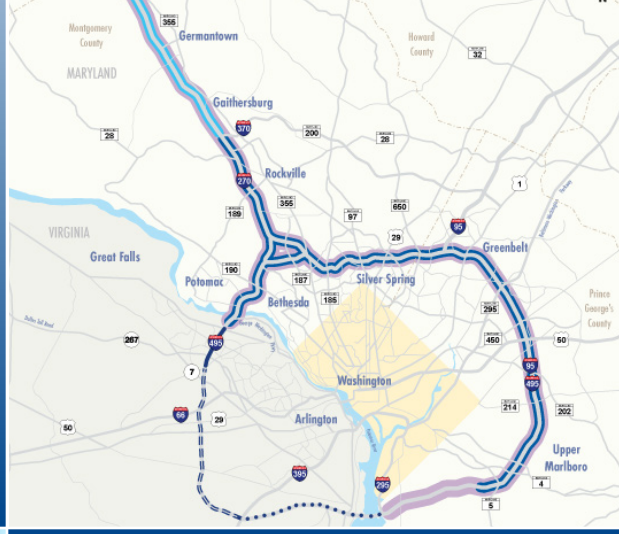
Final

I-495 and I-270 Phase 1 Priced Managed Lanes Comprehensive Traffic and Revenue Study



MDOT Maryland Department of Transportation State Highway Administration

November 4, 2019

CDM Smith

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Appendices

Appendix A I-495 & I-270 Express Lanes Stated Preference Survey Final Report 8-9-19
Appendix B I-270/I-495 Hot Lanes Independent Economic Assessment- Draft Report

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Chapter 1
Introduction

CDM Smith in conjunction with the Maryland Traffic Relief Partners was selected by the Maryland Department of Transportation State Highway Administration (SHA) to perform a comprehensive traffic and revenue study for adding priced managed lanes on I-495 and I-270 in Maryland. This report documents the study, including existing traffic and travel speeds along I-495 and I-270, a stated preference survey, an independent socioeconomic assessment of the region, model development, study assumptions, and the traffic and toll revenue projections for Phase 1 (also called Phase 1A and Phase 2A) of the I-495 and I-270 Priced Managed Lanes Project (the Project). **Figure 1-1** highlights the proposed limits of the full Maryland I-495 and I-270 Project and Phase 1 within the regional context of the D.C. metropolitan area. The limits of the existing Virginia I-95 Express Lanes, I-495 Express Lanes, and I-66 Express Lanes Inside the Beltway are shown. Future Virginia express lane projects are also shown.

Phase 1 of the I-495 and I-270 Priced Managed Lanes Project is assumed from I-495 at the George Washington Memorial Parkway interchange just south of the border with Virginia to I-270 at the I-370 interchange. A northern extension of the existing I-495 Express Lanes in Virginia to the George Washington Memorial Parkway interchange is assumed to connect the Maryland project with the existing I-495 Express Lanes. **Figures 1-2, 1-3, and 1-4** provide schematics illustrating the limits and configuration of the Phase 1 project included in this study.

1.1 Study Objective and Scope

This study's objective was to develop a comprehensive traffic and revenue forecast through 2071 for Phase 1 of the Maryland I-495 and I-270 Project. The priced managed lanes will be operated with the goal of maximizing revenue while limiting the managed lane volume to 1,700 passenger car equivalent vehicles per hour per lane by dynamically pricing most vehicles in the lanes. Full pricing and operating assumptions are described in detail later in this report.

The study was performed in sufficient detail to meet the above objective and included the following key work efforts:

- Development of a current traffic volume and speed profile for the full I-495 and I-270 Project limits, including detailed analysis by time of day and travel direction;
- Assembly of existing count data to validate the Metropolitan Washington Council of Governments (MWCOG) travel demand model across regional screenlines;
- Development of a network window model, calibrated to thirteen time periods to better reflect the volume and speed variations throughout the day;
- Development of future I-495 and I-270 demand based on the MWCOG demand model and independent socioeconomic forecasts;

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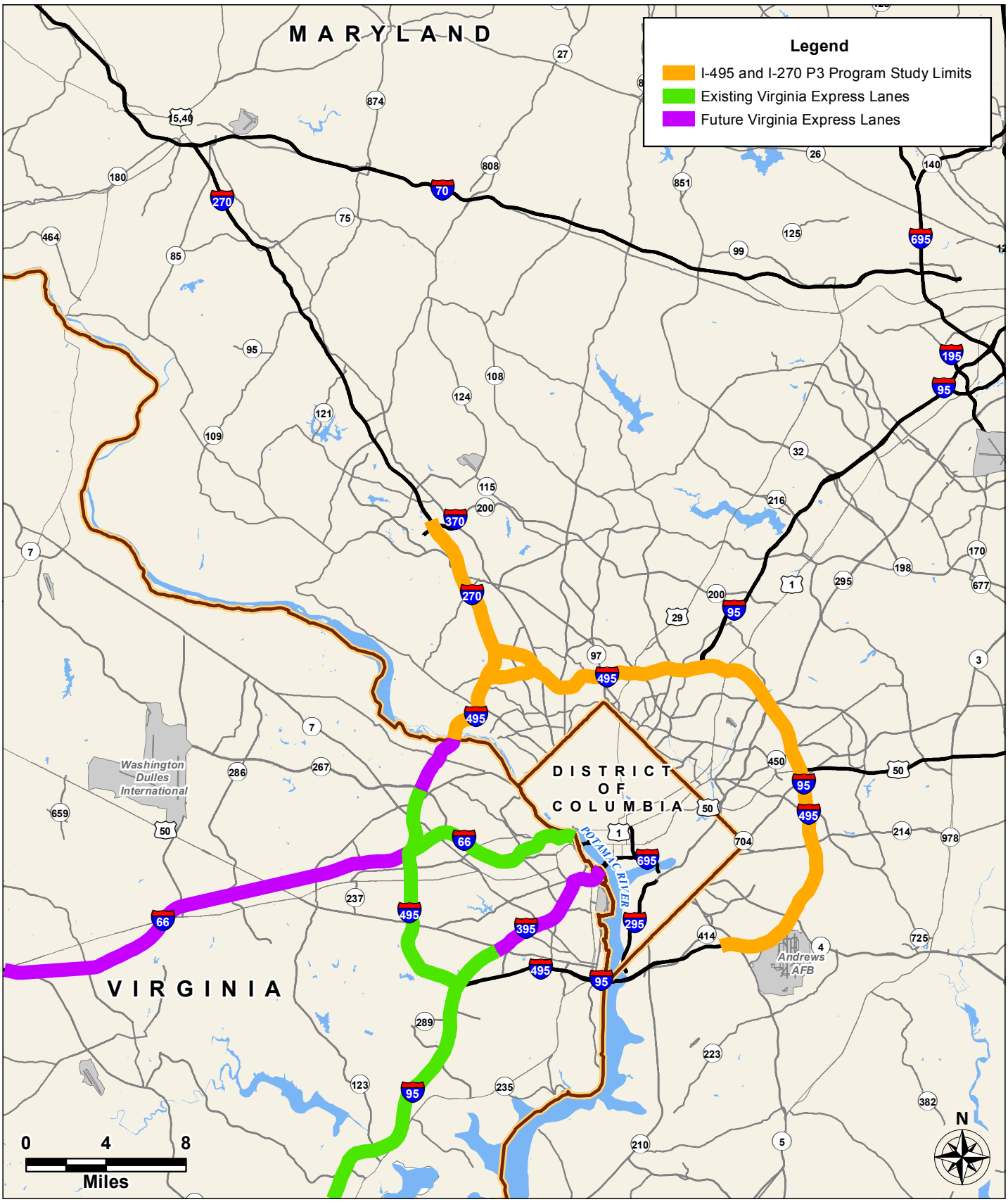

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PROJECT OVERVIEW

FIGURE 1-1

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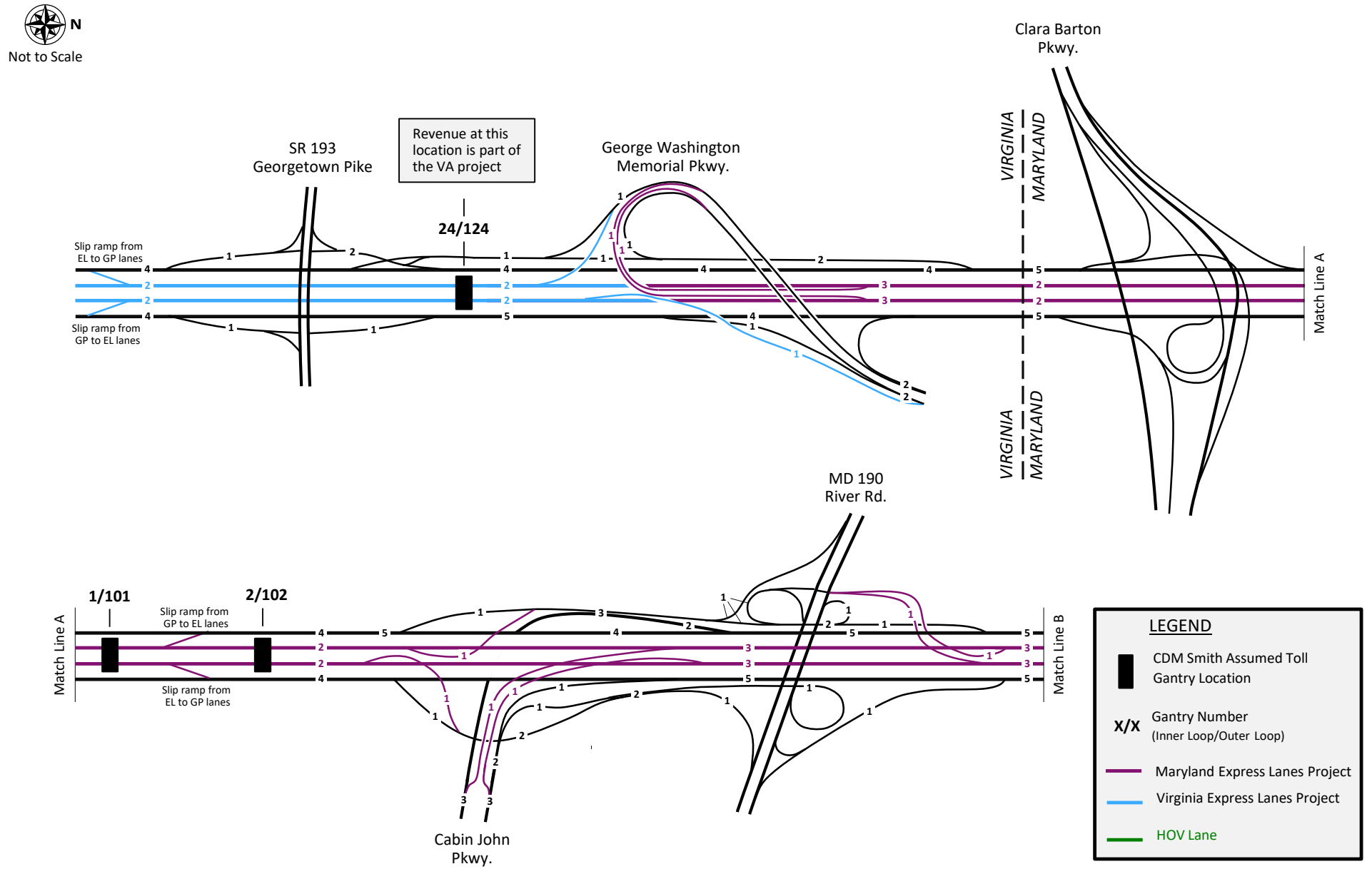

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FIGURE 1-2

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I-495 and I-270 Priced Managed Lanes Traffic and Revenue Study

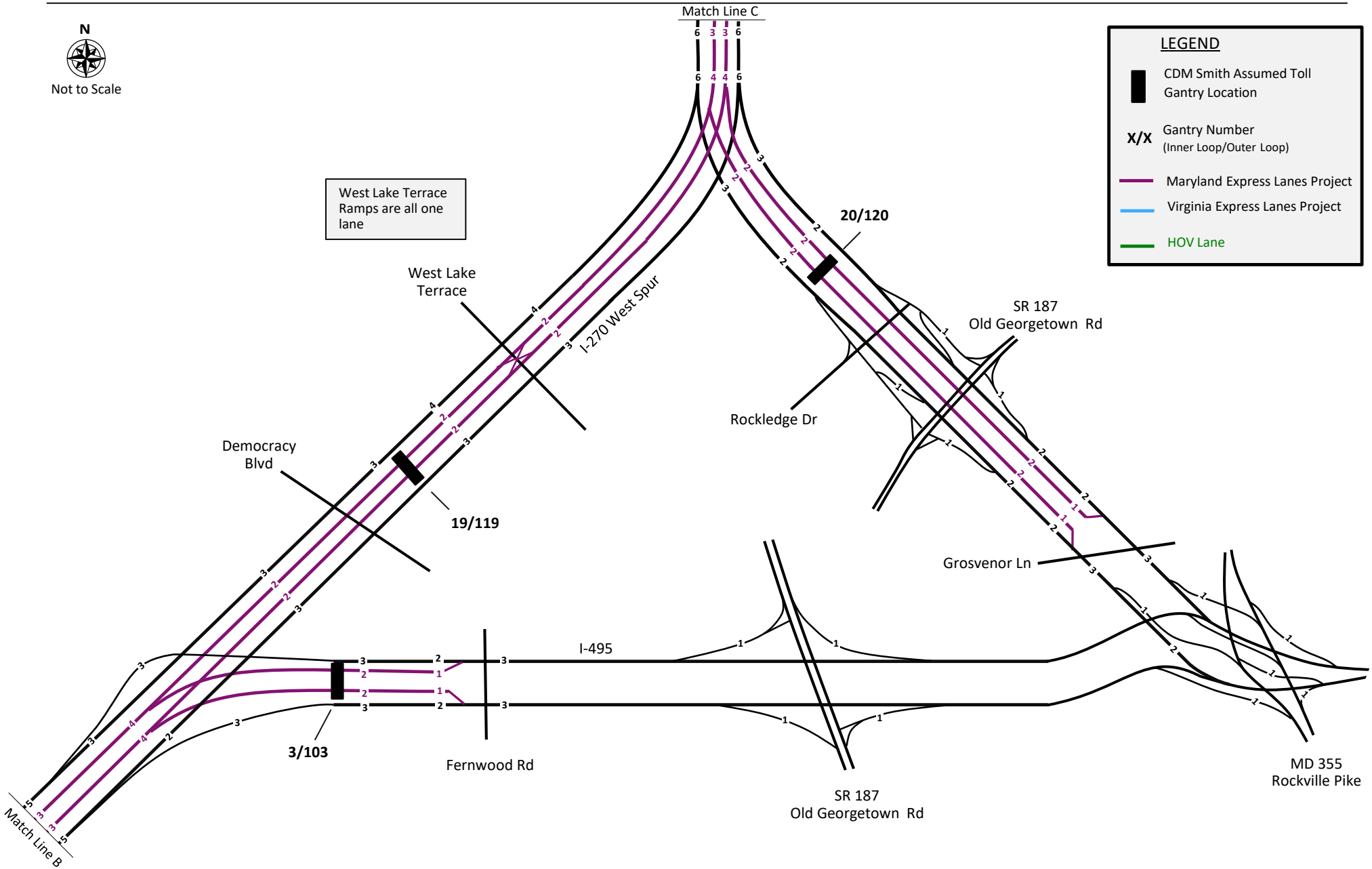

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FIGURE 1-3

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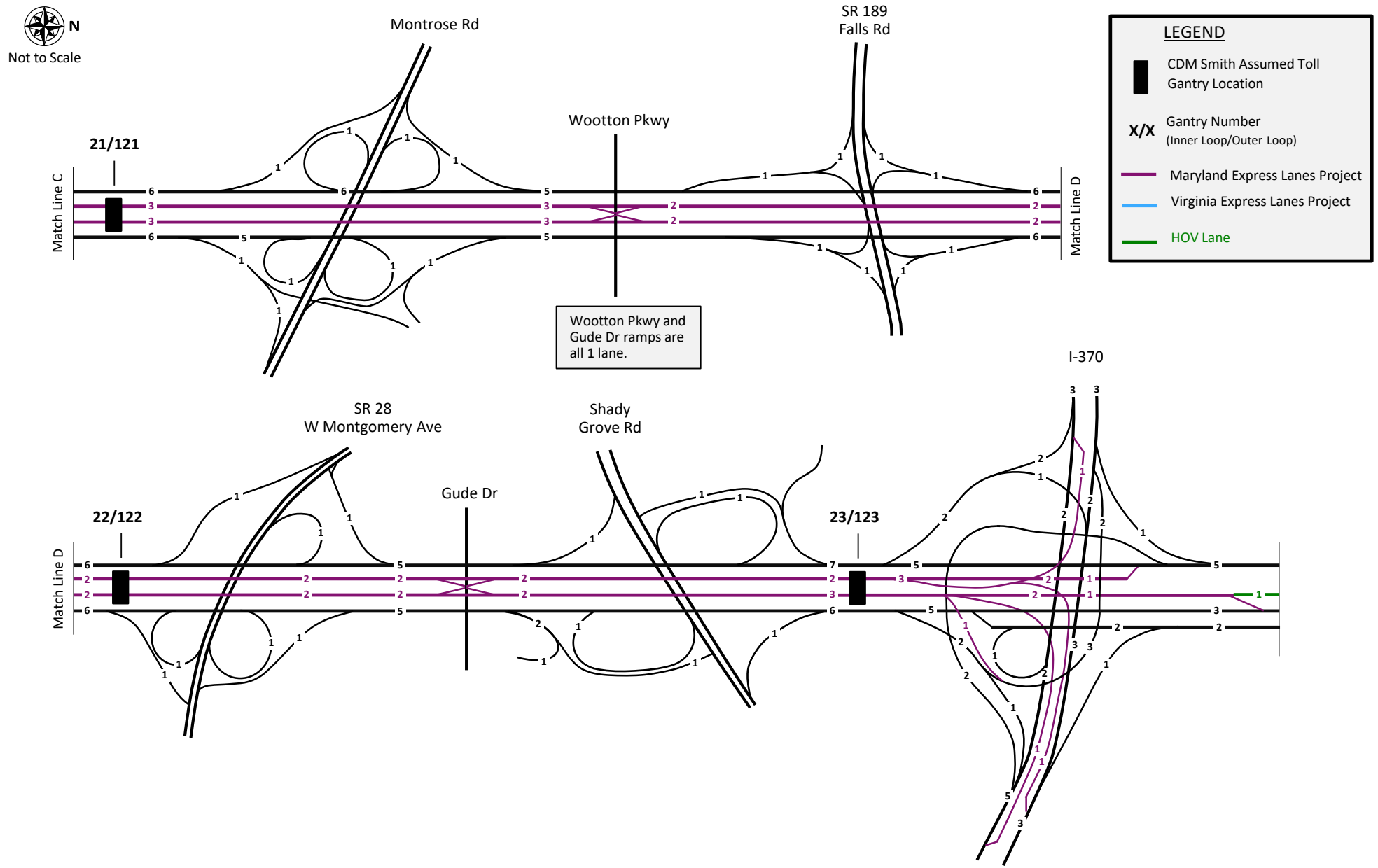

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FIGURE 1-4

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- Development of project-specific value of time estimates based on a Stated Preference Survey of I-495 and I-270 users;
- Development of a tolling model to estimate toll rates that maximize toll revenue and the corresponding toll paying traffic that would be expected on Phase 1 of the I-495 and I-270 Project at those toll rates; and
- Estimation of annual transactions and gross toll revenue through 2071.

1.2 Report Structure

Chapter 2, **Existing Traffic Conditions**, provides a traffic profile of existing I-495 and I-270 within the Phase 1 Project limits, including details on travel speeds. In addition, regional traffic volumes are presented for screenline locations.

Chapter 3, **Stated Preference Survey**, presents a summary of the stated preference survey conducted in the study corridor as part of this study. A copy of the technical details of the survey, along with full survey tabulations, is included in **Appendix A**.

Chapter 4, **Corridor Growth Assessment**, presents a summary of the independent economist's review and adjustment of the MWCOG socioeconomic and demographic forecasts used in the study. The full report of the independent economic consultant is included in **Appendix B** to this report.

Chapter 5, **Model Development and Calibration**, provides a summary of the Metropolitan Washington Council of Governments (MWCOG) Travel Demand Model. In addition, validation summaries of the regional model are presented. The approach splitting and calibrating a window subarea network model is discussed, along with tables and figures displaying calibration summaries.

Chapter 6, **Traffic and Revenue Analysis**, provides the underlying basic assumptions used in the toll modeling process. The chapter provides details on the traffic and revenue estimates for Phase 1 of the I-495 and I-270 Priced Managed Lanes.

Chapter 7, **Sensitivity Tests**, includes the estimated traffic and revenue impacts from varying several of the key assumptions used in the analysis.

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Chapter 2
Existing Traffic Conditions

The evaluation of traffic and revenue potential requires the documentation and analysis of existing traffic conditions on the corridor. Motorists' willingness to pay a toll to use Managed Lanes is dependent on levels of congestion in the adjacent non-tolled general purpose lanes. Therefore, it is important to consider not only daily traffic levels, but also hourly and directional traffic distributions and speeds.

This chapter presents a summary of the existing conditions for the study area including Interstate-495 (I-495) or Capital Beltway, and Interstate-270 (I-270) for use in this study, including a description of the project area and a summary of the data collection.

2.1 Project Area Description

I-495 (Capital Beltway) in the project area serves as a 64-mile loop in Virginia and Maryland, surrounding the capital region of Washington, DC and its inner suburbs. The Beltway also includes a small section in the District of Columbia, near the western end of the Woodrow Wilson Bridge over the Potomac River. The counties through which the Beltway passes include the Prince George's County and Montgomery County in Maryland, and Fairfax County and the independent city of Alexandria in Virginia. I-270 is entirely within Maryland from the I-495 Beltway just north of Bethesda within Montgomery County to I-70 in Frederick within Frederick County. The full Maryland I-495 and I-270 Priced Managed Lanes Project includes I-495 from the vicinity of the Virginia border on the northwestern I-495 Beltway to west of MD 5 on the southeastern I-495 Beltway and I-270 from I-495 to I-370 including both I-270 East and West Spurs.

This study includes Phase 1 of the full I-495 and I-270 project (also called Phase 1A and Phase 2A). The project limits for the priced managed lanes in this study are detailed below.

- **Maryland I-495 Priced Managed Lanes**: The assumed limits are from the George Washington Memorial Parkway interchange south of the border with Virginia to just east of the I-270 West Spur in the vicinity of the Fernwood Road overpass. Note that the exiting I-495 Express Lanes in Virginia are also assumed to be extended north to the George Washington Memorial Parkway by the Virginia Department of Transportation and Transurban for this study.
- **I-270 Priced Managed Lanes**: The assumed limits are from I-495 on the I-270 West Spur to I-370 in Gaithersburg, Maryland. The limits on I-270 also include the I-270 East Spur from the West Spur and East Spur merge point to the vicinity of the Grosvenor Lane overpass.

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2.2 Data Collection

A data collection program was conducted for this study to achieve a better understanding of traffic conditions on and around I-495 and I-270. While this study was conducted specifically for Phase 1 of the overall I-495 and I-270 project, data collection was conducted on the limits of the full I-495 and I-270 project to obtain a better understanding of regional patterns and prepare for study on future phases of the project. In addition to data collection in Maryland, data was also collected on the Virginia I-495 corridor to allow for calibration to recent I-495 Express Lane performance.

Data collection included obtaining traffic counts, speed data, and travel pattern data. A review of the reported historical traffic and revenue performance on existing Virginia Express Lanes was also conducted. This section summarizes the results of these data collection efforts.

2.2.1 Traffic Counts

Traffic counts used in this study came from the following sources:

- Traffic counts from the Maryland Internet Traffic Monitoring System (ITMS) which is available online at http://maps.roads.maryland.gov/itms_public/.
- Maryland permanent count station data (ATRs) from I-495 and I-270 provided by MDOT SHA staff.
- Traffic counts conducted by a CDM Smith subconsultant at selected locations in Maryland.
- Traffic counts organized by the Virginia Department of Transportation on the northern part of I-495 in Virginia.
- Traffic counts conducted by a CDM Smith subconsultant on the entire managed lane limits of I-495 in Virginia, both on the managed lane mainlines and ramps and the general purpose lane mainlines and ramps.
- Data from Transurban from the I-495 managed lanes in Virginia obtained through a non-disclosure agreement.
- Maryland Department of Transportation annual average daily traffic maps.
- Virginia Department of Transportation annual average daily traffic data files.

2.2.2 Historic Average Daily Traffic

Historical traffic trends on the project corridor were analyzed using permanent count stations and annual average daily traffic maps. According to the numbering system designated by MDOT on its historical maps, the following seven permanent ATR locations were selected:

1. ATR #4, ATR #60: Along I-270 north of Gaithersburg
2. ATR #55, ATR #43, ATR #49: Along I-495, in the eastern/south-eastern portion of the Beltway

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3. ATR #40, ATR #41: Along I-495, in the western/north-western portion of the Beltway

A map of the seven ATR locations is provided in **Figure 2-1. Table 2-1** contains historical data from these locations from 1990 to 2017. **Figure 2-2** shows the data in graphical form for locations on I-495, and **Figure 2-3** shows the data in graphical form for locations on I-270. The graphs present the data as an indexed to 1990 equals one. As shown in the graphs, traffic growth was higher in 1990 to 1999 than in more recent decades. Growth has also been higher on I-270 than I-495 with the most recent 2017 indices for I-270 between about 1.7 and 1.9 and for I-495 between 1.2 and 1.6. Traffic growth is still occurring in the most recent decade (2000 to 2017) which is notable especially given the very high levels of congestion on the study corridors as documented later in this chapter.

Figure 2-1
Permanent Count Station (ATR) Locations

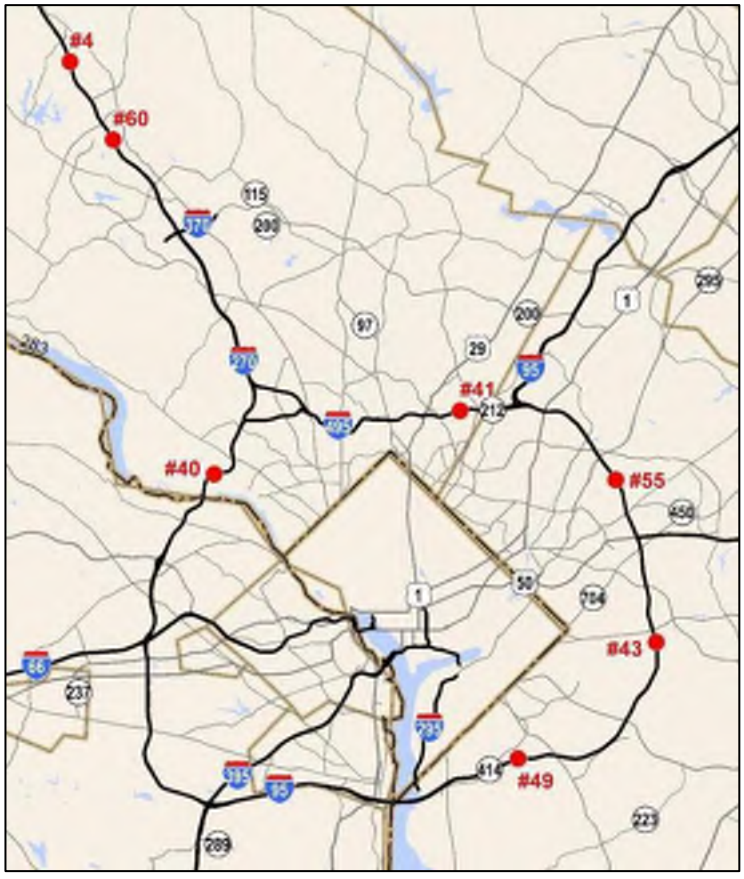

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Table 2-1

Historical Average Daily Traffic at Permanent Count Station Locations

Year	I-270 South of Middlebrook Rd ATR#60	I-270 South of MD 121 ATR#04	I-495 at Persimmon Tree Rd ATR#40	I-495 West of MD 650 ATR#41	I-495 at Good Luck Rd ATR#55	I-495 South of MD 214 ATR#43	I-495 at Temple Hill Rd ATR#49
1990	101,635	59,308	165,565	169,112	179,264	144,097	119,453
1991	104,314	61,220	165,885	173,144	179,112	144,097	119,314
1992	106,993	64,349	177,330	178,164	178,960	152,366	119,175
1993	109,672	66,712	189,266	186,429	178,808	157,555	119,036
1994	112,351	68,507	195,309	189,702	182,604	157,423	123,836
1995	112,807	69,834	199,996	196,458	186,341	167,373	129,107
1996	117,060	71,626	200,671	198,839	190,105	172,324	134,377
1997	121,313	73,417	205,559	199,883	193,869	165,213	130,784
1998	135,672	76,149	205,595	193,642	200,129	182,167	127,190
1999	136,832	78,882	197,537	194,000	201,258	178,745	129,400
2000	129,903	81,614	203,988	203,999	202,387	170,891	134,385
2001	141,032	84,347	210,182	198,089	203,516	176,547	140,427
2002	139,107	87,079	211,242	206,841	204,645	182,203	143,212
2003	151,644	89,812	214,977	216,058	205,773	187,859	144,570
2004	164,181	92,544	218,712	215,262	206,902	193,514	145,590
2005	161,933	95,277	222,447	214,466	208,031	199,170	141,180
2006	159,684	98,009	226,622	211,938	209,160	204,826	136,770
2007	158,986	97,717	225,600	212,166	210,289	205,156	138,862
2008	156,689	96,132	216,015	209,718	203,493	198,468	134,604
2009	154,247	98,097	214,005	210,927	204,147	201,196	143,828
2010	156,994	97,601	214,245	213,207	205,142	206,880	147,130
2011	159,740	98,355	214,484	213,265	202,574	204,312	154,159
2012	162,170	98,439	214,744	211,302	203,698	208,481	155,821
2013	164,585	99,331	220,751	209,339	204,178	209,720	157,732
2014	164,897	98,930	220,874	207,299	203,512	215,096	156,114
2015	168,562	101,459	225,555	210,814	194,742	220,472	154,496
2016	172,653	104,303	227,042	202,725	211,735	225,848	157,740
2017	177,821	108,079	231,375	215,036	214,487	225,351	174,800
Average Annual Percent Change							
1990-1999	3.0%	2.9%	1.8%	1.4%	1.2%	2.2%	0.8%
2000-2009	1.7%	1.9%	0.5%	0.3%	0.1%	1.6%	0.7%
2010-2017	1.8%	1.5%	1.1%	0.1%	0.6%	1.2%	2.5%

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Figure 2-2
Historical I-495 Permanent Count Station Average Daily Traffic Indexed to 1990

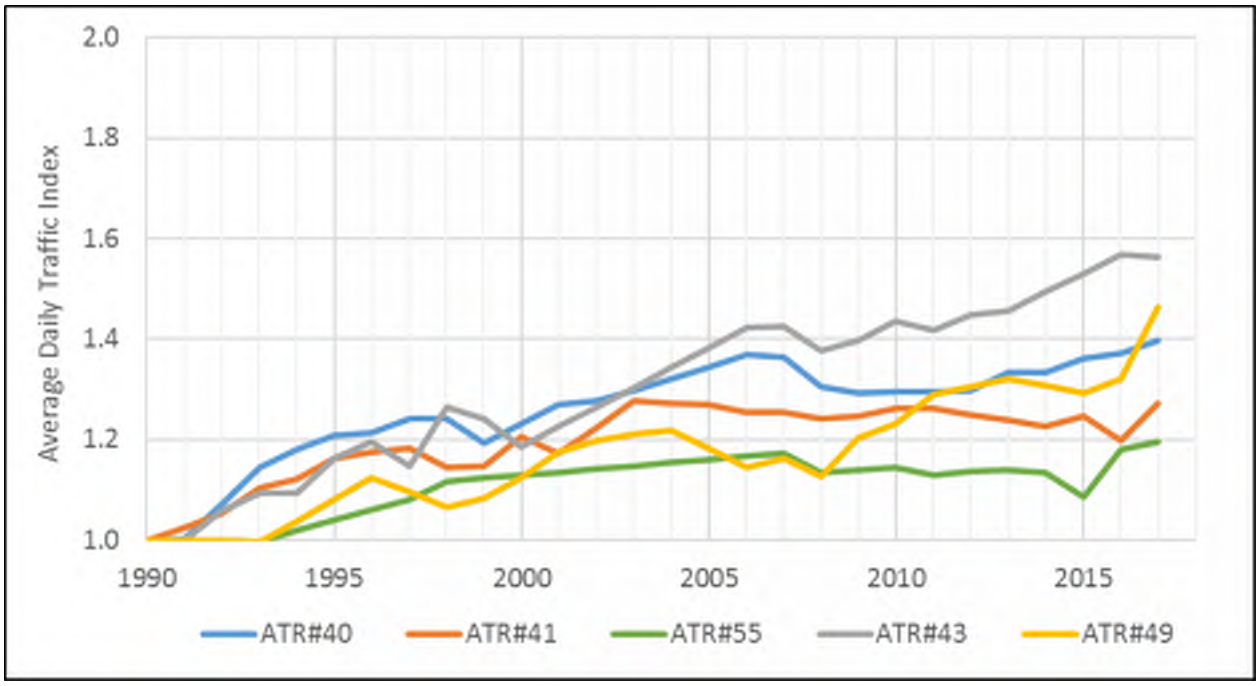
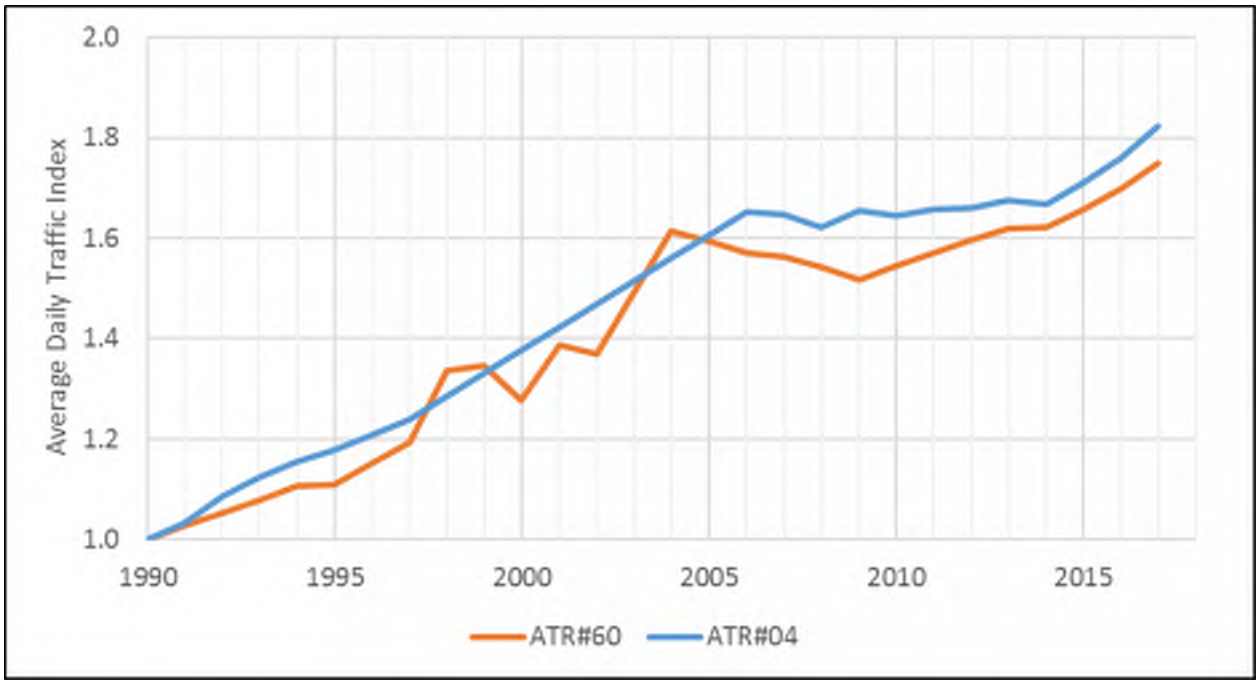


Figure 2-3
Historical I-270 Permanent Count Station Average Daily Traffic Indexed to 1990



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2.2.3 Screenline Counts

One assessment of the validity of the travel demand model is whether the total estimated volume crossing a grouping of parallel routes, called a screenline, compares well with actual traffic volumes. The variation between the traffic assignment from the model and the traffic counts may differ on individual roads; however, if the total assigned volumes crossing the screenlines are close to the counts, then this is an indication that overall traffic demand and travel patterns are being reasonably simulated by the model.

Data for 14 screenlines were compiled along major travel corridors in the region to assess travel patterns on routes that could feed traffic to I-495, I-270, or competing facilities. Ten screenlines, perpendicular to the study corridors, were set up to capture traffic along the competing facilities. Four screenlines, parallel to the study corridors, were set up to capture the traffic feeding into the corridors. **Figure 2-4** shows the fourteen screenlines developed for this study on a regional map.

Data for the screenlines was generally obtained from the ITMS database which contains historical count data updated in three- or six-year cycles at different locations. In order to ensure consistency in data across the count locations, data from different count years was converted to the base model year of 2017 using factors. The factor for a given location was estimated based on historical growth rates at the nearest ATR station. When the most recent counts in the ITMS database were older than 2015, updated traffic counts were conducted by a CDM Smith subconsultant and used in a the screenline analysis. AAWDT screenline count data for the 14 screenlines is provided in **Table 2-2**.

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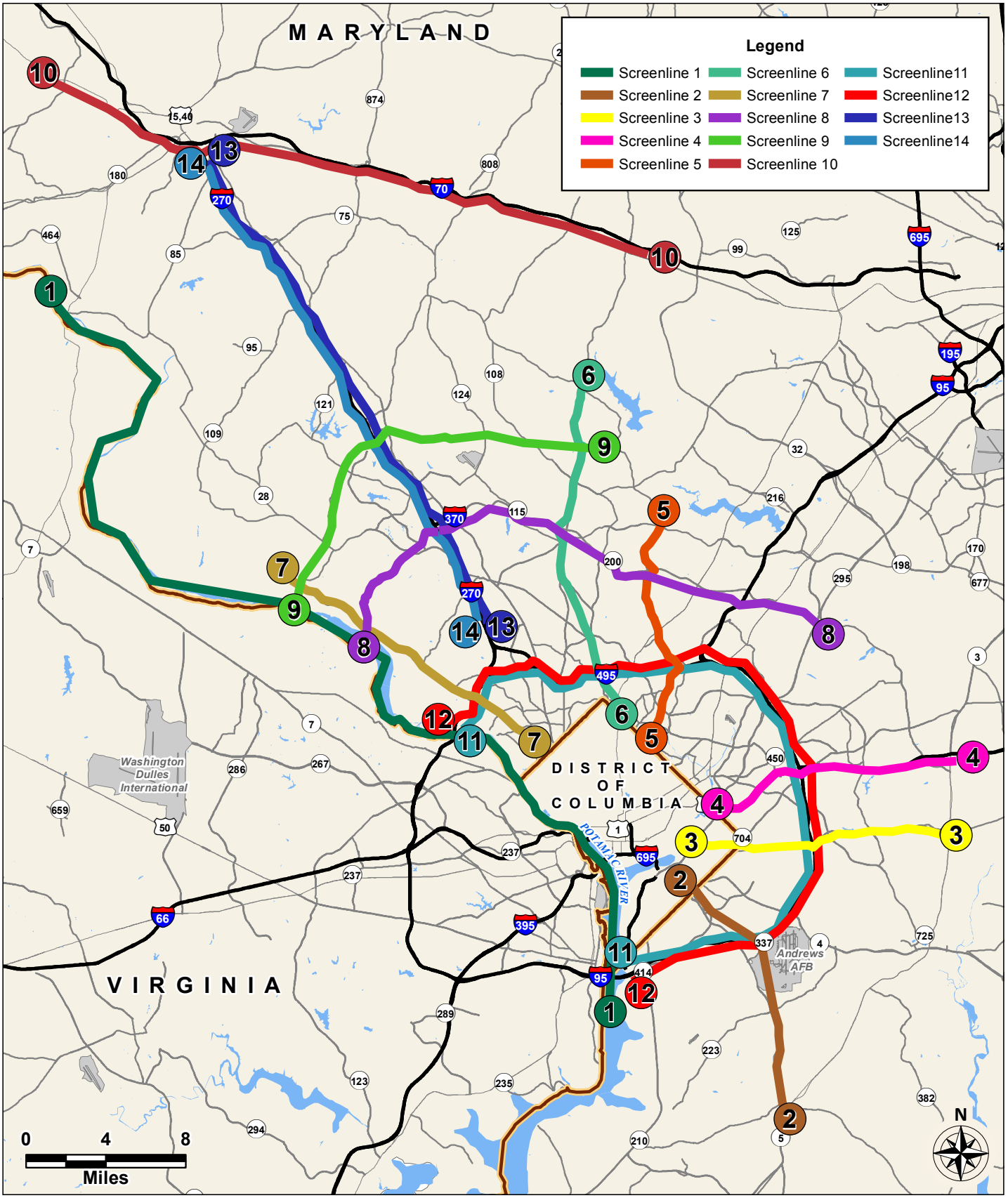

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CDM Smith

TRAFFIC SCREENLINES

FIGURE 2-4

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Table 2-2
2017 Average Annual Weekday Traffic Volumes at Screenline Locations

Screenline	Route No.	Road Name	2017 AAWDT Volume			
			NB/EB	SB/WB	Total	Market Share
Screenline 1 - Potomac River	US-15	Point of Rocks Bridge	10,600	10,800	21,400	2%
	I-495	American Legion Bridge	128,100	133,800	261,900	25%
	-	Chain Bridge	15,400	15,400	30,800	3%
	US-29	Francis Scott Key Bridge	28,100	28,100	56,200	5%
	US-50/I-66	Theodore Roosevelt Bridge	50,100	50,100	100,200	9%
	-	Arlington Memorial Bridge	26,700	26,700	53,400	5%
	I-395/US-1	14th Street Bridge	102,700	95,600	198,300	19%
	I-395 HOV	Rochambeau Memorial Bridge	35,300	41,400	76,700	7%
	I-495	Woodrow Wilson Memorial Bridge/ Capital Beltway	132,900	132,500	265,400	25%
		Total Screenline Volume	**529,900**	**534,400**	**1,064,300**	**100%**
Screenline 2 - East of MD 5	-	Suitland Pkwy	21,400	21,500	42,900	10%
	MD-458	Silver Hill Rd	24,800	22,100	46,900	11%
	I-495	Capital Beltway	95,300	97,800	193,100	46%
	MD-337	Allentown Rd	16,600	12,700	29,300	7%
	-	Old Alexandria Ferry Rd	13,000	14,600	27,600	7%
	MD-223	Woodyard Rd	11,800	10,900	22,700	5%
	-	Surratts Rd	6,300	8,800	15,100	4%
	-	Brandywine Dr	6,200	5,900	12,100	3%
	MD-301	Crain Hwy	14,900	15,700	30,600	7%
		Total Screenline Volume	**210,300**	**210,000**	**420,300**	**100%**
Screenline 3 - South of Capital St/Central Ave	MD-295	Anacostia Fwy	52,400	52,400	104,800	17%
	-	Minnesota Ave SE	9,800	9,800	19,600	3%
	-	Ridge Rd SE	5,100	5,100	10,200	2%
	-	Texas Ave SE	3,100	3,100	6,200	1%
	-	Benning Rd SE	8,500	8,500	17,000	3%
	-	Central Ave SE	3,800	3,800	7,600	1%
	-	Southern Ave SE	6,400	6,400	12,800	2%
	MD-332	Central Ave	6,200	6,000	12,200	2%
	-	Addison Rd S	7,100	7,000	14,100	2%
	-	Shady Glen Dr	8,800	8,300	17,100	3%
	-	Ritchie Rd	13,100	10,400	23,500	4%
	I-495	Capital Beltway	123,100	118,500	241,600	38%
	-	Harry S Truman Dr	9,700	9,700	19,400	3%
	MD-202	Largo Rd	18,900	16,600	35,500	6%
	MD-193	Watkins Park Dr	9,200	9,400	18,600	3%
	-	Church Rd	5,600	5,600	11,200	2%
	MD-301	Crain Hwy	30,800	28,500	59,300	9%
		Total Screenline Volume	**321,600**	**309,100**	**630,700**	**100%**
Screenline 4 - South of US 50	MD-201	Anacostia Fwy	80,300	82,800	163,100	22%
	-	Columbia Park Rd	10,400	10,400	20,800	3%
	MD-202	Landover Rd	28,400	26,800	55,200	8%
	MD-410	MD-410 / Veterans Pkwy	20,400	22,300	42,700	6%
	-	Pennsy Dr	10,600	7,100	17,700	2%
	-	Ardwick Ardmore Rd	9,700	9,600	19,300	3%
	I-495	Capital Beltway	111,000	112,800	223,800	30%
	-	Whitfield Chapel Rd	5,900	6,300	12,200	2%
	MD-704	MLK Jr Hwy	15,600	15,700	31,300	4%
	-	Lottsford Vista Rd	6,000	6,300	12,300	2%
	MD-193	Enterprise Rd	9,200	9,400	18,600	3%
	-	Church Rd	3,500	3,500	7,000	1%
	MD-197	Collington Rd	21,800	22,600	44,400	6%
	MD-301	Crain Hwy	32,100	34,000	66,100	9%
		Total Screenline Volume	**364,900**	**369,600**	**734,500**	**100%**

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Table 2-2 (Continued)

2017 Average Annual Weekday Traffic Volumes at Screenline Locations

Screenline	Route No.	Road Name	2017 AAWDT Volume			
			NB/EB	SB/WB	Total	Market Share
Screenline 5 - East of MD 650	MD-198	Spencerville Rd	11,400	12,200	23,600	4%
	-	Briggs Chaney Rd	3,900	4,000	7,900	1%
	-	Good Hope Rd	4,700	4,800	9,500	2%
	MD-200	Intercounty Connector	31,000	32,100	63,100	11%
	-	Randolph Rd	19,800	20,700	40,500	7%
	MD-29	Columbia Pike	34,400	34,000	68,400	12%
	-	Powder Mill Rd	5,400	8,000	13,400	2%
	I-495	Capital Beltway	131,800	124,700	256,500	44%
	-	Adelphi Rd	11,300	12,000	23,300	4%
	-	Metzerott Rd	6,400	6,300	12,700	2%
	-	Merrimac Dr	3,100	2,800	5,900	1%
	MD-193	University Blvd	19,600	20,200	39,800	7%
	MD-410	East-West Hwy	11,500	13,100	24,600	4%
		Total Screenline Volume	**294,300**	**294,900**	**589,200**	**100%**
Screenline 6 - West of MD 97	MD-650	Damascus Rd	3,800	3,700	7,500	1%
	-	Brookville Rd	400	400	800	0%
	MD-108	Olney Laytonsville Rd	14,600	14,200	28,800	5%
	-	Morningwood Rd	2,600	2,700	5,300	1%
	-	Hines Rd	3,000	2,900	5,900	1%
	-	Emory Ln	3,800	4,000	7,800	1%
	MD-200	Intercounty Connector	31,700	32,400	64,100	10%
	MD-28	Norbeck Rd	13,300	11,300	24,600	4%
	-	Bel Pre Rd	8,600	8,100	16,700	3%
	MD-185	Connecticut Ave	18,400	20,900	39,300	6%
	-	Aspen Hill Rd	8,200	7,600	15,800	3%
	-	Randolph Rd	15,200	15,100	30,300	5%
		Arcola Ave	200	600	800	0%
	MD-193	University Blvd	16,200	16,800	33,000	5%
	MD-586	Veirs Mill Rd	9,600	10,100	19,700	3%
	-	Plyers Mill Rd	2,700	3,000	5,700	1%
	MD-192	Forest Glen Rd	6,000	3,500	9,500	2%
	I-495	Capital Beltway	107,100	106,300	213,400	34%
	-	Seminary Rd	6,100	5,900	12,000	2%
	MD-390	16th St	15,500	17,300	32,800	5%
	-	Spring St	5,000	4,000	9,000	1%
	MD-384	Colesville Rd	15,500	16,100	31,600	5%
		Wayne Ave	7,500	7,800	15,300	2%
		Total Screenline Volume	**315,000**	**314,700**	**629,700**	**100%**
Screenline 7 - North of River Rd	MD-112	Seneca Rd	800	800	1,600	0%
	-	Esworthy Rd	1,200	1,200	2,400	1%
	-	Piney Meetinghouse Rd	3,300	3,700	7,000	2%
	MD-189	Falls Rd	7,900	7,900	15,800	5%
	MD-191	Bradley Blvd	3,900	3,900	7,800	2%
	-	Seven Locks Rd	6,100	5,800	11,900	3%
	I-495	Capital Beltway	134,100	134,600	268,700	78%
	-	Burdette Rd	2,000	1,800	3,800	1%
	MD-188	Wilson Ln	5,300	5,700	11,000	3%
	MD-614	Goldsboro Rd	7,900	8,800	16,700	5%
		Total Screenline Volume	**172,500**	**174,200**	**346,700**	**100%**

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Table 2-2 (Continued)
2017 Average Annual Weekday Traffic Volumes at Screenline Locations

Screenline	Route No.	Road Name	2017 AAWDT Volume			
			NB/EB	SB/WB	Total	Market Share
Screenline 8 - South of MD-200/Intercounty Connector	MD-190	River Rd	5,500	5,300	10,800	1%
	-	Travilah Rd	3,100	3,300	6,400	1%
	MD-28	Darnestown Rd	15,100	14,800	29,900	3%
	MD-119	Great Seneca Hwy	22,600	23,300	45,900	4%
	-	Fields Rd	8,200	10,100	18,300	2%
	I-270	Washington National Pike	116,100	121,800	237,900	21%
	-	Shady Grove Rd	26,900	16,800	43,700	4%
	MD-355	Frederick Rd	25,900	26,300	52,200	5%
	-	Park and Ride Ramp	15,400	9,500	24,900	2%
	-	Needwood Rd	3,600	3,600	7,200	1%
	MD-115	Muncaster Mill Rd	8,700	8,800	17,500	2%
	-	Emory Ln	3,000	3,200	6,200	1%
	MD-97	Georgia Ave	22,900	25,200	48,100	4%
	MD-182	Layhill Rd	10,100	9,500	19,600	2%
	-	Notley Rd	2,600	2,600	5,200	0%
	MD-650	New Hampshire Ave	23,300	23,900	47,200	4%
	MD-29	Columbia Pike	31,600	32,800	64,400	6%
	-	Briggs Chaney Rd	6,200	6,500	12,700	1%
	-	Old Gunpowder Rd	6,100	6,100	12,200	1%
	I-95	Capital Beltway	118,500	114,500	233,000	21%
	-	Virginia Manor Rd	5,700	5,700	11,400	1%
	US-1	Baltimore Ave	16,500	17,900	34,400	3%
	-	Cedarbrook Ln	1,700	1,700	3,400	0%
	MD-295	Baltimore-Washington Pkwy	64,800	65,300	130,100	12%
		Total Screenline Volume	**564,100**	**558,500**	**1,122,600**	**100%**
Screenline 9 - South of Germantown Rd	MD-190	River Rd	1,500	1,800	3,300	1%
	MD-112	Seneca Rd	800	800	1,600	0%
	MD-28	Darnestown Rd	8,500	8,900	17,400	5%
	-	Riffle Ford Rd	2,500	3,100	5,600	2%
	-	Richter Farm Rd	4,300	4,100	8,400	2%
	MD-117	Clopper Rd	13,200	11,000	24,200	7%
	-	Dawson Farm Rd	1,900	2,600	4,500	1%
	-	Wisteria Dr	6,900	6,700	13,600	4%
	-	Middlebrook Rd	12,800	13,700	26,500	7%
	I-270	Washington National Pike	72,900	66,700	139,600	38%
	MD-355	Frederick Rd	14,100	16,100	30,200	8%
	-	Watkins Mill Rd	6,800	7,000	13,800	4%
	-	Goshen Rd	7,200	6,600	13,800	4%
	-	Snouffer School Rd	7,600	6,700	14,300	4%
	MD-124	Woodfield Rd	8,000	8,000	16,000	4%
	-	Muncaster Rd	3,000	3,000	6,000	2%
	MD-108	Olney Laytonsville Rd	9,500	9,400	18,900	5%
	MD-97	Georgia Ave	4,900	5,100	10,000	3%
		Total Screenline Volume	**186,400**	**181,300**	**367,700**	**100%**
Screenline 10 - South of I-70	MD-17	Church St	2,700	2,700	5,400	1%
	-	Maryland Ave	1,300	1,200	2,500	1%
	MD-180	Jefferson Pike	2,100	2,100	4,200	1%
	MD-340	US Hwy 15/501	33,800	32,700	66,500	18%
	MD-351	Ballenger Creek Pike	15,600	10,000	25,600	7%
	-	New Design Rd	8,400	10,500	18,900	5%
	I-270	Washington National Pike	56,300	57,100	113,400	31%
	MD-85	Buckeystown Pike	12,700	13,400	26,100	7%
	MD-355	Urbana Pike	11,600	12,900	24,500	7%
	-	Reichs Ford Rd	1,900	2,000	3,900	1%
	-	Ijamsville Rd	1,600	1,900	3,500	1%
	-	Mussetter Rd	2,500	2,500	5,000	1%
	MD-75	Green Valley Rd	6,500	6,900	13,400	4%
	-	Bartholows Rd	2,900	2,800	5,700	2%
	MD-270	Ridge Rd	14,000	15,200	29,200	8%
	MD-94	Woodbine Rd	3,200	3,200	6,400	2%
	MD-97	Roxbury Mills Rd	8,000	7,900	15,900	4%
		Total Screenline Volume	**185,100**	**185,000**	**370,100**	**100%**

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Table 2-2 (Continued)

2017 Average Annual Weekday Traffic Volumes at Screenline Locations

Screenline	Route No.	Road Name	2017 AAWDT Volume			
			NB/EB	SB/WB	Total	Market Share
Screenline 11 - Inside I-495	-	Clara Barton Pkwy	10,500	9,400	19,900	1%
	-	Cabin John Pkwy	14,500	11,800	26,300	2%
	MD-190	River Rd	26,600	26,700	53,300	4%
	MD-187	Old Georgetown Rd	21,900	23,400	45,300	3%
	MD-355	Rockville Pike	33,300	29,900	63,200	4%
	MD-185	Connecticut Ave	41,300	38,200	79,500	6%
	MD-197	Georgia Ave	42,900	36,800	79,700	6%
	US-29	Colesville Rd	31,800	29,600	61,400	4%
	MD-193	University Blvd	27,500	25,500	53,000	4%
	MD-650	New Hampshire Ave	43,000	49,100	92,100	6%
	US-1	Baltimore Ave	23,800	27,000	50,800	4%
	MD-201	Kenilworth Ave	22,300	23,500	45,800	3%
	MD-295	Baltimore-Washington Pkwy	54,600	60,800	115,400	8%
	MD-450	Annapolis Rd	26,600	25,200	51,800	4%
	US-50	John Hanson Hwy	66,600	55,000	121,600	8%
	MD-202	Landover Rd	28,500	30,600	59,100	4%
	MD-214	Central Ave	29,200	28,900	58,100	4%
	-	Ritchie Marlboro Rd	16,800	17,000	33,800	2%
	MD-4	Pennsylvania Ave	33,400	37,600	71,000	5%
	MD-337	Forestville Rd	10,900	4,600	15,500	1%
	MD-5	Branch Ave	33,100	33,500	66,600	5%
	MD-414	St Barnabas Rd	24,000	22,800	46,800	3%
	MD-210	Indian Head Hwy	12,400	13,800	26,200	2%
	-	I-295	46,900	50,000	96,900	7%
		Total Screenline Volume	**722,400**	**710,700**	**1,433,100**	**100%**
Screenline 12 - Outside I-495	-	Clara Barton Pkwy	6,200	6,900	13,100	1%
	-	Persimmon Tree Rd	1,100	600	1,700	0%
	MD-190	River Rd	18,900	18,200	37,100	2%
	I-270	I-270 Spur	62,200	63,100	125,300	7%
	MD-187	Old Georgetown Rd	20,200	19,500	39,700	2%
	MD-355	Rockville Pike	33,300	30,000	63,300	4%
	MD-185	Connecticut Ave	23,900	24,300	48,200	3%
	MD-97	Georgia Ave	32,100	39,100	71,200	4%
	US-29	Colesville Rd	33,200	38,000	71,200	4%
	MD-193	University Blvd	20,600	21,600	42,200	2%
	MD-650	New Hampshire Ave	26,600	26,800	53,400	3%
		I-95	113,900	100,800	214,700	12%
	US-1	Baltimore Ave	20,300	22,900	43,200	2%
	MD-201	Kenilworth Ave	18,800	19,500	38,300	2%
	MD-295	MD 295	63,900	65,300	129,200	7%
	MD-450	Annapolis Rd	35,500	35,900	71,400	4%
	US-50	US 50	81,500	75,300	156,800	9%
	MD-202	Landover Rd	34,700	37,700	72,400	4%
	MD-214	Central Ave	41,200	37,100	78,300	4%
	-	Ritchie Marlboro Rd	21,300	24,000	45,300	3%
	MD-4	Pennsylvania Ave	35,300	34,100	69,400	4%
	MD-337	Allentown Rd	13,900	13,800	27,700	2%
	MD-5	Branch Ave	77,000	76,900	153,900	9%
	MD-414	Oxon Hill Rd	16,800	19,300	36,100	2%
	MD-210	Indian Head Hwy	46,400	42,300	88,700	5%
		Total Screenline Volume	**898,800**	**893,000**	**1,791,800**	**100%**

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Table 2-2 (Continued)
2017 Average Annual Weekday Traffic Volumes at Screenline Locations

Screenline	Route No.	Road Name	2017 AAWDT Volume NB/EB	SB/WB	Total	Market Share
Screenline 13 - East of I-270	-	Montrose Rd	29,400	33,600	63,000	11%
	MD-189	Maryland Ave	13,700	13,800	27,500	5%
	MD-28	Montgomery Ave	13,300	14,600	27,900	5%
	-	Redland Blvd	8,400	6,100	14,500	2%
	-	Shady Grove Rd	24,200	26,000	50,200	8%
	-	I-370	52,100	54,700	106,800	18%
	MD-117	Diamond Ave	14,700	18,300	33,000	6%
	MD-124	Montgomery Village Ave	36,800	37,700	74,500	13%
	-	Middlebrook Rd	17,400	19,100	36,500	6%
	MD-118	Germantown Rd	14,200	14,700	28,900	5%
	-	Ridge Rd	19,900	19,200	39,100	7%
	MD-121	Clarksburg Rd	11,500	11,400	22,900	4%
	MD-109	Old Hundred Rd	3,900	5,100	9,000	2%
	-	MD-80	11,700	12,100	23,800	4%
	-	MD-85	18,200	19,300	37,500	6%
		Total Screenline Volume	**289,400**	**305,700**	**595,100**	**100%**
Screenline 14 - West of I-270	-	Montrose Rd	19,800	17,400	37,200	7%
	MD-189	Maryland Ave	14,200	14,800	29,000	6%
	MD-28	Montgomery Ave	27,100	28,000	55,100	11%
	-	Shady Grove Rd	21,700	22,300	44,000	9%
	-	I-370	40,000	38,500	78,500	16%
	MD-117	Diamond Ave	28,700	25,100	53,800	11%
	MD-124	Montgomery Village Ave	15,400	15,200	30,600	6%
	-	Middlebrook Rd	12,800	13,700	26,500	5%
	MD-118	Germantown Rd	22,100	22,800	44,900	9%
	-	Ridge Rd	16,900	16,200	33,100	7%
	MD-109	Old Hundred Rd	1,600	1,700	3,300	1%
	-	MD-80	4,200	4,000	8,200	2%
	-	MD-85	25,800	28,900	54,700	11%
		Total Screenline Volume	**250,300**	**248,600**	**498,900**	**100%**

2.2.4 Hourly Traffic Distribution

The peaking characteristics of a facility are an important input to the study of managed lanes. This section details average vehicles per hour per lane for I-270 and I-495 by direction to evaluate the peaking characteristics of the corridors. Because the permanent ATR count stations had long-term historical data available, the resulting weekday averages were held at a higher confidence level than data from the Maryland ITMS system, which was generally based on 48-hour weekday counts. Thus, the ATR traffic were key check points in the evaluation of peaking characteristics of the corridors.

Figure 2-5 shows 2017 Tuesday to Thursday hourly average raw traffic counts from Maryland ATR data by PC and CV for three key ATR locations. As shown, ATR #40 PC traffic peaks in the morning in the 7 AM hour with about 8,000 vehicles per hour in both directions of travel. In the afternoon, PC traffic peaks in the eastbound direction in the 2 PM hour with just under 8,000 vehicles per hour before falling to about 5,000 vehicles per hour in the 4 PM and 5 PM hours. This significant decline in traffic during the peak is due to severe queuing in this direction near the Virginia-Maryland border. Peak traffic at ATR #55 is also around 8,000 vehicles per hour in the 7 AM hour in the northbound direction. PM peak PC traffic is flat at around 6,500 vehicles per hour in both directions, which indicates congested conditions. CV traffic is higher at ATR #55 than ATR #40, peaking at about 450 vehicles per hour compared to 350. I-95, which is a significant long-distance CV route, runs concurrent with the I-495 east beltway which leads to higher CV volumes at this location.

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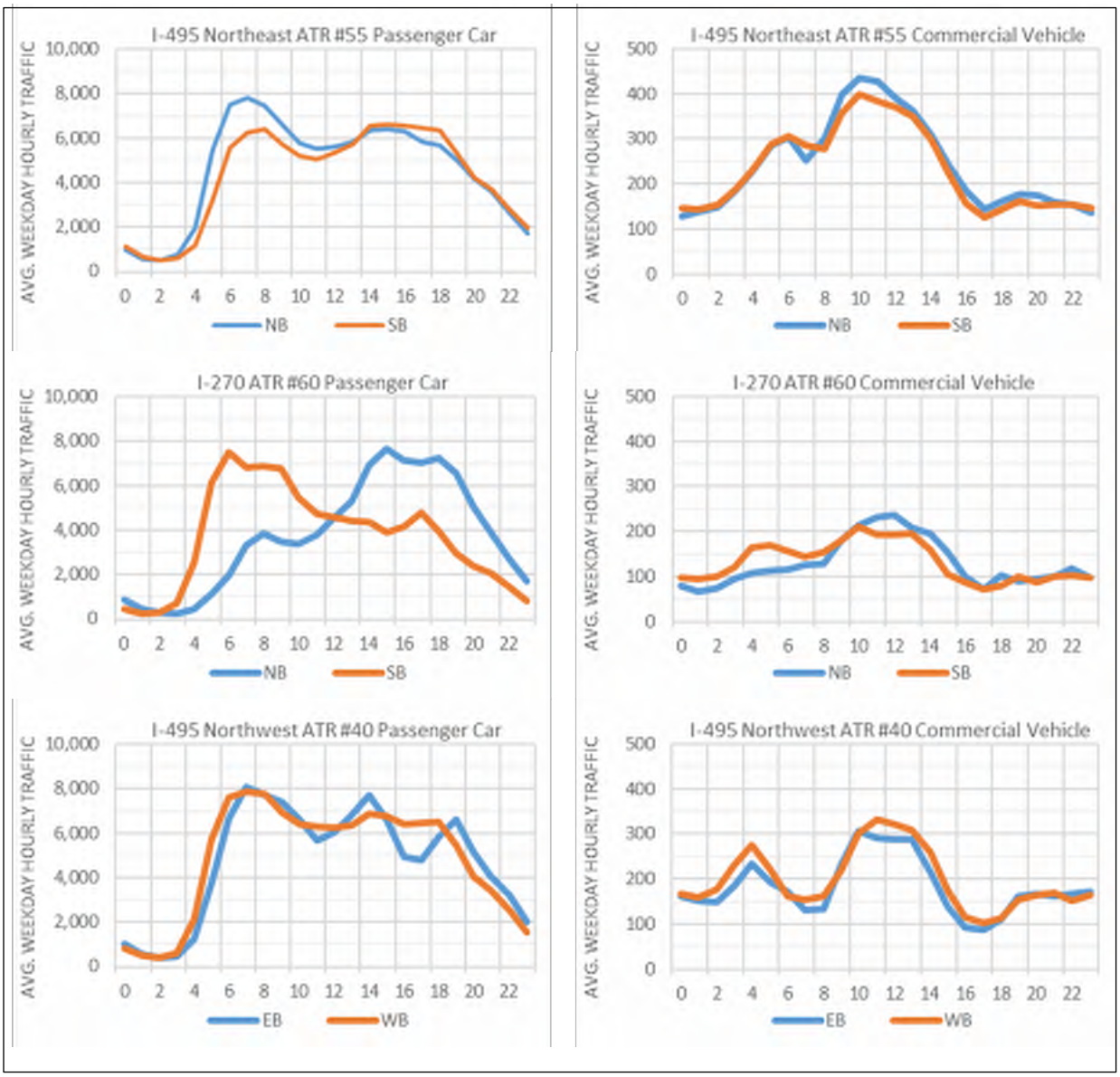
Figure 2-5
2017 Weekday Hourly Average Traffic at Permanent Traffic Count Stations (ATRs)



Compared to ATR #40 and ATR #55 on I-495, ATR #60 on I-270 shows more pronounced PC directional-peaking characteristics, as is typical of a radial route. PC traffic peaks at about 7,500 vehicles per hour in the southbound AM and at about the same level in the northbound PM. CV traffic is also lower on I-270 and peaks at only about 250 vehicles per hour during the midday.

2.2.5 Average Travel Speeds

Speed data for I-495 and I-270 was analyzed to quantify the existing congestion patterns throughout the I-495 and I-270 Priced Managed Lane study corridor and on the I-495 general purpose lanes in Virginia. The data was obtained from INRIX on Tuesdays to Thursdays for the 2017 calendar year. **Figure 2-6** shows the average hourly speed for I-270 including the East and

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West Spurs. **Figure 2-7** and **Figure 2-8** show the average hourly speed for I-495 Inner Loop and I-495 Outer Loop, respectively.

Northbound speeds on I-270 start to decrease around 3:00 PM, with the worst congestion in the 5:00 PM hour. On the I-270 Spur, there is significant congestion ranging from 4:00 PM until 7:00 PM in this direction. The morning hours show relatively little congestion as this is the off-peak travel direction. On Southbound I-270, congestion begins in the 6:00 AM hour and is most severe in the 8:00 AM hour. The southbound West Spur also shows congestion beginning at 1:00 PM prior to the merge with I-495 and backs up beyond Democracy Blvd. as a result.

The I-495 Inner Loop in Maryland shows relatively little congestion in the morning hours. In Virginia, congestion builds beginning near the American Legion Bridge and spills back beyond Braddock Road. The worst congestion in this area is in the 8:00 AM hour. In the PM, congestion builds from the I-270 Spur all the way back across the American Legion Bridge into Virginia and down to VA 123. This severe backup begins around 2:00 PM in some parts and does not clear until 7:00 PM in Maryland or 8:00 PM in Virginia. In addition, there are numerous bottlenecks on the northern and eastern sections of the Inner Loop, specifically building around MD 185 and in the area of the Greenbelt Metro station.

The I-495 Outer Loop shows one large area of congestion, spanning from between MD 185 and MD 97 all the way back to I-95. This backup lasts from 6:00 AM to 10:00 AM. In addition to this, there are minor slowdowns approaching the American Legion Bridge, and on the eastern side of the beltway near MD 202. In the evening, the worst congestion on the Maryland side of I-495 is approaching the American Legion Bridge, backing up past the I-270 Spur to Old Georgetown Road. Beyond that, and going further back, slowdowns persist all the way back to between MD 650 and I-95. There are additional slowdowns in the area of MD 202 in the PM as well. In Virginia, there is a heavy backup from VA 650 back to the Dulles Toll Road, spanning multiple hours from 4:00 PM to 7:00 PM.

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Figure 2-6
2017 Average Tuesday to Thursday Speeds on I-270 by Hour[1]

Interchange	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM
I-270 Northbound																
I-370	63	64	62	63	62	63	62	60	61	64	60	51	38	41	55	62
	62	63	62	63	62	62	63	61	57	62	57	48	31	32	53	62
Shady Grove Road	59	61	60	60	58	59	59	59	58	58	44	29	16	19	44	57
	57	58	59	61	61	62	59	60	57	61	59	53	35	37	57	59
Montgomery Ave/MD 28	57	57	55	53	52	55	56	55	55	55	54	52	47	47	52	54
	62	62	61	60	59	61	62	61	61	61	56	52	42	46	58	61
Maryland Ave/MD 189	59	59	58	58	55	57	56	57	57	57	50	43	33	38	52	56
	60	61	61	62	61	61	61	61	61	60	57	51	45	47	57	61
Montrose Rd	54	59	57	57	57	57	57	57	57	56	49	40	34	35	50	56
	63	63	63	62	62	61	61	62	62	60	50	33	29	33	54	60
I-270 East Spur Northbound																
I-270	63	63	63	62	62	61	61	62	62	60	50	33	29	33	54	60
	62	61	60	61	61	61	61	61	61	61	47	23	18	23	56	60
Old Georgetown Rd/MD 187	62	62	61	61	61	62	63	63	63	62	54	28	22	28	58	61
	61	60	59	59	59	60	60	60	60	60	56	36	28	36	58	59
I-495	58	56	54	52	53	55	55	55	52	54	50	31	23	32	52	55
I-270 West Spur Northbound																
I-270	62	64	65	63	63	62	61	62	61	57	46	36	30	31	45	58
	61	63	64	63	62	61	61	60	60	53	39	31	25	27	39	57
Democracy Blvd	61	63	64	63	62	61	61	61	59	51	29	24	20	22	33	56
	62	63	63	62	61	61	61	60	60	52	31	24	20	24	35	59
I-495	62	63	63	62	61	61	61	60	60	52	31	24	20	24	35	59
I-270 Southbound																
I-370	65	56	31	31	47	61	63	63	63	63	64	64	63	63	62	62
	65	54	21	21	37	58	62	62	61	62	62	63	62	61	61	60
Shady Grove Road	60	51	16	15	30	54	59	59	59	59	60	60	60	59	59	57
	68	52	22	21	30	54	65	65	65	65	65	66	65	65	65	64
Montgomery Ave/MD 28	63	50	25	21	30	51	61	62	62	62	63	63	61	62	61	60
	66	50	28	26	34	52	61	61	61	62	61	62	60	61	61	61
Maryland Ave/MD 189	64	48	25	22	31	50	59	59	59	60	61	62	60	60	60	60
	67	47	26	25	33	49	60	63	63	64	64	64	63	63	63	63
Montrose Rd	64	51	33	31	48	55	59	59	60	60	60	60	59	59	60	59
	66	50	41	39	46	58	58	63	63	63	63	64	64	63	64	63
I-270 East Spur Southbound																
I-270	66	50	41	39	46	58	58	63	63	63	63	64	64	63	64	63
	64	60	56	54	56	60	60	62	62	62	61	61	61	61	61	60
Old Georgetown Rd/MD 187	66	63	59	53	55	60	64	64	64	64	64	63	57	58	62	61
	65	63	57	47	55	62	62	63	63	62	58	42	42	42	61	62
I-495	62	59	51	41	47	54	55	53	51	42	30	24	16	22	46	55
I-270 West Spur Southbound																
I-270	63	34	25	23	28	41	56	60	60	59	57	56	55	56	61	60
	62	42	31	27	31	49	49	60	60	59	52	49	49	51	59	60
Democracy Blvd	64	52	36	30	26	36	52	62	64	59	33	19	15	25	54	63
	64	50	34	28	23	41	41	60	60	53	25	11	11	17	45	62
I-495	64	50	34	28	23	41	41	60	60	53	25	11	11	17	45	62

(1) Speeds on HOV lanes, express general purpose lanes, and local general purpose lanes are averaged, when applicable

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Figure 2-7
2017 Average Tuesday to Thursday Speeds on I-495 Inner Loop by Hour

Interchange	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM
I-495 Inner Loop Virginia																
Express Lane Terminus	64	49	26	24	34	55	61	59	60	57	60	60	54	54	60	62
	64	49	26	24	34	55	61	59	60	57	60	60	54	54	60	62
Braddock Rd/VA 620	65	42	22	20	26	49	62	54	58	59	61	61	61	61	62	62
	64	44	28	26	30	48	61	60	60	60	62	62	62	61	62	62
Little River Turnpike/VA 236	65	43	27	24	27	44	61	62	59	61	63	64	64	63	63	63
	63	50	39	35	36	49	59	60	59	59	61	62	62	61	61	61
Gallows Rd/VA 650	64	59	54	46	46	57	62	62	62	62	62	63	63	62	63	62
	65	62	56	42	42	60	64	64	64	64	64	65	65	64	64	64
Arlington Blvd/US 50	65	61	54	38	38	58	62	62	62	61	61	63	63	63	62	63
	63	59	51	37	37	56	59	59	59	59	58	59	59	60	61	60
I-66	64	61	48	30	27	52	61	62	62	62	60	60	61	63	63	62
	62	57	43	29	26	47	58	60	59	59	55	55	55	56	60	61
Leesburg Pike/VA 7	64	60	39	35	40	53	60	63	60	58	46	45	41	44	55	62
	64	60	34	31	36	51	58	63	58	53	41	39	34	37	49	62
Chain Bridge Rd/VA 123	64	60	31	28	35	49	57	61	57	48	33	29	24	24	39	61
	64	59	26	22	31	49	49	57	57	43	26	19	16	15	29	58
Dulles Toll Rd/VA 267	64	59	22	17	23	37	50	55	52	34	16	10	8	9	20	51
	64	58	27	20	24	42	42	54	54	31	15	9	9	10	19	47
Georgetown Pike/VA 193	64	57	24	17	19	27	48	56	52	23	12	8	8	9	16	42
	65	56	24	18	20	38	38	54	54	22	12	9	9	10	16	41
GW Memorial Pkwy	65	55	30	26	27	33	49	56	50	26	17	12	12	14	22	44
VA/MD Line	65	56	34	31	31	36	50	56	49	29	20	14	14	17	25	44
I-495 Inner Loop Maryland																
VA/MD Line	64	57	40	36	36	39	52	56	52	34	23	15	15	19	29	47
Clara Barton Parkway	61	55	45	43	43	45	53	56	53	42	27	15	15	19	33	49
	63	60	54	54	55	58	58	61	61	52	28	14	13	19	39	56
River Rd/MD 190	65	64	61	60	61	61	62	63	61	55	24	12	11	16	36	58
	65	65	63	61	61	62	62	62	62	56	30	19	17	22	40	59
I-270 Spur	60	60	60	60	58	59	59	60	60	58	55	51	49	50	53	57
	61	61	60	58	58	60	60	58	58	53	52	56	53	50	52	58
Old Georgetown Rd/MD 187	62	62	60	48	55	59	57	53	49	35	27	37	30	29	43	58
	61	59	52	38	46	52	52	44	44	26	16	19	14	18	34	54
I-270, Rockville Pike/MD 355	61	59	48	35	41	50	50	46	40	25	15	14	11	15	32	54
	62	59	44	33	37	46	46	41	41	25	17	15	14	16	29	51
Connecticut Ave/MD 185	63	61	52	45	48	50	50	47	40	29	20	15	14	16	27	50
	62	60	51	44	46	48	48	45	45	36	30	23	21	23	32	50
Georgia Ave/MD 97	63	62	56	54	54	54	55	54	50	46	37	26	23	25	38	54
	63	63	56	56	56	56	56	53	53	48	41	29	27	28	41	55
Colesville Rd	64	63	55	55	56	55	55	54	52	49	43	31	27	30	45	57
	63	61	50	51	54	53	53	51	51	47	39	27	22	25	42	57
University Blvd E/MD 193	64	61	49	52	54	53	53	53	50	47	37	26	22	23	39	57
	65	61	50	54	57	60	60	58	58	54	44	34	31	30	44	58
New Hampshire Ave/MD 650	63	59	51	55	58	60	58	59	56	53	47	40	35	36	46	56
	63	61	56	59	60	59	59	58	58	53	48	44	37	39	49	56
I-95	67	66	62	53	59	66	67	67	66	65	56	44	33	43	60	64
	64	62	39	26	35	58	58	59	59	55	30	18	16	25	51	60
US 1/Baltimore Ave	65	62	45	35	37	51	59	60	56	52	30	22	20	28	48	60
	65	62	45	35	37	55	55	58	58	52	30	22	20	28	48	60
Greenbelt METRO	66	62	54	50	47	54	59	61	58	52	33	26	25	34	49	59
	65	63	56	52	51	58	58	60	60	52	34	27	25	36	51	59
Kenilworth Ave/MD 201	64	61	55	52	50	54	60	60	58	50	33	26	25	35	48	57
	63	60	55	52	53	58	58	59	59	52	38	32	31	41	50	58
Baltimore-WA Pkwy/MD 295	65	63	58	55	57	59	61	60	59	54	39	33	33	43	51	60
	66	64	60	57	59	61	61	61	61	54	41	35	33	42	56	63
Annapolis Rd/MD 450	62	61	58	53	55	57	59	59	58	50	38	33	31	39	53	60
	61	59	57	53	54	57	57	57	57	53	45	38	35	42	52	58
US 50	66	64	61	53	54	62	64	65	63	59	42	30	26	35	52	63
	65	62	58	49	50	60	60	60	60	54	41	32	30	37	53	61
Landover Rd/MD 202	66	64	60	58	58	62	64	64	61	59	44	32	29	41	57	63
	67	64	59	56	57	62	62	61	61	55	38	26	24	35	54	63
Arena Drive	67	62	55	53	55	58	60	62	60	53	32	23	21	29	48	62
	66	62	54	51	54	58	58	61	61	52	34	26	24	30	46	60
Central Ave/MD 214	66	61	51	46	52	56	58	61	59	50	34	27	26	31	44	59
	64	56	51	48	52	54	59	60	58	53	45	41	39	42	49	57
Ritchie Marlboro Rd	64	56	51	48	52	54	59	60	58	53	45	41	39	42	49	57
	64	56	51	48	52	57	57	59	59	53	45	41	39	42	49	57
Pennsylvania Ave/MD 4	64	59	54	52	55	55	58	59	58	52	51	47	42	46	56	59
	64	57	57	54	57	57	57	59	59	52	52	48	41	45	56	58
Suitland Pkwy/MD 337	64	57	57	54	57	57	57	59	59	52	52	48	41	45	56	58
	64	60	60	57	58	59	59	61	61	51	56	54	49	49	55	56
Allentown Rd	64	60	60	57	58	59	59	61	61	51	56	54	49	49	55	56
	65	60	60	57	59	62	62	63	63	59	61	59	55	53	57	58
Branch Ave/MD 5	65	56	42	41	52	63	63	63	63	62	62	62	57	57	61	62
	66	47	24	26	49	64	64	65	65	63	64	63	60	60	63	64
St Barnabus Rd/MD 414	65	36	16	19	44	62	64	64	64	64	64	62	59	58	62	61

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Figure 2-8
2017 Average Tuesday to Thursday Speeds on I-495 Outer Loop by Hour

Interchange	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM
I-495 Outer Loop Virginia																
Express Lane Terminus	63	63	61	62	62	61	62	62	62	61	60	60	57	57	60	61
	63	63	61	62	62	61	62	62	62	61	60	60	57	57	60	61
Braddock Rd/VA 620	64	64	64	62	64	61	62	62	61	59	58	59	56	57	59	61
	65	65	64	65	65	63	63	63	62	59	58	60	58	58	60	62
Little River Turnpike/VA 236	65	65	65	65	65	63	64	63	63	59	57	58	56	57	59	63
	66	65	65	65	65	62	63	61	62	57	49	42	41	44	51	60
Gallows Rd/VA 650	65	65	64	64	64	62	61	58	60	53	40	31	30	33	43	56
	64	64	63	63	63	61	61	57	58	49	31	25	24	25	37	54
Arlington Blvd/US 50	65	65	64	64	64	63	63	59	60	50	31	24	22	24	37	55
	64	63	61	60	61	61	61	58	59	50	27	19	16	19	34	54
I-66	66	65	65	63	65	64	64	60	61	54	28	18	14	17	36	55
	63	63	62	62	61	60	60	56	56	49	37	26	22	26	42	54
Leesburg Pike/VA 7	63	64	63	63	61	61	60	52	53	44	32	22	17	20	37	53
	61	62	61	59	57	58	59	53	52	47	35	22	16	19	39	54
Chain Bridge Rd/VA 123	61	61	59	56	55	58	58	54	52	48	37	21	14	16	40	56
	60	58	54	45	45	56	56	53	53	51	42	19	19	16	43	56
Dulles Toll Rd/VA 267	60	59	58	53	51	56	58	56	54	53	49	33	18	20	47	57
	63	62	60	55	53	57	57	57	57	56	50	43	43	43	56	60
Georgetown Pike/VA 193	65	61	59	44	42	55	57	57	53	51	33	28	29	36	54	60
	63	61	59	41	39	56	56	55	55	51	33	26	26	35	52	59
GW Memorial Pkwy	63	61	58	41	39	54	57	57	53	51	33	25	27	36	52	59
VA/MD Line	63	59	56	46	43	53	57	57	56	54	41	32	34	42	54	60
I-495 Outer Loop Maryland																
VA/MD Line	67	61	57	46	42	55	60	61	59	56	40	30	31	39	56	64
Clara Barton Parkway	66	61	56	43	38	53	59	60	58	54	37	26	26	34	54	64
	64	59	54	39	34	52	52	57	57	52	35	24	24	30	50	61
River Rd/MD 190	65	59	53	34	28	42	55	58	57	50	28	18	17	22	44	61
	64	59	54	39	34	52	52	57	57	52	35	24	24	30	50	61
I-270 Spur	59	54	44	36	33	44	54	57	57	51	30	16	15	23	48	60
	62	58	52	46	39	51	51	61	61	56	37	20	20	31	53	62
Old Georgetown Rd/MD 187	60	57	54	50	43	49	52	58	60	57	43	27	32	42	52	59
	57	56	54	52	49	53	53	57	57	55	48	42	42	51	54	56
I-270, Rockville Pike/MD 355	58	57	56	53	53	55	55	56	55	55	52	42	38	45	54	56
	59	57	54	51	51	53	53	51	51	53	51	39	39	45	54	58
Connecticut Ave/MD 185	58	54	50	48	49	51	49	47	48	48	47	43	41	47	54	58
	55	48	43	41	44	51	51	48	48	46	42	43	43	49	54	59
Georgia Ave/MD 97	55	37	26	23	29	42	49	42	45	40	35	40	43	49	53	58
	55	30	22	19	24	44	44	46	46	40	33	42	42	47	52	59
Colesville Rd	57	23	16	14	20	37	51	50	48	41	33	40	48	49	54	61
	56	22	15	12	20	45	45	51	51	43	36	46	46	49	54	60
University Blvd E/MD 193	57	22	14	12	20	41	53	54	53	46	39	46	50	51	55	60
	60	18	11	10	16	38	38	45	45	42	37	46	46	50	56	62
New Hampshire Ave/MD 650	60	18	10	9	16	31	41	44	43	39	43	48	48	47	55	60
	61	20	11	11	21	45	45	56	56	46	52	52	52	46	54	59
I-95	67	28	14	18	41	59	63	65	65	62	64	63	62	59	62	64
	64	59	50	56	62	63	63	62	62	61	60	55	55	57	59	61
US 1/Baltimore Ave	65	61	57	60	62	63	63	62	62	60	58	56	54	56	58	61
	64	61	59	60	61	61	61	62	62	60	58	54	54	52	55	60
Greenbelt METRO	65	60	59	57	61	60	57	58	61	58	54	49	44	42	50	61
	67	62	60	57	62	57	57	59	59	58	51	39	39	34	48	64
Kenilworth Ave/MD 201	67	63	60	57	61	57	54	55	61	56	47	35	26	27	46	63
	65	61	57	55	59	56	56	57	57	54	46	28	28	26	47	59
Baltimore-WA Pkwy/MD 295	64	60	55	53	58	59	55	56	60	54	47	34	23	27	50	58
	65	55	49	49	55	58	58	60	60	57	53	35	35	30	51	61
Annapolis Rd/MD 450	65	50	35	36	49	57	59	58	59	56	54	45	25	28	52	59
	64	49	32	32	47	57	57	57	57	55	54	35	35	27	52	58
US 50	66	55	36	37	53	62	63	61	61	61	59	54	31	34	58	61
	65	57	34	32	40	55	55	53	53	44	35	32	32	34	51	59
Landover Rd/MD 202	67	58	25	21	32	51	58	54	47	35	24	21	21	27	49	61
	66	60	30	26	39	58	58	57	57	43	30	26	26	33	53	62
Arena Drive	65	61	41	36	48	59	62	62	59	52	39	36	38	45	57	62
	65	61	45	40	52	61	61	61	61	54	45	45	45	51	59	63
Central Ave/MD 214	66	62	45	42	53	60	62	62	60	56	49	48	51	55	61	63
	67	64	48	42	53	60	60	63	63	59	49	48	48	54	61	65
Ritchie Marlboro Rd	67	64	48	42	53	58	62	64	61	59	49	46	50	54	61	65
	67	64	48	42	53	58	62	64	61	59	49	46	50	54	61	65
Pennsylvania Ave/MD 4	65	64	54	42	54	55	60	63	62	57	42	37	40	49	58	62
	65	63	56	44	54	58	58	60	60	54	39	35	35	46	58	62
Suitland Pkwy/MD 337	65	63	56	44	54	58	58	60	60	54	39	35	35	46	58	62
	65	63	58	47	53	56	56	57	57	50	34	28	28	43	58	62
Allentown Rd	65	63	58	47	53	56	56	57	57	50	34	28	28	43	58	62
	63	59	54	52	52	56	56	58	58	50	36	30	30	44	55	58
Branch Ave/MD 5	64	63	57	56	57	59	61	62	61	54	39	29	33	44	53	57
	66	62	64	61	63	63	63	65	65	61	47	40	40	50	58	64
St Barnabus Rd/MD 414	66	63	64	62	64	63	64	65	64	60	53	47	47	54	61	64

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2.2.6 Balanced Traffic Profile

The traffic data was validated and averaged into a 2017 Tuesday to Thursday hourly average weekday traffic volume and speed profile. The profile included balanced traffic for the corridor mainlines and ramps on I-270 and I-495 for the full I-495 and I-270 Priced Managed Lanes project. When possible, data was collected separately for passenger cars (PCs) and commercial vehicles (CVs). For the purposes of this analysis, PCs were assumed to include Federal Highway Administration vehicle classes one to five and CVs were assumed to include vehicle classes six to 13.

The profile balancing process uses available raw count data on mainlines and ramps. A series of adjustments are made to the raw data so that the mainline and ramp traffic balances from one end of the study corridor to the other. Adjustments include those for counts performed in different years, time of the year (seasonal adjustments), and those based on the results of consistency and validation checks.

Further adjustments are also made to the traffic profile for better application of the profile data within the priced managed lane travel demand modeling process. Specifically, these are time of day adjustments to account for heavy queuing and congestion so that the highest volumes in the general purpose lanes are modeled when speeds in the general purpose lanes are lowest. Generally, these adjustments involve moving some traffic from the peak shoulders to the peak hours in locations with heavy queuing. The time shifting allowed better replication of traffic demand and resulting speeds in the travel demand model used for traffic and revenue estimation.

Figures 2-9, **2-10, and 2-11** show the resulting balanced traffic profile for the Phase 1 limits. Tables are also included within the figures to show the balanced time of day breakdown during the AM peak and PM peak periods.

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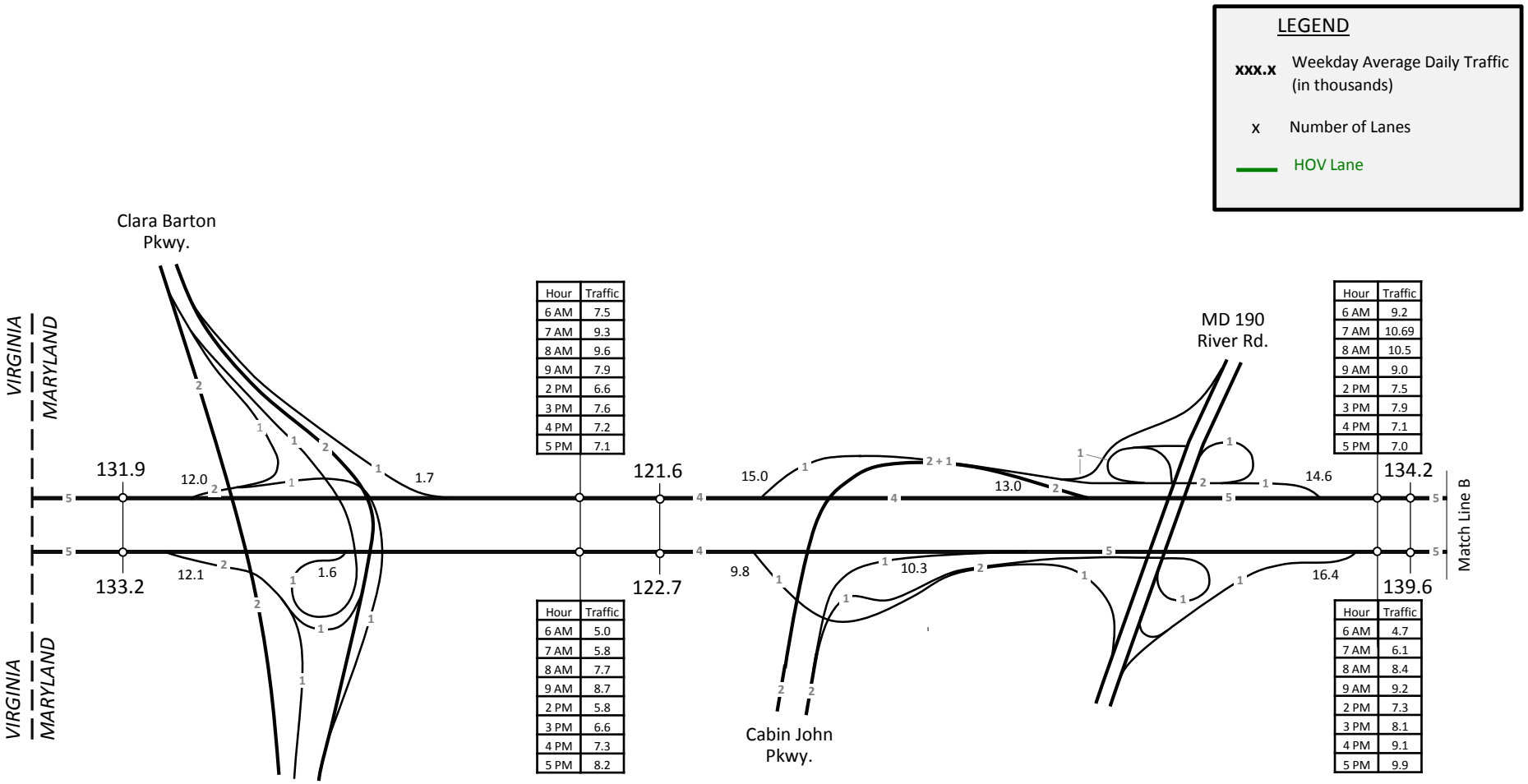

2017 BALANCED TRAFFIC PROFILE

FIGURE 2-9

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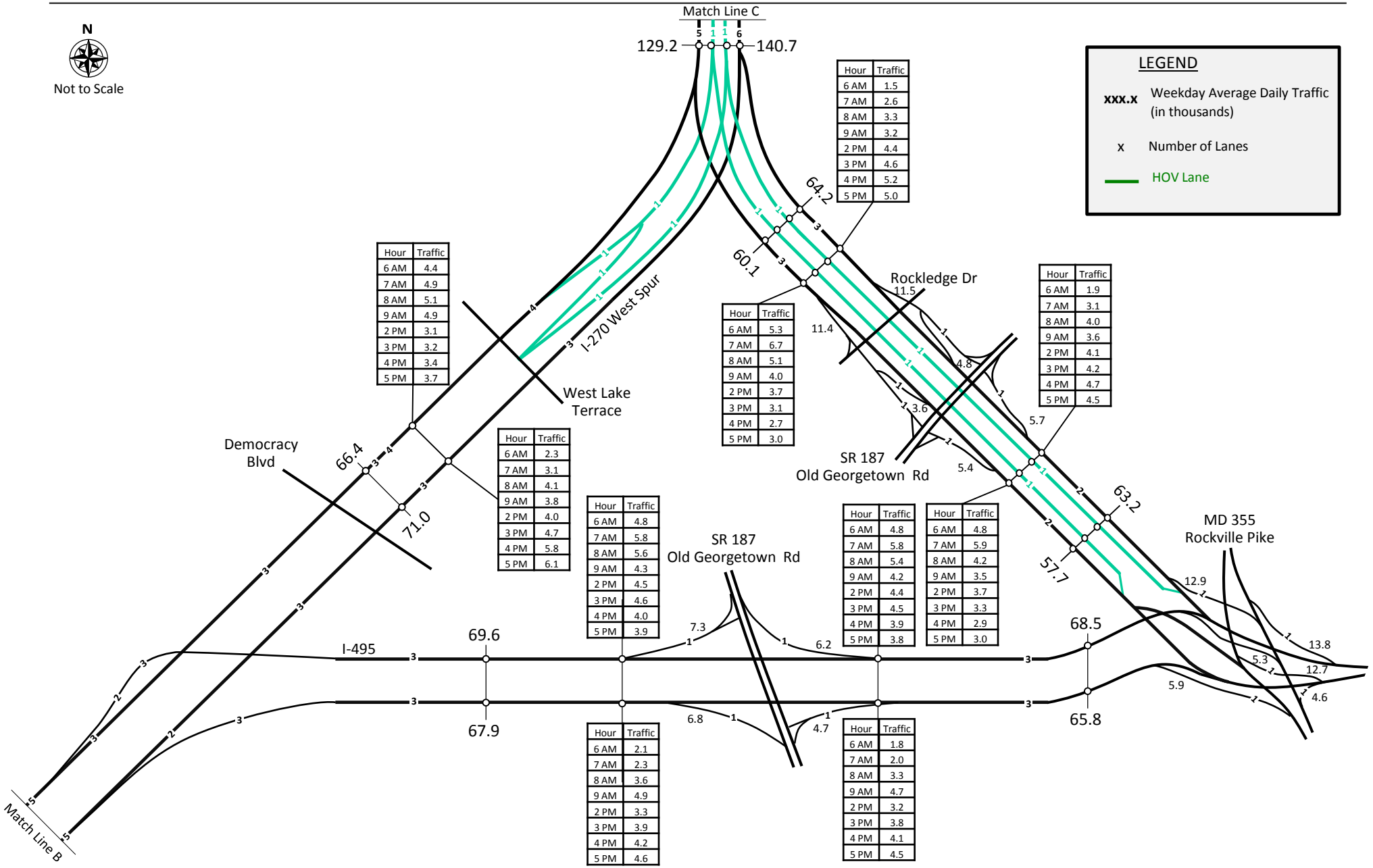
I-495 and I-270 Priced Managed Lanes Traffic and Revenue Study



2017 BALANCED TRAFFIC PROFILE

FIGURE 2-10

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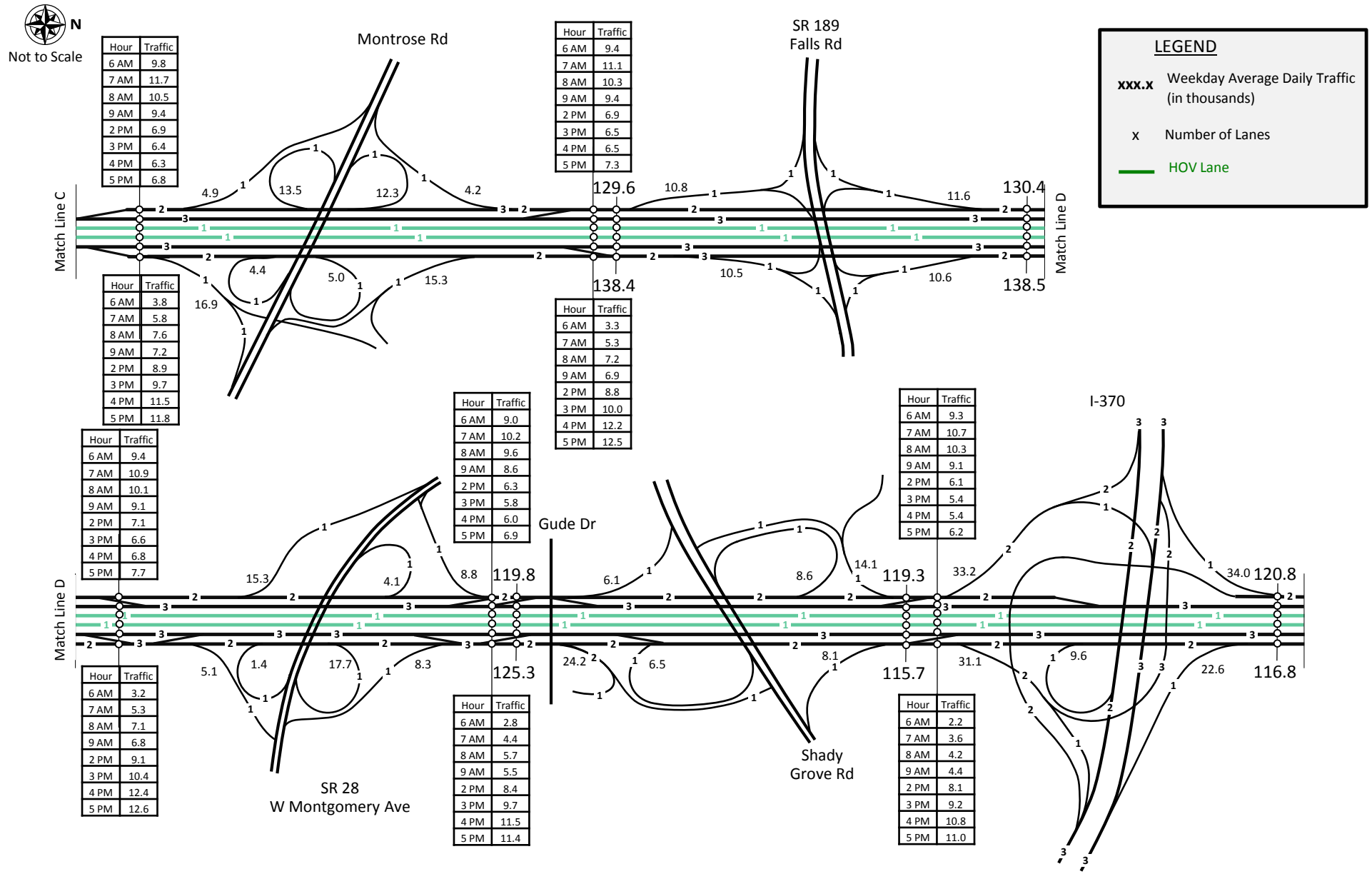

2017 BALANCED TRAFFIC PROFILE

FIGURE 2-11

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2.2.7 Streetlight Data

CDM Smith has obtained origin-destination (O-D) travel pattern data from the transportation data analytics company Streetlight Data, Inc. to support the study. Streetlight collects geospatial data created by mobile devices such as smart phones, connected cars, and fleet management systems and translates them into various products for transportation studies. CDM Smith has successfully used Streetlight O-D in other traffic and revenue studies to check that the base year travel demand model is replicating a sample of actual travel patterns. The similar process was applied on this study for major movements on the I-495 and I-270 corridors. It should be noted that, while Streetlight is based on actual data, is a relatively small sample of actual data. To help address this, CDM applied several data checks and filters and a factoring process to the data.

The Streetlight data obtained by CDM Smith encompassed travel on I-495 from the George Washington Parkway to MD 5 and on I-270 from I-495 (including both the east and west spurs) to I-370. Origins and destinations were defined as all possible entry and exit points along these corridors. The zones used to obtain the data include three endpoint mainline locations, I-495 south of George Washington Parkway, I-495 west of MD 5 and I-270 north of I-370, and at the cross streets on either side of every interchange in between. The zones used for this study are shown in **Figure 2-12**.

The resulting average weekday O-D matrix for major movements in the study corridor is provided in **Table 2-3.** The matrix includes the raw streetlight data with the results of the adjustments from the data checks and filers as well as the factoring process applied by CDM Smith. The summary matrix zones include the study corridor endpoints, the highest volume interchanges, and the groups of interchanges between the endpoints and highest volume interchanges. For example, it is estimated 22,600 average weekday daily trips are made from I-495 south of the American Legion Bridge to I-270 north of I-370.

2.2.8 Existing I-495 Express Lane Performance

Because of the proximity and similar user base of the existing I-495 Express Lanes and the I-495 and I-270 project, a review of recent performance on the existing I-495 HOT Lane performance was conducted to assess growth trends. Data from the existing I-495 Express Lanes is shown in **Table 2-4.** It contains quarterly and annual summaries of revenue and average daily trips. The data was obtained from Transurban performance reports available on their website.

As shown, revenue and trips increased significantly over the first five full years of operation, going from $17 million in 2013 to $81 million in 2017. Many factors accounted for this growth including general ramp-up, the growing economy and increasing employment, and the opening of the connecting I-95 priced managed lane facility. In 2018, revenue and trips declined compared to 2017. The reasons for this decline are not clear, although Transurban press releases indicated bad weather and the government shutdowns impacted trips and revenue in the January to March quarter of 2018 and September traffic was negatively impacted by Hurricane Florence. In Year-to-date 2019, revenue and trips have shown recovery from the 2018 declines at growth rates similar to those observed in late 2017.

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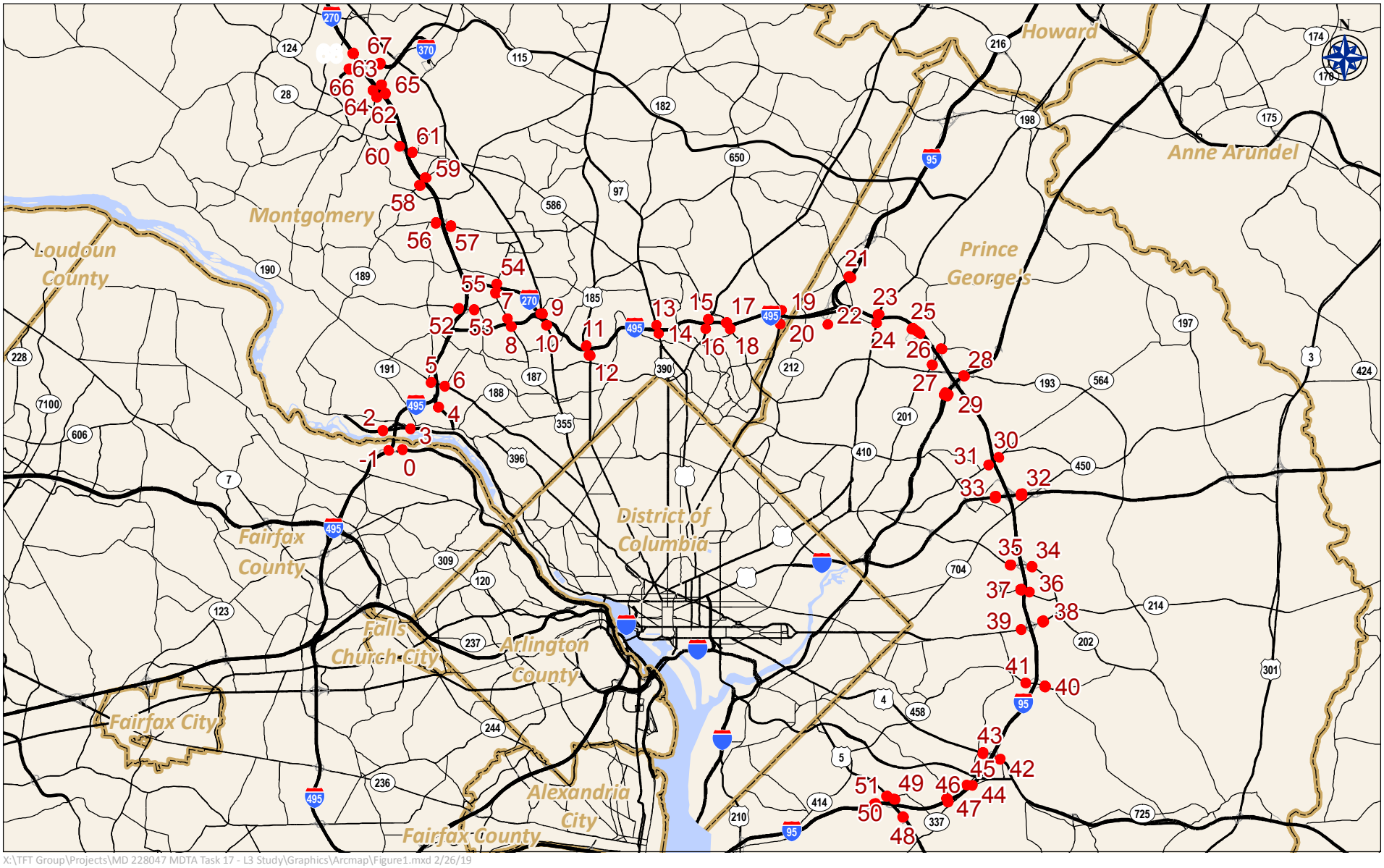

Streetlight Pass-Through Zones

FIGURE 2-12

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Table 2-3
Average Weekday Origin-Destination Estimates for Major Movements (in thousands)

Traffic From	Traffic To											
	I-495 S. of ALB	I-495 Bet. ALB and I-270 W. Spur	I-270 Spurs/I-495 Triangle	I-270 Bet. Spurs and I-370	I-270 N. of I-370	I-495 Bet. I-270 and I-95	I-95	I-495 Bet. I-95 and BW Pkwy	Balt-Wash Pkwy	US-50 or MD-450	I-495 Bet. US-50 and MD-5	I-495 W. of MD-5
I-495 S. of ALB	-	21.8	17.9	21.9	22.6	18.6	17.1	2.8	1.3	3.3	0.3	-
I-495 Bet. ALB and I-270 W. Spur	26.9	0.2	4.9	9.5	7.6	3.2	1.3	0.3	0.2	0.8	0.2	-
I-270 Spurs/I-495 Triangle	14.7	5.2	2.2	16.7	22.0	15.2	4.8	2.6	1.6	2.9	2.1	0.8
I-270 Bet. Spurs and I-370	15.1	7.8	15.2	20.8	42.4	9.7	1.1	1.7	0.8	1.4	0.6	0.2
I-270 N. of I-370	24.3	8.4	21.8	43.1	-	14.2	1.1	2.0	1.0	1.5	1.4	0.6
I-495 Bet. I-270 and I-95	23.2	4.2	15.8	12.9	14.2	27.4	29.0	11.5	8.8	10.9	8.0	4.2
I-95	18.3	1.7	4.6	1.4	1.0	26.1	-	10.1	12.2	5.2	6.9	10.3
I-495 Bet. I-95 and BW Pkwy	2.1	0.5	2.1	1.4	1.7	8.9	13.4	4.9	6.7	8.9	7.8	4.6
Balt-Wash Pkwy	1.2	0.1	1.4	0.7	0.8	6.3	11.2	7.8	-	6.0	8.6	8.9
US-50 or MD-450	4.2	1.1	3.1	1.8	1.9	11.7	9.2	10.9	9.2	-	39.0	24.3
I-495 Bet. US-50 and MD-5	0.5	0.2	1.7	0.6	1.2	6.6	7.2	6.9	9.0	35.1	52.0	52.1
I-495 W. of MD-5	-	-	0.4	0.3	0.6	3.3	9.8	3.7	8.5	22.5	52.0	-

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Table 2-4

Virginia I-495 Express Lanes Revenue and Trips Trends

Year	Time Period	Toll Revenue ($M)	Change from Prev. Year	Average Daily Trips[1] (thousands)	Change from Prev. Year
2012	Oct to Dec	$1		19	
2013	Jan to Mar	$2		21	
2013	Apr to June	$4		29	
2013	Jul to Sep	$5		31	
2013	Oct to Dec	$6	616.7%	30	63.6%
2014	Jan to Mar	$6	126.5%	29	36.3%
2014	Apr to June	$8	104.8%	35	22.2%
2014	Jul to Sep	$8	74.9%	35	14.3%
2014	Oct to Dec	$9	51.2%	35	16.4%
2015	Jan to Mar	$8	41.3%	33	15.2%
2015	Apr to June	$13	58.0%	42	18.9%
2015	Jul to Sep	$13	56.1%	39	11.8%
2015	Oct to Dec	$14	56.6%	40	13.0%
2016	Jan to Mar	$13	63.9%	36	9.1%
2016	Apr to June	$16	22.8%	43	2.4%
2016	Jul to Sep	$17	30.8%	45	15.4%
2016	Oct to Dec	$17	21.4%	46	15.0%
2017	Jan to Mar	$17	30.8%	44	22.2%
2017	Apr to June	$23	43.8%	51	18.6%
2017	Jul to Sep	$20	17.6%	47	4.4%
2017	Oct to Dec	$21	23.5%	46	0.0%
2018	Jan to Mar	$15	-11.8%	41	-6.8%
2018	Apr to June	$20	-13.0%	48	-5.9%
2018	Jul to Sep	$20	0.0%	47	0.0%
2018	Oct to Dec	$20	-4.8%	46	0.0%
2019	Jan to Mar	$18	20.0%	42	2.3%
2019	Apr to June	$22	10.0%	49	2.1%
2019	Jul to Sep			48	2.1%
2013	Annual	$17		28	
2014	Annual	$31	81.2%	34	21.0%
2015	Annual	$48	54.1%	39	14.7%
2016	Annual	$63	31.3%	43	10.4%
2017	Annual	$81	28.6%	47	10.6%
2018	Annual	$75	-7.4%	46	-3.2%

(1) Includes free trips

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Chapter 3

Stated Preference Survey

In the summer of 2019, Resource Systems Group (RSG) conducted a stated preference (SP) survey of drivers who used I-495 and/or I-270 in Maryland. The purpose of the survey was to estimate travelers' willingness to pay for travel time savings via a system of managed lanes proposed on I-495 and I-270 in Maryland. The survey collected data from potential users of the proposed managed lanes network, including some users of the existing express lanes on I-495 in Virginia. The toll price sensitivity and willingness to use the proposed managed lanes estimated from the survey were then incorporated into the travel demand model to support estimates of traffic and revenue.

This chapter summarizes the results of the stated preference survey report, the full text of which is included in the **Appendix A** of this document.

3.1 Survey Approach

The survey approach employed a computer-assisted self-interview technique developed by RSG. The SP survey instrument was customized for each respondent by presenting questions with modified wording based on each respondent's previous answers. These dynamic survey features provided an accurate and efficient means of data collection and allowed for the presentation of realistic future conditions in the SP exercises that corresponded with each respondent's reported trip details.

The survey was administered over the internet to travelers using three recruitment methods:

1. Email invitations sent to Maryland E-ZPass customers who reside around the study corridors
2. Email invitations sent to Virginia E-ZPass customers who reside around the study corridors.
3. Email invitations sent to members of an online research panel in the region.

A total of 2,511 completed surveys were collected across all administration methods during this time. Data from the SP survey were analyzed using accepted statistical techniques to estimate the coefficients of multinomial logit (MNL) models and mixed multinomial logit (MMNL) models to estimate a distribution of value of time of travelers who use the study corridors.

3.2 Survey Questionnaire

RSG designed a survey questionnaire to evaluate the potential behavioral response of travelers to the proposed managed lanes on I-495 and on I-270 in Maryland. The survey questionnaire asked respondents to describe their most recent trip that used one or both study corridors. Those trip details were then used to construct SP experiments corresponding with the respondent's reported trip. The survey questionnaire was divided into the following parts: (1) Introduction

and trip qualification questions; (2) Trip detail questions; (3) Stated preference exercises; (4) Debrief and opinion questions; (5) Express lane use questions to study how respondents decide to drive in the express lanes or in the regular lanes on I-495 in Virginia; and (6) Demographic questions.

The complete set of survey questions as they appeared to respondents on-screen is included in the full survey report in the appendix.

3.2.1 Introduction and Trip Qualification Questions

At the beginning of the survey questionnaire, respondents were presented with an introduction page describing the purpose of the survey, the time required to complete the questionnaire, and instructions for how to navigate through the online instrument.

Following the introduction screen, respondents were shown a trip qualification question to determine if they were eligible to participate in the survey. To participate in the survey, respondents had to have been the driver for an automobile trip that met the following criteria:

- The trip was made on any part of I-495 (Capital Beltway) in Maryland between the George Washington Memorial Parkway and MD 5 or on any part of I-270 between I-495 and I-370.
- The trip was made within the past 30days. This timeframe was selected to include respondents who make less-frequent trips while also ensuring trips were recent enough for respondents to accurately recall details.
- The trip was made in a personal vehicle. This ensured commercial vehicles and large trucks were not included.
- The trip took at least 15 minutes but less than four hours. This ensured that excessively short and long trips were excluded from the sample.
- The trip was made on a weekday.

Respondents were first asked if they had made a recent qualifying trip on either I-495 or I-270. The route (I-495 or I-270) that respondents were asked about first was determined at random. Respondents who completed a qualifying trip on the first route were then asked to recollect the details of their most recent trip that used that route. Respondents who did not complete a qualifying trip on the first route shown were next asked if they had completed a qualifying trip on the other route. Respondents who completed a qualifying trip on the second route advanced to the trip characteristics section of the survey. Respondents who did not complete a qualifying trip on either route were thanked for their time and terminated from completing the survey.

3.2.2 Trip Detail Questions

Those respondents who made a qualifying trip were next asked to focus on their most recent one-way trip that met the screening criteria. This most recent trip, referred to as the respondent's "reference trip", was the subject of the next section of the survey. Respondents were asked to think about their most recent trip to ensure that the sample included a diverse range of trip types and trip characteristics. Focusing on their most recent trip also gave respondents a more concrete frame of reference when considering the SP scenarios later in the survey.

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Respondents were then asked a series of questions regarding the specific details of their reference trips, including:

- Day of week traveled (Monday-Friday).
- Trip purpose (e.g., go to work, go to school, recreation).
- Type of origin and destination (i.e., home, work, or other).
- Specific locations of origin and destination (using a mapping interface described below).
- Use of alternate facility (if not shown the second trip-screening question).
- I-495 or I-270 entrance and exit ramps used.
- Departure time.
- Departure time adjustment made to avoid congestion.
- Door-to-door travel time.
- Amount of delay due to traffic congestion on I-495 or I-270 (if any).
- Trip frequency.
- Toll roads used (if any).
- E-ZPass or other electronic toll collection transponder ownership.

This range of questions gave RSG a thorough picture of an actual trip made by each respondent, which was used to create of realistic alternatives and customized questions in the stated preference section of the survey.

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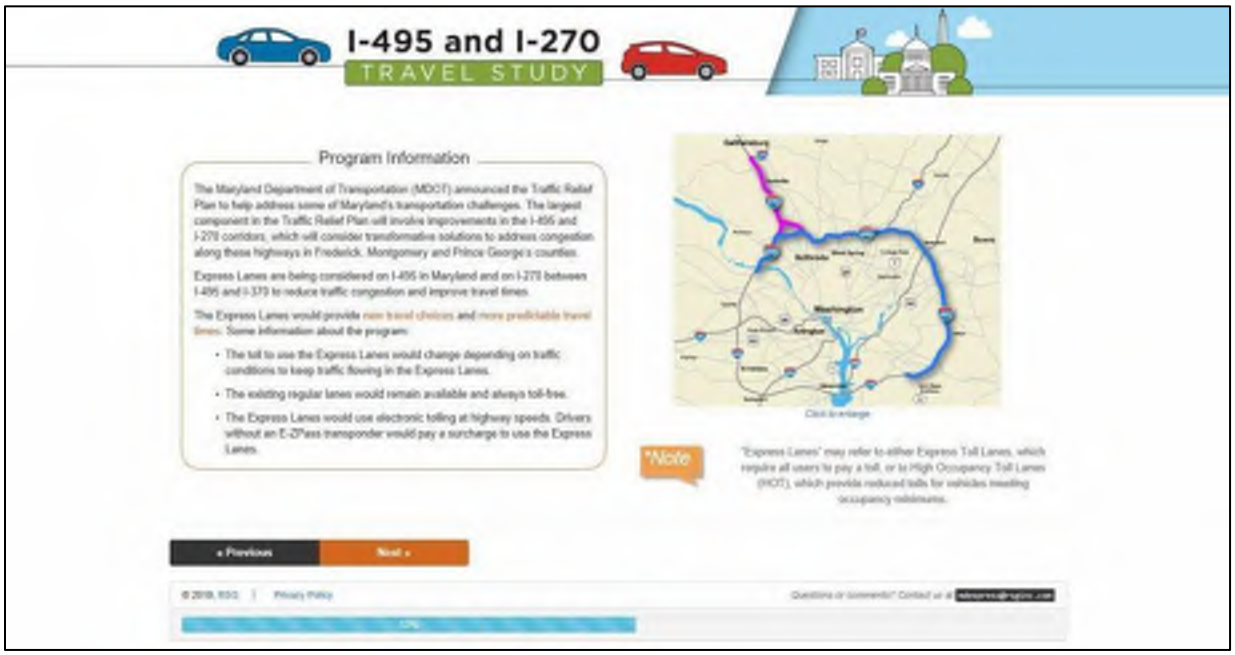
3.2.3 Stated Preference Exercises

Before the SP questions were administered, respondents were provided with details about the proposed I-495 and I-270 Managed Lanes (see **Figure 3-1**).



Source: Resource Systems Group, Inc.

Figure 3-1
Sample Survey Screen – Project Information

The stated preference questions were designed to estimate respondents' travel preferences and behavioral responses under hypothetical future conditions. Respondents' reference trip details were used to construct eight stated preference scenarios that included the following travel alternatives for making their trip in the future:

1. Use of managed lanes on I-495 or I-270.
2. Use of regular lanes on I-495 or I-270.

Each alternative was described by two attributes: travel time and toll cost. The values of the attributes varied independently across the eight questions and respondents were asked to select the alternative they preferred most in each scenario/question. To avoid potential bias associated with the layout of the attributes, the order of the alternatives was randomized for each respondent. **Figure 3-2** depicts a sample stated preference scenario.

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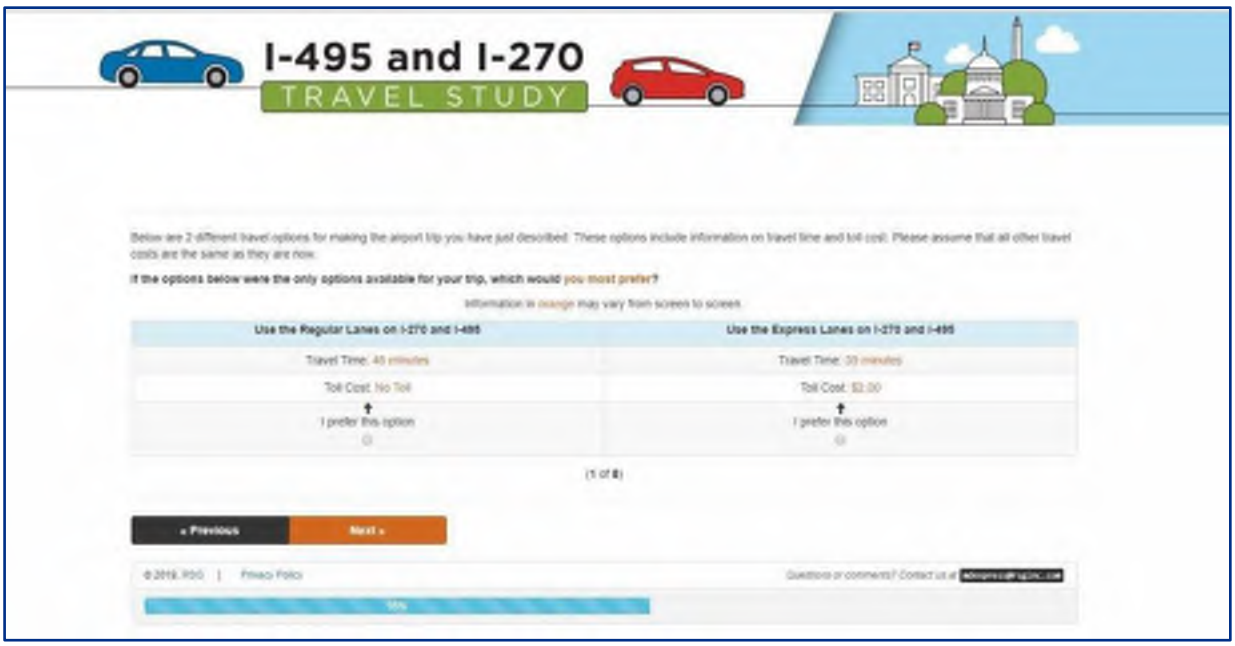

Source: Resource Systems Group, Inc.

Figure 3-2
Sample Stated Preference Experiment

The attribute values for travel time and toll cost that were presented in each scenario varied around a set of base values, which were based on the actual travel time and total cost of each respondent's reference trip. Respondents were presented with different time savings at different costs by varying the travel time and toll costs shown in each experiment in a statistically controlled manner; this allowed respondents to demonstrate their preferences across a wide range of VOT. The amount of variation for each attribute was dependent on distance traveled along the I-495 and I-270 study corridor and the respondents' reported delay. The full SP report in the appendix details the levels used for each attribute.

3.2.4 Debrief and Opinion Questions

After completing the eight SP experiments, respondents answered a series of questions to assess underlying reasons for their choices and to identify potential strategic bias in their responses. Respondents who never selected a managed lanes alternative in the SP experiments were asked to indicate their primary reason for this. Finally, respondents were asked their level of support for the project.

3.2.5 Demographic Questions

The final section of the survey collected demographic information to help identify differences in responses across traveler segments. This information also helped confirm that the sample contained a diverse cross section of the traveling population in the Washington D.C. study area.

Demographic questions shown to all respondents collected the following information:

- Gender

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- ZIP Code
- Employment status
- Household size
- Number of vehicles in household
- Household income

After completing the demographic questions, all respondents were given the opportunity to leave comments about the survey or the proposed managed lanes. These open-ended statements are presented in an appendix of the full survey report.

3.3 Survey Administration

RSG worked closely with the project team to design an administration plan to produce a generally representative sample of travelers who use or could potentially use the proposed system of managed lanes on I-495 and I-270. The sampling plan was designed to include a diverse sample of travelers and trip types to support the estimation of coefficients of a discrete choice model. It is possible to identify the ways in which different characteristics affect route choice behavior by collecting data from a range of traveler and trip types. These differences can then be reflected in the structure and coefficients of the resulting choice model. The survey sample that supports choice model estimation does not need to be perfectly population proportional if the following is true:

- Any behavioral differences are properly represented in the model
- The model is applied for forecasting using appropriate population proportions or sample weights

RSG distributed the survey instrument using three methods:

1. Email invitations sent to a random sample of Maryland E-ZPass customers who reside in the study area.
2. Email invitations sent to a random sample Virginia E-ZPass customers who reside in the study area.
3. Email invitations sent to members of an online research panel from the region.

The study area used for sampling is comprised of 147 ZIP Codes located around the study corridors.

RSG began survey administration on June 6, 2019 and concluded on July 1, 2019. A total of 2,511 passenger vehicle surveys were completed during this time. **Table 3-1** shows the number of completed surveys obtained through each of the three administration methods.

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Table 3-1
Completed Surveys by Administration Method

Administrative Method	Count	Percent
Email invitations to MD E-ZPass customers	1,049	42%
Email invitations to VA E-ZPass customers	861	34%
Email invitations to online research panel	601	24%
Total	2,511	100%

3.4 Survey Analysis

Summary tabulation and statistics are presented here for select survey questions. A complete set of survey tabulations for all questions is in the full survey report included the appendix.

Before using the survey results, RSG screened the data for outliers. The goal of the screening process was to ensure that all observations included in the data analysis and model estimation represented realistic trips in the study area and reasonable trade-offs in the SP exercises. Variables like trip origin and destination, travel speed, and survey duration were reviewed during the screening process.

A total of 2,511 respondents completed the SP survey during the data collection phase of the project. Responses from 128 participants were excluded from the dataset based on outlier analysis, resulting in 2,383 usable surveys. Respondents who met the following conditions were excluded from the final analysis after reviewing different variables and their effect on model results (the categories listed below are not mutually exclusive; a respondent could be removed for more than one reason):

- Respondents who completed in survey in less than 4 minutes (13 respondents, 104 choice observations).
- Respondents whose travel speeds were calculated to be less than 2 mph or greater than 120 mph (31 respondents, 248 choice observations).
- Respondents whose calculated trip distance was less than 3 miles (16 respondents, 128 choice observations).
- Respondents who demonstrated inconsistent behavior in the SP exercises by selecting to pay for a specific amount of time savings in one experiment, then rejecting an equal or greater amount of time savings for an equal or lesser toll cost in a subsequent scenario (60 respondents, 480 choice observations).
- Respondents whose trip beginning, and end locations indicated they could not have made reasonable use of the I-495 and I-270 study corridors (40 respondents, 320 choice observations).

The descriptive analysis of the survey responses is presented in four sections: trip detail and toll road use analysis, value of time stated preference analysis, debrief and opinion analysis, and demographic questions.

3.4.1 Responses to Trip Detail Questions

Respondents were shown a series of questions that asked them to recount the details of a recent trip on I-495, I-270, or both facilities. **Table 3-2** shows the facilities that respondents used on their reference trip. Forty-two percent (42%) of respondents traveled on I-495 only, while 16% of respondents traveled on I-270 only. Forty-two percent of respondents described a reference trip that traveled on both facilities.

Table 3-2
Facilities Used for Reference Trip

Facility	Count	Percent
I-495 Only	1,010	42%
I-270 Only	372	16%
Both I-495 and I-270	1,001	42%
Total	2,383	100%

Respondents were asked to identify the primary purpose for their trip. The most commonly reported trip purpose was to go to or from work (31 percent of trips), followed by social or recreational trips (24 percent of trips). **Figure 3-3** shows the distribution of primary trip purpose for all respondents.

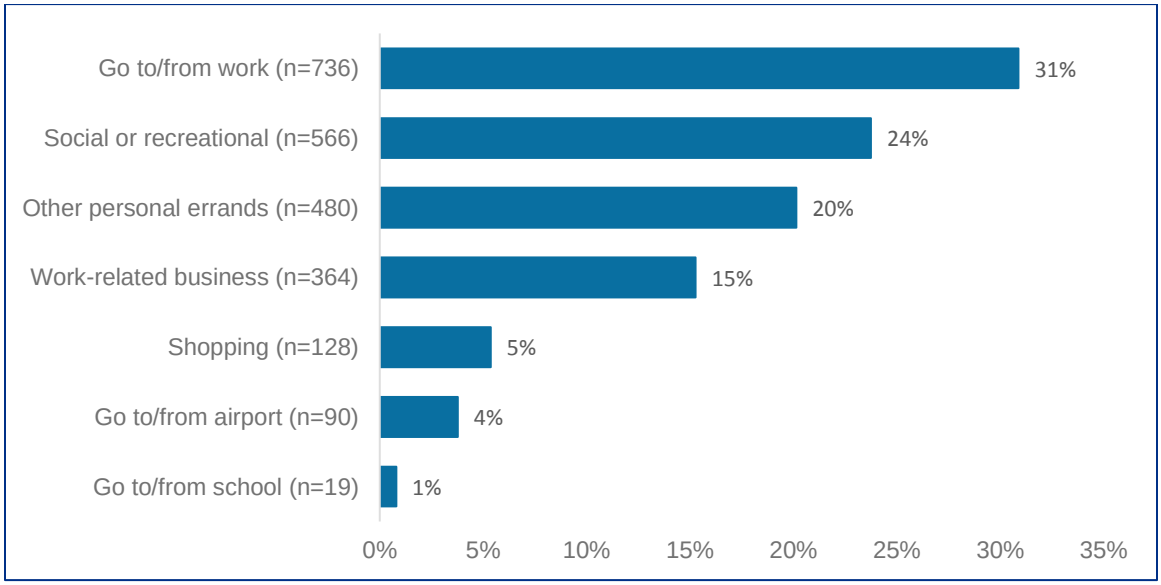

Figure 3-3
Trip Purpose

Respondents were asked the departure time of their trip. Forty-two percent (42%) of trips began during midday hours (9:00 a.m. to 2:59 p.m.). Just under half (49%) of reported trips began during either AM peak (6:00 a.m. to 8:59 a.m.) or PM peak (3:00 p.m. to 6:59 p.m.) hours. The smallest share of trips (9%) began during evening hours (7:00 p.m. to 5:59 a.m.). Fifty-nine percent (59%) of respondents indicated that they began their trip at the time they did to avoid delays due to traffic congestion.

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The latitude and longitude coordinates for each trip's origin-destination were used to estimate trip distances using a Bing Maps route-planning algorithm. The average calculated trip distance for all respondents was 38 miles, and the median distance was 25 miles. The average reported travel time for all respondents was 69 minutes, and the median reported travel time was 55 minutes. **Table 3-3** shows mean and median calculated trip distances and reported travel times, both by facility and for all respondents.

Table 3-3
Mean and Median Trip Distance and Reported Travel Time
By Facility

Facility	Distance (miles)		Travel Time (minutes)	
	Mean	Median	Mean	Median
I-495 Only	39	26	70	55
I-270 Only	32	18	56	45
Both I-495 and I-270	39	27	72	60
Total	38	25	69	55

Figure 3-4 shows categorized distribution of total travel time reported by each respondent by facility and for the aggregate sample. Forty-four percent (44%) of all reference trips were between 30 and 59 minutes. Since it is a shorter route, I-270 naturally had a higher share of reference trips that were under 30 minutes (20 percent). Twenty-five percent (25%) of reference trips that used both I-495 and I-270 travel for more than 90 minutes with 11 percent traveling for more than 2 hours.

Figure 3-5 shows the duration of delay encountered, by facility, for the 1,659 respondents who reported encountering a delay on their reference trip. Over two-thirds (68%) of all reported delays were under 30 minutes, and only 6% were one hour or longer. Of those who traveled only on I-495 and experienced a delay, 68% were delayed more than 15 minutes, while 63% of those who only traveled on I-270 were delayed more than 15 minutes. Seven percent (7%) of respondents who used both facilities and encountered delays were delayed by one hour or more.

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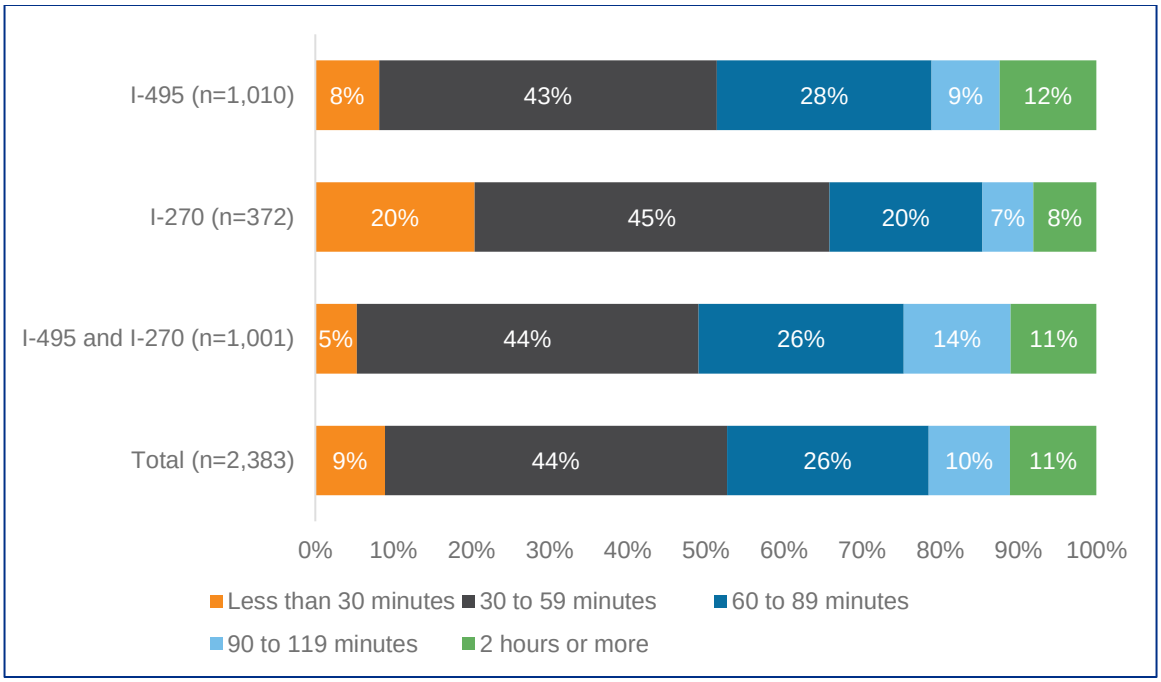

Figure 3-4
Reported Travel Time, By Roadway Used

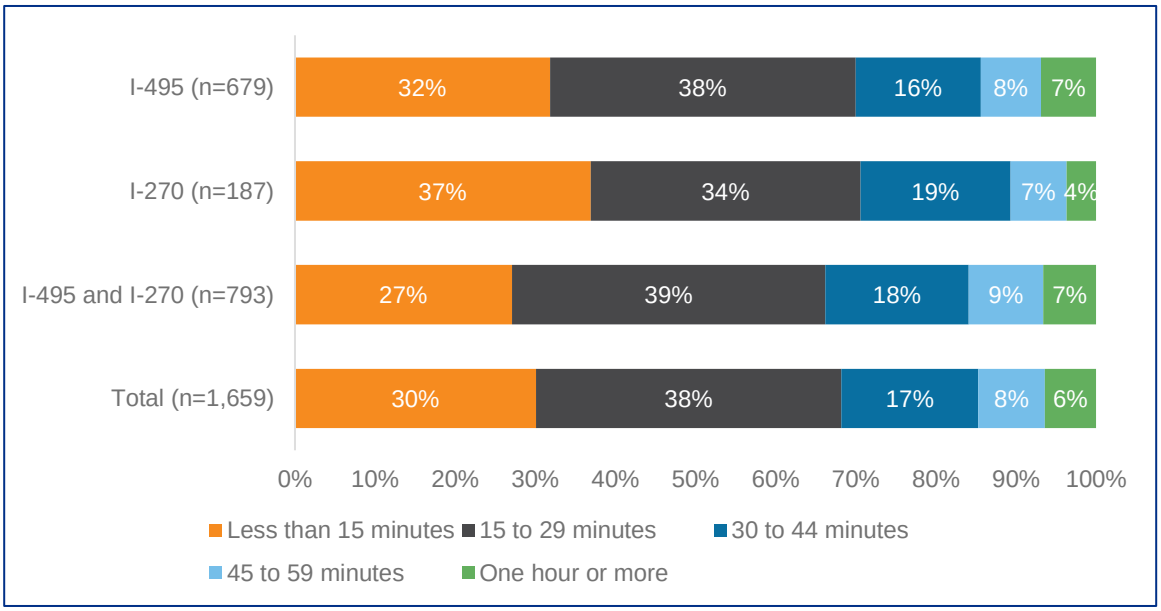

Figure 3-5
Amount of Delay, By Roadway Used

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Figure 3-6 and **Figure 3-7** show trip origin and destination points, respectively, stratified by road use. Both origin and destination points were clustered around the I-270 and I-495 study area.

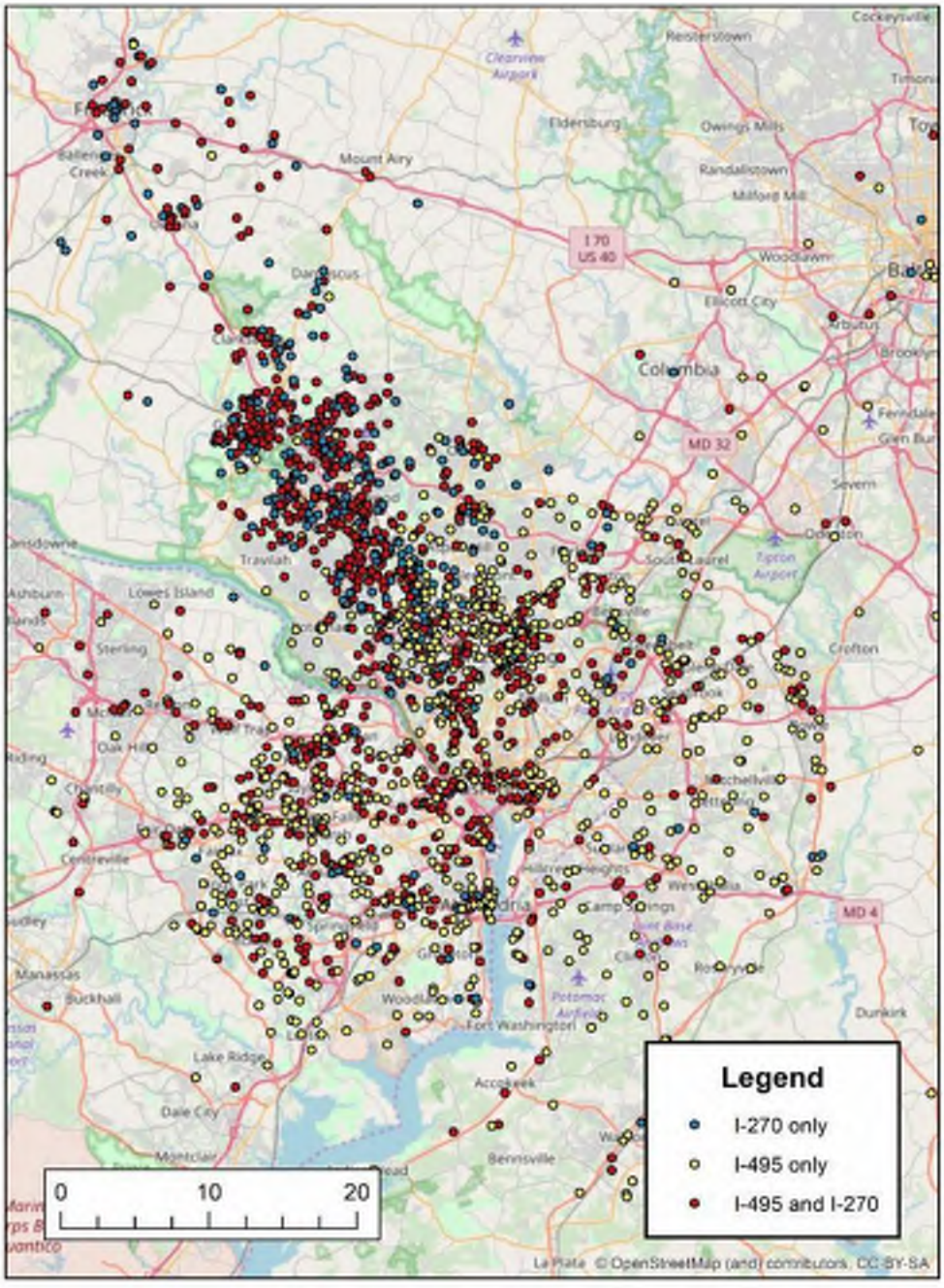

Figure 3-6
Trip Origins, By Roadway Used

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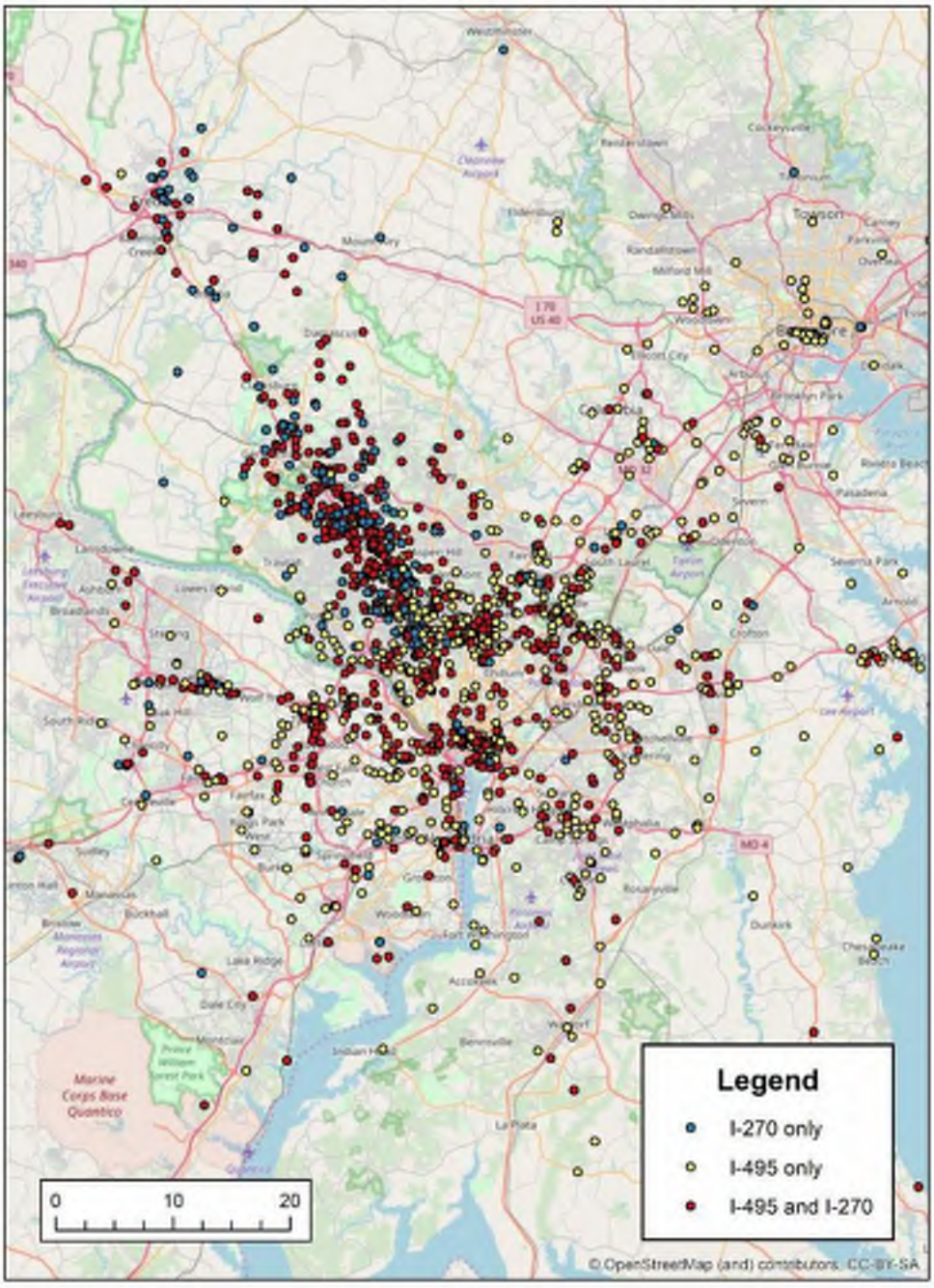

Figure 3-7
Trip Destinations, By Roadway Used

The distribution of reported entry and exit ramps for I-270 and I-495 are displayed in **Figure 3-8** and **Figure 3-9,** respectively. Respondents were asked to indicate the ramps they used to enter and exit I-495 or I-270. The most commonly reported entrance and exit location on I-270 was an exit north of Exit 9/I-370 (36% and 24%, respectively). The most commonly reported entrance and exit location on I-495 was an exit south of Exit 43 in Virginia (27% and 15%, respectively).

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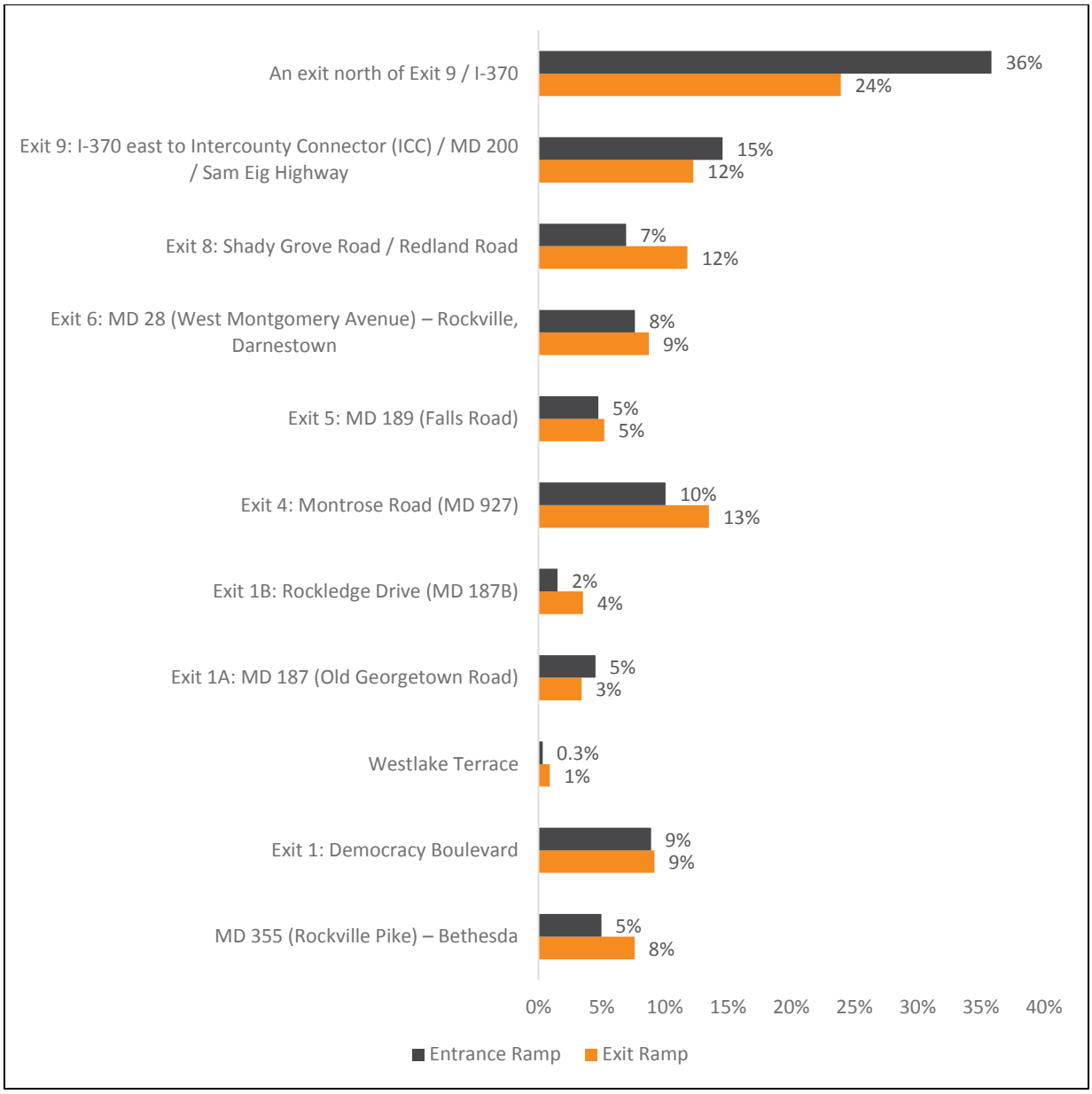

Figure 3-8
I-270 Entrance and Exit Ramps

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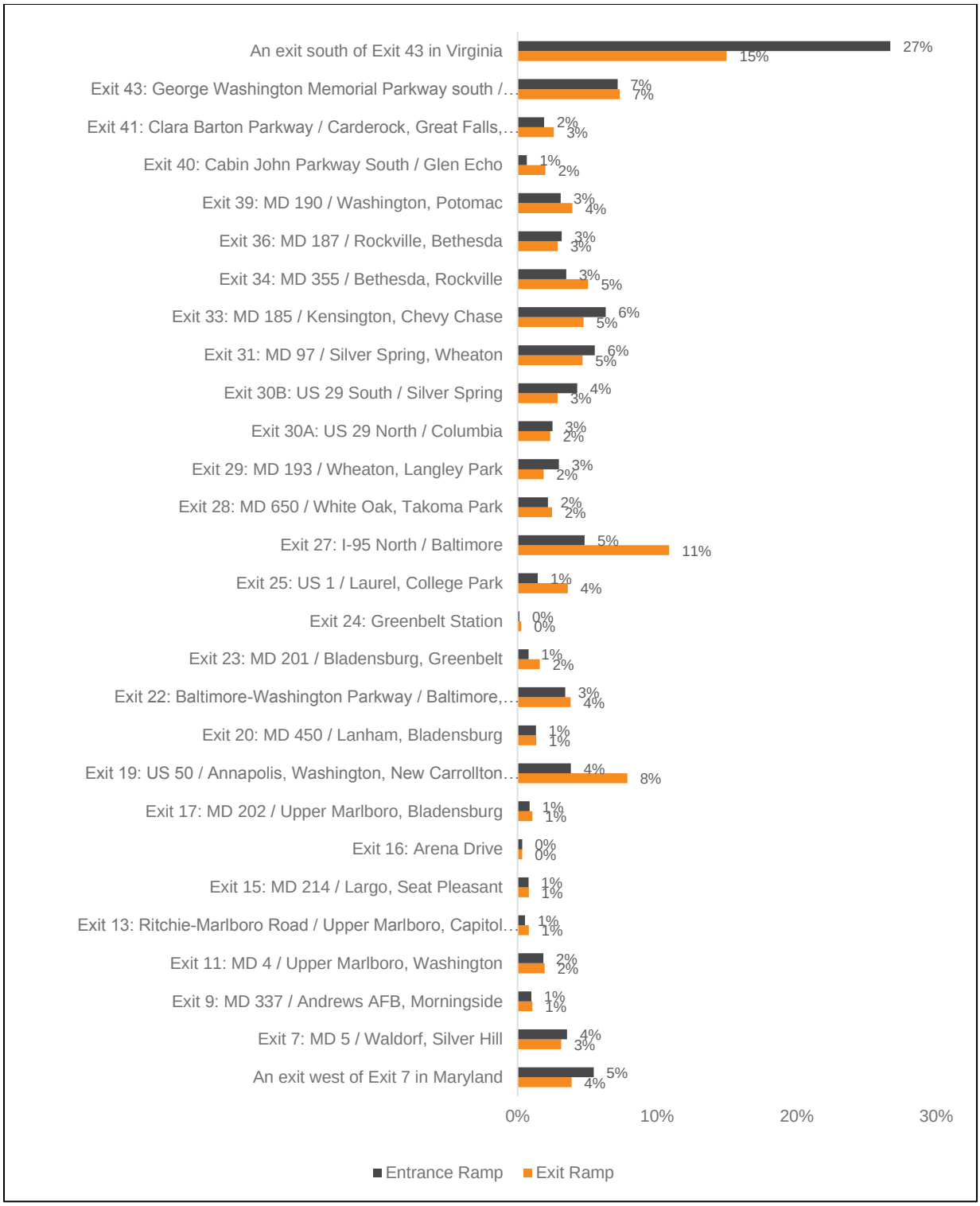

Figure 3-9
I-495 Entrance and Exit Ramps

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Approximately 43% of respondents reported a trip frequency of at least once per week, while 29% reported a trip frequency of less than once per month. Respondents whose reference trips included travel on both I-495 and I-270 were most likely to make their reference trip four or more times per week (27%). **Figure 3-10** shows trip frequency by facility and for the aggregate sample.

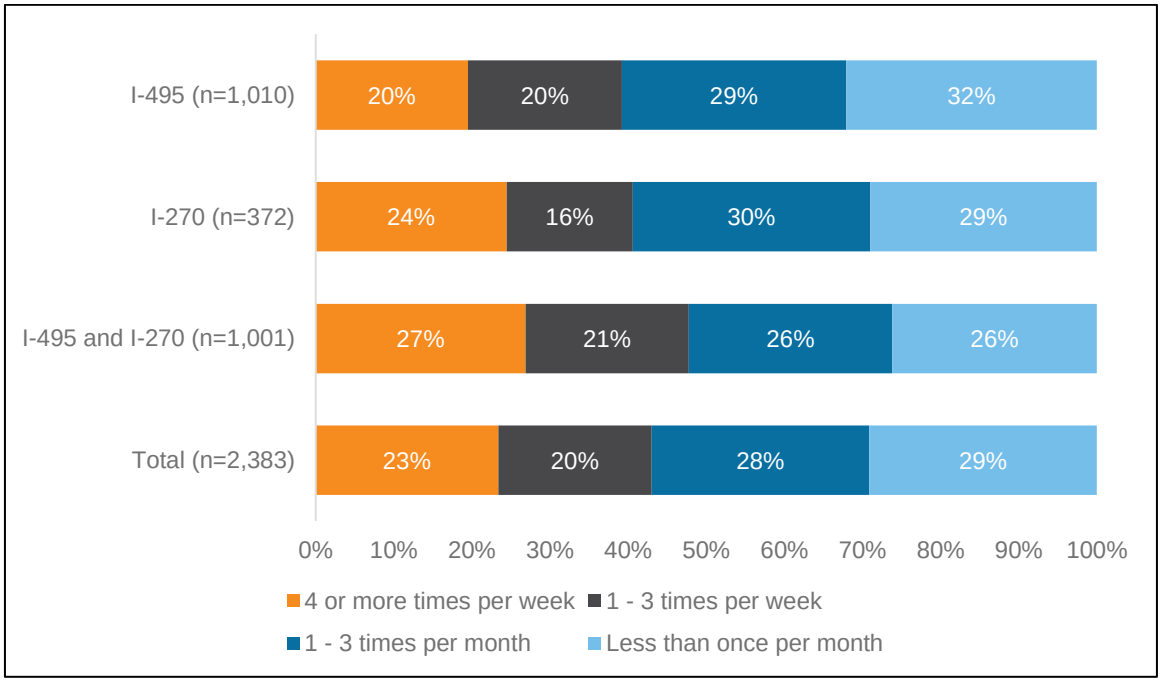

Figure 3-10
Trip Frequency, By Roadway Used

Respondents were asked if they had paid any tolls during their trip and whether they had an E-ZPass transponder or other electronic toll transponder in their vehicle. Approximately 19% of respondents reported paying a toll on their reference trip. Six percent (6%) of respondents paid a toll to travel on the Intercounty Connector (ICC)/MD 200 and 6% of respondents paid a toll to travel on the Virginia I-495 Express Lanes. Ninety-two percent (92%) of respondents had an E-ZPass transponder, and 8% did not have an E-ZPass or another electronic toll transponder.

3.4.2 Responses to Stated Preference Questions

After completing the trip characteristics portion of the survey, respondents answered eight SP trade-off questions, each tailored to their reported trips. Respondents chose the regular lanes alternative in the majority (75%) of SP scenarios. **Table 3-4** shows the frequency and percentage of times each SP alternative was selected.

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Table 3-4
Stated Preference Choices by Alternative

Alternative	Number of Experiments Shown	Number of Experiments Selected	Percent Selected
Alternative 1: Regular Lanes	19,064	14,245	75%
Alternative 2: Managed Lanes	19,064	4,819	25%

The full survey report shows additional metrics by which RSG determined that respondents behaved rationally in the SP experiments by selecting alternatives that maximized travel time savings while minimizing costs. Further analysis of the SP data will be described in more detail in the model estimation section of this chapter.

3.4.3 Responses to Debrief and Opinion Questions

After the experiments, respondents were asked to answer a series of debrief questions to better understand the underlying reasons for their choices in the eight SP scenarios. Thirty-five percent (35%) of respondents never chose the tolled managed lanes alternative in the SP scenarios. These respondents were asked to indicate the primary reason for their choices. The most frequently cited reason was that the time savings presented in the experiments were not high enough to justify the toll cost, followed by opposition to paying tolls (37% and 27%, respectively) (**Figure 3-11**).

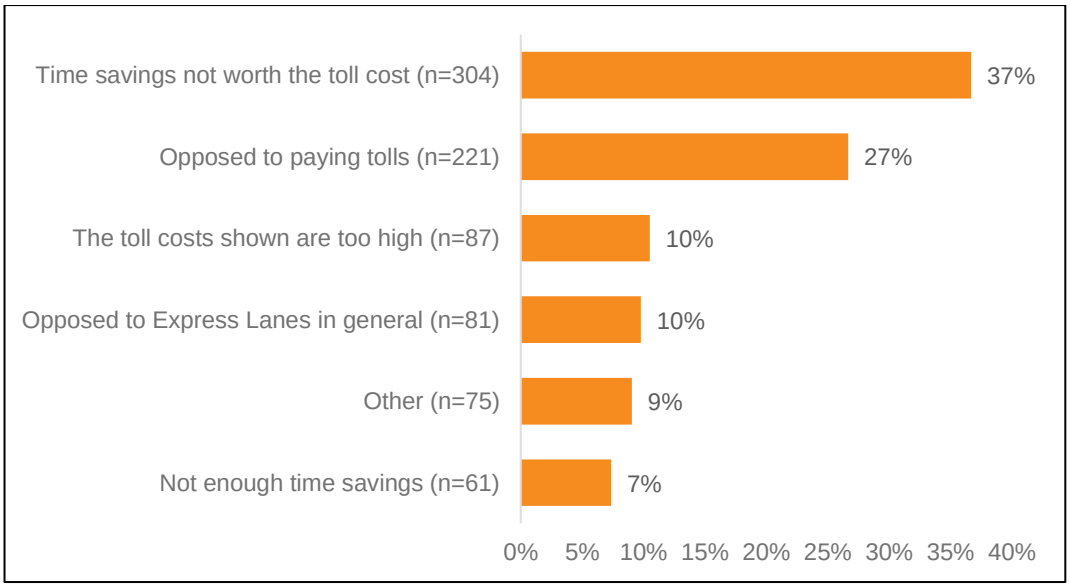

Figure 3-11
Reason for Never Choosing the Express Lanes

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Forty-three percent (43%) of all respondents indicated that they are in favor of the proposed managed lanes in Maryland on I-495 and I-270, while 39% of respondents indicated that they are opposed to the project (**Table 3-5**). Of the 43% of respondents who support the project, the most common reason was faster travel times (43%). Of the 39% of respondents who oppose the project, the most common reason was opposition to paying tolls (25%)

Table 3-5
Project Opinion

Project Opinion	Count	Percent
Stongly Favor	467	20%
Somewhat Favor	551	23%
Neutral	435	18%
Somewhat Opposed	363	15%
Strongly Opposed	567	24%
Total	2,383	100%

Levels of agreement were measured for a series of attitude statements to gauge respondents' opinions about issues related to tolling and managed lanes on I-495 and I-270 (**Figure 3-12**). Respondents were most likely to agree with the statements "I will use the toll route if the tolls are reasonable and I will save time" (70%) and "I can generally afford to pay tolls" (67%).

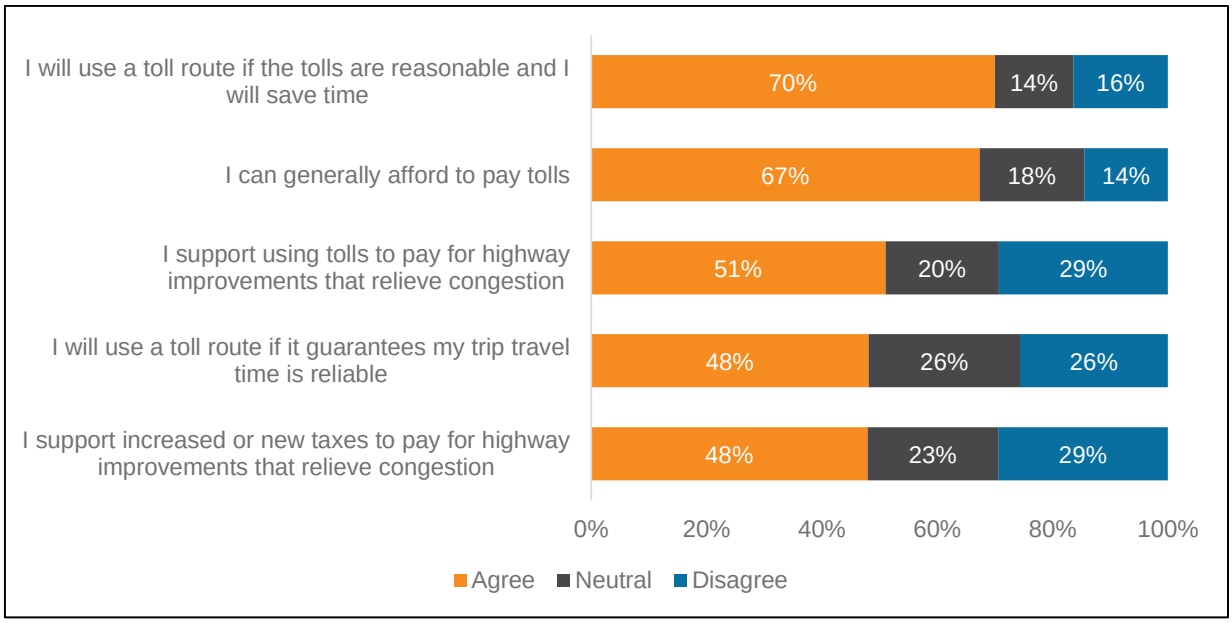

Figure 3-12
Toll Attitude Statements

3.4.4 Responses to Demographic Questions

Over half of all respondents identified as male (54%). The median age category for the sample was 55–64 years old. Forty-three percent (43%) of respondents lived in a two-person household,

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and 46% of all respondents had two household vehicles. Most respondents (63%) were employed full time, 20% were retired, and 8% were self-employed.

When reporting income, respondents could select a "prefer not to answer" option. The median household income of all respondents who chose to report their income was in the $125,000–$149,999 income category (**Table 3-6**).

Table 3-6
Annual Household Income of Sample

Income Category	Count	Percent
Less than $15,000	11	1%
15,000–$24,999	16	1%
25,000–$34,999	27	1%
$35,000–$49,999	73	4%
$50,000–$74,999	151	8%
$75,000–$99,999	241	12%
$100,000–$124,999	248	13%
$125,000–$149,999	251	13%
$150,000–$199,999	352	18%
$200,000 or more	565	29%
Total	1,935	100%

3.5 Discrete Choice Model Estimation

The primary objective of the SP survey was to estimate the value of time for passenger vehicle travelers who make trips on the I-495 or I-270 study corridors. These value of time estimates will be used as inputs to travel demand models used to forecast the traffic usage and toll revenue for the proposed managed lanes. The eight choice observations for each respondent were compiled into a dataset with 19,064 observations to support the estimations of value of time.

One way to evaluate the sensitivities from the respondents' data is to estimate multinomial logit models (MNL) to calculate the marginal rate of substitution for different travel attributes. In basic economic theory, the marginal rate of substitution is the amount of one good (e.g., money) that a person would exchange for a second good (e.g., travel time), while maintaining the same level of utility, or satisfaction. In this analysis, the marginal rate of substitution of the travel time and toll cost coefficients provides the implied toll value that travelers would be willing to pay for a given travel time savings accrued by using the express lanes.

For this express lane project, an additional layer of analysis, using mixed multi-nomial logit models (MMNL) were also conducted. MMNL models allow for the recognition of random variations in preference among respondents in addition to the systematic heterogeneity of toll choice. The MMNL model provides a mean estimate of value of time and the standard deviation of that estimate for each variable identified by the MNL models. This information can be used to simulate value of time distributions for the sample. This can then be used to establish the share of traffic that would be willing to choose the tolled express lanes option at any given combination of travel time savings and toll cost.

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3.5.1 Model Results: Willingness to Pay for Travel Time Savings

In each stated preference scenario, the following two alternatives were presented for making a future trip in the region:

1. Drive in the regular lanes on I-270/I-495
2. Drive in the managed lanes on I-270/I-495

RSG tested several utility equation structures using different variables from the collected data. In addition to the travel times and toll costs presented in the SP experiments, tested variables included trip characteristics, attitudinal indicators, and demographic variables. These variables were introduced, one at a time, to test potential interactions with the toll cost and travel-time coefficients and to determine whether respondents' trip or personal characteristics significantly influenced their choices in the SP scenarios.

After reviewing the significance of each variable, the final model specification was chosen based on model fit, the intuitiveness and reasonableness of the model coefficients, and the expected application of the model results. The final model specifications included variables for travel time and toll cost, with segmentation based on trip purpose and project opinion to control for strategic bias. The opposed segment comprises respondents who indicated that they were strongly opposed to the project. The unopposed segment was segmented into work and nonwork trips. The opposed segment contains 567 respondents, the unopposed work trip segment contains 847 respondents, and the unopposed nonwork segment contains 969 respondents.

The distribution of values of time were developed for the sample using the coefficients from the MMNL models. One of the key benefits of the MMNL model is that it captures actual random variations among respondents by assuming their preferences fall along a known distribution. One or more of the coefficients, such as travel time or toll cost, can be specified as random parameters. The MMNL model then produces two coefficients for each random parameter that describe the shape of the distribution for that random parameter. By simulating a population using 10,000 random draws, with variations that fall within the distribution of the random parameters, a distribution of the value of time can be developed from the survey data.

The distribution of VOT, which shows the percentage of respondents with a given VOT, is presented in **Figure 3-13** for work trips and in **Figure 3-14** for nonwork trips at the sample median income. The toll choice curve is shown in Error! Reference source not found. for work trips and in Error! Reference source not found. for nonwork trips; the choice curve illustrates the percentage of respondents with a VOT greater than or equal to a given value.

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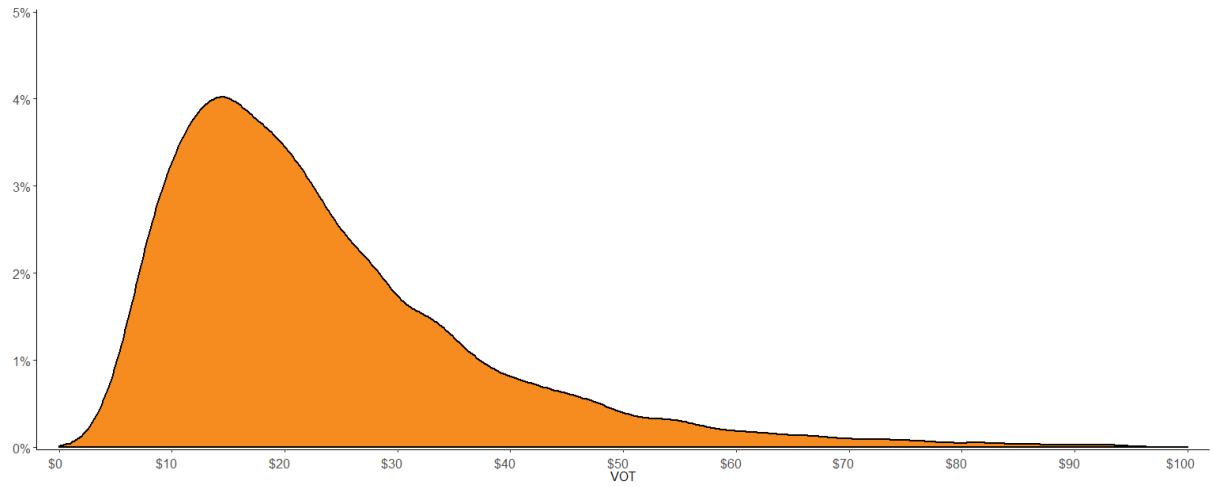

Figure 3-13: Work Trip VOT Distribution at an Income of $146,582

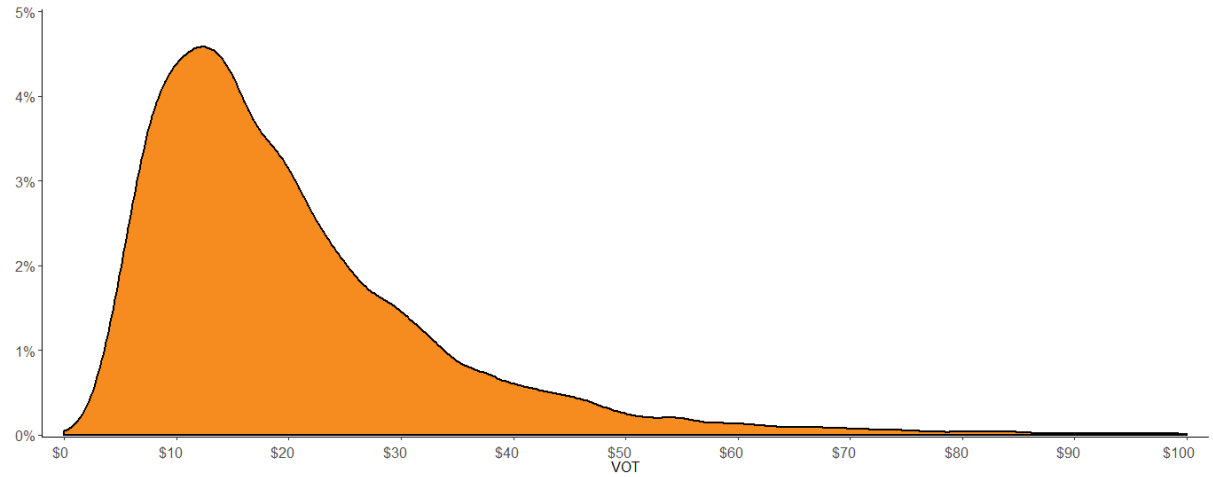

Figure 3-14: NonWork Trip VOT Distribution at an Income of $134,997

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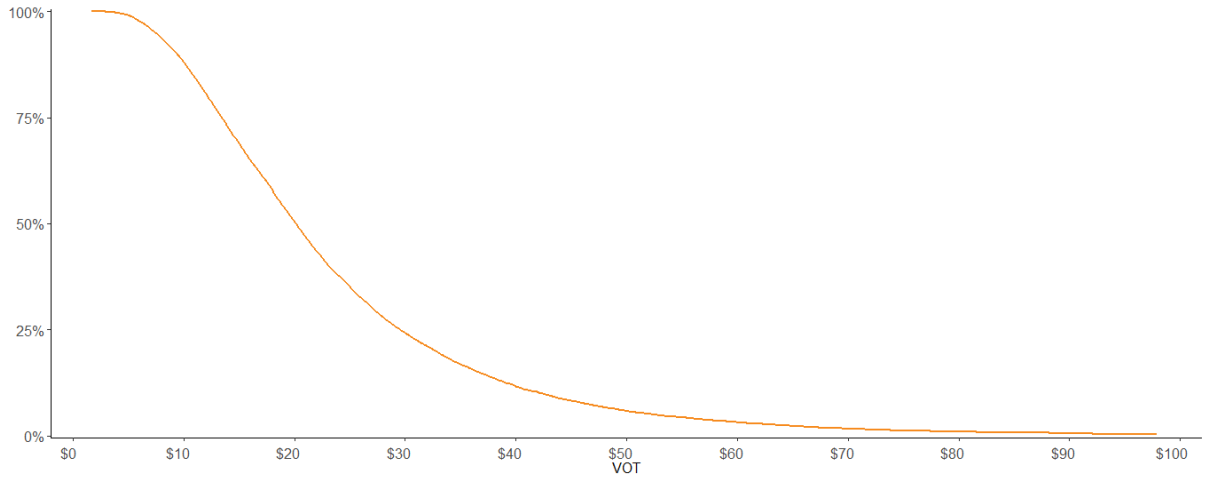

Figure 3-15: Work Trip Toll Choice Curve at an Income of $146,582

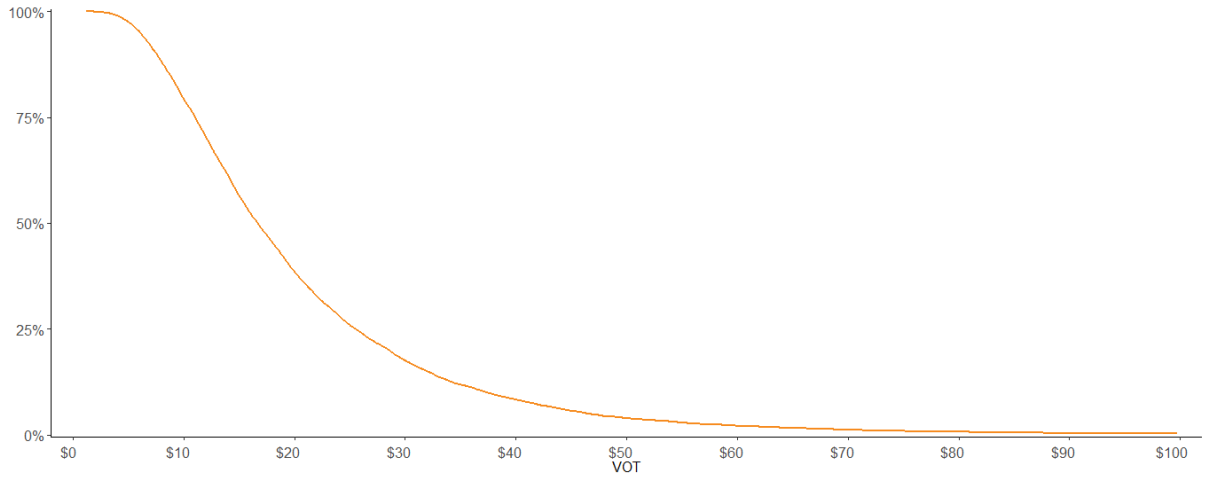

Figure 3-16: Nonwork Trip Toll Choice Curve at an Income of $134,997

3.6 Summary of Stated Preference Survey Findings

RSG successfully developed and implemented an SP survey to estimate the VOT for potential managed lane users who make trips in the I-495 or I-270 study corridors in Maryland. The survey gathered information from 2,511 passenger vehicle travelers who had recently made a qualifying trip on at least one of the facilities. The survey was administered to a wide selection of the I-495/I-270 traveling population, using multiple administration methods. The questionnaire collected data on current travel behavior, presented respondents with information about the proposed Express Lanes on I-495 and I-270, and engaged the travelers in a series of SP scenarios to obtain their precise travel preferences in a statistically controlled manner.

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RSG developed MNL and MMNL choice models using the survey data to produce estimates of VOT by trip purpose. Using the MNL model to inform the structure, RSG developed an MMNL model to estimate distributions of the VOT to account for random preference heterogeneity within the survey sample. The MMNL model identified significant heterogeneity in VOT, with some respondents having low VOT, others having high VOT, and the bulk of respondents being somewhere in between. As shown in **Table 3-7,** at the sample mean income, the mean VOT was $23.62 for work trips and $20.55 for nonwork trips, and the median VOT was $19.68 for work trips and $16.75 for nonwork trips.

Table 3-7
Resultant Value of Time at the Sample Mean Income

Type	Value of Time
Mean for Work Trips	$23.62
Mean for Nonwork Trips	$20.55
Median for Work Trips	$19.68
Median for Nonwork Trips	$16.75

The survey and choice model results indicate that the toll amount and travel-time savings provided by the proposed managed lanes could have a significant effect on travel behavior of residents and visitors who use I-495 and I-270 in Maryland. The incorporation of these results into the updated regional travel demand model will allow for an evaluation of a wide range of tolling scenarios and travel conditions for the proposed project.

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Chapter 4
Corridor Growth Assessment

4.1 Introduction

Forecasting the use of the I-495 and I-270 Managed Lanes is partially a function of determining growth in socioeconomic variables such as population and employment. An independent socioeconomic growth assessment for the area was undertaken to provide the context for and input to developing travel demand growth projections. This chapter provides a description of the methodology and findings related to the socioeconomic growth assessment and adjustments for the area. It begins with the outline of the need for this review and the geographical context. This is followed by an overview of the historical socioeconomic patterns in the area, adjustment methodology, the base adjusted forecast results, and sensitivity test results.

4.1.1 Need for Review of MWCOG Socioeconomic Assumptions

Population and employment forecasts serve as key inputs for developing trip generation estimates, the first step in building trip tables within the Metropolitan Washington Council of Governments (MWCOG) regional travel demand model, and ultimately demand for the I-495 and I-270 Managed Lanes Project. MWCOG created regional population and employment forecasts in cooperation with its member jurisdictions. The most recent MWCOG forecast, adopted in the fall of 2018 and known as Round 9.1, forecasts these metrics for the 26 counties and independent cities representing the Washington, D.C., metropolitan area through 2045, in five-year increments. The forecast is broken out into 3,722 Traffic Analysis Zones (TAZs), with each zone containing blocks of socioeconomically similar residential and/or commercial properties.

Projections developed as part of Metropolitan Planning Organizations' (MPOs') regional transportation plans such as MWCOG's can differ in terms of goals and focus when compared to traffic and revenue studies. While the former is typically policy-oriented and aspirational in steering development towards certain sustainability goals, the latter are geared toward providing a review and adjustment of the MPO forecasts to reflect the market conditions and pattern of development that is likely to occur under those conditions. For comprehensive traffic and revenue studies, this process is particularly important, because potential investors in toll road facility bonds are concerned about realistic growth underlying traffic and revenue to generate sufficient coverage of payment obligations.

Hence, there are several reasons for conducting a review of such socioeconomic forecasts by an economist for input into traffic and revenue modeling, particularly at a comprehensive level. First, a locally knowledgeable transportation economist should be able to make adjustments to the forecast that take into account recent economic developments not previously assumed within the regional planning agency dataset. Second, the socioeconomic forecasts developed by regional planning agencies are usually developed at a regional level. The economist can provide greater detail to forecasts, with a focus on the local study corridor area. Lastly, a review from the

economist provides another opinion for rating agencies to consider as they assess the results of the traffic and revenue study supported by the socioeconomic forecasts.

As part of this study, Renaissance Planning Group (RPG) made adjustments to the base MWCOG forecasts and provided independent economic growth projections throughout the area. RPG reviewed economic conditions and major development plans, focusing on those which could affect demand for the I-495 and I-270 Study Corridors. RPG prepared a separate report , which is included in **Appendix B**.

4.2 Geographical Context

As part of RPG's study methodology, a primary market area was composed of model traffic analysis zones (TAZs) with the highest concentration of both origins and destinations using the I-495 and I-270 facilities. TAZs were selected to form a cohesive study area by avoiding holes and rough edges. Prior analyses have demonstrated that a reasonable Primary Market Area encompasses 85 percent of total facility origins and destinations. Beyond 85 percent the remaining users are generally too dispersed to be cohesive, as was the case in this study.

The jurisdictions that include the primary market area used in this study are shown in **Figure 4-1.** These jurisdictions are Arlington and Fairfax Counties in Virginia, the city of Alexandria in Virginia, Washington, D.C., and Montgomery and Prince George's Counties in Maryland. These six jurisdictions generate most of the traffic using the I-495 and I-270 Corridors on a daily basis. The socioeconomic forecasts presented and discussed in this chapter generally focus on the primary market area jurisdictions. This level of aggregation is also a useful to compare historical and forecasted growth trends.

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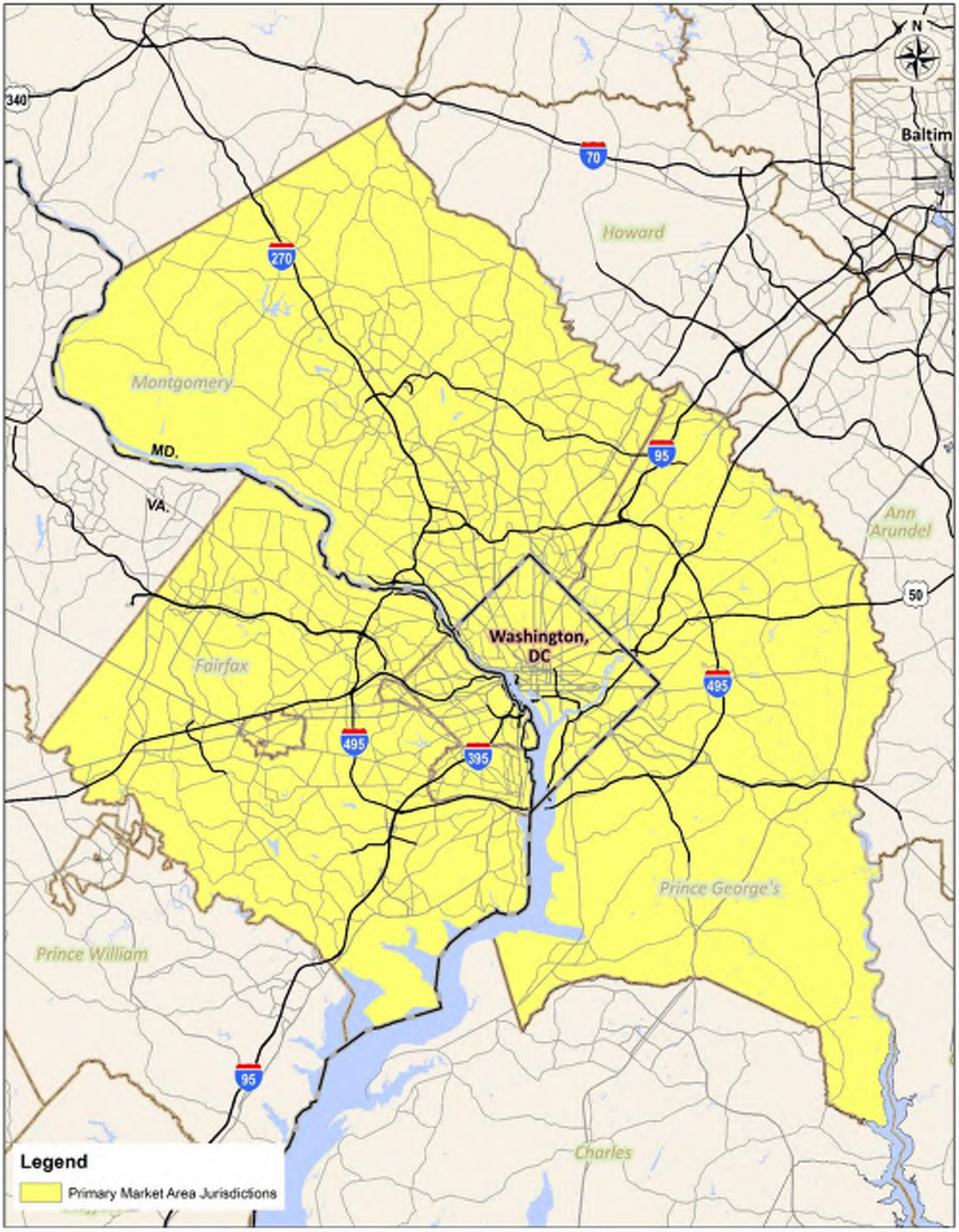

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PRIMARY MARKET AREA JURISDICTIONS

FIGURE 4-1

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4.3 Historical Growth Trends

The following section summarizes the historical socioeconomic trends in the primary market area jurisdictions. The major trends in the population and employment were assessed and are presented in the subsections below.

4.3.1 Historical Population Growth

Population is a key variable driving transportation demand within the I-495 and I-270 Study Area. The historical population data for the six main jurisdictions in the area were collected from the U.S. Census Bureau for the 1990 through 2017 timeframe.

The primary market area jurisdiction's total population grew from about 3.2 million people in 1990 to 4.2 million people in 2017, an increase of about one million people. This translates to a compound average annual growth rate (CAAGR) of 1.0 percent, as shown in **Table 4-1.** The largest growth rates have occurred in the City of Alexandria and in Fairfax County, both at the rate of 1.3 percent. The two counties in Maryland, Montgomery and Prince George's, have grown at 1.2 and 0.9 percent respectively, both higher than the overall Maryland growth of 0.8 percent. Virginia and the nation's population grew at a somewhat higher average annual rate of 1.1 percent and 0.9 percent, respectively.

Table 4-1

Historical Population Growth Trends

Jurisdiction	Level				CAAGR				Absolute Change
	1990	2000	2010	2017	1990-2000	2000-2010	2010-2017	1990-2017	1990-2017
Population									
Arlington	171,164	189,198	209,449	231,296	1.0%	1.0%	1.4%	1.1%	60,132
Alexandria	111,491	129,225	140,874	156,792	1.5%	0.9%	1.5%	1.3%	45,301
District of Columbia	605,321	572,046	605,183	684,498	-0.6%	0.6%	1.8%	0.5%	79,177
Fairfax[1]	851,111	1,007,517	1,121,804	1,195,669	1.7%	1.1%	0.9%	1.3%	344,558
Montgomery	765,476	877,478	976,321	1,052,862	1.4%	1.1%	1.1%	1.2%	287,386
Prince George's	725,896	803,111	865,821	914,385	1.0%	0.8%	0.8%	0.9%	188,489
Area Total	3,230,459	3,578,575	3,919,452	4,235,502	1.0%	0.9%	1.1%	1.0%	1,005,043
Virginia	6,187,358	7,078,515	8,001,024	8,365,952	1.4%	1.2%	0.6%	1.1%	2,178,594
Maryland	4,781,468	5,296,486	5,773,552	5,996,079	1.0%	0.9%	0.5%	0.8%	1,214,611
United States	248,790,925	281,421,906	308,745,538	321,004,407	1.2%	0.9%	0.6%	0.9%	72,213,482

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: U.S. Census Bureau

4.3.2 Historical Employment Growth

The total employment in primary market area jurisdictions grew by about 872 thousand, or 1.1 percent annually, from 1990 to 2017. The total employment in 2017 was approximately 3.4 million, as summarized in **Table 4-2**. On the Virginia side, Fairfax increased its employment rate at the highest rate (1.9 percent per year) within the area. On the Maryland side, Montgomery County had the higher growth at an average of 1.3 percent per year.

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Table 4-2

Historical Employment Growth Trends

Jurisdiction	Level				CAAGR				Absolute Change
	1990	2000	2010	2017	1990-2000	2000-2010	2010-2017	1990-2017	1990-2017
Employment									
Arlington	195,414	200,641	210,581	229,335	0.3%	0.5%	1.2%	0.6%	33,921
Alexandria	108,340	113,355	123,715	128,532	0.5%	0.9%	0.5%	0.6%	20,192
District of Columbia	773,210	735,305	809,918	908,676	-0.5%	1.0%	1.7%	0.6%	135,466
Fairfax[1]	556,596	746,708	826,400	921,210	3.0%	1.0%	1.6%	1.9%	364,614
Montgomery	512,643	598,974	652,369	723,121	1.6%	0.9%	1.5%	1.3%	210,478
Prince George's	372,365	394,556	427,155	480,340	0.6%	0.8%	1.7%	0.9%	107,975
Area Total	2,518,568	2,789,539	3,050,138	3,391,214	1.0%	0.9%	1.5%	1.1%	872,646
Virginia	3,699,593	4,399,151	4,743,189	5,229,218	1.7%	0.8%	1.4%	1.3%	1,529,625
Maryland	2,737,249	3,092,125	3,345,423	3,702,196	1.2%	0.8%	1.5%	1.1%	964,947
United States	138,330,900	165,370,800	172,901,700	196,825,300	1.8%	0.4%	1.9%	1.3%	58,494,400

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: Historical data at the sub-state level are based on Woods & Poole, adjusted to meet 2010 MWCOG definitions. BEA data for Virginia, Maryland, and the U.S.

4.4 Review of MWCOG Forecasts

This section presents the review of the latest adopted version of the socioeconomic forecasts within the MWCOG model available at the beginning of this study, known as Round 9.1.

Table 4-3 and **Table 4-4** show the MWCOG Round 9.1 population and employment forecast by jurisdiction between 2017 and 2045. The study area's total population is projected to grow at a CAAGR of 0.8 percent, reaching 5.2 million by 2045. The District of Columbia and Fairfax are the largest contributors, with total growth of 292,000 and 291,000 respectively. In CAAGR terms, the District of Columbia is estimated as the fastest growing area with annual growth of 1.3 percent per year.

Table 4-3

MWCOG Forecast Summary - Population by Jurisdiction, Round 9.1

Jurisdiction	Level				CAAGR				Absolute Change
	2017	2025	2035	2045	2017-2025	2025-2035	2035-2045	2017-2045	2017-2045
Population									
Arlington	227,860	249,462	274,563	301,167	1.1%	1.0%	0.9%	1.0%	73,307
Alexandria	152,260	167,515	180,463	208,451	1.2%	0.7%	1.5%	1.1%	56,191
District of Columbia	695,135	787,116	893,898	987,213	1.6%	1.3%	1.0%	1.3%	292,078
Fairfax[1]	1,178,155	1,255,535	1,374,998	1,469,595	0.8%	0.9%	0.7%	0.8%	291,440
Montgomery	1,029,947	1,087,292	1,167,704	1,223,345	0.7%	0.7%	0.5%	0.6%	193,398
Prince George's	911,915	938,023	967,842	995,874	0.4%	0.3%	0.3%	0.3%	83,959
Area Total	4,195,272	4,484,943	4,859,468	5,185,645	0.8%	0.8%	0.7%	0.8%	990,373

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: MWCOG TDM Round 9.1

The total employment is projected to grow at 0.9 percent annually to 3.5 million in 2045. Alexandria is expected to experience the fastest rate of growth at 1.3 percent per year in the study area. The largest absolute contribution to employment growth is expected to come from the District of Columbia at a total of 228,000 followed by Fairfax County at a total of 223,000.

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Table 4-4

MWCOG Forecast Summary - Employment by Jurisdiction, Round 9.1

Jurisdiction	Level				CAAGR				Absolute Change
	2017	2025	2035	2045	2017-2025	2025-2035	2035-2045	2017-2045	2017-2045
Employment									
Arlington	212,552	223,539	248,902	269,064	0.6%	1.1%	0.8%	0.8%	56,512
Alexandria	107,792	121,772	135,254	155,095	1.5%	1.1%	1.4%	1.3%	47,303
District of Columbia	817,462	895,120	978,223	1,045,390	1.1%	0.9%	0.7%	0.9%	227,928
Fairfax[1]	708,912	784,676	861,586	931,892	1.3%	0.9%	0.8%	1.0%	222,980
Montgomery	529,480	572,497	627,351	678,753	1.0%	0.9%	0.8%	0.9%	149,273
Prince George's	342,747	366,326	385,542	402,145	0.8%	0.5%	0.4%	0.6%	59,398
Area Total	2,718,945	2,963,930	3,236,858	3,482,339	1.1%	0.9%	0.7%	0.9%	763,394

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: MWCOG TDM Round 9.1

4.5 Adjustment Methodology

As described previously, RPG made adjustments to the MWCOG Round 9.1 forecasts as part of this study. As outlined in more detail in RPG's report in **Appendix B**, the RPG forecast adjustment methodology included top-down methods for analyzing population and employment totals, bottom-up methods for analyzing the supply of land, market-based macroeconomic information on the growth prospects, and a forecasting tool integrating different variables that was used to analyze and apply adjustments at the TAZ level. The overall approach included the following five steps:

1. Definition of a primary market area for focused suballocation of economic growth (as discussed previously in **Section 4.2.2**);
2. A macroeconomic assessment of the opportunities for short- and long-term growth and an independent, quantitative evaluation of jurisdiction-level macroeconomics;
3. Testing and adjusting regionwide- and jurisdiction-level population and employment control totals to result in a blended set of forecast control totals;
4. Suballocation of Primary Market Area opportunities and constraints for residential and non-residential development, including a forecasting tool that integrates predictive variables to analyze and adjust forecasts at the TAZ-level for a baseline forecast for all horizon years;
5. Preparation of alternate forecast sensitivity tests.

4.5.1 Assessment of Growth Trends

The Washington D.C. Metropolitan Area is unique due to its position as a national capital. This provides an employment base of federal agencies, complemented by the goods and services they attract. The relative consistency of federal government activities and federal stimulus, as contrasted with private-sector economic cycles, helped the Washington region through the Great Recession of 2007 to 2009 with less volatility than many other regions. However, economic growth has slowed somewhat in relative terms due to federal cutbacks, such as Base Realignment and Closure and sequestration. Employment growth may be constrained by continued dependency on federal jobs and federal contracts which may leave the regional economy more susceptible to certain types of downturns than other large regions. However, the region still hosts a strong and stable economy relative to the nation.

Accessibility investments serve shifting market preferences within the region and there are signs of modest but consequential changes in development patterns across the region. Residential and commercial market preferences, large-scale infrastructure investments, and focused policy efforts point to potential for changes in population and employment growth over time.

4.5.2 Blended Forecasts

RPG tested and adjusted MWCOG regionwide and jurisdiction-level population and employment control totals to result in a blended set of forecast control totals. As part of this process RPG reviewed and compared population and employment forecasts developed by public agencies, including state demographic centers, as well as private entities. **Table 4-5** shows key alternative projections from RPG, produced by the "Cohort Component" method, Woods & Poole, Moody's, Weldon Cooper, and Maryland State Data Center for jurisdictions in the study area. Data from Weldon Cooper was used for areas of Virginia, while the Maryland State Data Center cover areas in Maryland. Considering overall 2017 to 2045 trends, Woods & Poole is the most aggressive with 0.9 percent growth per year, while the Cohort Component is the most conservative at 0.5 percent per year.

Table 4-5

Area Population Forecasts by Alternative Source

Jurisdiction	Level				CAAGR				Absolute Change
	2017	2025	2035	2045	2017-2025	2025-2035	2035-2045	2017-2045	2017-2045
Population									
Cohort Component	4,247,651	4,527,373	4,758,882	4,911,545	0.8%	0.5%	0.3%	0.5%	663,894
Woods & Poole	4,235,502	4,587,484	5,021,862	5,397,033	1.0%	0.9%	0.7%	0.9%	1,161,531
Moody's	4,247,651	4,478,555	4,739,790	4,976,005	0.7%	0.6%	0.5%	0.6%	728,354
Weldon Cooper/State Data Center	4,159,003	4,512,348	4,855,184	5,127,144	1.0%	0.7%	0.5%	0.8%	968,141

Source: RPG, Woods & Poole, Moody's Analytics, Weldon Cooper, Maryland State Data Center

Alternative forecasts for employment are shown in **Table 4-6**. The definitions of employment differ between the sources making comparisons between growth rates important to compare. The sources used for this table include alternative forecasts produced by RPG, produced through the "Shift Share" methodology, Woods & Poole, Moody's, and Maryland State Data Center (as applicable) for each jurisdiction in the Primary Market Area. Woods & Poole is again the highest with their employment forecast showing a gain of about 1.1 percent per year. Moody's is the lowest with their forecast showing a gain of about 0.5 percent per year.

Table 4-6

Area Employment Forecasts by Alternative Source

Jurisdiction	Level				CAAGR				Absolute Change
	2017	2025	2035	2045	2017-2025	2025-2035	2035-2045	2017-2045	2017-2045
Employment									
Shift Share	2,695,692	2,917,002	3,193,640	3,470,277	1.0%	0.9%	0.8%	0.9%	774,585
Woods & Poole	3,391,214	3,806,043	4,282,214	4,659,161	1.5%	1.2%	0.8%	1.1%	1,267,947
Moody's	2,549,687	2,686,200	2,818,640	2,958,180	0.7%	0.5%	0.5%	0.5%	408,493
State Data Center	1,954,662	2,111,720	2,249,123	2,374,490	1.0%	0.6%	0.5%	0.7%	419,828

Source: RPG, Woods & Poole, Moody's Analytics, Maryland State Data Center

After review of different forecast sources included those shown in **Table 4-5** and **Table 4-6**, RPG developed control totals for each jurisdiction by weighting the alternative forecasts to develop a

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forecast that was in-line with the macroeconomic assessment of the region. These control totals then served as inputs to the allocation model.

4.5.3 Suballocation

The purpose of suballocation is to assign growth to each traffic analysis zone (TAZ) in the model area. In general terms, the process requires assigning demand potential, growth capacity, and then population and employment growth based on demand potential but constrained by capacity for each TAZ.

Growth potential is based on many factors including those below:

- Activities – the existing prevalence of uses and the recent growth trends that contributed to that existing condition;
- Access – the multi-modal infrastructure that exists now or is expected to exist in the future that allow an area to reach - and be reached by – the larger region;
- Policy – public sector land use and infrastructure decisions that reflect growth management regulations; and
- Market – the view that the private sector has about a place, usually identified through indirect measures like cost.

A suballocation model was developed to identify and quantify these categories, using two dozen different demand factors to best reflect the multivariate components of growth potential. Each TAZ was scored in population and employment demand potential based on these factors. Jurisdictional growth forecasts were then applied to the demand potential scores - constrained by development capacity – to calculate TAZ level growth estimates.

The results of the suballocation represent the "baseline forecast" for population and employment for each jurisdiction for the forecast years. Detailed discussion about these results is covered in **Section 4.6**.

4.5.4 Sensitivity Tests

For the purposes of this study, two alternative growth scenarios were developed that pivot off the baseline forecast: one low scenario and one high scenario.

The low growth scenario development process began with an evaluation of historical regional recessions in 1980-83, 1990-91, and 2007-09, and identified three key findings:

1. Recessions generally resulted in employment declines from trend growth for a few years about once every 10-20 years and are followed by a rebound period. RPG examined the variability in AAGR rates for rolling five-year growth periods on an annual basis and assumed recessions that have five-year cycles to be synchronized with the five-year periods in the baseline forecasts from 2020 through 2045.
2. Population losses have historically been less pronounced than employment losses and occurred more in the subsequent five-year period. In other words, population loss followed employment loss.

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3. Historical industrial and retail employment losses appear slightly more susceptible to loss in recession periods than office employment losses, although the differences are so slight as to be within the noise of the model.

With these findings in mind, and recognizing the increased reliance on office uses forecasted in the baseline condition, a low growth scenario was developed that fits within the bounds of historical patterns, but uses the following assumptions:

- Future recessions will occur in the 2020-2025 and 2040-2045 timeframes, with a single rebound occurring in 2025-2030. Other years are forecast to have the same net growth as baseline forecasts.
- The recessions will affect office jobs and non-office jobs equally.
- Population dips will see a slight latency relative to employment, so that the 2020-2025 recession affects population to a minor degree in 2020-2025 and to a larger degree in 2025-2030.
- Population impacts are felt more heavily in exurban regions where there is more homogeneity in housing options, and in the core where previous recessions have led to larger population impacts.

The high scenario assumptions and results are covered in detail in **Section 4.7**.

4.6 RPG Base Forecasts

This section shows the RPG Base forecasts used in this study. These forecasts were based on a combination of the top-down macroeconomic approach and bottom-up localized analysis, as well as a final step to test the validity of MWCOG forecasts at the TAZ level for the primary market area jurisdictions as previously described.

4.6.1 Forecast Results

The final population and employment forecasts, as well as the corresponding growth rates, are shown in **Table 4-7** and **Table 4-8**. These forecasts result in the area's population annual growth of 0.7 percent (or equivalent to 885,000) through 2045, which is slightly lower than the 0.8 percent annual rate projected in MWCOG Round 9.1.

Table 4-7

RPG Base Forecast Summary - Population by Jurisdiction

Jurisdiction	Level				CAAGR				Absolute Change
	2017	2025	2035	2045	2017-2025	2025-2035	2035-2045	2017-2045	2017-2045
Population									
Arlington	234,967	258,842	284,072	307,839	1.2%	0.9%	0.8%	1.0%	72,872
Alexandria	160,037	178,058	194,599	214,529	1.3%	0.9%	1.0%	1.1%	54,492
District of Columbia	693,977	759,251	830,893	889,859	1.1%	0.9%	0.7%	0.9%	195,882
Fairfax[1]	1,187,109	1,272,950	1,367,072	1,444,122	0.9%	0.7%	0.5%	0.7%	257,013
Montgomery	1,058,813	1,131,888	1,213,457	1,274,859	0.8%	0.7%	0.5%	0.7%	216,046
Prince George's	913,117	948,465	980,828	1,001,925	0.5%	0.3%	0.2%	0.3%	88,808
Area Total	4,248,020	4,549,454	4,870,921	5,133,133	0.9%	0.7%	0.5%	0.7%	885,113

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: RPG

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The area employment is also projected to increase at a 0.9 percent annually, adding 753,000 new jobs between 2017 and 2045. This is about the same percent annual growth rate expected according to the MWCOG Round 9.1 projections. Alexandria is forecasted to have the highest annual growth at 1.2% per year, while Prince George's County is the lowest at 0.5% per year.

Table 4-8

RPG Base Forecast Summary - Employment by Jurisdiction

Jurisdiction	Level				CAAGR				Absolute Change
	2017	2025	2035	2045	2017-2025	2025-2035	2035-2045	2017-2045	2017-2045
Employment									
Arlington	214,180	230,863	253,677	275,109	0.9%	0.9%	0.8%	0.9%	60,929
Alexandria	106,812	119,997	134,804	150,791	1.5%	1.2%	1.1%	1.2%	43,979
District of Columbia	815,714	881,525	952,606	1,011,989	1.0%	0.8%	0.6%	0.8%	196,275
Fairfax[1]	713,901	794,739	887,486	973,048	1.3%	1.1%	0.9%	1.1%	259,147
Montgomery	529,424	575,988	625,969	672,156	1.1%	0.8%	0.7%	0.9%	142,732
Prince George's	346,156	364,952	381,187	396,365	0.7%	0.4%	0.4%	0.5%	50,209
Area Total	2,726,187	2,968,064	3,235,729	3,479,458	1.1%	0.9%	0.7%	0.9%	753,271

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: RPG

The maps in **Figure 4-2** through **Figure 4-4** display the average annual population growth (in percentage terms) for the Primary Market Area TAZs for interval periods from 2017 through 2045. The corresponding maps for employment are illustrated in **Figure 4-5** through **Figure 4-7**. **Figures 4-8** through **4-11** show the population and employment per square mile in the RPG base forecasts for years 2017 and 2045.

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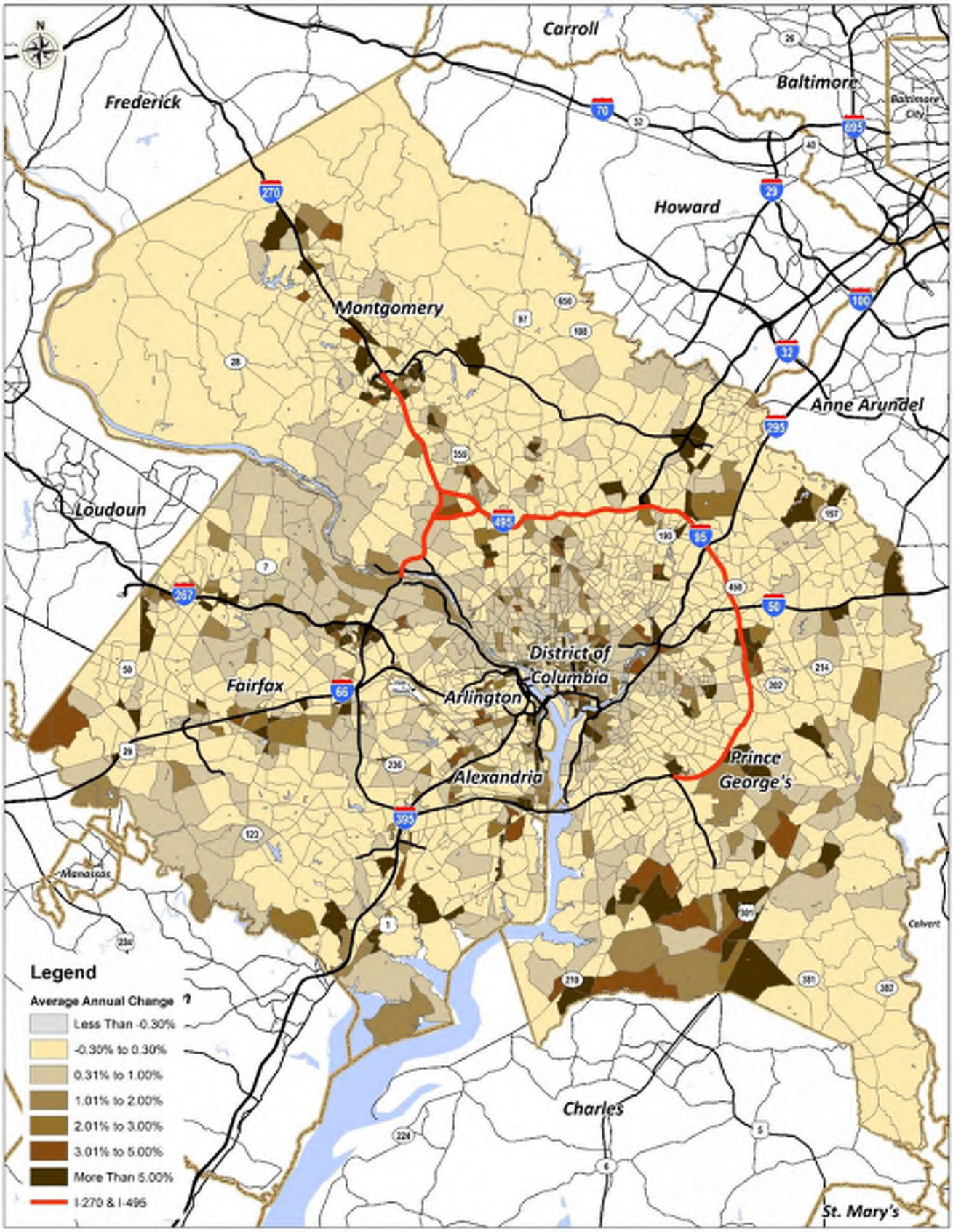

RPG BASE AVERAGE ANNUAL POPULATION CHANGE BY TAZ 2017-2025

FIGURE 4-2

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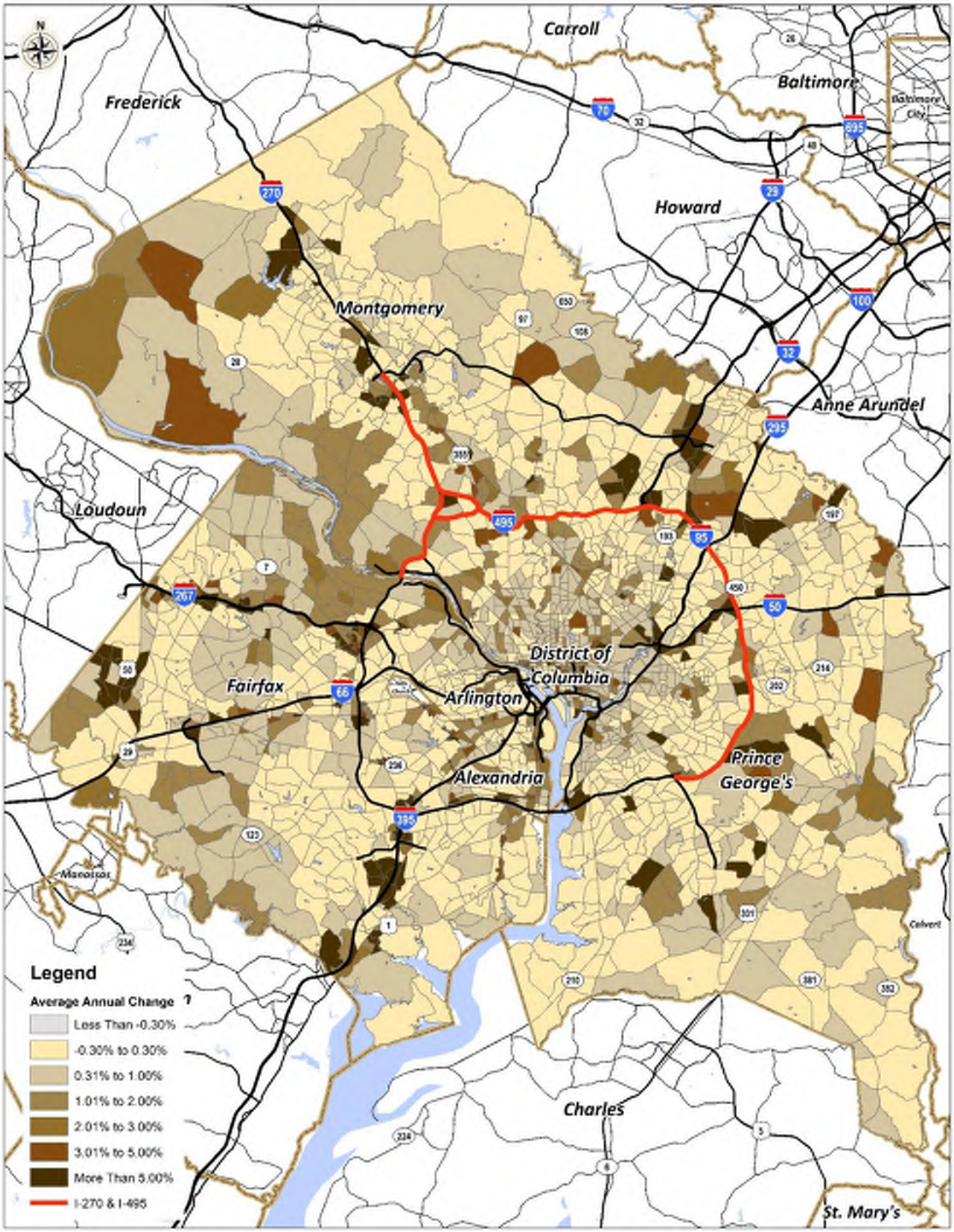

RPG BASE AVERAGE ANNUAL POPULATION CHANGE BY TAZ 2025-2045

FIGURE 4-3

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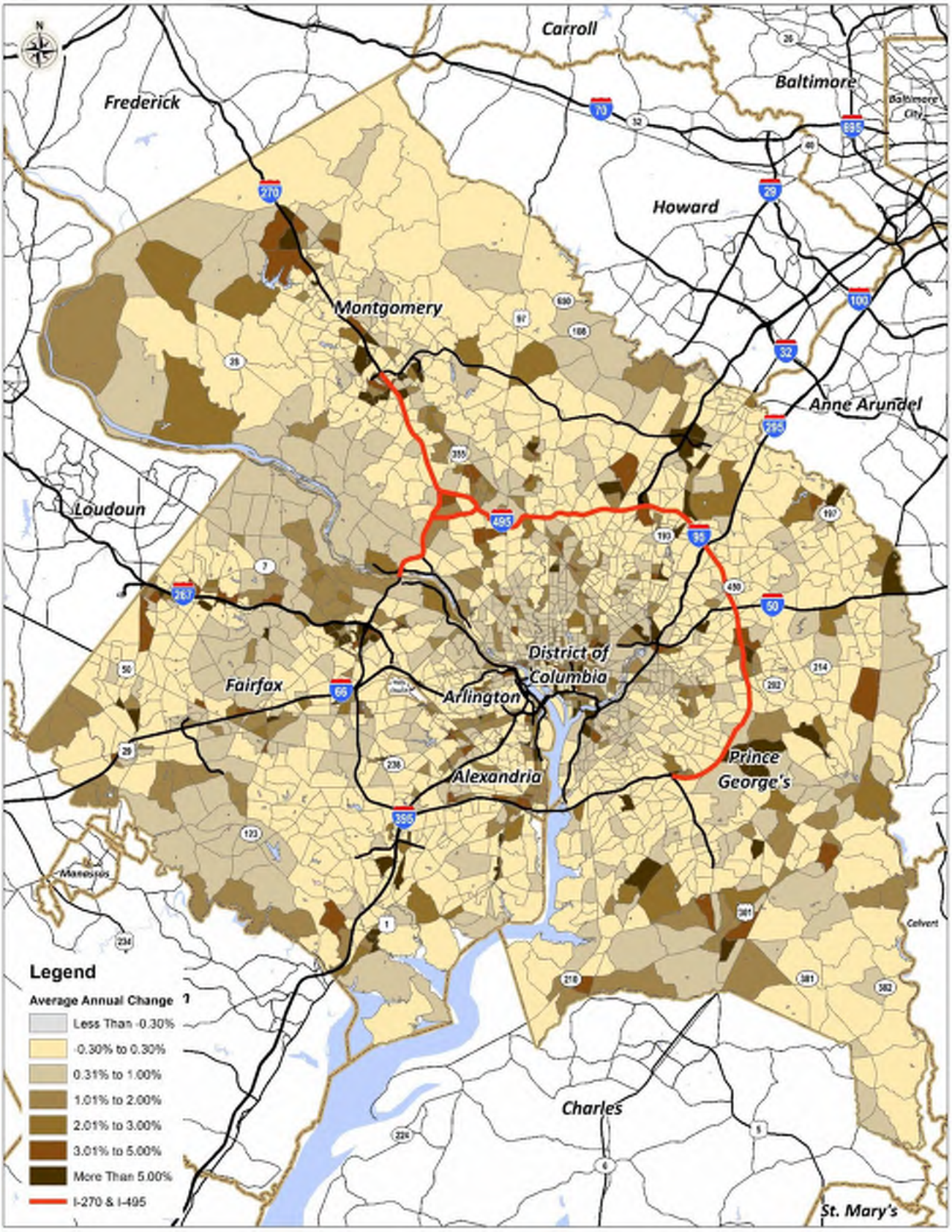

RPG BASE AVERAGE ANNUAL POPULATION CHANGE BY TAZ 2017-2045

FIGURE 4-4

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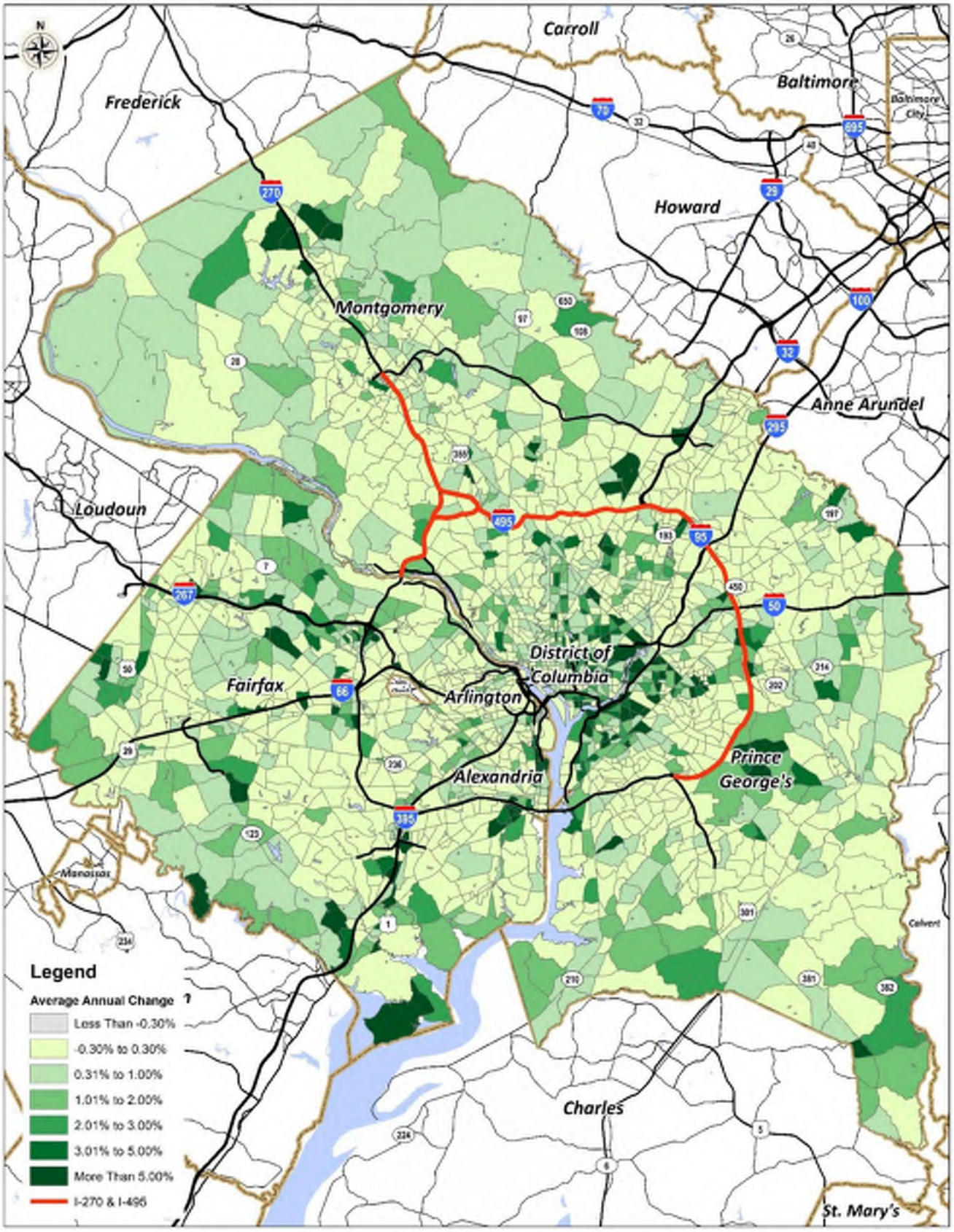

RPG BASE AVERAGE ANNUAL EMPLOYMENT CHANGE BY TAZ 2017-2025

FIGURE 4-5

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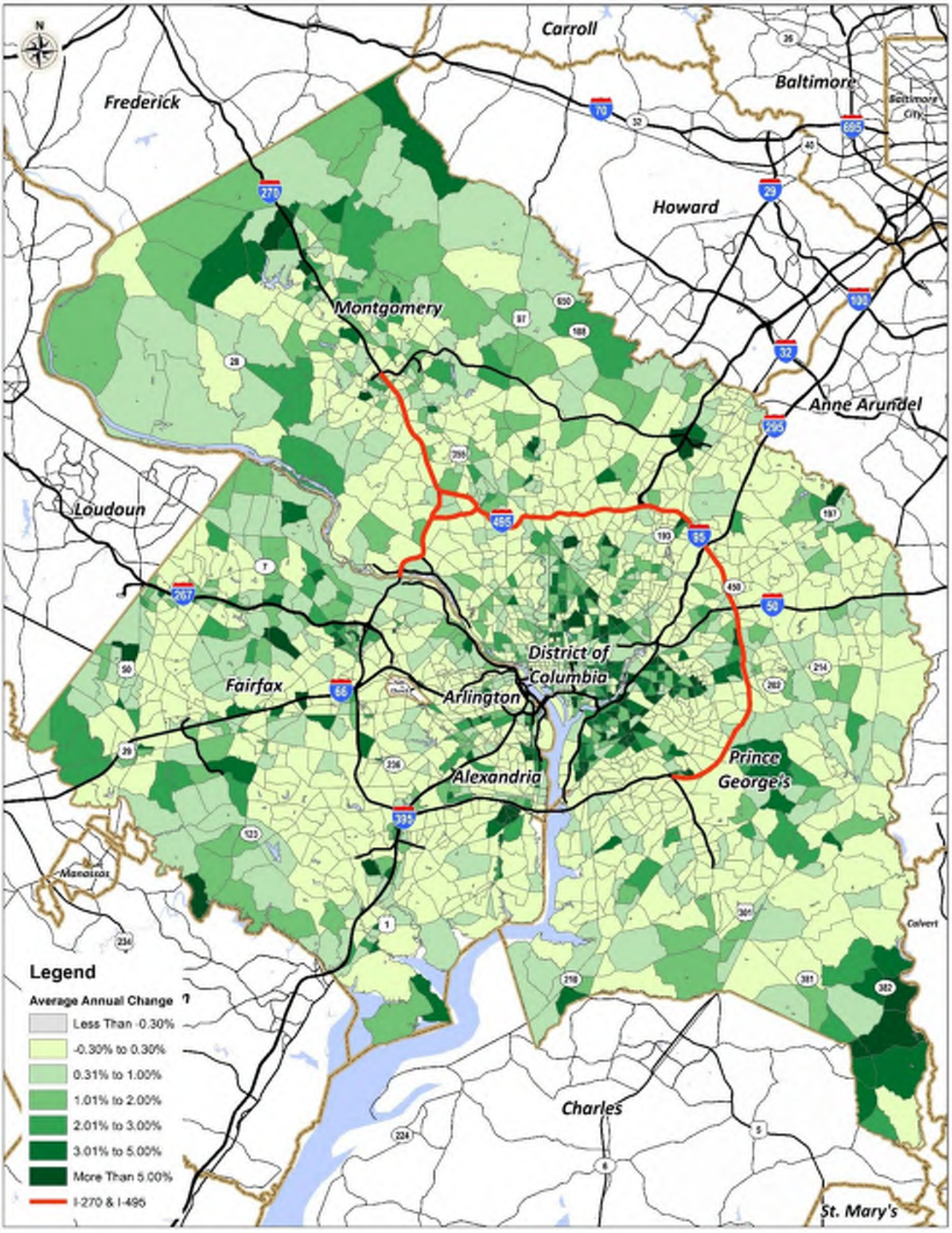

RPG BASE AVERAGE ANNUAL EMPLOYMENT CHANGE BY TAZ 2025-2045

FIGURE 4-6

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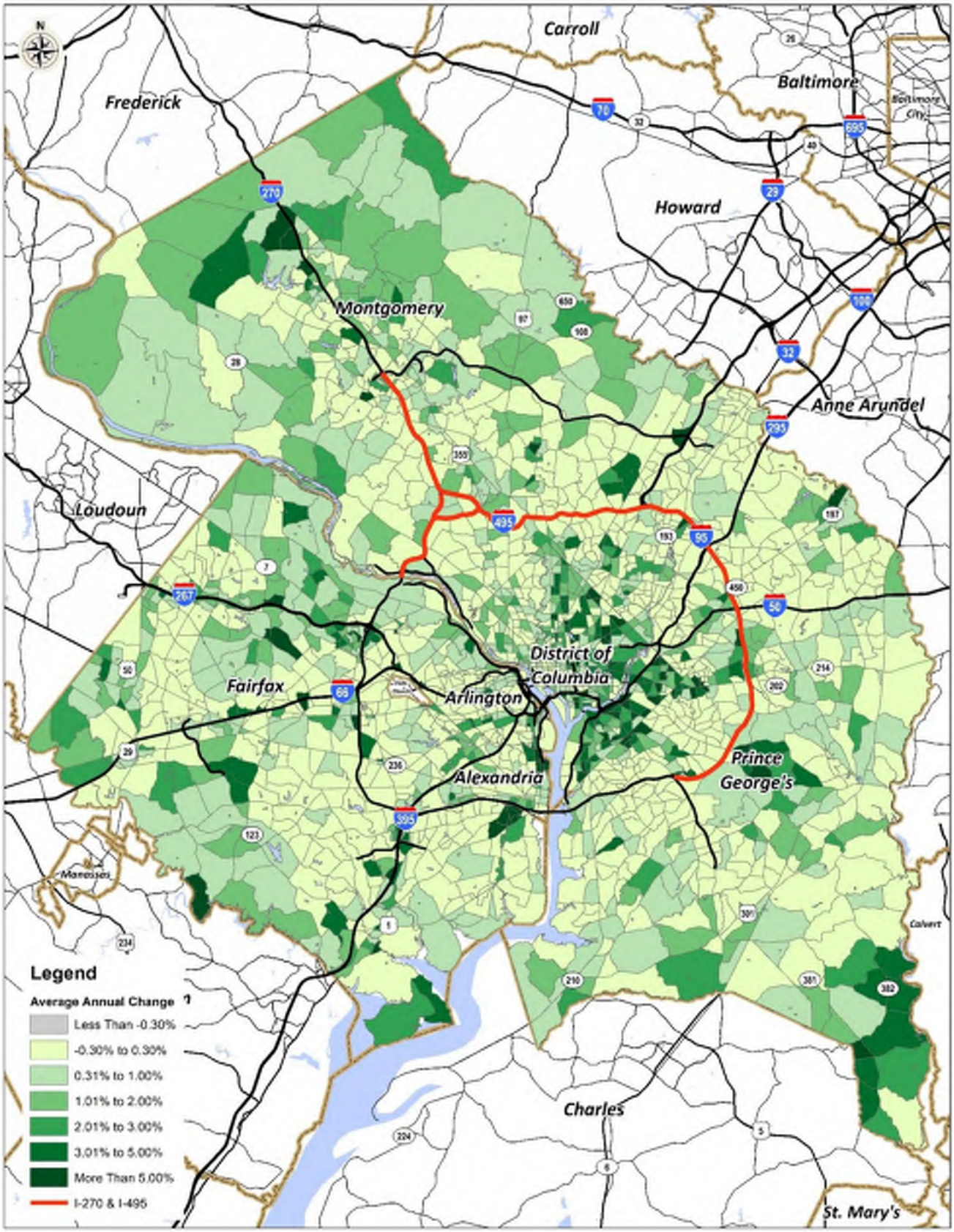

RPG BASE AVERAGE ANNUAL EMPLOYMENT CHANGE BY TAZ 2017-2045

FIGURE 4-7

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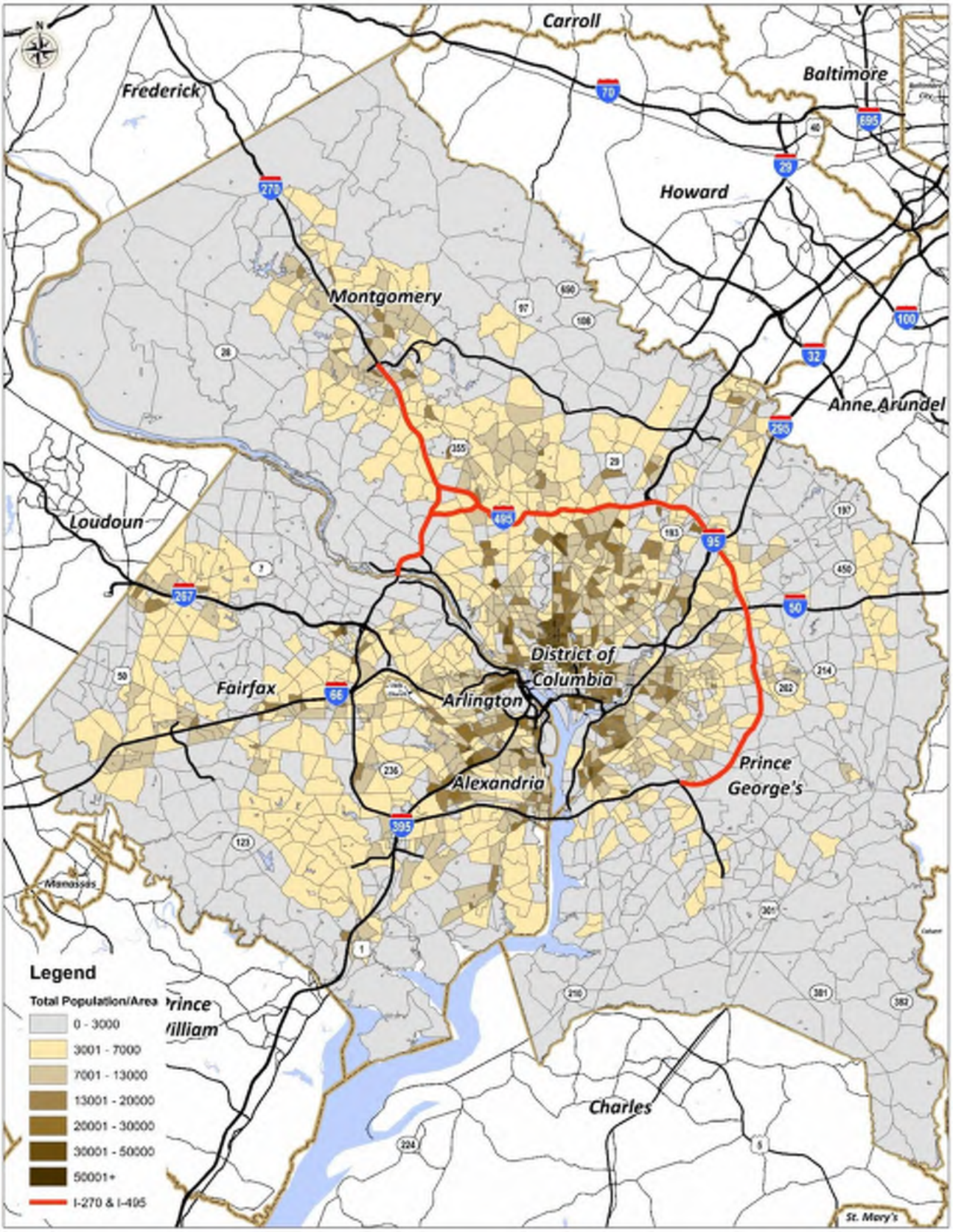

RPG BASE TOTAL POPULATION PER SQUARE MILE FOR 2017

FIGURE 4-8

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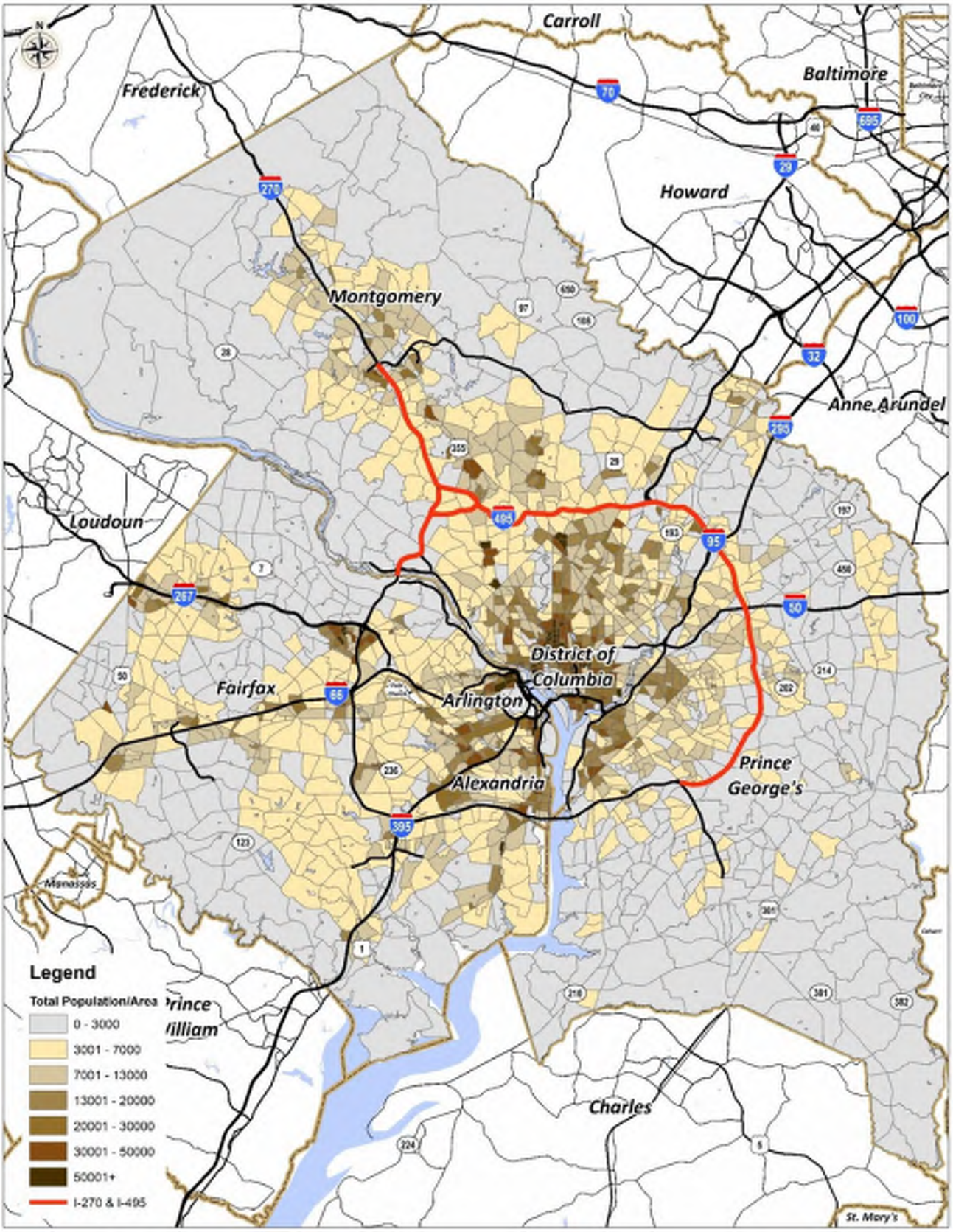

RPG BASE TOTAL POPULATION PER SQUARE MILE FOR 2045

FIGURE 4-9

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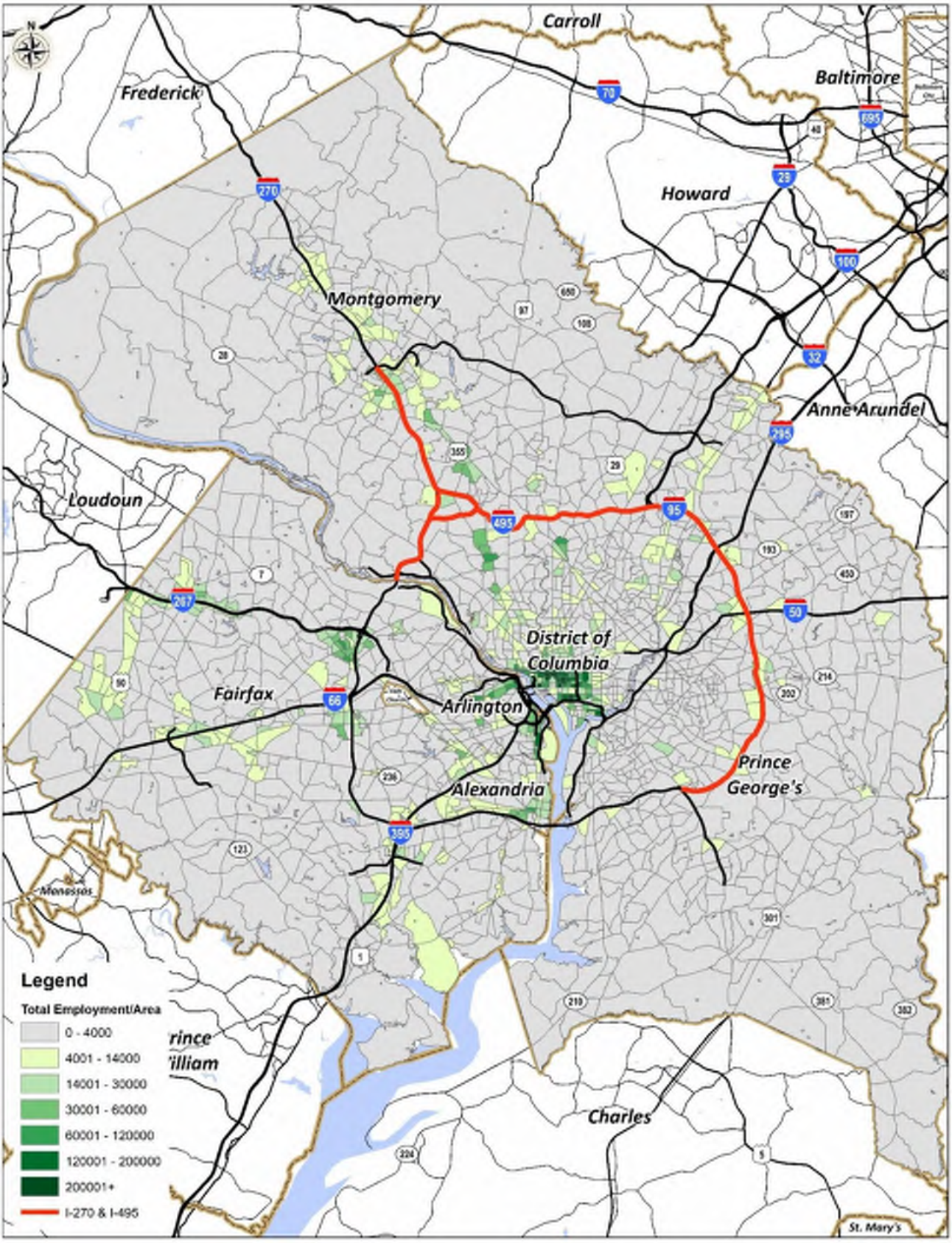

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RPG BASE TOTAL EMPLOYMENT PER SQUARE MILE FOR 2017

FIGURE 4-10

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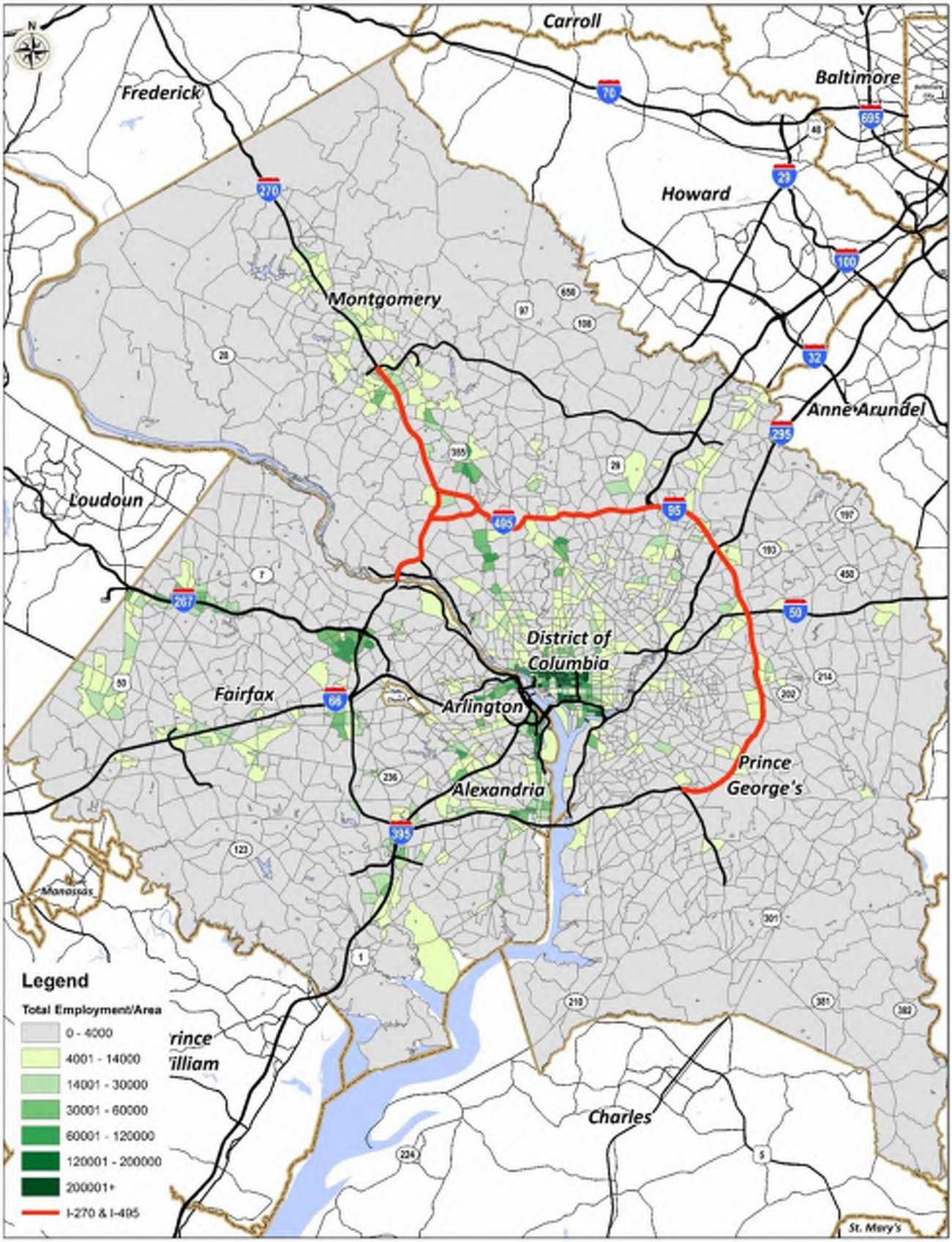

CDM Smith

RPG BASE TOTAL EMPLOYMENT PER SQUARE MILE FOR 2045

FIGURE 4-11

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4.6.2 Summary of Forecast Differences

Table 4-9 and **Table 4-10** summarize a comparison between the final RPG population and employment projections used in this study and the base MWCOG Round 9.1 projections. Positive differences designate upward forecast adjustments and negative differences indicate downward adjustments. With respect to population, the difference between the adjusted and Round 9.1 projections for the area shows growth in the early years and a decrease in 2045. The year 2017 shows an increase of about 53,000 residents (or about 1.3 percent) compared to 2045 showing a decrease of about 53 thousand (or about -1.0 percent). The biggest decreases in the adjustments are due to changes in the District of Columbia.

Table 4-9
Differences between RPG Base and Round 9.1 Population Forecasts

Jurisdiction	Absolute Difference (in '000s)				% Difference			
	2017	2025	2035	2045	2017	2025	2035	2045
Population								
Arlington	7.1	9.4	9.5	6.7	3.1%	3.8%	3.5%	2.2%
Alexandria	7.8	10.5	14.1	6.1	5.1%	6.3%	7.8%	2.9%
District of Columbia	-1.2	-27.9	-63.0	-97.4	-0.2%	-3.5%	-7.0%	-9.9%
Fairfax[1]	9.0	17.4	-7.9	-25.5	0.8%	1.4%	-0.6%	-1.7%
Montgomery	28.9	44.6	45.8	51.5	2.8%	4.1%	3.9%	4.2%
Prince George's	1.2	10.4	13.0	6.1	0.1%	1.1%	1.3%	0.6%
Area Total	52.7	64.5	11.5	-52.5	1.3%	1.4%	0.2%	-1.0%

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: MWCOG TDM Round 9.1, RPG

Employment differentials between the two forecasts are slightly positive in the early years and slightly negative in the outer years. The largest percent differences are seen in the District of Columbia (-3.2 percent in 2045) and Fairfax County (4.4 percent in 2045).

Table 4-10
Differences between RPG Base and Round 9.1 Employment Forecasts

Jurisdiction	Absolute Difference (in '000s)				% Difference			
	2017	2025	2035	2045	2017	2025	2035	2045
Employment								
Arlington	1.6	7.3	4.8	6.0	0.8%	3.3%	1.9%	2.2%
Alexandria	-1.0	-1.8	-0.5	-4.3	-0.9%	-1.5%	-0.3%	-2.8%
District of Columbia	-1.7	-13.6	-25.6	-33.4	-0.2%	-1.5%	-2.6%	-3.2%
Fairfax[1]	5.0	10.1	25.9	41.2	0.7%	1.3%	3.0%	4.4%
Montgomery	-0.1	3.5	-1.4	-6.6	0.0%	0.6%	-0.2%	-1.0%
Prince George's	3.4	-1.4	-4.4	-5.8	1.0%	-0.4%	-1.1%	-1.4%
Area Total	7.2	4.1	-1.1	-2.9	0.3%	0.1%	0.0%	-0.1%

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: MWCOG TDM Round 9.1, RPG

Figure 4-12 and **Figure 4-13** display the population differences by TAZ between the final forecasts and the base MWCOG Round 9.1 forecast for years 2025 and 2045. **Figure 4-14** and **Figure 4-15** illustrate the corresponding maps for employment.

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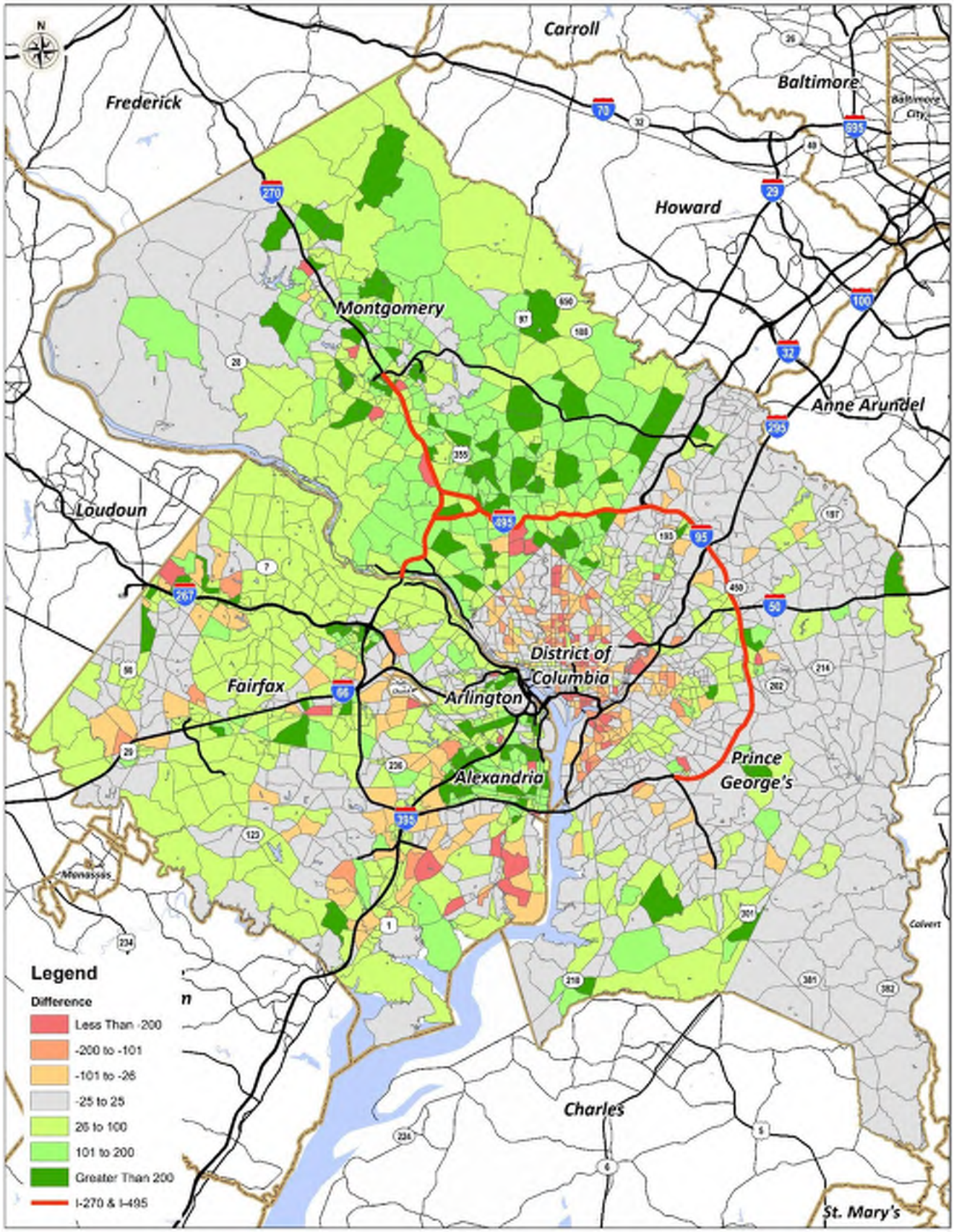

POPULATION FORECAST DIFFERENCE, RPG BASE VS. MWCOG BY TAZ, 2025

FIGURE 4-12

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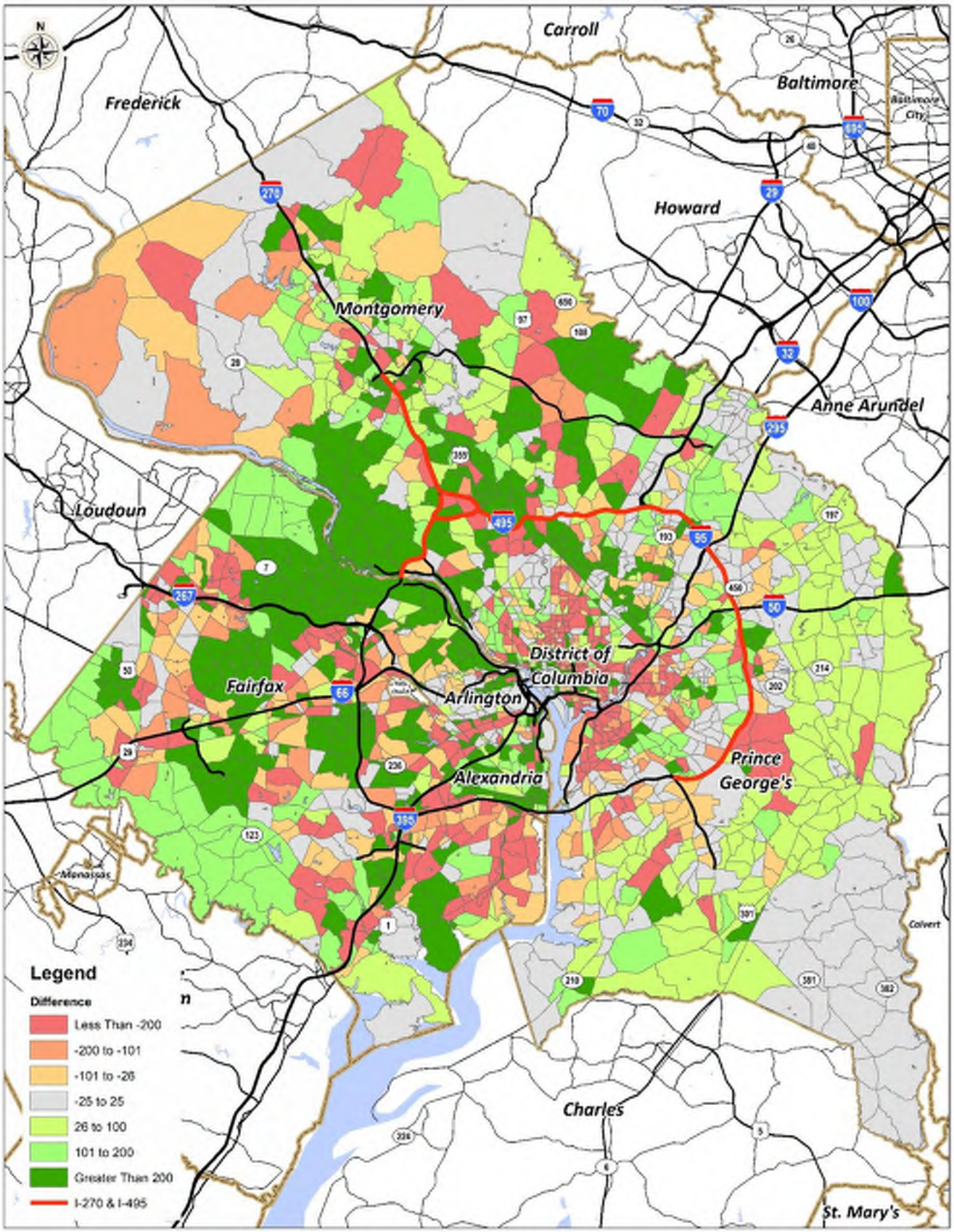

POPULATION FORECAST DIFFERENCE, RPG BASE VS. MWCOG BY TAZ, 2045

FIGURE 4-13

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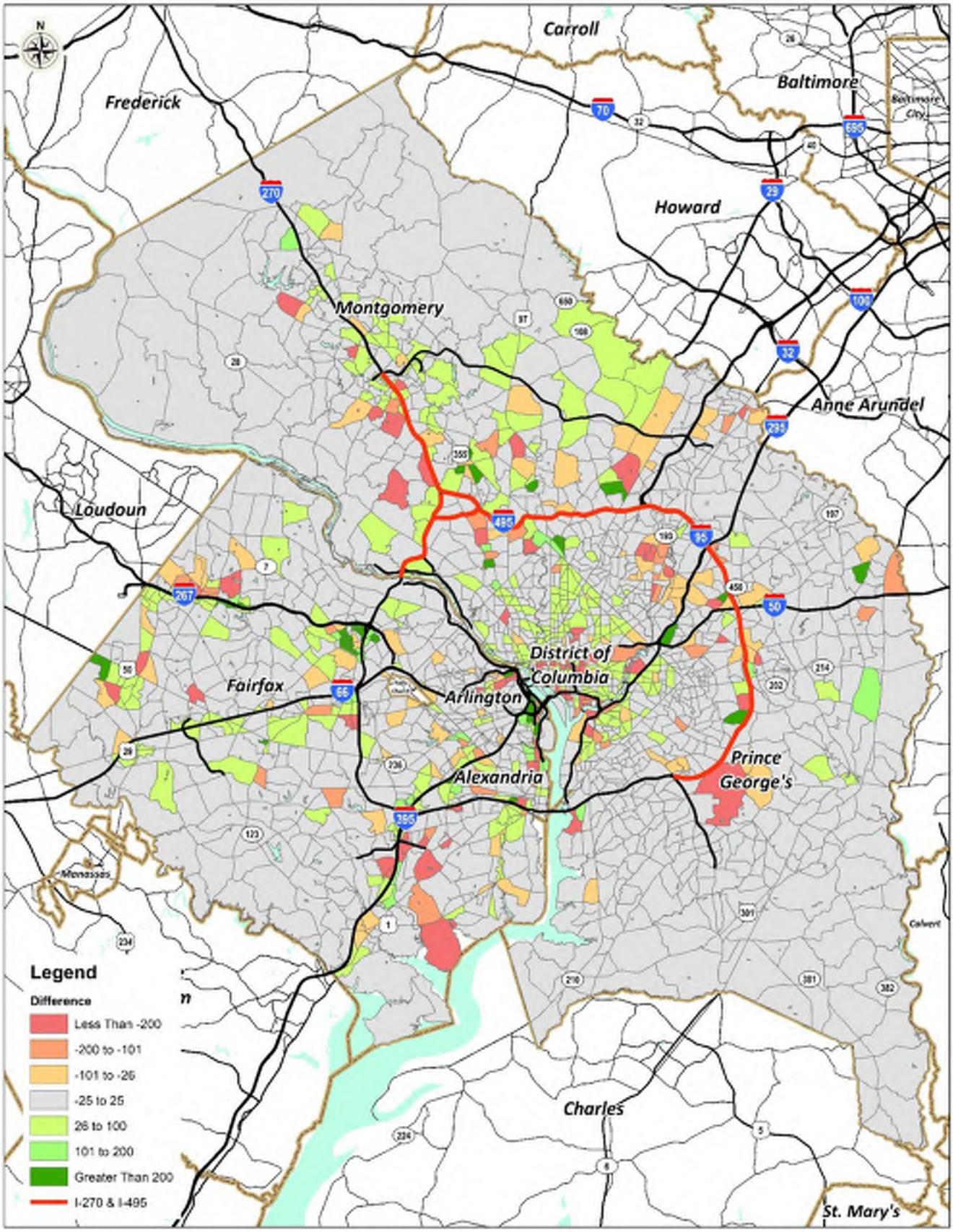

EMPLOYMENT FORECAST DIFFERENCE, RPG BASE VS. MWCOG BY TAZ, 2025

FIGURE 4-14

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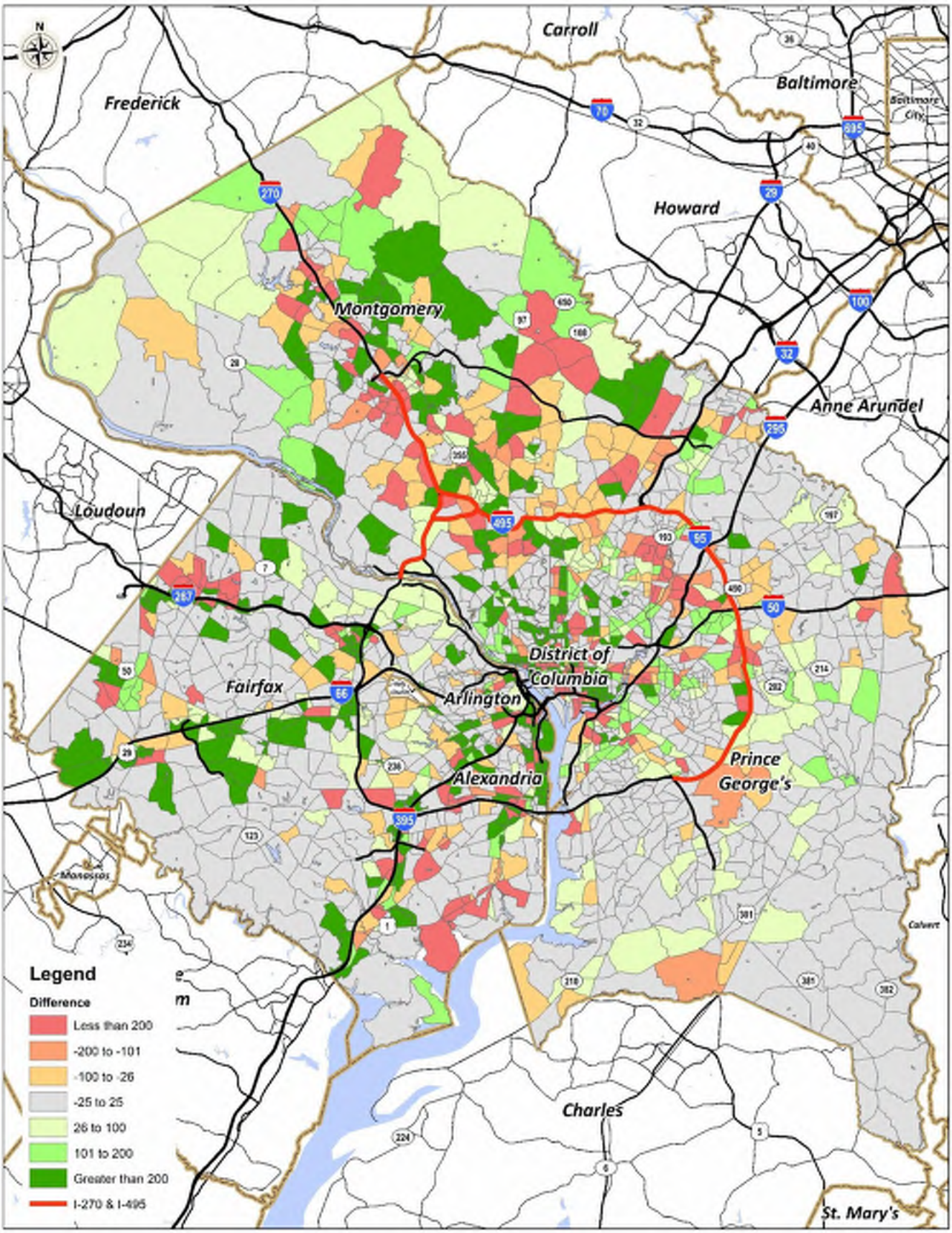

EMPLOYMENT FORECAST DIFFERENCE, RPG BASE VS MWCOG BY TAZ, 2045

FIGURE 4-15

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The balancing of quantitative factors that influence development suitability and market response as well as site-specific or property concerns results in some notable adjustments in the RPG forecasts compared to MWCOG. Several of the notable changes for several key activity centers are summarized in **Table 4-11**.

Table 4-11
Key Activity Development Centers in the PMA

Activity Center	Notable Characteristics
A. Germantown	Emerging employment center containing some of the last greenfield sites in Montgomery County, anchored by Department of Energy administration complex.
B. Life Sciences Center	Montgomery County activity center west of I-270 at its junction with the Intercounty Connector. Developed as a planned employment center through County land acquisition and marketing. Proximate to both the independent cities of Gaithersburg and Rockville, with annexation occurring as part of mixeduse developments such as King Farm in Rockville and Crown Farm in Gaithersburg.
C. White Flint	An emerging activity center housing the Nuclear Regulatory Commission headquarters. The 2009 White Flint Sector Plan initiated a new intense mixed-use zone, and subsequent development included North Bethesda Market, the tallest building in Montgomery County.
D. Bethesda	The most intensely developed activity center within five miles of the study segments and expected to increase employment by about 25% and double population by 2045. The CBD is adjacent to the National Naval Medical Center and the National Institutes of Health campuses. The Rock Spring Park activity center is located nearby in the land formed by the junction of I-270, the I-270 Spur, and I-495.
E. Silver Spring	The second most intensely developed activity center within five miles of the study segment and is expected to increase employment by about 25% and population by about 40% by 2045. The National Oceanic and Atmospheric Administration headquarters are in the CBD.
F. White Oak	FDA Headquarters relocated to White Oak Campus in 2003, and its establishment and expansion served as the primary impetus for the White Oak Science Gateway Master Plan adopted by Montgomery County in 2014. The Washington Adventist Hospital moved from Takoma Park to White Oak in 2019.
G. Konterra	A planned activity center at the junction of I-95 and the Intercounty Connector. Originally planned around two regional mall sites intended for more than six million square feet of retail space, site development is now proceeding as a series of smaller, more mixed-use neighborhoods.
H. University of Maryland	The largest educational institution in the region, with a student enrollment of about 41,000. The institutional activities extend beyond campus boundaries, including the nearby M2 technology center in Riverdale.
I. New Carrollton	An intermodal hub at the junction of I-495 and US 50 served by Metrorail, MARC commuter rail, and Amtrak. Home to the Internal Revenue Service's financial services center, New Carrollton and several adjacent industrially-zoned properties are seeing new commercial construction in technology-oriented industries.
J. Largo Town Center	The Largo Town Center activity center is oriented around the Largo Town Center Metrorail station in 2004, the first extension to the original 103-mile Metrorail system. The University of Maryland Capitol Region Medical Center is under construction, with opening scheduled in 2021. Across I-495, FedEx Field is the current home to the NFL Redskins and other stadium events.
K. Westphalia	One of the largest remaining greenfields sites in the PMA, with residential construction underway in implementing the 2007 Westphalia Sector Plan. As of summer 2019, the Prince George's County Council approved zoning changes that would facilitate Amazon distribution activities as an allowed use.
L. National Harbor	A planned community on the eastern shore of the Potomac River at the junction of I-495 and I-295, anchored by the Gaylord National Resort and Convention Center opening in 2008. The MGM National Harbor casino opened in December 2016.
M. National Landing	The branding given to the Amazon HQ2 sites in Arlington County and the City of Alexandria, organized around the Pentagon City, Crystal City, and (future) Potomac Yard Metrorail stations. Additional information on Amazon HQ2 is provided in **Appendix B**.
N. Tysons	An activity center located at the confluence of I-495 and the Dulles Toll Road, and often characterized as the downtown of Fairfax County. The 2010 Tysons amendment to the Fairfax County Comprehensive Plan set the stage for an ultimate buildout of 200,000 jobs and 100,000 residents; new high-rise construction is underway, catalyzed in part by the opening of four Silver Line Metrorail stations in 2014.

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4.7 Adjusted High Case Forecasts

To consider the potential for higher-than anticipated growth in the region, a high case was established using growth rate increases of 25 percent compared to the base case. For example, an average annual growth rate of 1.00 percent in the base case would be assumed to be 1.25 percent in the high case. The 25 percent higher growth assumption was determined to be suitable for the high case based on a review of historical growth rates for the region. This increase was distributed in two sets: first among jurisdictions and second among non-primary market area (but within the full MWCOG model area) jurisdictions based on the range of growth rates identified in the macroeconomic assessment. Therefore, the high scenario has 25 percent greater growth than the base scenario in both population and jobs across both the sum of all primary market area jurisdictions and the sum of all non-primary market area jurisdictions, but each jurisdiction's growth rate was allowed to vary.

4.7.1 High Case Forecast Results

The final population and employment high case forecasts, as well as the corresponding growth rates, are shown in **Table 4-12** and **Table 4-13**. These forecasts call for the area's population annual growth of 0.8 percent (or equivalent to 1,106,000) through 2045 which is higher than the 0.7 percent in the RGP base case forecasts, shown previously in **Table 4-7**. Employment forecasts in the high case call for an annual growth of 1.1 percent, compared to 0.9 percent in RPG base case.

Table 4-12

RPG High Case Forecast Summary - Population by Jurisdiction

Jurisdiction	Level				CAAGR				Absolute Change
	2017	2025	2035	2045	2017-2025	2025-2035	2035-2045	2017-2045	2017-2045
Population									
Arlington	234,967	265,088	293,910	319,735	1.5%	1.0%	0.8%	1.1%	84,768
Alexandria	160,037	180,760	200,413	220,752	1.5%	1.0%	1.0%	1.2%	60,715
District of Columbia	693,977	769,620	847,690	911,119	1.3%	1.0%	0.7%	1.0%	217,142
Fairfax[1]	1,187,109	1,298,106	1,428,035	1,539,785	1.1%	1.0%	0.8%	0.9%	352,676
Montgomery	1,058,813	1,143,376	1,242,274	1,317,648	1.0%	0.8%	0.6%	0.8%	258,835
Prince George's	913,117	967,866	1,014,354	1,045,386	0.7%	0.5%	0.3%	0.5%	132,269
Area Total	4,248,020	4,624,816	5,026,676	5,354,425	1.1%	0.8%	0.6%	0.8%	1,106,405

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: RPG

Table 4-13

RPG High Case Forecast Summary - Employment by Jurisdiction

Jurisdiction	Level				CAAGR				Absolute Change
	2017	2025	2035	2045	2017-2025	2025-2035	2035-2045	2017-2045	2017-2045
Employment									
Arlington	214,180	234,842	261,698	287,335	1.2%	1.1%	0.9%	1.1%	73,155
Alexandria	106,812	127,709	145,334	164,116	2.3%	1.3%	1.2%	1.5%	57,304
District of Columbia	815,714	895,309	982,545	1,055,125	1.2%	0.9%	0.7%	0.9%	239,411
Fairfax[1]	713,901	802,756	907,171	1,005,862	1.5%	1.2%	1.0%	1.2%	291,961
Montgomery	529,424	588,992	657,503	718,959	1.3%	1.1%	0.9%	1.1%	189,535
Prince George's	346,156	378,680	408,743	436,306	1.1%	0.8%	0.7%	0.8%	90,150
Area Total	2,726,187	3,028,288	3,362,994	3,667,703	1.3%	1.1%	0.9%	1.1%	941,516

[1] "Fairfax" includes Fairfax County, Fairfax City, and Falls Church City
Source: RPG

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The maps in **Figure 4-16** through **Figure 4-18** show the average annual population growth (in percentage terms) of the RPG high case forecast. The corresponding maps for employment are illustrated in **Figure 4-19** through **Figure 4-21**. **Figure 4-22** and **Figure 4-23** show the population and employment per square mile in the high case forecast for 2045. Note that the 2017 high case forecast is identical to the 2017 base case, because the two cases differ only in the assumed growth beyond 2017.

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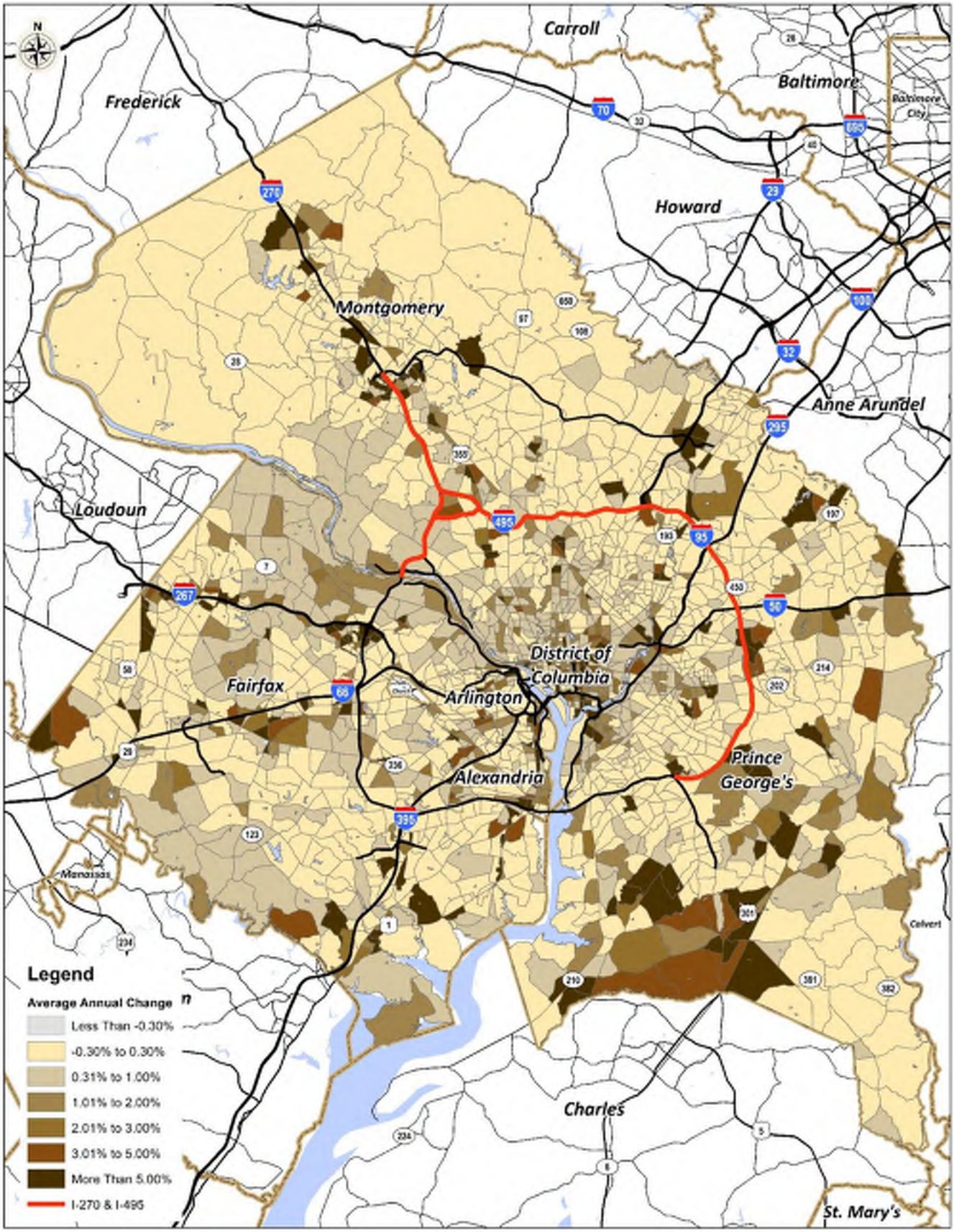
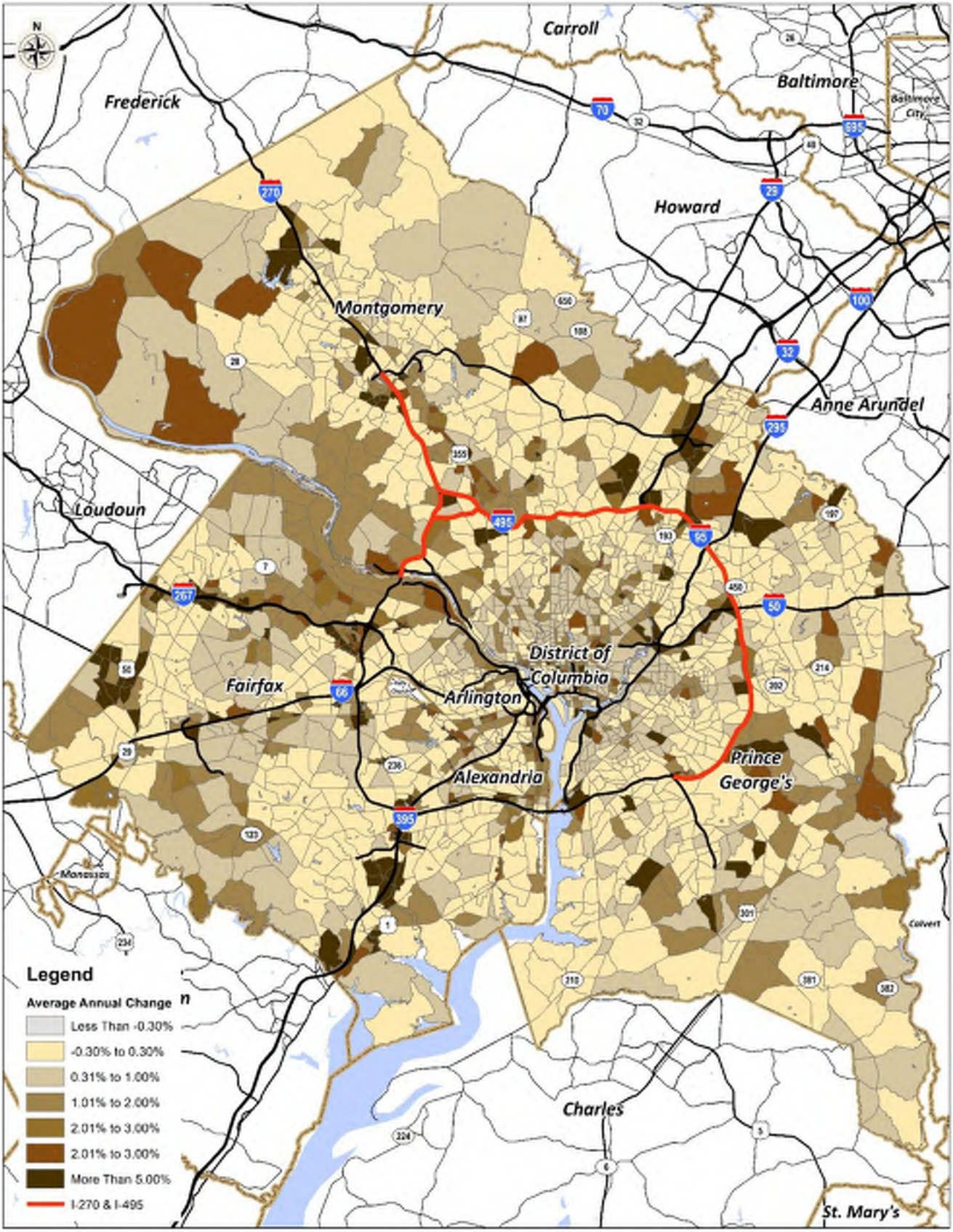


RPG HIGH AVERAGE ANNUAL POPULATION CHANGE BY TAZ, 2017-2025

FIGURE 4-16



RPG HIGH AVERAGE ANNUAL POPULATION CHANGE BY TAZ, 2025-2045

FIGURE 4-17

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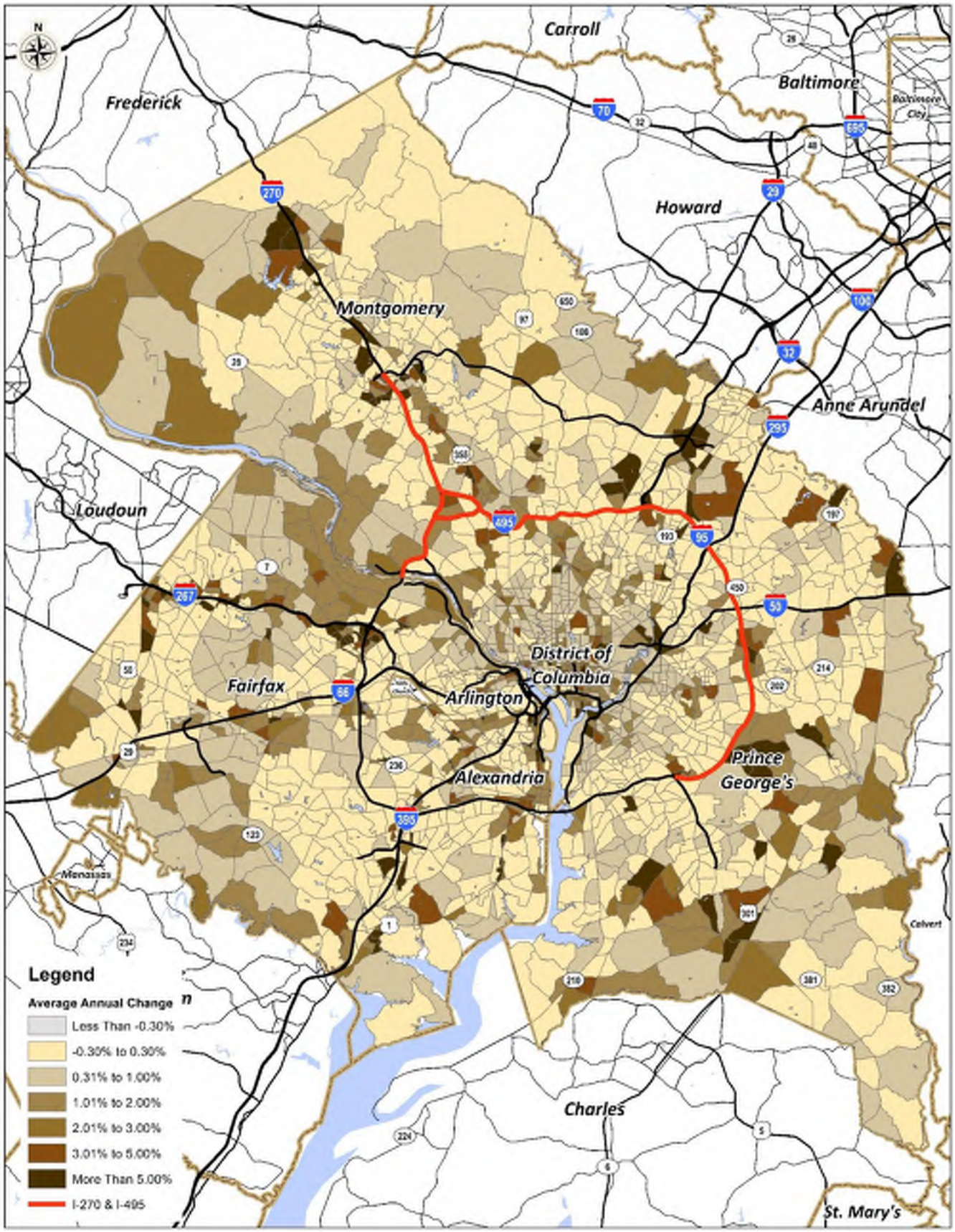

RPG HIGH AVERAGE ANNUAL POPULATION CHANGE BY TAZ, 2017-2045

FIGURE 4-18

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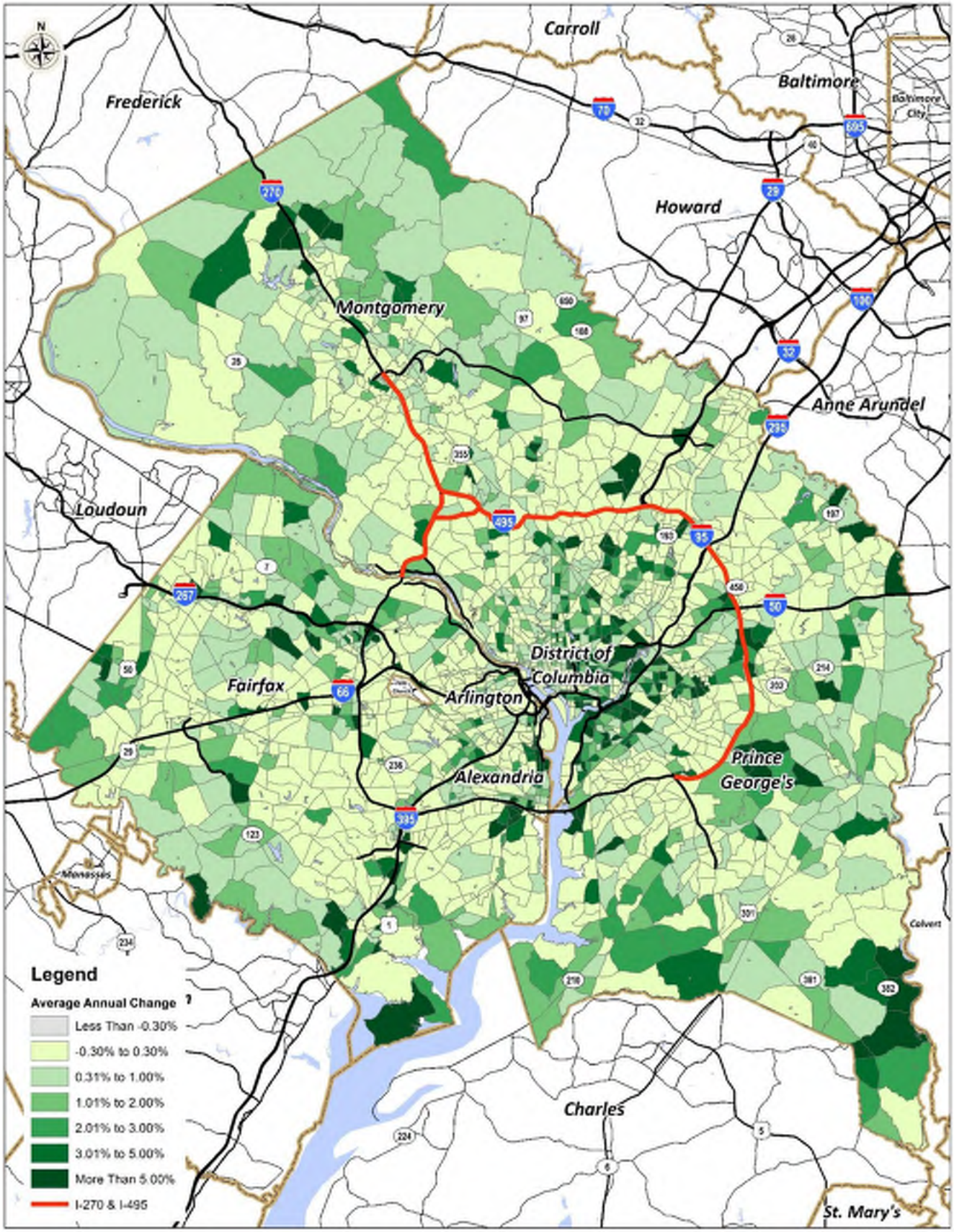

RPG HIGH AVERAGE ANNUAL EMPLOYMENT CHANGE BY TAZ, 2017-2025

FIGURE 4-19

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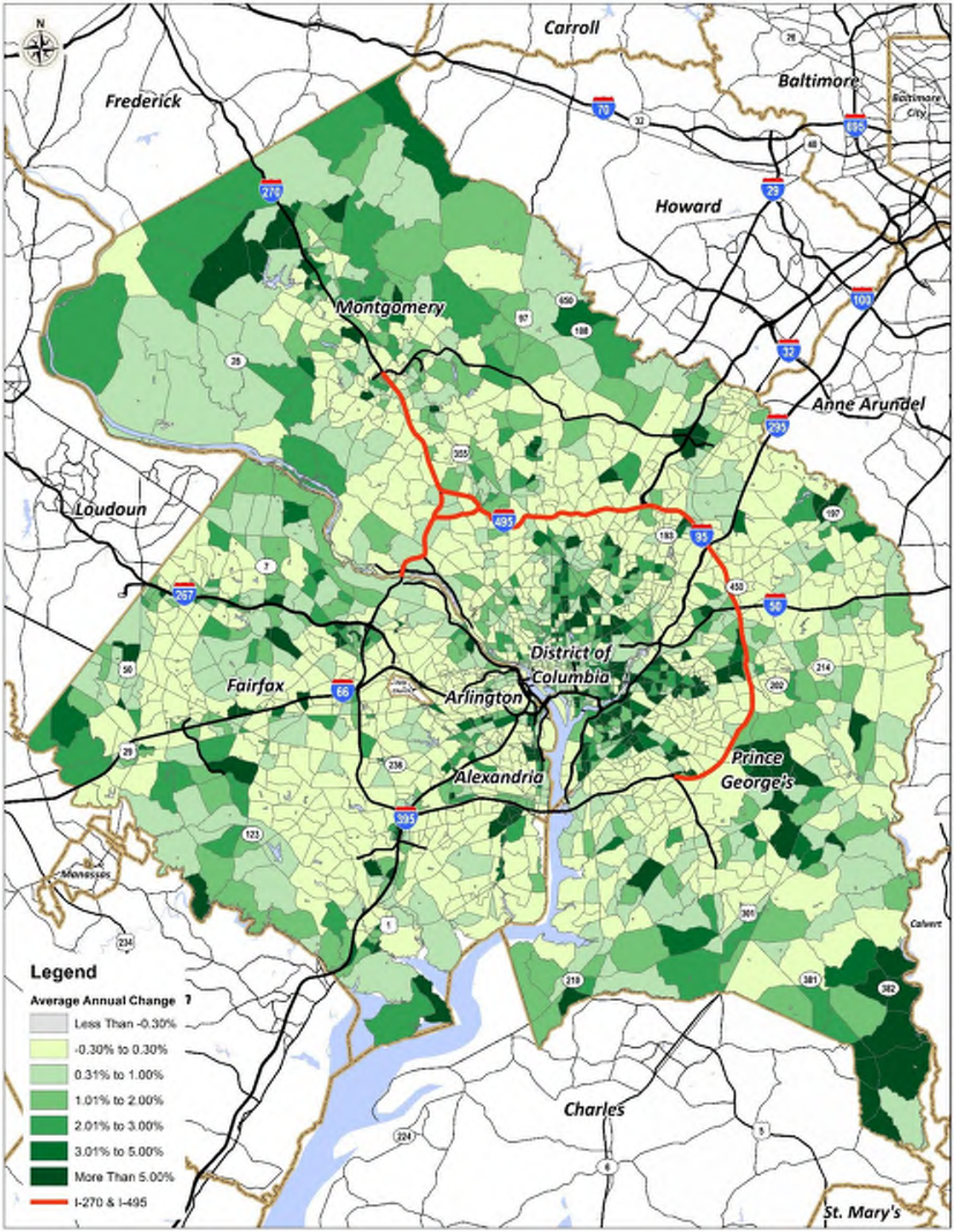

RPG HIGH AVERAGE ANNUAL EMPLOYMENT CHANGE BY TAZ, 2025-2045

FIGURE 4-20

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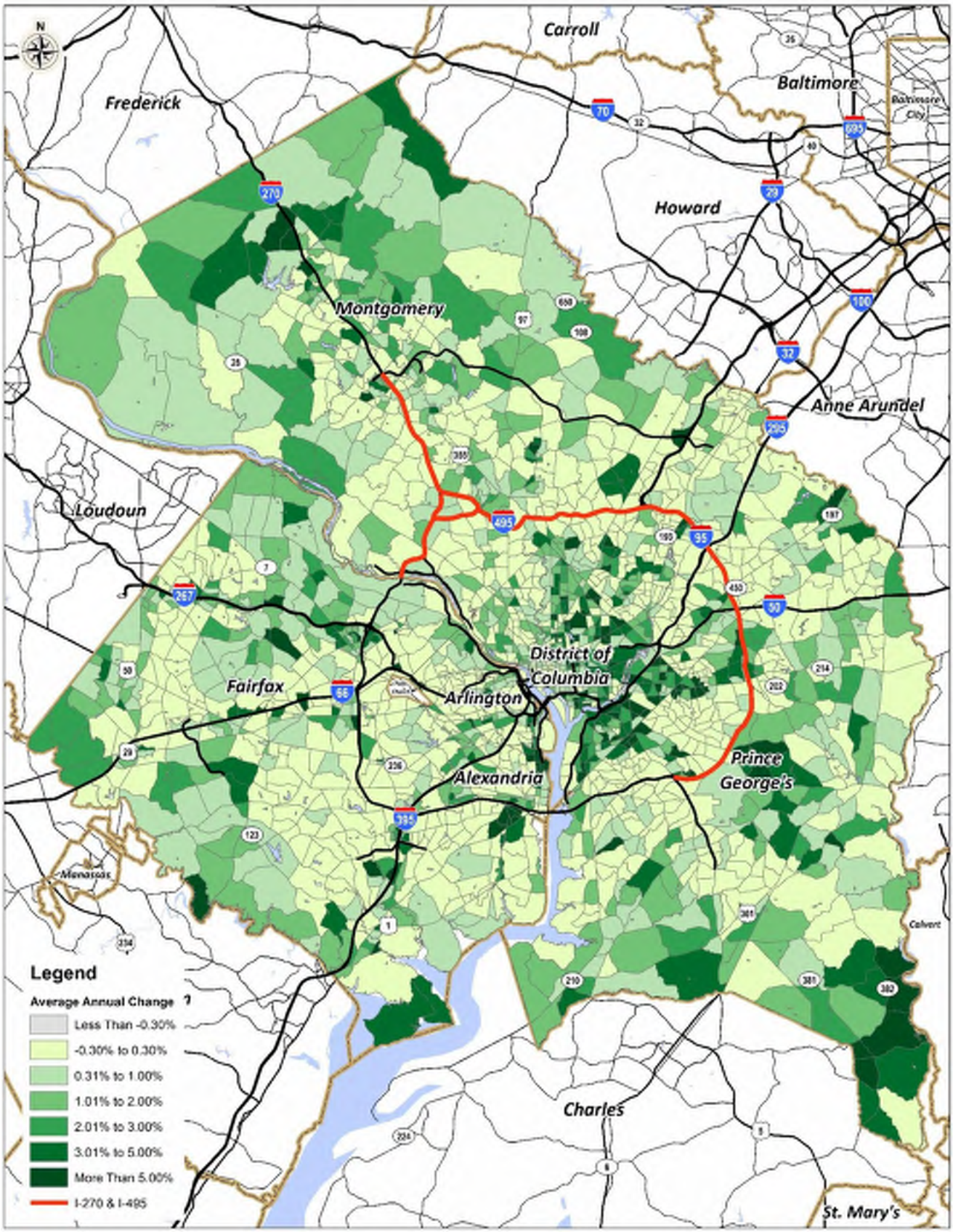

RPG HIGH AVERAGE ANNUAL EMPLOYMENT CHANGE BY TAZ, 2017-2045

FIGURE 4-21

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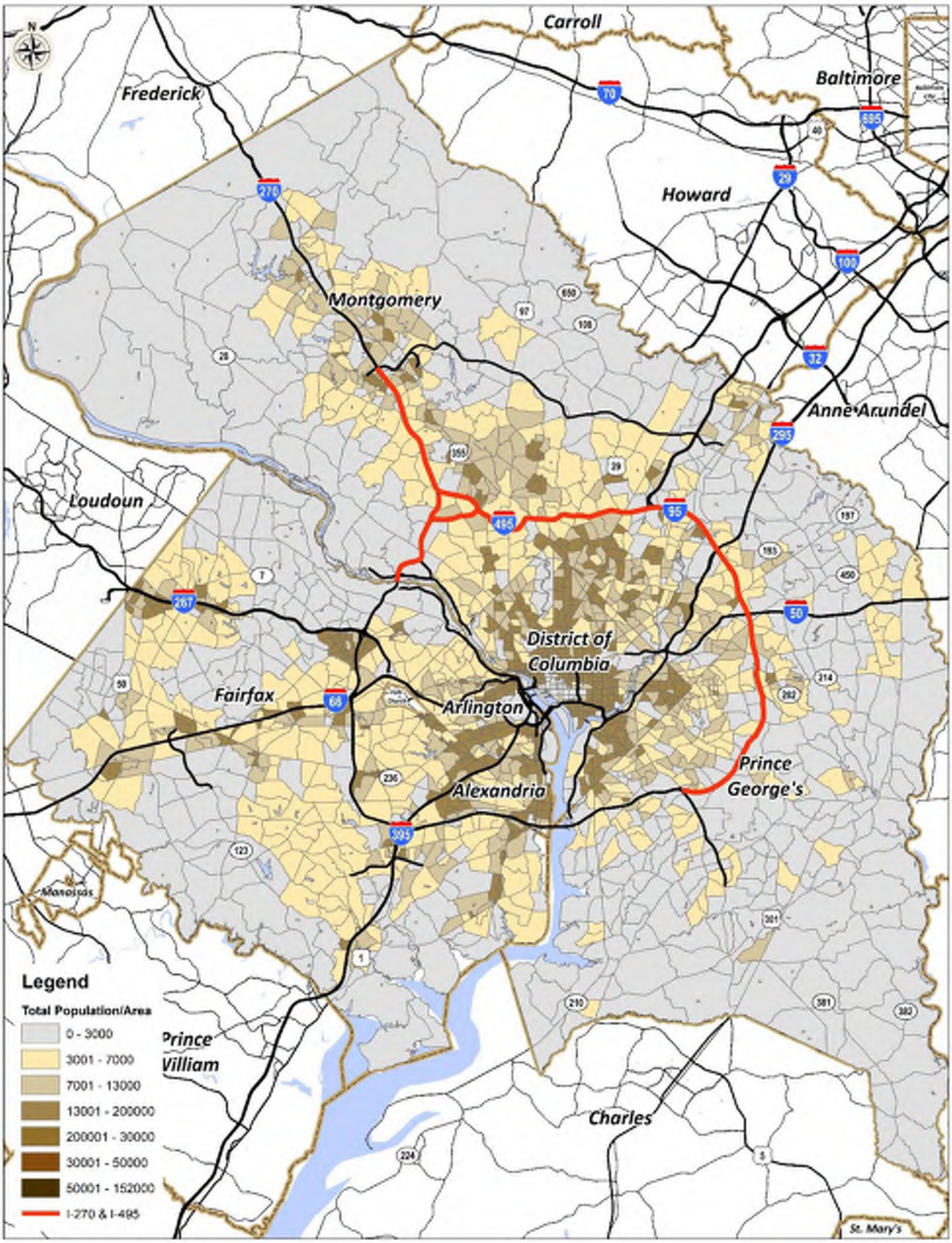

RPG HIGH TOTAL POPULATION PER SQUARE MILE FOR 2045

FIGURE 4-22

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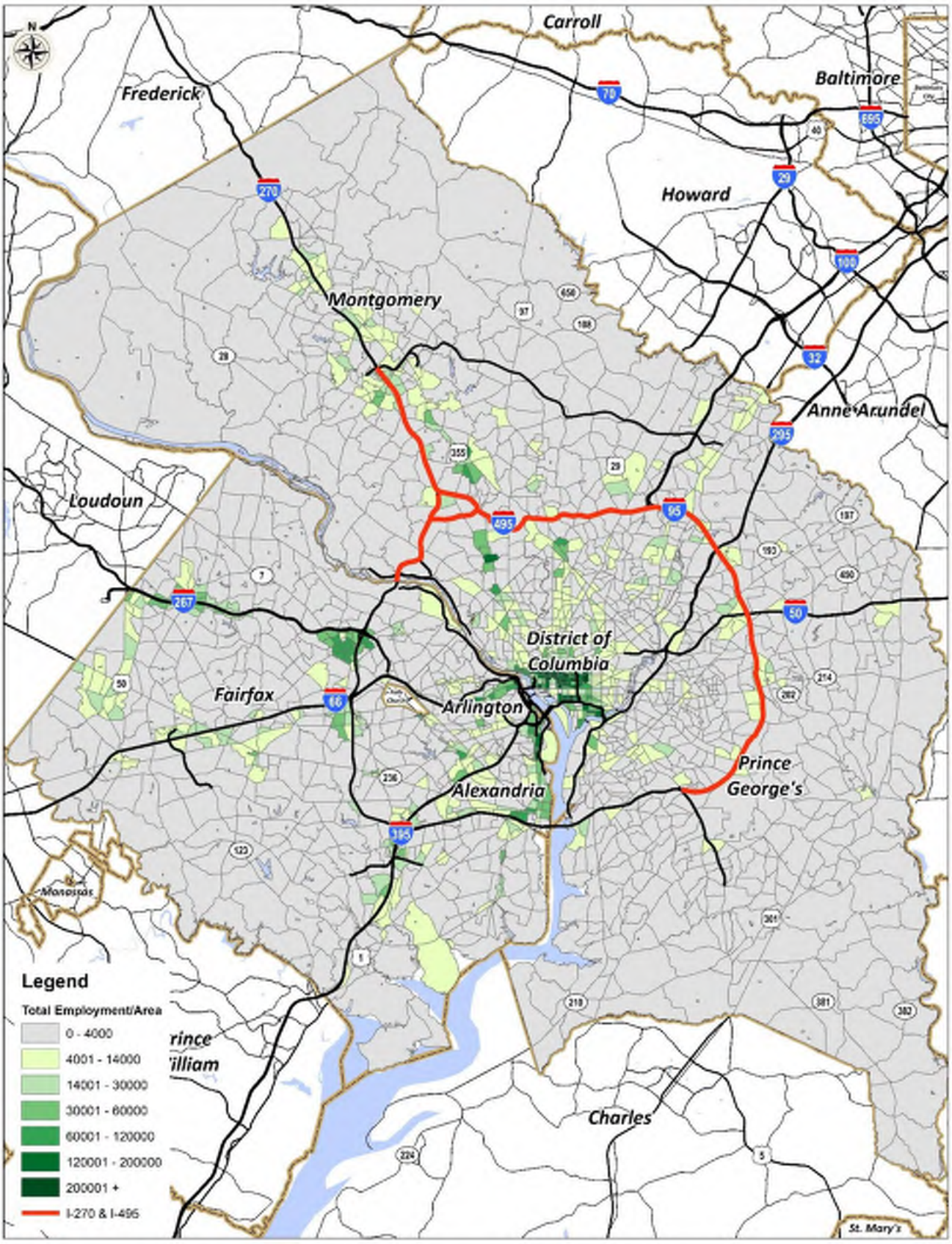

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RPG HIGH TOTAL EMPLOYMENT PER SQUARE MILE FOR 2045

FIGURE 4-23

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Chapter 5
Model Development and Calibration

As part of this traffic and revenue study, CDM Smith engaged in a calibration effort of the Metropolitan Washington Council of Governments (MWCOG) regional travel demand model, particularly on I-495, I-270 and the surrounding influence area. Regional models cover a significant area and are validated primarily against regional statistics such as vehicle miles traveled and traffic volumes across regional screenlines. The regional validation does not ensure an acceptable calibration within a specific corridor. This requires more refined effort to ensure the specific corridor under consideration (i.e., the I-495 and I-270 corridors where managed lanes are proposed) matches volumes and travel speeds to the best extent possible.

Additional effort was also required in this study compared to a study of a traditional toll facility because managed lanes are more sensitive to certain study inputs and assumptions. These include corridor demand and growth, free vehicles (in this case HOV3+ volumes), travel time savings, and the value placed on those savings. To recognize and account for this additional level of sensitivity, CDM Smith applied an approach to estimating traffic and revenue for managed lanes that relies on a more detailed analysis of current and forecasted traffic operations at smaller time intervals than those typically used in regional travel demand models. This chapter discusses model inputs, the calibration approach, and provides several measures of effectiveness of volume and speed calibration summaries.

Additionally, CDM Smith included the existing Virginia I-495 Express Lanes in the refined calibration process. Because this existing priced managed lane facility is in operation in the same region as the proposed Maryland project, including Virginia I-495 in the calibration allowed testing and refining of the toll algorithm to actual utilization and revenue performance.

5.1 MWCOG Model Description

Figure 5-1 shows the regional coverage of the MWCOG model along with the I-495 and I-270 Managed Lanes Project location and the location of the existing and proposed extension of the I-495 Virginia Express Lanes. The model itself encompasses several counties in western Maryland and northeastern Virginia, as well as the District of Columbia. It contains 3,722 Traffic Analysis Zones (TAZs) with 25,000 roadway miles. The project model subarea limits are also included in **Figure 5-1.** This was utilized for the more refined calibration effort and is discussed in more detail later in this chapter.

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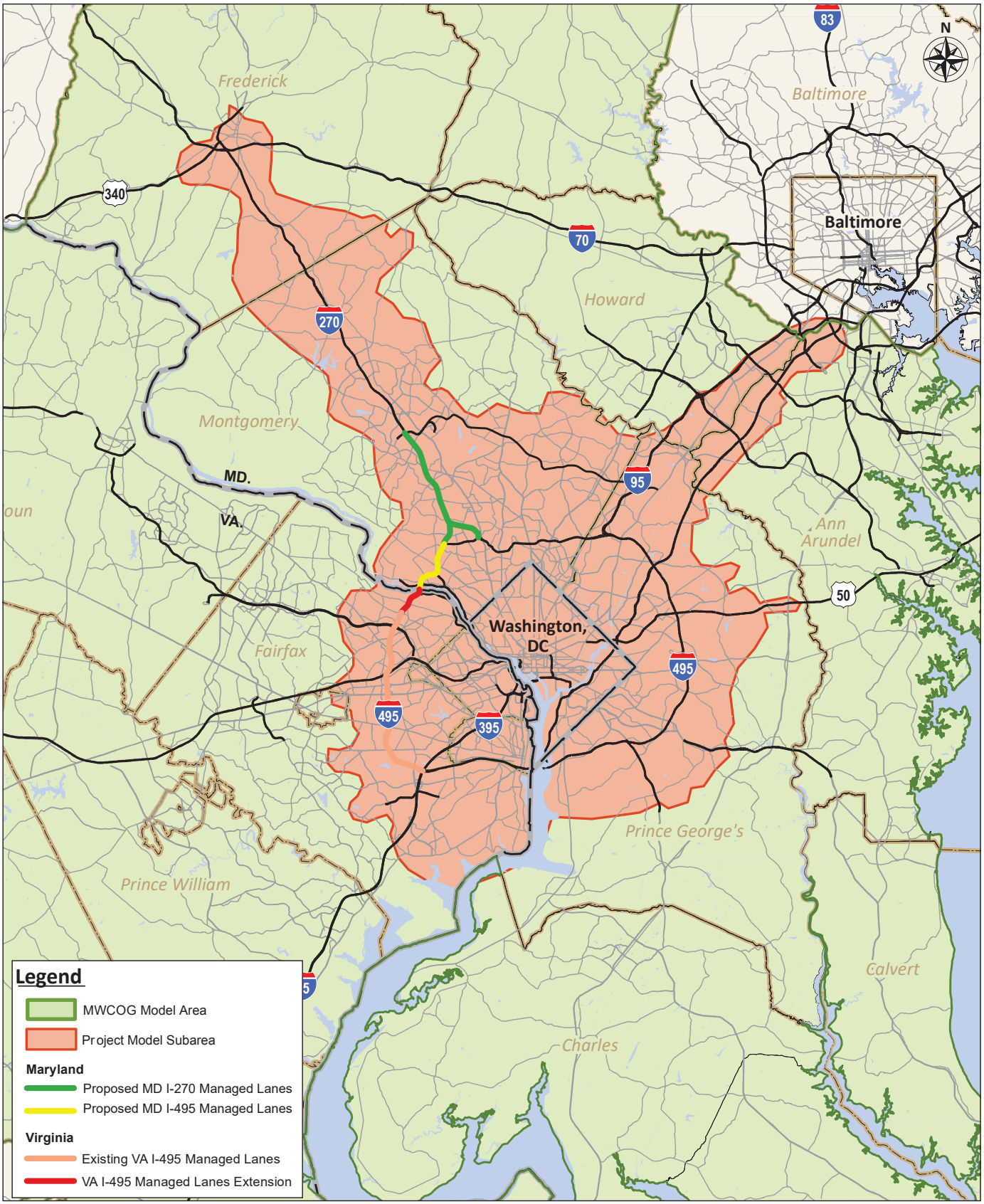

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CDM Smith

MWCOG MODEL AREA

FIGURE 5-1

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5.2 CDM Smith Model Validation and Calibration Process

The 2019 version of the MWCOG model[1] (version 2.3.75) formed the basis for validation and calibration for the study. This consisted of several interrelated steps, as shown in **Figure 5-2**. The steps consisted of refinements and adjustments to the model roadway network, trip tables, and toll assignment inputs. The value of time results described in **Chapter 3** were incorporated during the validation and calibration process. These and other modeling steps are described in more detail in **Chapter 6**.

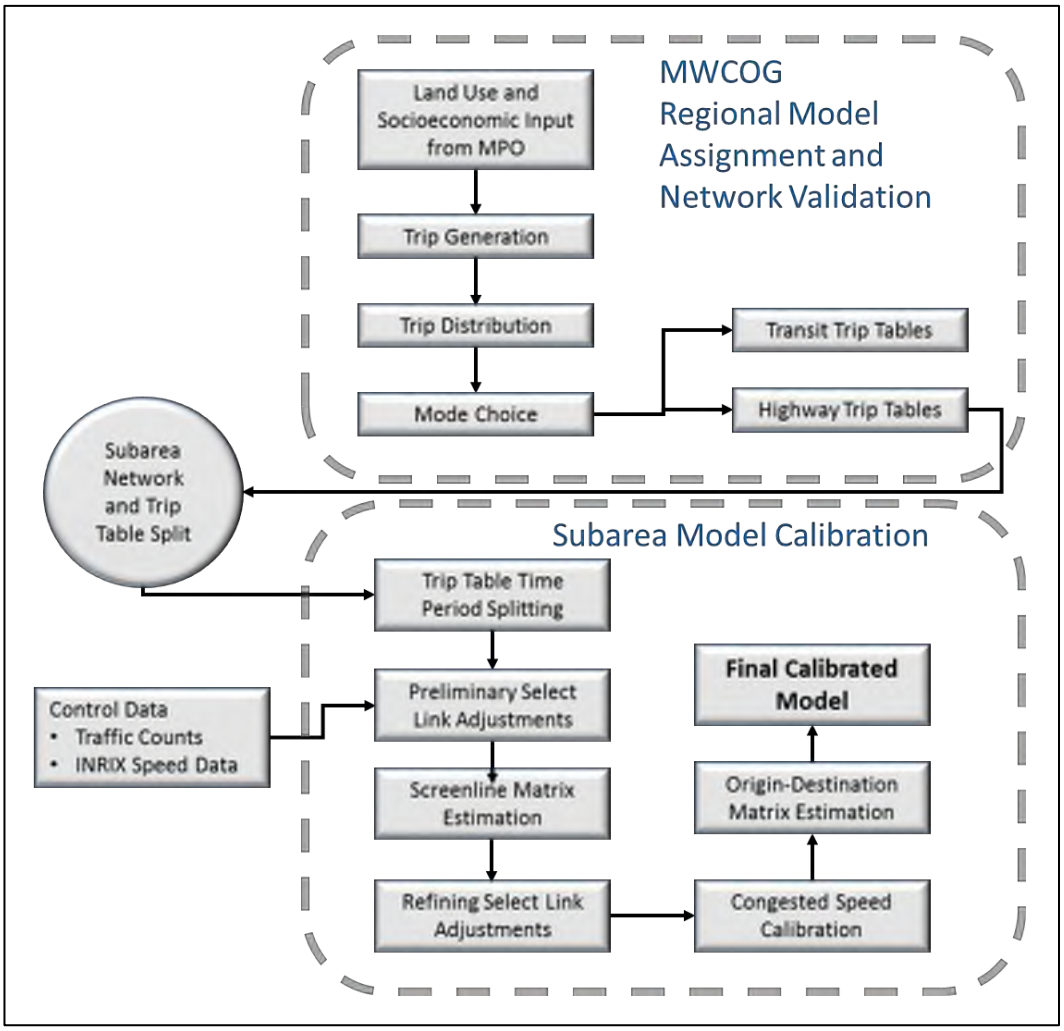

Figure 5-2
Modeling Process Diagram

[1] Although the 2019 version of the MWCOG model was used, the base year for calibration of the model utilized by CDM Smith was 2017, because 2017 data for the study was collected beginning in 2018. Network differences between 2017 and 2019 were negligible.

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5.2.1 Regional Traffic Assignment Model Validation

Several calibration and validation steps were taken in the full MWCOG regional model before the model was cut into a smaller area for more refined analysis around the I-495 and I-270 project influence area.

5.2.1.1 Network Review

To properly reflect roadway detail on the I-495 and I-270 project corridor and on adjacent roadways, CDM Smith conducted a detailed review of network attributes in the I-495 and I-270 corridor region of the MWCOG model, adjusting as necessary to reflect current roadway conditions. The roadway attribute review and adjustments included the following:

- Recoding the physical link configuration of the project corridor to more accurately reflect existing conditions;
- Reviewing and adjusting link capacity in the project area, including the number of lanes;
- Reviewing distances on roadway links and highway ramps on I-495 and I-270 and major competing routes;
- Reviewing and adjusting free-flow speeds based on INRIX data and observed conditions; and
- Reviewing and adjusting time penalties in the MWCOG model for the bridges over the Potomac River

5.2.1.2 Streetlight Travel Patterns

Origin-destination (O-D) patterns in the model were adjusted to be closer to observed patterns from the refined Streetlight data discussed previously in **Chapter 2**. The results of the Streetlight analysis were a factored matrix of trips for the project corridor. The base year model results were compared against the factored trips by passenger car and commercial vehicle determine where O-D patterns showed variance. Select link adjustments were made to the model trip tables where the comparison showed significant variance.

Table 5-1 shows the final comparison based on the sum of destinations being zero. A negative value means the model is showing fewer trips on a given movement than the data, while a positive value shows the model has more trips. For example, for all trips going from south of the American Legion Bridge (ALB) to I-95, the model showed three percent higher volumes than the Streetlight Data. The regional O-D pattern comparison was found to be at an acceptable level to proceed to the subarea model development and calibration.

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Table 5-1
Streetlight Patterns Based on Destination Zone

Traffic From	Traffic To											
	I-495 S. of ALB	I-495 Bet. ALB and I-270 W. Spur	I-270 Spurs/I-495 Triangle	I-270 Bet. Spurs and I-370	I-270 N. of I-370	I-495 Bet. I-270 and I-95	I-95	I-495 Bet. I-95 and BW Pkwy	Balt-Wash Pkwy	US-50 or MD-450	I-495 Bet. US-50 and MD-5	I-495 W. of MD-5
I-495 S. of ALB	0%	0%	-2%	-1%	1%	-1%	3%	0%	0%	-1%	0%	0%
I-495 Bet. ALB and I-270 W. Spur	-3%	6%	1%	1%	4%	-1%	0%	0%	0%	-1%	0%	0%
I-270 Spurs/I-495 Triangle	-1%	-1%	-1%	0%	-4%	0%	0%	1%	1%	0%	0%	0%
I-270 Bet. Spurs and I-370	0%	3%	1%	0%	-1%	1%	0%	0%	1%	0%	1%	0%
I-270 N. of I-370	0%	-1%	-3%	-1%	0%	-1%	-1%	-1%	0%	0%	1%	0%
I-495 Bet. I-270 and I-95	-1%	-3%	3%	1%	1%	1%	2%	2%	1%	1%	2%	-2%
I-95	7%	-1%	0%	0%	-1%	1%	0%	-3%	-4%	-1%	2%	8%
I-495 Bet. I-95 and BW Pkwy	0%	0%	0%	0%	0%	2%	-2%	1%	-1%	1%	3%	1%
Balt-Wash Pkwy	0%	0%	-1%	0%	0%	-2%	-9%	-7%	0%	-3%	-1%	-1%
US-50 or MD-450	-1%	-2%	-1%	0%	0%	-1%	-4%	1%	-8%	4%	-6%	-2%
I-495 Bet. US-50 and MD-5	0%	0%	0%	1%	1%	1%	2%	4%	3%	-5%	-5%	-3%
I-495 W. of MD-5	0%	0%	0%	0%	0%	-1%	8%	3%	6%	4%	4%	0%

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5.2.1.3 Screenline Volumes

A validation assessment of the screenlines presented previously in **Chapter 2** was made for the regional MWCOG model results. The results are shown in **Table 5-2**. Considering the limits of Phase 1 project included in this analysis, Screenline 1 is especially critical for the revenue potential of the project given the high congestion near the American Legion Bridge (ALB) which is included in Screenline 1 and few diversion routes for drivers crossing the ALB. As shown, this Screenline 1 is performing well. The regional model screenline comparison results were found to be at an acceptable level to proceed to the subarea model development and calibration.

Table 5-2
2017 Regional MWCOG Model Screenline Comparison

Screenline	Location	Total AWDT Count[2]	Total Model Result	Difference	% Difference
1	Potomac River	1,046,189	1,055,657	9,467	0.9%
2	East of MD 5	435,821	422,025	-13,796	-3.2%
3	South of Capital St/Central Ave	626,955	625,419	-1,535	-0.2%
4	South of US 50	759,465	714,723	-44,742	-5.9%
5	East of MD 650	582,731	628,220	45,489	7.8%
6	West of MD 97	642,747	707,475	64,728	10.1%
7	North of River Rd	345,882	355,605	9,723	2.8%
8	South of MD 200/ICC	971,314	1,002,615	31,301	3.2%
9	South of Germantown Rd	371,856	375,413	3,557	1.0%
10	South of I-70	369,764	395,003	25,239	6.8%
11	Inside I-495	1,433,139	1,420,264	-12,875	-0.9%
12	Outside I-495	1,861,001	1,869,845	8,844	0.5%
13	East of I-270	594,066	530,726	-63,340	-10.7%
14	West of I-270	498,876	471,931	-26,945	-5.4%
	Total	10,539,806	10,574,921	35,115	0.3%

[2] Note that some totals are slightly different than the screenline totals in **Table 2-2**, due to adjustments to the traffic count data in the final traffic profile.

5.2.1.4 Mainline Volumes

A review of the regional model was also performed on the mainline I-495 and I-270 corridor volumes within the larger regional model. **Table 5-3** shows a comparison in terms of total mainline average weekday counts versus model results for the limits of the project under study. On I-270 the volumes in this table represent the total of all existing express and local general purpose and HOV lanes.

As shown, the total difference across the entire project corridors was -0.8 percent. Different segments varied more significantly, with the largest variation occurring on the I-270 West Spur.

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However, all model volumes were within about 10 percent of their observed counts, which was an acceptable level of comparison to proceed to the subarea model development and calibration.

Table 5-3
2017 Regional MWCOG Model I-495 and I-270 Comparisons

Corridor Segment	Total AWDT Count	Total Model Result	Difference	% Difference
I-495 Section				
Georgetown Pike to GW Pkwy	210,529	215,040	4,511	2.1%
GW Pkwy to Clara Barton Pkwy (River)	265,119	256,181	-8,938	-3.4%
Clara Barton Pkwy to MD 190	244,291	229,350	-14,941	-6.1%
MD 190 to I-270 Spur	273,832	269,411	-4,421	-1.6%
I-270 Spur to MD 187	137,503	122,919	-14,584	-10.6%
TOTAL	1,131,274	1,092,902	-38,372	-3.4%
I-270 Section				
I-370 to Shady Grove Rd	234,947	224,094	-10,853	-4.6%
Shady Grove Rd to Montgomery Ave	245,146	234,555	-10,591	-4.3%
Montgomery Ave to Maryland Ave	268,892	271,827	2,935	1.1%
Maryland Ave to Montrose Rd	268,033	265,798	-2,235	-0.8%
Montrose Rd to I-270 Split	269,821	269,870	49	0.0%
E Spur - I-270 Split to MD 187	124,305	133,707	9,402	7.6%
E Spur - MD 187 to I-495	120,901	117,240	-3,661	-3.0%
W Spur - I-270 Split to Democracy Blvd	145,518	136,164	-9,354	-6.4%
W Spur - Democracy Blvd to I-495	136,323	146,492	10,169	7.5%
TOTAL	1,813,886	1,799,746	-14,140	-0.8%

5.2.2 Subarea Model Calibration

Most of the calibration efforts for this study were conducted in a smaller model, called the subarea model. This sub-section details the subarea model development and calibration results.

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5.2.2.1 Subarea Limits

Figure 5-1 earlier in this chapter shows the boundary of the subarea within the full MWCOG model network. Although this study covered Phase 1 of the managed lanes, as discussed in Chapter 1, the subarea was chosen with the intention to eventually model the full I-495 and I-270 Managed Lane Project. Thus, the subarea covers the entire I-495 beltway. It also covers I-270 to Frederick, I-95 and US-1 to the edge of the model at the Baltimore Beltway, and the Inter-County Connector (ICC) in between I-270 and US-1.

5.2.2.2 Trip Table Splitting and Refinement

The trip tables in the regional MWCOG model represent an average weekday for an AM Peak Period (6:00 to 9:00 AM), a PM Peak Period (3:00 to 7:00 PM), a Midday period (9:00 AM to 3:00 PM), and a Nighttime period (7:00 PM to 6:00 AM). CDM Smith performed trip table splits of the MWCOG trip tables into 13 subarea model time periods; four AM periods, two mid-day (MD), five PM, and two nighttime (NT). Time periods were split to provide a more detailed breakdown of traffic demand and better reflect congestion patterns within the peak periods. **Figure 5-3** shows a graph of the total counts at the permanent traffic count station on I-495 between Clara Barton Parkway and MD 190, color coded with the 13 time periods. The figure illustrates how time periods were divided with breakpoints consistent with varying traffic levels throughout the day.

Trip tables were split or shifted from the MWCOG time periods using the proportion of I-495 mainline traffic volumes falling within specific hours or periods. The proportion of each of the 13 subarea time periods relative to the parent MWCOG time period is shown in **Table 5-4.**

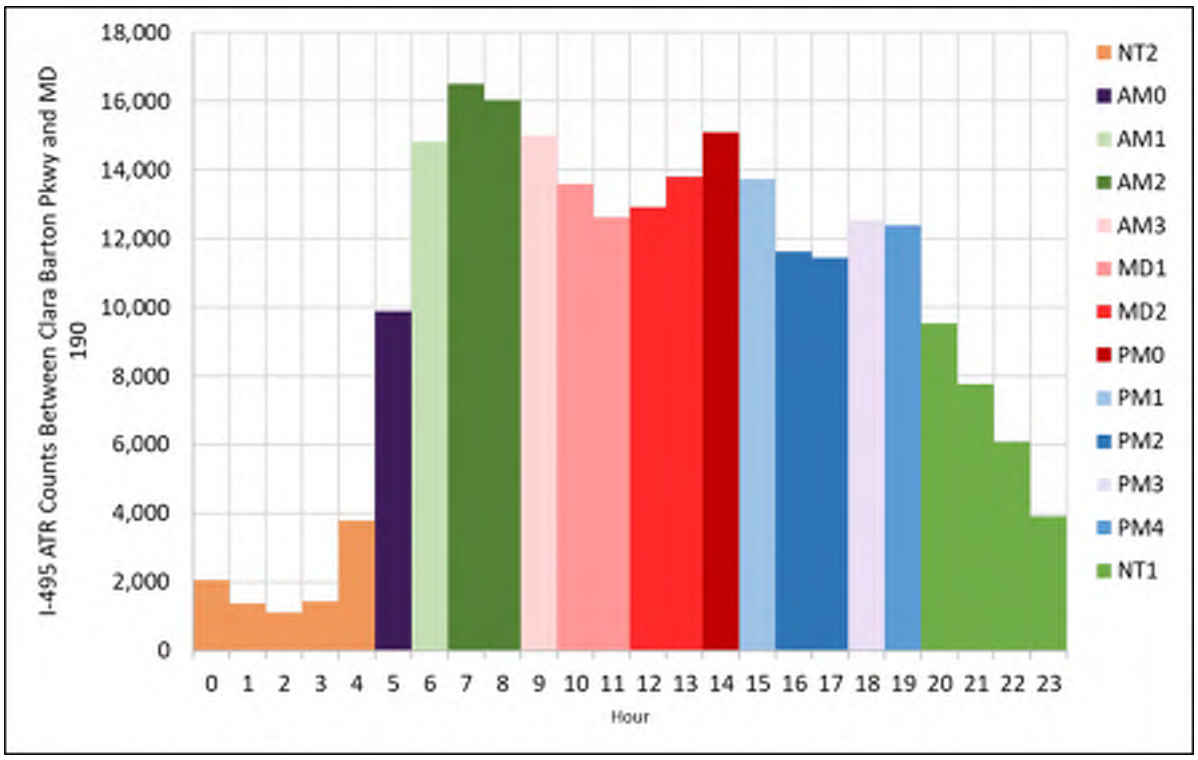

Figure 5-3
Model Time Periods and Sum of I-495 Mainline Counts

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Table 5-4
Model Time Periods

Time	Subarea Time Period	MWCOG Time Period	Proportion of MWCOG Time Period
Midnight - 5:00 AM	NT2	NT	13%
5:00 - 6:00 AM	AM0	NT	12%
6:00 - 7:00 AM	AM1	AM	28%
7:00 - 9:00 AM	AM2	AM	72%
9:00 - 10:00 AM	AM3	MD	18%
10:00 AM - Noon	MD1	MD	31%
Noon - 2:00 PM	MD2	MD	32%
2:00 - 3:00 PM	PM0	MD	19%
3:00 - 4:00 PM	PM1	PM	25%
4:00 - 6:00 PM	PM2	PM	51%
6:00 - 7:00 PM	PM3	PM	24%
7:00 - 8:00 PM	PM4	NT	24%
8:00 PM - Midnight	NT1	NT	51%

5.2.2.3 I-495 and I-270 Subarea Model Volumes

Scatterplots of counts versus model volumes for I-495 and I-270 mainlines and ramps are presented in **Figure 5-4** and **5-5** (for I-495 and I-270, respectively) to evaluate the subarea calibration. A separate scatterplot is provided for each of the AM, and PM time periods as well as the daily total. Each scatterplot is fitted with a linear trend line, and the corresponding factor and R-squared value are printed on each plot. Trend line factors close to 1 represent calibrations that are overall close to observed values on a total basis. R-squared values close to 1 represent a roadway calibration that does not vary greatly from counts on a link-by-link basis, provided that the trend line factor is also close to 1. The results show tightly clustered points for all time periods; all trend line factors are between 0.85 and 1.1, with most between 0.95 and 1.0, and R-squared values are at least 0.89.

Table 5-5 (in three parts) shows a comparison of the 2017 model volumes versus the count target along mainline segments of I-495 and I-270. Modeled volumes are within 10 percent of counts at most locations during the most congested peaks. These times are most critical for managed lane revenue estimation. On I-270, counts and volumes for the general purpose and existing HOV lanes, and the express and local lanes (where applicable) are combined.

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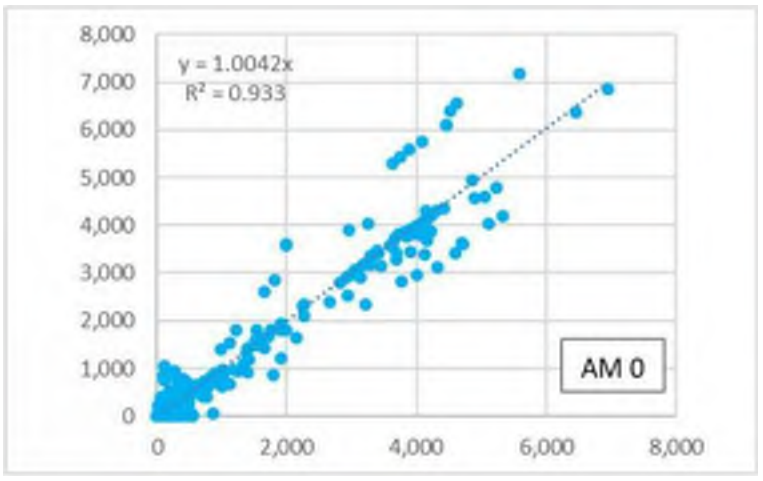

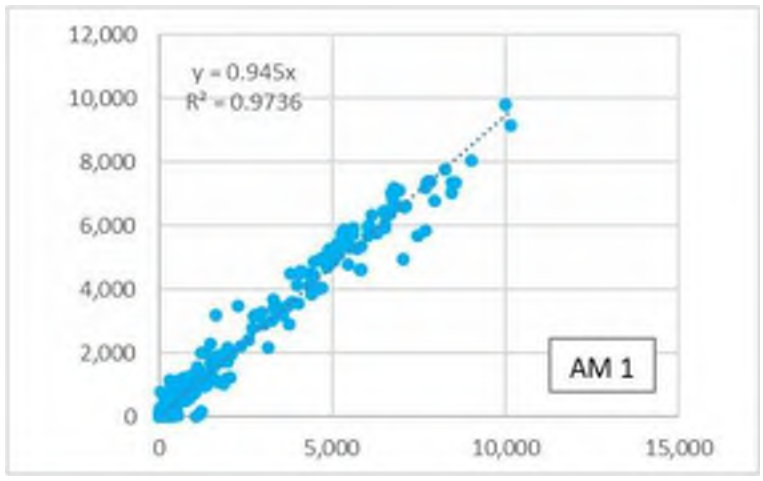

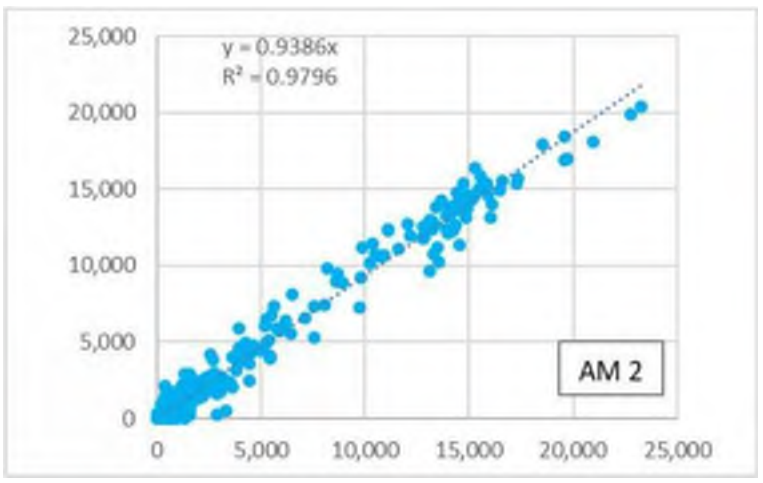

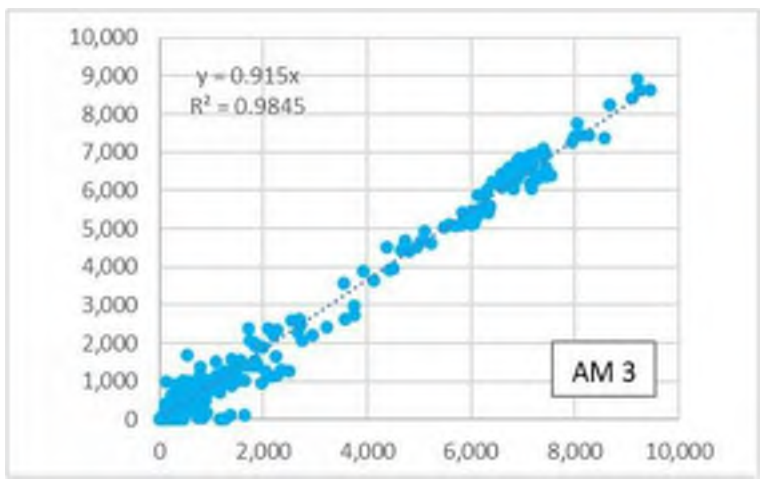

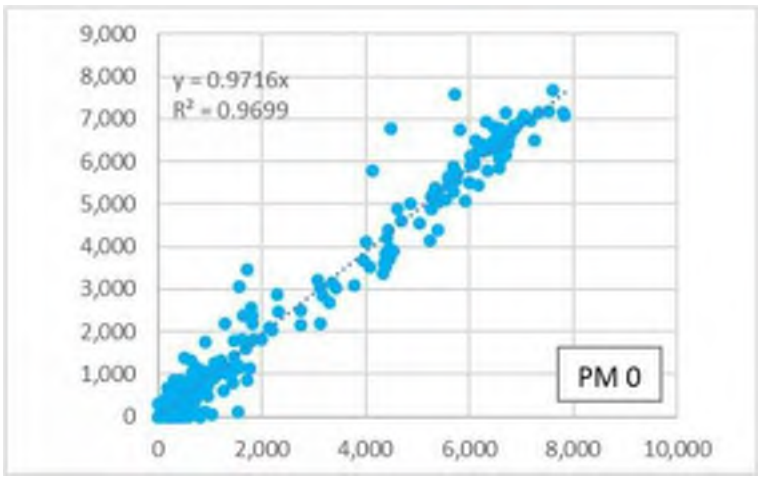

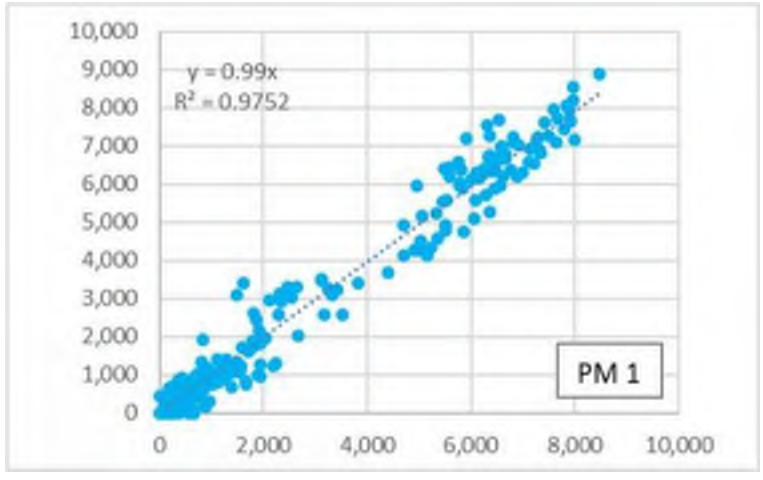

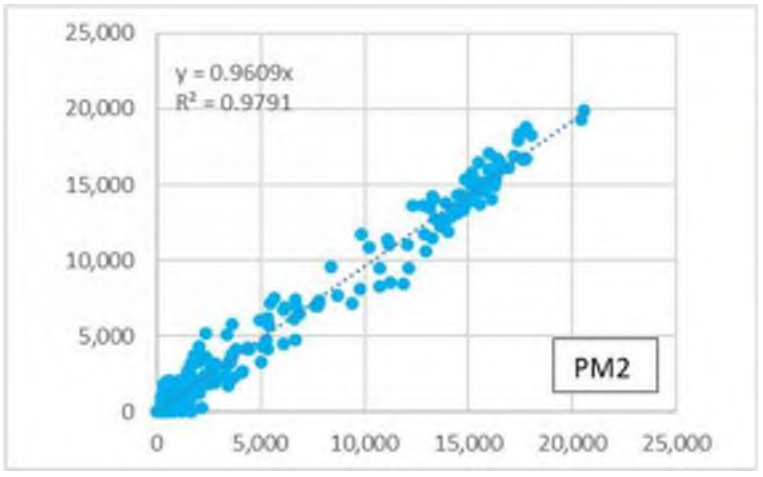

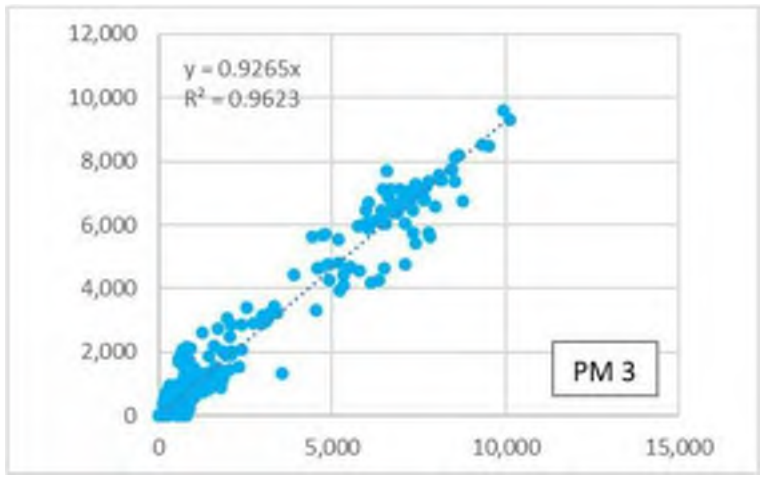

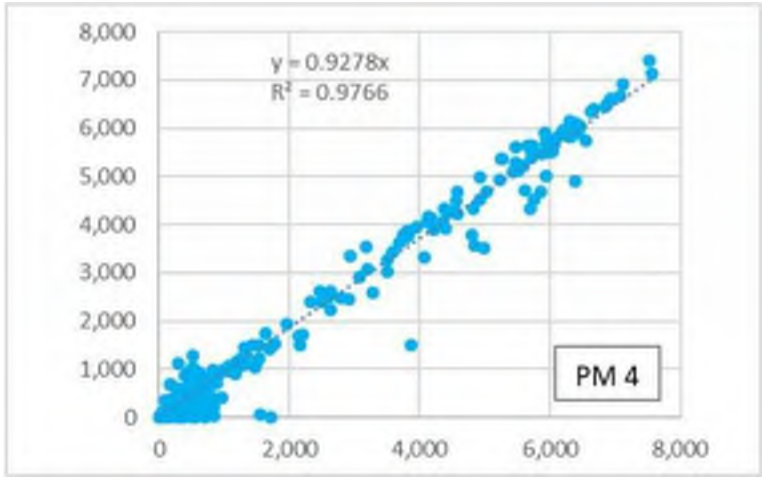

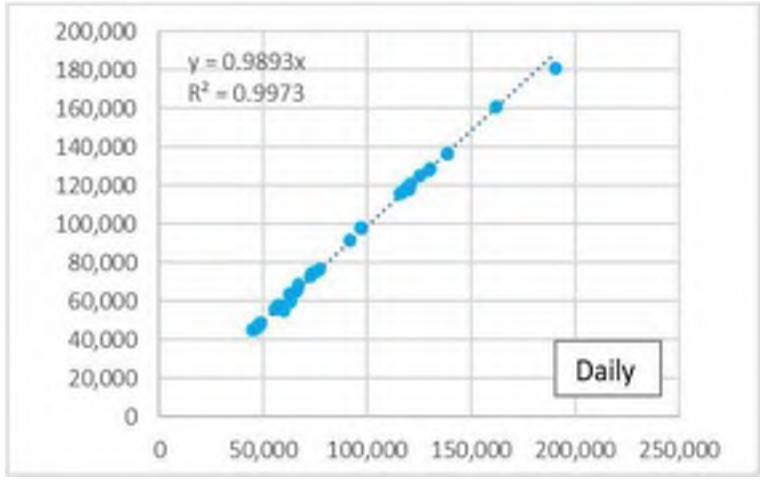

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MODEL VOLUME (y-axis) vs TRAFFIC COUNT (x-axis) I-495 MAINLINE AND RAMPS

Figure 5-4

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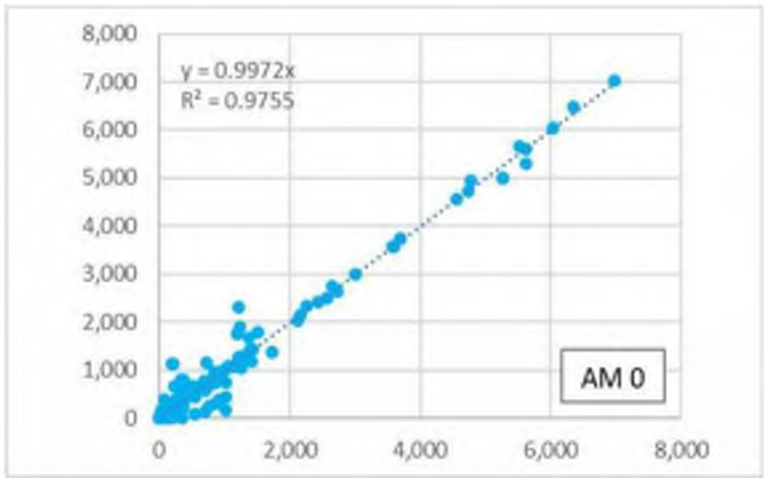

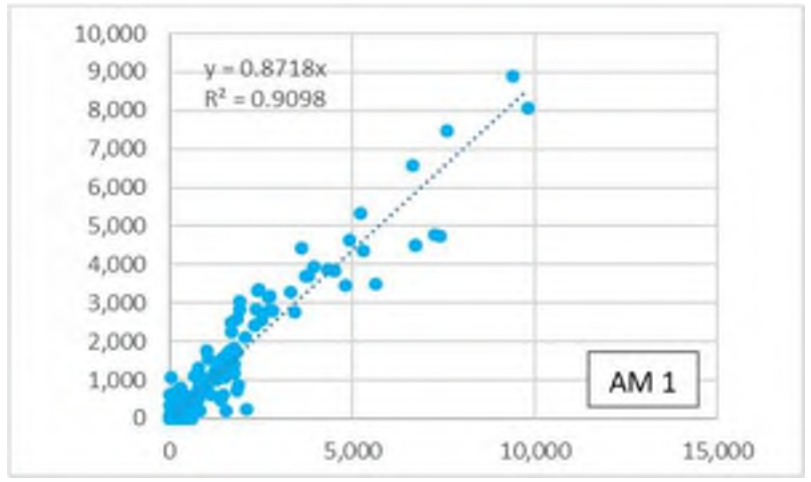

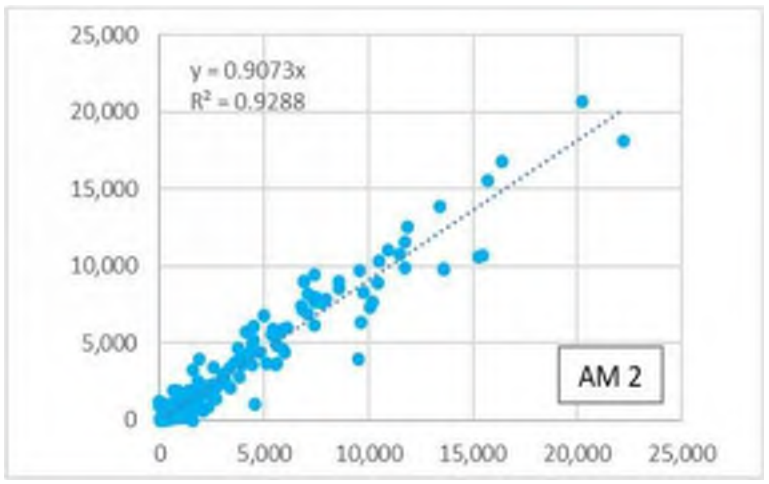

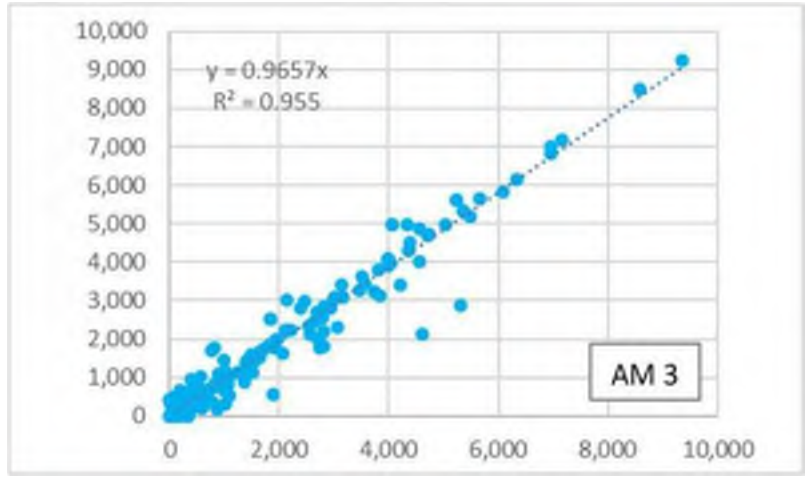

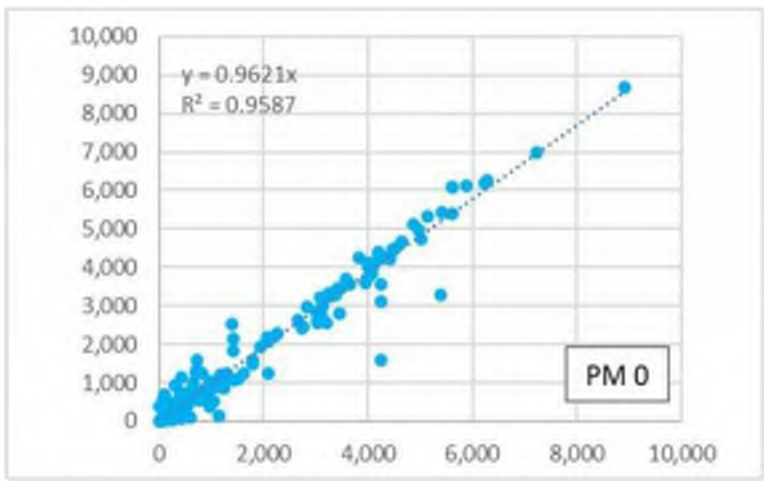

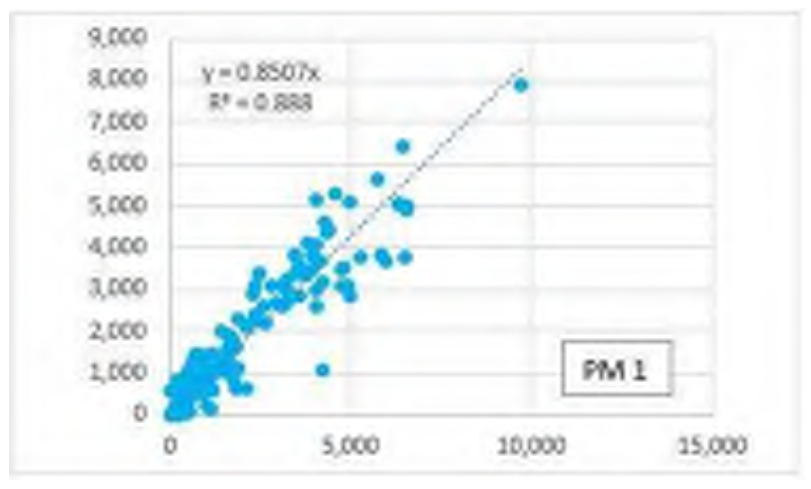

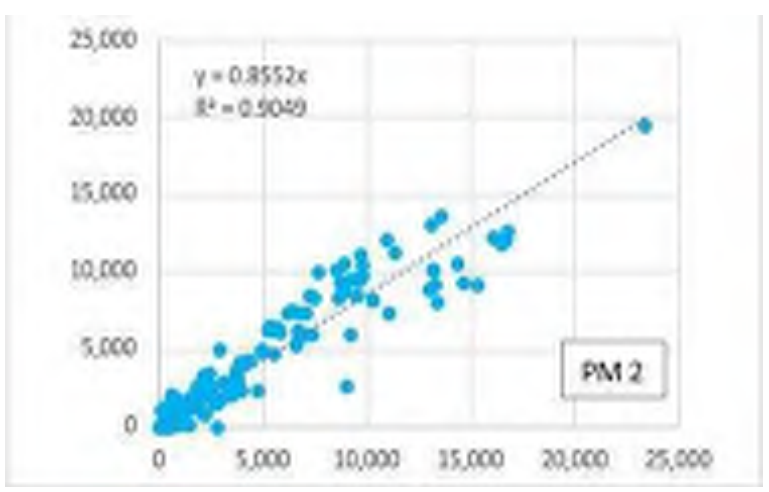

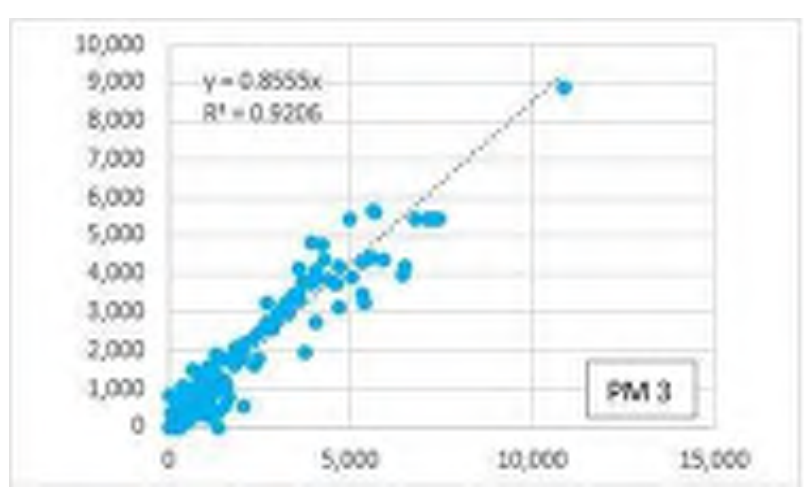

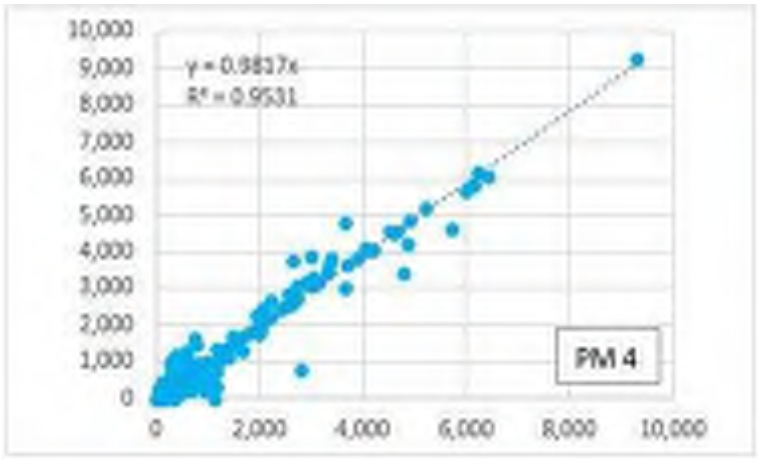

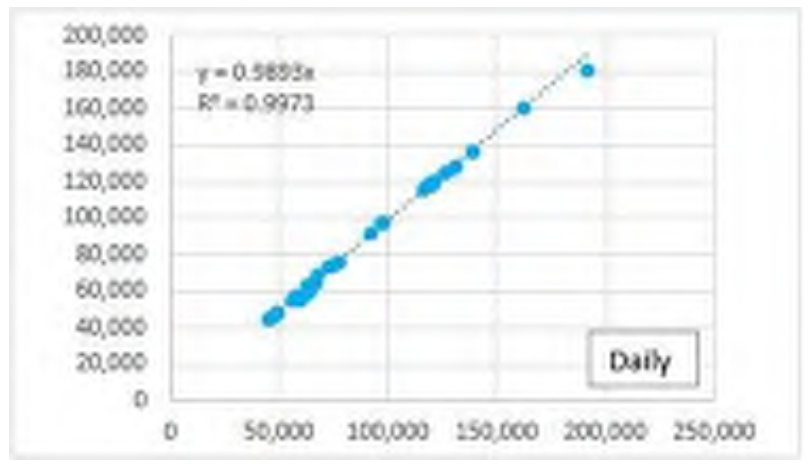

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MODEL VOLUME (y-axis) vs TRAFFIC COUNT (x-axis) I-270 MAINLINE AND RAMPS

Figure 5-5

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Table 5-5
I-495 and I-270 Subarea Model Calibration by Time Period (Part 1 of 3)

Location		5:00 - 6:00 AM			6:00 - 7:00 AM			7:00 - 9:00 AM			9:00 - 10:00 AM		
		Count	Model	% Diff	Count	Model	% Diff	Count	Model	% Diff	Count	Model	% Diff
Northbound / Inner Loop													
I-495	American Legion Bridge	5,635	5,944	5%	14,721	15,358	4%	9,441	8,624	-9%	14,092	12,581	-11%
	Clara Barton Pkwy to MD 190	4,952	5,263	6%	13,403	13,794	3%	8,678	8,232	-5%	13,295	12,060	-9%
	MD 190 to I-270 Spur	4,696	4,974	6%	14,414	14,734	2%	9,191	8,916	-3%	15,014	14,094	-6%
	I-270 Spur to MD 187	2,003	2,175	9%	5,832	5,733	-2%	4,801	4,400	-8%	7,519	6,579	-12%
I-270	W Spur Democracy Blvd to I-495	2,693	2,799	4%	8,582	9,001	5%	4,390	4,516	3%	7,496	7,515	0%
	W Spur I-270 Split to Democracy Blvd	2,333	2,435	4%	7,504	7,949	6%	3,979	4,100	3%	7,433	7,452	0%
	E Spur MD 187 to I-495	1,859	1,717	-8%	7,109	6,833	-4%	3,569	3,428	-4%	5,664	5,602	-1%
	E Spur I-270 Split to MD 187	1,462	1,265	-13%	5,923	5,876	-1%	3,177	3,076	-3%	5,389	5,304	-2%
	Montrose Rd to I-270 Split	5,674	4,551	-20%	19,423	18,224	-6%	9,973	9,386	-6%	18,015	16,460	-9%
	Maryland Ave to Montrose Rd	3,303	3,232	-2%	12,514	12,730	2%	6,873	6,769	-2%	12,090	12,015	-1%
	Mntgmy Ave to Maryland Ave	3,229	3,103	-4%	12,431	12,625	2%	6,798	6,720	-1%	12,096	11,833	-2%
	Shdy Grve Rd to Mntgmy Ave	2,786	2,919	5%	10,100	10,292	2%	5,543	5,301	-4%	10,686	10,863	2%
	I-370 to Shady Grove Rd	2,180	2,223	2%	7,809	8,287	6%	4,446	4,427	0%	9,772	9,598	-2%
Southbound / Outer Loop													
I-270	I-370 to Shady Grove Rd	9,276	8,888	-4%	21,010	20,942	0%	9,123	8,859	-3%	14,107	14,018	-1%
	Shdy Grve Rd to Mntgmy Ave	8,963	8,338	-7%	19,795	18,982	-4%	8,621	8,162	-5%	14,064	13,909	-1%
	Mntgmy Ave to Maryland Ave	9,417	8,976	-5%	21,045	20,632	-2%	9,064	8,735	-4%	15,400	15,251	-1%
	Maryland Ave to Montrose Rd	9,445	8,978	-5%	21,383	20,577	-4%	9,432	9,036	-4%	15,508	15,329	-1%
	Montrose Rd to I-270 Split	12,194	12,846	5%	28,991	28,995	0%	12,374	12,301	-1%	19,235	19,952	4%
	E Spur I-270 Split to MD 187	5,308	5,068	-5%	11,766	11,710	0%	3,983	3,909	-2%	7,283	7,289	0%
	E Spur MD 187 to I-495	4,796	4,178	-13%	10,182	9,537	-6%	3,473	3,273	-6%	6,827	6,689	-2%
	W Spur I-270 Split to Democracy Blvd	4,496	4,453	-1%	10,460	9,898	-5%	5,369	5,315	-1%	8,032	7,901	-2%
	W Spur Democracy Blvd to I-495	4,337	4,490	4%	9,790	9,248	-6%	4,724	4,675	-1%	7,392	7,267	-2%
I-495	I-270 Spur to MD 187	5,830	4,640	-20%	13,493	11,185	-17%	4,513	3,962	-12%	5,510	5,629	2%
	MD 190 to I-270 Spur	10,168	9,129	-10%	23,283	20,433	-12%	9,237	8,637	-6%	12,903	12,896	0%
	Clara Barton Pkwy to MD 190	8,470	7,361	-13%	20,992	18,125	-14%	8,111	7,443	-8%	11,043	11,519	4%
	American Legion Bridge	8,555	7,355	-14%	22,798	19,925	-13%	9,085	8,415	-7%	11,760	12,275	4%

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Table 5-5
I-495 and I-270 Subarea Model Calibration by Time Period (Part 2 of 3)

Location		10:00 AM - Noon			Noon - 2:00 PM			2:00 - 3:00 PM			3:00 - 4:00 PM		
		Count	Model	% Diff	Count	Model	% Diff	Count	Model	% Diff	Count	Model	% Diff
Northbound / Inner Loop													
I-495	American Legion Bridge	12,311	11,621	-6%	4,478	6,795	52%	5,583	6,448	15%	17,207	16,871	-2%
	Clara Barton Pkwy to MD 190	11,685	11,153	-5%	4,131	5,793	40%	4,953	5,950	20%	14,570	14,346	-2%
	MD 190 to I-270 Spur	14,180	13,735	-3%	5,720	7,588	33%	6,529	7,665	17%	18,032	18,234	1%
	I-270 Spur to MD 187	6,424	5,930	-8%	1,723	3,462	101%	1,619	3,392	110%	7,788	7,352	-6%
I-270	W Spur Democracy Blvd to I-495	7,756	7,806	1%	3,997	4,126	3%	4,910	4,273	-13%	10,244	10,883	6%
	W Spur I-270 Split to Democracy Blvd	8,283	8,332	1%	4,482	4,456	-1%	5,820	4,974	-15%	13,128	12,748	-3%
	E Spur MD 187 to I-495	7,382	6,878	-7%	4,071	3,838	-6%	3,517	3,970	13%	9,160	8,375	-9%
	E Spur I-270 Split to MD 187	7,608	7,075	-7%	4,425	4,229	-4%	3,872	4,583	18%	10,230	10,508	3%
	Montrose Rd to I-270 Split	21,552	20,265	-6%	11,938	11,251	-6%	12,885	12,556	-3%	30,123	30,597	2%
	Maryland Ave to Montrose Rd	15,466	14,909	-4%	8,830	8,642	-2%	9,964	9,833	-1%	24,681	24,131	-2%
	Mntgmy Ave to Maryland Ave	15,385	14,687	-5%	9,068	8,898	-2%	10,366	10,186	-2%	24,968	24,549	-2%
	Shdy Grve Rd to Mntgmy Ave	14,225	13,966	-2%	8,424	8,170	-3%	9,713	9,371	-4%	22,946	22,666	-1%
	I-370 to Shady Grove Rd	13,274	13,037	-2%	8,056	7,804	-3%	9,196	8,971	-2%	21,875	22,023	1%
Southbound / Outer Loop													
I-270	I-370 to Shady Grove Rd	12,628	12,514	-1%	6,300	6,091	-3%	5,373	5,335	-1%	11,576	12,148	5%
	Shdy Grve Rd to Mntgmy Ave	12,779	12,646	-1%	6,478	6,349	-2%	5,798	5,858	1%	12,848	12,943	1%
	Mntgmy Ave to Maryland Ave	14,237	14,151	-1%	7,317	7,119	-3%	6,621	6,525	-1%	14,523	14,500	0%
	Maryland Ave to Montrose Rd	14,208	14,106	-1%	7,236	6,986	-3%	6,463	6,426	-1%	13,787	13,781	0%
	Montrose Rd to I-270 Split	17,939	18,377	2%	9,017	8,586	-5%	8,306	7,597	-9%	16,462	15,187	-8%
	E Spur I-270 Split to MD 187	7,042	6,928	-2%	3,976	3,687	-7%	3,992	3,036	-24%	6,652	5,663	-15%
	E Spur MD 187 to I-495	6,888	6,724	-2%	3,959	3,577	-10%	4,177	3,194	-24%	6,958	6,027	-13%
	W Spur I-270 Split to Democracy Blvd	7,239	7,272	0%	3,244	3,313	2%	2,437	3,429	41%	6,385	7,485	17%
	W Spur Democracy Blvd to I-495	6,671	6,658	0%	3,084	3,210	4%	2,308	3,132	36%	5,344	6,226	17%
I-495	I-270 Spur to MD 187	6,037	5,109	-15%	4,452	3,971	-11%	5,345	4,565	-15%	7,824	7,232	-8%
	MD 190 to I-270 Spur	12,707	11,767	-7%	7,536	7,181	-5%	7,654	7,698	1%	13,168	13,458	2%
	Clara Barton Pkwy to MD 190	11,193	10,724	-4%	6,578	6,089	-7%	7,405	7,624	3%	13,248	14,253	8%
	American Legion Bridge	11,894	11,263	-5%	7,175	6,952	-3%	8,481	8,896	5%	16,013	17,090	7%

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Table 5-5
I-495 and I-270 Subarea Model Calibration by Time Period (Part 3 of 3)

Location		4:00 - 6:00 PM			6:00 - 7:00 PM			7:00 - 8:00 PM			Daily		
		Count	Model	% Diff	Count	Model	% Diff	Count	Model	% Diff	Count	Model	% Diff
Northbound / Inner Loop													
I-495	American Legion Bridge	9,519	8,460	-11%	6,851	6,460	-6%	20,342	18,513	-9%	128,632	126,082	-2%
	Clara Barton Pkwy to MD 190	8,547	7,350	-14%	6,300	6,142	-3%	19,693	17,902	-9%	118,147	115,870	-2%
	MD 190 to I-270 Spur	10,115	9,296	-8%	7,530	7,414	-2%	21,629	19,974	-8%	135,030	134,553	0%
	I-270 Spur to MD 187	5,525	4,676	-15%	3,836	3,784	-1%	11,270	9,545	-15%	62,587	61,167	-2%
I-270	W Spur Democracy Blvd to I-495	4,590	4,621	1%	3,694	3,630	-2%	10,360	10,429	1%	72,443	73,386	1%
	W Spur I-270 Split to Democracy Blvd	5,540	5,274	-5%	4,092	4,056	-1%	11,081	11,200	1%	77,144	76,500	-1%
	E Spur MD 187 to I-495	4,672	4,315	-8%	4,666	4,561	-2%	8,068	8,143	1%	62,845	60,259	-4%
	E Spur I-270 Split to MD 187	5,292	5,487	4%	5,202	5,223	0%	8,497	8,602	1%	63,821	63,469	-1%
	Montrose Rd to I-270 Split	14,241	14,246	0%	12,194	12,500	3%	25,821	23,943	-7%	190,885	180,700	-5%
	Maryland Ave to Montrose Rd	11,145	11,111	0%	9,162	9,149	0%	19,058	19,195	1%	138,706	136,864	-1%
	Mntgmy Ave to Maryland Ave	11,052	11,088	0%	9,025	8,937	-1%	18,836	18,711	-1%	138,789	136,327	-2%
	Shdy Grve Rd to Mntgmy Ave	9,964	10,049	1%	8,367	8,396	0%	17,866	18,312	2%	125,625	125,037	0%
	I-370 to Shady Grove Rd	9,561	9,939	4%	8,160	7,895	-3%	17,327	17,332	0%	115,992	115,541	0%
Southbound / Outer Loop													
I-270	I-370 to Shady Grove Rd	5,074	5,125	1%	3,879	4,035	4%	8,846	9,335	6%	119,455	119,455	0%
	Shdy Grve Rd to Mntgmy Ave	5,422	5,400	0%	4,041	4,213	4%	9,029	9,251	2%	120,021	117,885	-2%
	Mntgmy Ave to Maryland Ave	6,158	6,153	0%	4,573	4,724	3%	9,936	10,113	2%	130,603	128,940	-1%
	Maryland Ave to Montrose Rd	5,878	5,884	0%	4,535	4,607	2%	9,970	10,196	2%	129,927	127,854	-2%
	Montrose Rd to I-270 Split	6,908	7,382	7%	5,678	5,322	-6%	12,084	11,621	-4%	162,188	161,028	-1%
	E Spur I-270 Split to MD 187	1,953	1,831	-6%	1,801	1,809	0%	3,816	3,972	4%	62,284	59,469	-5%
	E Spur MD 187 to I-495	1,907	1,807	-5%	1,979	1,955	-1%	4,263	4,412	3%	59,856	55,533	-7%
	W Spur I-270 Split to Democracy Blvd	3,678	3,820	4%	2,717	2,759	2%	6,247	6,324	1%	67,174	68,865	3%
	W Spur Democracy Blvd to I-495	3,343	3,443	3%	2,625	2,610	-1%	6,284	6,330	1%	62,680	64,032	2%
I-495	I-270 Spur to MD 187	3,088	3,003	-3%	2,200	1,705	-23%	6,760	6,513	-4%	70,031	64,636	-8%
	MD 190 to I-270 Spur	6,431	6,446	0%	4,826	4,315	-11%	13,045	12,844	-2%	132,716	128,668	-3%
	Clara Barton Pkwy to MD 190	6,062	6,095	1%	4,537	4,303	-5%	12,263	12,438	1%	120,060	118,731	-1%
	American Legion Bridge	6,971	7,110	2%	4,926	4,529	-8%	12,651	12,549	-1%	130,400	128,906	-1%

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5.2.2.4 Travel Speeds

Willingness to use the I-495 and I-270 managed lanes is related to the amount of time savings that they can provide over the parallel general purpose lanes. Travel speeds must be accurately represented in the calibrated model by time of day and particularly in the direction of greatest congestion. This ensures the managed lanes will realize its proper time savings advantage for applicable movements in the diversion assignment. This section compares the observed travel speeds along I-495 and I-270 general purpose lanes against the calibrated model congested speeds for each model period. The INRIX speed data from 2017 previously described in Chapter 2 was used as the observed speed.

Table 5-6 (in three sections) shows a summary of travel speeds by time period and travel direction against observed speed data. Overall, speeds are represented well in the model. Moderate congestion in the southbound direction along the entire extent of the project (other than the I-270 East Spur) occurs at the beginning of the AM Peak (6:00 AM to 7:00 AM), and that congestion becomes severe from 7:00 to 10:00 AM. Southbound congestion also occurs on the I-270 West Spur and along the extent of the I-495 portion of the project under study between 3:00 PM and 7:00 PM. Northbound congestion occurs near the American Legion Bridge at most times of the day, and spreads to the extent of the project during the PM Peak (3:00 PM to 8:00 PM). This congestion is most severe during the 4:00 PM to 7:00 PM time period.

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Table 5-6
I-495 / I-270 Subarea Model Speed Calibration by Time Period (Part 1 of 3)

Location	5:00 - 6:00 AM			6:00 - 7:00 AM			7:00 - 9:00 AM			9:00 - 10:00 AM		
	INRIX	Model	Diff	INRIX	Model	Diff	INRIX	Model	Diff	INRIX	Model	Diff
Northbound / Inner Loop												
American Legion Bridge	65	62	-3	56	59	3	31	17	-14	30	35	5
Clara Barton Pkwy - Cabin John / River Rd	63	65	3	59	60	1	52	43	-9	52	57	5
Cabin John / River Rd - W 270 Spur	65	64	-1	64	64	0	62	60	-2	61	61	0
W Spur Beltway to Democracy Blvd	62	60	-2	63	60	-3	62	60	-2	61	60	-1
W Spur Democracy Blvd to Spur Merge	61	60	-1	63	60	-3	63	60	-3	62	60	-2
E Spur Beltway to MD 187	60	60	0	59	60	1	58	51	-7	58	58	0
E Spur MD 187 to Spur Merge	62	60	-2	61	60	-1	61	60	-1	61	60	-2
Spur Merge - Montrose Rd	63	64	1	63	63	0	62	59	-4	62	61	-1
Montrose Rd - MD 189	60	63	3	61	62	0	62	58	-3	61	57	-4
MD 189 - Montgomery Ave	62	64	2	62	63	1	61	60	-1	60	59	0
Montgomery Ave - Shady Grove Rd	57	62	5	58	62	3	59	60	1	59	60	0
Shady Grove Rd - I-370	62	63	1	63	62	-1	63	60	-3	62	60	-2
Southbound / Outer Loop												
I-370 - Shady Grove Rd	67	61	-6	56	37	-19	28	29	2	44	32	-12
Shady Grove Rd - Montgomery Ave	68	60	-7	52	44	-8	21	29	9	30	28	-2
Montgomery Ave - MD 189	66	61	-5	51	38	-12	27	23	-4	34	21	-13
MD 189 - Montrose Rd	67	63	-4	48	44	-4	25	27	2	33	30	-3
Montrose Rd - Spur Split	67	59	-8	48	45	-3	36	35	0	44	44	0
E Spur Split to MD 187	64	60	-4	60	42	-18	55	26	-29	56	53	-2
E Spur MD 187 to Beltway	65	60	-5	62	53	-10	52	49	-3	54	59	5
W Spur Split to Democracy Blvd	62	51	-11	39	48	9	27	20	-7	30	20	-10
W Spur Democracy Blvd to Beltway	64	57	-7	51	52	1	32	24	-7	24	23	-1
W 270 Spur - Cabin John / River Rd	64	65	1	57	60	3	44	52	9	34	30	-3
Cabin John / River Rd - Clara Barton Pkwy	64	64	0	59	63	4	45	54	8	32	35	4
American Legion Bridge	65	65	0	60	64	4	51	54	4	41	33	-7

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Table 5-6
I-495 / I-270 Subarea Model Speed Calibration by Time Period (Part 2 of 3)

Location	10:00 AM - Noon			Noon - 2:00 PM			2:00 - 3:00 PM			3:00 - 4:00 PM		
	INRIX	Model	Diff	INRIX	Model	Diff	INRIX	Model	Diff	INRIX	Model	Diff
Northbound / Inner Loop												
American Legion Bridge	42	58	15	53	59	6	28	19	-9	19	20	1
Clara Barton Pkwy - Cabin John / River Rd	56	65	10	59	65	6	50	45	-5	28	38	10
Cabin John / River Rd - W 270 Spur	62	64	2	62	64	2	56	36	-20	27	34	6
W Spur Beltway to Democracy Blvd	61	60	-1	60	60	0	52	46	-6	31	33	2
W Spur Democracy Blvd to Spur Merge	61	60	-1	60	60	0	53	57	3	36	37	1
E Spur Beltway to MD 187	59	60	1	59	57	-2	59	48	-11	55	41	-15
E Spur MD 187 to Spur Merge	62	60	-2	63	57	-5	62	53	-9	53	44	-9
Spur Merge - Montrose Rd	61	64	3	62	56	-6	60	50	-10	50	49	-1
Montrose Rd - MD 189	61	58	-3	61	56	-6	60	60	-1	55	56	1
MD 189 - Montgomery Ave	61	60	-1	62	57	-5	61	64	2	57	60	3
Montgomery Ave - Shady Grove Rd	60	60	0	58	58	0	60	59	-2	59	53	-6
Shady Grove Rd - I-370	62	60	-3	59	57	-2	62	56	-6	56	49	-6
Southbound / Outer Loop												
I-370 - Shady Grove Rd	63	49	-14	64	55	-9	64	54	-10	65	60	-5
Shady Grove Rd - Montgomery Ave	59	59	-1	65	60	-5	65	63	-2	65	64	-1
Montgomery Ave - MD 189	57	56	-1	62	61	-2	62	58	-5	62	58	-4
MD 189 - Montrose Rd	55	45	-10	63	51	-12	64	61	-2	64	62	-2
Montrose Rd - Spur Split	57	58	1	64	61	-3	64	62	-2	64	63	0
E Spur Split to MD 187	60	56	-4	62	58	-4	62	60	-2	61	60	-1
E Spur MD 187 to Beltway	61	54	-7	62	47	-15	59	53	-7	54	55	1
W Spur Split to Democracy Blvd	49	42	-7	60	49	-11	59	53	-6	53	53	0
W Spur Democracy Blvd to Beltway	42	44	2	61	51	-10	55	60	5	27	24	-3
W 270 Spur - Cabin John / River Rd	51	54	3	60	59	-1	54	45	-9	30	27	-3
Cabin John / River Rd - Clara Barton Pkwy	51	52	1	57	57	-1	51	49	-2	32	32	0
American Legion Bridge	56	54	-3	58	57	-1	55	47	-8	39	26	-13

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Table 5-6
I-495 / I-270 Subarea Model Speed Calibration by Time Period (Part 3 of 3)

Location	4:00 - 6:00 PM			6:00 - 7:00 PM			7:00 - 8:00 PM		
	INRIX	Model	Diff	INRIX	Model	Diff	INRIX	Model	Diff
Northbound / Inner Loop									
American Legion Bridge	13	12	-2	16	20	4	24	44	20
Clara Barton Pkwy - Cabin John / River Rd	14	16	3	19	29	9	38	44	6
Cabin John / River Rd - W 270 Spur	15	19	3	20	26	6	39	48	9
W Spur Beltway to Democracy Blvd	22	22	0	24	26	3	35	43	8
W Spur Democracy Blvd to Spur Merge	26	24	-2	25	24	-1	38	48	10
E Spur Beltway to MD 187	31	32	0	35	35	0	57	34	-23
E Spur MD 187 to Spur Merge	24	26	1	27	31	4	58	39	-19
Spur Merge - Montrose Rd	31	27	-4	33	32	-1	54	44	-11
Montrose Rd - MD 189	44	38	-6	44	38	-6	57	55	-2
MD 189 - Montgomery Ave	48	46	-1	46	37	-9	58	56	-2
Montgomery Ave - Shady Grove Rd	44	38	-6	38	28	-10	57	53	-4
Shady Grove Rd - I-370	36	35	-1	28	25	-3	53	39	-14
Southbound / Outer Loop									
I-370 - Shady Grove Rd	64	55	-9	64	61	-3	64	62	-2
Shady Grove Rd - Montgomery Ave	65	64	-1	65	64	-1	64	65	0
Montgomery Ave - MD 189	62	56	-5	62	59	-3	62	61	-1
MD 189 - Montrose Rd	64	62	-2	63	59	-4	63	61	-3
Montrose Rd - Spur Split	64	63	-1	64	61	-3	64	63	-1
E Spur Split to MD 187	61	60	-1	61	60	-1	61	60	-1
E Spur MD 187 to Beltway	41	40	-1	41	59	18	59	58	-1
W Spur Split to Democracy Blvd	51	47	-4	53	45	-7	60	58	-1
W Spur Democracy Blvd to Beltway	13	15	2	19	20	1	48	48	0
W 270 Spur - Cabin John / River Rd	17	14	-3	23	23	0	48	52	4
Cabin John / River Rd - Clara Barton Pkwy	21	17	-4	27	28	2	48	50	2
American Legion Bridge	29	33	4	38	30	-7	54	57	2

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5.2.3 Virginia Managed Lanes Conditions

In addition to checking modeled traffic volumes, speeds and travel patterns, CDM Smith ensured that the base year model was reasonably reflecting traffic, revenue, and shares of HOV3+ vehicles on the existing Virginia I-495 managed lanes. This calibration was to give confidence to the model's, especially the toll diversion algorithm's, ability to forecast traffic, revenue, and shares of HOV3+ vehicles on the Maryland I-495 and I-270 Managed Lanes Project, a similar and adjacent facility. CDM Smith's full toll diversion algorithm process is described in more detail in **Chapter 6.**

To obtain the toll rate data necessary for this calibration, CDM Smith used a query feature on the Virginia I-495 Express Lane website to estimate average weekday hourly toll rates between each origin-destination pair on the facility for the base year of analysis. This was used in the calibration process in combination with hourly traffic count data collected specifically for this study by a CDM Smith subconsultant, hourly transaction and HOV3+ share data obtained through a non-disclosure agreement with Transurban and the Virginia Department of Transportation, and publicly available Transurban quarterly trips and revenue data. The overall goal of the calibration was to achieve a similar base year average weekday revenue from the model as estimated from the data sources.

The target annual revenue for I-495 Express Lane calibration was estimated by deflating (considering inflation and an estimate of normal average growth) annual estimated 2019 revenue to 2017 base year levels. Annual 2019 revenue was estimated using the most recent available year-to-date 2019 revenue as shown previously in **Chapter 2.** Some adjustments were also made to the target revenue to account for minimum tolls for short distance trips not being accounted for in CDM Smith's modeling process. The target average weekday revenue was estimated by dividing the resulting 2017 annual revenue estimate obtained from the process described above by the revenue annualization factor assumed in the study (as discussed in **Chapter 6**). Using this methodology, a target base year 2017 average weekday revenue of about $275,000 was estimated for the study. The modeled revenue in the final calibration using base case toll diversion algorithm inputs (versus equity case inputs as described later in **Chapter 7**) was $255,000 or about seven percent lower than the actual. A lower than actual target was desirable to give a level of conservativeness to account for inherent uncertainty in the calibration process and data sources.

5.3 Future Year Transportation Improvement Assumptions

The integrated Visualize 2045 Long Range Transportation plan was reviewed to confirm all future regional transportation improvement projects that may have a significant impact on the I-495 and I-270 Managed lanes forecasts were included in the analysis. In addition to ensuring the projects were included, the different years of MWCOG model networks were reviewed to also confirm the correct timing of the projects was assumed. **Table 5-7** shows the significant projects identified, with projects in bold indicating CDM Smith edited the model networks to reflect these assumptions.

It is not included in **Table 5-7**, but the existing Virginia I-495 Express Lanes, which currently terminate north of the VA 167 interchange, were assumed to be extended north to the George Washington Parkway to connect with the Maryland I-495 and I-270 Managed Lane Project. The Virginia extension was assumed to open before the Maryland Project initial opening date.

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Table 5-7
Other Transportation Improvement Plan Projects of Significance for this Study
Projects Requiring Network Editing by CDM Smith are in Bold

Model Year Assumed	Route	Project	From	To
2015	I-395	Auxiliary lanes northbound	VA 236 (Duke St)	Seminary Rd
2015	I-395	HOV lanes revesible ramp at Seminary Rd	Seminary Rd	
2015	US 50	Widen to 6 lanes	VA 742 (Poland Rd)	VA 28
2015	**VA 123**	**Widen to 6 lanes**	**Fairfax County Pkwy**	**Braddock Rd**
2020	**I-395**	**Construct new southbound lane**	**N of VA 236 (Duke St)**	**S of VA 648 (Edsall Rd)**
2020	**US 1**	**Widen to 6 lanes**	**Telegraph Rd**	**VA 235 South**
2020	US 1	Widen to 6 lanes	VA 638	VA 636 (Featherstone Rd)
2020	**US 50**	**Widen/reconstruct 6 lanes and interchanges**	**ECL City of Fairfax**	**Arlington County Line**
2020	VA 123	Widen to 6 lanes	US 1	Annapolis Way
2020	**VA 123**	**Widen to 6 lanes**	**Hooes Rd**	**Fairfax County Pkwy**
2025	US 1	Widen to 6 lanes	Fuller Rd	Stafford County Line
2025	US 1	Widen to 6 lanes	Brady's Hill Rd	VA 234 (Dumfries Rd)
2025	VA 123	Widen to 8 lanes	VA 7	I-495
2025	I-66	Outside Beltway widen to 5 lanes (3 GP, 2 HOT)	I-495	US 15
2030	US 1	Widen to 6 lanes	VA 234 (Dumfries Rd)	Cardinal Dr / Neabsco Rd

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Chapter 6
Traffic and Revenue Analysis

This chapter presents a summary of the traffic and revenue analysis conducted for Phase 1 of the I-495 and I-270 Managed Lanes Project. This chapter starts with a list of assumptions upon which the traffic and revenue forecasts are based and details on the tolling concept and toll rate sensitivity analysis. Then, the results of the traffic and revenue analysis are provided in terms of selected toll rates, estimated volumes on the managed lanes at the tolling locations, and estimated weekday and annual toll transactions, toll trips, and gross toll revenue.

6.1 Basic Assumptions for Traffic and Revenue Analysis

Estimates of traffic and revenue for the proposed managed lanes are based on many assumptions, all of which are considered reasonable for purposes of this analysis. The assumptions are summarized in **Table 6-1**, organized by tolling and operations-related assumptions versus model assumptions.

Phase 1 of the I-495 and I-270 Managed Lanes are assumed to operate 24 hours a day. Passenger cars and commercial vehicles with 1 or 2 occupants would be allowed to access the managed lanes by paying a toll that varies dynamically to both maximize toll revenue and manage traffic to a maximum of 1,700 passenger car-equivalent vehicles per hour per lane. Tolls would be collected primarily via electronic high-speed toll collection (ETC). Vehicles without ETC transponders would be charged 1.5 times the ETC toll using a video-based toll. Passenger vehicles with 3 or more occupants, including buses and van pools, would be allowed into the managed lanes for free. Motorcycles would also be allowed for free. Light 2-axle commercial vehicles would be charged the same tolls as passenger cars. Heavier (3-axle or more) commercial vehicles would be permitted at all times but charged higher toll rates. The higher toll rates were based on toll rate multipliers for vehicles with more than 2 axles from the I-95 Express Toll Lane operated by the Maryland Transportation Authority.

Forecasts of traffic growth in the corridor are based on the MWCOG model. However, the future population and employment projections contained in the MWCOG model were reviewed and adjusted by Renaissance Planning Group (RPG), an independent economic subconsultant. These revised land use assumptions as discussed in **Chapter 4** were included in the MWCOG model to obtain revised estimates of future demand for the entire modelled region and more importantly the project corridor on I-495 and I-270. The revised estimates of demand in the project corridor were used to develop the traffic and revenue estimates summarized in this chapter.

The assumed share of HOV3+ vehicles in the model trip tables was calibrated to existing Virginia I-495 Express Lane performance. For Maryland, the share of HOV3+ was based on the share estimated as part of the MWCOG modeling methodology. The HOV3+ assumptions in Maryland do not include aggressive promotion of HOV3+ usage in Maryland in the future. The impact of higher HOV3+ shares in Maryland on the I-495 and I-270 Managed Lane Project are estimated as a sensitivity test in **Chapter 7.**

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Value of time for the tolling analysis was estimated through the application of the stated preference survey discussed in **Chapter 3**. The 2019 (in 2019 dollars) regional average value of time used in the analysis was $0.29 per minute for work trips and $0.26 per minute for non-work trips. Thus, each time period had a regional average value of time in between those two values, with peak hours closer to $0.29 and off-peak hours closer to $0.26. The value of time was applied in the model by first weighing the regional average by relative income of model traffic analysis zones (TAZs). Then the resulting value of time was converted to a matrix for each origin-destination pair by weighing for the number of households in each origin-destination pair. Value of time for vehicles with two or more occupants and light 2-axle trucks was assumed to be 20 percent higher than the single occupant drivers. Trucks with 3 or more axles were assumed to have an average value of time 3.7 times higher than the single occupant value of time.

An annual escalation factor was used to estimated future year value of time. Based on an analysis of past real income growth and on forecasts of real income growth for the D.C. region, an escalation factor of 0.75 percent per year was used to estimate future value of time. In addition to value of time, value of reliability and travel time weight factors were also applied in the toll analysis as explained later in this chapter.

An annualization factor was assumed to convert the average weekday model results to annual results. The annualization factor was assumed to be 270 equivalent weekdays for passenger car revenue and 295 days for passenger car transactions. This is based on observed factors from the existing Virginia I-495 Express Lanes. Commercial vehicles were assumed to have lower values: 260 for revenue and 280 for transactions. A ramp up factor of 0.80 was applied for the first year after opening (2027) and 0.90 for the second year (2028).

Table 6-1

Base Assumptions used for I-495 and I-270 Managed lanes Traffic and Toll Revenue Estimates

Tolling and Operations Assumptions – Base	
Hours of Operations	24 hours a day, 7 days a week. Assumes no reversible operations.
Opening Date	Phase 1 assumed to open January 1, 2027.
Horizon Date	The final year of the P3 concession is assumed to be 2071.
Number of Manged Lanes	Generally two new manged lanes in each direction on I-495. On I-270 the existing HOV lanes will be used for one of the two new managed lanes per direction. This corresponds to the Alternative 9 NEPA Configuration.
Managed Lane Configuration	Phase 1 of the project is from GW Parkway/ALB on I-495 to I-370 on I-270 and also includes the I-270 East Spur. See the schematics in **Chapter 1**.

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Toll Collection Methods	Tolls will be collected by transponder and video payment methods. Transponders will be lively marketed and widely available. Unregistered and pre-registered video tolling will be available to motorists who do not have a transponder. The non-ETC collection methods used by Transurban for the Virginia I-495 NEXT Managed lanes are assumed to be similar enough to Maryland video tolling policies so no special tolling policies need to be applied at the toll gantries near the Virginia-Maryland border to account for differences.
Eligible Tolled Traffic	Passenger vehicles and light commerical trucks (collectively identified as "PCs" in this report) will be allowed to use the managed lanes during all time periods. Medium and heavy trucks with three or more axles (identified as "CVs" in this report) will be allowed to use the managed lanes at proportionately higher toll rates during all time periods.
HOV/Motorcycles	HOV3+ and motorcycles free. HOV3+ must use a switchable transponder to be eligible for free travel. Motorcycles are accounted for in a post-processing free traffic adjustment.
Transit	Public transit and school buses free. Also "over-the-road" (for example Greyhound) buses would also be free per Federal Regulations. All are accounted for in a post-processing free traffic adjustment.
Other Free Traffic Usage	Active emergency responders including state and federal law enforcement, tow trucks responding to incidents in lanes, developer maintenance vehicles, Maryland national guard when traveling to or returning from duty.
Discount Programs	None.
Input Transponder Market Penetration Rate	85 percent of the trip tables will be able to obtain a transponder in the 2025 model year. The 2035 and later model years assume a 90 percent share.
Minimum Toll	Minimum toll is set to approximately $0.20 per mile (in 2019 dollars).
Toll Caps	None.
Tolling Objective	Revenue maximization through the use of Dynamic Tolling. The unregisterd video toll will be 1.5 times the transponder/ETC toll. The pre-registerd video toll (assumed to be 15% of all video transactions) will be 1.25 times the transponder/ETC toll. The CV tolls will have the same mutlipliers as the existing I-95 Express Toll Lanes in Baltimore, Maryland with adjustments to account for the lastest MDTA toll schedule changes.
Managed Lanes Minimum Speed Threshold	45 mph which corresponds to a maximum traffic of approximately 1,700 passenger car equivalent vehicles per hour per lane in the T&R analysis.

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Free Flow Speeds	Free flow speeds in the managed lanes input network were coded at 5 mph higher than the general purpose lane speeds.
Model Input Assumptions - Base	
Trip Table Growth	Estimated using base-case independent socioeconomic forecasts applied to full MWCOG model runs. HOV3+ trip table growth in the MWCOG model was compared with the SOV and HOV2 growth. The amount of HOV3+ growth that was higher than SOV and HOV2 growth was cut in half. The removed trips were distributed proportionally into the SOV and HOV2 trip tables.
Socioeconomic Forecasts	Independent socioeconomic forecasts
Highway Improvements	Other improvements to the present highway and local road system in the travel corridor will be limited to those included in readily available regional and local transportation improvement program summaries, including the Visualize 2045 LRTP, with no other competing facilities, or capacity expansions other than those documented, occurring during the forecast period. The most relevant highway improvements identified for this study are the I-495 Virginia Managed lanes northern extension and the I-270 ICM improvements, both of which are assumed to open before the Maryland Phase 1 priced managed lanes project.
Value of Time (VOT)	VOT for single occupant vehicles (SOV) is based on the stated preference survey. VOT for light commercial vehicles and multiple occupant PCs is 1.2 times the SOV PC VOT. VOT for medium or heavy commercial vehicles is assumed to be 3.7 times the SOV PC VOT.
Value of Reliability	Applied as coefficient of variation (standard deviation divided by mean travel time) on modeled travel time by time period to reflect additional willingness to pay to improve travel time reliability.
Real increase in VOT	0.75 percent per year.
Travel Time Weight Factor	S curve with a maximum factor of 1.55 applied in the model tolling algorithm to reflect additional value of users of managed lanes beyond value of time and value of reliability. The factor used is calibrated to existing VA I-495 Express Lane performance.
Revenue Adjustments	No adjustments for leakage, fines, fees, or other income are applied. Gross toll revenue estimates are provided.
Annualization Factors	Revenue = 270 average weekdays for PCs and 260 for CVs; Transactions = 295 average weekdays for PCs and 280 for CVs.
Ramp Up Factors	A factor of 0.8 was applied to the first year and 0.9 to the second year.
2060 Model	Used 2045 MWCOG Travel Demand Model network, 2060 socioeconomic forecasts

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Growth Beyond 2060	Systemwide total annual transactions and revenue growth rates are assumed to taper to about 76 percent of the 2059 to 2060 growth rates by 2071.
Long-Term Trends	• No major recession at the local or national level will occur to significantly disrupt the long-range pattern of future growth in traffic and revenue. • Over the long term, motor fuel will remain in adequate supply, with no unexpected or substantial increases in fuel prices other than those due to seasonal or inflationary causes, throughout the forecast period.
Acts of God	• No natural disasters will occur that could significantly alter travel patterns in and through the area. • No local, regional, or national emergency will arise that would abnormally restrict the use of motor vehicles.

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6.1.1 Value of Reliability

Driver's value of reliability (having more predictable travel times) has been estimated in other studies to be approximately equal to the value of time. However, the value of reliability is only applied to the standard deviation of the travel time distribution. The 2017 interior weekday speed data for I-495 and I-270 was used to calculate the standard deviation of the average travel time for traveling different segments of the study corridor. The reliability factor (which would be defined as the coefficient of variation in statistics) was then calculated as the standard deviation divided by average travel time. Higher factors indicate less reliability and lower factors indicate more reliability. Reliability factors for each of the 13 modelled time periods were calculated for each major segment in the corridor, as well as for the I-495 general purpose lanes in Virginia that run parallel to the existing I-495 Express Lanes. Factors ranged from less than 1 percent overnight to as much as 68 percent (in the PM peak on the I-270 West Spur). Generally, the peak period peak direction reliability factors were between 20 and 30 percent.

The base estimated travel time for the general purpose lanes on I-495 and I-270 was factored using the reliability factor to estimate the additional amount of variability in travel time for which drivers would be willing to pay. If a trip were to take 20 minutes, a reliability factor of 15 percent would add 3 minutes to the trip. The value of reliability could then be applied to estimate the value of the additional 3 minutes to drivers. Since the value of reliability is assumed to be approximately equal to the value of time, this calculation can be simplified by factoring the estimated travel time on the general purpose lanes by the applicable reliability factor to estimate the number of minutes associated with the unreliability. When the minutes associated with unreliability are summed with the base estimated travel time savings, this total travel time savings is then used in the diversion calculations to estimate the share of drivers that that would be willing to pay a toll on the managed lanes.

6.1.2 Travel Time Weight Factor

When calibrating to base year Virginia I-495 Express Lane performance as described previously in **Chapter 5**, the value of time and value of reliability were observed to not fully capture the value of the I-495 Express Lanes versus the general purpose lanes when comparing model results with actual facility performance. Another factor, called the travel time weight factor, was applied to more fully capture the value of using the managed lanes. This type of factor has been used by CDM Smith on other projects including when using the Florida Department of Transportation Express Lane Time of Day model. For this project the factor was adjusted to achieve the level of calibration of the I-495 Express Lanes described in **Chapter 5.** The factor was assumed to capture the additional value drivers are observed to place on traveling in the managed lanes compared to heavily traveled or congested general purpose lanes. This may include driver's perception that general purpose lane congestion and delay is worse than it actually is.

The travel time weight factor was applied using an S-curve function by volume to capacity ratio. At low volume to capacity ratios the travel time weight factor was 1.0[1]. The travel time weight factor increased from 1.0 to about 1.05 at volume to capacity ratios between 0.4 and 0.6. Between volume to capacity ratios of 0.6 to 0.8 the factor increased rapidly to a maximum of 1.55. Thus, at

[1] The factor is multiplicative, so a factor of 1.0 translates to no effect on perceived travel time.

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a volume to capacity ratio of 0.8 or higher, a trip of 20 minutes would be weighted to a perceived 31 minutes (20 times 1.55) by a driver considering whether to travel on the managed lanes or general purpose lanes. The additional time saving perceived due to the travel time weight factor was applied in the toll diversion algorithm.

6.2 Toll Concept and Toll Rate Analysis

It is assumed that the I-495 and I-270 Managed lanes would be operated under a dynamic toll-setting algorithm that adjusts the toll rates based on measured speeds and/or traffic densities. The use of dynamic pricing aims to ensure that the I-495 and I-270 Managed Lanes operate at free-flowing conditions. It is assumed that toll rates would be set to maximize toll revenue, while ensuring that volume in the managed lanes is not more than 1,700 passenger car-equivalent vehicles per hour per lane.

6.2.1 Segment-Based Tolling

Under the tolling concept assumed for the I-495 and I-270 corridors, a vehicle would be charged a toll for travel within each segment. The tolling locations are depicted in **Figures 1-2 to 1-4** in **Chapter 1** of this report. The per-mile toll rates used in the toll sensitivity analysis were converted into toll charges for each segment by multiplying the per-mile rates by the segment distance. It was also assumed that any trip would pay a minimum of $0.20 per mile.

6.2.2 Toll Sensitivity Analysis

A wide range of typical toll rates were tested to develop toll sensitivity curves and identify traffic and revenue at different toll rate levels. Toll sensitivity curves were developed by running the subarea network toll model at a range of per mile toll rates and assembling toll transactions and revenue for each tolling location, analysis period, travel direction, and analysis year. A selection of the toll sensitivity curves for model year 2025 are shown in **Figure 6-1** through **Figure 6-4** for northbound in the AM peak, southbound in the AM peak, northbound in the PM peak, and southbound in the PM peak, respectively. All toll rates shown are in 2019 dollars and are not adjusted for inflation.

In each figure, transactions and toll revenue by tolling location are shown. The range of toll rates tested are shown along the x-axis. These curves were used to select the initial toll rates for each tolling segment and modeled time period, based on the assumed pricing policy of maximizing toll revenue, while ensuring volume on the I-495 and I-270 Managed Lanes is no higher than 1,700 passenger car-equivalent vehicles per hour per lane. The final chosen toll rates for each tolling location are shown with a dot on each figure. It should be reinforced that the toll sensitivity curves shown are results of running the model with the same per mile toll rate at each tolling location. For example, when a rate of $0.50 per mile is tested, it is tested across all the tolling locations at once. Once the curves are examined for each tolling location, specific toll rates at each tolling location are selected that maximize toll revenue while ensuring that the toll rate chosen also manages total traffic to 1,700 passenger car-equivalent vehicles per hour per express lane. The model is then run again with the "composite" set of selected toll rates at each tolling location. This composite run will then have differences in volumes and revenue when compared to the toll sensitivity curve which assumed the same per mile toll rate at each tolling location. In some cases corresponding to toll gantries of high managed lane utilization, the composite set of toll rates

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needs to be adjusted to managed total traffic to 1,700 passenger car-equivalent vehicles per hour per managed lane.

Similar curves were generated for nine tolling locations[2] and two directions, in each of the 13 model time periods, and for four model years (2025, 2035, 2045, and 2060). A total of 936 revenue curves (9 locations * 2 directions * 13 time periods * 4 model years) were used to aid in selecting revenue maximizing toll rates for these forecasts.

Figure 6-1 displays the 2025 toll sensitivity analysis for the northbound AM peak hours. Four of the tolling locations are arranged from southernmost (left) to northernmost (right), with the revenue curves shown on top and the transaction curves shown on the bottom. Three curves are shown, covering 6:00 AM-7:00 AM, 7:00 AM-9:00 AM, and 9:00 AM-10:00 AM. A dot is shown at the selected toll for each segment. Note that the revenue and transactions per hour are shown to make the 7:00-9:00 period directly comparable to the other two periods. As is the typical approach by CDM Smith in toll studies, a toll rate slightly lower than the absolute revenue-maximizing toll was selected to add a degree of conservativeness to the results.

Figure 6-2 displays the 2025 toll sensitivity analysis at the same four locations for the southbound direction in the AM peak hours. The same layout is used as was shown for the northbound diagrams. On I-495 near the Virginia border, (the first graphs) the northbound (inner loop) revenue maximizing toll rates are generally a little higher than their corresponding southbound (outer loop) rates; this is consistent with relative congestion levels on this portion of I-495 which are more severe on the inner loop during most times of the day. However, on I-270 (the third and fourth graphs) the southbound revenue maximizing toll rates are substantially higher in the AM period than the northbound rates, consistent with the peak direction being southbound, towards Washington DC. On I-495 near I-270 (the second graph), the northbound and southbound revenue maximizing toll rates are about the same, with those two effects offsetting each other.

Figures 6-3 and **6-4** show, respectively, the PM period northbound and southbound toll sensitivity analysis results for 2025. As in the AM, northbound revenue maximizing rates are higher than southbound on I-495, but on I-270, the PM rates exhibit the reverse behavior of the AM, with northbound higher than southbound; when comparing AM and PM peaks, traffic on I-270 exhibits a more traditional directional imbalance, because one direction is clearly towards Washington DC. I-495, on the other hand, has less of clear peak direction. Congestion occurs in both directions to some extent, but on this corridor, the inner loop experiences more severe delays at most times. Thus, in the PM period, northbound rates are higher than southbound rates throughout the project corridor.

[2] There are 8 tolling locations for the project, plus CDM Smith maximized revenue for an additional tolling zone representing the extension of the Virginia I-495 Express Lanes to the American Legion Bridge, to more accurately reflect toll levels at the edge of the project. Revenue for that location is not included in the Maryland project forecasts.

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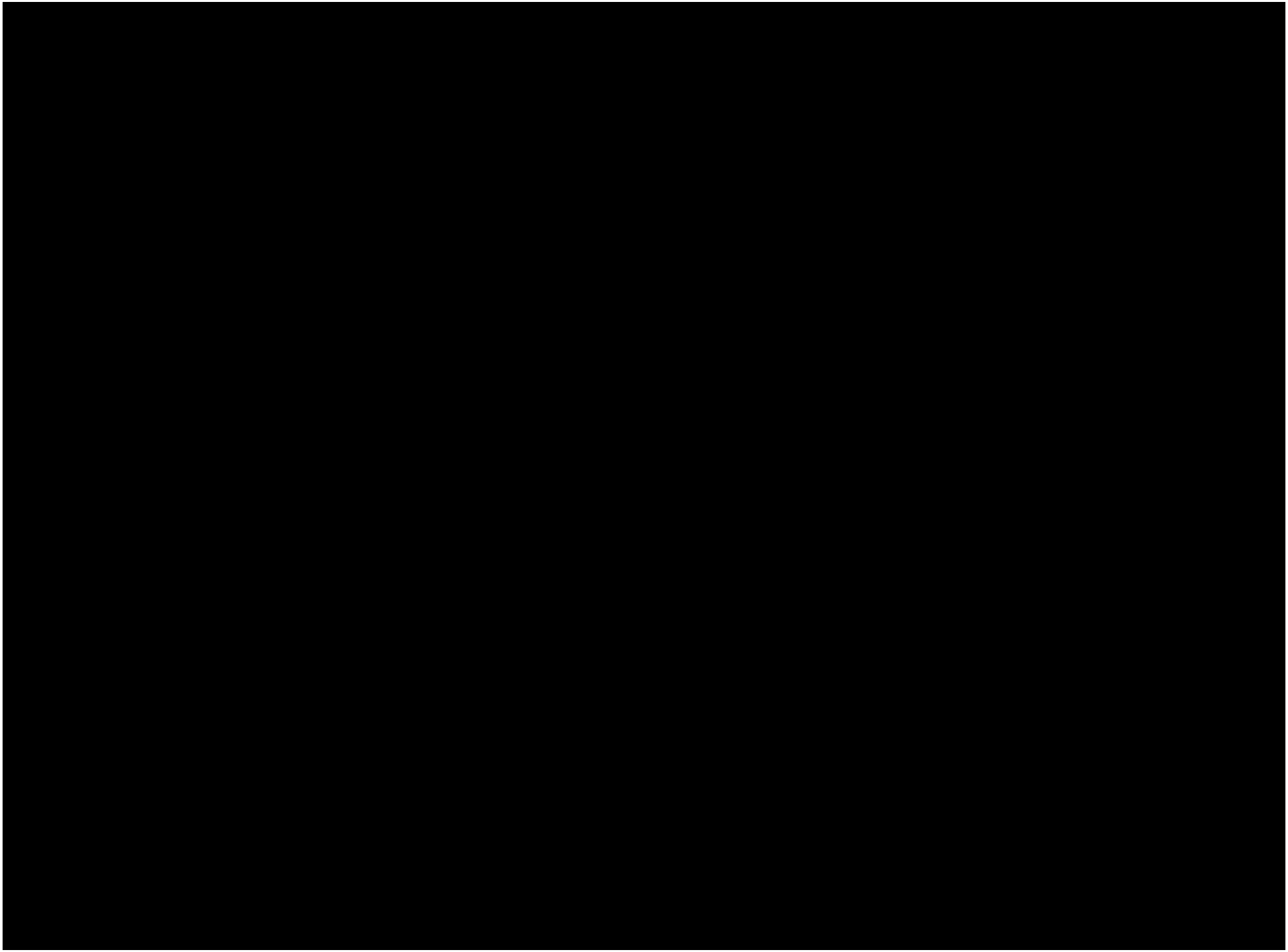

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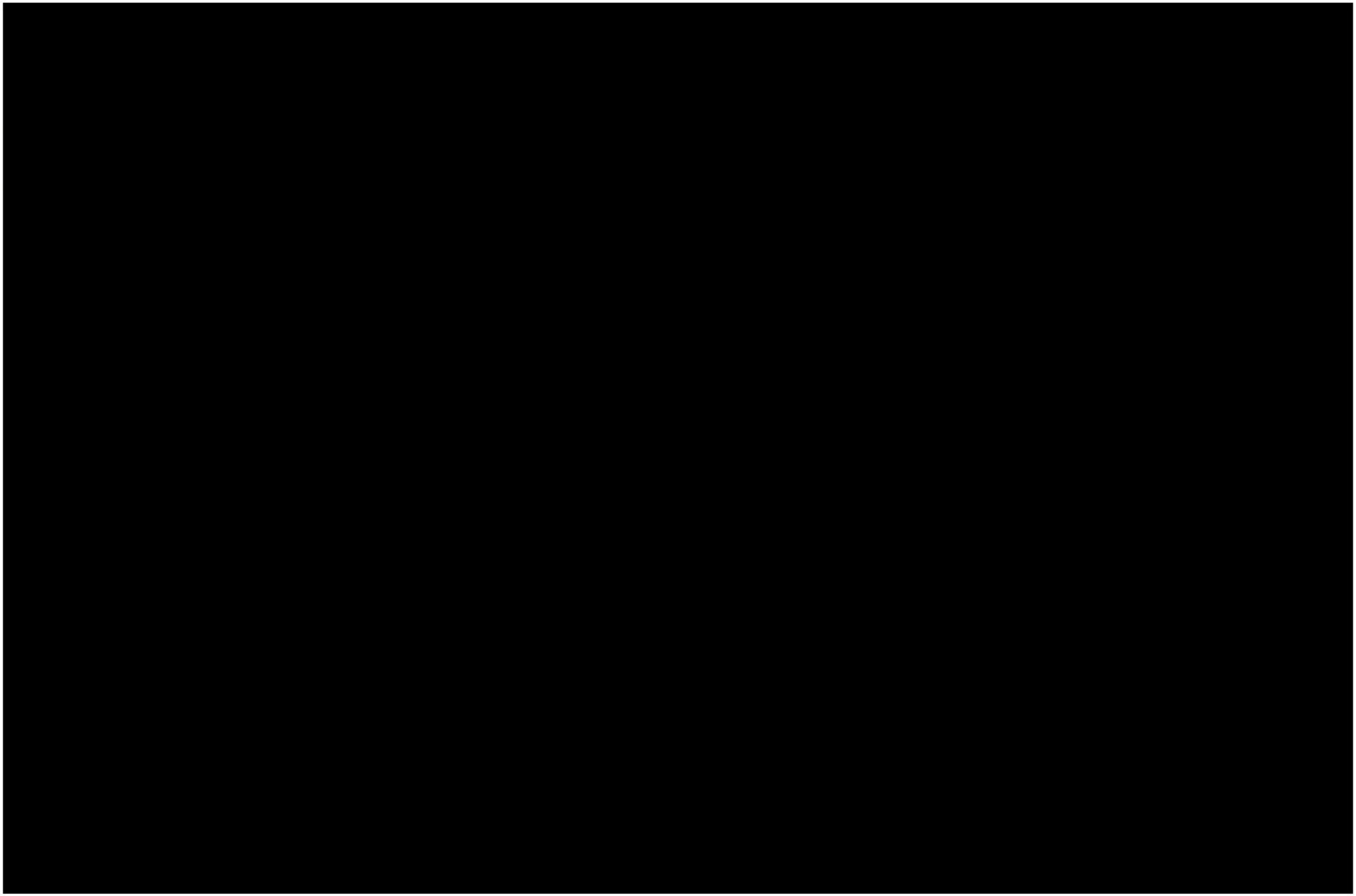

Figure 6-2

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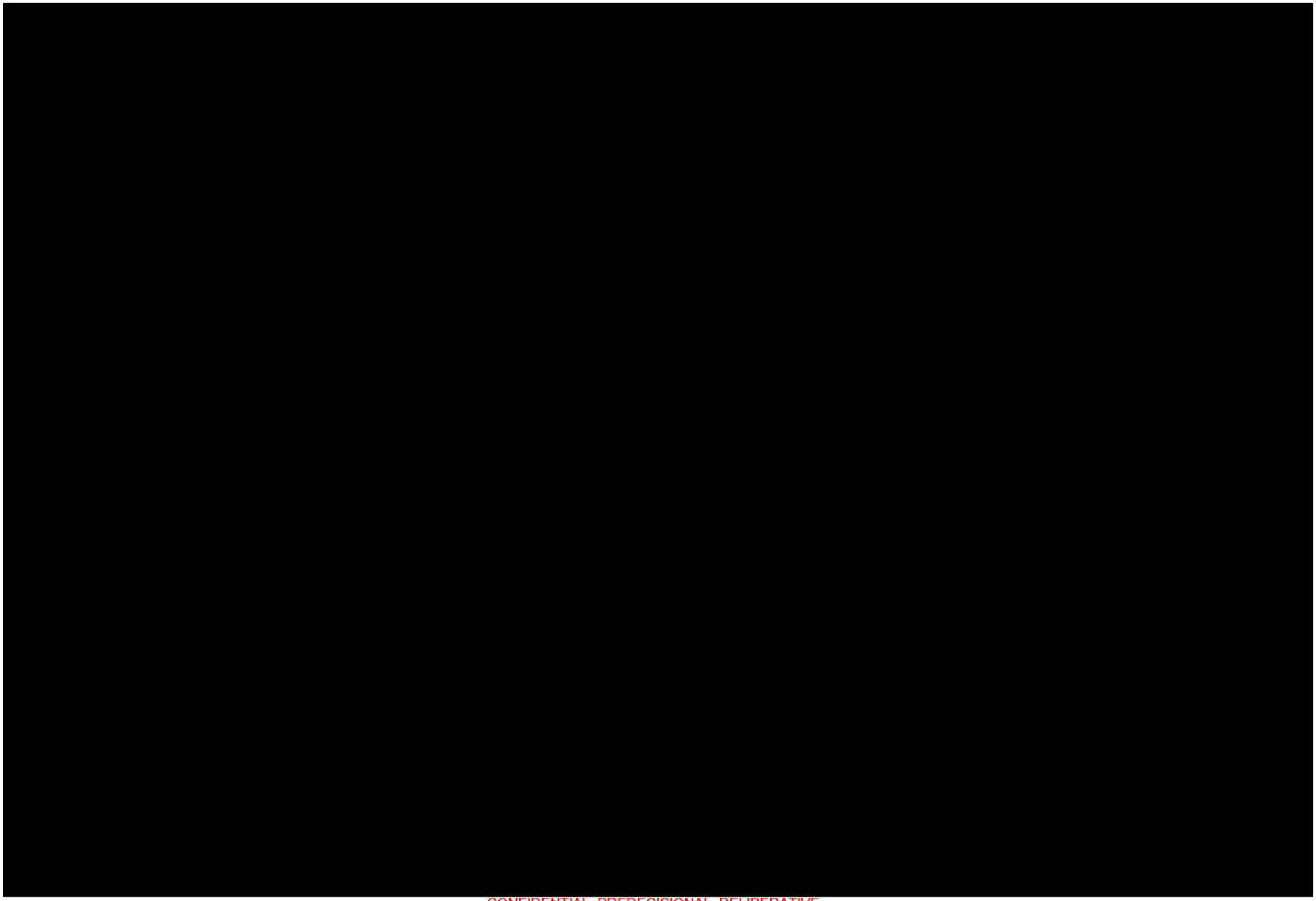

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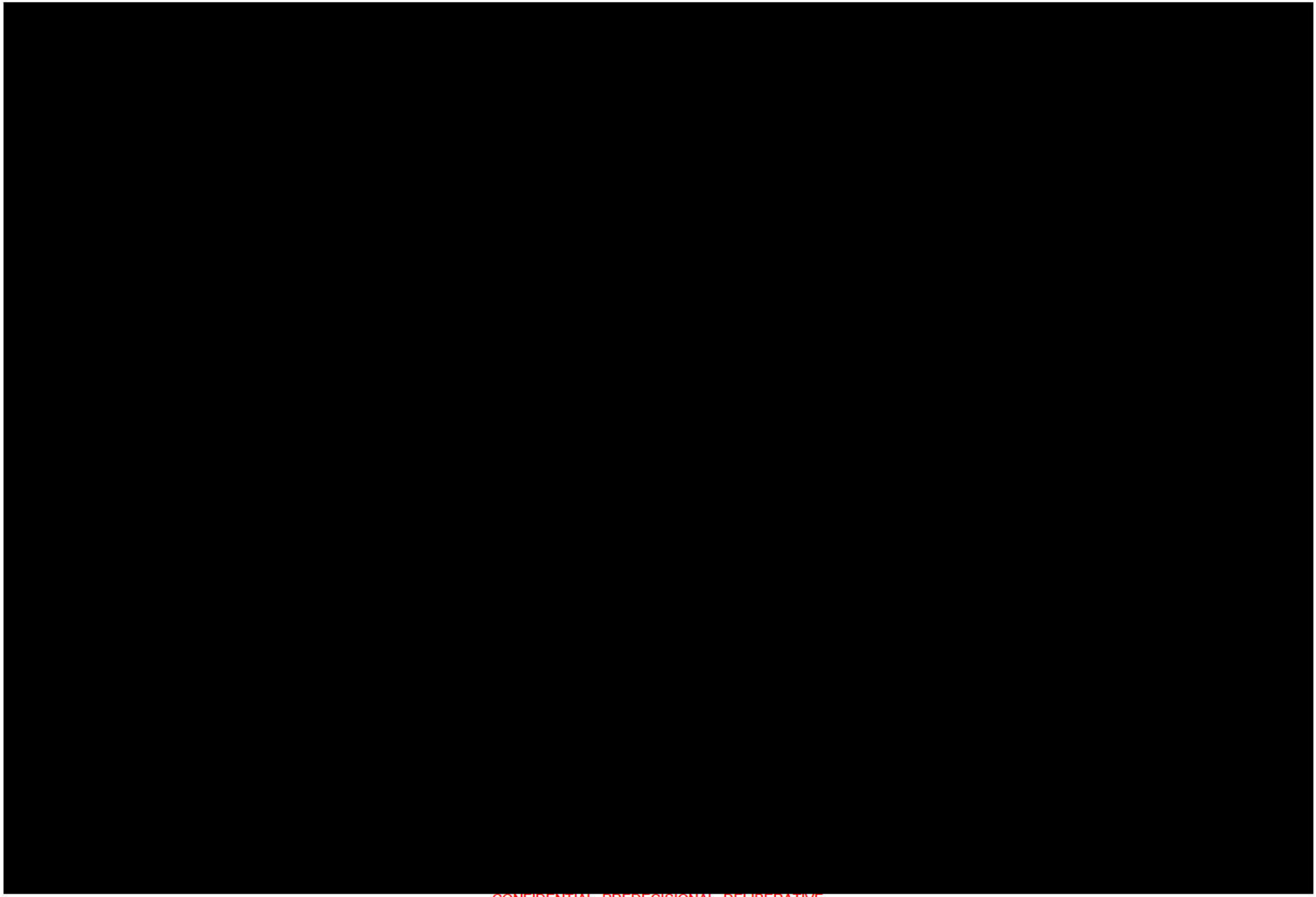

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6.2.3 Selected Tolls

The selected per-mile tolls for modeled years 2025, 2035 and 2045, all analysis time periods, and for each tolling location are shown in **Table 6-2** through **Table 6-4**. All tolls are shown in 2019 dollars; therefore, any rate increase shown in these tables reflect real increases due to increased demand, congestion, the need to manage demand to 1,700 passenger car-equivalent vehicles per hour per express lane, and real increases assumed in value of time.

The tables show that tolls are expected to increase significantly through the forecasting horizon. The highest per-mile tolls are generally paid from 4:00 – 6:00 PM in the northbound direction near the American Legion Bridge. These tolls increase by about 50% over 20 years, from $2.10 per mile in the year 2025 forecast to $3.65 per mile in the year 2045 forecast (both figures in 2019 dollars).

6.3 Estimated Average Weekday Traffic and Market Share

Table 6-5 through **Table 6-7** shows the forecasted weekday traffic volumes in thousands on the I-495 and I-270 Managed lanes at each tolling location, the parallel general purpose lanes, and a market share of express lane traffic as a percentage of total highway cross-section traffic at each location, for 2025, 2035 and 2045.

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Table 6-2

I-495 / I-270 Managed Lanes Base Scenario 2025 Per Mile Passenger Car ETC Toll Rates by Direction, Time Period, and Segment (2019 Dollars)

2025 Base Passenger Car ETC Per Mile Toll Rates		5:00 - 6:00 AM	6:00 - 7:00 AM	7:00 - 9:00 AM	9:00 - 10:00 AM	10:00 AM - Noon	Noon - 2:00 PM	2:00 - 3:00 PM	3:00 - 4:00 PM	4:00 - 6:00 PM	6:00 - 7:00 PM	7:00 - 8:00 PM	8:00 PM - Midnight	Midnight - 5:00 AM
Northbound / Inner Loop														
24	VA Slip ramps - GW Mem Pkwy	$0.20	$0.70	$1.35	$0.90	$0.35	$0.35	$0.95	$1.10	$2.15	$2.10	$0.75	$0.20	$0.20
1	GW Mem Pkwy - Persimmon Tree Rd	$0.20	$0.70	$1.25	$0.75	$0.35	$0.35	$0.85	$1.05	$2.10	$2.05	$0.70	$0.20	$0.20
2	Persimmon Tree Rd - River Rd	$0.20	$0.85	$1.25	$0.75	$0.35	$0.30	$0.85	$1.05	$2.10	$2.05	$0.70	$0.20	$0.20
3	River Rd - MD 187	$0.20	$0.70	$0.90	$0.60	$0.35	$0.25	$0.90	$1.00	$1.15	$1.70	$0.70	$0.20	$0.20
19	River Rd - Westlake Ter via W Spur	$0.20	$0.85	$0.80	$0.35	$0.20	$0.30	$0.60	$0.95	$1.85	$1.55	$0.55	$0.20	$0.20
20	I-270 E Spur I-495 to Y Split	$0.20	$0.20	$0.20	$0.20	$0.20	$0.20	$0.25	$0.35	$0.70	$0.80	$0.45	$0.20	$0.20
21	I-270 Y-Split - Wootton Pkwy	$0.20	$0.30	$0.35	$0.35	$0.20	$0.20	$0.50	$0.80	$1.35	$1.35	$0.50	$0.20	$0.20
22	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.20	$0.30	$0.30	$0.20	$0.30	$0.40	$0.70	$1.30	$1.35	$0.50	$0.20	$0.20
23	I-270 Gude Dr - I-370	$0.20	$0.20	$0.30	$0.35	$0.20	$0.35	$0.50	$0.80	$1.30	$1.45	$0.55	$0.20	$0.20
Southbound / Outer Loop														
124	VA Slip ramps - GW Mem Pkwy	$0.20	$0.30	$0.80	$0.75	$0.30	$0.20	$0.40	$0.80	$1.25	$0.95	$0.35	$0.20	$0.20
101	GW Mem Pkwy - Persimmon Tree Rd	$0.35	$0.75	$0.80	$0.75	$0.35	$0.35	$0.40	$0.85	$1.15	$0.90	$0.30	$0.20	$0.20
102	Persimmon Tree Rd - River Rd	$0.35	$0.70	$0.80	$0.75	$0.35	$0.35	$0.45	$0.85	$1.15	$0.90	$0.35	$0.20	$0.20
103	River Rd - MD 187	$0.30	$0.45	$0.60	$0.70	$0.35	$0.25	$0.55	$0.85	$1.20	$0.90	$0.30	$0.20	$0.20
119	River Rd - Westlake Ter via W Spur	$0.25	$0.65	$0.90	$0.80	$0.35	$0.35	$0.35	$0.60	$0.95	$0.75	$0.20	$0.20	$0.20
120	I-270 E Spur I-495 to Y Split	$0.20	$0.45	$0.80	$0.80	$0.25	$0.20	$0.20	$0.20	$0.30	$0.20	$0.20	$0.20	$0.20
121	I-270 Y-Split - Wootton Pkwy	$0.20	$0.55	$0.95	$0.85	$0.35	$0.30	$0.25	$0.35	$0.45	$0.50	$0.20	$0.20	$0.20
122	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.55	$1.10	$1.00	$0.35	$0.35	$0.30	$0.30	$0.35	$0.40	$0.20	$0.20	$0.20
123	I-270 Gude Dr - I-370	$0.20	$0.60	$1.15	$1.00	$0.35	$0.35	$0.25	$0.25	$0.35	$0.35	$0.20	$0.20	$0.20

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Table 6-3

I-495 / I-270 Managed Lanes Base Scenario 2035 Per Mile Passenger Car ETC Toll Rates by Direction, Time Period, and Segment (2019 Dollars)

2035 Base Passenger Car ETC Per Mile Toll Rates		5:00 - 6:00 AM	6:00 - 7:00 AM	7:00 - 9:00 AM	9:00 - 10:00 AM	10:00 AM - Noon	Noon - 2:00 PM	2:00 - 3:00 PM	3:00 - 4:00 PM	4:00 - 6:00 PM	6:00 - 7:00 PM	7:00 - 8:00 PM	8:00 PM - Midnight	Midnight - 5:00 AM
Northbound / Inner Loop														
24	VA Slip ramps - GW Mem Pkwy	$0.20	$0.80	$1.55	$0.95	$0.40	$0.35	$1.10	$1.40	$2.80	$2.50	$0.85	$0.20	$0.20
1	GW Mem Pkwy - Persimmon Tree Rd	$0.20	$0.75	$1.50	$0.80	$0.35	$0.35	$1.00	$1.35	$2.70	$2.45	$0.80	$0.20	$0.20
2	Persimmon Tree Rd - River Rd	$0.20	$0.85	$1.45	$0.75	$0.35	$0.35	$1.10	$1.35	$2.70	$2.45	$0.80	$0.20	$0.20
3	River Rd - MD 187	$0.20	$0.80	$1.15	$0.70	$0.35	$0.30	$1.10	$1.15	$1.15	$1.80	$0.80	$0.20	$0.20
19	River Rd - Westlake Ter via W Spur	$0.20	$0.85	$0.90	$0.45	$0.30	$0.35	$0.70	$1.25	$2.20	$1.90	$0.70	$0.20	$0.20
20	I-270 E Spur I-495 to Y Split	$0.20	$0.20	$0.20	$0.20	$0.20	$0.20	$0.30	$0.40	$0.75	$0.95	$0.55	$0.20	$0.20
21	I-270 Y-Split - Wootton Pkwy	$0.20	$0.35	$0.40	$0.35	$0.20	$0.35	$0.55	$1.05	$1.75	$1.80	$0.60	$0.20	$0.20
22	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.30	$0.35	$0.35	$0.20	$0.35	$0.50	$0.95	$1.70	$1.85	$0.60	$0.20	$0.20
23	I-270 Gude Dr - I-370	$0.20	$0.20	$0.35	$0.35	$0.20	$0.35	$0.55	$1.00	$1.70	$1.85	$0.65	$0.30	$0.20
Southbound / Outer Loop														
124	VA Slip ramps - GW Mem Pkwy	$0.20	$0.35	$1.10	$0.95	$0.35	$0.30	$0.50	$1.05	$1.40	$1.10	$0.40	$0.20	$0.20
101	GW Mem Pkwy - Persimmon Tree Rd	$0.35	$0.90	$1.15	$0.95	$0.40	$0.35	$0.50	$1.05	$1.35	$1.05	$0.35	$0.20	$0.20
102	Persimmon Tree Rd - River Rd	$0.35	$0.95	$1.15	$0.95	$0.45	$0.35	$0.50	$1.05	$1.35	$1.05	$0.35	$0.20	$0.20
103	River Rd - MD 187	$0.35	$0.55	$0.80	$0.75	$0.35	$0.35	$0.60	$0.95	$1.35	$0.95	$0.40	$0.20	$0.20
119	River Rd - Westlake Ter via W Spur	$0.30	$0.85	$1.25	$0.95	$0.45	$0.35	$0.40	$0.70	$1.15	$0.95	$0.30	$0.20	$0.20
120	I-270 E Spur I-495 to Y Split	$0.20	$0.55	$1.05	$0.90	$0.35	$0.30	$0.20	$0.20	$0.35	$0.20	$0.20	$0.20	$0.20
121	I-270 Y-Split - Wootton Pkwy	$0.20	$0.70	$1.20	$1.00	$0.40	$0.35	$0.35	$0.40	$0.55	$0.70	$0.20	$0.20	$0.20
122	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.75	$1.35	$1.15	$0.45	$0.35	$0.35	$0.35	$0.40	$0.45	$0.20	$0.20	$0.20
123	I-270 Gude Dr - I-370	$0.20	$0.75	$1.45	$1.15	$0.45	$0.35	$0.35	$0.35	$0.35	$0.35	$0.20	$0.20	$0.20

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Table 6-4

I-495 / I-270 Managed Lanes Base Scenario 2045 Per Mile Passenger Car ETC Toll Rates by Direction, Time Period, and Segment (2019 Dollars)

2045 Base Passenger Car ETC Per Mile Toll Rates		5:00 - 6:00 AM	6:00 - 7:00 AM	7:00 - 9:00 AM	9:00 - 10:00 AM	10:00 AM - Noon	Noon - 2:00 PM	2:00 - 3:00 PM	3:00 - 4:00 PM	4:00 - 6:00 PM	6:00 - 7:00 PM	7:00 - 8:00 PM	8:00 PM - Midnight	Midnight - 5:00 AM
Northbound / Inner Loop														
24	VA Slip ramps - GW Mem Pkwy	$0.20	$0.85	$1.70	$1.00	$0.40	$0.35	$1.35	$1.70	$3.25	$2.75	$1.00	$0.30	$0.20
1	GW Mem Pkwy - Persimmon Tree Rd	$0.20	$0.80	$1.60	$0.85	$0.40	$0.35	$1.30	$1.65	$3.65	$2.70	$0.95	$0.30	$0.20
2	Persimmon Tree Rd - River Rd	$0.20	$0.85	$1.60	$0.90	$0.40	$0.35	$1.30	$1.65	$3.65	$2.70	$0.95	$0.30	$0.20
3	River Rd - MD 187	$0.20	$0.80	$1.15	$0.75	$0.40	$0.35	$1.30	$1.25	$1.30	$1.80	$0.90	$0.20	$0.20
19	River Rd - Westlake Ter via W Spur	$0.20	$0.85	$0.90	$0.45	$0.35	$0.35	$0.90	$1.55	$2.60	$2.30	$0.85	$0.35	$0.20
20	I-270 E Spur I-495 to Y Split	$0.20	$0.20	$0.20	$0.20	$0.20	$0.30	$0.35	$0.45	$0.85	$1.05	$0.60	$0.20	$0.20
21	I-270 Y-Split - Wootton Pkwy	$0.20	$0.45	$0.45	$0.35	$0.30	$0.35	$0.75	$1.40	$2.15	$2.10	$0.70	$0.25	$0.20
22	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.30	$0.35	$0.35	$0.30	$0.35	$0.60	$1.20	$2.15	$2.20	$0.75	$0.30	$0.20
23	I-270 Gude Dr - I-370	$0.20	$0.25	$0.35	$0.35	$0.35	$0.40	$0.70	$1.30	$2.20	$2.25	$0.80	$0.35	$0.20
Southbound / Outer Loop														
124	VA Slip ramps - GW Mem Pkwy	$0.20	$0.45	$1.50	$1.15	$0.40	$0.35	$0.55	$1.15	$1.70	$1.25	$0.50	$0.20	$0.20
101	GW Mem Pkwy - Persimmon Tree Rd	$0.35	$1.15	$1.50	$1.15	$0.55	$0.35	$0.55	$1.15	$1.65	$1.20	$0.40	$0.20	$0.20
102	Persimmon Tree Rd - River Rd	$0.35	$1.15	$1.50	$1.15	$0.55	$0.40	$0.55	$1.15	$1.65	$1.20	$0.40	$0.20	$0.20
103	River Rd - MD 187	$0.35	$0.65	$1.00	$0.90	$0.45	$0.35	$0.75	$1.15	$1.65	$1.15	$0.50	$0.20	$0.20
119	River Rd - Westlake Ter via W Spur	$0.35	$0.95	$1.60	$1.25	$0.60	$0.45	$0.55	$0.85	$1.25	$1.00	$0.35	$0.20	$0.20
120	I-270 E Spur I-495 to Y Split	$0.20	$0.60	$1.30	$1.10	$0.35	$0.35	$0.25	$0.20	$0.35	$0.20	$0.20	$0.20	$0.20
121	I-270 Y-Split - Wootton Pkwy	$0.30	$0.85	$1.55	$1.20	$0.50	$0.40	$0.35	$0.50	$0.60	$0.80	$0.30	$0.20	$0.20
122	I-270 Wootton Pkwy - Gude Dr	$0.25	$0.95	$1.70	$1.35	$0.55	$0.40	$0.35	$0.40	$0.50	$0.60	$0.25	$0.20	$0.20
123	I-270 Gude Dr - I-370	$0.30	$0.95	$1.80	$1.35	$0.55	$0.40	$0.35	$0.40	$0.40	$0.50	$0.20	$0.20	$0.20

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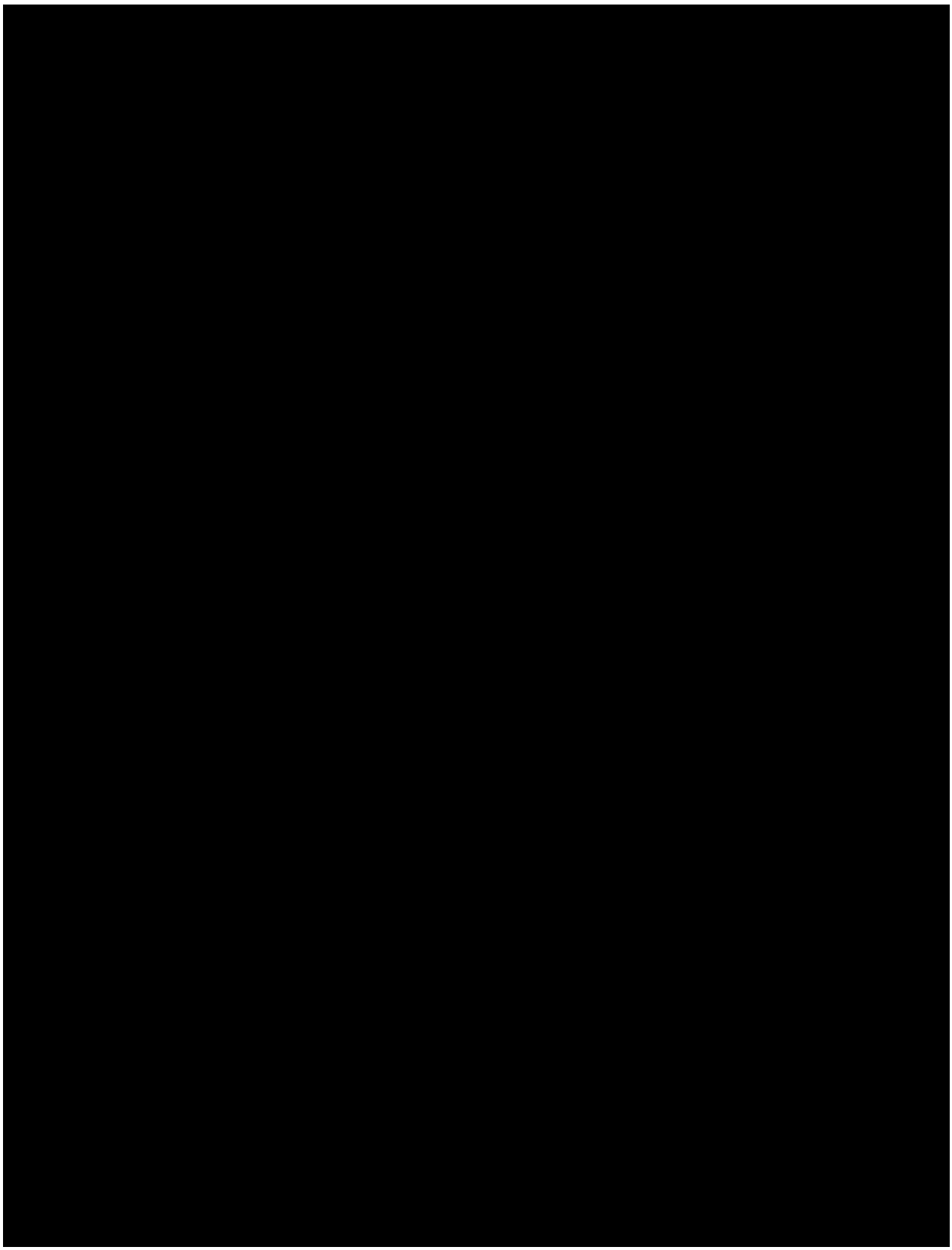

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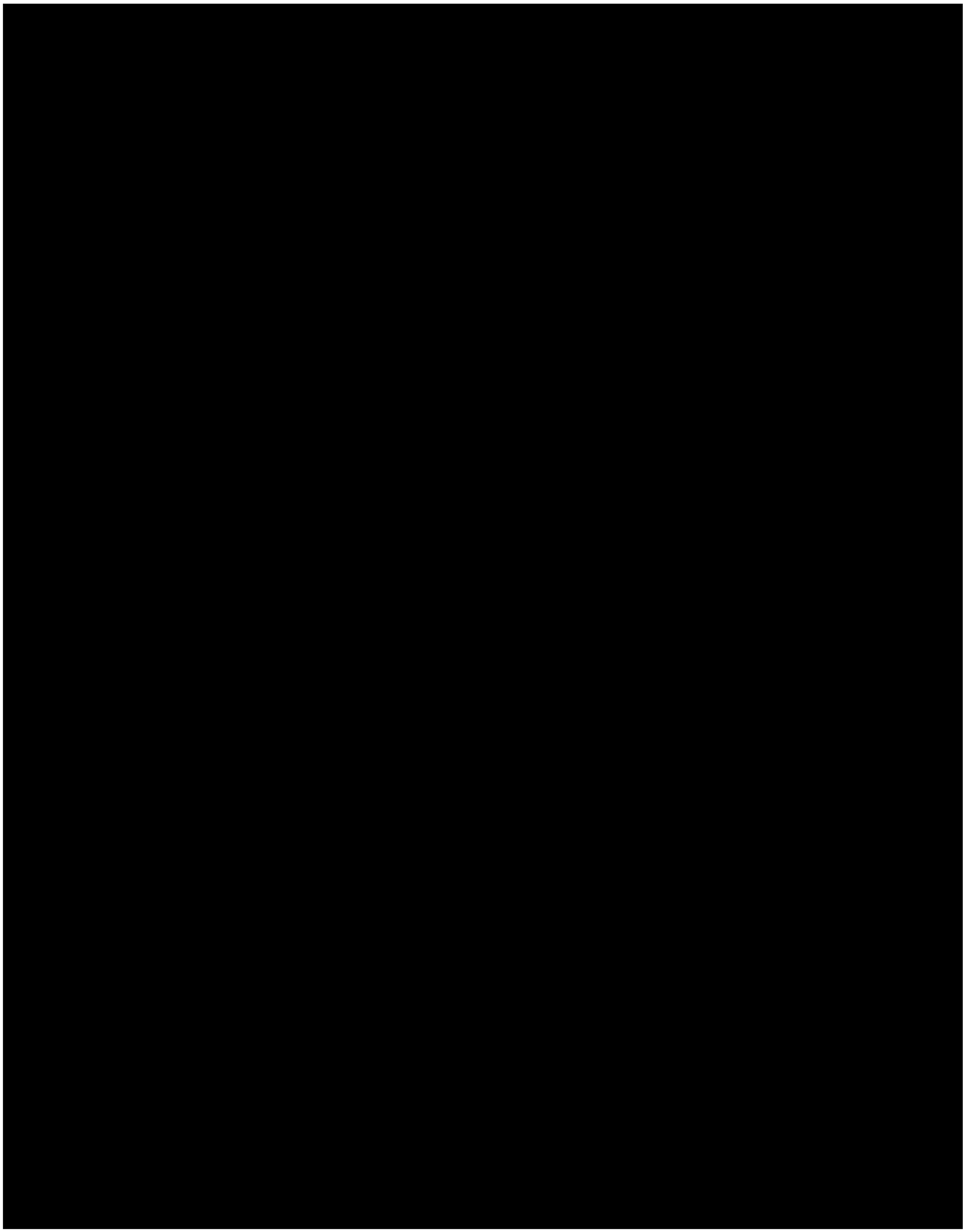

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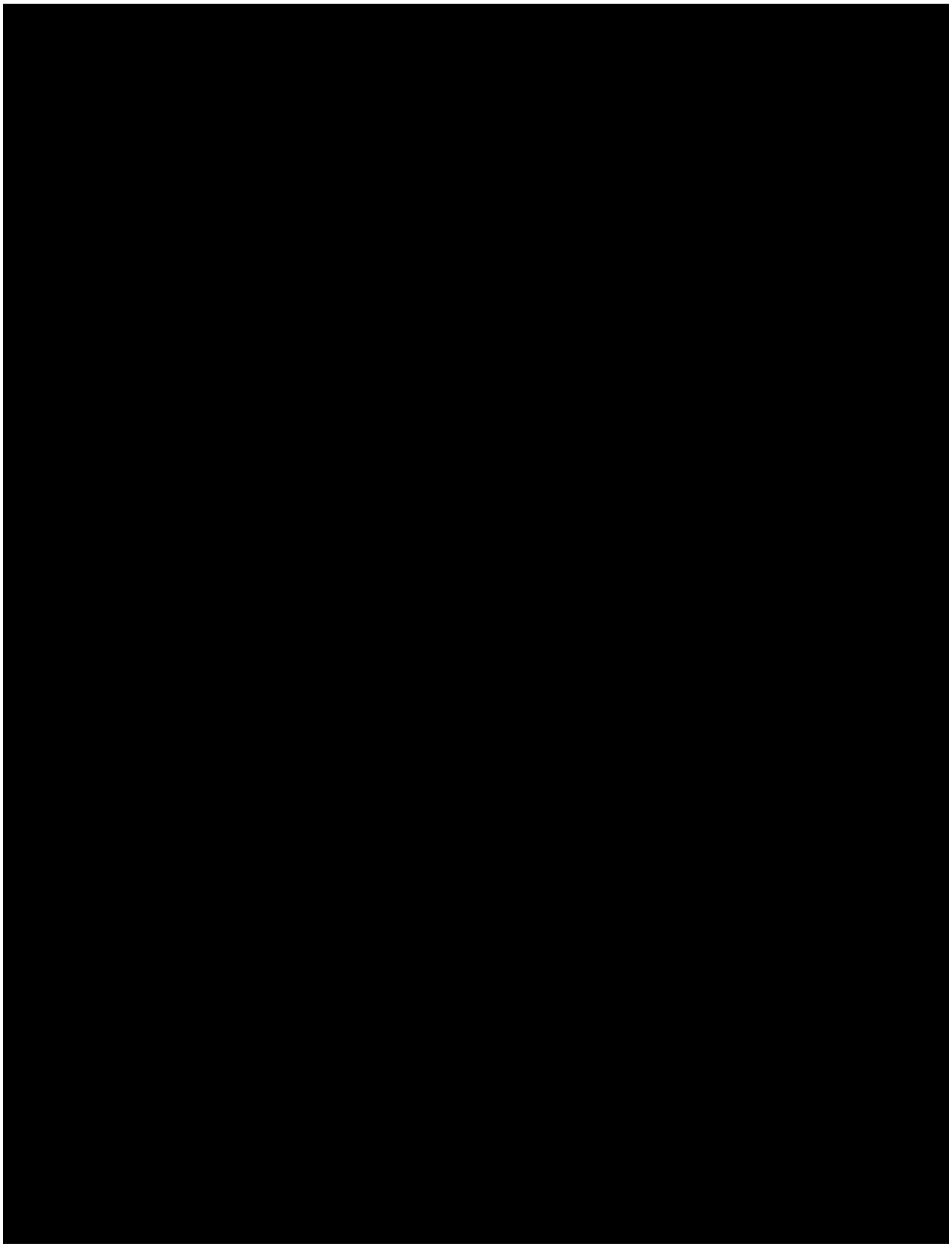

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6.4 Estimated Average Weekday Transactions and Revenue

The estimated average weekday transactions and revenue at the selected toll rates were summarized for the model years. Total numbers of vehicles and the percentage of vehicles not paying toll (HOV 3+) on the I-495 and I-270 Managed lanes are shown for each tolling location, time period, and travel direction in **Table 6-8** through **Table 6-10**. Each table first displays the northbound (or inner loop on I-495) total traffic at each tolling location, followed by the percentage of traffic not paying toll. The southbound (or outer loop on I-495) direction then follows with the same detail. The right most columns show the total of all tolling locations. The four tables correspond to the modeled years 2025, 2035 and 2045.

Tables 6-11 through **Table 6-13** show the average toll paid per paying (i.e. excluding HOV3+) transaction, followed by the average weekday toll revenue, at each tolling location and the total of all tolling locations. As in the previous tables, northbound detail is shown in the top half of the table, and southbound in the bottom half, and the three tables represent model years 2025, 2035 and 2045. Note that the tolls in these tables reflect a mix of ETC and video tolls, as well as a mix of passenger cars and heavy trucks, whereas the tolls in previous **Table 6-2** through **Table 6-4** are the per-mile passenger car ETC tolls.

Table 6-14 summarizes the daily transactions and revenue over both directions at each tolling location. The rightmost columns represent the total average weekday transactions and revenue forecasts, prior to application of annualization factors, assumptions of additional free traffic (motorcycles, buses, emergency vehicles), and ramp-up factors.

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Table 6-8

2025 I-495 / I-270 Estimated Transactions and HOV3+ Pcts on Managed Lanes (2019 Dollars)

NB/Inner Loop	Estimated Weekday Transactions and HOV3+ Pcts By Time Period								
	I-495 Amer. Legion Bridge	I-495 Cl Brtn Pkwy to River Rd	I-495 River Rd to MD-187	I-495 River Rd to I-270 W Spur	I-270 E Spur	I-270 Y Split to Wootton Pkwy	I-270 Wootton Pkwy to Gude Dr	I-270 Gude Dr to I-370	TOTAL NB/Inner Loop
Time Period	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+
Midnight - 5:00 AM	64%	67%	81%	53%	63%	40%	64%	17%	43%
5:00 - 6:00 AM	8%	8%	6%	14%	50%	20%	25%	20%	12%
6:00 - 7:00 AM	6%	6%	9%	6%	14%	8%	8%	8%	7%
7:00 - 9:00 AM	6%	6%	10%	6%	4%	5%	7%	6%	6%
9:00 - 10:00 AM	9%	10%	9%	6%	10%	7%	8%	9%	9%
10:00 AM - Noon	4%	4%	5%	3%	4%	4%	4%	4%	4%
Noon - 2:00 PM	6%	6%	5%	5%	6%	5%	6%	6%	6%
2:00 - 3:00 PM	9%	9%	11%	6%	15%	8%	9%	8%	9%
3:00 - 4:00 PM	6%	6%	8%	8%	15%	11%	14%	13%	10%
4:00 - 6:00 PM	6%	6%	9%	7%	16%	11%	13%	14%	10%
6:00 - 7:00 PM	7%	7%	11%	8%	13%	11%	12%	13%	10%
7:00 - 8:00 PM	3%	3%	4%	3%	6%	5%	6%	6%	5%
8:00 PM - Midnight	3%	3%	3%	4%	11%	6%	7%	6%	5%
Daily Total	**6%**	**6%**	**7%**	**6%**	**9%**	**8%**	**9%**	**9%**	**7%**
SB/Outer Loop	**Estimated Weekday Transactions and HOV3+ Pcts By Time Period**								
	I-495 Amer. Legion Bridge	I-495 Cl Brtn Pkwy to River Rd	I-495 River Rd to MD-187	I-495 River Rd to I-270 W Spur	I-270 E Spur	I-270 Y Split to Wootton Pkwy	I-270 Wootton Pkwy to Gude Dr	I-270 Gude Dr to I-370	TOTAL SB/Outer Loop
Time Period	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+
Midnight - 5:00 AM	36%	43%	17%	33%	88%	46%	52%	43%	39%
5:00 - 6:00 AM	5%	5%	6%	5%	10%	7%	7%	8%	6%
6:00 - 7:00 AM	7%	7%	5%	7%	8%	8%	9%	9%	8%
7:00 - 9:00 AM	7%	7%	7%	7%	10%	8%	11%	11%	9%
9:00 - 10:00 AM	8%	8%	8%	6%	15%	8%	9%	9%	8%
10:00 AM - Noon	3%	3%	3%	3%	7%	5%	6%	6%	4%
Noon - 2:00 PM	4%	4%	3%	6%	9%	7%	9%	9%	6%
2:00 - 3:00 PM	6%	6%	5%	5%	7%	5%	7%	7%	6%
3:00 - 4:00 PM	10%	10%	11%	7%	8%	7%	8%	8%	9%
4:00 - 6:00 PM	13%	13%	18%	8%	7%	8%	8%	9%	11%
6:00 - 7:00 PM	10%	10%	12%	7%	8%	7%	8%	10%	9%
7:00 - 8:00 PM	4%	4%	5%	3%	10%	5%	6%	7%	5%
8:00 PM - Midnight	14%	14%	11%	15%	72%	24%	31%	26%	19%
Daily Total	**7%**	**7%**	**8%**	**6%**	**9%**	**7%**	**9%**	**9%**	**8%**

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Table 6-9
2035 I-495 / I-270 Estimated Transactions and HOV3+ Pcts on Managed Lanes (2019 Dollars)

NB/Inner Loop	Estimated Weekday Transactions and HOV3+ Pcts By Time Period									
	I-495 Amer. Legion Bridge	I-495 Cl Brtn Pkwy to River Rd	I-495 River Rd to MD-187	I-495 River Rd to I-270 W Spur	I-270 E Spur	I-270 Y Split to Wootton Pkwy	I-270 Wootton Pkwy to Gude Dr	I-270 Gude Dr to I-370	TOTAL NB/Inner Loop
Time Period	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+
Midnight - 5 00 AM	44%	48%	53%	45%	59%	36%	57%	15%	36%
5:00 - 6:00 AM	9%	9%	7%	14%	36%	18%	21%	17%	12%
6:00 - 7:00 AM	7%	7%	10%	7%	11%	8%	9%	8%	8%
7:00 - 9:00 AM	8%	8%	12%	7%	5%	6%	8%	7%	8%
9:00 - 10 00 AM	10%	10%	10%	7%	10%	8%	8%	9%	9%
10:00 AM - Noon	5%	5%	5%	4%	4%	4%	4%	4%	4%
Noon - 2:00 PM	6%	6%	6%	6%	7%	7%	8%	7%	7%
2:00 - 3:00 PM	10%	10%	13%	6%	18%	9%	11%	9%	10%
3:00 - 4:00 PM	7%	7%	8%	9%	18%	12%	16%	16%	11%
4:00 - 6:00 PM	6%	6%	8%	8%	19%	13%	15%	17%	11%
6:00 - 7:00 PM	7%	7%	10%	9%	16%	12%	14%	15%	11%
7:00 - 8:00 PM	4%	4%	5%	3%	7%	5%	6%	6%	5%
8:00 PM - Midnight	3%	3%	3%	4%	9%	5%	6%	6%	4%
Daily Total	**7%**	**7%**	**8%**	**7%**	**10%**	**8%**	**10%**	**10%**	**8%**

SB/Outer Loop	Estimated Weekday Transactions and HOV3+ Pcts By Time Period								
	I-495 Amer. Legion Bridge	I-495 Cl Brtn Pkwy to River Rd	I-495 River Rd to MD-187	I-495 River Rd to I-270 W Spur	I-270 E Spur	I-270 Y Split to Wootton Pkwy	I-270 Wootton Pkwy to Gude Dr	I-270 Gude Dr to I-370	TOTAL SB/Outer Loop
Time Period	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+	% HOV 3+
Midnight - 5 00 AM	30%	36%	15%	31%	82%	40%	45%	36%	33%
5:00 - 6:00 AM	6%	6%	7%	6%	8%	7%	7%	8%	7%
6:00 - 7:00 AM	9%	9%	6%	9%	9%	9%	10%	10%	9%
7:00 - 9:00 AM	8%	8%	7%	9%	11%	10%	12%	13%	10%
9:00 - 10 00 AM	9%	9%	9%	7%	15%	8%	9%	9%	9%
10:00 AM - Noon	4%	4%	3%	4%	8%	5%	6%	7%	5%
Noon - 2:00 PM	5%	5%	4%	6%	10%	7%	8%	8%	7%
2:00 - 3:00 PM	7%	7%	5%	6%	8%	7%	8%	8%	7%
3:00 - 4:00 PM	12%	12%	12%	8%	8%	8%	9%	10%	10%
4:00 - 6:00 PM	12%	12%	17%	9%	7%	8%	8%	9%	11%
6:00 - 7:00 PM	11%	11%	12%	8%	10%	8%	9%	10%	10%
7:00 - 8:00 PM	4%	4%	6%	4%	7%	5%	5%	6%	5%
8:00 PM - Midnight	11%	11%	9%	12%	64%	20%	25%	22%	15%
Daily Total	**8%**	**8%**	**8%**	**7%**	**10%**	**8%**	**9%**	**10%**	**8%**

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Table 6-10

2045 I-495 / I-270 Estimated Transactions and HOV3+ Pcts on Managed Lanes (2019 Dollars)

NB/Inner Loop	Estimated Weekday Transactions and HOV3+ Pcts By Time Period									
Time Period	I-495 Amer. Legion Bridge % HOV 3+	I-495 Cl Brtn Pkwy to River Rd % HOV 3+	I-495 River Rd to MD-187 % HOV 3+	I-495 River Rd to I-270 W Spur % HOV 3+	I-270 E Spur % HOV 3+	I-270 Y Split to Wootton Pkwy % HOV 3+	I-270 Wootton Pkwy to Gude Dr % HOV 3+	I-270 Gude Dr to I-370 % HOV 3+	TOTAL NB/Inner Loop % HOV 3+
Midnight - 5:00 AM	42%	43%	48%	41%	55%	35%	53%	14%	34%
5:00 - 6:00 AM	10%	10%	8%	13%	28%	16%	18%	15%	13%
6:00 - 7:00 AM	9%	9%	12%	9%	12%	10%	10%	9%	9%
7:00 - 9:00 AM	9%	10%	13%	8%	5%	7%	8%	7%	8%
9:00 - 10:00 AM	10%	11%	11%	7%	8%	7%	7%	9%	9%
10:00 AM - Noon	6%	6%	6%	5%	5%	5%	5%	5%	5%
Noon - 2:00 PM	6%	6%	6%	6%	7%	6%	7%	7%	7%
2:00 - 3:00 PM	10%	10%	13%	7%	21%	10%	12%	10%	10%
3:00 - 4:00 PM	8%	8%	9%	10%	21%	13%	17%	17%	12%
4:00 - 6:00 PM	7%	7%	8%	9%	22%	14%	17%	18%	11%
6:00 - 7:00 PM	8%	8%	10%	9%	17%	12%	14%	15%	11%
7:00 - 8:00 PM	4%	4%	5%	3%	7%	6%	7%	7%	5%
8:00 PM - Midnight	4%	3%	3%	4%	8%	6%	6%	6%	5%
Daily Total	**7%**	**7%**	**8%**	**7%**	**11%**	**9%**	**10%**	**11%**	**9%**

SB/Outer Loop	Estimated Weekday Transactions and HOV3+ Pcts By Time Period									
Time Period	I-495 Amer. Legion Bridge % HOV 3+	I-495 Cl Brtn Pkwy to River Rd % HOV 3+	I-495 River Rd to MD-187 % HOV 3+	I-495 River Rd to I-270 W Spur % HOV 3+	I-270 E Spur % HOV 3+	I-270 Y Split to Wootton Pkwy % HOV 3+	I-270 Wootton Pkwy to Gude Dr % HOV 3+	I-270 Gude Dr to I-370 % HOV 3+	TOTAL SB/Outer Loop % HOV 3+
Midnight - 5:00 AM	27%	31%	13%	25%	77%	37%	39%	32%	29%
5:00 - 6:00 AM	6%	6%	7%	7%	10%	8%	8%	9%	8%
6:00 - 7:00 AM	10%	10%	6%	9%	10%	10%	12%	12%	10%
7:00 - 9:00 AM	9%	9%	7%	10%	12%	11%	13%	14%	11%
9:00 - 10:00 AM	10%	10%	8%	8%	14%	9%	9%	10%	9%
10:00 AM - Noon	4%	4%	4%	4%	8%	6%	7%	7%	5%
Noon - 2:00 PM	6%	6%	4%	6%	9%	7%	8%	8%	7%
2:00 - 3:00 PM	8%	8%	7%	6%	7%	6%	7%	7%	7%
3:00 - 4:00 PM	13%	13%	13%	9%	8%	9%	9%	10%	11%
4:00 - 6:00 PM	14%	14%	20%	9%	7%	8%	8%	9%	11%
6:00 - 7:00 PM	11%	11%	13%	8%	12%	8%	9%	11%	10%
7:00 - 8:00 PM	5%	5%	8%	4%	7%	5%	5%	6%	5%
8:00 PM - Midnight	10%	10%	8%	11%	56%	17%	21%	18%	13%
Daily Total	**9%**	**9%**	**9%**	**8%**	**10%**	**8%**	**10%**	**10%**	**9%**

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6.5 Estimated Annual Transactions and Toll Revenue

Estimated annual transactions and toll revenue are calculated by applying an annualization factor to the estimated average weekday transactions and toll revenue. As discussed in the assumptions section of this chapter, a revenue factor of 270 and a transaction factor of 295 for passenger cars (and factors of 260 and 280 for trucks) were used to annualize the average weekday estimates.

6.5.1 Annual Transactions, Toll Trips, and Gross Toll Revenue

The estimated annual transactions and gross toll revenue for Phase 1 of the I-495 and I-270 Managed lanes are shown in **Table 6-15** and **Table 6-16** for the 45-year period from 2027 through 2071. **Table 6-15** provides a breakdown between vehicle classes (PC=passenger cars, CV=heavy trucks), and payment types (ETC, Video), with HOV3+ free transactions separated out as well. **Table 6-16** combines all transactions and revenue and provides forecasted numbers of trips on the express lane system and average toll paid per trip. A trip can consist of multiple transactions by the same vehicle.

Transactions and revenue for years 2035, 2045 and 2060 were taken directly from model outputs, with deductions of 2.75% of PC ETC revenue to account for free traffic (other than HOV 3+ vehicles) and annualization factors as described above. Results for years 2027 through 2034 were based on interpolation between the 2025 and 2035 model runs, with ramp up factors of 0.8 and 0.9 applied for the first two years of operation (2027 and 2028). Results for years between 2035 and 2045 and between 2045 and 2060 were also based on interpolation between modeled outputs. Results after 2060 were extrapolated, assuming the year to year growth rates would gradually decrease from 2060 levels, by approximately 10 percent every five years.[3]

[redacted]

[3] In other words, by 2065, transaction and revenue growth would each be 90% as high as they are in 2060, 80% by 2070, etc.

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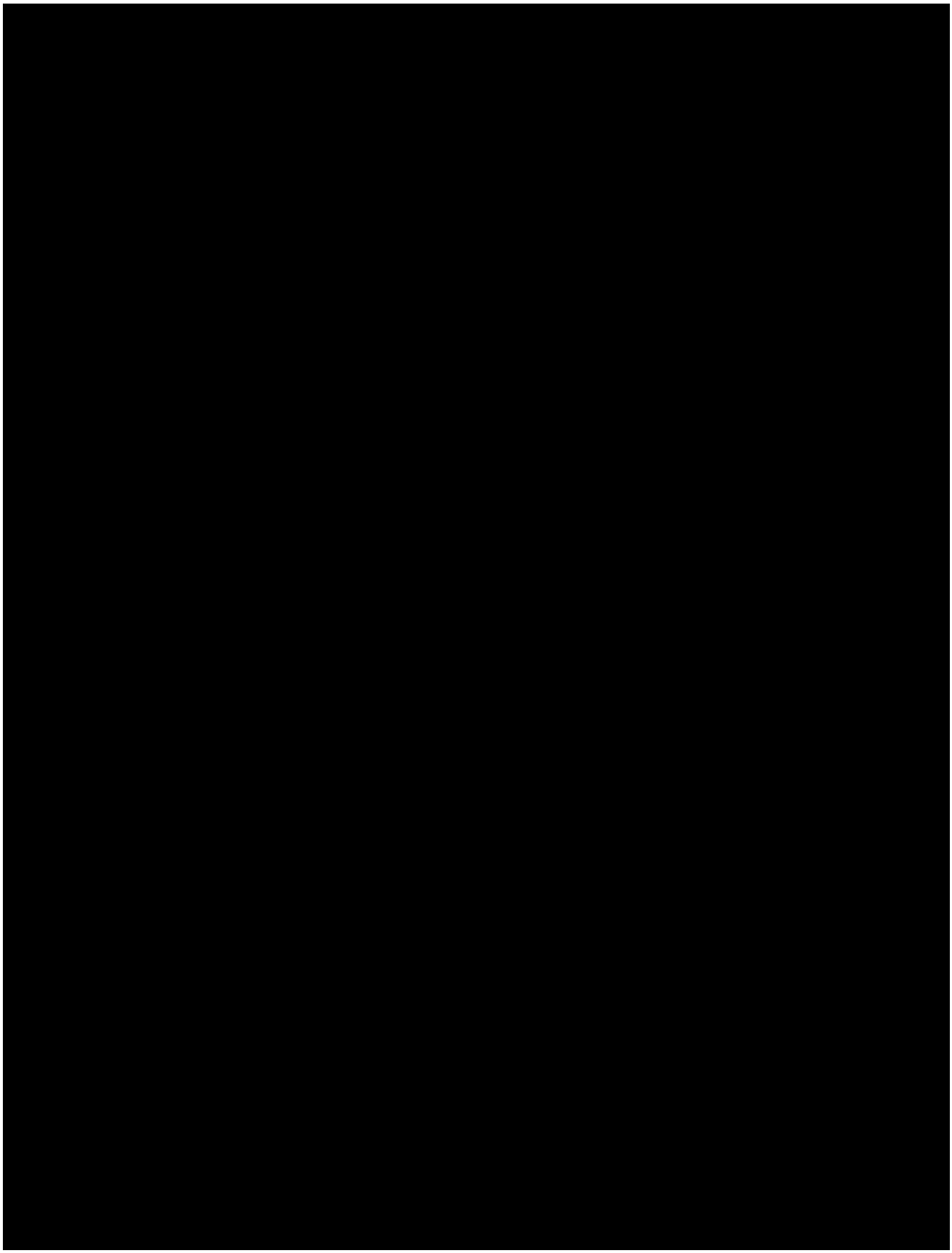

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Table 6-16
Phase 1 of I-495 and I-270 Managed Lanes Base Scenario
Estimated Annual Transactions, Trips, and Gross Toll Revenue (2019$)[1]
(in Millions)

Year	[redacted]	[redacted]	Percent HOV3+	[redacted]	[redacted]	[redacted]	[redacted]
2027			8%				
2028			8%				
2029			8%				
2030			8%				
2031			8%				
2032			8%				
2033			8%				
2034			8%				
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2062			9%				
2063			9%				
2064			9%				
2065			9%				
2066			9%				
2067			9%				
2068			9%				
2069			9%				
2070			9%				
2071			9%				

[1] Free trips (motorcycles, transit, active emergency responders, ...) are removed from trans. and revenue forecasts but are included in the trips forecasts, HOV3+ traffic is included in the trips forecasts, 2027 and 2028 includes ramp-up impact

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Disclaimer

CDM Smith used currently-accepted professional practices and procedures in the development of the traffic and revenue estimates in this report. However, as with any forecast, it should be understood that differences between forecasted and actual results may occur, as caused by events and circumstances beyond the control of the forecasters. In formulating the estimates, CDM Smith reasonably relied upon the accuracy and completeness of information provided (both written and oral) by MDOT. CDM Smith also relied upon the reasonable assurances of independent parties and is not aware of any material facts that would make such information misleading.

CDM Smith made qualitative judgments related to several key variables in the development and analysis of the traffic and revenue estimates that must be considered as a whole; therefore, selecting portions of any individual result without consideration of the intent of the whole may create a misleading or incomplete view of the results and the underlying methodologies used to obtain the results. CDM Smith gives no opinion as to the value or merit of partial information extracted from this report.

All estimates and projections reported herein are based on CDM Smith's experience and judgment and on a review of information obtained from multiple agencies, including MDOT. These estimates and projections may not be indicative of actual or future values and are therefore subject to substantial uncertainty. Future developments and economic conditions cannot be predicted with certainty, and may affect the estimates or projections expressed in this report, such that CDM Smith does not specifically guarantee or warrant any estimate or projection contained within this report.

While CDM Smith believes that the projections and other forward-looking statements contained within the report are based on reasonable assumptions as of the date of the report, such forward-looking statements involve risks and uncertainties that may cause actual results to differ materially from the results predicted. Therefore, following the date of this report, CDM Smith will take no responsibility or assume any obligation to advise of changes that may affect its assumptions contained within the report, as they pertain to socioeconomic and demographic forecasts, proposed residential or commercial land use development projects and/or potential improvements to the regional transportation network.

The report and its contents are intended solely for use by the MDOT and designated parties approved by MDOT and CDM Smith. Any use by third-parties, other than as noted above, is expressly prohibited. In addition, any publication of the report without the express written consent of CDM Smith is prohibited.

CDM Smith is not, and has not been, a municipal advisor as defined in Federal law (the Dodd Frank Bill) to MDOT and does not owe a fiduciary duty pursuant to Section 15B of the Exchange Act to MDOT with respect to the information and material contained in this report. CDM Smith is not recommending and has not recommended any action to MDOT. MDOT should discuss the information and material contained in this report with any and all internal and external advisors that it deems appropriate before acting on this information.

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Chapter 7
Sensitivity Tests

This chapter presents forecasts for sensitivity tests that vary certain assumptions from the base Phase 1 I-495 and I-270 Managed Lane project forecasts in **Chapter 6**. One test is an "equity" test representing a reasonable set of upside assumptions. The equity estimates are intended to represent a more aggressive approach to the project that may be taken by a private developer. The second test represents a more aggressive assumption for the share of managed lane trips with carpools of 3 or more persons (HOV3+). Additional sensitivity tests can be run and included as directed by the project team.

7.1 Equity Scenario

Table 7-1 presents the input assumptions in the equity case which differ from the base case. All other assumptions are identical to the forecasts from **Chapter 6**. The equity estimates are intended to represent a more aggressive approach to the project that may be taken by a private developer.

7.1.1 Toll Rate Analysis

Using the method described previously in **Section 6.2.1**, CDM Smith tested ranges of toll rates to identify revenue maximizing rates for each equity case tolling location, time period, and direction. Revenue maximizing rates for the equity scenario were always greater than or equal to those in the base scenario, since all the equity assumptions which differed from the base assumptions result in either higher travel demand or higher propensity to use the managed lanes.

Tables 7-2 through **Table 7-5** show the resultant per mile toll rates for passenger car ETC tolling for the equity scenario, analogous to **Table 6-2** through **Table 6-5** in the base scenario.

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Table 7-1
Equity Assumptions which differ from the Base Assumptions used for I-495 and I-270 Managed Lanes Traffic and Toll Revenue Estimates

Tolling and Operations Assumptions - Equity	
Tolling Objective	Revenue maximization through the use of Dynamic Tolling. The unregistered video toll will be 1.5 times the transponder/ETC toll. No pre-registered toll is assumed. The CV tolls will have the same multipliers (5.0) as the existing I-95 Express Toll Lanes in Baltimore, Maryland with adjustments to account for the latest MDTA toll schedule changes.
Model Input Assumptions - Equity	
Trip Table Growth	Estimated using high-case independent socioeconomic forecasts applied to full MWCOG model runs. HOV3+ trip table growth in the MWCOG model was adjusted to be the same as overall SOV and HOV2 growth.
Socioeconomic Forecasts	High growth scenario from independent socioeconomic forecasts - higher growth was targeted in areas likely to experience more development by independent socioeconomic forecaster.
Real increase in VOT	1.25 percent per year.
Travel Time Weight	S curve with a maximum factor of 1.6 applied in the model tolling algorithm to reflect additional value of users of managed lanes beyond value of time and value of reliability.
Annualization Factors	2025 Revenue = 270 average weekdays for PCs and 260 for CVs; 2025 Transactions = 295 average weekdays for PCs and 280 for CVs; 2035 and beyond Revenue = 280 average weekdays for PCs and 270 for CVs; 2035 and beyond Transactions = 300 average weekdays for PCs and 285 for CVs

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Table 7-2

I-495 / I-270 Managed Lanes Equity Scenario 2025 Per Mile Passenger Car ETC Toll Rates by Direction, Time Period, and Segment (2019 Dollars)

2025 Equity Passenger Car ETC Per Mile Toll Rates		5:00 - 6:00 AM	6:00 - 7:00 AM	7:00 - 9:00 AM	9:00 - 10:00 AM	10:00 AM - Noon	Noon - 2:00 PM	2:00 - 3:00 PM	3:00 - 4:00 PM	4:00 - 6:00 PM	6:00 - 7:00 PM	7:00 - 8:00 PM	8:00 PM - Midnight	Midnight - 5:00 AM
Northbound / Inner Loop														
24	VA Slip ramps - GW Mem Pkwy	$0.20	$0.80	$1.55	$0.95	$0.40	$0.35	$1.00	$1.20	$2.25	$2.25	$0.75	$0.20	$0.20
1	GW Mem Pkwy - Persimmon Tree Rd	$0.20	$0.75	$1.45	$0.85	$0.35	$0.35	$0.90	$1.15	$2.15	$2.25	$0.75	$0.20	$0.20
2	Persimmon Tree Rd - River Rd	$0.20	$0.95	$1.45	$0.80	$0.35	$0.35	$0.90	$1.15	$2.15	$2.25	$0.80	$0.20	$0.20
3	River Rd - MD 187	$0.20	$0.75	$1.10	$0.70	$0.35	$0.35	$1.00	$1.10	$1.15	$2.20	$0.75	$0.20	$0.20
19	River Rd - Westlake Ter via W Spur	$0.20	$0.85	$0.85	$0.45	$0.30	$0.35	$0.70	$1.05	$1.90	$1.70	$0.60	$0.20	$0.20
20	I-270 E Spur I-495 to Y Split	$0.20	$0.20	$0.20	$0.20	$0.20	$0.20	$0.30	$0.40	$0.70	$0.85	$0.50	$0.20	$0.20
21	I-270 Y-Split - Wootton Pkwy	$0.20	$0.35	$0.40	$0.35	$0.20	$0.30	$0.55	$0.85	$1.50	$1.45	$0.55	$0.20	$0.20
22	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.20	$0.35	$0.35	$0.20	$0.35	$0.50	$0.75	$1.45	$1.45	$0.55	$0.20	$0.20
23	I-270 Gude Dr - I-370	$0.20	$0.20	$0.35	$0.35	$0.20	$0.35	$0.55	$0.85	$1.45	$1.55	$0.55	$0.20	$0.20
Southbound / Outer Loop														
124	VA Slip ramps - GW Mem Pkwy	$0.20	$0.35	$0.85	$0.80	$0.35	$0.30	$0.45	$0.95	$1.35	$1.00	$0.35	$0.20	$0.20
101	GW Mem Pkwy - Persimmon Tree Rd	$0.35	$0.80	$0.85	$0.80	$0.35	$0.35	$0.40	$0.95	$1.30	$0.95	$0.35	$0.20	$0.20
102	Persimmon Tree Rd - River Rd	$0.35	$0.75	$0.85	$0.80	$0.35	$0.35	$0.50	$0.95	$1.30	$0.95	$0.35	$0.20	$0.20
103	River Rd - MD 187	$0.35	$0.50	$0.70	$0.70	$0.35	$0.35	$0.55	$0.95	$1.35	$0.90	$0.35	$0.20	$0.20
119	River Rd - Westlake Ter via W Spur	$0.30	$0.70	$1.00	$0.85	$0.40	$0.35	$0.35	$0.65	$1.10	$0.85	$0.30	$0.20	$0.20
120	I-270 E Spur I-495 to Y Split	$0.20	$0.50	$0.90	$0.85	$0.30	$0.20	$0.20	$0.20	$0.35	$0.20	$0.20	$0.20	$0.20
121	I-270 Y-Split - Wootton Pkwy	$0.20	$0.60	$1.00	$0.90	$0.35	$0.35	$0.30	$0.40	$0.50	$0.55	$0.20	$0.20	$0.20
122	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.65	$1.15	$1.05	$0.35	$0.35	$0.30	$0.35	$0.35	$0.45	$0.20	$0.20	$0.20
123	I-270 Gude Dr - I-370	$0.20	$0.65	$1.25	$1.10	$0.35	$0.35	$0.30	$0.30	$0.35	$0.35	$0.20	$0.20	$0.20

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Table 7-3

I-495 / I-270 Managed Lanes Equity Scenario 2035 Per Mile Passenger Car ETC Toll Rates by Direction, Time Period, and Segment (2019 Dollars)

2035 Equity Passenger Car ETC Per Mile Toll Rates		5:00 - 6:00 AM	6:00 - 7:00 AM	7:00 - 9:00 AM	9:00 - 10:00 AM	10:00 AM - Noon	Noon - 2:00 PM	2:00 - 3:00 PM	3:00 - 4:00 PM	4:00 - 6:00 PM	6:00 - 7:00 PM	7:00 - 8:00 PM	8:00 PM - Midnight	Midnight - 5:00 AM
Northbound / Inner Loop														
24	VA Slip ramps - GW Mem Pkwy	$0.20	$0.90	$2.05	$1.15	$0.45	$0.40	$1.35	$1.65	$3.05	$2.80	$1.00	$0.30	$0.20
1	GW Mem Pkwy - Persimmon Tree Rd	$0.20	$0.80	$1.75	$1.05	$0.40	$0.35	$1.25	$1.60	$3.00	$2.70	$0.95	$0.30	$0.20
2	Persimmon Tree Rd - River Rd	$0.20	$0.95	$1.75	$1.05	$0.40	$0.35	$1.30	$1.60	$3.00	$2.70	$0.95	$0.30	$0.20
3	River Rd - MD 187	$0.20	$0.85	$1.40	$0.85	$0.40	$0.35	$1.30	$1.45	$1.50	$2.20	$0.95	$0.20	$0.20
19	River Rd - Westlake Ter via W Spur	$0.20	$0.85	$1.10	$0.50	$0.35	$0.35	$0.80	$1.55	$2.45	$2.35	$0.75	$0.35	$0.20
20	I-270 E Spur I-495 to Y Split	$0.20	$0.20	$0.20	$0.20	$0.20	$0.35	$0.35	$0.50	$0.90	$1.10	$0.60	$0.20	$0.20
21	I-270 Y-Split - Wootton Pkwy	$0.20	$0.45	$0.50	$0.35	$0.35	$0.35	$0.70	$1.25	$1.95	$2.15	$0.70	$0.25	$0.20
22	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.35	$0.40	$0.35	$0.35	$0.35	$0.60	$1.15	$1.90	$2.20	$0.70	$0.30	$0.20
23	I-270 Gude Dr - I-370	$0.20	$0.25	$0.35	$0.35	$0.35	$0.40	$0.65	$1.25	$1.95	$2.25	$0.75	$0.35	$0.20
Southbound / Outer Loop														
124	VA Slip ramps - GW Mem Pkwy	$0.35	$0.40	$1.30	$1.05	$0.40	$0.35	$0.55	$1.25	$1.80	$1.35	$0.55	$0.20	$0.20
101	GW Mem Pkwy - Persimmon Tree Rd	$0.35	$1.00	$1.30	$1.05	$0.50	$0.40	$0.55	$1.25	$1.70	$1.25	$0.45	$0.20	$0.20
102	Persimmon Tree Rd - River Rd	$0.35	$1.00	$1.30	$1.05	$0.55	$0.45	$0.55	$1.25	$1.70	$1.25	$0.45	$0.20	$0.20
103	River Rd - MD 187	$0.35	$0.70	$0.95	$0.85	$0.40	$0.35	$0.70	$1.20	$1.70	$1.15	$0.50	$0.20	$0.20
119	River Rd - Westlake Ter via W Spur	$0.35	$0.95	$1.45	$1.10	$0.55	$0.45	$0.45	$0.85	$1.35	$1.10	$0.35	$0.20	$0.20
120	I-270 E Spur I-495 to Y Split	$0.20	$0.65	$1.20	$1.05	$0.40	$0.35	$0.30	$0.20	$0.35	$0.20	$0.20	$0.20	$0.20
121	I-270 Y-Split - Wootton Pkwy	$0.35	$0.85	$1.45	$1.15	$0.50	$0.35	$0.35	$0.50	$0.60	$0.80	$0.30	$0.20	$0.20
122	I-270 Wootton Pkwy - Gude Dr	$0.35	$0.90	$1.60	$1.30	$0.55	$0.40	$0.35	$0.40	$0.45	$0.55	$0.30	$0.20	$0.20
123	I-270 Gude Dr - I-370	$0.35	$0.90	$1.70	$1.35	$0.55	$0.40	$0.35	$0.40	$0.40	$0.50	$0.25	$0.20	$0.20

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Table 7-4

I-495 / I-270 Managed Lanes Equity Scenario 2045 Per Mile Passenger Car ETC Toll Rates by Direction, Time Period, and Segment (2019 Dollars)

2045 Equity Passenger Car ETC Per Mile Toll Rates		5:00 - 6:00 AM	6:00 - 7:00 AM	7:00 - 9:00 AM	9:00 - 10:00 AM	10:00 AM - Noon	Noon - 2:00 PM	2:00 - 3:00 PM	3:00 - 4:00 PM	4:00 - 6:00 PM	6:00 - 7:00 PM	7:00 - 8:00 PM	8:00 PM - Midnight	Midnight - 5:00 AM
Northbound / Inner Loop														
24	VA Slip ramps - GW Mem Pkwy	$0.20	$1.00	$2.50	$1.35	$0.55	$0.50	$1.70	$2.10	$3.80	$3.50	$1.25	$0.35	$0.20
1	GW Mem Pkwy - Persimmon Tree Rd	$0.20	$0.95	$2.05	$1.15	$0.50	$0.50	$1.60	$2.05	$3.70	$3.40	$1.20	$0.35	$0.20
2	Persimmon Tree Rd - River Rd	$0.20	$0.95	$2.30	$1.20	$0.60	$0.45	$1.65	$2.05	$3.70	$3.40	$1.20	$0.35	$0.20
3	River Rd - MD 187	$0.20	$0.95	$1.60	$1.00	$0.65	$0.40	$1.75	$1.80	$2.35	$2.60	$1.15	$0.35	$0.20
19	River Rd - Westlake Ter via W Spur	$0.20	$0.85	$1.25	$0.60	$0.35	$0.40	$1.15	$2.00	$3.20	$2.85	$1.10	$0.35	$0.20
20	I-270 E Spur I-495 to Y Split	$0.20	$0.20	$0.30	$0.25	$0.30	$0.35	$0.35	$0.55	$1.15	$1.30	$0.75	$0.20	$0.20
21	I-270 Y-Split - Wootton Pkwy	$0.20	$0.55	$0.65	$0.45	$0.35	$0.40	$0.95	$1.75	$2.55	$2.55	$0.90	$0.35	$0.20
22	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.40	$0.45	$0.40	$0.35	$0.45	$0.80	$1.60	$2.55	$2.70	$0.95	$0.35	$0.20
23	I-270 Gude Dr - I-370	$0.20	$0.40	$0.50	$0.45	$0.35	$0.55	$0.90	$1.70	$2.60	$2.85	$1.05	$0.35	$0.20
Southbound / Outer Loop														
124	VA Slip ramps - GW Mem Pkwy	$0.35	$0.55	$1.70	$1.40	$0.50	$0.45	$0.75	$1.60	$2.35	$1.70	$0.65	$0.20	$0.20
101	GW Mem Pkwy - Persimmon Tree Rd	$0.40	$1.35	$1.75	$1.40	$0.60	$0.50	$0.75	$1.55	$2.15	$1.60	$0.55	$0.20	$0.20
102	Persimmon Tree Rd - River Rd	$0.40	$1.35	$1.75	$1.40	$0.60	$0.50	$0.75	$1.55	$2.15	$1.60	$0.55	$0.20	$0.20
103	River Rd - MD 187	$0.35	$0.80	$1.20	$1.15	$0.55	$0.40	$0.90	$1.45	$2.25	$1.50	$0.65	$0.20	$0.20
119	River Rd - Westlake Ter via W Spur	$0.35	$1.25	$1.90	$1.40	$0.70	$0.55	$0.65	$1.10	$1.55	$1.30	$0.40	$0.20	$0.20
120	I-270 E Spur I-495 to Y Split	$0.20	$0.75	$1.65	$1.35	$0.50	$0.40	$0.35	$0.25	$0.40	$0.25	$0.20	$0.20	$0.20
121	I-270 Y-Split - Wootton Pkwy	$0.35	$1.10	$1.90	$1.45	$0.60	$0.50	$0.50	$0.65	$0.80	$1.05	$0.35	$0.20	$0.20
122	I-270 Wootton Pkwy - Gude Dr	$0.35	$1.20	$2.10	$1.60	$0.70	$0.55	$0.50	$0.50	$0.60	$0.80	$0.35	$0.20	$0.20
123	I-270 Gude Dr - I-370	$0.35	$1.20	$2.20	$1.65	$0.70	$0.55	$0.50	$0.45	$0.50	$0.65	$0.35	$0.20	$0.20

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Table 7-5

I-495 / I-270 Managed Lanes Equity Scenario 2060 Per Mile Passenger Car ETC Toll Rates by Direction, Time Period, and Segment (2019 Dollars)

2060 Equity Passenger Car ETC Per Mile Toll Rates		5:00 - 6:00 AM	6:00 - 7:00 AM	7:00 - 9:00 AM	9:00 - 10:00 AM	10:00 AM - Noon	Noon - 2:00 PM	2:00 - 3:00 PM	3:00 - 4:00 PM	4:00 - 6:00 PM	6:00 - 7:00 PM	7:00 - 8:00 PM	8:00 PM - Midnight	Midnight - 5:00 AM
Northbound / Inner Loop														
24	VA Slip ramps - GW Mem Pkwy	$0.20	$1.25	$3.25	$1.60	$0.60	$0.65	$2.30	$3.10	$5.15	$4.60	$1.70	$0.40	$0.20
1	GW Mem Pkwy - Persimmon Tree Rd	$0.20	$1.15	$3.00	$1.45	$0.60	$0.60	$2.20	$3.00	$6.45	$4.40	$1.60	$0.40	$0.20
2	Persimmon Tree Rd - River Rd	$0.25	$1.15	$3.00	$1.40	$0.65	$0.75	$2.20	$3.00	$6.45	$4.40	$1.60	$0.40	$0.20
3	River Rd - MD 187	$0.20	$1.10	$2.00	$1.15	$0.70	$0.75	$2.70	$1.80	$2.35	$3.80	$1.65	$0.35	$0.20
19	River Rd - Westlake Ter via W Spur	$0.30	$0.85	$1.65	$0.75	$0.45	$0.55	$1.60	$2.65	$4.55	$3.80	$1.35	$0.45	$0.20
20	I-270 E Spur I-495 to Y Split	$0.20	$0.20	$0.35	$0.35	$0.35	$0.45	$0.45	$0.80	$1.60	$1.80	$1.00	$0.35	$0.20
21	I-270 Y-Split - Wootton Pkwy	$0.20	$0.55	$0.80	$0.55	$0.40	$0.55	$1.25	$2.40	$3.55	$3.50	$1.20	$0.40	$0.20
22	I-270 Wootton Pkwy - Gude Dr	$0.20	$0.50	$0.65	$0.55	$0.40	$0.60	$1.00	$2.20	$3.65	$3.80	$1.30	$0.45	$0.20
23	I-270 Gude Dr - I-370	$0.20	$0.45	$0.65	$0.55	$0.45	$0.65	$1.10	$2.30	$3.65	$4.60	$1.35	$0.50	$0.20
Southbound / Outer Loop														
124	VA Slip ramps - GW Mem Pkwy	$0.35	$0.80	$2.35	$1.85	$0.65	$0.55	$1.05	$2.10	$3.05	$2.30	$0.75	$0.20	$0.20
101	GW Mem Pkwy - Persimmon Tree Rd	$0.45	$1.90	$2.40	$1.85	$0.80	$0.65	$1.05	$2.05	$2.75	$2.10	$0.70	$0.20	$0.20
102	Persimmon Tree Rd - River Rd	$0.50	$1.90	$2.40	$1.85	$0.80	$0.65	$1.05	$2.05	$2.75	$2.10	$0.70	$0.20	$0.20
103	River Rd - MD 187	$0.40	$1.05	$1.60	$1.60	$0.70	$0.55	$1.30	$1.90	$2.80	$1.90	$0.75	$0.20	$0.20
119	River Rd - Westlake Ter via W Spur	$0.40	$1.55	$2.60	$1.90	$0.90	$0.80	$0.85	$1.35	$2.00	$1.65	$0.50	$0.20	$0.20
120	I-270 E Spur I-495 to Y Split	$0.35	$1.00	$2.50	$1.50	$0.65	$0.55	$0.40	$0.35	$0.55	$0.35	$0.30	$0.20	$0.20
121	I-270 Y-Split - Wootton Pkwy	$0.35	$1.55	$2.65	$1.85	$0.80	$0.60	$0.65	$0.85	$1.05	$1.35	$0.40	$0.20	$0.20
122	I-270 Wootton Pkwy - Gude Dr	$0.35	$1.65	$3.00	$2.10	$0.85	$0.70	$0.65	$0.65	$0.75	$1.00	$0.40	$0.20	$0.20
123	I-270 Gude Dr - I-370	$0.35	$1.65	$3.10	$2.15	$0.90	$0.70	$0.60	$0.60	$0.60	$0.80	$0.35	$0.20	$0.20

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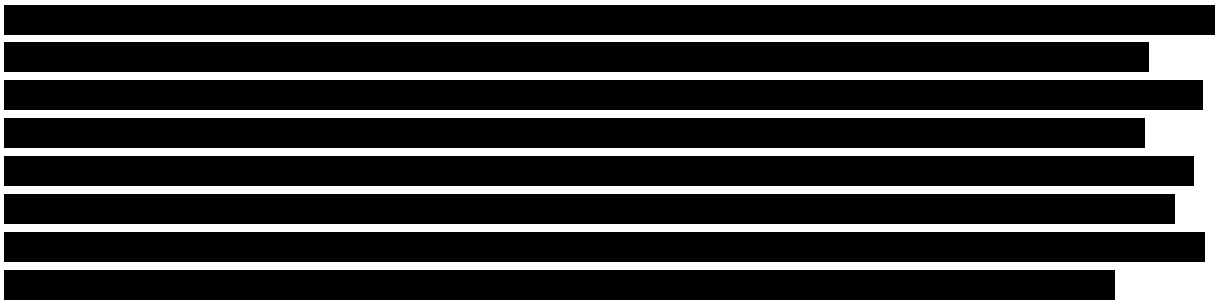
7.1.2 Estimated Annual Transactions, Toll Trips, and Gross Toll Revenue

As in the base forecasts, average weekday transactions and toll revenue are obtained from running the travel demand model for years 2025, 2035, 2045 and 2060, but in this case using the toll rates in **Table 7-2** through **Table 7-5.** Estimated annual transactions and toll revenue are calculated by applying an annualization factor to the estimated average weekday transactions and toll revenue. The annualization factors for the equity scenario are the same as in the base scenario for year 2025, but for years 2035 and beyond, the factors are higher as shown in **Table 7-1.**

The estimated annual transactions and gross toll revenue for the I-495 and I-270 Managed Lanes in the equity scenario are shown in **Table 7-6** for the 45-year period from 2027 through 2071. Interpolation and extrapolation assumptions were the same as described in **Chapter 6** for the base scenario. This table is analogous to **Table 6-15** for the base scenario. Similarly, **Table 7-7** combines all transactions and revenue and provides forecasted numbers of trips on the express lane system and average toll paid per trip, analogous to **Table 6-16**.



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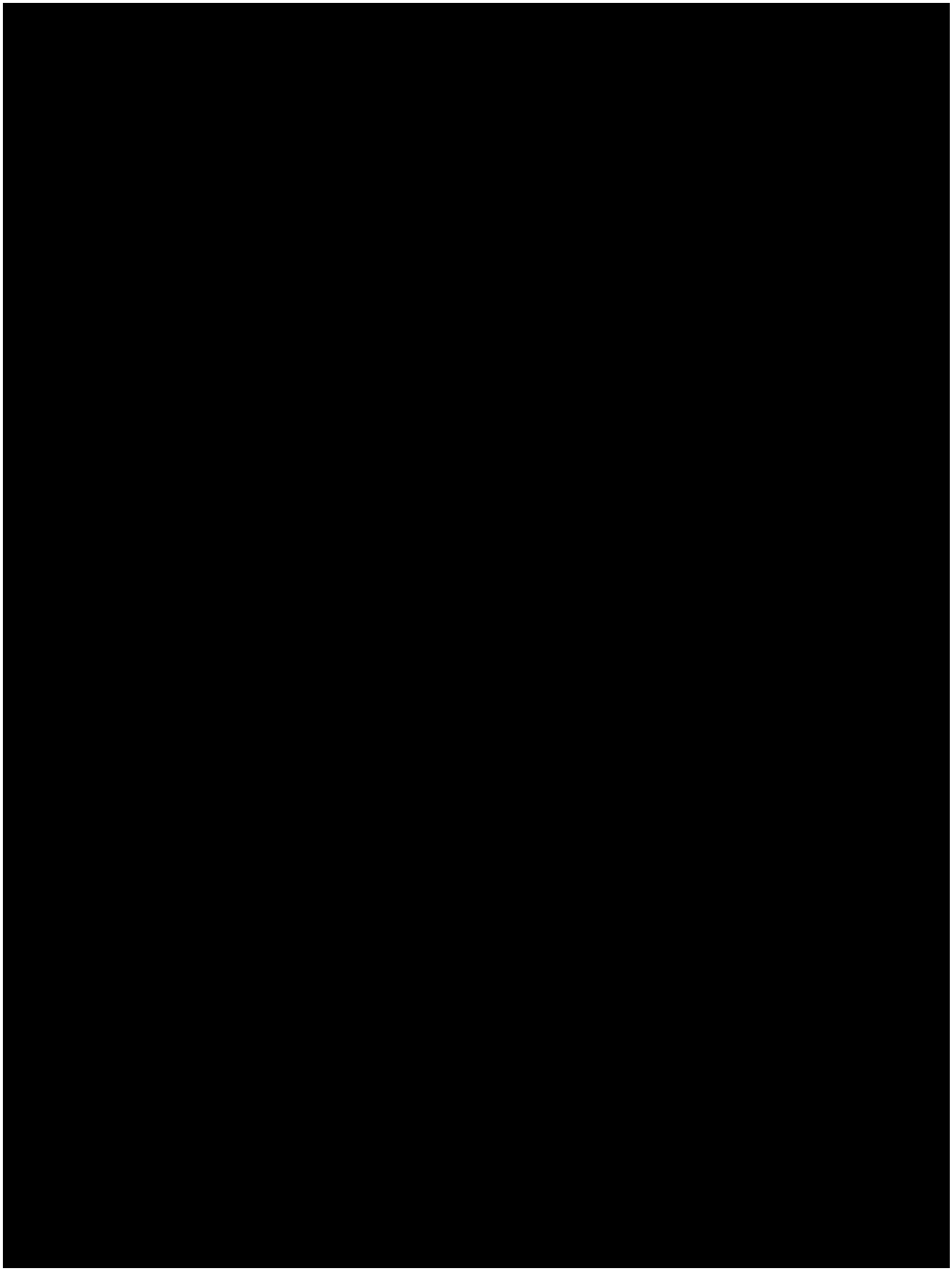

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Table 7-7
Phase 1 of I-495 and I-270 Priced Managed Lanes Equity Scenario
Estimated Annual Transactions, Toll Trips, and Gross Toll Revenue (2019 Dollars)[1]
(in Millions)

Year	[redacted]	[redacted]	Percent HOV3+	[redacted]	[redacted]	[redacted]	[redacted]
2027			8%				
2028			8%				
2029			8%				
2030			8%				
2031			8%				
2032			8%				
2033			8%				
2034			8%				
2035			8%				
2036			8%				
2037			8%				
2038			8%				
2039			8%				
2040			8%				
2041			8%				
2042			8%				
2043			8%				
2044			8%				
2045			9%				
2046			9%				
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2051			9%				
2052			9%				
2053			9%				
2054			9%				
2055			9%				
2056			9%				
2057			9%				
2058			9%				
2059			9%				
2060			9%				
2061			9%				
2062			9%				
2063			9%				
2064			9%				
2065			9%				
2066			9%				
2067			9%				
2068			9%				
2069			9%				
2070			9%				
2071			9%				

[1] Free trips (motorcycles, transit, active emergency responders, ...) are removed from trans. and revenue forecasts but are included in the trips forecasts, HOV3+ traffic is included in the trips forecasts, 2027 and 2028 includes ramp-up impact

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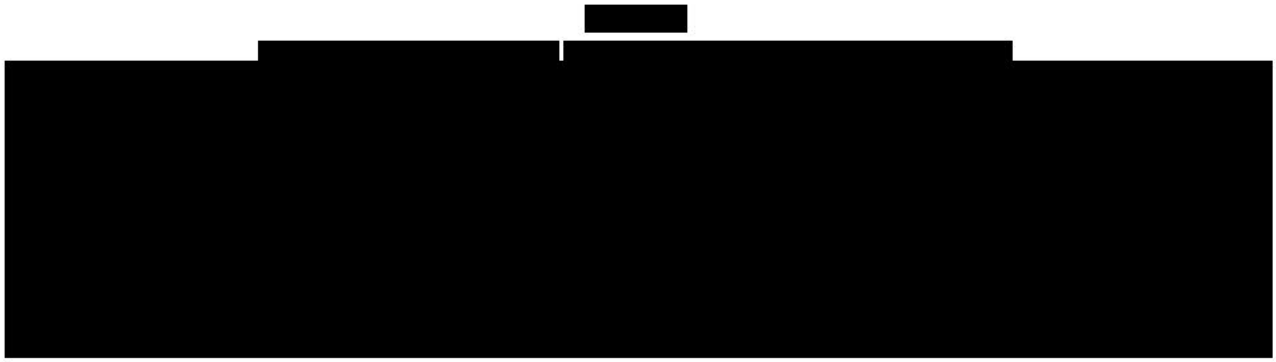
7.1.3 Comparison to Base Scenario

Table 7-8 compares the annual transactions and revenue forecasts for the equity scenario to those of the base scenario for opening year 2027 and for the three subsequent modeled years: 2035, 2045 and 2060. As shown, the percent difference in transactions and revenue is forecasted to increase over time.



7.2 Aggressive HOV3+ Share Scenario

Results in **Chapter 6** showed that in the base forecasts, HOV3+ transactions were estimated to make up between eight percent and ten percent of total transactions on the I-495 and I-270 Managed Lanes Project. The main factor affecting these results was calibrating the 2017 base model HOV3+ shares on the Virginia Express Lanes to actual HOV3+ performance data on the facility. While the Maryland HOV3+ share results are consistent with HOV3+ shares on the northern end of the existing Virginia I-495 Express Lanes, the overall HOV3+ share of transactions on the Virginia I-495 Express Lanes is higher at about 16%. Due to the uncertainty around HOV3+ usage in the future in Maryland and given the importance of the HOV3+ share to revenue, a sensitivity test of a higher share of HOV3+ trips was completed. For the test, the number of HOV3+ trips in the input trip matrix was doubled and the number of SOV and HOV2 passenger car trips was reduced proportionately. The sensitivity test was completed for 2025 and 2045 model years.

7.2.1 Toll Rate Analysis

CDM Smith ran ranges of toll rates to identify revenue maximizing rates for each tolling location, time period, and direction. The resultant toll rates for this sensitivity test did not vary significantly from the base scenario rates shown in **Table 6-2** through **Table 6-5.** Most toll rates did not change by more than 10 cents per mile.

7.2.2 Estimated Annual Transactions and Toll Revenue

Table 7-9 shows the impact of doubling the number of HOV3+ trips in the input trip matrix on the annual transactions and revenue of the priced managed lanes, as well as the impact on the share of transactions which are HOV3+.

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Table 7-9
Impact of Doubling Overall HOV3+ Travel on Base Forecasts
(2019 Dollars, in Millions)

	[redacted]	% HOV3+	[redacted]
Base Results		7.7%	
Increased HOV3+ Demand		14.6%	
Base Results		9.0%	
Increased HOV3+ Demand		17.0%	

[1]Includes 0.8 ramp up factor

[redacted]

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