



Metropolitan Washington Council of Governments
National Capital Region Transportation Planning Board

Expanded Evaluation of Peak Spreading

June 30, 2008



Vanasse Hangen Brustlin, Inc.

8300 Boone Blvd, Suite 700
Vienna, VA 22182
(703) 847-3071

Executive Summary

The Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board (TPB) engaged Vanasse Hangen Brustlin (VHB) to analyze peak spreading conditions in the TPB region. During FY 07 VHB completed a technical memorandum for TPB that summarized state of the practice and state of the art techniques for modeling peak spreading. The memo also included an initial evaluation of traffic count data to determine data availability and illustrate the peaking characteristics along the I-270 corridor in Montgomery County. For FY 08, VHB expanded the evaluation of traffic count data and determination of peak characteristics on I-270 and several other Maryland facilities in the TPB region. VHB also examined peak conditions for those facilities over time.

VHB used several different methodologies to evaluate roadways for peak spreading, including peak hour to total volume ratios, link-based volume-to-capacity (V/C) ratios, and regression analysis. VHB's analysis shows that the major freeway radial corridors in the Maryland areas of the TPB region behave in a similar manner in terms of peaking, peak spreading, and directional flows; however, the Beltway behaves differently. The findings indicate that once capacity is reached during the peak hour on a radial freeway an apparent peak hour trend emerges. VHB's analysis found that as the ADT per lane increases, the proportion that occurs in the peak hour goes down. This relationship could be very useful for estimating the peak hour percentage used for determining freeway ADT capacities used for trip assignment by the model. Once data are available the regression tests should also be performed on major arterial radial corridors to further test their behavior against nearby, parallel freeway facilities. Further analysis is needed to determine if the geographic extent of peak spreading is truly regional, is confined to a handful of major facilities, or symptomatic of specific regional travel markets.

Traffic Count Inventory

Full analysis of peak spreading requires 24-hour (hourly) traffic counts rather than daily volumes. To support the analysis, VHB staff researched and obtained Maryland State Highway Administration (SHA) historical 24 hour count volumes in Montgomery, Prince George's, Frederick, Howard, and Anne Arundel counties. The raw SHA counts are contained in an appendix to this memo and can also be obtained from the SHA website. The Virginia Department of Transportation (VDOT) releases only daily counts which were unsuitable for peak spreading analysis; therefore, this memo only covers Maryland roadways.

Analysis

VHB used several different methodologies to evaluate roadways for peak spreading. The procedure used in the FY 07 analysis of selected locations along I-270 in Montgomery County was based on the relationship of the peak volume-to-capacity ratio and the number of lanes in the roadway link. Link V/C ratios were calculated using the count volumes and capacities taken from the model links' CAPCLASS values. If the V/C exceeded 1.0 using this analysis, the link capacity was adjusted based on the ratio of the volume to the number of lanes in the link. The resulting V/C values were then plotted and sections of I-270 showed peak level volumes spreading beyond the traditional three-hour peak period into the shoulder hours and creating a five hour peak-period.

For the expanded analysis, the first procedure omitted the use of V/C ratios and instead compared the 24-hour count by year using the ratio of the peak hour (either AM or PM) traffic volume and the total AM/PM traffic volume for that location. This method was applied along I-270 from the Montgomery County / Frederick County line down to the I-270 East Spur at Old Georgetown Road (MD 187), and to I-95 from the Howard County / Baltimore County line down to the Capital Beltway. Charts illustrating sample outputs of this analysis along I-270 are shown in Figure 1 and Figure 2 on the next page; charts covering the entire I-270 and I-95 analysis corridors are contained in the appendix.

A second procedure refined the earlier method to adjust for a narrower range of available data and uses the ratio of the peak hour volume within a determined time range to the total volume of the time range. These procedures were applied to the US 50 corridor from the District of Columbia / Prince George's County line to the Prince George's County / Anne Arundel County line. Sample charts of these results are shown in Figure 3 and Figure 4.

The final methodology attempted to find a relationship between the ratio of the peak hour volume per lane and the average daily traffic (ADT) per lane using linear regression. All three previously analyzed corridors were tested using this procedure: I-270, I-95, and US 50. These facilities behaved similarly in that the AM peak hour occurred in the inbound (toward the Capital Beltway and the District of Columbia) direction and the PM peak hour occurred in the reverse direction (away from the Capital Beltway and the the District of Columbia). The regression analysis produced the following formulas for the three facilities:

$$AM\ Peak\ Hour: y = -0.00054x + 20.25875 \ (r^2=0.72558)$$

$$PM\ Peak\ Hour: y = -0.00031x + 16.0217 \ (r^2=0.59841)$$

Where:

y = Percentage of the ratio of Peak Hour per Lane to ADT per Lane

x = ADT per Lane.

The results of this analysis are shown in Figure 5 and Figure 6. As expected, the analysis shows that as the ADT per lane increases, the ratio of peak hour ADT per lane to ADT per lane decreases. This is probably true because the facility is approaching capacity, and once capacity is exceeded peak spreading is likely to occur.

Regression analyses were also performed on the data gathered for the Capital Beltway (I-95/I-495) from the Montgomery County / Prince George's County line southbound to the Potomac River. For this corridor, the relationship between the data and the peak / ADT ratio was less well defined (i.e., a poor fit to the line). The formulas for the Beltway are shown below:

$$NB\ AM\ Peak\ Hour: y=0.000113089x + 4.528703196 \ (r^2=0.30492)$$

$$NB\ PM\ Peak\ Hour: y=-0.000064x + 8.396757 \ (r^2=0.36988)$$

$$SB\ AM\ Peak\ Hour: y=-1.81513E-05x + 6.611981521 \ (r^2=0.02074)$$

$$SB\ PM\ Peak\ Hour: y=3.93E-05x + 6.314491 \ (r^2=0.08723)$$

Where:

Y = Percentage of the ratio of Peak Hour per Lane to ADT per Lane,

X = ADT per Lane.

The results of the regression analysis for the Beltway are shown in Figures 6 through 9. Separate charts illustrating the variability of the data at each station along the analysis corridor are contained in the appendix along with the actual data spreadsheets. In addition to the poor fit, the analysis for the Beltway shows that in the off-peak direction of travel (NB in the morning, SB in the evening), the ratio of the peak hour volume per lane to ADT per lane is directly related to the total ADT per lane (i.e., the regression line slopes up rather than down), whereas with the other corridors there was an inverse relationship. This is

indicative of significant available capacity on the Beltway during these times, which is confirmed historically and through present conditions by other observed data, including the TPB reports produced by Skycomp.

Implications for TPB Forecasting Procedures

VHB’s analysis shows that the major freeway radial corridors in Maryland behave in a similar manner in terms of peaking, peak spreading, and directional flows. Conversely, the relationship among these behaviors for the Prince George’s section of the Beltway, a circumferential facility, is not only significantly different than the radial corridors but also does not exhibit any discernable pattern. This may be due to the fact that the Beltway has not reached peak hour capacity at the locations observed. TPB’s peak spreading procedures cannot be broadly applied to all facility types but rather must consider how different families of facilities server the regional travel market. The number of through (external-external) trips that use the Prince George’s segment of the Beltway clearly impacts the fit of the data. A good comparison could be made with the remaining sections of the Beltway in Montgomery County and Virginia, which in many ways function like radial facilities in terms of how they ultimately distribute trips within the network; however, a lack of available data prevented such an analysis. The Montgomery section of the Beltway should also be analyzed for peak spreading using the methods applied to I-270, since other observations have indicated that capacity is exceeded along that corridor and peak spreading is occurring; again, more and better data are needed to support such an analysis.

The findings indicate that once capacity is reached during the peak hour on a radial freeway an apparent peak hour trend emerges. Our analysis found that as the ADT per lane increases, the proportion that occurs in the peak hour goes down. This relationship could be very useful for estimating the peak hour percentage used for determining freeway ADT capacities used for trip assignment by the model. As an example, if a radial freeway is projected to service 24,000 vehicles per lane per day then the expected AM peak hour percentage would be 7.3%. If that same freeway is projected to service 18,000 vehicles per lane per day then the AM peak hour percentage would be 10.5%. During the PM peak the peak percentages would be 8.6% and 10.4%, respectively. The typical range of values for which this relationship holds true is shown in Table 1. The analysis showed that the relationship begins to break down with ADT per lane values exceeding 29,000 vplpd.

Table 1: Relationship Between ADT / Lane and Peak Hour Percentages

ADT / lane	Percentage	Volume/lane	Percentage	Volume/lane
10,000	14.86	1486	12.92	1292
11,000	14.32	1575	12.61	1387
12,000	13.78	1653	12.30	1476
13,000	13.24	1721	11.99	1559
14,000	12.70	1778	11.68	1635
15,000	12.16	1824	11.37	1706
16,000	11.62	1859	11.06	1770
17,000	11.08	1883	10.75	1828
18,000	10.54	1897	10.44	1880
19,000	10.00	1900	10.13	1925
20,000	9.46	1892	9.82	1964
21,000	8.92	1873	9.51	1997
22,000	8.38	1843	9.20	2024
23,000	7.84	1803	8.89	2045
24,000	7.30	1752	8.58	2060
25,000	6.76	1690	8.27	2068
26,000	6.22	1617	7.96	2070
27,000	5.68	1533	7.65	2066
28,000	5.14	1439	7.34	2056
29,000	4.60	1334	7.03	2039

Finally, once data are available the regression tests should also be performed on major arterial radial corridors to further test their behavior against nearby, parallel freeway facilities. Particularly in cases where peak spreading exists, one would expect to see some similar patterns on the arterial network, especially since there is likely to be spillover traffic to these facilities in response to congestion on the freeways. Further analysis (which depends on better data) is needed to determine if the geographic extent of peak

spreading is truly regional, is confined to a handful of major facilities, or symptomatic of specific regional travel markets.

Figure 1: Historical Hourly NB Volumes - I-270 South of Middlebrook Road

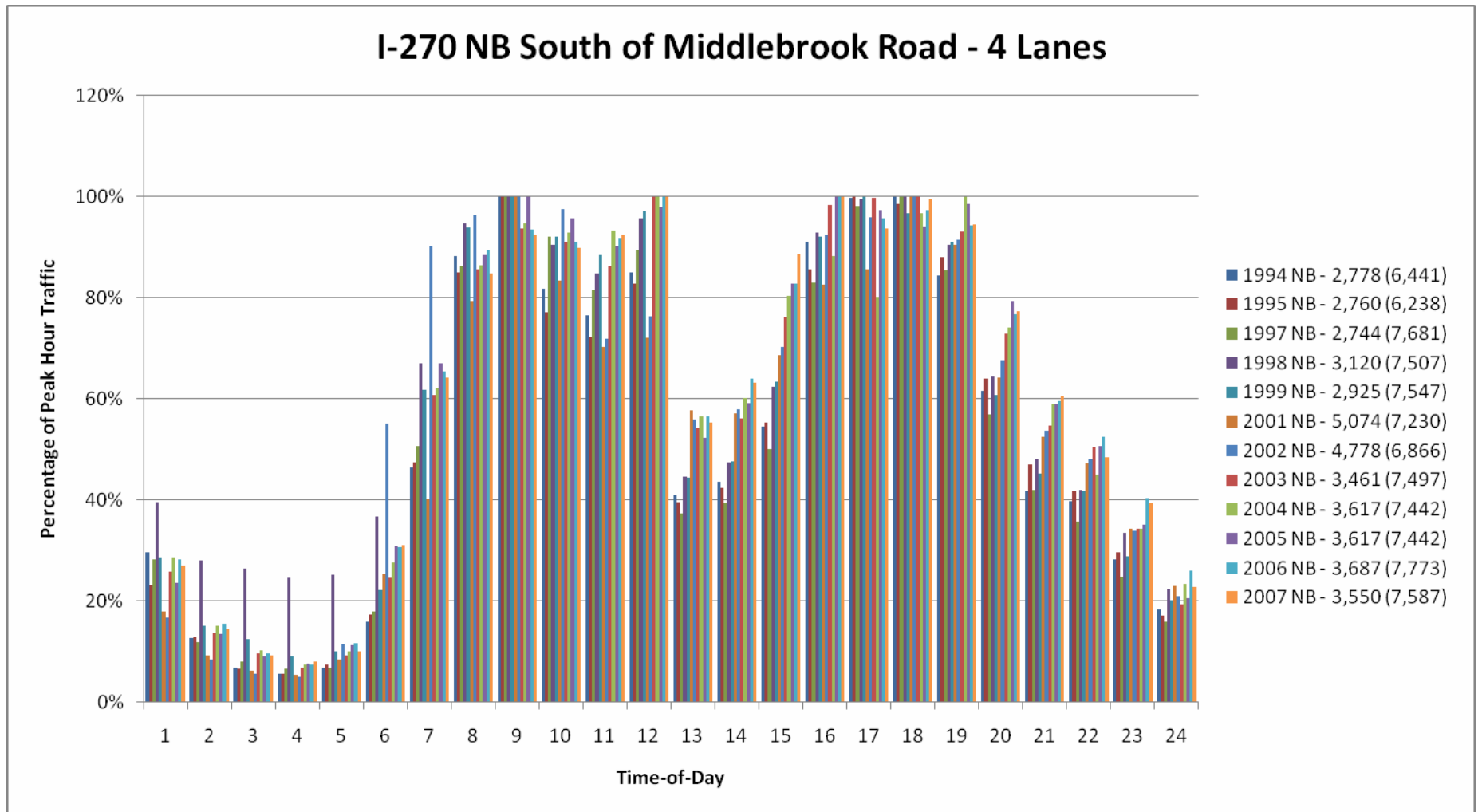


Figure 2: Historical Hourly SB Volumes - I-270 South of Middlebrook Road

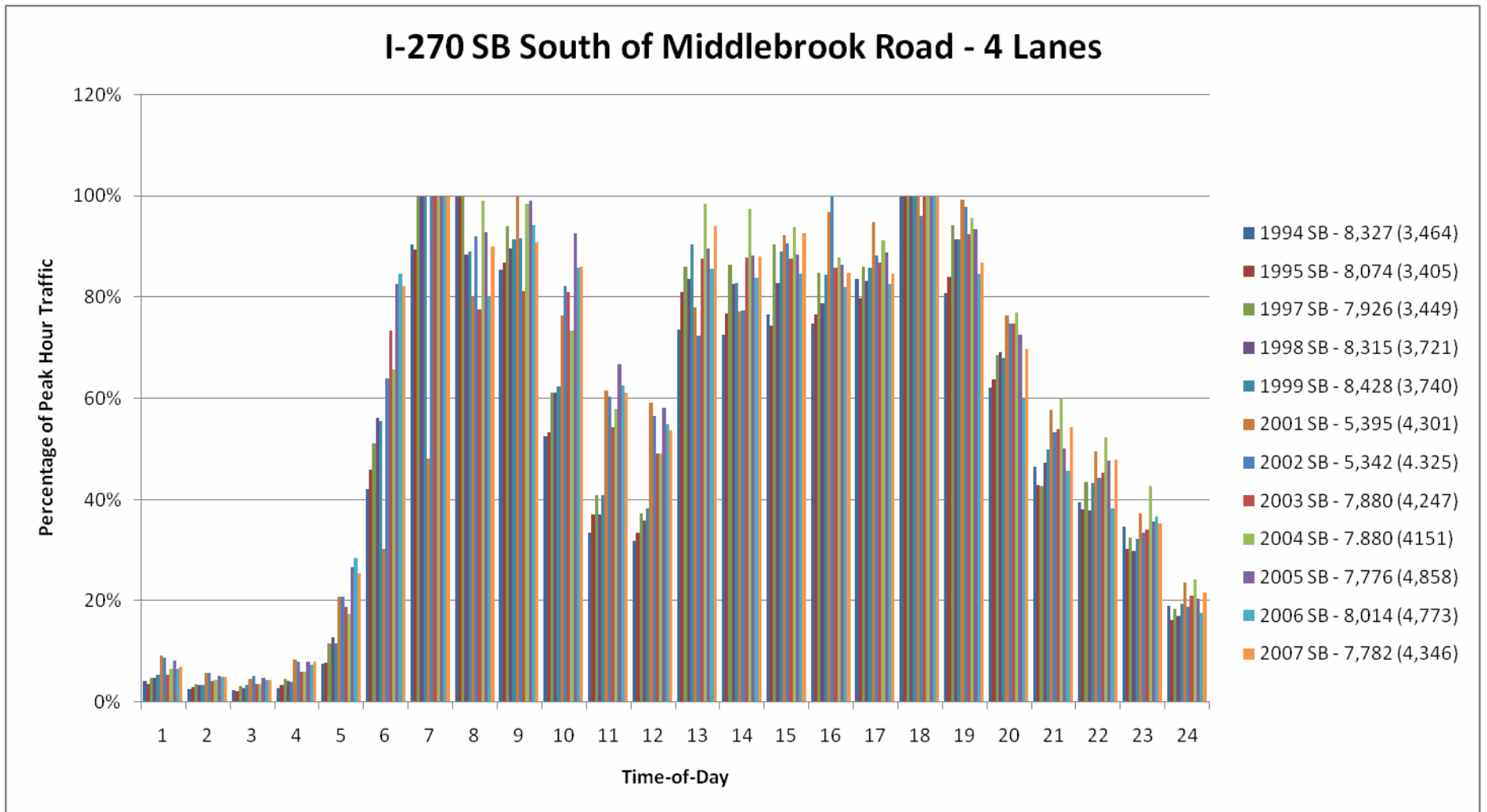


Figure 3: Historical Hourly Volumes, US 50 EB, Prince George's County

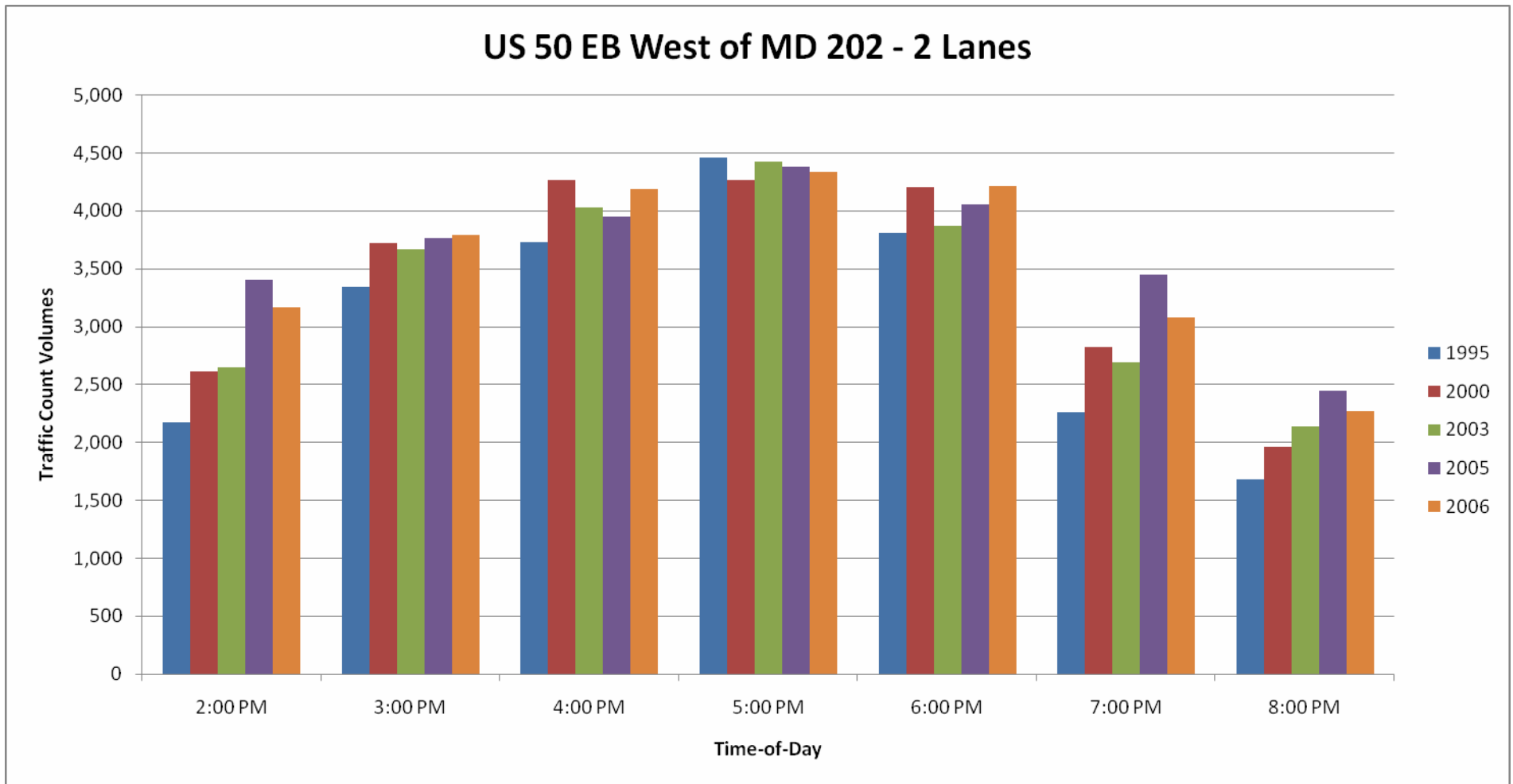


Figure 4: Historical Hourly Volumes, US 50 WB, Prince George's County

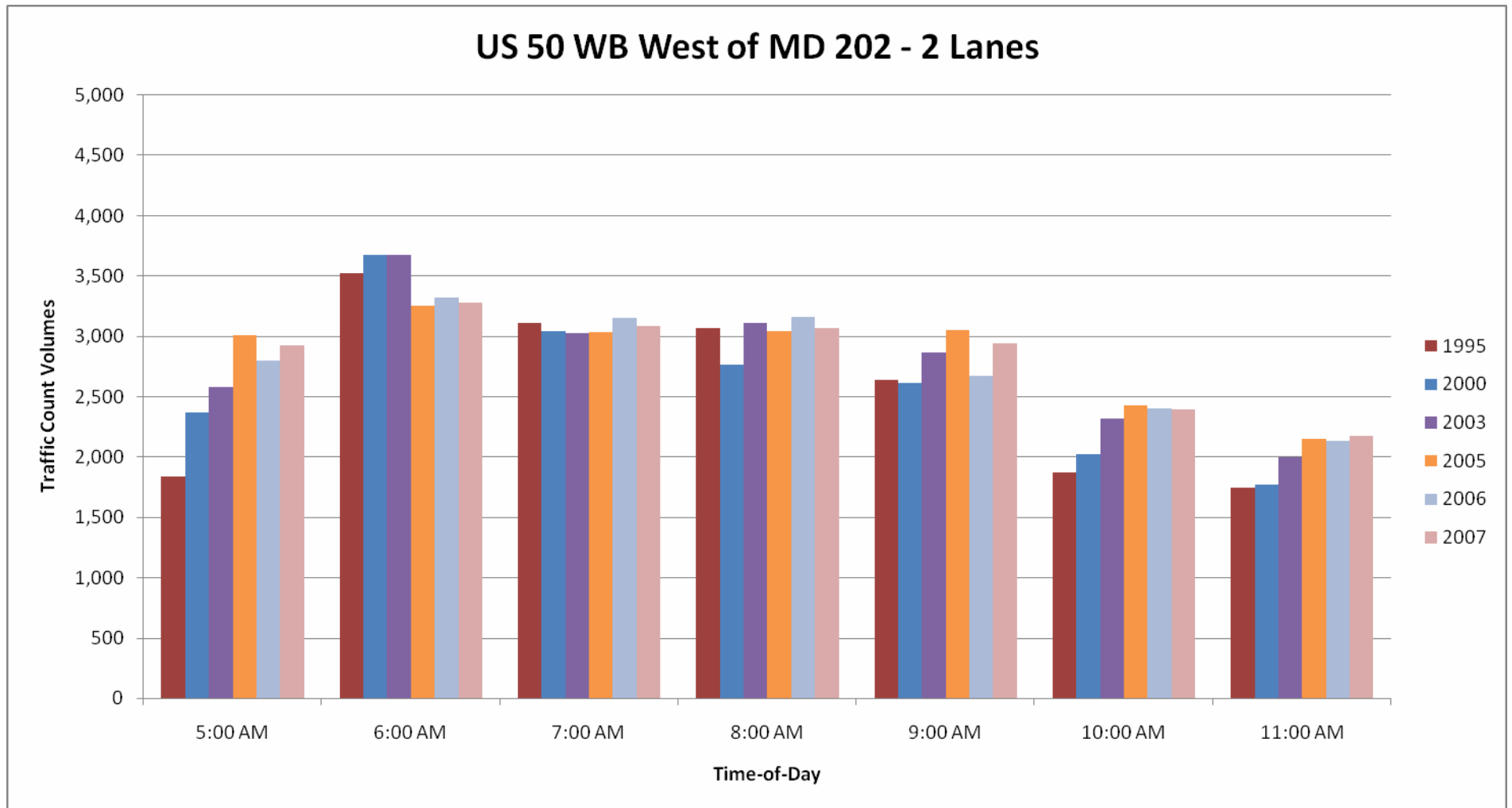


Figure 5: Regression Analysis for Combined Facilities - AM Peak Hour

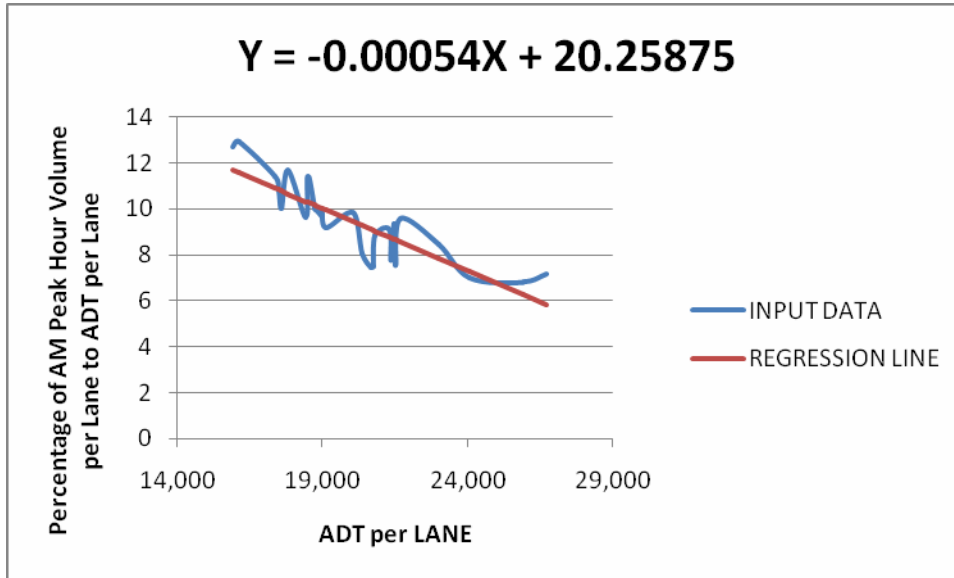


Figure 6: Regression Analysis for Combined Facilities - PM Peak Hour

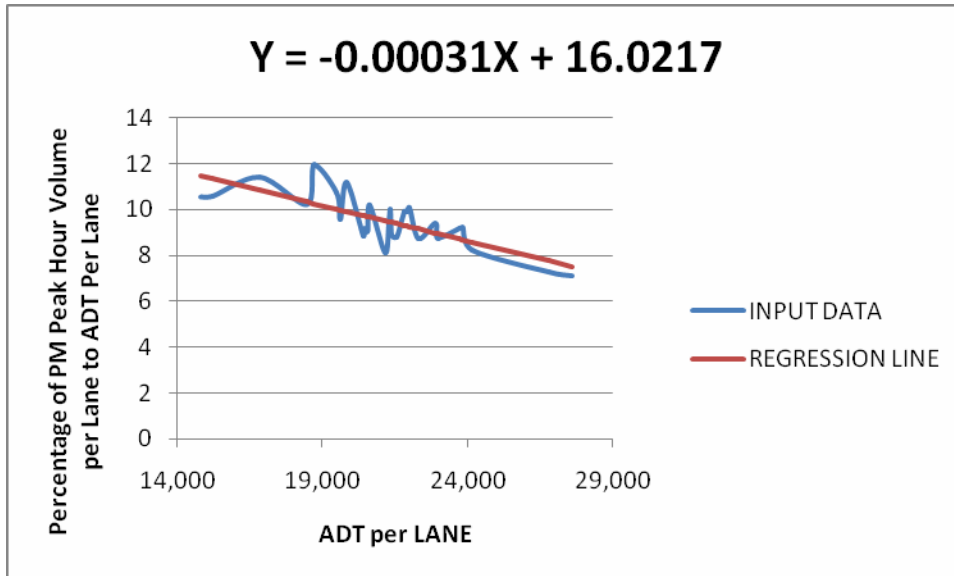


Figure 7: Regression Analysis for Capital Beltway in Prince George's County, NB, AM Peak Hour

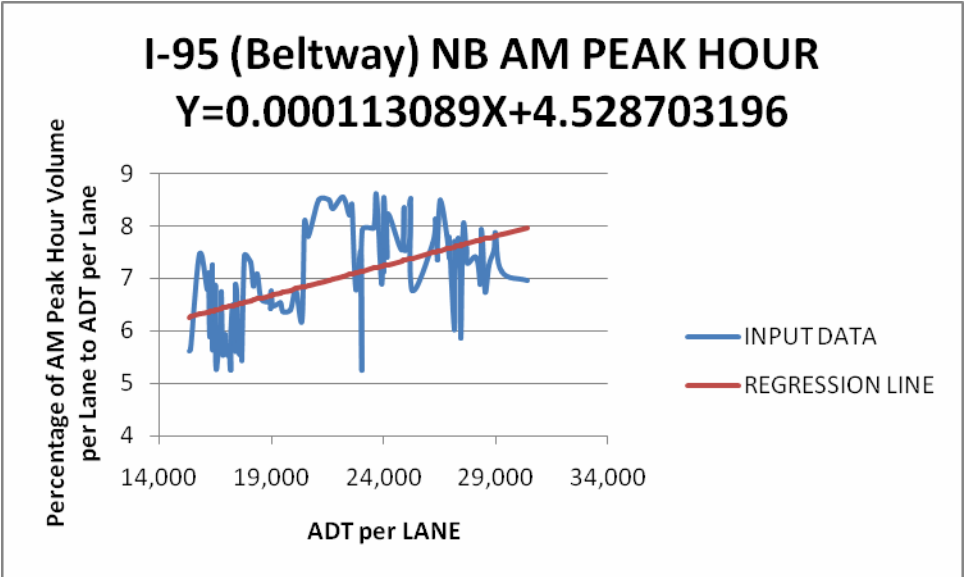


Figure 8: Regression Analysis for Capital Beltway in Prince George's County, NB, PM Peak Hour

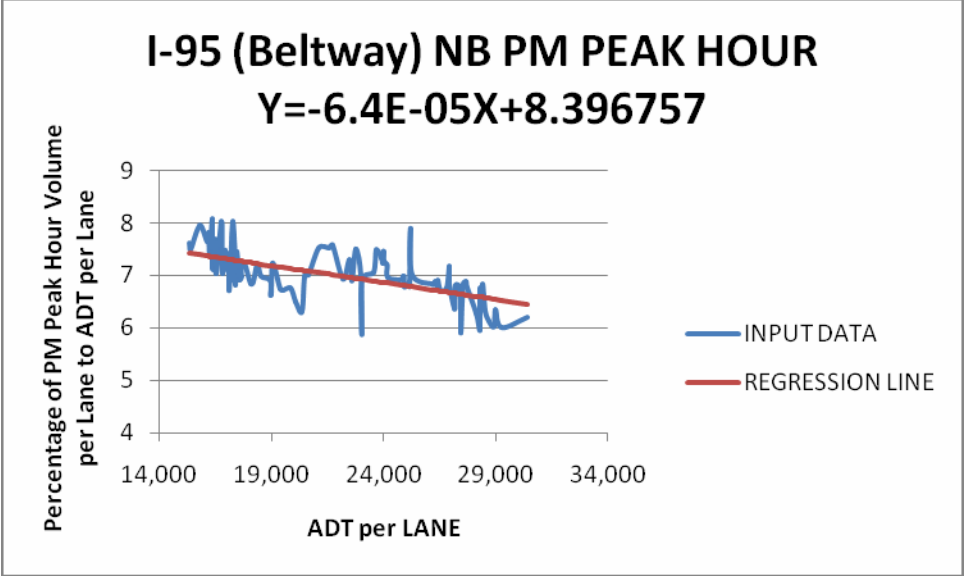


Figure 9: Regression Analysis for Capital Beltway in Prince George's County, SB, AM Peak Hour

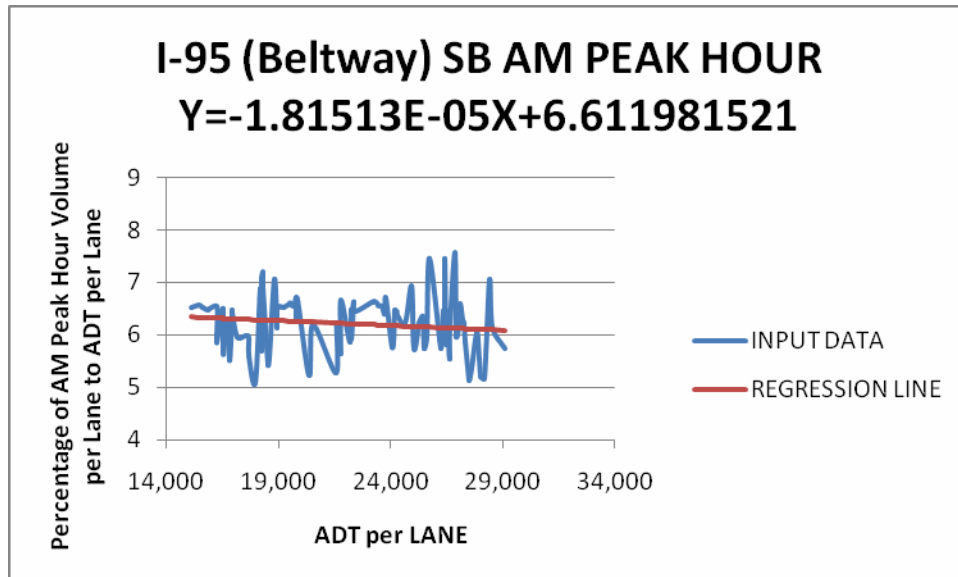


Figure 10: Regression Analysis for Capital Beltway in Prince George's County, SB, PM Peak Hour

