JPC

John Parker Consulting, LLC

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To: Carl Springer and Bob Schulte, DKS Associates

From: Randy Parker and Jennifer John, John/Parker Consulting

Subject: ODOT Congestion Pricing Proposals relative to the Portland Metro model and Tolling White Paper 3 Travel Demand Model Sufficiency

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Introduction

This memorandum summarizes a review of Tolling White Paper 3 *Travel Demand Model Sufficiency* prepared by Parsons Brinckerhoff (PB), David Evans and Associates (DEA), and Stantec Consulting Services, Inc. as it relates to three candidate projects recommended by the Technical Advisory Committee for consideration in the ODOT Congestion Pricing Proposals Analysis (CPPA) and as it relates to the capabilities of the proposed model to be used in the analysis, the current Metro regional model[1].

White Paper 3

White Paper 3 examines current travel demand modeling practices throughout the state of Oregon with special regard to tolling applications. The paper is very comprehensive and includes information related to the following topics:

- Current state of practice form modeling, including a summary of best-practice modeling principles related to tolling and an overview of how the Oregon-based travel demand models incorporate tolls or road prices in the model structure

- Types of tolling applications applicable to Oregon and related travel demand model needs

- Modeling requirements for investment-grade forecasts

- Incorporation of travel time reliability on travel demand models

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- Sources of uncertainty and systematic bias in traffic and revenue forecasts

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[1] Metro is constantly updating its Models and as a result several versions of the Portland Metro model exist. The version assessed in White Paper 3 was the latest generation of models at the time, specifically the 2008 "Ivan" version.

- Evaluation of the capability of Oregon's travel demand models to estimate tolling impacts
- Recommendations for improving Oregon's travel demand models for tolling applications

- Recommendations for a data collection program to support model improvements

As noted in White Paper 3 "an assessment of modeling requirements must necessarily start with a good understanding of the types of tolling applications under study". While the details of each candidate project are still being determined by project specific working groups and ODOT, the three candidate projects include:

1. Pricing selected ramp entries on Highway 217
2. Tolling on Cornelius Pass Road
3. Parking Pricing Strategies in Central Downtown including
    - Event Parking Fee – charge more for parking near major event venues during events.
    - Short-Term Parking Preference – regulate prices so parking providers charge an increasing hourly rate for each marginal hour of parking (i.e. inverse rate).
    - Per Stall Fees – charge a one-time (at construction) or annual fee for parking stalls.
    - Peak Period Pricing – Charge a congestion fee to those who enter or leave a paid parking facility during the AM or PM peak periods.

While there are model requirements that apply to any road pricing study, there are others that are relevant only for specific applications. Some model requirements are considered essential, while others may be considered in the advanced stages of a study. The following capabilities and recommendations are focused on the Metro model and its ability to accurately model the candidate projects proposed.

Travel Decisions Influenced by Tolling and Congestion Pricing

How travel demand models estimate tolling effects can be classified into first-order and second-order responses (refer to Table 1 in White Paper 3 for more information).

First Order Response – estimate how a traveler would immediately react to being tolled.
- Route Choice – use a different road
- Mode Choice – use a different mode (i.e. transit)
- Time-of-Day – chose a different time of day to make the trip

Second Order Response – additional pricing impacts
- Change trip destination
- Decide not to make the trip
- Change travel arrangements (i.e. carpool or trip chain)

Characteristics of the Portland Metro model relevant to its tolling application sufficiency (see Table 2 of White Paper 3):

- Three of the first-order responses are explicitly modeled: route choice, mode choice, and generalized costs are all sensitive to tolls. Time-of-day is insensitive to level of service attributes (time and costs). Consequently, as currently specified, this model assumes that tolls do not affect shifts in traffic demand across time periods. This is common among trip-based models but methods do exist to incorporate time and cost sensitivity in time-of-day choice.

- No pre-route choice model is applied. The choice of route/path is determined through the equilibrium highway assignment as a function of travel time and cost only. This is a weakness of the model whenever applied in a context where there is a real choice between toll routes and free routes.

- As with other models that lack a specific toll/no toll choice, sensitivity to tolls is largely a function of the magnitude of the time and cost coefficients, and the tradeoff between travel time and travel cost (essentially VOT). In the Metro model, VOT varies by trip purpose and household income. VOT's tend to be low while both time and cost coefficients are relatively high. Both of these factors tend to increase the cost sensitivity of the model, perhaps to the point where it is more sensitive to cost than is appropriate.

- The destination choice model is sensitive to tolls (a second order response) by using multi-modal accessibilities. The destination choice models are segmented by trip purpose only and not by time period like route and mode choice. Having said that, the logsums fed into destination choice do incorporate time of day in that both am and midday times are used to arrive at a weighted travel time according to the percentage of trips by purpose that occur within each time of day. One needed improvement is a re-evaluation of the accessibility coefficients; as currently implemented the destination choice models may be overly sensitive to changes in level of service (time and cost) factors. Also, an additional improvement would be to introduce time-of-day specific accessibilities.

- Highway assignment is based on four vehicle classes (SOV, HOV, medium trucks, and large trucks) and is typically performed for three time periods (AM peak, midday hour, and PM peak). However the standard VOT segmentation is only two classes (auto and truck). In previous tolling studies results were saved out of the model by income grouping and assignments were performed with more vehicle classes (SOV Low Income, SOV Middle Income, SOV High Income, HOV Low Income, HOV Middle Income, HOV High Income, Heavy Trucks and Medium Trucks). Additional vehicle classes reduce aggregation bias and consequently reduce the cost-sensitivity in the model. Even when low, middle and high income classifications are used the results assume averages across the entire income group and as a result one loses sensitivity on the outer edges of these groupings in terms of their sensitivities to the toll. This is true across all of the model components and not unique to tolling. Toll costs are converted to time-equivalent delays prior to highway assignment, so the time delay can be made to vary by each of the vehicle classifications. The EMME assignment that has been used in the past allows for a generalized cost to be included for weighting the tolls by the different classes. This means that if different income groups perceive a toll differently, this can be addressed in the assignment procedures.

Metro Model Capabilities to Analyze Tolling Projects

- The Portland Metro model is configured to handle tolls. The mode choice models, which are critical to the creation of generalized costs, are well developed. However, the Portland Metro model does not include a pre-route choice model, which means the choice of whether to use a toll road or not is left up to the network simulation. This is critical when there is a real choice between a free road and a toll road and less critical when all likely routes are tolled. This may be an issue for candidate projects on Cornelius Pass Road and Highway 217 ramps.
- The Portland Metro model already uses the minimum recommended market segmentation of the travel market by time of day, trip purpose and income levels. However, the values of time (VOT) that are currently specified do not distinguish between all of these various market segments. For example, home-based shopping, recreation, and other trips all share the same VOT, even though separate trip tables are generated in distribution. Also, the VOT's are relatively low, which tends to make the models overly sensitive to cost.

- The Portland Metro model includes only one first order decision, route choice, though handled in the assignment process instead of as a discrete choice.

- The Portland Metro time-of-day model is not sensitive to tolls or travel times. While time of day models based on invariant diurnal factors is the norm among state-of-the-practice MPO models, the state of the art has progressed enough that time of day models sensitive to level of service can be implemented.

- The Portland Metro model is capable of forecasting changes in trip destination due to tolls, which is an important second-order effect. Discussions should occur with Metro staff regarding the sensitivity of including tolls in destination choice to ensure that the model is not overly sensitive to these costs.

- The Portland Metro model, like all the models under study, suffers from relatively aggregate representation of market segments at the highway assignment (route choice) step. Where segmentation is present, it is typically along vehicle type (auto vs. trucks), which correlates with VOT to some degree but Metro has included income segmentation along with vehicle type in previous studies. Still this limited segmentation almost ensures a large degree of aggregation bias in the forecasts, because the number of classes currently available may not be sufficient to model both the full toll regime and the differences in VOT.

- Portland Metro has conducted speed studies and developed its volume-delay functions based on these data.

Recommended Travel Demand Model Improvements

In White Paper 3 recommended model improvements were not made on a model by model basis but instead classified by those that would be required for any type of tolling study and those that would be desirable for specific types of studies. Refer to Table 6 White Paper 3 for a prioritized list of recommended model improvements. The improvements identified below would be applicable to the Portland Metro model with respect to the candidate projects proposed.

Recommended improvements for all types of tolling applications:

Pre-route choice model **–** a pre-route choice model provides the ability to include attributes other than time and cost in the decision of whether to use a toll road or a free road. In many instances, a bias constant in pre-route choice may be used instead of explicitly modeling travel time reliability. As previously noted, the importance of this is largely project specific. It is considered critical when there is a choice between a free road and a toll road, which could be the case with two of the candidate projects.

Additional vehicle class segmentation – The designation of vehicle classes for highway assignment should be guided by difference in VOT and differences in potential toll fees, rather than simply by vehicle type (auto vs. trucks). Based on past work Metro has done, the capability exists to address this issue in the assignments.

Update VOT assumptions – VOT parameters have remained unchanged from their original estimation, which is based on home interview data collected in the mid 1990's. Estimation that is based on more recent survey data would help update the VOT's to account for real income growth that has occurred over the last 15 years.

Model Validation – A critical step before initiating a road pricing or traffic and revenue study is ensuring that the model is well-validated at a geographic scale commensurate with the scale of the project, Typically regional models are validated at a regional level and may be insufficient for tolling applications for a specific facility, corridor, or sub-area under study. The validation should not be limited to a comparison of model output to daily traffic volumes as is customary, but extended to include examination of how well the model reproduces diurnal traffic patterns. In addition, another important validation criterion is determining if the model adequately captures the major travel markets in the project influence area. Sensitivity tests can be used to ensure that the model responds adequately to changes in tolls or other service level attributes.

Time-of-day choice model – A time-of-day choice model that is sensitive to tolls and levels of service is highly desirable for projects that consider variable time-of-day tolls. This could affect both the Cornelius Pass Road proposal and the Highway 217 ramp proposal.

Assignment Periods – In order to study peak spreading and time-of-day effects due to tolls a more fine-grained segmentation of time periods in the assignment process may be required. Metro has defined unique time periods for tolling studies in the past and has the capability to look at different times of day for the assignments.

Recommended improvements for evaluating parking policies:

Parking Costs – Additional attention would be needed to ensure that parking costs are adequately represented in the model in order to assess some of candidate parking pricing proposals. The model would need to include differentiation of daily and hourly rates by zone, mode and destination choice models sensitive to parking costs. Currently the Portland Metro model includes parking costs applied on a zonal basis with an average daily rate for long term and short term parking with the short term parking rate being ½ the daily rate. Metro's destination choice model does not include parking costs. In addition, one of the parking pricing proposals includes implementing event parking; essentially charging more for parking near major event venues during events. The current Portland Metro model does not include modeling of major events, some of which may occur on weekends. Metro's model is based on an average weekday.