NVTA's TransAction

Transportation Action Plan for Northern Virginia

TransAction Technical Report

November 2018

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Introduction

TransAction Technical Report

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INTRODUCTION

This report details the scope and technical content of the TransAction planning effort. Whereas the TransAction Report and Project List constitute the formally adopted "Plan", this Technical Report provides detailed discussion of the planning process, stakeholder engagement, and technical analysis that culminated in the TransAction Plan. The Technical Report includes appendices that provide further information on topics that informed the Plan.

TRANSACTION LONG-RANGE TRANSPORTATION PLAN

TransAction is the multimodal transportation master plan for Northern Virginia. It is a long range plan addressing regional transportation needs through 2040. The TransAction Plan focuses on eleven major travel corridors in Northern Virginia, and identifies over 350 candidate regional projects for future transportation investments to improve travel throughout the region.

TransAction is developed and maintained by the Northern Virginia Transportation Authority ("NVTA" or "the Authority"). The NVTA is a regional body that is focused on delivering real transportation solutions and value for Northern Virginia's transportation dollars by bringing Northern Virginia jurisdictions and agencies together to prioritize projects and implement solutions.

TransAction is not bound to any budget, and proposes more projects than can realistically be funded. The results of TransAction are used to inform the NVTA's Six Year Program for capital funding, guiding decisions about which transportation improvements the NVTA should prioritize for investment.

Vision

The adopted vision for TransAction states:

"In the 21st century, Northern Virginia will develop and sustain a multimodal transportation system that enhances quality of life and supports economic growth. Investments in the system will provide effective transportation benefits, promote areas of concentrated growth, manage both demand and capacity, and employ the best technology, joining rail, roadway, bus, air, water, pedestrian, and bicycle facilities into an interconnected network that is fiscally sustainable."

The Authority's mandate, as authorized by the Code of Virginia, is to plan and program transportation improvements of regional significance in the Northern Virginia region (**Figure 1**). The TransAction plan is updated every five years to inform the NVTA's Six Year Program, which is updated every two years.

Goals and Objectives

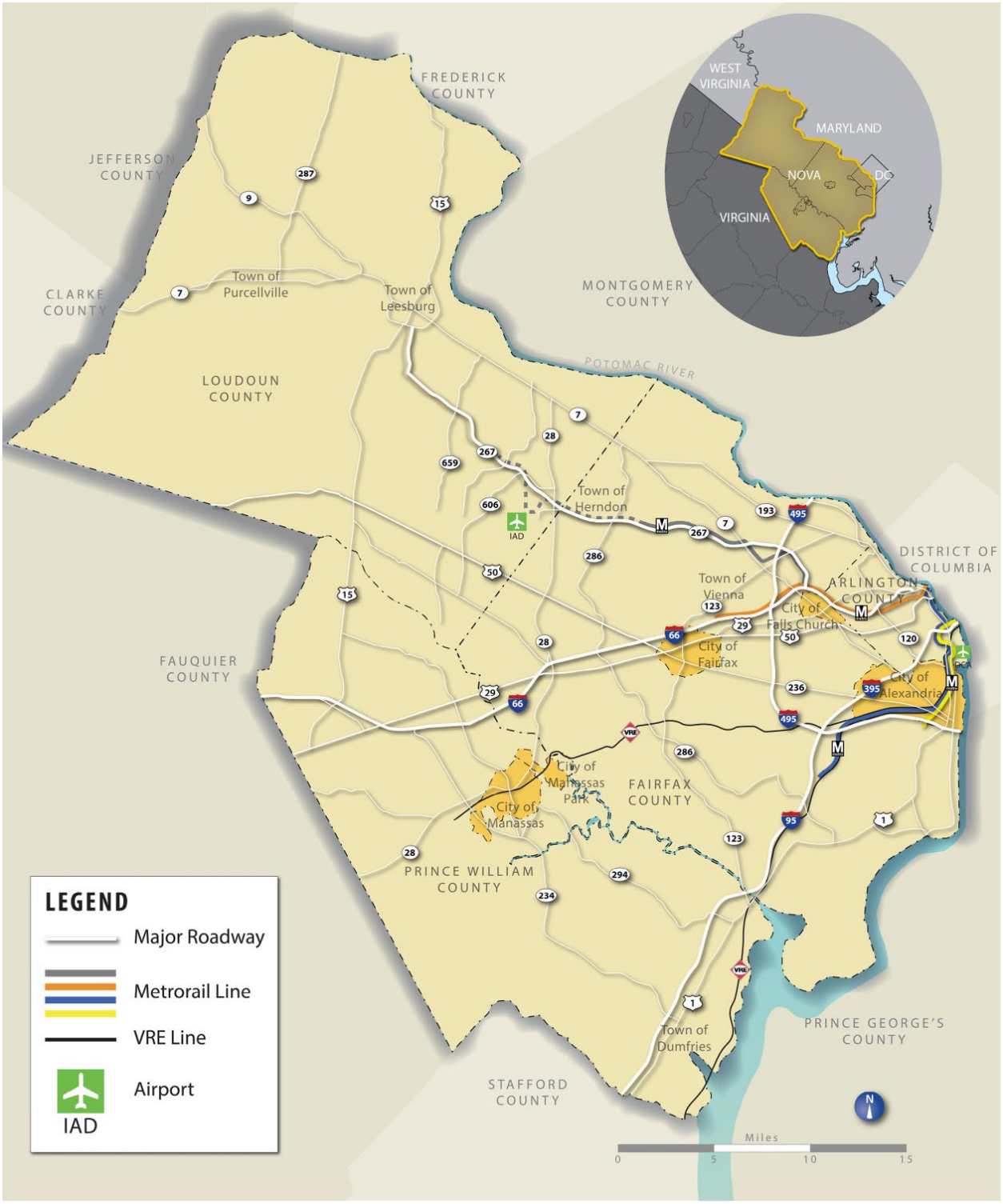
The overarching goals of TransAction are to:

1. Enhance quality of life and economic strength of Northern Virginia through transportation;
2. Enable optimal use of the transportation network and leverage the existing network; and
3. Reduce negative impacts of transportation on communities.

These goals are supported by measurable objectives that aim to:

1.1 Reduce congestion and crowding;
1.2 Improve travel time reliability;
1.3 Increase access to jobs and other destinations;
1.4 Improve connections among and within areas of concentrated growth;
2.1 Improve the safety of the transportation network;
2.2 Increase integration between travel modes and systems;
2.3 Provide more route and mode options and travel choices;
2.4 Sustain and improve operations of the regional system; and
3.1 Reduce transportation-related emissions.

Figure 1: Northern Virginia, The NVTA Region



AUTHORITY AND PLANNING CONTEXT

Virginia Senate Bill 576 established the NVTA in 2002 to prepare Northern Virginia's long-range transportation plan. The bill outlined the responsibilities and directives for the Authority essential to its mission as a regional transportation organization. Prior to the establishment of the NVTA, the Northern Virginia long-range transportation plan was prepared by the Transportation Coordinating Council. Following the creation of the NVTA in 2002, the Authority began to manage the Plan, now titled TransAction. The first two TransAction plans had planning horizon years of 2030 and 2040 respectively; this TransAction update also has a planning horizon year of 2040, but uses more recent planning data than the previous plan that it replaces.

The role and purview of the Authority and TransAction have evolved with direction from the Virginia General Assembly, which passed House Bill 2313 (HB 2313) in 2013 to establish the current transportation investment mechanism. As part of this directive, TransAction seeks to measure the extent to which transportation projects bring value to the NVTA region, including the degree to which they provide congestion reduction relative to capital cost. The Authority operates independently but in conjunction with its partner jurisdictions, the Commonwealth of Virginia and other regional agencies. The plan is updated every five years.

There is a synergy between the TransAction and the NVTA programming processes. First implemented for the NVTA fiscal year (FY) 2014 Program, the Code of Virginia mandates that projects funded by the NVTA with regional revenue funds must be included in TransAction. Following the adoption of this current TransAction version, the Authority will issue a "Call for Regional Transportation Projects" for the NVTA's inaugural Six Year Program to be funded using regional revenues collected in FY2018 through FY2023 (**Figure 2**).

PLAN ELEMENTS

TransAction follows a pattern typical of comprehensive long-range transportation plans. In the context of ongoing regional population and employment growth, it analyzes current and future travel needs, assesses how well the system meets those needs, identifies a range of projects to better meet those needs, and gives decision-makers the information needed to select the most impactful projects over the next 25 years.

TransAction is the multimodal transportation master plan for Northern Virginia. It is a long range plan addressing regional transportation needs through 2040. The Plan focuses on eleven major travel corridors in Northern Virginia, and identifies over 350 candidate regional projects for future transportation investments to improve travel throughout the region. The plan includes the following elements:

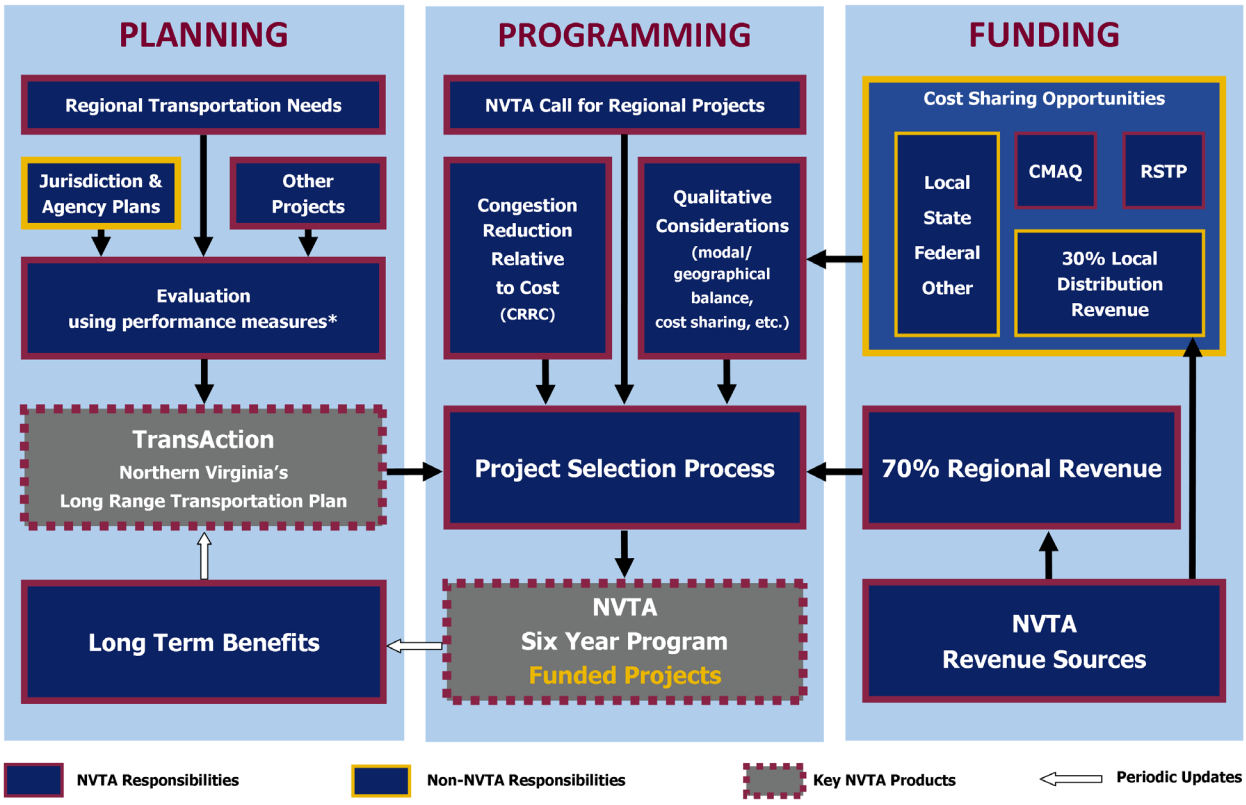
- Baseline data about the transportation system;
- A statement of goals and objectives;
- A set of performance measures to compare alternative strategies and track progress over time;
- Forecasts of future conditions or needs; and

- A set of project investments, policies, and strategies to support attaining the desired transportation conditions.

General Process

To develop TransAction, the NVTA worked within a collaborative structure with public officials, jurisdictional and agency staff, regional stakeholders, and individual citizens providing input to the Plan. Technical analysis included a rigorous modeling process based on accepted regional growth inputs and recent traffic and ridership data. The findings and recommendations will be used to develop the NVTA Six Year Program for transportation capital investment.

Figure 2: The NVTA Roles



Best Practices

There are a number of regions, transportation agencies, and states with similar characteristics that have best practice experience and innovative approaches, which informed this TransAction plan. Peer metropolitan regions including Chicago, Boston, Philadelphia, and Toronto are conducting intensive stakeholder outreach, applying multimodal tools to understand transportation dynamics, and testing future scenarios to understand the robustness of plan assumptions. The NVTA reviewed these programs in designing the TransAction planning process.

NVTA MEMBER JURISDICTIONS AND AGENCIES

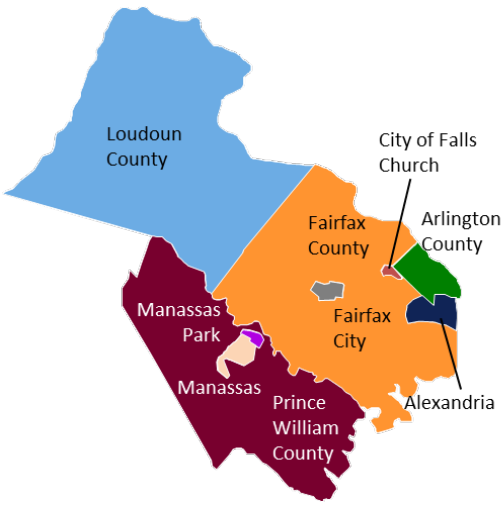
Jurisdictions

The development of TransAction relied heavily on close dialogue and coordination with the NVTA's member jurisdictions (**Table 1** and **Figure 3**), more specifically elected officials, jurisdiction staff, and community members.

Table 1: NVTA Jurisdictions

Counties	Cities
Arlington County	City of Alexandria
Fairfax County	City of Fairfax
Town of Herndon	City of Falls Church
Town of Vienna	City of Manassas
Loudoun County	City of Manassas Park
Town of Leesburg	
Town of Purcellville	
Prince William County	
Town of Dumfries	

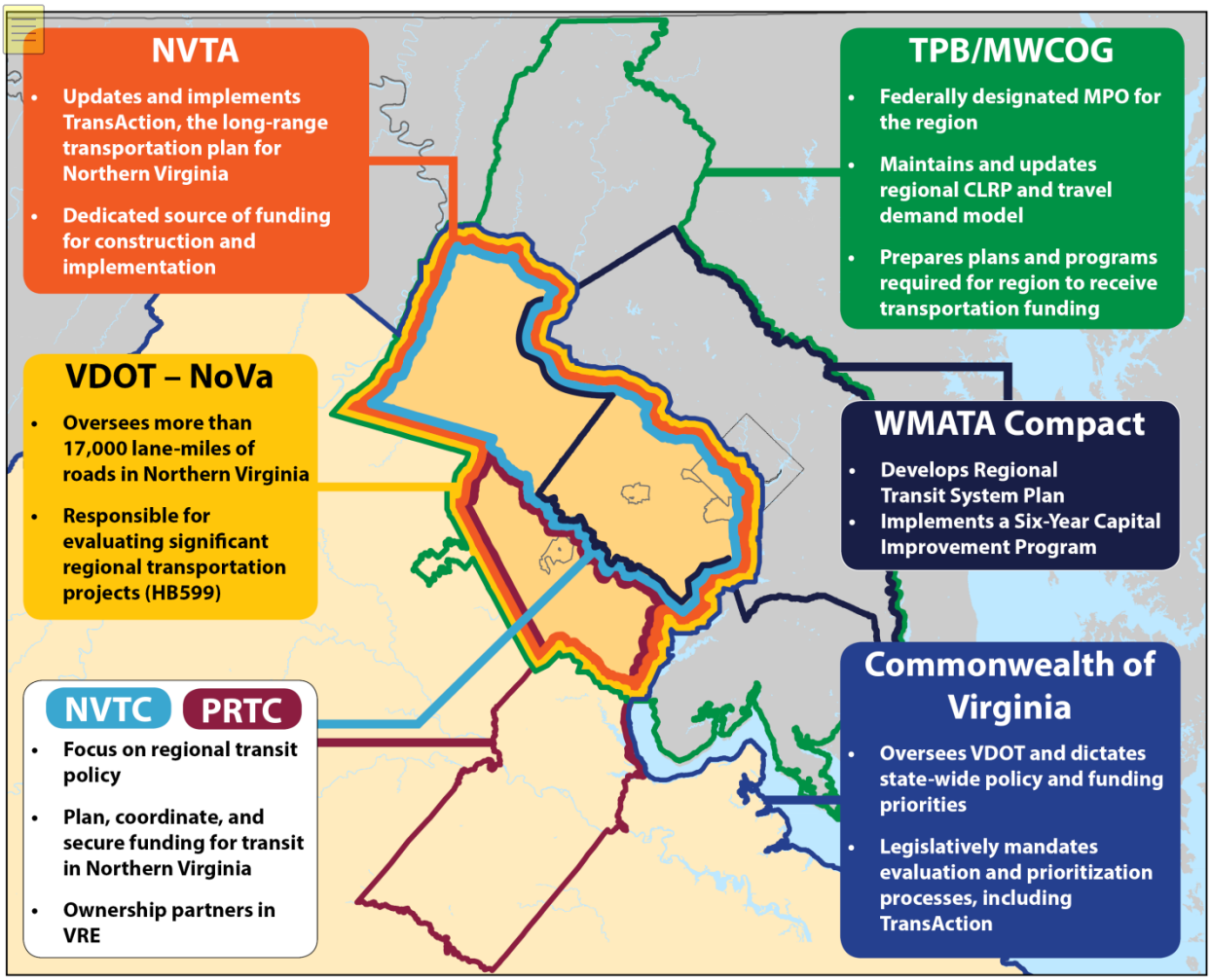
Figure 3: Northern Virginia Jurisdictional Boundaries



State and Regional Transportation Agencies

Planning the transportation system and funding projects involves numerous actors and plans (**Figure 4**). Along with the Northern Virginia counties, cities, and towns, the NVTA coordinates with other agencies that are engaged in planning and implementing transportation improvements across the region, including the National Capital Region Transportation Planning Board (TPB) at the Metropolitan Washington Council of Governments (MWCOG), Northern Virginia Transportation Commission (NVTC), Potomac and Rappahannock Transportation Commission (PRTC), Virginia Department of Transportation (VDOT), Virginia Department of Rail and Public Transportation (DRPT), Virginia Railway Express (VRE), and the Washington Metropolitan Area Transit Authority (WMATA).

Figure 4: Regional Planning in Northern Virginia



COLLABORATIVE PLANNING

Stakeholders played important roles in the development of TransAction. A joint committee structure of regional and community leaders was set up to facilitate review and action by each committee at an appropriate level of technical detail and policy impact.

- **TransAction Subcommittee:** Comprised of technical staff from the NVTA localities and regional agencies, the Subcommittee actively guided every step in the creation of TransAction. Participants met monthly—and as often as three times per month—to inform the Authority as it shaped planning policies and goals, review outreach results, shape technical methodology, and confirm analysis findings.
- **Technical Advisory Committee (TAC):** Members of this committee are appointees with leadership and technical experience in transportation. Meeting monthly through the course of TransAction development, the TAC reviewed interim technical products and made recommendations regarding the goals, objectives, and ultimate evaluation measures for the plan.

- **Planning Coordination Advisory Committee (PCAC):** Members of this committee are elected officials representing each of the 14 counties, cities, and towns with populations of 3,500 or more that comprise the NVTA region. Meeting monthly through the course of TransAction development, the PCAC reviewed interim technical products and made recommendations regarding the goals, objectives, and ultimate evaluation measures for the plan.
- **Planning and Programming Committee (PPC):** Comprised of five Authority members. The PPC reviews all plan-related matters before making final recommendations for consideration by the Authority. Meeting as needed, the PPC provided an opportunity for Authority members who are part of the PPC to be briefed in depth on key elements of TransAction, including plan objectives and evaluation measures, and public opinion surveys.

The TransAction plan is coordinated with other transportation plans at the local, regional, and state levels. The initial Draft Plan was developed through a thorough review of jurisdiction transportation plans and programs. Numerous projects are common to both TransAction and the National Capital Region Constrained Long-Range Plan (CLRP, 2016). However, while TransAction is coordinated with other plans, it also includes new proposed projects and initiatives beyond those that individual jurisdictions and other agencies have developed. TransAction is a fiscally unconstrained plan, meaning that it is not bound to any budget, and proposes more projects than can be realistically funded.

While TransAction is focused on Northern Virginia, it is also a geographically unconstrained plan. It includes projects beyond Northern Virginia that are potentially beneficial to the mobility of Northern Virginians. Referred to as extra-territorial projects, these projects are included in TransAction for the purposes of sound long range transportation planning. However, the NVTA is generally unable to fund extra-territorial projects.

The NVTA is a unique transportation planning entity. While the NVTA has many of the characteristics of a Metropolitan Planning Organization (MPO), the NVTA is not constrained by federal planning and performance monitoring requirements, and therefore has the ability to make independent funding decisions.

OUTCOMES

This report describes the TransAction process, but more importantly, it lays out findings and recommendations for an improved regional transportation system. TransAction directly informs the NVTA Six Year Program for capital funding, and it will serve as a guide for the jurisdictions and other transportation agencies as they prioritize projects, programs and policies.

GLOSSARY

Term	Definition
BRT	Bus Rapid Transit. Enhanced bus system that may include features such as dedicated bus lanes, off-board fare payment, specialized branding, and real-time arrival information at shelters.
CAV	Connected and autonomous vehicles. Connected vehicles use technologies to communicate with each other, drivers, and roadside infrastructure. Autonomous vehicles use technologies to enhance or replace vehicle driving functions.
CLRP	Financially-Constrained Long-Range Transportation Plan
DRPT	Virginia Department of Rail and Public Transportation
FAST Act	Fixing America's Surface Transportation Act. National funding and authorization bill enacted in 2015 to provide long-term funding for surface transportation planning and investment.
HB 2313	State legislation that designates tax revenues for use by the NVTA and Northern Virginia jurisdictions to invest in transportation.
HB 599	State legislation that requires evaluation of congestion impacts of NVTA-funded transportation investments.
ICM	Integrated Corridor Management: optimizes use of available infrastructure by directing travelers to underutilized capacity in a transportation corridor.
ITS	Intelligent Transportation Systems use information and communications technologies to enhance operation and management of transportation systems.
LRT	Light Rail Transit. Train system that uses similar rolling stock as a tram or streetcar but generally operates on a dedicated right-of-way at higher speeds.
MAP-21 Act	Moving Ahead for Progress in the 21st Century Act. National funding and authorization bill for surface transportation projects enacted in 2012.

Term	Definition
MWCOG	Metropolitan Washington Council of Governments
Motorized/Non-motorized Trips	Transportation forecasting generally accounts for trips that people take by car (via single-occupant vehicles and high-occupancy vehicles) and by transit (via Metrorail, commuter rail, bus). Non-motorized trips are made by walking or bicycle.
No Build 2040	Anticipated transportation conditions in 2040, including already funded projects but excluding new projects in the TransAction plan.
NVTA	Northern Virginia Transportation Authority
Regional Activity Centers (RACs)	MWCOG-designated areas of concentrated population and employment for strategic planning purposes.
Six Year Program (SYP)	The NVTA's program for prioritizing and funding multimodal transportation projects.
TDM	Transportation Demand Management is the application of strategies and policies to reduce travel demand, redistribute this demand in space or in time, or encourage travel by shared mode options such as carpooling and transit. Used interchangeably with Travel (or Traffic) Demand Management.
TPB	National Capital Region Transportation Planning Board. Serves as the federally-designated Metropolitan Planning Organization (MPO).
TransAction	The long-range regional multimodal transportation plan for Northern Virginia and the focus of this report.
VDOT	Virginia Department of Transportation
VRE	Virginia Railway Express commuter rail system
WMATA	Washington Metropolitan Area Transit Authority or "Metro"

PART 1

Background

TransAction Technical Report

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BACKGROUND

Part 1 sets the context for Northern Virginia's Long-Range Transportation Plan. With significant ongoing population and employment growth, regional economic growth will continue, supported by a strong integrated transportation network. New mobility options are changing the way people travel, and the impending deployment of connected and autonomous vehicles (CAVs) presents a new dynamic for regional plans and transportation investments. The NVTA conducted surveys to measure how Northern Virginians' transportation experiences affect their quality of life. This information gives a useful set of priorities to guide planners and decision makers.

Part 1 describes how the NVTA integrated input from members of the public and major stakeholders with the technical analysis to identify Northern Virginia's transportation needs and priorities. The NVTA formulated a series of performance-based goals and objectives designed to meet these identified needs and priorities. The process also considered potential contingencies, such as the introduction of new technology.

Part 1 contains the following chapters:

- **Chapter 1**: Northern Virginia – Growth and Transportation
- **Chapter 2**: The Regional Transportation Network
- **Chapter 3**: Future of Transportation – "What's New?"
- **Chapter 4**: Public Perceptions About Transportation
- **Chapter 5**: Integrated Public Engagement Approach
- **Chapter 6**: Performance-Based Planning

CHAPTER 1: NORTHERN VIRGINIA – GROWTH AND TRANSPORTATION

Northern Virginia is home to the largest centers of population and employment in the Commonwealth. The region's geographic and economic connections with Washington, DC are strong and have contributed to the growth of a robust workforce, an active business environment, and healthy residential communities over the past few decades.

TRANSPORTATION AND THE REGIONAL ECONOMY

Northern Virginia has undergone a dramatic economic transformation over the past thirty years. Since 1980, Northern Virginia has produced over half of the Washington metropolitan area's growth in new jobs and welcomed a comparable number of residents of working age.[1]

This growth and development has resulted in an increase in travel demand as Northern Virginia residents travel throughout the region, as well as into Washington, DC and Maryland, to access jobs, schools, and recreation. This interconnectedness is what makes the Washington metropolitan area an economically vibrant destination; however, these strong regional connections also contribute to increasing travel and accompanying congestion.

Improving transportation within and to Northern Virginia contributes to continued economic growth in the region. Multimodal transportation options that connect regional growth centers and alleviate bottlenecks will allow the region to continue adding jobs and households, strengthening the economic base and improving quality of life.

SOCIO-ECONOMIC GROWTH PATTERNS/TRENDS

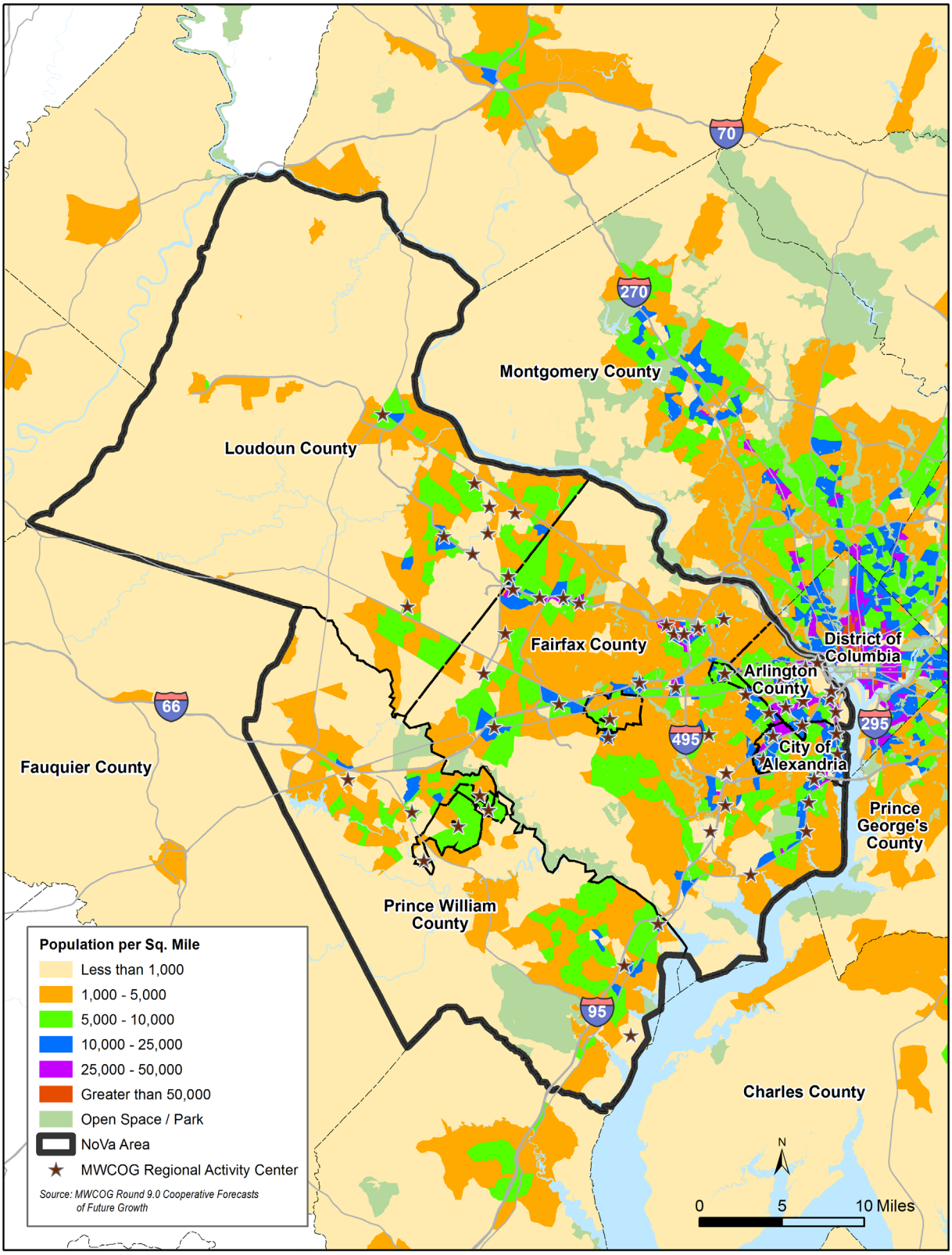
Population/Employment Density

The Washington metropolitan region is home to more than seven million residents and more than four million jobs. Northern Virginia accounts for approximately one third of that total, including 2.4 million residents and over 1.3 million jobs.[2]

The TransAction Plan analysis focuses on the Regional Activity Centers (RACs) defined by the Metropolitan Washington Council of Governments (MWCOG). RACs are identified for strategic planning purposes as they account for a large share of the region's current and projected population and employment. Northern Virginia has 63 RACs that account for around ten percent of the region's land area, and are mostly concentrated in higher-density areas, particularly inside the Beltway (**Figure 1-1**). Over 65 percent of Northern Virginia jobs are located within a RAC.

[1] Fuller, Stephen. S. "Northern Virginia's Economic Transformation" *NOVA Exec Magazine, Summer 2011*
[2] *MWCOG, 2016*

Figure 1-1: Population Density and Regional Activity Centers (2040)

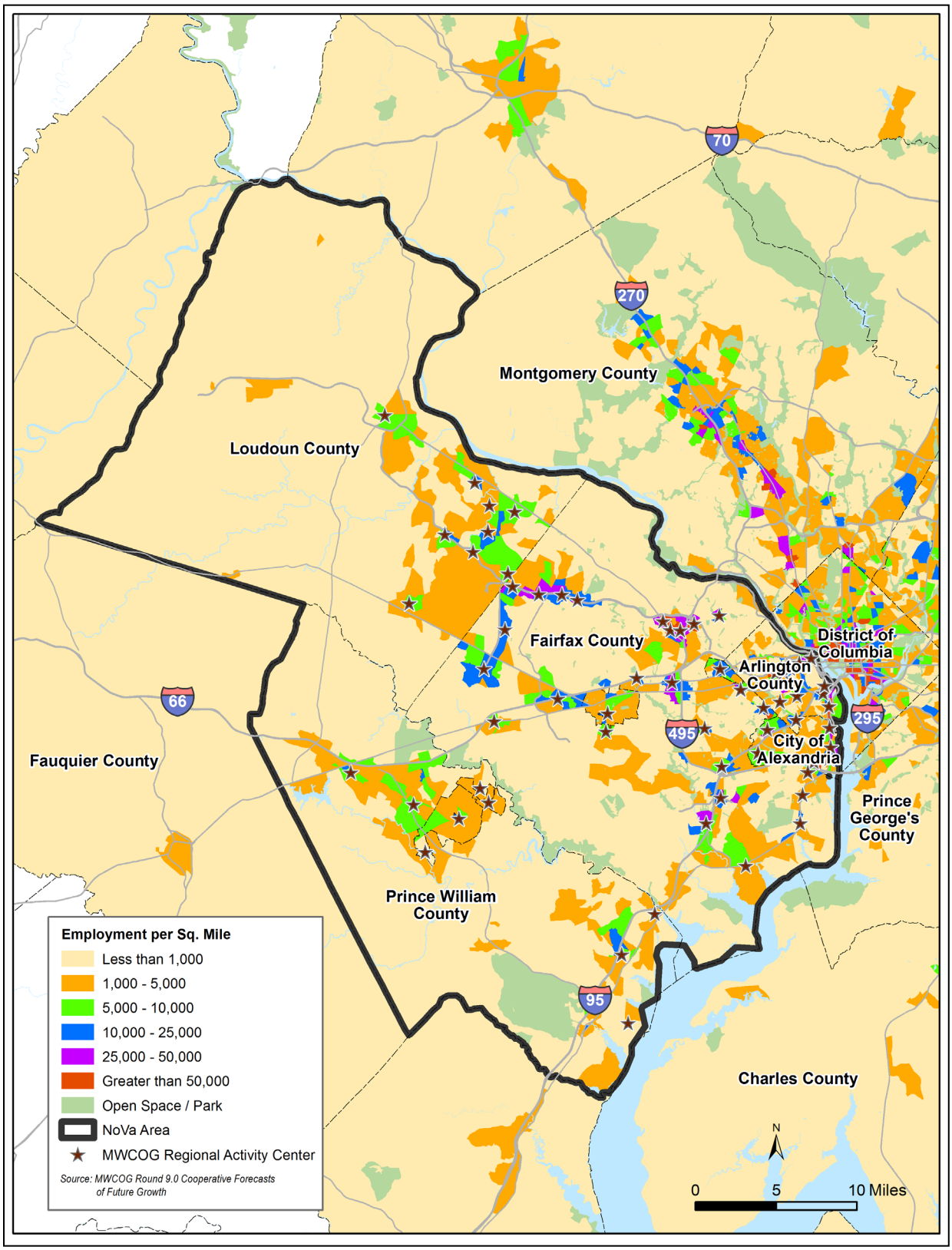


Source: MWCOG Round 9.0 Cooperative Land Use Forecasts

The Rosslyn-Ballston corridor in Arlington County, which spans five RACs, represents the largest area of high-density residential development in Northern Virginia, as well as one of the highest concentrations in the Washington metropolitan area. By 2040, many RACs outside the Capital Beltway (I-495) will have comparable residential density to locales within the Beltway.

Downtown DC will continue to have the highest concentration of jobs in the metropolitan area. Meanwhile, continued employment growth throughout Northern Virginia will add significant numbers of jobs to already prominent RACs such as Tysons, Reston, Old Town Alexandria, and throughout Arlington County (**Figure 1-2**).

Figure 1-2: Employment Density and Regional Activity Centers (2040)



Overall, Northern Virginia has a significant range of residential and employment density. The distribution of population and employment growth had numerous implications for the TransAction plan technical process, including key assumptions for the transportation network model. The distribution of growth between RACs and lower density areas (including within jurisdictions) is a critical consideration as smaller, more densely developed jurisdictions will see most of their growth within RACs. Jurisdictions with large land areas will see growth distributed across the jurisdiction.

Population Growth

MWCOG forecasts the Washington metropolitan area to experience significant growth, with an additional 1.6 million residents, resulting in a total metropolitan population of 8.8 million in 2040. This 23 percent growth will be matched in Northern Virginia, which is estimated to grow by 24 percent to almost three million residents. As shown in **Table 1-1**, the largest number of residents will be added in Fairfax County, while Loudoun County and the City of Falls Church are expected to experience the highest growth rates (30 percent or higher).

In 2040, population densities in Northern Virginia will still be highest in the inner jurisdictions, particularly clustered along Metrorail stations in Arlington and Fairfax Counties, and the City of Alexandria. Data shows that the majority of Northern Virginia's population growth will occur within RACs – a higher portion than in the metropolitan area as a whole.

Table 1-1: Population Growth 2016 to 2040

Jurisdiction	2016 Population	2040 Population	2016-2040 Growth	Percent Growth	Portion of Growth in RACs
City of Alexandria	149,947	190,824	40,877	27%	98%
Arlington County	222,962	278,055	55,093	25%	96%
City of Fairfax*	24,948	27,875	2,927	12%	100%
Fairfax County	1,132,792	1,362,443	229,651	20%	77%
City of Falls Church*	13,330	17,311	3,981	30%	100%
Loudoun County	373,757	492,517	118,760	32%	34%
City of Manassas*	43,613	51,452	7,839	18%	100%
City of Manassas Park*	14,591	15,864	1,273	9%	100%
Prince William County	437,069	558,060	120,991	28%	19%
Northern Virginia Total	2,413,009	2,994,401	581,392	24%	60%
Washington Metropolitan Total	7,150,948	8,788,431	1,637,483	23%	46%

Source: MWCOG, 2016

*The cities of Falls Church, Fairfax, Manassas, and Manassas Park are entirely within an RAC.

Employment Growth

The metropolitan area is also forecast to experience robust employment growth by 2040, with an additional 1.2 million jobs, for a metropolitan total of 5.3 million jobs. The metropolitan area's growth of 29 percent will be exceeded by that of Northern Virginia, where estimated job growth of 37 percent will result in approximately 1.9 million total jobs in Northern Virginia alone. As shown in **Table 1-2**, the largest numbers of jobs will be added in Fairfax County, while Prince William and Loudoun Counties are expected to experience the highest growth rates (60 percent or higher).

Employment in Northern Virginia is expected to remain clustered around major activity centers, with almost 70 percent of jobs located in Northern Virginia RACs. The highest density employment locations are forecast to be near Metrorail stations, including:

- Orange/Silver Line corridor from Rosslyn to Ballston;
- Yellow Line corridor from the Pentagon to Alexandria; and
- Tysons, Springfield, Merrifield, and Reston.

Beyond the Metrorail system, high employment densities are forecast around the Mark Center, Fort Belvoir, Fairfax Center, Woodbridge, Innovation, Quantico, and portions of the cities of Fairfax and Manassas.

Table 1-2: Employment Growth 2016 to 2040

Jurisdiction	2016 Employment	2040 Employment	2016-2040 Growth	Percent Growth	Portion of Growth in RACs
City of Alexandria	107,009	142,735	35,726	33%	97%
Arlington County	210,319	267,641	57,322	27%	96%
City of Fairfax	20,988	25,600	4,612	22%	100%*
Fairfax County	663,879	864,530	200,651	30%	87%
City of Falls Church	12,458	18,300	5,842	47%	100%*
Loudoun County	168,957	273,910	104,953	62%	58%
City of Manassas	27,200	31,551	4,351	16%	100%*
City of Manassas Park	4,644	5,106	462	10%	100%*
Prince William County	147,426	243,889	96,463	65%	30%
Northern Virginia Total	1,362,880	1,873,262	510,382	37%	72%
Washington Metropolitan Total	4,066,099	5,253,305	1,187,206	29%	60%

Source: MWCOG, 2016

*The cities of Falls Church, Fairfax, Manassas, and Manassas Park are entirely within an RAC.

CHAPTER 2: THE REGIONAL TRANSPORTATION NETWORK

Northern Virginia is located in one of the largest metropolitan areas in the country and has a complex and expansive transportation system to move people across the region. **Figure 2-1** below highlights the major transportation infrastructure and services within the region. **Table 2-1** on the following page provides a catalogue of major transportation infrastructure.

Figure 2-1: Regional Transportation Network Map

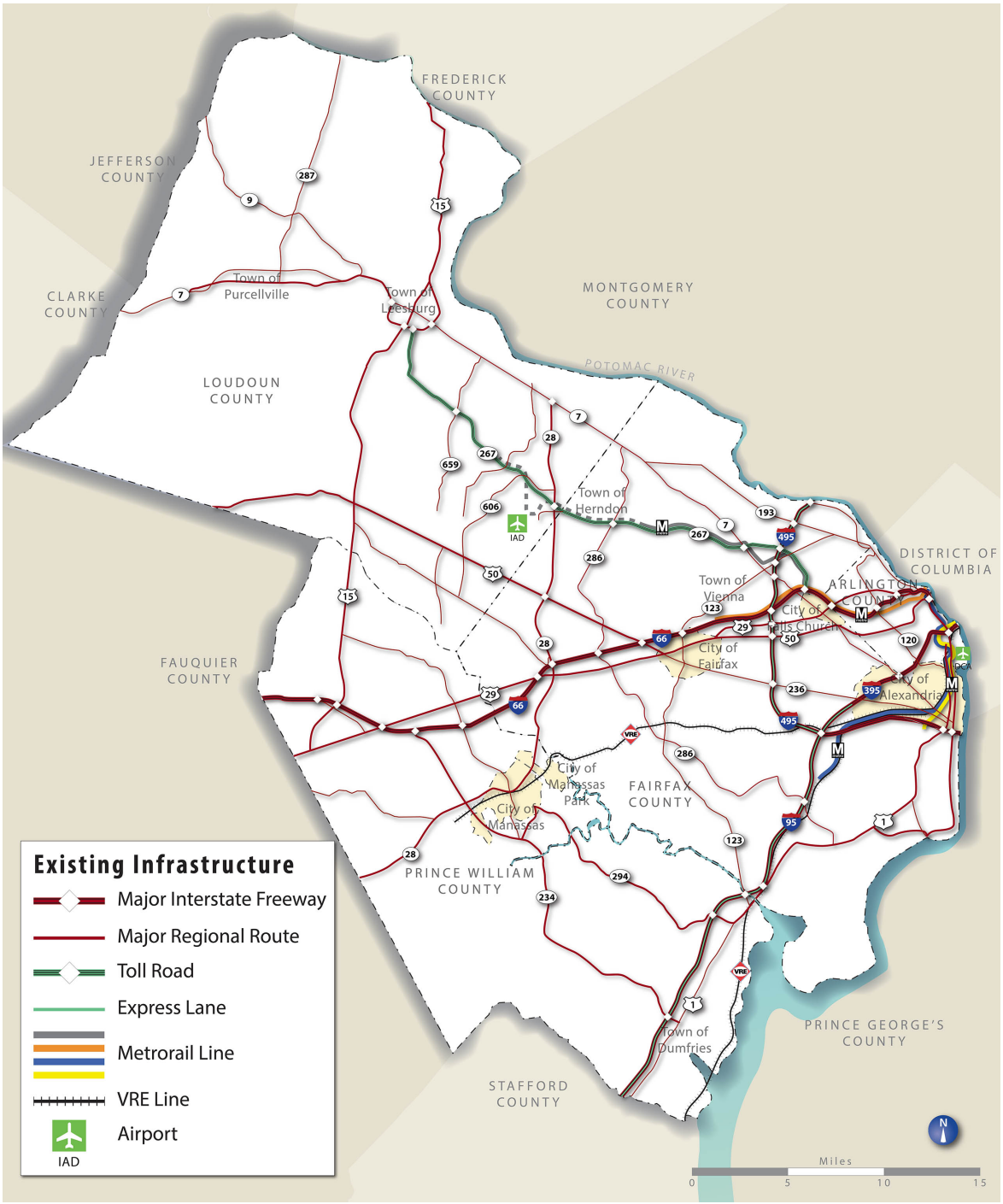


Table 2-1: Catalogue of Regional Transportation Facilities

Mode	Data Point	Description
Highway and Express Lanes	Over 100 total miles across the NoVa region	• Major Northern Virginia highways include: ○ I-495 (Capital Beltway) segments within the City of Alexandria and Fairfax County with crossings of the Potomac River into Maryland at the American Legion Bridge and Woodrow Wilson Bridge; ○ I-395/95 segments within Arlington County, the City of Alexandria, Fairfax County, and Prince William County with a crossing of the Potomac River into DC at the 14th Street Bridge; ○ I-66 segments within Arlington County, Fairfax County, and Prince William County, with a crossing of the Potomac River into DC at the Theodore Roosevelt Bridge; ○ Route 50 and Route 29 segments between Arlington County, and Loudoun and Prince William Counties, respectively; ○ Route 28 segments within Loudoun County, Fairfax County, and Prince William County; ○ Route 15 segments between Gainesville and Leesburg; ○ Route 1 segments between Arlington County and Prince William County; ○ Route 7 segments between the City of Alexandria and Loudoun County; ○ Fairfax County Parkway between Route 1 in southern Fairfax County and Route 7; ○ Route 267 Toll Road, consisting of the Dulles Toll Road and Dulles Greenway, between I-66 near the City of Falls Church and Route 15 in Leesburg; ○ I-495 Express Lanes between Tysons and Springfield; and ○ I-95 Express Lanes segment between Springfield and Prince William County.
Arterial and Local Street Network	Over 10,000 total miles across the NoVa region	• All vehicular trips use this network for some or all of their journey; TransAction analysis shows that this network is essential to the regional transportation system.
Rail and Transit	10 transit providers and over 200 routes	**Rail** • Washington Metropolitan Area Transit Authority (WMATA) operates four heavy rail lines – Blue, Orange, Silver, and Yellow – within Northern Virginia as part of its Metrorail system. Each line offers services seven days per week. • Virginia Railway Express (VRE), co-owned by NVTC and PRTC, operates two heavy rail commuter lines during weekday peak periods: • Amtrak provides passenger rail service for trips between Northern Virginia and many national destinations. **Bus** • Local and regional bus service is operated to, within, and between RACs by several NVTA member jurisdictions. Operators include ART, CUE, DASH, Fairfax Connector, LC

		Transit, and PRTC. • Within Northern Virginia, WMATA operates its Metrobus service within Fairfax County, Arlington County, the City of Fairfax, the City of Falls Church, and the City of Alexandria. WMATA also operates Metrobus service between Washington, DC and Washington Dulles International Airport in Loudoun County. • Metroway bus rapid transit (BRT) line operating along the Route 1 corridor in Arlington County and the City of Alexandria; • The District of Columbia Department of Transportation (DDOT) provides DC Circulator bus service between Rosslyn and Dupont Circle. • Inter-city bus services are provided by privately run companies such as Vamoose, SprinterBus, Bestbus, and Washington Deluxe.

Mode	Data Point	Description
Other Shared Travel Modes		• Transportation Network Companies, such as Uber and Lyft, are becoming more popular alternatives to taxis. • Slug lines allow commuters to save money and time and reduce emissions by meeting carpool requirements. • Short-term car rental services, including ZipCar, Car2Go, and Enterprise CarShare, offer users the opportunity to rent a car for specific, short trips and errands.
Bicycles and Pedestrians	Over 400 miles of paved and unpaved trails, bike lanes, and bikeways.	**Bicycle Network** • Northern Virginia's bicycle network includes an extensive network of bikeways. Notable examples include the Mount Vernon Trail, Custis Trail, and Washington & Old Dominion Trail. • Approximately 1/3 of the over 450 Capital Bikeshare stations throughout the Washington metropolitan area are located within Northern Virginia. **Pedestrian Network** • Pedestrian networks, including sidewalks, trails, and street crossings, are extensive throughout Northern Virginia's dense and urban jurisdictions. These facilities are also common on major roads in Northern Virginia, including multi-use trails, sidewalks, or both outside urban areas.
Freight	Trucks carry about 75% of the freight tonnage within the Commonwealth of Virginia.	• More than 16,000 miles of roadway carry more than 300 million tons of goods annually. • Two Class I railroads – operated by CSX Transportation and the Norfolk Southern Corporation – consist of over 250 miles of mainline track and transport more than 47 million tons of local freight annually. • One cargo airport – Washington Dulles International Airport.
Passenger Air	Dulles International and Reagan National airports	• Two major international airports – Ronald Reagan Washington National Airport and Washington Dulles International Airport – operated by the Metropolitan Washington Airports Authority

	each serve over 20 million passengers annually.	(MWAA). • Manassas Regional Airport and Leesburg Executive Airport primarily serve private aircraft within the region.

While the local jurisdictions are responsible for maintaining transportation plans for their roadway and transit systems, most county road networks are constructed, operated, and maintained by the Virginia Department of Transportation (VDOT). Conversely, Northern Virginia's cities and towns with populations over 3,500 maintain their own roads. Arlington County is the one local exception in that it is a county-level jurisdiction that maintains its own roads.

CHAPTER 3: FUTURE OF TRANSPORTATION – "WHAT'S NEW?"

Transportation is evolving rapidly, with new technologies and new traveler preferences. Many of these changes take advantage of new technology, with some of the most dramatic changes yet to come, including CAVs. New transportation services are now available, including those operated by private providers, while the proliferation of shared mobility services provide on-demand and real-time transportation services. Meanwhile, evolving travel preferences are changing perceptions of what is possible in terms of public and private mobility services.

From ride hailing and bike sharing to CAVs and micro transit, new technologies are providing mobility options that will significantly alter the transportation paradigm, including travel behavior, system performance, and future investments. Policy makers and transportation agencies will need to consider these complex issues as they develop plans and allocate resources. The following sections summarize the recent and emerging trends detailed in **Appendix A** and identify how they impact the TransAction Plan.

REAL-TIME TRAVEL INFORMATION

Travelers increasingly have real-time and multimodal information to take into consideration before making a trip. Information on congestion, travel times, and route options can be accessed by members of the public, helping them make informed choices about how to get around. Transit providers are also improving real-time data, both from GPS-equipped buses and time-stamped travel passes such as the region's SmarTrip card. With this robust new information, individuals and agencies can track decisions and provide real-time updates for travelers. This information can also support a series of dynamic actions, ranging from speed limits that vary based on expected congestion levels, to using tolls and transit fares that vary based on traffic volumes. This leads to a more efficient use of the overall regional transportation network.

Transportation agencies have used Intelligent Transportation Systems (ITS) to help manage transportation operations for several decades. However, new sources of near real-time information from GPS-based probes and advances in wireless communication now make it possible to manage the transportation network in an integrated and dynamic fashion. As a result, agencies are developing a new, integrated set of tools to help manage traffic congestion and transportation in general.

New data and traveler information has two sets of implications for TransAction. First, new and more comprehensive sets of performance measures, such as accessibility measures, are practical. Performance measures can be more robust than in the past given the significant increase in the volume and geographic distribution of available data. Second, the up-to-date, comprehensive, multi-modal information available for individual travel decisions may result in more reliable and cost-effective transportation choices and payment methods.

SHARING ECONOMY

Shared mobility services, such as ZipCar, Capital Bikeshare, car-sharing providers, among many others are now common in urban areas around the world, including Northern Virginia. Shared mobility refers to transportation services that allow individual users to access or "share" the use of a common vehicle (such as a bicycle, car, taxi, shuttle, bus, or scooter) on a short-term or as-needed basis rather than using a private vehicle. Often, users access a pool of vehicles through the aid of a smartphone, computer, or tablet. Common examples of technology enabled shared mobility include ride hailing, car-share, bike-share, and shared shuttles.

Did You Know?

In October 2016, Fairfax County added 17 new Capital Bikeshare stations in Tysons and Reston.

Across the country, this impressive growth in shared mobility points to strong demand for ownership of a trip rather than ownership of a personal vehicle. People are increasingly willing to forgo using a private vehicle for the comfort and ease of a shared option that meets their mobility needs. Shared mobility reduces the need for parking spaces, while less time spent looking for parking will reduce traffic congestion and emissions.

However, the market for shared mobility is still evolving with new sharing models emerging all the time. The evidence is mixed regarding the growth of shared mobility options and implications for private care ownership and use. For example, while some shared mobility options serve as a complement to public transportation, it is unclear if the growth in sharing will eventually become a substitute for public transportation in some places, and reduce the effectiveness of buses and rail.

Currently, the concentration of investment and availability of these new options is within core urbanized areas where activity levels are highest and where Metrorail and other transit services complement the new options.

TRAVEL PREFERENCES

Millennials now account for about 35 percent of the civilian labor force. Their travel patterns have changed from previous generations: only 46 percent of Americans have a driver's license by the time they are 19, versus 64 percent in 1998. More social interaction is carried out via social media, with 54 percent of Millennials reporting that they use social media to interact with friends rather than driving to meet in person.[3]

Telecommuting continues to grow and on some surveys appears as the fastest growing "mode" of urban work trips. Additionally, 34 percent of the workforce is now employed as independent contractors or temporary workers, moonlight on more than one job, or operate small private firms with flexible hours.

[3] *Street Smart: The Rise of Cities and the Fall of Cars – Sam Schwartz.*

Though demand for mass transit has increased nationwide, ridership growth in Northern Virginia (bus and rail) has stagnated in recent years. This is due, in part, to various challenges including Metrorail service reliability related to the SafeTrack repair program (2016-2017), an increase in telework options, and commercial availability of transportation choices in the urban mobility landscape. However, local systems are responding by adding capacity and improving systems overall to be more customer focused. As a result, travelers in the region now have greater access to transit choices than ever before and greater latitude with when and how to travel.

In sum, there appears to have been a decline in overall individual mobility. Increased use of social media, internet purchases, freelance employment, and reduced tendency to obtain drivers licenses mean that the future rate of per capita growth in automobile travel is likely to be slower than in past decades.

VEHICLE TECHNOLOGY

Vehicle technology is evolving rapidly. CAVs will include a range of functions that allow vehicles to automate the driving task, and communicate with roadside infrastructure and other vehicles. Advances in vehicle technology have the potential to improve safety, improve mobility for people with barriers to driving due to disability or age, and increase roadway capacity while allowing travelers to focus on other tasks. However, much remains unknown about the technology, including regulations, timing, and implementation requirements of CAVs and their impact on urban areas.

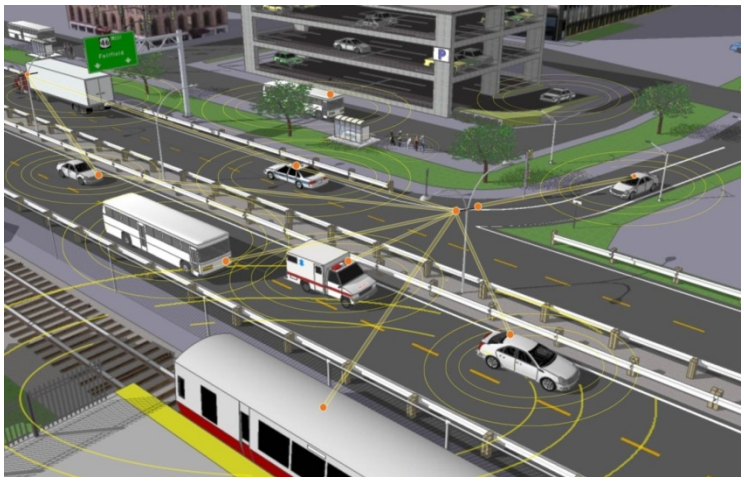


Figure 3-1: Illustration of Connected and Autonomous Vehicle Features

Source: National Highway Traffic Safety Administration

Of course, it will take time for these new vehicles to spread through the fleet. Retrofitting, regulations, and market demand will be key in determining the pace of deployment. Planning implications include increased capacity per roadway lane, reduced car ownership rates, reduced transit operating costs, and the need for additional infrastructure investments. It is not yet clear the effect these new technologies will have on overall vehicle miles traveled or levels of congestion. Uncertainty about these effects, deployment timelines, and the regulatory framework make considerations in long-term plans, such as TransAction, difficult.

FUTURE SCENARIOS

The trends described in this chapter have important implications for travel behavior, system performance, and future investments. Given uncertainty regarding the pace and breadth of new technologies and new mobility services, the TransAction Plan has incorporated analysis of several scenarios that cover the range of plausible possibilities. In developing the TransAction Plan, the NVTA has considered different possible futures, shaped in different ways by evolving technologies, behaviors, and policies. These scenarios, described and analyzed in **Chapter 12**, provide guidance on the range of possible futures, acting as a test of the Plan's resiliency as a whole.

CHAPTER 4: PUBLIC PERCEPTIONS ABOUT TRANSPORTATION

The TransAction planning effort included multiple types of public and stakeholder input. This chapter summarizes two surveys conducted by the NVTA to understand public perceptions of transportation related to quality of life in Northern Virginia. Chapter 7 summarizes TransAction public involvement efforts focused on specific transportation problems and solutions across Northern Virginia.

"IT'S ABOUT (YOUR) TIME" – OVERVIEW, PARTICIPATION, KEY TAKEAWAYS

The NVTA conducted several surveys to understand public perceptions of transportation issues and projects in the Northern Virginia region. The goal was to document the range of public views so that the resulting plan could respond directly to public values and concerns.

The TransAction Benchmark Survey conducted in October 2015 established an initial assessment of public perceptions of transportation issues and agencies; a follow-up Tracking Survey conducted in December 2016 measured changes in public opinion. Each survey had a sample size of 606 individuals across all age groups and across all Northern Virginia jurisdictions.

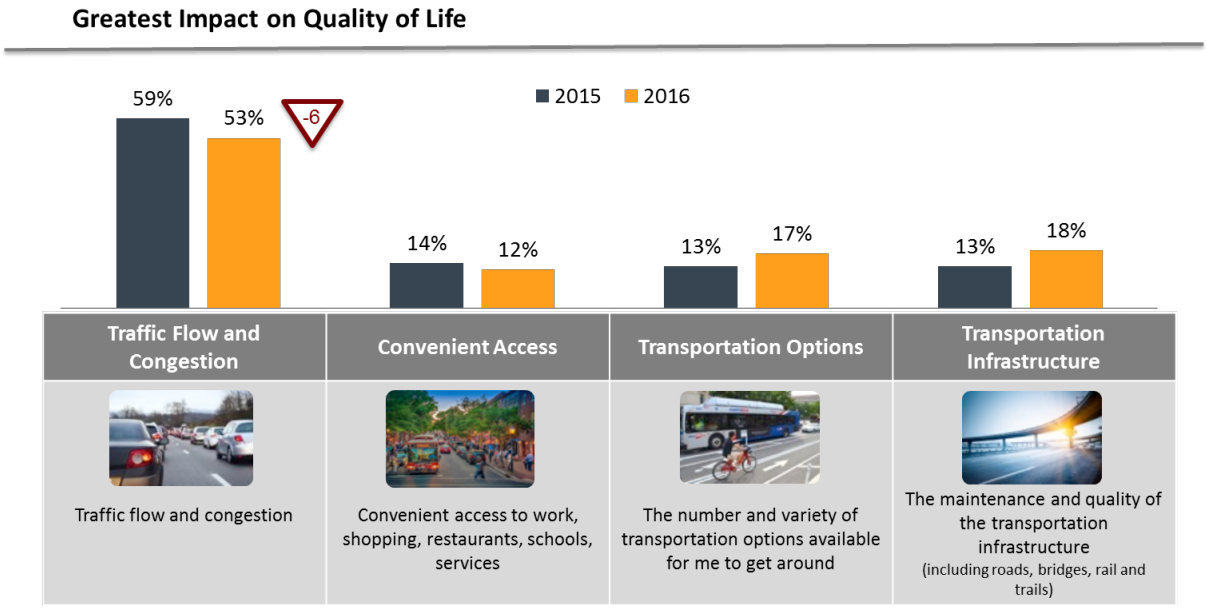
Detailed survey results are presented in **Appendix B**.

Quality of Life Perceptions

Over the one-year tracking period, the perception of quality of life and optimism for future improvement in the context of transportation increased favorably. Overall interest and knowledge of transportation issues also increased.

Among the transportation-related factors that affect quality of life for Northern Virginians, traffic flow and congestion continue to be of concern for the largest segment of respondents. Convenient access, transportation options, and the state of the transportation infrastructure were cited less often as the main factor influencing quality of life (**Figure 4-1**). The 2016 survey confirmed the growing importance of predictable trip times, increased travel options, and locating new growth near transit.

Figure 4-1: Transportation and Quality of Life—Survey Findings (2015-2016)



Press Coverage Perceptions

Press coverage of transportation issues in Northern Virginia is perceived as negative. Amongst residents who self-identify as aware of transportation issues, only a quarter of respondents cite positive press. Metro/WMATA safety, operations, ridership, and expansion are identified among the major transportation issues covered by the press. Surveyed residents also noted negative media coverage regarding the proposed I-66 toll lanes and general traffic congestion.

Traffic Flow and Congestion Perceptions

The Benchmark Survey and Tracking Survey evaluated personal transportation values of Northern Virginia respondents. Based on the surveys, traffic flow and congestion is the biggest factor contributing to quality of life. Residents believe the region is doing a poor job managing traffic flow and congestion (71 percent) and find the issue to be important due to time lost (81 percent). Respondents perceive that the region is doing a good job at addressing convenient access to transportation and is providing transportation options.

Respondents had a more favorable view of maintenance and quality of transportation infrastructure (including roads, bridges, rail and trails): in 2016, 68 percent said that the region is doing "mostly a good job", up from 43 percent in 2015. The percentage of respondents aware of the TransAction Plan doubled from eight percent to 15 percent over the year-long tracking period.

Survey results attributed high importance with poor performance, signifying that the region should prioritize improvements to poor-performing areas of the transportation network. Priorities for survey respondents included:

- Reducing trip times;
- Offering an affordable transportation system;
- Improving predictability of trip times;
- Investing in new highways and road improvements; and
- Utilizing new technologies to make the system more efficient and safer.

The survey determined that reducing travel time has the most support and interest among residents, particularly among those who live and work in different jurisdictions.

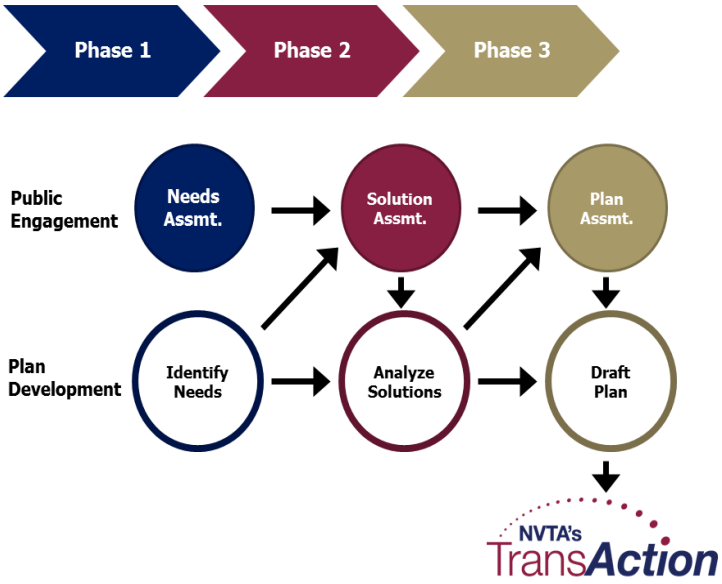
CHAPTER 5: INTEGRATED PUBLIC ENGAGEMENT APPROACH

The TransAction Plan incorporates stakeholder input and community dialogue to identify regional transportation needs and solutions. Throughout the planning process, stakeholder outreach and technical analysis complemented and informed one another to generate a balanced and effective transportation plan for Northern Virginia (**Figure 5-1**).

STAKEHOLDERS

The NVTA engaged a wide range of stakeholders across Northern Virginia to gather feedback, inform the technical process, and develop the TransAction Plan. Feedback was solicited using multiple communication platforms and in various forums throughout the region. Public meetings, pop-up events, workshops, and online engagement were strategically planned throughout the nearly two-year process to inform the technical process.

Figure 5-1: Integrated Technical/Public Engagement Approach



The TransAction planning effort facilitated ongoing dialogue with state, regional, and local government organizations, all of which have an active interest in Northern Virginia's future transportation system. Other stakeholders included: business improvements districts; chambers of commerce; and bicycle, environmental, and special interest advocacy groups.

This outreach played an important role throughout the TransAction process. Stakeholder engagement activities in spring and fall 2016 resulted in over 4,000 public comments and responses. Analysis of public input informed the identification of regional needs and the prioritization of projects by conveying public attitudes and values related to transportation investments.

PUBLIC ENGAGEMENT

The public engagement initiative behind TransAction featured three phases of public engagement, along with a preliminary benchmark survey and mid-point public perception tracking survey. These were staged to align with the ongoing technical analysis: needs identification, project prioritization, and consensus-building. For each phase, outreach activities ran in tandem with the plan's technical analysis and direction.

Throughout all three phases of outreach, the TransAction team posted on social media sites, such as Twitter and Facebook, to inform the public of the plan's progress and participation opportunities. Similarly, the TransAction team communicated by email to a large mailing list of interested Northern Virginians. These "e-blasts" included in-depth articles explaining different technical aspects of the planning process.

Phase 1: Needs Assessment

Public engagement began in fall 2015 when TransAction was introduced to the region with a press event and website launch. The website, *NVTATransAction.org*, included background on the plan, opportunities to participate, calendar, news, and contact information. It was directly linked to the primary NVTA website.

"Young people want to work in urban areas with walkability, bikeability, and public transportation."

The first phase of public engagement in spring 2016 focused on identification of transportation needs. It consisted of 12 pop-up events and five workshops held throughout Northern Virginia. Activities and boards focused around a central question: "What's your transportation problem?"

Participants provided over 1,400 responses to this question, letting the NVTA know about their transportation needs and concerns (**Appendix B**). Public input was collected in parallel to the technical modeling analysis. These simultaneous efforts were used to generate lists of major transportation needs by corridor and sub-area within Northern Virginia. These needs lists were subsequently used to brainstorm potential solutions.

Phase 2: Solution Assessment

The second phase of outreach focused on prioritization of solutions related to the transportation needs identified during the first phase of the outreach process. It consisted of an online survey with almost 2,800 responses; one stakeholder workshop, three workshops on George Mason University campuses, four pop-up events; an online poll; and four professionally led focus groups – two comprised of residents from inside the Beltway and two comprised of residents

from outside the Beltway (**Appendix B**). Public input on solutions was used to aid project prioritization. Projects employing solutions preferred by the public were given greater priority in the selection process.

Benchmark Survey and Tracking Survey

The benchmark survey was conducted in December 2015 to gauge general attitudes and opinions towards transportation in Northern Virginia. A follow-up tracking survey in December 2016 highlighted changes in public perceptions over the course of the first year of public outreach.

Phase 3: Plan Assessment

The third and final phase of outreach centered around receiving feedback on the TransAction Draft Report. To publicize the TransAction public comment period and public hearing, the NVTA implemented a communications plan through print and online mediums, as well as multiple town hall forums and jurisdictional presentations across the region. The TransAction Draft Plan was released on June 9, 2017, with the subsequent comment period ending on July 23, 2017. The Authority's July 13 public hearing also featured on open house with information about the TransAction Plan, process, and implementation schedule.

CHAPTER 6: PERFORMANCE-BASED PLANNING

WHAT IS PERFORMANCE-BASED PLANNING?

Performance-based planning is a data-driven, strategic approach that allows agencies to weigh the tradeoffs between competing packages of transportation investments. It allows policies and goals to be expressed in quantifiable terms and creates an analytical framework to determine the degree to which different investment packages meet the policies and goals. This approach is intended to lead to a more systematic and analytical selection process for investment priorities. It also allows for ongoing monitoring of the performance of investments to inform future decision-making and to enable adjustments to be made as necessary over time as the plan is updated every five years.

- **Vision:** The vision statement articulates a preferred idealized state.
- **Goals:** Goals focus on priorities and outcomes the region desires to move toward.
- **Objectives:** Objectives are measurable and targeted actions that result in incremental but tangible advancement toward the stated goals.
- **Performance Measures:** Performance measures are used to evaluate potential performance of the transportation network. They derive from the stated objectives. Objectives can and should change over time as the region progresses and diverse aspects of goals become more pronounced in response to contemporary issues or understanding.

A performance-based planning process includes setting a strategic direction ("where do we want to go?") built on a foundation of data from monitoring and evaluation of system performance ("where are we now?"), followed by analysis of how the region will move toward achieving its goals through investments and policies ("how are we going to get there?"). **Appendix C** goes into more detail about existing literature, case studies, and best practices on performance-based planning.

MAP-21 AND FAST ACT REQUIREMENTS

Across the country, there is increasing emphasis on using performance management approaches in federal and state programs, planning requirements, and funding opportunities. Recent MAP-21 and FAST Act legislation[4] established a transportation performance management program. These laws establish national performance goals and require states and regions to invest resources in projects that collectively advance national goals. The performance planning process is systematically applied, creating a regular ongoing process of communicating key information to decision makers to help them understand the consequences of investment decisions across transportation assets and modes.

[4] The Moving Ahead for Progress in the 21st Century (MAP-21) Act and Fixing America's Surface Transportation (FAST) Act are federal funding and authorization bills enacted in 2012 and 2015, respectively.

As previously mentioned, the NVTA is not required to follow such federal legislation but chooses to do so as to utilize best practices for long-range transportation planning. For the TransAction planning, the NVTA incorporated the performance- and goal- based planning standards as established in the legislation to align the TransAction plan with current best practices.

VISION, GOALS, AND OBJECTIVES

The adopted vision for TransAction states:

"In the 21st century, Northern Virginia will develop and sustain a multimodal transportation system that enhances quality of life and supports economic growth. Investments in the system will provide effective transportation benefits, promote areas of concentrated growth, manage both demand and capacity, and employ the best technology, joining rail, roadway, bus, air, water, pedestrian, and bicycle facilities into an interconnected network that is fiscally sustainable."

The TransAction regional vision is articulated through goals and objectives, and the Plan components are quantified through performance measures, which can support multiple goals and objectives. These goals and objectives are intended to be nuanced and flexible enough to reflect changing and uncertain conditions in the real world, while at the same time being simple and reliable enough to be consistently evaluated with available data and tools. In addition, they must be readily understood by stakeholders and decision-makers.

Objectives are measurable and targeted actions that result in incremental but tangible advancement toward the stated goals. Objectives will evolve over time and in subsequent updates to the TransAction Plan. The region will continue to change, and different goals will become more pronounced in response to contemporary issues.

The objectives address a range of different transportation needs. Performance by location and by objective varies across the region. The performance measures facilitate quantitative comparison and discussion about which improvements are best for the given context.

PERFORMANCE MEASURES AND WEIGHTS

The TransAction Subcommittee, the NVTA Planning and Programming Committee, the NVTA Technical Advisory Committee, and the NVTA Planning Coordination Advisory Committee provided input on the definition and weighting of performance measures. The set of measures and weights establishes continuity between TransAction and the NVTA's FY2018-23 Six Year Program.[5] The approach, approved on February 9, 2017, also strives for simplicity in explaining measures and weights to the public while respecting the priorities identified by the committees. The measures and weights ultimately adopted by the NVTA for TransAction are shown in **Table 6-1**. Refer to **Appendix D** for more detailed information on goals, objectives, performance measures, and weights.

[5] *Virginia Code mandates that the NVTA is responsible for developing and maintaining the long range transportation plan forNorthern Virginia. Any project to be included in the NVTA Six Year Program must be evaluated in accordance with a state-mandated process referred to as HB 599, which takes its name from legislation enacted by the Virginia Assembly in 2012.*

Table 6-1: Weighted Measures

Goals	Objectives		Performance Measures[1]		Goals Supported[2]			NVTA Adopted Weights
Goal 1: Enhance quality of life and economic strength of Northern Virginia through transportation	1.1	Reduce congestion and crowding experienced by travelers in the region	1.1.1	Total Person Hours of Delay (**HB599**)	❶		③	10%
			1.1.2	Transit Crowding (**HB599**)	❶	②		5%
			1.1.3	Person Hours of Congested Travel in Automobiles (**HB599**)	❶		③	5%
			1.1.4	Person Hours of Congested Travel in Transit Vehicles (**HB599**)	❶		③	5%
	1.2	Improve Travel Time Reliability	1.2.1	Congestion Severity: Maximum Travel Time Ratio	❶	②		5%
			1.2.2	Congestion Duration (**HB599**)	❶	②	③	10%
	1.3	Increase access to jobs, employees, markets, and destinations	1.3.1	Percent of jobs/population within 1/2 mile of high frequency and/or high performance transit	❶			5%
			1.3.2	Access to Jobs within 45 mins by auto or within 60 mins by transit (**HB599**)	❶			5%
	1.4	Improve connections among and within areas of concentrated growth	1.4.1	Average travel time per motorized trip between Regional Activity Centers	❶			5%
			1.4.2	Walkable/bikeable environment within a Regional Activity Center	❶		③	5%
Goal 2: Enable optimal use of the transportation network and leverage the existing network	2.1	Improve the safety of transportation network	2.1.1	Safety of the transportation system	①	❷		5%
	2.2	Increase integration between modes and systems	2.2.1	First and last mile connections	①	❷		10%
	2.3	Provide more route and mode options to expand travel choices and improve resiliency of the system	2.3.1	Travel by non-SOV modes	①	❷	③	10%
	2.4	Sustain and improve operation of the regional system	2.4.1	Person hours of travel caused by 10% increase in PM peak hour demand (**HB599**)		❷		5%
Goal 3: Reduce negative impacts of transportation on communities and the environment	3.1	Reduce transportation-related emissions	3.1.1	Vehicle miles traveled (VMT) by speed			❸	10%

[1] 'HB599' indicates measure used by VDOT during the HB599 Evaluation and Rating process for the FY2015-16 and FY2017 Programs.

[2] TransAction performance measures are designed to support multiple goals. See below for distinction between primary and secondary goals, as supported by each measure.

❶❷❸ indicate primary goal supported by each measure.

①②③ indicate other goals supported by each measure.

PART 2

Regional Transportation Needs

TransAction Technical Report

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REGIONAL TRANSPORTATION NEEDS

Residents of Northern Virginia overwhelmingly agree that transportation plays a critical role in their quality of life. The results of stakeholder outreach validate and reaffirm TransAction's goals and measures, and informed the technical analysis used to create the Plan. Between 2016 and 2040, daily vehicular trips in Northern Virginia are anticipated to increase by 1.6 million (21 percent). Modeled trip patterns forecast high growth in travel among RACs in Northern Virginia, and lower growth in trips to the traditional DC core. Similarly, 2040 travel conditions reflect increasing congestion on regional roadways and transit lines within Northern Virginia further from the DC core.

This part contains the following chapters:

- **Chapter 7**: Stakeholder and Public Inputs
- **Chapter 8**: Regional Travel Patterns and Trends
- **Chapter 9**: Travel Conditions

CHAPTER 7: STAKEHOLDER AND PUBLIC INPUTS

The NVTA sought to engage stakeholders and members of the public in a meaningful and effective way to develop the TransAction Plan. The NVTA invested in a thorough public opinion survey to gauge the attitudes of Northern Virginians towards transportation. The NVTA designed each phase of the two-year planning and public engagement process to define, then act upon, transportation needs, priorities, and solutions within Northern Virginia.

"WHAT'S YOUR (TRANSPORTATION) PROBLEM?"

Phase 1 of the public engagement approach involved a needs assessment. To gather public input on regional transportation needs for TransAction, the NVTA held twelve pop-up and five workshop events in three counties and five municipalities in Northern Virginia. In addition to pop-ups and workshops, the public also had the opportunity to submit their feedback online at *NVTATransAction.org*.

"I've lived here 60 years, and watched the evolution of the Metro region to become the 6th largest Metro area."

-Online survey respondent

The NVTA sought to include participants from all counties and municipalities within Northern Virginia. Two events were located at Metrorail stations to capture the opinions of transit users. Participation at the annual Bike to Work Day event allowed the NVTA staff to engage with cyclists. The Authority also sought to include people of all backgrounds and ages, such as senior citizens, Spanish-speakers, millennials, and families. Comments were collected via comment sheets, an activity board, and the project website.

Future Transportation Trends

The NVTA engaged with the public to discuss five transportation trends that may impact congestion by the year 2040. These trends encompass changes in technology and evolving work and consumer habits, including:

- Population and employment growth
- Increased cost of driving
- Increased ubiquity of ridesharing and connected and autonomous vehicles
- Increased use of information technology
- Reduction in travel for work and shopping

Congestion on Interstate 95

An overwhelming percentage of the 270 online and in-person respondents (approximately 87 percent) identified population and employment growth as the trend most likely to contribute to worsening congestion. Opinions of the transportation trends most likely to decrease congestion were less unanimous. Half of the respondents indicated that a declining need to travel for work and shopping would have the most significant impact for improved future congestion. Respondents attributed this impact to the growing popularity of online shopping and

teleworking. Around 20 percent of respondents believed an increase in the cost of driving would be the future transportation trend most likely to improve congestion in the region.

Travel Choices and Travel Time

VRE's Burke Centre Station

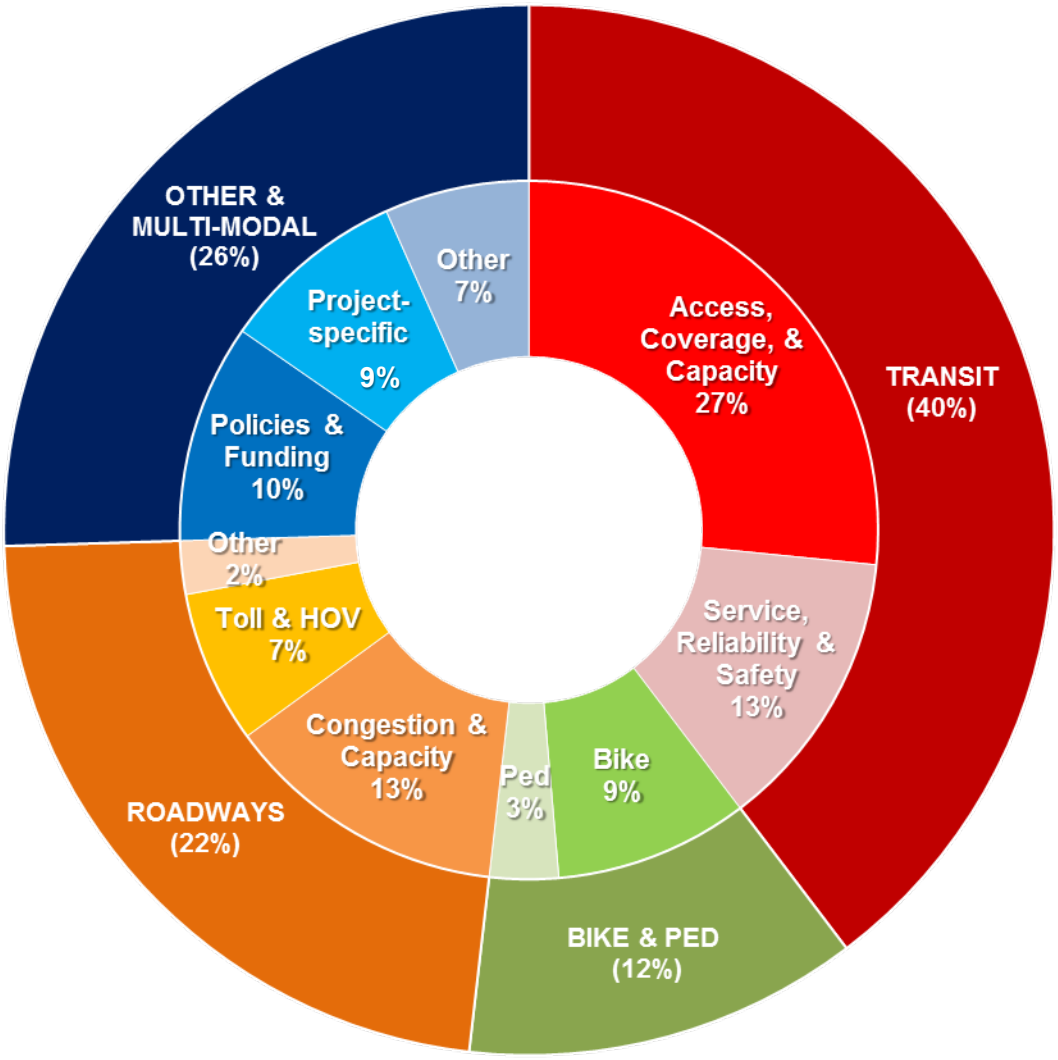
The benchmark survey indicated that the average Northern Virginian resident makes around seven non-work vehicular trips per week, each of which may include multiple destinations. An important part of the TransAction plan is understanding travelers mode of transportation when taking non-work trips. A modal choice activity was conducted to determine how travel time and destination affected which mode participants used to complete these non-work trips. 72 percent of the 800 participants indicated they use a car for non-work trips, a figure higher than the overall commute rate. Many individuals indicated that convenience and travel time motivated the decision to travel by car, while others made their decision based on accessibility to options and safety considerations. In general, however, reducing travel time was influential in determining which mode to take, as nearly 60 percent of non-work car trips by the respondents were less than 20 minutes.

"What one thing would you change about transportation in Northern Virginia?"

Participants also had the opportunity to respond to the question: "What one thing would you change about transportation in Northern Virginia?"

This activity garnered 1,373 comments, of which 418 were submitted online. The comment responses, illustrated by type in **Figure 7-1**, reflected the multimodal nature of transportation in Northern Virginia. Respondents were particularly concerned with improving the coverage, reliability, and safety of the transit network in Northern Virginia, as well as increasing the capacity of roadways to help relieve congestion. Other respondents felt that bicycle facilities could be improved throughout the region.

Figure 7-1: Responses by Type to Survey Question: "What One Thing Would You Change About Transportation in Northern Virginia?"



PRIORITIES AND SOLUTIONS

Initial TransAction outreach in spring 2016 confirmed a general perception regarding the state of transportation in Northern Virginia: it is not easy to get around the region. In response, NVTA staff engaged with regional stakeholders and citizens during fall 2016 to learn how the public values and prioritizes transportation improvements, and more importantly, the measures required to evaluate whether these improvements will effectively alleviate congestion and improve mobility within the region. An extensive outreach approach, including a second online public survey, targeted workshops, and focus groups, was undertaken by the NVTA to gain a greater understanding of the public priorities towards transportation in Northern Virginia. A key strategy of the outreach plan was to distinguish specific subregions of Northern Virginia for improved public input.

Public Survey

A separate public online survey to gauge opinions about transportation improvements was conducted in fall 2016 and garnered over 2,800 individual responses. The survey provided participants with an opportunity to voice their opinions about regional transportation priorities in Northern Virginia. While the survey was accessible online, the NVTA also appeared at locations throughout the region to perform on-site surveys targeting demographic groups, including multilingual communities, often underrepresented by online outreach. In particular, the NVTA engaged with Spanish and Vietnamese-speaking populations at these on-site outreach events.

The key takeaway from the public survey is that Northern Virginians find all TransAction measures relevant and important indicators for an improved transportation network and quality of life. The confirmation of regional values validated the technical approach to developing Northern Virginia's transportation plan.

Inside the Beltway Residents

Outside the Beltway Residents

The results demonstrated the importance of transit and alternative commute options in Northern Virginia. Both access and capacity improvements to transit were identified as priorities. Improved connections and mode capacity to regional activity centers within Northern Virginia and the DC core were also a shared priority for respondents. Roadway safety and capacity were concerns for all major corridors, most notably the I-95 corridor.

Respondents felt that travel reliability and reduced delays were the most important indicators of an improved transportation network, as well as an improved quality of life. These opinions were consistently expressed throughout Northern Virginia subregions with differing existing

transportation infrastructure and were not specific to a mode. Likewise, increasing the number of multi-modal travel options was deemed a high priority to the public.

Focus Groups and Workshops

In October 2016, the NVTA invited business and transportation interest groups to participate in facilitated round-table discussions on regional transportation priorities. Regional differences in transportation priorities varied by distance from DC, as well as by current access to transit. Inside the Beltway residents identified reduced crowding on bus and rail as an important measure for the TransAction plan. Outside the Beltway residents viewed improved safety for crash reduction as an important measure. Although these priorities differed slightly based on the existing transportation network of the respective areas, the priorities were both viewed as important to achieving the regional goal of improved reliability and more travel options. Overall, priorities for inside the Beltway residents and outside the Beltway residents had more similarities than differences. **Figure 7-2** ranks priorities by importance among participants; **Figure 7-3** shows generalized needs for areas within the region.

Figure 7-2: Top Regional Transportation Priorities

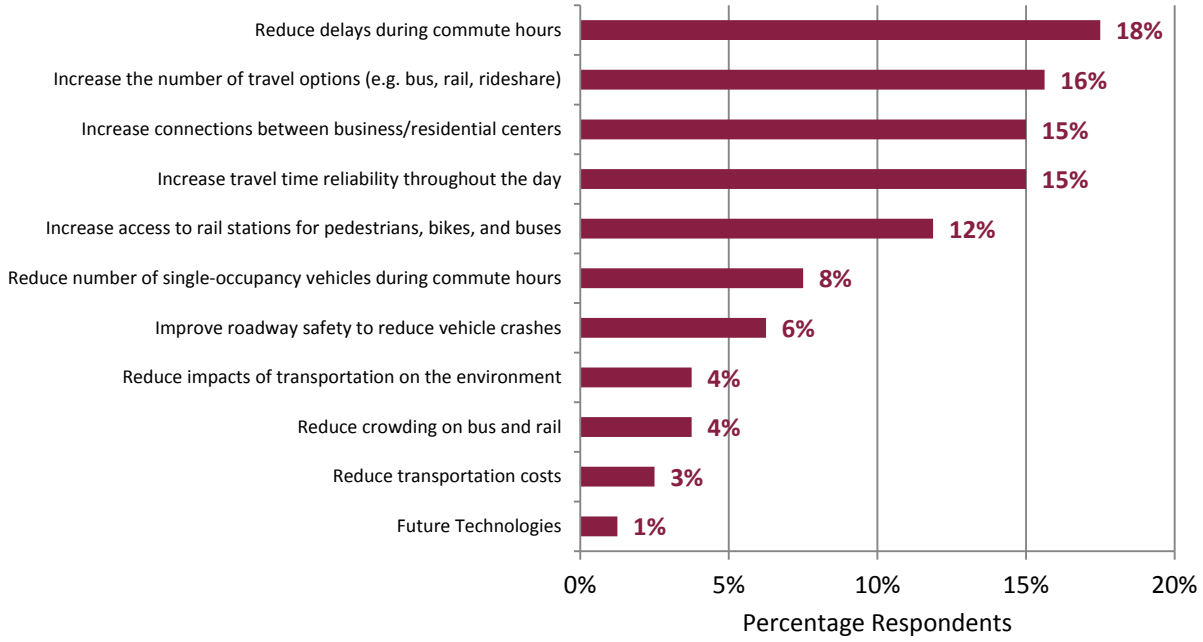
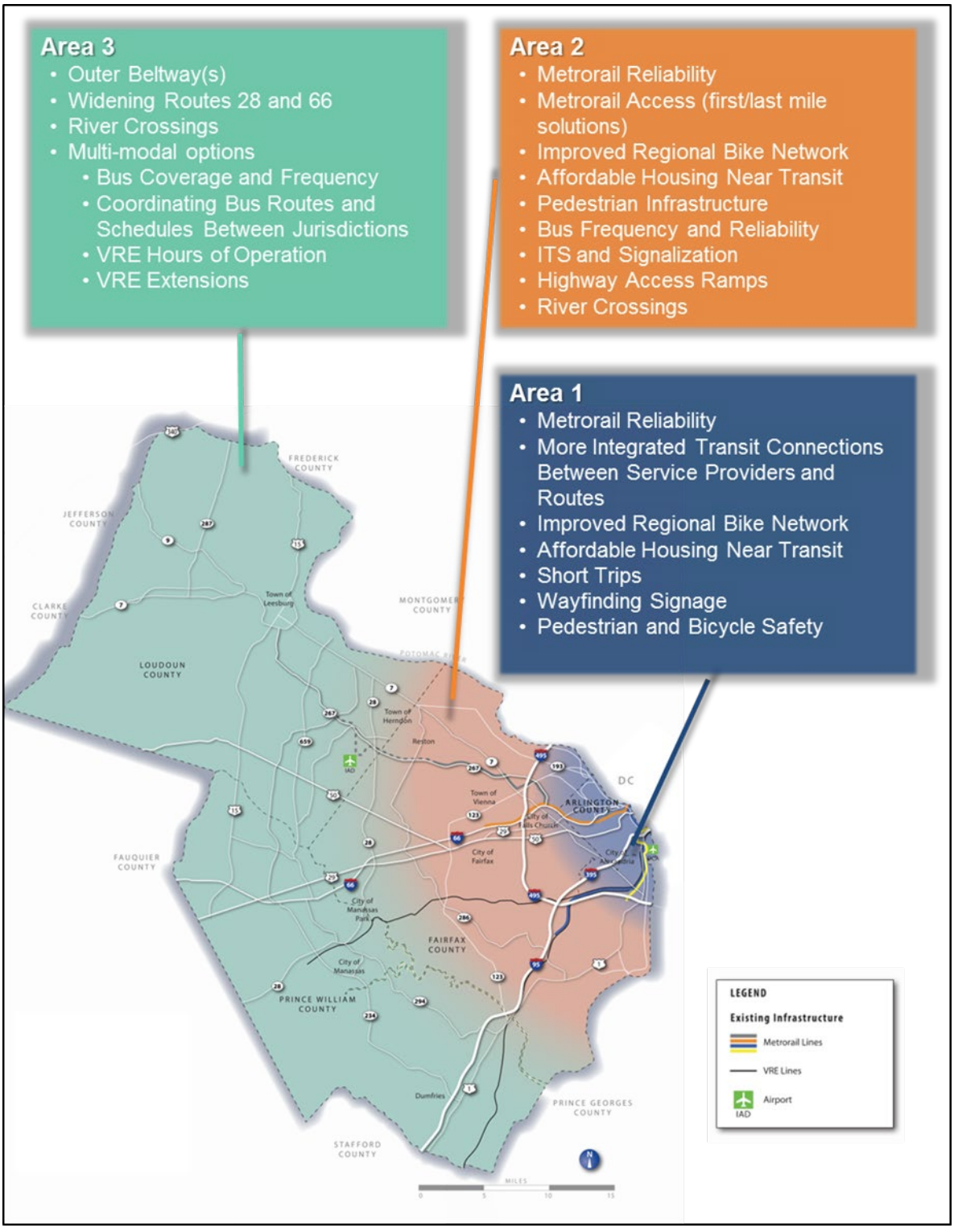


Figure 7-3: Transportation Needs by Geography



In November 2016, the NVTA conducted four focus group discussions of regional transportation issues and priorities to identify objectives to guide the TransAction plan. These focus group discussions represented a cross-section of Northern Virginia residents, with two discussions oriented towards residents living inside the Beltway and two discussions oriented towards residents living outside the Beltway.

The transportation priorities and issues identified at the November focus groups were generally consistent with the findings from the October workshop. Reducing delays during commute hours was the greatest priority for participants, followed by increasing travel time reliability. Mode choice use and priority was determined by the travel destination and origin. Public transportation was deemed a viable option for trips to and from DC; however, travel by automobile was found to be the most prevalent mode of respondents to get around Northern Virginia. While residents living inside the Beltway were more likely to use and prioritize transit, participants living outside the Beltway were also supportive of transit and other multi-modal travel options as means to help relieve congestion. Participants in the focus groups agreed that congestion has a significant impact on their daily routines and life decisions, including where they choose to live and work, and how much time they get to spend with family. Investments in multi-modal transportation improvements throughout Northern Virginia were therefore deemed critical to addressing increases in congestion within the region.

Additionally, NVTA conducted workshops at George Mason University locations in the City of Fairfax and Arlington County to engage a younger demographic. Most participants belonged to the millennial generation. Attendees at the workshop included students from various academic disciplines, including some students familiar with engineering, transportation systems, and emerging trends in technology.

Feedback on priority objectives was comparable to both the general public as well as key stakeholders. Reliability and reduced delays were the highest priority. The key difference was the higher importance of transportation impacts on the environment, as well as the reduction of Single Occupancy Vehicles (SOVs) during commute hours. This may reflect differing generational values and/or a more adept knowledge of transportation analysis. Reduced transportation costs were the lowest priority; which is notable considering the limited income and working status common of students.

JURISDICTION AND AGENCY PLANS

To assess the perceived needs of these various jurisdictions and agencies, an extensive review of jurisdictional comprehensive master plans, transit development plans, transportation demand management plans, and regional plans for Northern Virginia was conducted. Additionally, joint meetings between the Authority, representative staff from each jurisdiction/agency, and the consultant team included discussions of needs.

CHAPTER 8: REGIONAL TRAVEL PATTERNS ANDTRENDS

Northern Virginia is projected to grow by an additional 510,000 residents and 580,000 jobs by 2040. With this anticipated growth comes additional travel on Northern Virginia's transportation facilities.

TRAVEL TRENDS

In 2016, over 7.5 million vehicular trips, which includes travel by automobile and transit, were made daily within Northern Virginia. Commute trips accounted for 1.7 million daily trips, or 23 percent of daily total trips. However, a clear majority of trips within Northern Virginia are made for non-work purposes, such as shopping, school trips, or doctor's visits. These trips occur almost entirely within Northern Virginia and generally take place within 5 miles of the traveler's home. These figures include trips with their starting and/or ending location in Northern Virginia.

Projected Travel Growth in Northern Virginia, 2016 – 2040

Vehicular trips:
+27% Commute
+20% Non-commute

Non-motorized trips:
+85% Commute
+50% Non-commute

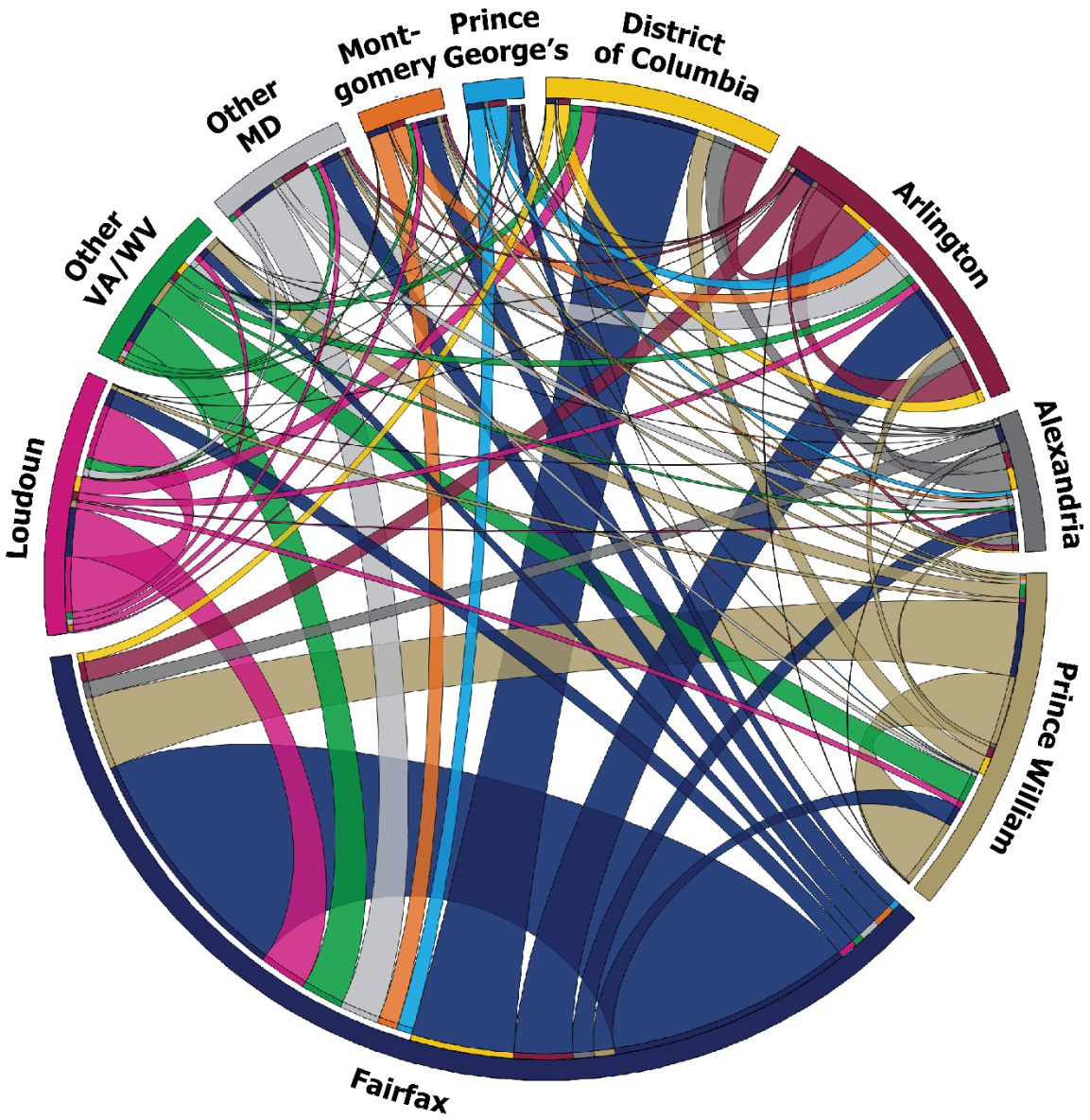
MWCOG forecasts that total daily vehicular trips within Northern Virginia in 2040 will surpass 9.1 million vehicular trips. Over one half million more commute trips will occur daily on Northern Virginia transportation facilities in 2040, increasing to 2.2 million trips. Commute trips will account for 24 percent of all vehicular trips made in 2040. Furthermore, an additional 1.1 million non-work trips are anticipated to occur daily for non-work purposes. For more detail on transportation modeling techniques used to derive these and other future numbers, refer to **Appendix E**.

Non-motorized transportation modes, which includes bicycle and pedestrian travel, make up a relatively small, but rapidly increasing share of commute trips within Northern Virginia. An extensive regional trail network, expansion of bikesharing facilities, and improvements to the bicycle and pedestrian environment within activity centers have made non-motorized travel an appealing option for many commuters. In 2016, approximately 3 percent of commute trips originating in Northern Virginia were made by bicycle or pedestrian modes. By 2040, the number of non-motorized commute trips is anticipated to nearly double, bringing their regional share of daily commute trips up to 5 percent. Among residents living and working within RACs, higher non-motorized shares apply.

REGIONAL TRAVEL PATTERNS

Given the sustained development in population and employment centers throughout Northern Virginia and across the greater DC metropolitan area, a diverse set of commute trip patterns exists in the region today. **Figure 8-1** illustrates the various locations where Northern Virginians travel to and from on their daily commutes.

Figure 8-1: 2016 Vehicular Commute Trip Patterns Within Northern Virginia



Fairfax County is the largest contributor to vehicular travel in Northern Virginia, with more than half of all trips in Northern Virginia starting and/or ending within the county. This is perhaps unsurprising considering that Fairfax County also accounts for nearly half the population and employment within Northern Virginia. Fairfax County is a major attractor of trips from Prince William and Loudoun Counties, as well as trips originating within Fairfax County. Arlington County and DC are also significant attractors of commute trips for trips originating in Northern Virginia. Approximately one-third of commute trips stay within the city or county where they originated. These points altogether indicate that many people both work and live in Northern Virginia.

Between 2016 and 2040, the region is forecasted to experience significant growth in the number of commute trips traveling to/from counties and cities within Northern Virginia, as shown in **Table 8-1** and **Table 8-2**, respectively. While growth is anticipated throughout Northern Virginia, Fairfax County is forecast to see the greatest absolute increase in commute trips. While not contributing the absolute totals of Fairfax County, Loudoun and Prince William Counties are anticipated to have the largest relative growth in commutes between 2016 and 2040. This growth in commute trips within the region places additional stress on a transportation system that is already highly utilized during peak periods and subject to increasingly severe and recurring congestion and crowding on its roadway and transit facilities.

Table 8-1: Commute Trips Originating in Northern Virginia

Jurisdiction	2016	2040	Difference	% Growth
City of Alexandria	98,103	120,510	22,407	**23%**
Arlington County	138,514	165,813	27,299	**20%**
Fairfax County	709,832	856,841	147,009	**21%**
Loudoun County	209,369	280,362	70,994	**34%**
Prince William County	275,222	355,702	80,480	**29%**
District of Columbia	308,893	393,407	84,514	**27%**

Table 8-2: Commute Trips Destined for Northern Virginia

Jurisdiction	2016	2040	Difference	% Growth
City of Alexandria	82,260	106,741	24,482	**30%**
Arlington County	273,285	349,990	76,705	**28%**
Fairfax County	696,737	887,548	190,811	**27%**
Loudoun County	128,143	199,797	71,653	**56%**
Prince William County	171,866	254,240	82,374	**48%**
District of Columbia	1,017,300	1,188,371	171,071	**17%**

Between 2016 and 2040, sustained, concentrated growth for both population and jobs is anticipated for RACs throughout the DC metropolitan area and particularly within Northern Virginia. In 2016, over four million vehicular trips, including one million commute trips, either started and/or ended within a RAC within Northern Virginia. By 2040, the number of trips starting and/or ending within a RAC will increase to over 5.4 million vehicular trips and 1.5million commute trips daily. While growth is expected throughout nearly all RACs in Northern Virginia by 2040, the most substantial increases in population and employment are anticipated in Tysons, Reston Town Center, the Rosslyn-Ballston and Dulles-Route 28 corridors, and emerging RACs within eastern Loudoun County, and along the I-66 and I-95 corridors in Prince William County.

Table 8-3 and **Table 8-4** summarize the Northern Virginia RACs anticipated to be the largest employment and residential centers, respectively, in 2040.

Table 8-3: Major Employment Centers

Activity Center	2016	2040	% Growth
Dulles South	152,709	190,942	**25%**
Merrifield / Dunn Loring	130,804	171,268	**31%**
Tysons Central 123	143,894	159,791	**11%**
Fairfax Center	147,737	155,197	**5%**
Crystal City	110,621	138,456	**25%**
City of Manassas	123,980	128,995	**4%**

Table 8-4: Major Residential Centers

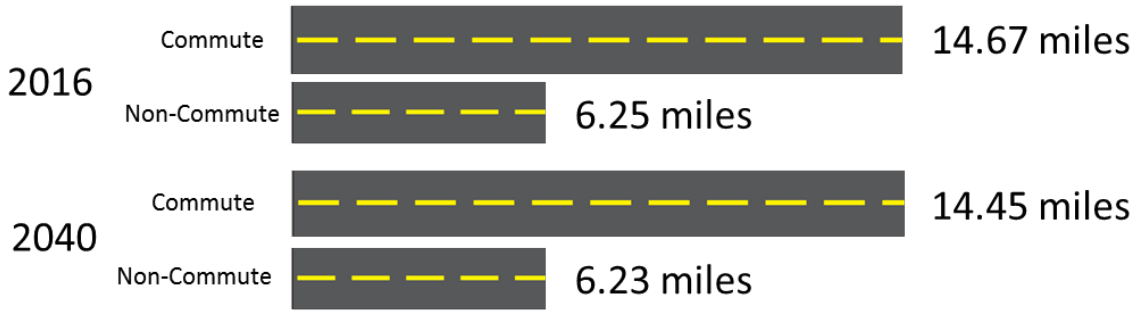
Activity Center	2016	2040	% Growth
City of Manassas	120,436	132,832	**10%**
Fairfax Center	108,389	122,320	**13%**
Merrifield / Dunn Loring	70,440	97,193	**38%**
Fairfax City	83,782	92,956	**11%**
Bailey's Crossroads / Western Gateway	66,226	80,523	**22%**
Landmark / Van Dorn	70,960	77,702	**10%**

TRIP LENGTH

Within Northern Virginia, home-based commute trips are generally longer than trips made for non-commuting purposes, such as shopping, doctor's appointments, or trips to school. The average length of daily commute trips varies widely by jurisdiction within Northern Virginia. Commute trips from Prince William and Loudoun counties on average exceed 18 miles one-way in 2016, while the average commute from Arlington County or the City of Alexandria is less than nine miles. However, non-commute trips, which are more localized in nature, vary minimally throughout Northern Virginia; shoppers travel nearly the same distance to run errands throughout the region. Over 50 percent of non-commuting trips made daily within Northern Virginia are less than five miles in length.

As shown in **Figure 8-2**, commute trips in 2040 will still be lengthy for many commuters, but given increasing densities of housing and employment in major activity centers within Northern Virginia, the average distance a commuter will travel daily will decrease slightly. For similar reasons, the average length of a non-commuting trip within Northern Virginia is anticipated to change little from 2016 conditions.

Figure 8-2: Average Trip Length in Northern Virginia



CHAPTER 9: TRAVEL CONDITIONS

The TransAction analysis includes a detailed assessment of travel conditions along major travel corridors within Northern Virginia, as shown in **Appendix F**. Needs for both the existing and future transportation systems in the year 2040 are identified by assessing the impacts of travel congestion and transit crowding along regional travel corridors.

EXISTING CONDITIONS

Travel Congestion along Regional Corridors

Currently, over 8.7 million motorized trips are made daily throughout Northern Virginia. This includes over 7.8 million trips by automobile and 870,000 trips by transit. Altogether, transportation facilities within the region accommodate nearly 105 million person miles of travel on a daily basis.

The region's interstate highways--I-66, I-95, I-395, and I-495—are heavily utilized. **Figure 9-1** shows daily traffic volumes along major roadways across Northern Virginia. Analyses of commute trip patterns for selected links on I-95 and I-66 approaching the Capital Beltway are shown in **Figure 9-2** and **Figure 9-3**, respectively:

- Northbound travelers on I-95 approaching the Capital Beltway mostly originate in Fairfax County and to a lesser extent, Prince William County, but there is also a significant amount of traffic originating from Stafford County and points south. Travelers using I-95 to commute are mostly heading to locations in Arlington, Alexandria, and DC, although some travelers continue across the American Legion or Woodrow Wilson Bridge into Maryland.
- Most of the eastbound traffic on I-66 approaching the Beltway originates in Fairfax and Prince William counties. Most these trips are bound for DC. While Maryland is a major generator and attractor of trips using I-66 outside the Beltway, a much smaller number of trips travel to/from points west in Virginia and West Virginia.

Each weekday, Northern Virginians collectively experience over one million person-hours of delay. **Person-hours of Delay** quantifies the excess daily travel time, relative to trips experiencing no traffic delays, added to auto and transit trips because of congested conditions. This measure, illustrated in **Figure 9-4**, highlights the travel corridors within Northern Virginia where congestion is most detrimental to travel conditions, both in terms of severity and the volume of vehicles impacted. Currently, Northern Virginia experiences severe congestion resulting in significant person-hours of delay on many of the region's travel corridors, for example:

- I-95 south of Dumfries Road (Route 234) towards Fredericksburg;
- I-95 approaching the Occoquan River from Prince William County;
- I-395 within the Capital Beltway;
- I-495 between the American Legion Bridge and Woodrow Wilson Bridge;
- I-66 between the City of Fairfax and I-495 and locations near Falls Church;

- Route 28 along the Dulles corridor and approaching I-66 near Centreville;
- Route 267 between Town of Herndon and Tysons;
- Route 50 both inside and outside the Capital Beltway;
- Route 7 in eastern Loudoun County and at key junctions within the Capital Beltway;
- Activity centers including: Tysons, City of Alexandria, Arlington County, City of Fairfax, City of Falls Church, Seven Corners, Sterling, Fort Belvoir;
- Reston Parkway and Dulles Greenway Toll Plaza.

Transit Ridership

In 2016, just over one million transit boardings occurred each weekday within Northern Virginia. Transit accounts for approximately ten percent of all vehicular travel within the region. **Figure 9-5** shows average weekday ridership on transit corridors within Northern Virginia. Transit corridors with the highest daily ridership include:

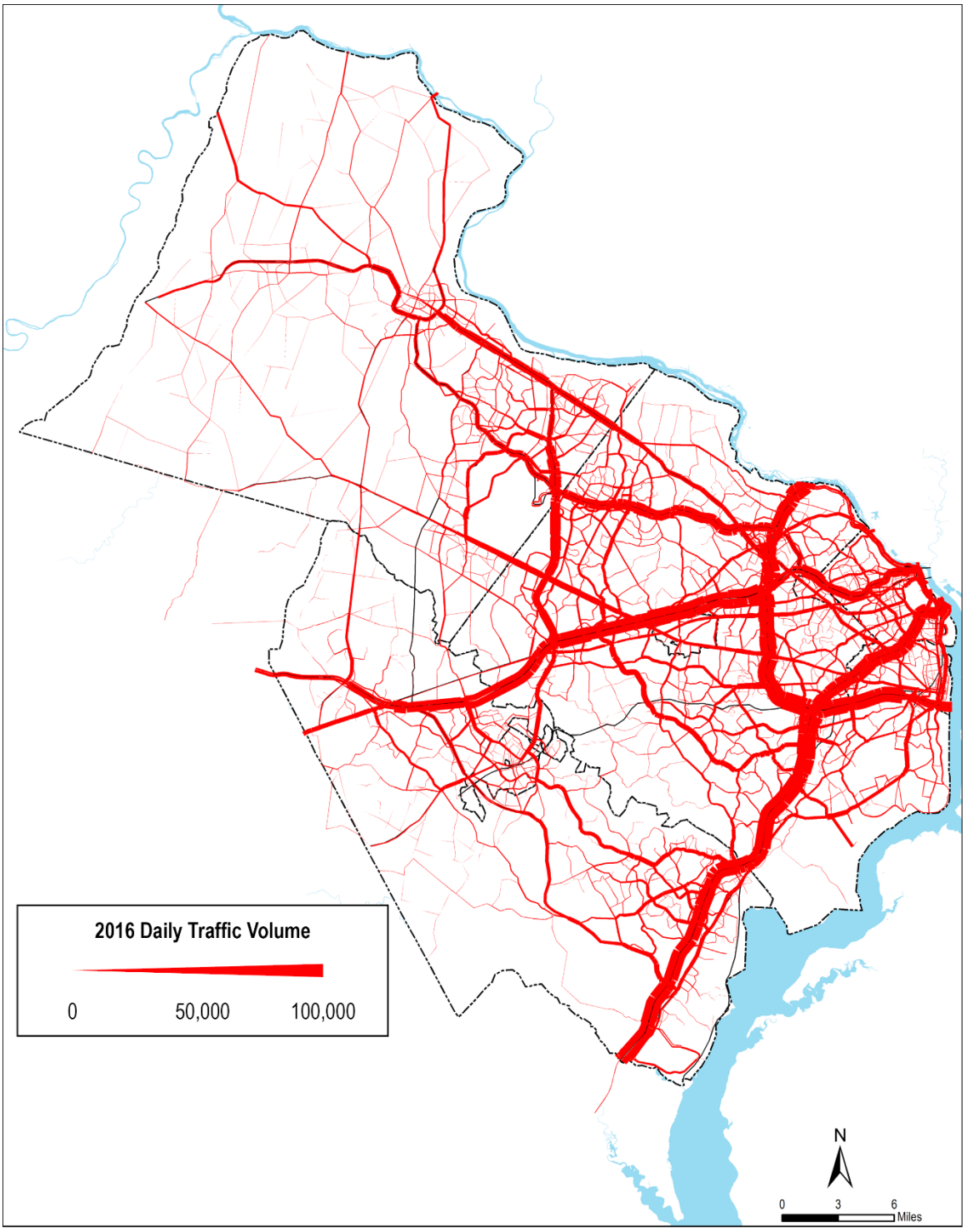
- Metrorail Orange/Silver corridor experiences ridership >50,000 east of Ballston;
- Metrorail Blue/Yellow corridor experiences ridership >30,000 approaching Pentagon;
- VRE Manassas and Fredericksburg Lines;
- I-395 approaching Pentagon and Columbia Pike are the bus corridors with the highest ridership;
- Local Metrobus, ART, and DASH service inside the Capital Beltway;
- Local Metrobus and Fairfax Connector service on Richmond Highway.

Transit Crowding

Travelers in Northern Virginia are experiencing increasingly crowded conditions on transit vehicles during their daily commutes. **Transit Crowding** occurs when local buses are at 100% seating capacity, express buses are at 90% seating capacity, commuter rail train cars are at 90% seating capacity, and when Metrorail trains have at least 100 passengers per car. **Figure 9-6** shows locations where transit crowding currently exists, with darker shades indicating corridors that experience the most significant recurring congestion on a single transit bus or Metro route or occurring on multiple transit routes. Significantly crowded transit corridors include:

- Metrorail Orange, Blue, and Silver Lines, and bus transit routes on the Rosslyn-Ballston corridor;
- Columbia Pike corridor;
- Pentagon-Crystal City-Potomac Yard corridor;
- US 1 corridor between Fort Belvoir and the Beltway;
- Connector service to the Wiehle-Reston East Metrorail station;
- Transit service along Route 123 and Gallows Road approaching Tysons.

Figure 9-1: 2016 Daily Traffic Volumes in Northern Virginia



A "select link" analysis conducted on regional highway facilities within Northern Virginia, including I-66 and I-95, indicates travel patterns for vehicles passing through a selected location in the highway network. **Figures 9-2** and **9-3** show traffic volumes and facilities used on trips by vehicles approaching the Capital Beltway on I-95 and I-66, respectively. The thickness of the lines indicates the magnitude of trips using a particular facility that also traveled on the selected highway link just outside the Capital Beltway.

Figure 9-2: Traffic Volumes and Trip Patterns for Vehicles Traveling on I-95 at Franconia-Springfield Parkway near Springfield

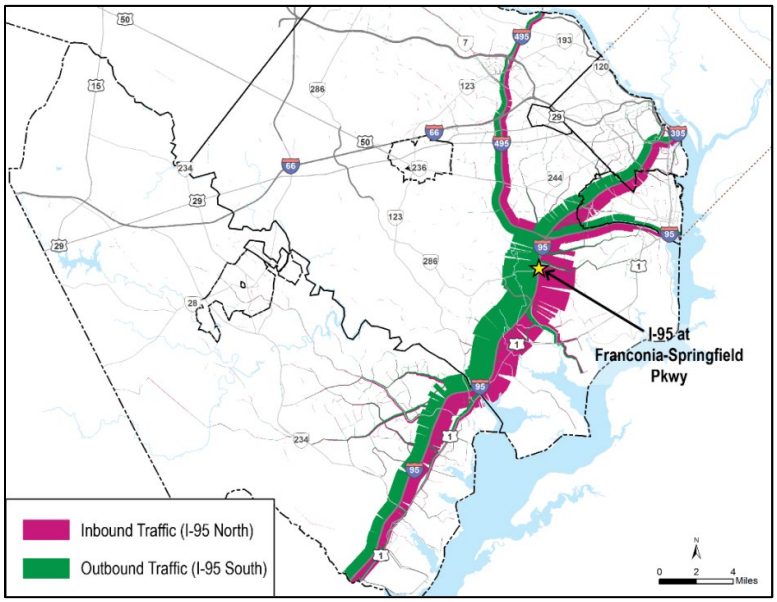


Figure 9-3: Traffic Volumes and Trip Patterns for Vehicles Traveling on I-66 at Nutley Street near Vienna

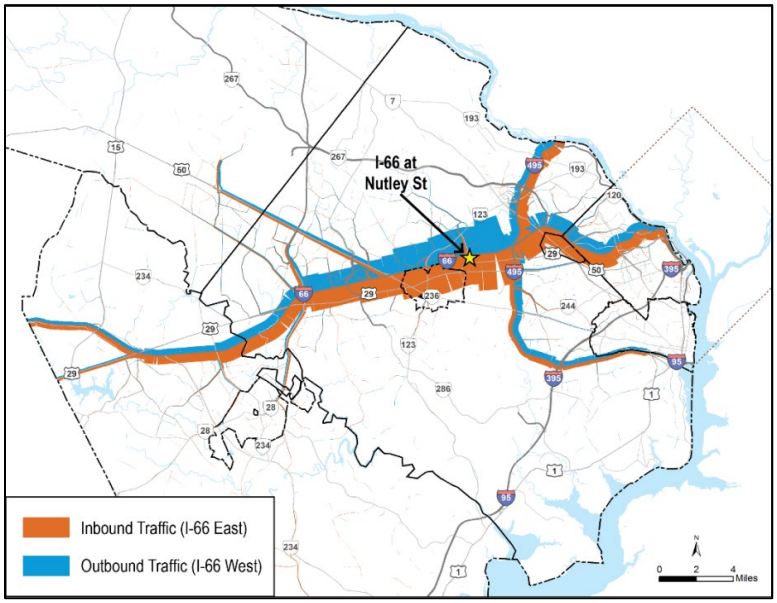


Figure 9-4: 2016 Congestion in Northern Virginia

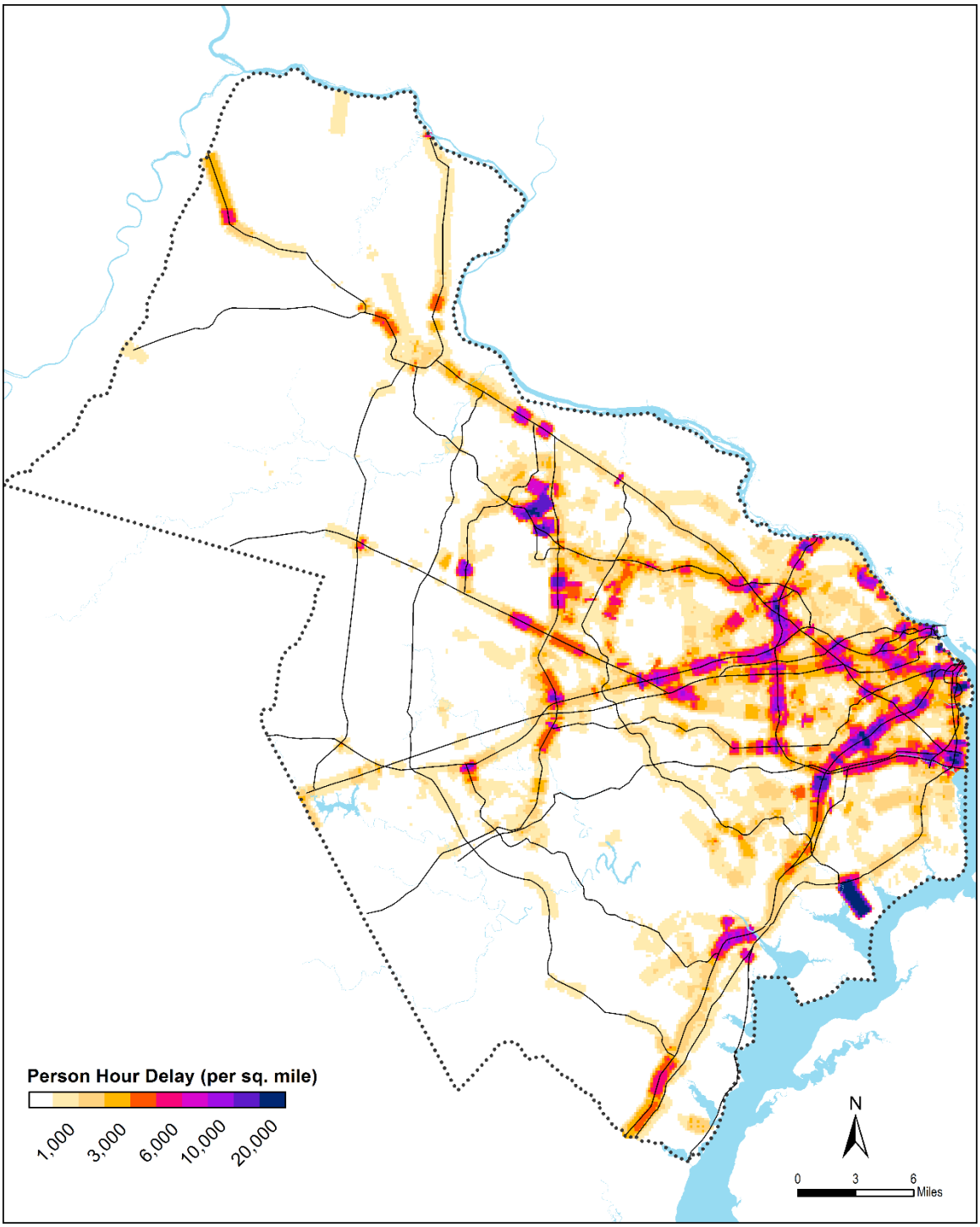


Figure 9-5: 2016 Weekday Daily Transit Ridership

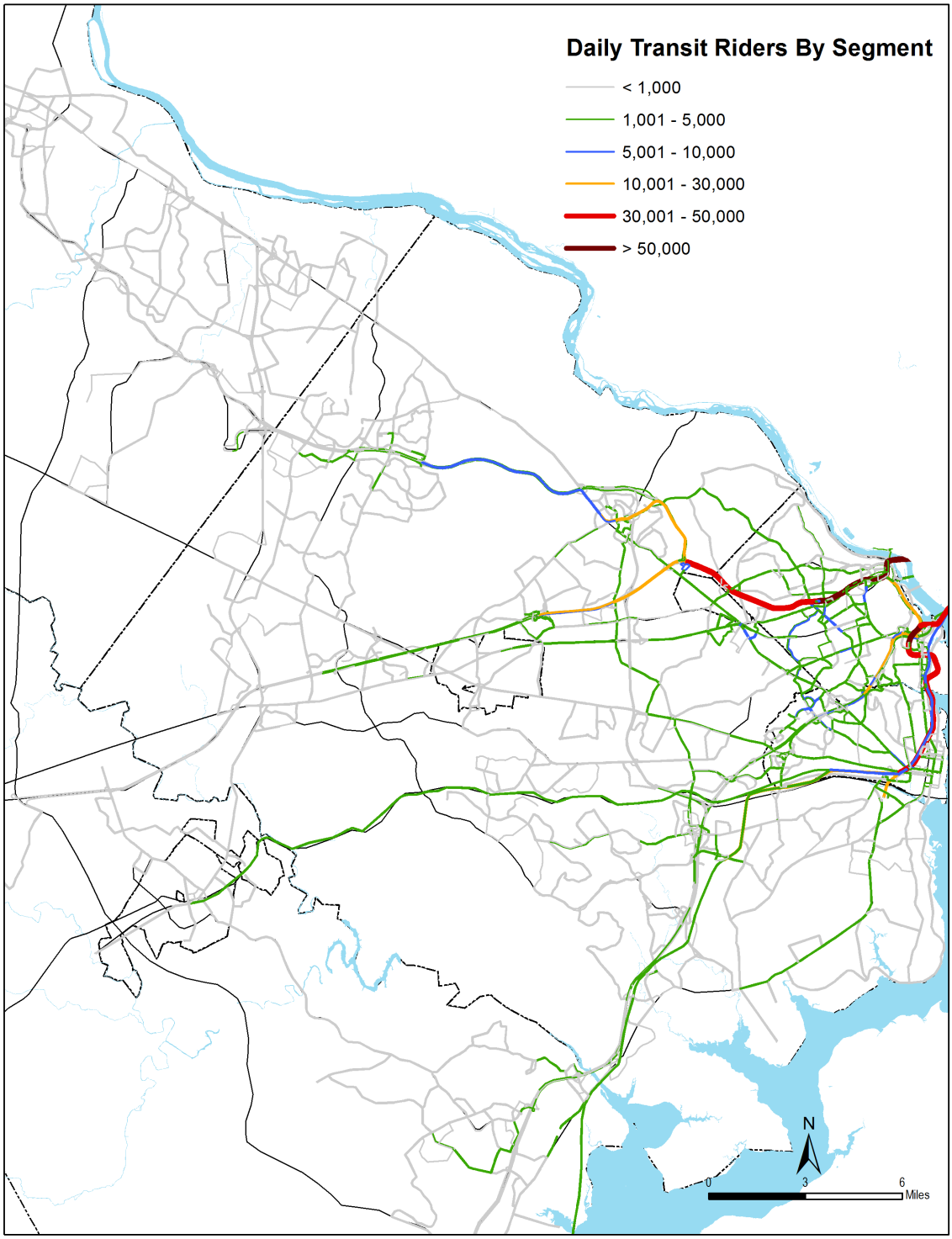
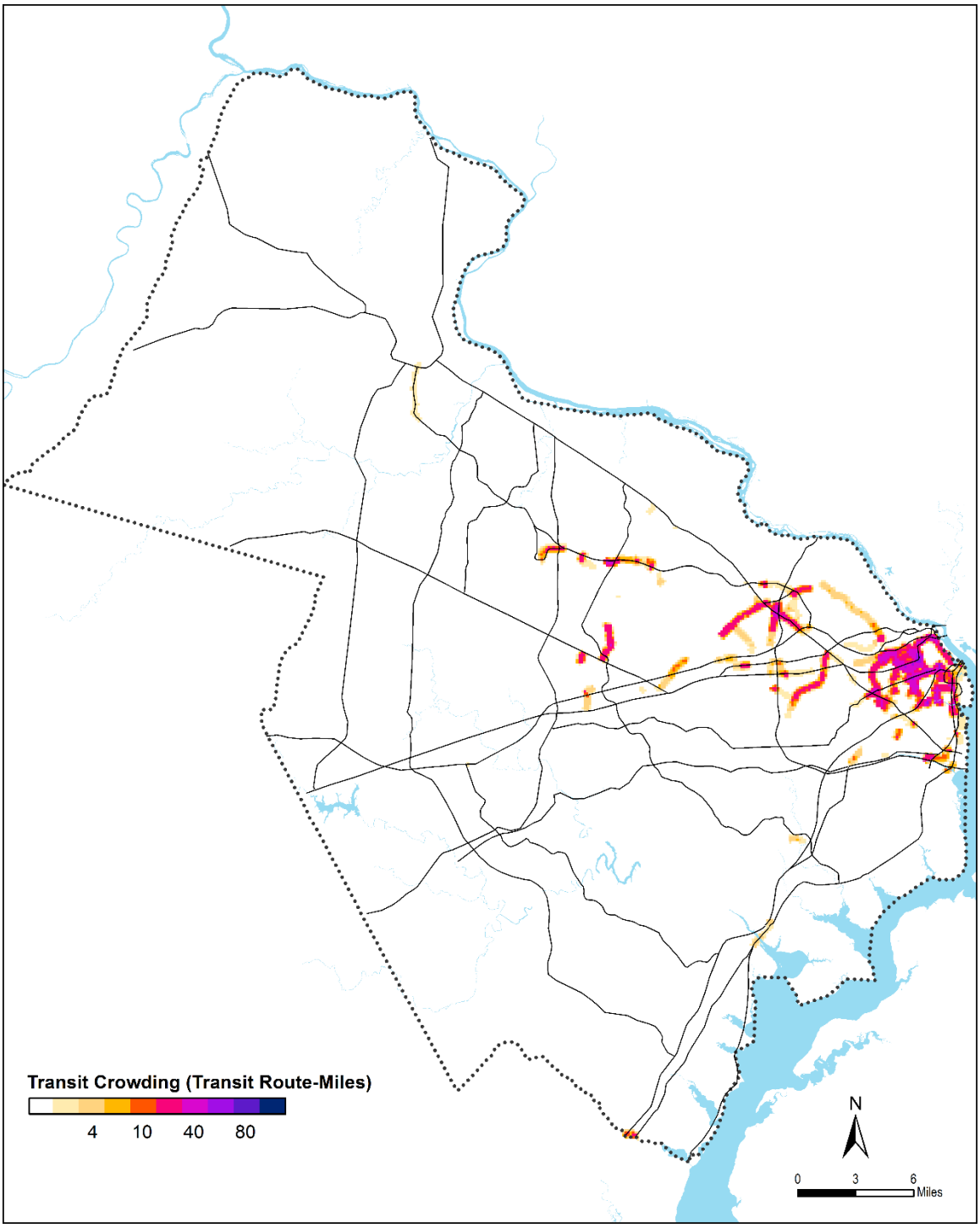


Figure 9-6: 2016 Transit Crowding



FUTURE CONDITIONS

Given the continued growth within Northern Virginia, traffic and crowding levels across the transportation network are projected to worsen considerably by 2040.

2040 'No Build'

The 2040 'No Build' transportation system includes existing transportation facilities in Northern Virginia, as well as all transportation improvements that are fully committed to be constructed or implemented by 2040. Transportation improvements assumed as part of the 2040 'No Build' transportation system include:

- Metrorail Silver Line Phase 2 – six stations west of the current terminus at Wiehle-Reston East to Ashburn in eastern Loudoun County.
- Transform 66 Inside the Beltway – implementation of dynamically tolled express lanes on I-66 between I-495 and Route 29 in Rosslyn during peak commuting periods in peak directions, as well as an additional eastbound lane between the Dulles Connector Road and Fairfax Drive/Glebe Road (Exit 71).
- Transform 66 Outside the Beltway – new dynamically tolled express lanes on I-66 between Haymarket and I-495, new and expanded park-and-ride lots, and improved bus service along I-66.
- I-395 Express Lanes Extension – extension of I-395 Express Lanes from Edsall Road to Eads Street in Arlington, including three reversible dynamically tolled express lanes (currently two reversible high occupancy vehicle lanes) and implementation of active traffic management.
- Metrorail Infill Station at Potomac Yard – station served by Metrorail Blue and Yellow Lines.
- VRE Infill Station at Potomac Shores – station served by VRE Fredericksburg Line.

Traffic Volumes

Travel volumes are projected to increase significantly between 2016 and 2040. **Figure 9-7** shows the projected volumes of motorized travel for the 'No Build' 2040 condition; **Figure 9-8** shows the differences between current conditions and 'No Build' 2040. Growth in traffic volume is highest along several of the region's major travel corridors, including:

- Route 267 and Silver Line corridor between Tysons and Dulles Airport
- I-66 and I-95 corridors, especially within Prince William County; and
- Fairfax County Parkway between Route 50 and Route 267

Person Hours of Delay

Congestion and corresponding vehicular delays are anticipated to become much more severe in Northern Virginia by 2040 in the absence of additional transportation improvements. Total person-hours of delay on roadways in Northern Virginia are forecast to triple from one million to three million hours daily between 2016 and the 2040 'No Build' condition. **Figure 9-7** shows that the most severe delays would be anticipated on I-95, I-495, and I-66 outside I-495.

Figure 9-10 indicates that delays would be worse across nearly all major travel corridors in Northern Virginia, as well as local facilities throughout the region. Much of the increase in delay is forecast for areas outside the Beltway, particularly in Loudoun County, the Town of Leesburg, the City of Manassas, the City of Manassas Park, and Prince William County. Projected reductions in delay, anticipated at some spot locations along I-66, I-395, and parallel arterial facilities, are partially attributable to transportation improvements associated with the Transform 66 and I-395 Express Lanes projects. Likewise, some reductions in delay near Sterling and the Route 28 corridor may occur as travelers choose to ride the Silver Line Phase 2 extension instead of driving.

Transit Ridership

Given the committed projects and expected demographic growth, transit ridership is expected to increase by more than 36% between 2016 and 2040. **Table 9-1** shows the projected growth in transit ridership for the range of regional transit modes. Bus and Metrorail services will account for the majority of ridership growth, adding some 337,000 daily riders. **Figure 9-11** shows the weekday daily transit ridership for the 'No Build' 2040 condition. **Figure 9-12** shows the change in weekday daily transit ridership between 2016 and the 'No Build' 2040 condition.

Table 9-1: 2016 and 2040 'No Build' Daily Transit Boardings by Mode

Daily Boardings	2016	2040 'No Build'	Change between 2016 and 2040 'No Build'	% Change between 2016 and 2040 'No Build'
Metrorail	690,600	848,000	157,400	23%
VRE	18,700	26,800	8,100	43%
Bus Rapid Transit (BRT)	4,100	14,600	10,500	256%
Local / Express Buses	288,900	469,300	180,400	62%
Total	**1,002,300**	**1,358,700**	**356,400**	**36%**

Transit Crowding

With sustained growth forecast for transit usage between 2016 and 2040, transit crowding is expected to become a more serious issue for the future 'No Build' transportation system. **Figure 9-13** shows transit crowding for the 'No Build' 2040 condition, while **Figure 9-14** shows the change in transit crowding between 2016 and the 'No Build' 2040 condition. Throughout the region, the total number of transit route miles experiencing crowded conditions is anticipated to double. While the extension of the Silver Line to Ashburn Metrorail station relieves some crowding on buses traveling to Wiehle-Reston East Metrorail station, overall, crowding on transit vehicles is anticipated to get worse throughout Northern Virginia. Crowded transit conditions are forecast to be most prevalent within the Capital Beltway, but crowding is

anticipated to worsen on bus and rail corridors in portions of Fairfax County, Prince William County, and eastern Loudoun County. Major bus and rail corridors with crowded transit conditions in 2040 'No Build' include:

- Metrorail Orange, Silver, Blue, and Yellow Lines
- Route 1 and Route 7 bus services
- VRE Manassas and Fredericksburg Lines
- Tysons
- Manassas; and
- Southern Fairfax County

Figure 9-7: 2040 'No Build' Vehicular Volumes

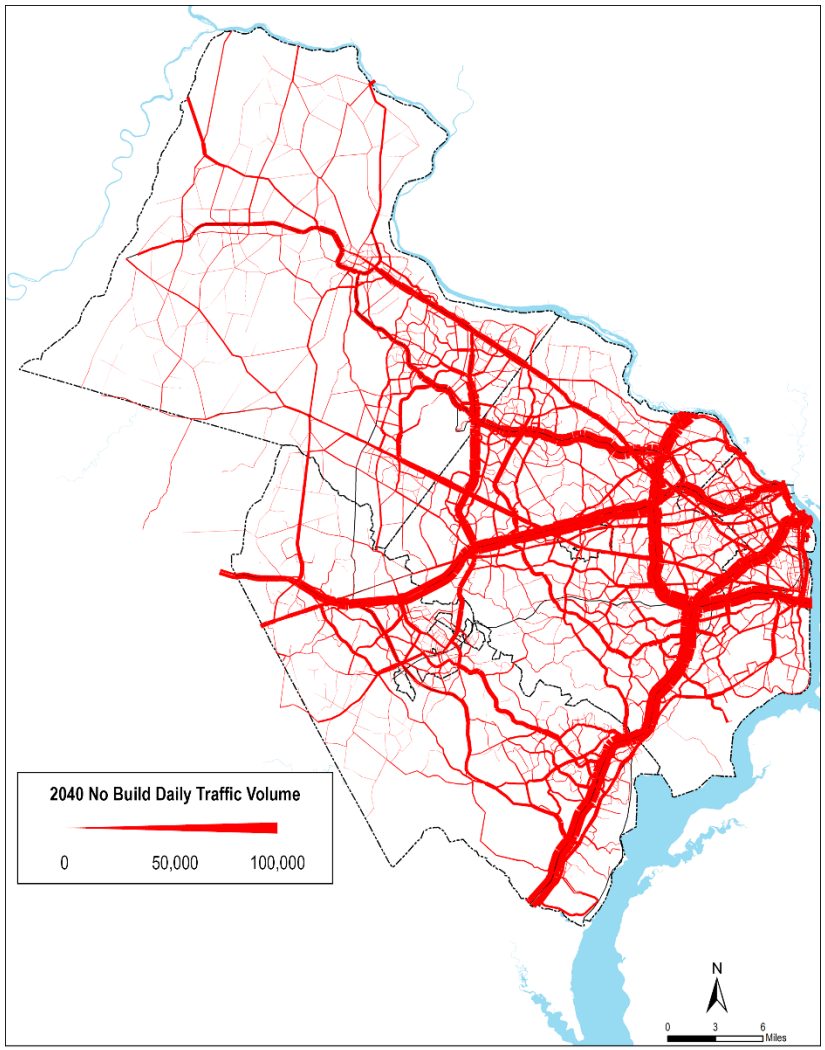


Figure 9-8: Change in Vehicular Volumes, 2016 to 2040 'No Build'

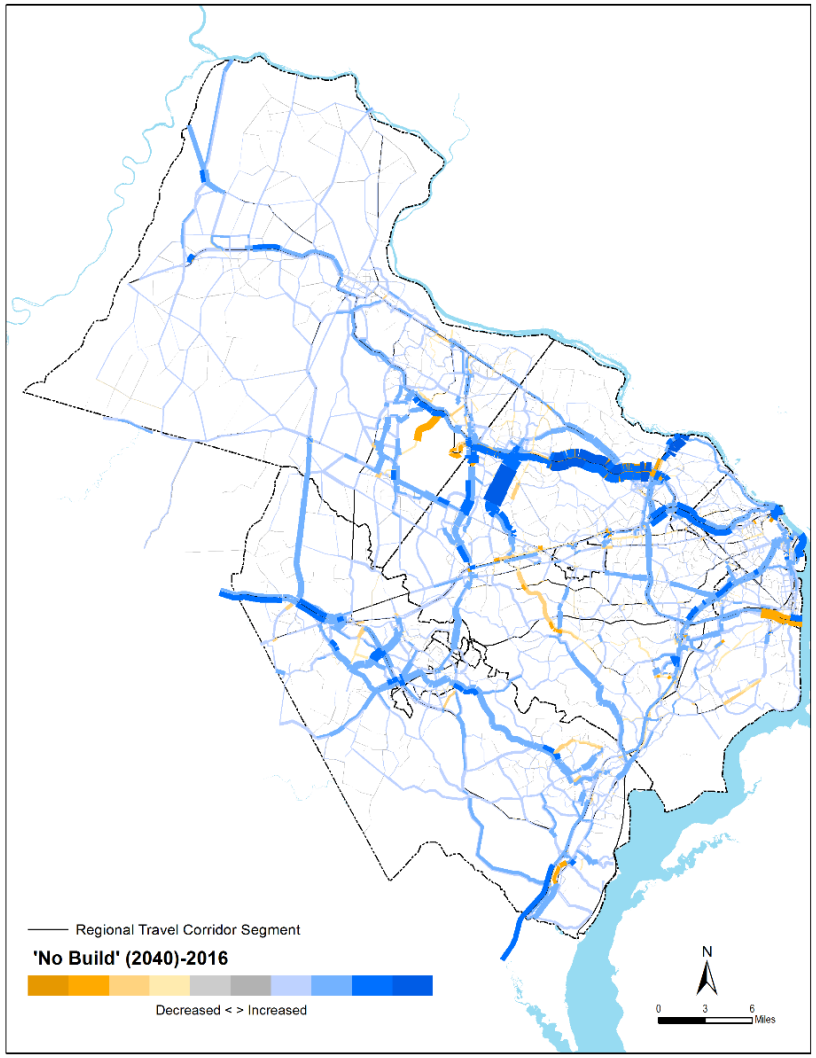


Figure 9-9: 2040 'No Build' Delay

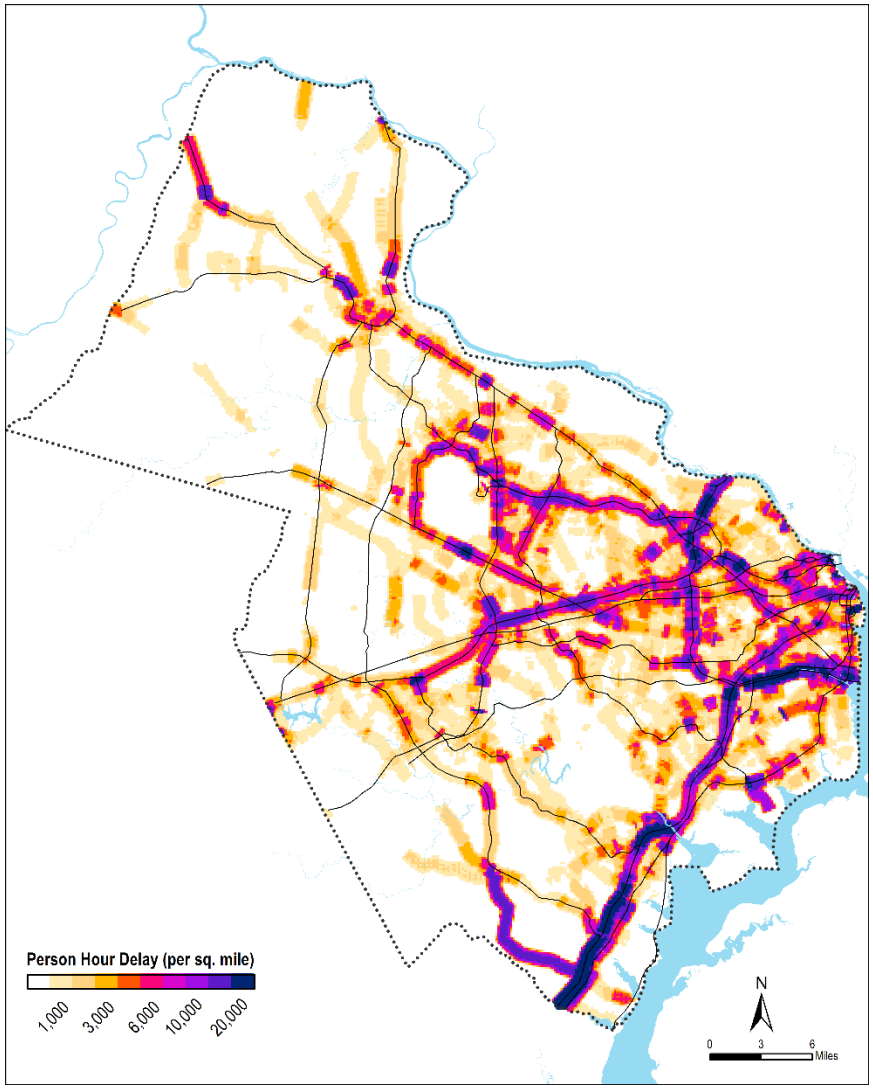


Figure 9-10: Change in Delay, 2016 to 2040 'No Build'

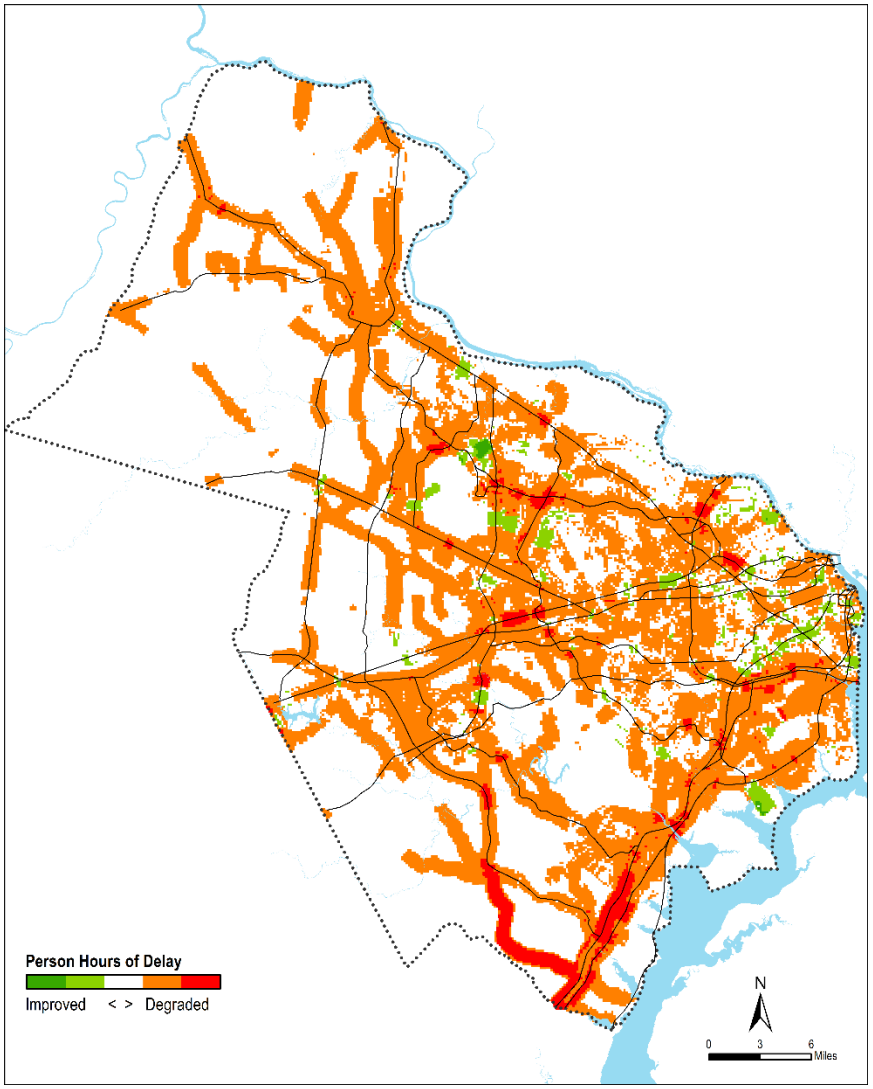


Figure 9-11: 2040 'No Build' Weekday Daily Transit Ridership

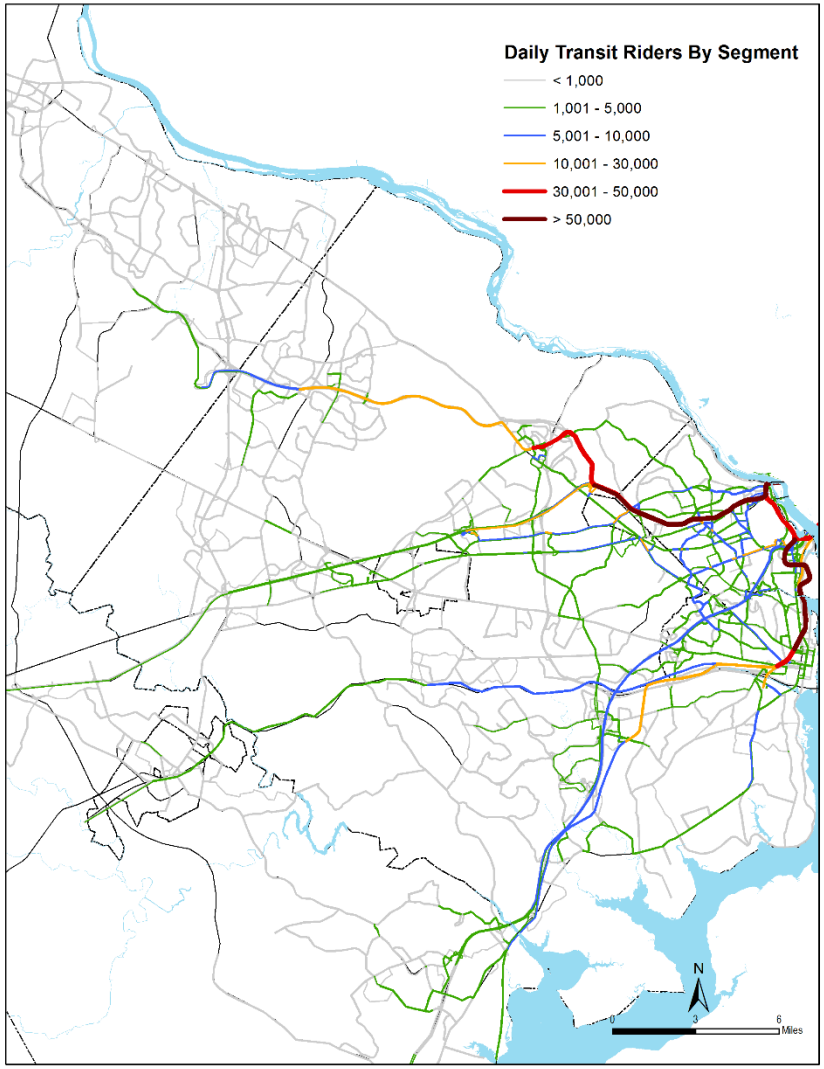


Figure 9-12: Change in Weekday Daily Transit Ridership, 2016 to 2040 'No Build'

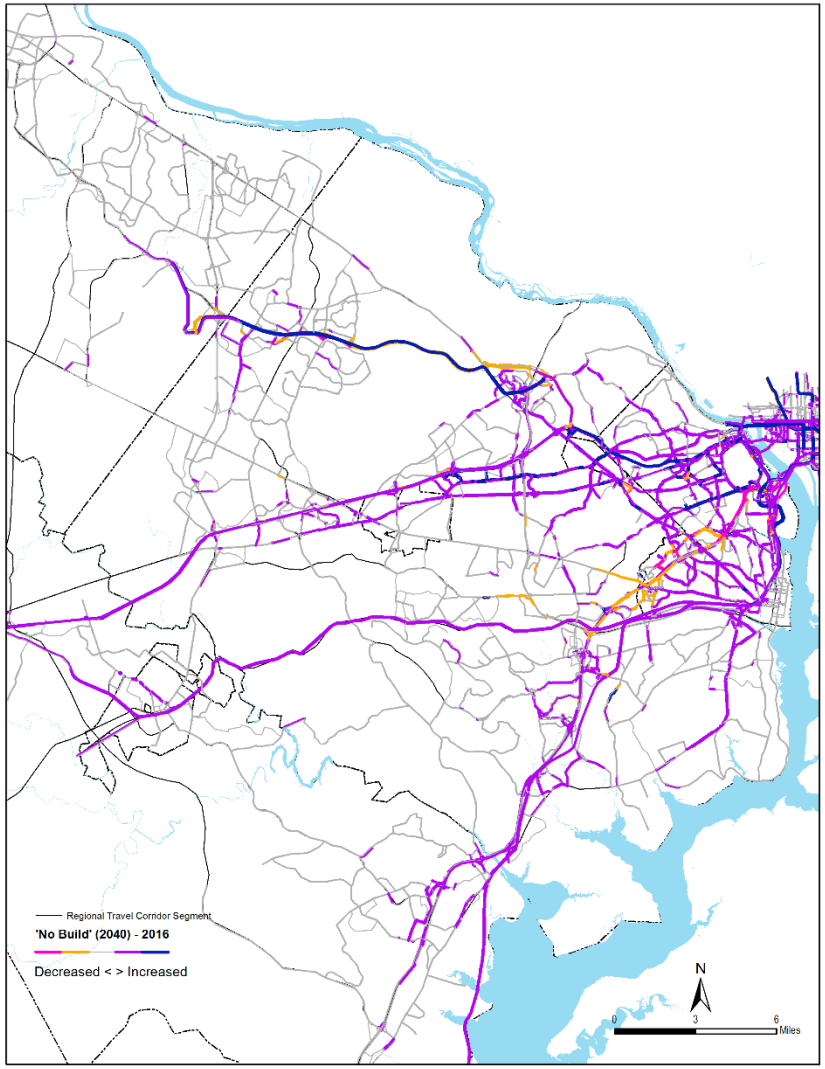


Figure 9-13: 2040 'No Build' Transit Crowding

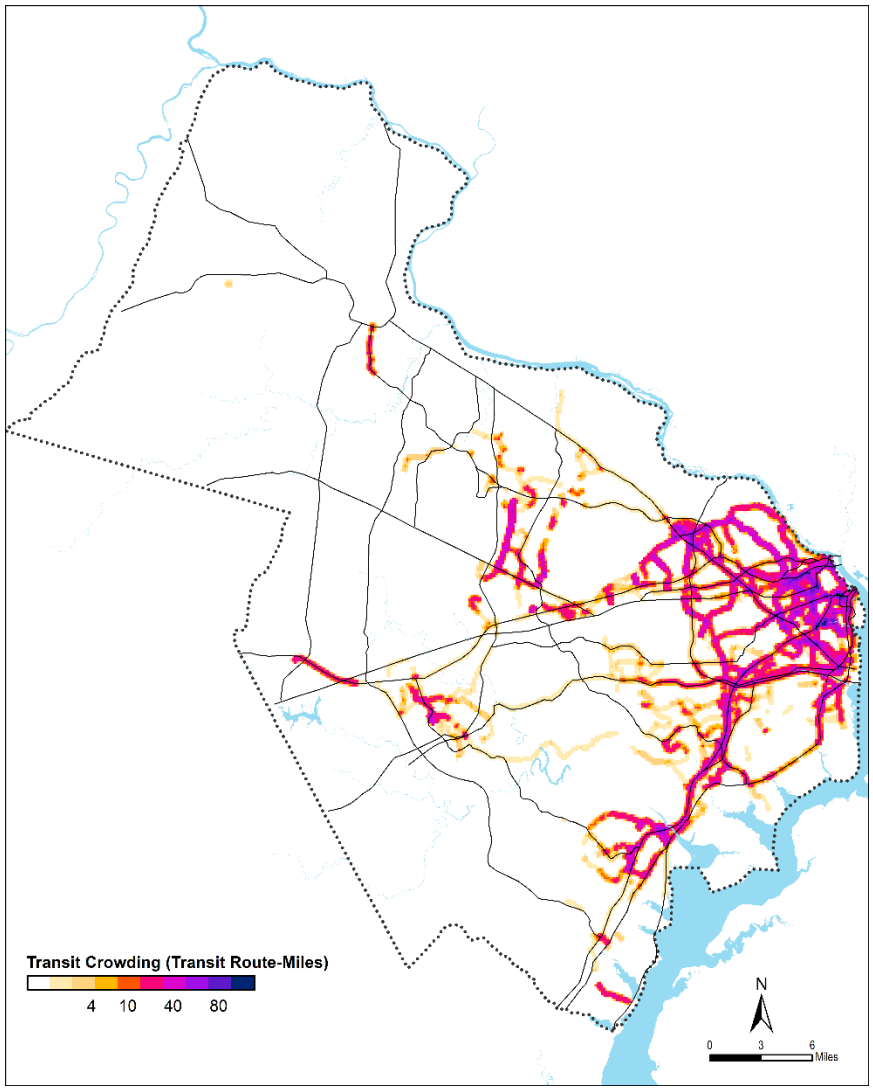
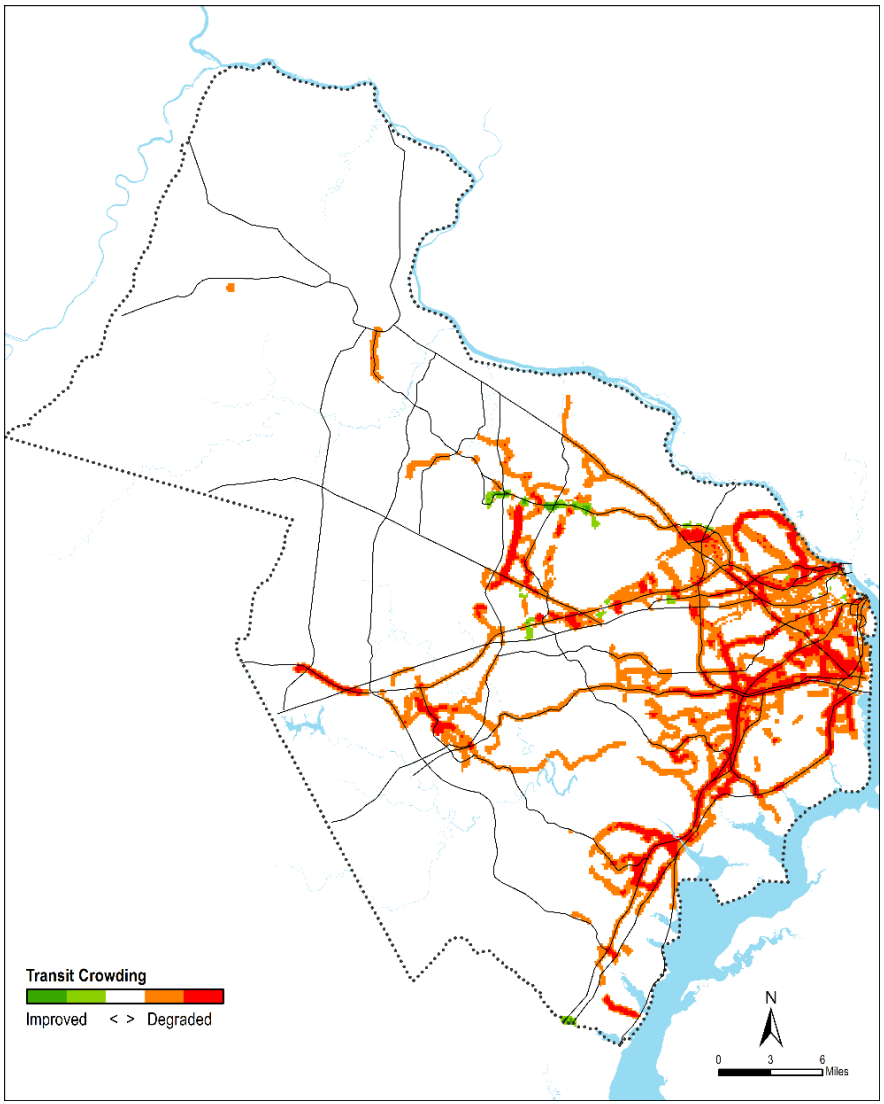


Figure 9-14: Change in Transit Crowding, 2016 to 2040 'No Build'



NEEDS ASSESSMENT

To address current and future transportation needs, different subregions within Northern Virginia (depicted in **Figure 9-16**) require distinct combinations of transportation infrastructure investments. Combining extensive public input with detailed technical analysis, general areas of need emerge for each subregion, outlined in **Table 9-2**.

Figure 9-15: Needs Assessment by Subregion

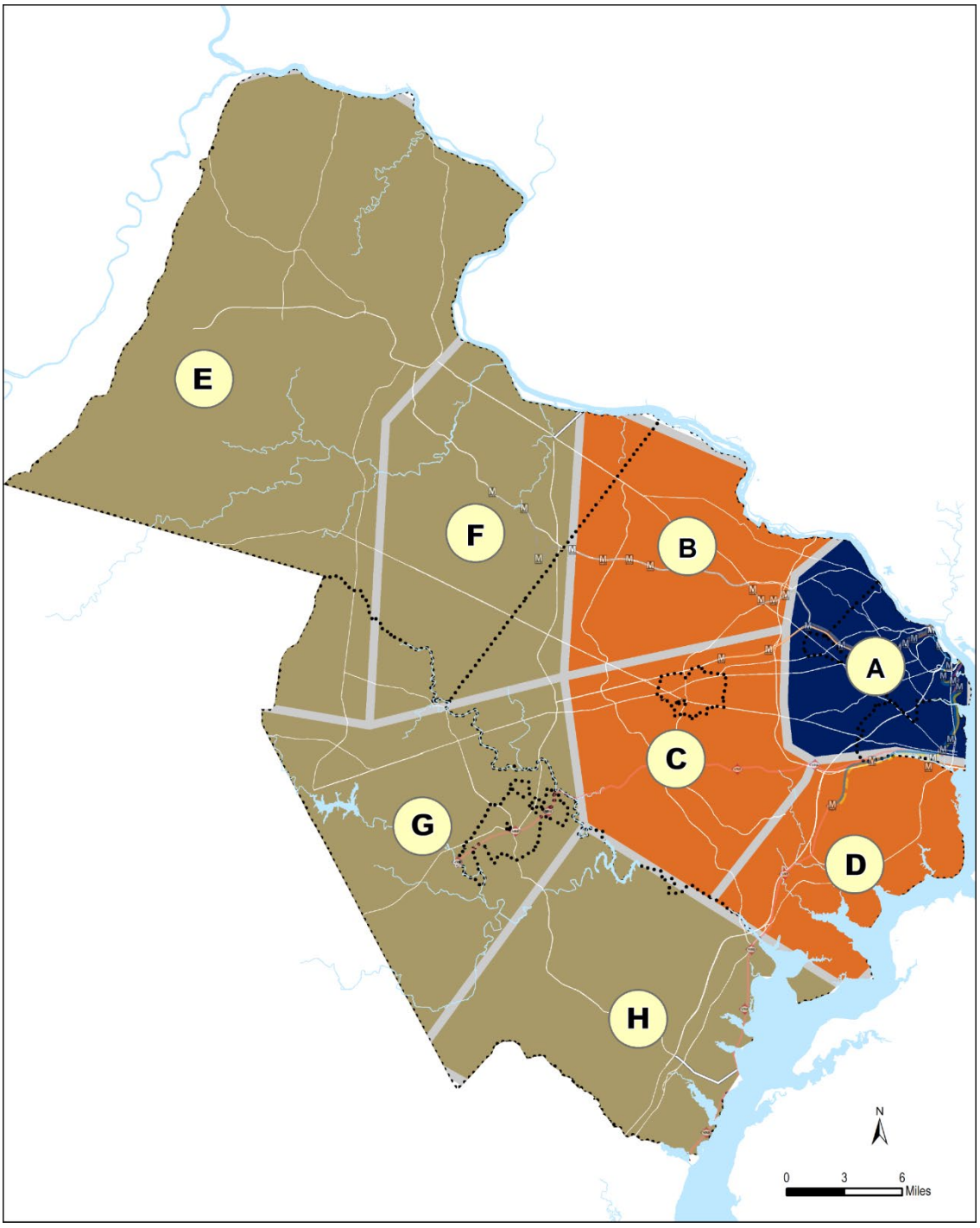


Table 9-2: Transportation Needs by Subregion

Needs
Subregion A: Inside the Beltway
Improve transit core capacity and frequency to improve transit service and reduce crowding on bus and rail
Improve multi-modal connections between regional activity centers
Address severe, recurring congestion on I-66 and I-395, and along major arterial links
Provide improvements to the bicycle and pedestrian environment throughout the area
Subregion B: Northern Fairfax County
Improve the street grid, transit service, and pedestrian environment in Tysons and Reston
Address recurring congestion resulting from additional growth in Tysons and along the Reston-Herndon corridor
Provide multi-modal options to support travel patterns on I-495, Route 7, Route 267, and Route 123
Subregion C: Central/Western Fairfax County, City of Fairfax
Facilitate local connections and movement of through travelers on I-66 and major arterial roadways, including Route 29, Route 50 and Route 236
Improve pedestrian and bicycle environment within City of Fairfax and Town of Vienna
Increase access to transit and transit service to support radial and cross-county travel patterns
Subregion D: Southern Fairfax County
Relieve severe, recurring congestion on I-95/Route 1 corridor during weekday commute and weekend periods
Support forecasted growth near Springfield and along Route 1 corridor
Improve access to Fort Belvoir
Improve access to transit and improve local transit circulation in high growth areas along Route 1 corridor
Subregion E: Western Loudoun County
Preserve rural character of transportation facilities, but address additional congestion due to forecasted growth in the area
Improve connections between Northern Virginia, Maryland and West Virginia to relieve congestion
Subregion F: Eastern Loudoun County, Western Fairfax County
Construct transportation network to anticipate future growth in area and facilitate movements on Route 50 and Route 7 corridors
Address recurring congestion and provide transit service along Route 28 to anticipate growth in Dulles corridor
Provide multi-modal access improvements to Metrorail Silver Line Phase 2 stations and Dulles International Airport
Subregion G: Western Prince William County, City of Manassas, City of Manassas Park, Western Fairfax County
Relieve severe congestion on I-66 corridor and improve access to transit along the corridor
Facilitate growth in activity centers near Innovation District, Gainesville, and Manassas
Improve connections to support major travel patterns to Loudoun and Fairfax Counties
Subregion H: Eastern Prince William County
Relieve severe, recurring congestion on I-95/Route 1 corridor entering the NVTA region from points south and at bottleneck near the Occoquan River
Improve travel connections between cross-county and radial travel patterns, particularly near Prince William Parkway and Dumfries Road
Support forecasted growth in Potomac Town Center and Potomac Shores and provide additional transit access and service, including new and additional park-and-ride capacity along corridor

PART 3

Key Findings & Recommendations

TransAction Technical Report

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KEY FINDINGS AND RECOMMENDATIONS

Part 3 presents the results and findings of the analyses that have been conducted as part of TransAction. The three chapters included in this part are:

- **Chapter 10:** Northern Virginia Transportation System
- **Chapter 11**: Findings and Evaluation
- **Chapter 12**: Managing Uncertainty and Risk

CHAPTER 10: NORTHERN VIRGINIA TRANSPORTATION SYSTEM

TransAction is the multimodal transportation master plan for Northern Virginia. It is a long range plan addressing regional transportation needs through 2040. The Plan focuses on eleven major travel corridors in Northern Virginia, and identifies over 350 candidate regional projects for future transportation investments to improve travel throughout the region. TransAction is not bound to any budget, and proposes more projects than can realistically be funded. In addition, while TransAction is focused on Northern Virginia, it is also a geographically unconstrained plan. It includes extra-territorial projects, or those beyond Northern Virginia, that are potentially beneficial to the mobility of Northern Virginians. The NVTA is generally unable to fund these projects, but they are nonetheless considered in order to ensure a more robust planning process.

The results of TransAction are used to inform the NVTA's Six Year Program for capital funding, guiding decisions about which transportation improvements the NVTA should prioritize for investment. This Plan incorporates a comprehensive review of regional transportation needs. The results of the Needs Assessment described in **Chapter 9** provide a basis for identifying candidate transportation projects that address these needs.

2040 'NO BUILD'

TransAction is consistent with the MWCOG Transportation Planning Board (TPB) Constrained Long Range Plan (CLRP, 2016). Fully funded CLRP projects are assumed to be part of the baseline condition, 2040 'No Build', as these projects do not require additional NVTA regional funds. **Table 10-1** lists selected major projects included as part of the 2040 'No Build' conditions.

Table 10-1: Selected Transportation Improvements in 'No Build' 2040

I-395 Express Lanes Improvements
I-95 Express Lanes Southern Extension
Metrorail Potomac Yard Infill Station
Metrorail Silver Line Phase II
Transform 66 Inside the Beltway
Transform 66 Outside the Beltway
VRE Potomac Shores Infill Station

DEVELOPMENT OF THE TRANSACTION PLAN

Following the Needs Assessment, the NVTA compiled a comprehensive list of partially funded or unfunded regional transportation improvements included in:

- The previous TransAction 2040 Plan (2012);
- TPB's CLRP (2016);
- Local jurisdictional Comprehensive and Transportation Master Plans;
- Local Transit Development Plans; and
- Transportation Demand Management (TDM) Plans.

The NVTA conducted several rounds of technical analysis in coordination with technical staff from regional jurisdictions and transportation agencies to identify existing or new projects that would address regional transportation needs.

In coordination with the Needs Assessment, the NVTA recommended additional candidate projects for inclusion in the Plan to address identified needs that were not specifically or adequately addressed by improvements identified in existing transportation plans.

The TransAction Plan includes 352 regionally-significant transportation improvement projects within Northern Virginia. Transportation improvements included in the Plan comprise a variety of multi-modal elements including roadway, transit, bicycle and pedestrian, intelligent transportation system (ITS), Integrated Corridor Management (ICM), and transportation demand management (TDM) improvements. The project totals shown in **Figure 10-1** recognize the fact that some projects fall into more than one modal category. The circles in the graphic are not specific to the number or scale of projects.

The projects vary in scope from small scale intersection and sidewalk improvements at specific locations to mega-projects involving the expansion of freeway facilities and extension of heavy rail transit lines. Readiness of the project for implementation ranges from "shovel ready" to long-range planning studies with significant lead times. **Figure 10-2** shows the locations of all transportation improvements included in this Plan. All projects included focus on addressing specific regional transportation needs such as reducing congestion and improving the efficiency of transportation facilities along regional travel corridors.

Figure 10-1: Modal Elements in the TransAction Plan (representation is not precise)

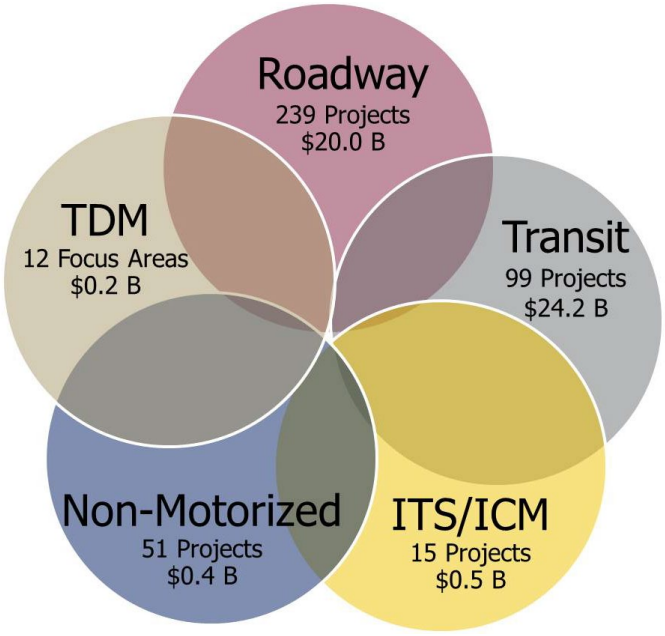
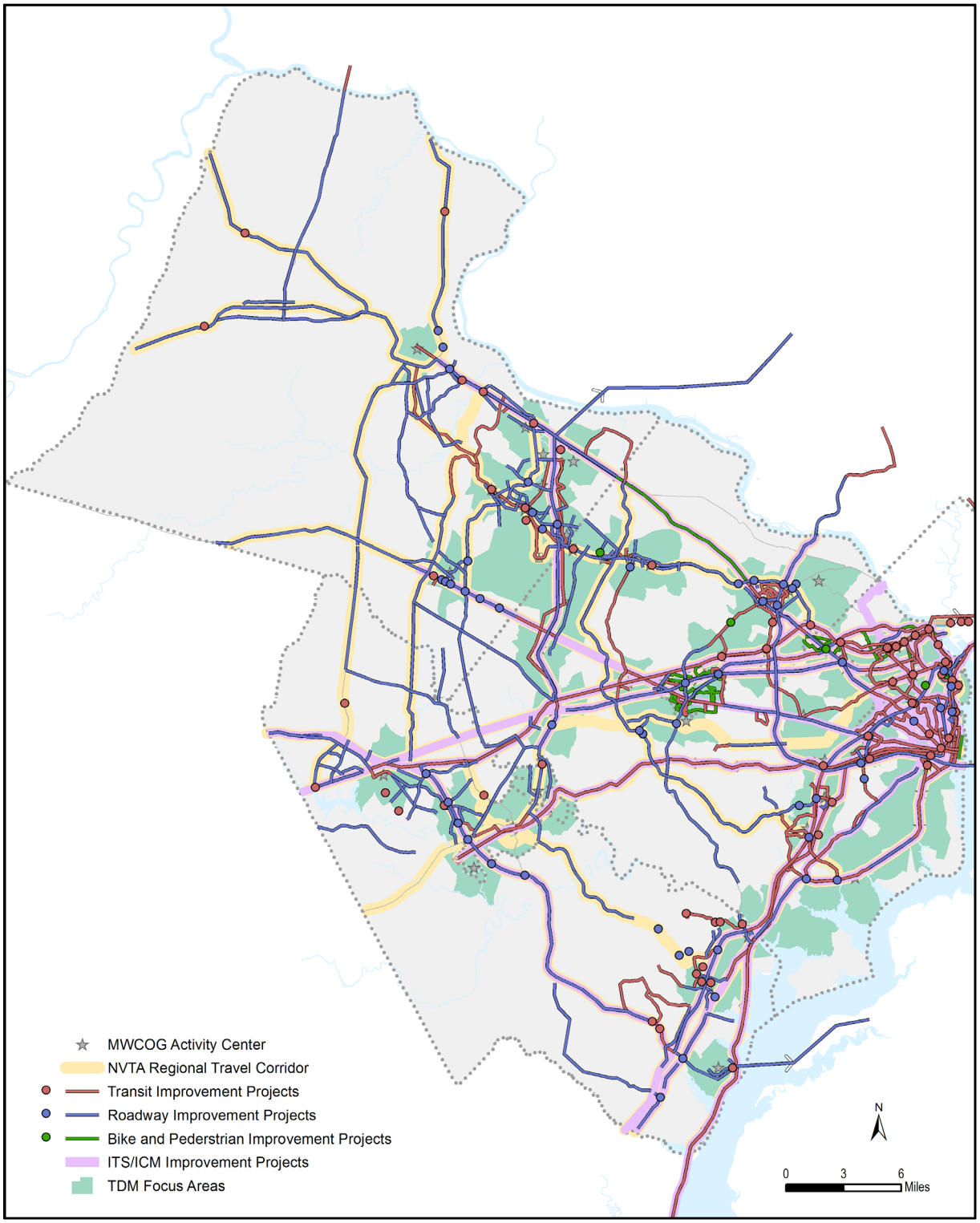


Figure 10-2: Projects in TransAction Plan

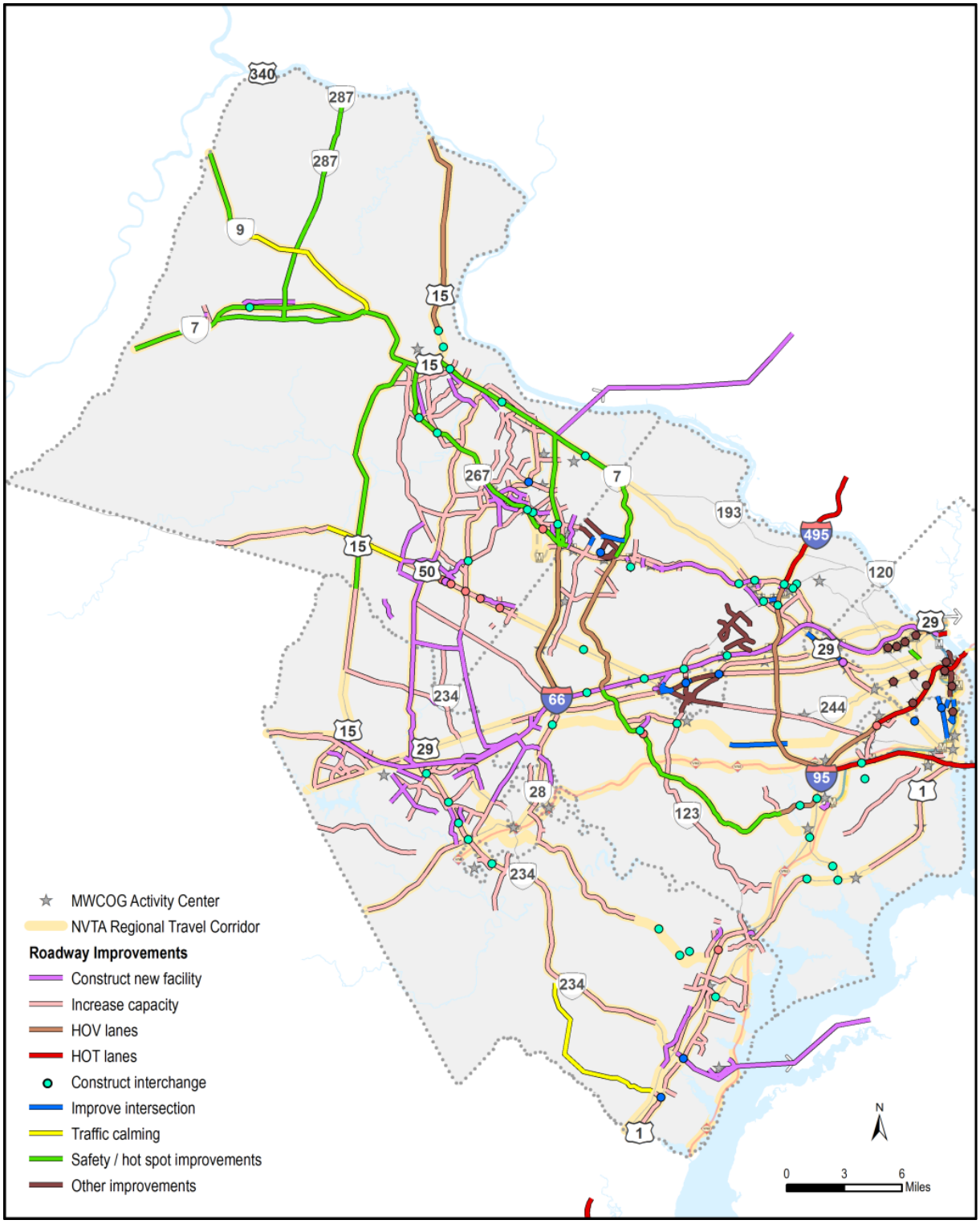


ROADWAY ELEMENTS

Figure 10-3 illustrates the roadway elements of the TransAction Plan. These include the construction of new facilities, capacity improvements, and upgrading of existing facilities. The following are some of the roadway improvements included in the Plan:

- Capacity improvements on roadway facilities throughout the region, but mostly outside the Beltway;
- Build-out of street grids in Tysons and Reston;
- Expansion of express lanes on Capital Beltway across both bridges into Maryland;
- HOV lanes on Route 28, Fairfax County Parkway, Franconia-Springfield Parkway;
- Limited access freeway segments on US 50 and Route 7 in Loudoun County;
- Complete streets and intersection improvements within activity centers; and
- Potomac River crossings into Maryland at Route 28 (connecting to Montgomery County) and near Route 234 (connecting to Prince George's County).

Figure 10-3: Roadway Elements of the TransAction Plan

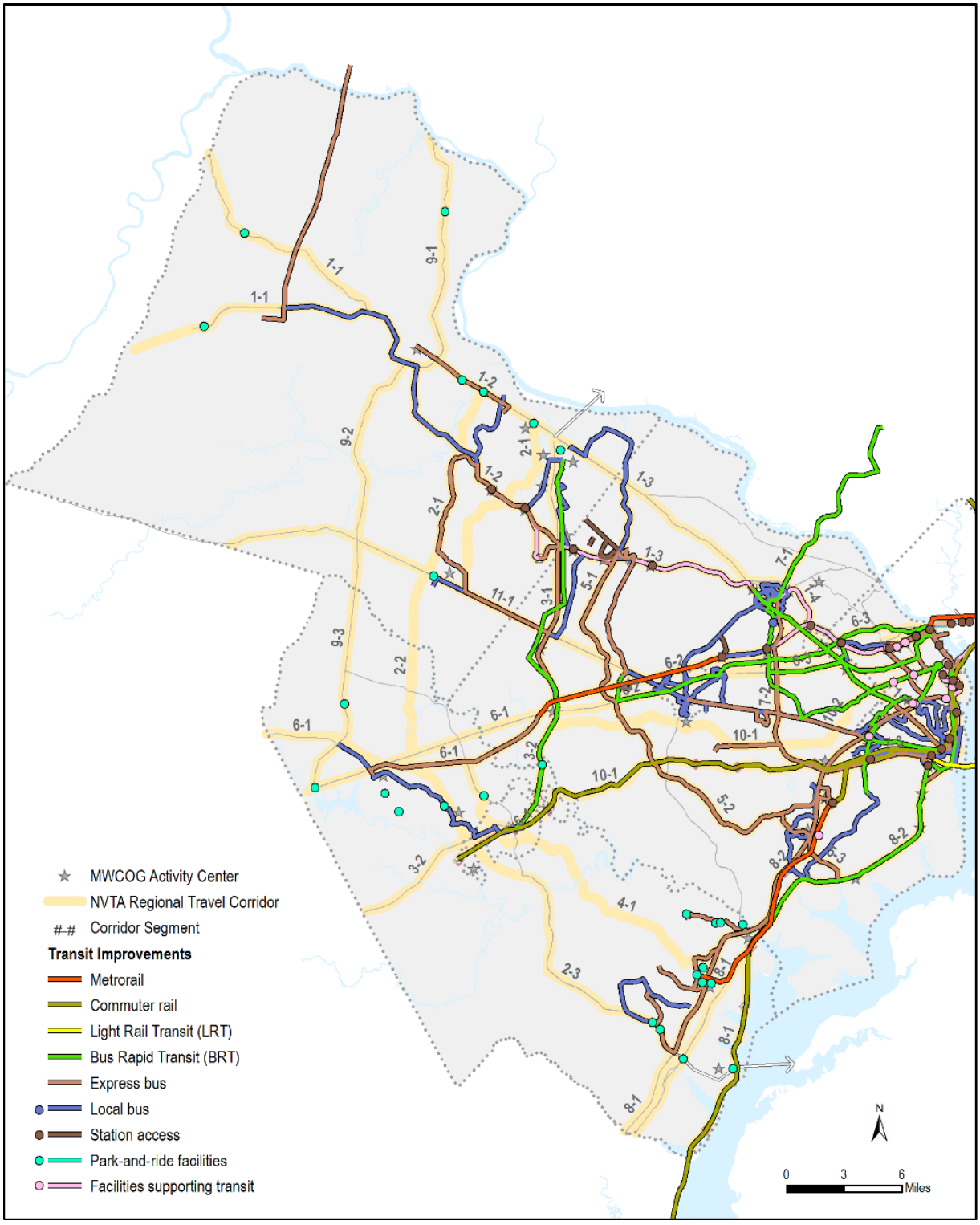


TRANSIT ELEMENTS

Figure 10-4 illustrates the transit elements of the TransAction Plan. These include Metrorail extensions, new Light Rail Transit (LRT) and Bus Rapid Transit (BRT) lines, improvements to existing bus and rail services, and access improvements. Selected transit elements in the Plan include:

- Express buses on major regional travel corridors;
- Expansion of local bus service to feed into Metrorail, VRE and activity centers;
- Intermodal transit centers and transit maintenance facilities needed to implement service improvements;
- Additional Park-and-Ride facilities along the I-66 and I-95 corridors, particularly in Prince William County;
- Metrorail core capacity improvements including the 2nd Potomac tunnel and eight car trains;
- Orange and Blue line Metrorail extensions to Centreville and Potomac Mills;
- Increased peak VRE service, reverse peak service, third track and Long Bridge widening;
- BRT network including Alexandria's West End Transitway, Route 7, Route 1, Route 28, US 29, Duke Street/Route 236, Gallows Rd, US 50 inside the Beltway, Columbia Pike, and Legion Bridge to Maryland; and
- LRT across the Woodrow Wilson Bridge to Maryland.

Figure 10-4: Transit Elements of TransAction Plan

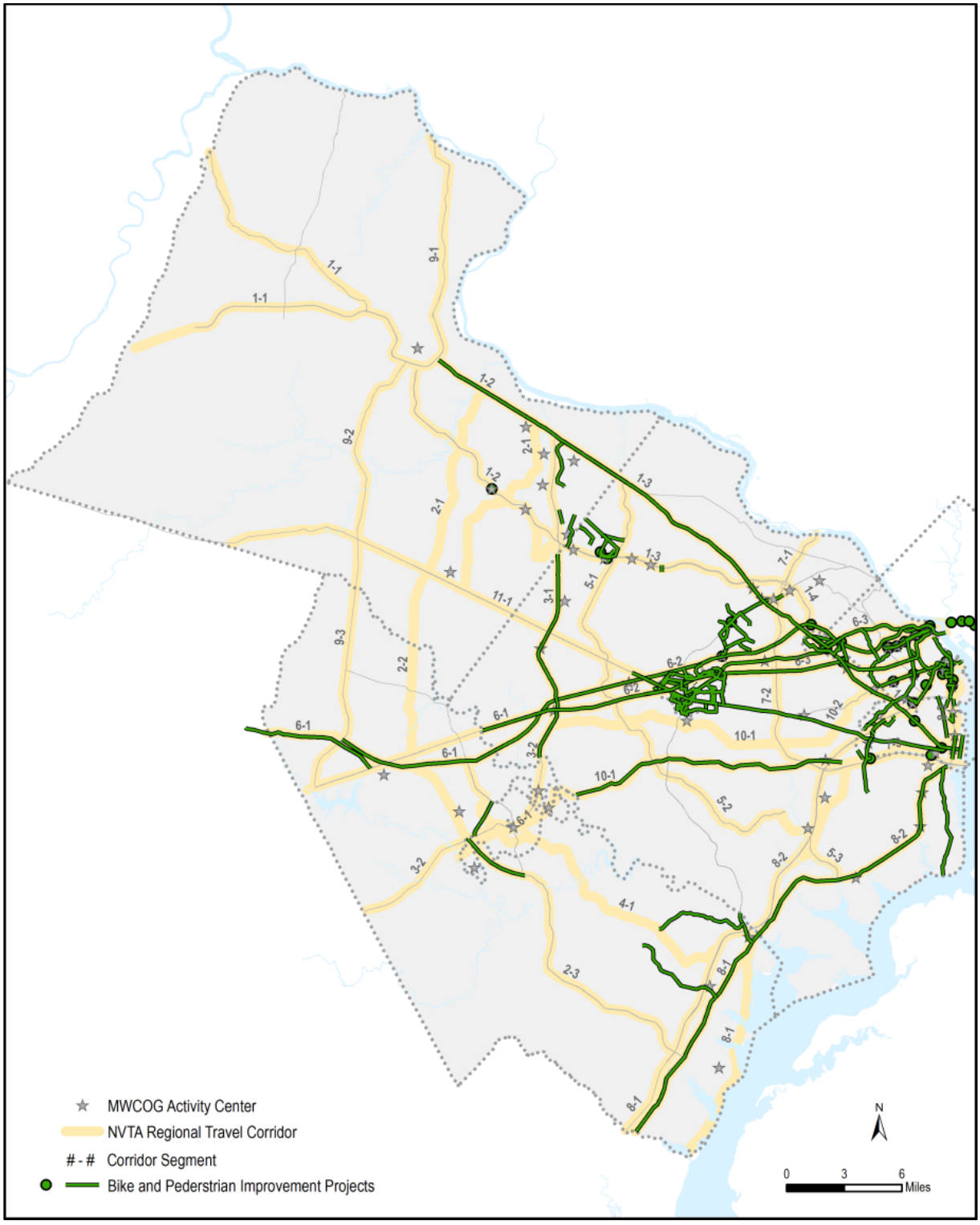


NON-MOTORIZED ELEMENTS

Figure 10-5 displays an array of bicycle and pedestrian projects were included in the TransAction Plan, identified to address location-specific issues or to augment non-motorized connectivity at a regional level. Some of the elements included are:

- Multimodal transit station access;
- Dedicated bicycle lanes;
- Regional trail connectivity and expansion;
- Bikesharing facilities such as bicycle parking, lockers, and/or shelters; and
- Improvements in bicycle and pedestrian facilities, access, and safety in activity centers.

Figure 10-5: Bicycle and Pedestrian Elements of the TransAction Plan



ITS/ICM ELEMENTS

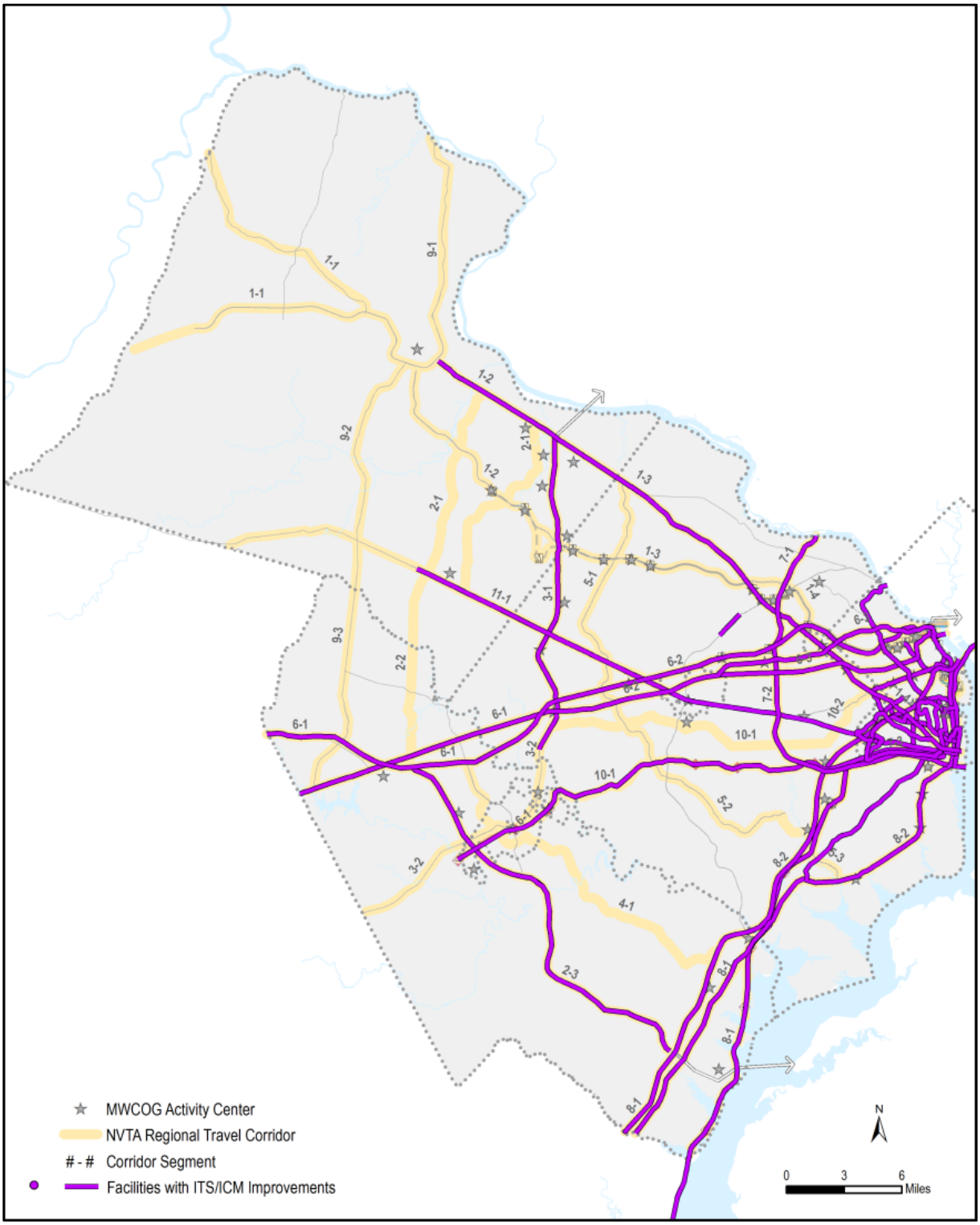
Figure 10-6 illustrates the Intelligent Transportation Systems (ITS) and Integrated Corridor Management (ICM) elements of the TransAction Plan. ITS utilizes technologies to process and communicate traffic information, in order to optimize operations, provide information to travelers in real-time, and improve the safety, efficiency, and service levels on roadway facilities. ICM optimizes use of available infrastructure by directing travelers to underutilized capacity in a transportation corridor. It uses ITS technologies and transportation demand management (TDM) services to address congestion.

Managing demand and providing traveler decision support are considered cost-effective methods for improving operations on existing roadway facilities.

The following ITS and ICM improvements are included as part of the TransAction Plan:

- Active traffic management on freeway facilities including dynamic ramp metering, reversible lanes, and hard shoulder running lanes;
- Intelligent signal monitoring/control technology on parallel arterial facilities;
- Multimodal traveler information and parking management;
- Decision support systems for corridor management; and
- Infrastructure improvements to support connected and autonomous vehicle technologies.

Figure 10-6: ITS/ICM Elements of the TransAction Plan

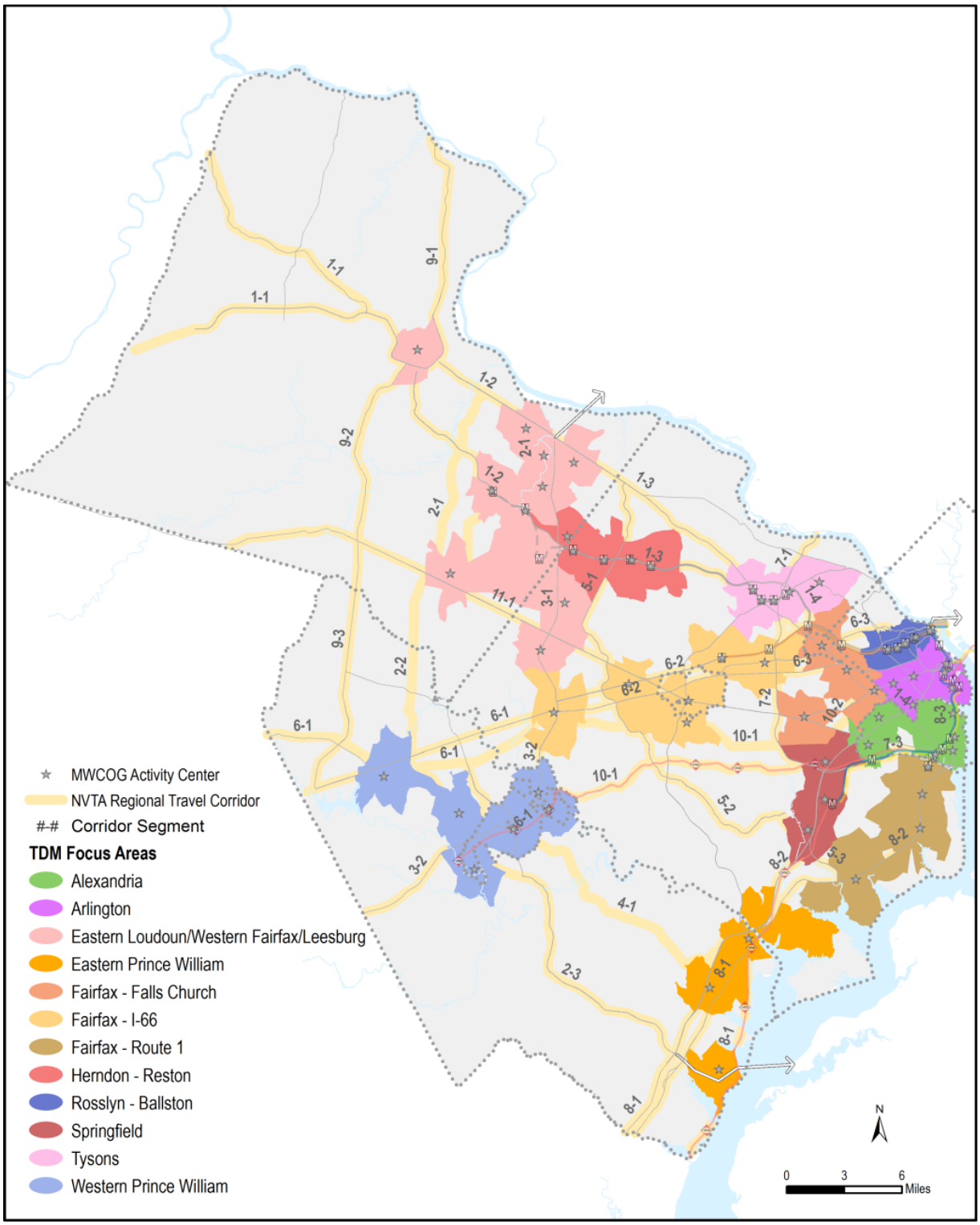


TDM ELEMENTS

Figure 10-7 illustrates the TDM elements of the TransAction Plan. TDM is a set of services designed to provide commuters with alternative options to driving alone by providing information, programs, and incentives to encourage shifts in traveler mode, route, time of travel, and need to travel. Within Northern Virginia, TDM services are provided through a partnership between the Department of Rail and Public Transportation (DRPT), Virginia Department of Transportation (VDOT), Commuter Connections, local jurisdictional programs like the Arlington County Commuter Services (ACCS), and Transportation Management Associations (TMAs), such as the Dulles Area Transportation Association (DATA).

The NVTA recognizes that implementation of TDM strategies within Northern Virginia can help address the stated goals of TransAction by reducing the number of daily commute trips in the region and shifting travel away from single-occupancy vehicles. TransAction specifies the introduction or expansion of TDM policies and programs within 12 focus areas throughout Northern Virginia, as shown in **Figure 10-7**. These areas are forecast to have high concentrations of employment and population in 2040, and are locations where TDM strategies can be most effectively marketed to commuters.

Figure 10-7: TDM Focus Areas of the TransAction Plan



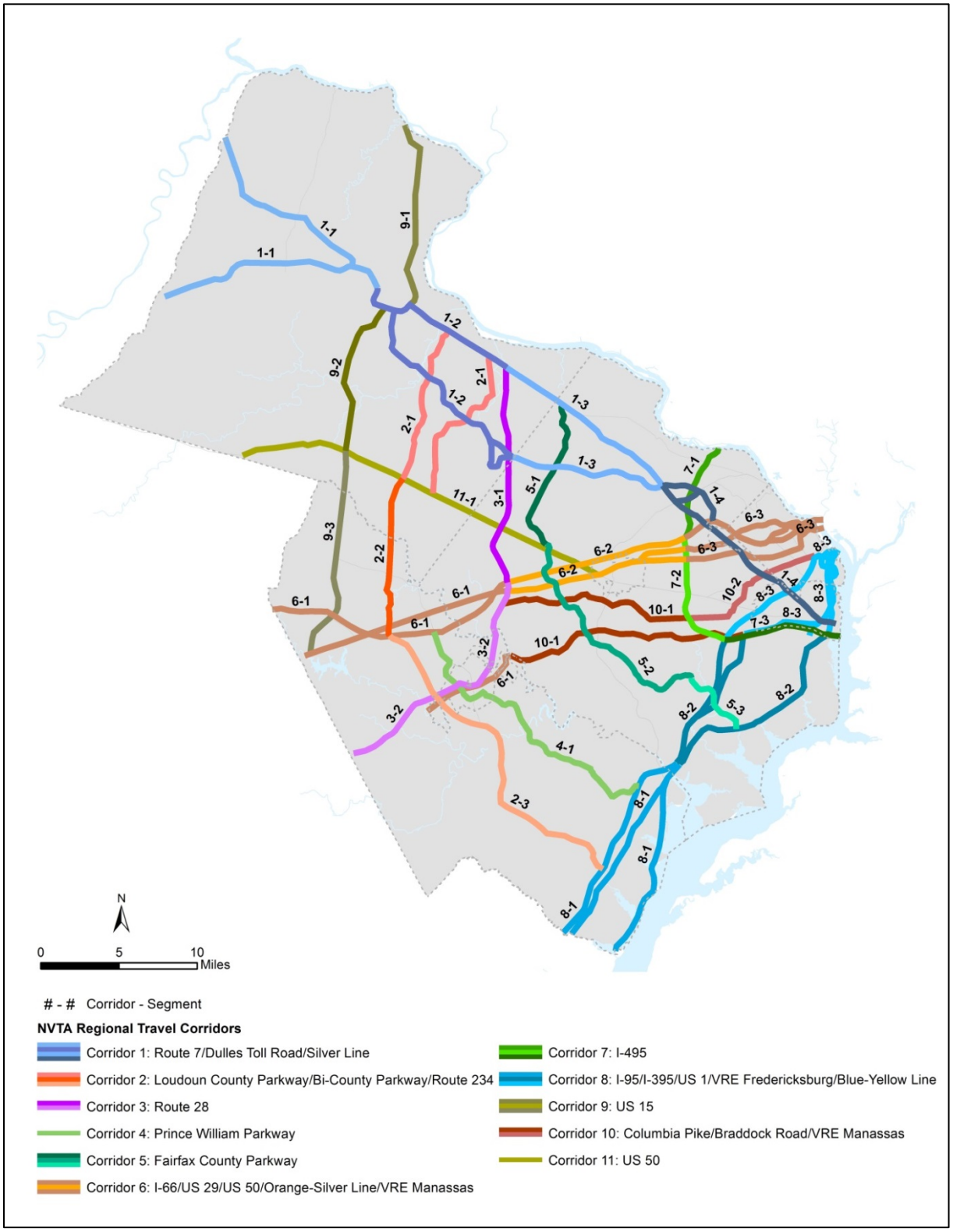
CHAPTER 11: FINDINGS AND EVALUATION

The regional benefits of the TransAction Plan are quantified by comparing the 2040 'No Build' condition with the Plan. The 2040 'No Build' includes the existing 2016 transportation system as well as fully-funded projects that are currently under construction or planned for completion by 2040.

TRANSACTION CORRIDORS AND SEGMENTS

Public feedback and thorough analysis of travel needs indicated that the most effective strategy to reduce congestion in Northern Virginia, and to attain the other goals outlined in TransAction, is to focus on improving travel along several major travel corridors within the region. These travel corridors contain the roadways and transit lines that carry the heaviest volumes of travelers and experience the most severe congestion and delay within Northern Virginia. Providing more efficient travel through these corridors is necessary to relieve congestion throughout the whole region. Because these travel corridors are regional in extent and influence, they were subdivided into smaller corridor segments that better reflect the travel patterns and transportation infrastructure present along a particular portion of each regional corridor. **Figure 11-1** shows the locations of the 11 regional travel corridors and 28 corridor segments used to quantify and evaluate the impact of the TransAction Plan within Northern Virginia. The analysis develops solutions and reports results at the corridor segment level to focus on the combined impact of individual projects.

Figure 11-1: TransAction Corridors and Segments



WEIGHTED PERFORMANCE RATING

In order to efficiently and effectively evaluate the performance of the TransAction Plan against the 2040 'No Build' conditions detailed in **Chapter 9**, the NVTA generated performance ratings for the region's transportation network under these two cases.

First, the region was divided 1/8-mile square grid cells to ensure results at a fine level of geographic detail. Computer models were used to calculate values associated with each performance measure described in **Chapter 6** for every grid cell. This process was completed for both the 2040 'No Build' and TransAction Plan conditions.

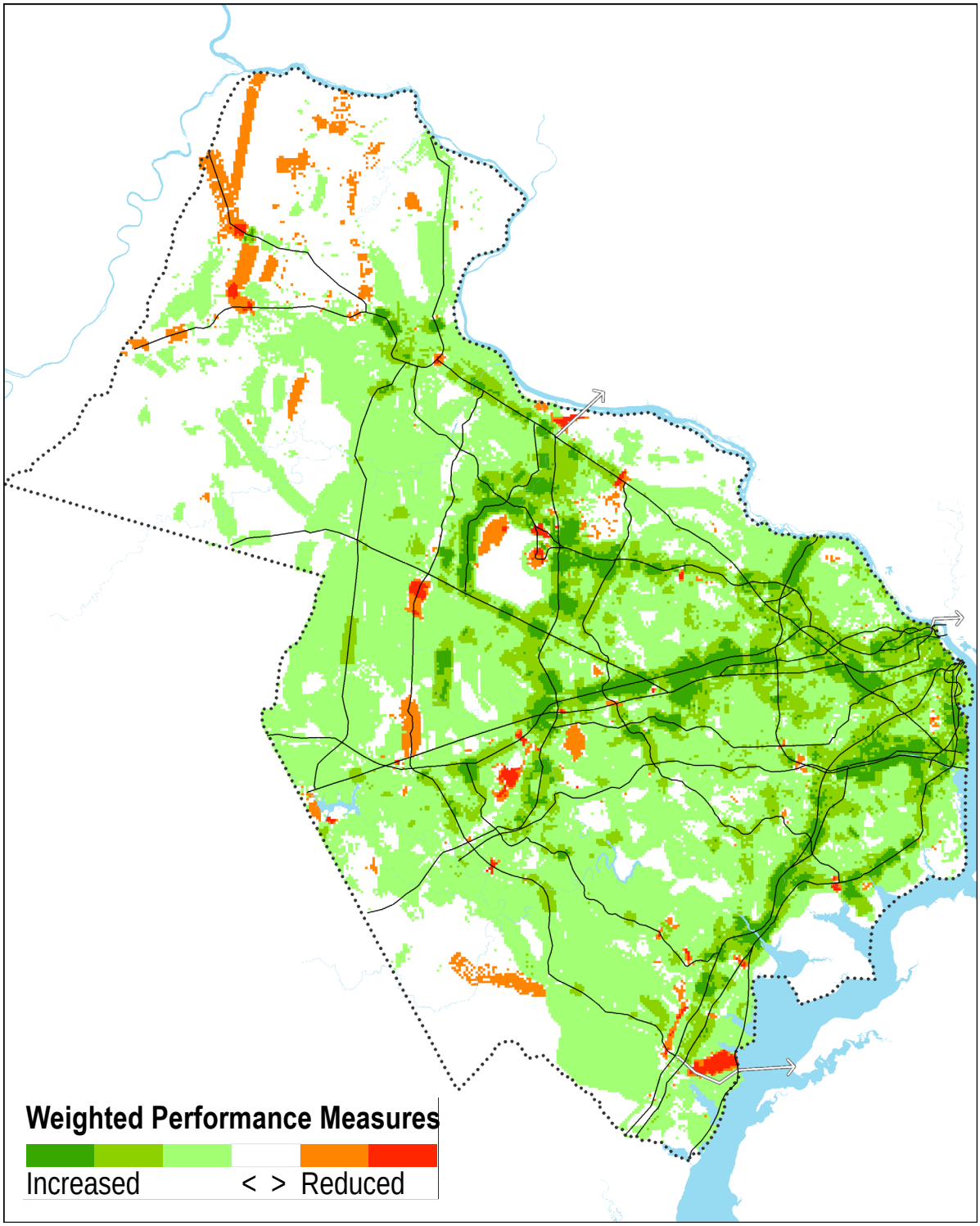
To standardize the values, they were converted onto a 0 to 100 scale, where the highest performing grid cell was assigned 100 for that measure and other grid cells were assigned a value less than 100 based on how well they performed in comparison. The values associated with each cell under each condition were then weighted based on the NVTA adopted weights shown in **Table 6-1**. The sum of these weighted values represents the performance rating for that cell under the 2040 'No Build' or TransAction Plan conditions.

As a result of this process, the NVTA was able to directly and quickly compare the overall performance of the 2040 'No Build' condition to the performance of the TransAction Plan. **Figure 11-2** shows how the performance rating (aggregated across all measures) for each grid cell under the Plan compares to the 2040 'No Build' condition.

Nearly the entirety of Northern Virginia experiences benefits from the proposed transportation improvements. These benefits are most apparent along I-66, I-495, I-95, Loudoun County Parkway, Route 28, and portions of Route 7. However, there are several locations where conditions would get worse with the projects in the TransAction Plan. One reason for this is that new facilities carry no traffic and therefore experience no congestion before their construction, but do experience some afterwards. Another reason is the diversion of traffic onto facilities that cannot be widened for various reasons (designated scenic byways, right-of-way limitations, etc.). This is particularly the case in some of the outer suburbs, especially in western Loudoun County where increases in congestion are causing decreases in performance.

The following descriptions highlight the geographical results for three of the 15 performance measures – delay, transit crowding, and accesbility to jobs. **Figures 11-3** through **11-5**, show a representative sample of how performance ratings varied based on measure and geography.

Figure 11-2: Change of Performance Ratings with the TransAction Plan

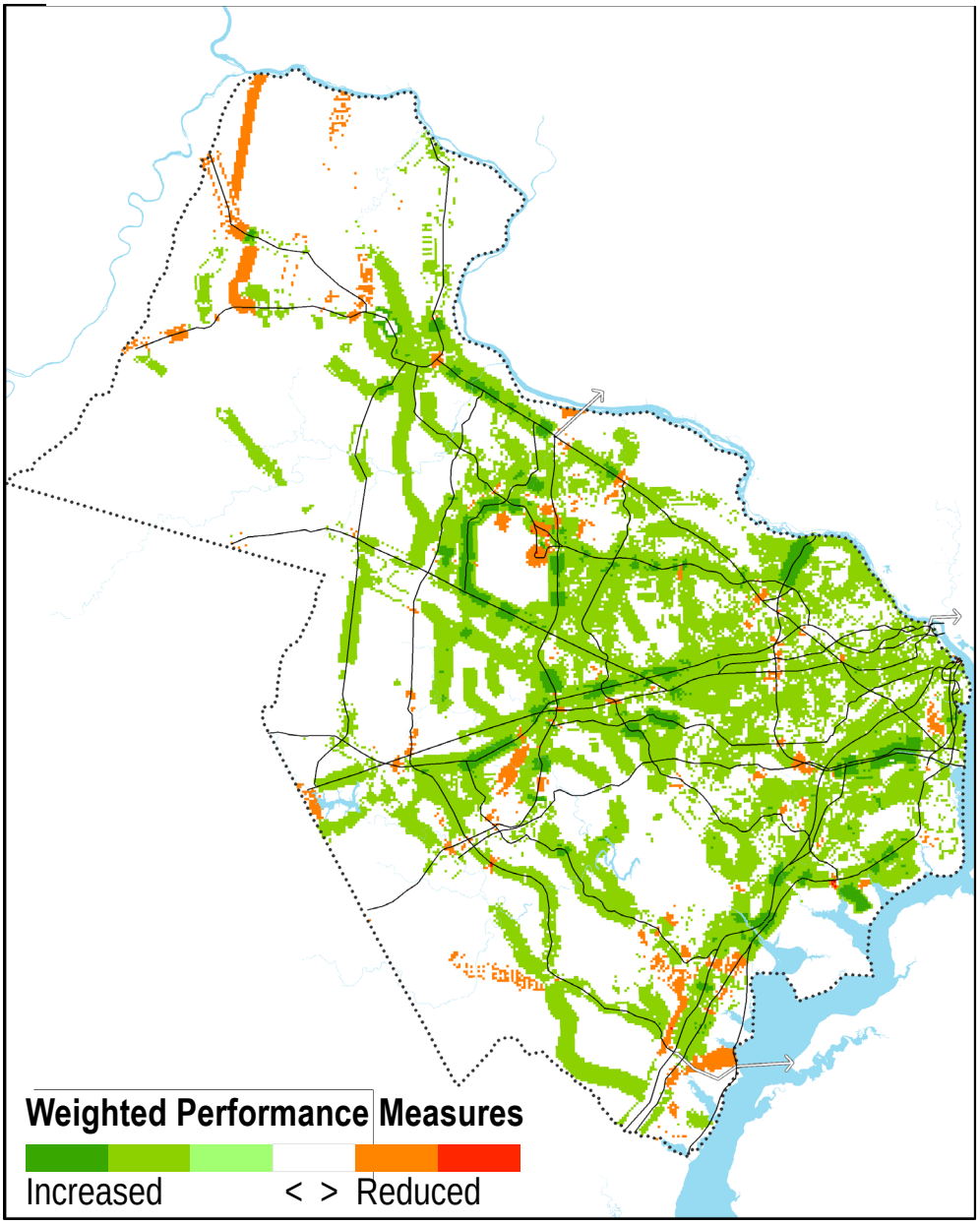


TRAVEL DELAY

Figure 11-3 shows the impacts of the TransAction Plan on person-hours of delay (performance measure 1.1.1). These results closely mirror those for the overall weighted performance measures, with the highest levels of improvement along major corridors including I-95, I-66, I-495, Route 7, and the Loudoun County Parkway.

Delay does increase in certain locations with implementation of the TransAction Plan. These locations include roadways constructed as part of the Plan (such as the new Potomac River crossings) and roads that feed into them. In addition, a few locations in the outer suburbs experience increased delay due to traffic diversions onto roadways that cannot be widened as mentioned in the previous section.

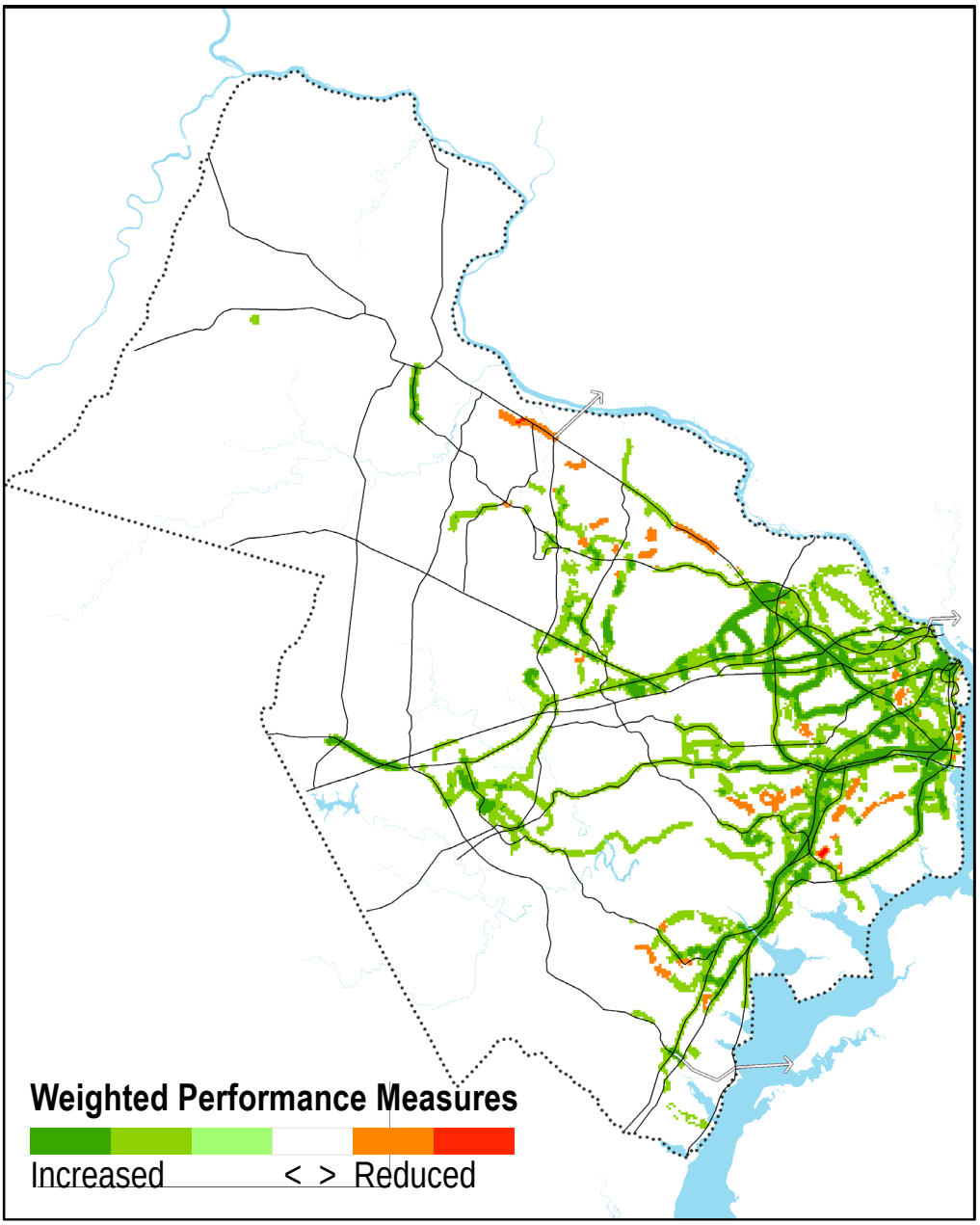
Figure 11-3: Change in Delay with the TransAction Plan



REGIONAL TRANSIT CROWDING

Figure 11-4 shows the impacts of the TransAction Plan on transit crowding (performance measure 1.1.2). Transit crowding is reduced along major corridors in the region, with particular improvements along the I-95 corridor, inside the Capital Beltway, and in the I-66 corridor. These improvements can be seen particularly in locations where new transit services have been added as part of the TransAction Plan. These improvements in transit crowding are achieved in conjunction with a 14 percent increase in transit boardings in the region. Transit crowding can only be improved in locations where transit service was experiencing crowding without the improvements in the TransAction Plan.

Figure 11-4: Change in Transit Crowding with the TransAction Plan

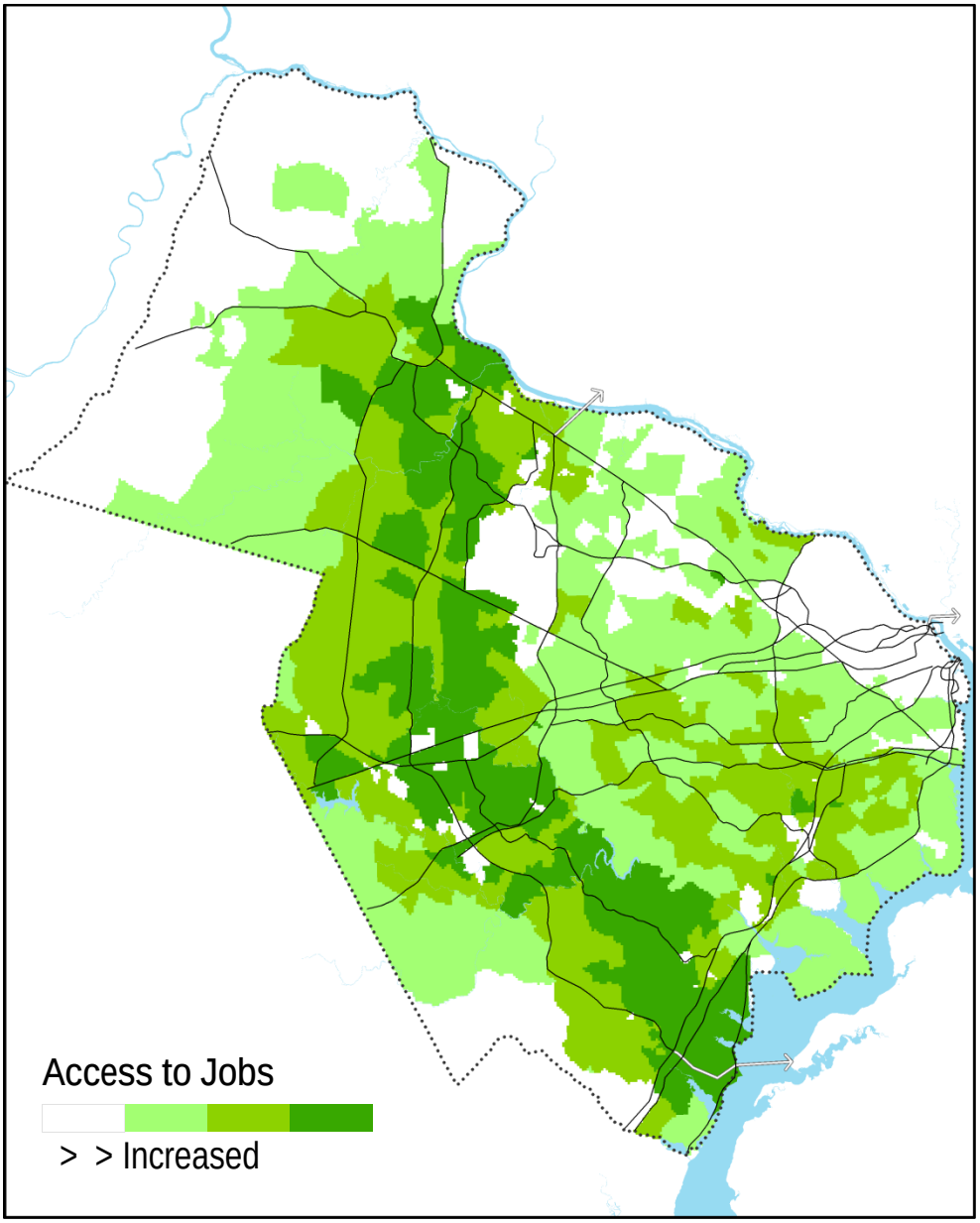


REGIONAL ACCESSIBILITY TO JOBS

Figure 11-5 shows the impacts of the TransAction Plan on access to jobs (performance measure 1.3.2). This measure looks at the average number of jobs that are accessible from households throughout the region, assuming a 45-minute commute via auto or a 60-minute commute via transit.

As shown, there are widespread improvements in accessibility to jobs throughout the region. In particular, the Plan results in the greatest improvements in a wide swath of suburban communities in Loudoun and Prince William Counties, stretching from Leesburg in the north to Dumfries in the south. Improvement tends to be lower inside the Beltway, as jobs are already highly accessible from this area.

Figure 11-5: Change in Access to Jobs with the TransAction Plan



CORRIDOR PERFORMANCE

Performance ratings were completed for each of the eleven corridors in the region. As shown in **Table 11-1**, the highest performing corridor as a whole is Corridor 8 along I-95/I-395/US 1/VRE Fredericksburg/Blue-Yellow Line. Corridor 6 (along I-66/US 29/US 50/Orange-Silver Line/VRE Manassas) and Corridor 1 (along Route 7/Dulles Toll Road/Route 9/Silver Line) also perform well.

Each corridor receives a performance rating that is relative to the highest performing segment in each performance measure. That means that the highest potential performance rating for any corridor would be 100 points. **Table 11-2:** presents the ratings by corridor and identifies the locations that benefit the most from the TransAction Plan. Higher scoring segments are those that performed the best across the 15 performance measures detailed in **Chapter 6**.

Table 11-1: Corridor Performance Rating

Corridor	Description	Performance Rating
8	I-95/I-395/US 1/VRE Fredericksburg/Blue-Yellow Line	80.0
6	I-66/US 29/US 50/Orange-Silver Line/VRE Manassas	69.2
1	Route 7/Dulles Toll Road/ Silver Line	61.3
7	I-495	55.1
10	Columbia Pike/Braddock Road/VRE Manassas	41.9
11	US 50	38.4
5	Fairfax County Parkway	37.0
3	Route 28	36.7
2	Loudoun County Parkway/Bi-County Parkway/Route 234	35.9
4	Prince William Parkway	30.5
9	US 15	19.8

CORRIDOR SEGMENT PERFORMANCE

For each of the 28 corridor segments in Northern Virginia, corridor segment performance ratings were calculated based on the Plan's impacts within a one-mile area around its primary highway and transit facilities. A map of each of the regional travel corridors and the corridor segments is shown in **Figure 11-1**.

Each segment receives a performance rating that is relative to the highest performing segment for each performance measure. That means that the highest potential performance rating for any corridor segment would be 100 points. **Table 11-2:** presents the ratings by corridor segment, and **Appendix F** shows how each segment rates for each measure. Higher scoring segments are those that performed the best across the 15 performance measures detailed in **Chapter 6**.

Performance ratings are influenced by a variety of factors, such as:

- As detailed in **Table 6-1**, performance measures have different weights. Corridor segments with projects that address more highly weighted factors (such as person hours of delay, congestion duration, first and last mile connections, travel by non-SOV modes, and VMT) will receive higher performance ratings than corridor segments with projects that address lower weighted measures (such as safety, transit crowding, or walkable/bikeable environments in a Regional Activity Center).
- Roadways that are newly constructed in the TransAction Plan are attracting traffic (and congestion) that was not present in that area in the 2040 'No Build'. By diverting traffic, these facilities such as the Bi-County Parkway in Segment 2-2, may be providing congestion relief in other segments further away than the 1-mile radius used to calculate performance ratings.
- The performance rating calculations are designed to identify the corridor segments that have the biggest impact on the region. Therefore, improvements that effect larger numbers of people or larger problems, will receive higher ratings. For example, Segment 1-1 (Rt. 7/Rt. 9 — West Virginia State Line to Town of Leesburg) and Segment 9-3 (US 15 — US 50 to US 29) show these effects. Conversely, improvements that effect fewer numbers of people or smaller problems will receive lower scores.

Table 11-2 also displays segment performance ratings relative to cost. Cost estimates were generally provided by the submitting jurisdiction or agency. If project capital costs were not provided or available, planning-level estimates of project capital costs were generated based on project type, features, surrounding land use, and/or similar projects. All costs were converted into 2017 dollars. Cost estimates for each project are provided in **Appendix G.** The costs were distributed proportionally across all corridor segments located within a half-mile buffer of the project's extents or to the nearest segment if the project was not located within a half mile of any corridor. A segment's performance rating was divided by the costs allocated to that segment to produce the performance rating relative to cost calculation.

Table 11-2: Corridor Segment Performance Rating

Segment	Description	Performance Rating	Improvement of Plan Rating Over 'No Build' Rating	Estimated Cost ($M)	Performance Rating Relative to Cost
8-3	I-395/US 1/VRE Fredericksburg/Blue-Yellow Line – I-495 to Potomac River	65.8	25%	$3,303	19.9
7-3	I-495 – I-95 to Woodrow Wilson Bridge	59.2	29%	$1,397	42.4
6-2	I-66/US 29/US 50/Orange-Silver Line – Rt. 28 to I-495	58.1	37%	$2,194	26.5
1-4	Rt. 7/Dulles Toll Road/Silver Line – Tysons to US 1	54.7	22%	$2,917	18.7
8-2	I-95/US 1/VRE Fredericksburg – Prince William County line to I-495	54.6	33%	$2,556	21.4
6-3	I-66/US 29/US 50/Orange-Silver Line – I-495 to Potomac River	49.5	22%	$8,698	5.7
8-1	I-95/US 1/VRE Fredericksburg – Stafford County line to Fairfax County line	48.5	32%	$3,521	13.8
10-1	Braddock Road/VRE Manassas – Rt. 28 to I-495	45.4	38%	$1,230	36.9
2-1	Loudoun County Parkway/Belmont Ridge Road – Rt. 7 to US 50	43.9	46%	$1,004	43.7
11-1	US 50 – Fauquier County line to City of Fairfax	42.3	39%	$1,148	36.8
3-1	Rt. 28 – Rt. 7 to I-66	40.7	34%	$1,817	22.4
6-1	I-66/US 29/VRE Manassas – Prince William County line to Rt. 28	40.5	42%	$1,512	26.8
1-3	Rt. 7/Dulles Toll Road/Silver Line – Rt. 28 to Tysons	39.9	30%	$1,762	22.7
7-1	I-495 – American Legion Bridge to I-66	39.6	28%	$1,081	36.6
10-2	Columbia Pike/Braddock Road – I-495 to Pentagon	35.8	22%	$706	50.8
1-2	Rt. 7/Dulles Greenway – Town of Leesburg to Rt. 28	34.5	31%	$1,389	24.8
4-1	Prince William Parkway – I-66 to I-95	34.2	43%	$923	37.1
7-2	I-495 – I-66 to I-395	33	24%	$383	86.2
5-2	Fairfax County Parkway – US 50 to Rolling Road	31	43%	$1,014	30.6
5-1	Fairfax County Parkway – Rt. 7 to US 50	27	31%	$611	44.2
5-3	Fairfax County Parkway – Rolling Road to US 1	26.4	27%	$555	47.5
3-2	Rt. 28 – I-66 to Fauquier County line	24.9	37%	$953	26.1
2-3	Rt. 234 – I-66 to I-95	21	30%	$919	22.9
1-1	Rt. 7/Rt. 9 – West Virginia state line to Town of Leesburg	15.8	22%	$357	44.3
9-2	US 15 – Rt. 7 to US 50	13.6	34%	$179	75.8
9-1	US 15 – Potomac River to Rt. 7	11.8	20%	$185	63.7
2-2	North-South Corridor/Bi-County Parkway – US 50 to I-66	7.7	13%	$647	11.9
9-3	US 15 — US 50 to US 29	5.8	26%	$249	23.4
	Total Estimated Cost			$43,210	

Table 11-2 highlights the locations where the Plan improves transportation conditions. Benefits vary across the region, with different areas seeing varying levels of improvements in different performance measures. Overall, the corridors with the most significant benefits, as shown in **Table 11-1**, include:

- Corridor 8: I-95/I-395/US 1/VRE/Blue-Yellow Line;
- Corridor 6: I-66 /US 29/US 50 Inner/Orange-Sliver Line/VRE Manassas; and
- Corridor 1: VA 7/Dulles Toll Road/VA 9/Silver Line.

Generally, the Plan has the greatest benefits for corridor segments inside or near the Beltway. One of the main drivers for this pattern is the fact that solutions in this area have a greater impact on more people. Based on the full range of performance measures, the corridor segments with the highest performance ratings are:

- Segment 8-3: I-395/US 1/VRE/Blue-Yellow Link – I-495 to Potomac River
- Segment 7-3: I-495 Beltway – I-66 to I-95
- Segment 6-2: I-66/US 29/US 50 Inner/Orange-Silver Line – VA 28 to I-495
- Segment 1-4: VA 7/Dulles Toll Road/Silver Line – Tysons to Old Town Alexandria
- Segment 8-2: I-95/US 1/VRE – Fairfax County Line to I-495

The results were analyzed to determine how well the Plan addresses each of the regional needs identified in **Chapter 9.** The needs are categorized based on the subregions that were shown previously in **Figure 9-16**. As detailed in **Table 11-3**, the Plan addresses most of these major needs, with significant improvements in localized conditions relative to 2040 'No Build' conditions. However, no package of improvements can solve all of the region's transportation problems, and some issues would remain at least partially unresolved with the implementation of the full TransAction Plan.

Table 11-3: Plan Performance Related to Needs Assessment

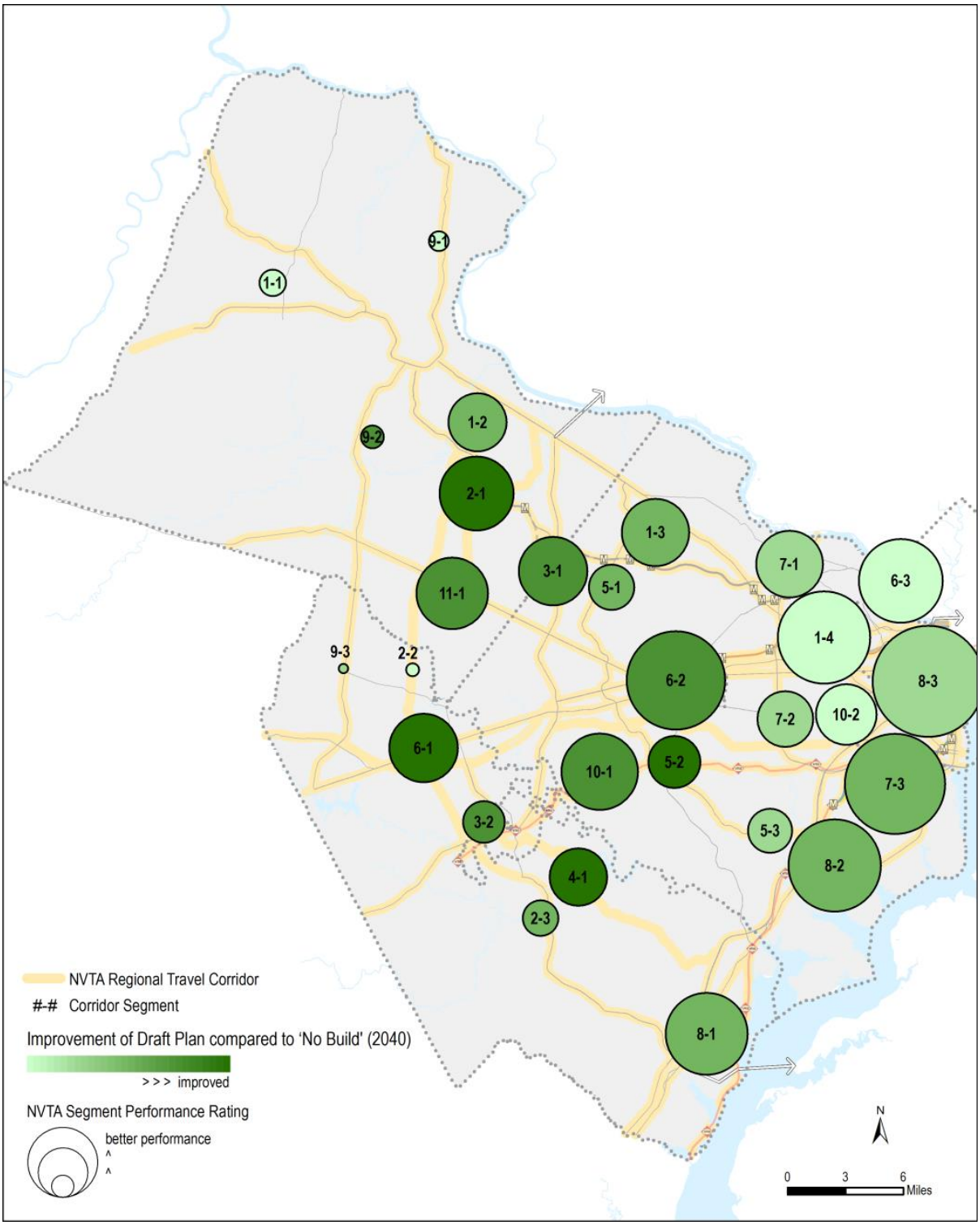
Needs	Plan Performance Relative to 2040 'No Build' Conditions
Subregion A: Inside the Beltway	
Improve transit core capacity and service levels to reduce transit crowding on bus and rail transit modes	Significant decreases in transit crowding throughout the area. Some crowding still remains, particularly on feeder routes to Metrorail lines.
Improve multi-modal connections between regional activity centers	Improvements in connections between all RACs in this area.
Address severe, recurring congestion on I-66 and I-395, and along major arterial links	Major congestion improvements are expected throughout the area, especially along I-495 approaching the Woodrow Wilson and American Legion bridges. Some severe congestion still remains along I-66, particularly near the Dulles Toll Road.
Provide improvements to the bicycle and pedestrian environment throughout the area	Significant improvements to the non-motorized environment, particularly within the RACs.
Subregion B: Northern Fairfax County	
Improve the street grid, transit service, and pedestrian environment in Tysons and Reston	Improvements to the non-motorized environment, decreased transit crowding, and congestion improvements in Tysons and Reston.
Address recurring congestion resulting from additional growth in Tysons and along Reston-Herndon corridor	Significant reductions in congestion severity and delay, particularly in the Reston-Herndon corridor. Significant congestion remains, particularly in Tysons.
Provide multi-modal options to support major travel patterns to and from Maryland	Addition of BRT and HOT lanes providing connections into Montgomery County resulting in congestion reductions.
Subregion C: Central/Western Fairfax County, City of Fairfax	
Facilitate local connections and movement of through travelers on I-66 and parallel facilities, such as US 29, US 50 and Route 236	Significant congestion improvements throughout the area. Major improvements in overall performance are especially strong along the I-66 corridor and parallel facilities.
Improve pedestrian and bicycle environment within City of Fairfax and Town of Vienna	Improvements to the non-motorized environment in all RACs in the area, especially in the City of Fairfax.
Increase access to transit and transit service to support radial and cross-county travel patterns	Significant improvements in transit service, including BRT and local bus. Improved transit access near the Town of Vienna. Improvements in transit crowding along the I-66/Orange-Silver Line corridor.
Subregion D: Southern Fairfax County	
Relieve severe, recurring congestion on I-95/US 1 corridor during weekday commute and weekend periods	Significant reductions in delay along this corridor, particularly along I-95 near Lorton. Some areas of significant congestion remain.
Support forecasted growth near Springfield and along US 1 corridor	Performance improvements in these areas, especially along US 1 near Mt. Vernon. Improvements to non-motorized environment in RACs. Significant congestion near Springfield remains.
Improve access to Fort Belvoir	Some accessibility improvements to Ft. Belvoir, including improved transit access. Some congestion issues still remain.
Improve access to transit and improve local transit circulation in high growth areas along US 1 corridor	Some transit accessibility improvements along US 1 corridor. Significant improvements to transit crowding.
Subregion E: Western Loudoun County	
Preserve rural character of transportation facilities, but address additional congestion due to forecasted growth in the area	Rural character of transportation facilities preserved, however in some locations, congestion increases somewhat due to traffic diverted from other locations. Areas of concern for congestion severity remain.
Improve connections between Northern Virginia, Maryland and West Virginia to relieve congestion	New connection to Montgomery County helps alleviate some congestion in this area, but primarily provides relief to I-495 approaching the American Legion Bridge.

Needs	Plan Performance Relative to 2040 'No Build' Conditions
Subregion F: Eastern Loudoun County, Western Fairfax County	
Construct transportation network to anticipate future growth in area and facilitate movements on US 50 and Route 7 corridors	TransAction Transportation Improvements result in significant decreases in congestion on major corridors in the area, including US 50 and most of Route 7. Some areas of poor performance remain.
Address recurring congestion and provide transit service along Route 28 to anticipate growth in Dulles corridor	Significant reductions in congestion along Route 28. Provision of BRT along Route 28 accompanied by improved first/last mile connections.
Provide multi-modal access improvements to Metrorail Silver Line Phase II stations and Dulles International Airport	Improvements to the non-motorized environment in all RACs in the area. Significant improvements in all transit measures near Silver Line Phase II stations.
Subregion G: Western Prince William County, City of Manassas, City of Manassas Park, Western Fairfax County	
Relieve severe congestion on I-66 corridor and improve access to transit along the corridor	Significant reductions in congestion along I-66, particularly east of Route 234 in Manassas. Transit Access improvement near Centreville and Fair Lakes.
Facilitate growth in activity centers near Innovation, Gainesville, and Manassas	Reductions in congestion and delay on major corridors near these locations. Improved non-motorized environments in RACs.
Improve connections to support major travel patterns to Loudoun and Fairfax Counties	Significant reductions in congestion along I-66, particularly east of Route 234 in Manassas. Some significant congestion remains on I-66 between Route 28 and Fairfax County Parkway.
Subregion H: Eastern Prince William County	
Relieve severe, recurring congestion on I-95/US 1 corridor entering the NVTA region from points south and at bottleneck near the Occoquan River	Some reductions in congestion on the I-95/US 1 corridor in southern Prince William County. Very significant congestion still remains.
Improve travel connections between cross-county and radial travel patterns, particularly near Prince William Parkway and Dumfries Road	Some performance improvements in these areas, particularly related to congestion reduction. Significant congestion still remains.
Support forecasted growth in Potomac Town Center and Potomac Shores and provide additional transit access and service	Transit accessibility improves near Woodbridge. New transit service is provided in these areas, including Express Bus, BRT, and a Metrorail extension.

Figure 11-6 presents the performance ratings by corridor segment. A circle is shown for each corridor segment; the size of the circle represents performance rating of the corridor segment, as reported in **Table 11-2:** . The color of the circle indicates the percent improvement that the TransAction Plan was able to achieve over the 2040 'No Build' conditions in that corridor. It corresponds to the fourth column in **Table 11-2**. That means that the largest circle (Segment 8-3 along I-395) has the highest score, while the darkest circle (Segment 2-1, Loudoun County Parkway/Belmont Ridge Road — Rt. 7 to US 50) was able to solve the largest portion of the problems.

Some segments (e.g., Segment 9-2) achieve large percent improvements as compared to 2040 'No Build' conditions, despite relatively low performance ratings because their problems were smaller relative to other segments in the region.

Figure 11-6: Corridor Segment Scores



FINDINGS

Overall, the results of this study and analysis show that the improvements included in the TransAction Plan benefit the entire Northern Virginia region and improve travel conditions in all corridors when compared to the 2040 'No Build' conditions. With an overall estimated capital investment of $43.2 billion, the Plan achieves major benefit.

Some of the major improvements noted on a regional level include:

- Noticeable reductions in person-hours of travel and person-hours of delay (24 and 44 percent, respectively), despite a slight increase in motorized trips in the region.
- Significant decrease in transit crowding (64 percent) to below 2016 levels, in part due to the inclusion of expansions to the regional transit network such as BRT and Metrorail expansions. This improvement is achieved with a simultaneous increase in transit ridership.
- Job accessibility is noticeably improved for residents in a broad segment of the region, from Leesburg to Dumfries because of improvements in the Plan.

Table 11-4 summarizes some of the key regional performance measures resulting from the Plan. As shown, the Plan results in a small increase in the total number of motorized trips occurring in Northern Virginia. Despite this increase, the Plan manages to decrease the total person-miles traveled in Northern Virginia slightly, while significantly reducing the amount of time spent traveling (by almost 24 percent) and the total amount of delay in the region (by almost 44 percent). In addition, the Plan manages to reduce transit crowding by over 64 percent, despite an 8.2 percent increase in transit ridership.

Table 11-4: TransAction Plan – Regional Totals for Selected Measures

Daily Measures	2016	No Build 2040	TransAction Plan	Percent Improvement
Motorized Trips	8,737,000	10,462,000	10,565,000	1.0%
Transit Mode Share	10.0%	9.8%	10.6%	8.2%
Transit Boardings	1,002,000	1,359,000	1,551,000	14.1%
Person-Miles of Travel	104,839,000	125,379,000	124,869,000	-0.4%
Person-Hours of Travel	3,298,000	5,811,000	4,446,000	-23.5%
Person-Hours of Delay	1,007,000	3,030,000	1,704,000	-43.8%
Service Hours of Crowded Transit	10,800	20,100	7,200	-64.4%

CHAPTER 12: MANAGING UNCERTAINTY AND RISK

Transportation is in the midst of a series of quiet but profound revolutions. Travelers in the future will have choices that go beyond the classic dichotomy of private cars versus bus and rail transit. Many of these changes will take advantage of new technology, with some of the most dramatic changes yet to come. Many of these changes differ from a simple extension of past trends, and represent the potential for a series of non-linear changes that could generate increased uncertainty regarding forecasts. Some of the trends that present a high degree of uncertainty in the long-term include:

- Demographic characteristics and preference (like family size or desire to age in place);
- Development Patterns (such as tendency towards density or sprawl);
- Activity Patterns (for instance, greater prevalence of remote work);
- Connected and Autonomous Vehicles (pace and extent of technology development and use);
- Shared Travel (including the popularity, legality, and cost of transportation network companies);
- Economics (i.e. gas prices and unemployment rates);
- Freight and Goods Movement (particularly the need to supply and deliver traditional retailers or online customers);
- Climate Change and World Events (like changes in the frequency of natural disasters);
- Information and Management Technologies (for example, the advancement of cellular and Internet technology); and
- Policy and Legal Evolution (such as changes to environmental documentation requirements).

Uncertainty in how the future will unfold means that by 2040 individual trends could take multiple paths or directions, could happen in many different combinations, with different and potentially counteracting impacts and effects. The specific impact of these changes on demand for traditional modes, including private cars, transit, walking, biking, taxis, and telecommuting is unknown but will have important implications for how we plan, fund, and operate regional transportation. This update to the TransAction Plan for Northern Virginia considers the potential impacts of some of these changes on the transportation network.

While the future is uncertain, scenario testing manages risk in transportation investments by assessing performance of the network under a number of different future conditions and behaviors. TransAction analyzed four alternative future scenarios that represent a range of plausible outcomes to ensure that the TransAction Plan is robust and useful regardless of the future that comes to pass. This chapter includes a summary overview of the scenario analysis conducted as part of the TransAction planning process. **Appendix H** provides further detail on the assumptions and methodology for developing the Scenarios.

SCENARIO DEFINITIONS

Scenario planning is a tool that helps organizations hedge against the unknown. Scenario planning, also known as scenario testing or scenario analysis, defines a range of possible futures in order to test the resiliency of improvements across this spectrum. It does not attempt to identify or assess every possible future, nor does it try to establish one exact picture of the future. Instead, scenario planning defines a limited number of futures that – between them – encompass a wide array of potential outcomes resulting from a number of changing factors.

Because of technology's pervasive impact and the extensive research currently underway, Scenarios A and B have been built around major technological changes and their potential impacts to travel behavior and services. Scenarios C and D have been built around potential changes to development patterns in the region. The four scenarios and their travel impacts are as follows in **Table 12-1**.

Table 12-1: Scenario Descriptions and Travel Impacts

Scenario	Title	Description	Assumptions	Impacts
A	Technology Makes Driving Easier	Significant evolution in vehicle and/or system information and management technologies	• Improved efficiency on longer trips • Extensive automated vehicle usage on freeways and arterials • Low costs of travel	• Less congestion • More efficient vehicle travel • More first/last mile trip and short trip options
B	Changes in Travel Behavior	Urban living and mixed-use centers, telecommuting options, increase in fuel and travel costs	• Technology solutions focused on local and short distance travel • More efficient use of the transportation network • Shared mobility solutions • Increased reliance on telecommuting and e-commerce • Significant increases in private travel cost	• Less vehicle travel • Shorter trips • Less peak period travel • More first/last mile and short trip options • More delivery vehicles
C	Dispersed Land Use Growth	Lower density development farther from the metropolitan core and regional activity centers	• Less efficient use of the transportation network • Reliance on private vehicles • Residents living farther away from workplaces	• More auto trips • Longer distance commute trips • Fewer transit trips; transit less effective
D	Concentrated Land Use Growth	Dense development inside the Beltway and near regional activity centers	• Significant increases in private travel cost • More residents living along transit corridors • Shared mobility solutions • More efficient use of the transportation network • Residents living closer to workplaces	• Fewer auto trips • More transit and non-motorized trips • Shorter commute trips • Transit more effective

BASELINE SCENARIO RESULTS

Each of these potential future scenarios was analyzed for performance in 2040. These results include the same improvements as the 2040 'No Build' outlined in **Chapter 10**. Summary statistics are presented in

Table 12-2 shows the full details of the performance of each of the future scenarios under the baseline 'No Build' 2040 conditions can be found in **Appendix H**.

Table 12-2: Alternative Future Scenarios, 2040 "No Build"

Daily Measures	2016	No Build 2040	Scenario A	Scenario B	Scenario C	Scenario D
Motorized Trips	8,737,000	10,462,000	10,847,000	10,063,000	10,733,000	10,320,000
Transit Mode Share	10.0%	9.8%	10.3%	9.9%	8.6%	10.0%
Transit Boardings	1,002,000	1,359,000	1,382,000	1,144,000	1,239,000	1,389,000
Person-Miles of Travel	104,839,000	125,379,000	127,819,000	116,615,000	129,719,000	121,587,000
Person-Hours of Travel	3,298,000	5,811,000	4,305,000	4,515,000	5,850,000	5,188,000
Person-Hours of Delay	1,007,000	3,030,000	1,324,000	1,932,135	2,996,000	2,520,000
Service Hours of Crowded Transit	10,800	20,100	13,800	12,900	16,500	19,700

All four of the alternate future scenarios show some level of improvement in at least some of the key performance indicators compared to the 2040 'No Build' conditions. The benefits are spread across the region, although some of the scenarios result in more widespread improvements than others. Maps highlighting the change in the performance measures for each scenario can be found in **Appendix H**.

The figures below show the percent improvement achieved for two key performance measures for each of the alternative scenarios, as compared to the standard future forecasts (as shown by the red diamond). These graphics show that the Plan achieves a larger reduction in transit crowding under Scenarios C and B, than the standard future forecast. Benefits are forecast for most areas across the region under each of the alternate future scenarios tested. This scenario analysis does not define or attempt to achieve a preferred future, nor does it attempt to predict a specific future. Instead, the analysis is designed to test the resiliency of the Plan under different possible futures.

Figure 12-1 through **Figure 12-3** display some of the key results visually for the purpose of quick comparisons. For both person-hours of delay and transit crowding, all four of the scenarios perform better than the 2040 'No Build' (as shown by the red diamond). The technology and behavioral changes (Scenarios A and B) appear to result in greater improvements than the land use scenarios (C and D), but it is less straightforward to identify a clear winner or loser across all metrics. It is also important to consider the full picture as to how these results are achieved. For example, **Figure 12-2** indicates that Scenario A achieves relatively low levels of transit crowding, despite having almost the highest transit ridership of all the scenarios as shown in **Figure 12-3**. In contrast, Scenario B's improvement in transit crowding appears to come as a result of significantly lowering transit ridership.

Figure 12-1: Person Hours of Delay – 'No Build' Scenarios

Figure 12-2: Transit Crowding – 'No Build' Scenarios

Figure 12-3: Transit Ridership – 'No Build' Scenarios

Overall, the results show that the Plan does provide significant benefits under each of the potential alternate futures, although the percent improvement varies by performance measure across the scenarios. These results indicate that the Plan is likely to provide benefits to Northern Virginia regardless of any of the major trends highlighted, but these trends should be monitored to identify potential future impacts.

PLAN SCENARIO RESULTS

The performance of the Plan was analyzed under each of these future scenarios. These results include the same improvements as the Plan outlined in **Chapter 10**. Summary statistics are presented in **Table 12-3** and show the conditions if these future scenarios were to come to be, and the improvements in the TransAction Plan were implemented.

Table 12-3: Alternative Future Scenario Results with TransAction Plan

Daily Measures	TransAction Plan	TransAction Plan – Scenario A	TransAction Plan – Scenario B	TransAction Plan – Scenario C	TransAction Plan – Scenario D
Motorized Trips	10,565,000	10,936,000	10,148,000	10,793,000	10,407,000
Transit Mode Share	10.6%	11.8%	10.8%	9.6%	11.3%
Transit Boardings	1,551,000	1,617,000	1,266,000	1,416,000	1,611,000
Person-Miles of Travel	124,869k	126,349k	115,473k	126,721k	118,888k
Person-Hours of Travel	4,446,000	3,730,000	3,647,000	4,461,000	4,025,000
Person-Hours of Delay	1,704,000	844,000	1,109,000	1,671,000	1,415,000
Service Hours of Crowded Transit	7,200	7,200	3,300	5,700	7,800

However, it is important to consider that the future scenarios and the TransAction Plan are two separate and distinct considerations; the future scenario Northern Virginia ultimately ends up with is not dependent on the implementation of the Plan (although there may be some synergies.) To quantify the benefit of the Plan in these alternate futures, it is therefore necessary to compare the scenarios with the Plan to the scenarios without the Plan. This quantifies the direct impacts caused by the improvements in the Plan directly.

Table 12-4 compares the results of each of the alternative future scenarios with the Plan to the appropriate 'No Build' condition (i.e., Plan Scenario A is compared to 2040 'No Build' Scenario A). This analysis is designed to identify if the Plan would provide benefits to the region even if one of the alternate future scenarios were to occur. The results show that the Plan does provide significant benefits under each of the potential alternate futures, although the percent improvement varies by performance measure across the scenarios.

Table 12-4: Alternative Future Scenario Results with TransAction Plan

Daily Measures	TransAction Plan	TransAction Plan – Scen A	TransAction Plan – Scen B	TransAction Plan – Scen C	TransAction Plan – Scen D
Motorized Trips	1.0%	0.8%	0.9%	0.6%	0.8%
Transit Mode Share	8.2%	14.6%	8.7%	11.0%	13.0%
Transit Boardings	14.1%	17.0%	10.7%	14.3%	15.9%
Person-Miles of Travel	-0.4%	-1.2%	-1.0%	-2.3%	-2.2%
Person-Hours of Travel	-23.5%	-13.4%	-19.2%	-23.7%	-22.4%
Person-Hours of Delay	-43.8%	-36.3%	-42.6%	-44.2%	-43.9%
Service Hours of Crowded Transit	-64.4%	-47.5%	-74.1%	-65.6%	-60.7%

Figure 12-4 illustrates that under each of the potential futures, including the standard future represented by the red diamond, the Plan improves person-hours of delay in the region by 36-44 percent. It is important to consider the 'No Build' conditions when analyzing these results; while Scenarios A and B result in the lowest person-hours of delay under the Plan, they also reduce the delay by the smallest percentages, because they had the lowest amount of delay in the 'No Build' conditions. Similarly, **Figure 12-5** illustrates that the Plan improves transit crowding by 36-43 percent in all of the potential futures.

Figure 12-4: Improvement in Person-Hours of Delay with the Plan

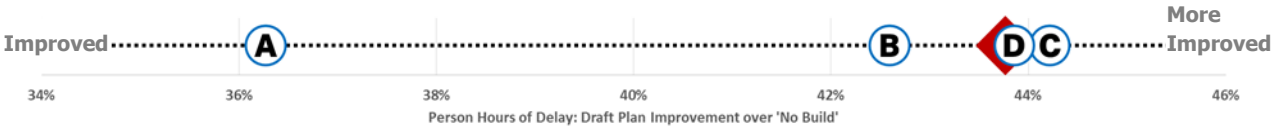


Figure 12-5: Improvement in Transit Crowding with the Plan