APPENDIX D:
Scenario Definition and Methodology

February 2022

Introduction

Uncertainty is a part of long-range transportation planning; it is impossible to know precisely what the future will look like as transportation technologies, preferences, and options evolve over time. Traditional long-range planning and travel demand forecasting have been built around the assumption that this evolution would be a slow process, and that future behaviors would look similar to current and past behaviors, with changes mostly influenced by natural growth in population and employment and changes to the underlying transportation networks. In fact, the whole process of model validation is designed to prove that a model is capable of replicating current observed conditions, so that it can then be applied to future conditions, generally with no changes to important assumptions like the number of trips produced by each household on a daily basis (trip generation rates) or how individuals choose their mode of travel (mode choice constants). This approach is a good approach; it uses the best data available (observed data is always the best data) and makes the very reasonable assumption that people in the future will still have to travel for the same reasons and will continue to make mode choices based on the familiar factors of time, cost, comfort and convenience.

Sometimes, however, evolution takes a more dramatic pace and disrupts the transportation system so completely, that these assumptions may no longer be valid. It happened in the early 20th century with the introduction of automobiles; it happened again later in the century when the rise of two-income households essentially doubled trip generation rates as women joined the work force in massive numbers. The 21st century will include its share of disruptions as well. And while we don't know precisely what they will be, we can see glimpses of likely possibilities in current trends and market expectations.

NVTA is incorporating the uncertainty about these disruptions into the TransAction process to ensure that the Plan and the subsequent programming decisions that are made based on the Plan, account for the uncertainty of these types of disruptions. By analyzing multiple potential future scenarios, NVTA can ensure that the TransAction Plan is nimble enough to absorb these disruptions by understanding how they might change travel behaviors and transportation needs and opportunities across Northern Virginia. This analysis will also allow the Authority to make wise investment decisions, ensuring that the projects that NVTA funds will be good investments regardless of how the future plays out.

NVTA's TransAction
Transportation Action Plan for Northern Virginia

Scenario Identification

TransAction will use scenario analysis to better understand the potential for disruption and uncertainty in the long-range transportation planning process. In addition to a 'standard' forecast of the future in 2045, this scenario analysis will identify multiple 'alternate' futures that incorporate one or more plausible disruptions – behavioral, technological, or policy disruptions that could have significant impacts on individual travel choices and the operation of the multimodal transportation network in the future. These alternate futures are identified as plausible scenarios – but they are not necessarily preferred visions for the future, nor are they necessarily the most likely scenarios. At this point in the process, three scenarios have been identified as plausible alternate futures for analysis:

1. Post-Pandemic 'New Normal' in which many of the behavioral changes observed during the COVID-19 pandemic continue into the long-term future;

2. Advanced Transportation Technology focusing on implementation of Connected, Automated, Shared, Electric (CASE) Vehicles; and

3. Transportation Incentives/Pricing focusing on policy strategies to shift travel behavior.

Each of these scenarios represents a plausible set of disruptions by 2045, but as disruptions, these are mostly elements that are out of NVTA's control. Of course, there are infinite variations of each of these disruptive scenarios that could be identified (e.g. different CASE penetration rates, varying levels of telework or grocery delivery, ranges of incentives for transit use, etc.) and this analysis will not be able to address every possibility. Instead, this scenario analysis will use an assumption-based approach in which the best available research will be used to identify a reasonable and plausible set of assumptions for each of the scenarios. The results will provide a directional understanding of what could change given these assumptions (e.g. will congestion go up or down?) and provide guidance on where new problems may arise to help identify appropriate policy and project actions for NVTA and member jurisdictions in the future.

Of course, these three scenarios do not represent an 'either-or' view of the future. An increase in telework (from the Post-Pandemic New Normal scenario) could occur in tandem with the widespread adoption of CASE vehicles across the region (from the technology scenario). And while this scenario analysis cannot address all of the plausible combinations, a fourth scenario may be added later that incorporates some of the key elements of all three scenarios identified above.

The scenarios that are tested as part of this analysis will provide insight into the potential impacts if these disruptions occur. The analysis will also identify the extent to which proposed TransAction projects are able to meet the goals of TransAction in these alternate futures. This analysis can help identify any projects that may be more/less beneficial to the region under a different set of assumptions, helping NVTA invest only in projects that will be the most resilient to change, uncertainty, and disruption.

Initial Scenario Definitions

As outlined above, this scenario analysis process will start by analyzing the three distinct potential future scenarios described in this section.

Scenario 1: Post-Pandemic New Normal

Throughout 2020 and 2021 residents of Northern Virginia and around the country have dramatically changed their travel behaviors in response to the global coronavirus pandemic. While many changes began as short-term adaptations to social distancing requirements, as the pandemic has continued to linger, many seem likely to continue as part of normal travel patterns into the future. Hopefully, by 2045 the pandemic is only a distant memory, but it is possible that many of the behaviors that residents have adopted during the pandemic will be fully normalized as part of regular travel behaviors in the long term. Telework, for example, was initially assumed to be something that people would do for a few weeks until everyone could return to their offices. Two years later, many companies are questioning whether their employees will ever return to their offices full time, and telework is considered an essential part of attracting/retaining employees. This scenario is not assuming that an ongoing pandemic continues to shape travel patterns in 2045, but instead that the convenience associated with some of the new pandemic-related behaviors makes them attractive for people in the future.

Some of the key changes that are currently the most likely candidates for wide-scale, long-term adoption include:

a. Increased telework for workers that are able to telework, especially office workers;

b. Decrease in other work-based trips due to increased telework;

c. Replacement of shopping trips with at-home deliveries;

d. Increases in non-motorized trips;

e. No changes in car ownership levels; and

f. No changes to land use.

1a: Telework

Even before the pandemic, telework has been an important part of the commuting landscape in Northern Virginia. In 2019, 35 percent of Washington-area workers teleworked regularly or occasionally, up from 19 percent in 2007.[1] On a typical day in 2019, about 8.6 percent of Washington-area workers teleworked, which is approximately equivalent to one-third of the workforce teleworking 1.1 days per week. Teleworking also increased as household income increased. While only five percent of workers with incomes below $30,000 teleworked, almost half of workers making over $140,000 teleworked. These differences are shown in Table 1 for the four household-income levels used by the Transportation Planning Board (TPB) travel demand model.

Table 1: Telework Share by Household Income Level

Income Group	2019 Telework Commute Share
1 (Lowest)	10%
2	25%

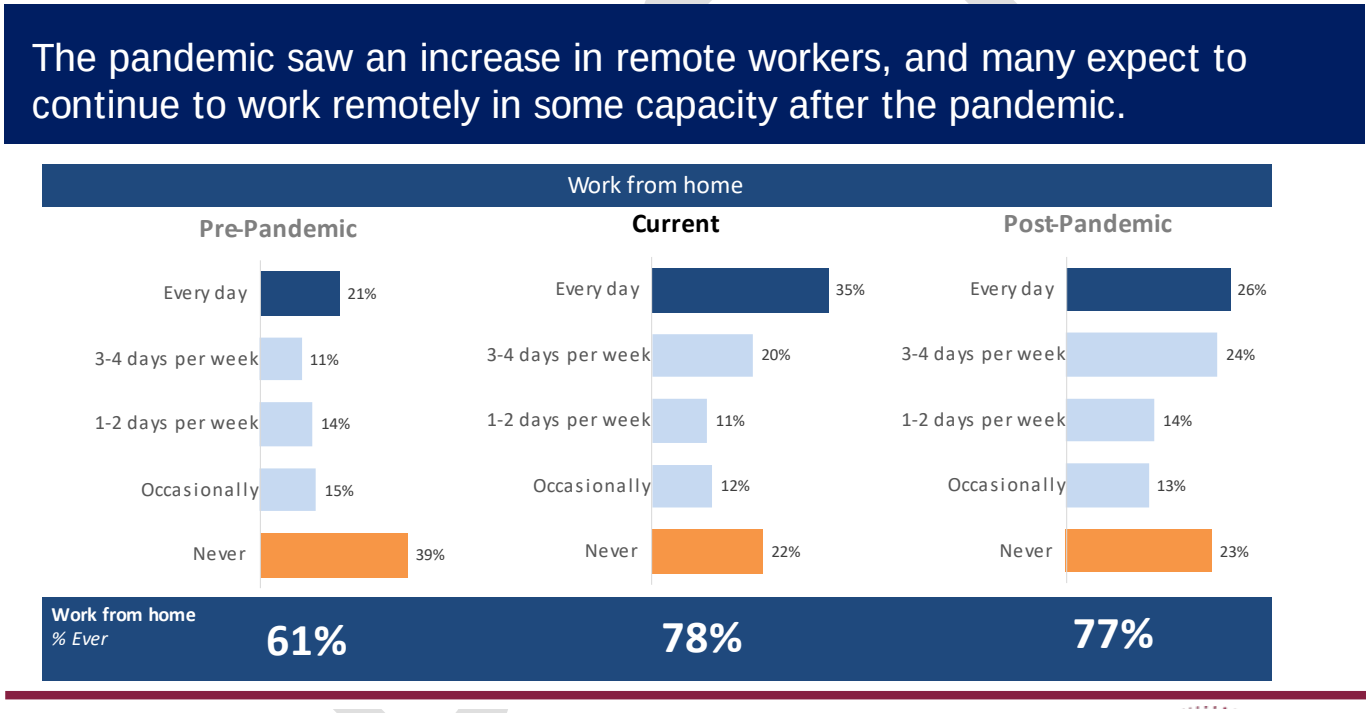
[1] Metropolitan Washington Council of Governments (2019). https://www.mwcog.org/documents/2020/06/17/state-of-the-commute-survey-report--carsharing-state-of-the-commute-travel-surveys/

Income Group	2019 Telework Commute Share
3	36%
4 (Highest)	48%

Source: MWCOG State of the Commute Survey, 2019

Extensive full-time telework has been one of the defining characteristics of travel during the pandemic. The pandemic has illustrated that many jobs can be done efficiently and effectively without a physical work site, and 60-65 percent of Washington-area workers worked at home on a given day. Surveys in the region and across the US have indicated that many would like to continue to work remotely, at least a few days per week, once the pandemic subsides. But telework cannot be adopted universally across the labor market, as some types of positions require in-person work. Many of the types of positions that cannot be shifted to telework are also lower-income jobs, such as retail, service industry, hospitality, construction, industrial jobs, and many jobs in the medical industry.

Figure 1: Respondents to NVTA's 2021 Tracking Survey indicated that they are likely to continue teleworking at higher rates once the pandemic ends.



Thinking forward to 2045, it is likely that this disparity in the propensity of telework will continue to allow office workers in both the public and private sectors to work remotely. In this scenario, post-pandemic telework levels are assumed to be higher than current levels, but lower than the social-distancing mandated levels seen at the height of the pandemic. In this scenario, it is assumed that 55 percent of workers in the region will telework 1.5 days per week, including private sector and government employees. This will be represented by changes to the assumed trip generation rates. As shown in Table 2, adjustments to trip generation rates vary by income group to account for the differences in ability for different types of workers to telework. For example, home-based work (HBW) or commute trip generation rates will be reduced by five percent for the lowest income group, but reduced by 18 percent for the highest income group. Collectively, these assumptions are roughly equivalent to replacing nearly 21 percent of commute trips with telework. The 2021 TransAction Tracking Survey conducted by NVTA indicated that

residents and workers in Northern Virginia are expecting this level of change in their commute and telework patterns once the pandemic abates.

Table 2: HBW and NHW Trip Generation Adjustments by Household Income Level

Income Group	Adjustment to HBW Trip Generation Rates
1 (Lowest)	0.95
2	0.90
3	0.86
4 (Highest)	0.82

1b: Other Work-Related Trips

In addition to this growth in telework impacting commute trips, telework also has a major impact on non-home-based-work (NHW) trips. These NHW trips are workplace-based trips as people travel to meetings at off-site locations, went out to lunch, and/or ran errands near their offices. With more telework, many of these trips will no longer occur. NHW trips will therefore also be decreased by 21 percent.

1c: Shopping Trips and Deliveries

Over the course of the pandemic, shopping behaviors have changed dramatically with many consumers decreasing the frequency of in-person shopping trips to avoid unnecessary interactions. While some portion of these trips have already returned, the convenience and ease of online shopping and at-home delivery will likely mean that many people continue to use them long into the future. The 2021 TransAction Tracking Survey showed significant growth in online shopping, with a seven percent increase in households who shop online at least once per week. In this sense, the pandemic can be seen as a force hastening a shift towards e-commerce that has been predicted by the industry for several years. As of May 2021, travel to all retail establishments was reported to be 5.6 percent lower[2] than pre-pandemic levels, even as vaccines became widespread and many Americans returned to a new-normal in life. This scenario assumes that drop to represent a permanent change in shopping behaviors.

Supposing that the economy fully recovers from the pandemic by 2045, reduced in-person shopping trips will be accompanied by increases in the number of delivery trips. There is not a one-to-one replacement between shopping trips and delivery trips, as carriers can group multiple deliveries together to optimize efficiency. Therefore, commercial trips will be increased by 1/3 of the number of shopping trips that are reduced.

1d: Non-Motorized Travel

Non-motorized travel has also been impacted by the pandemic, seeing dramatic decreases in the early days as lock-down orders were enforced and overall travel dropped dramatically. Through 2020, bicycling in particular saw dramatic growth, as people used it as a socially-distant alternative to public transit. Bicycles were hard to come by through much of 2020, as most stores were out of stock. Interestingly, bikeshare providers didn't see the same level of growth, and most major bikeshare programs saw decreases in use. Walking has shown more mixed

[2] https://fortune.com/2021/05/27/shoppers-retailers-stores-online-spending-covid/

results, as the number of utilitarian trips declined in line with the decrease in general travel, while recreational trips increased as a form of physical activity and opportunity to leave the house.

The long-term impacts of these changes are difficult to predict. We assume that indoor gyms and recreation will be fully available again by 2045, and further, that the public's confidence in transit will have been fully restored. Therefore, any increase in non-motorized travel will be related to the fact that if more people are staying closer to home (instead of commuting to work) that they will be more likely to use non-motorized options for short errands, exercise, or recreational trips. A five percent increase in non-motorized trips generated will be assumed as part of this scenario.

1e: Car Ownership

For several years prior to the pandemic, data from around the country indicated that car ownership was declining, as new vehicle registrations and new driver's licenses began decreasing for the first time in history. But the pandemic may have reversed these trends, as several surveys taken during the pandemic have indicated that many households would like to increase their vehcle ownership. As of November 2020, one survey[3] indicated that 31 percent of non-car owners are planning to buy one in the next 6 months, and that 20 percent of households that do own a car are open to buying an additional car. However, despite these findings, both the economic downturn and supply chain issues that accompanied the pandemic have impacted people's ability to purchase vehicles in the short term, and car sales remain somewhat below pre-pandemic levels. Additional surveys have indicated that while the perceived value of owning car has increased dramatically during the pandemic, people aren't necessarily driving more.

Based on this analysis, and the fact that the TPB model had never fully incorporated the new pre-pandemic trends of decreasing vehicle ownership, no changes will be made to the model assumptions for this scenario.

1f: Land Use Changes

The pandemic, and the ensuing changes in travel patterns already discussed, have the potential to dramatically change the long-term future of the real estate market in the region. In particular, the rise of telework may have two major impacts:

1. Residents may choose to live further from job centers since they will no longer have to deal with a commute on a daily basis. Population estimates showed that the population of Northern Virginia actually decreased between 2020 and 2021 as more people moved out of the region than into the region[4]. Within the region, the outer jurisdictions of Loudoun and Prince William Counties saw population growth, while all the remaining jurisdiction (except for the City of Fairfax) saw a decrease. This is illustrative of people choosing to live further away from job centers.

2. Office space may become unprofitable as office footprints shrink, encouraging conversion to other uses. Northern Virginia's office vacancy rate has risen from just over 14% in 2019, to just over 16% at the end of

[3] https://www.ey.com/en_gl/news/2020/11/millennials-to-lead-covid-induced-car-ownership-boom-ey-survey

[4] Source: NVRC 2022, https://www.novaregiondashboard.com/population

2021. Vacancy rates in DC have grown even more, from over 11% in 2019 to over 14% in 2021[5]. This is illustrative of the potential decrease in office footprints across the region.

These two impacts should be considered as part of this scenario, and they are expected to have opposing impacts. For example, DC is considering efforts to convert the growing stock of empty office space downtown into residential space. Similar moves in other employment hubs (such as Arlington or Tysons) could shift population into these areas. This would be directly opposing the decentralizing force of people chosing to locate further from employment centers. Because these two impacts will counter-balance one another, no changes in land use assumptions will be incorporated into the scenario. No assumptions to the changes in income distribution are being assumed.

A third potential impact could be a decrease in the future population of Northern Virginia if people who are employed in the region are able to live anywhere in the country (or even around the world). While theoretically possible, this impact will not be considered an assumption for this scenario since we expect that people will still choose to live in Northern Virginia for other reasons.

Scenario 2: Technology Scenario

A number of new vehicle technologies and applications are on the horizon, and are expected to have achieved significant market penetration by 2045. This scenario will focus on a future in which multiple emerging technologies overlap:

- Connected Vehicle (CV) technologies allow vehicles to communicate with other vehicles, roadway infrastructure, and other roadway users. CV is expected to improve safety and operational efficiency by allowing infrastructure to adapt to demand and providing more information about the intentions of all roadway users.

- Automated Vehicle (AV) technologies allow part or all of the driving task to be performed by the vehicle itself. Fully automated vehicles (SAE Level 4 or 5) are able to drive fully independently without human intervention and are expected to help increase roadway capacity and improve safety by removing human error and increasing reaction speeds. While some of the benefits associated with vehicle automation can be realized at lower levels of automation, this scenario is focused on vehicles that can be fully operated without a driver.

- Electric Vehicle (EV) technologies include battery and associated charging technologies that allow vehicles to be powered from the electric grid, instead of using internal combustion engines.

- Shared Vehicles (SV) use a range of technologies to enable multiple households and users to share vehicles. Similar to existing Transportation Network Companies (TNCs, such as Uber and Lyft), SV services would allow individuals to purchase mobility (i.e., rides) instead of purchasing a vehicle. SVs make more efficient use of vehicles, reduce vehicle ownership levels, and can encourage the use of a mix of modes to complete daily trips.

[5] Source: TPB 2022, https://www.mwcog.org/file.aspx?&A=IwRWee826zs4BCZzkRXTBmkW8D0L5XV2gwOTKXdi8Lo%3d

When combined, these four technologies have the potential to amplify the benefits of each technology alone. This scenario will focus on adoption of these technologies in combinations, including adoption into the private vehicle fleet (CAE), and through the introduction of shared vehicle fleets (CASE). This changes and impacts assumed as part of this scenario include:

a. Market Penetrations of Connected, Automated, Shared and Electric vehicles;

b. Changes in operating costs for automated vehicles – shared and privately owned;

c. Increases in effective roadway capacity;

d. Changes in trip generation;

e. Automated transit shuttles; and

f. No changes in land use.

2a: Market Penetration

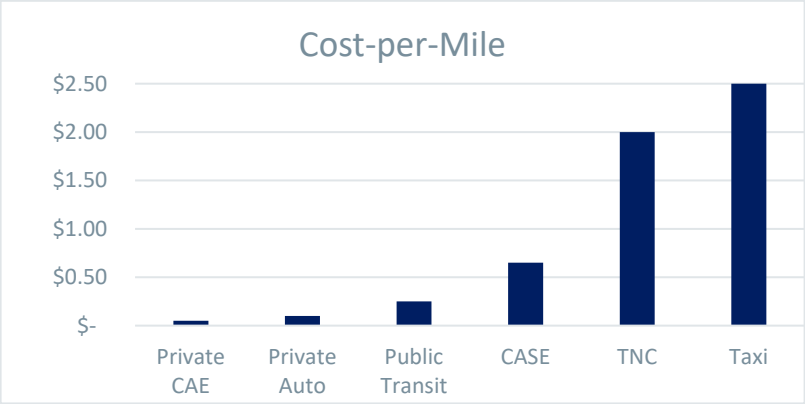
Predictions of the market penetration of these new technologies vary significantly, but are generally less optimistic for automated vehicles now than they were several years ago. Based on a review of many of these forecasts, it is estimated that only approximately 20 percent of the vehicle fleet will be fully automated by 2045[6]. At this phase of technology adoption, the majority of new vehicles sold will still be only partially-automated, as fully automated vehicles will still be somewhat rare and significantly more expensive to purchase than traditional vehicles. This cost differential means that high-income households will be much more likely to own an AV than lower-income households. This same cost differential will also encourage the use of AVs as part of shared vehicle fleets, where these expensive resources can be utilized efficiently to provide mobility for many users throughout the day.

For the purposes of this scenario, the following market penetration assumptions will be used:

- Twenty percent of privately-owned vehicles (Connected, Automated and Electric – CAE) will be fully automated by 2045.
- Automated TNCs will replace human-driven TNCs, and will be available in all jurisdictions within Northern Virginia, and for trips to the District of Columbia, Montgomery County, or Prince George's County. TNCs will not be available for trips to/from other jurisdictions in the metropolitan region. These CASE vehicles will account for another five percent of the vehicle fleet.
- All fully automated vehicles will be assumed to be both electric and equipped with CV technology.
- Full-size transit buses will still require human drivers
- One-third of large trucks will be fully automated and connected by 2045.

[6] https://www.vtpi.org/avip.pdf

2b: Operating Costs



Operating costs are calculated on a per-mile basis and expected to decrease with the introduction of CASE options. The current TPB model assumes that private automobiles cost ten cents per mile to operate (in 2007 dollars); this will remain the case for traditional vehicle operating costs in 2045. However, privately owned CAEs are expected to cost about 50 percent less to operate per-mile. As part of a shared fleet, CASE vehicles are expected to cost significantly more (between $0.50 - $0.75 per mile) to users. While higher on a per-mile basis than privately owned vehicles, this represents significant cost savings over traditional taxis or TNCs. These costs are also higher than transit fares, appropriately stratifying user operating costs between private vehicles, shared vehicles, and public transit.

2c: Roadway Capacity

Increases in roadway capacity are one of the potential benefits of CV and AV technology, as they could allow for more efficient use of roadway space. The advanced information provided by CV technology, combined with the faster reaction times of computers (as compared to human drivers) could reduce following distances and limit the impacts of merging and other activities that change vehicle speeds. Increases in the number of vehicles able to use the same roadways space could have major impacts on congestion and delay in Northern Virginia. Additional effective capacity could be gained through safety improvements that reduce crashes, although this is more likely to address non-recurring congestion, which is not represented in the travel demand models.

Over the last decade, estimates of the impacts of widespread CV and AV adoption on roadway capacity have varied significantly, with estimates ranging from zero to 500 percent increases. In the last TransAction Update, one of the scenarios included a 50 percent capacity increase on freeways and expressways, and a 15 percent increase in capacity on major arterials, in addition to changes in the volume-delay functions (VDF). Most of these more optimistic assumptions assume full adoption of CV and AV technologies; all recognize that the most benefits accrue when the technologies are combined. The most recent edition of the Highway Capacity Manual (HCM) recommends using an increase of 2-15 percent at 20 percent market penetration, as shown in Table 3. Another recent simulation study looked specifically at capacity improvements on freeways in Virginia, and found that significant increases in capacity may be possible at full market penetration; however, at the lower levels expected by 2045, capacity increases are likely to be more modest. Assuming a market penetration rate of approximately 25 percent by 2045, this scenario will assume a capacity increase on freeways and expressways of 15 percent, and 5 percent on major arterials.

Table 3: Capacity Increase on Freeways by CAV Market Penetration

Percent CAV	HCM V7	VTRC Study
20%	2-15%	13%
40%	7-27%	22%

60%	13-40%	29%
80%	22-60%	43%
100%	33-78%	60%

Source: Highway Capacity Manual v7; Virginia Transportation Research Council, https://www.virginiadot.org/vtrc/main/online_reports/pdf/21-r1.pdf

No changes to the volume-delay functions will be assumed, since the market penetration rates are still expected to be fairly low overall. Further, because of the relatively low market penetration rates, the scenario will not assume the presence of any dedicated travel lanes for CASE vehicles by 2045.

2d: Trip Generation

Person-trips and vehicle-trips are both likely to be impacted by the adoption of AV and CV technologies. Generally, households that opt to own a CAE vehicle are expected to make slightly more person-trips[7], approximately 2.5% more of each purpose. This generally represents trip-making by non-driving population groups such as children and the elderly to travel more easily. Trip lengths for households that own CAE vehicles are also expected to be somewhat longer, as people may be willing to ride longer distances if they are able to use their travel time productively. Values of time will be adjusted so that trips for households that own CAE vehicles will be approximately 15 to 18 percent longer than other households.

Zero-occupancy vehicle (ZOV) trips will be introduced along with fully automated vehicles. There will be two primary sources of ZOV trips in this scenario:

1. Parking Relocation: Commuters who own a CAE vehicle may be able to use their vehicle to commute to work, without paying to park at work (where parking is often limited and/or expensive). This scenario assumes that ten percent of commuters with CAE vehicles will send their vehicle home to park (or to be used by other household members) and have it return to pick them up at the end of the day.

2. CASE (shared) vehicles will need to relocate between passenger trips in order to pick up their next passengers. The number of these repositioning trips will be dependent on the number and location of person-trips that use CASE vehicles.

2e: Automated Shuttles

Small, low-speed shuttles are likely to be among the first major use cases of AV technology, and pilots have already been implemented across the country – including in Northern Virginia to connect the Mosaic District to the Dunn Loring Metrorail station. These types of shuttles can provide access around and between neighborhoods and activity centers, and can improve access to high-capacity transit. This scenario will supplement the widespread availability of CASE vehicles with a series of free, automated shuttles that will provide feeder service into rail stations (both Metrorail and VRE) across Northern Virginia. This will make it easier for travelers to access transit services.

[7] Cambridge Systematics,2020, Houston SMART Study Travel Demand Model Calibration, Validation and Sensitivity Testing, prepared for TxDOT.

2f: Land Use Changes

A number of long-term land use changes are possible in a future of fully-automated vehicles. For example, some people may choose to live further from their jobs and other regional centers, as automated vehicles make the longer trip less onorous as they are able to work and/or sleep in the vehicle. On the other hand, the decreased demand for parking may allow for the conversion of space previously devoted to parking to residential uses, making it less expensive to live closer into the core. Further, the availability of cheap and accessible CASE vehicles may make it even more desirable to live in denser, more mixed-use areas where transportation options are plentiful, more convenient, and cheaper. These competing forces will likely be implemented on different timelines, and it is difficul to know how they will balance out in the long term. Because it is possible that these forces will ultimately end up balancing each other out, this scenario will not incoporate any assumed changes in the MWCOG Cooperative Land Use Forecasts.

Scenario 3: Incentives/Pricing Scenario

Northern Virginia's continued growth has led to ongoing growth in the demand for mobility as more people travel around the region for school, work, shopping and recreation. As vehicle miles traveled (VMT) and congestion have grown across the region, planners, stakeholders, and politicians have proposed a range of ideas on how to encourage more of this travel to be accomplished using transit and other shared-ride options. Expansion of the region's transit network, the introduction of High-Occupancy Vehicle (HOV/HOT) lanes, and concentrating residential and employment centers near transit stations in Transit Oriented Development (TOD) have all helped to encourage transit usage, but the majority of travel in the region still occurs in Single Occupancy Vehicles (SOV).

The next evolution of this trend encouraging the use of transit is leveraging technology advances to incentivize shared rides through financial means. These market-based options may take the form of incentives for transit usage and/or pricing driving so that people more fully account for the external costs of driving, such as environmental impacts, congestion, safety risks, etc. This scenario will incorporate a number of monetary inducements designed to encourage benefical behavior, and discourage undesirable behavior, including:

a. VMT Pricing;

b. Parking/Curbside Pricing;

c. Free Transit Fares; and

d. Incentives to shift travel times.

Pricing strategies could be used as a revenue stream to fund incentive programs.

3a: VMT Pricing

One of the most commonly considered pricing strategies is implementing a VMT fee that charges users a fee per each VMT that they drive. This option has even been discussed at the Federal level as a replacement for gas taxes, which have been in decline due to increases in vehicle fuel efficiency. Growth in vehicle electrification will continute this trend and make it even harder to maintain the transportation system with limited funding. The purpose of implementing a VMT fee in Northern Virginia would be two-fold: 1) to encourage people to use

alternative modes of travel when possible and 2) to provide transportation revenues. As such, VMT fees should be set at a level that is high enough to encourage behavioral shifts, but not so high as to stifle mobility and economic activity in the region. Recommended VMT fees are shown in Table 4. The difference in peak and off-peak period fees will also encourage people to shift travel from the peak periods for trips that are not especially time-sensitive.

Table 4: Proposed VMT Fee by Time Period

Time Period	Fee Per Mile (2007$)
Peak Periods	$0.25
Off-Peak Periods	$0.12

The scenario envisions these fees being applied to all roadways in Northern Virginia, in addition to the District of Columbia and Prince George's and Montgomery Counties in Maryland. VMT Pricing could be implemented by any number of jurisdictions independently, but it would make the most sense as a coherent method for managing regional travel demand and congestion if implemented in a coordinated way across the entire metropolitan region.

One of the major concerns with any roadway pricing strategy are the equity considerations: a VMT pricing plan that is not thoughtfully designed could place an undue burden on low income residents, and could limit their mobility and/or their ability to access certain employment, educational, shopping and recreation opportunities. Such a stratification of the transportation system is not a desired outcome, and needs to be addressed to ensure that low-income residents can take advantage of the whole multimodal transportation system as much as their higher-income neighbors. There are many potential ways to counteract any negative equity issues associated with a VMT pricing system, including a subsidy for low-income households and/or fees that vary by income level. The details of any such policy would need to be studied and fine-tuned before and even during implementation. For the sake of this scenario, it is assumed that the fees will vary based on household income level, as shown in Table 5 below. This variation would be applied to all roadway tolls in the region.

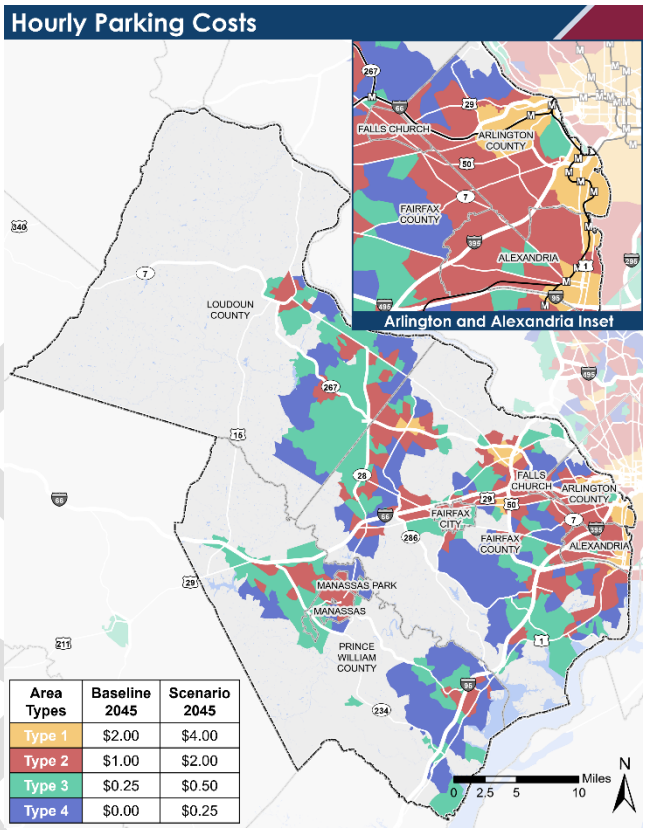
Table 5: VMT Pricing by Household Income Level

Household Income Group	Percent of VMT Fee Paid
Group 1 (Lowest)	20%
Group 2	50%
Group 3	80%
Group 4 (Highest)	100%

3b: Parking Pricing

Another way to manage auto demand is to price parking in order to encourage transit use. Many places in the region already charge for parking – for example, the cost of parking is often cited as a major driver for transit usage to downtown DC. As shown in Figure 3, the cost for daily parking for commuters varies significantly across the region, with the highest costs in major employment centers, most of which are transit accessible including Tysons, Reston, the Rosslyn-Ballston corridor, Alexandria, and Arlington's National Landing. However, parking remains free or low cost to commuters in much of the region. Short-term parking costs are more of interest to people traveling for non-commute purposes, such as shopping or recreation. As shown in Figure 1, most of the region provides free (or almost free) short-term parking. Similarly, the cost of daily parking will be increased across the region, along with an expansion of areas that charge for daily parking, as shown in Figure 2.

Figure 2: Hourly Parking Costs (2007$)



Area Types	Baseline 2045	Scenario 2045
Type 1	$2.00	$4.00
Type 2	$1.00	$2.00
Type 3	$0.25	$0.50
Type 4	$0.00	$0.25

To encourage the use of transit for all types of trips in Northern Virginia, this scenario will assume increase in both short-term and daily parking costs. As shown in Figure 1, short-term parking costs will be double their current values in the three densest area types. Further, low parking costs will be added to some of the areas that currently have no short-term parking costs. These costs represent an average parking cost for each zone, and as such are not differentiated by the type of parking facility (e.g. on-street or off-street, public garages or privately provided.)

Figure 3: Standard Daily Parking Costs (2045 costs in 2007$)

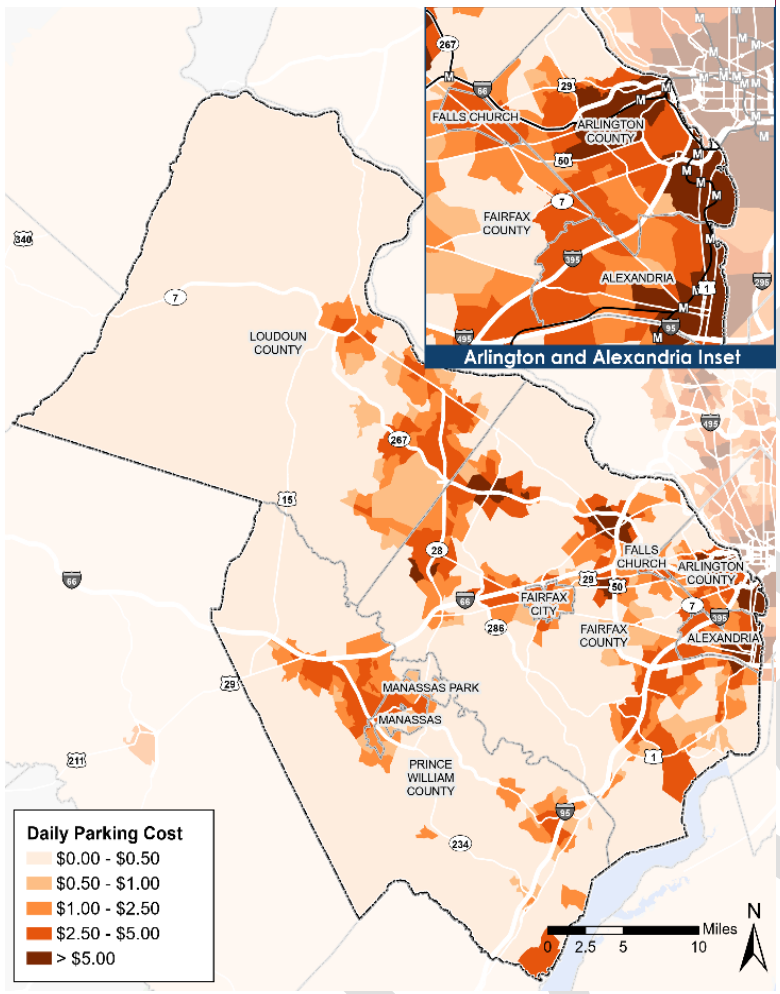
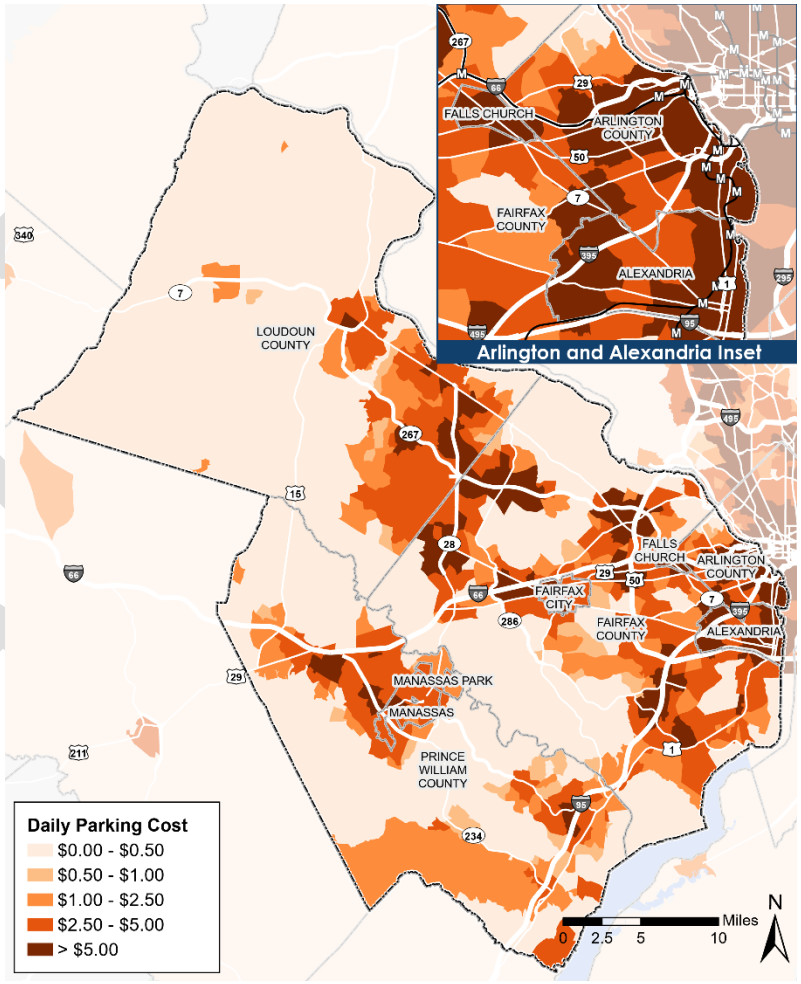


Figure 4: Scenario Daily Parking Costs (2045 costs in 2007$)



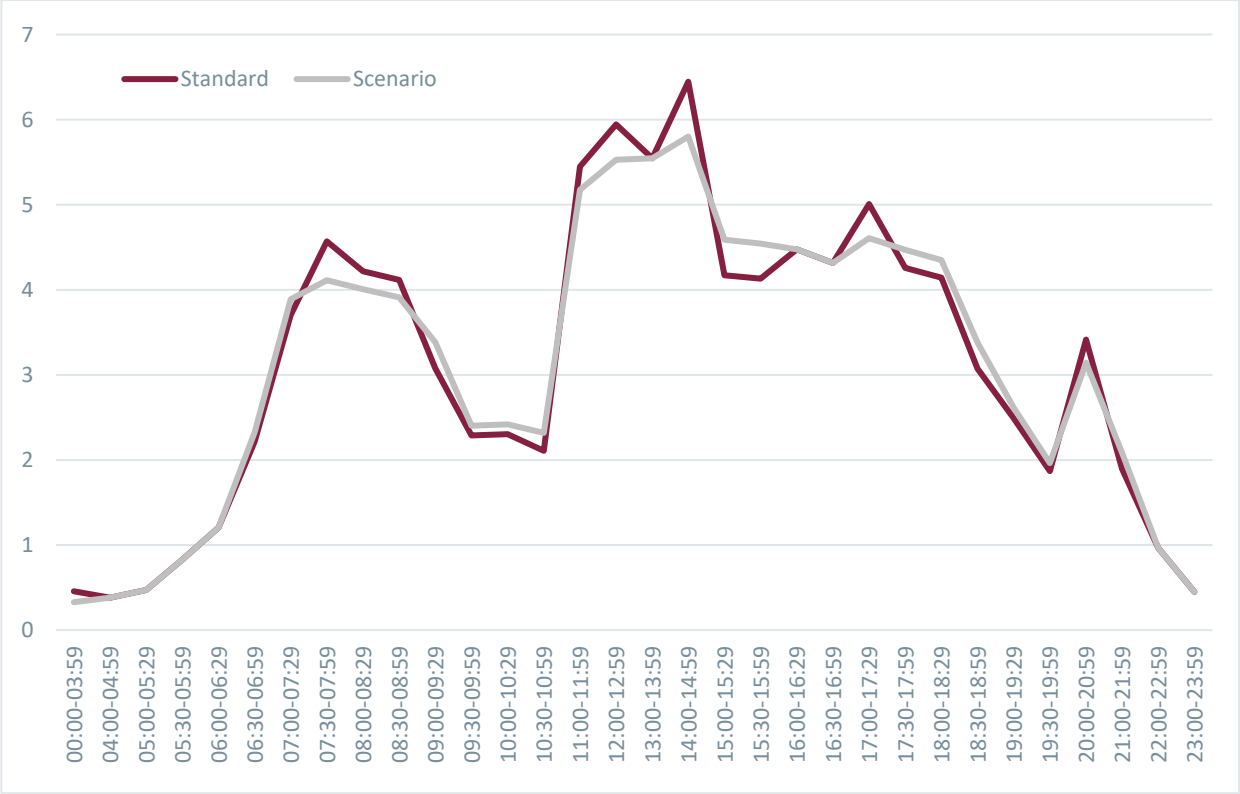
3c: Free Transit Fares

To further incentivize the use of transit, this scenario will assume that all transit in the model region will be fare free, including Metrorail, Metrobus, VRE, and all local bus operators. Parking fees at Metrorail stations will be retained, because parking capacity at most stations is limited.

3d: Shifting Travel Times

Additional thinking on incentive strategies for travel demand mangement are considered ways to encourage people to shift the time of their trip out of the peak periods, or out out the peak-of-the-peak to help alleviate congestion. In addition to the incentive of avoiding congestion itself, experiments with monetary incentives are ongoing. The Incentrip app, developed by the University of Maryland, has been tested by MWCOG as a way to encourage a range of travel behavior changes, including changing travel times. As part of this scenario, it will be assumed that this type of program is in place across the region. When combined with the difference in peak and off-peak VMT fees, the effect will be to spread peak period trips over a wider time period, and even out some of the most extreme peaks in demand, as shown in Figure 3.

Figure 5: Temporal Distribution of Trip Departures

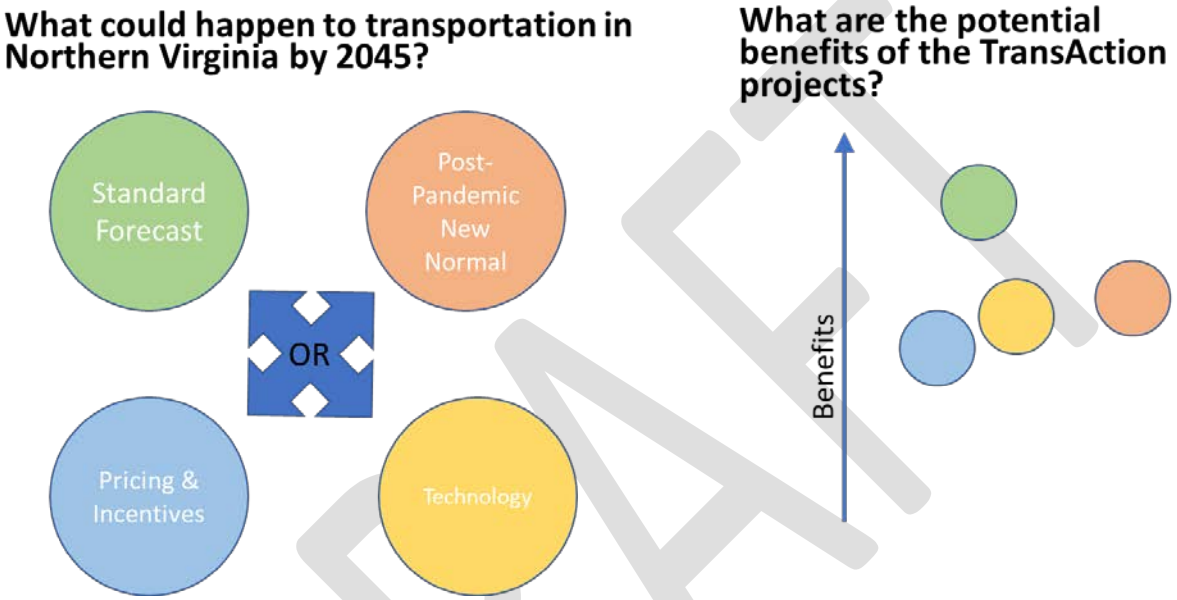


Scenario Testing Methodology

Each of these identified scenarios will be analyzed using the model set developed for TransAction. The assumptions identified in this memo will be appropriately represented in the model, through changes in input

values, network coding, or scripting changes, as appropriate. Each scenario will be analyzed for a No-Build run (based on the TransAction No-Build network) and a Build run (based on the TransAction Build network which includes all 400+ projects in the TransAction project list). These runs will be analzed for each of the ten TransAction performance measures, to compare how well the regional transportation system performs under these potential future circumstances and provide answer to two specific questions as shown in Figure 6. The first set of No-Build runs will be compared to help understand what could happen to transportation in Northern Virginia by 2045, including identifying new needs or challenges.

Figure 6: Questions to be answered by the TransAction Scenario Analysis



Within each scenario, the Build and No-Build runs will be analyzed across the performance measures to answer the second question to understand how effective the TransAction projects are at meeting the regions goals and objectives even under significantly altered assumptions about the future. This analyses will be used to identify if there are projects that may be unnecessary (or less essential) in these alternative futures, or if new needs may be triggered. This analysis will help NVTA avoid investment obselesence in future programming decisions.