Report on Findings of the Peer Review Panel of the Pikes Peak Area Council of Governments Travel Demand Model

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Report on the Findings of the TMIP Peer Review Panel of the Pikes Peak Area Council of Governments

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Pikes Peak Area Council of Governments Contact Person: Craig Casper, ccasper@ppacg.org

Peer Panelists

Name	Organization
Dick Walker	Portland Metro, committee chairman
Erik Sabina	Denver Regional Council of Governments
Ron Eash	Northwestern University
Tom Cooney	Pima Association of Government

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Executive Summary
This report summarizes the results of a travel model peer review held by the Pikes Peak Area Council of Governments (PPACG). The peer review was sponsored by the Federal Highway Administration's Transportation Model Improvement Program. PPACG requested that peer review panelists provide suggestions on short- and long-term model enhancements, analyze its existing model and comment on the ability of the model to forecast conditions based on comparisons with field data and independently collected information, and make recommendations regarding possible incorporation of new functionalities in its modeling methodologies.

The panel felt that PPCCG has requested a peer review at an opportune point in their modeling process since they are in the early stages of extensive model revisions. The panel's primary recommendations were:

- Develop in-house expertise to understand and interpret the modeling process (although it does not necessarily need model development experts on staff).
- Decide upon the main questions the model must answer and choose among the various potential model enhancements accordingly.
- Be sure that model results reflect actual speeds. For free flow speeds, the model should use the actual speed, which is typically higher than the posted speed.
- Consult with the Federal Transit Administration (FTA) before collecting transit data and making modifications to the mode choice model to ensure that new data and model enhancement are consistent with FTA New Starts requirement.
- Incorporate additional socio-economic variables in the trip generation and mode choice models.
- Develop a traffic analysis zone structure with more and smaller zones.
- Develop model automation that provides intermediate results so that the user can understand the basis for model results.

I. Background

Pikes Peak Area Council of Governments (PPACG) is the metropolitan planning organization (MPO) for the Colorado Springs area. Its MPO planning region encompasses most of the western half of El Paso County and the Woodland Park area of Teller County in central Colorado, as shown in Figure 1. The MPO planning region has a population of about 560,000. About 67 percent (370,000) of this population lives in the City of Colorado Springs, which is Colorado's second largest city. An additional 31 percent live in El Paso County outside of Colorado Springs. The remaining two percent of the population lives in the Woodland Park area of Teller County. The MPO planning region covers an area of about 794 square miles.

The PPACG is beginning the process of updating its travel demand model. Model enhancement is the top priority in its 2005 work program. It asked the FHWA Travel Model Improvement Program (TMIP) Peer Review Program to provide suggestion on short- and long-term model changes and enhancements. The PPACG will use the recommendations of the peer review panel when developing a request for proposals (RFP) and hiring a model development consultant. Concurrent with the Peer Review, PPACG will update the TAZ system, the small area forecast, and the roadway network and functional classification. This revised model will be used for a

transit New Starts project, funded in part by the newly approved (January 1, 2005) 1 percent sales tax for transportation improvements.

PPACG requested that peer review panelists analyze its existing model and comment on the ability of the model to forecast conditions based on comparisons with field data and independently collected information. In addition, PPACG wanted recommendations regarding possible incorporation of the following in its modeling methodologies:

- Freight sub-model
- Trip chaining
- Intersection delay
- Interactive land use modeling
- Special generators, and
- Land use and/or demographic forecasting models.

II. The Current Model

The meeting began with PPACG and Springs Transit staff presenting the current model, modeling issues, and objectives for the updated model, detailed below.

a. Small Area Land Use Forecasts

During the 1990s and before, PPACG Staff prepared small area land use forecasts using an early version of DRAM/EMPAL. For the most recent long-range plan update, forecasts were done by a consultant, although PPACG would like to resume doing this work in house in the future. It would also like to explore using an updated forecasting package, such as TELUM or UrbanSIM.

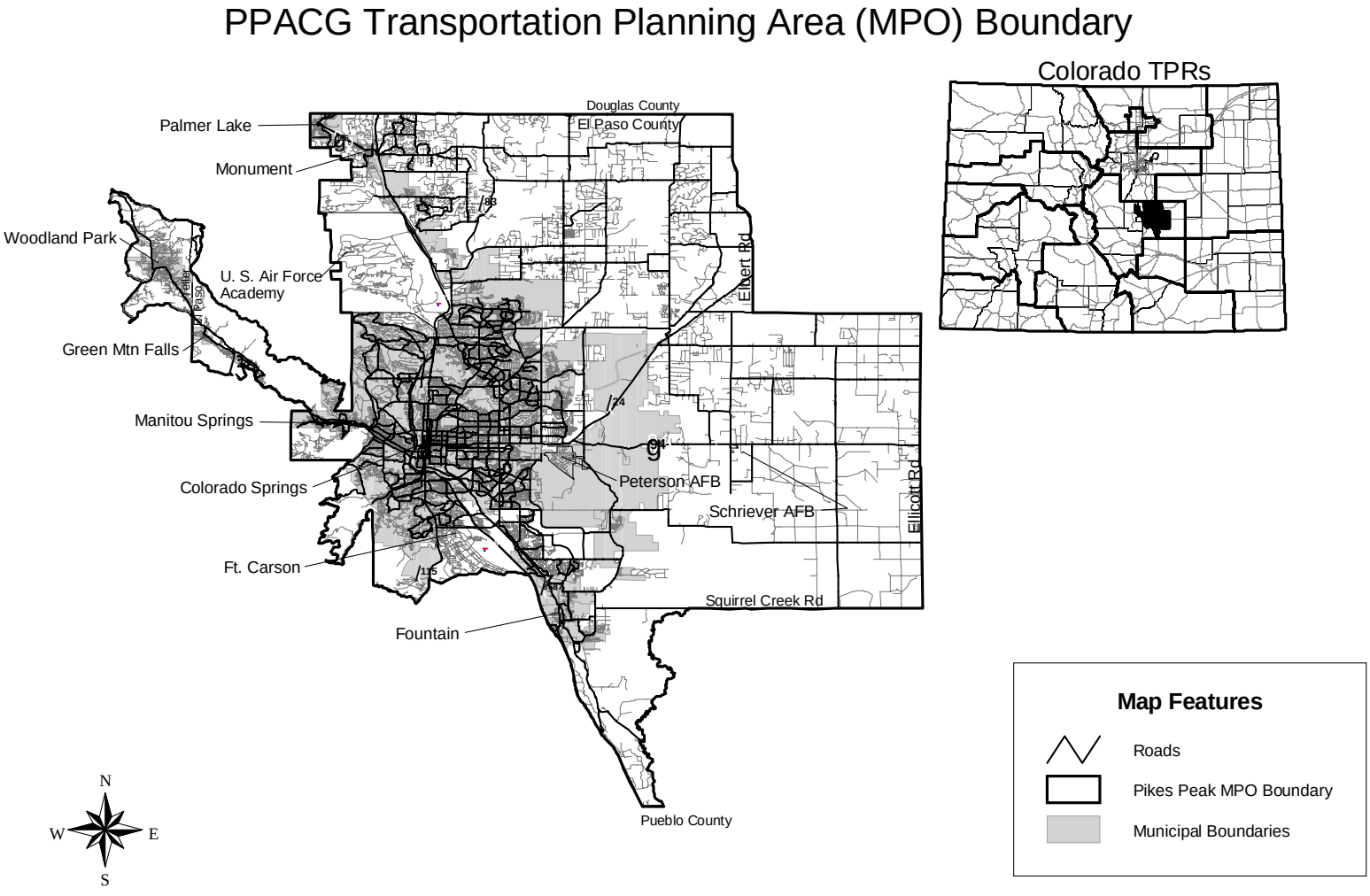
PPACG gets control totals from the Colorado Demography Office. However, these totals do not reflect temporary changes in employment totals, caused primarily by deployments from the military bases in the area. This results in large fluctuations in employment forecasts that do not necessarily reflect actual, permanent changes in employment in the area. This may be sufficient to meet federal requirements, but, as a practical matter, they are not sufficient for planning purposes.

The model currently has 505 traffic analysis zones (TAZ), covering only El Paso County (including the eastern part that is outside the MPO planning area). PPACG is adding all of Teller County to its transportation planning region, which will require new TAZs. Also, it would like to create smaller TAZs in the urbanized area. It currently uses census guidelines to determine the size of TAZs. In the sparsely populated areas, this results in very large TAZs.

b. Trip Generation

A cross-classification modeling procedure was used in the construction of trip production rates for the PPACG model. In this technique, a change in one variable (trips) can be determined when variations in other variable(s) (household characteristics) are taken into account. Cross-classification analysis is based on the fundamental assumption that trip generation rates are neither continuous nor linear in nature, and that the defined categories of independent variables are stable across the sample and through time.

Figure 1. PPACG Transportation Planning Area (MPO) Boundary



Trip destination information is used to determine the land use at each attraction: residential and/or basic retail or service employment. To determine trip attraction rates, the number of attractions is divided by the number of households, basic employment, retail employment, or service employment.

Because initial model assignment validation showed that the model was underestimating traffic volumes, calibrated trips rates were adjusted upward during the traffic assignment validation process. The changes were greater for non-work trips than for work trips because reporting of work trips in household surveys is generally more accurate than reporting for non-work trips.

Transit trips are deducted from the trip rate. Only "transit-captive" trips, which account for about half of transit riders, are generated. The main determinant of the number of transit trips is access to transit. The model provides a transit choice to any traveler living within a mile of a transit line. Other travelers do not "see" the transit option in the model. This formulation results in the model choosing "transit-captive" trips for residents of some wealthy neighborhoods as long as the traveler lives within a mile of a transit line. This certainly overstates transit trips for these residents. The model cannot consider improved transit access due to park and ride lots.

c. Trip Distribution

The PPACG model uses the gravity model for trip distribution. The modeling procedure synthesizes observed trip tables for peak and off-peak travel. These trip tables are assigned during the early stages of trip distribution to create skims that reflect congestion. Although total trips, including non-motorized, are distributed, auto travel times are used as the measure of spatial separation. The balanced daily productions and attractions are split into peak (including all trips from both the morning and afternoon peaks) and off-peak trips, divided according to trip purpose. Trips are then distributed on a peak/off-peak basis using travel times estimated from assignments in the observed trip tables.

d. Mode Choice

The PPACG mode choice model actually begins during the trip generation phase when transit-captive trips are estimated. The model takes the person-trip information produced by the distribution model and allocates these trips to non-motorized, transit and auto modes by purpose and zonal interchange. This information is then used to create daily vehicle-demand trip tables and daily transit trip tables for assignment. Non-motorized and transit trips are allocated to TAZs but are not assigned to any network links.

The mode choice model for motorized trips is a binary logit model; auto and transit are the only two choices in the choice set. The model first estimates the probability of each mode being chosen and multiplies the probabilities by the number of person trips to produce a distribution of trips among available modes and trip purposes.

e. Trip Assignment

The assignment portion of the model uses an equilibrium assignment. The equilibrium assignment procedure initially produces a minimum path (all-or-nothing) assignment in which trips from zone to zone are assigned to the shortest path between each O-D pair. The assignment program then calculates congested travel times upon the resulting volume-to-capacity (V/C)

ratios, chooses portions of volumes from the previous assignment that will minimize link travel times for each O-D pair, and then produces a new minimum path assignment using the congested travel times and weighted impedances. The assignment process iterates until the time paths between all O-D pairs have reached equilibrium. The computation of congested travel times in the equilibrium assignment process is made through the use of a volume-delay function (VDF) which contains speed, distance, volume, and capacity as independent variables.

III. Recommendations

After the first day's presentations and discussion, the panel met in private to discuss PPACG's model and modeling process and to develop recommendations for their enhancement. The panel felt that PPACG was at an important turning point in its model development process, and was glad to see that it had chosen to host a peer review before it got further along in the model revision process. At this stage, PPACG has a lot of freedom to implement the recommendations of the panel, since the momentum of the modeling process has not yet been established.

The panel's recommendations are categorized as follows:

- General comments
- Forecasts and data
- Trip generation
- Trip distribution
- Mode choice
- TAZs
- Road pricing
- Truck model
- Time of day issues
- Traffic assignment
- Volume/delay functions

a. General Comments

- PPACG must ensure that modeled travel time results accurately reflect actual travel times. This requires that speeds be fed back from the assignment stage to the trip distribution stage, and the model be run iteratively until input speeds match output speeds. The accuracy of travel times is particularly important because it is one of the most important criteria travelers use to make travel decisions.
- As PPACG is well aware, the agency must have staff who understand the model and can interpret its results. PPACG does not necessarily need a model developer on staff, but it must have staff who understands the theory behind the model.
- PPACG must consult with the FTA early and often to be sure that its model is consistent with New Starts regulations.
- The effects of ITS, travel demand management, and transportation system management techniques are very difficult to predict on a large scale. They are usually better handled through microsimulation. The panel recommended that PPACG consult the FHWA's ITS Deployment Analysis System, developed by Cambridge Systematics, for guidance on this topic.

- Before making changes to the model, PPACG needs to ask itself "What are the most important questions the model should answer?" The response to this question will help determine priorities for short- and long-term model improvements.

b. Land Use Forecasts and Data

PPACG expressed interest in keeping small area land use forecasts in-house. If they are to do this, the panel felt that it must formalize the process. This includes developing an inventory of available data and keeping abreast of data available from outside sources. A data inventory will almost certainly be required for the upcoming RFP. Also, PPACG must be sure that its foundation data are solid and defensible. Further, data that interface directly with the travel demand model may have to be modified to be suitable for this application. PPACG should consider whether to do this data manipulation in-house or send it to a consultant. In the longer-term, PPACG might want to move to newer, state of the practice land use forecasting packages such as UrbanSIM or TELUM.

The panel recommended continued and enhanced coordination between PPACG and its neighboring MPOs, especially DRCOG, which accounts for many of PPACG's inbound and outbound external trips. Coordination should include data sharing and consistent network coding at the MPO boundaries. The MPOs should also consider developing a sketch planning tool for an intercity model.

PPACG needs current data on travel on I-25 and U.S. 24. If a survey that stops traffic for interviews is not possible, PPACG can consider automated methodologies such as license plate matching. For truck traffic, PPACG may be able to gather information by surveying drivers at the weigh station on I-25 between Colorado Springs and Denver. The data collection effort should also include vehicle classification counts. These counts are very important for emissions analysis.

Regarding the planned transit-on-board survey, Springs Transit and PPACG should be sure that they collect data that will meet FTA data requirements. If time constraints preclude an FTA review of the survey, the agencies can review other, similar transit-on-board surveys that the FTA has reviewed, such as those recently done in Tucson and Dallas/Fort Worth. Also, Springs Transit should coordinate with PPACG to ensure that the survey collects the data necessary for its modeling efforts. Upon completion of the survey, PPACG should consider hiring a consultant to do survey expansion since this can be a difficult activity that requires technical expertise.

c. Trip Generation

The current cross-classification scheme needs to be revised so that it is more sensitive to market characteristics that are likely to change over time. This is especially important for high-growth areas, where demographic and socio-economic characteristics are changing rapidly. Also, the current "transit captive" component of the trip generation model should be moved to the mode choice model to allow it to be considered on equal footing with other travel modes. Additionally, PPACG should gather more data on the trip characteristics of special generators.

While not mandatory, some benefits could be derived if the trip generation model could capture trip chaining characteristics. This is because chained trips are an increasing proportion of total

trips, and because these trips are less likely to take place on transit than are other trips, and therefore should not be treated the same as other trips with respect to mode choice. In the long term, trip chaining is best incorporated by switching to a tour-based model. However, PPACG can better capture trip chaining in the short term by adding trip purposes that reflect chaining, especially work-based trips such as work-based shopping, that reflect an intermediate stop.

d. Trip Distribution

PPACG is trying to better match high-paying jobs with high-income workers in its trip distribution model. The panel supported this effort and recommended that it continue. The panel further recommended that, in the long term, PPACG should consider moving to a destination choice model rather than its current gravity model. There are several reasons for this.

- Destination choice models can incorporate more variables than can easily be incorporated into the gravity model.
- The mathematical form of a destination choice model is easier to estimate than the gravity model. For example, no friction factors are required.
- It is easier to draw linkages between workers and specific job types in destination choice than in a gravity model.

Modeling land use and transportation interactions can be a very valuable tool to bring technical rigor to what is often a political decision making process. Any consideration of this topic must include variables for transit and roadway accessibility and land use allocation in the small area forecasts. PPACG can look at the tools used by DRCOG and in the Phoenix/Tucson areas for examples of how land use/transportation interactions are handled. In addition, the model must maintain reasonable consistency between household (worker) and employment locations.

e. Mode Choice

The panel felt that the current mode choice model would not be acceptable to the FTA based on the criteria for the New Starts program. The model should be reconstituted to include the variables that are good predictors of mode choice, such as demographic and socio-economic characteristics such as the ratio of cars per workers in a household, and the relative cost of transit with respect to driving, rather than relying solely on time and distance.

Also, the panel noted that the model prediction for the percentage of non-motorized trips was much lower than the actual number of such trips. Given that non-motorized trips account for about eight percent of all trips, they are an important component of the overall transportation system. For non-motorized trips, the mode choice phase should consider other factors relevant to non-motorized trips such as density and urban design characteristics such as whether or not the area has sidewalks. Non-motorized trips can be handled in one of two ways. First, they can be treated in a “pre-mode choice” model. Non-motorized trips would be included in the trip generation phase, but then be separated out and not carried forward to the mode choice model. Alternatively, non-motorized trips can be treated as a mode in the mode choice model.

f. TAZs

The panel felt that “more is better” when considering traffic analysis zones. More and smaller zones allow the model to more accurately calculate travel times (due to improved geographic

precision) and increase the sensitivity of the model without greatly increasing its complexity. Given PPACG's current plan to increase the number of TAZs, it should consider the following:

- Zones structure should be somewhat consistent with the transit and roadway networks. For example, zones around a transit line should be small enough to adequately consider the walk distance to a transit stop. Also, a zone with several parallel roadways running through it may not be small enough to analyze the travel patterns in the individual corridors.
- The transition from the small zones of the urbanized area to the large zones in the less dense areas should be smoother.
- The zones in the expected growth areas should be smaller. This will eliminate the need to subdivide zones in the future as new growth occurs.

g. Road Pricing

Incorporating road pricing into travel demand models can be very complicated. The panel urged PPACG to keep the pricing aspect of its travel model very simple. The model should only account for tolls (versus other pricing strategies) and should include feedback to the trip distribution phase. If it wants to consider more sophisticated pricing elements, PPACG should strongly consider hiring a consultant.

h. Travel Time of Day

PPACG's model currently uses three time periods. The panel suggested that it consider adding time periods, especially "shoulders" at the beginning and ends of the peak periods. This would more effectively account for the travel characteristics immediately prior to and after the peak periods, which are likely to be different from those at other times of the day, peak and non-peak. This is especially important because of the various military installations in the area. They are likely to generate travel that is quite different from other travel in the region. For example, the bases generate substantial traffic early in the morning before the peak period. The current model does not account for this heavy travel during the off-peak. PPACG should review its count and survey data to better understand travel time of day variations.

i. Traffic and Transit Assignments

A frequent question in the traffic assignment phase is how many iterations to run. Currently, the PPACG model is hard-coded to allow only 15 iterations. The panel expressed some concern this may not be sufficient for good model convergence. They suggested that PPACG run the model with additional iterations to understand the effect that better convergence has on the model outputs.

The current model does not do transit assignments. However, because Spring Transit is planning to significantly expand its service, the region would benefit from the ability to evaluate service alternatives using the travel demand model. Transit assignment outcomes would also enable PPACG to better judge the quality of the mode choice model, as transit assignments can be compared to observed transit ridership. This is a standard calibration/validation exercise for regional models.

j. Volume/Delay Functions

Since PPACG staff felt that free-flow speeds are higher than the posted speed limit, the panel recommended that the model use these actual speeds instead of the posted speed limit as its

starting point. They further recommended that PPACG collect data on free-flow speeds at various times of day for its emissions analysis. If the model does not accurately represent the actual speeds, some post-processing may be required to match model speeds with actual speeds. This is common practice among modelers.

The panel recommended that the model developer consider various options, rather than just the BPR curve. The volume delay functions used in Portland, Oregon are an example of the type of function that could be used in Colorado Springs. Portland's method separates arterial link delay from intersection delay. PPACG should develop a list of specific volume/delay techniques it wants the model developer to consider (generalized delay, intersection delay, mid-block delay, left turn delays). The panel recommends that the treatment should be kept more traditional (generalized) for now, but consider more detailed treatment in the future.

k. Seasonal Variations

PPACG experiences seasonal variations in travel due to an influx of vacationers in the summer. The panel felt that developing a separate model to represent summer travel would be a lot of work and probably not a lot of benefit. Also, PPACG does not have enough data on seasonal variations to create a new model. The state of the practice for seasonal variation is to simply adjust model output volumes to account for seasonal differences. Also, seasonal travel differences are probably important in localized areas in the transportation network. PPACG should concentrate its efforts on these areas, rather than looking at variations in the entire network.

l. Model Validation

For model validation, PPACG must do more comparison between model results and empirical data. This, of course, introduces the question of "how good is good enough?" The panel recommended that PPACG consult Federal guidelines on this such as the FHWA 1997 manual *Checking the Reasonableness of Travel Model Forecasts*, available on the TMIP web site.

m. Model Automation

Model automation can make the model easier to run. However, it must be done cautiously so that it does not become a surrogate for thorough knowledge about the model. Any model automation should display intermediate results so that the user can understand the basis for the subsequent results.

n. Borrowing Data

PPACG's model can borrow coefficients from models in comparable regions. It should choose a region that is similar to Colorado Springs in characteristics that heavily influence transportation characteristics, such as population, size, density, the presence of military bases and not a port city. Further, the structure of the model must be similar to that in Colorado Springs. Because the existing mode choice model is non-standard, PPACG probably cannot borrow coefficients for mode choice without fundamentally changing the model.

Guidance for how to choose appropriate regions for borrowing data can be found on the TMIP web site. Also, the model development consultant should be able to help with this issue.