PART 5

Exhibit DC-1

David Cuneo

Director

I am an engineer by training who has spent my whole career focused on transportation. This experience has taken place at an engineering firm, followed by an academic institution, then at an airline, and now at a consulting firm. This diverse background has provided me with a broad understanding of transportation projects and the essential elements required for their success. I have always been attracted to transportation, as it affects people's lives every day.

I specialize in travel demand forecasting, transportation planning, economics, and pricing and revenue management, with a key focus on toll facilities. My work in transportation has included domestic and international work on airline, highway, rail, and public transportation projects.

I lead Steer's North American Toll Facilities and Highways team. I have managed and led many traffic and revenue studies and am a trusted advisor to public and private sector clients alike. Recent traffic and revenue projects have focused on bridges, managed lanes, P3 toll roads, and seasonal toll facilities.

I joined Steer with the acquisition of the transportation planning capabilities of CRA International, and I have also worked for Northwest Airlines, the Intelligent Transportation Systems Laboratory at MIT, and at Parsons Brinckerhoff.

Relevant skills

Traffic & Revenue Forecasting & Analysis: While an essential service, the provision of transportation must still constitute a solid business case for transportation providers to remain operational. Therefore, it is essential to understand the revenue potential of transportation projects. Revenue forecasting and analysis has been a consistent theme of David's work, from his earlier airline revenue management focus to his recent assessments of the revenue generating potential of transportation infrastructure projects, including toll facilities and high-speed rail. He has served as project manager and lead modeler for many traffic and revenue studies.

Travel Demand Forecasting: A solid understanding of travel demand is an essential part of transportation planning, and David has been involved in travel demand forecasting for many transportation studies. He has led and managed the development and application of demand models for use in studies ranging from alternatives assessments, comprehensive transportation plans, and accessibility studies. In these studies, he has worked with planners and engineers to ensure that the demand forecasting is conducted in a manner to provide useful forecasts that can support decision making.

Qualifications

Massachusetts Institute of Technology
MS Transportation
1998

Washington University
BS Civil Engineering,
BS Engineering and Public Policy
1994

Professional memberships

Engineering in Training
Missouri: 40827-E

Years of experience

27 Client and Consultancy

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Projects summary

	Project	Client	Year/Location	Role
Traffic & Revenue Forecasting & Analysis	Chesapeake Transportation System Traffic & Revenue Support	City of Chesapeake	2010-2023, Chesapeake, VA	Project Manager /Project Director
	LSIORB Traffic & Revenue Support	KYTC	2017-23, Louisville, KY	Project Director
	Puerto Rico Toll Study	PRHTA	2018 & 2021-2023, Puerto Rico	Project Director / Peer Reviewer
	Chesapeake Bay Bridge-Tunnel Traffic & Revenue Support	Chesapeake Bay Bridge-Tunnel District	2014-23, VA	Project Manager / Project Director
	North Tarrant Express Refinancing	NTE Mobility Partners	2018-23, TX	Project Director
	LBJ Express Lanes Refinancing	LBJ Infrastructure Group	2018-23, TX	Project Director
	NYC Congestion Charging Study	Port Authority of NY & NJ	2022-223, NY/NJ	Project Director
	I-10 Calcasieu River Bridge	Confidential	2021-23, LA	Project Director
	I-77 HOT Lanes T&R	Various	2012-22, Charlotte, NC	Project Manager / Project Director
	Elizabeth River Crossing Traffic & Revenue	Elizabeth River Crossing LLC	2020-22, VA	Project Director
	I-495/I-270 Managed Lane Traffic & Revenue Study	Confidential	2018-2020, MD	Project Director
	PR-22/PR-5 T&R Support	Metropistas	2012-2021, San Juan, PR	Project Director/Project Manager
	SH 288 Toll Lanes T&R Support	Blueridge Transportation Group	2013-2022, Houston, TX	Project Director / Peer Reviewer
	Service Plaza Forecast Review	Confidential	2020	Project Director
	I-10 Mobile River & Bayway Traffic & Revenue Study	Confidential	2018-19, Mobile, AL	Senior Advisor / Peer Review
	Joliet Bridge Traffic & Revenue Study	Confidential	2018, Joliet, IL	Project Director
	American Roads raffic & Revenue	American Roads	2015-18, AL & MI	Project Director

I-55 Managed Lanes T&R Study	Illinois DOT	2016-2019, Chicago, IL	Project Director
A25 Sell-Side Traffic & Revenue Study	Macquarie	2017-18, Montreal, QC	Peer Review
I-75 Traffic Advisor	Confidential	2018, Detroit, MI	Project Director
I-66 Outside the Beltway HOT Lanes T&R Study	Express Mobility Partners	2016-17, Washington, D.C./VA	Project Director
Toll Revenue Increase Opportunities for Operating Concession	Confidential	2016-2017	Project Director
Indiana Toll Road T&R Study	Various	2014-16, Indiana	Project Director / Peer Reviewer
Pocahontas Parkway T&R Study	Confidential	2015-2016, Richmond, VA	Project Director
Brent Spence Bridge T&R Study	Ohio DOT / KYTC	2012-2015, Cincinnati, OH	Project Manager /Project Director
Illiana Corridor T&R Study	Illinois DOT	2013-2014	Project Manager
US 36 Express Lanes Traffic Advisor	Confidential	2012, Denver, CO	Project Director
Tolled Urban Road Project in Mexico	ICA	2012, Mexico	Project Director
Georgia Northwest Corridor Traffic and Revenue Study	Georgia Dept. of Transportation	2009-11, Atlanta, GA	Project Manager
Toll Road / Rail Corridor T&R Forecasting	Confidential	2011, San Juan, PR	Project Manager
Hampton Roads Bridge-Tunnel Conceptual Proposal	ACS Development	2010-2011, Norfolk, VA	Project Manager
Traffic Advice on a Distressed Toll Road	Confidential	2010, Southern California	Project Manager
Jordan Bridge Traffic and Revenue Advice	BBVA	2010, Chesapeake, VA	Project Manager
Advice on Grand Parkway Market Valuation	Houston-Galveston Area Council	2008-2009	Project Manager
Chesapeake Expressway Traffic and Finance Study / Dominion Boulevard T&R Forecasting	City of Chesapeake	2008-2010, Chesapeake, VA	Project Manager

	Project	Client	Year/Location	Role
	New Jersey Asset Monetization Study	Department of Treasury, State of New Jersey	2006-2007, New Jersey	Demand Modeler
	Coleman Bridge Toll Rate Study	Virginia Department of Transportation	2004-2005, Yorktown, VA	Project Manager
	Amtrak Northeast Corridor Revenue Maximizing Fares	US DOT Office of Inspector General	2005, Northeast US	Modeler Designer

	Project	**Client**	**Year/Location**	**Role**
Travel Demand Forecasting	I-25 South PEL & EA Traffic Modelling	CDOT	2016-18, Colorado	Project Director
	Uber Elevate Demand Study	Uber	2017, Dubai	Project Director
	Intercity Passenger Rail	Confidential	2009-10, Mexico	Lead Modeler
	Tier 1 EIS for High-Speed Ground Transportation in Atlanta-Chattanooga	Georgia Department of Transportation	2007-2009, Georgia and Tennessee	Demand Modeler
	A Major Highway/Toll Road Controversy	City of Golden	2006-2009, Denver, CO	Project Manager, Lead Modeler

	Project	**Client**	**Year/Location**	**Role**
Transportation Project Evaluation	Strategic Regional Thoroughfare Plan	Atlanta Regional Commission	2010-2011, Atlanta, GA	Analyst
	Mobility Alternatives Finance Study	City of Austin and CTRMA	2005-2006, Austin, TX	Lead Modeler and Analyst
	Decision Support Tool Analysis for Car hauler	Confidential	2008, US	Project Manager and Lead Analyst

	Project	**Client**	**Year/Location**	**Role**
Aviation	Aviation Unfair Pricing	European Commission	2004-2005, Brussels	Pricing Expert
	Regional Airline Spin-off Valuation	Confidential	2003, US	Lead Analyst
	Impact of Airline Withdrawal	Confidential	2003, US	Analyst
	Overbooking Strategy	Northwest Airlines	2001-2002, St Paul, MN	Lead Analyst
	Revenue Management System Enhancements	Northwest Airlines	1998-2002, St Paul, MN	Lead Analyst and Business Partner

Selected projects

I-66 Outside the Beltway Express Lanes

Client *Express Mobility Partners*
Year/Location *2016-17, VA*
Position Held *Project Director*

David was Project Director of the Steer team that was traffic advisor to the winning bidder of the managed lane P3 project. He oversaw the development of a managed lane forecasting model and helped present the T&R forecasts to the lenders traffic advisors, rating agencies, and TIFIA, leading to a successful financial close in 2017..

I-495 / I-270 Managed Lane Bid

Client *Confidential*
Year/Location *2018-20, MD*
Position Held *Project Director*

David served as the Project Director for this assignment to develop traffic and revenue forecasts to support our client's P3 bid for proposed managed lanes along I-270 & I-495 in Maryland. David helped oversee the development of a custom managed lane forecasting model and the preparation of the traffic and revenue forecasts. He also presented our forecasts to the rating agencies. He participated in a coordination role for an add-on assignment to perform a transit and mobility planning study for the proposed managed lanes.

Chesapeake Bay Bridge-Tunnel Traffic & Revenue Study

Client *Chesapeake Bay Bridge and Tunnel District*
Year/Location *2014-23, VA*
Position Held *Project Manager / Project Director*

David led Steer's work to prepare the traffic and revenue forecasts that were used to help support the bond issuance for the Thimble Shoals Project. In this role, he oversaw the development of forecasts that used econometric and network models and utilized data from a travel survey, GPS travel times, and cellphone trip patterns. He presented the forecasts to the credit rating agencies, TIFIA, and potential investors. He continues to provide traffic monitoring support to the CBBT District.

LBJ and NTE Express Lanes Refinancing

Client *LBJ Infrastructure Group / NTE Mobility Partners*
Year/Location *2018-23, TX*
Position Held *Project Director*

David has led the Steer team that first built managed lane forecasting models for two operational managed lane concessions and then used those models to prepare traffic and revenue forecasts that were used to support a refinancing of project debt. The NTE Express Lanes were refinanced first in December 2019 for a total amount of $1.2 billion. The LBJ Express Lanes were refinanced in September 2020 and accordingly David guided adjustments to the forecasts to account for COVID-19's impact, leading to an issuance of $600 million followed by a subsequent refinancing of TIFIA debt.

Elizabeth River Crossing Sell-Side Advisor

Client	*Elizabeth River Crossing LLC*
Year/Location	*2020, VA*
Position Held	*Project Director*

Steer was appointed as the Traffic and Technical advisor to the Elizabeth River Crossing in preparation for a sale of the concession. David served as the Project Director on the traffic assignment and led Steer's traffic and revenue study of the Elizabeth River Crossing's tolled tunnels. He presented our work to potential bidders, helping lead to a successful sale.

Pocahontas Parkway Sell-Side Traffic & Revenue Study

Client	Confidential
Year/Location	*2016-17, Richmond, VA*
Position Held	*Project Director*

David led Steer's traffic and revenue study of of the Pocahontas Parkway. Our work was used to help market the toll facility, and David participated in discussions with potential bidders.

I-55 Managed Lanes T&R Study

Client	*Illinois DOT*
Year/Location	*2016-2018, Chicago, IL*
Position Held	*Project Director*

David led Steer's traffic and revenue forecasting for the potential addition of managed lanes onto I-55 outside Chicago. As Project Director, David guided Steer's development of a forecasting model, reviewed the forecasts prepared, and helped advise IDOT on the project development.

Louisville-Southern Indiana Ohio River Bridges T&R Study

Client	*Kentucky Transportation Cabinet*
Year/Location	*2012-13, 2016, Louisville, KY, US*
Position Held	*Project Manager / Project Director*

David served as the Project Manager of this investment grade traffic and revenue study. An extensive data collection effort was conducted to help establish the traffic and forecasting model that provided the traffic and revenue forecasts. These T&R forecasts were included in the OS of the bonds issued in December 2013. David has served as Project Director for on-going support.

Chesapeake Transportation System Investment Grade T&R Study

Client	*City of Chesapeake*
Year/Location	*2010-23, Chesapeake, VA, US*
Position Held	*Project Manager / Project Director*

David led Steer's preparation of investment grade traffic and revenue forecasts for the Chesapeake Transportation System that includes the Chesapeake Expressway and Dominion Boulevard Veterans Bridge. Steer's T&R forecasts were included in the OS of the bonds issued in Fall 2012. Steer continues to provide annual support, reviewing the traffic and revenue performance and advising on toll rates.

Publications

- *Evaluation of Freeway Control Using a Microscopic Simulation Laboratory*. With M. Ben-Akiva, M. Hasan, M. Jha, and Q. Yang. Transportation Research Part C 11 (2003), pp. 29–50.
- *Evaluation of Lane Control Signal Design for Freeway Lane Closures*. With M. Ben-Akiva and M. Jha. ASCE Journal of Transportation (1999), pp. 495–501.
- A System-Wide Evaluation of a Traffic Control System Using Microscopic Simulation. Master's thesis, MIT, 1998.
- *Evaluation of Freeway Control Using MITSIM Microscopic Simulation Laboratory*. With M. Ben-Akiva, M. Hasan, M. Jha, and Q. Yang. DACCORD Workshop on Advanced Motorway Traffic Control, Lancaster University, UK, 1998.
- *Analysis of Traffic Video to Develop Driver Behavior Models for Microscopic Traffic Simulation*. With A.C. Chachich and M. Hasan. IEEE Conference on Intelligent Transportation Systems, Boston, Massachusetts, 1997.
- *Video Data Analysis for Driver Behavior Modeling*. With A.C. Chachich and M. Hasan. SPIE's International Symposium and Education Program on Intelligent Systems and Advanced Manufacturing, Pittsburgh, Pennsylvania, 1997.

Presentations

- IBTTA 2011 Transportation Finance and Policy Summit, Panel Member *"Traffic and Revenue Studies – New Realities, New Solutions?"*
- Virginia 2011 Freight Summit, Panel Member *"The Importance of Considering Freight in Transportation Policy, Planning, Prioritization and Investment"*
- IBTTA 2013 Annual Meeting, *"Seasonal Tolls: The Chesapeake Expressway Case Study"*
- Uber Elevate 2017 Summit, Urban VTOL Network Optimization and Demand Modeling Across Early Adopter Cities Session, *"Travel Demand Study of Uber Elevate Service"*
- ARTBA 2018 P3 Conference, Panel Member, P3 Emerging Leaders Session #1, *"Leveraging Technology Disruptions & Opportunities in the Transportation Space"*
- IBTTA 2019 Summit on Finance and Policy, Making the Transition from Road Financier to Mobility Service Provider, *"The Role of Toll Facilities in the Future of Mobility"*

Exhibit DC-2

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Final Report
July 2023

Dulles Greenway Rate Case Support

TRIP II
Our ref: 23872707

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Exhibit DC-2

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Final Report
July 2023

Dulles Greenway Rate Case Support

Disclaimer

This Dulles Greenway Rate Case Support document (the "Report") was prepared by Steer ("Consultant") for the benefit of Hunton Andrews Kurth LLP ("Hunton") and Toll Road Investors Partnership II, L.P. ("TRIP II") (TRIP II, together with Hunton, the "Client") solely in its capacity as Consultant for the toll rate and traffic analysis it performed for the Dulles Greenway (the "Project") pursuant to the engagement letter and related schedules (collectively, the "Agreement"), dated October 5, 2021.

This Report, information contained herein and any statements contained within, are all based upon information provided to the Consultant, and obtained from proprietary data purchased or confidential information provided by the Client, from publicly available information or sources, in the course of evaluations of the Project. The Consultant provides no assurance as to the accuracy of any such third-party information and bears no responsibility for the results of any actions taken on the basis of the third-party information contained in the Report, except to the extent that such actions result from the willful misconduct, recklessness, fraud or gross negligence of the Consultant.

Certain forward-looking statements are based on interpretations, assessments, and assumptions on and from available information at the time of writing. Actual events may differ from those assumed, and events are subject to change. Findings are time-sensitive and relevant only to current conditions and those forecasted at the time of writing. The Report speaks only as of the date of issuance and the Consultant undertakes no obligation to update the Report for any reason. Factors influencing the accuracy and completeness of the forward-looking statements may exist that are outside of the purview or control of the Consultant. The Consultant makes or provides no warranty, whether implied or otherwise, as to the reliability of the outcome of the forward-looking information presented, nor does it take any responsibility or bear any liability whatsoever as to the actions taken by others, including third parties, based upon the forward-looking statements made in the Report, except to the extent that such actions result from the willful misconduct, recklessness, fraud or gross negligence of the Consultant. The Report should be viewed as an assessment that is time-relevant, specifically referring to conditions at the time of review.

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In particular, readers of this Report must note that the Consultant developed the relationships in the model to produce the forecasts for this Project based on data through December 2022 and earlier. During this period, the outbreak of the viral illness known as COVID-19 has spread throughout the world and has been defined by the World Health Organization as a pandemic. The COVID-19 outbreak has materially impacted global economic and political affairs, including significantly impacting all transportation industries. Toll road traffic in particular has been impacted, where vehicle volumes have fallen in response to quarantine, shelter in place and related measures that governments, including state and local governments in the United States, have imposed and we cannot rule out imposing in the future. Against this backdrop, the Consultant has made assumptions of a delayed economic recovery and decreased travel demand. However, it is important to note that the Consultant's post-COVID-19 analysis is only one view, and there continues to remain uncertainty as to the short-term, intermediate or prolonged effects of and responses to the COVID-19 pandemic on the Project.

All of these effects could impact the COVID-19-related aspects of this Report. While this Report was prepared in good faith, no assurance can be provided by the Consultant that the scenario and assumptions the Consultant has identified in such update will prove to be accurate.

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Contents

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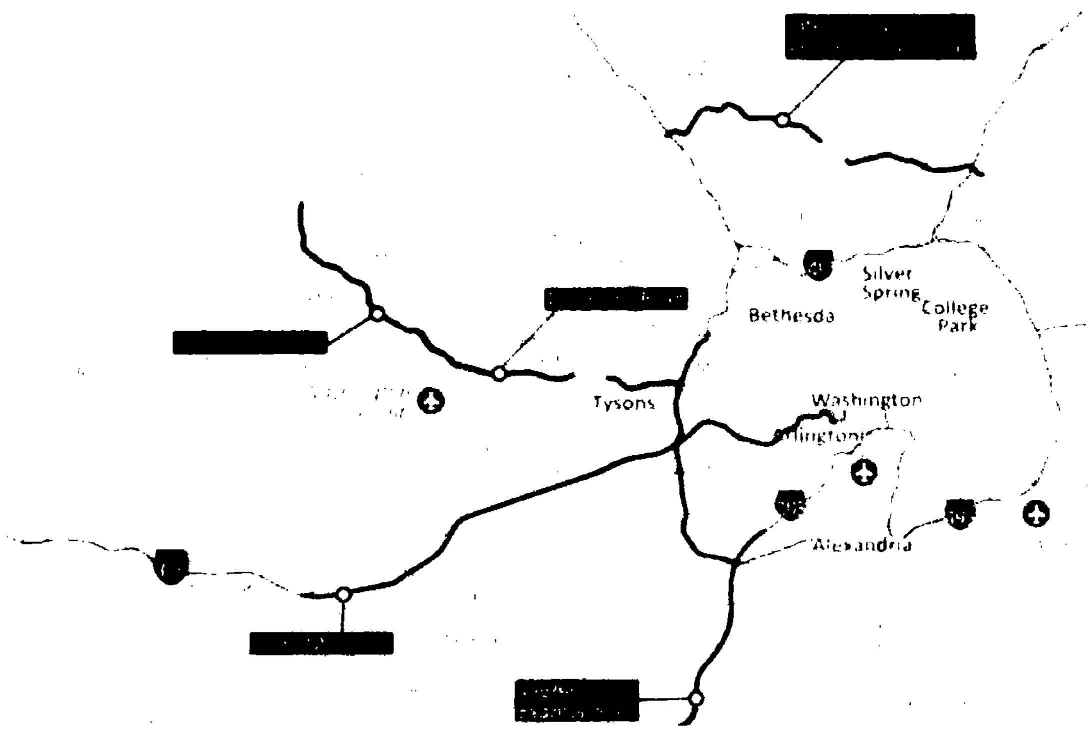
1 Introduction

Background

1.1 The Dulles Greenway (DG) is a 14-mile toll road located northwest of Washington DC in Northern Virginia. It is owned and operated by Toll Road Investors Partnership (TRIP II). It connects with the western terminus of the Dulles Toll Road (DTR) on the east side and the Leesburg Bypass on the west side. The DG provides a tolled alternative to commuters and travelers from Loudoun County to various destinations including the Washington Dulles International Airport (Dulles Airport), and the Washington DC area. Figure 1-1 shows the DG and the surrounding area.

Figure 1-1: Map of Dulles Greenway and the Surrounding Area



Source: Steer

1.2 The State Corporate Commission (SCC) regulates the maximum tolls that can be charged on the DG based on the Virginia Highway Corporation Act of 1988, which requires, among other things, that the tolls charged should be reasonable compared to the benefit obtained and should not materially discourage travelers from using the facility.

1.3 TRIP II requested SCC approval to increase peak and off-peak tolls for years 2020 through 2025 on the DG on December 20, 2019. The Commission approved only the requested off-peak tolls and for years 2021 and 2022. TRIP II now seeks approval to increase peak and off-peak tolls for year 2024. Hunton Andrews Kurth LLP, on behalf of TRIP II, has engaged Steer to provide support for its application to increase tolls on DC.

1.4 As part of this effort, Steer reviewed existing conditions and socioeconomic performance, built an investment grade travel demand model, and used it to produce forecasts to evaluate the impact of the proposed toll increases on DG traffic. It also quantified the benefits and costs of using the DG, and published all findings and conclusions in the Report.

About Steer

1.5 Steer is one of the world's largest independent specialist transportation consultancies, with more than 400 professional staff and a worldwide client base. Steer's head office is in London and we have U.S. offices in Boston, Los Angeles, New York, Pittsburgh, San Juan, and Washington D.C. Steer is an employee owned company that was founded in 1978. Our independence means that we offer truly unbiased and objective advice.

1.6 Having worked on over 500 toll and shadow toll road projects around the world, Steer has developed a recognized specialty in the appraisal of toll-financed facilities, especially in the preparation of robust Investment Grade Traffic and Revenue Forecasts. In recent years, we have been involved in most of the major high profile P3 projects in the US.

Report Structure

1.7 The Report is organized as follows:

- Chapter 1: Introduction.
- Chapter 2: Existing Conditions: summarizes the existing traffic conditions and non-tolled alternatives to DG.
- Chapter 3: Socioeconomic Conditions: provides a review of the historical and forecasted socioeconomic conditions of the study area.
- Chapter 4: Network Modeling: describes our traffic forecasting methodology.
- Chapter 5: Benefits to Users: presents the methodology and results of the Benefit-Cost Analysis.
- Chapter 6: Traffic Forecast and Material Discouragement: presents traffic forecasts for 2024 and evaluates material discouragement for the proposed toll rate increase.

2 Existing Conditions

2.1 This chapter describes the existing conditions of the DG and its surrounding area. It presents the current and historical trends in traffic and congestion levels on the DG and the major alternatives.

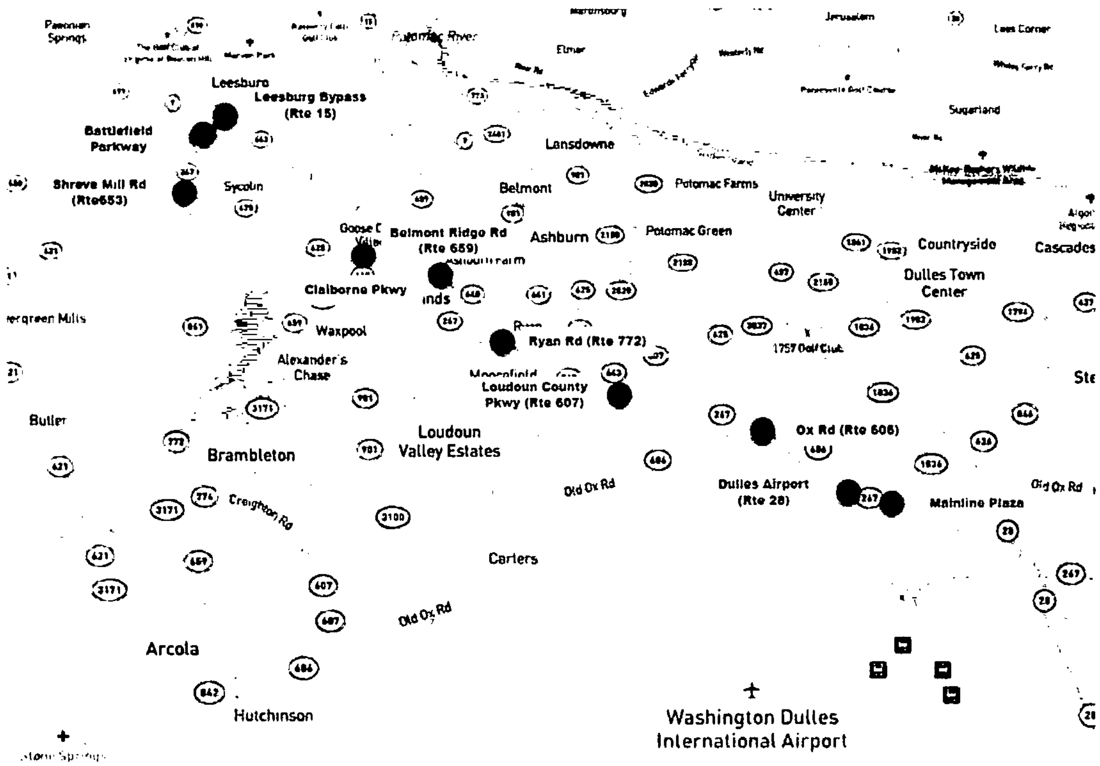
Asset Overview

Alignment

2.2 The DG is a major tolled East-West highway serving Fairfax and Loudoun County travelers. As previously shown in Figure 1-1, the DG connects the fast-growing residential neighborhoods in Loudoun County with employment centers in Reston, Tysons Corner, and Washington DC. At the east end, the DG connects to the DTR, Route 28, and Dulles Airport, while on the west end, the DG connects to the Leesburg Bypass and the Town of Leesburg.

2.3 The DG has 11 interchanges with 17 entry and exit points along its 14-mile length. Figure 2-1 shows the locations of entry and exits of the DG on a map.

Figure 2-1: DG Location of Entrances and Exits



Source: Dulles Greenway Website (https://www.dullesgreenway.com/toll-calculator/)

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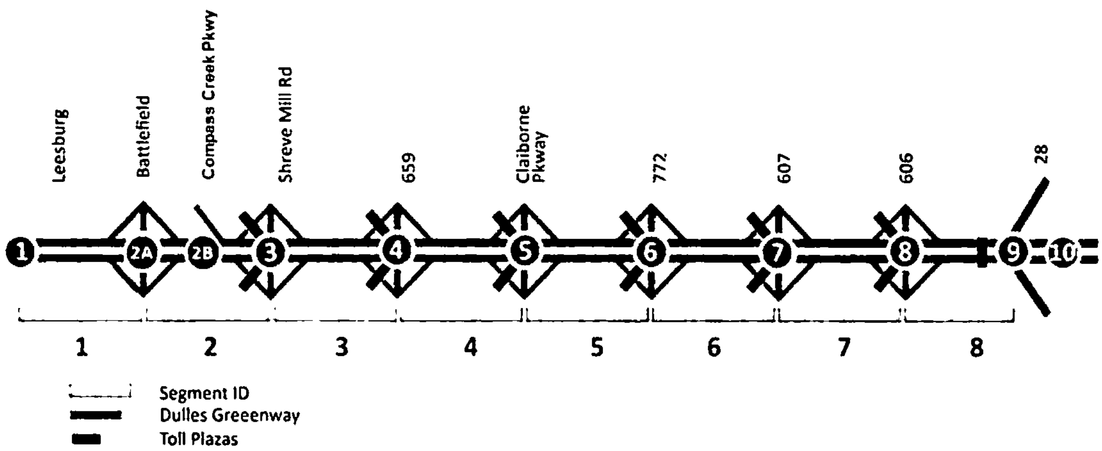
Toll Collection

2.4 The DG toll collection system is designed to ensure that travelers are tolled only at one location (either an entrance or an exit) for their trip along the DG. In the eastbound direction only the exits are tolled, while in the westbound direction only the entrances are tolled. Tolling occurs in both directions at the Mainline Plaza, which connects the DTR to the DG, as this is the "exit" to eastbound traffic and the "entrance" to westbound traffic. Further, the interchanges at Compass Creek Parkway and Battlefield Parkway are not tolled as Compass Creek Parkway is only a westbound exit and Battlefield Parkway provides toll free access to the DG within the Town of Leesburg.

2.5 Figure 2-2 shows the schematic of the DG toll plazas and entry/exit ramps and Table 2-1 provides the directional tolling details for each entrance/exit to the DG.

Figure 2-2: DG Entry and Exits Schematic with Toll Plaza Identification



Source: Steer

Table 2-1: DG Entrance and Exit Locations

Entry /Exit No	Location	Tolling Direction
1	James Monroe Highway, US 15 (West end)	No Toll
2A	Battlefield Parkway	No Toll
2B	Compass Creek Shopping Center	No Toll
3	Shreve Mill Road (VA 653)	Westbound Entry and Eastbound Exit
4	Belmont Ridge Road (SR 659)	Westbound Entry and Eastbound Exit
5	Claiborne Parkway (VA 909)	Westbound Entry and Eastbound Exit
6	Ryan Road (VA 772)	Westbound Entry and Eastbound Exit
7	Loudoun County Parkway (VA 607)	Westbound Entry and Eastbound Exit
8	Old Ox Road (VA 606)	Westbound Entry and Eastbound Exit
9	Sully Road (VA 28) for IAD (Dulles Airport)	Westbound Entry and Eastbound Exit
10	Mainline Plaza to DTR (East end)	Both Direction

Source: Steer presentation of Dulles Greenway information

2.6 Table 2-2 shows the current DG 2-axle vehicles E-ZPass peak and off-peak toll rates in 2023 by toll plaza. Vehicles pay tolls by transponder (SmartTag or E-ZPass) or credit card.

Table 2-2: 2023 Toll Rates – 2-Axle E-ZPass Westbound Entrance Ramps

ID	Ramps	Peak	Off-Peak
2A	Battlefield Pkwy	-	-
2B	Compass Creek Shopping Center	-	-
3	Shreve Mill	$4.10	$4.10
4	Route 659	$5.10	$4.55
5	Claiborne Pkwy	$5.10	$4.55
6	Route 772	$5.10	$4.55
7	Route 607	$5.80	$5.25
8	Route 606	$5.80	$5.25
9	Route 28	$5.80	$5.25
10	Main Plaza	$5.80	$5.25

Source: Steer presentation of Dulles Greenway information

2.7 Table 2-3 shows the time periods and direction of travel for which the peak period toll rates are applied for all tolling locations except at Shreve Mill Road, where the same toll rate is applied throughout the day.

Table 2-3: Peak Tolling Times and Direction

Time Period	Time Range	Direction of Travel
AM Peak	6:30 – 9:00 am	Eastbound
PM Peak	4:00 – 6:30 pm	Westbound

Source: Steer presentation of Dulles Greenway information

2.8 Larger vehicles pay higher tolls based on the number of axles. Specifically, a toll multiplier is applied to the 2-axle toll rate, these multipliers are shown in the table below[1].

Table 2-4 Toll Multiplier by Number of Axles

Number of Axles	Multiplier Applied to 2-Axle Toll Rate
3	2
4	2.5
5+	3

Source: Steer presentation of Dulles Greenway information

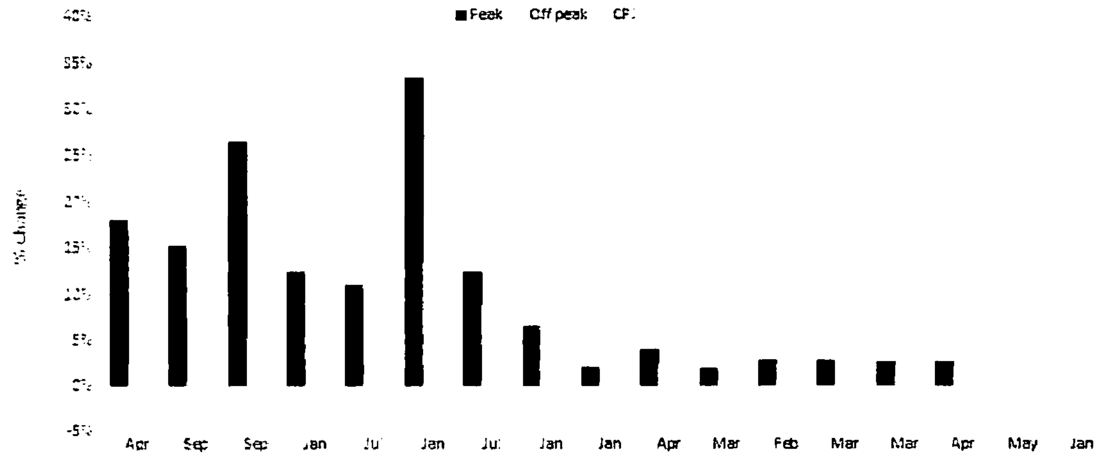
Trends

Historical Tolls

2.9 Figure 2-3 shows the change in the full-year average toll rates since 2007. The nominal toll increases between 2007 and 2012 were above inflation, while from 2013 to 2020, toll increases were lower and generally in line with inflation. That trend has not continued more recently. Since 2020, there has only been increases in off-peak toll rates in 2021, and 2022. However, even the off-peak toll rate increases were lower than actual inflation.

[1] Note that due to rounding of the implemented toll rate for 4-axle vehicles, the factors may not match exactly.

Figure 2-3: Historical Toll Increase on the DG



	Apr 2000	Sep 2002	Sep 2004	Jan 2006	Jul 2007	Jan 2009	Jul 2010	Jan 2012	Jan 2013	Apr 2014	Mar 2015	Feb 2016	Mar 2017	Mar 2018	Apr 2019	May 2021	Jan 2022
Peak	17.86%	15.15%	26.32%	12.50%	11.11%	33.33%	12.50%	6.67%	2.08%	4.08%	1.96%	2.88%	2.80%	2.73%	2.65%	0.00%	0.00%
Off peak	17.86%	15.15%	5.26%	35.00%	11.11%	13.33%	8.82%	8.11%	2.50%	2.44%	2.38%	2.35%	3.41%	2.20%	2.15%	5.26%	5.00%
CF	[illegible]	5.66%	4.92%	4.40%	5.02%	1.36%	3.25%	3.97%	1.59%	2.95%	-0.40%	0.42%	2.92%	2.36%	2.40%	5.34%	4.44%

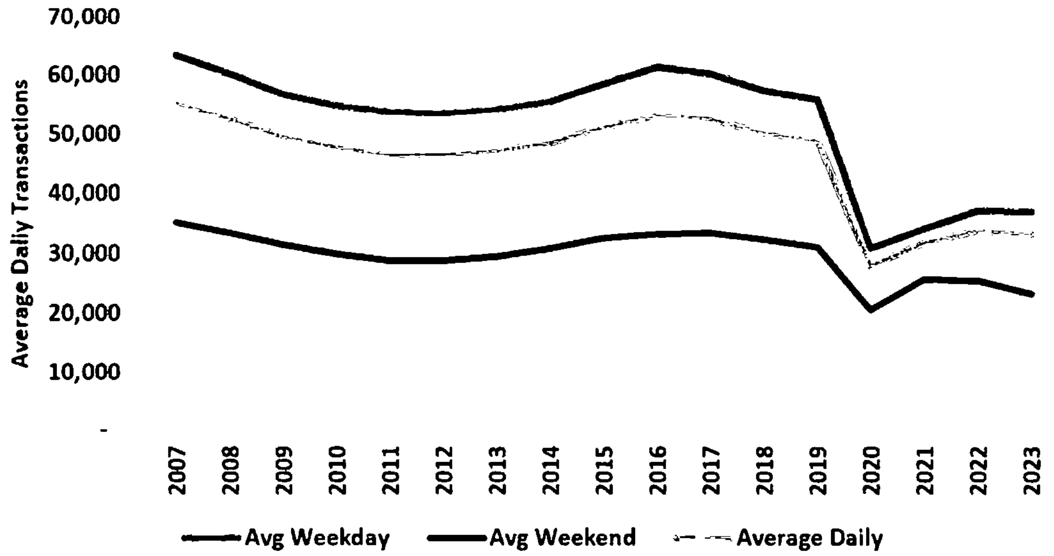
Source: Steer Analysis of DG Toll Data

Historical Transactions and Revenue

2.10 Figure 2-4 presents the transaction trends on the DG since 2007, showing that transactions have generally decreased since 2007. Between 2007 and 2022, the overall traffic levels have fallen with a compounded annual growth rate (CAGR) of -3%.

2.11 While overall traffic has decreased during 2007-2022, there has been shorter periods of growth. The traffic level experienced a period of growth between 2012 and 2016, before falling slightly from 2016 to 2018. Between 2016-2018, several local construction and network enhancement projects were completed. These include widening, grade separation and intersection improvements on Route 7, Route 28 and Waxpool Rd, which provide alternatives to the DG.

Figure 2-4 Historical Average DG Daily Transactions



Source: Steer Analysis of DG Toll Data

Average Weekday Transactions by Time-of-Day 2019 vs. 2022

2.12 In 2020 traffic dropped significantly (a 43% decrease) due to COVID-19 as can be seen in the figure. Since 2020, the DG has experienced recovery growth following COVID-19. By the end of 2022, the average daily transactions on the DG had recovered to 70% of pre-COVID-19 levels. Table 2-7 shows the change in average weekday transaction between 2019 and 2022.

2.13 Figure 2-5 shows the quarterly transaction and revenue growth on the DG since 2018. Revenue follows similar growth trends as the transactions since 2018 because the growth in toll rates has been limited (as discussed in previous section).

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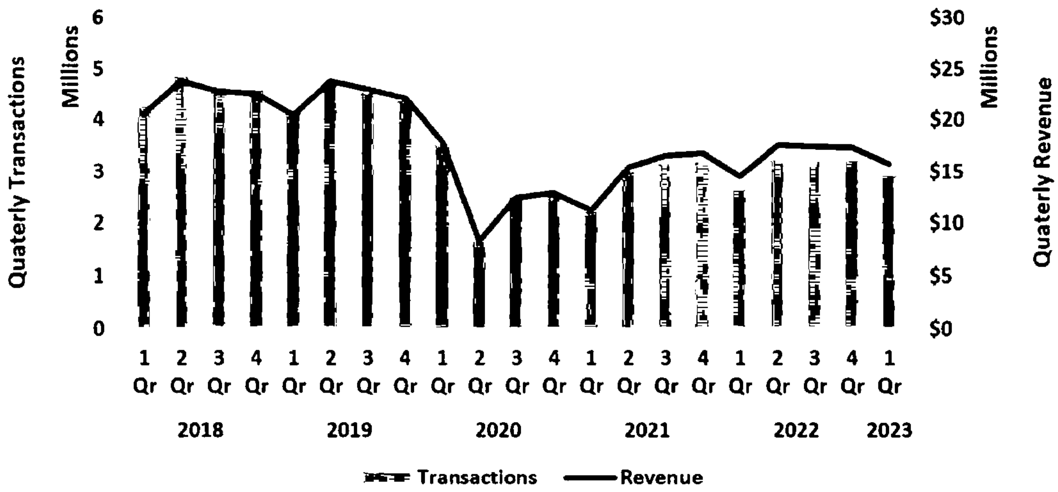
Figure 2-5: Historical Quarterly Transaction and Revenue



Source: Steer analysis of DG transaction data

Current Transactions and Revenue

2.14 In 2022, the DG had 12.3 million total transactions and $67.3 million of total revenue.

2.15 Table 2-5 shows the average weekday transactions for the DG in 2022 by toll plazas. The table shows that more than 80% of DG traffic enters or exits the DG at the mainline plaza. The traffic from DTR to DG at the mainline plaza is mostly long-distance trips. The traffic entering the DG from other entrances are mostly local traffic traveling shorter distances.

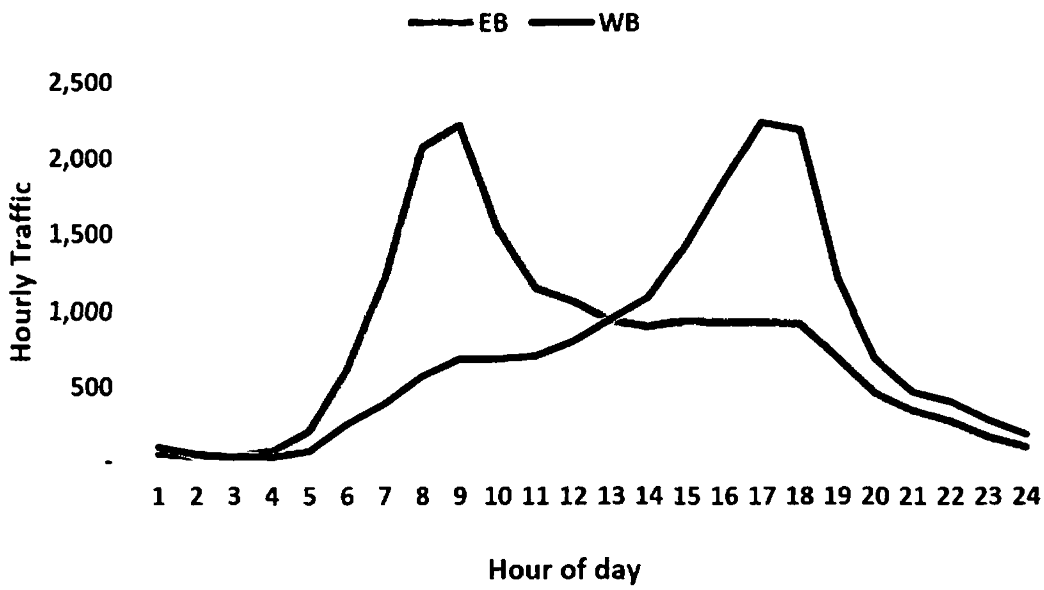
Table 2-5: DG 2022 Average Weekday Transactions

Location	Eastbound	Westbound	Total	% of Total DG Transactions
Mainline Plaza	15,791	14,890	30,681	83.1%
Old Ox Rd (Rte 606)	1,207	1,413	2,619	7.1%
Loudoun County Pkwy (Rte 607)	345	464	808	2.2%
Ryan Rd (Rte 772)	546	586	1,132	3.1%
Claiborne Pkwy (Rte 901)	355	367	722	2.0%
Belmont Ridge Rd (Rte 659)	327	466	792	2.1%
Shreve Mill Rd	71	77	148	0.4%
Total	**18,640**	**18,263**	**36,903**	100%

Source: Steer analysis of DG transaction data

2.16 The average weekday hourly profile of the DG shows very well-defined peaks coinciding with eastbound in the AM peak period and westbound in the PM peak period.

Figure 2-6: 2022 Weekday Traffic Profile on Greenway



Source: Steer analysis of DG transaction data

2.17 Autos form the bulk of traffic on the DG, with the overall truck percentage (which includes light, medium and heavy trucks) of transactions around 4%. The truck percentage varies by individual entrance to the DG as shown in Table 2-6.

Table 2-6: Truck % on DG in 2022

Location	Eastbound	Westbound
Mainline Plaza	2.9%	3.2%
Old Ox Rd (Rt. 606)	9.7%	6.3%
Loudoun County Pkwy (Rt. 607)	3.3%	5.7%
Ryan Rd (Rt. 772)	2.0%	2.4%
Claiborne Pkwy (Rt. 901)	2.2%	1.8%
Belmont Ridge Rd (Rt 659)	5.1%	3.1%
Shreve Mill Rd	7.5%	9.5%
Total	**3.3%**	**3.6%**

Source: Steer analysis of DG transaction data

COVID-19 Impacts and Recovery

2.18 The COVID-19 pandemic had a large impact on the DG traffic – more severe than traffic impacts observed on other toll facilities. This is likely because the DG serves a high proportion of commute trips by office-based employees to jobs based in Reston, Tysons, Washington, DC, and similar locations. Many of these commuters switched to working from home at the start of the pandemic.

In 2022 at around 82%, weekend transactions have recovered the most, nearing to pre-pandemic levels. Off-Peak period transactions have returned to 66% of pre-pandemic levels. Peak Period-Peak Direction transactions have recovered the least at only 50% of the pre-pandemic levels.

2.19 Thus, it is the Peak Period traffic that has been the slowest to recover and is bringing down the overall recovery profile. The detail of this situation is shown in Table 2-7 which compares 2019 and 2022 average weekday transactions by time period and direction. The Peak Period travelers are predominantly comprised of commuters, which in this corridor includes many office workers in the technology and professional service sectors. Workers in these sectors have generally been the slowest to return to office-based working, with most adopting hybrid working as a standard.

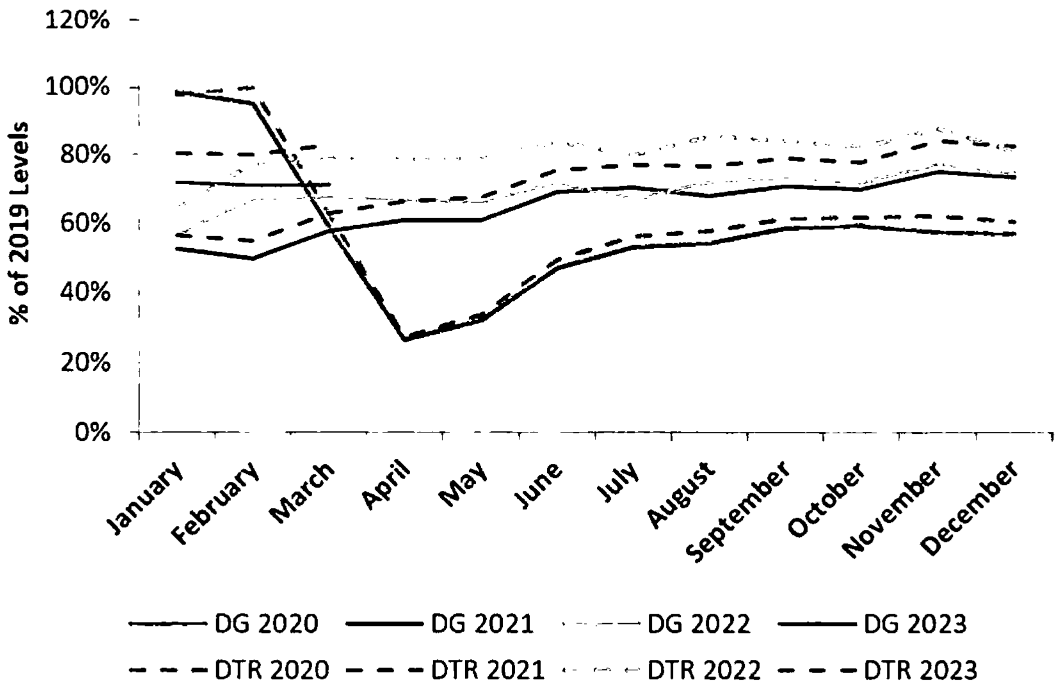
Table 2-7: Average Weekday Transactions by Time-of-Day 2019 vs. 2022

TOD	2019 Transactions			2022 Transactions			%Diff		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
AM Peak	9,500	1,700	11,200	5,100	1,500	6,700	-46%	-9%	-41%
PM Peak	2,300	10,400	12,700	2,200	4,700	6,900	-4%	-54%	-45%
Off-Peak	15,000	16,200	31,200	11,400	12,000	23,300	-24%	-26%	-25%
Daily	26,800	28,300	55,100	18,600	18,300	36,900	-30%	-36%	-33%

Source: Steer analysis of DG transaction data

2.20 Figure 2-7 shows the DG traffic levels in 2020, 2021 and 2022 as a percentage of the 2019 level for the DG as well as for the DTR as a comparison. The figure shows that while both facilities had a similar initial traffic reduction, the DTR has had a larger recovery than the DG. The DG's lower recovery in peak periods is also due to flexible working times for DG commuters, who could shift to shoulder periods to avoid traffic congestions and hence are able to travel on alternate routes in off-peak periods.

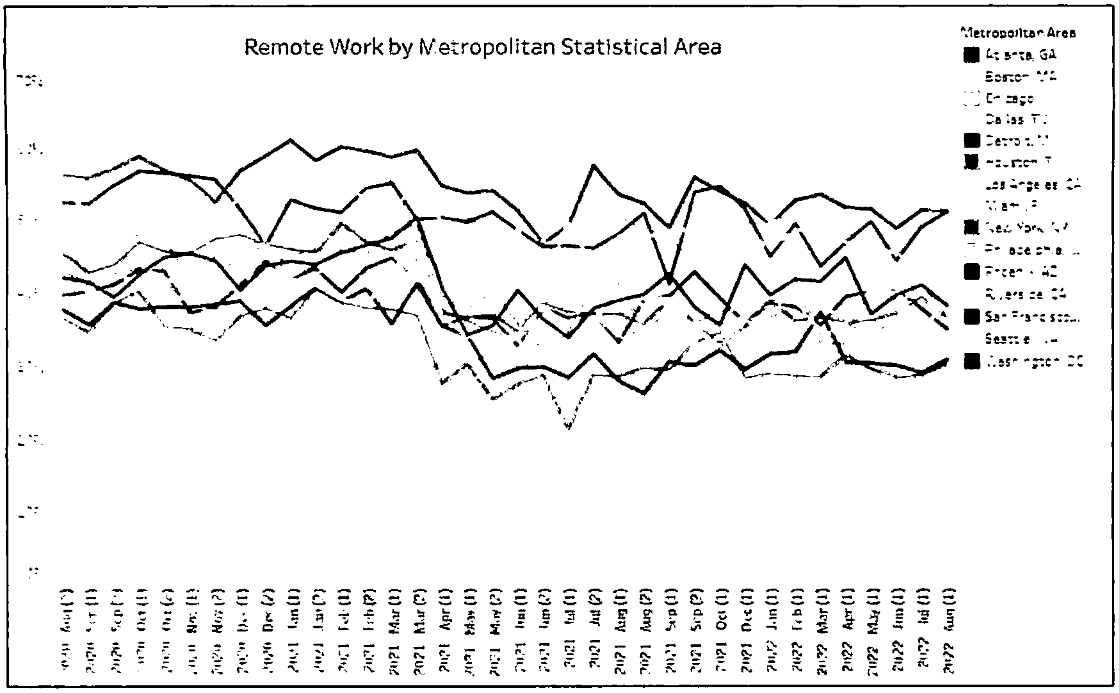
Figure 2-7: DG and DTR Post-COVID Recovery



Source: Steer analysis of DG and DTR transaction data

2.21 Some of the low recovery of DG traffic can be explained by the high working from home in the Washington D.C. area as discussed above. Census data highlights the high working from home in the region. According to US Census Household Pulse Survey, the Washington D.C. metro area has the highest percentage of remote workers out of all major U.S metro areas, with over 50% of workers regularly working from home in August 2022 as shown in Figure 2-8. The latest data from Census show that this number had gone down to around 40% in February 2023.

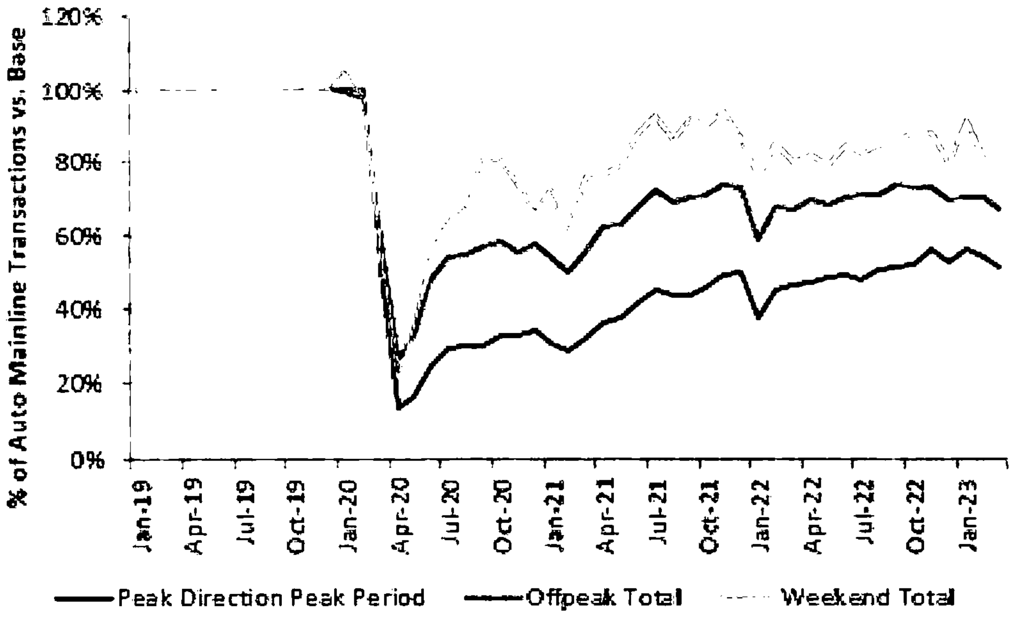
Figure 2-8: Remote Working Trends Post COVID-19



Source: Rockefeller Institute of Government's Analysis of US Census Household Pulse Data

2.22 Figure 2-9 shows the recovery profile of the DG for peak, off-peak, and weekend auto travel at the mainline. While post- COVID-19 growth is seen in all time periods, the peak travel has been the slowest to recover, and the weekend travel has recovered the fastest as it is close to 90% recovered by January 2023.

Figure 2-9: % of Auto Mainline Transactions vs 2019 Base

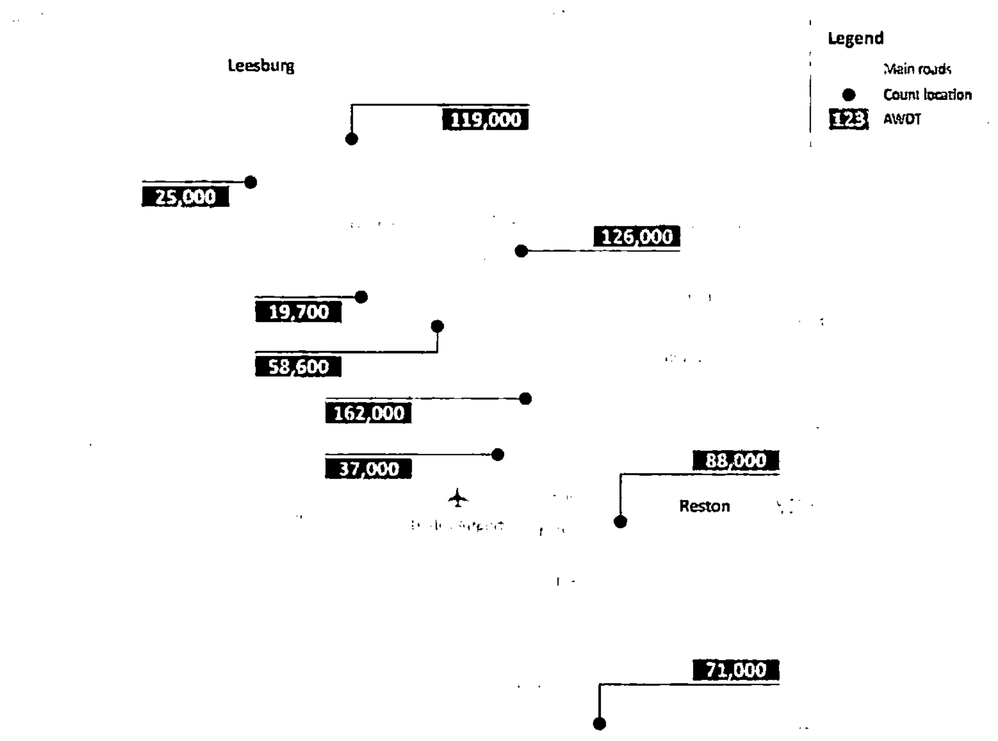


Source: Steer analysis of DG transaction data

Study Area

2.23 The DG study area consists of the DG, connecting roads to the DG, and alternative routes. Figure 2-10 shows the study area roads and their 2022 Average Weekday Daily Traffic (AWDT) traffic levels.

Figure 2-10: Study Area 2022 AWDT Counts



Source: Steer

Alternative Routes

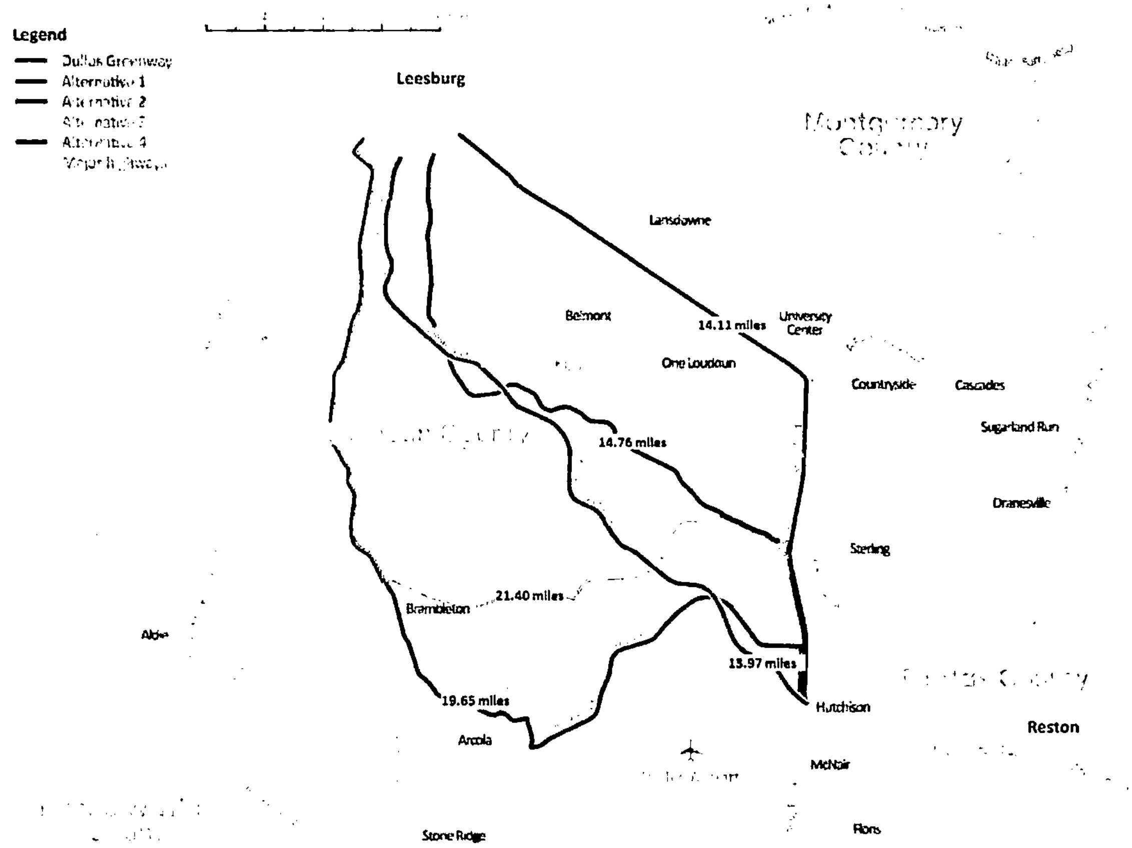
2.24 There are four alternative routes to the DG available as listed in Table 2-8 and displayed in Figure 2-11. All the alternate routes are toll-free and begin before the mainline plaza on the DG and end at Leesburg Pike.

Table 2-8: Alternate Routes to Dulles Greenway

Route	Description
Alternative 1	VA7 and State Route 28
Alternative 2	Sycolin Road, Ashburn Farm Parkway, Waxpool Road
Alternative 3	Evergreen Mills Road, Ryan Road, Loudoun County Parkway
Alternative 4	Evergreen Mills Road, Ryan Road, Old Ox Road

Source: Dulles Greenway, Traffic Count Data

Figure 2-11: Alternate Routes to the DG

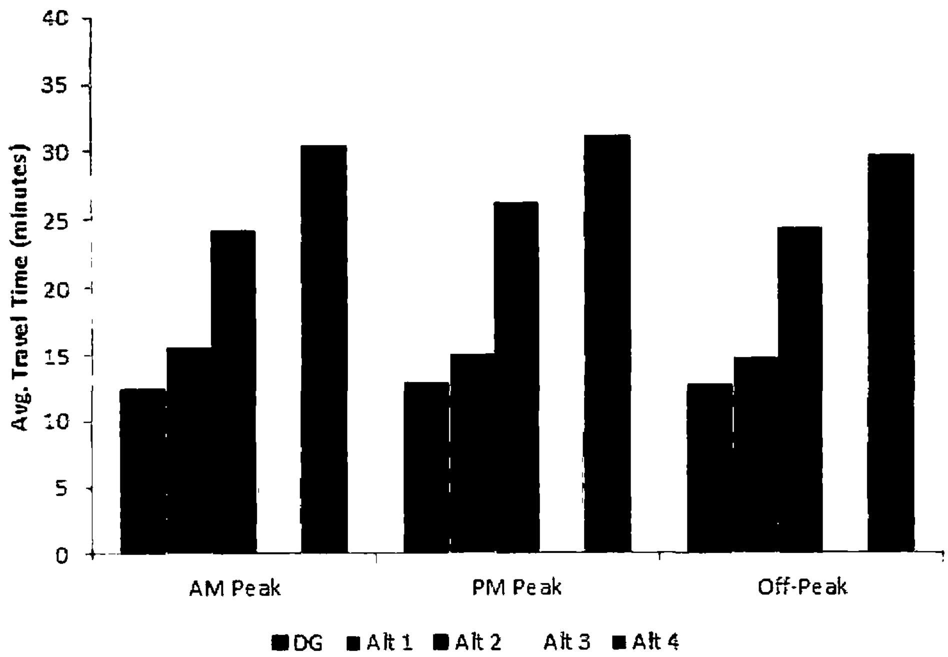


Source: Steer

2.25 Alternative 1 is a combination of Route 7 and Route 28. The other roads that are parallel to the DG are Sycolin Road (Alternative 2) and Evergreen Mills Road which is part of Alternative 3 and 4.

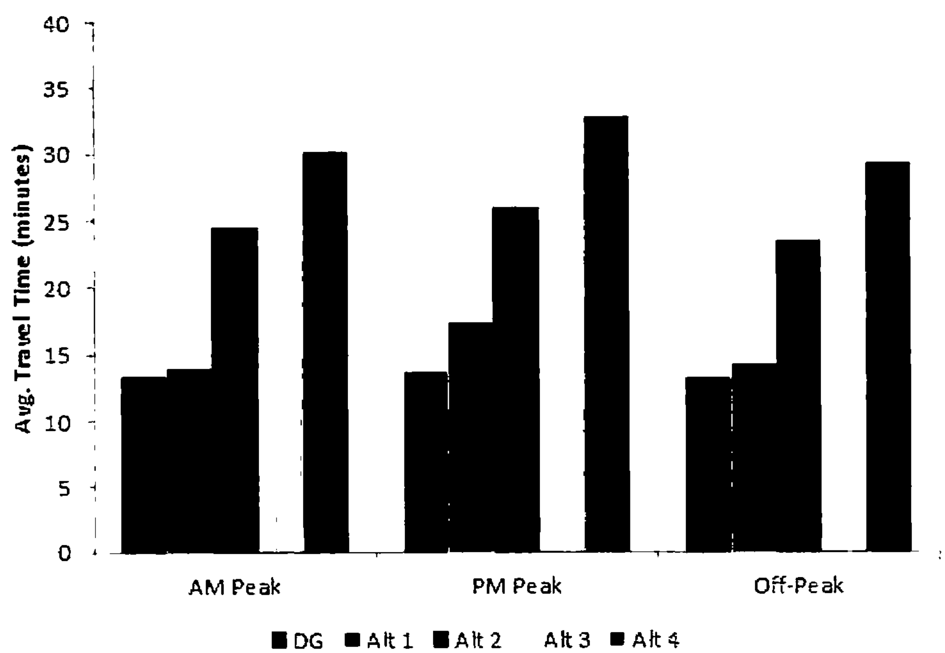
2.26 Figure 2-12 and Figure 2-13 show the eastbound and westbound travel times for the DG and alternate routes. It shows that Alternative 1 provides the most competitive travel times and travel distance compared to the other alternative routes. Alternative 2, while a shorter route, is much slower. Alternative 3 and 4 are much longer routes, however, they can provide competitive routes to the DG depending on the trip's origins and destinations and traveler preferences.

Figure 2-12: 2022 – EB Travel Time on the DG and Alternate Routes



Source: Steer Analysis of TomTom Data

Figure 2-13: 2022 – WB Travel Time on the DG and Alternate Routes



Source: Steer Analysis of TomTom Data

2.27 The figures above show the mean travel times on the DG and alternatives. Overall, the difference in mean travel time for the DG and Alternative 1 is smaller (<2-3 minutes) in off-peak directions and around 4-5 minutes in the peak direction. Table 2-9 shows the range of travel times on the DG vs. Alternate 1 during the peak direction – peak periods.

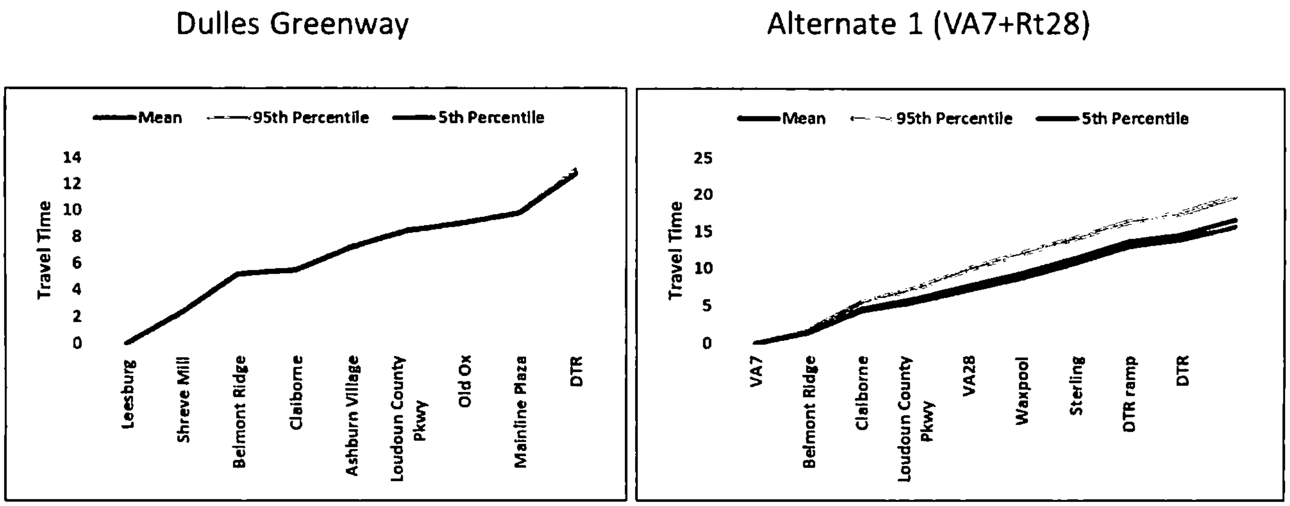
Table 2-9: Dulles Greenway and Alternate Route Travel Times

Facility	Distance	AM Eastbound	PM Westbound
Dulles Greenway	14 miles	12-13 mins	13-20 mins (5-7 mins delay @Shreve Mill Road)
Alternate 1 (Rt 28 + VA7)	14 miles	19-24 mins	15-32 mins

Source: Steer Analysis of 2022 TomTom data

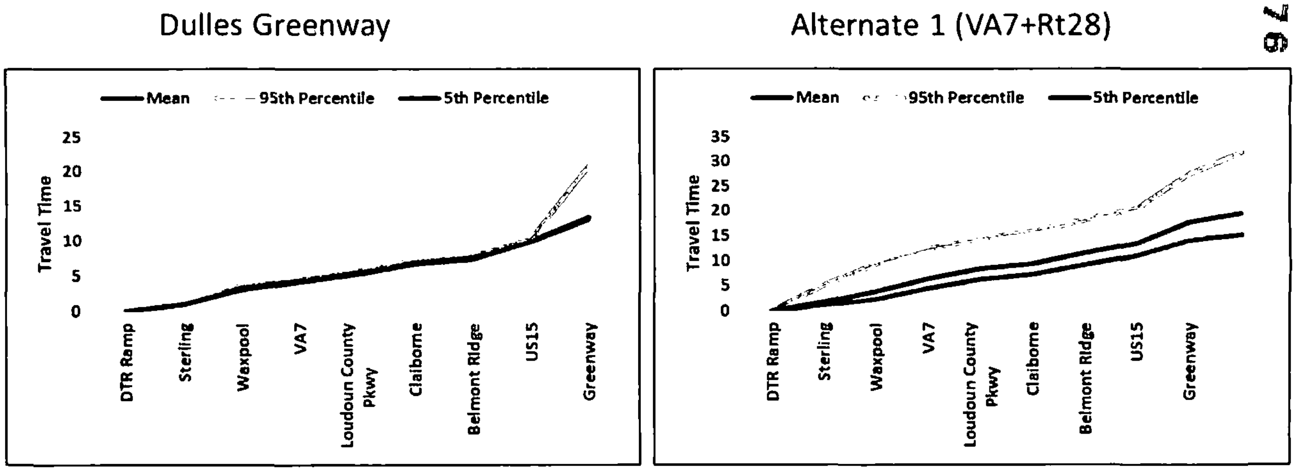
2.28 Figure 2-14 and Figure 2-15 show the unreliability of travel times on Alternate 1 as compared to the DG for the peak direction of travel. The figures show the mean, 95th percentile and 5th percentile travel times for each alternative. If travel times at mean, 95th and 5th percentile are vastly different, it highlights the uncertainty of travel times. Alternate 1 has travel times varying between 15-20 minutes in the AM EB direction and between 15-32 minutes in the PM WB direction. The DG operates at near free flow speeds during peak hours and hence does not have much variability in travel times, except during westbound travel in the PM peak period when traffic builds up west of Shreve Mill Road due to entry of a large number of toll-free riders onto the DG from Battlefield Parkway. Due to this large variation of travel time on Alternate 1, the DG offers a more reliable travel alternative in the corridor.

Figure 2-14: Travel Time Comparison of the DG and Alternative 1 – AM Peak (Eastbound)



Source: Steer Analysis of 2022 TomTom data

Figure 2-15: Travel Time Comparison of the DG and Alternative 1 – PM Peak (Westbound)

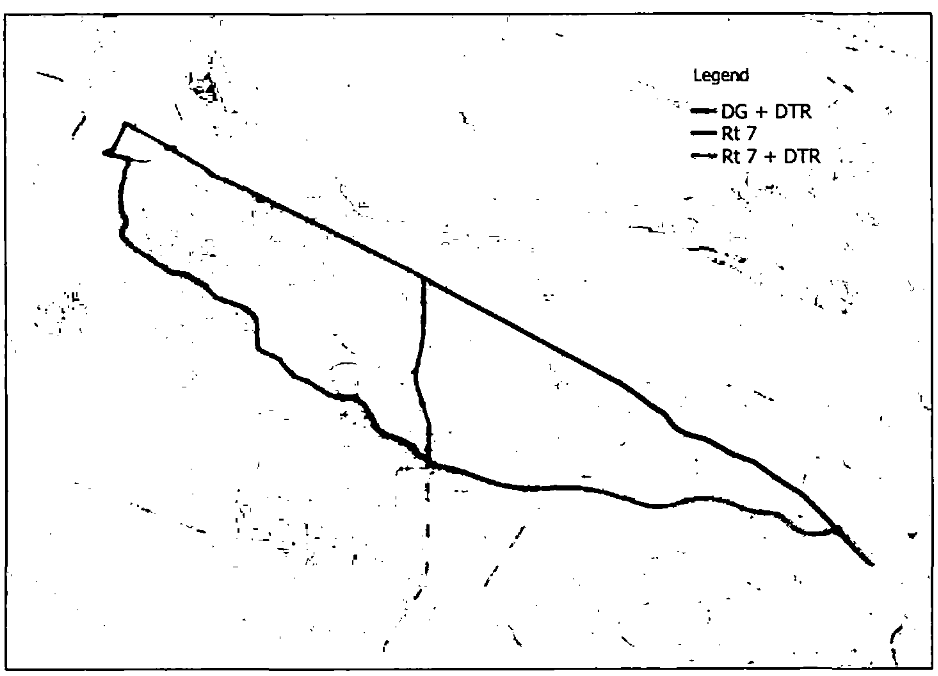


Source: Steer Analysis of 2022 TomTom data

Long Distance Alternatives

2.29 For longer distance travelers traveling from Leesburg to Tysons or Washington D.C., the main alternative to the DG is VA-7. This can be used solely or in conjunction with DTR when traveling between Leesburg and Tysons, or onwards towards Washington D.C. VA-7 represents a shorter but more congested route, resulting in slower and less reliable travel times than on the DG.

Figure 2-16: Alternative Routes – Through Traffic



Source: Steer

Rail Alternative

2.30 In addition to the highway alternatives, the Silver Line Metrorail offers a transit alternative. The Silver Line Metro line extension opened in 2022 and it provides a direct transit service between Washington D.C. and Loudoun County. The Silver Line thus can be considered an alternative to the DG for long-distance commuters between Loudoun County and Washington D.C., Tysons Corner, and Reston. Since the Metrorail has its last stop in Ashburn in Loudoun County, it is not a feasible alternative to commuters for Leesburg and locations further west.

3 Socioeconomic Conditions

3.1 In this chapter, we assess the socioeconomic conditions of the area around the DG. We first review the trends in key socioeconomic variables, then we consider the future growth outlook, and finally assess the DG traffic recovery from COVID-19 and the likely impact of that continued recovery on DG traffic.

Trends in Socioeconomic Variables

3.2 This section provides a background on socioeconomic variables that impact DG traffic levels. We present some of the recent trends in population, employment, Gross Domestic Product (GDP) per capita and real income per capita in Loudoun County, Fairfax County, Virginia, and the United States. The historical data is derived directly from official sources, as noted accordingly.

Population

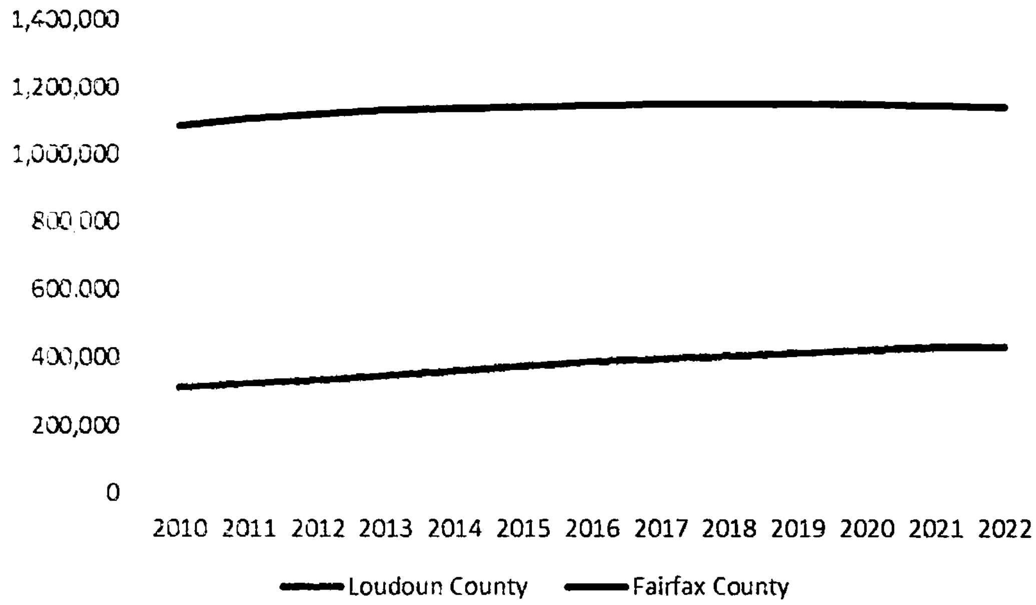
3.3 In general, traffic growth is driven by population growth. Higher levels of households and population have increased the number of vehicles on the road as the average vehicle occupancy rate has remained relatively stable[2]. Furthermore, the number of vehicles per household has remained relatively constant as well, which further shows that higher population has led to increased traffic from more vehicles on the road.

3.4 When considering the contribution of population growth to DG's peak period-peak direction traffic, Loudoun County is most important as many of those peak trips originate in Loudoun County. Loudoun County has been experiencing the highest population growth of all the counties in Virginia. From 2010 to 2022, Loudoun County recorded a population CAGR of 2.7%, which was four times Virginia's growth rate and over four times the growth rate of the US. As seen in Figure 3-1, Loudoun County's population stood at 432,085 in 2022, which was roughly 5% of Virginia's population. Since 2010, Loudoun County has gained annually on average about 10,000 residents. This follows periods of strong growth in the 1990s and early 2000s. The population growth is in line with traffic growth and large housing developments that are located near the DG.

3.5 The neighboring Fairfax County has not been growing as fast as Loudoun County, especially in recent years. This has resulted in a population CAGR of only 0.4% since 2010, which was below the growth rates of Virginia (0.7%) and the US (0.6%). In 2022, the population of Fairfax County was 1,138,331, which was over 13% of Virginia's population. Figure 3-2 displays the population growth rates of the two neighboring counties, along with Virginia and the US.

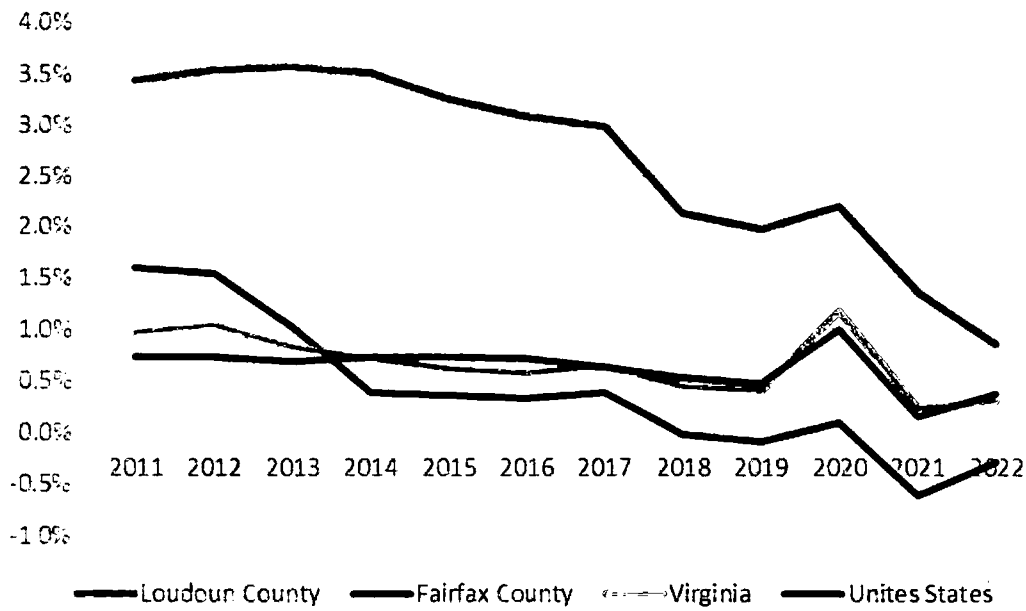
[2] This is confirmed by the 2008 and 2018 Household Travel Surveys prepared by the National Capital Region Transportation Planning Board

Figure 3-1: Population Growth Trend



Source: U.S. Census Bureau

Figure 3-2: Population Growth Rates



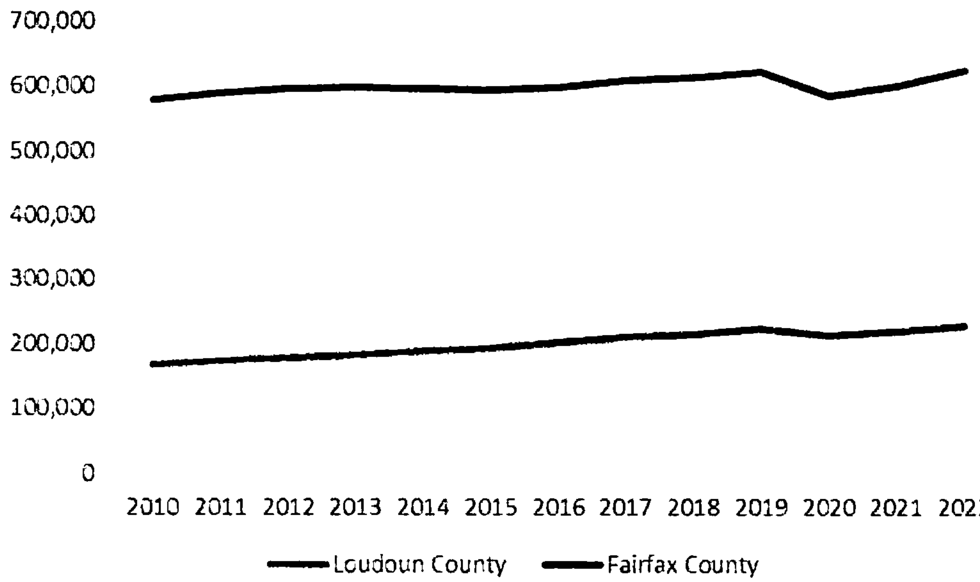
Source: U.S. Census Bureau

Employment

3.6 Much like population, Loudoun County has been enjoying the highest employment growth of all the counties in Virginia. From 2010 to 2022, Loudoun County posted an employment CAGR of 2.6%, which was nearly three times Virginia's growth rate and over two times the growth rate of the US. As seen in Figure 3-3, Loudoun County's employment was 226,976 in 2022, which was about 5% of Virginia's employment. Since 2010, the county has gained annually on average about 5,000 jobs. Recently, Loudoun County's employment/population (EP) ratio has been improving, reaching roughly 53% in 2022, but still below its pre-pandemic share of 54%.

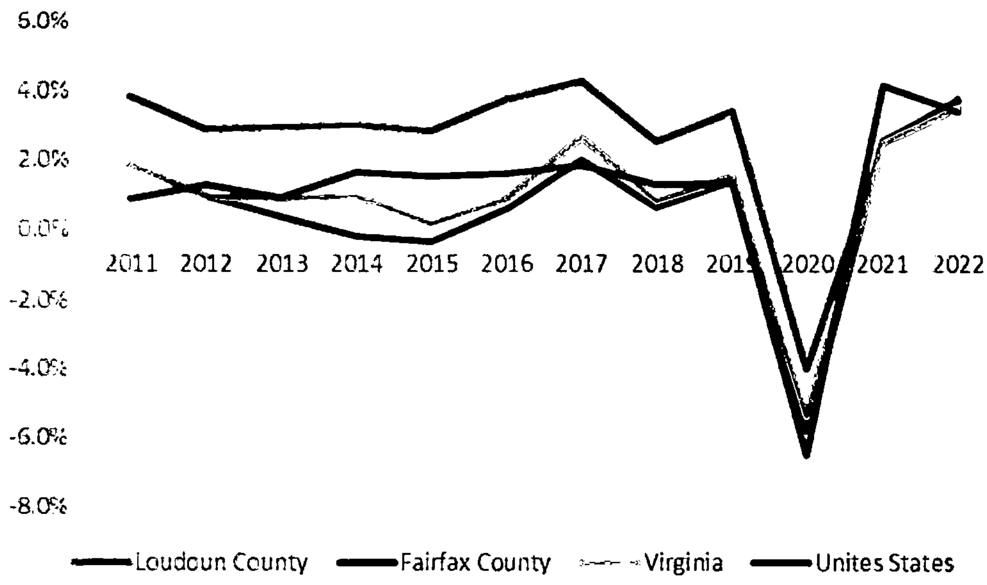
3.7 When considering the importance of employment to DG's peak period-peak direction traffic, Fairfax County is very important as many of those peak trips are destined to jobs in Fairfax County. In Fairfax County, recent employment growth has been performing better than its population growth, indicating relative labor market improvements. This has led to an EP ratio of 55% in 2022, which was above its pre-pandemic share of 54%. Despite its recent improvements, Fairfax County has had relatively modest growth in prior years, thus resulting in CAGR of just 0.6% since 2010. In 2022, employment in Fairfax County reached 623,827, which was over 14% of Virginia's employment. Figure 3-4 shows the employment growth rates of the two counties, along with the growth rates for Virginia and the US.

Figure 3-3: Employment Growth Trend



Source: U.S. Bureau of Labor Statistics

Figure 3-4: Employment Growth Rates



Source: U.S. Bureau of Labor Statistics

Real GDP Per Capita

3.8 GDP captures the total income generated by economic activity in a region. Relating it to the region's population gives GDP per capita, which represents economic activity generated per person. Generally, it is a standard measure of the region's average standard of living and willingness to pay for goods and services. Specifically, a higher income per capita implies a higher value of travel time savings and reliability, which is associated with a higher willingness to pay tolls. Adjusting for inflation, real GDP per capita shows the real economic value generated per person in a region, which is generally used to compare economic activity across regions and time.

3.9 Loudoun County's real GDP per capita was $64,948 in 2021 (in chained 2012$), which was 11% higher than in Virginia and 10% higher than in the whole US. From 2010 to 2021, Loudoun County recorded a real GDP per capita CAGR of 0.7%, which was slightly above Virginia's growth rate of 0.6%, but half of the growth rate of the US.

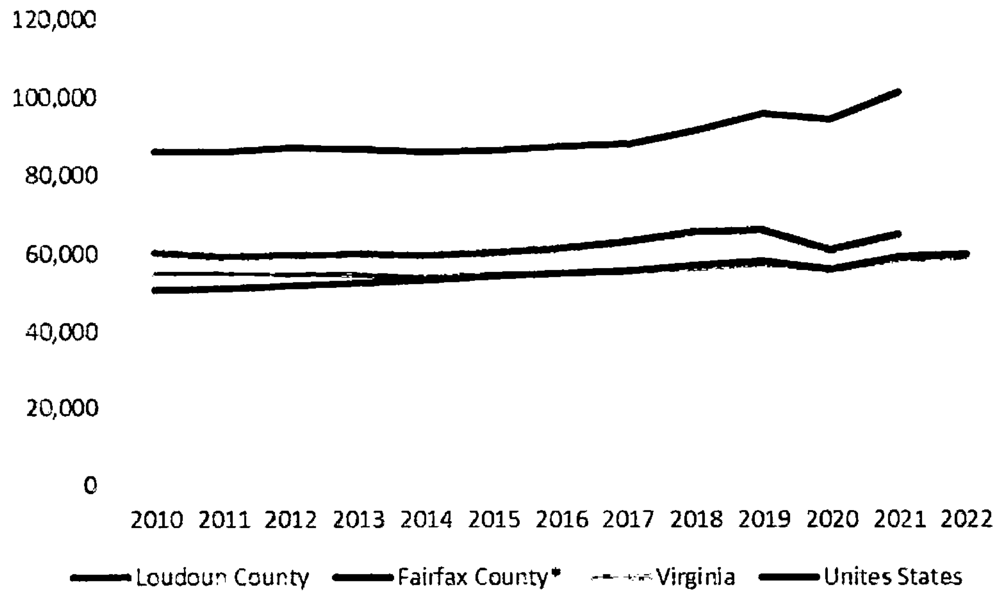
3.10 Real GDP data for Fairfax County is available as a group that also includes the small towns of Fairfax City, VA and Falls Church, VA. To be consistent with real GDP, the same group's total population was used in calculating the GDP per capita. The real GDP per capita in the Fairfax County group was $101,257 in 2021, which was 73% higher than in Virginia and 71% higher than in the US. This has resulted in a real GDP per capita CAGR of 1.5% since 2010, much higher than that of Virginia, and similar to the growth rate across the US. Figure 3-5 shows the relative levels and movements of real GDP per capita among the regions.

3.11 Following a general positive trend in real GDP per capita growth, the pandemic led to negative growth rates across the regions, as seen in Figure 3-6. Notably, Loudoun County's real GDP per capita fell significantly by 7.8% in 2020, while Fairfax County fell by only 1.4%. While Fairfax County, Virginia, and the US all recovered in 2021, Loudoun County's real GDP per capita was still below its pre-pandemic level.

3.12 The available population and employment data for Loudoun County indicates that GDP per capita grew in 2022, as GDP growth is driven by employment growth, which was 3.8% in 2022, much higher than the population growth of 0.9%. This follows 2021 when employment increased 2.5%, while population rose 1.4%, which led to GDP per capita increasing by 6.6%.

3.13 Loudoun County's economic recovery is expected to receive a further boost from planned local developments, as discussed in the Local Development section below. Given the nature and productivity of Loudoun County's economy, along with the relative capital-intensity of its major industries, the rise in economic activity due to the planned developments is expected to push real GDP growth above population growth and lift real GDP per capita.

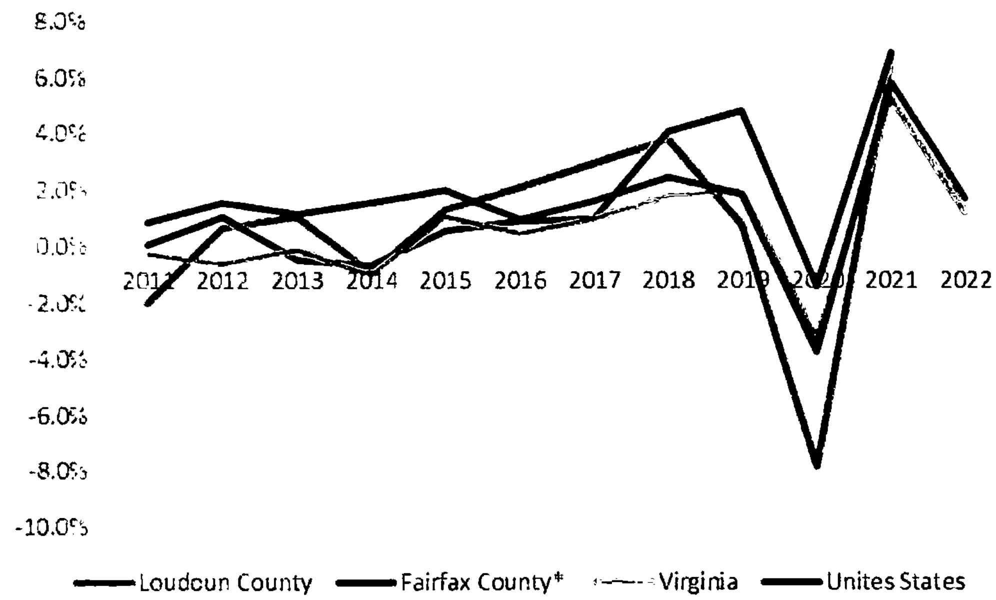
Figure 3-5: Real GDP Per Capita Growth Trend (Chained 2012$)



Note: Fairfax County* includes Fairfax County and the towns of Fairfax City and Falls Church.

Source: U.S. Census Bureau; U.S. Bureau of Economic Analysis

Figure 3-6: Real GDP Per Capita Growth Rates (Chained 2012$)



Note: Fairfax County* includes Fairfax County and the towns of Fairfax City and Falls Church.

Source: U.S. Census Bureau; U.S. Bureau of Economic Analysis

Household Income

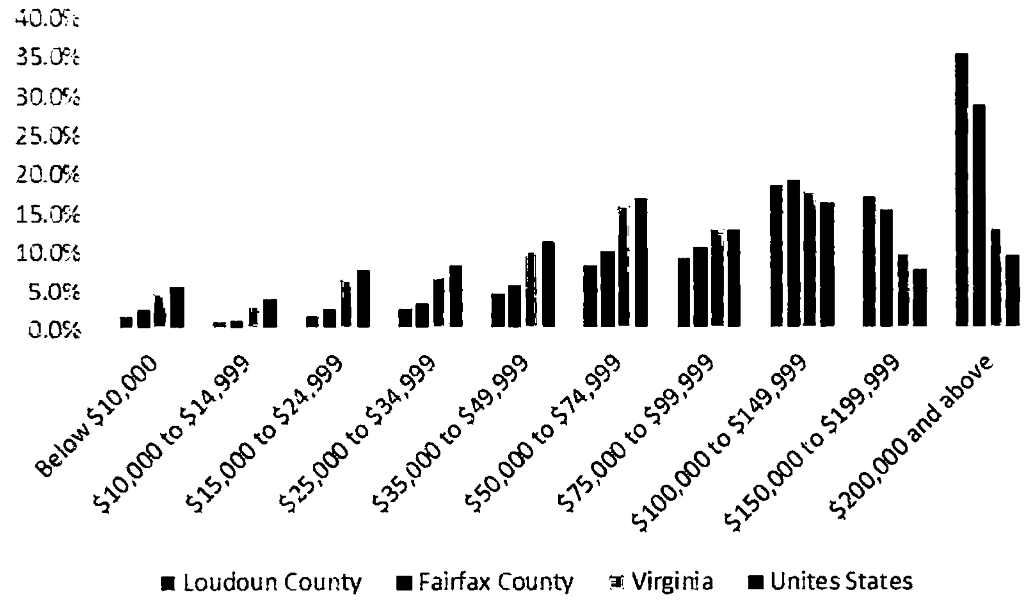
3.14 In addition to economic activity generated per person that is captured by GDP per capita, we can also look at income and benefits received by households to further analyze standard of living and willingness to pay. Figure 3-7 shows the distribution of households by each category of income and benefits received in 2021.

3.15 Of the four regions in 2021, Loudoun County had the largest share of households in the two highest earnings categories. It also had the largest median household income at $156,821, which is above Fairfax County ($133,974), and significantly above Virginia ($80,615), and the US ($69,021). Loudoun County's average household income was $184,367, again higher than in Fairfax County ($170,527), Virginia ($111,013), and the US ($97,196).

3.16 The distribution of household incomes, along with the median and average household income, shows that the willingness to pay in Loudoun County should be relatively strong. This also points to a high value of travel time savings and reliability.

3.17 Note that Fairfax County had a higher GDP per capita than Loudoun County, while Loudoun County had a higher income per household. Aside from the fact that the former measure is per person, while the latter measure is per household, the difference in relative county levels is largely due to the former measure indicating income that is locally produced, while the latter measure is capturing income that is locally received. Given Fairfax County's higher GDP per capita and lower household income, it would imply that income produced in Fairfax County is not received by local households as much as it is in Loudoun County.

Figure 3-7: Distribution of Households by Income and Benefits (2021$)



Source: U.S. Census Bureau, 2021 ACS 5-Year Estimates Data Profiles

Future Outlook

MWCOG's Population and Employment Forecasts

3.18 The Metropolitan Washington Council of Governments (MWCOG) is the official planning organization for the Washington D.C. metro area. MWCOG produces population and employment forecasts that are used as part of the transportation planning process. The forecasts are developed in 5-year intervals, with the key interval for 2024 analysis being between 2020 and 2025. Table 3-1 presents the latest MWCOG forecasts (version 2.4) population and employment growth rates from 2020 to 2025 and compares them against the observed growth rates from 2010 to 2022. For Loudoun County, MWCOG is forecasting that the population growth will slow a bit, from the 2.7% annual growth recently observed to 2.0% per year, while the employment will grow faster, increasing from 0.4% to 0.7% per year. Similarly for Fairfax County, MWCOG is also forecasting population growth to slow, from 2.6% to 1.5% per year, but employment growth to increase, from 0.6% to 1.3% per year.

3.19 As discussed in the next chapter, we used these MWCOG population and employment forecasts in our network modeling.

Table 3-1: Population and Employment Forecasts for Loudoun and Fairfax Counties

	Observed 2010-2022 CAGR	Forecasted 2020-2025 CAGR
Loudoun County Population	2.7%	2.0%
Loudoun County Employment	0.4%	0.7%
Fairfax County Population	2.6%	1.5%
Fairfax County Employment	0.6%	1.3%

Note: Fairfax County* includes Fairfax County and the towns of Fairfax City and Falls Church.

Source: U.S. Census Bureau, U.S. Bureau of Labor Statistics, MWCOG

Local Development

3.20 While the MWCOG forecasts reflect the expected population and employment growth across the whole region, it is useful to consider specific examples of expected development that are incorporated into their growth totals, particularly those that will likely influence travel levels on the DG. The DG runs through Loudoun County and connects traffic from Fairfax County. Some major sectors in Loudoun County include Data Centers, Information and Communication Technology, Federal Government Contracting, Aerospace and Defense, Aviation and Transportation, Health Innovation and Technology, and Agriculture and Related Businesses.

3.21 Fairfax County's major industries are Aerospace and Defense, Cybersecurity, Healthcare Services, and Technical, Scientific, and Professional services.[3] The DG connects to the Dulles Toll Road and Tysons Corner in Fairfax County, which is a popular employment center and a growing hub.

3.22 Figure 3-8 shows the locations of some major planned developments in Loudoun County near the DG, which include[4]:

- **Silver District West** at Ashburn Metro Station has 158 acres of mixed-use development, which will include over 3,700 residential units and nearly 1 million square feet of commercial and office space.

- **Commonwealth Center** is planned for over 2 million square feet of office, commercial, and retail uses, along with 507 residential units. It is strategically located at the highly traveled intersection of Route 7 and Loudoun County Parkway, near a booming office and residential market, and close to Dulles Airport.

[3] Fairfax County Economic Development Authority, Accessed May 25, 2023 (https://www.fairfaxcountyeda.org/key-industries/)

[4] Loudoun Virginia Economic Development, Loudoun's Major Developments, Accessed May 25, 2023 (https://biz.loudoun.gov/major-developments/)

- **Gramercy District** on the Ashburn Metro Station will have 590 residential units, and nearly 1 million square feet of commercial and office uses. It is strategically located near the Dulles Airport.

- **Loudoun Station** at Ashburn Metro Station is approved for 924 apartment units, and 1.8 million square feet of non-residential uses including office, retail, and hotels.

- **Moorefield Station** will be located on the Ashburn Metro Station, and it will feature over 6,000 units and over 10 million square feet of commercial and office space.

- **Rivana at Innovation Station** will be located at the DG and Route 28 and will include: a retail village with 225 thousand square feet of space, a 1.8 million square feet of Class-A office space, over 2,100 residential units, a 300-room full-service hotel, a world-class performing arts venue, and two expansive parks.

- **One Loudoun** will have over 2.4 million square feet of office space, over 1.1 million square feet of retail space, 750 hotel rooms, and 1,267 residential units.

- **Kincora** is planned for a total of 2,400 residential units and around 4.3 million square feet of commercial and public/civic/institutional uses. It will be the future home of the Children's Science Center and the National Museum of Intelligence and Special Operations.

- **Brambleton South Industrial** will be located at the northwest corner of Arcola Mills Drive and Belmont Ridge Road. It is approved for 350 thousand square feet of flex/industrial space.

- **The Shops and Tech at Arcola Center** will be located northwest of Route 50 along Dulles West Boulevard. It will feature around 300 square feet of retail space and 450 thousand square feet of flex/industrial space.

- **Tuscarora Crossing** will include about 200 thousand square feet of flex/industrial space, located along Crosstrail Boulevard in Leesburg.

Figure 3-8: Loudoun's Major Developments Near the DG

Source: Loudoun Virginia Economic Development, Loudoun's Major Developments

Econometric Modeling

Overview

3.23 DG traffic levels have been impacted by COVID-19. In this section, we describe the econometric modeling we used to forecast the profile of the remainder of the COVID-19 recovery. Specifically, we developed two sets of econometric models:

- Econometric models that tie traffic growth on the facility with regional economic variables such as employment in the DC MSA[5]. These models help establish long-term pre-COVID-19 relationships between traffic growth and regional economic activity and were used to first produce what a long-term trend of traffic growth would look like had COVID-19 not occurred.
- Time-series econometric models that only utilize traffic data since the COVID-19 pandemic while traffic was recovering back to pre-COVID-19 levels to estimate a statistically based recovery path moving forward, incorporating not only seasonality into the recovery path but also different rates of trend growth back to pre-COVID-19 levels of traffic.

3.24 In the first step, we input socioeconomic variable forecasts of the regional economic variables included in the econometric models to generate a baseline long-term growth trend (assuming COVID-19 had not occurred). These socioeconomic forecasts were obtained from Moody's and reflect assumptions of future growth in the region based on Moody's October 2022 outlook. We produced the long-term growth trend using 2019 as the base year (i.e., based off pre-COVID-19 conditions).

3.25 In the second step, we estimated individual time-series models using traffic data from July 2020 to December 2022 and used the statistical relationships from these models to produce projected paths of traffic recovery out to 2024. We then compare the projected recovery by market with their respective long-term growth (as implied from step one above). We focus our attention on step two in this report.

Time-Series Forecasting of Traffic Recovery Path

3.26 To better forecast the traffic recovery path, we first segmented DG transactions into eleven markets. Table 3-2 shows the markets along with their respective share of total DG transactions as of 2019. The table also includes the % of their 2019 Average Annual Daily Traffic (AADT) values that these individual markets recovered to by the end of December 2022. The markets are labelled "A" through "K" and will henceforth be referred to using these labels for ease and simplicity.

[5] Washington–Arlington–Alexandria, DC–VA–MD–WV metropolitan statistical area. A metropolitan statistical area (MSA) consists of one or more counties that contain a city of 50,000 or more inhabitants, or contain a Census Bureau-defined urbanized area (UA) and have a total population of at least 100,000.

Table 3-2: Market Segments for Time-Series Modeling of Recovery Path

Market	Description	2019 % share of Total Transactions	% Of 2019 AADT (January-December 2022)
A	Auto-Mainline-Peak Period-Peak Direction	25%	49%
B	Auto-Mainline-Peak Period-Contra Peak Direction	4%	97%
C	Auto-Mainline-Off Peak Period	39%	70%
D	Auto-Mainline-Weekend	15%	83%
E	Auto-Ramps-Peak Period-Peak Direction	3%	61%
F	Auto-Ramps-Peak Period-Contra Peak Direction	1%	77%
G	Auto-Ramps-Weekday Off Peak + Weekend	10%	72%
H	Trucks-Mainline-Peak Period	0%	98%
I	Trucks-Mainline-Weekday Off Peak + Weekend	1%	92%
J	Trucks-Ramps-Peak Period	0%	81%
K	Trucks-Ramps-Weekday Off Peak + Weekend	1%	78%
R*	**DG Total (Auto+Trucks, Ramps+Mainline)**	**100%**	**68%**

Source: Steer analysis of 2019 DG Transaction data; "R" is the label assigned for DG Total – not a specific market that was modeled

3.27 The rationale for developing independent time-series models for different markets was two-fold:

- Since different markets have recovered at different rates, evidenced by the values in the last column of the table, it is natural to assume that these markets will follow different rates of recovery going forward as well and are thus governed by different trend behaviors.
- Allowing different markets to recover at different rates provides a more nuanced view of overall traffic recovery on the Greenway, which can then be summed across all markets (or market groups) to understand what the expected total traffic recovery path would be going forward. This includes the incorporation of seasonality to mimic actual recovery data, as well as differential trend growth rates.

3.28 The time-series models we developed are Seasonal Autoregressive Integrated Moving Average[6] (or "SARIMA") models – a standard and well-established type of time-series econometric model that estimates the statistical relationship of a univariate data series with its lagged values. Separate models were estimated for eight of the eleven markets shown in Table 3-2 above – markets A, C, D, E, F, G, J and K. For markets B, H, and I, we did not estimate models as these markets have generally returned to pre-COVID-19 levels of traffic and collectively form a small share of total DG transactions. We therefore assumed that they would follow their long-term growth trend (i.e., what they would have followed in the absence of COVID-19) from April 2023 onwards.

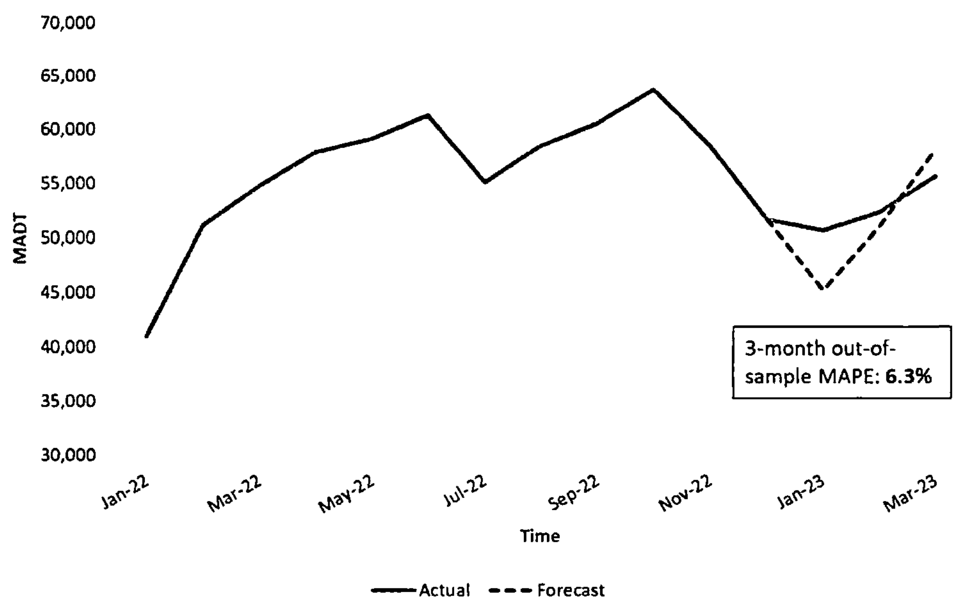
3.29 We estimated all time-series models using actual traffic data over the period of July 2020 – December 2022. We estimated the models excluding the months around the peak of the pandemic

[6] ARIMA models for time-series forecasting

(i.e., March 2020-June 2020) to prevent model bias that could result from estimating over the extreme variations during those months. While actual data was available through March 2023, we excluded the first three months of data in 2023 from the estimation to allow us to assess the out-of-sample forecast performance of our models during the development phase and iteratively finalize the 'best' specifications that resulted in the lowest forecast error.

3.30 Overall, we determined recovery profiles using a mix of model applications (time-series models/forecasting) and analytical judgment (inspecting past growth/recovery with future projected recovery). The finalized models predominantly include imposed Moving Average (MA) error 'dependence' structures[7]. Figure 3-9 below presents the performance of the model forecasts against actuals over the 3-month period out-of-sample (i.e., January 2023 – March 2023) across all eleven markets aggregated together.

Figure 3-9: DG Actuals vs. Steer Forecast (January 2022 - March 2023)



Source: Steer Analysis

Forecast Recovery

3.31 Figure 3-10 and Figure 3-11 below show the monthly projected recovery paths for all eight markets analyzed, as well as for market 'B','H','I' (for which no time series model was estimated[8]) which we assumed to follow the underlying growth trend from April 2023 to December 2024. The solid part

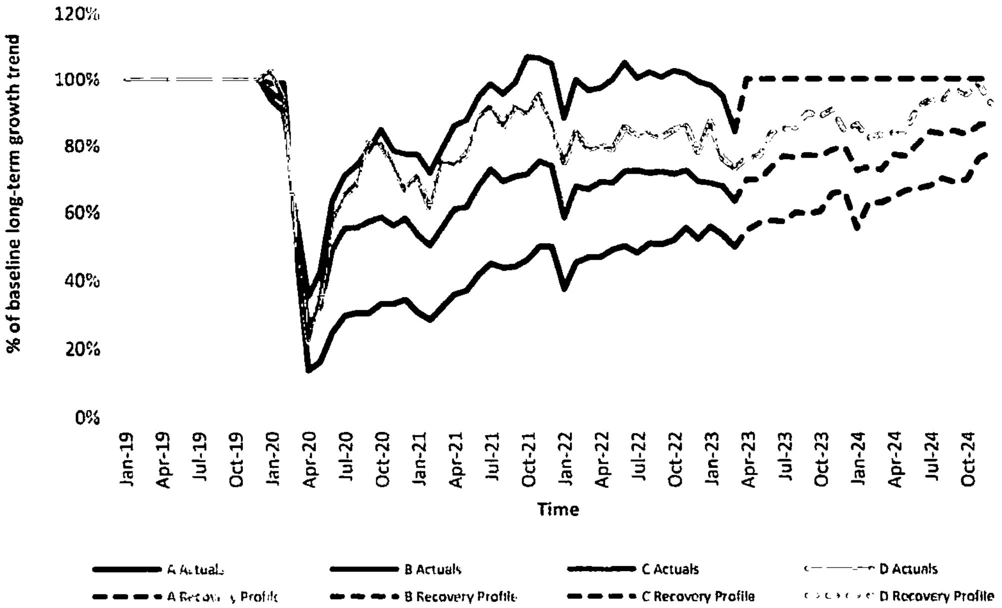
[7] These models estimate forecasts based on a weighted average of errors between observed actuals and prior forecasted values. In our case, the model's forecasted values are informed by it's prior 'mistakes' in forecasting, and continually updated as more data becomes available.

[8] The recovery in traffic for markets B, H, & I were found to be very near, or to have exceeded our long-term growth trend for these markets; hence, no models were estimated to determine their future recovery path.

of the lines shows actual traffic recovery compared as a percentage of our estimated long-term growth trend (had COVID-19 not occurred), whereas the dashed part of the lines indicates how our projected recovery paths for the same markets evolve relative to the underlying growth trend. As evidenced from the plots, the pace of traffic recovery differs by market.

- Most markets will return to ~80% of estimated long-term growth trend by the end of 2024. Market B and Market D are expected to recover back to the pre-COVID-19 long-term trends in 2023 and 2024, respectively.
- Market A and E are peak period markets and are forecast to have the slowest recovery rate among the eleven markets, consistent with the recovery trend observed thus far (i.e., through March 2023).

Figure 3-10: Monthly Projected Traffic Recovery Path (Markets A, B, C, and D)



Source: Steer

Figure 3-11: Monthly Projected Traffic Recovery Path (Markets E, F, G, and K)

Source: Steer

3.32 Table 3-3 shows the 2024 AWDT forecasts for the DG by aggregated market (total for mainlines and ramps) based on the modeling described above. Overall, DG transactions are expected to increase to an AWDT of 43,215 by 2024, which represents an increase of 17% from 2022 levels. As discussed later in Chapter 6, we used these 2024 AWDTs to guide the growth of the trips "in-scope" to use the DG in the 2024 demand matrices so that their resulting 2024 traffic levels approximate these AWDTs. The AADT on the DG is expected to increase by 16% from 33,755 in 2022 to 39,100 in 2024.

Table 3-3: 2024 DG AWDT Forecasts by Aggregated Market

Market	AWDT
Auto peak period peak direction	12,708
Auto peak period contra peak direction	3,640
Auto off-peak	25,326
Truck peak period	411
Truck off-peak + weekend)	1,129
Total	**43,215**

Source: Steer

4 Network Modeling

Overview

4.1 The regional travel demand model developed by MWCOG is the official model used for planning studies in the Washington Metropolitan Area. The MWCOG model is regional in nature and is not well calibrated to every road, and thus may not be well-suited for analysis of toll roads, hence Steer developed an in-house travel demand model (Steer model) focusing on the DG and surrounding areas. To test impacts of planned network and future improvements and to use elements for the development of the Steer model, Steer obtained version 2.4 of the MWCOG model, which includes the MWCOG population and employment forecasts which we had previously discussed in Chapter 3. We used information from the MWCOG model and 2022 observed baseline conditions to update a prior version of the Steer model that we originally developed in 2019. We used the Steer model to determine the traffic impact of the proposed toll rate increase on the DG. This chapter provides background on the Steer model and a description of how we updated it for this study.

Approach

4.2 The Steer model uses a detailed network model of the study area along with a capture model to estimate the change in toll traffic resulting from changes in toll rates. Relative to an econometric modeling approach, the advantages of this network model and capture model approach include:

- High level of detail – small zones support better representation of local routing and willingness to pay decisions.
- Better representation of congestion (through link level calculations) in the routing and capture decisions.
- Representation of future network projects allows their impacts to be incorporated into future forecasts.
- Incorporation of an iteration with a separate capture model. The capture model is calibrated to observed capture levels.

Model Development

Structure

4.3 We developed the Steer model using the Cube/Voyager software platform. The key components of the model were adapted from the MWCOG travel demand model. The MWCOG model is a classic 4-step modeling system that includes: 1) trip generation, 2) trip distribution, 3) mode choice, and 4) traffic assignment. The model has over 3,700 traffic analysis zones (TAZs, representing geographical areas from which trips originate or are attracted to) and almost 50,000 links representing segments of the highway network.

4.4 The MWCOG model uses four time periods (AM, Midday, PM, and Night), which we further divided for the Steer model to include AM shoulder peak and PM shoulder peak periods. The MWCOG model has five user classes; we have split the truck user class into two, resulting in six user classes in the Steer model.

4.5 Table 4-1 summarizes the key trip characteristics of the Steer model system.

Table 4-1: Steer Model Trip Characteristics

Model Trip Characteristic	Details
User Classes	Auto SOV Auto HOV2 Auto HOV3+ Auto Airport Passengers Commercial Vehicles and Light Trucks (2-axle) Heavy Truck (3+ axle)
Time Periods	AM Peak: 6:30 - 9:00 AM AM Shoulder: 9:00 - 10:00 AM Midday: 10:00 AM - 3:00 PM PM Shoulder: 3:00 - 4:00 PM & 6:30 - 8:00 PM PM Peak: 4:00 - 6:30 PM Night: 8:00 PM - 6:30 AM

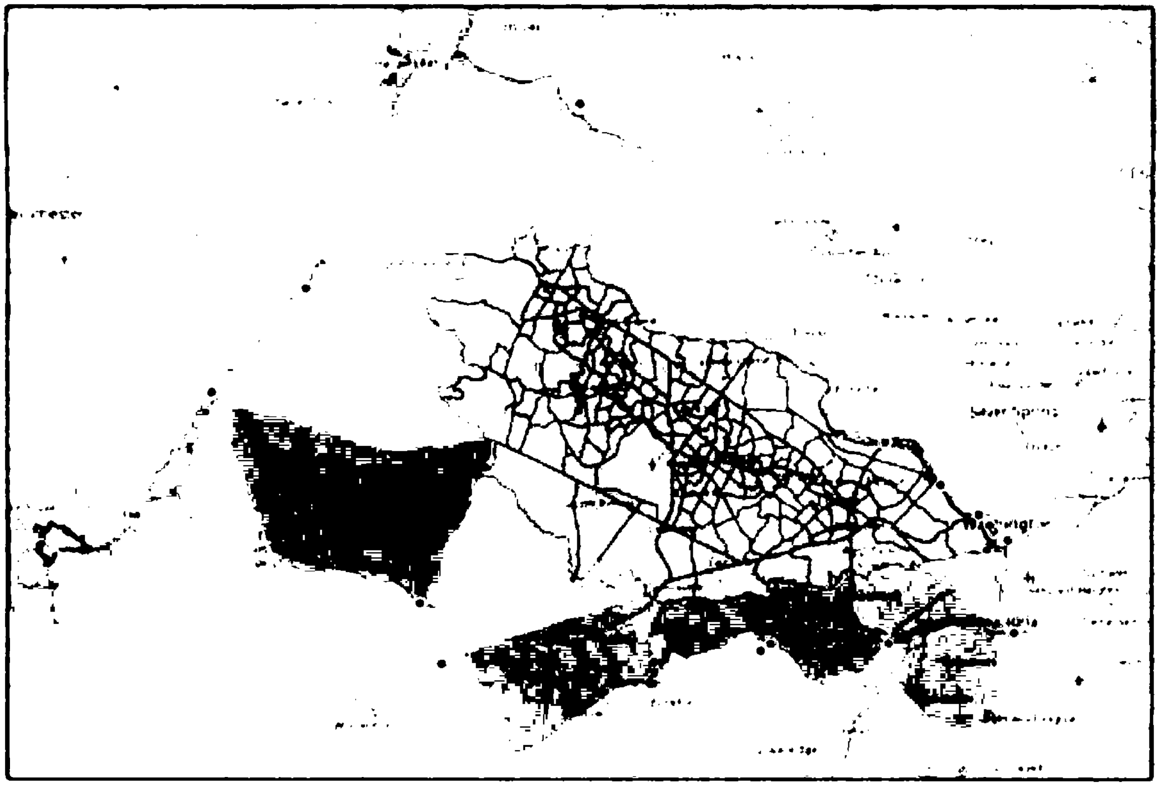
Zoning

4.6 We based the zoning system for the Steer model on the MWCOG model zones. Specifically, we extracted a subarea from the MWCOG model to focus on the study area, and it comprises:

- 210 internal zones – smaller zones close to the DG, generally following MWCOG zone boundaries. We created larger zones from the aggregation of zones towards the edge of the subarea, which are furthest from the DG.
- 8 external zones – larger zones capturing trips into the study area from local surrounding areas.
- 15 external 'gates' – representing demand entering the study area from further away on major highways.

4.7 Figure 4-1 shows the resulting zones.

Figure 4-1: Steer Model Zoning System



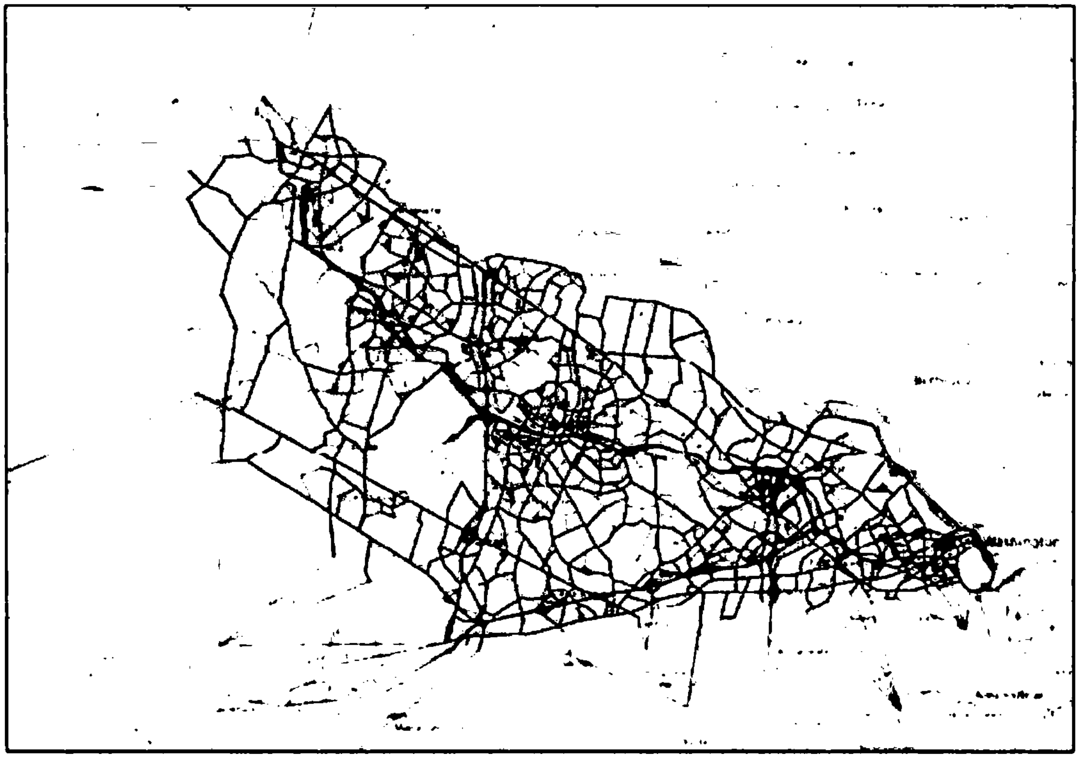
Source: Steer

Highway Network

4.8 We used a subarea of the MWCOG model network as the basis of the highway network. We performed a detailed audit to ensure the number of lanes, lane capacity, ramps, and toll plazas along DG and DTR were accurately modeled. Links at the interchanges along DG and DTR were recoded to better represent ramps at complex junctions, giving a clearer understanding of all possible movements.

4.9 During this work we reviewed the major competing roads (such as Route 7) and the wider network in general. Figure 4-2 shows the network coverage of our model.

Figure 4-2: Highway Network Coverage



Source: Steer

Capture Model

4.10 Steer developed a capture model to forecast capture rates on the DG relative to its alternatives. The model used is a logistic regression (logit), a statistically robust and prevalent technique used to model probabilities, or in this context, capture rates for the toll facilities. We established the capture model using a combination of detailed 2019 data and aggregated capture data from 2022.

4.11 We started with very detailed trip pattern data by travel route for 2019 from Streetlight Data. Specifically, this data included DG demand and the total in-scope demand by Origin-Destination (OD) pair which allowed us to determine the capture rate for each OD.

4.12 We carried out logistic regressions to relate these capture rates to the difference in generalized cost (combined time and cost) between the toll facilities and the alternatives. We established the travel times for the toll facilities and alternatives from 2019 travel time from INRIX[9], while the toll rates were based on the prevailing toll rates and assumptions on which entry and exit ramp each OD uses.

[9] INRIX is a company that analyzes traffic information from road sensors and vehicle systems, and they maintain a product that provides historical travel time data.

4.13 To combine time and costs to generalized cost of travel we assumed the following value of time (VOT) and electronic payment bonus based on our understanding of prevailing household incomes in Loudoun and Fairfax Counties:

- VOT: Peak $32.90/hour, Off-peak, $25.60/hour (in 2019$)
- Electronic Payment Bonus: 50 cents

4.14 When paying tolls electronically, travelers typically only review the tolls that they pay monthly when they receive their account statement. Due to this time lag, travelers may not perceive the actual toll they pay, but discount the toll rates in their mind. Accordingly, we apply the electronic payment bonus to reflect this perceived discount to the toll cost that most travelers experience.

4.15 We estimated capture rates for the six time periods consistent with the Steer model (AM Peak, AM Shoulder, Midday, PM Peak, PM Shoulders, and Night).

4.16 Since DG capture rates decreased from 2019 to 2022, it was necessary for us to update the capture model to reflect aggregate 2022 conditions. Specifically, we calculated the magnitude of the capture rate changes from 2019 to 2022 by direction and time period and implemented factors to reflect the changes.

2022 Base Year Model

4.17 As discussed above, we estimated the capture model in 2019 as part of an overall calibration of the Steer model to represent 2019 traffic conditions in the study area. For this analysis we recalibrated the model to 2022 conditions using the following data for 2022 provided by TRIP II and described in Chapter 2:

- Traffic counts along screenline locations in the study area
- DG transaction data by plaza, direction and time period
- Travel times along DG and alternative routes

Network

4.18 We updated the Steer model network to 2022 conditions based on a review of the roadway improvement projects that were completed by the end of 2022 per the latest regional Transportation Improvement Program (TIP). Table 4-2 shows the three projects in the study area completed between 2020 and 2022.

Table 4-2: Roadway Improvement Projects (2020-2022)

Project Description	County	Completion Date
Widen Sycolin Road from 2 to 4 lanes	Loudoun	2020
Construct new interchange at Route 7/Belmont Ridge	Loudoun	2020
Widen I-66 Inside the Beltway EB to 4 lanes (Exit 67 Dulles Airport Access Road to George Mason Drive	Arlington	2021

Source: MWCOG TIP

Trip Matrices

4.19 In order to develop 2022 trip matrices for the Steer model, we first extracted subarea trip matrices from the latest version of the MWCOG model (version 2.4) for the 2021 and 2023 scenarios. We then used these matrices to develop 2022 subarea trip matrices via interpolation. We applied the growth between MWCOG model's 2019 and 2022 subarea matrices to the previously calibrated 2019 Steer model trip matrices to obtain 2022 Steer model trip matrices that we used as a starting point for our recalibration effort.

Toll Rates

4.20 Table 4-3 shows the 2022 DG tolls by plaza for the peak and off-peak time periods.

Table 4-3: 2022 DG Tolls by Plaza (Nominal $)

Toll Plaza	Peak	Off-Peak
Shreve Mill	$4.10	$4.10
RT 659/Belmont	$5.10	$4.55
Claiborne	$5.10	$4.55
RT 772/Ashburn	$5.10	$4.55
RT 607/Loudoun Co Pkwy	$5.80	$5.25
RT 606/Old Ox	$5.80	$5.25
RT 28	$5.80	$5.25
Mainline	$5.80	$5.25

Source: TRIP II

Calibration

4.21 We performed various adjustments in the model to study area roadway characteristics such as free-flow speed and capacity, volume-delay functions, observed capture rates (based on screenline counts) as well as adjustments to the trip matrices to obtain a better fit between observed and model-estimated volumes along screenlines, DG transactions, DG capture, and travel times along DG and alternative routes.

4.22 We reviewed the performance of the model estimated DG transactions and volumes at the screenlines using the GEH statistic, which is a common measure calculated to determine how well forecasted traffic matches observed traffic. The GEH statistic is calculated as:

$$GEH = \sqrt{\frac{(Volume_{Modeled} - Volume_{Observed})^2}{(Volume_{Modeled} + Volume_{Observed}) * 0.5}}$$

4.23 GEH values less than 5 indicate a good fit of observed levels, while GEH values greater than 10 indicate that more attention is needed on a specific location of the model. We sought to have a majority of measurements with a GEH less than 5 and almost all with a GEH of less than 10. For the screenline volume calibration, we also aimed to have the difference between observed and forecasted values within 10%.

DG Transactions

4.24 Table 4-4 shows a comparison of model and observed 2022 DG transactions by toll plaza at the daily, AM peak, PM peak and Off-peak levels for an average weekday. As can be seen from the table, we obtained a very good fit between model and observed conditions.

Table 4-4: DG Transactions (2022): Model vs Observed

Daily

Location	Observed		Modeled		GEH	
	EB Exit	WB Entrance	EB Exit	WB Entrance	EB Exit	WB Entrance
Mainline Plaza	15,791	14,890	14,436	13,500	2	2
Old Ox Rd (Rte 606)	1,207	1,413	787	1,564	3	1
Loudoun County Pkwy (Rte 607)	345	464	203	743	2	2
Ryan Rd (Rte 772)	546	586	1,129	1,077	4	3
Claiborne Pkwy (Rte 901)	355	367	585	926	2	4
Belmont Ridge Rd (Rte 659)	327	466	402	854	1	3
Shreve Mill Rd	71	77	128	347	1	4
TOTAL	**18,640**	**18,263**	**17,671**	**19,011**	**1**	**1**

AM Peak

Location	Observed		Modeled		GEH	
	EB Exit	WB Entrance	EB Exit	WB Entrance	EB Exit	WB Entrance
Mainline Plaza	4,393	1,191	4,162	1,145	2	1
Old Ox Rd (Rte 606)	350	128	239	246	4	5
Loudoun County Pkwy (Rte 607)	86	53	19	26	6	3
Ryan Rd (Rte 772)	129	59	206	113	4	4
Claiborne Pkwy (Rte 901)	75	43	108	111	2	5
Belmont Ridge Rd (Rte 659)	66	58	46	110	2	4
Shreve Mill Rd	15	10	15	26	0	2
TOTAL	**5,115**	**1,542**	**4,794**	**1,776**	**3**	**4**

PM Peak

Location	Observed		Modeled		GEH	
	EB Exit	WB Entrance	EB Exit	WB Entrance	EB Exit	WB Entrance
Mainline Plaza	1,837	4,030	1,851	3,651	0	4
Old Ox Rd (Rte 606)	100	330	70	256	2	3
Loudoun County Pkwy (Rte 607)	41	88	34	322	1	10
Ryan Rd (Rte 772)	71	121	247	337	9	9
Claiborne Pkwy (Rte 901)	60	72	135	261	5	9
Belmont Ridge Rd (Rte 659)	58	90	85	160	2	4
Shreve Mill Rd	9	12	22	118	2	8
TOTAL	**2,176**	**4,743**	**2,445**	**5,105**	**4**	**3**

Off Peak

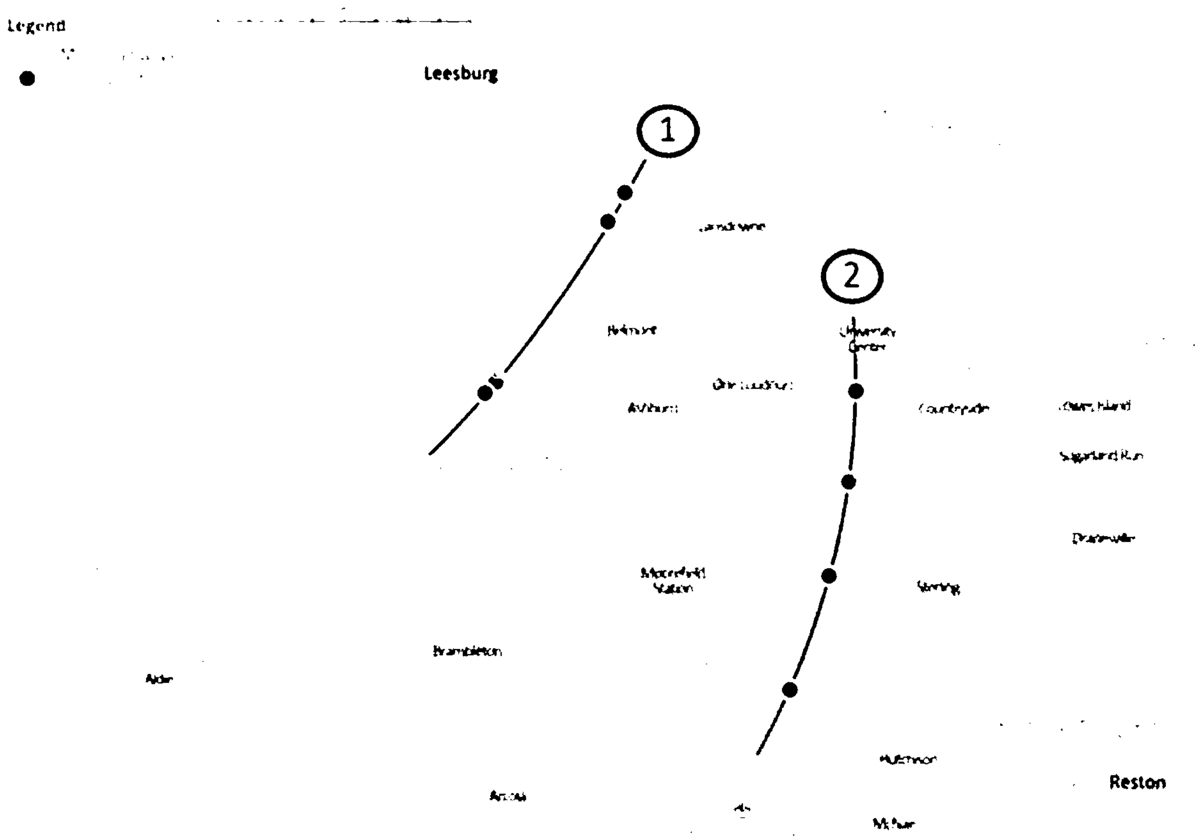
Location	Observed		Modeled		GEH	
	EB Exit	WB Entrance	EB Exit	WB Entrance	EB Exit	WB Entrance
Mainline Plaza	9,561	9,669	8,422	8,704	3	2
Old Ox Rd (Rte 606)	756	955	478	1,062	3	1
Loudoun County Pkwy (Rte 607)	218	323	150	395	1	1
Ryan Rd (Rte 772)	346	406	677	628	3	2
Claiborne Pkwy (Rte 901)	220	251	342	553	2	3
Belmont Ridge Rd (Rte 659)	203	318	271	584	1	3
Shreve Mill Rd	46	55	91	204	1	3
TOTAL	**11,350**	**11,977**	**10,432**	**12,130**	**2**	**0**

Source: Steer

Screenline Volumes

4.25 We defined two screenlines in the study area to assess the performance of model-estimated volumes against observed counts at key locations that include Route 7 and the DG. Figure 4-3 shows the two screenlines.

Figure 4-3: Traffic Volume Screenlines



Source: Steer

4.26 Table 4-5 shows a comparison of model and observed volumes along screenline 1 at the daily, AM peak, PM peak and Off-peak conditions as well as DG captures. Table 4-6 shows similar information for screenline 2. As with the DG transactions, the model estimates of screenline volumes exhibit a good fit with the observed data.

Table 4-5: Screenline 1 Volumes (2022): Model vs Observed

Daily

Location	Observed			Modeled			GEH		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Route 7	59,794	59,341	119,135	63,723	62,603	126,327	3	3	4
Greenway	9,401	10,386	19,786	8,793	11,913	20,705	1	3	1
Sycolin Road	5,456	6,076	11,532	5,397	5,893	11,290	0	0	0
Riverside Parkway	5,355	7,635	12,990	6,001	6,104	12,105	2	4	2
Total	**80,005**	**83,438**	**163,443**	**83,914**	**86,513**	**170,427**	3	2	3
Total (Route 7 + DG)	**69,195**	**69,727**	**138,921**	**72,516**	**74,516**	**147,032**	3	4	4
DG Capture	***14%***	***15%***	***14%***	***12%***	***16%***	***14%***			

AM Peak

Location	Observed			Modeled			GEH		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Route 7	12,672	6,566	19,238	12,968	6,738	19,706	2	1	2
Greenway	2,883	741	3,623	2,608	1,011	3,619	3	6	0
Sycolin Road	851	881	1,732	775	583	1,358	2	7	6
Riverside Parkway	1,053	643	1,696	1,289	469	1,757	4	5	1
Total	**17,458**	**8,830**	**26,288**	**17,639**	**8,801**	**26,440**	0	0	0
Total (Route 7 + DG)	**15,554**	**7,307**	**22,861**	**15,576**	**7,749**	**23,325**	0	3	2
DG Capture	***19%***	***10%***	***16%***	***17%***	***13%***	***16%***			

PM Peak

Location	Observed			Modeled			GEH		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Route 7	9,179	13,298	22,477	9,832	13,472	23,304	4	1	3
Greenway	967	3,254	4,220	1,019	2,739	3,758	1	6	5
Sycolin Road	1,017	1,379	2,396	1,156	1,586	2,741	3	3	4
Riverside Parkway	938	2,082	3,020	753	1,793	2,546	4	4	6
Total	**12,100**	**20,013**	**32,114**	**12,760**	**19,589**	**32,349**	1	1	0
Total (Route 7 + DG)	**10,146**	**16,552**	**26,698**	**10,851**	**16,211**	**27,062**	4	2	1
DG Capture	***10%***	***20%***	***16%***	***9%***	***17%***	***14%***			

Off-Peak

Location	Observed			Modeled			GEH		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Route 7	37,943	39,477	77,420	40,923	42,393	83,317	3	3	5
Greenway	5,551	6,391	11,943	5,166	8,163	13,328	1	5	3
Sycolin Road	3,588	3,817	7,405	3,467	3,724	7,191	0	0	1
Riverside Parkway	3,364	4,910	8,274	3,959	3,843	7,802	2	4	1
Total	**50,447**	**54,595**	**105,042**	**53,515**	**58,123**	**111,637**	3	3	4
Total (Route 7 + DG)	**43,495**	**45,868**	**89,363**	**46,089**	**50,556**	**96,645**	3	5	5
DG Capture	***13%***	***14%***	***13%***	***11%***	***16%***	***14%***			

Source: Steer

Table 4-6: Screenline 2 Volumes (2022): Model vs Observed

Daily

Location	Observed			Modeled			GEH		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Route 7	63,185	62,835	126,020	67,282	62,418	129,701	3	0	2
Greenway	15,791	14,890	30,681	14,436	13,500	27,936	2	2	3
Waxpool Road	31,085	27,524	58,610	27,671	26,160	53,832	4	2	4
Gloucester Pkwy	13,976	13,047	27,023	17,192	16,361	33,553	5	6	8
Total	**124,037**	**118,297**	**242,335**	**126,581**	**118,440**	**245,021**	1	0	1
Total (Route 7 + DG)	**78,976**	**77,726**	**156,702**	**81,718**	**75,918**	**157,636**	2	1	0
DG Capture	***20%***	***19%***	***20%***	***18%***	***18%***	***18%***			

AM Peak

Location	Observed			Modeled			GEH		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Route 7	12,570	7,967	20,537	13,822	7,637	21,459	7	2	4
Greenway	4,393	1,191	5,584	4,162	1,145	5,307	2	1	2
Waxpool Road	5,323	3,690	9,013	5,108	2,808	7,916	2	10	8
Gloucester Pkwy	2,325	1,426	3,751	3,392	1,617	5,009	13	3	12
Total	**24,611**	**14,274**	**38,885**	**26,484**	**13,207**	**39,691**	7	6	3
Total (Route 7 + DG)	**16,963**	**9,158**	**26,121**	**17,985**	**8,781**	**26,766**	5	3	3
DG Capture	***26%***	***13%***	***21%***	***23%***	***13%***	***20%***			

PM Peak

Location	Observed			Modeled			GEH		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Route 7	10,128	6,513	16,641	9,873	6,943	16,817	2	3	1
Greenway	1,837	4,030	5,867	1,851	3,651	5,502	0	4	3
Waxpool Road	5,470	5,489	10,959	4,581	5,193	9,774	8	3	7
Gloucester Pkwy	2,685	2,843	5,528	3,100	3,447	6,547	5	7	8
Total	**20,120**	**18,875**	**38,995**	**19,405**	**19,235**	**38,640**	3	2	1
Total (Route 7 + DG)	**11,965**	**10,543**	**22,508**	**11,724**	**10,594**	**22,319**	1	0	1
DG Capture	***15%***	***38%***	***26%***	***16%***	***34%***	***25%***			

Off-Peak

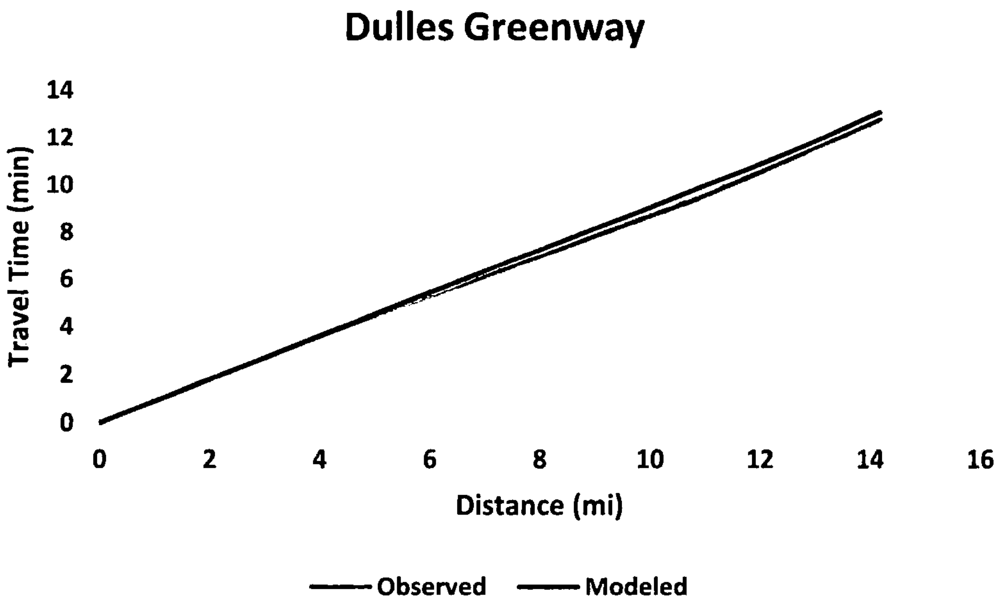
Location	Observed			Modeled			GEH		
	EB	WB	Total	EB	WB	Total	EB	WB	Total
Route 7	40,487	48,356	88,843	43,587	47,839	91,426	3	1	2
Greenway	9,561	9,669	19,230	8,422	8,704	17,126	3	2	4
Waxpool Road	20,292	18,346	38,638	17,982	18,159	36,142	4	0	3
Gloucester Pkwy	8,966	8,778	17,744	10,700	11,297	21,997	4	6	7
Total	**79,306**	**85,149**	**164,455**	**80,692**	**85,999**	**166,691**	1	1	1
Total (Route 7 + DG)	**50,048**	**58,025**	**108,073**	**52,009**	**56,542**	**108,552**	2	1	0
DG Capture	***19%***	***17%***	***18%***	***16%***	***15%***	***16%***			

Source: Steer

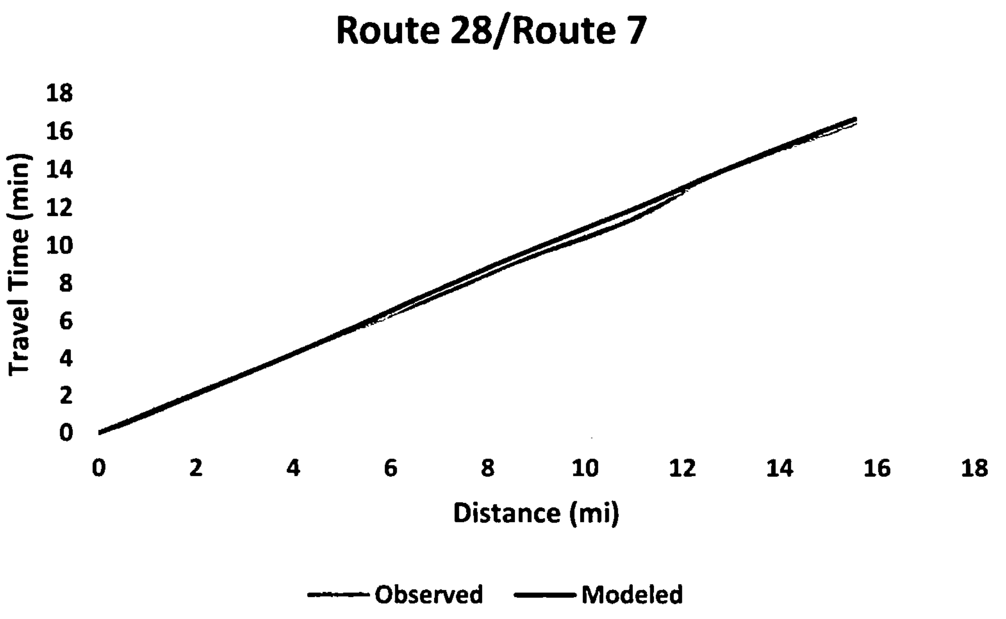
Travel Times

4.27 Figure 4-4 and Figure 4-5 show the travel times along DG and the main alternative route (Route 7/VA-28) for the AM Peak Eastbound and PM Peak Westbound directions (representing the peak periods and peak directions), which also show a reasonable match.

Figure 4-4: Travel Times: Model vs Observed (AM Peak-Eastbound)

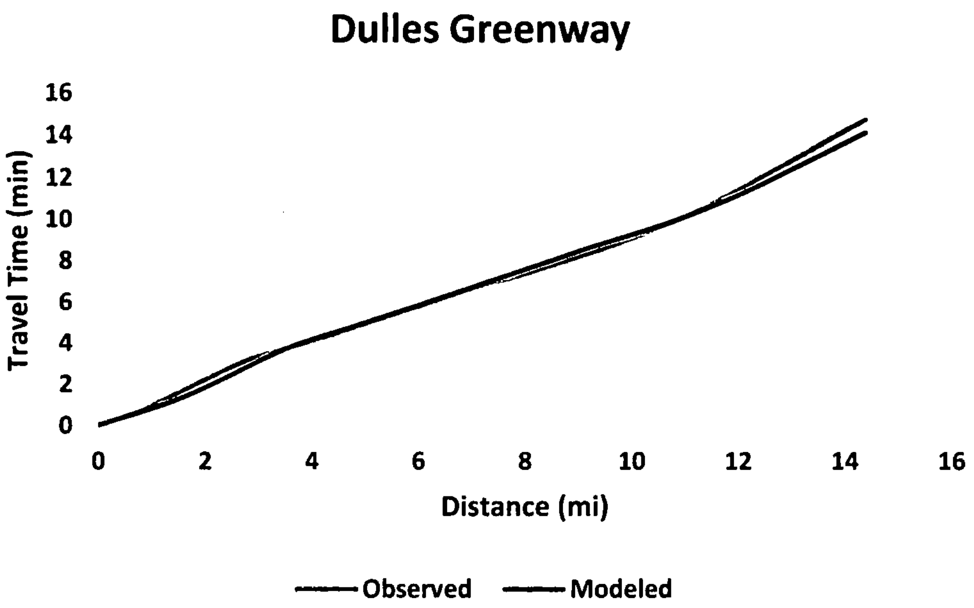


Source: Steer

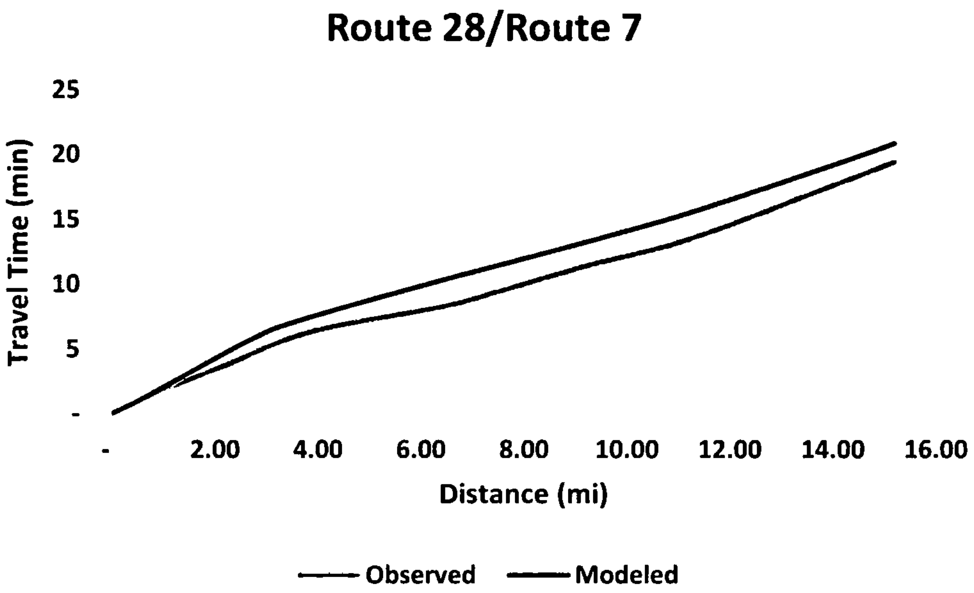


Source: Steer

Figure 4-5: Travel Times: Model vs Observed (PM Peak-Westbound)



Source: Steer



Source: Steer

4.28 Based on the calibration results, we considered the model suitable to forecast traffic conditions on the DG and alternative routes in the Rate Year 2024 and to analyze the impact of toll rate increases.

Steer Model Advantages

4.29 Compared to the MWCOG model, the Steer model has the following advantages:

- More accurate representation of study area roadways.
- Refined time periods to better reflect sensitivity of traffic demand within peak periods.
- State-of-the-practice methods to forecast travel demand on toll facilities.

5 Benefits to Users

5.1 The DG provides benefits to users, including travel time savings, travel time reliability savings, vehicle operating cost savings, and safety advantages when compared to alternative routes. Steer analyzed the expected user benefits and costs of proposed toll rate changes to the DG and this chapter describes the analysis.

Approach

5.2 Steer assessed the user benefits of the proposed toll rate changes following the guidance and best practices recommended by the U.S. Department of Transportation for developing benefit-cost analyses.[10] A benefit-cost analysis (BCA) provides a systematic framework for quantifying and evaluating the expected benefits and costs of proposed changes to DG's toll costs.

5.3 The objective of the BCA is to use a consistent methodology that carefully measures user benefits and costs associated with the proposed toll rate changes. Accounting for average vehicle occupancy rates, user benefits and costs are assessed on a per-trip basis.

5.4 The BCA considers the materiality of benefits and costs to focus efforts on estimating impacts that represent a large share of total benefits and costs. For example, we have excluded benefits related to emissions reductions because initial estimates were not appreciable in the context of total benefits and costs. The BCA also takes into consideration the sensitivity of benefit and cost estimates to input and parameter assumptions.

Measures of Benefits and Costs

5.5 We quantified the following categories of DG benefits and costs for the BCA. Each benefit and cost is compared to equivalent measures for alternative routes to the DG.

- User Benefits
  - Travel Time Savings
  - Reliability Savings
  - Vehicle Operating Cost Savings
  - Accident Cost Savings
- User Costs
  - Cost of Using the DG

Technical Parameters and Concepts

5.6 *Analysis Period.* We utilized the following periods in our analysis:

- 2021 for baseline input estimates including value of time (VOT), value of reliability (VOR) and other input costs (latest year of data available)
- 2022 for current traffic and travel time conditions
- 2024 for benefit-cost evaluation (proposed rate year)

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[10] U.S. Department of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, February 2021.

5.7 *Dollar valuation*. We quantified benefits and costs in inflation-adjusted dollars (real terms), using a constant dollar base year of 2022 (latest year of inflation data available). Quantified benefits are also reported in 2024 dollars to allow for comparison with the proposed nominal toll costs for 2024.

5.8 BCA measure. The analysis uses benefit-cost ratio (B/C ratio) to evaluate user benefits per dollar cost of proposed toll rates.

5.9 Discounting. Given that user benefits are accrued contemporaneously with user costs, future benefits and costs are not discounted for the opportunity cost of money.

Market Segmentation

5.10 The benefits accrued by DG users may vary based on their preferences and behaviors. Accordingly, we conducted the BCA for different market segments of DG users that are classified based on their primary user class.

- Personal travel: users making trips related to work, shopping, school, or other personal reasons.
- Business travel: users making trips related to official business.
- Airport trips: users making trips to travel from Dulles Airport (access) and after they return to Dulles Airport (egress).
- Truck trips: users operating heavy-duty vehicles (class 2-4 or vehicles with 3-or-more axles).

Table 5-1: Share of DG User Classes

Market Segment	Share
Commuting/Personal	66.3%
Business	24.7%
Airport Access/Egress	6.2%
Trucks	2.7%

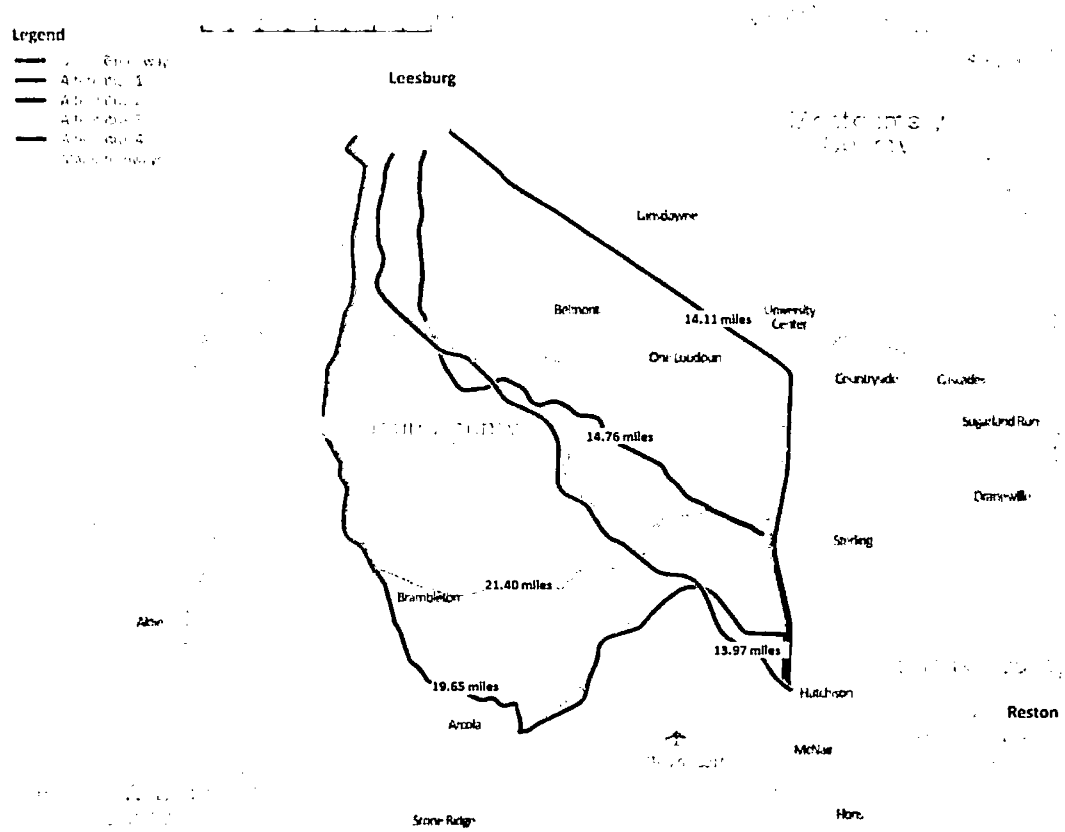
Sources:

- Commuting/personal and business trip shares are estimated using inputs to National Capital Region Transportation Planning Board 2017-2018 Regional Travel Survey
- Airport trip shares are estimated based on screenline traffic counts at Eastbound DG to Airport (access) and Airport Flyover Ramp from IAD to Westbound DG (egress)
- Truck shares are estimated from transactions data based on vehicle axle configuration.

Alternative Routes

5.11 The estimated benefits and costs in the BCA are determined by comparing with the benefits and costs associated with alternative routes to the DG. Figure 5-1 shows the location of DG and alternative routes.

Figure 5-1: DG and Alternative Routes



Source: Steer

5.12 Route 7/VA-28 (Alternative 1) is the most competitive alternative route to DG. The other alternatives to DG are Sycolin Road/Waxpool Road (Alternative 2), Evergreen Mills Road/Loudoun Co Pkwy (Alternative 3) and Evergreen Mills Road/Old Ox Road (Alternative 4). Alternative 1 provides the most competitive travel times, speeds and distances compared to the other alternative routes. Alternatives 2 through 4, however, can provide competitive routes to DG depending on user locations, trip destinations and preferences. For simplicity in the comparison to DG, we developed a composite alternative ("Composite Alternative") reflecting the performance of all alternatives based on their relative traffic share.

5.13 The following sections discuss the BCA inputs, assumptions and estimates in more detail.

User Benefits

5.14 In this section, we discuss how we determined user benefits. The lower congestion and higher posted speed limits on the DG provide users with benefits of travel time reductions and increased reliability on their trips. The DG also provides benefits of reduced vehicle operating costs and increased safety.

Value of Travel Time Savings (VTTS):

5.15 The DG provides travel time savings that benefit drivers and passengers. For the purpose of the BCA, these personal travel time savings are quantified and monetized based on values of travel time savings (VTTS). The monetized VTTS represent the dollars per person-hour that are assumed to be saved when travelers make choices between the DG and alternative routes. Following the US DOT's guidance,[11] we established VTTS values for the various user classes of the DG to use in the BCA, as described below.

Personal Travel

5.16 For purposes of the BCA, we assume that DG personal travel users reside or work within Loudoun and Fairfax Counties, and thus we calculated VTTS for personal travel, including commuting trips, as 50 percent of the hourly median annual household incomes for Virginia's Loudoun and Fairfax Counties in 2021 (latest year of data available), converted to 2022$. The median household annual incomes for the two counties are weighted and the hourly rates are calculated using 2,080 hours per year (rather than 2,000) to be consistent with the Bureau of Labor Statistics (BLS) data. Table 5-2 shows how the county-level demographic data were used to calculate the hourly median annual household incomes and the VTTS per vehicle.

Table 5-2: Hourly Median Annual Household Incomes, 2021

		Loudoun County	Fairfax County	Weighted Average
a)	Households	135,690	408,673	**544,363**
b)	Share of Total (Weights)	25%	75%	**100%**
c)	Median Annual Household Income, 2021$	$156,821	$133,974	**$139,669**
d)	Median Hourly Income, 2021$ (c / 2080)	$75.39	$64.41	**$67.15**
e)	Median Hourly Income, 2022$ (d * 2022 CPI / 2021 CPI)	$81.43	$69.57	**$72.52**
f)	VTTS per Person (50% of Median Hourly Income), 2022$	$40.71	$34.78	**$36.26**
g)	Vehicle Occupancy (2018 HTS)	1.06	1.06	**1.06**
	VTTS per Vehicle, 2022$ (f x g)	$43.16	$36.87	**$38.44**

Source: ACS 5-Year Estimates Data Profiles (2017-2021)

5.17 To estimate the VTTS on a per-vehicle basis, VTTS in dollars per person-hour are multiplied by the average vehicle occupancy rates. We assumed the average vehicle occupancy rate for the metropolitan Washington area's home-based work trips to be 1.06, based on the 2018 Household Travel Survey prepared by the National Capital Region Transportation Planning Board. Table 5-3 below shows that the average vehicle occupancy for home-based work trips for this area has

[11] U.S. Department of Transportation, Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, 2016.

remained constant for over 10 years, while the occupancy rate for trips that are not home-based (NHW and NHO) have declined slightly.

Table 5-3: Average Vehicle Occupancy

Mode/Purpose	HBW	NHW	NHO	Total
HTS 2008	1.06	1.11	1.50	1.39
HTS 2018	1.06	1.07	1.43	1.37

Source: 2008 and 2018 Household Travel Survey prepared by the National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments (MWCOG).

Airport Trips

5.18 Local residents flying from (or to) Dulles Airport can use the DG to access the airport. Given the importance of being on time for air travel, this segment of DG users is expected to have a higher VTTS compared to other personal travelers. Accounting for the overall higher value that is placed on personal and business air travel, studies have shown that airport-related trips can be valued at 1.35 times other personal travel trips.[12] We applied this factor to estimate a VTTS for airport trips of $51.89, as summarized in Table 5-4.

Table 5-4: Value of Time by Trip Category – Airport Access/Egress

Measure	Value
h) VTTS per Vehicle for Personal Travel, 2022$	$38.44
i) Adjustment for value of air-travel related trips	1.35
VTTS per Vehicle for Airport trips, 2022$ (h x i)	**$51.89**

Sources: ACS 5-Year Estimates Data Profiles (2017-2021) and 2018 Household Travel Survey prepared by the National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments (MWCOG), Transportation Research Board Paper 16-4101, Measuring Air Carrier Passengers Values of Time by Trip Component, 2016.

Business Travel

5.19 Business travel includes work-related trips in personal vehicles by users that are "on-the-clock". Business travel does not include commuting travel, which is included in the personal travel category. We estimated the business travel VTTS based on the regional median hourly wage, consistent with US DOT guidance. This approach captures the decision making of travelers that are mindful of time as they make business-related trips. We conducted the following steps to estimate the VTTS for business travel, and Table 5-5 displays the calculations.

- We begin with the median hourly wage for Washington-Arlington-Alexandria, DC-VA-MD-WV metro area in 2022 (latest year of data available) to establish the representative regional median hourly wage.

[12] Transportation Research Board Paper 16-4101, *Measuring Air Carrier Passengers Values of Time by Trip Component*, 2016.

- We factored the median hourly wage rate to account for benefits, using an *employer cost for employee cost multiplier* from the BLS. We calculated this multiplier by diving the median total compensation for employees by the sum of their wages and salaries (US employer cost of compensation) in 2022.
- In keeping with the US DOT's guidance, we then determined the VTTS per person (in dollars per person-hour) to be 100% of the full median hourly income including benefits.
- We then determined the VTTS per vehicle by adjusting the VTTS for vehicle occupancy, based on the NHW vehicle occupancy rates from MWCOG's 2018 HTS.

Table 5-5: VTTS of Business Travel

Measure		Value
j)	2022 Median Hourly Wage (2022$) for Washington-Arlington-Alexandria, DC-VA-MD-WV metro area	$27.08
k)	Benefits Adjustment	1.49
l)	VTTS per Person (100% of Median Hourly Wage), 2022$ (j x k)	$40.27
m)	Vehicle Occupancy (2018 HTS)	1.07
	VTTS per Vehicle, 2022$ (l x m)	**$43.09**

Sources: BLS National Occupational Employment and Wage Estimates, Employer Costs for Employee Compensation by Wage Percentiles (Mar. 2022)

Truck Trips

5.20 We established the VTTS for truck trips based on time-dependent factors of truck operating costs. The main factors include:

- Driver wages and benefits (representing time-dependent trucking costs for carriers) and
- Supply chain costs (representing the time-dependent costs of shippers without transportation).

5.21 We reviewed data on driver wages and benefits from the 2020 American Transportation Research Institute's (ATRI) national survey of commercial vehicle operators.[13] The survey results indicated that these driver-based costs totaled $0.81 per mile in 2021. For the cost category representing shippers without their own transportation, we used estimates from the survey results of the 2019 National Cooperative Highway Research Program (NCHRP) Research Report 925 (Project 07-24).[14] The estimated VTTS for shippers without their own transportation was $15.30 per shipment hour. Table 5-6 outlines the calculation steps taken to estimate the VTTS for truck trips and to express it in 2022$.

[13] American Transportation Research Institute, An Analysis of the Operational Costs of Trucking: 2022 Update. (Arlington, VA: American Transportation Research Institute).

[14] NCHRP Report 925 (Project 07-24), National Academies of Sciences, Engineering, and Medicine 2019. Estimating the Value of Truck Travel Time Reliability. Washington, DC: The National Academies Press. https://doi.org/10.17226/25655.

Table 5-6: VTTS of Truck Trips

Measure		Value
n)	Driver Wages and Benefits per mile, 2021$	$0.81
o)	Average Truck Speed (mph) for Metro Washington DC*	53.1 mph
p)	Driver Wages and Benefits per hour, 2021$ (n x o)	$36.64
q)	Shipper w/o transportation VOT per hour, 2021$	$16.22
r)	Truck VTTS per vehicle, 2021$ (c + d)	$59.17
	Truck VTTS per Vehicle, 2022$ (r * 2022 CPI / 2021 CPI)	**$63.91**

Source: Steer, ATRI and FHWA
* 2019 FHWA Average truck speed data for Washington, DC area.

Value of Reliability (VOR)

5.22 In addition to offering reduced travel times, the DG provides more consistent travel times compared to alternative routes. The consistency of travel times on trips, or specific segments of a road, at different times of the day is referred to as travel time reliability. Travel time reliability is measured by estimating the additional time travelers plan to offset potential delays, known as buffer time. The US DOT defines reliability as "the degree of certainty and predictability in travel times on the transportation system."[15] Travel time reliability can be affected by changes in travel demand by time of day and other factors including traffic incidents, bottlenecks, planned events or other exogenous events such as weather.

5.23 Reliability benefits may be correlated with travel time savings, especially on heavily congested roads where travelers likely face more travel time variability with longer mean travel times.[16] Travelers are expected to take travel time variability into account, giving the worst-case travel times for their planned journeys more weight than average travel times.[17]

5.24 Although the US DOT BCA guidance does not provide specific recommendations on how to measure travel time reliability, there are different reliability metrics that have been developed in

[15] Federal Highway Administration, "Planning Glossary," (website) U.S. Department of Transportation, Washington, DC. https://www.fhwa.dot.gov/planning/glossary/glossary_listing.cfm?TitleStart=R.

[16] U.S. Department of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, February 2021.

[17] Federal Highway Administration, Travel Time Reliability: Making It There On-Time, All the Time, 2017.

relevant studies and are recommended as performance measures by the Federal Highway Administration (FHWA). Table 5-7 summarizes some of the most common reliability metrics:[18,19,20]

Table 5-7: Travel Time Reliability Metrics

Metric	Details
Buffer Time and Buffer Time Index	Buffer Time is measured as the **extra** time road users plan to ensure they arrive on-time in 95 percent of their trips along a particular route. Buffer Time Index is measured as the ratio of buffer time to the average (mean) travel time along the route.
Planning Time and Planning Time Index	Planning Time is measured as the **total** time road users plan to ensure they arrive on-time in 95 percent of their trips. Planning Index is measured as the ratio of planning time to the average (mean) travel time along the route.
Travel Time Index	Measured as the ratio of travel time during peak periods to travel time during free-flow traffic.
Misery Index	Measured as the ratio of excess travel time to average (mean) travel times.
On-time Share	Measured as the share of trips that arrive on-time or early. The threshold for on-time trips can be based on the mean travel times plus an additional 10 percent. This metric can also be interpreted as a failure rate, measuring the share of trips that arrive later than the threshold period.

5.25 Figure 5-2 below displays the relationships between Travel Time Index, Buffer Time, and Planning Time Index. It shows the difference between the Planning Time Index and the Travel Time Index, as the Planning Time Index is a measure of reliability for any time of day while Travel Time Index is a measure of reliability for peak periods.[21, 22]

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[18] Federal Highway Administration, Does Travel Time Reliability Matter?, 2019.

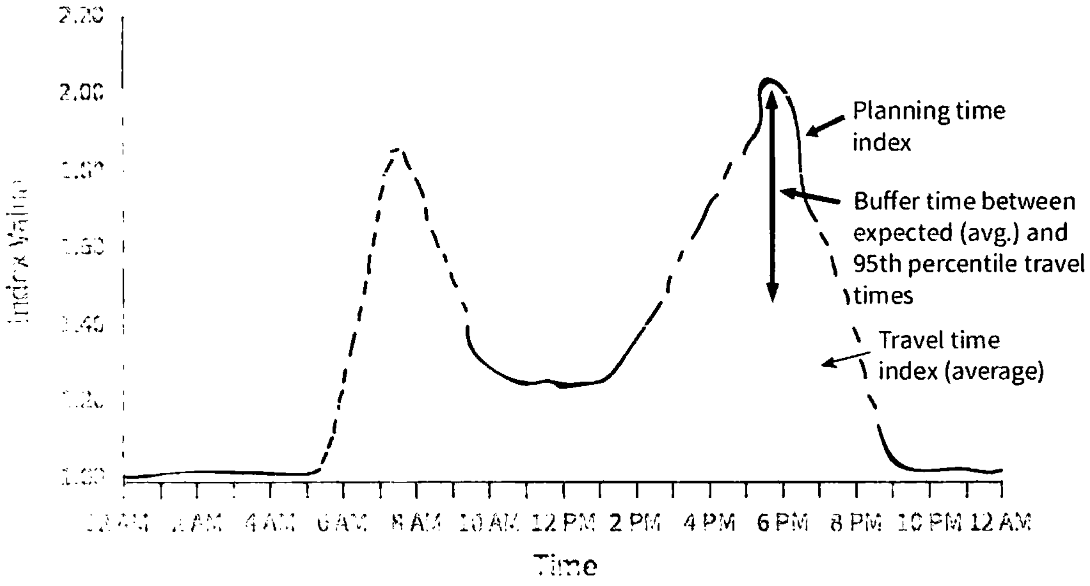
[19] Cambridge Systematics, Inc., Analytical Procedures for Determining the Impacts of Reliability Mitigation Strategies, SHRP2 Report No. S2-L03-RR-1, Transportation Research Board of the National Academies, Washington, DC, 2013.

[20] Van Lint, J.W.C., Van Zuylen, H.J., and Tu, H., "Travel Time Unreliability on Freeways: Why Measures Based on Variance Tell Only Half the Story," Transportation Research Part A: Policy and Practice, 42(1), pp. 258–277, 2008.

[21] Federal Highway Administration, Does Travel Time Reliability Matter?, 2019.

[22] Office of Operations. (2006). Travel Time Reliability: Making it There on Time, All the Time, Report No. FHWA-HOP-06-070, Federal Highway Administration, Washington, DC. Available online: https://ops.fhwa.dot.gov/publications/tt_reliability/brochure/ttr_brochure.pdf

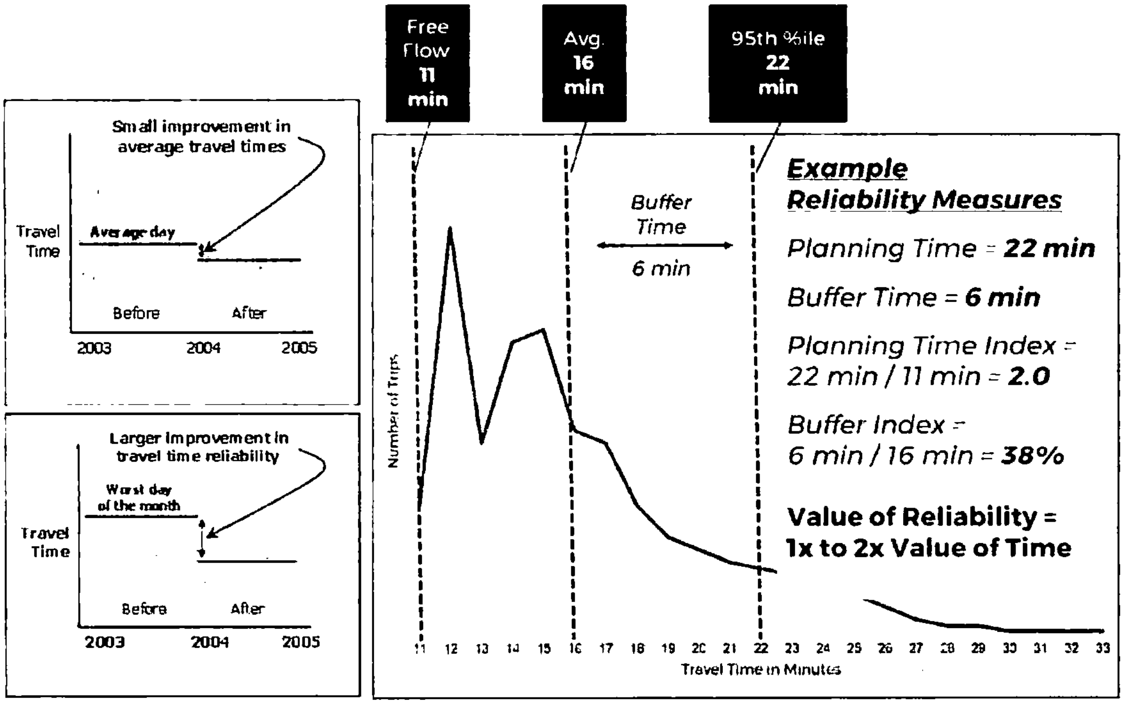
Figure 5-2: Reliability Indices by Time of Day



Source: Federal Highway Administration, Does Travel Time Reliability Matter?, 2019.

5.26 For this study, we adopt the FHWA recommended approach for measuring travel time reliability, based on buffer time. Buffer time is estimated as the difference between planning (95th percentile) and average (mean) observed travel times. Figure 5-3 shows an example calculation of travel time reliability, including the calculation of Buffer Time.

Figure 5-3: Example Calculations of Travel Time Reliability



Source: Federal Highway Administration, Travel Time Reliability: Making It There On-Time, All the Time, 2017.

5.27 We used Value of Reliability (VOR) to convert the travel time reliability savings into a monetary value. Research supports the theory that travelers value travel time reliability more than they value travel time savings. A comprehensive metanalysis of reliability studies through 2014 showed that the ratio of the value of reliability to the value of time (reliability ratio) can range from 0.08 to 3.29 (averages ranging from 0.1 to 2.51).[23] However, more recent studies on pricing strategies, including toll roads and managed high occupancy toll lanes, have estimated the value of travel time reliability can be higher than 3 times the value of travel time savings for users.[24]

5.28 For this BCA, we assume a reliability ratio of 1.5, consistent with the ratios estimated for toll roads of similar length and in comparable metropolitan areas surrounding the DG.[25] This reliability ratio

[23] SHRP 2 Reliability Project L35B. Value of Travel Time Reliability in Transportation Decision Making: Proof of Concept Maryland, 2014.

[24] Brent, D.A. and Gross, A. (2018). "Dynamic Road Pricing and the Value of Time and Reliability," Journal of Regional Science, 58(2), pp. 330–349.

[25] SHRP 2 Report S2-C04-RW01: Improving Our Understanding of How Highway Congestion and Pricing Affect Travel Demand, 2013

is also supported by recent studies focusing on the trucking industry, which estimate the value of reliability at around 1.49 times the value of time for shippers and freight carriers.[26,27]

Travel Time Savings and Travel Time Reliability Savings

5.29 Travel time savings are estimated by calculating the difference in travel times between the DG and alternative routes. We used available 2022 travel times to approximate travel time conditions in 2022. Specifically, we calculated representative travel times from route-level average travel time data obtained from TomTom International BV for the period between October 4, 2022 and October 10, 2022.

5.30 We calculated Buffer Times as the difference between the average travel time and the planning travel time, which is assumed to be the 95th percentile travel times. For the DG and Alternative Route 1, we used the direct travel time values, while for alternative routes 2, 3 and 4, we estimated route travel times by adding the average and 95th percentile "Cumulative Travel Times" of the segments of each road that made up that route.

5.31 The following tables summarize the VTTS, VOR, travel time savings and reliability savings and converts them into monetary benefits for the different user market segments in the peak and off-peak periods. Table 5-8 compares the savings of the DG to the Alternative 1 in 2022$ and Table 5-9 compares the savings of the DG to the Composite Alternative route in 2022$.

Table 5-8: Time and Reliability Savings | DG vs. Alternative 1 (2022$)

		VTTS ($/hr/trip)	VOR ($/hr/trip)	Time Savings (min)	Reliability Savings (min)	Time Savings ($)	Reliability Savings ($)	Total VTTS ($)
Peak	**Share of Trips**							
Commute/Personal	15.1%	$38.44	$57.66	4.35	7.18	$2.79	$6.90	$9.69
Business	5.6%	$43.09	$64.63	4.35	7.18	$3.13	$7.73	$10.86
Airport Access/Egress	1.4%	$51.89	$77.84	4.35	7.18	$3.77	$9.31	$13.08
Trucks	0.6%	$63.91	$95.86	4.20	5.82	$4.47	$9.30	$13.77
Weighted Average:	**22.8%**	**$41.08**	**$61.61**	**4.35**	**7.15**	**$2.98**	**$7.32**	**$10.30**
Off-Peak	**Share of Trips**							
Commute/Personal	51.2%	$38.44	$57.66	1.85	2.10	$1.18	$2.02	$3.20
Business	19.1%	$43.09	$64.63	1.85	2.10	$1.33	$2.26	$3.59

[26] Shams, K., Asgari, H., and Jin, X., "Valuation of Travel Time Reliability in Freight Transportation: A Review and Meta-Analysis of Stated Preference Studies," Transportation Research Part A: Policy and Practice, 102, pp. 228–243, 2017.

[27] Shams, K., Jin, X., Fitzgerald, R., Asgari, H., and Hossan, M.S., "Value of Reliability for Road Freight Transportation: Evidence from a Stated Preference Survey in Florida," Transportation Research Record 2610, pp. 35–43, 2017.

		VTTS ($/hr/trip)	VOR ($/hr/trip)	Time Savings (min)	Reliability Savings (min)	Time Savings ($)	Reliability Savings ($)	Total VTTS ($)
Airport	4.8%	$51.89	$77.84	1.85	2.10	$1.60	$2.73	$4.33
Trucks	2.2%	$63.91	$95.86	1.79	2.03	$1.91	$3.25	$5.16
Weighted Average:	**77.2%**	**$41.14**	**$61.71**	**1.85**	**2.10**	**$1.27**	**$2.16**	**$3.42**
Total Weighted	**100.0%**	**$41.12**	**$61.69**	**2.42**	**3.2**	**$1.66**	**$3.33**	**$4.99**

Source: Steer

Table 5-9: Time and Reliability Savings | DG vs. Composite Alternative (2022$)

		VTTS ($/hr/trip)	VOR ($/hr/trip)	Time Savings (min)	Reliability Savings (min)	Time Savings ($)	Reliability Savings ($)	Total VTTS ($)
Peak	**Share of Trips**							
Commute/Personal	15.1%	$38.44	$57.66	5.69	8.45	$3.65	$8.12	$11.77
Business	5.6%	$43.09	$64.63	5.69	8.45	$4.09	$9.11	$13.19
Airport	1.4%	$51.89	$77.84	5.69	8.45	$4.92	$10.97	$15.89
Trucks	0.6%	$63.91	$95.86	5.53	7.20	$5.89	$11.50	$17.39
Weighted Average:	**22.8%**	**$41.08**	**$61.61**	**5.69**	**8.42**	**$3.89**	**$8.63**	**$12.52**
Off-Peak	**Share of Trips**							
Commute/Personal	51.2%	$38.44	$57.66	3.20	3.54	$2.05	$3.40	$5.45
Business	19.1%	$43.09	$64.63	3.20	3.54	$2.30	$3.81	$6.11
Airport	4.8%	$51.89	$77.84	3.20	3.54	$2.77	$4.59	$7.36
Trucks	2.2%	$63.91	$95.86	3.14	3.48	$3.35	$5.56	$8.91
Weighted	**77.2%**	**$41.14**	**$61.71**	**3.20**	**3.54**	**$2.19**	**$3.64**	**$5.83**
Total Weighted	**100.0%**	**$41.12**	**$61.69**	**3.76**	**4.65**	**$2.58**	**$4.78**	**$7.35**

Source: Steer

Vehicle Operating Cost Savings

5.32 This section discusses the estimation of vehicle operating cost savings that the DG provides in comparison to alternative routes. The improvements and efficiencies in traffic conditions that toll roads like the DG provide to users generate savings in vehicle operating costs, which can be estimated and allocated to user benefits. Given the differences in these savings for the main vehicle types of the DG, they are estimated separately for autos and trucks.

Variable Vehicle Operating Costs: Fuel

5.33 The cost of fuel is an important source of variable operating cost savings to vehicle operators. It is driven by the price of fuel and vehicle-specific fuel consumption rates. While the price of fuel may not differ across the DG and alternative routes, fuel consumption rates are closely tied to vehicle operating speeds, which vary between the DG and alternative routes. Average travel time data obtained from TomTom International BV (TomTom) indicate that vehicles are able to travel faster on the DG, particularly during peak hours. Therefore, accounting for the shift in traffic during different times of the day, fuel cost savings can be estimated for DG users, separately for autos and trucks.

5.34 Table 5-10 shows the prevailing average retail fuel price for regular gasoline and diesel in the Lower Atlantic region at the time of our analysis (also consistent with period of the vehicle travel time data from TomTom).

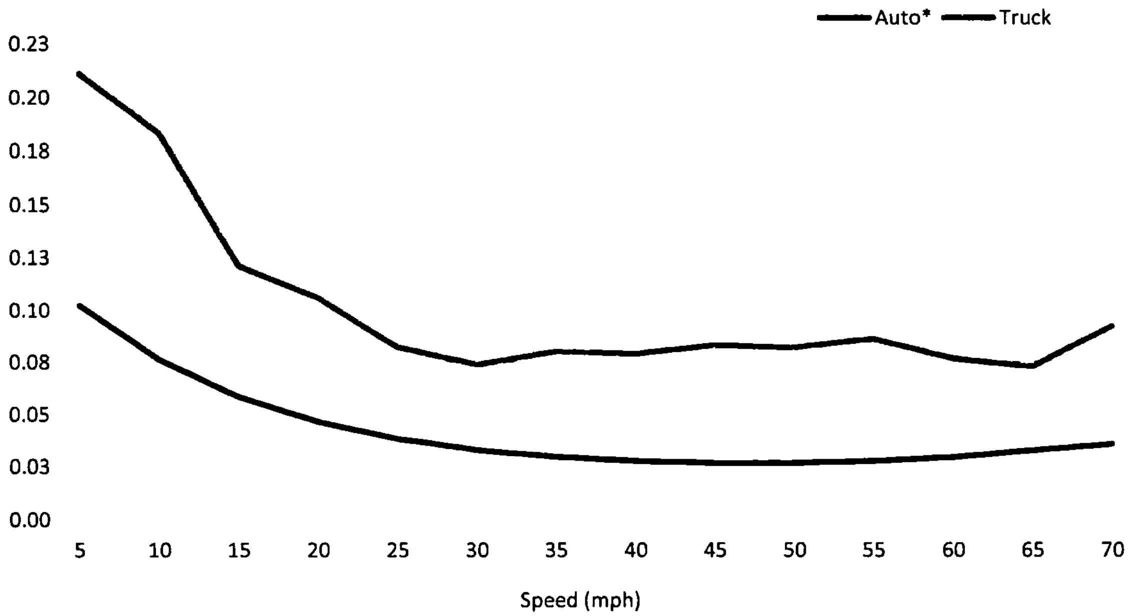
Table 5-10: Average Fuel Price as of May 15, 2023

Year	Auto (PADD 1C RG)	Truck (PADD 1C Diesel)
2019	$2.41	$2.94
2022	$3.65	$4.92
2024	$3.00	$3.62

Source: U.S. Energy Information Administration, Weekly Lower Atlantic (PADD 1C) Regular All Formulations Retail Gasoline Prices and Weekly Lower Atlantic (PADD 1C) No 2 Diesel Retail Prices, Retrieved May 1, 2023. U.S. Energy Information Administration, Short-term Energy Outlook Data Browser, Released May 9, 2023, Retrieved May 15, 2023.

5.35 Figure 5-4 below shows how fuel consumption varies by vehicle speed and by vehicle class, based on information from the California Air Resources Board's cost-benefit model for mobile-source emissions.

Figure 5-4: Fuel Consumption Rates (gal/veh-mi) by Vehicle Class and Speed



Source: California Air Resources Board, EMFAC 2014, 2016 & 2036 average.
* Includes motorcycles & motorhomes

Variable Vehicle Operating Costs: Other

5.36 Other cost savings related to vehicle operations that are distance-based are also considered in the analysis. For both autos and trucks, standard industry sources are used to estimate these costs, broadly categorized as maintenance, repair, and tires. Following the US DOT's BCA guidance, we use national-level marginal vehicle operating costs data from the US DOT Bureau of Transportation Statistics. For trucks, we use data from the American Transportation

5.37 Research Institute.

Table 5-11: Per-Mile Variable Vehicle Operating Costs in 2021 (Maintenance, Repair, and Tires)

Vehicle Class	Cost, 2021$
Auto	$0.10
Truck	$0.22

Source: American Automobile Association, Newsroom, Your Driving Costs Fact Sheet, as of August 15, 2022; Analysis of the Operational Costs of Trucking: August 2022 Update.

Fixed Vehicle Operating Costs

5.38 Fixed costs related to vehicle ownership are also considered in the analysis, based on the same industry sources used to estimate the variable vehicle operating costs for autos and trucks. For autos, these costs include insurance, license, registration, taxes, depreciation, and finance charges. For commercial trucks, the fixed costs include lease or purchase payments, insurance premiums and other permits and licenses. For trucks, driver wages and benefits are excluded from fixed costs because they are already included in the value of travel time savings.

Table 5-12: Per-Mile Vehicle Ownership (Fixed) Costs in 2021

Vehicle Class	Cost, 2021$
Auto	$0.44
Truck	$0.38

Source: American Automobile Association, Newsroom, Your Driving Costs Fact Sheet, as of August 15, 2022; Analysis of the Operational Costs of Trucking: August 2022 Update.

User Benefits: Vehicle Operating Cost Savings

5.39 Table 5-13 and Table 5-14 summarize the vehicle operating cost savings for users of the DG relative to alternative routes. The calculations account for the distances and average travel speeds of each route. The results indicate that per-mile costs are slightly higher for DG users with respect to Alternative 1. The DG provides a shorter route distance and faster travel speeds compared to Alternative 1. However, the fuel consumption rates are higher for the average travel speeds on the DG in comparison to the fuel consumption rates on Alternative 1, more than offsetting savings from the distance-based operating cost factors.

Table 5-13: Vehicle Operating Costs Per Mile

		Fixed Cost per Mile (2019$)		Fuel Consump. (gal/mi)		Fuel Cost per Mile (2022$)		Other Variable Cost (2022$)		Total Cost per Mile (2022$)	
	Speed (mph)	Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck
Peak											
DG	64.00	$0.44	$0.40	0.032	0.073	$0.11	$0.38	$0.10	$0.23	$0.67	$1.08
Alternative 1	50.00	$0.44	$0.40	0.027	0.082	$0.09	$0.42	$0.10	$0.23	$0.65	$1.13
Composite Alt.	49.00	$0.44	$0.40	0.027	0.082	$0.11	$0.51	$0.12	$0.23	$0.69	$1.22
Off-Peak											
DG	65.00	$0.44	$0.40	0.033	0.073	$0.11	$0.38	$0.10	$0.23	$0.68	$1.07
Alternative 1	58.00	$0.44	$0.40	0.029	0.080	$0.09	$0.42	$0.10	$0.23	$0.66	$1.12
Composite Alt.	56.00	$0.44	$0.40	0.028	0.084	$0.11	$0.52	$0.12	$0.27	$0.69	$1.27

Sources: TomTom International BV 2021 (average speeds), EIA (fuel costs as of Oct. 25, 2021), California Air Resources Board, EMFAC 2014, 2016 and 2036 avg. (fuel consumption per mile), AAA and ATRI 2019 (vehicle operating and ownership costs).

Table 5-14: Vehicle Operating Costs Savings Per Trip

		Per Trip Cost (2022$)		Greenway Savings Compared to Alternatives (2022$)	
	Distance (mi)	Auto	Truck	Auto	Truck
Peak					
DG	14.0	$9.41	$15.06		
Alternative 1	14.1	$9.17	$15.93	-$0.23	$0.87
Composite Alt.	14.4	$9.88	$17.47	$0.48	$2.41
Off-Peak					
DG	14.0	$9.44	$14.99		
Alternative 1	14.1	$9.30	$15.80	-$0.15	$0.81
Composite Alt.	14.4	$9.98	$18.33	$0.53	$3.34

Source: Steer

Accident Cost Savings

5.40 The DG provides safety benefits to users by reducing the likelihood of fatalities, injuries, and property damage from automobile crashes due to lower rates of accidents or levels of each accident's severity. The value of safety benefits provided to DG users can be measured by comparing vehicle accident rates on the DG with vehicle accident rates on alternative routes. The monetized value of these benefits to DG users can then be estimated based on crash-cost valuations provided by FHWA.

5.41 The DG's vehicle crash records show that accident rates – categorized by severity in terms of the number of individuals killed, injured or not injured (property damage only (PDO)) per 100 million vehicle miles travelled (VMT) – are substantially lower than the rates of accidents for all of Loudoun County (including the DG) and the Commonwealth of Virginia. Table 5-15, Table 5-16 and Table 5-17 summarize the number of accident injuries by level of severity for the DG, Loudoun County, and the Commonwealth of Virginia, respectively, between 2013 and 2021. The tables also provide the annual VMT estimates that are used to calculate the accident rates by the category of severity for the nine-year period (2013-2021).

Table 5-15: DG Crash Summary, 2013-2021

	Fatalities	Injuries	No Injuries (PDO)	VMT (millions)
2013	2	25	57	159
2014	0	16	70	163
2015	0	18	58	168
2016	0	25	74	173
2017	0	29	77	174
2018	0	16	73	161
2019	0	21	65	160
2020	0	6	50	73
2021	1	11	48	68
2013-2021 Subtotal	3	167	572	1,344
2013-2021 Rate per 100M VMT:	0.2	12.4	42.6	

Source: Steer analysis of traffic data from TRIP II and traffic crash records from the Virginia Department of Motor Vehicles, retrieved April 2023.

Table 5-16: Loudoun County Crash Summary, 2013-2021

	Fatalities	Injuries	No Injuries (PDO)	VMT (millions)
2013	13	1,917	2,269	2,536
2014	12	2,123	2,158	2,588
2015	11	2,143	2,681	2,598
2016	12	2,289	2,632	2,676
2017	22	2,081	2,794	2,785
2018	11	2,299	2,850	2,809
2019	13	2,079	2,872	2,860
2020	12	1,317	2,104	2,210
2021	8	1,523	2,528	2,652
2013-2021 Subtotal	114	17,771	22,888	23,713
2013-2021 Rate per 100M VMT:	0.5	74.9	96.5	

Source: Steer analysis of traffic data from TRIP II and traffic crash records from the Virginia Department of Motor Vehicles, retrieved April 2023.

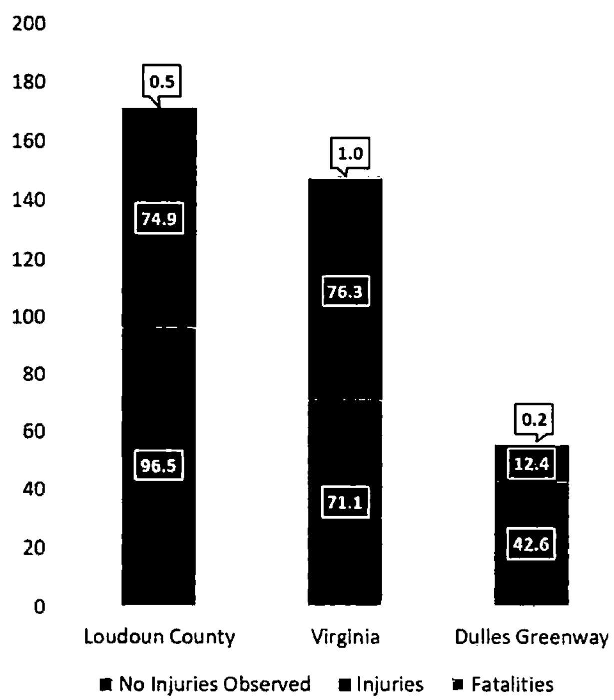
Table 5-17: Commonwealth of Virginia Crash Summary, 2013-2021

	Fatalities	Injuries	No Injuries (PDO)	VMT (millions)
2013	741	65,114	55,908	80,258
2014	700	63,384	56,198	80,985
2015	753	65,029	60,018	82,970
2016	761	67,292	60,472	84,278
2017	843	65,306	61,226	85,964
2018	819	66,523	64,506	86,968
2019	827	65,708	61,637	88,707
2020	847	52,668	52,085	74,476
2021	968	58,786	58,744	81,944
2013-2021 Subtotal	7,259	569,810	530,794	746,550
2013-2021 Rate per 100M VMT:	1.0	76.3	71.1	

Source: Steer analysis of traffic data from TRIP II and traffic crash records from the Virginia Department of Motor Vehicles, retrieved April 2023.

5.42 Also based on monthly traffic crash records between 2013 and 2021, Figure 5-5 highlights the lower rates of accidents on the DG, across all measures of accident severity.

Figure 5-5: Accident Rates per 100 million VMT, 2013-2021



Source: Steer analysis of traffic data from Dulles Greenway and traffic crash records from the Virginia Department of Motor Vehicles, retrieved April 2023.

5.43 Using the accident rates shown above, along with average costs per accident type to convert into monetary terms, we determined the accident cost savings, which contribute to the total benefits of the DG.

5.44 We derived the average costs associated with each of accident category following FHWA's guidance handbook on "Crash Costs for Highway Safety Analysis, 2018". Table 5-18 summarizes the average value of each accident category converted into 2024$. Using these costs, the accident rates per million VMT for the DG and Loudoun County for the alternatives, and trip lengths, we calculated the costs for the DG and alternatives.

5.45 The table shows that due to the lower rate of crashes for the DG, the costs associated with crashes are lower for the DG. This results in the average cost saving per trip for the DG compared with other Loudoun County roads of $2.96 (2024$).

Table 5-18: Monetary Values of Crashes (in 2024$)

	Monetary Value[28] (2024 $)	Crashes per 100M VMT		Cost per 100M VMT	
		DG	Alt	DG	Alt
No Injury	$15,105	42.56	96.52	$642,792	$1,457,882
Injury	$258,698	12.42	74.94	$3,214,229	$19,387,075
Fatality	$14,337,128	0.22	0.48	$3,200,003	$6,892,457
Total		55.20	171.94	$7,057,024	$27,737,414
			Per Trip Cost:	$0.99	$3.95
				Greenway Savings	**$2.96**

Source: Steer

Benefit Cost Ratio

5.46 Using the various benefit values described above and the proposed toll rates, we determined the benefit cost ratio (BCR) for the various travel segments compared against Alternative 1 and the Composite Alternative. The top of Table 5-19 summarizes the benefits relative to Alternative 1 by user class, while the bottom of the table shows the values that are used in the BCR. The BCR is determined by dividing the Total Benefit by the Toll Cost.

[28] Crash Costs for Highway Safety Analysis, FHWA, 2018 | Table 34. Recommended national KABCO comprehensive crash unit costs for the FHWA BCA Guide and Tool (2016$) https://safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf

5.47 In order to facilitate the comparison with the proposed toll rates that are in 2024$, we have inflated the benefits from 2022$ (as presented in prior sections) to 2024$ using an assumed inflation of 6.9% based upon the consensus forecasts published by Focus Economics.

5.48 The table shows that for the categories of auto travelers, the BCR ranges from 0.97 for commuters and personal travel during the off-peak to 2.06 for peak airport access/egress. The BCR values are lower for trucks, with the off-peak truck BCR at 0.57. It is worth noting that these benefit calculations only capture certain, quantifiable benefits and are for the average traveler, and that even without the proposed toll increase the calculated truck BCRs would be below 1.0. However, since there are trucks that use the DG, that behavior suggests that those individual trucks assign greater value to driving on the Greenway and/or value the DG greater than the average traveler or else they would not be using the DG.

5.49 Overall, the DG provides a BCR of 1.15 relative to Alternative 1.

Table 5-19:Benefits and BCR of the DG vs. Alternative 1 (2024$)

	Time Savings ($)	Reliability Savings ($)	Vehicle Operations Savings ($)	Accident Cost Savings ($)	Total ($)
Peak					
Commute/Personal	$2.98	$7.38	-$0.25	$2.96	$13.08
Business	$3.34	$8.27	-$0.25	$2.96	$14.33
Airport Access/Egress	$4.03	$9.96	-$0.25	$2.96	$16.70
Trucks	$4.78	$9.94	$0.93	$2.96	$18.62
Off-Peak					
Commute/Personal	$1.27	$2.16	-$0.16	$2.96	$6.23
Business	$1.42	$2.42	-$0.16	$2.96	$6.65
Airport Access/Egress	$1.71	$2.92	-$0.16	$2.96	$7.43
Trucks	$2.04	$3.47	$0.86	$2.96	$9.34

	Share of Trips	Total Benefit	Toll Cost	Net Benefit	BCR
Peak					
Commute/Personal	15.1%	$13.08	$8.10	$4.98	1.61
Business	5.6%	$14.33	$8.10	$6.23	1.77
Airport Access/Egress	1.4%	$16.70	$8.10	$8.60	2.06
Trucks	0.6%	$18.62	$20.39	-$1.77	0.91
Off-Peak					
Commute/Personal	51.2%	$6.23	$6.40	-$0.17	0.97
Business	19.1%	$6.65	$6.40	$0.25	1.04
Airport Access/Egress	4.8%	$7.43	$6.40	$1.03	1.16
Trucks	2.2%	$9.34	$16.37	-$7.03	0.57
All Day					
Commute/Personal	66.3%	$7.80	$6.79	$1.01	1.15
Business	24.7%	$8.40	$6.79	$1.61	1.24
Airport Access/Egress	6.2%	$9.55	$6.79	$2.76	1.41
Trucks	2.7%	$11.29	$17.22	-$5.92	0.66
Weighted Average	**100.0%**	**$8.15**	**$7.07**	**$1.08**	**1.15**

Source: Steer

5.50 Similarly, Table 5-20 presents the benefits and BCR for the DG relative to the Composite Alternative. This table shows greater benefits, with the auto BCRs ranging from 1.46 to 2.53. The total weighted BCR is 1.62. This shows that even with the proposed toll increase, the DG provides a positive net benefit to average travelers.

Table 5-20: Benefits and BCR of the DG vs. Composite Alternative (2024$)

	Time Savings ($)	Reliability Savings ($)	Vehicle Operations Savings ($)	Accident Cost Savings ($)	Total ($)
Peak					
Commute/Personal	$3.90	$8.68	$0.51	$2.96	$16.06
Business	$4.37	$9.74	$0.51	$2.96	$17.58
Airport Access/Egress	$5.26	$11.72	$0.51	$2.96	$20.46
Trucks	$6.30	$12.29	$2.58	$2.96	$24.13
Off-Peak					
Commute/Personal	$2.19	$3.64	$0.57	$2.96	$9.36
Business	$2.46	$4.08	$0.57	$2.96	$10.07
Airport Access/Egress	$2.96	$4.91	$0.57	$2.96	$11.40
Trucks	$3.58	$5.94	$3.57	$2.96	$16.06

	Share of Trips	Total Benefit	Toll Cost	Net Benefit	BCR
Peak					
Commute/Personal	15.1%	$16.06	$8.10	$7.96	1.98
Business	5.6%	$17.58	$8.10	$9.48	2.17
Airport Access/Egress	1.4%	$20.46	$8.10	$12.36	2.53
Trucks	0.6%	$24.13	$20.39	$3.74	1.18
Off-Peak					
Commute/Personal	51.2%	$9.36	$6.40	$2.96	1.46
Business	19.1%	$10.07	$6.40	$3.67	1.57
Airport Access/Egress	4.8%	$11.40	$6.40	$5.00	1.78
Trucks	2.2%	$16.06	$16.37	-$0.32	0.98
All Day					
Commute/Personal	66.3%	$10.89	$6.79	$4.10	1.60
Business	24.7%	$11.78	$6.79	$4.99	1.74
Airport Access/Egress	6.2%	$13.47	$6.79	$6.68	1.98
Trucks	2.7%	$17.76	$17.22	$0.54	1.03
Weighted Average	**100.0%**	**$11.46**	**$7.07**	**$4.39**	**1.62**

Source: Steer

6 Traffic Forecast and Material Discouragement

Overview

6.1 In Chapter 4, we presented details of the development of the Steer Network Model, which was calibrated to 2022 traffic conditions. We used this model to develop a 2024 Rate Year model year, incorporating the MWCOG population and employment growth forecasts described in Chapter 3, to forecast traffic along the DG for various tolling scenarios, including the proposed toll rates, for year 2024. This chapter discusses the forecasted 2024 traffic levels for these scenarios and considers the forecasts resulting from the proposed toll rates in relation to the material discouragement condition.

2024 Rate Year Model

6.2 In order to evaluate the impact of the DG toll rate increases in the Rate Year 2024, we developed a 2024 model year for the Steer model. This model year includes changes in network and socio-economic data as discussed in the following sections.

Network

6.3 We created the 2024 network by updating the 2022 network to include the roadway improvement projects in the study area that would be complete by the end of 2024. These improvement projects, per the latest MWCOG TIP, are shown in Table 6-1.

Table 6-1: Roadway Improvement Projects (2023-2024)

Project Description	County	Completion Date
Widen Evergreen Mill Road from 2 to 4 lanes	Loudoun	2024
Widen Farmwell Road from Smith Switch Road to Ashburn Rd to 6 lanes	Loudoun	2024
Northstar Blvd Extension between US-50 and Shreveport Drive (6 lanes)	Loudoun	2024
Widen Route 7 by adding one lane in each direction (Reston Ave to Colvin Forest Dr)	Fairfax	2024
Widen I-66 HOT (Outside Beltway) from I-495 to US-15 to 2 lanes	Fairfax	2024

Source: MWCOG TIP

Growth

6.4 We developed initial 2024 subarea trip matrices by interpolating the 2023 and 2025 matrices extracted from the MWCOG model. The 2025 trip matrices reflect the population and employment growth that were presented earlier in Table 3-1. We then applied the growth between the 2022 and 2024 subarea matrices extracted from the MWCOG model to the calibrated 2022 Steer model matrices to estimate 2024 model year matrices. Through this process, the 2024 trip matrix is grown reflecting MWCOG's assumptions of population and employment growth. While this initial growth using MWCOG population and employment growth forecasts represents the background growth in the study area, we further adjusted the matrix growth for trips in-scope to use the DG based on our COVID-19 recovery analysis and econometric time-series forecasting model described in Chapter 3.

Toll Rates

6.5 We used the model to forecast DG traffic levels for 3 toll rate scenarios in 2024. First, we evaluated a scenario where the toll rates are not increased and remain at the current levels, these are called the "Base Rates." Due to inflation, these rates would be around 12.5% lower in real terms than they were in 2022. The second set of rates we analyzed are the "proposed toll rates" that represent an increase of 40% in the peak period-peak direction and 22% to off-peak toll rates. The final set of toll rates we analyzed are ones that have a modest 11.5% increase to all toll rates, these are termed as "alternate rates" for analysis purposes. The 2-axle transponder toll rates for each toll scenario are stated in Table 6-2.

Table 6-2: 2024 2-Axle Transponder Toll Rates Analyzed (Nominal Dollars)

Toll Plaza	Base Rates		Proposed Rates		Alternate Rates	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Shreve Mill	$4.10	$4.10	$5.75	$5.00	$4.55	$4.55
RT 659/Belmont	$5.10	$4.55	$7.10	$5.55	$5.70	$5.05
Claiborne	$5.10	$4.55	$7.10	$5.55	$5.70	$5.05
RT 772/Ashburn	$5.10	$4.55	$7.10	$5.55	$5.70	$5.05
RT 607/Loudoun Co Pkwy	$5.80	$5.25	$8.10	$6.40	$6.45	$5.85
RT 606/Old Ox	$5.80	$5.25	$8.10	$6.40	$6.45	$5.85
RT 28	$5.80	$5.25	$8.10	$6.40	$6.45	$5.85
Mainline	$5.80	$5.25	$8.10	$6.40	$6.45	$5.85

Source: Steer

2024 Forecasts

We used the 2024 Rate Year Model to generate traffic forecasts for the 3 toll scenarios. The average weekday traffic for the DG by toll plazas and implied toll elasticities by peak and off-peak travel are reported in this section.

While the model produces forecasts of average weekday traffic, we converted those forecasts into average daily traffic forecasts for reporting purposes in the tables in this section.

Forecasts

6.6 Table 6-3 shows the forecasted average daily traffic levels at each toll plaza for each of the toll rate scenarios. It shows that without a toll rate increase, at the current toll rates which represent a reduction in real terms, the model estimates 2-way total average daily transactions of 38,797, while the model estimates 36,352 total average daily transactions after implementing the proposed toll rates.

Table 6-3: Estimated 2024 Average Daily Transactions by Toll Plaza

Toll Plaza	Base Rates		Proposed Rates		Alternate Rate	
	EB Exit	WB Entrance	EB Exit	WB Entrance	EB Exit	WB Entrance
Mainline Plaza	16,522	15,839	15,545	14,888	16,046	15,468
Old Ox Rd (Rte 606)	1,164	1,347	1,063	1,270	1,140	1,282
Loudoun County Pkwy (Rte 607)	402	507	372	460	380	485
Ryan Rd (Rte 772)	627	653	577	599	611	638
Claiborne Pkwy (Rte 901)	369	412	332	363	354	388
Belmont Ridge Rd (Rte 659)	350	471	330	438	339	463
Shreve Mill Rd	56	78	52	62	57	70
Total	19,490	19,307	18,272	18,081	18,926	18,794
2-Way Total	**38,797**		**36,352**		**37,720**	

Source: Steer

Implied Toll Elasticities

6.7 Toll price elasticity is an economic concept that measures the sensitivity of demand, in this case traffic, to prices. Network travel demand models do not directly include toll elasticities, but toll elasticities can be calculated from model outputs. We calculated these implied toll elasticities to help us assess the reasonableness of the network model's forecasts. Table 6-4 displays the peak and off-peak transactions and weighted toll rate changes for each scenario. We estimated the implied toll elasticities by dividing the %-change in traffic by the %-change in toll rates. Thus, for the proposed toll rate increase, we divided the -6.3% daily traffic change by the 27.3% toll rate increase to estimate an overall daily toll elasticity of -0.24. Similarly, we calculated implied toll elasticities of -0.23 for the peak and -0.25 for the off-peak. These implied toll elasticities compare with an overall toll elasticity of -0.24 that we estimated as part of our econometric modeling of the DG. Other comparisons include a -0.18-toll elasticity exhibited on the DTR, and more generally a range of -0.12 to -0.35 that we have found for other North American toll facilities.

Table 6-4: Implied Toll Elasticities

Time Period	Base Rates	Proposed Rates		Alternate Rate	
	Transactions	Transactions	% Change	Transactions	% Change
Traffic					
Peak	9,132	8,297	-9.1%	8,845	-3.1%
Off-Peak	29,665	28,054	-5.4%	28,875	-2.7%
Daily	38,798	36,352	-6.3%	37,720	-2.8%
Toll Rates Changes from Base					
Peak			39.5%		11.1%
Off-Peak			22.0%		11.5%
Daily			27.3%		11.4%
Implied Elasticities					
Peak		-0.23		-0.28	
Off-Peak		-0.25		-0.23	
Daily		-0.24		-0.25	

Source: Steer

Material Discouragement

6.8 An important consideration when reviewing proposed toll rate increases is whether the toll increase results in *Material Discouragement*. According to Virginia Code § 56-542, material discouragement is defined to reflect a change in traffic in response to increased toll levels. The statute also requires that the analysis use traffic estimates for the toll forecast year which "takes population growth into consideration".

6.9 Steer has a long-history developing investment-grade travel demand models and using them to prepare forecasts to successfully support the financing of many toll facilities. We leveraged this experience to develop the investment-grade travel demand model described in Chapter 4 and this chapter. As discussed in the last section, using the model to test different toll rates produced traffic forecasts with implied toll elasticities that were consistent with the DG's past performance and within the range of toll facility benchmark performance.

6.10 Because of timing of rate case submittals, the material discouragement should be applied from the last toll rate application, in this case, the last toll increase approved by the SCC was in 2022. We therefore performed the calculation for the material discouragement by comparing the projected 2024 AADT with the observed 2022 AADT for the DG. This calculation of the difference between the projected 2024 AADT and the observed 2022 AADT determine the percent difference used to estimate material discouragement of traffic due to the toll increases. Table 6-5 presents this comparison. It shows that since the 2024 model forecasts that take population, employment, and other growth factors into account are greater than the 2022 AADT, there will be no material discouragement with the proposed toll increases.

Table 6-5: Traffic Change from 2022 Levels

Toll Plaza	2022	2024 Proposed Rates	
	Traffic	Traffic	% Change
Mainline Plaza	27,950	30,432	8.9%
Old Ox Rd (Rte 606)	2,386	2,333	-2.2%
Loudoun County Pkwy (Rte 607)	736	832	13.0%
Ryan Rd (Rte 772)	1,031	1,177	14.1%
Claiborne Pkwy (Rte 901)	658	695	5.7%
Belmont Ridge Rd (Rte 659)	722	769	6.6%
Shreve Mill Rd	135	114	-15.4%
Total	33,618	36,352	8.1%

Source: Steer

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