associated with incidents that occur somewhat randomly, as well as periodic events that take place from time-to-time. Such non-recurring, incident-based congestion is often observed in the speed and travel time samples.

In 2004, the Department analyzed the performance of the County's arterial network by reviewing travel times and speeds along selected routes, as surveyed by a series of GPS-equipped probe vehicles. With the assistance of the consultant (Motion Maps, LLC) and the subcontractor (MCV), a series of data samples were collected along the freeways, a series of major arterial corridors, and a few minor arterials throughout most of the County during weekday AM and PM peak periods. Those samples were structured to emphasize greater spatial coverage rather than having more samples over the peak period for a particular roadway, although some repeated sampling was done along certain routes. Additional secondary GPS-based travel time and speed data was obtained from the Metropolitan Washington Council of Governments (MWCOG), as they perform collection of travel time and speed data samples on a three-year cycle for a selected set of arterials in the region, including a significant amount in Montgomery County.

In 2005, the Department conducted a similar set of travel time and speed samples using the same consultant team. However, based upon feedback received following the 2004 report, the 2005 sampling focused on: (a) a selection of County and State arterials, (b) getting more frequent samples within each peak period, and (c) establishing an ability to track year-to-year changes in congestion patterns based on archived travel time and speed data. Fourteen route-corridors were sampled in 2005. Each of these route-corridors was sampled in 2004 as well, although some had a small set of samples at that time. In 2005, an increased number of secondary source GPS-based travel time and speed runs (in Montgomery County) were made available. In addition to the fourteen route-corridors associated with the primary data collection, the secondary data source samples included four additional corridors. The availability of the secondary data sources enabled the primary data collection to cover a few different corridors that might have otherwise been excluded due to resource limitations. Secondary data was available from two new sources: (1) the State Highway Administration (SHA), and (2) the Montgomery County Department of Public Works and Transportation (DPWT), as well as from the prior year source of the MWCOG. Specific documentation of the corridors sampled by the primary and secondary sources was provided in the 2005 report. For the primary and secondary routes sampled in 2005, there was an overall total of about 550 travel time and speed samples. For the typical route-corridor sampled, there were a total of about 28 travel time runs on average, or about 7 travel time runs per direction and time period.

Readers should recognize that there is a high degree of variability in the congestion along a route during the peak periods of congested or slow traffic – at any given time, some segments may be congested and others not; and at any given place, the congestion may peak at a time different than other places along a corridor. In other words, congestion particularly on arterials can be localized and intense. Yet at other locations along that arterial, the congestion may be most intense at a different time or for a different duration. For some arterials, the slowness can be very directional, but for other arterials, the slowness can be more evenly distributed bi-directionally. For that reason and the practicality of conducting the probe samples, each corridor is typically sampled in both directions during both the AM and the PM peak periods to capture both the peak and off-peak directional flows according to the following general procedures:

- **Sample Frequency per Hour**: The more travel time and speed samples that are collected, the easier it is to capture such variability and the full range of congested conditions. Yet, more samples require more resources to collect the data, and given the general limitations of Department's resources, there is a limit to the number of observations that can be performed. The sampling approach attempts to obtain between two and four observations per hour per direction for the corridors. Between one and three probes are used to sample each corridor and direction by driving back and forth along the route. The field supervision tries to have a somewhat even time spacing between the probes when more than one probe is used.
- **Sampling Duration per Peak Period**: Three probes are typically used on longer more congested routes, while one probe tends to be used on shorter less congested routes. However, to get to the start or return from the end of a particular route, at times it is more feasible to use a route that is being sampled on a different day, referred to as a "deadheading sample". The duration of the sampling per peak period is generally about two and a half to three hours, but sometimes more or sometimes less. The field supervision generally tries to start the first sample and stop the last sample as a full sample of the corridor, but this is not always the most practical approach

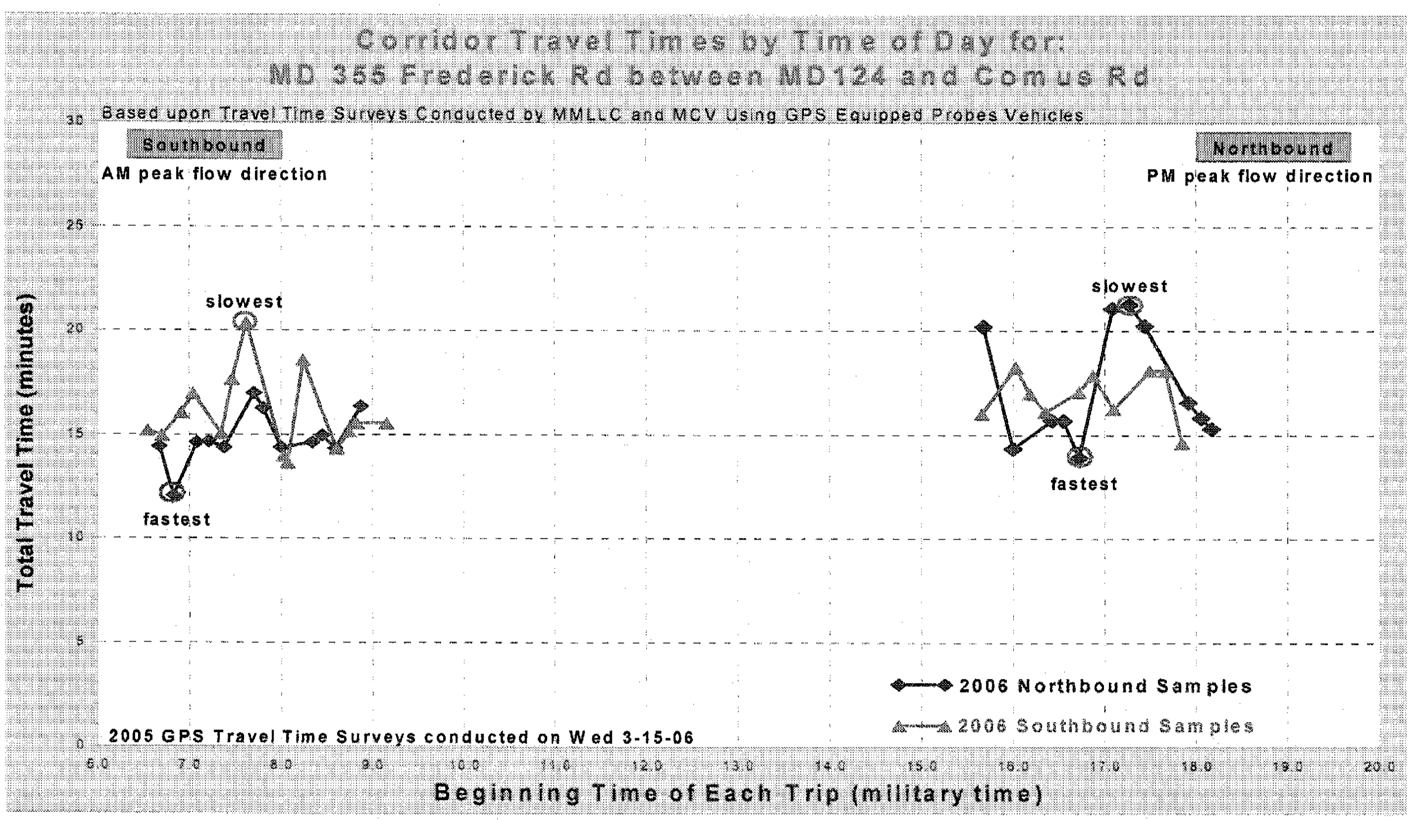
The following discussion and illustrations presents the results of the travel time and speed samples for two specific corridors. As mentioned earlier, new primary data was collected for only two corridors: (1) Frederick Road (MD 355) between Montgomery Village Avenue (MD 124) and Comus Road, and (2) the combined corridor of First Street (MD 911) and Norbeck Road (MD 28) / MD 28-198 Connector between Rockville Pike (MD 355) and New Hampshire Avenue (MD 650). In addition, some secondary GPS-based travel time and speed data was available for 2006 for adjacent sections of these two corridors. The results of the travel time and speed data analysis are discussed below:

Frederick Road (MD 355) from Montgomery Village Avenue (MD 124) to Comus Road: In the 2005 report, the MD 355 corridor between Montgomery Village Avenue and Comus Road was presented as an example to illustrate the impact on congestion levels associated with growth and development. Figure 3.4 presents a summary of the travel time results by time-of-day graphically for the data collected in 2006. Comus Rd intersects MD 355 on the north side of the Clarksburg area. This approximately 8.4 mile roadway segment passes through the Gaithersburg, Germantown, and Clarksburg areas on the east side of the I-270 Corridor. This roadway segment serves an area of the County that has experienced and will continue to experience a significant pace of development, especially of recent in sections of Clarksburg.

In Figure 3.4, the horizontal axis gives the time of day (in military time) for the start of each travel time sample, the vertical axis gives the total travel time from the start to the end of the particular corridor. The results of each of the travel time samples are shown as the points in the Figure. Figure 3.4 shows that there were 47 completed directional travel time samples in 2006 for this corridor, with 12 during the AM peak-period northbound, 14 during the AM peak-period southbound, 11 during the PM peak-period northbound, and 10 during the PM peak-period southbound. The figure shows that from this collection of data samples, the slowest southbound AM peak travel time was about 20.4 minutes for the sample that started about 7:37 AM, while the slowest northbound PM peak travel time was about 21.2 minutes for a sample that started at about 5:16 PM. No traffic related incidents were observed that would have affected these travel times.

The fastest northbound sample observed was about 12.1 minutes while the slowest northbound sample observed was about 21.2 minutes. When contrasting these two samples, there is a resulting travel-time-ratio of about 1.8 of the slowest northbound time to the fastest northbound time. The fastest southbound sample observed was about 13.7 minutes, and when contrasted to the slowest southbound sample of 20.4 minutes, the result is a travel-time-ratio of about 1.5 of the slowest southbound time to the fastest southbound time.

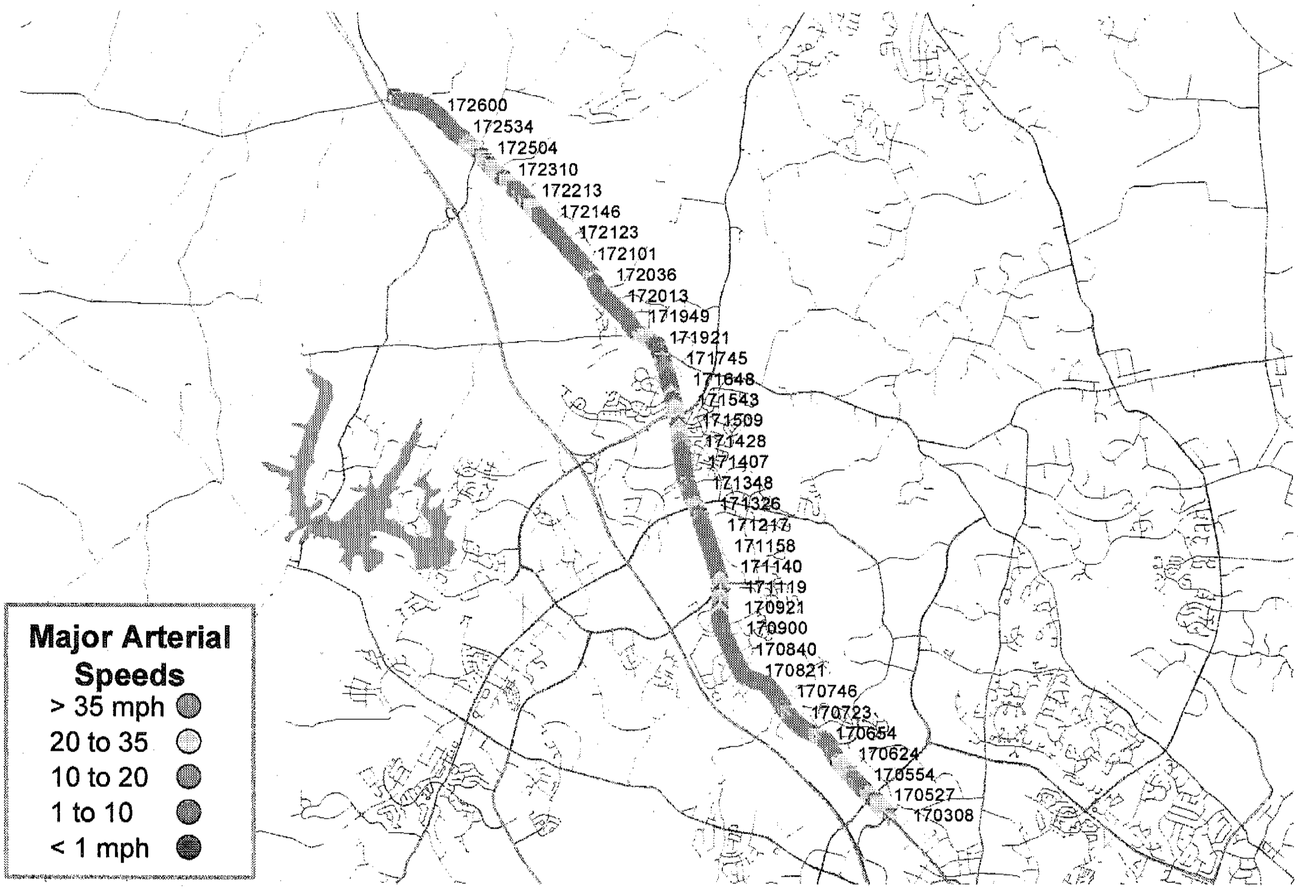
Figure 3.4: Frederick Rd (MD 355) Travel Time Samples - Results



It should be noted that for that slowest AM southbound trip, the slowest speeds and congestion were experienced at two main locations: (1) the north end of this corridor approaching Clarksburg Road (MD 121), and continuing south to Stringtown Road, and (2) the south end of the corridor from Watkins Mill Road through Montgomery Village Avenue. For other southbound samples earlier that morning, queues were observed stretching north from Clarksburg Road to as far north as Comus Road.

A similar review of the specific results of the northbound samples for the PM peak period as well as the AM peak period, presents a somewhat different set of congestion patterns. Some for which, certain potential short-term roadway improvements are seen as perhaps being appropriate from the perspective of reducing traffic congestion conditions and improving safety. Based on the 2005 data, it was noted in last year's report that for the slowest PM northbound sample, and the others before and after, the slow speeds and congestion were experienced starting at Ridge Road (MD 27) and generally continued as a rolling delay until the intersection with Clarksburg Road was cleared. The sample further indicated that it took roughly 15 min to travel this 3.2-mile long stretch of road, at an average speed of about 13 mph. In late 2005, a new traffic signal was installed at Stringtown Road and vertical curvature improvements were under construction during the 2006 sampling. The very long queues observed in 2005 were not observed in the 2006 samples, and the slowest PM peak northbound travel time in 2006 was about 3 minutes and 45 seconds faster than the slowest sample observed in 2005. However, significant northbound queues of very slow traffic were observed during several 2006 samples that started between about 5 and 6 PM. One of these, that for the longest queue and nearly the slowest travel time sample, is given in Figure 3.5 for the sample that started at about 5:05 PM at MD 124.

Figure 3.5: Northbound Frederick Rd (MD 355) PM Congestion



The longer queues observed in 2005 perhaps masked an interesting aspect of the queue shown in Figure 3.5 – as the congestion appears to be associated with traffic conditions found at the intersection of West Old Baltimore Road with Frederick Road. The congested conditions are compounded by the nearby intersection with Brink Road, as well as the lack of shoulders in the northbound direction along Frederick Road at West Old Baltimore Road. A detailed version of the same queue is presented in Figure 3.6, which shows 5 distinct stop or near-stoppages in the queue as the probe vehicle moved north. For the northbound samples in the AM peak period, 8 of the 12 samples observed delay at that location as shown in one example in Figure 3.7.

Given the lack of a northbound left-turn lane from Frederick Road onto West Old Baltimore Road, the heavy southbound flows in the AM peak period observed before 7 AM as shown in Figure 3.7, and no shoulder for a northbound vehicle to use to bypass a left turning vehicle, together these factors can result in a queue of several vehicles if just one vehicle wants to make that left turn. The heavier PM peak period flows can cause the queue to extend back south of Brink Road, which has its own queue of traffic merging onto MD 355. It is likely that some of this traffic is making the immediate left turn onto West Old Baltimore Road. The queue, which extends south along MD 355 a few hundred feet south of Brink Road, marks the end of the transition area where the two-northbound lanes on MD 355 to the south become one

Figure 3.6: Frederick Rd (MD 355) at W Old Baltimore Rd PM Congestion

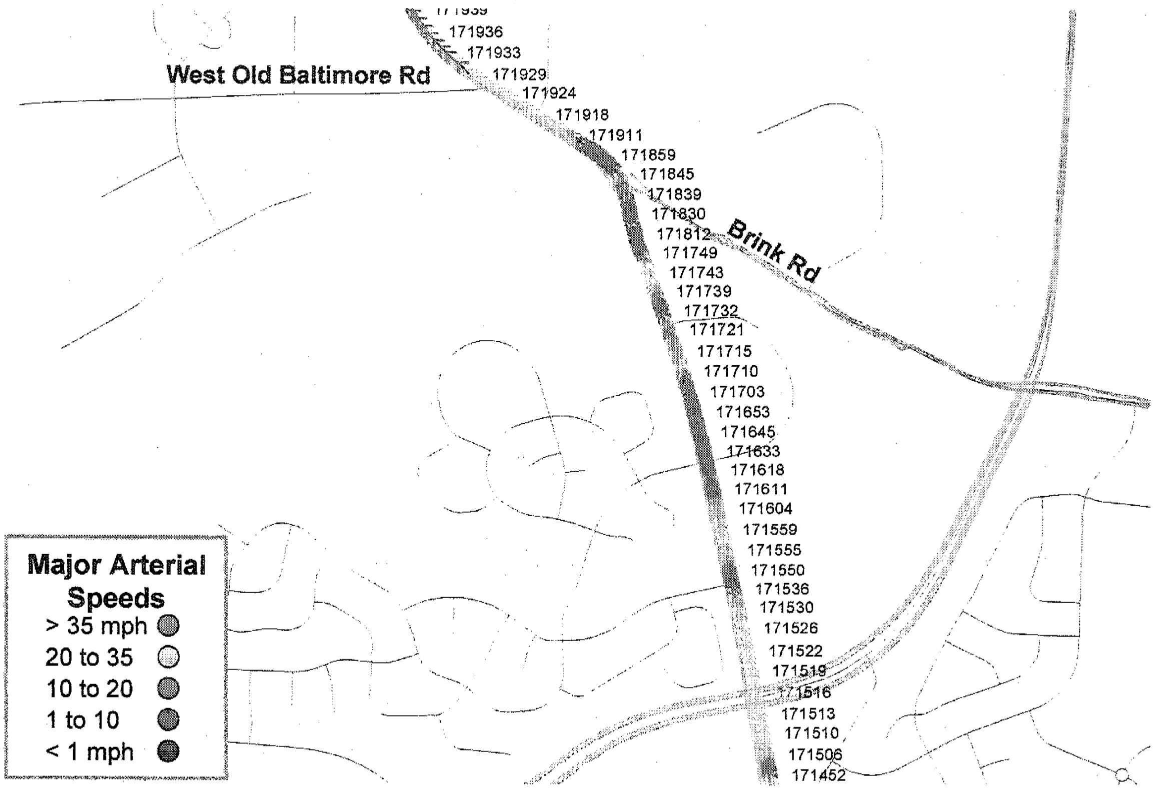
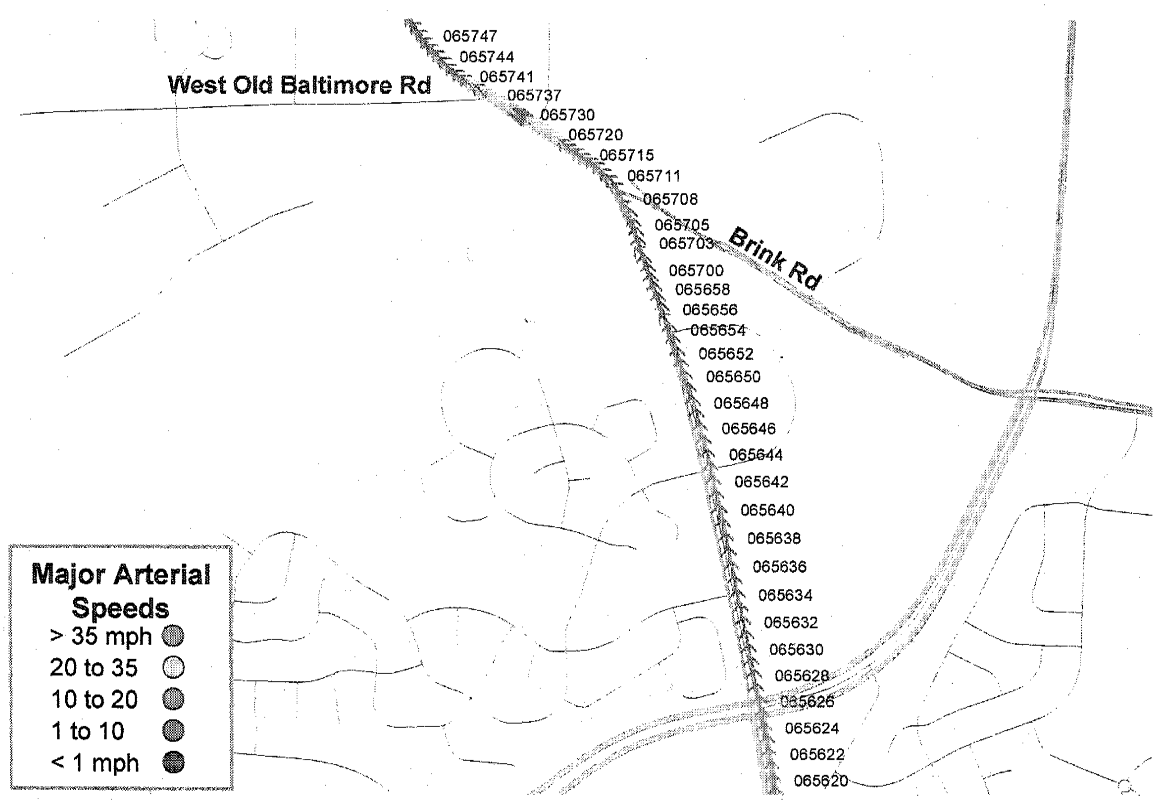


Figure 3.7: Frederick Rd (MD 355) at W Old Baltimore Rd AM Congestion



northbound lane. The transition down to one-northbound lane, when the traffic flow is heavy enough such as at that time of day, then further results in the queue extending to the south, as shown in the example in Figure 3.6. At the very least, consideration should be given to developing an appropriate intersection improvement to address the conditions at the West Old Baltimore intersection with MD 355 to be included in the State's Consolidated Transportation Program (CTP) or Spot Improvement Program.

In the 2005 report, discussion was presented that compared the sample from 2004 with those observed in 2005 for this roadway corridor. The next set of figures refines that analysis and examines the trends over the three-year period of 2004 through 2006. To make it easier for the reader to discern the trends, the year-to-year changes in the corridor travel times by time-of-day (for the start of each sample) are shown separately for the southbound and northbound directions in Figures 3.8 and 3.9, respectively. These two figures are similar to the previous Figure 3.4 displayed above.

In Figure 3.8 which shows the southbound samples for the morning peak period; (1) the 2005 and 2006 samples both show markedly slower travel times than the samples for 2004, and (2) while the 2006 versus the 2005 samples seem to show little, if any, discernable differences in the corridor travel time by time of day. Moreover, the reported travel times for the 2006 data samples are somewhat faster overall. For the southbound samples during the evening peak period, the 2006 data samples appear to be consistently slower, by about one to three minutes, than the comparable samples from 2004 and most of the samples for 2005. It is also interesting to note that for just the 2006 data, the evening samples are just as generally slow as the morning samples, with the exception of two of the fourteen observations in the morning peak period. Conversely, several of the southbound morning samples are faster than the fastest southbound samples in the evening. These differences may be the result of some of the traffic signal retiming and traffic flow optimization measures that have been implemented in this corridor, as an attempt to alleviate congestion in the interim.

In Figure 3.9 showing the northbound samples for the evening peak period, the 2006 data samples are considerably faster than the comparable samples from 2005, and are more consistent with and similar to those of 2004. This appears to be the case although several (four) of the samples were considerably slower than the limited number of samples in 2004. For the northbound samples in the morning peak period, the same general observation can be made – that the 2006 samples are consistently faster than the comparable samples from 2005 and are more in line and similar to those of 2004, although several (three) of them were slower than the limited number of samples in 2004. Again, these differences may be the result of some of the traffic signal retiming and traffic flow optimization measures that have been implemented in this corridor. These differences may also be the result of the intersection improvements that were underway at the MD 355 at Stringtown Rd intersection.

Figure 3.8: Southbound MD 355 Corridor Travel Time Trend Analysis

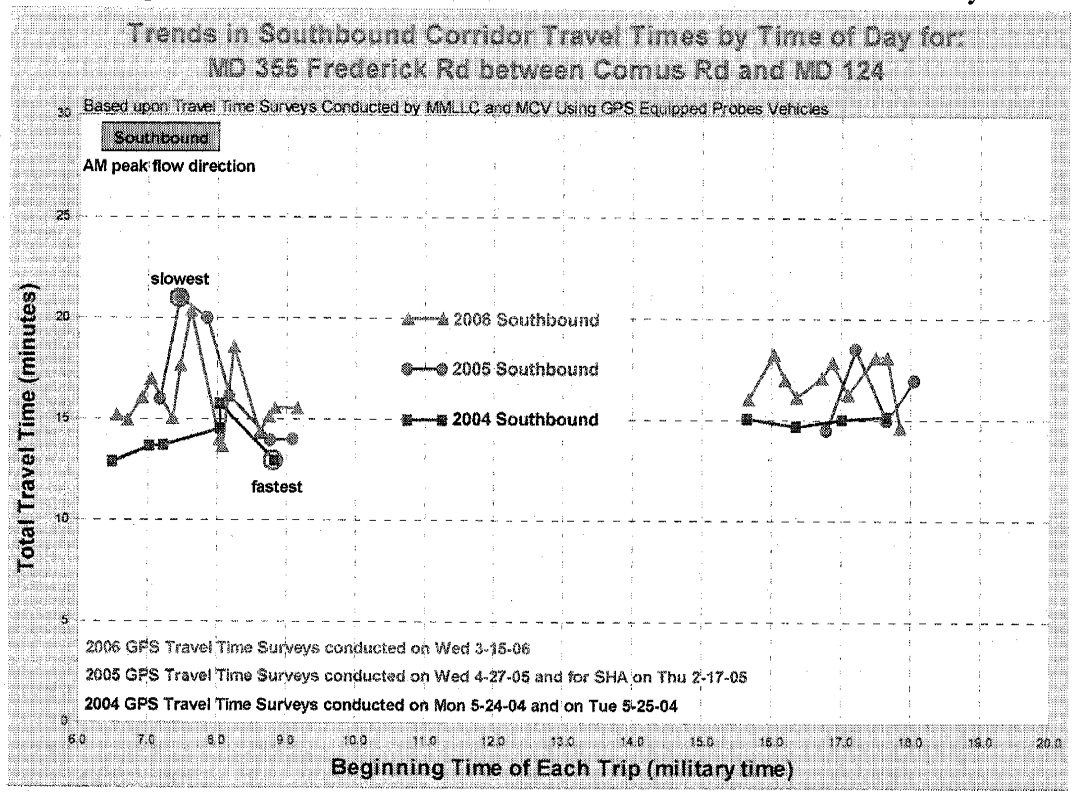
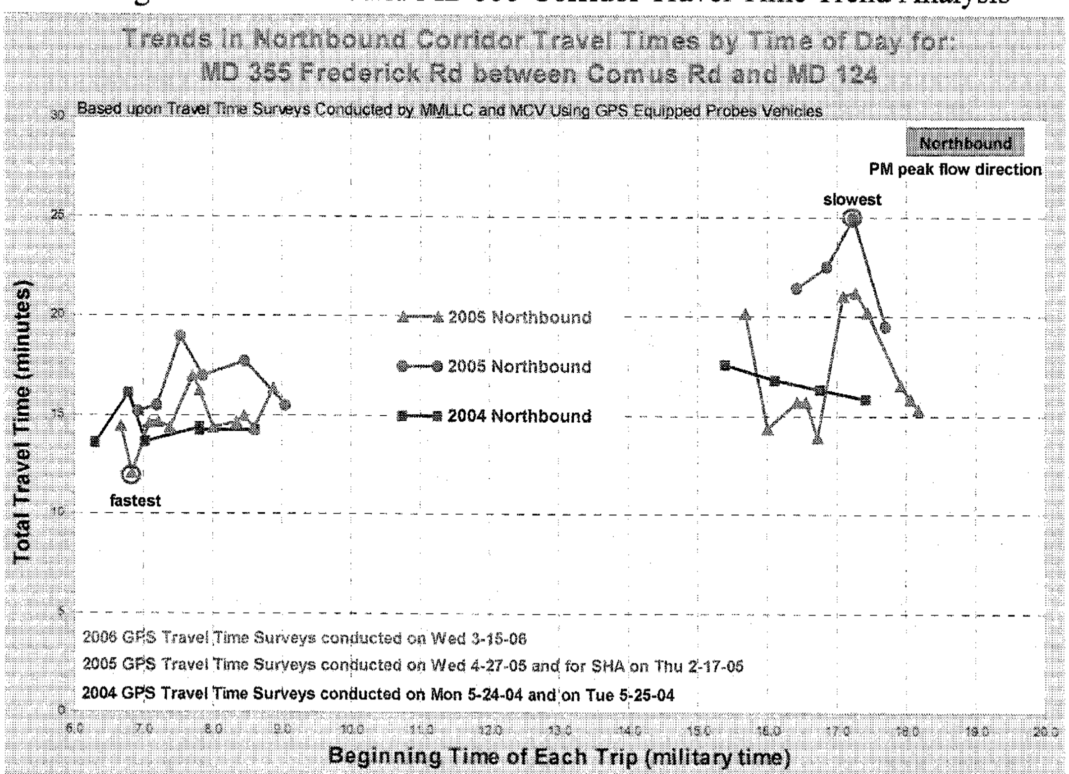


Figure 3.9: Northbound MD 355 Corridor Travel Time Trend Analysis



Norbeck Road (MD 28) / Spencerville Road (MD 198) – MD 28 / 198 Connector: In the 2005 report, the results of the data sampling for the MD 28 / MD 198 corridor showed the impacts associated with having a sparse transportation network resulting in: (a) limited route alternatives and excessive congestion, and (b) having travelers being severely inconvenienced when parts of the system break down due to incidents. Figure 3.10 summarizes the results for just the eastbound travel time data collected in 2005 and 2006. The results are displayed in a time-of-day graph for the combined routes of MD 28 and MD 198, which consists of several route segments traveling from west to east for: (a) First Street, (b) Norbeck Road, (c) MD28-198 Connector, and (d) Spencerville Road, between MD 355 in Rockville and Riding Stable Road (just before the Prince George's County Line). The combined length of the set of travel route segments is approximately 14.1 miles.

The graph showing the corridor travel times for the nine AM samples (for the 2005 data set) has somewhat of a "bell shaped" curve, even though the westbound flows are the peak flows in the AM. The data samples shown here have the benefit of including some very early morning pre-AM peak and late morning post-AM peak observations, which were obtained in support of another data collection project focusing on travel to and/or from the Baltimore area. These data samples indicated that the ambient, un-congested travel time was about 20 to 21 minutes for this 14.1-mile travel corridor, or an average speed of about 41 to 42 miles per hour. The observed peak travel time of about 40 minutes is about 2.0 times more than the ambient travel time. The well-defined peak for this data sample indicates the presence of excessive congestion. The duration of the peak-slower travel time of about 25 to 30 minutes lasted from about 7 to 9 AM.

Figure 3.10 also shows the evening corridor travel times observed in 2005 and 2006. In 2005, a series of significant incidents occurred during the day the sample was conducted, which resulted in very congested travel times of more than 50 minutes. In contrast, two samples conducted on different days in 2005 suggest that the peak eastbound travel times were considerably faster during conditions free of incidents. Two sets of samples were conducted in 2006: (a) directly for this report between Rockville Pike (MD 355) and New Hampshire Avenue MD (650), and (b) by the staff of MWCOG between New Hampshire Avenue (MD 650) into Prince George's County, as part of their annual Congestion Management Program activities. The MNCPPC samples were coordinated with the MWCOG samples to take place on the same day during the same general time period but for a lesser duration. There were 9 samples conducted for MNCPPC and 24 conducted by MWCOG. By selecting specific pairs of travel time samples, the combined travel times for the two data sets were combined, as if the probe vehicles continued driving onto the next segment. The combined 2006 eastbound PM data shows a peak-slowest travel time of over 37 minutes, and a fastest travel time of about 25 minutes. No significant incident conditions were observed during the time period in which this sample was conducted. Moreover, this combined data set is generally consistent with the two-non-incident samples from 2005.

Figure 3.10: Eastbound MD 28 / MD 198 Corridor Travel Time Trend Analysis

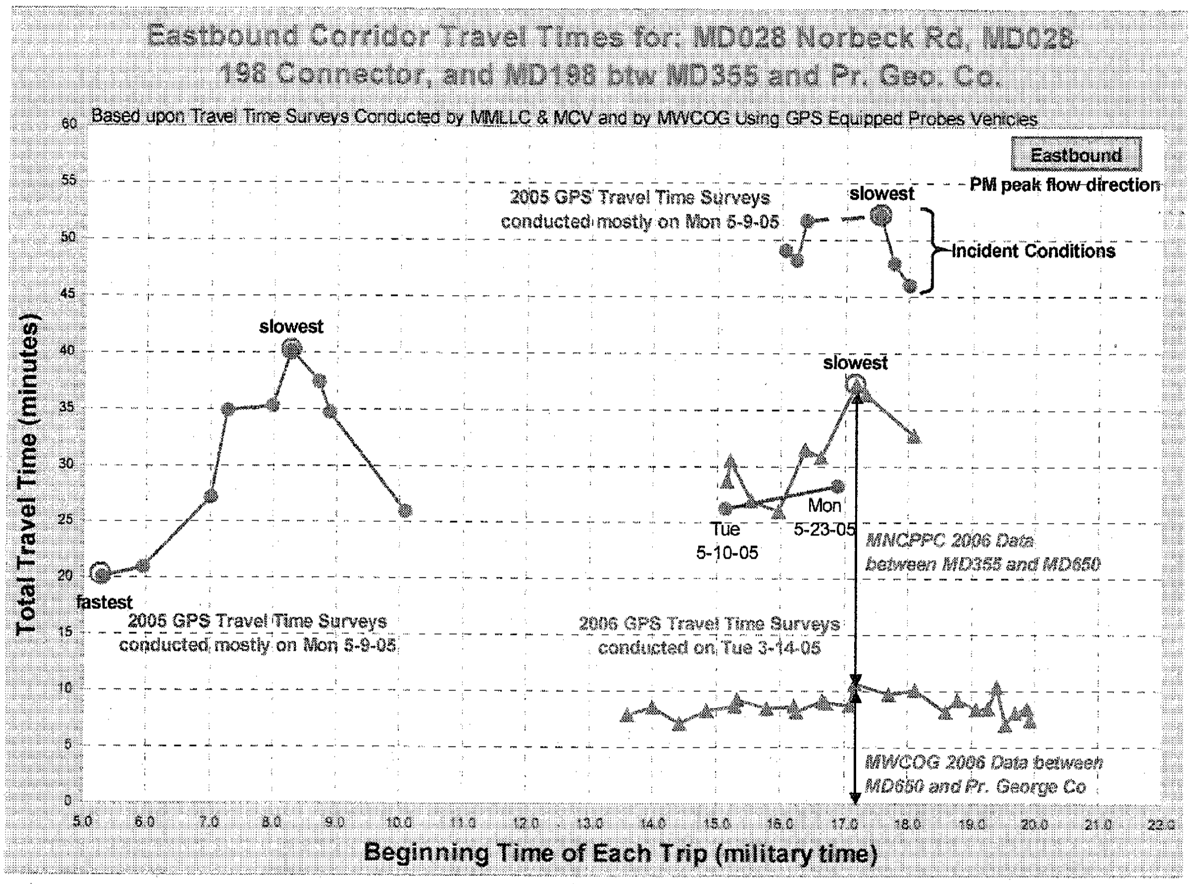
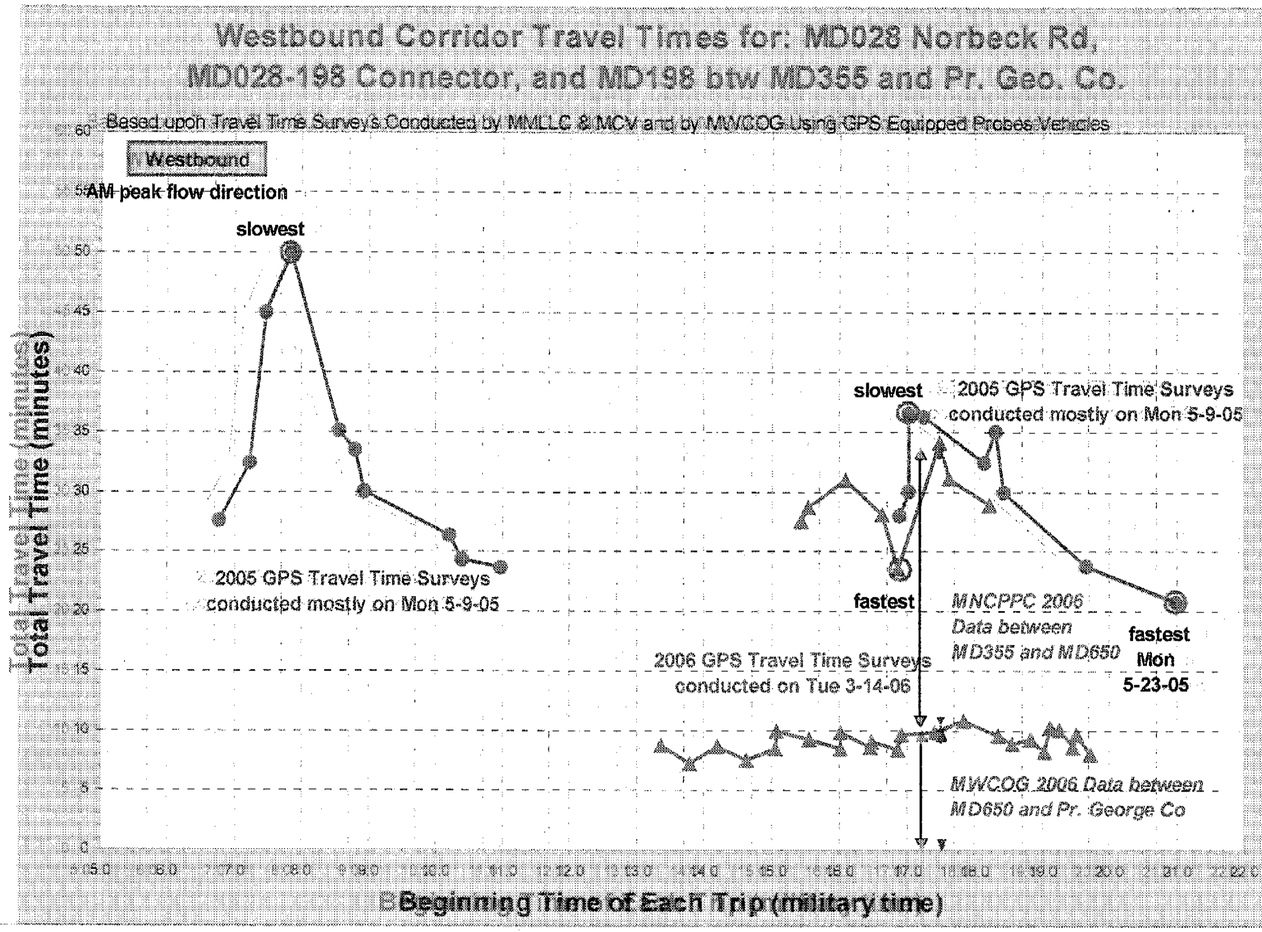


Figure 3.11 shows the results for just the westbound travel time data collected in 2005 and 2006, in a time-of-day graph for the combined routes of MD 28 / MD 198. The 2005 AM travel time data collection results revealed that the slowest westbound AM peak travel time was about 50 minutes. The ten AM westbound travel time samples show a very distinct, consistent, and peaked "bell shaped" curve for this peak flow direction travel and time period. The PM data showed that the ambient, un-congested travel time was 21 minutes for this 14.1-mile travel corridor, or an average speed of about 42 miles per hour. The observed peak travel time of about 50 minutes is about 2.5 times more than the un-congested westbound travel time in the late PM.

The 2006 westbound travel time data, also shown in Figure 3.11, for the PM time period is again the combination of: (a) primary data collected for MNCPPC between Rockville Pike (MD 355) and New Hampshire Avenue (MD 650), and (b) secondary data collected by staff of MWCOG between New Hampshire Avenue (MD 650) into Prince George's County. The samples were coordinated in the same fashion as the samples that were conducted for the eastbound travel runs. The combined 2006 westbound PM data shows a peak-slowest travel time of about 34 minutes and a fastest travel time of about 23 minutes. No significant incident conditions were observed during that this sampling period, although there was a stalled vehicle in the left approach lane to Muncaster Mill Road (MD 115) for about a half hour that was quickly moved into the left turning lane and towed away shortly afterwards.

Figure 3.11: Westbound MD 28 / MD 198 Corridor Travel Time Trend Analysis



The sample of combined westbound PM travel times consistently show about 10% faster travel times (roughly 3 minutes) when compared to similar data for 2005. In late 2005, the new grade-separate interchange at US 29 and Spencerville Rd / Sandy Spring Rd (MD 198) was completed, which resulted in the re-direction of the north and southbound through-traffic around the former intersection via an overpass. While this improvement should have resulted in improved conditions for traffic traveling along Spencerville Road (MD 198), it is not clear solely from this comparison of travel time and speed data trends that the observed differences are *different* in a statistical sense.

IV. FUTURE CONGESTION

Year 2010 Forecasted Volume-to-Capacity (V/C) Ratios

For the purposes of this report, a year 2010 traffic forecast was conducted using the Department's current TRAVEL/2 model. Although the process by which this model run was conducted was similar to that of the model run that was completed for the 2004 ADAC Report, there were some notable changes in this year's process as a result of new assumptions about future conditions. One of the most notable changes in this year's process was the incorporation of MWCOG Round 7.0 cooperative land use forecasts. This input assumption is an update of the Round 6.3 land use forecasts that were used for the model run that was done in 2004. Another key input data refinement to this year's modeling process was the use of an updated version of the Constrained Long-Range Plan (CLRP) network, which consists of all projects of regional significance that are anticipated to be completed by the year 2010. The CLRP network used for this model run now includes the Intercounty Connector (ICC), along with some other smaller-scale road capacity improvement projects. Similar to the previous model run for 2010 (conducted for the ADAC Report), this model run also reports results for the PM peak period only. These results were compared to the model run results for the 1998 base year for analysis purposes, focusing particularly on the non-freeway facilities.

Table 4.1 shows a comparison of model run results for the 1998 base year and 2010 CLRP networks. Based on the model results, the average V/C ratio countywide is anticipated to increase by 8.5% relative to the base year by 2010. In addition, the vehicle-miles traveled (VMT) and the vehicle-hours traveled (VHT) are anticipated to increase by 17.1% and 20.5%, respectively. State and County capacity improvements such as; road widenings, new roads (i.e. the ICC) and interchanges will help to account for an 9.2% increase in the County's total lane-miles by the year 2010 relative to the base year.

Table 4.1: Comparison of County-wide TRAVEL/2 Model Results

TRAVEL/2 Model County-wide Results - All Facilities			
	Base Year (1998) Network	2010 CLRP Network	% Chg From Base
Total Lane-Miles	2,474	2,725	9.2%
Vehicle-Miles Traveled (in 000s)	1495.2	1803.4	17.1%
Vehicle-Hours Traveled (in 000s)	55	69.2	20.5%
Average Speed (mph)	27.2	26	-4.6%
Average V/C Ratio*	0.43	0.47	8.5%

*Calculated using the model network's policy area capacities

Figures 4.1 and 4.2 show the V/C ratio lane-mile distribution for all facilities countywide for the years 1998 and 2010, respectively. A majority of the increase in the percentage of lane-miles with a V/C ratio of 0.80 to 0.99 can be attributed to the addition of the ICC to the County's transportation network. Despite the increase in the total amount of congested lane-miles, the V/C ratio lane-mile distribution does not differ much from that of the base year, as indicated in the graphics below. This illustrates how well the planned infrastructure for the year 2010 should help to regulate the anticipated percentage increase in congested lane-miles countywide. Refer to appendices 5.2A, 5.2C – 5.2D to view the complete V/C ratio lane mile distribution.

Figure 4.1: 1998 V/C Ratio Lane-Mile Distribution – Countywide

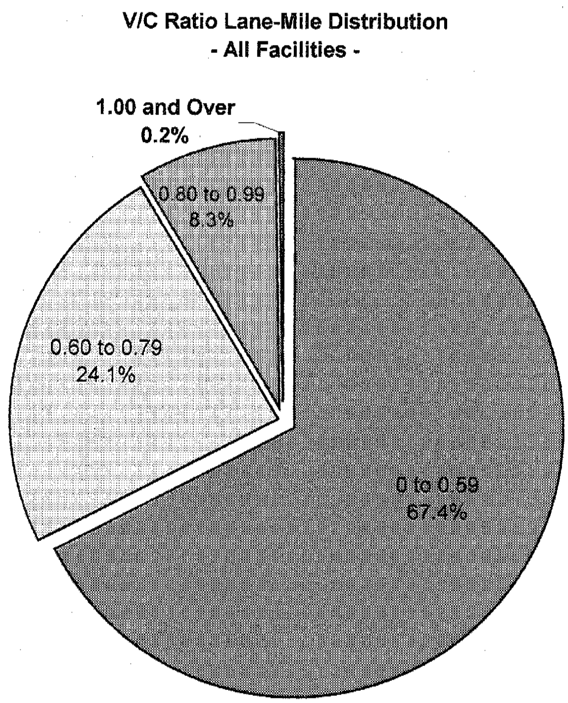


Figure 4.2: 2010 V/C Ratio Lane-Mile Distribution - Countywide

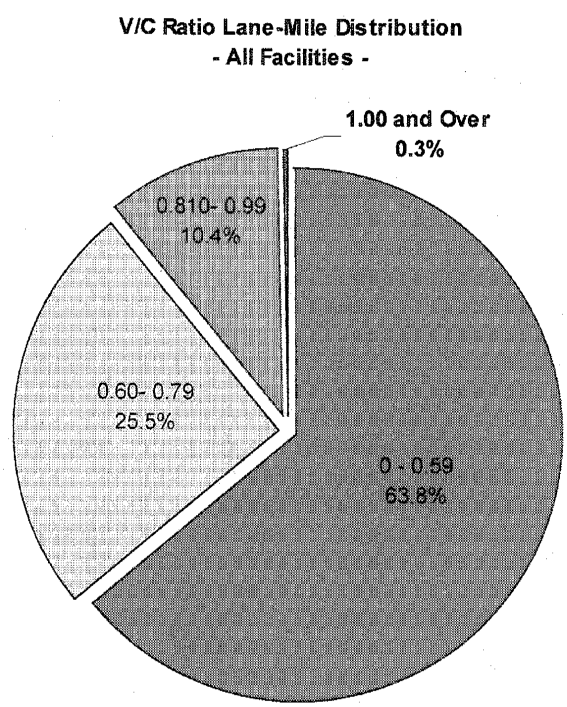


Table 4.2 compares model results for the non-freeway facilities (i.e. major highways, arterials, etc.). The results indicate that the average V/C ratio on these facilities is anticipated to increase 2.2% by the year 2010 relative to the base year. Concurrently, the average speed on these facilities is forecasted to have decreased 2.8% by the horizon year. Despite an increase in the average V/C ratio and a decrease in the average speed on these facilities, most of the non-freeway roadways are anticipated to perform reasonably well during the PM peak period, as roughly 93% of the total lane-miles are forecasted to have a V/C ratio 0.79 or lower. Furthermore, the non-freeway facilities, when compared to the freeways, are anticipated to have a lower average V/C ratio (0.46 compared to 0.64). Table 5.2B in the appendix shows the model results for the freeways.

Table 4.2: Comparison of Model Results – Non-freeway Facilities

TRAVEL/2 Model Results - Non-freeway Facilities			
	Base Year (1998) Network	2010 CLRP Network	% Chg From Base
Total Lane-Miles	2,162	2,327	7.1%
Vehicle-Miles Traveled (in 000s)	1030.3	1202.8	14.3%
Vehicle-Hours Traveled (in 000s)	40.6	50.5	19.6%
Average Speed (mph)	29.3	28.5	-2.8%
Average V/C Ratio*	0.45	0.46	2.2%
V/C Ratio Lane-Mile Distribution - Non-freeway Facilities			
	Base Year (1998) Network	2010 CLRP Network	
% of lane-mi w/ V/C 0 to 0.59	71.7%	69.3%	
% of lane-mi w/ V/C 0.60 to 0.79	22.9%	23.7%	
% of lane-mi w/ V/C 0.80 to 0.99	4.9%	6.8%	
% of lane-mi w/ V/C 1.00 and up	0.5%	0.3%	

*Calculated using the model network's policy area capacities

Figure 4.3 shows a map of the forecasted PM peak V/C ratios and volumes on the County's transportation network for the year 2010. For reference purposes, appendix 5.2E shows a map of the same information for the 1998 base year network. Based on the model results for 2010, planned widenings for sections of Clopper Rd (MD 117), Woodfield Rd (MD 124), Father Hurley Blvd, Goshen Rd and Longdraft Rd, are forecasted to result in V/C ratios of 0.70 or less on these roadways. Recently widened sections of Darnestown Rd (MD 28) and Great Seneca Hwy (MD 119) are anticipated to have V/C ratios between 0.60 and 0.89. In addition, the planned extension of Stringtown Rd from Frederick Rd (MD 355) to I-270 / MD 121 is