Alabama Statewide Mobility Report 2014

By

Alex Hainen
Michael Dunn

Department of Civil, Construction, and Environmental Engineering
The University of Alabama
Tuscaloosa, Alabama

Prepared by

UTCA

University Transportation Center for Alabama
The University of Alabama, The University of Alabama at Birmingham, and
The University of Alabama in Huntsville

ALDOT Report Number 930-893
UTCA Report Number 14413
September 2015

UTCA Theme: Management and Safety of Transportation Systems

University Transportation Center for Alabama

About UTCA The University Transportation Center for Alabama (UTCA) is headquartered in the Department of Civil, Construction, and Environmental Engineering at the University of Alabama (UA). Interdisciplinary faculty members perform research, education, and technology-transfer projects using funds provided by UTCA and external sponsors.

Mission Statement and Strategic Plan The mission of UTCA is "to advance the technology and expertise in the multiple disciplines that comprise transportation through the mechanisms of education, research, and technology transfer while serving as a university-based center of excellence."

The UTCA strategic plan contains six goals that support this mission:

- Education – conduct a multidisciplinary program of coursework and experiential learning that reinforces the theme of transportation;
- Human Resources – increase the number of students, faculty and staff who are attracted to and substantively involved in the undergraduate, graduate, and professional programs of UTCA;
- Diversity – develop students, faculty and staff who reflect the growing diversity of the US workforce and are substantively involved in the undergraduate, graduate, and professional programs of UTCA;
- Research Selection – utilize an objective process for selecting and reviewing research that balances the multiple objectives of the program;
- Research Performance – conduct an ongoing program of basic and applied research, the products of which are judged by peers or other experts in the field to advance the body of knowledge in transportation; and
- Technology Transfer – ensure the availability of research results to potential users in a form that can be directly implemented, utilized or otherwise applied.

Theme The UTCA theme is *"MANAGEMENT AND SAFETY OF TRANSPORTATION SYSTEMS."* UTCA concentrates upon the highway and mass transit modes but also conducts projects featuring rail, waterway, air, and other transportation modes as well as intermodal issues.

Acknowledgement This project was sponsored by Alabama Department of Transportation (ALDOT). UTCA is grateful for ALDOT's continued encouragement and support.

Alabama Statewide Mobility Report 2014

By

Alex Hainen
Michael Dunn

Department of Civil, Construction, and Environmental Engineering
The University of Alabama
Tuscaloosa, Alabama

Prepared by

UTCA

University Transportation Center for Alabama
The University of Alabama, The University of Alabama at Birmingham,
and The University of Alabama in Huntsville

UTCA Report Number 14413
September 2015

Technical Report Documentation Page

1. Report No	2. Government Accession No.	3. Recipient Catalog No.

4. Title and Subtitle	5. Report Date
Alabama Statewide Mobility Report 2014	September 1, 2015
	6. Performing Organization Code
7. Authors	8. Performing Organization Report No.
Alex Hainen, Michael Dunn	UTCA Report Number 14413
9. Performing Organization Name and Address University Transportation Center for Alabama The University of Alabama Box 870205 Tuscaloosa, Alabama 35487-0205	10. Work Unit No.
	11. Contract or Grant No. GR 24926
12. Sponsoring Agency Name and Address Alabama Department of Transportation 1409 Coliseum Boulevard Montgomery, AL 36110	13. Type of Report and Period Covered January 1, 2015 – September 1, 2015
	14. Sponsoring Agency Code ALDOT 930-893
15. Supplementary Notes	

16. Abstract

This Alabama Statewide Mobility Report for 2014 is a new way to analyze interstate mobility performance over an entire year. Over half a billion speed records were acquired, stored, and analyzed for this report. These observations capture recurring congestion events (queues during peak periods, weekend travel, etc.) and non-recurring congestion (crashes, special events, and other activities). Four metrics were established that provide a detailed look at each interstate's performance by month. These metrics looked at the amount of time (either by month or over the entire year) that speeds were above or below certain thresholds. Each metric is explained and provides different insight depending on the characteristics of each interstate (length, urban or rural, posted speed limit, etc.). This report could be compiled on an annual basis to compare year-to-year performance and quantify the mobility improvement due to interstate improvement projects.

17. Key Words	18. Distribution Statement		
Statewide Mobility, Interstate, Crowdsourced Data			
19. Security Classification (of this report) Unclassified	**20. Security Classification (of this page)** Unclassified	**20. No of Pages** 123	**22. Price**

Contents


1:2,500,000
1 in = 39 miles
20 10 0 20 40 60 80
Miles
N
W
E
S
Interstate Highway 565
Interstate Highway 65
Interstate Highway 59
Interstate Highway 20
I-20
I-65
Interstate 20; Interstate 59
I-85
Interstate Highway 10
Athens
Huntsville
Scottsboro
Hartselle
Fort Payne
Gadsden
Jasper
Birmingham
Hoover
Bessemer
Tuscaloosa
Talladega
Sylacauga
Alexander City
Auburn
Opelika
Prattville
Millbrook
Selma
Montgomery
Tuskegee
Troy
Georgetown
Ozark
Enterprise
Dothan
Saraland
Daphne
Fairhope
Foley
Crestview
Tupelo
Columbus
Starkville
West Point
Meridian
Corinth
Jacinto
Calhoun
Cartersville
Kennesaw
Marietta
Carrollton
LaGrange
William B. Bankhead National Forest
Talladega National Forest
Conecuh National Forest
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
A. Hainen

1.0 Executive Summary

This Alabama Statewide Mobility Report for 2014 is a new way to analyze interstate performance over an entire year. Over half a billion speed records were acquired, stored, and analyzed for this report. These observations capture recurring congestion events (queues during peak periods, weekend travel, etc.) and non-recurring congestion (crashes, special events, and other activities). Four metrics were established that provide a detailed look at each interstate's performance by month (Appendices A-D). These metrics looked at the amount of time (either by month or over the entire year) that speeds were above or below certain thresholds. Each metric is explained (section 5.0 through section 8.0) and provides different insight depending on the characteristics of each interstate (length, urban or rural, posted speed limit, etc.). Turning to broad seasonal findings:

- Inclement weather caused January 2014 to experience delay and low speeds. This month experienced over 10,000 weighted congestion hours as discussed in the conclusion.
- July 2014 also had a relatively high number of weighted congestion hours (nearly 8,000 hours), likely due to summer travel and road work.

Also, each interstate exhibited the following:

- I-10 has heavy traffic and congestion during the summer months, particularly in the downtown Mobile area. Future improvements in this area should be compared to quantify the improvement to mobility.
- I-20 east of Birmingham had good mobility performance and only experienced a few isolated hours of congestion (most notably in December near the Georgia state line).
- I-59 east of Birmingham also had good mobility, except for small congestion in May and June near milepost 130 in Birmingham.
- I-20/I-59 west of Birmingham experiences seasonal congestion near Tuscaloosa due to football. Also, milepost 130 in Birmingham is an area with much congestion.
- I-65 has many small areas of congestion across the 366-mile length. Most of the congestion does occur in the downtown Birmingham area, although congestion between milepost 114 and milepost 128 and congestion near milepost 318 was also evident.
- I-85 in Auburn between milepost 51 and milepost 58 also had congestion likely associated with special events (football, basketball, and other attractions).
- I-459 performed well, except for the month of April near the I-65 interchange at milepost 15.
- For the shorter urban commuter interstates including I-165, I-359, I-565, and I-759, the monthly travel time plots in Appendix D are useful for closer examination.

These highlights are evident in each of the four performance metrics and can be thoroughly examined as desired by the reader. These metrics will be useful in future reports when comparing year-to-year-performance. Agency feedback of each metric is encouraged as future versions can be adjusted as needed.

2.0 Introduction

With large interstate networks, departments of transportation benefit from understanding how the system is performing over time. In the past, spot speed locations and other tools have been used to assess interstate mobility performance, but new and emerging technology has changed how DOTs can understand and characterize how their networks are performing. Crowdsourced data is a new probe data set using data obtained from driver cell phone and other GPS-information that can characterize statewide interstate mobility. ALDOT maintains over 1,035 miles of interstate. Reducing congestion on interstates is important from both a mobility and safety standpoint. Historical crowdsourced data can reveal trends in recurring congestion and impacts from non-recurring congestion. Both types of congestion contribute to reduced mobility and safety through increased occurrences of primary and secondary crashes, capacity reduction through lane restrictions, and impacts to work zone operations.

Crowdsourced data is collected by commercial vendors from probe vehicles on Alabama interstates. Probe vehicles include vehicles with certain cell phone apps or GPS devices, commercially tracked vehicles, and other vehicles with the necessary technology. Probe vehicles usually represent 5-20% of all vehicular traffic. The interstate network is split up into hundreds of segments called TMC segments (Traffic Message Channels) ranging from 0.1-miles to 15-miles in length (depending on the area and interchange locations). Each TMC segment usually has several probe vehicles in it at any given time and the commercial vendors provide a 1-minute average speed from the probe vehicles for every TMC. One year of statewide data for the 1,104 TMCs in Alabama is over 500 million 1-minute average speed records. This much data can provide a very detailed depiction of the interstate mobility performance. Each of the interstates shown in Figure 2-2 is analyzed in this report using each of the metrics as later discussed.

ALDOT is already using crowdsourced data in Jefferson County and Shelby County and has explored using real-time data analysis. This project bridges the gap with an enhanced statewide analysis using techniques that can be scaled to a real-time system once the data stream is are in place. A sample picture of the real-time speed data is shown below in Figure 2-1. Congestion from a crash on I-20 eastbound is indicated by the red lines. The data behind these colored lines is what this report is based on.

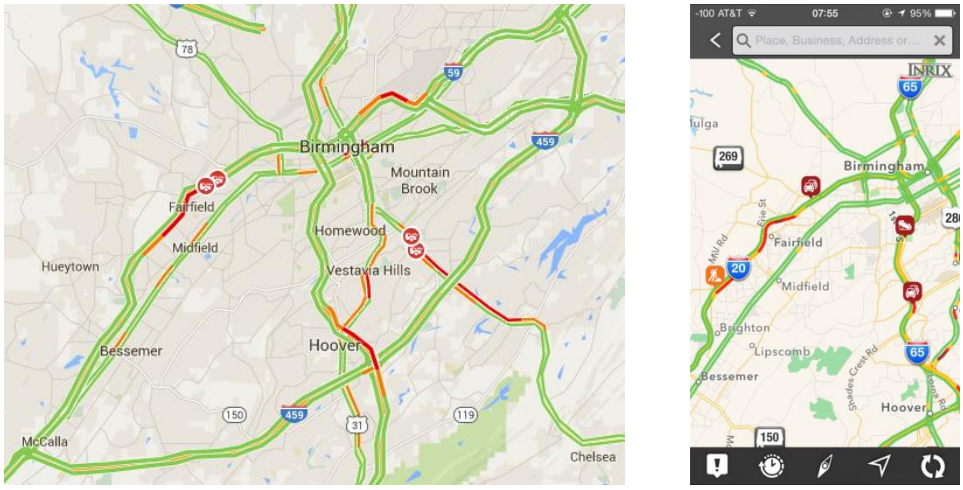
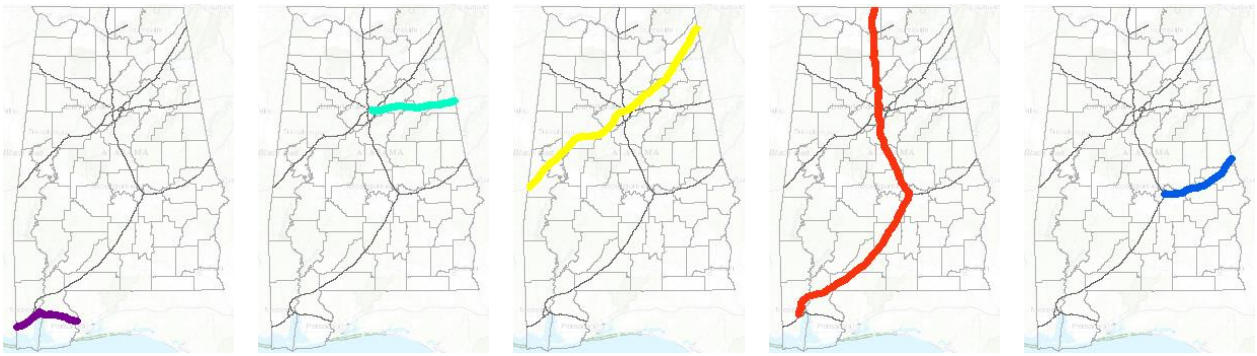


Figure 2-1. Sample views of Google Traffic featuring live speed data



a) I-10 b) I-20 c) I-59 d) I-65 e) I-85

f) I-165 g) I-359 h) I-459 i) I-565 j) I-759

Figure 2-2 Maps showing each interstate segment

2.1 Organization of the Report

The report starts with an introduction of the data and an example of a few congestion events on I-65. The next section discusses storing the data so that the entire set of data can be considered on an annual basis.

Next, four performance charts are introduced. The first chart is known as a speed profile graph which shows the worst 100-hours of speeds by month for each direction on each interstate. The next performance chart is an area chart based on the number of congestion hours for an interstate. This shows by location and by month the number of congested hours where speeds were less than 45 MPH on the interstate. The third chart looks at the speed differential from the 70^{th} percentile speed during the early AM hours, which serves as an approximation of the free-flow speed. The final performance metric looks at the average daily travel time for each month so observe seasonal spikes in travel time by time-of-day.

Finally, the report concludes with ranking each of the interstates based on two metrics. The metrics provide a way for the entire system to be assessed by month and to examine which interstates experienced the most congestion.

3.0 Congestion Event Example

To understand how congestion events occur, the following example shows a few crashes on I-65 NB in Jefferson county near the I-20/59 interchange on August 1, 2014. Three crashes were identified in the Center for Advanced Public Safety (CAPS) crash database as shown in Table 3-1. The table has information for when the crash occurred, the milepost (mp), and the police notification and arrival delay.

Table 3-1. Three crash records for I-65

Crash Data Identifier	Timestamp	Route	Milepost	Police Notification Delay	Police Arrival Delay	Cause
1	8/1/2014 13:45	I-65	261.4	11 to 15 minutes	11 to 15 minutes	Rear End
2	8/1/2014 15:55	I-65	261.0	0 to 5 minutes	11 to 15 minutes	Side Swipe
3	8/1/2014 17:15	I-65	251.8	0 to 5 minutes	6 to 10 minutes	Rear End

The locations of the three crashes are mapped below in Figure 3-1.

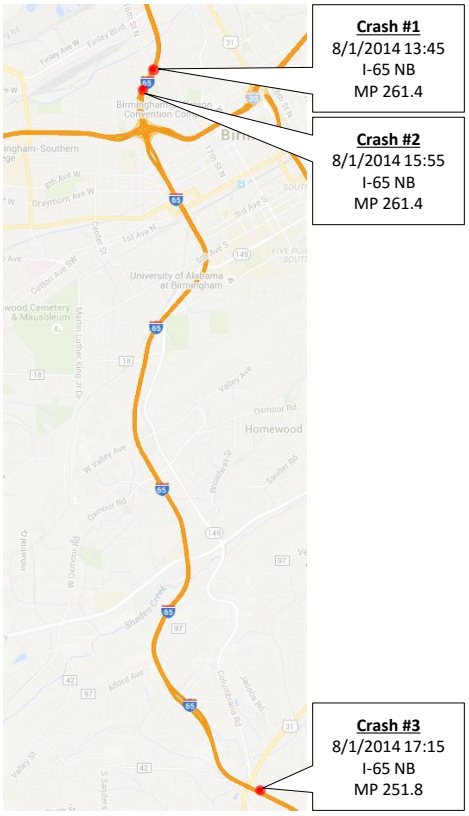


Figure 3-1. Locations of the three I-65 NB crashes on August 1, 2014

The 1-minute speed data can be used to examine the impact to traffic from each of the three crashes. Figure 3-2 shows the time and location of the crash (the white diamond marker) along with the police response time (the black line) to when police arrive on site (the gray diamond). Looking at crash #1, a congestion event between mp 262 and mp 264 may have been the triggering event where the vehicle rear ended slow moving traffic (as suggested in the crash report from Table 3-1). While the police response time is approximate to the nearest 10-minutes, it appears that traffic remained stable at speeds greater than 50MPH until the police arrived and likely directed traffic to move over from the outside lane.

Later on in the afternoon, crash #2 occurred around 3:55PM as a primary side-swipe crash. Based on the data, it looks as though the vehicle was not able to move immediately to the shoulder and traffic congestion quickly began building before police arrived. The queue built over about an hour to a length of about 10-miles. Just before the end of the queue cleared, crash #3 occurred as a secondary crash where the vehicle likely rear-ended a vehicle in the nearly standing queue. Based on the data for this crash, it looks as though the vehicles were able to be moved to the side of the road and no additional queue formed upstream of the crash location at mp 251.8. However, the final callout on Figure 3-2 does identify residual congestion during the PM peak period near the interchange ramps.

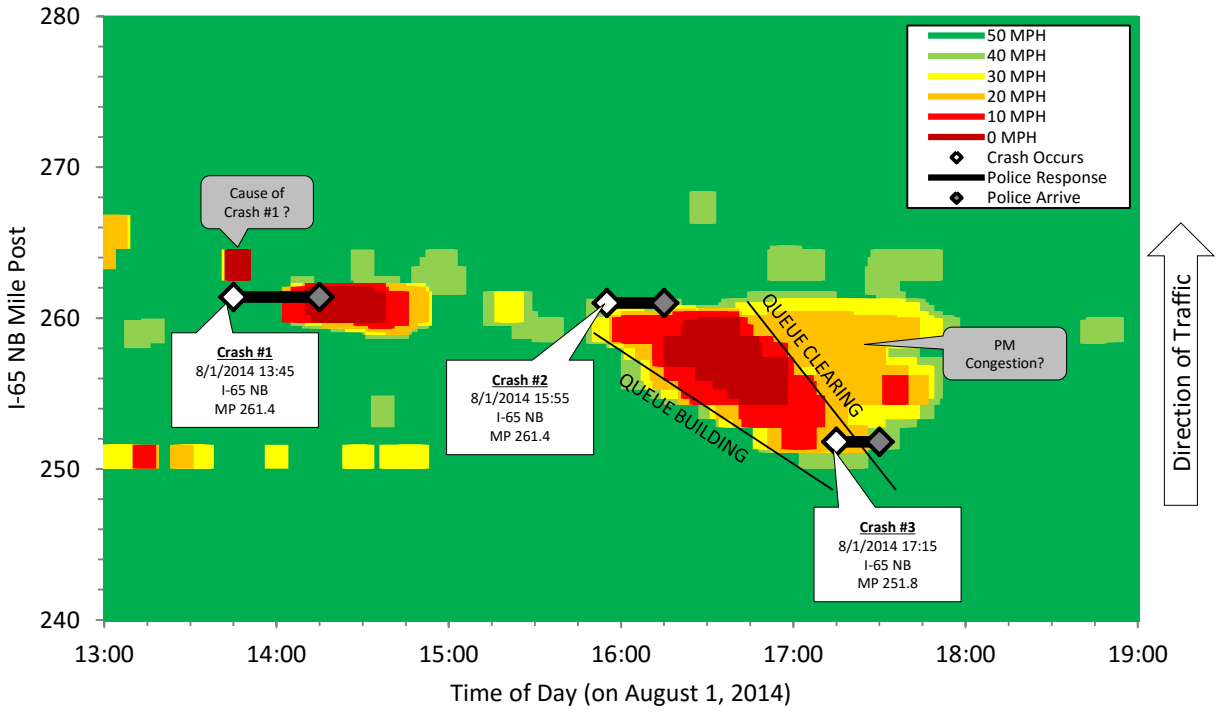


Figure 3-2. Speed data analysis of the three I-65 NB crashes on August 1, 2014

This detailed example is only on one segment during a specific time period. To better understand how the entire system is doing over the entire year, more aggregated metrics are used to characterize the net effect of all congestion events as discussed in the following sections. A final note, this figure is based on 26 TMCs over 360 minutes for a total of 9,360 speed records.

4.0 Computational Data Processing and Archiving

Since an entire year of speed data for a state network is so large, a large portion of the time for this first project was spent acquiring the data from the vendor and storing the data in a server for efficient computational use. To show the data format, an example for I-759 is demonstrated below. There was a total of 14 TMCs representing I-759 as shown in Table 4-1. This table contains all the information provided by the vendor that can be used to characterize each TMC.

Table 4-1. I-75 TMC Characterization dataset

TMC	Road	Direction	Intersection	State	County	Zip	Start Latitude	Start Longitude	End Latitude	End Longitude	Miles
101-04743	I-759	EASTBOUND	BLACK CREEK PKWY/EXIT 2	AL	ETOWAH	35904	34.00516	-86.0758	33.99206	-86.0423	2.162708
101N04743	I-759	EASTBOUND	BLACK CREEK PKWY/EXIT 2	AL	ETOWAH	35904	33.99206	-86.0423	33.99174	-86.0341	0.473737
101-04742	I-759	EASTBOUND	US-411/S 4TH ST/EXIT 4	AL	ETOWAH	35901	33.99174	-86.0341	33.99352	-86.0009	1.925178
101N04742	I-759	EASTBOUND	US-411/S 4TH ST/EXIT 4	AL	ETOWAH	35901	33.99352	-86.0009	33.99358	-86.0006	0.013944
101P04745	I-759	EASTBOUND	US-411/S 4TH ST/EXIT 4	AL	ETOWAH	35901	33.99155	-86.0106	33.99358	-86.0006	0.59056
101+04746	I-759	EASTBOUND	I-759 END OF FREEWAY	AL	ETOWAH	35901	33.99358	-86.0006	33.99921	-85.994	0.610146
101P04746	I-759	EASTBOUND	I-759 END OF FREEWAY	AL	ETOWAH	35901	33.99921	-85.994	34.00011	-85.9935	0.069354
101N04746	I-759	WESTBOUND	I-759 END OF FREEWAY	AL	ETOWAH	35901	34.00017	-85.9936	33.99888	-85.9941	0.095665
101-04745	I-759	WESTBOUND	US-411/S 4TH ST/EXIT 4	AL	ETOWAH	35901	33.99888	-85.9941	33.99368	-86.0012	0.599197
101N04745	I-759	WESTBOUND	US-411/S 4TH ST/EXIT 4	AL	ETOWAH	35901	33.99368	-86.0012	33.99185	-86.0091	0.471276
101P04742	I-759	WESTBOUND	US-411/S 4TH ST/EXIT 4	AL	ETOWAH	35901	33.99368	-86.0012	33.99341	-86.0022	0.064215
101+04743	I-759	WESTBOUND	BLACK CREEK PKWY/EXIT 2	AL	ETOWAH	35904	33.99341	-86.0022	33.99195	-86.0328	1.771761
101P04743	I-759	WESTBOUND	BLACK CREEK PKWY/EXIT 2	AL	ETOWAH	35904	33.99195	-86.0328	33.99213	-86.0414	0.490533
101+04744	I-759	WESTBOUND	I-59	AL	ETOWAH	35904	33.99213	-86.0414	34.00629	-86.0746	2.175366

The TMC set is shown graphically in Figure 4-1, specifically identifying TMC 101-04743.

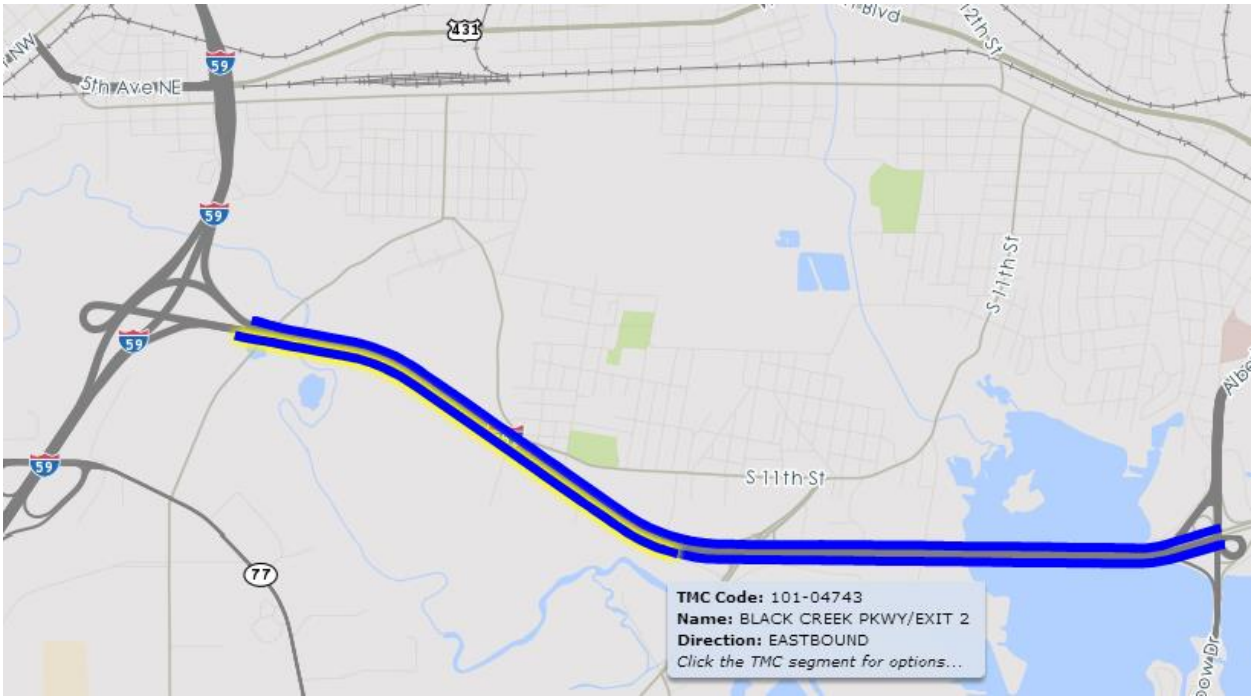


Figure 4-1. Map of the I-759 TMC segments

Finally a set of the example speed information is shown for one TMC 101-04743 over 15 minutes in Table 4-2. The first three columns (TMC, Timestamp, and Speed) are the most important for the analysis in this report. The average speed and reference speed are historical measurements based on the data. The travel time is a computed value based on the segment length. Finally, the confidence score and C-Value indicate the level of data quality for each 1-minute record. This is based on the number of vehicles in the TMC during the minute of observation. In this particular table example, the data is very good with a confidence score of 30 (high confidence) suggesting that these records are based on actual vehicles and not historical data.

Table 4-2. Sample data showing 15-minutes of speed information for TMC 101-04743

TMC	Timestamp	Speed	Average Speed	Reference Speed	Travel Time (minutes)	Confidence Score 30=High 20=Medium 10=Low	C-Value
101-04743	8/1/14 18:00:00	67	65	65	1.94	30	100
101-04743	8/1/14 18:01:00	67	65	65	1.94	30	100
101-04743	8/1/14 18:02:00	67	65	65	1.94	30	100
101-04743	8/1/14 18:03:00	67	65	65	1.94	30	100
101-04743	8/1/14 18:04:00	65	65	65	2.00	30	100
101-04743	8/1/14 18:05:00	65	65	65	2.00	30	100
101-04743	8/1/14 18:06:00	64	65	65	2.03	30	100
101-04743	8/1/14 18:07:00	64	65	65	2.03	30	100
101-04743	8/1/14 18:08:00	63	65	65	2.06	30	100
101-04743	8/1/14 18:09:00	63	65	65	2.06	30	100
101-04743	8/1/14 18:10:00	65	65	65	2.00	30	100
101-04743	8/1/14 18:11:00	68	65	65	1.91	30	100
101-04743	8/1/14 18:12:00	68	65	65	1.91	30	100
101-04743	8/1/14 18:13:00	68	65	65	1.91	30	100
101-04743	8/1/14 18:14:00	68	65	65	1.91	30	100

4.1 Data for the entire state

For the Alabama interstates, there were 1,104 TMC segments that made up the whole system. The data for the entire report was shipped in two CSV files including the speed data (as explained in Table 4-2) and the TMC characterization (as explained in Table 4-1). The total data set contained $(1{,}104\ Segments) * (365\ days) * (1{,}440\ minutes\ /\ day) \approx$ **580 million records**, which in plain-text CSV format was about 32.8GB. Microsoft SQL-Server 12.0 was used to store the data. Some advanced techniques using partitioning and indexing were used to assist with query times and the final set of .ndf files (one for each month) took up about 70GB due to storage inefficiencies (about 5.8GB per month of data).

While this section of the report isn't specifically traffic related, it does provide important insight into much of the work involved using this data. With these good practices in place, the following sections discuss four different aggregated metrics used to characterize statewide mobility.

5.0 Speed Profile Graphs

The speed profile graphics depict the speed measurements for each TMC along the entire length of a roadway. Figure 1 shows a speed profile for southbound I-65 from the Tennessee state border to Mobile, AL. The different colors present on the chart represent different speed ranges that each measurement may fall into as shown in the key (callout “i”). The vertical axis represents the length of the roadway, with the left side showing mileposts (callout “ii”) and the right side detailing important locations or exits (callout “iii”). Each vertical strip of graph represents the slowest 100 hours of each month (callout “iv”), allowing the true problem areas to be immediately visible.

This graphic can be useful in understanding fluctuations in congestion throughout the year, as well as picking out reoccurring trouble-spots along a route. For I-65 southbound in this example, most of the congestion occurs in the Birmingham metro region (a picture of this location is shown below in Figure 5-1). However, some additional congestion is noted between Cullman and Priceville (milepost 308 to milepost 334).

Figure 5-1. SB I-65 at milepost 261

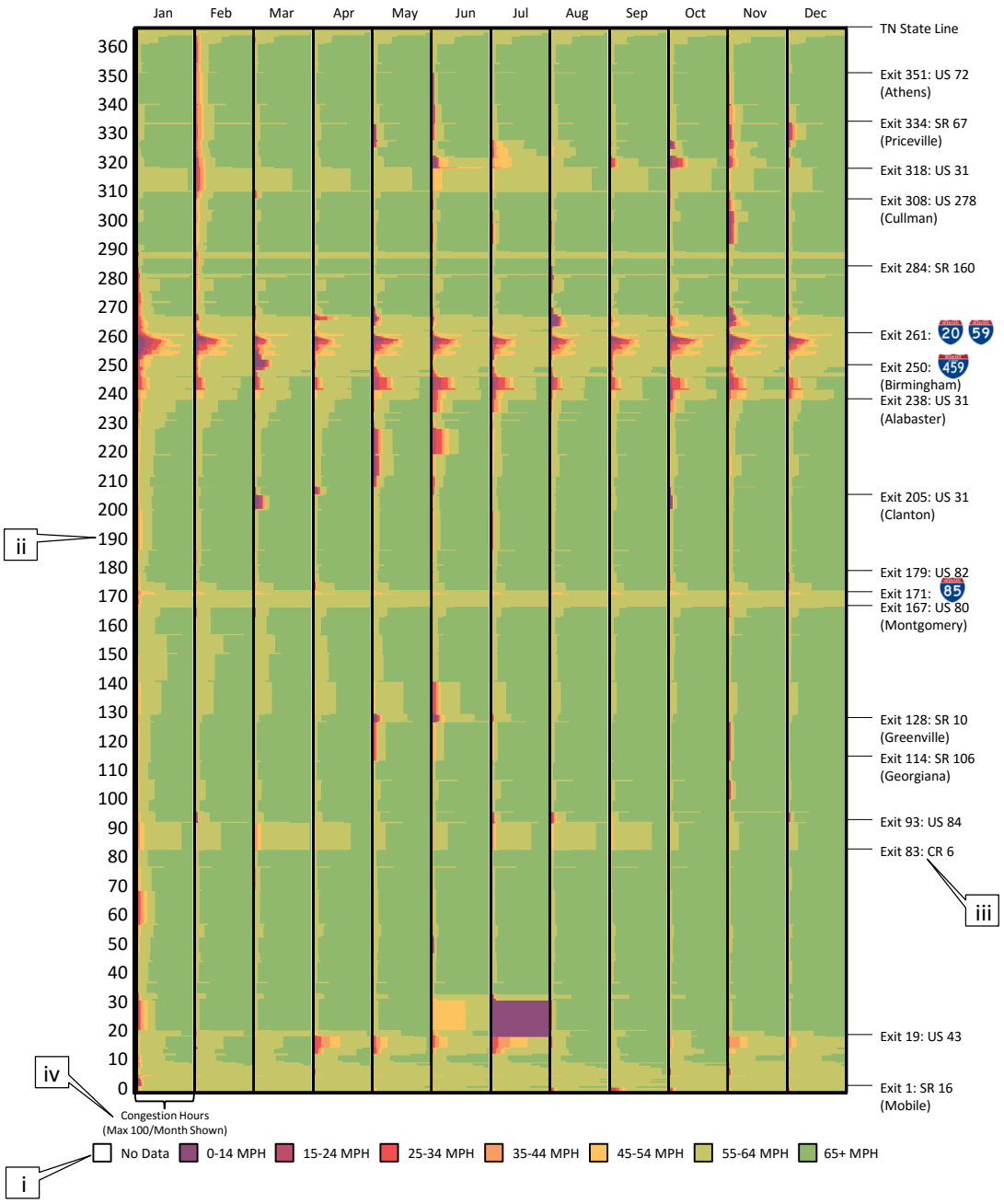


Figure 5-2. Example speed profile graph of I-65 Southbound

Items of Interest

i. Legend showing speeds by color
ii. Milepost along interstate segment
iii. Exit descriptions and other points of interest
iv. Each month shows the worst 100 hours of speeds

6.0 Congestion Hours

The congestion hours metric uses a critical threshold speed (in this case, 45 mph) and reports the number of hours for which the measured speed fell below that threshold speed. Each colored band on the graphic represents a different month, as shown in the key (callout “i”). Figure 2 shows the congestion hours plot for I-459 southbound. The milepost axis represents the length of the roadway, with one side showing mileposts (callout “ii”) and the other side detailing important intersections or exits (callout “iii”). The other axis denotes the number of cumulative hours spent under 45 mph for the year (callout “iv”).

The graph of congestion hours is particularly useful in targeting extreme “hot spots” of congestions and depicting their severity compared to other sections of the roadway. For instance, it is clear that congestion around the I-65 interchange is the most significant trouble spot on this stretch of interstate (a picture of the segment to the immediate west of this interchange is shown below in Figure 6-1). The figure can also make clear the impact of seasonal weather or construction projects on interstate congestion, denoted by the sometimes comparatively thicker bands of color for certain months. For instance, in Figure 2 the month of January experienced a relatively high number congestion hours across the entire length of the interstate segment (callout “v”). Additionally, the thick teal band seen between mileposts 13 and 20 (callout “vi”) is the result of a double lane closure through the I-65 interchange that occurred in April in order to repair concrete pavements.

Figure 6-1. I-459 Southbound at Milepost 13

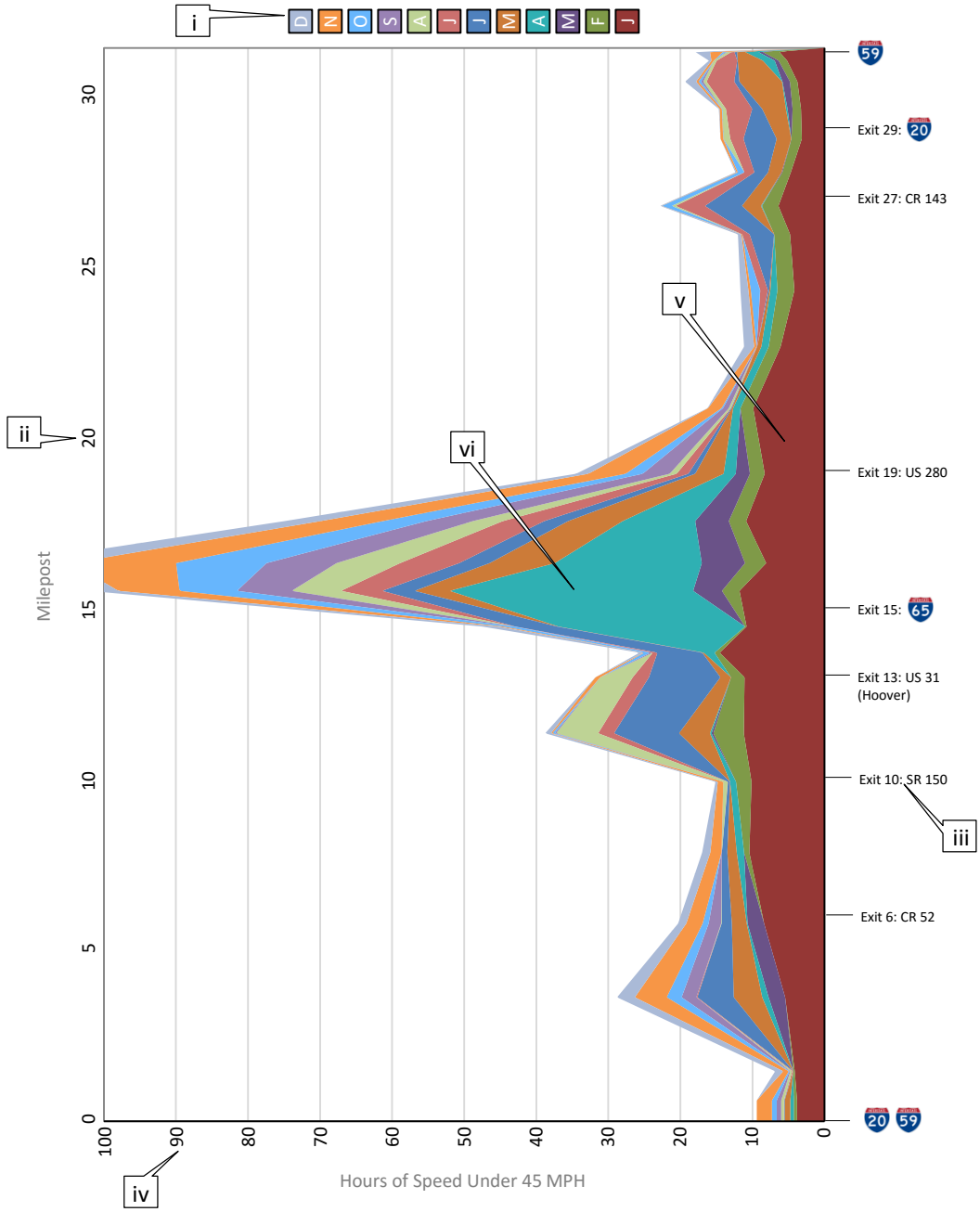


Figure 6-2. Sample congestion hour graph for I-459 Southbound

Items of Interest

i. Legend showing month by color
ii. Milepost along interstate segment
iii. Exit descriptions and other points of interest
iv. The number of hours under 45 MPH
v. Inclement weather in January contributed high congestion hours across the whole interstate
vi. August had a high amount of non-recurring congestion around Exit 15

7.0 70th Percentile Speed Differential Graphs

The 70th percentile speed differential graphics is one way of assessing the amount of time a segment was moving faster than the measured free-flow speed. An early version of this graphic looked at the number of hours above or below the posted speed limit, but the figure had a lot of noise and didn't work well. Instead of the speed limit, the 70th percentile of speeds between 2am and 6am was used as the measured free-flow speed. So instead of the posted speed limit, this graphic uses the 70th percentile speed for each section of roadway as its point of reference. It shows where the sample of measurements for each segment of the roadway falls in relation to that 70th percentile speed for the entire year. Figure 3 depicts the 70th Percentile Speed graph for I-20 / I-59 in the eastbound direction. The gradations in color depict how many miles per hour above or below the 70th percentile speed each measurement was, as shown in the key (callout "i"). As in the two previous graphs, the Milepost axis denotes distance along the interstate (callout "ii") and the opposite side contains information about important intersections and exits (callout "iii"). The other axis consists of two zones: Hours Above 70th Percentile Speed and Hours Below 70th Percentile Speed (callouts "iv" and "v"). Congestion can clearly be identified in the form of a work zone near Tuscaloosa (callout "vi") and also near the interchanges for I-65, US-280, and the I-20 / I-59 split (milepost 124-130). The picture below (Figure 7-1) shows the work zone just east of Tuscaloosa and Cottondale and shows an instance where police speed enforcement is affecting speeds as intended.

Figure 7-1. Eastbound I-59/I-20 in a work zone, noting state police speed enforcement

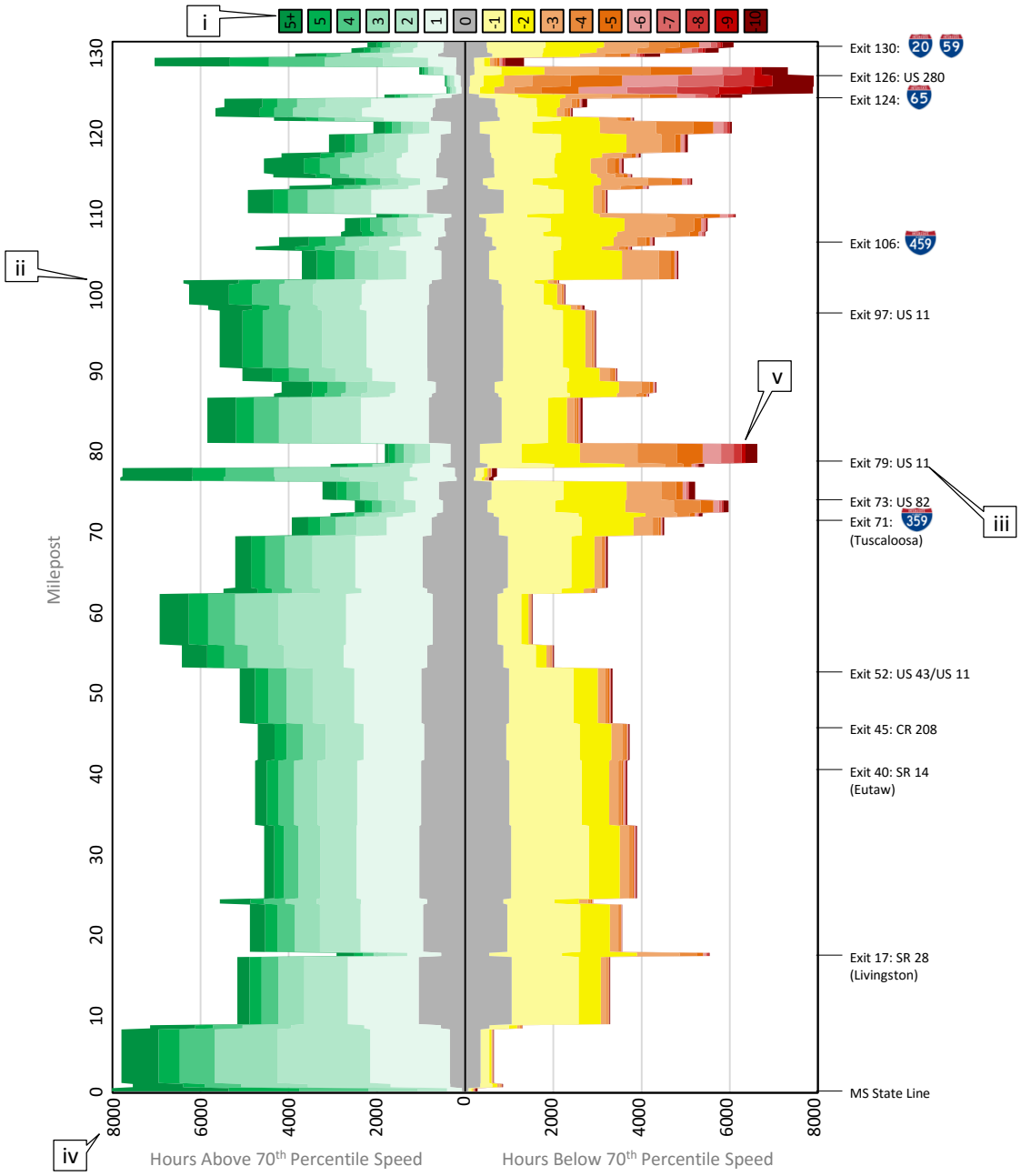


Figure 7-2. Sample 70th Percentile Speed Differential Graph for I-59/I-20 Eastbound

Items of Interest

i. Legend showing speed differential by color
ii. Milepost along interstate segment
iii. Exit descriptions and other points of interest
iv. The number of hours above or below the 70th percentile speed
v. Area of high congestion in a work zone near milepost 79 in Cottondale

8.0 Monthly Travel Time Plots

Travel time plots are a common graphic used to depict both daily and seasonal fluctuations in congestion. The amount of congestion is quantified by displaying the time it takes to travel the route in question at different times throughout the day or year. This report displays travel time graphs as shown in Figure 4, which shows one plot per month for the year of 2014 on westbound I-565. The vertical axis displays the travel time (callout "i") and the horizontal axis displays the time of day (callout "ii"). The line for each month is a distinct color, shown overlaid on fainter outlines of the other months' lines. This allows for comparison between the month in question and the rest of the year. For instance, you can see that each month displays a jump in the travel time between 16:00 and 19:00 (or, peak evening hour). However, the charts clearly show that the month of November experienced significantly greater congestion around this time (callout "iii"). A picture of light traffic on I-565 taken in August 2015 is shown below (Figure 8-1) during the AM peak, which consistent with Figure 8-2h which does not indicate any major increase in travel time during this month.

Figure 8-1. I-565 during the AM peak period in August (Photo Credit: Ozelim)

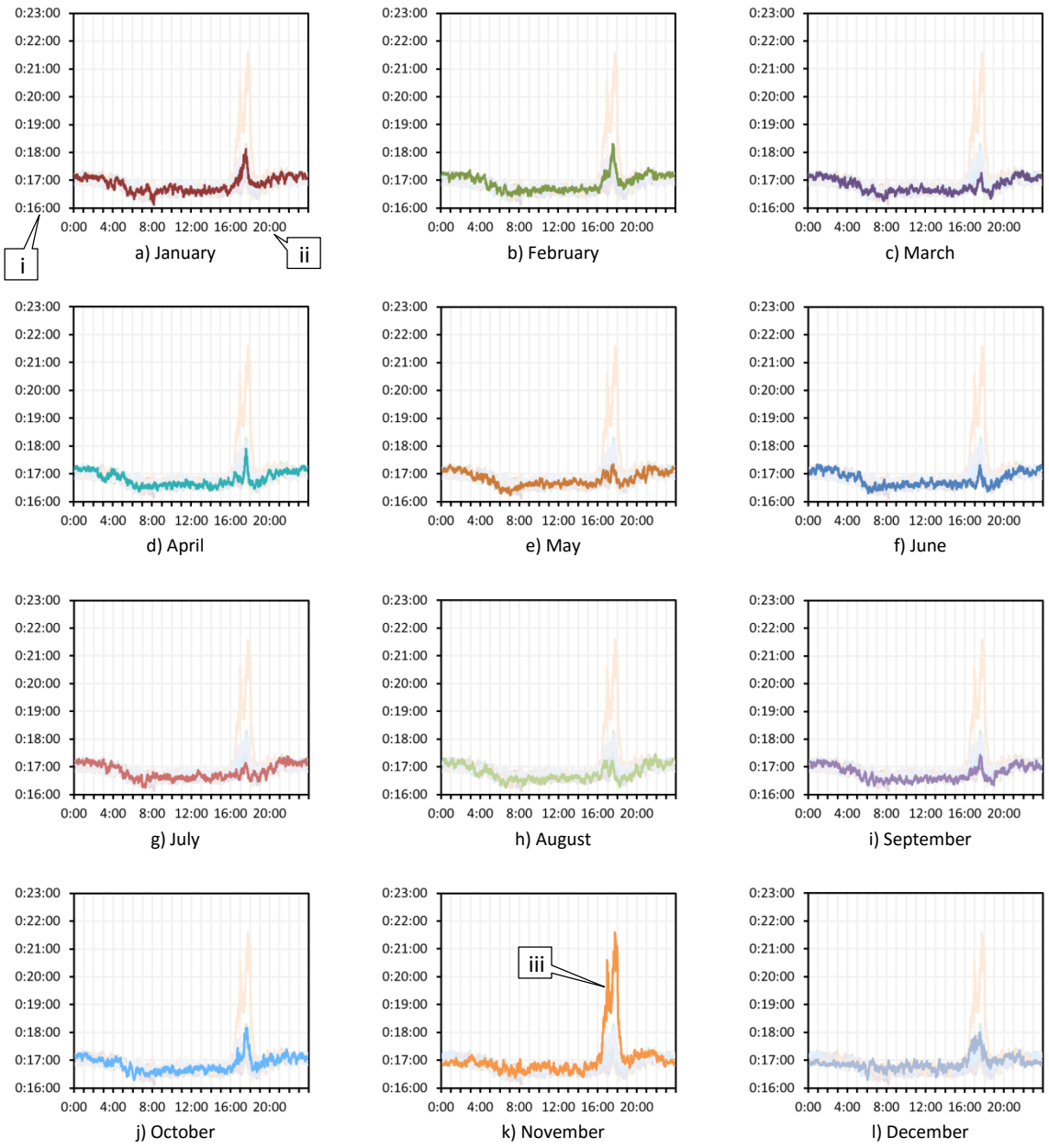


Figure 8-2. Sample Monthly Travel Time Plots for I-565 Westbound

9.0 Conclusions

Each of the appendices contains a detailed analysis of each of the interstates in Alabama, but ranking and prioritizing by congestion is important for decision makers. In Figure 9-1, weighted congestion hours are used to characterize each month of travel for each of the interstates. Weighted congestion hours multiplies the number of congestion hours per TMC by the TMC length in miles. The month of January was a month that had a higher number of congestion hours across all interstates due to inclement weather. July was a busy month with summer travel (in particular, I-10 stands out with a higher than average number of weighted congestion hours). Also, I-65 had the majority of the weighted congestion hours due to having the longest overall length of about 366 miles.

To normalize for different length interstates, a congestion index was established to compare interstates independent of length. The congestion index is the number of weighted congestion hours divided by the total length of the interstate. Looking at Figure 9-2, January again stands out due to inclement weather. The figure also highlights I-359 with having a relatively large congestion index. However, I-359 had a work zone for resurfacing for several months in the summer and fall. Also, local traffic near at the north end may have been influenced by standing queues from the first signal before downtown Tuscaloosa. I-759 also exhibits a larger congestion index in the late fall, perhaps due to similar construction efforts.

Taking the information from both Figure 9-1 and Figure 9-2 for the entire year, a ranking for each metric was established as shown in Table 9-1. Depending on the metric, different segments achieved different scores. In general, the congestion index tends to emphasize shorter, urban segments due to recurring queueing and normalizing over a relatively short length segment.

9.1 Future Work

While the information in this report is a completely new way to assess interstate performance, it is highly encouraged to explore these metrics for 2015 and future years to understand improvements from different projects and note the improvement in congestion hours and congestion index. For example, the I-10 weighted congestion hours (Figure 9-1) in July should be expected to be significantly improved with the new bridge through downtown mobile. As such, using these metrics in the future can help to estimate the improvement from large projects and report success.

Also, early exploratory work has begun on examining ways to link crash data with this mobility (see section 3.0 for the congestion event example). By looking at a collection of crash records over time, the impact on congestion could be measured and practices to reduce congestion from non-reoccurring events could be identified.

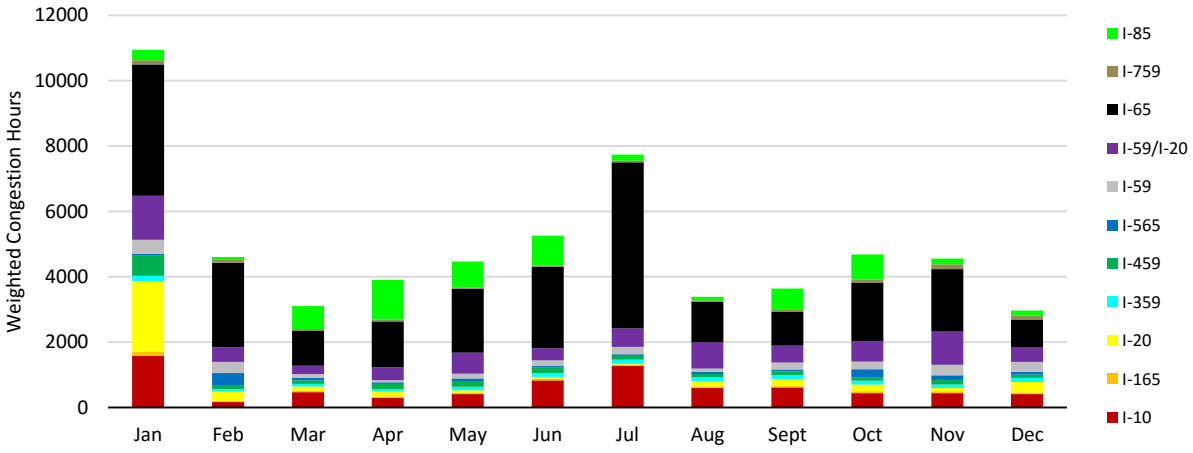


Figure 9-1. Weighted Congestion Hours by month

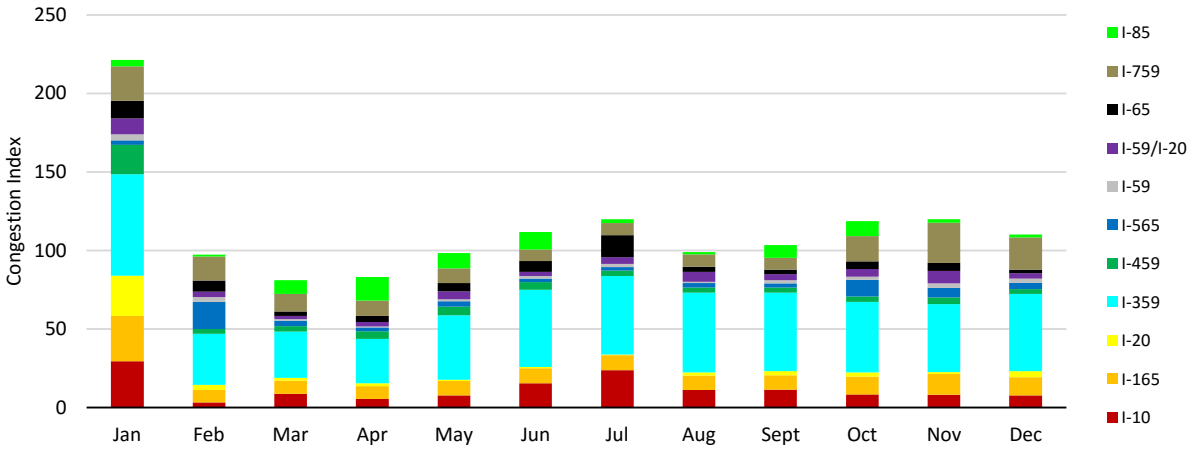


Figure 9-2. Congestion Index by month (Weighted Congestion Hours normalized by total interstate length)

Table 9-1. Ranking of interstate congestion by Weighted Congestion Hours and Congestion Index

Interstate	2014 Weighted Congestion Hours	Rank	2014 Congestion Index	Rank
I-10	7525	2	141	3
I-165	627	11	136	4
I-20	3903	5	46	10
I-359	1334	9	534	1
I-459	1993	7	61	7
I-565	1357	8	60	8
I-59	2675	6	24	11
I-59/I-20	7401	3	57	9
I-65	25437	1	69	6
I-759	928	10	160	2
I-85	6066	4	76	5

10.0 Acknowledgements

This work is largely shaped and influenced by previous Statewide Mobility Reports for the Indiana Department of Transportation, assembled by the Joint Transportation Research Program and Purdue University. Thomas M. Brennan Jr., Ph.D., P.E. and Stephen M. Remias, Ph.D. both provided valuable feedback. The 70th percentile speed graphs were based on recent research by Brennan and proved insightful to this report. The reports are formally cited below in the Works Cited section.

11.0 Works Cited

[1] C. Day, S. Remias, H. Li, M. Mekker, M. McNamara, E. Cox, D. Horton and D. Bullock, "2013–2014 Indiana Mobility Report," Joint Transportation Research Program Indiana Mobility Reports, West Lafayette, 2014.

[2] S. M. Remias, T. M. Brennan Jr., C. M. Day, H. Summers, E. Cox, D. Horton and D. M. Bullock, "2012 Indiana Mobility Report," Joint Transportation Research Program, West Lafayette, 2012.

[3] S. Remias, T. Brennan, G. Grimmer, E. Cox, D. Horton and D. Bullock, "2011 Indiana Interstate Mobility Report," Joint Transportation Research Program, West Lafayette, 2011.

12.0 Appendix A – Speed Profile Graphs

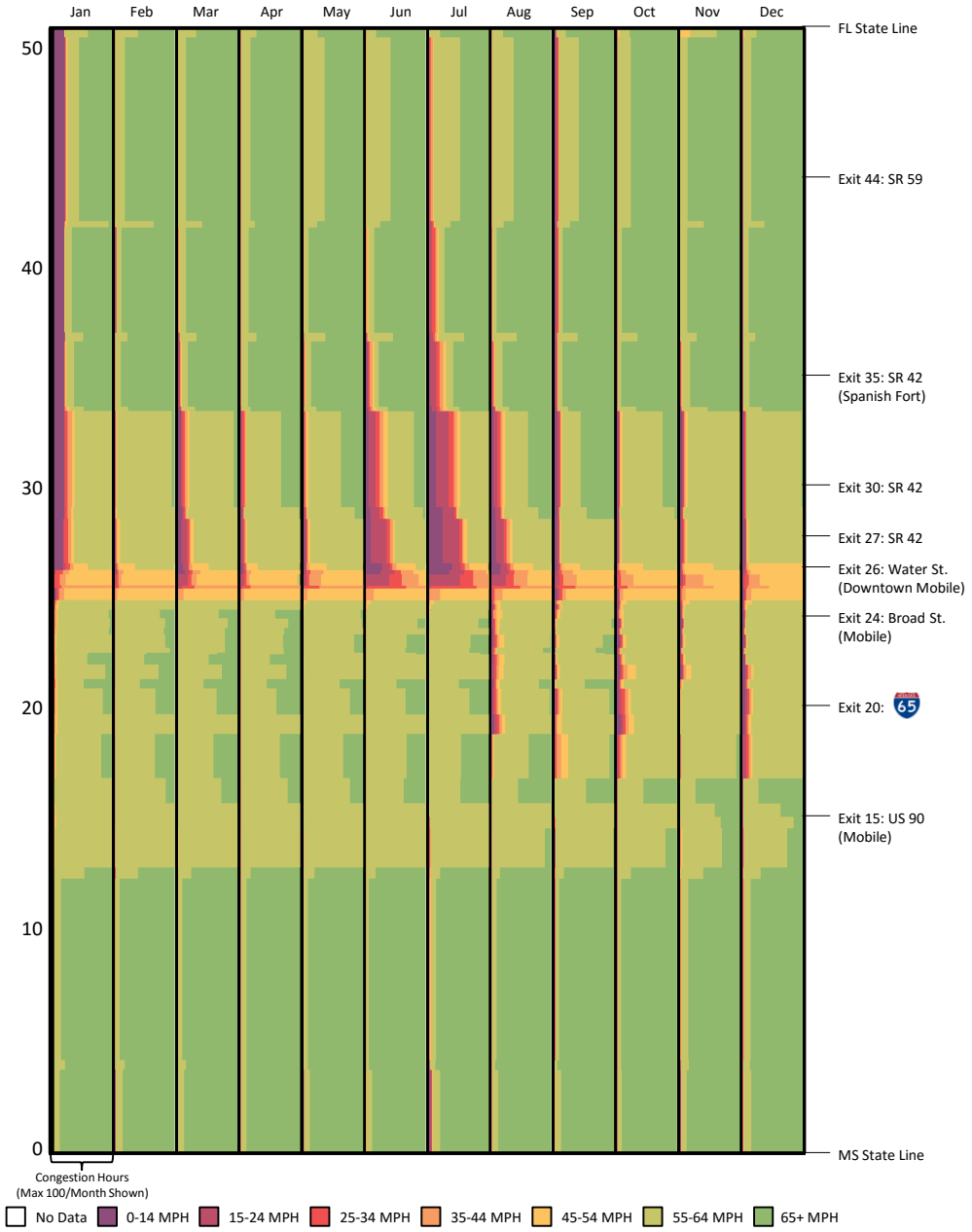


Figure 12-1. Speed Profile Graph for I-10 Westbound

Notes

- Seasonal congestion around Exit 26 during summer travel months

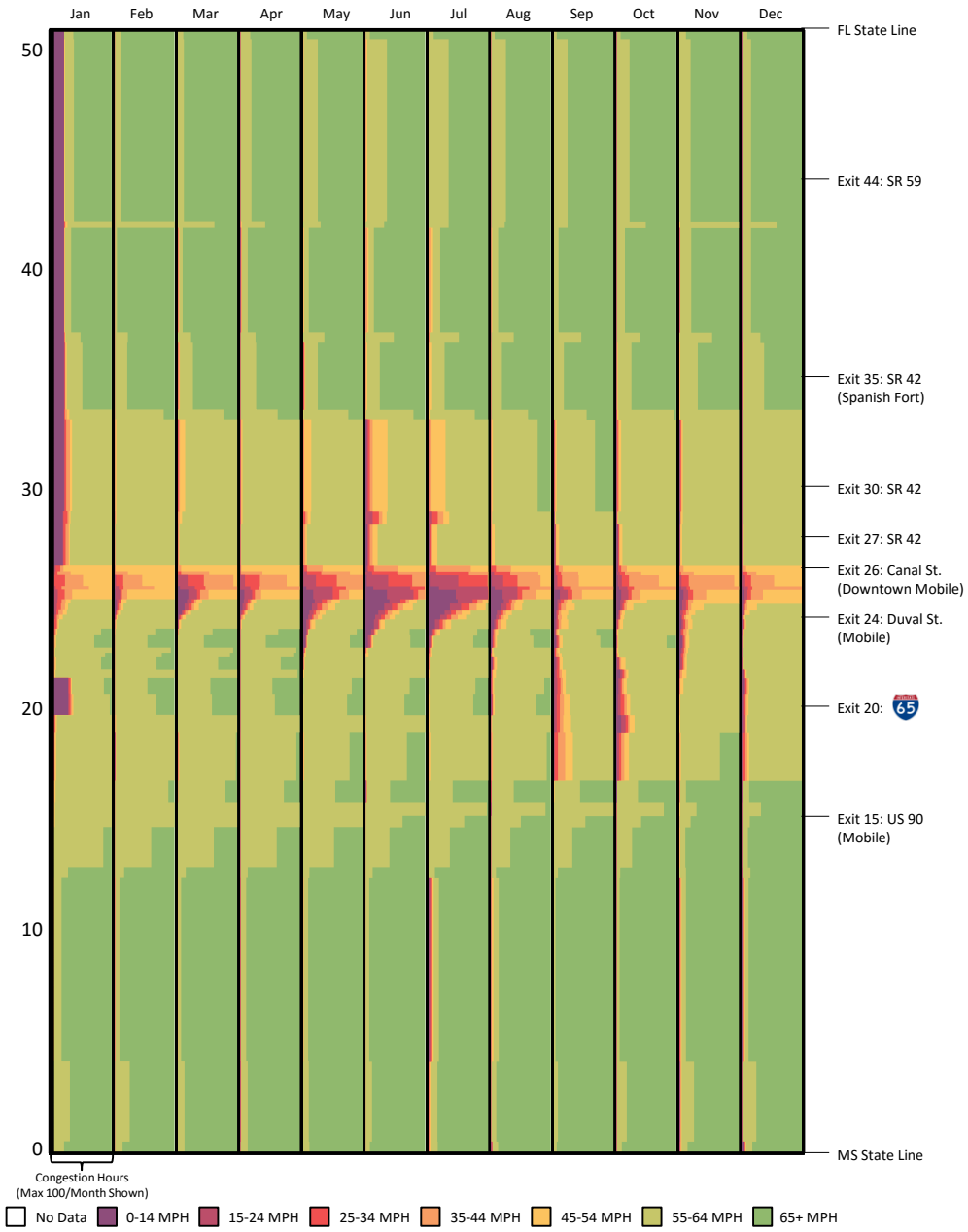


Figure 12-2. Speed Profile Graph for I-10 Eastbound

Notes

- Seasonal congestion around Exit 26 during summer travel months
- Slightly more reoccurring congestion in this direction throughout the year

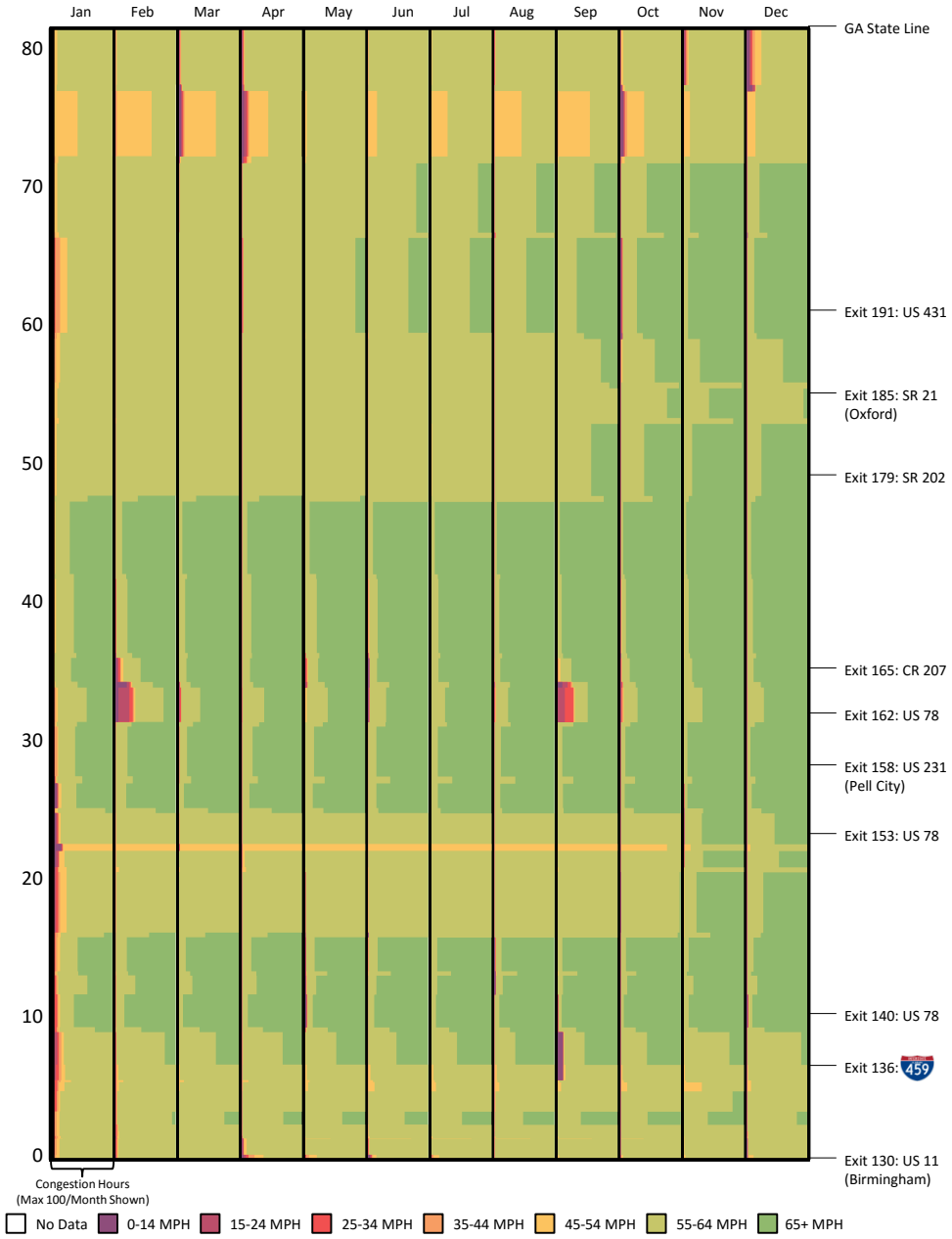


Figure 12-3. Speed Profile Graph for I-20 Westbound

Notes

- Minor congestion events around milepost 162

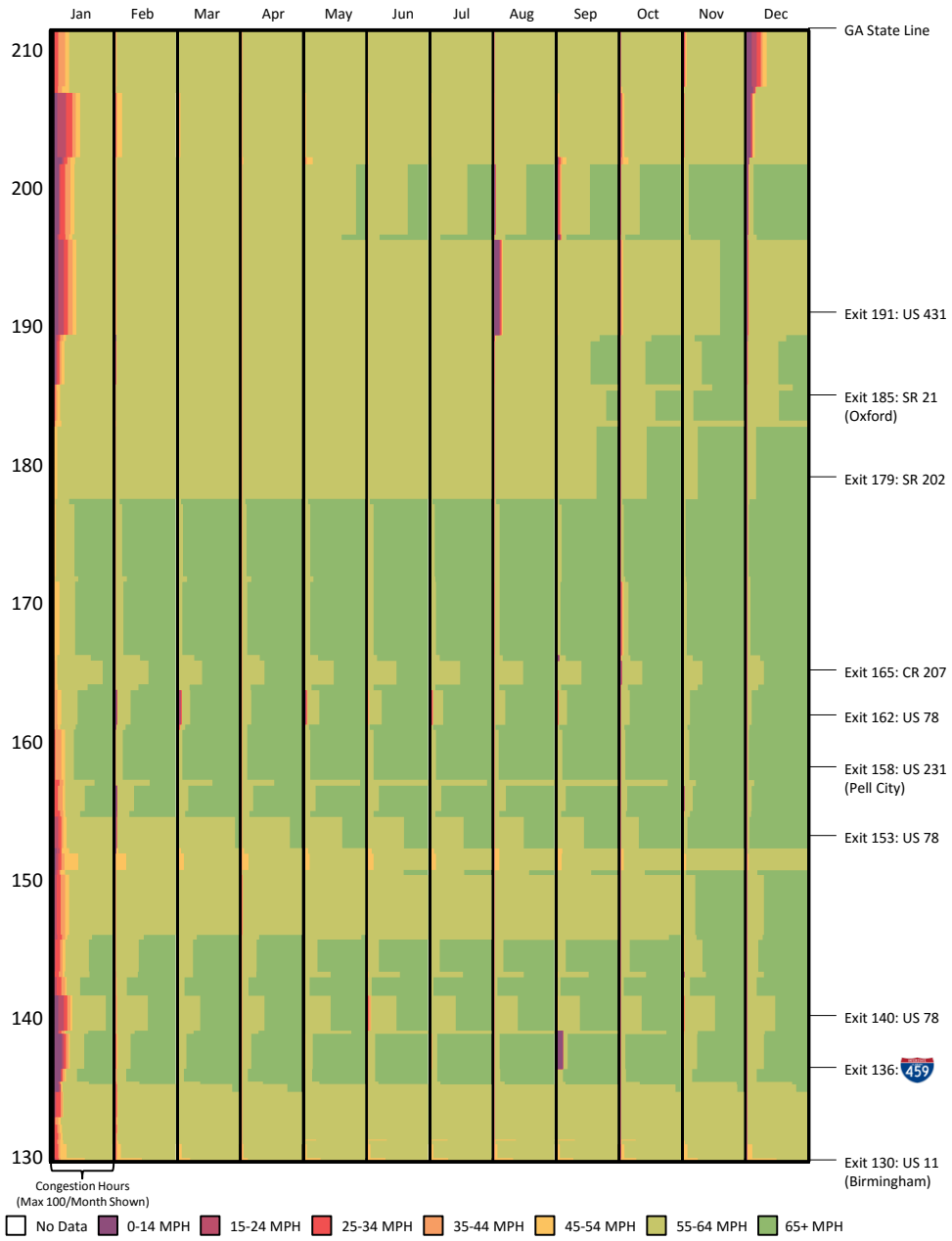


Figure 12-4. Speed Profile Graph for I-20 Eastbound

Notes

- Congestion due to weather in January
- Unknown congestion in December

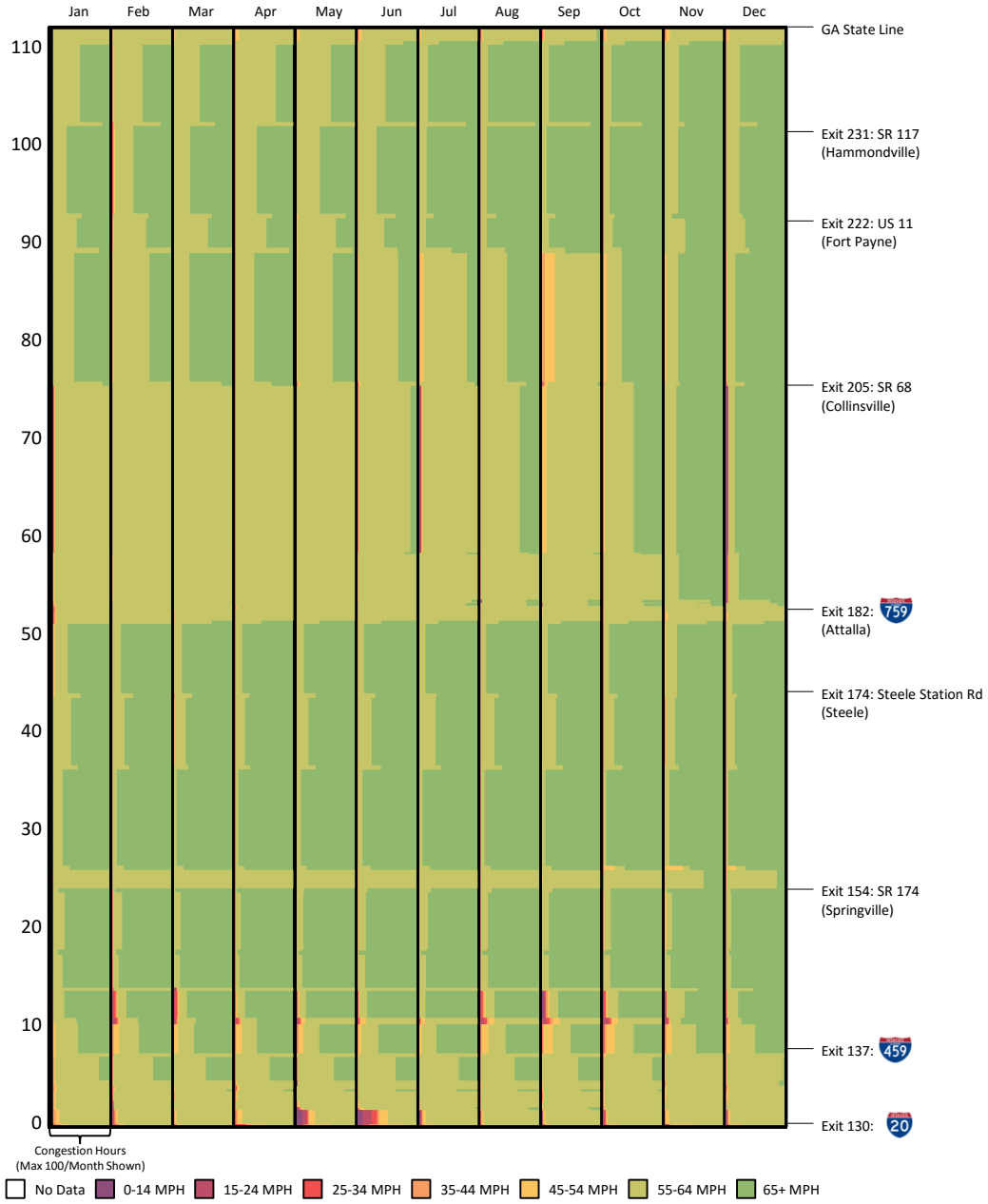


Figure 12-5. Speed Profile Graph for I-59 Southbound

Notes

- Congestion around milepost 130 in May/June

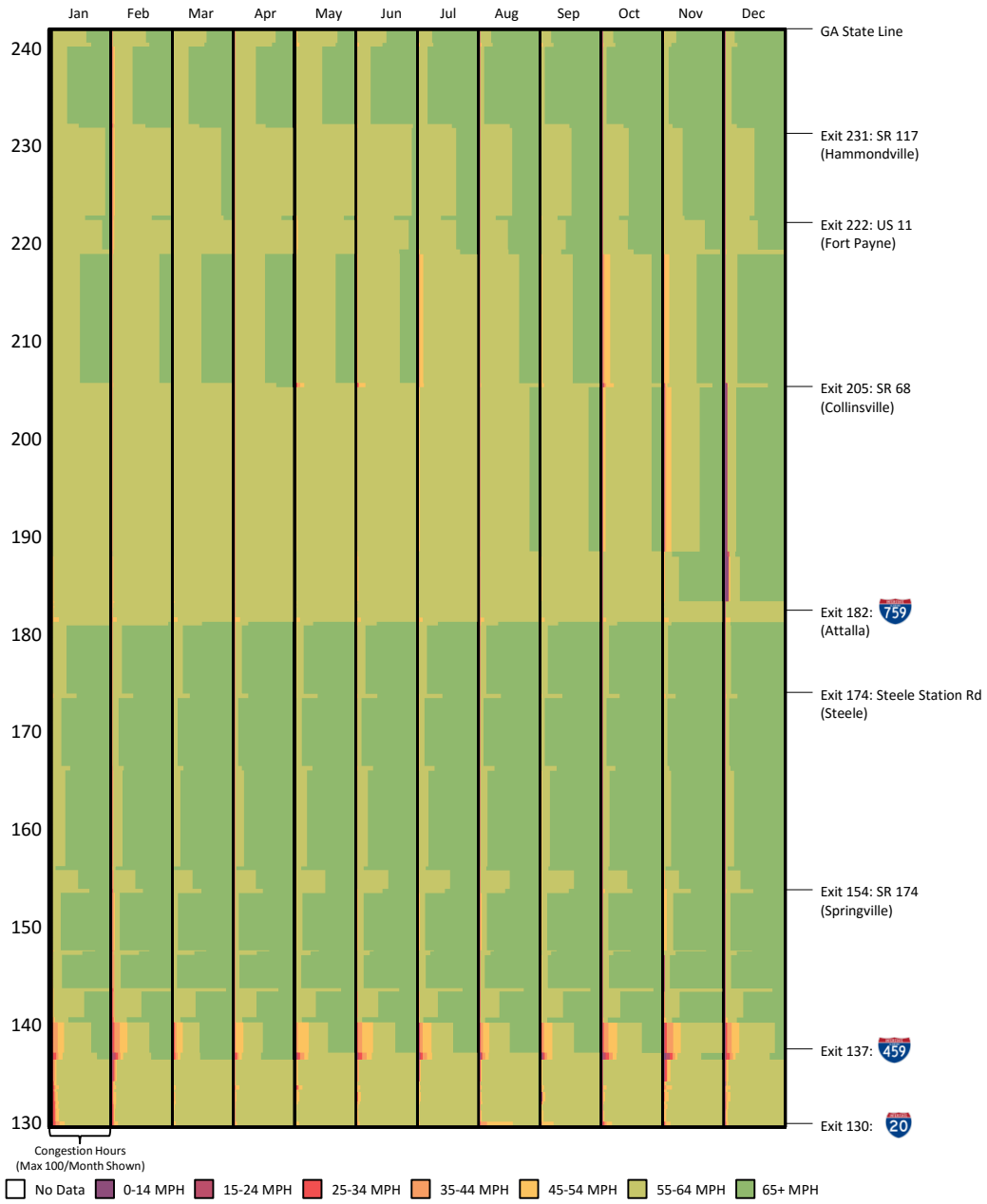


Figure 12-6. Speed Profile Graph for I-59 Northbound

Notes

- Minor congestion around milepost 137 exit for I-459

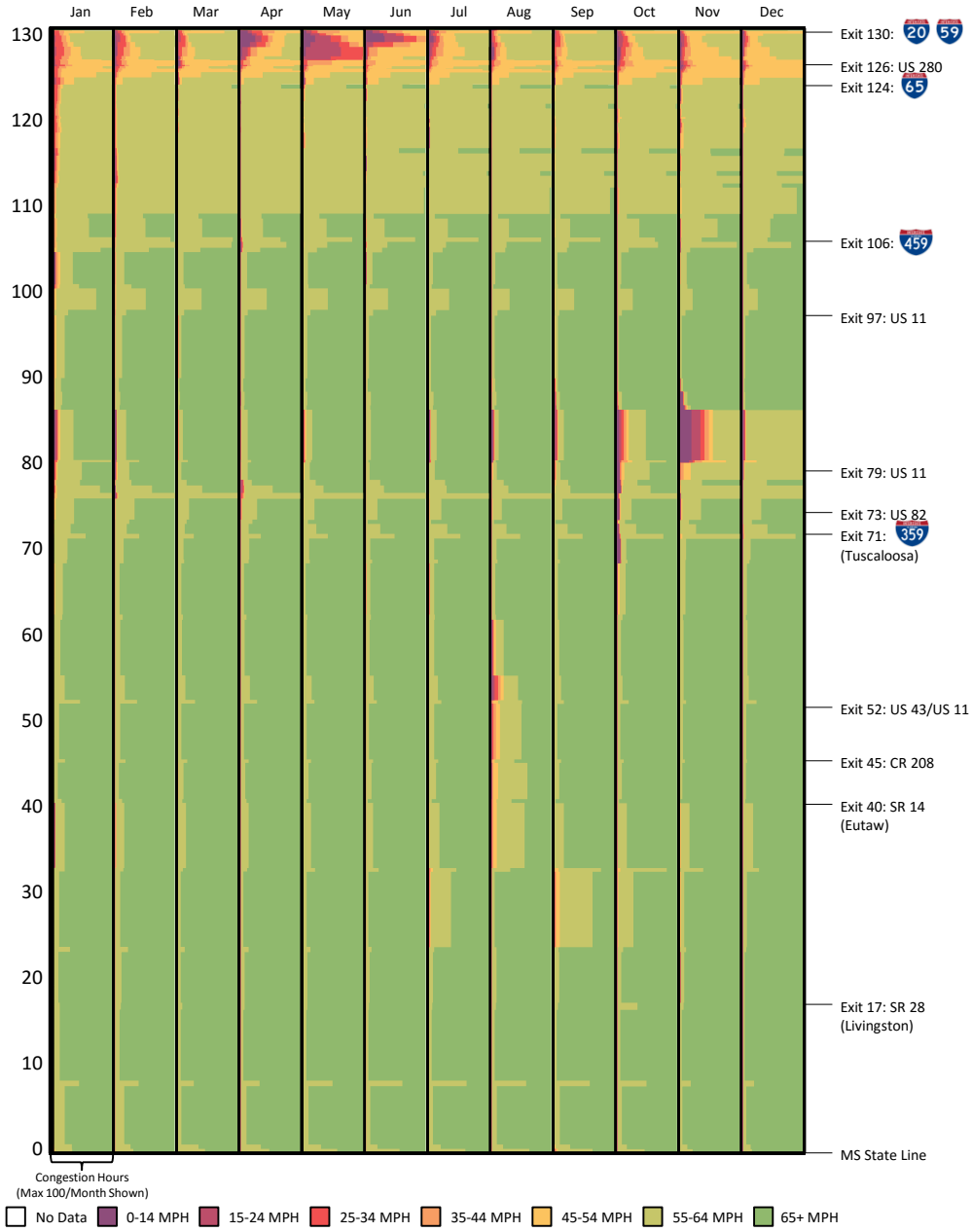


Figure 12-7. Speed Profile Graph for I-59 I-20 Westbound

Notes

- Major congestion during April, May, and June in Birmingham around interchanges for I-65, US-280, and I-20/I-59 split
- Congestion around Tuscaloosa / Cottondale area milepost 79 during football events in the fall

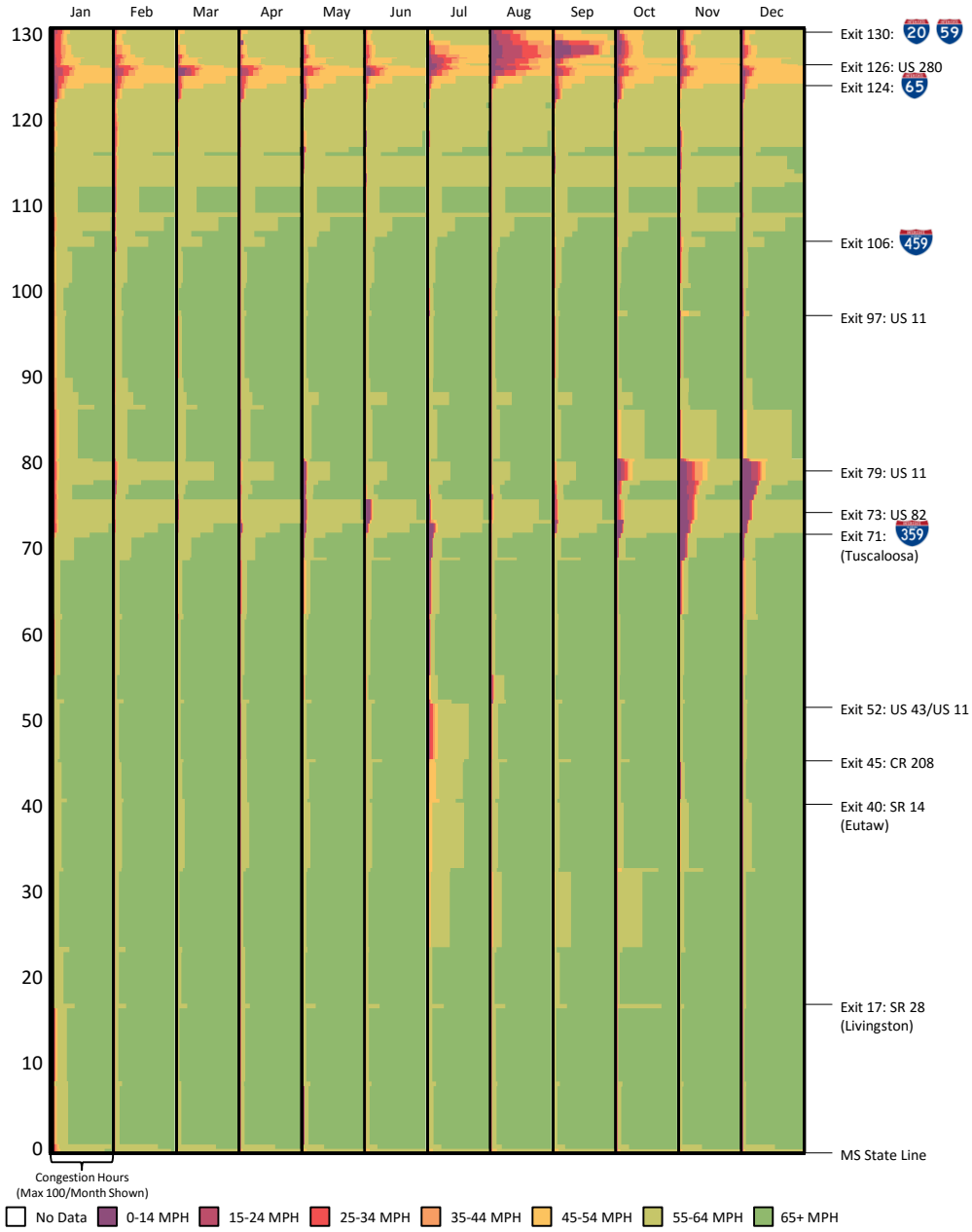


Figure 12-8. Speed Profile Graph for I-59 I-20 Eastbound

Notes

- Major congestion during April, May, and June in Birmingham around interchanges for I-65, US-280, and I-20/I-59 split
- Congestion around Tuscaloosa / Cottondale area milepost 79 during football events in the fall

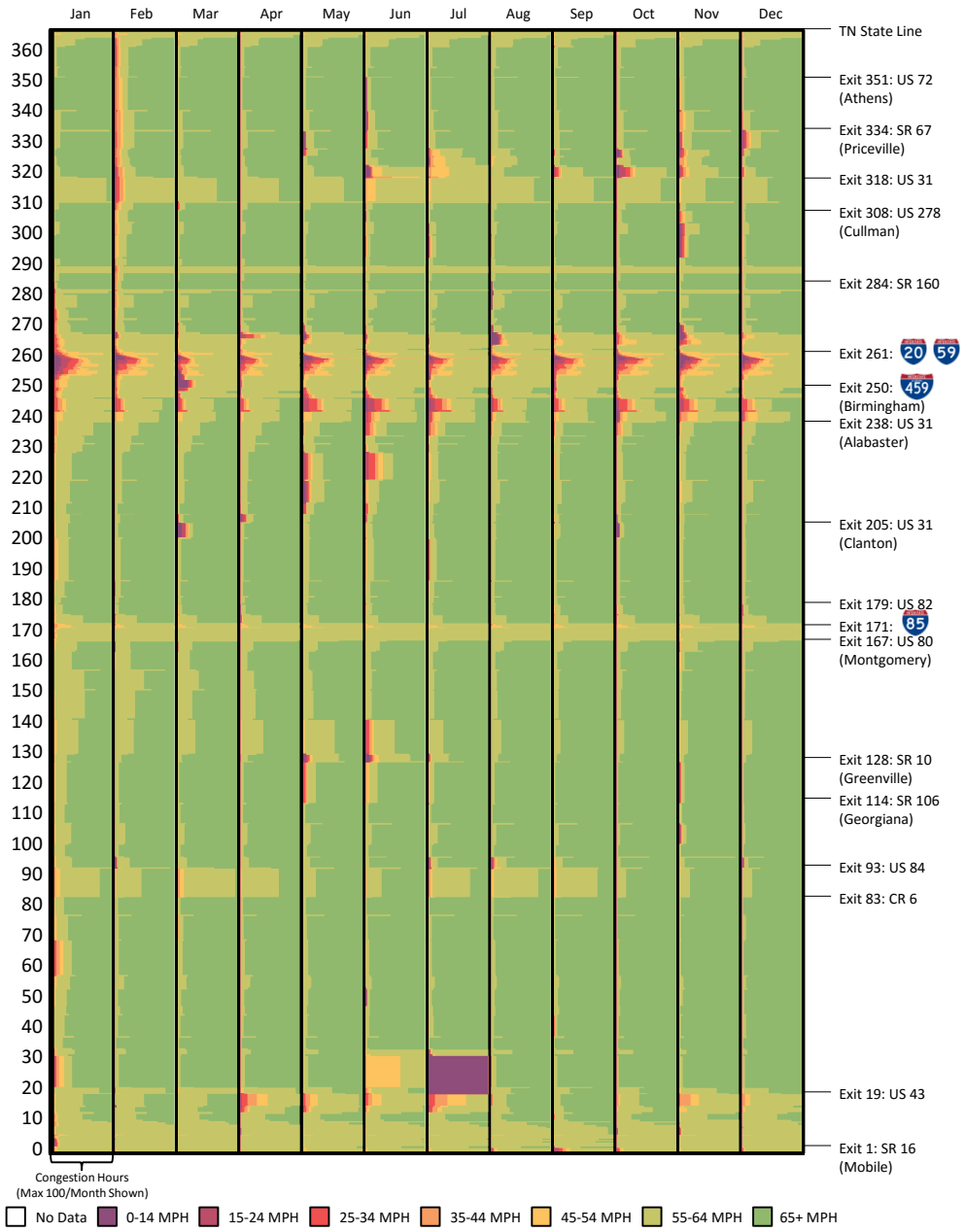


Figure 12-9. Speed Profile Graph for I-65 Southbound

Notes

- Major congestion between I-459 and I-20/I-59
- Some congestion around Priceville milepost 318 to milepost 334
- Unknown event in July around milepost 19

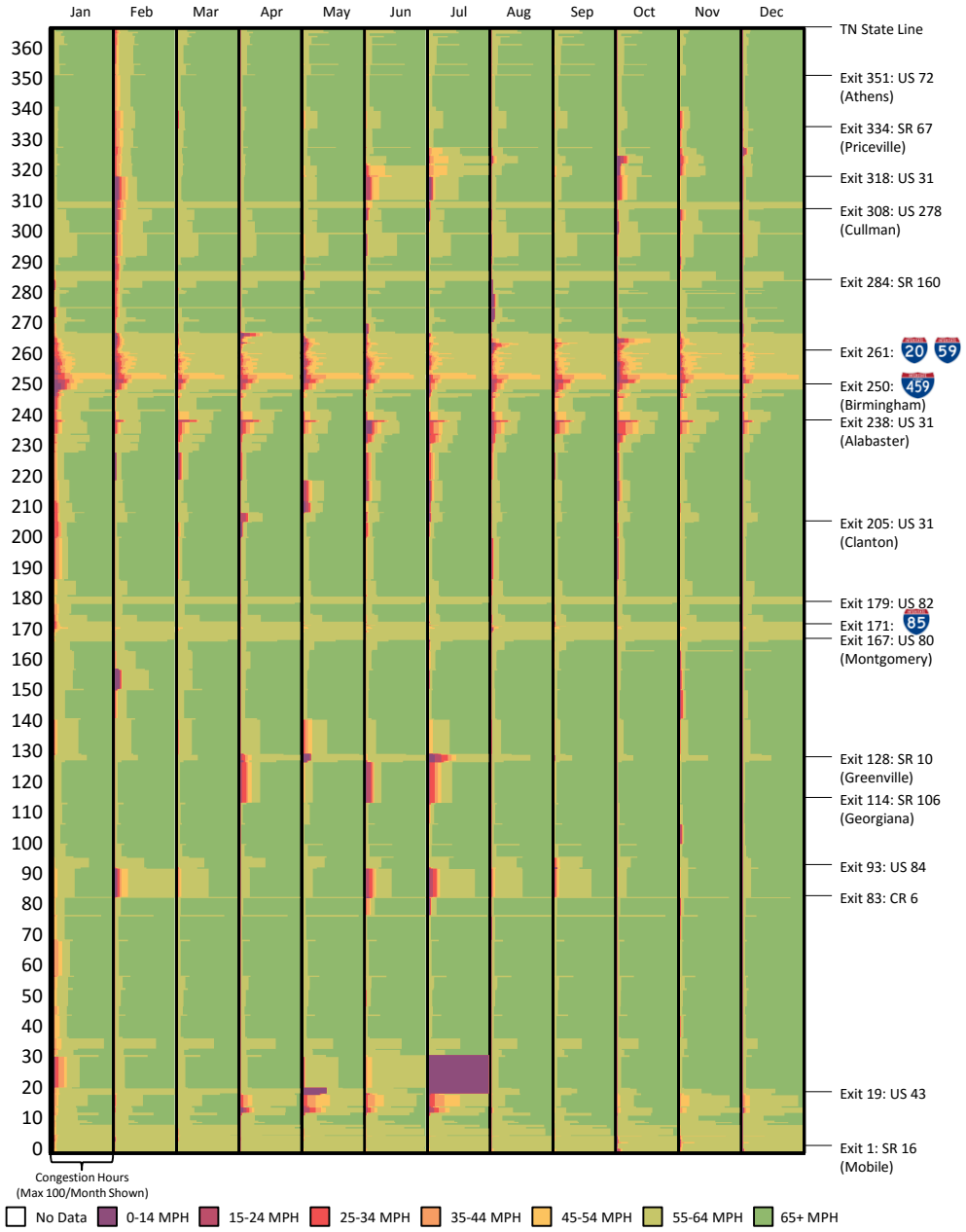


Figure 12-10. Speed Profile Graph for I-65 Northbound

Notes

- Major congestion between I-459 and I-20/I-59
- Some congestion around Priceville milepost 318 to milepost 334
- Unknown event in July around milepost 19

Figure 12-11. Speed Profile Graph for I-85 Southbound

Notes

- Major congestion during Auburn special events between milepost 51 and milepost 58
- Possible work zone congestion around milepost 42 in April and May

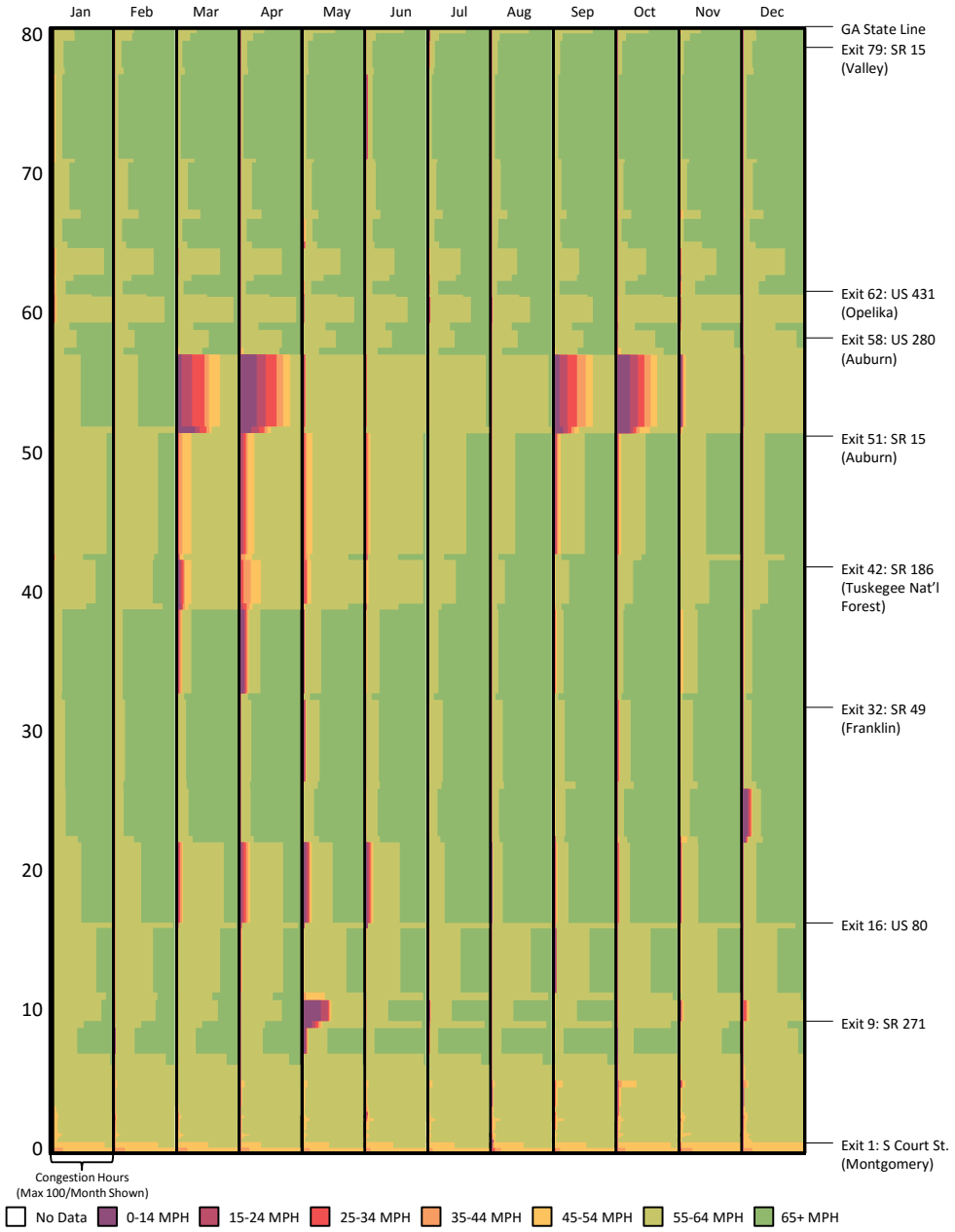


Figure 12-12. Speed Profile Graph for I-85 Northbound

Notes

- Major congestion during Auburn special events between milepost 51 and milepost 58
- Unknown cause of congestion around milepost 9 in May

Figure 12-13. Speed Profile Graph for I-165 Southbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

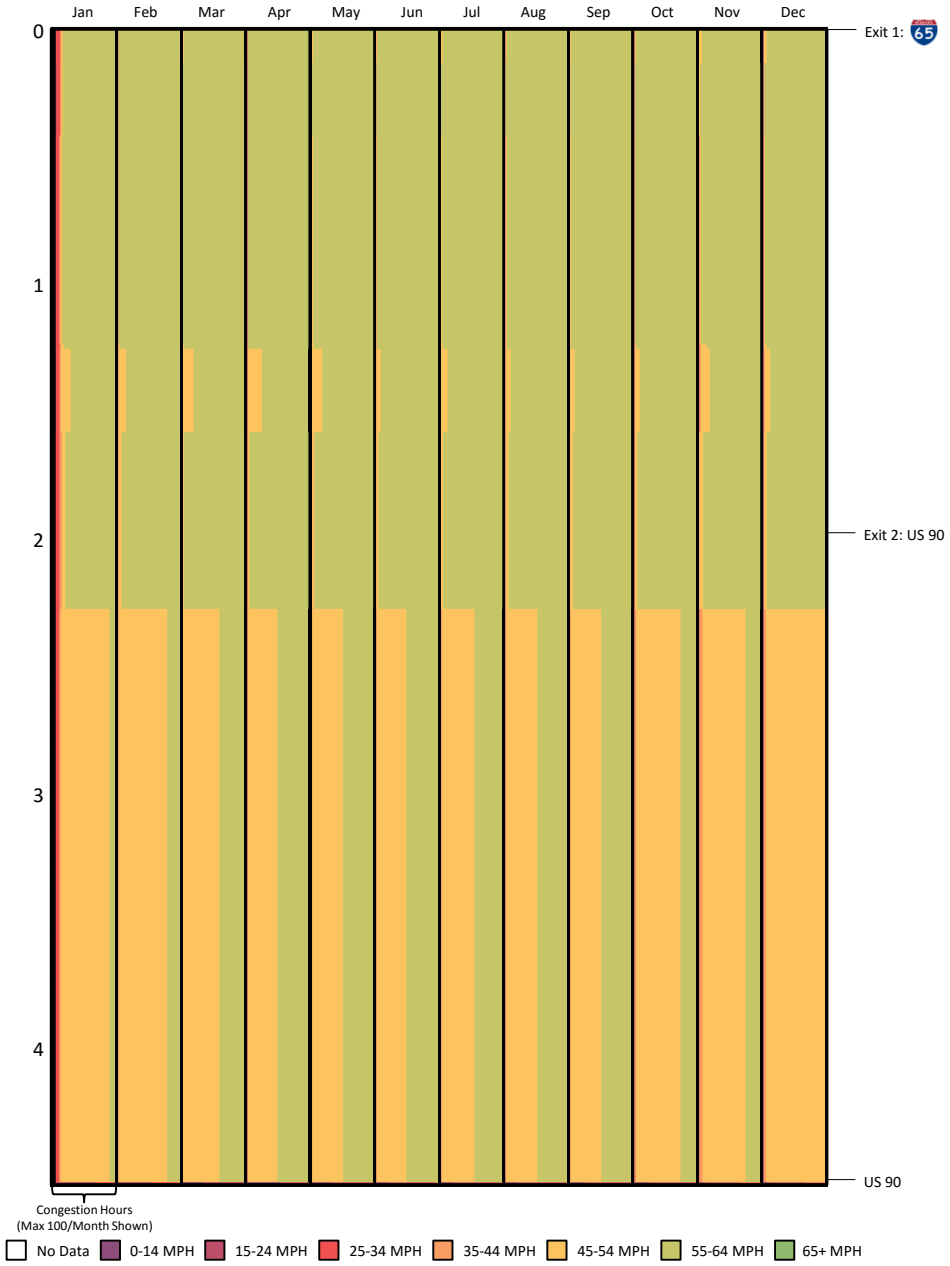


Figure 12-14. Speed Profile Graph for I-165 Northbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

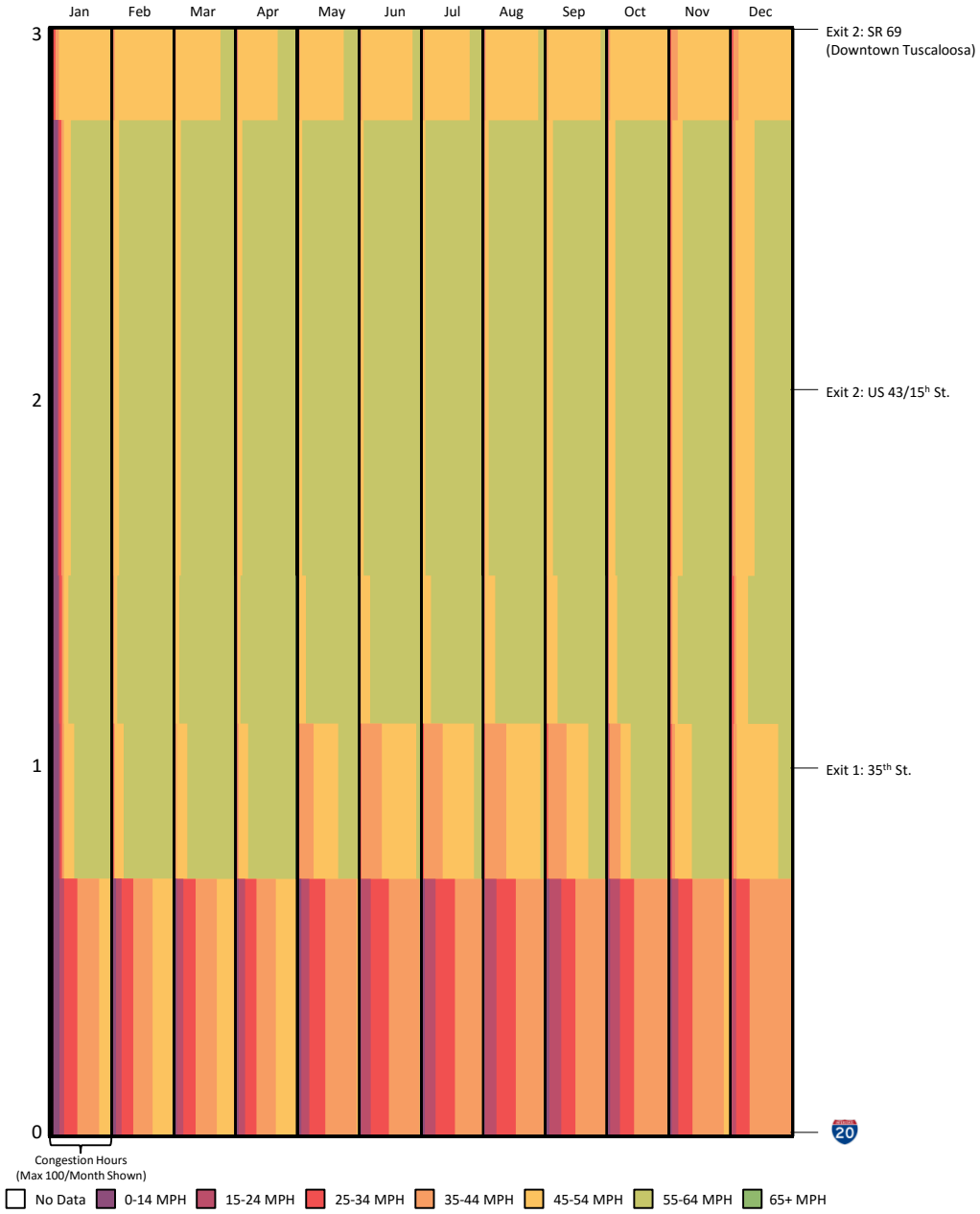


Figure 12-15. Speed Profile Graph for I-359 Southbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

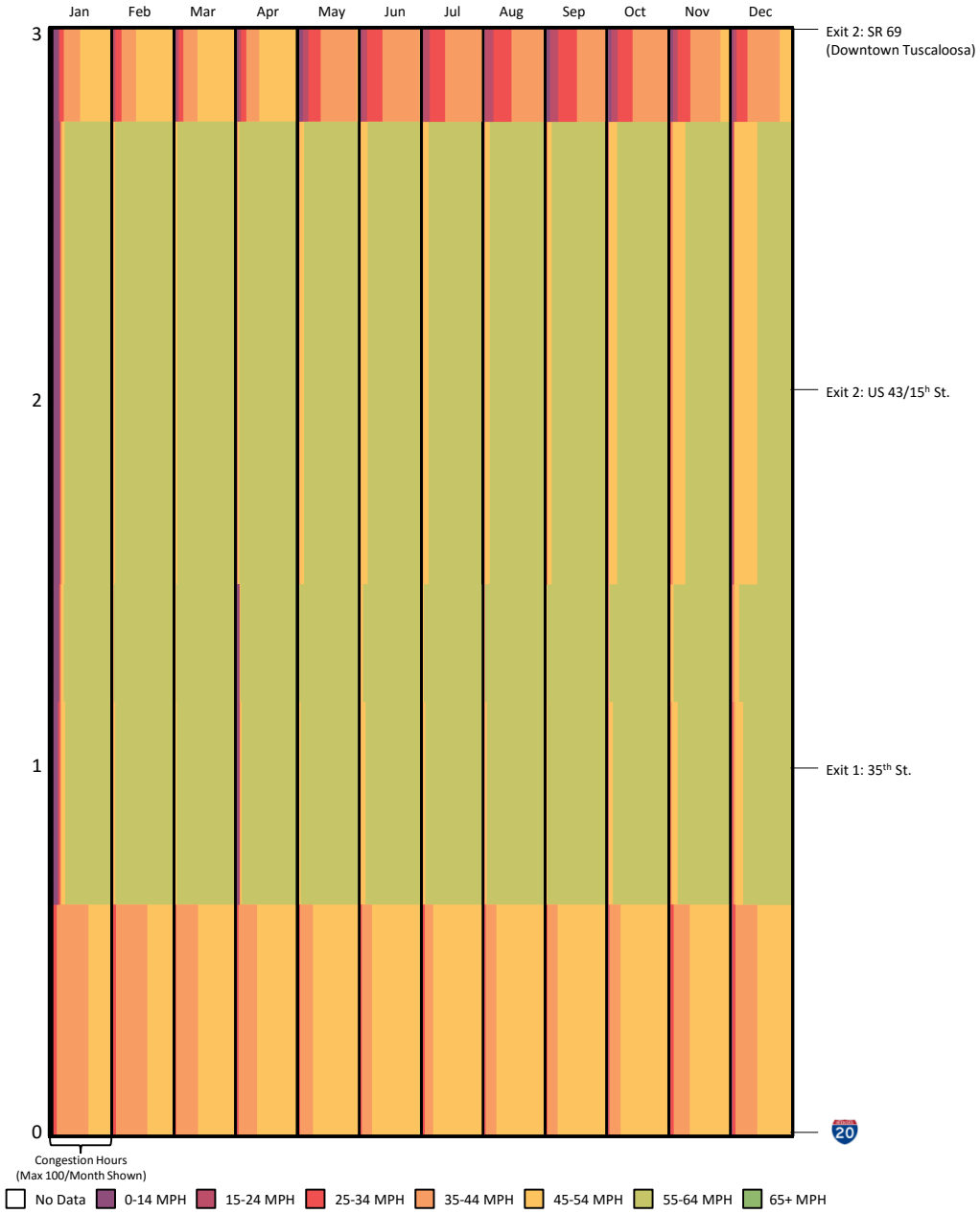


Figure 12-16. Speed Profile Graph for I-359 Northbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

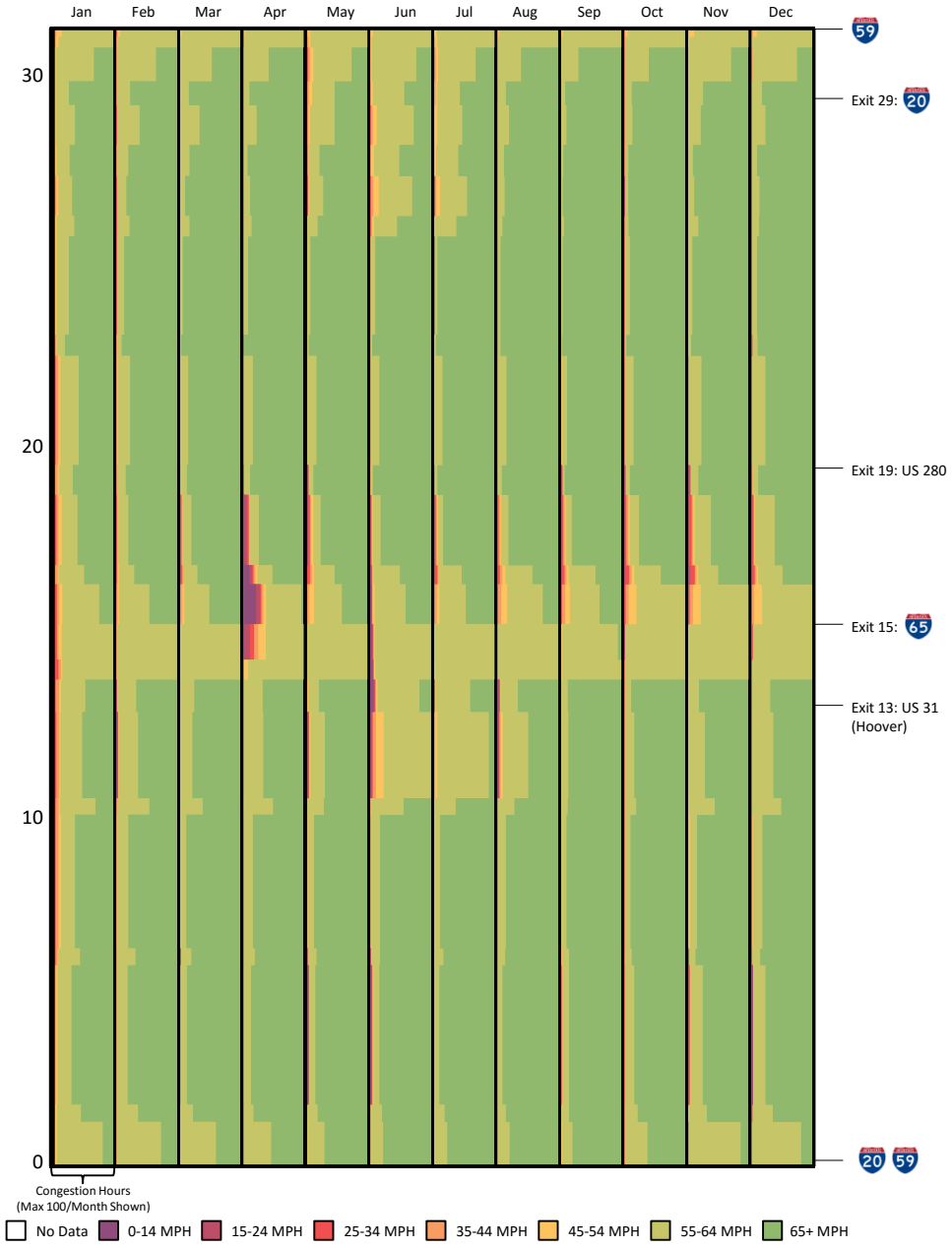


Figure 12-17. Speed Profile Graph for I-459 Westbound

Notes

- Possible work zone congestion in April around milepost 15 I-65 interchange

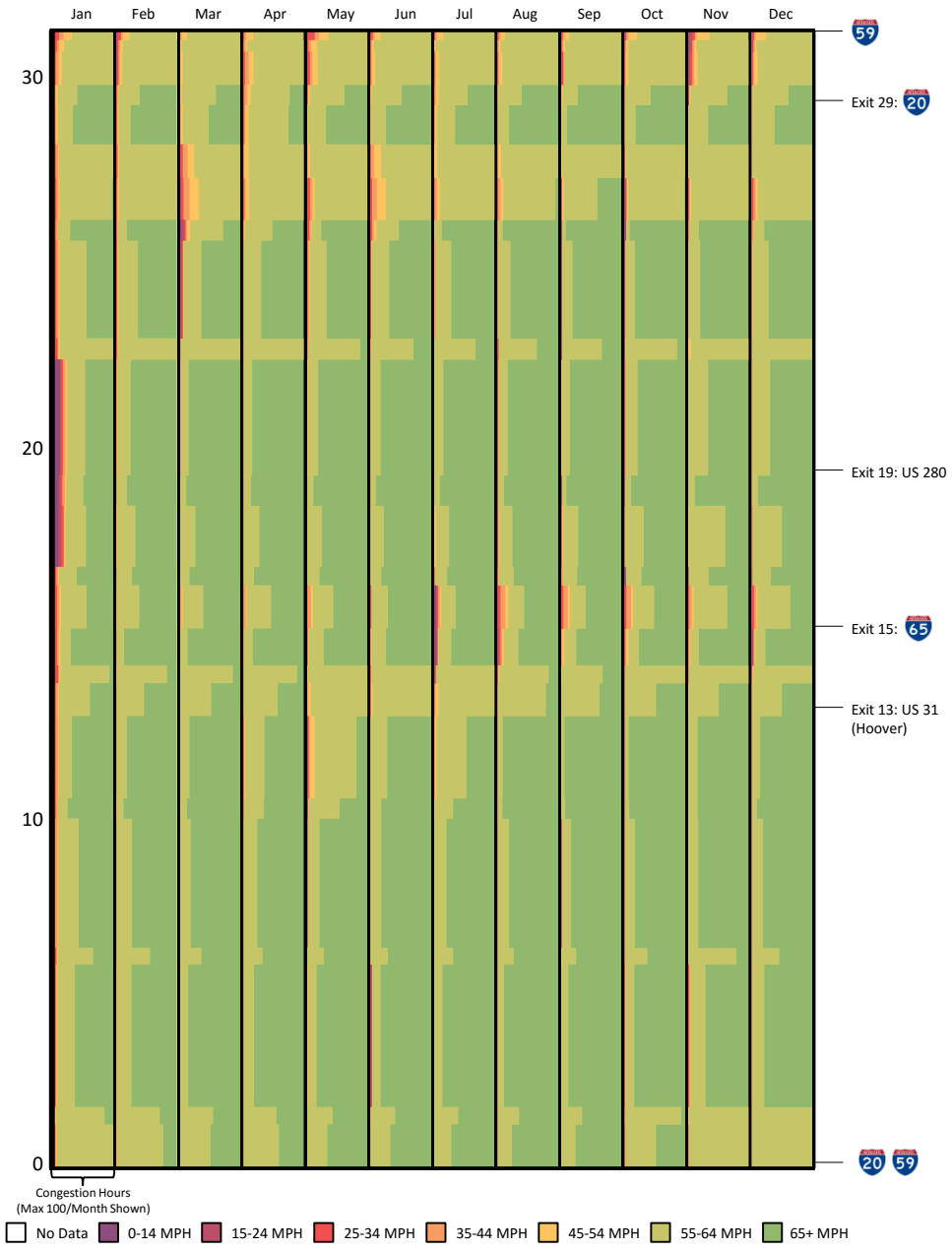


Figure 12-18. Speed Profile Graph for I-459 Eastbound

Notes

- Inclement weather congestion in January

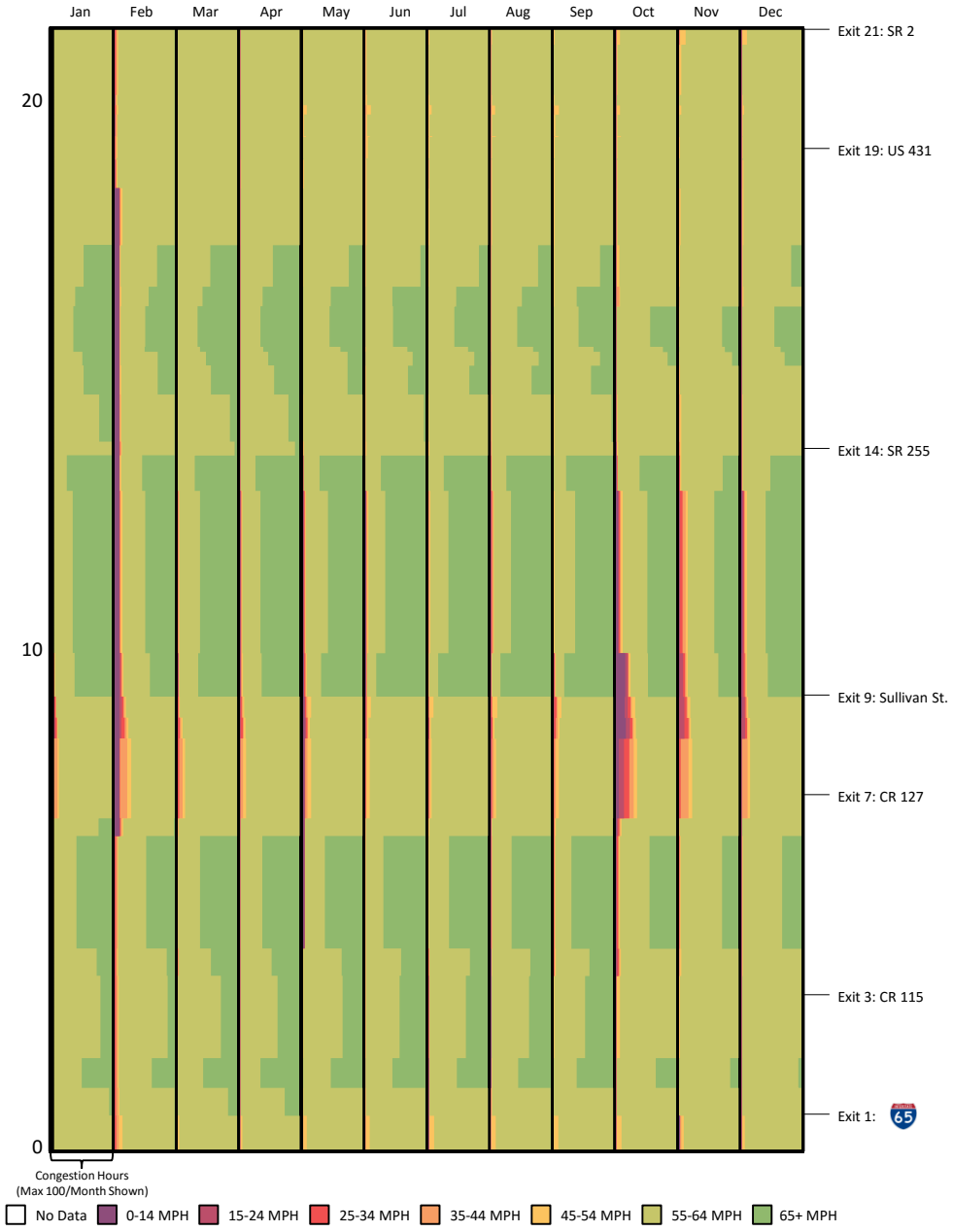


Figure 12-19. Speed Profile Graph for I-565 Westbound

Notes

- Possible seasonal event or work zone congestion in October and November between milepost 7 and milepost 9

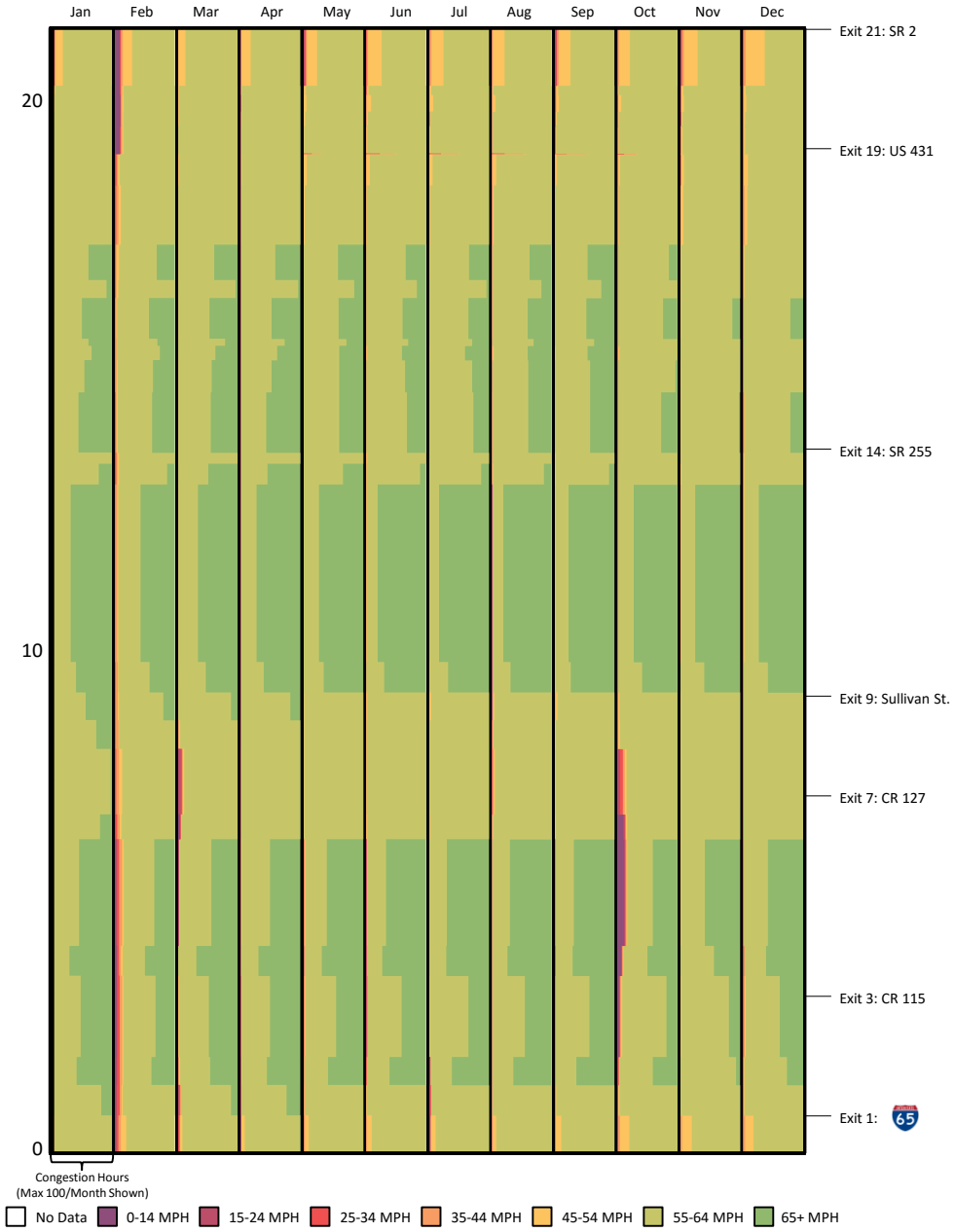


Figure 12-20. Speed Profile Graph for I-565 Eastbound

Notes

- Unknown non-recurring congestion in October between milepost 3 and milepost 7

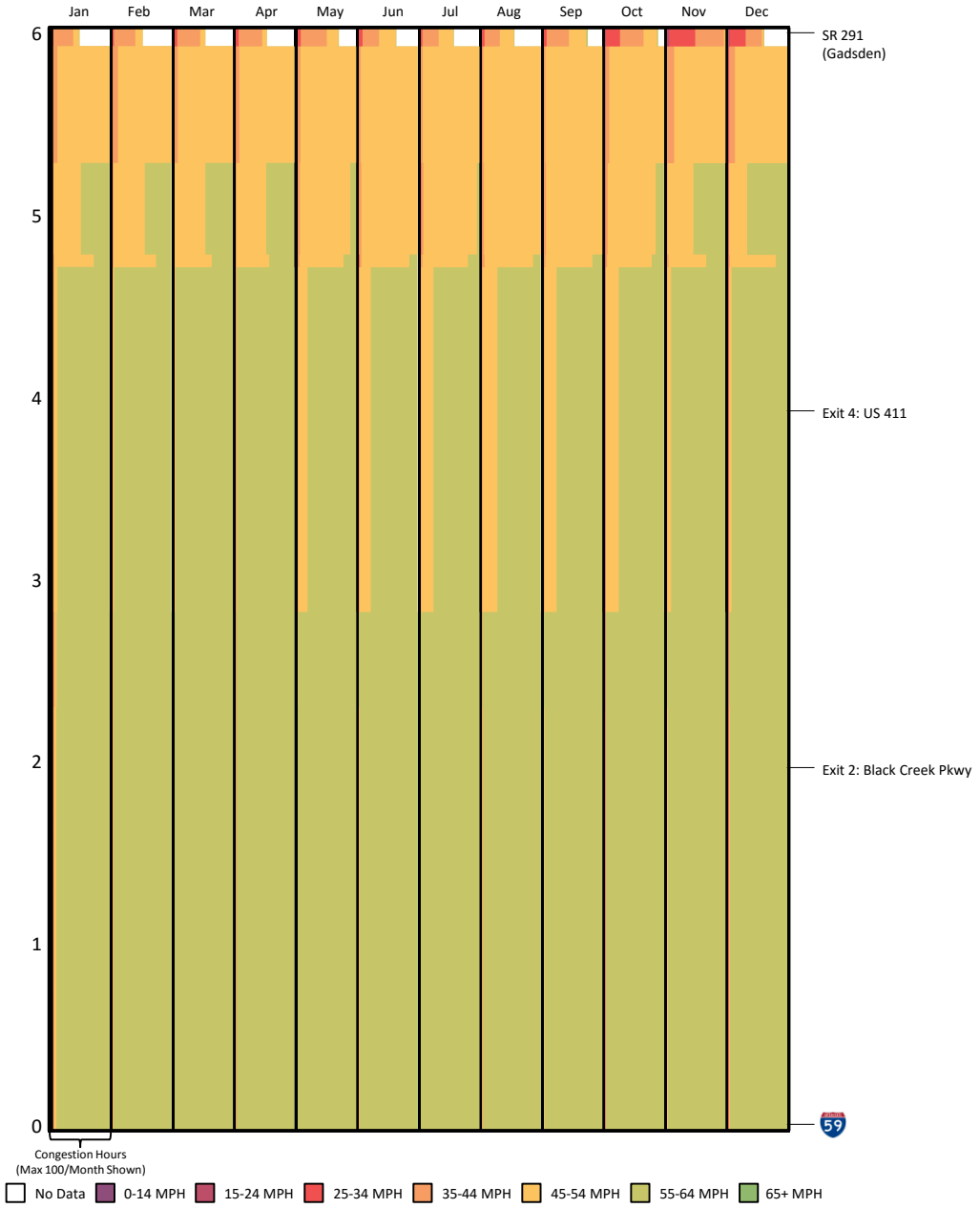


Figure 12-21. Speed Profile Graph for I-759 Westbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

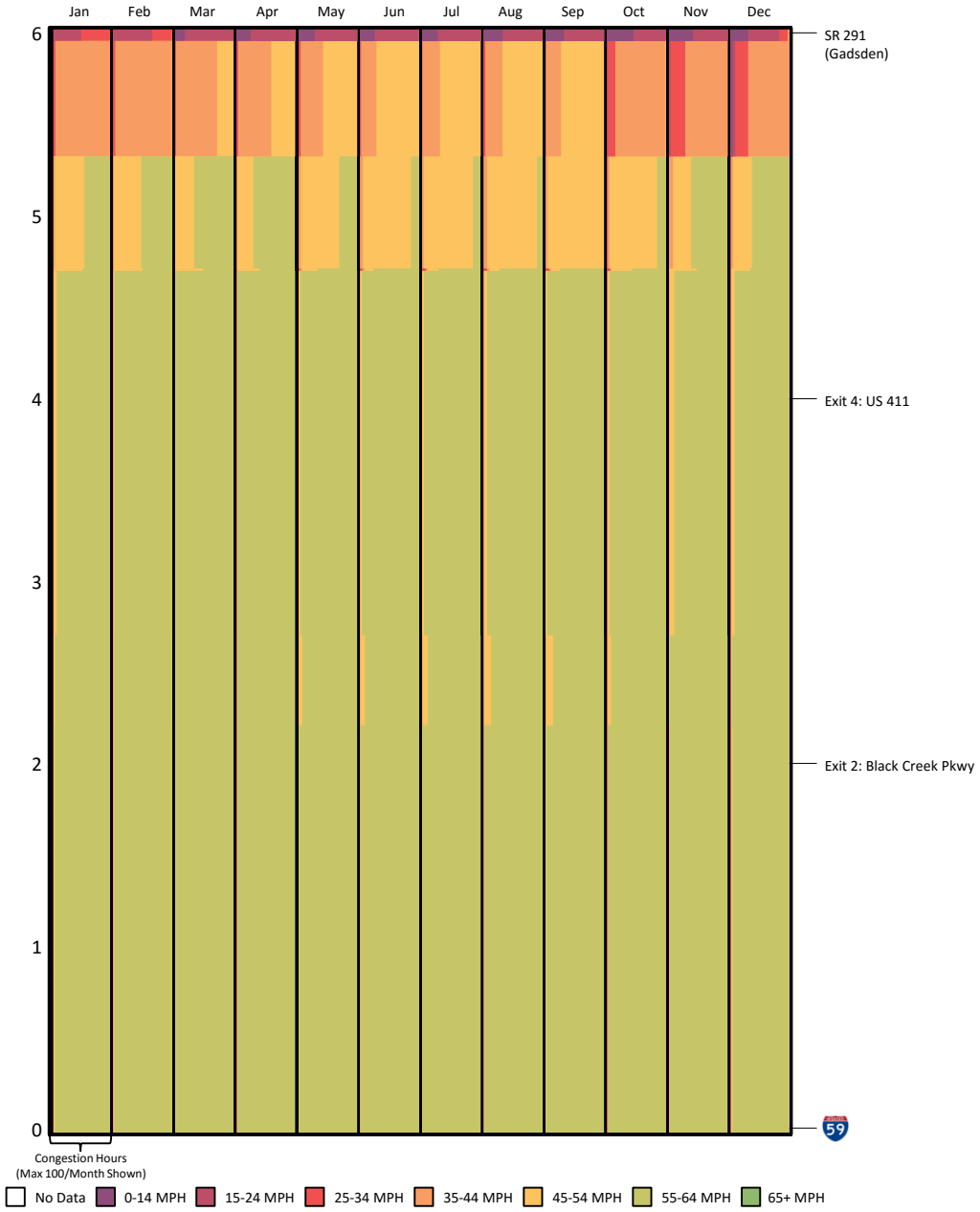


Figure 12-22. Speed Profile Graph for I-759 Eastbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

13.0 Appendix B – Congestion Hours

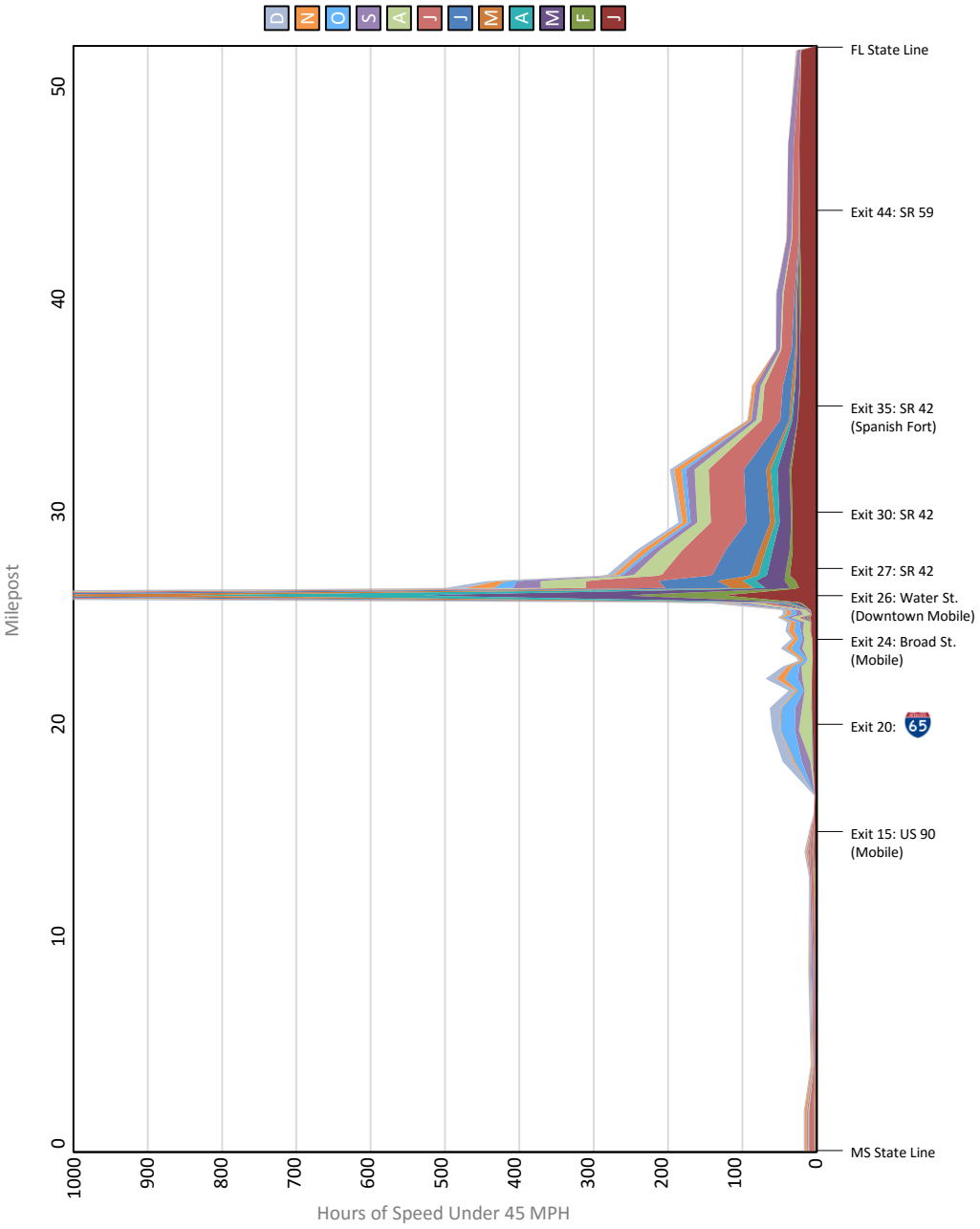


Figure 13-1. Congestion Hours for I-10 Westbound

Notes

- Large accumulation of congestion hours around milepost 26

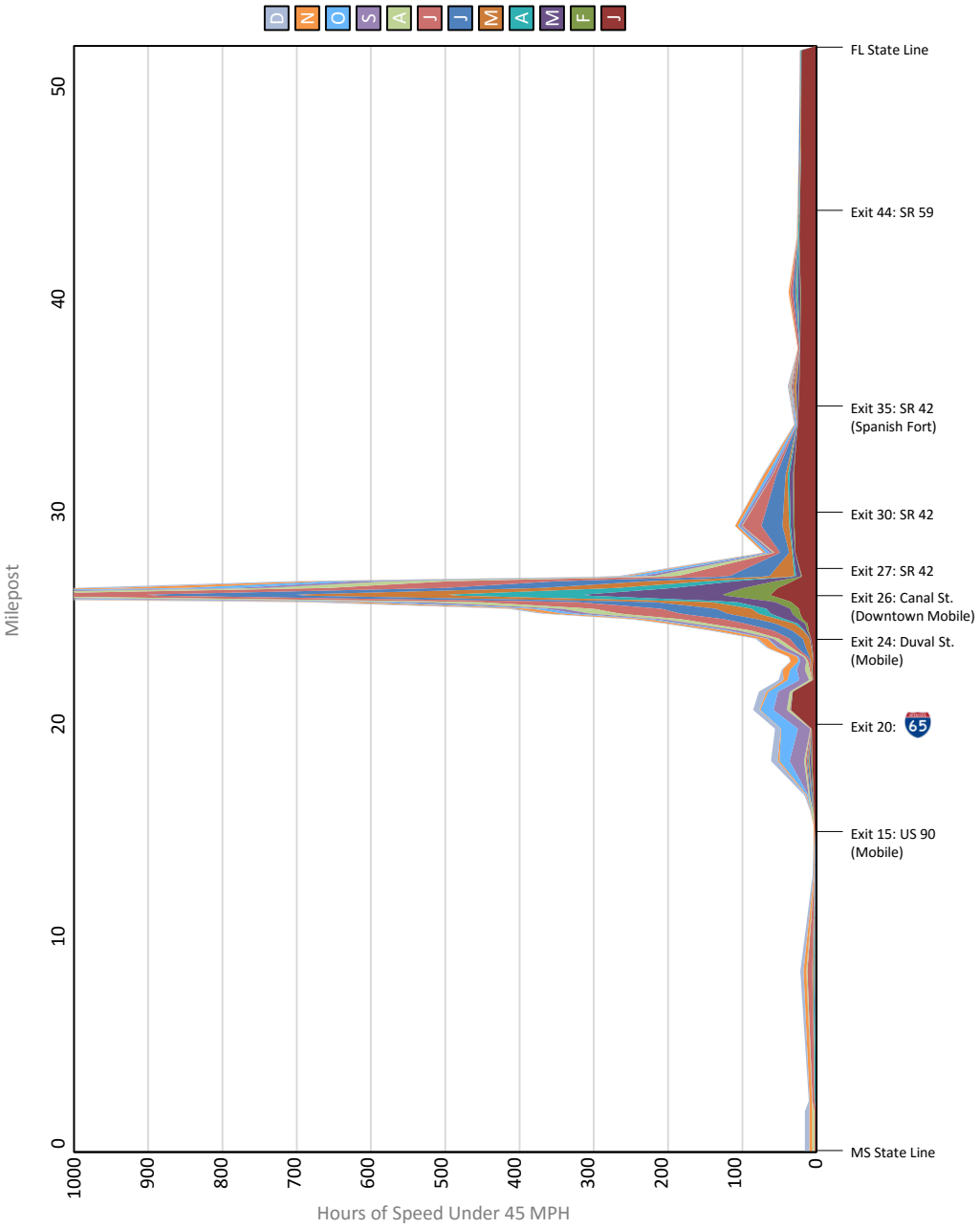


Figure 13-2. Congestion Hours for I-10 Eastbound

Notes

- Large accumulation of congestion hours around milepost 26

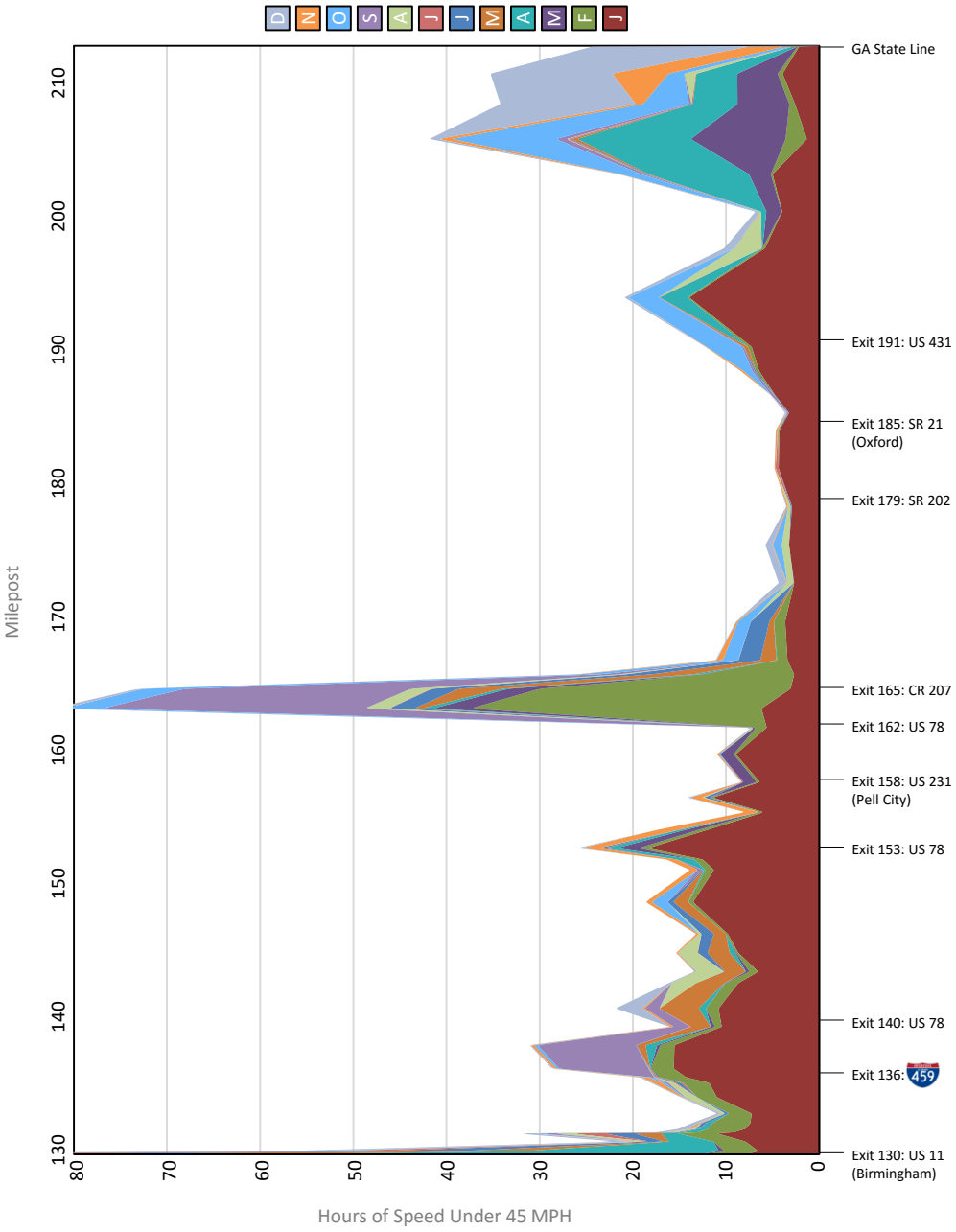


Figure 13-3. Congestion Hours for I-20 Westbound

Notes

- January congestion hours likely due to weather
- Lots of congestion hours accumulated between milepost 162 and 165 in February (likely weather related) and September

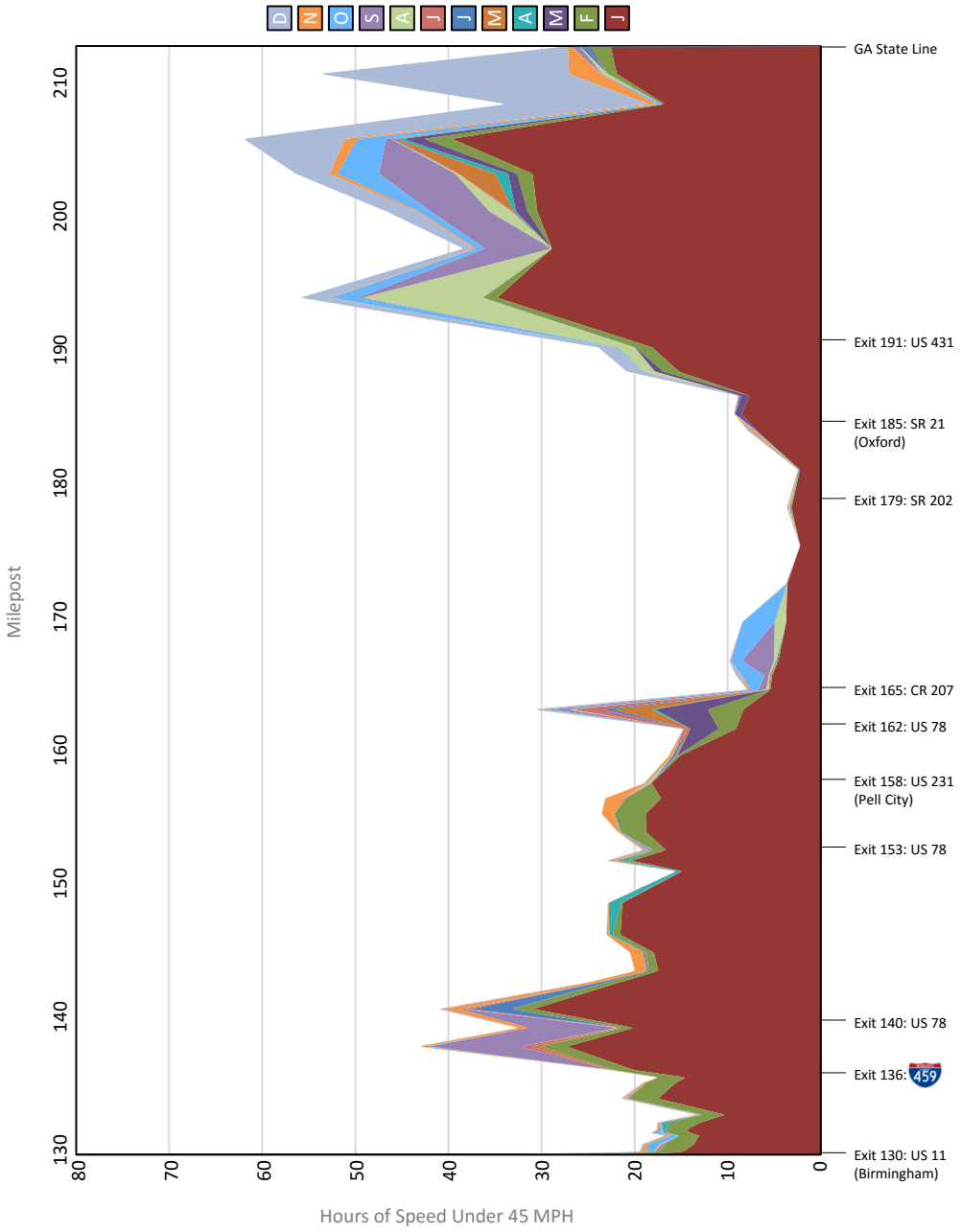


Figure 13-4. Congestion Hours for I-20 Eastbound

Notes

- January congestion hours likely due to weather

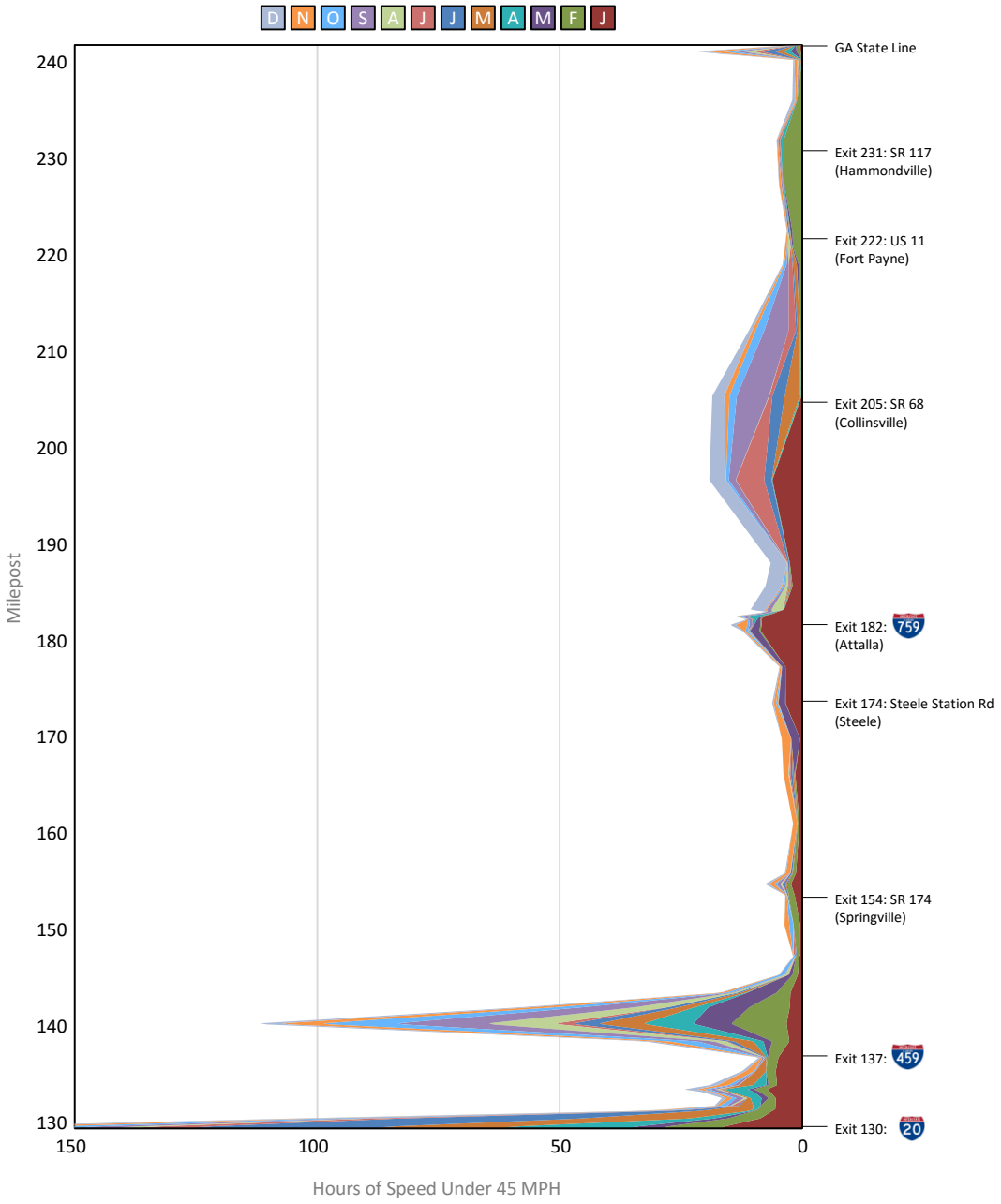


Figure 13-5. Congestion Hours for I-59 Southbound

Notes

- Large accumulation of congestion hours near the interchanges for I-459 and I-20

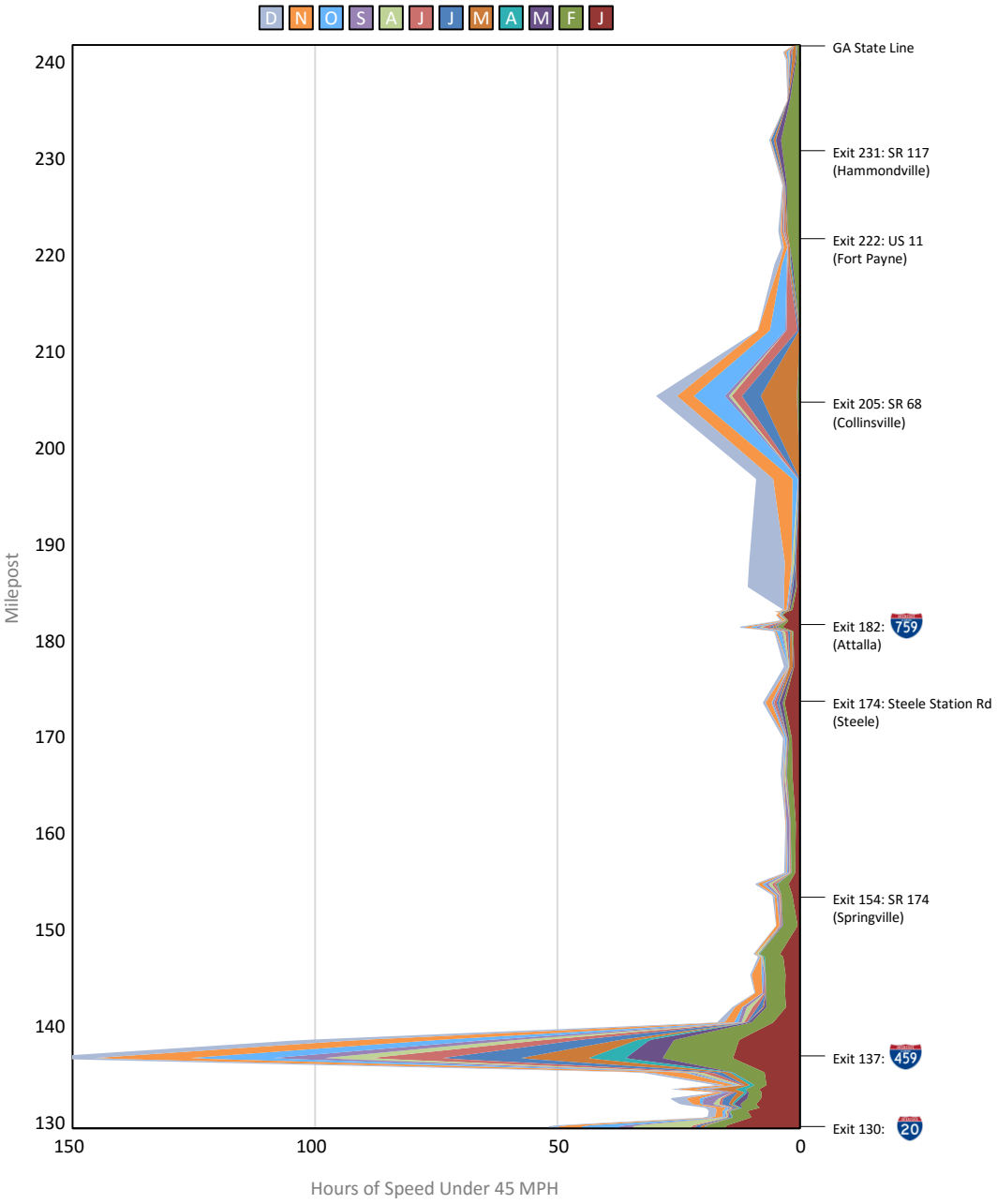


Figure 13-6. Congestion Hours for I-59 Northbound

Notes

- Large accumulation of congestion hours around milepost 137 I-459 interchange
- Some accumulation of congestion hours around Collinsville

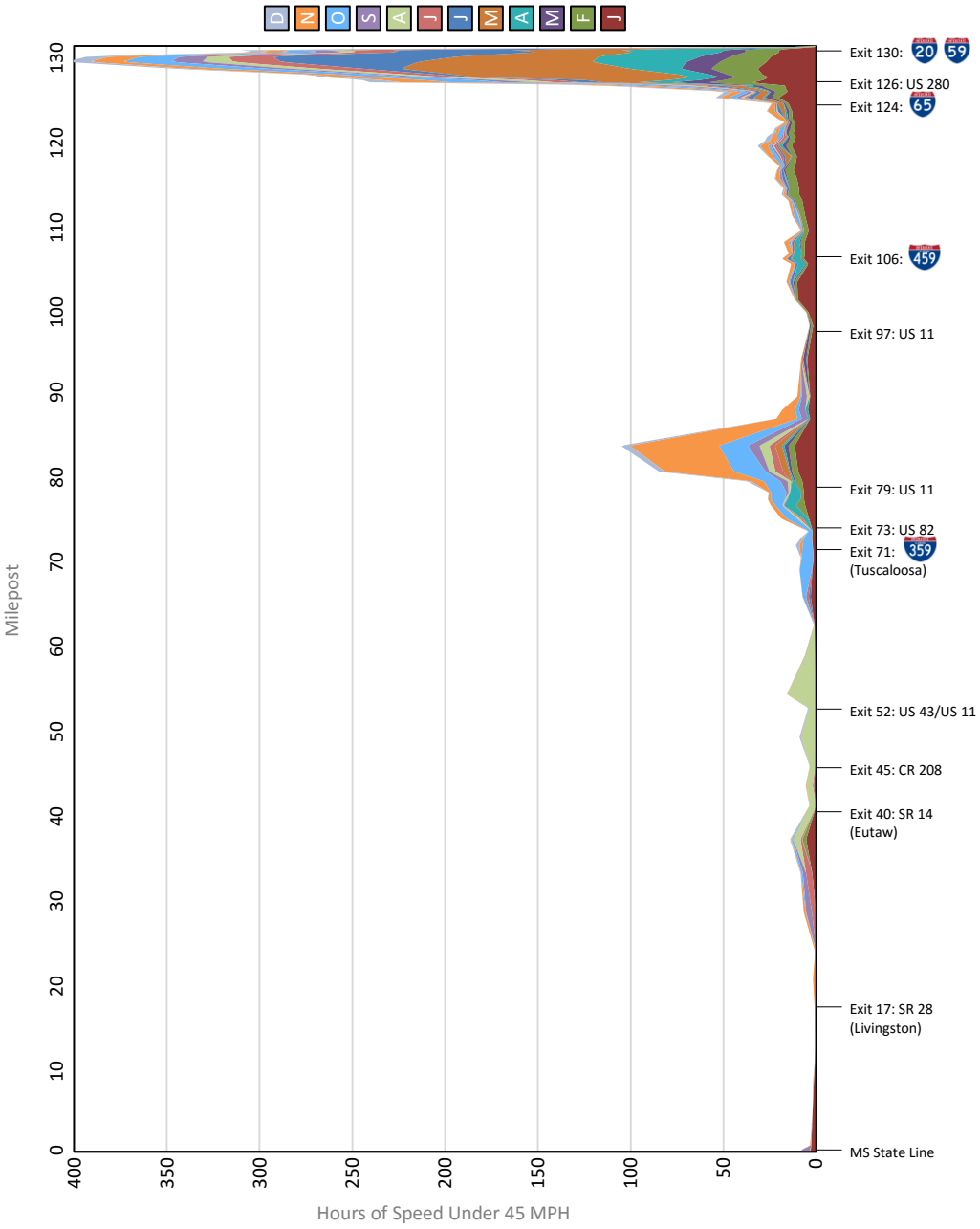


Figure 13-7. Congestion Hours for I-59/I-20 Westbound

Notes

- Large accumulation of congestion hours between milepost 126 and milepost 130 for the I-459 and I-65 interchanges
- Some accumulation of congestion hours around Tuscaloosa / Cottondale, especially in November

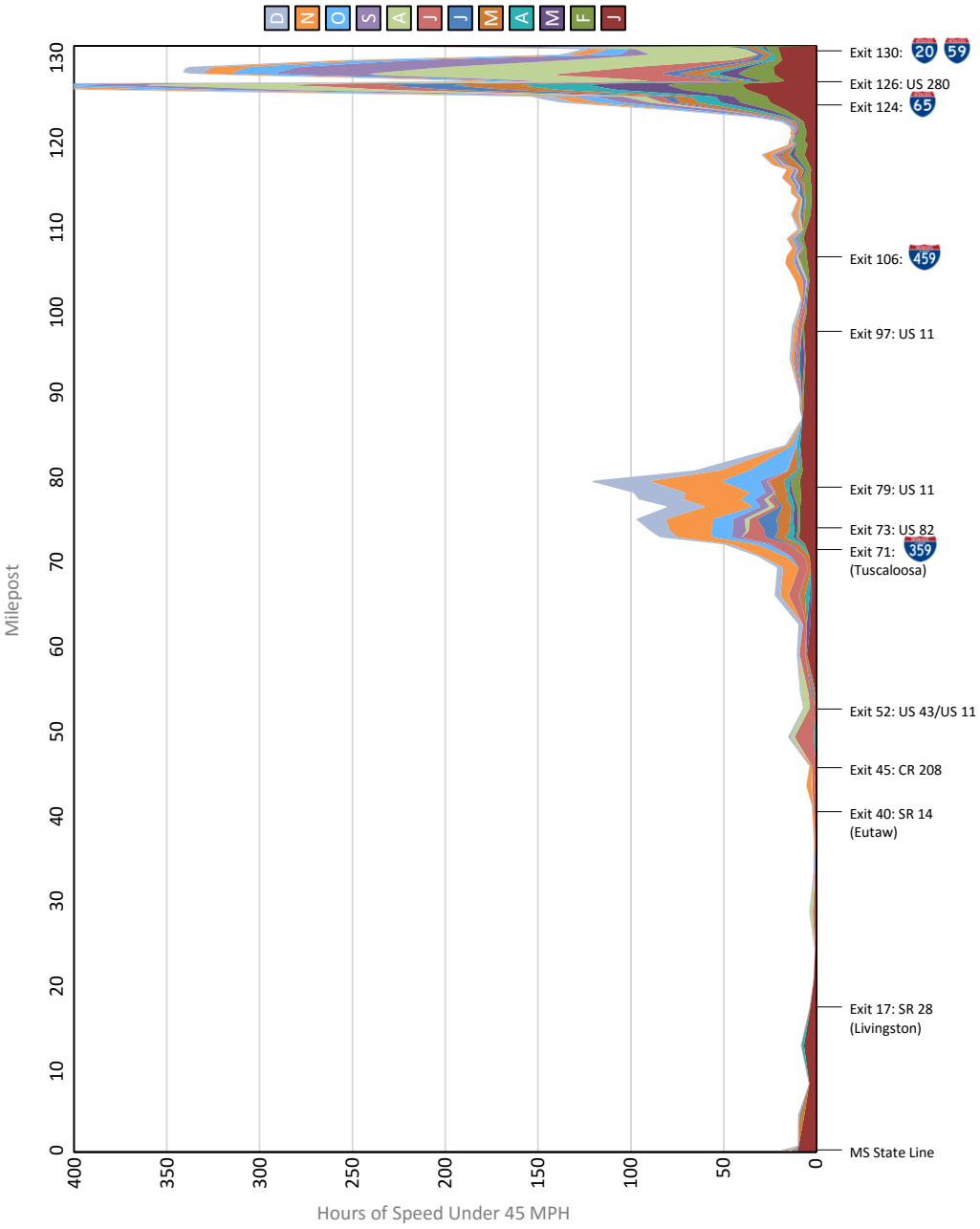


Figure 13-8. Congestion Hours for I-59/I-20 Eastbound

Notes

- Large accumulation of congestion hours between milepost 126 and milepost 130 for the I-459 and I-65 interchanges
- Some accumulation of congestion hours around Tuscaloosa, especially in the fall months

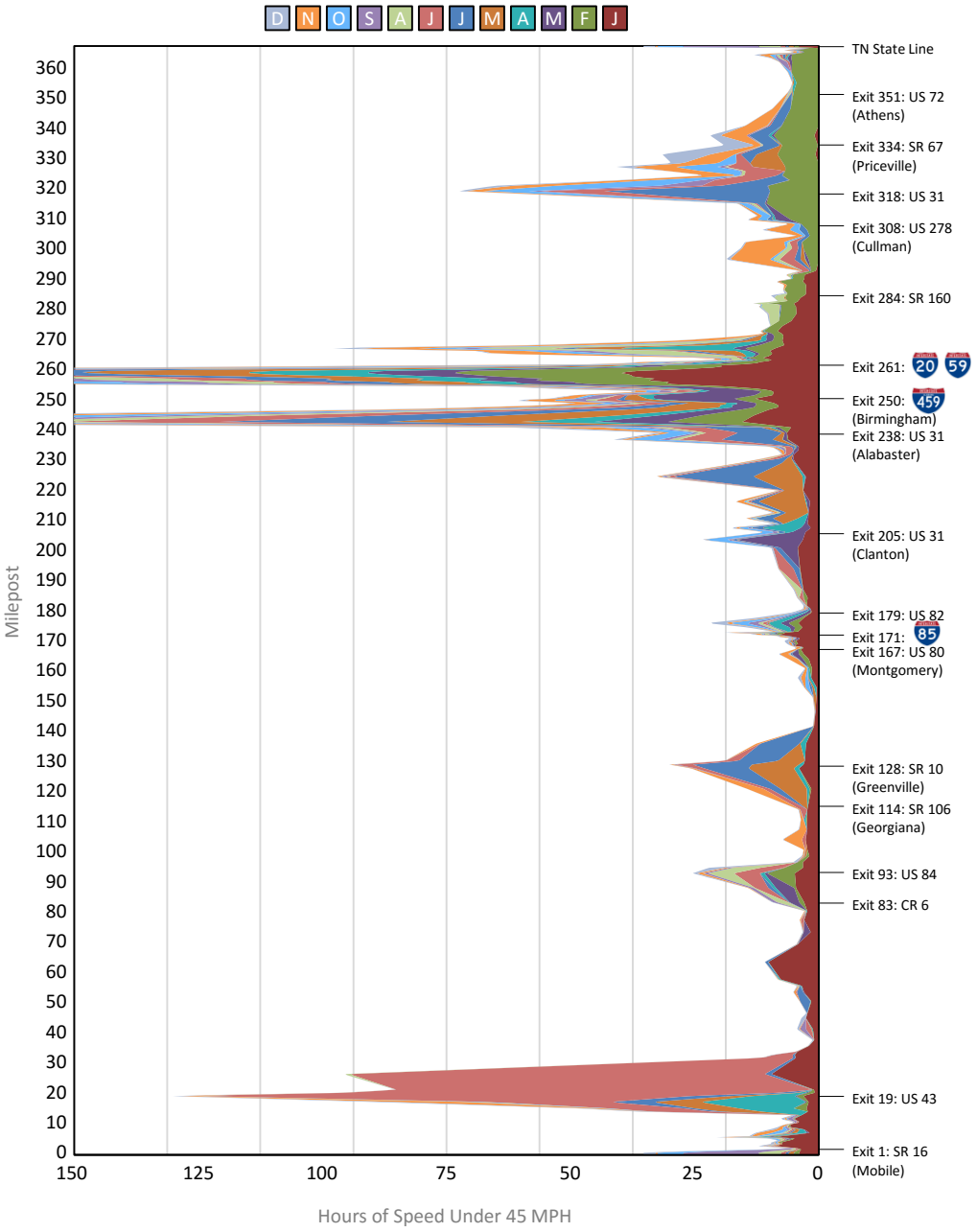


Figure 13-9. Congestion Hours for I-65 Southbound

Notes

- Large accumulation of congestion hours in metro Birmingham area
- Large spike in congestion hours in July near milepost 19 (possible summer travel)

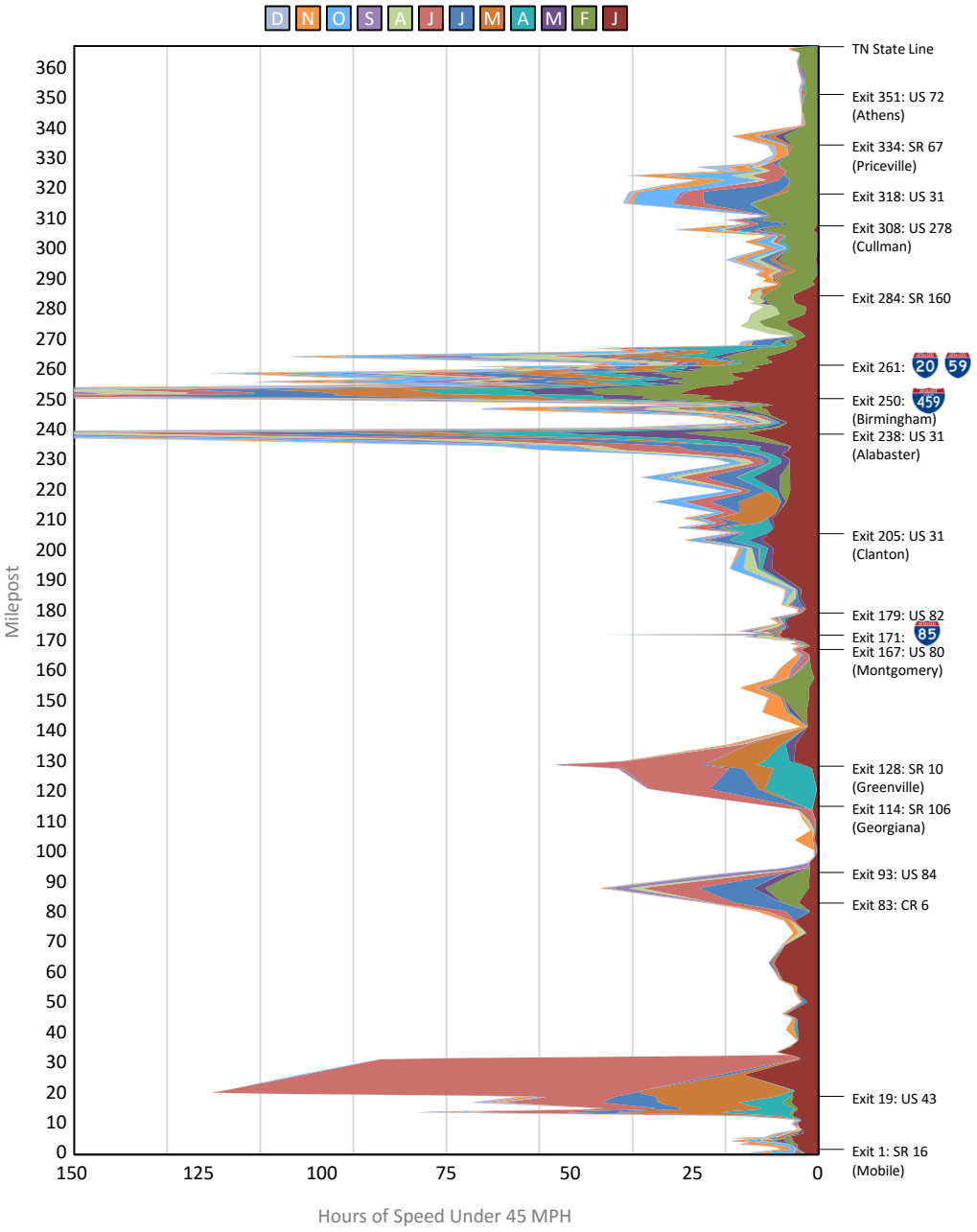


Figure 13-10. Congestion Hours for I-65 Northbound

Notes

- Large accumulation of congestion hours in metro Birmingham area
- Large spike in congestion hours in July near milepost 19 (possible summer travel)

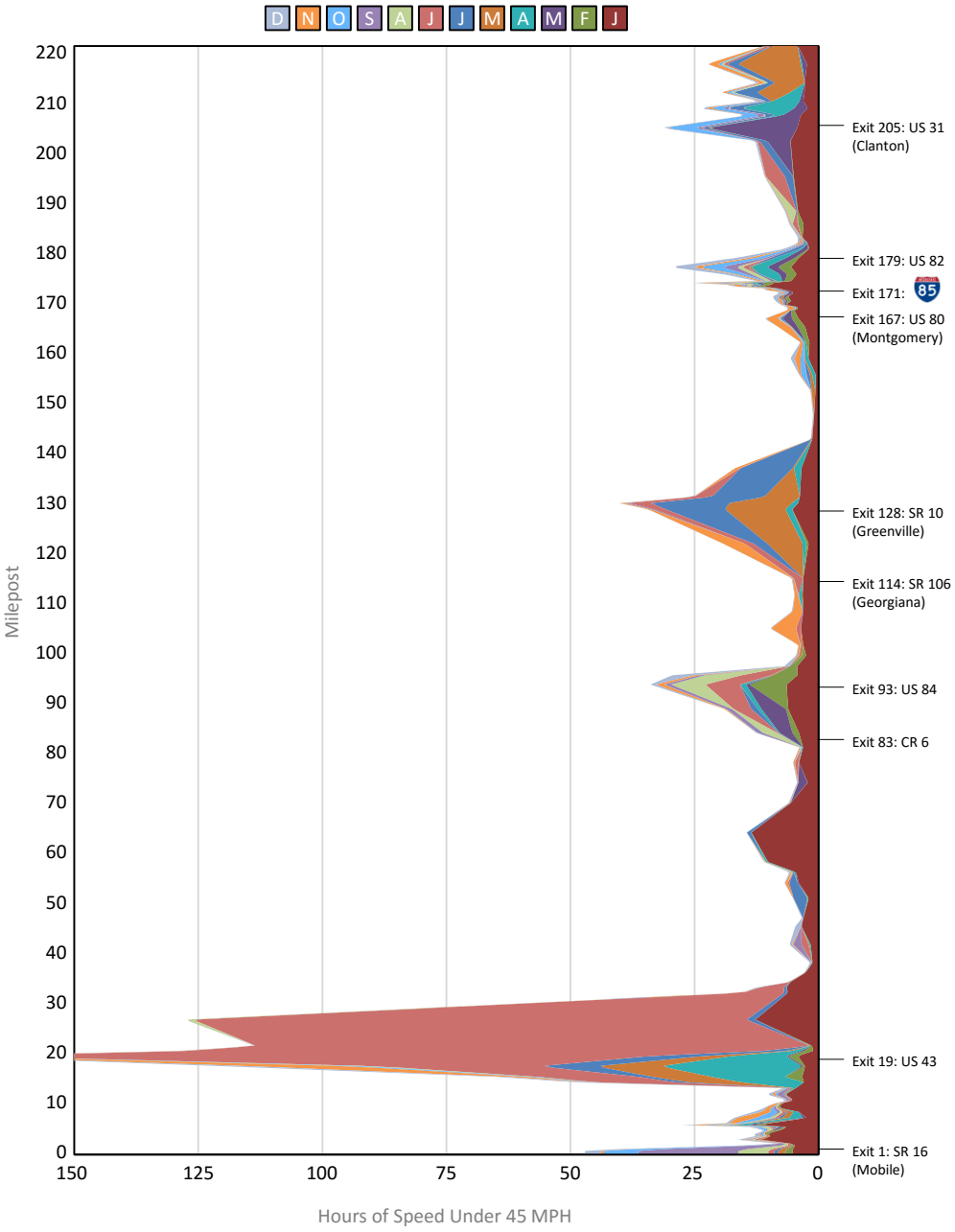


Figure 13-11. Congestion Hours for I-65 Southbound (Mobile to Birmingham)

Notes

- Large spike in congestion hours in July near milepost 19 (possible summer travel)
- Greensville also shows some congestion hours

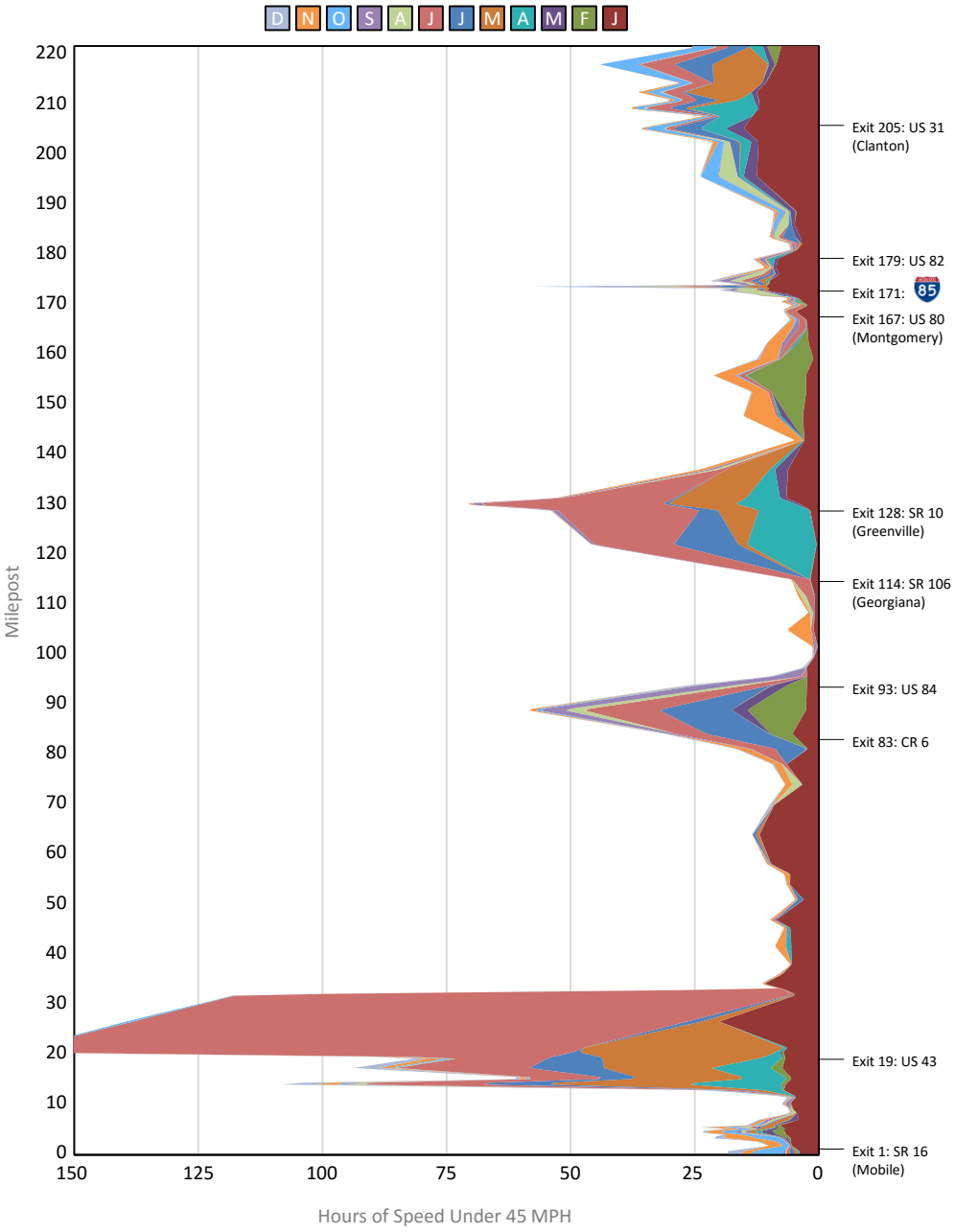


Figure 13-12. Congestion Hours for I-65 Northbound (Mobile to Birmingham)

Notes

- Large spike in congestion hours in July near milepost 19 (possible summer travel)
- Greensville also shows some congestion hours

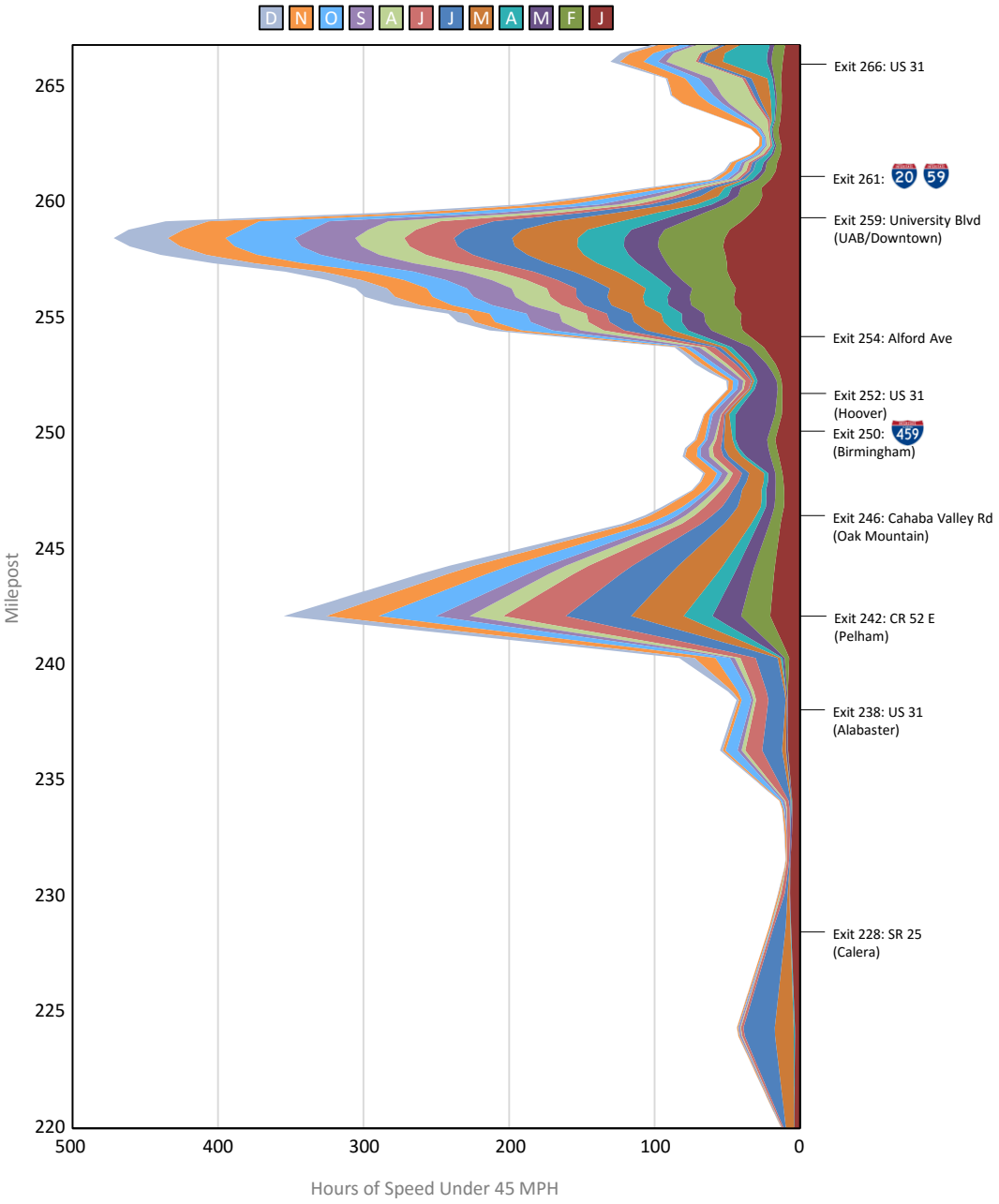


Figure 13-13. Congestion Hours for I-65 Southbound (Birmingham)

Notes

- Lots of congestion hours around milepost 242 in Pelham and milepost 259 downtown

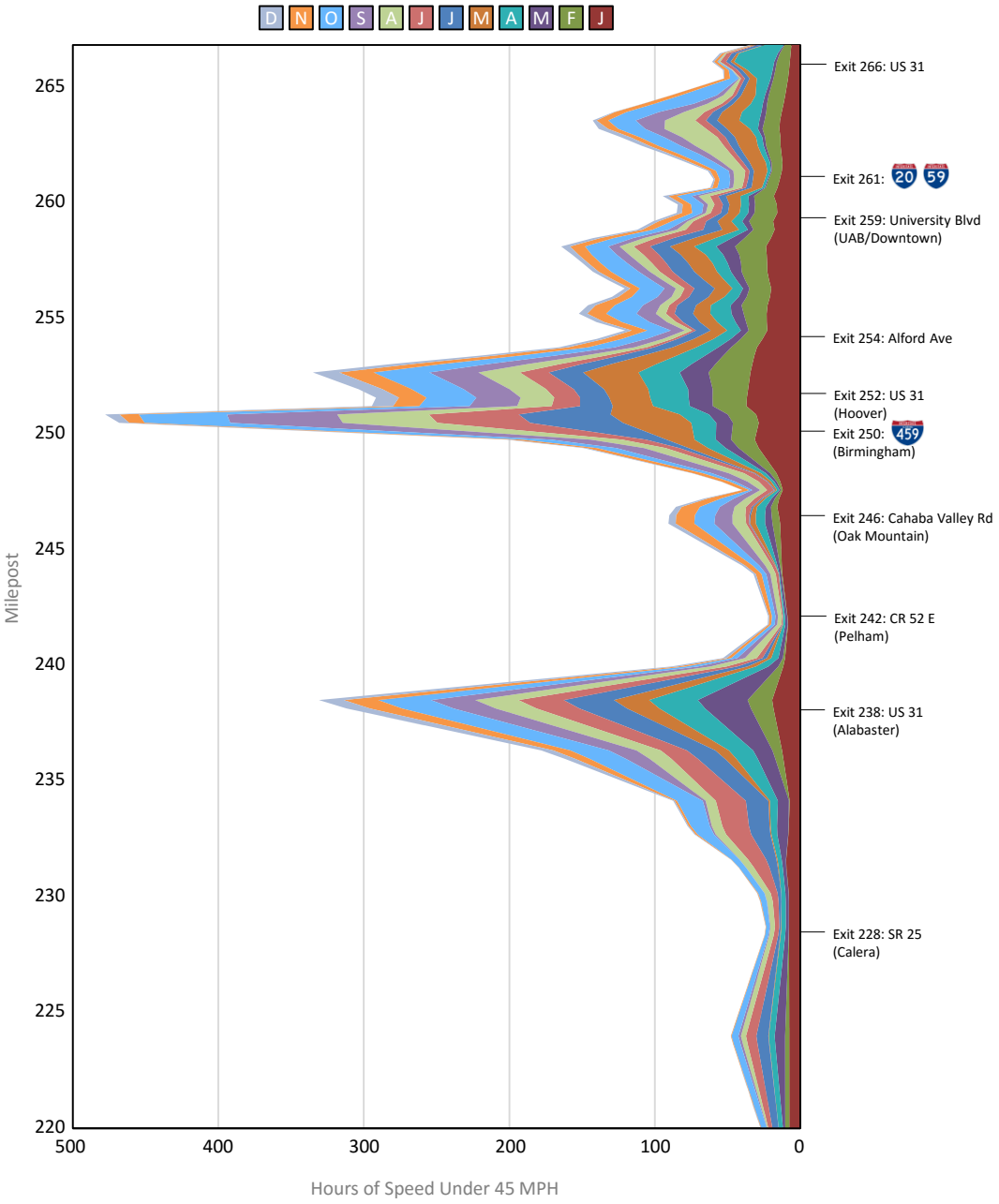


Figure 13-14. Congestion Hours for I-65 Northbound (Birmingham)

Notes

- Lots of congestion hours around milepost 242 in Pelham and milepost 259 downtown

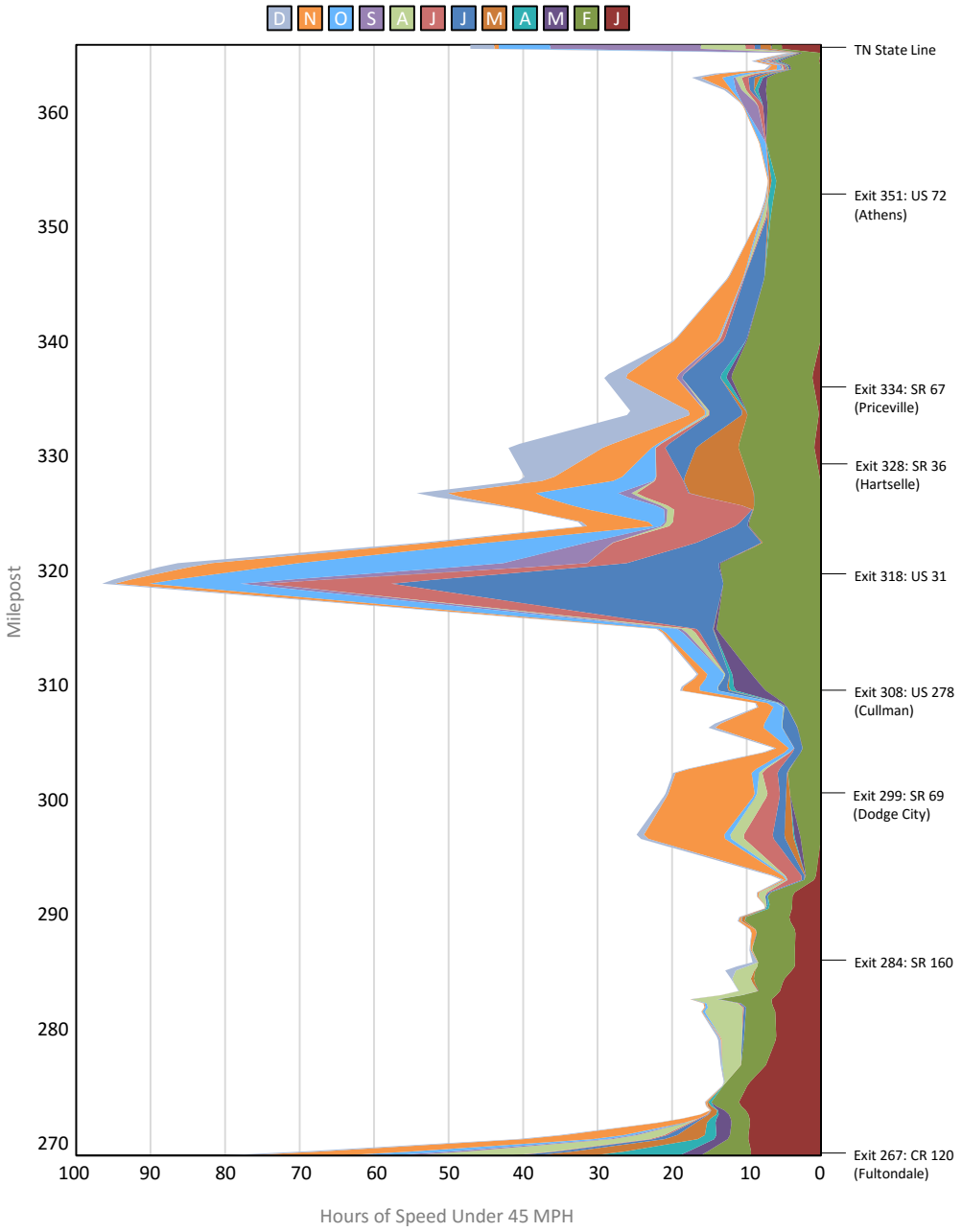


Figure 13-15. Congestion Hours for I-65 Southbound (Birmingham to Tennessee)

Notes

- Lots of congestion hours accumulated around milepost 318

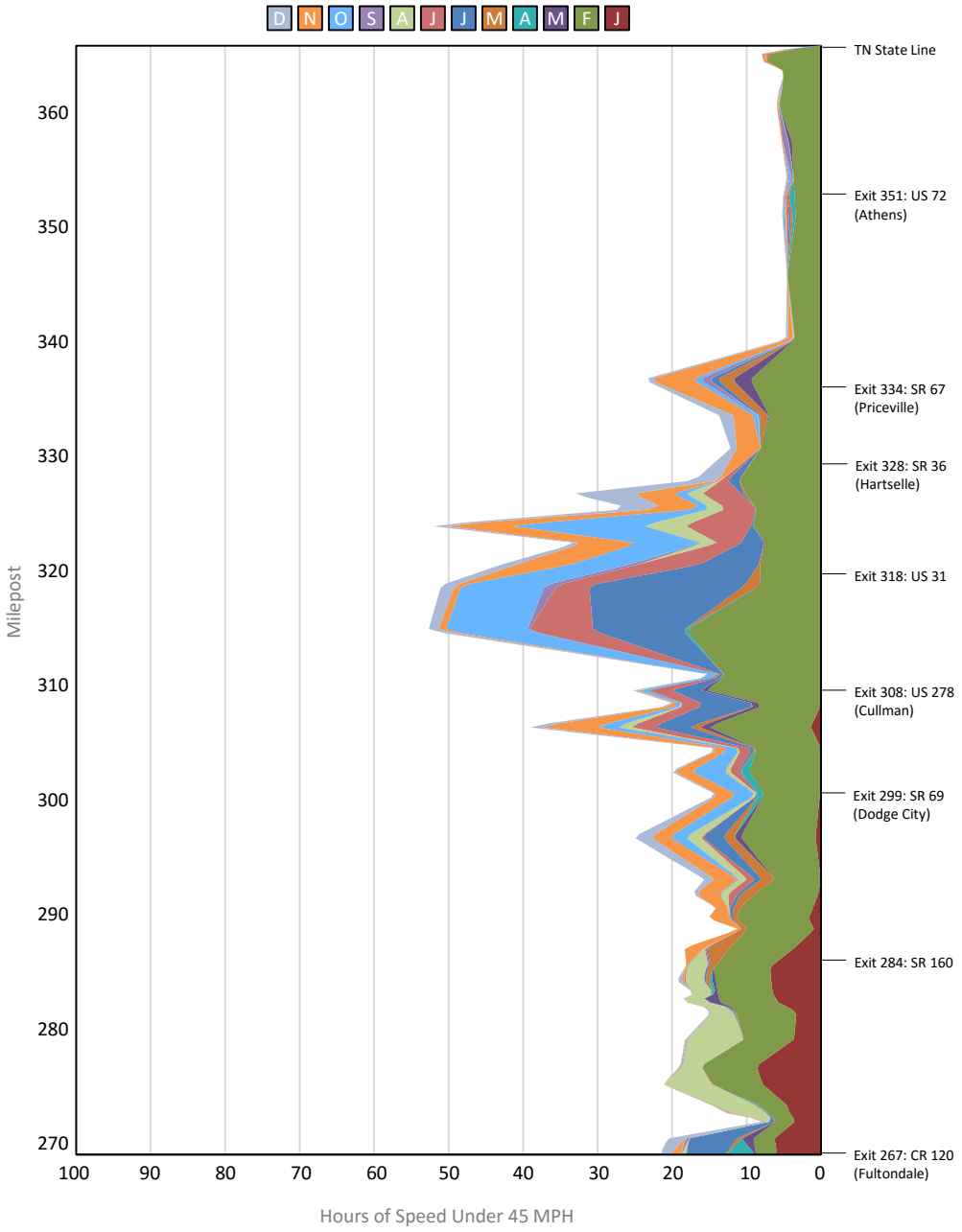


Figure 13-16. Congestion Hours for I-65 Northbound (Birmingham to Tennessee)

Notes

- Lots of congestion hours accumulated around milepost 318, especially in July and October

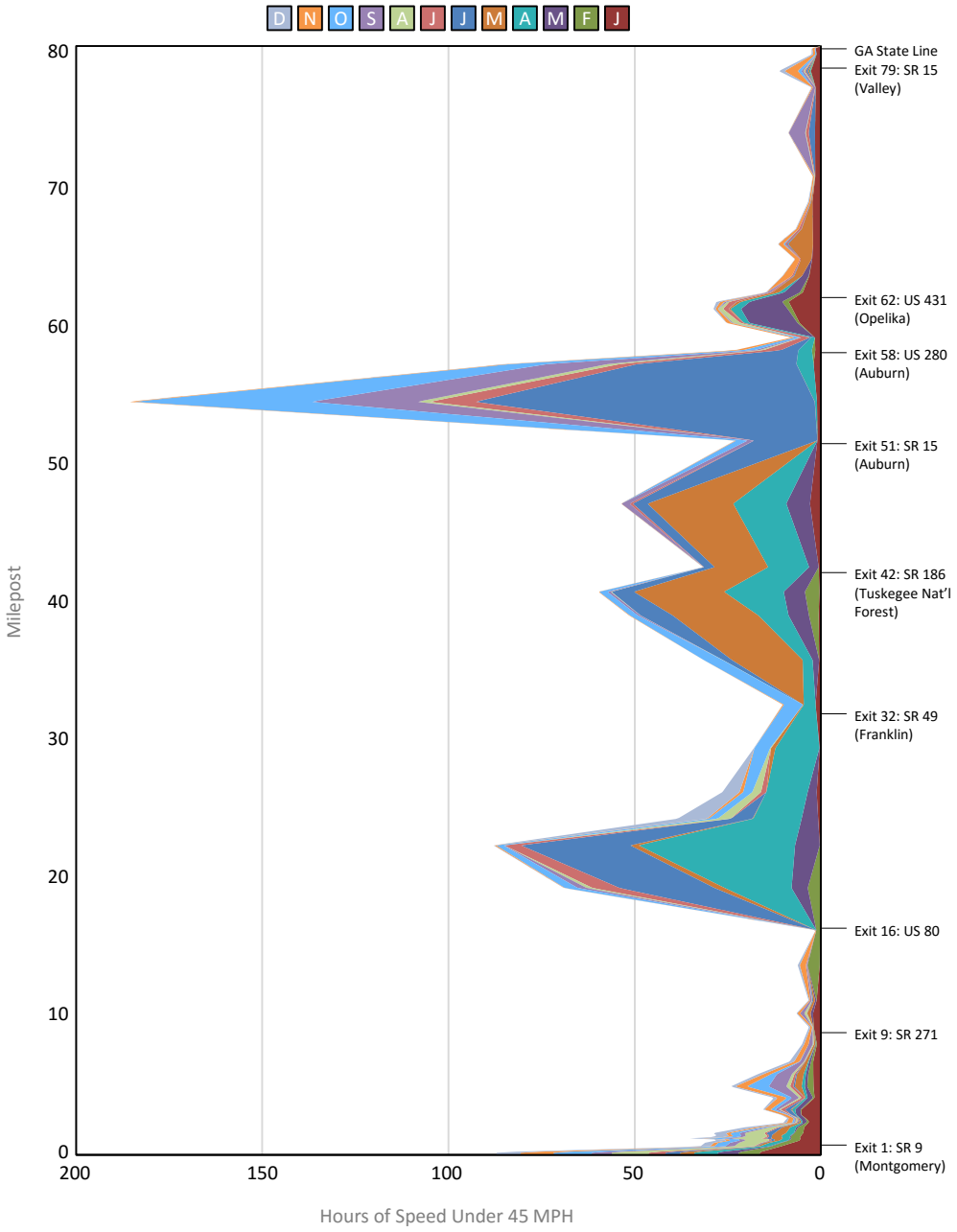


Figure 13-17. Congestion Hours for I-85 Southbound

Notes

- Lots of congestion hours accumulated between milepost 51 and milepost 58 in Auburn, especially in July and October
- Also, significant congestion around milepost 16 in April and July

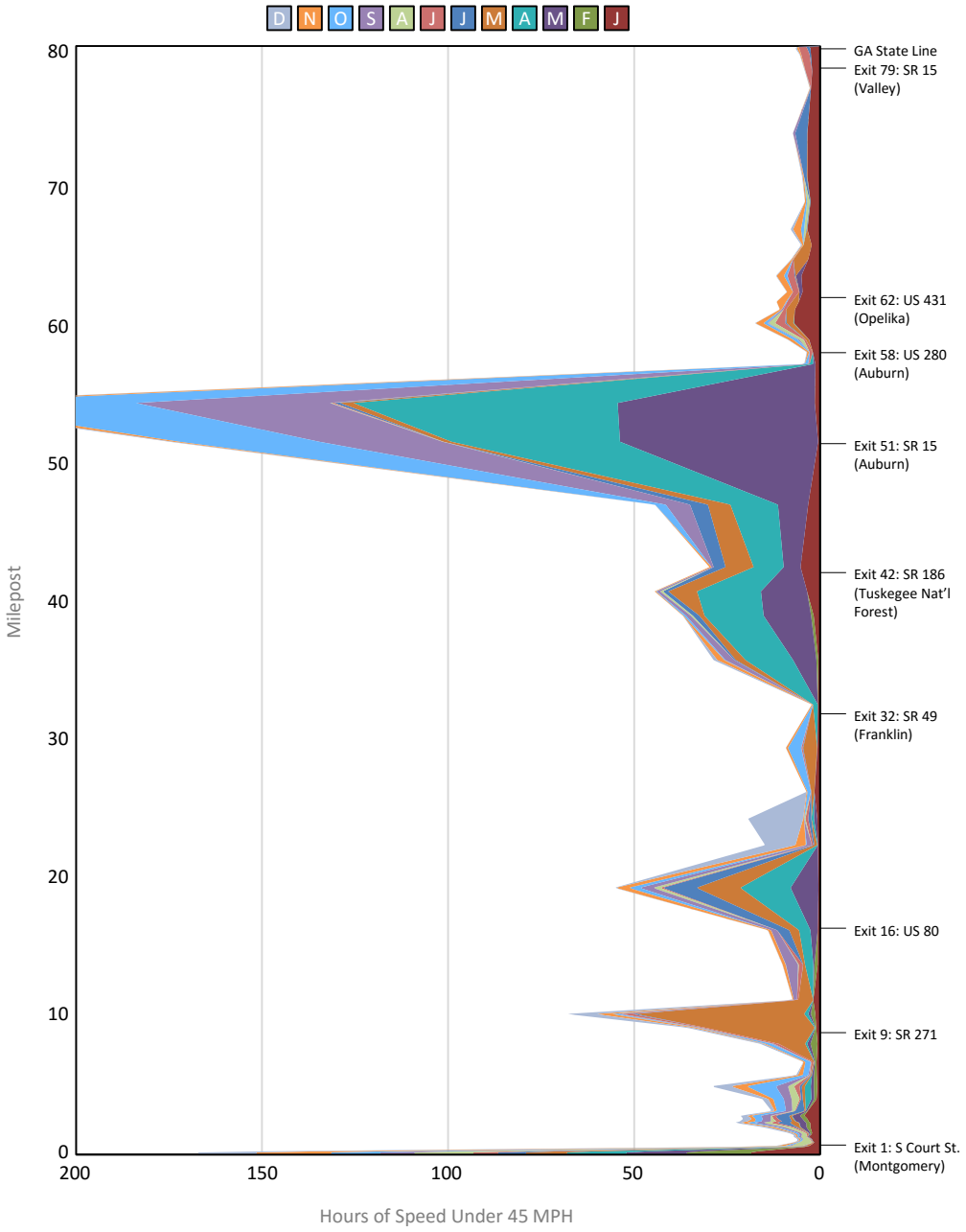


Figure 13-18. Congestion Hours for I-85 Northbound

Notes

- Lots of congestion hours accumulated between milepost 51 and milepost 58 in Auburn, especially in March, April, September, and October

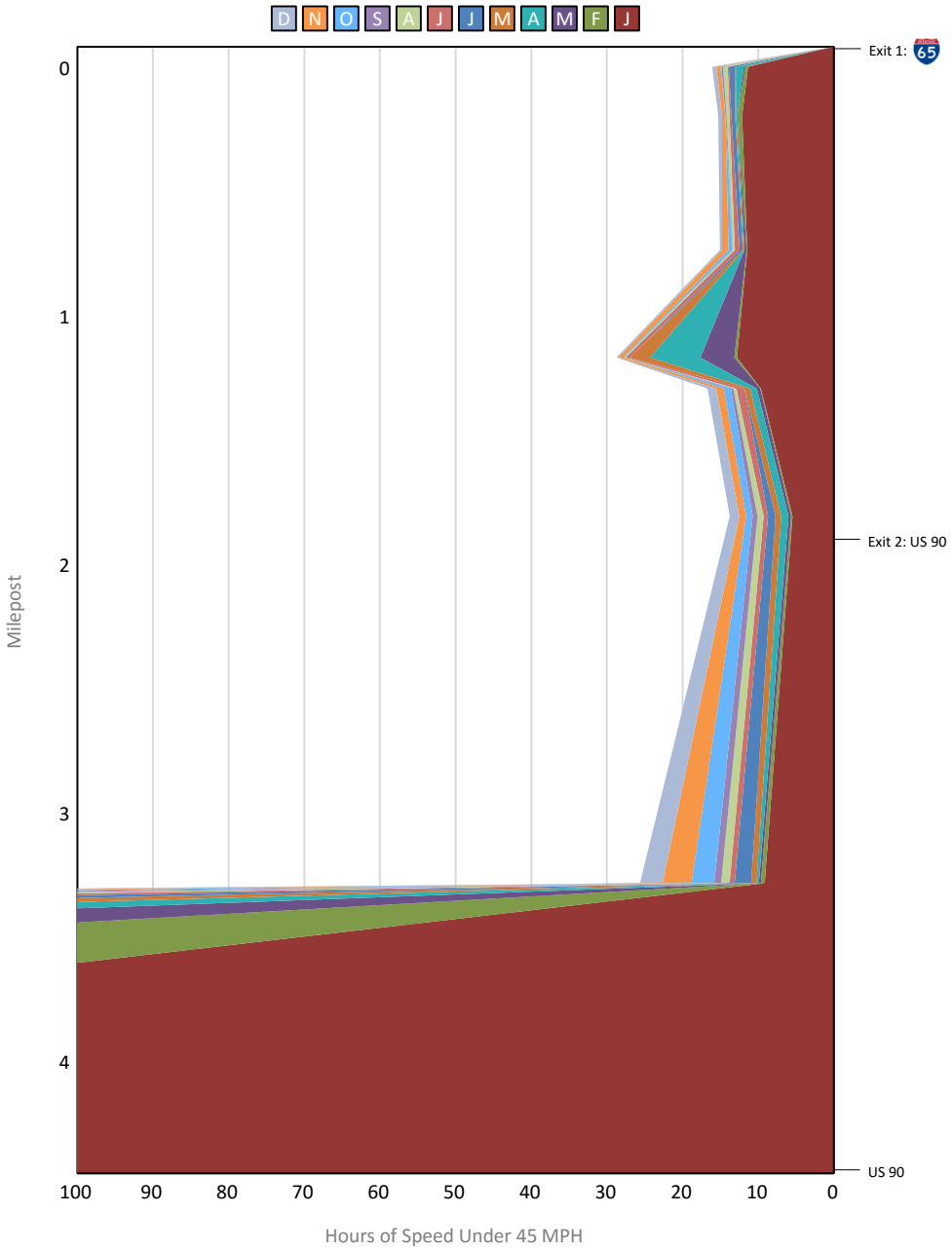


Figure 13-19. Congestion Hours for I-165 Southbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

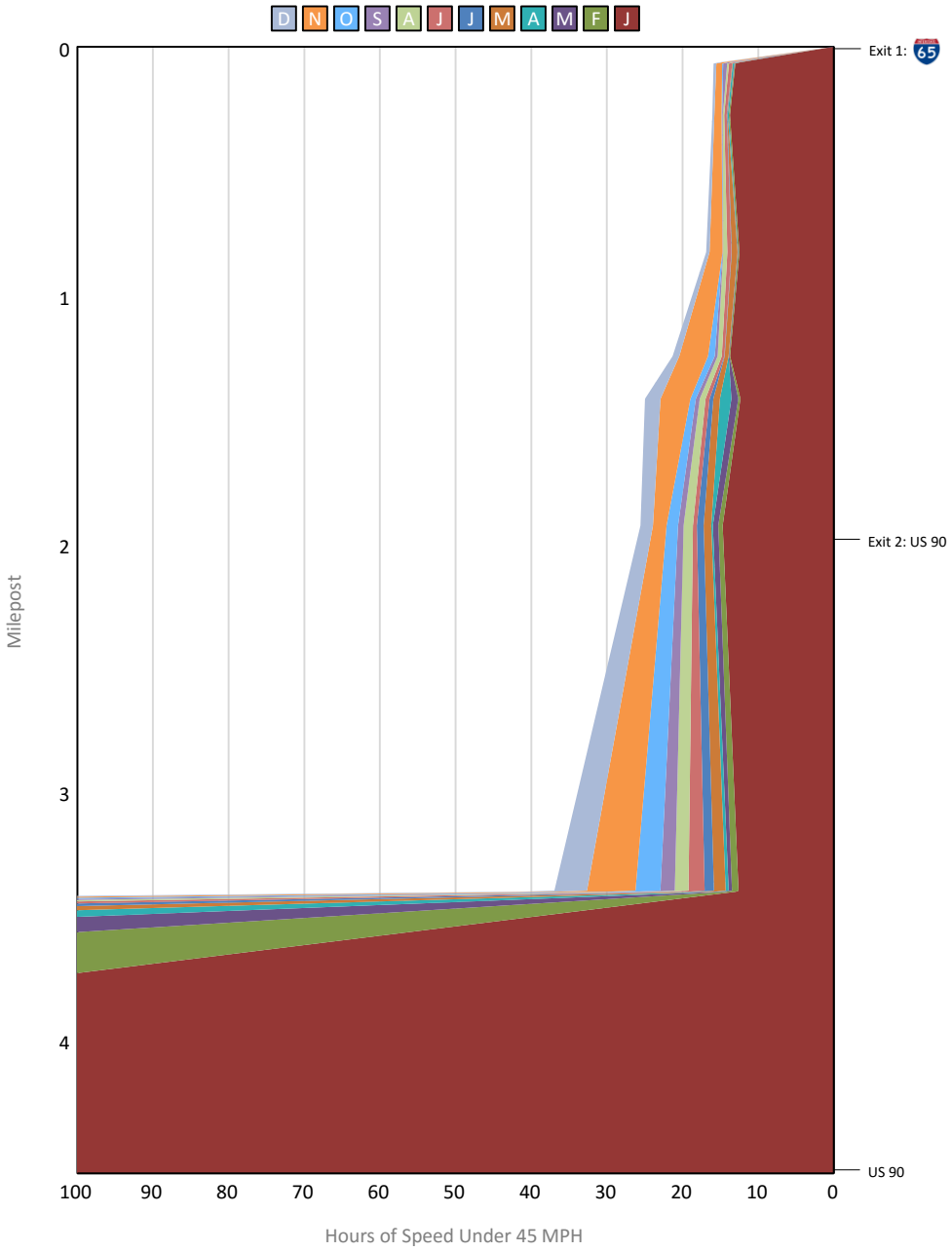


Figure 13-20. Congestion Hours for I-165 Northbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

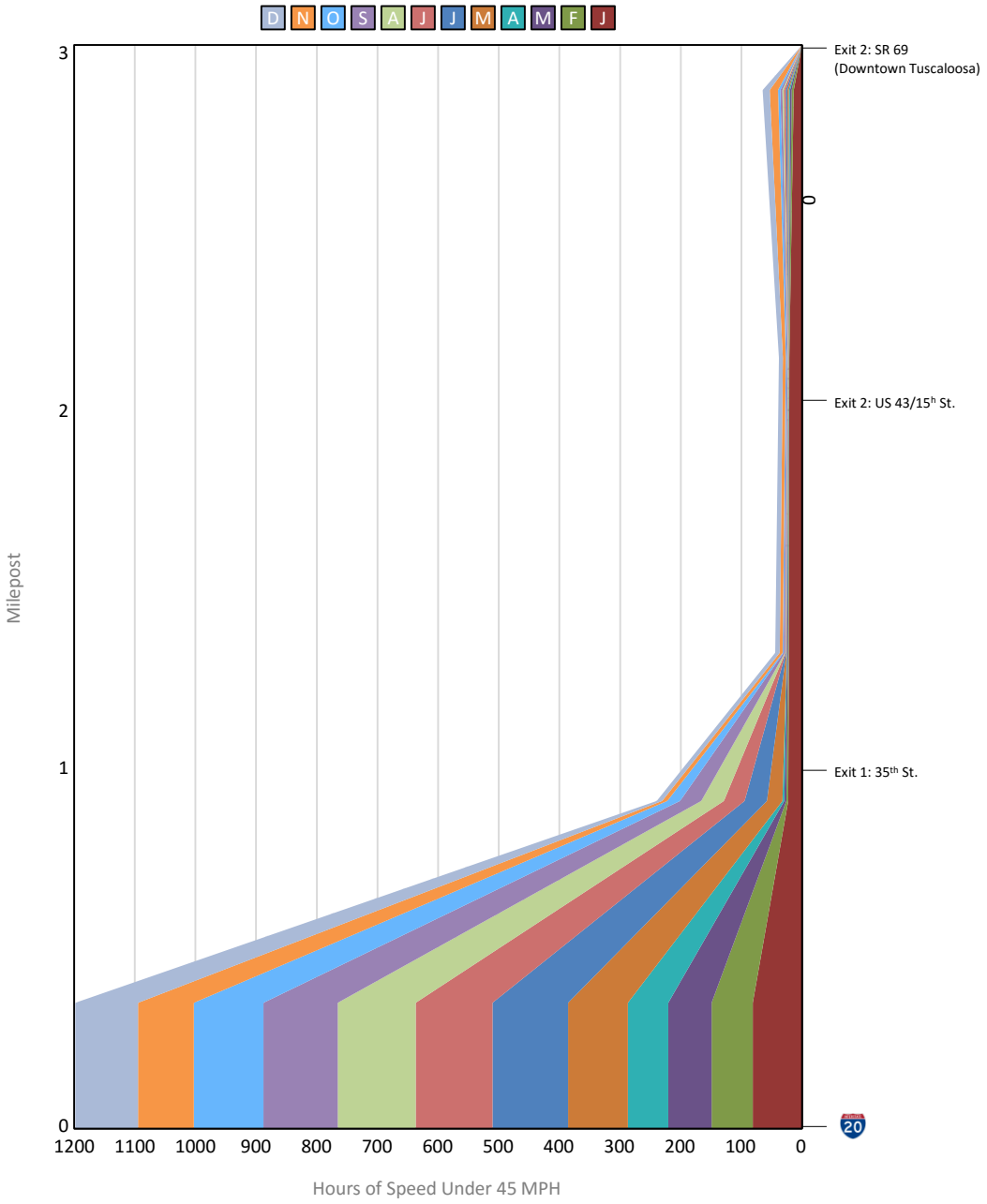


Figure 13-21. Congestion Hours for I-359 Southbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

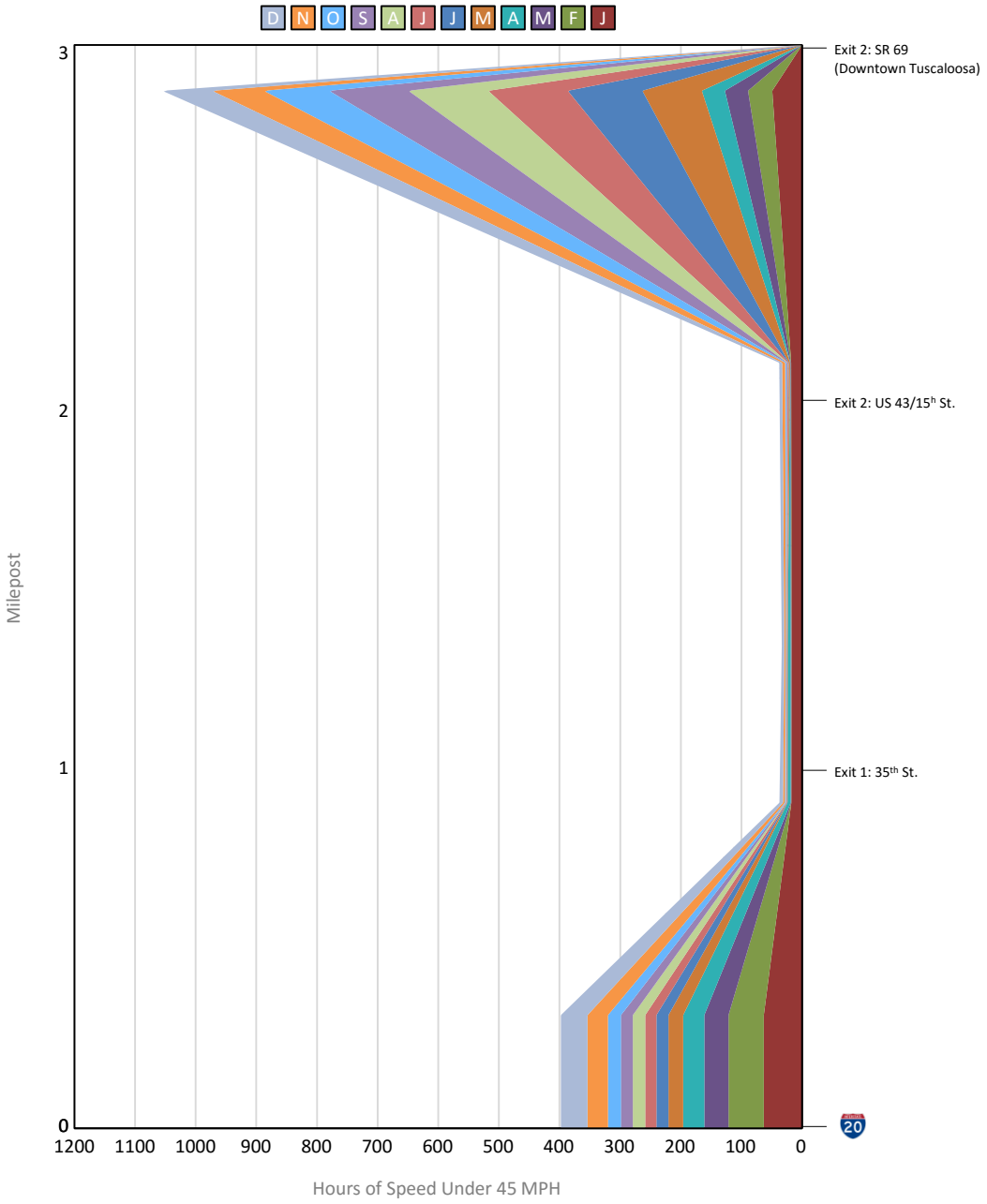


Figure 13-22. Congestion Hours for I-359 Northbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

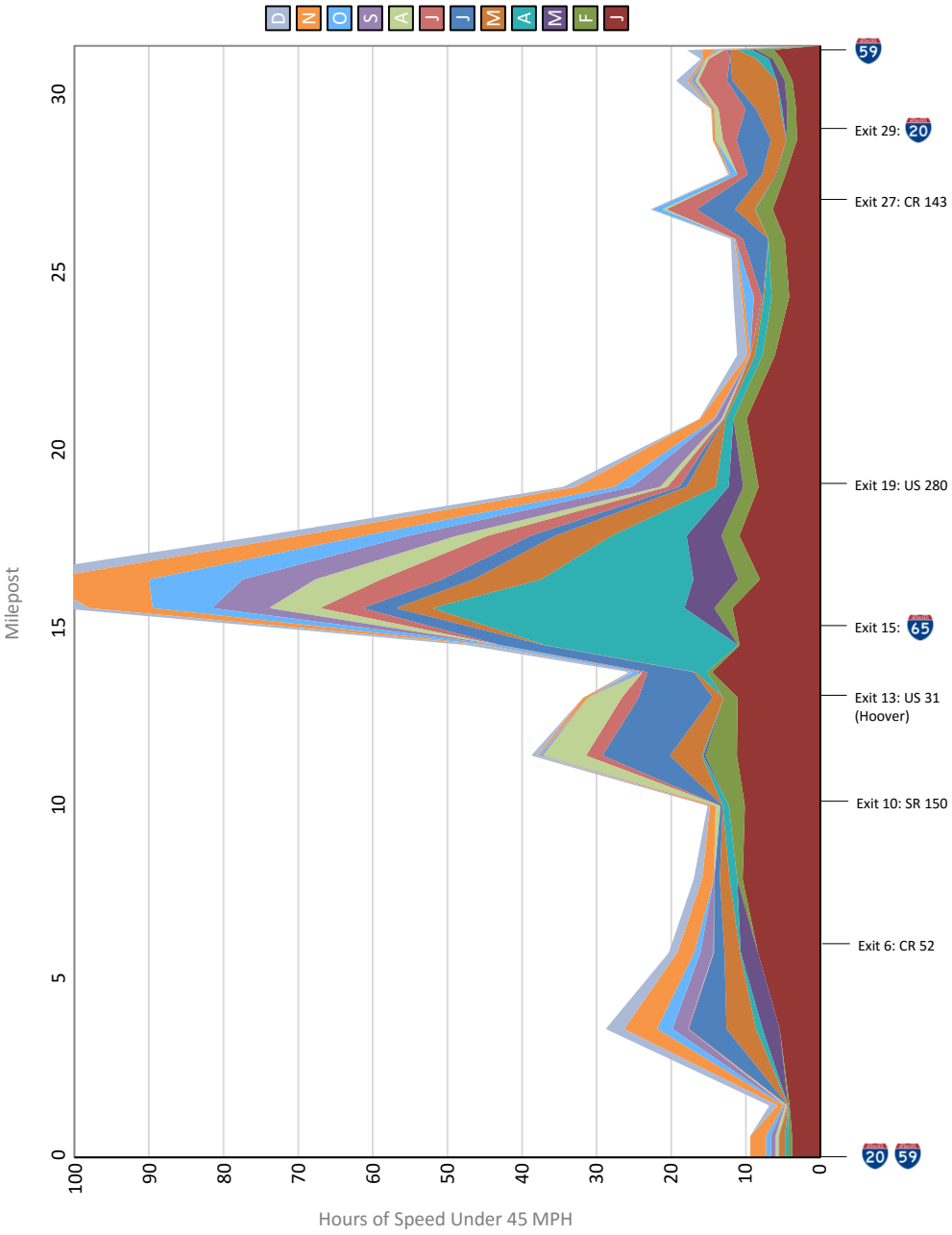


Figure 13-23. Congestion Hours for I-459 Westbound

Notes

- Lots of congestion hours accumulated near milepost 15 at the I-65 interchange

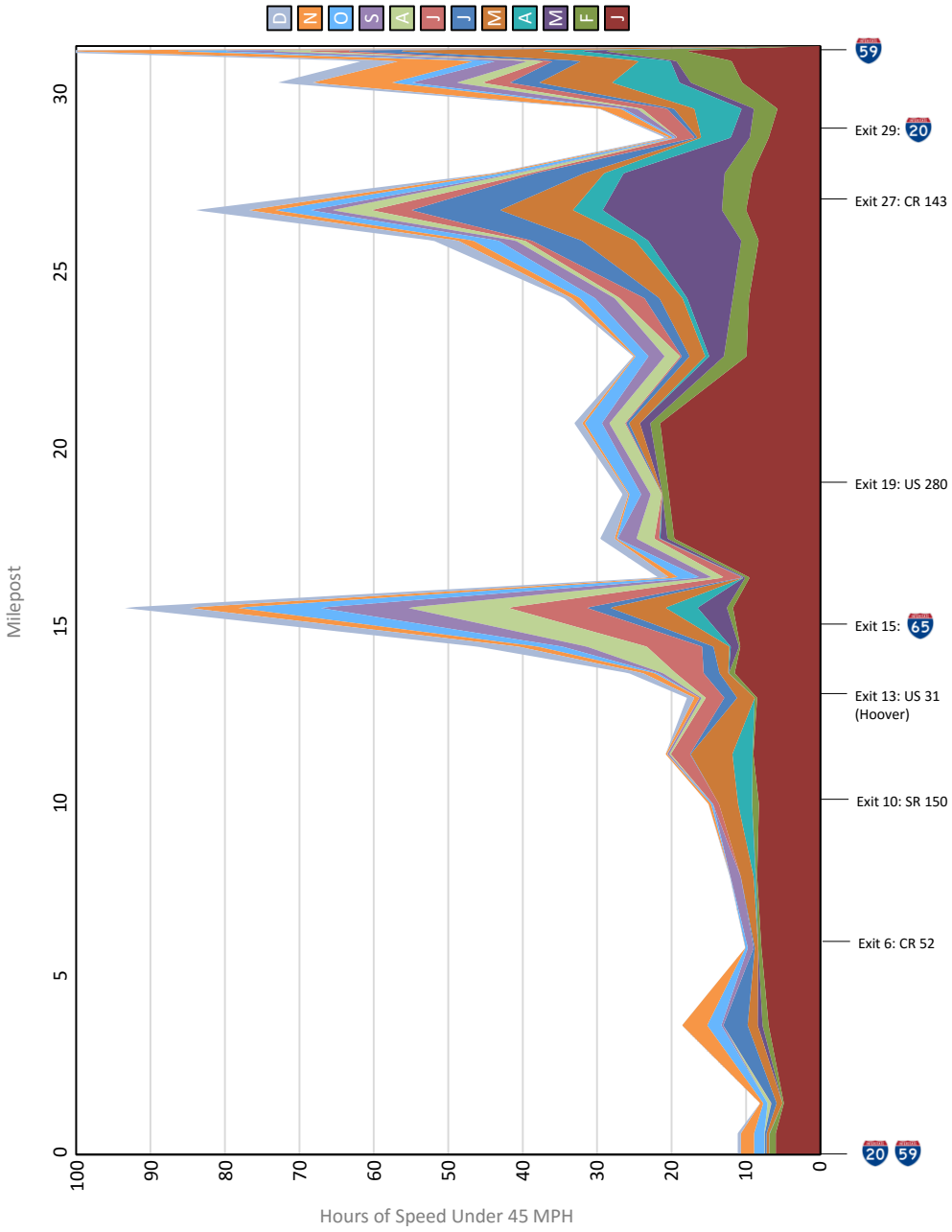


Figure 13-24. Congestion Hours for I-459 Eastbound

Notes

- Lots of congestion hours accumulated near milepost 15 at the I-65 interchange
- Lots of congestion hours accumulated near milepost 27

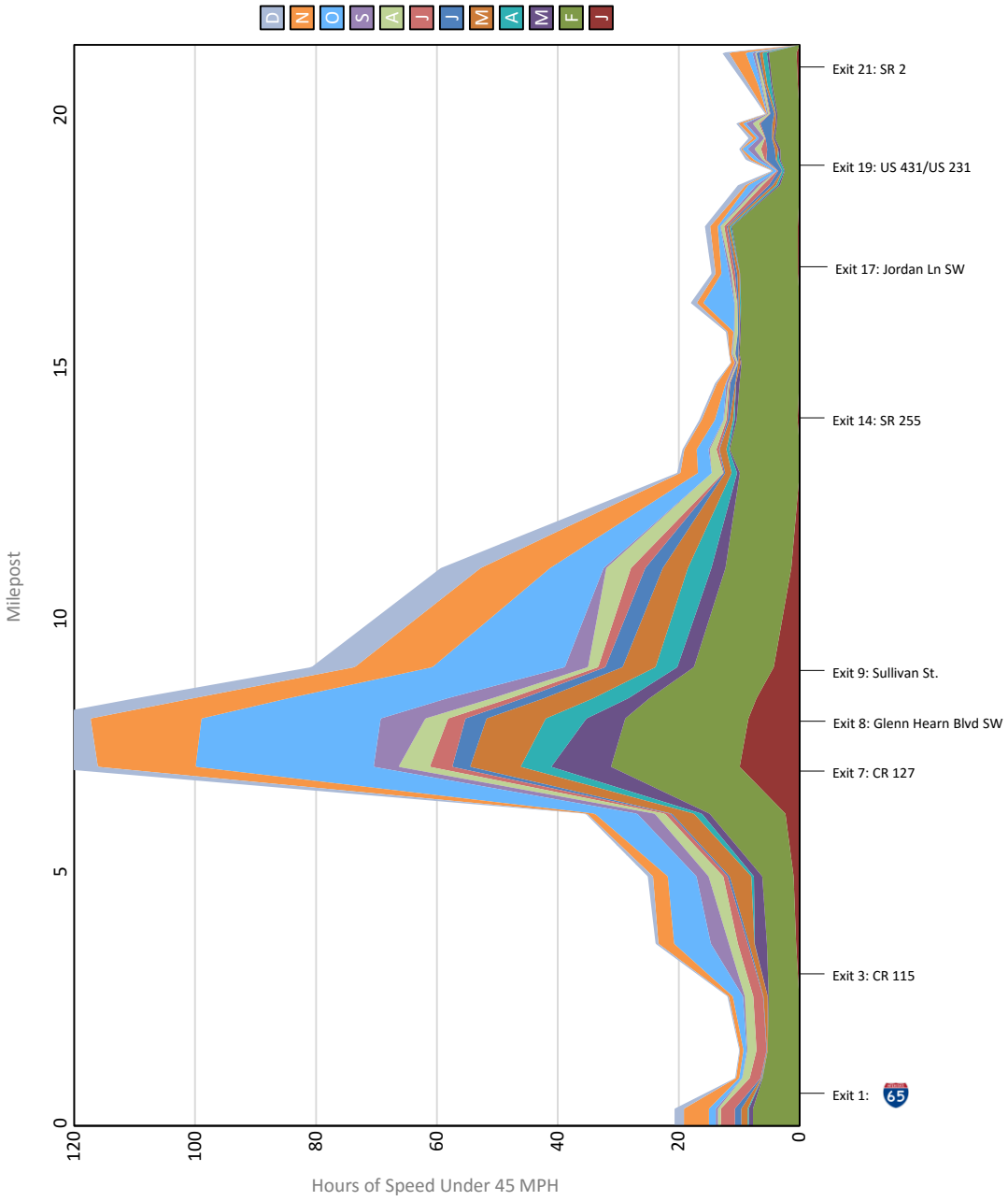


Figure 13-25. Congestion Hours for I-565 Westbound

Notes

- Lots of congestion hours accumulated between milepost 6 and milepost 13. Appears to be recurring commuter congestion.

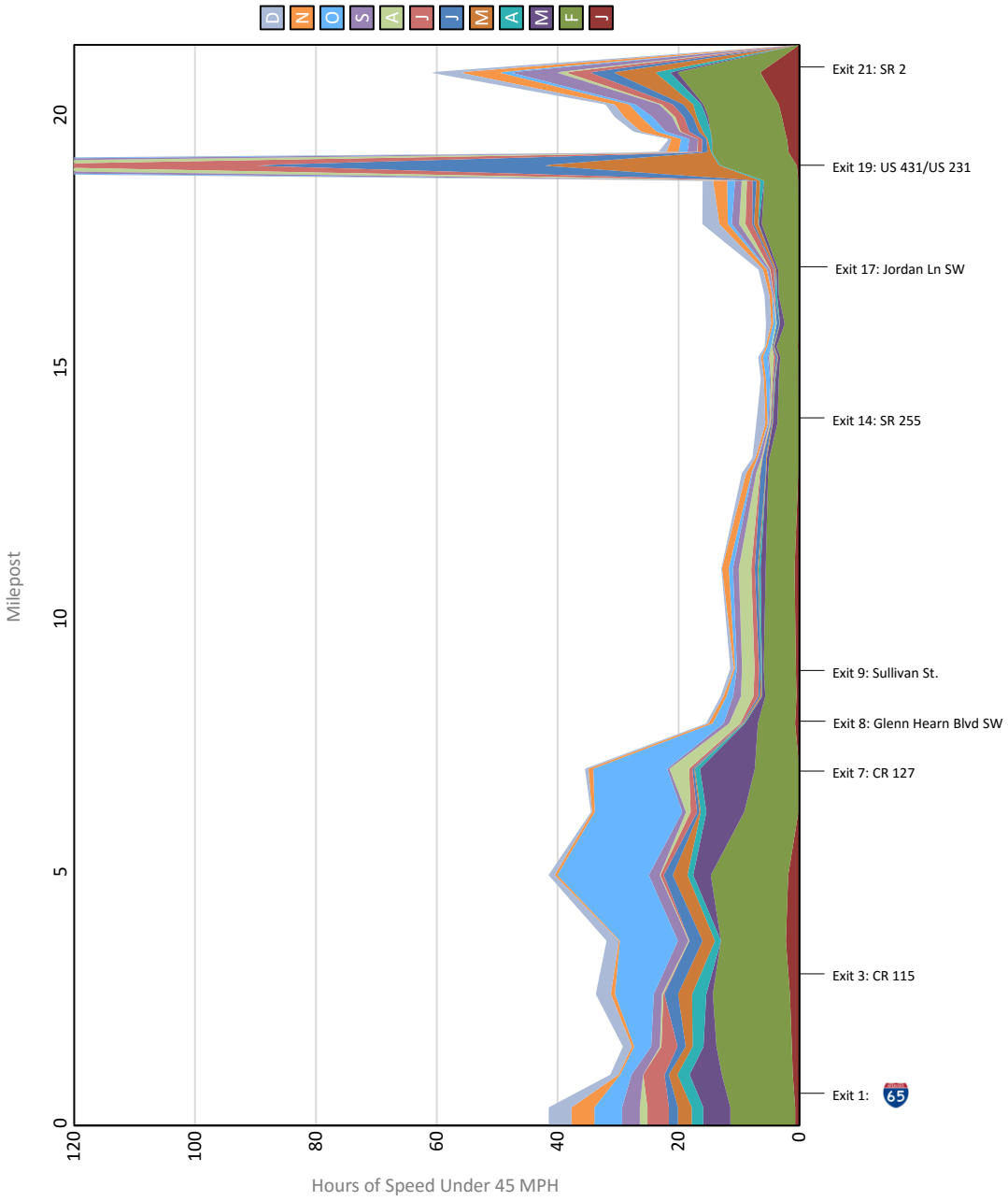


Figure 13-26. Congestion Hours for I-565 Eastbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates
- Large spike of congestion hours near milepost 19

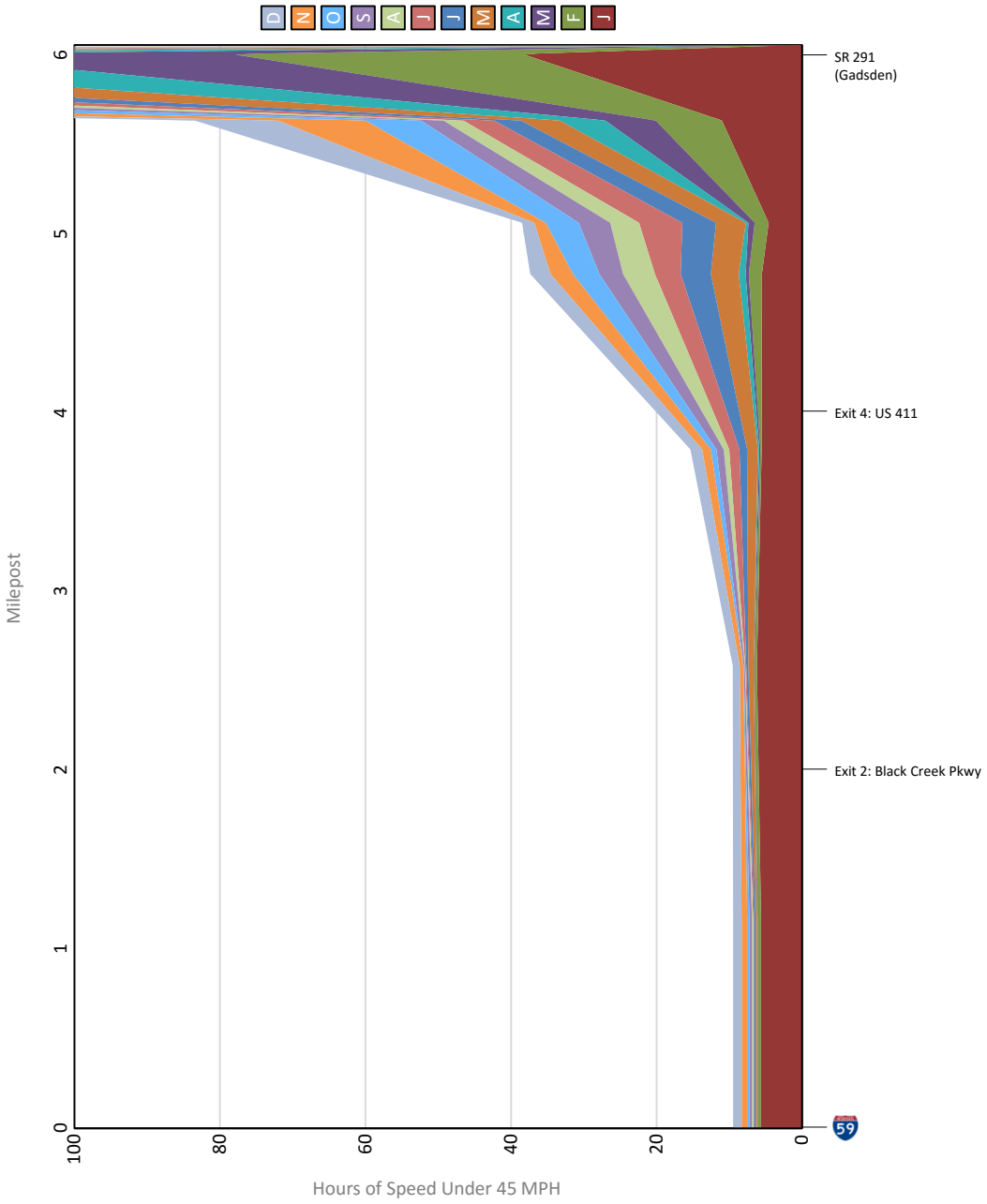


Figure 13-27. Congestion Hours for I-759 Westbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

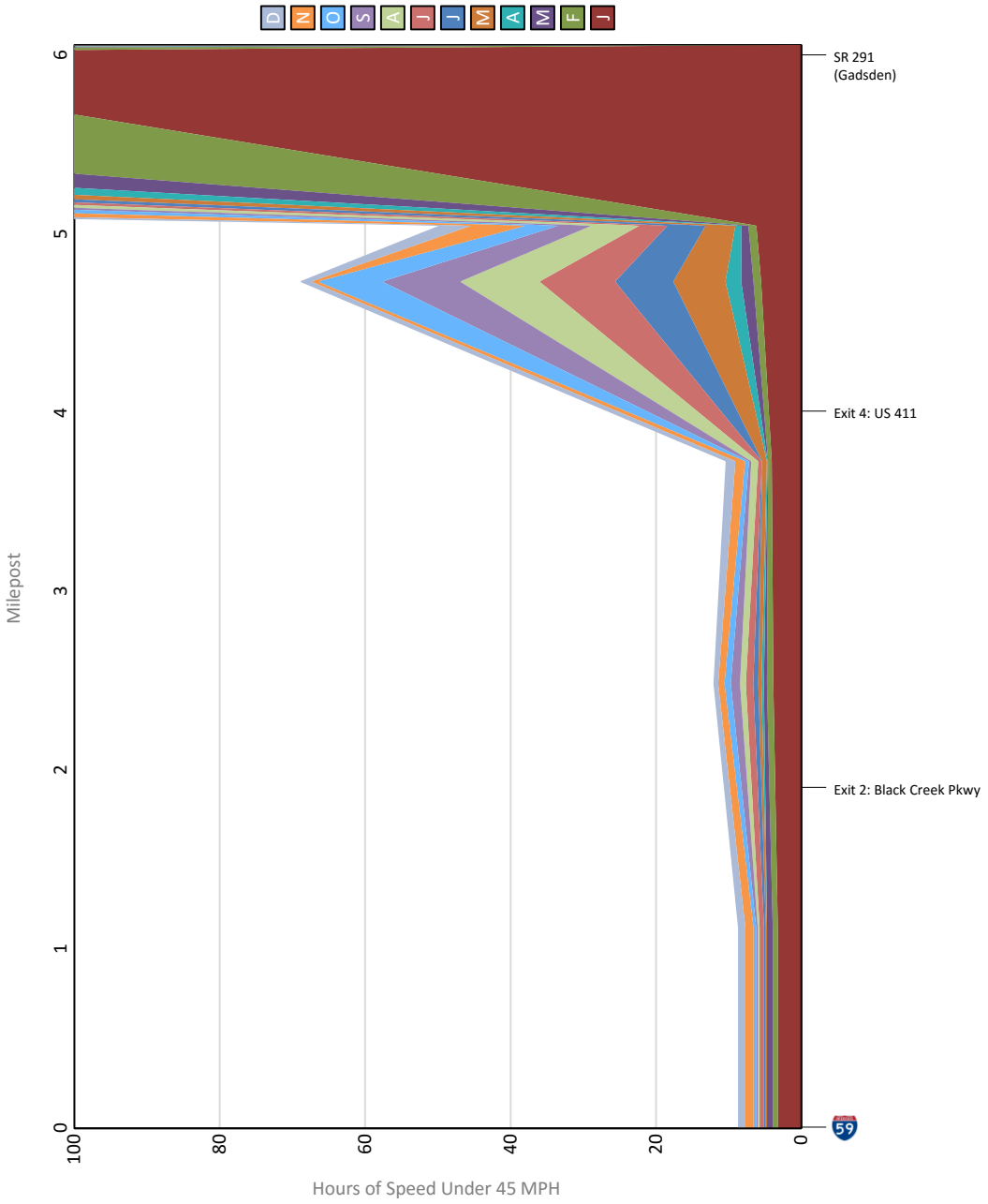


Figure 13-28. Congestion Hours for I-759 Eastbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

14.0 Appendix C – 70th Percentile Speed Differential Graphs

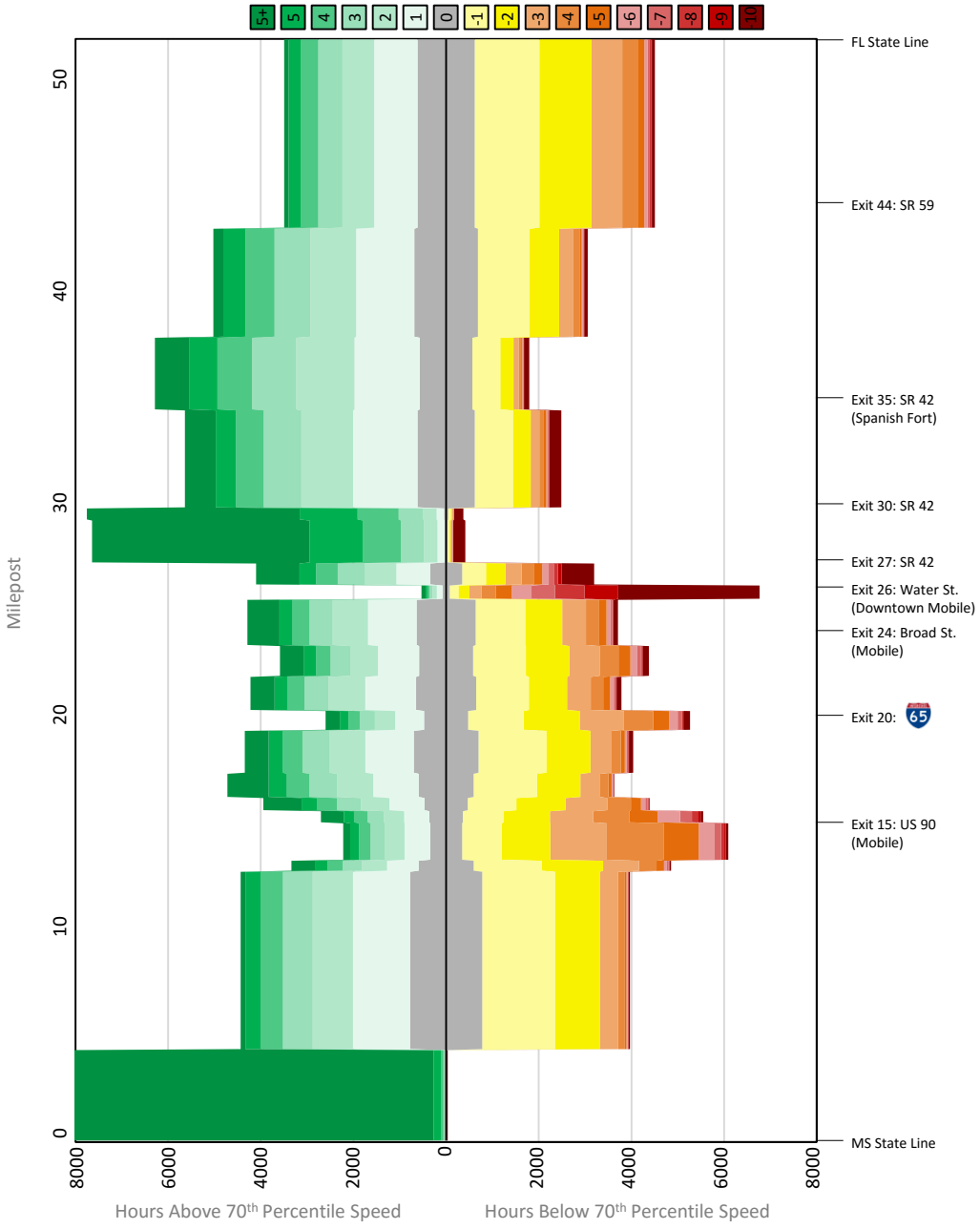


Figure 14-1. 70th Percentile Speed Graph for I-10 Westbound

Notes

- Large accumulation of hours below free flow speed near milepost 26 due to seasonal travel

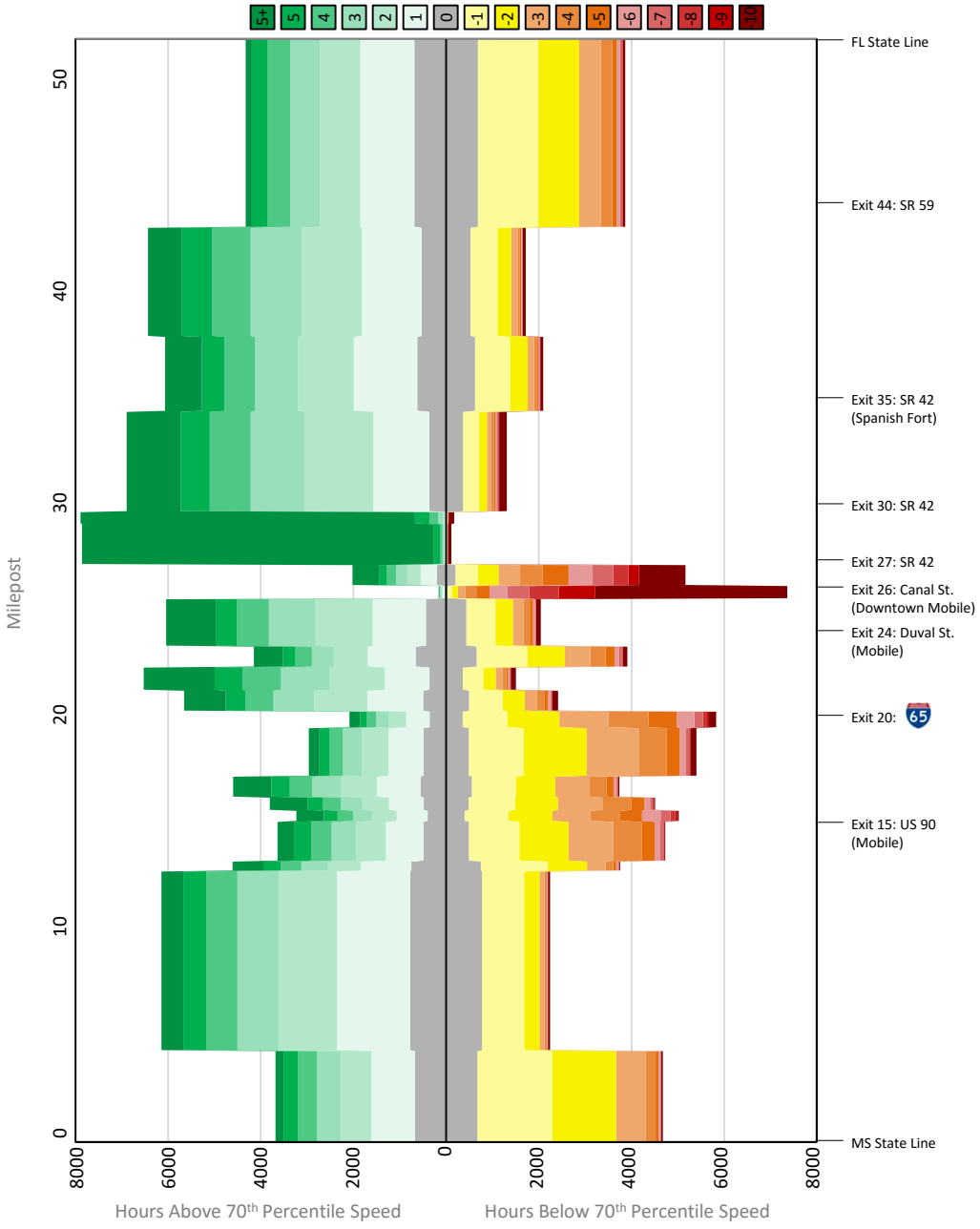


Figure 14-2. 70th Percentile Speed Graph for I-10 Eastbound

Notes

- Large accumulation of hours below free flow speed near milepost 26 due to seasonal travel

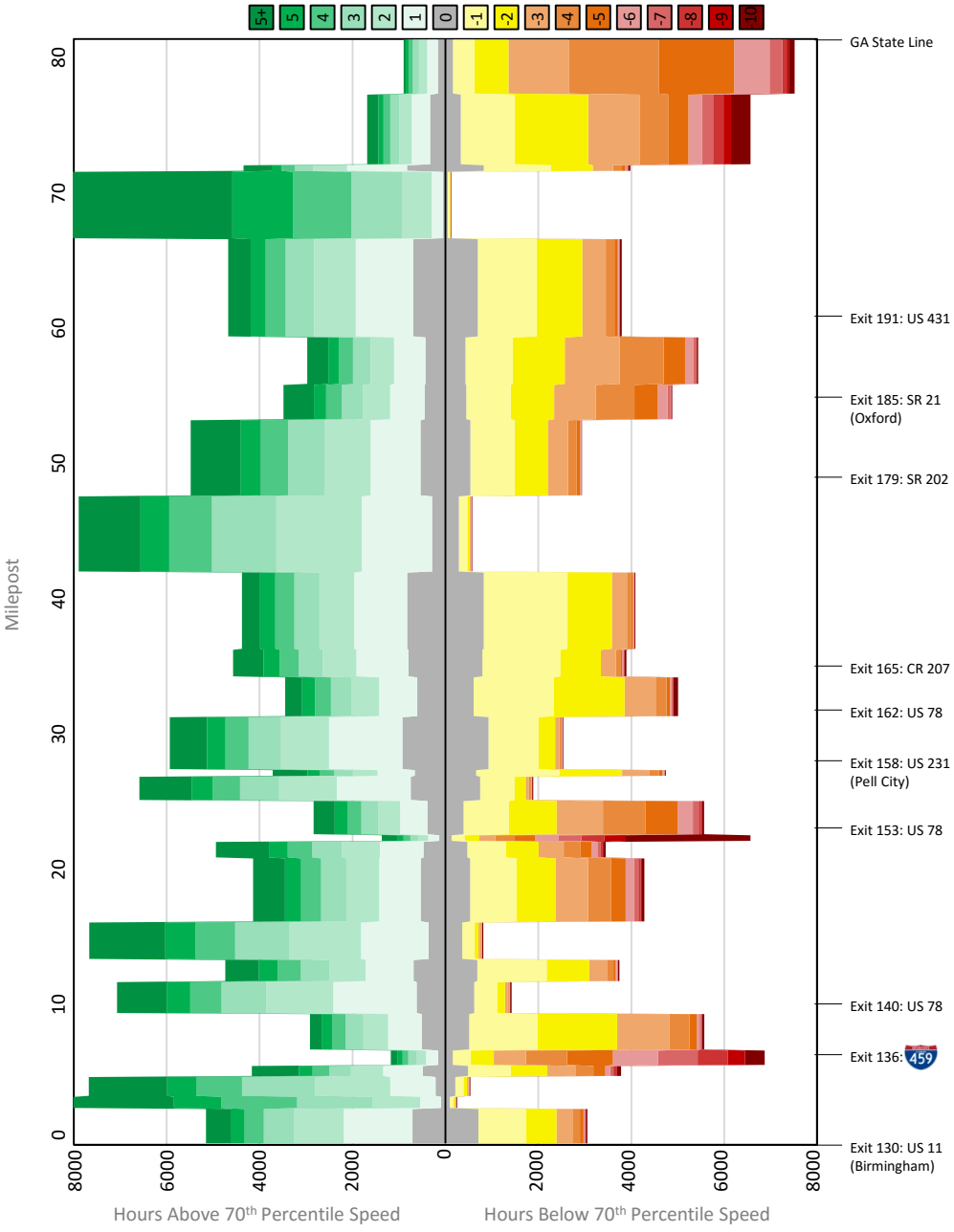


Figure 14-3. 70th Percentile Speed Graph for I-20 Westbound

Notes

- Large accumulation of hours below free flow speed near the Georgia state line

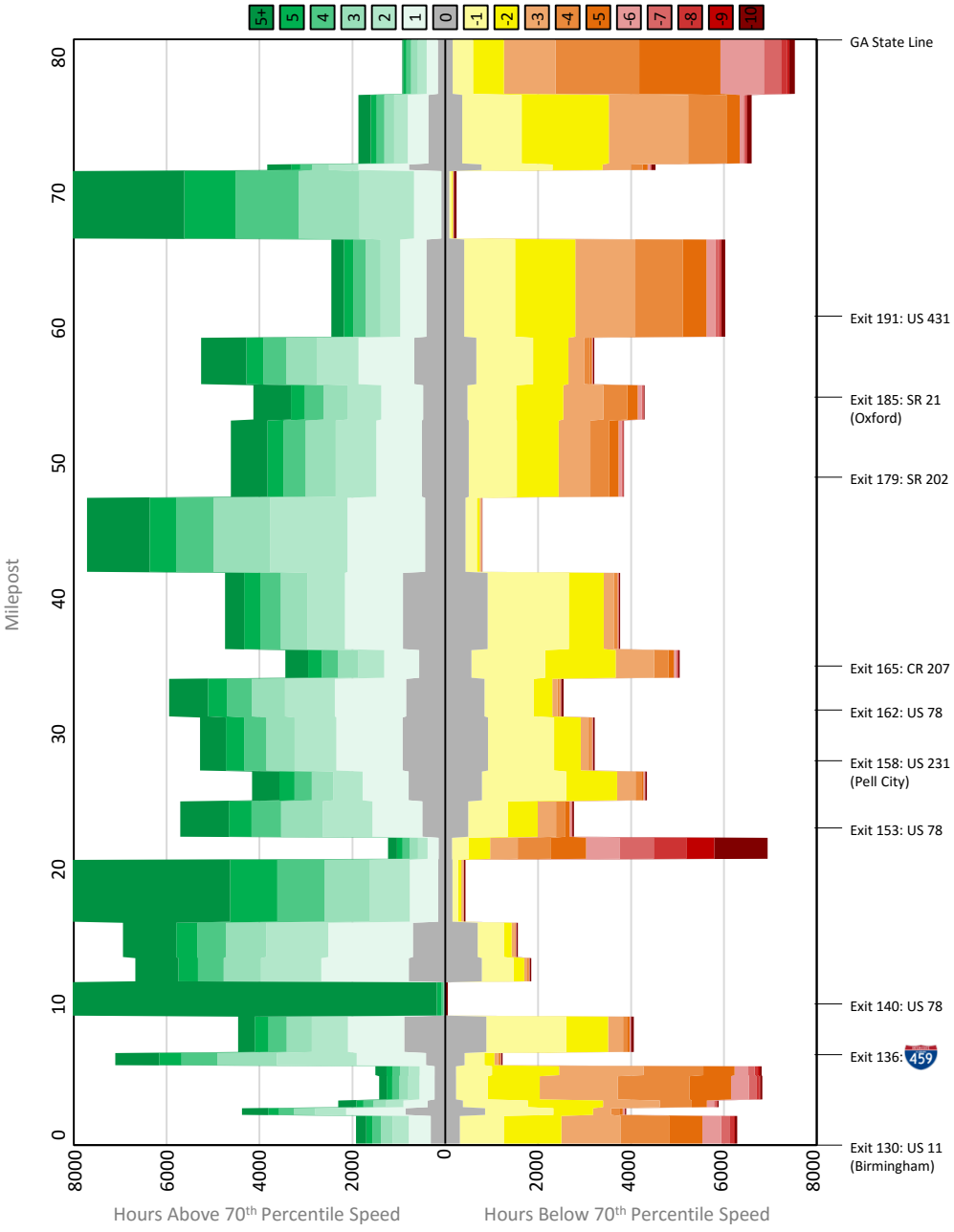


Figure 14-4. 70th Percentile Speed Graph for I-20 Eastbound

Notes

- Large accumulation of hours below free flow speed near the Georgia state line
- Large accumulation of hours below free flow speed near mile post 153

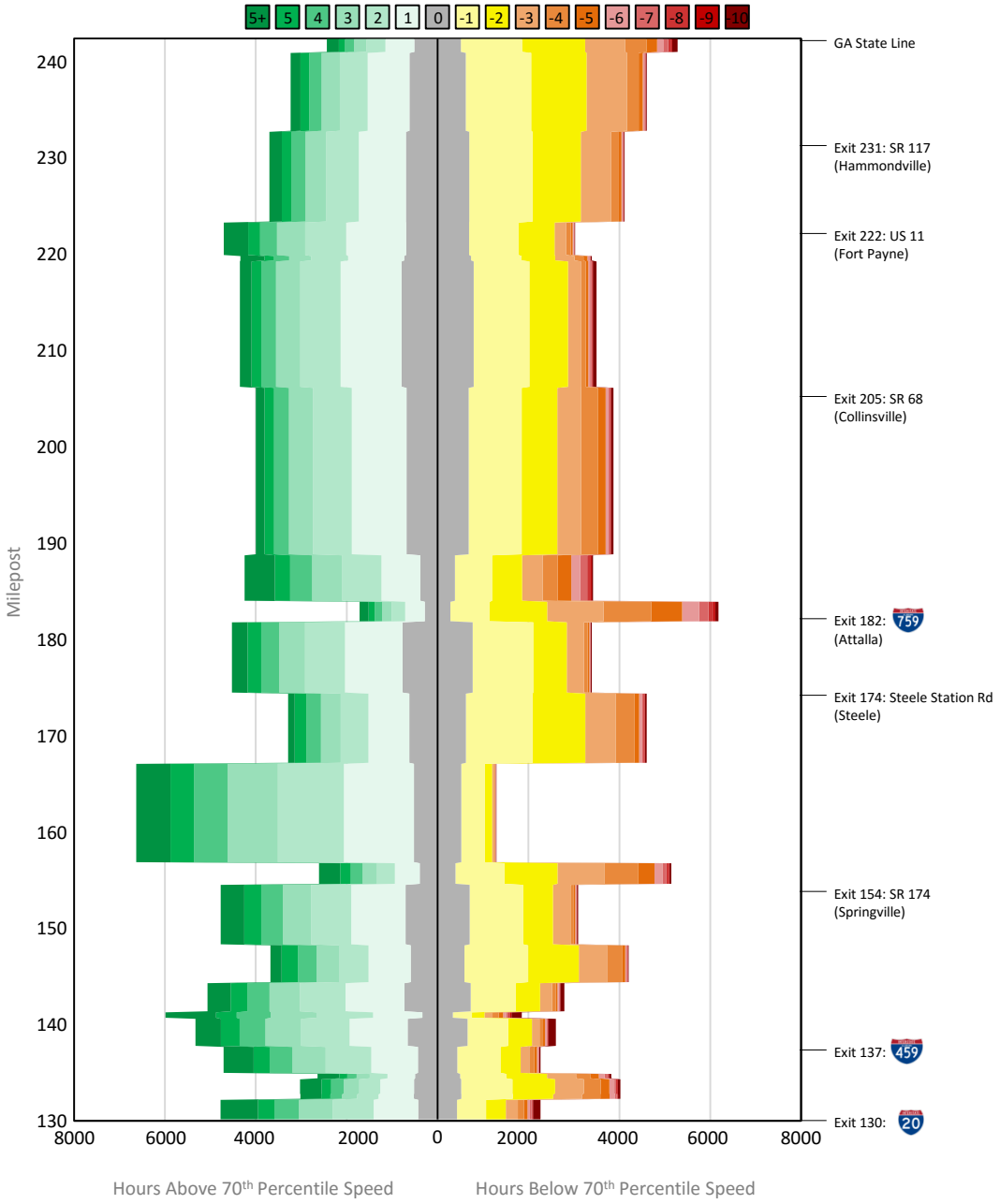


Figure 14-5. 70th Percentile Speed Graph for I-59 Southbound

Notes

- Minor accumulation of hours below the free flow speed near milepost 182

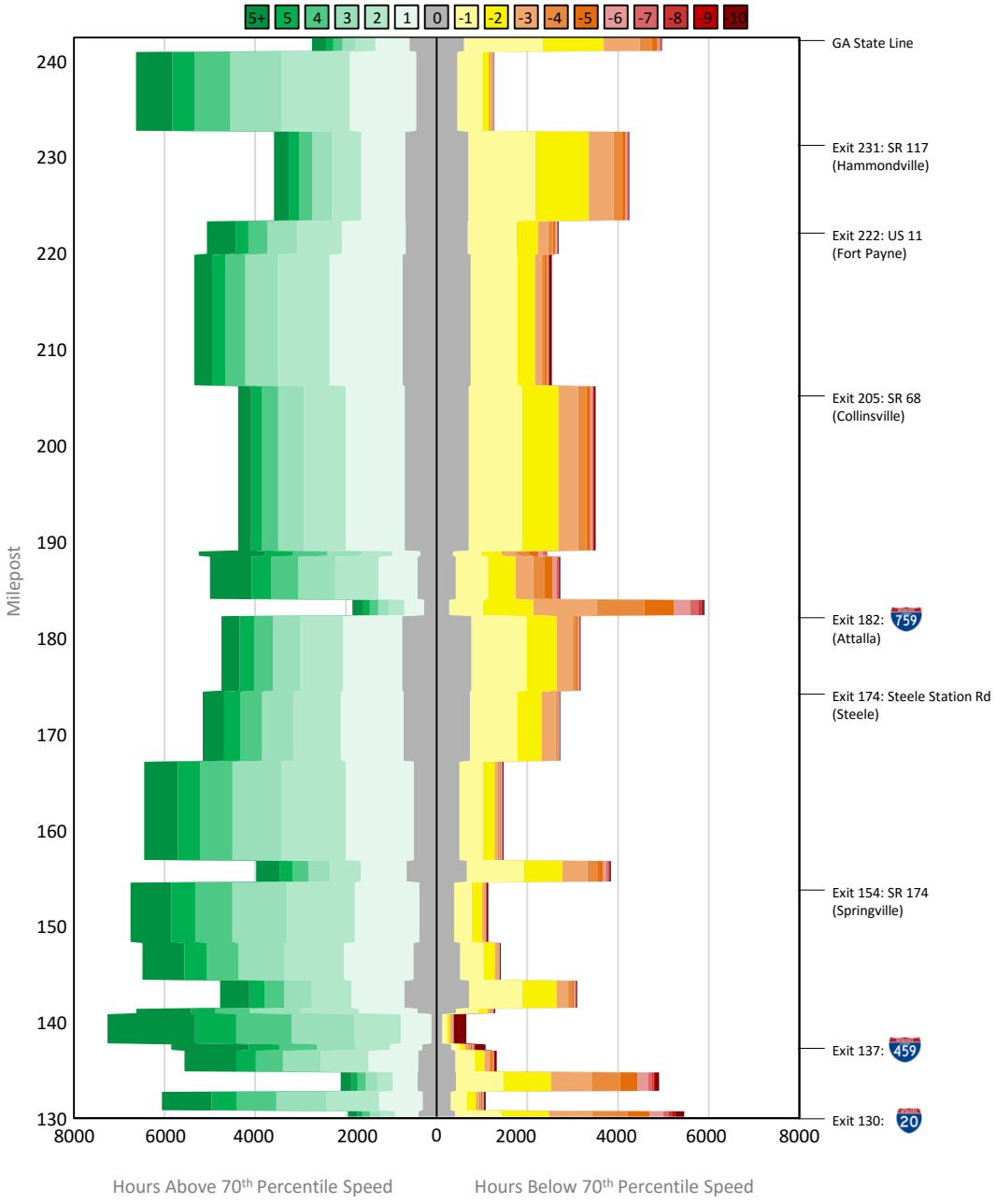


Figure 14-6. 70th Percentile Speed Graph for I-59 Northbound

Notes

- Minor accumulation of hours below the free flow speed near milepost 182
- Minor accumulation of hours below the free flow speed near milepost 134

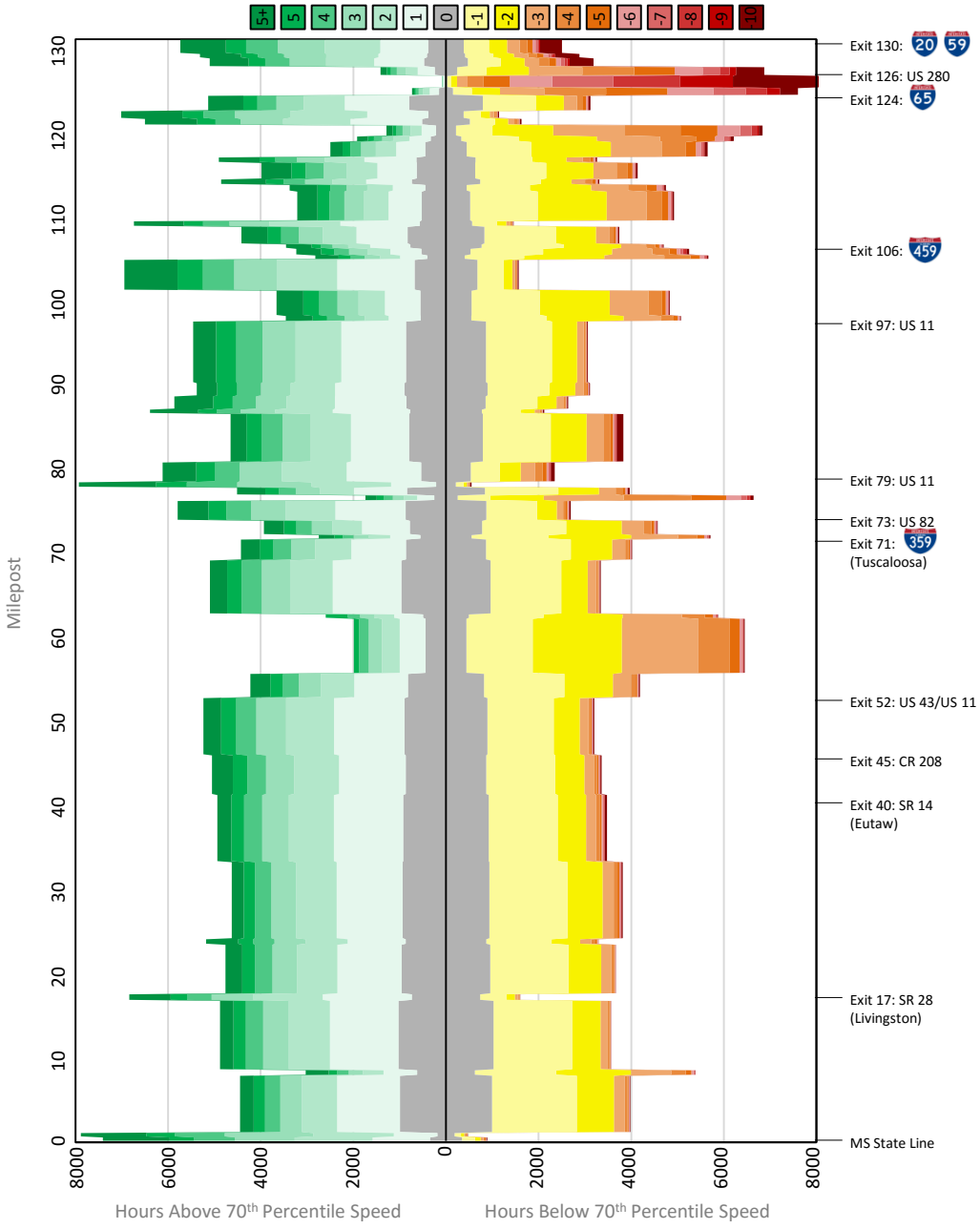


Figure 14-7. 70th Percentile Speed Graph for I-59/I-20 Westbound

Notes

- Large accumulation of hours below the free flow speed between milepost 124 and milepost 126

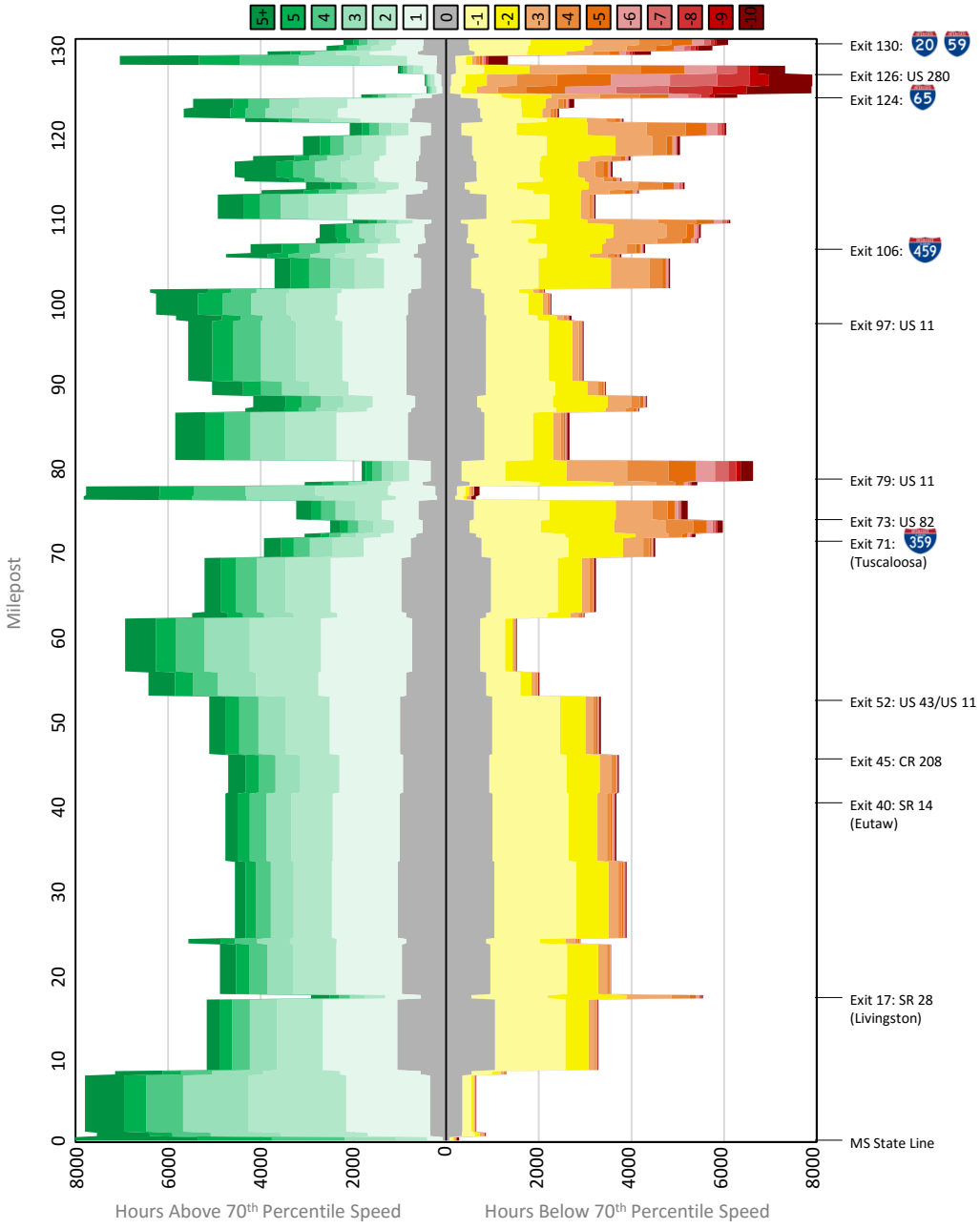


Figure 14-8. 70th Percentile Speed Graph for I-59/I-20 Eastbound

Notes

- Large accumulation of hours below the free flow speed between milepost 124 and milepost 126

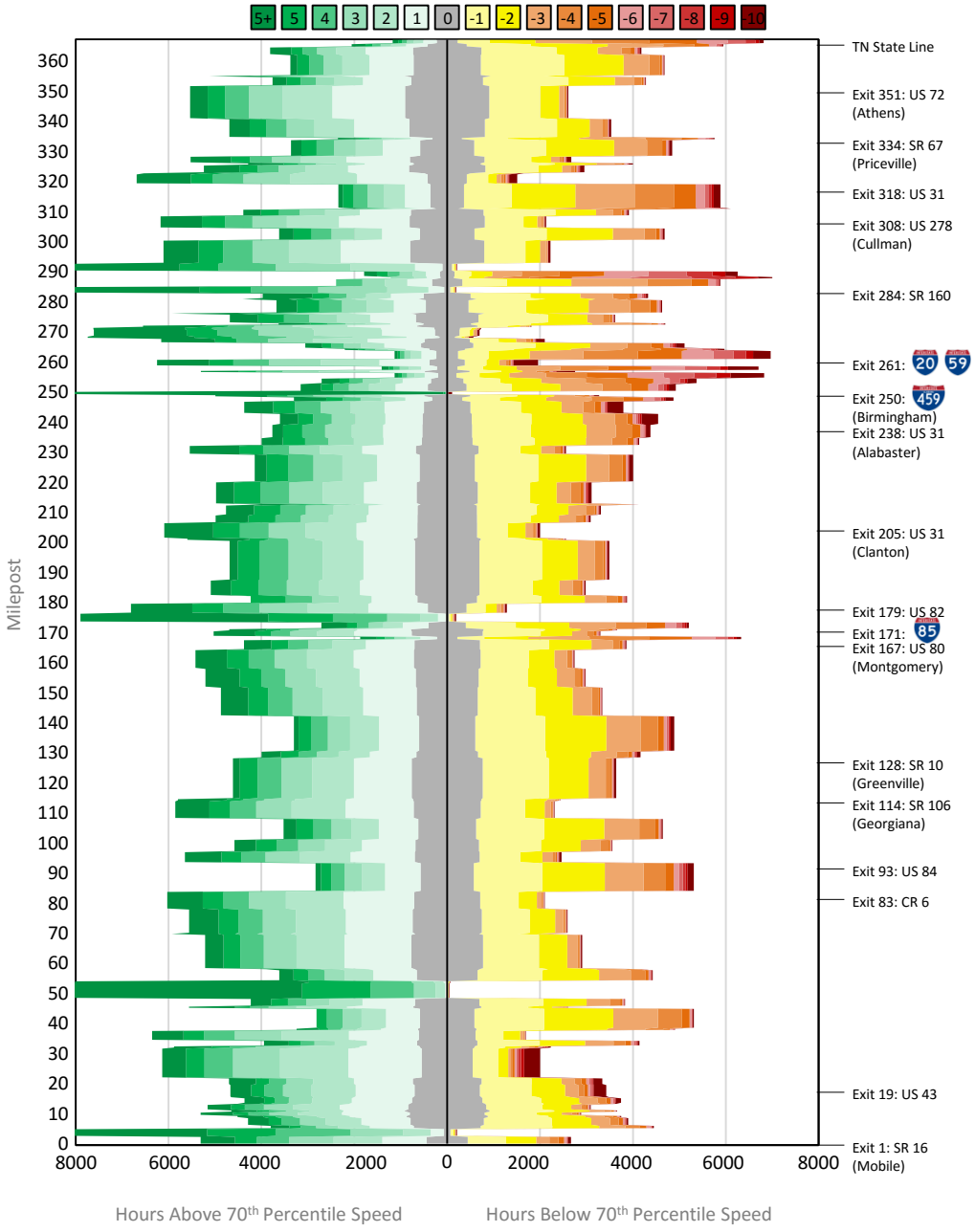


Figure 14-9. 70th Percentile Speed Graph for I-65 Southbound

Notes

- Some accumulation of hours below the free flow speed between milepost 250 and milepost 262

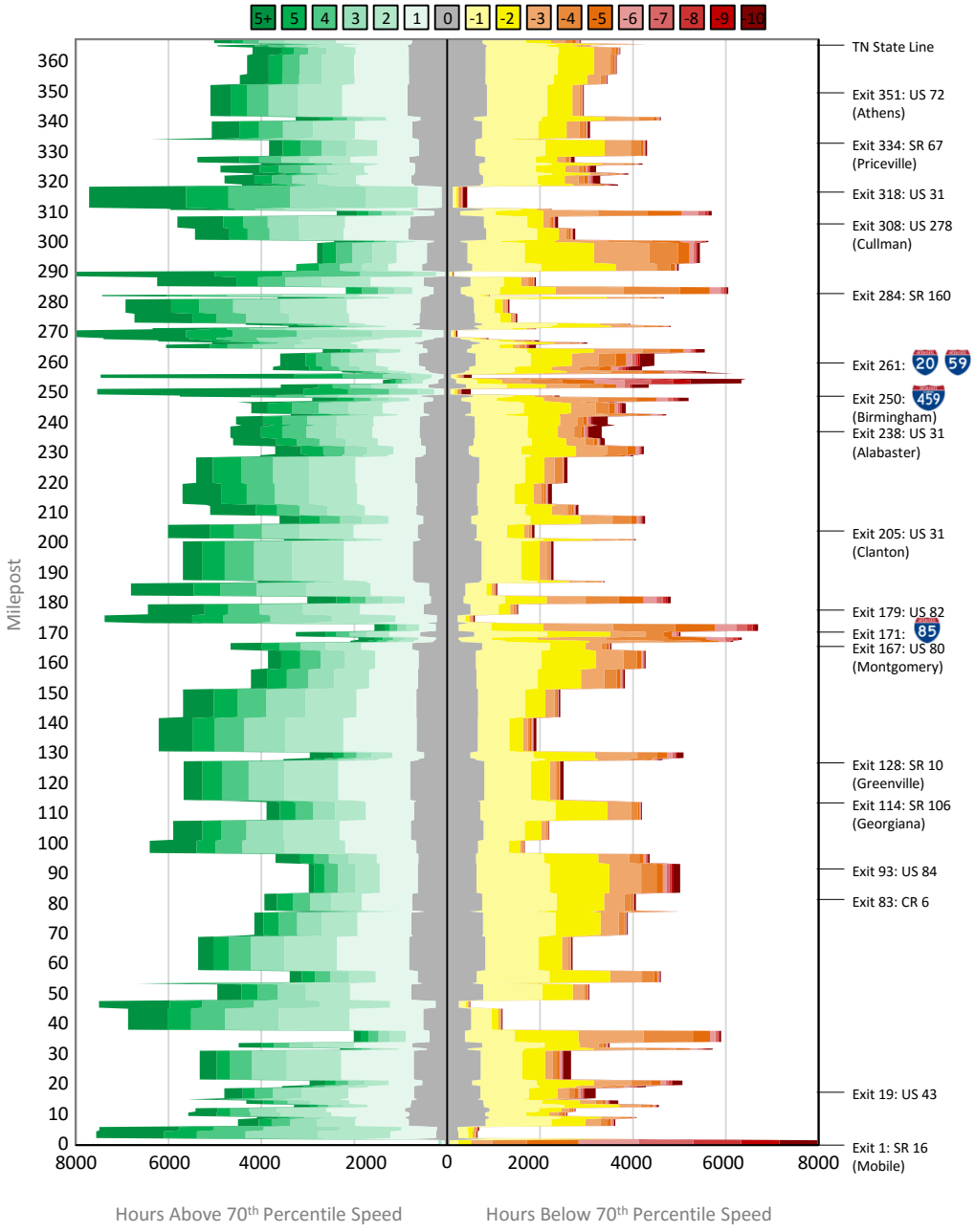


Figure 14-10. 70th Percentile Speed Graph for I-65 Northbound

Notes

- Some accumulation of hours below the free flow speed between milepost 250 and milepost 262

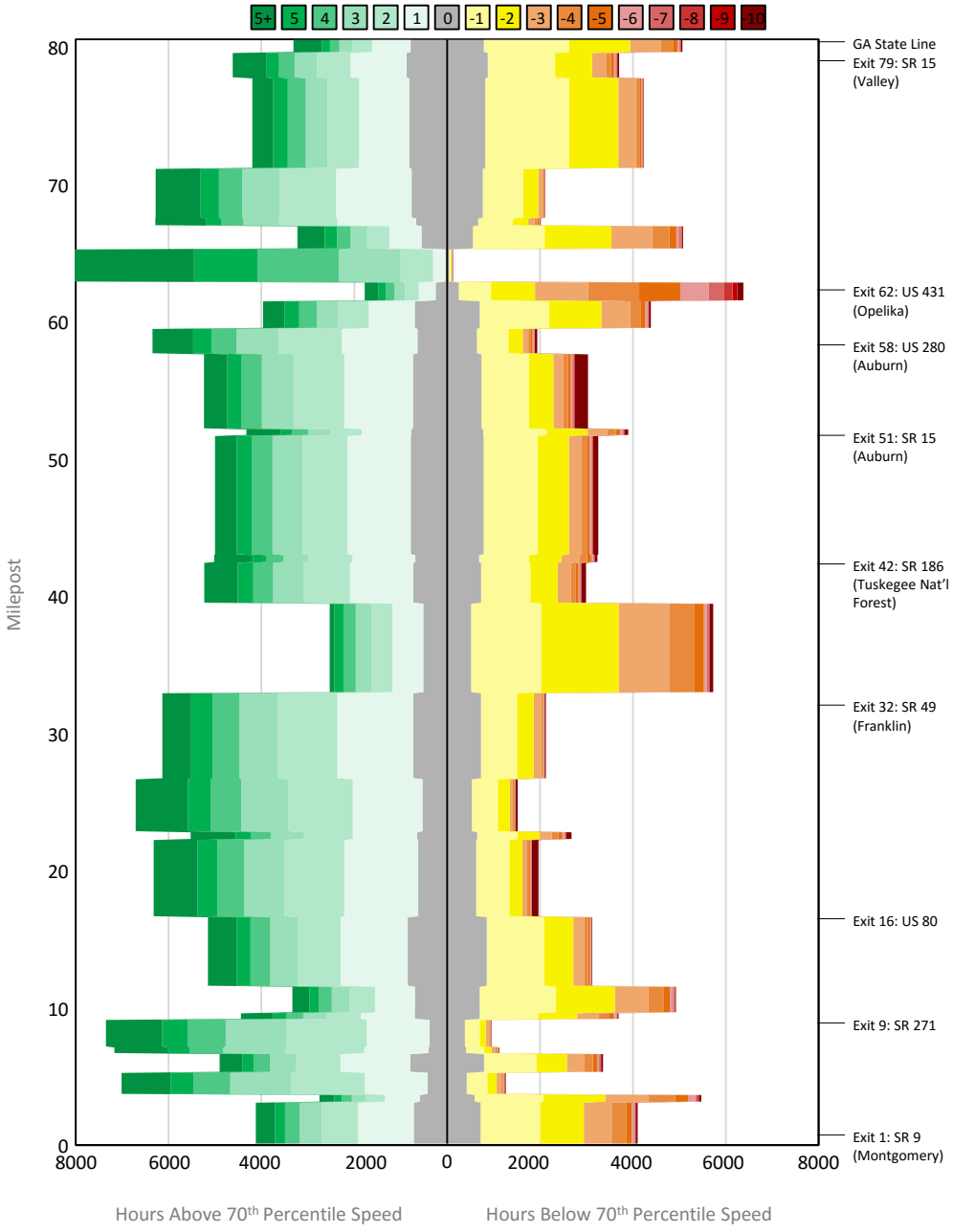


Figure 14-11. 70th Percentile Speed Graph for I-85 Southbound

Notes

- Some accumulation of hours below the free flow speed between milepost 34 and milepost 40

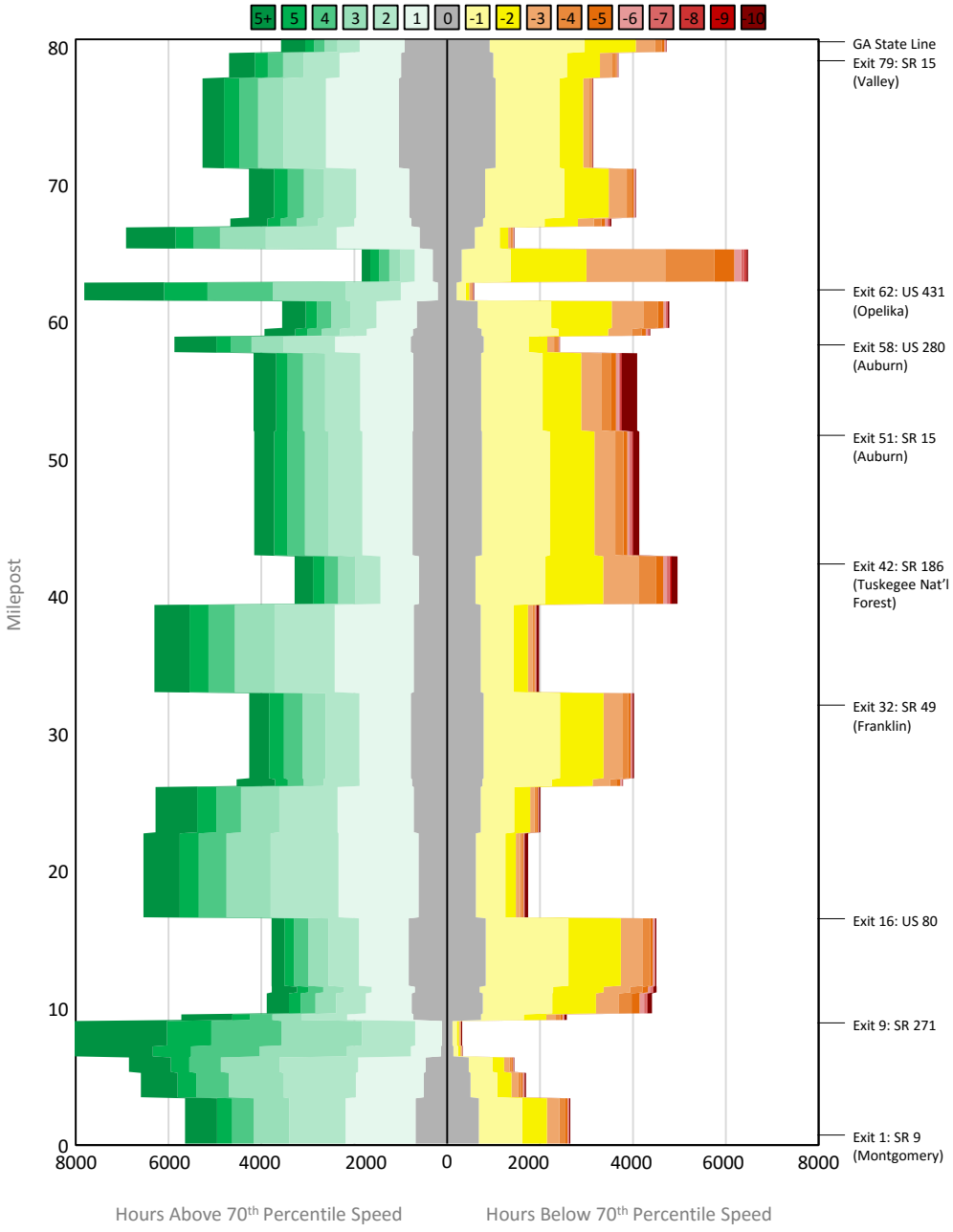


Figure 14-12. 70th Percentile Speed Graph for I-85 Northbound

Notes

- Relatively good performance near milepost 1 in Montgomery

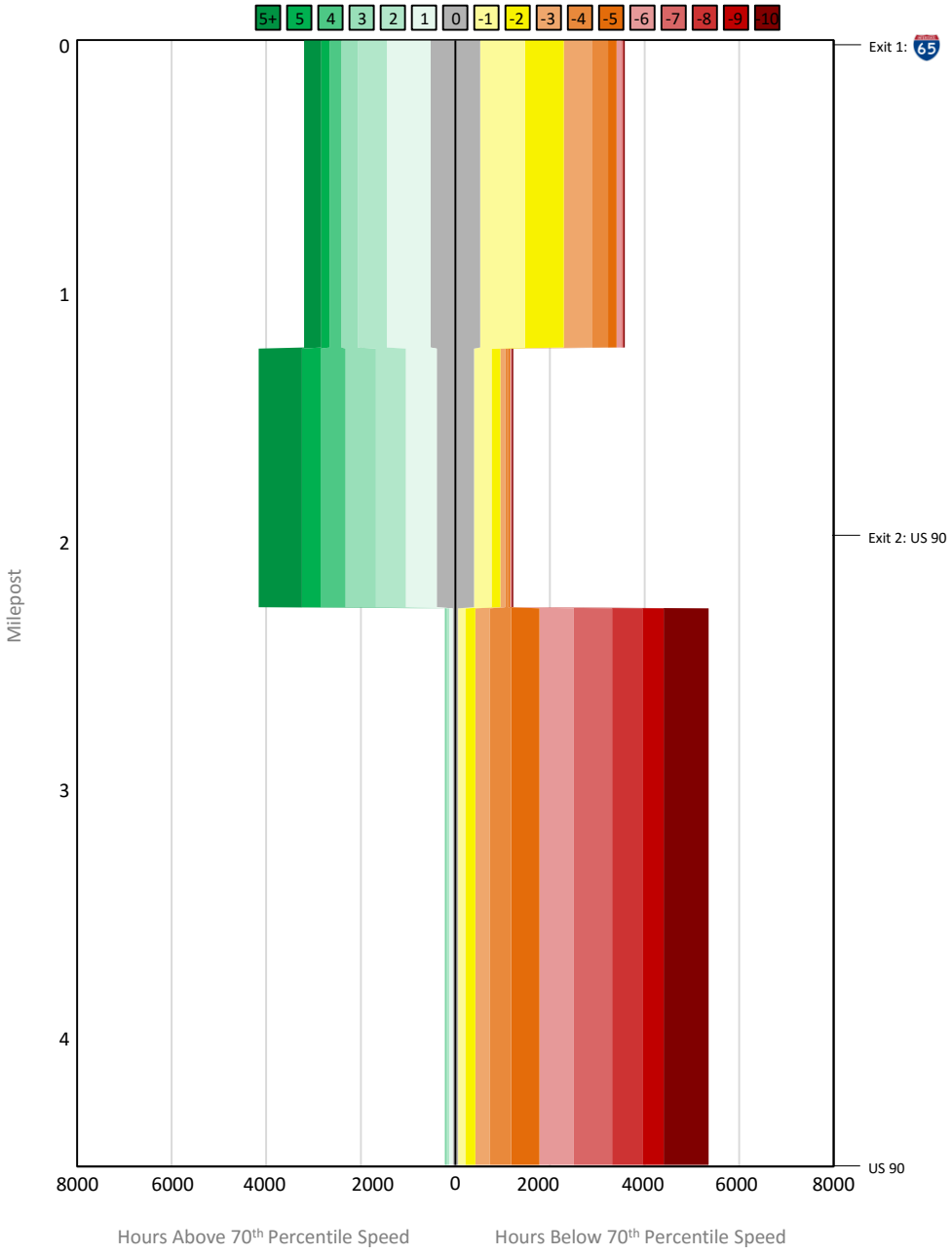


Figure 14-13. 70th Percentile Speed Graph for I-165 Southbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

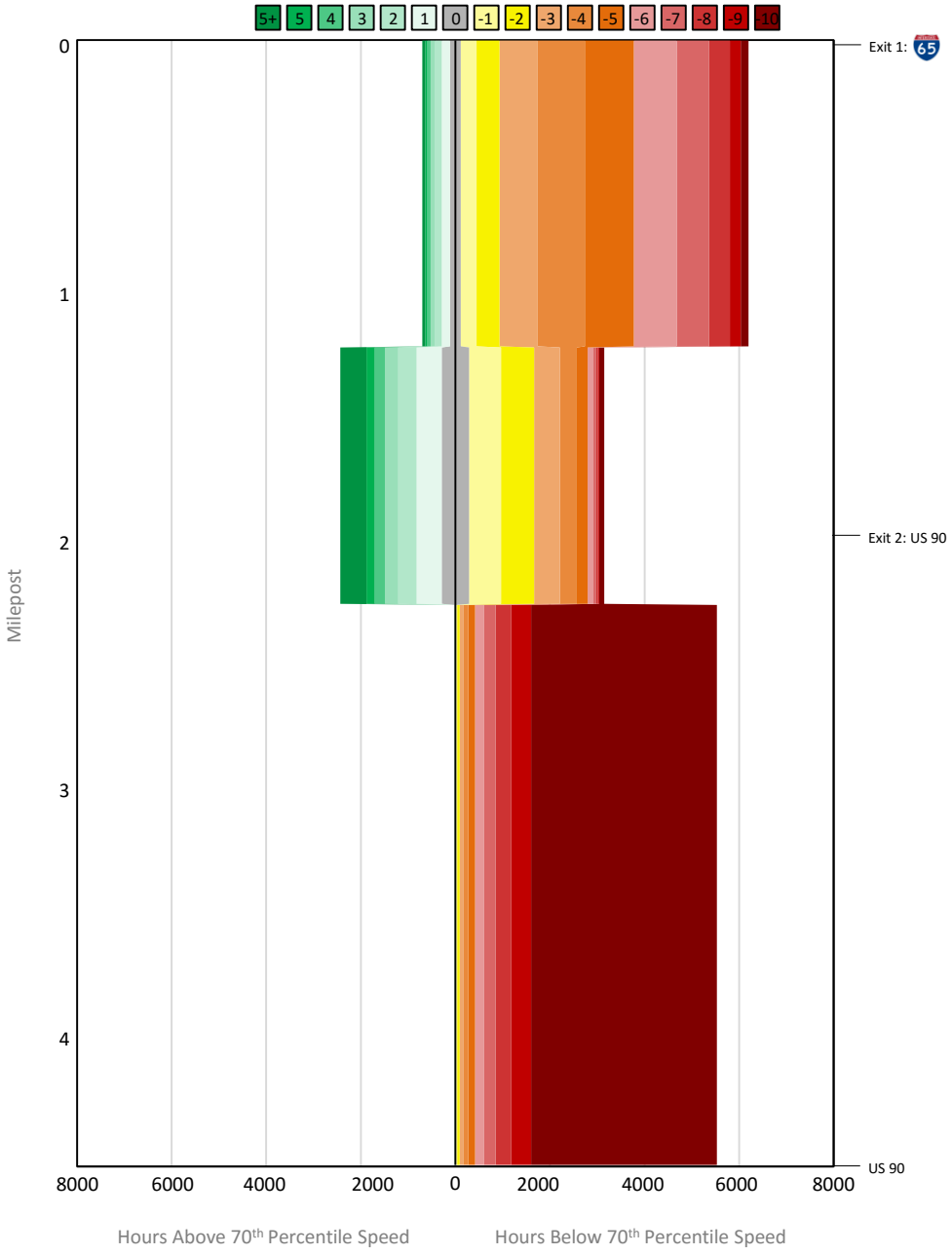


Figure 14-14. 70th Percentile Speed Graph for I-165 Northbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

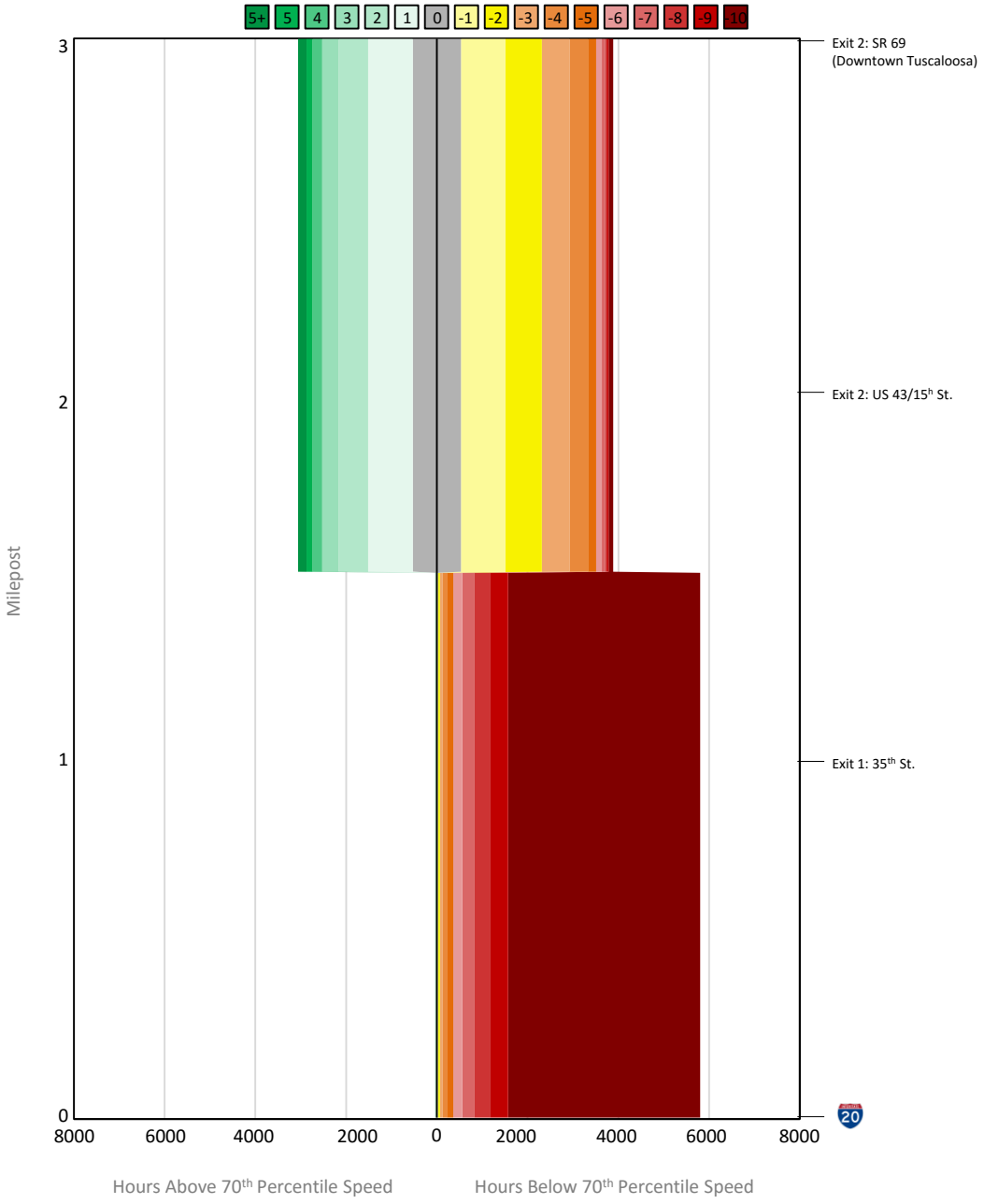


Figure 14-15. 70th Percentile Speed Graph for I-359 Southbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

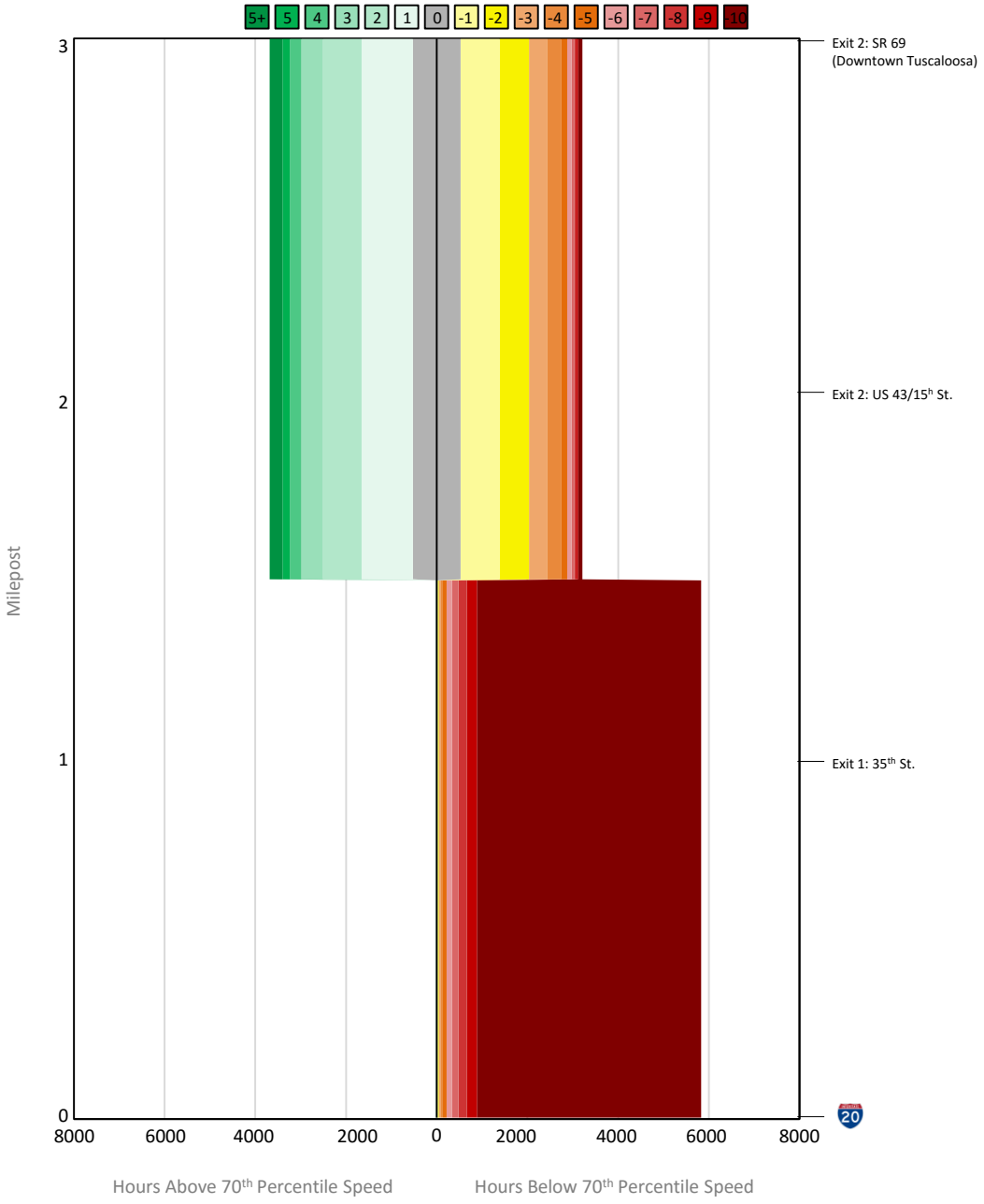


Figure 14-16. 70th Percentile Speed Graph for I-359 Northbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

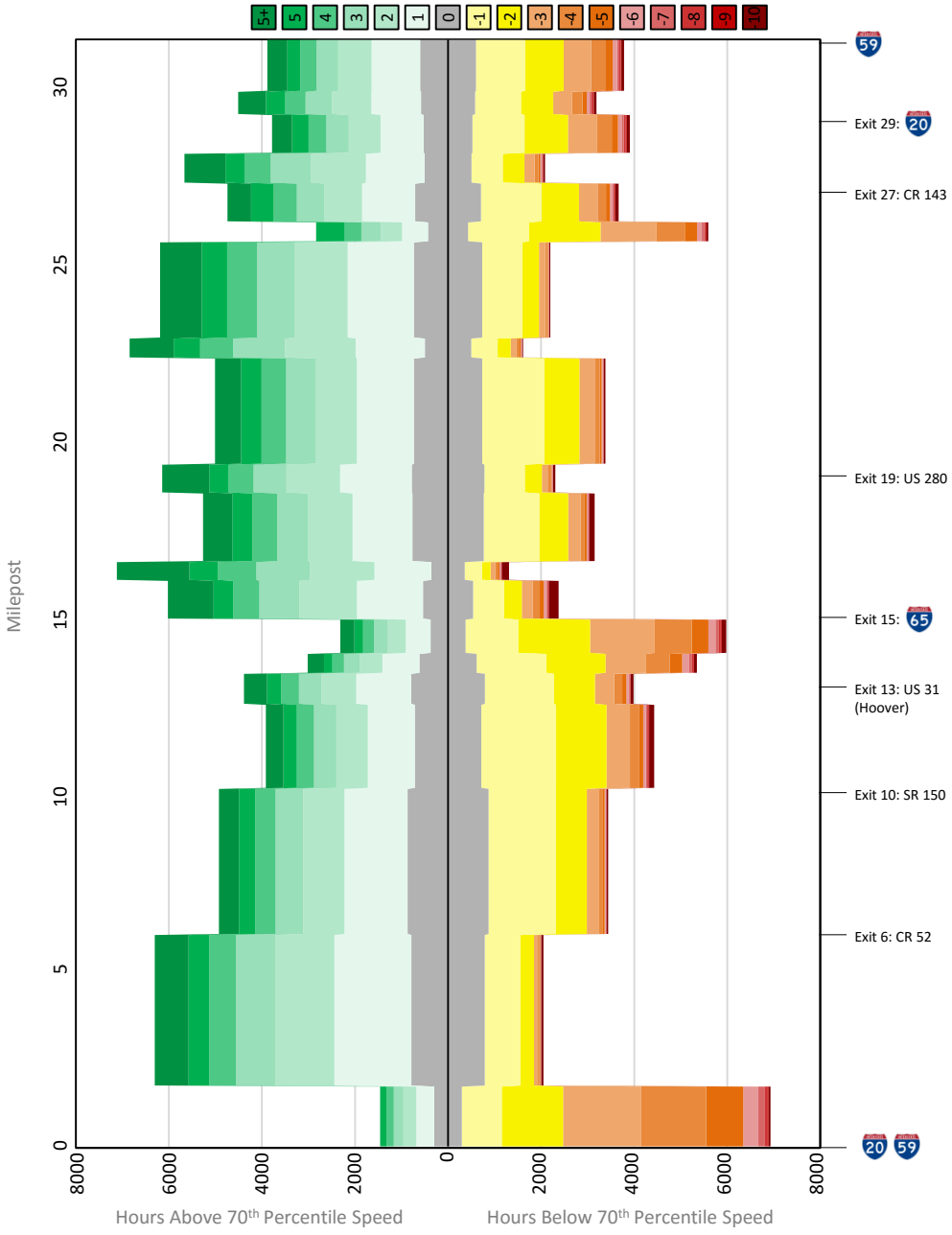


Figure 14-17. 70th Percentile Speed Graph for I-459 Westbound

Notes

- Some accumulation of hours below the free flow speed around milepost 15 I-65 interchange
- Some accumulation of hours below the free flow speed around milepost 1

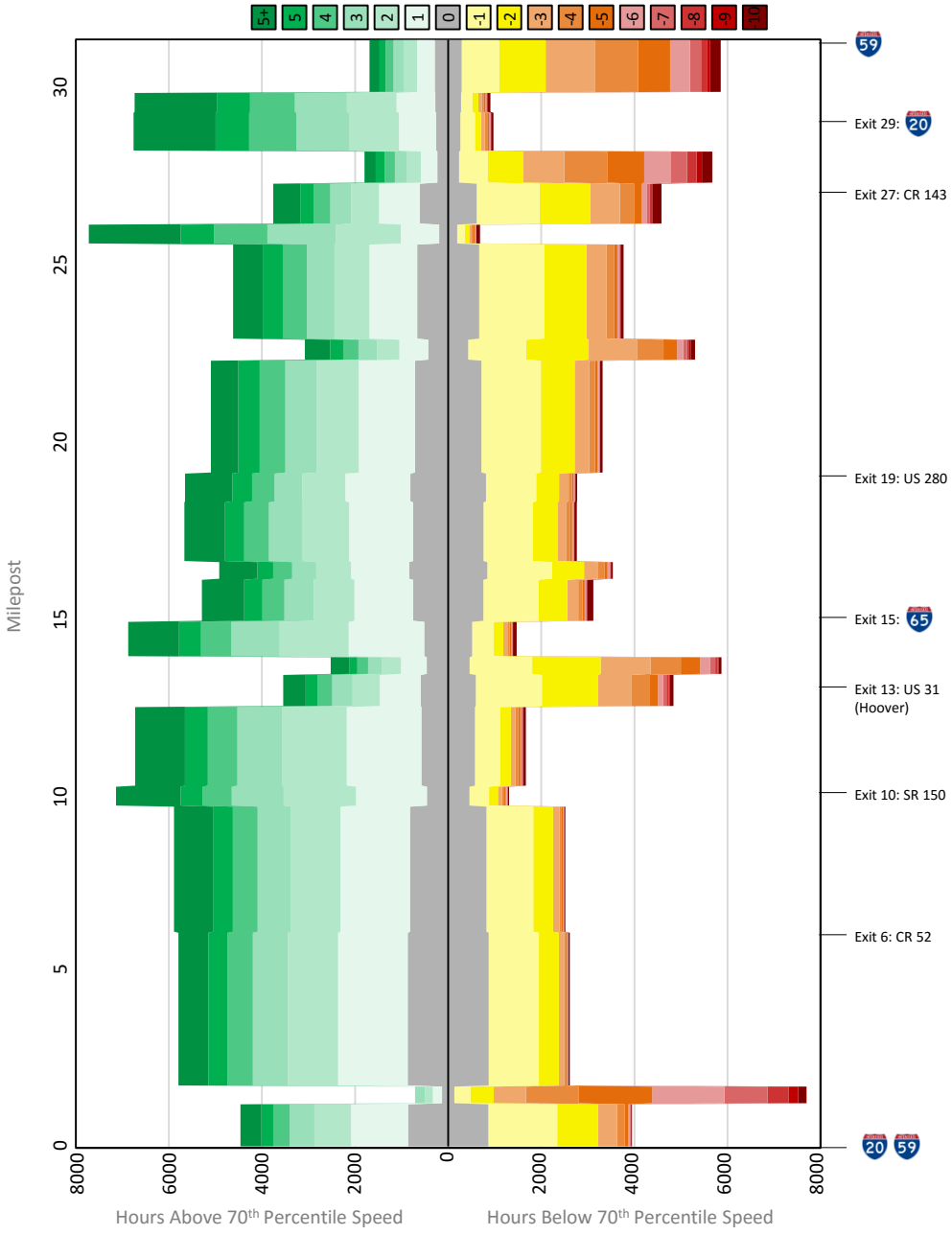


Figure 14-18. 70th Percentile Speed Graph for I-459 Eastbound

Notes

- Some accumulation of hours below the free flow speed near milepost 30 I-59 interchange

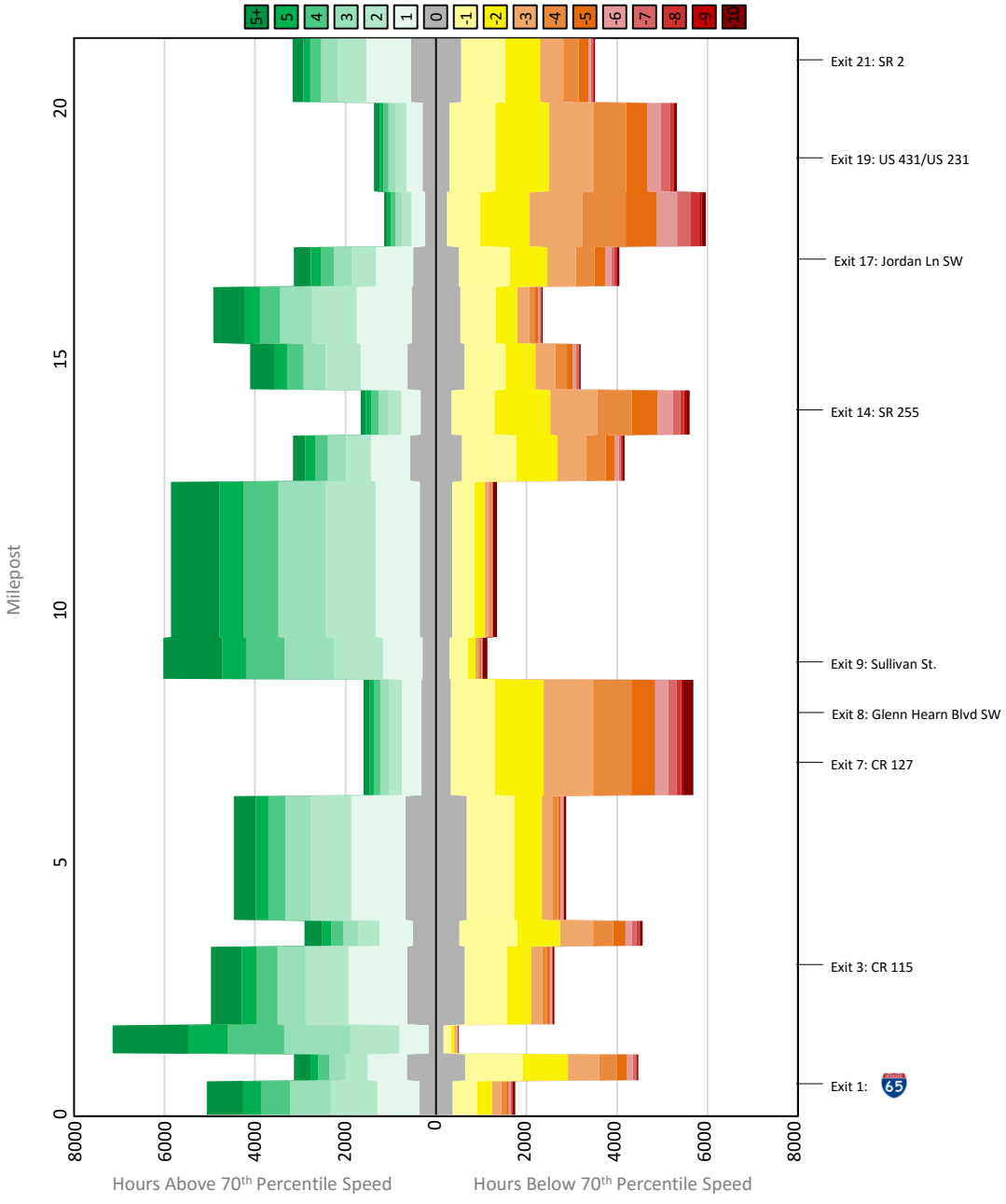


Figure 14-19. 70th Percentile Speed Graph for I-565 Westbound

Notes

- Some accumulation of hours below the free flow speed between milepost 7 and milepost 9

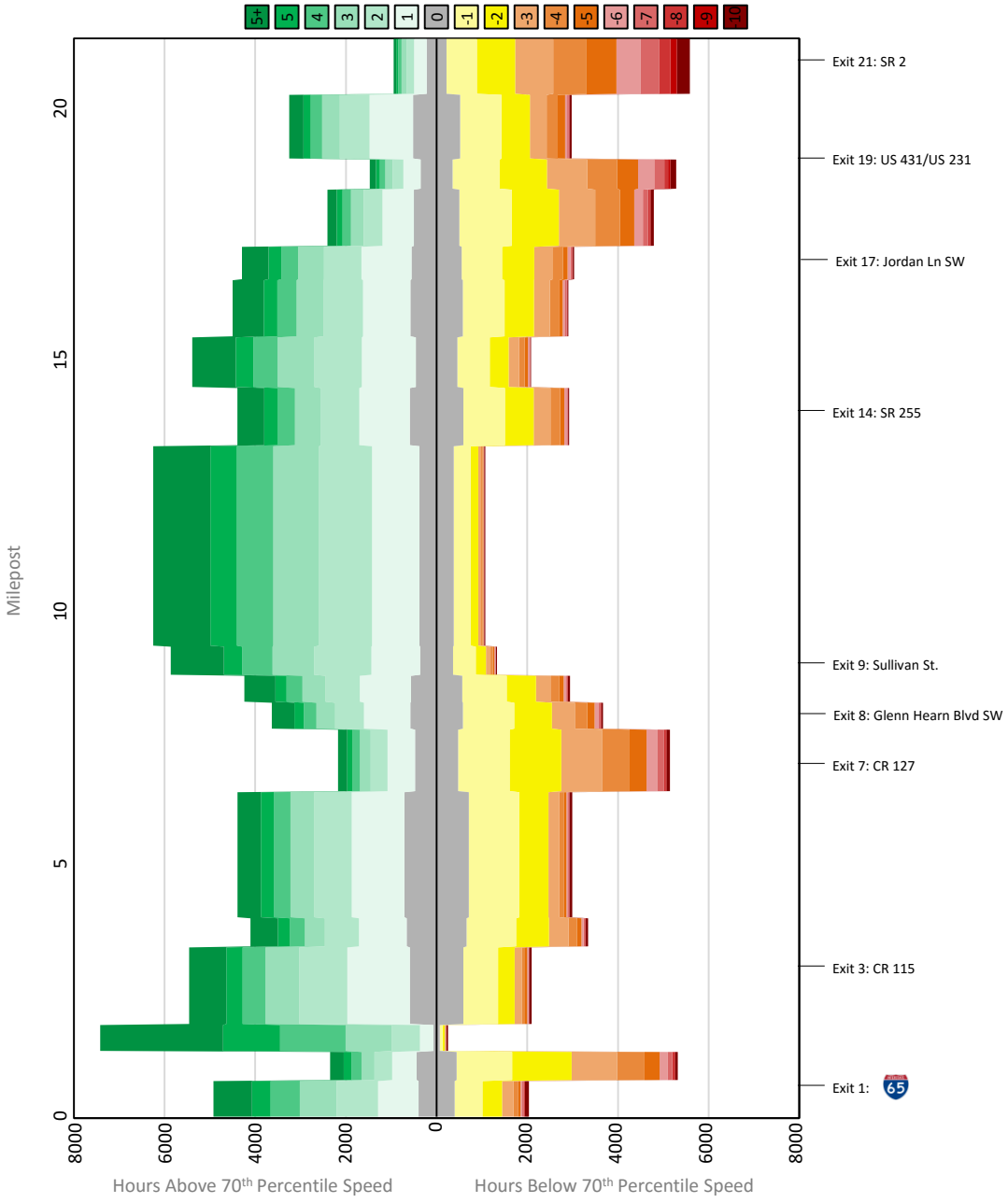


Figure 14-20. 70th Percentile Speed Graph for I-565 Eastbound

Notes

- Good performance between milepost 9 and milepost 14
- Some accumulation of hours below the free flow speed near milepost 21

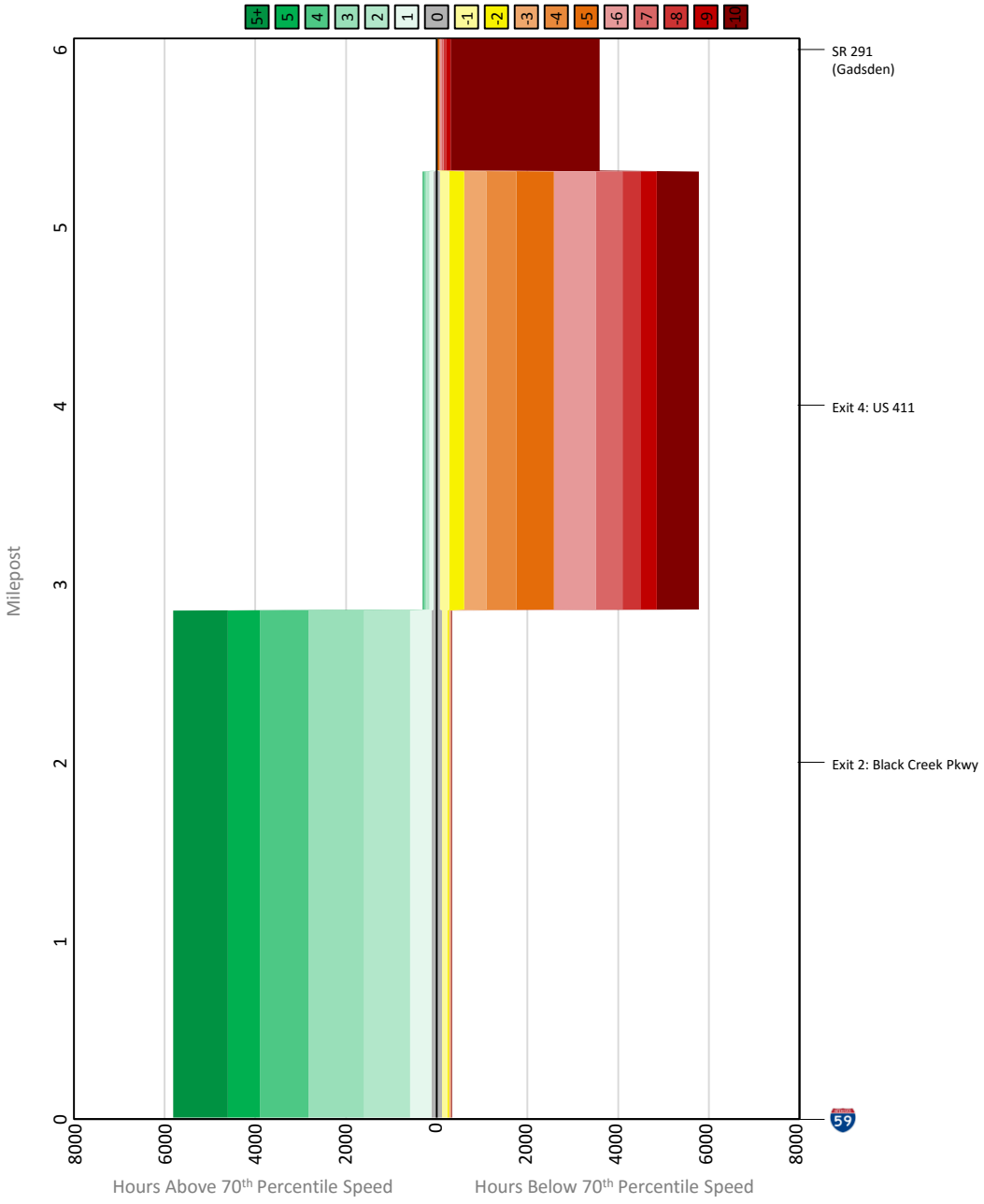


Figure 14-21. 70th Percentile Speed Graph for I-759 Westbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

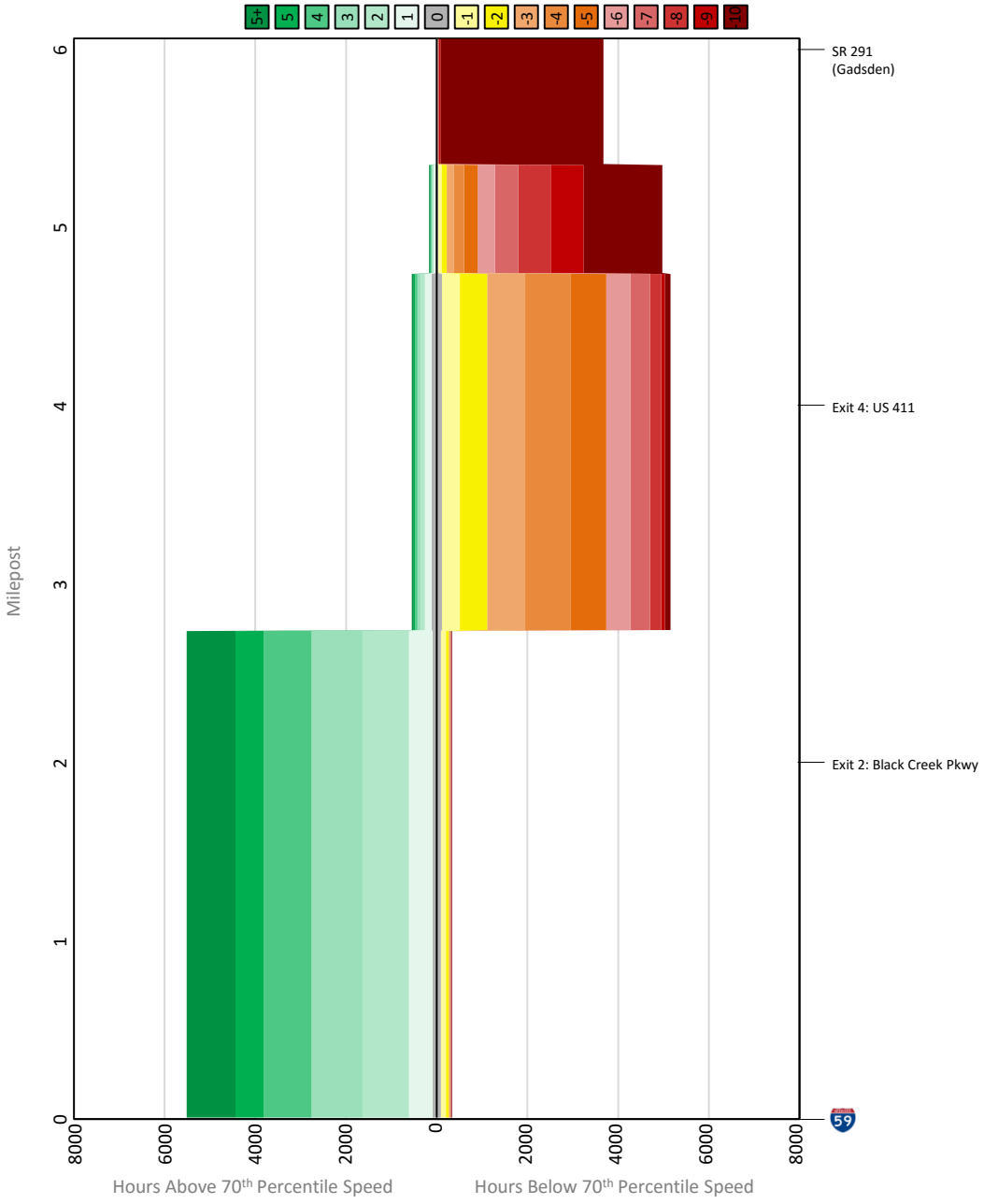


Figure 14-22. 70th Percentile Speed Graph for I-759 Eastbound

Notes

- See monthly travel time plots for more information on shorter commuter interstates

15.0 Appendix D – Monthly Travel Time Plots

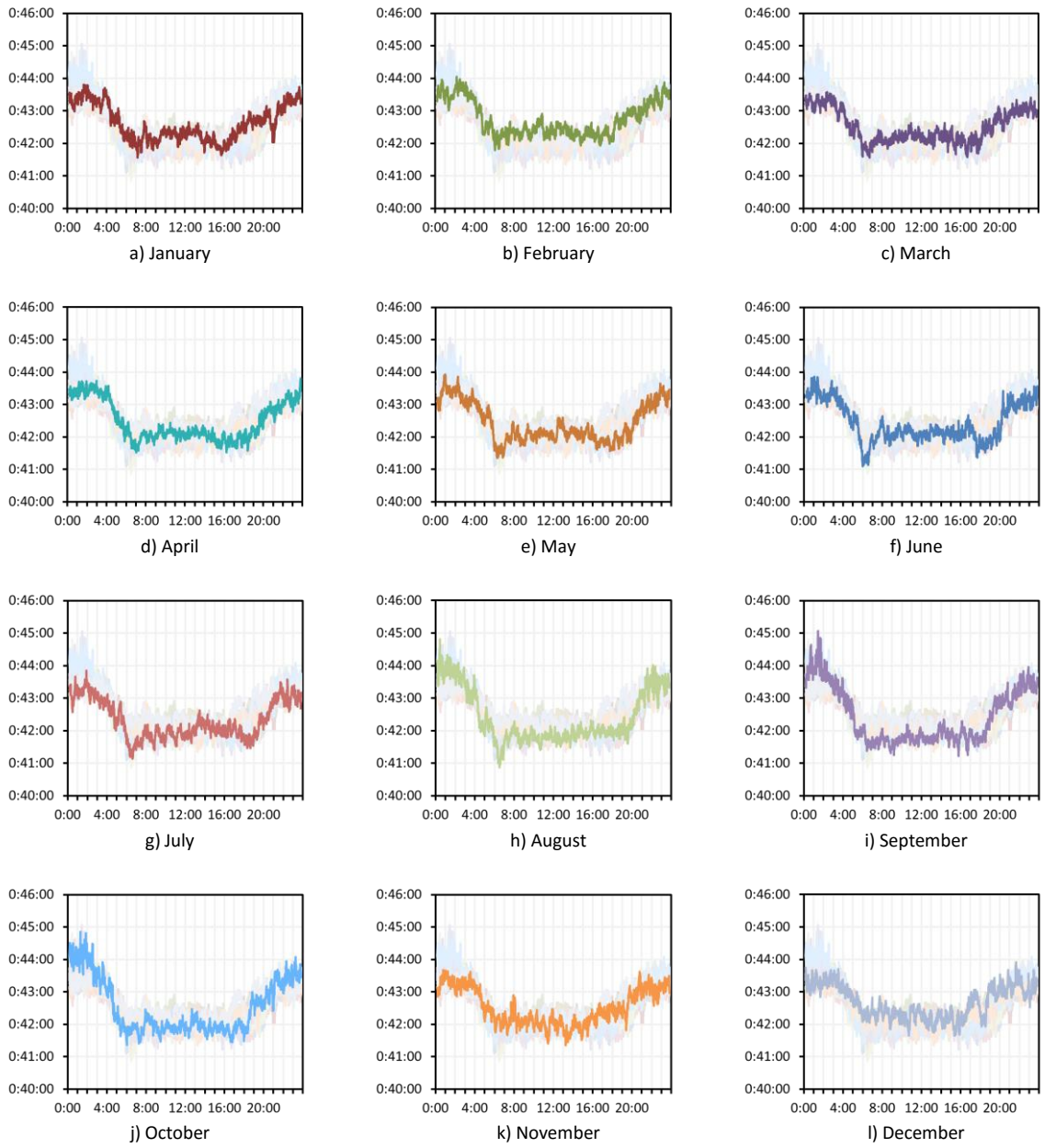


Figure 15-1. Monthly Travel Time Plots for I-10 Westbound

Notes

- Relatively stable travel times on a month-to-month basis

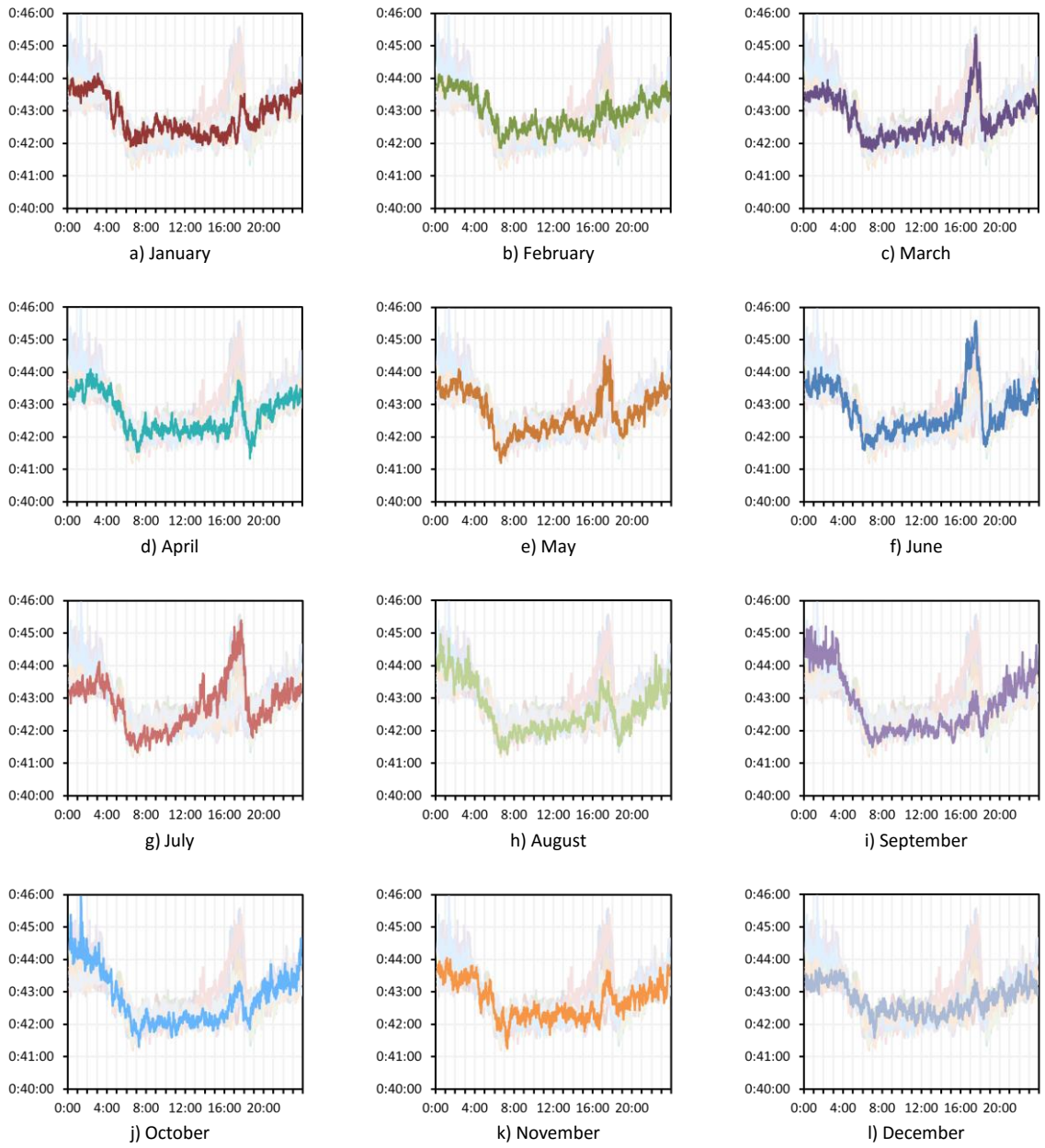


Figure 15-2. Monthly Travel Time Plots for I-10 Eastbound

Notes

- Large spikes in the PM travel times in most months, particularly in June and July

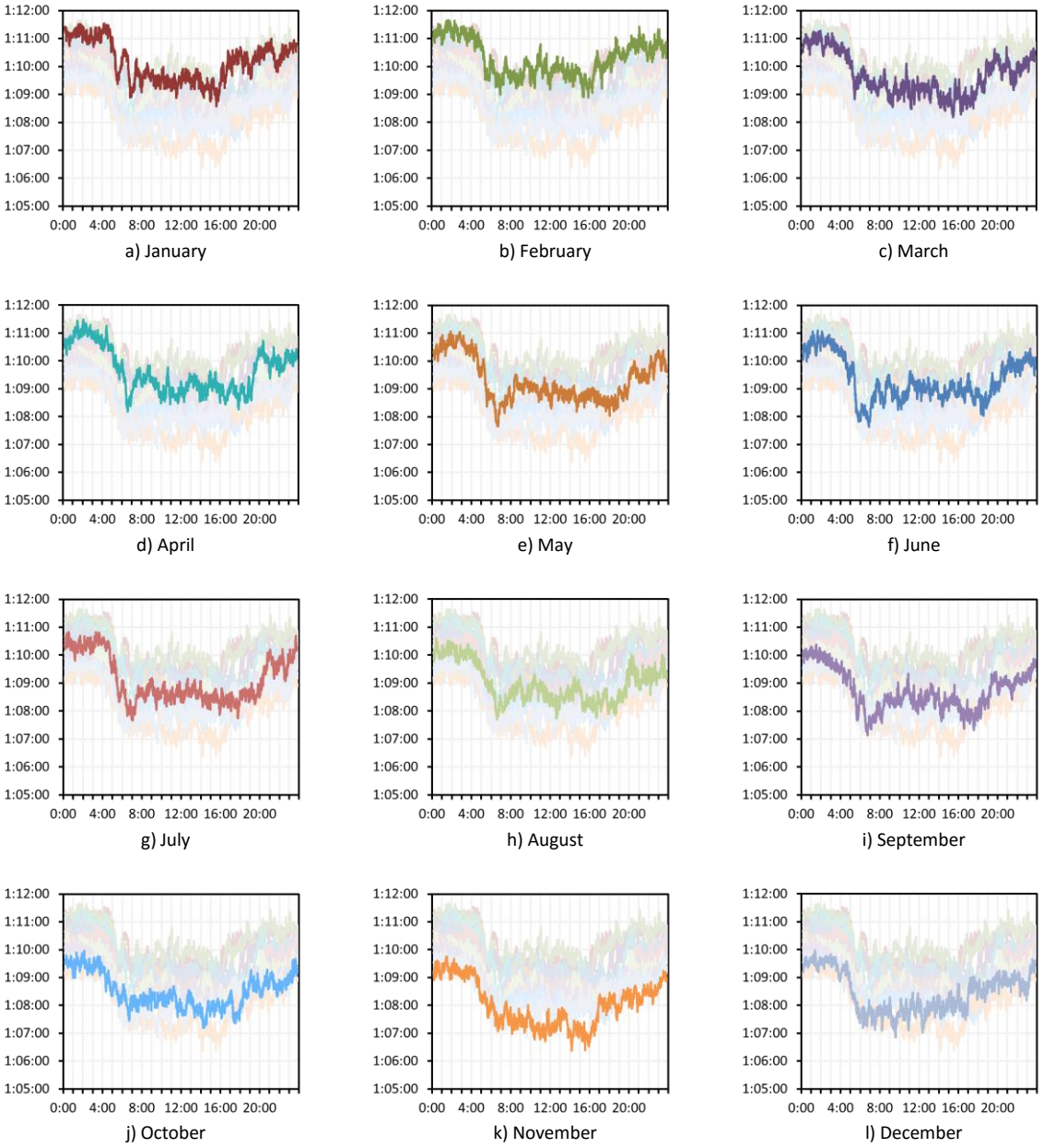


Figure 15-3. Monthly Travel Time Plots for I-20 Westbound

Notes

- November and December had good performance with low travel times

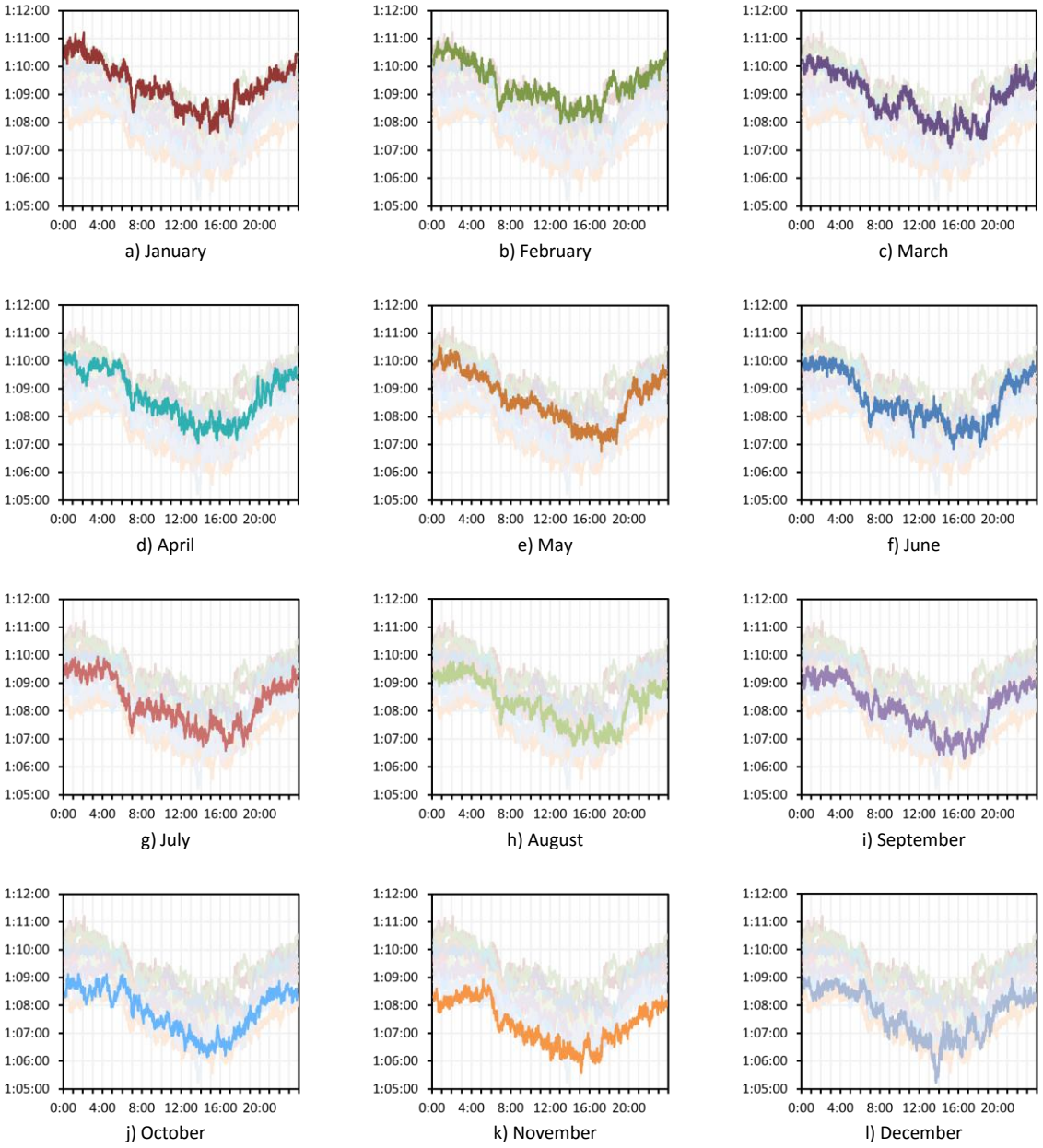


Figure 15-4. Monthly Travel Time Plots for I-20 Eastbound

Notes

- November and December had good performance with low travel times

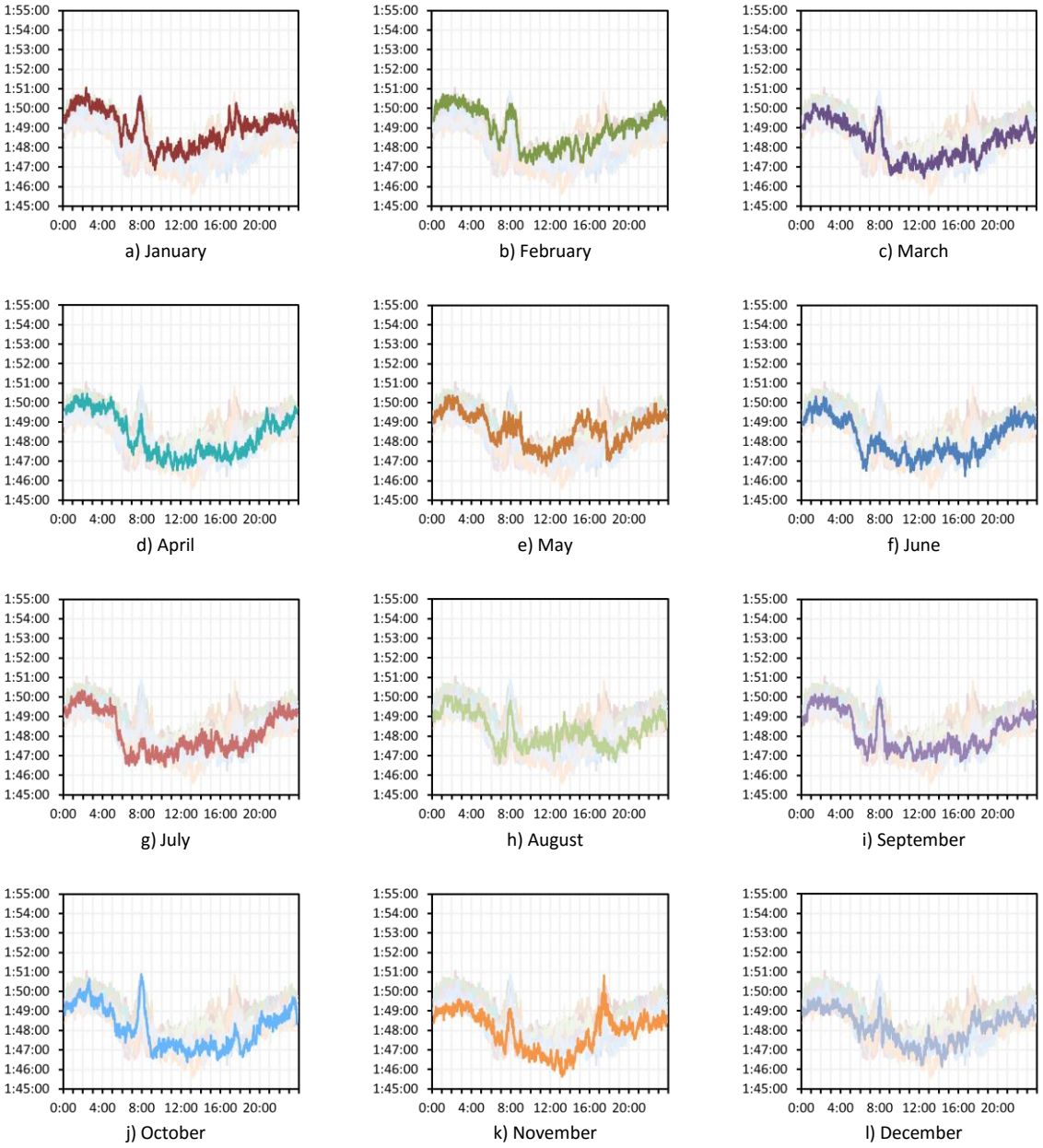


Figure 15-5. Monthly Travel Time Plots for I-20/I-59 Westbound

Notes

- Large spike in travel time during the AM peak in October
- Large spike in travel time during the PM peak in November

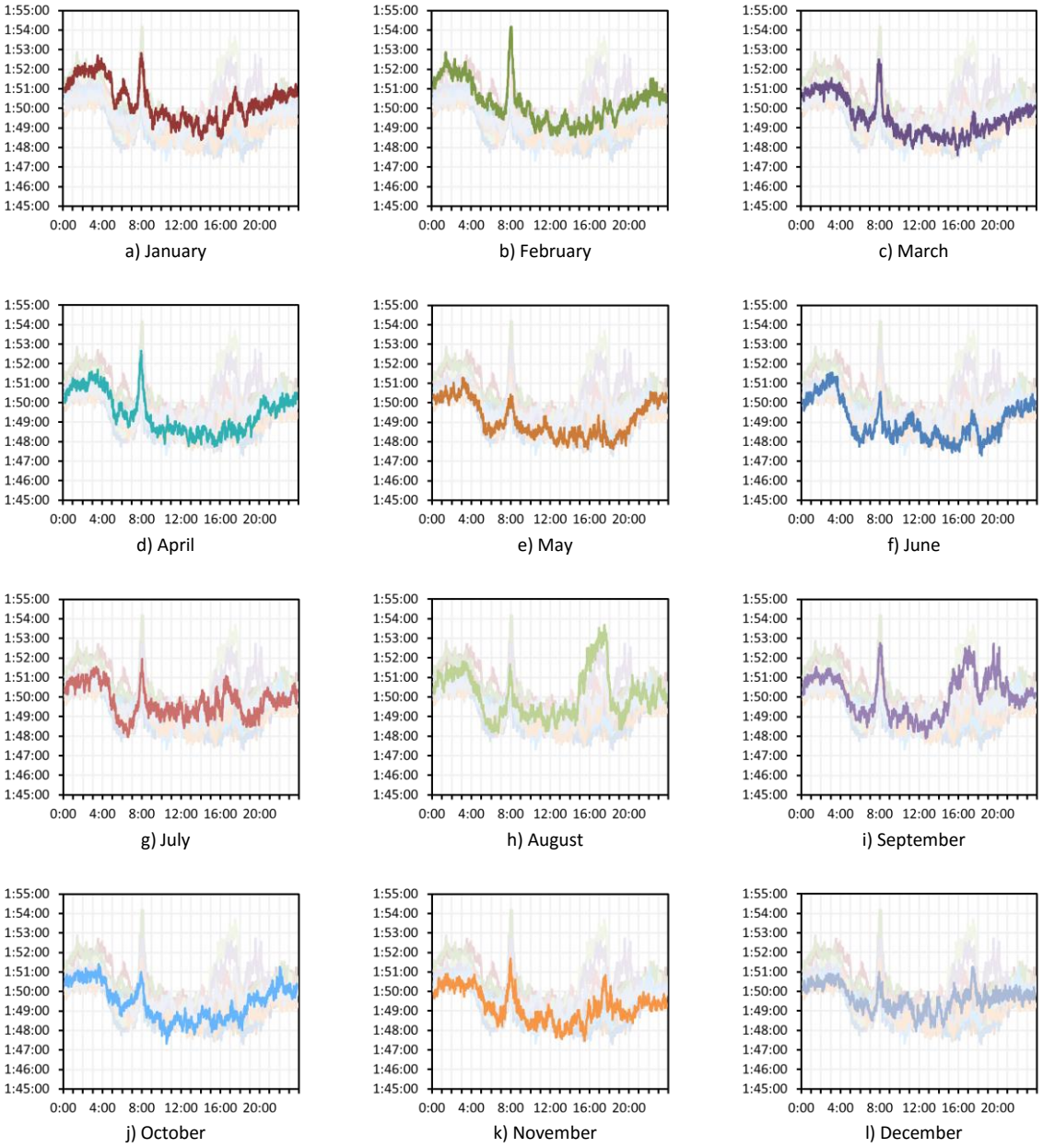


Figure 15-6. Monthly Travel Time Plots for I-20/I-59 Eastbound

Notes

- Large spike in travel time during the PM peak in August
- Large spike in travel time during the AM peak in February

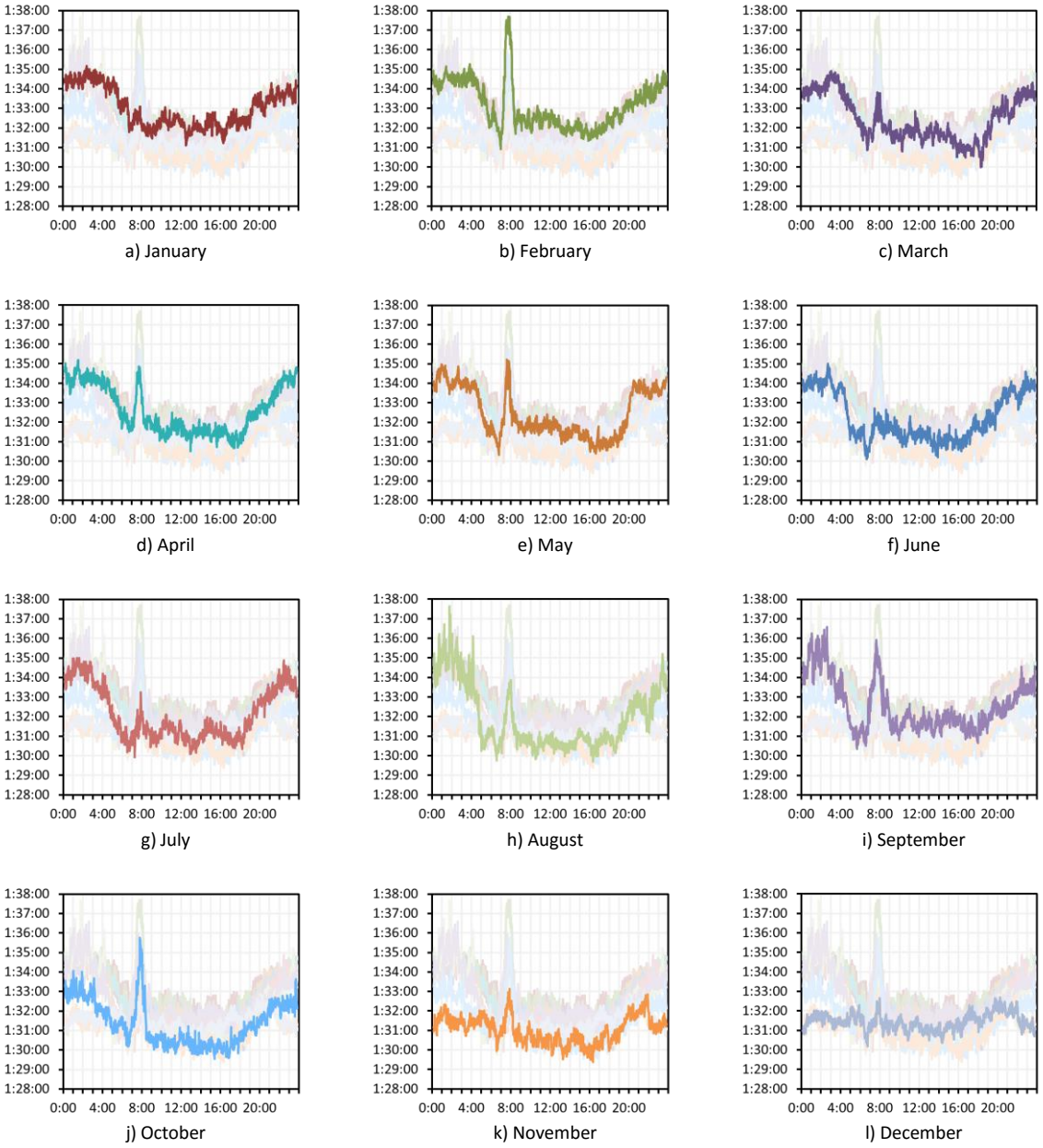


Figure 15-7. Monthly Travel Time Plots for I-59 Southbound

Notes

- Large spike in travel time during the AM peak in February and October

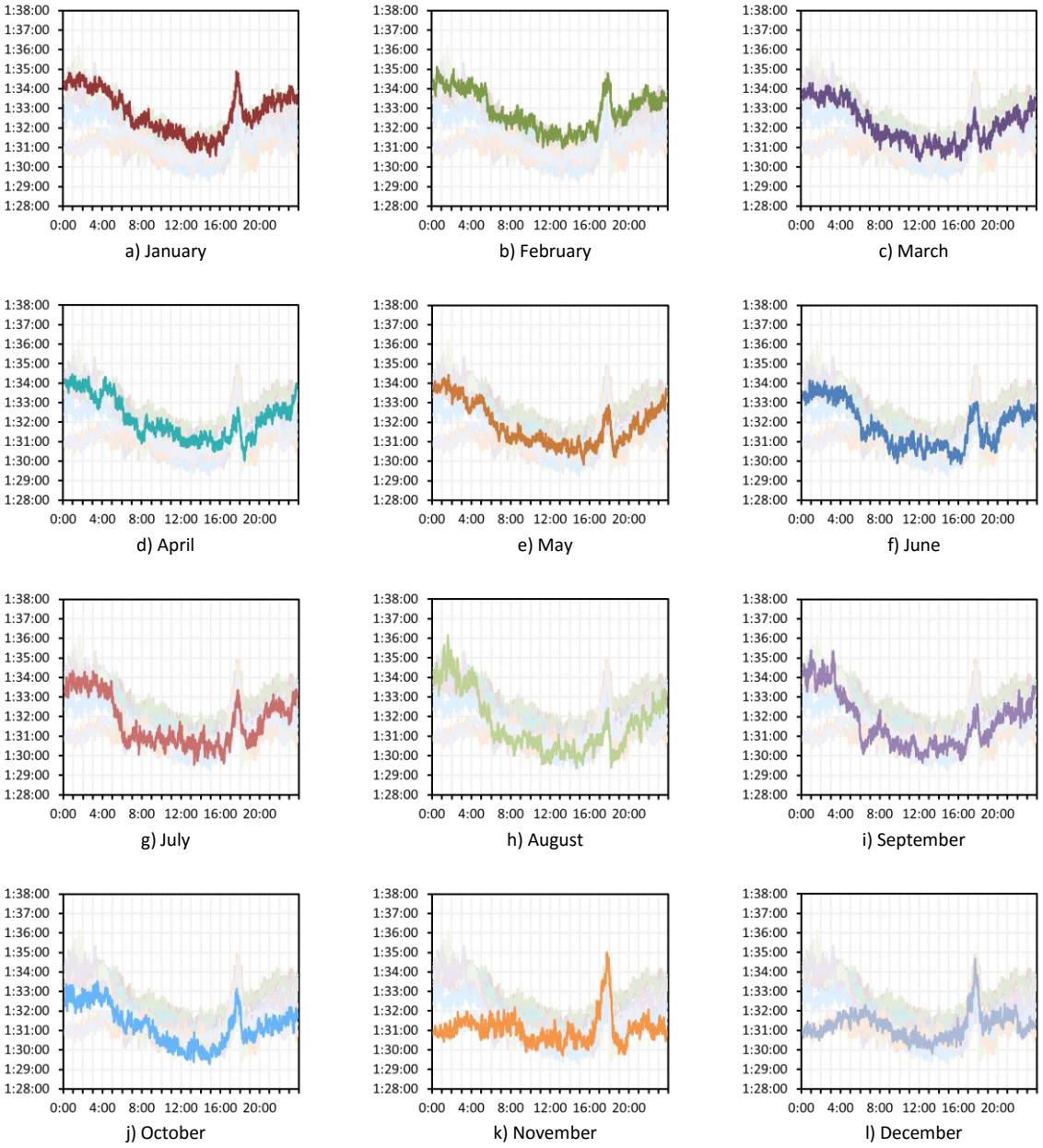


Figure 15-8. Monthly Travel Time Plots for I-59 Northbound

Notes

- Large spike in travel time during the PM peak in November, December, and January

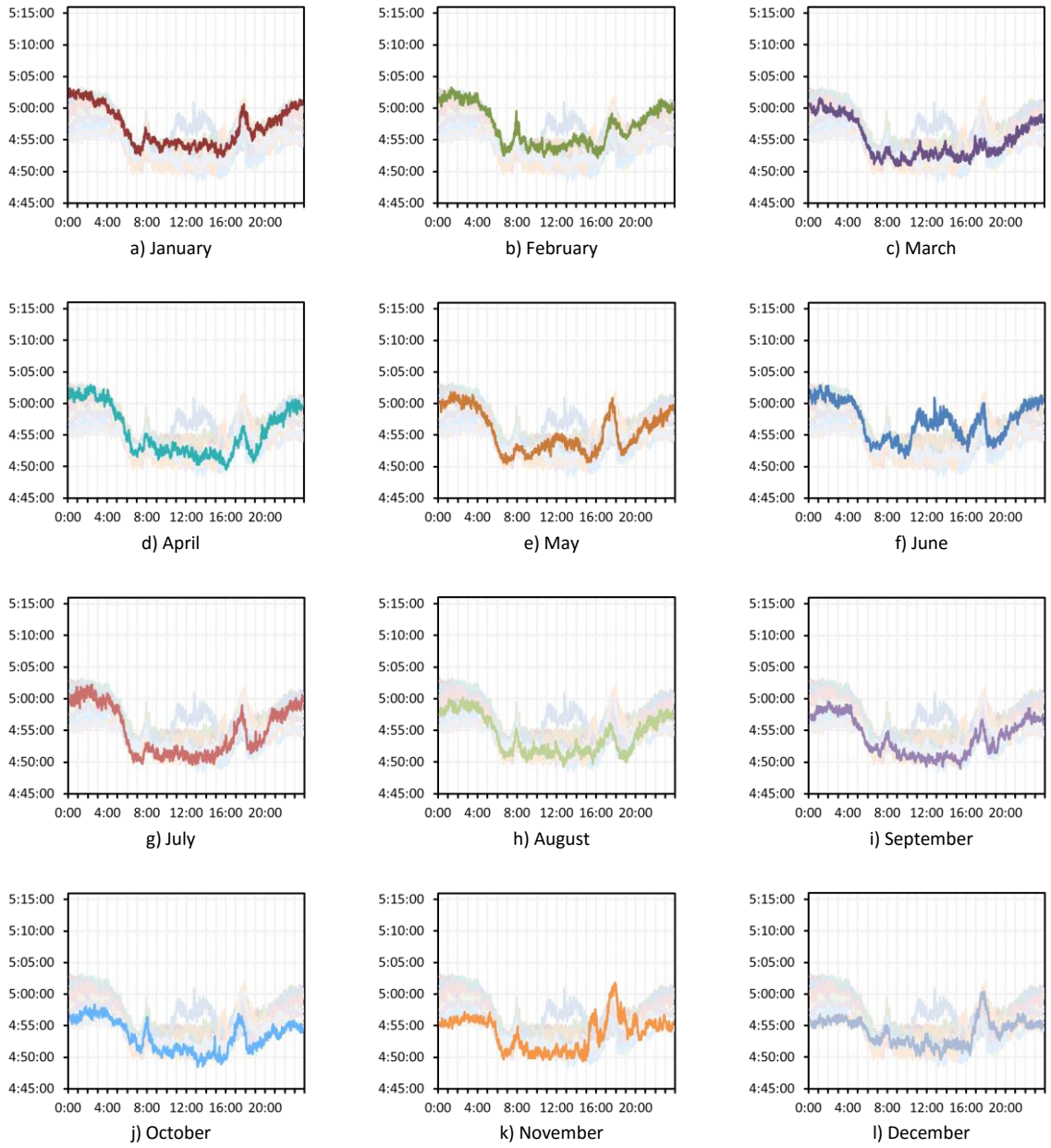


Figure 15-9. Monthly Travel Time Plots for I-65 Southbound

Notes

- June was a very volatile month, perhaps due to seasonal construction

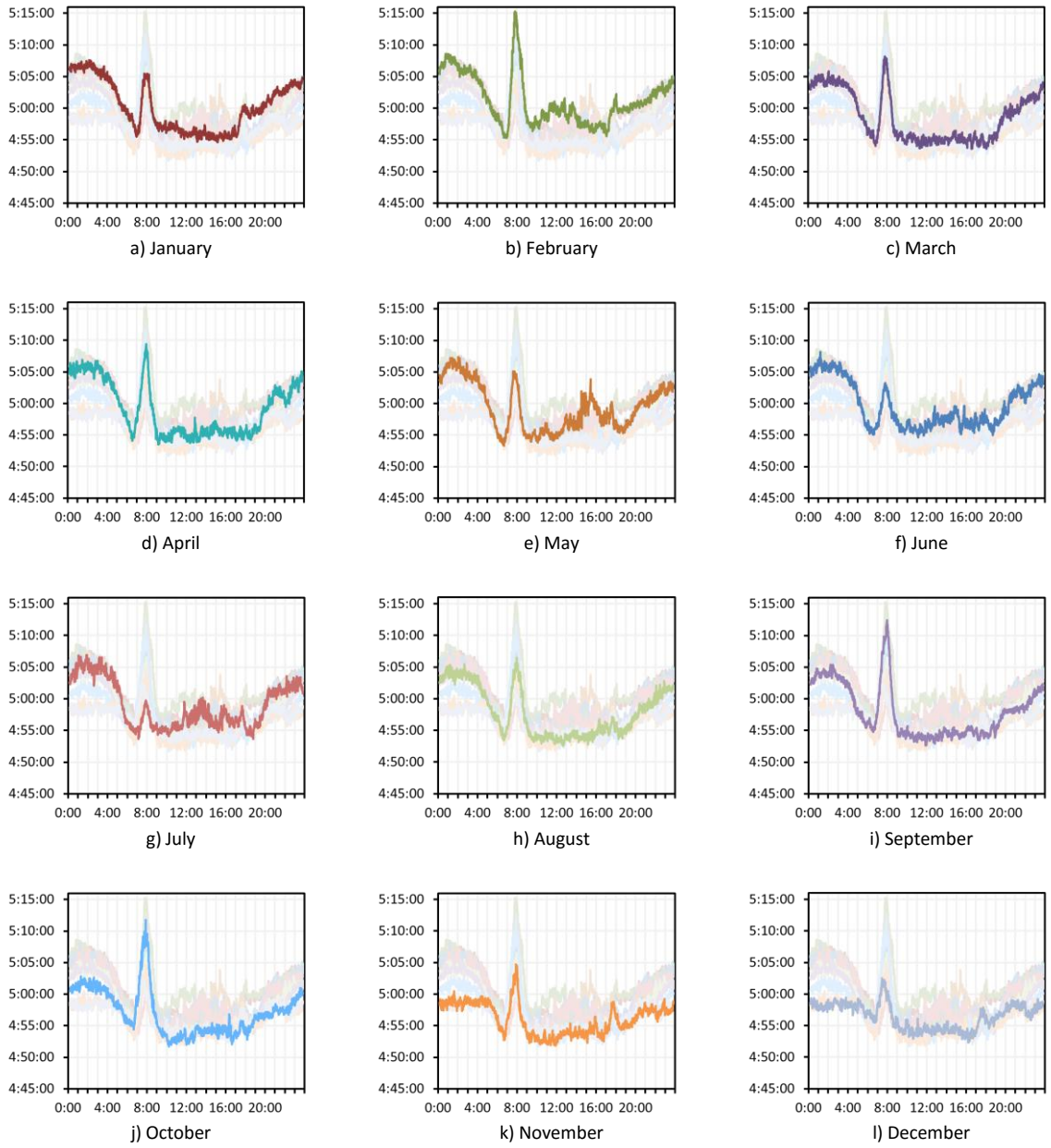


Figure 15-10. Monthly Travel Time Plots for I-65 Northbound

Notes

- Large spike in travel time during the AM peak in February and October

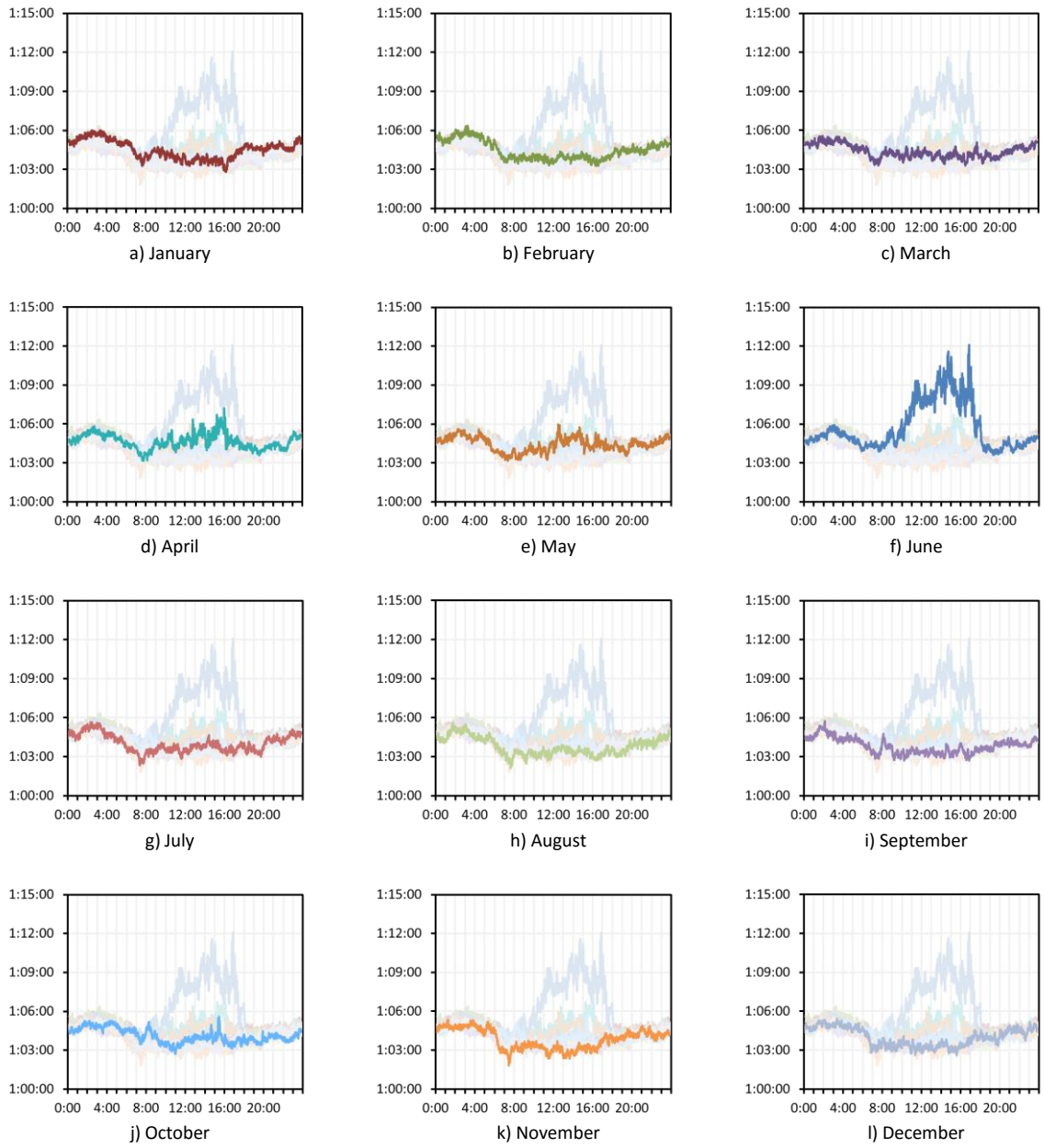


Figure 15-11. Monthly Travel Time Plots for I-85 Southbound

Notes

- June was a very volatile month, perhaps due to seasonal construction

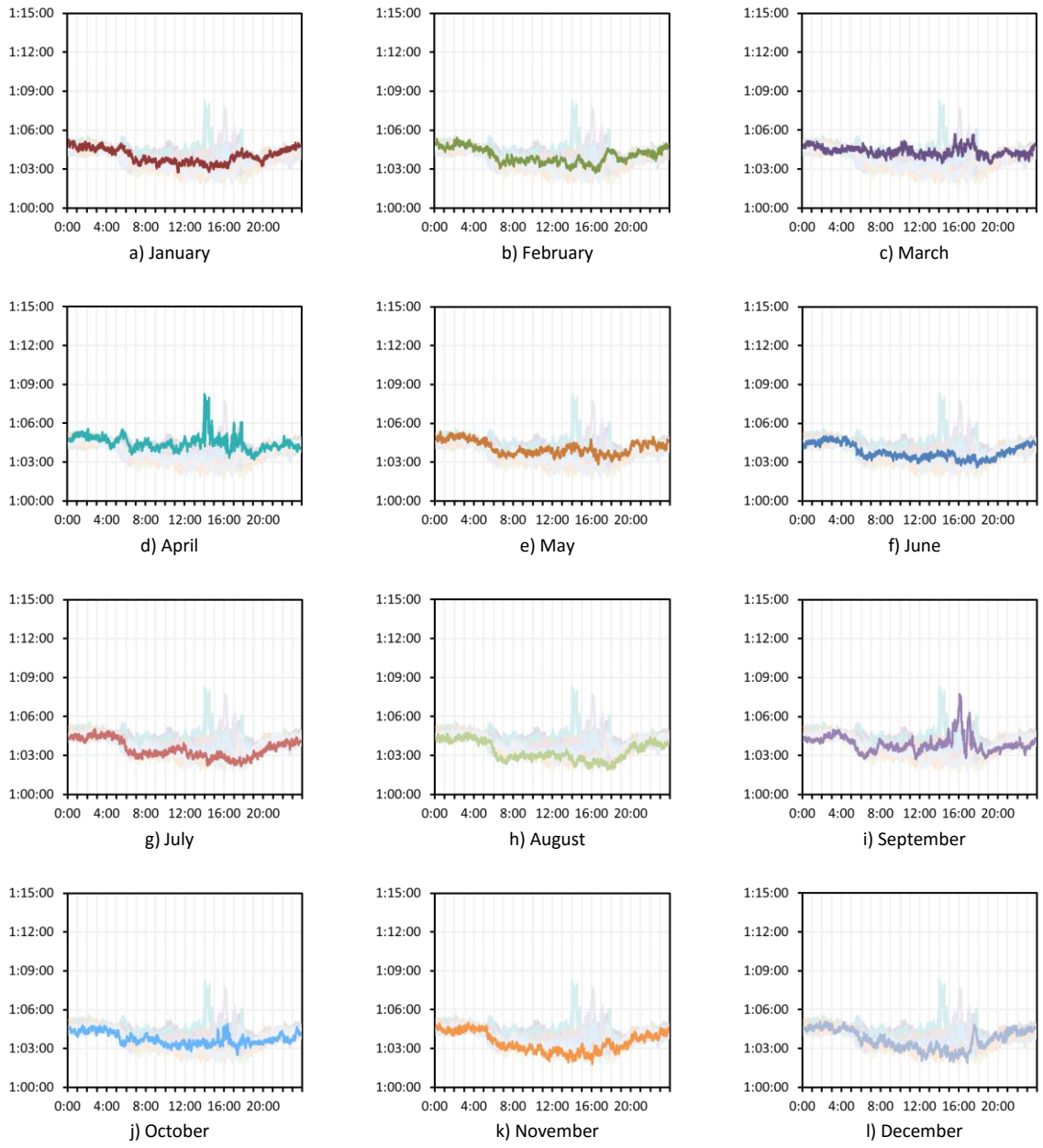


Figure 15-12. Monthly Travel Time Plots for I-85 Northbound

Notes

- Most of the months were relatively stable, except for small mid-day increase in travel time in April

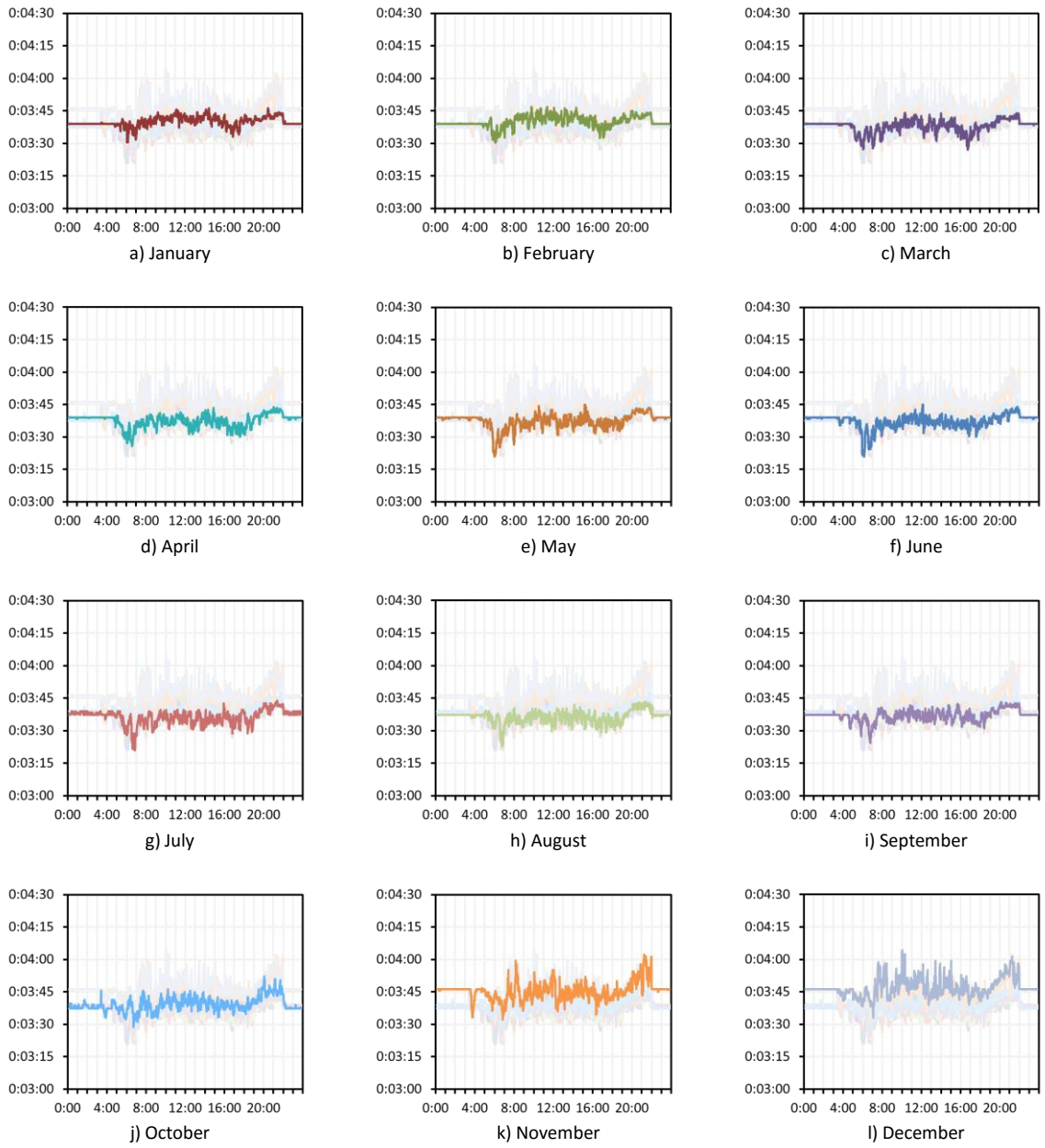


Figure 15-13. Monthly Travel Time Plots for I-165 Southbound

Notes

- November and December had higher corridor travel times, on average

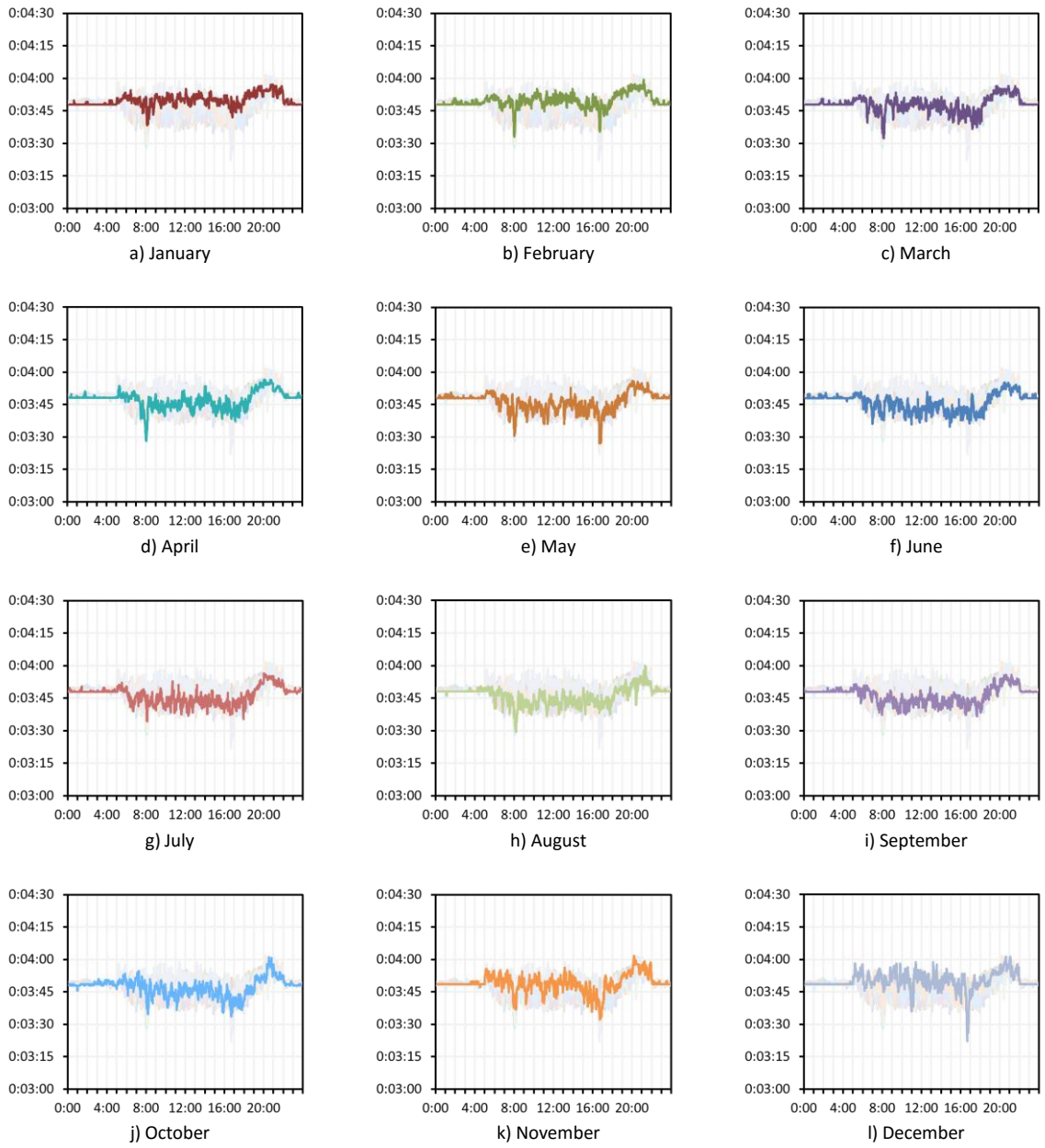


Figure 15-14. Monthly Travel Time Plots for I-165 Northbound

Notes

- November and December had higher corridor travel times, on average

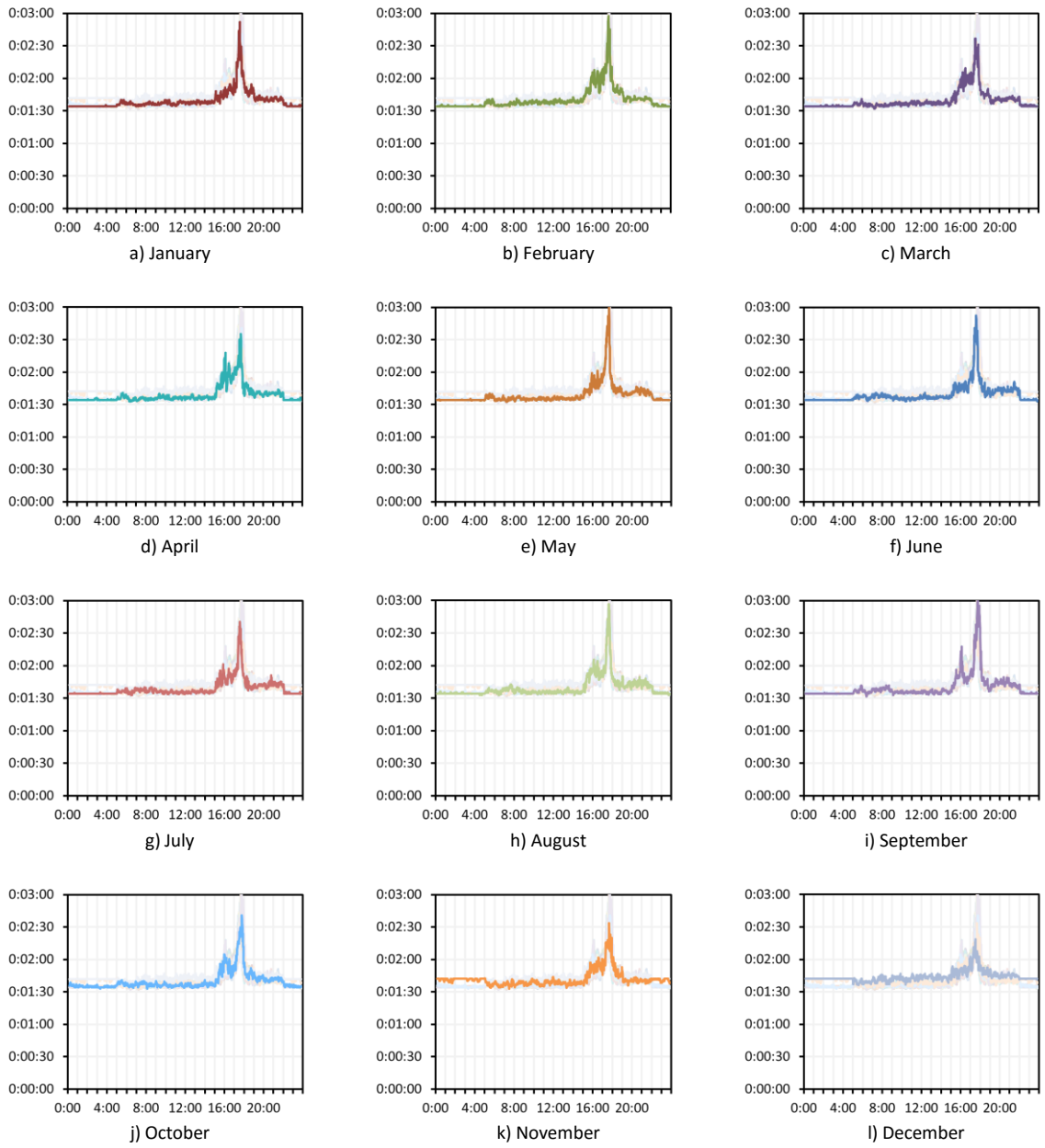


Figure 15-15. Monthly Travel Time Plots for I-359 Southbound

Notes

- Major PM peak congestion for all months

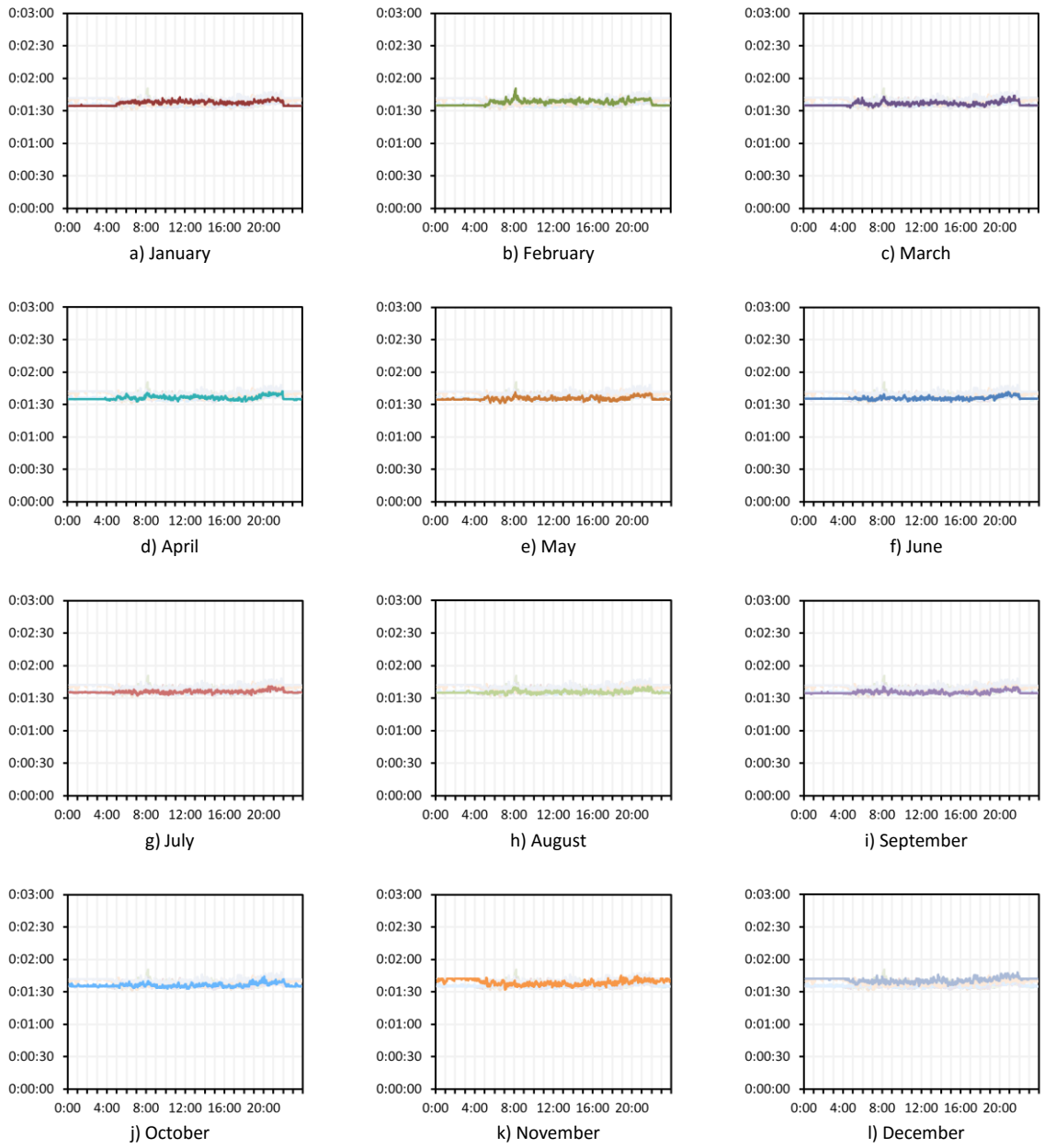


Figure 15-16. Monthly Travel Time Plots for I-359 Northbound

Notes

- Very stable and repeatable corridor travel times

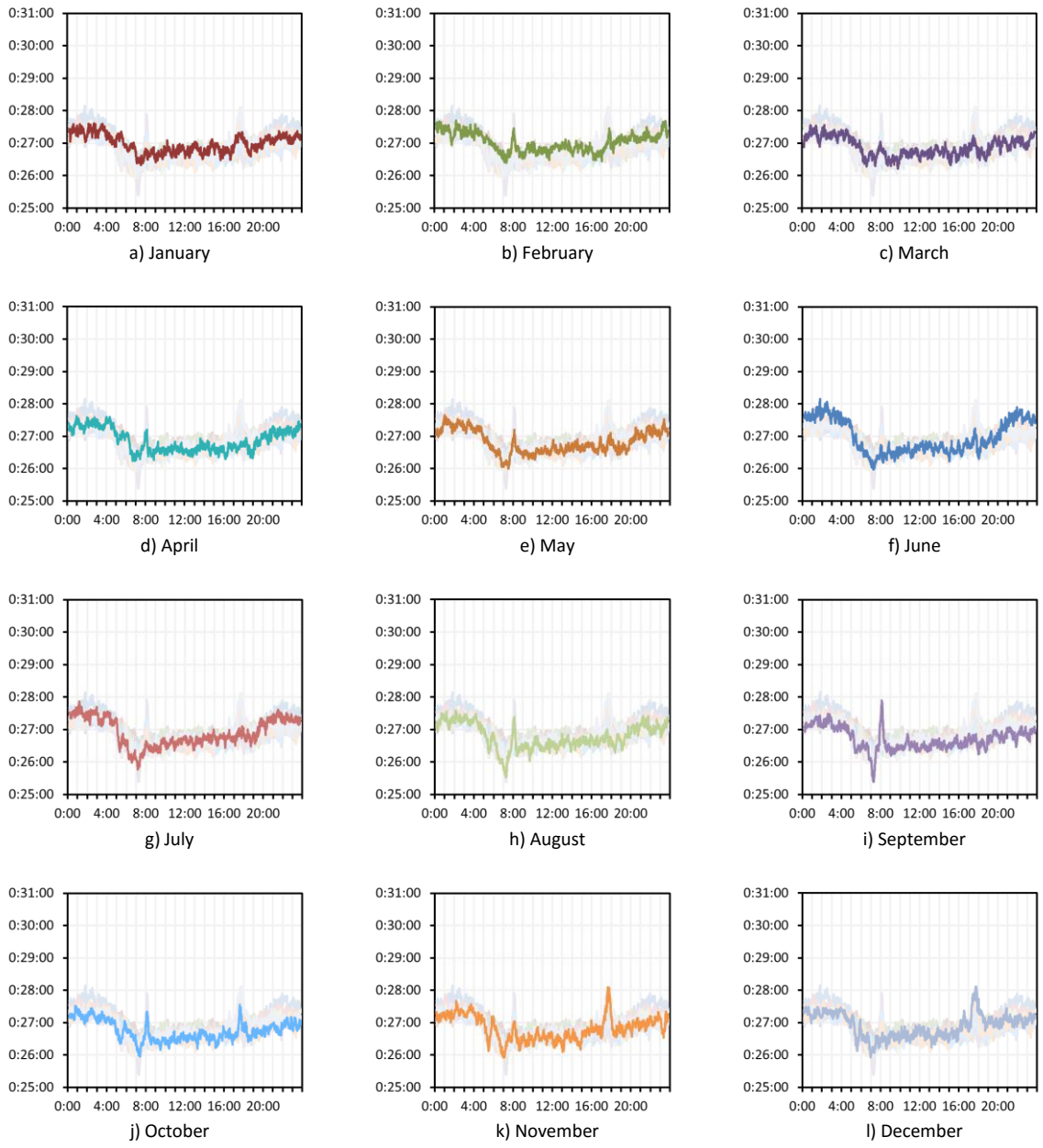


Figure 15-17. Monthly Travel Time Plots for I-459 Westbound

Notes

- Relatively stable and repeatable corridor travel times

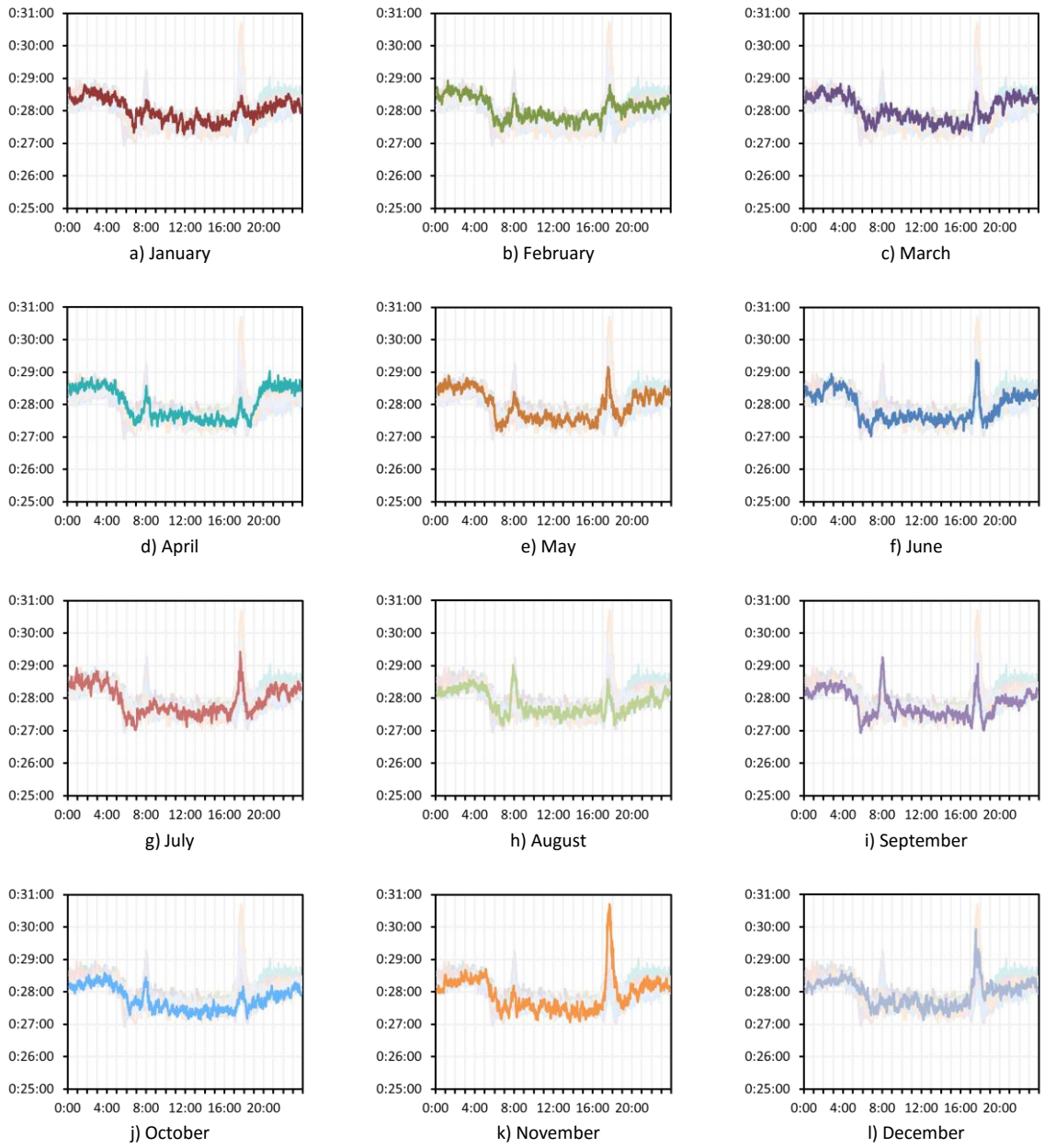


Figure 15-18. Monthly Travel Time Plots for I-459 Eastbound

Notes

- Large spike in the PM corridor travel time in November

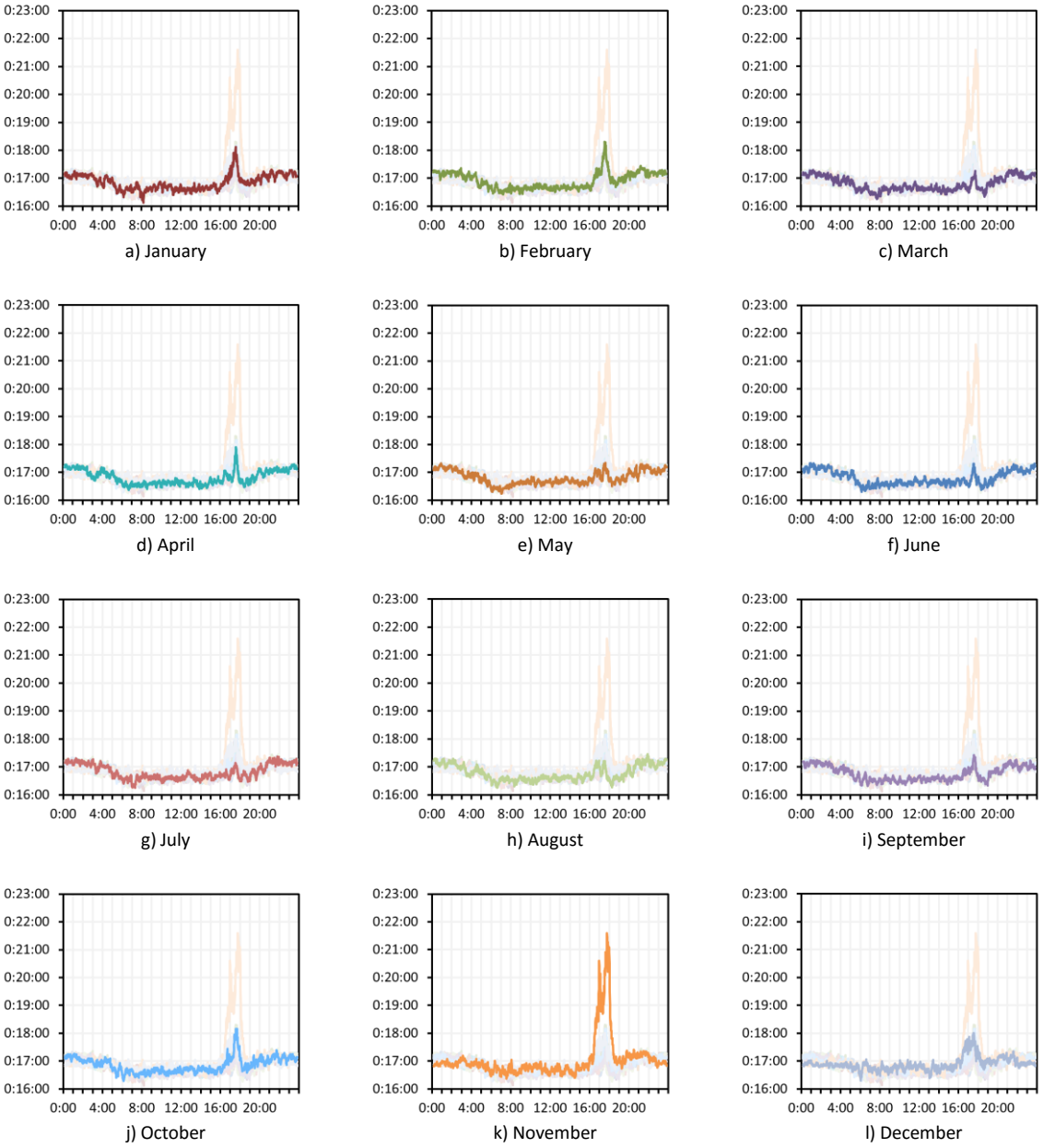


Figure 15-19. Monthly Travel Time Plots for I-565 Westbound

Notes

- Large spike in the PM corridor travel time in November

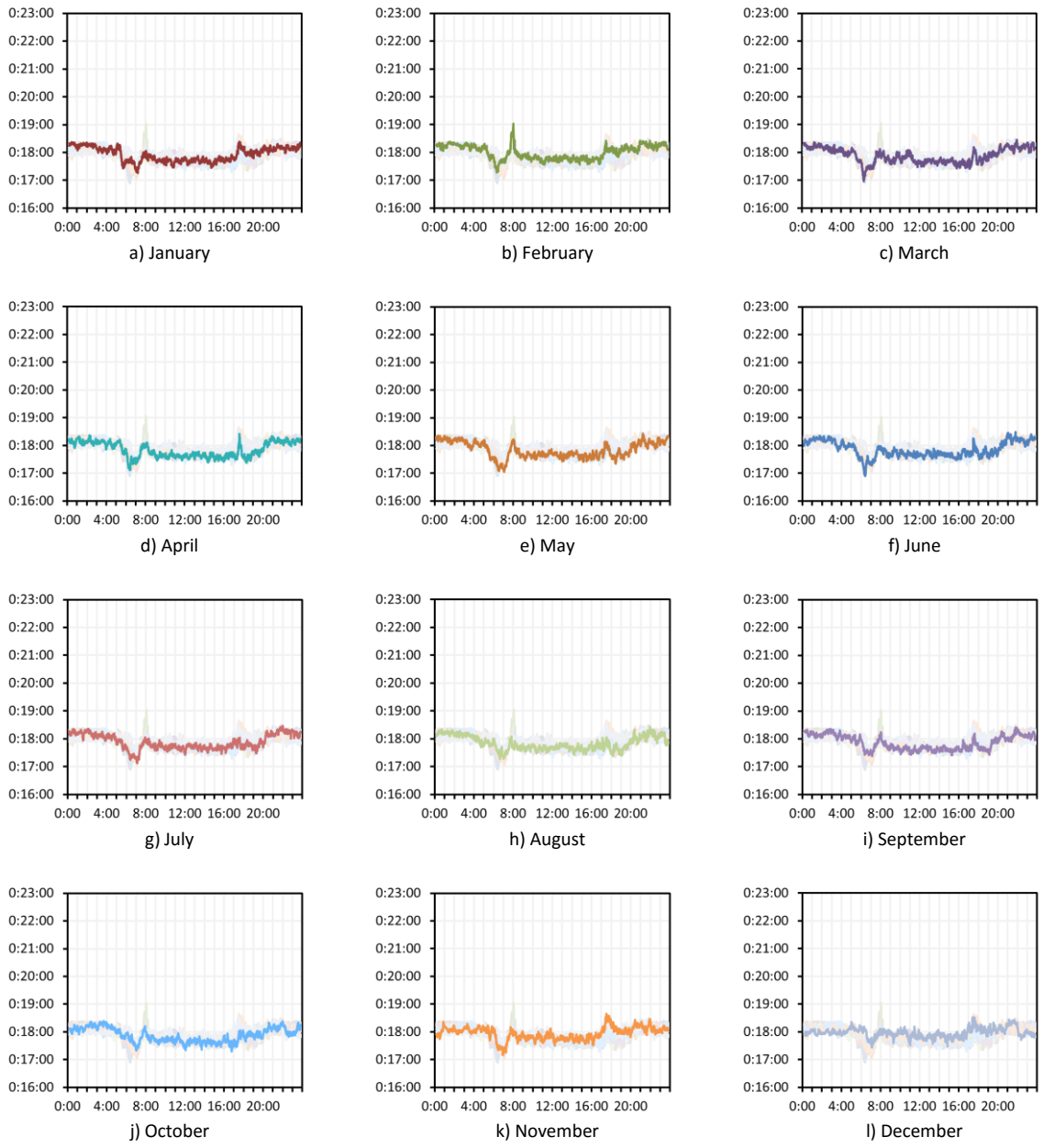


Figure 15-20. Monthly Travel Time Plots for I-565 Eastbound

Notes

- Relatively consistent travel times from month-to-month

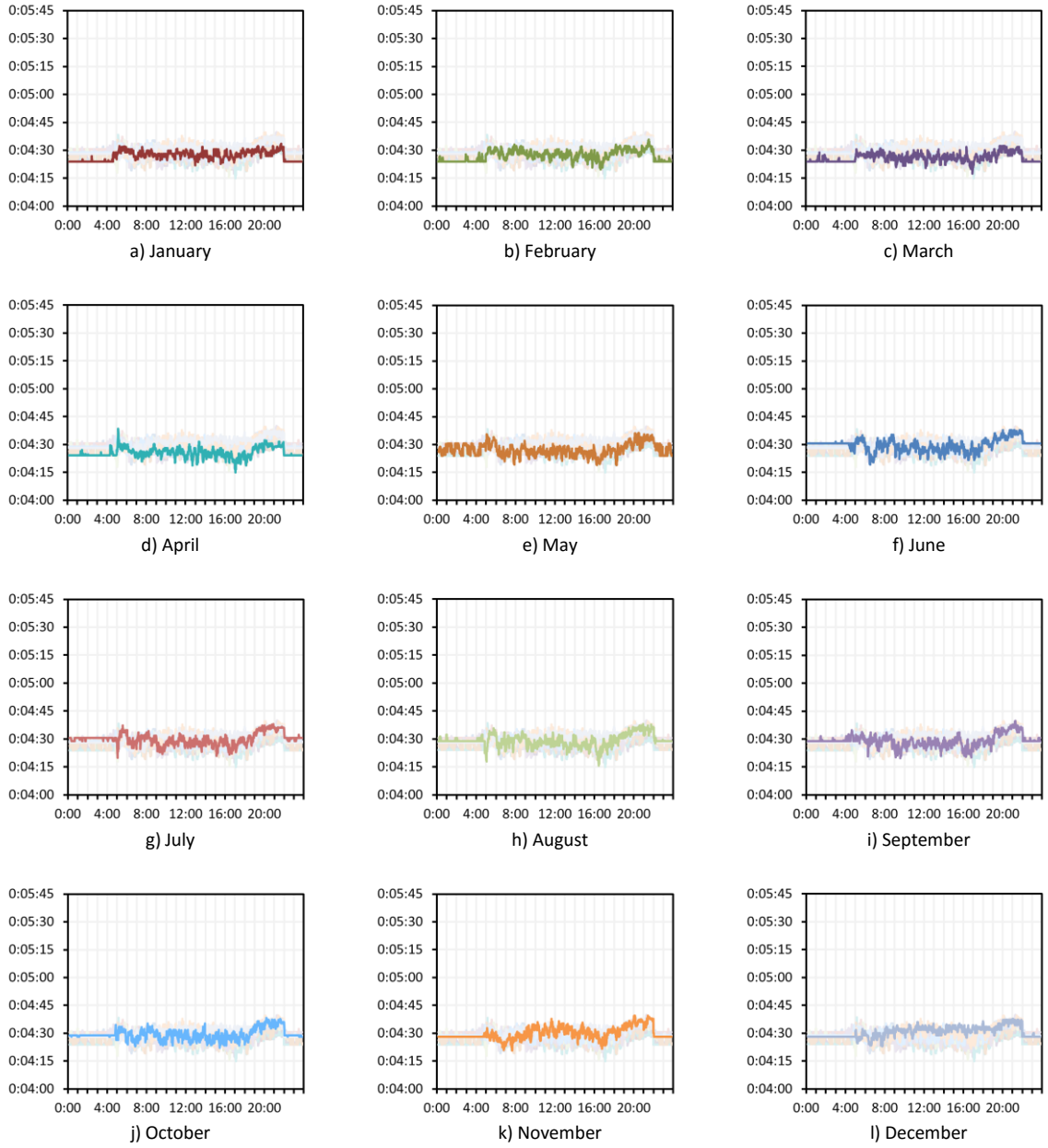


Figure 15-21. Monthly Travel Time Plots for I-759 Westbound

Notes

- Relatively consistent travel times from month-to-month, with a slight increase in December

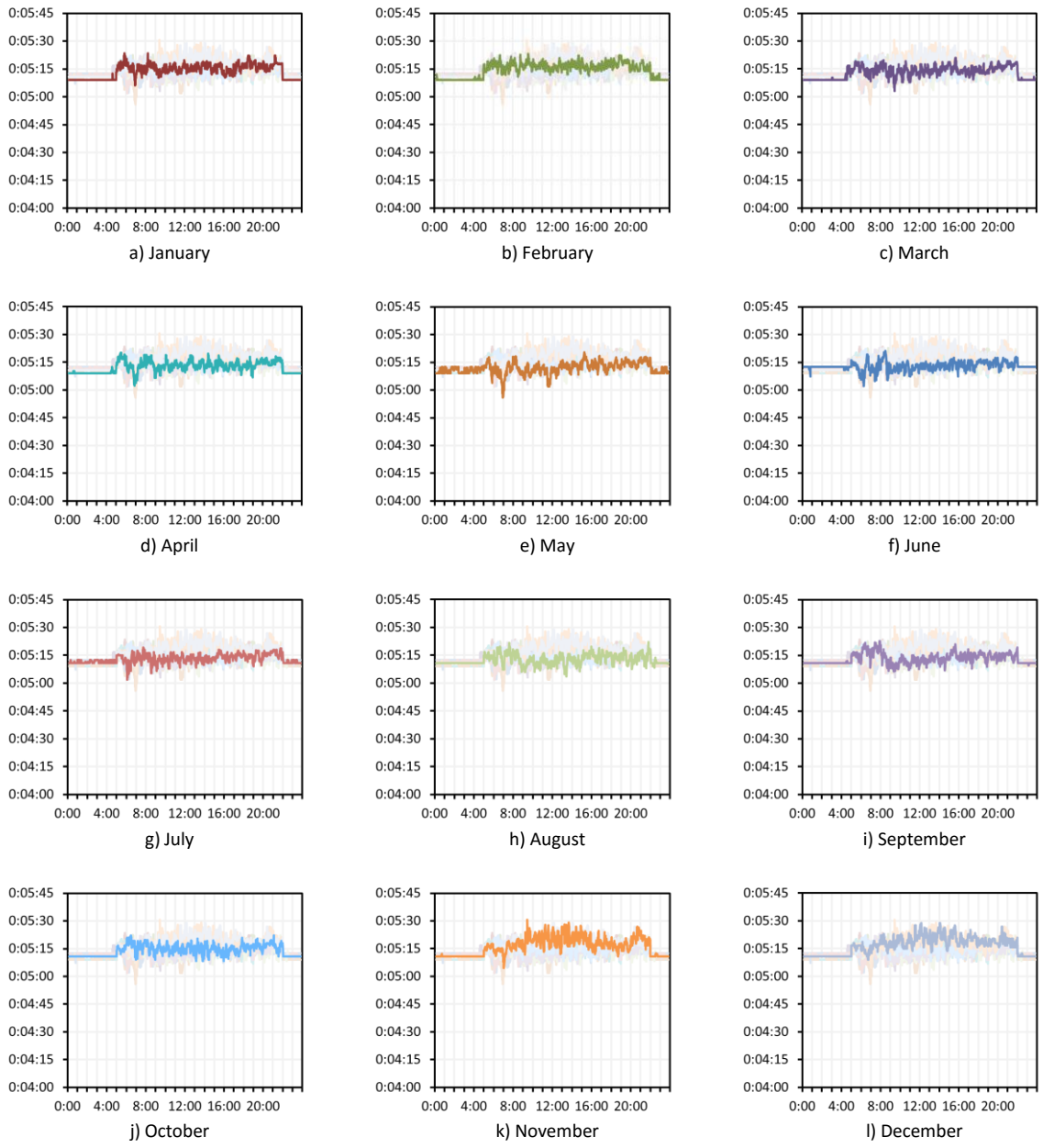


Figure 15-22. Monthly Travel Time Plots for I-759 Eastbound

Notes

- Relatively consistent travel times from month-to-month, with slight increases in November and December

University Transportation Center for Alabama

Executive Committee

Dr. Jay K. Lindly, Director UTCA
The University of Alabama

Dr. Michael Hardin, Associate Director UTCA
The University of Alabama

Dr. Fouad H. Fouad, Associate Director UTCA
The University of Alabama at Birmingham

Dr. Houssam A. Toutanji, Associate Director UTCA
The University of Alabama in Huntsville

Staff

Ms. Connie Harris, Secretary UTCA

Contact Information

University Transportation Center for Alabama
1105 Bevill Building
Box 870205
Tuscaloosa, AL 35487-0205
(205) 348-9925
(205) 348-6862 fax

utca@eng.ua.edu
http://utca.eng.ua.edu