Virginia Department of Rail and Public Transportation

Springfield to Quantico Enhanced Public Transportation Feasibility Study

Final Report

prepared by

Cambridge Systematics, Inc. and KFH Group, Inc.

with

Kittelson & Associates, Inc.

PRR, Inc.

LDA Consulting

November 2021

SPRINGFIELD TO QUANTICO ENHANCED PUBLIC TRANSPORTATION FEASIBILITY STUDY

Final Report

prepared for

DRPT
Virginia Department of Rail and Public Transportation

prepared by

Cambridge Systematics, Inc. and KFH Group, Inc.

with

Kittelson & Associates, Inc.

PRR, Inc.

LDA Consulting

date

November 2021

TABLE OF CONTENTS

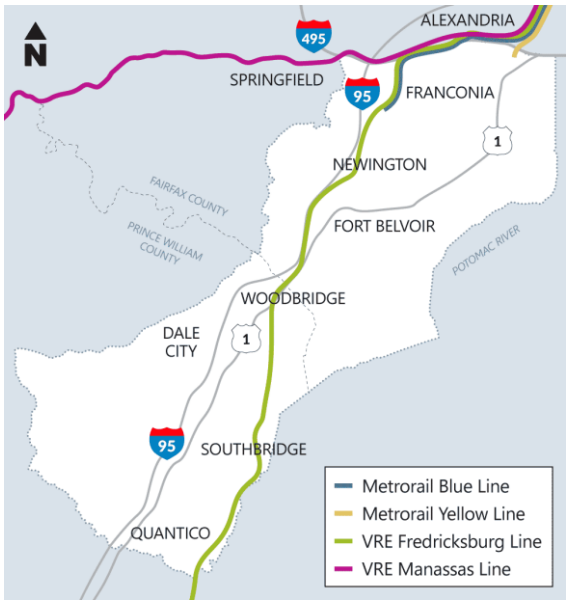
LIST OF TABLES

LIST OF FIGURES

1. Introduction & Study Purpose

1.1 Background

The corridor between the Franconia-Springfield Metro Station and Marine Corps Base Quantico is a critical link in the Northern Virginia transportation network. The corridor is served by a range of transit services including Metrorail, Virginia Railway Express (VRE) commuter rail service, express and local bus service provided by multiple operators, as well as vanpool and carpool options that take advantage of the I-95/I-395 express/HOT lanes and a network of park-and-ride lots. Future growth in population and jobs will continue to increase demand for multimodal commuting options.



A number of significant transit improvements are already planned for the corridor including additional express bus services, VRE expansion, and bus rapid transit in the Richmond Highway corridor. The Franconia-Springfield and Huntington Metro stations play an important role as major transfer hubs to the region's Metrorail system and previous studies have examined extensions of both the Blue Line and Yellow Lines into southern Fairfax and Prince William counties.

Given the importance of this multimodal corridor to the Washington metropolitan region and the entire Commonwealth, the Virginia General Assembly approved a 2020 budget amendment directing the Department of Rail and Public Transportation (DRPT) to conduct a feasibility study for enhanced public transportation services between the Franconia-Springfield Metro station in Fairfax County and the Marine Corps Base Quantico in Prince William County:

> "F. The Department of Rail and Public Transportation, in cooperation with Fairfax and Prince William Counties, shall evaluate enhanced public transportation services from the Franconia-Springfield Metro Station to Fort Belvoir, Lorton, Potomac Mills, and Marine Corps Base Quantico in Prince William County, including the cost and feasibility of extending the Blue Line and other multimodal options such as bus rapid transit along Interstate 95 and U.S. Route 1. The Director of the Department of Rail and Public Transportation shall submit a report of its findings to the Chairs of the House Appropriations Committee and the Senate Finance and Appropriations Committee by December 1, 2021."

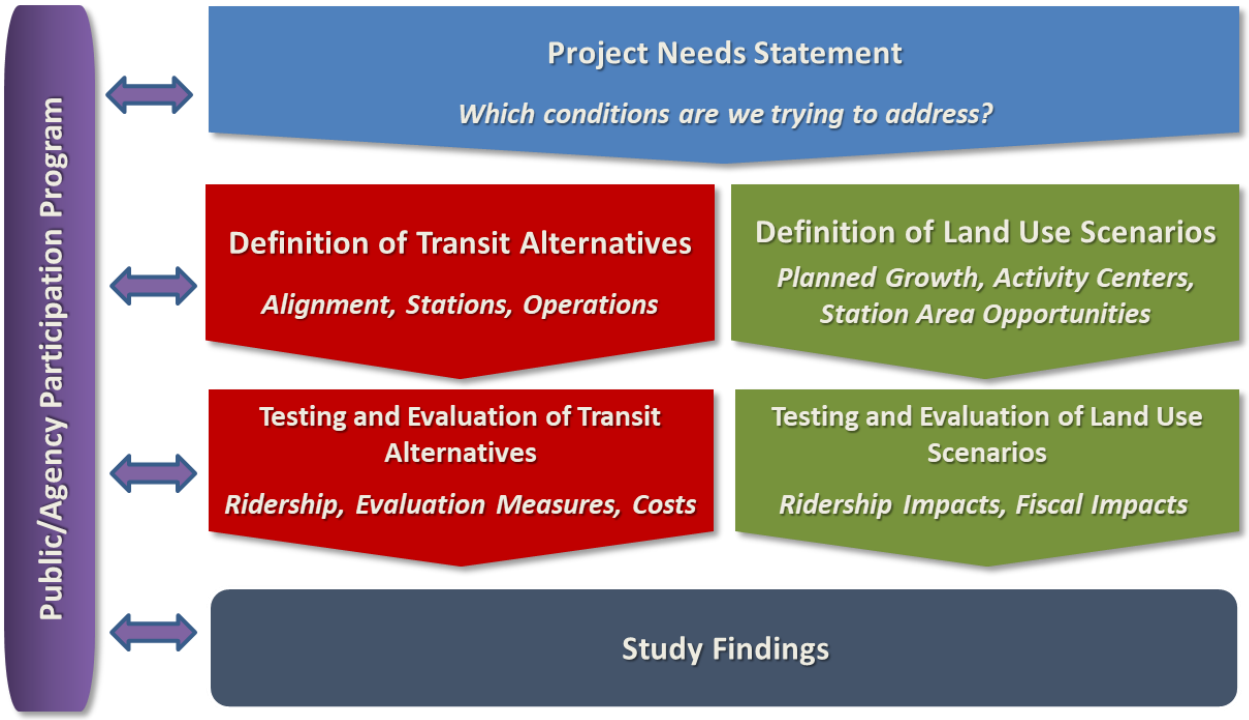
1.2 Study Approach

The feasibility study was structured into three primary phases of analysis and an ongoing engagement program (**Error! Reference source not found.**). Key steps in the study process included defining the transportation needs within the Study Corridor, developing and testing a set of transit alternatives, and documenting feasible alternatives. A parallel task included an assessment of land use scenarios to identify potential transit station areas and development opportunities.

Study Purpose

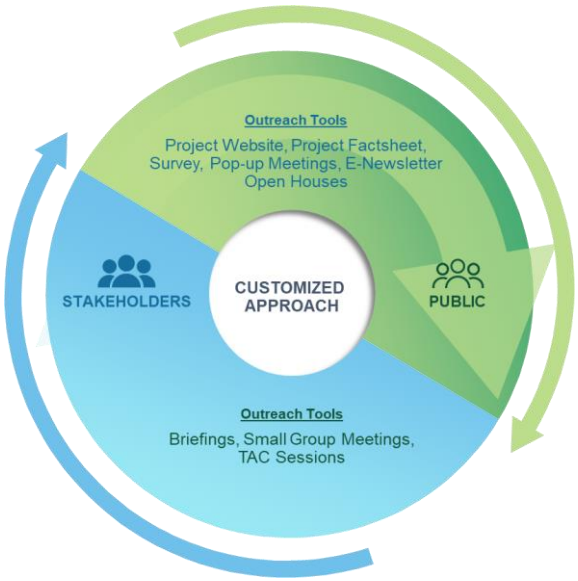
This study provides a comprehensive, objective evaluation of a range of potential future enhanced transit alternatives that compares the cost, benefits, and impacts of each option to inform recommendations about future investment in the study area.

FIGURE 1.1 STUDY APPROACH FLOW CHART



1.3 Public and Agency Participation

Throughout the study, the DRPT study team encouraged input from the public and stakeholders, including local organizations and communities along the corridor to identify important and desirable transit improvements. Monthly meetings were held with a Technical Advisory Committee (TAC) consisting of local and regional transportation agencies. State and local elected officials were briefed regularly throughout the study. The engagement process served multiple objectives:



- Alerting and educating stakeholders about the purpose, scope, and schedule of the study
- Gathering community and stakeholder input on the transportation needs in the study area and potential transit improvements to address those needs; and
- Presenting study findings on the costs, benefits, and impacts of each option to inform decisions about future investment in the study area.

As the public health crisis continued and in-person gatherings were initially prohibited and later discouraged, DRPT and the study team developed a multi-faceted approach to engage with communities in the study area. The team conducted outreach targeted at historically underrepresented groups along the corridor by reaching out to community-based organizations, routinely translating materials, and offering interpretation at public meetings. While most of the engagement was conducted virtually, the study team found opportunities to reach people with low or no internet connectivity through in-person (Covid-safe) pop-ups and providing printable materials to community-based organizations. Through the study process, the public had a variety of avenues and opportunities to engage and provide input.

Some of the key outreach activities, conducted in English and Spanish, completed during the study included:

- Disseminating project information through a DRPT website project page (including a project factsheet), TAC meeting information, and recordings of public meetings and elected officials briefings;
- Conducting an online survey completed by over 1,300 respondents that gathered input on travel behavior and preferences in the corridor (for example, see **Error! Reference source not found.**);
- Hosting three rounds of virtual public meetings (May, July, and September) at key project milestones to discuss study findings and receive feedback;

- Utilizing social media, email blasts, and two pop-up events to spread awareness of project activities; and
- Coordinating communications with elected officials, TAC member's public information offices, and community groups.

A detailed summary of the outreach activities by month is provided in **Table 1-1**.

FIGURE 1.2 ON-LINE SURVEY RESULTS: TRANSIT MOTIVATORS

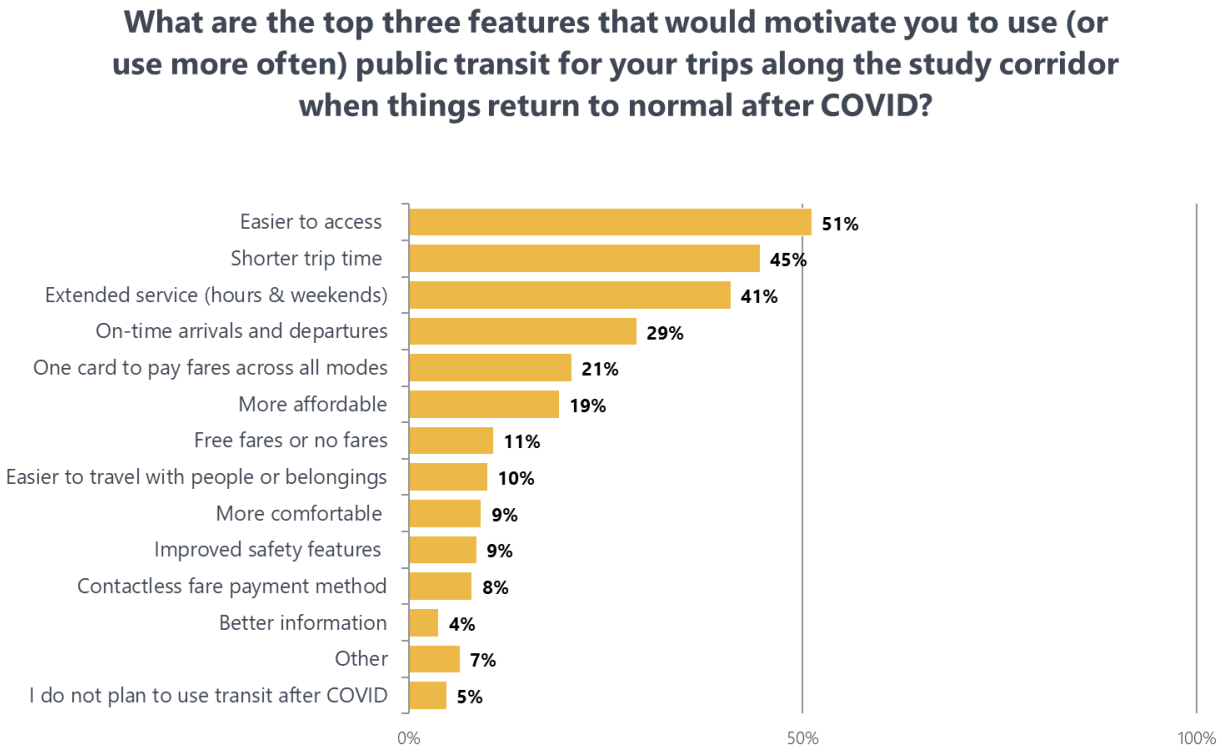


TABLE 1-1 SUMMARY OF PUBLIC OUTREACH ACTIVITIES

Timing	Public outreach activities	Results
February 2021	• Developed project factsheet in English and Spanish • Developed and launched project webpage	▪ 2,660 project page visits
April 2021	• Public input survey launched in English and Spanish, April 19 - May 17, 2021 • Webpage survey announcement • DRPT social media featured survey announcements on Twitter and Facebook • Social media toolkit distributed to TAC members, community-based organizations, and elected officials • Email survey announcement to: - Elected official contact list - 43 community-based organization contacts in the region - 164 people on general public contact list	▪ 1,352 people took the survey ▪ Four people took the survey in Spanish
May 2021	• Virtual public meeting May 4 • Webpage and flyer meeting announcement • DRPT social media meeting announcements on Facebook and Twitter • Social media toolkit distributed to TAC members, community-based organizations, and elected officials • Email meeting announcement to: - Elected official contact list - 43 community-based organization contacts in the region - 164 people on general public contact list • Meeting announcement translated to Spanish and distributed to community-based organizations • Spanish and Vietnamese interpretation offered during the meetings	▪ 112 people registered for the meeting ▪ 79 people attended the meeting

Timing	Public outreach activities	Results
July 2021	• Virtual public meeting July 27 • Webpage and flyer meeting announcement • DRPT social media meeting announcements on Facebook and Twitter • Social media toolkit distributed to TAC members, community-based organizations and elected officials • Email meeting announcement to: - Elected official contact list - 94 community-based organization contacts in the region - 164 people on general public contact list • Meeting announcement translated to Spanish and distributed to community-based organizations • Spanish interpretation available during the meeting	• 83 people registered for the meeting • 42 people attended the meeting
September 2021	• Virtual public meetings September 21 and 23, 2021 • Webpage and flyer meeting announcement • DRPT social media meeting announcements on Facebook and Twitter • Social media toolkit distributed to TAC members, community-based organizations and elected officials • Email meeting announcement to: - Elected official contact list - 94 community-based organization contacts in the region - 164 people on general public contact list • Pop-up in-person outreach to distribute meeting announcement flyer at Franconia-Springfield Metro station and OmniRide Transit Center in Woodbridge -48 flyers, including 5 in Spanish, at the Potomac and Rappahannock Transportation Commission (PRTC) OmniRide Transit Center -99 flyers, including 7 in Spanish, at the Franconia-Springfield Metro station • Meeting announcement translated to Spanish and distributed to community-based organizations and at pop-ups • Spanish interpretation available during the meeting	• 90 people registered for the meetings • 40 people total attended the meetings

2. EXISTING CONDITIONS

This chapter provides an overview of the existing transportation network and baseline conditions in the Study Corridor during 2019 (pre-COVID). This summary of baseline conditions includes the land use and demographics of the Study Corridor, the transportation and transit systems, and travel demand management (TDM) organizations and programs.

The analysis of existing conditions was used in two ways: (1) to begin to identify transit needs in the corridor, documented in Chapter 3 of this report; and (2) as a basis to evaluate the relative performance of enhancements tested later in the study. The issues identified in these existing conditions are likely to be exacerbated in the future as the corridor continues to grow and become even more congested than it is today.

2.1 Study Corridor

The Study Corridor defined for this study is shown in Error! Reference source not found. and covers portions of Prince William and Fairfax Counties between I-495 and the Stafford County line. Several major highways run through the Study Corridor, including I-95 and Richmond Highway (U.S. 1). Public transit in the Study Corridor includes bus services operated by Fairfax Connector, OmniRide, WMATA Metrobus, and rail services operated by WMATA Metrorail and VRE on its Fredericksburg line. These services are used by travelers to access locations across the wider region, including population centers south of the Study Corridor in Spotsylvania and Stafford Counties, and major employment centers to the north in Arlington, Alexandria, Tysons, and Washington, DC. Analyses conducted as part of this study considered the potential benefits to any trips that might use this corridor, whether or not they start or end within the defined area.

For analysis purposes, the Study Corridor and the surrounding region have been subdivided into zones, as shown in **Figure 2-2**. The seven zones within the Study Corridor are representative of major activity centers in the corridor which display different land use and travel patterns. Outside the Study Corridor, these zones are much larger, and primarily used to identify regional destinations for travelers using the Study Corridor.

FIGURE 2-1 STUDY CORRIDOR MAP

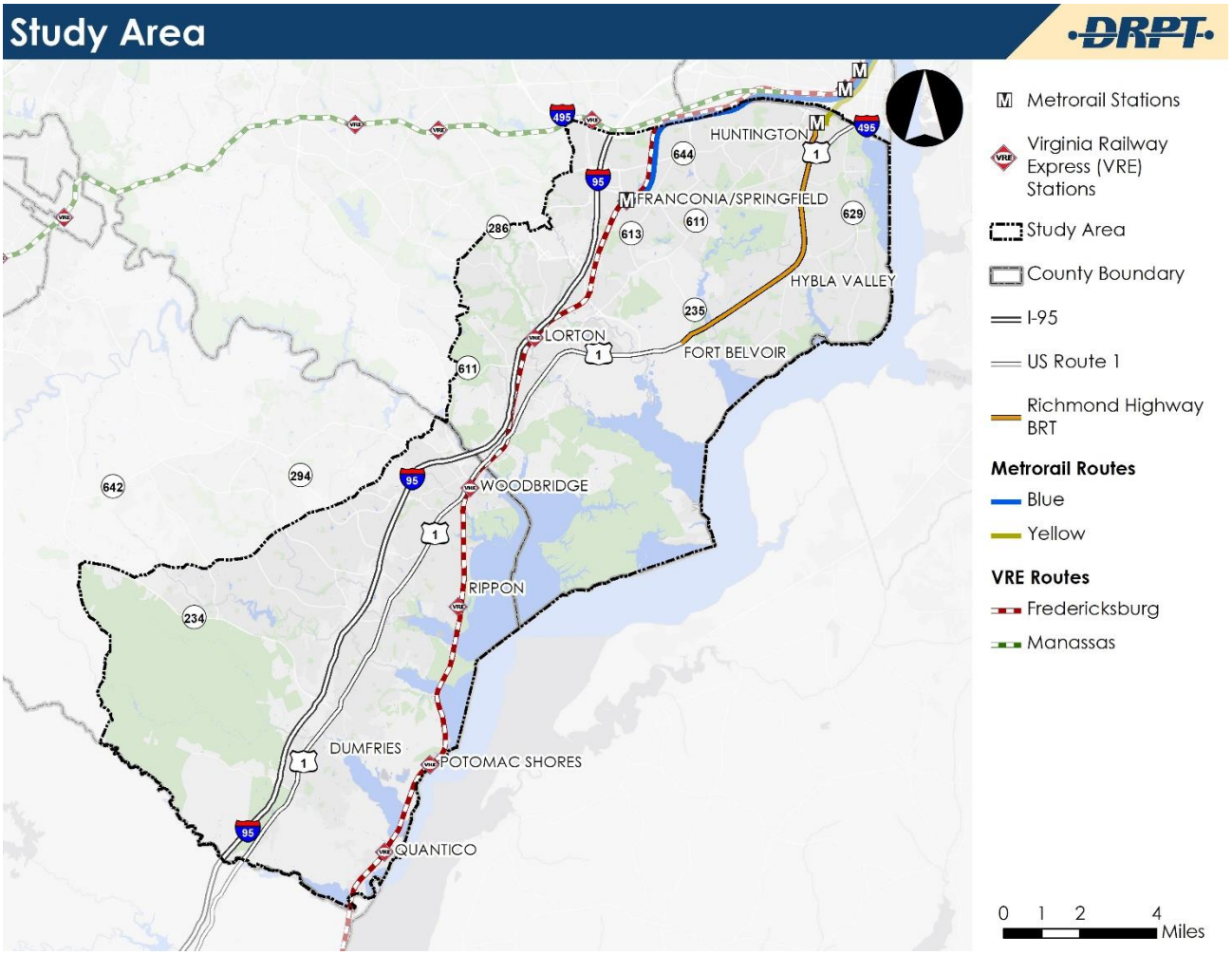
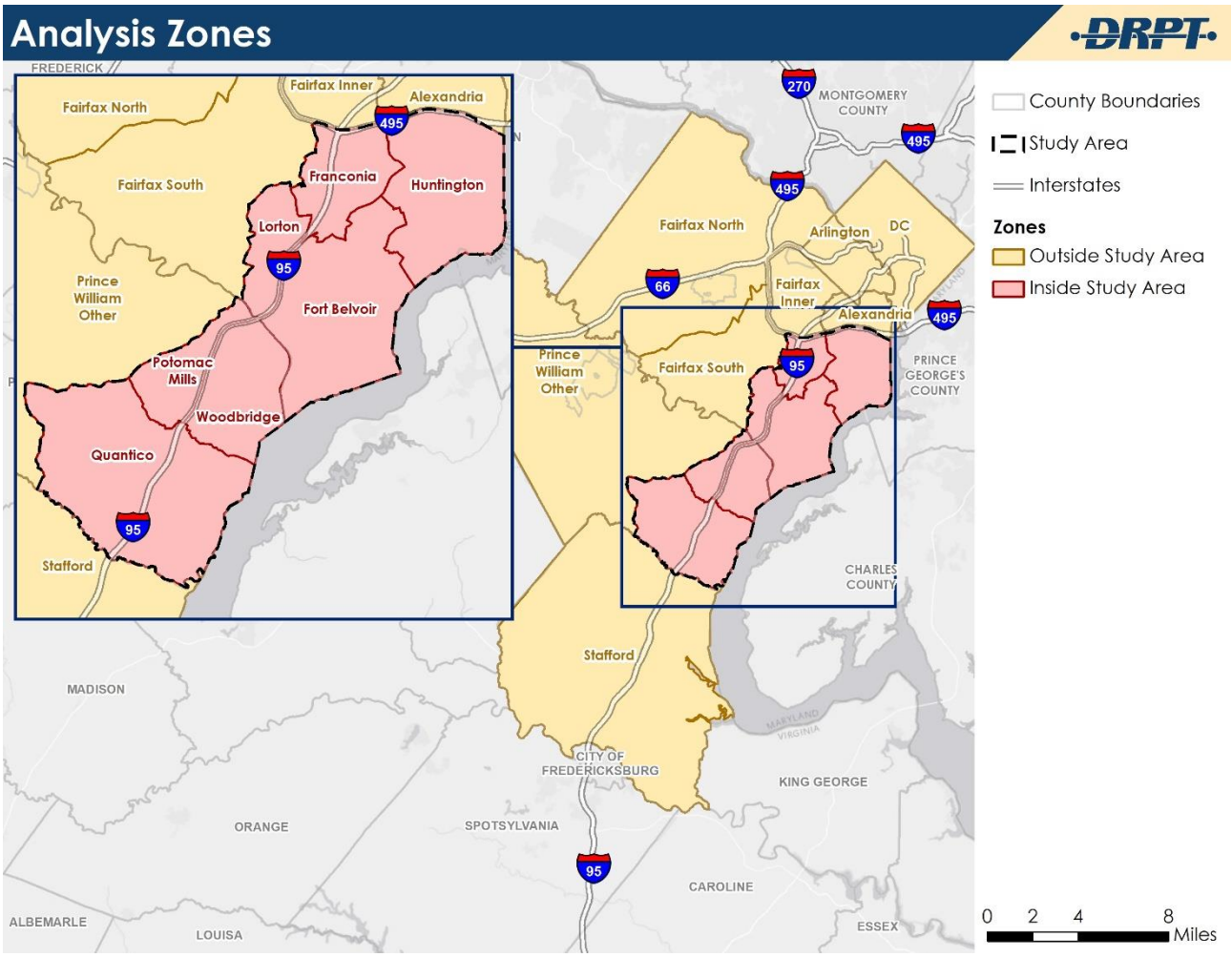


FIGURE 2-2 ANALYSIS ZONES



2.2 Demographics and Land Use

This section provides an overview of existing land use and demographics in the Study Corridor and the surrounding region, based on the Metropolitan Washington Council of Governments (MWCOG) Round 9.1a Cooperative Land Use Forecasts and the 2015-2019 American Community Survey (ACS).

Population

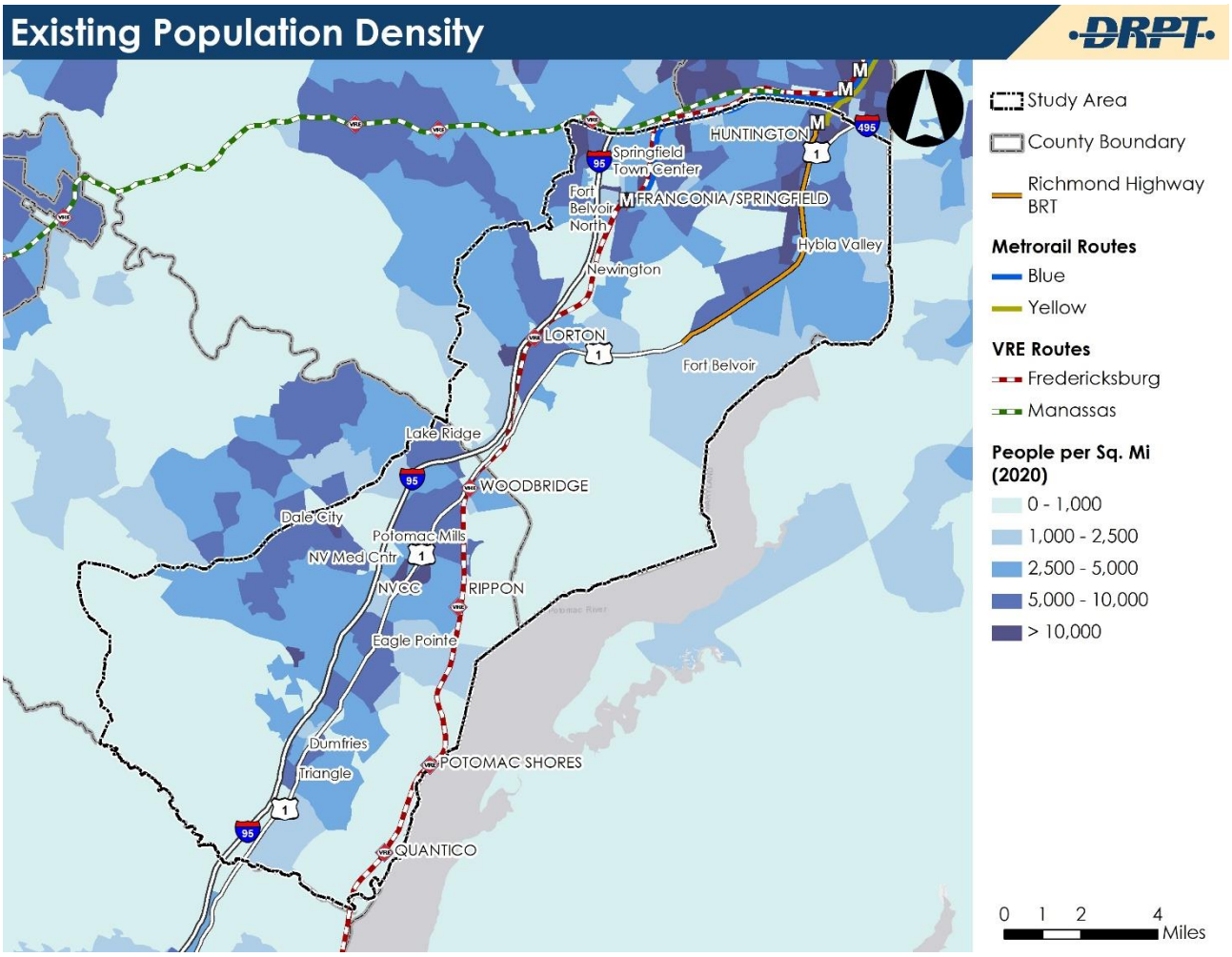
As of 2020, more than 437,000 people reside in the Study Corridor, representing more than 25 percent of the combined populations of Fairfax and Prince William counties (1.7 million). As shown in **Table 2-1** and **Figure 2-3,** population is concentrated along the I-95 and U.S. 1 corridors in both Counties, and near the Franconia-Springfield and Huntington Metrorail stations in Fairfax County. Despite significant density across the Study

Corridor, there are some notable exceptions, particularly around the Fort Belvoir and Quantico military installations.

TABLE 2-1 EXISTING STUDY CORRIDOR POPULATION

Zones	Existing Population	Average Population Density (per sq. mile)
Franconia	63,300	3,800
Huntington	128,400	5,900
Fort Belvoir	29,200	2,000
Lorton	33,700	4,300
Woodbridge	63,600	4,400
Potomac Mills	47,900	4,300
Quantico	71,200	2,400
Study Corridor Total	437,300	3,900

FIGURE 2-3 2020 POPULATION DENSITY



Source: MWCOG Round 9.1a Cooperative Land Use Forecasts

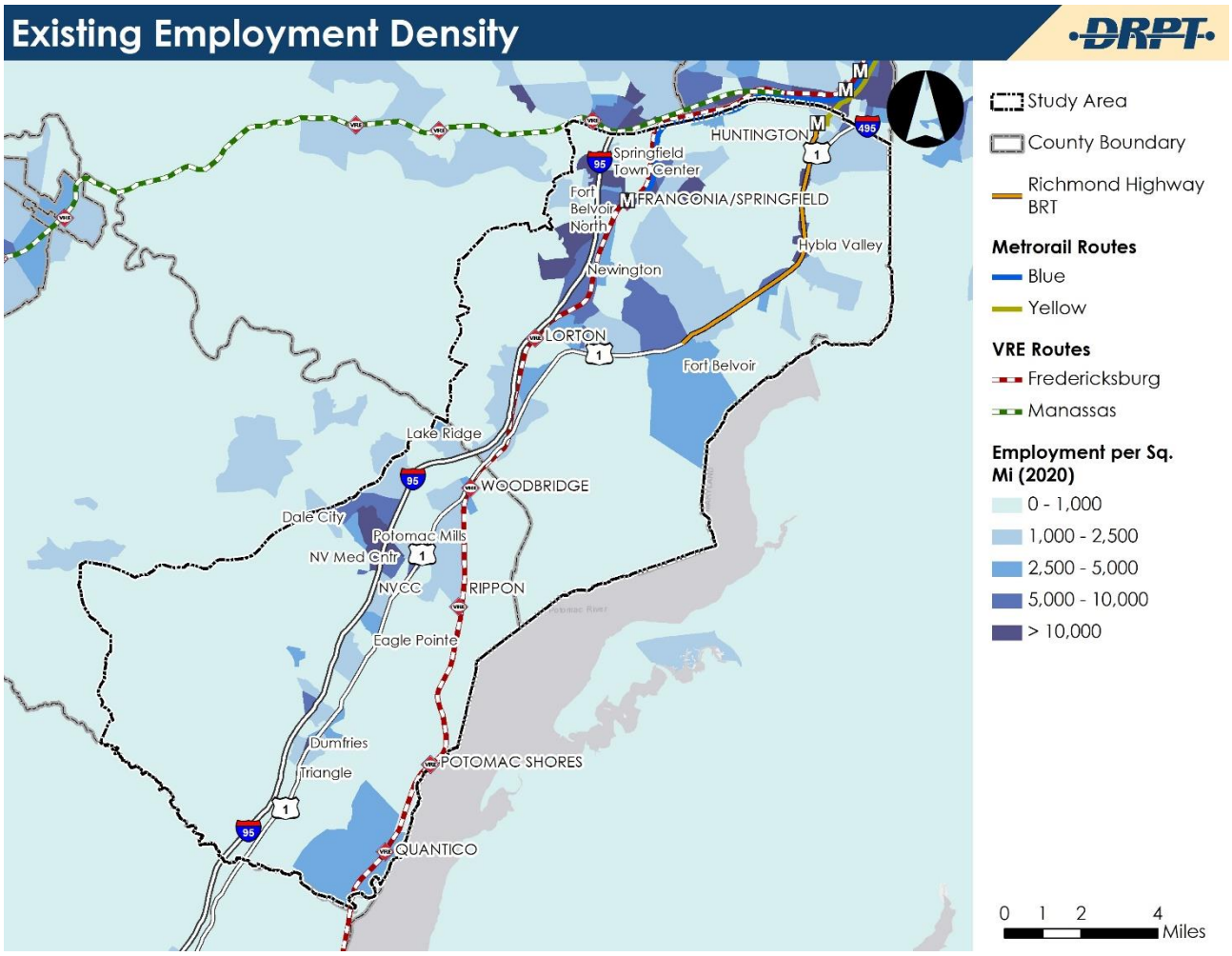
Employment

As of 2020, more than 200,000 people work in the Study Corridor. As shown in **Table 2-2** and **Figure 2-4**, employment is much more concentrated than population in a few key activity centers. Key employment centers in Prince William County include Quantico at the far south of the Study Corridor, and a cluster of retail and other businesses in and around Potomac Mills. In Fairfax County, employment centers are focused along I-95 and U.S. 1, including Springfield Town Center, Fort Belvoir, and Fort Belvoir North, where the National Geospatial-Intelligence Agency (NGA) is located. Jobs are also concentrated near Hybla Valley, but clustered in the businesses along U.S. 1.

TABLE 2-2 EXISTING STUDY CORRIDOR EMPLOYMENT

Zones	Existing Employment	Average Employment Density
Franconia	58,900	5,700
Huntington	26,200	2,100
Fort Belvoir	44,900	1,700
Lorton	4,300	400
Woodbridge	15,200	2,000
Potomac Mills	22,500	2,800
Quantico	28,500	1,100
Study Corridor Total	200,500	2,500

FIGURE 2-4 2020 EMPLOYMENT DENSITY



Source: MWCOG Round 9.1a Cooperative Land Use Forecasts

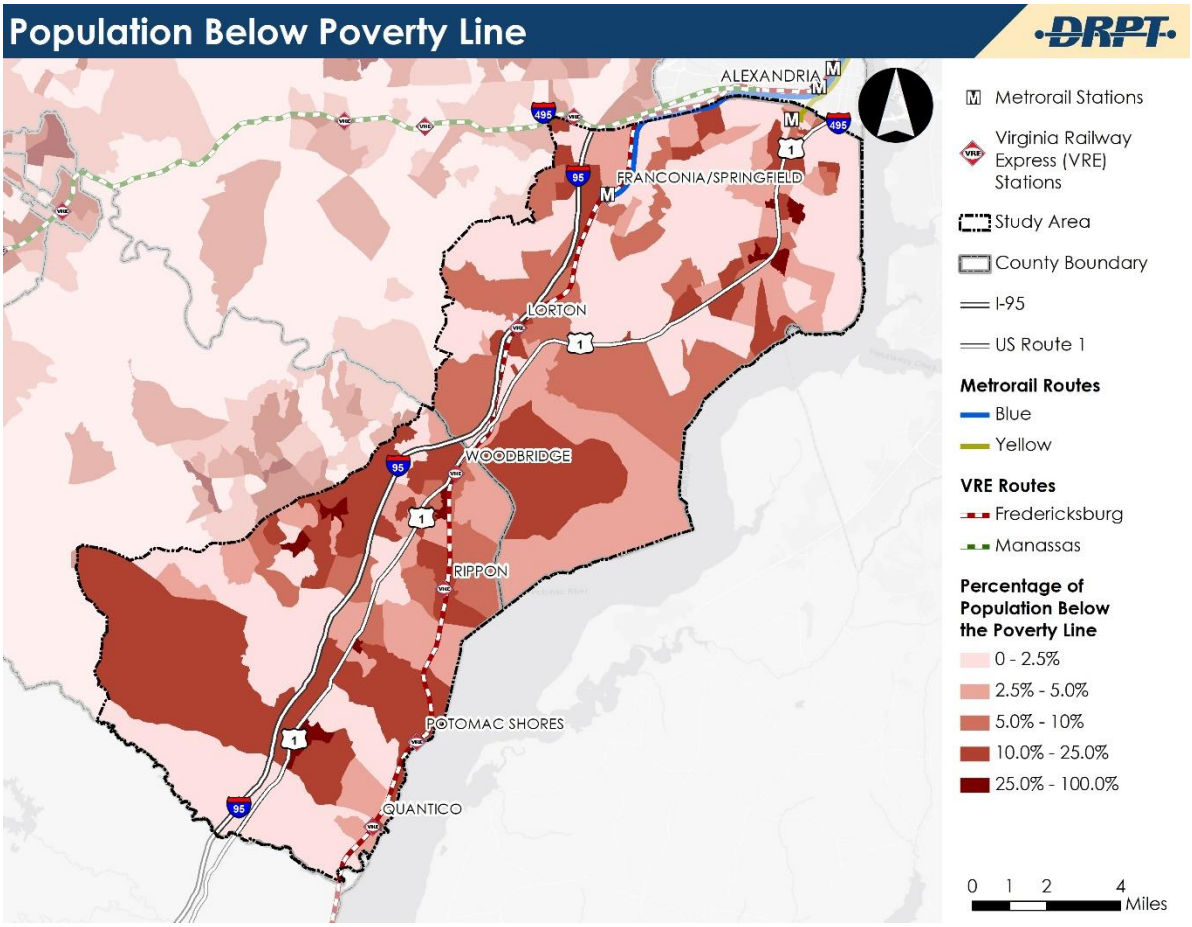
Poverty

In the Study Corridor, 7.7 percent of the population were living in poverty in 2019. While this is lower than the national poverty rate (10.5 percent) or the statewide average (9.9 percent),[1] it still represents 33,600 people living below the Federal definition of poverty, which does not account for the cost of living in Northern Virginia. It is higher compared to average poverty rates in Fairfax County (6.1 percent) and Prince William County (6.6 percent). As shown in **Figure 2-5**, there are pockets of higher poverty rates, even over 25 percent along U.S. 1 in Fairfax County, and in Dale City, Woodbridge, and Dumfries in Prince William County.

[1] U.S. Census Bureau

The suburbanization of poverty has become a growing issue in recent years, as many poor households have been priced out of more urban communities which most often have better access to transit.

FIGURE 2-5 POVERTY



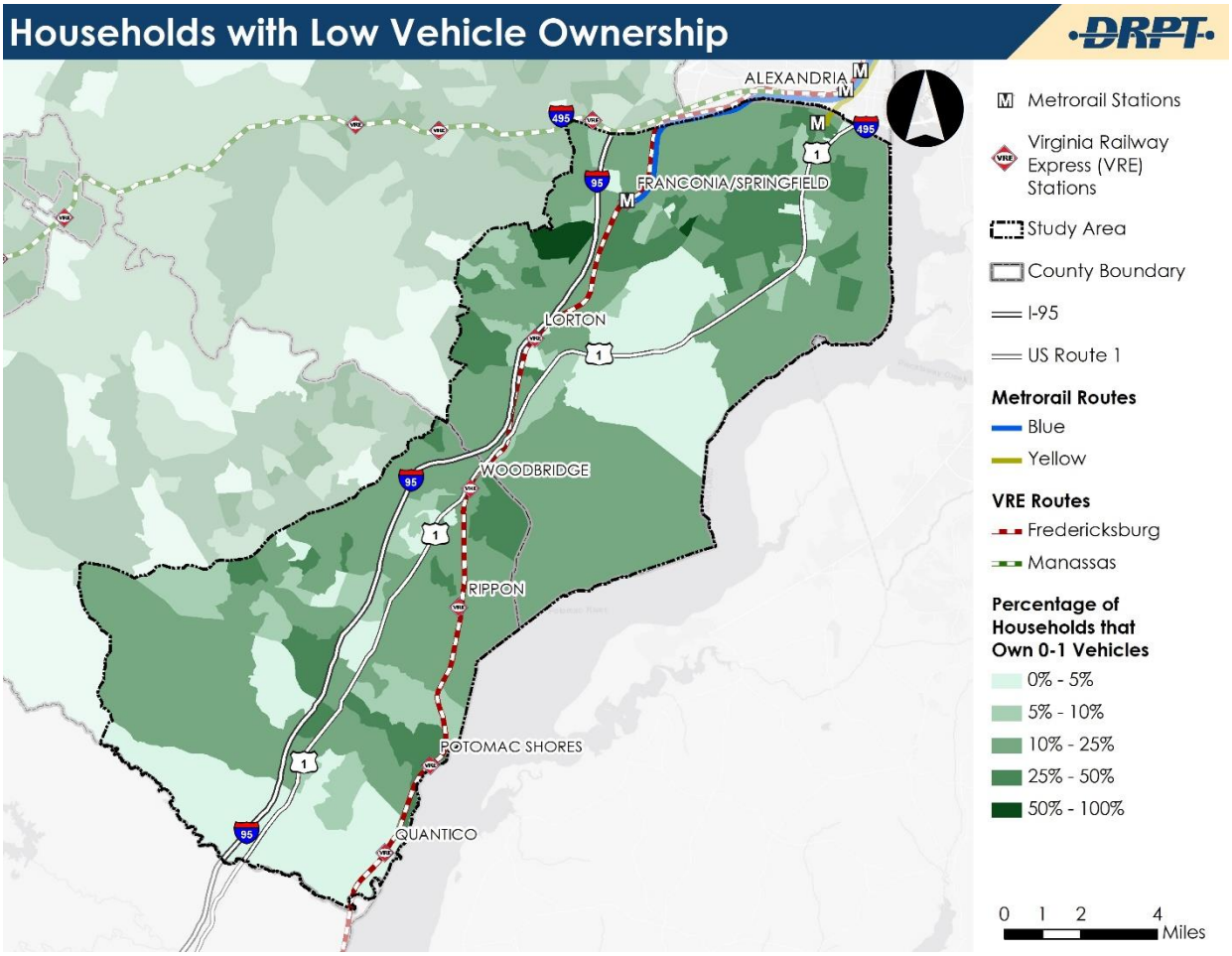
Source: 2015-2019 ACS

Vehicle Ownership

Low vehicle households — those with zero or one vehicles — are more likely to rely on transit for all or some of their transportation needs. Nationally, 8.6 percent of occupied housing was associated with zero vehicle ownership, and 32.7 percent with one vehicle.[2] Within the Study Corridor, an average of 16.2 percent of households were associated with low vehicle ownership, distributed as shown in **Figure 2-6**.

[2] 2015-2019 ACS. https://www.census.gov/acs/www/about/why-we-ask-each-question/vehicles/

FIGURE 2-6 VEHICLE OWNERSHIP

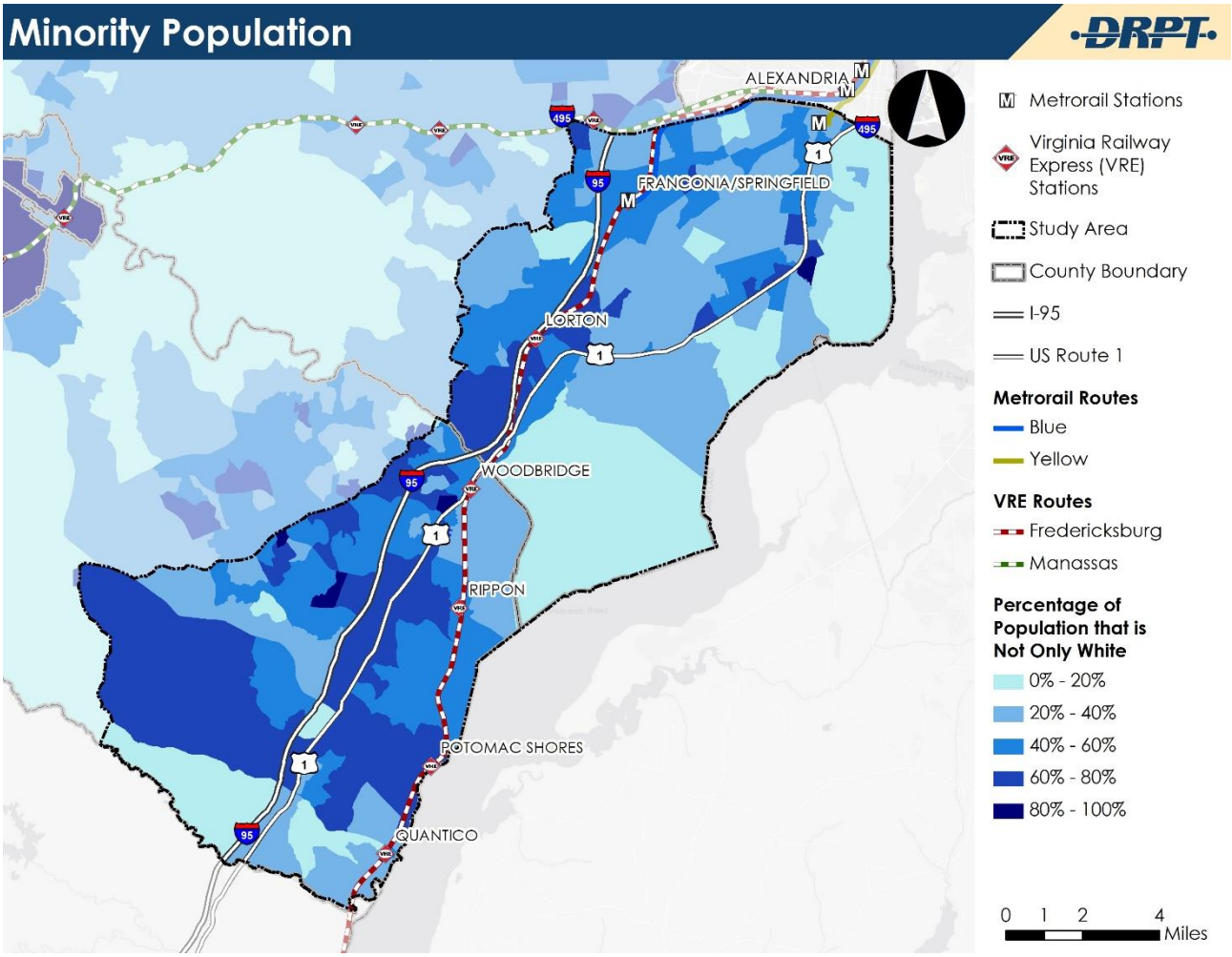


Source: 2015-2019 ACS

Race and Ethnicity

The population of the Study Corridor is 47 percent minority (defined here as Black, Asian, Native American, and Other, or more than one race). **Figure 2-7** shows that non-White populations are concentrated in the southern part of the Study Corridor in Prince William County, with the Woodbridge zone having the largest share at nearly 58 percent.

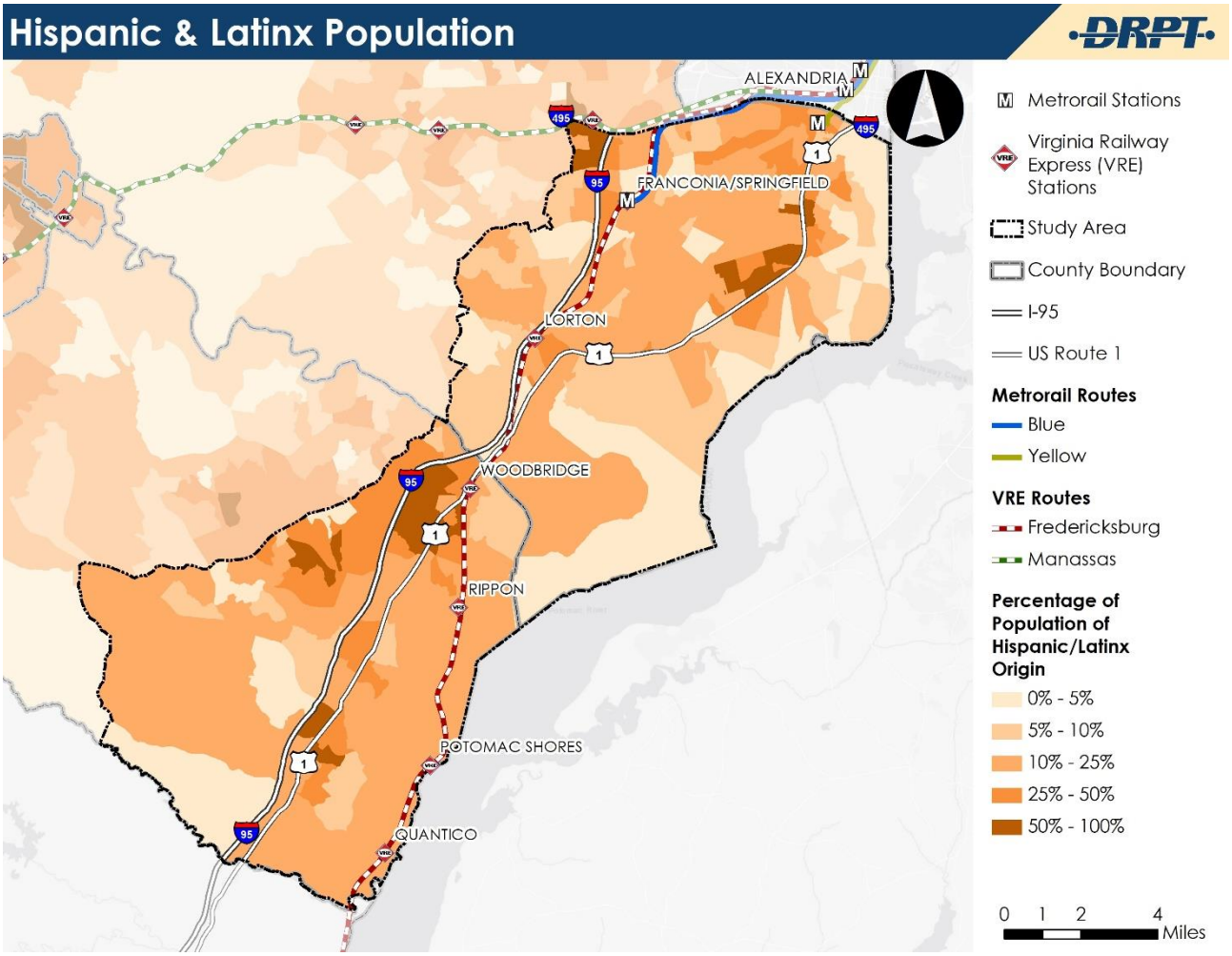
FIGURE 2-7 PERCENTAGE OF POPULATION THAT IS NOT ONLY WHITE



Source: 2015-2019 ACS

The Study Corridor has significant populations that identify as Hispanic (Spanish speaking) and/or Latinx (from Latin America), at 22.6 percent (note that minority and Hispanic populations can overlap). The national average is 18 percent, and the statewide average is 9.7 percent. As shown in Figure 2-8, higher densities of Hispanic/Latinx populations exist around Woodbridge and Dumfries in Prince William County, and in Springfield and Hybla Valley in Fairfax County.

FIGURE 2-8 HISPANIC AND LATINX POPULATION

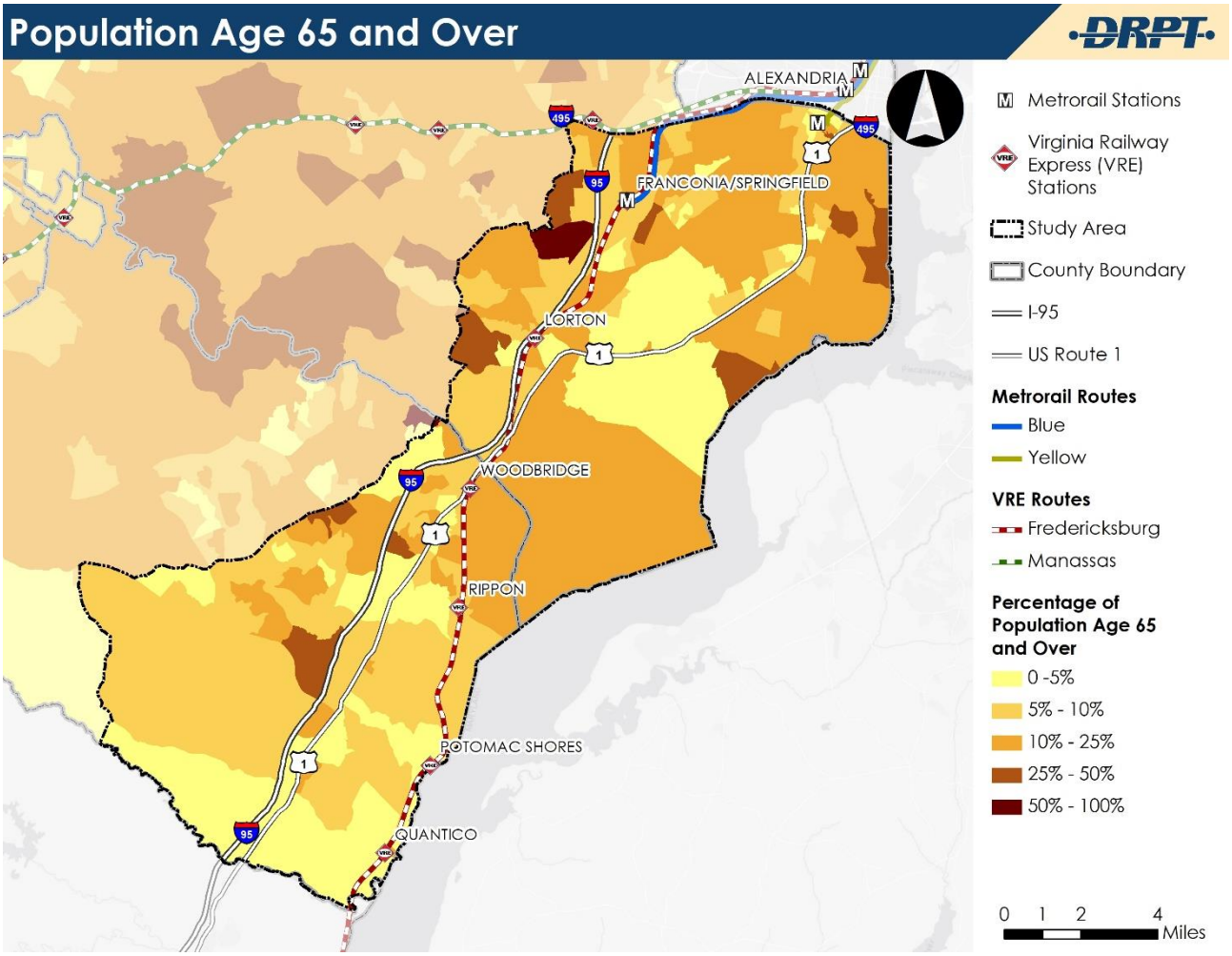


Source: 2015-2019 ACS

Age

Older adults also tend to be more reliant on transit than younger populations, and often face declining mobility without good access to transit. The population over the age of 65 is growing nationally. The U.S. Census reports that over the last decade, this segment grew by more than a third (34.2 percent). In the Study Corridor, on average, 10.4 percent of the population are over the age of 65, distributed as shown in **Figure 2-9**.

FIGURE 2-9 PERCENT OF POPULATION AGE 65 AND OVER



Source: 2015-2019 ACS

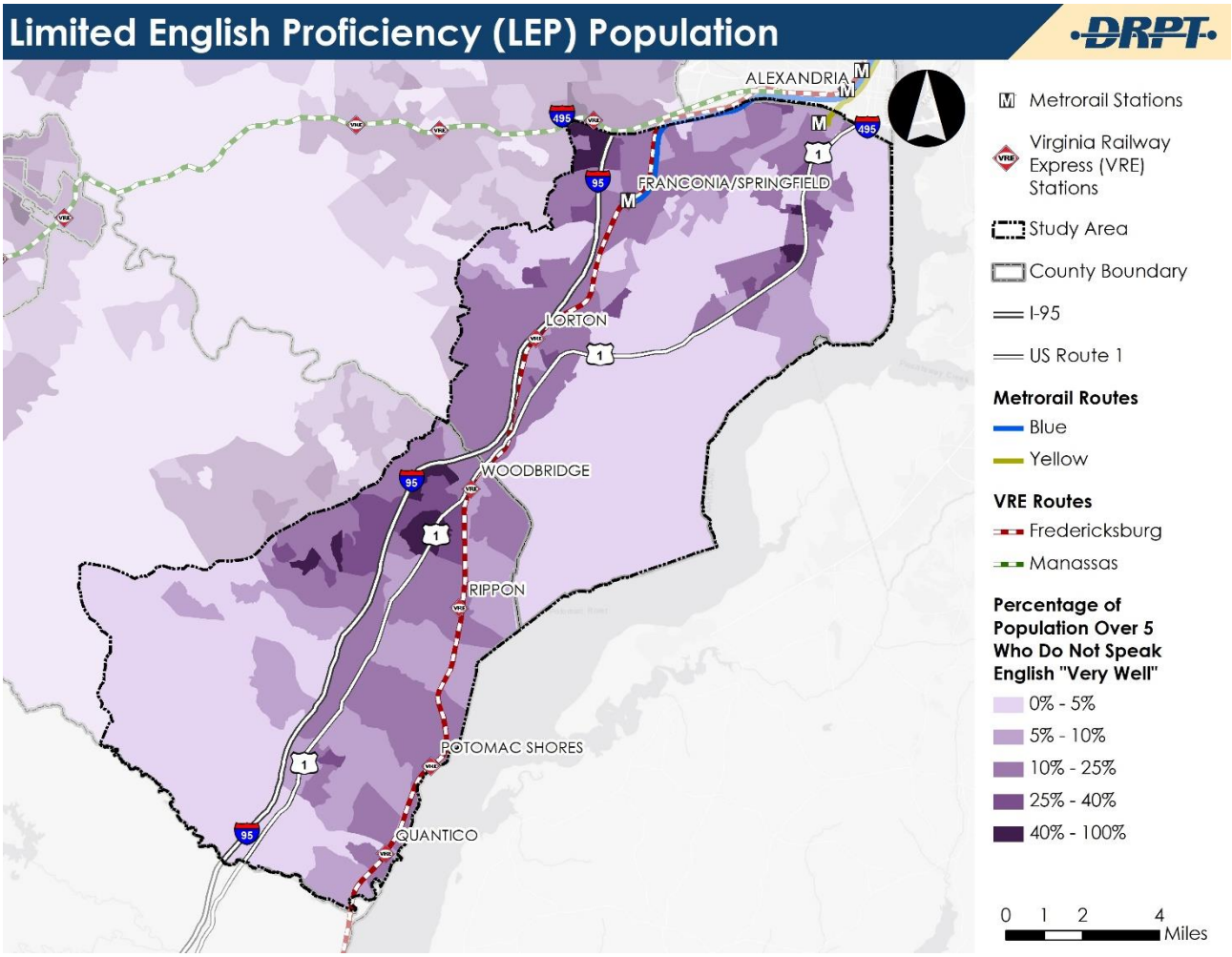
Limited English Proficiency

Analysis of Limited English Proficiency (LEP) informs governments on the need for language services for communities, including in communications from transit agencies. Nationally, 8.4 percent of the population reported that they did not speak English "very well."[3] In the Study Corridor, the average percentage of LEP people is 14.2 percent, while in the Woodbridge zone, more than 24 percent of the population does not speak English "very well." As shown in **Figure 2-10**, there are census block groups where more than 40 percent of the population does not speak English "very well" around Woodbridge and Dale City in Prince William County and in Springfield and Hybla Valley in Fairfax County. Among households that speak English

[3] U.S. Census Bureau. https://www.census.gov/acs/www/data/data-tables-and-tools/narrative-profiles/2019/report.php?geotype=nation&usVal=us

less than "very well", approximately 57 percent speak Spanish at home. The next most prevalent group of languages spoken at home are Asian-Pacific languages, comprising roughly 20 percent of limited-English households, and includes Vietnamese, Tagalog, Chinese, and Korean.

FIGURE 2-10 PERCENTAGE OF LEP POPULATION OVER AGE 5



Source: 2015-2019 ACS

Demographics Summary

Table 2-3 aggregates the data by county and zones within the Study Corridor. In some demographic segments, Fairfax County is very different from Prince William County. Fairfax County has much higher rates of low vehicle ownership, which can be attributed the presence of a more built-out transit network, including Metrorail along multiple lines. Additionally, Prince William County has a smaller population over the age of 65.

Across the Study Corridor there is wide variation in the poverty rates and the aging population, as there are widely varying communities across the Study Corridor.

TABLE 2-3 AVERAGE STUDY CORRIDOR DEMOGRAPHICS

Geography	% Minority	% Age Over 65	% Households with Low Vehicle Ownership (0-1 vehicle)	% Below Poverty Line	% Limited English Proficiency	% Hispanic Population
Fairfax County	47.5%	10.6%	15.0%	6.5%	11.6%	19.1%
Prince William County	41.1%	13.6%	21.4%	4.2%	13.7%	15.9%
Study Corridor						
Franconia	41.1%	13.6%	21.4%	4.2%	13.7%	15.9%
Huntington	33.6%	13.7%	18.6%	7.5%	11.6%	21.5%
Fort Belvoir	47.5%	10.6%	15.0%	6.5%	11.6%	19.1%
Lorton	44.5%	10.8%	18.0%	5.5%	12.1%	12.7%
Woodbridge	57.6%	8.4%	12.6%	11.4%	24.2%	37.8%
Potomac Mills	55.7%	8.3%	17.6%	10.6%	18.5%	32.0%
Quantico	44.7%	7.7%	10.2%	8.1%	7.9%	18.9%
Study Corridor Average	46.4%	10.4%	16.2%	7.7%	14.2%	22.6%

Existing Transit Service and Facilities

Public transit in the Study Corridor includes bus services operated by Fairfax County, OmniRide services offered by the Potomac and Rappahannock Transportation Commission (PRTC), WMATA, and Martz and rail services operated by WMATA Metrorail and VRE. This section presents a summary of the existing services, defined as pre-pandemic (2019). This summary relies on the public information/websites for each of the operators in addition to data provided by each public transit provider. **Table 2-4** summarizes the services provided by each transit operator.

TABLE 2-4 SERVICES IN THE STUDY CORRIDOR BY PROVIDER

Service Provider	Service Type	Services Currently Operating in Study Corridor	Services Not Operating Due to Covid	Services to VRE	Services to Metrorail	Services Utilizing I-95	Services Utilizing U.S. 1
Bus Service							
Fairfax Connector	Local and Commuter / Express Bus Service	31	0	20	31	5	7
PRTC / OmniRide	Local and Commuter /Express Bus Service	16	0	3	11	11	7
Metrobus (WMATA)	Local bus, Express Bus, and	9	8	3	16	5	2

	Commuter Bus						
Martz	Commuter Bus	1	4	0	5	5	0
Rail Service							
Metrorail (WMATA)	High Frequency Rail	Yellow Line, Blue Line	0	1	2	N/A	N/A
VRE	Commuter Rail	Fredericksburg Line	0	N/A	1	N/A	N/A

Bus Services

Fixed route bus services are provided in the study area by four operators – Fairfax Connector, OmniRide (PRTC), WMATA Metrobus, and Martz (a private company). All three of the public agencies operate both local services and commuter/express service while Martz only provided commuter services from the Fredericksburg area to DC with stops along the corridor. **Table 2-5** lists the current local and commuter/express routes operated in the corridor in 2019 and identifies those which are not currently operating due to the pandemic.

TABLE 2-5 EXISTING STUDY CORRIDOR BUS SERVICE

Service Provider	Local Bus Service	Commuter Bus Service
Fairfax Connector	101, 109, 151, 152, 161, 162, 171, 231, 232, 305, 306, 308, 310, 321, 322, 334, 340, 341, 371, 372, 373, 401, 402	159, 301, 335, 393, 394, 395, 396, 494

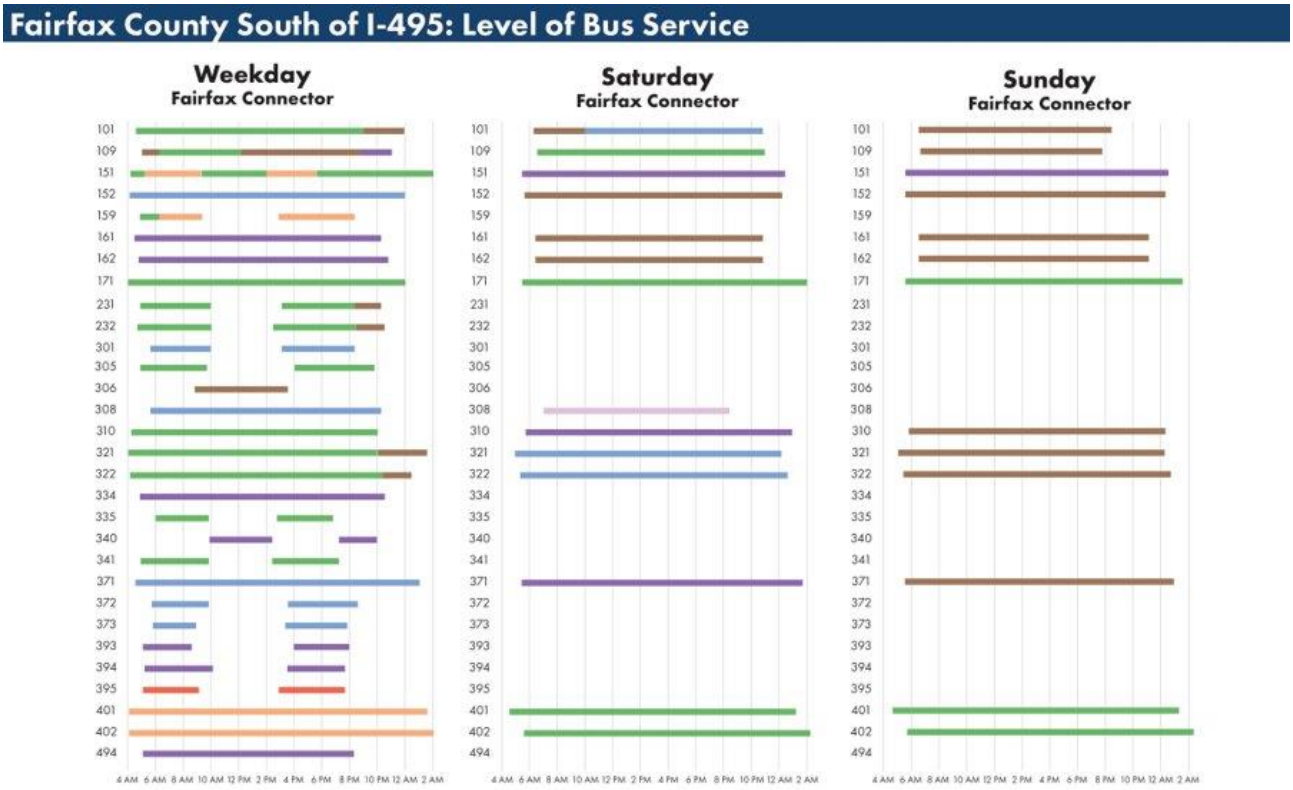
OmniRide	Prince William Express, Dale City Local, Dumfries Local, Route 1 Local, Woodbridge-Lake Ridge A, Woodbridge Lake Ridge B	D-100, D-200, D-300, D-400, L-100, L-200, L-300, MC-100, MC-200, Route 1 Express
Metrobus	REX, 10A, S80, S91	11Y, 18G, 18H, 18J, 18P
Martz	-	DC1, DC2, DC3, DC4, DC5

Fairfax Connector Route 396 is no longer operating but Fairfax Connector added 350/351 in January 2021. Martz operated only one round trip during the pandemic. As of April 2021, Martz ended the Fredericksburg area bus service.

Fairfax Connector

Fairfax Connector provides fixed route bus service in Fairfax County. Many services in the Connector's South County zone operate in the Study Corridor, including 23 local routes and 8 commuter/express routes. **Figure 2-11** shows the level of service (span and frequency) for each Fairfax Connector route in the Study Corridor. The local routes generally provide service all day seven days a week, while most of the commuter/express routes operate only weekdays during peak periods.

FIGURE 2-11 FAIRFAX CONNECTOR LEVEL OF SERVICE

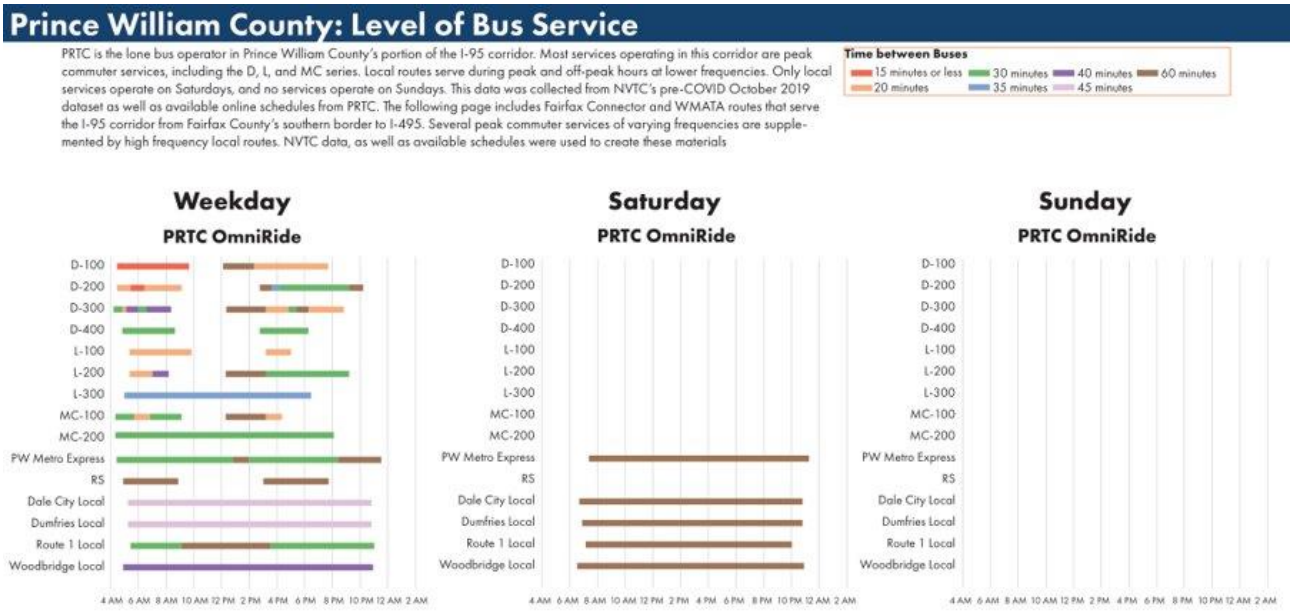


Note: Route 396 was operating in 2019 but was discontinued while a new shuttle route (350/351- the Springfield Business Circulator) was implemented in January 2021.

Potomac and Rappahannock Transportation Commission (PRTC) / OmniRide

PRTC, provides fixed route bus services under the OmniRide name in the Prince William County portion of the Study Corridor. PRTC operates 16 total routes in the area, including 10 commuter/express routes and six local routes. The commuter routes serve destinations such as downtown DC, the Pentagon, Crystal City, Tysons, and Mark Center. As shown in **Figure 2-12**, express/commuter services generally operate at relatively high frequencies but only during weekday peak hours, while local services operate at lower frequencies but throughout the weekdays and on Saturdays.

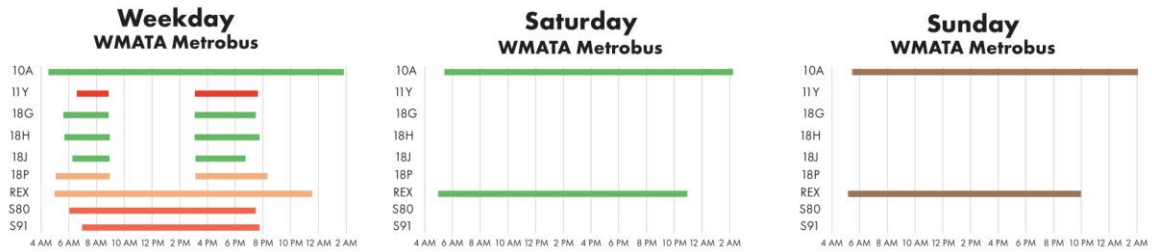
FIGURE 2-12 OMNIRIDE LEVEL OF SERVICE



Washington Metropolitan Area Transit Authority (WMATA) Metrobus

WMATA is the regional transit provider in the Washington Metropolitan region, providing rail, bus, and paratransit services. Metrobus operates nine routes in the Study Corridor including four local routes (10A, S80, S91 and REX) and five commuter routes (11Y and the 18s). As shown in **Figure 2-13**, the local routes operate throughout the weekdays while the commuter routes operate only in peak hours. Only the 10A and REX operate on weekends.

FIGURE 2-13 METROBUS LEVEL OF SERVICE



Martz

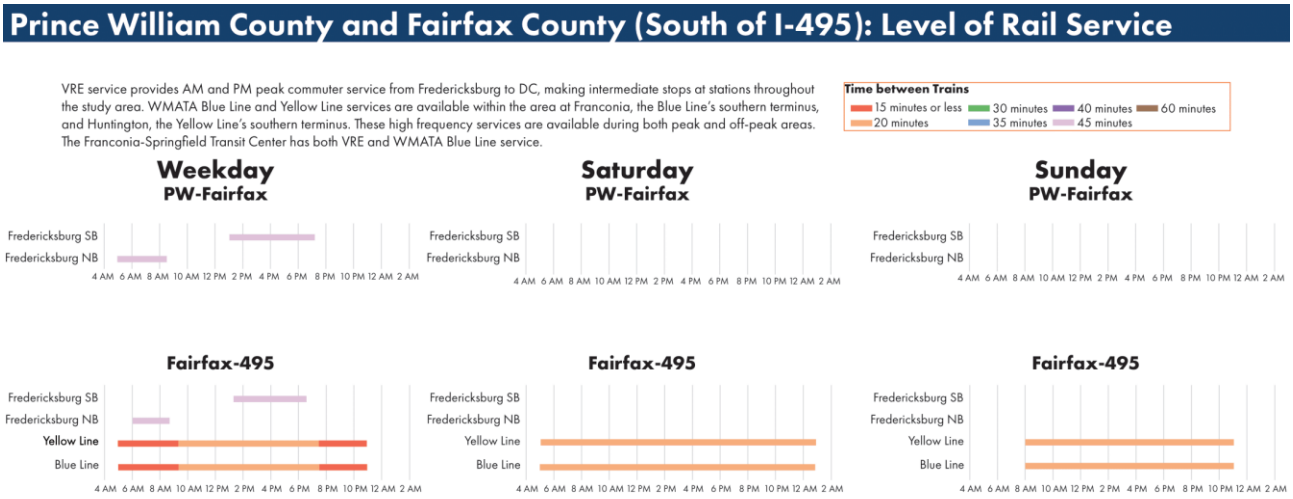
Martz is a private company that operated commuter bus service from northern Spotsylvania County and Stafford County to Pentagon City, the Pentagon, and downtown DC. In 2019, the routes served VDOT park-and-ride lots in Fredericksburg and Quantico, and then used I-95 to reach the Pentagon and DC. During the

pandemic, Martz decreased and then, as of April 2021, stopped operating service. During 2019, Martz commuter bus service operated on weekdays during peak periods only, providing five roundtrips per day.

Rail Services

The Study Corridor has rail service provided by WMATA Metrorail and the Virginia Railway Express (VRE). **Figure 2-14** presents the level of service for rail services in the corridor. Metrorail provides high frequency, daily connections from the northern portion of the Study Corridor into DC and to other areas throughout the region. VRE serves the entire corridor connecting areas south of the study boundary to the region's core and DC.

FIGURE 2-14 LEVEL OF RAIL SERVICE



WMATA Metrorail

WMATA operates the Blue and Yellow Metrorail lines seven days a week, providing frequent service all day. The Study Corridor includes two Metrorail stations — Franconia-Springfield on the Blue line and Huntington on the Yellow line. Both are end-of-line stations and serve both local residents and riders traveling from the south. Prior to the Covid-19 pandemic, Metrorail hours were 5 am-11:30 pm Monday-Thursday, 5 am-1 am Friday, 7 am-1 am Saturday, 8 am-11 pm Sunday. For study purposes, it is assumed that Metrorail will return to these or similar hours post-pandemic.

Virginia Railway Express (VRE)

The Fredericksburg line of VRE provides commuter rail service along the corridor from Spotsylvania County to Alexandria, Crystal City, and downtown DC. VRE service operates on weekdays only, primarily during peak

periods with a few midday trips. VRE passengers holding passes may use Amtrak trains listed in the VRE schedule for an additional "step-up" fee.

Existing Coverage and Ridership

Figure 2-15 and **Figure 2-16** present maps of transit services in the Study Corridor in the peak and off-peak hours, respectively. As expected, there is more extensive coverage and higher frequencies in the northern portion of the Study Corridor where population densities are greater. Services are more frequent and coverage more extensive during peak hours.

FIGURE 2-15 PEAK TRANSIT SERVICES: AVERAGE HEADWAYS

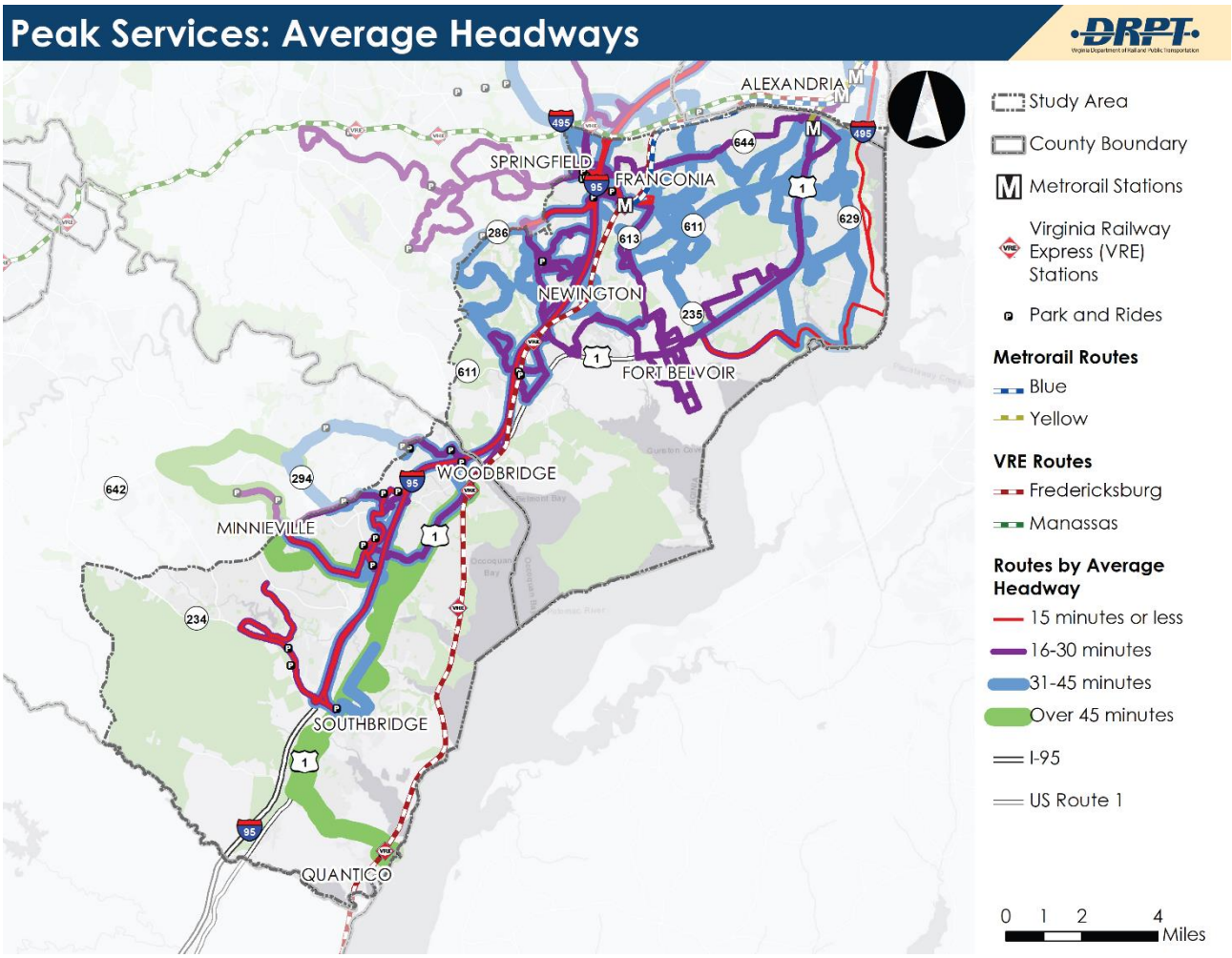


FIGURE 2-16 OFF-PEAK TRANSIT SERVICES: AVERAGE HEADWAY

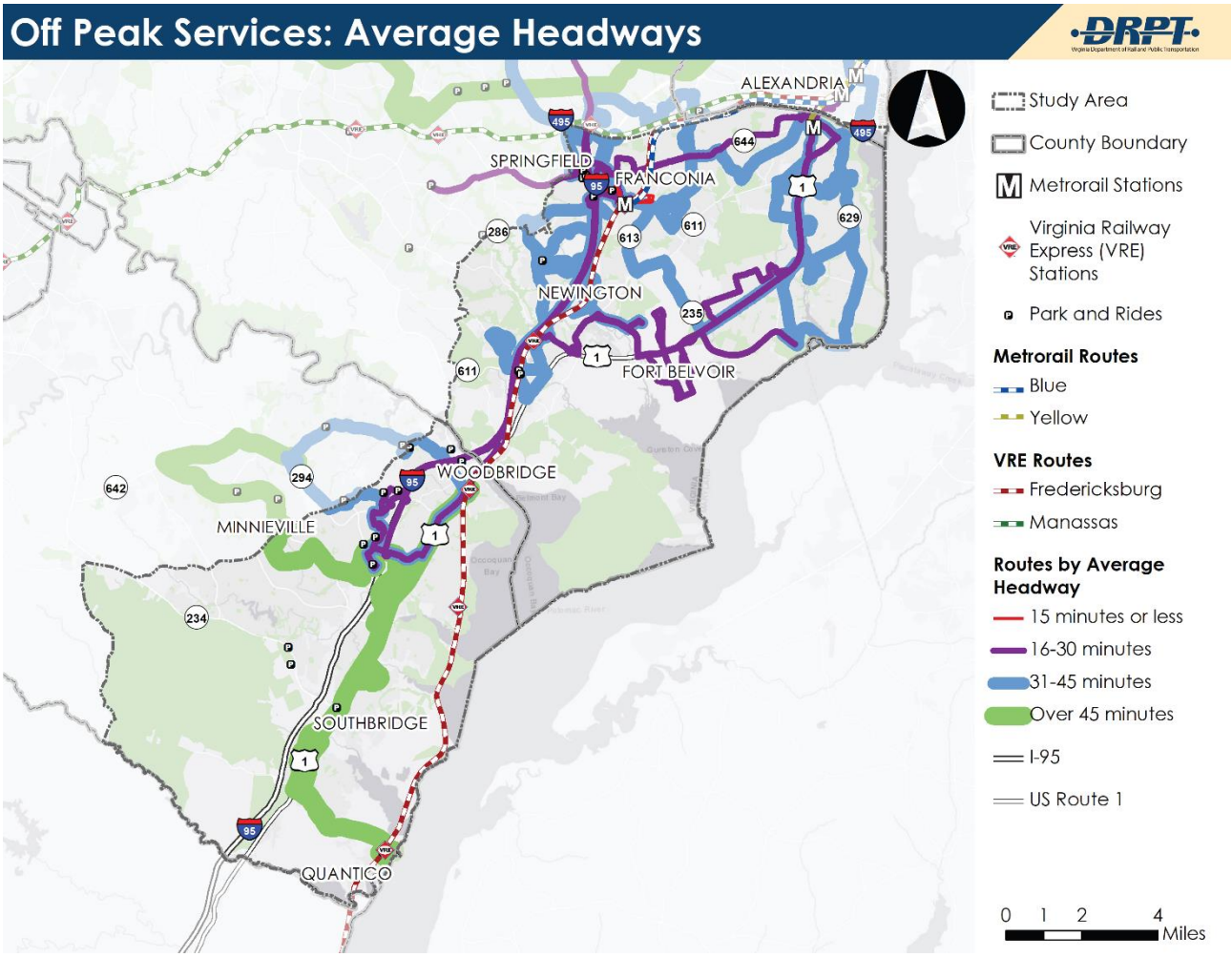


Figure 2-17 presents average weekday boardings for each of the bus routes in the Study Corridor by operator. The Fairfax Connector routes with the highest ridership are those routes that serve either the Huntington Metro station (171,151, 310) or the Franconia-Springfield Metrorail/VRE stations (310, 402, 494). Two of the higher ridership Connector Routes also serve the Tysons area (494, 402). The Metrobus route with the highest ridership is the Richmond Highway Express (REX) branded service. The OmniRide routes in the study area with the highest ridership are the routes from Dale City or Lake Ridge into downtown DC.

FIGURE 2-17 EXISTING BUS RIDERSHIP BY PROVIDER, OCTOBER 2019

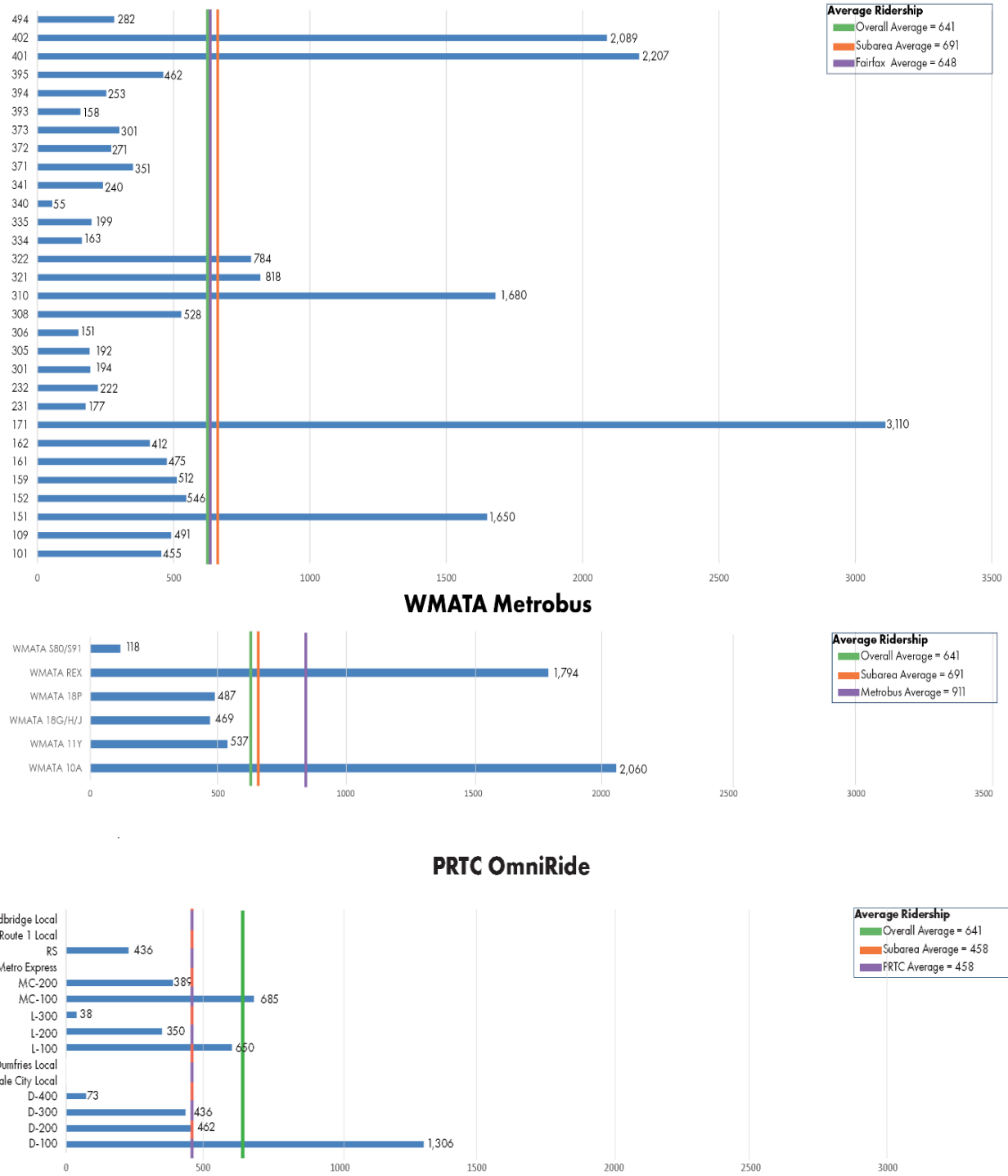
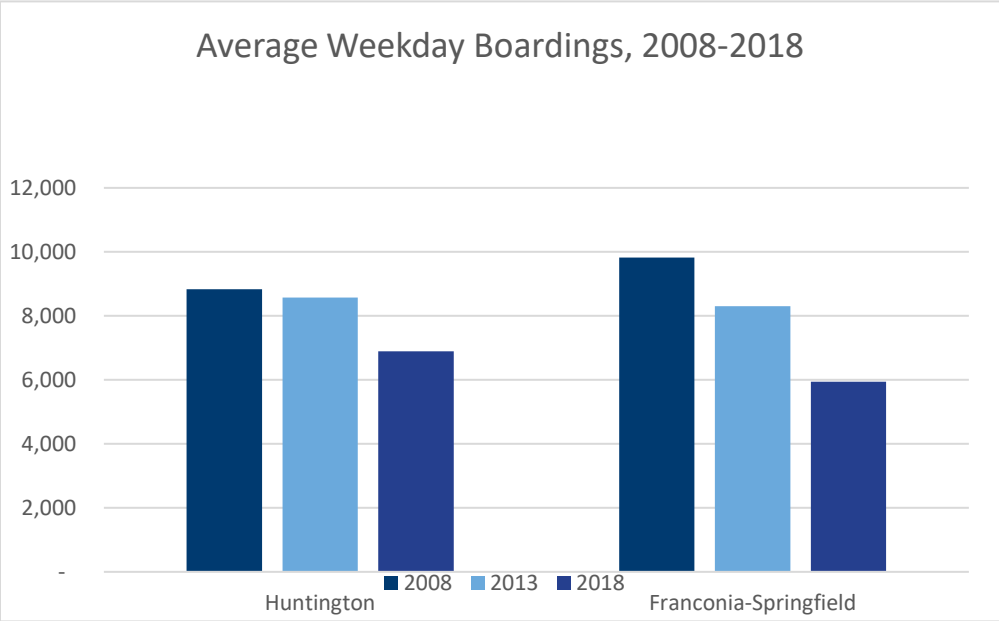


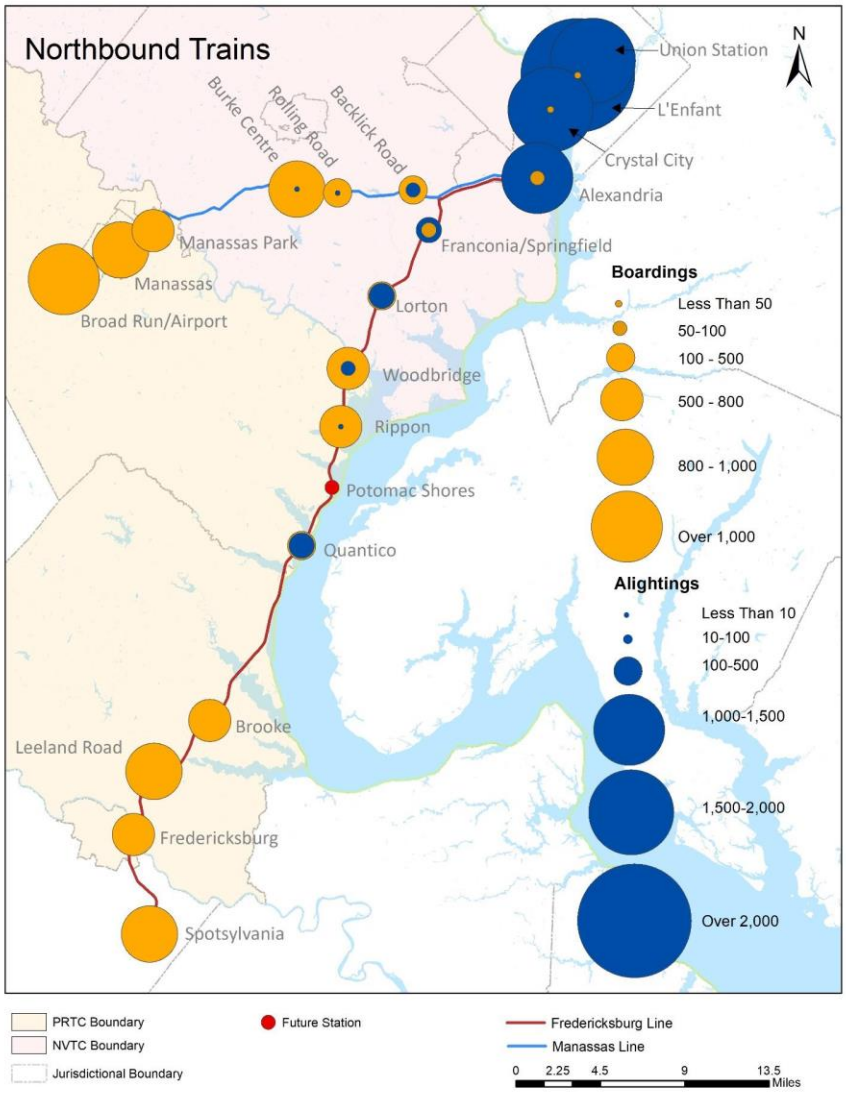
Figure 2-18 presents average weekday boardings at the Franconia-Springfield and Huntington Metrorail stations. Ridership at Huntington Station averaged roughly 6,900 daily boardings in May 2018, a decrease from 8,800 daily boardings in May 2008. Ridership at Franconia-Springfield Station averaged roughly 5,900 daily boardings in May 2018, a decrease from 9,800 daily boardings in May 2008. Systemwide Metrorail ridership decreased 14 percent between 2010 and 2019, however prior to March 2020 it had been increasing since 2017.

FIGURE 2-18 AVERAGE WEEKDAY METRORAIL RIDERSHIP BY STATION, 2008 TO 2018



Weekday ridership on the VRE Fredericksburg Line averaged roughly 10,000 boardings per day in FY2019, of which about 2,500 boardings were at the five VRE stations in the Study Corridor. **Figure 2-19** illustrates the split between boardings and alightings for northbound trains by station. Quantico and Lorton stations have a greater share of alightings than boardings, indicating that these stations are destinations for riders traveling from the southern portions of the line, most likely to access jobs at Marine Corps Base Quantico and Fort Belvoir.

FIGURE 2-19 VRE BOARDINGS AND ALIGHTINGS BY STATION, NORTHBOUND TRAINS



Source: FY2020 – FY2025 Transit Development Plan

Roadway Conditions

Congestion is a major issue in the Study Corridor, particularly on I-95 and U.S. 1, which experience extremely high traffic volumes, severe congestion, and unreliable travel times. While particularly acute during the morning and evening peak periods, these issues occur frequently during off peak periods and on the weekends as well. Expansion of roadway capacity, managed lanes, and improved transit options have all been implemented to solve these issues, but growth continues to make congestion a challenge.

Congestion

The Study Corridor experiences significant levels of vehicle traffic and major congestion during the peak periods, based on 2019 estimates developed with the regional travel demand model. As shown in **Table 2-6**, there are over two million vehicle miles traveled (VMT) during the morning peak period, and more than three million vehicle miles traveled during the evening peak period each weekday. This equates to almost 12 miles of peak period vehicle travel for every resident of the corridor —regardless of age or employment status. As shown, approximately80 percent of this VMT is lightly, moderately, or severely congested. Approximately 24 percent in the morning peak and 21 percent in the evening peak occurs in severe congestion. **Figure 2-20** and **Figure 2-21** illustrate where that congestion is occurring in the morning and evening peak periods.

TABLE 2-6 EXISTING CONDITIONS PEAK PERIOD VMT BY LEVEL OF CONGESTION

	Morning Peak Period		**Evening Peak Period**	
	Total	**Percent of Total**	**Total**	**Percent of Total**
Severe Congestion (v/c ≥ 1)	502,700	24%	641,000	21%
Moderate Congestion (0.79 < v/c < 1)	649,500	32%	1,373,700	44%
Light Congestion (0.63 <v/c < 0.79)	465,400	23%	473,100	15%
Uncongested (v/c ≤ 0.63)	442,600	21%	613,100	20%
Total	**2,060,200**	**100%**	**3,100,900**	**100%**

Source: Existing Conditions Baseline Travel Demand Model

FIGURE 2-20 MORNING PEAK CONGESTION - EXISTING

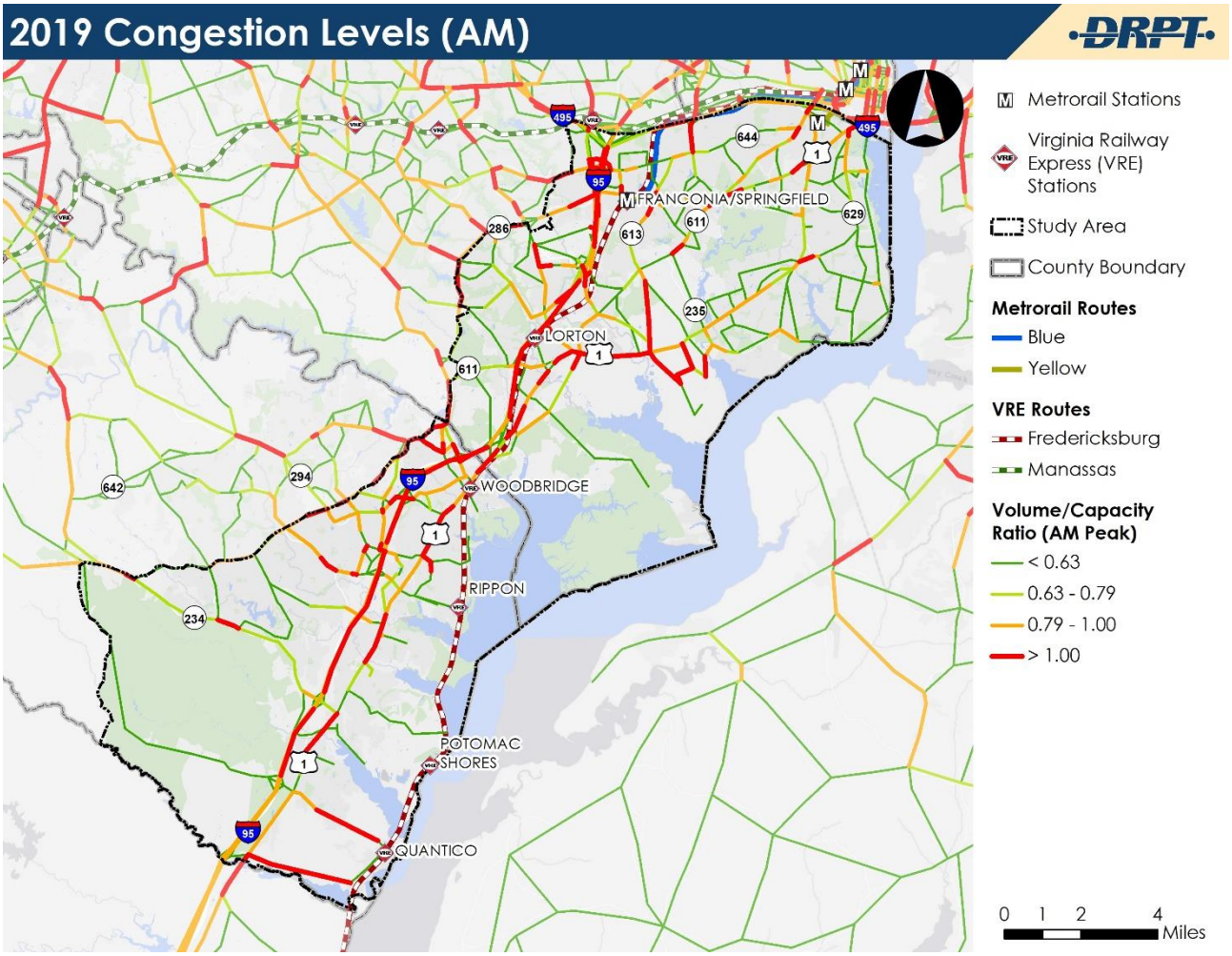
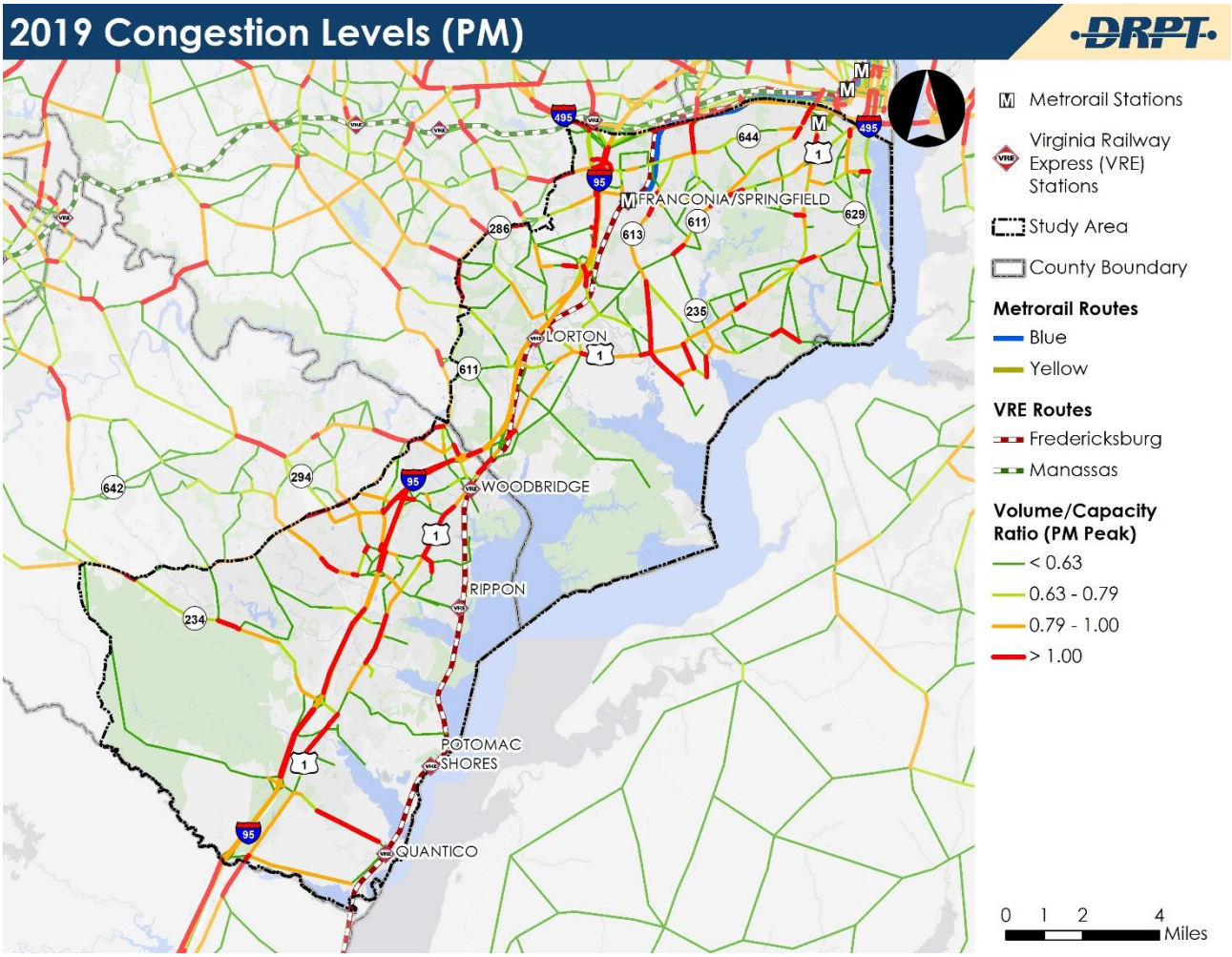


FIGURE 2-21 EVENING PEAK CONGESTION - EXISTING



Based on this initial analysis, congestion is most severe and consistent along I-95 and U.S. 1. Therefore, additional analysis of auto travel time and reliability has been conducted to highlight the severity of the congestion issues on these key facilities. This analysis is based on 2019 (pre-COVID) observed from Federal Highway Administration's National Performance Management Research Data Set (NPMRDS).

Figure 2-22 illustrates the daily recurring congestion that occurs along I-95 northbound in the morning peak hours using speed observations from INRIX, a transportation analytics firm, in the month of October 2019. As shown, severe congestion (shown in red) recurs every weekday at two major bottlenecks: the Occoquan River and the I-95/I-395/I-495 interchange. Sporadic congestion occurs at both of these locations northbound during the midday and evening peak periods. Severe congestion along I-95 recurs consistently southbound north of the lane drop at the Occoquan River during the evening peak (as shown in **Figure 2-23**), and somewhat less reliably during the mid-day.

By contrast, the I-95 Express Lanes are dynamically tolled to maintain free-flow speeds at all times. Review of travel speeds on the Express Lanes indicated that with a few exceptions, the dynamic tolling successfully achieves this goal, resulting in a congestion-free path for high-occupancy vehicles, including buses, and toll payers.

FIGURE 2-22 SPEED HEAT MAP: I-95 NORTHBOUND MORNING PEAK

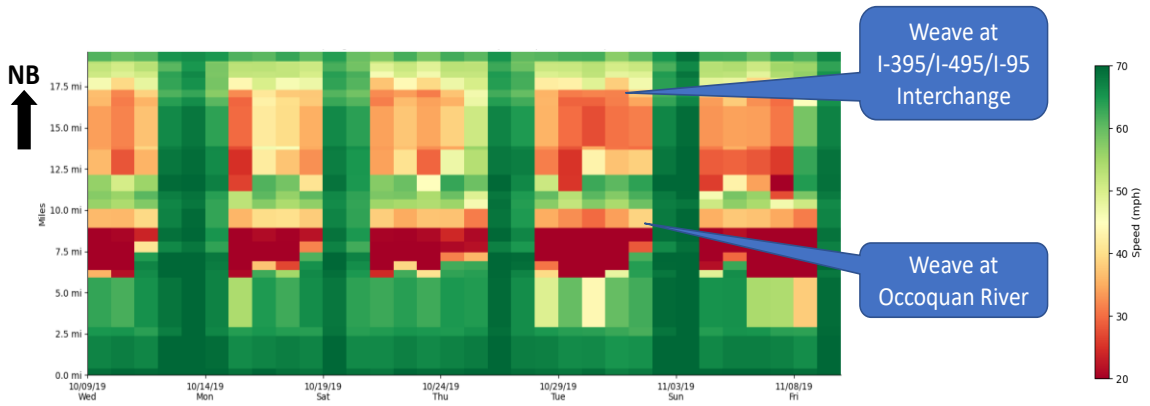
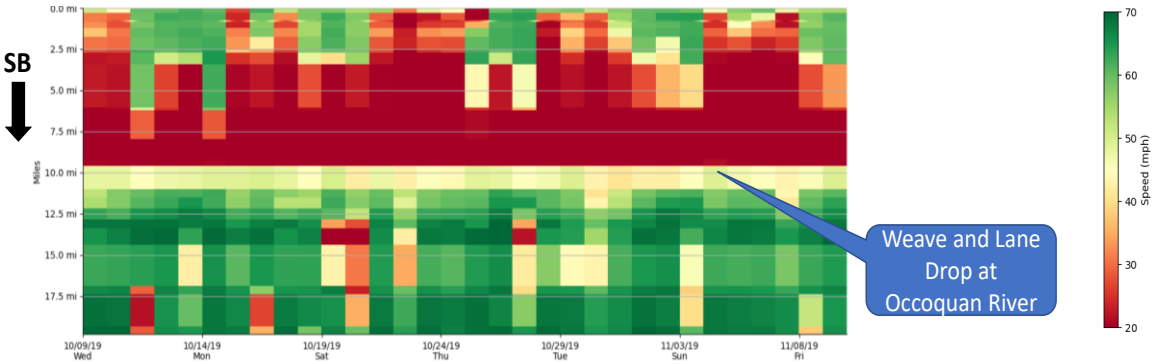


FIGURE 2-23 SPEED HEATMAP: I-95 SOUTHBOUND EVENING PEAK



Congestion along U.S. 1 behaves differently, as free-flow speeds are much lower and are frequently interrupted by traffic signals. Northbound in the morning peak, travel speeds slow significantly through Woodbridge as shown in **Figure 2-24**, but is otherwise fairly reliable in the morning. However, congestion on U.S. 1 is worse during the midday and evening peak periods, when more people are accessing the stores and businesses along U.S. 1, making more frequent turns at driveways and access points. Congestion is worst southbound in the evening peak, when high levels of commuters traveling home interact with shopping and other trips, as shown in **Figure 2-25**.

FIGURE 2-24 SPEED HEATMAP: U.S. 1 NORTHBOUND MORNING PEAK

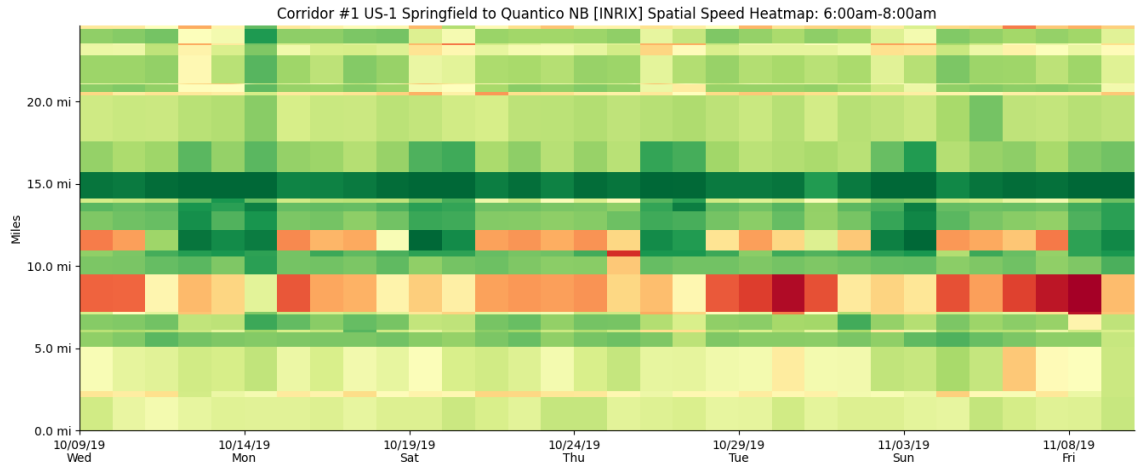
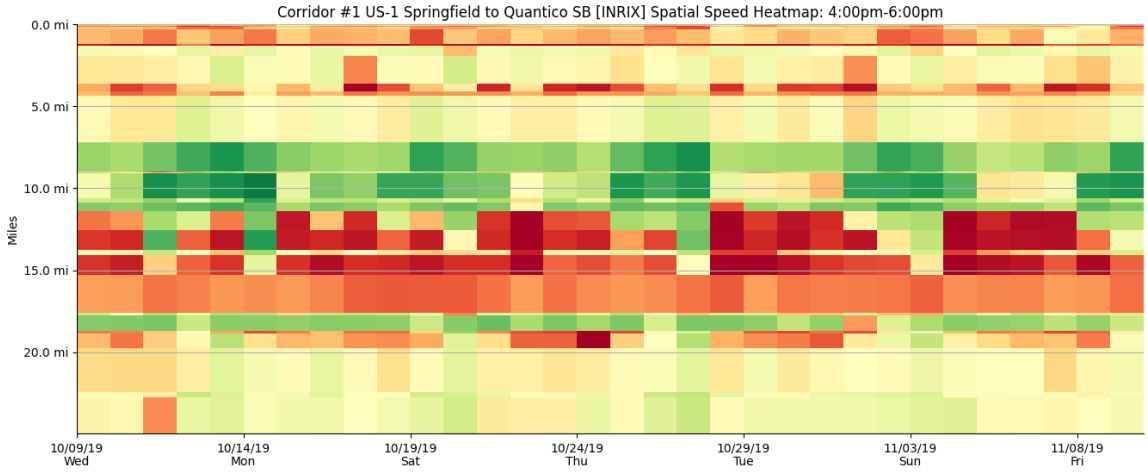


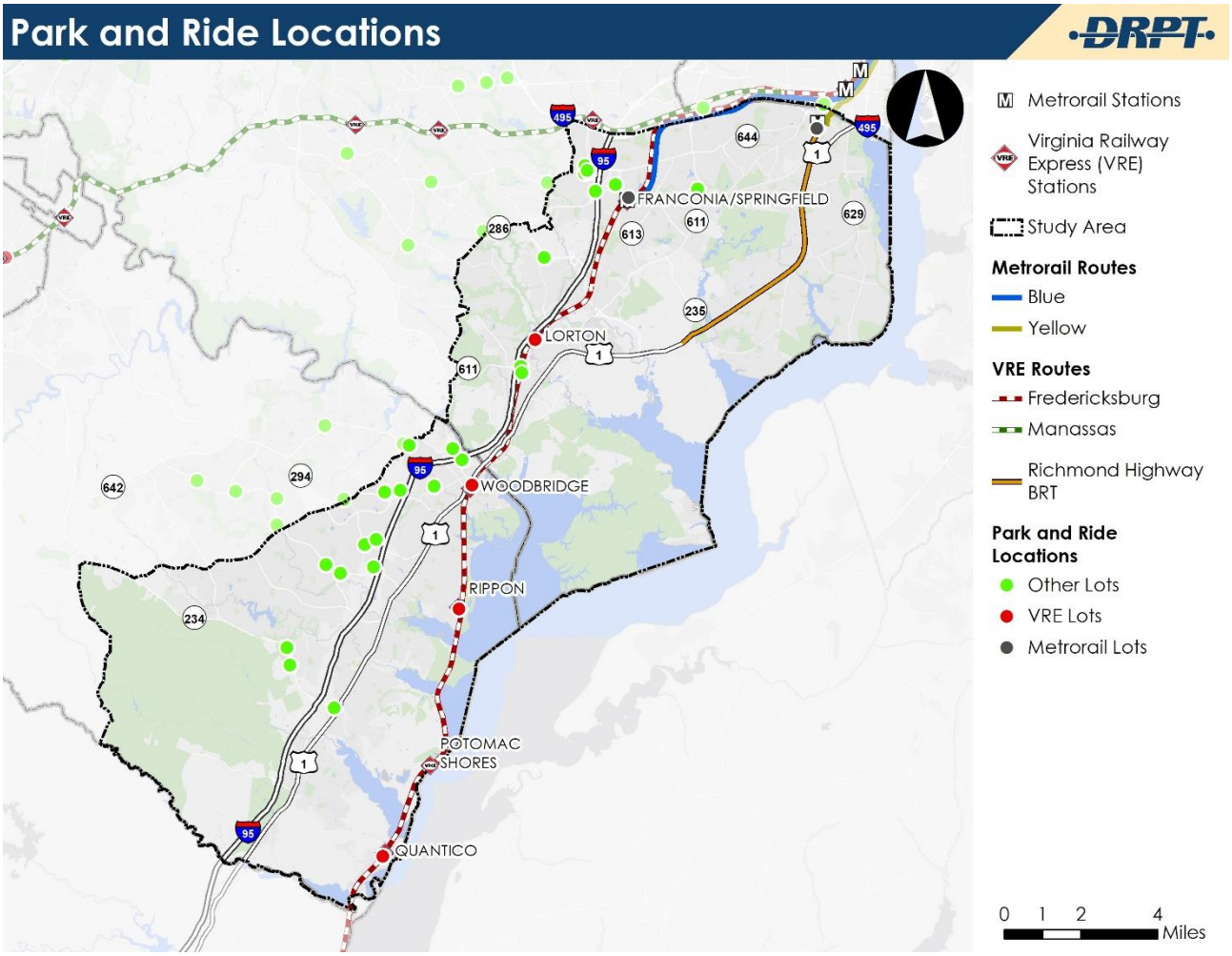
FIGURE 2-25 SPEED HEATMAP: U.S. 1 SOUTHBOUND EVENING PEAK



Park-and-Ride Facilities

There are currently 31 park-and-ride facilities located within the Study Corridor providing parking for more than 20,000 vehicles, including those at Metrorail and VRE stations. As shown in **Figure 2-26,** they tend to be located along I-95.

FIGURE 2-26 EXISTING PARK-AND-RIDE FACILITIES IN THE STUDY CORRIDOR



Existing Transportation Demand Management

Numerous organizations deliver, fund, or administer transportation demand management (TDM) services to commuters who travel within or through the study area. **Figure 2-27** displays the primary regional and local organizations of interest and the services they provide. These organizations operate commuter assistance programs that promote transit, vanpooling, carpooling, bicycling, and walking and offer information and assistance services to encourage residents and workers in the study area to use these modes for commuting. Typical TDM services offered to commuters in the Study Corridor are briefly noted below.

- Commute Information Marketing, Websites, and Events – These services inform commuters about non-single-occupancy vehicle (SOV) commute options that might be feasible for their travel, the benefits of choosing those options, and the services that are available to assist them. Services in this category includewebsites, online ride matching servicesmarketing campaigns, and promotional events, such as Bike-to-Work Day, Car-Free Day, and Try Transit Week, that encourage the use of transit, vanpooling, and carpooling.

- Carpool/Vanpool Support Services – Carpooling and vanpooling support includes high-occupancy vehicles (HOV)/Express lanes; casual carpool formation points (e.g., slug lines); online carpool/ vanpool ride matching; financial incentives, such as VanStart and VanSave; and instant carpool/dynamic carpool matching mobile applications, which facilitate single-trip carpooling.

Carpool/Vanpool on I-95

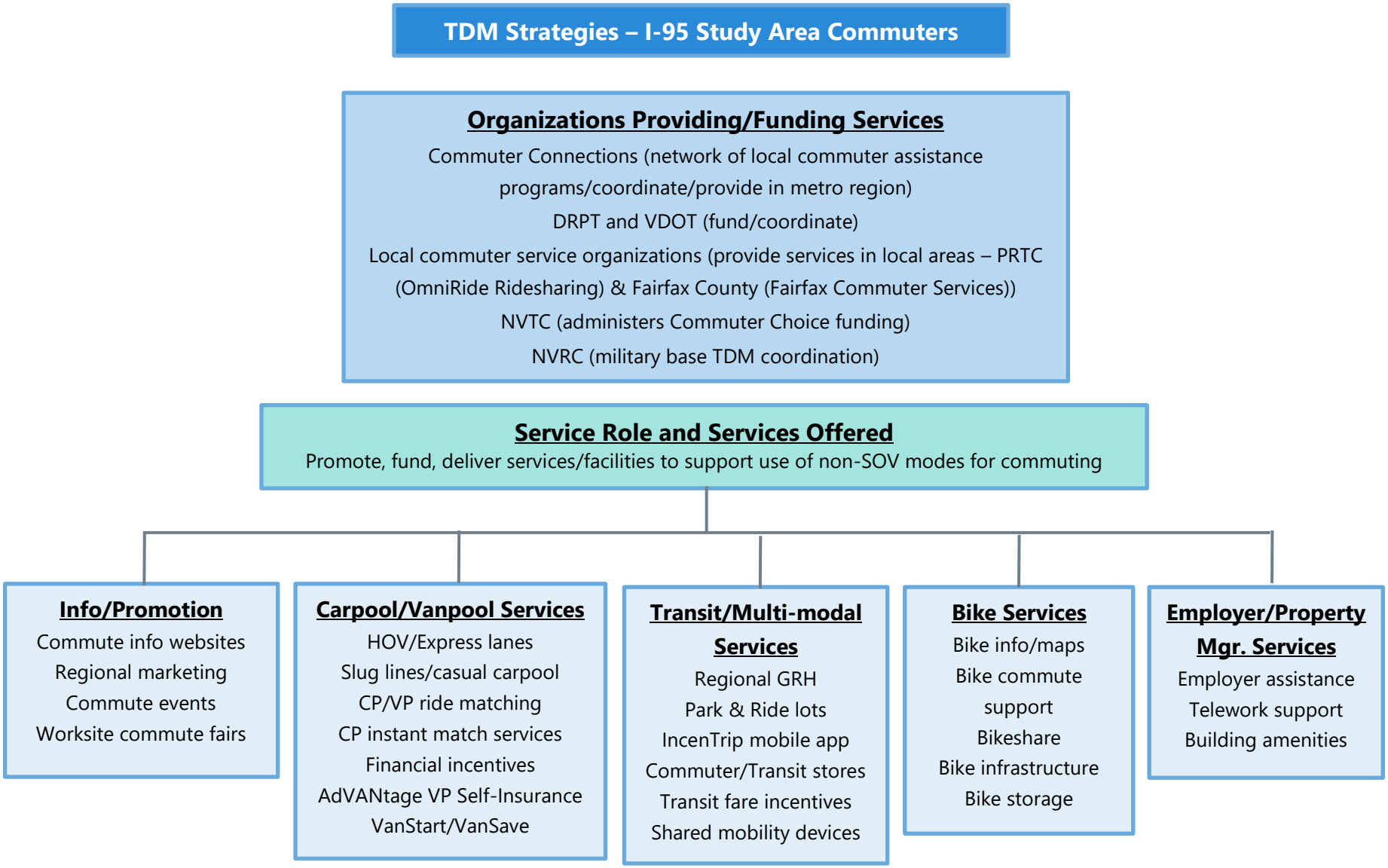
In 2019, 20 percent of all commuters who carpooled/vanpooled to work in the Washington metropolitan region used I-95 in Virginia for a portion of their commute. *(Source: 2019 MWCOG State of Commute survey.)*

- Transit/Multi-modal Support Services – Some regional and local TDM services support use of transit and/or multiple non-SOV modes. Prominent services in this category include regional Guaranteed Ride Home, park-and-ride lots, transit/commuter stores and other services that sell or distribute transit fare media, , promoting and managing shared mobility device services, and programs offering transit fare discounts.

- Bicycle Services – Services of this type currently available in the region include bike events, bike commute information and maps, bikeshare programs, such as Capital Bikeshare, and active transportation plans and bike advocacy and infrastructure programs, such as bicycle paths and trails, implemented by state, county, and city governments.

- Employer/Property Manager Assistance (Including Telework): Commuter service organizations maximize their access to employees by reaching out to employers in their service area. Services typically include outreach to encourage employers to implement transit and vanpool incentives or employee benefit, commute information, parking management programs, and other commute assistance for their employees. Telework has become an increasingly important component of employer assistance and local commuter assistance organizations and DRPT assist employers with making telework programs successful for employers and employees. Employer assistance is conducted through DRPT's Telework!VA program using telework experts to offer sample telework program guidance, telework case studies, telework manager training, and the Telework!VA website containing online resources.

FIGURE 2-27 TDM ORGANIZATIONS AND SERVICES IN THE STUDY CORRIDOR



2.3 Existing Travel Patterns

This section considers where and how people travel to, from, and through the Study Corridor. Understanding travel patterns will help identify needs that any potential enhancements to the public transportation system can address.

Total Travel

On an average day, more than 1.24 million trips start in the Study Corridor;[4] these trips are destined for areas throughout the National Capital Region (NCR) and represent travel to work, for shopping, and other purposes. By 2045, this number is expected to reach more than 1.52 million, an increase of 22 percent. Approximately 20 percent of daily travel in the Study Corridor is related to commute travel — the remaining trips are for other purposes, such as shopping or other errands, that tend to be much shorter in length and are less likely to occur during the peak hours. For the purposes of reviewing travel patterns to, from, and through the Study Corridor, seven zones have been defined as shown in Figure 2-2Error! Reference source not found.

Of the trips starting in the Study Corridor, more than 60 percent of these daily trips stay within the corridor. This includes 38 percent of trips that start and end within the same zone. While this includes a wide range of trip types and purposes, this data highlights the large portion of travel in the Study Corridor that is local in nature.

Commute trips are generally more likely to be long-distance trips, and analysis of the most recent Census Transportation Planning Products Program (CTPP) data shows that only 36 percent of commute trips generated in the Study Corridor stay within the corridor. There is some variation in this percentage as shown in Error! Reference source not found., and zones on the northern end of the Study Corridor have a lower percentage of trips internal to the corridor. In these northern zones, more commuters travel out of the Study Corridor, particularly to points to the north including DC, Arlington, and Alexandria.

[4] Based on the MWCOG/TPB v 2.3.78 2019 Existing Conditions model run.

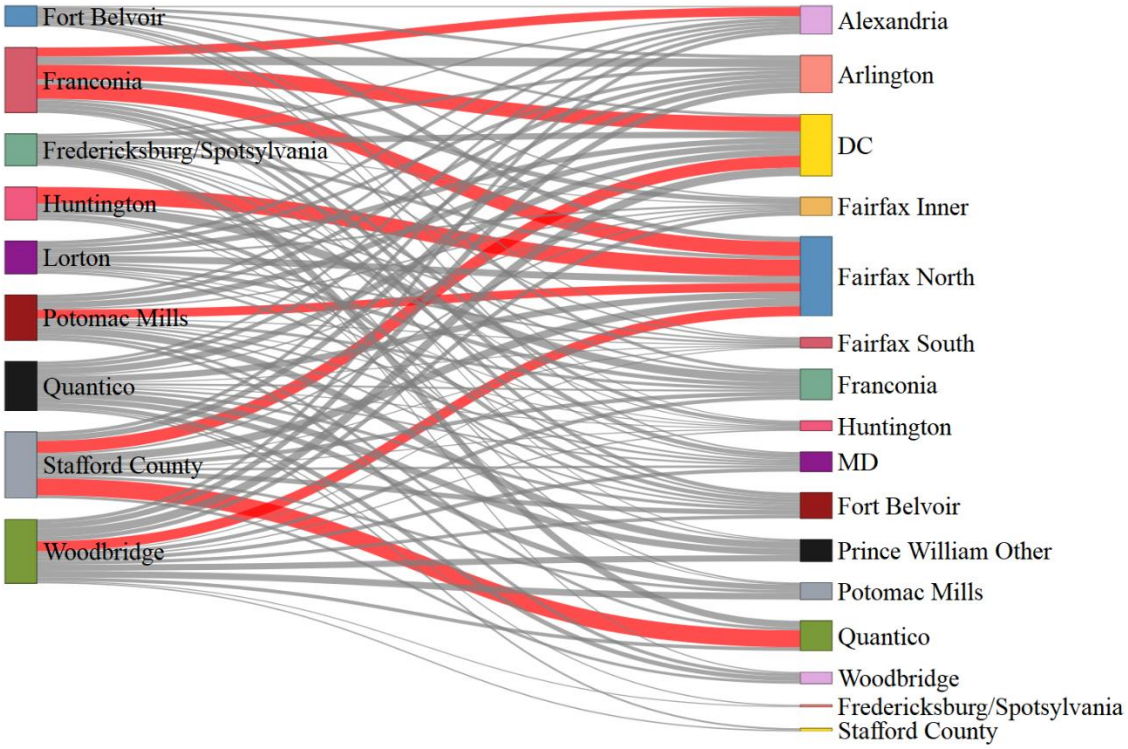
TABLE 2-7 TRIPS INTERNAL TO THE STUDY CORRIDOR

Origin Zones	Percent of Commute Trips Internal to Study Corridor	Percent of Total Daily Trips Internal to Study Corridor
Franconia	29%	50%
Huntington	30%	59%
Fort Belvoir	43%	68%
Lorton	33%	50%
Woodbridge	40%	68%
Potomac Mills	38%	67%
Quantico	49%	67%
Study Corridor Total	**36%**	**61%**

Source: 2012-2016 CTPP, MWCOG Model

Figure 2-28 highlights the major commute flows from the more than 280,000 daily commute trips from the Study Corridor. The top commute destinations include job centers within northern Fairfax County at Tysons and Reston, DC, Fort Belvoir and Marine Corps Base Quantico, Arlington, and Alexandria. 38 percent of commute trips that start in the Study Corridor (or further south) are heading to points north including Fairfax County DC, Arlington, and Alexandria. 23 percent of commute trips that start in the Study Corridor (or further south) may be using the corridor to access suburban job centers located along the Capital Beltway corridor.

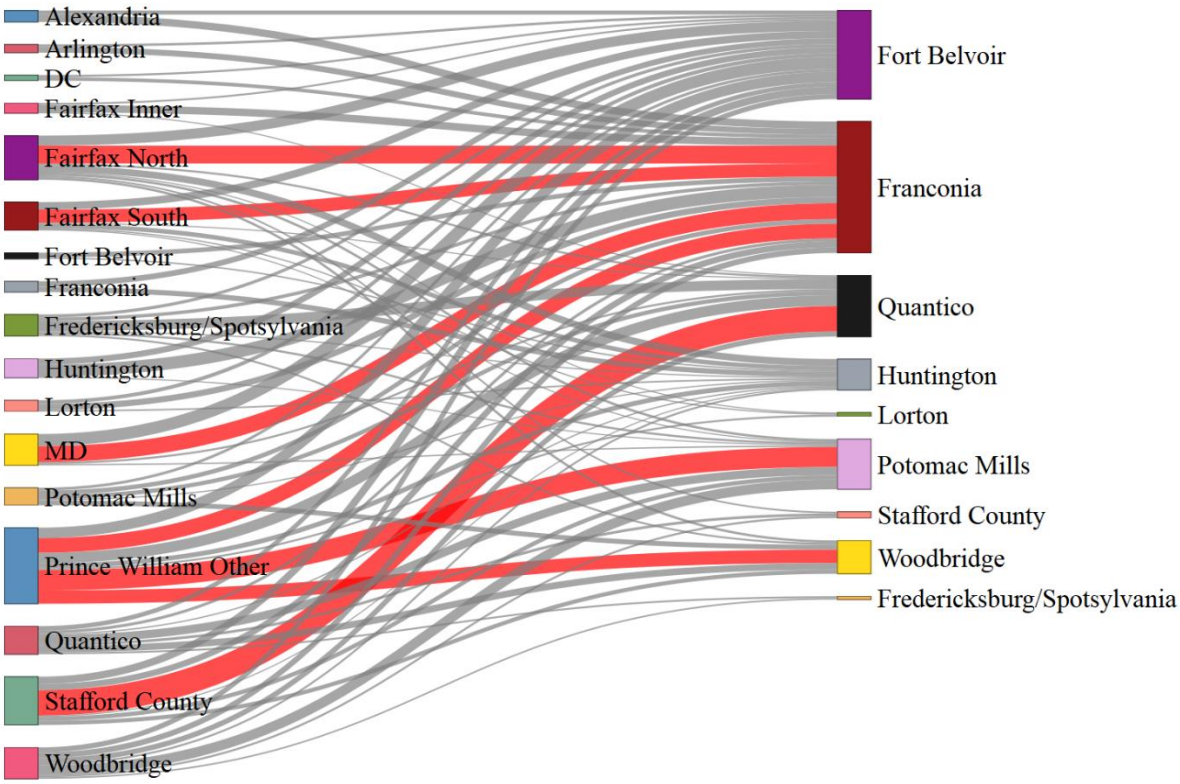
FIGURE 2-28 DAILY COMMUTING TRIP FLOWS FROM THE STUDY CORRIDOR



Source: 2012-2016 CTPP; Red lines represent flows with more than 3,000 daily commute trips.

A similar analysis is shown in **Figure 2-29** for commute trips traveling to the Study Corridor. More than 137,000 commute trips come to the corridor on an average day; 46 percent of these trips are coming from other locations within the Study Corridor. Major origin locations for employees in the Study Corridor include other locations in Fairfax County, Prince William County, Stafford County, Maryland, and Woodbridge.

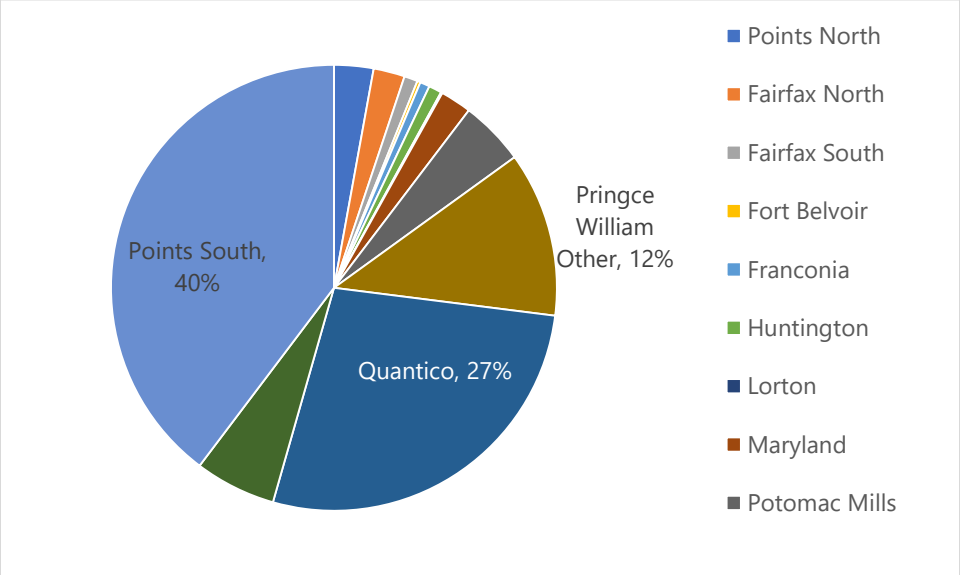
FIGURE 2-29 DAILY COMMUTING TRIP FLOWS TO THE STUDY CORRIDOR



Source: 2012-2016 CTPP; Red Lines represent flows with more than 3,000 daily commute trips.

Two major commute destinations in the Study Corridor are the military installations at Quantico and around Fort Belvoir. Commute trips to Quantico (defined as the whole zone, not just the installation) are primarily coming from points to the south, including Spotsylvania County, Stafford County, and the City of Fredericksburg. In addition to local commuters coming from within the zone, these trips from the south account for two-thirds of all commute trips to Quantico, as shown in **Figure 2-30**. An additional 12 percent of commute trips are coming from other non-Study Corridor locations in Prince William County which would also be unlikely to use the Study Corridor. Relatively small numbers of daily commute trips are coming from points north of Quantico along I-95 and/or U.S. 1. It may therefore be difficult for any alternative considered as part of this study to serve the market to Quantico well.

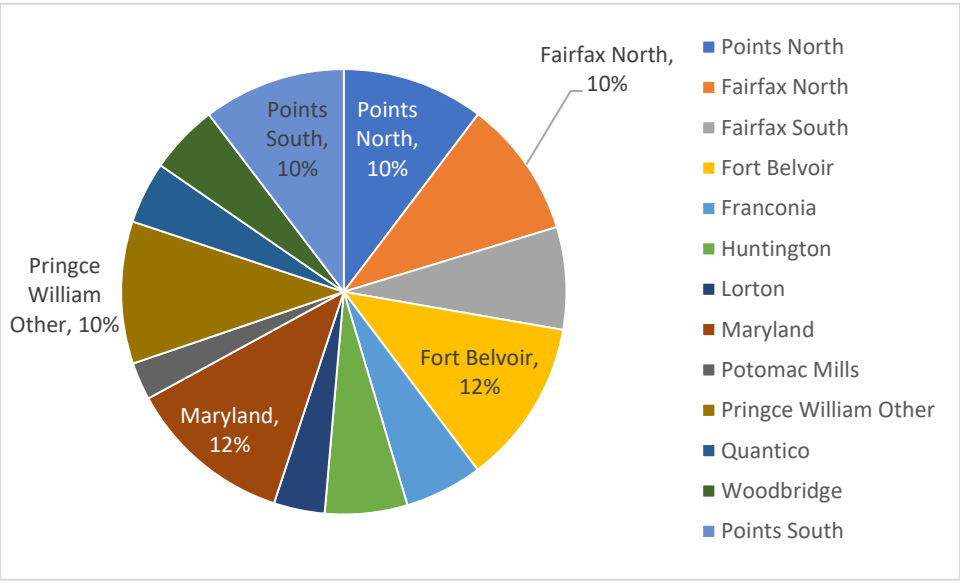
FIGURE 2-30 COMMUTE TRIPS TO QUANTICO



Source: 2012-16 CTPP

A similar analysis for the Fort Belvoir zone is shown in **Figure 2-31.** Unlike at Quantico, commuters to Fort Belvoir come from a wide range of origins along the corridor and the region, more of which are likely to use the Study Corridor to complete their trips.

FIGURE 2-31 COMMUTE TRIPS TO FORT BELVOIR



Source: 2012-16 CTPP

Transit Trips

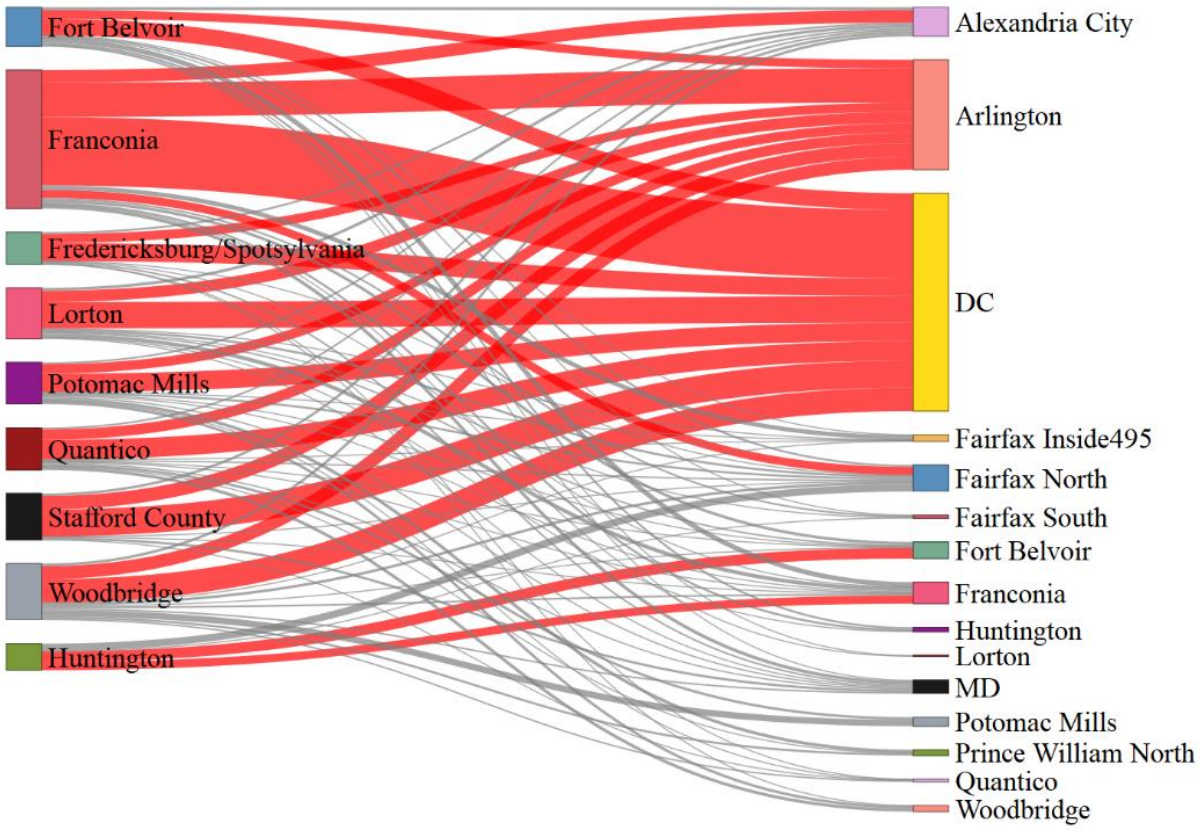
Transit accounts for a relatively small amount of total daily travel in the Study Corridor, with a total mode share of less than four percent of all daily trips taken by transit. Mode share is higher in the zones in the Northern portion of the Study Corridor, as shown in **Table 2-8** — the two northernmost zones have direct access to the Metrorail system.

TABLE 2-8 TRANSIT MODE SHARE IN THE STUDY CORRIDOR

Origin Zone	Total Daily Trips	Commute Trips
Franconia	4.9%	21.4%
Huntington	6.5%	24.0%
Fort Belvoir	2.9%	15.6%
Lorton	4.3%	17.0%
Woodbridge	2.5%	9.7%
Potomac Mills	1.9%	10.4%
Quantico	1.6%	7.2%
Study Corridor Total	**3.9%**	**16.5%**

Figure 2-32 highlights the major transit travel flows through the Study Corridor. By far, the largest transit market for trips beginning in the Study Corridor or points further south is the region's core including DC, Arlington, and Alexandria, which together account for more than 77 percent of the Study Corridor's daily transit travel. Despite the fact that the majority of daily travel stays within the corridor, these intra-corridor trips only account for 15 percent of transit trips.

FIGURE 2-32 TRANSIT TRIPS ORIGINATING IN THE STUDY CORRIDOR (ALL PURPOSES)



Note: Travel flows greater than 500 trips per day are shown in red.

3. FUTURE BASELINE CONDITIONS & NEEDS

In order to evaluate the long-term feasibility of transit enhancements in the Study Corridor, the baseline conditions for the forecast year 2045 were analyzed. The future baseline was used in the evaluation of potential transit alternatives to quantify their potential benefits relative to how the future conditions are expected to be without further investment beyond what is currently planned in the corridor. Defining the future baseline conditions required identification of two key elements:

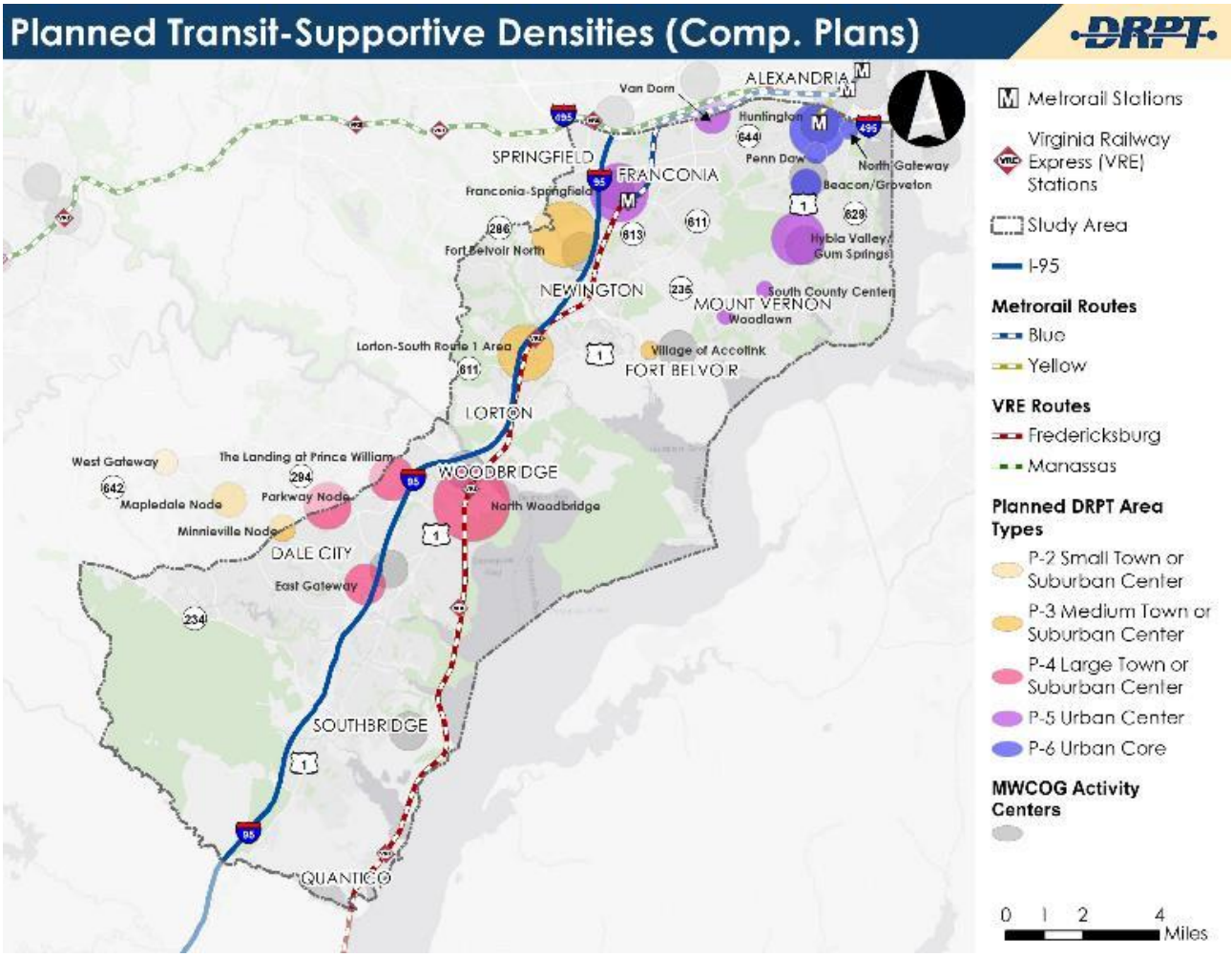
- Planned land use in the Study Corridor; and
- Planned and programmed improvements to the transportation systems that are expected to be in place.

This section highlights the land use and transportation assumptions that were included in the future 2045 baseline scenario. Some initial analysis of congestion levels and transit ridership is also included as it related to potential future needs in the Study Corridor. Both the land use and transportation network assumptions were developed based on existing plans for the region and local jurisdictions.

3.1 Future Land Use

The land use assumptions are based on the MWCOG Round 9.1a Cooperative Land Use forecasts. These baseline conditions incorporate the land use planning in place in the jurisdictions in the Study Corridor. Both Fairfax and Prince William Counties are planned to see concentrated growth in a number of activity centers, as shown in **Figure 3-1.**

FIGURE 3-1 PLANNED TRANSIT-SUPPORTIVE DENSITIES FROM COUNTY COMPREHENSIVE PLANS



Population

By 2045, the Study Corridor is expected to add 108,000 new residents resulting in a total population of approximately 544,800 residents. This represents an increase of more than 24 percent over 25 years as shown in **Table 3-1.** In addition, the jurisdictions to the south of the Study Corridor are expected to grow by more than 58 percent in the same time period. These new residents will place additional demand on a transportation system that is already strained and subject to significant congestion. The growth will be distributed unevenly around the Study Corridor, as shown in Table 3-1.

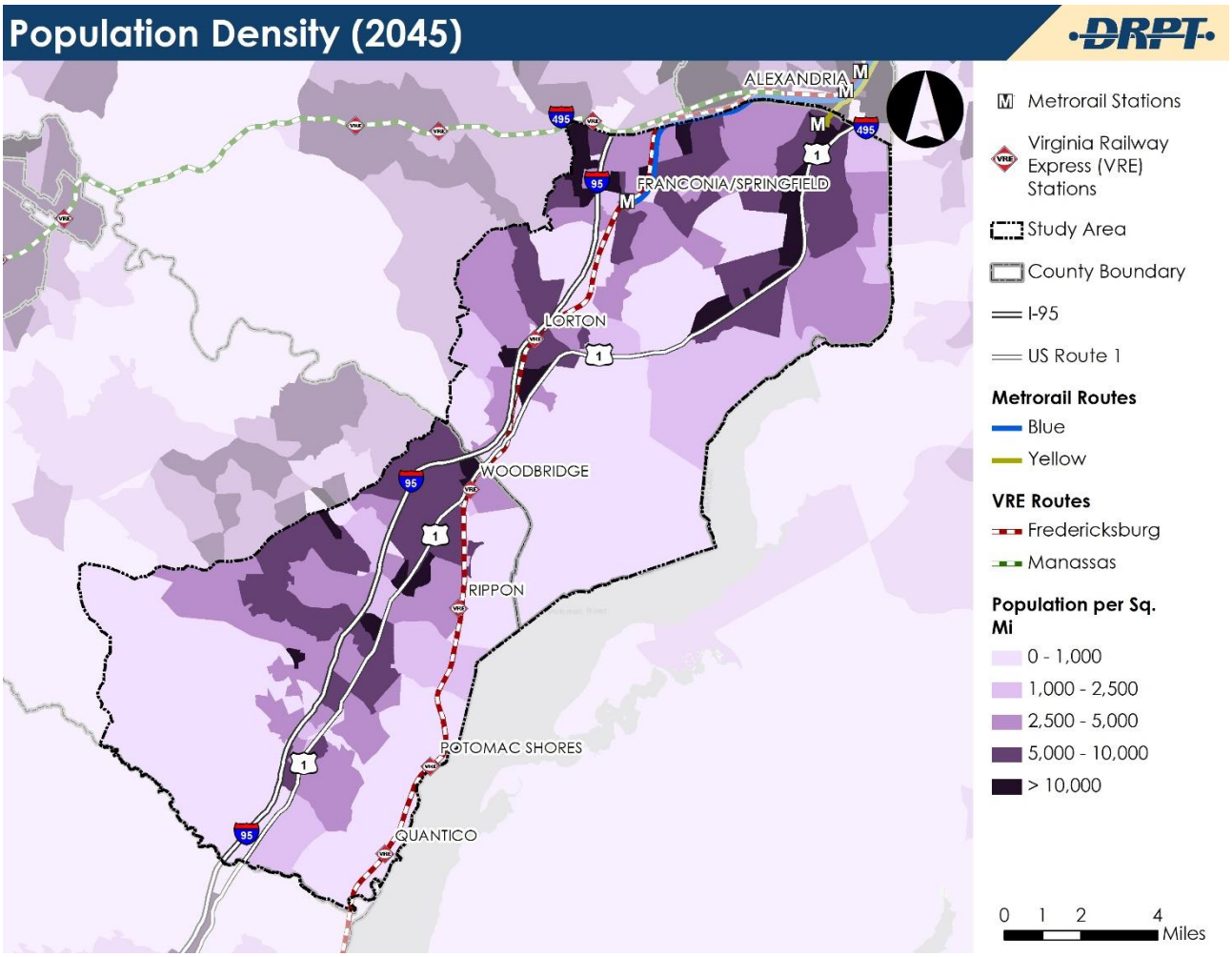
TABLE 3-1 CHANGE IN POPULATION BY ZONE 2020-2045

Zones	Existing	2025	2045	Percent Change Existing to 2045
Franconia	63,300	64,400	74,700	17.9%
Huntington	128,400	139,100	178,900	39.4%
Fort Belvoir	29,200	29,400	33,500	14.7%
Lorton	33,700	34,800	37,300	10.8%
Woodbridge	63,600	68,300	81,500	28.3%
Potomac Mills	47,900	50,800	59,600	24.4%
Quantico	71,200	73,900	79,300	11.3%
Study Area Total	**437,300**	**460,800**	**544,800**	**24.6%**

Source: MWCOG, Round 9.1a Cooperative Land Use Forecasts

Figure 3-2 depicts how this population is forecast to be distributed across the Study Corridor in 2045. Similar to the existing population density, there are areas of higher densities in both Fairfax and Prince William County.

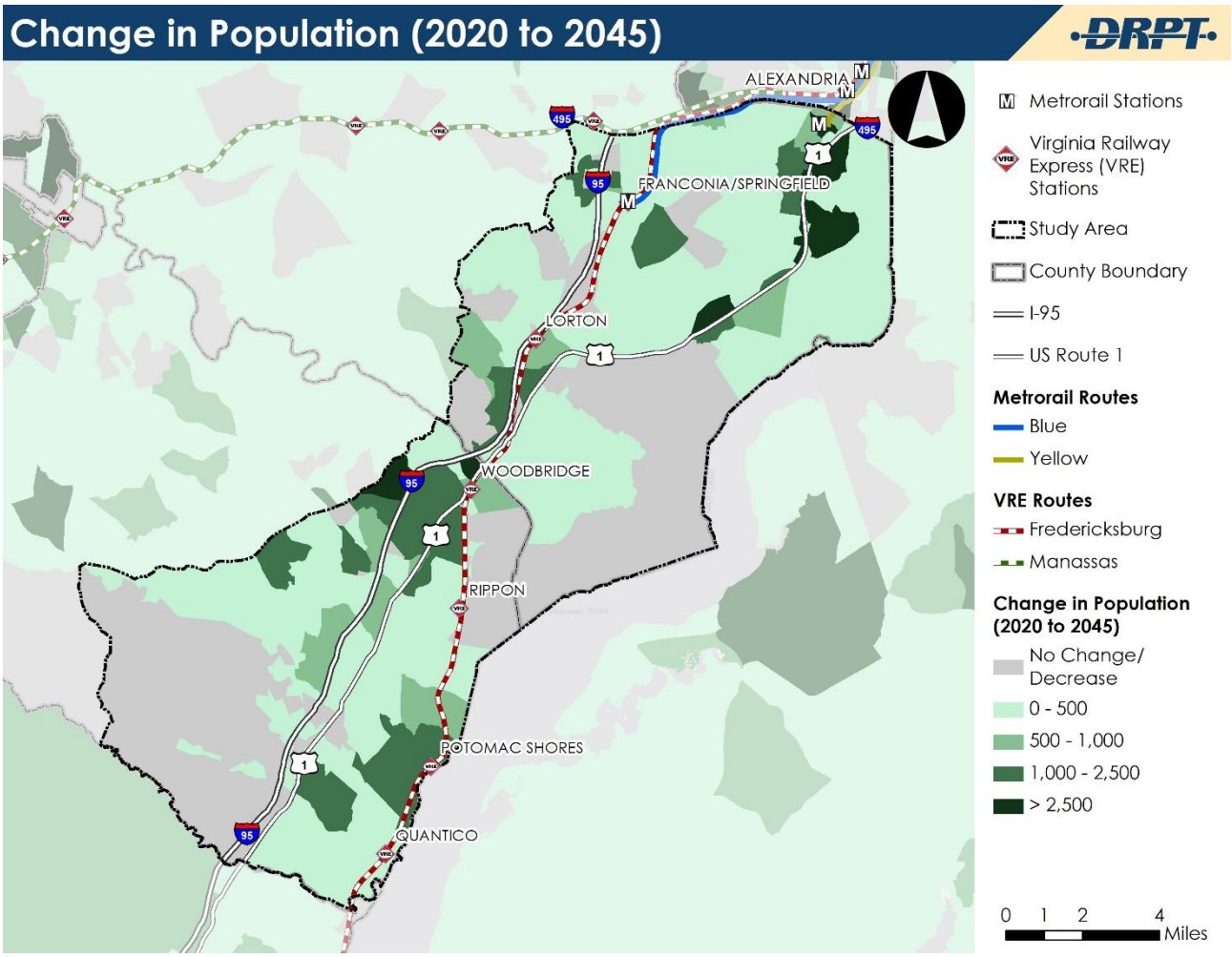
FIGURE 3-2 2045 POPULATION DENSITY



Source: Source: MWCOG Round 9.1a Cooperative Land Use Forecasts

Figure 3-3 highlights the areas of population growth between 2020 and 2045. Growth is expected to be concentrated around the two existing Metrorail stations in the Study Corridor (Huntington and Franconia-Springfield), along U.S. 1 in Fairfax County, and around Potomac Mills in Prince William County.

FIGURE 3-3 CHANGE IN POPULATION DENSITY 2020-2045



Source: MWCOG Round 9.1a Cooperative Land Use Forecasts

Employment

By 2045, the Study Corridor is expected to add more than 68,000 jobs for a total of over 269,000. This increase (more than 34 percent) is higher than the expected growth in population, indicating that there will be a larger portion of commute trips coming into (or staying within) the Study Corridor, instead of the traditional patterns of commuting into the region's core. As highlighted in **Table 3-2**, the biggest growth in employment is expected in the Franconia and Huntington zones, both of have an existing Metrorail stations. Significant growth is also expected south of the Study Corridor, in Fredericksburg, Spotsylvania County, and Stafford County.

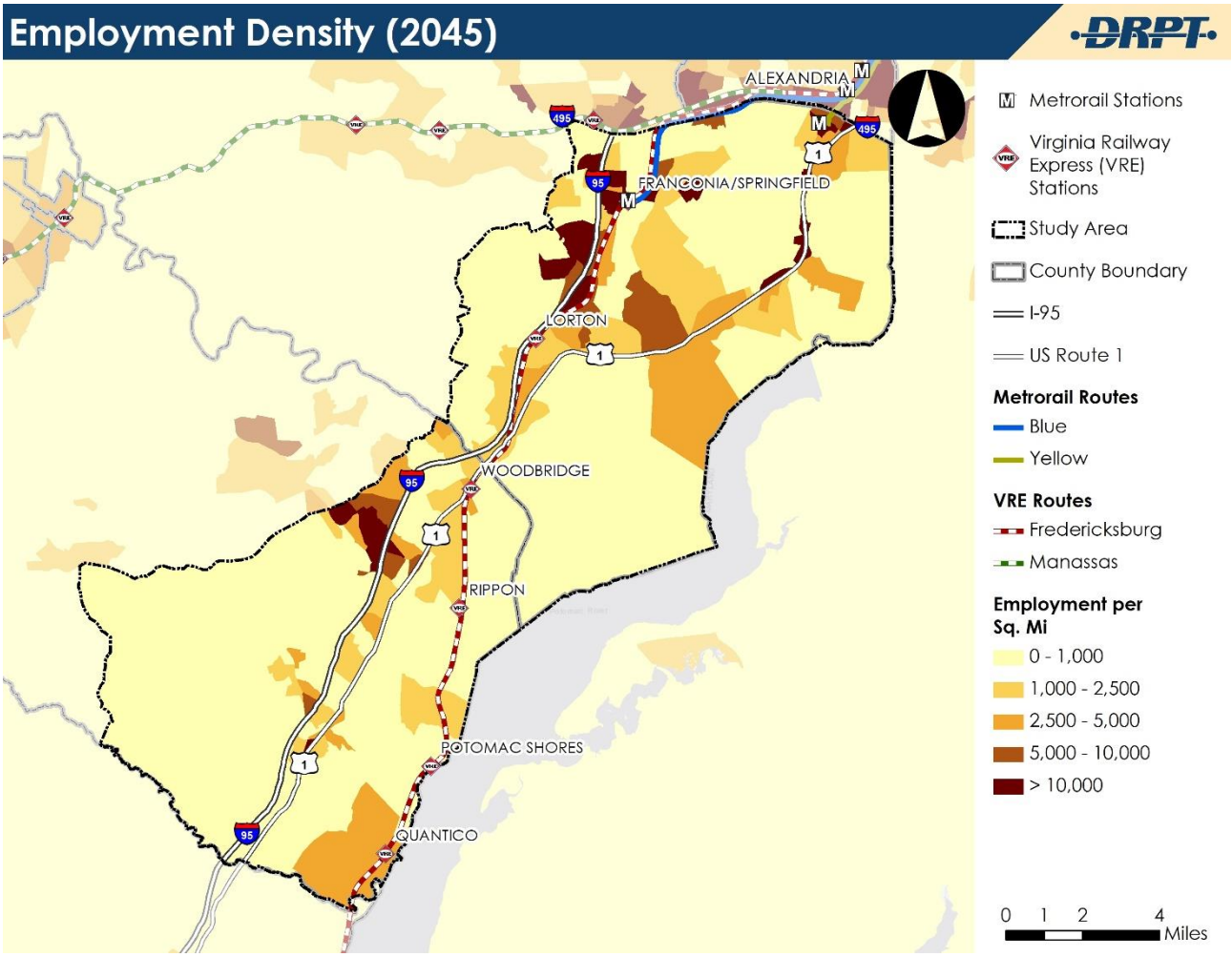
TABLE 3-2 CHANGE IN EMPLOYMENT BY ZONE, 2020-2045

Zones	Existing	2025	2045	Percent Change Existing to 2045
Franconia	58,900	71,100	85,900	45.9%
Huntington	26,200	27,900	44,800	70.7%
Fort Belvoir	44,900	47,300	51,200	14.2%
Lorton	4,300	4,700	5,000	15.2%
Woodbridge	15,200	15,500	16,600	9.5%
Potomac Mills	22,500	23,300	26,900	20.0%
Quantico	28,500	30,700	38,700	36.0%
STUDY CORRIDOR TOTAL	200,500	220,400	269,300	34.3%

Source: MWCOG Round 9.1a Cooperative Land Use Forecasts

Figure 3-4 shows expected employment density in 2045, which shows similar patterns of density as the existing employment distribution. The highest density employment centers will remain in Franconia and Lorton along I-95, around the Springfield-Franconia Metrorail station, and in Potomac Mills, in addition to the two major military installations.

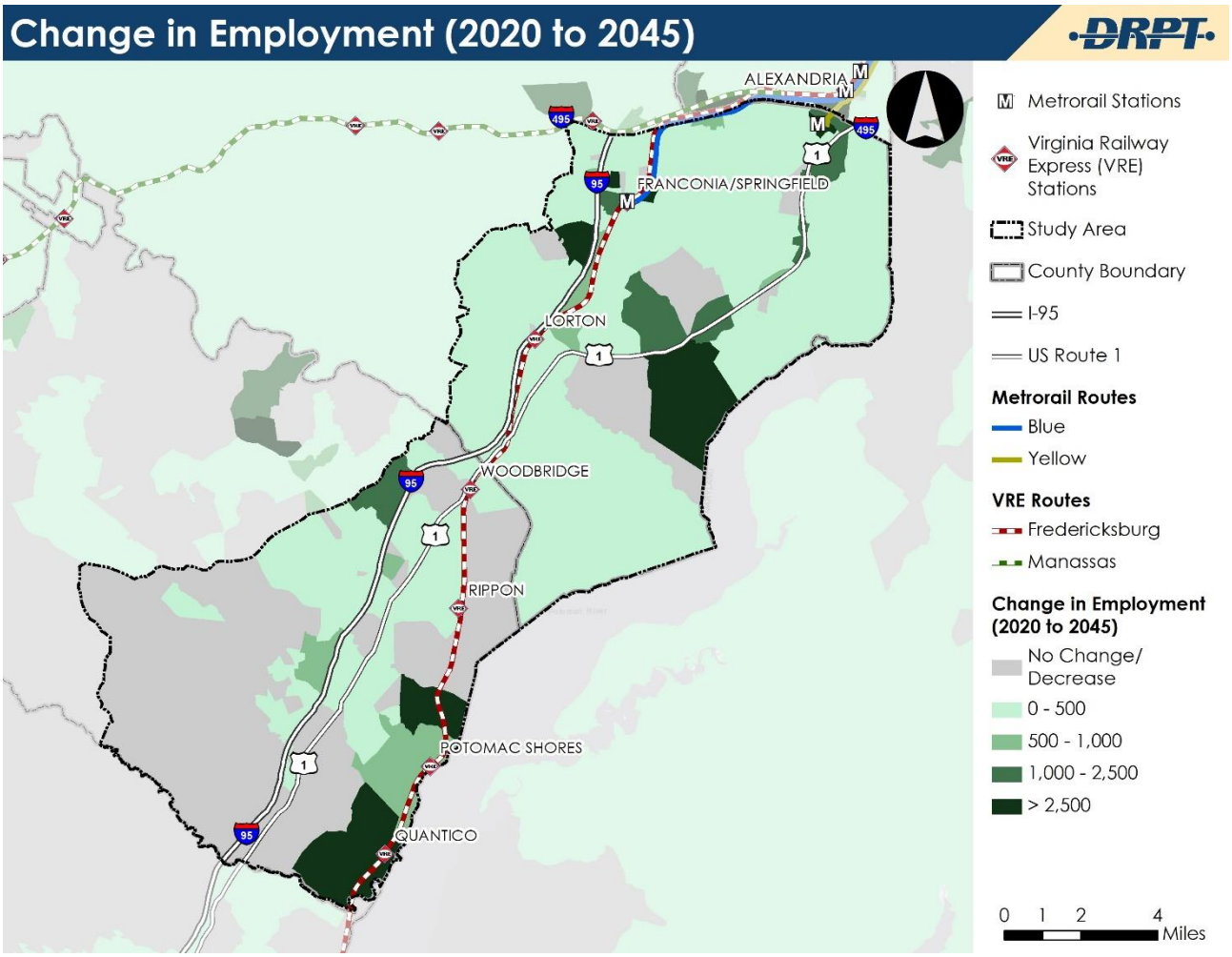
FIGURE 3-4 2045 EMPLOYMENT DENSITY



Source: MWCOG Round 9.1a Cooperative Land Use Forecasts

Figure 3-5 highlights the changes in employment density between 2020 and 2045. Growth is concentrated around the two Metrorail stations in the Study Corridor, along U.S. 1 in Fairfax County, and around Potomac Mills in Prince William County.

FIGURE 3-5 CHANGE IN EMPLOYMENT DENSITY 2020-2045



Source: MWCOG Round 9.1a Cooperative Land Use Forecasts

3.2 Baseline Transportation System

Transit Network

The baseline transit network assumes that all current transit services continue to operate in the future, unless specifically noted otherwise. For the purposes of this study, the baseline transit networks further assume that all of the changes in transit service made due to the pandemic will be temporary, and that service will return as demand recovers. The baseline transit networks also include any improvements that can reasonably be expected to be in place in the future. For this study, this includes any transit improvements that are planned and funded, whether or not they are included in MWCOG's Constrained Long-Range Transportation Plan (CLRP) for the region.

Figure 3-6 highlights the transit projects from the CLRP that are included in the baseline, which includes the replacement of the REX bus service with the Richmond Highway BRT, a new VRE station at Potomac Shores, and VRE service improvements along the Study Corridor.

FIGURE 3-6 BASELINE TRANSIT PROJECTS IN THE CLRP

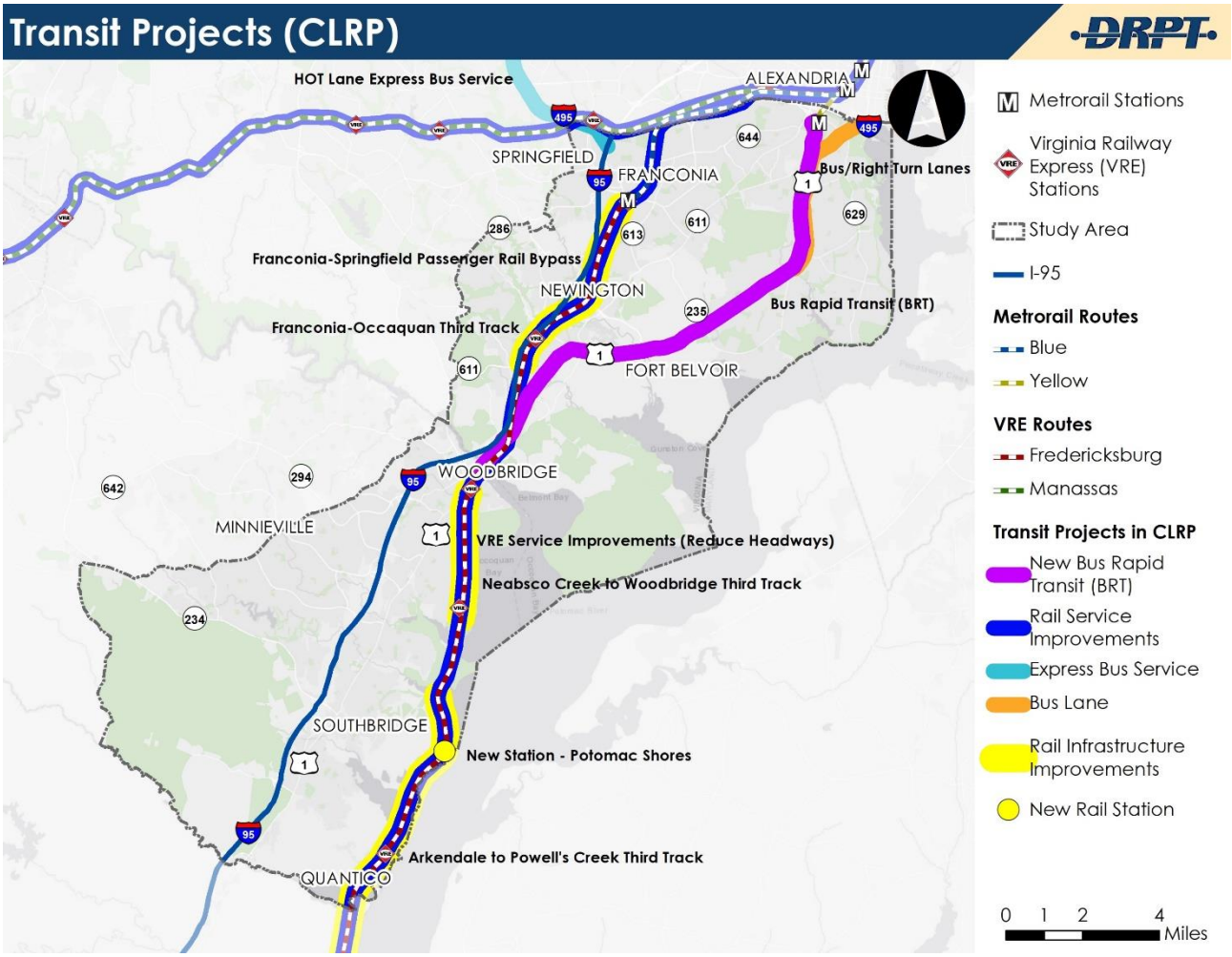
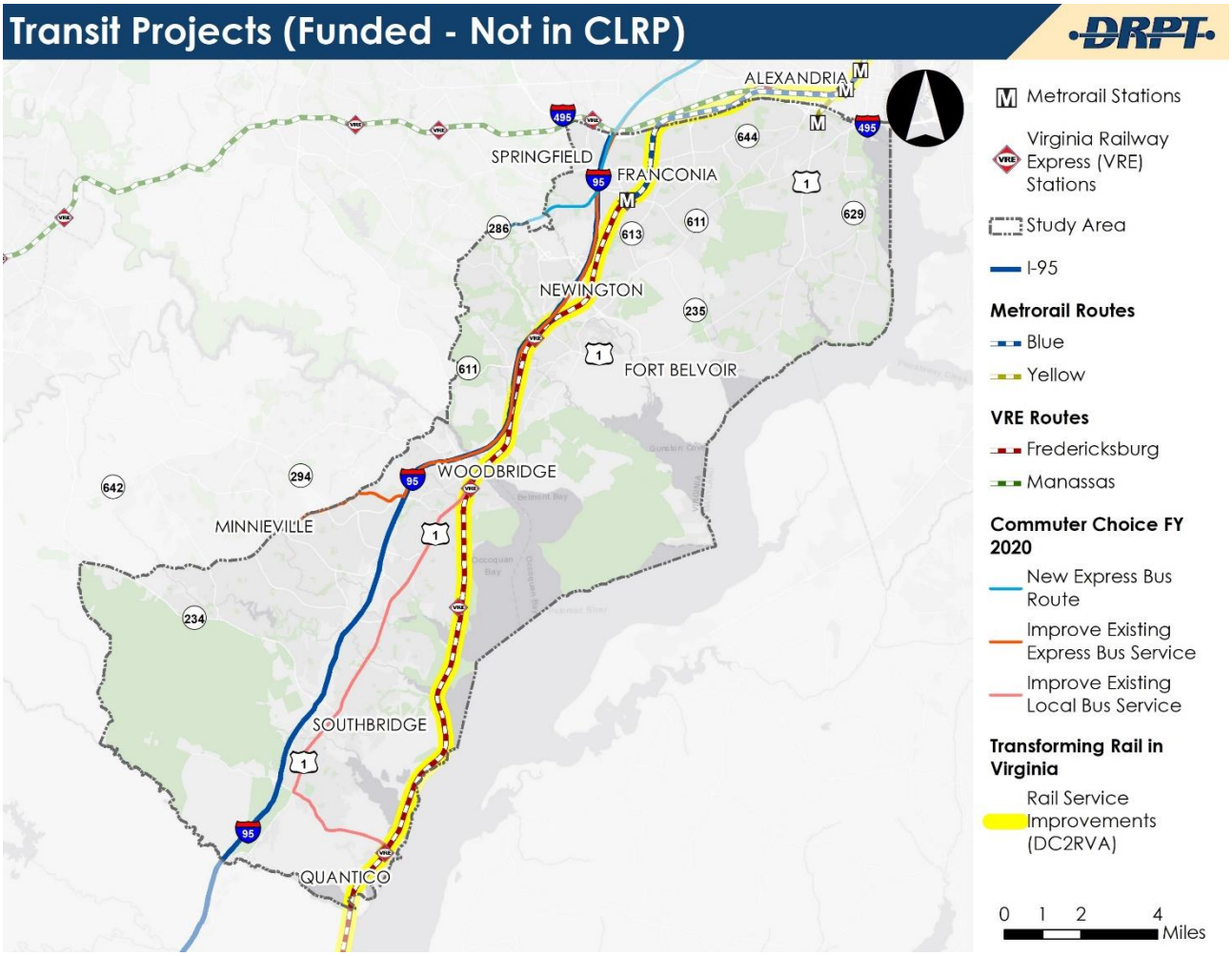


Figure 3-7 highlights additional planned and funded projects included in the baseline network, even though they are not currently included in the CLRP. These include improvements to VRE service based on the Transforming Rail in Virginia plans and some improvements to local and express bus services. More details on the transit services included in the baseline transit network can be found in the following sections.

FIGURE 3-7 BASELINE TRANSIT PROJECTS – NOT IN CLRP



Bus Services

Table 3-3 presents a list of the bus services included in the future baseline.

TABLE 3-3 FUTURE BASELINE STUDY CORRIDOR BUS SERVICE

Service Provider	Local Bus Service	Commuter Bus Service
Fairfax Connector	101, 109, 151, 152, 161, 162, 171, 231, 232, 305, 306, 308, 310, 321,	159, 301, 335, 393, 394, 395, 396, 494, 172 (Huntington Metro to Lorton VRE)

Service Provider	Local Bus Service	Commuter Bus Service
	322, 334, 340, 341, 350, 351, 371, 372, 373, 401, 402	
OmniRide	Prince William Express, Dale City Local, Dumfries Local, Route 1 Local, Woodbridge-Lake Ridge A, Woodbridge Lake Ridge B	D-100, D-200, D-300, D-400, L-100, L-200, L-300, MC-100, MC-200, Route 1 Express
Metrobus	Route 1 BRT to replace REX, 10A, S80, S91	11Y, 18G, 18H, 18J, 18P
Martz	-	DC1, DC2, DC3, DC4, DC5

Only a few bus service improvements are included in the baseline network:

- Richmond Highway BRT — to replace REX service along U.S. 1 in Fairfax County
- Fairfax Connector — U.S. 1 Commuter Route 172 between Huntington Metro and Lorton VRE
- PRTC — increases in frequency on some routes

Other bus service improvements are planned by each of the operators but are not included in the baseline since funding is not secure.

VRE

The future baseline network for VRE includes a number of increases in service levels consistent with Transforming Rail in Virginia as well as the opening of the new VRE station at Potomac Shores. Frequencies on VRE would increase to every 20 minutes in the peak hours/peak direction (increased from 30 minutes in 2019), 60 minutes in the peak hours/reverse direction, and 120 minutes in the off-peak.

Metrorail

The future baseline for Metrorail uses the CLRP assumptions of 8-minute headways in the peak and 12 minutes in the off peak for both the Blue and Yellow lines as shown in **Table 3-4.**

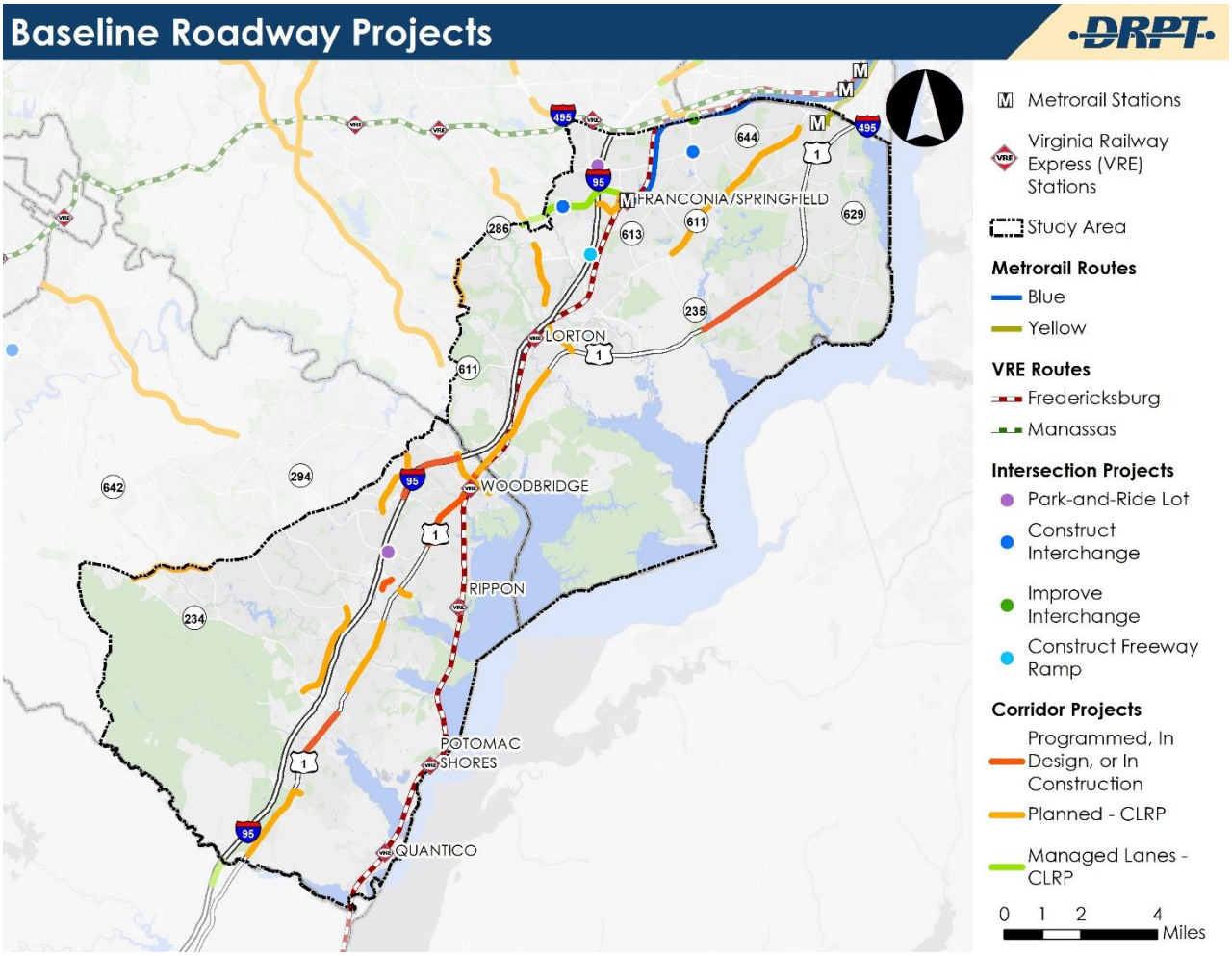
TABLE 3-4 METRORAIL BASELINE ASSUMPTIONS

Line	Route	Peak Headway (min)	Off-Peak Headway (min)
Blue	Franconia-Springfield to Largo	8	12
Yellow	Huntington to Greenbelt	8	12

Baseline Roadway Network

The baseline roadway network includes those roadway and park-and-ride improvements that are included in the most recent MWCOG CLRP and a few projects that are programmed for design and construction through other sources. These projects are summarized in **Figure 3-8** and include projects to improve interchanges with the Express Lanes along I-95, widening of U.S. 1 to six lanes, and widening of other roadways across or near the Study Corridor.

FIGURE 3-8 BASELINE ROADWAY AND PARK-AND-RIDE PROJECTS



Future Baseline Transportation Demand Management (TDM) Assumptions

Commute mode choice, and thus the TDM services designed to influence mode choice, is driven substantially by job/home location, job type/job requirements, travel economics, travel time, and mode opportunity (e.g., availability of mode options). These factors work together to influence individual travel mode decisions.

Commuters who travel to work along the I-95 study area have a variety of travel mode choices; TDM services focus on managing the demand for peak period travel by shifting travel from SOV travel to other modes, by shifting trips from peak periods to off-peak periods, or by eliminating certain trips altogether.

The portfolio of TDM services that will be in place 2045 will be designed to respond to the travel needs of commuters at that time. While it is difficult to definitively define those conditions, commute mode choice in future years and the TDM strategies developed to support choice will be driven by the same fundamental factors that have always been important in mode choice decisions: job/home location and worker demographics, considerations of travel economics and travel time, and availability and convenience of mode options. Information about travel options will continue to be essential to travel mode decisions. If the public does not know what travel options exist and how to use them, they are not likely to use transit, vanpool or carpool. New trends, technology, and mode developments that likely will influence mode choice substantially in the future will be greater use of telework and other work location and work hours arrangement, wider access to flexible and shared travel options, and expanded use of information technology in transportation. These trends and developments will enhance the convenience and competitiveness of non-drive alone options and make it possible for commuters who have multiple modes available to choose the mode that best suits a specific trip at a specific moment.

The baseline TDM strategies assumed for the Study Corridor for the near-term (2020-2025) will continue activities and services in place in 2020, but with a growing emphasis on enhanced local access to public transit and vanpooling, and availability of real-time information regarding mode options. Over the longer-term (2045), TDM strategies will expand further to support employers' telework and alternative work hours programs, encourage development and use of new transit and vanpool, andcarpool options in the corridor, particularly those that make these modes more flexible and accessible and that encourage implementation of new shared-ride and multi-modal services, and develop additional information-based strategies to inform commuters of the availability and benefits of the strategies. Implementation of many of these strategies will involve coordination among commuter service organizations and/or involvement of private vendors to develop market-based transportation options.

Regional Telework Pre-Pandemic

In 2019, 35 percent of regional commuters teleworked at least occasionally. Of those who teleworked, the average frequency was 1.2 days per week.

(Source: 2019 MWCOG SOC survey)

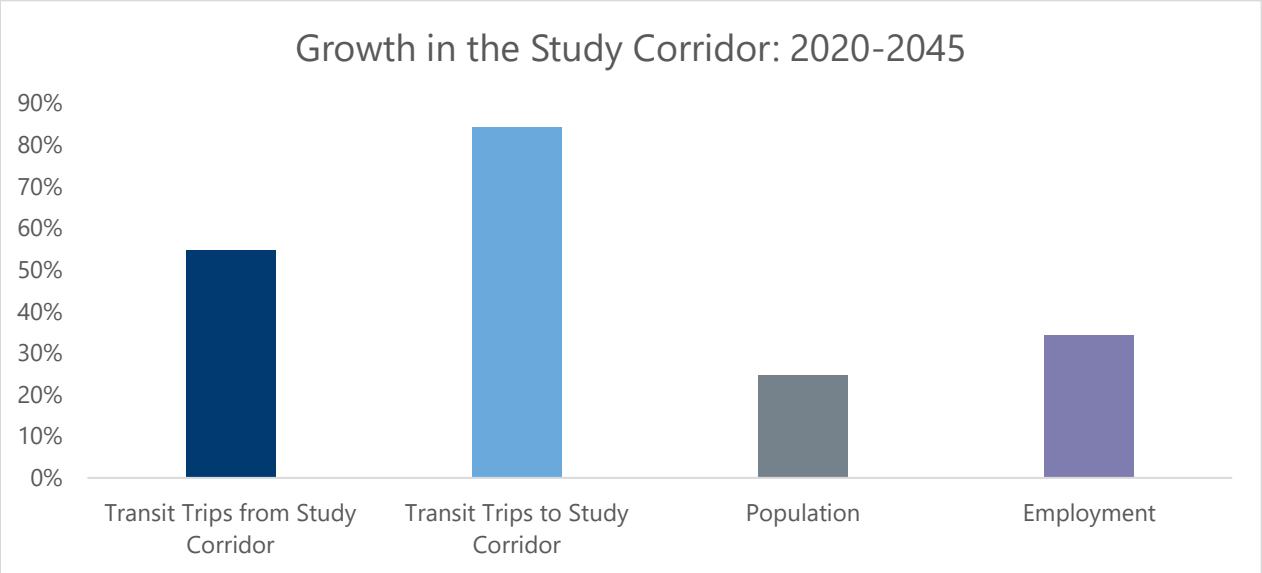
The continued impact of the pandemic on telework remains something of an unknown, although it will certainly be greater in the short-term than in the long-term. The pandemic has illustrated that many jobs can be done efficiently and effectively without a physical work site. Surveys in the region and across the US have indicated that many would like to continue to work remotely, at least part time, once the pandemic subsides. The baseline conditions assume that in the long term, telework rates will recalibrate to levels similar to those prior to the pandemic. But because of the uncertainty associated with telework, separate sensitivity analyses were conducted to identify the

potential impacts of different levels of telework on the long-term feasibility of the transit alternatives to be considered.

3.3 Baseline Growth Forecasts

Fueled by the expected growth in the Study Corridor and the surrounding region and the currently planned improvements to the transit network, transit ridership is expected to grow significantly by 2045. Transit trips from the Study Corridor are expected to grow by 55 percent, while transit trips to the Study Corridor are expected to grow by 85 percent. As shown in **Figure 3-9,** transit trips to and from the Study Corridor are expected to grow more than the population and employment levels, meaning that a higher proportion of people will be using transit than today.

FIGURE 3-9 BASELINE GROWTH: 2020-2045



Note: Transit trips can be counted as both "to the Study Corridor" and "from the Study Corridor"

Transit boardings in the Study Corridor are expected to grow by more than 58 percent across all modes. As shown in **Table 3-5**, the highest growth is expected to occur on VRE, at almost 84 percent growth and an additional 2,100 passengers on an average day. Metrorail boardings are also expected to grow significantly, although boardings at Huntington are expected to grow much more than at Franconia-Springfield. This difference is likely due to the implementation of the Richmond Highway BRT which will feed into Huntington.

Bus ridership is forecast to grow by almost 25 percent; when BRT boardings are included, this growth reflects a 62 percent increase from existing bus ridership in the corridor.

TABLE 3-5 GROWTH IN TRANSIT BOARDINGS BY MODE

	Existing Boardings	2045 Baseline Boardings	Growth to 2045
Bus	29,700	37,000	24.6%
Fairfax Connector	19,400	21,600	11.4%
Metrobus	5,500	7,800	42.4%
OmniRide	4,800	7,600	58.2%
BRT	-	11,000	-
Metrorail	11,900	17,200	44.5%
Franconia-Springfield	5,800	6,800	16.5%
Huntington	6,100	10,400	69.6%
VRE	2,600	4,700	83.7%
Total	**44,200**	**69,900**	**58.3%**

3.4 Needs Assessment

An important step in the feasibility study is the identification of a needs statement that concisely states the primary transportation challenges to be addressed in the Study Corridor. The needs statement serves as the basis for defining the study goals and objectives, identifying evaluation measures, and providing a framework for determining which alternatives should be considered as reasonable transportation solutions for addressing the needs. Based on the analysis of existing and future baseline conditions, as well as stakeholder engagement including an online survey, several types of transit needs were identified for the corridor. Six key needs were identified, as outlined in **Figure 3.10**. Each of these needs is discussed in more detail in this section.

FIGURE 3.10 KEY NEEDS IDENTIFIED IN THE STUDY CORRIDOR

Access to Transit Services: Access is reliant on park-and-ride or long walks to bus, posing a particular challenge for transit-dependent riders

Future Development: Existing transportation services and networks may need enhancements to support planned land uses and economic development

Equity: Specifically need to connect low-income and minority populations to job opportunities

Connections to Activity Centers: Transit connections to key regional activity centers, such as Fort Belvoir and Marine Corps Base Quantico, are limited and infrequent

Transit Service Quality: Transit service is competitive for commute trips to the core. Other trips have little/no service

Traffic Congestion and Travel Times: Traffic congestion is severe and continuing to get worse, resulting in slow and unreliable travel times for drivers and buses in mixed traffic

Access to Transit Services

Figure 3-11 and **Figure 3-12** highlight the peak and off-peak walk sheds for the current transit services, assuming that most people are willing to walk ¼-mile to access transit. Overall, approximately 56 percent of the Study Corridor's residents are able to walk to transit during peak hours. This means that even during peak hours, more than 330,000 residents must walk long-distances (>1/4-mile) to access transit or must drive to

access transit at a park-and-ride facility. This will be especially difficult for the almost 17 percent of households in the Study Corridor with low levels of vehicle ownership (zero or one car).

During the off-peak periods, only 47 percent of residents in the Study Corridor are able to walk to transit. In addition to this drop in accessibility during the off-peak periods, service frequencies are also significantly lower in the off-peak, making transit usage even more difficult and unattractive.

FIGURE 3-11 AREA WITHIN WALKING DISTANCE TO TRANSIT DURING THE PEAK PERIODS

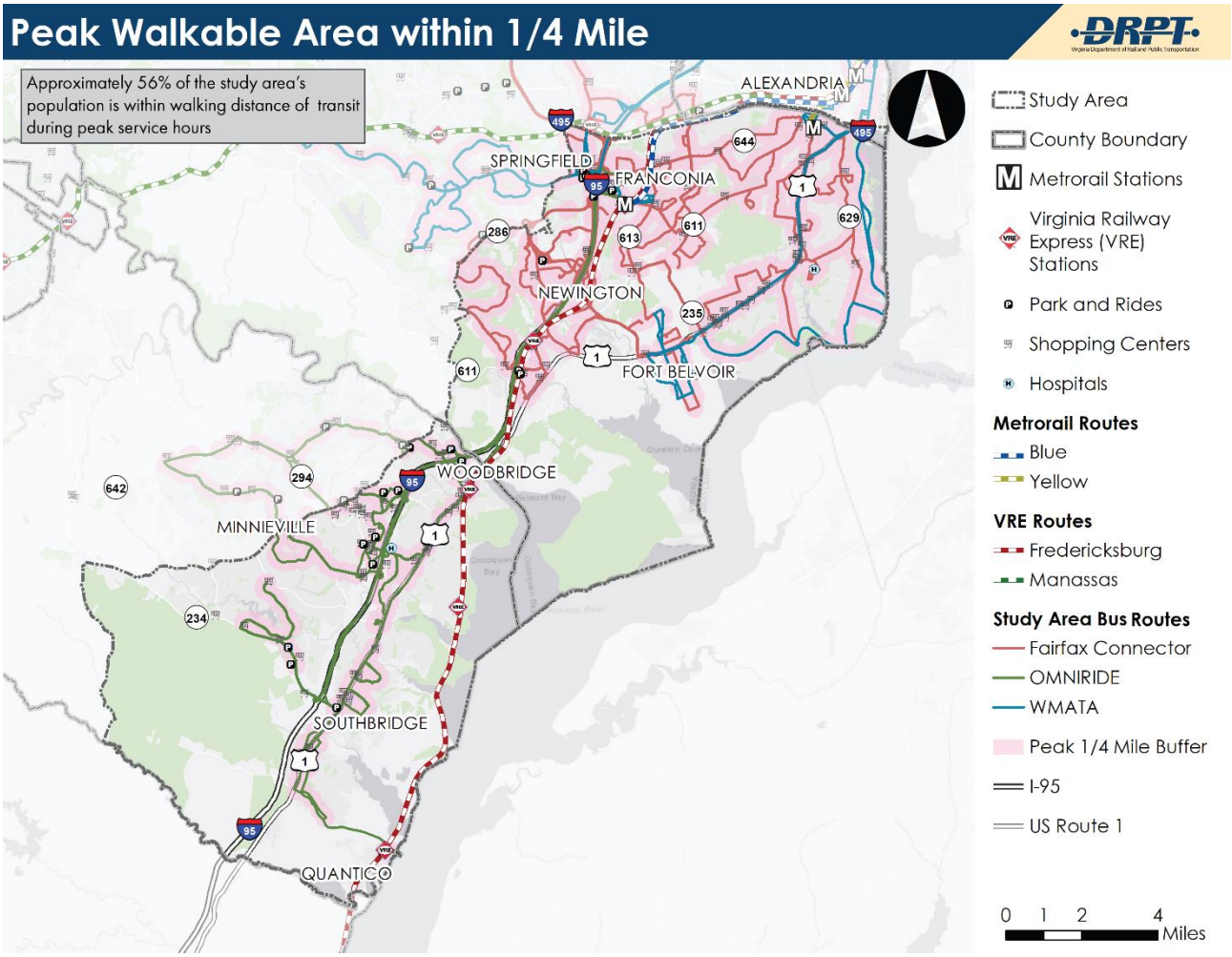
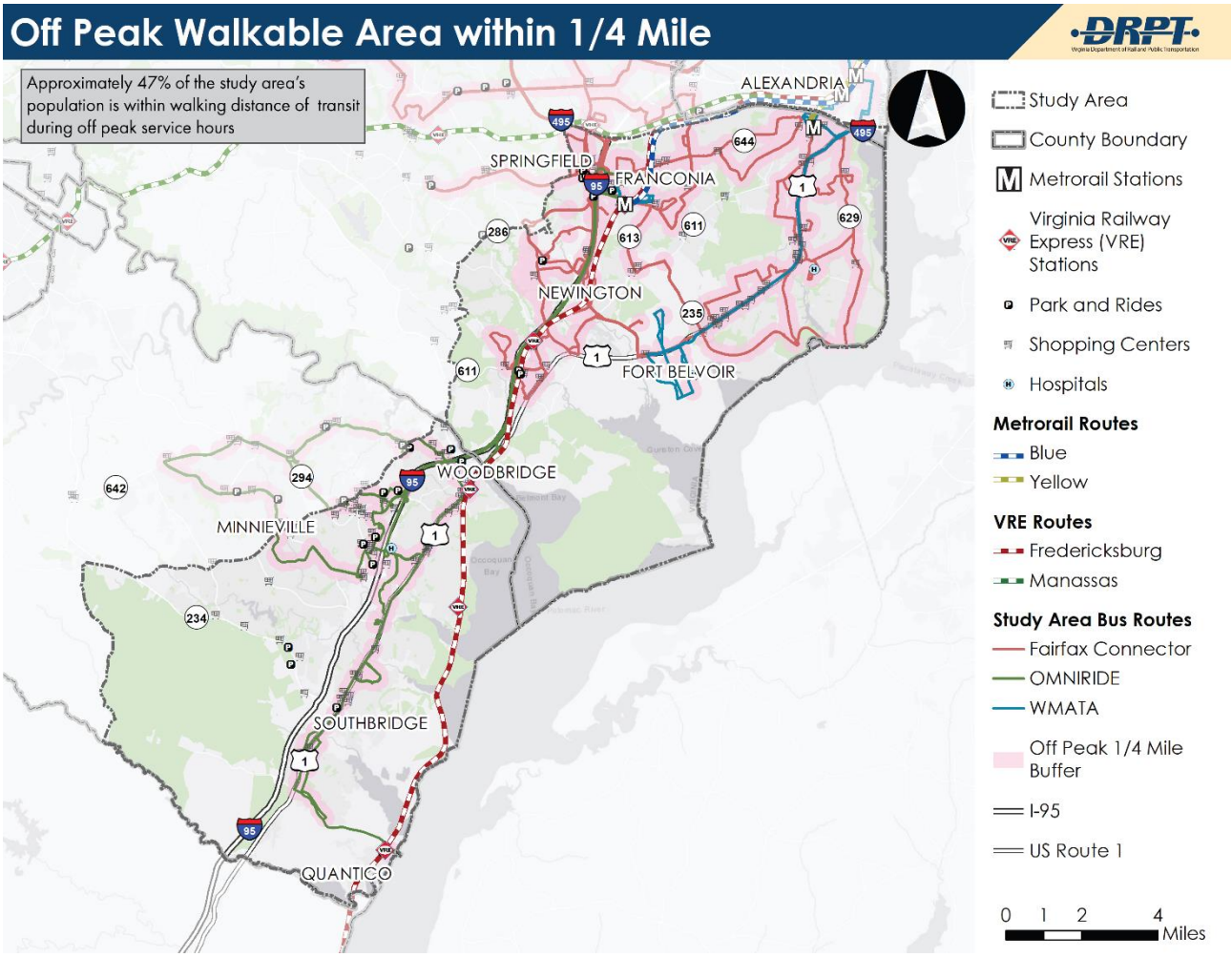


FIGURE 3-12 AREA WITHIN WALKING DISTANCE TO TRANSIT DURING OFF-PEAK PERIODS



Equity

As highlighted in Section 2.2, significant segments of the population in the Study Corridor fall into groups that are typically more reliant on transit and often underrepresented in the planning process. Minorities comprise almost 47 percent of the Study Corridor's population — higher than the average for either Fairfax or Prince William Counties. The rate of poverty is also higher in the Study Corridor than the average for those counties. As shown in **Table 3-6**, service coverage is higher for each of the transit-reliant demographic groups than the overall average in the peak and the off-peak periods. The only exception is the population of older adults, which may be living in less dense areas and may therefore be harder to serve with traditional transit services. While higher than average, it should be noted that less than two-thirds of households living in poverty have access to transit within ¼ mile, which may be limiting their mobility and/or placing strains on their household finances. Ensuring that these demographic groups have the mobility they need to access

employment opportunities, medical services, and fresh food is a need that could be addressed by improved transit options in the Study Corridor.

TABLE 3-6 SERVICE COVERAGE BY DEMOGRAPHIC GROUPS

	Peak	Off-Peak
Total Population	56.1%	46.7%
Households Below Poverty Line	61.5%	57.8%
Minority Population	57.4%	50.6%
Older Adults (65+)	55.1%	43.6%
Limited English Proficiency	60.4%	55.1%
Low Vehicle Households	69.3%	65.9%

Future Development

As detailed in Section 3.1, significant commercial and residential development is expected in the Study Corridor by 2045. Adding an additional 108,000 residents and 68,000 jobs will place even greater demands on the transportation network, as this growth will result in more than 18 percent more trips made every day. This growth may also increase the number of key activity centers in the corridor, as planned developments like the Landing at Prince William and/or AlpineX in Fairfax County are made into reality. Enhanced transit in the Study Corridor will be necessary to accommodate this planned growth successfully and sustainably. Any specific alternatives will need to consider both the location and type of these planned developments in order to provide the right kind of service to meet these evolving needs.

Traffic Conditions and Travel Times

The continued growth expected in the corridor (highlighted in Section 3.1) will increase trip making in the Study Corridor by 2045. The addition of new trips on an already congested highway network will result in

even more severe congestion. More severe congestion has greater impacts on reliability, as even a small crash is even more disruptive to the overall system at such high traffic volumes. As shown in **Table 3-7**, the amount of vehicle travel occurring in the Study Corridor during the peak periods is expected to grow by more than 13 percent. Almost all of the additional VMT is expected to be severely congested as more and more roadways shift into severe congestion from other less congested categories. **Figure 3-13** and **Figure 3-14** show the locations of congestion in 2045 for the morning and evening peak periods, respectively.

TABLE 3-7 2045 BASELINE CONDITIONS PEAK PERIOD VMT BY LEVEL OF CONGESTION

	Morning Peak Period			Evening Peak Period		
	Existing	**2045**	**Growth from Existing**	**Existing**	**2045**	**Growth from Existing**
Serve Congestion (v/c ≥ 1)	502,700	770,800	53%	641,000	1,343,100	110%
Moderate Congestion (0.79 < v/c < 1)	649,500	707,200	9%	1,373,700	1,232,800	-10%
Light Congestion (0.63 <v/c < 0.79)	465,400	442,200	-5%	473,100	409,700	-13%
Uncongested (v/c ≤ 0.63)	442,600	412,500	-7%	613,100	547,300	-11%
Total	**2,060,200**	**2,332,700**	**13%**	**3,100,900**	**3,532,800**	**14%**

Source: 2045 Baseline Travel Demand Model

FIGURE 3-13 MORNING PEAK CONGESTION – 2045 BASELINE

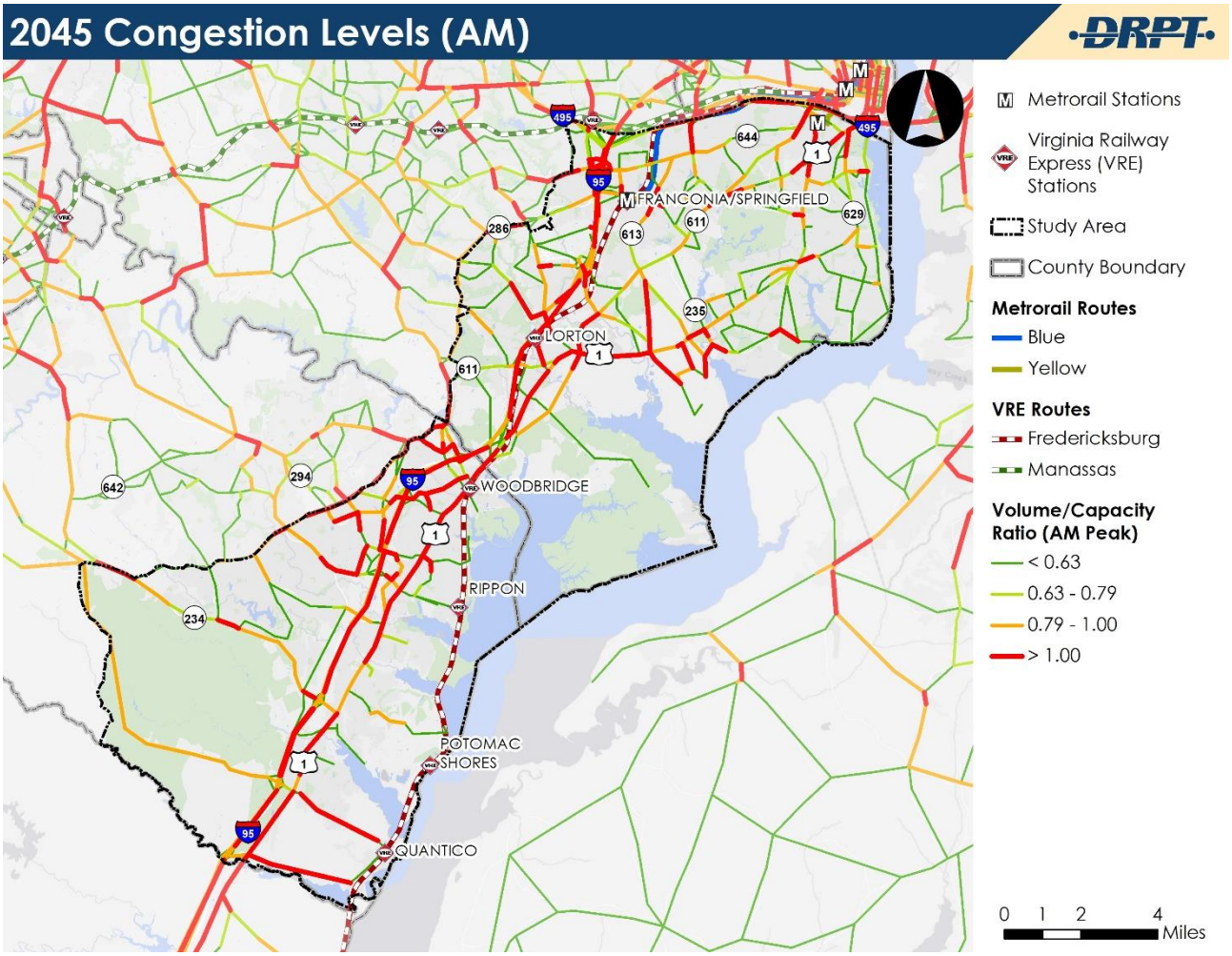
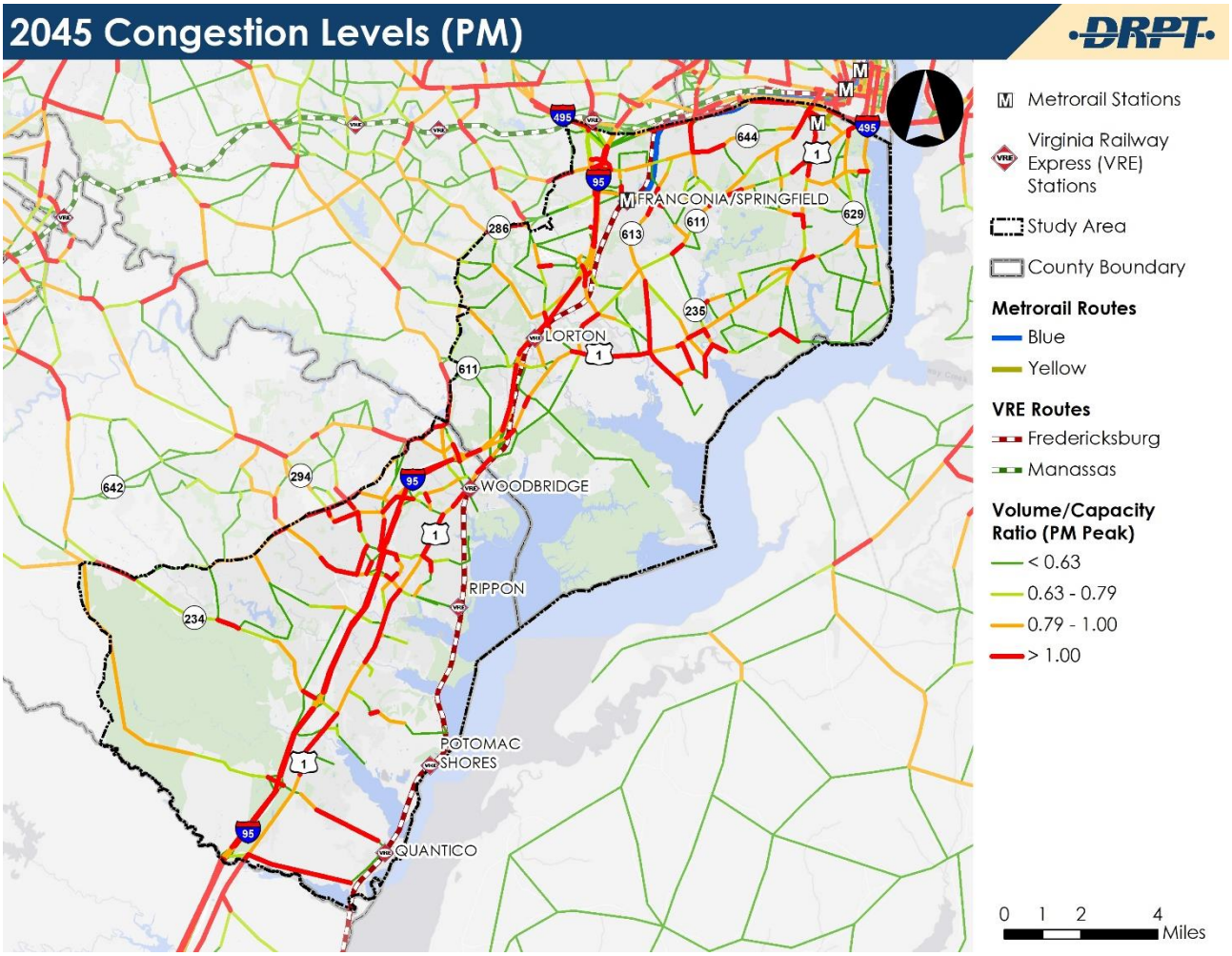


FIGURE 3-14 EVENING PEAK CONGESTION – 2045 BASELINE



Transit Service Quality

Transit services are not fully aligned with the daily travel needs of Study Corridor residents. A significant amount of transit in the corridor is focused on commute trips into the region's core, including Arlington, DC, and Alexandria. In addition to the strong travel markets to the core, analysis of existing travel patterns indicate that significant portions of travel occur within the Study Corridor, and to/from other suburban activity centers in the region, such as Tysons. Where transit is available between other potential locations, service is often infrequent, indirect, and/or only operating during the peak hours. This can make it extremely difficult for residents or employees in the Study Corridor to fully rely on transit to meet their daily travel needs. Improving the quality of transit service available to serve a wider range of travel markets would make it easier to live in the Study Corridor without a car, especially for lower-income residents who cannot afford one. Encouraging this type of transit service could also have positive impacts for the environment and for equity.

To illustrate this point, the average travel times for some of the significant travel markets using the Study Corridor were compared across different modes during the peak and off-peak time periods. Ten representative origin-destination pairs were selected as shown in **Table 3-8**. While the specific travel times will vary based on exact origin and destination points, the discrepancies in travel times are illustrative of many potential transit trips in the Study Corridor.

TABLE 3-8 TRAVEL TIME COMPARISONS

Origin	Destination	Average Transit Travel Time (min)		Average Drive Travel Time (min)	
		Peak	Off-Peak	Peak	Off-Peak
Dale City	Gallery Place-Chinatown	85	136	59	47
Fredericksburg	Fort Belvoir	46	NA	41	36
Woodbridge	Springfield	116	141	23	17
Woodbridge	Tysons	108	170	46	37
Woodbridge	Quantico	NA	NA	18	18
Rippon	Franconia	24	24	29	23
Dumfries	National Mall	94	NA	56	43
Minnieville	Pentagon	74	NA	54	40
Stafford	Springfield	134	300	30	24
Alexandria	Fort Belvoir	61	68	18	19

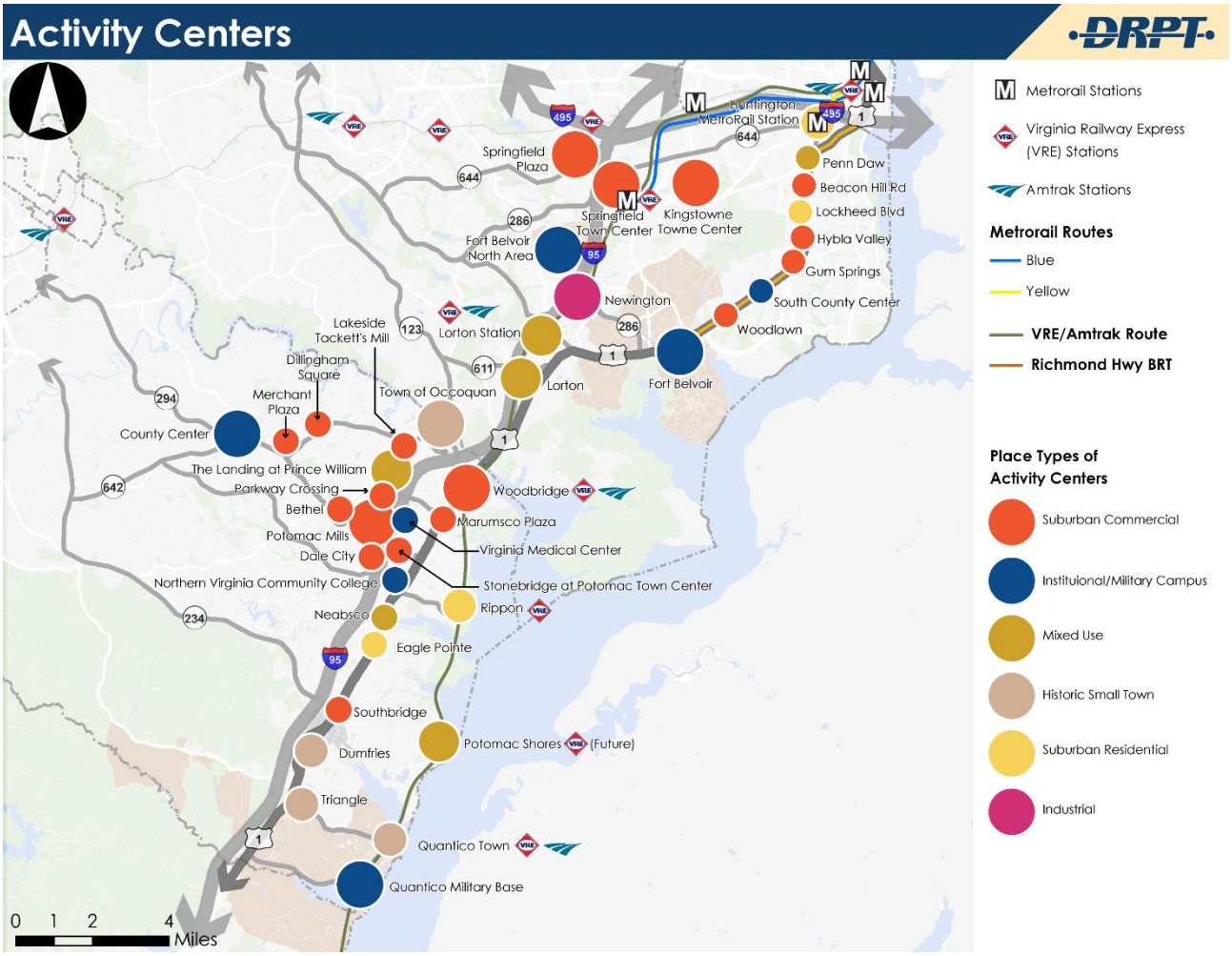
As shown, during the peak period nine of these trips can be made via transit; two of them require driving to access a VRE station and an additional five require walks of more than 15 minutes to access transit service. These are not conditions conducive to transit use unless no other option is available. During the off-peak periods, only five of these trips could be made via transit in less than three hours — and all of them can be made in less than an hour by car. On average, a transit trip takes more than 40 percent longer in the off-peak than during the peak periods — if it can be made at all. Improving the span of reliable transit service, along with the breadth of destinations that transit trips can reach will have a major impact on the quality of service provided, and therefore the usability of the network in the Study Corridor.

Because transit service in the Study Corridor is oriented towards the downtown core, those trips offer travel times that are the most competitive with driving. In particular, trips that are able to take advantage of VRE and/or Metrorail tend to be the most competitive with driving times and they carry the added benefit of not requiring parking in DC or Arlington upon arrival. Other potential trips by transit are not as competitive due to low transit frequencies and long walks to get to the bus. Transit trips are even less competitive during the off-peak periods, when lower transit frequencies must compete with uncongested roads. For many trips, the I-95 Express Lanes provide an even faster alternative to the times shown in **Table 3-8**— but only for those who can afford to pay the tolls.

Connections to Activity Centers

Existing land use is focused around 44 major activity centers in the Study Corridor. These activity centers are clusters of employment centers, retail establishments, historic downtowns, high-density residential neighborhoods, existing transit stations, and major park-and-ride locations as shown in **Figure 3-15**.

FIGURE 3-15 ACTIVITY CENTERS

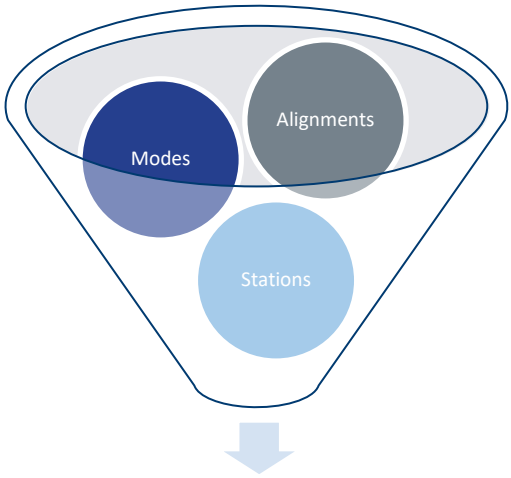


Providing access to these Activity Centers by transit remains a major need that must be addressed in order to ensure that residents and employees have options for all types of travel throughout the Study Corridor. This includes ensuring transit travel is possible and convenient to the military bases at Fort Belvoir and Quantico, which pose additional challenges due to their enhanced security requirements. Considerations for first mile/last mile connections to and from these larger institutions and large-scale developments will need to be included as part of any enhanced transit options.

4. ENHANCED TRANSIT ALTERNATIVES

The objective of alternatives definition phase of the study was to identify a set of transit service and facility improvement alternatives based on the feasibility study purpose, identified travel markets and needs in the Study Corridor, and stakeholder and public input. The final set of selected transit alternatives were then tested and evaluated to understand the costs, benefits, and tradeoffs of different options.

Identifying transit alternatives is a multi-step process that involves looking at a range of potential transit possibilities, carefully eliminating impractical options, and finally arriving at potential alternatives to be tested. For this study, this was done in a three-step screening process that resulted in five final transit alternatives to be tested and evaluated.



This three-step screening process involved:

- Identifying potential transit modes for the Study Corridor, then eliminating the modes that were less suitable based on a set of screening criteria;
- Identifying possible alignments for the transit modes and choosing the ones that best served the existing and planned land uses in the Study Corridor; and
- Identifying potential station locations that would serve activity centers and allow for walk-access to stations.

4.1 Alternatives Definition Process

Modal Screening

The first step in identifying transit alternatives was to screen the universe of potential transit modes. The potential transit modes considered in this step are as follows:

- Metro: Heavy rail with dedicated right-of-way and high travel speeds that would most likely connect to the existing WMATA Metrorail Blue or Yellow Lines.

- VRE Commuter Rail: passenger rail service on the Fredericksburg line currently provides peak period service to the region's core. Service improvements to VRE beyond baseline improvements being made in the next decade including increased frequency during peak periods, for both peak and reverse direction, and the off-peak period..
- Bus Rapid Transit (BRT): Bus service that may have features such as transit-signal priority, off-vehicle payment options, fewer stops further apart, or dedicated right-of-way to provide for a higher standard of service compared to local buses. The service analyzed for this mode would be additional BRT service beyond the already-committed Richmond Highway BRT project.
- Express Bus: Bus routes that travel primarily on high-speed roads, such as limited-access highways, and generally have stops at either end of the route as opposed to stops at intervals along the route
- Light Rail Transit (LRT): Rail transit that operates predominantly in its own right-of-way, but may have at-grade crossing with roads and generally is slower than heavy rail.
- Local Bus: Bus routes that operate in mixed traffic, generally with short distances between stops and longer headways than BRT.
- Water Ferry: Boats that would travel along the Potomac River and its tributaries to provide transit access.

Each mode choice comes with specific benefits and drawbacks, which were analyzed using the five criteria defined below:

- Ability to Serve Intra-Corridor Travel Markets: Does the proposed mode serve trips that both start and end in the Study Corridor?
- Ability to Serve Regional Travel Markets: Does the proposed mode serve trips that either start or end outside the Study Corridor?
- Compatibility with Corridor Land Use: Does the proposed mode provide the proper amount of ridership potential for the densities and land use in the Study Corridor? For example, heavy rail would not be appropriate for a rural area.
- Cost Effectiveness (Capital and Operating): For the projected number of riders, is the total cost (both the initial cost of construction and the cost of maintaining and operating the service) feasible?

- Interoperability with Existing Transit System: How well with this new proposed mode interact with existing transit services in the Study Corridor? How easy will it be to transfer between this new transit service and existing transit services?

Table 4-1 below shows the seven potential modes mentioned above for the Study Corridor and how well they score in each of the five aforementioned criteria. A full black circle equates to a high score, a half-black circle is a medium score, and a white circle is a low-score.

TABLE 4-1 POTENTIAL MODES AND SCREENING CRITERIA

Screening Criteria	Metro	VRE	BRT	Express Bus	LRT	Local Bus	Water Ferry
Ability to Serve Intra-Corridor Travel Markets	●	◒	●	◒	●	●	○
Ability to Serve Regional Travel Markets	●	●	●	●	◒	○	◒
Compatibility with Corridor Land Use	◒	●	●	●	◒	●	◒
Cost Effectiveness (Capital and Operating)	◒	●	●	●	◒	◒	◒
Interoperability with Existing Transit System	●	●	●	●	○	●	○
Recommended for Alternatives Testing	✓	✓	✓	✓			

Based on this screening exercise, the study team determined that Metrorail, VRE, BRT, and Express Bus were the four modes to be analyzed further (as indicated by the checkmarks in Table 4-1). All of these modes scored well in all five criteria.

Reasons for eliminating the other three modes include:

- LRT was not recommended for further analysis primarily because the corridor does not already have LRT service, so it would require a mode transfer to leave the Study Corridor. Metrorail and Express Bus services already exist, and BRT will exist in the future in the Richmond Highway corridor, so those two modes received a high score in the "Interoperability with Existing Transit System" criterion while LRT received a low score.

- Water ferry was not recommended for the lack of interoperability and for the inability to serve intra-corridor destinations, such as Potomac Mills and Lorton, because the station locations would be limited to areas along the Potomac River.

- Local bus scored well on serving intra-corridor trips, but is not well suited to serving longer-distance regional travel markets due to lower speeds and capacities.

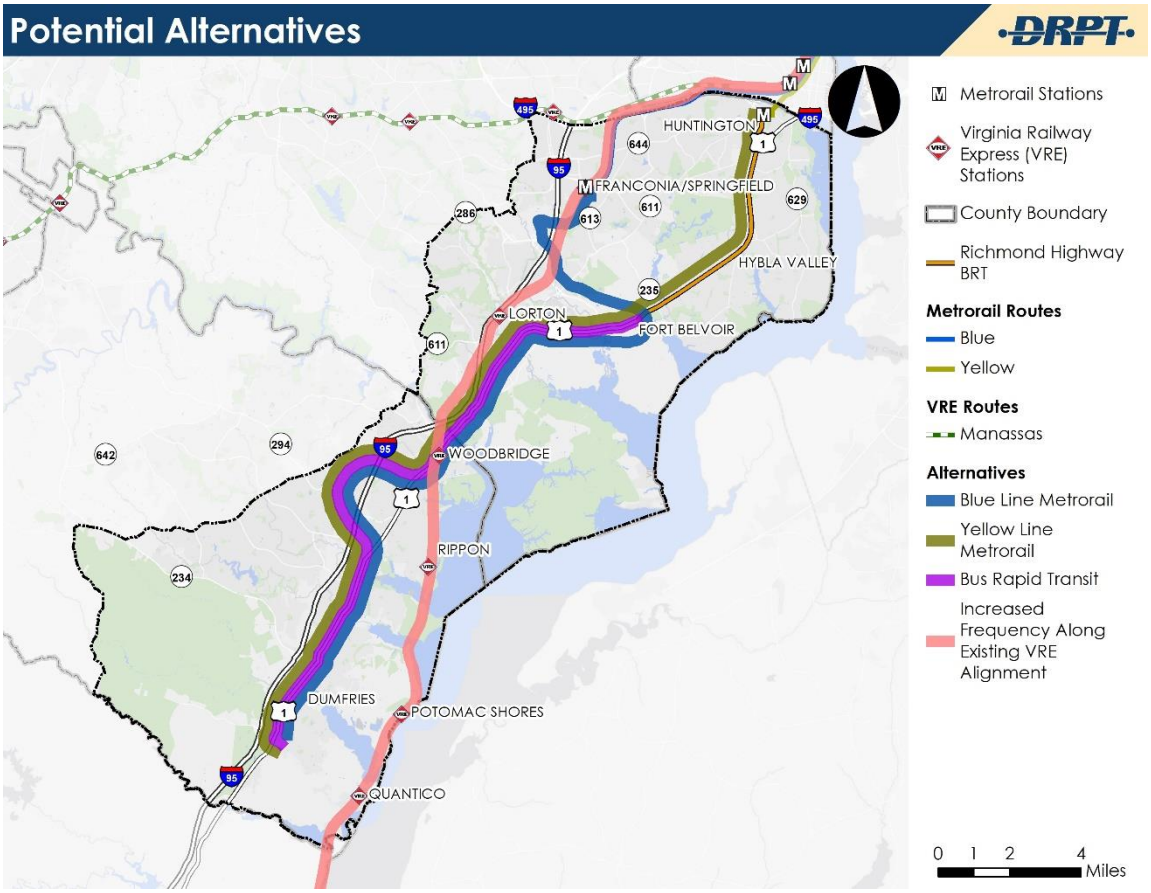
Alignment Screening

A set of potential alignments was considered and screened so that a single alignment was selected for testing of each alternative. This approach, appropriate for a feasibility study being used to narrow down a list of feasible options, differs from a typical alternatives analysis where multiple alignments are often evaluated for the same transit mode. Of the four modal options, BRT and Metrorail alternatives required a more detailed review of alignment options. The VRE service alternative used the same alignment as the existing Fredericksburg Line. Express bus connections were based on origin and destinations, as described later in this chapter.

Selection of BRT and Metrorail alignment alternatives considered the key activity centers that should potentially be served by enhanced transit, including the locations specified in the General Assembly directive to conduct this feasibility study: Franconia-Springfield Metro Station, Fort Belvoir, Lorton, Potomac Mills, and Marine Corps Base Quantico. More information on the identification of activity centers, done concurrently with selection of alignments, is provided in the next section.

Error! Reference source not found. shows the selected set of alignments for the VRE, BRT and Metrorail alternatives. In Fairfax County, two alignments were selected for Metrorail – an extension of the Blue Line and an extension of the Yellow Line. Both alignments meet at Fort Belvoir and would follow Richmond Highway (U.S. 1) south into Prince William County. The BRT alignment would be an extension of the planned Richmond Highway BRT beginning at Fort Belvoir extending south into Prince William County. The details of the alignments and potential station areas are described in the next section.

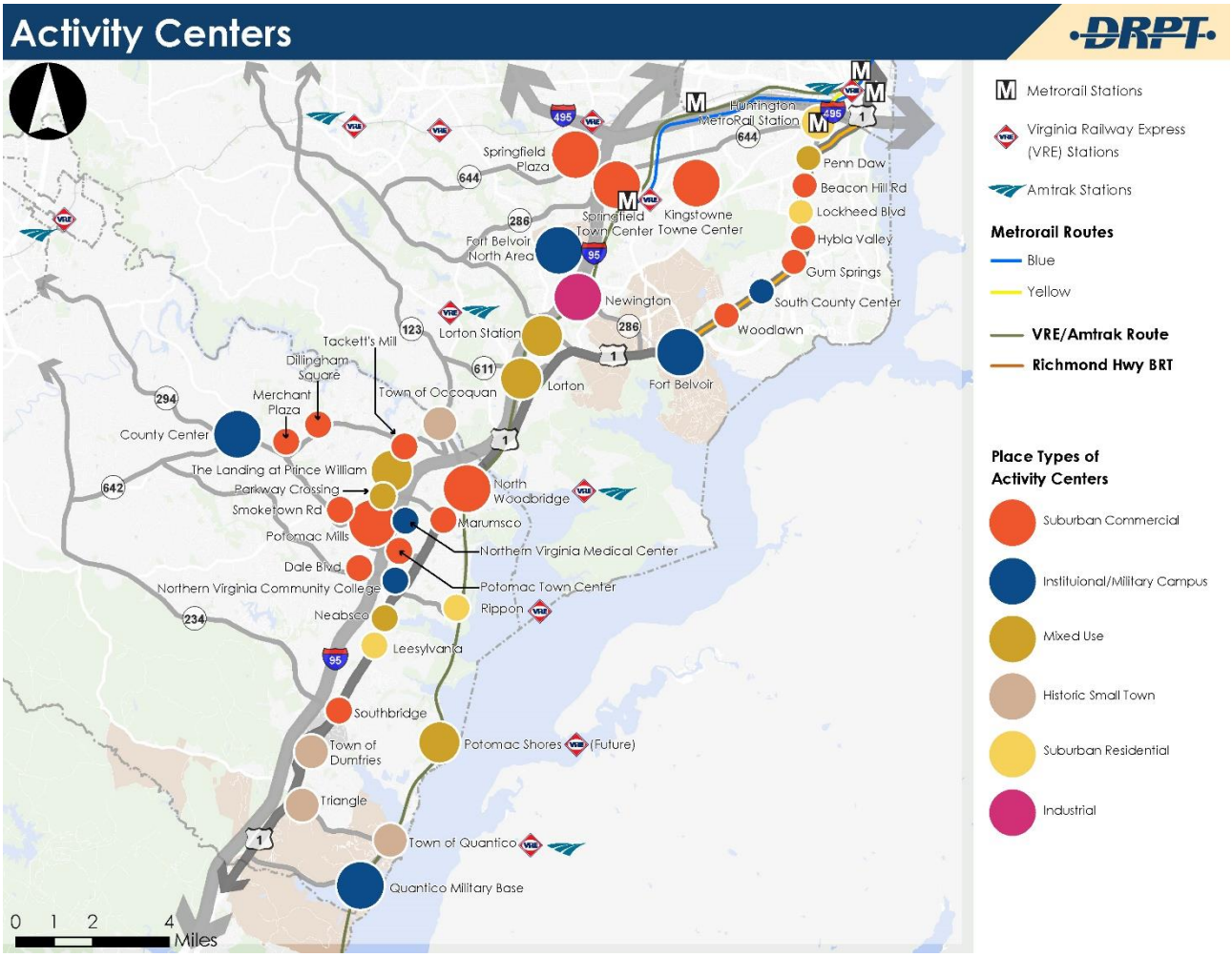
FIGURE 4.1 POTENTIAL ALIGNMENT ALTERNATIVES



Identification of Station Locations

Existing land use and demographic analysis resulted in the identification of 44 major activity centers in the Study Corridor, seen in Error! Reference source not found.**-2**. These activity centers are clusters of destinations such as employment centers, retail establishments, historic downtowns, high-density residential neighborhoods, existing transit stations, and major park-and-ride locations. Some activity centers were identified based on input received from Fairfax County and Prince William County staff and a review of proposed development activity, adopted small area plans, and comprehensive plans.

FIGURE 4-2 ACTIVITY CENTERS



Some of the major activity centers were identified as potential Metrorail and BRT stations for each alternative. Station locations were shortlisted among the activity centers for the Metrorail Blue Line extension, Metrorail Yellow Line extension, and BRT alternatives using the following 5-step process:

- Step 1: Major activity centers were shortlisted that were located on or within ¼-mile of the proposed alternatives alignments.
- Step 2: The resulting activity centers from Step 1 were further shortlisted by identifying potential transfer locations such as:
    - Existing VRE/Metro stations
    - Planned or proposed BRT stops as identified in small area plans and in the regional model
    - Existing park-and-ride locations

  - Existing local bus routes

- Step 3: The activity centers from Step 2 were analyzed by population, employment, and other demographic data within one mile of the selected activity centers.

- Step 4: High-ranking activity centers from Step 3 were identified as potential Metro or BRT stations for respective alternatives. The exact station locations were adjusted to achieve an average station spacing of 2 to 3 miles for Metro alternatives and around 1 to 1.5 mile spacing for the BRT alternative. The stations were located at major intersections, at existing VRE or park-and-ride locations, or a specific location identified in the adopted small area plans or comprehensive plans.

- Step 5: The draft list of stations resulting from Step 4 was shared with the TAC, Fairfax County staff, Prince William County staff, Elected Officials and the public as part of the stakeholder and public engagement activities. The draft list of stations was revised based on input from the TAC, Elected Officials, stakeholders, and the public.

This 5-step process identified 12 potential Metro stations, ten each on the Blue Line and Yellow line extensions. Eight stations, south of Fort Belvoir, are common to both the Metro line alternatives. In total, 18 BRT stations were identified for the BRT alternative. These exclude the stations already planned as part of the planned future Richmond Highway BRT system from Huntington to Fort Belvoir.

These potential stations are seen in Error! Reference source not found.**1-3** through Error! Reference source not found.**1-5**, along with the other Study Corridor activity centers included in the station screening process.

FIGURE 4-3 BLUE LINE POTENTIAL STATION LOCATIONS

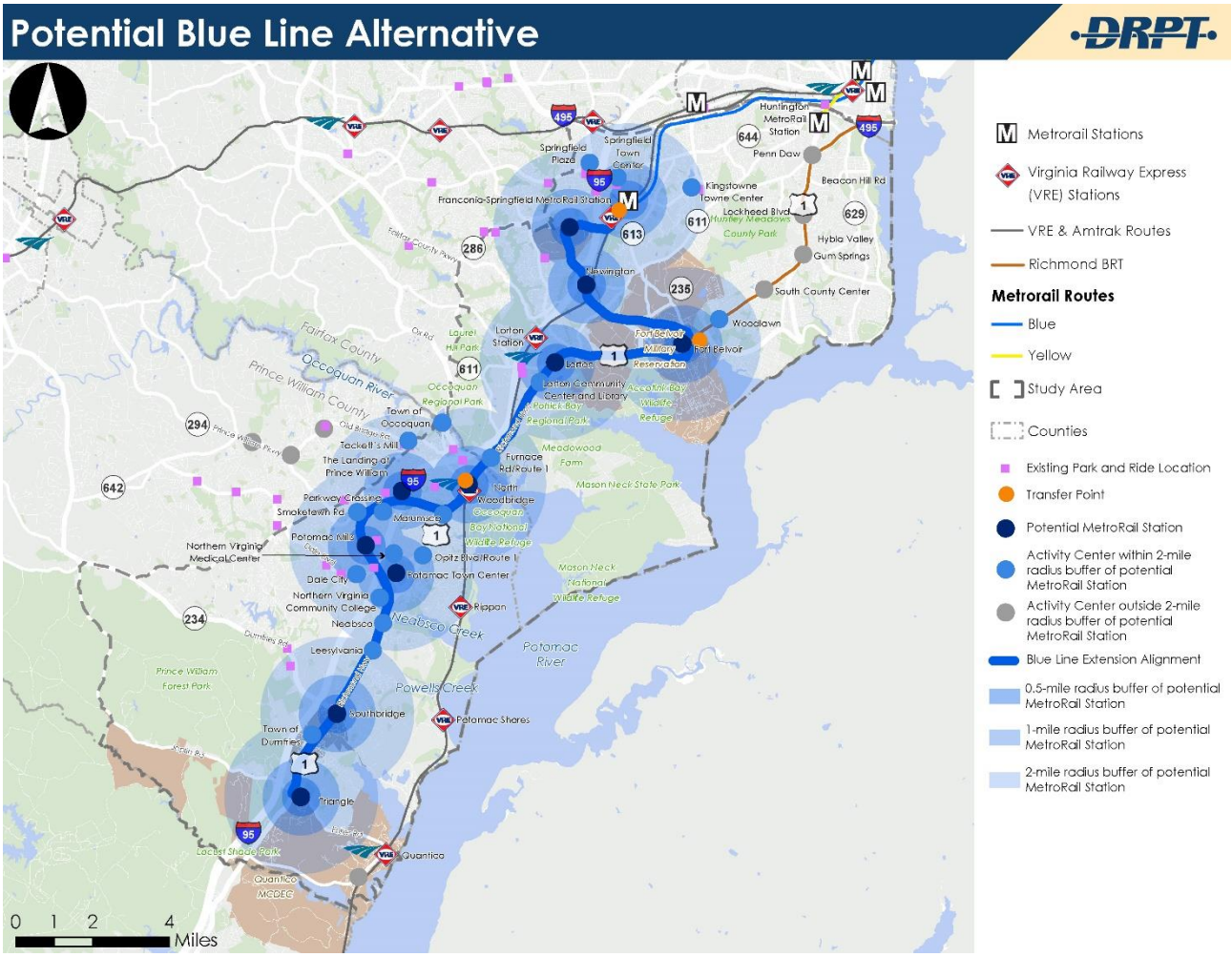


FIGURE 4-4 YELLOW LINE POTENTIAL STATION LOCATIONS

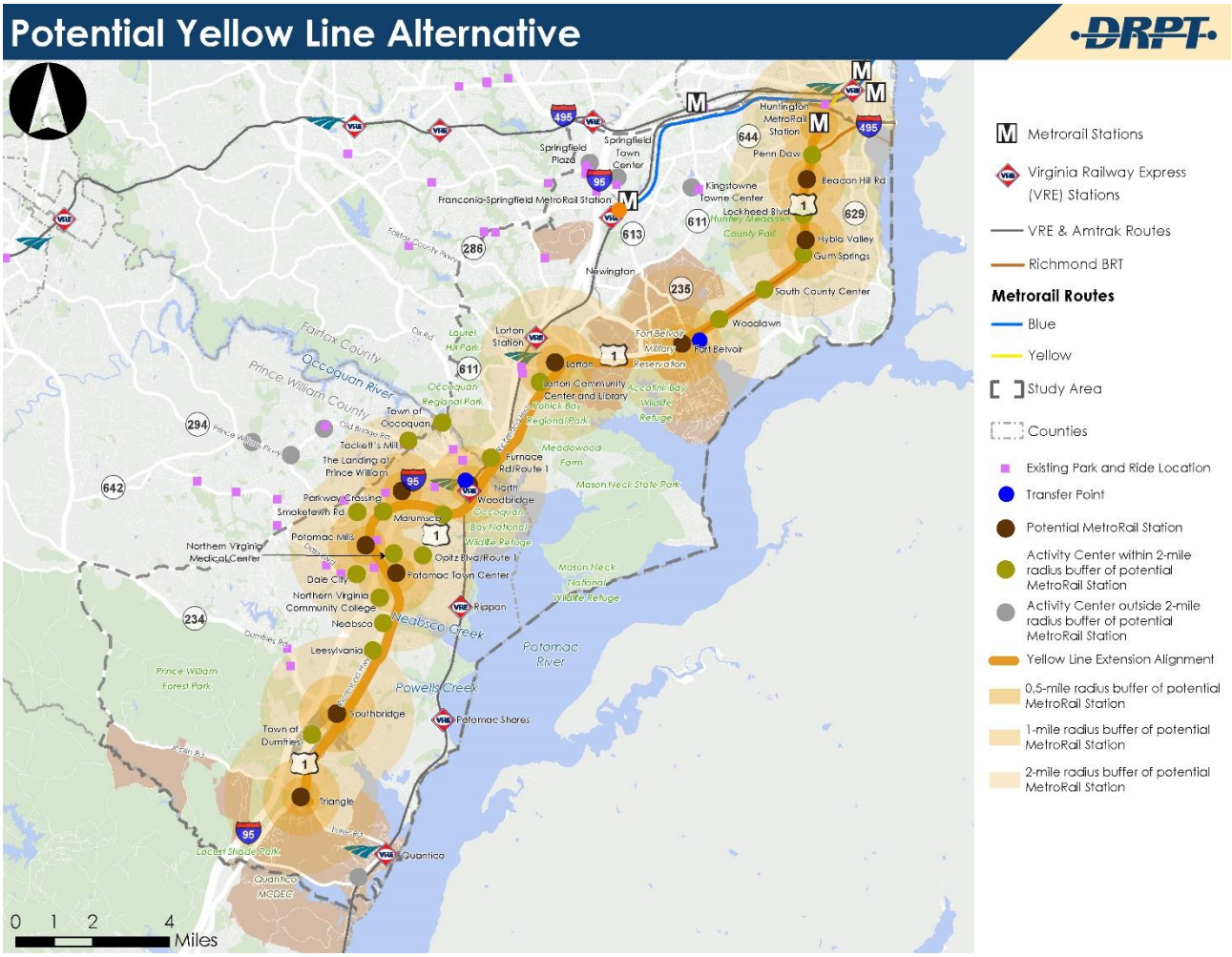
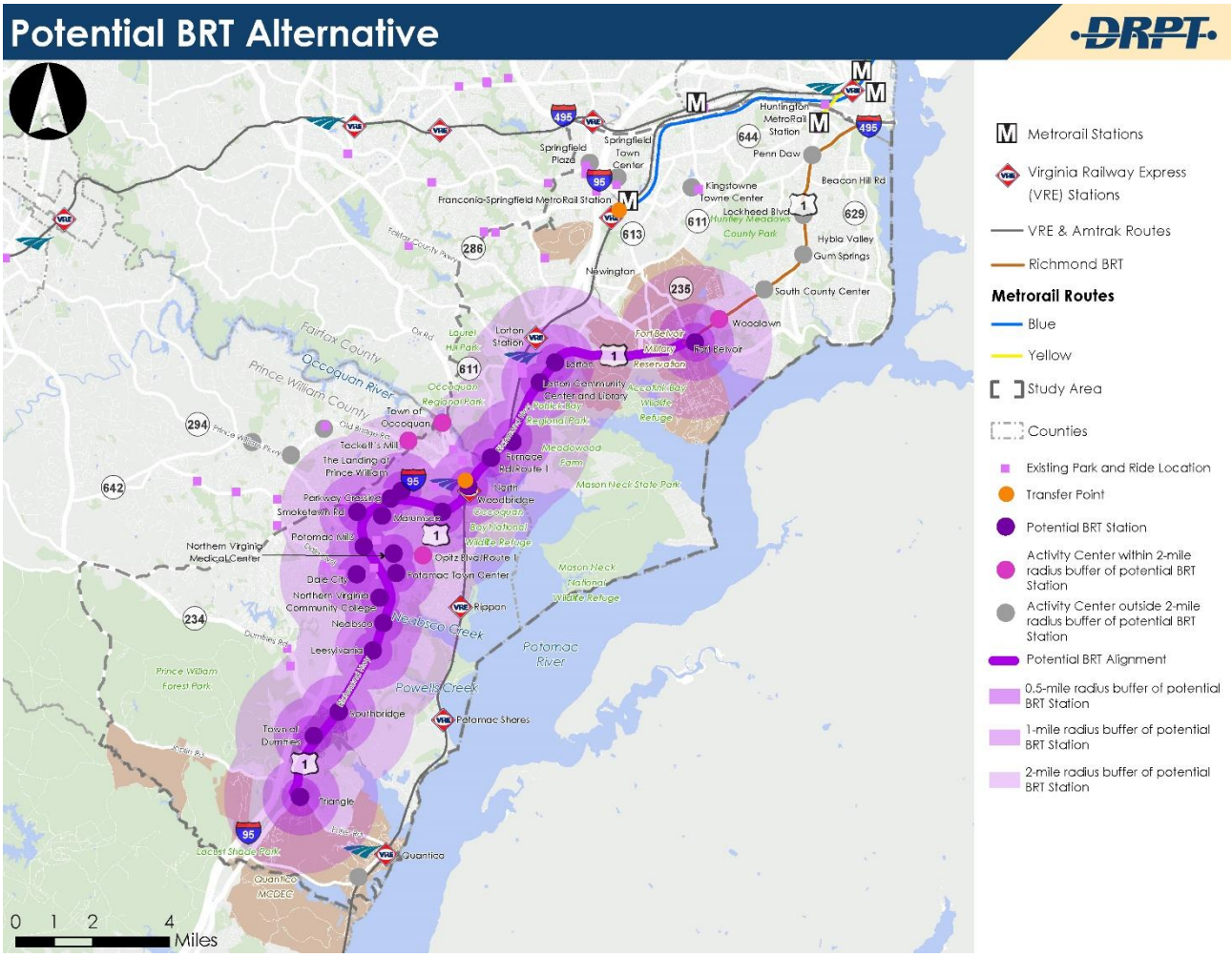


FIGURE 4-5 BRT POTENTIAL STATION LOCATIONS



4.2 Alternatives Descriptions

A final set of five transit alternatives were selected and defined for testing and evaluation in the study including Metrorail, VRE improvements, bus rapid transit (BRT), and express bus. These alternatives are described in more detail below.

- Metrorail – Blue Line Extension
- Metrorail – Yellow Line Extension
- Bus Rapid Transit
- VRE Service Improvements
- Express Bus Routes

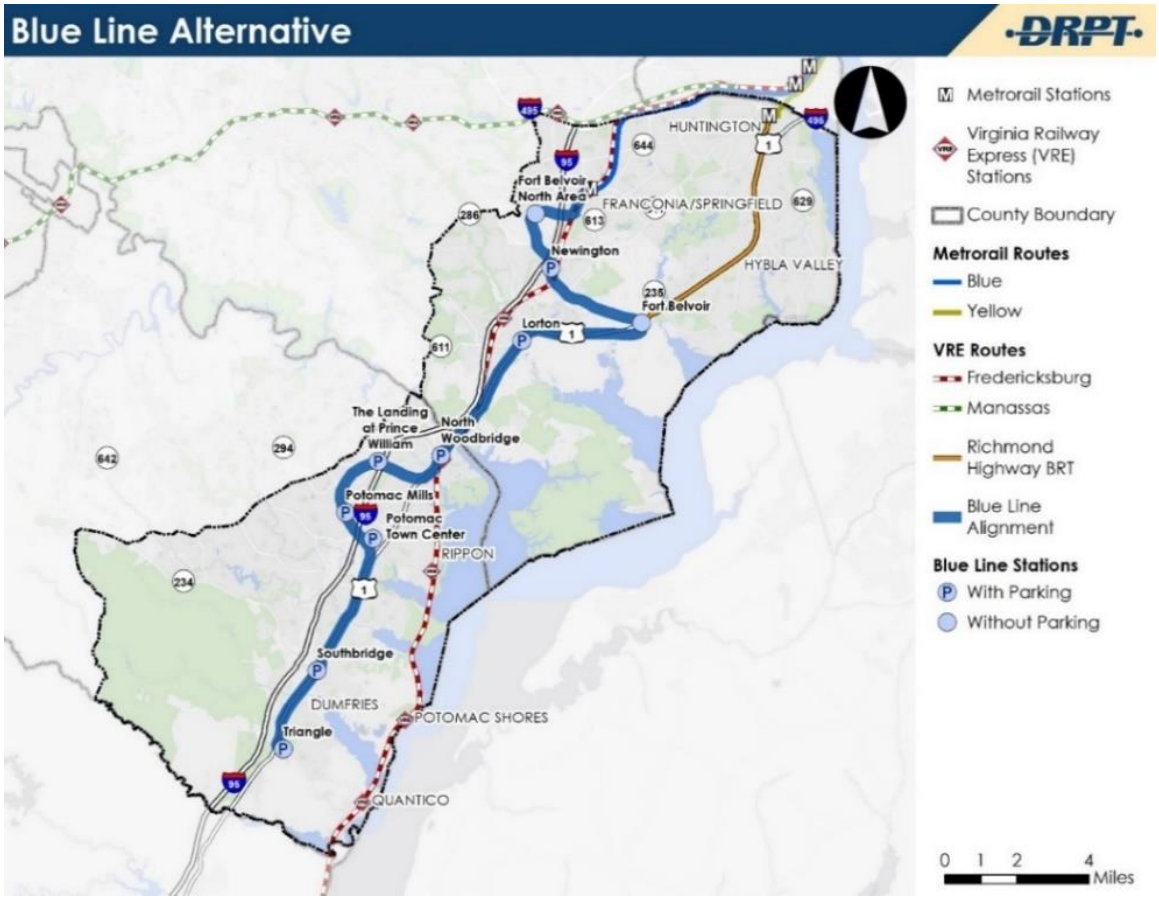
Metrorail—Blue Line Extension

The Metrorail Blue Line Extension alternative would extend the Blue Line from the current terminus at Franconia-Springfield. This extension would have up to 10 Metro stations in Fairfax and Prince William Counties. The northern segment of the alignment would extend south from Franconia-Springfield crossing I-95 to the west to connect to Fort Belvoir North and

Metrorail—Blue Line Extension

Length: 26.3 mi
New Stations: 10
New Stations w/ Parking: 8
Headway (peak): 8 min
Headway (off-peak): 12 min

FIGURE 4.6 BLUE LINE ALTERNATIVE MAP



then running east through Newington to Fort Belvoir. South of Fort Belvoir, the alignment would extend south along the U.S. 1 corridor, crossing I-95 to the west after Woodbridge to serve the Potomac Mills area and then returning east to the U.S. 1 corridor to a new terminus at Triangle.

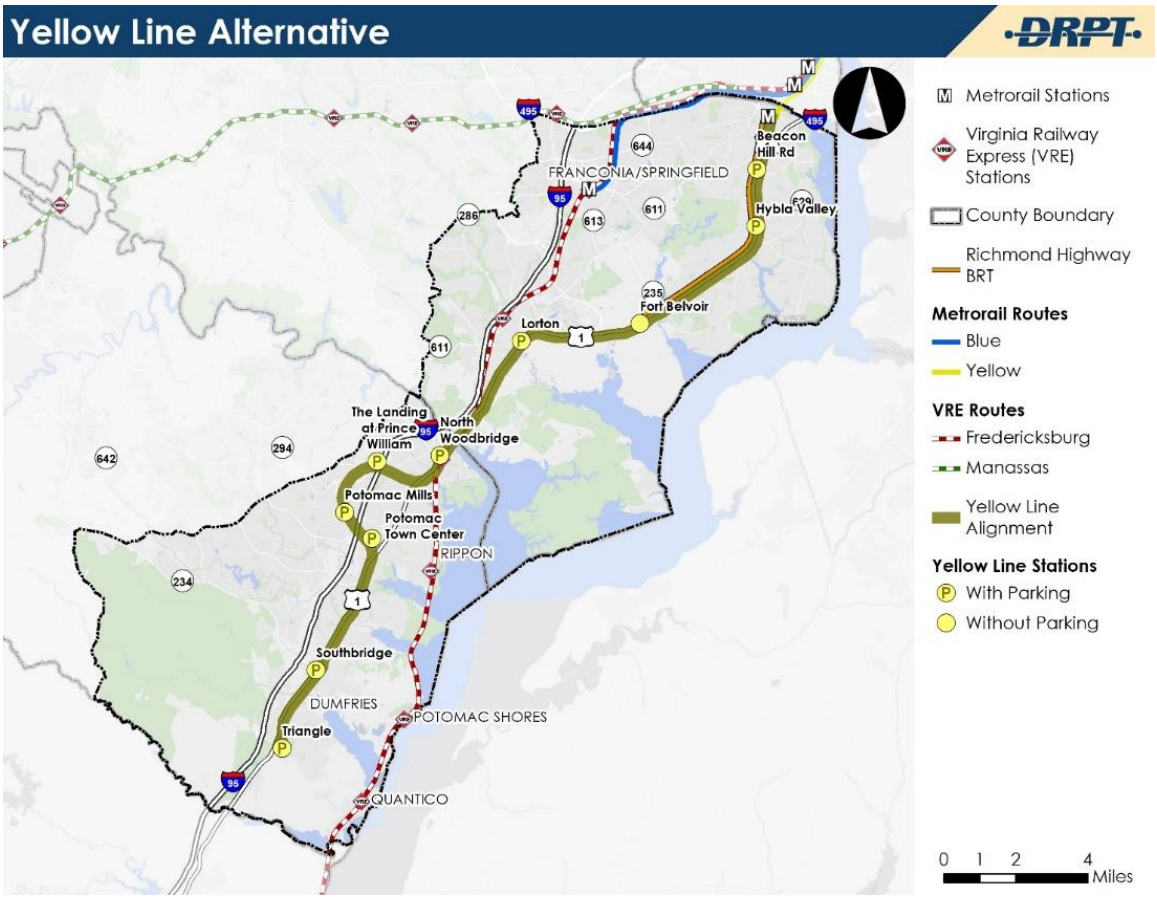
Metrorail—Yellow Line Extension

The Metrorail Yellow Line Extension alternative begins at the current Yellow Line terminus at Huntington Station. The alignment would extend south along the U.S. 1 corridor to Fort Belvoir. South of Fort Belvoir, the Yellow Line would follow the same alignment as the Blue Line, crossing I-95 to the west after Woodbridge to serve the Potomac Mills area and then returning east to the U.S. 1 corridor and south to a new terminus at Triangle. The Yellow Line has two northern stations that differentiate it from the Blue Line—Beacon Hill Road and Hybla Valley.

Yellow Line Extension

Length: 26.6 mi
No. of Stations: 10
No. of New Stations w/ Parking: 9
Headway (peak): 8 min
Headway (off-peak): 12 min

FIGURE 4-7 YELLOW LINE ALTERNATIVE MAP



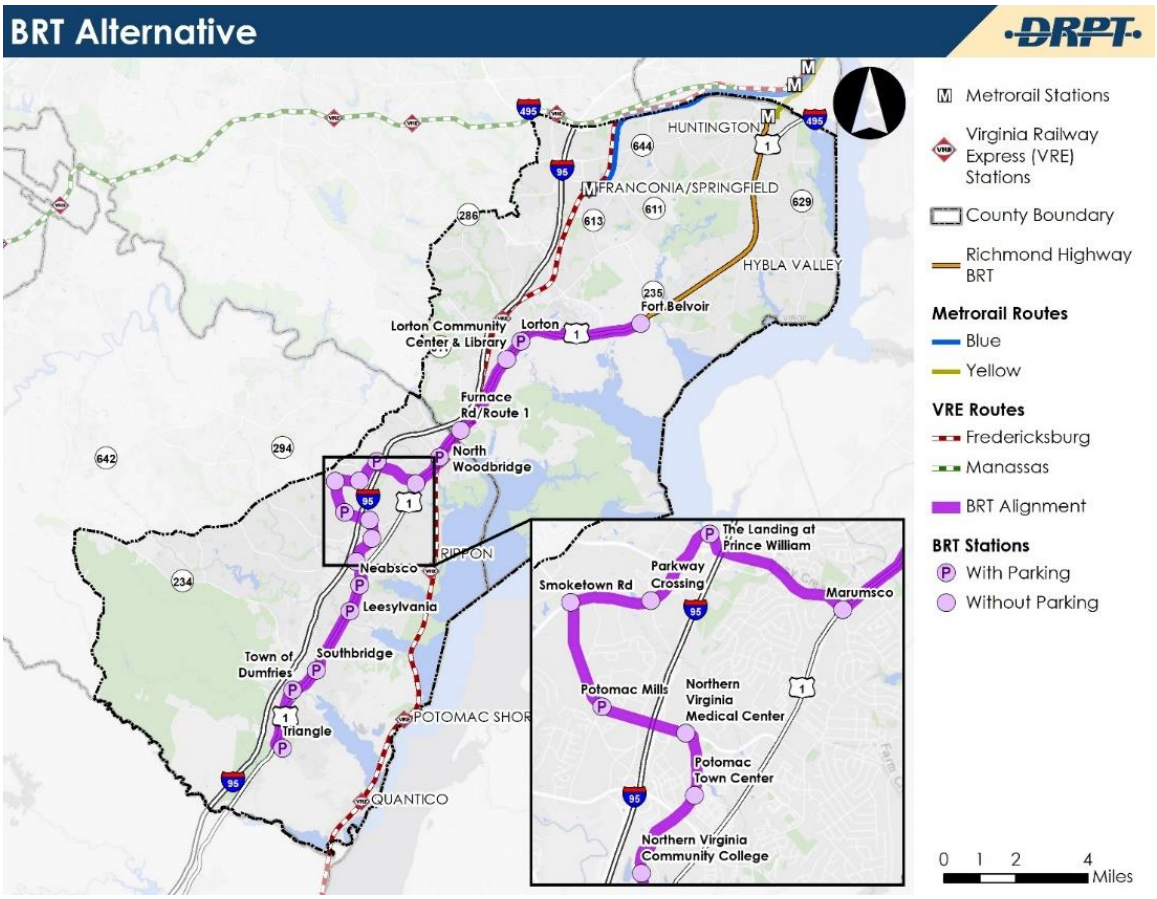
Bus Rapid Transit (BRT)

The Bus Rapid Transit (BRT) alternative would extend south from the terminus of the future Fairfax County Richmond Highway BRT at Fort Belvoir and would then run 20.5 miles south to Triangle, following a similar route to the Metrorail alternatives. BRT has the most proposed new stations of any of the alternatives, resulting in stations that are closer together.

Bus Rapid Transit

Length: 20.5 mi
New Stations: 18
New Stations w/ Parking: 9
Headway (peak): 6 min
Headway (off-peak): 12 min

FIGURE 4-8 BRT ALTERNATIVE MAP



VRE Service Improvements

VRE Service Improvements

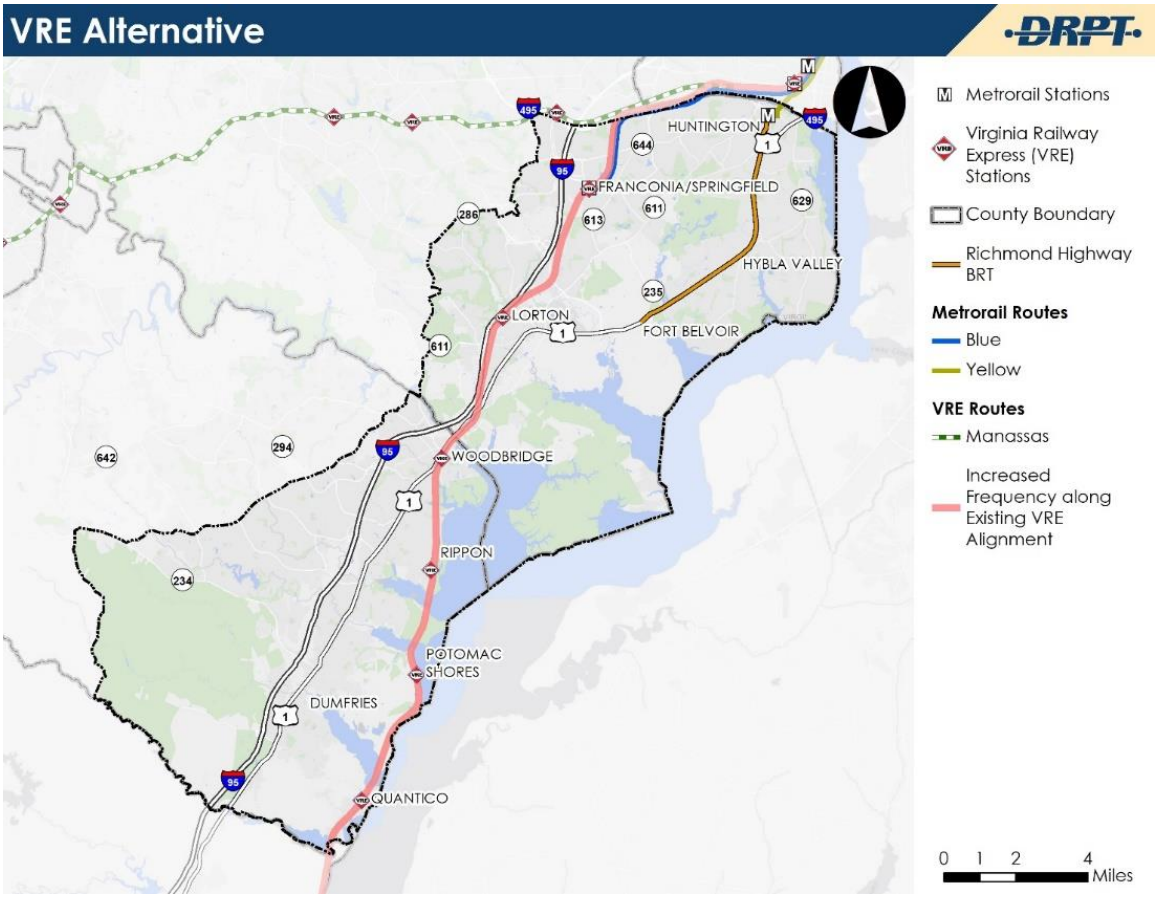
Length: 22.7 mi (in corridor)
No. of New Stations: n/a
Headway (peak): 15 mins
Headway (peak/reverse): 30 mins
Headway (off-peak): 60 mins

The Transforming Rail in Virginia program will expand and improve passenger, commuter, and freight rail in Virginia and create a vital connection in America's national rail network between the Northeast and Southeast corridors. Through strategic partnerships, investments, and capital improvements, Transforming Rail in Virginia allows Virginia to nearly double Amtrak state-supported service and VRE Fredericksburg Line service (including first-time-ever weekend and late-night service) during the next decade. These investments are financially committed and, as such, are part of the study baseline scenario allowing for significant expansion of VRE service as envisioned in the VRE 2040 System Plan. By 2045, ridership demand at the VRE stations in the Study Corridor is expected to increase 82 percent over existing ridership levels. The tested VRE service alternative would include incremental service improvements beyond those included in the baseline (**Table 4-2**). These improvements would include reducing the headways (and increasing the frequency of trains) to further expand the capacity of the existing VRE line beyond the significant enhancements that are already planned.

TABLE 4-2 VRE ALTERNATIVE HEADWAYS

Headway Type	Baseline	Proposed Alternative
Peak Period (Peak Direction)	20 minutes	15 minutes
Peak Period (Reverse Direction)	60 minutes	30 minutes
Off-Peak Period	120 minutes	60 minutes

FIGURE 4-9 VRE SERVICE ALTERNATIVE MAP



Express Bus

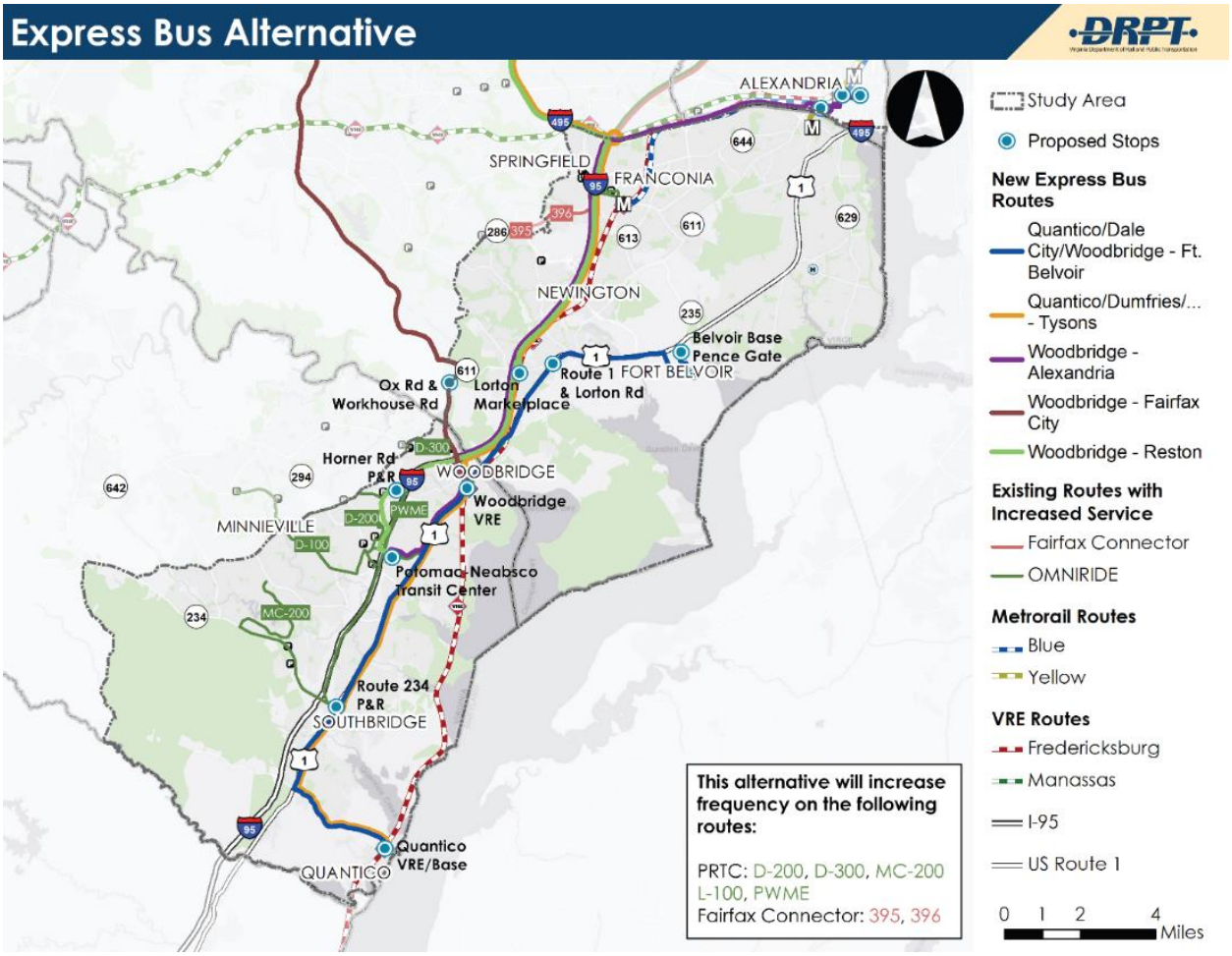
The Express Bus alternative package includes new planned or funded service not already in the baseline, enhancements to existing express bus routes, and the addition of new routes to serve promising but currently unserved activity centers. Headways were reduced for a variety of routes and frequency was increased for routes with high productivity.

Bus Rapid Transit

New Express Routes: 5

Existing Routes with Increased Frequency: 2

FIGURE 4-10 EXPRESS BUS ALTERNATIVE MAP



The Express Bus alternative consists of a package of enhanced and new Express Bus routes. It was developed based on a number of assumptions:

1. The Study Corridor already has a significant number of express bus routes aimed primarily at linking activity centers in the corridor to locations in northern Virginia and DC.
2. Some improvements to express buses have been planned and funded and were already included in the baseline. This alternative includes only new routes and services beyond the baseline.
3. To facilitate comparison with the rail and BRT alternatives, the express bus routes should extend to the southern end of the corridor – to Dumfries/Quantico.
4. Services are needed to the two military bases in the study area – Quantico and Fort Belvoir/Fort Belvoir North.
5. There may be opportunities to enhance services on existing express routes.

6. There may be opportunities to serve new activity centers with new routes.
7. Some origin destinations pairs warrant off-peak and/or bi-directional reverse commute services while other do not.

The Express Bus alternative package includes new planned or funded service not already it the baseline, enhancements to existing express routes, and the addition of new routes to serve promising unserved activity centers. Headways were reduced for a variety of routes and frequency was increased for routes with high productivity, noted in **Error! Reference source not found.**. There are nine new proposed stops in this alternative and new parking was not assumed for new proposed stops.

Planned Services – Beyond the Baseline

The Future Baseline includes current bus services as well as some improvements planned/funded but not in the Financially Constrained Long-Range Plan (CLRP). Two enhancements that are included in the Express Bus alternative beyond the baseline include:

1. **Fairfax Connector** - New shuttle route alignment:
    - Lorton VRE Park-and-Ride to Franconia-Springfield Metro – Combines 371/372/373 (15 minute all day)
2. **OmniRide** - New alignment to T-100 with 45 minute frequency peak hour peak direction.
    - In future it will also connect to the new transit center at the Stonebridge/Neasbsco garage in Woodbridge. T-100 now serves the Franconia-Springfield Metro station and stays to the north of Highway 123 rather than looping through the mall.
3. **OmniRide** – Increases in frequency on:
    - D-100 – Dale City – Downtown (10 min)
    - MC-100 – Montclair - Downtown (30 min)
    - RS - Route 1 Express – Triangle/Dumfries/Woodbridge – Pentagon/Downtown (30 min)

Enhancements to Existing Express Bus Services

To identify opportunities for enhancements to existing routes, the study team considered the service characteristics and productivity on existing express bus routes. The frequency on routes with high

productivity were doubled (none would have less than 10 minute headways). High productivity routes with increased service include:

- **Fairfax Connector –** doubled service for high ridership route:
    - FC 395/396 Gambrill-Backlick to Pentagon
- **OmniRide** – doubled service for high ridership route:
    - L-100 – Lake Ridge to Downtown
- **OmniRide Metro Express** – doubled service for Dale City/Woodbridge – SF Metro

Headways were reduced on a number of additional routes with adequate ridership but long headways (60 minutes). Headways were reduced from 60 minutes to 45 minutes on the following OmniRide low frequency routes:

- **D-200 – Dale City – Pentagon/Rosslyn/Ballston**
- **D-300 – Dale City to Pentagon but mostly downtown**
- **MC-200 – Montclair – Pentagon**

New Express Bus Routes

In addition, new express bus routes were added to the improvement package. These were identified by examining the 2045 origin-destination travel data and identifying origin-destination pairs with a large number of trips that do not have existing express bus services. Five potential new OmniRide routes were identified (see **Figure 4-10**):

- **Quantico - Woodbridge – Ft. Belvoir South –** utilizing U.S. 1
- **Woodbridge – Alexandria -** using I-95/495 to Eisenhower Avenue – circulates through Alexandria and serves both Eisenhower Avenue and King Street Metro stations
- **Quantico/Dumfries – Tysons** - extends the T-100 to Dumfries/Quantico using the OmniRide Route 1 local alignment
- **Woodbridge – Fairfax City -** using Route 123 to University Boulevard with stops at George Mason University and the City Hall area

- **Woodbridge – Reston** - using I-95/495 to the Dulles Access Road, exiting at Reston parkway then Bluemont to the Reston Transit Center

Services on the Fort Belvoir and Alexandria routes were assumed to run all day. Headways were set as 30 minutes during peak hours and 60 minutes in the off-peak and would operate bi-directionally. For the other three routes, service was to be during peak hours and in the peak direction only with 30 minute frequencies.

The routes utilize I-95/495 and the Express Lanes as much as possible with limited numbers of stops. The routes also stop at the new transit center at the Stonebridge/Neabsco Park-and-Ride Lot where possible. Where the military bases are served, it is assumed that the buses can get through the gates for authorized personnel.

5. Alternatives Evaluation

5.1 Evaluation Approach

Goals and Measures

An evaluation framework was established for testing the potential enhanced transit alternatives to determine overall and relative performance of the different options. Five goals for enhanced transit are summarized in **Figure 5-1** and include:

- Ridership potential;
- Congestion mitigation;
- Regional access/connectivity;
- Equity; and
- Cost-effectiveness.

A set of evaluation measures aligned with each of the goals is presented in **Table 5-1**.

FIGURE 5-1 GOALS FOR ENHANCED TRANSIT

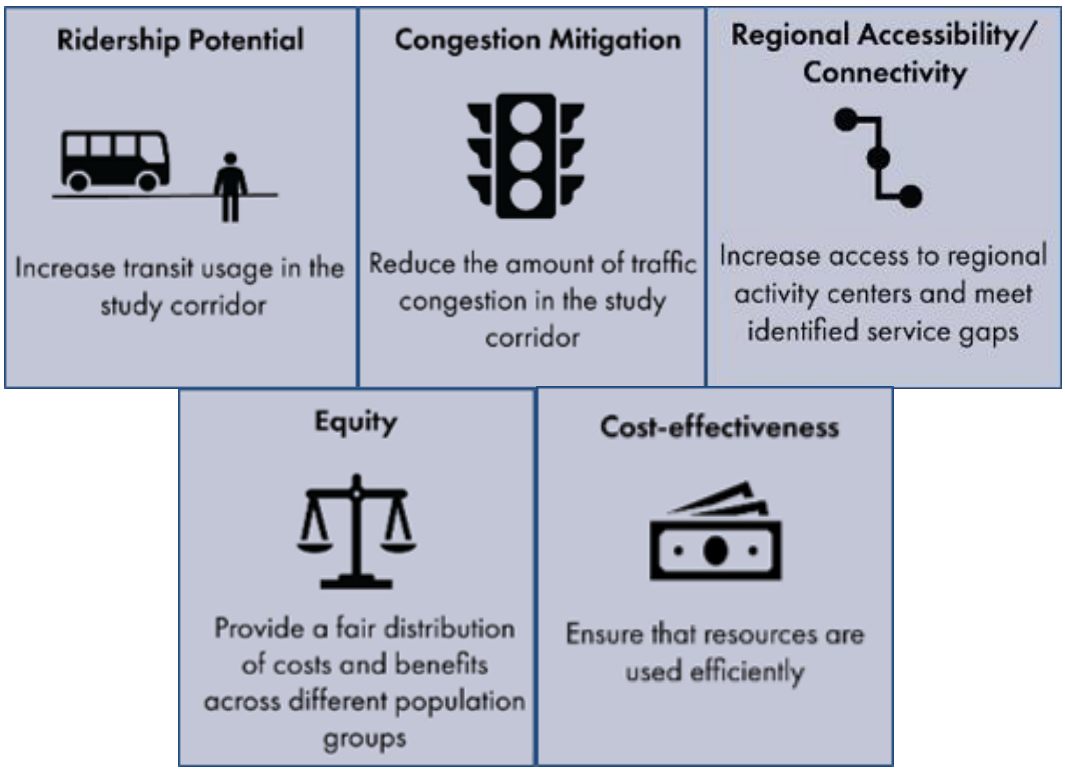


TABLE 5-1 EVALUATION MEASURES

Goal	Measure
Ridership Potential	▸ Transit boardings in the study corridor ▸ New daily transit trips ▸ Passenger miles traveled (PMT)
Congestion Mitigation	▸ Congested vehicle-miles of travel (VMT) in the study corridor
Regional Accessibility/ Connectivity	▸ Population and jobs within ½ mile of transit ▸ Number of jobs accessible within 60 minutes by transit ▸ Number of residents able to access key employment centers (within 60 minutes by transit)
Equity	▸ Access to jobs for residents of Equity Emphasis Areas (EEAs) within 60 minutes by transit ▸ Total daily transit trips to/from EEAs ▸ EEA population within ½ mile of transit
Cost-Effectiveness	▸ Cost per rider ▸ Cost per new transit trip ▸ Cost per passenger miles traveled (PMT)

Modeling

The travel demand model used in this project is the latest officially adopted production-use travel demand forecasting model (Ver. 2.3.78), which was developed by MWCOG/TPB, and its associated input files (networks and land use data) from the Air Quality Conformity (AQC) Analysis of the 2020 Amendment to Visualize 2045, a Long-Range Transportation Plan (LRTP) for the National Capital Region, and the FY 2021-2024 Transportation Improvement Program (TIP). The TPB approved the AQC analysis on March 18, 2020. Two major inputs to the model include: (1) the transportation network that represents the Visualize 2045 and FY 2021-2024 TIP; (2) land use—COG Round 9.1a Cooperative Forecasts.

Version 2.3.78 is a sophisticated, conventional trip-based travel demand model with six major steps:

- Demographic models with market stratifications by four household income groups, four household size groups, and four vehicle availability groups.
- Trip generation models for five personal trip purposes, a commercial vehicle trip purpose, and two truck trip types.
- Trip distribution model with doubly-constrained gravity model formulation with a composite impedance of transit and highway travel times.

- Mode choice model with nested logit structure for five trip purposes and two time periods.
- Time of day model with four time periods: AM peak, midday, PM peak, and nighttime/early morning.
- Traffic assignment with six user classes and equilibrium assignment methodology.

The mode choice model estimates demand for usage of motorized modes, including single-occupancy vehicles (SOV), high-occupancy vehicles with two or more occupants (HOV), commuter rail passengers, heavy rail passengers, bus passengers, and bus-to-rail passengers. These forecasts were used to analyze and evaluate a set of alternatives in the study corridor. The year 2045 (Round 9.1a) was used as the forecasting year since the transit alternatives would take substantial time to implement.

5.2 Evaluation Results

Evaluation measures were calculated for each of the five transit alternatives across each of the five goals. This section provides a brief overview of the key findings in each goal area.

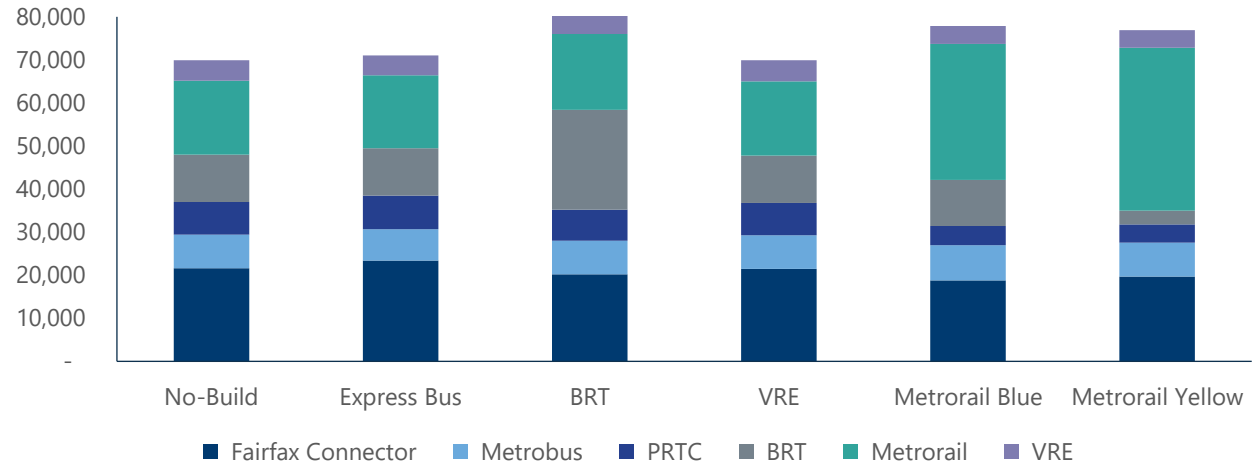
Ridership Potential

For the Ridership Potential goal, alternatives were evaluated to determine how the alternatives are expected to increase transit usage in the Study Corridor. Evaluation measures included total transit boardings and new daily transit trips.

Total transit boardings refers to the number of times people get on a transit vehicle within the Study Corridor. As seen in **Figure 5-2**, the BRT alternative had the highest overall number of daily transit boardings in the corridor. There are some shifts between the types of transit people are using—as the alternative provides faster or more direct service. For example, the two Metrorail alternatives are attracting some riders from VRE and express bus. Note that given the length of the Metrorail and VRE lines, these systems do have additional daily boardings related to the alternative that are outside of the Study Corridor.

Although VRE's ridership gain for the service enhancement alternative is relatively modest, the majority of the ridership increase associated with Transforming Rail in Virginia improvements are included in the study baseline or No Build scenario. In fact, VRE is expected to have an over 80 percent increase in ridership from today's levels, based on the investment that is committed in the future baseline.

FIGURE 5-2 TOTAL TRANSIT BOARDINGS IN THE STUDY CORRIDOR



Boardings at individual stations indicate the relative performance of different segments of the alternatives. The figures below show forecasted 2045 ridership by station for the BRT alternative and the Blue Line and Yellow Line Metrorail alternatives.

Figure 5-3 presents a map of the predicted ridership at stations of the BRT alternative in 2045. A majority of the ridership potential is in the north in Fairfax County, such as Penn Daw, Lockheed Boulevard, and Gum Springs, and fairly high ridership in the Potomac Mills area, such as the Potomac Mills and Marumsco stations. Lower ridership is predicted at several stations, particularly in the southern end of the route, such as Triangle and Dumfries. The BRT alternative provides the largest number of stations of any of the alternatives, so ridership is spread out between those stations compared to the other heavy-build alternatives.

FIGURE 5-3 PROJECTED BRT DAILY BOARDINGS

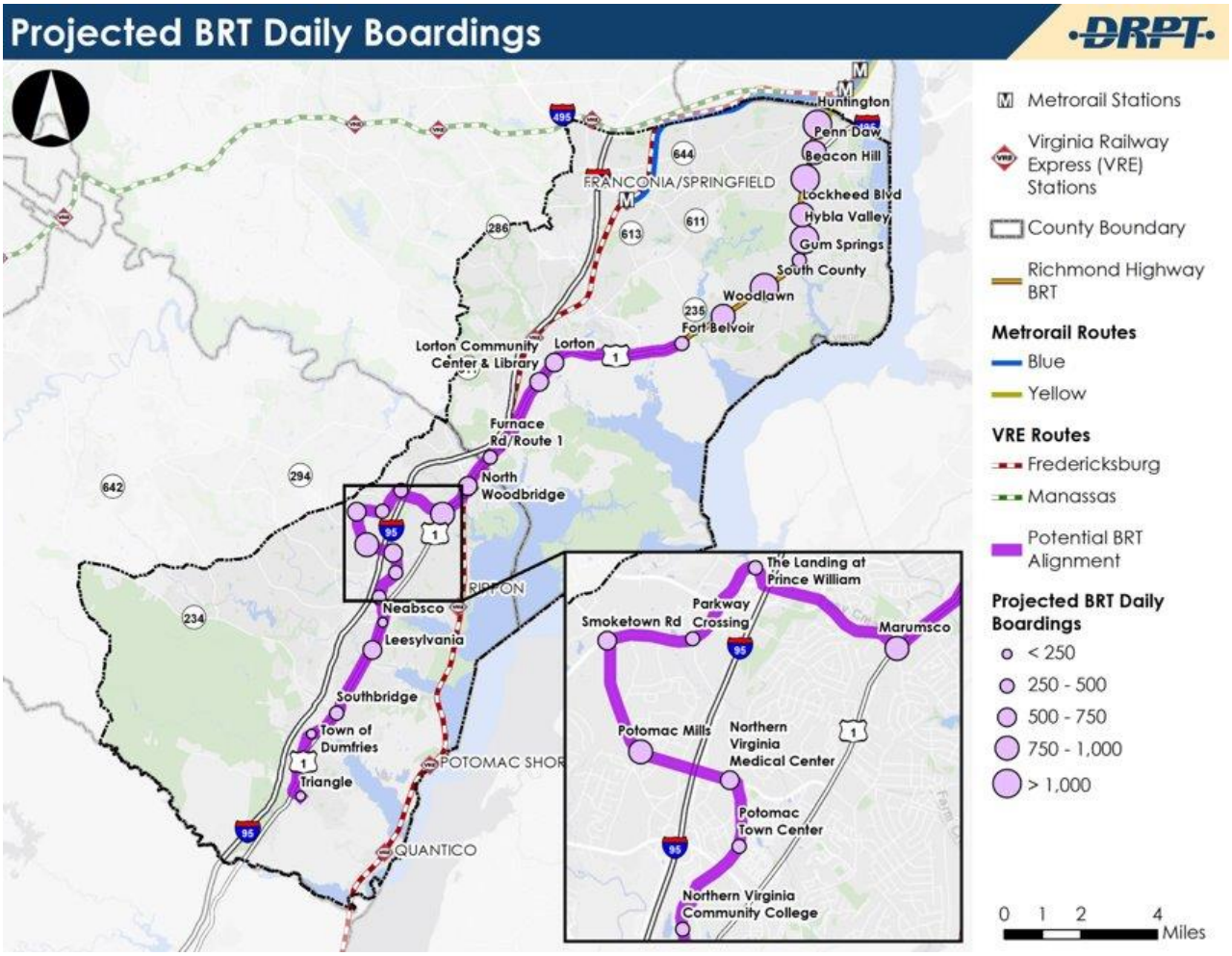


Figure 5-4 presents a map of the Blue Metrorail line extension with potential ridership by station. The existing Franconia-Springfield station is the only station expected to exceed 2,000 boardings per day. A number of stations are projected to be in the 1,000 to 1,500 boardings per day range including Fort Belvoir, North Woodbridge, and Potomac Mills stations. Several stations show lower ridership below 1,000 boardings per day, particularly at the southern stations such as Southbridge and Triangle.

FIGURE 5-4 PROJECTED BLUE LINE DAILY BOARDINGS

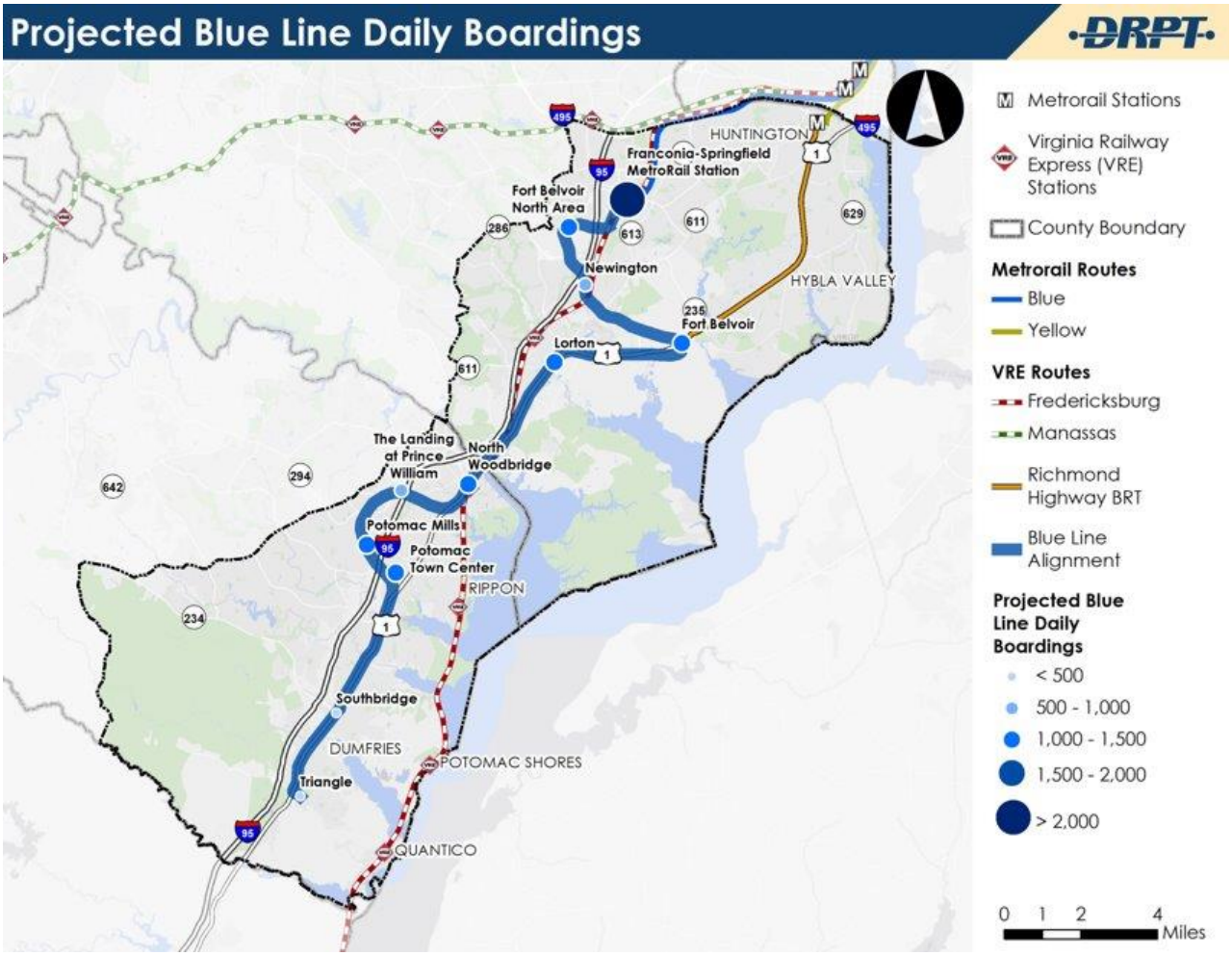
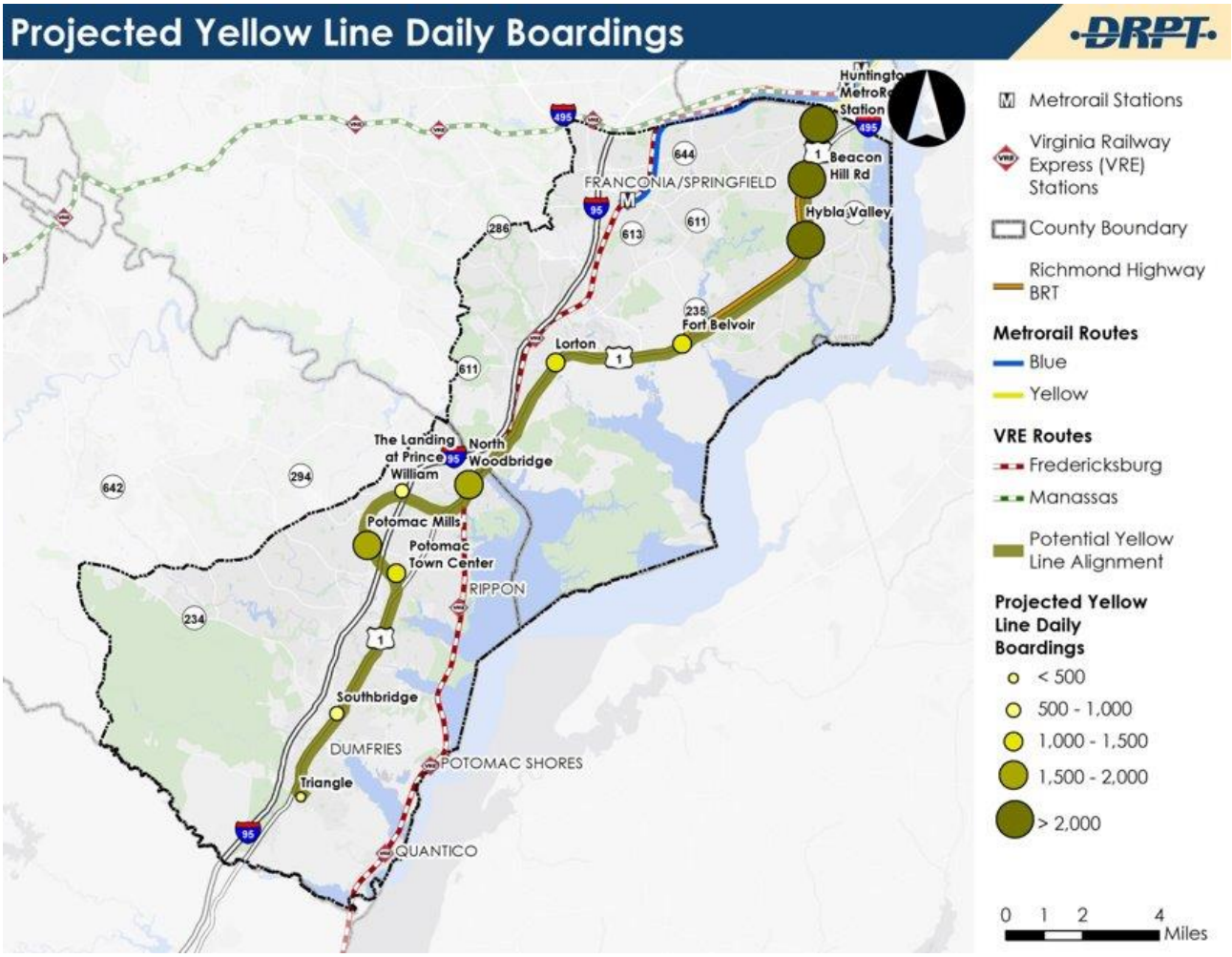


Figure 5-5 presents a map of the potential ridership by station for the Yellow Metrorail line extension. Overall, transit boardings were highest in the northern portion of the corridor. For the Yellow Line alternative, new stations at Beacon Hill, Hybla Valley, and North Woodbridge are expected to exceed 2,500 boardings per day. Boardings at stations in the Potomac Mills area are expected to be in the 1,500 to 2,500 range, but stations south of Potomac Town Center are expected to be much lower in ridership.

FIGURE 5-5 PROJECTED YELLOW LINE DAILY BOARDINGS



New daily transit trips reflect a new full trip made that would not have happened in the no-build scenario. Unlike boardings, transit trips are only counted once end to end, regardless of how many transfers are used.

Figure 5-6 presents the new daily transit trips made within the Study Corridor for each alternative, both from and to the corridor. Both Metrorail lines generate the most new daily transit trips in the Study Corridor, particularly trips starting from the corridor. The two Metrorail alternatives were best at attracting new daily transit trips. The Yellow Line and Blue Line extensions perform better than the BRT at inducing new daily transit trips (fewer trips requiring transfers). More new trips are coming from the study area in all alternatives, but BRT and the Blue Line extension have more balanced ridership than other alternatives.

FIGURE 5-6 NEW DAILY TRANSIT TRIPS IN THE STUDY CORRIDOR

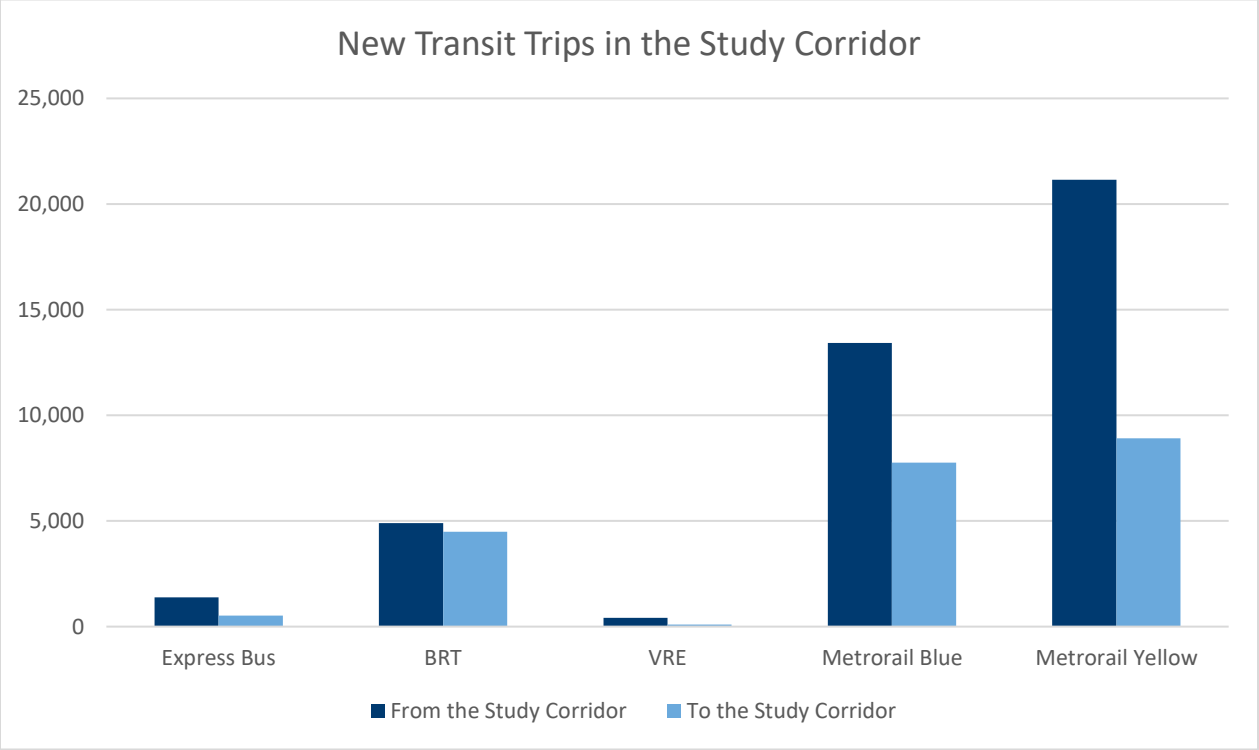
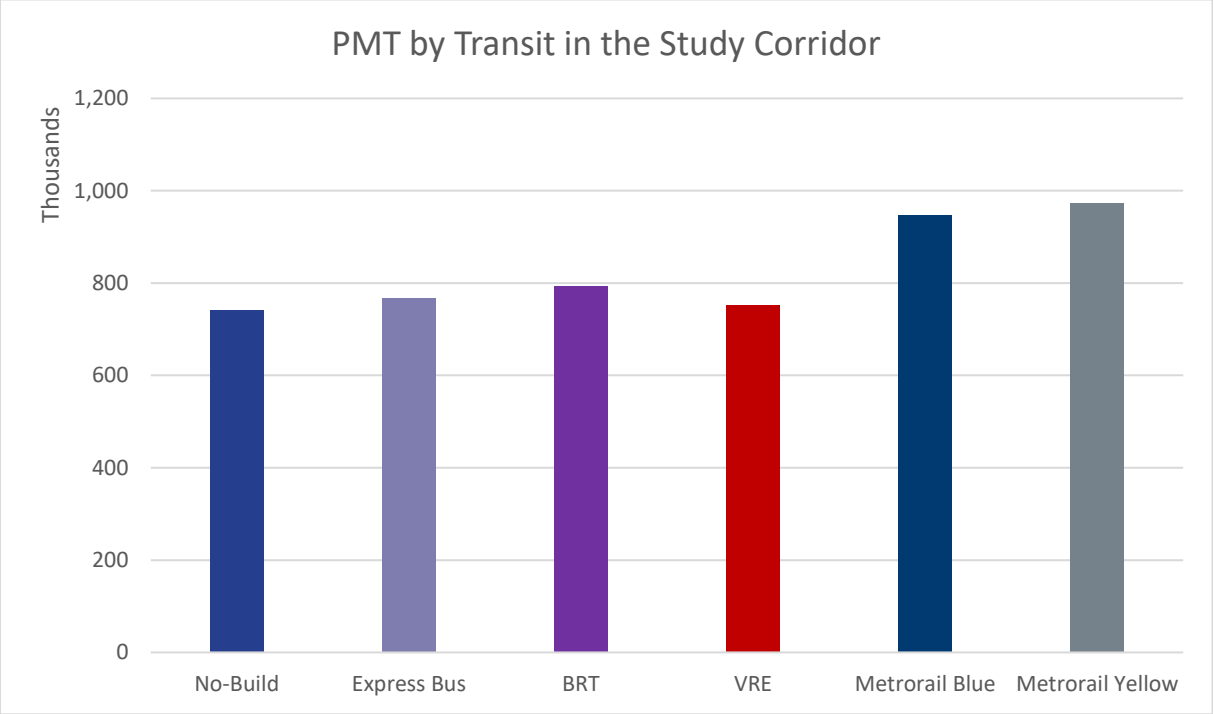


Figure 5-7 presents the daily passenger miles traveled (PMT) by transit in the Study Corridor. PMT quantifies the distance people are traveling on transit—so longer trips count more in this metric. The Metrorail alternatives carry more people for longer distances in the Study Corridor than the other alternatives. BRT also carries more people than the other alternatives but for shorter and more local trips than the Metrorail extensions.

FIGURE 5-7 PASSENGER MILES TRAVELED BY TRANSIT IN THE STUDY CORRIDOR



Congestion Mitigation

For the Congestion Mitigation goal, alternatives were evaluated in terms of the ability to reduce traffic congestion in the Study Corridor. Only one evaluation measure was used – the Vehicle Miles Traveled (VMT) by level of congestion.

Figure 5-8 conveys the Vehicle Miles Traveled (VMT) by level of congestion. In all cases, total vehicle-miles of travel (VMT) goes down compared to the No-Build scenario—but by less than two percent.

Figure 5-9 shows only the amount of congested VMT – including both the "congested" and "severely congested" categories. All of the alternatives decrease congested VMT on roads in the Study Corridor compared with the No Build scenario. The Yellow Line alternative had the largest decrease in congested VMT of about four percent.

FIGURE 5-8 TOTAL VMT BY CONGESTION LEVEL

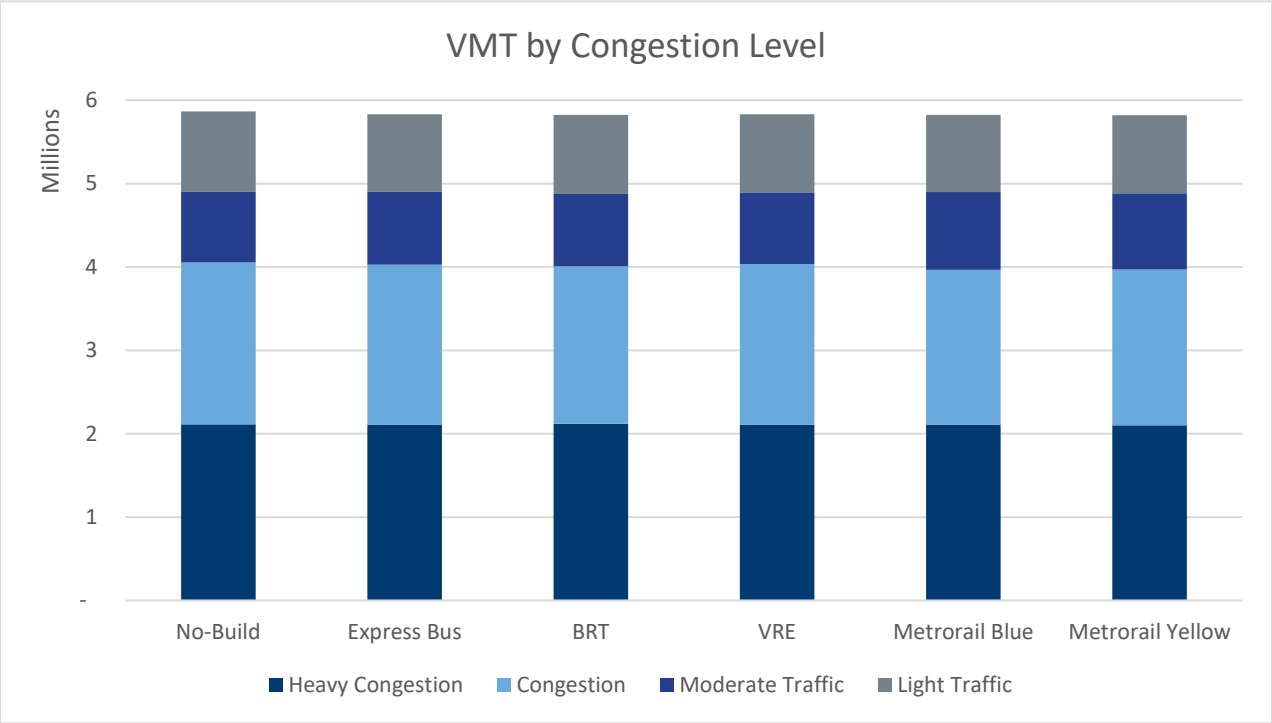
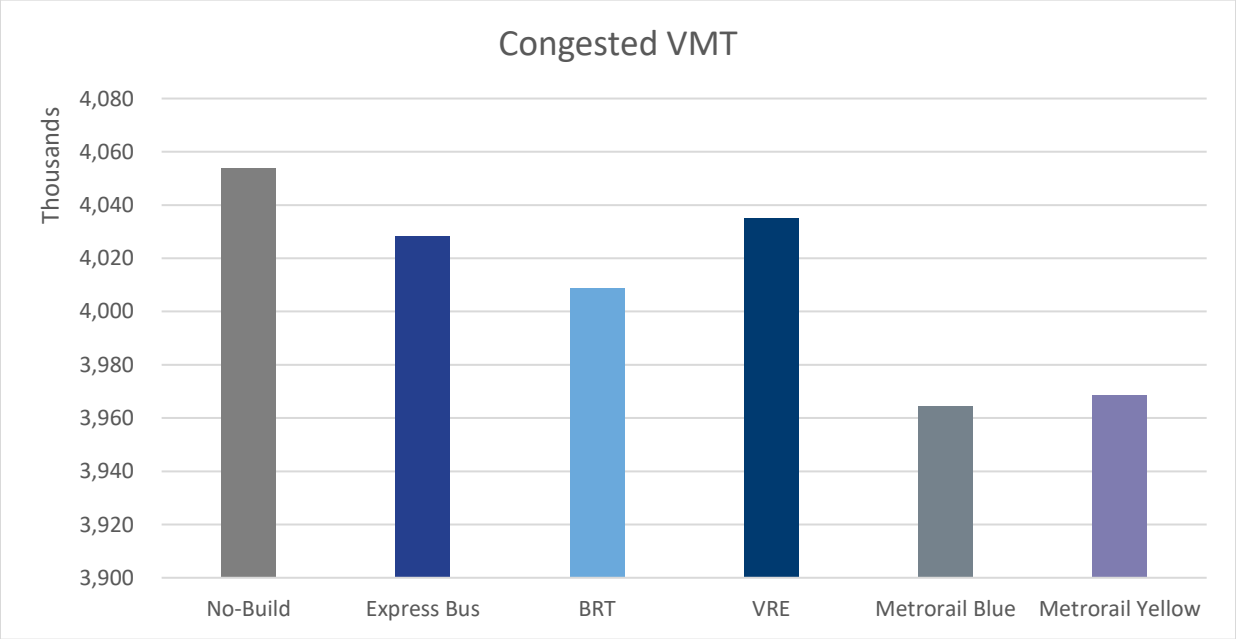


FIGURE 5-9 CONGESTED VMT



Regional Accessibility/Connectivity

For the Regional Accessibility/Connectivity goal, alternatives were evaluated in terms of the ability to improve access to regional activity centers and to meet identified service gaps. Evaluation measures included population and jobs within ½ mile of transit, number of jobs accessible within 60 minutes by transit, and number of residents able to access key employment centers (within 60 minutes. by transit).

Figure 5-10 reflects the number of people that would live or work within ½ mile of a proposed transit stop based on 2020 land use conditions. One-half mile is considered a reasonable walking distance to rapid transit stations; this is a longer distance than the one-quarter mile considered a reasonable walking distance to local bus service. Based on 2020 land use, the highest number of people would both live and work within walking distance of a BRT station, followed by the Metrorail Yellow Line with the next highest access for residents and the Metrorail Blue Line for the third highest access for jobs.

FIGURE 5-10 JOBS AND POPULATION NEAR TRANSIT (2020)

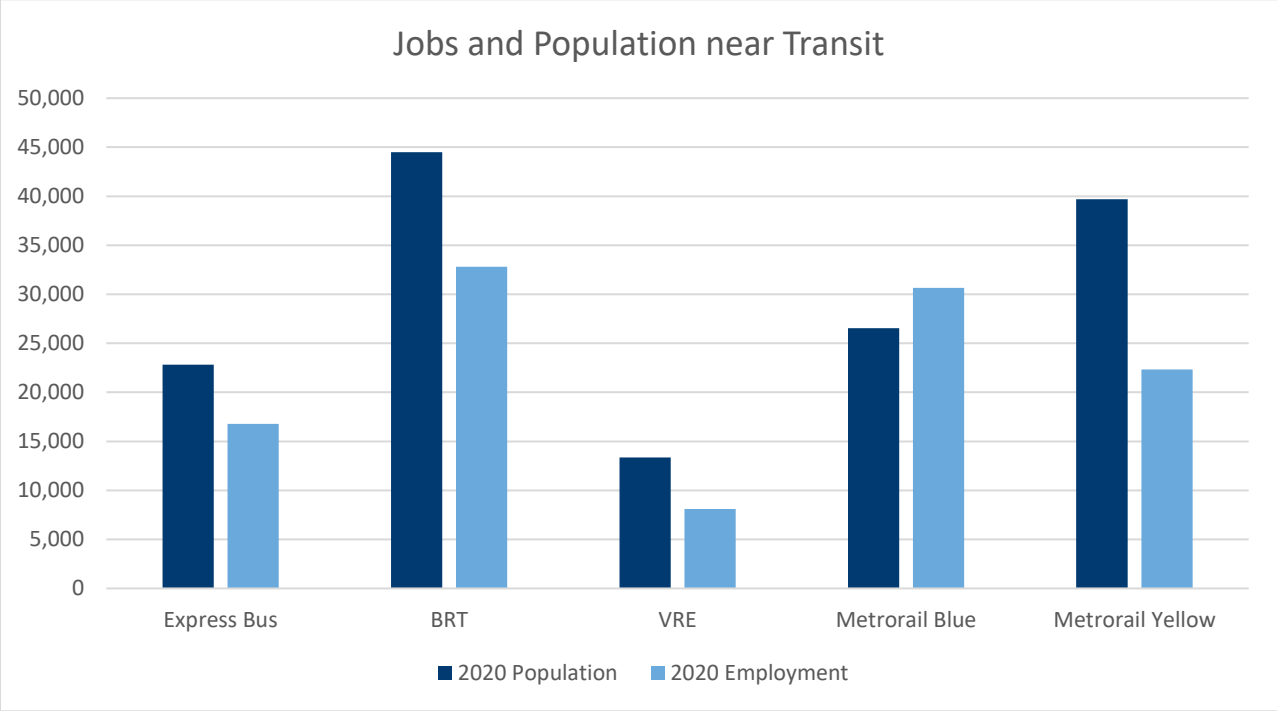


Figure 5-11 also calculates the population and employment within ½ mile access to transit stations, but for the 2045 forecasted land use conditions. Based on these future land use totals, the Metrorail Yellow Line would provide walk access for the most people within the Study Corridor, over 70,000 residents. The Blue Line Metrorail alternative would provide walk access to transit for the most jobs in 2045, over 40,000

employees. However, BRT provides the most balanced access, with walking distance access to transit to over 60,000 residents and almost 40,000 employees.

FIGURE 5-11 JOBS AND POPULATION NEAR TRANSIT (2045)

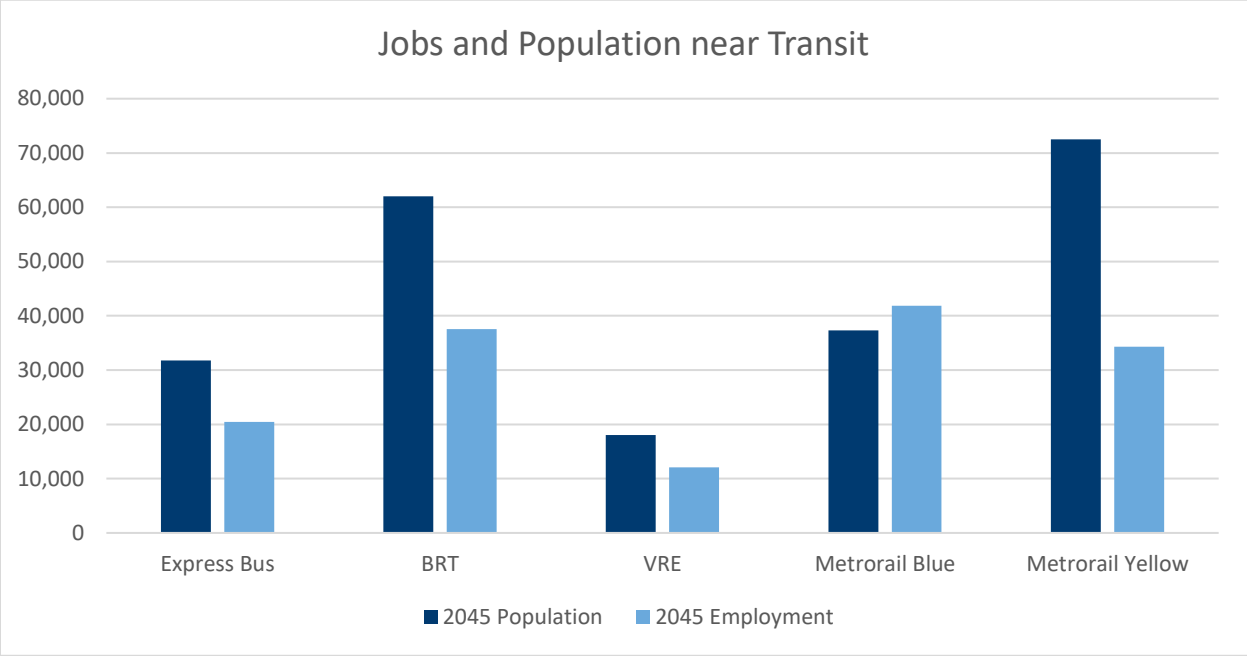


Figure 5-12 shows the increase in the number of jobs the average user in the Study Corridor could get to within a reasonable time (60 minutes). The largest increases are seen in both Metrorail lines, since those lines will connect to the major job hubs of DC, Alexandria, and Arlington. BRT and VRE see modest increases but those with new stations, such as the Metrorail lines and BRT, will generate the higher growth. Since the Express Buses do not include new stations, just additional service, there is no change in how many jobs can be reached.

FIGURE 5-12 NEW JOBS ACCESSIBLE WITHIN 60 MINUTES BY TRANSIT (PEAK)

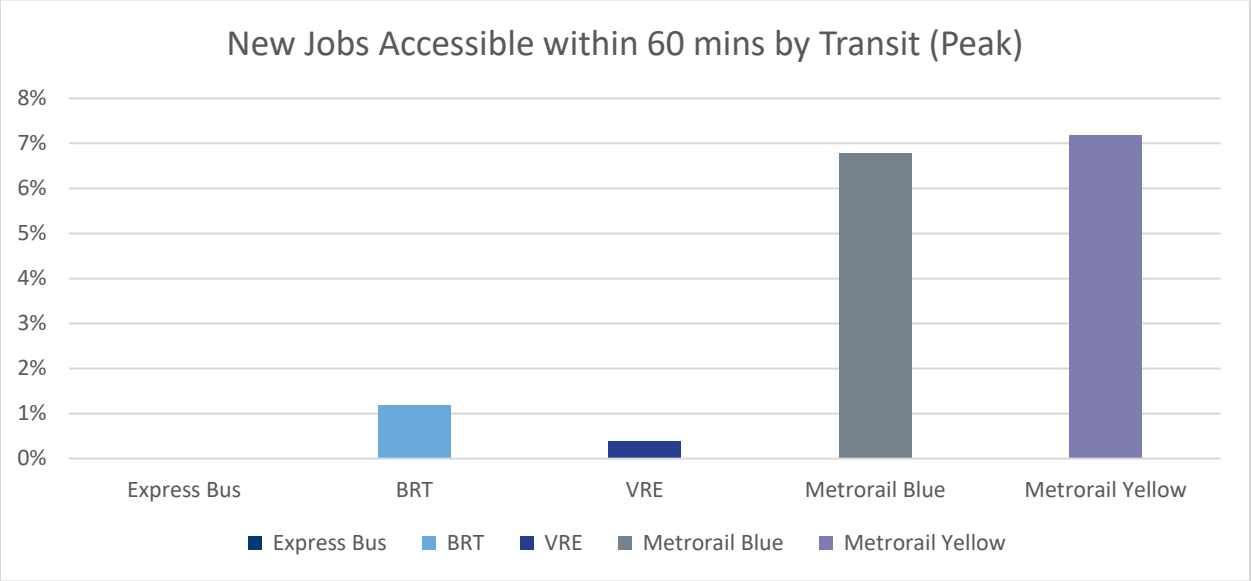


Figure 5-13 shows the accessibility to four main job centers within the Study Corridor (Fort Belvoir, Lorton, Potomac Mills, and Quantico) for each transit alternative. Across all transit alternatives, Lorton and Quantico have the highest growth in accessibility. Fort Belvoir and Potomac Mills would both have two percent or less growth in accessibility from any of the transit alternatives. Improvements to VRE would provide the highest growth in accessibility to Lorton while the Express Buses would provide Quantico the highest growth in accessibility.

FIGURE 5-13 GROWTH IN RESIDENTS WITH ACCESS TO JOB CENTERS

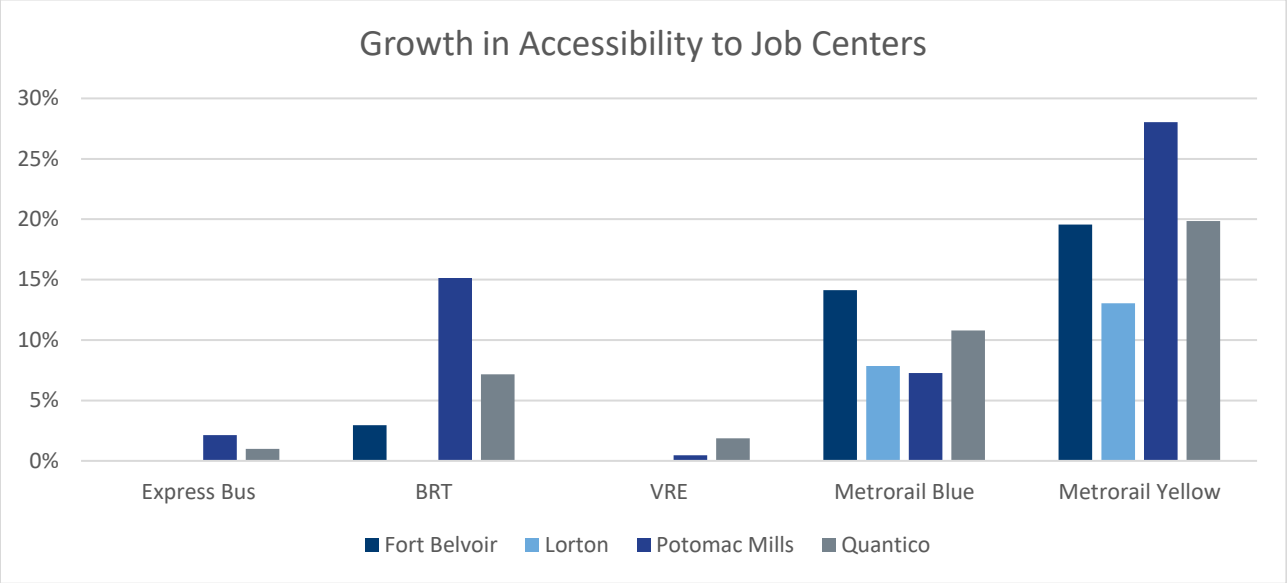


Figure 5-14 through **Figure 5-18** show the growth in job accessibility for each of these five alternatives, per traffic analysis zone (TAZ). The darker green the TAZ, the more additional jobs that TAZ would have access to within 60 minutes by transit compared to the no-build alternative. These results mirror the results from Figure 5-13. The Metrorail alternatives have multiple TAZs that experience job accessibility growth of over 100,000, while Express Bus, BRT and VRE alternatives do not have any TAZs that reach 100,000 new jobs within 60 minutes.

FIGURE 5-14 INCREASE IN JOB ACCESSIBILITY (WITHIN 60 MINUTES), EXPRESS BUS ALTERNATIVE

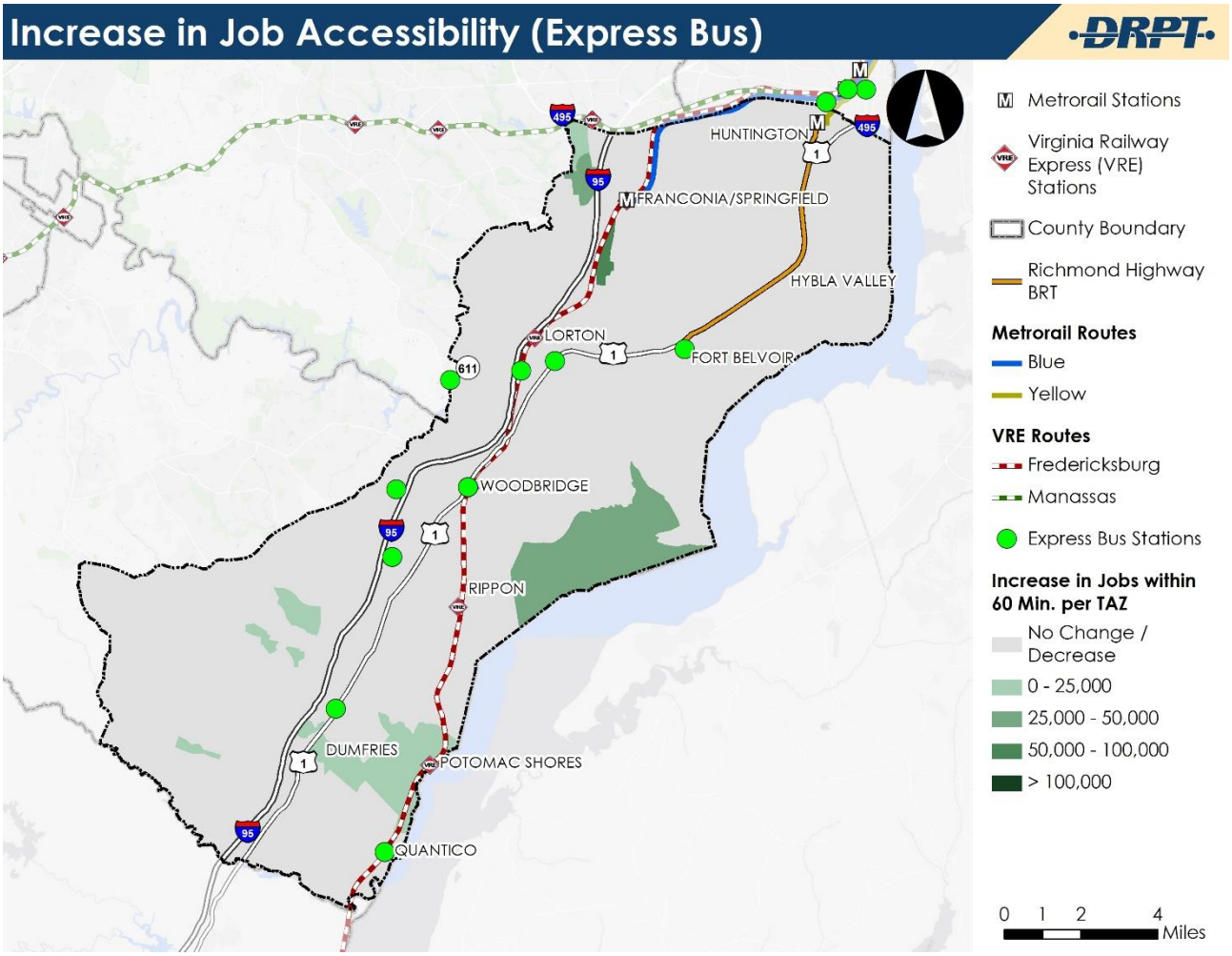


FIGURE 5-15 INCREASE IN JOB ACCESSIBILITY (WITHIN 60 MINUTES), BRT ALTERNATIVE

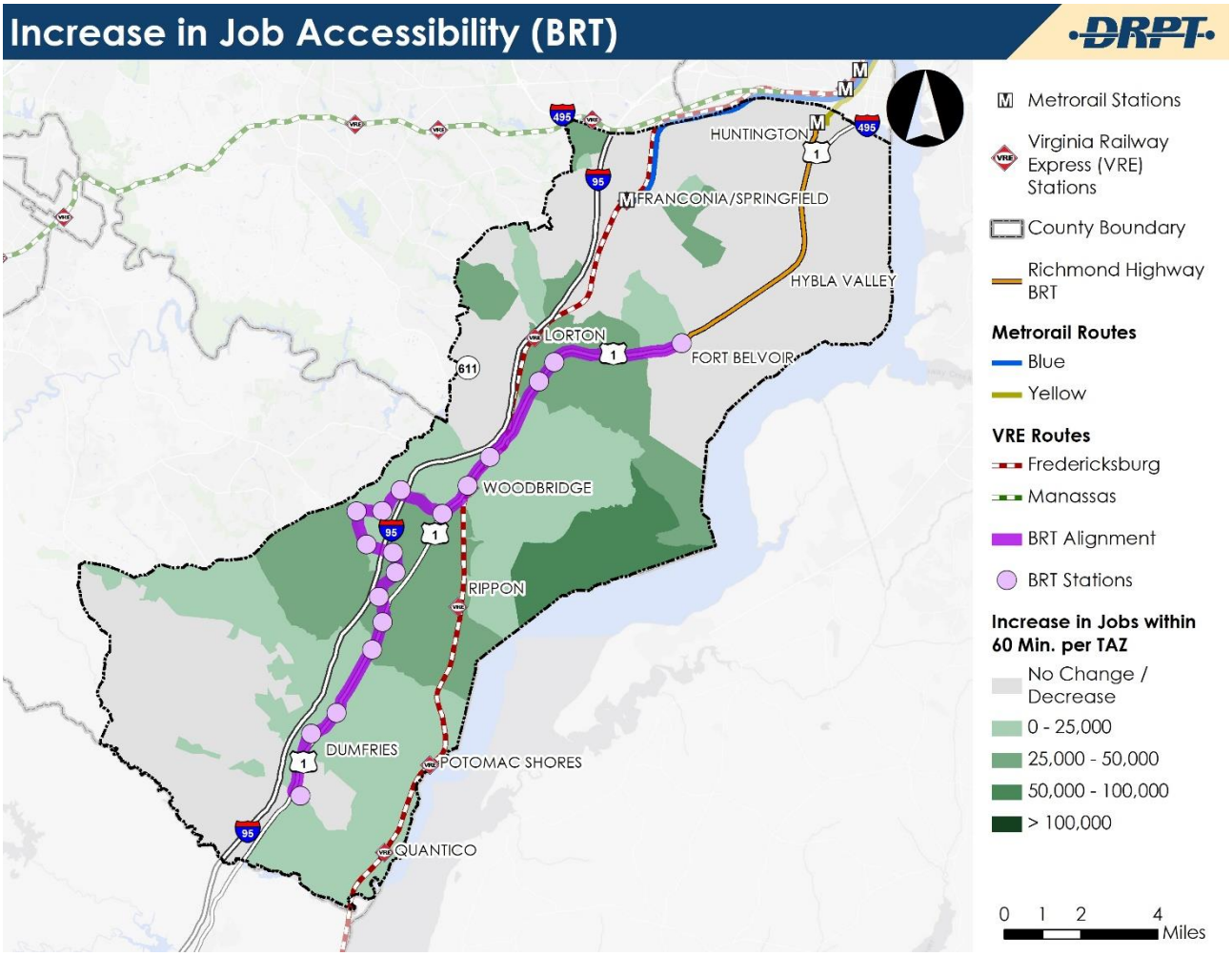


FIGURE 5-16 INCREASE IN JOB ACCESSIBILITY (WITHIN 60 MINUTES), VRE ALTERNATIVE

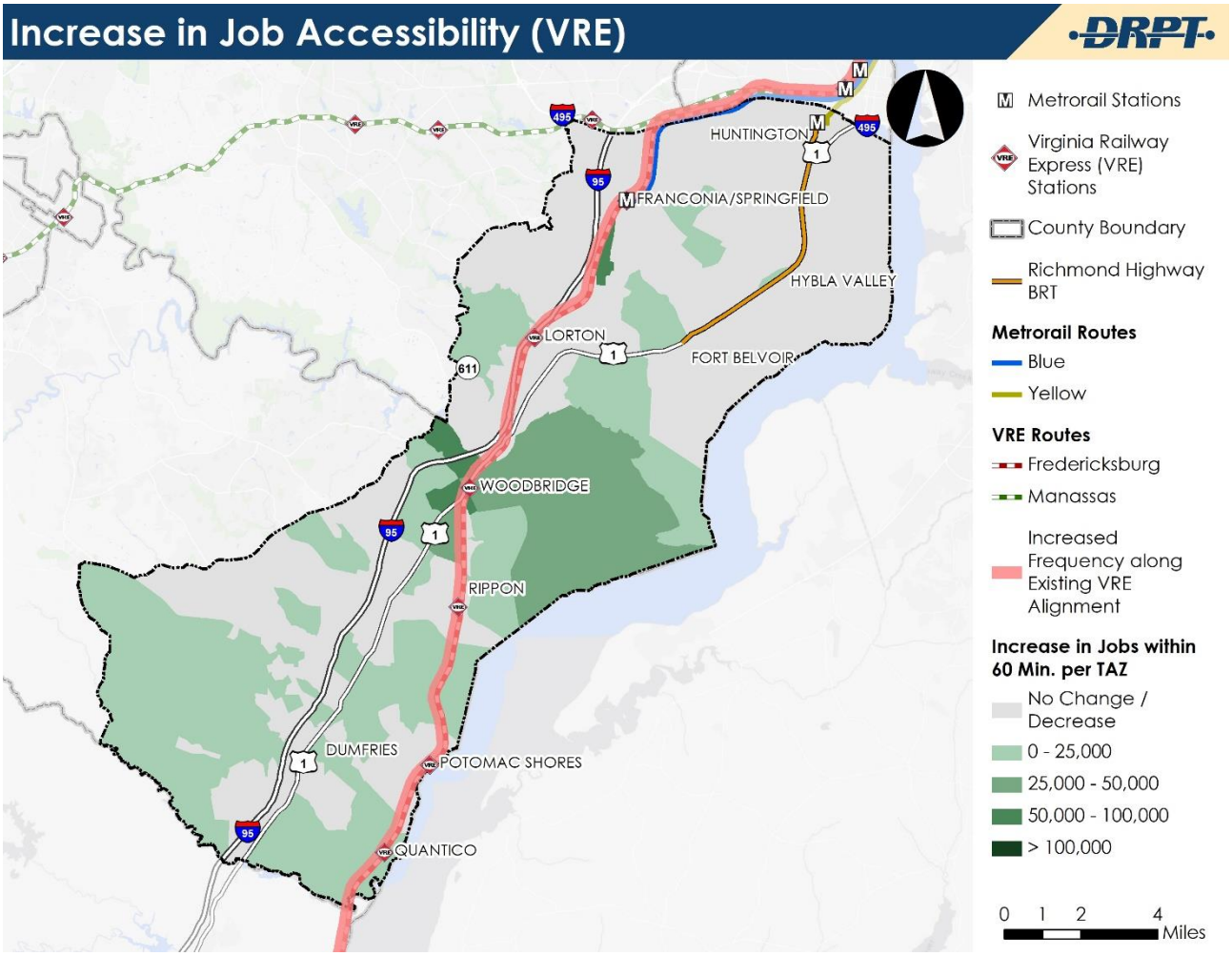


FIGURE 5-17 INCREASE IN JOB ACCESSIBILITY (WITHIN 60 MINUTES), METRORAIL BLUE LINE ALTERNATIVE

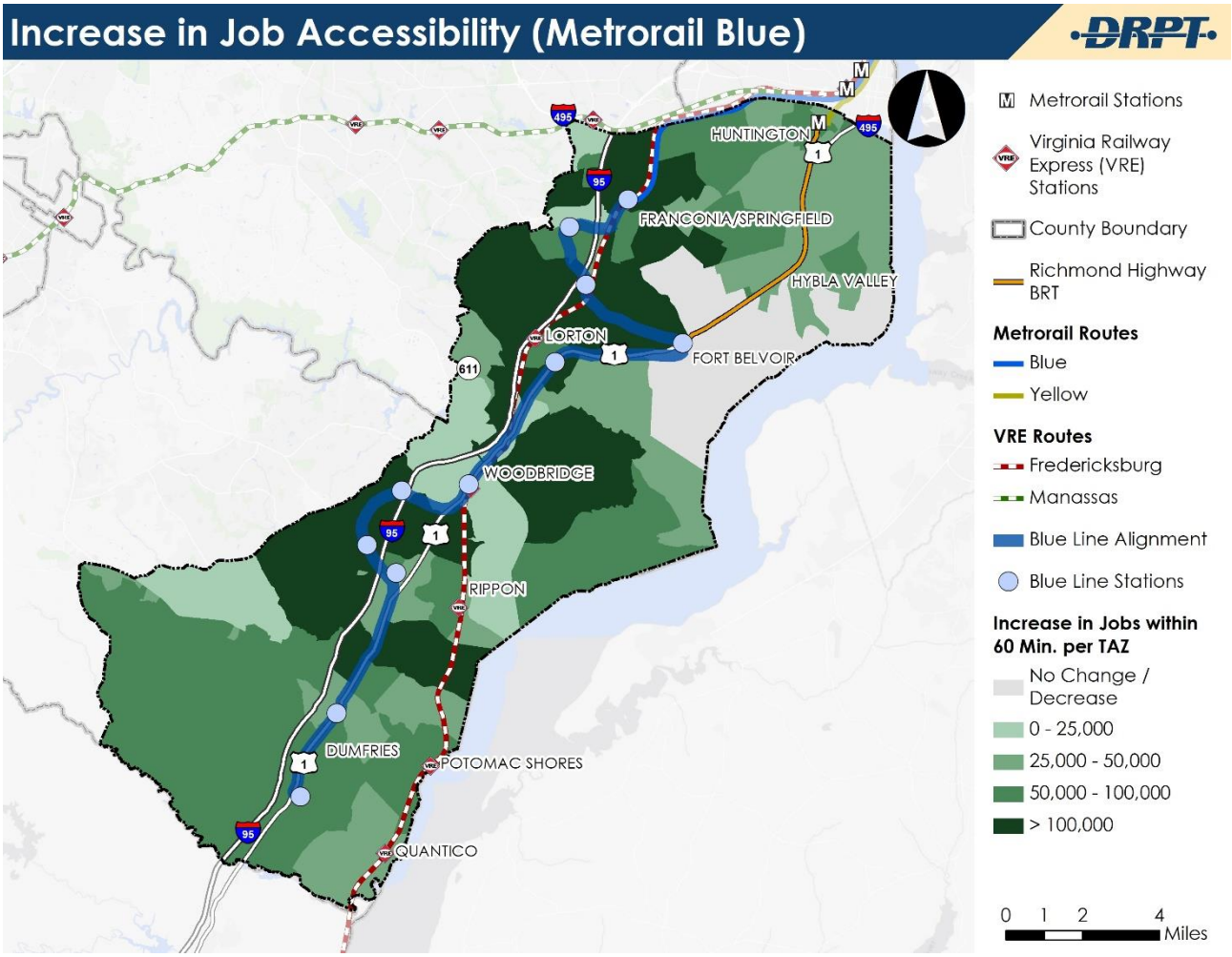
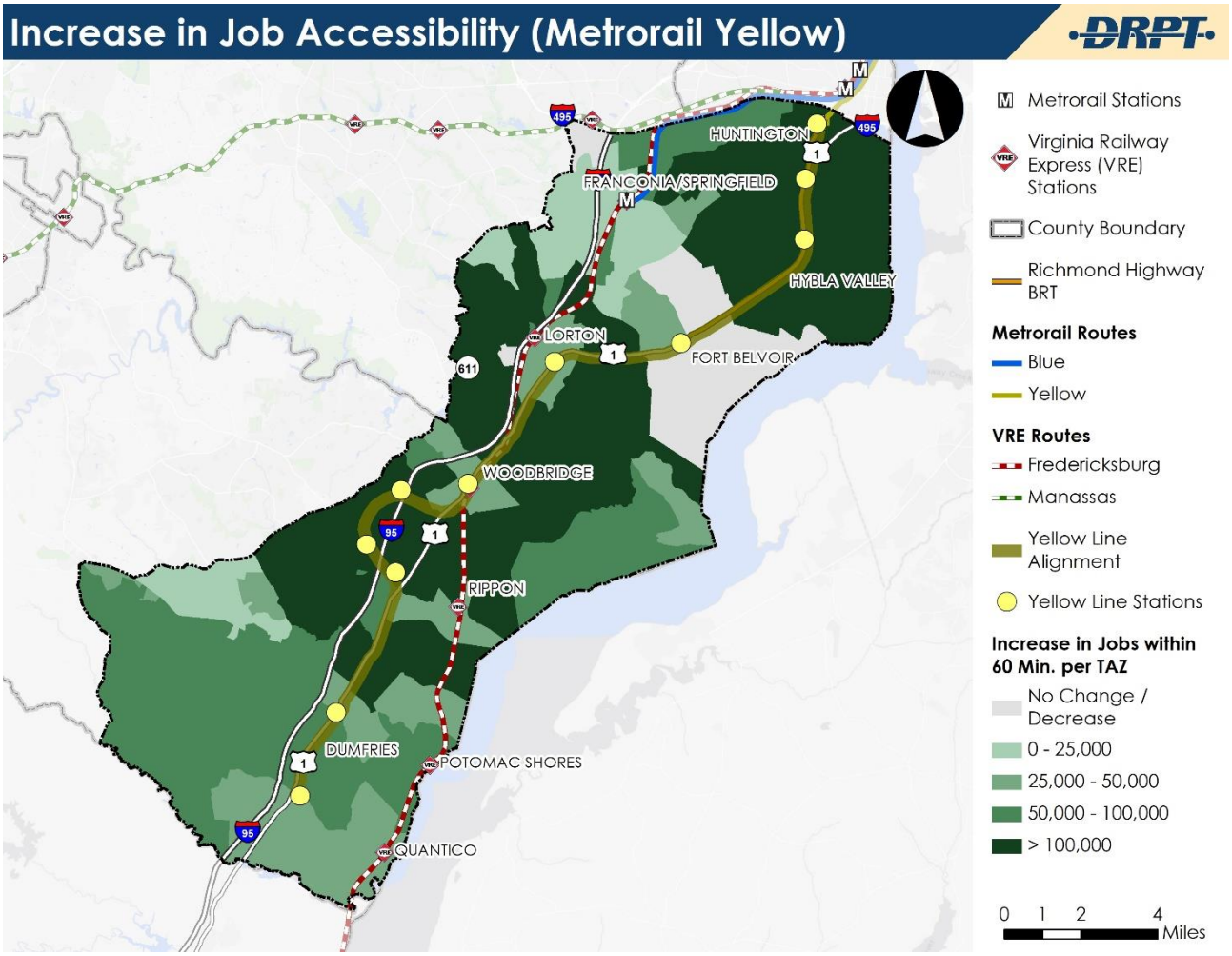


FIGURE 5-18 INCREASE IN JOB ACCESSIBILITY (WITHIN 60 MINUTES), METRORAIL YELLOW LINE ALTERNATIVE



Equity

For the Equity goal, alternatives were evaluated in terms of the ability to provide a fair distribution of costs and benefits across different population groups. The Metropolitan Washington Council of Governments (MWCOG) and the National Capital Region Transportation Planning Board (TPB) have designated Equity Emphasis Areas (EEAs) in the Washington, DC region. EEAs are based on concentrations of low-income residents and minority residents. Evaluation measures for this study included access to jobs within 60 minutes by transit, walk access to transit stations (within ½ mile), and number of daily transit trips by residents of EEAs.

Figure 5-19 presents a map of EEAs within the Study Corridor, shown in Magenta. The EEAs cluster around US 1 and I-95 both in the south and north of the Study Corridor.

FIGURE 5-19 EQUITY EMPHASIS AREA (EEA) MAP

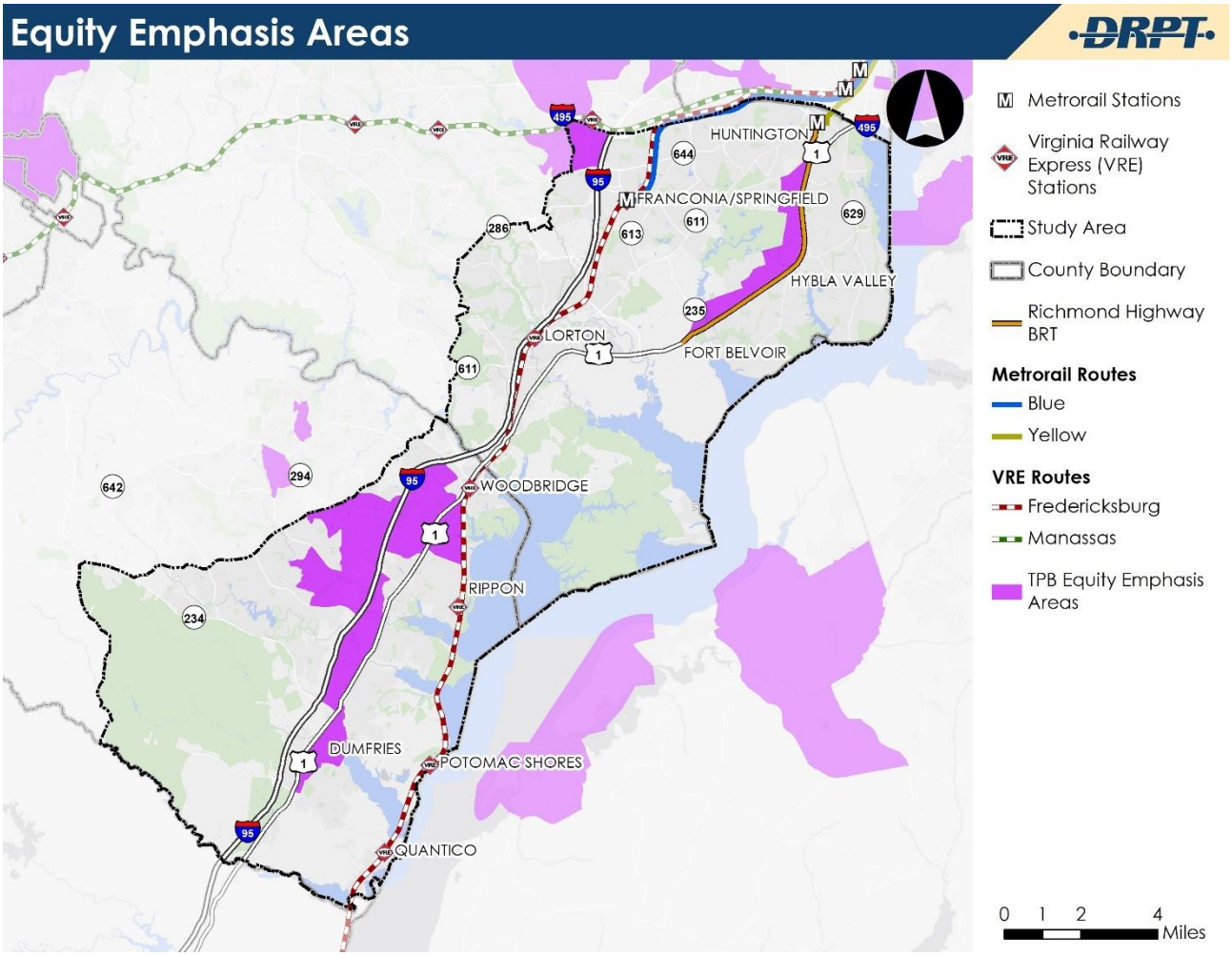
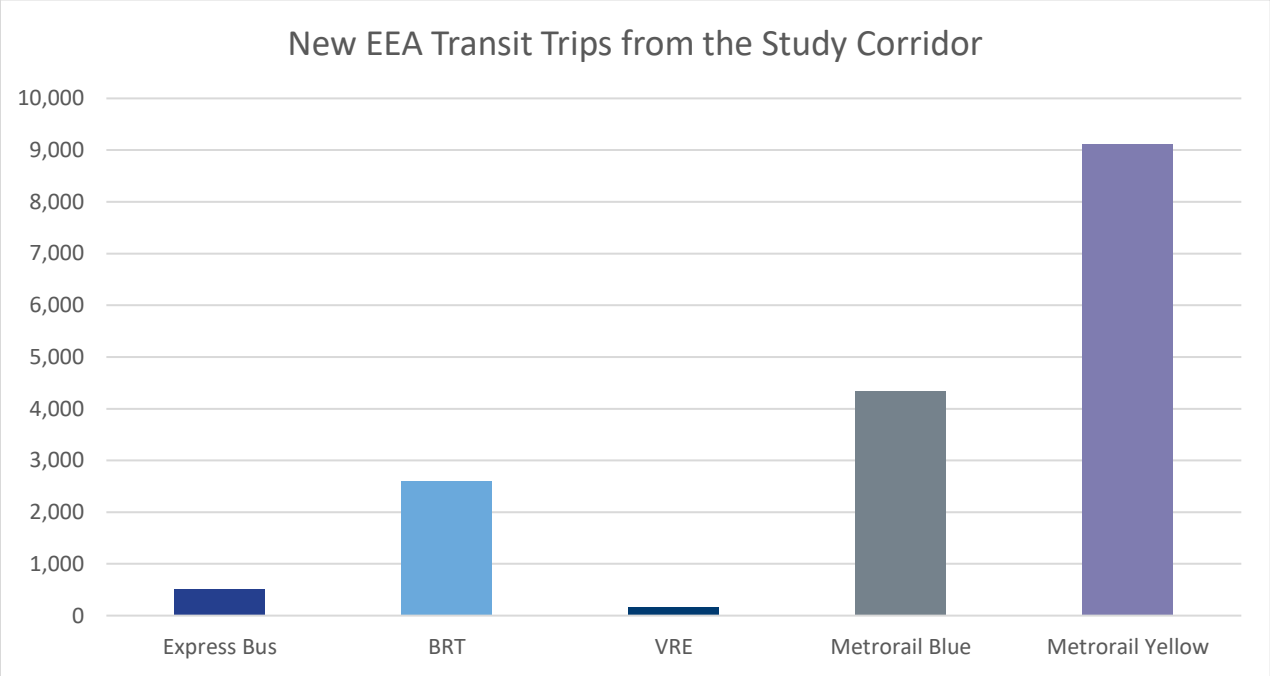


Figure 5-20 presents new transit trips made by residents of EEAs. Trips from EEAs are predicted to increase at a higher rate compared to overall new transit trips. The Yellow Line alternative is expected to have the most new transit trips made by EEA residents, followed by the Blue Line and BRT. This is largely due to the Yellow Line running through EEA areas in both the northern and southern segments of the Study Corridor.

FIGURE 5-20 NEW EEA TRANSIT TRIPS FROM THE STUDY CORRIDOR



Job accessibility within 60 minutes by transit for EEAs grows more than for the overall Study Corridor for all alternatives that show any increase, as shown in **Figure 5-21**. The largest increase is predicted for the Yellow Line alternative, with 30 percent more jobs available within 60 minutes by transit to those in EEAs, followed by the Blue Line alternative with a 10 percent increase.

FIGURE 5-21 JOB ACCESSIBILITY FOR EEAS

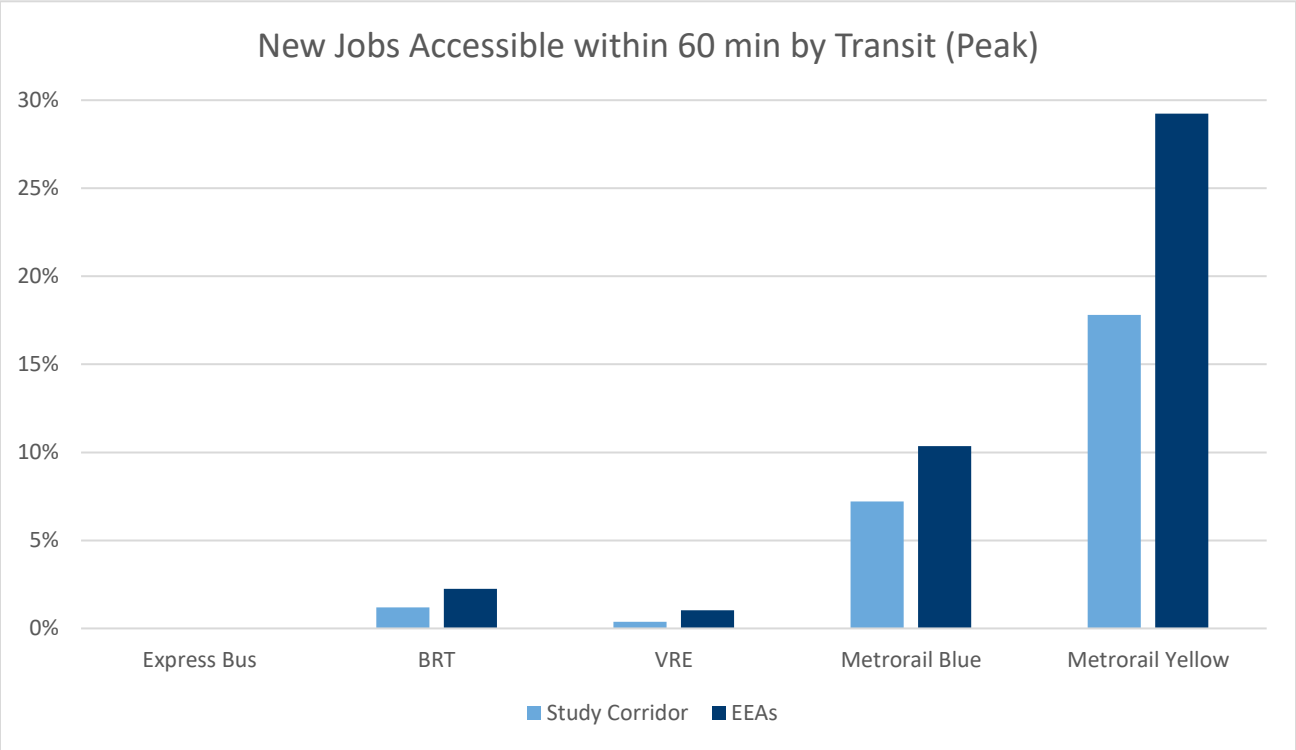
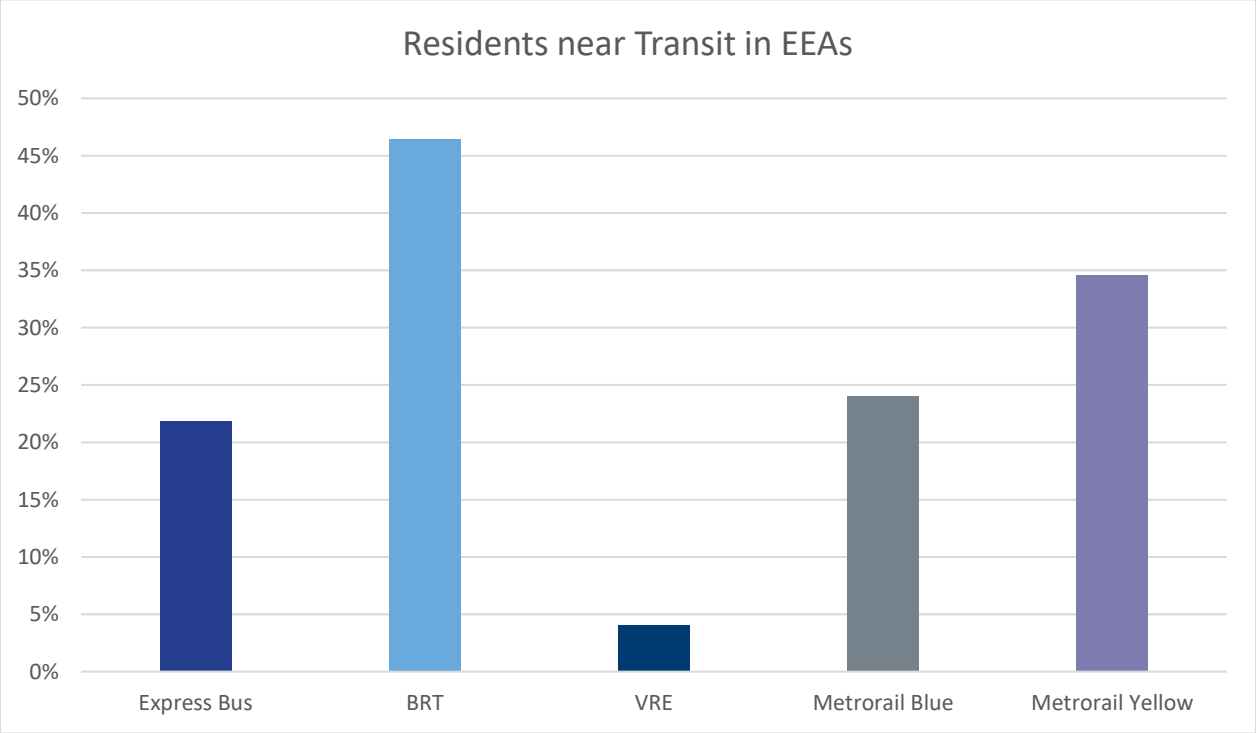


Figure 5-22 presents the portion of residents within ½ mile of transit that live in an EEA in the Study Corridor. Almost half of residents near the BRT alternative live in an EEA, meaning they are more likely to be low-income and/or a minority. This suggests that the BRT alternative may have the most equitable impact of the transportation alternatives in terms of expanding walk access. Trips taken by residents of EEAs still make up a large part of new transit trips for both Metrorail lines and the express bus alternative, all over 20 percent. However, the VRE alternative has the lowest percentage of EEA residents living with ½ mile, at less than five percent.

FIGURE 5-22 PORTION OF RESIDENTS NEAR TRANSIT THAT LIVE IN EEAS

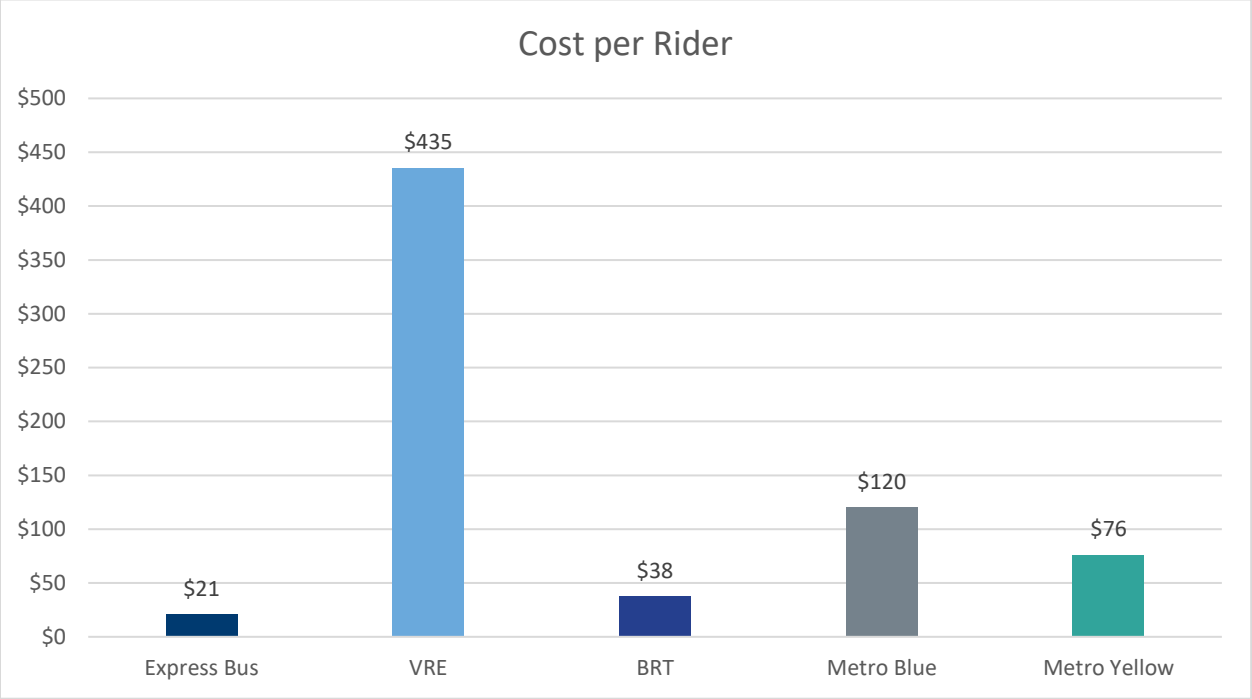


Cost-Effectiveness

For the Cost-Effectiveness goal, alternatives were evaluated to ensure that resources are used efficiently, by comparing the usage relative to the total cost of the alternatives. Evaluation measures included cost per rider, cost per new transit trip, and cost per new transit passenger miles traveled (PMT).

Figure 5-23 shows the total cost per rider for each of the alternatives. In calculating this measure, rail boardings are doubled to reflect return trips (alightings) made within the Study Corridor. For the BRT and Express Bus alternatives, total ridership on the entire line is already captured by the total boardings. The VRE and Metrorail alternatives are the most expensive per rider, ranging from $76 to $435 per rider. The BRT cost per rider is roughly half of the Yellow Line alternative, at $38. Express Bus has a significantly lower cost per rider at about $21 per rider.

FIGURE 5-23 COST PER RIDER



As shown in **Figure 5-24**, a similar pattern emerges when cost is compared to the number of new transit trips for each alternative. Similar to the previous measure, bus alternatives cost less per new trip than the rail alternatives.

The cost per new transit PMT, as shown in **Figure 5-25**, also shows the rail alternatives being more costly than the bus alternatives. Each new transit PMT would cost $9.00 for the VRE alternative, with the two Metrorail lines costing $6.00. The BRT alternative is the next lowest cost per new transit PMT and again, the Express Bus alternative is the least expensive, costing $1.00 per new PMT.

FIGURE 5-24 COST PER NEW TRANSIT TRIP

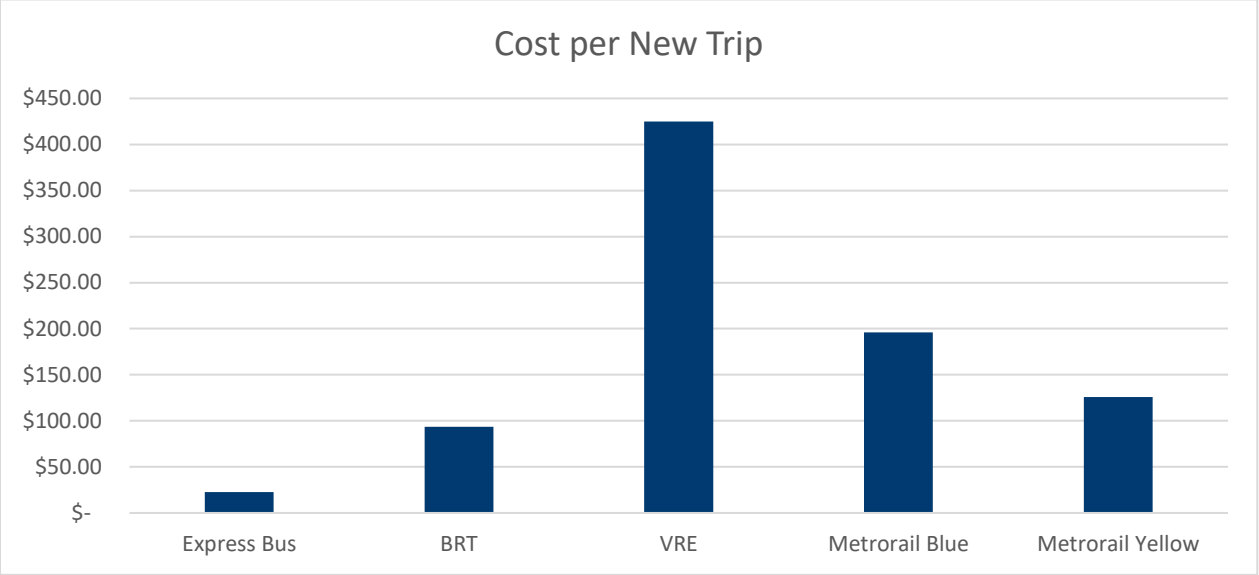
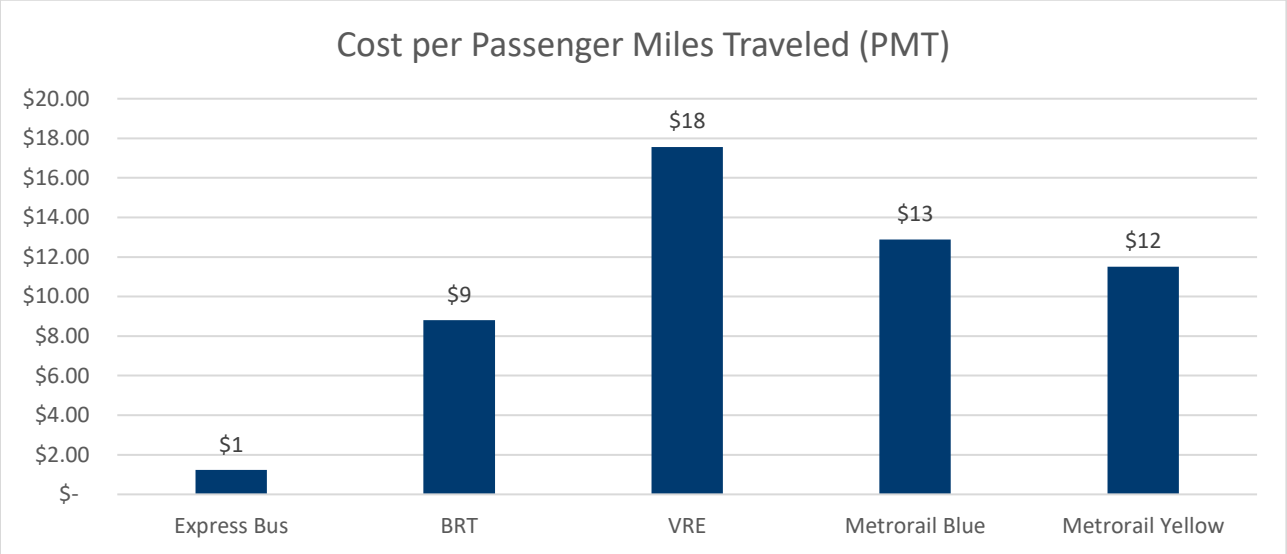


FIGURE 5-25 COST PER TRANSIT PMT



5.3 Sensitivity Tests

In addition to the evaluation of the five alternatives, the study team performed additional sensitivity tests to address key questions:

- 1) Can alternatives be made more cost-effective by *shortening the alignments*, and
- 2) Given uncertainty related to the current COVID-19 pandemic impacts, what might happen to ridership forecasts if people keep *teleworking at enhanced levels*?

Shortened Alignments

The ridership forecasts for the full alignments showed very low ridership in the southern segments of the BRT and two Metrorail alternatives. All three of these alternatives predicted less than 700 daily boardings at stations south of Potomac Town Center. This section analyzes the predicted impact of shortening the alignments in those three transit alternatives, to see if doing so would improve the cost-effectiveness of the alternatives.

Figure 5-26 shows the proposed Yellow Line if it was shortened to end at Potomac Town Center instead of Triangle. This version eliminates two stations, Southbridge and Triangle, from the original alignment.

Figure 5-27 shows a shortened version of the Blue Line alternative, which proposes eliminating the same two stations, Southbridge and Triangle.

The shortened BRT alignment, shown in **Figure 5-28,** also ends at Potomac Center; however, it had more proposed stops than the Metrorail alternatives. This alignment eliminates the proposed BRT stations at Northern Virginia Community College, Neabsco, Leesylvania, Southbridge, Dumfries and Triangle.

FIGURE 5-26 SHORTENED YELLOW LINE

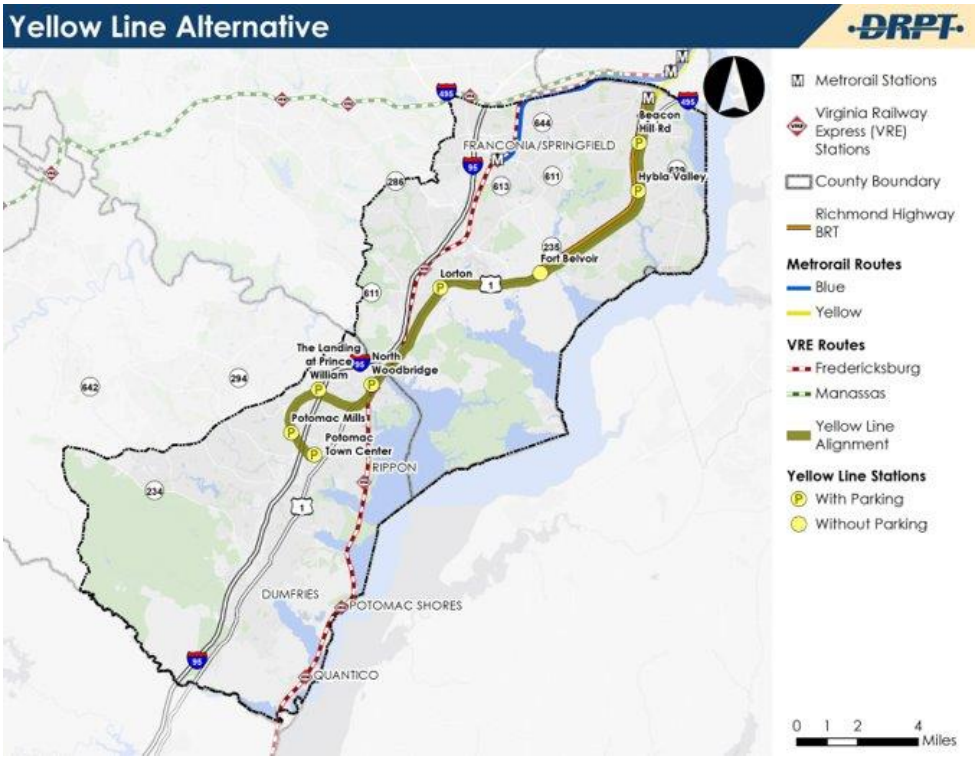


FIGURE 5-27 SHORTENED BLUE LINE

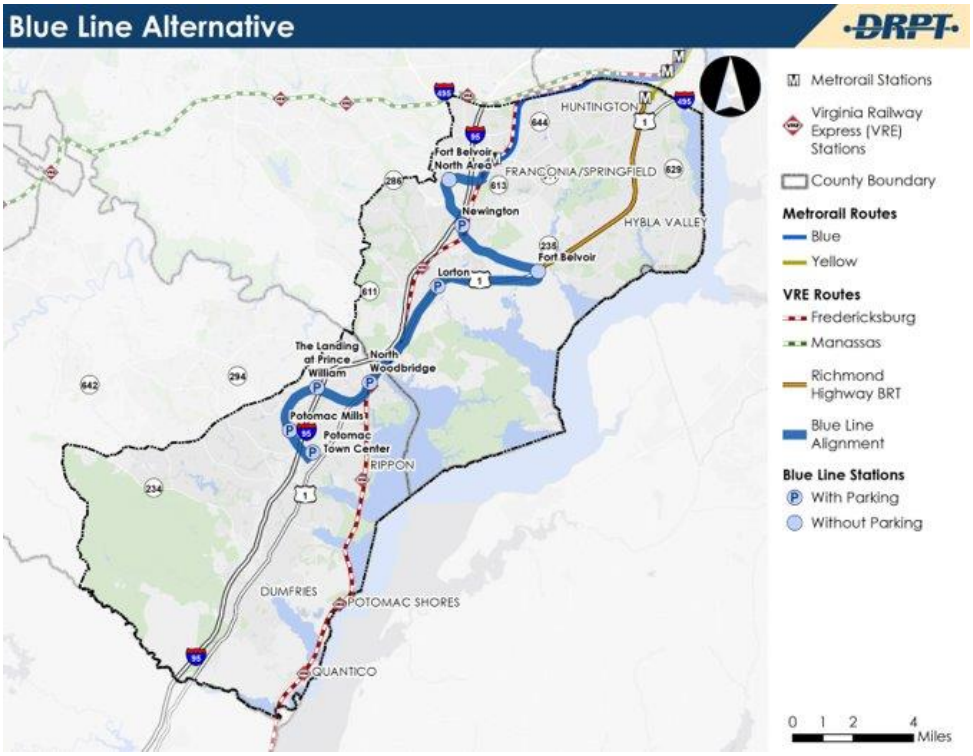
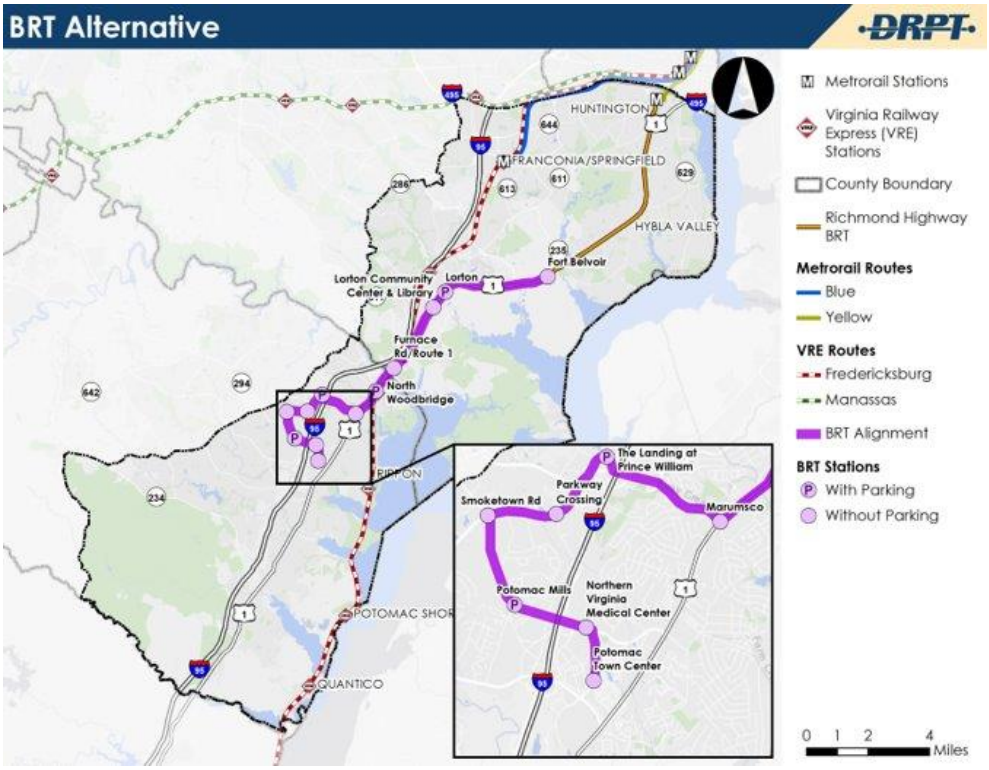


FIGURE 5-28 SHORTENED BRT ALIGNMENT



After analyzing the predicted ridership impact of truncating the three alignments, shown in **Table 5-2**, BRT is impacted more than the two Metrorail lines. BRT loses 14 percent ridership and sees a reduction of a third of new transit trips within the Study Corridor. However, shortening the BRT line results in almost no change in cost per rider.

TABLE 5-2 SHORTENED ALIGNMENT SENSITIVITY RESULTS

	BRT	Metrorail Blue Line	Metrorail Yellow Line
Line Ridership	-3,200 (-14%)	-1,000 (-4%)	-900 (-3%)
Total Corridor Transit Boardings	-3,100 (-4%)	0%	0%
New Transit Trips in Study Corridor	-1,600 (-32%)	-1,400 (-10%)	-1,300 (-6%)
Cost per New Trip	-$0.05 (-0%)	-$30.37 (-15%)	-$23.75 (-19%)

Both Metrorail lines show smaller decreases in ridership (under four percent) and new transit trips (less than ten percent) than BRT when those alignments are truncated. The difference in impact can likely be attributed to the difference in type of trips between BRT and Metrorail riders. The BRT alternative has more stations, so it is more likely to be serving local trips in the Study Corridor and would attract more riders that would walk to the stations. The Metrorail alternatives would see longer, commuting trips and many of the riders would drive to the station. Truncating the alignments does not affect the Metrorail alternatives as much because those riders can likely drive to the nearest station without as much inconvenience as for the BRT. Both Metrorail lines show a more substantial cost reduction with the shortened alignment due to the expense of heavy rail compared to BRT. Between the two Metrorail lines, the Blue Line's ridership is slightly more affected by the truncated alignment and sees a smaller percentage reduction of cost per rider.

Overall, the sensitivity test results suggest that it would be cost effective to truncate both Metrorail lines, but not necessarily BRT at Potomac Town center. BRT would lose significant ridership, while staying at roughly the same cost-effectiveness. Further study is warranted to find the most cost-effective location to truncate BRT, since Potomac Mills may be too far north.

Post-Pandemic Telework Changes

While telework had recently already become a more common option, the COVID-19 pandemic spurred an unprecedented amount of telework that will have impacts on the working environment for years to come. In 2019, 35 percent of Washington-area workers teleworked regularly or occasionally, up from 19 percent in 2007.[5] On a typical day in 2019, about 8.6 percent of Washington-area workers teleworked. Within the Study Corridor, 33 percent of Fairfax and Prince William workers teleworked 1.1 days per week, similar to the rest of the Washington region. Telework frequency also increased as household income increased. While only five percent of workers with incomes below $30,000 teleworked, almost half of workers making over $140,000 teleworked.

While many lower-income workers, particularly essential workers, were required to work in person during the pandemic, many others switched to teleworking. It is estimated that between 60 to 65 percent of Washington-area workers worked at home during the height of the pandemic. It is estimated that teleworking will be more common post-pandemic than it was pre-pandemic, so 2045 teleworking levels will likely be between the 33 percent teleworking 1.1 days per week pre-pandemic and the 60 percent during the pandemic.

[5] Metropolitan Washington Council of Governments (2019). https://www.mwcog.org/documents/2020/06/17/state-of-the-commute-survey-report--carsharing-state-of-the-commute-travel-surveys/

Regional survey data suggests an upper limit of teleworking at two days per week.[6] Table 5-3 shows three scenarios of teleworking in 2045 based on these predictions. The "low" scenario is 45 percent of the workforce teleworking an average of 1.1 days per week. The "medium" scenario is 50 percent of the workforce teleworking 1.3 days per week and the "high" scenario is 55 percent of the workforce teleworking an average of 1.5 days per week. These predictions for 2045 suggest that nearly three in ten work trips will be eliminated by teleworking.

Using a validated travel demand forecasting model, **Table 5-3** shows how each of these scenarios would affect ridership for the BRT and Metrorail alternatives. The BRT alternative sees less of an impact for all three scenarios, losing between eight to 17 percent of ridership. Metrorail alternatives are predicted to lose between 12 and 26 percent of ridership due to teleworking, which is high, particularly when taking into account the costs of the Metrorail alternatives.

The BRT and Metrorail alternatives would likely attract a different ridership as well. Metrorail is more likely to be used for commuting and longer trips, which is typical for white collar office workers that are more likely to have the option to telework. However, BRT trips are generally more local and more likely a commuting option for those that do not have the option to telework, such as those in the service or retail industries, or for more local shopping trips, which would not be as impacted in the long term by teleworking.

[6] Metropolitan Washington Council of Governments (2019). https://www.mwcog.org/documents/2020/06/17/state-of-the-commute-survey-report--carsharing-state-of-the-commute-travel-surveys/

TABLE 5-3 TELEWORK IMPACT ON RIDERSHIP SENSITIVITY RESULTS

	Future Telework Assumption	BRT Alternative Ridership Impact	Metrorail Alternatives Ridership Impact
Low	45% telework an average 1.1 days/week	-1,900 (-8%)	-5,000 (-12%)
Medium	50% telework an average 1.3 days/week	-2,800 (-12%)	-7,200 (-18%)
High	55% telework an average 1.5 days/week	-4,000 (-17%)	-10,600 (-26%)

6. Land Use Assessment

A comprehensive land use assessment was conducted in parallel with the screening and evaluation of potential transit improvements. The goal of the land use assessment was to identify the opportunities in the corridor for place making and network connectivity necessary for transit to be successful and to assess the potential for changes to land use that might result with major transit investment. This chapter summarizes the existing and planned land use, development and testing of land use development scenarios, and the implementation steps needed to advance transit-oriented development plans in the Study Corridor.

6.1 Existing and Future Land Use

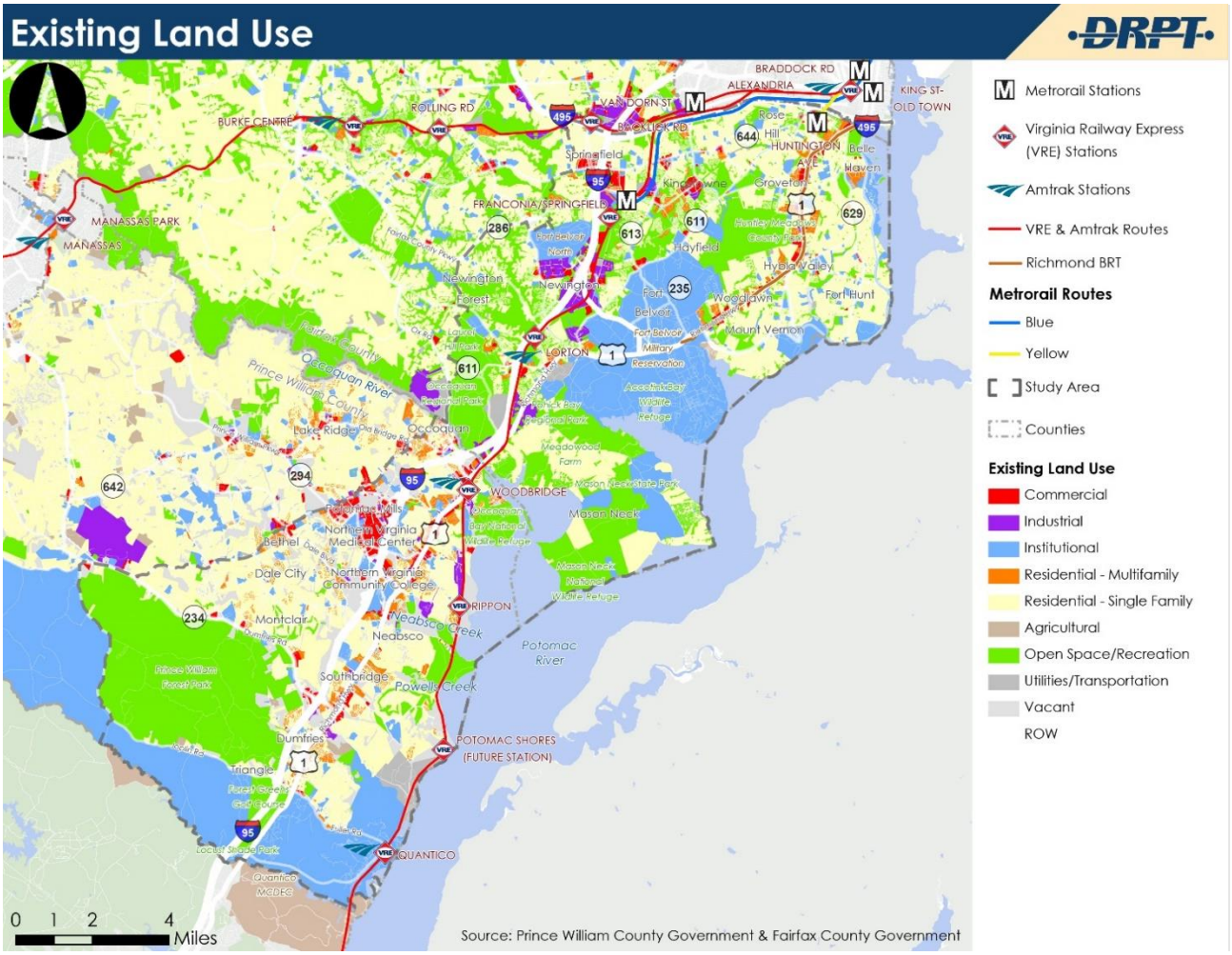
Existing Land Use

Existing land use was mapped and analyzed at the parcel level for the study area. The study area is characterized by predominantly suburban and exurban development along U.S. 1 and the I-95 corridor.

Commercial, retail, and medium to high-density residential areas are located in the northern part of the Study Corridor along U.S. 1 from the Huntington Metrorail station to Mount Vernon. This segment includes nodes such as Beacon Hill Road and Hybla Valley. Other commercial nodes with clusters of medium to high-density residential areas include Lorton and Woodbridge. Both Lorton and Woodbridge have VRE stations on the Fredericksburg Line. Woodbridge is also served by Amtrak's Northeast Regional rail service. Newington in Fairfax County has a cluster of distribution and warehouse industrial uses and is one of the few industrial areas in the County. Further south, significant suburban big-box retail centers are clustered in the Potomac Mills area. Low to medium density residential with pockets of commercial nodes are present south of Neabsco Creek including Dumfries and Triangle.

The study area also includes large military bases of Fort Belvoir, Fort Belvoir North, and Quantico. A significant area is also covered by environmentally sensitive and conserved open spaces such as the Huntley Meadows Park, Mason Neck State Park, Occoquan Bay National Wildlife Refuge, Featherstone National Wildlife Refuge, Leesylvania State Park, and Prince William Forest Park, amongst others. **Figure 6-1** maps existing land uses.

FIGURE 6-1 STUDY CORRIDOR EXISTING LAND USE



Future Land Use and Zoning

Future land use and zoning maps indicate that areas along the US 1 (Richmond Highway) and I-95 corridors are anticipated to be the focus of growth in the Study Corridor. Apart from commercial development, significant new residential and mixed-use development is planned on the west side of I-95 in the West Springfield and Dale City areas. **Figure 6-2** and **Figure 6-3** map future land use and zoning respectively. Change is envisioned along the VRE corridor south of Woodbridge to accommodate higher levels of residential and commercial activity but is more constrained in land area due in part to natural barriers and lower levels of regional highway connectivity. A new mixed-use master planned community is planned in Potomac Shores along with a new proposed VRE station.

FIGURE 6-2 STUDY CORRIDOR FUTURE LAND USE

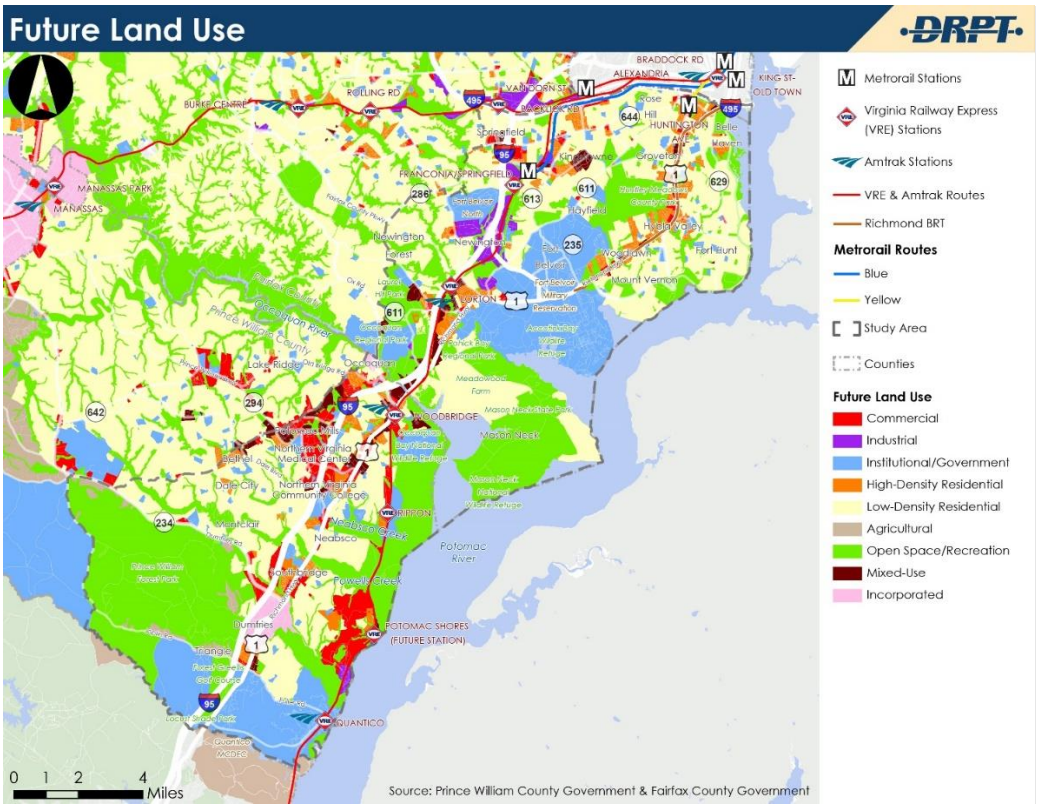
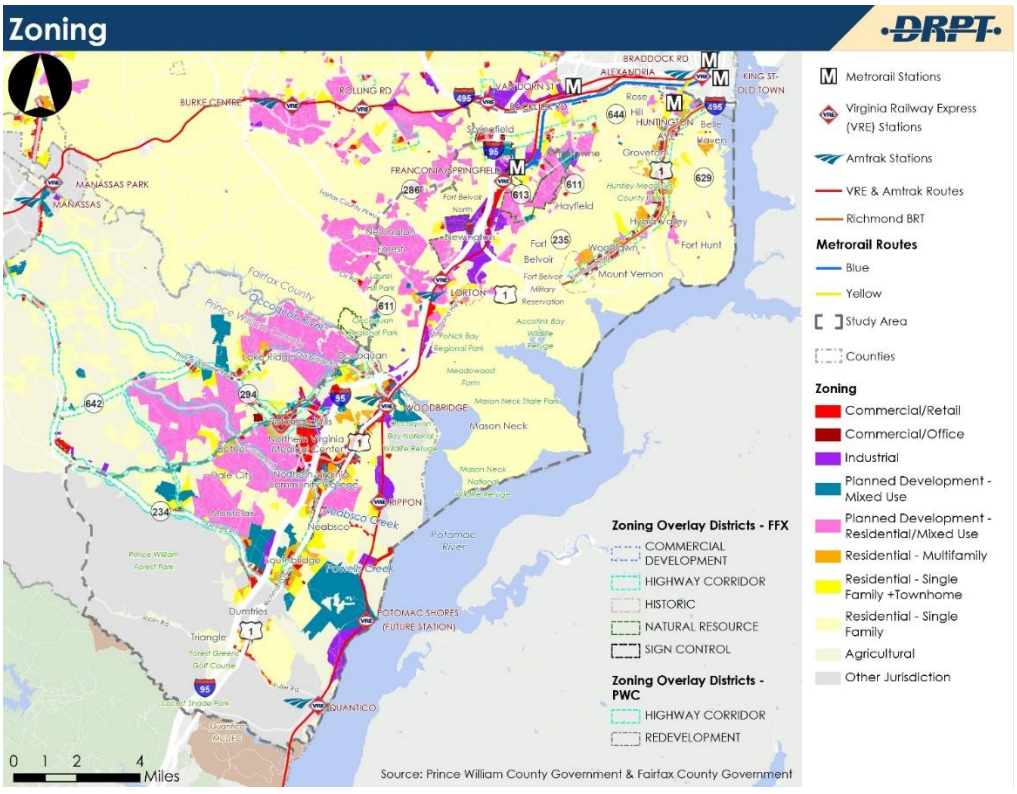


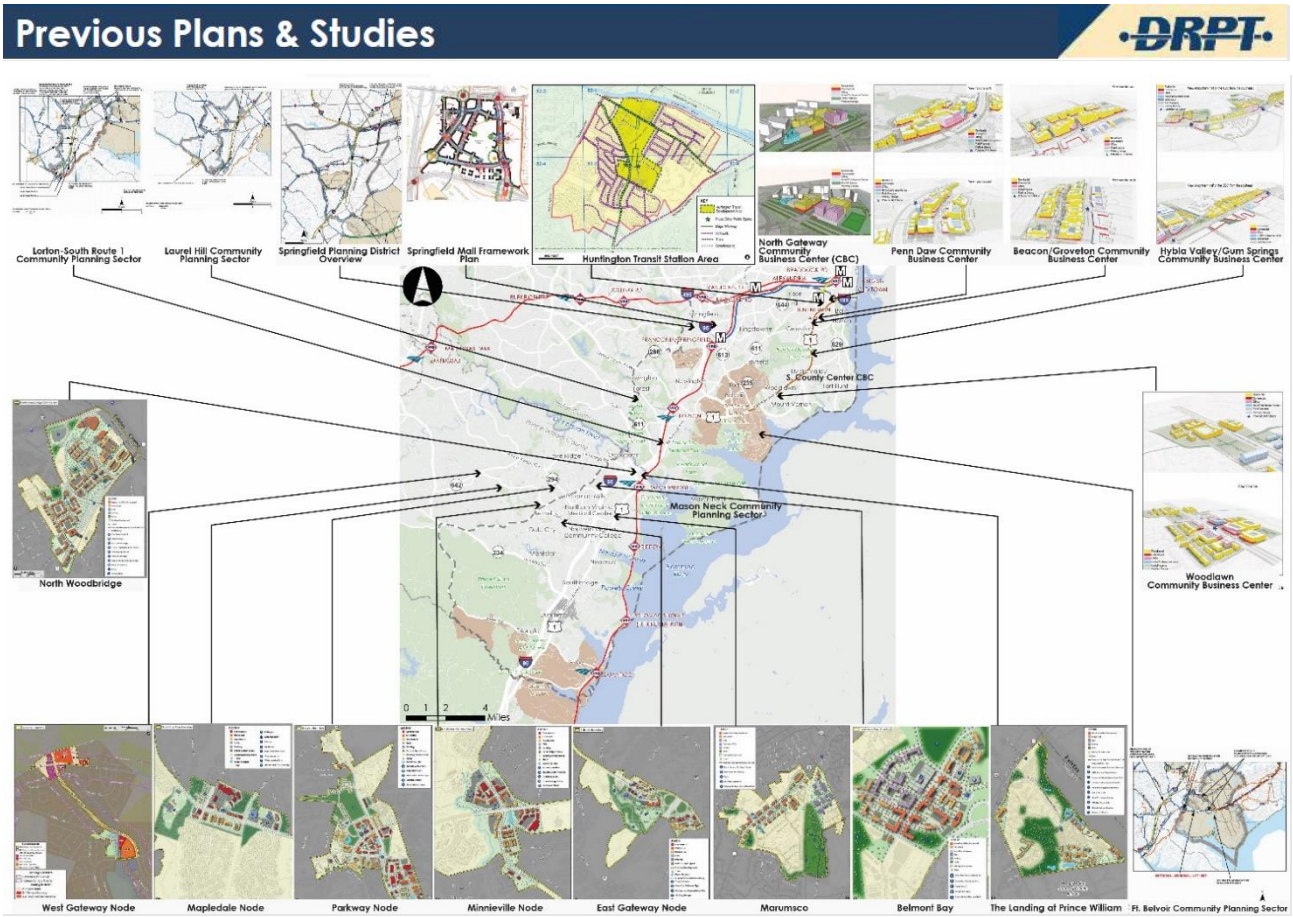
FIGURE 6-3 STUDY CORRIDOR ZONING



6.2 Previous & Ongoing Plans

Fairfax County and Prince William County have developed and adopted several Special Planning Area Plans and Small Area Plans in the Study Corridor. Apart from these, Fairfax County has developed additional plans specific to the Richmond Highway BRT project. These plans were reviewed in detail to identify future land use development and transportation projects. Existing and future Activity Centers and potential station locations were identified in part by reviewing recommendations in these plans. **Figure 6-4** illustrates the images and respective locations of the small area plans and studies that were reviewed.

FIGURE 6-4 PREVIOUS PLANS & STUDIES



The previous and ongoing plans that were reviewed include the following:

- Embark Richmond Highway BRT Study
- Lower Potomac Planning District Comprehensive Plan
- Franconia-Springfield Area and Fort Belvoir North Area
- North Woodbridge Small Area Plan

- The Landing at Prince William Small Area Plan
- Dale City Small Area Plan
- Triangle Small Area Plan

6.3 Growth Scenarios

Two land use development scenarios were tested. This sensitivity analysis looked at two different land use scenarios that added transit-oriented development (TOD) by increasing densities around the station areas:

1. Metrorail-focused TOD
2. BRT-focused TOD

Eight stations south of Fort Belvoir were selected for a detailed review of existing and planned land use and potential for Transit Oriented Development (TOD). These stations include Newington, Lorton, North Woodbridge, The Landing at Prince William, Potomac Mills, Potomac Town Center, Southbridge, and Triangle. Fort Belvoir and Fort Belvoir North stations were not reviewed since they are located adjacent to the military bases with limited potential for TOD. Beacon Hill and Hybla Valley stations on the Yellow Line were also not reviewed since Fairfax County has done significant TOD planning around these stations as part of the Richmond Highway BRT project.

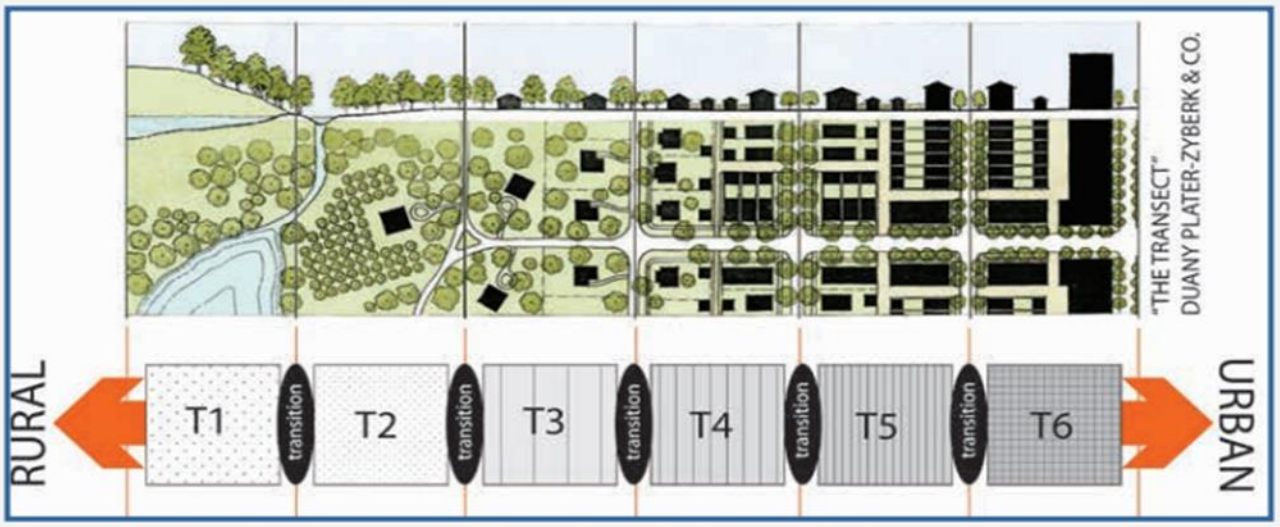
Land use intensities were adjusted around the eight station areas based on TOD potential using a tool called UrbanFootprint. Land use characteristics were drawn from the DRPT Multimodal System Design Guidelines (2020). The UrbanFootprint tool has the capability to create components, building types, and place types. Components include things such as individual buildings, parking areas and structures, landscaped and grassy recreational areas, right of way for streets, etc. Building types include mixtures of components in varying ratios to establish development densities that can be "painted" onto individual parcels. Building types (BTs) could more accurately be thought of as "parcel types." Place types (PTs) include mixes of building types and ratios of rights of way for utilities and streets, and may be utilized at the block level and larger areas.

In reference to the DRPT Multimodal Design Guidelines, Transect is a core concept that describes natural and built environments "as a set of bands of uniform density" named Transect Zones (**Figure 6.5**. The Transect Zones are often used at the block level, with "a consistency scale of density and intensity of development and the whole complement of streets, buildings, and open space". For painting development densities over transit corridors, PTs are considered more analogous to Transect Zones. Among the nine UrbanFootprint PTs developed for the project as shown in **Table 6-1**, six of the PTs were developed in accordance with Transect Zone Intensities as specified in the DRPT Multimodal Design Guidelines.

For both project scenarios, three tiers of land use intensities (**Table 6-2** and **Table 6-3**) were painted over parcels within one mile around the eight station areas based on current (year 2020) and baseline 2045 land use intensities (MWCOG Round 9.1a Cooperative Land Use Forecasts) such that the project scenarios reflect an overall growth over the baseline 2045 levels. The BRT scenario is shown in **Figure 6-6** and the Metro scenario is shown in **Figure 6-7.** Parcels that fall in "Parks and Recreation", "Cemeteries", "Civic Facilities" (including military), and "Education" were not painted. In addition, industrial parcels around Newington were not painted so as to preserve the industrial employment in the area.

Both Fairfax County and Prince William County are expected to add a significant population and jobs in the next 25 years. TOD planning within the Study Corridor that enhances transit ridership will be critical to leverage investments in premium transit. Successful TOD planning can result in more people choosing to ride transit or walk/bike to nearby destinations. TOD planning will assist the Study Corridor to grow more sustainably and reduce the future vehicular transportation impacts on existing roadways.

FIGURE 6.5 TRANSECT ZONES USED IN STATION AREA ASSESSMENT



TRANSECT ZONE INTENSITY			
Transect Zone	Activity Density (Jobs + people/acre)	Gross Development FAR (residenial + non-residential)	Net Development FAR (residenial + non-residential)
T-1	1 or less	0.01 or less	0.02 or less
T-2	1 to 10	0.01 to 0.15	0.02 to 0.23
T-3	10 to 25	0.15 to 0.37	0.23 to 0.57
T-4	25 to 60	0.37 to 0.9	0.57 to 1.38
T-5	60 to 100	0.9 to 1.49	1.38 to 2.3
T-6	100 or more	1.49 or more	2.3 or more

TABLE 6-1 URBANFOOTPRINT PLACE TYPES AND DENSITIES

Place Type & Transect Zone Description	Net floor area ratio (FAR)	Gross residential density (du/ac)	Gross population density (pop/ac)	Gross employment density (emp/ac)	Gross Activity Density (pop+emp per ac)	Gross parking density (spcs/1000 sq ft)
T-1 Very low intensity	0.02	0.10	0.22	0.40	0.62	2.24
T-2 Low intensity	0.12	1.18	2.14	1.67	3.81	1.97
T-3 Moderate intensity	0.28	4.69	8.11	4.64	12.75	1.7
T-3.5 Moderate intensity	0.59	12.20	21.01	8.23	29.24	2.07
T-4 Moderate intensity	0.91	17.96	30.92	12.47	43.39	1.67
T-4.5 Moderate-to-high intensity	1.36	32.03	54.55	22.52	77.07	1.78
T-5 High intensity	1.75	42.79	72.88	29.52	102.40	1.66
T-5.5 High intensity	2.21	54.43	92.69	37.04	129.73	1.52
T-6 High intensity	3.15	76.59	129.84	59.98	189.82	1.27

TABLE 6-2 BRT SCENARIO PLACE TYPES

No.	Station Name	Place Type		
		Quarter Mile	Quarter to Half Mile	Half to One Mile
1	**Newington**	**T-4**	**T-3.5**	**T-3.5**
2	**Lorton**	**T-4.5**	**T-3.5**	**T-3**
3	**North Woodbridge**	**T-4**	**T-4**	**T-4**
4	**The Landing at Prince William**	**T-3.5**	**T-3.5**	**T-4**
5	**Potomac Mills**	**T-4.5**	**T-4**	**T-4**
6	**Potomac Town Center**	**T-4.5**	**T-4**	**T-4**
7	**Southbridge**	**T-3.5**	**T-3**	**T-2**
8	**Triangle**	**T-3**	**T-3**	**T-2**

TABLE 6-3 METRO SCENARIO PLACE TYPES

No.	Station Name	Place Type		
		Quarter Mile	Quarter to Half Mile	Half to One Mile
1	Newington	T-4	T-3.5	T-3.5
2	Lorton	T-5	T-4	T-3
3	North Woodbridge	T-5	T-4.5	T-4
4	The Landing at Prince William	T-4	T-4	T-4
5	Potomac Mills	T-5	T-4	T-4
6	Potomac Town Center	T-5	T-4	T-4
7	Southbridge	T-4	T-3.5	T-3
8	Triangle	T-4	T-3	T-3

FIGURE 6-6 PARCELS PAINTED AROUND STATION AREAS UNDER THE BRT SCENARIO

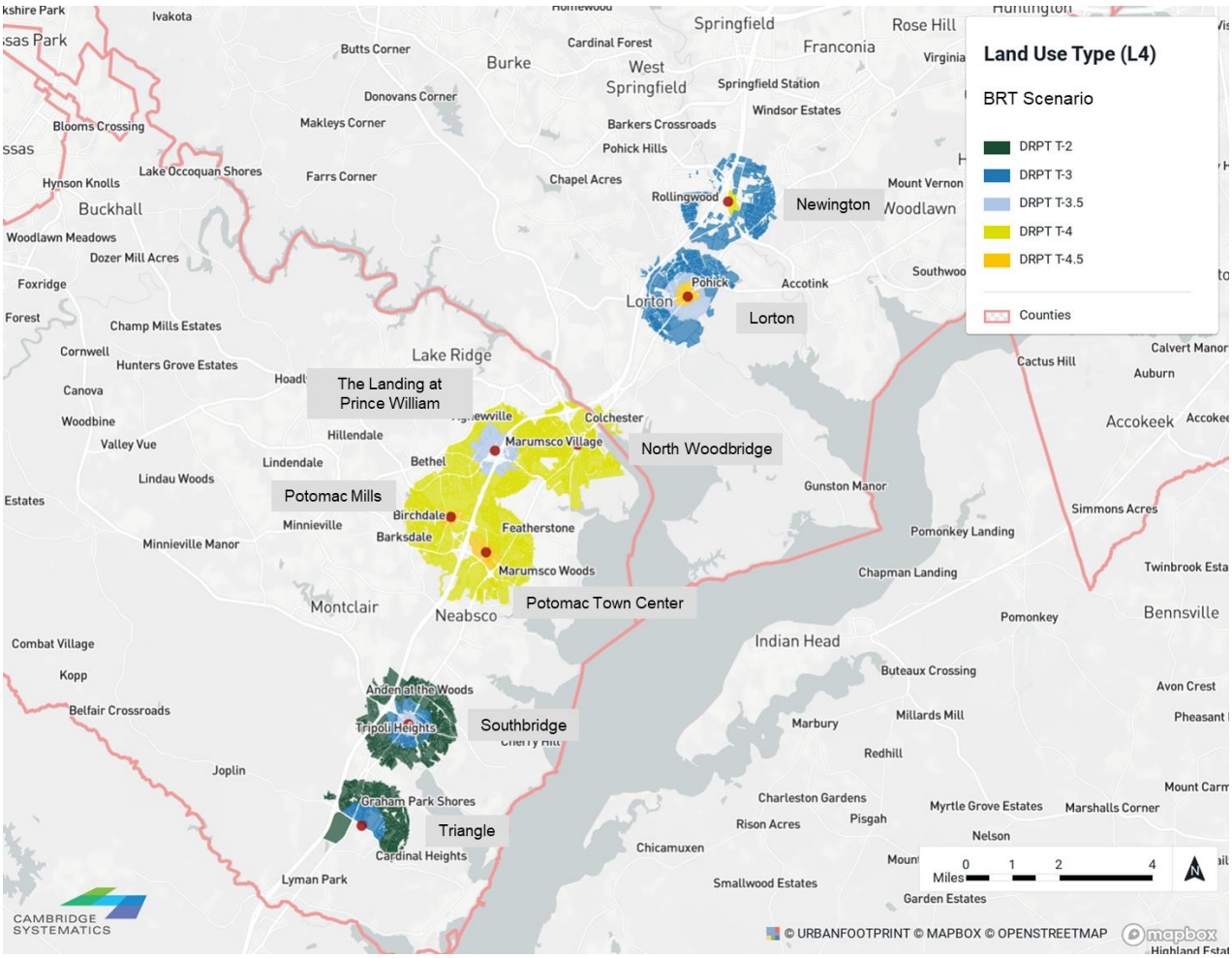
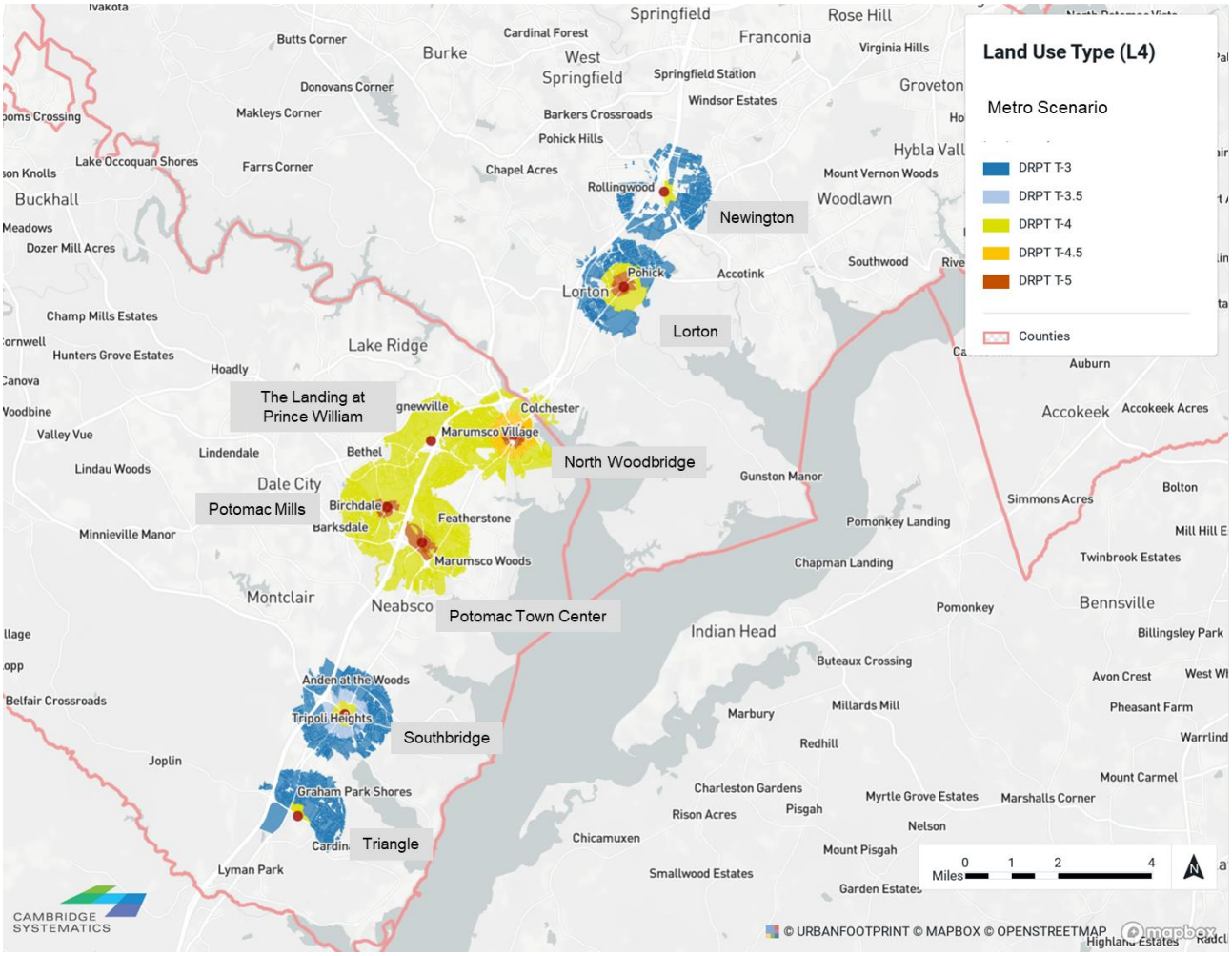


FIGURE 6-7 PARCELS PAINTED AROUND STATION AREAS UNDER THE METRO SCENARIO



6.4 Impact on Performance of Alternatives

The land use scenarios tested assumed dramatic increases to the population and jobs in the Study Corridor. The results of the land use scenario tests are shown in **Table 6-4** and indicate that significant increases in ridership ranging from 30 to 50 percent are possible with increased, dense development in the station areas. The totals for the Study Corridor and the Station Areas can be found in **Table 6-5** and **Table 6-6**. The scenario totals by station is shown in **Table 6-7**.

TABLE 6-4 LAND USE SCENARIO RESULTS

	BRT	Metrorail Blue Line	Metrorail Yellow Line
Residents Added to Station Areas	85,800 (+55%)	116,000 (+69%)	113,000 (+73%)
Jobs Added to Station Areas	46,800 (+85%)	62,600 (75%)	60,800 (+111%)
Ridership Increase	+29%	+50%	+32%

TABLE 6-5 SPRINGFIELD-QUANTICO: SUMMARY STATISTICS REPORT, STUDY CORRIDOR

	Scenario Totals				Percentage Change Over No-Build	
	2020 COG/TPB	No-Build Scenario (2045 COG/TPB)	BRT Scenario	Metro Scenario	BRT Scenario	Metro Scenario
Population	423,700	529,400	552,000	586,800	4%	11%
Households	148,200	190,600	234,100	253,000	23%	33%
Employment	186,200	245,500	242,100	256,400	-1%	4%
All Retail Employment	41,500	53,900	79,000	88,100	47%	63%
All Office Employment	103,200	138,100	125,100	130,100	-9%	-6%
All Industrial Employment	18,600	21,800	15,700	15,700	-28%	-28%
Other employment (agriculture, public, military)	22,900	31,600	22,400	22,400	-29%	-29%

TABLE 6-6 SPRINGFIELD-QUANTICO: SUMMARY STATISTICS REPORT, STATION AREA

	Scenario Totals				Percentage Change Over No-Build	
	2020 COG/TPB	No-Build Scenario (2045 COG/TPB)	BRT Scenario	Metro Scenario	BRT Scenario	Metro Scenario
Population	135,500	168,600	261,600	295,500	55%	75%
Households	47,500	60,700	131,900	150,400	117%	148%
Employment	67,400	83,500	122,900	136,900	47%	64%
All Retail Employment	23,400	27,000	60,000	68,900	122%	155%
All Office Employment	24,000	31,400	46,100	51,200	47%	63%
All Industrial Employment	12,800	16,000	10,000	10,000	-37%	-37%
Other employment (agriculture, public, military)	7,200	9,000	6,700	6,700	-25%	-25%

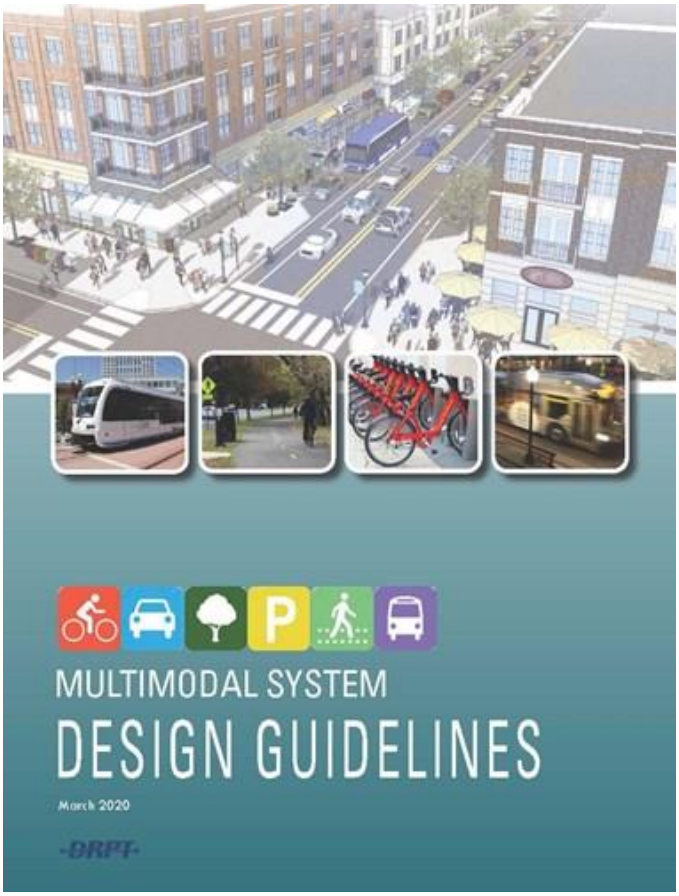
TABLE 6-7 SCENARIO TOTALS BY STATION

Station Name	2045 Baseline Population	2045 Baseline Jobs	BRT Scenario Population	BRT Scenario Jobs	Metrorail Scenario Population	Metrorail Scenario Jobs
Lorton	18,400	6,100	19,600	11,200	24,400	13,200
Newington	12,700	28,600	16,900	21,900	16,900	21,900
North Woodbridge	28,200	5,700	40,800	16,400	47,700	18,900
Potomac Mills	15,400	14,800	42,600	19,300	43,800	19,800
Potomac Town Center	27,700	10,600	59,700	22,400	62,200	23,400
Southbridge	28,500	6,400	22,300	7,200	33,400	11,900
The Landing at Prince William	26,300	10,000	52,700	21,400	55,200	22,600
Triangle	11,300	1,300	7,000	2,900	12,000	5,300
Yellow Line Total	**155,900**	**54,900**	**244,700**	**101,000**	**278,600**	**115,100**
Blue Line Total	**168,600**	**83,500**	**261,600**	**122,900**	**295,500**	**136,900**

6.5 Elements of Transit Oriented Development

Transit Oriented Development (TOD) is a planning concept to organize development around transit stations to create compact, mixed-use communities where people enjoy easy access to jobs, everyday destinations, and other services. A successful TOD at its best creates a place that fully leverages the presence of transit to become a vibrant community node. **Figure 6-8** illustrates various elements of a successful TOD project.

Both Fairfax County and Prince William County are expected to add a significant population and jobs in the next 25 years. TOD planning within the Study Corridor that enhances transit ridership will be critical to leverage investments in premium transit. Successful TOD planning can result in more people choosing to ride transit or walk/bike to nearby destinations. TOD planning will assist in the Study Corridor growing more sustainably and reduce the future vehicular transportation impacts on existing roadways.



DRPT has developed Multimodal System Design Guidelines that provide detailed information on planning for context-sensitive TOD in Virginia. These Guidelines categorize places into various transect zones or place types ranging from 'P1- Rural or Village Center' to 'P6- Urban Core'. Identifying place types for station areas is critical to identify potential development density and land use mix. These Guidelines define a process to develop Multimodal System Plans that incorporate best practices for TOD planning in Multimodal Centers (roughly equivalent to a 10-minute walk-shed from a transit station) and Multimodal Districts (a larger area around transit centers with high population and employment density). The document also highlights the importance of planning multimodal corridors with a defined modal hierarchy to connect Multimodal Centers and Districts.

FIGURE 6-8 ELEMENTS OF TRANSIT ORIENTED DEVELOPMENT

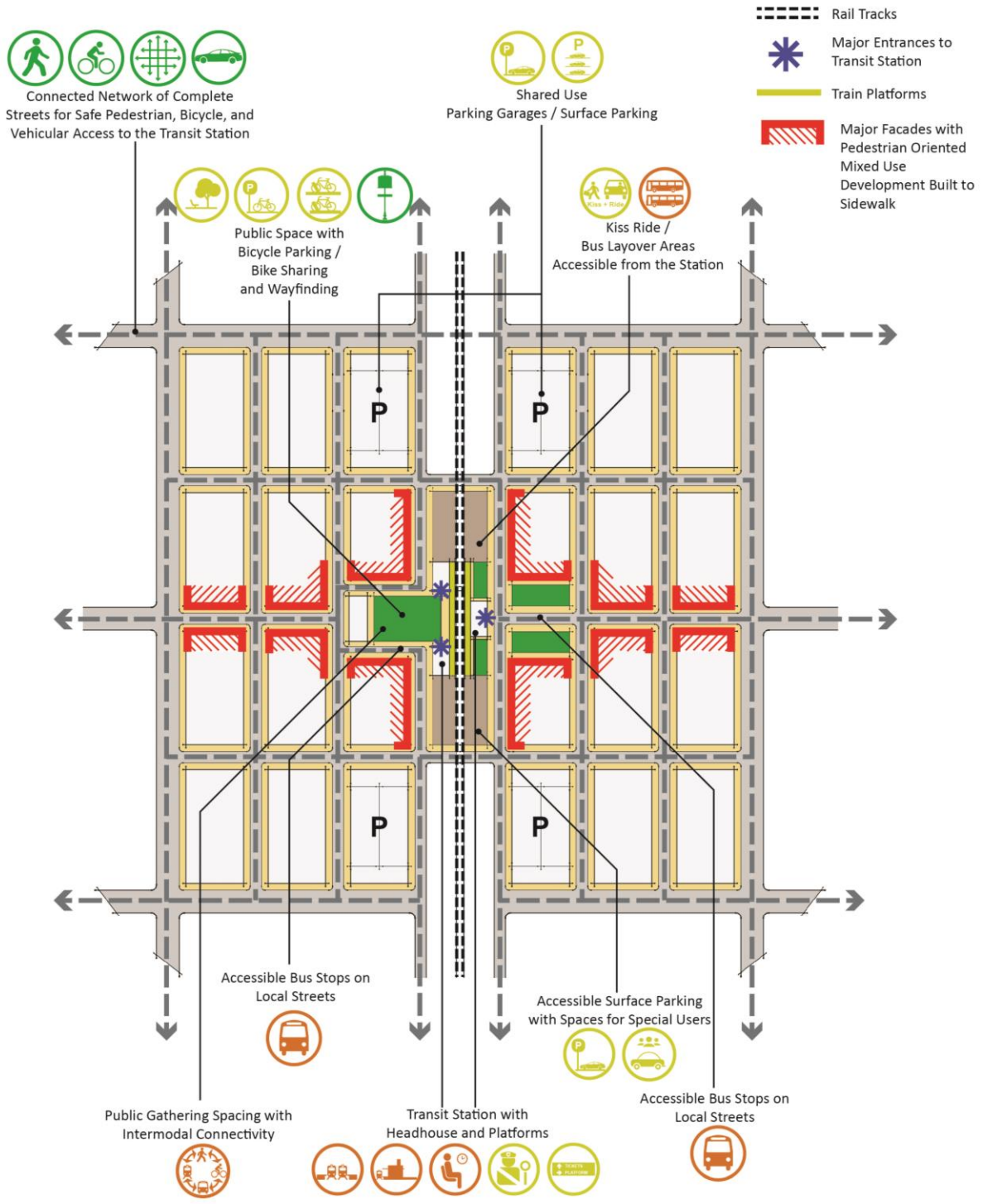


Image Source: Kittelson & Associates, MDOT MTA TOD Guidelines

6.6 Case Studies

This section presents two TOD case studies within the region that hold valuable lessons for planning and implementing TOD in the Study Corridor. Pike & Rose/White Flint is located on the Metrorail Red Line in Montgomery County, Maryland. Dunn-Loring Merrifield/Mosaic District is located on the Metrorail Orange Line in Fairfax County. These locations have successfully transformed automobile-oriented suburban areas into walkable mixed-use compact development around and near Metrorail stations. These projects have been implemented through long-term comprehensive planning that integrated land use and multi-modal transportation infrastructure and established successful public-private partnerships.

Pike & Rose/White Flint; Montgomery County, MD

Pike & Rose District

Image Source: M-NCPPC Montgomery County Planning Department

Park in the Pike & Rose District

Image Source: Visit Montgomery

Quick Facts

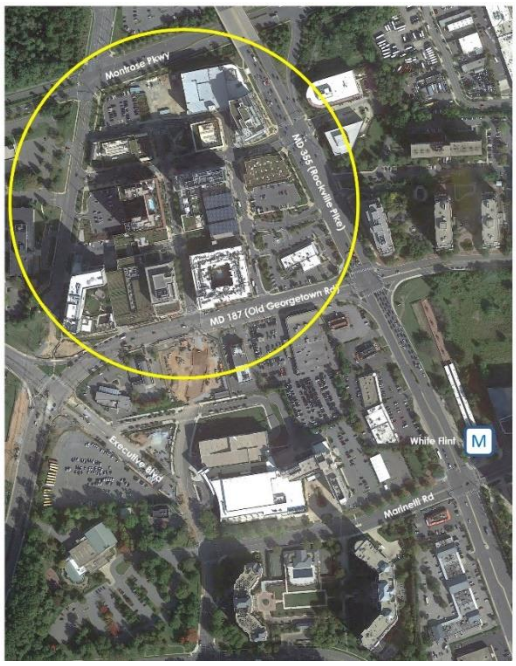
- **Location:** North Bethesda, Montgomery County, MD
- **Transit Stop:** White Flint (Red line)
- **Redevelopment Area:** 430 acres
- **Previous Use:** Mall, shopping center
- **Distance to Downtown DC:** 14 miles

Key Takeaways

- Transformed regional mall and strip commercial sites to cohesive compact, walkable, mixed-use TOD.
- Addressed fragmented parcel sizes and ownership.
- County has developed a plan to convert auto-oriented suburban arterial corridors to multi-modal corridors.
- Reduced impervious surface and added green infrastructure.
- New infrastructure created through public-private partnerships.

FIGURE 6-9 BEFORE (2010) AND AFTER (2021) AERIALS OF THE PIKE & ROSE DISTRICT NEAR THE WHITE FLINT METRORAIL STATION

2010 Aerial



2021 Aerial

Image Source: Google Earth

Dunn-Loring Merrifield/Mosaic District; Fairfax County, VA

Halstead Square Rd

Image Source: Walk Score

Mosaic District

Image Source: Northern Virginia Magazine

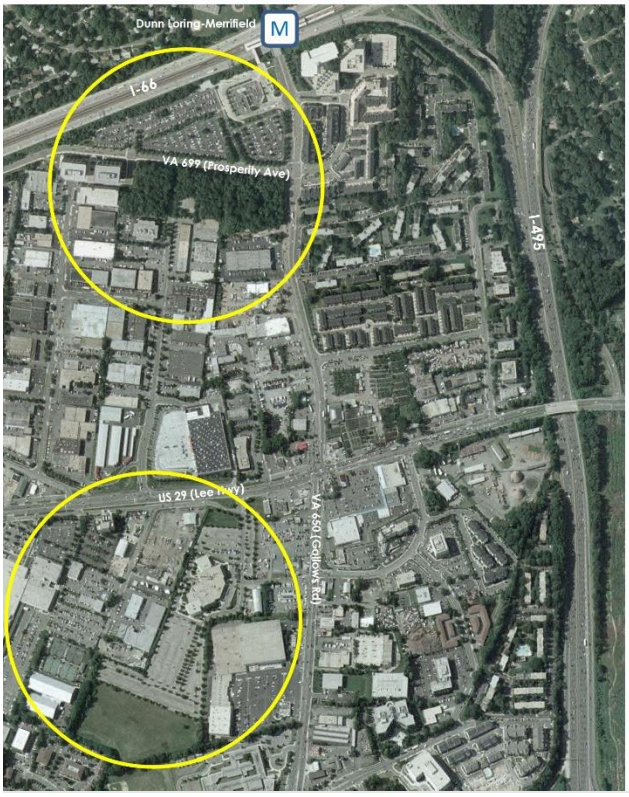
Quick Facts

- **Location:** Merrifield, Fairfax County, VA
- **Transit Stop:** Dunn Loring-Merrifield (Orange)
- **Redevelopment Area:** 160 acres
- **Previous Use: Industrial,** Parking, Movie Theatre
- **Distance to Downtown DC:** 10 miles

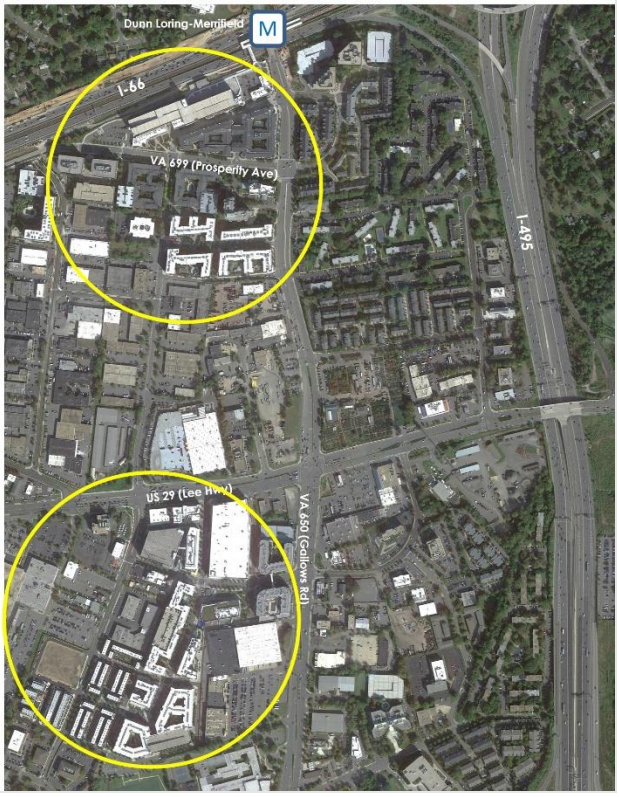
Key Takeaways:

- Transformed multiplex theatre to compact, walkable, mixed-use development.
- County has developed a long-term plan to covert auto-oriented arterial corridors to multi-modal corridors with comfortable pedestrian, bicycle, and transit facilities.
- Reduced impervious surface and added green infrastructure.
- Implemented TIF to finance new infrastructure through public-private partnerships.

FIGURE 6-10 BEFORE (2010) AND AFTER (2021) AERIALS OF THE MOSAIC DISTRICT AND THE DEVELOPMENT NEAR THE DUNN LORING-MERRIFIELD METRORAIL STATION



2010 Aerial



2021 Aerial

Image Source: Google Earth

6.7 Transit Readiness Factors

Transit readiness describes the degree to which a place has or planned for the land uses, the transit-access infrastructure, the inviting environment, and the concentrations of people and activity that generate transit demand and allow people to access transit service comfortably and directly. This section provides methods and tools to create successful station areas and TOD. These methods and tools list best practices in planning processes and policies related to land use, zoning, multi-modal transportation infrastructure, and implementation.

Land Use & Zoning

- Create or update Small Area Plans/TOD station area plans to articulate a clear long-term vision that can be implemented in phases.
- Rezone or add overlay districts for station areas for TOD supportive zoning that enable mixed use, compact, walkable development.
- Adopt urban design guidelines/form-based codes to enable walkable urban form.
- Integrate urban design reviews as part of the development review process to make certain that new development conforms to urban design vision for the station area.
- Integrate public gathering spaces such as parks and plazas as part of the TOD station area to create a sense of place.

Multi-modal Transportation Infrastructure

- Create a dense network of internal walkable streets and small-block pattern in station areas.
- Plan, design, and implement pedestrian and bicycle facilities connecting the station area internally as well as to existing nearby neighborhoods and everyday destinations.
- Redesign or plan new feeder transit or shuttle service to connect the station area to nearby activity centers, neighborhoods, and everyday destinations that maybe beyond comfortable walking or biking distance.
- Integrate new mobility or micromobility options such as bike-share, scooter-share, and/or car-share as part of mobility hubs at transit stations.
- Encourage shared parking, TDM measures, and cross-access easement among private properties.

- Redesign arterial roads as multi-modal corridors with frequent crossings and comfortable pedestrian and bicycle facilities.

Implementation

- Identify multi-modal infrastructure projects that can be implemented by developers as part of development projects.
- Establish a station area-wide or district-wide funding mechanism to allow developers to pay a fee-in-lieu for district-wide projects.
- Identify agencies or processes for property consolidation to enable redevelopment.
- Designate a staff member to coordinate between different agencies and private partners to implement the TOD vision.

7. SUMMARY OF FINDINGS

7.1 Overall Evaluation Summary

Evaluation measures were calculated for each of the five transit alternatives across each of the five goals, as summarized in Chapter 5. This section provides a brief summary of the evaluation results in each goal area as illustrated in **Figure 7-1.** Each measure is out of a maximum of three stars.

FIGURE 7-1 SUMMARY OF EVALUATION RESULTS

	Additional Express Bus Service	BRT Extension	Additional VRE Service	Metrorail Blue Extension	Metrorail Yellow Extension
Ridership Potential	★★	★★★	★★	★★★	★★★
Congestion Mitigation	★	★★	★	★★★	★★★
Regional Accessibility	★★	★★★	★★	★★★	★★★
Equity	★	★★★	★★	★★★	★★★
Cost-Effectiveness	★★★	★★	★	★	★

- **Ridership Potential** - Overall, the BRT and Metrorail alternatives performed best on the ridership measures. The BRT alternative had the highest overall number of daily transit boardings in the Study Corridor. The two Metrorail alternatives were best at attracting new transit trips and in total transit PMT.
- **Congestion Mitigation** - The Metrorail alternatives decreased congested VMT on roads in the Study Corridor the most compared with the No-Build scenario.
- **Regional Accessibility** - The Yellow Line and BRT alternatives have the most residents within walk access to transit. The Blue Line Alternative has the most jobs within 1/2-mile of transit. The Metrorail alternatives provide a significantly higher increase in accessibility to regional jobs by transit within 60 minutes for Study Corridor residents, relative to the other alternatives.

- **Equity -** The BRT alternative had the most residents with walk access to a transit station residing with an EEA (more than 45 percent). The Yellow Line alternative has the biggest gain in new transit trips and in job accessibility for residents of EEAs.
- **Cost-Effectiveness** - The Express Bus and BRT alternatives are significantly more cost effective than the rail alternatives. The BRT alternative has higher costs than the Express Bus, but does increase ridership, making it 2-3 times more cost-effective than the Metrorail alternatives which have high ridership, but significantly higher costs.

7.2 Summary of Costs

Each of the transit alternatives require unique levels of planning and implementation, as reflected in their costs, which are shown in **Table 7-1**. The Express Bus and VRE alternatives do not require new construction of facilities or fixed-guideway, just vehicles required to provide improved services, so these are the least expensive alternatives. BRT would require funding for station construction, buses, and running-way improvements. Both Metrorail lines would require large construction efforts, including stations and parking, rail infrastructure and systems, a new rail yard and other facilities, right-of-way, and acquisition of new trains, making these the highest cost options.

TABLE 7-1 ORDER OF MAGNITUDE COSTS (2030 DOLLARS)

Transit Alternative	Total Capital Cost*	Annual O&M Cost	Annual Net Cost: Capital and O&M - Fare Revenue
Express Bus	$37 M – $54 M	$7 M	$8 M
VRE**	$116 M – 174 M	$80 M	$46 M
BRT	$2.4 B – 3.6 B	$19 M	$133 M
Short BRT	$1.6 B – 2.4 B	$15 M	$90 M
Blue Line	$18.1 B – $27.2 B	$168 M	$764 M
Short Blue Line	$13.6 B – $20.5 B	$135 M	$579 M
Yellow Line	$18.3 B – $27.5 B	$168 M	$771 M
Short Yellow Line	$13.8 B – 20.8B	$135 M	$587 M

* Capital costs include contingency

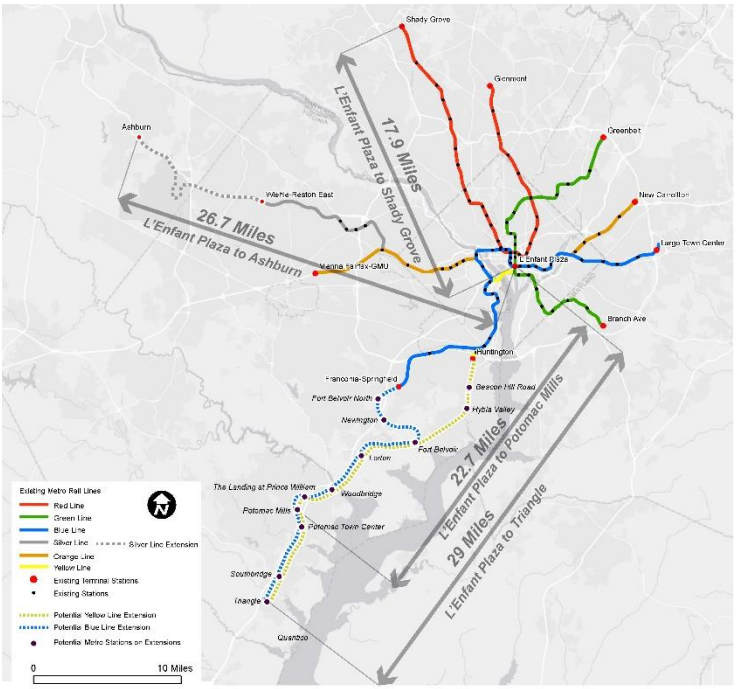
** Additional service above Transforming Rail in Virginia improvements included in baseline.

7.3 Other Considerations for Metrorail Extensions

A Metrorail extension into Prince William County would be a significant addition to the Metro system, particularly for the alternatives that extend down to the Triangle/Quantico area. The straight-line distance from Triangle to L'Enfant Plaza is 29 miles, but would require roughly a 45-mile trip on the Blue Line.

WMATA has prioritized maintaining the current Metrorail system in a state-of-good repair and addressing core capacity needs first, prior to consideration of an extension. Core capacity projects identified in Metro's plans include investments in rail cars and infrastructure needed to achieve 100 percent 8-car trains on the system, core station capacity improvements, and relief for the Rosslyn bottleneck where the Blue, Orange, and Silver (BOS) lines merge together. Options for addressing the capacity and reliability needs of the BOS corridor are currently being studied by WMATA.

Extending Metrorail Service to Prince William County also has unique legal and governance ramifications. A review of the legal and governance actions and requirements is summarized below:



- *Extending Metrorail service into Prince William County does not require amending the WMATA Compact*. It does require PWC to become a member of the Northern Virginia Transportation District (District) and the Washington Metropolitan Area Transit Zone (Zone).
- *Enlarging the District to include Prince William County* —The Northern Virginia Transportation Commission (NVTC) would control the process by which the NOVA District is enlarged to include Prince William County , as well as Prince William County's obligations as they relate to NVTC members' responsibilities.
- *Enlarging the Zone to include Prince William County* — NVTC would notify WMATA that the District has been enlarged, delivering the terms of Prince William County 's financial commitment to Metro services as part of this notification, and the WMATA Board would need to approve an action to add Prince William County to the Zone.
- Terms of the service to be provided to PWC through WMATA would need to be negotiated, (e.g., whether bus services will be provided by WMATA, etc.).

- Prince William County's financial commitments would extend beyond the construction costs of the Metrorail extension to include a share of the annual operating and capital subsidy (by formula), annual obligations to Virginia's Metro Capital Fund, and other negotiated financial obligations.
- The potential impacts on the PRTC as a result of Prince William County membership in the NOVA District would need to be resolved.

The annual operating budget subsidy contributions for WMATA member jurisdictions is determined through a formula that factors in the population (weighted by density), ridership, and station count within each jurisdiction, plus a "max fare" subsidy is added for longer trips. On the basis of these factors, it is estimated that Prince William County would be responsible for over 5 percent of the annual operating subsidy of the Metro system. Fairfax County's share of the Metrorail subsidy requirements would also increase as a result of the additional stations and ridership. All of the WMATA jurisdictions, including DC and Maryland, would face some increased operating costs resulting from a Metrorail extension.

7.4 Next Steps

This study has confirmed that there are significant transportation needs and issues in the corridor between the Franconia-Springfield Metro station and Marine Corps Base Quantico. The purpose of this study was to analyze and present the performance of a range of transit investment options, in order to highlight strengths and weaknesses. This analysis has also identified some potential costs and constraints of the various alternatives.

A feasibility study is typically a first step in the planning and project development process leading to a major capital investment. For major capital projects, such as the BRT and Metrorail alternatives that were evaluated, seeking Federal funding through the Federal Transit Administration (FTA) New Starts/Small Starts capital investment grants would add significant steps to the project development and approval process as indicated in Error! Reference source not found.Error! Reference source not found.. As noted in the previous section, a Metrorail extension would also require additional local and regional decisions and actions needed to move forward.

Given the conceptual level of planning conducted in this study, additional analysis and refinement of the alternatives is warranted and would need to be conducted prior to the selection of a locally preferred alternative. This study determined that all five alternatives tested, and the two shorter Metrorail extensions, are feasible; however, no recommendation is being made regarding selection of a preferred alternative in this study. Further detailing of the design and operating characteristics would be needed to improve the estimates of costs and benefits. Future investment in public transportation is already planned for the Study Corridor, as evidenced by the Transforming Rail in Virginia initiative and the Richmond Highway BRT project.

The importance of the corridor as a growing, diverse community that includes regionally significant job centers supports further investigation of transit enhancement options.

FIGURE 7-2 MULTI-STEP PROJECT DEVELOPMENT PROCESS