DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION

US 422 RIVER CROSSING TRAFFIC STUDY

February 2011

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190 N Independence Mall West
ACP Building, 8th Floor
Philadelphia, PA 19106-1520
Phone: 215-592-1800
Fax: 215-592-9125
Website: www.dvrpc.org

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The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals, and the public with a common vision of making a great region even greater. Shaping the way we live, work, and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment, and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC is the federally designated Metropolitan Planning Organization for the Greater Philadelphia Region leading the way to a better future.

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

The symbol in our logo is adapted from the official DVRPC seal and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources, including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for the findings and conclusions herein, which may not represent the official views or policies of the funding agencies.

DVRPC fully complies with Title VI of the Civil Rights Act of 1964 and related statutes and regulations in all programs and activities. DVRPC's website (www.dvrpc.org) may be translated into multiple languages. Publications and other public documents can be made available in alternative languages and formats, if requested. For more information, please call (215) 238-2871.

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Executive Summary

The US 422 River Crossing Traffic Study provides daily and peak hour traffic forecasts to support planning and design efforts along the limited-access US 422 Expressway in the King of Prussia area. This portion of the Expressway, which was constructed in the 1980s, is the most heavily-traveled portion of US 422. Daily traffic volumes range from over 60,000 to nearly 100,000 vehicles per day between the PA 29 interchange in Upper Providence Township and US 202 along the Chester and Montgomery county line.

This area of US 422 experiences extensive, recurring congestion and significant delay during both the morning and afternoon peak periods, impacting local commuters, regional traffic, and visitors to the nearby Valley Forge National Historical Park. In addition to the capacity constraints, there are several operational deficiencies in the corridor. These include short weaving areas, limited storage capacity, and inadequate acceleration lanes. Furthermore, there are several aging bridges in the corridor, including the US 422 bridge over the Schuylkill River, that require rehabilitation or replacement.

The Pennsylvania Department of Transportation (PennDOT), has undertaken an extensive planning and engineering design effort to address these issues and to also provide a “gateway” into Valley Forge Park that would allow a buffer between Park visitors and commuters along the adjacent highway corridor. The culmination of this effort is two new alternative roadway configurations that address the transportation needs of the corridor, but at a reduced cost compared to earlier proposals.

The Delaware Valley Regional Planning Commission (DVRPC) was asked to provide traffic forecasts throughout the US 422 corridor under the anticipated opening year (2015) and horizon year (2035) conditions for the new alternatives. Those forecasts are presented in this report. They include average daily traffic volumes as well as AM and PM peak hour volumes for US 422 mainline, ramps, and selected parallel and crossing facilities in the study area. The forecasts incorporate the most recent planning assumptions from DVRPC’s 2035 Long-Range Plan and the latest development proposals in the area.

Introduction

Within southeastern Pennsylvania, the limited-access US 422 Expressway extends from just west of Pottstown to King of Prussia, where it provides connections to the Pennsylvania Turnpike (I-76 and I-276), the Schuylkill Expressway (I-76) and the US 202 Expressway. The eastern end of the Expressway, which was constructed in the 1980s, is the most heavily/traveled portion of US 422. Daily traffic volumes range from over 60,000 to nearly 100,000 vehicles per day between the PA 29 interchange in Upper Providence Township and US 202 along the Chester and Montgomery county line.

This area of US 422 experiences extensive, recurring congestion and significant delay during both the morning and afternoon peak periods, impacting local commuters, regional traffic, and visitors to the Valley Forge National Historical Park. In addition to the capacity constraints, there are several operational deficiencies, such as short weaving areas, limited storage capacity, and inadequate acceleration lanes. Furthermore, there are several aging bridges in the corridor, including the US 422 bridge over the Schuylkill River, that require rehabilitation or replacement.

The Pennsylvania Department of Transportation (PennDOT) has undertaken an extensive planning and engineering design effort to address these issues and to also provide a “gateway” into Valley Forge National Historical Park that would allow a buffer between Park visitors and commuters along the adjacent highway corridor. The culmination of this effort is two alternative roadway configurations to address the transportation needs of the corridor at a reduced cost. This project has been dubbed the US 422 River Crossing Traffic Study.

The Delaware Valley Regional Planning Commission (DVRPC) was asked to provide traffic forecasts throughout the corridor under the anticipated opening year (2015) and horizon year (2035) conditions. Those forecasts are presented in this report. They include average daily traffic volumes as well as AM and PM peak hour volumes for US 422 mainline, ramps, and selected parallel and crossing facilities in the study area. The forecasts incorporate the most recent planning assumptions from DVRPC’s 2035 Long-Range Plan and the latest development proposals in the area.

Chapter II of this report documents the existing conditions of the corridor, including current traffic volumes. Chapter III discusses the improvement alternatives under consideration and explains the travel forecasting methodology and DVRPC’s travel demand model. Chapter IV presents and analyzes the traffic forecasts in the study area. Conclusions are discussed in Chapter V.

DVRPC uses state of the practice methods to determine the effect of various improvements on traveler behavior and system function. These include highway volumes, travel times, and modal splits of various alternatives. Alternative selection is a complex task including these and many other factors. This report does not endorse or recommend any specific alternative or project. Only projects that are included in DVRPC's Transportation Improvement Program (TIP) or Long-Range Plan are officially endorsed by DVRPC.

Characteristics of the Study Area

For the purposes of developing traffic forecasts, the greater study area of the US 422 River Crossing traffic study is defined to include the Montgomery County municipalities of Lower Providence, Upper Merion, Upper Providence, and West Norriton townships and Schuylkill and Tredyffrin townships in Chester County. The study area, which is shown in **Figure 1**, is approximately bisected by US 422.

From the western edge of the study area to Trooper Road, US 422 is a four-lane, divided expressway. Between Trooper Road and PA 23, US 422 has two eastbound lanes; a third westbound lane was added in January 2009. US 422 continues as a four-lane roadway until just before its terminus at US 202, where it has a six-lane cross-section.

Within the study area, access to and from US 422 is provided by interchanges with Phoenixville-Collegeville Road (PA 29), Egypt Road, Trooper Road (PA 363), Port Kennedy/Valley Forge Road (PA 23), 1st Avenue, and US 202. The Trooper Road interchange is a partial interchange that provides only an on-ramp to US 422 eastbound and a off-ramp from US 422 westbound. The 1st Avenue interchange serves only eastbound off- and on-ramps. This traffic study is primarily focused on the US 422 corridor between Egypt Road and US 202.

The US 422/PA 23 interchange and adjacent roadways are congested in both the morning and afternoon peak periods. Delays on US 422 regularly exceed 20 minutes, and sometimes approach 40 minutes. In addition to high traffic volumes on US 422 that exceed the capacity of the roadway, several other problems also contribute to the congestion and resulting delay in the study area. These include inadequate acceleration lane lengths, US 422 eastbound constraints at the ramp terminus with PA 23, limited storage capacity between the PA 23 signalized intersections with North Gulph Road and the US 422 eastbound ramps, and the weave condition on PA 23 eastbound between the US 422 westbound off-ramp and Moore Road.

The current congestion along the US 422 corridor causes some traffic to avoid this regional freeway in the peak periods and divert to local roadways, including those through Valley Forge National Historical Park.

Current Average Daily Traffic Volumes

Figure 2 displays the current daily traffic volumes for US 422 and significant parallel and intersecting roadways within the study area. For this analysis, the “current year” is defined as 2009. Traffic volumes along US 422 and the PA Turnpike were collected using permanent sensors installed and maintained by Traffic.com. Traffic counts at other locations, including the US 422 interchange ramps, were collected by DVRPC

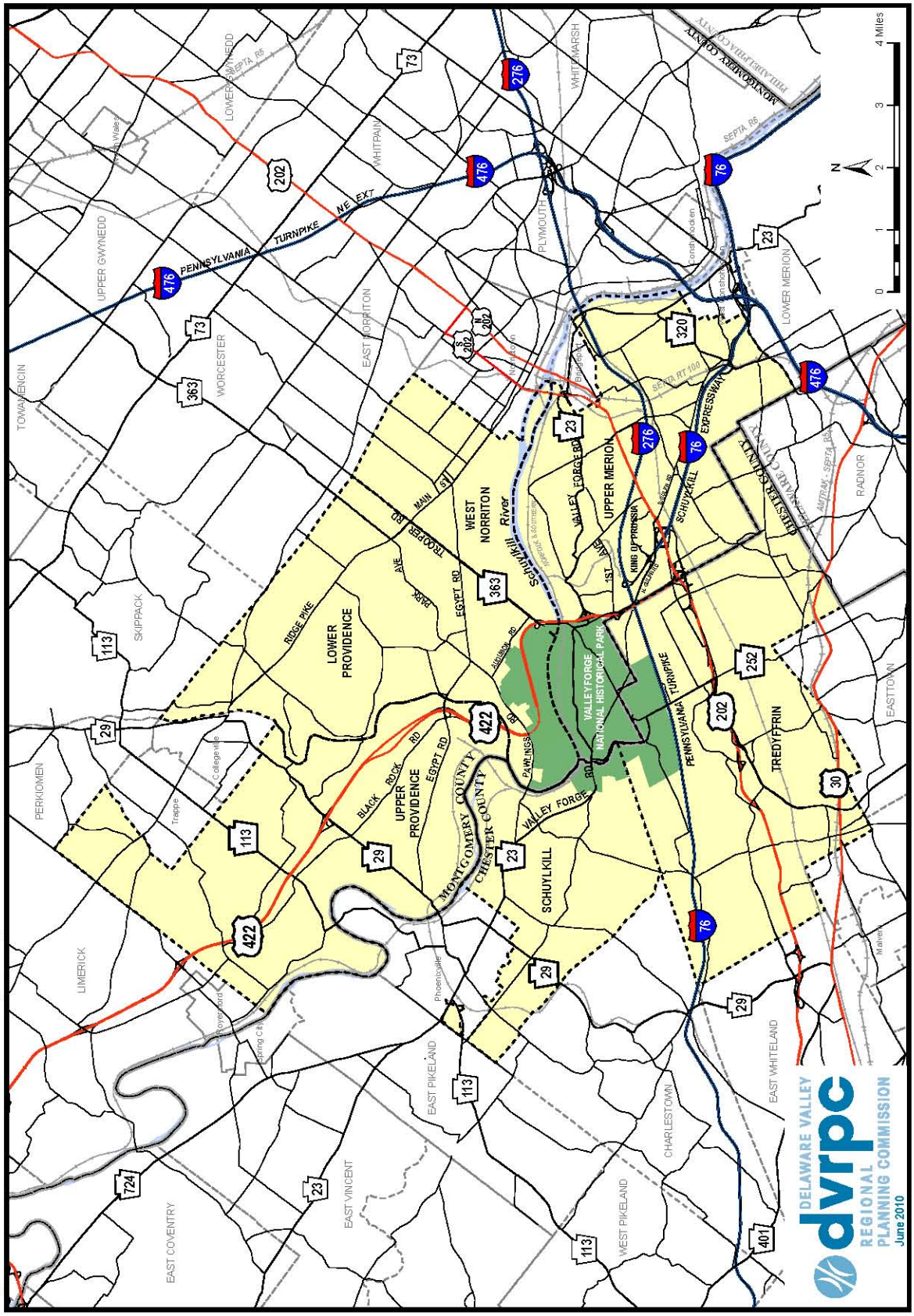


Figure 1. US 422 River Crossing Study Area

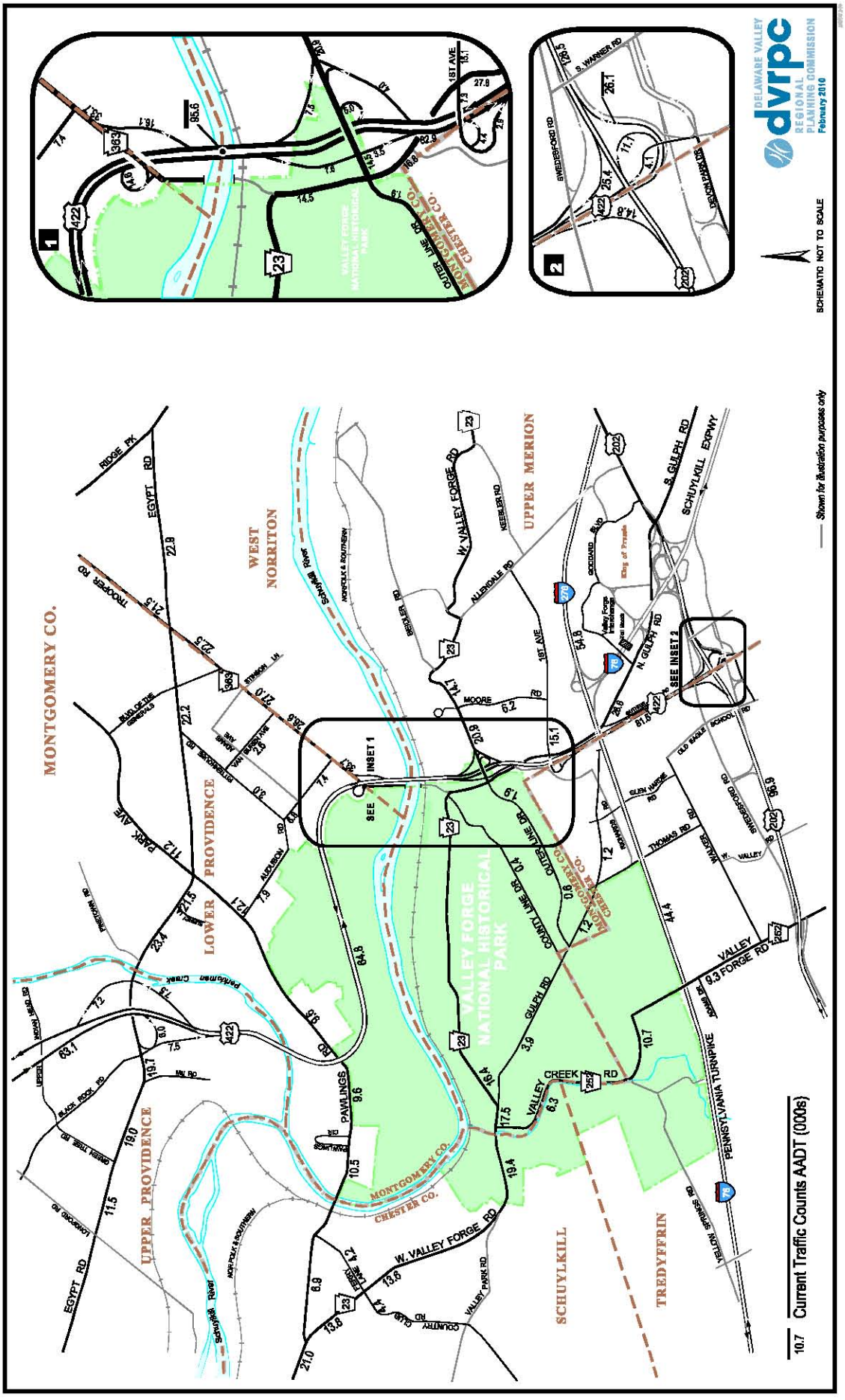


Figure 2. Current Average Daily Traffic Volumes

using pneumatic tube traffic recorders. All counted volumes were factored to represent average annual daily traffic (AADT) volumes indicative of 2009.

Daily traffic volumes on US 422 between points west of its interchange with Egypt Road and its terminus at US 202 range from 63,100 to 95,600 vehicles per day (vpd). By far, the highest volume occurs on the Schuylkill River Bridge. West of the Trooper Road interchange, US 422 volumes are between 63,100 and 64,800 vpd; east of the PA 23 interchange, they range from 81,500 to 82,900 vpd.

Individual ramp volumes range from 2,900 to 26,100 vpd. The highest ramp volumes occur on the US 422 eastbound ramp to US 202 northbound (26,000 vpd) and the US 202 southbound ramp to US 422 westbound (25,400 vpd). The partial interchange at Trooper Road also serves very high traffic volumes: 14,600 vpd on the on-ramp to US 422 eastbound and 16,100 vpd on the off-ramp from US 422 westbound. Other high-volume ramps, serving 6,000 to 7,600 vpd, include all four Egypt Road interchange ramps and two of the ramps at the US 422 and PA 23 interchange.

All of the area facilities that have an interchange with US 422 also serve high traffic volumes. Volumes on Egypt Road range from 11,500 to 23,400 vpd; Trooper Road volumes are between 21,500 and 33,700 vpd. Traffic volumes on PA 23 range from 13,600 to 20,900 vpd, while 1st Avenue serves 15,100 vpd just east of US 422.

No facilities in the immediate study area are truly parallel to US 422 for any significant distance. Those that can provide an alternative to US 422 include North Gulph Road, PA 252, and portions of PA 23. North Gulph Road serves 16,800 to 27,600 vpd, PA 252 carries between 6,300 and 10,700 vpd, and the section of PA 23 between County Line Drive and Outer Line Drive in Valley Forge Park carries 14,500 vpd.

Current AM and PM Peak Hour Traffic Volumes

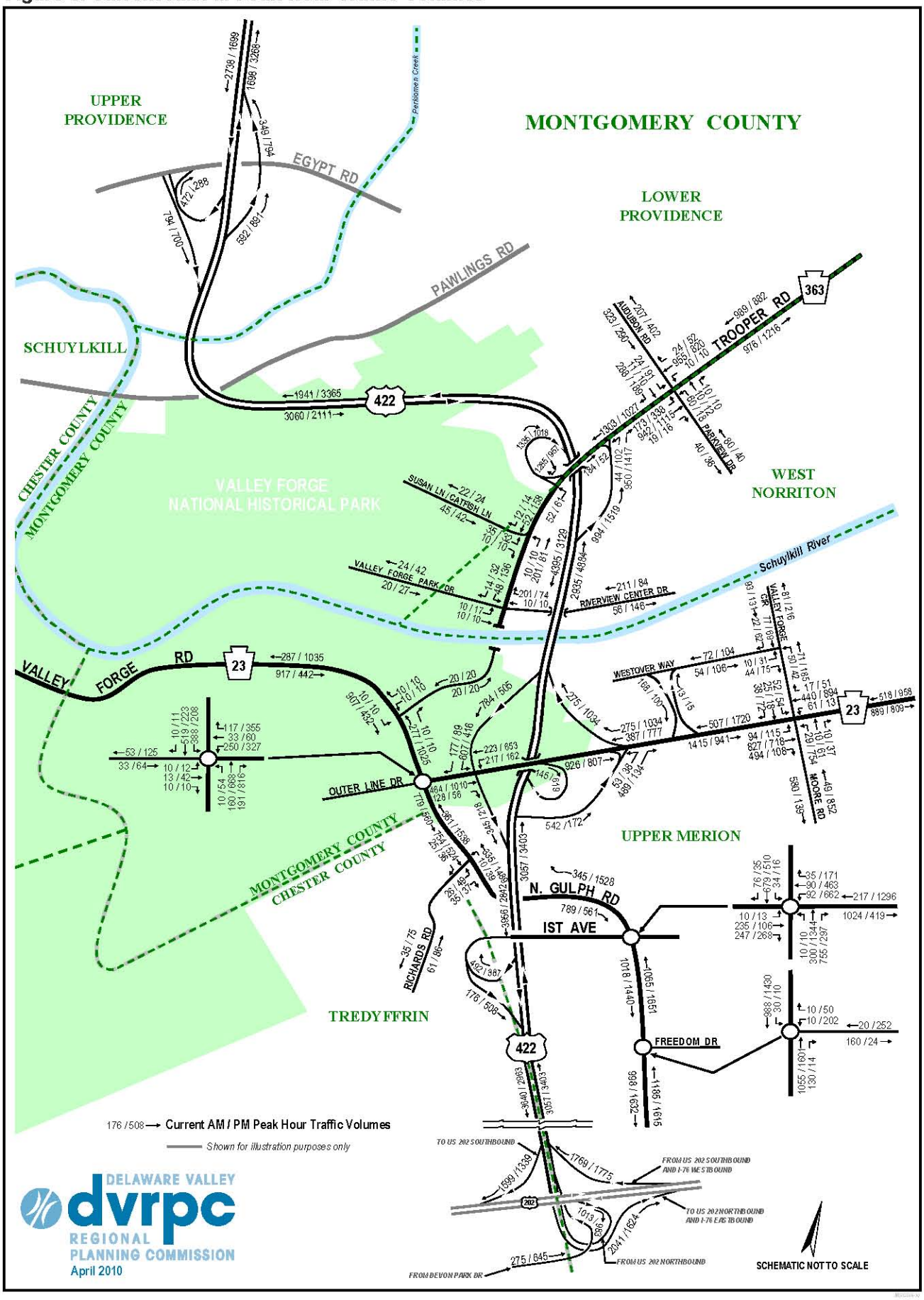
The AM and PM peak hour traffic volumes in the study area were also collected and tabulated for current conditions in 2009. These volumes are shown in **Figure 3**. Peak hour volumes are provided for the US 422 mainline, its ramps, as well as turning movements at selected intersections. In the figure, the AM peak hour volume is shown before the slash and the PM peak hour volume is shown after the slash.

Along US 422 in the study area, traffic volumes during the AM peak hour are heavier in the eastbound direction. During the PM peak hour, they are heavier in the westbound direction. During both the AM and PM peak hours, the highest hourly volumes on US 422 occur at the Trooper Road and PA 23 interchanges.

During the AM peak hour, eastbound US 422 volumes vary from 2,930 to 4,780 vehicles per hour (vph). The 2,930 volume occurs just west of Egypt Road. Eastbound AM peak hour volumes increase at Egypt Road, and again at Trooper Road. They begin to decline at the PA 23 interchange, and decline again at the 1st Avenue interchange.

In the westbound direction, the AM volumes range from 1,850 to 3,320 vph. In this direction, the highest volumes occur between US 202 and PA 23. They decrease at the PA 23, Trooper Road, and Egypt Road interchanges, with the lowest volumes occurring west of Egypt Road.

Figure 3. Current AM/PM Peak Hour Traffic Volumes



The peak direction of travel is reversed during the PM peak hour. At this time, eastbound US 422 volumes are between 1,860 and 3,450 vph. As was the case during the AM peak, the volumes increase at Egypt Road and Trooper Road, and then decline at the PA 23 interchange. During the PM peak hour, however, eastbound US 422 volumes increase at 1st Avenue.

In the westbound direction, the PM peak hour volumes range from 3,650 to 5,410 vph. While the Schuylkill River Bridge, between PA 23 and Trooper Road, carries 4,884 vph, all other locations along US 422 westbound serve between 3,650 and 3,800 vehicles during the PM peak hour.

Travel Forecasting Procedures

DVRPC's travel simulation models are used to forecast future travel patterns. These models utilize a system of traffic zones that follow Census boundaries and rely on demographic and employment data, land use, and transportation network characteristics to simulate trip making patterns throughout the region.

Traffic forecasts are prepared and evaluated for the years 2015 and 2035 under three different highway network scenarios: a No-Build alternative (Scenario 1) and two Build alternatives (Scenarios 2 and 3). For each of these alternatives, DVRPC's travel simulation model is modified to reflect the alternative under consideration and is used to prepare travel forecasts representative of that scenario. The No-Build scenario provides a useful future-year reference against which any impacts associated with the build alternatives may be compared and quantified.

Improvement Alternatives

The No-Build scenario does not include any changes to US 422. This alternative does, however, include improvements to other regional facilities that are included in DVRPC's Transportation Improvement Program (TIP) and Long-Range Plan, and may have an impact on US 422 traffic volumes once they are built. These TIP and Plan projects include several improvements to the Pennsylvania Turnpike, US 202, and other facilities.

The Turnpike improvements include widening to three lanes by direction between the Downingtown and Valley Forge interchanges, the Mid-County (I-476) and Lansdale interchanges, and the Bensalem and Delaware River interchanges and constructing new interchanges at PA 29 in Chester County, Norristown's Lafayette Street in Montgomery County, and I-95 and Street Road in Bucks County.

US 202 improvements include widening to three lanes by direction between the Delaware State line and Matlack Street in Delaware County and between US 30 and Swedesford Road in Chester County, widening to two lanes by direction between Johnson Highway and PA 63 in Montgomery County, and constructing a new parkway between PA 63 and PA 611 in Montgomery and Bucks counties.

Other TIP and Plan projects include widening County Line Road, construction of the French Creek Parkway, reconstruction of the US 30 Coatesville-Downingtown Bypass, construction of the PA 309 connector, and several closed-loop traffic signal systems.

Both Build scenarios also include these TIP and Plan projects. Scenario 2 includes widening US 422 from four to six lanes from a point 2,500 feet east of the PA Turnpike to a point 8,200 feet west of the PA 363 interchange, replacing the US 422 Schuylkill River bridge to accommodate six through lanes and two auxiliary lanes between the PA 23

and PA 363 interchanges, widening the US 422 eastbound off-ramp to 1st Avenue to two lanes, replacing the US 422 eastbound off-ramp to PA 23 with a new fly-over ramp, relocating North Gulph Road/PA 23 toward the east in the vicinity of the Valley Forge Park entrance, removing the PA 23 on-ramp to US 422 eastbound, widening North Gulph Road from Freedom Drive to the US 422 overpass, widening PA 23 from US 422 to a point 1,000 feet east of Moore Road, widening the PA 363 on-ramp to US 422 eastbound, constructing a new on-ramp from PA 363 to US 422 westbound, and constructing a new off-ramp from US 422 eastbound to PA 363.

Scenario 3 is similar to Scenario 2 except that it does not include the North Gulph Road/PA 23 relocation at Valley Forge Park or the removal of the PA 23 on-ramp to US 422 eastbound. The improvements associated with Scenario 2 and Scenario 3 are shown in **Figures 4** and **5**, respectively.

Socioeconomic Projections

DVRPC's long-range population and employment forecasts are revised periodically to reflect changing market trends, development patterns, local and national economic conditions, and available data. The completed forecasts reflect all reasonably known current information and the best professional judgment of predicted future conditions. The revised forecasts adopted by the DVRPC Board in February 2005 are an update to municipal forecasts that were last completed in 2000.

DVRPC uses a multi-step, multi-source methodology to produce its forecasts at the county level. County forecasts serve as control totals for municipal forecasts, which are disaggregated from county totals. Municipal forecasts are based on an analysis of historical data trends adjusted to account for infrastructure availability, environmental constraints to development, local zoning policy, and development proposals. Municipal population forecasts are constrained using density ceilings and floors. County and, where necessary, municipal input is used throughout the process to derive the most likely population forecasts for all geographic levels.

Population Forecasting

Population forecasting at the regional level involves review and analysis of six major components: births, deaths, domestic in-migration, domestic out-migration, international immigration, and changes in group quarters populations (e.g., dormitories, military barracks, prisons, and nursing homes). DVRPC uses both the cohort survival concept to age individuals from one age group to the next, and a modified Markov transition probability model based on the most recent U.S. Census and the U.S. Census' recent Current Population Survey (CPS) research to determine the flow of individuals between the Delaware Valley and areas outside the region. For movement within the region, Census and IRS migration data, coupled with CPS data, are used to determine migration rates between counties. DVRPC relies on county planning offices to provide information on any known, expected, or forecasted changes in group quarters populations. These major population components are then aggregated and the resulting population forecasts are reviewed by member governments for final adjustments based on local knowledge.

Figure 4. Scenario 2 Improvements

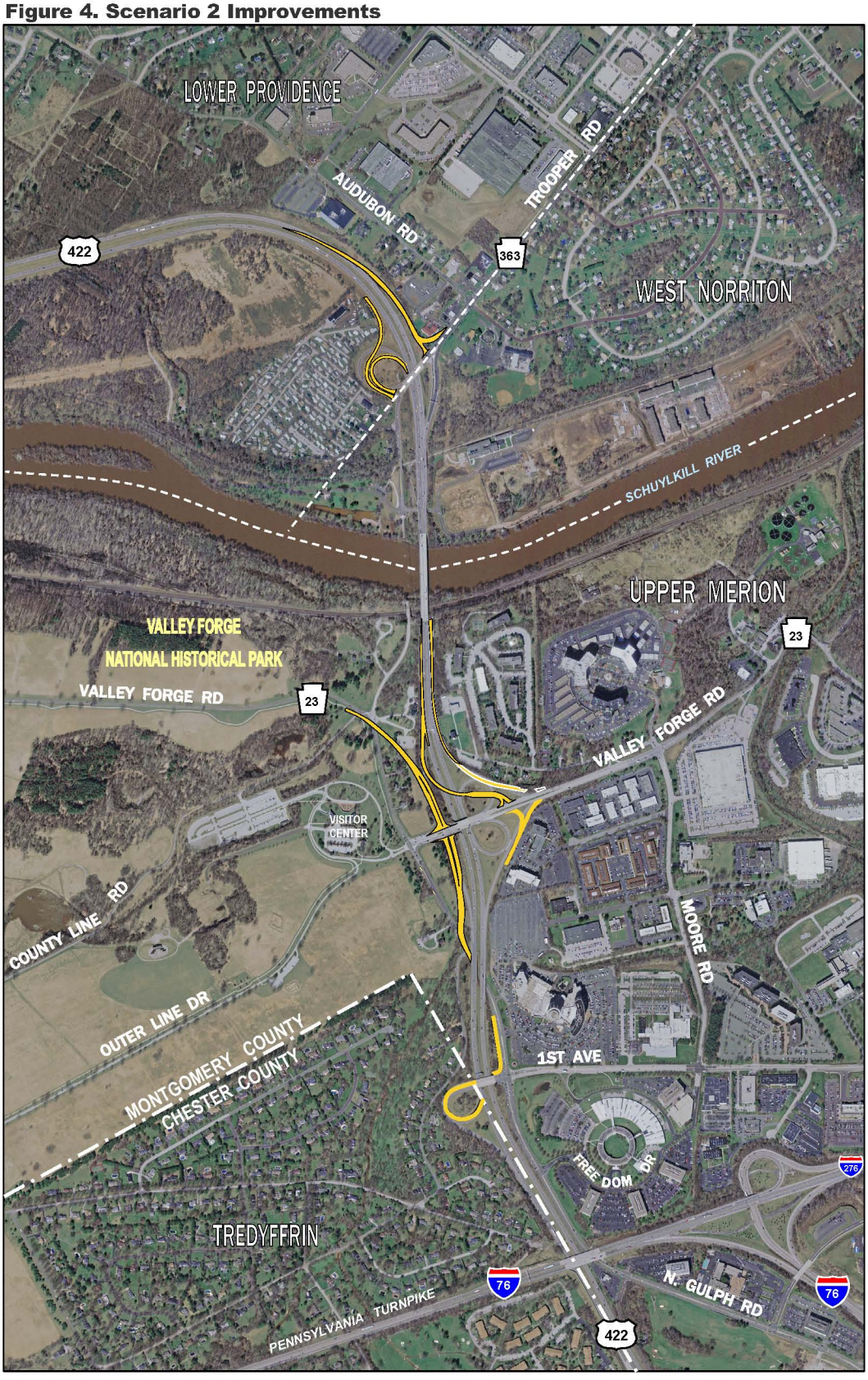


Figure 5. Scenario 3 Improvements

Employment Forecasting

Employment is influenced by local, national, and global political and socioeconomic factors. The U.S. Census Bureau provides the most reasonable and consistent time series data on county employment by sector, and serves as DVRPC's primary data source for employment forecasting. Employment sectors include mining, agriculture, construction, manufacturing, transportation, wholesale, retail, finance/insurance, service, government, and military. Other supplemental sources of data include the Bureau of Economic Analysis, the Bureau of Labor Statistics, Occupational Privilege tax data, and other public and private sector forecasts. As in the population forecasts, county-level total employment is used as a control total for sector distribution and municipal level forecasts. Forecasts are then reviewed by member counties for final adjustments based on local knowledge.

US 422 Study Area Forecasts

As part of the US 422 River Crossing Traffic Study, DVRPC staff reviewed its most recent current population and employment estimates, its long-range population and employment forecasts, and all proposed land use developments in the study area. Based on this review, DVRPC developed 2015 and 2035 municipal-level population and employment forecasts for use as inputs to the traffic simulation models. **Table 1** summarizes the population and employment forecasts used in the study.

Between 2010 and 2035, the total population in the US 422 River Crossing Traffic Study area is projected to increase by 21,718 residents to 148,837. This represents an increase of just over 17 percent from the 2010 value of 127,119. Upper Providence and Schuylkill townships have the greatest relative increase in population at 31.3 and 29.3 percent, respectively, while Upper Providence and Lower Providence townships have the greatest absolute increases at 6,184 and 4,525 new residents, respectively. All study area municipalities are expected to add more than 2,000 new residents between 2010 and 2035.

The study area will also add over 27,000 new jobs between 2010 and 2035, an increase of 21.3 percent. The highest absolute growth occurs in Upper Merion and Upper Providence townships, with 9,545 and 8.962 new jobs, respectively. Together, these two townships are responsible for just over two-thirds of the study area's employment growth during this time period.

Most of the study area's growth in both population and employment is forecast to occur after 2015. From 2010 to 2015, both the population and employment in the study area are forecast to grow by less than five percent.

DVRPC Travel Simulation Process

The focusing process increases the accuracy of the travel forecasts within the detailed study area. At the same time, all existing and proposed highways throughout the region, and their impact on both regional and interregional travel patterns, become an integral part of the simulation process.

Table 1. US 422 River Crossing Study Area Population and Employment Forecasts

Study Area Municipalities	Population						Employment					
					2010 - 2035 Growth						2010 - 2035 Growth	
	2005	2010	2015	2035	Abs.	Pct.	2005	2010	2015	2035	Abs.	Pct.
Lower Providence Township	24,899	25,975	26,991	30,500	4,525	17.4%	11,021	11,423	11,804	13,123	1,700	14.9%
Upper Merion Township	27,400	27,764	28,109	30,479	2,715	9.8%	54,143	55,653	57,281	65,198	9,545	17.2%
Upper Providence Township	18,391	19,772	21,449	25,956	6,184	31.3%	9,922	11,454	14,203	20,416	8,962	78.2%
West Norriton Township	14,771	15,886	17,130	18,512	2,626	16.5%	7,481	7,647	7,803	9,339	1,692	22.1%
Montgomery Co. Subtotal	**85,461**	**89,397**	**93,679**	**105,447**	**16,050**	**18.0%**	**82,567**	**86,177**	**91,091**	**108,076**	**21,899**	**25.4%**
Schuylkill Township	7,368	8,208	8,748	10,612	2,404	29.3%	2,619	2,676	2,729	2,912	236	8.8%
Tredyffrin Township	29,074	29,514	30,265	32,778	3,264	11.1%	37,578	38,660	39,826	43,728	5,068	13.1%
Chester Co. Subtotal	**36,442**	**37,722**	**39,013**	**43,390**	**5,668**	**15.0%**	**40,197**	**41,336**	**42,555**	**46,640**	**5,304**	**12.8%**
Study Area Totals	**121,903**	**127,119**	**132,692**	**148,837**	**21,718**	**17.1%**	**122,764**	**127,513**	**133,646**	**154,716**	**27,203**	**21.3%**

Source: DVRPC February 2011

DVRPC's travel models follow the traditional steps of trip generation, trip distribution, modal split, and traffic assignment. However, an iterative feedback loop is employed from traffic assignment to the trip distribution step. The feedback loop ensures that the congestion levels used by the models when determining trip origins and destinations are equivalent to those that result from the traffic assignment step. Additionally, the iterative model structure allows trip making patterns to change in response to changes in traffic patterns, congestion levels, and improvements to the transportation system.

The DVRPC travel simulation process uses the Evans algorithm to iterate the model. Evans re-executes the trip distribution and modal split models based on updated highway speeds after each iteration of highway assignment, and assigns a weight to each iteration. This weight is then used to prepare a convex combination of the link volumes and trip tables for the current iteration and a running weighted average of the previous iterations. This algorithm converges rapidly to the equilibrium solution on highway travel speeds and congestion levels. About seven iterations are required for the process to converge to the equilibrium state for study area travel patterns.

The DVRPC travel simulation models are disaggregated into separate peak, midday, and evening time periods. This disaggregation begins in trip generation, where factors are used to separate daily trips into peak, midday, and evening travel. The enhanced process then utilizes completely separate model chains for peak, midday, and evening travel simulation runs. Time-of-day sensitive inputs to the models, such as highway capacities and transit service levels, are disaggregated to be reflective of time-period-specific conditions. Capacity factors are used to allocate daily highway capacity to each time period. Separate transit networks are used to represent the difference in transit service over the course of a day.

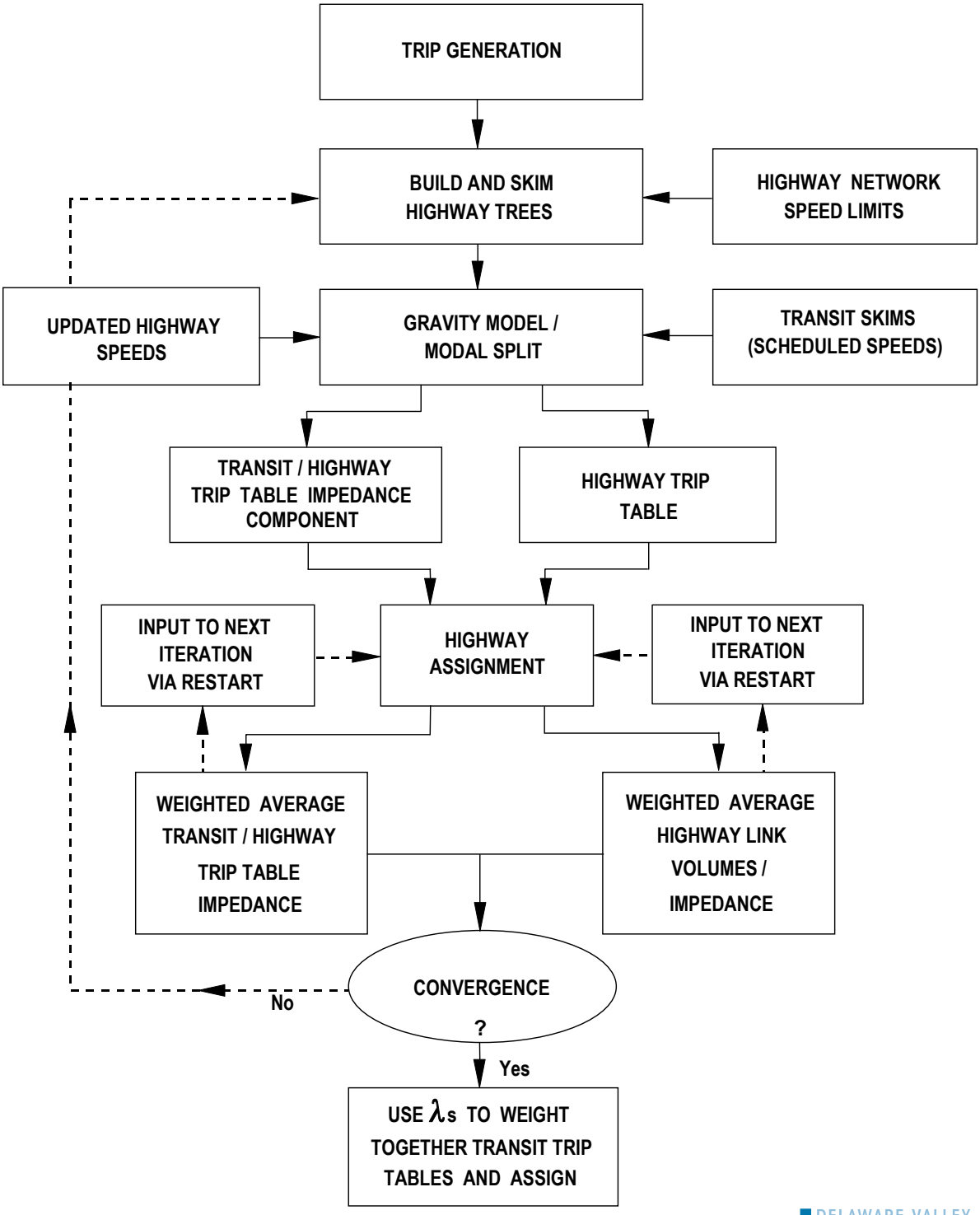
The enhanced model is disaggregated into separate model chains for the peak (combined AM and PM), midday (the period between the AM and PM peaks), and evening (the remainder of the day) periods for the trip distribution, modal split, and travel assignment phases of the process. The peak period is defined as 7:00 AM to 9:00 AM and 3:00 PM to 6:00 PM. Peak period and midday travel are based on a series of factors that determine the percentage of daily trips that occur during those periods. Evening travel is then defined as the residual after peak and midday travel are removed from daily travel. External-local productions at the nine-county cordon stations are disaggregated into peak, midday, and evening components using percentages derived from the temporal distribution of traffic counts taken at each cordon station.

Figure 6 provides a flow chart of the travel demand forecasting process. The first step in the process involves generating the number of trips that are produced by and destined for each traffic zone and cordon station throughout the nine-county region.

Trip Generation

Both internal trips (those made within the DVRPC region) and external trips (those that cross the boundary of the region) must be considered in the simulation of regional travel. For the simulation of travel demand, internal trip generation is based on zonal forecasts of population and employment, whereas external trips are extrapolated from cordon line traffic counts and other sources. The latter also includes trips that pass through the Delaware Valley region. Estimates of internal trip productions and attractions by zone

Figure 6. DVRPC Travel Demand Forecasting Process



are established for each trip purpose on the basis of trip rates applied to the zonal estimates of demographic and employment data. Trip purposes include work and nonwork trips, light and heavy truck trips, and taxi trips. This part of the DVRPC model is not iterated on highway travel speed. Rather, estimates of daily trip making by traffic zone are calculated and then disaggregated into peak, midday, and evening time periods.

Evans Iterations

The iterative portion of the Evans forecasting process involves updating the highway network restrained link travel speeds, rebuilding the minimum time paths through the network, and skimming the interzonal travel time for the minimum paths. Then the trip distribution, modal split, and highway assignment models are executed in sequence for each pass through the model chain. After convergence is reached, the transit trip tables for each iteration are weighted together and the weighted average table is assigned to the transit network. The highway trip tables are loaded onto the network during each Evans iteration. For each time period, seven iterations of the Evans process are performed to ensure that convergence on travel times is reached.

Trip Distribution

Trip distribution is the process by which the zonal trip ends established in the trip generation analysis are linked together to form origin-destination patterns in a trip table format. Peak, midday, and evening trip ends are distributed separately. For each Evans iteration, a series of ten gravity-type distribution models are applied at the zonal level. These models follow the trip purpose and vehicle type stratifications established in trip generation.

Modal Split

The modal split model is also run separately for the peak, midday, and evening time periods. The modal split model calculates the fraction of each person-trip interchange in the trip table that should be allocated to transit, and then assigns the residual to the highway side. The choice between highway and transit usage is made on the basis of comparative cost, travel time, and frequency of service, with other aspects of modal choice being used to modify this basic relationship. In general, the better the transit service, the higher the fraction assigned to transit, although trip purpose and auto ownership also affect the allocation. The model subdivides highway trips into auto drivers and passengers. Auto driver trips are added to the truck, taxi, and external vehicle trips in preparation for assignment to the highway network.

Highway Assignment

For highway trips, the final step in the focused simulation process is the assignment of vehicle trips to the highway network representative of the alternative being modeled. For peak, midday, and evening travel, the assignment model produces the future traffic volumes for individual highway links that are required for the evaluation of each alternative. The regional nature of the highway network and trip table underlying the focused assignment process allows the diversion of travel into and through the study area to various points of entry and exit in response to the improvements made in the transportation system.

For each Evans iteration, highway trips are assigned to the network representative of a given alternative by determining the best (minimum time) route through the highway network for each zonal interchange, and then allocating the interzonal highway travel to the highway facilities along that route. This assignment model is "capacity restrained," which means that congestion levels are considered when determining the best route. The Evans equilibrium assignment method is used to implement the capacity constraint. When the assignment and associated trip table reach equilibrium, no path faster than the one actually assigned for each trip can be found through the network, given the capacity restrained travel times on each link.

Transit Assignment

After equilibrium is achieved, the weighted average transit trip tables are assigned to the transit network to produce link and route passenger volumes. The transit person trips produced by the modal split model are "linked," which means that they do not include any transfers that occur either between transit trips or between auto approaches and transit lines. The transit assignment procedure accomplishes two major tasks. First, the transit trips are "unlinked" to include transfers, and second, the unlinked transit trips are associated with specific transit facilities to produce link, line, and station volumes. These tasks are accomplished simultaneously within the transit assignment model, which assigns the transit trip matrix to minimum impedance paths built through the transit network. There is no capacity-restraining procedure in the transit assignment model.

Highway Traffic Assignment Validation

Before a focused simulation model can be used to predict future trip making patterns, its ability to replicate existing conditions is tested. The simulated highway assignment outputs are compared to current traffic counts taken on roadways serving the study area. The focused simulation model is executed with current conditions, and the results are compared with recent traffic counts. Based on this analysis, the focused model produced accurate traffic volumes. The validated model was then executed for the No-Build and each Build alternative with socioeconomic and land use inputs reflective of future-year conditions.

Table 2 summarizes the error in the assigned daily traffic volumes. A total of 84 locations throughout the greater study area with available daily traffic counts were used for model validation. Seven of these locations are along US 422; 18 are ramp counts at interchanges; 17 are other facilities that are generally parallel to US 422, including portions of PA 23, PA 252, and North Gulph Road; 34 are on facilities that either cross US 422 or are perpendicular to it, such as the PA Turnpike, US 202, and Trooper Road; and 8 are local roadways in either Valley Forge Park or the corporate campus adjacent to Trooper Road. The total assigned traffic on all facilities, 1.74 million vehicles, is within about two percent of the total counted volume of 1.78 million vehicles. The overall correlation between predicted and actual facility volumes is 0.98. The corresponding coefficient of determination (R^2) is 0.96, which indicates that the travel model explains about ninety six percent of the statistical variation contained in the traffic counts.

Table 2. Summary of Error in the Assigned Daily Traffic Volumes

Location	Number of Facilities	Counted Volume	Simulated Volume	Percent Diff.	Root-Mean Squared Error	Coefficient of Correlation (R)	Coefficient of Determination (R2)
US 422 Mainline	7	513,496	510,607	-0.6%	4,226	0.944	0.891
US 422 Ramps	18	175,286	171,624	-2.1%	3,758	0.838	0.702
Parallel Facilities	17	226,045	233,907	3.5%	2,590	0.944	0.892
Crossing Facilities	34	834,571	790,738	-5.3%	6,852	0.974	0.948
Other Local Roads	8	30,498	33,095	8.5%	2,216	0.788	0.620
All Facilities	**84**	**1,779,896**	**1,739,971**	**-2.2%**	**5,034**	**0.980**	**0.961**

Source: DVRPC February 2011

Projected Traffic Volumes

Projected traffic volumes for the anticipated opening year, 2015, and a horizon year of 2035 are presented and analyzed in this chapter. For each scenario, a daily traffic forecast is prepared at each location where a current count was provided in Chapter II. In addition, AM and PM peak hour forecasts are provided for each scenario at the same locations that were shown in **Figure 3**.

Daily Traffic Forecasts

Average annual daily traffic forecasts for 2015 and 2035 for Scenarios 1, 2, and 3 are analyzed and presented in this section. The discussion of daily traffic volume forecasts for each alternative are generally divided into groups that focus on the US 422 mainline, US 422 ramps, parallel facilities, and intersecting facilities.

Scenario 1

Figure 7 provides the current and Scenario 1 (No-Build) average annual daily traffic volumes for both 2015 and 2035. In 2015, daily traffic volumes along US 422 are projected to range from 69,800 to 105,500 vpd. These volumes are approximately 6,700 to 9,900 vpd higher than current daily traffic volumes. The largest absolute increase occurs on the Schuylkill River Bridge. However, the largest percentage increase (10.4 percent) occurs between the Egypt and Trooper road interchanges. By 2035, the forecasted volumes on US 422 in the study area are between 74,700 and 112,200 vpd. These volumes are approximately 14 to 16 percent higher than current volumes. They result in 11,600 to 16,600 additional vehicles per day on US 422.

Under Scenario 1, volumes on individual ramps increase by 400 to 2,300 vpd by 2015 and by 1,100 to 4,300 vpd by 2035. By 2035, the ramps in the Egypt Road interchange are 1,200 to 1,400 vpd higher than current volumes. Trooper Road ramp volumes are 2,000 to 2,700 vpd higher than current volumes. The largest absolute increases occur within the US 422/US 202 interchange while the largest relative increases occur within the 1st Avenue and PA 23 interchanges.

With a few exceptions, 2015 daily traffic volumes on facilities parallel to US 422 are projected to be less than 10 percent higher than current volumes. The absolute increases on these facilities are 1,400 vpd or fewer. Only North Gulph Road south of 1st Avenue will experience increases greater than 2,000 vpd. Here, traffic volumes will reach 29,700 vpd between 1st Avenue and Guthrie Road and 29,800 vpd between Guthrie Road and Goddard Boulevard. By 2035, these North Gulph Road volumes

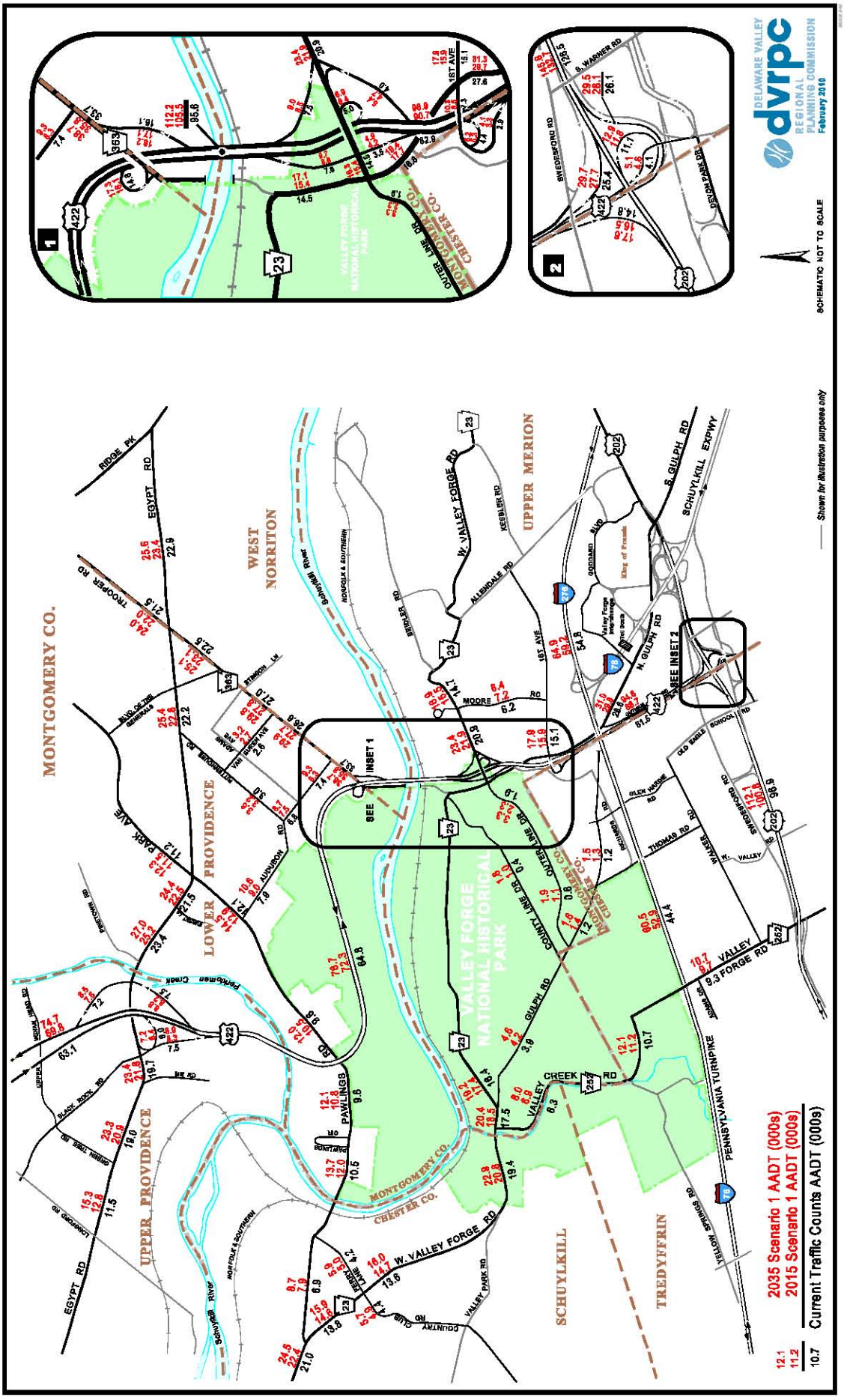


Figure 7. Current, 2015, and 2035 Scenario 1 Average Daily Traffic Volumes

increase to 31,000 vpd between Guthrie Road and Goddard Boulevard and 31,000 vpd between 1st Avenue and Guthrie Road. Under Scenario 1, 2035 daily volumes on PA 23 will range from 15,900 to 24,500 vpd. These volumes are 2,100 to 3,500 vpd higher than current volumes.

Traffic volume growth on facilities that cross US 422 is highly variable under Scenario 1. The highest growth occurs on the US 202 Expressway and the Pennsylvania Turnpike. Daily traffic volumes on US 202 in 2015 are 4,400 to 8,500 vpd higher than current volumes; by 2035, US 202 volumes are 11,100 to 16,100 vpd above current traffic volumes. Egypt Road volumes in 2035 are approximately 2,700 to 4,300 vpd higher than current volumes, while Trooper Road volumes are 2,500 to 5,000 vpd above current daily traffic volumes. Traffic volume increases on other intersecting facilities range from 1,300 to 3,200 vpd.

Table 3 provides a summary of the current and 2015 average daily traffic volumes, along with absolute and relative comparisons between current volumes and Scenario 1 forecasts. The table also provides comparisons between Scenario 1 and Scenario 2 forecasts and comparisons between Scenario 2 and Scenario 3 forecasts. **Table 4** provides these same tabulations and comparisons for the 2035 daily traffic forecasts.

Scenarios 2 and 3

Figures 8 and **9** display the average daily traffic forecasts for all three future-year Scenarios for 2015 and 2035, respectively. In the figures, the Scenario 1 forecasts are shown in red, underneath the relevant highway facility; Scenario 2 forecasts are shown in green, above the highway facility; and Scenario 3 forecasts are shown in blue, above the Scenario 2 number. These figures readily allow for comparisons to be made between no-build and build alternative forecasts and between the two build alternatives.

The highway facility improvements associated with Scenarios 2 and 3 result in higher traffic volumes along US 422, compared to Scenario 1 (No-Build). Under Scenario 2, the 2015 daily traffic volumes between the PA 29 and PA 23 interchanges are 4,900 to 6,400 vpd higher than the corresponding Scenario 1 volumes, which represent increases of five to nine percent. Below the PA 23 interchange, the Scenario 2 volumes are only 400 to 1,100 vpd, or less than two percent, higher than the Scenario 1 volumes. Along US 422, the differences between the Scenario 2 and Scenario 3 volumes are very small. The largest difference, 1,500 vpd or 1.6 percent, occurs between the PA 23 and 1st Avenue interchanges. This difference is primarily due to the closure of the PA 23 on-ramp to US 422 eastbound, which is part of Scenario 2 but not Scenario 3.

By 2035, daily traffic volumes on US 422 under the improvement scenarios range from 85,000 to 121,300 vpd. These volumes are 3,100 to 11,200 vpd higher than the corresponding Scenario 1 volumes, and represent increases of 3.3 to 14.6 percent. Again, the differences between Scenario 2 and 3 volumes are less than two percent, with the largest difference (1,700 vpd) occurring between the PA 23 and 1st Avenue interchanges.

The new westbound on-ramp and eastbound off-ramp at the Trooper Road interchange under Scenarios 2 and 3 are forecast to carry 2,100 to 2,500 vpd in 2015 and 2,900 to 3,100 vpd in 2035. The construction of these ramps results in traffic volume reductions

Table 3. Current and 2015 Average Daily Traffic Volumes

Location / Limits	Current Counts	2015 Forecast Scenario 1	Current - 2015 Change Absolute	Current - 2015 Change Percent	2015 Forecast Scenario 2	Scenario 2/Scenario 1 Difference Absolute	Scenario 2/Scenario 1 Difference Percent	2015 Forecast Scenario 3	Scenario 3/Scenario 2 Difference Absolute	Scenario 3/Scenario 2 Difference Percent
US 422 Mainline										
PA 29 (Collegeville Road) Interchange to Egypt Road Interchange	63,088	69,800	6,712	9.6%	74,700	4,900	7.0%	74,600	-100	-0.1%
Egypt Road Interchange to Pawlings Road	64,776	72,300	7,524	10.4%	78,700	6,400	8.9%	78,400	-300	-0.4%
Pawlings Road to PA 363 (Trooper Road) Interchange	64,776	72,300	7,524	10.4%	78,700	6,400	8.9%	78,400	-300	-0.4%
PA 363 (Trooper Road) Interchange to PA 23 (Valley Forge Road) Interchange	95,560	105,500	9,940	9.4%	110,800	5,300	5.0%	109,900	-900	-0.8%
PA 23 (Valley Forge Road) Interchange to 1st Avenue Interchange	82,947	90,700	7,753	8.5%	91,100	400	0.4%	92,600	1,500	1.6%
1st Avenue Interchange to US 202 Interchange	81,499	88,700	7,201	8.1%	89,800	1,100	1.2%	90,000	200	0.2%
US 422 Interchange Ramps										
US 422 Eastbound Off-Ramp to Egypt Road	5,984	6,400	416	6.5%	5,700	-700	-10.9%	5,600	-100	-1.8%
US 422 Eastbound On-Ramp from Egypt Road	7,467	8,300	833	10.0%	8,200	-100	-1.2%	8,000	-200	-2.4%
US 422 Westbound On-Ramp from Egypt Road	7,247	7,600	353	4.6%	6,700	-900	-11.8%	6,800	100	1.5%
US 422 Westbound Off-Ramp to Egypt Road	7,452	8,200	748	9.1%	8,200	0	0.0%	8,200	0	0.0%
US 422 Eastbound Off-Ramp to PA 363 (Trooper Road) (Proposed)	0	0	0	-----	2,400	2,400	-----	2,500	100	4.2%
US 422 Eastbound On-Ramp from PA 363 (Trooper Road)	14,635	16,100	1,465	9.1%	18,200	2,100	13.0%	18,000	-200	-1.1%
US 422 Westbound On-Ramp from PA 363 (Trooper Road) (Proposed)	0	0	0	-----	2,100	2,100	-----	2,200	100	4.8%
US 422 Westbound Off-Ramp to PA 363 (Trooper Road)	16,149	17,100	951	5.6%	18,400	1,300	7.6%	18,200	-200	-1.1%
US 422 Eastbound Off-Ramp to PA 23	7,621	8,800	1,179	13.4%	8,100	-700	-8.0%	8,700	600	7.4%
US 422 Eastbound On-Ramp from PA 23	3,476	4,200	724	17.2%	-----	-4,200	-100.0%	3,000	3,000	-----
US 422 Westbound On-Ramp from PA 23 Westbound	7,459	8,500	1,041	12.2%	9,300	800	9.4%	9,500	200	2.2%
US 422 Westbound On-Ramp from PA 23 Eastbound	5,015	6,400	1,385	21.6%	7,200	800	12.5%	6,900	-300	-4.2%
US 422 Westbound Off-Ramp to PA 23	4,006	4,700	694	14.8%	4,900	200	4.3%	4,800	-100	-2.0%
1st Avenue Interchange to US 202 Interchange	4,362	5,300	938	17.7%	6,200	900	17.0%	6,400	200	3.2%
US 422 Eastbound On-Ramp from 1st Avenue	2,914	3,300	386	11.7%	4,900	1,600	48.5%	3,800	-1,100	-22.4%
US 422 Eastbound Off-Ramp to US 202 Southbound	14,838	16,500	1,662	10.1%	17,000	500	3.0%	17,200	200	1.2%
US 422 Eastbound Off-Ramp to US 202 Northbound/I-76 Eastbound	26,143	28,100	1,957	7.0%	28,300	200	0.7%	28,500	200	0.7%
US 422 Westbound On-Ramp from US 202 Southbound/I-76 Westbound	25,369	27,700	2,331	8.4%	27,800	100	0.4%	27,700	-100	-0.4%
US 422 Westbound On-Ramp from US 202 Northbound	11,099	11,800	701	5.9%	12,000	200	1.7%	11,900	-100	-0.8%
US 422 Westbound On-Ramp from Devon Park Drive	4,050	4,600	550	12.0%	4,700	100	2.2%	4,700	0	0.0%
Parallel Facilities										
PA 23 - West of Pawlings Road	21,039	22,400	1,361	6.1%	20,600	-1,800	-8.0%	20,900	300	1.5%
PA 23 - Pawlings Road to Ferry Lane	13,832	14,600	768	5.3%	13,300	-1,300	-8.9%	13,600	300	2.3%
PA 23 - Ferry Lane to Valley Park Road	13,553	14,700	1,147	7.8%	13,000	-1,700	-11.6%	13,400	400	3.1%
PA 23 - Valley Park Road to PA 252	19,414	20,800	1,386	6.7%	18,500	-2,300	-11.1%	18,800	300	1.6%
PA 23 - PA 252 to Gulph Road	17,542	18,500	958	5.2%	17,100	-1,400	-7.6%	17,200	100	0.6%
PA 23 - Gulph Road to County Line Road	16,371	17,400	1,029	5.9%	16,200	-1,200	-6.9%	16,100	-100	-0.6%
PA 23 - County Line Road to Outer Line Road	14,491	15,400	909	5.9%	14,400	-1,000	-6.5%	14,200	-200	-1.4%
North Gulph Road - PA 23 to 1st Avenue	16,789	17,700	911	5.1%	19,200	1,500	8.5%	16,800	-2,400	-12.5%
North Gulph Road - 1st Avenue to Guthrie Road	27,562	29,700	2,138	7.2%	32,200	2,500	8.4%	28,700	-3,500	-10.9%
North Gulph Road - Guthrie Road to Goddard Boulevard	26,592	29,800	3,208	10.8%	29,600	-200	-0.7%	28,800	-800	-2.7%
PA 252 - PA 23 to Yellow Springs Road	6,345	6,900	555	8.0%	6,500	-400	-5.8%	6,600	100	1.5%
PA 252 - Yellow Springs Road to Adams Drive	10,744	11,200	456	4.1%	10,800	-400	-3.6%	10,800	0	0.0%
PA 252 - Adams Drive to Walker Road	9,300	9,700	400	4.1%	9,200	-500	-5.2%	9,200	0	0.0%
Gulph Road - PA 23 to County Line Road	3,907	4,200	293	7.0%	4,100	-100	-2.4%	4,200	100	2.4%
Gulph Road - County Line Road to Thomas Road	1,213	1,400	187	13.4%	1,300	-100	-7.1%	1,300	0	0.0%
Gulph Road - Thomas Road to Glenhardie Road	1,158	1,300	142	10.9%	1,300	0	0.0%	1,300	0	0.0%
Moore Road - PA 23 to 1st Avenue	6,278	7,200	922	12.8%	6,900	-300	-4.2%	7,000	100	1.4%

Table 3. Current and 2015 Average Daily Traffic Volumes (Continued)

Location / Limits	Current Counts	2015 Forecast Scenario 1	Current - 2015 Change Absolute	Current - 2015 Change Percent	2015 Forecast Scenario 2	Scenario 2/Scenario 1 Difference Absolute	Scenario 2/Scenario 1 Difference Percent	2015 Forecast Scenario 3	Scenario 3/Scenario 2 Difference Absolute	Scenario 3/Scenario 2 Difference Percent
Intersecting Facilities										
Egypt Road - PA 29 to Greentree Road	11,519	12,800	1,281	10.0%	12,800	0	0.0%	12,800	0	0.0%
Egypt Road - Greentree Road to Mill Road	19,000	20,900	1,900	9.1%	20,800	-100	-0.5%	20,900	100	0.5%
Egypt Road - Mill Road to Black Rock Road/US 422	19,727	21,800	2,073	9.5%	21,600	-200	-0.9%	21,700	100	0.5%
Egypt Road - US 422 to Surrey Lane	23,352	25,200	1,848	7.3%	24,400	-800	-3.2%	24,400	0	0.0%
Egypt Road - Surrey Lane to Pawlings Road/Park Avenue	21,494	22,500	1,006	4.5%	22,000	-500	-2.2%	22,000	0	0.0%
Egypt Road - Pawlings Road/Park Avenue to PA 363 (Trooper Road)	22,219	22,800	581	2.5%	23,000	200	0.9%	23,000	0	0.0%
Egypt Road - PA 363 (Trooper Road) to Main Street/Ridge Pike	22,867	23,400	533	2.3%	24,000	600	2.6%	24,000	0	0.0%
Country Club Road - Valley Park Road to PA 23	4,432	4,900	468	9.6%	4,400	-500	-10.2%	4,400	0	0.0%
Ferry Lane - PA 23 to Pawlings Road	4,160	5,000	840	16.8%	4,200	-800	-16.0%	4,300	100	2.4%
Pawlings Road - Valley Forge Road to Ferry Lane	6,894	7,900	1,006	12.7%	7,300	-600	-7.6%	7,300	0	0.0%
Pawlings Road - Ferry Lane to Pawlings Circle	10,532	12,000	1,468	12.2%	11,300	-700	-5.8%	11,400	100	0.9%
Pawlings Road - Pawlings Circle to US 422	9,572	10,800	1,228	11.4%	10,000	-800	-7.4%	10,000	0	0.0%
Pawlings Road - US 422 to Audubon Road	9,572	10,500	928	8.8%	9,700	-800	-7.6%	9,700	0	0.0%
Pawlings Road - Audubon Road to Egypt Road	12,084	12,900	816	6.3%	12,400	-500	-3.9%	12,400	0	0.0%
Park Avenue - Egypt Road to Woodward Road	11,160	11,500	340	3.0%	11,200	-300	-2.6%	11,200	0	0.0%
PA 363 (Trooper Road) - US 422 to Audobon Road	33,658	35,800	2,142	6.0%	37,900	2,100	5.9%	38,100	200	0.5%
PA 363 (Trooper Road) - Audubon Road to Van Buren Avenue	26,623	27,700	1,077	3.9%	29,900	2,200	7.9%	30,000	100	0.3%
PA 363 (Trooper Road) - Van Buren Avenue to Boulevard of the Generals	26,981	27,800	819	2.9%	28,900	1,100	4.0%	28,900	0	0.0%
PA 363 (Trooper Road) - Boulevard of the Generals to Egypt Road	22,487	23,100	613	2.7%	24,000	900	3.9%	23,900	-100	-0.4%
PA 363 (Trooper Road) - Egypt Road to Mill Road	21,489	22,000	511	2.3%	22,700	700	3.2%	22,600	-100	-0.4%
PA 23 - Outer Line Road to US 422 Eastbound Ramps	14,481	15,400	919	6.0%	16,300	900	5.8%	15,500	-800	-4.9%
PA 23 - US 422 Westbound Ramps to Moore Road	20,924	21,900	976	4.5%	23,100	1,200	5.5%	22,200	-900	-3.9%
PA 23 - Moore Road to Beidler Road	14,665	15,500	835	5.4%	17,400	1,900	12.3%	17,100	-300	-1.7%
First Avenue - US 422 to Gulph Road	7,276	8,600	1,324	15.4%	11,100	2,500	29.1%	10,200	-900	-8.1%
First Avenue - Gulph Road to Moore Road	15,134	15,900	766	4.8%	15,800	-100	-0.6%	16,000	200	1.3%
Pennsylvania Turnpike - Downingtown Interchange to Valley Forge Interchange	44,412	52,900	8,488	16.0%	52,200	-700	-1.3%	52,200	0	0.0%
Pennsylvania Turnpike - Valley Forge Interchange to Norristown Interchange	54,829	59,200	4,371	7.4%	58,800	-400	-0.7%	58,800	0	0.0%
US 202 Expressway - West Valley Road to US 422	96,905	100,800	3,895	3.9%	102,100	1,300	1.3%	101,900	-200	-0.2%
US 202 Expressway - US 422 to South Warner Road	126,480	132,700	6,220	4.7%	133,600	900	0.7%	133,400	-200	-0.1%
Local Area Roadways										
Audubon Road - Pawlings Road to Rittenhouse Road	7,894	9,000	1,106	12.3%	8,300	-700	-7.8%	8,400	100	1.2%
Audubon Road - Rittenhouse Road to Adams Avenue	6,752	7,500	748	10.0%	7,200	-300	-4.0%	7,300	100	1.4%
Audubon Road - Adams Avenue to PA 363 (Trooper Road)	7,405	8,300	895	10.8%	8,500	200	2.4%	8,500	0	0.0%
Rittenhouse Road - Audubon Road to Van Buren Avenue	2,998	3,200	202	6.3%	3,100	-100	-3.1%	3,000	-100	-3.2%
Van Buren Avenue - Adams Avenue to PA 363 (Trooper Road)	2,554	2,700	146	5.4%	2,900	200	7.4%	2,900	0	0.0%
Outer Line Drive - Gulph Road to Visitors Center Drive	595	1,100	505	45.9%	1,100	0	0.0%	1,200	100	9.1%
Outer Line Drive - Visitors Center Drive to PA 23	1,870	2,300	430	18.7%	2,300	0	0.0%	2,400	100	4.3%
County Line Road - Gulph Road to PA 23	430	1,000	570	57.0%	1,000	0	0.0%	900	-100	-10.0%

Source: DVRPC February 2011

Table 4. Current and 2035 Average Daily Traffic Volumes

Location / Limits	Current Counts	2035 Forecast Scenario 1	Current - 2035 Change Absolute	Current - 2035 Change Percent	2035 Forecast Scenario 2	Scenario 2/Scenario 1 Difference Absolute	Scenario 2/Scenario 1 Difference Percent	2035 Forecast Scenario 3	Scenario 3/Scenario 2 Difference Absolute	Scenario 3/Scenario 2 Difference Percent
US 422 Mainline										
PA 29 (Collegeville Road) Interchange to Egypt Road Interchange	63,088	74,700	11,612	15.5%	85,000	10,300	13.8%	85,000	0	0.0%
Egypt Road Interchange to Pawlings Road	64,776	76,700	11,924	15.5%	87,900	11,200	14.6%	87,900	0	0.0%
Pawlings Road to PA 363 (Trooper Road) Interchange	64,776	76,700	11,924	15.5%	87,900	11,200	14.6%	87,900	0	0.0%
PA 363 (Trooper Road) Interchange to PA 23 (Valley Forge Road) Interchange	95,560	112,200	16,640	14.8%	121,300	9,100	8.1%	120,800	-500	-0.4%
PA 23 (Valley Forge Road) Interchange to 1st Avenue Interchange	82,947	96,900	13,953	14.4%	100,100	3,200	3.3%	101,800	1,700	1.7%
1st Avenue Interchange to US 202 Interchange	81,499	94,800	13,301	14.0%	97,900	3,100	3.3%	98,200	300	0.3%
US 422 Interchange Ramps										
US 422 Eastbound Off-Ramp to Egypt Road	5,984	7,200	1,216	16.9%	6,600	-600	-8.3%	6,500	-100	-1.5%
US 422 Eastbound On-Ramp from Egypt Road	7,467	8,900	1,433	16.1%	8,600	-300	-3.4%	8,400	-200	-2.3%
US 422 Westbound On-Ramp from Egypt Road	7,247	8,500	1,253	14.7%	7,700	-800	-9.4%	7,700	0	0.0%
US 422 Westbound Off-Ramp to Egypt Road	7,452	8,800	1,348	15.3%	8,600	-200	-2.3%	8,700	100	1.2%
US 422 Eastbound Off-Ramp to PA 363 (Trooper Road) (Proposed)	0	0	0	-----	3,100	3,100	-----	3,100	0	0.0%
US 422 Eastbound On-Ramp from PA 363 (Trooper Road)	14,635	17,300	2,665	15.4%	21,200	3,900	22.5%	20,900	-300	-1.4%
US 422 Westbound On-Ramp from PA 363 (Trooper Road) (Proposed)	0	0	0	-----	2,900	2,900	-----	2,900	0	0.0%
US 422 Westbound Off-Ramp to PA 363 (Trooper Road)	16,149	18,200	2,051	11.3%	18,200	0	0.0%	18,000	-200	-1.1%
US 422 Eastbound Off-Ramp to PA 23	7,621	9,700	2,079	21.4%	9,100	-600	-6.2%	9,900	800	8.8%
US 422 Eastbound On-Ramp from PA 23	3,476	4,900	1,424	29.1%	-----	-4,900	-100.0%	3,200	3,200	-----
US 422 Westbound On-Ramp from PA 23 Westbound	7,459	9,000	1,541	17.1%	9,900	900	10.0%	10,100	200	2.0%
US 422 Westbound On-Ramp from PA 23 Eastbound	5,015	6,900	1,885	27.3%	7,900	1,000	14.5%	7,700	-200	-2.5%
US 422 Westbound Off-Ramp to PA 23	4,006	5,400	1,394	25.8%	5,700	300	5.6%	5,500	-200	-3.5%
US 422 Eastbound Off-Ramp to 1st Avenue	4,362	6,200	1,838	29.6%	7,300	1,100	17.7%	7,900	600	8.2%
US 422 Eastbound On-Ramp from 1st Avenue	2,914	4,100	1,186	28.9%	5,100	1,000	24.4%	4,300	-800	-15.7%
US 422 Eastbound Off-Ramp to US 202 Southbound	14,838	17,600	2,762	15.7%	18,600	1,000	5.7%	18,800	200	1.1%
US 422 Eastbound Off-Ramp to US 202 Northbound/I-76 Eastbound	26,143	29,500	3,357	11.4%	30,300	800	2.7%	30,600	300	1.0%
US 422 Westbound On-Ramp from US 202 Southbound/I-76 Westbound	25,369	29,700	4,331	14.6%	30,300	600	2.0%	30,200	-100	-0.3%
US 422 Westbound On-Ramp from US 202 Northbound	11,099	12,900	1,801	14.0%	13,500	600	4.7%	13,400	-100	-0.7%
US 422 Westbound On-Ramp from Devon Park Drive	4,050	5,100	1,050	20.6%	5,200	100	2.0%	5,200	0	0.0%
Parallel Facilities										
PA 23 - West of Pawlings Road	21,039	24,500	3,461	14.1%	23,300	-1,200	-4.9%	23,300	0	0.0%
PA 23 - Pawlings Road to Ferry Lane	13,832	15,900	2,068	13.0%	15,200	-700	-4.4%	15,300	100	0.7%
PA 23 - Ferry Lane to Valley Park Road	13,553	16,000	2,447	15.3%	15,400	-600	-3.8%	15,600	200	1.3%
PA 23 - Valley Park Road to PA 252	19,414	22,900	3,486	15.2%	22,200	-700	-3.1%	22,300	100	0.5%
PA 23 - PA 252 to Gulph Road	17,542	20,400	2,858	14.0%	20,100	-300	-1.5%	20,200	100	0.5%
PA 23 - Gulph Road to County Line Road	16,371	19,200	2,829	14.7%	18,800	-400	-2.1%	18,900	100	0.5%
PA 23 - County Line Road to Outer Line Road	14,491	17,100	2,609	15.3%	16,700	-400	-2.3%	16,400	-300	-1.8%
North Gulph Road - PA 23 to 1st Avenue	16,789	19,400	2,611	13.5%	22,000	2,600	13.4%	19,100	-2,900	-13.2%
North Gulph Road - 1st Avenue to Guthrie Road	27,562	31,300	3,738	11.9%	34,400	3,100	9.9%	30,900	-3,500	-10.2%
North Gulph Road - Guthrie Road to Goddard Boulevard	26,592	31,000	4,408	14.2%	31,700	700	2.3%	31,100	-600	-1.9%
PA 252 - PA 23 to Yellow Springs Road	6,345	8,000	1,655	20.7%	7,900	-100	-1.3%	8,000	100	1.3%
PA 252 - Yellow Springs Road to Adams Drive	10,744	12,100	1,356	11.2%	11,900	-200	-1.7%	11,900	0	0.0%
PA 252 - Adams Drive to Walker Road	9,300	10,700	1,400	13.1%	10,100	-600	-5.6%	10,100	0	0.0%
Gulph Road - PA 23 to County Line Road	3,907	4,600	693	15.1%	4,500	-100	-2.2%	4,500	0	0.0%
Gulph Road - County Line Road to Thomas Road	1,213	1,600	387	24.2%	1,600	0	0.0%	1,600	0	0.0%
Gulph Road - Thomas Road to Glenhardie Road	1,158	1,500	342	22.8%	1,500	0	0.0%	1,500	0	0.0%
Moore Road - PA 23 to 1st Avenue	6,278	8,400	2,122	25.3%	8,600	200	2.4%	8,600	0	0.0%

Table 4. Current and 2035 Average Daily Traffic Volumes (Continued)

Location / Limits	Current Counts	2035 Forecast Scenario 1	Current - 2035 Change Absolute	Current - 2035 Change Percent	2035 Forecast Scenario 2	Scenario 2/Scenario 1 Difference Absolute	Scenario 2/Scenario 1 Difference Percent	2035 Forecast Scenario 3	Scenario 3/Scenario 2 Difference Absolute	Scenario 3/Scenario 2 Difference Percent
Intersecting Facilities										
Egypt Road - PA 29 to Greentree Road	11,519	15,300	3,781	24.7%	15,400	100	0.7%	15,400	0	0.0%
Egypt Road - Greentree Road to Mill Road	19,000	23,300	4,300	18.5%	23,400	100	0.4%	23,400	0	0.0%
Egypt Road - Mill Road to Black Rock Road/US 422	19,727	23,400	3,673	15.7%	23,700	300	1.3%	23,500	-200	-0.8%
Egypt Road - US 422 to Surrey Lane	23,352	27,000	3,648	13.5%	27,300	300	1.1%	27,200	-100	-0.4%
Egypt Road - Surrey Lane to Pawlings Road/Park Avenue	21,494	24,400	2,906	11.9%	25,000	600	2.5%	24,900	-100	-0.4%
Egypt Road - Pawlings Road/Park Avenue to Trooper Road	22,219	25,400	3,181	12.5%	25,600	200	0.8%	25,500	-100	-0.4%
Egypt Road - PA 363 (Trooper Road) to Main Street/Ridge Pike	22,867	25,600	2,733	10.7%	25,700	100	0.4%	25,600	-100	-0.4%
Country Club Road - Valley Park Road to PA 23	4,432	5,700	1,268	22.2%	5,700	0	0.0%	5,600	-100	-1.8%
Ferry Lane - PA 23 to Pawlings Road	4,160	5,900	1,740	29.5%	5,600	-300	-5.1%	5,500	-100	-1.8%
Pawlings Road - Valley Forge Road to Ferry Lane	6,894	8,700	1,806	20.8%	8,100	-600	-6.9%	8,000	-100	-1.2%
Pawlings Road - Ferry Lane to Pawlings Circle	10,532	13,700	3,168	23.1%	12,900	-800	-5.8%	12,700	-200	-1.6%
Pawlings Road - Pawlings Circle to US 422	9,572	12,100	2,528	20.9%	11,200	-900	-7.4%	11,000	-200	-1.8%
Pawlings Road - US 422 to Audobon Road	9,572	12,000	2,428	20.2%	11,100	-900	-7.5%	10,800	-300	-2.7%
Pawlings Road - Audubon Road to Egypt Road	12,084	14,500	2,416	16.7%	13,800	-700	-4.8%	13,600	-200	-1.4%
Park Avenue - Egypt Road to Woodward Road	11,160	12,300	1,140	9.3%	11,700	-600	-4.9%	11,600	-100	-0.9%
PA 363 (Trooper Road) - US 422 to Audubon Road	33,658	38,700	5,042	13.0%	41,900	3,200	8.3%	41,700	-200	-0.5%
PA 363 (Trooper Road) - Audubon Road to Van Buren Avenue	26,623	29,900	3,277	11.0%	32,800	2,900	9.7%	32,500	-300	-0.9%
PA 363 (Trooper Road) - Van Buren Avenue to Boulevard of the Generals	26,981	29,800	2,819	9.5%	31,200	1,400	4.7%	31,000	-200	-0.6%
PA 363 (Trooper Road) - Boulevard of the Generals to Egypt Road	22,487	25,100	2,613	10.4%	25,900	800	3.2%	25,600	-300	-1.2%
PA 363 (Trooper Road) - Egypt Road to Mill Road	21,489	24,000	2,511	10.5%	24,600	600	2.5%	24,300	-300	-1.2%
PA 23 - Outer Line Road to US 422 Eastbound Ramps	14,481	16,800	2,319	13.8%	17,900	1,100	6.5%	17,200	-700	-3.9%
PA 23 - US 422 Westbound Ramps to Moore Road	20,924	23,400	2,476	10.6%	25,300	1,900	8.1%	23,900	-1,400	-5.5%
PA 23 - Moore Road to Beidler Road	14,665	16,900	2,235	13.2%	18,100	1,200	7.1%	17,400	-700	-3.9%
1st Avenue - US 422 to Gulph Road	7,276	10,300	3,024	29.4%	12,400	2,100	20.4%	12,200	-200	-1.6%
1st Avenue - Gulph Road to Moore Road	15,134	17,900	2,766	15.5%	17,000	-900	-5.0%	17,100	100	0.6%
Pennsylvania Turnpike - Downingtown Interchange to Valley Forge Interchange	44,412	60,500	16,088	26.6%	61,000	500	0.8%	60,700	-300	-0.5%
Pennsylvania Turnpike - Valley Forge Interchange to Norristown Interchange	54,829	64,900	10,071	15.5%	64,100	-800	-1.2%	64,000	-100	-0.2%
US 202 Expressway - West Valley Road to US 422	96,905	112,100	15,195	13.6%	112,500	400	0.4%	111,500	-1,000	-0.9%
US 202 Expressway - US 422 to South Warner Road	126,480	145,800	19,320	13.3%	146,000	200	0.1%	145,100	-900	-0.6%
Local Area Roadways										
Audubon Road - Pawlings Road to Rittenhouse Road	7,894	10,600	2,706	25.5%	10,100	-500	-4.7%	10,000	-100	-1.0%
Audubon Road - Rittenhouse Road to Adams Avenue	6,752	8,700	1,948	22.4%	8,100	-600	-6.9%	8,000	-100	-1.2%
Audubon Road - Adams Avenue to Trooper Road	7,405	9,300	1,895	20.4%	8,700	-600	-6.5%	8,500	-200	-2.3%
Rittenhouse Road - Audubon Road to Van Buren Avenue	2,998	3,600	602	16.7%	3,500	-100	-2.8%	3,500	0	0.0%
Van Buren Avenue - Adams Avenue to PA 363 (Trooper Road)	2,554	3,200	646	20.2%	3,200	0	0.0%	3,300	100	3.1%
Outer Line Drive - Gulph Road to Visitors Center Drive	595	1,900	1,305	68.7%	1,900	0	0.0%	1,900	0	0.0%
Outer Line Drive - Visitors Center Drive to PA 23	1,870	3,300	1,430	43.3%	3,300	0	0.0%	3,300	0	0.0%
County Line Road - Gulph Road to PA 23	430	1,800	1,370	76.1%	1,900	100	5.6%	1,800	-100	-5.3%

Source: DVRPC February 2011

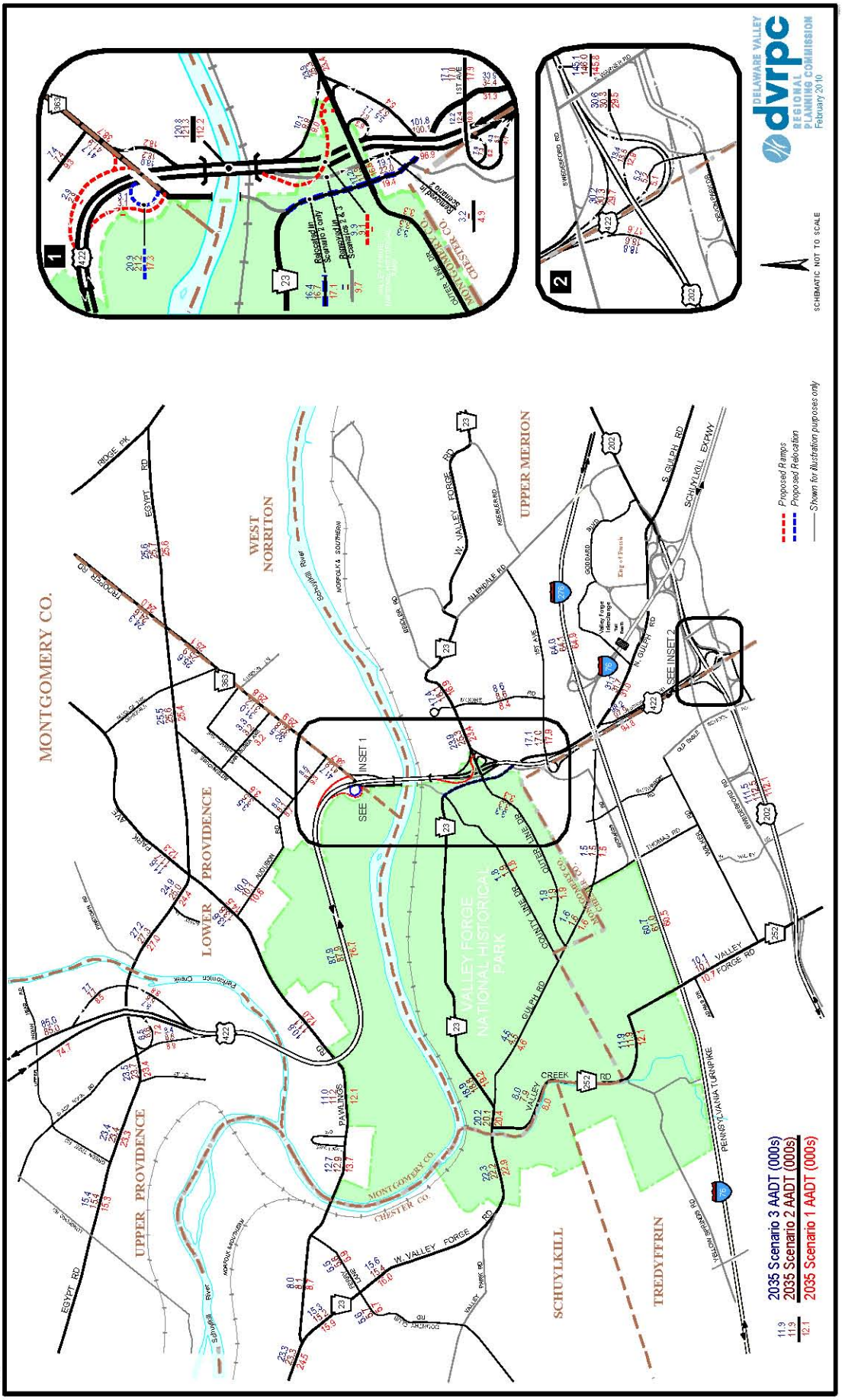


Figure 8. 2015 Senarios 1, 2, and 3 Average Daily Traffic Volumes

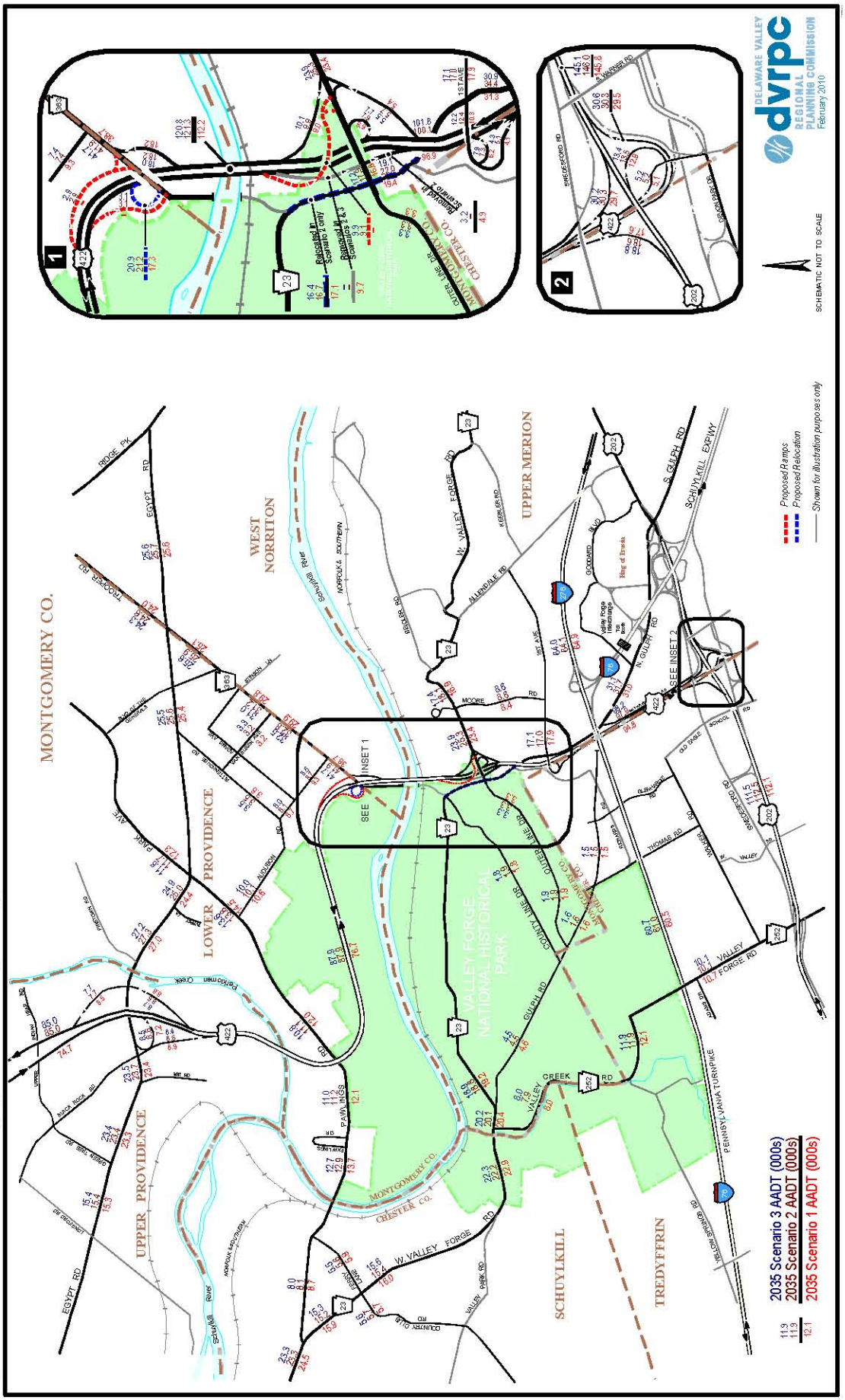


Figure 9. 2035 Scenarios 1, 2, and 3 Average Daily Traffic Volumes

on the westbound on-ramp and eastbound off-ramp at the Egypt Road interchange; these reductions range from 700 to 900 vpd in 2015 and 600 to 800 vpd in 2035.

Compared to the Scenario 1 forecasts, the eastbound ramps at the PA 23 interchange carry less traffic under Scenarios 2 and 3. The westbound ramps carry the same, or slightly higher, traffic volumes. Under Scenario 2, the closure of the eastbound on-ramp at PA 23 results in more traffic using the on-ramp at 1st Avenue. Although the eastbound on-ramp at PA 23 is not closed under Scenario 3, this scenario also exhibits reduced volumes on the eastbound ramps at PA 23 and increased volumes at 1st Avenue, compared to Scenario 1. In 2035, the PA 23 on-ramp serves 1,700 fewer vehicles per day and the 1st Avenue on-ramp serves 1,700 more vehicles per day under Scenario 3 than under Scenario 1.

Facilities parallel to US 422 carry lower traffic volumes under Scenarios 2 and 3 than under Scenario 1, due to the additional capacity that is provided on US 422 under these scenarios. One exception is North Gulph Road between PA 23 and 1st Avenue under Scenario 2. Here, volumes are increased due to the diversion of traffic from the PA 23 eastbound on-ramp to the 1st Avenue ramp.

Compared to Scenario 1, the daily traffic volume changes on facilities that intersect US 422 are mixed under Scenarios 2 and 3. Egypt Road volumes are reduced slightly, due to the diversion to the new Trooper Road ramps. Volumes are also reduced on Pawlings Road. Most other intersecting facilities, however, serve higher traffic volumes under Scenarios 2 and 3, as more traffic uses these roads for access to or egress from US 422. These increases tend to be relatively small, typically in the three to five percent range. The largest increases occur on Trooper Road, which serves 2,100 to 2,300 additional vpd in 2015 and 2,600 to 3,200 additional vpd in 2035, compared to the Scenario 1 forecasts. They represent between 5.9 and 9.7 percent more traffic than the comparable Scenario 1 forecasts.

Peak Hour Traffic Forecasts

Generally, the relationships between current and future peak hour volumes and between the various future-year scenarios follow the same patterns and trends as the daily traffic volumes. However, the percentage of daily traffic that occurs during the future AM and PM peak hours is somewhat less than the percentage under current conditions. This is consistent with the “peak spreading” that occurs as traffic volumes increase. As traffic volumes rise and congestion levels increase, a greater percentage of traffic is shifted to the “shoulders” of the peak, i.e., immediately before and after the peak hour.

AM and PM peak hour traffic forecasts for the US 422 mainline, individual interchange ramps, and selected highway facilities, including intersection turning movements, are shown in **Figures 10** through **15** in the Appendix. **Figures 10** through **12** display the 2015 peak hour forecasts for Scenarios 1, 2, and 3, respectively. The 2035 peak hour forecasts are displayed in **Figures 13** through **15**. In each case, peak hour forecasts are provided at each location where current peak hour traffic counts were shown in **Figure 3**.

Conclusions

The US 422 River Crossing Complex traffic study is focused on the US 422 corridor between Egypt Road and US 202. The current daily traffic volumes along this portion of US 422 range from 63,100 to 95,600 vehicles. High traffic volumes combined with operation deficiencies result in recurring congestion and delay throughout the corridor.

The study area surrounding this portion of US 422 is home to over 127,000 residents and the location of about the same number of jobs. Between 2010 and 2035, the study area is projected to increase its population by nearly 22,000 residents. It will also add 27,000 new jobs, an increase of 21 percent, during this time period.

Forecasts of future-year traffic volumes are prepared and evaluated for three different highway network scenarios: a no-build scenario and two build scenarios. Under Scenario 1 (No-Build), volumes on US 422 are projected to be between 74,700 and 112,200 vpd by 2035. These 2035 volumes represent increases of 11,600 to 16,600 vpd over current traffic volumes.

Both of the build scenarios widen US 422 to six lanes from the US 202 interchange through the PA 363 interchange, along with interchange reconstructions and associated improvements to intersecting and parallel roads in the corridor. These scenarios accommodate higher traffic volumes than Scenario 1. By 2035, US 422 volumes are forecast to range from 85,000 to 121,300 vpd under the build scenarios. However, these scenarios will see a significant reduction in traffic volume per lane compared to Scenario 1.

APPENDIX

2015 and 2035 AM/PM Peak Hour Traffic Forecasts

Figure 10. 2015 AM/PM Peak Hour Traffic Forecasts for Scenario 1

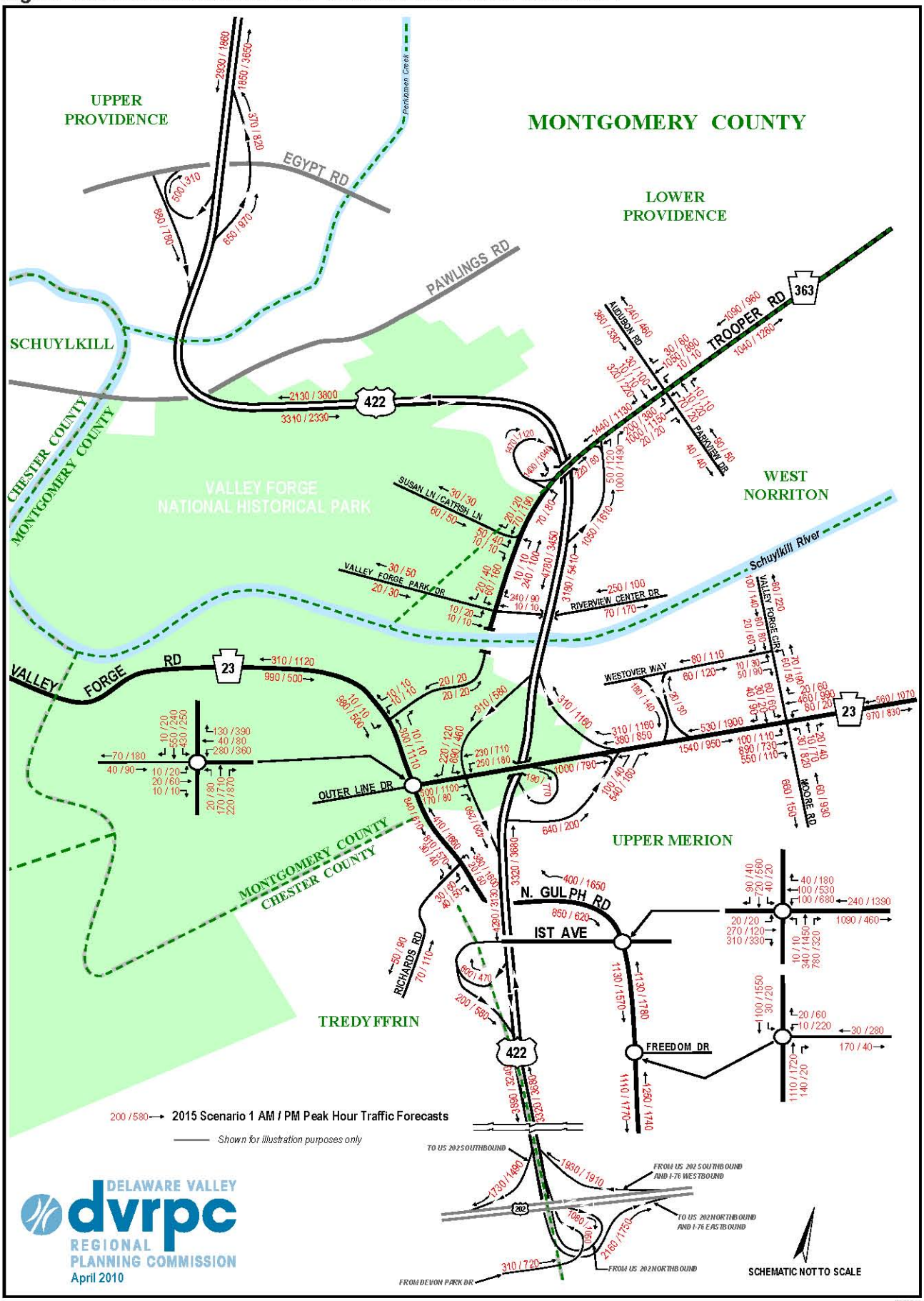


Figure 11. 2015 AM/PM Peak Hour Traffic Forecasts for Scenario 2

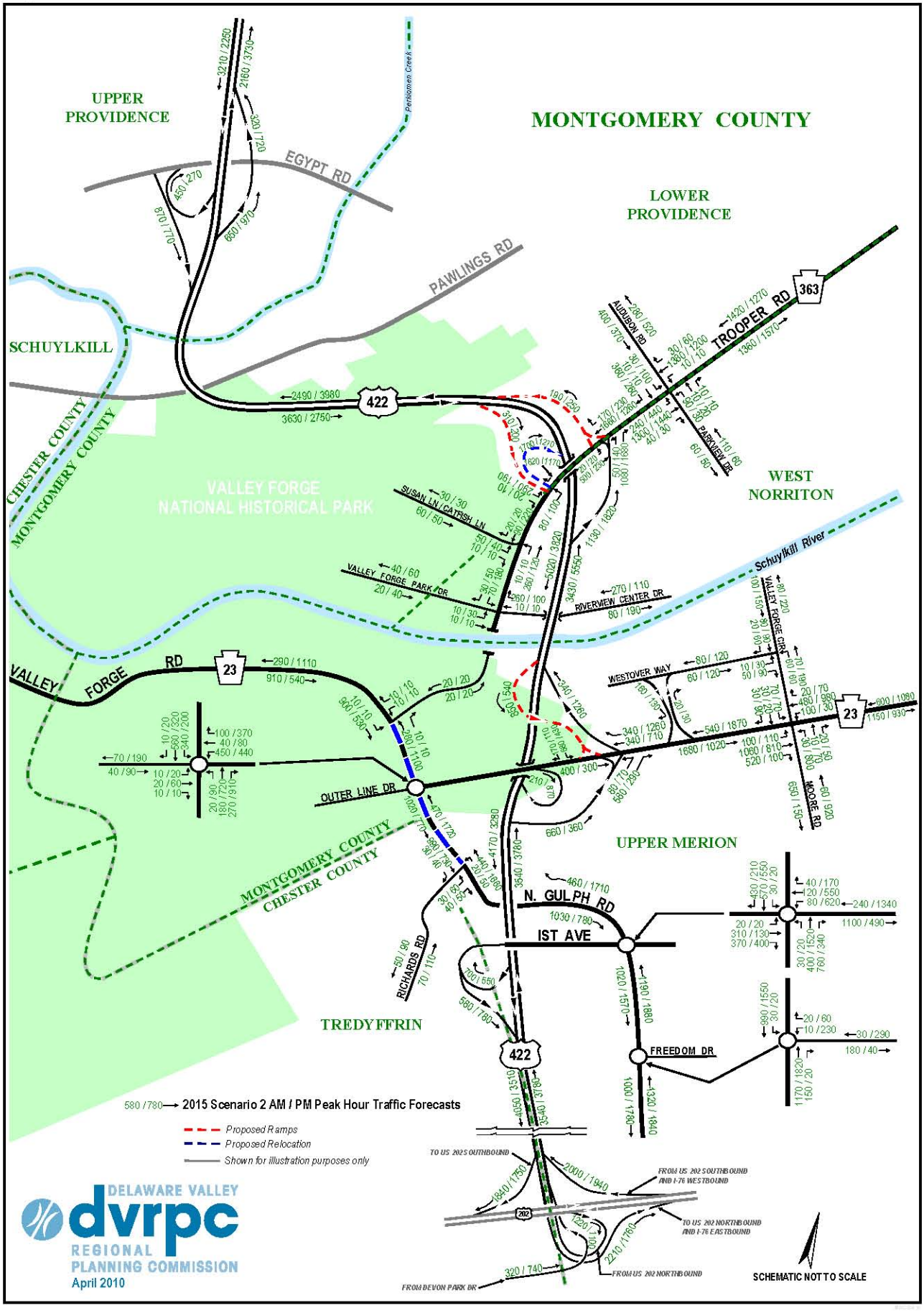


Figure 13. 2035 AM/PM Peak Hour Traffic Forecasts for Scenario 1

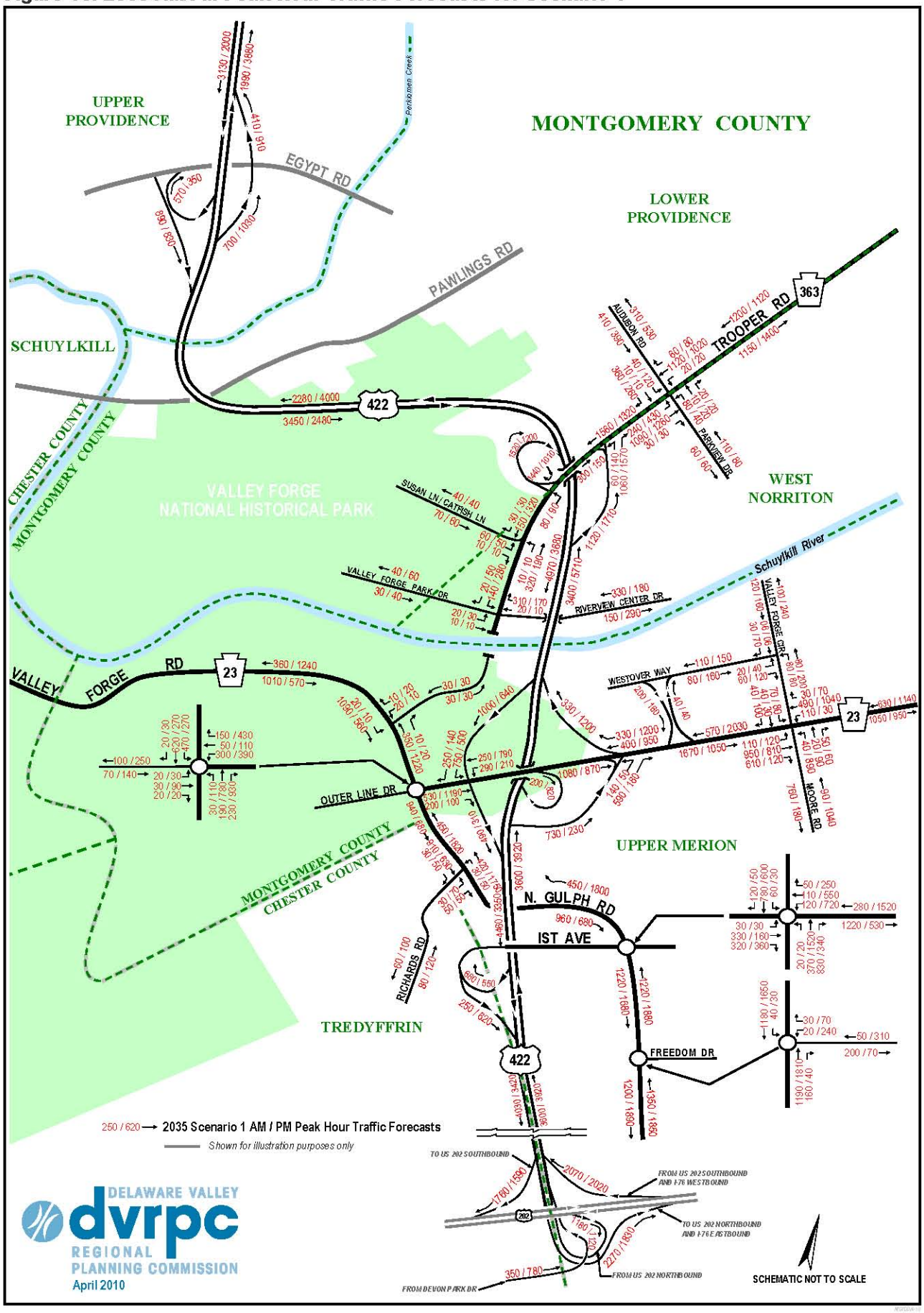


Figure 14. 2035 AM/PM Peak Hour Traffic Forecasts for Scenario 2

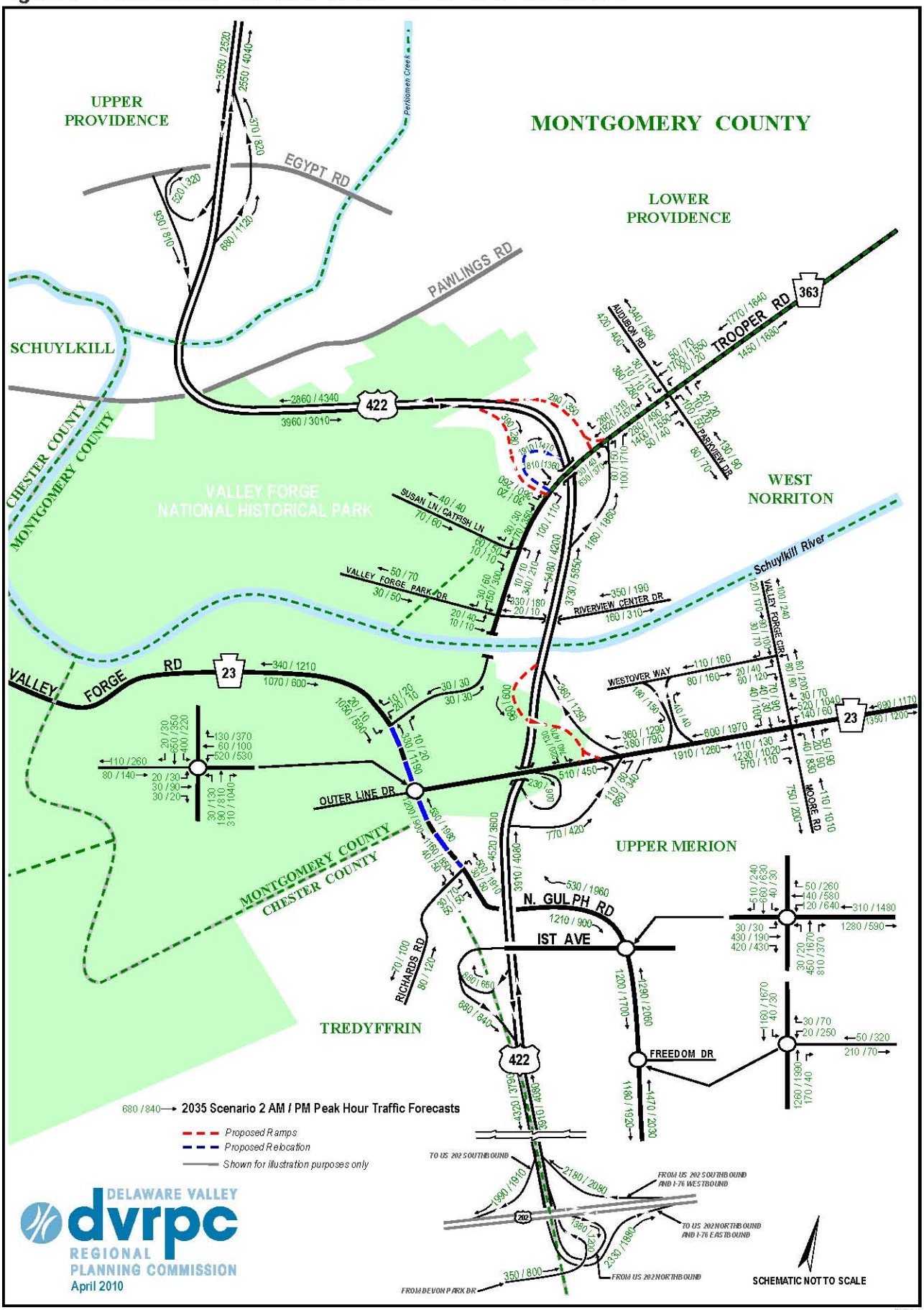


Figure 14. 2035 AM/PM Peak Hour Traffic Forecasts for Scenario 2

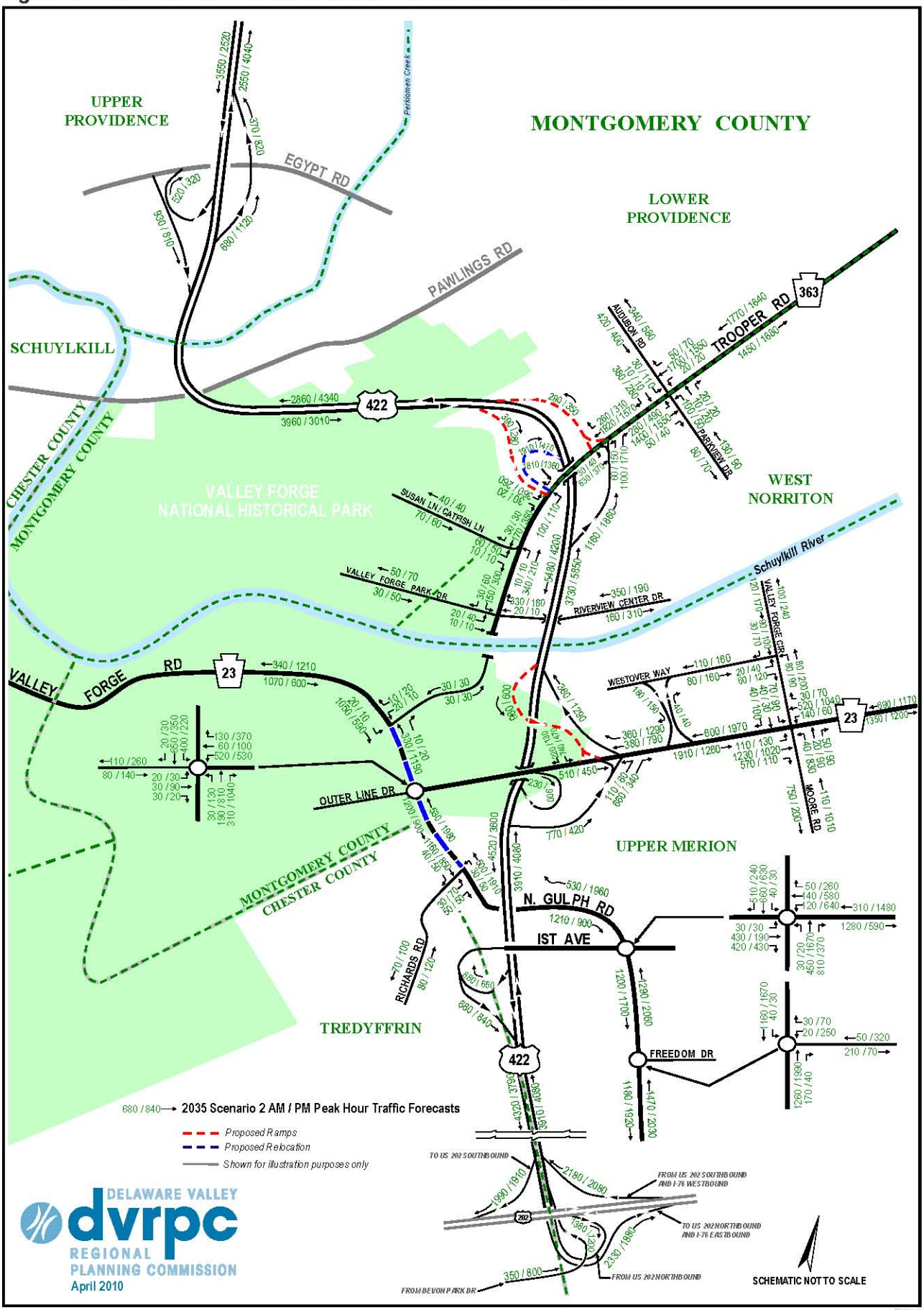
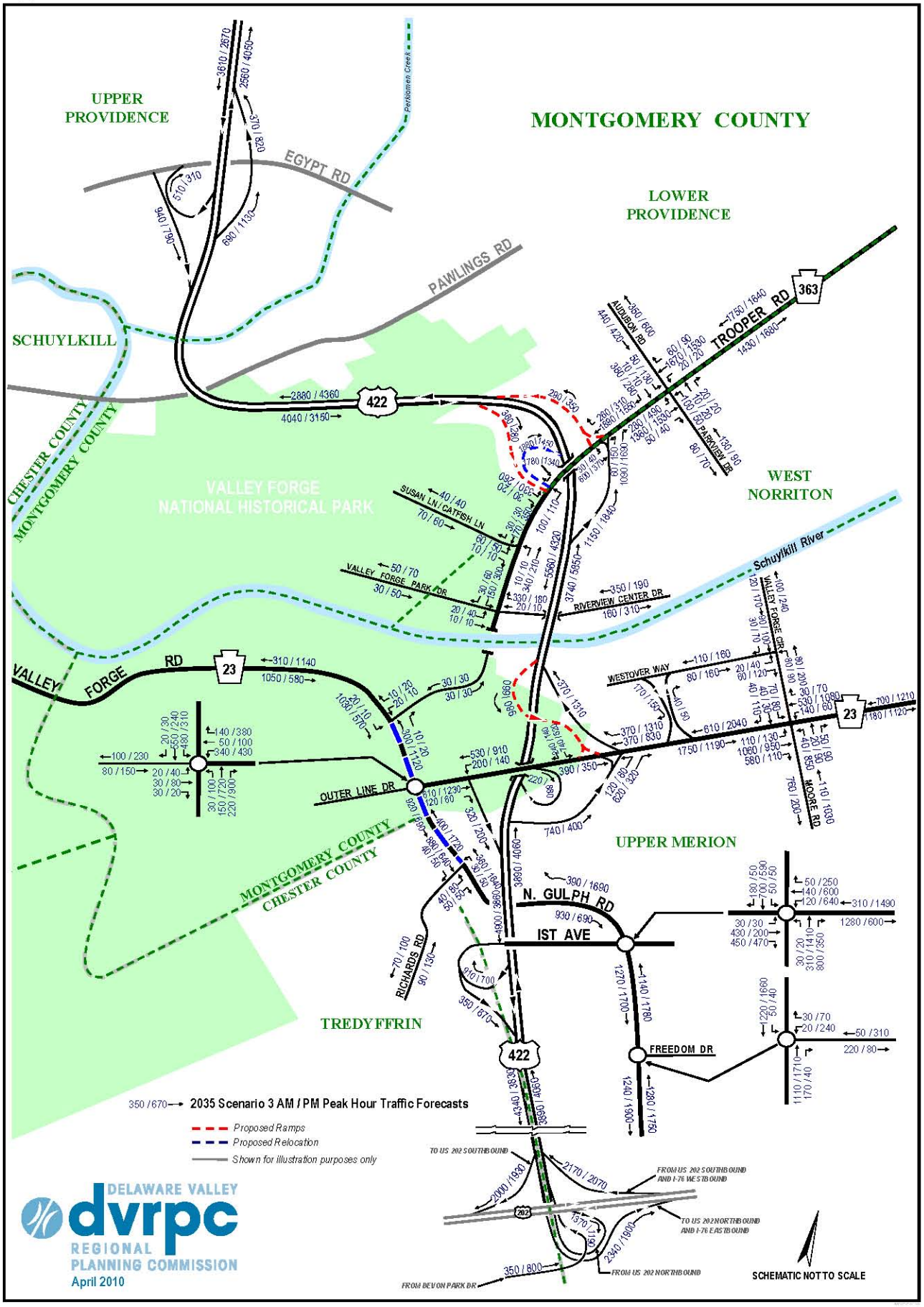


Figure 15. 2035 AM/PM Peak Hour Traffic Forecasts for Scenario 3



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Key Words:	US 422, River Crossing, Traffic Forecasts, Travel Simulation, AADT, AM and PM Peak Hour Traffic Volumes
Abstract:	This report documents 2015 and 2035 traffic forecasts for the US 422 River Crossing Traffic Study Area. Average daily and AM and PM peak hour forecasts are provided for Scenario 1 (No-Build Alternative) and Scenarios 2 and 3 (Build Alternatives) and compared to current traffic volumes.

Staff Contact:

Matthew T. Gates
Senior Transportation Engineer
☏ (215) 238-2911
mgates@dvrpc.org

Delaware Valley Regional Planning Commission
190 N Independence Mall West
ACP Building, 8th Floor
Philadelphia, PA 19106-1520
Phone: (215) 592-1800
Fax: (215) 592-9125
Internet: www.dvrpc.org

DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION

190 N Independence Mall West
ACP Building, 8th Floor
Philadelphia, PA 19106-1520
Phone: 215-592-1800
Fax: 215-592-9125
Website: www.dvrpc.org