Thurston Regional Planning Council (TRPC) Travel Model Peer Review Report

July 2012

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U.S. Department of Transportation
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1.0 Introduction

1.1 Disclaimer

The views expressed in this document do not represent the opinions of FHWA and do not constitute an endorsement, recommendation, or specification by FHWA. The document is based solely on the discussions that took place during the peer review sessions and supporting technical documentation provided by Thurston Regional Planning Council (TRPC).

1.2 Acknowledgements

The FHWA wishes to acknowledge and thank the peer review panel members for volunteering their time to participate in the peer review of the TRPC travel demand model (TDFM) and for sharing their valuable experience.

The Peer Review Panel Members were:

- Richard Walker (Portland Metro)
- Elizabeth Sall (San Francisco County Transportation Authority)
- Chris Johnson (Puget Sound Regional Council)
- Michael Mahut (INRO)
- Stacey Bricka (Texas Transportation Institute)

Brief biographies for each of the peer review panel members are presented in Appendix C.

1.3 Report Purpose

This report summarizes the results of a peer review of the current TRPC travel model and TRPC's draft model improvement work plan. The peer review was supported by the Travel Model Improvement Program (TMIP) sponsored by FHWA. Given the increasing complexities of travel demand forecasting practice and the growing demands by decision-makers for information about policy alternatives, it is essential that travel forecasting practitioners have the opportunity to share experiences and insights. The TMIP-supported peer review provides a forum for this knowledge exchange.

The peer review of a travel model can serve multiple purposes; this review focused on recommendations for model enhancements given TRPC's overall goals. Those goals included being able to execute a model improvement effort motivated by a desire to have a model representing the state-of-the-practice in travel forecasting--a model that equips the agency, its policy board, and local jurisdictions for informed decision-making in the region. TRPC looked to the review panel for advice on a systematic approach to model enhancements and technical guidance on modeling processes to address its key analytic needs.

To that end, the peer reviewers spent one day (with web-based pre-meeting) responding to specific questions from TRPC and its planning partners. The results of that discussion in the form of observations from the panel are presented here. TRPC and its partner agencies should carefully assess the feedback from the peers when prioritizing its final model development plan. While the advice of the peers is invaluable, there are many factors to work through when considering a model improvement strategy: the peer recommendations should be regarded as suggestions for TRPC and its partners to consider rather than prescriptions to be followed.

1.4 Report Organization

This report is organized into the following sections:

1. *Introduction* – introduces the peer review panel and this resulting report
2. *Overview of TRPC* – gives an introduction to the demographics, land use and transportation characteristics of the region, TRPC's planning responsibilities, and the agency's goals for the peer review.
3. *Development of the TRPC TDFM* – this section provides a historical context of travel modeling at TRPC, including past and current model versions.
4. *TRPC Model Improvement Plan* -- TRPC's draft model improvement program.
5. *Topics of Interest to TRPC* – an assessment of TRPC's future analytical needs and related topics of interest about potential model improvements.
6. *Peer review panel response to TRPC questions* – review panel responses to the TRPC questions posed in their application for the peer review.
7. *Panel Discussion and Recommendations* -- panel's recommendations to TRPC organized as a potential action plan.

In addition, the report includes Number of Appendices:

Appendix A – list of peer review participants

Appendix B – peer review meeting agenda

Appendix C – biographies for each of the peer review panel members

Appendix D – summary of the current TRPC TDFM and data sources

2.0 Thurston Regional Planning Council Overview

2.1 Thurston Regional Planning Council Responsibilities

Thurston Regional Planning Council (TRPC) is the regional planning agency for the Thurston County, Washington region. Thurston County is located at the southern end of Puget Sound on the I-5 corridor, about 60 miles south of Seattle. TRPC and the Thurston region have a long-standing commitment to integrated transportation-land use policy and development of an integrated multimodal transportation system. The region places a high priority on system efficiency and demand management.

TRPC is the federally-designated Metropolitan Planning Organization (MPO) for the Olympia urbanized area and is also the state-designated Regional Transportation Planning Organization (RTPO) for Thurston County (see Figure 1 area in gray). TRPC conducts an MPO-compliant planning process for its full planning area--which consists of the entire County--and land use planning under Washington's Growth Management Act (GMA).

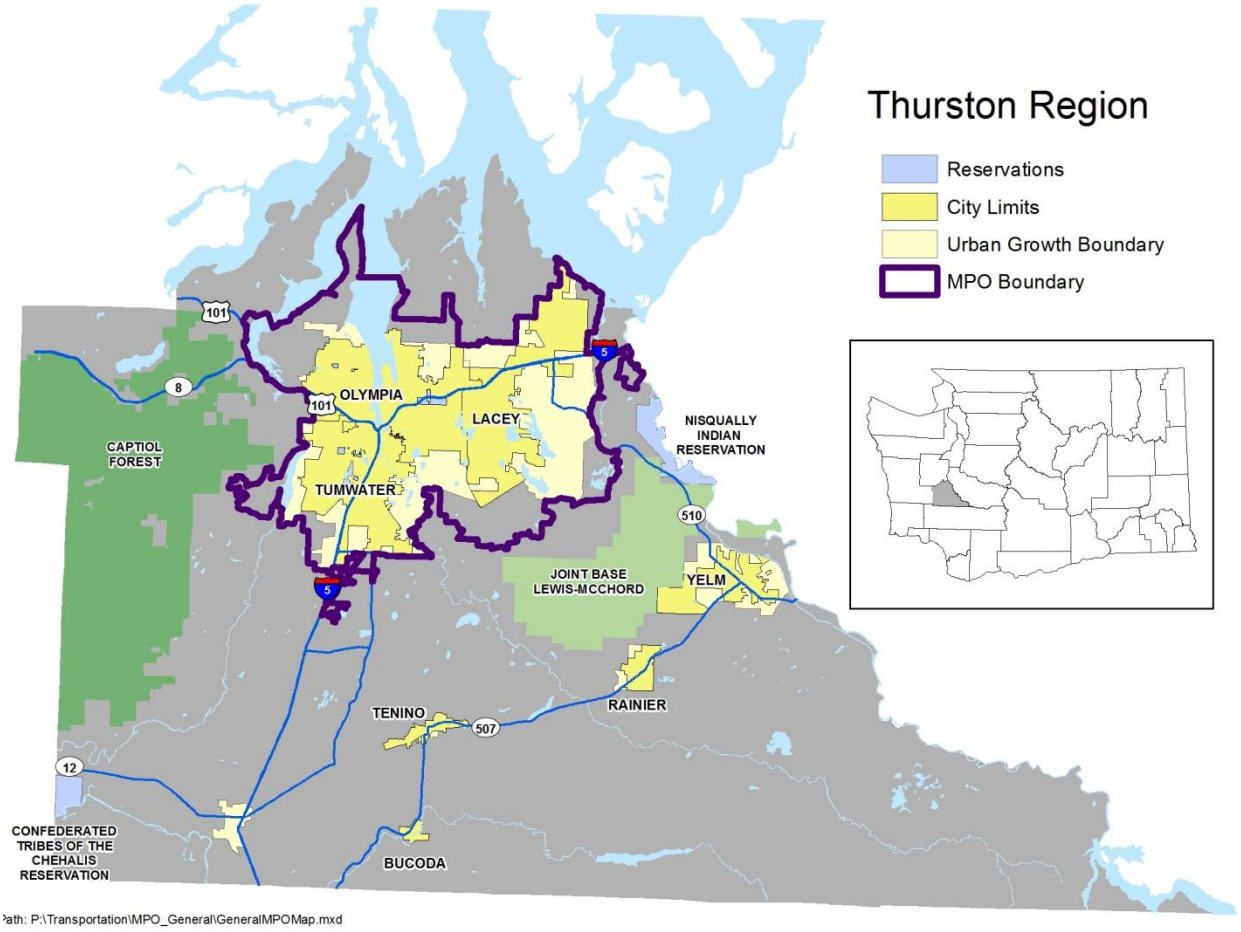

Figure 1: TRPC Planning Area (gray—all of Thurston County, Washington). Source: TRPC

2.2 Regional Characteristics and Transportation Issues

Olympia is the Washington State capital and the TRPC region's primary city, bordered closely by the cities of Lacey to the east and Tumwater to the south. TRPC's MPO area had a population of 176,600 people in the 2010 Census while its full planning area—Thurston County—had a population of 255,000. The County had approximately 130,000 jobs in year 2010 and is one of the fastest-growing counties in Washington State.[1] Seattle and Tacoma, the two largest cities of the Puget Sound Regional Council (PSRC) MPO planning area, lie respectively 30 and 60 miles to the north while Portland, Oregon lies to the south.

With respect to transportation issues, it is first critical to note that all the cities listed above are linked by Interstate 5 (I-5) which is the most important roadway in the TRPC region and, indeed, its lifeline. US 101 is another major divided highway which carries significant amounts of traffic to and from Mason County and Washington's Kitsap peninsula on TRPC's west and northwest. Pierce County to the northeast contains the main part of Joint Base Lewis McChord (JBLM, the firing range of which actually lies within Thurston County). JBLM and Pierce County generate large amounts of travel to and from the Thurston region but lie within the PSRC planning area. I-5 in the vicinity of the TRPC/Pierce County boundary—formed by the Nisqually River, the basin of which is environmentally sensitive—is heavily congested during much of each weekday and also on the weekends during the summer tourist season. The environmental sensitivity plus state budget constraints make the contemplation of traditional capacity investments in the key I-5 corridor difficult.

The evolution of the region's urban structure and the formation of its cities prior to Washington's Growth Management Act in conjunction with rapid growth have created a network of auto-oriented arterials while at the same time the combined geography of Puget Sound, public forest land, and the JBLM firing range has constrained the routing of major freeways. These "facts on the ground" complicate the region's goal of creating transit-supportive land use in its urban areas. Simultaneously much of the TRPC region remains rural, often with a major state route as the local towns' main street, creating a separate challenge of sustaining rural mobility and livability. Finally, Olympia has a saltwater port that carries log-export-related freight movements and the region has started to see the growth of large freight distribution centers.

Within this context TRPC and its members have developed and sustained a strong transportation policy framework focused on preserving the region's environmental quality and livability. The region is committed to a vision of a fully multimodal transportation system, integrating land use policy with transportation planning, using system and demand management as a means of creating efficiencies that obviate the need for traditional roadway capacity expansion, and ultimately creating good accessibility for all the region's citizens. The sincerity of this balanced commitment can be seen in the endurance of a policy not to expand regional arterials beyond a five-lane cross-section (four travel lanes plus a center turn lane).

[1] TRPC. *Travel Model Improvement Program (TMIP) Peer Review Meeting--Review of Proposed TRPC Model Improvements.* Presentation for the Peer Review. June 11, 2012. Slides 17-23.

3.0 Development of the Thurston Regional Planning Council Travel Demand Forecast Model (TDFM)

3.1 Introduction

As the federally-designated Metropolitan Planning Organization (MPO) and the state-designated Regional Transportation Planning Organization (RTPO) TRPC is responsible for developing, maintaining, and applying the regional travel demand model. The county-wide regional model includes the Lacey-Olympia-Tumwater metropolitan area as well as the more suburban and rural portions of Thurston County. The regional model has a high level of detail to support all local planning and concurrency analysis efforts.

3.2 History of Thurston Regional Planning Council TDFM

The current TRPC model was developed to replace a T-Model2 implementation that estimated only vehicle trips based on national average travel data rather than a region-specific survey. The region needed to plan for transit, demand management strategies, the state-mandated Commute Trip Reduction (CTR) program, and other issues, and found the T-Model2 tool inadequate. The agency made a conscious commitment to both develop the model and manage its necessary data acquisition in-house, and hired qualified staff to do so.[2]

The resulting model development effort took place during 1997-2000, beginning with the 1997 I-5/US 101 external origin-destination survey (supported with WSDOT funding) followed closely by the 1998/1999 TRPC Household Travel Survey (supported with Intercity Transit funding). Model development proceeded during the entire time, resulting in an operational model by early year 2000.

3.3 Current Thurston Regional Planning Council TDFM

The current implementation is a trip-based, 4-step, typical-weekday model built using INRO's EMME software platform and based upon the data described in section 3.2 above. With three peak-hour assignment time periods per day, six trip purposes, six passenger modes, and a truck mode it is well-stratified compared to models in similar regions elsewhere. It uses multinomial logit models for destination choice and multinomial logit models for mode choice. It performs a multi-class vehicle assignment and a multi-path transit assignment in each of the three modeled peak hours (AM, midday, and PM) and includes LOS skim feedback mechanisms to trip distribution and mode choice. Appendix D and the TRPC documents cited in the footnotes provide more detail on the current model.

3.4 Thurston Regional Planning Council Goals for Peer Review

The Thurston region has experienced significant growth and demographic change since the current model was first developed. A new household travel survey will be conducted in the fall of 2012 to collect data on the current demographic characteristics and travel behavior in the region. TRPC will be updating its base year and forecast year travel demand models using, among other resources, the new household survey.

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[2] Thurston Regional Planning Council. *Thurston Region Multimodal Travel Demand Forecasting Model Development.* 2000. p. 2.

As already mentioned in Section 1.3 TRPC's overall goal for seeking a TMIP peer review was to receive a transparent, un-biased, external expert review to inform its model update work. TRPC's application to TMIP expressed the belief that a peer review would help ensure that the agency's model improvements will be representative of the state-of-the-practice in travel demand modeling. Having a state-of-the-practice model is a TRPC agency goal and in the interest of its regional partners.

3.5 Previous Peer Reviews

To the knowledge of this panel TRPC has not previously held a formal TMIP model peer review.

4.0 TRPC Model Improvement Plan

TRPC has a clear vision for the functions needed in its updated travel model. This section describes the draft TRPC work plan for acquiring the necessary data and carrying out the model updates. Much of this section of the report is taken from the TRPC presentation to the review panel[3] and its RFQ for consultant support for model development.[4]

4.1 Thurston Regional Planning Council Priorities for Model

TRPC has been careful to link its modeling needs to its planning business needs. Its vision is to create a model that both addresses its fundamental planning mandates (e.g. long range plan update analysis, and air quality conformity determination) and helps to answer the following major planning questions:

- What is the future travel demand between the TRPC region and the PSRC region to the north, and what are the resultant impacts both on the TRPC region as a whole and on key facilities such as I-5? A corollary question is: how will the presence and growth of Joint Base Lewis-McChord (JBLM) affect these travel patterns?
- How can the TRPC region absorb its projected future growth and provide good transport services while achieving its environmental and land use goals? The latter, for example, include a policy of capping arterial cross-sections at four travel lanes plus a center left turn lane.
- What specific strategies for managing demand and maximizing system efficiency (e.g. congestion pricing, managed lanes, and increased vanpooling.) would be effective for the TRPC region given its goals and values?
- What are likely daily congestion patterns across all modes as the region grows?
- How can the region's particular transit services best respond to future growth in light of regional goals and values?
- Where and how will freight be moving within, into, and out of the TRPC region?

In light of these key planning issues TRPC staff proposed a list of topics for the panel to consider with the understanding that while the agency is fortunate to have model development resources they are finite. The peers' understanding of that list's priorities (below) framed their discussion and structured their suggestions (the latter appear in Sections 6 and 7 below).

- Highest TRPC Priorities
    - Meaningfully modeling interregional travel to and from the Puget Sound Regional Council planning area on the north, especially along I-5.
    - Incorporating sensitivity to managed lane, priced managed lane, and general congestion pricing strategies.

[3] TRPC. *Travel Model Improvement Program (TMIP) Peer Review Meeting--Review of Proposed TRPC Model Improvements.* Presentation for the Peer Review. June 11, 2012

[4] REQUEST FOR QUALIFICATIONS #2 – TRAVEL DEMAND MODEL CONSULTANT Thurston Regional Planning Council (TRPC) Travel Demand Model Enhancements April, 2012

  - Identifying survey techniques or ways to appropriately borrow and apply existing surveys (e.g. the PSRC 2006 household travel survey) to TRPC needs, especially the interregional travel analysis.
  - Better modeling of peak spreading and other congestion responses.

- Other TRPC Priorities
  - Better treatment of transit in general but especially of carpooling and vanpooling, and the use by those modes of park-and-ride (PNR) facilities.
  - Deciding how best to model bicycle and walk access to transit, and how to efficiently obtain transit data necessary for routine model calibration and base year updates.
  - Expanding the existing TRPC Dynamic Traffic Assignment (DTA) model spatial coverage to key additional subareas as well as enhancing the existing model with the necessary detail in several strategic corridors within the existing spatial boundary, and setting up the most efficient relationships and data exchanges between the DTA and travel demand models.
  - Deciding how and in what model (demand or DTA) to capture responses to detailed network/operational strategies such as two way left turn lanes, auxiliary lanes, and hard shoulder running.
  - Better modeling of regional freight movements, particularly existing and emerging freight distribution centers within the region.

4.2 Summary of Model Update and Data Acquisition Plan

TRPC tentatively plans to execute its overall model update in four main phases, each of which consists of several tasks. TRPC proposes to support these model updates with a comprehensive data collection effort. The centerpiece of new data will be a new household travel survey to be conducted in the fall of 2012. The plan, including data collection, can be summarized as follows:[5]

1. Update Model Structure (June 2012 - December 2012)
   - Revise current internal TAZ structure to accommodate zonal refinements
   - Expand model boundary to the north up to SR512: Add zones and network detail
   - Revise network attributes: lanes, speeds and capacities
   - Transit network: add walk and bike access, auto access, park and ride lots, and review transit routes
   - Refresh existing screenlines
   - Revise trip distribution criteria of current truck model and external model
   - Develop a new district system for model validation
2. Data Collection and Analysis (June 2012 – January 2013)

[5] TRPC. *Travel Model Improvement Program (TMIP) Peer Review Meeting--Review of Proposed TRPC Model Improvements.* Presentation for the Peer Review. June 11, 2012. Slides 74-77.

- Design and administer a new household travel survey
- Form a regionwide database of traffic counts
- Obtain transit ridership data from Intercity Transit
- Collect additional traffic and network data such as travel times, speeds, intersection geometry, signal timing, intersection queues and other pertinent information, in key strategic traffic corridors to support detailed DTA modeling.

3. Model Calibration and Forecasts (January 2013 – December 2013)
    - Estimate new model coefficients in all stages of the model
    - Move from current peak hour trip assignments to peak period modeling
    - Update external trip distribution models using recent Origin & Destination data
    - Work with the Puget Sound Regional Council to develop interregional trip tables for consistency in the two models
    - Conduct base year model validation
    - Develop 2040 forecast year model
4. Develop 2010 and 2017 DTA Models (August 2013 – January 2014)
    - Identify priority corridors for which the DTA model will be built
    - Refine the model network on priority corridors: add intersection geometry, traffic control, and signal timing data
    - Calibrate the DTA model assignments on priority corridors using travel time, speed, and intersection queue data.

5.0 Topics of Interest to Thurston Regional Planning Council

Prior to the peer review, TRPC issued two Requests for Qualifications (RFQs) for modeling support, one for a model developer and one for a model consultant. TRPC intends for the model developer to co-locate with TRPC staff to carry out a comprehensive update to the region's travel model under the direct management of the TRPC project manager and with the support and advice of the model consultant. The RFQs specify a draft scope for the model update work. That draft work scope, the TRPC application for a TMIP peer review, and materials prepared and presented by TRPC staff to the peers together identify the issues driving the model update and its potential work tasks.

This section of the report blends the materials listed above to set a detailed context for the specific TRPC questions and panel responses following in Sections 6 and 7. The intent here is to organize stated TRPC modeling interests in a framework easily recognizable to a modeler for quick identification of the model and data features on which TRPC planned to focus the most attention. Each subtopic within this section describes the stated TRPC interest and indicates the scope of the peers' response. Actual peer responses follow in Section 6. This section also includes topics about which TRPC did not originally express interest but which the panel concluded deserved attention.

5.1 Overall Modeling Framework

- Geographic Extent and External Travel

The highest TRPC model update priority is to appropriately treat travel to and from the PSRC region to the north, especially in the I-5 corridor and for travel to and from Joint Base Lewis-McChord (JBLM). Prior to requesting this peer review TRPC had already concluded that this would entail expanding the geographic coverage internal to its travel demand model with both additional TAZs and additional network details. The question of geographic coverage creates implications for almost every other model update task; the panel spent considerable time discussing and making recommendations on this topic.

- Trip Generation

TRPC's original draft scope of work includes coefficient re-calibration "in all stages of the model"[6] plus appropriate general re-calibration and re-validation. The geographic expansion of the model already mentioned will create additional demands upon the trip generation components, their update, and the necessary supporting data. The panel discussion touched in several ways upon these needs.

- Trip Distribution/Destination Choice

Similar to the update of trip generation, TRPC intends to re-calibrate trip distribution (currently a multinomial logit destination choice model). Similarly to trip generation, the necessary geographic expansion of the model will impinge upon the updates needed in destination choice and its supporting data. The panel made several suggestions on this topic.

[6] REQUEST FOR QUALIFICATIONS #2 – TRAVEL DEMAND MODEL CONSULTANT Thurston Regional Planning Council (TRPC) Travel Demand Model Enhancements April, 2012. p. 3.

- Mode Choice Model

The TRPC region needs to analyze vanpoolers/carpoolers who rendezvous at Park and Rides to access their shared-ride vehicles. The agency would also like to improve its capabilities for modeling fixed-route transit and to ensure that walk and bike access to transit are treated appropriately to avoid distorting the model's overall transit response. The panel offered some observations on how these needs create potential additional update considerations beyond a general coefficient recalibration in mode choice.

- Network Characteristics and Assignment

TRPC has several interests in updating the network component of its travel model. First, modeling travel flows well in all modes along the I-5 corridor and to/from JBLM is a high priority, even in areas outside the official TRPC planning area. Second, the region has policies in place that focus transportation investments--especially on arterials--on system and demand management techniques rather than capacity expansion. Third, the region is contemplating geometry-specific strategies including hard shoulder running, managed lanes, priced managed lanes, and congestion pricing as potential components of an overall system management approach. Fourth, the geographic expansion of the model will create a need simply for more network links and coverage. Finally, TRPC perceives that this update is an opportunity to ensure that the model representation of network characteristics (lanes, capacities, speed limits, etc.) is as up-to-date as possible for its new base year. The panel's recommendations touch on these interests in a variety of ways.

- Temporal Detail

TRPC expressed an interest in expanding its model's current three peak-hour assignments (AM, midday, and PM) to period assignments (multiple hours each) with the goal of being able to model congestion effects such as peak spreading. While by itself this objective is sufficient to justify examining the model's time-of-day capabilities, other agency priorities including pricing analysis, demand management analysis, and system management analysis add impetus to updating time-of-day estimation. The panel offered several suggestions on this topic.

- Feedback

While TRPC's explicitly-stated interests did not include feedback aspects of the model, several of its priority analysis needs (e.g. pricing, time-of-day response) justify examining the opportunities for updating feedback mechanisms to enhance the model's sensitivity. Some of the panel's remarks identify such opportunities.

5.2 Modeling Framework Specific To Transit

- Special Modes

The Thurston region has a significant number of vanpool and carpool travelers who use Park and Ride lots as rendezvous points. The panel made a suggestion on how these could be treated in the updated model.

- Access to Transit

TRPC, especially given a policy commitment to treating all transportation modes, wants to ensure that its model is representing access modes to transit appropriately. The panel offered several recommendations on this topic.

5.3 Modeling Framework Specific to Freight

- Trucks--Trip Generation and Distribution

Given that the Thurston region has attracted a number of freight distribution centers and also has the Port of Olympia (to which a majority of trips are log export-related), it has an interest in a "high level"[7] freight model update, primarily focused on truck travel. The panel offered a series of observations on freight modeling predicated on the understanding that "high level" means less costly. Potential updates to the model's freight elements could affect both truck trip generation and truck trip distribution.

5.4 New and Existing Data Sources

- Travel Surveys

TRPC plans to commission a new travel survey to commence in fall 2012 for support of its model update. It therefore has a keen interest in ensuring that the survey is well-designed and is coordinated with its overall model update plan. The geographic expansion of the model area, the presence of JBLM, and extensive interregional travel all create special considerations for the survey. TRPC posed many questions about the survey and the panel responded in some detail.

- External Origin-Destination Surveys

The importance of what are now treated as external trips to the TRPC region is such that TRPC conducted a new external trip origin-destination survey in 2010. This will provide valuable insights for the model updates. The panel made additional data-related recommendations on this topic.

- Transit Data

TRPC is interested in having robust transit analysis capabilities in its model and in regular updates to the model base year. It expressed curiosity about transit data sources that it should maintain in-house for these purposes and what other data might be necessary to support appropriate representations of bike/walk access to transit. Note that the region is fortunate that its sole internal transit provider has a robust Automatic Passenger Count (APC) system. The panel addressed these topics and added a recommendation regarding a transit on-board survey.

- System Characteristics and Performance Data (including Network, Traffic Counts, Speeds, and others)

The scope of TRPC's planned model updates is such that it has a natural interest in up-to-date observed system data both in terms of system characteristics and system performance. Given partnerships with local agencies and WSDOT, TRPC will have reasonably robust roadway data available in its new base year (2012); as mentioned above it will also have useful transit ridership information. The panel did not explicitly address these specific data aspects, but its other recommendations implicitly assume a reasonably robust set of this "foundation" data.

[7] TRPC Application for a TMIP Peer Review. 2012. p.5.

- Truck/Commercial Vehicles

Aside from its general interest in high-level freight model enhancements TRPC preparatory material did not explicitly mention new freight data. Even a high-level approach to truck modeling, though, requires a certain minimum amount of data with which to work—this gives the agency a natural interest in obtaining new freight data and the panel made a suggestion in this regard.

5.5 Integration with Simulation and Dynamic Traffic Assignment (DTA) tools

With its system-management-oriented policies TRPC has a strong interest in analysis capabilities that provide more operational and temporal detail than the demand model. Indeed, the agency has already developed a DTA model for its "Smart Corridors" project involving two bisecting corridors that converge in downtown Olympia. TRPC intends to enhance its DTA capability for a number of reasons including its preference for operational/management strategies and its need to support more locally-driven studies. The panel made a series of recommendations on this topic.

5.6 Other Panel Observations/Recommendations

Section 6 below lists the explicit TRPC questions posed to the panel along with the panel's responses. As is often the case in model peer reviews, though, the draft scope of model update work and accompanying explicit questions do not necessarily cover all points necessary for the panel to make a complete and consistent set of recommendations. Section 6 therefore includes these extra topics under the heading to which they most logically apply and also lists them for quick reference under their own separate heading, 6.6, for easy identification.

5.7 Model Application Discussion

It is worth concluding this section's discussion of TRPC's modeling interests with a brief overview of the applications TRPC intends for its updated model. The panel recommendations were made with the clear understanding that the updated model will be used to:

- Evaluate and Prioritize I-5 Mobility Alternatives
- Support a Transit Alternatives Analysis
- Conduct operational analysis of key travel corridors, including the evaluation of demand management techniques, access management strategies, and land use policy/investment strategies
- Conduct forecasting for Regional Transportation Plan updates
- Conduct air quality conformity analyses
- Support the development and application of regional transportation performance measures
- Support sustainable/livable communities analyses
- Support state- and locally-sponsored studies (it is important to note that all agencies within the TRPC region use the TRPC model, or start with the TRPC model, for their studies), including:
    - Traffic Impact Analyses

- Concurrency Demonstration
- Interchange Justification Reports (IJRs)
- Transit System and Park-and-Ride planning
- Local comprehensive plan updates.

6.0 Peer Review Panel Response to Technical Questions

In its application to TMIP for this peer review and its presentation to the peers during the review TCRP proposed a series of specific questions. Those questions formed the basis of the peers' discussion and are listed below with the panel's responses in italics. The major headings in this section match those in Section 5 above for easy cross-reference.

6.1 Overall Modeling Framework

6.1.1 How can we make our model sensitive to travel demand management strategies on I-5, such as a potential addition of HOV lane, conversion of an existing general purpose lane to HOV, congestion pricing, etc.? In response to this question the panel proposed a multi-part approach:

6.1.1.1 Build LOS sensitivity into trip generation to handle latent demand or flex work response to congestion

6.1.1.2 Feed LOS and accessibility back to auto ownership (e.g. location-efficient mortgage scenario).

6.1.1.3 See also section 6.1.4 below, "…peak hour to peak period…"

6.1.1.4 The panel observed that there are two general options for structural changes to the model: a "basic" approach and a "state of the practice" approach; TRPC can choose based on its assessment of its needs and resources. Both approaches include borrowing PSRC's 11 assignment classes (HBW by 4 income categories, HOV2, HOV3+, etc.) or doing similar income stratification.

(a) Basic approach:

(i) Carry income classification through the entire model chain consistently (however, note that recent literature shows that low income travelers can have very high value of time(VoT) so this approach entails inaccuracies)

(b) State of practice approach:

(i) Replace the current trip generation submodel with a population synthesizer

(ii) Use distributed VoT from the population synthesis in mode choice and assignment; even if the distribution is asserted it will be more useful than the static alternative.

(iii) See Joan Walker's paper[8] on microsimulating a 4–step model

[8] Walker, J.L., "Making Household Microsimulation of Travel and Activity Accessible to Planners," *Transportation Research Record*, 2005, No. 1931, pp. 86-98. See http://pubsindex.trb.org/view.aspx?id=803554

6.1.2 To better account for inter-regional commute pattern between Thurston County and Pierce plus King Counties, especially from Thurston County to the Joint Base Lewis McChord(JBLM), we are planning to expand our model boundary to include JBLM at an appropriate zone structure and network detail. Is this the right approach, and what are some related data and modeling issues we need to consider?

6.1.2.1 Consistent internal representation (in other words, subject to complete treatment by all model components including trip generation, trip distribution, and so on) in both TRPC and PSRC models of zones and networks, will create useful sensitivity to factors affecting LOS in areas of "overlap." The preferable goal is to endogenously treat all factors driving LOS and trip generation.

6.1.2.2 The extent of geographic expansion should be data-driven (using the 2010 External OD Survey) to ensure internalizing all significant origins and destinations WITHIN the enhanced model. For example, it may be advantageous to extend the TRPC model boundary farther north than SR 512.

6.1.2.3 Borrowed survey data can inform this development task; see the question regarding travel survey data for related comments.

6.1.2.4 A usual workplace location choice model (even at a coarse geography) would build in useful sensitivity; this could potentially be estimated from 2010 Census data, the 2010 OD Survey, and appropriate American Community Survey (ACS) Census Transportation Planning Package (CTPP) data.

6.1.2.5 Ensure appropriate and consistent incorporation of special generators with their supporting network details (e.g. JBLM, campuses), informed by count and gate data already available, and consistent treatment of these elements in both the PSRC and TRPC models.

6.1.3 TRPC and PSRC travel demand models share the border at the north Thurston and Pierce Counties' boundary. We have found discrepancies between the two models at the boundary and want to work on resolving the differences. What are the core features and assumptions that must be in agreement between the models?

6.1.3.1 The technical steps enumerated in section 6.1.2 "Model Boundaries" should ameliorate drastic discrepancies.

6.1.3.2 Institutional steps will be necessary to enable the technical steps. The panel recommended establishing close collaboration with key partner agencies—especially PSRC and Pierce County—to address the technical needs.

6.1.4 We are transitioning from peak hour modeling to peak period modeling as part of this model update. Are there any factors to be aware of or lessons learned based on prior experience elsewhere?

6.1.4.1 The panel advised that regardless of final assignment time periods it is most important to ensure accurate representation of peak-hour LOS (several methods are available; PSRC uses peaking factors derived from base year traffic counts to convert to hourly volumes within its multi-hour modeling periods).

6.1.4.2 Add a time-of-day choice model: this makes the model sensitive to demand management policies and pricing strategies in ways that using static proportions does not. A time-of-day submodel should be responsive to the peak-hour LOS (some agencies like PSRC use smaller time periods for their time-of-day submodel) and is a useful way of addressing peak spreading issues.

6.1.4.3 The panel endorsed the use of DTA for understanding fine-grained time-dependent response to congestion. Demand models can only be taken so far in capturing temporal responses.

6.1.5 What are some guidelines in modeling freeway auxiliary lanes and hard shoulder running?

6.1.5.1 Within the limitations of the demand model (see DTA note just above) there are common and feasible treatments to ensure reasonable representations of the capacity two way left turn and other arterial treatments create. One approach to arterial geometries is to develop from observed traffic data customized volume-delay-functions by a somewhat detailed facility typology (e.g. 5-lane urban arterial, 4-lane urban arterial, 3-lane urban arterial, etc.). Another approach that may be applicable to hard shoulder running is to use fractional lane attributes (e.g. add 0.75 of a lane in time periods when hard shoulder running is activated). For auxiliary lanes, networks can be coded so that links end whenever the real-world cross section changes to avoid needing fractional lane attributes, or fractional lanes can be used. Fractional lane approaches should be supported by observed count and speed data to ensure accurate representation of capacity.

6.2 Modeling Framework Specific to Transit

6.2.1 TRPC posed several specific transit-related questions (6.2.2 through 6.2.4 below), but the discussion they engendered led the panel to make additional structural recommendations first:

6.2.1.1 Build more robust treatment of zone-to-zone transit LOS in destination choice (i.e. incorporate transit LOS in demand portions of the model through transit-, bike-, and walk-inclusive logsums) AND in mode choice. Bus stop density was mentioned as a possibility but it is an ineffective proxy for zone-to-zone transit LOS.

6.2.1.2 Consider more detailed wait-time treatment. This could be informed by a low-budget data collection effort (i.e. have staff spend short periods of time at selected key stops and time the actual waits).

6.2.2 What Park and Ride treatment can be done to model vanpool/carpool formation?

6.2.2.1 Full treatment (for fixed-route transit also) of PNR is a high priority (see INRO's packaged PNR macros); in addition to internal trips, be sure to properly represent PNR access to northbound and southbound trips now treated as "internal-external" or "external-internal" in collaboration with PSRC to provide accurate LOS skims.

6.2.2.2 Consider treating "park and pool" (vanpool/carpool) as PNR fixed-route transit supply; CTR data can help with this.

6.2.3 What transit data sources should TRPC maintain in-house?

6.2.3.1 Establish a relationship with Intercity Transit to pull data as needed. Special attention should be given to getting datasets for validation and survey time periods and base years for projects. Route-level ridership by time of day from APC data has been useful for other agencies as has stop-level ridership for stops of interest (i.e. near important areas of interest and high transfer areas). Both APC and AVL data can also be useful for validating transit travel times in the travel model. Intercity Transit reports[9] that all its fixed-route fare services are instrumented with Automatic Passenger Count (APC) equipment plus Automatic Vehicle Location (AVL) systems, and that the AVL data is integrated with its GIS database in which all fixed-route stops are geocoded.

6.2.3.2 See "New and Existing Data Sources" below for a suggested on-board survey.

6.2.4 Do we need to differentiate walk and bike access? If so, what additional data do we need to collect to account for the same?

6.2.4.1 In the new, denser TAZs ensure sufficient network representation to accurately represent walk access.

6.2.4.2 Treat walk-, bike-, and auto-access separately with appropriate "travel sheds" and speeds for each access mode. These can be calibrated based on on-board survey data and cross-checked with the HH survey.

6.2.4.3 An oversample in the HH survey of this segment could help validate walk and bike skims and also allow for the estimation of separate models for each access mode.

6.3 Modeling Framework Specific to Freight

6.3.1 Can we account for major freight distribution centers in the region, using our fairly basic truck model? Is there a suggested high level freight model enhancement that we should consider incorporating in our scope of work?

6.3.1.1 The panel offered a few overall freight-related observations:

(a) First, the panel understood that by "high level" TRPC desires a relatively low-cost means of improving the freight component of its model. Due to the intricacies of freight travel behavior and the challenges with getting relevant observed data, advanced freight modeling tends to be a significant financial investment.

[9] Direct communication with Mr. Dennis Bloom of Intercity Transit on 7/24/12

(b) Since this level of effort is not within the TRPC budget at this time, the panel recommends not making any significant investments in the freight component of the travel model and instead recommends keeping it simple by relying on national parameters and existing data. Focus improvements on your major planning needs by ensure that freight flows on I-5 and US 101 are accurate. To this end consider engaging WSDOT for data acquisition support (and perhaps even model development support) given the statewide importance of these facilities.

6.3.1.2 Employ Quick Response Freight Manual, second edition (QRFM2) techniques and parameters to make quick but well-founded improvements.

6.3.1.3 Use more detailed employment categories in truck trip generation than simple total employment. A corollary suggestion is to ensure that the employment data used for truck trip generation is accurately categorized. For example, the Production Distribution and Repair (PDR) category should capture the freight distribution centers, but care should be taken to make sure that it is appropriately categorized in the TRPC land use data.

6.4 New and Existing Data Sources

6.4.1 Given that we are expanding the model boundary outside Thurston County; can we 'borrow' survey data from the adjacent regions? What do we need to keep in mind while dealing with surveys from different sources and different points of time?

6.4.1.1 The PSRC 2006 HH Survey will be useful given the overlap in markets and the fact that PSRC survey records have specific locations for what PSRC considers to be "external" trip ends (some of which are likely to be in the TRPC region).

6.4.1.2 A useful way to ensure compatibility between the PSRC 2006 HH survey and the upcoming TRPC survey would be to conduct an independent sample in the TRPC region using the PSRC survey design.

6.4.1.3 The panel strongly recommended coordinating the "boundary expansion" of the model with the use of borrowed survey data and the targeted samples recommended below (military and outbound commuters) to ensure consistent representation in both model geography and collated survey data.

6.4.2 What aspects of the National HHTS are appropriate to use to augment our HHTS?

6.4.2.1 The panel observed that the NHTS is not likely to be useful given a probable difference in trip length frequency distribution and the fact that the NHTS had a small sample size within the region.

6.4.3 We are experiencing pronounced growth in outbound commuting. How does that influence the design and analysis of our HHTS?

6.4.3.1 Perform a targeted sample of outbound commuters.

6.4.4 Some parts of our County have experienced significant growth since the prior HHTS was conducted. Do we emphasize this area and collect more samples in these areas, while scoping our new HHTS? How to we take care of statistical validity across the region?

6.4.4.1 First, to ensure representative demographics in the completed survey TRPC should consider a multi-frame sample, combining an address-based sample with a cell-phone sample.

*6.4.4.2 Second, geographic targeting is likely necessary but a proper overall survey design should sample from **both** high-growth and low-growth areas in order to provide statistically valid samples of both population groups.*

6.4.5 The military population commuting from Thurston County to JBLM has unique travel patterns and constraints. Should we collect extra samples of this population?

6.4.5.1 Yes, JBLM travelers should be the subject of a targeted sub-sample similar to the outbound commuting population cited earlier. These two groups are the most important targeted samples to obtain. The best approach would be a geographic over-sample of the areas where most off-base housing is known to exist.

6.4.6 Questions not to forget while designing the survey, given our vision for the model enhancements and how we plan to use our models?

6.4.6.1 Capture all detail for all respondents (e.g. trip end locations for what TRPC now considers to be "external" trips); the entire state is the TRPC survey area in a very real sense given the interregional flows.

6.4.6.2 Coordinate the model geographic expansion with the collation of borrowed surveys (PSRC) and targeted samples (e.g. JBLM) to ensure consistency.

6.4.7 What are the pros and cons of various technologies out there that we should consider in scoping our HHTS? Which of those would be best suited to our agency needs and why?

6.4.7.1 Newer technologies are a must given the available budget. This means that the survey approach should be multi-modal – offering mail, phone and web options.

6.4.7.2 With regards to some type of GPS collection, the most cost-effective approach would be a Smartphone application, similar to the SFCTA Cycle Tracks. A volunteer-based, smartphone-deployed instrument would capture the younger demographic group without costly special recruitment.

6.4.8 Additional panel discussion led to these observations/recommendations regarding data:

6.4.8.1 A transit on-board survey is highly desirable, in same time frame as HH survey.

6.4.8.2 It will be useful to mine the CTR data to supplement the new HHTS, particularly giving insights into the behavior of the in-bound commuters.

6.4.8.3 The 2010 External Origin-Destination Survey is a critical source to mine, especially to inform the question of what geography to internalize within the full coverage of the model.

6.4.8.4 In the longer term, TRPC should consider partnering with PSRC, WSDOT, and other western Washington agencies to conduct a future "Cascadia" survey covering both PSRC and TRPC regions together; one strategy for accomplishing this could be to do an "add-on" to the next PSRC HH survey. We also encourage PSRC to do an "add-on" to the next TRPC survey

6.5 Integration with simulation and Dynamic Traffic Assignment (DTA) tools

6.5.1 TRPC's vision is to develop and maintain a region wide Dynameq DTA model. We have a Dynameq model that we developed as part of our Smart Corridors project. Our strategy is to build on the existing model, and expand the model to some more priority corridors as part of this model update. Is this a valid approach? Does addition of more corridors to the model mean recalibration of the whole model?

6.5.1.1 The panel observed that the network coding effort is low relative to the calibration effort; it can therefore be advantageous to proceed by coding all the base-year network detail across all priority corridors at one time. This would avoid the potential need for significant recalibration efforts if each corridor study were to add significant network coding detail. However, note that:

(a) One must have high-quality data with which to code network characteristics and understand the observed, base-year travel demand, including field data used for model calibration and validation: good data reduces the calibration effort. It should also be emphasized that field data for calibration and validation must be collected for key facilities and in general with good coverage of the study area or corridor.

(b) Freeways should be fully coded with all lane detail from the beginning; this provides a common and solid reference framework for individual corridor studies as needed.

(c) Basic calibration (not detailed calibration) should be done on the full system once it is completely coded.

(d) See the following question for more related to this topic.

6.5.2 What is the suggested frequency of model updates, given the dynamic nature of traffic operations and travel pattern in analysis corridors?

6.5.2.1 It is wise to perform detailed calibration then validate the model in the study corridor at the time of the study; this allows use of the most recent data in the corridor.

6.5.2.2 In relation to the previous point about model coverage expansion strategies, note that adding minor network detail should not require major re-calibration.

6.5.2.3 It would be wise to craft institutional arrangements so that TRPC is notified of major operational changes that would require larger-scale updates and more detailed re-calibration (see San Diego's arrangement for distributed system data entry: the TRB Planning Applications conference in Reno had a presentation on it by Joaquin Ortega). Updates can then be data-driven on an as-needed basis rather than on a fixed, and thus potentially arbitrary, schedule.

6.5.3 In general, the panel endorsed the TRPC past and proposed uses of DTA as appropriate and useful.

6.6 Other Panel Observations/Recommendations

6.6.1 Are there any other low hanging fruit or significant improvements that our draft scope of work missed, and those we should consider including? *The panel did make recommendations beyond the scope of the original questions in the answers listed above; these are repeated here for easy identification.*

6.6.1.1 An optional idea would be to replace trip generation submodels with a population synthesizer to enable use of distributed values-of-time, complemented with an expansion of user classes to match those of, for example PSRC, to allow assignment of more value-of-time groups. This will add appropriate sensitivity for pricing analysis.

6.6.1.2 Consider enhancing the current work trip production and appropriate parts of the existing destination choice model with a usual workplace location choice submodel. Even at a coarse geography, this coupled with the "internalization" of geographies that produce or attract what are now considered to be "external" flows, would much improve the model's treatment of the major north-south flows that are now so challenging.

6.6.1.3 Consider adding a time-of-day choice model. This would usefully complement the proposal of assigning peak periods instead of just peak hours by building in actual sensitivity to traveler and system factors that influence peak spreading and traveler response to pricing.

6.6.1.4 Consider adding full treatment of Park and Ride (PNR) travel, including fixed route transit service, as a means to strengthening the mode choice model, complementing the desired treatment of vanpool/carpool travel, and properly internalizing the transit-using flows now considered "external" (the geographic expansion discussed above will enable this treatment).

7.0 Panel Discussion and Observations

This section summarizes the panel's answers to TRPC questions and offers the peers' overall observations. TRPC staff already have a healthy appreciation of the uses and limitations of models, a strong consultant team ready to get started, and budget for the upcoming household survey. The agency has in the past demonstrated a sensible approach to model development and application. This discussion can thus proceed quickly to a focus upon short- and long-term suggestions for the model update after a relatively brief treatment of TRPC's analysis needs. While this section covers much of the same material found in the previous section's point-by-point response to TRPC questions, it pivots that material into a potential action plan.

7.1 Observations: Analysis Needs

7.1.1 General Comments

TRPC has a precise understanding of its modeling needs and priorities including its responsibilities under federal and state law plus its locally-driven analysis requirements (see Section 4.2). Its current model appears to have amply served the legally-mandated applications. The panel expects that judiciously-implemented updates will allow the model to continue doing so in the future. TRPC's stated analysis priorities make sense both in terms of the mandated applications and the locally-driven applications.

7.1.2 Panel Observations on TRPC Analysis Priorities

The high priority TRPC places on updates, enabling better modeling of interregional travel flows and their impacts on I-5, is sensible. Anecdotal remarks from TRPC and partner staff during the peer review indicated that the current model has to be "tricked" into handling future interregional flows along the I-5 corridor by the addition of two I-5 travel lanes (one each direction) which do not now exist and for which there are no future plans. Such tricks benefit neither general planning/air quality applications nor investment study modeling. Since the most direct solution (expanding the model boundary appropriately) has a profound effect on the model and supporting data gathering, it makes sense for TRPC to treat this as a high-priority analysis need.

Another main TRPC analysis priority—mobility alternatives analysis on I-5, with managed-lane/pricing alternatives—is related to the general priority of addressing interregional travel. Keeping this as a priority likewise makes sense for two reasons: successfully modeling I-5 is part of the solution to the general interregional issue; and enabling meaningful analysis of pricing and managed lanes will drive other fundamental model update tasks in useful directions.

TRPC's third stated priority follows logically from the above. The potential for transit and carpool/vanpool solutions to help with the interregional and I-5 issues is well worth assessing given environmental and budgetary pressures on potential action alternatives in the I-5 corridor.

The main comment the panel made about TRPC analysis priorities regards what the agency listed as "Corridor Analysis": studying possible operational solutions on existing and potential "Smart Corridors"; and studying related system/demand management options, in general. This corridor analysis drives the stated intent of enhancing TRPC's DTA capability, which is sensible. The panel observed in addition, though, that as important as it is to do what one can to treat managed lanes properly in the demand model, to really understand them operationally and when priced, the demand model is insufficient. DTA has demonstrated its ability to address priced managed lane analyses (e.g. US 36 in Colorado) and TRPC already has both existing

DTA capabilities plus plans to enhance those capabilities. The panel therefore suggests using DTA for managed lane analysis, where appropriate, to supplement the demand model.

7.2 Potential Shorter-Term Model Updates

The panel observed that TRPC could focus on the following steps in the near term:

A. Expanding the model boundary to "internalize", in all model components, all Puget Sound Region geography that produces or attracts significant amounts of travel to and from the TRPC region. This should be in close coordination with supporting data acquisition tasks, especially the design and scope of the upcoming 2012 TRPC household travel survey and its supplementation using data from the 2006 PSRC survey. Specifically, this would entail:
    - Choosing the new boundary based on careful understanding of existing travel flows (the 2010 I-5/US101 and the 2006 PSRC HH surveys being prime sources of such information) so that all significant movements are internalized.
    - Carefully building in consistent demand and network treatments of "special generators" such as JBLM and government campuses using observed performance data (gate count, traffic count), asset data (lanes, capacities, etc.), and (for JBLM) a targeted sample from the 2012 TRPC HH travel survey.
    - The potentially useful (but optional) additional enhancement of replacing passenger work trip generation/destination choice with a usual workplace location choice model. This could potentially be estimated from 2010 Census data, the 2010 OD Survey, and appropriate American Community Survey (ACS) Census Transportation Planning Package (CTPP) data. PSRC has an operational submodel of this type that could be used for comparison.
    - Establishing active coordination with PSRC on all model expansion tasks, but especially special generator treatments.
    - Carefully coordinating the design and implementation of the new 2012 TRPC model survey by:
        - Extracting data on trips to/from the TRPC model area from the existing PSRC HH survey.
        - Targeting samples of the JBLM population and the travelers currently considered to be "outbound commuters."
        - Borrowing the PSRC survey design for the survey to be conducted in the TRPC region (but also being careful to ensure that all necessary details are captured for all respondents, such as trip end location, no matter where the trip starts and stops).
        - Carefully designing targeted sampling and deploying multi-modal instruments (phone, mail, web) in the survey to ensure complete sampling of representative demographic groups.
        - Seeking to have a transit on-board survey done by Intercity Transit in a time frame compatible with the TRPC 2012 HH survey.

B. Improving the model's sensitivity to pricing analysis with a series of individual enhancements. Note that these enhancements are also likely to help with the boundary

expansion task since high-priority model applications are intended to analyze pricing in the I-5 corridor which carries much of the travel that TRPC desires to "internalize."

- Establish a more-detailed and consistent treatment of value-of-time (VoT) in all model components. TRPC has two basic alternative approaches to this:
  - Option 1 (the "basic" approach):
    - Borrow PSRC's 11 assignment classes (HBW x 4 income categories, etc.) or something similar.
    - Carry the income classes through the entire model chain
    - Be careful in application since recent research has found that low income travelers can have very high VoT in some cases, meaning that aggregate approaches like this entail inaccuracies.
  - Option 2 (the "state of practice" approach):
    - Again borrow PSRC's 11 assignment classes or something similar.
    - Replace the current trip generation submodel with a population synthesizer (see Joan Walker's paper on microsimulating a 4–step model)
    - Use distributed VoT from the population synthesis in mode choice and assignment; even if the distribution is asserted, it will be more useful than the static alternative.
- Ensure accurate representation of peak-hour LOS in all modeled time periods. Without this, the model is less sensitive than it should be to pricing and congestion.
- Build LOS sensitivity into trip generation to handle latent demand and flexible work response to pricing and congestion.
- Feed LOS and accessibility into the auto ownership submodel. For example, think of the concept of location-efficient mortgages.
- Add a time-of-day choice model in conjunction with moving to peak period assignments: this makes the model sensitive to demand management policies and pricing strategies in ways that static proportions from base year diurnal factors cannot. The time-of-day submodel should be responsive to the peak-hour LOS (some agencies like PSRC use smaller time periods such as half hours for their time-of-day submodel), and is a useful way of addressing peak spreading issues. Without time-of-day choice, the model will not be responsive to variable pricing.
- Strongly consider applying the TRPC DTA capability for understanding fine-grained time-dependent response to congestion, where appropriate. The demand model will not have the time granularity of the DTA.

C. Steps A and B will naturally benefit from a solid foundation in the form of proper representation of appropriate network detail. Within the context of the demand model, it is helpful to properly represent capacity, especially in pricing analysis. Two-way-left-turn lanes (TWLT), auxiliary lanes, and hard-shoulder running are instances of real-world

solutions that are sometimes coarsely represented in demand model networks. Given that TRPC intends to update its network representation as a part of this overall effort, the panel made some specific suggestions regarding these special features:

- Arterial geometries with TWLT and other features can be represented by developing from observed traffic data facility-specific volume-delay functions (VDFs). A facility typology might be something like 5-lane arterial, 4-lane arterial, 3-lane arterial, 2-lane local, etc. Alternatively, coding TWLTL as a half-lane would be consistent with PSRC's current practice.
- Hard shoulder running could be treated by the use of an additional fraction of a lane in the modeled time periods when the shoulder is open to traffic; the additional fraction would depend upon the facility type, shoulder geometry, permitted speed, or similar factors.
- Auxiliary lanes can be treated as a full additional lane if the network is coded so that every change in overall cross section starts another model link. Some agencies use a fraction of a lane to represent the auxiliary lane if they choose not to create separate links every time the facility cross-section changes.

7.3 Potential Mid-Term Model Updates

The shorter term possibilities listed above are mutually supportive and in several cases (e.g. time-of-day choice and peak-hour LOS representation) highly interdependent. In a certain sense, they make a complete set and they also address what the panel understands to be TRPC's highest-priority analytic needs. The mid-term potential tasks are those that would be useful to TRPC's analytic priorities but that are not quite as wrapped up together with the potential short-term items listed above. The following steps are more self-contained (and therefore easier to do later):

A. Enhance the model's treatment of carpool/vanpool and general transit modes.
   - A key enhancement is a more representative treatment of zone-to-zone transit LOS in destination choice and mode choice. This should be achieved by incorporating transit, walk, and bike in the utility logsums.
   - It would be very useful to fully treat Park and Ride (PNR) and drive-access to fixed-route transit in the model. This can help the desired enhancements to the modeling of carpool/vanpool use of PNR facilities. INRO supplies pre-packaged PNR macros that can help. In addition to internal trips, be sure to represent PNR access to northbound and southbound trips now treated as "external-internal" or "internal-external" in--collaboration with PSRC--to provide accurate LOS skims.
   - Evaluate the potential of treating "park and pool" travelers (the vanpoolers/carpoolers using PNRs as rendezvous parking locations) as fixed-route transit, since such arrangements are typically scheduled in advance and repetitive. The region's Commute Trip Reduction (CTR) data can help here.
   - Do proceed to differentiate walk and bike access to transit by:
     - Building in sufficient network representation to accurately represent walk access in the new, denser TAZs.
     - Treating walk-, bike-, and auto-access separately with appropriate "travel sheds" and speeds.

B. Upgrade the TRPC DTA model to encompass the existing and anticipated subareas to be analyzed for operational, managed lane, or system management purposes.

- Start by coding all base year freeways with all lane details; this provides the common reference framework for all further subareas and enables managed-lane analysis in the DTA model.
- Next code all base year network details across all analysis subareas.
- With the required network in place conduct a basic (not fully detailed) calibration on the entire system. This will provide insight into any major demand/supply inconsistencies (since the DTA model is capacity-constrained), and if required possible implications for the demand model can be considered. Coding options for intersections that are outside of the detailed study corridors can also be considered at this point, e.g. as was done in the Smart Corridors project.
- Note that, although coding effort is low relative to calibration effort, it is crucial to have comprehensive high quality network data for coding AND high quality observed performance data for calibration. Good data on both topics reduces the calibration effort required.
- As individual studies commence, perform detailed calibration and validation in the study area. Note that adding minor network detail should not require major recalibration.
- The panel also recommended crafting institutional arrangements so that TRPC is notified of major operational changes that would require larger-scale updates and more detailed re-calibration in the future (see San Diego's arrangement for distributed system data entry: the TRB Planning Applications conference in Reno in 2011 had a presentation on it by Joaquin Ortega). Overall network updates can then be data-driven on an as-needed basis.
- The panel suggested approaching sponsor agencies for the individual studies not only for data but also for model development and calibration funding.

7.4 Potential Long-Term Model Updates

The panel observed that it may be sensible for TRPC to implement freight model updates later, in the longer term. The justifications for this observation are indications from TRPC materials and verbal responses to panel questions that (a) much Port of Olympia traffic is specialized (log-export related), (b) there are some but not a high number of freight distribution centers in the region, and (c) a good proportion of freight movements in the region are "through" movements. Regions with more sophisticated freight models by comparison have (a) larger ports (or similar special generators) serving diverse commodities, (b) many distribution and transfer centers, and (c) large amounts of internal freight productions/attractions in addition to through movements. Freight is still important to model; it just might not be as important as other features at this time. When TRPC does invest in its freight capabilities the panel recommends the relatively simple approach described below.

A. Enhance the model's freight treatment using existing data and national parameters (i.e. Quick Response Freight Manual, second edition).
    - Focus improvements on major TRPC planning needs by ensuring that freight flows on I-5 and US 101 are accurate. To this end, consider engaging WSDOT for data collection and even model development and calibration support given the statewide importance of these facilities.
    - Use more detailed employment categories in truck trip generation than simple total employment. The Production, Distribution, and Repair (PDR) category should capture distribution centers, but it is important to verify that the employment data used for truck trip generation is accurately categorized.

B. On a separate topic, TRPC should consider partnering with PSRC, WSDOT, and other western Washington agencies to conduct a "Cascadia" travel survey covering both PSRC and TRPC regions together. One way of accomplishing this would be to do an "add-on" to the next PSRC HH survey and for PSRC to support an "add-on" to the proposed 2012 TRPC survey.

Appendix A List of Peer Review Panel Participants

This section contains a list of the peer review participants, including the panel members, local agency staff, and TMIP documentation support staff.

A.1 Peer Review Panel Members

Panel Member	Affiliation
Richard Walker	Portland Metro
Elizabeth Sall	San Francisco County Transportation Authority
Chris Johnson	Puget Sound Regional Council
Michael Mahut	INRO
Stacey Bricka	Texas Transportation Institute

A.2 Local Agency and Partner Agency Staff

Name	Affiliation
Bharath Paladugu	Thurston Regional Planning Council
Thera Black	Thurston Regional Planning Council
Lon Wyrick	Thurston Regional Planning Council
Jailyn Brown	Thurston Regional Planning Council
Paul Brewster	Thurston Regional Planning Council
Steve Morrison	Thurston Regional Planning Council
Jared Burbidge	Thurston Regional Planning Council
John Donahue	Washington Department of Transportation
Nazmul Alam	Washington Department of Transportation
Natarajan Janarthanana	Washington Department of Transportation
Steve Kim	Washington Department of Transportation
Dave Smith	City of Olympia
Scott Davis	Thurston County Public Works
Pat McGuin	City of Lacey
Dennis Bloom	Intercity Transit
Hu Dong	City of Bellevue
Sean Wellander	City of Bellevue
Gary Hendricks	Pierce County

A.3 Consultant Staff

Name	Affiliation
Kimon Proussaloglou	Cambridge Systematics, Incorporated
Cemal Aualik	Cambridge Systematics, Incorporated
Clyde Scott	Scott & Associates
George Smith	Shea Carr Jewell

A.4 TMIP Peer Review Support Staff

Name	Affiliation
Jeff Frkonja	Resource Systems Group, Incorporated

Appendix B Peer Review Panel Meeting Agenda

B.1 Thurston Regional Planning Council Model Peer Review

June 11, 2012

9:00 am – 9:10 am	Introductions Face-to-Face, Meeting Structure and Logistics
9:10 am – 9:30 am	Additional Background on TRPC and the Thurston Region
9:30 am – 10:15 am	Additional Technical Overview of the TRPC Model
10:15 am-10:30 pm	Break
10:30 am-11:30 pm	Additional Information on TRPC Model Enhancements Project
11:30pm-Noon	Moderated Discussion: Setting the Agenda for Lunch Discussion and Caucus New or outstanding panelist questions Preview TRPC questions for panel and prioritize with panelist input
12:00 pm-1:00 pm	Working Lunch Questions for the panel and discussion
1:00 pm-3:00 pm	Panel Caucus Review/Critique and comment on practices
3:00 pm-3:15 pm	Break
3:15 pm-4:30 pm	Panel Report, Presentation and Discussion
4:30 pm-5:00 pm	Conclusion/Adjourn

B.2 Pre-Review Web Briefing June 8, 2012

10:00am –10:15 am	Welcome, Introductions and Peer Review Objectives
10:15 am–10:30 am	Background on TRPC and the Thurston Region
10:30 am–11:00 am	Technical Overview of the TRPC Model
11:00 am-11:30 am	Presentation and Discussion on the TRPC Model Enhancements Project
11:30 am-11:45 am	TRPC Hopes & Expectations for the Panel
11:45 am-Noon	Discussion

Appendix C Peer Review Panel Biographies

C.1 Richard Walker (Metro Portland)

Richard E. Walker is the manager for the Modeling and Forecasting Division at Metro Portland, the MPO for Portland, Oregon. He manages all programs related to travel forecasting: including data collection, model development, and model applications. His areas of expertise include multimodal, freight, transit, and air quality conformity modeling. He has previously participated in the peer review of metropolitan travel forecasting models in Santa Cruz, Salt Lake City, Las Vegas, Anchorage, Phoenix, and Philadelphia. In Oregon, Mr. Walker is a past chair of the statewide Modeling Steering Committee and the Modeling Program Coordination Committee. As a recipient of a BS degree in civil engineering from Montana State University, he has been a member of the modeling profession for over 35 years.

C.2 Elizabeth Sall (San Francisco County Transportation Authority)

Elizabeth Sall is the Deputy Director for Technology Services at the San Francisco County Transportation Authority. She has previously worked as a consultant for various travel analysis studies around the country. She has a B.S. and M.S. in Civil Engineering from North Carolina State University and the University of Texas at Austin, respectively. Her research interests include integrated dynamic network modeling and representing alternative transit service and non-motorized modes in travel models. Elizabeth has been active in a variety of Transportation Research Board committees and currently serves on the Planning Applications and Metropolitan Policy and Practices standing committees.

C.3 Chris Johnson (Puget Sound Regional Council)

Chris Johnson is a principal planner at the PSRC responsible for the development and improvement of the regional travel demand models. He has a BS and MS in Urban and Regional Planning from the University of Wisconsin. He has over 18 years of modeling experience in the public and private sectors and has completed projects in several states. He is currently leading the PSRC's transition from a trip-based to an activity-based travel demand model. In total, development and deployment of the activity-based model will span 4 to 5 years and have a consultant budget of nearly $1 million.

C.4 Michael Mahut (INRO Consultants)

Michael Mahut is a Senior Scientist at INRO Consultants, where he leads the company's research on dynamic traffic assignment (DTA) and traffic simulation, as well as providing modeling expertise on consulting projects involving the application and calibration of simulation-based DTA. Michael has a doctoral degree in Operations Research and Computer Science from the University of Montreal, and is an associate member of the Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT). Michael is also an active member of the TRB committees on Network Modeling and Traffic Flow Theory and Characteristics.

C.5 Stacey Bricka (Texas Transportation Institute)

Stacey Bricka, Ph.D., is a Research Scientist with the Texas A&M Transportation Institute. Her research focuses on all aspects of travel behavior, travel survey methods, and the application of survey data to travel demand modeling and emerging uses, such as understanding long distance travel and electric vehicle usage. She has more than 20 years of experience in designing, conducting and analyzing travel surveys, having managed travel surveys in more than 35 metropolitan regions across the country, including the 1998 TRPC survey. She is an experienced user of the National Household Travel Survey data series, and currently serves as chair of the TRB Task Force on Understanding New Directions for the National Household Travel Survey. She is a member of the TRB Committees on Travel Survey Methods and Travel Demand Forecasting.

Appendix D Overview of Thurston Regional Planning Council TDFM

The following text summarizes the current version of the TRPC model at the time of the review, along with data sources used in the development of the model.

D.1 Thurston Regional Planning Council Model Components

The following sections summarize models components as described in the current model documentation.[10] The trip-based model is made up of four primary modules with relatively sophisticated submodels and feedback as shown in Figure 2 and described below.

- Trip Generation
    - Inputs: TRPC Employment and Population Forecasting Data (single-family and multi-family dwelling units by TAZ) plus the base year housing occupancy rate reported by the Washington State Office of Financial Management (OFM) to factor DUs to households.
    - Cross-classifies the households by household size, income, and age of head of household.
    - Applies to the HH size-income-age classification a multinomial logit choice model to estimate households' number of workers by HH classification category.
    - Applies to the HH size-income-age-workers outputs a multinomial logit choice model to estimate the number of schoolchildren by HH classification category.
    - Applies to the HH size-income-age-workers outputs a multinomial logit choice model to estimate the number of vehicles by HH classification category.
    - Outputs: Applies trip production rates to generate productions by TAZ by HH classification category for the following trip purposes:
        - Home-Based Work (HBW)
        - Home-Based Shopping (HBShp)
        - Home-Based School (HBSch)
        - Home-Based College (HBC)
        - Other origin to other purpose (Other-Other or OO)
        - Work origin to other purpose (Work-Other or WO)
- Trip Distribution/Destination Choice
    - Inputs: Trip productions by purpose by TAZ from the Trip Generation component.
    - Applies to HBW, HBShp, WO, OO and Truck (see section D.2 below) multinomial logit destination choice models using the following explanatory variables variously in purpose-specific utility expressions:

[10] Ren, Jin. *Thurston Region Multimodal Travel Demand Forecasting Model Implementation in EMME/2*. 15th International EMME/2 Users' Group Conference, Sept. 18, 2000.

        - daily average TAZ-to-TAZ auto travel time = (AM_TTime + Midday_TTime + PM_TTime)/3
        - number of retail employees in attraction TAZ
        - number of service employees in attraction TAZ
        - number of government employees in attraction TAZ
        - number of employees other than the above in attraction TAZ
        - number of households in attraction TAZ
        - Notes on trip distribution/destination choice:
            - WO and OO use production TAZ utilities to distribute total regional productions to production TAZs before applying attraction TAZ utilities to link WO and OO trips
            - average travel time is not used in the WO and OO production utility expressions
    - Links HBSch productions to attraction TAZs using school catchment boundaries defined by the school district within which the origin HH TAZ is located.
    - Links HBC productions to attraction TAZs using 1998 college enrollment data, singly balanced.
    - Outputs: trip tables by purpose in production-attraction (PA) format.
- Mode Choice
    - Inputs: trip tables by purpose in production-attraction (PA) format.
    - Applies a multinomial logit choice model to split trips by purpose into the following modes (except for the HBC purpose, see below) on a daily basis
        - drive-alone (DA)
        - drive with passengers (DP; essentially the driver of a shared-ride vehicle)
        - auto passenger (AP; essentially a rider in a shared-ride vehicle)
        - transit (TR)
        - bike (BK)
        - walk (WK)
    - The mode choice utility explanatory variables are (note that not all variables are used in all purposes):
        - Lcost = low-income household cost
        - Mcost = mid-income household cost
        - Hcost = high-income household cost
        - CV01 = no-car or cars<workers household
        - CV34 = cars=workers or cars>workers household
        - HH34 = 3-person or 4+person household
        - Lhh = low-income households
        - Tdist = trip distance
        - Tm = trip time
        - Trfare = transit fare
        - Twait = transit wait time
        - Twalk = transit walk time
        - Pkcost = parking cost
        - Em20tr = total employment accessibility within 20 minutes of transit time to TAZ

        - Em1 = total employment density within 1 mile of walking distance to TAZ
    - HBC purpose mode split on a daily basis is calculated using fixed proportions taken from the 1998/1999 household travel survey.
    - Outputs: trip tables by purpose and mode in PA format.
- Time of Day
    - Applies peak hour factors derived from the 1998 household survey to each mode/purpose/PA/AP combination to create AM, midday, and PM peak hour OD trip tables.
    - See Section D.2 below for a description of the truck and external trip handling.
- Assignment
    - Inputs: trip tables from the mode choice/time of day step for AM, midday, and PM by purpose by the truck, auto, and transit modes (bike and walk are not assigned).
    - Performs a multi-class vehicle assignment for all truck and auto modes in the AM, Midday, and PM peak hours.
    - Performs a multi-path transit assignment for the transit mode in the AM, Midday, and PM peak hours.
    - Outputs: auto travel time and distance matrices; transit travel time, wait time, boarding time, number boardings, and access/egress time matrices; auto and transit volumes on network links.
- Feedback
    - The following data are fed back into trip distribution and mode choice (note that there is no feedback to trip generation; see also the parenthetical note in the transit skim bullet):
        - Walk travel time skims
        - Bike travel time skims using the walk skims divided by four (assuming bikes are 4 times faster than pedestrians).
        - Auto travel time skims from the three peak hours modeled (AM, Midday, and PM) are averaged for use in the submodels described above.
        - Transit travel time, fare, wait, and access/egress time skims are fed back to mode choice (but NOT to trip distribution).
        - Intra-zonal travel times by mode are created assuming 0.5 or 0.75 of the value for the nearest zone-to-zone trip.
    - The model makes three global iterations[11] through all components described above with auto assignments using 100 iterations, bgap=0.001%, ngap=0.001% as convergence criteria.

[11] TRPC. *Travel Model Improvement Program (TMIP) Peer Review Meeting--Review of Proposed TRPC Model Improvements.* Presentation for the Peer Review. June 11, 2012. Slide 54

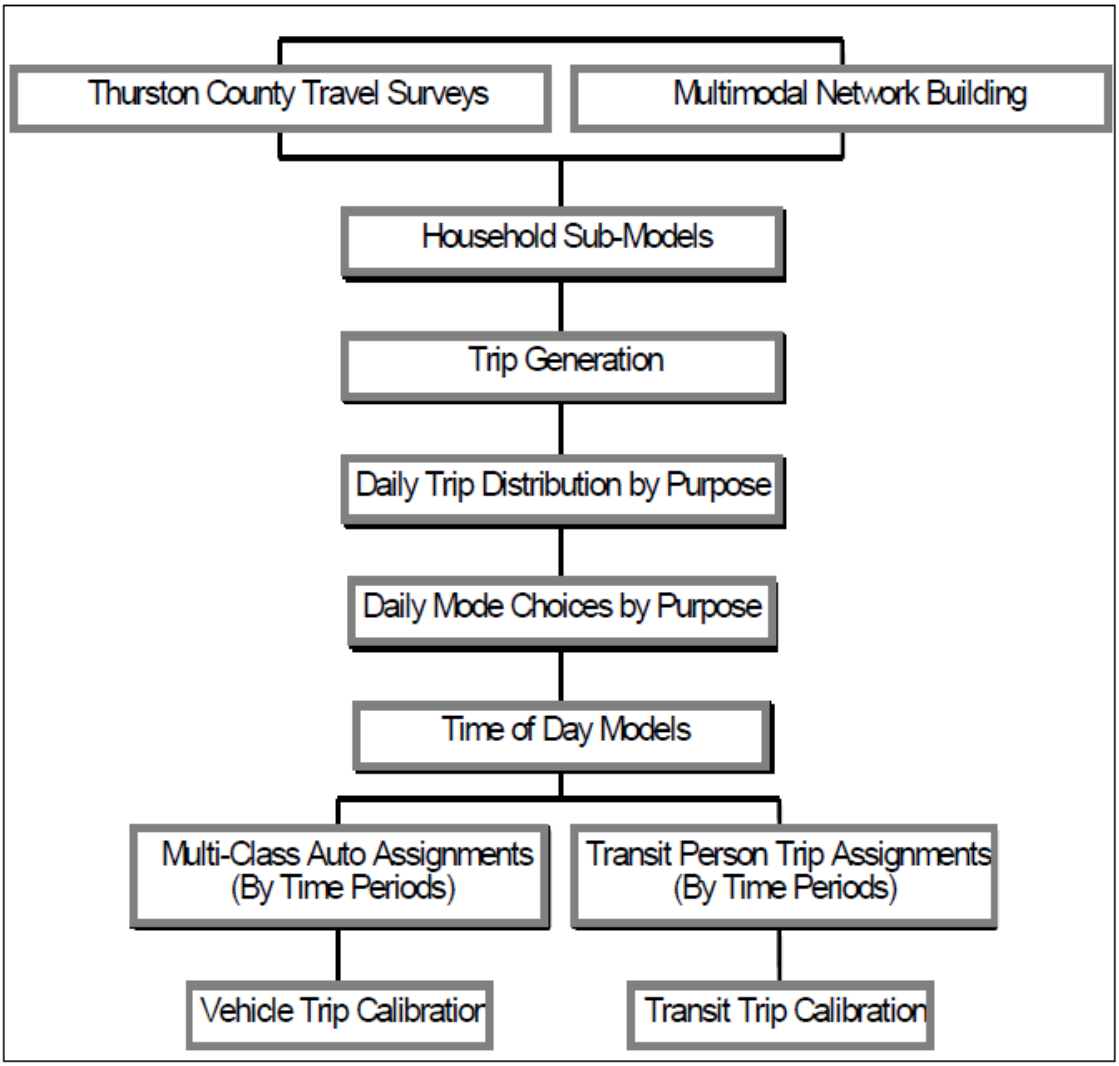

Figure 2: General Modeling Structure of TRPC Model[12]

D.2 Other Relevant Aspects of Thurston Regional Planning Council Model

D.2.1 Transit Modeling

- The model estimates walk-access to transit usage in the same three peak hours as it estimates other travel. It does not treat drive-access to transit, although the model network does include several Park-and-Ride lots as dummy zones.[13]

[12] Thurston Regional Planning Council. *Thurston Region Multimodal Travel Demand Forecasting Model Development.* 2000. p. 3

[13] Ren, Jin. *Thurston Region Multimodal Travel Demand Forecasting Model Implementation in EMME/2*. 15th International EMME/2 Users' Group Conference, Sept. 18, 2000. p. 28

D.2.2 Commercial Travel

- Truck trip productions are calculated regionwide as a function of:
  - total retail employment
  - total service employment
  - total government employment
  - total other employment
  - total households
- Regional truck productions are allocated to TAZs based on truck production utilities
- Truck attraction trip ends are calculated using a multinomial destination choice model similar to the auto mode destination choice models.

D.2.3 External Travel

- Through trips are taken directly from the 1997/1998 vehicle classification counts and the 1997 I-5/SR-101 external origin-destination surveys.
- Outbound trips are derived from the same data as through trips but scaled and balanced to the internal trip productions for each modeled peak hour before being added to the drive-alone mode trip tables
- Inbound trips are derived from the same data as through trips but scaled and balanced to the internal trip attractions for each modeled peak hour before being added to the drive-alone mode trip tables.

D.3 Thurston Regional Planning Council Model Validation

- Comparison of observed-to-modeled volumes on links with traffic counts in the AM, Midday, and PM peak hours obtained R-squared results of 0.94, 0.95, and 0.95 respectively.[14]
- Comparison of observed to modeled PM peak-hour auto volumes crossing 18 screenlines obtained percent differences ranging from 13% to -11% (with most percent differences in single digits). Directional daily volume comparisons on the same screenlines resulted in a range of -15% to 22% (again with most differences in the single digits).[15]
- Total modeled daily transit person-trips totaled 97% of surveyed trips on routes surveyed by Intercity Transit in the base year (1998/1999).[16] There was considerable variation between modeled and surveyed trips on individual routes, but this is not necessarily an issue given the known variability in route-specific findings from transit surveys and the fact that few regional models calibrate to the transit route level.

[14] Ibid. p. 25.

[15] Ibid. p. 26

[16] Ibid. p26.

D.4 Thurston Regional Planning Council Current Model Data Sources

D.4.1 Household Survey
- Conducted in 1998-1999
- 1,537 complete responses
- 2-day travel diary with household, person, vehicle, and trip data
- Validated using 1990 CTPP

D.4.2 Demographic and Census Data
- 1990 Census
- 1990 CTPP

D.4.3 Transit Counts
- Intercity Transit Ridership Survey
- Conducted last quarter 1998/first quarter 1999

D.4.4 Traffic Volume Data
- WSDOT loop detector data on I-5
- Arterial traffic counts from various sources

D.4.5 Travel Time and Speed Data
- WSDOT loop detector data on I-5

D.4.6 Truck Data
- 1999 vehicle class counts
- 1997 I-5/US 101 OD Survey
- 1997 Reebie Freight data

D.4.7 External Surveys
- 1997 I-5/SR-101 External Origin-Destination Survey

D.4.8 GIS Data
- TRPC in-house GIS data
- Thurston County GIS clearinghouse

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