



Alexandria Transit Choices Report

Final Draft

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1. Introduction and Summary

Introduction and Summary

What is the Alexandria Transit Vision?

The Alexandria Transit Vision Study is taking a fresh look at transit service in the City of Alexandria. Through this Vision Study, the City is taking an unconstrained look at how the bus network in the city can best serve existing needs, as well as the new residents, business, and visitors who will come to Alexandria in the next 10–20 years.

The City's DASH system and WMATA's Metrobus services within the city connect a variety of people and places, including places where people work, live, and shop. They also link to key transit connections such as Virginia Railway Express (VRE), Metrorail, and other bus operators such as Fairfax Connector and Arlington Transit (ART).

The bus network in Alexandria has been adjusted in small ways over time but has never been rethought in its entirety.

It may be based too much on history and not enough on the needs and values of Alexandria today, or the forecasted demands from future growth.

This study is about the bus network in the City of Alexandria. It will, and must, consider the context of travel patterns into, out of, and through Alexandria, because the city is part of the much larger regional economy and so many people need and want to travel into, out of, and through the city every day. Improved transit in Alexandria means easier access to more of the city from surrounding areas, and easier access to jobs and opportunities in surrounding areas for Alexandrians.

The Transit Vision Study will identify existing and future bus transit needs and community priorities in the City of Alexandria as a basis for designing a future bus network that improves mobility, access, and overall cost efficiency. This process is being led by the City of Alexandria and the local transit agency, DASH. This vision process will do the following:

- » Assess the existing transit network and the geometry of today's city;
- » Analyze existing travel patterns and consider changing trends and technologies in transportation;
- » Engage the public, stakeholders and elected officials in a conversation about the goals of transit in Alexandria;
- » Develop recommendations for changing the transit network.

What is a Choices Report?

This Choices Report is the first step in the Alexandria Transit Vision. The Choices Report helps guide the Transit Vision, by laying out relevant facts about transit and development in Alexandria. This report describes the existing land use and demographics and the existing transit network and its performance. The facts about where people are and who they are helps clarify the geometric facts that define the opportunities and constraints for what is possible with transit service in the city.

Ultimately, this report is called a Choices Report because it draws the reader's attention to major value choices (described in Chapter 6) that will need to be made as part of this transit vision. These value choices, such as whether Alexandrians are willing to walk farther to wait less or would prefer to walk shorter distances in exchange for longer waits, are critical decisions that determine the kind of transit network that can be designed for the city. These value choices cannot be made by technical staff, as they are choices about what the city values as a whole. Thus, this report is designed to educate people who live, work, shop, and play in Alexandria about these value choices and their trade-offs, so each can make an informed choice about how transit should serve the city.

Figure 1: A DASH bus at King Street Metrorail Station connects people within Alexandria to the greater Washington region.



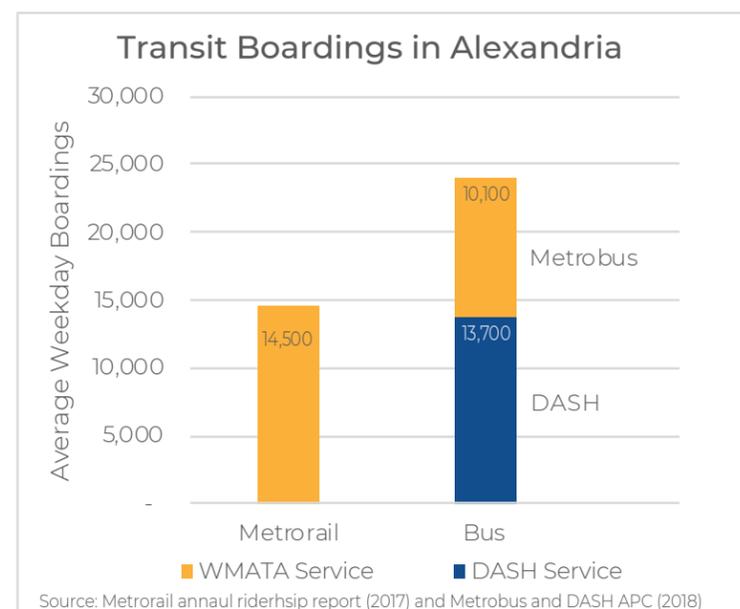
Why focus on buses?

Metrorail service tends to get the most attention and discussion when it comes to talking transit in the greater Washington region. In Alexandria, Metrorail is obviously crucial to the life of the city—in 2016, about 14,500 boardings per weekday occurred at the four Metrorail stations in Alexandria and the City and WMATA are planning a fifth station at Potomac Yard. But with only four stations, Metrorail provides access to only a small part of the city.

Buses are crucial to providing access to all of Alexandria. They also carry more total riders in Alexandria than Metrorail. DASH, the city's transit agency, sees over 13,000 boardings per weekday and Metrobus routes that come through Alexandria (including the Metroway BRT) see over 10,000 boardings on the average weekday. Figure 2 compares bus and Metrorail boardings in Alexandria on an average weekday.

A study of the bus network in Alexandria is a study of the whole city, and most of its current transit ridership, since buses cover nearly the whole city, and carry most of the transit riders. It is also a study of what can be done soon, because buses are the only high-capacity public transit offering whose services can be revised without large infrastructure spending.

Figure 2: On an average weekday, buses get more boardings than Metrorail trains in Alexandria.



Limitations in Space

Public transit is essential to a growing city like Alexandria, particularly within the larger Washington region, because there is simply not room for everyone's car. While not all of Alexandria is dense, large parts of it are, and like all places with high density, Alexandria presents features that make transit essential, and require that it be highly efficient:

» **Severe road space limitations.** Across many parts of Alexandria, the road-width is fixed and will never be wider. Efforts at widening roads in built-up areas are extremely costly, frequently destructive and counterproductive—research shows that widening roads does not reduce congestion due to induced demand. Curb space is also limited and cannot be readily expanded. Lastly, widening for the purposes of accommodating cars would generally be contrary to the City's own Complete Streets Policy.

» **Intensification of land use.** In response to growing demands for housing and commercial space, both central and outlying areas are growing more dense. More and more people are living within the same limited area.

These two factors combined mean that more and more people are trying to use a fixed amount of road space. If they are all in cars, they simply do not fit in the space available. The result is congestion, which cuts people off from opportunity and strangles economic growth. Figure 3 shows how much space the same number of people take in cars, bikes, and buses. **In a dense city, relying on bikes and buses as major modes of transportation is the only way to have room for everyone.**

Even autonomous cars will not change this basic geometric challenge, as they take up almost the same amount of space as today's cars and even carrying three to four people per car, they cannot be anywhere near as space efficient as buses or bicycles.

The only alternative to congestion is for a larger share of the population to rely on public transit and other modes that carry many people in few vehicles, or that take far less space per person than cars (i.e. bicycles). This requires services that most efficiently respond to the city's changing needs, as well as corridor improvements to give buses a level of priority over cars that reflect the vastly larger numbers of people on each bus.

A study of the bus network in Alexandria is study of what can be done soon, since buses are the only high-capacity public transit that can be revised quickly and with minimal infrastructure investment.



Figure 3: The road space required to move the same number of people using public transit, bicycles, and cars.

Photo copyright We Ride Australia

What are the recent trends?

Overall DASH system ridership since 2006 is shown in Figure 4. Ridership has generally increased over the last decade, but has declined slightly since 2013. Total ridership is not the only factor of concern. Ridership can go up and down for many reason. The city has been growing and it has been investing in more transit service with more total service hours.

Two key measures, investment and relevance, are shown in Figure 5. Investment is the quantity of transit service provided per person, measured as bus service hours per person. Alexandria has been adding service over most of the time from 2006 to 2016, with some cuts in service from 2009 to 2011.

Relevance, which is the number of boardings per person, tended to track with investment from 2006 to 2013, but has diverged in a negative direction since 2013. Ridership has not kept pace with investment since then. The flattening and declining of ridership, though, is a national and regional phenomenon that is not exclusive to DASH, as we discuss on page 53.

In summary, three major factors beyond the control of the City are likely affecting ridership:

- » Service reliability problems and service cuts at Metrorail have hurt the usefulness of DASH service, since many people use DASH to reach Metrorail.
- » Gas prices began to decline significantly beginning in 2014 and research shows that it has significantly reduced transit ridership in cities across the country.¹
- » Recent research shows that ride sourcing companies (Uber, Lyft, etc.) are drawing some transit riders away. Specifically, a recent UC Davis study showed that when people start using ride sourcing, their use of transit declined by 6%.²

The decline in gas prices and corresponding rise in auto use also further affects bus ridership by increasing congestion, which slows buses, and thereby increases the cost of bus service. Other factors may also be causing declines in ridership, including increases in telecommuting, the overall aging of the population (and related decline in working age population) but the evidence for these factors is less certain.

¹ Alam, B, Nixon, H, Zhang, Q. "Investigating the Determining Factors for Transit Travel Demand by Bus Mode in US Metropolitan Statistical Areas," Mineta Transportation Institute. May 2015.

² Clewlow, R, Mishra, G. "Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States," Institute of Transportation Studies, University of California, Davis. October 2017.

Some of these factors are likely to be temporary. WMATA is making strides to improve the reliability of its service and the three regional entities (DC, Maryland, and Virginia) have promised dedicated funding toward the capital and maintenance needs for Metrorail. While it is impossible to predict if or when Metrorail service will improve, the renewed investment and focus on basic maintenance should result in a return to reliable service in the near future.

Ride sourcing, as it is currently operating, may not be sustainable. Evidence from company financial reports suggests that Uber, Lyft and similar companies are only covering half their costs with current fares, which means their prices are unsustainable. Consolidation of the ride sourcing industry or shifts in its business model, which are likely to happen at some point, will likely increase fares, which would reduce its impact on transit ridership. Even with higher fares, there is likely to be demand for the services of ride sourcing, just as there has long been demand for taxis. Other aspects of the relationship between ride sourcing and transit and other trends that are more complementary to fixed route transit, are discussed in Chapter 5.

There is also evidence that improving the usefulness and effectiveness of transit can help reverse these trends. Ridership has been rising in Houston, where the network was redesigned to be more useful in 2015, and in Seattle, where an aggressive effort at giving buses more priority in traffic has played a key role in higher transit mode share.

Figure 4: Annual boardings on DASH have grown modestly since 2006.

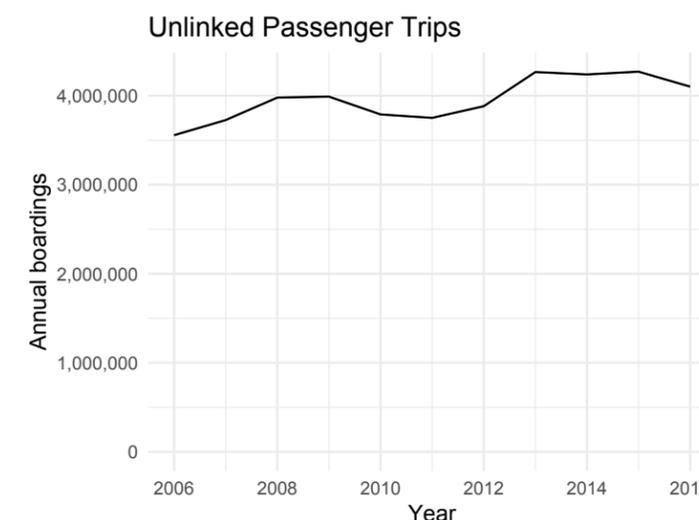


Figure 5: Investment and relevance closely tracked each other until 2013, but Relevance has recently declined in spite of increasing investment.



The Transit Network as an Instrument of Freedom

High transit ridership results when transit is useful to large numbers of people. A helpful way to illustrate the usefulness of a network is to visualize where a person could go using public transit and walking, from a certain location, in a certain amount of time.

The map at right shows where someone can go if they start out from TC Williams High School at noon on a weekday.¹ From the selected point, the map shows where someone could be, on public transit combined with walking, in 15, 30, 45, or 60 minutes. The technical term for this illustration is isochrone. A more useful transit network is one in which these isochrones are larger, so that each person is likely to find the network useful for more trips.

What goes into the travel time reflected in this isochrone? Time spent walking to a bus or rail station. Time spent waiting for the bus or train, which is one-half of the frequency. Time spent riding the bus or train (the faster the vehicle goes, the farther someone can get). And time spent walking to the final destination.

Frequency, speed and distance govern people's travel time on transit. While speed and distance are mostly out of the control of DASH or other bus operators, the frequency of different transit services is a decision made by DASH or Metrobus. Long waits for low frequency services can consume a great deal or all of someone's travel time budget, making for smaller isochrones.

The example here shows this problem clearly. TC Williams is served by multiple bus routes, which is why access is available in many directions. But most of the routes that serve it only come once every 30 minutes. On average, a person will have to wait 15 minutes for a bus, so a large part of a person's travel budget is taken up by wait time for any trip by transit from TC Williams.

We can think of these shapes as the walls around someone's life. A transit network can be liberating, giving people access to the opportunities of their city, the freedom to find work, go to school, worship, meet people, and do all of the other things that have drawn humans to cities for thousands of years. The transit network can be an instrument of freedom for current and future Alexandrians.

¹ Our choice of noon, rather than morning or evening rush hour, is intentional. While travel peaks at rush hours, many different kinds of people need to travel at midday. The retail and restaurant industries tend to change shifts and midday. Office workers need to travel for personal appointments or meetings. College students often finish or start classes at midday. And any parent values being able to get home to pick up a sick kid from school!

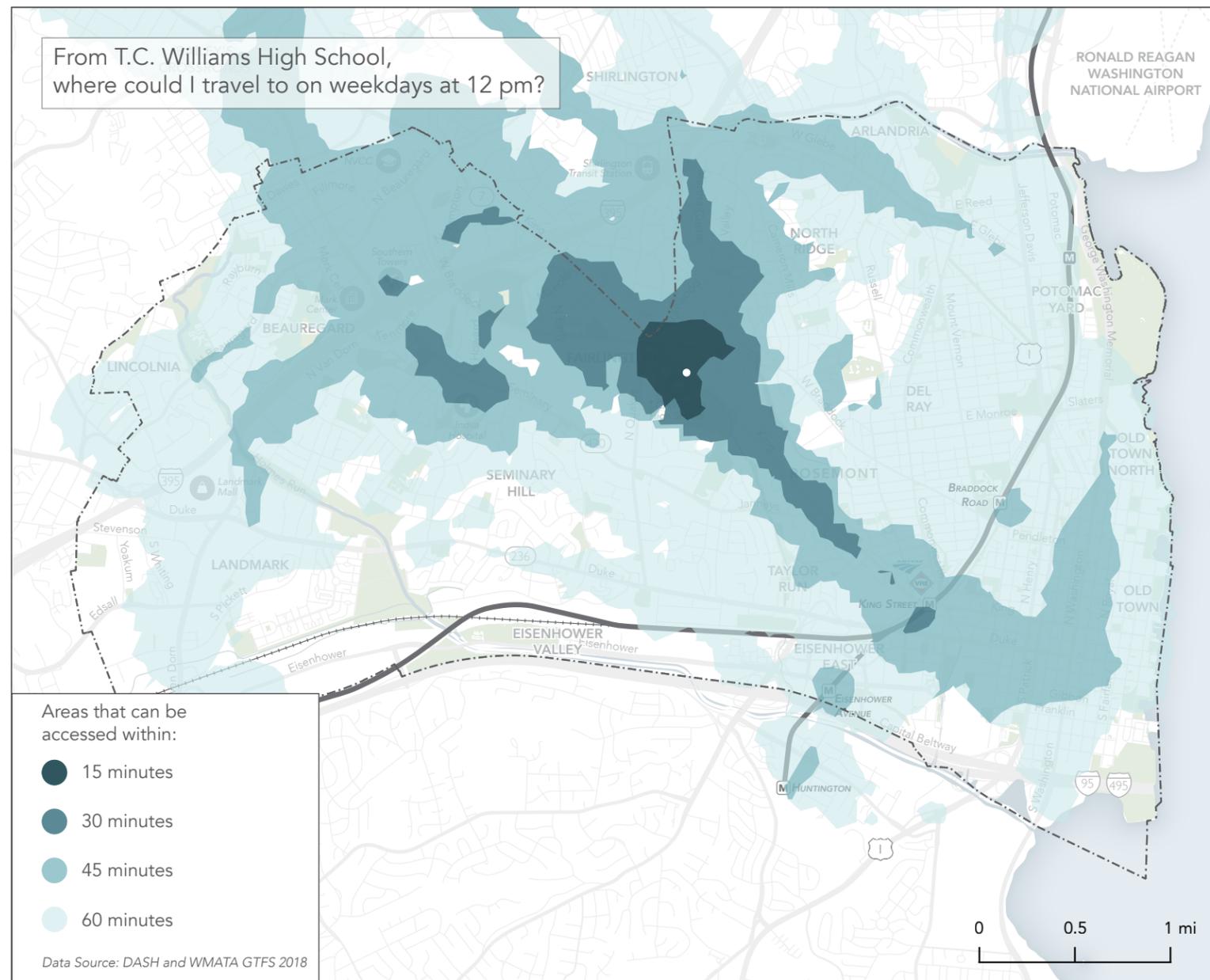


Figure 6: From TC Williams High School only a small part of the city is reachable within 30 minutes, but most is reachable within an hour.

To **maximize liberty and opportunity for the greatest number of people**, one must deploy a network of **frequent service**, with optimal **speed and reliability**, and following **favorable patterns in the built environment**.

Frequency is Freedom

In transit conversations, there is always a great focus on where transit is provided, but sometimes not enough attention paid to when it is provided.

The “when” of transit service can be described as “frequency” or “headway” (how many minutes between each bus) and “span” (how many hours per day, and days per week, it runs).

Low frequencies and short spans are one of the main ways that transit fails to be useful, because it means service is simply not there when the customer needs to travel.

Frequent service:

- » Reduces waiting time (and thus overall travel time).
- » Improves reliability for the customer, because if something happens to your bus, another one is always coming soon.
- » Makes transit service more legible, by reducing the need to consult a schedule.
- » Makes transferring (between two frequent services) fast and reliable.

Existing Alexandria Transit Network

Figure 7 shows the transit network in Alexandria, with every bus route color-coded based on its frequency during midday on a weekday. Metrorail stations and lines are shown in gray. The Metrorail Yellow and Blue lines through Alexandria are scheduled to operate every 12 minutes in the midday, and thus where they run together the combined frequency is every 6 minutes.

Most DASH routes in Alexandria operate at every 30 minutes in the midday, except for the AT3/4 and AT7. The most frequent routes (running every 15 minutes or better) are mostly Metrobus routes (Metroway, the combination of 10A+B, and the 7M). The most frequent DASH route is the King Street Trolley.

The existing network is explored in more detail in Chapter 4 along with strategies that might improve the usefulness of service.

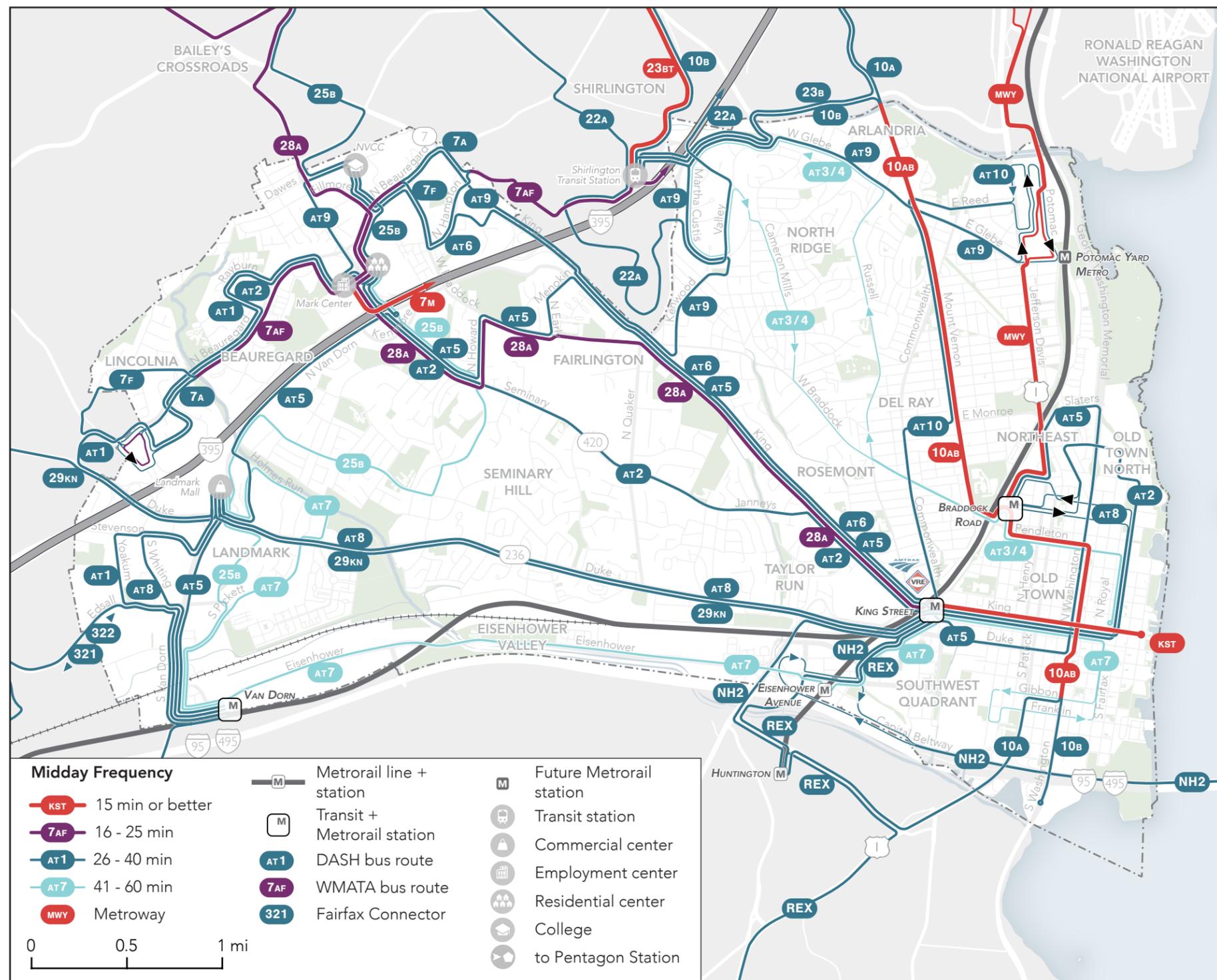


Figure 7: Most bus routes in Alexandria run about every 30 minutes in the midday.

Development Patterns Affect Ridership

Achieving high ridership requires more than clean, comfortable or even frequent service.

Many factors outside the control of a transit agency—land use, development, urban design, street networks, and price of parking and roads (tolls)—strongly affect transit’s usefulness.

If the City and DASH want to achieve higher ridership, then service must be focused on areas where high ridership is likely and operating costs are low. Land use decisions, in turn, can arrange development in patterns that transit can reach with useful, frequent service, for a reasonable operating cost.

The City and DASH could attract higher ridership, within a fixed budget, by targeting the places where the most people will find transit useful. This means:

- » **Density:** Demand for transit is higher when there are more people, jobs, and activities near each transit stop.
- » **Walkability:** Service is only useful to people who can safely and comfortably walk to the transit stop.
- » **Linearity:** Direct paths among destinations are faster, cheaper to operate, easier to understand, and more appealing to customers.
- » **Proximity:** Shorter distances between destinations attract more riders per hour and are cheaper to operate.

These are geometric facts of a city and its design. They are not a matter of opinion or values, unlike the Key Choices presented in this report. For example, some people react strongly to the term “density” and infer a value or judgment that must come with it. Yet density is a simple geometric fact: the number of people close to any given transit stop.

All of these factors affect both the costs of providing transit in a particular place and how many people will find the service useful.

Density and walkability tell us about the overall ridership potential: “Are there are a lot of people around, and can they get to the transit stop?”

Linearity and proximity tell us about both ridership potential and cost: “Are we going to be able to serve the market with fast, direct lines, or will we have to run indirect or long routes, which cost more to operate (and cost riders time)?”

In addition to these four factors, the mix of uses along a corridor affects how much ridership transit can achieve, relative to cost. When homes, jobs, shopping destinations, medical offices, and all the other needs and wants of life are mixed along a street, many people will ride transit along that street for many different reasons all throughout the day.

Four Geographic Indicators of High Ridership Potential

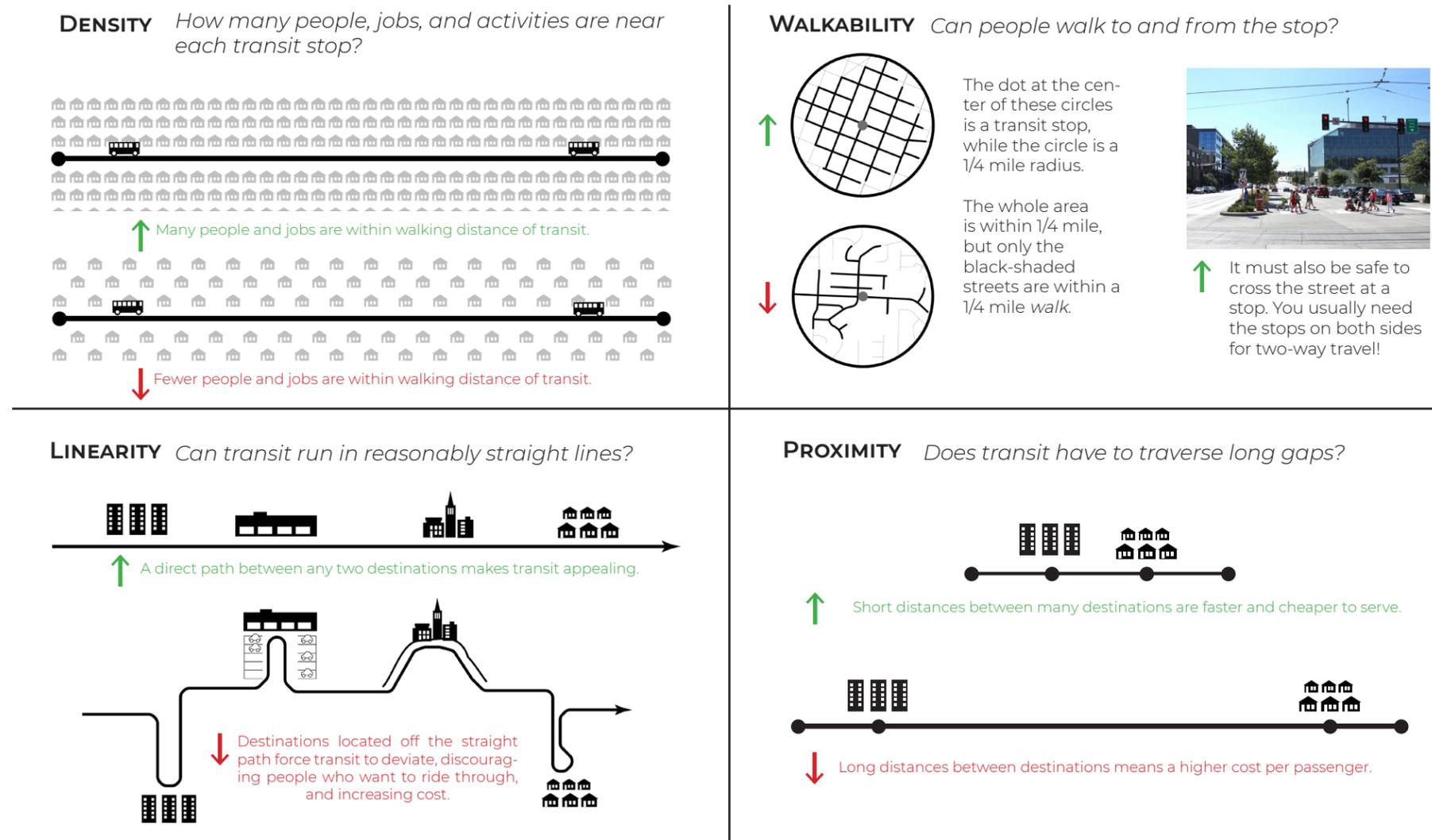


Figure 8: These four land use factors have an enormous influence over how much ridership transit can attract.

Increasing Usefulness Increases Ridership

Expanding freedom and opportunity is foundational for ridership growth. While other factors also affect ridership, this measure of freedom and opportunity isolates the transit network's role in attracting ridership. It reveals ways that a transit network can help more people get to more places sooner, so that they can do more things.

In this Vision Plan, the City of Alexandria, DASH, and the public will have an opportunity to consider changes in the short and long-term that would increase access for large numbers of people. Making these changes within the existing service budget would require major trade-offs, but would greatly increase the potential ridership of the network.

The biggest limits on how much access a transit network can offer are the quantity of service provided, the frequency of service, and the span of service throughout each day and week. Frequency and span trade-off against geographic coverage, within any fixed budget. And even with more funding to add service, every city or transit agency must consider the balance of different goals that it is trying to achieve with its transit service.

Ridership Is Not the Only Goal

If Alexandria wanted to maximize transit ridership, it would focus its service only on routes useful to the greatest number of potential riders. The City and DASH would be thinking like a business, focusing on places where its service are competitive for a large number of people. Businesses are under no obligation to operate where they would spend a lot of money to reach few customers.

For example, McDonald's is under no obligation to provide a restaurant within 1/2 mile of everyone in Virginia. If it were, then the company would have to add hundreds of additional locations, some serving just a handful of homes, and most operating at a loss because of the few customers nearby.

People understand that rural areas will naturally have fewer McDonald's locations than urban areas. We don't describe this as McDonald's being unfair to rural

or suburban areas; they are just acting like a private business. McDonald's has no obligation to cover all areas with its restaurants.

Transit agencies are not private businesses, and most transit agencies decide that they do have some obligation to cover most or all of their service area. Elected officials may value the insurance policy that coverage services provide to constituents so that nearly every person has at least some access to transit. They may therefore decide that coverage, even in low-ridership places, is an important transit goal.

Transit agencies are often accused of failing to maximize ridership, as if that were their only goal.

In fact, most transit agencies are intentionally operating "coverage services" that are not expected to generate high ridership precisely because the communities they serve have said that they value and want transit to meet other goals.

What Goals Does Transit Serve?

Transit can serve many goals. But different people and communities value these goals differently. Understanding which goals matter most in Alexandria is a key step in developing the Transit Vision.

Possible goals for transit include:

- » **Economic:** transit can give businesses access to more workers, and workers access to more jobs. Transit can also help attract certain industries, new residents, tourists, or other economic contributors. Higher ridership transit costs less to operate per rider. By maintaining access and mobility in the face of congestion, transit can also increase the economic potential of a city.
- » **Environmental:** increased transit use can reduce air pollution and greenhouse gas emissions. Transit can also support more compact development and help conserve land.
- » **Health:** transit can be a tool to support physical activity by walking. This is partly because most riders walk to their bus

stop, but also because riders will tend to walk more in between their transit trips.

- » **Personal Liberty:** By providing people the ability to reach more places than they otherwise would, a transit system can be a tool for personal liberty, empowering people to make choices and fulfill their individual goals.
- » **Social:** transit can help meet the needs of people who are in various situations of disadvantage, such as low-income or disability, providing lifeline access to services and jobs. Transit also provides mobility options to people who might not otherwise have many options.

Some of these goals are served by high transit ridership. For example, the environmental benefits of transit only arise from many people riding the bus rather than driving. Subsidy per rider is lower when ridership is maximized. We call such goals "ridership goals" because they are achieved in part through many people riding transit.

Other goals are served by the mere presence of transit. A bus route through a neighborhood provides residents insurance against isolation, even if the route is infrequent, not very useful, and few people ride it.

A route may fulfill political or social obligations, for example by getting service close to every taxpayer or into every political district. We call these types of goals "coverage goals" because they are achieved in part by covering geographic areas with service, regardless of ridership.

Figure 9: Is an empty bus failing? It depends on why you are running it.



Ridership and Coverage Goals Conflict

Ridership and coverage goals are both important to many people, but they lead us in opposite directions. Within a fixed budget, if a transit agency wants to do more of one, it must do less of the other.

Here is an illustration of how ridership and coverage goals conflict with one another, due to geometry and geography. In the fictional town in Figure 10, the little dots indicate dwellings and commercial buildings and other land uses. The lines indicate roads. Most of the activity in the town is concentrated around a few roads, as in most towns.

A transit agency pursuing only a ridership goal would focus service on the streets where there are large numbers of people and destinations around each stop, where walking to the stops is easy, and where the service can run straight, not meandering, so that it is a logical direct path for many people. Because service is concentrated into fewer routes, frequency is high and a bus is always coming soon. This would result in a network like the one at bottom-left.

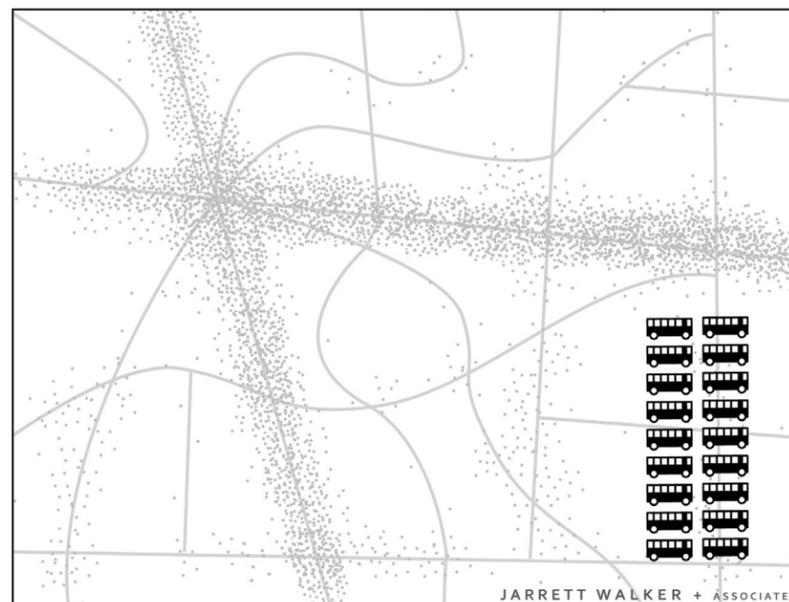
If the town were pursuing only a coverage goal, on the other hand, the transit agency would spread out services so that every street had a bus route, as in the network at bottom-right. As a result, all routes would be infrequent, even those on the main roads.

In these two scenarios, the town is using the same number of buses.

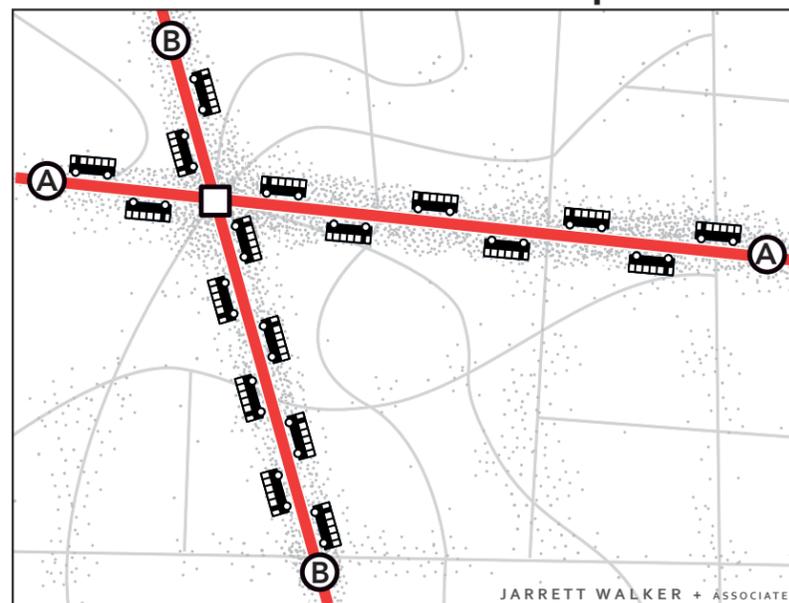
These two networks cost the same amount to operate, but they deliver very different outcomes.

On a fixed budget, designing transit for both ridership and coverage is a zero-sum game. In the networks at right, each bus that the transit agency runs down a main road, to provide more frequent and competitive service in that market, is not running on the neighborhood streets, providing coverage. While an agency can pursue ridership and provide coverage within the same budget, it cannot do both with the same dollar. The more it does of one, the less it does of the other.

These illustrations also show a relationship between coverage and complexity. Networks offering high levels of coverage are naturally more complex.



Maximum Ridership



All 18 buses are focused on the busiest area. Waits for service are short but walks to service are longer for people in less populated areas. Frequency and ridership are high, but some places have no service.

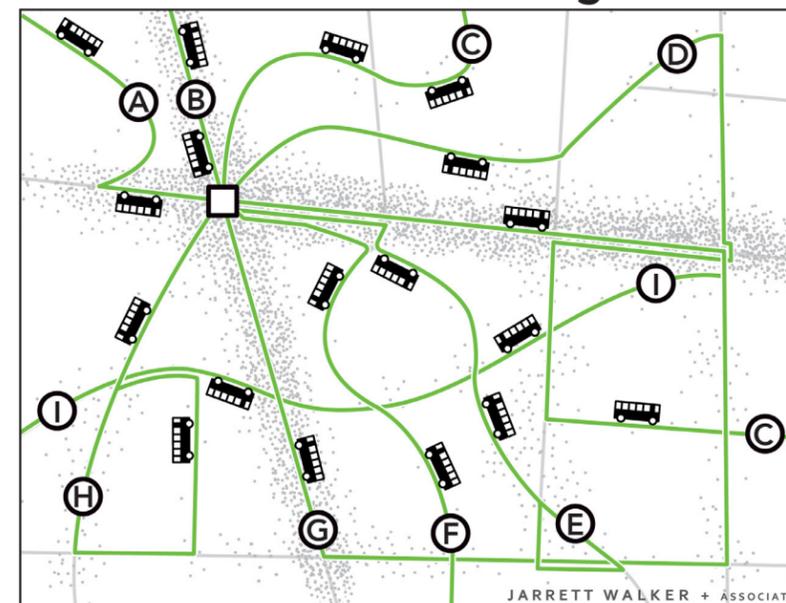
Imagine you are the transit planner for this fictional town.

The dots scattered around the map are people and jobs.

The 18 buses are the resources the town has to run transit.

Before you can plan transit routes, you must first decide: **What is the purpose of your transit system?**

Maximum Coverage



The 18 buses are spread around so that there is a route on every street. Everyone lives near a stop, but every route is infrequent, so waits for service are long. Only a few people can bear to wait so long, so ridership is low.

Figure 10: Ridership and coverage goals are in direct conflict within a fixed budget.

Key Choices for the Transit Vision

At the end of this report, we present some key choices that the public, stakeholders and elected officials may want to make as part of a transit vision. These choices are suggested by the existing conditions of transit and land use in Alexandria.

How should Alexandria balance ridership and coverage goals?

In every public transit system, a basic trade-off must be made between concentrating service into very useful routes that serve large numbers of people, and spreading service out to make sure that people everywhere have access to at least some service.

How should Alexandria balance ridership and coverage goals in its network? Is the current balance (which derives from the historical tweaks and changes to the network over the years) the right one? Should Alexandria shift the balance? Within a fixed budget, a shift towards higher frequencies and higher ridership would require reducing geographic coverage, and vice versa.

How should Alexandria balance walking versus waiting?

The lived experience of the ridership versus coverage trade-off is the concrete reality of walking farther for a shorter wait versus a shorter walk for a longer wait. Do most Alexandrians value their total travel time (including wait time) more than a short walk? Or do most people prefer short walks, even if it means a longer wait and a longer travel time.

Are Alexandrians willing to transfer if it means a faster trip?

Today parts of the bus network in Alexandria are designed to minimize transfers and provide as many one-seat rides to Old Town as possible. But the trade-off is there are many overlapping routes that do not provide much added value (in combined frequency) where they run together. If routes were consolidated and frequency increased, service could be more useful for more trips,

but some trips would require a transfer that do not today. So how do most Alexandrians value total travel time versus the need to transfer?

How much transit service does Alexandria want?

Alexandria has been growing its transit service over the last 10 years. And as discussed further in this report, places that are growing more dense face a critical need to expand transit faster than population and employment growth. In light of the projected 20% growth in population and employment, a key question for this Transit Vision is whether the existing amount of transit service is sufficient and, if not, how much should Alexandria expand service?

How should Alexandria balance peak versus all-day service?

The current service is very concentrated during the peak commute periods in the morning and afternoon, with much less service at other times. While it is important to meet peak travel needs, peak-only service can be very inefficient, as we discuss in Chapter 4. In some cases, the transit trips that are most cost-effective to compete for may be those that happen all day and evening, including shopping, errands, and above all access to lower-wage jobs that tend not to be “nine to five.”

So a key question for Alexandria is what is the right balance between serving the peak commute hours, where demand is quite high, and serving evening and weekends.

Chapter Summaries

Chapter 2: Markets and Needs

Chapter 2 presents demographic and geographic data for Alexandria. The first part of the chapter focuses on where there are large numbers of people and activity and, therefore, where high-ridership transit is a possibility. The second half focuses on where there are people with severe needs for transit who could benefit

from access to service. It also includes an analysis of trip patterns from cell phone data sources.

Chapter 3: Current Plan

Chapter 3 presents a summary of recent land use plans, transportation plans, and city surveys that shed light on what the City wants transit to do and what its priorities for transit have been.

Chapter 4: Network Analysis

Chapter 4 presents data relating to the performance of the existing network and individual routes. It also includes descriptions of some of the network and service design techniques that are currently used in the transit network, and others that could be considered in the future.

Chapter 5: Emerging Transportation Technologies

Chapter 5 describes recent trends in transportation technologies and how some mobility options are being deployed by different agencies and firms. Much marketing hype has been made of ride sourcing companies like Uber and Lyft and this chapter helps to clarify their role in the overall realm of mobility options.

Chapter 6: Key Choices

The final chapter of this report lays out the key choices that Alexandria can make as part of the Transit Vision. These choices will be the focus of public and stakeholder involvement in September and October.



2. Markets and Needs

Where are potential transit riders?

Markets and Needs

In this chapter, we present and discuss data that inform two different types of considerations in transit planning:

- » Where are the strongest markets for transit? Where is density the highest? Where are there long, continuous corridors of demand? Where is ridership likely to be high relative to cost? In other words, if Alexandria was thinking of transit like a business, where would it be most likely to invest its resources?
- » Where are there moderate or severe needs for transit? Where are pockets of poverty or seniors in hard to reach places? Where are there many zero-vehicle households but it would cost a lot to run a bus there? In other words, where are places that have acute needs, but the service is unlikely to get many riders relative to cost?

These two types of considerations help everyone see how the current and future patterns of development affect decisions about the transit network. And thinking about where the strong transit markets are compared to acute needs helps everyone think more clearly about the right balance between the competing goals of high ridership and wide coverage for Alexandria.

Market Assessment

The transit market is mostly defined by **where** people are, and **how many** of them are there, rather than by **who** people are.

If you asked a transit planner to draw you a very high-ridership bus route, that planner would look mostly at densities of all residents and jobs; at the walkability of streets and neighborhoods; and at the cost of running a bus route long enough to reach them. Only secondarily would that planner look into the income or age of those residents or workers.

The **who** attribute that has the strongest influence on transit ridership potential is income. Low income people are, as individuals, more likely to choose transit. That said, the density of all people (including low-income people) around a transit stop will still be the overriding factor in predicting whether that stop gets high ridership.

On pages 16 to 26, these maps and diagrams help us visualize the **transit market**:

- » Residential density map
- » Job density map
- » Activity density map
- » Walkability examples
- » Street connectivity map
- » Existing transit commuters

None of these data alone tell us that a place has high ridership potential and is therefore a strong transit market. Rather, these data must be considered in combination.

This is not to say that who people are is not important. It is extremely important, especially when designing transit services to achieve a coverage goal, like equity with respect to race or ethnicity.

Needs Assessment

We learn about transit needs by examining **who** people are and what life situation they are in.

If you asked a transit planner to draw you a route that met as many needs as possible, that planner would look at where low income people, seniors, youth, and people with disabilities live and where they need to go.

While the densities at which disadvantaged people live would matter, because at higher densities a single bus stop can be useful to more people in need, the planner would still try to get the route close to even small numbers of people. In fact, the more distant and scattered people are, the more isolated they can be and the more badly they might need access to transit.

On pages 27 to 32, these maps help us visualize where **transit needs** are in Alexandria:

- » Density of zero-vehicle households
- » Median household income
- » Density of residents in poverty
- » Density of seniors
- » Density of youth

Most of these measures cannot by themselves tell us that a person has a severe need for transit. For example, many seniors are affluent and able to afford cars, or even taxis, or drivers. The same is true of youth.

People living in zero-vehicle households may be choosing to rely on transit, walking or cycling when they could theoretically afford a car. We must consider these measures in combination to understand where there are people with the greatest need for transit in Alexandria.

One map included in the Need Assessment pages does not relate directly to people's need for transit. That is the map of the race or ethnicity of Alexandria residents. A person's race or ethnicity does not tell us if they need transit, or if they have a propensity to use transit.

Alexandria is a diverse city and assessing how transit serves different racial and ethnic groups is important to ensuring it is an equitable city. Furthermore, unequal treatment on the basis of race or ethnicity is illegal under the Civil Rights Act of 1964; unequal treatment on the basis of other characteristics, including income and age, is also prohibited by law. Thus an examination of where non-white people live in Alexandria is also a civil rights assessment.

Trip Patterns

In assessing markets and needs, it is also useful to consider where people are traveling and when. The last section of this chapter looks at trip patterns to, from, and within Alexandria using estimated trip data from cell phone data.



Market Assessment

Residential Density

Residential density is the simplest measure of public transit's ridership potential. While not all trips start or end at home, nearly everybody makes at least one trip starting or ending at their place of residence every day.

Figure 11 shows the density of residents across Alexandria. Dense residential developments are in:

- » Arlandria and northern Del Ray, along West Glebe Road and continuing into Arlington County;
- » Landmark, south of Duke Street on South Van Dorn Street and Edsall Road, continuing into Fairfax County;
- » Lincolnia area along North Beauregard Street near Duke Street and continuing into Fairfax County;
- » In the Beauregard area, north of Seminary Road to King Street and continuing into the Fairlington and Shirlington areas in Arlington County;
- » In Old Town and Old Town West, particularly around the Braddock Road Metrorail station.

A key challenge apparent from this map is that the density pattern of the city is like a donut with most of the high-density areas around the edges of the city and often around freeways and wide arterial roads. In particular, the areas with the highest residential density levels are almost all in western Alexandria, near I-395.

With density spread around the edges, and separated by a low-density area in the middle, transit has a proximity problem. It must traverse large, low-ridership areas to connect the pockets of density around the edges of the city. This is further complicated by the walkability problems created by so much density being near freeways and wide arterial highways.

By comparing this map to the map of the existing network on page 9, we can see that at least some transit service is provided close to the densest pockets of residential development. However, "close to" is a relative statement. In some developments, the local street pattern puts most homes a long walk away from the nearest through-street, making it impossible to provide transit close to very many residents. The walkability problem is illustrated on page 24.

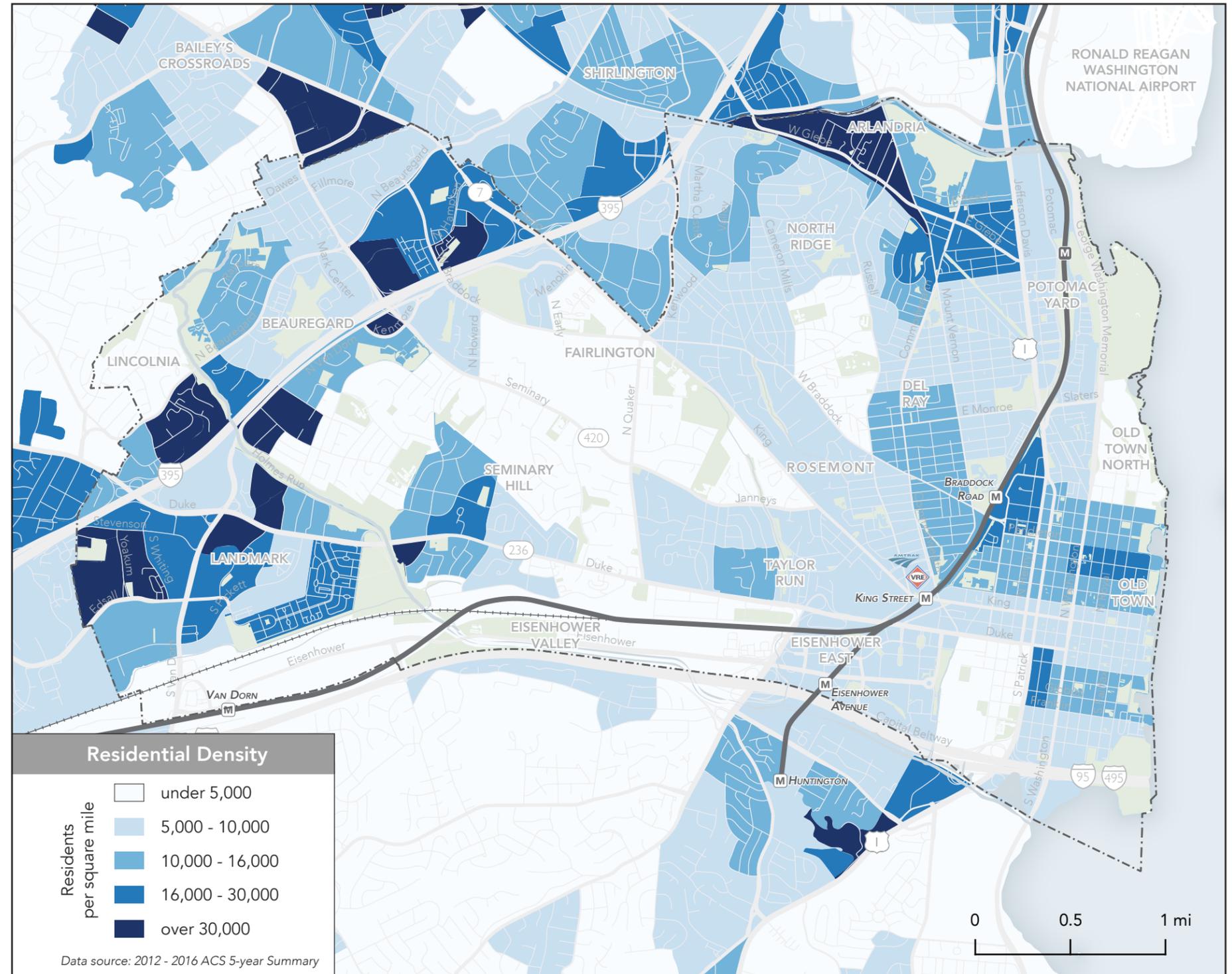


Figure 11: The density of residents in Alexandria shows a strong pattern of density around the edges of the city.

Job Density

A map of job density shows us not only the places people travel for work, but also places people go for services, shopping, community, health care, and more. A person's workplace may be, throughout the day, a destination for dozens or even hundreds of people.

The map to the right shows the existing job density for Alexandria. Some of the largest clusters of jobs are in:

- » Old Town;
- » Old Town North;
- » Eisenhower East;
- » Landmark, particularly along Edsall Road and extending into Fairfax County;
- » Beauregard area, around Seminary Road and North Beauregard Street;
- » Northern Beauregard area and Fairlington on both sides of Route 7 and north of I-395 and extending into the Shirlington area of Arlington County.

Similar to residential density, job density is highest along the edges of Alexandria and relatively low in the middle. Unlike residential density, though, the highest job densities are generally in eastern Alexandria. With the exception of Old Town, most of the dense job areas are near major highways, further adding to the proximity and walkability problem.

This density pattern means that much of Alexandria's densest development is continuous with density in adjacent jurisdictions (Arlington and Fairfax), so that large volumes of local trips will cross the city boundary while intracity travel is relatively less than it would be if the density patterns across the city were more continuous.

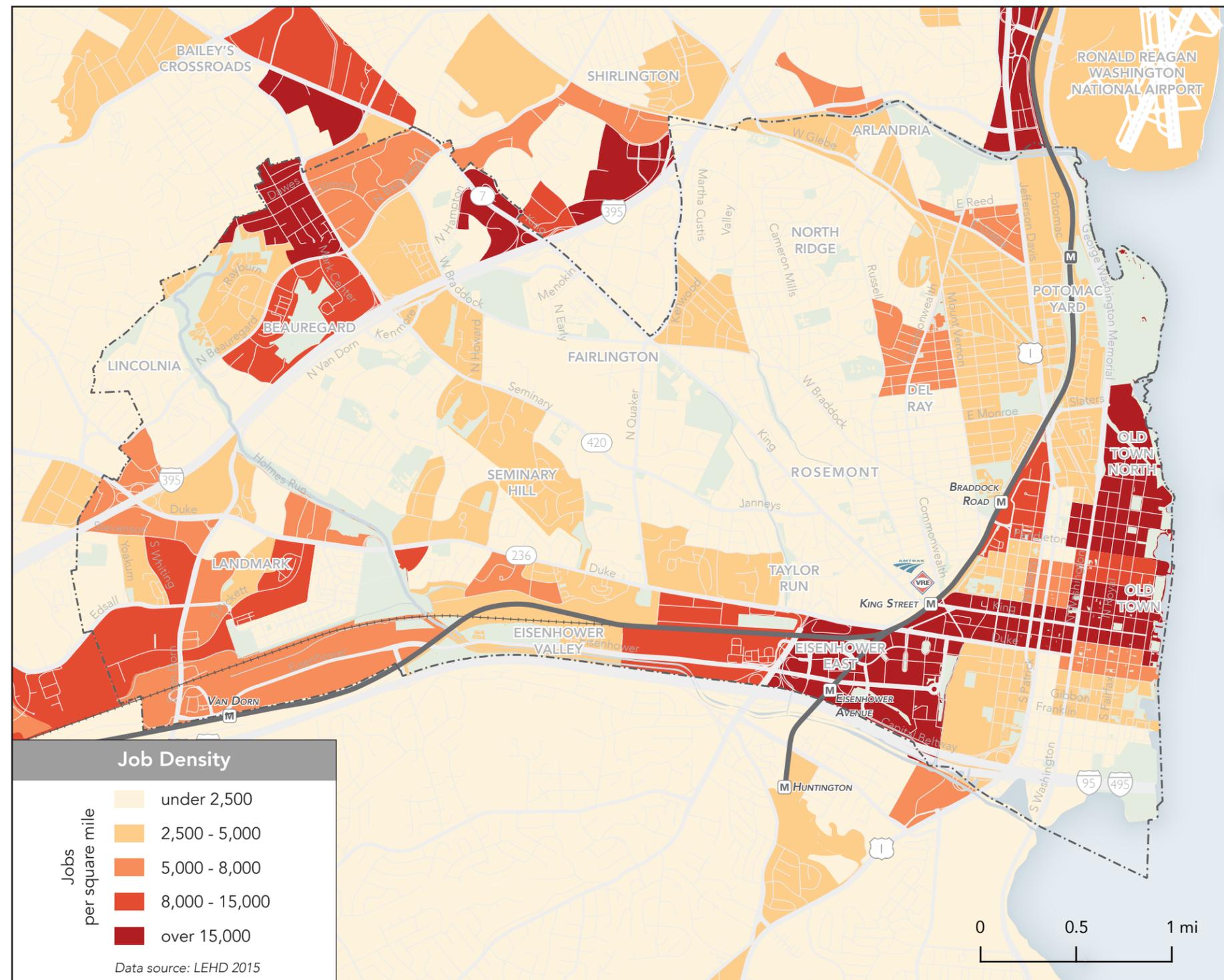


Figure 12: The density of jobs in Alexandria shows a strong pattern of density around the edges of the city.



Activity Density

Residential and job densities are combined into Activity Density in the map at right. Shades of red indicate high density mixtures of jobs and housing. Shades of yellow indicate areas of higher jobs densities. Shades of blue indicate areas of higher housing densities.

This allows us to see how the total density of activities, the mix of uses, and their proximity and linearity could affect transit ridership across Alexandria.

A few areas that have high or moderate mixed-use density are:

- » Landmark, particularly south of Duke Street;
- » Beaugard area, particularly around North Beaugard Street and Seminary Road.
- » The Fairlington area, north of I-395 along King Street, and north into the Shirlington area of Arlington County and continuing west along King Street into the Skyline City area in Fairfax County;
- » Old Town;
- » Old Town North;
- » Old Town West, particularly around the Braddock Road Metrorail station;
- » Eisenhower East.

This map shows a donut-like pattern of high-density jobs and residents encircling low-density areas in the middle of Alexandria.

The mix of uses along a corridor affects how much ridership transit can achieve, relative to cost. This is because a mix of uses tends to generate demand for transit in both directions, at many times of day.

Transit lines serving purely residential neighborhoods tend to be used mostly during peak hours and primarily in one direction—away from the residential neighborhood and towards jobs and services in the morning and the reverse in the evening. Buses serving a mix of uses can be full in both directions, all day and all week.

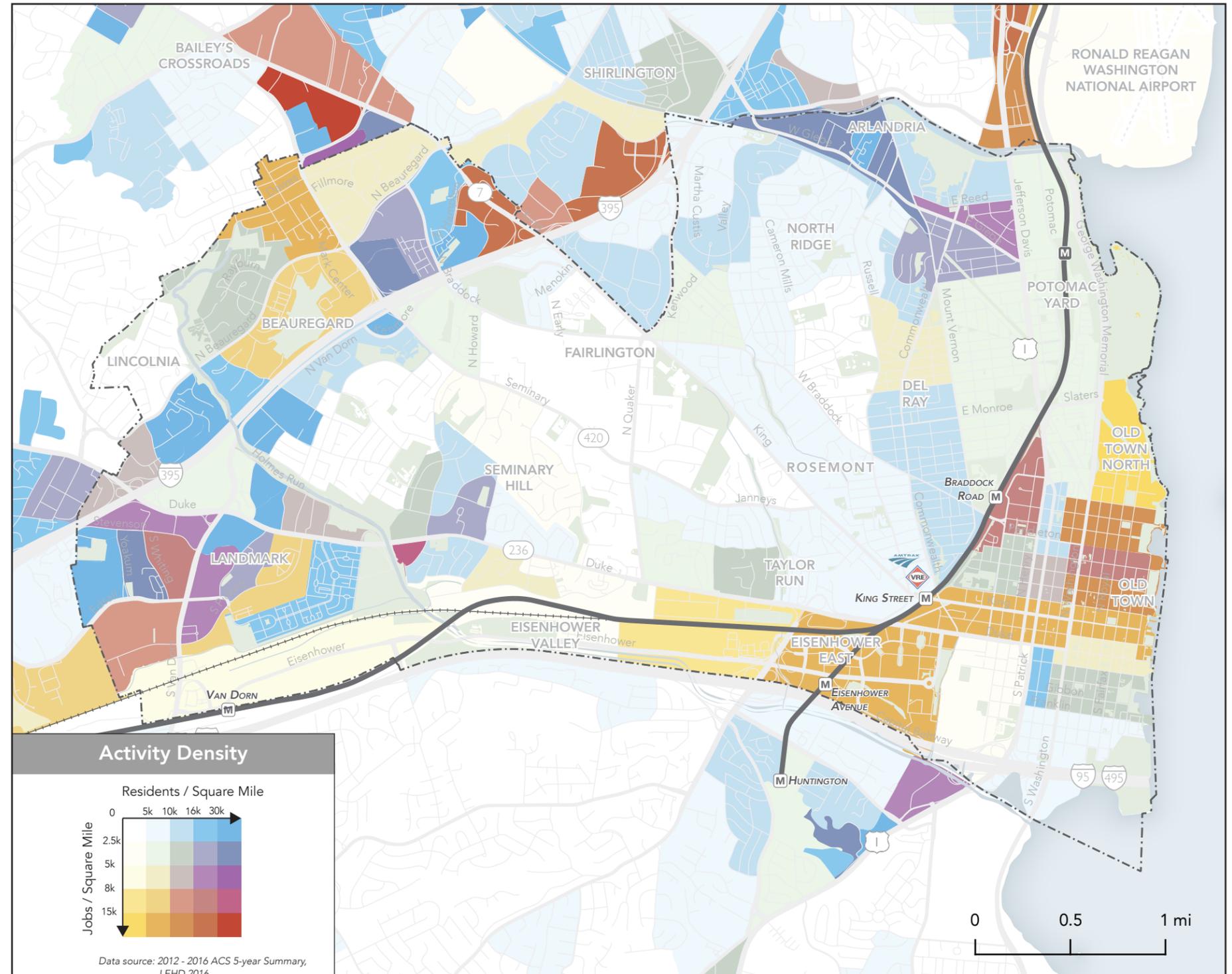


Figure 13: The density of residents and jobs shows a general donut pattern with a lot of activity at the edges, but relatively little in the middle.

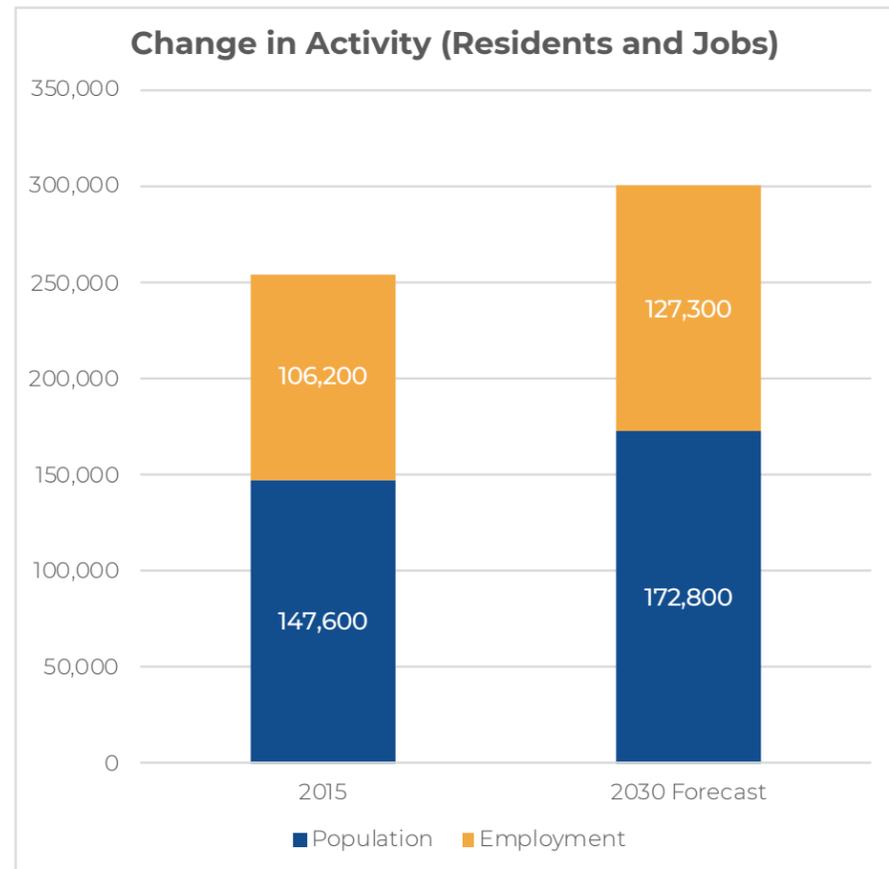
Growth in Residents and Jobs

As a 10-year transit plan, the Alexandria Transit Vision is also concerned with where residents and jobs will be in the future. Forecasts of resident and job growth were obtained from the Metropolitan Washington Council of Governments (MWCOG) Cooperative Land Use Forecasts (Version 9.0). These are regional growth forecasts, developed through an extensive coordination process which includes input from each city and county in the region. Forecasted data in the next three maps are displayed by traffic analysis zones (TAZ), which have different boundaries than the Census data shown on other maps.

Figure 14 shows that the total number of residents and jobs is forecasted to increase between 2015 and 2030. The number of residents will increase by 17% to 172,800 and the number of jobs will increase by 20% to 127,300. The ratio of people to jobs is expected to remain relatively stable, shifting from 1.39 residents per job in 2015 to 1.36 residents per job in 2030.

This forecasted growth means that Alexandria will become more dense. And cities that become more dense begin following the steep uphill curve of increasing transit demand as shown in Figure 15. Transit demand accelerates as density increase from suburban to urban levels, until cities reach density levels similar to Downtown DC or Manhattan, where density becomes so high that walking begins to take on a larger share of trips. Thus, if Alexandria wants to accommodate this forecasted growth while limiting the rise in congestion, more transit service is essential to serving this growth.

Figure 14: Forecasts of population and jobs growth show that both will increase nearly 20% by 2030.

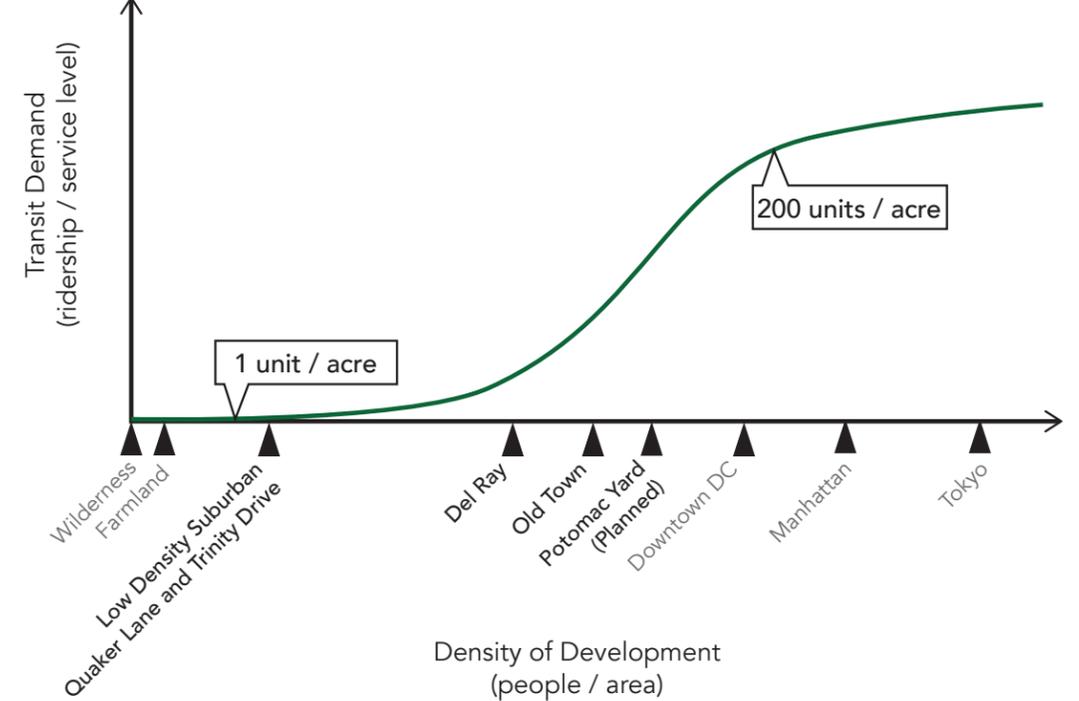


Alexandria's Growth Crescent

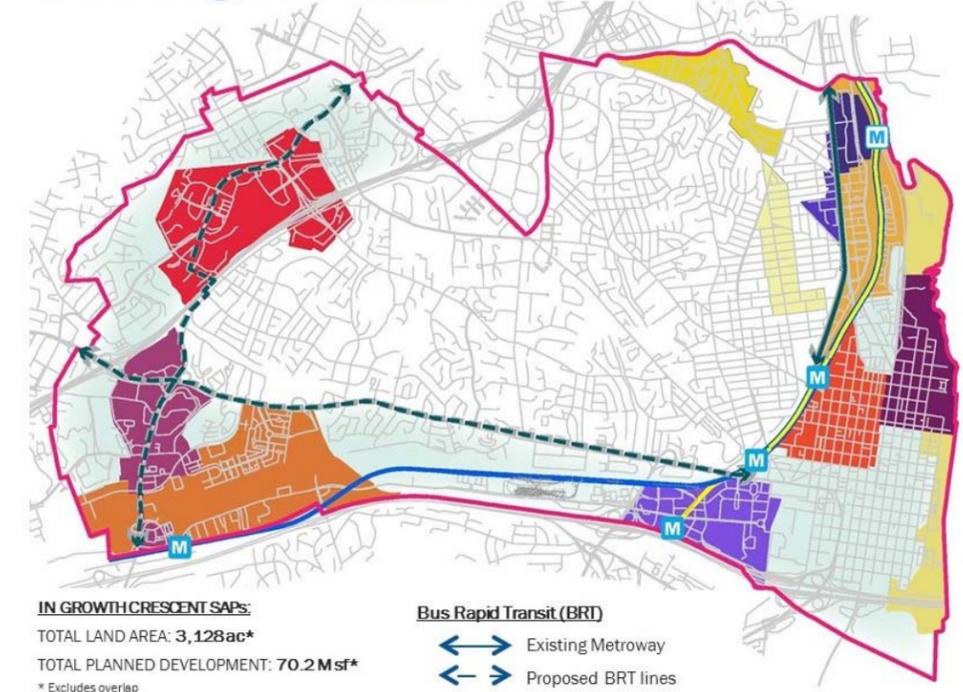
In planning for growth, Alexandria has chosen to focus density increases in a pattern it describes as a growth crescent around the edges of the city. Figure 16 shows the areas of the city with the highest levels of planned growth based on the City's small area plans. These plans are described in more detail in Chapter 3. But they are important context for the future growth patterns shown in the next few pages.

Figure 16: The City of Alexandria's plans are concentrating growth in a crescent pattern around the edges of the city.

Figure 15: As density increases from suburban to urban levels, transit demand increases faster than density.



Planning for Growth



Future Residential Density

The number of residents in the city is expected to grow from 147,600 to 172,800 people between 2015 and 2030. That is a 17% increase. Figure 17 shows the forecasted density of residents in 2030. The size of the zones in the forecasted data is different from the existing data shown on page 16, but some useful comparisons are still possible.

Compared to the existing density of residents, there are significant increases in density in the northern part of Potomac Yard and in the Eisenhower East area, both areas adjacent to existing or future Metrorail stations. Both of these areas reach the highest density levels in the city by 2030.

Old Town North and the northern Beauregard area also show some increases in density by 2030, but the increase is less significant.

The forecasted increases in density shown in this map are based on the regional forecasting of growth by the Metropolitan Washington Council of Governments (MWCOG). These forecasts are based in part on local plans for growth, but the City's most recent plans for growth are not necessarily reflected in these forecasts. So some of the City's small area plans (discussed in more detail in Chapter 3) are not fully reflected in these forecasts.

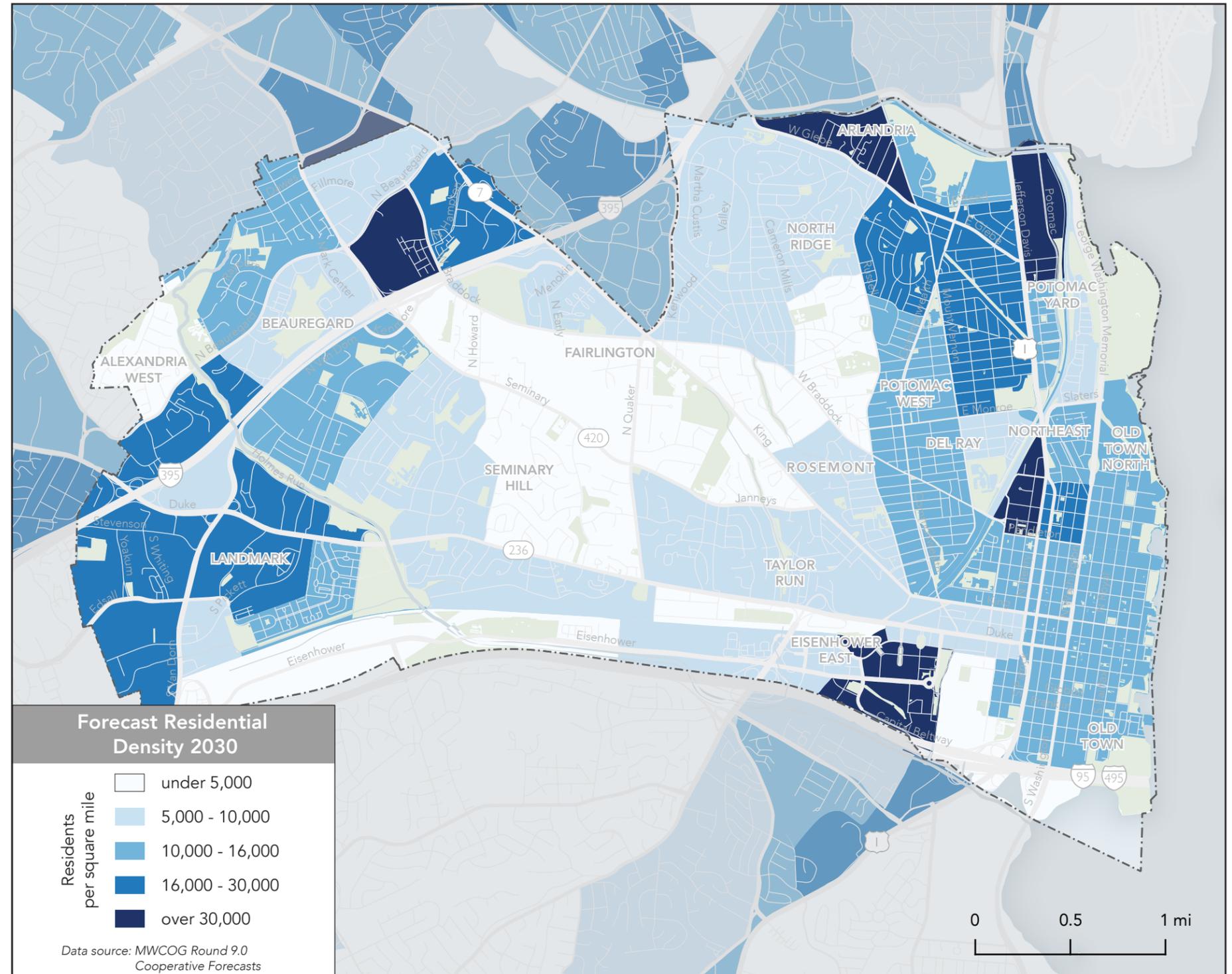


Figure 17: Residential density in 2030 is expected to maintain and reinforce the donut pattern that is already present in the city.

Future Job Density

The number of jobs in the city is expected to increase from 106,200 to 127,300 from 2015 to 2030, a 20% increase. Figure 18 shows the forecasted density of jobs in 2030. The size of the zones in the forecasted data is different from the existing data shown on page 17, but some useful comparisons are still possible.

Job density is forecasted to increase significantly in the Potomac Yard area as redevelopment of the area happens alongside the opening of the new Metrorail station. The central part of the Potomac Yard area stands out with a forecasted increase of 30,000 more employees per square mile.

Job density in Old Town North is also forecasted to increase substantially. Much of this area is planned for redevelopment as recommended in the City's *Old Town North Small Area Plan*.

In the southwestern parts of Landmark job density is expected to grow, but at a lesser rate (3,000–6,000 additional employees per square mile). The Eisenhower East district and the central portion of Potomac Yard are expected to increase by 12,000–22,000 employees per square mile.

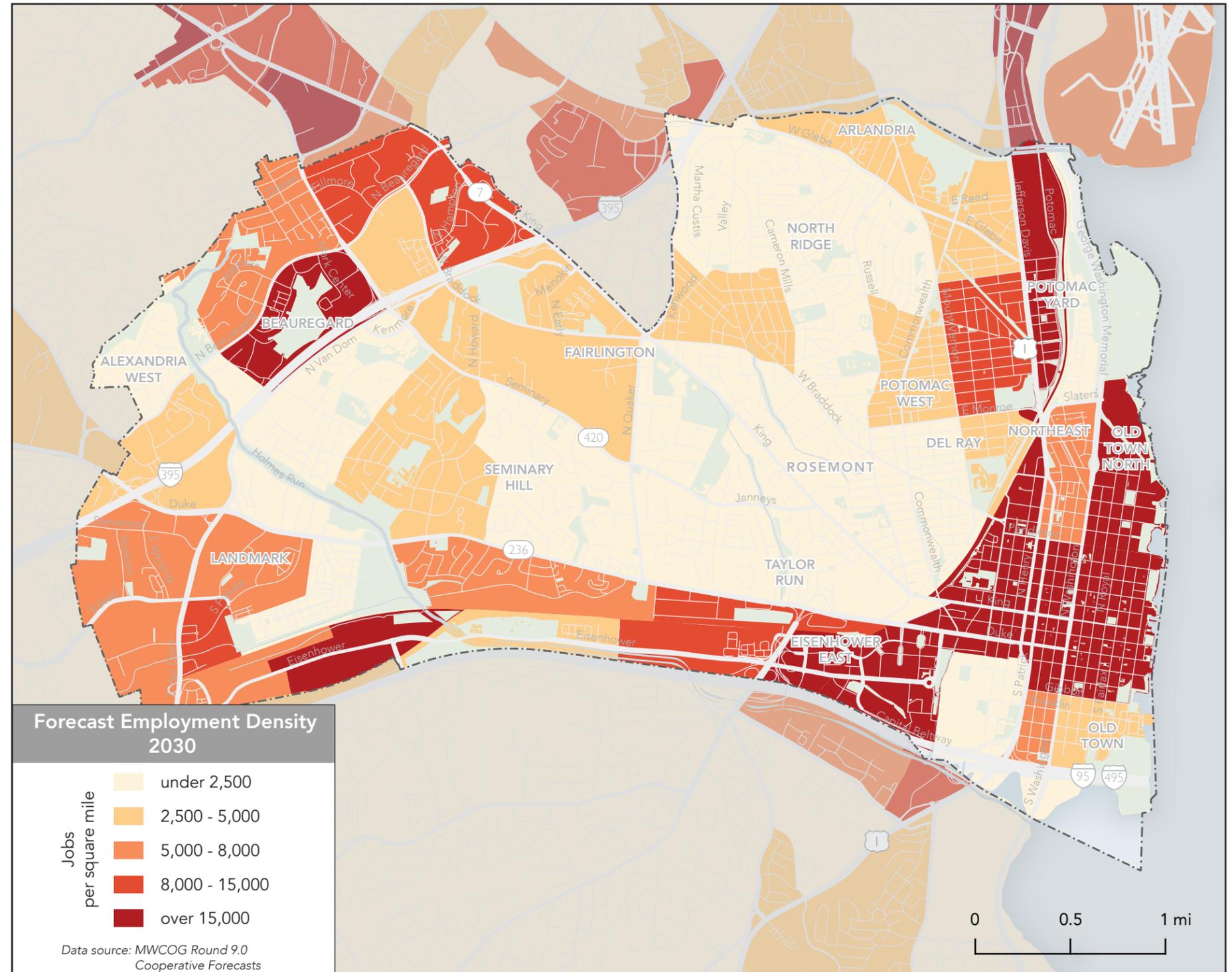


Figure 18: Forecasted job density increases are particularly high around existing and future Metrorail stations.

Future Activity Density

Combining the forecasted residential density and job density gives us an estimate of the future activity density in Alexandria. Similar to the existing activity density map on page 18, the city still exhibits a donut pattern of development, with high activity density around the edges.

Activity density around some edges is forecasted to increase significantly. In particular, the increase in residential and job density in the Potomac Yard area will dramatically increase the overall activity density in that area. Similarly, the increase in density of both jobs and residents in the Eisenhower East area will increase activity density significantly. In Old Town North, the increase in residential density significantly increases the overall activity density of that part of the city as well.

Growth is concentrating in a few areas, and mostly in places that are easy to service with useful transit.

Residential and job growth are concentrating together, creating more mixed-use areas, which is good for high transit ridership.

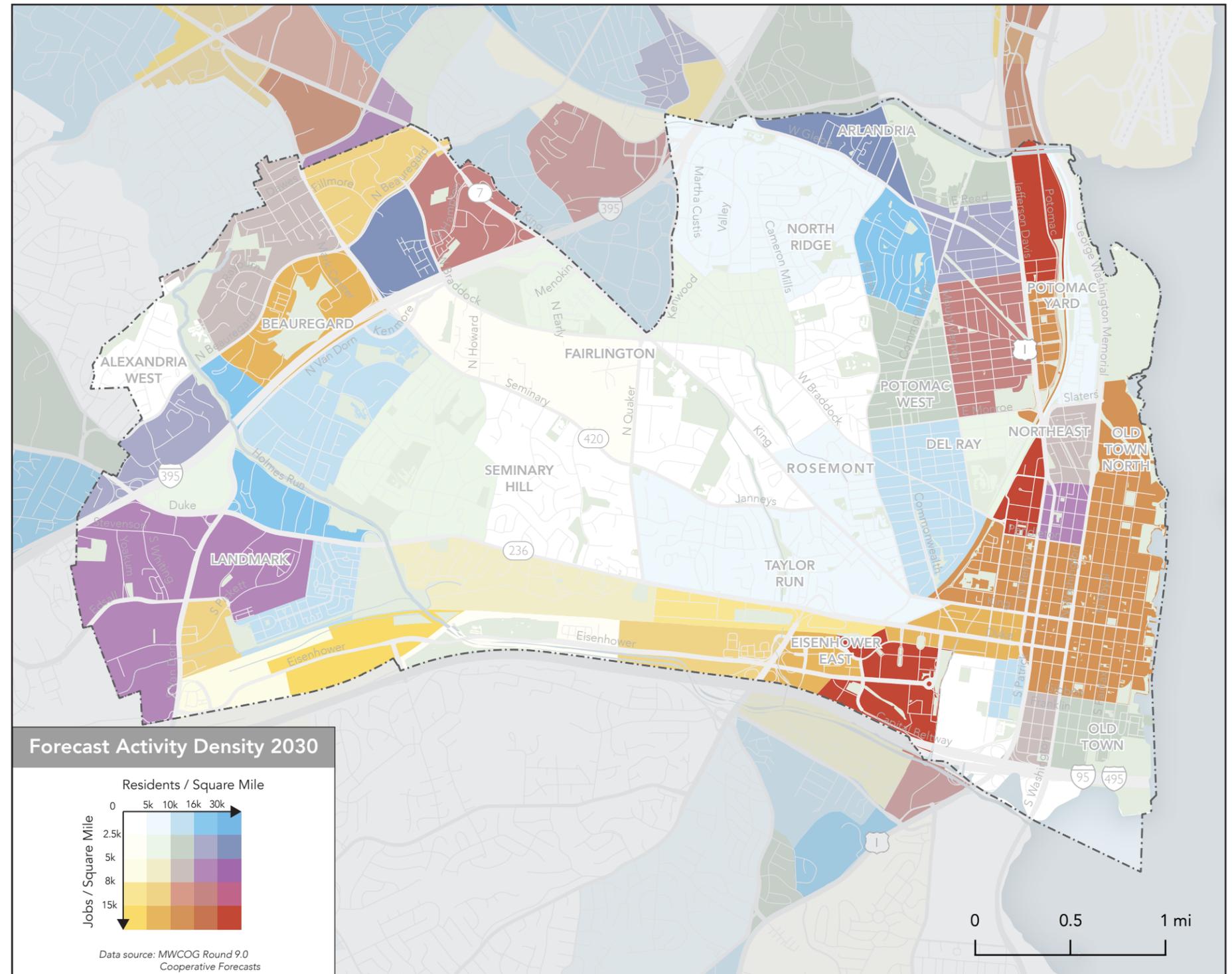


Figure 19: Forecasted increases in activity density are particularly high around existing and future Metrorail stations.

Historic Change in Residential Density

Alexandria, and the entire Metropolitan Washington region, has been growing significantly over the past 30 years, and is projected to continue growing.

Figure 20 shows the change in the density of residents across Alexandria from 1990 to 2016. This helps identify where growth has been concentrating over that time, and perhaps identify areas where growth has occurred, but the transit network has not responded. The pattern of density increase is remarkably similar to the pattern of existing residential density seen on the page 16. The largest clusters where residential density has increased in the last 26 years includes:

- » Landmark, particularly south of Duke Street;
- » East of Braddock Road Metro Station;
- » Eisenhower East;
- » North of Potomac Yard and west of Route 1 along West Glebe Road; and
- » Between North Beauregard Street and I-395.

The consistency of this donut pattern of density raises the question of why the city is shaped this way. The eastern parts of the city, particularly Old Town, Del Ray and Rosemont, were all developed before World War II. These neighborhoods were built at a time when most people walked or used transit for daily trips. Thus, these places include connected streets and moderate to high density levels to accommodate that need.

Areas in central and western Alexandria were mostly built during or after World War II, when the prevailing assumption was that most people would drive. Therefore, new developments tended to be set farther back from the street, included large parking lots for commercial development, and had disconnected street networks (to reduce cut through vehicular traffic).

The neighborhoods of Seminary Hill and Taylor Run developed as early automobile suburbs of Alexandria and Washington, with a low density pattern. And, as has been common in many places, residents of affluent, low-density suburban areas have been highly resistant to increases in density. Thus, most high-density development in recent years has been pushed toward the edges of the city.

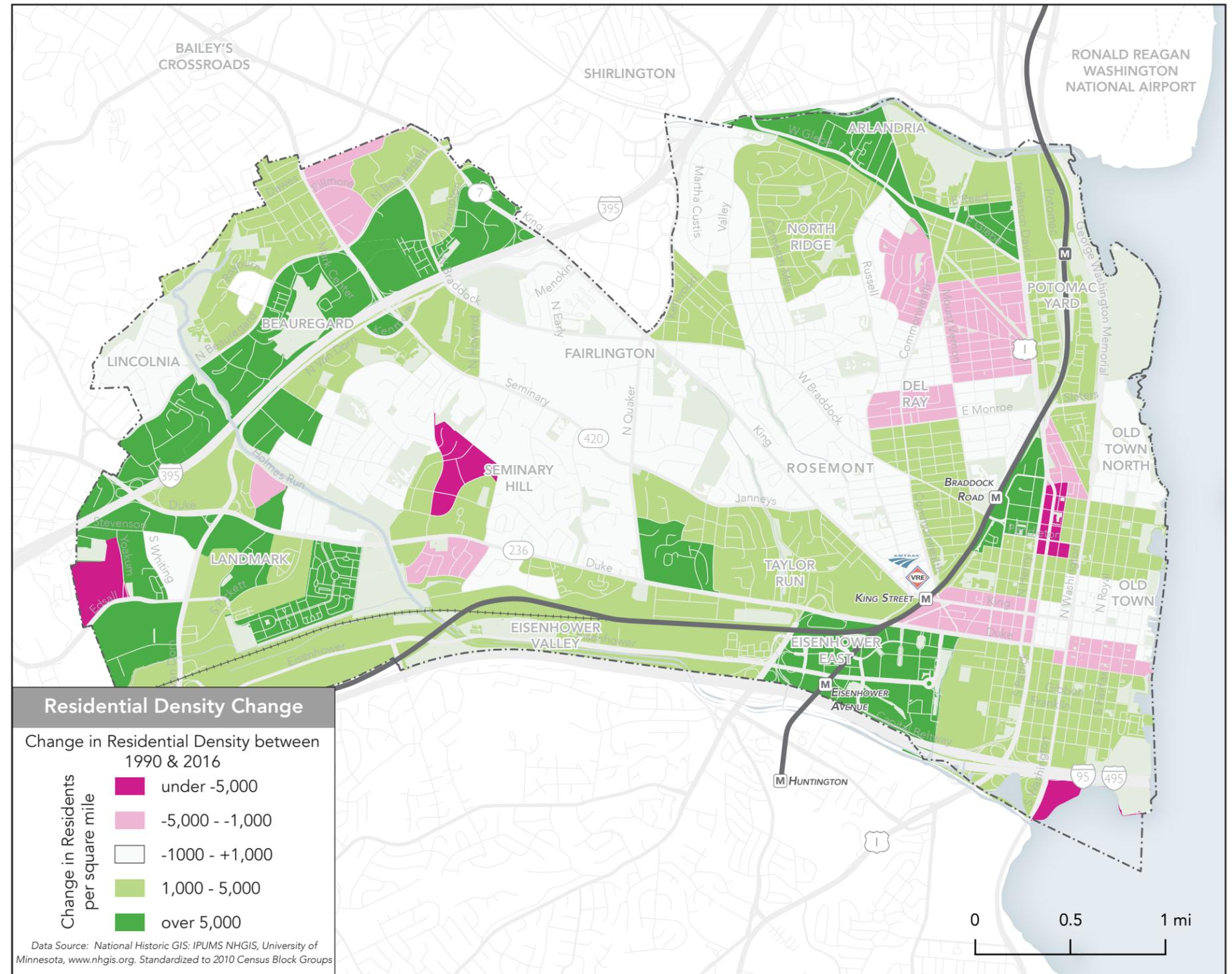


Figure 20: The change in density of residents in Alexandria shows a strong pattern of increasing density around the edges of the city.

Walkability

People will walk farther to more useful transit, but everyone has a limit. The actual distance that someone must walk to a stop is greatly affected by the way streets connect. The fewer streets that go through and connect to one another, the longer people must walk to reach a bus stop from the home, workplace, or place of origin. In addition, without sidewalks or safe crossings at major streets, people may have to walk yet further to find a safe path to a transit stop.

For these reasons, walking distances to and from bus stops can far exceed *flying* distances. Figure 21 shows the differences in walking efficiency of example locations in Alexandria based on the street network. The legend shows a geometric 1/2 mile circle, which is perfectly round, that represents the *flying* distance to a stop. But a street network is never so direct that it can provide access to the entire 1/2 mile *geometric* circle. The orange diamond shows the typical area that would be covered by a perfect street grid, and it represents the maximum efficiency possible in most street networks. The gray area is the area that can actually be walked to or from a stop within a 1/2 mile walking distance over the street network. Dividing the area in gray by the area within the orange diamond tells us how efficient the local street network is.

Circuitous streets and freeways often lead to poor walkability, while a consistent grid street network offer high walkability. Areas with high street connectivity provide short and direct paths between any two locations. For example, in Old Town and Potomac West, the mostly grid-oriented street pattern and tight block spacing leads to a walk efficiency of about 90% in both locations.

Low street connectivity, common in auto-oriented development, forces long and circuitous paths between locations, discouraging walking. The Landmark and Beauregard areas show the impact of lower street connectivity, with walk efficiency scores closer to 70%. The Eisenhower corridor is much worse (31%) due to Cameron Run, the Capital Beltway, and the railroad creating major barriers to north-south pedestrian travel. In places like Beauregard, where density is already high, walkability improvements are one of the most important capital investments that the City could make to encourage more transit ridership.

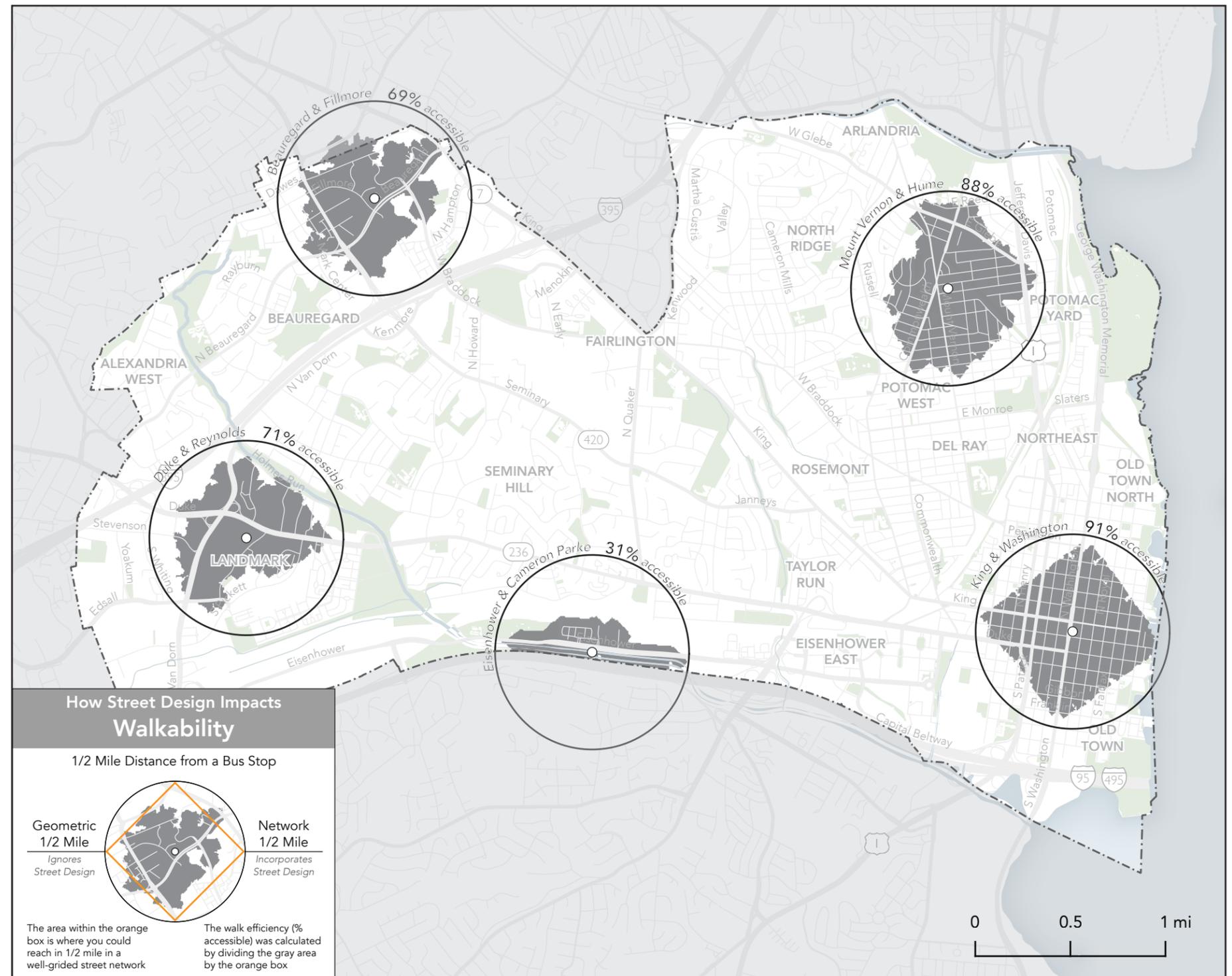


Figure 21: Well connected street networks mean that many more people can reach transit in places like Old Town.

Street Connectivity

Figure 22 describes how likely streets are to offer people reasonable-length walks to destinations that are within a straight-line *flying* distance. The map uses the same process shown in Figure 21 to analyze street connectivity across the city. The pattern clearly follows the historic development patterns of the city, with much higher connectivity in eastern Alexandria and much lower connectivity in western Alexandria.

The combination of high density and low street connectivity in western Alexandria is a limitation to the ridership potential of transit in the city.

No matter how dense each neighborhood is, and how likely the individuals living there are to use transit, it will be hard to get high ridership out of a place with lower street connectivity because it is simply so much harder for people to access a bus stop.

Density is the first, and most important land use factor affecting ridership (as discussed on page 10) because it answers the most fundamental question that governs ridership: How many potential riders are near any given transit stop?

Walkability is the second most important factor because it governs whether the people nearby can actually reach the transit stop. Street connectivity is fundamental to walkability—it governs whether a walking trip is possible at all, and how long it is.

Street connectivity also influences how safe a walking trip is. Low street-connectivity is often paired with wide, fast arterial roads and longer distances between safe crossings, because what few streets do go through have to handle all of the area's car traffic. But, wide, fast arterial roads can be found even in well connected parts of the city, such as the George Washington Parkway in Old Town North.

Other factors that are harder to measure are also critical to walkability. The presence, width, and quality of sidewalks as well as accessible infrastructure like curb cuts are important, particularly for people with physical disabilities. Walkability includes consideration of all the factors that affect how people access a bus stop by foot or with the aid of a mobility device like a wheelchair.

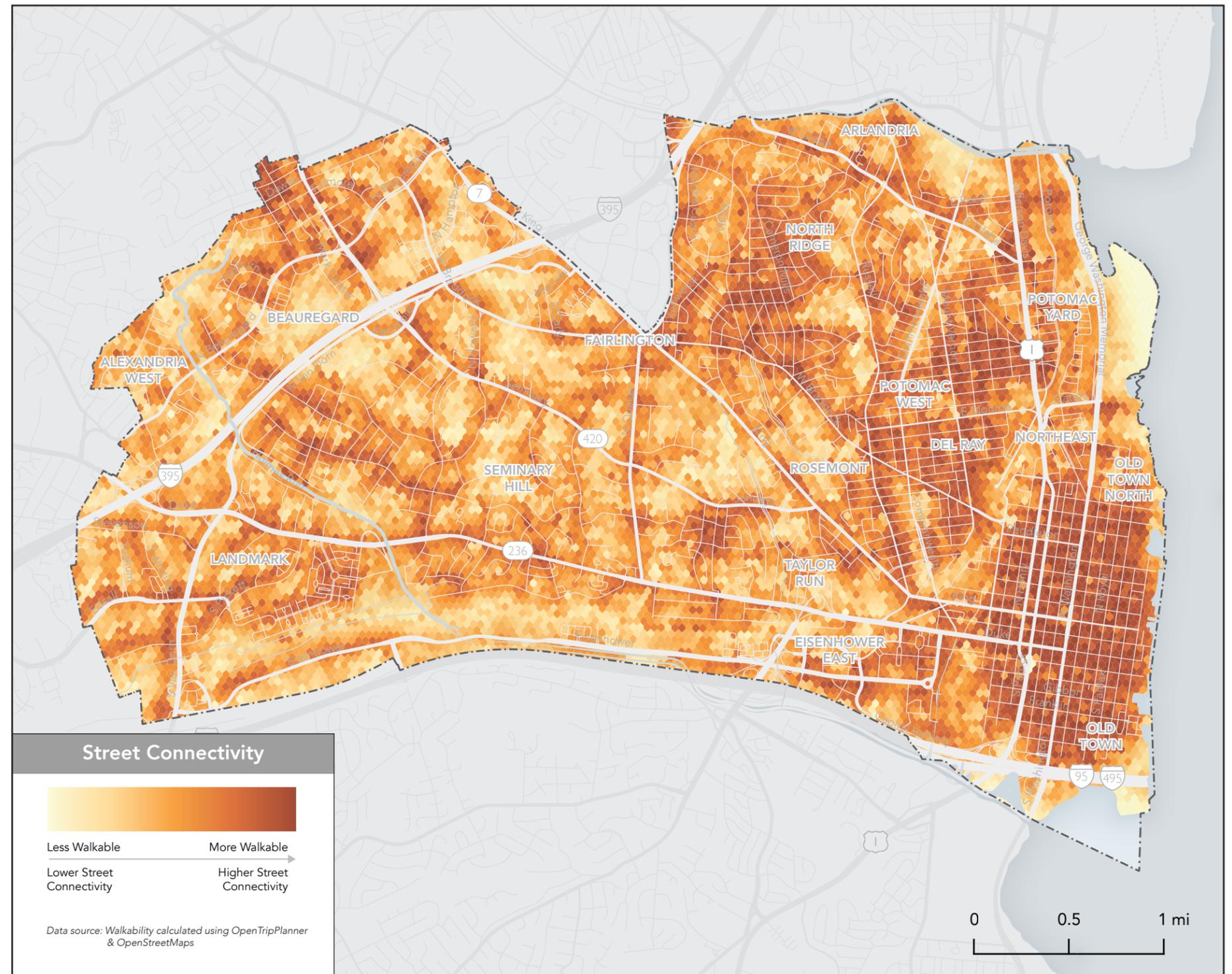


Figure 22: Street connectivity is highest in Old Town and Del Ray while it is generally much lower in the western half of the city.

Transit Commuters

The map at right shows the density of people who commute by transit based on their home location. This gives us an idea of the location of dense pockets of people who commute to work via transit, which is an important driver of transit demand. Trips to work tend to be longer than most other trips taken on a regular basis, and people are often willing to accept a longer wait for a longer trip. Also, many work trips tend to be regularly timed, so it is easier to coordinate work trips with a transit schedule. For these reasons, transit tends to capture a higher percentage of work trips than other kinds of trips. In 2016, about 22% of commute trips originating in Alexandria used transit.

However, this map tells us only so much about the whole range of transit demand. While existing commute behavior can be a good indicator, these data should not be construed as an absolute measurement of public transport use, for a variety of reasons:

- » This map shows only the home end of work commute trips; commuters are all headed to work somewhere else, where they will also generate demand.
- » The journey to work is only one of the average person's daily trips, and not everyone takes this trip. According to the National Household Travel Survey, commute-related trips are fewer than 20% of total trips.
- » Many people combine their commute with a variety of different purposes such as shopping, appointments, socializing, school, and many others. Transit can be useful for all, or any combination of these trips.

Existing transit riders are people for whom the existing network works well. There may be others for whom it could work if the network were different.

Another factor that encourages transit use in general, and particularly for work trips, is employer provided assistance for commuting expenses. Many employers in the region, and particularly the federal government agencies, provide assistance with commute expenses by subsidizing transit costs through the SmartBenefits program. The most recent regional survey indicated that 37% of all regional commuters had access to employer assistance for transit commuting, and 57% of workers in the District of Columbia, Arlington, and Alexandria received some kind of employer assistance with transit commuting costs.

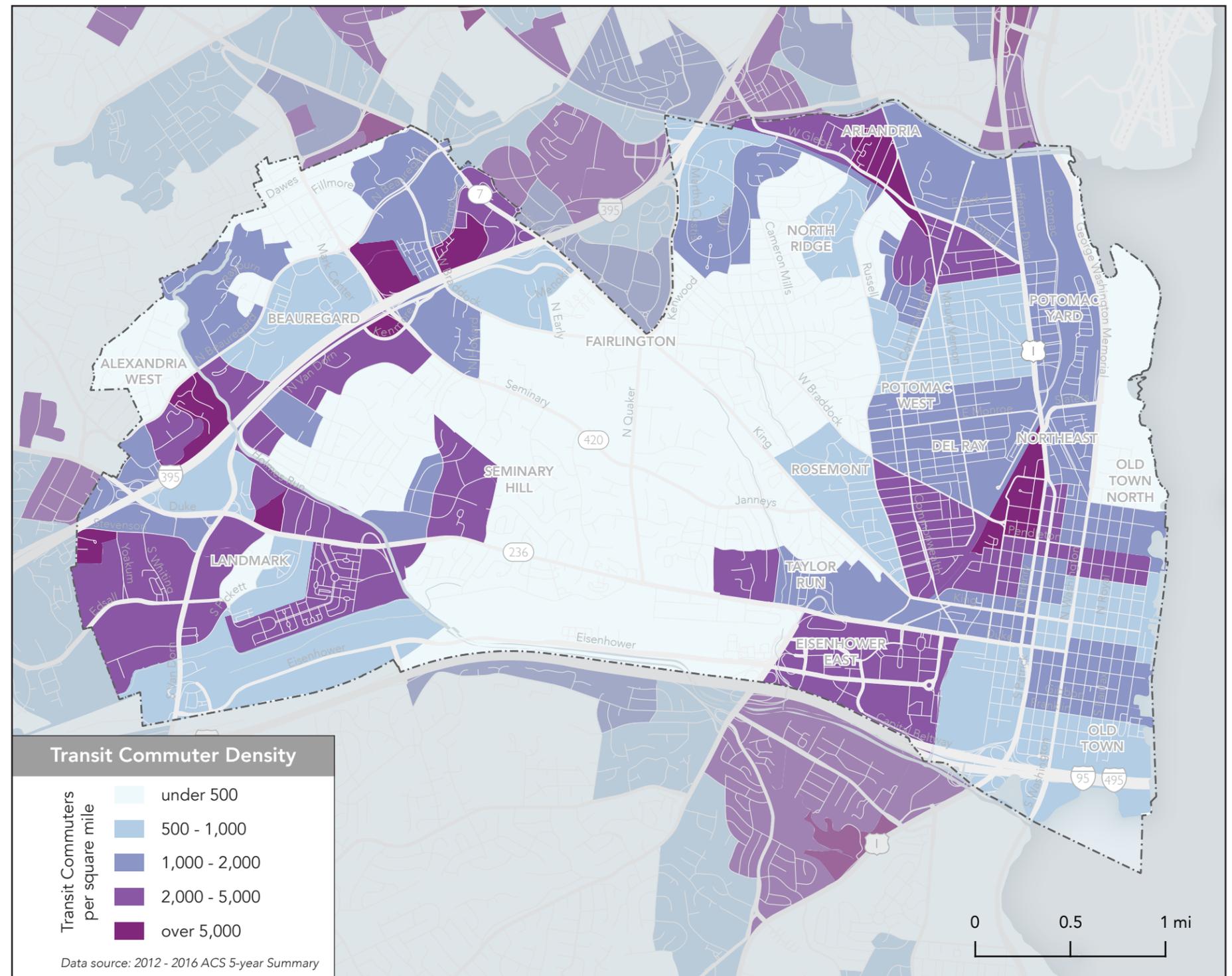


Figure 23: The density of transit commuters is highest near Metrorail stations and in Arlandria, Landmark, Lincolnia, and Beauregard areas.

Needs Assessment

Median Household Income

Figure 24 shows the median household income in Alexandria and surrounding areas. This map uses a diverging color scale with orange colors showing areas where the median household income is below \$80,000 per year, and areas in purple where the median household income is above \$120,000 per year. This dividing point is around the estimated median income for all households in Alexandria, which was \$89,200 in 2016.

The general trend of this map is that households with lower incomes tend to be on the west and northwest side of Alexandria, while higher income households live in central Alexandria and in Old Town. There are some exceptions, such as Seminary Hill and Alexandria West, where there are mixed incomes.

While it is useful to compare the income levels across the city and region, this map only shows us the relative level of income. It does not tell us about the density or concentration of low-income household. And it is the density, or concentration, that is more useful in helping us see where most low-income people live.

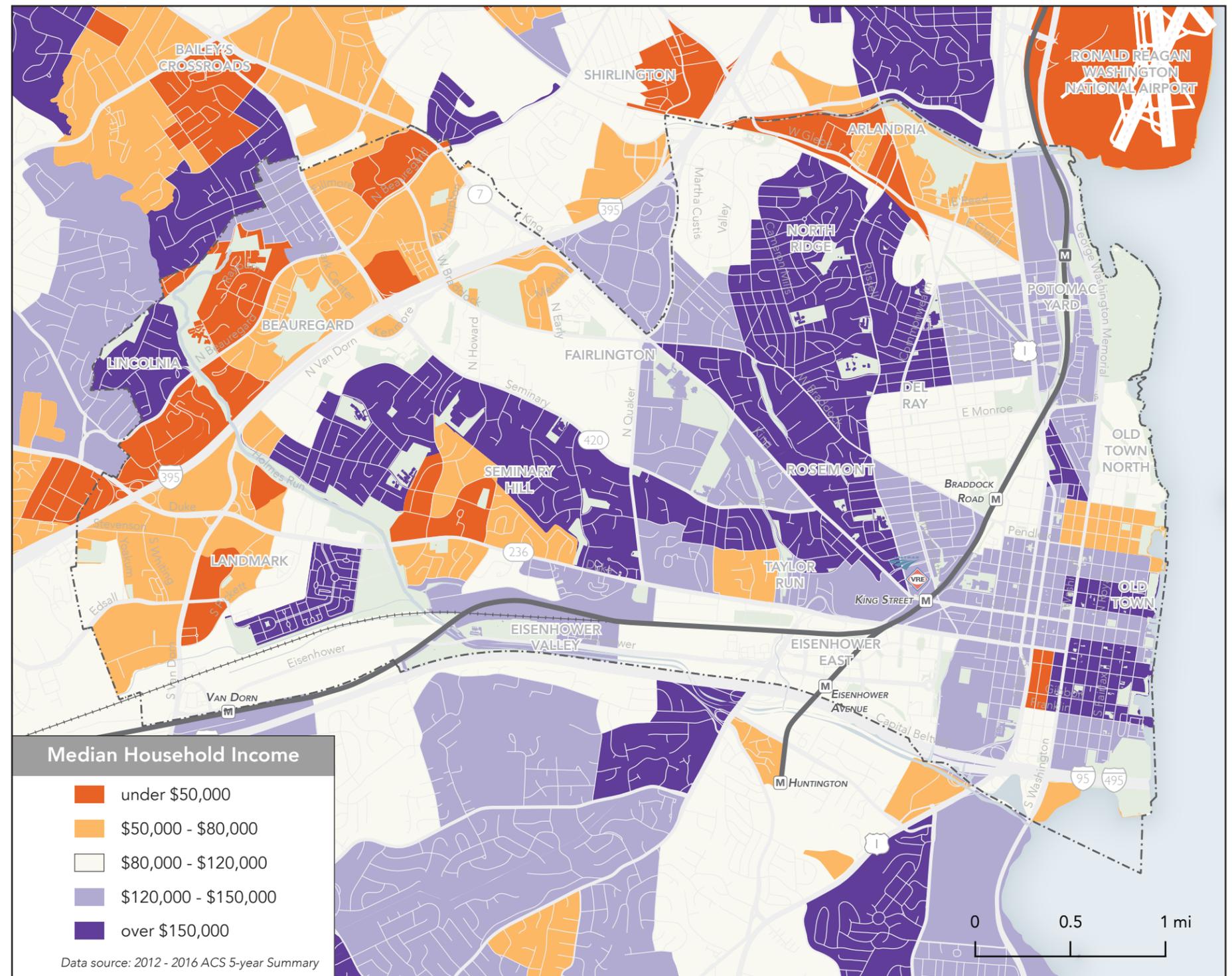


Figure 24: Median incomes are lowest around Landmark, Lincolnia, Beauregard, and Arlandria.

Poverty Density

People who are living on limited incomes can represent a strong market for transit, depending on the built environment around them.

A common misconception is that transit, especially all-day transit, is only useful to low-income people who cannot afford a car. People at all points on the income spectrum make choices about how to travel, based on their evaluation of cost, time, safety, comfort and other factors.

The more carefully a person must manage their money, the more attractive transit's value proposition may be. This doesn't mean that lower-income people will automatically choose transit because it's the cheapest option. Transit service must be useful and reliable for the kinds of trips they need to make, to compete for their ridership.

Figure 25 shows the density of people in poverty in Alexandria. The areas with the highest density of residents living in poverty are overwhelmingly in the Landmark area and the northeast area of Beauregard (north of I-395 and east of Seminary Road). There is high and moderate density in Old Town, Old Town North (particularly near the Braddock Road Metrorail station), southern Seminary Hill, and Arlandria.

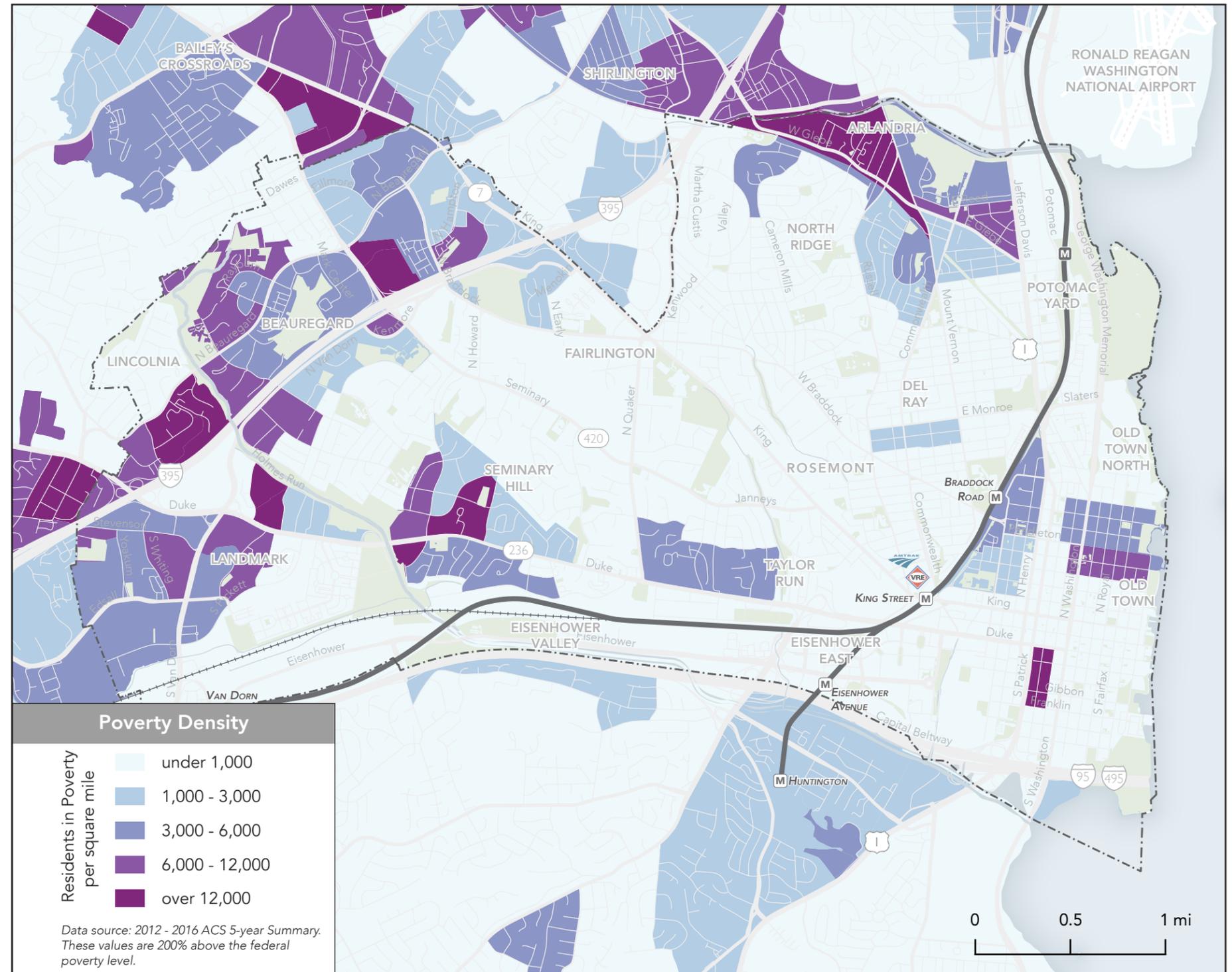


Figure 25: The density of poverty is highest around Landmark, Lincolnia, the northern Beauregard area, and Arlandria.

Zero-Vehicle Households

Figure 26 shows the density of households without any vehicles available in Alexandria. Darker areas have more households without vehicles.

The greatest densities of households without vehicles are in Landmark, Arlandria, the area around Braddock Road Metro, and at Southern Towers (north of I-395 and east of Seminary Road). If we compare this map to a map of Poverty Density on page 28, these areas without vehicles often correspond to dense areas of people with low income. However, the poverty map also shows areas where there are many low-income residents but high car ownership. These areas include parts of Old Town, Old Town North, Del Ray, the northern parts of North Ridge, and the area along Van Dorn Street north of Duke Street along I-395.

People living at low incomes may require a personal car, if they live and work in places and at times when transit doesn't operate, or if they can't afford to wait for infrequent transit. Some low-income people living south of Duke Street and east of Van Dorn Street, or north of Duke Street along Van Dorn Street east of I-395, appear to be more likely to own cars (based on these two maps) than are low-income people living in Arlandria. This may relate to the usefulness of transit in those places: somewhat frequent, long-span transit between Seminary Road and King Street, north of I-395 (Route AT1, AT2, AT9), may have attracted low-income residents, because it allows them to live and work with fewer cars.

Areas of high poverty and high car ownership are potentially ripe for more transit ridership, if they also have some of the four geographic factors that drive high ridership (density, walkability, linearity, and proximity). Areas of high poverty that do not meet any of the four factors are often high priority areas to serve with coverage-oriented transit service. And in general, serving low income households with transit is part of a larger strategy for making these households wealthier, by reducing their need for a car and, thereby, reducing their transportation costs.

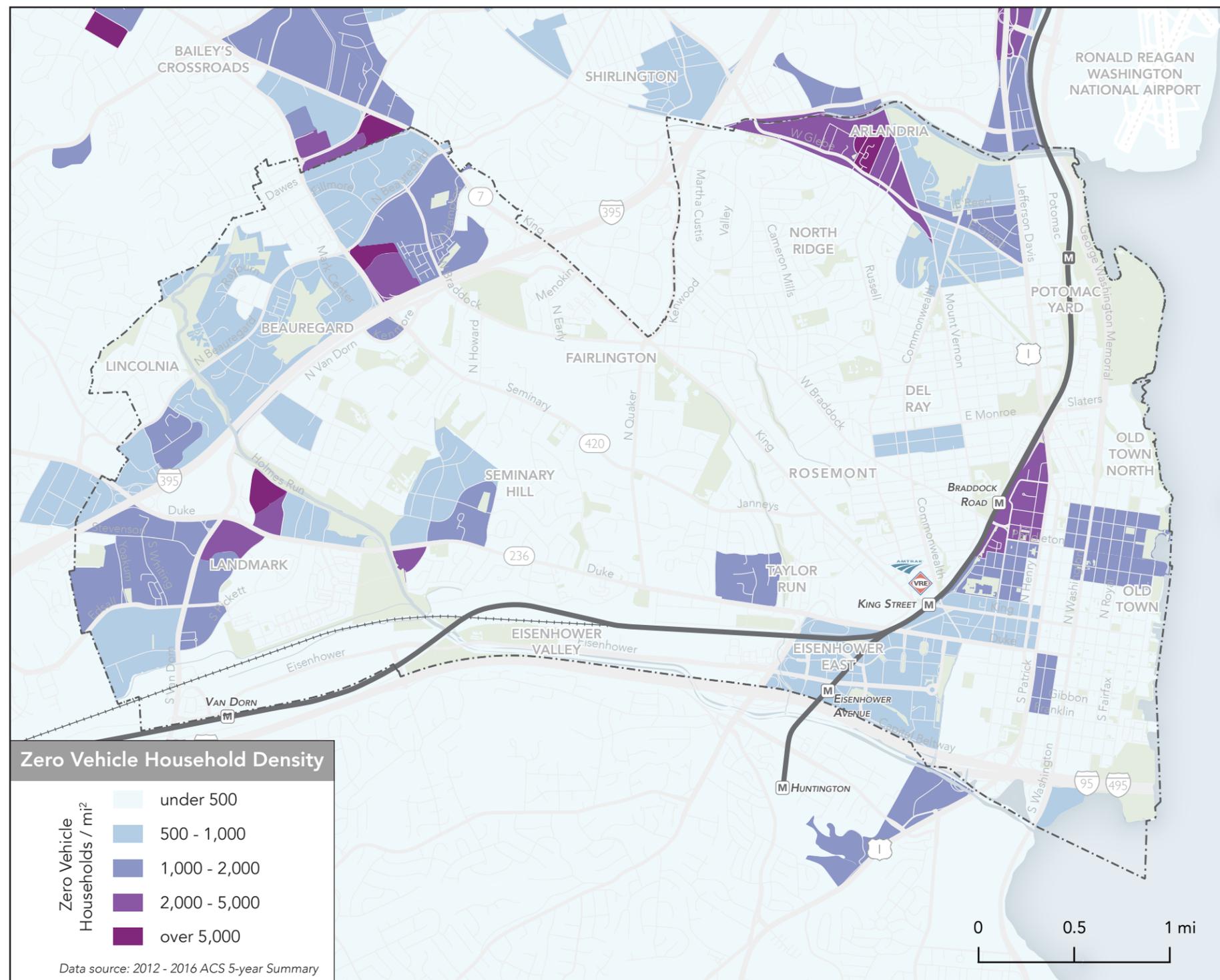


Figure 26: The density of zero-vehicle household is highest at Braddock Road Metrorail, Southern Towers, Arlandria, and Landmark.

Density of Minority Residents

Figure 27 shows the density of minority residents in the Alexandria area. The definition of minority residents includes anyone who identifies as a race or ethnicity other than Non-Hispanic White. Darker areas on the map have higher densities of minority residents.

Race and ethnicity, by themselves, are not indicators of transit demand or need, though they often correlate with other indicators such as low income. However, this information is important for assessing a plan's compliance with civil rights laws that prohibit disparity of outcomes based on these factors.

While our current civil rights laws provide specific protections for transit service for minority residents through Title VI and other laws, those protections are generally limited to ensuring that service changes do not disproportionately affect minority residents in a negative way. These laws do not require us to think about how transit service can actually be useful to minority communities.

Given the history of political, economic, and social discrimination against minorities at a national, state, and local scale, we should be considerate of how this past discrimination still affects the city today and how transit service can affect the lives of minority residents today. But where minority residents live is only one part of the story. For transit to be useful to minority residents, or any resident, it must connect them to jobs, shops, medical centers, and all the other necessities of life.

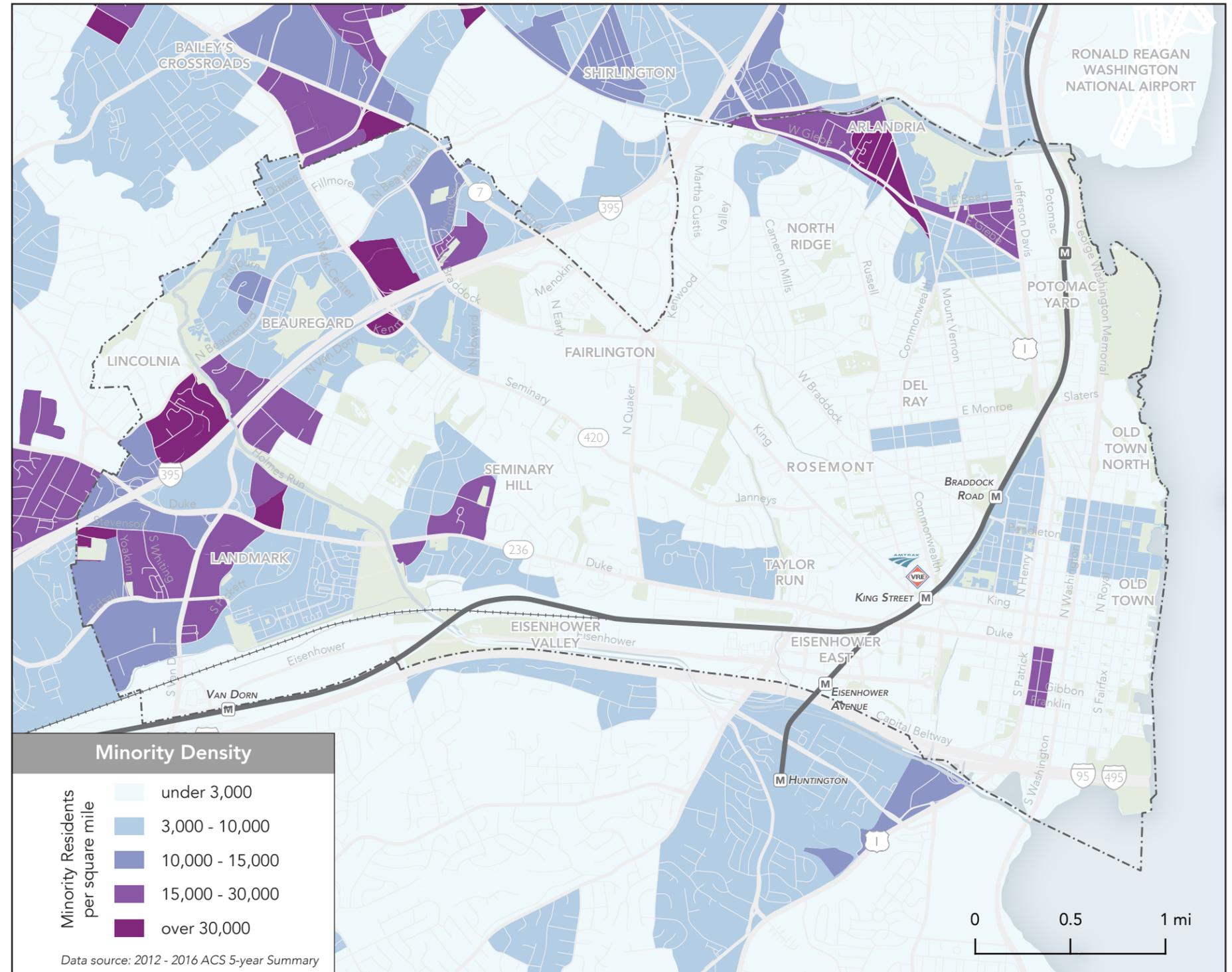


Figure 27: The density of minority residents is highest in Arlandria, Landmark, Lincolnia, and Beauregard areas.

Senior Density

A major value of transit coverage is providing service for people who cannot drive, no matter where they live. This need can be particularly acute among seniors.

Figure 28 shows the density of residents over the age of 65 in Alexandria. The highest densities of seniors are in Landmark and the north section of Beauregard. There is a moderate density of seniors in Old Town and Old Town North as well.

Seniors' needs and preferences are, on average, different from those of younger people.

- » Seniors are more likely to be discouraged by long walks, because a higher percentage of seniors have limitations on their physical ability than among younger people.
- » Seniors are less likely to be discouraged by long waits for transit, because on average they are less likely to be in a hurry.
- » For the same reasons, seniors are less likely to be discouraged by slow or indirect routes that take them out of their way.

Because of these factors, transit service designed primarily to meet the needs of seniors rarely attracts high overall ridership. Most riders who are employed, in school or caring for kids in school will find service with long waits to be intolerable. Thus, the amount of focus that transit agencies place on meeting the needs of seniors must be thoughtfully balanced with the needs and desires of the rest of the community.

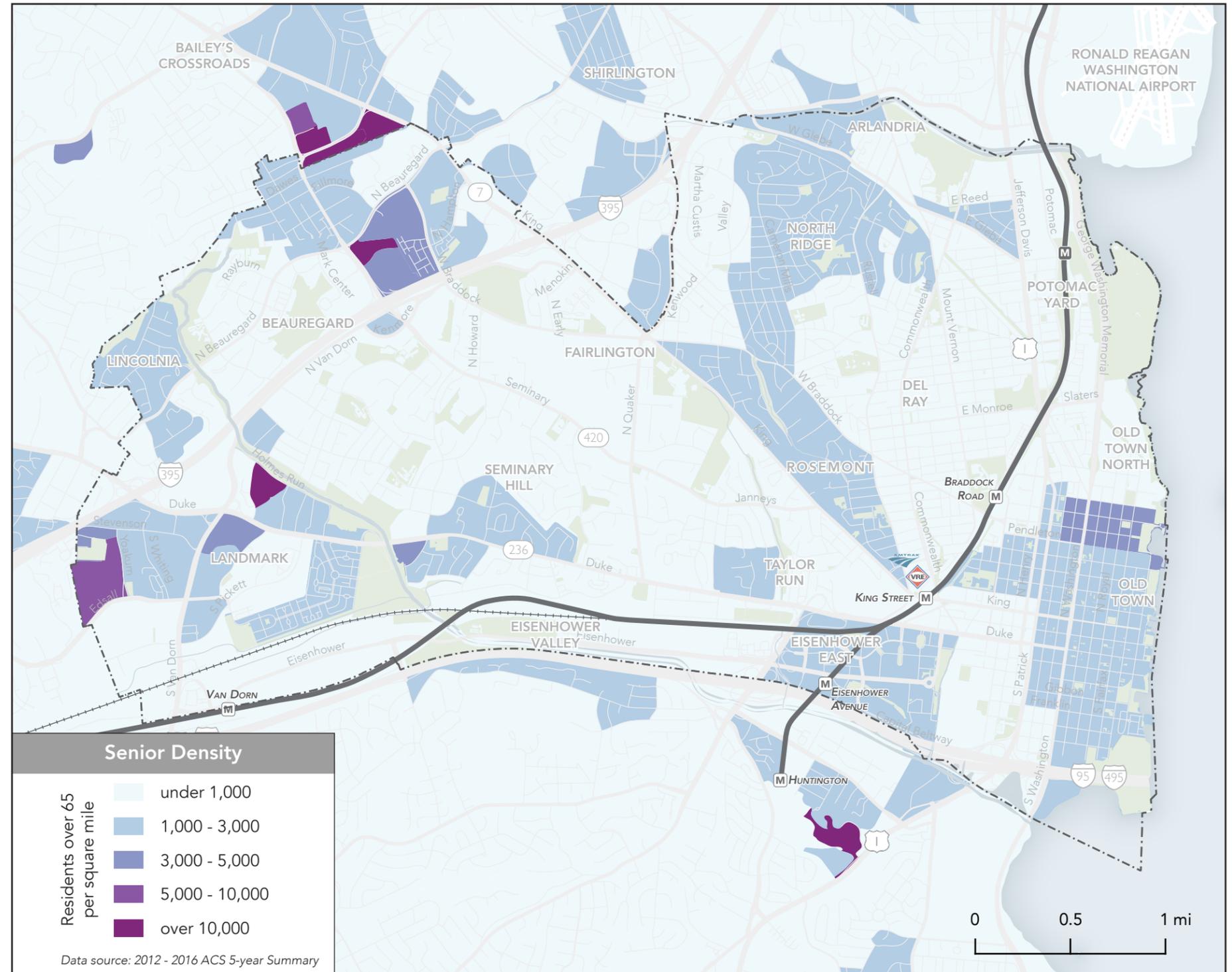


Figure 28: The density of senior residents is highest in Landmark and northern Beauregard areas.

Youth Density

Just as transit coverage can meet the needs of seniors who cannot or choose not to drive, transit coverage can also meet the needs of children and teenagers who are too young to drive.

Figure 29 shows the density of residents under the age of 18 in Alexandria.

Like seniors, young people often live on a tighter budget than people of working age. For this reason, both are very sensitive to transit fares, and parents are sensitive to paying a fare for each child.

However, young people and seniors are very different in their ability and willingness to walk to transit service. Most young people can and will walk farther to reach service than seniors.

Whatever effect an increase in price has on ridership among working age people, it will have an even stronger effect on ridership among younger people and seniors. (This is why most transit agencies, along with movie theaters and other for-profit businesses, offer a discounted price for seniors and children.)

A few areas have moderate to high densities of young people:

- » Landmark
- » Parts of Seminary Hill
- » Lincolnia
- » Arlandria
- » Northern Beauregard

Youth and seniors both tend to have a higher need for transit, but each group has different preferences—seniors tend to prefer less walking than youth.

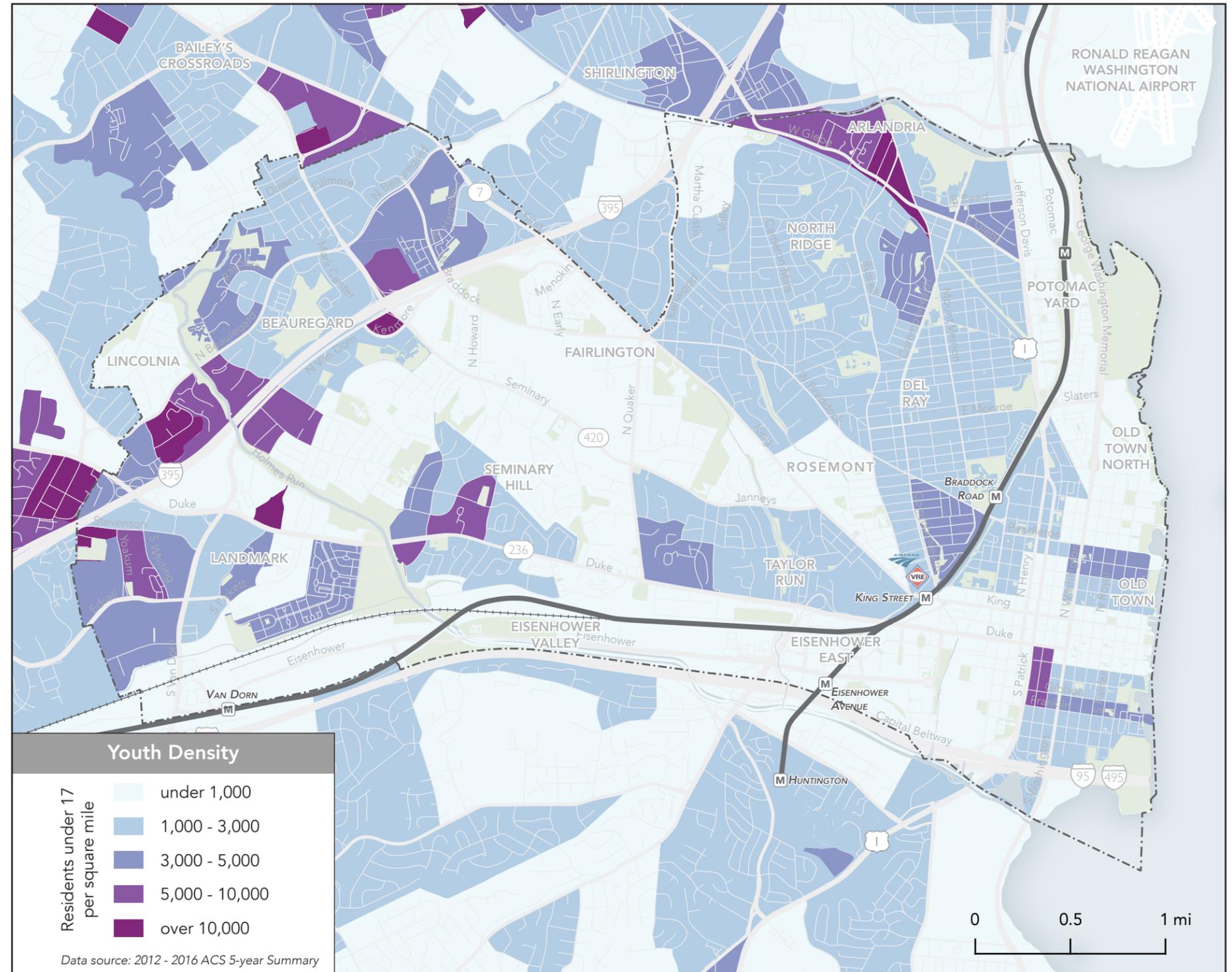


Figure 29: The density of young residents is highest in Landmark, Lincolnia, northern Beauregard, and Arlandria.

Commuting Patterns

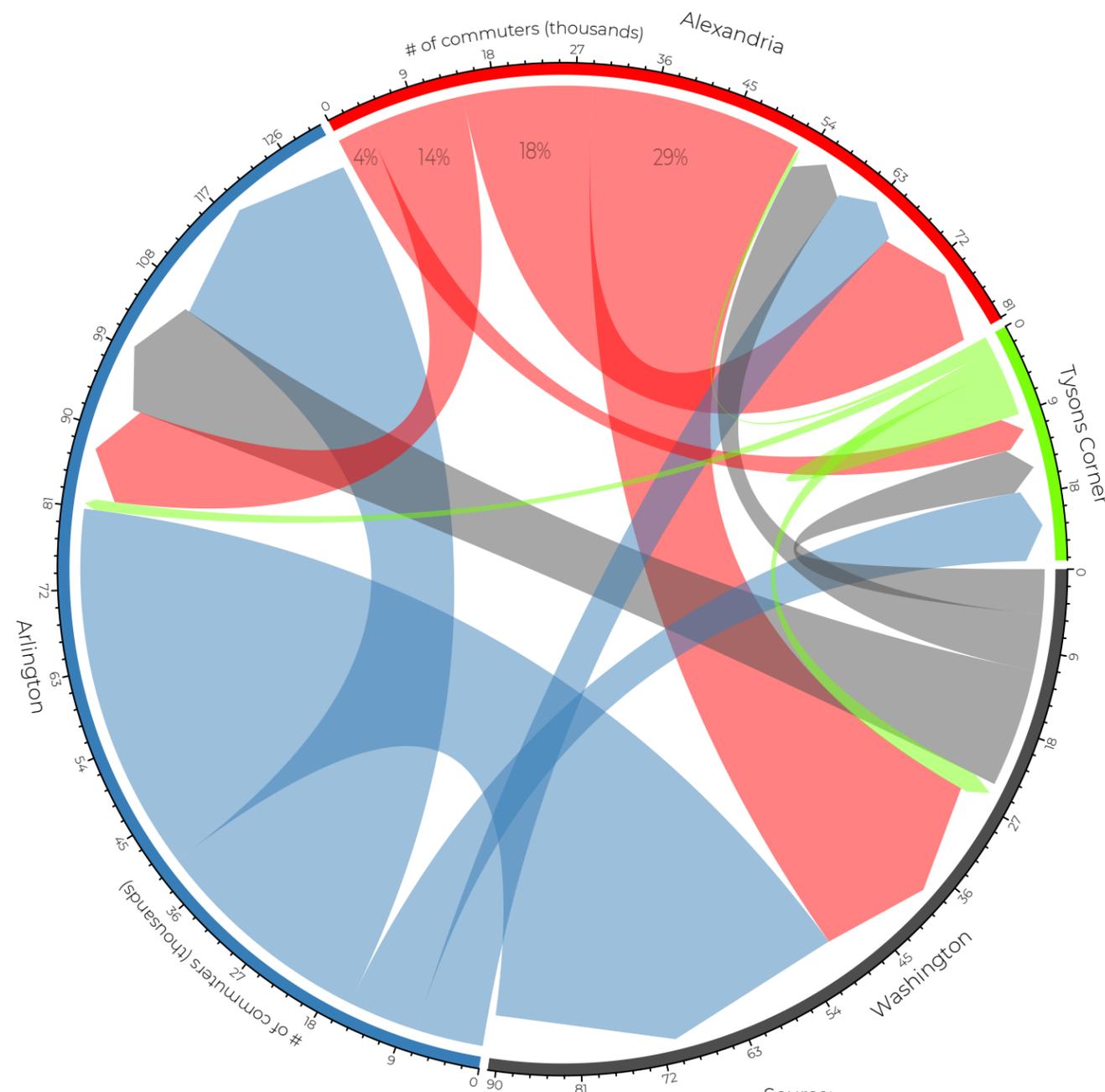
The circular diagram in Figure 30 represents the flows of commuters among places within and between Alexandria, Arlington, Washington, and Tysons Corner, by car, transit, or any other mode, as of 2015, based on Census data. Trips originating in each place are color-coded; for example, trips originating in Alexandria are shown in red. Trips that start and end within Alexandria appear as a red “hump,” and trips from Alexandria to jobs in Washington appear as a red band going from the top of the diagram to the bottom right. The wider the colored band (or hump), the more commute trips it represents.

A very high proportion of commutes by Alexandria residents are to jobs in Washington, compared to other places. The second largest group of Alexandrians are commuting to jobs within the city. And the third largest group of commuters originating in Alexandria are going to jobs in Arlington County.

Compared to the commuter outflows from Alexandria, there are relatively few commuter inflows from Washington or Arlington to jobs within Alexandria.

The trips shown in this diagram are a very small minority of the trips that people make in the region! Nationally, less than 20% of people’s trips are to and from work. The rest are trips to socialize, shop, access services, and do all of the other things that make for a complete life.

Work trips are, however, well-suited to transit, for a few reasons: they are longer than other types of trips, job sites are more likely to have parking constraints than other destinations, and people make work trips so regularly that they can plan ahead for a regular transit itinerary.



Source: LEHD 2015
Percent of commuters does not sum to 100% because not all commute destinations are included.

Figure 30: The flow of commute trips in the region shows that many Alexandrians are commuting out of the city to DC and Arlington.

Trip Patterns

Patterns of density, walkability, and demographics tell us much about transit ridership potential. But actual trip data can also shed light on possible transit markets. In recent years, the proliferation of cell phone usage with highly accurate location information has provided transportation planners with a wealth of new data on how people are actually traveling in their daily lives. StreetLight Data is a transportation analytics company that provides origin-destination information based on historical samples for cell phones. This data provides information about where and when people are traveling, based on historical data collected 24 hours a day, 365 days a year.

These data are a relative sample of trips, reported in an index format that has been normalized across the nation. These data enable analysis of far more trips than transportation planners have been able to analyze in the past. And it allows us to compare and contrast the magnitude of trips completed from one origin-destination pairing to another. Additional detail and methodology related to this origin-destination analysis is presented in Appendix 1.

Activity Center Analysis

Since Alexandria is one part of the much larger Metropolitan Washington region, trips **to** and **from** major activity centers across the region are an important part of the potential transit market. Figure 31 shows the trip indices **from** 18 regional activity center origins **to** areas in the City of Alexandria. The activity centers with the highest relative trip flows are close to the city: Columbia Pike Corridor, Crystal City, and the Pentagon/Pentagon City. Crystal City and the Pentagon/Pentagon City are well connected to eastern Alexandria by Metrorail, but Columbia Pike Corridor is not as well connected by transit to most of Alexandria.

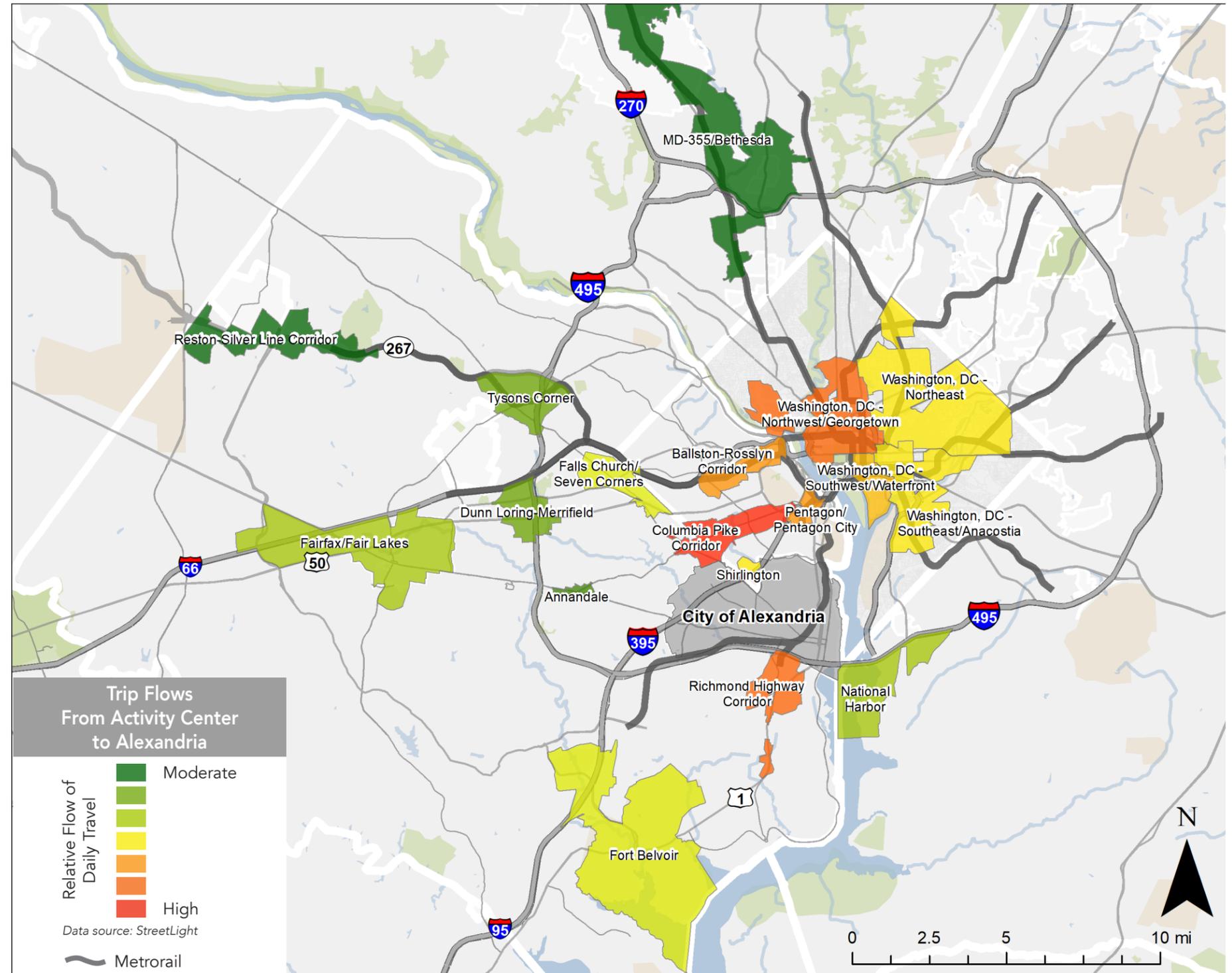


Figure 31: The regional activity centers closest to Alexandria, like the Columbia Pike Corridor, have the highest relative flow of trips to and from Alexandria.

Figure 32 shows the comparison of trip indices **from** Alexandria **to** the 18 regional activity centers. Like the previous figure, the centers with the highest activity are close to Alexandria.

The Columbia Pike Corridor stands out as the highest rated activity center for both origins and destinations. Also, the Pentagon/Pentagon City and Richmond Highway Corridor activity centers rated high in both origins and destinations. Because those activity centers are not far from Alexandria, a key factor in transit trip times for going to or from those location would be the wait time for a bus or train.

Crystal City and Pentagon/Pentagon City have frequent transit service via Metrorail and Metroway bus service. The combination of Metrorail and Metrobus 16 routes provides a frequent connection from eastern Alexandria to the Columbia Pike Corridor, but there is no frequent transit service to the Columbia Pike Corridor from western Alexandria. While the Richmond Highway Express service is very popular, the frequency of service at midday is only every 30 minutes.

Tolerance for waiting is proportional to trip distance. For transit to compete for trips to nearby regional activity centers, like the Columbia Pike Corridor, service must be frequent, so that waits are short.

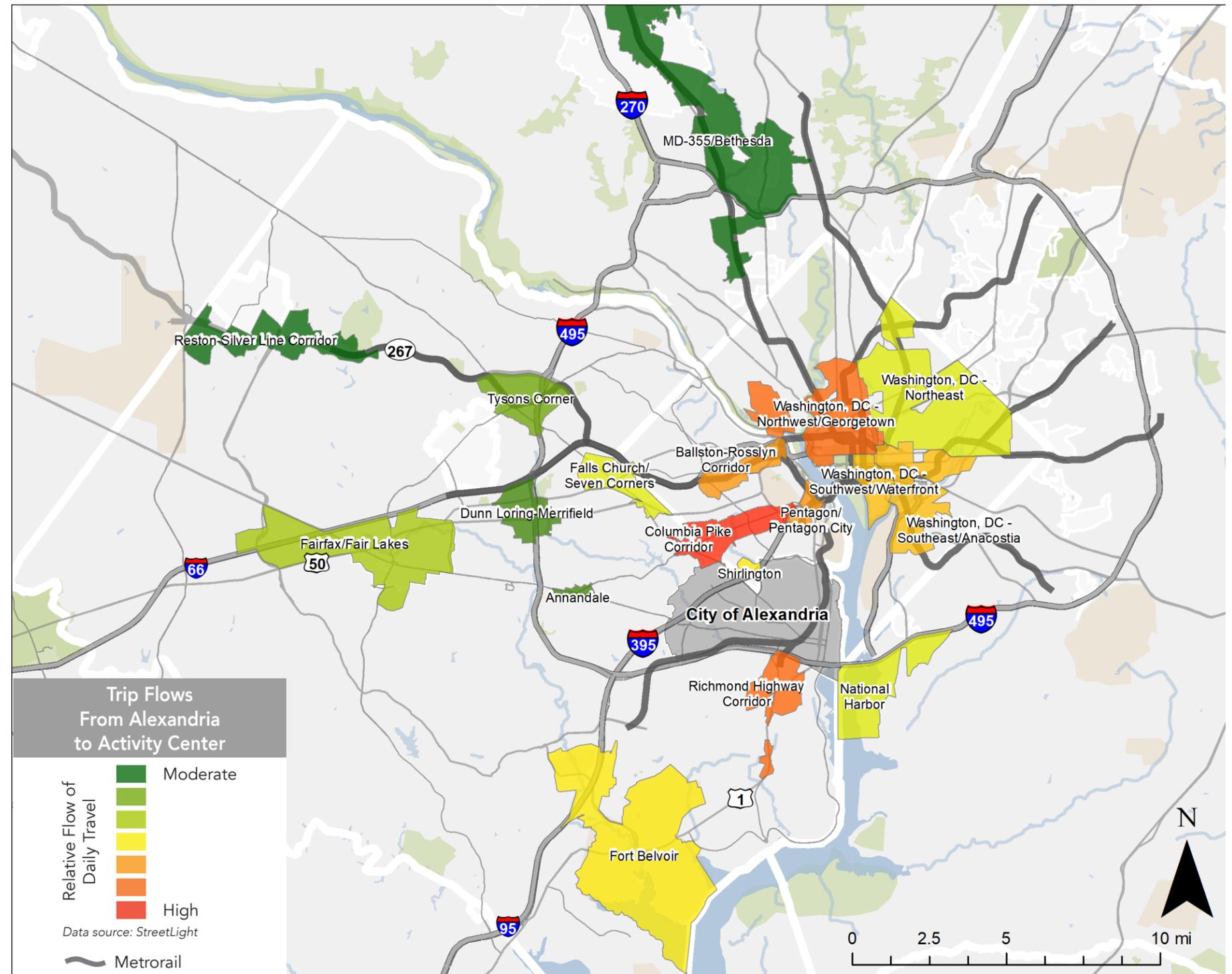


Figure 32: Similar to the previous figure, the regional activity centers closest to Alexandria, like the Columbia Pike Corridor, have the highest relative flow of trips to and from Alexandria.

Internal and Adjacent Origin-Destination Analysis

Since most DASH service is within or very close to the city, it is useful to look at trip patterns just within or adjacent to the city. Data from StreetLight about all weekday and weekend trips between 84 zones (64 within Alexandria and 16 in adjacent areas) were analyzed to show the trip patterns in the maps below.

Figure 33 shows the direction and relative magnitude of all trips between the top 50 origin and destination pairs on an average weekday. Figure 34 shows the same information for an average weekend. Note that the starting and ending location of the arrows in the maps

correspond to the geographic center of each zone, and not a specific destination or origin within each zone. This analysis includes trips with a center-to-center distance of over one mile. For this analysis, the number of vehicle trips was estimated using a calibration of the StreetLight Index based on reported traffic volumes (see Appendix 1).

These maps show that most trips are going to or from Old Town, the Landmark area, Crystal City, and Shirlington/Fairlington areas. The most common weekday origins include Crystal City, Arlington Ridge, Lincolnia, and Landmark. The most common weekday destinations include Landmark, Potomac Yard, and the Beaugard area. Weekend trips follow similar trends

as the weekday trips, although generally the trips are shorter in length, with less activity around Eisenhower Avenue Metro rail station, and more activity occurring within Old Town.

Figure 33: Most weekday trips to and from areas within and near Alexandria are relatively short.

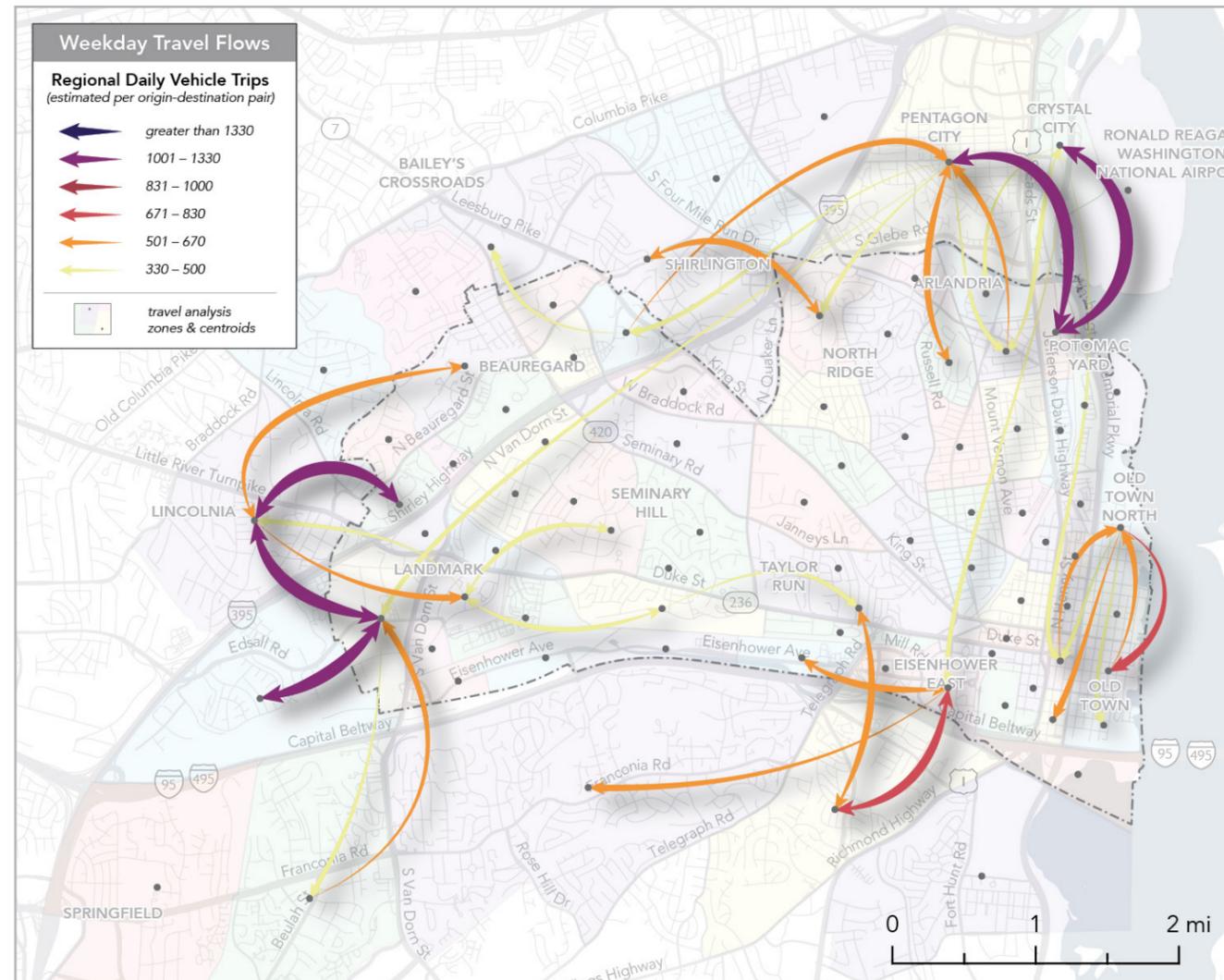
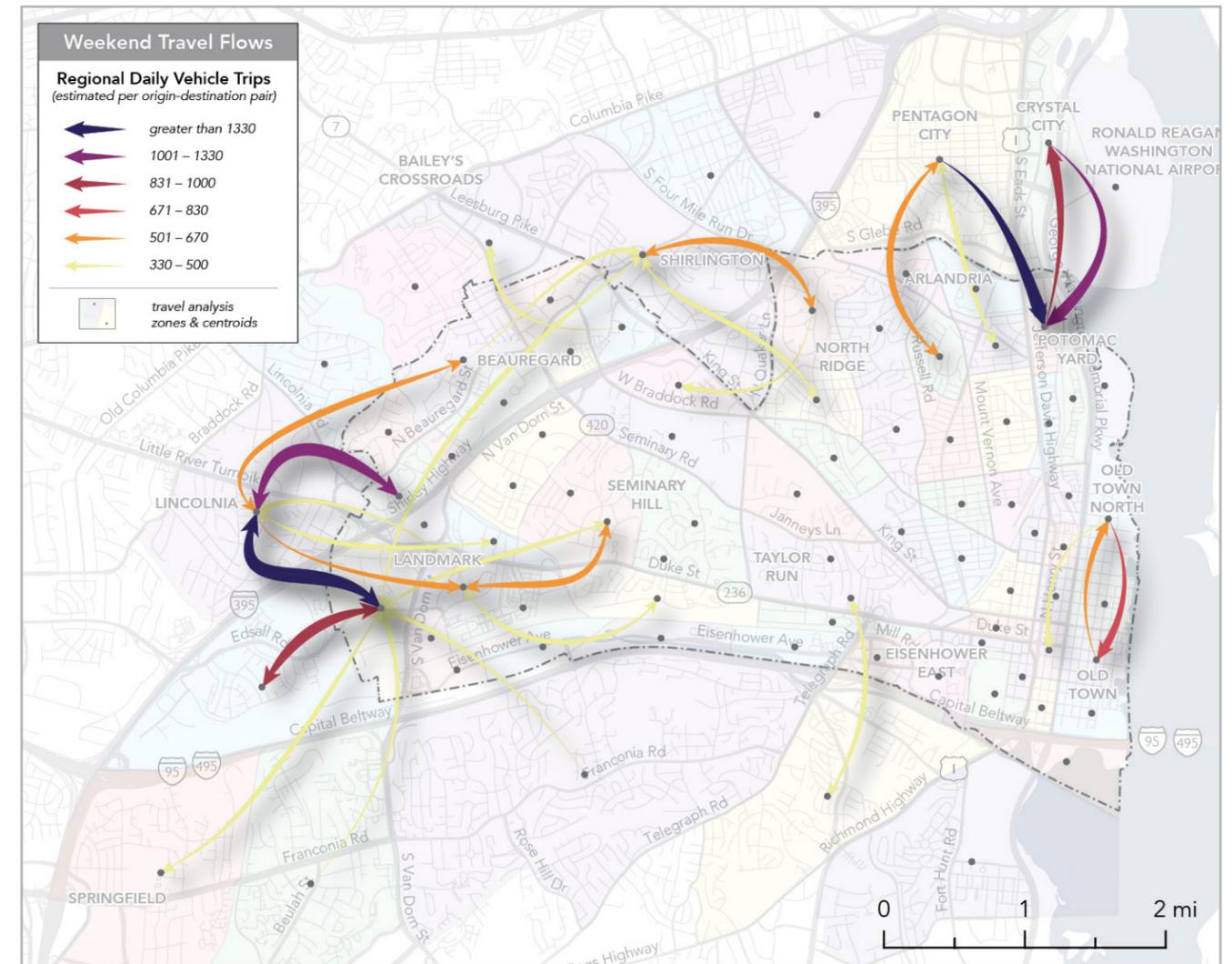


Figure 34: Weekend trips show a similar pattern to weekdays, though the magnitude is lower.



Internal Origin-Destination Analysis

Figure 35 shows the top 50 origin and destination pairs for weekday trips entirely within Alexandria, while Figure 36 shows the same data for weekend trips. The top trip pairs are primarily in the Landmark and Old Town areas. On weekdays there is more activity in Eisenhower East and the northern Beaugard area.

Most of the trips identified in this analysis are very short. And for short trips by transit, the largest part of travel time is the wait time for a bus or train. For trips less than two miles, transit is rarely competitive, even at very high frequency (10 minutes or better).

Therefore, where trip data is showing high demand for short distance trips, and it is hard to walk or bike between those areas, transit may not be the best solution in the long term. Pedestrian and bicycle infrastructure improvements may be the better investment.

Note that of all average weekday trips that begin or end within the City of Alexandria, approximately 48% were completed wholly within city limits. For further information on the origin-destination analysis with StreetLight data, see the Origin-Destination Data Technical Memorandum (Appendix 1).

When wait time and in-vehicle time are included, walking or biking is often faster than taking transit for trips less than two miles.

Figure 35: Most weekday trips that stay within Alexandria are very short.

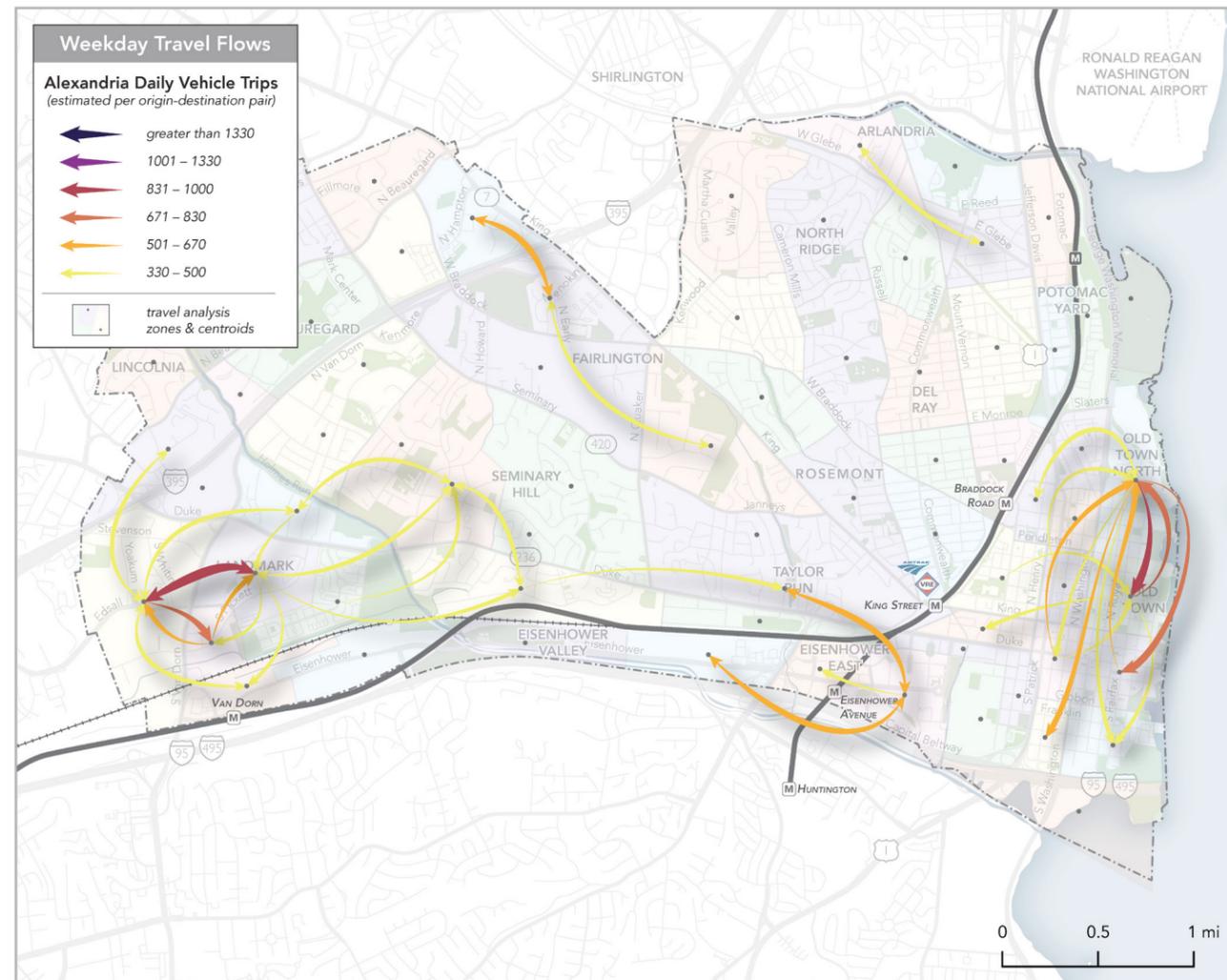
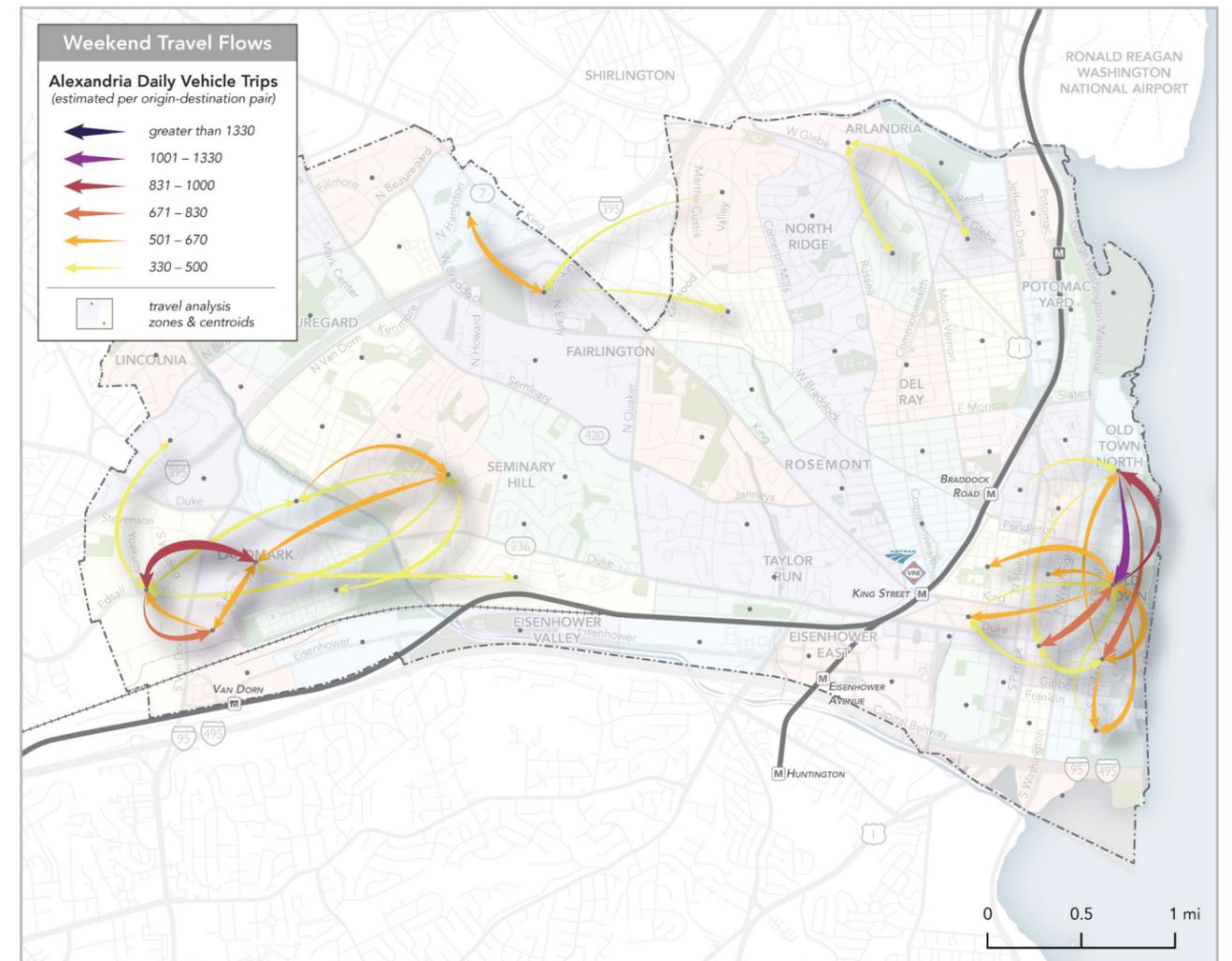


Figure 36: Weekend trips tend to be shorter than weekday trips.





3. Current Plans

How has Alexandria planned for transit?

Current Plans

This Transit Vision is not the first or last plan that will guide transit and transportation in Alexandria. Many previous plans have guided the development of transit and land use in the city, and continue guiding it today. In reviewing the current land use and transportation plans, a number of key themes that overlap between them have been identified. Additionally, several surveys are conducted by the City of Alexandria and DASH and these were reviewed for key input toward the development of the Transit Vision and to inform priorities of the citizens of Alexandria and DASH riders.

City's Strategic and Transportation Master Plans

Two major guiding documents for the City of Alexandria are the City Strategic Plan and the Transportation Master Plan. This section briefly describes each plan and summarizes some key themes that are takeaways related to transit planning. These themes should be strongly considered in the development of goals and objectives for the Transit Vision.

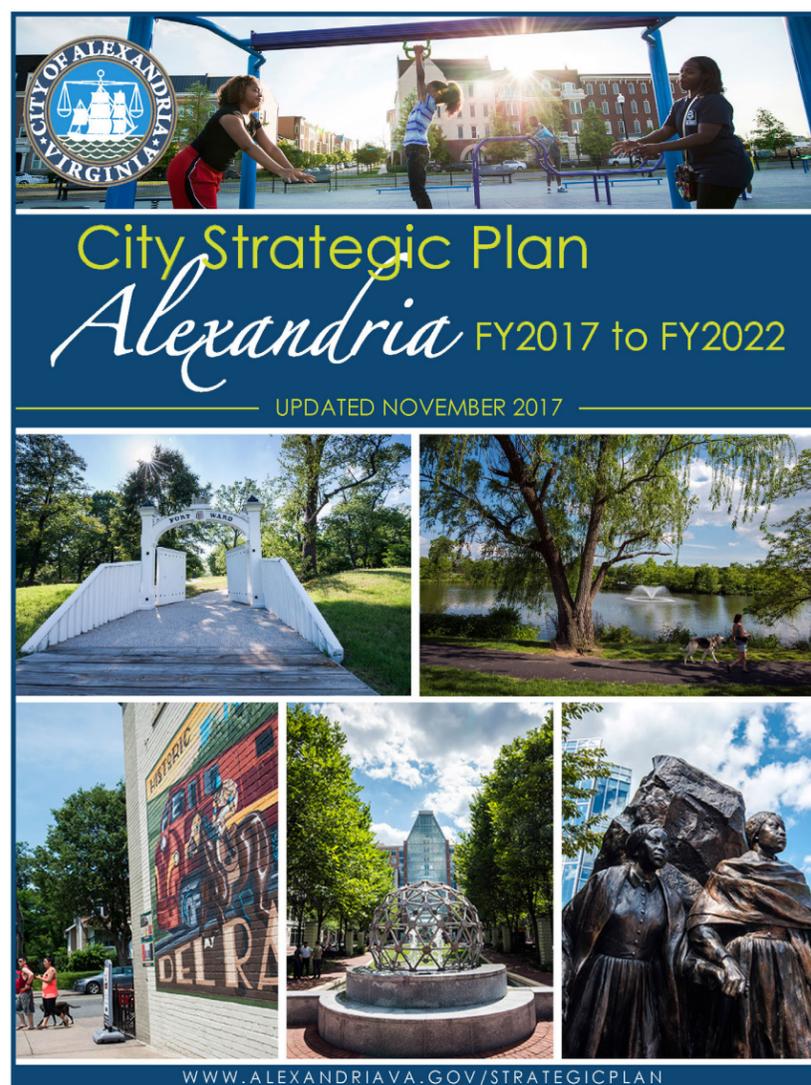
City Strategic Plan, Alexandria FY2017 to FY2022

On January 28, 2017, the Alexandria City Council unanimously adopted a Strategic Plan for Fiscal Years 2017 to 2022. The plan was updated in November 2017, with new action items that will get the City closer to the goals for 2022. The Plan is being used by City Council and staff to guide the City's direction and priorities for the next five years. It contains ten thematic areas, key indicators, and action items. Transit service can apply to almost all thematic areas but is especially relevant to:

- » Distinctive and Vibrant Neighborhoods
- » Inclusive City
- » Strong Economy
- » Environmental Sustainability
- » Healthy Residents
- » Multimodal Transportation

In 2022, Alexandria is regionally linked and easy to navigate regardless of resources or ability. City government supports a wide variety of safe, connected transportation options that enable access to daily activities. These options include bus, metro, bicycle, automobile, and walking. Public transportation has reliable and frequent service that is clearly communicated and understood.

City of Alexandria Strategic Plan – Multimodal Transportation Vision



Comprehensive Transportation Master Plan

In 2008, the City of Alexandria first developed the concept-oriented Transportation Master Plan (TMP) with the objectives to successfully integrate and link walking, bicycling, and transit together, providing connectivity and accessibility to all of the City's recreational, cultural, and economic assets, along with those of the greater Northern Virginia region. The plan aims to prioritize people and goods' mobility and improves access to economic, social and leisure activities. As Alexandria becomes increasingly urban, technology-driven integrated mobility solutions will be key to providing safe, reliable, efficient and equitable mobility for all Alexandrians.

The Transit Concept portion of the TMP outlined a progressive vision for the future of travel throughout the City with a system of innovative transit vehicles operating along three primary transit corridors within secure rights-of-way dedicated exclusively to transit use. The three corridors identified and their current status (as of July 2018) are summarized below and shown in Figure 37.

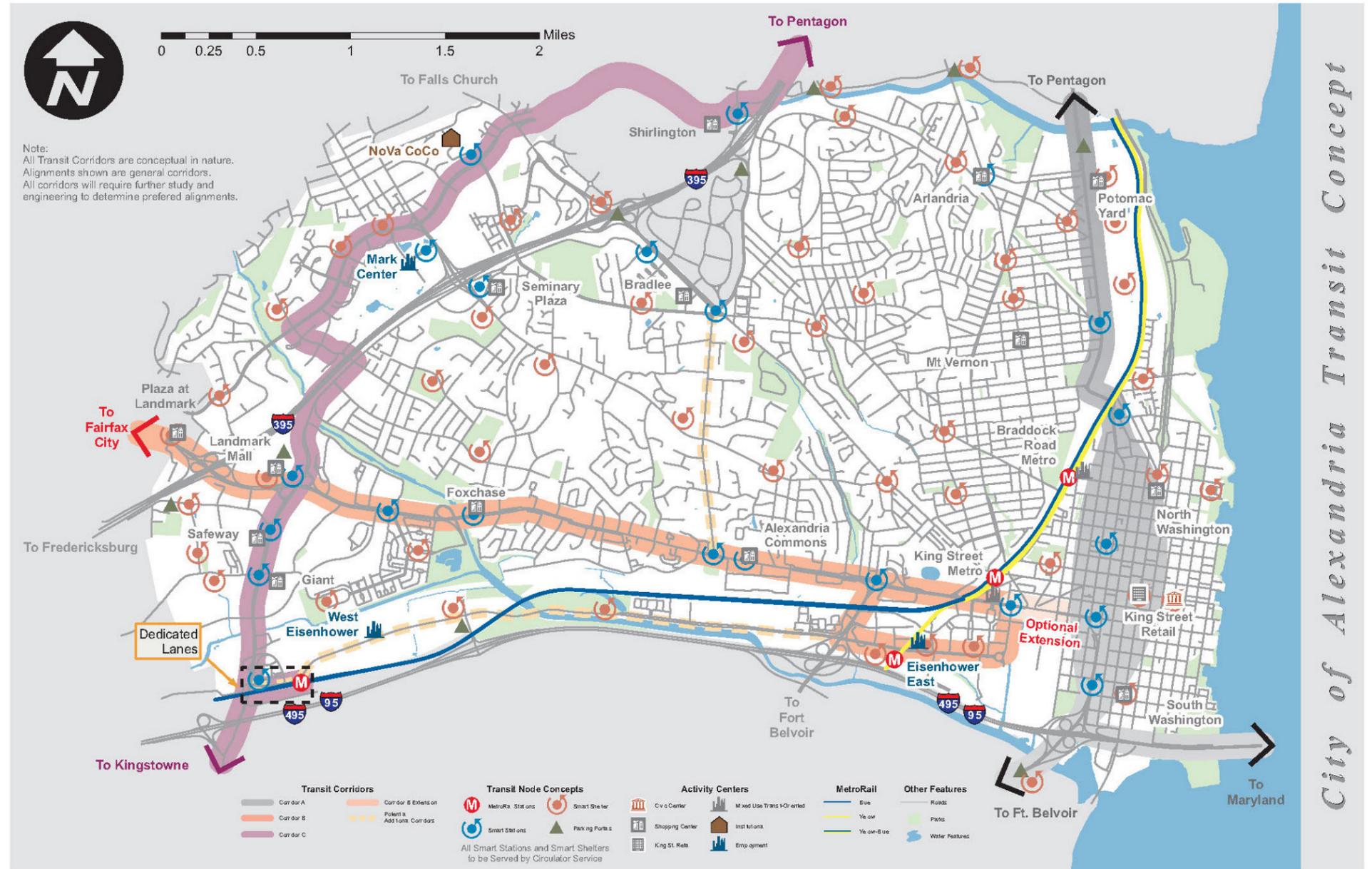
Corridor A: North-South Corridor – Partially implemented through what is now referred to as Metroway in 2014.

Corridor B: Duke Street – The City has recently received funding to advance the planning and design

Corridor C: Van Dorn/Beauregard – Environmental documentation completed for what is now referred to as the West End Transitway.

Existing Metroway infrastructure and improvements that are planned through the West End Transitway process will be a key consideration in developing the planned network for the Transit Vision. But existing or planned infrastructure should not, by themselves, define how the transit network in Alexandria should be designed. The design of the transit network should be guided by the values of Alexandrians and a logical network design that follows favorable patterns of development and serves the areas that Alexandrians identify as priorities for coverage service.

Figure 37: The 2008 Transportation Master Plan recommended three primary transit corridors with dedicated space for transit vehicles.



This map is the original adopted map from the 2008 plan. In 2010, a more detailed Transitway Corridor Feasibility Study of Corridor A concluded with a recommendation to terminate the high-capacity transitway at Braddock Road Metrorail station.

Major Transit Infrastructure Investment

Based on the recommendations of the Strategic Plan and the Transportation Master Plan, The City has made significant investments in advancing three major transit infrastructure projects:

- » Potomac Yard Metrorail Station,
- » Metroway, and
- » West End Transitway.

The Transit Vision Study is taking a fresh look at transit service and incorporate these investments into the transit service planning process. These investments can be valuable elements of the transit network by improving the speed and reliability of existing and planned transit service, even if operational changes are recommended for the services that use this infrastructure. During the network design process, it will be critical to assess how these investments interact with the proposed networks.

Potomac Yard Metrorail

The City and WMATA are working together to construct an in-fill station (a new station on an existing transit line) on the Blue and Yellow Metrorail Lines in the Potomac Yard neighborhood of Alexandria. The new station is viewed as a critical component of Alexandria's vision for Potomac Yard, a 295-acre former railroad yard that is being transformed into an urban center with residential, commercial and office development. There will be facilities provided to accommodate bus-rail connections to the station. The documentation of environmental effects has been completed and the station is scheduled to open in 2022. The latest cost estimate for the project is approximately \$320 million. City staff are working with WMATA to select a contractor to design and build the station and work is expected to begin in the fall of 2018.

Metroway

Metroway, which opened in August 2014, is Bus Rapid Transit (BRT) style route that offers a faster trip along Route 1 between Pentagon City and Braddock Road Metrorail stations, via Potomac Yard, than previous local bus service. The service features dedicated bus-only lanes, wider bus stop spacing, and frequent bus service (about every 12-15 minutes on weekdays). There are six stations with robust infrastructure and technology in the City of Alexandria. Approximately 0.7 miles of dedicated bus lanes were constructed on US Route 1 between East Glebe Road and Potomac Avenue within Alexandria.

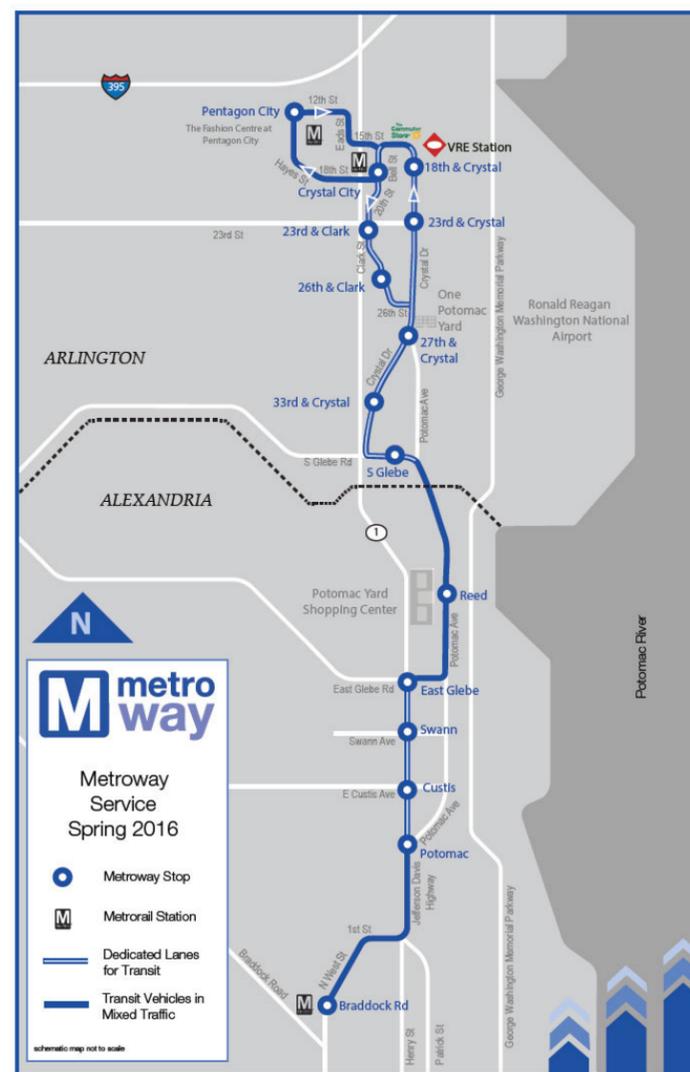


Figure 38: Metroway runs from Braddock Road Metrorail station in Alexandria to Pentagon City in Arlington.

West End Transitway

In the western parts of Alexandria, the City is proposing a BRT system to provide high-capacity transit service using a combination of dedicated and shared lanes and high-quality stations with rider amenities. The ultimate vision is for the West End Transitway to connect major transit centers, like Van Dorn Metro Station, Mark Center Transit Center, Shirlington Transit Center, and the Pentagon Transit Center with several neighborhoods along the corridor, including Landmark, a redeveloped Landmark Mall, and Beauregard. Environmental documentation was completed in March 2017 and the City is currently looking to construct the transitway in phases, beginning with the northern segment between Landmark Mall and the Pentagon.



Figure 39: The proposed West End Transitway would improve the speed and reliability of bus service in the Landmark and Beauregard areas of the city.

Key Themes

Consistent themes both directly and indirectly related to transit emerged from the review of the goals, objectives, and strategies of the City’s guiding plans. Themes and selected representative statements (such as goals, objectives, strategies, actions, etc.) from the plans are summarized in the table below. The themes

and descriptions identified were summarized based on the consultant team’s review of the elements of each plan that were most relevant to this Vision Study. As previously noted, the Alexandria Transit Vision will consider the design of the transit network with a blank slate approach and while these existing plans are informative, they will not limit the possibilities of the Transit Vision network design process.

Key Theme	Description	Selected Plan Statement(s) (Goals, Objectives, Strategies, Actions, etc) & Source
Transit Connectivity	Transit is available as a viable choice for people to move between City activity centers and to regional activity centers. Owning a vehicle car is not the only option to get around the City.	Ensure that people can travel into, within, and out of the City of Alexandria by providing a mass transit system that combines different modes of travel into a seamless, comprehensive, and coordinated effort. (TMP – Goal)
Transit Efficiency	Transit operates with reliable and predictable travel times. Transit routes are logical and direct, avoiding circuitous service. Transit runs on or close to the expected schedule.	The City will incorporate traffic signal priority, traffic circulation changes, pedestrian, and other on-street enhancements into the new system for the benefit of transit vehicles and riders. (TMP – Action)
Equity	Transit options are accessible, affordable, and understandable for all persons. Accommodations are made for those who need it. Service does not disproportionately serve different areas.	Alexandria will ensure accessible, reliable, and safe transportation for older and disabled citizens. (Strategic Plan – Guiding Transportation Principle) The city will coordinate with pertinent Alexandria Boards and Commissions, such as the Commission on Aging and The Alexandria Commission on Persons with Disabilities, to ensure that the special transportation needs of all citizens are considered. (TMP – Action)
Technology	Use the latest advancements in technology to make transit more efficient. Provide real-time information to keep passengers informed about service updates.	The City will further identify specific transit mode technology and newest techniques best suited in the identified transit corridors and for the system as a whole. (TMP – Action)
Livability	Alexandria is a fun, enjoyable place to live. Transportation is not a primary challenge or source of frustration in the lives of Alexandrians. Alexandria is committed to honor its historic and archaeological past.	Maintain the percentage of residents with a positive view of their neighborhood as a place to live at or above 2016’s 83% favorable rating. (Strategic Plan – Key Indicator) Increase the percentage of commuters using alternative transportation options from 37% in 2013 to 40%. (Strategic Plan – Key Indicator)
Safety	Specific actions are taken to plan and design complete streets that safely accommodate all modes of travel. Transit riders feel safe riding and waiting for their ride. Strict transit driver training for in vehicle operations and emergency situations.	Ensure that all streets, trails, and intersections are accessible, safe, and well designed using national best practices for safety and accessibility. (TMP – Objective)
State of Good Repair	Preventative maintenance is used to prolong the useful life of assets. Funding is available to replace and upgrade buses and other transit assets.	Increase Alexandria’s Pavement Condition Index rating from 58 out of 100 (fair) in 2016 to 71 out of 100. (satisfactory) (Strategic Plan – Key Indicator) The City will investigate potential funding available through existing, new, and innovative revenue sources. (TMP- Action)

Small Area Plans

Alexandria has also produced at least 20 small area plans that include recommendations about land use and transportation for the many different neighborhoods and communities around the city. Figure 40 shows the different small area planning areas and overlay planning areas around the city.

Many of the city's small area plans were completed in 1992 and have been partially amended over the intervening 26 years. Many of these older plans for the lower density parts of the city strongly call for the preservation of single-family and other low-density residential areas and the buffering of residential areas from commercial development or higher density development. This is a common theme in the following small area plans:

- » Alexandria West,
- » Fairlington/Bradlee,
- » Landmark/Van Dorn Small Area Plan,
- » Northeast,
- » North Ridge/Rosemont,
- » Potomac West,
- » Seminary Hill/Strawberry Hill,
- » Southwest Quadrant, and
- » Taylor Run/Duke Street.

The result of this common theme is that the donut pattern of low density in the middle of the city is likely to be maintained.

Other small area plans, most of which have been completed more recently, call for more mixed uses, with urban development scales of five or more story buildings, and interconnected streets. These themes are common in the following small area plans:

- » Beaugard,
- » Braddock Road Metro,
- » Eisenhower East,
- » Eisenhower West,
- » King Street Metro/Eisenhower Avenue,
- » Landmark/Van Dorn Corridor Plan,
- » North Potomac Yard,

- » Old Town,
- » Old Town North,
- » Potomac Yard/Potomac Green, and
- » Waterfront Plan.

The results of these small area plans are to concentrate most growth around the edges of the city, in a pattern the City describes as its growth crescent.

The following pages detail some important elements of three plans that are in key areas for proposed development and will likely be critical areas for thinking about the future bus network: Beaugard, Old Town North, and North Potomac Yard.

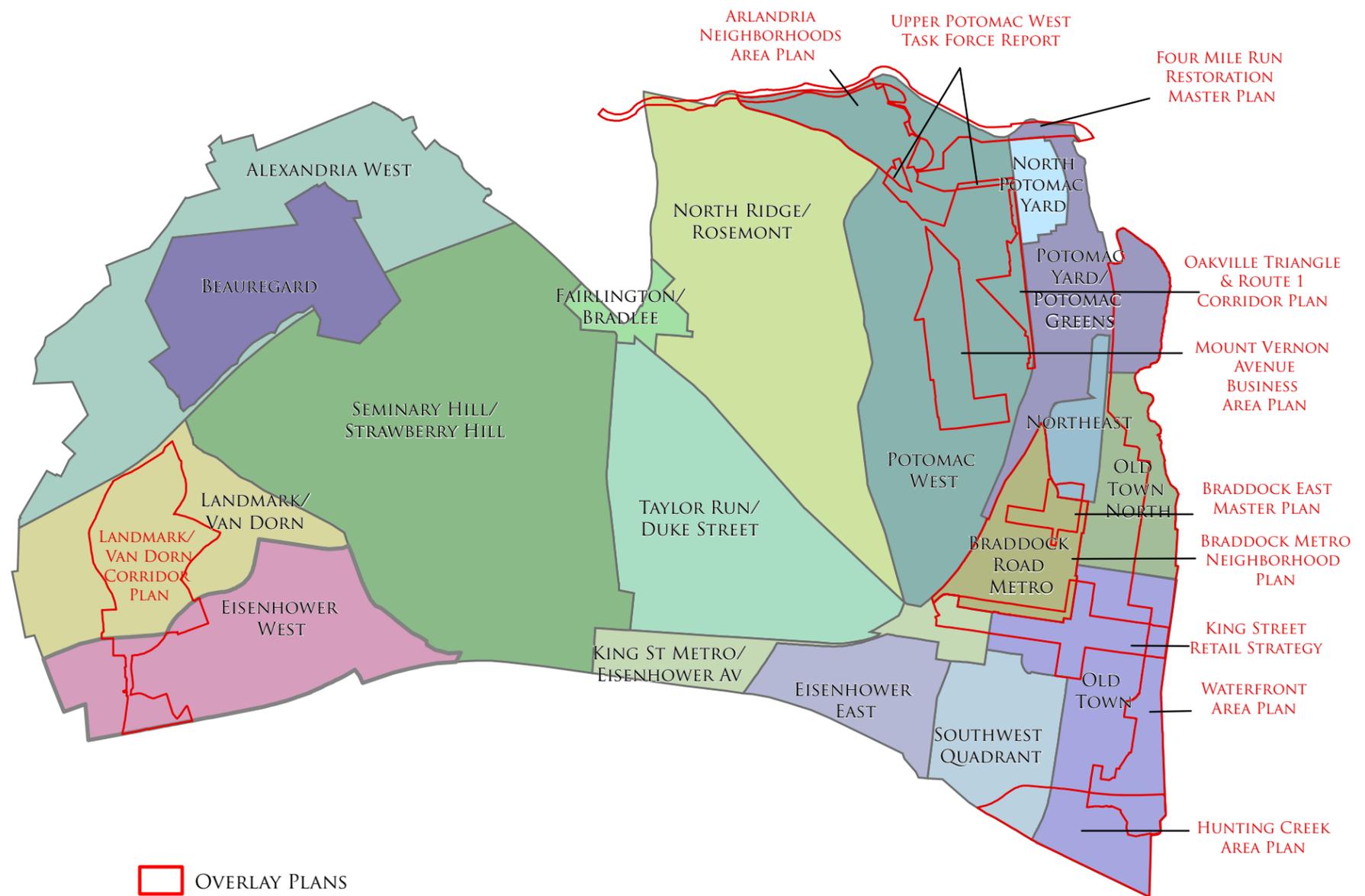


Figure 40: The City of Alexandria has multiple small area plans and overlay plans for specific areas of the city.

Beauregard

The Beauregard Small Area Plan is significant because it covers an area of relatively high density that is growing, but that also lacks key geographic patterns that are conducive to high ridership transit. Figure 41 shows the urban framework plan for the area and some key features are highlighted that would significantly improve the density, walkability, and linearity of this area, including a more connected street pattern and buildings that front streets, instead of turning away from the main streets.

Old Town North

The Old Town North Plan recommends significant growth and redevelopment in the area north of Oronoco Street and east of the George Washington Parkway. This part of the greater Old Town area is between 1/2 to 3/4 of a mile from the Braddock Road Metrorail station, and therefore many people will need bus service to fully access the newly developed and redeveloped areas. A large part of the growth of this area is expected to be along the waterfront, on the site of an old power plant.

transit route along Fairfax Street, through the proposed redevelopment at the power plant site, and on to the Potomac Yard Metrorail station via Slaters Lane. Whether this particular service design is most useful will depend on many other choices in how the rest of the DASH and Metrobus networks in Alexandria are design during this Vision Study. But, if this area is to redevelop and grow to the degree recommended, then useful transit through Old Town North will be essential to the life of this neighborhood.

Figure 42 shows the transit recommendations from this small area plan. The proposal recommends a new

Figure 41: The Beauregard SAP envisions a more urban community that create a land use and street pattern that is more conducive to high ridership transit.

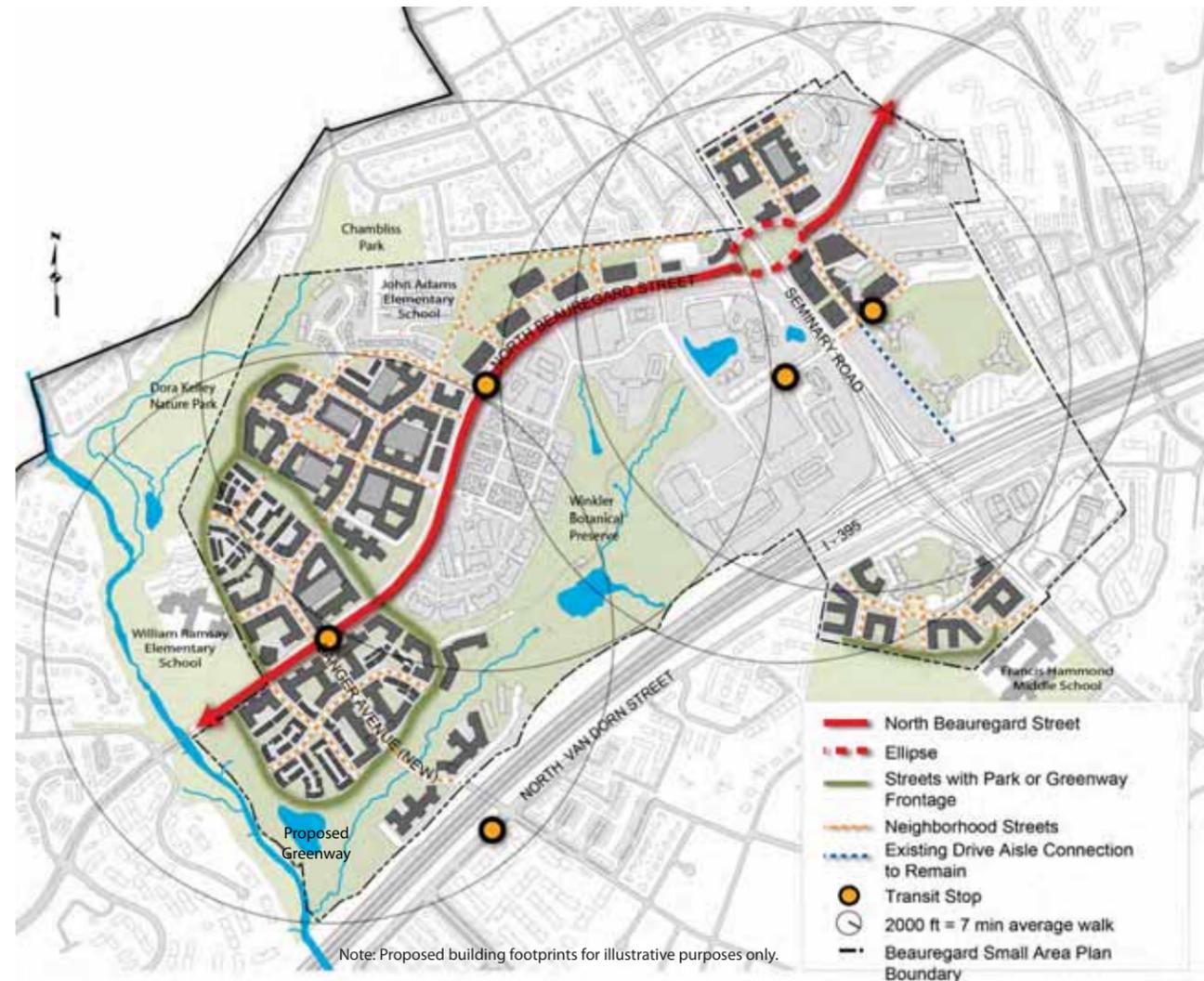


Figure 42: The Old Town North SAP recommended significant redevelopment and a new transit line along an extended Fairfax Street to Slaters Lane.



North Potomac Yard

The North Potomac Yard Small Area Plan covers the redevelopment of the area to the north and west of the planned Potomac Yard Metrorail station. The plan calls for mixed-use community with walkable and connected streets, development fronting the street, and buildings from 5 to 25 stories tall and with retail frontage on key streets (see Figure 43).

The redevelopment of this area would bring a substantial increase in the activity density of the area, as indicated in the forecasted activity density on page 22. The Metrorail station will be essential to serving residents, employees, and visitors to this area, but so will buses. Metroway already serves this area, and two stations are included in the redevelopment plan for the area. DASH currently serves the area as well with the AT9 (which comes from the Beauregard and Shirlington area) and AT10 (from the Mount Vernon corridor).

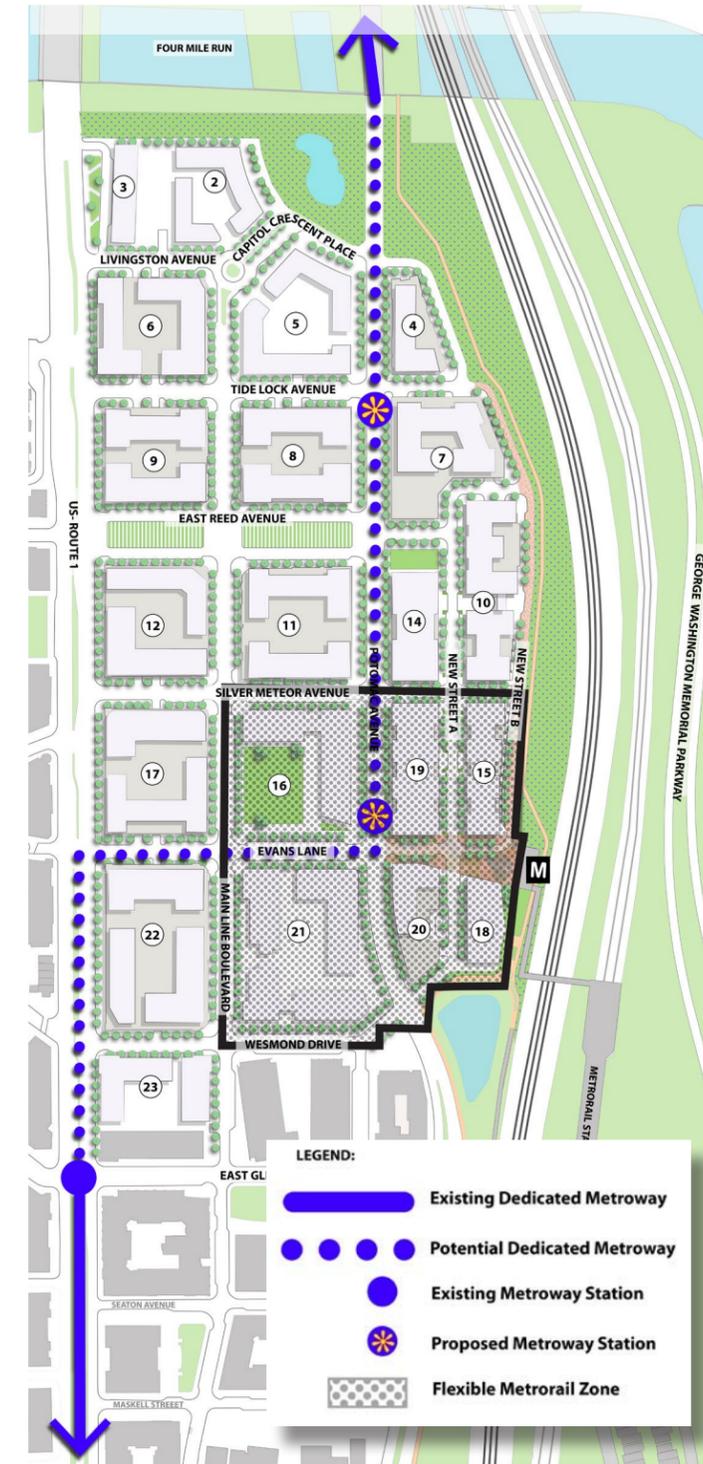
The proposed transit infrastructure from the plan is shown in Figure 44. The plan includes recommendations for dedicated lanes and stations for the Metroway bus rapid transit line. However, the proposal would put the Evans Lane station about 400 feet from the Metrorail station entrance. Since the platforms for the Metrorail station are on the other side of the freight railroad tracks, the additional 400 feet walk will be on top of a very long walk up and over the railroad tracks.

Furthermore, the streets plan and access plan around the station entrance does not specifically show space for buses to circulate and layover near the station entrance. If nothing changed in the DASH network, then routes AT9 and AT10 would need to turn around, and possibly layover near the Potomac Yard Metrorail station. Also, it is natural that other bus routes may need to connect to this station. City staff have indicated that planners did consider and develop preliminary ideas for creating bus layover space along New Street A near the Metrorail station entrance, but these details were not included in the final plan document. Given the importance of bus connections to this Metrorail station, it would be useful to future developers and planners to have a clear conceptual design for bus bays and turnarounds at this site to be sure that future design decisions do not preclude good bus access to this station.

Figure 43: In North Potomac Yard, the City envisions a mixed use community, with buildings ranging from 6 to 25 stories.



Figure 44: The proposed transit infrastructure puts the Metroway station 400 feet from the Metrorail entrance.



Recent Surveys

Over the previous several years, the City of Alexandria has performed a number of resident surveys. These surveys indicate the opinions and perceptions of the residents of the City of Alexandria, and help the City to identify areas of key needs and concerns.

Two groups of surveys are particularly useful to this transit planning effort. The first group is a pair of on-board surveys performed with DASH customers which asked questions about the quality of service and ways that DASH could improve.

The second group of surveys are the last three years of resident surveys completed by the City as part of the National Citizen Survey (NCS). The NCS is a national benchmark survey conducted with statistical relevance to the City's population, and reflects the general livability of the City of Alexandria.

On-Board DASH Surveys

The two on-board surveys conducted with DASH customers show that DASH is generally held in high regard. Rides say that drivers are high quality and helpful. Respondents stress that DASH is important for commuters that rely on public transportation, and there is a desire to have greater access to real-time system information.

As a result of the on-board survey and a other analyses in 2012, the Comprehensive Operations Analysis recommended increased frequency system-wide, starting with the core system routes. It also recommended the implementation of an Old Town Circulator by coordinating schedules on the AT2 and AT5, a Van Dorn Circulator, an Eisenhower East circulator, and an AT9 route. Another recommendation was to improve Old Town service by modifying the AT2, AT3, and AT5 routes.

National Citizen Survey

The NCS primarily focused on the overall livability of the City of Alexandria. It is based on a representative sample of residents from across the city, and includes questions focused on transportation needs. The NCS has surveyed

Alexandrians for the previous three years, from 2016 through 2018.

The 2016 survey asked additional questions specifically about transportation. Figure 45 summarizes some of the key results from the 2016 survey. According to the survey results, residents are generally happy with the quality of service provided by DASH, and opinion of the public transit system is higher than that of the national benchmark. Although residents may be satisfied with the service, private vehicle use has increased over the last three years, while perceived conditions of traffic flow and travel by transit has decreased.

Significant factors that residents see as affecting the attractiveness of transit include:

- » Access to transit – How close is my nearest transit stop?
- » Travel Time – How long will it take me to reach my destination?
- » Frequency and Reliability – When is the next vehicle arriving?

The results from the survey suggest that perception of performance is as important as the actual metrics of the transit system. Trends also suggest that travel by transit is getting more difficult, compared to traveling by car. Trends also suggest that despite improvements in transit, people are still choosing to travel by personal vehicle.

As discussed on page 9, the frequency of service is an often overlooked element of the travel time and reliability of transit—two factors noted by survey respondents as key issues that affect their willingness to use transit.

Access to transit is often an issue of the length of walk to a bus stop or the perception of safety. If the walk to a bus stop is relatively short, but feels unsafe due to traffic speeds, difficult street crossings, or a sense of personal safety problems, then many people will choose not to use transit.

Figure 45: Surveys show that many residents would try transit if it were useful.

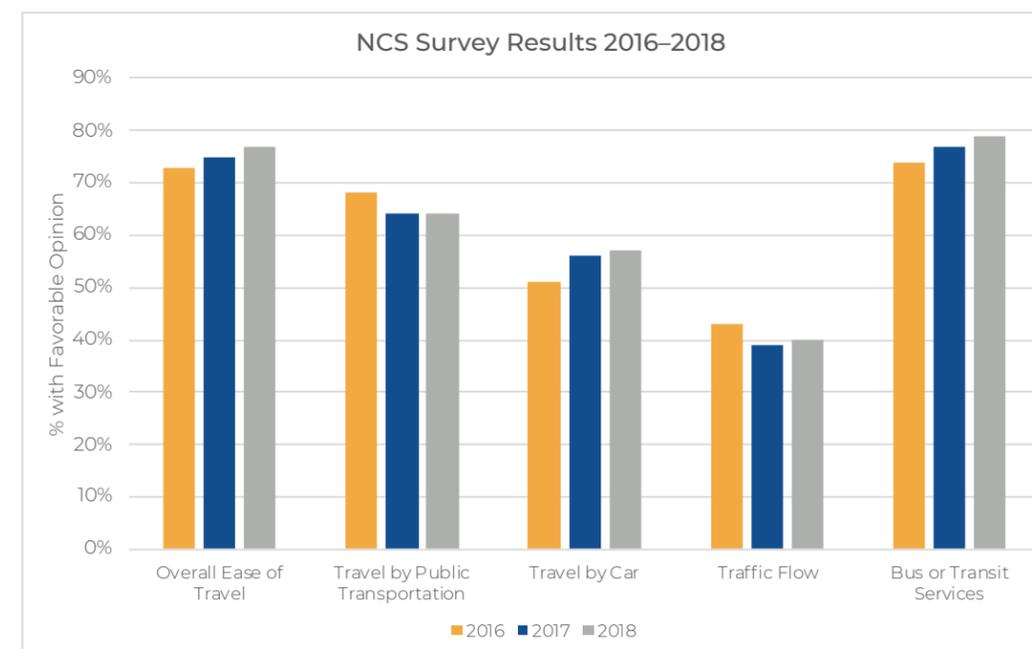


Figure 46: NCS survey results indicate that people are finding it easier to travel by car but harder to travel by transit.





4. Network Analysis

How is transit performing?

Network Analysis

Existing Network

Figure 47 shows the transit network in Alexandria, with every bus route color-coded based on its frequency during midday on a weekday. Metrorail stations and lines are shown in gray. The Metrorail Yellow and Blue lines through Alexandria are scheduled to operate every 12 minutes in the midday, and thus where they run together the combined frequency is every 6 minutes.

As the map shows, there are only four frequent routes in the city today, and only three actually serve Alexandria significantly. The four frequent routes (running every 15 minutes or better) include

- » Metroway from Braddock Road Metro, through Potomac Yard, to Crystal City in Arlington;
- » Metrobus Route 10A and B combine for frequent service from Old Town to Braddock Road Metro and north along Mount Vernon Avenue to Arlington;
- » The King Street Trolley, operated by DASH, from King Street Metro to the Waterfront; and
- » Metrobus Route 7M from Pentagon to Mark Center, direct with no stops in between.

The King Street Trolley is unique in that it does not run in the AM peak period and it does not cost anything to ride. Being free makes the service very easy to use, but by not being available before 10AM, the service is not useful for many trips.

Other than Route 7M, which only touches Alexandria at one stop, there is no frequent service west of Mount Vernon Avenue. But there are many overlapping routes that, if combined or coordinated, could provide more frequent service across the western parts of the city.

The remainder of this section will explore the trends in ridership and service, the productivity of service, and some interesting features of the Alexandria transit network.

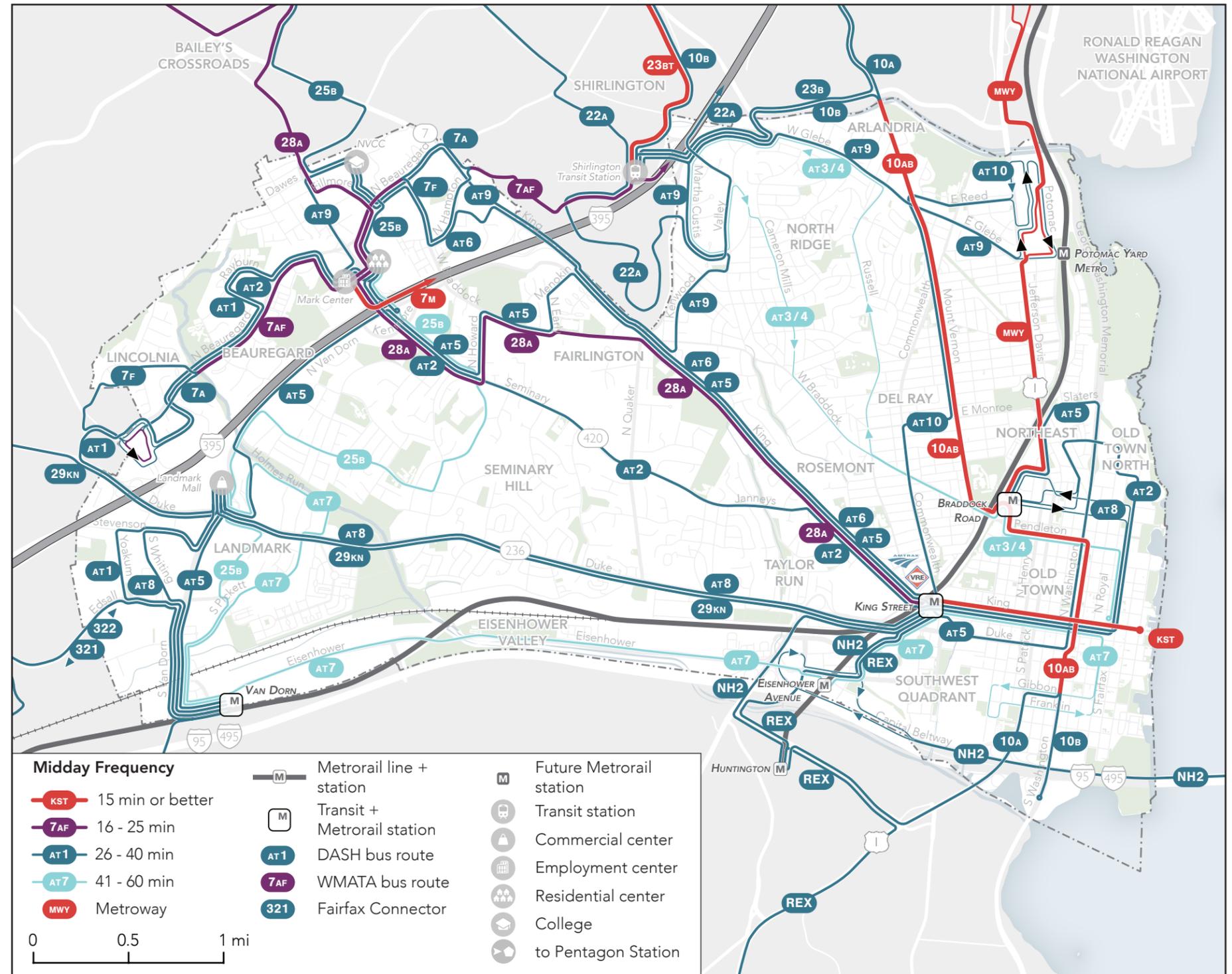


Figure 47: The current bus network has no frequent service west of Mount Vernon.

Old Town Network

Figure 48 shows the current bus network just within and around Old Town Alexandria. Despite having three frequent routes that approach Old Town, only two frequent routes (the trolley and Metrobus 10A+B) actually serve Old Town. Metroway, which runs from Pentagon City to Braddock Road Metrorail station, does not penetrate into Old Town.

Also, service is spread across many different streets around Old Town. For example, buses are running on three different north/south streets from King Street to Pendleton Street.

- » AT5 and Metrobus 10A+B run north/south on Washington Street.
- » AT2 and AT8 run both directions north/south on Fairfax Street, while AT 3/4 runs northbound only here.
- » AT3/4 runs southbound on Royal Street.

This is close route spacing, as Washington and Fairfax Streets are less than 1/4 mile apart. And Fairfax Street is only 800 feet from the waterfront. Similarly, many routes run on King Street (the trolley, AT2, AT7, and AT8) while AT5 runs on Duke Street, only 800 feet to the south. Many people are willing to walk up to 1/4 mile for frequent transit service. Thus a logical route spacing of frequent service would space routes 1/2 mile apart. Of course, local geography often limits the ability to space routes in a perfectly consistent pattern.

In Old Town North, many routes are running in circuitous patterns. AT2 meanders from the waterfront area to Braddock Road Metrorail station via Second, Bashford, Powhatan, and Montgomery Streets. Meanwhile, the AT5 takes Washington Street due north to Slaters Lane and then back south on Henry Street to also reach Braddock Road Metrorail station. In contrast, Metrobus 10A+B take a direct route from Old Town South, via Washington, Pendleton, and West Streets to reach the same destination. Overall, it appears that DASH routes are trying to minimize walks in the Old Town and Old Town North areas, with the trade-off that service is less frequent than it could otherwise be.

A limitation on running buses on King and Washington Streets is that left turns are prohibited in all directions at the intersection of these two streets. Thus, since the AT5 needs to turn left to go north onto Washington Street, it must do so from a street other than King Street.

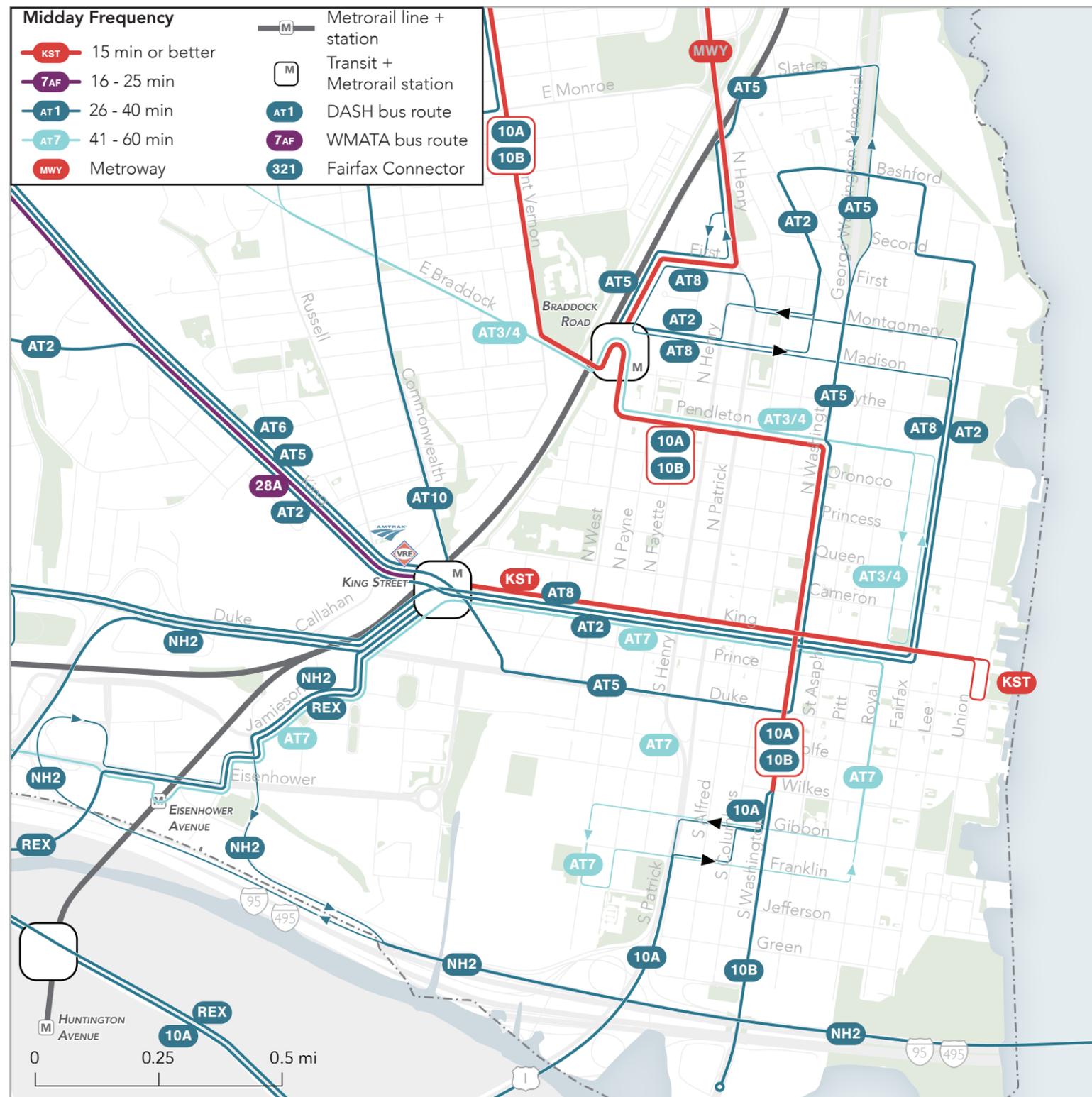


Figure 48: Many routes run within close proximity of each other downtown, but are not coordinated.

Existing Ridership

To understand the patterns of ridership demand and route performance in detail, we look at ridership at each stop, as shown in Figure 49.

From this map, we can observe that the highest boardings occur:

- » At the Braddock, King & Van Dorn Metrorail stations;
- » Along the King Street Trolley;
- » In a cluster around TC Williams High School and Bradlee Shopping Center;
- » At Southern Towers, a major residential development;
- » At Mark Center, a major regional employment center;
- » Along Van Dorn between Seminary and Duke Street;
- » To a lesser degree along West Glebe and Duke Street.

Some of the largest boardings dots on the map are at Metrorail stations or transit centers, where many routes terminate and people are transferring among routes. For example, Mark Center, in addition to being a major destination, is also the place where people traveling from west Alexandria to Northern Virginia Community College would transfer from the AT1 or AT2 to the AT9. The observed boardings at transit centers represent trips that start and end there as well as transfers between routes.

Looking at this map, keep in mind that not every stop is offering the same level of service. Some of these stops are served just a few times a day. Some are served every 15 minutes, as the map of the existing network in Figure 47 shows on the previous page.

A small dot on a low-frequency route may simply reflect the low level of service. A small dot on a more frequent route, on the other hand, suggests other problems.

Conversely, a large dot on an infrequent route means that ridership is high despite a low level of service, which suggests that underlying transit demand may be high. We see evidence of this for route AT8 along Duke Street, where boardings remain relatively high throughout midday despite 30 minute frequency service. This is predictable, though, given the activity density is consistently high in this corridor as shown in Figure 13 on page 18.

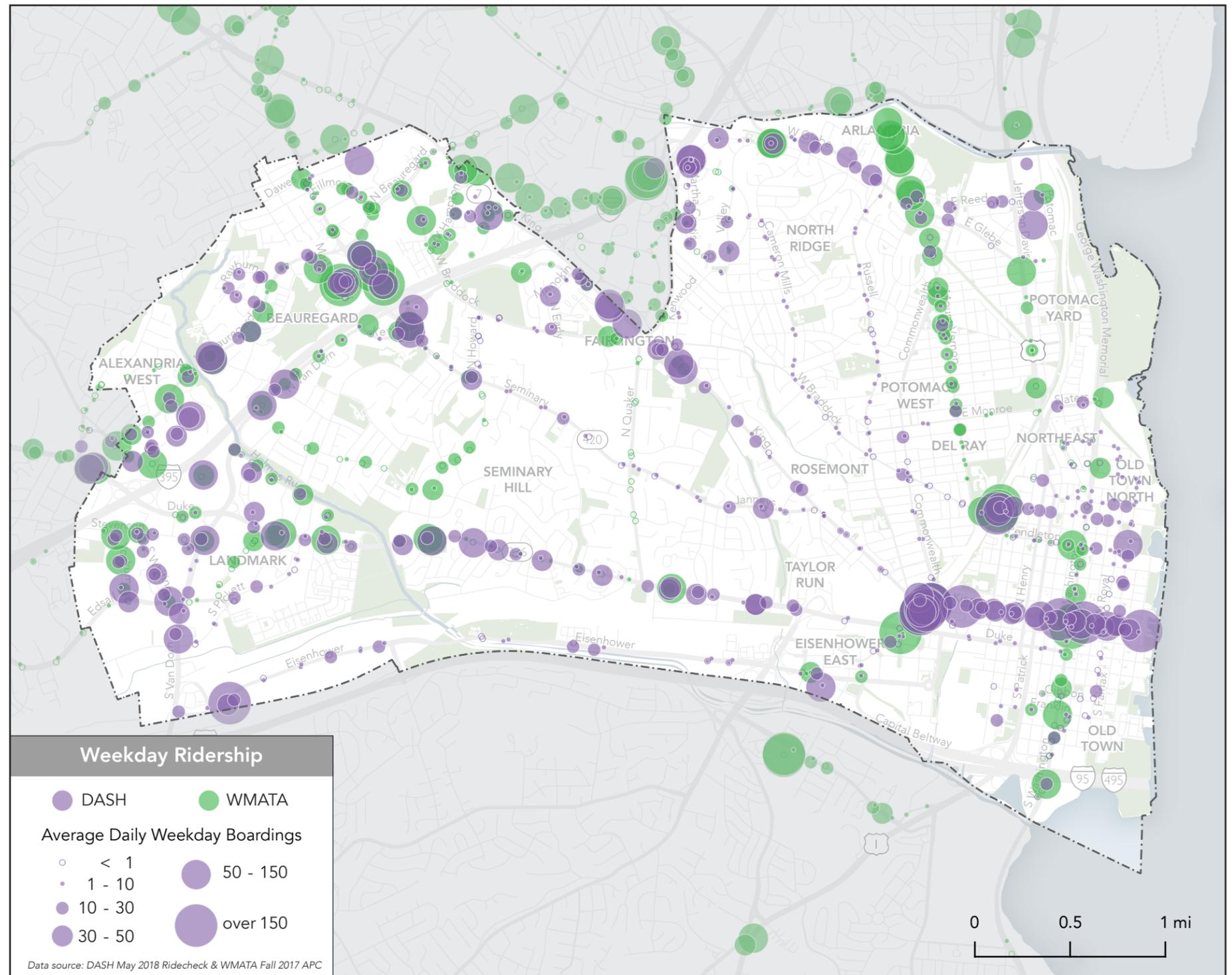


Figure 49: The map of boardings by stop shows many people get on DASH and WMATA buses at Metrorail stations.

Old Town Ridership

Figure 50 shows the current bus ridership by stop in Old Town and surrounding areas. From this map we can observe the following:

- » King Street stands out as the highest ridership corridor in Old Town. This is not surprising given the density and walkability combined with high frequency service that is fare free (the trolley).
- » Washington Street also stands out as having high ridership. Both Metrobus 10A+B and AT5 serve this street and Metrobus 10A+B is the only other high frequency route that penetrates into Old Town.
- » Fairfax and Madison Streets also have relatively large boarding dots, following the route of the AT8, the highest ridership route in the DASH system.



Figure 50: King Street stands out as the highest ridership corridor in Old Town and surrounding neighborhoods.

Recent Trends

Ridership

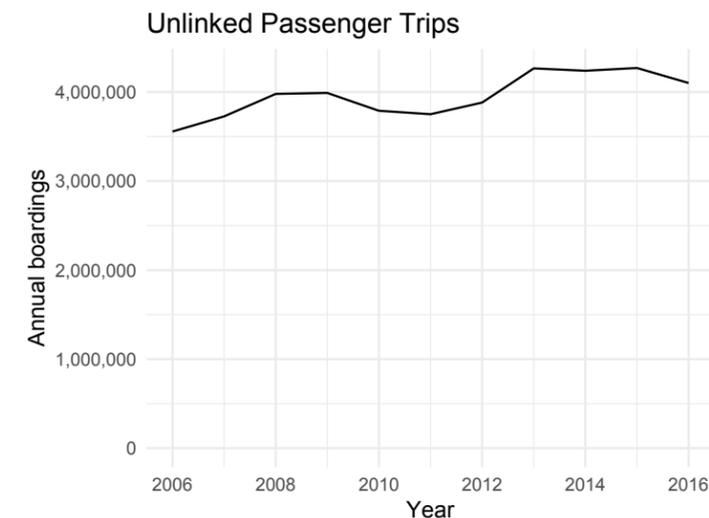
Total annual boardings on DASH have grown modestly from 2006 to 2016 (Figure 51), adding about 57,000 rides a year over that time. However, the number of boardings per year has flattened since 2013.

Over the same period, 2006–2016, the population of Alexandria has grown from about 133,000 to about 151,000 (based on the City’s official forecasts). Because ridership has flattened at a time when the population has grown, transit has become less relevant to the life of the city as there are fewer rides per person (Figure 52).

As shown in Figure 20 on page 23, much of residential growth in Alexandria has occurred on the edges of the city, in areas with unfavorable development patterns for transit, which limits the potential for high ridership. Thus, while more people are living in Alexandria, many are living in places that are harder to serve with useful transit. Therefore, it is unsurprising that transit relevance has not kept pace with population growth.

Some more recent developments, such as the Modera Tempo development at Van Dorn Street and Pickett Street, are creating a more connected street grid in western Alexandria and this may help shift the trend in ridership growth, over the long term.

Figure 51: Annual boardings on DASH have grown modestly since 2006.



Investment and Relevance

Figure 54 shows the relative change in rides per person and service hours per person from 2006 to 2016. By measuring the number of rides per person, it helps us see whether transit is becoming more or less relevant to the life of the city, and therefore we call it Transit Relevance. Service hours per person helps us see whether the quantity of transit service is changing in tandem with population changes, and whether the city is investing in the quantity of service.

Figure 52: Boardings per capita have declined since population has been growing faster than ridership.

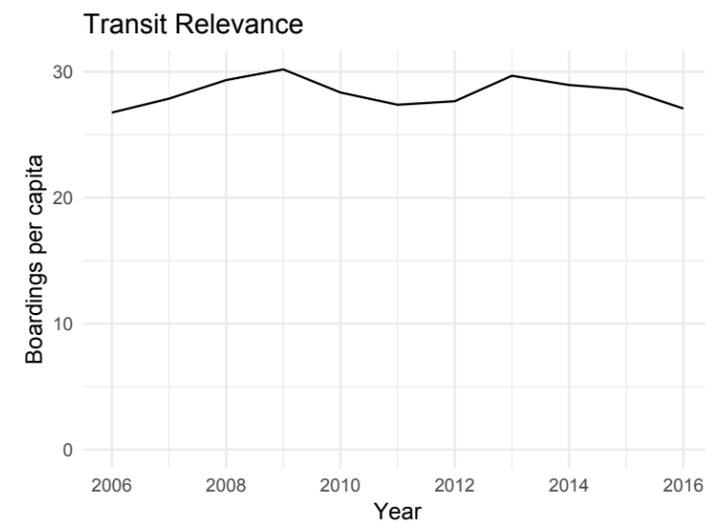
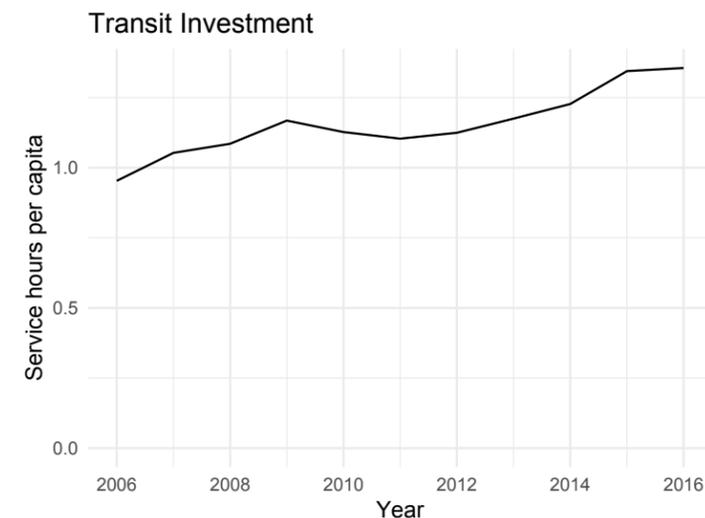


Figure 53: DASH has been adding service faster than population growth since 2012.



Before 2013 the average number of rides per person (relevance) appeared to be related to how much service was provided per person (investment). However, beginning in 2013, relevance fell despite a striking increase in investment. Possible explanations are explored in the rest of this chapter.

Ridership on DASH increased with investment in service from 2006 to 2013, but has declined, despite increasing investment, since 2013.

Figure 54: Investment and relevance closely tracked each other until 2013, but Relevance has recently declined in spite of increasing investment.



Systemwide Productivity

Some transit agencies and cities have adopted a goal of “maximizing ridership.” Implicit in this statement, however, is a constraint: there is a limit to how much funding is available to increase ridership. Transit agencies cannot spend infinite amounts of money pursuing each additional rider in order to maximize ridership.

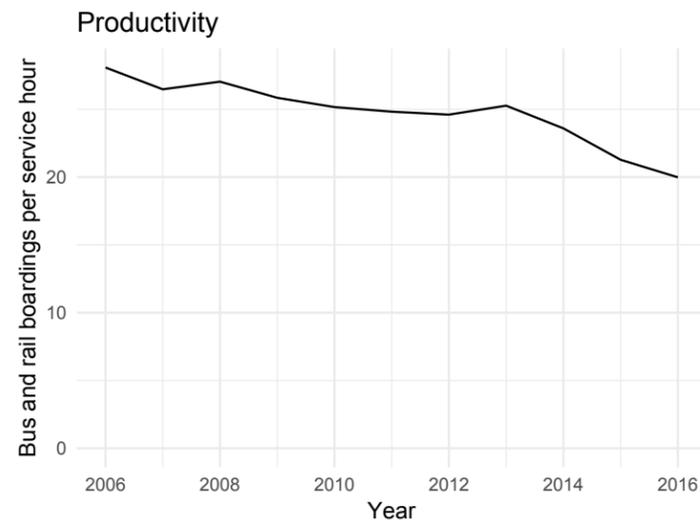
The more specific way to state this goal, then, is “maximize ridership within a fixed budget.” Even if the budget grows, it is (and will always) be limited. Thus, the measure to track is not ridership alone but ridership relative to cost.

Ridership relative to cost is called “productivity.” In this report, productivity is measured as boardings per service hour. A service hour is one bus operating for one hour.

$$\text{Productivity} = \frac{\text{Ridership}}{\text{Cost}} = \frac{\text{Boardings}}{\text{Service Hours}}$$

Productivity is strictly a measure of achievement towards a ridership goal. Services that are designed for coverage goals will likely have low productivity. This does not mean that these services are failing or that the transit agency should cut them. Low productivity just means that funding is not being spent to maximize ridership. See the discussion of ridership and coverage goals on page 12.

Figure 55: Productivity on DASH has declined consistently since 2006.



Peer Trends

Figure 56 shows investment in transit service per capita for Alexandria and peer agencies in the Metropolitan Washington region (Metrobus, Montgomery County Ride On, Arlington Transit, and Fairfax Connector). Investment has been increasing in all of these places. Since most of these places are growing, and growing more densely, an increase in transit investment is essential to these communities. Alexandria has a higher rate of investment than the other agencies.

Figure 56: Investment in transit has been increasing for all peers in the Metropolitan Washington area.

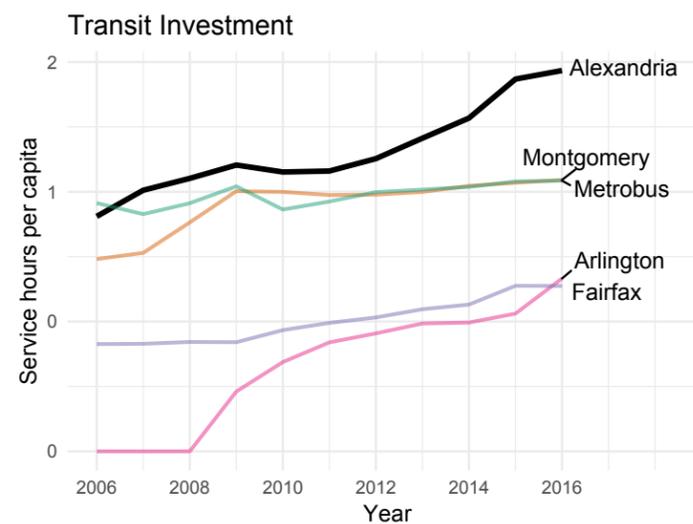
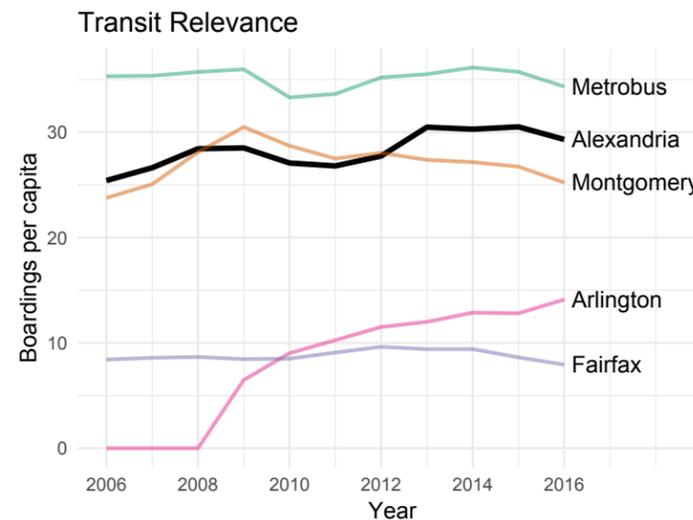


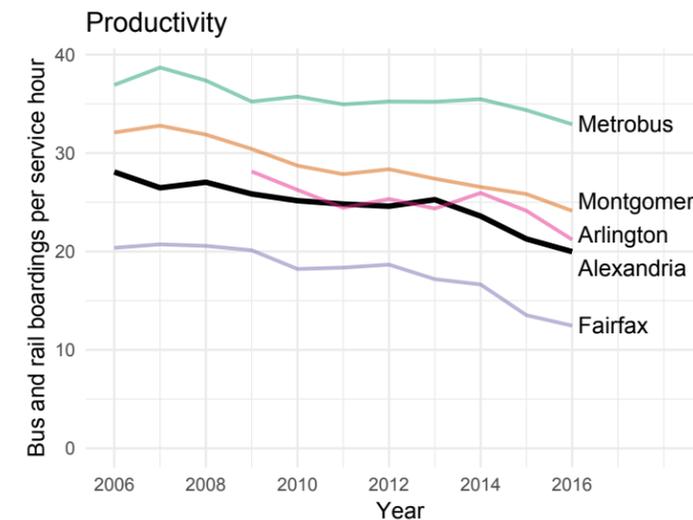
Figure 57: Relevance for most peers has been declining in recent years, except for Arlington.



Yet for most of the agencies, ridership has been flat or declining in the last two or three years. Thus, the relevance of transit service (boardings per capita shown in Figure 57) as been declining, except in Arlington.

Figure 58 shows the systemwide productivity results for all peer agencies. Since investment has been increasing but ridership has been relatively flat or declining across most agencies, the trend is downward for most of the last 10 years. The productivity levels for DASH have consistently been similar to those of Arlington and a little lower than those in Montgomery County.

Figure 58: Productivity for all peers has been declining for most of the last 10 years.



Why Has Productivity Fallen?

In stark contrast to the ridership trend, systemwide productivity on DASH buses has fallen almost every year since 2006 (see page 53). Productivity has fallen especially rapidly since 2013, the same period where relevance declined.

Why have productivity and relevance fallen since 2013? It is impossible to determine all the reasons for the decline, but a few key ones include:

- » The sharp decline in gas prices starting in 2014, which has depressed ridership nationwide¹, has likely affected DASH;
- » The major disruptions to Metrorail service due to maintenance issues that have hurt both Metrorail and DASH ridership since 2015; and
- » Recent changes to the DASH system that have tended to focus on coverage goals, or on less productive service.

Other factors may be contributing to the decline in productivity: decreasing costs to buy (or lease) a car, competition from low-cost ride-hailing services, the aging of the population (and resulting decline in working age population), the increase in telecommuting, and a growth trend toward dense but isolated housing developments in the less-walkable neighborhoods in western Alexandria. Fare increases in 2009, 2010 and 2013 also coincide with declines in ridership. However, the increases were small (25¢ or less), and DASH fares remain relatively low at \$1.75.

DASH and Metrorail

Recent reliability issues on Metrorail could be driving down demand for DASH service that connects residents of Alexandria to the Metrorail network. All DASH routes but one connect to at least one Metrorail station, and several connect to two.

Figure 59 shows the trends in service hours, boardings and productivity for DASH and Metrorail over the last 10 years. Since 2012, DASH has invested more in service, proportionally, than Metrorail. Yet, DASH ridership has not grown in proportion to the additional service. In the same period, Metrorail productivity rapidly declined as boardings on Metrorail declined.

Since so much DASH service is connecting to Metrorail, the recent reliability and service problems with Metrorail are affecting DASH ridership.

The years of the greatest ridership declines on Metrorail correspond with the flattening of the boardings trend on DASH. This suggests that whatever is driving ridership declines on Metrorail is related to the recent productivity declines on the DASH network.

Recent DASH Changes

The major changes that DASH has implemented since 2012 include the following:

- » Starting and improving the frequency of the King Street Trolley;
- » Increasing peak service on AT1 (Van Dorn and Beauregard), AT6 (King Street), and AT8 (Duke Street);
- » Increasing service on AT10 (Mount Vernon Avenue);
- » Adding route AT9 (Mark Center to Potomac Yard);
- » Substantial route realignments in Old Town, Old Town North and the Eisenhower Avenue in late 2016; and
- » Cutting back on weekend service on AT1 and AT2.

Much of new investment has gone to peak service, rather than increasing frequency throughout the day. **Peak services are the most expensive to operate**, and do not serve the needs of the majority of trips people take. Only about 20% of all trips for commuting to work.

Peak-only services tend to be less productive, because demand is in one direction, forcing DASH to run nearly empty buses in the other direction.

Peak service has higher labor costs, because drivers are paid for shorter shifts or split shifts. And peak service is more expensive in general because DASH must purchase and maintain buses that it uses only

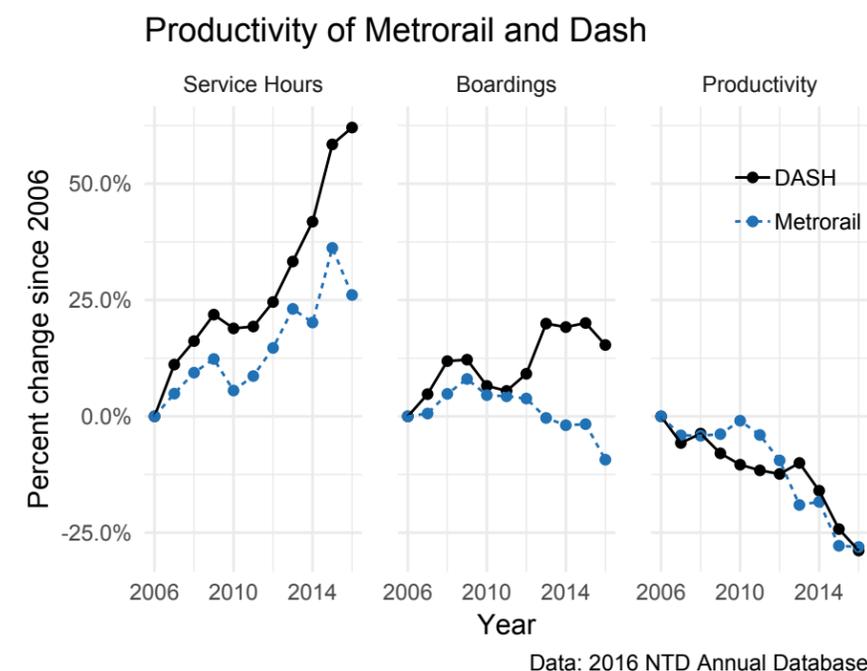
a few hours a day. See page 59 for a more detailed explanation of peak service productivity.

Also, the additional service on Mount Vernon with AT10 is directly competing with Metrobus 10A+B. And the AT9 overlaps with many other DASH and WMATA routes. Only the King Street Trolley investment is clearly a high productivity service.

This is not to say that investments that aren't maximizing ridership or productivity are wrong. Investments in service that increase coverage or meet other goals can be reasonable and valuable investments in service.

As long as the City and DASH are clearly and consciously deciding what goals they want transit to meet, and the values they want transit to serve, then investing in service that gets a low productivity is not a failure of the transit agency or the City.

Figure 59: The years of greatest ridership decline on Metrorail correspond with flattening of boardings on DASH.



¹ Alam, B, Nixon, H, Zhang, Q. "Investigating the Determining Factors for Transit Travel Demand by Bus Mode in US Metropolitan Statistical Areas," Mineta Transportation Institute. May 2015.

Frequency Comes First

Riders respond to many features of a service, including speed and reliability, but the dominant factor is often frequency. Frequency is the time between consecutive buses (or trains, or ferries) on a line, which determines someone's maximum waiting time. So for example, if two AT8 buses are scheduled to depart the same stop in the same direction 30 minutes apart, we say the AT8 has a 30 minute frequency.

People who are accustomed to traveling by car often underestimate the importance of frequency, because there is not an equivalent experience in driving. A car is ready to go when you are, but public transit is not available until it comes. The closest approximation to frequency for drivers is parking availability. The longer you have to walk to your car the less available it is when you need it. Few people are willing to walk 15 minutes to their parking spot, yet the design of the bus network in Alexandria means that often people must wait 15 minutes or more for a bus.

High frequency means public transit is coming soon, which means that it approximates the feeling of liberty you have with a private vehicle—namely that you can go anytime. Frequency has three independent benefits for the passenger:

- » **Frequency reduces waiting**, which is everyone's least favorite part of a trip. The ease of being able to go when you want to go is the essence of frequency.
- » **Frequency makes connections easy**, which makes it possible for individual transit routes to become a network. A transit line without good connections is useful for traveling only along that line. A network of frequent lines can make it easy to travel all over the city. This massively expands the usefulness of each line.
- » **Frequency makes service more reliable**. If a vehicle breaks down or is late, high-frequency means another will be along soon.

Many people assume that nobody needs to wait anymore with real-time transit arrival information and smartphones, and frequency therefore does not matter. A bus that comes only every 30 minutes should be fine, because your phone will tell you when it's a few minutes away and you should start walking.

Despite smartphones, real-time information and other new technologies, frequency still matters enormously because:

- » Waiting happens at the start or end of a ride. You may not need to leave your home much before your departure. But for a bus that comes every 30 minutes you may have to choose between arriving at your destination 20 minutes early or 10 minutes late.
- » There's not always a safe or comfortable place to wait before going to a bus stop. Many of the places we go do not let us hang out until our bus arrives. We can easily do this when leaving home, but it is more awkward when leaving a restaurant or a workplace that is closing.

A good example of the power of frequency can be seen along Mount Vernon Avenue in Alexandria. WMATA Metrobus 10A+B combine to offer 15 minute frequency along a shared segment of Mount Vernon Avenue, from Glebe to Monroe. The DASH AT10 serves this same segment, but only every 30 minutes. In the figure at the right, Metrobus boardings are in green and DASH boardings are in purple. The WMATA boardings are much larger than DASH boardings on this segment, showing that the high-frequency Metrobus 10A and 10B pick up far more passengers than the low frequency DASH AT10.

For southbound trips the AT10 terminates at King Street Metro whereas the Metrobus 10 routes serve Braddock Metro, and then continue south through Old Town. The slightly more direct route of the Metrobus 10 to a Metro station and the additional destinations served may attract a few more riders than the AT10, but at shared southbound stops the Metrobus attracts about 4 times more riders than the AT10. The frequency of service is likely a major attractor of riders to the Metrobus route over the AT10.

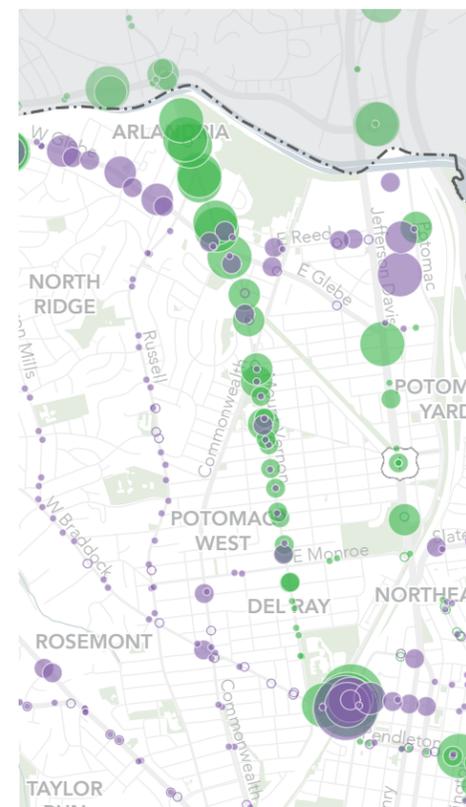
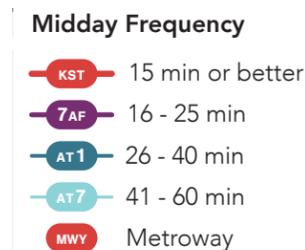
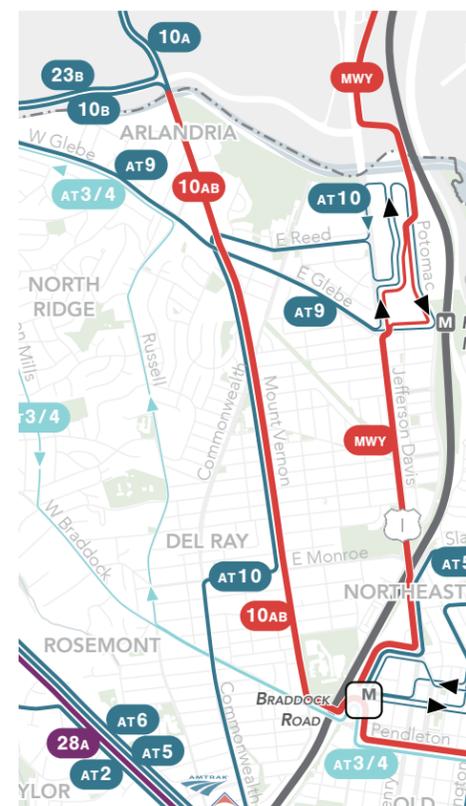
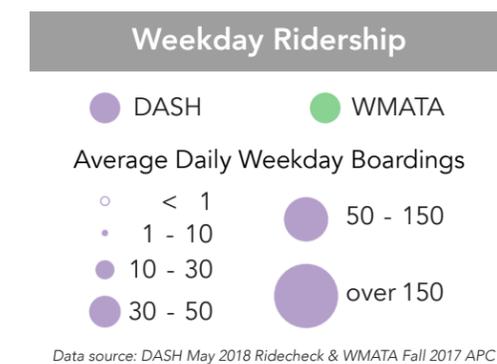


Figure 60: Metrobus 10A+B provides much higher frequency, and gets much higher ridership on Mount Vernon Avenue.



Frequency and Productivity

The boardings map on page 50 showed the number of boardings by stop and showed that there are some high ridership corridors and areas in Alexandria, particularly

- » At the Braddock, King & Van Dorn Metrorail stations.
- » Along the King Street Trolley
- » In a cluster around TC Williams High School and Bradlee Shopping Center
- » At Southern Towers, a major residential development.
- » At Mark Center, a major regional employment center.
- » Along Van Dorn Street between Seminary Road and Duke Street.
- » To a lesser degree along West Glebe Road and Duke Street.

Yet, a large boarding dot does not tell us the entire story. A particular stop may get high ridership, but it may be in a very hard to reach place that costs a lot to serve. Assessing productivity at the route level clarifies where ridership is high or low, relative to cost.

Route Productivity

Even if ridership doesn't change, productivity can still change if the service hours on a route change. The service hours provided on any particular route, and to any particular stop, will depend on a few factors:

- » route length,
- » operating speed of the bus (since a slower operating speed means that covering the same distance takes more time),
- » frequency of service along the route or to the stop (since higher frequency is created by more buses and drivers working the route simultaneously), and
- » span of service along the route throughout the day and week.

Changing any of these factors for a transit route will affect the service hours in the productivity ratio. For example, doubling the frequency of service on a route will double the number of service hours. This means the denominator of the productivity ratio has been doubled. We might therefore expect that productivity of the route

would be cut in half—unless boardings, the numerator of the productivity ratio, also increase.

Figure 61 shows the individual DASH (black) and WMATA (red) bus routes, each plotted according to their midday frequency (on the horizontal axis) and their productivity (on the vertical axis). Routes that run at rush-hours only are shown on the far right.

Higher frequency routes, like the King Street Trolley (KST) are to the left, indicating that they have short waits between buses. Higher productivity routes are higher up. So, for example, among routes that run every 30 minutes at midday, route AT9 has the lowest productivity at just less than 10 boardings per service hour.

The all-day productivity and frequency relationship trends up and to the left—more frequent services tend to have higher productivity (ridership per service hour), even though providing high frequency requires spending more service hours. This is true not only in Alexandria but also all over the world. Figure 62 shows the same frequency and productivity analysis is applied to hundreds of routes in 24 cities across North America (shown in black), plus DASH routes, shown in red. Here again, the power of frequency, when deployed in the right places, proves to be a critical element to increasing ridership.

However, you can not simply increase the frequency of a route and expect productivity to increase as well. All of the other factors that predict ridership—good density, linearity, walkability, connections among activity centers, and connections to other frequent routes—must be in place.

More frequent routes tend to have higher productivity, even though providing high frequency requires spending more resources.

Figure 61: In Alexandria, higher frequency routes tend to have higher productivity.

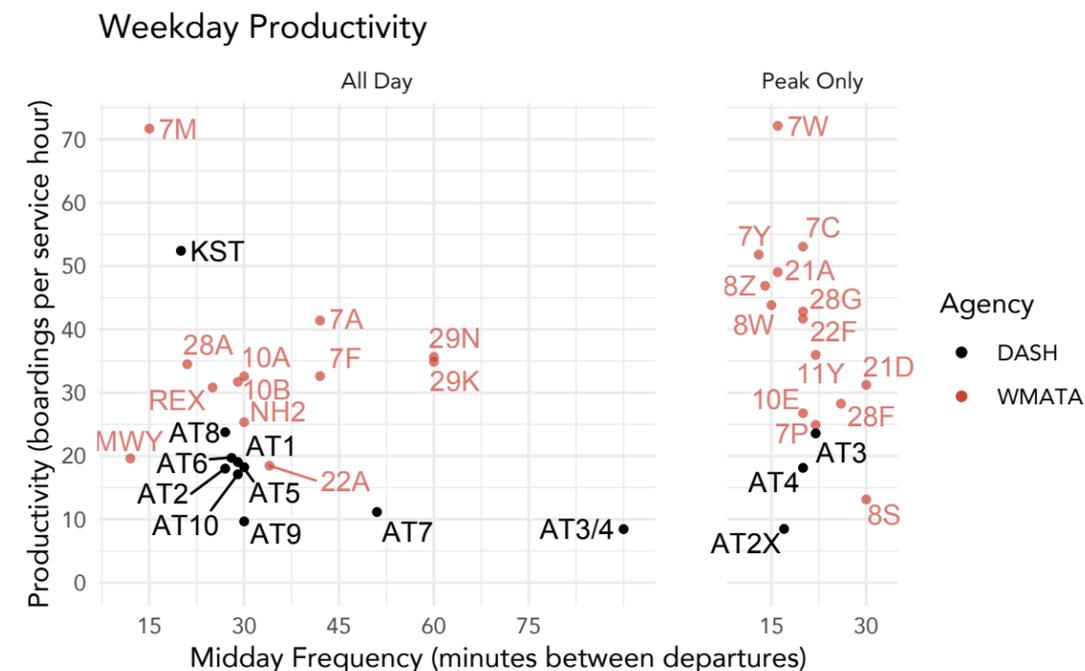
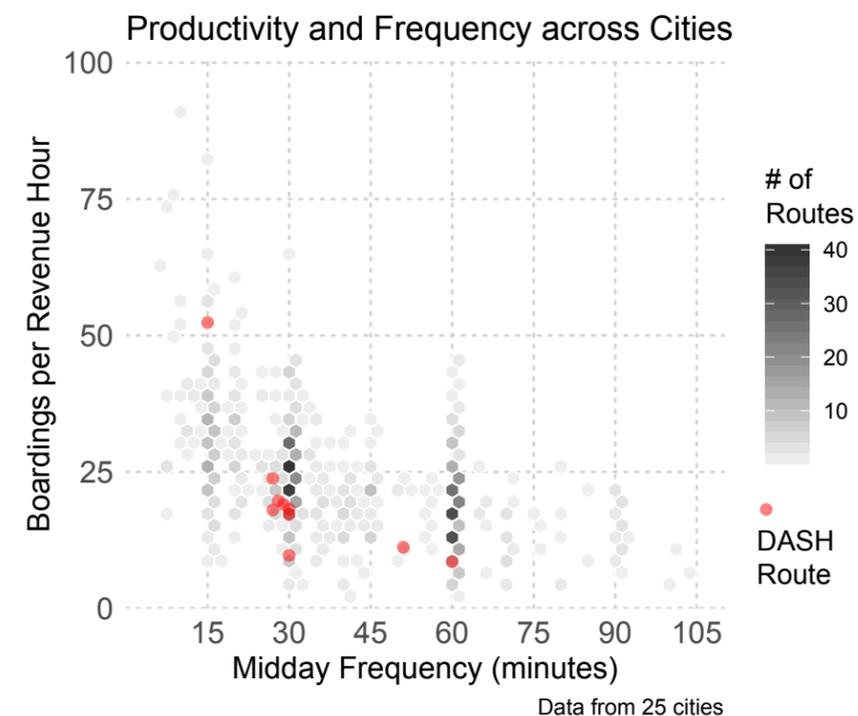


Figure 62: Higher frequency is correlated with higher productivity in 25 North American cities.



Productivity Outliers

Many routes follow the productivity trend, but some outliers provide insights into local conditions.

The King Street Trolley has much higher productivity than any other DASH route. The productivity measure tends to overvalue short trips, so the trolley gets an even higher productivity level compared to other routes in similar situations. The fact that it's free helps. Overall, **the trolley has all of the characteristics of a high-ridership route—it connects major destinations (including Metrorail) that are arranged in a linear pattern, with high density and walkability.**

The AT9, which runs from Potomac Yard to the Beauregard area, has the lowest productivity of any of the 30 minute routes. The low productivity of the AT9 should not be a surprise. **The AT9 meanders through the northern side of the city, mostly passing through low-density areas that are not very walkable** (see the four land use factors affecting ridership on page 10).

The AT2X has very low productivity for a peak-only route. As an express route it shuttles people between the regional transit hub at King Street Metro and the 6,000 jobs at Mark Center. Despite potentially high demand for travel between a major jobs center and a regional transit hub, the AT2X rarely has more than 10 people on it in either direction. **For each morning trip it makes bringing people from the Metro to Mark Center, it drives back to King Street Metro nearly empty. The same thing happens in the afternoon peak.**

Metrobus routes 29N and 29K have very high productivity for routes with 60-minute frequency. They actually combine to offer 30 minute frequency for a large portion of their routes through Alexandria, and their productivity fits with the trend for 30 minute routes. Similarly, routes 7A and 7F offer combined 15–20 minute frequencies, and have productivity similar to other 15–20 minute routes like the 28A. **Where two routes can be scheduled to provide a higher combined frequency in a dense, linear corridor, the payoff is often higher productivity than each route would achieve separately.**

Specialization

The AT2 and AT2X both serve the King Street Metro to Mark Center market, but the AT2X is useful only for travel between those two locations. On the other hand, the AT2 goes many more places than Mark Center, and is therefore more useful for more riders for whom the AT2X is irrelevant. The AT2, designed around many different types of trips, starting and ending in many different places at all times of day attracts much higher ridership.

Services useful to diverse markets are more productive than specialized ones.

Another explanation for the low productivity of the AT2X is that it's not much faster than the AT2 that people would let an AT2 pass by and wait longer for the AT2X. Figure 64 shows the morning schedule for both routes for the first seven trips of the day. If you arrived at King Street Metrorail station at 6:21, you would have just missed the AT2X that leaves at 6:20. You could wait twenty minutes for the next AT2X at 6:40, but you would get to Mark Center a little faster by taking the AT2 at 6:30. **That additional frequency is very valuable, but it is only available for the people riding to Mark Center and it is unavailable for anyone riding to other destinations along the AT2X path.**

Changing the stop pattern or making other adjustments to the AT2X might make the trip a little longer, but would likely capture more riders. The AT2X service is paid for by the Department of Defense as part of its effort to reduce traffic associated with the Mark Center. So it may not be easy to change the route, or its stop pattern. Yet, it may be worth opening the conversation with Department staff to help create service that is useful to more people and is more productive overall.

Figure 64: The King Street Trolley, Metroway, AT9, and AT2X are productivity outliers.

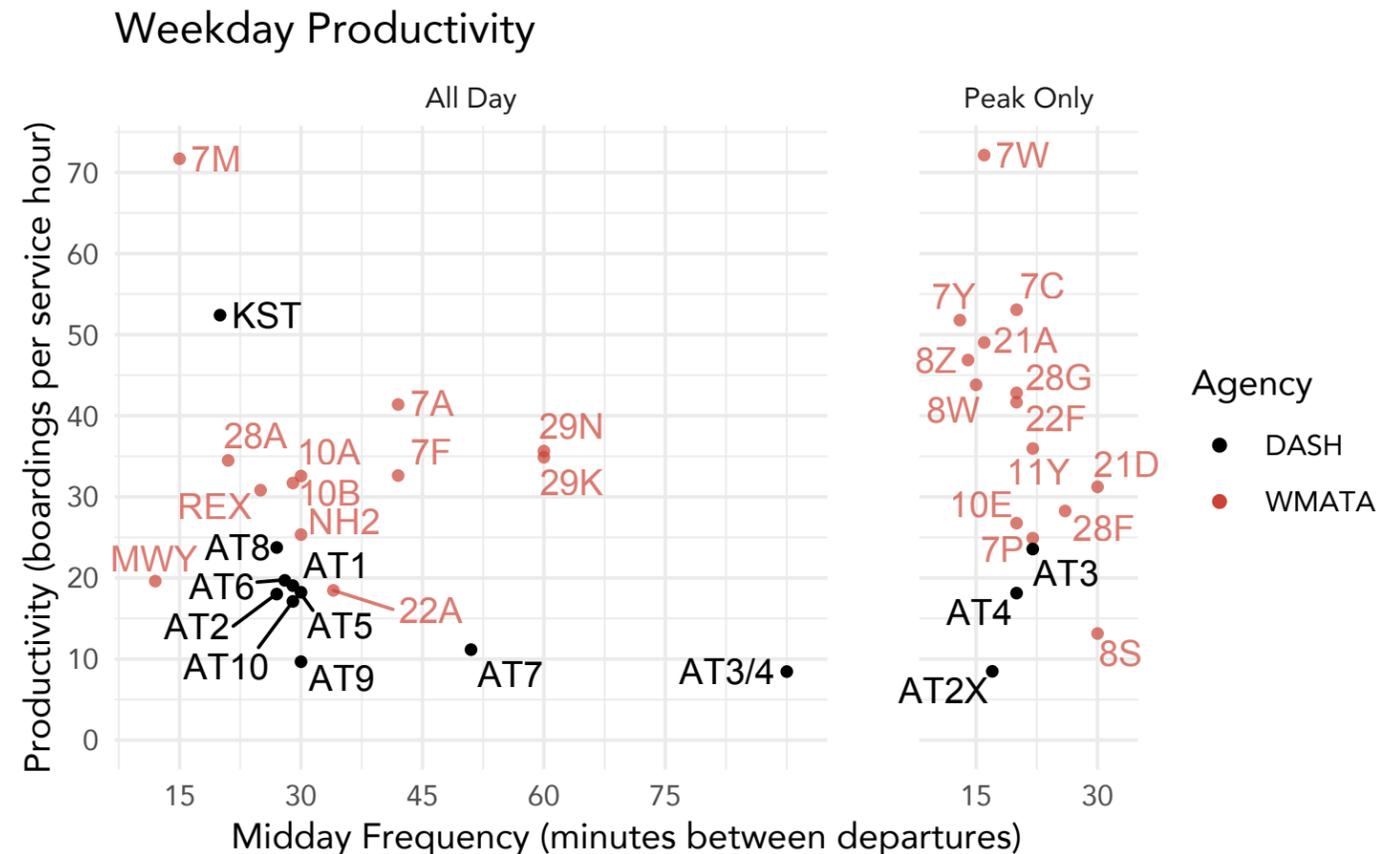


Figure 63: The AT2 and AT2X provide a combined 10 minute frequency from King Street Metrorail Station, but if you miss an AT2X, you'd get to Mark Center faster taking the next AT2.

BAY E BRADDOCK RD METRO	N FAIRFAX ST & PENDLETON ST	KING ST & N WASHINGTON ST	KING ST METRO	ALEXANDRIA HOSPITAL	STRATFORD BUILDING SOUTHERN TOWERS	BAY 6 MARK CENTER STATION	N BEAUREGARD & SANGER AVE	LINCOLNIA & N BRECKINRIDGE
J	H	G	F	E	D	C	B	A
ID#4000591	ID#4000813	ID#4000858	ID#4000607	ID#4000278	ID#4000340	ID#40001018	ID#4000301	FINAL STOP
WEEKDAY (AM)								
AT2X trips run non-stop between Mark Center Station and King St Metro Station								
5:39	5:49	5:53	6:00	6:15	6:19	6:24	6:30	6:38
AT2X —	—	—	6:10	—	—	6:25	—	—
AT2X —	—	—	6:20	—	—	6:35	—	—
6:09	6:19	6:23	6:30	6:45	6:51	6:56	7:02	7:10
AT2X —	—	—	6:40	—	—	6:58	—	—
AT2X —	—	—	6:50	—	—	7:08	—	—
6:38	6:49	6:53	7:00	7:15	7:21	7:26	7:32	7:40

Metroway

Metroway operates on average every 12 minutes in the mid-day, but achieves a productivity of about 20 boardings per service hour, which is far below lower frequency routes, like the REX or 28A. Part of the explanation for the lower productivity is that Metroway was created as a frequent route that would lead development, meaning that it would serve an area where new development would bring a significant increase in activity and density in the near future. That density is under construction in many parts of the corridor, but it will be many more years before Potomac Yard is fully developed. Leading development with frequent transit can be beneficial as it can build habits of transit use among new residents and workers as a new community develops. But it does come at the short-term cost of lower productivity.

Another factor that is reducing the usefulness of Metroway service, and therefore likely reducing potential ridership, is that the service misses two major centers



Figure 65: At its northern end, Metroway stops at Pentagon City, and misses bus connections with numerous routes that are possible at the Pentagon Metrorail station.

of activity and connection at its northern and southern ends. Figure 65 shows a section of the WMATA bus network map for Virginia, specifically the area around Pentagon and Pentagon City. As the map shows, at its northern end, Metroway ends at Pentagon City Metrorail station, just short of the much larger bus transfer center at Pentagon Metrorail Station. At Pentagon, many more bus connections are possible that would significantly expand the liberty and opportunity available to riders of Metroway.

Major transfer centers, like Pentagon, are similar to airline hubs in a network. The more connections that can be brought into the hub, the more potential connections are possible, and the more useful all service becomes.

A similar missed connection is occurring at the southern end of the Metroway route. Figure 66 shows just the WMATA routes that converge on King Street Metrorail and Braddock Road Metrorail stations. Metroway and Metrobus 10A+B meet at Braddock Road, but only Metrobus 10A+B continues into Old Town. As a major destination, the fact that riders on Metroway who wish to go to Old Town must transfer for such a short distance wastes a lot of time and discourages ridership. Moreover, the fact that Metroway and 10A+B riders cannot directly connect to the 28A, NH2, and REX routes that converge at King Street Metrorail substantially reduces the potential access for all people near these routes.

DASH routes AT2, AT5, and AT8 do connect all of these routes, but forcing multiple transfer, particularly when the distances covered are very short, adds a lot of extra time for riders. It also reduces the possible workers who could reach jobs in Old Town and the jobs that residents within Old Town could reach.

Forcing multiple transfer for short distances adds a lot of extra time for riders and reduces the overall access to jobs, destinations, and residents.

Productivity of Peak Routes

The productivity of most peak-only routes is higher than all-day routes. But, the productivity analysis is measured using service hours only, so it does not count the time needed to drive back (in the non-peak direction) to the beginning of the route because this time is not in the schedule of service.

For example, Metrobus Route 7W is a peak-only route that operates only in the peak direction. In the morning, it provides service nearly every 15 minutes from Lincolnia to Pentagon via the Mark Center and Southern Towers. But it does not provide service in the opposite direction in the morning. All of those buses that go to the Pentagon must either return empty to Lincolnia to start their next trip, or go back to the garage if they are done with all their trips for that shift. Therefore, **the peak only productivities shown here are overestimates because they don't account for the full cost of operating the service.**

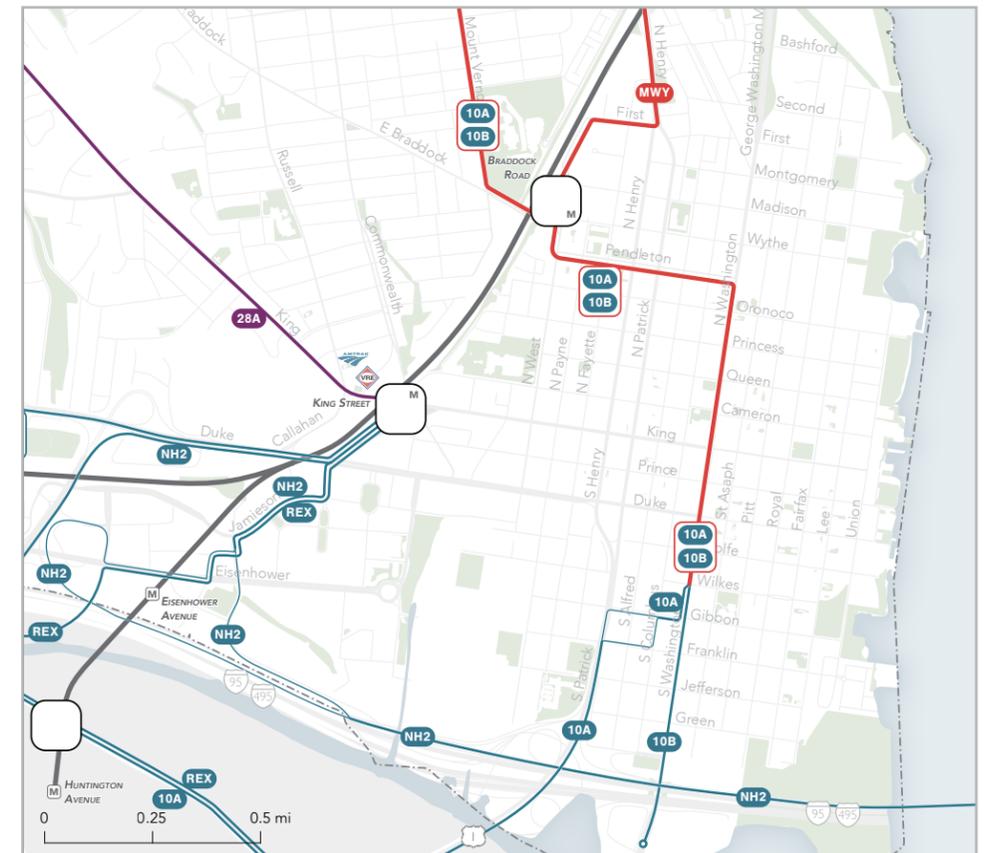


Figure 66: WMATA routes coming into Alexandria do not all connect directly, limiting the potential access available across the network.

Peak vs all day service

For many people, an interest in transit arises from the difficulty of commuting during rush hours, also called peak times. Transit agencies may also be expected to serve a school rush, which matches the morning rush hour, but is 2-3 hours earlier in the afternoon.

In suburban areas, rush hour demand is often radically different from the all-day demand, and much more intense. In those contexts it often makes sense to run extensive services only during the peak period, including entire bus routes that may run only then.

Such is the case in Alexandria, as shown in the map of peak bus service in Figure 67. Compared to the midday map on page 48, there are many more routes and much higher frequency on many routes. Compared to the midday, DASH runs higher frequency on routes AT1, AT3, AT4, AT6, and AT8, plus DASH operates the previously mentioned AT2X.

However, peak-only service—which means running a bus for only a few hours, carries several added costs for DASH that may not be apparent to the people who use it:

- » **Labor is more expensive** because a driver cannot be expected to report to work for a shift of only three hours. Splitting shifts across the morning and afternoon rush hours usually costs more than paying drivers for a straight 8-hour shift.
- » **Fleet costs are higher** because a transit agency must own, store, and maintain a buses that are being used for only short periods of the day.
- » **Peak-only demand is often one-way** in nature—into a downtown in the morning and out in the afternoon. This requires buses or trains to run empty in the reverse-peak direction, which increases costs relative to ridership.

Peak service carries several added costs that may not be readily apparent: additional labor costs, higher fleet costs, and the hidden costs of more empty trips.

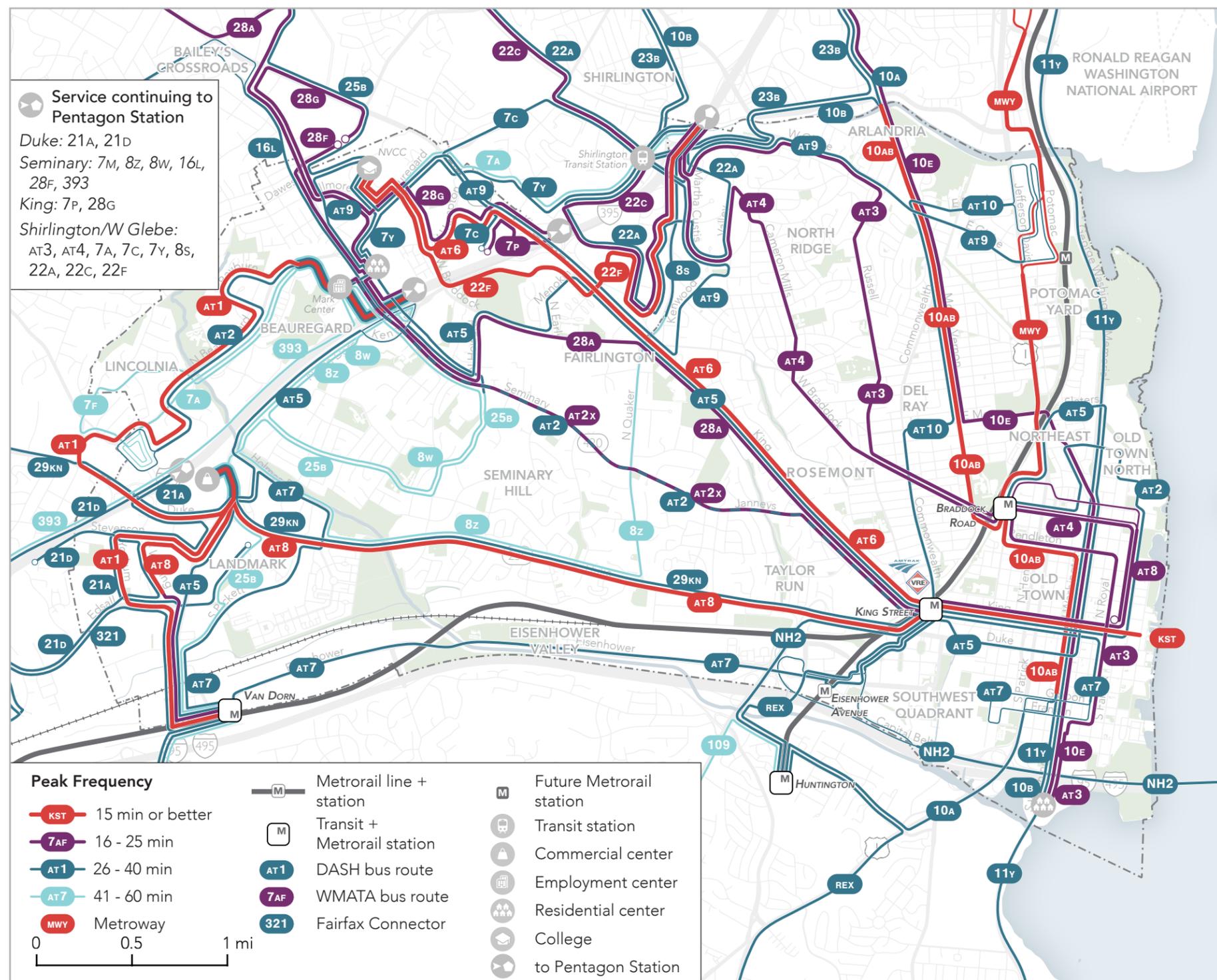


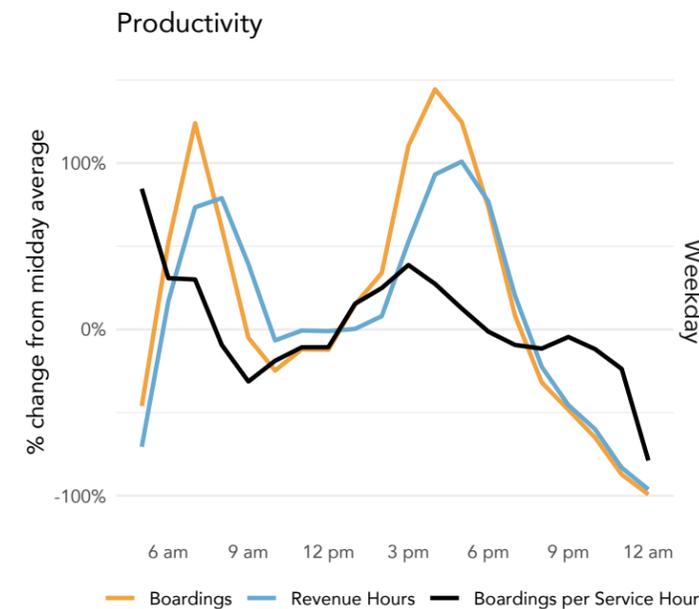
Figure 67: DASH and Metrobus run significantly more routes and higher frequencies at the peak compared to midday.

Productivity by Hour

Peak-only services are necessary in places where the demand warrants. However, transit agencies often provide too much rush hour service. Productivity in the rush hours should be higher than the midday, because buses should carry more passengers. If service hours increased to match the increase in demand, productivity would be flat throughout the day, and buses at the peaks would have a lot of extra room on them.

Figure 68 shows the average boardings and service hours for each hour of a weekday for DASH service. Boardings in Alexandria are strongly concentrated around rush hours, with more than twice as many boardings in some of the rush hours than the midday hours. To manage rush hour demand DASH provides many more service hours, as shown by the blue line. The black line shows productivity, or the number of boardings per service hour, for each hour of the day. Productivity is highest in the early morning and early afternoon, lower in the midday and evening. However, productivity falls to or below midday levels at the end of each rush period. **Also, the peak of productivity is only about 30% higher than the midday average productivity, suggesting that DASH provides too much peak service, given the extra costs involved.**

Figure 68: Productivity of DASH service is higher at the peak, but not dramatically higher.



Network Coverage

Ridership and productivity are not the only measures of transit performance. Another goal for transit is served when transit is available to people, whether or not they ride it in large numbers. We describe this goal as a coverage goal, because a transit agency can meet it by covering many areas, or particularly important areas, with transit service. See the full discussion of ridership and coverage goals on page 12.

Figure 69 shows the coverage provided by the existing DASH network to residents and jobs within Alexandria and Figure 70 shows the same measure for the combination of DASH and WMATA service.

This chart measures coverage by any service as well as to frequent service. The distinction is important because frequent service is most likely to attract high ridership relative to its cost.

Only about 4% of residents are within ¼ mile of frequent DASH service, which represents the number of people near the King Street Trolley, the only frequent service in the DASH system. This improves to 12% when including WMATA frequent service (which includes the frequent Metrobus 10A+B and Metroway routes) as shown in the chart on the bottom. With such low access to frequent service, expectations for ridership in Alexandria should be low.

Non-white residents are slightly more likely than all residents to live close to some transit service but are slightly less likely to live near frequent service. Low income residents are also just as likely to live close to some service and they have the same access to frequent service as all residents. The disparity in access to frequent service is relatively small but still worth considering as the Transit Vision Study considers future investments in service.

These conditions are not static and may change in coming years as a result of a changing economy and a changing city. If increasing housing demand near transit and in urban areas is not matched by increases in the supply of housing, then people living on low incomes may move away from frequent transit or any transit service to seek lower housing costs. Whether or not this is a consequence of growth and the desirability of urban, walkable areas depends on land use planning, growth permitting, and affordable housing policies at local jurisdictions.

Figure 69: DASH provides at least some service to nearly all people and jobs, but barely any frequent service.

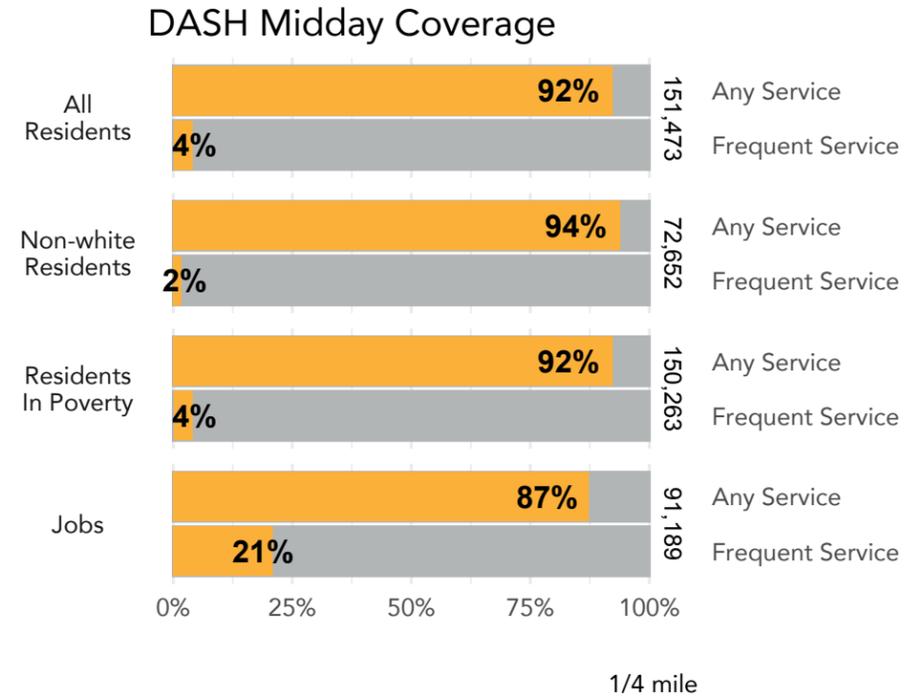
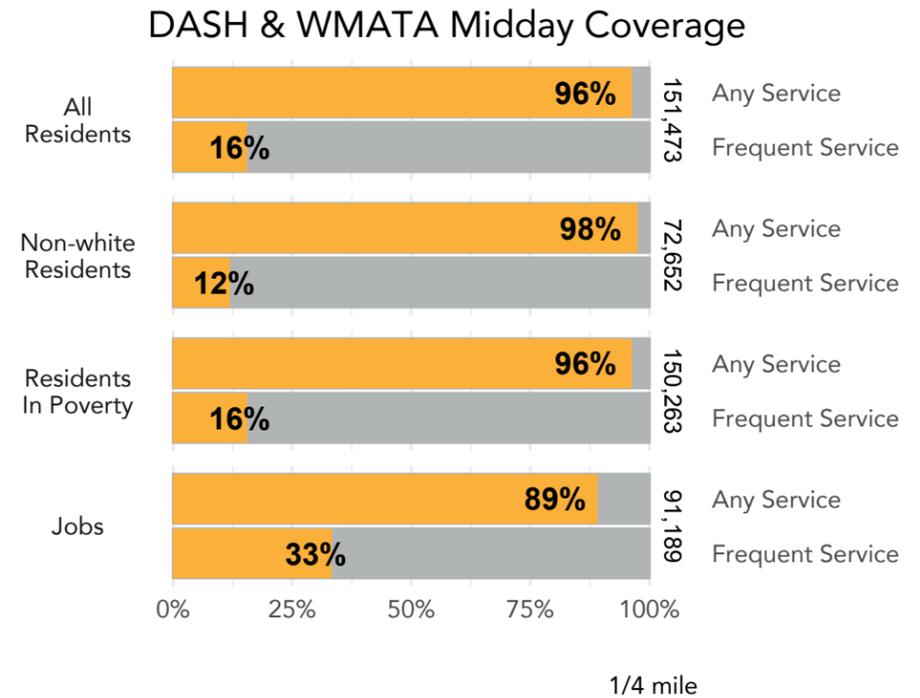


Figure 70: The combination of DASH and WMATA provides a little more frequent service.



Span of Service

For transit to be useful, it must be there at the times of day you need it. The times of day transit operates is called “span of service.” In Alexandria only three DASH routes provide service after 11 pm, and only one route, AT8, serves customers after midnight. Metrobus provides some service after 11pm on four routes.

Frequency of service varies dramatically throughout the day and week, with most service concentrated in the weekday rush hours. Three routes (AT2X, AT3 and AT4) provide service only during the morning and evening peaks. On weekdays, the less-frequent route AT3/4 replaces the AT3 and AT4 during the midday and evening. Five routes—AT1, AT2, AT6, AT7 and AT8—run at higher frequencies during rush hours than at midday.

Only one DASH route provides frequent service at midday, the King Street Trolley. However, the King Street Trolley doesn’t operate at all in the morning peak. The AT6 and AT7 do not operate at all on weekends.

The inconsistencies in frequency and which routes are available throughout the day make the network more difficult to understand, and limit the types of trips the network can be useful for. Further complicating the network is that some routes run different patterns on the weekend. In particular, AT5 runs down Eisenhower Avenue on weekends, to cover the area where the AT7 does not run on weekends.

The transportation profession has long been focused on the weekday rush hours, because those are the times when our road capacity is most-used and congested. Yet people need to travel at all times of day and week. Anyone taking an evening class, pursuing a hobby, going to worship, or staying late at work to finish a report needs a bus ride home outside of the traditional 9-to-5 workday.

Service at all times of day is essential if transit is to support denser development, or if it is to compete for lower-income commuters whose shifts tend to start and finish throughout the day and evening. Weekend service is critical for the same reasons.

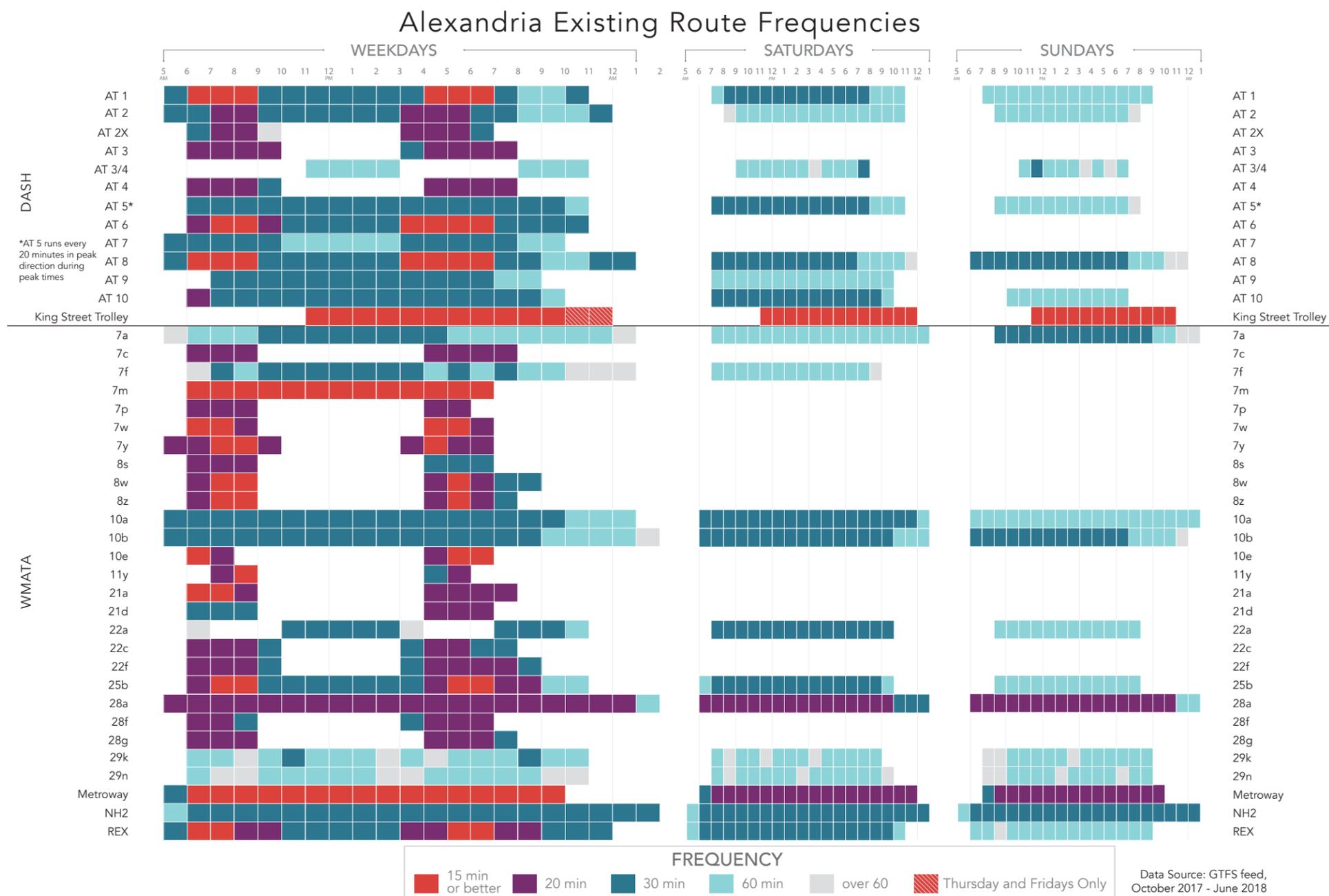


Figure 71: The availability and frequency of service is much lower on weekends and drops off significantly in the evening.

Network Structure

Radials and Orbitals

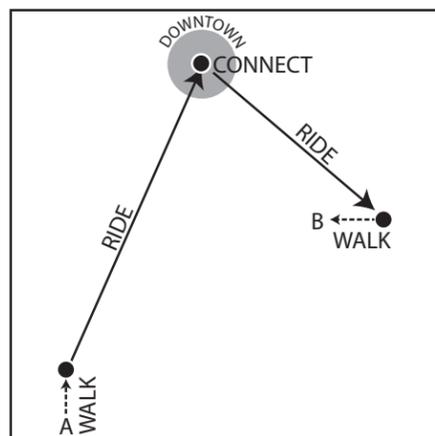
“Radial” networks have a central point, usually in a downtown, and nearly all routes go to that point. A radial network design ensures that anyone looking to travel to the central point can make their trip without the need to transfer between routes. Anyone wishing to travel to another outlying neighborhood makes a transfer between routes downtown. Radial networks arose naturally in pre-car cities because so much commerce and culture was centralized and dense.

As a city grows larger, radial networks become less practical because the out-of-direction travel required to get between two non-downtown points gets so much longer. In addition, since the invention of the car and freeways, most U.S. cities have developed many more “centers.” A radial system struggles to accommodate multiple centers or sprawling and scattered development.

In response to the growing demand for travel among multiple centers many transit agencies operating radial networks add “orbitals”, or routes that orbit around the downtown without traveling into it. Orbitals, sometimes also called crosstowns, make it possible to travel from one major destination to another outside the city center without first having to travel into downtown.

Not all of the radial routes serve Old Town Alexandria. Two routes, AT6 and AT10, terminate at King Street Metro.

Network Structure



Radial Network

Most routes lead to and from downtown. Anyone wishing to travel from one non-central location to another must pass through downtown and transfer to another route there.

A radial structure makes sense when one part of a city (typically the downtown) is a dominant destination all day – for work, for play, and for commerce. Often, routes are scheduled to converge at a set time (called a “pulse”) to reduce transfer times between routes.

AT3/4 serves Braddock Road Metro Station and then serves Old Town, but does not reach King Street Metro. Thus, if someone wishes to travel from North Ridge to Northern Virginia Community College, they must catch the outbound trip on Russell to reach the AT9, or ride inbound and transfer twice to catch the AT6.

Timed Connections (Pulsing)

In a radial network, and particularly ones with low frequency routes, there is usually one center. This is in part to facilitate easy transfers among all routes. Usually, the single center has a timed connection (or pulse) where all routes meet at the same time each hour or half-hour to make transferring between routes easier. Typically, this can only work at one central location, as it is rarely possible to time connections at multiple places around a city.

A transfer between low-frequency routes can be appealing if the routes are designed to meet one another at the same time and the same place, in a recurring pattern.

These timed-connections or pulses occur when multiple buses dwell at the same location, allow a few minutes for transfers among them, and then continue on.

Pulses are hard to see. A rider must use a trip-planner or decipher and reconcile multiple schedules to confirm that a transfer between two 60 minute routes won't require a long wait.

In contrast, a frequent grid guarantees a low maximum wait time at the connection point, without the complexity of pulses.

Scheduling repeated timed-connections among infrequent routes requires recurring frequency patterns. For example, a pair of routes can connect repeatedly throughout the day if both have 60-minute frequencies.

Or, if Route A comes every 60 minutes and Route B every 30 minutes, they can connect on every-other trip of Route B. As long as their frequencies repeat reliably, and divide into one another (as 30 does into 60), then the timed-connection can be scheduled to happen many times each day.

If most of the DASH network will remain low frequency, then a pulse would improve access by making transfers easier. But then most routes would need to converge at one point. Since most routes already converge at King Street Metrorail or in Old Town, those would make good locations for a pulse point. But there would need to be sufficient space for all the buses to arrive and wait a few minutes every 30 minutes and there may not be sufficient space at any current location.

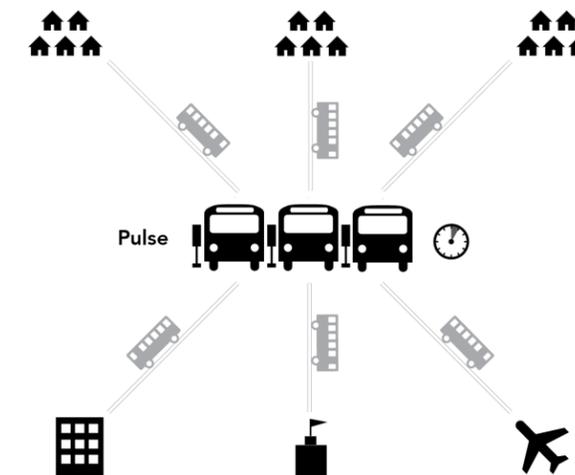


Figure 73: In a pulse, multiple routes meet at a central point at the same time to minimize waits for a transfer.

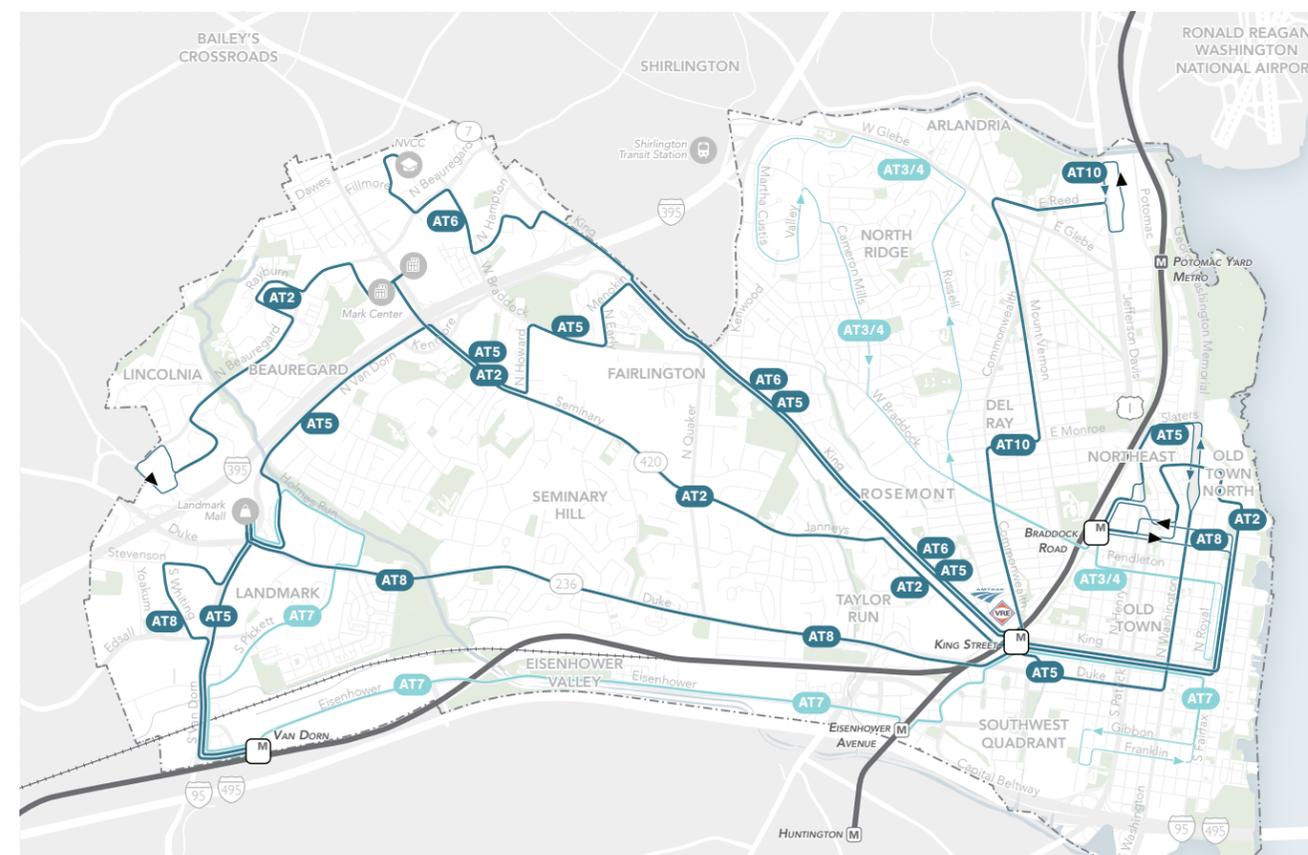


Figure 72: Radial routes converge on King Street Metro Station or Old Town.

Orbital Compensation

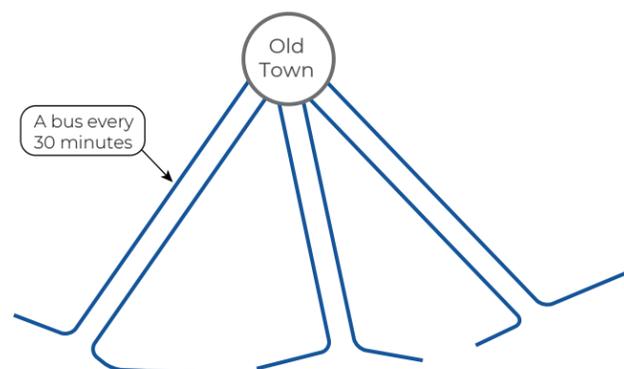
Orbital movements are often served by pieces of radial lines bending in an L shape. This helps connect many places to the city center, but is not effective for connecting places outside of the city center to each other. Many of the radial routes in the DASH network do some “orbital compensation”, that is, they operate as orbitals after traveling to the edge of the city. Figure 74 provides a schematic perspective on this pattern.

For example, AT2 is a radial between Old Town and Mark Center on Seminary Road, but assumes the role of an orbital from Mark Center to Lincolnia on Beauregard Street, even though AT1 is already operating as an orbital route in that area (see Figure 75). Similarly, the AT5 provides direct radial service between Old Town and Fairlington and western Seminary Hill on King St, and acts like an orbital to Van Dorn Metrorail station, mostly along Van Dorn Street. AT8 is a radial between Old Town and Van Dorn Street where it starts acting like an orbital down to Van Dorn Metrorail station.

The orbital compensation provided by these routes allows for more one-seat rides from the dense areas in the west of the city to central destinations in and around Old Town. However, there is a big downside to this network design strategy: orbital compensation creates infrequent orbital fragments that don't go far enough to be useful for many orbital trips while still creating a lot of duplication on radial segments. And it makes it hard to create more frequent service on either the orbital or radial trips.

Figure 74: In the DASH network, many radial routes do some orbital compensation at their outer ends.

Typical Pattern of Radial Routes



Grid Connections

In cities with many centers (such as DC, LA, Chicago, or Houston) a frequent grid allows people to travel from-anywhere-to-anywhere with a single fast transfer. It requires much less out-of-direction travel than a radial network. A frequent grid offers the simplicity and reliability of a street network—you can use it just about anytime, without checking a schedule or making an advanced plan. It is easy to keep the map in your head.

A necessary precursor to a successful frequent grid, however, is high frequency. DASH and Metrobus do not have enough frequent service to support a frequent grid within or around Alexandria today. But, there are many overlapping resources on corridors like King Street (AT5 and AT6), Mount Vernon Avenue (Metrobus 10A+B and AT10), South Van Dorn Street (AT1, AT5, AT8), and Beauregard Street (AT1, AT2), that the beginnings of a frequent grid might be possible with a redesign of the network. It is likely, though, that to create a true frequent grid across the city, more resources would be needed.

A frequent grid for Alexandria would also be most useful as part of a larger frequent grid of service for regional travel. As noted in the analysis of commute patterns on page 33 and overall trip patterns on page 36, many trips in and around Alexandria are to and from places just across the border, or for commute trips to Washington.

The trip patterns in particular reveal that many trips are going to and from nearby destinations in Arlington, like Shirlington, Columbia Pike, Crystal City, Pentagon City, and Bailey's Crossroads. **A frequent grid of service for Alexandria might connect western Alexandria more closely to Bailey's Crossroad, Shirlington, and Columbia Pike than to Old Town.** Likewise, a frequent grid network in Alexandria might connect Old Town and Potomac Yard more closely to Crystal City and the Richmond Highway Corridor in Fairfax than to western Alexandria, because that is where the patterns of demand are.

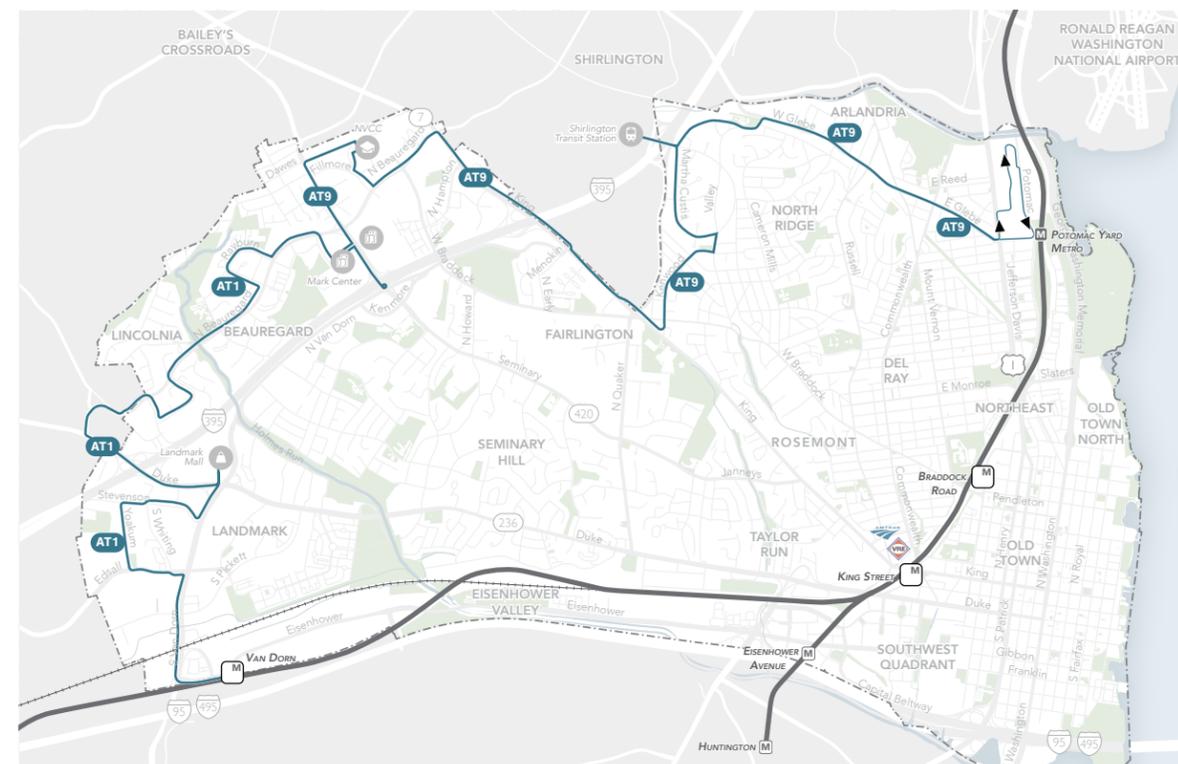
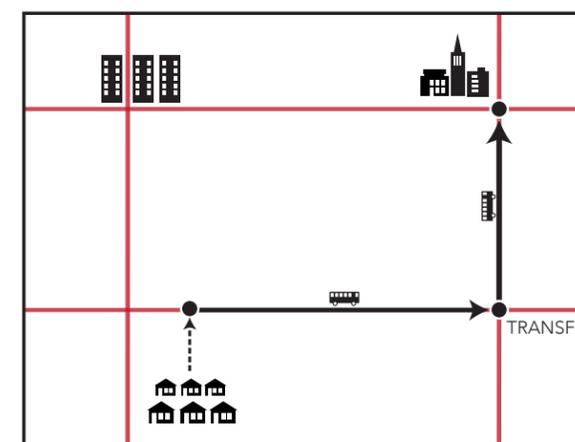


Figure 75: AT1 and AT9 are orbital routes in the structure of the DASH network.



Grid Network

A grid structure is most suited to a city with multiple activity centers and corridors, where many people are traveling to many different destinations.



Linearity and Walkability Challenges

The overall pattern of development in Alexandria, described in Chapter 2, has resulted in a donut of denser areas of residents and jobs located around the edges of the city and a low density hole in the middle. This pattern forces radial routes connecting Old Town to outlying activity centers to travel through large areas with low ridership-potential. AT2, 3, 4, 3/4 and 7 travel through areas of particularly low ridership-potential on Seminary Road, Eisenhower Avenue and through North Ridge, as evidenced by the small boarding dots on these streets in Figure 76.

The extra time spent traveling through areas of low ridership-potential in the hole of the donut increases the cost of serving the areas of higher ridership potential

and drives down productivity on these routes (see productivity by route on page 56).

In addition to the donut pattern, there are smaller scale land-use and development patterns that are very difficult to connect with useful transit service throughout Alexandria. When buildings are located on linear, walkable streets, on the way to other destinations, they are easy to connect with frequent, useful transit. That development pattern is clearly visible in Old Town.

Outside of Old Town, development has resulted in small islands of activity, surrounded in parking lots or highways that force long walks through car-oriented places. Transit appropriate development places the front doors of destinations along streets that pedestrians can easily and safely cross.

A clear example of this is at Mark Center, with approximately 6,000 government jobs, and Southern Towers, a major housing development. These major activity centers are located near the intersections of highways and wide, median-divided roadways. Both developments are insulated from the street by large parking lots, maximizing distances people must walk to on-street bus stops. As a result, AT1 and AT2 buses make long deviations to get close to the front doors of the Mark Center and Southern Towers (the map in Figure 77 shows the deviations required to serve Southern Towers). These deviations make the routes slow to ride unless your destination is in one of the deviations.

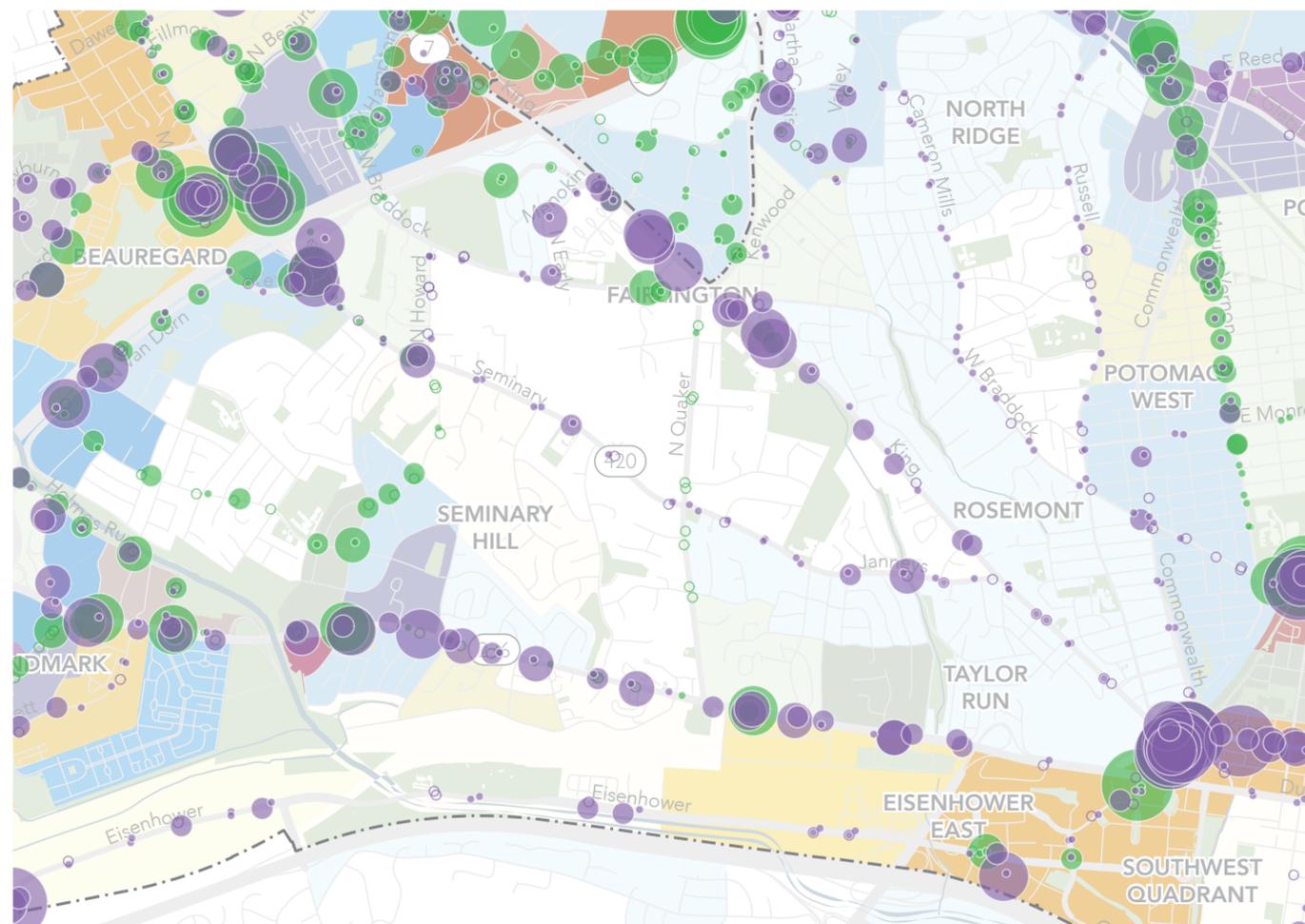


Figure 76: Ridership is very low along the low-density segments of Seminary and King Streets in the center of Alexandria

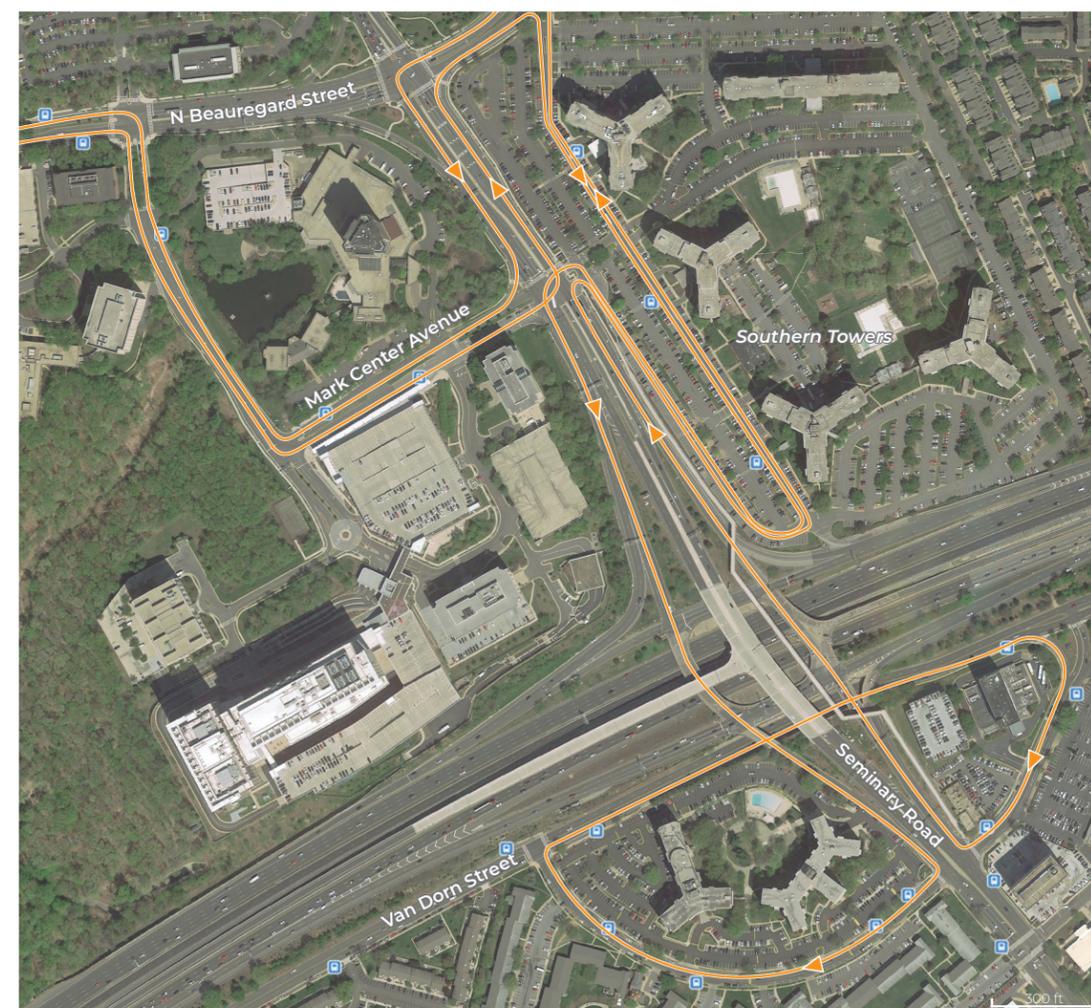


Figure 77: AT1 winds its way from Mark Center through Southern Towers and an interchange in an environment that is hard to serve with transit.

Circuitous and Deviating Routes

This pattern of dense development oriented away from streets that buses can drive down is common outside of Old Town. In Landmark, west of Van Dorn Street, DASH provides service on three consecutive streets, Van Dorn Street, Whiting Parkway, and Yoakum Street. Although the streets are only ¼ mile apart, walking between them is possible in only one place. As a result, DASH has to split service into three parallel routes in order to provide reasonable walking distances to transit for people in this area. Splitting service across multiple streets results in lower frequencies. This split contributes to the lack of frequent service between Van Dorn Metro and Landmark Mall.

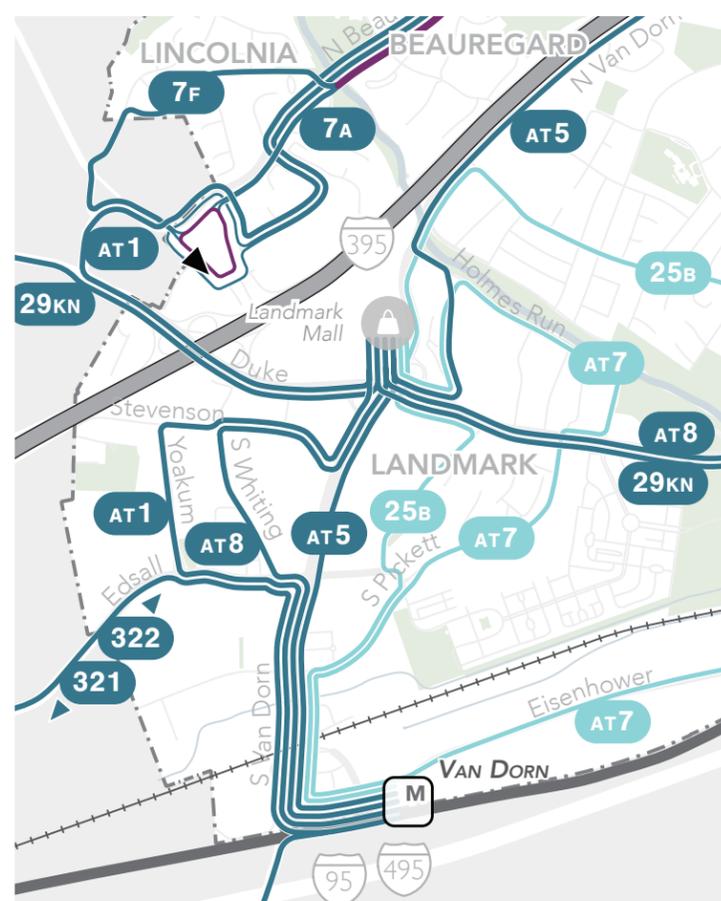


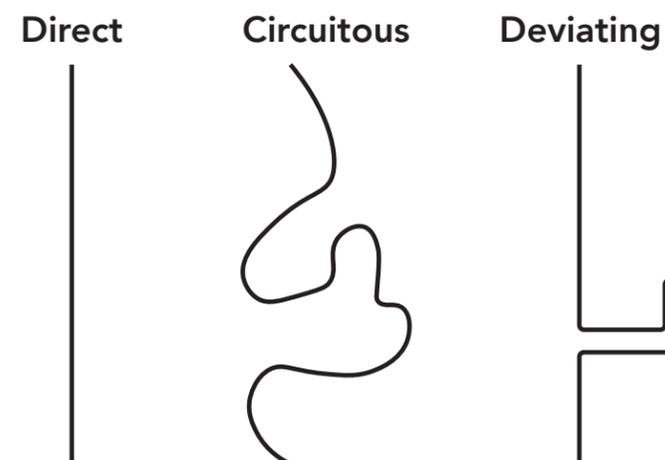
Figure 78: Multiple routes split across many streets in southern Landmark because walkability is poor.

Landmark Mall is another place where car oriented development patterns make it difficult for DASH to provide useful transit. To serve the mall directly, routes must make a long deviation around the back side of the mall (see Figure 79), because that is the only way buses can enter and exit the property. This deviation adds at least 5 minutes of travel time and operating cost to routes AT 1, AT 5, AT 7, AT 8, and Metrobus 29K+N. Serving the front of the mall by stopping on street without deviating would reduce travel times but result in a long walk, often along or across wide roads. Currently many riders use this stop to transfer between the five routes that converge here, so an off-street transfer location is a sensible idea.

Given that the mall is largely empty, and is awaiting a likely redevelopment, it might make more sense in the short-term to stop serving the mall directly or revise the path buses take on the site to reduce the circulation time through the site. The City and DASH are coordinating with the site owners on a possible new location for a transit hub that would be integrated with the redevelopment of the site. Most importantly, in the long-term the City, DASH, and Metrobus must insist on a more direct way to serve the new development that comes to this site, and preferably require a small transfer center be located on the property in a location that can be served in a direct manner, with a minimum of deviation.

Whether it's Mark Center, Southern Towers, Landmark Mall or nearly any other destination outside of Old Town, **the current placement and design of these developments forces DASH or Metrobus to run more route-miles, which takes more time, and costs more money. This means service is less frequent than it could be, and thus less useful. Therefore, ridership expectations will be low.**

It is also important to note, that as routes get longer, and include more deviations and turns, it gets harder to maintain the reliability of service. More turns means more opportunities for delay from congestion and conflicting traffic. Thus, direct routes tend to be more reliable, which adds to their usefulness.



Direct routes are cheaper to operate and tend to achieve higher ridership compared to circuitous or deviating routes.

Figure 79: AT8 must take a very circuitous path to serve Landmark Mall. AT 1, AT 5, and AT 7 also use the same circuitous path, which takes about 5 minutes each way.



Large Loops

AT3 and AT4 are rush hour only routes serving the North Ridge neighborhood. Outside of rush hours the area is covered by a single route, the AT3/4.

While the AT3/4 continues to provide geographic coverage, meaning service is available to people, it is not very useful service. AT3/4 includes a large one-way loop through the North Ridge neighborhood that provides some transit access, but it means many trips require out-of-direction travel that takes extra time. Also, as shown in Figure 80, the route misses many possible connections at the nearby Shirlington transfer center just across I-395 from the northern end of the route loop.

One-way loops are cost effective ways of covering large areas, but require passengers to either walk far to the other side of the loop, or ride far out of direction. For example, someone traveling from Russell Road & West Glebe Road to City Hall would have to either ride an extra 10 minutes until the route loops back to towards Old Town, or walk a mile to Cameron Mills Rd to catch the AT3/4 going directly in to City Hall (see Figure 81).

A route split by direction appears to cover more, actually covers less.

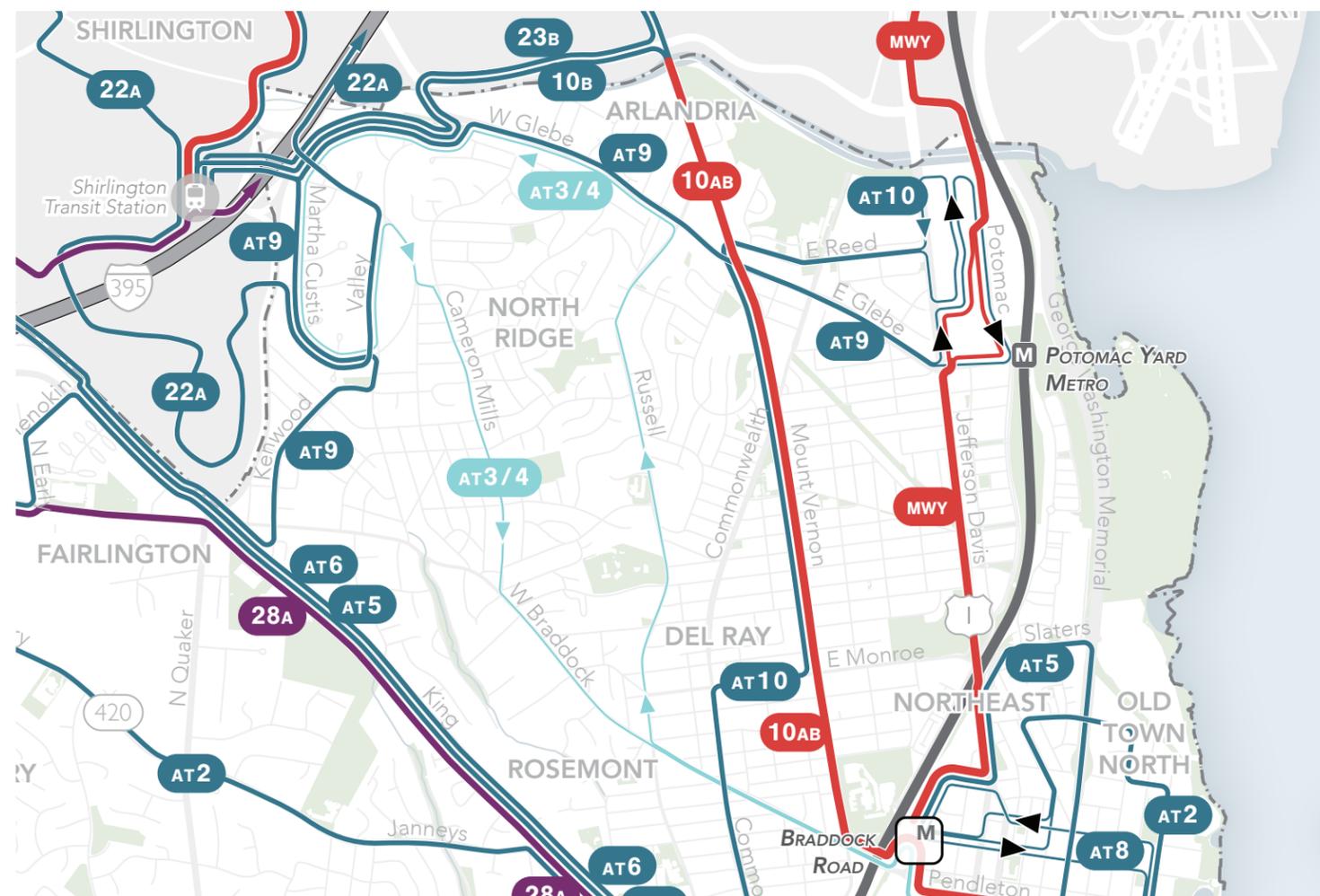
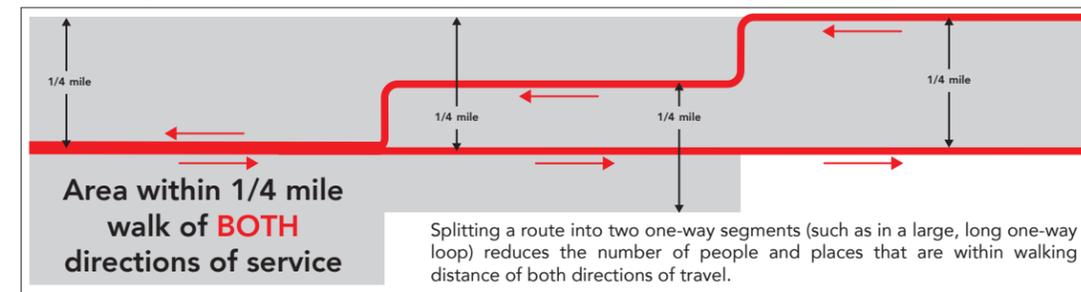
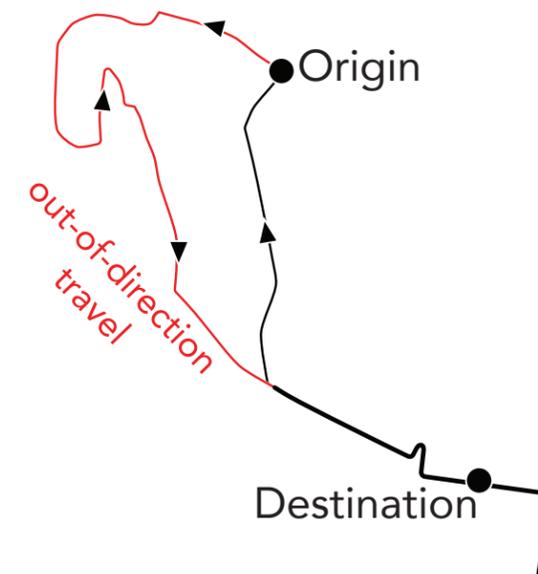


Figure 80: The AT3/4 loops through Northridge, but misses many useful connections at the nearby Shirlington transfer center.

Figure 81: The large one-way loop on AT3/4 through North Ridge means many trips are out of the way.



Local vs Rapid Patterns

The pattern of service operated on Duke and King Streets by these routes is often called a local/rapid or local/limited pattern. In this pattern two different routes run the same street, one stopping in a local route pattern, perhaps every 1,000 feet, and the other in a limited or rapid pattern, perhaps every mile (see Figure 83 for differences between how different route types stop).

This pattern is a common solution in very long corridors with long trip lengths and where the frequency of local service is already very high. At a high frequency, perhaps a bus every 5 minutes, there is limited value in improving the frequency, because it won't save most people much time. But, adding a rapid service will save time, because it will speed up service for riders going a long distance. So this pattern is common on long, high demand corridors like 16th Street in DC or Wilshire Boulevard in Los Angeles.

In the context of King Street and Duke Street, the pattern has been implemented because DASH began

providing service and both agencies coordinated to develop this pattern as a way of maximizing the usefulness of each of their services separately. Since each service is being run by different operators it is difficult to coordinate schedules and operations to create a high frequency local pattern.

But the resources that are being spent on two different services in the same corridor split into a local/rapid pattern might be better spent on a higher frequency service that served the whole corridor. In the current pattern, Metrobus 29K+N takes 17 minutes from Landmark Mall to King Street Metrorail station and runs every 30 minutes. The AT8 takes 22 minutes to make the same trip and runs every 30 minutes as well. So on average, by Metrobus, it would take 32 minutes to make the trip (15 minutes of waiting and 17 minutes traveling) and by DASH it would take 37 minutes (15 waiting and 22 traveling).

If the routes were combined so that Metrobus 29K+N made local stops, but had service every 15 minutes from Landmark Mall to the King Street Metro Station, then the same trip would take 29.5 minutes (7.5 minutes

waiting and 22 minutes traveling). That is a savings of 2.5 minutes over the existing route, even with the additional travel time from making local stops. And by reducing the number of local stops, the travel time could be improved.

The additional travel time for Metrobus 29K+N might be unacceptable for riders who are traveling from Fairfax or Annandale. It also might cost Metrobus too much if the extra five minutes means they must add a bus to each route. Thus, the decision of how to coordinate and organize service between DASH and Metrobus along Duke and King Streets is ultimately both a local and regional issue.

Stop Spacing and Speed

On many routes in Alexandria, particularly in Old Town, stops are extremely close together. For most people, it is easy to walk to any of several stops on a route. But a customer does not need several stops; they need one.

There is a geometric trade-off between closer stop spacing and faster bus speeds. Figure 84 shows the basic trade-off in conceptual terms. As stops are placed farther apart, buses can travel faster and cover more distance in the same time.

This is because most of the time required at a stop is not proportional to the number of passengers served. Most of the time required for a stop is the time decelerating to a stop and accelerating back into traffic. When passengers gather at fewer stops, stopping time is used more efficiently, resulting in faster operations.

This increased speed has two benefits. First, riders can get farther faster and reach their destinations sooner. Also, as speeds increase across the entire transit system, more service can be provided for the same cost. Since the primary cost of transit service is the cost for labor which is paid based on time worked, the faster buses operate, the more service that can be provided for the same cost.

This is why standards for stop spacing in the US are generally in the range of 750 to 1,500 feet on high-frequency bus routes. On Duke and King Streets in western Alexandria, most stops are on average 800 feet apart. In Old Town, stops are closer together, often 500 feet, or less, apart.

Figure 83: Difference between Express, Rapid, Local, and Flexible stop patterns.

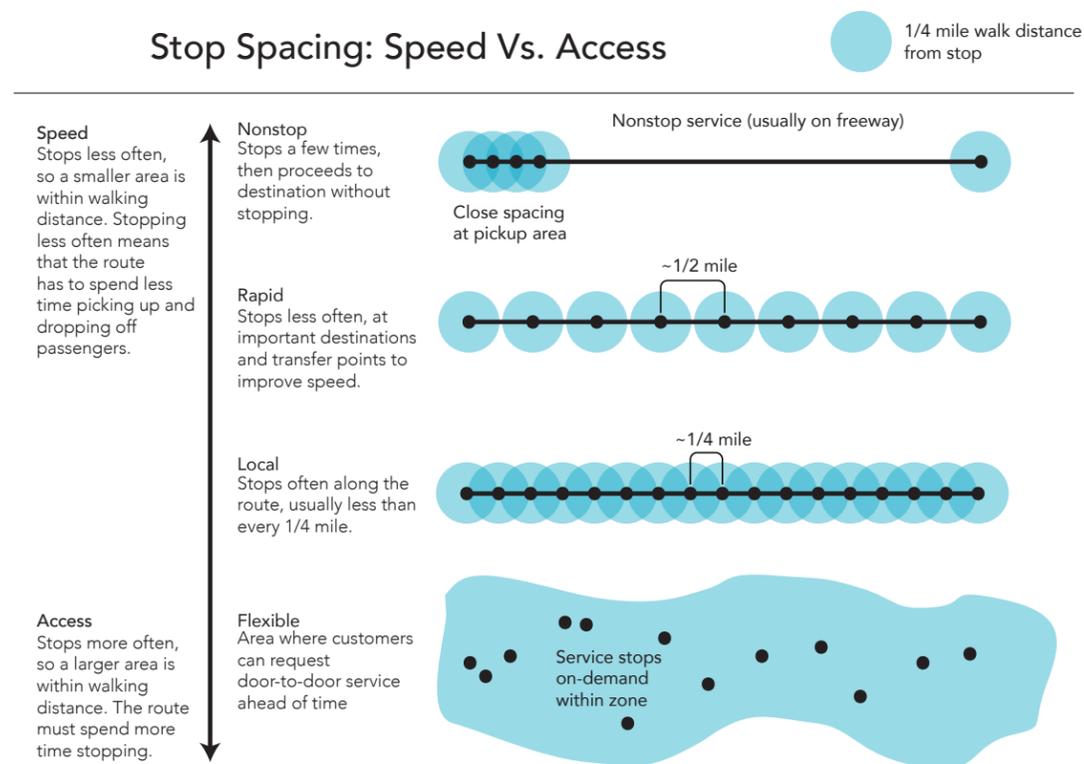
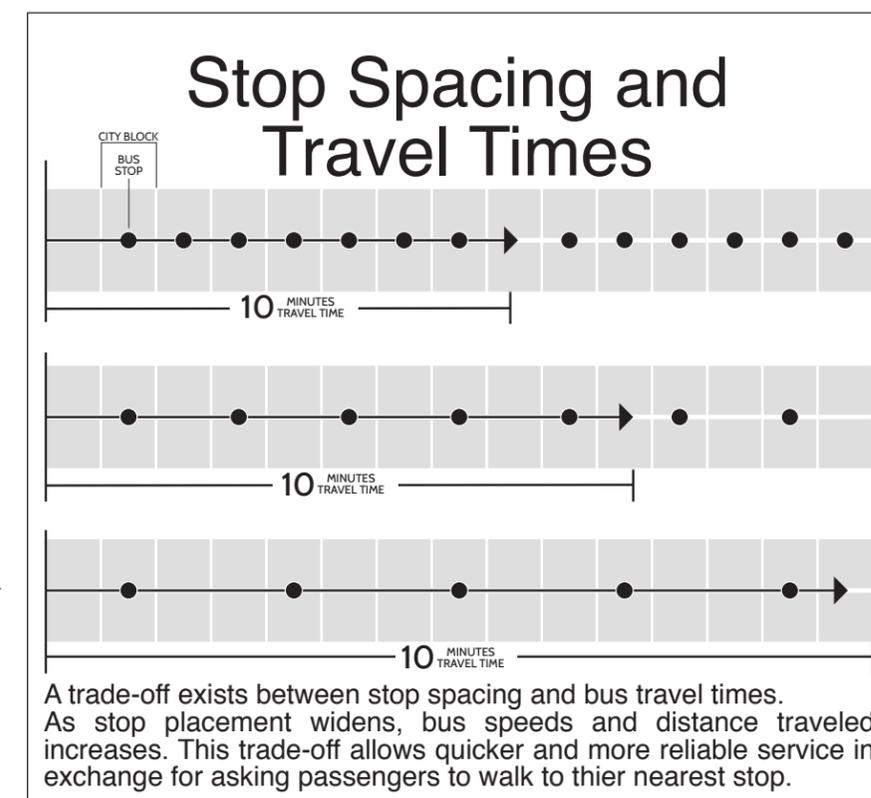


Figure 84: Trade-off between stop spacing and travel time.



Shuttles: Complements or Competitors?

Within Alexandria, a number of commercial and residential developments operate shuttle services to and from Metrorail stations and other major destinations. The City of Alexandria recently compiled information about shuttle providers at the four Metrorail stations within the city (Braddock Road, Eisenhower Avenue, King Street, and Van Dorn) to better understand how shuttle operators were using these stations.

A variety of organizations operate shuttles including residential developments, major employers, hotels, and car repair businesses. Many shuttles for residential communities were created as part of a transportation management plan (TMP), required by the City's development process. These TMPs describe the specific mode split goal and reduction in vehicular trips that each community is trying to achieve to meet the required TMP goals of reducing vehicular traffic impacts. Other shuttles are provided by hotels and commercial developments, offering courtesy transportation for customers to and from Metrorail stations.

Of 871 residents surveyed about shuttle service, about two-thirds did not have a shuttle available. About 90 people (10.6%) used shuttles provided by residential buildings. Among employees surveyed, 61 used a shuttle (23% of 265 respondents).

While shuttles can be effective in moving more people in fewer vehicles, they can create conflicts with transit service, particularly at pick-up and drop-off areas around Metrorail stations where curb space is limited and heavily used. In addition, many shuttle services are connecting origins and destinations that are already served by DASH or Metrobus. For example, Northern Virginia Community College runs a shuttle to King Street Metrorail station during the spring and fall semesters, even though the AT6 serves the same trip at least every 30 minutes all day. So if resources for shuttles like this could be reallocated to transit, more efficient use of scarce road space and scarce resources could go toward greater mobility for more people to go more places.

There is limited data on the routing, service span, frequency, and ridership of existing shuttles. Based on the TMP surveys, there are 48 shuttles operating to and from Metrorail stations in Alexandria. Figure 85 shows the origin points for various shuttles within the city.

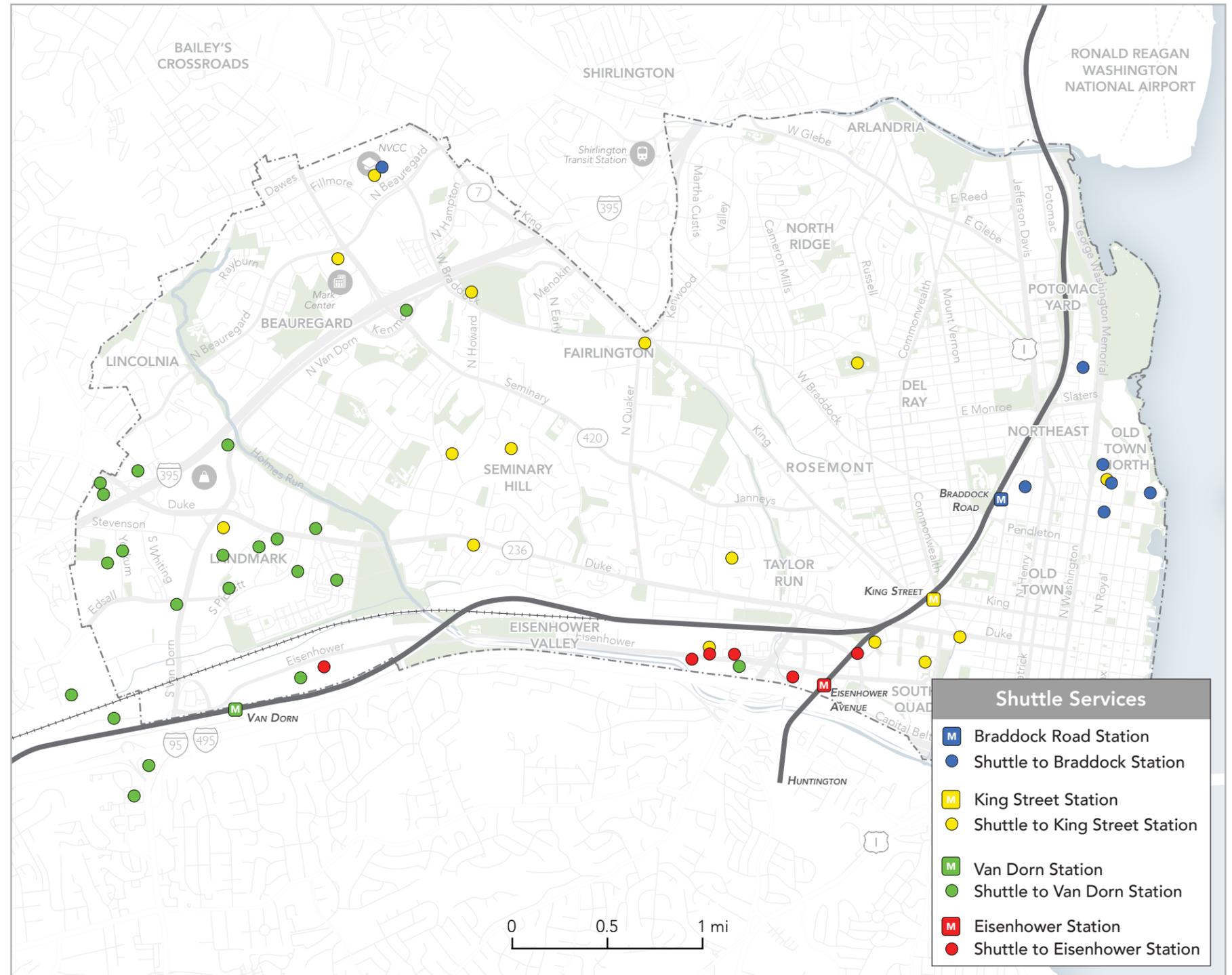


Figure 85: Many private entities operate shuttle services to and from Metrorail stations in Alexandria.

The survey data on shuttles is incomplete and there may be other shuttle services that are operating that were not included in this analysis because they were not part of the surveys.

Most of the shuttle origin points are on or near an existing DASH or Metrobus line. Some services may not be compatible with a traditional fixed route:

- » School buses (primarily private schools or after hours)
- » On-demand shuttles for automotive service centers
- » On-demand shuttles for hotels

Some services may be compatible with traditional fixed-route:

- » Residential peak period commuter shuttles
- » Hotel peak period commuter shuttles
- » Business park peak commuter shuttles
- » Community college shuttle

Four clusters of shuttle origins exist:

- » Approximately 20 within 1 mile of Landmark Mall
- » Nine within half a mile of Braddock Road Metro Station
- » Five within Old Town North
- » Four near the I-395/Seminary Road interchange

The largest cluster, near Landmark Mall, consists of a number of uses including residential buildings, commercial businesses, and the Bishop Ireton High School. The nine origins around Braddock Road Metro Station and the five within Old Town North consist mostly of hotel shuttles, with one or two employer shuttles. The four at the I-395/Seminary Road interchange are split evenly between education and hotel uses.

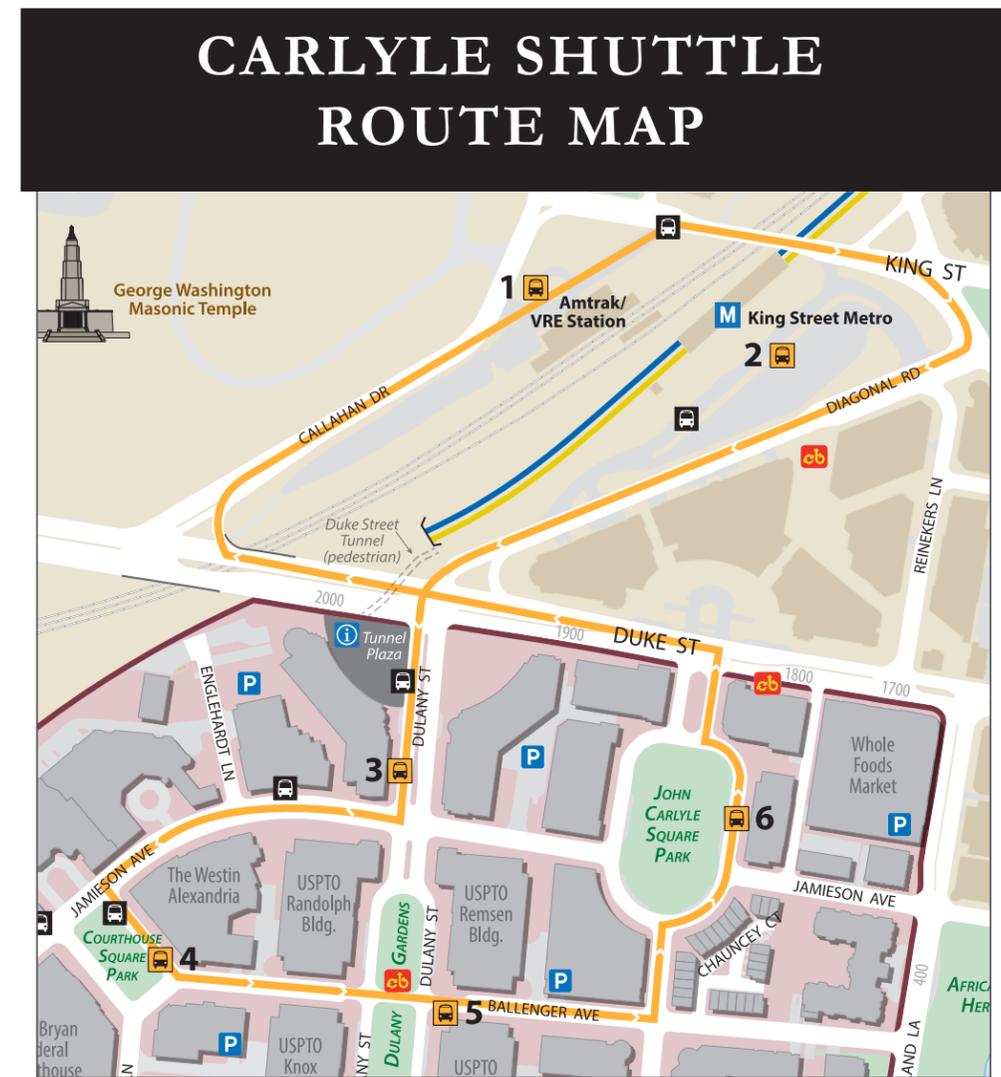
The largest clusters provide two primary opportunities to potentially reduce the number of private shuttles using the Metro Station bus loops in coordination with the property owners:

- » Organize and improve existing transit service in the Van Dorn Street/Landmark area to provide more frequent service to major residential and commercial buildings through a partnership with current shuttle providers.

- » Organize and improve transit service connections to the Braddock Road Metrorail Station with improved frequency through a partnership with local businesses and existing shuttle providers.

In both cases, close coordination with existing shuttle providers would be required to move resources currently used for some shuttle services toward traditional transit services. Negotiation with current providers would be required to ensure that the replacement transit service is of a high enough frequency and reliable enough to adequately replace the shuttle services previously provided. Using these approaches, the City of Alexandria may be able to reduce congestion and capacity issues at Metrorail station bus loops, and increase ridership on Metrobus and DASH services.

There are multiple opportunities to coordinate with current shuttle providers to shift resources and trips to existing or redesigned DASH or Metrobus routes, which would save space and expand access for many people.



The Carlyle Shuttle is a 1.5 mile long, one-way loop shuttle that runs every 10 minutes and it carries about 5,000 riders per month. Its total round-trip length, however, is less than 1.5 miles. Therefore, the shuttle service is more of a replacement for walking than it is a transit service. Even at such a high frequency, the route is so short that, if you just missed the shuttle bus, you could walk to the end of the route before the next bus arrived.



5. Emerging Transportation Technologies

What is and isn't changing in transportation?

Emerging Transportation Technologies

New technologies and concepts are emerging that could address some transportation needs and change aspects of the transit agency role. A key idea is that a trip must be understood from end to end, and may consist of an ever-widening range of services, public and private. Mobility as a Service (*MaaS*) refers to the goal of making it easier to plan and pay for these trips. A number of transit agencies are exploring how to expand their services or their connection to other service to be *MaaS* providers, or are exploring ways to integrate their service into other *MaaS* provider systems. A key question about *MaaS* and other technology trends is whether, and how much, they are actually adding to freedom and access.

Definitions & Examples

Among the widening range of services and technologies are car sharing, ride sharing, ride sourcing, bike sharing, micro transit, dockless bike sharing, and even connected and autonomous vehicles. Many of these seem like all new modes of transportation, but many are older modes where new technology has made the process of finding and paying much easier. As technology has made these modes easier to provide in new ways, many have become commonplace.

Mobility on Demand (overarching trend): An integrated and connected multi-modal network of safe, affordable, and reliable transportation options that are available and accessible to all travelers.

Microtransit: Building on the familiar model of Dial-a-Ride, or demand responsive service, microtransit is a service where a bus or van route's actual path is variable depending on who requests it. Microtransit refers to services of this form that are expedited with modern communications (most often a smartphone) to produce higher efficiency and faster response times, so that trips do not need to be reserved so far in advance. It is a relevant option for low-demand coverage services.

Car Sharing: A service that provides members with access to an automobile for intervals of less than a day. Some companies require users to borrow and return vehicles at the same location. Others have one-way or free-floating approaches, so users can pick up and drop

off at different locations. Some operate peer-to-peer (p2p), which allows car owners to earn money at times when they are not using their vehicles by making them available for rent to other carshare members.

» Zipcar, has 11 locations (July 2018) within Alexandria and provides one-way hourly or daily car rentals.

Ride Sharing: Ride sharing involves adding passengers to a private trip when driver and passengers share a destination. Such an arrangement provides additional transportation options for riders while allowing drivers to fill otherwise empty seats in their vehicles. Traditional forms of ride sharing include carpooling and vanpooling. This term is sometimes used to refer to ride sourcing.

» The City of Alexandria Employer Outreach team (Go Alex) actively promotes regional and statewide carpooling and vanpooling initiatives and works with individuals to seek out matches.

» The casual carpooling, or slugging, phenomenon along I-95 and I-66 in Northern Virginia is an example of ride sharing that has, and continues, to occur without much assistance from technology or direct organization.

Ride Sourcing: Use of online platforms to connect passengers with drivers and automate reservations, payments, and customer feedback. Riders can choose from a variety of service classes such as drivers who use personal vehicles, traditional taxicabs dispatched via apps, and premium services with professional livery drivers and vehicles. Ride sourcing has become one of the most ubiquitous forms of shared mobility.

» Uber and Lyft are ride sourcing companies permitted to operate in Alexandria and offer both private and shared rides. Rides are ordered on-demand through a mobile app.

Bike Share: Short-term bike rental, usually for individual periods of an hour or less. Information technology-enabled public bike sharing provides real-time information about the location and demand for bikes at docking stations throughout a community.

» Alexandria is a partner in Capital Bikeshare, which allows users to rent bikes that are returned to any station in the system. In 2017, there were 513 docks at

31 stations in Alexandria. In 2017, users in Alexandria took 7,200 trips per month, or about 237 per day. This is a 25% increase over the 5,740 trips per month, or 168 per day, in 2016. By comparison, in 2018, DASH had about 11,000 boardings per day. The City plans to add 10 more stations in 2018.

Dockless bikes, scooters, etc.: Similar to bikeshare, but docking stations are replaced with individual unit location information.

» As of July 2018, companies have not been granted any permit to operate or restriction from operating in the City of Alexandria. Washington, DC is conducting a pilot program and many bicycles and scooters have been sighted across the river in Alexandria.

Bike share and emerging scooter share options can complement transit by expanding the area reachable from a bus stop.



Connected and Autonomous Vehicles: An overarching descriptor for varying levels of vehicle control. Also included in this category are the implementation of autonomous, low-speed shuttles which operate in general traffic roadways. Six distinct levels of automation exist, as described in Figure 86.

Transit Technology

Lastly, other more traditional technology solutions may aid DASH in improving the rider experience and encouraging more people to ride. Mobile fare payment is becoming more common among transit agencies around the nation and region. Many agencies (DASH included) are exploring methods to integrate a cross-platform fare payment option so riders could use one mobile app to pay for multiple transit or other mobility services.

This may aid in connecting DASH to other services in the area, expanding the options to transfers easily to other services and opening opportunities to use DASH to travel past the borders of Alexandria. In an ongoing effort in coordination with the Northern Virginia Transportation Commission (NVTC) and other Northern Virginia transit providers, DASH has expressed interest in piloting mobile ticketing on behalf of Northern Virginia.

Another element of transit technology that can help attract and retain more riders is real-time information for bus location and arrivals. Real-time information, which DASH provides through its public transit data feed and is accessible through multiple third-party applications, helps inform riders about their travel options.

Opportunities

Several transit agencies have tried or are trying pilot projects with private providers of microtransit services. Most of these pilot projects are using app-based services to extend or replace fixed-route transit service in areas where ridership is relatively low. One common marketing pitch for these pilots is that the new demand responsive services will improve customer service by reaching people where they are, or that the new services will be able to expand service to areas which are difficult to serve cost-effectively using traditional fixed-route service.

Demand-Response Service (Microtransit or Dial-a-Ride)

Demand-response service of any kind—including new *microtransit* services that use an app and take real-time requests—cannot achieve high ridership relative to service levels, simply because driving to and from everyone’s requested places takes a lot of time. This is a physical limitation and is not altered by the size of the vehicle, or the strength of the marketing campaign, or amount of demand.

The record productivity of a traditional dial-a-ride service is 6 boardings per vehicle hour. No app-enabled demand-response service has exceeded 3 boardings per hour. Early results of a pilot project using an app-based microtransit service in Sacramento suggest that it will not exceed 3 boardings per hour. By comparison, the worst performing DASH route by productivity, AT3/4, is getting nearly 9 boardings per hour. So for a microtransit service to be more cost-effective than AT3/4, the cost for each hour of service would have to be 66% lower.

One of the challenges that is unique to *microtransit* is the promised real-time responsiveness of the service. With traditional dial-a-ride, the transit agency can ask passengers who have some flexibility in when they travel to make their trip at a slightly different time, and that can help to improve productivity. If a “microtransit” service has promised to respond to requests in real-time:

- » People’s trips cannot be nudged to times that are more efficient to service.
- » Extra buses and drivers have to be on the ready (and on the clock) at many more times of the day, so that all requests can be handled.
- » If all requests can’t actually be handled in real time, and requests are only fulfilled on a space-available basis, that means that people cannot depend on the service, and must have a car in the driveway, a fixed route nearby,

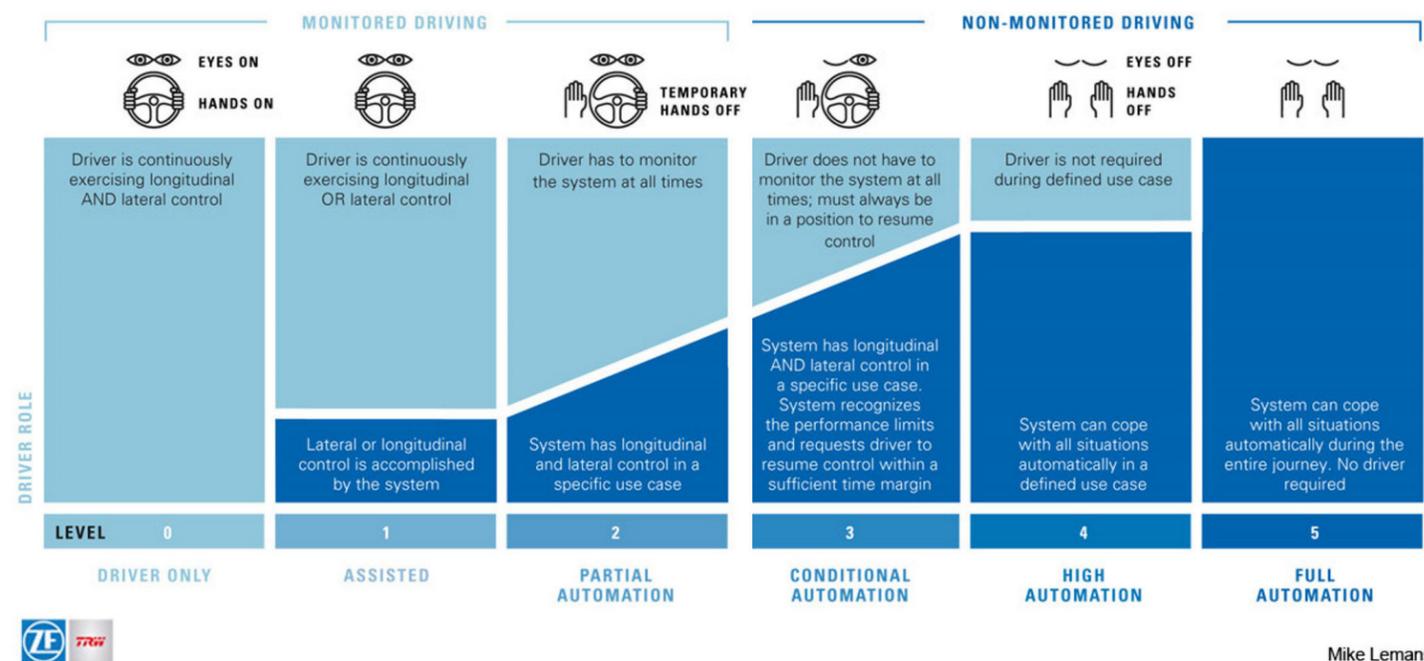
or the ability to pay a higher fare for a taxi, Uber or Lyft.

Demand response service, whether it is called *dial-a-ride* or *microtransit*, is generally used as a specialized coverage service. It provides access to transit over a large geographic area, but cannot be expected to achieve high ridership relative to its costs. It is specialized around the needs of people who cannot or do not like to walk, especially in places where walking distances are long or conditions are difficult. If fares are set to reflect its higher cost per passenger, then it is useful only to people who can afford that higher fare. If it is offered on a “space-available” basis, then it is useful only to people who have some back-up option at the ready, or who are making discretionary trips.

Microtransit services may start to ask customers to walk to a more convenient stop location on a main road, and to travel at a time that makes the service more efficient. This is a way to reach and perhaps exceed 6 boardings per vehicle hour. It is also a version of microtransit that is more like a fixed route.

Some of the more successful pilots are being employed as extensions of and supplement to paratransit service.

Figure 86: Automation is expected to progress along six stages, but no one can predict when it will achieve full automation.



Mike Lemanski

These could include methods of improved routing for increased efficiency during trips, or varying levels of trip creation automation to reduce administrative and dispatch costs. In Richmond, GRTC is currently partnering with reservation companies (UZURV and Roundtrip) that book trips through ride sourcing companies or other vehicles depending on the person's needs and abilities.

Transit Cooperative Research Program Report 195, titled "Broadening Understanding of the Interplay Among Public Transit, Shared Mobility, and Personal Automobiles," analyzed five metropolitan areas (including Washington, D.C.) to find some key conclusions regarding TNC use. Based on the study findings, the report provides some guidance for how transit agencies might engage with TNC operators in ways that are more cooperative and that result in more effective service. Recommendations included:

- » Designate specific curb space near transit stops and stations for for-hire vehicle pick-ups and drop-offs.
- » Pursue opportunities for cost savings through call-n-ride, paratransit, and late-night partnerships, particularly at times and areas where fixed-route transit would have low productivity.
- » Track and understand TNC usage through surveying and requiring data sharing from TNC companies.

These provide some groundwork in which transit operators (including Alexandria) may work alongside TNC operators to provide a better service to the public.

First and last mile connections are also a frequently-seen opportunity for technology solutions. Most often, bike- and scooter-share fills this gap in urban settings. The connection of multiple modes in a single trip is becoming a key exploratory area in the move to mobility as a service, where coordination between private and public mobility services can improve access and mobility for many.

Statewide Study of Integrated Mobility

The City of Alexandria and DASH are active participants in an ongoing Department of Rail and Public Transportation (DRPT) Integrated Statewide Mobility Study. To better understand the emergence of private mobility services, DRPT is conducting research and seeking input of transit agencies. The plan will assist

DRPT and its grantees (such as DASH) in using emerging transit technology and adapting to changes in the mobility industry. The study is currently in its research stage, which involved a survey of transit agencies around the Commonwealth.

The following summarize some of the key points that DASH indicated in their survey responses:

- » Agrees that community has underserved areas, primarily low-density residential with no high-volume trip generators
- » Strongly agrees that other transportation services in the community are competing with current transit services
- » Agrees that community is ready for a cultural shift to shared rides and shared mobility
- » Views shared mobility slightly more as a threat than opportunity related to current ridership and services
- » Has interest in partnering with the private sector on shared mobility solutions
- » Disagrees that shared mobility services will change the way we provide transit service in the future (vehicle types, operator responsibilities, etc.), but agree that it will impact the technology needed on transit vehicles
- » Does not see slow-speed automated shuttles as applicable and useful in community in short-term
- » Actively uses data from technology systems to assess service and make changes

Generally, this feedback aligns with the summary of statewide findings from other transit agencies. While agencies differ on their interest, readiness and executive support for partnering with shared mobility providers, there is a collective view that transit will change in the future and transit agencies need to adapt. The Alexandria Transit Vision Study will monitor this parallel study and continue to integrate findings to the development of recommendations.

Challenges

Despite the opportunities which exist to enhance transportation options with technology solutions, challenges and barriers exist which limit implementation or feasibility. Expanded service will always come at

a cost, regardless of the efficiency of technology. Paratransit and demand-responsive service will continue to be costly options as a result of the labor-intensive nature of the operations. Only full automation (which is rather far off) would aid in cost reduction. However, automation of the service eliminates the customer service component of a trip, which may impact the quality of service the user experiences. As such, efficiency and service should be weighted carefully in determining the appropriateness of a solution.

Private company competition (such as that from ride sourcing companies like Uber and Lyft) may or may not be working with transit agencies. While partnerships are beginning to be explored, strong evidence suggests that ride sourcing service in urban areas is drawing riders away from transit. For users that are not constrained by cost, a more responsive service is often an attractive option over a more efficient service (one that costs less per rider to provide) that requires them to wait longer, walk farther, or just takes more time. People have become accustomed to getting into vehicles with strangers and that is shifting the paradigm of travel.

At a higher level, there should always be a need that transit agencies are trying to meet when considering new technologies and approaches. Technology solutions take significant cost and effort to implement, so the solutions should always be based on users' needs. For example, one guiding question may ask what service are travelers willing to pay for?

Lastly, in considering whether to adopt any of these emerging options, or coordinate with new private mobility providers, the City and DASH must consider if the solutions are detrimental to the purpose or values the community is trying to achieve. What is the core purpose of the transit agency, and does this solution undermine that purpose? Fixed-route transit will always remain the most space-efficient form of travel in an urban area. And if high ridership relative to cost and making the most efficient use of scarce road space are high priorities of the City of Alexandria, then most microtransit services would undermine those priorities. But, if the City wants to prioritize minimizing walks and maximizing rider comfort and is less concerned with the efficient use of space or ridership relative to cost, then microtransit options may be a useful tool in some parts of the city.

It is also useful to consider the time of day in thinking about possible microtransit or demand-responsive

solutions. Fixed-route transit is likely to be the most efficient for most of the day, but in the late night hours, when demand is much lower, and spread across the city, demand-responsive solutions may achieve the mobility goals of the city more effectively.

Automation

The presence of automation in the transportation and transit industries has been growing since the advent of cruise control and positive train control. Only recently has automation entered the mainstream transportation sector with the advent of self-driving cars.

The primary opportunities for automation technology today are to improve safety, through features such as brake assist, lane control guidance, or adaptive cruise control. Other opportunities include short distance, controlled driverless connections such as low-speed shuttles (either in fixed guideway or outside of fixed guideway). Fixed-guideway automation is well-tested, but rarely is the vehicle driverless or uncontrolled for large-scale transit purposes.

Benefits of automation, when more fully implemented for transit service, may include reduced labor costs. In the earliest phases of automated vehicle use, the reduced labor cost will be partially offset by significantly higher capital cost and the challenges of research, development, and implementation of the new technology. In the long term, though, automated transit vehicles present a major opportunity to increase service at low marginal operating costs, since most transit operating costs are the labor costs. Other key benefits include the improvement of mobility for those unable or unwilling to drive. These populations are often described as the young, elderly, and disabled.

Considerations in Adopting New Approaches

There exist ample opportunities for transit agencies to invest in trending technology. However, the fact that a technology is new or interesting is not a reason to adopt it. Needs of the customers and the goals of transit service for the City should dictate the solutions, not the other way around.

For the City of Alexandria, several solutions described above stand as plausible options to help achieve mobility improvements for residents, visitors, employees, and others in the city. Simple solutions such as ride sharing have been commonplace in the Washington Metropolitan area, however their effectiveness may be improved with organization and guidance from a transportation agency. Furthermore, technology solutions including matching services or organizers would improve ease of use. This option would allow individuals to more effectively utilize HOV lanes and private vehicle facilities throughout the region.

Another option for the City of Alexandria may include the implementation of shared mobility zones. These are curb zones which are designate for shared transportation options (such as ride sourcing companies), which do not impede the rest of the street. As such, these areas become more attractive for both riders and providers, improving the user experience and market penetration of shared mobility technologies. Curbspace limitations have always been a challenge with transit, freight, parking, and other users. Now the need for curbspace uses are challenging cities to rethink how the space can be used most effectively.

Lastly, automation remains an exciting possibility, but it is not a universal answer to all urban problems, nor can anyone predict how soon the technology will scale. In the near term, the City of Alexandria may consider where automation makes the most sense as part of the greater transportation network. This includes planning for key corridors, routes, or services, and include consideration of autonomous vehicles in greater transportation network modifications. Services that are considered to be good automation candidates in the near term are where stops are closely spaced, have high ridership, require high frequency, and follow a simple and direct pattern. This would suggest the King Street Trolley as a possible candidate for early adoption of automated vehicles. The automated replacement of a traditional fixed route may provide the opportunity to reduce labor costs.



6. Key Choices

What are the trade-offs?

Key Choices

How Should Alexandria Balance High Ridership with Wide Coverage?

The Alexandria Transit Vision presents a unique opportunity for the people of Alexandria to rethink the basic purpose of their transit system.

The current transit network is a legacy of past generations, and has accrued decades worth of history and complexity. Much of the existing network may be worth keeping as is, perhaps because it suits the city and its values, or perhaps because it is known and familiar to riders, which is a value in and of itself.

It is also possible that since this transit network was designed, the city has changed and grown enough to justify a fresh start. Transit networks are intricate, interwoven, living things, and adapting them incrementally over time is very difficult. DASH has done a laudable job of making improvements, one route and one area at a time, over recent years. For numerous reasons, this moment in Alexandria's history may be the right time to consider a clean-slate rethinking of the transit network:

- » Alexandria has been growing and is expected to continue growing. The City has plans to grow in a more transit-oriented manner, with more of a mixture of uses and a better connected street network. At the current and planned density of places in Alexandria, transit demand increases faster than density increases (see explanation on page 19). Therefore, more useful transit is an essential component to ensure the city can continue to grow without traffic becoming an impossible burden.
- » Alexandria has been expanding its transit service in the last decade, but ridership has not risen along with that investment in service in the last few years. Expanding on the network as it is currently designed may be less useful than expanding on a new network that is better matched to the city as it is today.

The city has grown and changed substantially since the "bones" of the existing network were put in place.

The most difficult choices for Alexandria will be between providing high frequency, long-span services, in order to attract high ridership; and providing wide geographic coverage.

Recall that high ridership serves several popular goals for transit, including:

- » Reducing car costs, emissions and traffic.
- » Achieving low public subsidy per rider.
- » Allowing denser development without apocalyptic traffic congestion.
- » Giving people more personal and economic freedom.

On the other hand, many popular transit goals do not require high ridership in order to be achieved. These include:

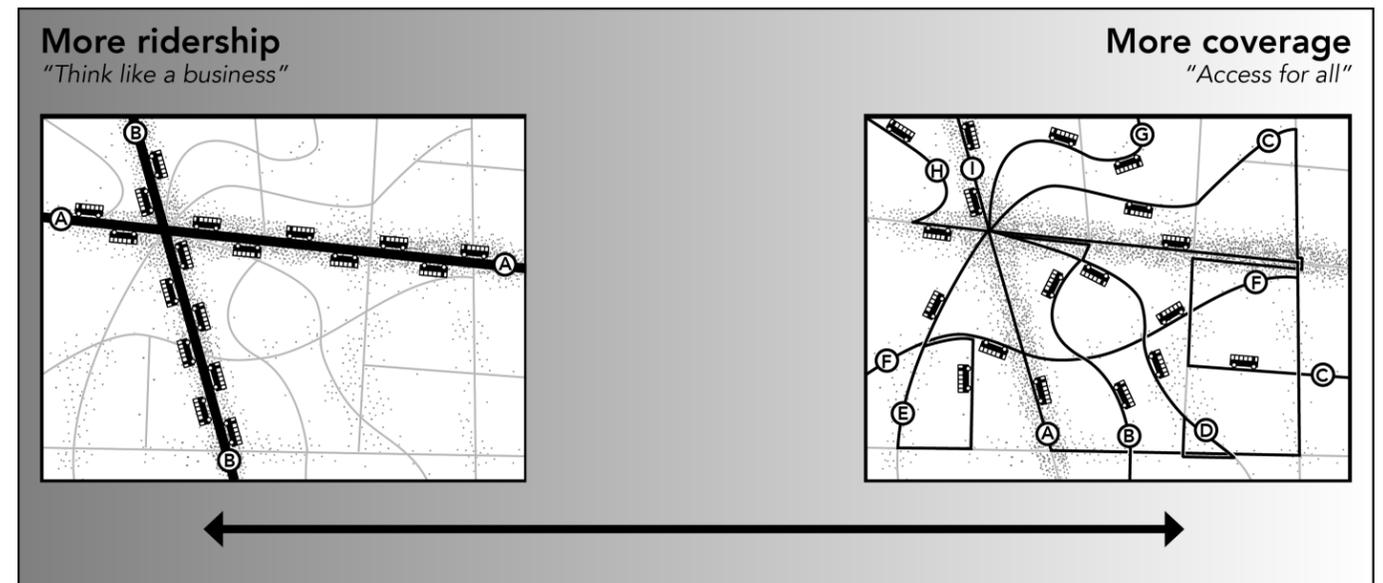
- » Ensuring that everyone in Alexandria has access to some transit service, no matter where they live;
- » Providing lifeline access to critical services; and
- » Providing access for people with severe needs.

No transit agency focuses solely on just one of these goals. Most transit agencies have some direct, frequent, long-span routes on which ridership and productivity are high, and others which run at lower frequencies and more limited times, for specific coverage purposes.

Alexandrians should think about this choice not as binary, "yes or no" decision, but as a sliding scale (as in the drawing above) that the community can help to set.

This is not a technical question, but one that relates to the values and needs of a community.

As noted on page 67, we estimate that about 20% of the existing network is duplicative. Of the remaining service, we estimate that about 50% of the existing network is designed as it would be if maximizing ridership were its only goal. About 30% has predictably low-ridership, suggesting that it is being provided to meet coverage goals. This may be the right balance



for Alexandria, or the community may value a shift in emphasis.

The direction of that shift—either towards higher ridership or towards wider coverage—and how fast Alexandria should make such a shift are both questions for stakeholders to discuss in this planning process.

One way to manage the perennial conflict between ridership and coverage goals is to define the percentage of a fixed route budget that should be spent in pursuit of each one. For example, Alexandria could, as a result of this study, establish that it will continue to spend about 50% of its budget maximizing ridership, or it could decide to spend more or less towards that purpose.

Alexandria could also decide to maintain the existing balance in the short term, but devote any new funding to either improving ridership or expanding coverage, and in that way shift the balance without cutting any existing riders' coverage or frequency.

How much of the transit budget should Alexandria spend on the most useful service, in pursuit of high ridership? How much should Alexandria spend providing coverage so that people with acute needs have access to some service?

How Do Alexandrians Value Walking versus Waiting?

Related to the question of ridership or coverage is a more concrete question about how people trade-off walking and waiting. The Alexandria transit network offers very inconsistent route spacing:

- » In some areas (such as the Del Ray) service is generally concentrated into fewer routes. These are spaced so that most people are within a ten minute walk of service. Service is more frequent, so waits are shorter.
- » In other areas (such as the Old Town and Old Town North) service is divided into many routes that run very close to one another. Nearly everyone is within 3 blocks of service, but routes run less frequently, so waits are long.

There is a limit to how much a transit agency can increase ridership, within a fixed budget, without increasing walking distances to service and thereby increasing frequencies. This choice relates the question of how to balance ridership and coverage goals.

If there is a strong desire in Alexandria to increase ridership, more frequent routes are key to that goal. But within a fixed budget, increasing frequency means consolidating service into fewer routes, and thereby increasing walking distances.

So as Alexandrians consider whether or not DASH and Metrobus should increase ridership on the transit network, the City needs to wrestle with this more concrete trade-off.

Do Alexandrians Prefer Connections or Complexity?

The biggest source of complexity in most transit networks is the sheer number of routes. One way to think about this is to ask, "In how many different patterns is my transit agency dividing a fixed amount of service?"

Although this study and report are focused on Alexandria, the city is but one part of a large and complex region with multiple job and housing centers. There is demand for everywhere-to-everywhere travel

both within Alexandria, and across the region. A debate should naturally arise about whether there should be single bus routes from everywhere, to everywhere, or whether that access should be provided by a network, through connections.

Making a connection between two bus routes needn't be an unpleasant or unreliable experience, though the reliability of the waiting time and the quality and safety of the waiting environment both matter enormously.

If a community can accept connections as part of a transit network—and if the transit agency can make the capital investments necessary to make them pleasant—it frees up an enormous amount of service that no longer must be spent providing one-seat-rides from everywhere, to everywhere. It also allows for a much simpler network and higher frequencies, making it both more useful and easier for people to understand.

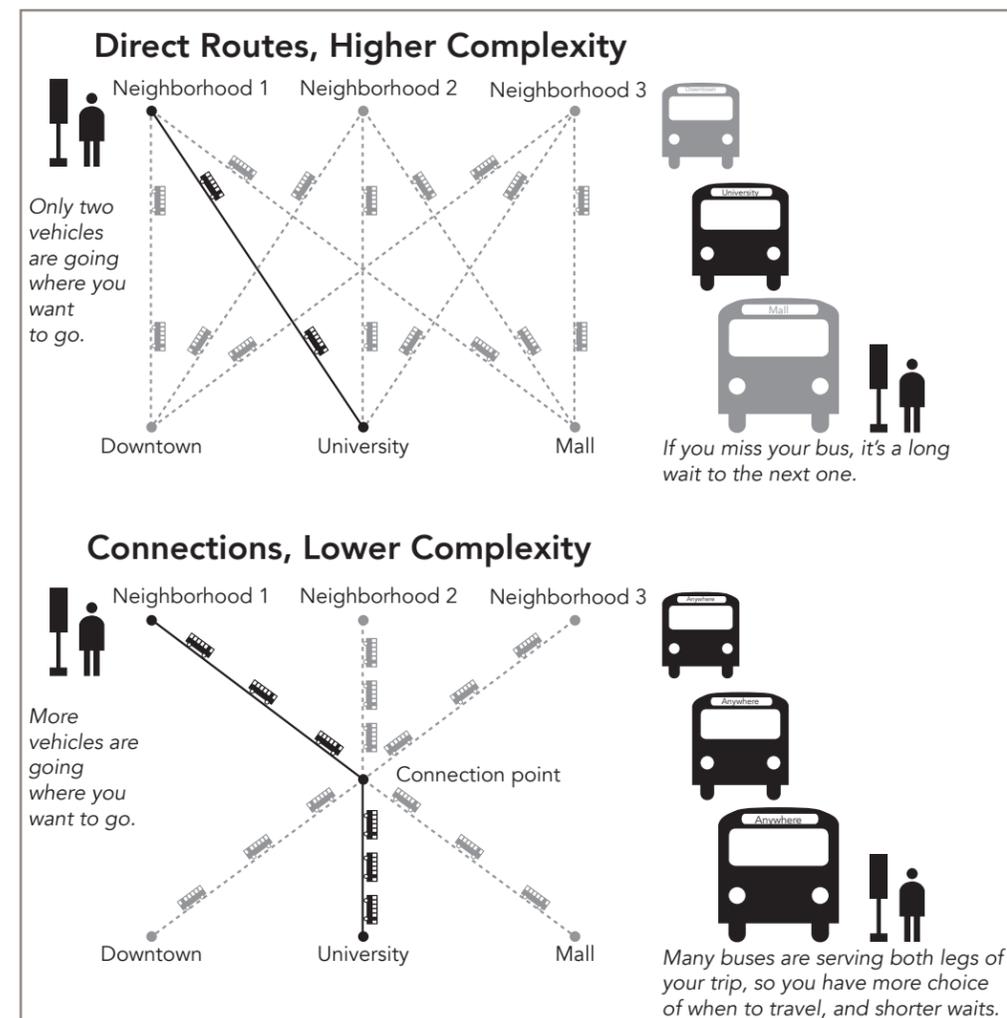
The illustration at right shows how it is possible that requiring connections can improve frequency, reliability and even shorten travel times.

At the top, a network is made of direct routes, one from each of three neighborhoods to each of three major destinations. There are nine routes total, but each is only run by two buses, so the frequencies are low. A person traveling from Neighborhood 1 to the University gets a direct ride, but they must wait a long time for their bus, and if they miss it, it's a long wait until the next one.

At the bottom, a network is made up of fewer routes, operating at much higher frequencies, but people must make a connection to get to some major destinations. Now, a person traveling from Neighborhood 1 to the University can step outside their door whenever they are ready, because a bus is always coming soon. While they must get off and make a connection midway, the bus to the University is coming soon.

It is essential to observe about these two networks that:

- » They cost the same to operate. Both networks are made up of 18 buses and drivers.
- » The travel time required by the Connected network is actually less than the Direct Routes network, because so much of the time in the Direct Routes network is spent waiting for infrequent service.
- » While the Connected network shown at bottom is radial, the same math is the same for a network using a grid pattern.



- » In the Connected network, the connection point is in an arbitrary place. In reality, transit centers are often at universities, malls, or in downtowns. This means that some of the most popular destinations are on high frequency routes.

A Connected network will generate much larger isochrones than a Direct Routes network with infrequent service from everywhere, to everywhere. A Connected network is part of a high ridership strategy.

Some changes that are under DASH and Metrobus control would affect connections: the frequencies of connecting routes and the timing of connections. Other changes would need to be led by the City or private property owners, because they relate to the walking and waiting environment that supports a connected network.

How Much Transit Does Alexandria Want?

Wrestling with the first choice—how to balance ridership and coverage—and altering the transit network to meet new, clearer goals and match community values, may improve people’s sense that the transit network is delivering on their goals and is therefore worth further investment.

From 2006 to 2009, the City invested in more transit service and saw a commensurate return in transit ridership. After the financial crisis and recession in 2008, service was cut back, and the economy declined, and ridership dropped. But investment and ridership started to bounce back from 2012 to 2013.

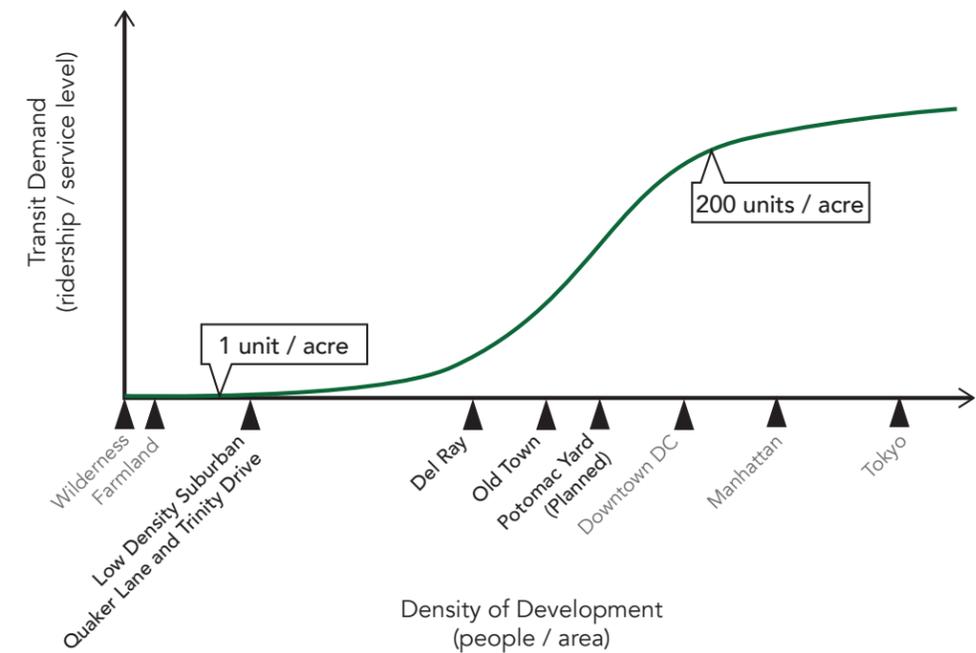
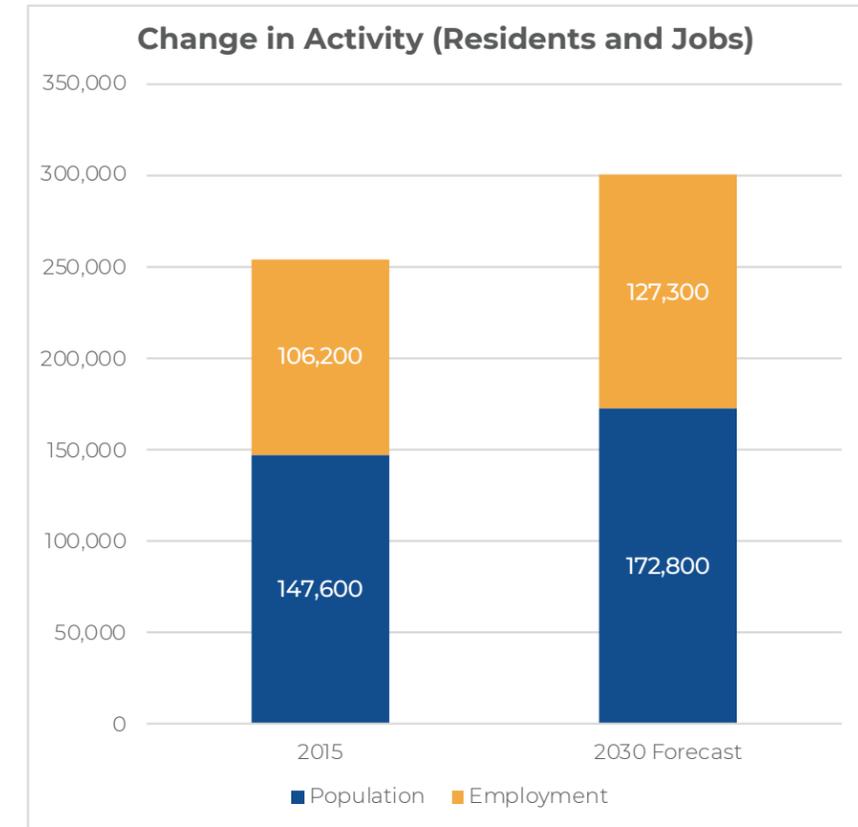
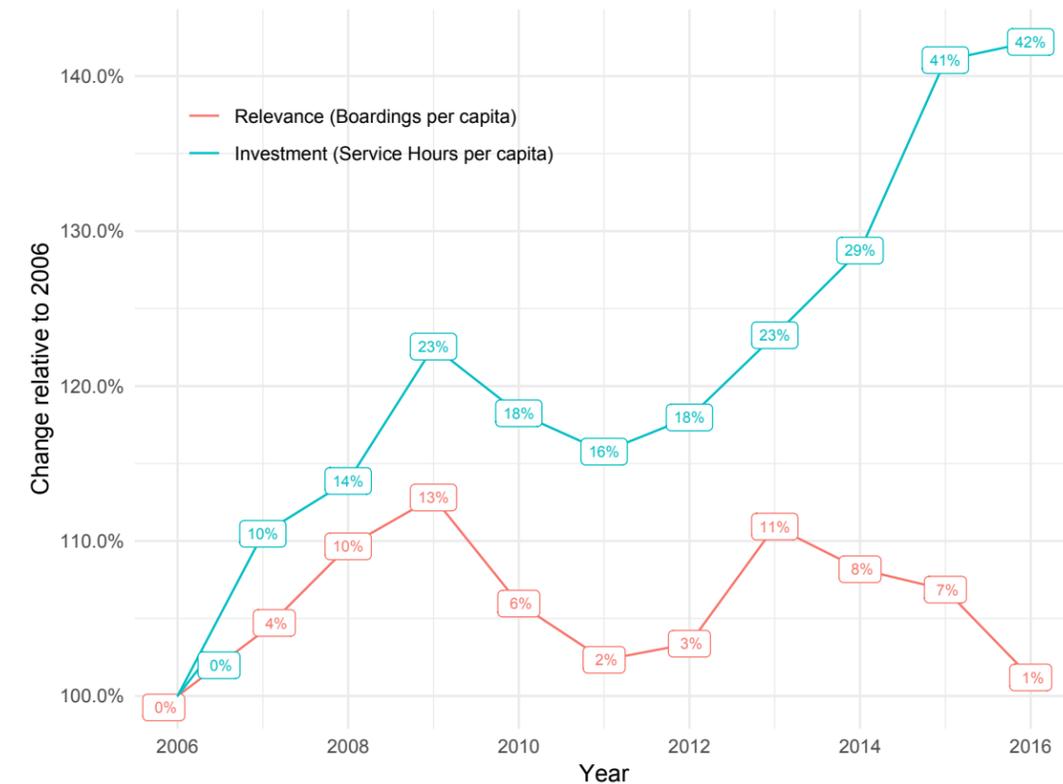
Since 2013, the City has invested in more service but ridership has not increased. Part of this divergence is likely tied to the major reliability problems and service cuts on Metrorail, to which DASH is closely connected. While the problems of Metrorail are serious and must be solved, the short-term trends caused by those problems should not overshadow the question of whether transit is a good investment. In addition, some recent

investments in DASH service have not been in ridership maximizing investments.

As previously discussed, Alexandria is growing, and is expected to grow by about 20% in both jobs and residents by 2030. The typical transit demand curve tells us that the forecasted increases in density will greatly increase the demand for transit. And, because transit is one of the most space efficient forms of mobility, it is absolutely essential that transit service increase if the City wishes to grow without traffic becoming an impossible burden.

The challenge of maintaining and improving mobility in a growing city that is growing more dense can also be addressed through improving other space-efficient modes, like walking and biking. And new technology solutions, like bike share, scooter share, and car sharing, can play a role in reducing the number of private cars and vehicular traffic.

How much should Alexandria invest in transit service, considering its plans for development and forecasted growth?



Peak-Hour or All-Day Service?

Demand for transit service tends to be higher at peak periods during weekday mornings and evenings. These peak periods occur at similar times of day as peak traffic on a city's major streets and highways.

On a typical weekday in Alexandria, the number of transit boardings is highest between 6 and 8 AM, and between 3 and 6 PM. At the same time, there is always some demand for transit service outside peak hours and on the weekend.

There are distinct advantages to focusing a transit network on peak-hour services. For example:

- » Peak-hour services have the most potential to produce full buses.
- » Peak-hour services have the highest potential to relieve traffic congestion on regional streets and highways.
- » Peak-hour services have the highest potential to relieve individual riders of the stress of driving.

However, focusing on peak-hour services also has real disadvantages and costs, such as:

- » Services focused on peak demand require transit agencies to maintain large fleets of buses that sit unused at most times. These buses must be purchased, maintained, stored and replaced on a regular basis.
- » Peak-hour services tend to have a higher average labor cost than all-day services. This is because transit agencies must either:
 - » Pay a higher hourly rate to drivers who work peak hours, or
 - » Hire more drivers so that their fleet is staffed at both ends of the day.

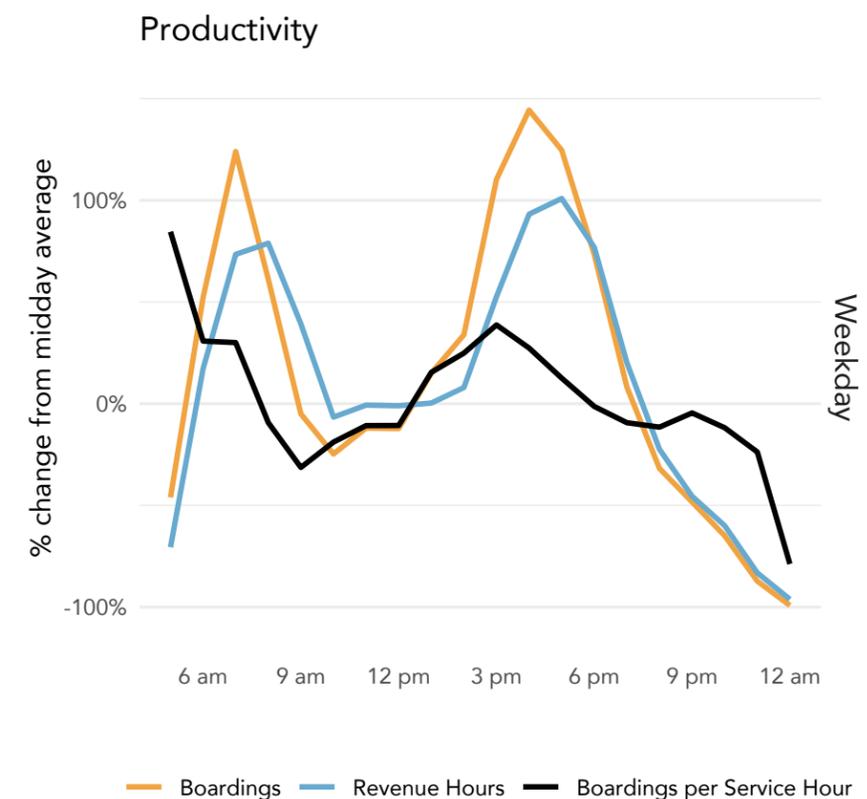
Peak-hour service tends to focus on the commuting needs of full-time office workers and others who work a traditional 9-to-5 schedule. But there are many other reasons to ride transit and many other types of potential riders. If service is only (or mostly) available at peak hours, many potential transit riders may find that they are able to make a trip in one direction but not in another.

Most transit agencies, including DASH and Metrobus, have networks that draw some compromise between

meeting peak-hour demand and maintaining some level of service for the many transit rides that occur at other weekday times and on weekends. However, it is worth asking whether the current balance is appropriate and whether it should be shifted.

What is more important: fully serving higher demand at peak hours, or providing a useful level of transit service all day, everyday?

What is more important: fully serving higher demand at peak hours, or providing a useful level of transit service all day, everyday?



Next Steps

This Choices Report is the first step in the Alexandria Transit Vision. It has laid out certain key facts and choices about transit in Alexandria. It has highlighted the opportunities and limitations for transit within the existing geography and development pattern. The next step in this Transit Vision will be for the public, stakeholders and officials to provide input on these key choices. See Figure 87 for a timeline of the planning process for this Transit Vision.

Later in the planning process, the study team will develop some illustrative future concepts. These conceptual alternatives will help people see how pursuing different goals would result in very different transit networks, and imagine how those different networks would affect them and other Alexandrians. The concepts will represent a spectrum of choices, so that people can tell us where, in the range of potential futures, they think the Alexandria transit network should be.

After receiving feedback on the key choices and the concepts, the planning team will design a full Transit Vision Plan. In addition to this long-term vision, the team will also develop short-term recommendations that can be implemented in the next 2-3 years, and can serve as a first step towards the ultimate transit vision. These plans will be presented to the public for consideration in the spring of 2019.

Figure 87: This Choices Report starts the first of three rounds of engagement during the Transit Vision.

