Traffic Quality on the Metropolitan Washington Area Freeway System

Spring 2011 Report

Prepared by
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DRAFT

NATIONAL CAPITAL REGION TRANSPORTATION PLANNING BOARD
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Skycomp

ABSTRACT

TITLE: Traffic Quality on the Metropolitan Area Freeway System, Spring 2011 Report

DATE: TBD

AGENCY: The Metropolitan Washington Council of Governments is the regional planning organization of the Washington area's major local governments. COG works on finding solutions to regional problems, especially those related to regional growth, transportation, housing, human services, and the environment.

ABSTRACT: This report presents findings of the Spring 2011 survey of the metropolitan Washington region's limited access highway system. The findings include the system performance represented by levels of service and the changes to the system performance over time by comparing the 2011 results with 1993, 1996, 1999, 2002, 2005 and 2008 survey data.

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EXECUTIVE SUMMARY

This report documents the findings of the Spring 2011 aerial survey of the metropolitan Washington region's freeway system during the AM and PM peak periods. The report also presents changes through time by comparing the 2011 results with data from the 1993, 1996, 1999, 2002, 2005 and 2008 surveys.

After the introductory and methodology sections, Chapter III of the report presents AM and PM peak period conditions represented by levels of service for individual routes. For segments with congested conditions, the severity of the congestion is indicated by density of traffic in passenger cars per lane per mile along with a narrative of observations.

Chapter IV of the report identifies top 10 congested locations in terms of density, along with a performance metric which identifies the top 5 corridors with the longest delay.

Chapter V provides regional congestion summaries for the peak periods as well as hourly displays for the morning and evening survey periods. Chapter VI discusses changes to the system over time by comparing 2011 data with prior years' survey data including changes to lane miles of congestion.

Appendix A discusses the methodology used for estimating level of service based on the Highway Capacity Manual (HCM). Appendix B documents the use of the locally calibrated Van Aerde model used to develop speed estimates from densities.

TABLE OF CONTENTS

Chapter I

Introduction

a. BACKGROUND

The purpose of this ongoing mobility-monitoring program is to rate the performance of the regional Washington, D.C. highway system on a recurring basis, and provide the information it produces to regional planners, stakeholders, and decision-makers. This initiative began in the spring of 1993, at which time approximately 300 centerline miles of limited-access highway in the Washington, D.C. metropolitan area was surveyed. Coverage was repeated every three years (1996, 1999, 2002, 2005 and 2008), leading to an identification of locations experiencing both improved and degraded mobility. Most recently, coverage of the regional network was repeated in the spring of 2011. This document presents the findings of this last survey.

b. FEATURES OF THE AERIAL SURVEY PROGRAM

The aerial survey methodology takes advantage of the mobility and vantage point of fixed-wing aircraft, permitting data collection across a large highway network that would not be affordable using traditional ground-based survey methods. During the survey flights, overlapping photographic coverage was obtained of each designated highway, repeated once an hour over four morning and four evening commuter periods (this means that, altogether, there were 12 morning and 12 evening observations of each highway segment). The morning times of coverage were 6:00-9:00 a.m. outside the Capital Beltway and 6:30-9:30 a.m. inside the Capital Beltway. The evening times were 4:00-7:00 p.m. inside the Capital Beltway and 4:30-7:30 p.m. outside the Capital Beltway. Survey flights were conducted on weekdays, excluding Monday mornings, Friday evenings and mornings after holidays. Data were extracted from the aerial photographs to measure average recurring daily traffic conditions by link and by time period. Products of the aerial survey program include:

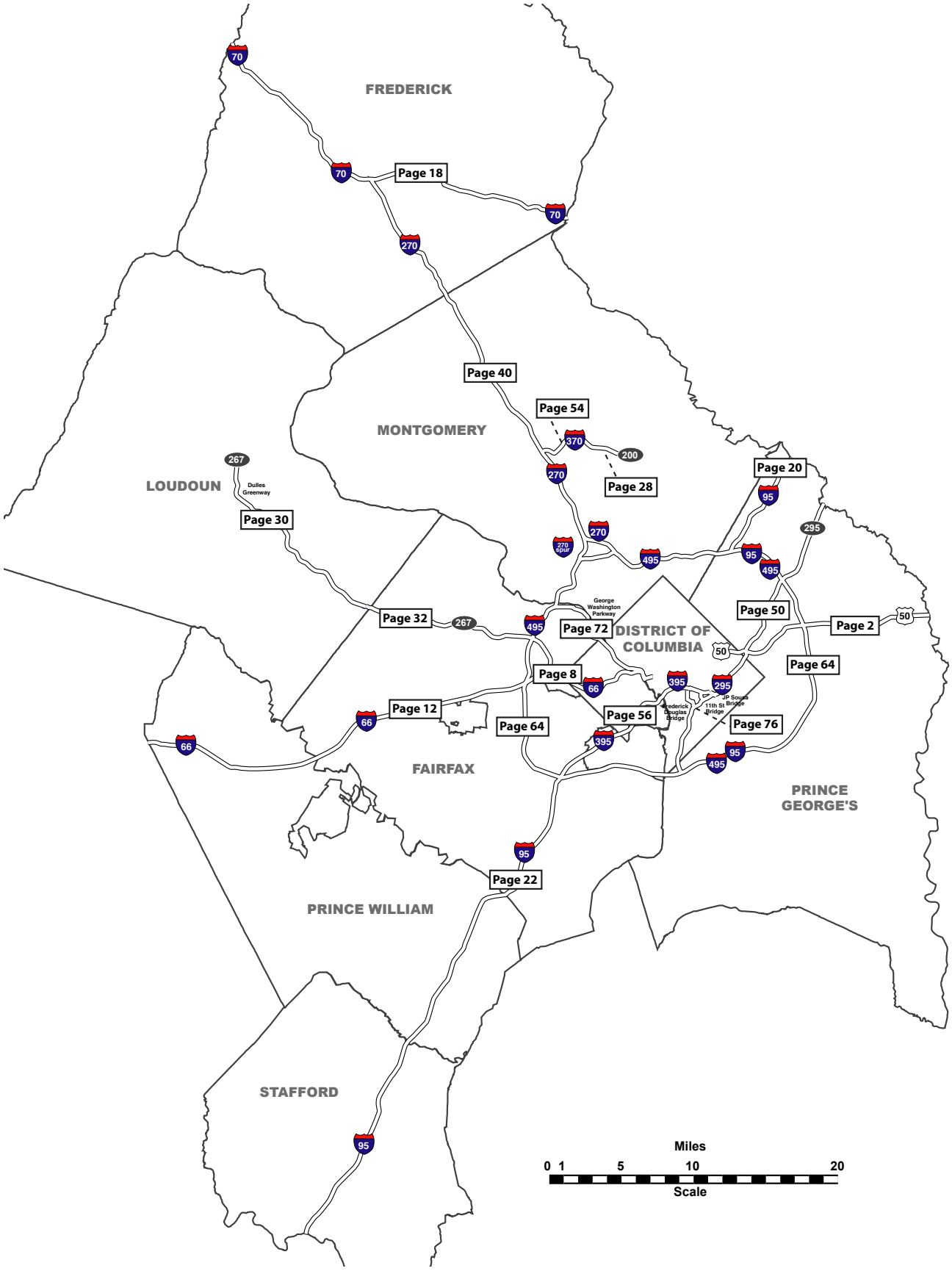
c. SURVEY DATABASE

A primary task for this project is to produce a 2011 Survey Database (built in the Microsoft Access format). This database contains all of the data collected from the 2011 aerial survey, from vehicle counts and road segmentation parameters to survey flight records.

d. WEB-BASED INTERACTIVE SLIDE SHOW

Another primary task is to create a web-based interactive slide show. This slide show provides user access to highlight aerial photographs of congested bottlenecks; users open these photos by clicking on any of the bottleneck arrowheads on morning and evening congestion inventory maps.

Map of Surveyed Highways, Spring 2011



Chapter II

Report Layout

Traffic Quality on the Metropolitan Washington Area Freeway System, Spring 2011 report is made up of six chapters and three appendices.

Chapter I provides a background of the aerial survey program and discusses the features of the program.

Chapter II (this chapter) discusses the layout of the report.

Chapter III provides details of individual route levels of service along with narratives of congestion found on the freeway system. For segments with congested conditions, the severity of the congestion is indicated by density of traffic in passenger cars per lane per mile.

Chapter IV of the report provides the following information: 1) 2011 top 10 congested locations in terms of density; 2) a performance metric that indicates the top 5 corridors with the longest delay; and 3) a comparison of lane mile hours at LOS F by survey year. Note: The 2008 top 10 congested locations and top 5 congested corridors are presented In Appendix C for reference.

Chapter V provides level-of-service and congestion summaries for the AM and PM peak periods as well as hourly displays for each of the survey periods.

Chapter VI discusses changes to the system over time by comparing 2011 data with prior years' survey data.

Appendix A discusses the methodology used for estimating level of service based on the highway capacity manual (HCM).

Appendix B documents the use of the locally calibrated Van Aerde model used to develop speed estimates from densities.

Appendix C presents graphics for the 2008 top 10 congested locations and top 5 congested corridors.

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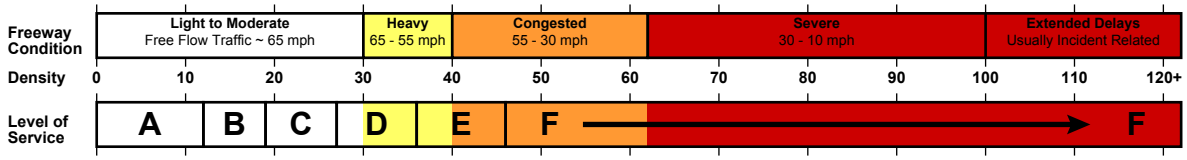
Chapter III

Metropolitan Washington Area Surveyed Highways - Spring 2011

Traffic Quality Rating Tables

The following pages contain morning and evening traffic quality rating tables for all highways surveyed in the spring of 2011. Traffic quality ratings are presented by segment, hour and direction. Each rating is a composite reflecting all ratings for that hour – usually four –derived from survey flights on four different days, except that ratings affected by incidents or other unusual events were segregated and excluded from consideration.

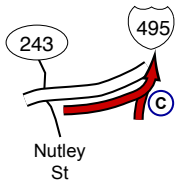
Traffic Quality Ratings:



Congested Locations

Each level-of-service table includes arrowheads that depict locations where congestion was found. A narrative that clarifies the frequency and severity of the congestion accompanies each arrowhead; where evident, apparent causes of the problems are also described. See example below:

I-66 (Outside Beltway)
Morning



C
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Eastbound
Location: Between Nutley St & the Beltway
Queue Length: 2 to 3 miles
Estimated Speed: 10 to 40 mph
Potential Cause(s): The head of the queue was found on the one-lane ramp to the inner loop of the Beltway; congestion typically extended back into the right lane (and eventually across all lanes) of I-66. Although conditions closely resembled those found during previous surveys, it is possible that construction at the I-495 interchange contributed to the congestion.

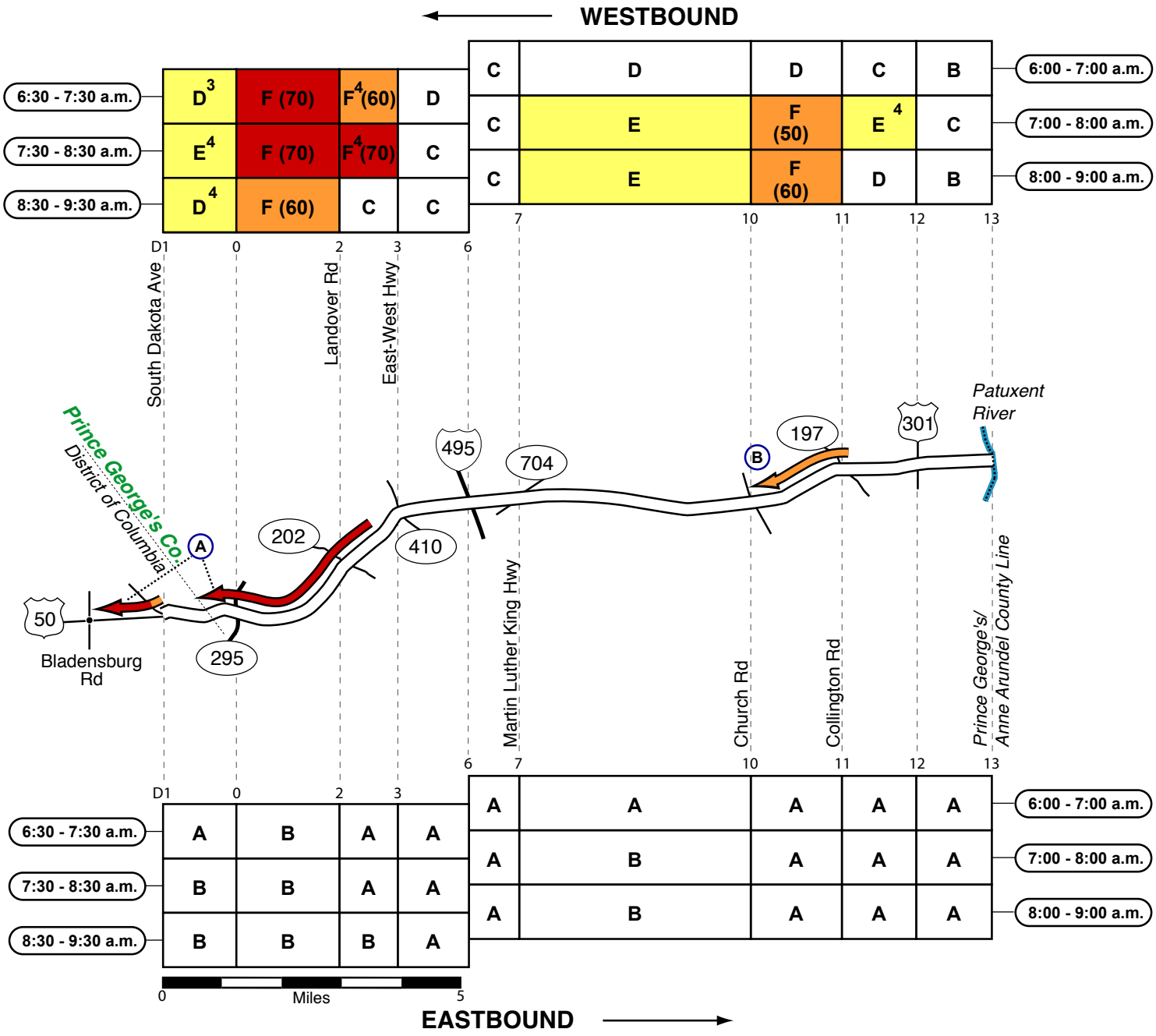
A scale accompanies each rating table in this section of the report.

Nested Congestion

Level-of-Service data for some highway segments represent the mathematical average of densities that varied widely; these data have been tagged with a superscript number in the LOS tables. Four types of "nested" congestion that contributes to the variability have been identified as follows:

Descriptions	Type
Type 1 - Congestion present on some days, but not others.	1
Type 2 - Congestion more severe in left or right-hand lanes.	2
Type 3 - Congestion present only in the first or second half-hour (hourly averages).	3
Type 4 - The length of the congested zone within the segment varies.	4

US 50 (Maryland) - Morning



Traffic Quality Rating

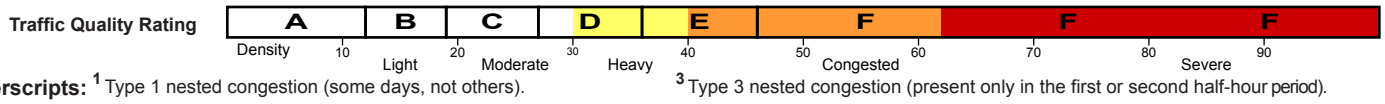
A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

US 50 (Maryland) - Morning

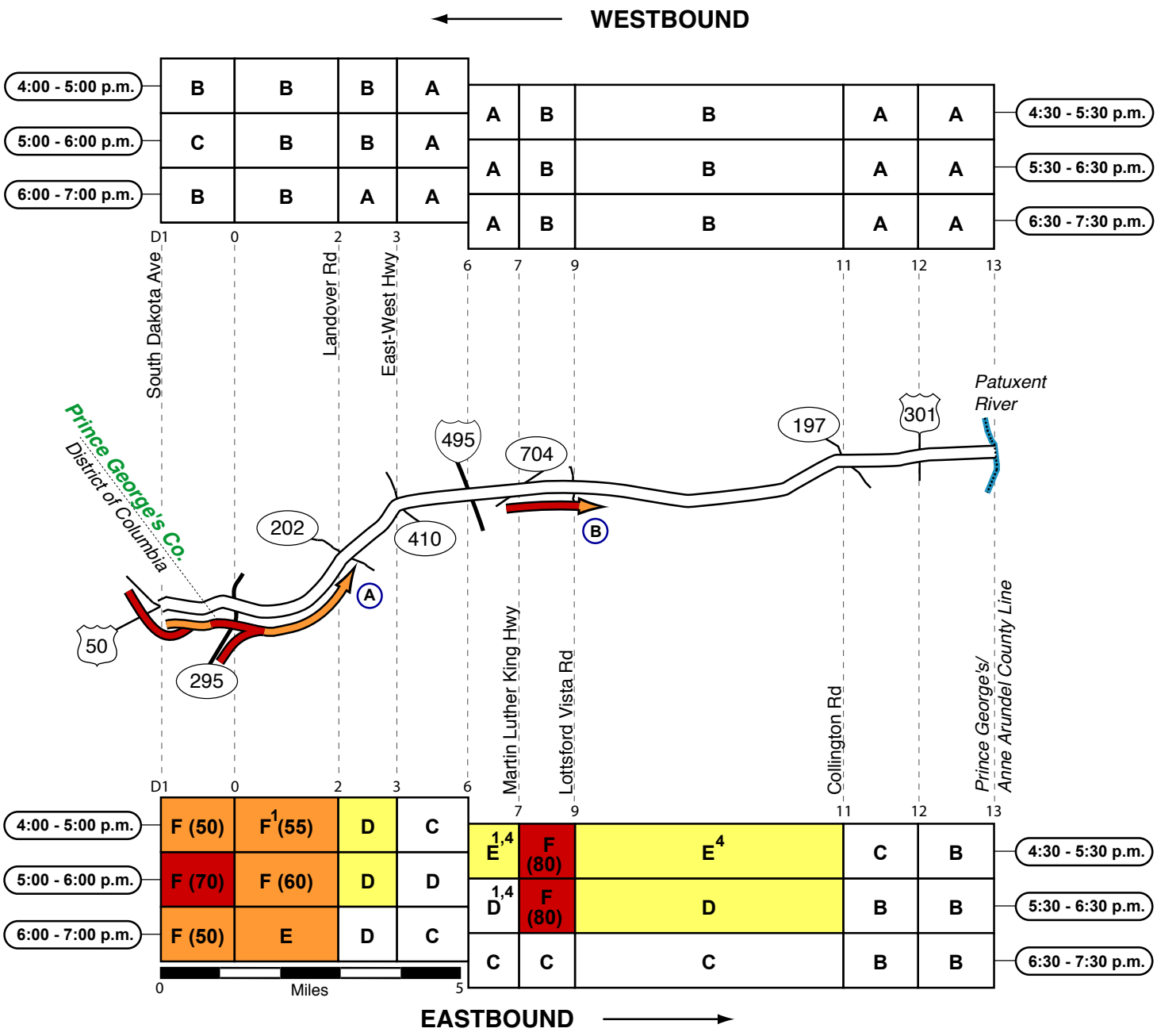
A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Westbound
Location: Approaching & beyond BW Parkway into DC
Queue Length: 3 to 5 miles
Estimated Speed: 20 to 40 mph
Note: Facotrs contributing to severe westbound congestion on US 50 included: 1) merging at the MD 295 ramps and; 2) the signal at Bladensburg Rd in D.C.

B
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Westbound
Location: West of MD 197
Queue Length: 1.5 to 2 miles
Estimated Speed: 30 to 50 mph
Note: Congestion appeared to be exacerbated by traffic entering from MD 197. Weaving associated with the HOV facility may also have contributed to the congestion; HOV users from MD 197 had to weave across three lanes to access the HOV facility.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

US 50 (Maryland) - Evening



Traffic Quality Rating

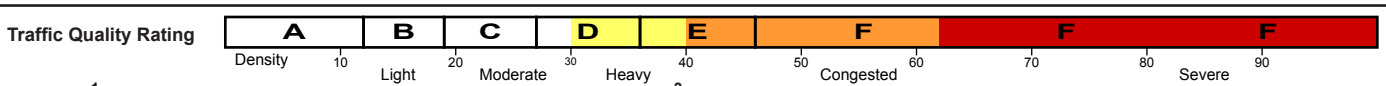
A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

US 50 (Maryland) - Evening

A
Congestion Type: Mainline Congestion
Frequency: Throughout the evening survey period
Direction: Eastbound
Location: Approaching MD 295 merge
Queue Length: 2 to 4 miles
Estimated Speed: 25 to 50 mph
Note: Congestion was caused or exacerbated by the merging associated with the South Dakota Ave, MD 295 and MD 202 interchanges; traffic flow typically improved east of MD 202 where the roadway widened from 2 to 3 lanes. Congestion on the South Dakota Ave entrance ramp was particularly severe; the ramp queue typically extended back into the mainline on South Dakota Ave.

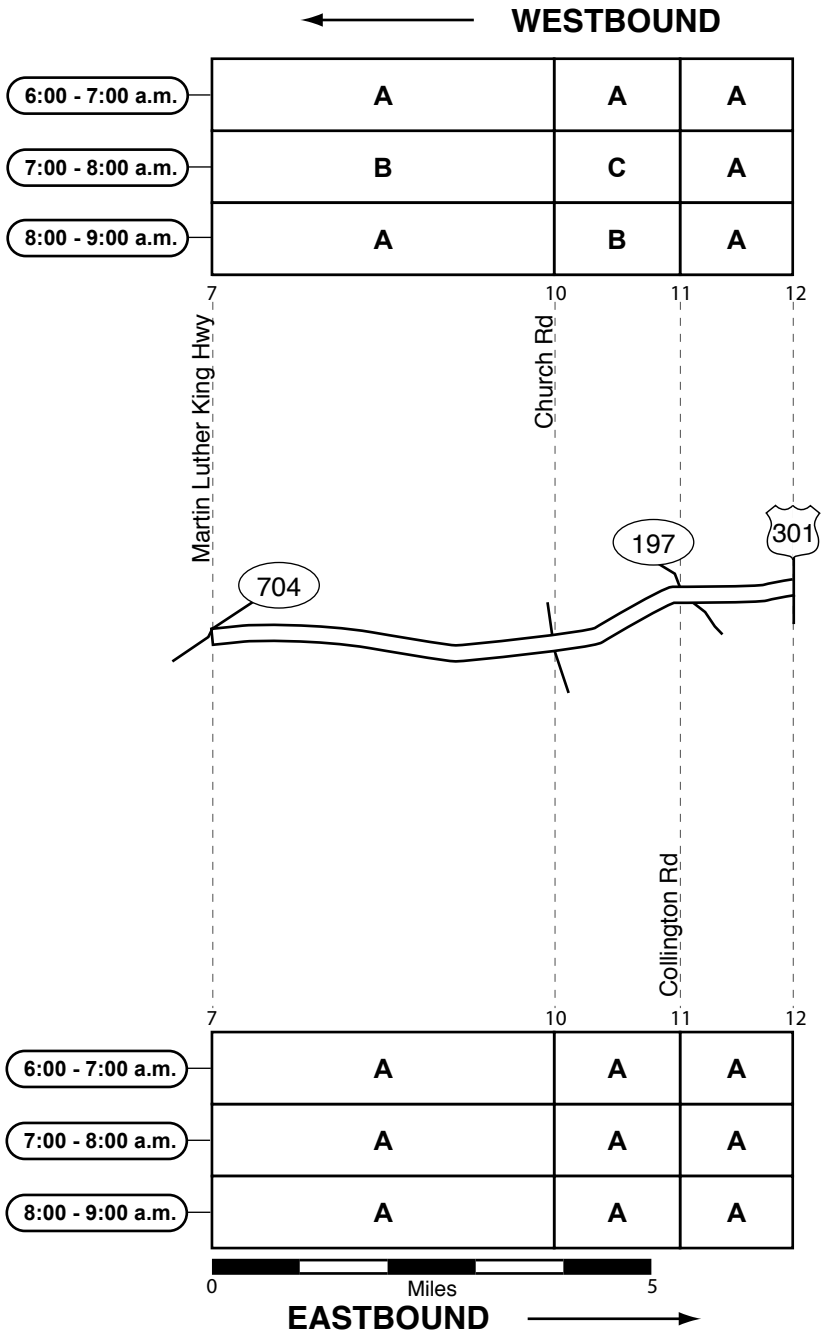
B
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:30 p.m.
Direction: Eastbound
Location: Lane drop at Lottsford Vista Rd
Queue Length: 1 to 1.5 miles
Estimated Speed: 20 to 30 mph
Note: The primary bottleneck was the lane drop from 4 lanes to 3 at Lottsford Vista Rd; traffic entering from MLK Hwy also appeared to exacerbate the congestion.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

US 50 HOV (Maryland) - Morning

HOV OPERATIONS
HOV 2
24 HOUR



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
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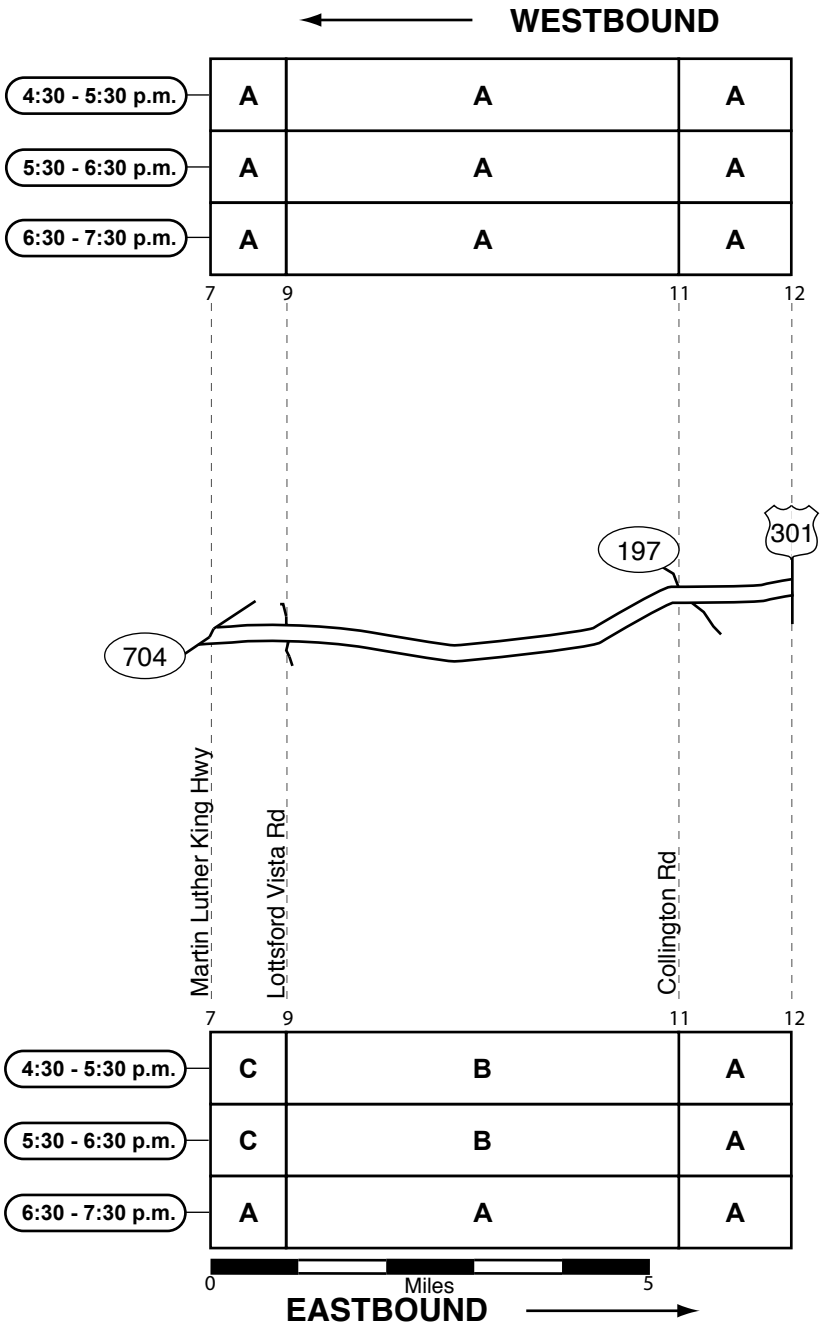
US 50 HOV (MARYLAND) - EVENING

HOV OPERATIONS
HOV 2
24 HOUR



Traffic Quality Rating

A	B	C	D	E	F	F	F

Density 10 Light 20 Moderate 30 Heavy 40 50 Congested 60 70 80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
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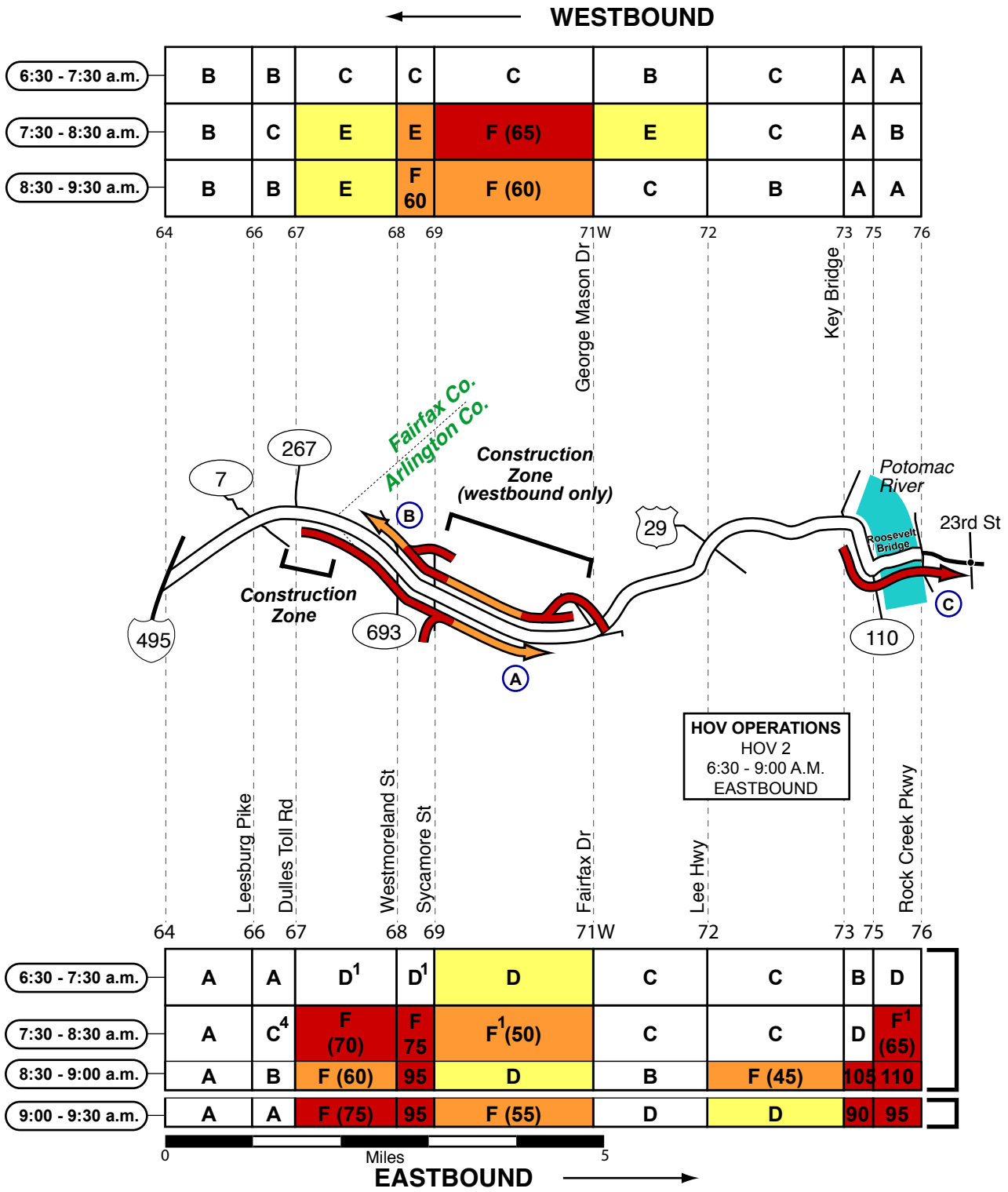
I-66 Inside Beltway (Virginia) - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F

Density 10 20 30 40 50 60 70 80 90

Light Moderate Heavy Congested Severe

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).

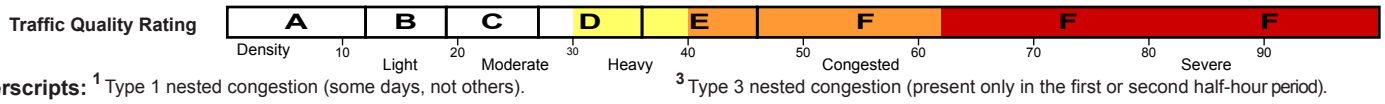
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-66 Inside Beltway (Virginia) - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:30 a.m.
Direction: Eastbound
Location: Between VA 267 & George Mason Dr
Queue Length: 2 to 4 miles
Estimated Speed: 20 to 50 mph
Note: After 7:30 a.m., moderate to severe eastbound congestion was consistently found on I-66 between VA 267 and George Mason Dr; factors that contributed to the congestion included; 1) the lane drop (3 lanes to 2) at US 29; 2) traffic entering the mainline from Sycamore St; 3) sun glare. Historically, severe eastbound congestion did not develop here until after HOV restrictions (after 9:00 a.m.).

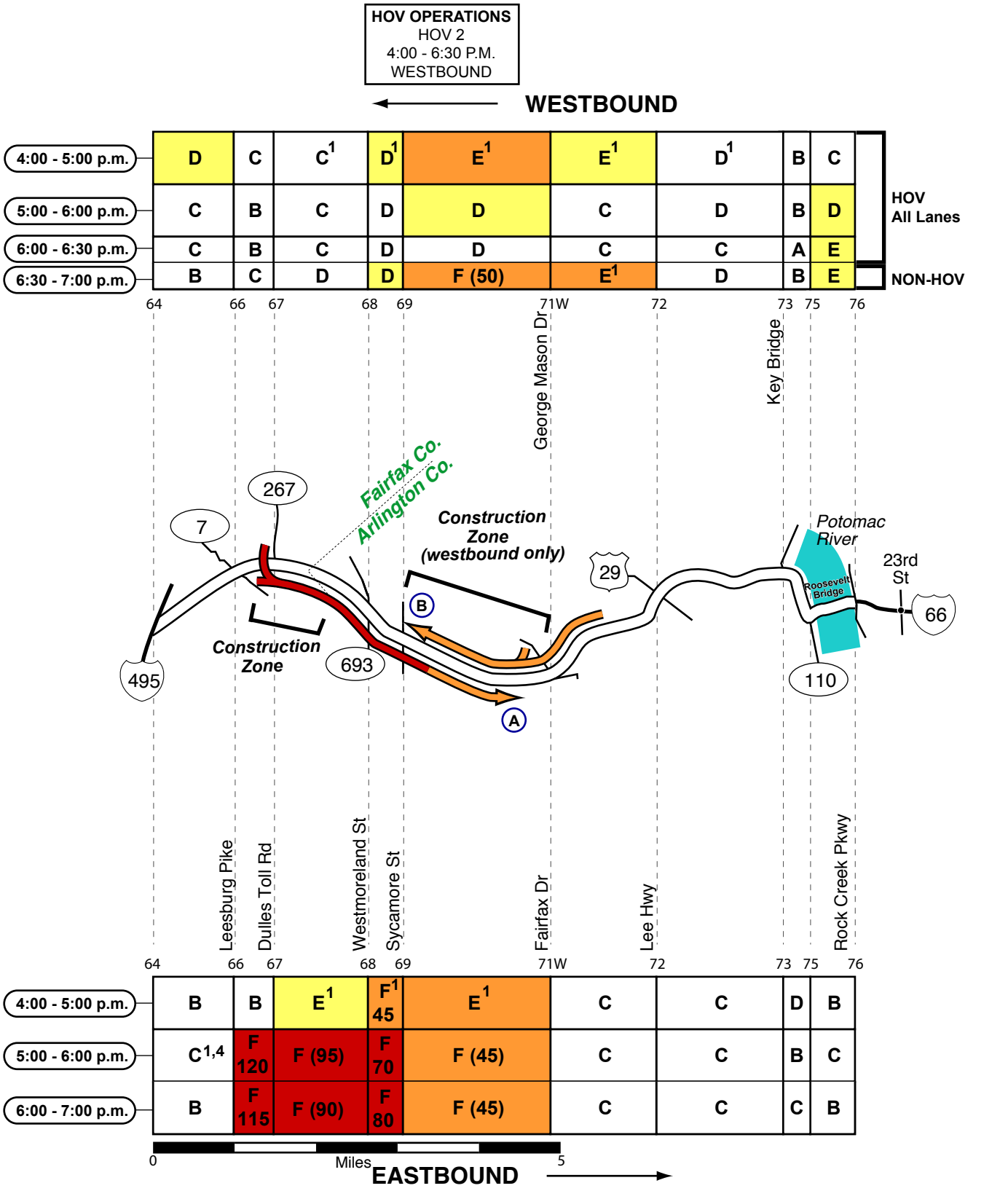
B
Congestion Type: Mainline Congestion
Frequency: Most Observations after 7:30 a.m.
Direction: Westbound
Location: Between Fairfax Dr & Westmoreland St
Queue Length: 2 to 3 miles
Estimated Speed: 30 to 50 mph
Note: Westbound congestion on I-66 typically developed after 7:30 a.m.; traffic entering at Washington Blvd and Fairfax Dr appeared to contribute to the congestion. Construction between Fairfax Dr and Sycamore St may also have exacerbated the congestion

C
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:30 a.m.
Direction: Eastbound
Location: Approaching and across the Roosevelt Bridge
Queue Length: 1 to 1.5 miles
Estimated Speed: 20 to 40 mph
Note: A short zone of severe eastbound congestion was found on I-66 approaching the Potomac River crossing at the Roosevelt Bridge; factors contributing to the congestion included: 1)traffic entering from the local streets in Rosslyn; 2) traffic from Arlington Blvd merging onto the bridge span. The head of the queue was found in Washington D.C. on Constitution Ave approaching the signal at 23rd St NW.



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-66 Inside Beltway (Virginia) - Evening



Traffic Quality Rating

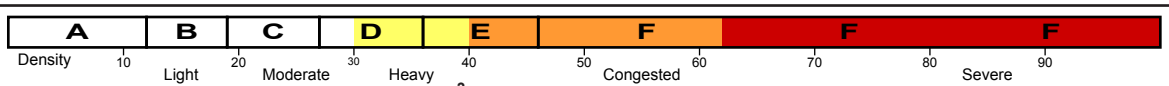
A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-66 Inside Beltway (Virginia) - Evening

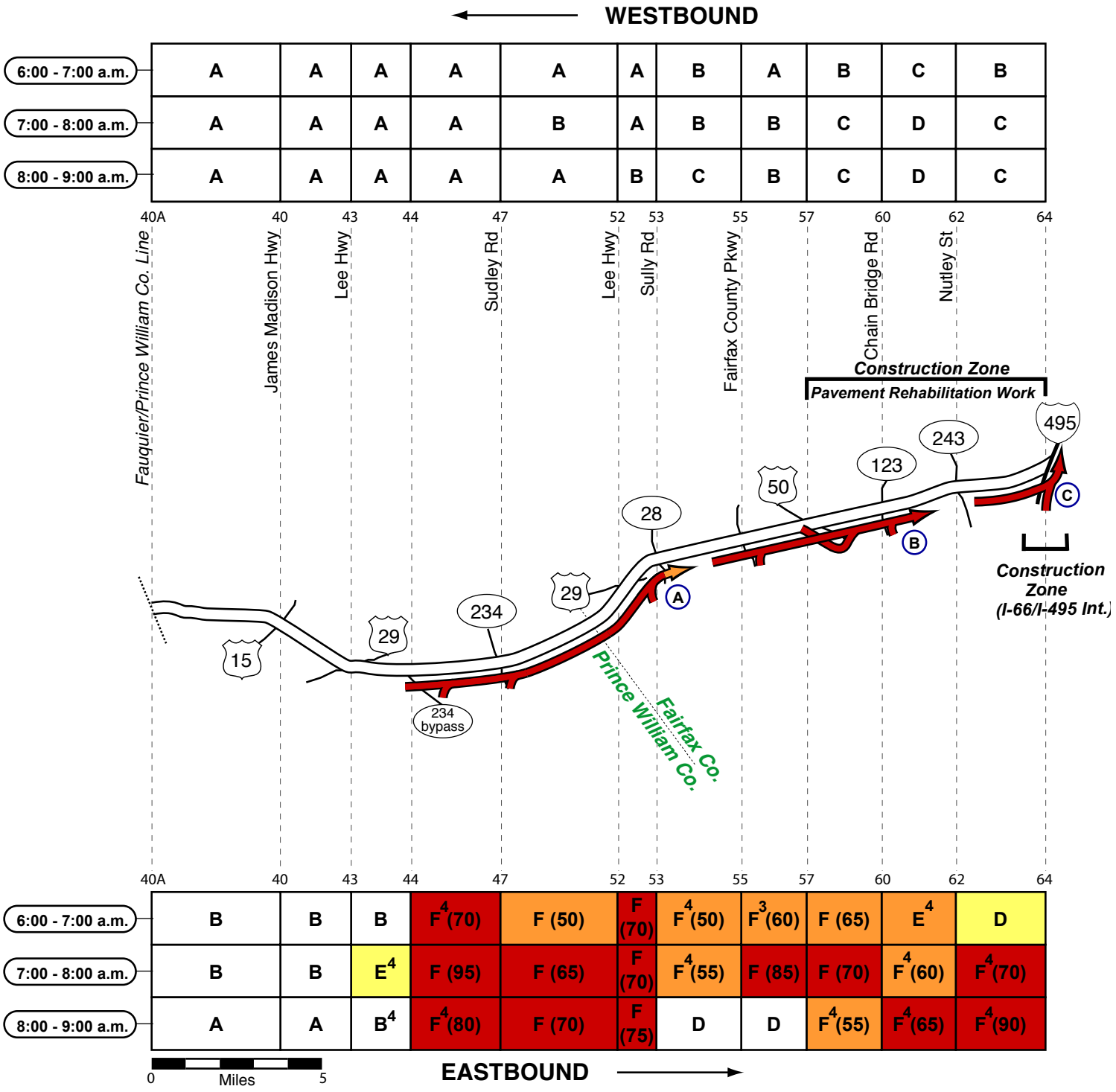
A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Eastbound
Location: Between VA 7 and Fairfax Dr
Queue Length: 3 to 4 miles
Estimated Speed: 15 to 50 mph
Note: As was found during previous surveys, severe eastbound congestion persisted on I-66 throughout most of the evening survey period; factors contributing to the congestion included: 1) traffic entering at VA 267 and Sycamore St; 2) the lane drop (3 lanes to 2) at US 29 (Lee Hwy). Construction at the VA 267 interchange appeared to exacerbate congestion as well.

B
Congestion Type: Mainline Congestion
Frequency: Early and late in the evening commuter period
Direction: Westbound
Location: Between US 29 & Sycamore St
Queue Length: 2 to 3 miles
Estimated Speed: 40 to 55 mph
Note: Shortly after HOV restrictions begin (4:00 p.m.), and soon after (6:30 p.m.) moderate westbound congestion is typically found on I-66 between US 29 and Sycamore St; delays in general did not appear significant.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-66 Outside Beltway (Virginia) - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

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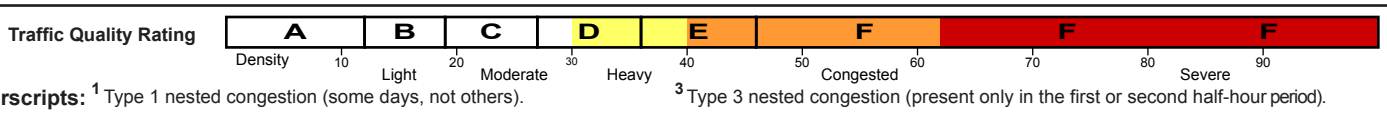
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-66 Outside Beltway (Virginia) - Morning

A
Congestion Type: Mainline Congestion
Frequency: Throughout the morning survey period
Direction: Eastbound
Location: Between VA 234 Bypass and VA 28
Queue Length: 7 to 9 miles
Estimated Speed: 15 to 25 mph
Note: Congestion appeared to be caused or exacerbated by traffic entering at the VA 234 Bypass, VA 234 and US 29 interchanges; weaving associated with the HOV facility likely contributed to the congestion.

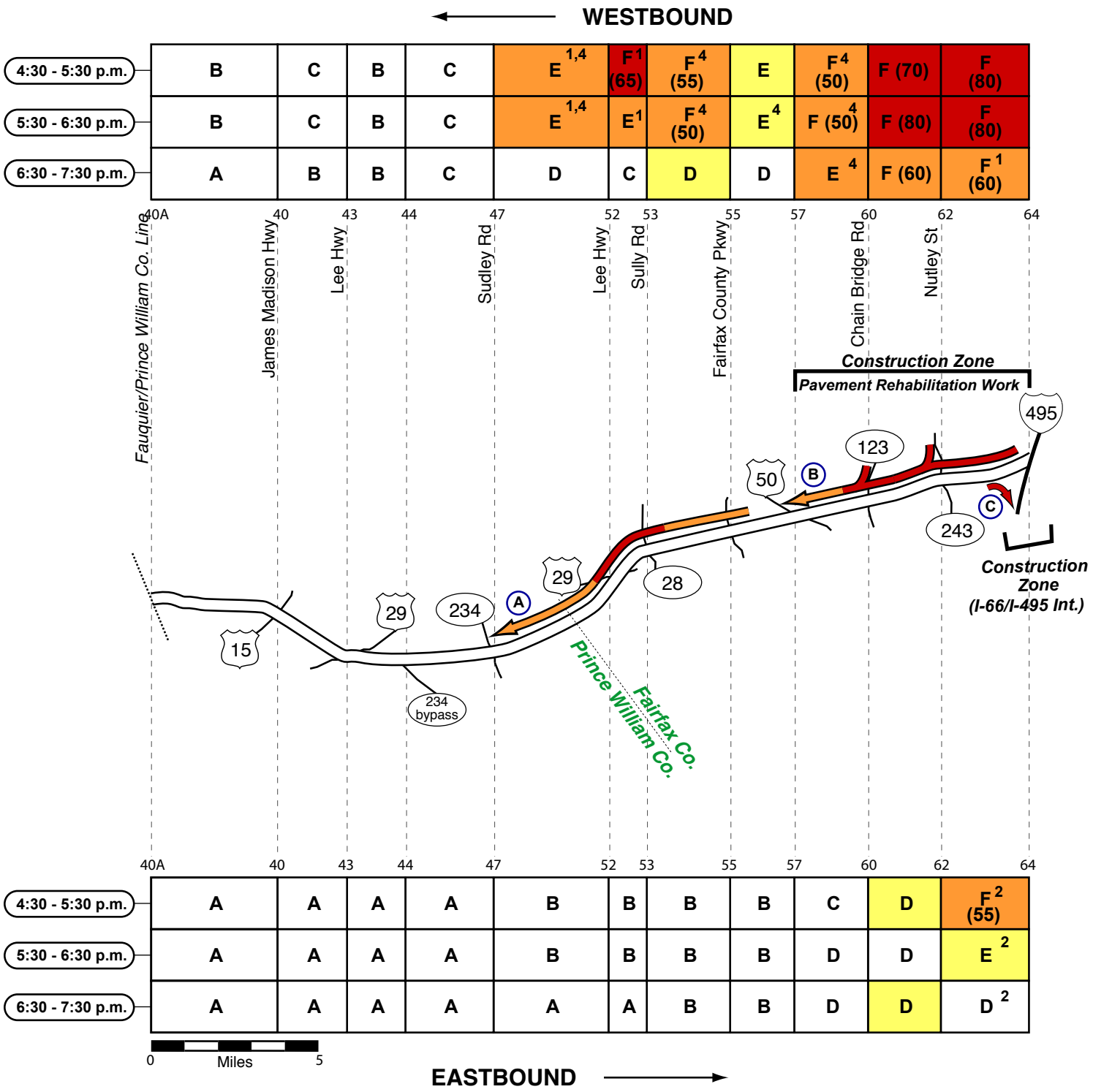
B
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Eastbound
Location: Between VA 28 & Nutley St
Queue Length: 7 to 9 miles
Estimated Speed: 15 to 45 mph
Note: The head of the queue was found on the Nutley St exit ramp (Note: Metro service begins at Nutley St); traffic entering at Fairfax County Parkway, US 50 and Chain Bridge Rd contributed to the congestion. Congestion on the US 50 entrance ramp was particularly severe; the ramp queue typically extended back into the mainline on US 50.

C
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Eastbound
Location: Between Nutley St & the Beltway
Queue Length: 2 to 3 miles
Estimated Speed: 10 to 40 mph
Note: The head of the queue was found on the one-lane ramp to the inner loop of the Beltway; congestion typically extended back into the right lane (and eventually across all lanes) of I-66. Although conditions closely resembled those found during previous surveys, it is possible that construction at the I-495 interchange contributed to the congestion.



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-66 Outside Beltway (Virginia) - Evening



Traffic Quality Rating: A | B | C | D | E | F | F | F

Density: 10 Light | 20 Moderate | 30 Heavy | 40 | 50 Congested | 60 | 70 | 80 Severe | 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).

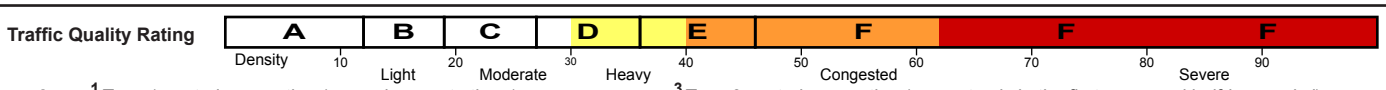
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-66 Outside Beltway (Virginia) - Evening

A
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:00 p.m.
Direction: Westbound
Location: Between Fairfax County Pkwy & Sudley Rd (SR 234)
Queue Length: 5 to 9 miles
Estimated Speed: 20 to 50 mph
Note: On two of the four evening surveys, westbound congestion was found on I-66 between Fairfax County Pkwy and Sudley Rd (SR 234); on the other two evenings, westbound travelers experienced only minor delays along this section of I-66. Traffic entering at the interchanges appeared to contribute to the congestion; however, the entrance ramps were not congested.

B
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Westbound
Location: Between I-495 & US 50
Queue Length: 4 to 6 miles
Estimated Speed: 20 to 50 mph
Note: The tail of the queue on westbound I-66 was typically found at the I-495 interchange (during several observations the queue extended a short distance inside the beltway); congestion was particularly severe in the vicinity of the Nutley St and Chain Bridge Rd interchanges where traffic entered the mainline. Westbound travelers typically resumed free flow speeds approaching the interchange at US 50.

C
Congestion Type: Exit queue
Frequency: Most observations
Direction: Eastbound
Location: Between Nutley St and I-495
Queue Length: 1 to 2 miles
Note: During most observations, eastbound congestion (stop-and-go) was found in the right lane on I-66 approaching the exit ramp to the outer loop of the Beltway; construction at the I-495/I-66 interchange may have caused or exacerbated the congestion. Intermittently, congestion in the right lane extended back across all lanes on I-66.



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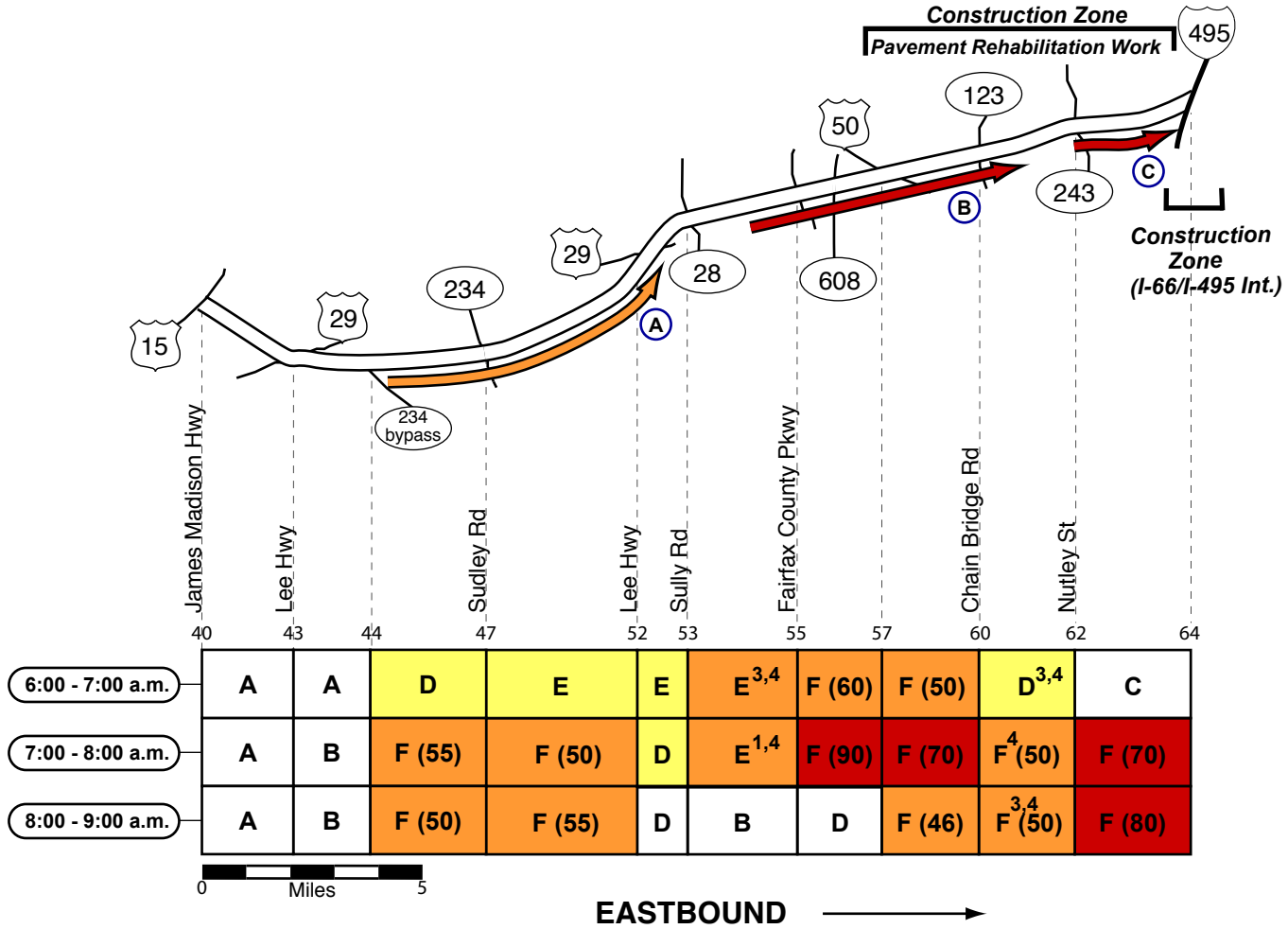
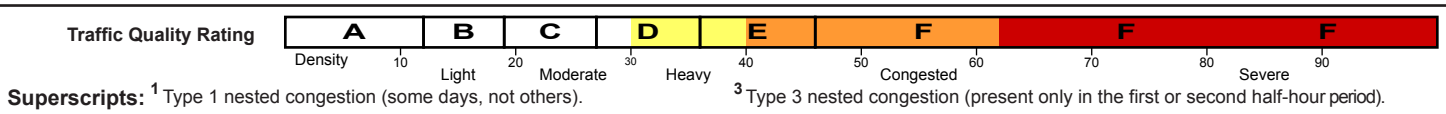
I-66 (Outside Beltway) Left Lane / Concurrent Flow HOV - Morning



A
Congestion Type: HOV Congestion
Frequency: Most observations
Direction: Eastbound
Location: Between VA 234 Bypass & US 29
Queue Length: 6 to 9 miles
Estimated Speed: 30 to 50 mph
Note: Congestion appeared to be exacerbated by weaving and friction between the HOV facility and the congested general-purpose lanes.

B
Congestion Type: HOV Congestion
Frequency: Most observations between 6:30 and 8:30 a.m.
Direction: Eastbound
Location: Between VA 28 & Nutley St
Queue Length: 6 to 9 miles
Estimated Speed: 15 to 50 mph
Note: Factors contributing to the congestion were: 1) traffic entering from the center of the roadway at VA 608; and 2) friction between the HOV roadway and the congested general-purpose lanes.

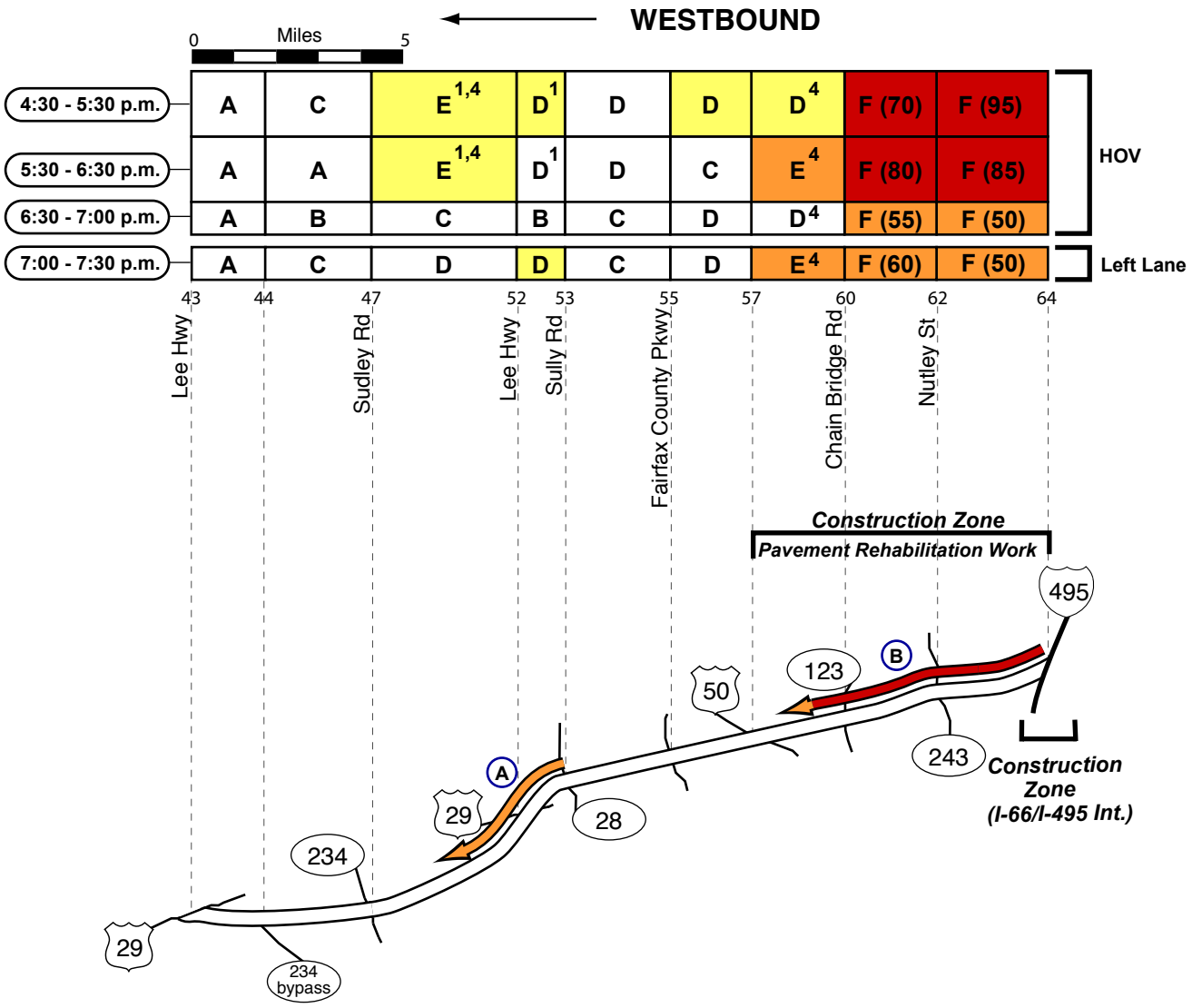
C
Congestion Type: HOV Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Eastbound
Location: Between Nutley St & the Beltway
Queue Length: 1 to 2 miles
Estimated Speed: 20 to 50 mph
Note: Congestion appeared to be exacerbated by weaving and friction between the HOV facility and the congested general-purpose lanes; HOV vehicles consistently resumed free flow speeds east of the ramps to the inner loop of the Beltway.



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-66 (Outside Beltway) Left Lane / Concurrent Flow HOV - Evening

HOV OPERATIONS
HOV 2
3:00 - 7:00 P.M.
WESTBOUND



A
Congestion Type: HOV Congestion
Frequency: Intermittent (before 6:00 p.m.)
Direction: Westbound
Location: Between Sully Rd (SR 28) & Sudley Rd (SR 234)
Queue Length: 1 to 4 miles
Estimated Speed: 40 to 55 mph

B
Congestion Type: HOV Congestion
Frequency: Most observations
Direction: Westbound
Location: Between I-495 & US 50
Queue Length: 4 to 5 miles
Estimated Speed: 20 to 50 mph
Note: Westbound travelers in the HOV lane typically resumed free flow speeds at the location where use of the shoulder drops for the general-purpose lanes (between Chain Bridge Rd and US 50), and where HOV vehicles shift to the left to access the continuation of the HOV facility.

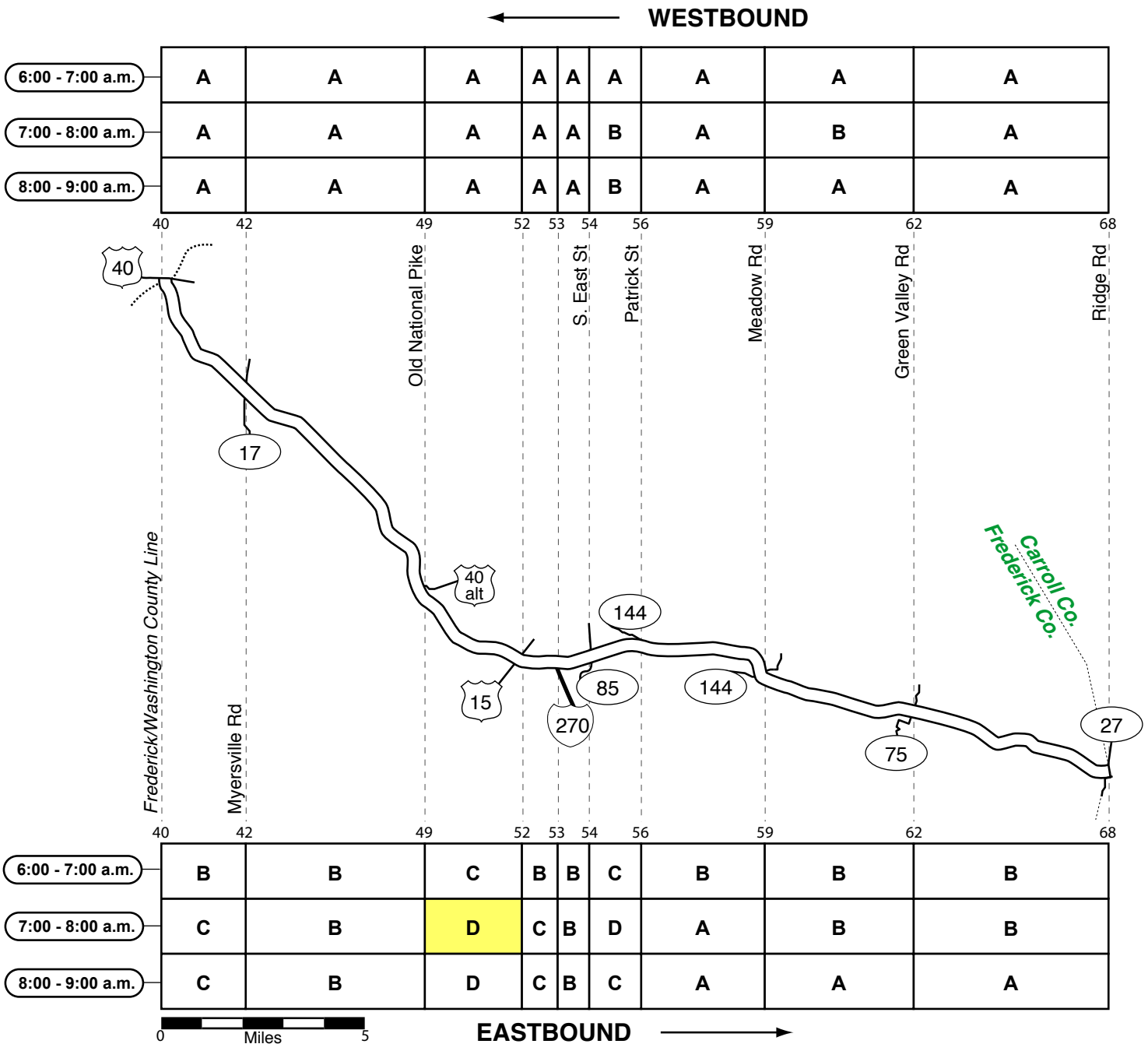
Traffic Quality Rating

A	B	C	D	E	F	F	F

Density 10 20 30 40 50 60 70 80 90
Light Moderate Heavy Congested Severe

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-70 (Maryland) - Morning

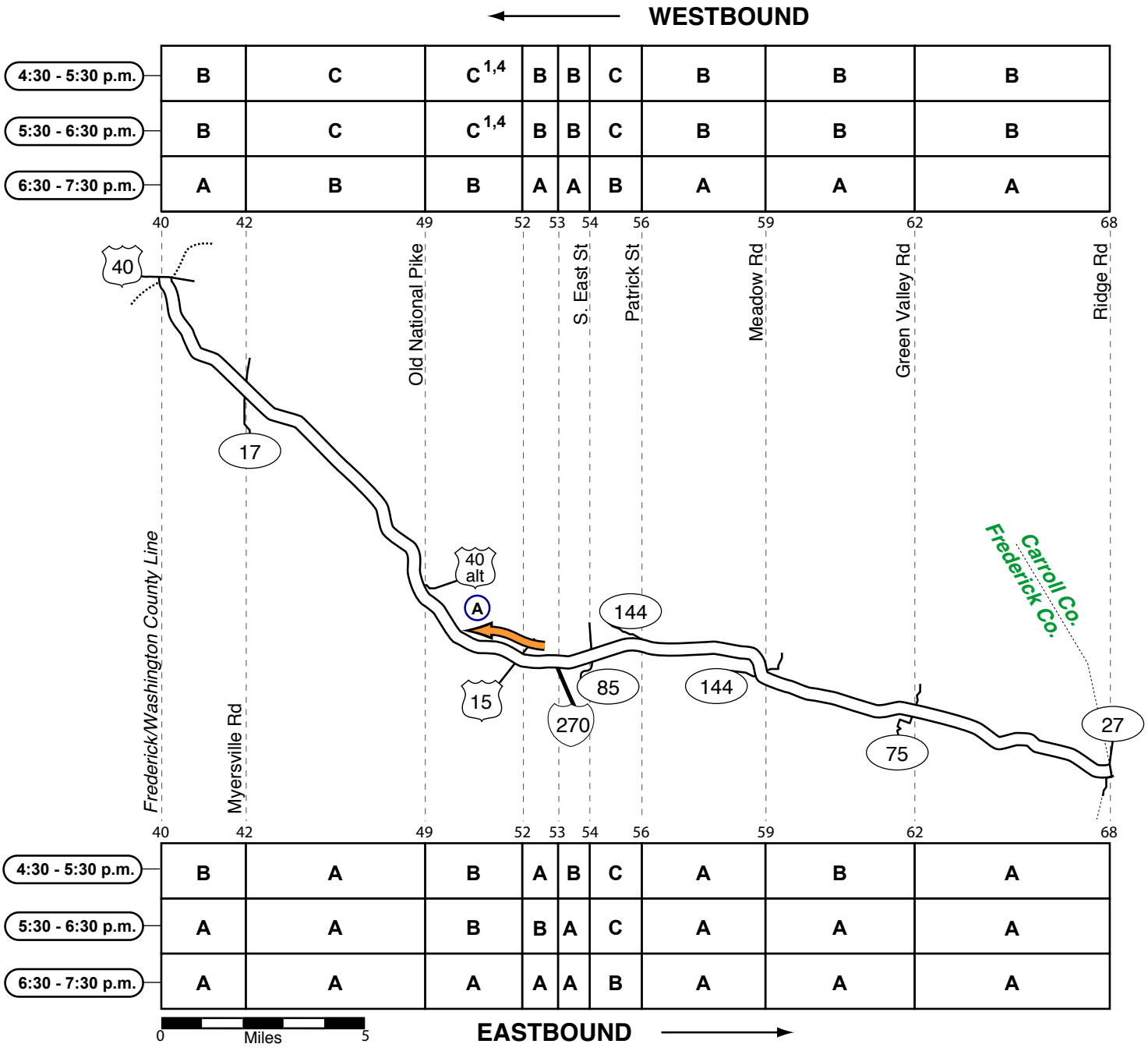


Traffic Quality Rating

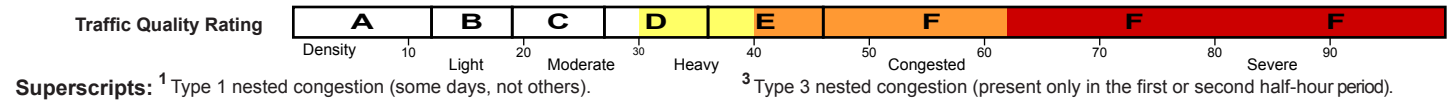
A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-70 (Maryland) - Evening

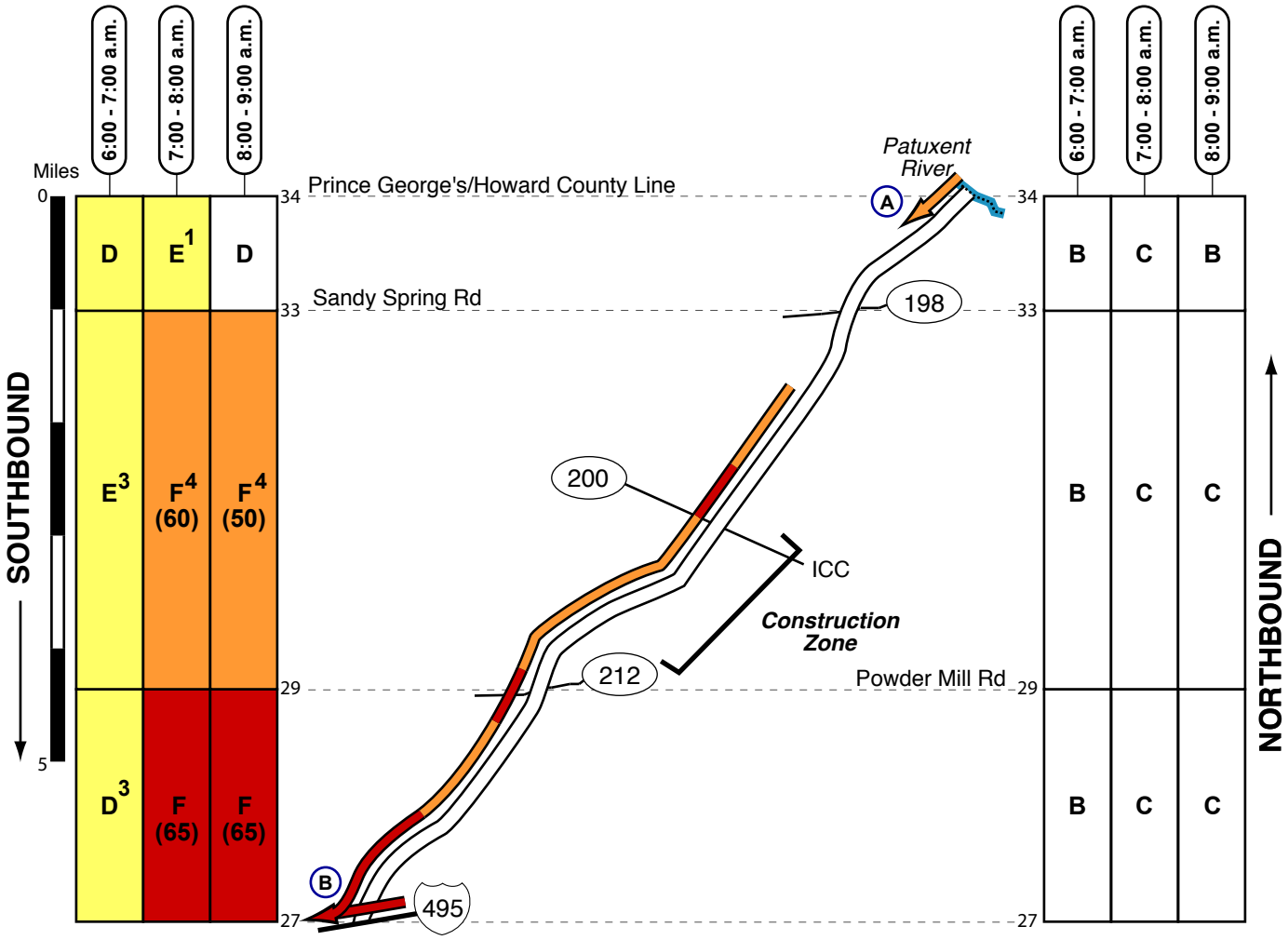


C
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Westbound
Location: Just west of US 15 / 40
Queue Length: 0.5 to 1 miles
Estimated Speed: 30 to 50 mph
Note: Congestion appeared to be caused or exacerbated by traffic entering from US 15; west of the merge, traffic flow typically improved.



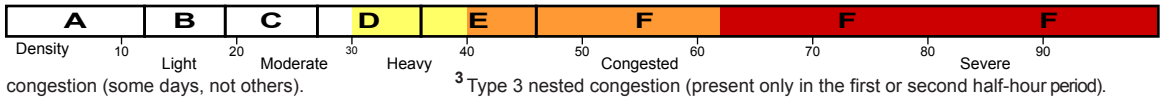
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-95 (Maryland) - Morning



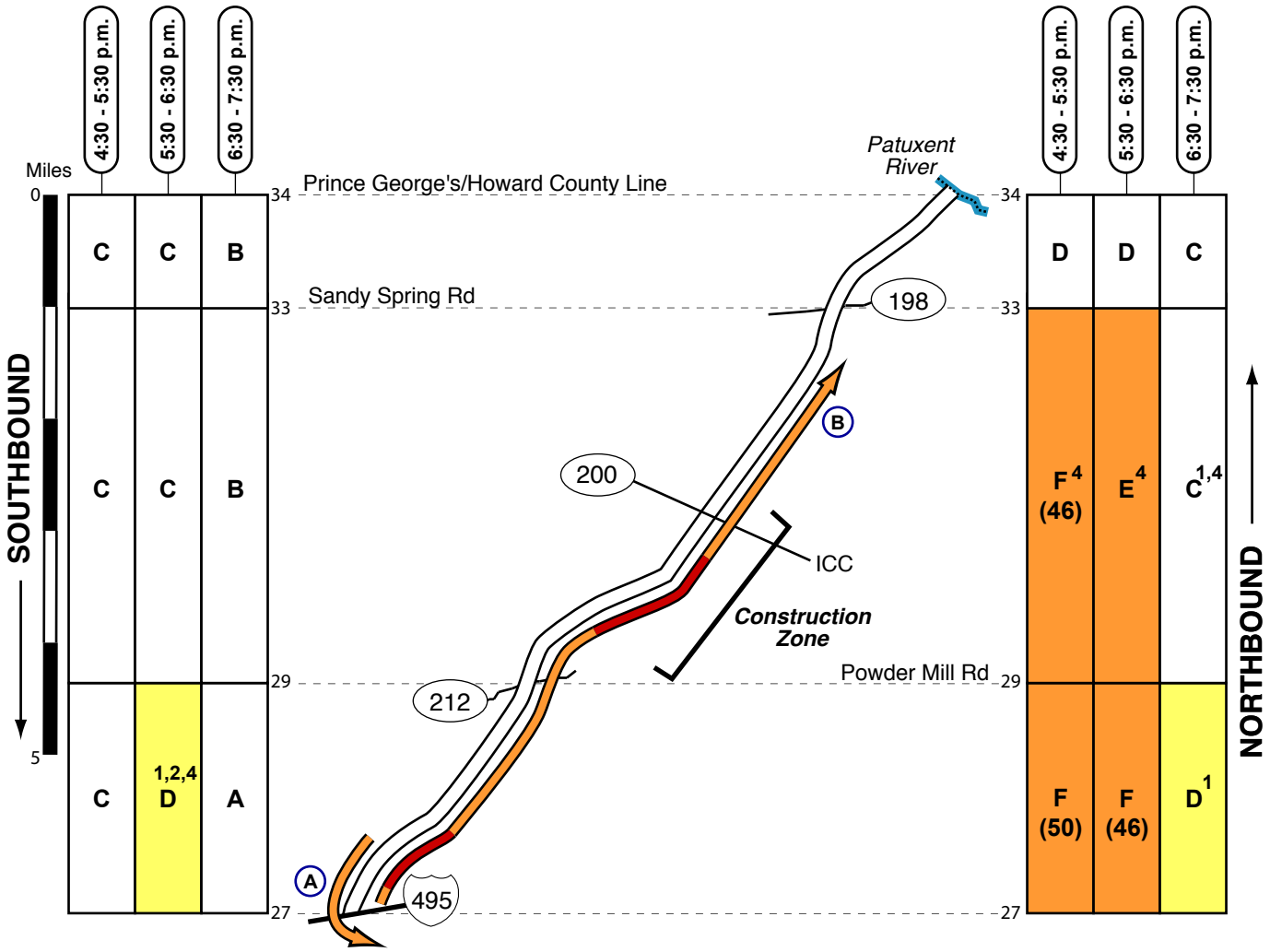
A
Congestion Type: Marginal mainline Congestion
Frequency: Intermittent
Direction: Southbound
Location: Crossing the Patuxent River
Queue Length: 0.25 to 0.5 miles
Estimated Speed: 40 to 50 mph

B
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Southbound
Location: Approaching I-495 (beltway)
Queue Length: 3 to 6 miles
Estimated Speed: 25 to 50 mph
Note: Factors contributing to the congestion were: 1) downstream congestion on the outer loop of I-495; 2) weaving approaching the I-95/I-495 split; and 3) ongoing construction of the new ICC interchange. Intermittently, congestion was found on the ramp to the inner loop of I-495.



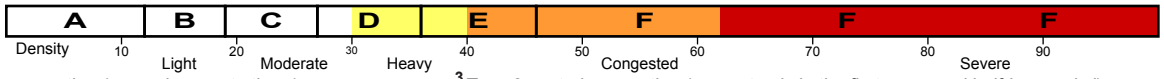
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-95 (Maryland) - Evening



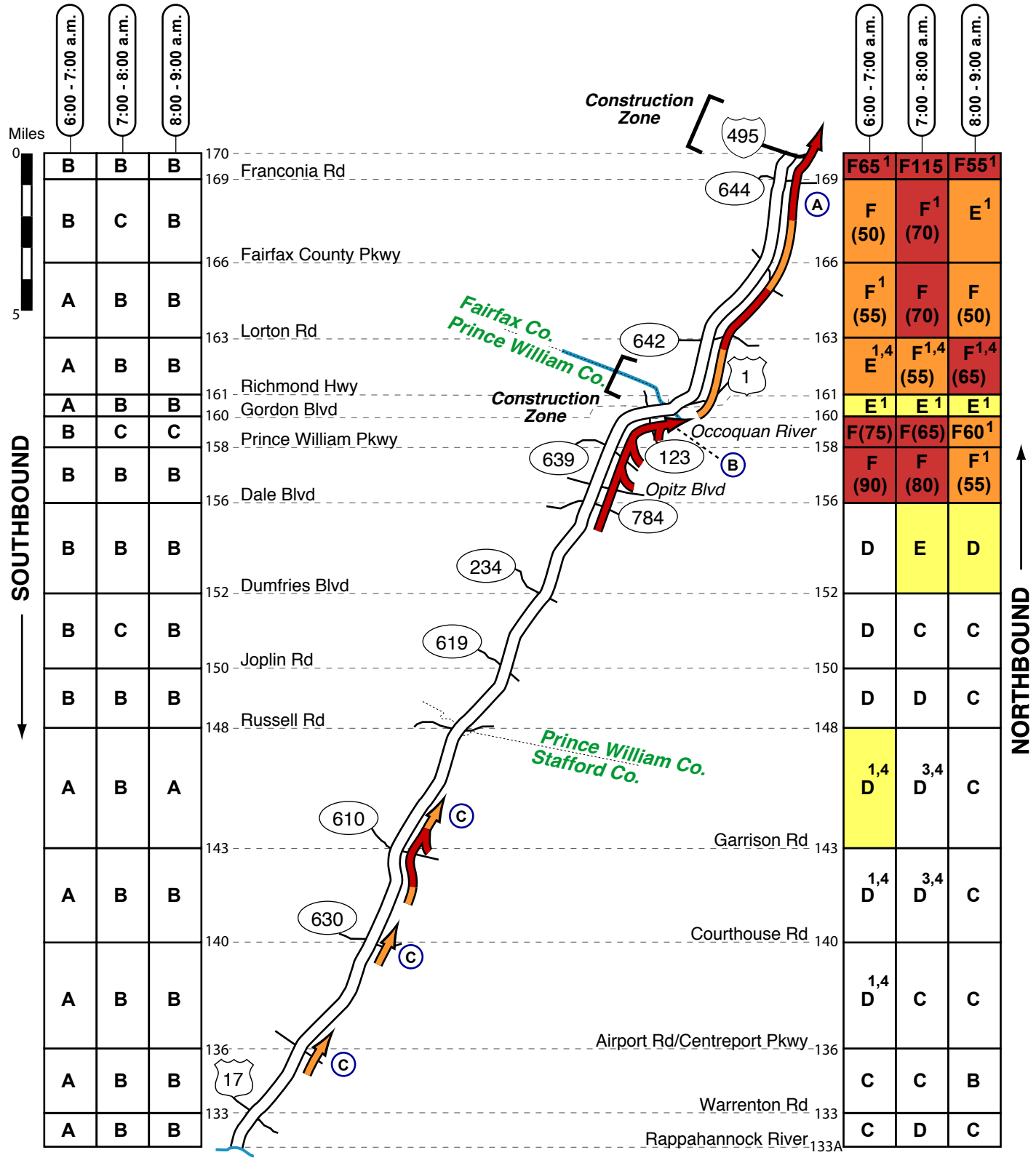
A
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Southbound
Location: Approaching I-495 (beltway)
Queue Length: 1 to 1.5 miles
Estimated Speed: 30 to 50 mph
Note: The head of the queue was found downstream on the inner loop of the Beltway; congestion extended back into the left two lanes of I-95.

B
Congestion Type: Mainline Congestion
Frequency: Most observations before 7:00 p.m.
Direction: Northbound
Location: I-495 (beltway ramps) to MD 198
Queue Length: 4 to 6 miles
Estimated Speed: 35 to 50 mph
Note: Factors contributing to the congestion were: 1) the merge from the inner and outer loops of the Beltway; 2) traffic entering from Powder Mill Rd; 3) ongoing construction at the ICC interchange.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-95 (Virginia) - Morning



6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
B	B	B
B	C	B
A	B	B
A	B	B
A	B	B
B	C	C
B	B	B
B	B	B
B	C	B
B	B	B
A	B	A
A	B	B
A	B	B
A	B	B
A	B	B

6:00 - 7:00 a.m.	7:00 - 8:00 a.m.	8:00 - 9:00 a.m.
F65 [1]	F115	F55 [1]
F (50)	F [1] (70)	E [1]
F [1] (55)	F (70)	F (50)
E [1,4]	F [1,4] (55)	F [1,4] (65)
E [1]	E [1]	E [1]
F(75)	F(65)	F60 [1]
F (90)	F (80)	F [1] (55)
D	E	D
D	C	C
D	D	C
D [1,4]	D [3,4]	C
D [1,4]	D [3,4]	C
D [1,4]	C	C
C	C	B
C	D	C

Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

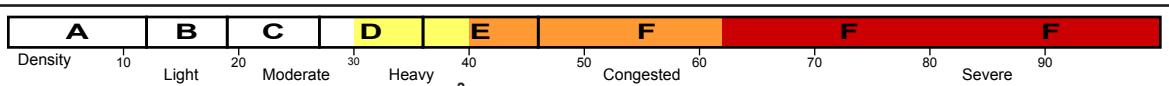
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-95 (Virginia) - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Northbound
Location: Between the Occoquan River and I-495
Queue Length: 6 to 9 miles
Estimated Speed: 20 to 45 mph
Note: During the peak period, a continuous zone of northbound congestion was typically found on I-95 between the Occoquan River and the Beltway; the severity of congestion varied day to day. Stop-and-go flow was consistently found on the final approach to the Beltway where construction at the Springfield Interchange may have exacerbated congestion.

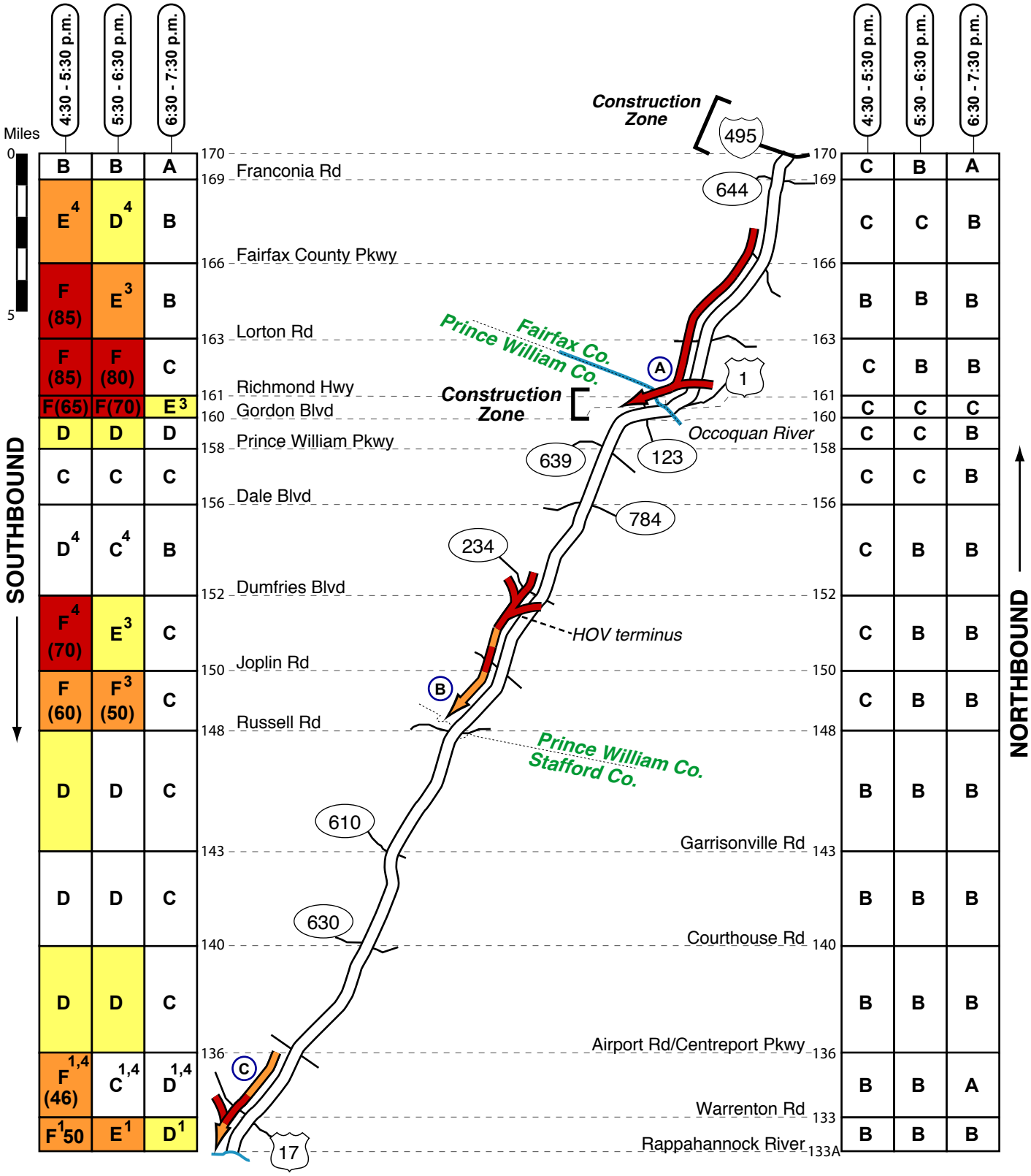
B
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Northbound
Location: Between Dale Blvd & the Occoquan River
Queue Length: 3 to 5 miles
Estimated Speed: 25 to 45 mph
Note: Throughout the morning survey period, northbound congestion was found on I-95 approaching the Occoquan River; the primary bottlenecks were found where traffic merged into the mainline from the auxiliary lanes just north of Opitz Blvd, and at the interchanges at Prince William Pkwy and Gordon Blvd. After the merge at Gordon Blvd, traffic typically resumed free flow speeds crossing the Occoquan River.

C
Congestion Type: Mainline Congestion
Frequency: Intermittently before 7:30 a.m.
Direction: Northbound
Location: Stafford County
Estimated Speed: 30 to 50 mph
Note: Traffic entering at the series of interchanges in Stafford County appeared to intermittently cause minor northbound congestion on I-95. Stop-and-go flow was intermittently found in the vicinity of VA 610 (Garrison Rd).



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-95 (Virginia) - Evening



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

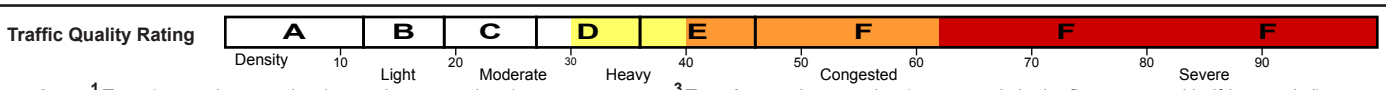
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-95 (Virginia) - Evening

A
Congestion Type: Mainline Congestion
Frequency: Most observations before 7:00 p.m.
Direction: Southbound
Location: Between Franconia Rd & Gordon Blvd
Queue Length: 5 to 8 miles
Estimated Speed: 20 to 40 mph
Note: Prior to 6:00 p.m., severe southbound congestion was consistently found on I-95 between Franconia Rd and Gordon Blvd; later in the survey period, congestion gradually dissipated (shorter queue length). The primary bottlenecks were found where traffic entered the mainline from the interchanges at US Route 1 and Gordon Blvd. During the two evening observations at 7:25 p.m., free flow conditions were found along this section of I-95.

B
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:00 p.m.
Direction: Southbound
Location: Between Dumfries Blvd & Russell Rd
Queue Length: 4 to 7 miles
Estimated Speed: 30 to 50 mph
Note: Prior to the expiration of HOV restrictions (6:00 p.m.), southbound congestion was consistently found on I-95 between Dumfries Rd and Russell Rd; stop-and-go flow was typically found approaching the terminus of the HOV facility located just south of the Dumfries Rd interchange. Vehicles from the HOV facility merge into the left lane on I-95 while traffic entering from Dumfries Rd merge into the right lane.

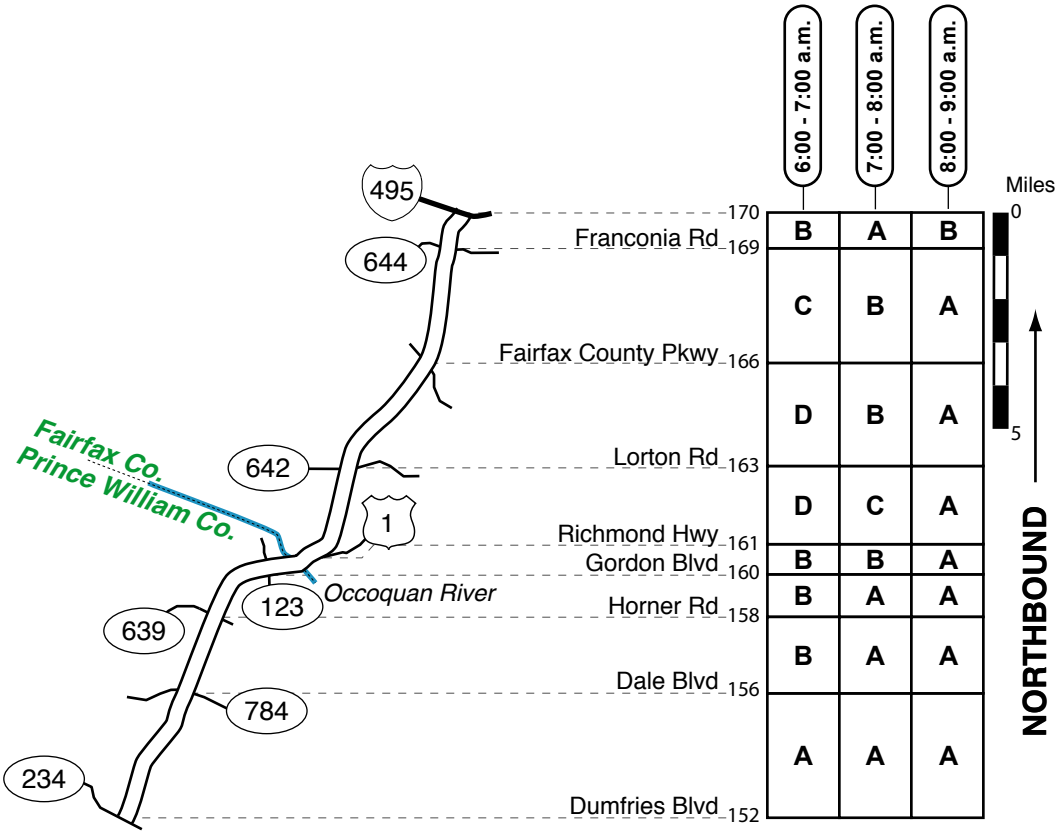
C
Congestion Type: Mainline Congestion
Frequency: Most observations before 7:00 p.m.
Direction: Southbound
Location: Approaching the Rappahannock River
Queue Length: 1 to 4 miles
Estimated Speed: 30 to 50 mph
Note: During most observations, southbound congestion was found on I-95 approaching the Rappahannock River; a short zone of stop-and-go flow was typically found in the vicinity of the entrance ramp at US 17 where vehicles merged into the mainline. Construction on the bridge at the Occoquan River may also have exacerbated congestion. On some days but not others, moderate congestion extended upstream to the vicinity of Airport Rd (a distance of approximately 3 miles).



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-95 Barrier Separated HOV (Virginia) - Morning

HOV OPERATIONS
HOV 3
6:00 - 9:00 A.M.
NORTHBOUND



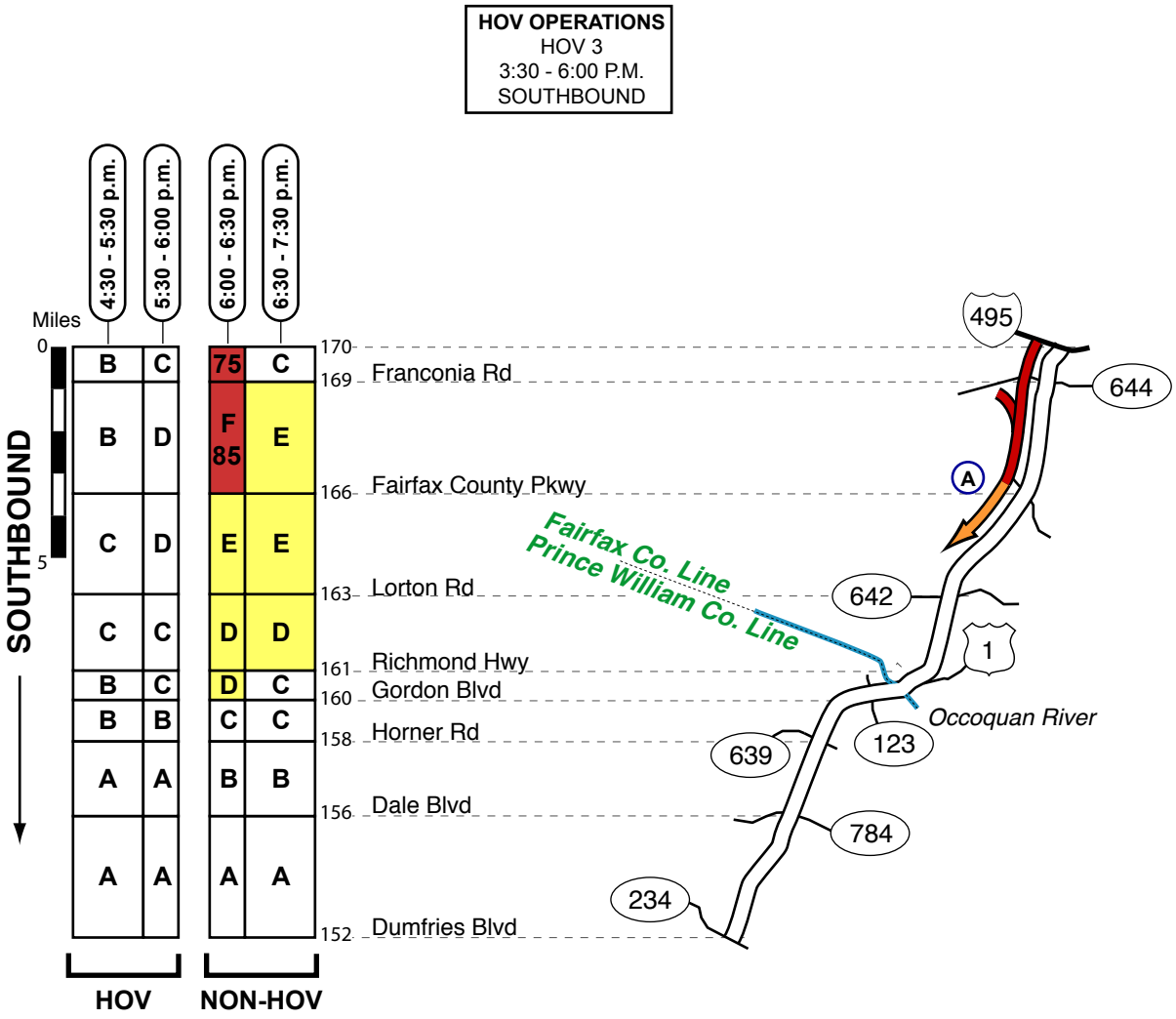
Traffic Quality Rating

A	B	C	D	E	F	F	F

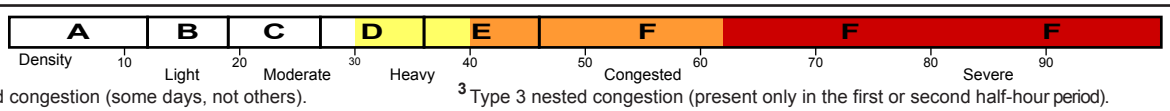
Density 10 20 30 40 50 60 70 80 90
Light Moderate Heavy Congested Severe

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-95 BARRIER SEPARATED HOV (VIRGINIA) - EVENING

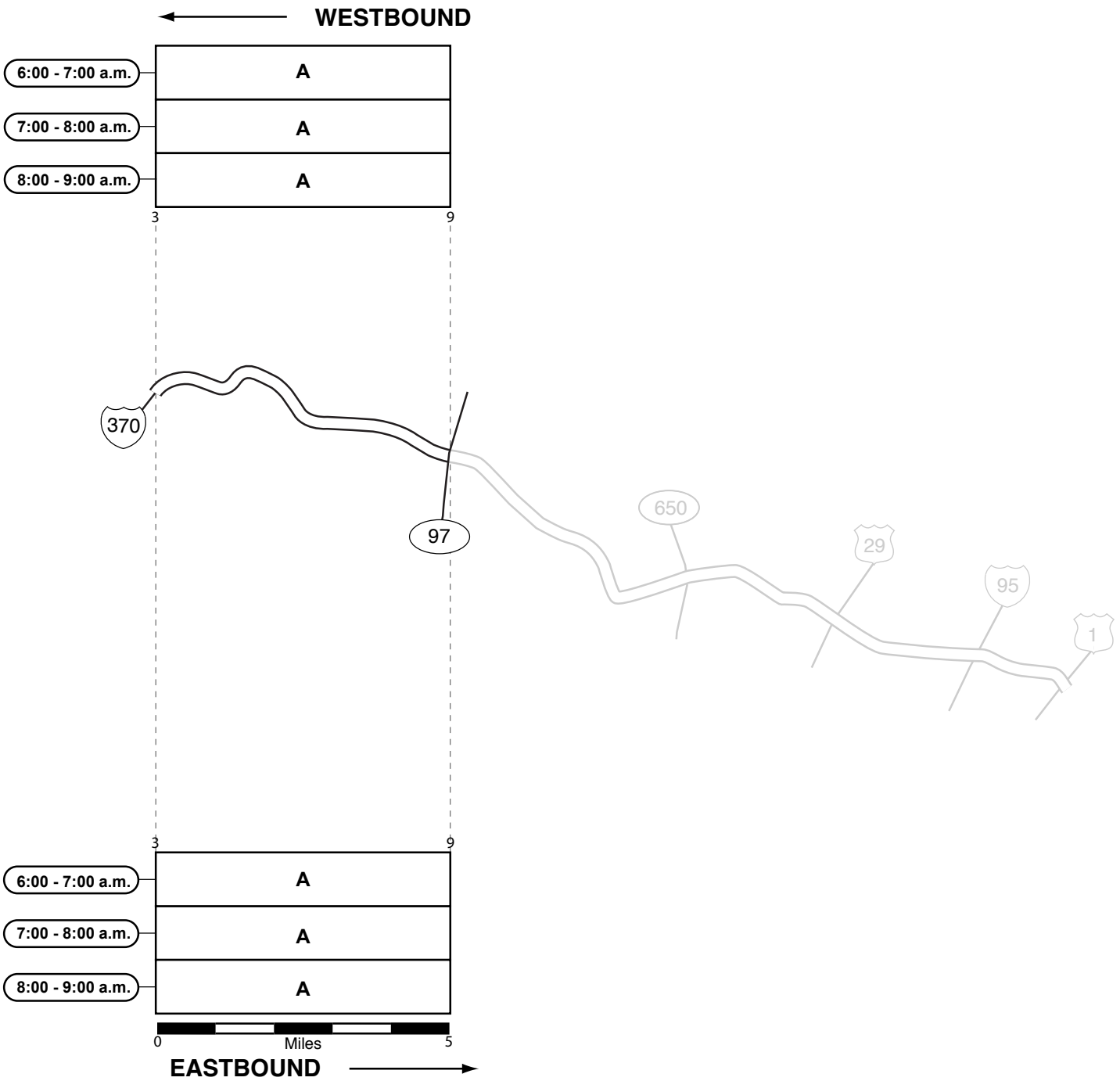


A
Congestion Type: Mainline Congestion
Frequency: Most observations between 6:00 and 7:00 p.m.
Direction: Southbound
Location: Between I-495 & Fairfax County Parkway
Queue Length: 1 to 3 miles
Estimated Speed: 20 to 50 mph



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

MD 200 (Intercounty Connector) - Morning

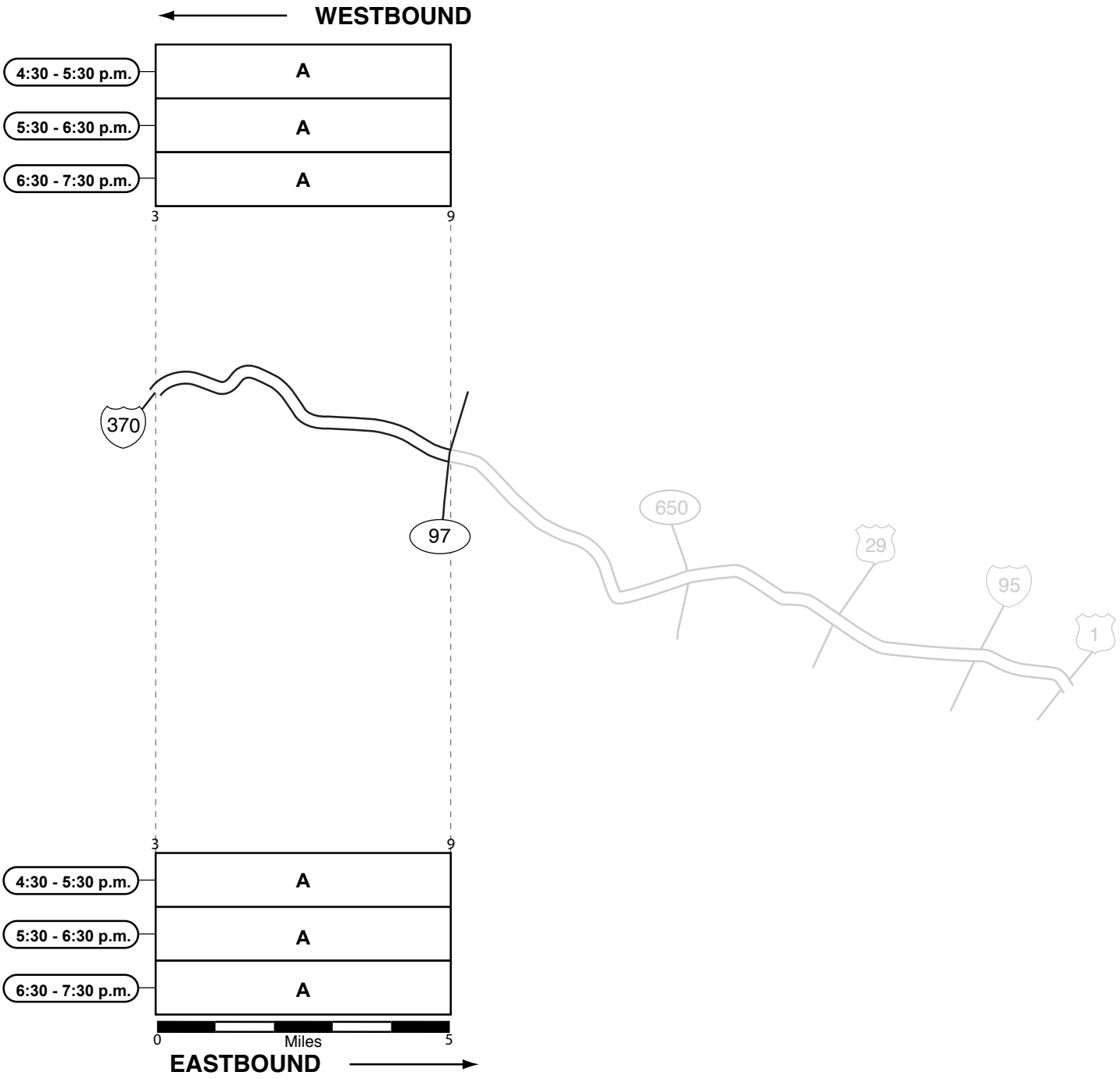


Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

MD 200 (Intercounty Connector) - Evening

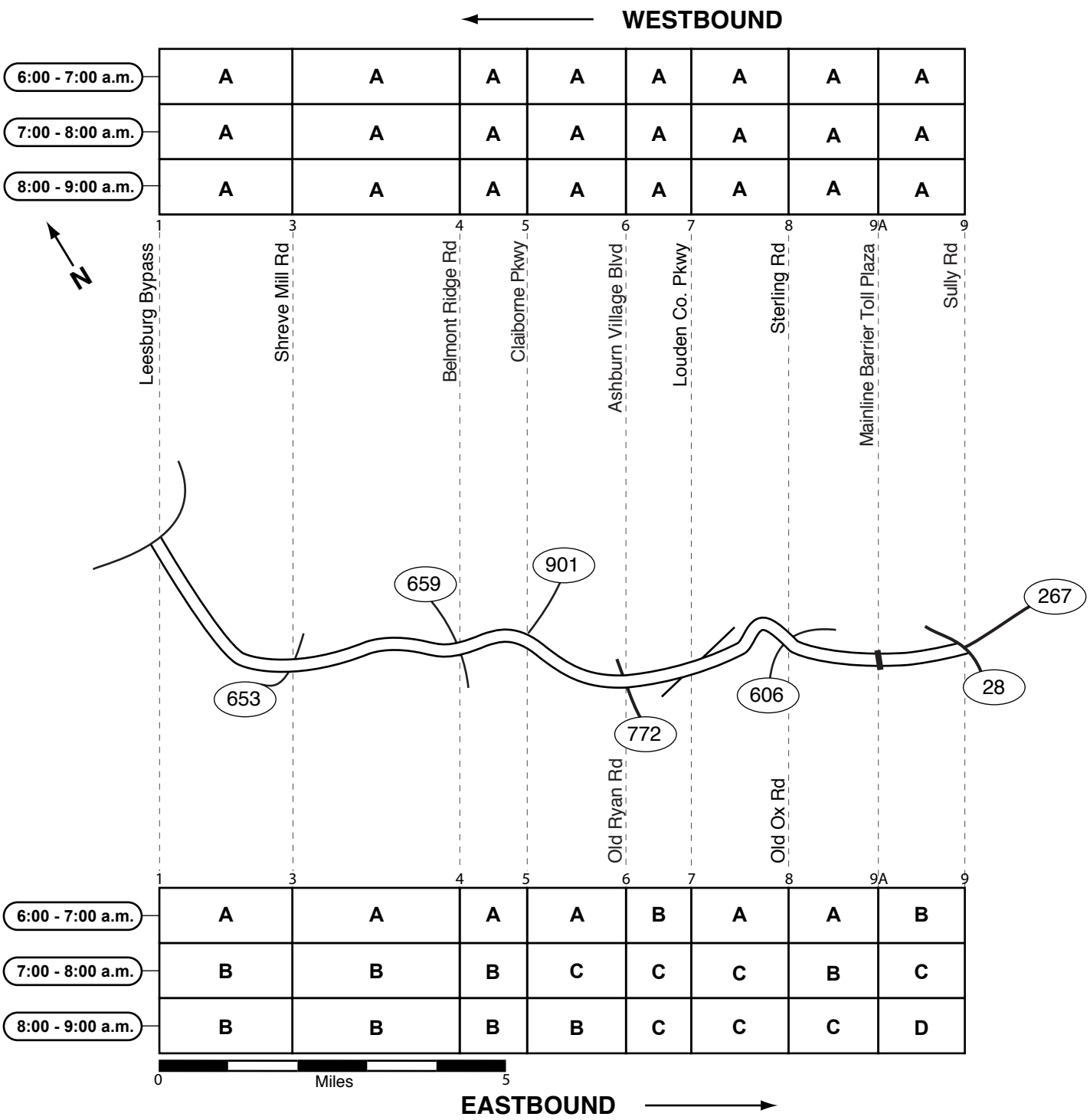


Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Dulles Greenway) - Morning

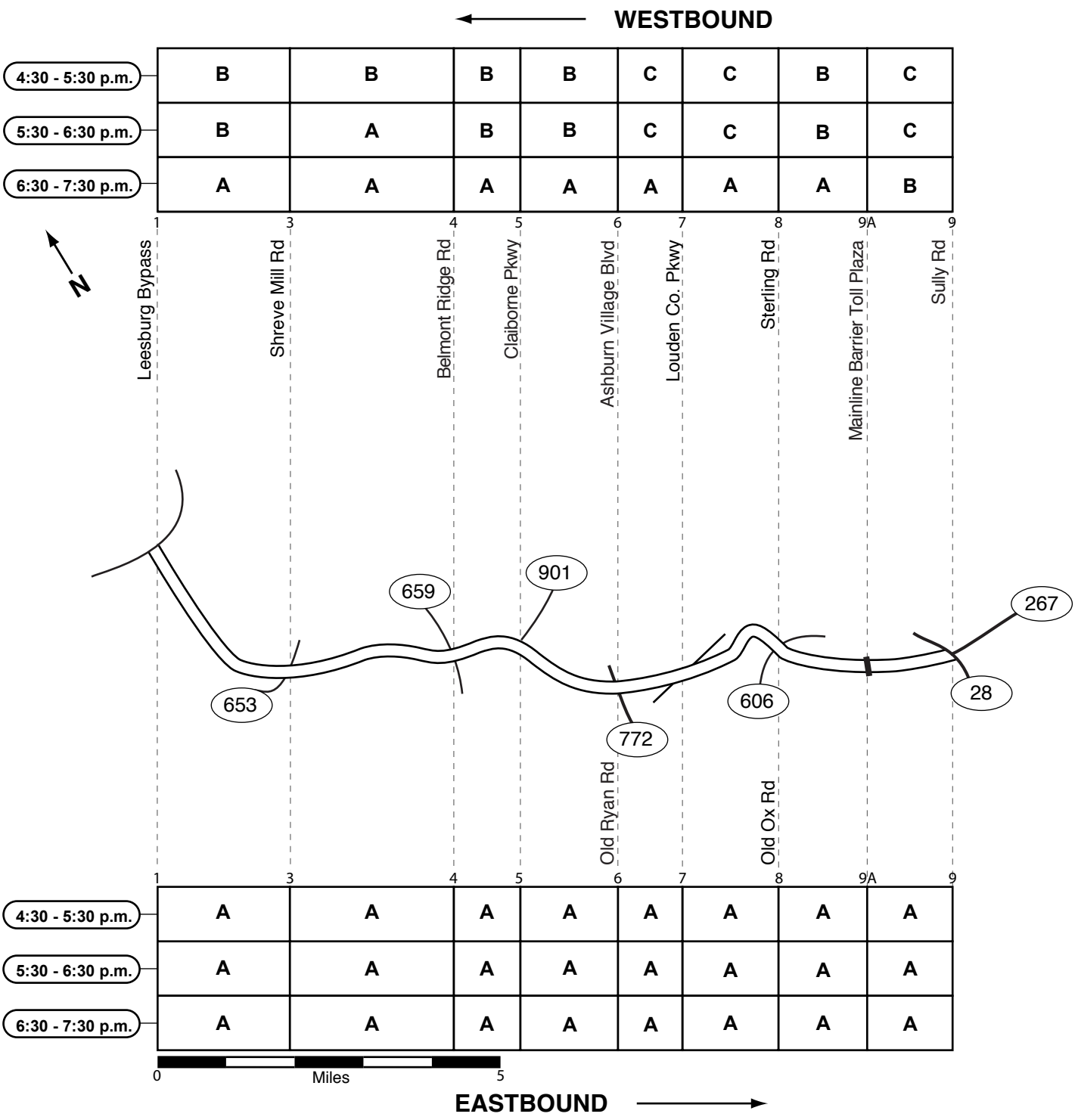


Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Dulles Greenway) - Evening

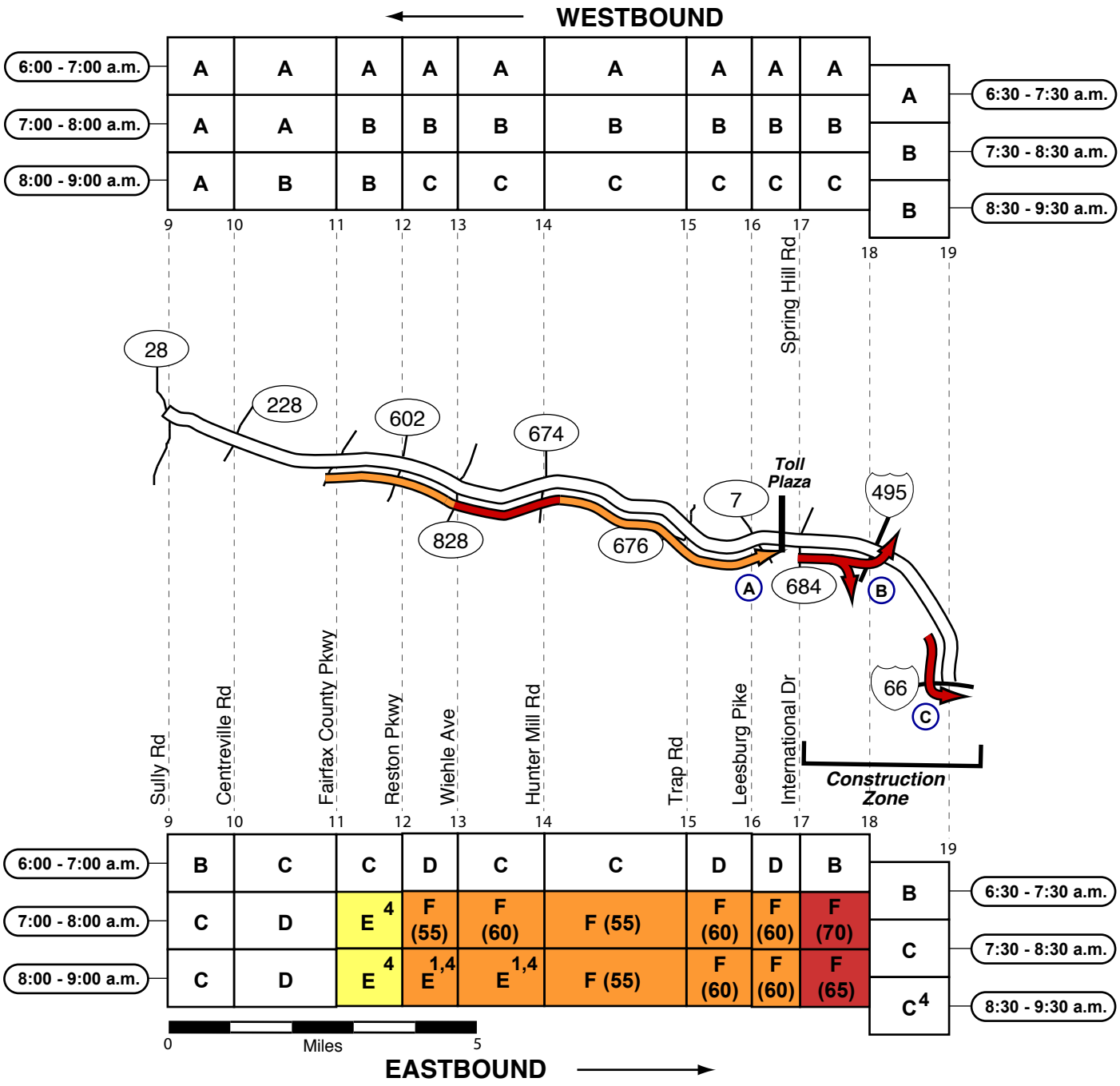


Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Toll Road) - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

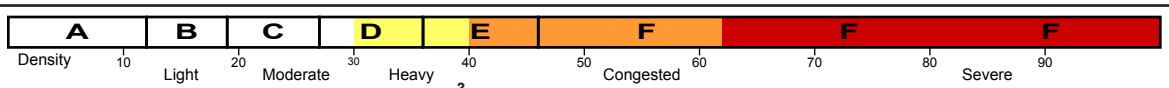
Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Toll Road) - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations after 7::00 a.m.
Direction: Eastbound
Location: Approaching the Mainline Toll Plaza.
Queue Length: 6 to 8 miles
Estimated Speed: 20 to 50 mph
Note: Factors contributing to the congestion were: 1) the merging associated with the interchanges along this corridor; and 2) the weaving associated with the high speed EZPass lanes at the mainline toll plaza. The toll plaza was not the capacity constraint.

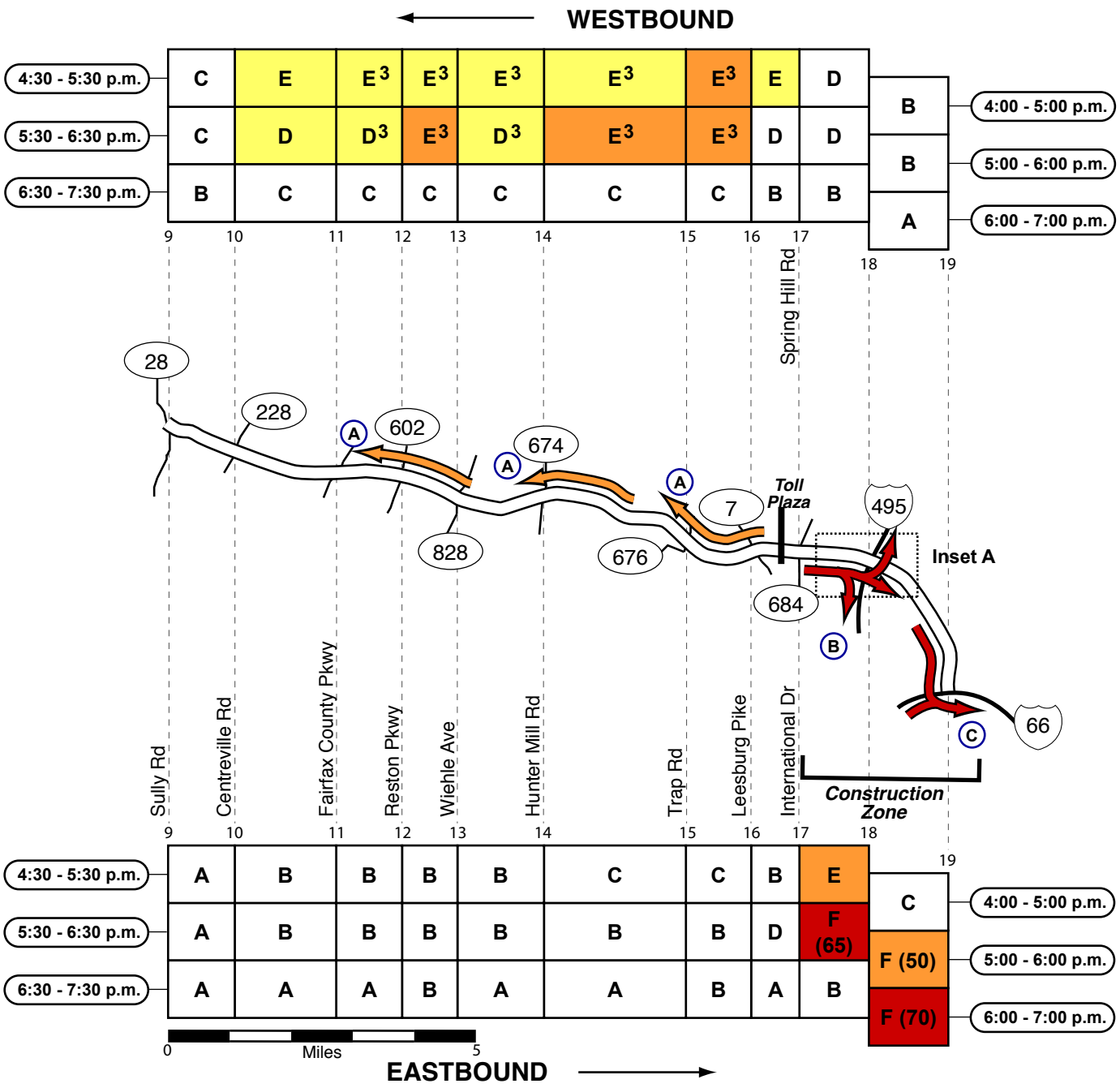
B
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Eastbound
Location: Between the Mainline Toll Plaza and the Beltway
Queue Length: 1 to 2 miles
Estimated Speed: 25 to 45 mph
Note: The head of the queue was found on the ramps to the Beltway; congestion appeared to be caused or exacerbated by ongoing construction at the Beltway interchange. Congestion typically extended back into the right lane (and eventually across all lanes) of VA 267.

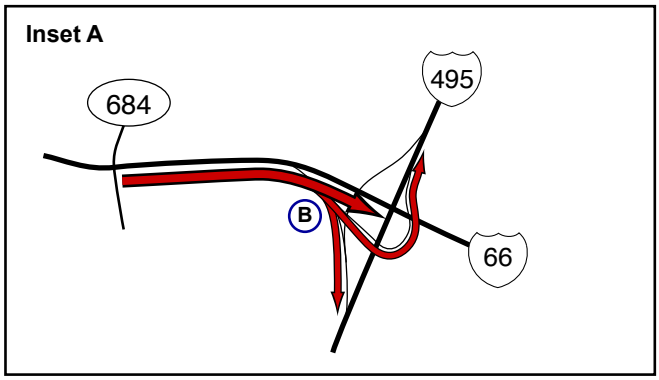
C
Congestion Type: Mainline Congestion
Frequency: Intermittently after 8:30 a.m.
Direction: Eastbound
Location: Approaching I-66
Queue Length: 0.5 to 1 miles
Estimated Speed: 30 to 50 mph
Note: The head of the queue was found at the merge into congested flow on I-66 (eastbound); congestion appeared to exacerbate the congestion.



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Toll Road) - Evening





Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

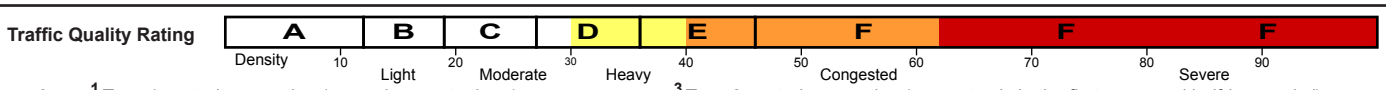
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Toll Road) - Evening

A
Congestion Type: Mainline Congestion
Frequency: Between 5:00 and 6:00 p.m.
Direction: Westbound
Location: Between the Mainline Toll Plaza and Fairfax County Pkwy
Queue Length: 6 to 8 miles
Estimated Speed: 40 to 50 mph
Note: Intermittent westbound congestion was exacerbated by the weaving and merging associated with the interchanges along this corridor.

B
Congestion Type: Mainline Congestion/Exit Ramp Queue
Frequency: On some days but not others
Direction: Eastbound
Location: Approaching the Beltway
Queue Length: 1 to 2 miles
Estimated Speed: 15 to 35 mph
Note: Factors contributing to the congestion were: 1) congestion on the ramps to the Beltway which extended back into the right lane (and eventually across all lanes) of VA 267 and; 2) the lane drop (3 lanes to 2) at the Beltway. Ongoing construction at the Beltway Interchange may have contributed the congestion.

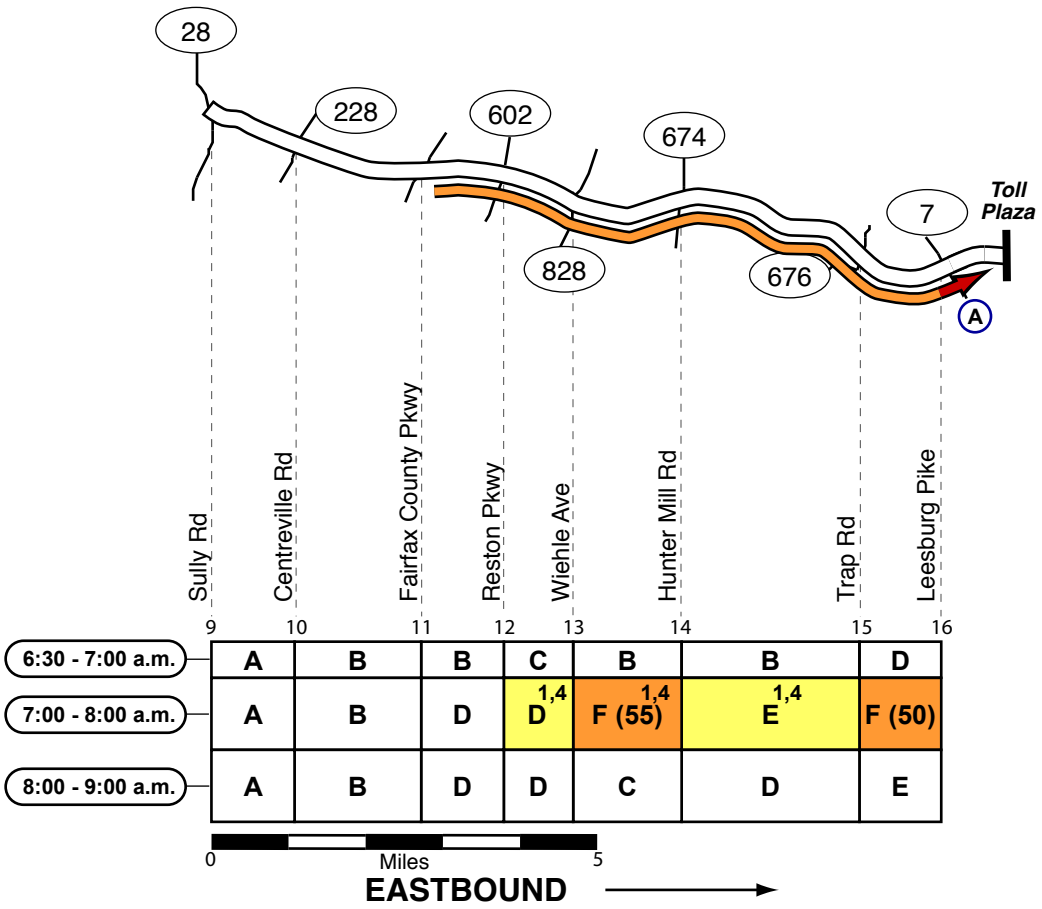
C
Congestion Type: Mainline Congestion
Frequency: Most observations after 5:00 p.m.
Direction: Eastbound
Location: Approaching I-66
Queue Length: 1 to 2 miles
Estimated Speed: 30 to 50 mph
Note: The head of the queue was found at the merge into congested flow on I-66 (eastbound); congestion appeared to exacerbate the congestion.



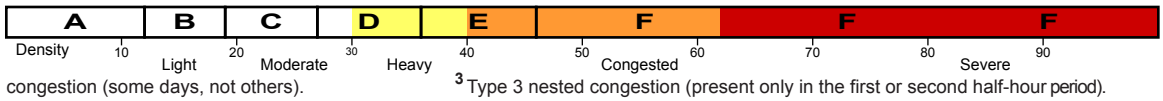
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Dulles Toll Road) Left Lane Concurrent HOV - Morning

HOV OPERATIONS
HOV 2
6:30 - 9:00 A.M.
EASTBOUND



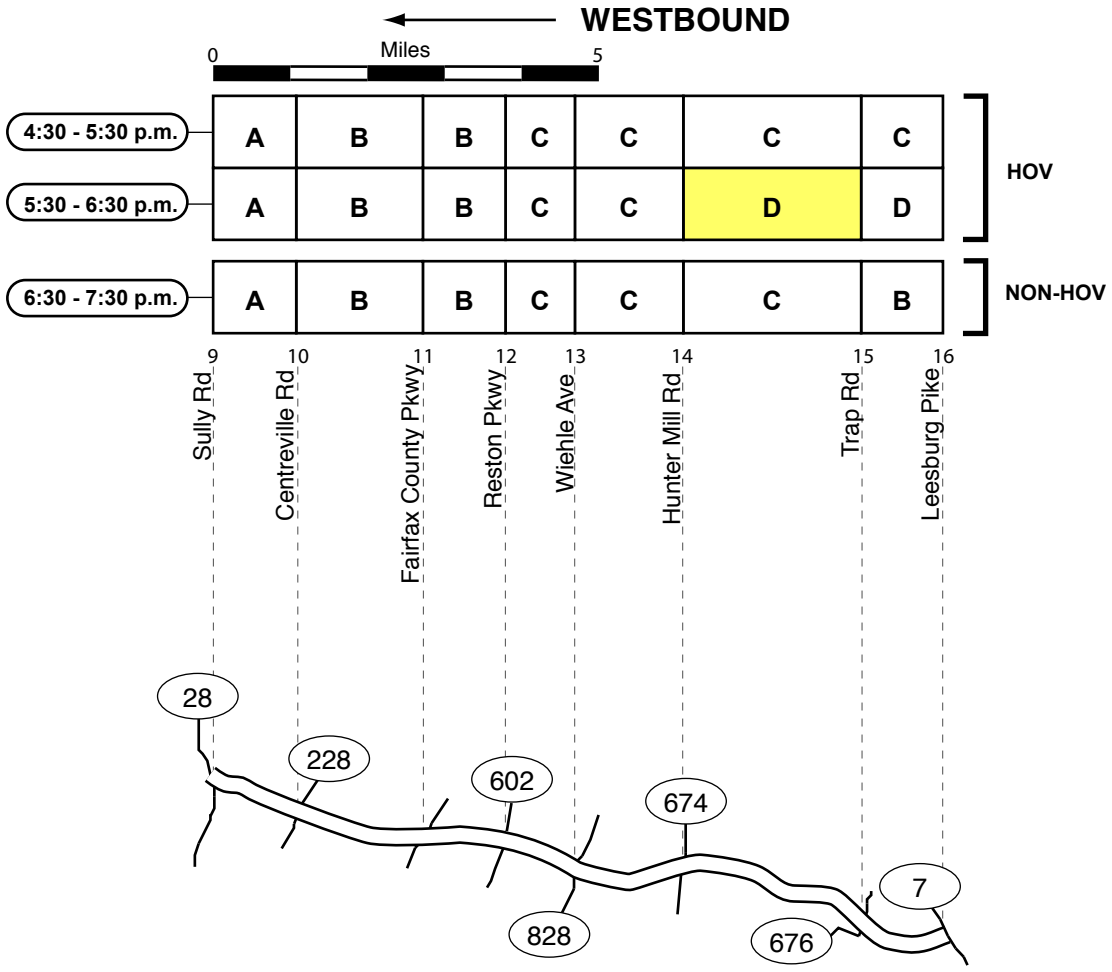
A
Congestion Type: Mainline Congestion
Frequency: Most observations between 7:00 and 8:30 a.m.
Direction: Eastbound
Location: Between Fairfax County Parkway and the Mainline Toll Plaza
Queue Length: 2 to 6 miles
Estimated Speed: 30 to 50 mph
Note: The head of the queue was found at the HOV terminus where the HOV lanes become dedicated EZPass lanes; congestion was exacerbated by the weaving associated with the general-purpose and HOV lanes approaching the mainline toll plaza.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Dulles Toll Road) Left Lane Concurrent HOV - Evening

HOV OPERATIONS
HOV 2
4:00 - 6:30 P.M.
WESTBOUND



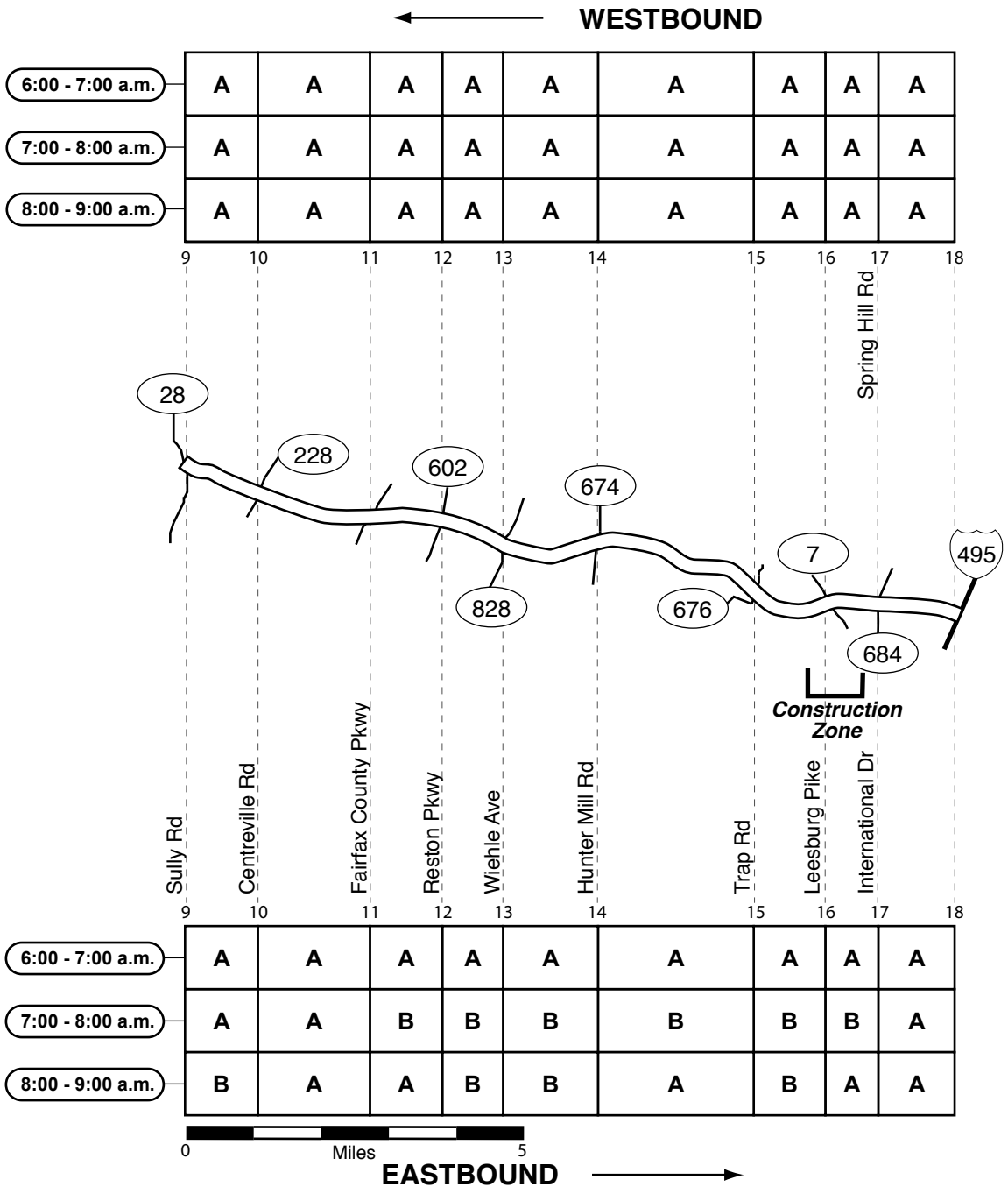
Traffic Quality Rating

A	B	C	D	E	F	F	F

Density 10 20 30 40 50 60 70 80 90
Light Moderate Heavy Congested Severe

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Dulles Airport Access Road) - Morning

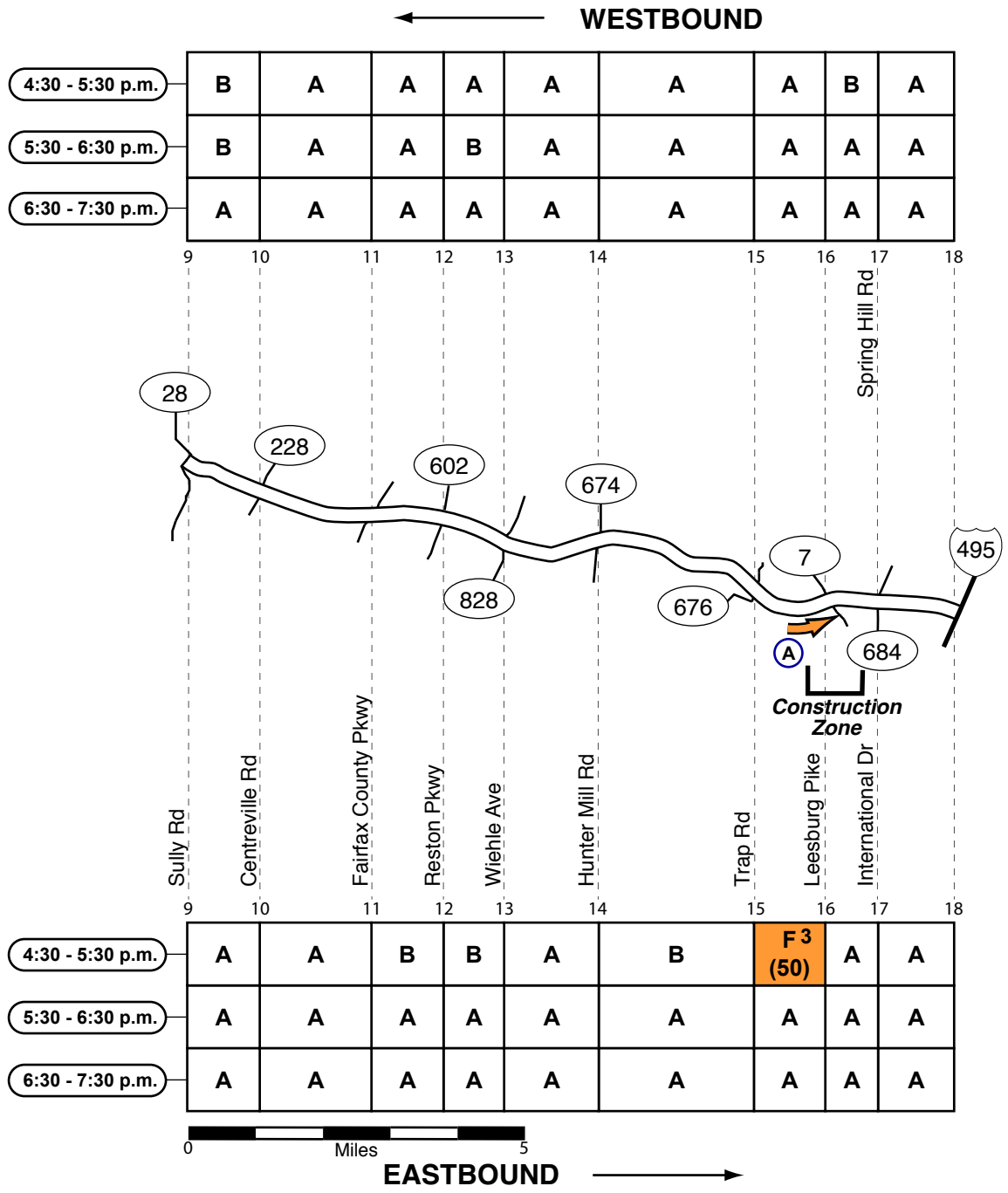


Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

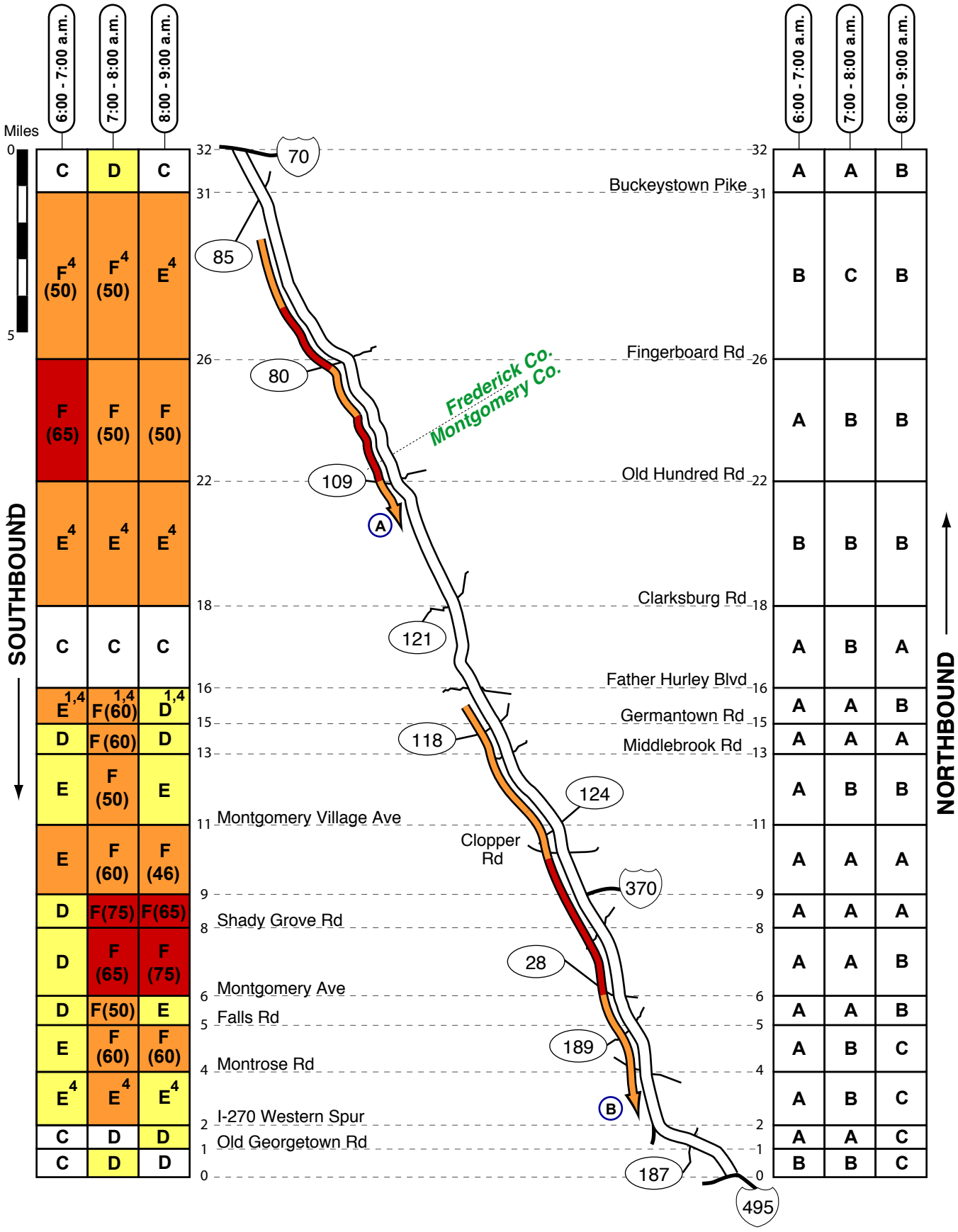
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

VA 267 (Dulles Airport Access Road) - Evening



A
Congestion Type: Mainline Congestion
Frequency: Before 5:00 p.m.
Direction: Location: Approaching VA 7
Queue Length: 0.5 to 1 miles
Estimated Speed: 15 to 35 mph
Note: The head of the queue was found at the lane drop (2 lanes to 1) in the construction zone at VA 7.

I-270 (Maryland) - Morning



Traffic Quality Rating

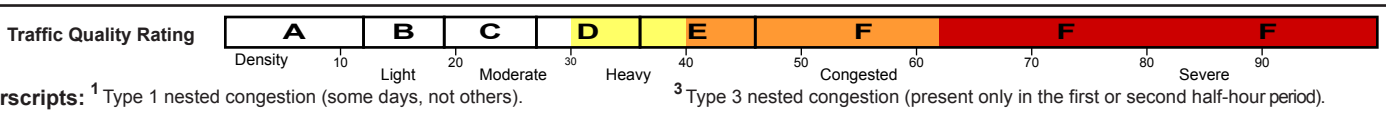
A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-270 (Maryland) - Morning

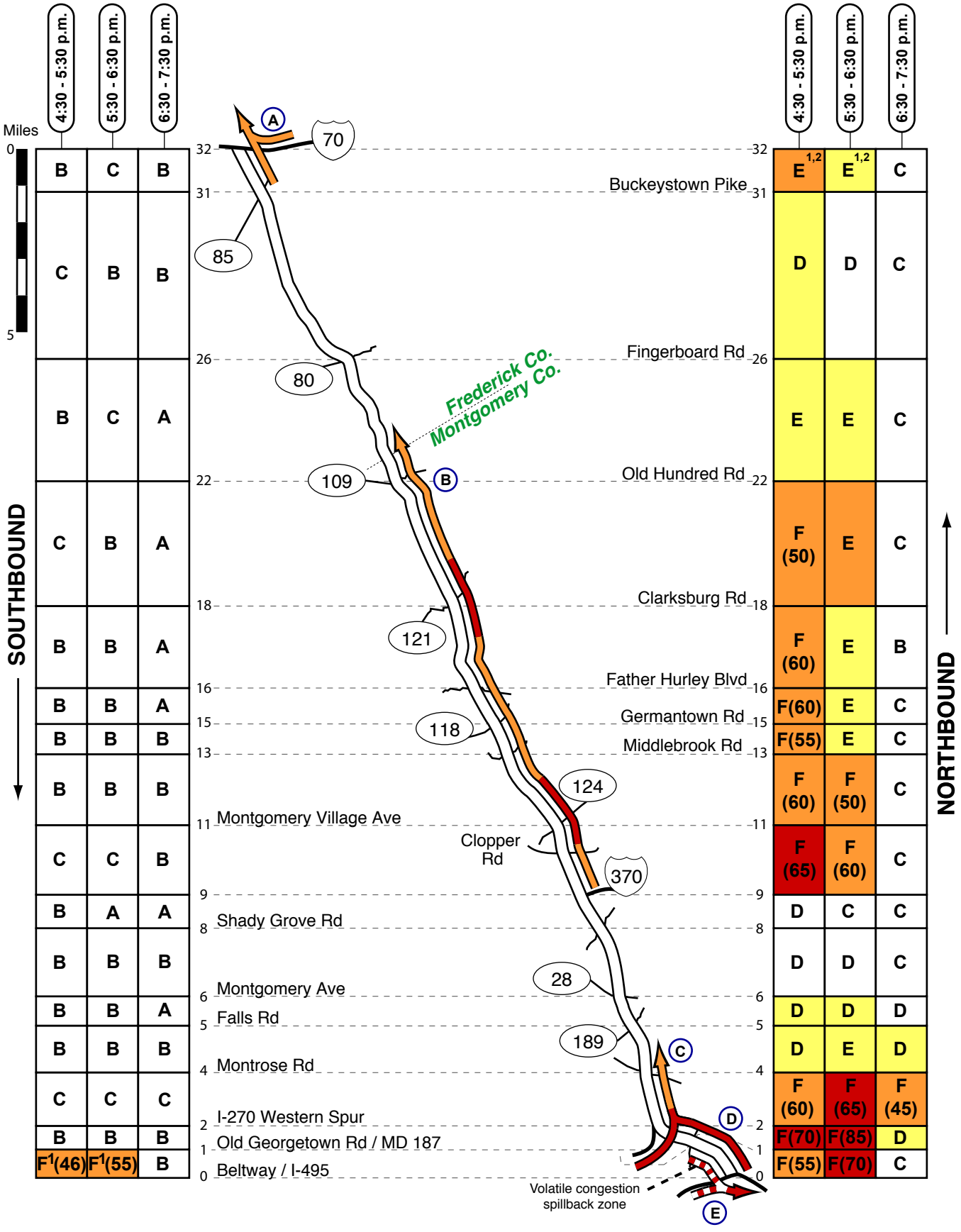
A
Congestion Type: Mainline Congestion
Frequency: Throughout the morning survey period
Direction: Southbound
Location: Frederick into Montgomery County
Queue Length: 4 to 7 miles
Estimated Speed: 30 to 50 mph
Note: A long zone of southbound congestion was found on I-270 through lower Frederick County and into Montgomery County. The primary cause of congestion appeared to be traffic merging into the mainline at the interchanges at MD 80 and MD 109; stop-and-go flow was often found approaching these interchanges.

B
Congestion Type: Mainline Congestion
Frequency: Most observations after 6:30 a.m.
Direction: Southbound
Location: Father Hurley Blvd to I-270 western spur
Queue Length: 8 to 12 miles
Estimated Speed: 20 to 50 mph
Note: Southbound travelers on the I-270 corridor experienced extended delays during most of the morning commuter period; both the express lanes and local lanes (beginning at I-370) were moderately to severely congested. While the HOV facility (concurrent flow - left lane) typically provided better service, intermittent moderate to severe congestion was found, particularly between Shady Grove Rd and Montgomery Ave.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-270 (Maryland) - Evening



Traffic Quality Rating

A	B	C	D	E	F	F	F

Density 10 20 30 40 50 60 70 80 90

Light Moderate Heavy Congested Severe

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).

[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-270 (Maryland) - Evening

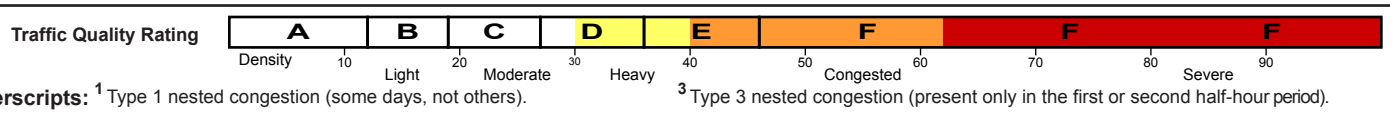
A
Congestion Type: Mainline Congestion
Frequency: Intermittent (before 6:00 p.m.)
Direction: Northbound
Location: Approaching I-70 and Frederick
Queue Length: 1 to 2 miles
Estimated Speed: 30 to 50 mph
Note: On some days but not others, a short zone of northbound congestion was found on I-270 approaching the I-70 interchange; weaving/merging at the MD 85 and I-270 interchanges appeared to exacerbate the congestion.

B
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:00 p.m.
Direction: Northbound
Location: Between I-370 and MD 109 (Old Hundred Rd)
Queue Length: 8 to 12 miles
Estimated Speed: 30 to 50 mph
Note: Early in the evening survey period (before 6:00 p.m.), an extended zone of northbound congestion was found on I-270 beginning in the vicinity of the I-370 interchange. For the most part, congestion was moderate; however, severe stop-and-go flow was intermittently found approaching the terminus of the local lanes at Montgomery Village Ave, and farther north where the HOV facility ends (just north of Clarksburg Rd).

C
Congestion Type: Mainline Congestion
Frequency: Most observations before 7:00 p.m.
Direction: Northbound
Location: From I-270 spur to MD 189 (Falls Rd)
Queue Length: 1 to 3 miles
Estimated Speed: 30 to 50 mph
Note: After the assimilation of traffic converging from I-270 and the 270 spur, moderate congestion persisted northbound on I-270 for several miles.

D
Congestion Type: Mainline Congestion
Frequency: Most observations before 7:00 p.m.
Direction: Northbound
Location: From I-495 to merge at I-270 Spur
Queue Length: 1 to 2 miles
Estimated Speed: 20 to 40 mph
Note: Severe northbound congestion was typically found in the two general purpose lanes (non HOV) between the beltway and the 270 spur. Intermittent stop-and-go flow was found approaching the interchange at MD 187 where traffic entered the mainline.

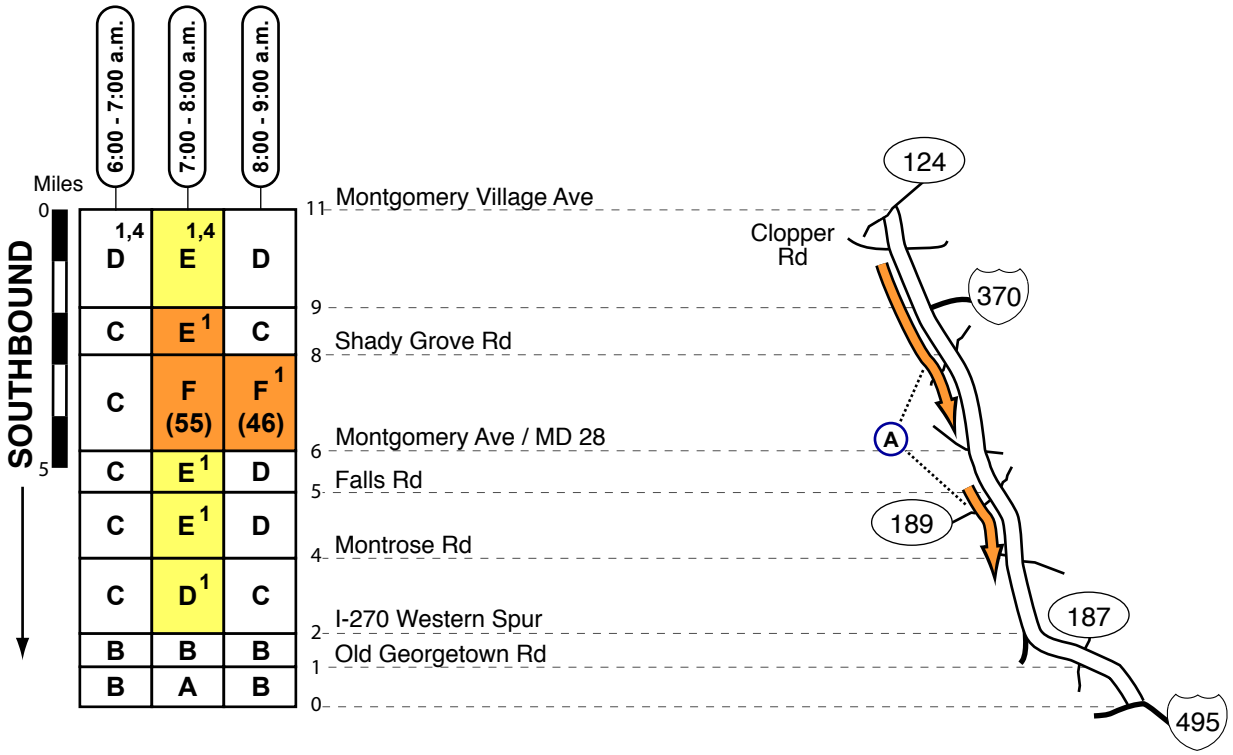
E
Congestion Type: Mainline Congestion
Frequency: Intermittently before 6:30 p.m.
Direction: Southbound
Location: I-270 approaching I-495 (beltway)
Queue Length: 1 to 2 miles
Estimated Speed: 20 to 30 mph
Note: The last several segments of I-270 approaching the beltway appeared to serve as a “spillback zone” for congestion on the beltway that occurred some evenings but not others; when congested, the tail of the queue was typically found somewhere between Old Gorgetown Rd and the I-270 spur.



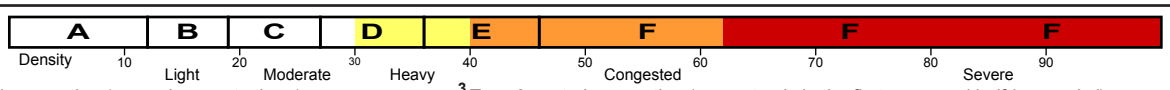
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-270 (Maryland) Left Lane / Concurrent Flow HOV - Morning

HOV OPERATIONS
HOV 2
6:00 - 9:00 A.M.
SOUTHBOUND

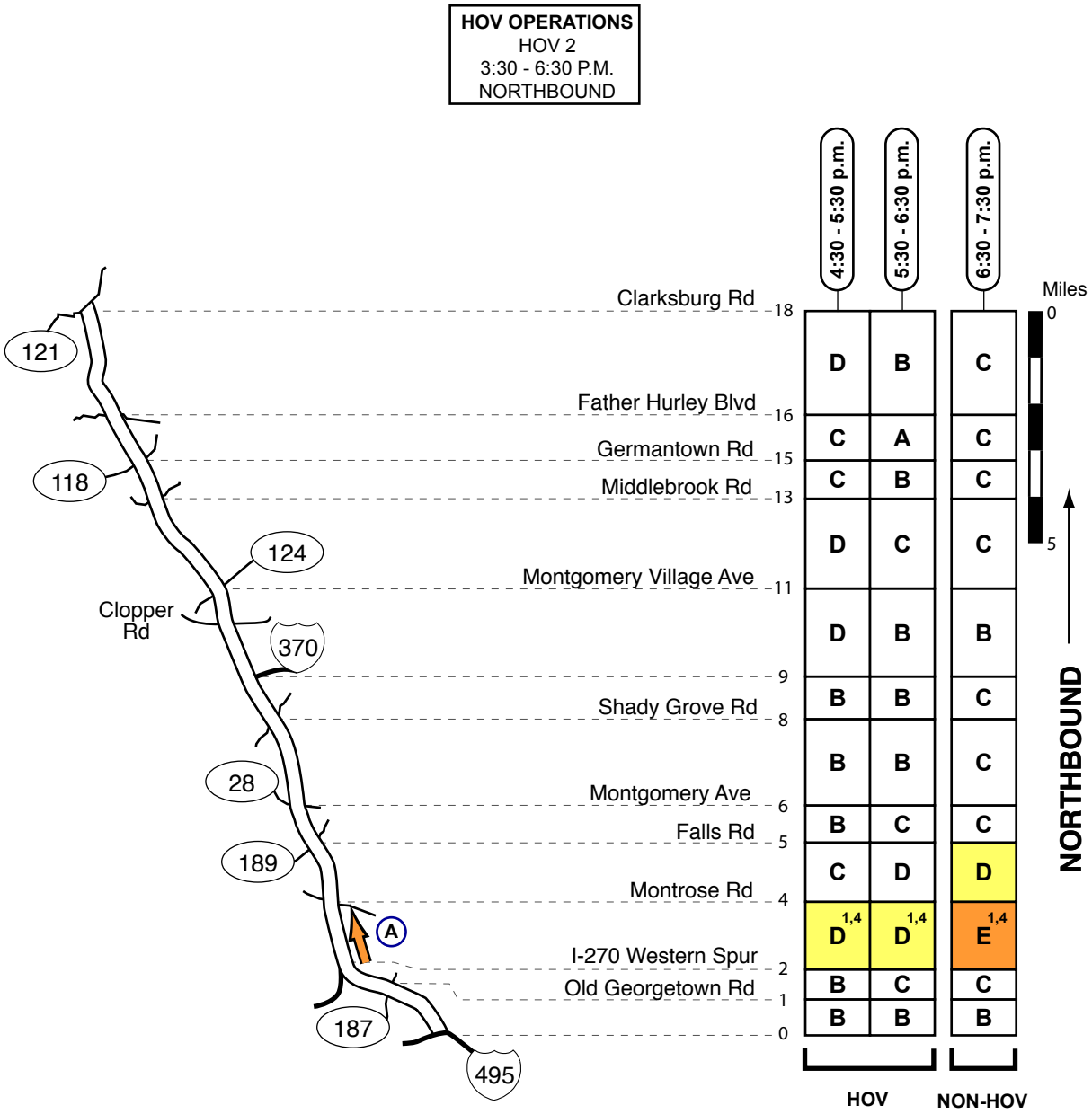


A
Congestion Type: Concurrent-flow HOV lane
Frequency: Most observations between 7:00 and 8:30 a.m.
Direction: Southbound
Location: MD 124 to Montrose Rd
Queue Length: 3 to 5 miles
Estimated Speed: 30 to 50 mph
Note: During the peak period, moderate southbound congestion was typically found in the HOV facility (left-lane) between Montgomery Village Ave and MD 28 (Montgomery Ave); south of MD 28, only minor intermittent congestion was found approaching the split at the I-270 spur.

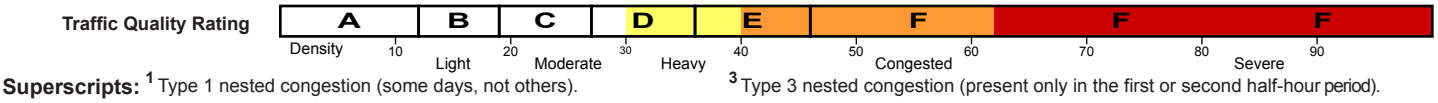


Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-270 (Maryland) Left Lane / Concurrent Flow HOV - Evening

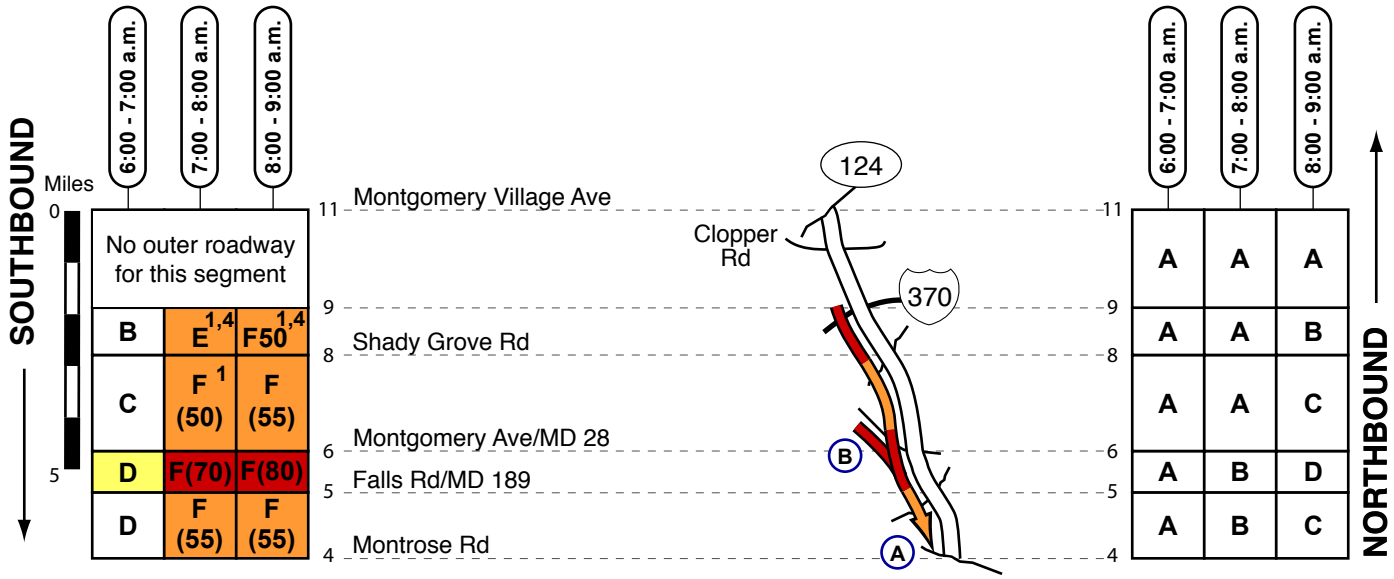


A
Congestion Type: Concurrent-flow HOV lane
Frequency: Intermittent
Direction: Northbound
Location: I-270 spur to Montrose Rd
Queue Length: 1 to 2 miles
Estimated Speed: 30 to 50 mph
Note: Intermittently, minor northbound congestion was found in the HOV facility (left lane) in the vicinity of the merge with traffic from I-270 and the 270 spur.



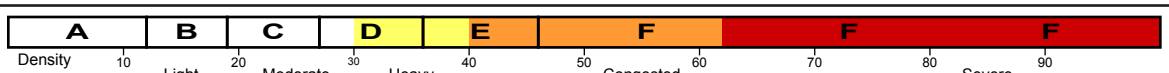
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-270 Local Lanes - Morning



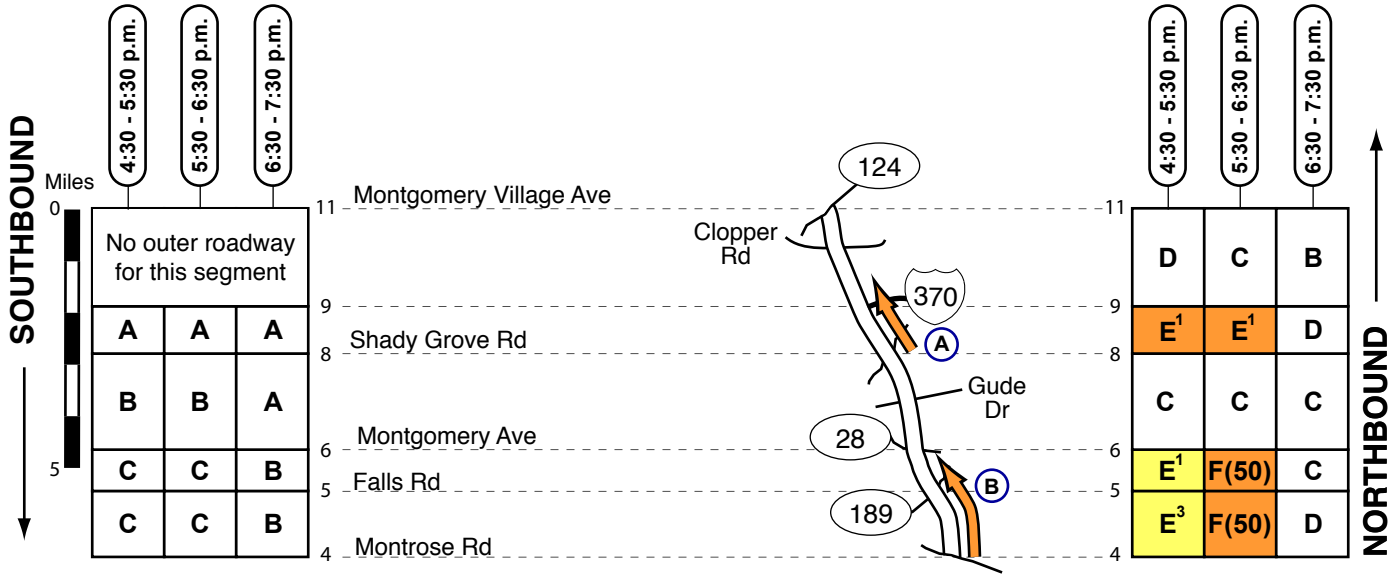
A
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Southbound
Location: Local lanes
Queue Length: 3 to 5 miles
Estimated Speed: 20 to 50 mph
Note: After 7:00 a.m., moderate to severe southbound congestion was typically found in the local lanes beginning at I-370 to the terminus just south of Montrose Rd. The primary bottlenecks were found at the following locations 1) traffic entering at Shady Grove Rd and W. Montgomery Ave; 2) traffic merging from the express lanes (between MD 28 and Falls Rd).

B
Congestion Type: Entrance Ramp Queue
Location: W. Montgomery Ave
Frequency: Peak hour
Direction: Southbound
Queue Population: 20 to 40 vpl
Number of Lanes: 1



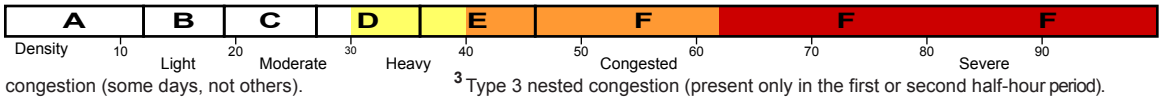
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-270 Local Lanes - Evening



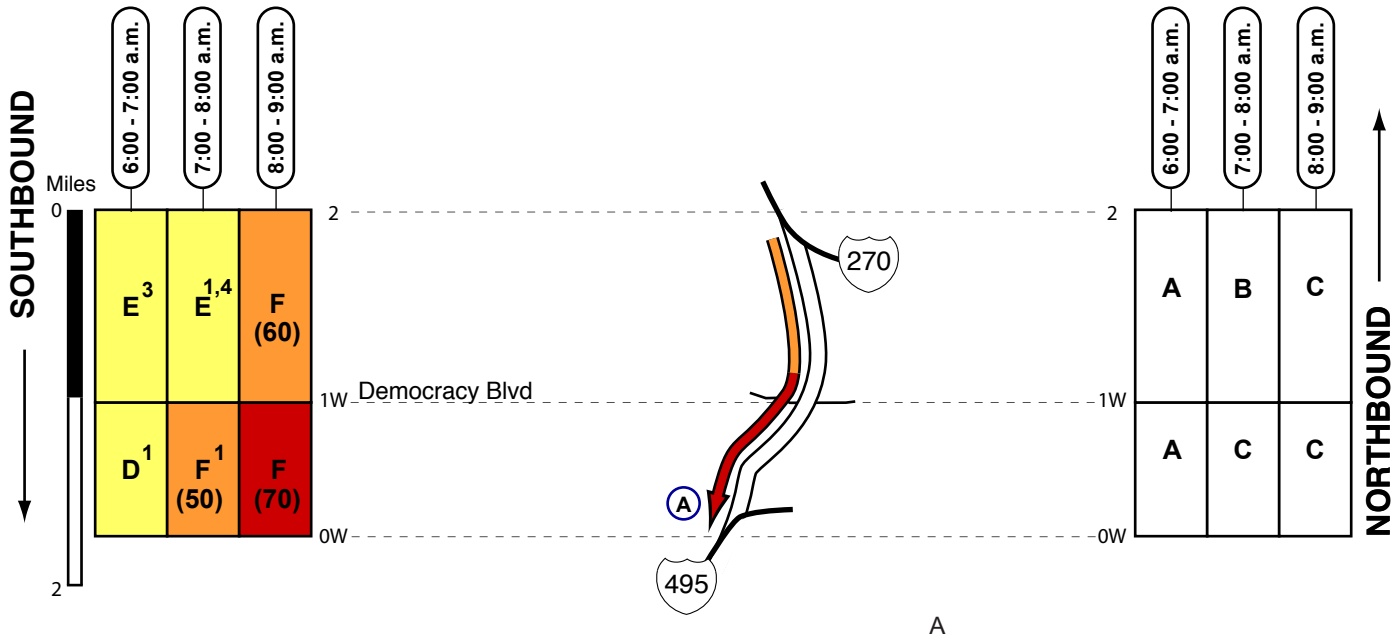
A
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:30 p.m.
Direction: Northbound
Location: Local lanes vic. Shady Grove Rd
Queue Length: 1 to 1.5 miles
Estimated Speed: 25 to 45 mph
Note: Northbound congestion in the vicinity of Shady Grove Rd appeared to be caused by traffic merging from the entrance ramp, and weaving between the ramp and the next crossover to the express lanes.

B
Congestion Type: Mainline Congestion
Frequency: Most observations between 5:00 and 6:30 p.m.
Direction: Northbound
Location: Local lanes between Montrose Rd and MD 28
Queue Length: 1 to 2 miles
Estimated Speed: 40 to 55 mph
Note: Northbound congestion in the local lanes appeared to be exacerbated by traffic merging from the entrance ramps at Montrose Rd and Falls Rd.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

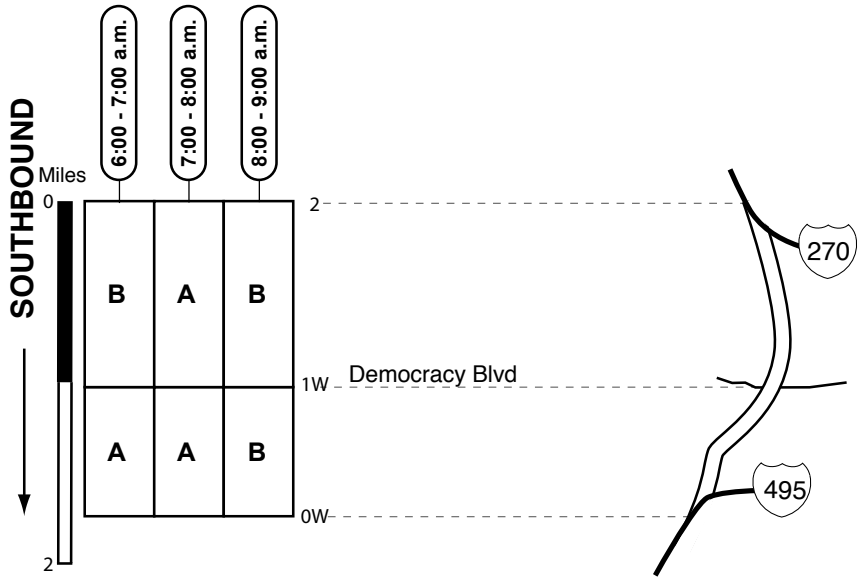
I-270 Western Spur (Maryland) - Morning

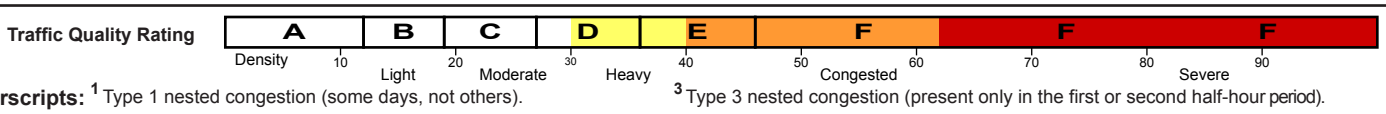


A
Congestion Type: Mainline Congestion
Frequency: Most observations after 6:30 a.m.
Direction: Southbound
Location: Western spur
Queue Length: 1 to 2 miles
Estimated Speed: 30 to 50 mph
Note: Moderate southbound congestion was typically found in the two general purpose lanes on the western spur; traffic entering at Democracy Blvd, and the merge with I-495 traffic at the terminus of the spur appeared to cause the congestion. The increase in severity of congestion relative to that dcocumented in 2008 may have been attributable to congestion on the beltway outer loop; this congestion was exacerbated by construction downstream in Virginia.

Left Lane / Concurrent Flow HOV - Morning

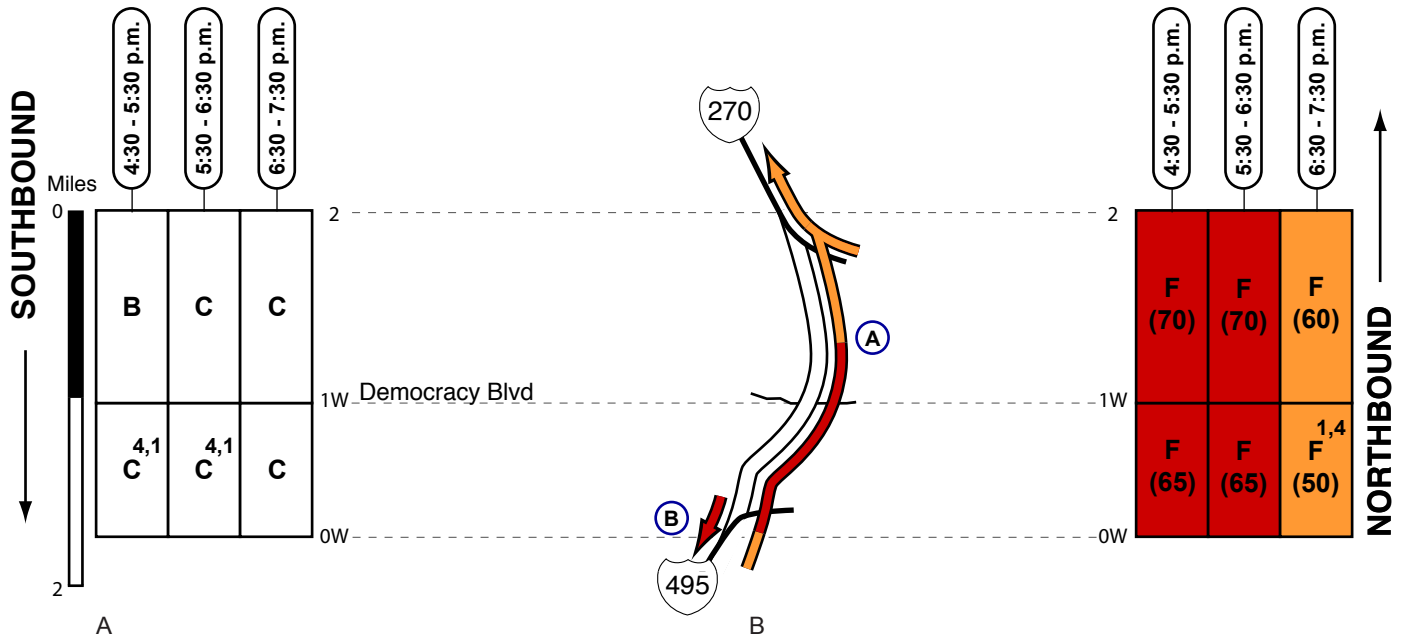
HOV OPERATIONS
HOV 2
6:00 - 9:00 A.M.
SOUTHBOUND





Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-270 Western Spur (Maryland) - Evening

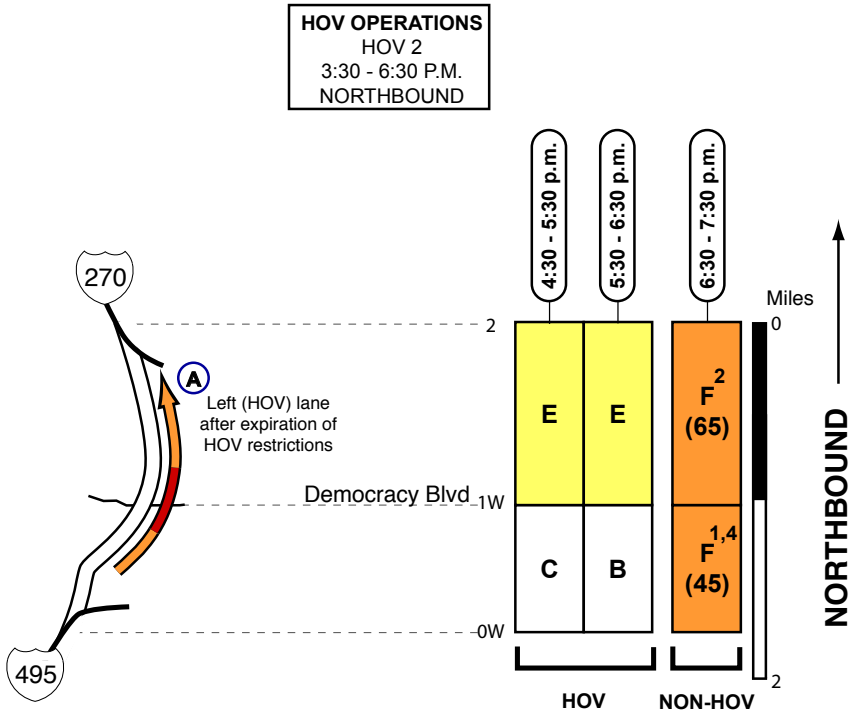


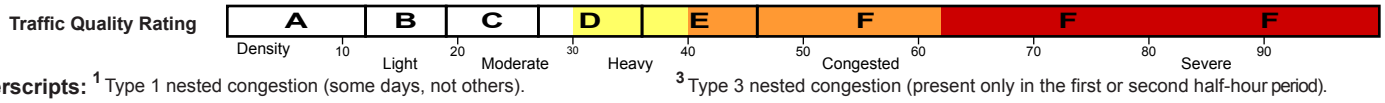
A
Congestion Type: Mainline Congestion
Frequency: Throughout the evening survey period
Direction: Northbound
Location: Length of spur
Queue Length: 1 to 2 miles
Estimated Speed: 20 to 30 mph
Note: Northbound congestion was consistently found in the two general purpose lanes on the western spur; the head of the queue was found at the merge with I-270 traffic.

B
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Southbound
Location: Western spur
Queue Length: 0.5 to 1 miles
Estimated Speed: 20 to 30 mph
Note: A short zone of severe southbound congestion was intermittently found at the terrminus of the western spur; the head of the queue was found where vehicles from the spur encountered southbound congesetion on the outer loop of the beltway. Congestion on the beltway was likely exacerbated by construction downstream in Virginia.

Left Lane / Concurrent Flow HOV - Evening

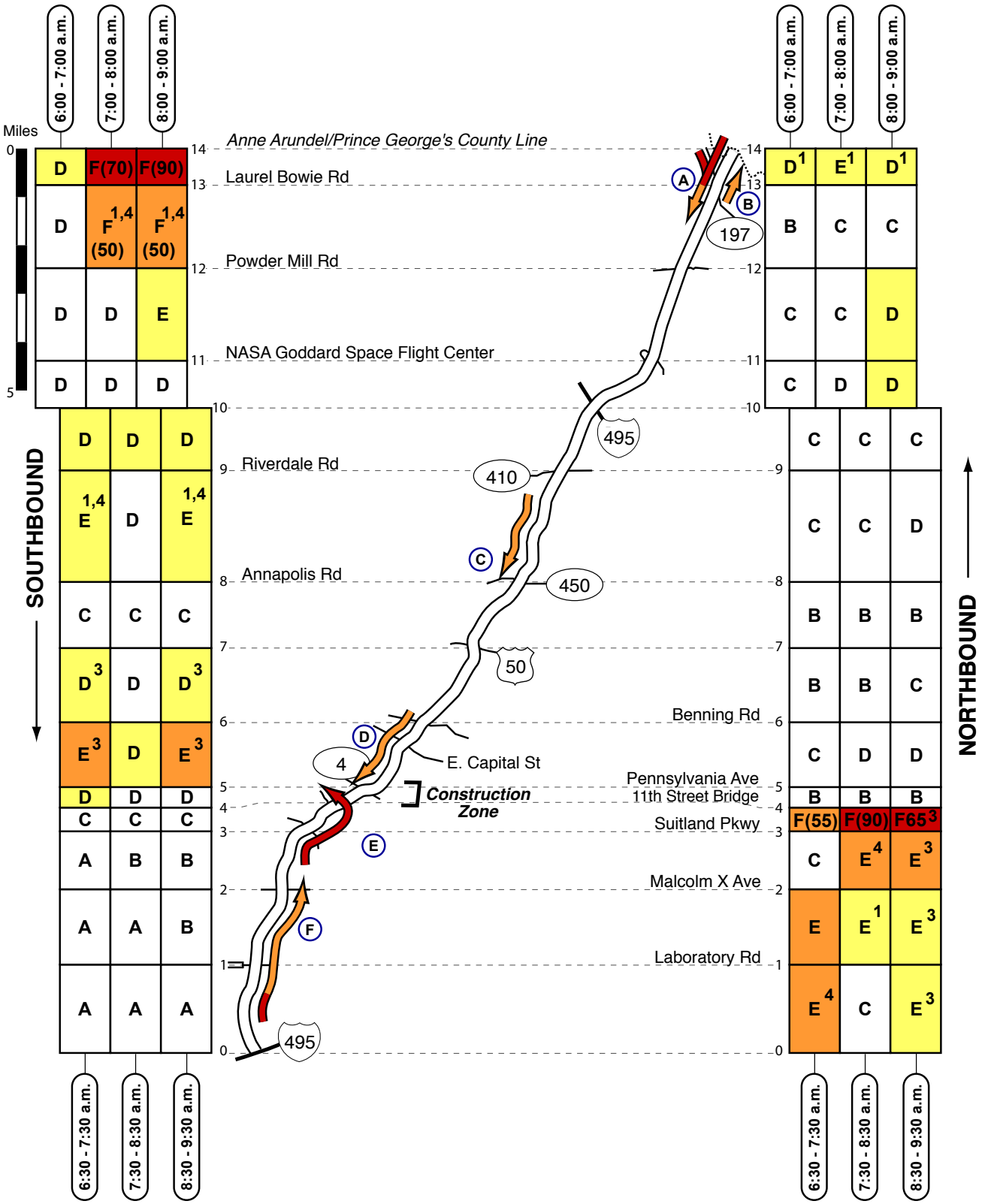
A
Congestion Type: HOV
Frequency: After restrictions lifted at 6:30 p.m.
Direction: Northbound
Location: Left HOV lane
Queue Length: 0.5 to 1.5 miles
Estimated Speed: 30 to 50 mph
Note: Northbound travelers in the left-concurrent flow HOV lane were not significantly delayed until after restrictions were lifted after 6:30 p.m.; moderate congestion normally persisted until the end of the survey period at 7:30 p.m.





Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-295/D.C. 295/Kenilworth Ave/Baltimore-Washington Parkway - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-295/D.C. 295/Kenilworth Ave/Baltimore-Washington Parkway - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Southbound
Location: Between the Anne Arundel County Line and MD 197
Queue Length: 1 to 2 miles
Estimated Speed: 20 to 40 mph
Note: Congestion was caused by traffic entering at MD 197 (short acceleration lane).

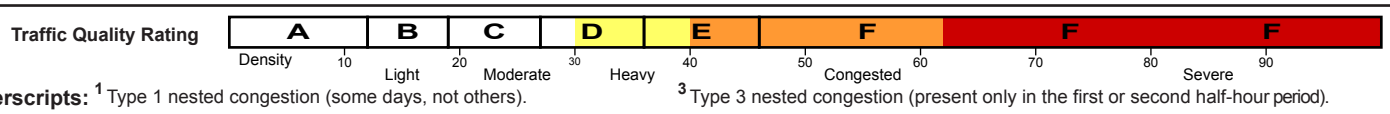
B
Congestion Type: Mainline congestion
Frequency: Intermittent
Direction: Northbound
Location: MD 197 merge
Queue Length: 0.5 to 1 mile
Estimated Speed: 35 to 50 mph
Note: Congestion appeared to be caused by traffic entering at MD 197.

C
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Southbound
Location: Approaching MD 450
Queue Length: 1 to 2 miles
Estimated Speed: 40 to 50 mph
Note: Factors contributing to the congestion were: 1) traffic entering at MD 410; and 2) the geometrics of the roadway (sharp bends). Traffic flow typically improved south of MD 450 where the roadway widened from 2 to 3 lanes.

D
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Southbound
Location: Between US 50 and MD 4 (Pennsylvania Ave)
Queue Length: 2 to 3 miles
Estimated Speed: 40 to 50 mph
Note: The primary bottleneck was found at the lane drop (3 lanes to 2) at the East Capitol St interchange; south of the interchange, traffic flow typically improved.

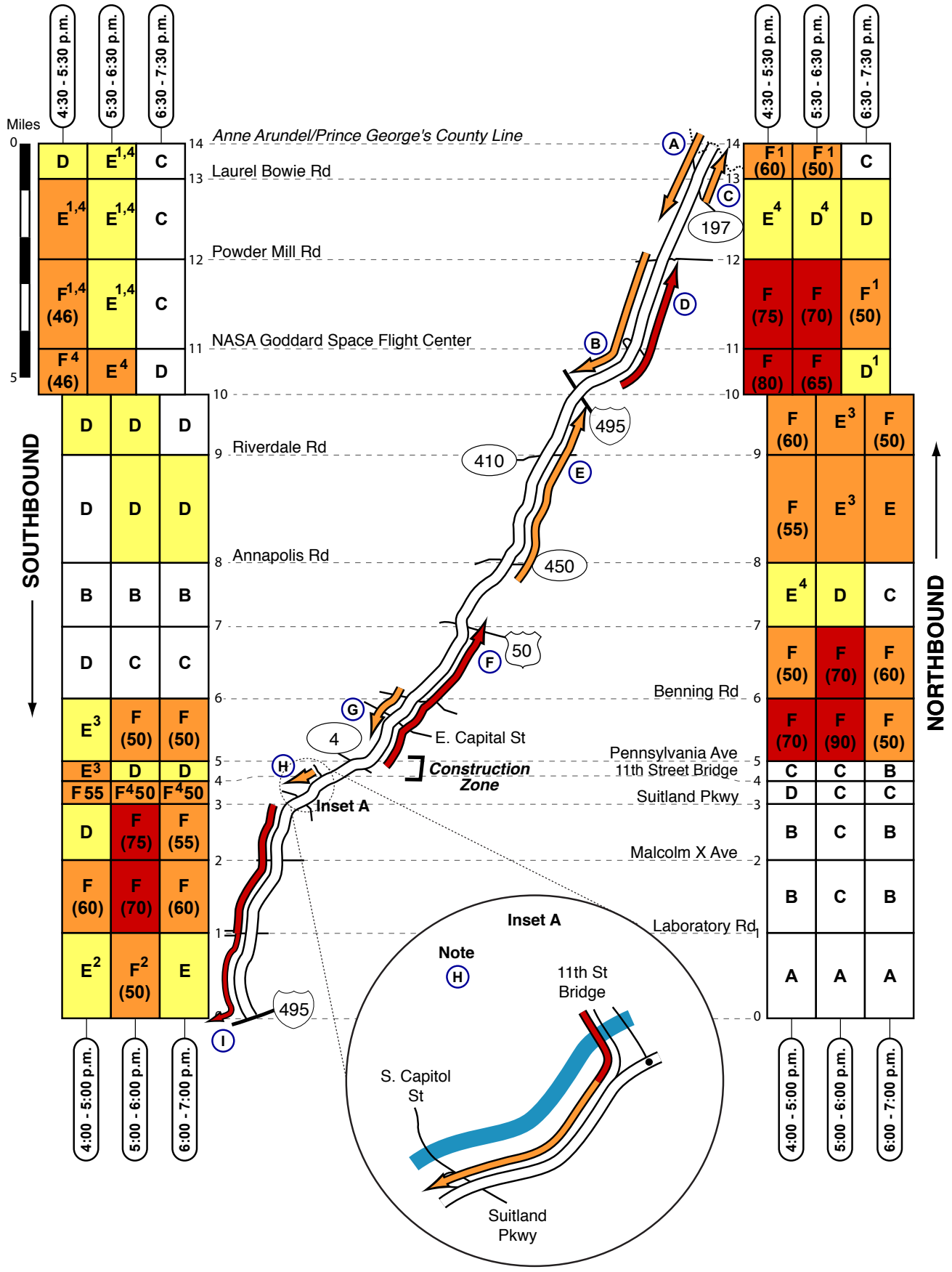
E
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Northbound
Location: Approaching ramp to 11th St Bridge
Queue Length: 1 to 5 miles
Estimated Speed: 10 to 50 mph
Note: The head of the queue was found on the exit ramp to the 11th St bridge; congestion extended back into the right lane, and eventually across all lanes of DC 295/I-295. Between 8:30 and 9:00 a.m., a mostly continuous zone of congestion was found between the Beltway and the 11th St Bridge.

F
Congestion Type: Mainline Congestion
Frequency: On some days but not others
Direction: Northbound
Location: Approaching Laboratory Rd and Malcolm X Ave
Queue Length: 2 to 3 miles
Estimated Speed: 30 to 50 mph
Note: The primary bottleneck was the series of lane drops (4 lanes to 3 and 3 lanes to 2) at the Laboratory Rd interchange. Between 8:30 and 9:00 a.m., it appeared that congestion was exacerbated by the downstream queue approaching the 11th St Bridge.



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-295/D.C. 295/Kenilworth Ave/Baltimore-Washington Parkway - Evening



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-295/D.C. 295/Kenilworth Ave/Baltimore-Washington Parkway - Evening

A
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Southbound
Location: Between Anne Arundel County Line and MD 197
Queue Length: 1 to 2 miles
Estimated Speed: 40 to 50 mph
Note: Congestion appeared to be caused by traffic entering at MD 197.

B
Congestion Type: Minor mainline congestion
Frequency: Most observations before 6:30 p.m.
Direction: Southbound
Location: Between Powder Mill Rd and I-495
Queue Length: 2 to 3 miles
Estimated Speed: 40 to 50 mph
Note: The primary bottleneck appeared to be where traffic entered at Explorer Rd (NASA Goddard).

C
Congestion Type: Minor mainline congestion
Frequency: Most observations before 6:30 p.m.
Direction: Northbound
Location: MD 197 merge
Queue Length: 1 to 2 miles
Estimated Speed: 20 to 50 mph
Note: The head of the queue was downstream of the survey area in Anne Arundel County. It appeared that traffic entering form MD 197 contributed to the congestion.

D
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Northbound
Location: Approaching Powder Mill Rd
Queue Length: 3 to 4 miles
Estimated Speed: 20 to 45 mph
Note: The primary bottleneck was found where traffic entered at Powder Mill Rd.

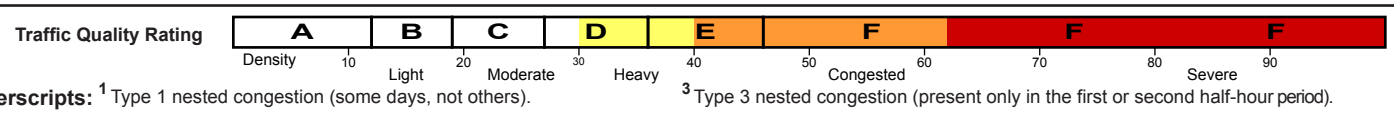
E
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:00 p.m.
Direction: Northbound
Location: Approaching I-495 / Beltway
Queue Length: 2.5 to 4.5 miles
Estimated Speed: 30 to 50 mph
Note: Factors contributing to the congestion were: 1) traffic entering at MD 410; and 2) the geometrics of the roadway (sharp bends).

F
Congestion Type: Mainline Congestion
Frequency: Throughout the evening survey period
Direction: Northbound
Location: Approaching US 50
Queue Length: 3 to 4 miles
Estimated Speed: 15 to 35 mph
Note: The head of the queue was found on the ramp to US 50 (eastbound); congestion extended back into the right lane, and eventually across all lanes, of DC 295. Congestion was exacerbated by the merging associated with the interchanges along this corridor.

G
Congestion Type: Marginal Mainline Congestion
Frequency: Most observations after 5:00 p.m.
Direction: Southbound
Location: vic. E. Capitol St.
Queue Length: 0.5 to 1 miles
Estimated Speed: 40 to 50 mph
Note: The primary bottleneck was the lane drop (3 lanes to 2) at the East Capitol St interchange; south of the interchange, traffic flow typically improved.

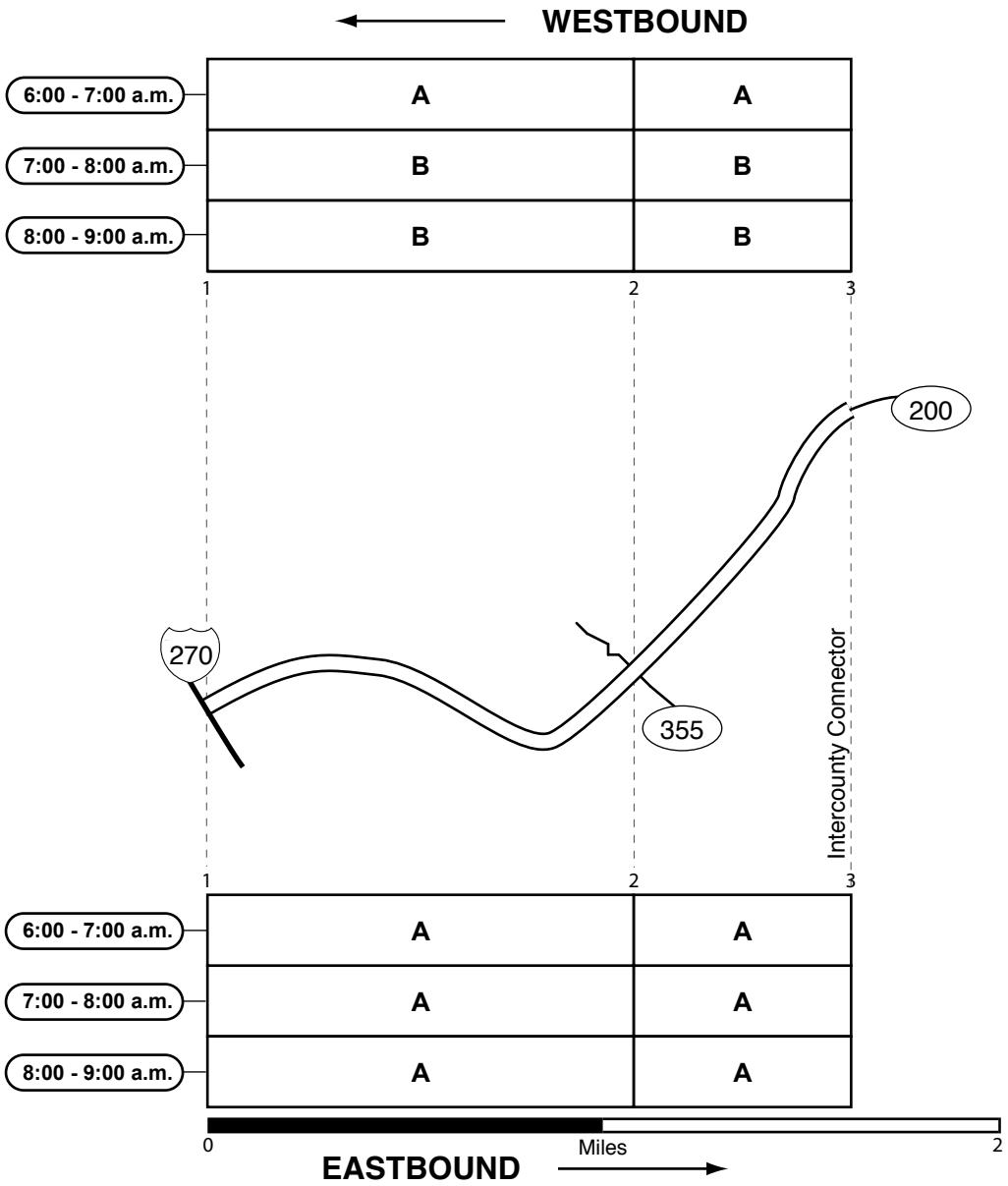
H
Congestion Type: Mainline congestion and exit ramp queue
Frequency: Most observations
Direction: Southbound
Location: vic. 11th St Bridge
Queue Length: 0.5 to 1 mile
Estimated Speed: 30 to 50 mph
Note: The primary bottleneck was the merge with outbound traffic from the 11th St Bridge; weaving and merging approaching the Howard Rd and Suitland Parkway interchanges also appeared to cause congestion.

I
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Southbound
Location: Approaching I-495 / Beltway
Queue Length: 4 to 5 miles
Estimated Speed: 20 to 50 mph
Note: The head of the queue was found on the ramp to the Beltway; congestion extended back into the right lane, and eventually across all lanes, of I-295. Congestion was also exacerbated by traffic entering at the interchanges along this corridor.



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-370 - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F

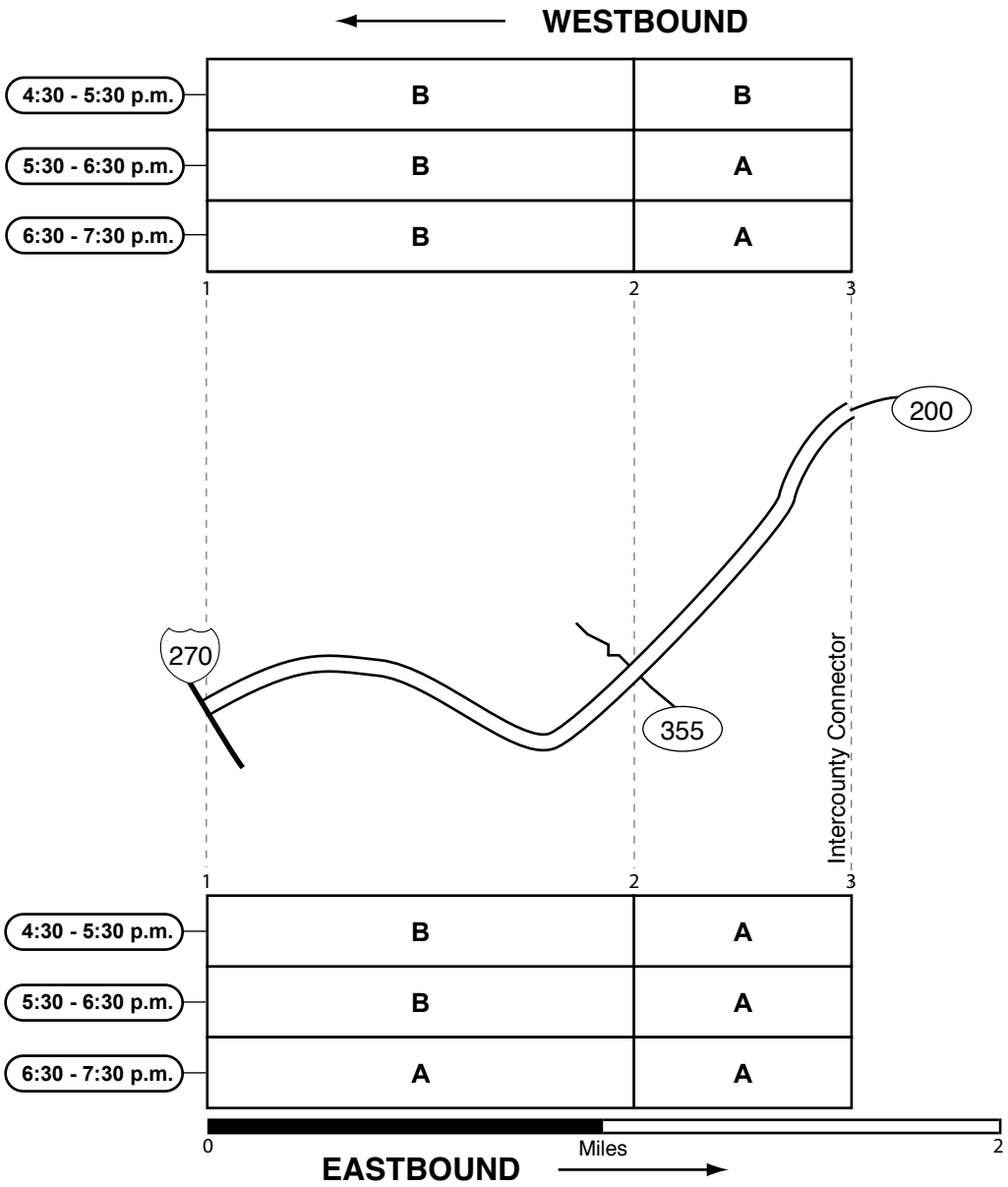
Density 10 20 30 40 50 60 70 80 90

Light Moderate Heavy Congested Severe

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).

[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-370 - Evening

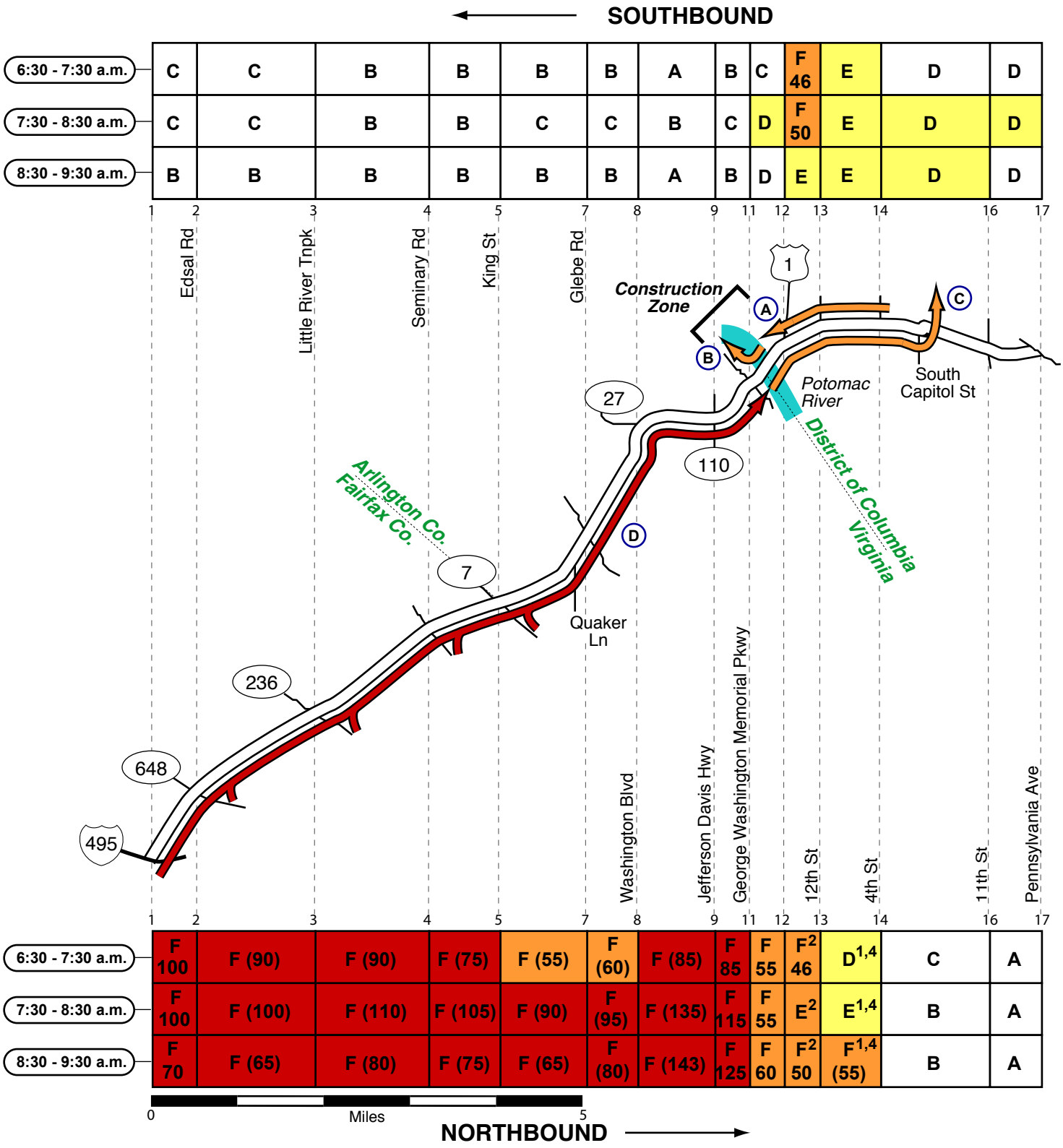


Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-395/Southeast/Southwest Freeway (Virginia/District of Columbia) - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

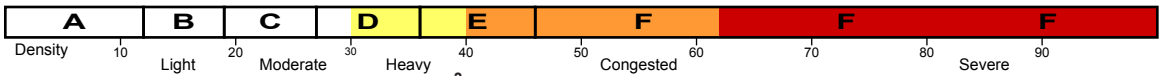
I-395/Southeast/Southwest Freeway (Virginia/District of Columbia) - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations before 9:00 a.m.
Direction: Southbound
Location: Between 11th St & 14th St/US 1
Queue Length: 0.5 to 1.5 miles
Estimated Speed: 35 to 50 mph
Note: Congestion was caused or exacerbated by the two separate lane drops, at 7th St (4 lanes to 3) and 14th St (3 lanes to 2).

B
Congestion Type: Exit Ramp Queue
Frequency: Most observations
Direction: Southbound
Location: George Washington Memorial Parkway
Queue Length: 0.5 to 1 miles
Estimated Speed: to mph
Note: On some days but not others, congestion on the ramp extended back into the right lane on the 14th St Bridge; ongoing construction on George Washington Memorial Parkway exacerbated the congestion.

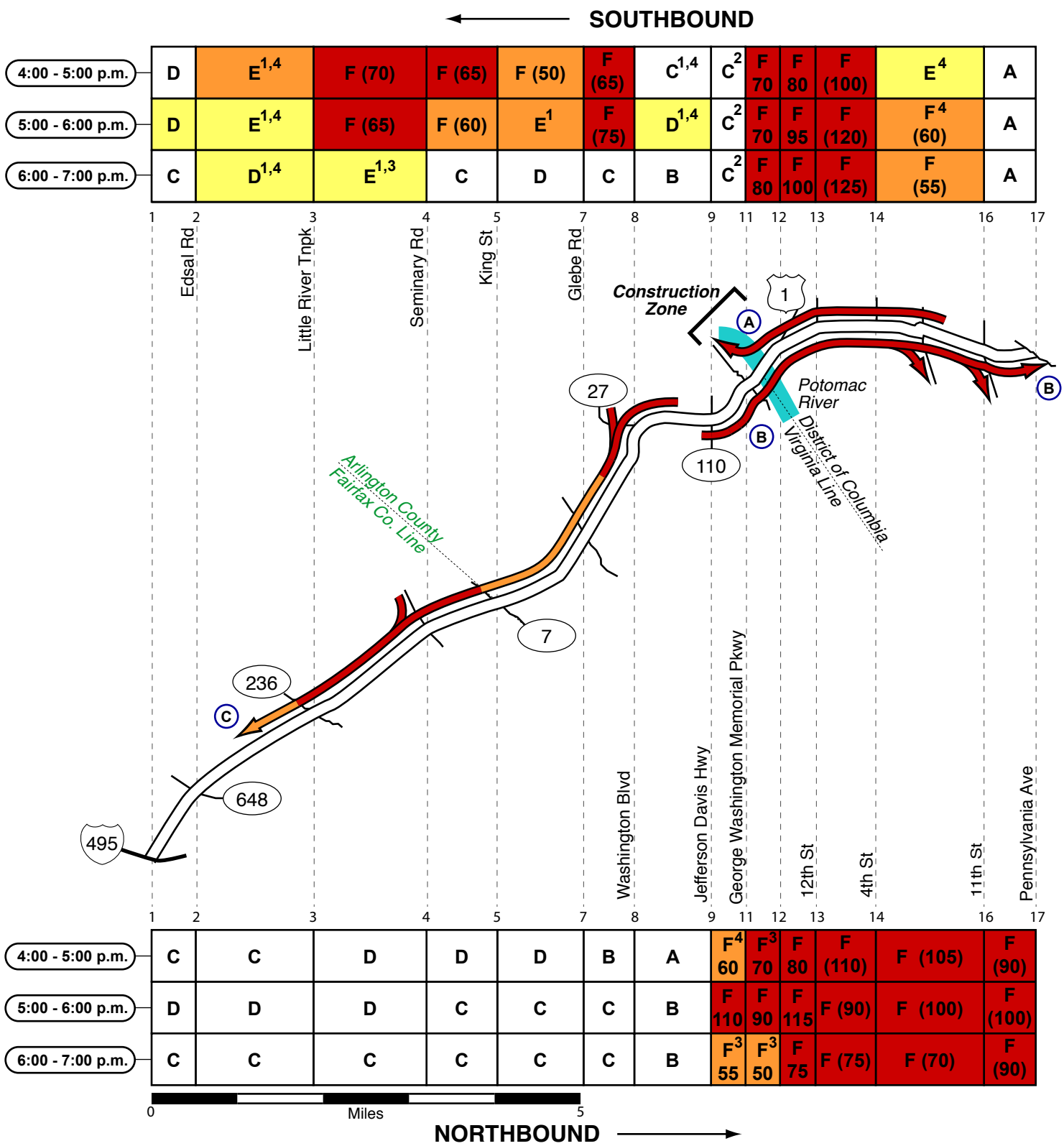
C
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Northbound
Location: Between the 14th St Bridge & South Capitol St
Queue Length: 1 to 2 miles
Estimated Speed: 30 to 50 mph
Note: The head of the queue was found at the exit to the mall (I-395 terminus); congestion on the ramp typically extended back into the right two lanes (and eventually across all lanes) of I-395/ Southwest Freeway. Congestion here was less severe than in previous surveys; upstream congestion related to construction on the 14th St Bridge may have metered traffic flow and thus contributed to improved conditions.

D
Congestion Type: Mainline Congestion
Frequency: All observations before 9:00 a.m.
Direction: Northbound
Location: Between I-495 & the 14th St Bridge
Queue Length: 8 to 10 miles
Estimated Speed: 5 to 25 mph
Note: Throughout the 2011 survey, the 14th Street Bridge was under construction; in the northbound direction, one of four lanes was closed. At the center of the bridge the roadway was divided by jersey barriers; one lane on the left - two lanes on the right. While this bottleneck caused moderate congestion on the bridge, the primary bottleneck was just upstream at the George Washington Memorial Pkwy interchange; the short acceleration lane for vehicles entering from the GWMP was blocked by jersey barriers; this required vehicles entering from the ramp to merge into the right
lane with no speed



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-395/Southeast/Southwest Freeway (Virginia/District of Columbia) - Evening



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

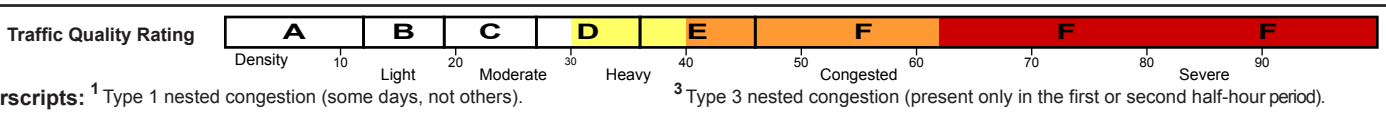
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-395/Southeast/Southwest Freeway (Virginia/District of Columbia) - Evening

A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Southbound
Location: Between 11th St & the George Washington Memorial Pkwy
Queue Length: 1.5 to 2.5 miles
Estimated Speed: 5 to 25 mph
Note: Factors contributing to the congestion were: 1) the two separate lane drops at Maine Ave (5 lanes to 3) and the start of the HOV facility (3 lanes to 2) and; 2) congestion on the ramp to the George Washington Memorial Parkway (GWMP) that extended back into the right lane (and eventually across all lanes) of I-395. Ongoing construction on the GWMP likely contributed to the congestion.

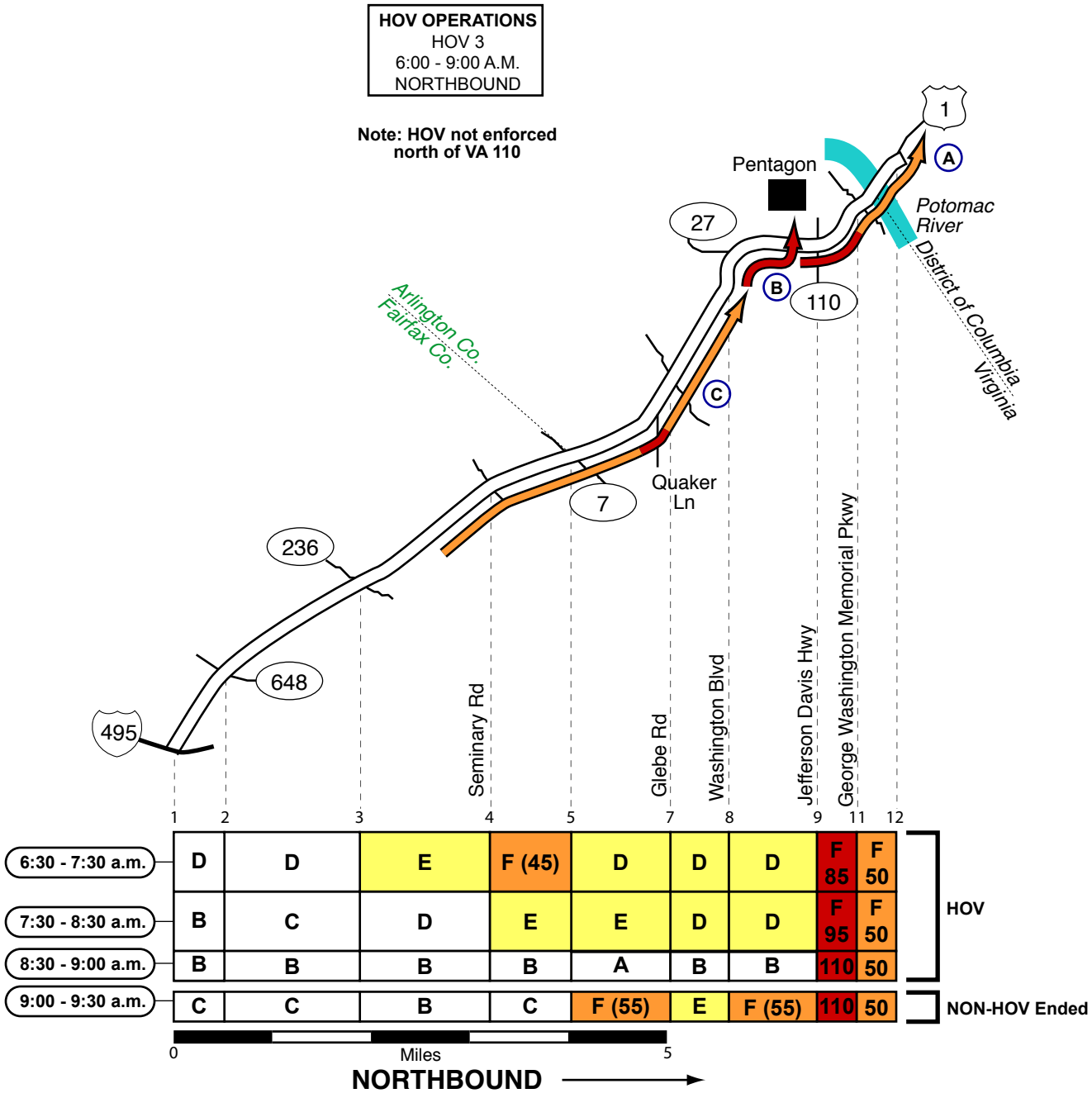
B
Congestion Type: Mainline Congestion
Frequency: Throughout the evening survey period
Direction: Northbound
Location: Between the GWMP and Pennsylvania Ave
Queue Length: 4 to 5 miles
Estimated Speed: 5 to 30 mph
Note: Factors contributing to the congestion were: 1) the lane drop (4 lanes to 3) in the vicinity of the George Washington Memorial Parkway; 2) HOV traffic entering the mainline at the Case Bridge (HOV terminus); 3) congestion on the ramps to South Capitol St and 11th St that extended back into the mainline of the Southeast Freeway and; 4) the signal queue at Pennsylvania Ave/Sousa Bridge (Southeast Freeway terminus). Congestion was also exacerbated by ongoing construction on the 14th St and 11th St Bridges.

C
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:00 p.m.
Direction: Southbound
Location: Between VA 27 & Edsal Rd
Queue Length: 5 to 8 miles
Estimated Speed: 20 to 50 mph
Note: Southbound congestion on I-395 was very similar to that found during the previous survey in 2008. During the peak period, southbound travelers normally encountered congestion in the vicinity of Washington Blvd (VA 27); congestion typically persisted south for approximately seven miles to Little River Tnpk. Factors contributing to the congestion included: 1) trafffic entering at VA 110, VA 27 and Seminary Rd; 2) the lane drop (4 lanes to 3) at Little River Tnpk (VA 236).



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-395/SE Fwy (Virginia/District of Columbia) Barrier Separated HOV - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

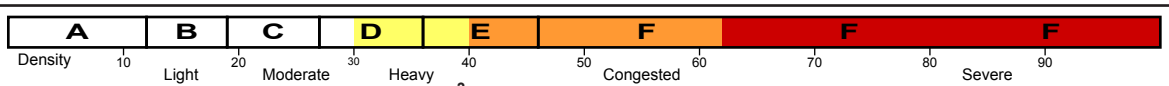
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-395/SE Fwy (Virginia/District of Columbia) Barrier Separated HOV - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Northbound
Location: Approaching and across the 14th St Bridge
Queue Length: 0.5 to 1.5 miles
Estimated Speed: 10 to 40 mph
Note: The head of the queue was found on the ramp where HOV traffic merges with the general-purpose lanes at the Case Bridge (Note: HOV restrictions are not enforced north of VA 110). Congestion was particularly severe where traffic entered the HOV facility in the vicinity of VA 110.

B
Congestion Type: HOV Congestion
Frequency: Peak hour
Direction: Northbound
Location: Approaching the exit to the Pentagon (Eads St)
Queue Length: to miles
Note: The northbound exit ramp to the Pentagon at Eads Rd was typically congested during the peak period; during some observations, the exit queue extended back into the right lane in the HOV facility, and ultimately across all lanes.

C
Congestion Type: Mainline Congestion
Frequency: Most observations between 7:00 and 8:00 a.m.
Direction: Northbound
Location: Between Seminary Rd & Washington Blvd (VA 27)
Queue Length: 2 to 4 miles
Estimated Speed: 30 to 50 mph
Note: During the peak period, moderate northbound congestion was found on the HOV facility on I-395; however, travelers here benefited greatly in terms of travel time relative to the general purpose lanes which were severely congested. Congestion on the HOV facility may have been attributable to greater demand with commuters avoiding the severity of congestion found daily in the general purpose lanes.

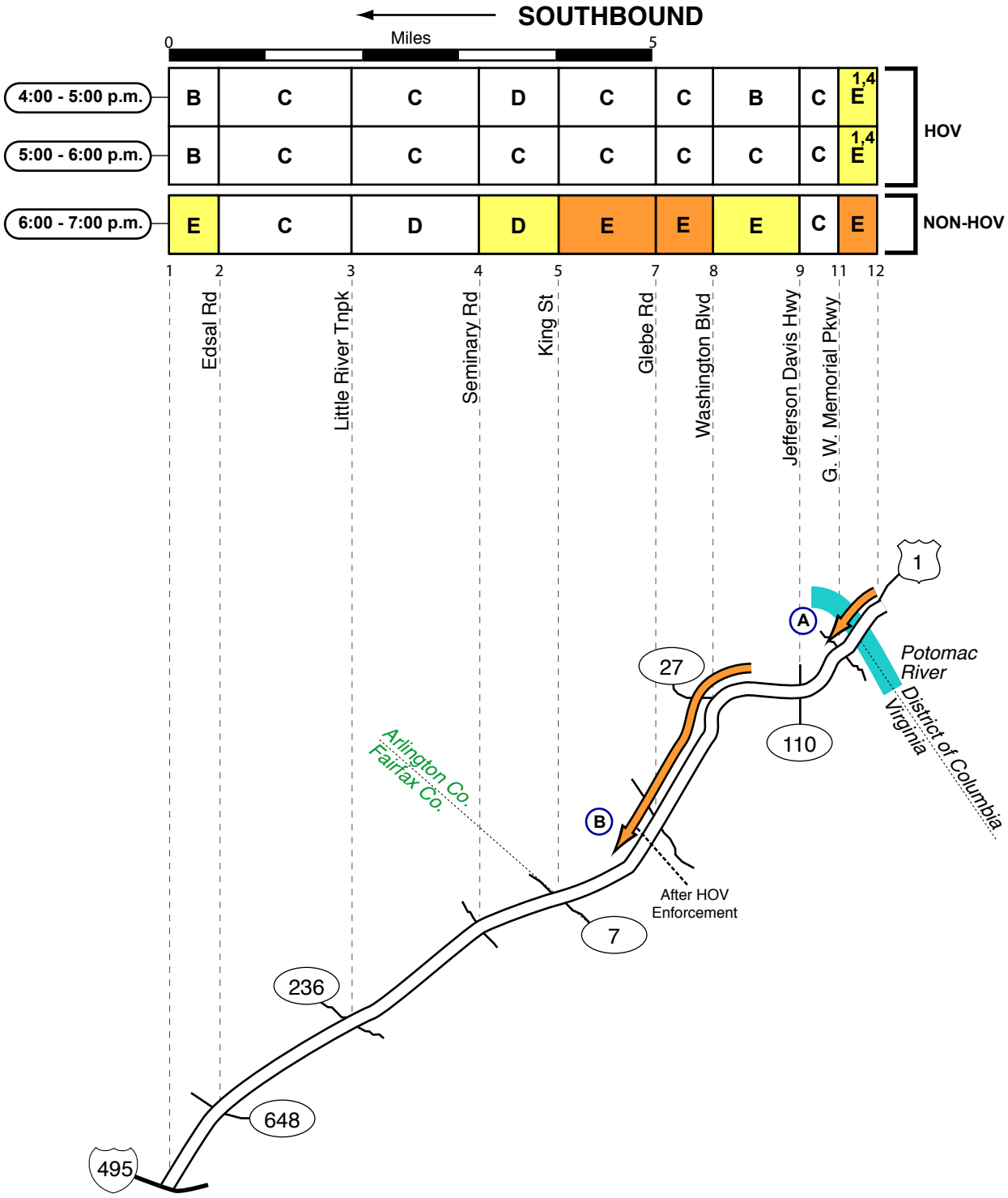


Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-395/SE Fwy (Virginia/Distict of Columbia) Barrier Separated HOV - Evening

HOV OPERATIONS
HOV 3
3:30 - 6:00 P.M.
SOUTHBOUND

Note: HOV not enforced north of VA 110



Traffic Quality Rating

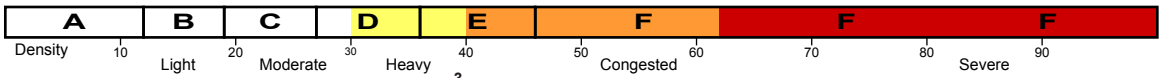
A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-395/SE Fwy (Virginia/Distict of Columbia) Barrier Separated HOV - Evening

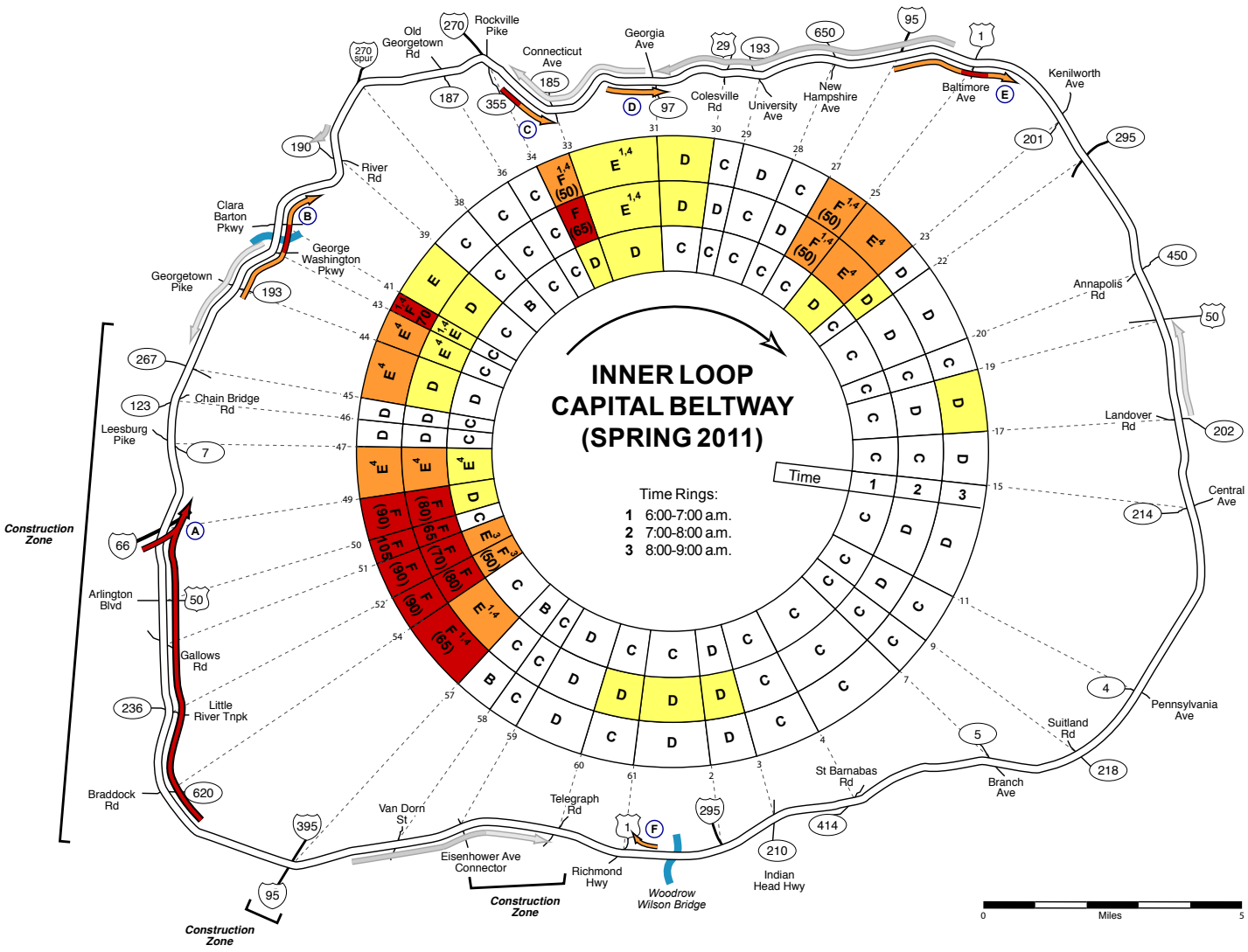
A
Congestion Type: Mainline Congestion
Frequency: On some days but not others
Direction: Southbound
Location: Between US 1 & VA 110
Queue Length: 0.5 to 1 miles
Estimated Speed: 40 to 50 mph
Note: Intermittently, congestion was found crossing the 14th St Bridge; weaving approaching the ramp to the general-purpose lanes may have contributed to the congesiton (Note: HOV restrictions are not enforced north of VA 110).

B
Congestion Type: Mainline Congestion
Frequency: After HOV Enforcement (after 6:00 p.m.)
Direction: Southbound
Location: Between VA 110 and VA 7
Queue Length: 2 to 3 miles
Estimated Speed: 40 to 50 mph
Note: Minor southbound congestion was intermittently found on the HOV facility during observations after 6:00; delays here were relatively minor compared to non HOV travelers in the general purpose lanes.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-495/95 Capital Beltway (Inner Loop) - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-495/95 Capital Beltway (Inner Loop) - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Northbound
Location: Northbound inner-loop in VA
Queue Length: 4 to 7 miles
Estimated Speed: 15 to 30 mph
Note: Historical northbound congestion on the inner loop in Virginia was again found during the 2011 survey flights. Congestion first formed at two distinct locations: between the Braddock Rd and Gallows Rd interchanges, and downstream at the I-66 merge. Ultimately, the I-66 bottleneck caused severe congestion that extended to a point about 5-8 miles upstream, somewhere between Braddock Rd the I-95/395 interchange. Construction along this section of the beltway appeared to exacerbate traffic flow through the interchanges.

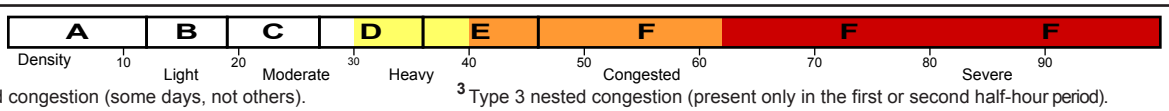
B
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:30 a.m.
Direction: Northbound
Location: Inner loop approaching the American Legion Bridge
Queue Length: 2 to 4 miles
Estimated Speed: 25 to 50 mph
Note: Inner loop congestion found later in the morning survey period appeared to be exacerbated by sun glare; after crossing from Virginia into Maryland on the American Legion Bridge, the roadway bends sharply to the right into the direction of the sun (eastbound). Merging and weaving at the Clara Barton Pkwy interchange may also have contributed to the congestion.

C
Congestion Type: Mainline Congestion & Exit Queues
Frequency: Most observations after 7:00 a.m.
Direction: Eastbound
Location: Between I-270 and Connecticut Ave (MD 185)
Queue Length: 0.5 to 1.5 miles
Estimated Speed: 25 to 50 mph
Note: Factors contributing to the mainline congestion included: 1) traffic merging from the left (vehicles from I-270 southbound); 2) highway curves; 3) weaving associated with the Connecticutt Ave interchange. Exit queues were also found in both directions at Connecticut Ave.

D
Congestion Type: Minor mainline congestion
Frequency: Intermittent
Direction: Eastbound
Location: Approaching MD 97
Queue Length: 0.5 to 1.5 miles
Estimated Speed: 40 to 55 mph
Note: Heavy eastbound flow at slightly reduced speeds was intermittently found approaching the interchange at MD 97 (Georgia Ave).

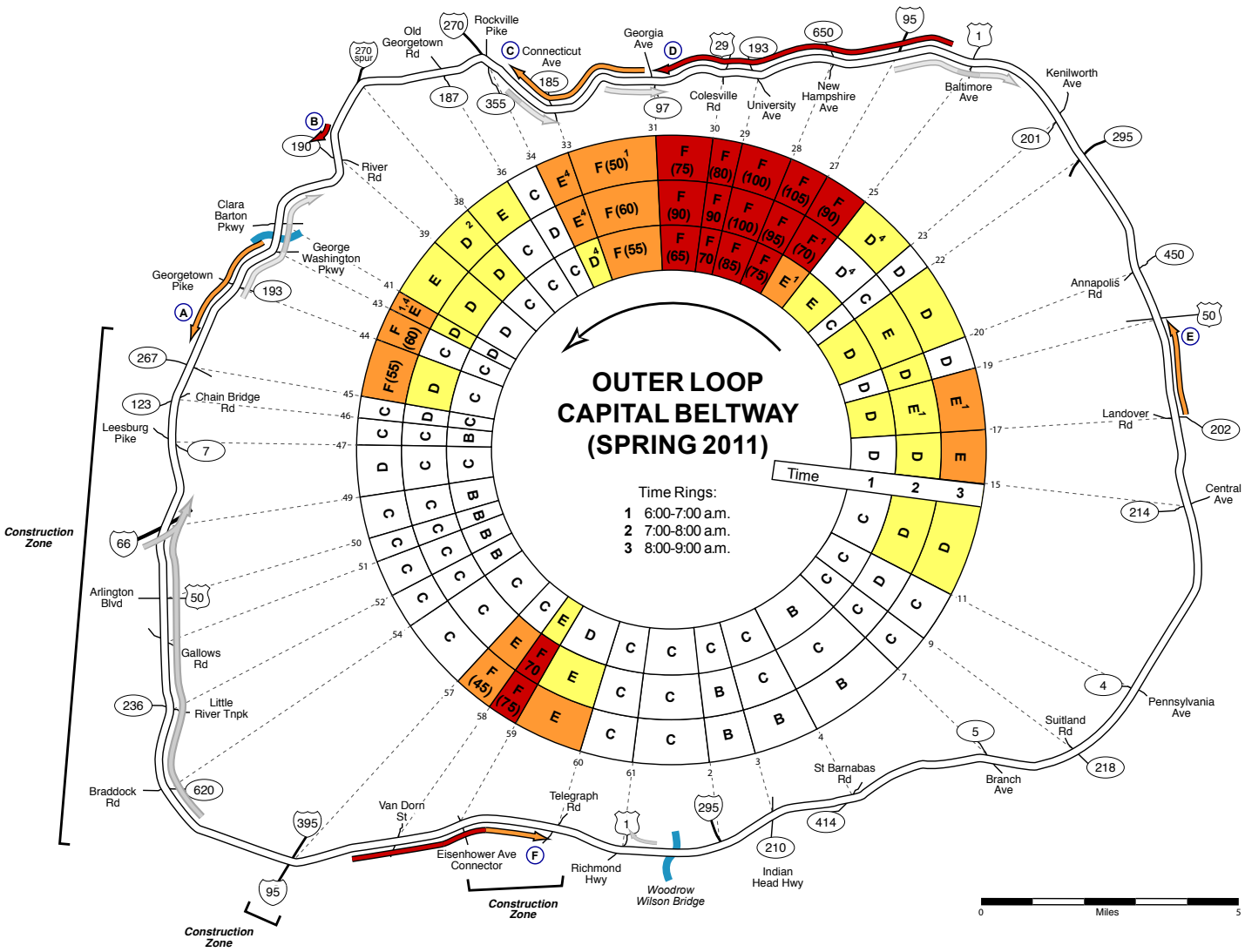
E
Congestion Type: Mainline Congestion
Frequency: Most observations after 7:00 a.m.
Direction: Eastbound
Location: Between I-95 and Greenbelt Metro Station
Queue Length: 1 to 2 miles
Estimated Speed: 25 to 50 mph
Note: Factors contributing to the congestion included: 1) two lanes of traffic merging from the left (vehicles from southbound I-95); 2) traffic entering from the auxiliary lane at US Route 1.

F
Congestion Type: Right lane exit queue
Frequency: Intermittent
Direction: Westbound
Location: Approaching ramp to NB US 1
Queue Length: 0.5 to 1.5 miles
Estimated Speed: to mph
Note: The exit queue at US Route 1 (northbound ramp) generated upstream congestion that extended back into the right lane on the Woodrow Wilson Bridge. Through travelers on the beltway appeared to bypass te queue with minimal delay.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-495/95 Capital Beltway (Outer Loop) - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-495/95 Capital Beltway (Outer Loop) - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations after 8:00 a.m.
Direction: Southbound
Location: American Legion Bridge to VA 267
Queue Length: 2 to 3 miles
Estimated Speed: 30 to 50 mph
Note: Outer loop congestion between the American Legion Bridge and VA 267 consistently developed after 8:00 a.m.; southbound travelers resumed free flow speeds on the outer loop after passing through the VA 267 interchange (under construction).

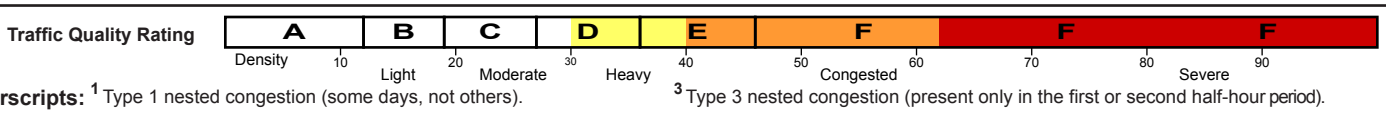
B
Congestion Type: Exit Queue
Frequency: Most observations after 8:00 a.m.
Direction: Southbound
Location: River Rd (MD 190)
Note: Southbound congestion was typically found in the exit/ auxiliary lane at River Rd; during some observations, congestion extended back into the right lane on the outer loop, and eventaully across all lanes.The head of the exit queue was found on eastbound River Rd at the signal at Burdette Rd.

C
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Westbound
Location: Georgia Ave (MD 97) to I-270/MD 355
Queue Length: 1 to 3 miles
Estimated Speed: 30 to 50 mph
Note: Outer-loop flow consistently improved west of MD 97; however, minor congestion with flow at reduced speeds typically persisted until the vicinity of the I-270 / MD 355 interchange. Highway curves and weaving between interchanges were contributing factors.

D
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Westbound
Location: Outer loop between I-95 and Georgia Ave
Queue Length: 5 to 6 miles
Estimated Speed: 10 to 25 mph
Note: Historical westbound congestion between I-95 and MD 97 (Georgia Ave) was again found during the 2011 survey flights; during most observations after 7:00 a.m., the tail of the queue was typically found in the vicinity of the US Route 1.

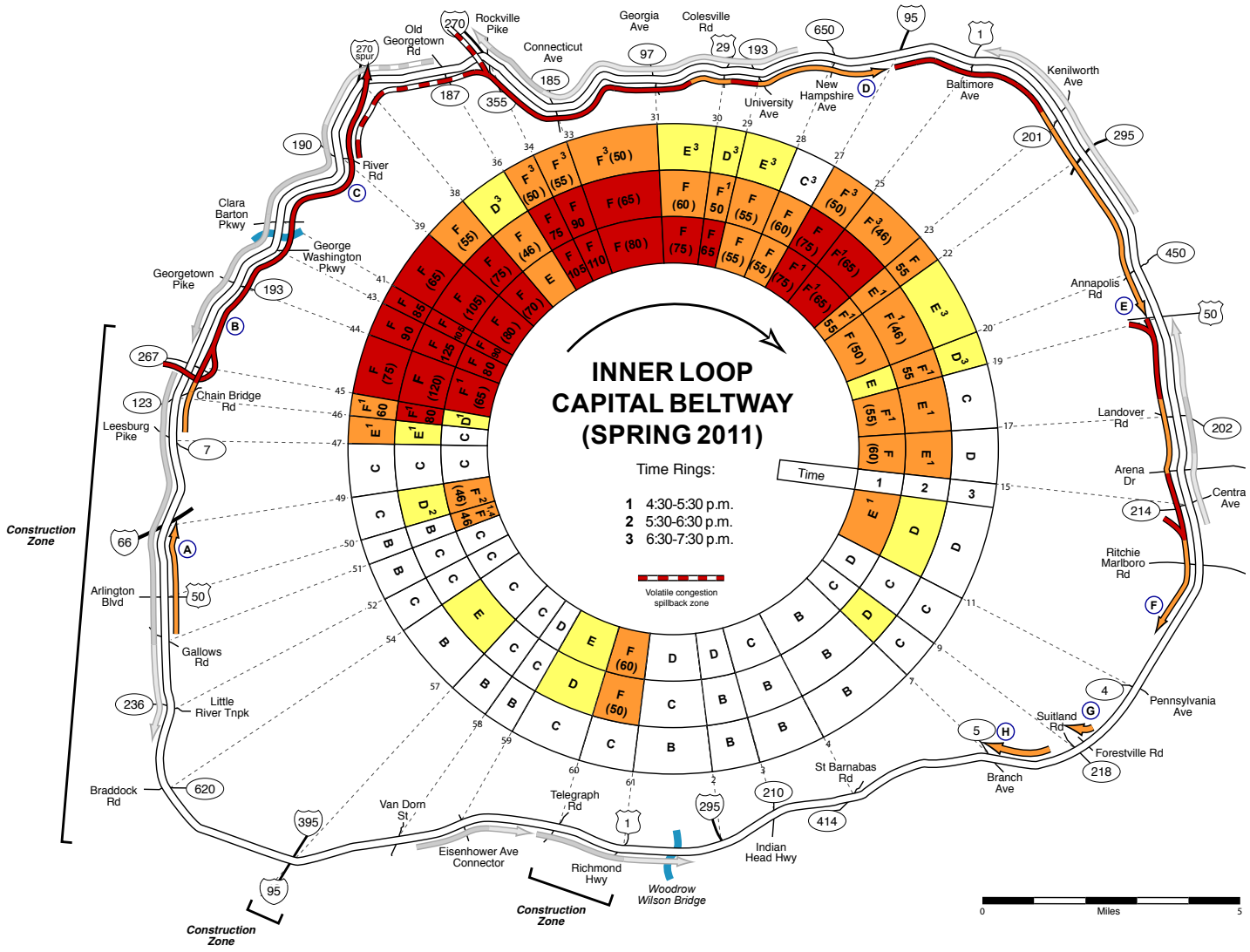
E
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Northbound
Location: Between Landover Rd (SR 202) & US 50
Queue Length: 1 to 2 miles
Estimated Speed: 40 to 55 mph
Note: Congestion may have been caused or exacerbated by merging and weaving associated with the auxilliary lane that runs the length of the segment between SR 202 and US 50.

F
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Eastbound
Location: Approaching WW Bridge construction zone
Queue Length: 3 to 5 miles
Estimated Speed: 25 to 50 mph
Note: A lane drop in the construction zone at Eisenhower Ave caused upstream congestion throughout most of the evening survey period; during some observations, the queue extended back to the I-95 interchange and onto the flyover ramp from I-95 north.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-495/95 Capital Beltway (Inner Loop) -Evening



A
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Northbound
Location: Between Gallows Rd and I-66
Queue Length: 1 to 2 miles
Estimated Speed: 25 to 45 mph
Note: Early in the evening survey period, congestion was found in the left lane on the inner loop approaching the exit to westbound I-66; congestion in the left lane intermittently extended back across all lanes on the beltway. Construction associated with the I-495 HOV/HOT Lanes project likley contributed to the congestion.

B
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Northbound
Location: From VA 123 to the American Legion Bridge
Queue Length: 3 to 5 miles
Estimated Speed: 10 to 30 mph
Note: Throughout the evening survey period, severe northbound congestion was found on the inner loop of the beltway in Virginia approaching the American Legion Bridge; congestion typically extended back to the vicinity of the VA 123 interchange. Traffic merging from the entrance ramps at the VA 193 and George Washington Pkwy interchanges appeared to exacerbate the congestion.

Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-495/95 Capital Beltway (Inner Loop) -Evening

C
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Northbound
Location: American Legion Bridge to I-270 Spur
Queue Length: 3 to 4 miles
Estimated Speed: 10 to 30 mph
Note: Throughout the evening survey period, severe northbound congestion was found on the inner loop of the beltway between then American Legion Bridge and the I-270 spur; congestion was typically more severe in the left lanes on the approach to the split (270 spur and continuation of the inner loop).

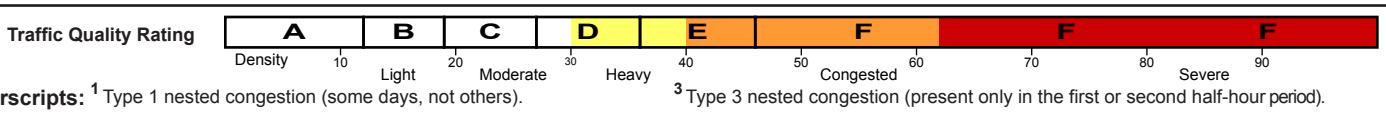
D
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Eastbound
Location: From I-270 spur to I-95
Queue Length: 8 to 11 miles
Estimated Speed: 20 to 55 mph
Note: Throughout most of the evening survey period, extensive eastbound delays were found on the inner loop of the beltway between the interchanges at I-270 and I-95; stop-and-go conditions were intermittently found at various locations, particularly west of Georgia Ave. As found during previous surveys, severe congestion between the 270 spur and MD 355 was present on some days, but not others. Note: During two evening observations just prior to 7:30 p.m., free flow conditions were found along the entire length of this corrodor (270 spur to I-95).

E
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Eastbound / Southbound
Location: Between I-95 (MD) and US 50
Queue Length: 4 to 8 miles
Estimated Speed: 30 to 55 mph
Note: On some days, but not others, moderate to severe congestion caused significant delay for eastbound/ southbound travelers on the inner loop of the beltway; congestion was typcially more severe between the interchanges at I-95 and MD 295; while flow typically improved on the southbound approach to US 50, downstream congestion intermittently backed through the interchange.

F
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:30 p.m.
Direction: Southbound
Location: Between US 50 & SR 4
Queue Length: 5 to 8 miles
Estimated Speed: 25 to 55 mph
Note: Factors contributing to the congestion included: 1) the merge at US 50 where two lanes of traffic enter the mainline; 2) weaving at the lane drop (4 lanes to 3) where the roadway divides on the approach to the SR 202 interchange; 3) traffic entering the mainline from the ramp at SR 214; 4) weaving approaching the SR 4 interchange.

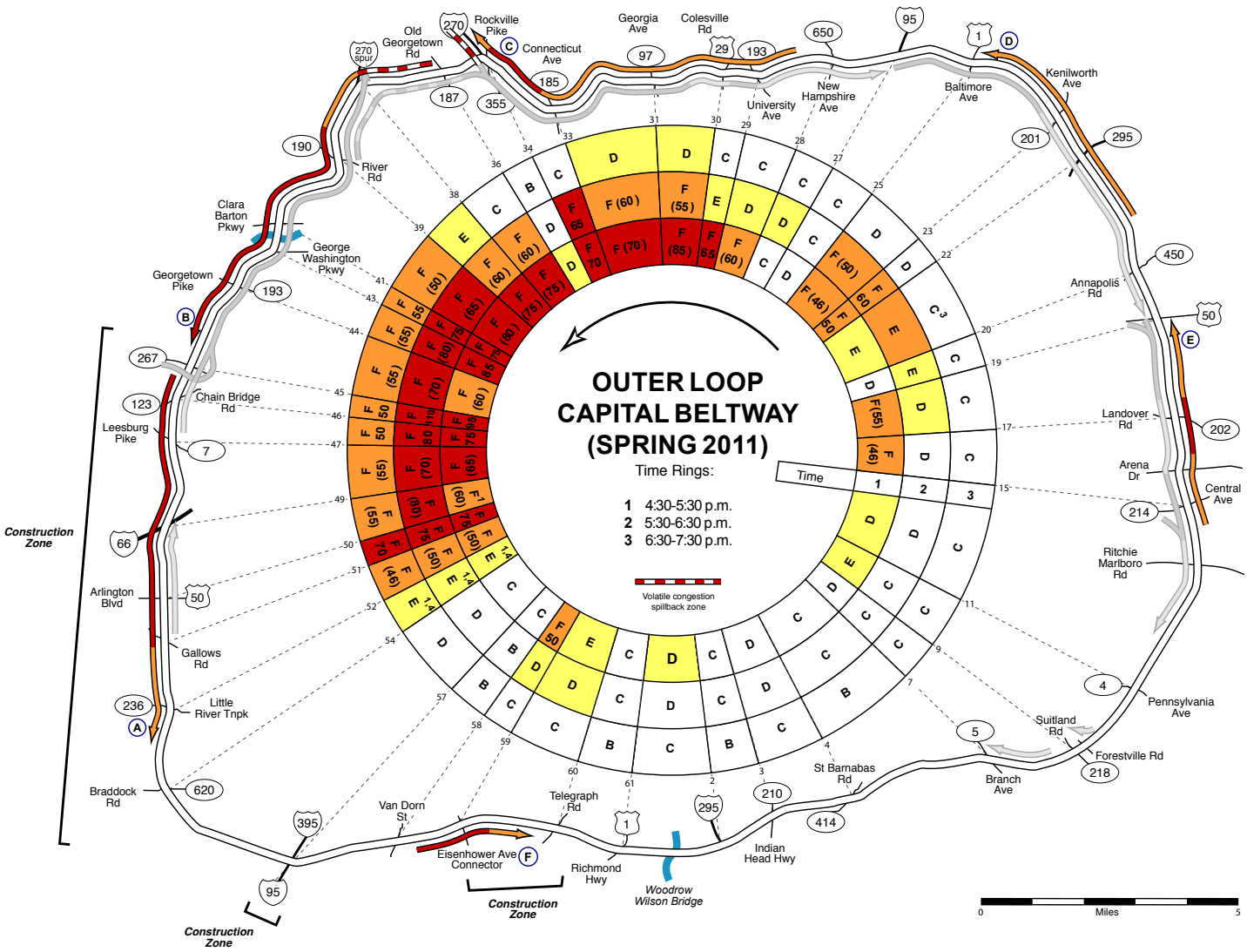
G
Congestion Type: Right lane to exit queue
Frequency: Intermittent
Direction: Westbound
Location: Forestville Rd exit
Note: Intermittently, the right lane exit queue at at Forestville Rd extended upstream into the right lane on the beltway; the head of the queue was at the end of the ramp where vehicles waited to merge into southbound traffic on Forestville Rd.

H
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Westbound
Location: MD 5 interchange exit queue
Note: Intermittently, the right lane exit queue at at Forestville Rd extended upstream into the right lane on the beltway; through traffic on the beltway inner loop appeared to bypass the queue with little or no delay.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

I-495/95 Capital Beltway (Outer Loop) -Evening



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

I-495/95 Capital Beltway (Outer Loop) -Evening

A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Southbound
Location: Between VA 267 and VA 236 (Little River Turnpike)
Queue Length: 6 to 7 miles
Estimated Speed: 20 to 40 mph
Note: South of VA 267, severe southbound congestion on the outer loop appeared to be exacerbated by construction associated with the HOV/HOV Lanes project; south and east of VA 236, traffic typically flowed at free flow speeds on the approach to the I-95/395 interchange.

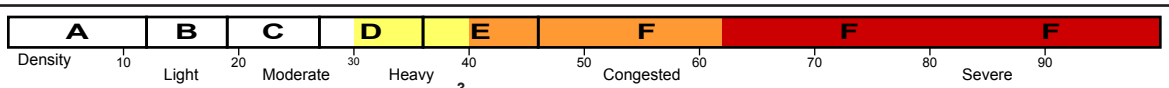
B
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Southbound
Location: Between I-270 spur and VA 267
Queue Length: 5 to 7 miles
Estimated Speed: 10 to 30 mph
Note: Severe southbound congestion found along this section of the outer loop resembled conditions found during the surveys conducted between 1999 and 2005. During those surveys, the bottleneck was found where vehicles exited to VA 267; improved flow documented in 2008 resulted directly from a project to widen the VA 267 exit ramp to 2 lanes. During the 2011 survey, southbound congestion on the outer loop appeared to be exacerbated by construction related to the I-495 HOV/HOT Lanes project (beginning at the VA 267 interchange).

C
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Westbound
Location: Between New Hampshire Ave and I-270
Queue Length: 4 to 7 miles
Estimated Speed: 25 to 50 mph
Note: During most observations (5:00-6:30 p.m.), westbound congestion was found on the outer loop of the beltway between Georgia Ave and I-270; congestion upstream of Georgia Ave was intermittenly found (some days not others), with the tail of the queue typically in the vicinity of New Hampshire Ave.

D
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:30 p.m.
Direction: Northbound
Location: Between MD 450 (Annapolis Rd) and US 1
Queue Length: 3 to 5 miles
Estimated Speed: 40 to 55 mph
Note: Northbound congestion along this section of the outer loop of the beltway appeared to be caused or exacerbated by merging and weaving at MD 295, MD 201 and US 1.

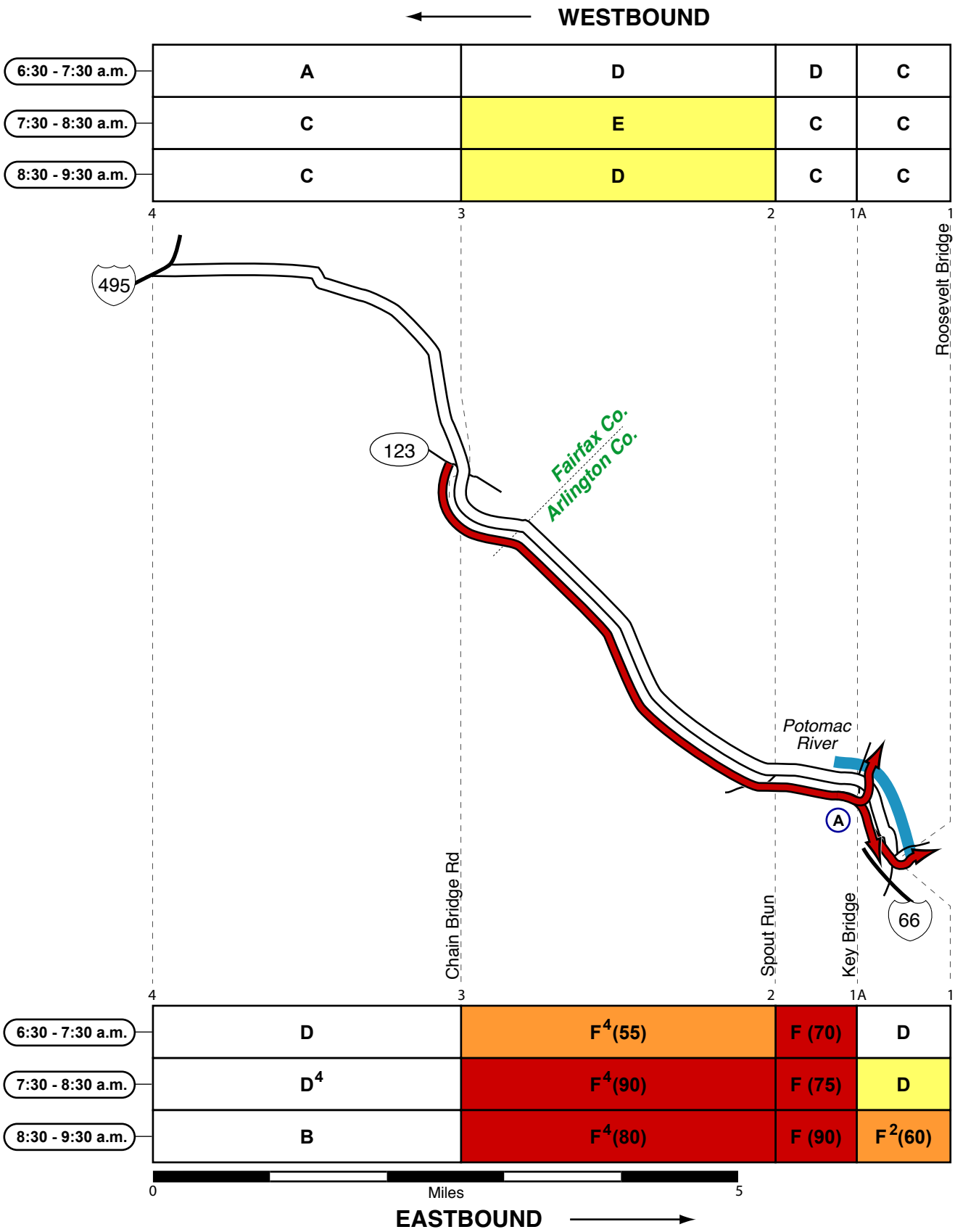
E
Congestion Type: Mainline Congestion
Frequency: Most observations before 5:30 p.m.
Direction: Northbound
Location: Between SR 214 to US 50
Queue Length: 2 to 4 miles
Estimated Speed: 30 to 50 mph
Note: Congestion appeared to exacerbated by merging and weaving along the divided highway section of I-495 (vicinity of Arena Dr and SR 202).

F
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Eastbound
Location: Approaching Eisenhower Ave construction zone
Queue Length: 1 to 2 miles
Estimated Speed: 30 to 50 mph
Note: A lane drop in the construction zone at Eisenhower Ave caused upstream congestion intermittently.



Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

George Washington Memorial Parkway (Virginia) - Morning



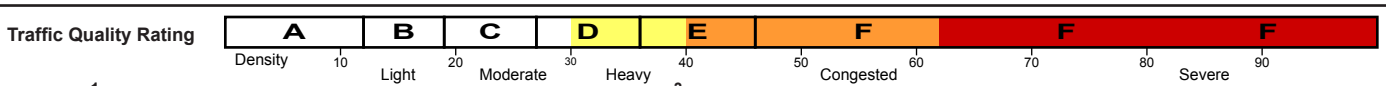
Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

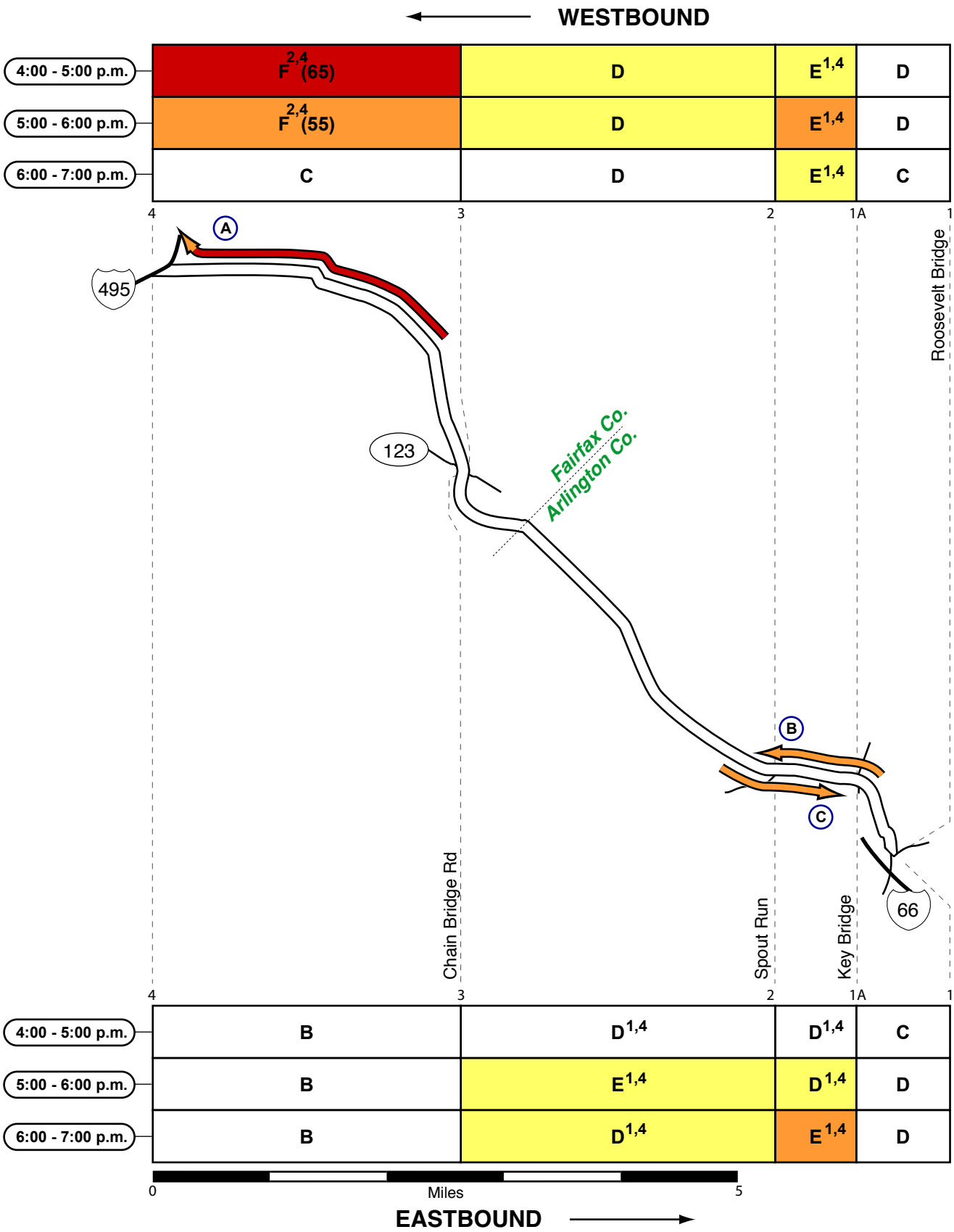
George Washington Memorial Parkway (Virginia) - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Eastbound
Location: Between Chain Bridge Rd & I-66
Queue Length: 3 to 5 miles
Estimated Speed: 10 to 40 mph
Note: The primary bottleneck was the lane drop (3 lanes to 2) where traffic entered at Spout Run. After 8:00 a.m., the head of the queue was found further east, where congestion on the Roosevelt and Key bridges extended back into the mainline of the GW Parkway.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

George Washington Memorial Parkway (Virginia) - Evening



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

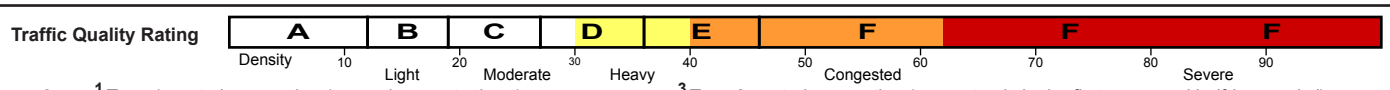
Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

George Washington Memorial Parkway (Virginia) - Evening

A
Congestion Type: Mainline Congestion
Frequency: Most observations before 6:00 p.m.
Direction: Westbound
Location: Approaching I-495
Queue Length: 1 to 3 miles
Estimated Speed: 20 to 40 mph
Note: The head of the queue was found on the ramp to the inner loop of the Beltway; congestion typically extended back into the right lane, and eventually across all lanes of the GWMP.

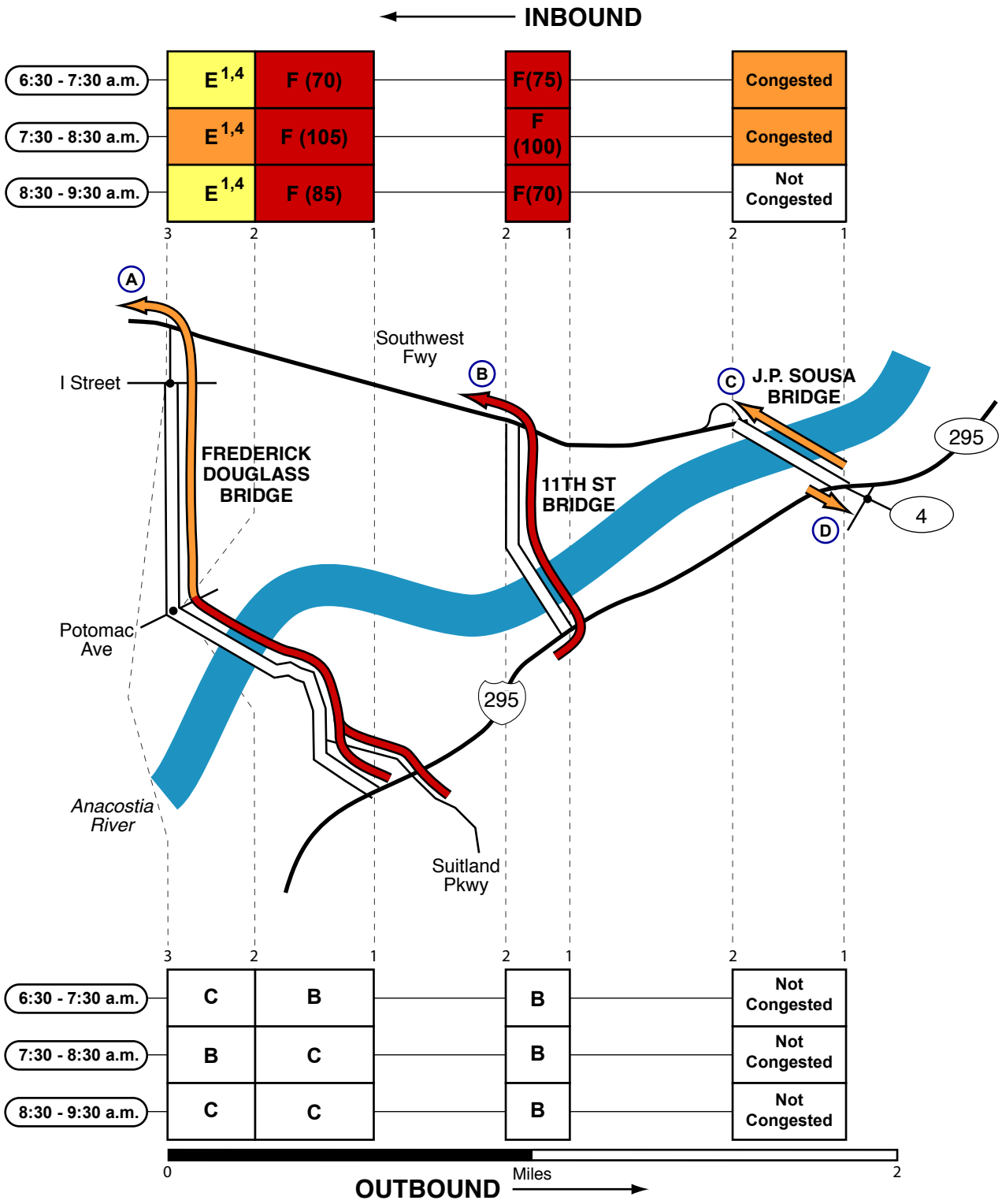
B
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Westbound
Location: Between I-66 & Spout Run
Queue Length: 0.5 to 1 mile
Estimated Speed: 30 to 50 mph
Note: Congestion appeared to be caused or exacerbated by merging and weaving associated with the Key Bridge and Spout Run interchanges.

C
Congestion Type: Mainline Congestion
Frequency: Intermittently after 5:00 p.m.
Direction: Eastbound
Location: Approaching the Key Bridge
Queue Length: 1 to 3 miles
Estimated Speed: 30 to 50 mph
Note: Congestion appeared to be caused by merging associated with the Spout Run entrance ramp and weaving at the ramp to the Key Bridge.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

Anacostia River Bridges - Morning



Traffic Quality Rating

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

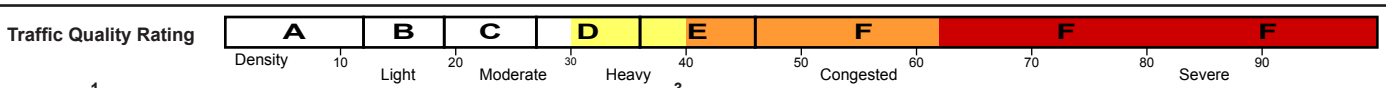
Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

Anacostia River Bridges - Morning

A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Inbound
Location: Between I-295 & Southeast Freeway
Queue Length: 1 to 2 miles
Estimated Speed: 10 to 40 mph
Note: The primary bottleneck was found at the signal at Potomac Ave; north of the signal, traffic flow typically improved. Intermittently, minor queuing was found approaching the signal at I St.

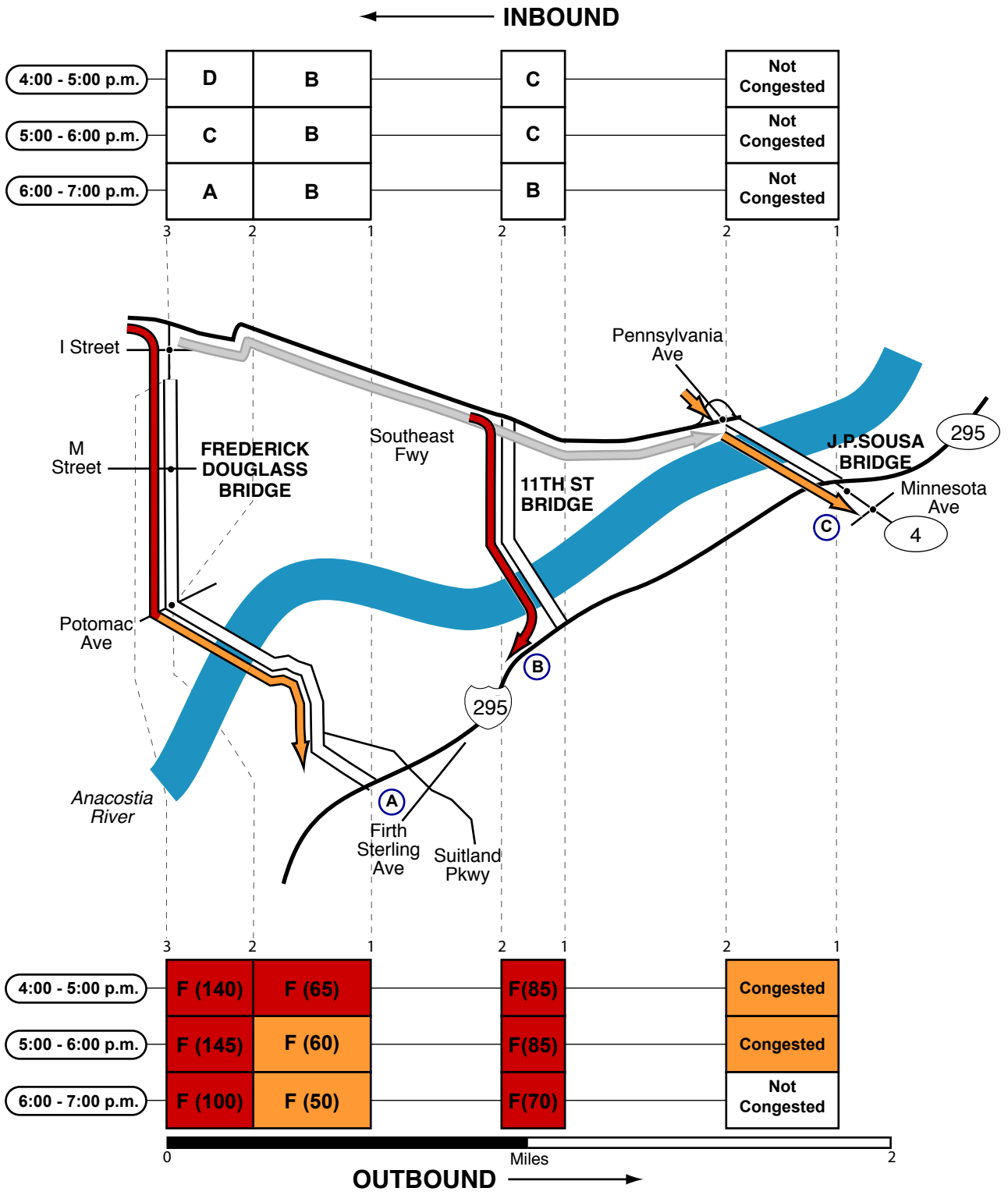
B
Congestion Type: Mainline Congestion
Frequency: Throughout the morning survey period
Direction: Inbound
Location: 11th St Bridge
Queue Length: 0.5 to 1 miles
Estimated Speed: 10 to 30 mph
Note: The head of the queue was found on the ramp to the Southeast Freeway; congestion at this river crossing may have been exacerbated by ongoing construction on the bridge.

C
Congestion Type: Mainline Congestion
Frequency: Intermittent
Direction: Inbound
Location: J.P. Sousa Bridge
Queue Length: 0.25 to 0.5 miles
Note: Factors contributing to the congestion were: 1) weaving approaching the Pennsylvania Ave/ Southeast Freeway split and; 2) the geometrics of the ramp to Southeast Freeway (sharp bend).



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

Anacostia River Bridges - Evening



Traffic Quality Rating: A | B | C | D | E | F | F | F

Density: 10 Light, 20 Moderate, 30 Heavy, 40, 50 Congested, 60, 70, 80 Severe, 90

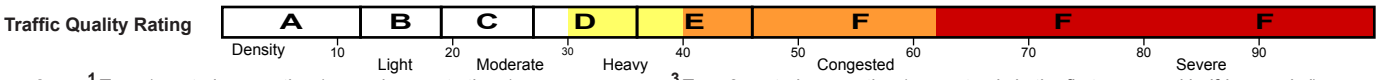
Superscripts: [1] Type 1 nested congestion (some days, not others). [2] Type 2 nested congestion (more severe in left or right-hand lanes). [3] Type 3 nested congestion (present only in the first or second half-hour period). [4] Type 4 nested congestion (partial length of segment).

Anacostia River Bridges - Evening

A
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Outbound
Location: Between Southeast Freeway and I-295
Queue Length: 1 to 2 miles
Estimated Speed: 5 to 40 mph
Note: Stop-and-go congestion was caused by the signals at I St, M St, and Potomac Ave; south of Potomac Ave, traffic flow typically improved.

B
Congestion Type: Mainline Congestion
Frequency: Most observations
Direction: Outbound
Location: 11th St Bridge
Queue Length: 0.5 to 1 miles
Estimated Speed: 5 to 25 mph
Note: Factors contributing to the congestion were: 1) weaving approaching the 13th St/I-295 split; 2) the lane drop (2 lanes to 1) on the ramp to I-295 (southbound) and; 3) construction on the bridge (left lane closed).

C
Congestion Type: Mainline Congestion
Frequency: On some days but not others
Direction: Outbound
Location: J.P. Sousa Bridge
Note: Congestion was caused or exacerbated by the signal at D.C. 295; congestion in the left-turn bay at the signal typically extended back into the mainline of Pennsylvania Ave.



Superscripts: [1] Type 1 nested congestion (some days, not others). [3] Type 3 nested congestion (present only in the first or second half-hour period).
[2] Type 2 nested congestion (more severe in left or right-hand lanes). [4] Type 4 nested congestion (partial length of segment).

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Chapter IV

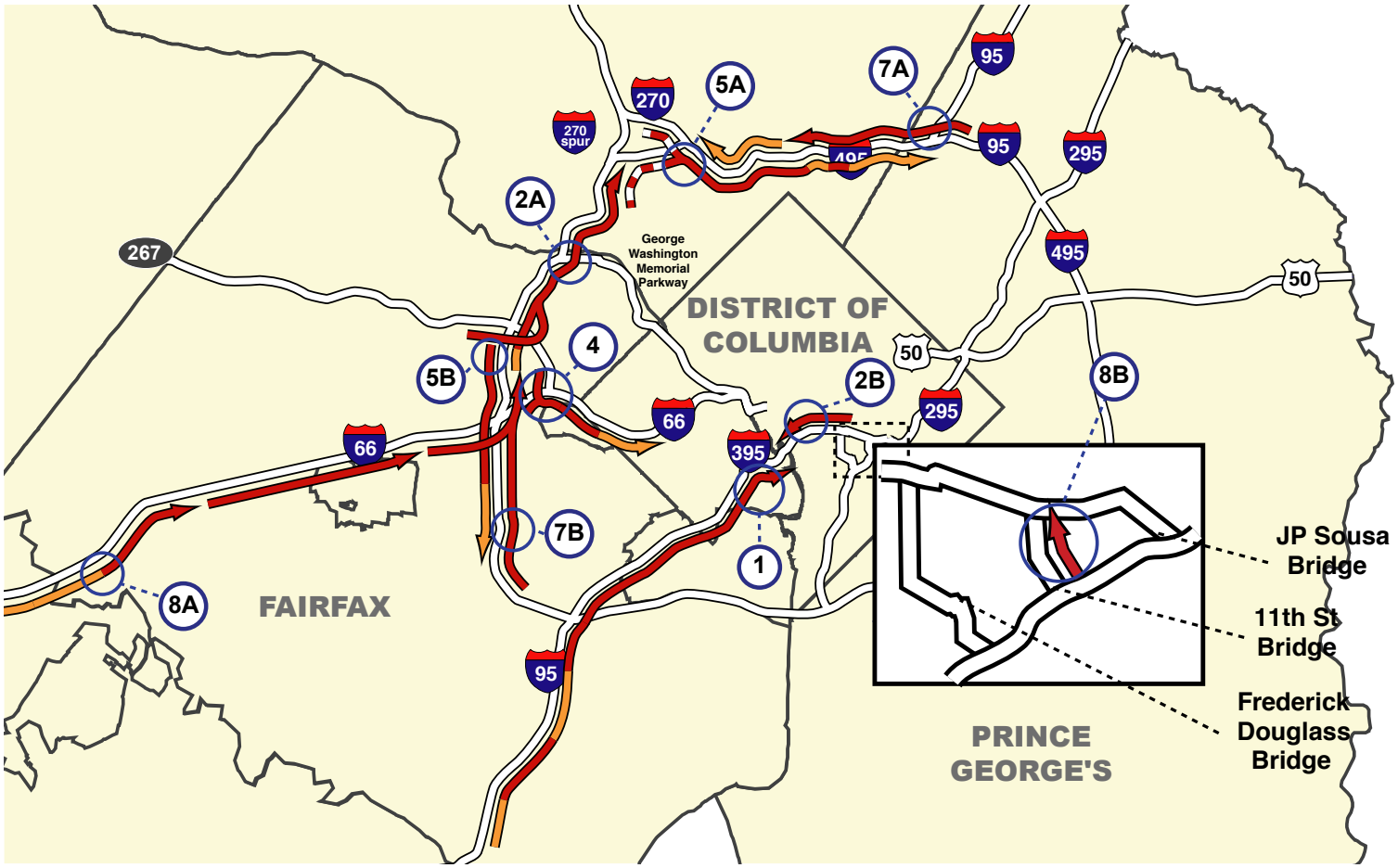
Summary of Congested Locations and Corridors

This chapter provides a summary of the 2011 “Top Ten Congested Locations” by ranking the densities of all segments and picking the top ten irrespective of whether they are congested during the AM or PM peak period. The 2008 Top Ten Congested locations are included for reference in Appendix C.

Corridors with the longest delay are also presented in this chapter. The purpose of this metric is to identify corridors which may not have bottlenecks in the Top Ten Congested Locations but are long congested corridors. Delay is calculated by estimating the additional travel time during congested conditions over the free flow travel time. Free flow speed is assumed to be 60 mph. This chapter lists the “Top Five Congested Corridors” in the AM and PM peak period. The 2008 Top Five Congested Corridors are presented in Appendix C for reference.

A comparison of lane mile hours at level-of-service F by survey year (1999-2011) are also presented in this chapter.

Top Ten Congested Locations (2011)



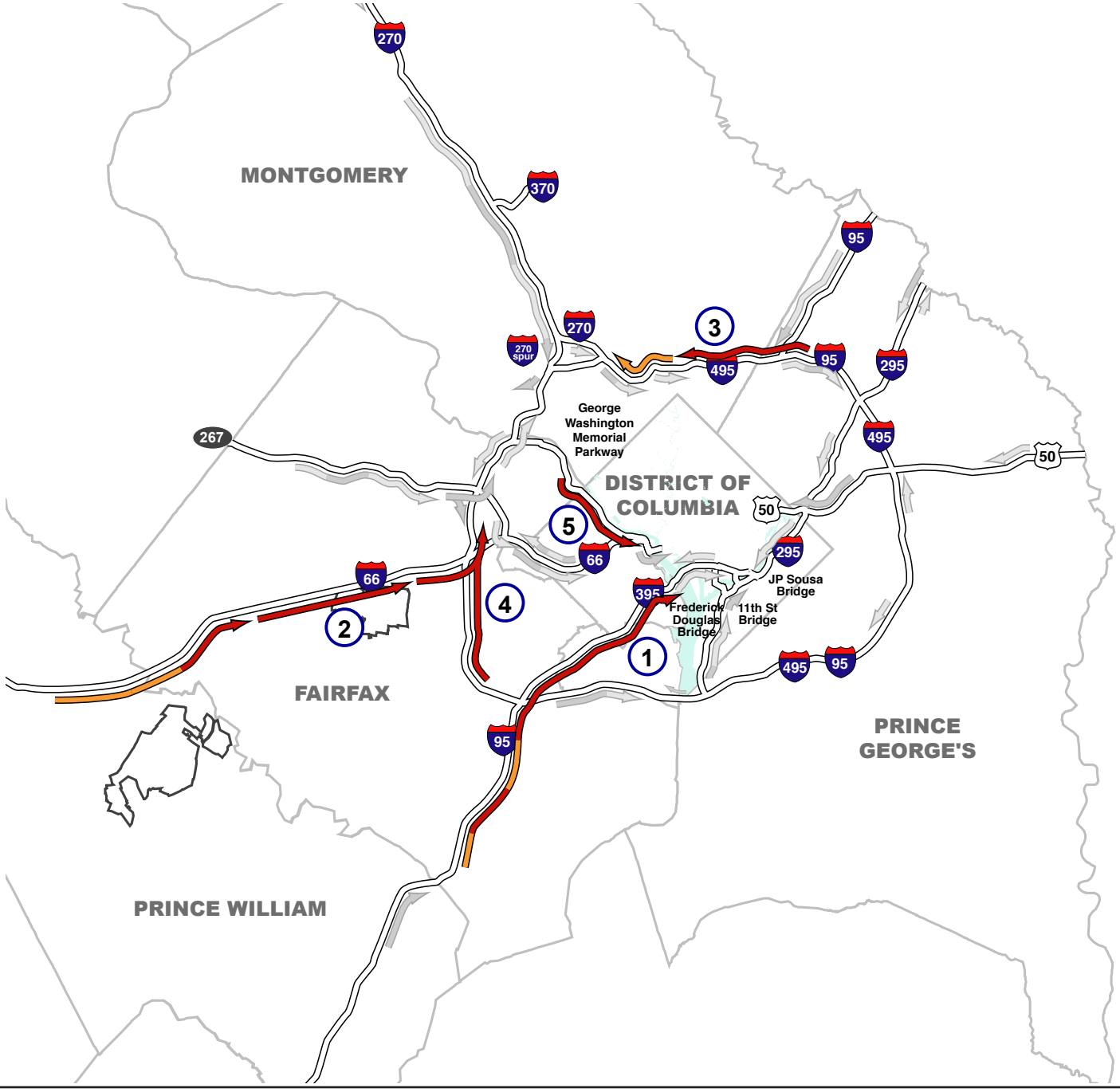
Top Ten Congested Segments on the Freeway System (2011)

Rank	Route	From	To	Density	Speed Range
1*	NB I-395 (8:30 to 9:30 AM)	VA 27 (Washington Blvd)	VA 110 (Jefferson Davis Hwy)	145	5 MPH
2A	IL I-495 (5:30 to 6:30 PM)	VA 193 (Georgetown Pike)	George Washington Mem Pkwy	125	5 to 10 MPH
2B	SB I-395/SW Fwy (6:00 to 7:00 PM)	4th St	12th St	125	5 to 10 MPH
4	EB I-66 (6:00 to 7:00 PM)	VA 7 (Leesburg Pike)	Dulles Access	115	7 to 12 MPH
5A	IL I-495 (4:30 to 5:30 PM)	MD 355 / I-270	MD 185 (Connecticut Ave)	110	10 to 15 MPH
5B*	OL I-495 (5:30 to 6:30 PM)	VA 267 (Dulles Toll Rd)	VA 123 (Chain Bridge Rd)	110	10 to 15 MPH
7A	OL I-495 (8:00 to 9:00 AM)	I-95	MD 650 (New Hampshire Ave)	105	12 to 20 MPH
7B*	IL I-495 (8:00 to 9:00 AM)	Gallows Rd	US 50 (Arlington Blvd)	105	12 to 20 MPH
8A	EB I-66 (7:00 to 8:00 AM)	VA 234 Bypass	VA 234 (Sudley Rd)	95	15 to 25 MPH
8B*	WB 11th St Bridge (7:30 to 8:30 AM)	I-295	Southeast Fwy	95	15 to 25 MPH

* While impacted by construction, these links are historically congested

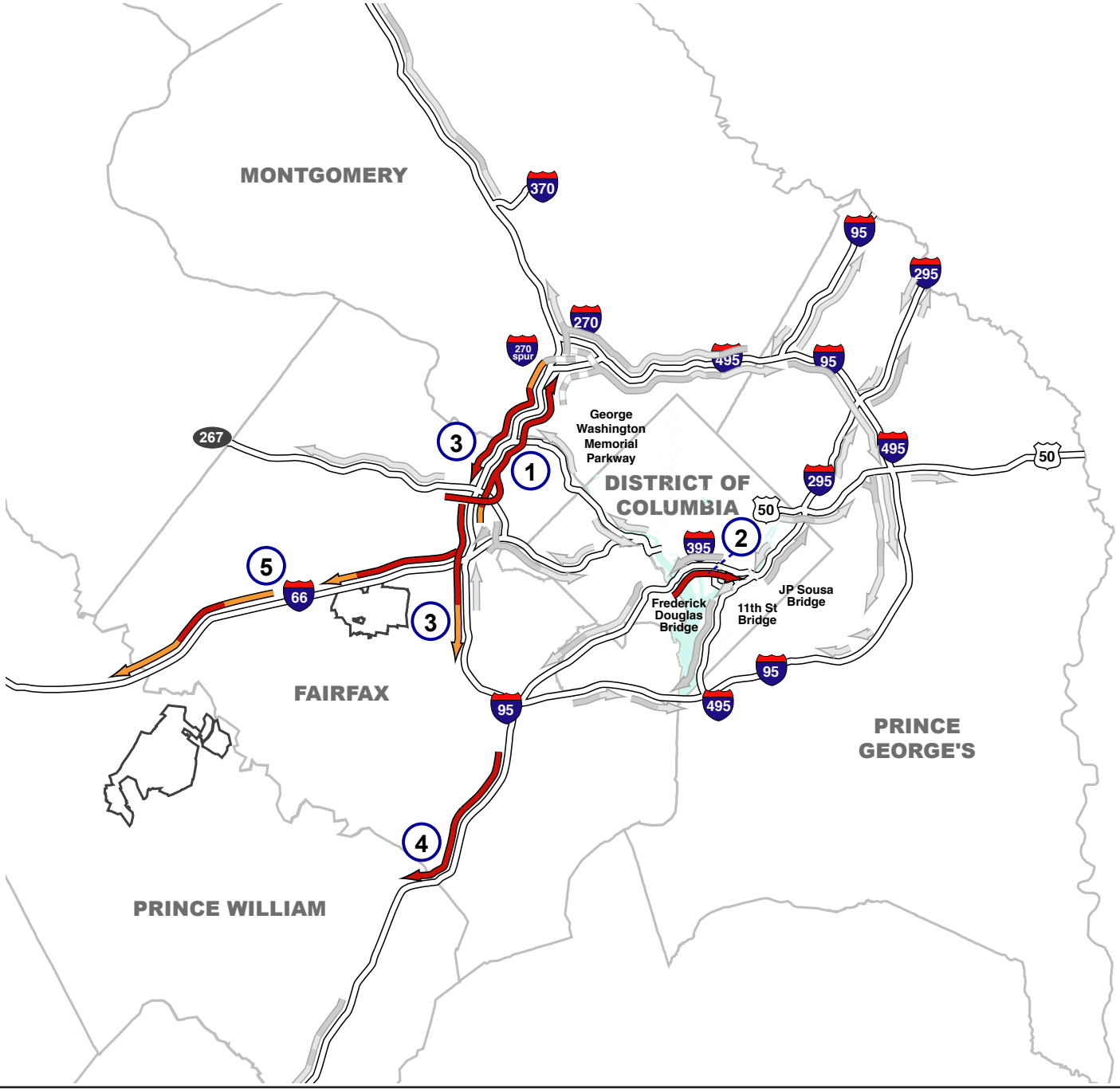
Longest Delay Corridors- Morning Peak Period (2011)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-95/I-395	7:30 – 8:30	Northbound	US 1	GWMP	18.3	62.8	18	44.4
Site #2	I-66	7:00 – 8:00	Eastbound	VA 234 Bypass	I-495	19.4	48.0	24	28.6
Site #3	I-495	7:00 – 8:00	Outerloop	US 1	I-270	10.0	28.7	21	18.7
Site #4	I-495	8:00 – 9:00	Innerloop	I-95	I-66	8.0	24.9	19	16.9
Site #5	GWMP	7:30 – 8:30	Eastbound	Chain Bridge Rd	I-66	5.3	16.5	19	11.2

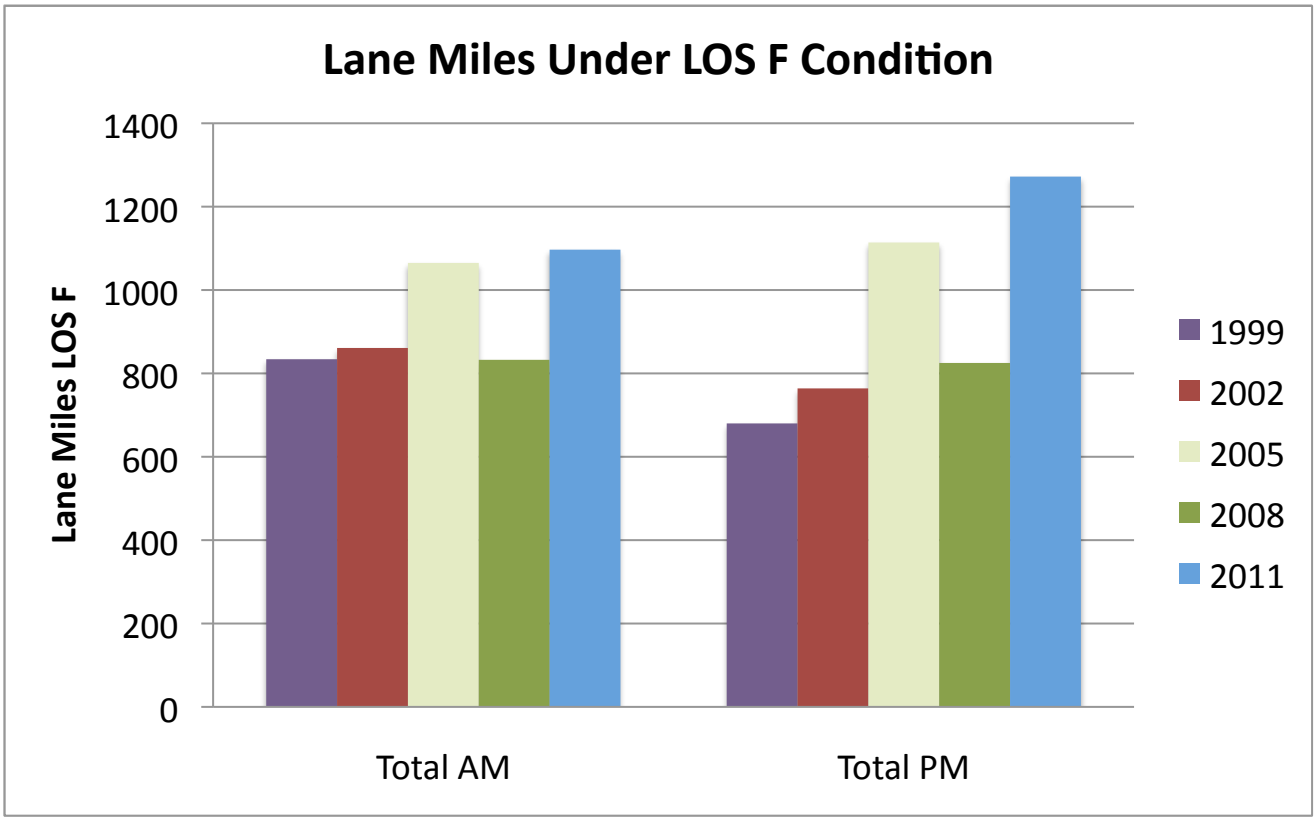


Longest Delay Corridors- Evening Peak Period (2011)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-495	5:30 – 6:30	Innerloop	VA 7(Leesburg Pike)	I-270 Spur	10.3	41.8	15	31.5
Site #2	I-395	5:00 – 6:00	Northbound	VA 110 (Jeff. Davis Hwy)	Pennsylvania Ave	4.3	19.2	13	14.9
Site #3	I-495	4:30 – 5:30	Outerloop	MD 187 (Old Georgetonwn Rd)	VA 236 (Lttle River Turnpike)	8.8	22.6	23	13.8
Site #4	I-95	4:30 – 5:30	Southbound	I-495	VA 123 (Gordon Blvd)	9.7	22.4	26	12.8
Site #5	I-66	4:30 – 5:30	Westbound	I-495	VA 234 (Sudley Rd)	16.8	28.3	36	11.5



Lane Miles of Congestion AM and PM Peak Period (2011)

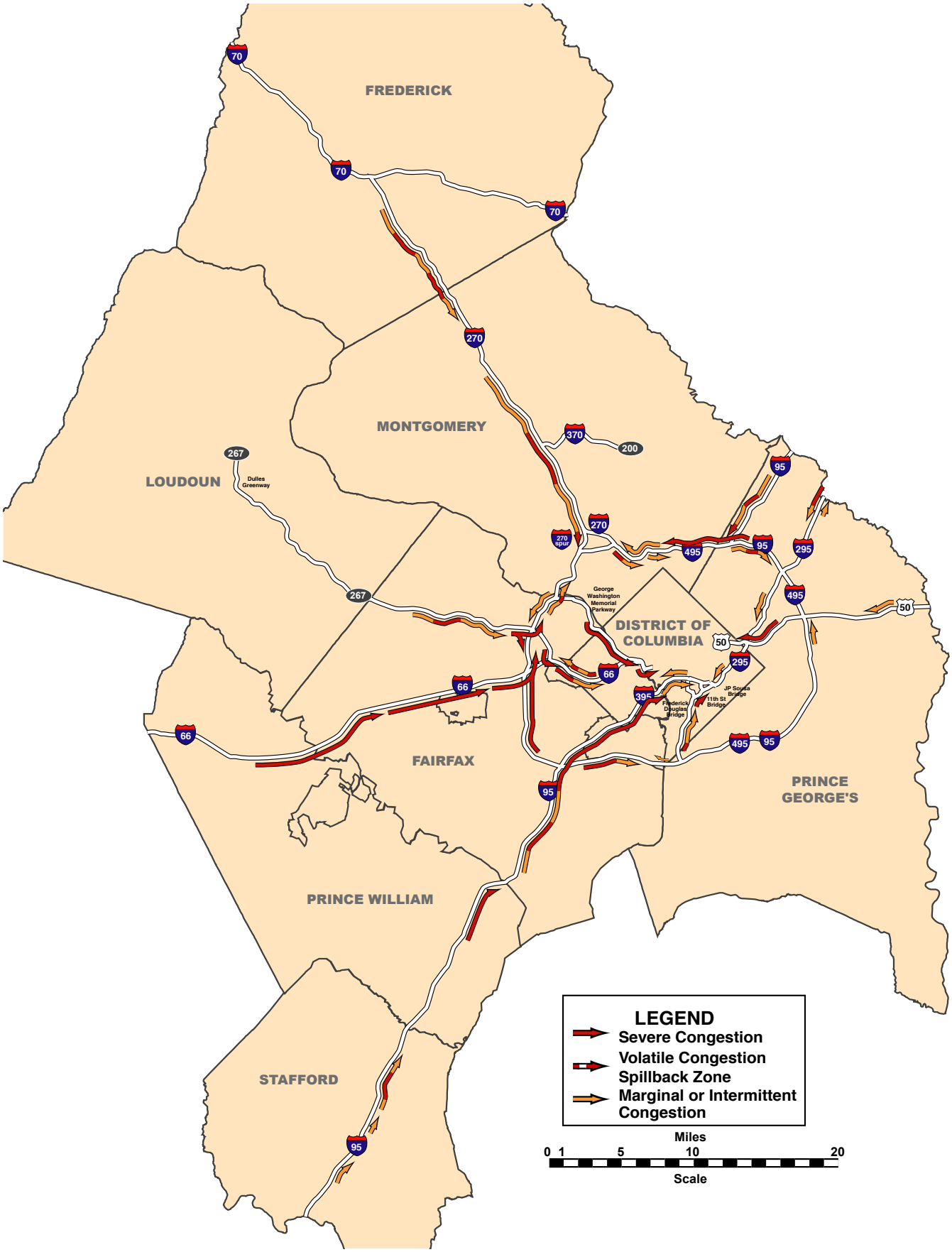


Chapter V

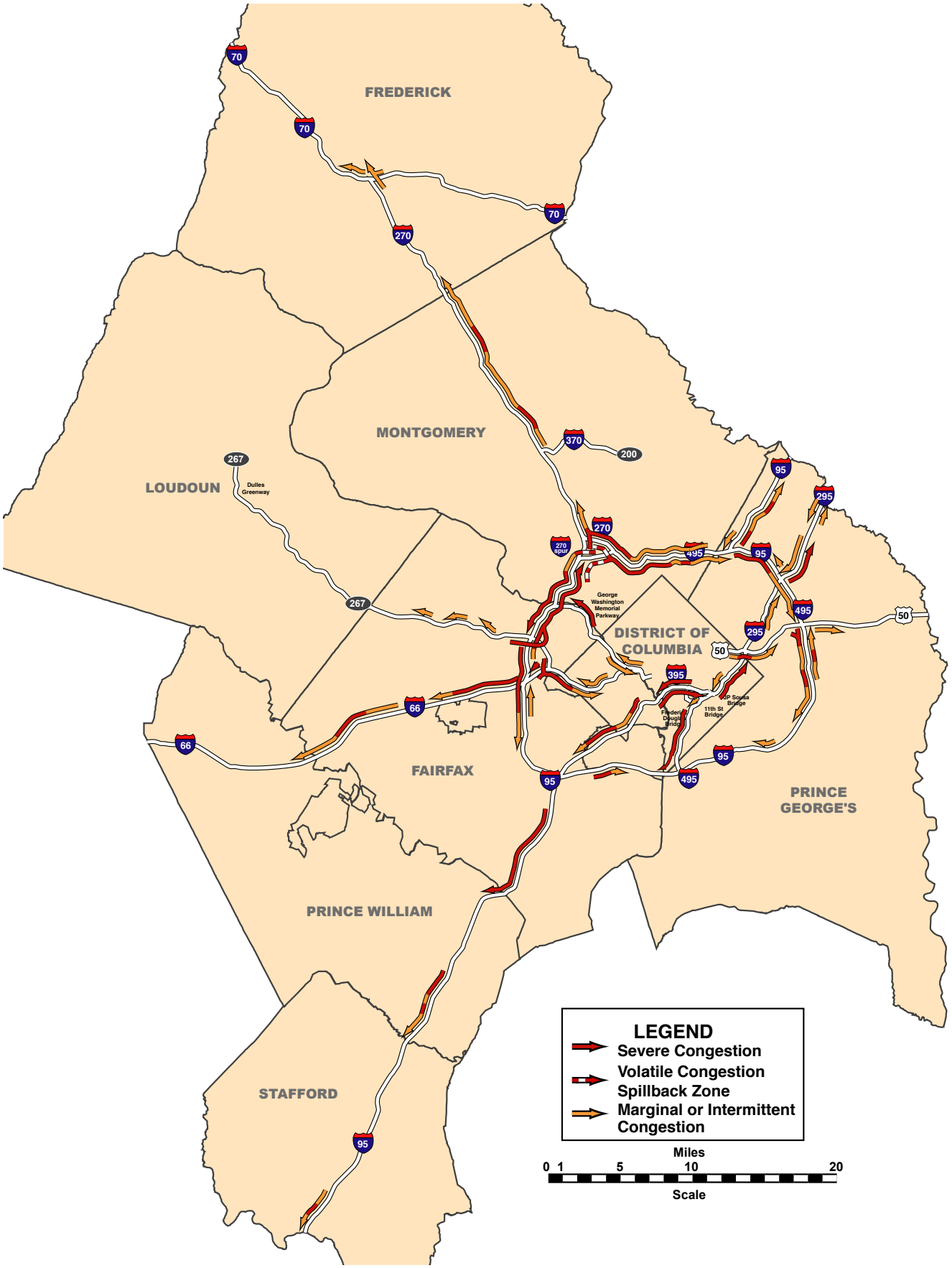
Regional Congestion Summary

This chapter shows summary maps of congestion in the region. The first set of maps summarizes all congestion that occurs within the three hour AM and PM peak period windows. If a segment is congested in two or three hours, the peak hour will be used. The second set of maps (six) illustrates congestion by the first hour, second hour and third hour during the AM and PM peak period; note that times vary for facilities located within the Beltway and outside the Beltway.

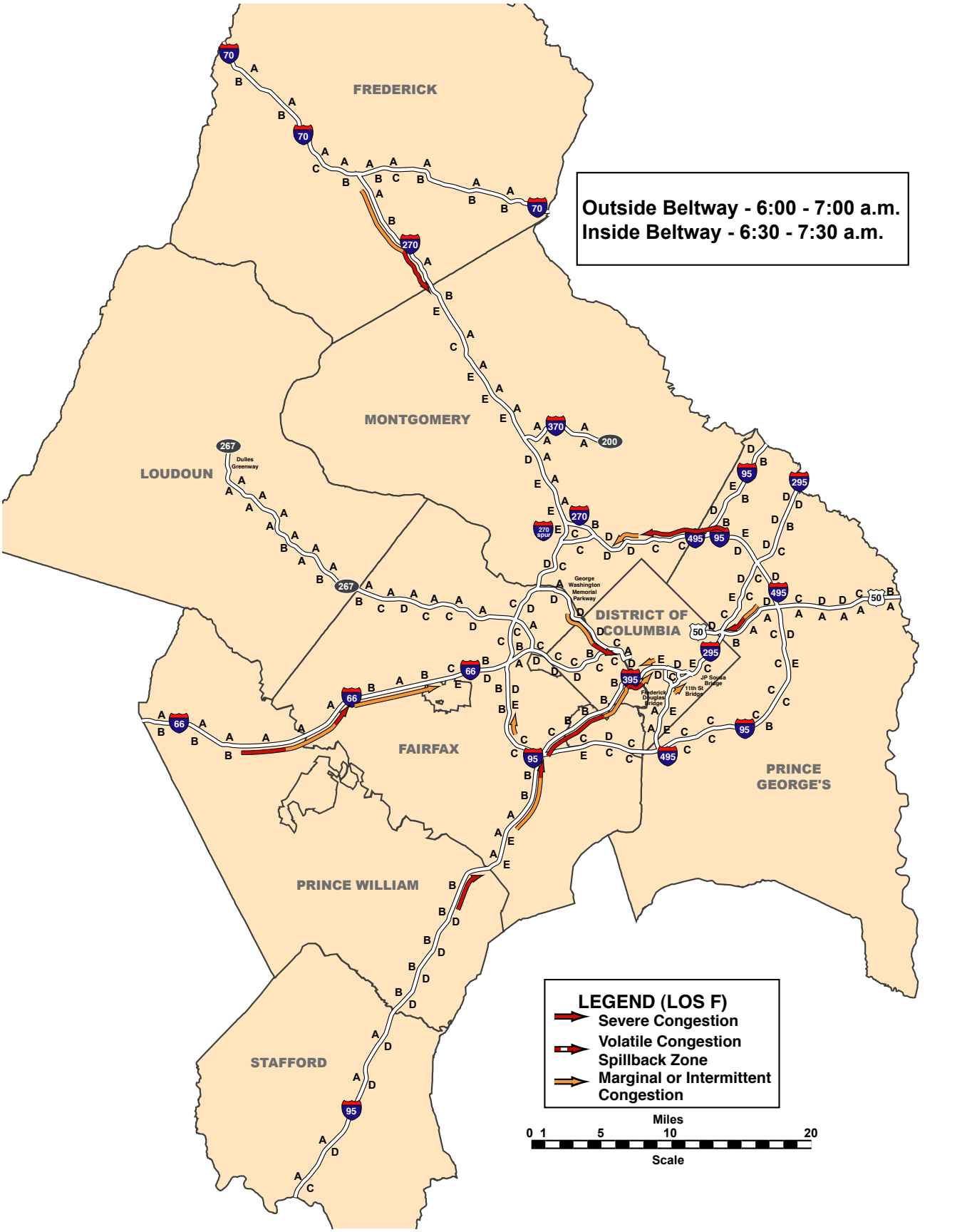
Morning Regional Congestion (Peak Period)-Spring 2011



Evening Regional Congestion (Peak Period)-Spring 2011



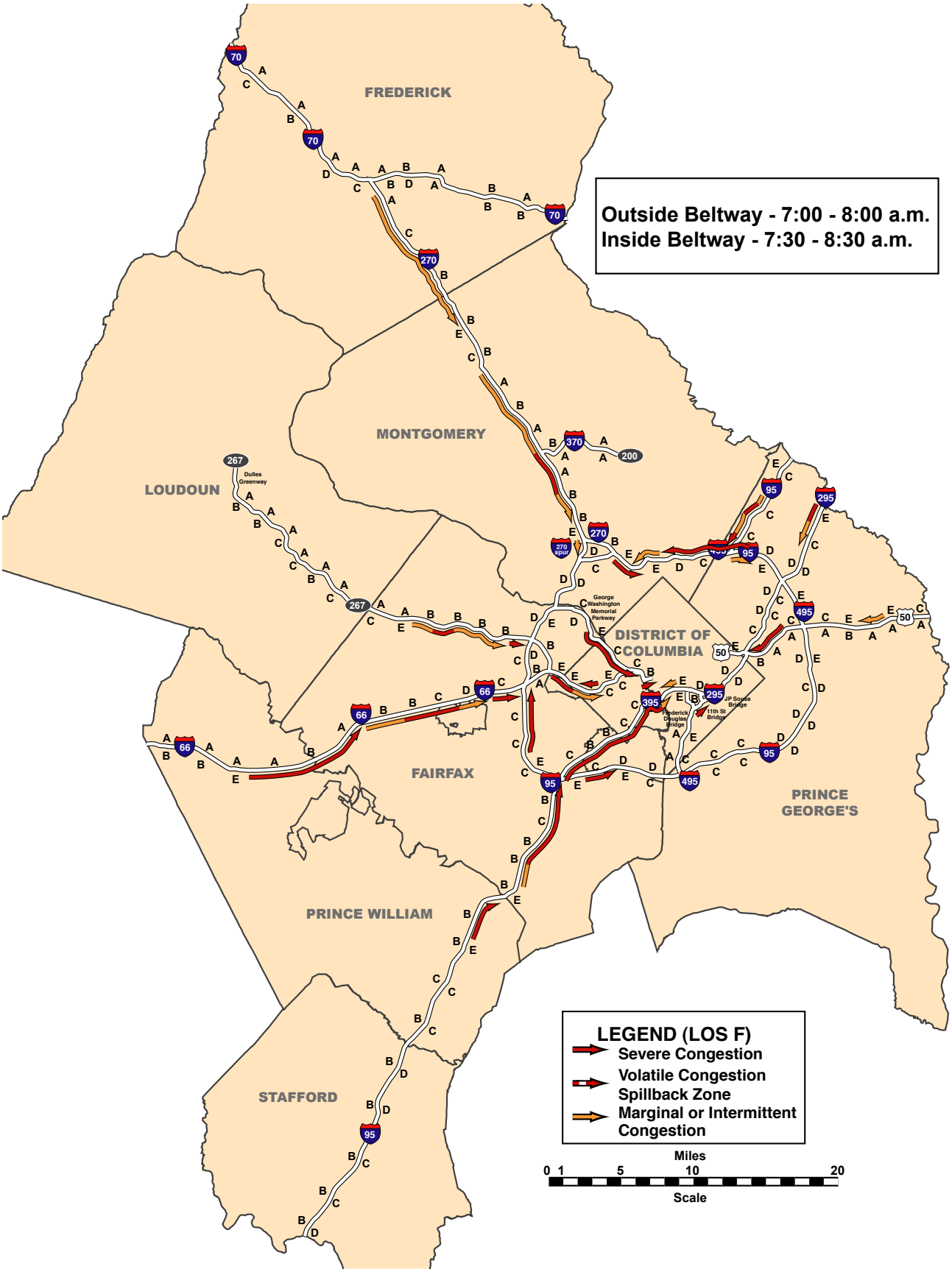
Morning - First Time Period



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40		50 Congested	60 70 80	Severe 90

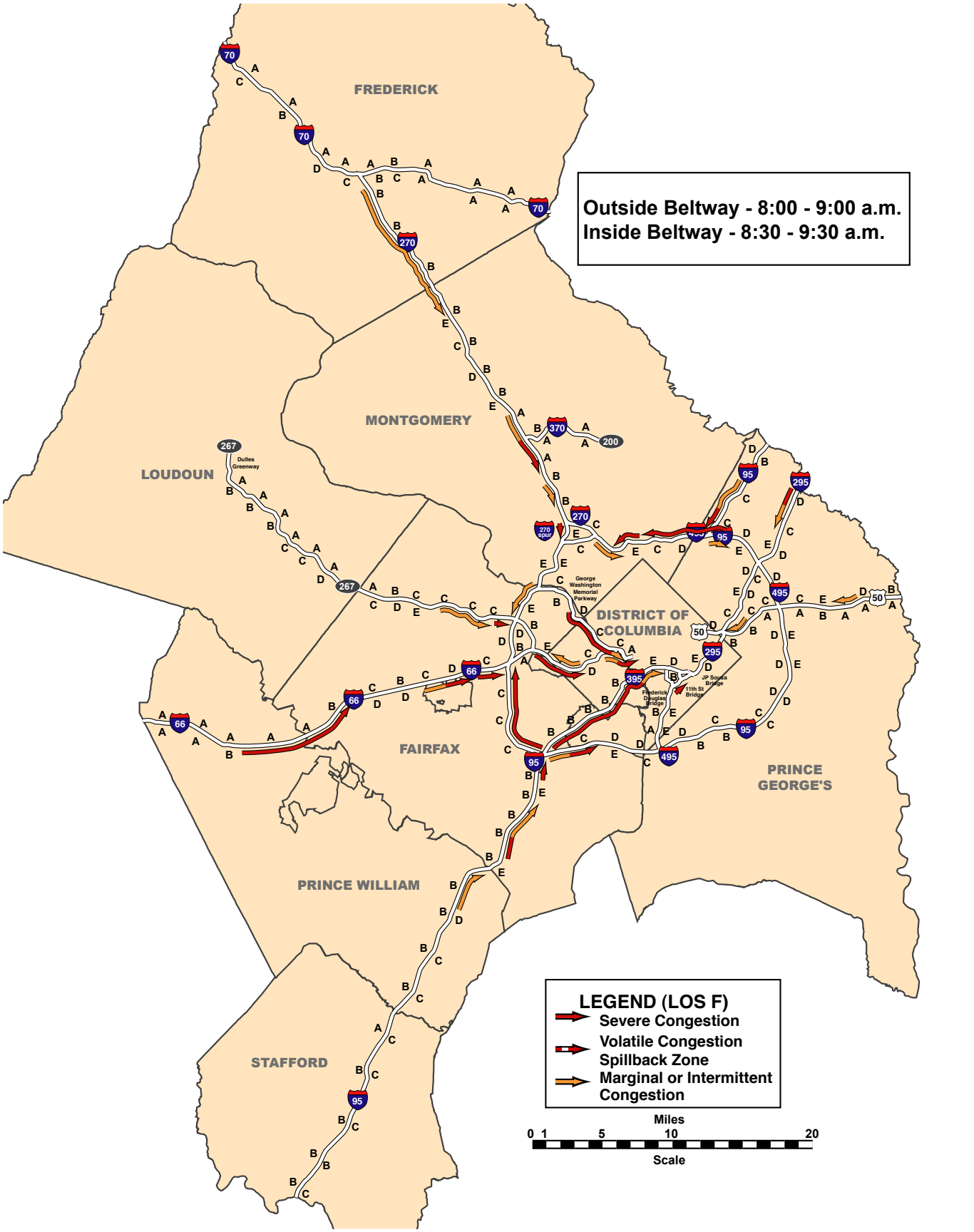
Morning - Second Time Period



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	20	30		40	50	60	70 80 90
Light	Moderate	Heavy			Congested		Severe

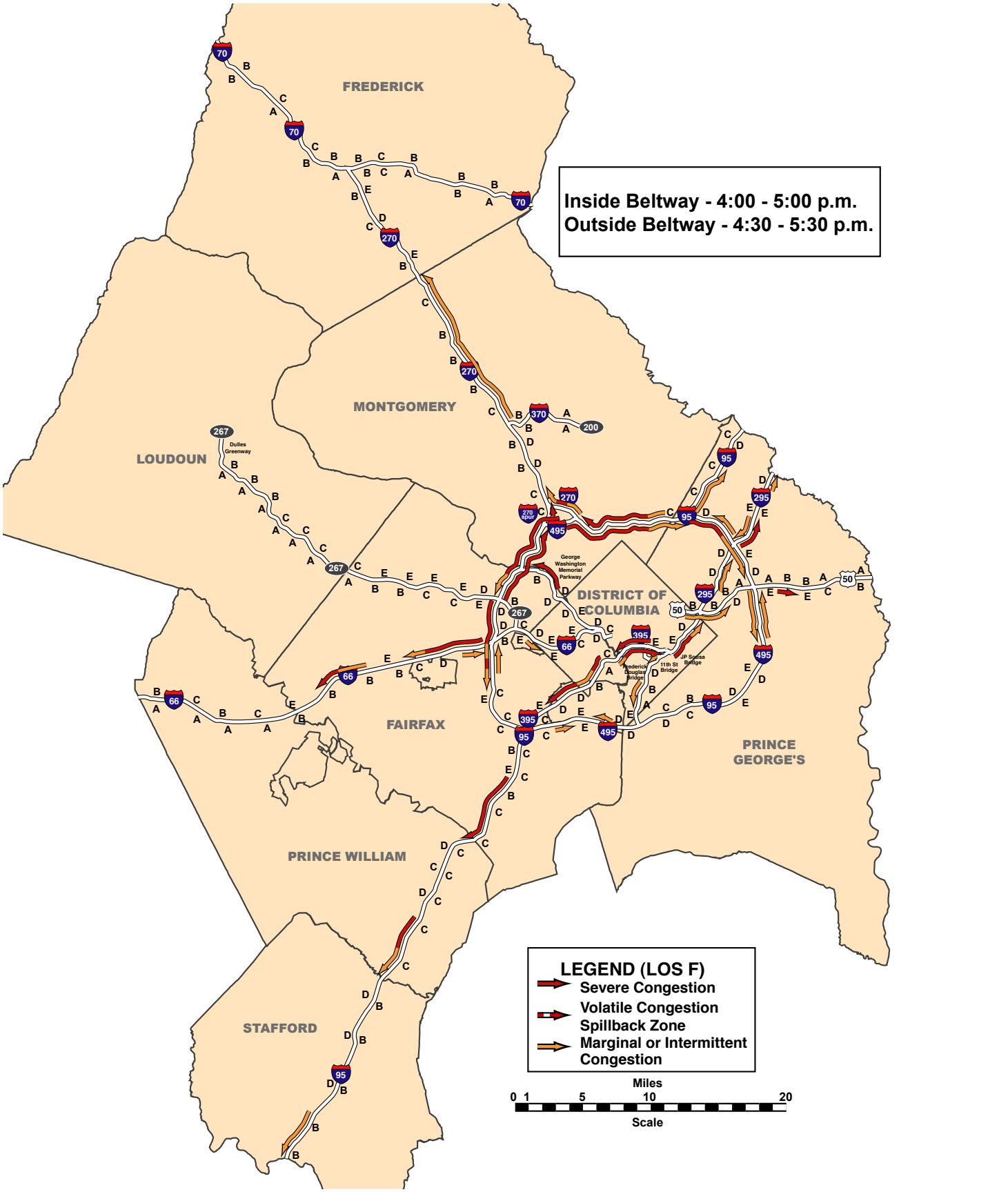
Morning - Third Time Period



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40		50 Congested	60 70	80 Severe 90

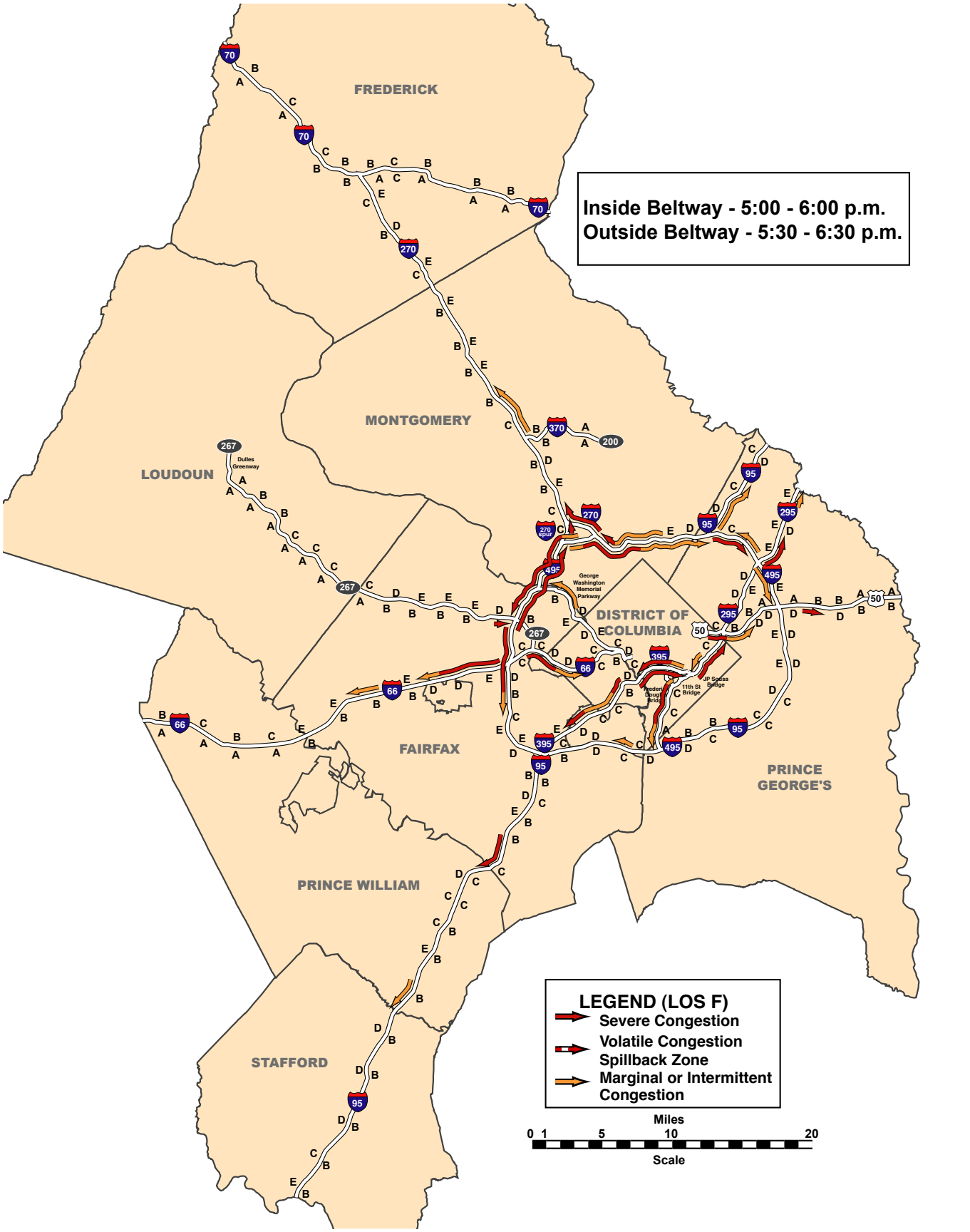
Evening - First Time Period



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	20		30	40	50	60	70	80	90
Light	Moderate		Heavy		Congested		Severe

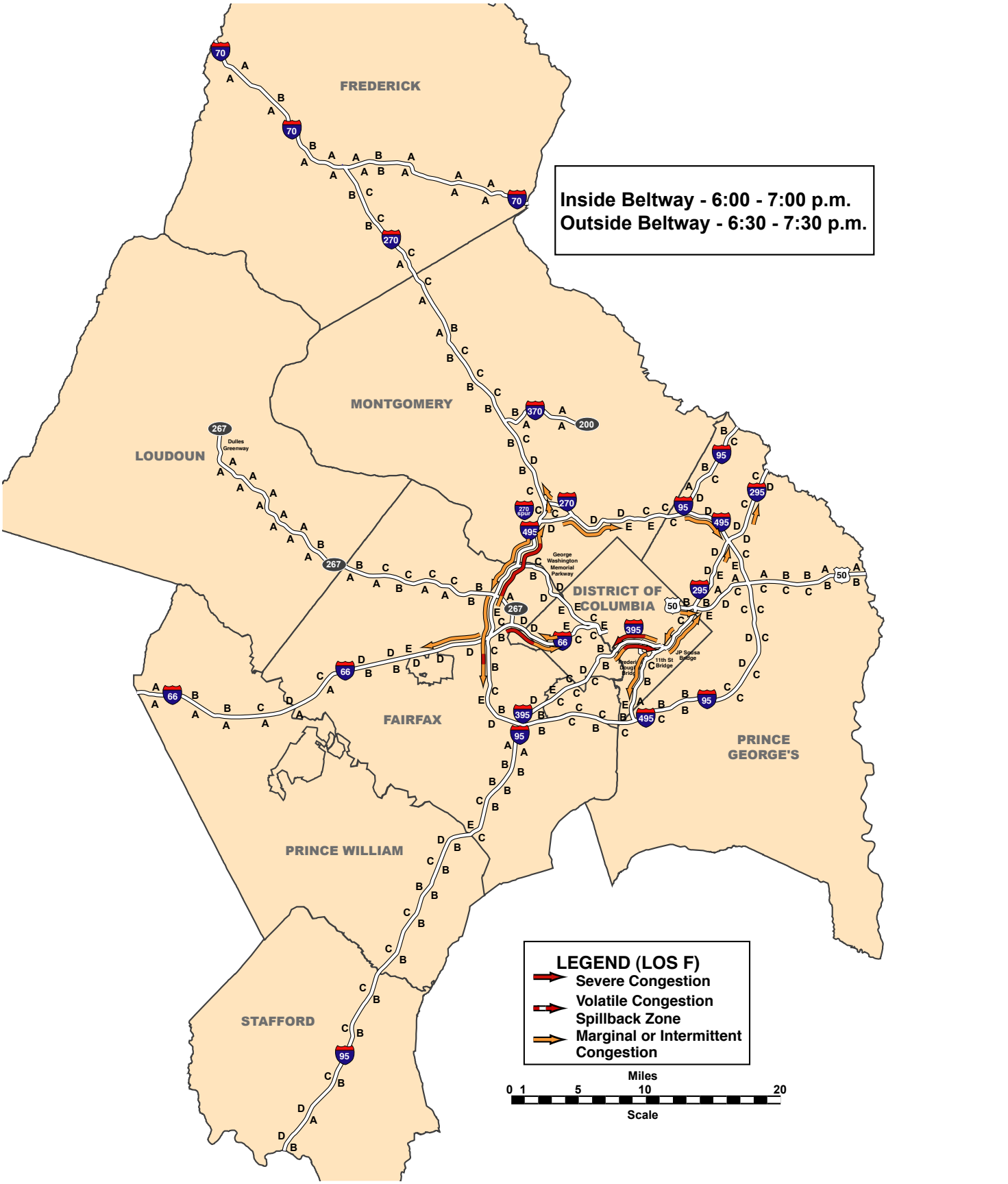
Evening - Second Time Period



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40		50 Congested 60	70	80 Severe 90

Evening - Third Time Period



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

(Blank)

Chapter VI

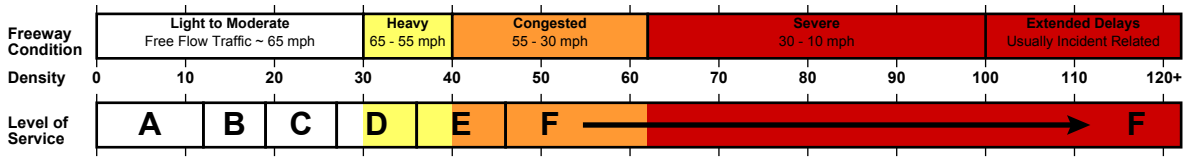
Major Trends and Changes in Traffic Conditions Between 1993 and 2011

This section of the report identifies locations on the highway system where major trends or changes in traffic conditions were found since the first aerial survey in 1993. On some highways, the absence or presence of construction contributed to the changed conditions. On other highways, added capacity contributed to improved flow; in some cases, no apparent cause could be attributed to the improvement or degradation of traffic flow.

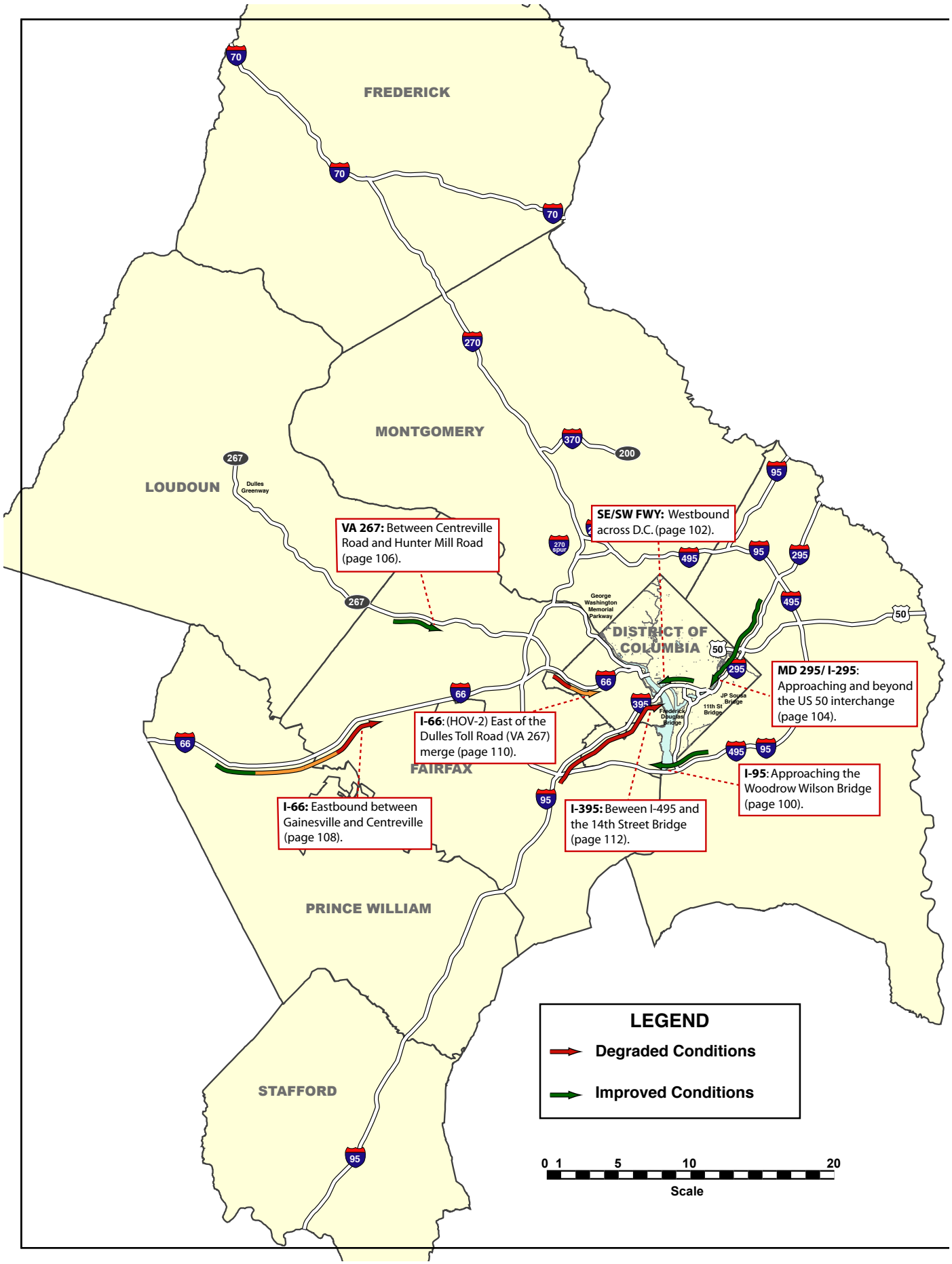
Excerpts from the level-of-service (LOS) tables contained in Chapter III have been used in this section of the report to depict the changes in traffic conditions. For the purpose of comparing conditions from year to year, density data from the 1993, 1996, and 1999 surveys have been converted to levels-of-service using the boundaries outlined in the 2000 Highway Capacity Manual.

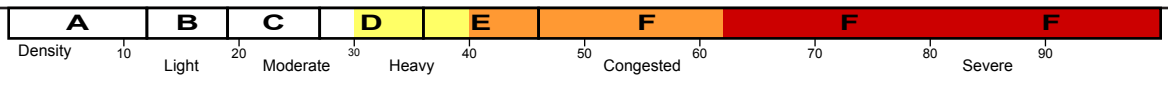
A summary of traffic conditions for each level-of-service is provided below.

Traffic Quality Ratings:

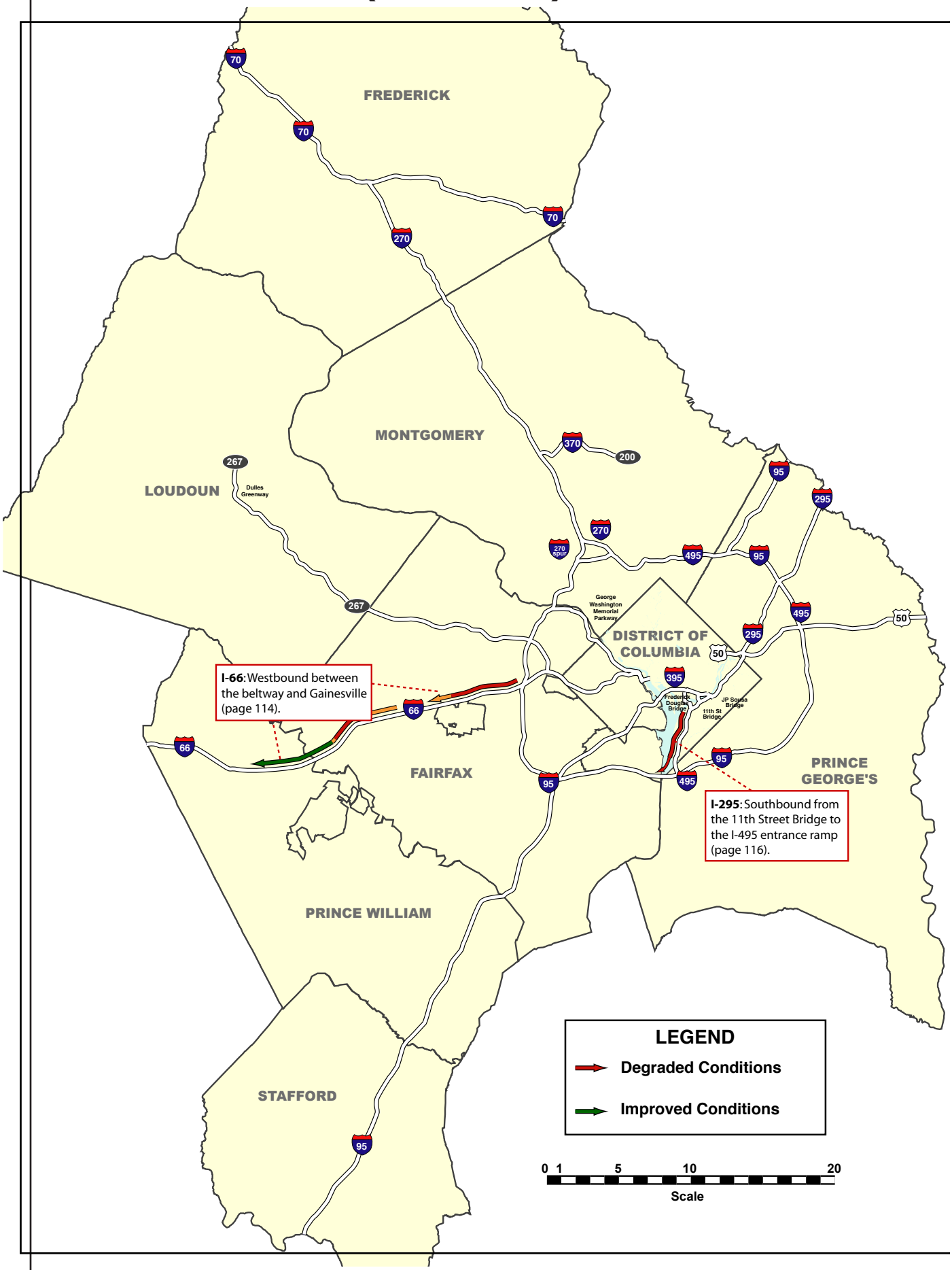


Significant Changes (2008 - 2011) - Morning Peak Period





SIGNIFICANT CHANGES (2008 - 2011) - EVENING PEAK PERIOD



Capital Beltway / I-95 Maryland (Prince George's County) - Morning
Capital Beltway / I-95 Virginia (Fairfax County) - Evening

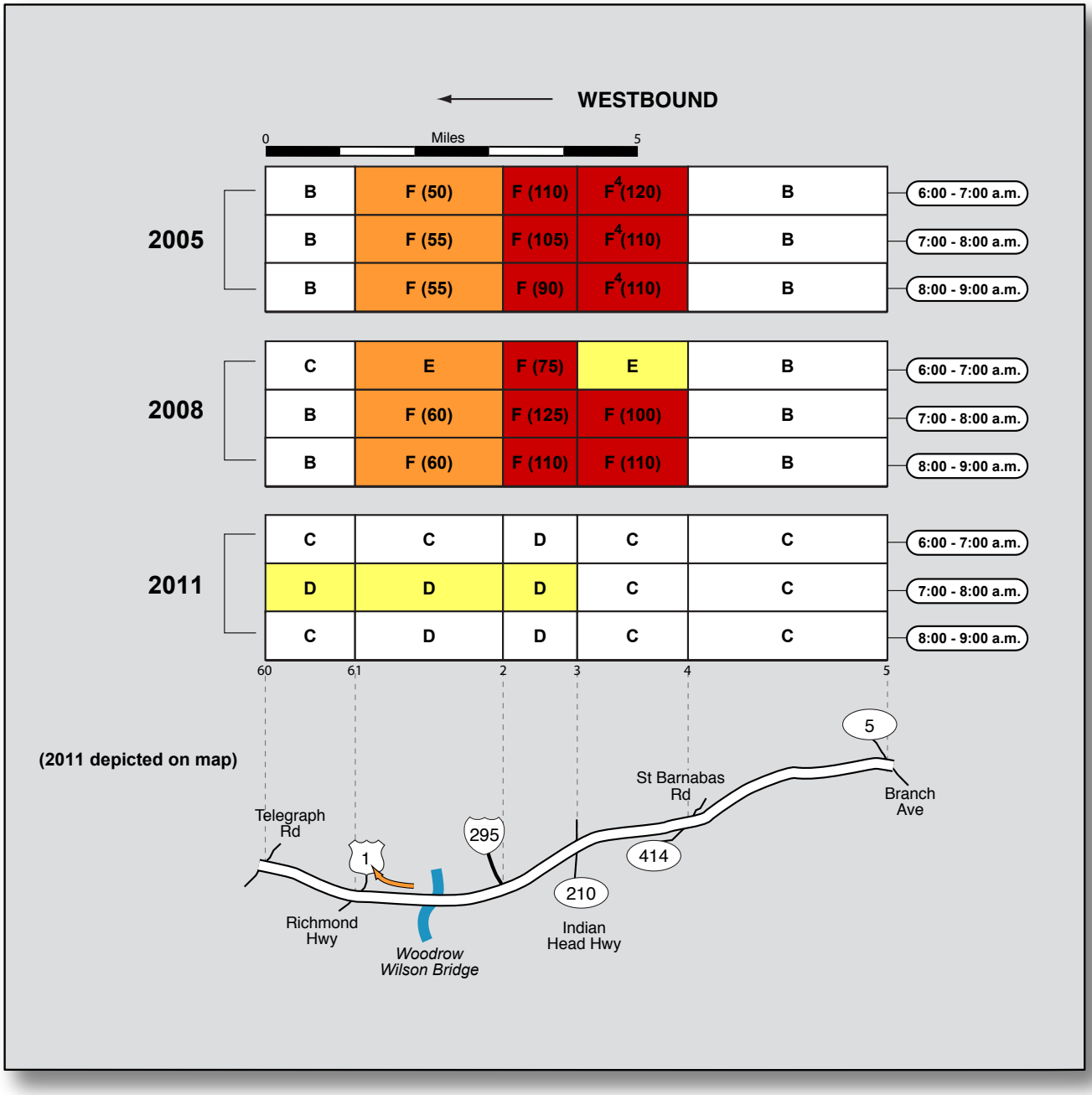
Location: I-95 approaching the Woodrow Wilson Bridge

Time Period: Morning (6:00 to 9:00 a.m.) and evening (4:30 to 7:30 p.m.)

Type of Change: Improved

Potential Cause: Bridge replacement and interchange upgrades; elimination of lane drops

Prior to the replacement of the Woodrow Wilson Bridge and during all survey periods since this freeway monitoring program was initiated in 1993, severe westbound congestion has been found during the morning survey period on I-95, typically extending for almost three miles from the St. Barnabus Road interchange to the lane drop (four lanes to three) at the bridge. The replacement of the bridge means that there are now 12 total travel lanes across the Potomac River, six each way. The morning congestion zone has been entirely eliminated. Likewise, congested flow in the eastbound direction has also been removed during the evening peak commuter period.



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Capital Beltway / I-95 Maryland (Prince George's County) - Morning

2002

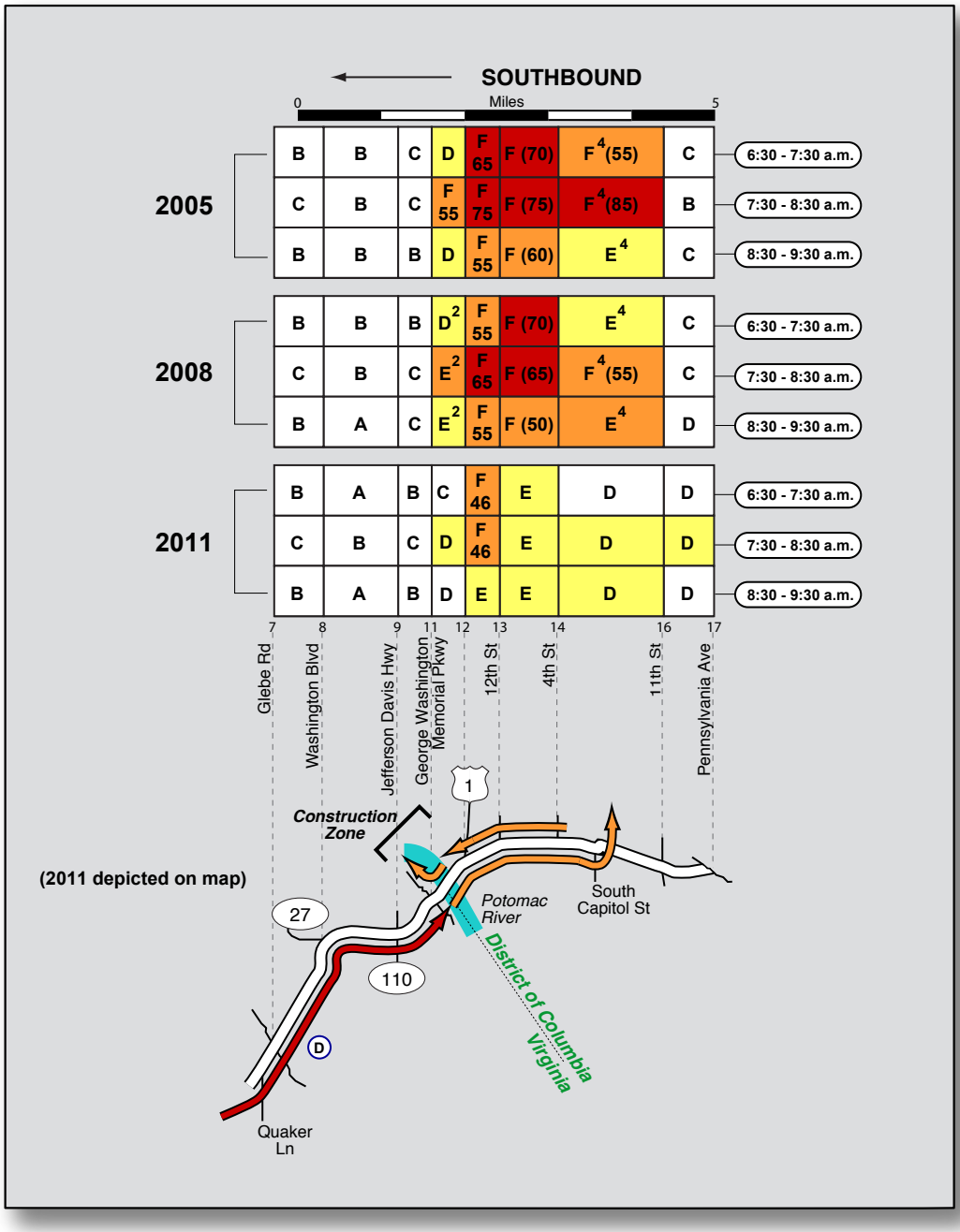
2011

Photographs:
The interchange at Indian Head Highway is shown in both photographs, which is located in the approximate center of the typical morning congested zone. The upper photograph was taken in 2002. The 2011 photograph shows how the congestion had been entirely eliminated.

Southwest Freeway / I-395 (District of Columbia) - Morning

Location:	Westbound / southbound Southwest and Southeast Freeway across the District of Columbia
Time Period:	Morning (6:30 to 9:30 a.m.)
Type of Change:	**Improved**
Potential Cause:	Elimination of a severe bottleneck on an alternate route to Virginia (unverified)

A perennially-congested link across DC has been mitigated, based on the findings of the 2011 survey flights. The flow rate of commuters toward jobs in Virginia from points in Maryland and DC (as has been documented in previous years) seems to have been reduced along the Southeast / Southwest Freeway / I-395 corridor. This improvement – in the absence of any other significant capacity changes or bottleneck elimination projects – probably is the result of the elimination of major westbound congestion on the capital beltway approach to the Woodrow Wilson Bridge. It is plausible (but unverified) that enough Maryland-to-Virginia commuters may have diverted to the now-free-flow beltway bridge such that significant congestion on I-395 approaching the 14th Street Bridge no longer forms.



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

Southwest Freeway / I-395 (District of Columbia) - Morning

2008

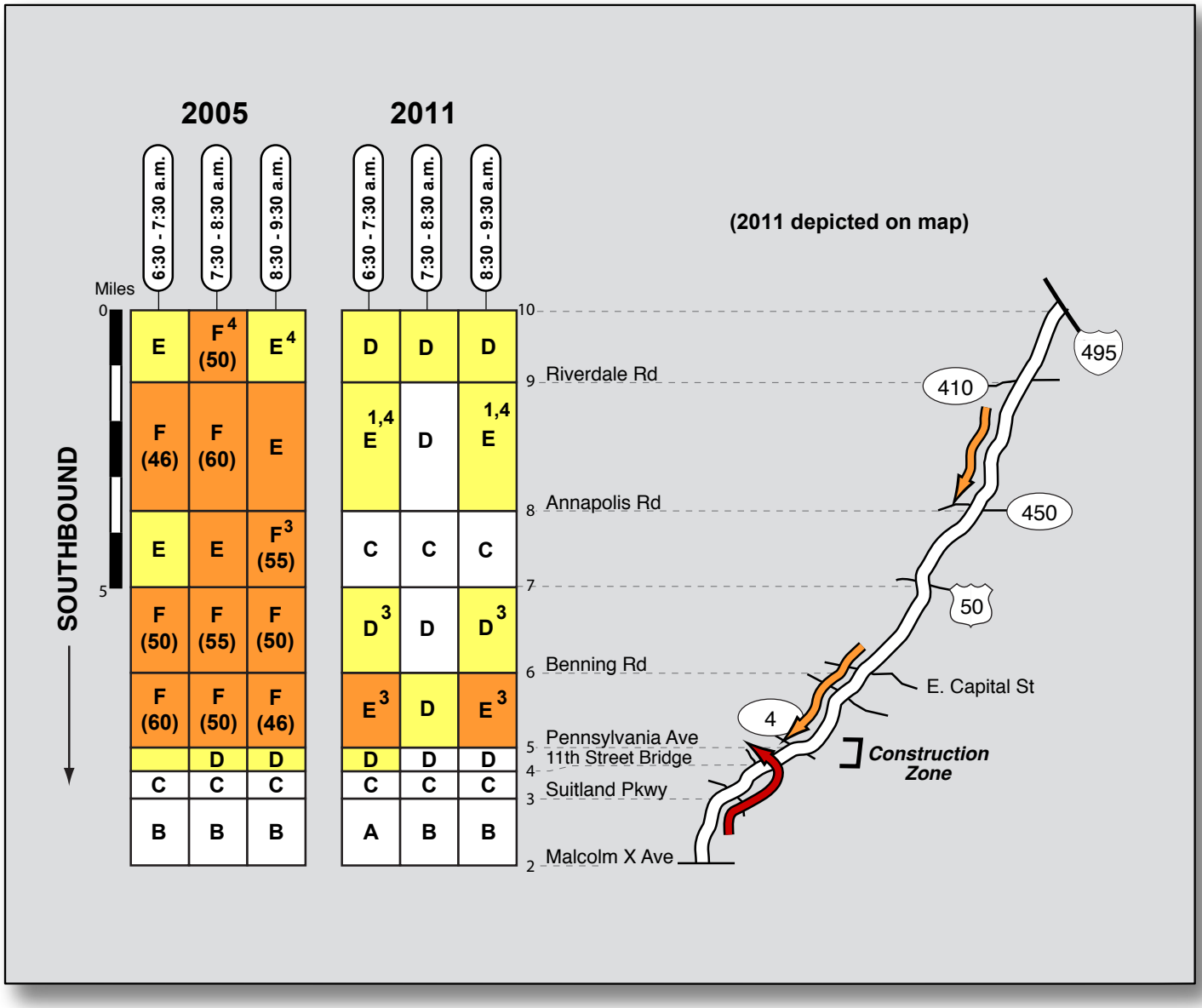
2011

Photographs:
The top photograph from 2008 shows typical and perennially-congested westbound traffic flow approaching and past the South Capitol Street and I-395 interchanges. The bottom photograph shows how mostly free-flowing traffic was found during the 2011 survey flights.

MD 295 Maryland (Prince Georges County) and DC 295 (Kenilworth Ave NE / District of Columbia) - Morning

Location:	Southbound MD / DC 295 approaching and beyond the US 50 interchange
Time Period:	Morning (6:00 to 9:00 a.m.)
Type of Change:	**Improved**
Potential Cause:	Rehabilitated highway lanes with a new widened bridge across the Northeast Corridor railroad right-of-way, and a reconfigured interchange south of US 50.

Rehabilitation of DC 295 was completed after the 2008 survey flights had been completed; this work included replacing the obsolete railroad bridge just south of US 50 (the old bridge had a short acceleration lane, which had produced a perennial queue on the ramp and flow disruptions on both US 50 and on MD/DC 295). Farther south, the overpass was rebuilt and associated ramps were improved at the Nannie Helen Burroughs Ave NE interchange. These projects, together with a prior widening of US 50 at South Dakota Ave, have served to improve southbound travel speeds on the MD/DC 295 corridor the entire way from the capital beltway in Greenbelt to the Anacostia River crossings into downtown Washington DC.



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	20	30		40	50	60	70 80 90
	Light	Moderate	Heavy		Congested		Severe

MD 295 Maryland (Prince Georges County) and DC 295 (Kenilworth Ave NE / District of Columbia) - Morning

Photo Set One: 2005

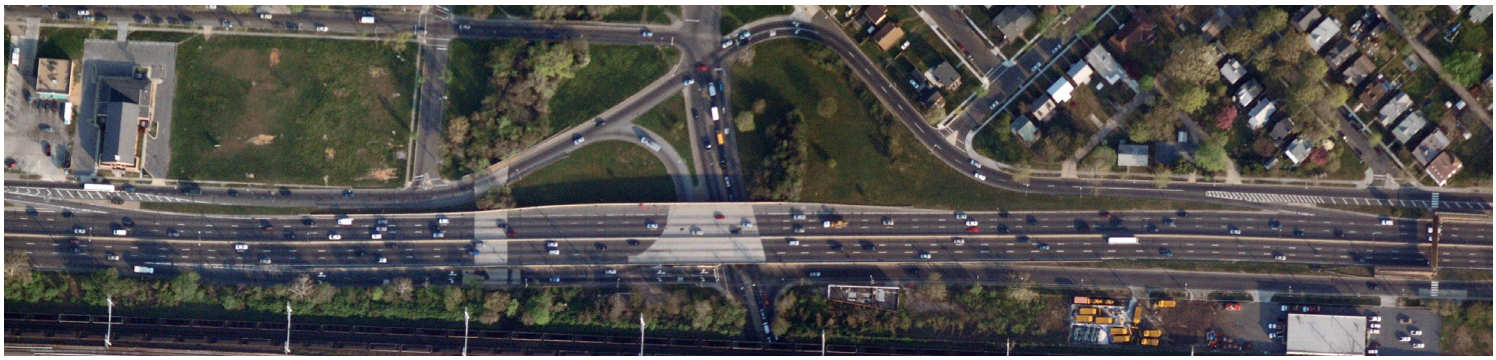


Photo Set One: 2011

Photo Set One: This pair of photographs show the reconfiguration of the Nannie Helen Burroughs Ave NE interchange between 2005 and 2011. Note the lengthened deceleration lane to the right side of the 2011 image.

Photo Set Two: 2005

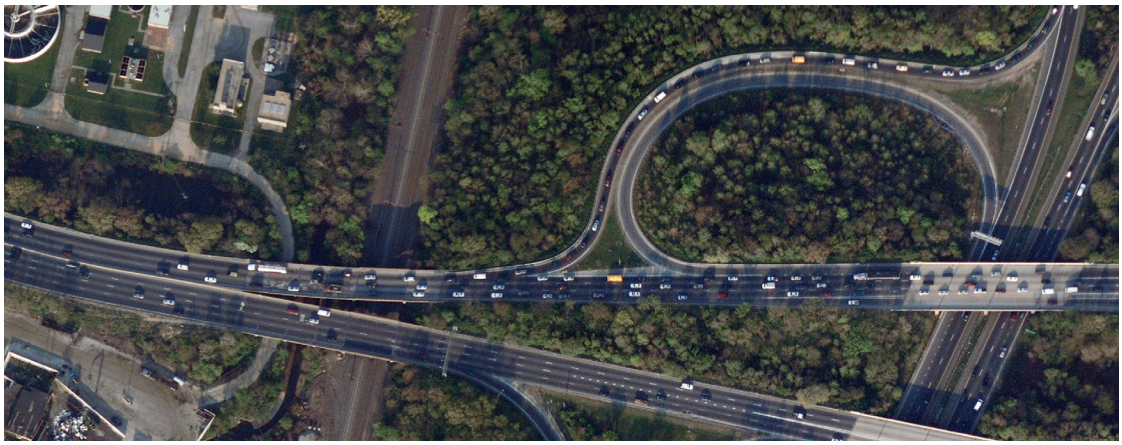


Photo Set Two: These photographs show the 2005 (top) and 2011 (bottom) configuration of the DC 295 bridge across the Northeast Corridor railroad right-of-way; note the absence of a significant merge lane in the 2005 photograph, and the friction that caused for southbound traffic on DC 295.

Photo Set Two: 2011

VA 267 Virginia (Fairfax County) - Morning

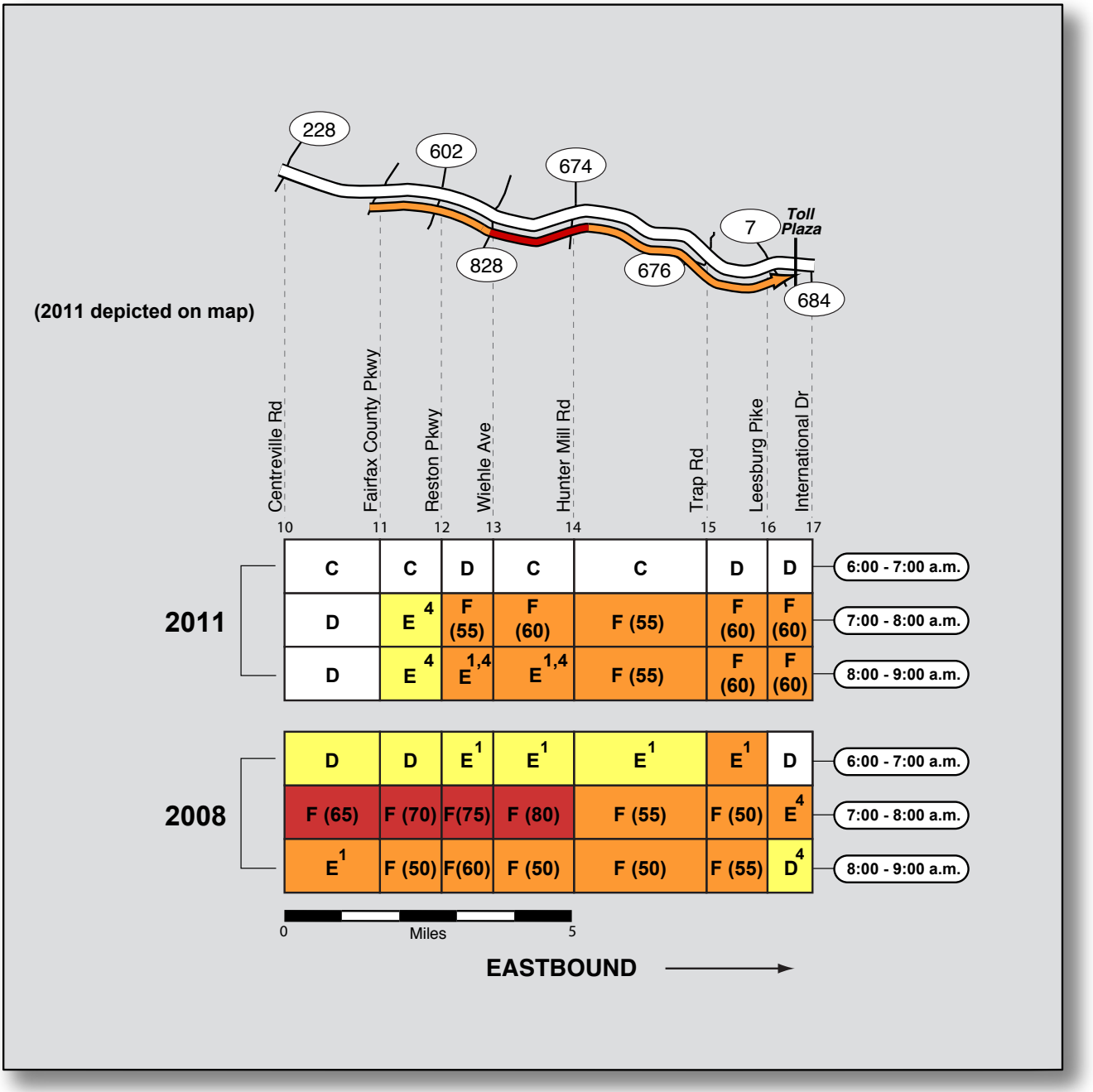
Location: Eastbound Dulles Toll Road (VA 267) between Centreville Road and Hunter Mill Road

Time Period: Morning (6:00 to 9:00 a.m.)

Type of Change: **Improved (unverified)**

Potential Cause: Unknown

During the morning survey period, eastbound traffic on the Dulles Toll Road flowed better during all three surveyed hours (6:00 to 9:00 a.m.). Evidence of capacity or operational changes could not be found. Only relatively minor delays were found during the 2011 survey flights, compared to more significant congestion found during the 2008 survey flights. Atypical volatility may account for the apparent differences, because other potential reasons could not be identified.



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	20	30	40	50	60	70	80	90
Light	Moderate	Heavy	Congested	Severe

VA 267 Virginia (Fairfax County) - Morning

2008

2011

Photographs:
These two photographs highlight the disparity found in the photography between the 2008 (top) and 2011 (bottom) survey periods. The Weihle Ave. interchange is in the center; major congestion with significant delays was the primary finding during the 2008 survey flights but not in 2011.

I-66 Virginia (Prince William County) - Morning

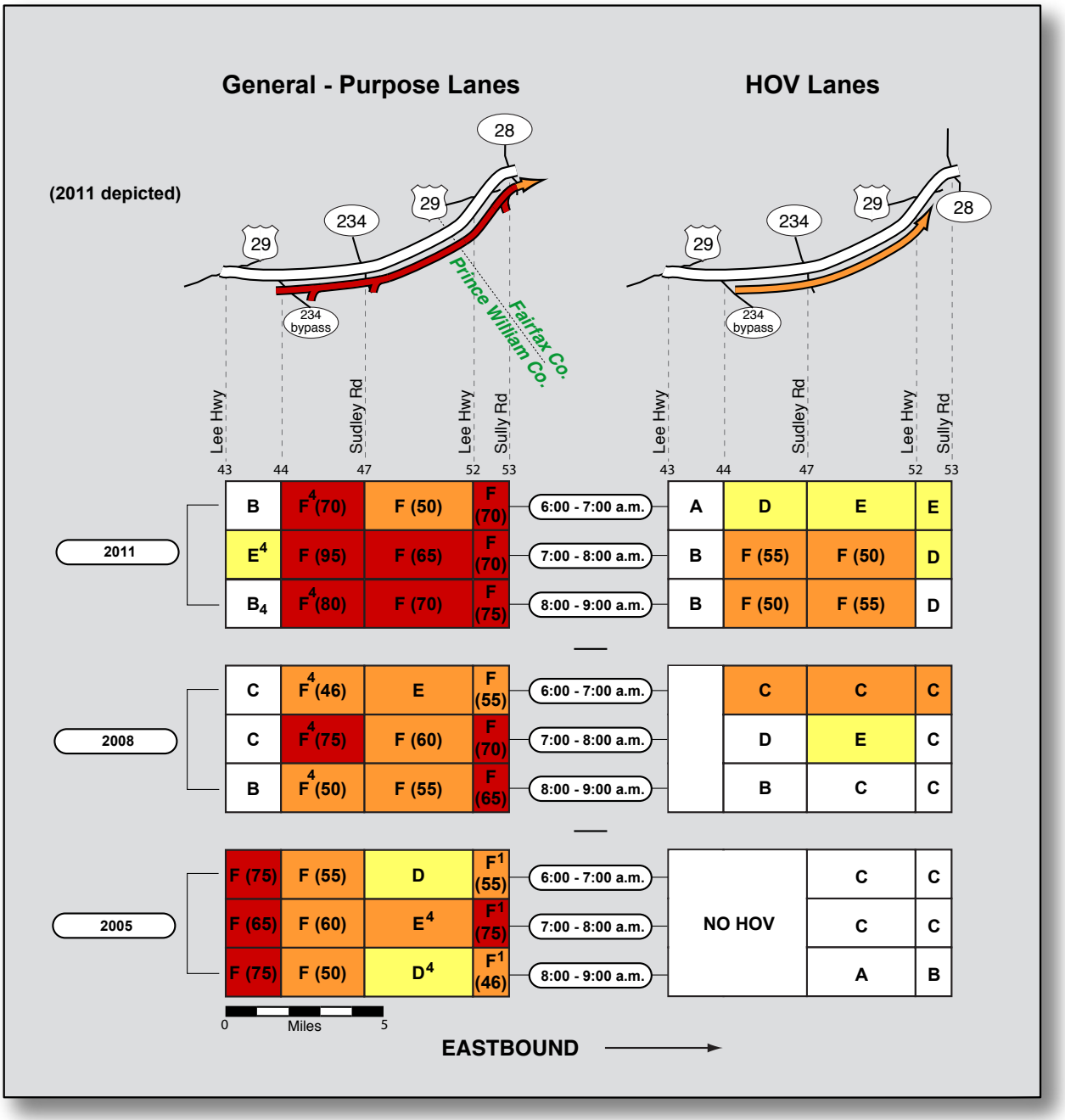
Location: Eastbound I-66 between Gainesville and Centreville

Time Period: Morning (6:00 to 9:00 a.m.)

Type of Change: **Degraded**

Potential Cause: Increased demand

Following the minor eastbound degradation found here in 2008, there is further evidence of congestion filling in along the recently-widened section of I-66 west of Centreville. A general increase in demand due to development is the most likely cause. Traffic entering the highway at Lee Highway, Prince William Parkway and Sudley Road were primary contributing factors. The HOV lanes were found to be operating close to capacity (densities were recorded in the 50 cars-per-lane-mile range, indicating minor slowing and average travel speeds of close to 50 mph). Nevertheless, HOV now afforded significant time savings for users due to increased congestion in the general purpose lanes.



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	Light 20	Moderate 30	Heavy 40	50	Congested 60	70	80 Severe 90

I-66 Virginia (Prince William County) - Morning

Photo Set One: 2005

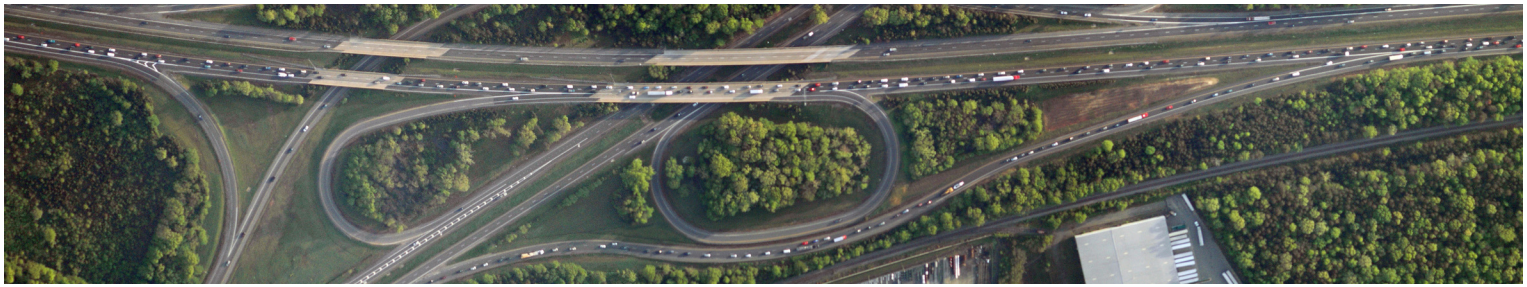


Photo Set One: 2011

Photo Set One: both photographs show I-66 at the Lee Highway interchange in Gainesville. The 2005 photograph (top) shows eastbound congestion in 2005, prior to widening; the 2011 photograph (bottom) shows that free flow conditions prevailed here during the 2011 survey period (as they had during 2008; see graphic).

Photo Set Two: 2005

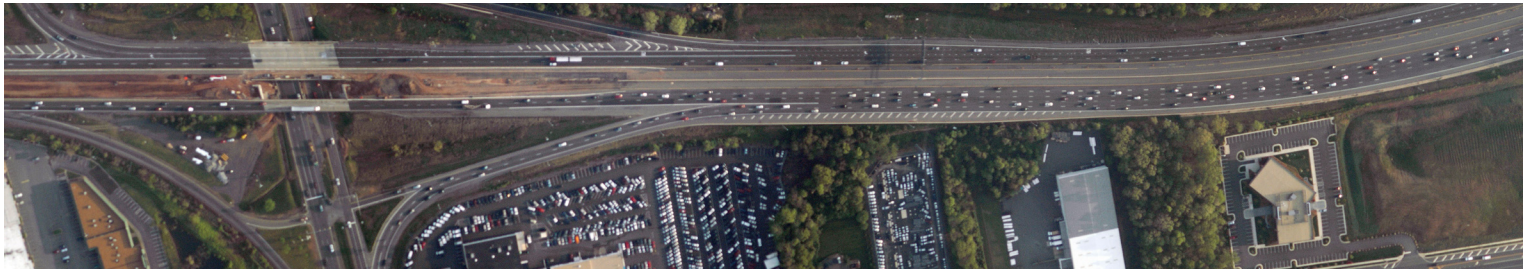


Photo Set Two: these two photos show how congestion has filled in east of Gainesville; the interchange at Sudley Road in Manassas is shown (2005 top; 2011 bottom).

Photo Set Two: 2011

I-66 Virginia (Fairfax and Arlington Counties) - Morning

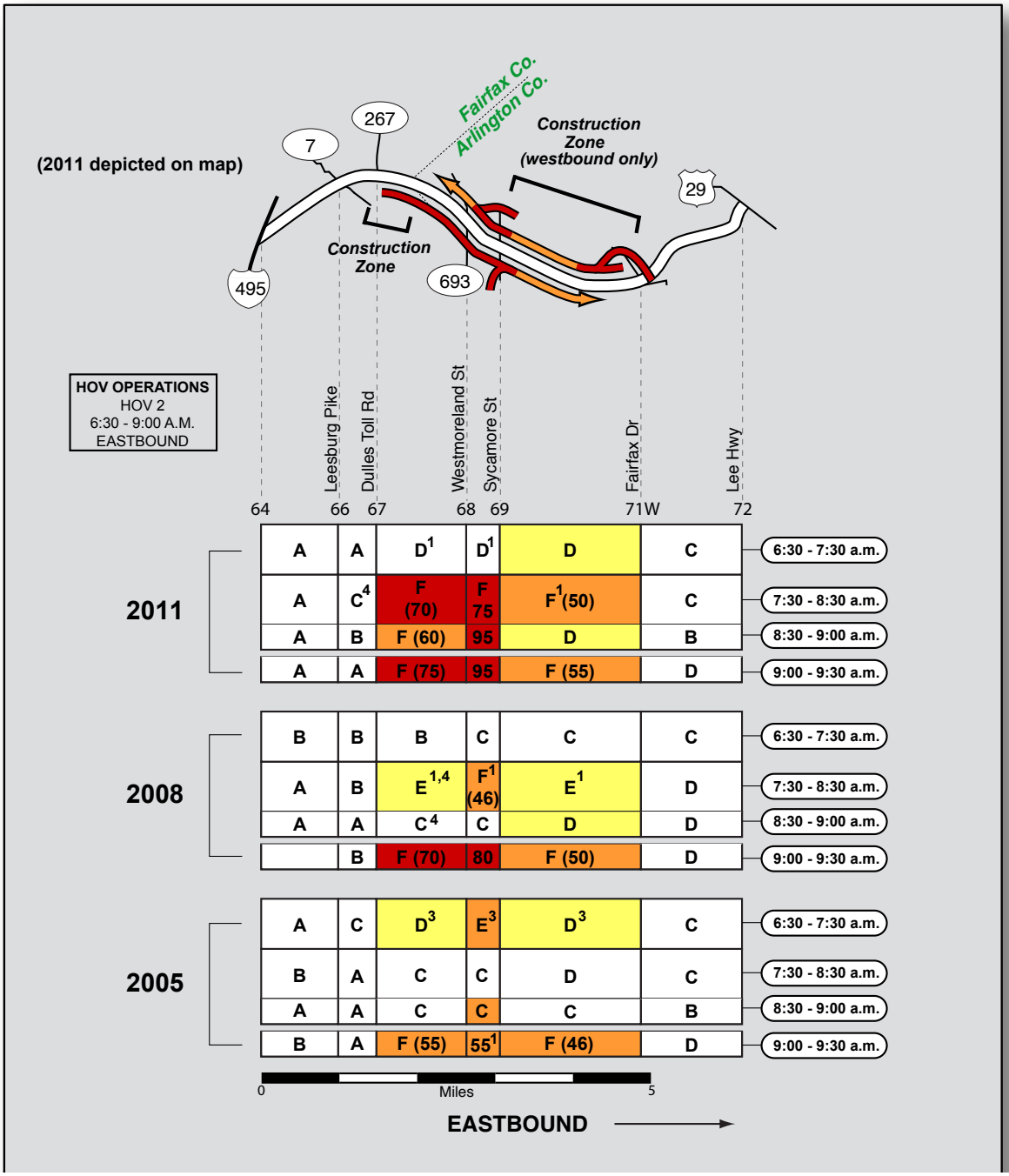
Location: I-66 (HOV-2) east of the Dulles Toll Road (VA 267) merge

Time Period: Morning (6:30 to 9:00 a.m.)

Type of Change: Degraded

Potential Cause: Increasing demand for HOV services; sufficient use by permitted (alternatively-fueled) SOV's (unverified)

I-66 inside the capital beltway has long been congested in the non-HOV direction during peak periods of commuter travel. However, minor inbound HOV congestion seemed to be occurring during the 2008 survey period. This apparent trend now appears to be confirmed by the findings of the 2011 survey flights: moderate to heavy congestion was repeatedly found during the morning survey period on I-66 (HOV-2) between the Toll Road merge and the entrance ramp at Sycamore Street. In addition to greater demand for HOV facilities, it is also possible that use was significantly affected by the permitting of "green-fueled" vehicles for operation on restricted HOV lanes (not verified).



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	20	30	40	50	60	70	80	90
Light	Moderate	Heavy	Congested	Severe

I-66 Virginia (Fairfax and Arlington Counties) - Morning

2008

2011

Photographs:
Because "north" is oriented "up", both photographs show eastbound flow beneath westbound flow, heading toward the right edge of each photograph. In the 2008 image (top), this flow was not significantly delayed. However, as several stretches of tightly-packed vehicles in the bottom photograph indicates, moderate to severe congestion was found repeatedly for short stretches during the 2011 survey period.

I-395 Virginia (Arlington County) - Morning

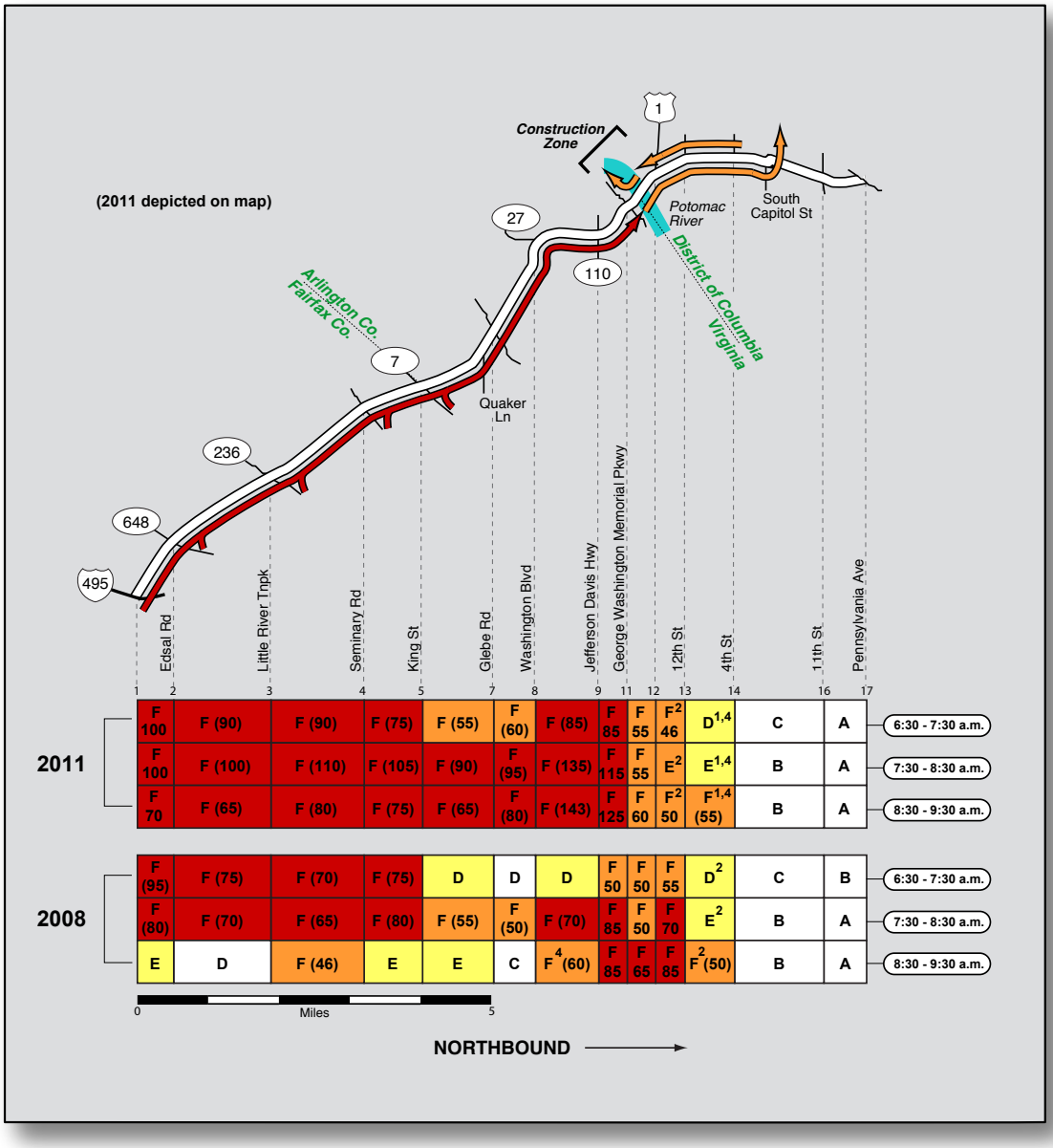
Location: Northbound I-395 approaching the Potomac River / 14th Street Bridge

Time Period: Morning

Type of Change: Degraded

Potential Cause: Narrowed lanes for bridge rehabilitation

While this report section normally excludes highway segments where construction-related activities generate temporary patterns of congestion, an exception was made in this case. Rehabilitation of the surface of the 14th Street Bridge required that northbound travel lanes be narrowed, that a slight lateral shift be imposed, and the already-too-short acceleration lane for traffic merging from southbound George Washington Parkway be taken away. The effect was that, while the number of thru-lanes remained the same, upstream traffic flow was severely degraded. While this already was a perennial bottleneck, high-density congestion that normally extended just for 1-2 miles now reached upstream to the capital beltway in Springfield, almost 10 miles away. Northbound commuters in the general-purpose lanes typically have experienced major congestion between the Springfield interchange and King Street, and then flow at much higher speeds until reaching the vicinity of the Pentagon. Now there was just one zone of severe congestion, and the densities were higher -- these were consistent with average travel speeds in the 5-10 mph range.



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	20	30	40	50	60	70	80	90
Light	Moderate	Heavy	Congested	Severe

I-395 Virginia (Arlington County) - Morning

Photo Set One: 2008

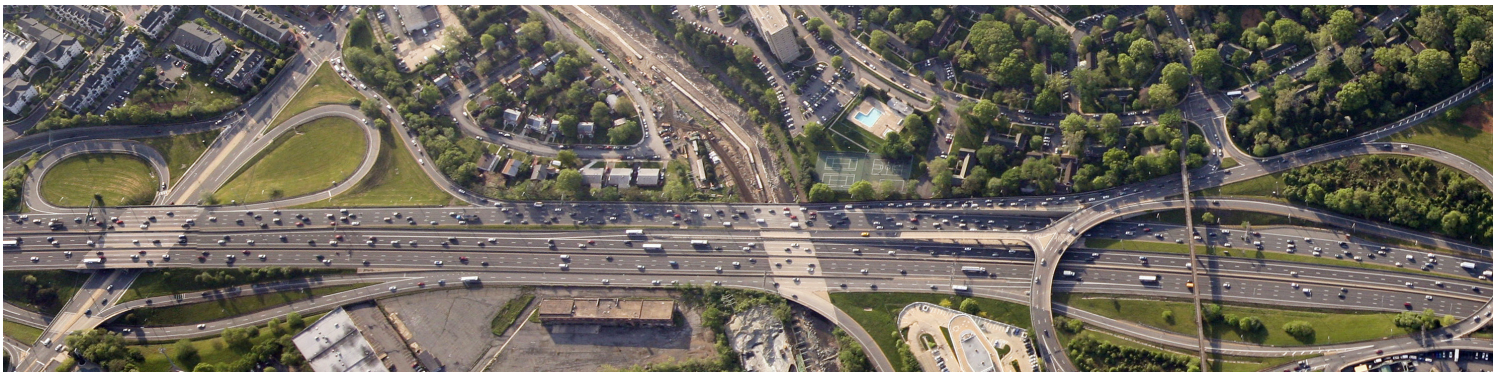


Photo Set One: 2011

Photo Set Two: 2008

Photo Set Two: 2011

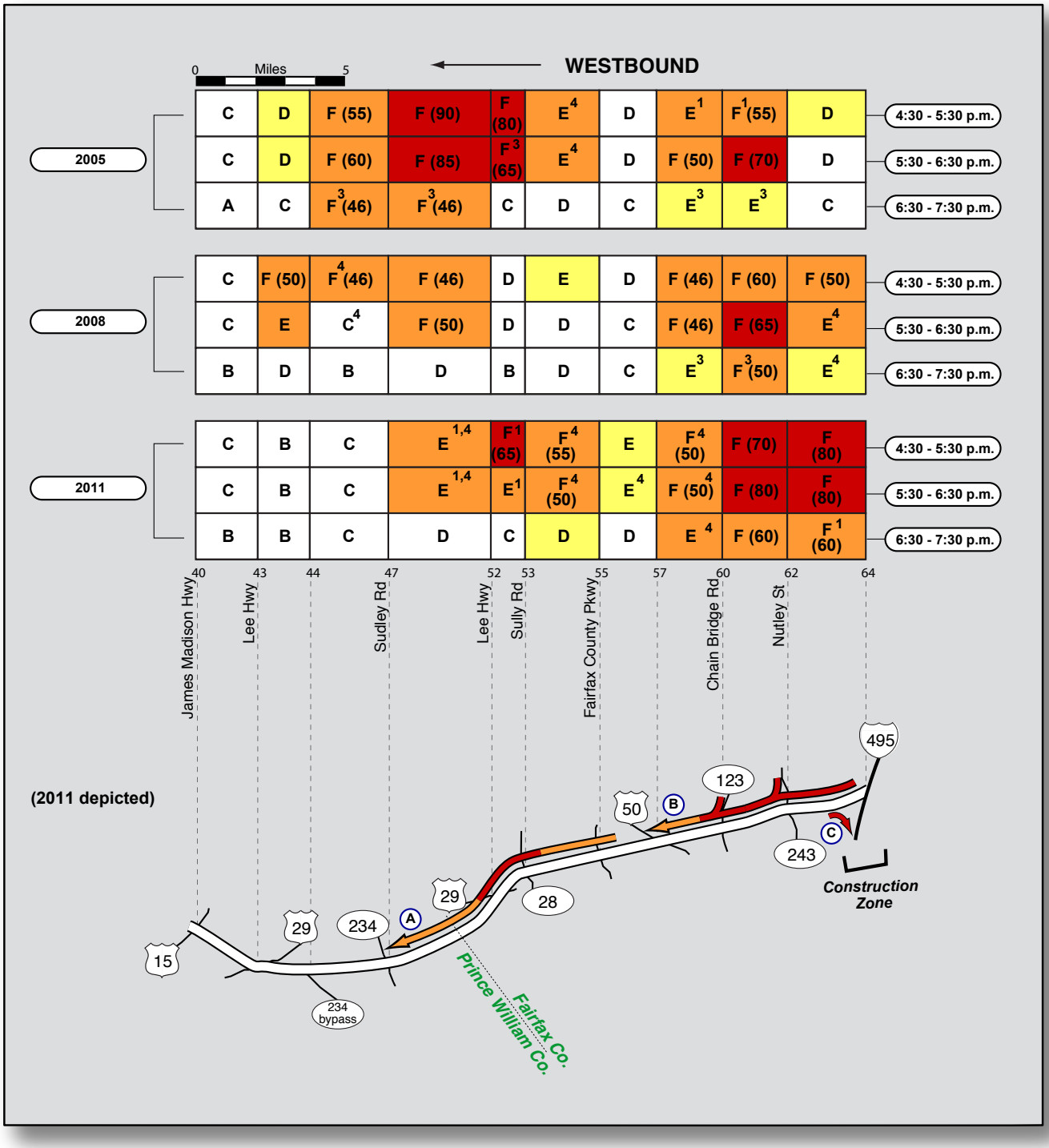
Photo Set One (Above):
The top photograph from 2008 shows normal flow in the vicinity of Quaker Lane and Glebe Rd, in-between the two large congestion zones. The bottom photo from 2011 shows the extremely high densities that typically extended for a large part of the distance.

Photo Set Two (above and right):
This pair shows the normal configuration of the lanes at the GWP merge in 2008, and then it shows the modifications needed for the rehabilitation work in 2011.

I-66 Virginia (Fairfax and Prince William Counties) - Evening

Location:	Westbound I-66 between the beltway and Gainesville
Time Period:	Evening (4:30 to 7:30 p.m.)
Type of Change:	**Mixed**
Potential Cause:	Rough pavement close to beltway; evolving demand patterns after highway widening

Reports of rough pavement on I-66 near the beltway may help account for greater levels of congestion found there in 2011 approaching Nutley Street and Chain Bridge Road. Traffic flow was also generally degraded in 2011 farther west approaching VA 28 and US 29 (Lee Highway). Farther west, intermittent congestion found in 2008 between 4:30 and 5:30 p.m. (before widening had been completed) was gone during all 2011 survey flights.



Freeway LOS Legend

A	B	C	D	E	F	F	F
Density 10	20	30	40	50	60	70	80	90
Light	Moderate	Heavy	Congested	Severe

I-66 Virginia (Fairfax and Prince William Counties) - Evening

2005

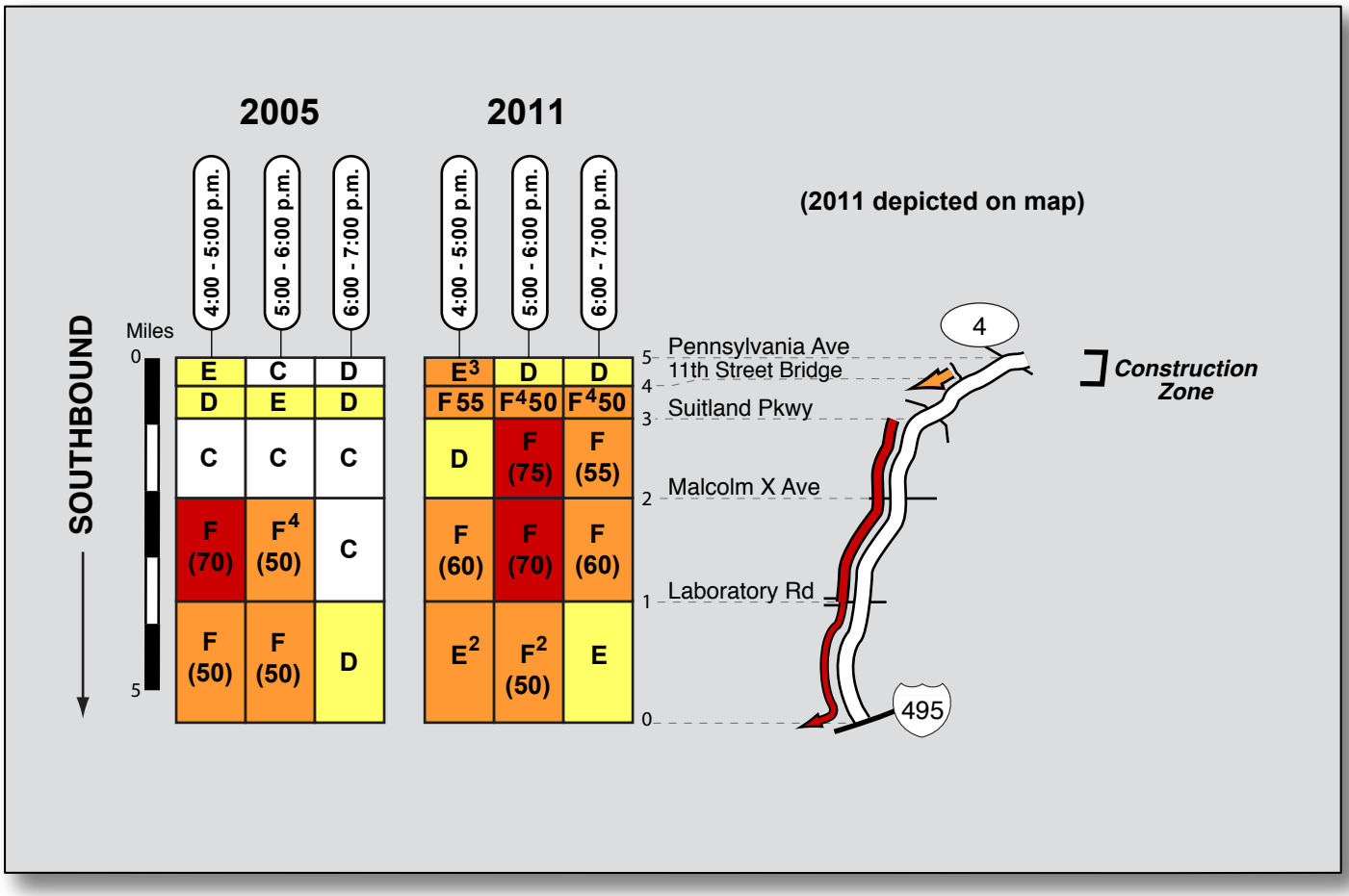
2011

Photographs:
The top photograph was taken in 2005 and shows typical westbound congestion on I-66 in the vicinity of the Sudley Road interchange in Manassas. Once this widening project had been completed, congestion was no longer found (see 2011 photograph, bottom).

I-295 Maryland (Prince Georges County) and District of Columbia - Evening

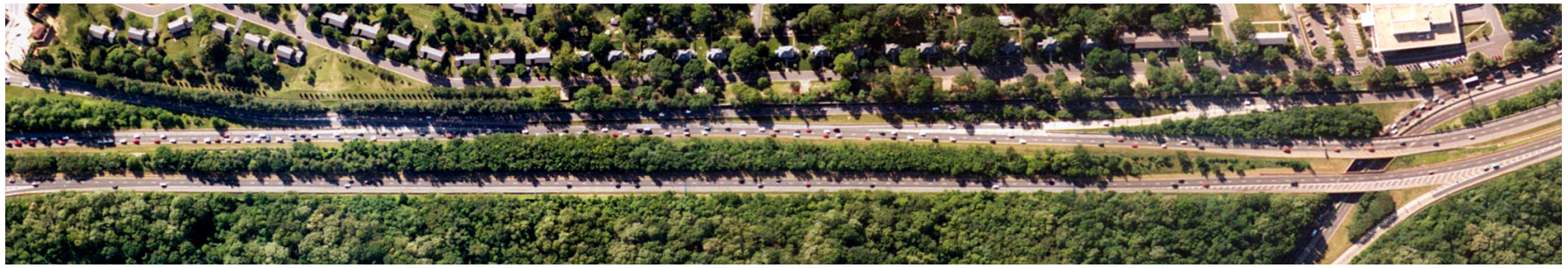
Location:	Southbound I-295 from the 11th Street Bridge to the Laboratory Road entrance ramp
Time Period:	Evening
Type of Change:	**Degraded**
Potential Cause:	increased demand (possibly affected by the increased appeal of the new, uncongested Woodrow Wilson Bridge)

Traffic merging onto southbound I-295 from Blue Plains, Bellevue and the Bolling Air Force Base has long generated southbound congestion along the interstate. However, for the first time in the absence of construction or incidents, significant recurring southbound congestion has been found along the adjacent segment, a three-lane section of I-295 -- specifically, from the Suitland Parkway interchange near the 11th Street Bridge to the lane drop / exit to South Capital Street SW (a distance of about 1.75 miles). In fact, one continuous queue was found there in 2011 between the Suitland Parkway interchange to the entrance ramp at Laboratory Road. Beyond that, traffic was queued toward the south in the right lane, in preparation for exiting to the one-lane ramp to the new Woodrow Wilson Bridge. (It was not clear from the photography whether or not a two-lane ramp to the bridge would have improved flow upstream of Laboratory Road.)

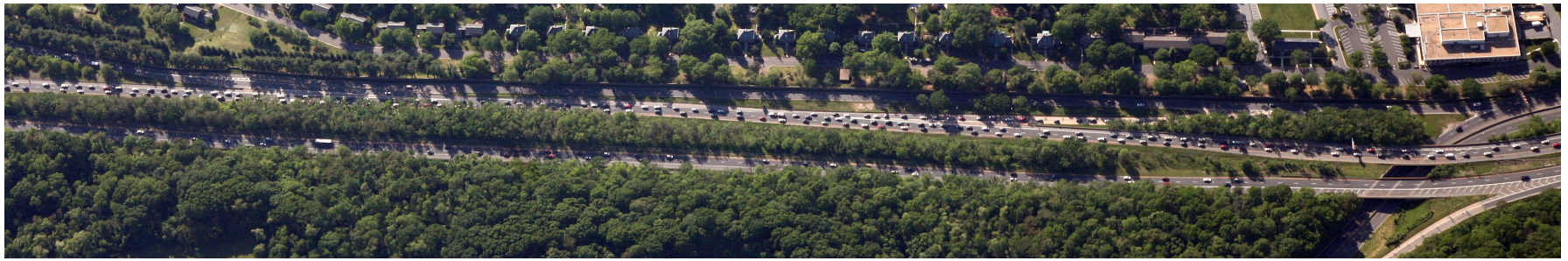


I-295 Maryland (Prince Georges County) and District of Columbia - Evening

2002



2011



2011

Photographs:
I-295 in the vicinity of South Capitol St is shown in the top two photographs; in 2002 this was the typical location of the tail of the evening congested zone. In 2011, the tail of the queue was typically found further upstream in the vicinity of Suitland Parkway as shown in the bottom photograph.

(Blank)

APPENDIX A

PROCEDURE FOR DETERMINING FREEWAY LEVEL-OF-SERVICE

Introduction

Overlapping aerial photography can document many useful characteristics of traffic flow on highway networks. The photographs can be invaluable for screening problem sites, winning support for ideas, and explaining decisions to others. If formal rules and procedures are applied to the analysis of aerial photographs, the photography can provide a cost-effective basis for periodically rating the performance of large highway systems on a link-by-link basis.

Background

For highways, traffic flow is normally measured in terms of three basic parameters: *volume*, *speed*, and *density*. These parameters are related mathematically such that, if only two are known, the third can be calculated (volume equals speed times density). Other useful flow parameters related to speed are *travel time* and *delay* between specific points on a system.

The *Highway Capacity Manual (HCM),* updated in 2000 by the Transportation Research Board of the National Research Council, is an authoritative resource that has established a simplified concept by which the performance of all types of transportation facilities can be described and compared. This concept is called *level of service,* or *LOS*. For each type of facility, a single traffic flow parameter – the one deemed most appropriate by the committee that publishes the manual – is chosen to be the basis for defining six rating categories. These categories are represented by the letters “A” through “F”, ranging from the most favorable rating of LOS A (indicating high service quality associated with lightly-used facilities) to the poorest rating of LOS F (indicating a facility burdened by congestion or other undesirable performance characteristics). This LOS system, introduced in 1965 version of the HCM and revised periodically since, has been widely adopted for evaluating existing highway systems and planning future improvements. Because six LOS classes are easier to understand than tables of numbers, LOS has been widely used in the political process. In some jurisdictions, LOS standards are even found in legislation attempting to guide facility planning or control real estate development.

Uninterrupted-flow highways (grade-separated highways without signals)

Summary

The defining parameter for HCM LOS on freeways and other uninterrupted-flow highways is the *density* of traffic flow (in units of passenger cars per lane per mile). Density was chosen as the basis for HCM LOS because, when traffic flows without interruption, traffic density relates mathematically to both speed and volume. This means that a single LOS measure based on density provides not only general speed information, but also provides an approximation of how heavily the facility is utilized. It also indicates where demand has exceeded capacity, resulting in congestion and delays. (Speed is less desirable as a defining basis for LOS because uninterrupted-flow highways can process high volumes of traffic at high speeds; ratings based on speed alone might not differentiate clearly between facilities that were heavily or lightly utilized.) The most common way to determine LOS on an existing freeway is to measure the speed and volume of the traffic, and then calculate the density. Another method is to determine density directly from aerial photographs, which allows for cost effective data collection across very large highway networks. (This also affords the other benefits of aerial photography, which often shows the underlying causes of congestion as well as conditions on interchange ramps, merges and crossroads.) Accordingly, when Skycomp evaluates the performance

of uninterrupted-flow highway facilities, Skycomp derives traffic densities from aerial photographs and then determines density-based HCM LOS ratings.

As discussed above, the LOS rating system uses the letters "A" through "F" to describe traffic conditions: LOS "A" represents superior traffic conditions (very light traffic), while LOS "F" represents poor traffic conditions (congested flow involving various degrees of delay). These letters are assigned based on how densely cars are traveling on the road. Research has shown that for all densities below 40 pcplpm, vehicles generally move at or close to normal highway speed; LOS "A" through "E" represent these densities according to the following table (pcplpm):

LOS "A": densities from **zero to 11** (very light traffic);
LOS "B": densities from **12 to 18** (light to moderate traffic);
LOS "C": densities from **19 to 26** (moderate traffic);
LOS "D": densities from **27 to 35** (moderate to heavy traffic);
LOS "E": densities from **36 to approx. 45** (heavy traffic, but still at speeds close to free-flow)

At densities greater than **40**, speeds typically decrease and traveler delays are incurred. Because flow at all densities greater than **46** (approximately) are regarded as LOS "F", this report attaches actual densities to all LOS "F" ratings. Accordingly:

LOS "F":
- Densities from **46 to 60** indicate delay involving minor degrees of slowing; average speeds usually range between 50 and 30 mph;
- Densities from **60 to 80** indicate traffic flow at average speeds usually ranging between 40 and 15 mph;
- Densities from **80 to 100** indicate congested traffic flow, with some stopping possible; average speeds usually range between 10 and 25 mph;
- Densities above **100** indicate severe congestion, with considerable stop-and-go flow likely. For reference, densities above 120 almost always indicate the presence of unusual events (accidents, roadwork, etc.). The practical maximum value for density measurements is **180**; the theoretical maximum value is **264** (at 20 feet per vehicle).

Data Reduction Procedures

From overlapping time-stamped photographs, densities by highway segment were determined by manual counts taken along the entire segment length. Vehicles were classified as cars, trucks, buses, or tractor-trailers when counted; later, passenger-car equivalents (pce's) were derived according to the following table:

Vehicle type:	PCE's:
cars	1
buses	1.5
trucks	1.5
tractor-trailers	2.0

Data that were atypical due to roadwork or to known or suspected incidents were coded for exclusion

from the averaging process. All data were then entered into a microcomputer database program, which performed the following tasks: 1) samples were grouped by time slice; 2) average densities were calculated; and 3) densities were converted into service levels “A” through “F”. The computer then prepared matrices showing each averaged service level rating plotted by time and highway segment. These data matrices were then copied into the traffic quality tables, which are provided in this report.

In the tables, all LOS F conditions (congested traffic flow) have darkly shaded; this permits quick identification of locations experiencing demand at levels exceeding capacity. Because LOS “F” encompasses a wide range of densities, the actual density values are entered next to the “F”; using the travel characteristics in the density ranges provided above, the nature of the flow in LOS F segments can be determined.

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APPENDIX B

METHODOLOGY DESCRIPTION

Procedures for obtaining speed/density samples for calibration of
the Van Aerde Speed / Density Model

BACKGROUND

In the spring of 1995, Skycomp collected data to compare the speed of vehicles through congested freeway zones with corresponding densities obtained from aerial photographs. The purpose was to explore the relationship between the two, and, given a reasonable correlation, to prepare a model by which vehicle speeds could be estimated from aerial density photographs.

The program was conceived and executed by the Metropolitan Washington (D.C.) Council of Governments (MWCOG). Aerial data were collected by Skycomp; analysis of the data and calibration of the Van Aerde speed/density model were conducted by MWCOG.

A secondary objective was to evaluate the accuracy of aerial speed and density measurements by comparing them to data collected by traditional methods (floating cars and loop detectors embedded in the pavement).

Accordingly, segments of freeway were chosen to be surveyed that: 1) were expected to generate congested traffic flow; and 2) either contained a loop detector station or would accommodate quick turnarounds for multiple floating car runs. Thus, while data were being collected in the air (290 speed samples were obtained from the air, along with corresponding densities), loop detector or floating car data were collected concurrently on the ground.

The outcome of this study was a finding that travel speeds across congested freeway segments could be determined with reasonable accuracy using only aerial density photographs. It was also found that speeds and densities obtained through aerial techniques closely matched data obtained using the traditional ground methods.

PROCEDURES TO OBTAIN SPEED / DENSITY SAMPLES:

The observer/photographer followed the following procedure to obtain all speed/density samples: he first flew along the selected survey segment while taking time-stamped overlapping density photographs of the entire segment; next, at the upstream end, he selected a target "floating" car for tracking; he photographed the target as it entered and departed the segment, while simultaneously timing its run to the nearest second. He then took an "after" density photo set; and then recorded the following information on a clipboard: the time of the sample, the target vehicle description, lane(s) traveled, elapsed time, and any special notes. This procedure was repeated for each speed/density data point.

In the actual course of sampling, this procedure was modified in several ways. First, where cars were moving at high (free-flow) speeds, the density did not change significantly between samples; thus sometimes three or more floating cars were timed between density runs.

Another modification done in-flight is as follows: the observer noted in several cases that the density set taken before the target vehicle went through better reflected the conditions the car encountered than the density set taken after the vehicle went through (or vice versa). This was usually due to a delay in changing film, extra maneuvering the airplane, or any other event which delayed the "after" density sample for several minutes after the completion of the run. While normally the density associated with each speed sample was an average of the "before" and "after" density sets, in these cases only the "before" or "after" density set would be used (as directed by the observer).

With regard to selection of target vehicles, the plan was to select cars that reflected the average speed of traffic, just as floating car drivers are instructed to approximate the speed of traffic flow. Fortunately, vehicles have little freedom to choose their speeds in the congested density ranges (above 40 pcplpm). So, for example, almost any vehicle in a congested traffic stream in the middle lane of three will give a suitable floating car measurement. Even tractor-trailers (unless heavily loaded and traveling uphill) moved at the same speed as passenger cars. Thus the criteria the observer used in selecting each target vehicle was 1) is it in the correct lane; and 2) does the vehicle stand out so that it is easy to keep track of?

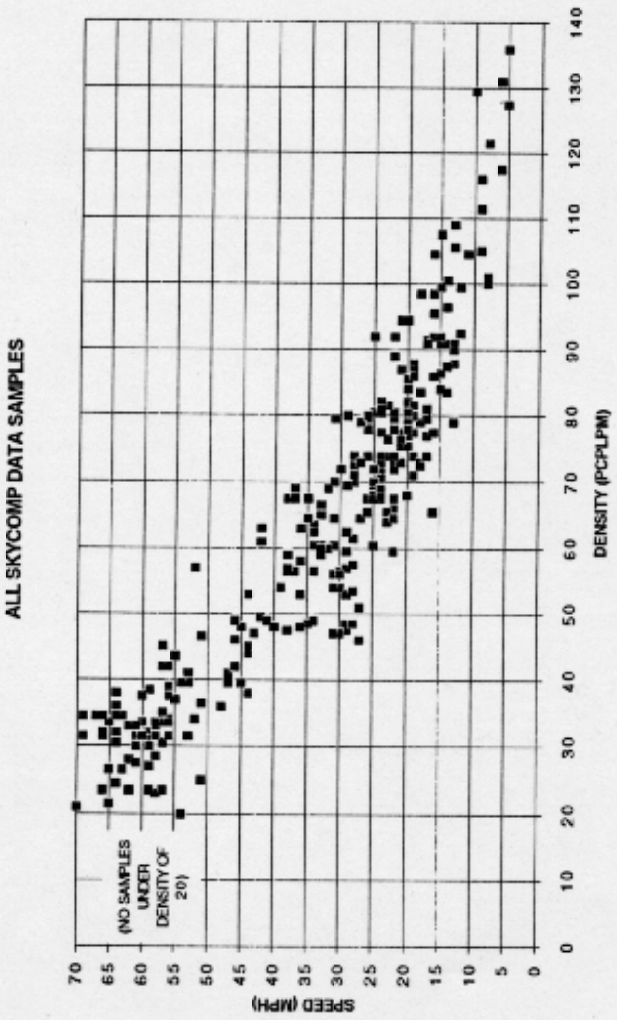
Also, in the event that the highway had four travel lanes in one direction, alternating samples were taken from both middle lanes.

In the event that a driver switched lanes while being tracked, the observer noted the lane change and also noted which lane the car spent the majority of time in (this is the lane for which a density count would be made later). In several cases (infrequently), the observer

abandoned tracking certain vehicles when: 1) the driver made multiple lane changes, trying to beat the average speed of traffic; 2) the driver switched lanes and changed speeds obviously and significantly; 3) the vehicle turned out to be a heavily loaded truck which delayed the traffic stream; or 4) the observer "lost" the vehicle being tracked. Also, for the samples made with traffic traveling at free-flow speeds, vehicles were abandoned which proved to be traveling significantly faster or slower than the average speed of traffic.

In the event that the target vehicle moved to the right lane in apparent preparation to exit, the observer often was able to switch tracking to another vehicle that had been just behind or ahead of the original vehicle in the same lane (and used the newly adopted vehicle to complete the sample). This was necessary because in some cases six or seven minutes had been invested in the tracking of a specific vehicle, and it was important to avoid wasting that time where possible.

It should also be pointed out that speeds were not tracked for very slow moving queues (densities over 120 / MWCOG samples only). Instead, density runs were made at 5 or 10 minute intervals, such that later on the ground the same vehicles could be found in succeeding sets of density photos; this allowed computation of speeds and associated densities.


ALL SKYCOMP DATA SAMPLES
SPEED (MPH)
DENSITY (PCPLPM)
(NO SAMPLES UNDER DENSITY OF 20)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140

DATA PROCESSING

After each flight, a topographic map was prepared for each zone which showed the starting and stopping points for each tracked car. Measurements were then made of the segment length (distance traveled). Then each tracked vehicle was entered into the computer database, including:

1. vehicle description
2. time-of-day
3. initial lane and subsequent lane changes
4. precise travel time (from stopwatch or time-lapse photographs)
5. density-photo preference, if any (default was to average the before- and after- density samples)
6. any special notes pertaining to that vehicle.

After the photos had been processed, each set of overlapping "density" photographs was taped together into a "mosaic" that showed each entire segment. Then vehicles in the required lane(s) were counted, listed by "car", "truck", "tractor-trailer" and "bus". These totals were translated into passenger-car equivalents (PCE's) using the following values:

Vehicle type:	PCE's:
cars	1
trucks	1.5
tractor-trailers	2.0
buses	1.5

(It should be noted that the distinction between "cars" and "trucks" could not be cleanly made, since there are many varieties of light and heavy pick-ups (both covered and uncovered). In general, a pick-up or van had to be at least twice the size of an average-sized car to be considered a "truck".)

PCE's were then divided by segment length to calculate densities. These density samples were then matched to corresponding speed samples; each speed/density data pair was then plotted on the chart.

CALIBRATION OF THE VAN AERDE MODEL

Van Aerde Model

The main advantages to a single-regime model are that boundaries between regimes do not have to be defined; and curves from adjacent regimes do not have to be spliced at the boundaries. A single-regime model allows for a more subjective and repeatable calibration process. This will be is especially true if more data from the high-speed end of the curve is ever incorporated into this process.

The disadvantages to this particular model are that it expresses this project's independent variable as a function of the dependent variable; and that it is a non-linear function. These disadvantages make performing the initial calibration more difficult. However, once SAS programs for the task are written, they can be used again usually with a minimum of effort.

The procedure for calibration was as follows: 1) The model's equation was coded into a spreadsheet so that the shape could be defined by recognizable parameters: two points that the curve passes through, the free-flow speed, and the speed at capacity. By overlaying this curve with the scatter plot of the observations, initial estimates of the parameters were made. 2) The initial parameter estimates, the equation, and the observations were used in a SAS PROC NLIN job to machine-calibrate the parameter estimates. 3) A second SAS program translated the calibrated equation into a look-up table that expresses speed as a function of density. 4) The results of the SAS work were imported into a spreadsheet for plotting and for calculation of prediction intervals.

Two outstanding technical issues related to this procedure are determination of the free-flow speed, and calculation of prediction intervals.

The free-flow speed for best fit can be determined by the PROC NLIN program, as are all other parameters. Due to the lack of data at the low-density region of the model, PROC NLIN returns a very high free-flow speed. Additional data from MD SHA was used to calculate a free-flow speed for general application on the Beltway. The calibration of the model presented here resulted from forcing the free-flow speed to match the SHA data analysis.

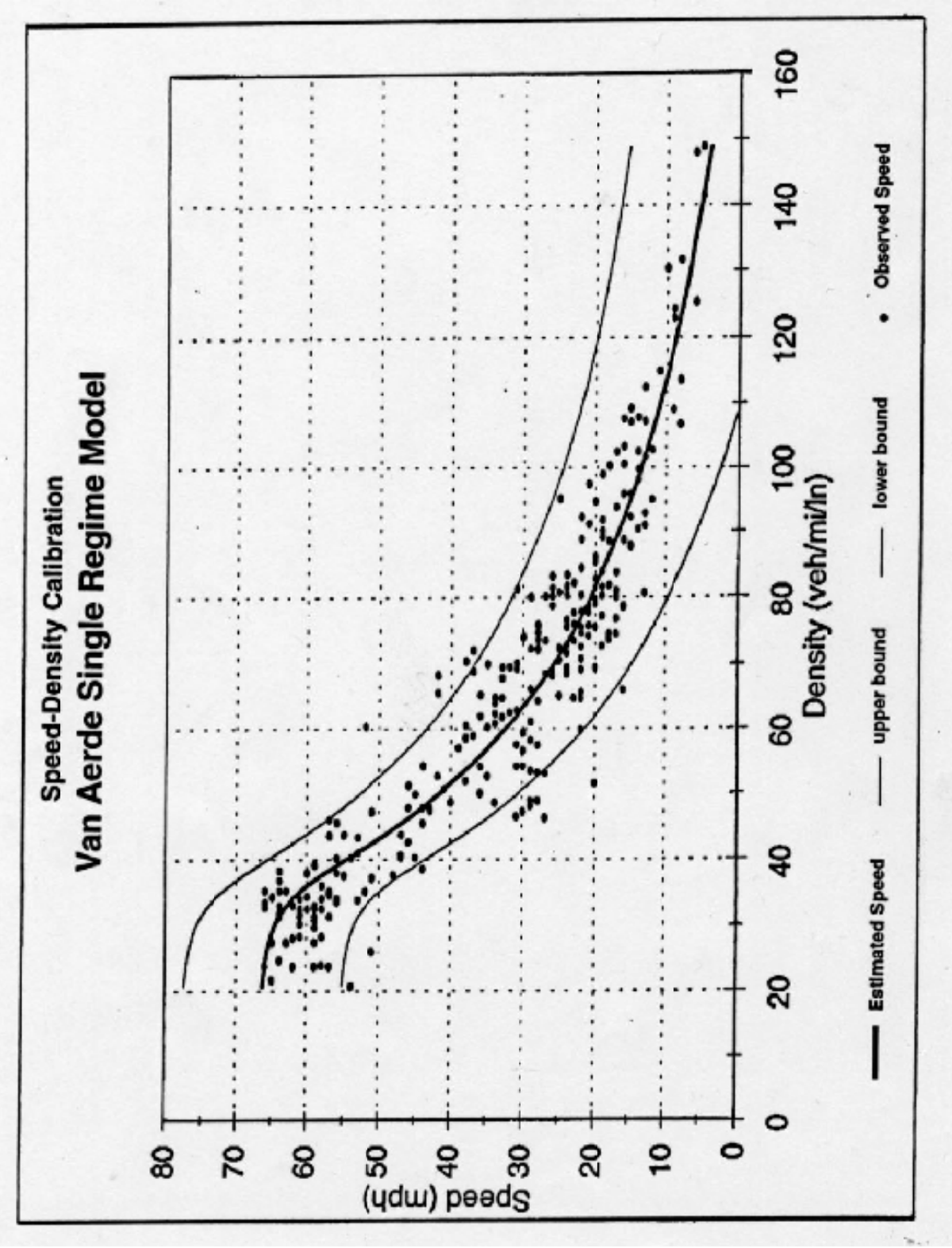
The prediction intervals shown in the current plot were calculated after the model was translated. This may have not been appropriate. PROC NLIN calculates prediction intervals directly as it calibrates the model. Those prediction intervals express density as a function of speed, however. Work is in progress to translate them, and to otherwise arrive at the most appropriate method of determining prediction intervals.
Since a single-regime model is more suitable in a computerized process, and for lack of significant difference in performance, the Van Aerde model is preferred over earlier approaches examined by MWCOG staff and presented before subcommittees.

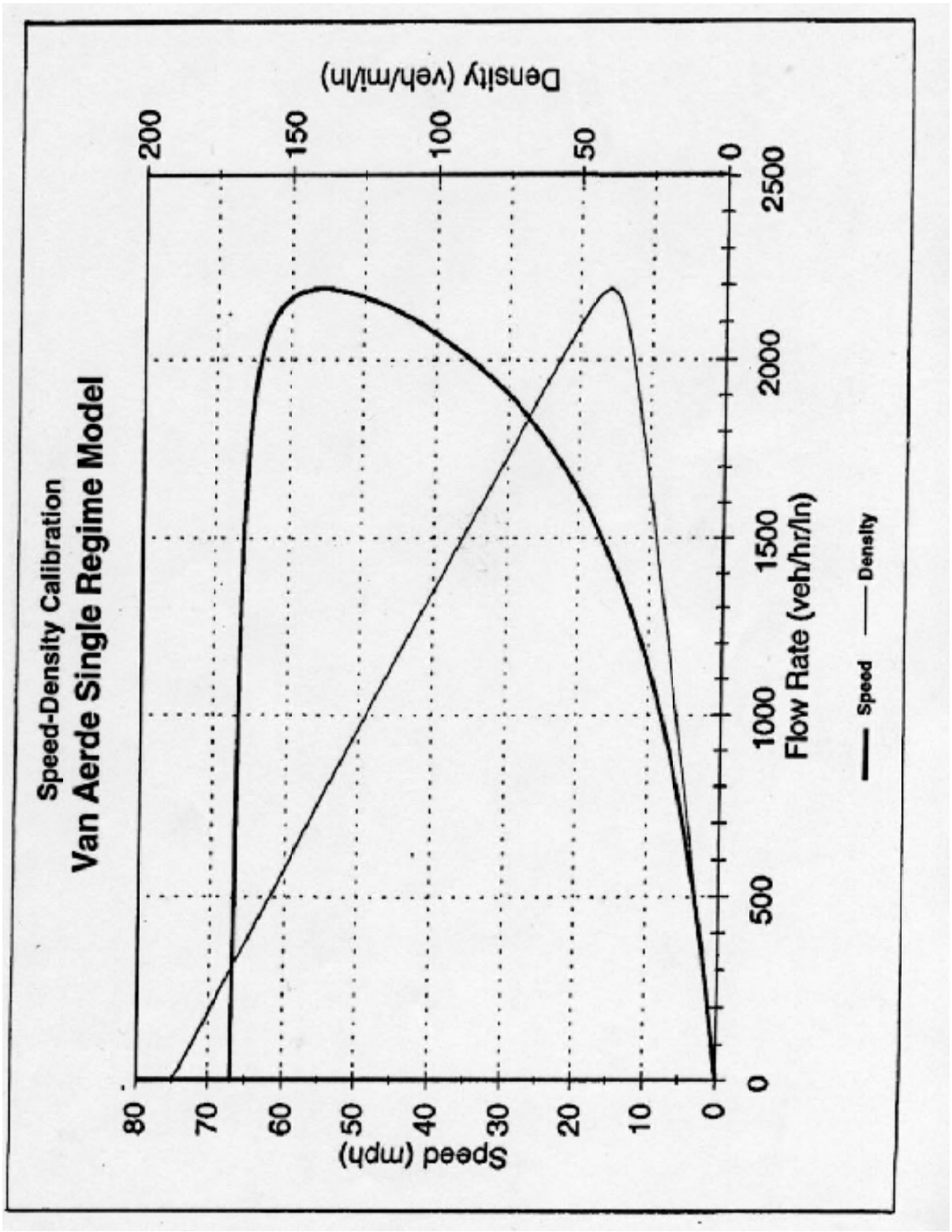
Speed-Density Calibration
Van Aerde Single Regime Model

free-flow spd = 67 mph / c1 = 0.00512 / c2 = 0.0114 / c3 = 0.000342

	DENSITY (veh/ln/mi)	SPEED (mph)	VOLUME (veh/ln/hr)
free-flow	0	67.0	0
	20	66.4	1,328
	25	65.8	1,661
	30	64.6	1,946
	35	61.3	2,144
capacity	39	55.8	2,190
	40	54.7	2,189
	45	47.8	2,153
	50	41.9	2,094
	55	36.8	2,025
	60	32.6	1,954
	65	28.9	1,880
	70	25.8	1,806
	75	23.1	1,731

DENSITY (veh/ln/mi)	SPEED (mph)	VOLUME (veh/ln/hr)	
80	20.7	1655	
85	18.6	1580	
90	16.7	1503	
95	15.0	1425	
100	13.5	1350	
105	12.1	1271	
110	10.9	1197	
115	9.7	1117	
120	8.7	1043	
125	7.7	963	
130	6.8	885	
135	6.0	810	
140	5.2	729	
187	0	0	jam


Speed-Density Calibration
Van Aerde Single Regime Model
Speed (mph)
0
10
20
30
40
50
60
70
80
Density (veh/mi/ln)
0
20
40
60
80
100
120
140
160
Estimated Speed
upper bound
lower bound
Observed Speed


Speed-Density Calibration
Van Aerde Single Regime Model
Speed (mph)
80
70
60
50
40
30
20
10
0
Density (veh/mi/ln)
200
150
100
50
0
Flow Rate (veh/hr/ln)
0
500
1000
1500
2000
2500
Speed
Density

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APPENDIX C

2008 Congestion Summaries (Locations and Corridors)

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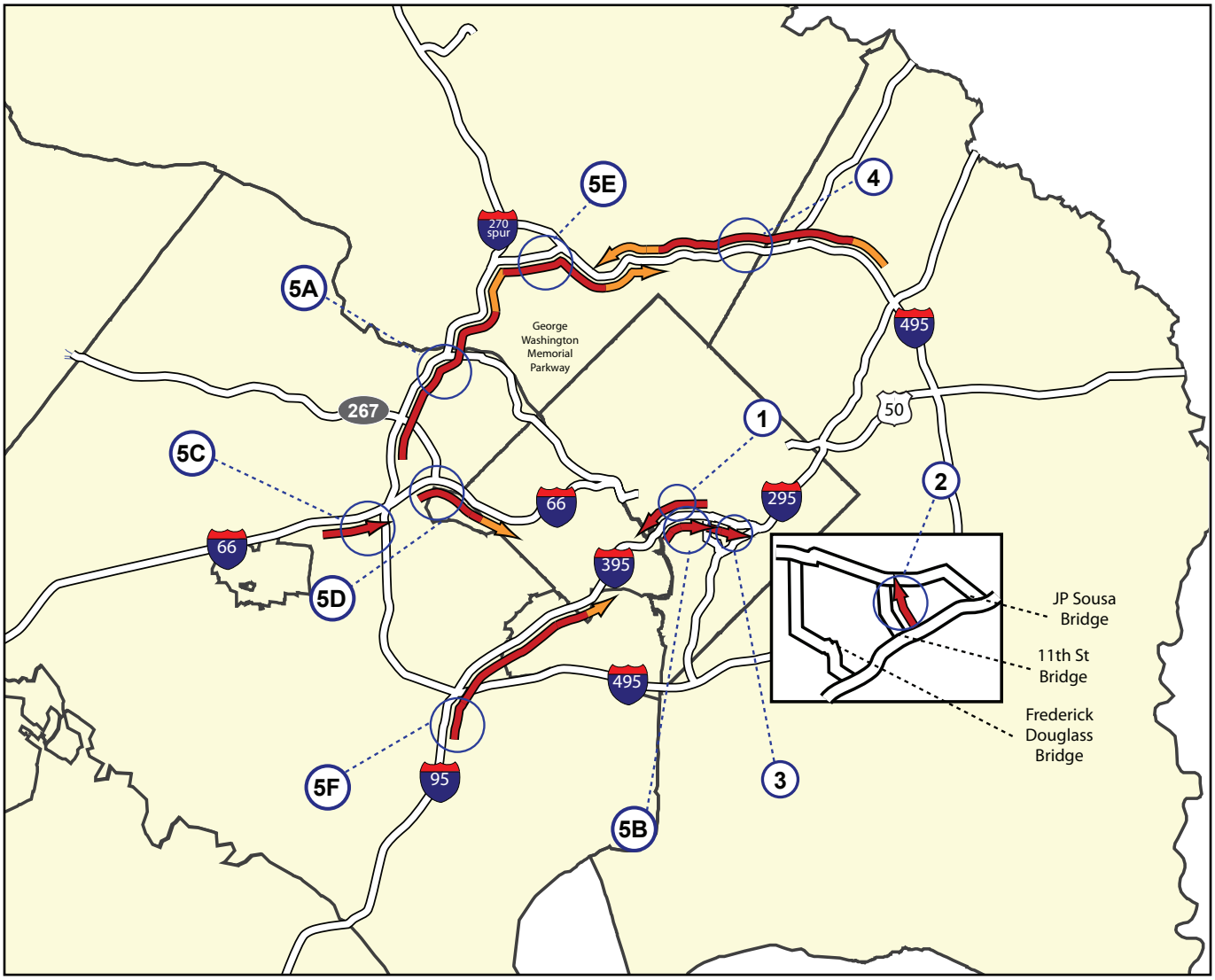
Top Ten Congested Locations 2008



Top Ten Congested Segments on the Freeway System (2008)

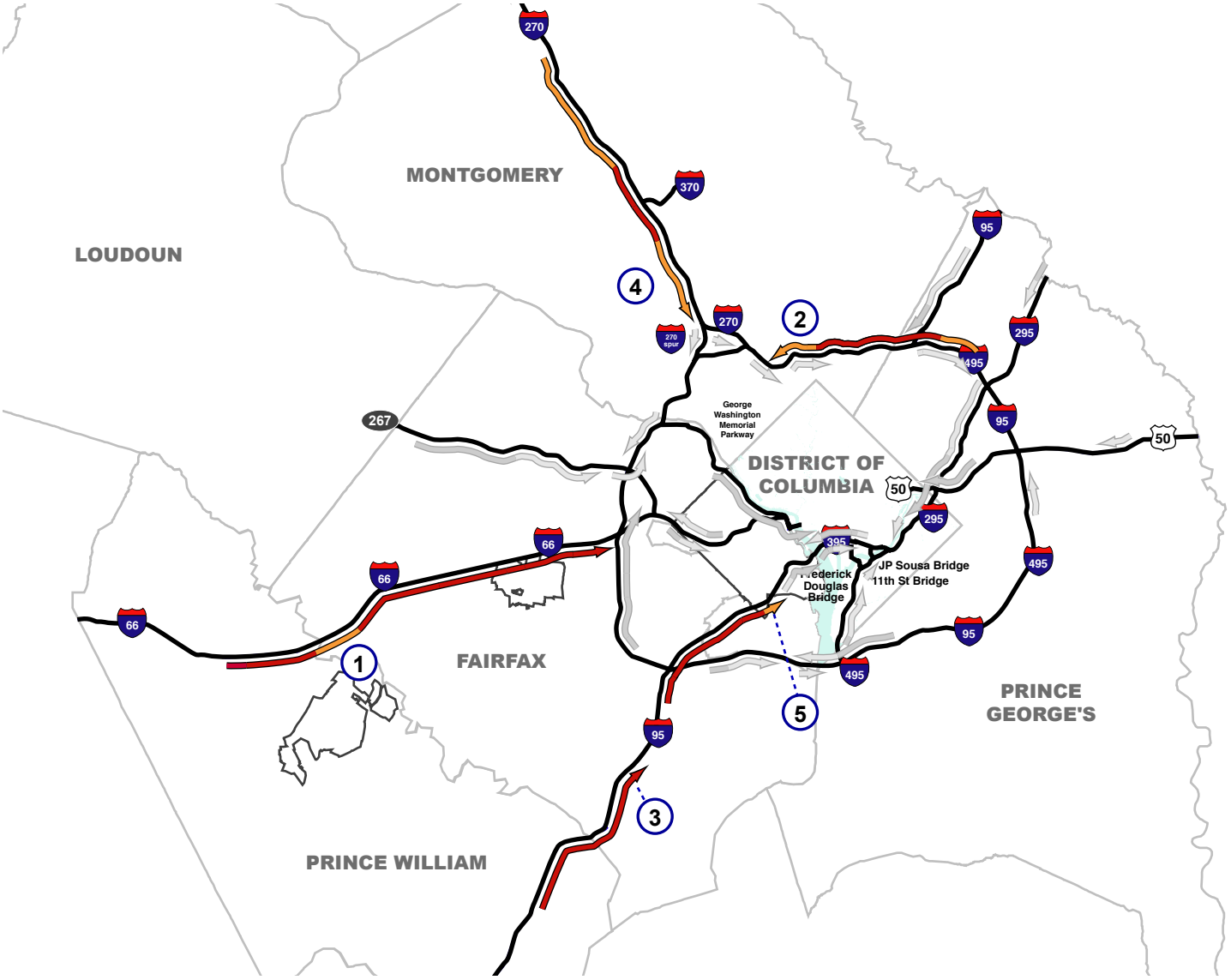
Rank	Route	From	To	Density	Speed Range
1	SB Southwest/Southeast Fwy (5:30 to 6:30 PM)	Southwest Fwy/I-395 merge	US Route 1	115	10 to 15 MPH
2	WB 11th St Bridge (8 to 9 AM)	I-295/DC 295	Southeast Fwy	110	10 to 15 MPH
3	NB Southeast Fwy (4:30 to 6:30 PM)	11th Street	Pennsylvania Ave	105	12 to 20 MPH
4	OL I-495 (8 to 9 AM)	MD 650 (New Hampshire Ave)	US 29 (Colesville Rd)	100-105	12 to 20 MPH
5A	IL I-495 (5:30 to 6:30 PM)	VA 193 (Georgetown Pike)	George Washington Pkwy	100	14 to 20 MPH
5B	NB Southwest Fwy (4:30 to 5:30 PM)	US Route 1	Lenfant Plaza	100	14 to 20 MPH
5C	EB I-66 HOV (8 to 9 AM)	VA 243 (Nutley St)	I-495	100	14 to 20 MPH
5D	EB I-66 (6:30 to 7:30 PM)	VA 267	VA 693 (Westmoreland St)	100	14 to 20 MPH
5E	IL I-495 (5:30 to 6:30 PM)	MD 187 (Old Georgetown Rd)	MD 355 / I-270	100	14 to 20 MPH
5F	NB I-95 VA (7 to 8 AM)	VA 644 (Franconia Rd)	I-495	100	14 to 20 MPH

Longest Delay Corridors- Morning Peak Period (2008)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-66	8:00 – 9:00	Eastbound	VA 234 Bypass	I-495	19.5	41	30	21
Site #2	I-495	8:00 – 9:00	Outerloop	MD 201	I-270	12	31	25	19
Site #3	I-95	7:00 – 8:00	Northbound	Dale Blvd	Lorton Rd	7	19.5	20	12.5
Site #4	I-270	8:00 – 9:00	Southbound	Clarksburg Rd	I-270 Spur	16	28.5	35	12.5
Site #5	I-395	7:30 – 8:30	Northbound	Franconia Rd	VA 7	7	18	25	11

* Free flow travel times based on speed of 60 mph

Note: Congestion on I-495 in the vicinity of the Woodrow Wilson Bridge was excluded due to ongoing construction



Longest Delay Corridors- Evening Peak Period (2008)

Site Name	Road Name	Time	Direction	From	To	Queue Length (miles)	Estimated Travel Time (minutes)	Estimated Speed (mph)	Estimated Delay (minutes)
Site #1	I-495	5:30 – 6:30	Innerloop	VA 7	I-270 Spur	8	24	20	16
Site #2	I-495	4:30 – 5:30	Innerloop	I-270 Spur	University Ave	10	24.5	25	14.5
Site #3	I-270	4:30 – 5:30	Northbound	I-370	I-70	23	34	40	11
Site #4	SE/SW Freeway	5:00 – 6:00	Northbound	VA 27	Pennsylvania Ave	5	15.5	20	10.5
Site #5	MD 295	4:30 – 5:30	Northbound	MD 450	MD 197	9.5	17.5	35	8

* Free flow travel times based on speed of 60 mph

Note: Congestion on I-495 in the vicinity of the Woodrow Wilson Bridge was excluded due to ongoing construction