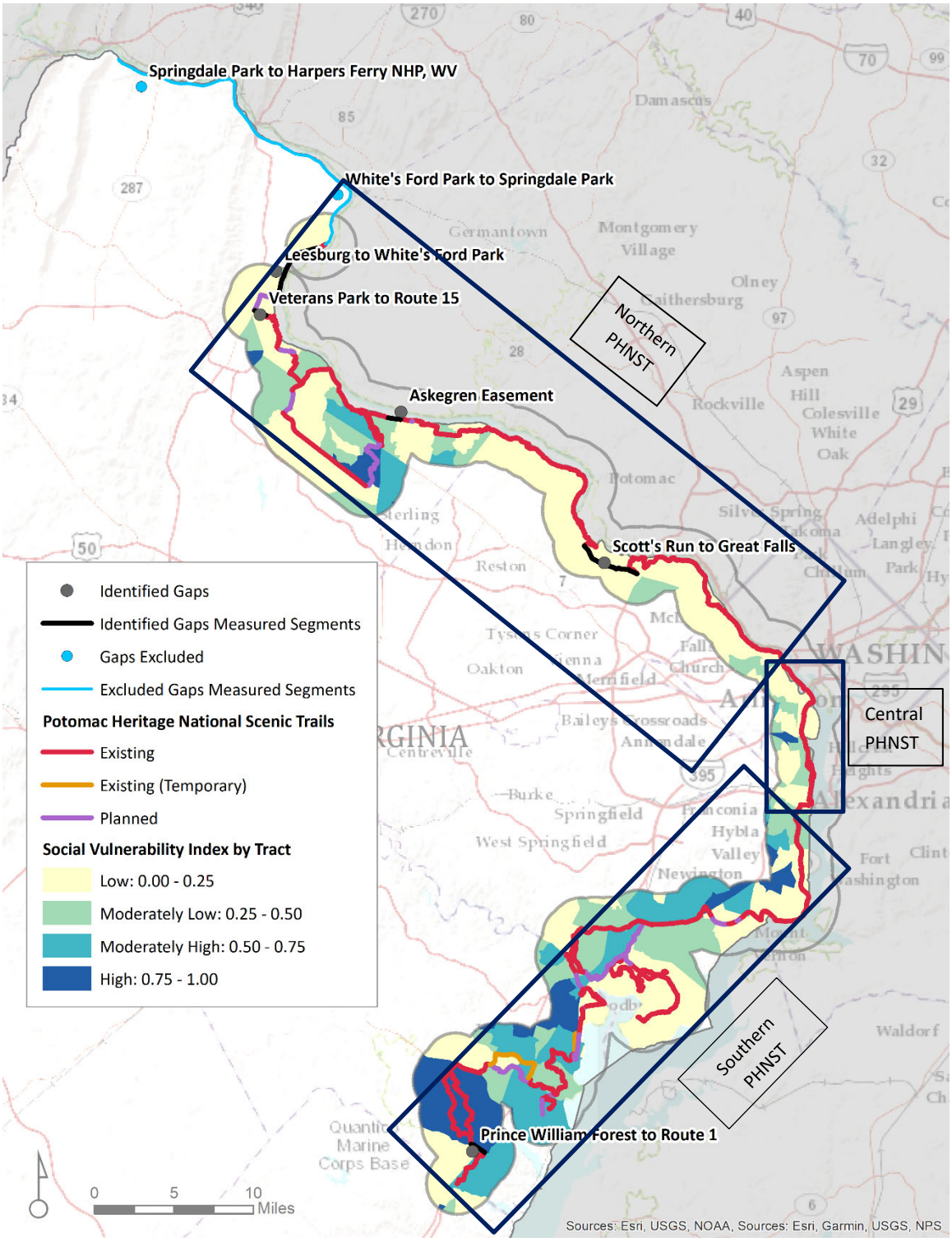
Notes. For the purposes of analysis, BBC used data from the following counters in Figure D-3: 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 14, 35, 36, 38, 40, 41, and the three mobile counters from Figure D-4.

Figure D-4.
Mobile Arlington County Counter Map



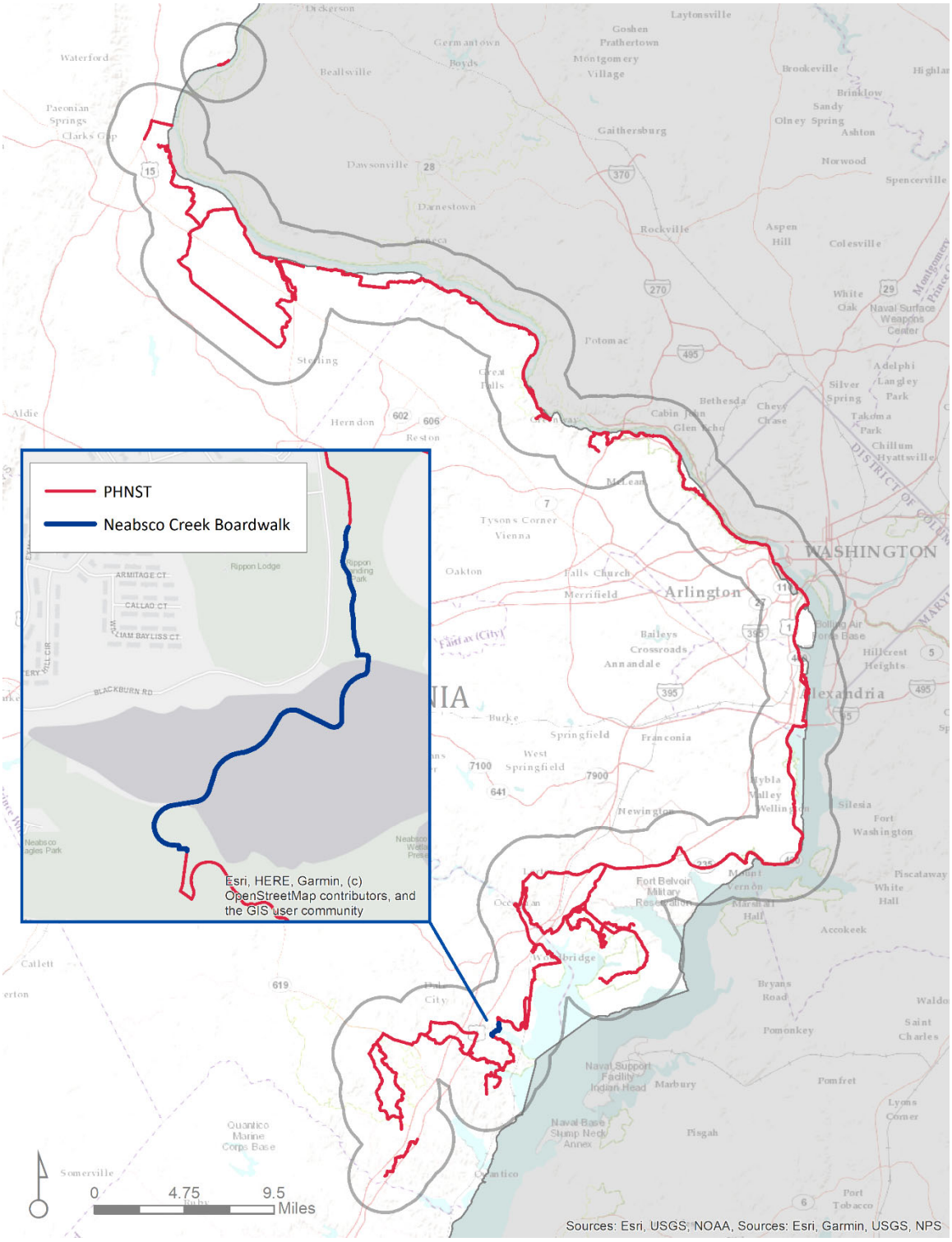
Source: Arlington County Virginia, August 2021.

Figure D-5.
PHNST in Northern Virginia with Areas of Analysis Identified



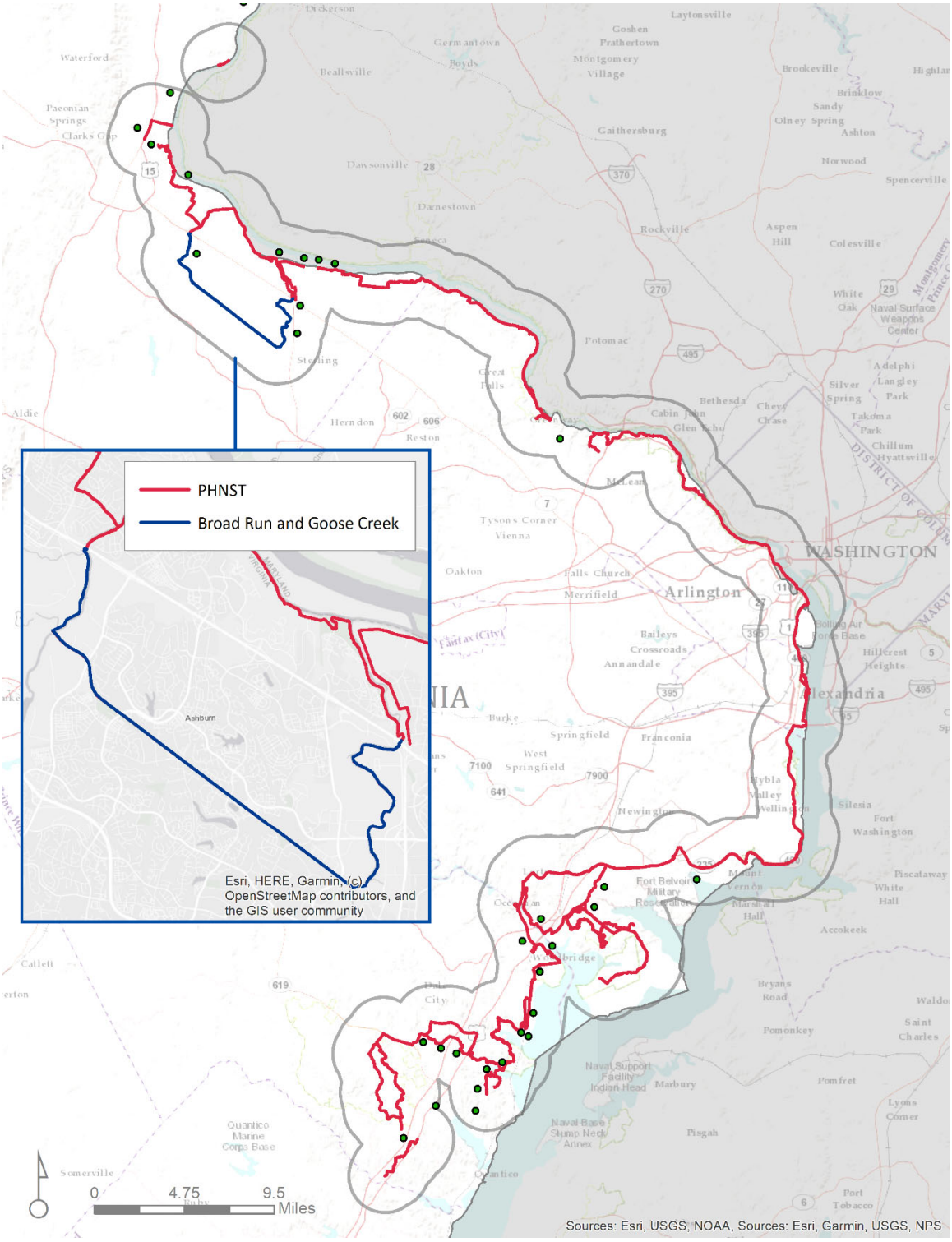
Source: BBC Research & Consulting from NVRC and CDC data..

Figure D-6.
Neabsco Creek Boardwalk



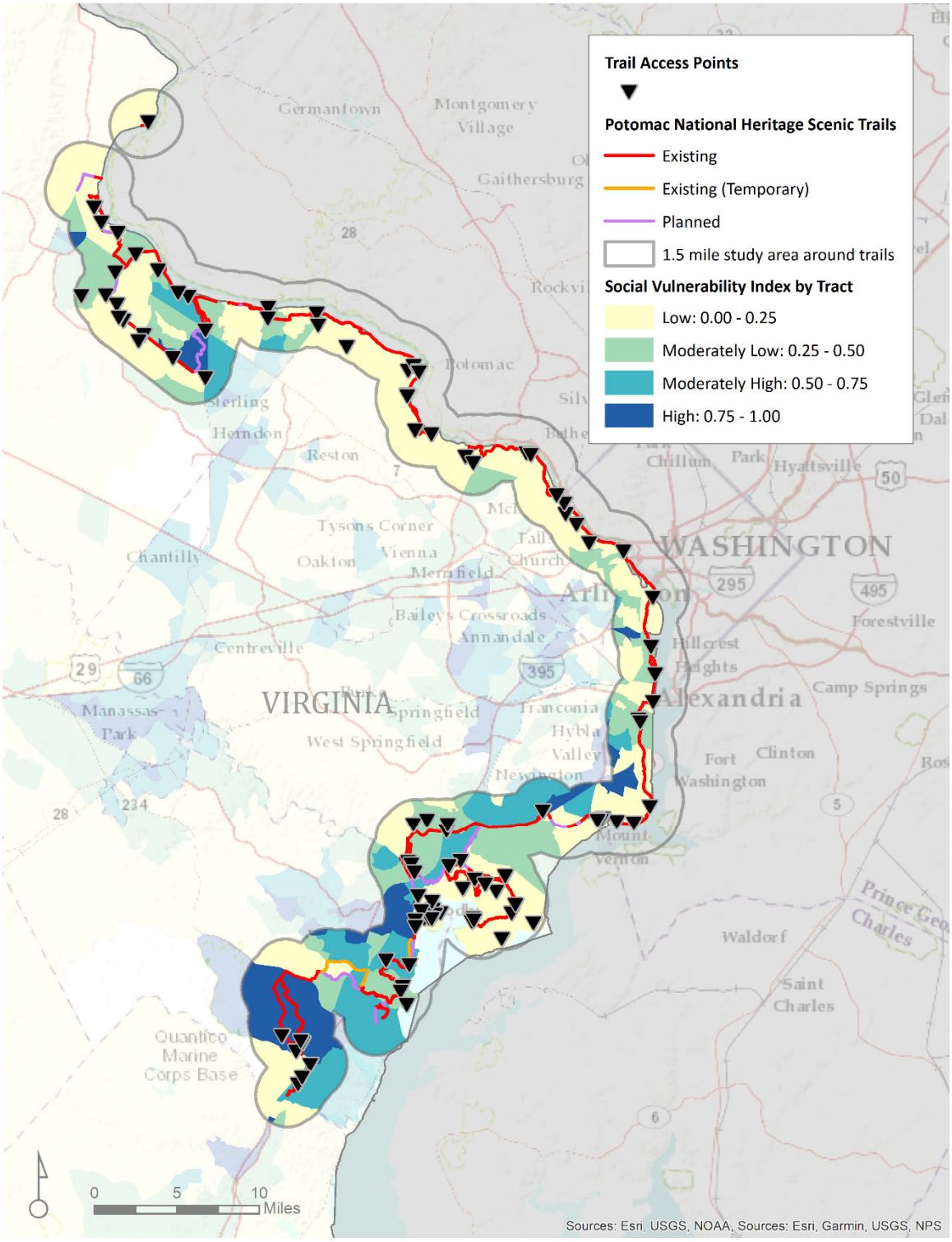
Source: BBC Research & Consulting from NVRC data.

Figure D-7.
Broad Creek and Goose Creek Gap



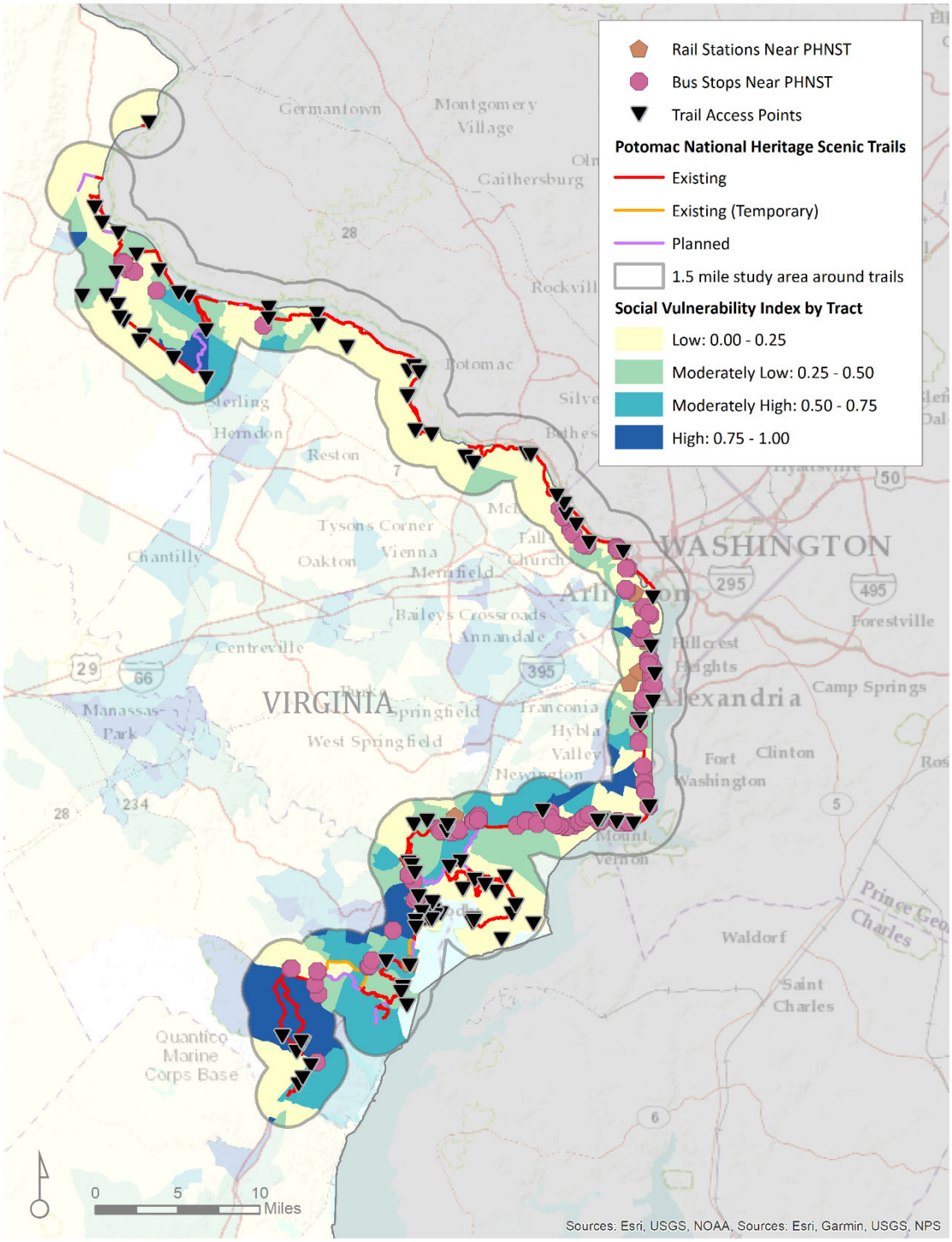
Source: BBC Research & Consulting from NVRC data.

Figure D-8.
PHNST in Northern Virginia with Access Points



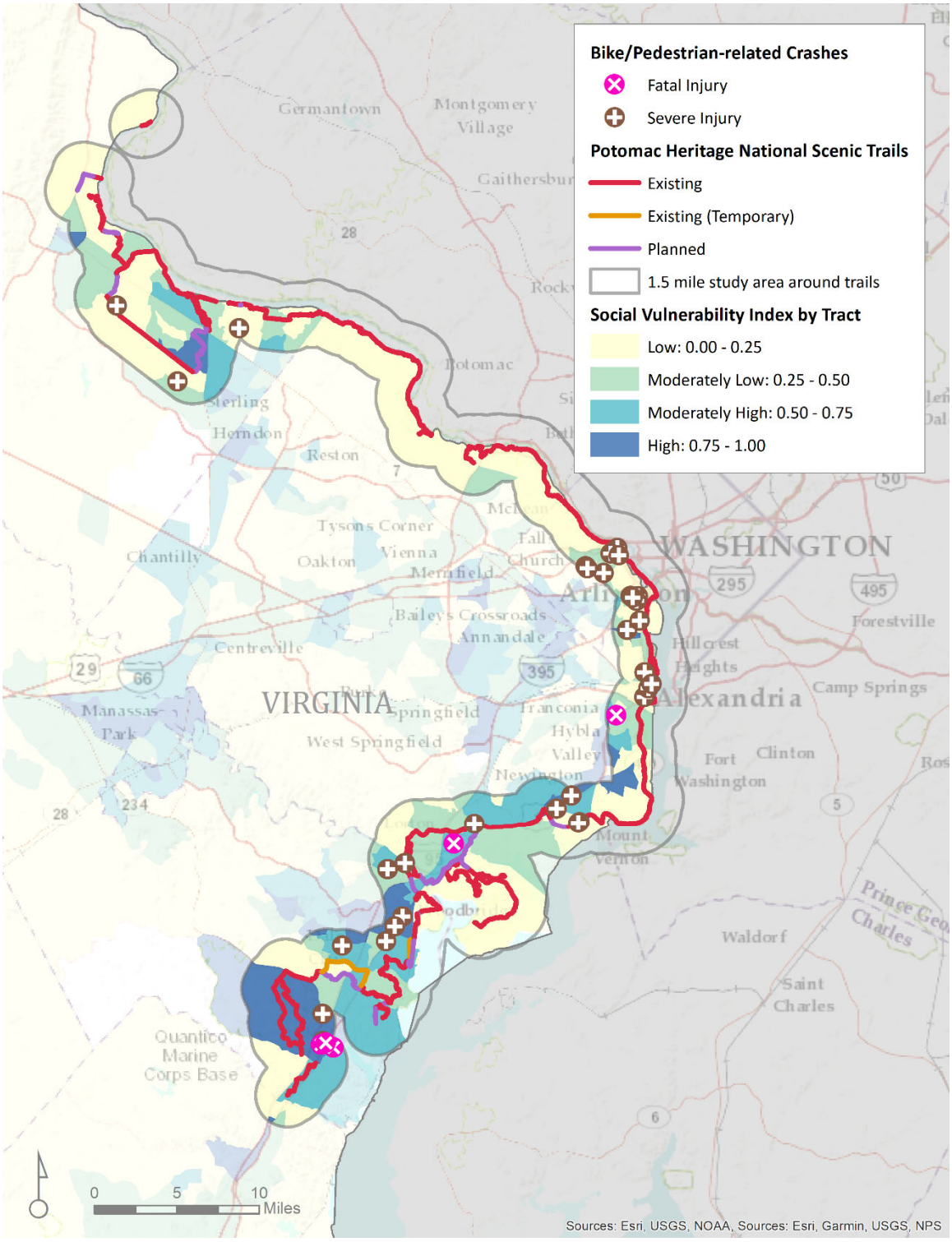
Source: BBC Research & Consulting from NVRC and CDC data.

Figure D-9.
PHNST in Northern Virginia with Bus and Rail Stations



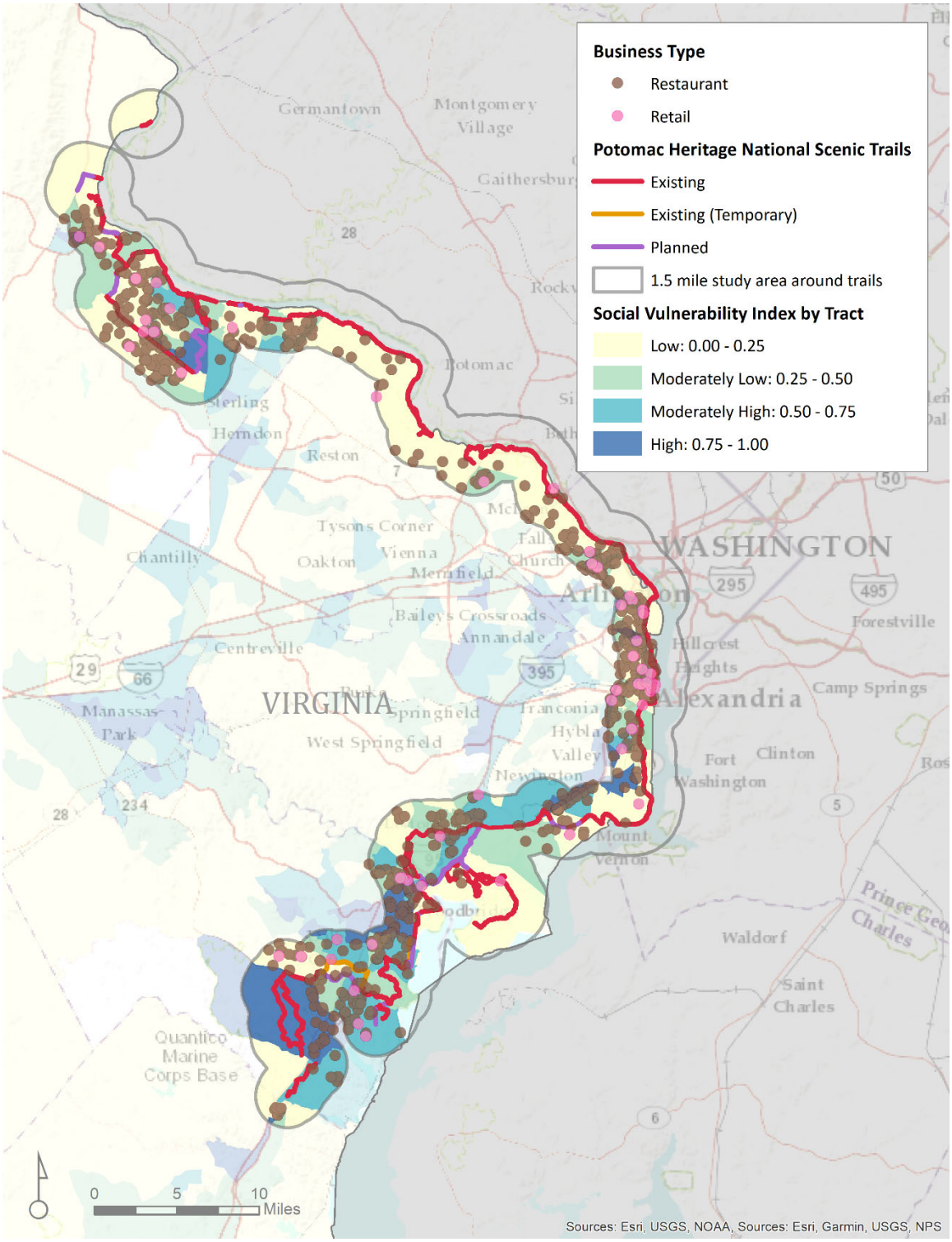
Source: BBC Research & Consulting from NVRC and CDC data.

Figure D-10.
Crashes in the PHNST corridor in Northern Virginia



Source: BBC Research & Consulting from NVRC, VDOT and CDC data.

Figure D-11.
Businesses in the PHNST in Northern Virginia



Source: BBC Research & Consulting from NVRC, CDC, and Hoovers Dun & Bradstreet data.