Selecting Software to Evaluate the Anticipated Effectiveness of CMP Strategies

August 2011

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.

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.

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Executive Summary

The Delaware Valley Regional Planning Commission (DVRPC) is seeking a software program or programs to use with strategies recommended by the Congestion Management Process (CMP). Per federal regulations, the primary goal of this effort is to find a means to identify and evaluate the anticipated performance and expected benefits of appropriate congestion management strategies that will contribute to the more effective use and improved safety of existing and future transportation systems, based on performance measures established by the CMP. The ability to evaluate the anticipated effects of strategies is envisioned as a helpful resource that DVRPC staff would offer to partner organizations. It is important to keep in mind that no model can account for all of the factors that impact travel behavior.

When analyzing the impacts of strategies, individually or as a group, a set of common measures is needed that can be used across various modes. As a starting point, the following measurements will be used to analyze the impacts of CMP strategies:

- Volume-to-Capacity (V/C) Ratios—where in general, a decrease in V/C ratio is a positive outcome, although corridor implications must also be considered; and
- Benefit-Cost (B/C) Ratios—where a higher B/C ratio is positive.

After reviewing 34 software packages, the central challenge to this effort remains the fact that there is no one sketch-level program able to analyze all of the strategy categories used in the CMP. Another challenge is the fact that the ability to analyze multiple strategies is found in very few software packages. It would be helpful to analyze multiple strategies together to understand if their effects would be complementary or duplicative. Several programs were identified as having potential. Further testing of these programs is underway. The programs include:

- Cal-B/C;
- Commuter Model 2.0; and
- Center for Clean Air Policy (CCAP) *Transportation Emissions Guidebook* (TEG).

Cal-B/C is a free, downloadable spreadsheet-based sketch modeling tool that can prepare analyses of highway, transit, operations, and transportation systems management strategies. The program's primary function is to calculate B/C ratios, but it also calculates vehicle miles traveled (VMT) and volume, which could be used to calculate a V/C ratio. The CCAP TEG is a spreadsheet-based sketch modeling program. It uses rule of thumb estimates to determine changes to VMT. Many of the strategies it addresses cannot be analyzed by the other programs under consideration. Commuter Model 2.0 was developed by the United States Environmental Protection Agency (US EPA). It quantifies changes as a result of travel demand management programs, calculating the impact of the mode share changes from these programs and translating the mode share changes into changes in VMT. Commuter Model 2.0 uses a pivot point (logit choice) approach to allow for analysis of multiple strategies at once.

The current report includes discussion of preliminary testing of Cal-B/C. The West Chester Pike (PA 3) corridor was selected for a first test, in part because the corridor was the subject of a more detailed modeling analysis by the DVRPC Office of Modeling and Analysis, using the VISUM software. These results were compared with the sketch model results. West Chester Pike was evaluated for Transit Signal Priority (TSP) treatment, which would speed the service of the Southeastern Pennsylvania Transportation Authority (SEPTA) bus routes operating on PA 3 (primarily the Route 104 bus line). TSP is listed in the CMP as a Very Appropriate Strategy for West Chester Pike. Data sources included the CMP, the DVRPC traffic count database, transit ridership information, and data related to project costs.

The B/C equation was driven by estimated savings of about five minutes in the average transit travel time, which would be gained by deploying TSP. Cal-B/C showed life-cycle costs for the project to be approximately $1.7 million, with benefits of $11 million over 20 years. This results in a B/C ratio of 6.6, with a calculated payback of two years for the project. After the VISUM modeling work was completed, the Cal-B/C analysis was revisited. VISUM was able to estimate more precise travel time savings, based on information about the West Chester Pike corridor that was much more detailed than what Cal-B/C required. The default travel time savings numbers provided by the Cal-B/C software were replaced with the numbers estimated by VISUM. The Cal-B/C result using the revised travel time number was a B/C ratio of 5.3, which represents a 15-percent change from the result obtained using Cal-B/C's assumptions. The calculated payback period for the project was still two years.

In addition to testing TSP, a sample project was entered into Cal-B/C that imagined widening a five-mile stretch of PA 3. This project showed a negative B/C ratio result of –2.4. While the extra capacity provided some travel time savings, it added significant vehicle operation costs, accident costs, and emission costs over the 20-year time horizon. Adding lanes (General Purpose Lanes) is *not* a strategy recommended by the CMP for the West Chester Pike corridor. Finally, a Bus Rapid Transit (BRT) scenario was tested, assuming a separate right-of-way for the BRT system. Cal-B/C showed a B/C ratio of zero for the project. There were significant travel time savings of nearly 4,750,000 person hours over 20 years, but high capital costs negated these savings.

More work is required to determine whether Cal-B/C will be regularly used for the CMP. Further testing will attempt to devise a method for modeling multiple strategies. In addition, the following options will be explored in the near-term:

- Utilize Commuter Model 2.0 to analyze the strategies it can consider, including Transportation Demand Management (TDM), nonmotorized transportation, and public transportation improvements.
- Utilize Cal-B/C for the strategies it can consider. Attempt to combine with outputs from Commuter Model 2.0 to create multiple-strategy analysis.
- Utilize the CCAP TEG for the strategies it can consider. Attempt to combine with outputs from Cal-B/C and Commuter Model 2.0 to create multiple-strategy analysis.

A basic focus of this effort is on figuring out what can reasonably be done with the data and software packages available. So far, the data required for Cal-B/C seems to be relatively easy to acquire and enter, allowing for rapid turnaround of sketch-level analysis. In Fiscal Year (FY) 2012, DVRPC will continue to test software programs to analyze the anticipated effects of CMP strategies. Testing efforts will be coordinated with the DVRPC Office of Modeling and Analysis, in order to compare the outputs of the sketch modeling and traffic modeling efforts.

CHAPTER 1

The Challenge: Evaluating Sets of Strategies

Background

Among other elements, the Safe, Accountable, Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) guidelines state that a metropolitan planning organization (MPO)'s CMP shall include:

> "Identification and evaluation of the anticipated performance and expected benefits of appropriate congestion management strategies that will contribute to the more effective use and improved safety of existing and future transportation systems…"[1]

DVRPC is seeking a software program or programs to use with congestion management strategies, in order to help provide insight into the probable effects of specific strategies and sets of strategies. **The primary goal of this effort is to find a means to identify and evaluate the anticipated performance and expected benefits of appropriate congestion management strategies**.

Particularly challenging to evaluate are the anticipated effects of sets of multiple congestion management strategies. For example, certain strategies, when implemented together, may have a greater impact than any of the strategies involved would have had individually. In other words, some strategies may have a complementary, or synergistic, relationship. However, other combinations of strategies may have duplicative effects, such that when implemented together, their overall impact would not be as great as the impact each strategy would have had if it was implemented on its own.

As an example, two different CMP strategies may each individually be expected to reduce V/C ratios on a road segment by 5 percent. When paired together, they may have a synergistic effect that results in reducing V/C by a total of 12 percent. Two other strategies, each expected to individually reduce V/C by 5 percent, may have duplicative effects such that, when implemented together, they reduce V/C by a total of only 6 percent. These synergistic or duplicative effects grow more complex as the number of strategies employed increases. **Understanding how different groups of strategies interact is another important goal of software-based analysis.**

The *2011 DVRPC Congestion Management Process (CMP) Report* (Publication #11042, anticipated publication Fall 2011) lists and defines over 100 strategies, grouped into the following five strategy categories:

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[1] 23 CFR 450.320(c).

- Operational Improvements, Transportation System Management (TSM), and Intelligent Transportation Systems (ITS);
- Transportation Demand Management (TDM), Policy Approaches, and Smart Transportation;
- Public Transit Improvements and New Investments;
- Road Improvements and New Roads; and
- Goods Movement.

It is unlikely that a single model will be able to consider all five strategy categories, and even less likely that one will be able to consider every strategy listed in the CMP. Therefore, this effort will attempt to find a software package that can analyze as many strategy types as possible, with emphasis on covering the most commonly used strategies.

The ability to evaluate the anticipated effects of strategies is envisioned as a helpful resource that DVRPC staff would offer to partner organizations. For example, software analysis could be used by Department of Transportation (DOT) staff, members of the CMP Advisory Committee such as county planning staff, and other stakeholders to develop and refine transportation projects.

Selecting Common Measures

When analyzing the impacts of strategies, individually or as a group, a set of common measures is needed that can be used across various modes. A critical step in developing the CMP is the analysis of the performance of the regional transportation system. The criteria used to develop the 2011 CMP were a refinement of those used in the 2009 CMP, and flowed from the goals of the Long-Range Plan. Briefly, the current CMP criteria used in selecting corridors and as a consideration in developing strategies are:

- roads with current peak-hour congestion measured by high V/C ratios;
- locations where comparison of the current and future travel model simulations suggest high growth in peak-period V/C ratios;
- roads with high duration of congestion based on available archived operations data;
- existing transit service (bus, trolley, or train);
- areas where transit might succeed in 2035 based on demographic forecasts regardless of whether they have transit service now;
- major roads and freight facilities;
- roads where high crash rates lead to unexpected congestion;
- critical population and employment centers, bridges, and other facilities of special concern for security preparedness;
- current or future development areas and Land Use Centers identified in the Long-Range Plan; and
- areas of high and low environmental impact, with low impacts being preferred for transportation investments.

Many of these measures, such as facilities of concern for security preparedness, Land Use Centers, and areas of low environmental impact are critical for making decisions about how to prioritize regional transportation investments. However, they are not necessarily quantifiable by most modeling programs. Other measures, such as crash rates and transit ridership information, are important inputs for nearly all of the software programs evaluated.

For this effort, it was important to choose simple measures that most of the programs would be capable of producing. V/C ratios are most suited to analysis of road projects, and may present challenges when evaluating transit or pedestrian enhancements. However, they are a useful and readily available measure of congestion. In the current economic environment, in which limited funds are available for transportation improvements, B/C analysis could be a useful tool to help ensure that the region receives the best value for its investments. Therefore, although B/C ratios are not a criterion in the CMP, they were selected as a useful output for CMP software analysis.

Based on these considerations, as well as the capabilities and limitations of the available software options, the measurements in Table 1 will be used to analyze the impacts of CMP strategies, at least for now:

Table 1: Common Measurements for Congestion Management Process Software Analysis

Measurement	Outcome
V/C ratios	In general, a decrease in V/C ratio would be considered a positive outcome, although corridor implications must also be considered. (For example, a higher V/C ratio may be a healthy sign in a central business district, and a decrease in V/C at one point in a corridor may just move congestion to another point.)
B/C ratios	In general, a higher B/C ratio would be considered a positive outcome.

Source: Delaware Valley Regional Planning Commission (Philadelphia: DVRPC, 2011).
Note: B/C = Benefit-Cost. V/C = Volume-to-Capacity.

It is important to keep in mind that no model can account for all of the factors that impact travel behavior. Using software for analysis helps with making decisions but presents an incomplete picture of the transportation system and must be combined with review and discussion.

Selection of Software Packages

Choosing the Right Tool

DVRPC began considering different modeling options for the CMP in 2006. A first step was to seek guidance from the Federal Highway Administration (FHWA), which has developed a significant amount of documentation relating to transportation software. The *Traffic Analysis Toolbox Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools* document reviews the different types of models used in transportation planning, design, and operations, and develops a decision-making process to determine which kind of model is most appropriate for an agency's need.

In order to help an agency better determine its modeling needs, FHWA created a decision support spreadsheet as part of the *Traffic Analysis Toolbox Volume II*. This spreadsheet considers the relevance of factors such as context (planning, design, or operations), scope, facility, mode, management strategy, traveler response, performance measures, and tool/cost effectiveness.[2] After completing the spreadsheet, DVRPC determined that travel demand models are most in line with CMP modeling needs but are impractical for the application. Sketch planning tools are the second-most appropriate and, given staff and budget resources, are the preferred approach.

For the purposes of this discussion, sketch planning tools and travel demand models will be examined for their potential to evaluate the anticipated effects of CMP strategies. Sketch planning tools, travel demand models, the other five major types of transportation models, and the results of the decision support spreadsheet exercise are summarized in Appendix B.

An integrated travel demand model and land use model might be the best solution to analyze CMP strategies and their possible impacts, but unfortunately these models are difficult to set up and use. DVRPC does use UPlan,[3] which is an integrated travel demand and land use model for analysis related to the Long-Range Plan. However, these complex models must be run by the DVRPC Office of Modeling and Analysis, which can help with the CMP effort to some extent but does not have the resources to perform all, or even most, CMP modeling needs. **Sketch planning tools, therefore, offer a more viable alternative.**

Besides the seven types of models described by FHWA, various other types have been identified that may have relevance to the CMP. These include land use, geographic information system (GIS)-based, engineering, and economic models. Additionally, a number of post-processors have

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[2] The spreadsheet can be found at http://ops.fhwa.dot.gov/trafficanalysistools/tat_vol2/dsm_auto_tool.xls.
[3] See Appendix A for more information about UPlan and other software packages.

been developed that take results from the four-step travel demand model and further analyze them for specific purposes.

Summary of Software Packages

DVRPC next located and reviewed 34 transportation software programs as being potentially capable of the type of analysis needed for the CMP. These included:

- BCA.net;
- Cal-B/C;
- CCAP TEG;
- Central 4;
- Community Viz;
- Commuter Model 2.0;
- DVRPC Travel Improvement Model (TIM);
- Dynamic Network Assignment-Simulation Model for Advanced Roadway Telematics (Planning Version) (Dynasmart–P);
- Dynamic Urban Systems for Transportation (DynusT);
- Geographic Intermodal Freight Transportation (GIFT);
- Highway Economic Analysis Tool (HEAT);
- Highway Economic Requirements System–State Version (HERS–ST);
- IMPACTS;
- ITS Deployment and Analysis System (IDAS);
- MicroBENCOST;
- New Jersey Air Quality Off-Network Estimator (NJAQONE) and Pennsylvania Air Quality Off-Network Estimator (PAQONE);
- Planning for Community Energy, Economic and Environmental Sustainability (Place^{3}s);
- Screening for ITS (SCRITS);
- Sketch Planning Analysis Spreadsheet Model (SPASM);
- Smart Growth Index (INDEX);
- Spreadsheet Model for Induced Travel Estimation (SMITE);
- Surface Transportation Efficiency Analysis Model v2.0 (STEAM);
- Synchro and SimTraffic;
- TransCAD;
- TRansportation ANalysis and SIMulation System (TRANSIMS);
- Transportation Decision Analysis Software (TransDec);
- Transportation, Economic and Land Use Model (TELUM);
- TRANUS;
- Trip Reduction Impacts of Mobility Management Strategies (TRIMMS);

- UPlan; and
- VISUM and VISSIM.

For a brief review of the capabilities and limitations of each program identified and reviewed by DVRPC staff, refer to Appendix A.

A summary table was prepared for the software packages analyzed, with regard to their usefulness for the DVRPC CMP. Several of the less useful programs were dropped from the summary table for simplicity. Community Viz, Place^{3}s, and TELUM are land use models that do not significantly add to the capabilities of the UPlan land use model already in use at DVRPC. NJDOT's Central 4 post-processor was left off because it is not capable of addressing specific CMP strategies. TransCAD was omitted because it is the travel demand model with the least functionality for addressing CMP strategies. BCA.Net and MicroBENCOST were omitted because they are only capable of analyzing road capacity and road improvement strategies such as repaving. TransDec is more of a decision-making guide than a tool for analysis.

Table 2 shows each program's ability to analyze at least some of the strategies in the five different strategy categories: (1) whether the program analyzes at the corridor or local level; (2) if it can analyze the impact of multiple strategies simultaneously; (3) whether the user needs to estimate the resulting travel demand from an improvement; (4) if output data is needed from a four-step model; and (5) whether the program can estimate induced travel. Some of the strategy categories were broken out into separate subcategories for the purposes of the table.

After reviewing 34 software packages, the central challenge to this effort remains the fact that there is no one sketch-level program able to analyze all of the strategy categories used in the CMP. Policy Approaches, Smart Transportation, and Goods Movement are particularly challenging to model; only a few of the software packages are capable of evaluating strategies in these categories. Another challenge is that the ability to analyze multiple strategies together is found in very few software packages. Only Commuter Model 2.0, IDAS, INDEX, and STEAM were designed to analyze multiple strategies at one time. A few other programs, labeled with cross-hatching in Table 2, may offer opportunities to analyze multiple strategies, although they were not expressly designed to do so.

Table 2: Software Programs and Capabilities

	Strategy Type	Cal-B/C	CCAP TEG	Commuter Model 2.0	DVRPC TIM	Dynasmart-P	GIFT	HEAT	HERS-ST	IDAS	IMPACTS	INDEX	NJAQONE / PAQONE	SCRITS	SMITE	SPASM	STEAM	Synchro SimTraffic	TRANSIMS	TRANUS	Uplan	VISUM / VISSIM
		Software Program																				
	Operational Improvements, Transportation System Management (TSM) and Intelligent Transportation Systems (ITS)																					
	Transportation Demand Management (TDM)																					
	Policy Approaches																					
	Smart Transportation																					
	Public Transit Improvements																					
	Road Improvements																					
	New Public Transit																					
	Goods Movement																					
	New Roads																					
	Type of Model	Sketch	Sketch	Sketch	Travel Demand	Meso-simulation	GIS Based	Engineering/ Economic	Engineering/ Economic	Travel Demand	Sketch	Sketch	Sketch	Sketch	Sketch	Sketch	Sketch	Micro-simulation	Travel Demand	Travel Demand/ Land Use	Land Use	Travel Demand
Area	Regionwide Analysis																					
	Corridor/Local Analysis																					
Capabilities	Multiple-Strategy Analysis[1]																					
	User Defines Trip Reduction Tables																					
	Uses 4 Step Model Data (Or is a 4 Step Model)																					
	Estimates Induced Travel																					
Out-puts	Estimates Vehicle Miles Traveled Change																					
	Estimates Vehicle Hours of Travel Change																					

[1] Note:

Programs fully shaded have been specifically designed for multiple-strategy analysis.

Those shaded in cross hatching are considered to be capable of such analysis but not specifically designed to do so.

Selection Process

It would be ideal if all CMP analyses could be performed by a single software program that could consider the full range of strategies and types, and quantify how different strategies interact with each other. However, as illustrated in Table 2, DVRPC has not identified a single program to date that is capable of performing all or even most of these functions. The next best alternative is to find a program capable of analyzing the effects of implementing various different strategies at once.

Preliminary Findings

In the first round of DVRPC's software evaluation effort, it was determined that three programs were capable of analyzing the effects of implementing multiple strategies at once: Commuter Model 2.0, IDAS and STEAM. However, each of these can analyze only two or three of the nine different strategy types.

STEAM would add to the outputs of the four-step travel demand model. This type of analysis may be useful as the CMP becomes more sophisticated, but the current outputs needed for CMP analysis are already computed in the DVRPC travel demand model. Therefore, STEAM was dropped from consideration.

Based on the preliminary findings of DVRPC's software evaluation effort, an initial list of software programs to investigate was developed. The initial short-term list included:

- SMITE to predict induced traffic levels from roadway improvements or expansion;
- SPASM for corridor-level analysis of public transportation improvements or expansion, as well as road improvements or expansion, and also to calculate induced demand;
- NJAQONE and PAQONE to test the impacts of a variety of strategy types, including Operational Improvements, TSM, TDM, nonmotorized transportation, public transportation improvements and expansion, and roadway improvements and expansion;
- Synchro and SimTraffic to analyze more specific operational and roadway improvements; and
- Commuter Model 2.0 to analyze the strategies it can consider, including TDM, nonmotorized transportation, and public transportation improvements.

DVRPC CMP staff met with staff from the Office of Modeling and Analysis in 2006 to coordinate how to move forward with using software programs in CMP strategy tasks. SMITE (since SPASM can also estimate induced traffic) and SYNCHRO (a microsimulation program) were eliminated from consideration based on these discussions.

IDAS is a hybrid sketch and travel demand modeling program, developed by Cambridge Systematics (CS). It can analyze alternative ITS operations deployment scenarios and test tradeoffs of traditional highway and transit infrastructure options, using the outputs of a four-step model. IDAS was added to the list because of its multiple-strategy analysis capabilities.

SPASM and Commuter Model 2.0 were selected for additional review and possible use, depending on data requirements and availability. DVRPC staff analyzed the specific capabilities of these programs to review sets of strategies. The review found that Commuter Model 2.0 is capable of a single analysis of three jointly implemented strategies: More Frequent Transit of More Hours of Service, Pedestrian and Bicycle Improvements, and Marketing of TDM and Transit. SPASM does not have a multiple-strategy analysis capability and it can only cover a limited range of strategies. The AQONE model can cover more strategies, though it cannot consider them together. Therefore, SPASM and AQONE were dropped from consideration.

This left the following short set of programs:

- Commuter Model 2.0; and
- IDAS.

Commuter Model 2.0 was developed by the US EPA and is a spreadsheet-based program. It quantifies changes as a result of travel demand management programs, calculating the impact of the mode share changes from these programs and translating the mode share changes into changes in VMT. Commuter Model 2.0 uses a pivot point (logit choice) approach to allow for analysis of multiple strategies at once. The program does not calculate V/C ratios or perform B/C analysis.

Upon completion of the internal review, DVRPC staff requested assistance from the FHWA national resource person for the CMP. FHWA complimented DVRPC for its research and documentation efforts on the subject of CMP modeling needs. FHWA provided funding for DVRPC and the Mid-America Regional Council to test IDAS through their standing contract with CS. It was confirmed by CS staff that IDAS could analyze different strategies based on a single run of the travel demand model, although depending on the strategies, some iteration might be necessary. DVRPC has a license and has had some staff training for the use of IDAS. However, CS was ultimately unable to get IDAS to work with the travel demand model DVRPC had at the time. DVRPC is now moving toward using a new model that operates in the VISUM program platform, but elements of IDAS may have become outdated.

As a longer term piece of the CMP software evaluation effort, **DVRPC will investigate whether improvements have been made to IDAS and whether it would work with the new VISUM travel demand model.**

Programs Selected for Testing

The first phase of DVRPC's evaluation of software packages for CMP strategy evaluation resulted in the short set of recommendations described in the previous section. New programs and tool kits have become available since the 2006 *Software Evaluation* report was drafted; these have been incorporated into the current report and can be found in Appendix A. Of these, one new program of note was added, as follows.

Cal-B/C

Cal-B/C is a free, downloadable spreadsheet-based sketch modeling tool that can prepare analyses of highway, transit, operations, and transportation systems management strategies. The model calculates B/C ratios and can measure four categories of benefits that result from highway or transit projects. These include travel time savings, vehicle operating cost savings, accident cost savings, and emission reductions. Cal-B/C is capable of providing data for both of the measurements that will be used to analyze the impacts of CMP strategies, as described on page 1 of this report. The program's primary function is to calculate B/C ratios, but it also calculates volumes that could be used to calculate a V/C ratio.

Cal-B/C was added to the short list of programs for further consideration (in addition to IDAS and Commuter Model 2.0). Pros and cons for each of the shortlist programs, as well as the DVRPC TIM, were considered, as shown in Table 3.

Table 3: Pros and Cons of Short-Listed Software Programs

	Model			
Pros	**Cal-B/C**	**IDAS**	**Commuter Model 2.0**	**Travel Improvement Model/UPlan**
Estimates Induced Travel	■			■
Spreadsheet-Based	■		■	
Transparent			■	
Corridor-Level Analysis	■			
In-House	■	■	■	■
No Cost	■		■	
Wide Range of Strategies	■			
Calibrated to the Region			■	■
Multiple-Strategy Analysis	■	■	■	
DVRPC Has Expertise				■
Cons	**Cal-B/C**	**IDAS**	**Commuter Model 2.0**	**Travel Improvement Model/UPlan**
Data-Intensive				■
Set-up Time-Intensive		■		■
Blackbox Effect		■		■
Air Quality/Emissions-Based			■	
Site Specific—Needs Precise Numbers	■		■	
Project-Level Analysis	■			
Difficult to Run				■
Needs Data Input from Travel Improvement Model		■		

Source: Delaware Valley Regional Planning Commission (Philadelphia: DVRPC, 2011).

As described in the Selection Process section above, after working with CS staff it was determined that IDAS was not feasible for use with the DVRPC TIM as it existed at the time. FHWA staff also recommended looking into HERS–ST. While HERS–ST is valuable for helping to evaluate and rank categories of projects for a long-range plan, it is too limited in the strategies it can analyze to be useful for CMP strategy evaluation purposes.

Commuter Model 2.0 is still one of the few software packages able to model multiple strategies at one time. **DVRPC staff will test Commuter Model 2.0 in a corridor where modeling work is also being done in the new VISUM model, to see how the results compare. This testing will take place in FY 2012.**

Cal-B/C appears to have the ability to evaluate many of the strategy categories that Commuter Model 2.0 cannot. In addition, it offers the ability to perform B/C analysis using relatively few inputs. **DVRPC staff has completed testing of Cal-B/C in a corridor where modeling work was recently completed in VISUM, to see how the results compare. The test results are detailed in Chapter 3.**

One other potentially interesting resource is the CCAP TEG. The CCAP TEG is a spreadsheet-based sketch model planning program that uses rule-of-thumb estimates to determine changes to VMT based on a number of strategies, including many that are not included in either Cal-B/C or Commuter Model 2.0. These estimates can be adjusted to reflect local conditions, if adequate data is available. **DVRPC has completed initial tests of the CCAP TEG's ability to fill in the gaps of Cal-B/C and Commuter Model 2.0. The test results are detailed in Chapter 3.**

Evaluating CMP Strategies

Table 4 illustrates the most frequently used strategies in the 2011 CMP, in order from most to least used. Although Cal-B/C and Commuter Model 2.0 are not able to model all of the most used strategies, together they should be able to cover at least 14 out of the 26 most used strategies. It is possible that as many as 18 of the 26 most used strategies could be analyzed.

Table 4: Ability of Selected Programs to Analyze Most Used Congestion Management Process Strategies

Most Used CMP Strategies (by Rank)	Strategy Category	Cal-B/C	Commuter Model 2.0
Modifications to Existing Transit Routes or Services	Transit Improvements	Yes	Yes
Signal Improvements	Operations	Yes	Yes
Transit Infrastructure Improvements	Transit Improvements	No	Yes
Improve Circulation	Operations	No	No
Turning Movement Enhancements	Operations	No	No
Engineering for Smart Growth	TDM/Policy/Smart Transportation	No	No
New Passenger Rail Improvements	Transit Improvements	Yes	Yes
Park-and-Ride Lots	TDM/Policy/Smart Transportation	No	Maybe
TOD	TDM/Policy/Smart Transportation	No	No
New Bus Services	Transit Improvements	Yes	Yes
Transportation Services for Specific Populations	Transit Improvements	No	Yes

Table 4: Ability of Selected Programs to Analyze Most Used Congestion Management Process Strategies (con't)

Most Used CMP Strategies (by Rank)	Strategy Category	Cal-B/C	Commuter Model 2.0
Walking and Bicycling Improvements	TDM/Policy/Smart Transportation	No	Yes
BRT or Exclusive Right-of-Way Bus Lanes	Transit Improvements	Yes	Yes
Transit First Policy	TDM/Policy/Smart Transportation	No	Maybe
Maintenance Management	Operations	Yes	No
Environmentally Friendly Transportation Policies	TDM/Policy/Smart Transportation	No	No
Minor Road Expansions	Road Improvements	Maybe	No
ITS Improvements for Transit	Transit Improvements	Yes	Maybe
Land Use Transportation Policies	TDM/Policy/Smart Transportation	No	No
Local Delivery Service	TDM/Policy/Smart Transportation	No	No
Adding Capacity to Existing Roads	Road Improvements	Yes	No
Comprehensive Policy Approaches	TDM/Policy/Smart Transportation	No	Maybe
Multilingual Communication	TDM/Policy/Smart Transportation	No	No
Incident Management	Operations	Yes	No
Planning and Design for Nonmotorized Transportation	TDM/Policy/Smart Transportation	No	Yes
Shuttle Service to Stations	Transit Improvements	No	Yes

Source: Delaware Valley Regional Planning Commission (Philadelphia: DVRPC, 2011 CMP).
Note: BRT = Bus Rapid Transit. CMP = Congestion Management Process. ITS = Intelligent Transportation Systems. TDM = Transportation Demand Management. TOD = Transit-Oriented Development.

In addition to some of the most used strategies, it is also desirable to be able to model the 13 strategies listed as "Appropriate Everywhere" in the CMP. Table 5 illustrates the ability of Cal-B/C and Commuter Model 2.0 to analyze these strategies. The two programs are able to model five of the Strategies Appropriate Everywhere, and may be able to analyze as many as nine.

Table 5: Ability to Analyze Congestion Management Process Strategies Appropriate Everywhere

CMP Strategies Appropriate Everywhere	Strategy Category	Cal-B/C	Commuter Model 2.0
Safety Improvements and Programs	Operations	Maybe	No
Signage	Operations	No	No
Improvements for Walking and Bicycling as appropriate	Smart Transportation	No	Yes
Basic Upgrading of Traffic Signals	Operations	Yes	No
Signal Preemption for Emergency Vehicles	Operations	Maybe	No
Intersection Improvements of a Limited Scale	Operations	Yes	No
Bottleneck Improvements of a Limited Scale, Vehicle or Rail	Operations/New Transit	Yes	Yes (Rail only)
Environmental Justice Outreach for Decision-Making	Policy	No	No

Table 5: Ability to Analyze Congestion Management Process Strategies Appropriate Everywhere (con't)

CMP Strategies Appropriate Everywhere	Strategy Category	Cal-B/C	Commuter Model 2.0
Access Management (both engineering and policy strategies)	Operations/Policy	No	No
Marketing/Outreach for Transit and TDM Services where applicable*	TDM	No	Yes
Revisions to Existing Land Use/Transportation Regulations	Policy	No	Maybe
Growth Management and Smart Growth	Policy	No	Maybe
Context-Sensitive Design	Smart Transportation	No	No

Source: Delaware Valley Regional Planning Commission (Philadelphia: DVRPC, 2011 CMP).
Notes: CMP = Congestion Management Process. TDM = Transportation Demand Management.
*Includes carpool, vanpool, and ride-matching programs; alternative work hours; telecommuting; emergency ride home; TransitChek; and car-sharing programs.

Initial Software Testing

Testing Cal-B/C in the West Chester Pike Corridor

A basic focus of the DVRPC effort to use software to evaluate the anticipated effects of strategies and sets of strategies is to figure out what can reasonably be done with the data and software packages available. Although the review of software programs found that there is no one sketch-level program able to analyze all of the strategy categories used in the CMP, the decision was made to push forward with testing the programs that seemed to hold some promise for at least evaluating certain commonly used strategies.

The West Chester Pike (PA 3) corridor was selected for a first test, in part because the corridor is also the subject of more detailed modeling work by the DVRPC Office of Modeling and Analysis, using the VISUM software. The initial Cal-B/C sketch model results were compared to the more sophisticated VISUM modeling results, which were published in the report, *Boosting the Bus: Better Transit Integration Along West Chester Pike* (Publication #10033).

The portion of West Chester Pike being studied is contained within CMP corridors PA 10B (PA 3 from Cobbs Creek to US 1) and 10C (PA 3 from I-476 to US 202). CMP strategies for the subcorridors studied in the West Chester Pike report are listed in Table 6.

Table 6: Congestion Management Process Strategies for the West Chester Pike (PA 3) Corridor

CMP Corridor	Very Appropriate Strategies	Secondary Strategies
PA 10B PA 3 from Cobbs Creek to US 1	■ Closed Loop Computerized Traffic Signals ■ **TSP** ■ Improve Circulation ■ County and Local Road Connectivity ■ TOD ■ Transportation Services for Specific Populations	■ Safety Improvements and Programs ■ Transit Station Security ■ Traffic Calming ■ Planning and Design for Nonmotorized Transportation ■ ITS Improvements for Transit ■ Transit Infrastructure Improvements ■ Passenger Intermodal Center or Garage for Transit Riders ■ Local Delivery Service ■ Parking Supply-and-Demand Management ■ Engineering for Smart Growth ■ Park-and-Ride Lots ■ Transit First Policy ■ Modifications to Existing Transit Routes or Services ■ Major Reconstruction with Minor Capacity Additions ■ New Bus Services ■ BRT or Exclusive Right-of-Way Bus Lanes

Table 6: Congestion Management Process Strategies for the West Chester Pike (PA 3) Corridor (con't)

CMP Corridor	Very Appropriate Strategies	Secondary Strategies
PA 10C PA 3 (PA 476 to US 202)	■ Closed Loop Computerized Traffic Signals ■ **TSP** ■ Enhanced Transit Amenities and Safety ■ Turning Movement Enhancements ■ Improve Circulation ■ County and Local Road Connectivity	■ Planning and Design for Nonmotorized Transportation ■ ITS Improvements for Transit ■ Expanded Parking/Improved Access to Stations (all modes) ■ Local Delivery Service ■ Comprehensive Policy Approaches ■ Parking Supply-and-Demand Managment ■ Land Use-Transportation Policies ■ Engineering for Smart Growth ■ Environmentally Friendly Transportation Policies ■ Park-and-Ride Lots ■ Modifications to Existing Transit Routes or Services ■ More Frequent Transit or More Hours of Service ■ Frontage or Service Roads ■ Transportation Services for Specific Populations ■ BRT or Exclusive Right-of-Way Bus Lanes ■ New Passenger Rail Investments

Source: Delaware Valley Regional Planning Commission (Philadelphia: DVRPC, 2011 CMP).
Note: BRT = Bus Rapid Transit. CMP = Congestion Management Process. ITS = Intelligent Transportation Systems. TDM = Transportation Demand Management. TOD = Transit-Oriented Development. TSP = Transit Signal Priority.

It is clear from Table 6 that the number of strategies to potentially evaluate is quite extensive for the selected subcorridors. This is true for many CMP subcorridors. The Very Appropriate strategies are intended to be the starting point for developing improvement concepts and represent a shorter set of strategy recommendations. TSP is listed as a Very Appropriate Strategy in the CMP for subcorridors 10B and 10C, based in part on previous studies that led to the current modeling effort.

Improving the quality and effectiveness of bus service in the West Chester Pike corridor has been the subject of several recent planning efforts. These include a 2007 DVRPC study that analyzed constructing a dedicated median busway along the portion of the corridor between 69th Street Terminal and I-476, as detailed in the report *Feasibility Analysis of West Chester Pike Busway* (Publication #07001). In addition, a study by the Transportation Management Association of Chester County from the same year considered the feasibility of TSP in the Chester County portion of the corridor. Drawing on the generally favorable findings of the latter study, DVRPC's 2008 *Speeding Up SEPTA* report (Publication #08066) included a case study on SEPTA Route 104 (the bus route with the highest ridership along the West Chester Pike corridor) in a chapter addressing strategies to improve the effectiveness of suburban bus service.

In addition to recommending TSP in the West Chester Pike corridor, previous DVRPC studies listed Growth Management and Smart Growth as especially important for the corridor, as noted in the *2011 CMP Report* (Publication #11042, anticipated publication Fall 2011).

Method

The West Chester Pike corridor was evaluated for TSP treatment, which would speed the service of the SEPTA bus routes operating on PA 3 (primarily the Route 104 bus line). Information about conditions in the corridor (traffic volumes, crash rates, transit ridership, etc.) was entered into Cal-B/C as required to test the TSP strategy. Data was gathered from a variety of readily available sources, including the CMP, the DVRPC traffic count database, GIS files, SEPTA reports, and other sources. See Appendix C for more detail on the data inputs used for this test. In coordination with staff from the DVRPC Office of Transit, Bicycle, and Pedestrian Planning and the Office of Project Implementation, data related to project costs and transit ridership was collected for the test scenarios.

In addition to testing the TSP strategy, a sample project was also entered that imagined widening a five-mile stretch of PA 3. It should be noted that adding lanes (General Purpose Lanes) is *not* a strategy recommended by the CMP for the West Chester Pike corridor. However, it was thought that testing the general purpose lanes strategy would be useful. Finally, a BRT scenario was tested, assuming a separate right-of-way for the BRT system. BRT is listed as a Secondary Strategy in the CMP for the West Chester Pike corridors.

Findings

For Cal-B/C's evaluation of TSP, the B/C equation was driven by estimated savings of about five minutes in transit travel time, which would be gained by deploying TSP. This value was automatically calculated by Cal-B/C based on assumptions built into the software. The test scenario included the high end of estimated costs for various scenarios under evaluation, and consisted of building 10 new bus shelters with "next bus" digital displays, enhancing crosswalks at select locations, relocating 46 nearside stops to the far side of their intersections, and providing TSP equipment for buses and traffic signals along the 20-mile corridor. Cal-B/C estimated life-cycle costs for the project of $1.7 million, with benefits of $11 million over 20 years. This resulted in a B/C ratio of 6.6, with a calculated payback period of two years for the project. The benefits were derived entirely from travel time savings, estimated as approximately 1.6 million person hours of time saved over 20 years.

By contrast, a sample project was entered that imagined widening a five-mile stretch of PA 3. This project showed a negative B/C ratio result of –2.4. While the extra capacity provided some travel time savings, it also added significant vehicle operation costs, accident costs, and emission costs over the 20-year time horizon. It should be noted that adding lanes (General Purpose Lanes) is *not* a strategy recommended by the CMP for the West Chester Pike corridor.

Finally, a BRT scenario was tested, assuming a separate right-of-way for the BRT system. BRT is a Secondary Strategy for the West Chester Pike corridors in the CMP. The BRT scenario was analyzed in *Feasibility Analysis of West Chester Pike Busway (*DVRPC Publication #07001). This report determined that a BRT system might be prohibitively expensive, which was confirmed by the Cal-B/C sketch modeling analysis. Cal-B/C showed a B/C ratio of zero for the project. Although there were significant travel time savings of nearly 4,750,000 person hours over 20 years, high capital costs negated these savings. In fact, it is possible that the actual project could be even more expensive than the estimate, which was based on the high end of numbers provided by the Federal Transit Administration document, *Characteristics of Bus Rapid Transit for Decision-Making*.

After the VISUM modeling work was completed, the Cal-B/C analysis was revisited. VISUM was able to estimate more precise travel time savings, based on information about the West Chester Pike corridor that was much more detailed than what Cal-B/C required. For example, the VISUM model included information about intersection geometry and signal timing. The VISUM analysis evaluated three enhancement scenarios for the Route 104 Bus Line:

- a corridor-length implementation of TSP;
- TSP plus a relocation of many nearside stops to the far side of their intersections; and
- TSP plus a new limited-stop operating pattern (the West Chester RapidBus).

The VISUM analysis calculated travel time savings for the first two scenarios that were closer to two minutes, rather than the five minutes that Cal-B/C assumed. VISUM estimated that the RapidBus scenario would result in travel time savings of four minutes.

Cost estimates for these three scenarios were entered into Cal-B/C. The default travel time savings numbers provided by the Cal-B/C software were replaced with the numbers estimated by VISUM. The Cal-B/C result for the RapidBus scenario with the revised travel time number was a B/C ratio of 5.3, which represents a 15-percent change from the result obtained using Cal-B/C's assumptions. The calculated payback period for the project was still two years. The other two scenarios showed B/C ratios of 14 (TSP only) and 6.6 (TSP plus relocation of nearside stops) when entered into Cal-B/C with the lower travel time savings estimate of two minutes. These results seem to indicate a bias toward less expensive projects. Nevertheless, the initial Cal-B/C results were similar to those obtained after manipulating the default travel time savings value.

Attempting Multiple-Strategy Analysis

As mentioned on page 13, the CCAP TEG gives rule-of-thumb estimates for VMT reductions on certain strategies. After running the Cal-B/C analysis, an attempt was made to find out if the CCAP TEG could be used to make estimates about the effects of multiple strategies.

To test this tool, the current and future volumes used in the test case scenario were analyzed. V/C is a criteria used in the CMP and one of the shared measures selected for this analysis. (See page 5.) A generalized V/C ratio was calculated for the stretch of PA 3 considered in this analysis.[4] The V/C ratio was calculated as .84 in the current year, and 1.05 in the future year, without additional strategies beyond TSP. The V/C threshold used in the CMP for a generalized Level of Service E across functional classes is .85.

Two strategies were then tested for their effects on V/C ratio: Pedestrian Oriented Design and Smart Growth. The CCAP TEG lists a potential VMT reduction range for Pedestrian Oriented Design of 1 percent to 10 percent. For Smart Growth, the VMT reduction range is 3 percent to 20 percent. Within the Smart Growth strategy, Limited, Comprehensive, and Aggressive Smart Growth are valued at 5, 10, and 15 percent reductions in VMT, respectively.

Using the outputs from Cal-B/C, reductions in VMT for the test strategies were calculated, then translated to V/C ratios. The results are displayed in Table 7.

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[4] Note that the CMP calculates V/C at the link level, and that the calculation used in this report is a more generalized approximation of the average V/C in the corridor.

Table 7: Potential Change in Volume-to-Capacity from Select Strategies

Strategy	Percent Change	Starting V/C	Future V/C (without Strategy)	Future V/C (with Strategy)
Improvements for Pedestrians	1–10% VMT Reduction	.84	1.05	1.04–.81 (1–10%)
Limited Smart Growth	5% VMT Reduction	.84	1.05	.86
Comprehensive Smart Growth	10% VMT Reduction	.84	1.05	.81
Aggressive Smart Growth	15% VMT Reduction	.84	1.05	.77

Source: Delaware Valley Regional Planning Commission (Philadelphia: DVRPC, 2011).
Note: V/C = Volume-to-Capacity. VMT = Vehicle Miles Traveled.

While these results do not achieve the level of strategy evaluation sought by DVRPC staff, they at least provide some insight into how a combination of strategies might relieve some of the congestion experienced on the West Chester Pike. It is likely that Improvements for Pedestrians and Smart Growth strategies would have synergistic effects complementing transit improvement strategies. **However, the CCAP TEG is not able to determine synergistic or duplicative effects of multiple strategies deployed together.**

C H A P T E R 4

Next Steps

More work will be required to determine whether Cal-B/C is a useful sketch modeling tool for the CMP. However, this preliminary test indicates that the tool does provide some useful results, in addition to being relatively simple to set up and run. Further testing will explore other methods for modeling multiple strategies.

The following strategy evaluation options, some of which have been tested in this report, will be further explored by CMP staff in the near term:

- Utilize Commuter Model 2.0 to analyze the strategies it can consider, including TDM, nonmotorized transportation, and public transportation improvements.
- Utilize Cal-B/C for the strategies it can consider. Attempt to combine with outputs from Commuter Model 2.0 to create multiple-strategy analysis.
- Utilize the CCAP TEG for the strategies it can consider. Attempt to combine with outputs from Cal-B/C and Commuter Model 2.0 to create multiple-strategy analysis.

A basic focus of this effort is on figuring out what can reasonably be done with the data and software packages available. So far, the data required for Cal-B/C seems to be relatively easy to acquire and enter, allowing for rapid turnaround of sketch-level analysis. Initial evaluations of Commuter Model 2.0 indicate that it will be more difficult to set up and run, as the data requirements are more difficult to satisfy. Future efforts will further explore the use of the Commuter Model 2.0 and CCAP TEG software packages, as indicated above.

In the long term, the following options remain considerations:

- Continue to monitor the feasibility of using UPlan and VISUM for CMP strategy analysis.
- Continue to explore the feasibility of IDAS, including finding out if updates are planned.
- Reevaluate SPASM.
- Continue to track new sketch-level programs for strategy analysis to determine if a useful program comes on the market.
- Continue to coordinate with FHWA on this issue shared among MPOs.

In FY 2012, DVRPC will continue to test software programs to analyze the anticipated effects of CMP strategies. Testing efforts will be coordinated with the DVRPC Office of Modeling and Analysis, in order to compare the outputs of the sketch modeling and traffic modeling efforts.

APPENDIX A

Software Programs Reviewed

The Delaware Valley Regional Planning Commission (DVRPC) located and reviewed 34 transportation software programs that are potentially capable of the type of analysis needed for the CMP. These included:

- BCA.net;
- Cal-B/C;
- CCAP TEG;
- Central 4;
- Community Viz;
- Commuter Model 2.0;
- DVRPC TIM;
- Dynasmart–P;
- DynusT;
- GIFT;
- HEAT;
- HERS–ST;
- IDAS;
- IMPACTS;
- INDEX
- MicroBENCOST;
- NJAQONE and PAQONE;
- Place^{3}s;
- SCRITS;
- SMITE;
- SPASM;
- STEAM;
- Synchro and SimTraffic;
- TELUM;
- TransCAD;
- TransDec;
- TRANSIMS;
- TRANUS;
- TRIMMS;
- UPlan; and
- VISUM and VISSIM.

A brief summary of each of these programs follows.

BCA.Net

Developed by the Federal Highway Administration (FHWA), BCA.Net is a web-based benefit-cost (B/C) analysis tool to support the highway project decision-making process. BCA.Net enables users to develop cases corresponding to alternative strategies for improving and managing highway facilities. It can also evaluate and compare the benefits and costs of the alternative strategies and provide a summary of certain metrics including cost, emissions, and travel time. BCA.Net is free and may be accessed over the internet with any internet browser.

BCA.Net uses inputs including capital costs, physical and performance characteristics, and forecasted travel demand for the project in question. The user specifies strategies for improvements and maintenance, and builds a Base Case and an Alternate Case for evaluation. BCA.Net calculates the traffic impacts and the present values of agency and user costs and benefits for each case, and compares them to arrive at measures including the net present value, B/C ratio, and internal rate of return for the Alternate Case relative to the Base Case.

The program is limited for Congestion Management Process (CMP) purposes, because the only strategies it can analyze are projects that would add single-occupant vehicle capacity, such as by constructing general purpose lanes or reconstructing intersections, or maintenance work such as repaving, which is not listed as a CMP strategy.

More information on BCA.Net can be found at:
www.fhwa.dot.gov/infrastructure/asstmgmt/bcanet.cfm

Cal-B/C

Cal-B/C is a free, downloadable spreadsheet-based sketch modeling tool that can prepare analyses of highway, transit, operations, and transportation systems management strategies. Users input data defining the type, scope, and cost of projects. The model calculates life-cycle costs, net present values, B/C ratios, internal rates of return, payback periods, annual benefits, and life-cycle benefits.

The Cal-B/C model has been expanded since its origin to focus on projects including transportation systems management (TSM) and operational improvements in addition to capacity expansion projects. The latest revision includes companion tools that support link and network analysis. Cal-B/C is capable of modeling the following strategies in the four categories below:

- Highway Capacity Expansion
    - General Highway;
    - High-Occupancy Vehicle (HOV) Lane;
    - Passing Lane;
    - Interchange;
    - Bypass; and

- Pavement.

- Transit Capacity Expansion
  - Passenger Rail;
  - Light Rail; and
  - Bus.
- Operational Improvements
  - Auxiliary Lane;
  - Freeway Connector;
  - HOV Connector;
  - HOV Drop Ramp;
  - Off-Ramp Widening; and
  - On-Ramp Widening.
- TSM
  - Ramp Metering;
  - Ramp Metering Signal Coordination;
  - Incident Management;
  - Traveler Information;
  - Arterial Signal Management;
  - Transit Vehicle Location;
  - Transit Vehicle Signal Priority; and
  - Bus Rapid Transit (BRT).

Cal-B/C is a free, downloadable spreadsheet tool, developed in Microsoft Excel. The model measures four categories of benefits that result from highway or transit projects, in constant dollars. These include:

- travel time savings (reduced travel time and new trips);
- vehicle operating cost savings (fuel and nonfuel operating cost reductions);
- accident cost savings (safety benefits); and
- emission reductions (air quality and greenhouse gas benefits).

Each of these benefits is estimated for a peak (or congested) period and a nonpeak (or uncongested period). Model inputs include information about the highway speed, volume, number of trips, and crash rates. Users can choose to override the calculated values with project-specific information, if such information is available. Users can also override default parameters in other worksheets to produce tailored results if detailed information is available for specific projects.

More information on Cal-B/C can be found at: www.dot.ca.gov/hq/tpp/offices/ote/benefit.html

Center for Clean Air Policy (CCAP) *Transportation Emissions Guidebook* (TEG)

The CCAP TEG is a spreadsheet-based sketch model planning program. This program uses rule-of-thumb estimates to determine changes to vehicle miles traveled (VMT) based on the following strategies:

- Transit Oriented Development;
- Infill/Brownfield Development;
- Pedestrian-Oriented Design;
- Smart School Siting;
- Permitting/Zoning Reform;
- Improved Transit Service;
- Light-Rail Transit Corridor;
- BRT Corridor;
- Bicycle Initiatives;
- Targeted Infrastructure Spending;
- Road Pricing;
- Commuter Incentives (with parking pricing);
- Pay-As-You-Drive Insurance (5-percent penetration rate);
- Green Mortgages;
- Limited Smart Growth;
- Comprehensive Smart Growth;
- Public Participation;
- Open Space Preservation;
- Municipal Parking Programs (with parking pricing); and
- Safe Routes to School.

The CCAP TEG is intended for corridor-, area-, or site-level analysis. It is not intended to analyze an entire region at once, and it cannot consider the impacts of multiple strategies implemented simultaneously. The TEG requires the user to estimate mode choice change for all trips within a corridor or region (it does give an option to use default values). Changes to VMT are based on average vehicle trip (VT) length, which is based on default values, but could be updated using regional figures.

More information on the CCAP TEG can be found at:
www.ccap.org/safe/guidebook/guide_complete.html

Central 4

Central 4 was created by a consortium of engineering firms including Raytheon, JHK, Eng-Wong Taub, Ian Jerome Associates, and Garmen Associates for use in Congestion Management

System analysis by the New Jersey Department of Transportation (NJDOT). It is a post-processor which uses highway traffic volumes and roadway network characteristics taken from the output of a traffic model to further measure performance and operations in the State of New Jersey.

NJDOT has used this software suite to analyze capital investment strategies; statewide performance measures; corridor congestion management studies; signalized intersection operations; and safety, pedestrian, and other planning studies. The software considers a full range of transportation modes including vehicular (both diesel and gas for personal, light-duty trucks, and heavy-duty trucks, as well as motorcycles), transit (bus and rail), and pedestrian. Central 4 is able to evaluate different geographic areas ranging from statewide to municipal, corridor, and facility levels.

DVRPC has a license for Central 4 but has not been able to run it successfully. This program does not specifically analyze congestion mitigation strategies, such as those found in the CMP. Since expertise is at NJDOT, and the program covers less than half of the Delaware Valley region, this program is not considered to be well suited for CMP analysis.

Community Viz

Community Viz is a geographic information system (GIS) extension for land use planning. The program can analyze land use scenarios, project future build-out conditions given current zoning, etc. However, it does not contain any transportation components, which are desired for CMP analysis.

More information on Community Viz can be found at: www.placeways.com/communityviz

Commuter Model 2.0

Commuter Model 2.0 was developed by the United States Environmental Protection Agency (US EPA) and is a spreadsheet-based travel demand management program. Commuter Model 2.0 does not establish baseline travel or emission rates; instead, it quantifies changes as a result of travel demand management programs. Commuter Model 2.0 can quantify the travel demand and emissions impact of the following travel demand management strategies:

- transit fare decreases or other incentives that reduce the cost of using transit;
- transit service improvements (faster or more frequent service);
- ridesharing programs, in which employers support carpooling and/or vanpooling through on-site programs, financial incentives, or preferential parking;
- other actions, such as increased parking charges or cash-out programs, that change the time and/or cost of traveling by any particular mode;
- nonmotorized (e.g., bicycle and pedestrian) commuting programs;
- alternative work schedules, including flex-time, compressed work weeks, and staggered work hours; and
- telecommuting.

Commuter Model 2.0 uses a pivot point (logit choice) approach to allow for analysis of multiple strategies at once. Mode choice models have been developed for many cities and regions nationwide, including DVRPC, meaning coefficients have already been developed to reflect local characteristics. This component will calculate the impact of the mode share changes from these programs and translate the mode share changes into changes in trips and VMT. It is most appropriately applied at a worksite, employment center, or subarea for sketch planning purposes. Commuter Model 2.0 will not perform as well for larger programs, particularly those large enough to impact travel speeds throughout an area.

More information on Commuter Model 2.0 can be found at:
www.epa.gov/otaq/stateresources/policy/transp/commuter/420b05017.pdf

DVRPC Travel Improvement Model (TIM)

DVRPC uses a conventional four-step travel demand model to simulate travel behavior in the Delaware Valley. The current version of the TIM uses the VISUM software package, and is a translation of an earlier TRANPLAN model. This model is referred to as TIM 1.0. Both highway and transit are represented in an integrated transportation network. Nonmotorized travel is also modeled but on a less detailed basis. The region is broken up into Traffic Analysis Zones (TAZs) for modeling purposes.

Among the outputs of the DVRPC TIM are VMT; peak, midday, and evening speeds by TAZ; person trips; VT; in-vehicle time; out-of-vehicle time; and total travel time. A full transportation study can take upwards of 12 months to set up, run, and analyze the output. However, more modest analysis needs can take less time, depending on the scope of the modeling effort.

Regional, or macroscopic, travel models are ideal for analyzing the effects of large-scale capacity projects. These types of models have also been adapted to simulate the effects of other transportation system improvements. However, a weakness of regional traffic models is that they do not generally integrate roadway operations or intelligent transportation systems (ITS) improvements. It can be difficult to assess how to represent some of the less traditional improvements. Each strategy would have to be coded in to assess its effects; this may not be ideal for the CMP, which is essentially regional sketch-level planning.

DVRPC staff are currently developing an improved four-step model, TIM 2.0. TIM 2.0, while still a macro-level model, will add increased detail and accuracy in modeling highway, transit, pedestrian, and bicycle improvements. Beginning in the fall of 2011, DVRPC will begin developing TIM 3.0, which will use an activity-based approach to simulating travel behavior.

Dynamic Network Assignment-Simulation Model for Advanced Roadway Telematics (Planning Version) (Dynasmart–P)

Dynasmart–P is a transportation simulation model. It was developed by the University of Maryland with FHWA support and is currently being used by the Hampton Roads Planning District Commission in Virginia Beach, VA. Its primary use is for traffic operations and the deployment of ITS strategies. Dynasmart–P takes output data from the four-step model and can estimate output variables such as volume, speed, travel time, and delay. Traffic is simulated over a network that can include HOV and high-occupancy/toll (HOT) lanes, ramp metering, transit service, signalized intersections, and incidents. It can be used on networks with up to 35,000 nodes and 100,000 links. Specific operations strategies that Dynasmart–P can estimate include:

- assessing impacts of ITS and non-ITS technologies on the transportation network, such as dynamic message signs, under different information supply strategies and behavioral response scenarios, dynamic route guidance, incident management, etc.;
- workzone planning and traffic management;
- HOV lanes and HOT lanes;
- congestion pricing schemes;
- special events and emergency situations; and
- traffic assignment analyses in traditional planning functions, as well as in conjunction with activity-based and tour-based approaches.

The cost of Dynasmart–P is $1,750. A limited support version is available for $1,000. More information on Dynasmart–P can be found at: mctrans.ce.ufl.edu/featured/dynasmart/

Dynamic Urban Systems for Transportation (DynusT)

DynusT is a dynamic traffic assignment and simulation model developed by McTrans at the University of Arizona. It has both planning and operations capabilities, and can analyze the following types of scenarios:

- value pricing;
- emergency evacuation planning;
- traveler information;
- build-out scenarios;
- workzone areas;
- incident management;
- ramp metering; and
- variable dynamic message signs.

More information about DynusT can be found at: dynust.net/wikibin/doku.php

Geographic Intermodal Freight Transportation (GIFT) Model

GIFT is currently being developed by the University of Delaware (UDEL) as a GIS-based integrated freight transportation analysis model. It combines water, road, and rail into a single network and can analyze operations impacts, such as travel time, energy use, air quality, and transportation cost. This can be used to determine best routes, the impact of additional freight to the transportation system, and the impacts from changes to the freight infrastructure network. This tool, which is nearly complete, is being developed specifically for the I-95 corridor and may eventually be web-based in order to facilitate decision making.

More information on GIFT can be found at: www.ce.udel.edu/UTC/corbett.html

Highway Economic Analysis Tool (HEAT)

HEAT was developed by Cambridge Systematics (CS) to analyze the economic impacts of additional highway capacity. It is a GIS-based tool which can quantify the impacts to traffic volume, speed, and safety on highways as a result of adding lanes or passing lanes, widening shoulders, or building new roads. HEAT also measures economic impacts for freight through reduced cost of business, business retention and attraction, and tourist expenditures. It estimates the economic effect of improvements to the gross state product, number of jobs, and residents' income levels, as well estimating the overall B/C ratios for the improvements.

More information on HEAT can be found at: www.camsys.com/pro_planpro_heat.htm

Highway Economic Requirements System–State Version (HERS–ST)

HERS–ST is an engineering/economic analysis tool developed by CS. It uses engineering concepts to pinpoint roadway inadequacies and then applies economic principles to determine the best set of strategies for improving the network.

HERS–ST takes inputs for each highway section based on data in the Highway Performance Monitoring System (HPMS). Roadway capacity is estimated from the inputs using equations found in the HPMS. Future needs for each roadway segment are estimated by multiplying current annual average daily traffic (AADT) by an expansion factor. The expansion factor is based on functional class, with default national values provided, or the user can input a value derived from regional conditions. Using traffic volume to roadway capacity and other inputs, HERS–ST performs a series of equations to estimate future:

- pavement condition;
- volume-to-capacity (V/C) ratio;
- roadway speed;
- travel time and delay;
- user costs; and
- average annual maintenance costs.

HERS–ST can also develop a set of improvement recommendations for each road segment. The set of possible improvements includes:

- resurfacing;
- reconstruction;
- widening;
- additional lanes;
- shoulders; and
- realignment.

For each potential improvement, HERS–ST develops a B/C ratio for comparison of the economic impacts. Through use of elasticity, it is able to consider increased traffic from induced demand. HERS–ST can do scenario planning such as estimating service levels for given investment levels, evaluating the impacts of alternative sets of strategies, determining the best use for constrained funds, and determining what total expenses would be for optimal results. HERS–ST analyzes improvements to the existing road network only; it cannot quantify impacts for new roads or other modes of transportation.

The UDEL Department of Civil and Environmental Engineering included the DVRPC region as one of three case studies in an asset management research project. This project included using HERS–ST and resulted in a presentation and doctoral dissertation in 2008.

The UDEL study found that by using HERS–ST to investigate B/C ratios of each possible improvement type in a long-range plan, better system conditions over each funding period could be achieved with the same total available funds. In addition, using HERS–ST to perform B/C analysis could result in higher overall return on investment and user benefits, as well as a significant reduction of system maintenance costs. The study suggested that HERS–ST could be a useful tool for metropolitan planning organizations (MPOs) like DVRPC when formulating the project list for a long-range plan. However, the study cautions that the modeling results from HERS–ST need to be used selectively, manual adjustments are often required, and decisions still need to be made with consideration of the regions' specific political situations, which do not lend themselves to modeling. While HERS–ST may be a useful tool for helping to decide the project list for the Long-Range Plan, the limited range of strategies it can analyze makes it unsuitable for the CMP.

More information on HERS–ST can be found at:
www.fhwa.dot.gov/infrastructure/asstmgmt/hersfact.cfm

IMPACTS

IMPACTS is a series of seven Excel worksheets that can analyze transportation alternatives, including highway expansion, bus system expansion, light-rail transit investment, HOV lanes, conversion of an existing facility to a toll facility, employer-based travel demand management, and bicycle lanes. It was developed by FHWA for use with the workshop exercises for National Highway Institute course number 15257 "Estimating The Impacts of Urban Transportation Alternatives".

The spreadsheets enable estimation of the key impacts of the alternatives. The impacts estimated include:

- costs of implementation, including capital, operation, and maintenance costs;
- benefits (or disbenefits) accruing to previous "base case" users, including trip time and out-of-pocket costs such as fares, parking fees, and tolls;
- benefits (or disbenefits) accruing to induced (or discouraged) trips;
- savings to highway users due to reduced congestion;
- changes in other highway user costs such as accident costs and costs for parking;

- revenue transfers due to tolls, fares, or parking fees;
- changes in fuel consumption; and
- changes in emissions.

Multiple mode improvements can be accommodated but require a separate analysis for each. The program is available as a free download. IMPACTS was strongly considered for CMP strategy analysis, but the data requirements exceeded those of Cal-B/C and the other programs selected for the initial testing effort described in this report.

More information on IMPACTS can be found at: www.fhwa.dot.gov/steam/impacts.htm

ITS Deployment and Analysis System (IDAS)

IDAS is a hybrid sketch and travel demand modeling program, originally developed by CS. It is capable of analyzing alternative ITS operations deployment scenarios and testing tradeoffs of traditional highway and transit infrastructure options, using the outputs of a four-step model.

IDAS can analyze 60 different ITS strategies, organized by the following categories:

- regional multimodal traveler information;
- freeway management;
- arterial management;
- commercial vehicle operations (CVO);
- advanced public transportation systems;
- electronic toll collection;
- electronic fare payment;
- advanced vehicle control and safety systems;
- incident management;
- emergency management;
- railroad grade crossings; and
- support for generic deployments.

IDAS has the ability to analyze multiple scenarios at once, and to determine improvements to travel time reliability as a result of ITS operations. IDAS can be applied at a regionwide scale. DVRPC already has a license and some training in using this model. A drawback, identified by a partner MPO, is that IDAS is not able to adjust traffic volumes and speed due to nonrecurring congestion.

DVRPC worked with FHWA to develop a scope of work after FHWA offered technical support with IDAS through their standing contract with CS. Although CS staff tried hard to make IDAS work with the DVRPC TIM as it existed at the time, the effort was ultimately unsuccessful. IDAS may be an option with the new DVRPC TIM 2.0, although there was concern in the past that elements of IDAS were becoming outdated. The feasibility of using IDAS will be investigated further in the future.

More information on IDAS can be found at: idas.camsys.com/

MicroBENCOST

MicroBENCOST is capable of analyzing seven categories of projects: added-capacity, bypass, intersection/interchange, pavement rehabilitation, bridge, safety, and highway-railroad grade crossing. In addition to these major categories, MicroBENCOST can be used to analyze workzones and incidents in conjunction with any of the project types.

In general, the program compares the motorist costs in the existing situation (the “without improvement” alternative) to the motorist costs if the improvement is completed (the “with improvement” alternative). In all cases, the “without improvement” alternative includes an existing route and an optional alternate route.

MicroBENCOST is a DOS-based program, and is sold at a cost of $50.

More information on MicroBENCOST can be found at:
mctrans.ce.ufl.edu/store/description.asp?itemID=166

New Jersey Air Quality Off-Network Estimator (NJAQONE) and Pennsylvania Air Quality Off-Network Estimator (PAQONE)

NJAQONE and PAQONE are sketch-level planning emissions estimators, which consider approximately 30 different congestion-mitigation project types. NJAQONE has been developed specifically using data from the state of New Jersey, while PAQONE has been specially modified for Pennsylvania. Both model transportation impacts at the county level, so each program has been preset for DVRPC region-specific analysis.

NJAQONE and PAQONE use VT and VMT to estimate emissions. They use average trip length for nonwork and work trips, using 2000 census population and modeshare data by county. Modeshare changes are estimated for each type of improvement using a logit choice method. Modeshare is then distributed through the number of resulting trips for each mode of transportation (including biking and walking), and a resulting table of VMT change is computed. The following are strategies PAQONE can estimate VMT and VT changes for:

- Arterial Improvements;
- Park-and-Ride—transit, carpool, and fixed service;
- High-Speed Rail;
- Bikeway Improvements;
- Improved Bicycle Access to Transit;
- Pedestrian Improvement Networks;
- Bike Use Promotional Events;
- Areawide Rideshare Programs;
- Employer Rideshare Programs;

- New Vanpool Programs;
- Guaranteed Ride Home;
- Parking Incentive Programs;
- Parking Management Programs;
- Compressed Work Week;
- Telework Promotion Programs;
- Bus Replacements;
- Change in Frequency for Existing Service;
- Change in Time of Day;
- Existing Vanpool Programs;
- New Express Service;
- New Local Service;
- New Shuttle at Transit Stop;
- Transit Center;
- Transit Amenities Improvements;
- Financial Incentive to Potential Transit Users;
- BRT;
- Electronic Toll Collection; and
- Incident Management.

PAQONE and NJAQONE cover a variety of strategies, but are focused on air-quality impacts. Estimates can be developed only for implementation of individual strategies. Caution must be used when developing VMT impacts on multiple strategies simultaneously, as this will likely result in the double counting of some transportation system users. Another critical component of any estimate developed using PAQONE or NJAQONE is the number of commuters affected by the proposed strategy. Estimating too many or too few individuals can lead to drastically over- or underestimated results.

Planning for Community Energy, Economic and Environmental Sustainability (Place^{3}s)

Place^{3}s uses GIS to create a database on energy use in an area. It allows a community to see how different plans would change energy use patterns, including transportation, and can analyze various tradeoffs and benefits for different development options. While a useful program, it does not have any of the components that can be applied to a CMP analysis.

More information on Place^{3}s can be found at: www.places.energy.ca.gov/places/

Screening for ITS (SCRITS)

SCRITS is a spreadsheet-based sketch planning tool, and is available for free from FHWA. It provides approximate user benefits to the application of different ITS/operations strategies. Analysis can be performed on a regional, corridor, or facility level.

SCRITS can analyze the following ITS strategies:

- closed-circuit TV;
- loop detectors;
- highway advisory radio;
- variable (dynamic message signs);
- weigh-in-motion;
- rail grade crossing;
- traveler information;
- pager-based communication;
- kiosks;
- CVO kiosks;
- internet communication;
- transit automatic vehicle location;
- electronic transit fare collection;
- electronic toll collection; and
- transit signal priority.

SCRITS requires little input data. SCRITS cannot analyze combinations of strategies. There is no resulting B/C analysis.

More information on SCRITS can be found at: www.fhwa.dot.gov/steam/scrits.htm

Sketch Planning Analysis Spreadsheet Model (SPASM)

SPASM is a spreadsheet-based sketch modeling program for corridor-level planning created by FHWA and available for free. It is capable of performing economic B/C estimates and comparisons between different transportation investments such as transit system improvements, highway capacity expansion, HOV improvements, auto-use disincentives such as tolling, and traveler information systems.

SPASM generates estimates of annualized public capital and operating costs, employer costs, system user costs and benefits, air quality and energy impacts, and cost-effectiveness measures.

SPASM assumes all trips are for an average trip length along the analysis corridor, and uses this average trip length to calculate resulting VMT changes. The user must develop estimates for transportation modeshare changes as a result of the improvement(s). SPASM is not able to consider the impact of multiple strategies, nor does it consider bike and pedestrian trips. It is primarily designed for corridor analysis in small- to medium-sized urban areas.

More information on SPASM can be found at: www.fhwa.dot.gov/steam/spasm.htm

Smart Growth Index (INDEX)

INDEX is a GIS-based land use analysis program. It is used to analyze various development scenarios for their relationship to smart growth principles. This program was initially developed by the US EPA but is now maintained and supported by Criterion Planners, Inc. It costs around $1,900 for the starter package, with annual license fees.

Setting up INDEX requires several GIS data layers, many of which DVRPC has already developed. These include parcels with land use designations, a future land use plan, street centerlines, and transit routes. Two additional layers are needed but not readily available at DVRPC: (1) a point file of housing locations and (2) a point file of job (by type) locations. It may be possible to obtain these from the Census Bureau. Any sort of physical change to the transportation network for analysis would need to be done in the appropriate GIS layer.

INDEX can be used to analyze regional growth management plans, environmental impact changes, comprehensive land use plans, transportation plans, neighborhood plans, land development proposals, environmental impact reports, special projects such as brownfields redevelopment or annexation proposals, proposed indicators of community quality of life, and environmental assessment. While intended to be used for sketch modeling purposes, INDEX contains an internal transportation demand model. This can estimate transportation outcomes as a result of changes in land use within a single software program. The model can be run for future conditions, based on proposed land use or transportation changes, and can display the resulting impacts to VT, VMT, changes in job/housing density, and pedestrian friendliness.

More information on INDEX can be found at: www.crit.com/

Spreadsheet Model for Induced Travel Estimation (SMITE)

SMITE is a spreadsheet-based sketch planning tool for predicting levels of induced travel due to highway expansion using economic analysis methods. It was developed by FHWA and is available at no cost.

SMITE develops estimates for multiple travel demand elasticities. To do this it uses inputs of daily VMT for freeways and arterials in a corridor, and their existing capacity (determined by AADT to an estimate for daily capacity, sort of a daily V/C ratio) along with elasticity of travel demand for freeways (–0.5 by default, but can be revised based on regional conditions). From these inputs, SMITE estimates freeway delay (based on the daily VMT to roadway capacity), vehicle speed, and vehicle hours traveled (VHT) for the base case conditions.

To compare to the baseline conditions, the user provides an estimate for the capacity increase as a result of roadway improvements. Using the estimated capacity increase and base case traffic conditions, SMITE calculates VMT, speed, delay, and VHT for both existing and induced travelers as a result of the roadway improvements. Outputs also include B/C analysis for existing users and new induced users based on travel time savings (if any) and the resulting net present value of the improvements.

More information on SMITE can be found at: www.fhwa.dot.gov/steam/smite.htm

Surface Transportation Efficiency Analysis Model v2.0 (STEAM)

This is a post-processor program which can be used to create a systemwide analysis of alternative transportation investments; it is available for free from FHWA. It takes the results of a four-step model and further analyzes them for a variety of benefits and costs for users, transportation agencies, and society as a whole. It should be noted that the four-step model must be set up and run for each unique scenario. STEAM can analyze a variety of scenarios and can consider regionwide impacts.

STEAM accounts for delays due to accidents, day-to-day traffic variations, and decreases in capacity occurring when volumes exceed the ability of the road to handle them. Its accessibility analysis can estimate proximity changes between workers and jobs as a result of different transportation investments.

Each scenario must be set and run in the four-step model, then imported into STEAM for further analysis. There is a set-up time involved in transforming the output of the four-step model into the format required by STEAM. The impacts of some alternatives may not be large enough to measure in comparison to the region as a whole. STEAM does not allow for multiyear analysis, and the resulting B/C ratio is developed for a single year only.

More information on STEAM can be found at: www.fhwa.dot.gov/steam/

Synchro and SimTraffic

Synchro is a macro traffic model and signal optimization program, based on *Highway Capacity Manual* standards. It is currently used for operations planning and analysis at DVRPC. Synchro is intersection-based and requires physical roadway conditions, signal timing plans, and traffic volume data. Synchro can develop signal optimization plans, determine intersection capacity and delay, determine queue lengths for traffic volumes (existing or projected), and account for downstream bottlenecks. In addition, it can analyze and optimize roundabouts and consider the impacts of pedestrian volume and signal phases to traffic flow.

SimTraffic is a microscopic model, which can simulate and animate small- to medium-sized traffic networks using a stochastic choice methodology. SimTraffic accounts for different driver behaviors; thus, no two simulations will have the exact same results. SimTraffic is a companion model to Synchro and runs with data input from it.

Both Synchro and SimTraffic can simulate traffic conditions and measure traffic flow through delay, number of stops, travel time (over a distance determined by the model), average speed, fuel used, volume (entries and exits), and denied entries (due to congestion). Synchro and SimTraffic are based on different modeling methodologies, so results will vary between them.

This suite of software programs can be used to model corridors or groups of intersections. However, it is impractical for modeling the entire DVRPC region.

More information on Synchro and SimTraffic can be found at: www.trafficware.com/synchro7.html and www.trafficware.com/simtraffic7.html

Transportation, Economic and Land Use Model (TELUM)

TELUM is an integrated land use and transportation model. It evaluates land use impacts from transportation improvements at the regional scale. It does this by forecasting future employment and household locations based on accessibility and travel times.

TELUM is very similar in purpose to UPlan, which DVRPC already has in-house. TELUM differs from UPlan in that it considers employment and residential changes to zones, as opposed to a grid of specific sites; it allows for existing households and jobs to change locations, allowing for increased density as a result; and it considers multiple household and job types.

Resulting land use as determined by TELUM is used to generate origin-destination matrices for all zones that can be fed back into a four-step transportation model. Outcomes include employment density, household density, land consumption, and a measure of sprawl called the density gradient. TELUM is a free-license program.

More information on TELUM can be found at: www.telus-national.org/products/telum.htm

TransCAD

TransCAD is a GIS-based program which can perform various levels of modeling from sketch to travel demand. TransCAD was developed by Caliper Corporation, and can model freight movements in addition to auto and transit passenger. It is capable of local to international levels of analysis. Its transportation network can consider:

- turn delays or restrictions;
- intersection and junction attributes;
- intermodal or interline terminals, transfer points, and delay functions;
- link classifications and performance functions; and
- transit access, egress, and walk transfer links.

TransCAD does not appear to integrate land use into its transportation model. Nor does it consider pedestrian or bicycling modes.

More information on TransCAD can be found at: www.caliper.com/tcovu.htm

Transportation Decision Analysis Software (TransDec)

TransDec is designed to provide the transportation practitioner with an easy-to-use tool for performing multimodal, multicriteria investment analysis.

TransDec evaluates transportation investment alternatives, focusing on rail versus highway tradeoffs. While the focus is on direct costs, indirect costs such as economic impacts, energy use, productivity, air quality, and safety impacts are also considered. TransDec is a menu-driven software system designed to allow transportation practitioners to evaluate and provide structure to transportation investment decisions based on multiple goals, objectives, and measures.

TransDec guides the decision-making process through a hierarchical formulation of broadly defined project goals tied to specific objectives, with each objective operationalized by a value measure.

TransDec operates on the Windows 98/NT platform, and is sold at a cost of $55.

More information on TransDec can be found at:
mctrans.ce.ufl.edu/store/description.asp?itemID=495

TRansportation ANalysis and SIMulation System (TRANSIMS)

TRANSIMS is an agent-based travel demand model. TRANSIMS simulates travel behavior for each household in the model based on activities, using census and land use data. Each trip is conducted within the transportation network as carried out by an individual, over a 24-hour period.

TRANSIMS can analyze the impacts that changes (physical or policy) can have on travel behavior. Actions are modeled by each individual trying to find the best route and mode. Individuals can choose to forego a trip if they deem travel demand and congestion levels will take too much time to travel.

TRANSIMS varies from traditional travel demand models in a number of ways. Its microsimulation model can produce vehicle speeds and intersection operations and also assess strategies such as signal optimization.

TRANSIMS is an open-source software program. It is highly data- and computation-intensive, with single runs possibly taking several computers several days to complete. This makes it much less appealing for use with the CMP.

More information on TRANSIMS can be found at: www.transims-opensource.net/

TRANUS

TRANUS is an integrated regional travel demand and land use model. It is able to calculate the travel demand for individuals and freight, integrating roadways, rail, other forms of public transport, and nonmotorized modes. It models rents for land based on access to the transportation network. Land use then drives travel demand between locations.

TRANUS has been used to forecast the impacts of different policies. Some of the policies it can analyze include:

- urban development plans;

- land use controls;
- impact of specific urban projects, such as industries, residential estates or shopping centers;
- regional development plans;
- housing plans or incentives;
- environmental protection plans, or protection to special areas;
- new roads or improvements to existing roads;
- reorganization of the public transport system (new routes, fares, etc.);
- exclusive busways and integrated networks (BRT);
- mass transportation systems (metros, light rail, etc.);
- highways with tolls, urban or interurban;
- HOV lanes;
- restrictions to automobile use;
- pricing policies, such as fuel taxes or parking fares;
- park-and-ride;
- selective road pricing or congestion pricing;
- rehabilitation of highways;
- road maintenance policies;
- railway projects or improvements to the existing rail network;
- new port facilities or relocation of existing ones; and
- relocation of freight and passengers airports.

TRANUS is able to compute travel elasticity and repressed demand (trips which are put off because of congested conditions). Land use location and travel decisions are a linked set of discrete choice models.

TRANUS is a free-license program. The program is highly setup and data intensive. Using it would likely require assistance from the DVRPC Office of Modeling and Analysis.

More information on TRANUS can be found at: www.tranus.com/tranus-english

Trip Reduction Impacts of Mobility Management Strategies (TRIMMS)

The TRIMMS model was developed by the National Center for Transit Research for the Florida DOT. It is a sketch planning tool which measures the implementation benefits of transportation demand management (TDM) programs such as:

- financial incentives and disincentives (parking price changes, pay-as-you go, etc.);
- program promotion;
- guaranteed ride home;
- flexible-work hours;

- telecommuting; and
- presence of amenities (restaurants, ATMs, childcare).

TRIMMS also computes impacts for strategies that reduce or increase travel times for different modes. It is designed for site-level analysis and allows for some local customization such as modal cost externalities and travel demand elasticity. It computes changes in vehicle trips and VMT, as well as a B/C analysis for the project. The program does compute synergistic effects of multiple programs but in a simplified manner. If one program has a 7-percent reduction in VMT and a second has a 5-percent reduction in VMT, the net result is an 11.5-percent reduction in VMT, determined by multiplying .93 times .95.

TRIMMS was partly developed due to dissatisfaction with the logit-based US EPA's Commuter Model. The developers of this program found there was no evidence that actual TDM program impacts follow the logit curve (as is used in the US EPA Commuter Model). Instead, TRIMMS uses Hedonic Regression, based on actual program implementations.

More information on TRIMMS can be found at: www.nctr.usf.edu/abstracts/abs77704.htm

UPlan

UPlan is a land use modeling program that forecasts urban growth based on microlevel development location decisions. A location's attractiveness is determined through development attractors and detractors. Development attractors include transportation accessibility, availability of open space, and positive municipal policies. Detractors are highway congestion, steep slopes, conservation easements, flood zones, landfills, airport safety zones, negative municipal policies, etc.

The model starts with the existing conditions in the area or region as its base. Growth forecasts are then put into the model, which places new residences and employers based on the most desirable location available. UPlan analyzes the location for the following different land uses, in this order, based on market bidding ability:

- industrial;
- commercial high-density;
- residential high-density;
- commercial low-density;
- residential medium density;
- residential low-density; and
- residential very low-density (not used in the DVRPC implementation).

The resulting land use, with new population and employment figures for each TAZ, can be fed back into a travel demand model. UPlan also calculates the number of new households generated by population growth.

UPlan can be used as a scenario testing tool for general plan changes, urban growth boundaries, habitat/open-space preserves, riverway/floodplain protection, new freeways and roads, and new rail transit lines. Different transportation enhancements can be fed into the allocation model, resulting in different projected land uses.

The 2009 DVRPC report *Application of the UPlan Land Use Planning Model* (Publication #09060) completed the documentation of the UPlan calibration process and presented the development and application of a generalized forecasting methodology for applying UPlan in ongoing DVRPC studies. The implementation strategy involves emulating ongoing DVRPC land use and transportation planning activities in UPlan, as much as possible, while implementing the transportation/land use linkage recommended by federal guidelines. Ultimately, the goal is to integrate UPlan into ongoing regional, county, and local land use/transportation planning activities.

In Fiscal Year (FY) 2009, the UPlan data was updated to reflect the 2005 and 2035 land use inventory and other demographic, transport, land use planning inputs. In FY 2010, UPlan was reconfigured to run for the DVRPC region as a whole.

The fully implemented UPlan model was employed in a regional scenario analysis, documented in the UPlan report mentioned above. Four land use scenarios were tested as part of this analysis.

VISUM and VISSIM

VISUM is a travel demand model. It integrates all modes into a single transportation network and four-step model. It can also simulate microscopic traffic conditions, consider intersection delay and road capacity, and perform a level-of-service analysis for roadway links.

It offers some benefits over many other travel demand models. The first is dynamic route assignment, which means that the model accounts for congestion and allows vehicles to find their own shortest path. The second benefit is improved graphical and mapping outputs. Additionally, it can incorporate nonmotorized transportation uses into the model. Also, since transit and roadway networks are joined together, bus travel times will better reflect roadway congestion.

In FY 2009 DVRPC began upgrading the travel simulation process. The VISUM modeling package was selected to replace the previous TRANPLAN software. The travel model was translated from TRANPLAN to VISUM and validated in FY 2009. In FY 2010 the documentation of the validation for the translated model was completed, a new user's manual was written, and staff were trained in using the VISUM based model. In FY 2011 DVRPC staff and consultants built a new four-step travel demand model, TIM 2.0, in the VISUM software. A new network model generated from various GIS data sources was used. The representation of transit fare, transit access (walk and drive), highway assignment algorithms, transfer times, parking costs, and other network and supply-side elements were improved. In FY 2012, TIM 2.0 will be tested and refined. This will include two back-casting exercises in which previously built projects are tested in TIM 2.0 to insure that the model appropriately predicts the change that happened. After successful testing and refinement, base model cases will be coded and validated for future years such as 2015, 2025, and 2040.

More information on VISUM can be found at: www.ptvamerica.com/index.php?id=1481

APPENDIX B

Model Types and Selection

Seven Major Types of Transportation Models

Definitions of the basic concepts for seven major types of transportation models are summarized below. The definitions were adapted from the Federal Highway Administration (FHWA) document, *Traffic Analysis Toolbox Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools*.

Analytical/Deterministic Tools (*Highway Capacity Manual* ***[HCM]*****-Based):** Tools that can quickly calculate capacity, density, speed, delay, and queuing on a variety of transportation facilities, by implementing the procedures of the *HCM*. These tools are good for analyzing the performance of isolated or small-scale transportation facilities, but they are limited in their ability to analyze network or systemwide effects.

Macroscopic Simulation Models: Models based on deterministic relationships of the flow, speed, and density of the traffic stream. Simulation takes place on a section-by-section basis by tracking groups of vehicles in traffic flow over brief time increments. They do not take into account trip generation, trip distribution, and mode choice in estimating changes to transportation systems.

Mesoscopic Simulation Models: In mesoscopic models, individual vehicles constitute the traffic flow and have differing vehicle types, driver behavior, and relationships with roadway characteristics. Travel prediction takes place on an aggregate level and does not consider dynamic speed/volume relationships.

Microscopic Simulation Models: Models that simulate movement of individual vehicles based on car-following and lane-changing theories. Computer time and storage requirements for microscopic models are significant, usually limiting the network size and/or the number of simulation runs that can be completed.

Sketch Planning Tools: Tools that generate rough estimates of travel demand and traffic operations in response to transportation improvements and can be used to assess specific projects or alternatives without performing a detailed engineering study. Typically, these tools are the simplest and least costly of the traffic analysis techniques. However, they are usually limited in scope, analytical robustness, and presentation capabilities.

Traffic Signal Optimization Tools: Tools primarily designed to develop optimal signal phasings and timing plans for isolated signal intersections, arterial streets, or signal networks. Similar to analytical/deterministic tools.

Travel Demand Models: Mathematical models that can predict travel demand, destination choice, mode choice, and route choice and use these to represent traffic flow on a specific roadway network. They are used to forecast future travel demand based on current conditions and future projections of household and employment characteristics, but they were not designed to evaluate travel management strategies. Travel demand models have limited capabilities to accurately estimate changes in operational characteristics resulting from implementation of ITS/operational strategies.

FHWA Decision Support Spreadsheet Results

The following table documents the results of the Delaware Valley Regional Planning Commission (DVRPC)'s scoring of a decision support spreadsheet created by FHWA as part of the *Traffic Analysis Toolbox Volume II*. (The spreadsheet can be found at http://ops.fhwa.dot.gov/trafficanalysistools/tat_vol2/dsm_auto_tool.xls.) Rating each item in the spreadsheet on a scale of 1 to 5, based on appropriateness, DVRPC determined that travel demand models are most in-line with Congestion Management Process (CMP) modeling needs. However, the DVRPC travel demand model is not practical to use for the CMP, given resource limitation. Sketch models are the second most appropriate model type.

Relevance of Model Types

Type of Model	Relevance
Travel Demand Models	723
Sketch Planning Tools	448
Microscopic Simulation	115
Mesoscopic Simulation	–148
Macroscopic Simulation	–351
Traffic Signal Optimization Tools	–595
Analytical/Deterministic Tools (*Highway Capacity Manual-Based*)	–1,229

Sources: Federal Highway Administration, *Traffic Analysis Toolbox Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools* (McLean, VA: U.S. Department of Transportation, FHA, 2004); DVRPC staff.

APPENDIX C

Cal-B/C Inputs

Inputs Used to Test Transit Signal Priority (TSP) in the West Chester Pike Corridor

The following tables and figure document the data and sources that were used to test the TSP strategy in Cal-B/C.

Inputs Used for Cal-B/C Transit Signal Priority Test

Input	Data Used for Test	Source
Length of Construction Period	5 years	Developed with staff from the DVRPC Office of Project Implementation.
Number of General Traffic Lanes (no build and build)	4	GIS
Highway Free-Flow Speed (no build)	40	Boosting the Bus
Length of Highway Segment (miles)	20	GIS
Current Average Daily Traffic	16,000	DVRPC Traffic Count Database
Forecast ADT (year 20)	20,000	Travel Demand Model
Average Vehicle Occupancy	1.3	Travel Demand Model
Highway Accident Data -Total Accidents -Fatal -Injury -PDO	983 = Total 1% = Fatal (6) 66% = Injury (648) 33% = PDO (329)	P:\09-41-030 Transportation Safety\Crash Data Interface\PA\2005-2009
Statewide Basic Average Accident Rate -Rate Group -Accident Rate (per million vehicle miles) -Percent Fatal Accidents -Percent Injury Accidents	60.2% = PDO 0.5% = fatal 39.3% = injury	*Traffic Crash Analysis of the Delaware Valley* (DVRPC, 08054). Table 1, p. 4.
Rail and Transit Data -Annual Person-Trips Base Year (no build and build) -Annual Person-Trips Forecast Year 20 (no build and build) -Percent Trips during Peak Period	Base year = 1,000,000 (no build)	Boosting the Bus
Annual Vehicle-Miles -Base Year (no build and build) -Forecast Year 20 (no build and build)	640,000 (both)	Boosting the Bus
Average Transit Travel Time (in-vehicle) -Nonpeak (minutes) -Peak	AM peak eastbound: 53 minutes AM peak westbound: 56 minutes PM peak eastbound: 60 minutes PM peak westbound: 57 minutes	Boosting the Bus
Transit Agency Costs (if TMS report) -Annual Capital Expenditure (no build) -Annual Operations and Maintenance Expenditure	$4.4 million total	Boosting the Bus
Project Costs -Project Support -Right-of-Way -Construction -Maintenance/Operations	LA Metro Rapid: station program $100,000 per mile; TSP $15–20,000 per intersection. Overall annual operating cost avg. $500,000 per mile.	*Final Report: Los Angeles Metro Rapid Demonstration Program* (DVRPC, 08066)

Input	Data Used for Test	Source
-Rehabilitation -Mitigation -Transit Agency Cost Savings	DVRPC 08066 estimates $2,000 per bus for emitters, or $20,000 to $25,000 for Route 104's 10 peak vehicles plus $2,500 each for 5 intersections lacking preemption receivers (only the Chester County ones)	
Fuel Cost per Gallon (excluding taxes) -Auto -Truck	$2.51 (NJ, Auto); $2.81 (NJ, Truck); $2.65 (PA, Auto); $3.06 (PA, Truck)	AAA.com; tax info from http://www.taxadmin.org/fta/rate/tax_stru.html

Source: Delaware Valley Regional Planning Commission (Philadelphia: DVRPC, 2011).

Note: ADT = Average Daily Traffic. DVRPC = Delaware Valley Regional Planning Commission. GIS = Gepgraphic Information System, PDO = Property Damage Only. TMS = Transportation Management Systems. TSP = Transit Signal Priority.

Cost Information Used for Cal-B/C Transit Signal Priority Test

Construction Period	Cost	Notes	Cost Source
Year 1	$55,000	Estimated design and engineering costs, based on total project cost.	Developed with staff from the DVRPC Office of Project Implementation.
Year 2	$55,000	Same as above.	Same as above.
Year 3	$55,000	Same as above.	Same as above.
Year 4	$55,000	Same as above.	Same as above.
Year 5	$1,275,000	1. $770,000 for 22 enhanced bus shelters ($35,000 each). Assumes two enhanced shelters at each corridor RapidBus stop location (one each direction), plus one each at 69th Street and West Chester University. 2. $400,000 for 10 enhanced crosswalks. $17 per square foot; roughly 2,300 square feet per intersection for 10-foot crosswalks across four legs; treatment applied at all 10 RapidBus station locations. Based on recent PennDOT-approved treatment for local streetscape project. 3. $65,000 for Optical TSP equipment at signals; $5,000 per unit. 13 signals need receivers per TMACC and DCTMA studies (5 in Chester County and 8 in Delaware County). Other signals have emergency preemption equipment that can also accommodate TSP. Cost assumes no signal controllers will need to be replaced for TSP equipment to be added. 4. $40,000 for 20 TSP emitters on buses; $2,000 per unit. Assumes emitters for Route 104's 11 peak vehicles plus 9 additional buses to permit vehicle rotation.	1. *Characteristics of Bus Rapid Transit for Decision-Making* (FTA, 2004) 2. DVRPC, 2011 3. USDOT ITS Cost Database 4. USDOT ITS Cost Database
Years 6–20	$44,000 (per year)	Ongoing maintenance costs. $2,000 per shelter, per year.	*Characteristics of Bus Rapid Transit for Decision-Making* (FTA, 2004)

Sources: Delaware Valley Regional Planning Commission (Philadelphia: DVRPC, 2011); Federal Transit Authority, *Characteristics of Bus Rapid Transit for Decision-Making* (Washington, DC: FTA, 2004); United States Department of Transportation Intelligent Transportation Systems Cost Database.

Note: DCTMA = Delaware County Transportation Management Association. DVRPC = Delaware Valley Regional Planning Commission. FTA = Federal Transit Administation. ITS = Intelligent Transportation Systems. PennDOT = Pennsylvania Department of Transportation. TMACC = Transportation Management Association of Chester County. TSP = Transit Signal Priority. USDOT = United States Department of Transportation.

Below is a screenshot illustrating the interface for entering project cost information into Cal-B/C.

Cal-B/C Project Costs Entry Screenshot

1E **PROJECT COSTS (enter costs in thousands of dollars)**

Col. no.	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
	DIRECT PROJECT COSTS						Transit Agency Cost Savings	TOTAL COSTS (in dollars)	
	INITIAL COSTS			SUBSEQUENT COSTS					
Year	Project Support	R / W	Construction	Maint./ Op.	Rehab.	Mitigation		Constant Dollars	Present Value
Construction Period									
1	$55							$55,000	$55,000
2	55							55,000	52,885
3	55							55,000	50,851
4	55							55,000	48,895
5			1,275					1,275,000	1,089,875
6								0	0
7								0	0
8								0	0
Project Open									
1								$0	$0
2								0	0
3								0	0
4								0	0
5								0	0
6				44				44,000	29,725
7				44				44,000	28,582
8				44				44,000	27,482
9				44				44,000	26,425
10				44				44,000	25,409
11				44				44,000	24,432
12				44				44,000	23,492
13				44				44,000	22,588
14				44				44,000	21,720
15				44				44,000	20,884
16				44				44,000	20,081
17				44				44,000	19,309
18				44				44,000	18,566
19				44				44,000	17,852
20				44				44,000	17,165
Total	$220	$0	$1,275	$660	$0	$0	$0	$2,155,000	$1,641,217

Publication Title: Selecting Software to Evaluate the Anticipated Effectiveness of CMP Strategies

Publication Number: 10023

Date Published: August 2011

Geographic Area Covered: The nine-county Philadelphia metropolitan area which includes the counties of Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey

Key Words: Congestion Management Process (CMP), congestion, traffic, multimodal, goods movement, transportation, corridors, strategies, Single-Occupancy Vehicles (SOV), capacity, long-range plan, Transportation Improvement Program (TIP), regional transportation planning, software, performance measures, evaluation, benefit-cost

Abstract: DVRPC is seeking a software program or programs to evaluate the anticipated performance of a range of congestion management strategies. This is a required task in federal regulations for the Congestion Management Process (CMP). DVRPC staff would share this resource with partner organizations.

Thirty-four software packages are reviewed. The conclusion is that a sketch planning-level program would be the most useful type of software; however, there is no one program able to analyze all of the strategies used in the CMP. Initial testing of Cal-B/C, a free, downloadable spreadsheet-based sketch modeling tool, shows potential. Future plans to continue testing software for CMP strategy analysis are outlined.

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