# Anne Arundel County
# Transit Accessibility Analysis
# and
# Map Consolidation

Iryna Bondarenko, Jennifer Hopkins, James Hull, David Lipscomb, Abidemi Olafusi

under the supervision of Professor Chao Liu

URSP688L: Planning Technologies

The University of Maryland – College Park

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PALS - Partnership for Action Learning in Sustainability

An initiative of the National Center for Smart Growth

Gerrit Knaap, NCSG Executive Director

Uri Avin, PALS Director

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## Executive Summary

Currently, Anne Arundel County has multiple state and local transit systems that serve its residents, but no single resource that provides information on all of them. The team has been tasked with creating a consolidated transit map, assessing transit accessibility, and making recommendations for improving transit access.

Anne Arundel County residents, city officials, and tourists will benefit from bridging the gap between accessibility and mobility with a modern transportation map. Our final product will provide users with an online, user-friendly, and interactive application. This application will visually integrate various transit systems to create an intermodal regional network map. The online map includes features that help users discern route schedules, estimate their location in relation to transit stops, and visualize links to other regional transportation networks. This consolidated map will be an invaluable resource to transit users in Anne Arundel County.

We also investigated some transportation challenges within Anne Arundel County as it moves towards a more comprehensive program. Though the current transportation network serves many populated regions of the county, there are also areas with important amenities that lack connectivity. These gaps and some potential remedies are also addressed in this report. This analysis will aid planners and county officials as they approach transportation issues in the future.

PALS SUMMARY: The foremost goal of this project was to prepare a consolidated transit map for Anne Arundel County. In completing this task, we were able to examine some of the underlying data that structures the network. The scrutiny of the underlying data compelled us to create worker and population distribution maps with the transit network overlay. This visualization allows us to make recommendations and see room for improvements.

## Background

Anne Arundel County is located just south of the City of Baltimore in the State of Maryland. It is the home of the state capital, Annapolis. The county totals 558 square miles and the Chesapeake Bay determines the majority of the eastern border of the county. Between 2010 and 2015, the county saw its population grow by 4.9% and now has a population of 564,195.[1] About 77,400 of residents are 65 years and older, and this number increased by 21.8% from 2010. Major employers in the region include Fort George G. Meade, Northrop Grumman, the Anne Arundel Medical Center, and the United States Naval Academy.[2] The Baltimore/Washington International Thurgood Marshall Airport (BWI) serves as the major international transportation hub for the City of Baltimore and is located in the northern region of the county. At the local level, the county is home to stops on the Maryland Transit Administration's Light Rail and the MARC Commuter rail service as well as numerous bus networks.

## Research Questions

Our primary subject areas include:

- an analysis of transit accessibility to and from employment centers
- an investigation into whom the transit system serves
- how best to present the consolidated transit map.

At the core of this project are questions about the accessibility of transit services throughout Anne Arundel County. By creating a consolidated transit map, we will be positioned to examine population and employment characteristics as they relate to transit accessibility (at the Census block group and tract levels). The map will also visualize access to local services and amenities, which can be further analyzed to determine the reach and effectiveness of county transit services. We seek to answer the following questions:

[1]US Census QuickFacts, Anne Arundel County, 2015.
[2]Major Employers in Anne Arundel County, Maryland Department of Commerce.

- With accessibility in mind, what are the strengths and weaknesses of each Anne Arundel County transit system and what roles do they play in the network?
- What services and amenities are most/least accessible? What are the impacts of those findings?
- What are the opportunities and challenges the transit system may face in the future?
- Overall, what recommendations can we make with respect to current and future service?
- What data or information might be missing that would provide a more complete or more accurate analysis?
- How can a consolidated transit map most effectively be used to improve transit?

## Analysis Approach

To analyze the existing transportation system, its regional context, and its level of accessibility, ArcGIS Desktop 10.3.1, ArcGIS Online, and ESRI Web AppBuilder were used. The following list outlines the report's areas of analysis:

- provided data and regional context
- strengths and weaknesses in current public transit system
- population and employment distribution
- transit accessibility to and from employment centers
- accessibility to points of interest
- walking accessibility to transit stops
- mapping of key findings with points of interest and transit routes
- online application to search and view transit routes, stops and key destinations.

## Final Deliverables

- Consolidated transit map with all transit systems and various variables related to transit
- Locations of services and amenities throughout the county

- Interactive consolidated transit map application hosted on ArcGIS Online (AGOL)
- Concise analysis of the transit network
- Basic recommendations to improve transit service

## Overview of Results

Anne Arundel County's transit network service is diverse. Users can choose between the MARC rail system or bus. MTA (Maryland Transit Authority), RTA (Regional Transit Authority) and the City of Annapolis all contribute to the county's bus transportation network. The MARC rail stations are mostly concentrated in the northern part of the county near Baltimore. A few stops outside city limits provide service to Odenton, Georgetown, and Maryland City. In total there are 11 light rail stations in Anne Arundel County. RTA provides service to the northwestern part of the county with stations in Maryland City, Severn, Fort Meade, and Glen Burnie. There are 26 RTA transit stops.

RTA serves specific regions within Maryland, including Anne Arundel County, while the MTA serves the entire state of Maryland. Analyzing the MTA bus stops reveals a dense network of stops along Ritchie Highway, Maryland Route 2, and other roads connecting Baltimore to the Annapolis area in the east by way of Glen Burnie and areas northeast of the Severn River. Annapolis, the State's capital, is a major population center in Anne Arundel County. The city's transit network has 238 bus stops of the total 414 transit stops in Anne Arundel County, accounting for 57% of the county's total transit stops.

**Amenities**

- Airport: BWI is in the northern part of Anne Arundel County. The MARC line is the most suitable means of transit to the airport from the northwestern parts of the county. Though residents of Annapolis do not have direct access to MARC rail, they can transfer from Annapolis transit to MTA, then to MARC. Though not easy, it is still an option for residents trying to reach the airport on public transportation. For the northwestern area of the county,

the RTA and MARC transportation networks follow similar routes and provide a convenient option for BWI access.

- Education: There are 218 educational institutions in the county, which include elementary, middle, and high schools, as well as private schools and libraries. Some are accessible by MARC, Annapolis transit, RTA and MTA, depending on their location, however educational institutions in the south, central, and portions of the east side of Anne Arundel County are not accessible via transit.
- Government: There are 95 municipal or government buildings in Anne Arundel County that were included in this study, as they likely serve as employment hubs and the location of many county services. Payment centers, courts, and city, county, state and federal buildings were included. They are widely dispersed, and there is relatively good access in the northern and eastern parts of the county, though reaching some may require network transfers. For government buildings located in the eastern part of the county, the Annapolis bus transit provides access.
- Health: There are 14 hospitals and health centers in the county. MARC, RTA, and MTA provide service in the northern region of the county. Three out of the 14 health centers in Annapolis can be reached by local Annapolis transit or the MTA services. Owensville Medical Center, in the southern part of the county, lacks connectivity to any existing transit network.
- Park-and-Ride: There are 22 Park-and-Ride facilities in the county, and county transit systems reach all except one; Tracy's Landing Park-and-Ride. Tracy's Landing is in the southern part of the county, which is underserved by transit.
- Parks and Recreation: There are 132 parks and community recreation centers in the county. Many of them are within reach of transit, however, with they are widely spread out throughout the county, and there are a fair number that the transit network do not reach. These areas are in the southern and central parts of the county and in the eastern part of the county along the Chesapeake Bay north of Annapolis. Driving seems to be the only way of getting to those locations.
- Shopping: There are 138 shopping centers in the county and all of them are easily accessible by the existing transit network. The majority are in the northern part of the county and

around Annapolis. These areas have strong transit systems that provide citizens a means of transportation to the shopping centers and boost local economies.

- Churches: There are 287 churches in the county, many of which are accessible using public transit. There is far more access to churches using transit for residents in the northern part of the county as well as in the city of Annapolis versus the central and southern portions of the county.

## Online Transit Web Application

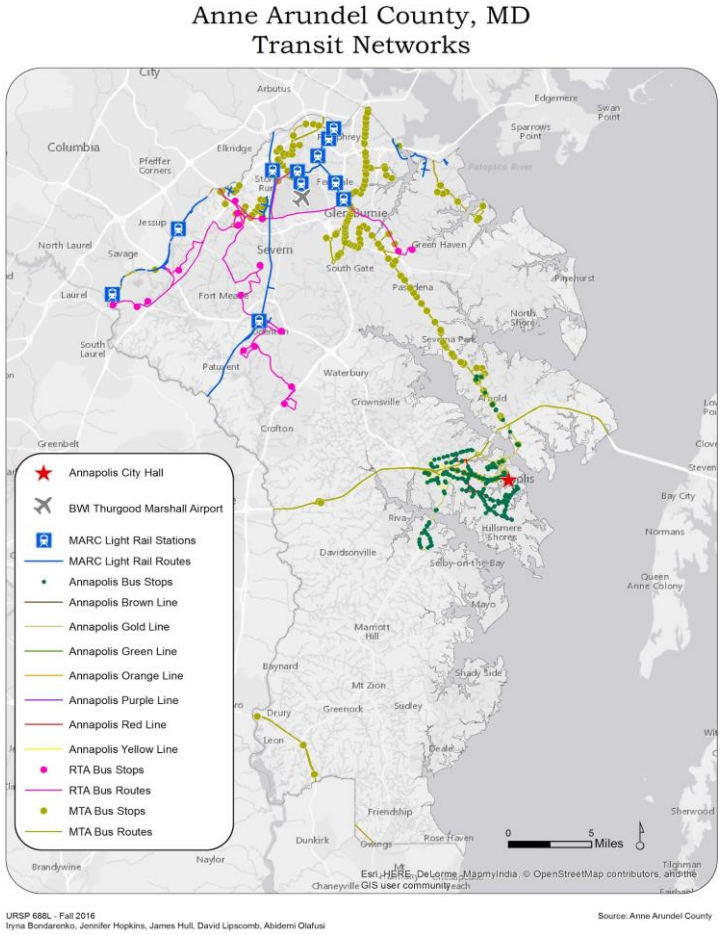
To assist the county in improving transit access for residents and visitors, we developed a web application that maps all transit systems available in the county. Data was first formatted and symbolized in ArcGIS Desktop 10.3 before being published and hosted on ArcGIS Online as a collection of feature services. The feature services were compiled into a WebMap, which was used as the source of data to develop an application using ESRI's Web AppBuilder. This application is available using a web browser on a desktop computer or mobile device. Users must have an ArcGIS Online account to access the application. The application allows users to view a map of the county transit systems and regional points of interest. It is designed to be user-friendly and does not require any GIS experience or training for use.

These tools are available in the application:

- About: provides basic information regarding the application's purpose
- Basemap Switcher: changes the basemap on the application
- Directions: accesses directions between addresses and/or locations indicated on the map
- Near Me: highlights transit stops and points of interest within a determined distance from an address or location indicated on the map
- Layer List: turns provided layers on and off, and zooms to layers

**Consolidated Transit Network Map**

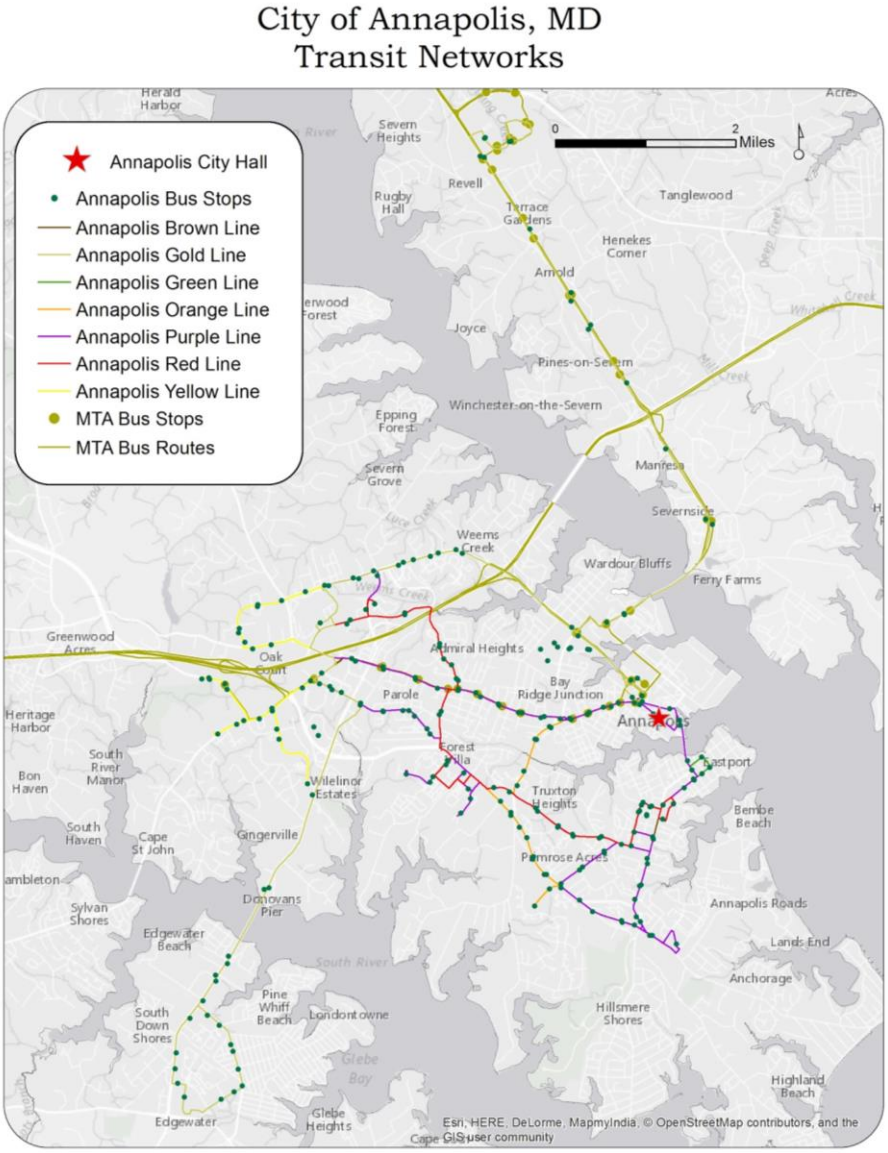
This map shows all transit networks in Anne Arundel County: MARC, RTA, MTA, and Annapolis City transit. There is good, if limited, connectivity from Annapolis north toward Baltimore and west toward Prince George's County. MARC stations in the northwestern area of the county allow for easy connection to both Washington, D.C., and Baltimore. However, there are large portions of the county without any transportation connectivity. South of Annapolis, transportation service is minimal except for a small continuation of an MTA bus line in the far southwest corner of the county.




**Annapolis Transit Map**

This map displays a consolidated transit map for the city of Annapolis, a seven-line bus network that connects the city to neighboring communities and to the MTA route toward Baltimore. The

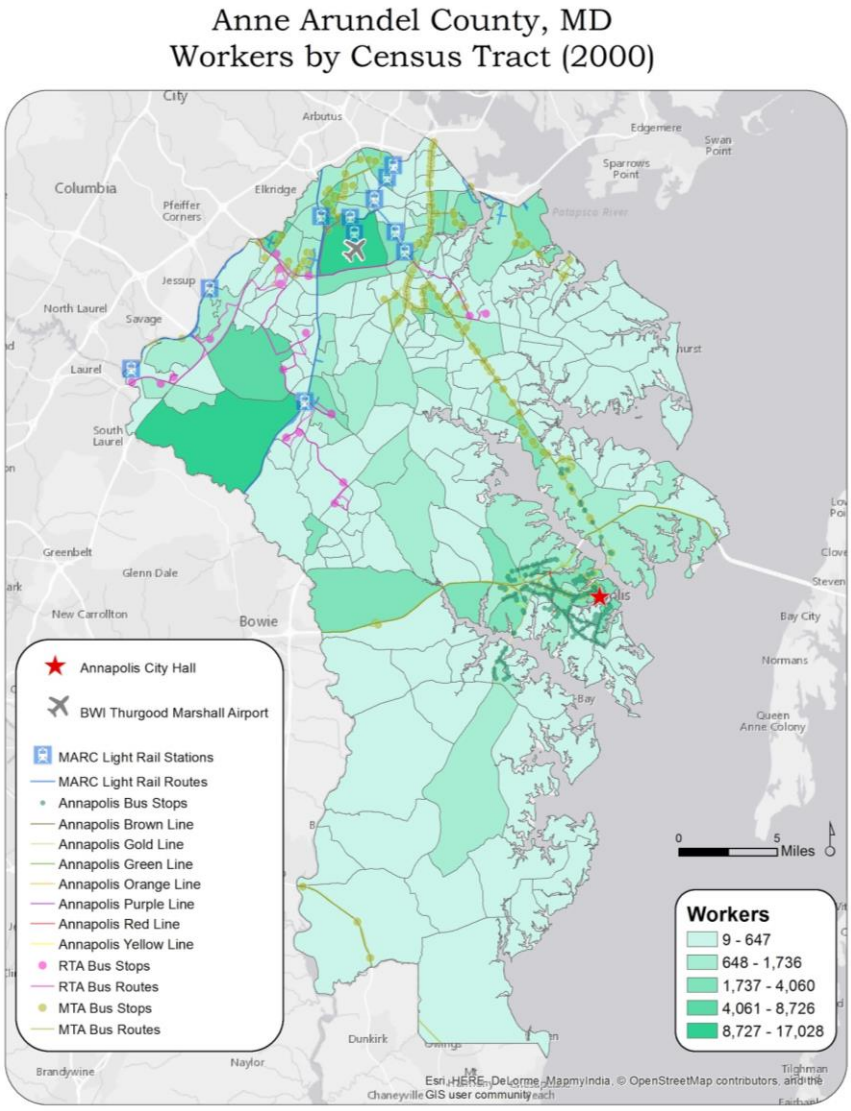
buses serve many amenities in Annapolis, including the SPCA Nature Preserve, the Bay Ridge Shopping Center, numerous schools, Annapolis Plaza, and the Navy-Marine Corps Memorial Stadium.




**Anne Arundel County Transit Networks with Workers**

This map displays the number of workers per census tract with the county transit system overlaid. The visualization helps determine if transit networks pass through areas where workers live. Ideally, public transportation would follow the tracts with more workers to offer an alternative to driving. With this in mind, the current transportation network serves the worker

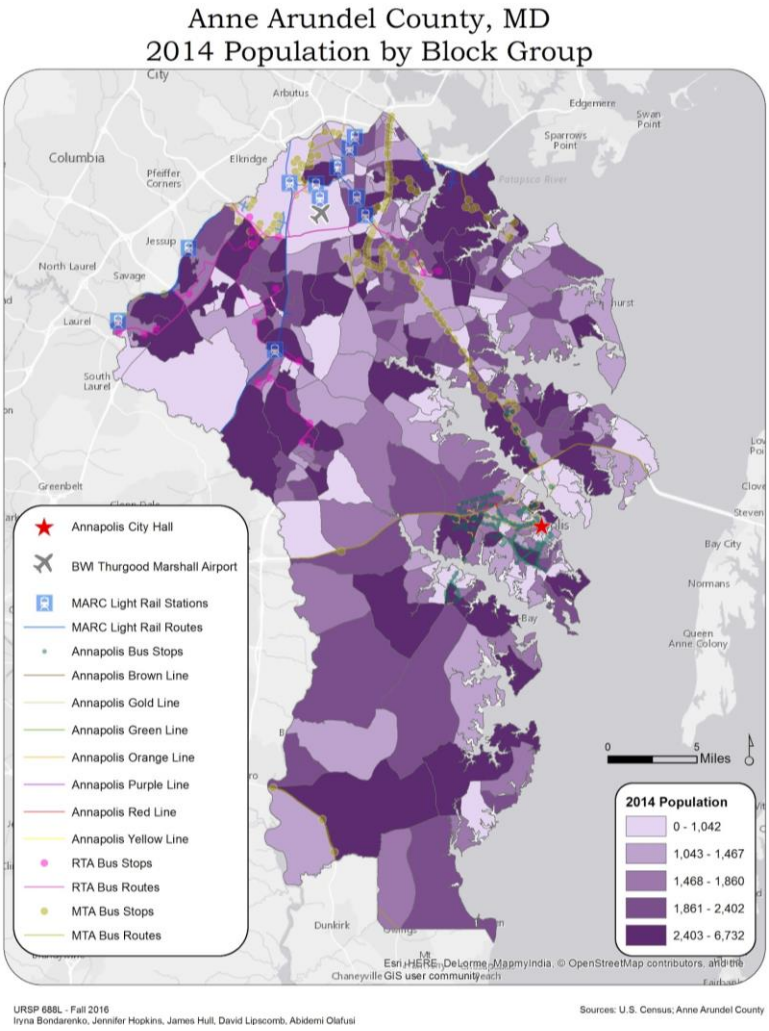
population well; denser tracts along U.S. Route 50 into Annapolis and areas in the northern part of the county have ample transit access.




**Anne Arundel County Transit Networks with Population**

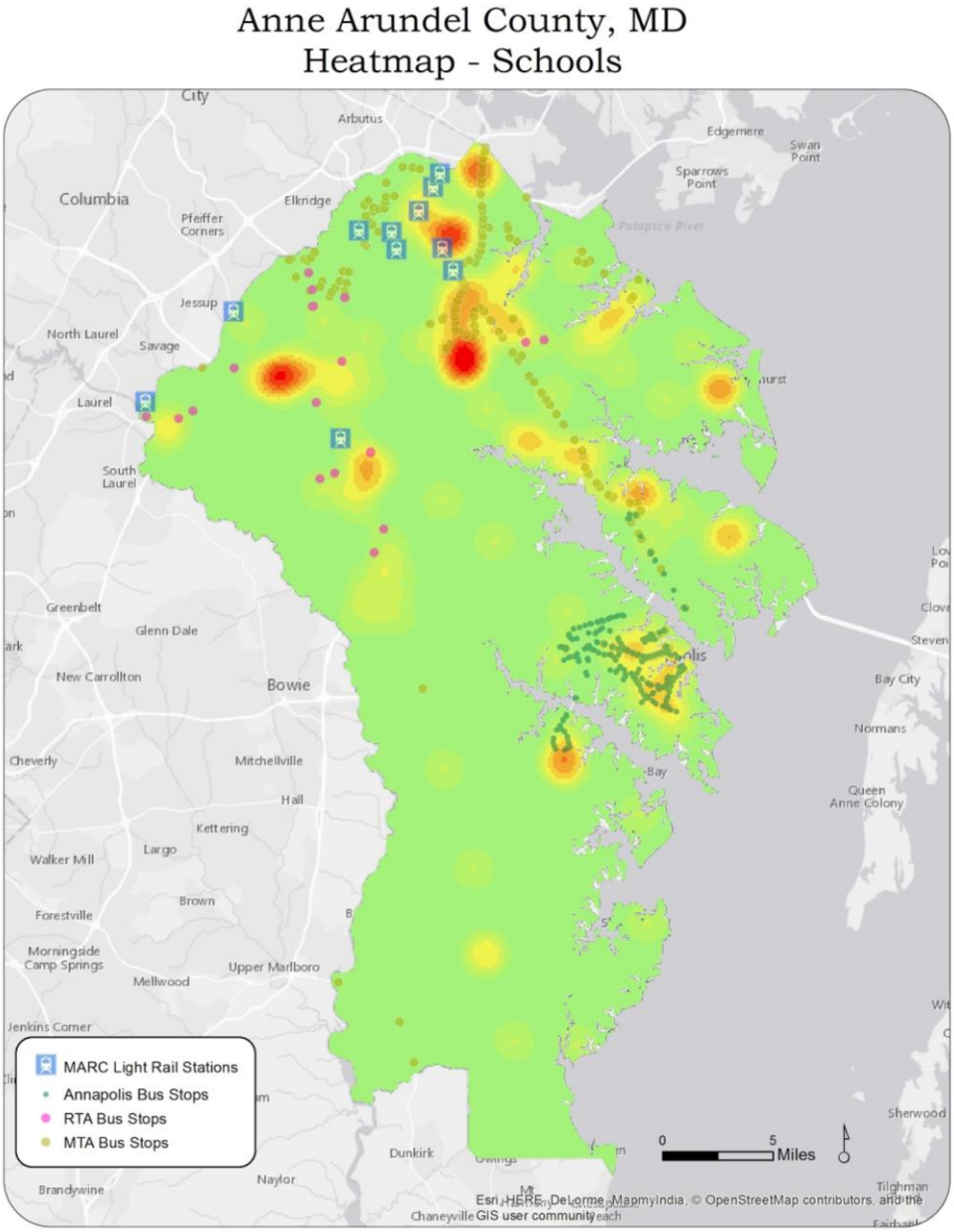
This map displays the population in each census tract by block group with the county transportation network overlaid. The visualization helps determine if transit networks pass through areas with higher populations. The current transportation network does pass through populous and dense census tracts, especially in the northern part of the county, particularly the tracts surrounding the MARC rail network. However, there is a gap in the southern half of the county. These tracts are have high populations but no comprehensive access to transit other

than the MTA bus route that cuts through the southwest corner of the county.



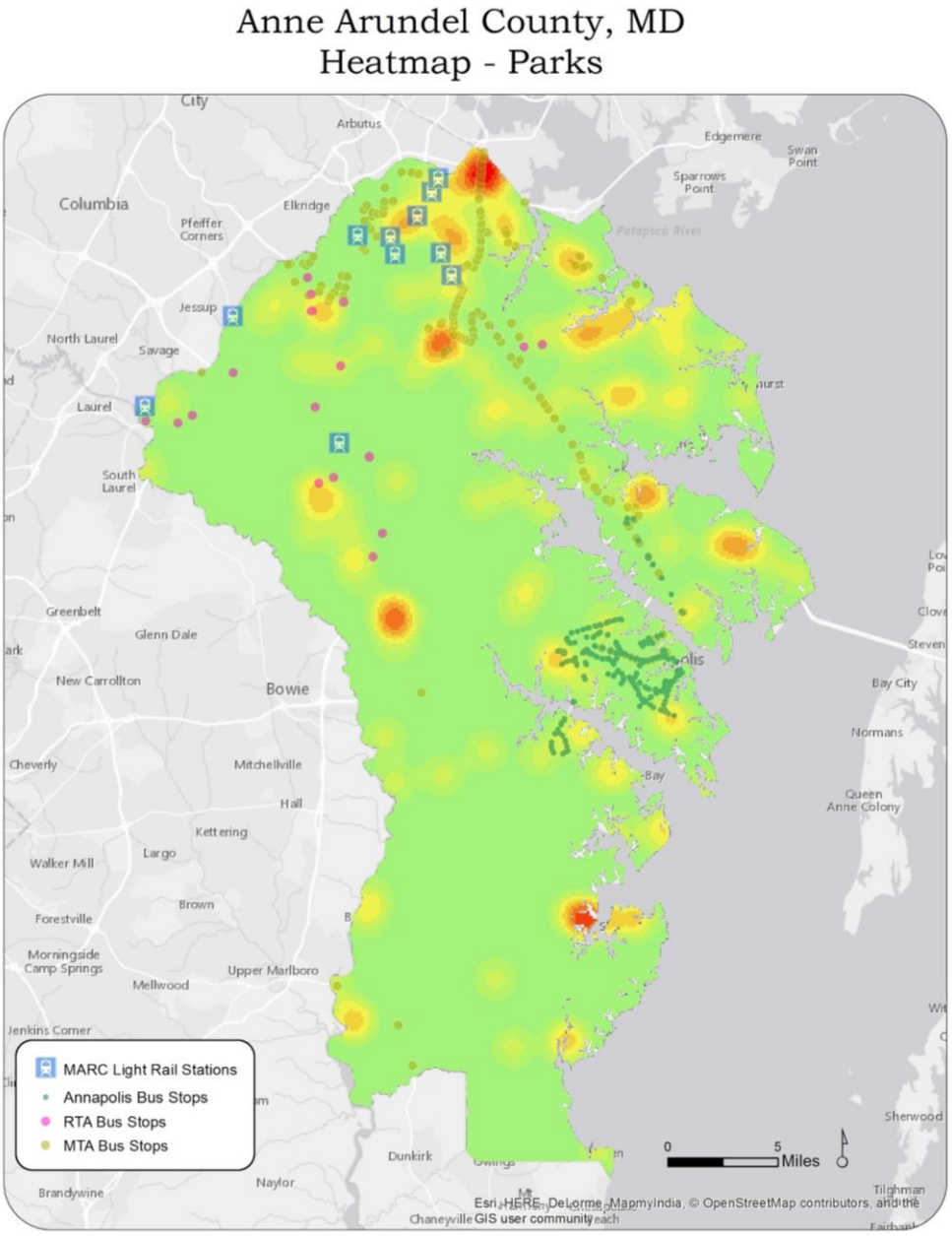
**Anne Arundel County Heatmap: Schools**

On this map, red indicates a high density of schools. Northern Anne Arundel County's schools are well served, as is Annapolis. But there is a high density of schools in the Fort Meade area, which is also a service gap area. The county should aim to provide more bus stops to facilitate access.



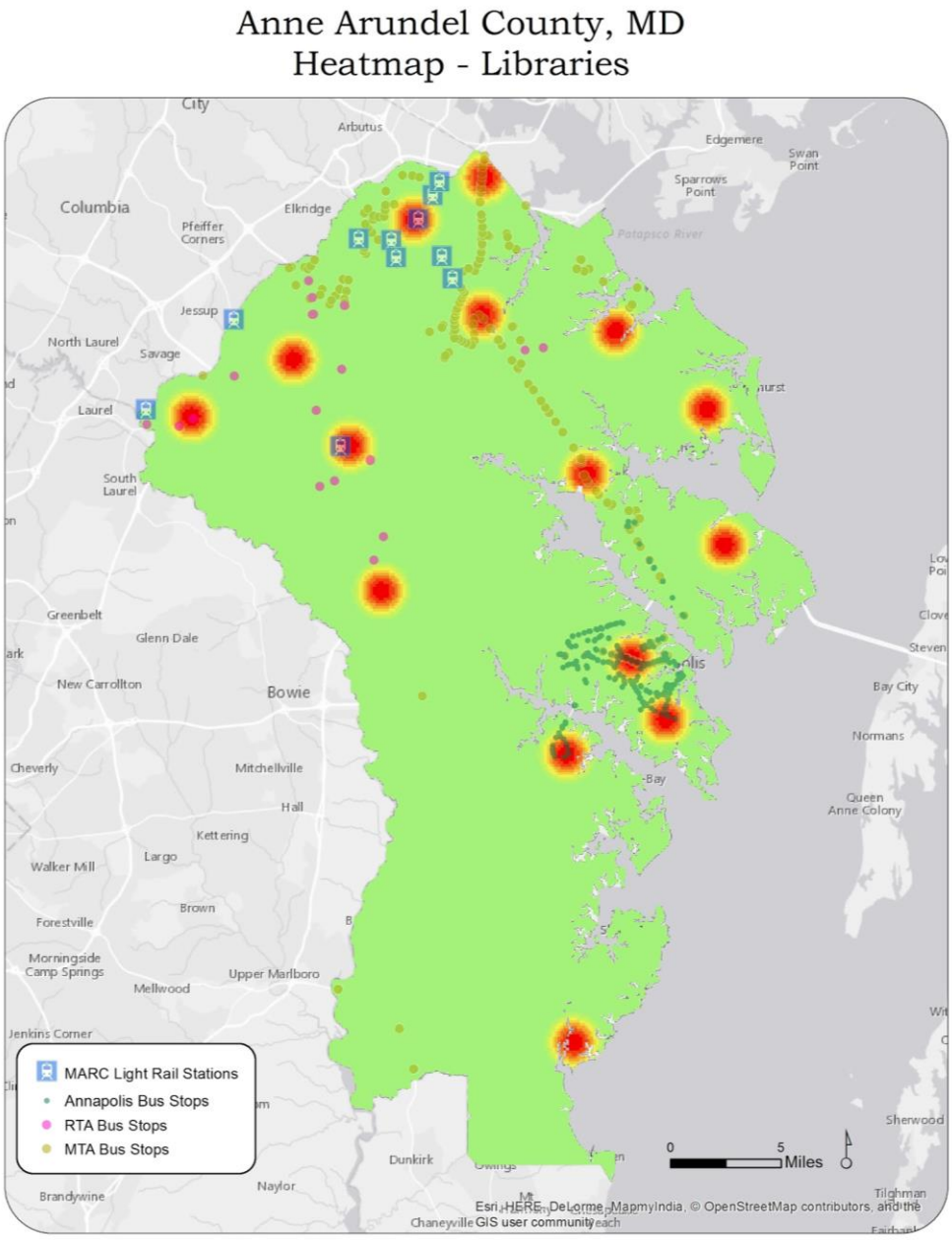
**Anne Arundel County Heatmap: Parks**

On this map, red indicates a high density of parks and recreational spaces. The northern third of the county's parks and recreational spaces are well served, but there are some transit gaps around the Patuxent Research Refuge and towars the terminus of Maryland Route 214.



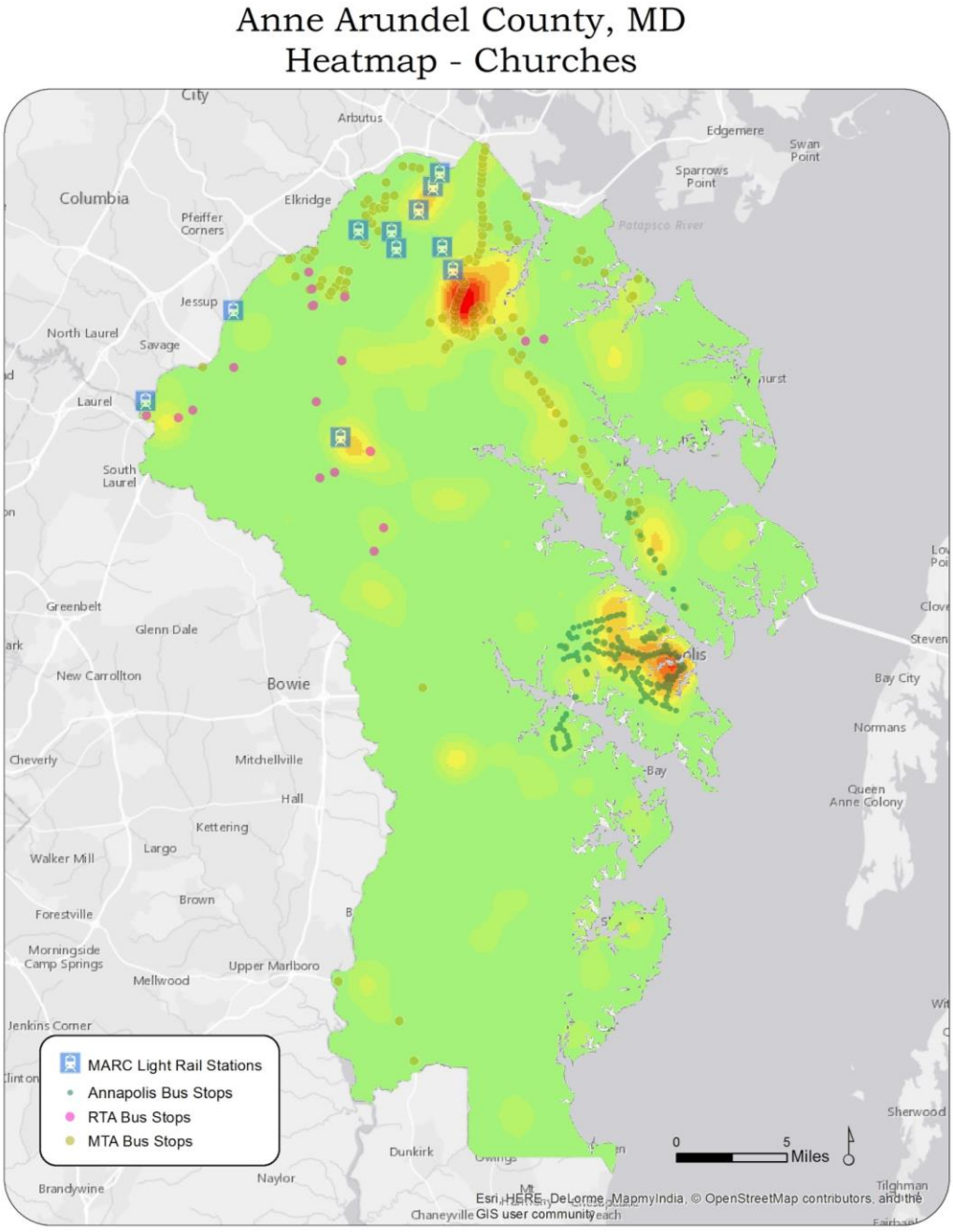
**Anne Arundel County Heatmap: Libraries**

On this map, red indicates a high density of libraries. The county's populous regions have transit access to libraries. There are some gaps near Deale and Woods Landing, but overall the county transit does serve the more densely populated regions.



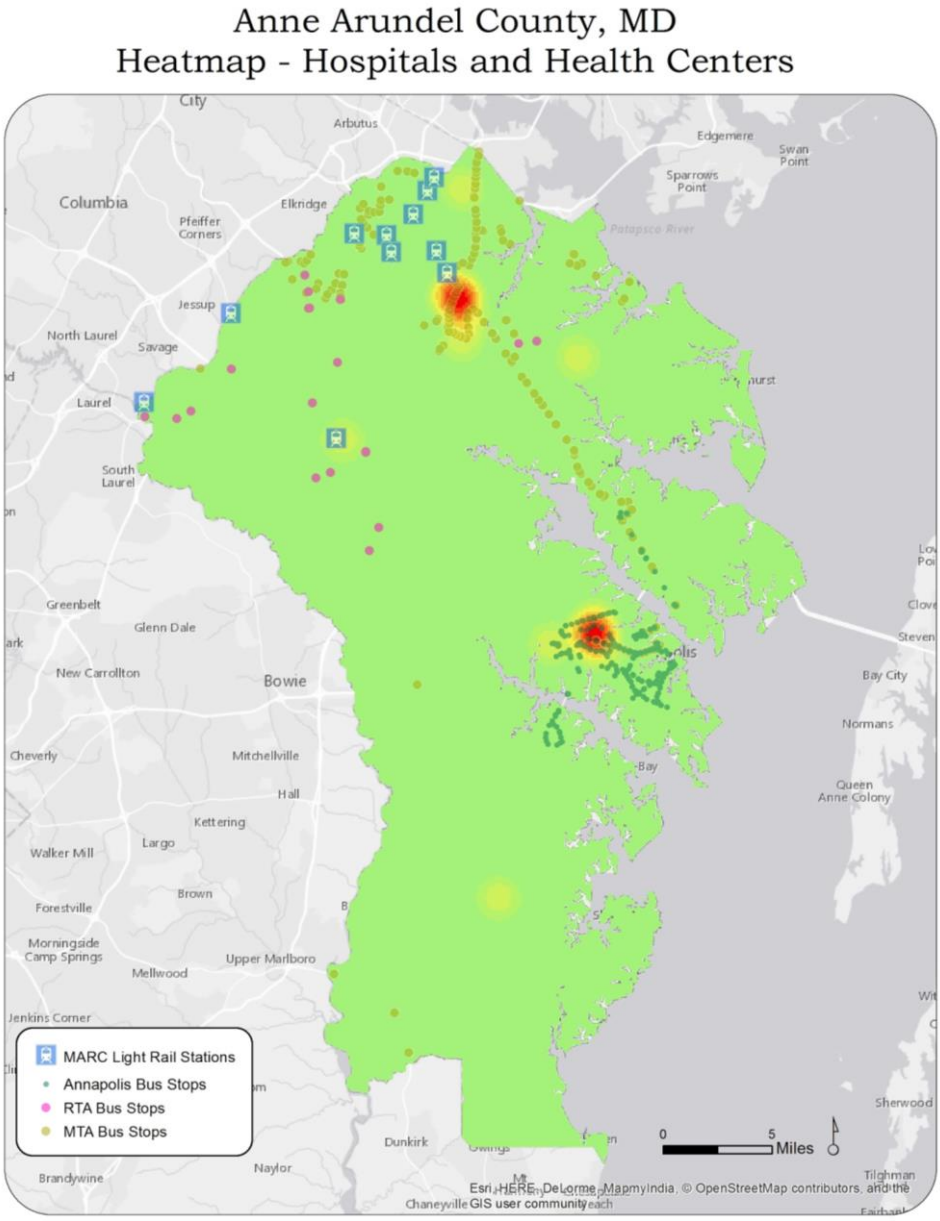
**Anne Arundel County Heatmap: Churches**

On this map, red indicates a high density of churches. Overall, the county's current transportation network serves this amenity well.



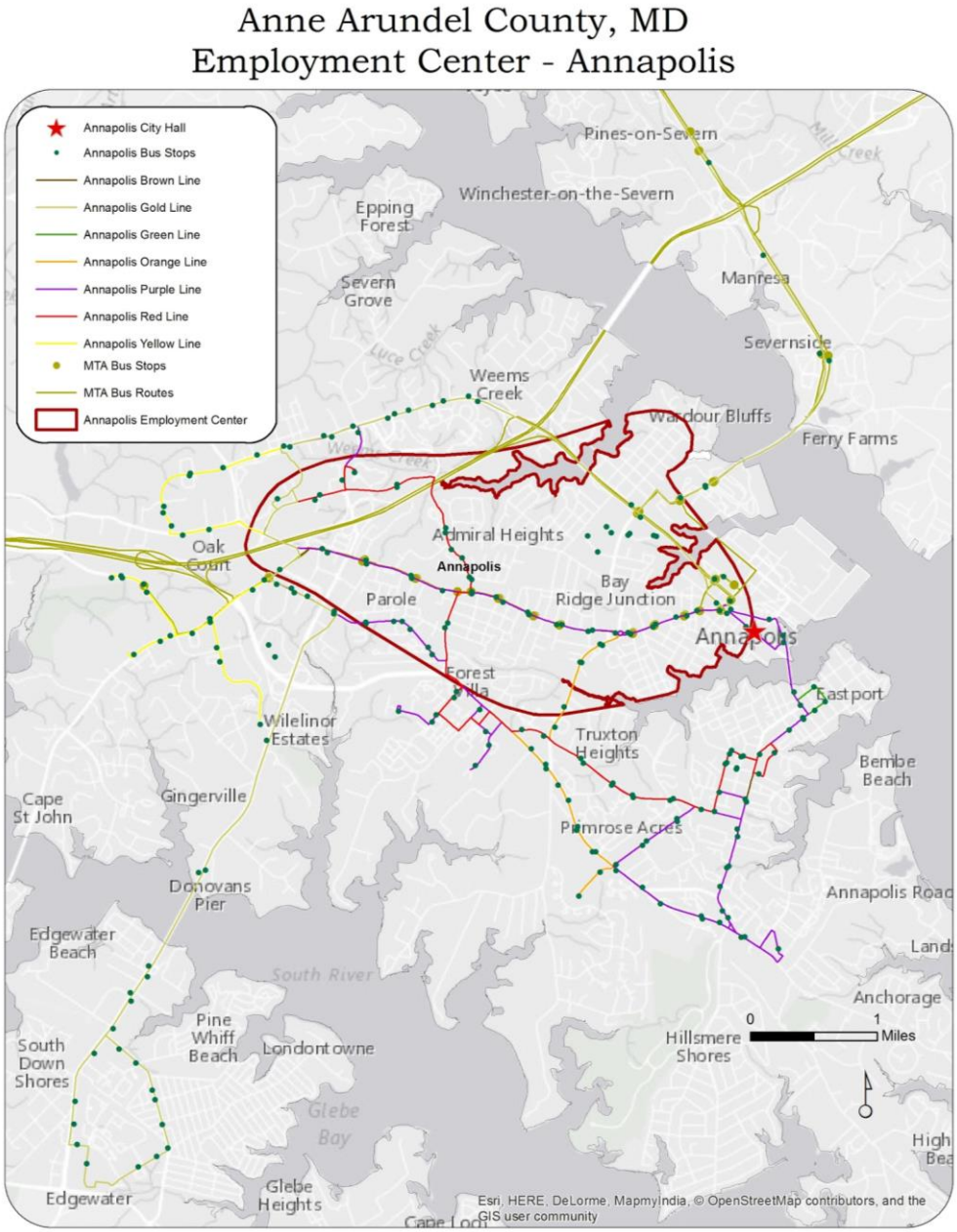
**Anne Arundel County Heatmap: Hospitals and Health Centers**

On this map, red indicates major hospitals and health centers. The medical hubs around Glen Burnie and Annapolis are well served by transit.



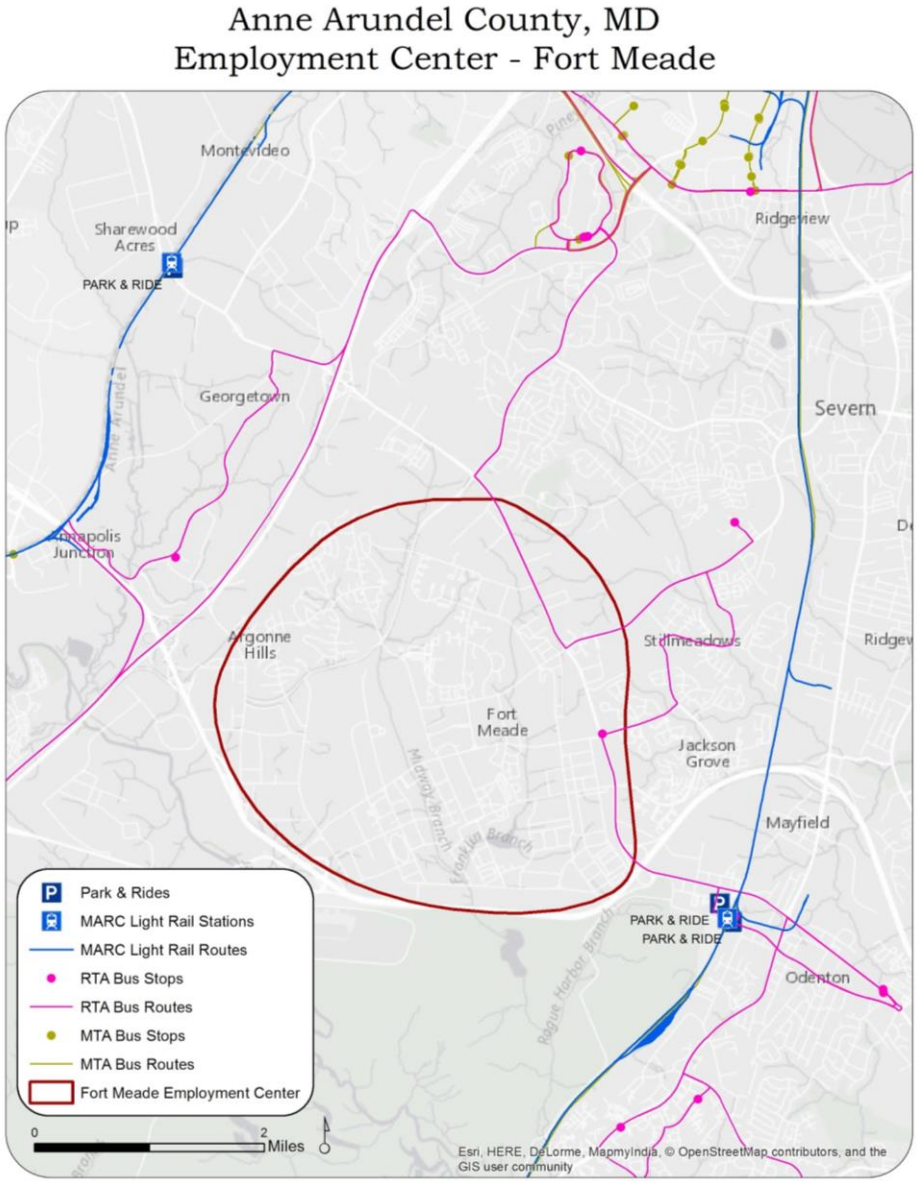
**Anne Arundel County Employment Center: Annapolis**

Annapolis has excellent transit accessibility in and outside of the Annapolis. The bus lines cover a substantial portion of the city including areas separated from the employment center by the south river. Additionally, MTA buses connect communities north of the Severn River to downtown.



**Anne Arundel County Employment Center: Fort Meade**

The Fort Meade employment center has the weakest transit access based on the services the team was asked to examine. However, the MeadeRide partnership operates several shuttle services that connect commuters at locations inside the employment center to MARC rail stations, BWI, and other parts of Maryland via the Intercounty Connector.[3]




[3] "Transit Map." MeadeRide. November 2016

**Anne Arundel County Employment Center: Linthicum Heights**

The Linthicum Heights employment center is fairly well served by MTA buses and nearby MARC rail stations. The entire area is within one mile of a transit station and substantial amounts of the area are within quarter-mile and half-mile of transit.

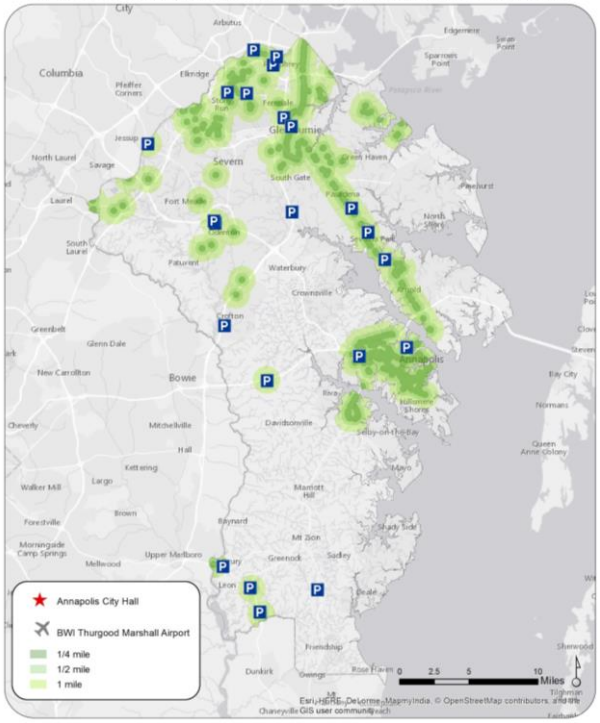
## Transit Buffers Analysis

To visualize how many people in the county have pedestrian access to public transit, buffers around bus and rail stops were created. According to research, most walking trips are no longer than one mile.[4] Maps were created showing quarter-, half- and one-mile walkable radii to public transit stops. Of the County's population 20% (110,822 people) live within a quarter-mile from bus or rail stops, 42% (230,890 people) within a half-mile, and 77% (425,191 people) within one mile of public transit. These percentages were reached using straight-line measures of distance, which do not control for road detours and cul-de-sacs.

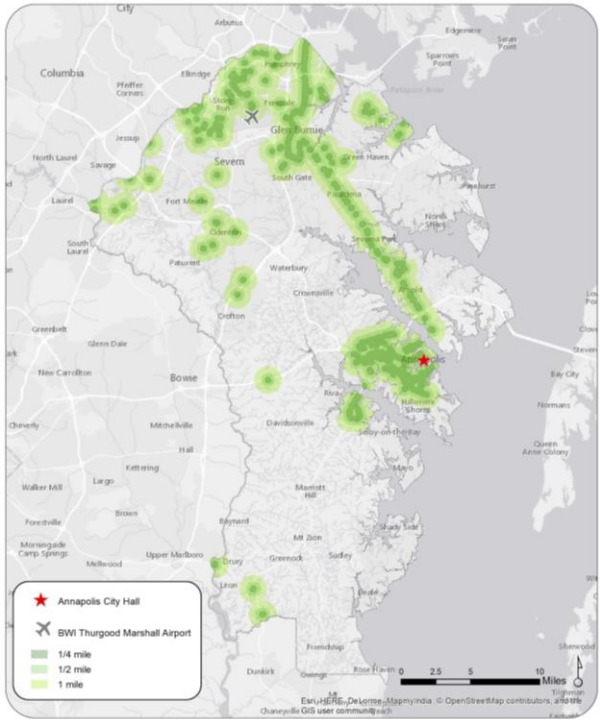
There are some large portions of the county with low access to public transit. These include areas south and north of Annapolis, the southern region of the county, and central parts of the county that fall between MTA and RTA bus transit routes. Areas with large concentrations of workers are better covered by public transit routes. The main employment centers, Fort Meade, Lithicum Heights, BWI, Glen Burnie, have at least one transit stop within walking distance. The density of transit stops and routes is low in the county, which creates the problem of "last mile access" for employers. With limited ability to reach jobs by transit, workers must use cars instead of public transit. Furthermore, having transit access to employment centers, but not access to residences results in poor transit connectivity, and systems cannot be used to their full potential. Improving walkable access to transit from residences should be a focus for the County. For further analysis, maps with these buffers are shown below.

[4] Akar & Clifton, 2009, Nelson, Foley, O'gorman, Moyna & Woods, 2008

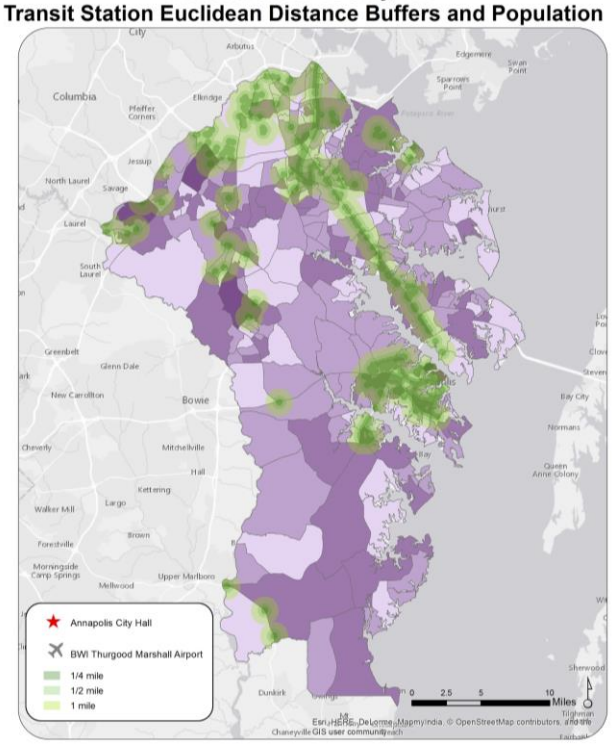
**Anne Arundel County, MD**
**Transit Euclidean Distance Buffers and Park & Rides**



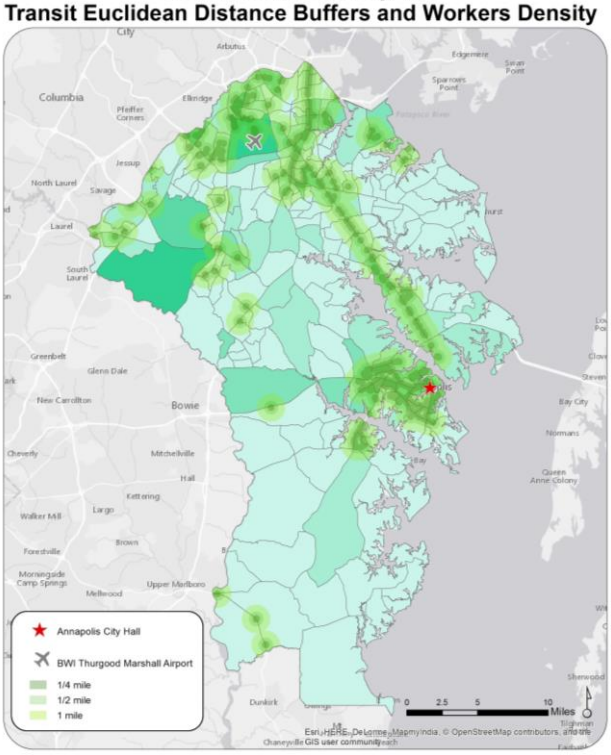

**Anne Arundel County, MD**
**Transit Station Euclidean Distance Buffers**




**Anne Arundel County, MD**
**Transit Station Euclidean Distance Buffers and Population**




**Anne Arundel County, MD**
**Transit Euclidean Distance Buffers and Workers Density**



## Recommendations

After a full analysis, the following recommendations were determined:

- Expand the existing transit system to the southern and central portions of the county, with a particular need in the south.
- Improve existing “last mile” gaps by extending bus routes closer to main employment centers.
- Provide riders access to a consolidated transit map to assist in navigation and transit awareness.
- Improve walking access to transit stops from residences and points of interest.
- Promote walking to transit stops to encourage transit use, especially for those living within a half-mile of transit stops.

## Limitations of the Analysis

- Straight-line (Euclidian) distances are not completely accurate due to possible detours and cul-de-sacs that limit or increase accessibility, depending on the situation.
- Even if walkable access to a transit stop exists, proper connections, such as sidewalks, may not be available. Such data was not available for analysis, nor did time permit such an analysis for this report.
- There is a lack of data about traffic and transit schedules and so, could not be included in the analysis.
- The maps of population and worker densities are approximations.
- The land area calculations are based on each feature boundary, which includes water features in addition to land, thus inflating the area of each feature.
- The lack of data about other county transit services such as MeadeRide, limits the sharing of transit-related data to transit users.

## Further Research

- Assess how many residents are within walkable distances from transit stops, by creating buffers using the road network rather than straight-line measurements.
- Determine number of workers in main employment centers and where they live to create journey maps and better understand where connection gaps exist.
- Analyze transit schedules to further assess transit connectivity and accessibility.
    - Locate potential barriers and accessibility gaps between pedestrian routes to transit to prioritize where pedestrian routes can be improved and expanded.

## Task Coordination

Iryna Bondarenko: analysis, recommendations, presentations, GIS mapping

Jennifer Hopkins: GIS mapping, AGOL functionality, application development

James Hull: analysis, lead final report, preliminary GIS mapping

David Lipscomb: analysis, recommendations, presentations, lead GIS mapping

Abidemi Olafusi: recommendations, analysis, presentations, overview of results

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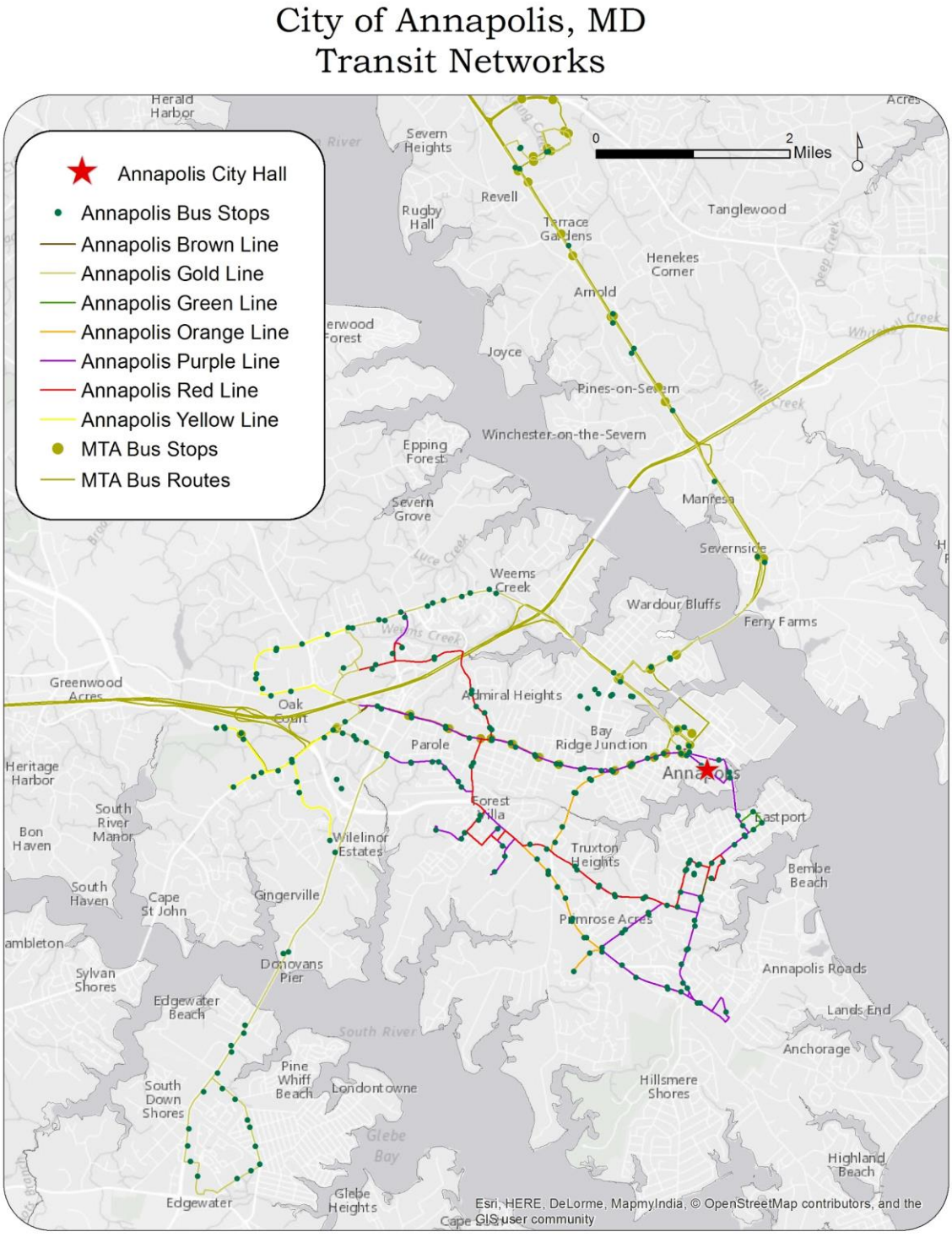
Nelson, N. M., Foley, E., O'gorman, D. J., Moyna, N. M., & Woods, C. B. (2008). Active commuting to school: How far is too far? *Int J Behav Nutr Phys Act International Journal of Behavioral Nutrition and Physical Activity, 5*(1), 1.

## Appendix

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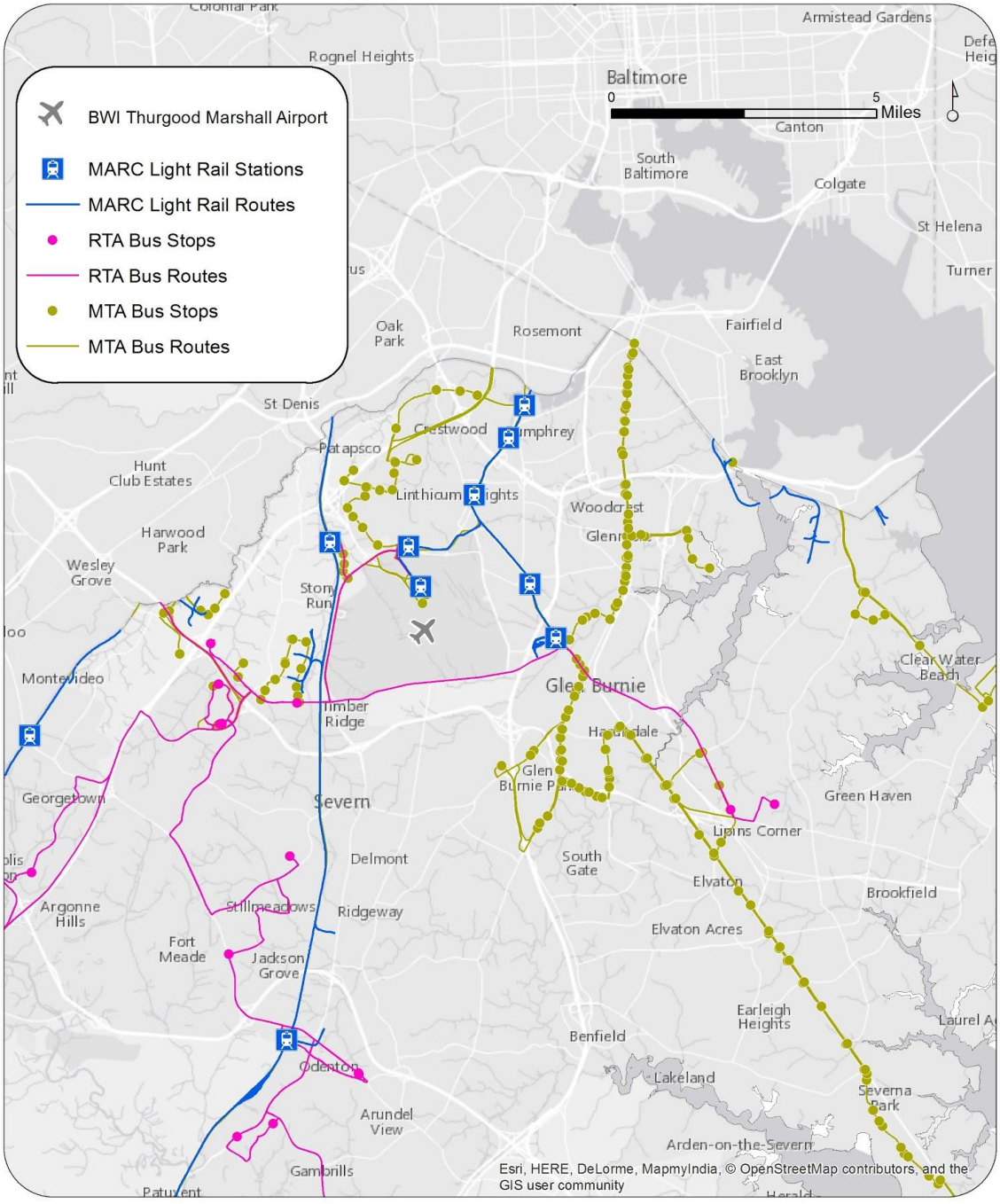
Source: Anne Arundel County

# Anne Arundel County, MD
# Transit Networks - Baltimore Suburbs

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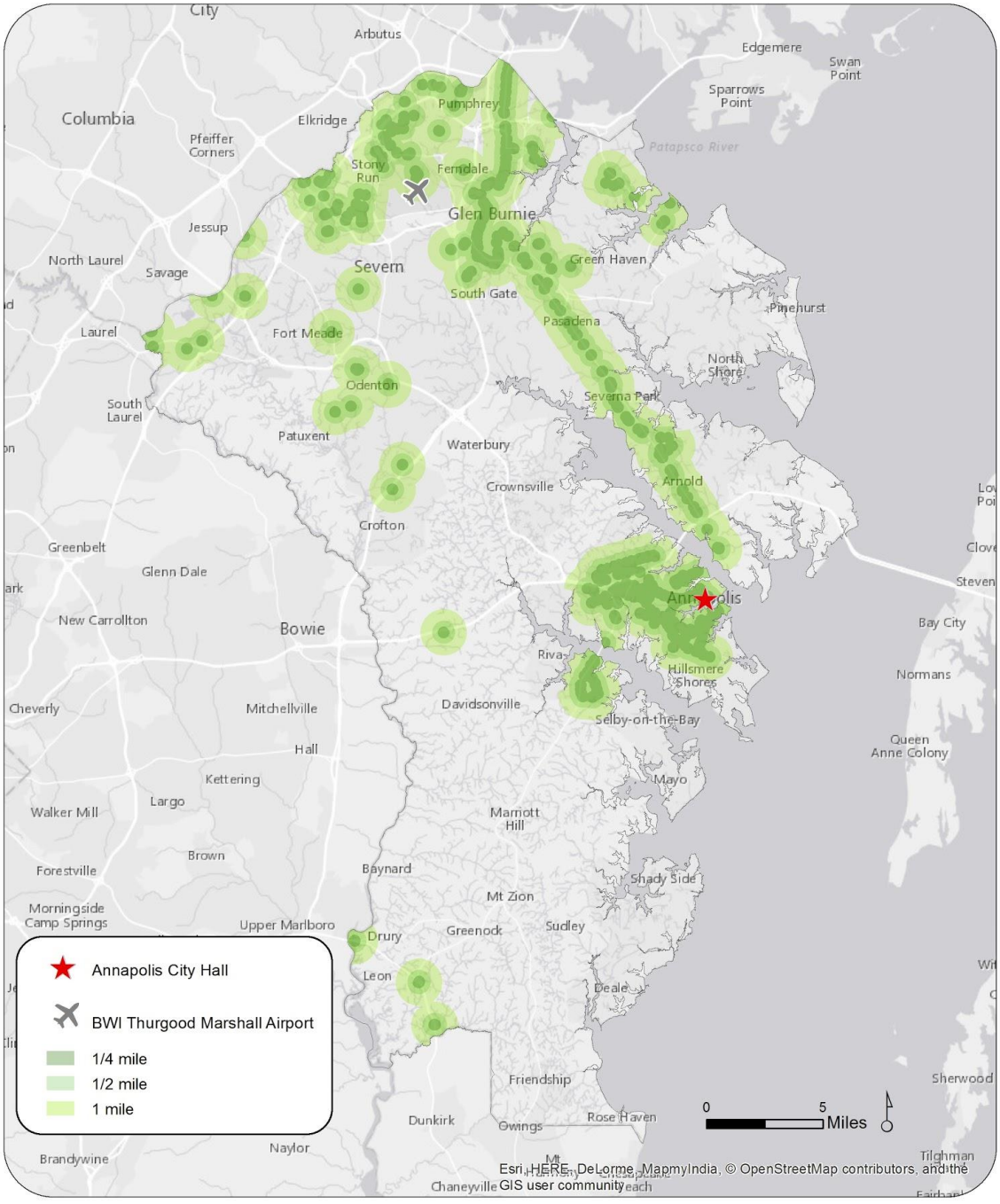
Source: Anne Arundel County

# Anne Arundel County, MD
# All Transit Stations - Euclidean Distance Buffers

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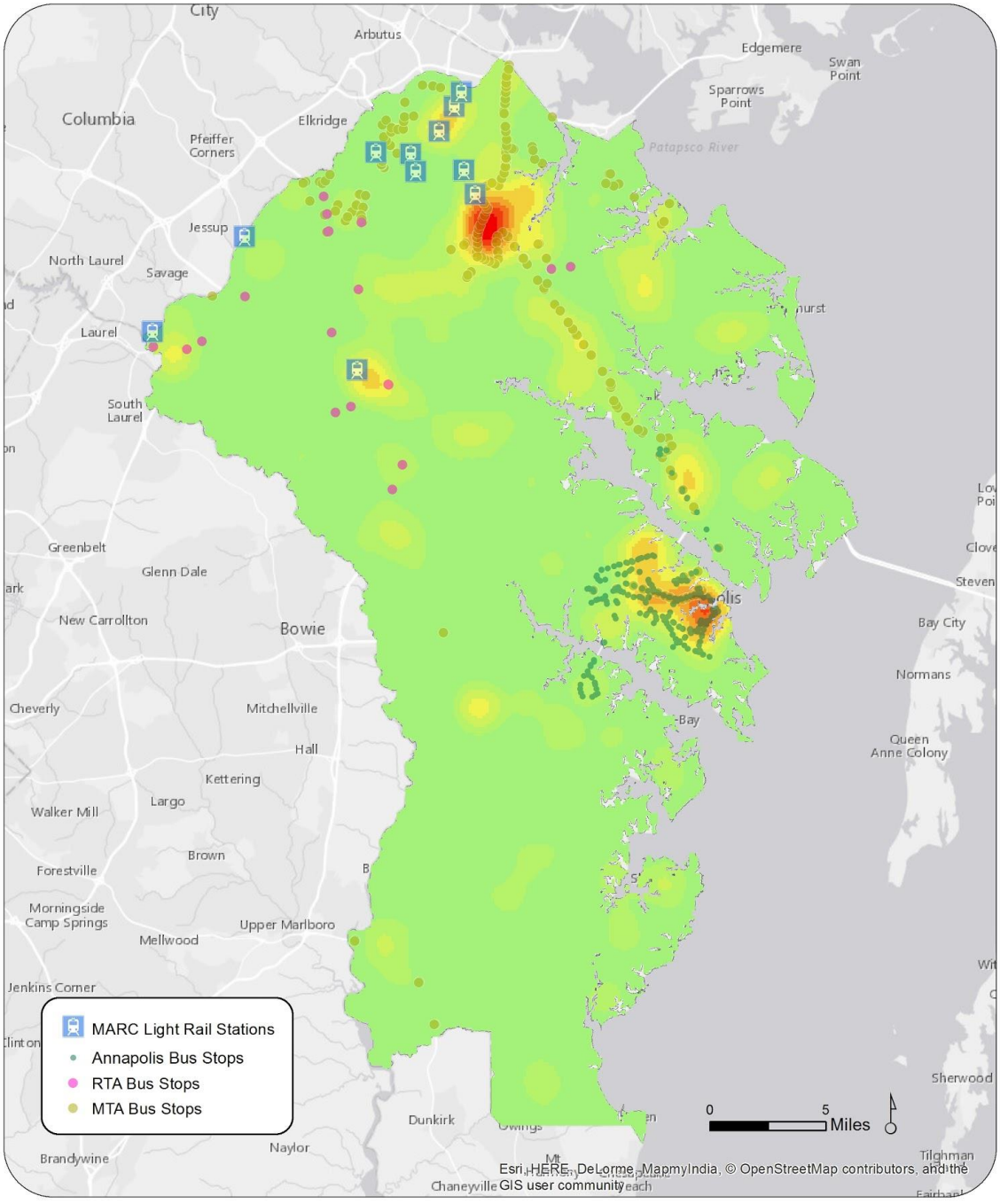
Source: Anne Arundel County

# Anne Arundel County, MD
# Heatmap - Churches

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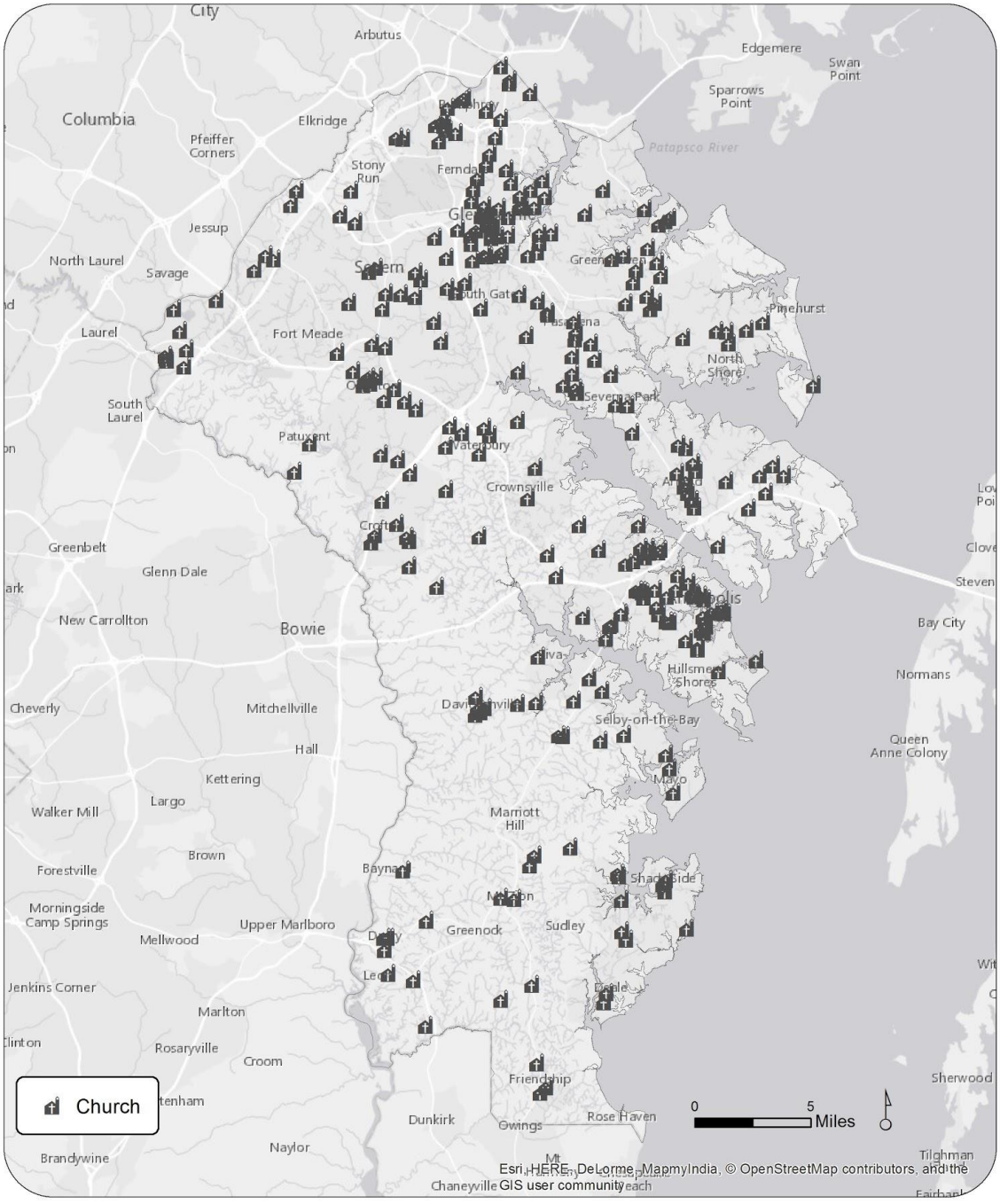
Source: Anne Arundel County

# Anne Arundel County, MD
# Churches

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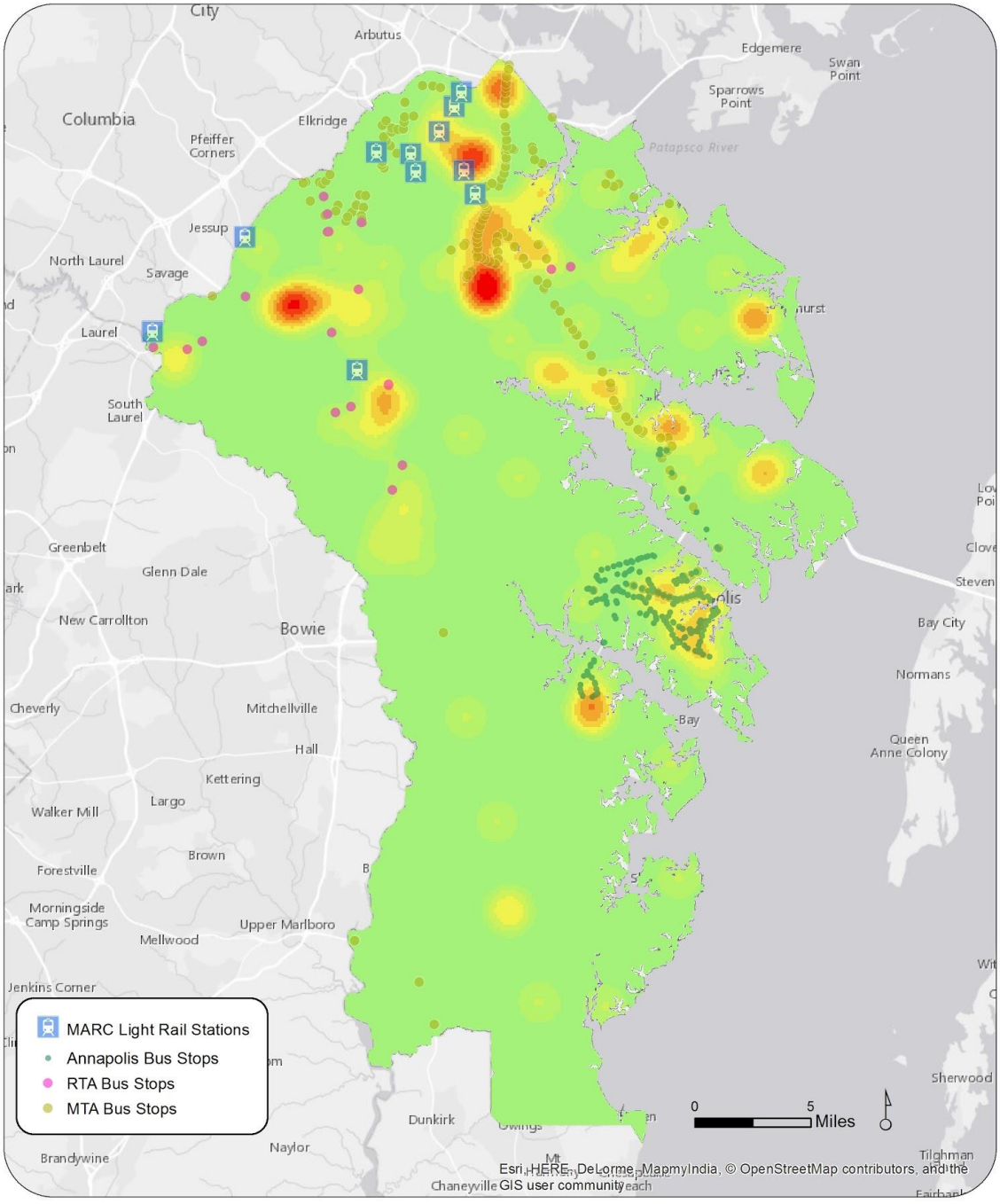
Source: Anne Arundel County

# Anne Arundel County, MD
# Heatmap - Schools

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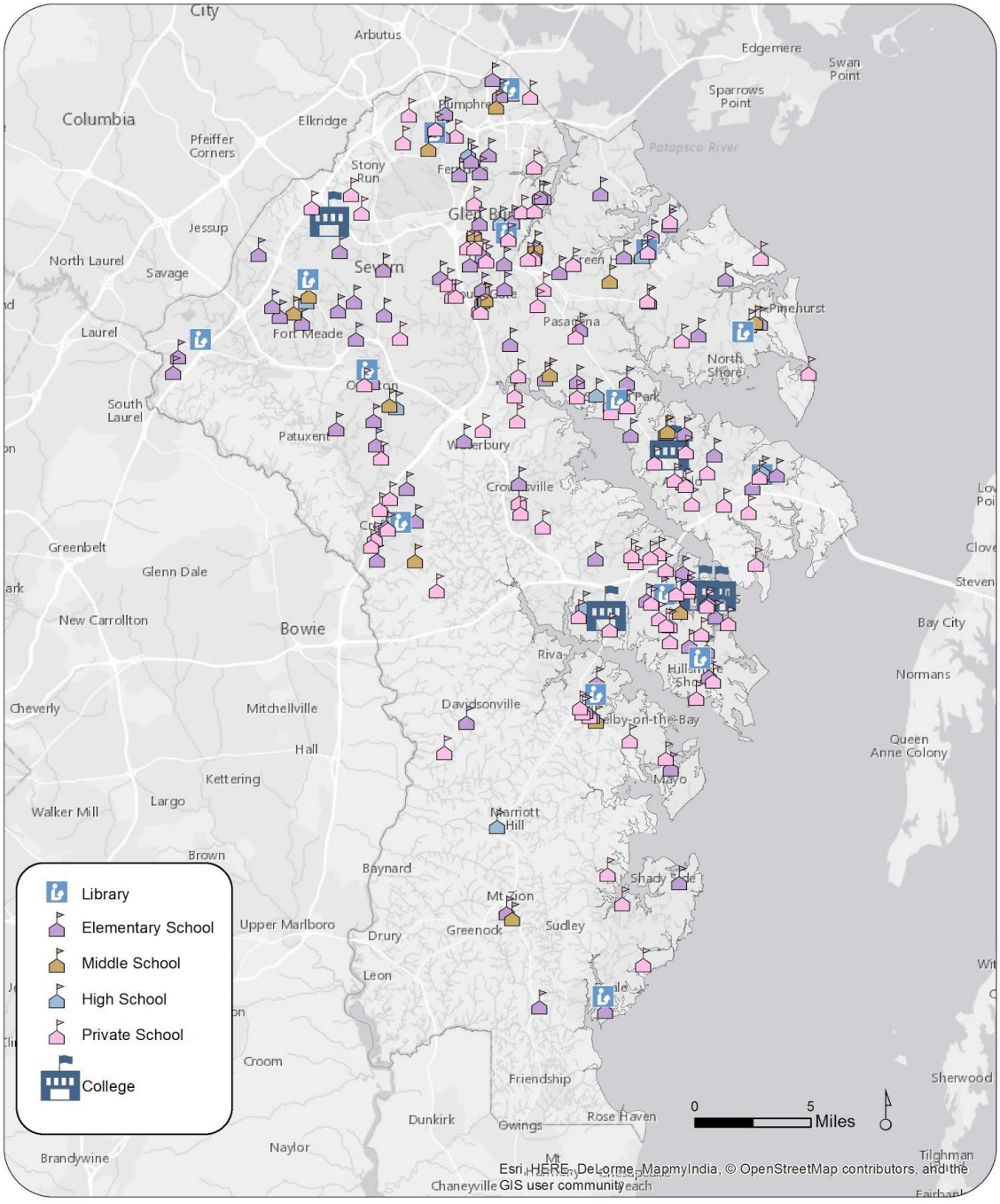
Source: Anne Arundel County

# Anne Arundel County, MD
# Educational Institutions

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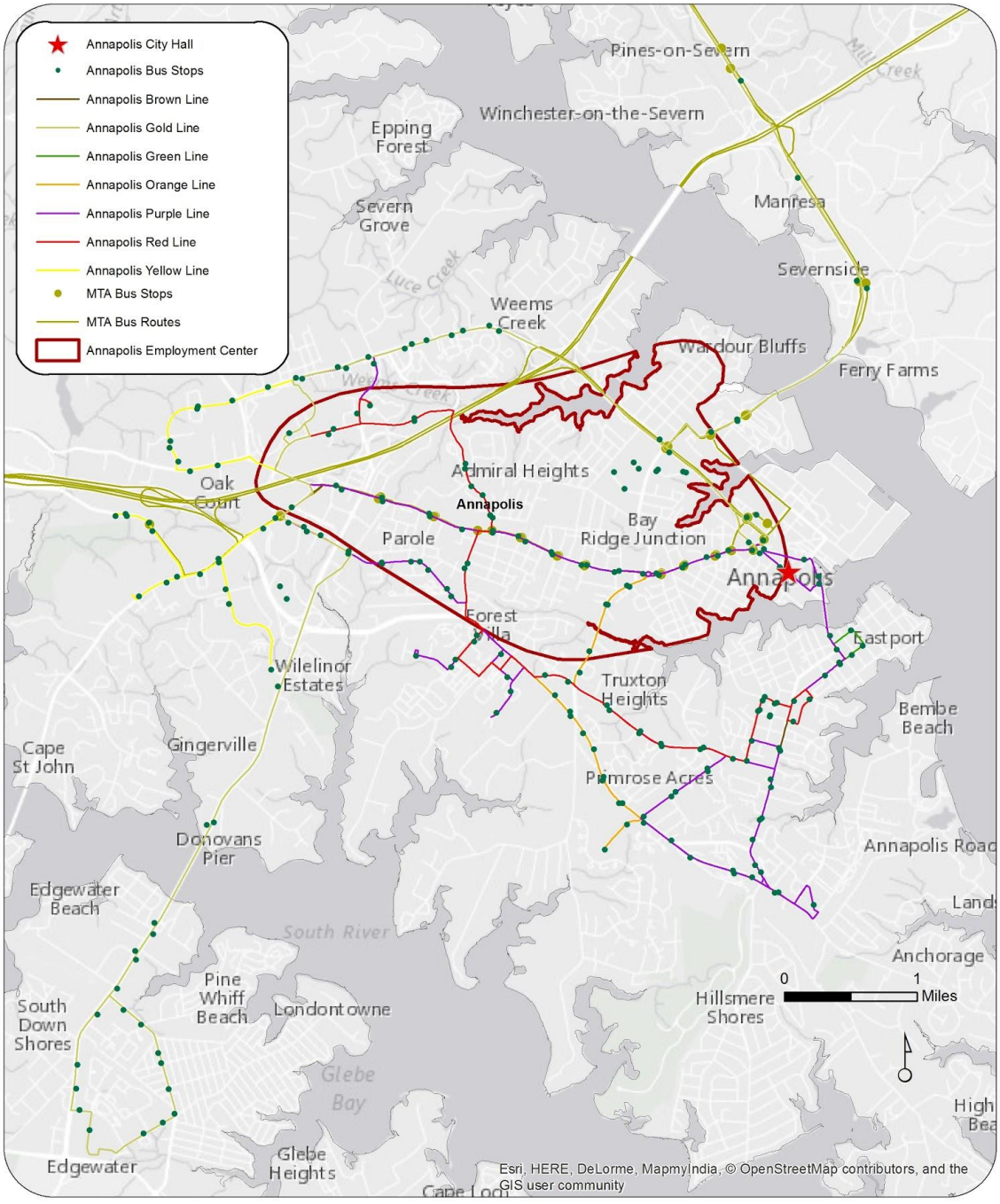
Source: Anne Arundel County

# Anne Arundel County, MD
# Employment Center - Annapolis

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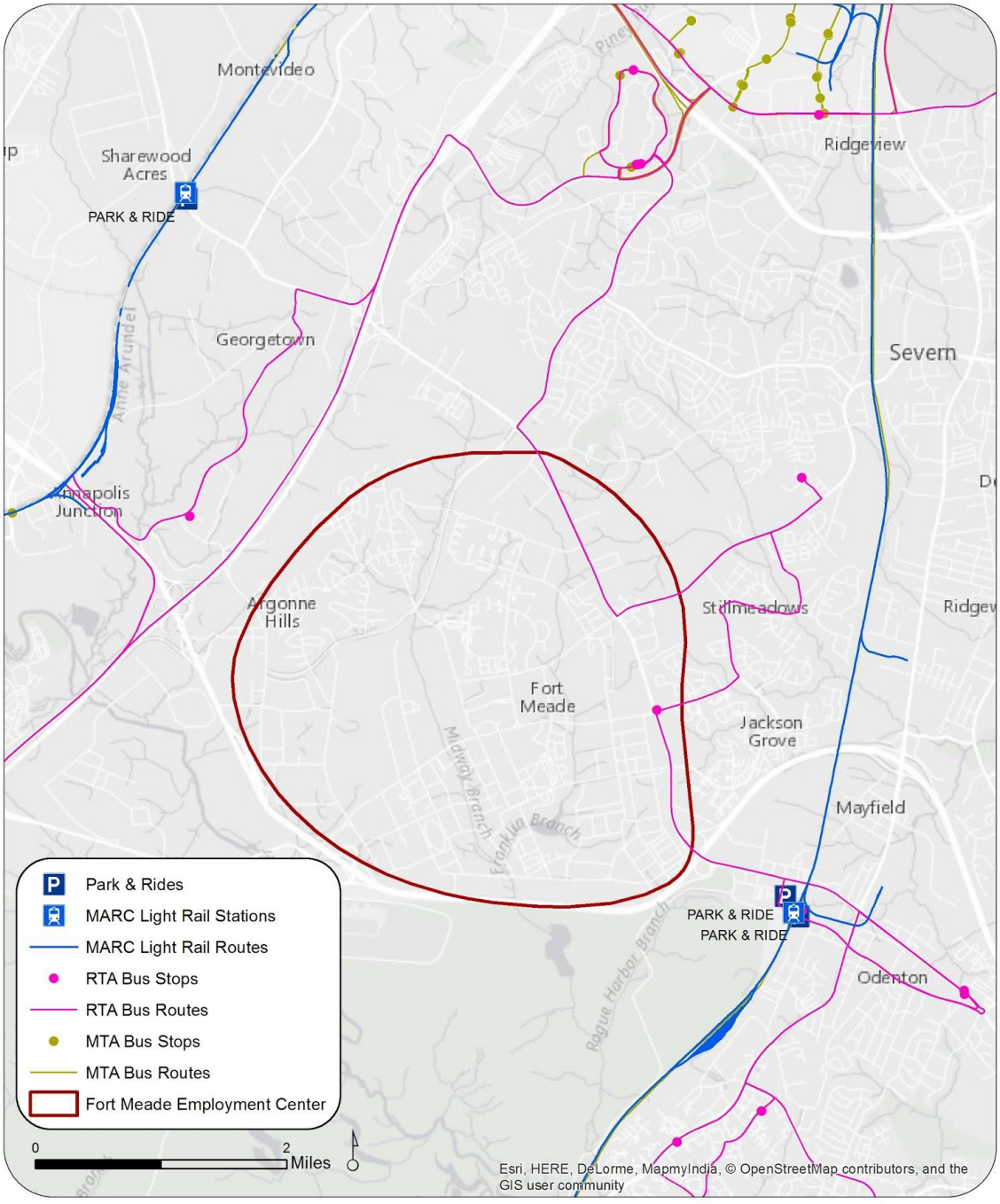
Source: Anne Arundel County

# Anne Arundel County, MD
# Employment Center - Fort Meade

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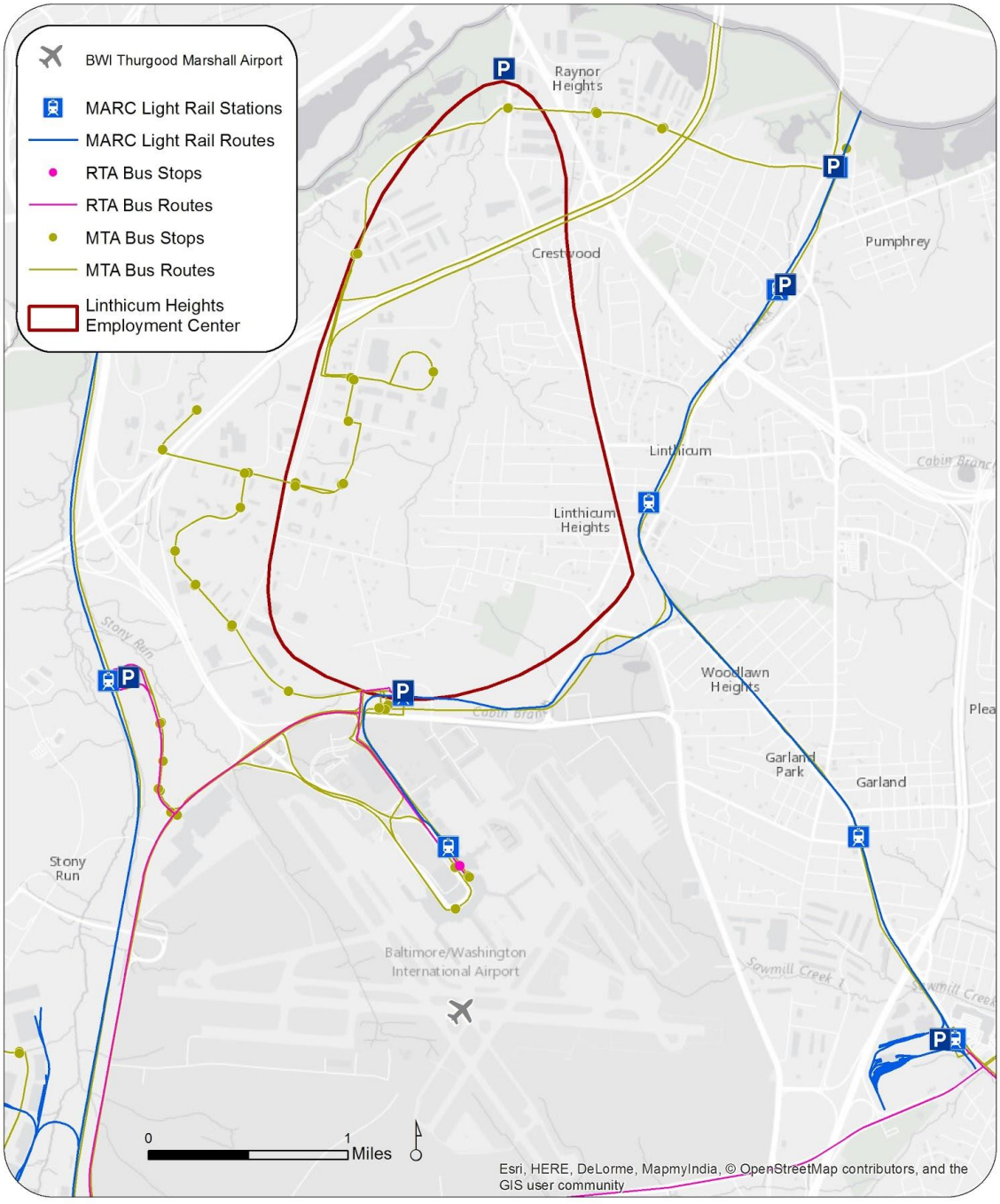
Source: Anne Arundel County

# Anne Arundel County, MD
# Employment Center - Linthicum Heights

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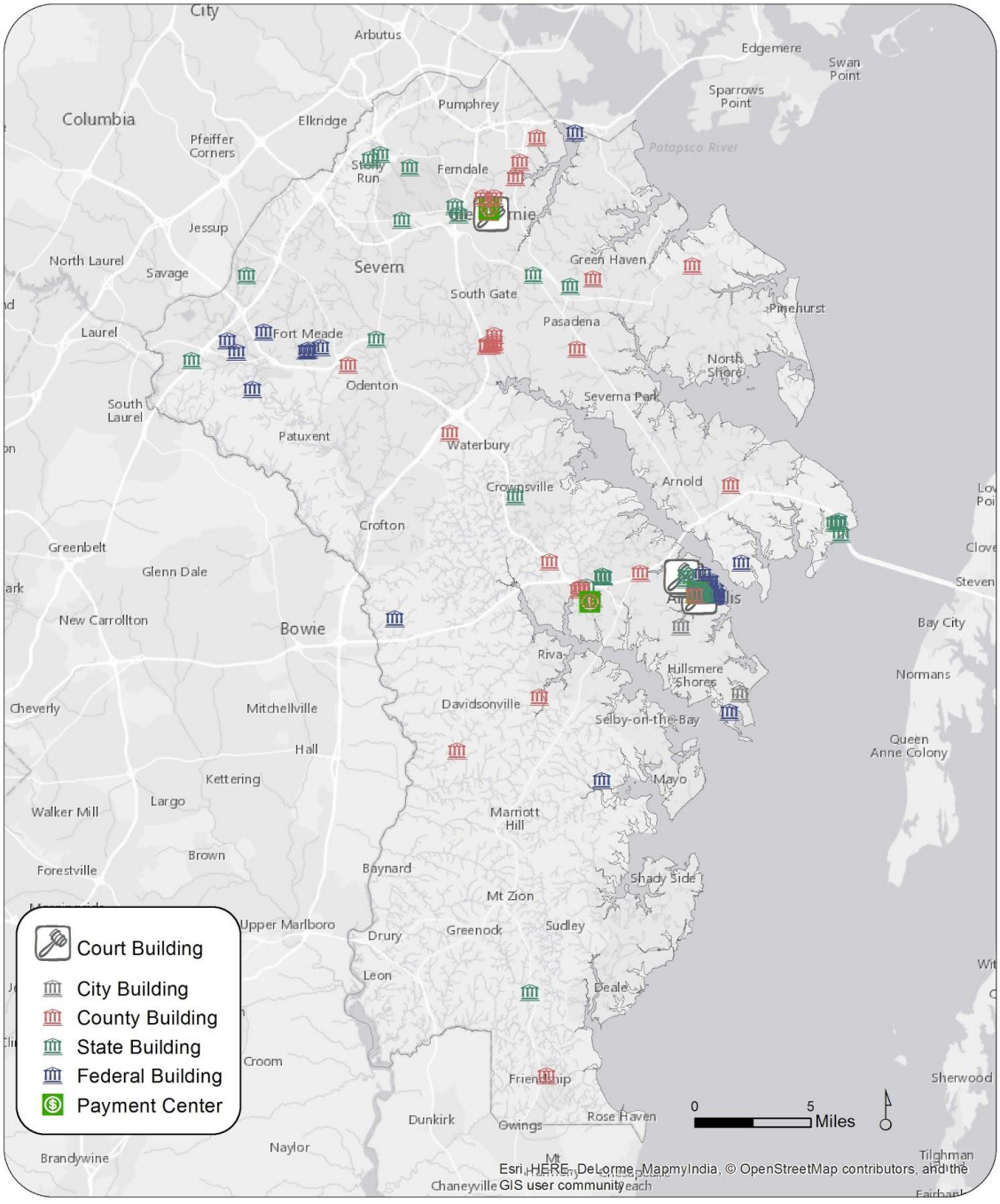
Source: Anne Arundel County

# Anne Arundel County, MD
# Government Buildings

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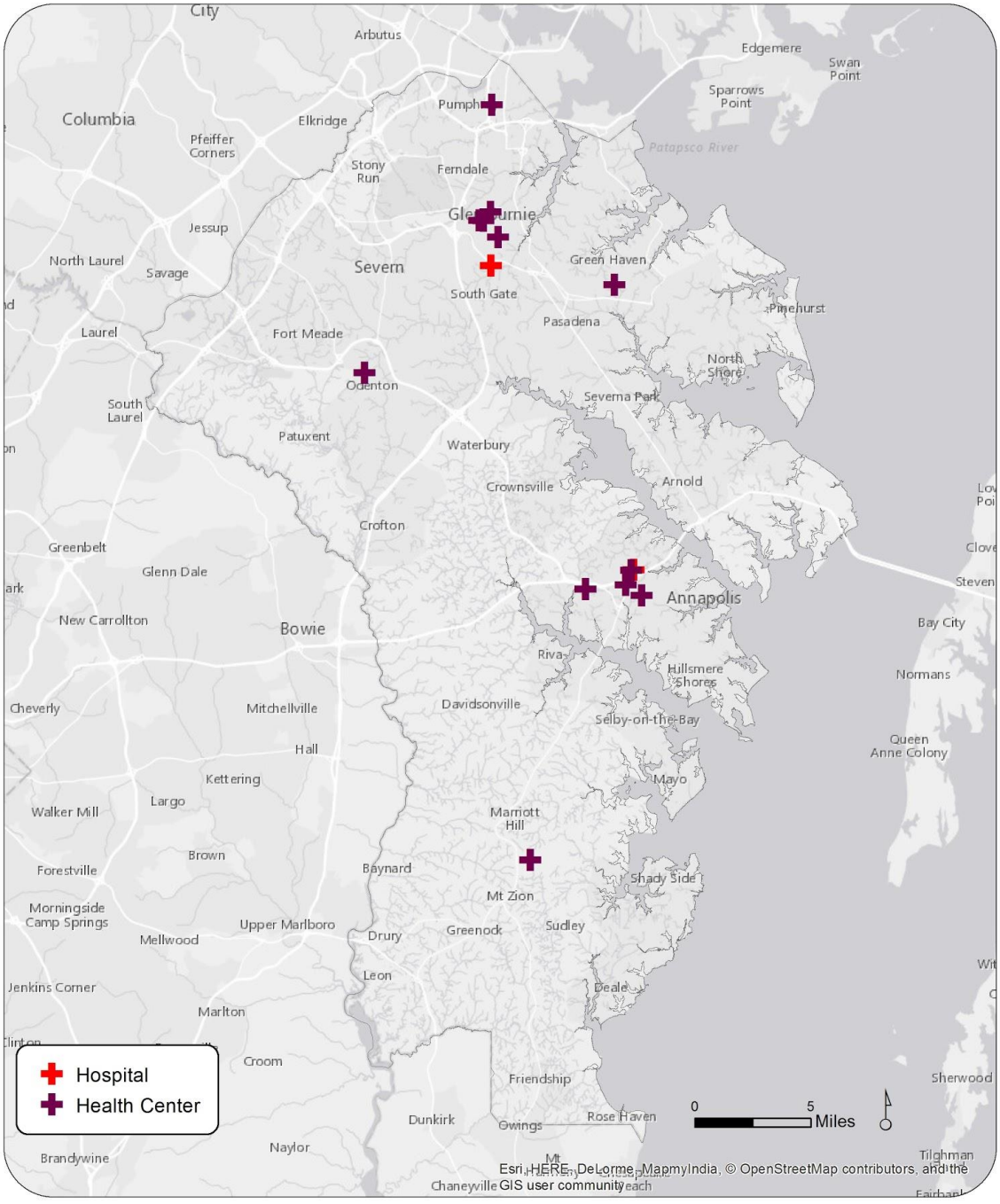
Source: Anne Arundel County

# Anne Arundel County, MD
# Hospitals and Health Centers

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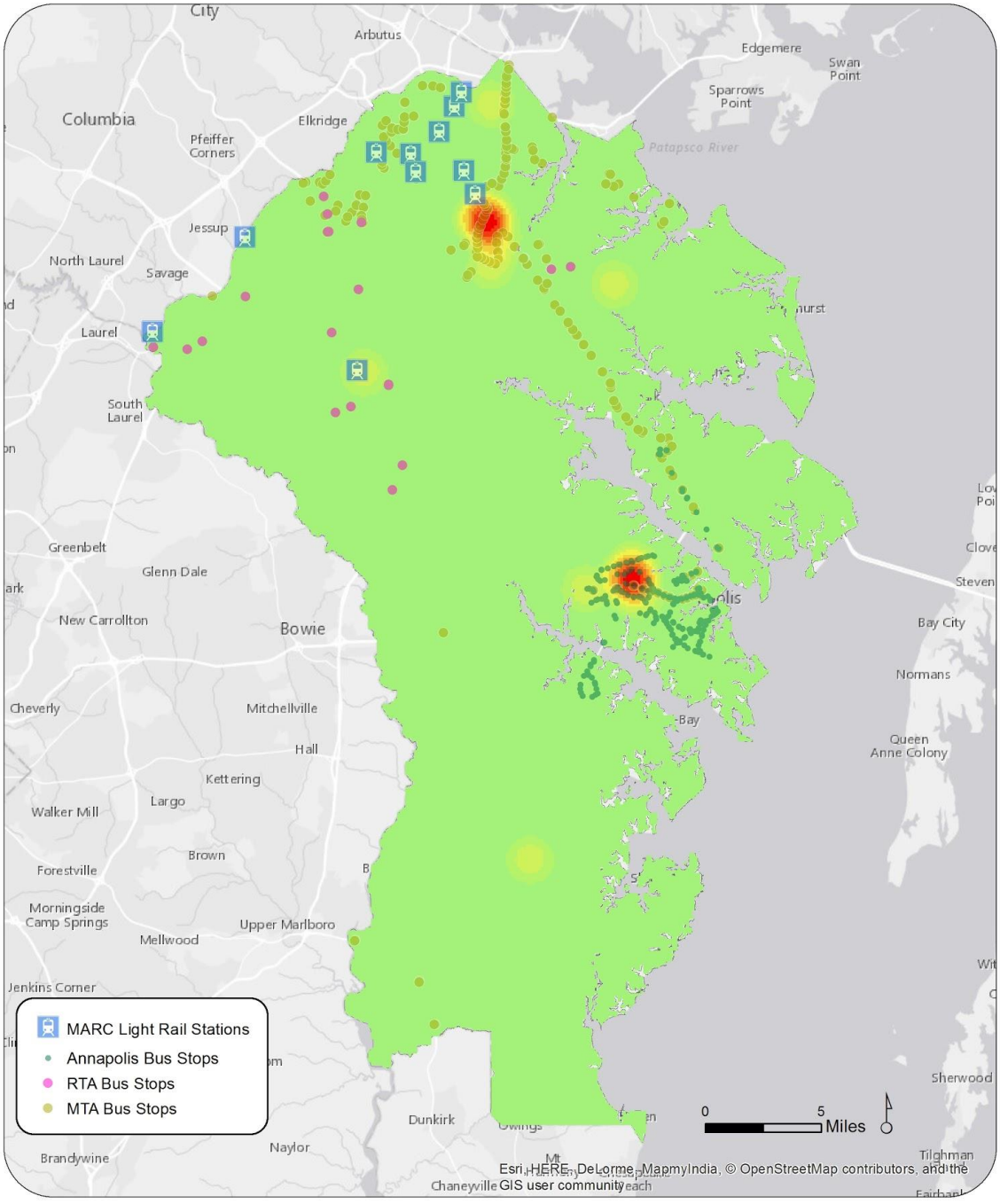
Source: Anne Arundel County

# Anne Arundel County, MD
# Heatmap - Hospitals and Health Centers

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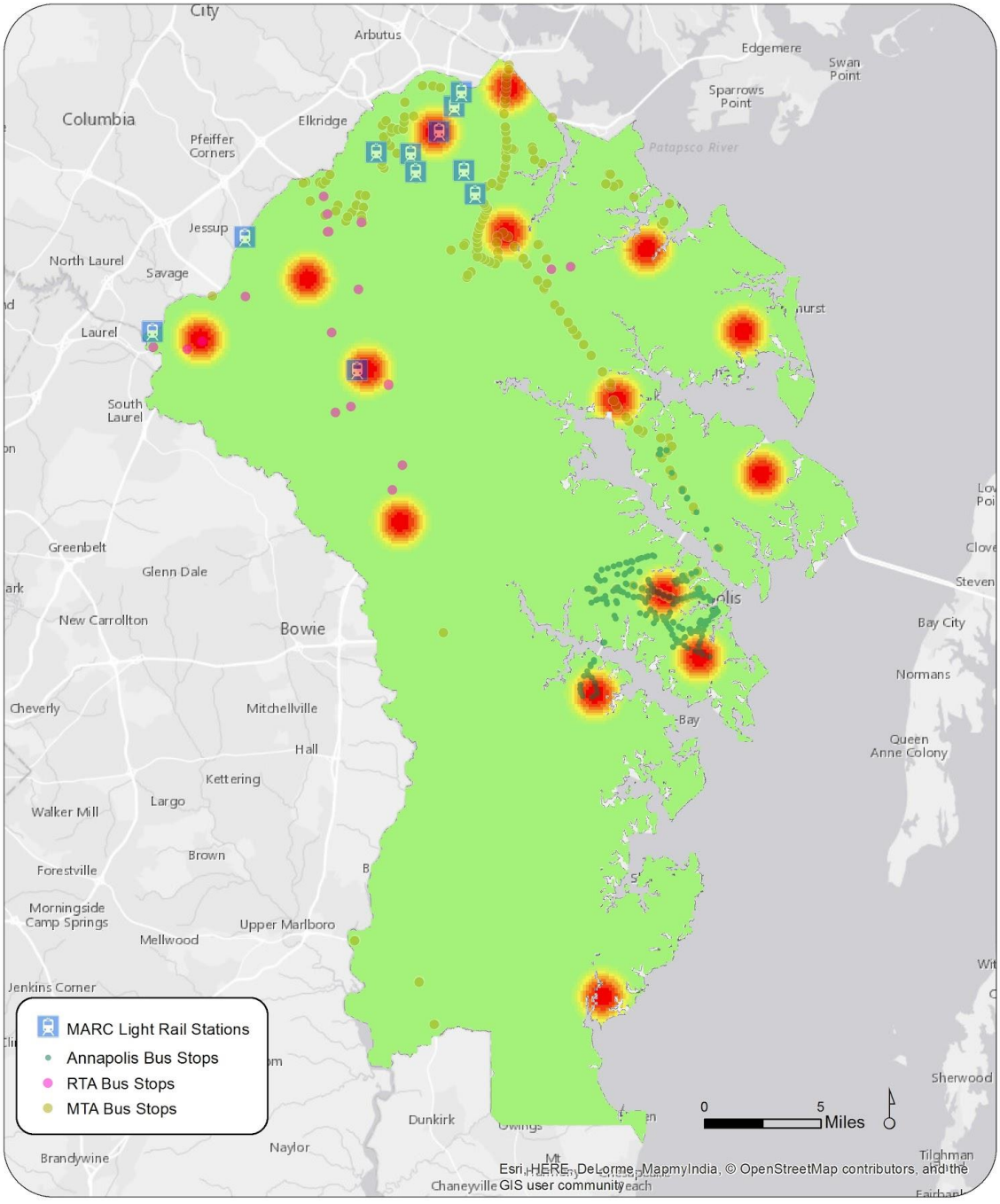
Source: Anne Arundel County

# Anne Arundel County, MD
# Heatmap - Libraries

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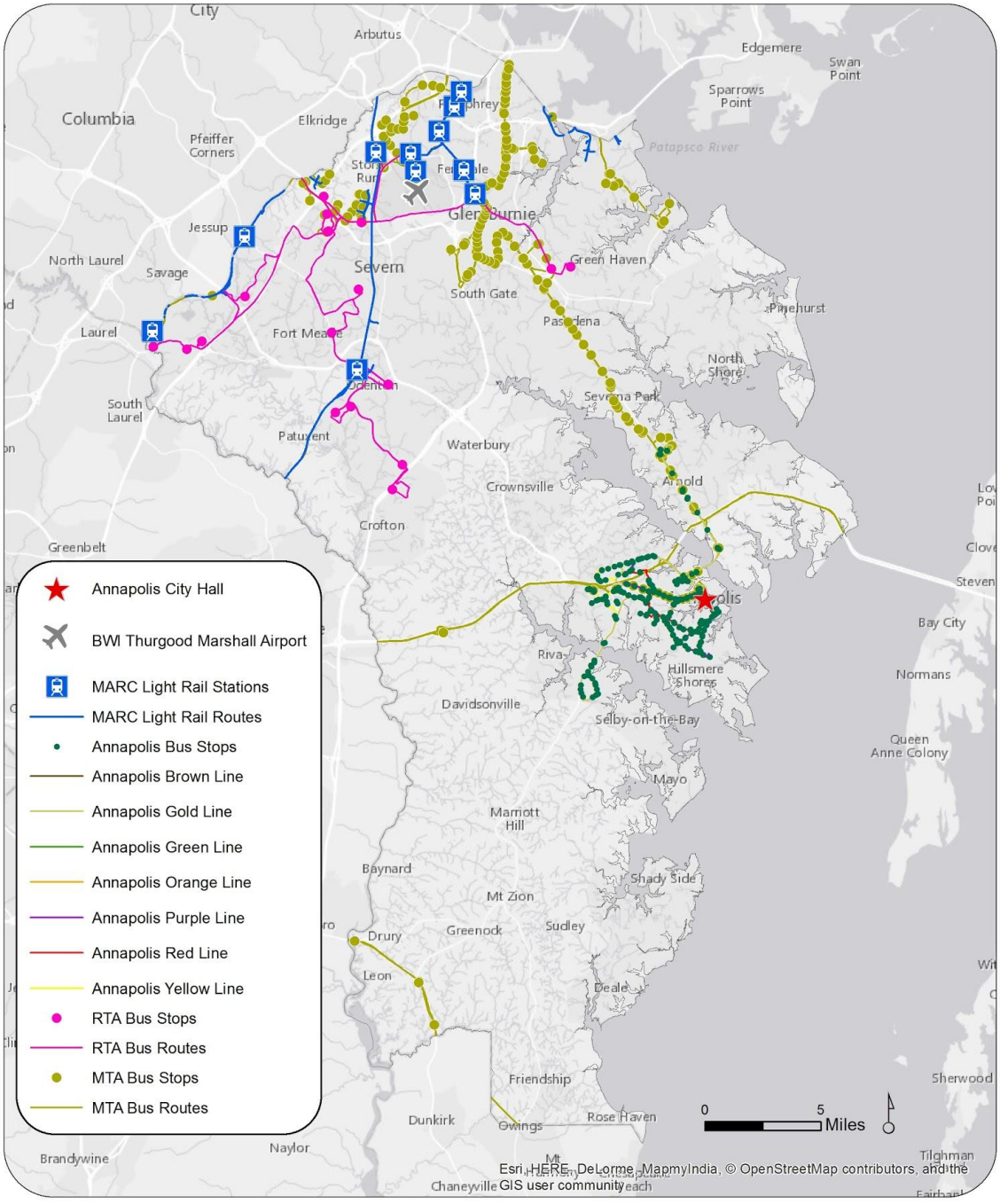
Source: Anne Arundel County

# Anne Arundel County, MD
# Transit Networks

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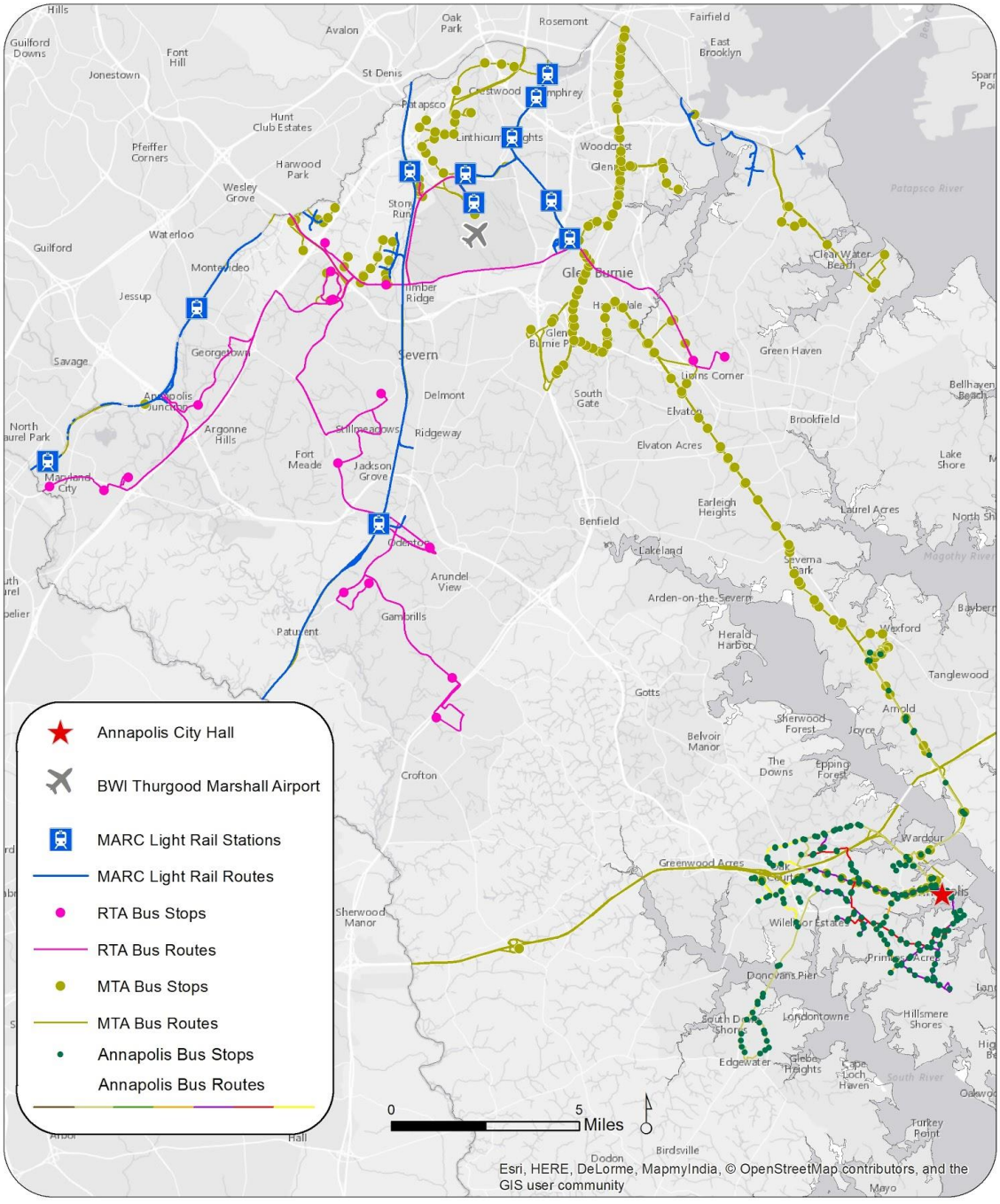
Source: Anne Arundel County

# North and Central Anne Arundel County, MD
# Transit Networks

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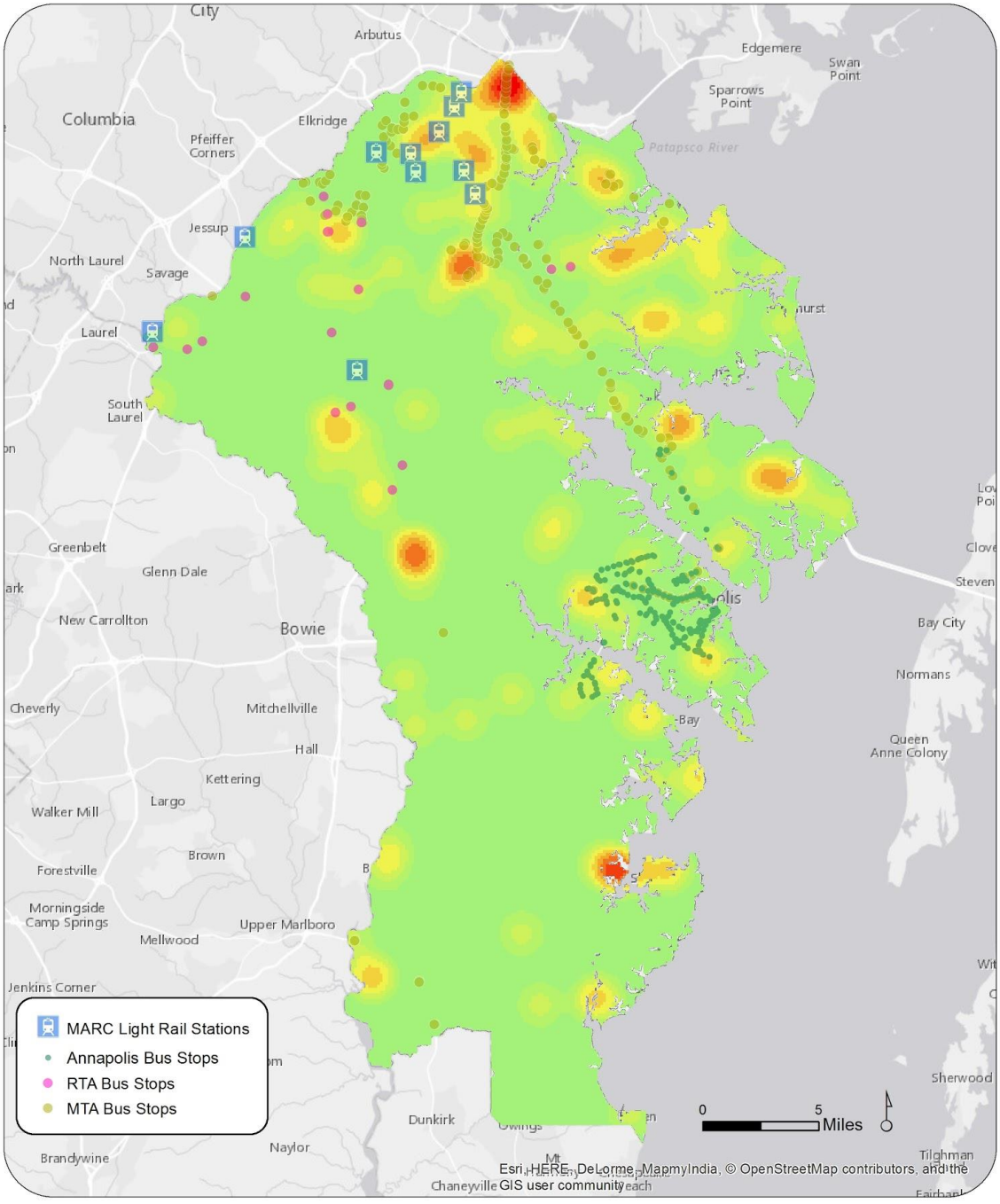
Source: Anne Arundel County

# Anne Arundel County, MD
# Heatmap - Parks

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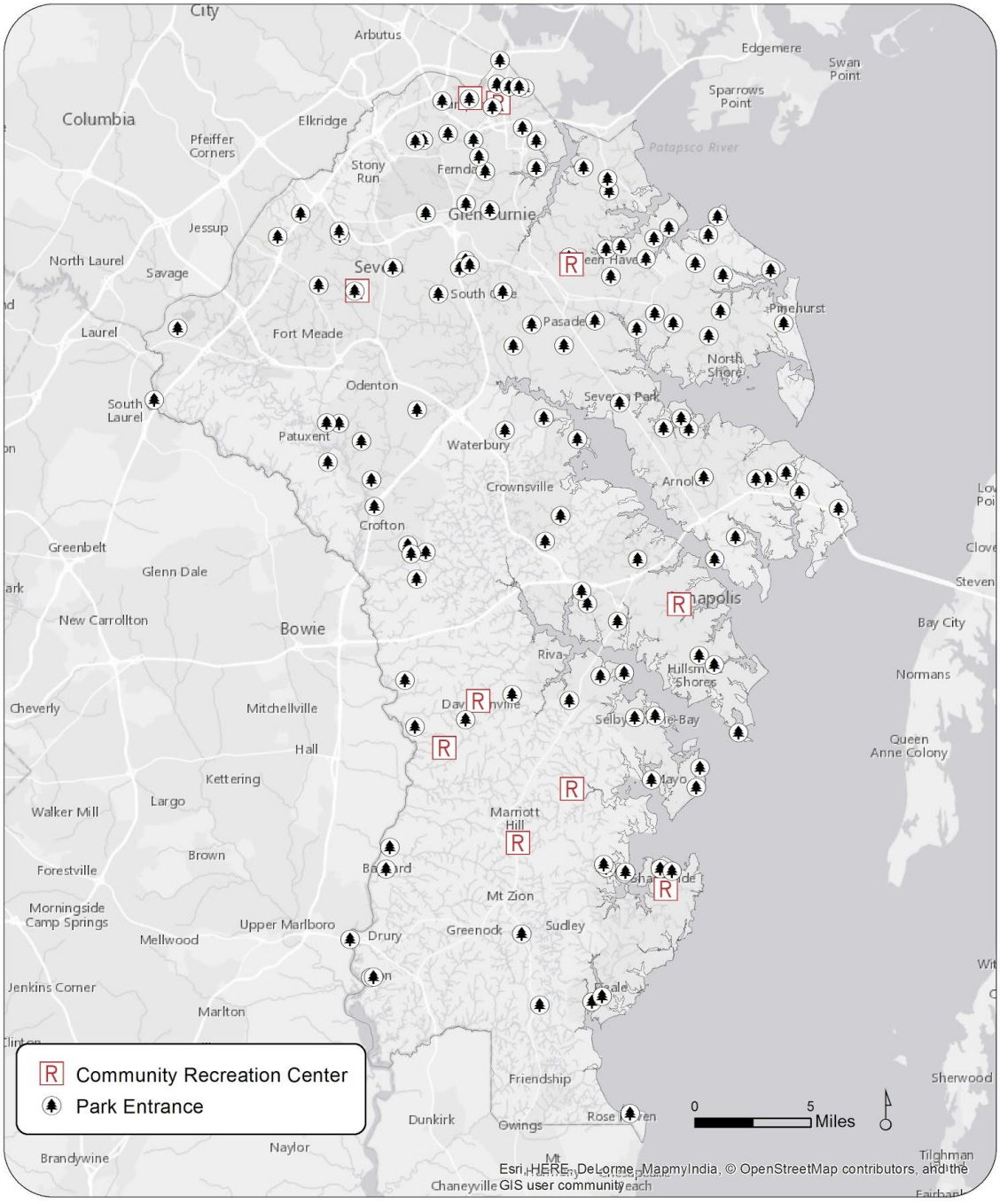
Source: Anne Arundel County

# Anne Arundel County, MD
# Parks and Recreation Centers

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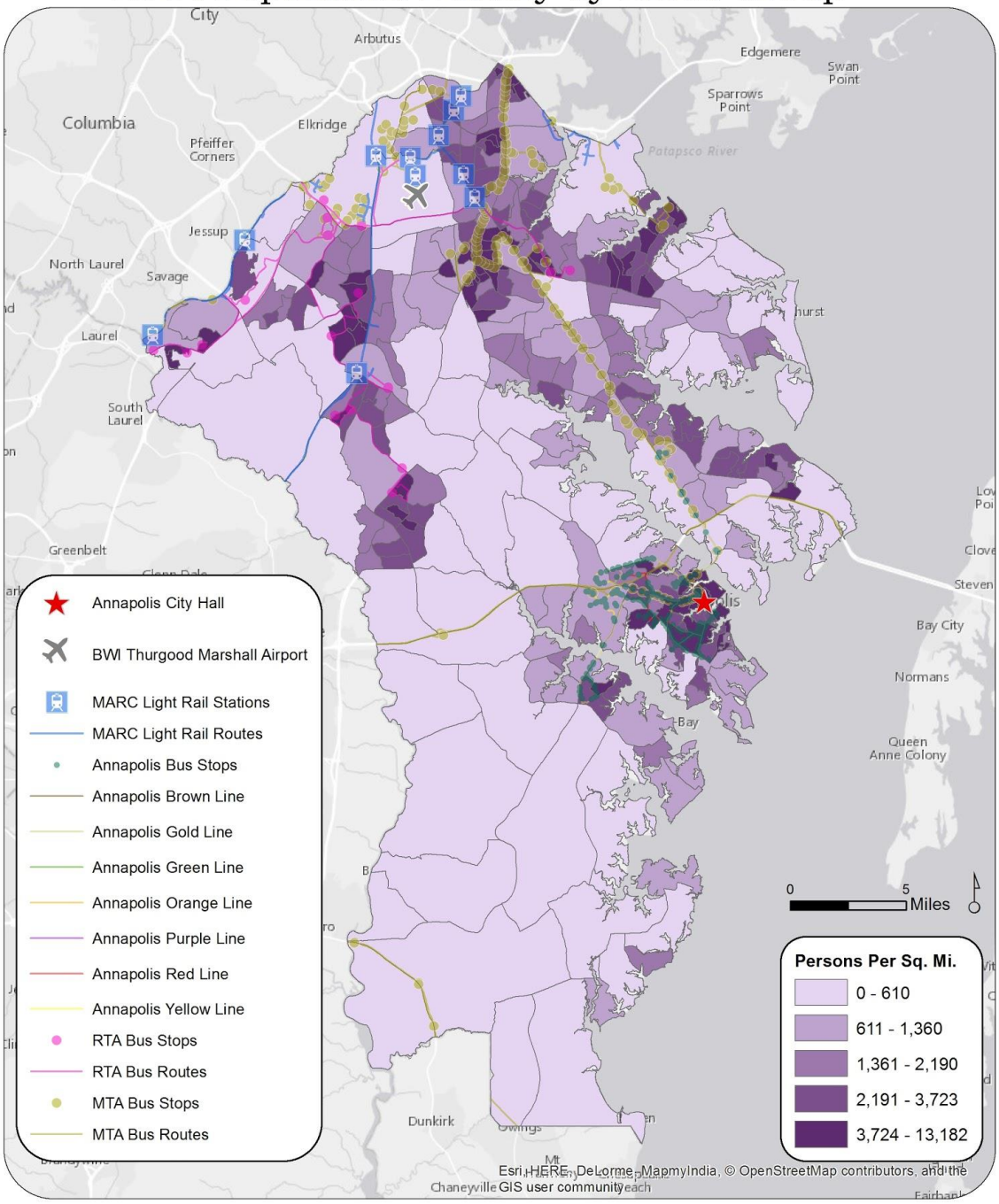
Source: Anne Arundel County

# Anne Arundel County, MD
# 2014 Population Density by Block Group

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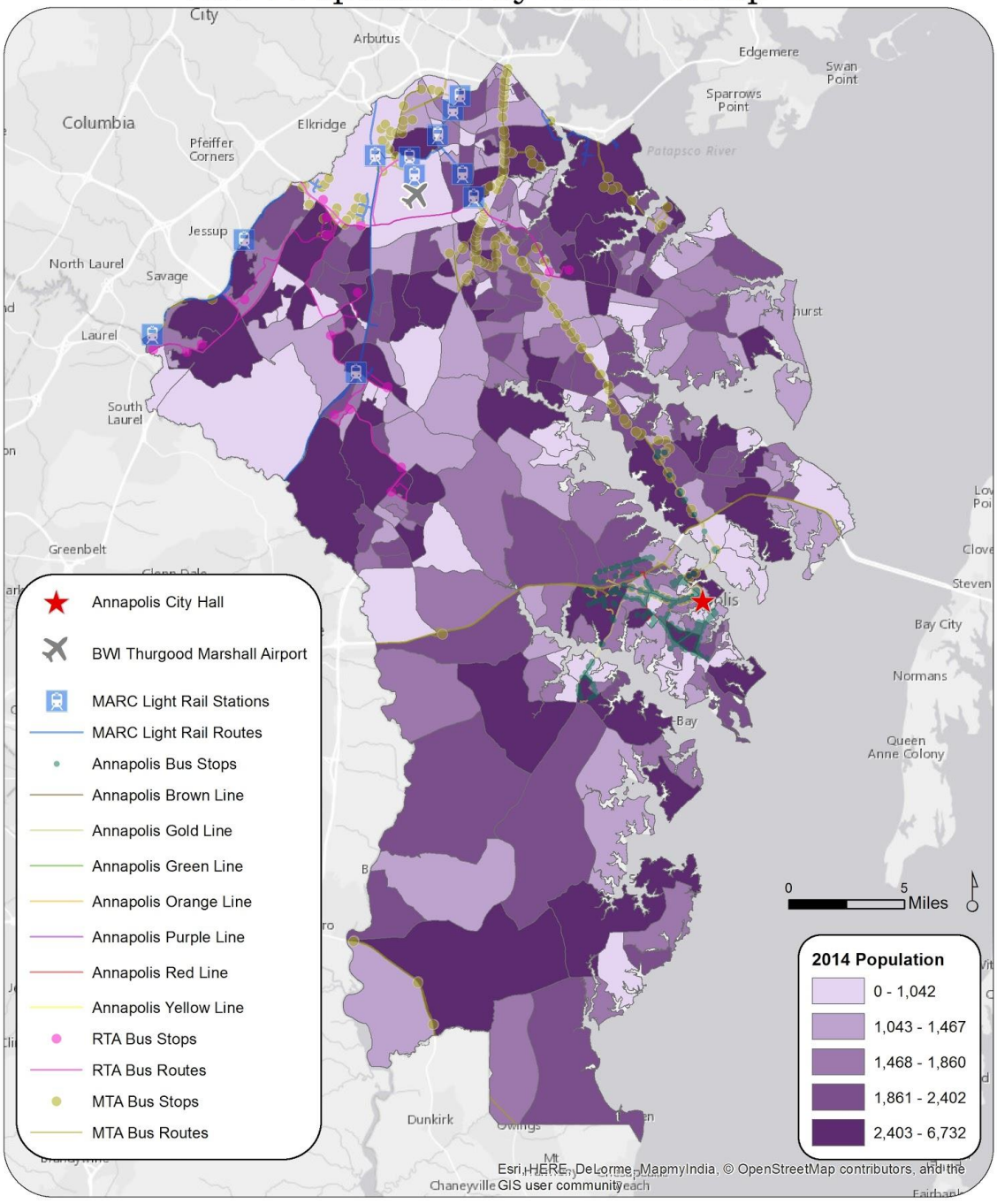
Sources: U.S. Census; Anne Arundel County

# Anne Arundel County, MD
# 2014 Population by Block Group

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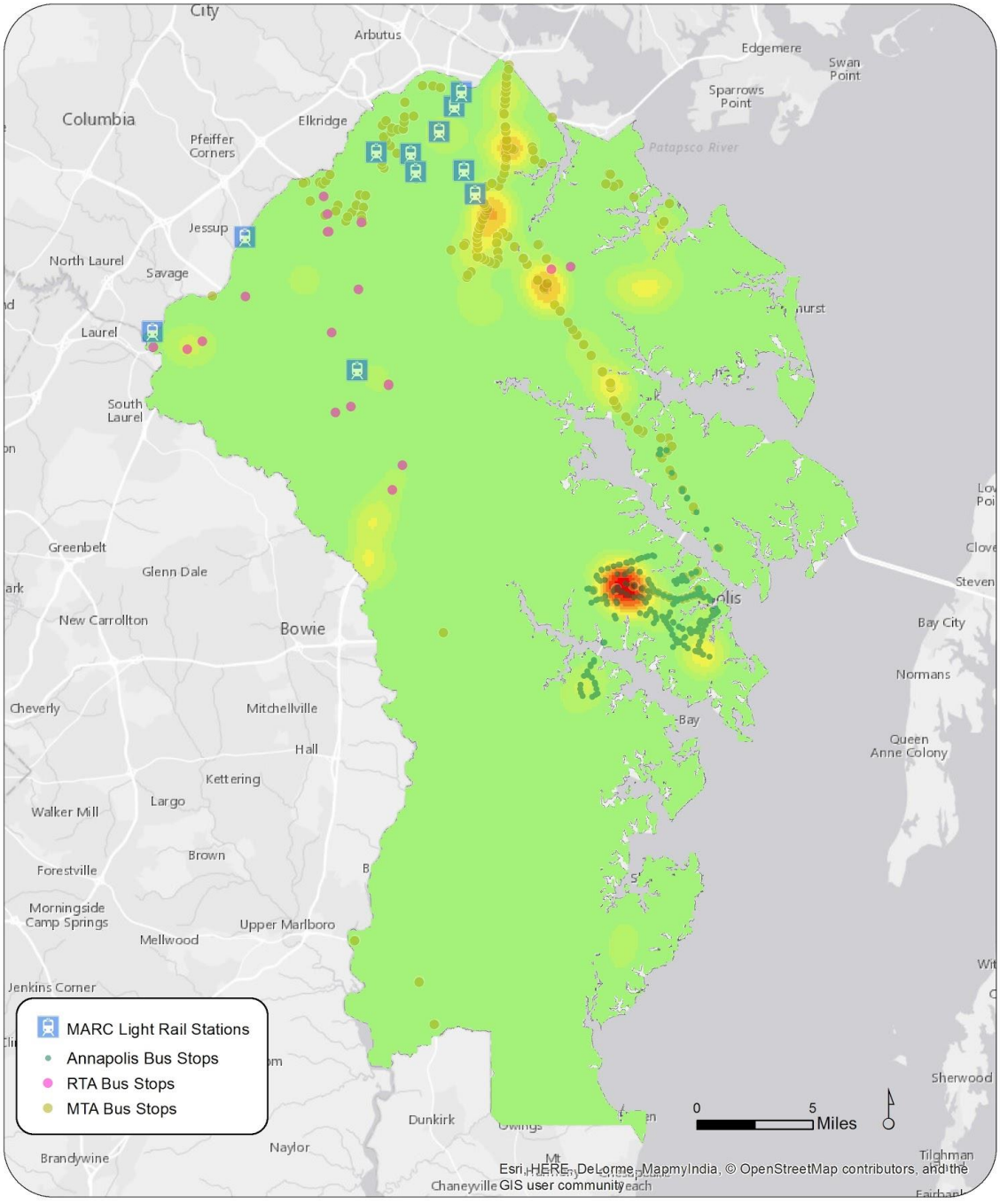
Sources: U.S. Census; Anne Arundel County

# Anne Arundel County, MD
# Heatmap - Shopping Centers

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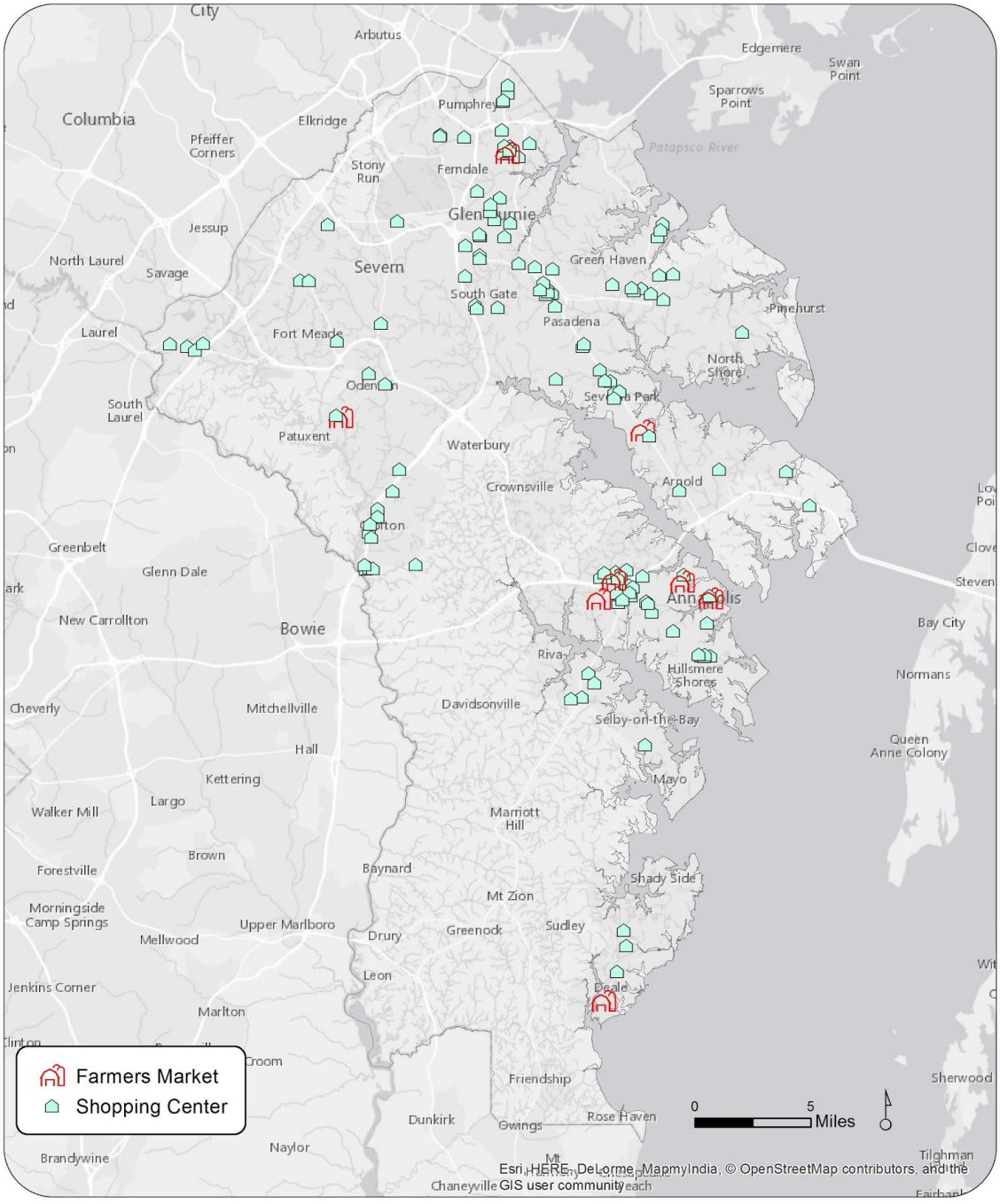
Source: Anne Arundel County

# Anne Arundel County, MD
# Shopping Centers and Farmers Markets

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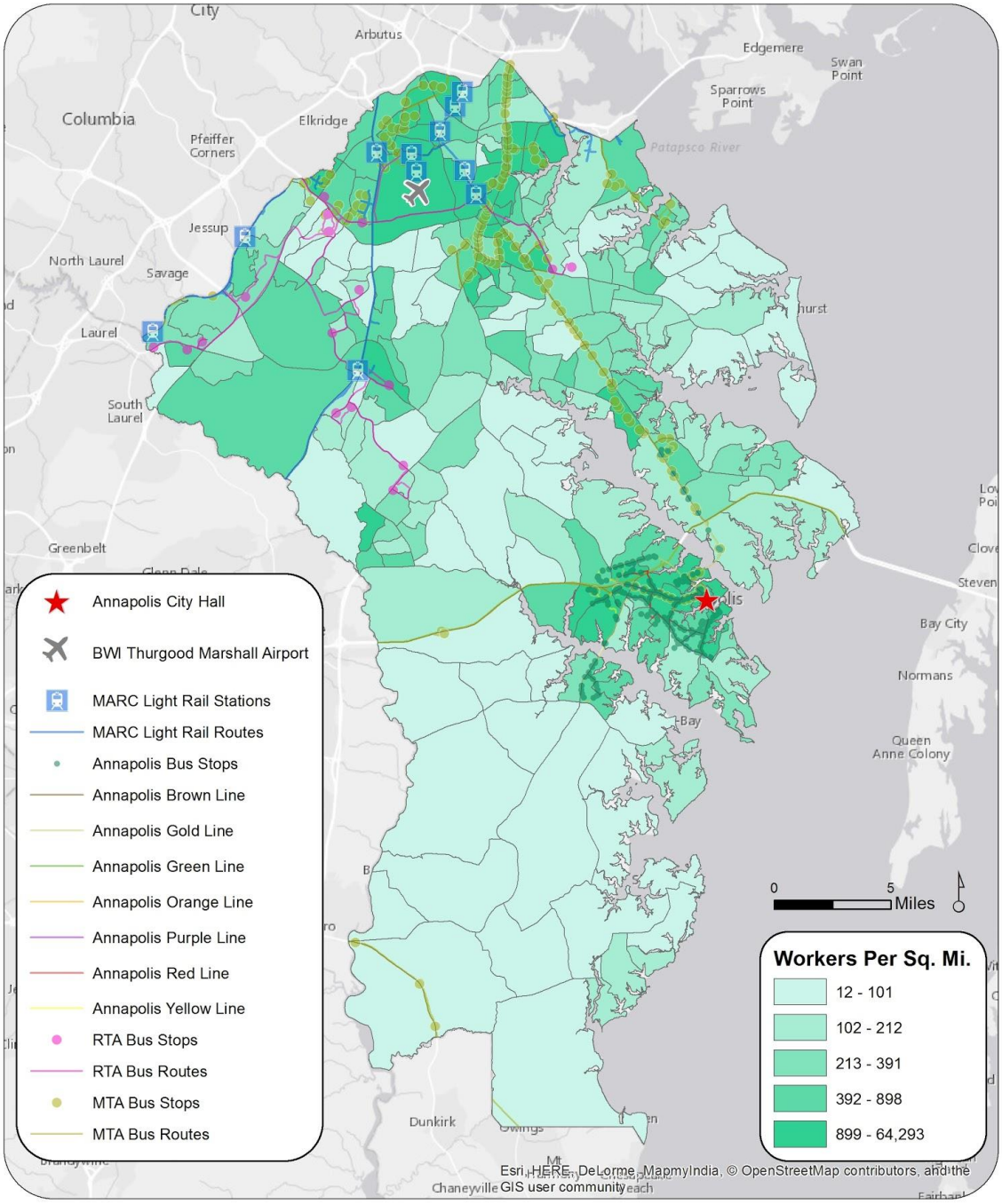
Source: Anne Arundel County

# Anne Arundel County, MD
# Worker Density by Census Tract (2000)

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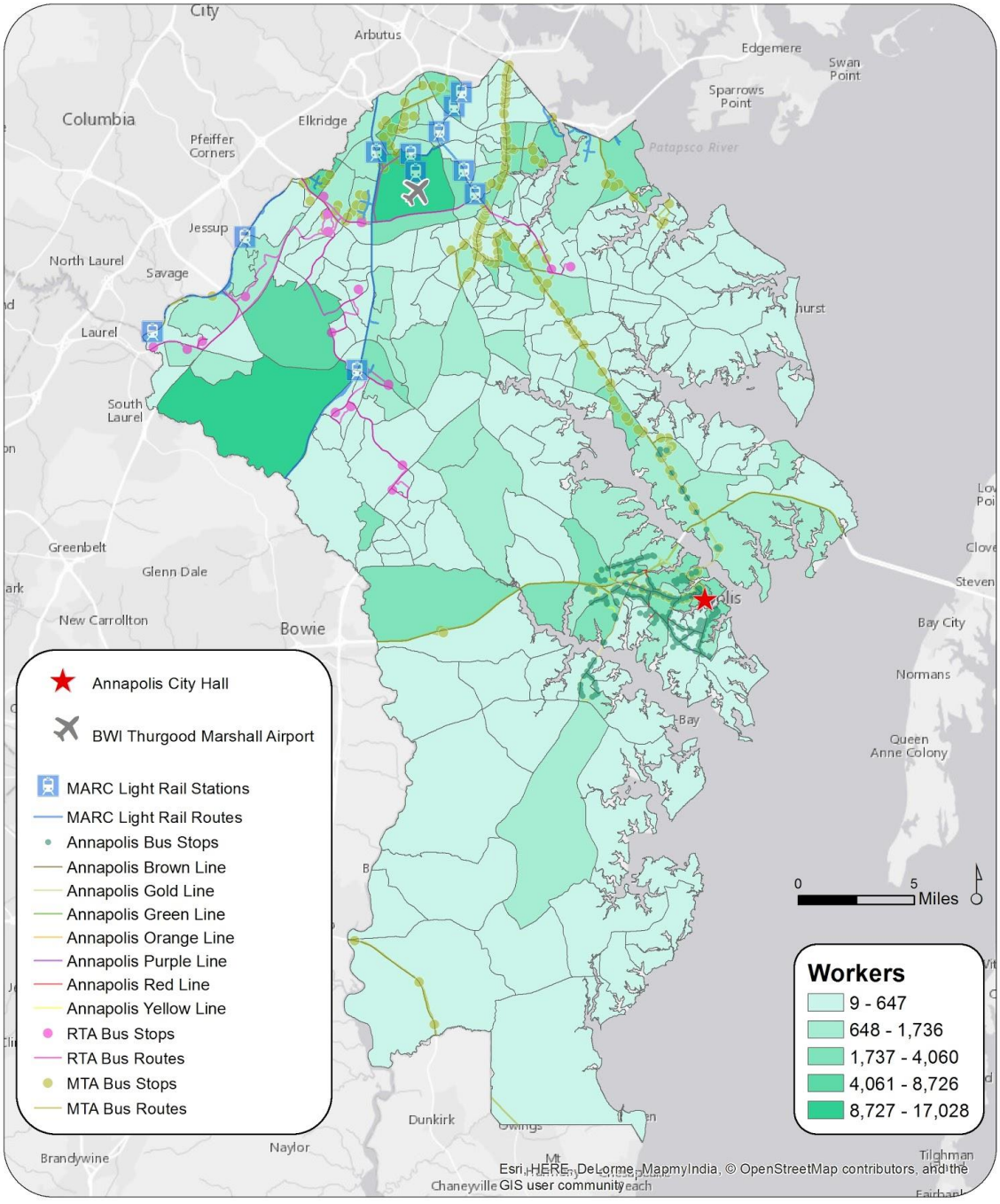
Sources: U.S. Census; Anne Arundel County

# Anne Arundel County, MD
# Workers by Census Tract (2000)

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Sources: U.S. Census; Anne Arundel County