I-5 to 99W Corridor Study – Advances in Travel Demand Forecasting for Corridor Study Decision Making

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INTRODUCTION

The southwest region of the Portland, Oregon metropolitan area has experienced rapid population growth over the past 10 years. Historic major transportation facilities through the area (Tualatin, Sherwood, Wilsonville, and Tigard) have become congested for major portions of the weekday, which has impacted the mobility for freight and commuter traffic and has diverted trips onto rural roadways that are not designed to handle high traffic volumes. Metro (the Metropolitan Planning Organization for the Portland, Oregon region), the Oregon Department of Transportation (ODOT), and Washington County have embarked on a Corridor Study to identify potential east-west capacity improvements to connect I-5 to Highway 99W.

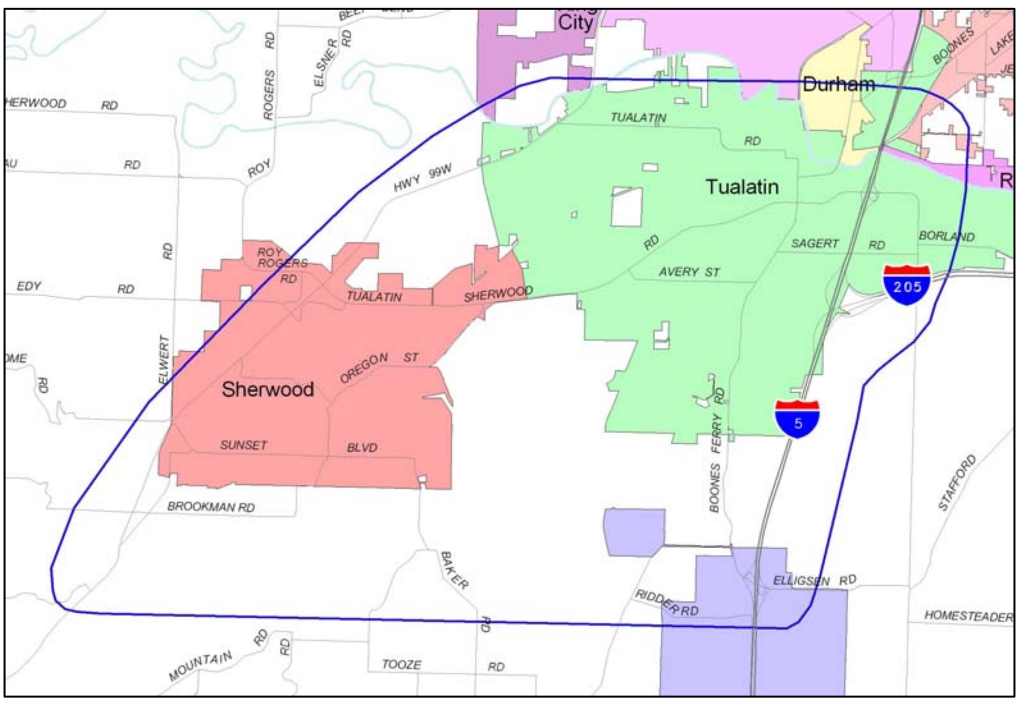

Figure 1: Project Study Area

A key component of this (and any) corridor study is the ability to reasonably forecast the future travel conditions of the study area. Future conditions information can be used to assess the needs for future capacity improvements, determine which markets (network users) are utilizing transportation corridors, and compare the performance of improvement options. As long range (year 2030) travel forecasts were prepared for the I-5 to 99W Corridor Study, simple corridor traffic volumes and major intersections operations estimates have not been adequate to answer "big-picture" questions that have arisen from an extensive project vesting process with local stakeholders and agency staff.

In support of this effort, Metro's new VISUM regional travel demand model was refined to a level of detail that can accurately estimate each signalized intersection within the study corridors, as well as monitor and assess the surrounding rural farm-to-market roads that are at risk of significant traffic diversion impacts. In addition, methods were created to summarize travel patterns within, into, and through the study area using convenient and expeditious features of VISUM. The combination of these efforts resulted in a new approach to presenting travel demand modeling for a corridor study that combined detailed operations analysis and key corridor conditions to improve information dissemination to a diverse decision making body.

This paper outlines the methods used to refine the regional travel demand model and the key components of the future year conditions analysis.

REGIONAL MODEL REFINEMENT

The regional travel demand model developed by Metro is a valuable resource for determining regional travel demand needs and identifying future year improvement projects in the Portland area. However, Metro's model focuses primarily on major arterial roadways and does not reflect local roadways and restrictions of local land use access to the transportation network, as is typical for major urban models. To improve the regional forecasting tool for use in the I-5 to 99W Corridor Study, a series of refinements were implemented as described in the following sections.

Model Network Detail

The initial roadway network developed for Metro's travel demand model is focused on regional facilities. For the detailed level of analysis needed for the I-5 to 99W Corridor Study, additional network detail was required in order to reasonably model lower classification roadways (e.g. urban collectors and rural farm-to-market roads) and several study intersections (which include the majority of signalized intersections in Tualatin, Sherwood, and north Wilsonville). Using a GIS background of streets, rivers, railroads, and TAZ boundaries, additional network detail was combined with TAZ refinement to create a sub-area model (see sample in downtown Tualatin - Figure 2). While this level of refinement was possible with previous version and platforms of Metro's model, the current VISUM structure provided significant time savings to this effort compared to past efforts with their EMME/2 model in the following ways:

- GIS data can be readily added into the graphical display of the model, including attribute labeling.
- Zone connectors can be manually weighted for vehicle assignment, which reduces the

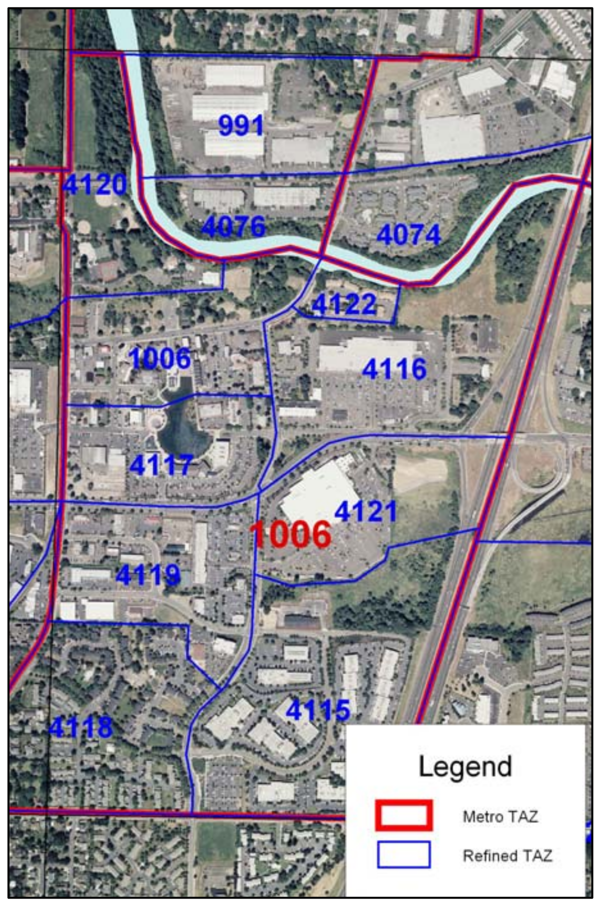

Figure 2: Sample TAZ Refinement (Tualatin)

amount of disaggregation required to accurately load land use onto a detailed roadway network where land use within a zone is built-out.

- Trip table disaggregation is automated by the use of code files that can be easily generated from a database or spreadsheet.

Intersection Capacity

For the past several years, Metro has been using a model structure that distinguishes between links approaching an intersection and links departing an intersection. A key reason for this structure is the desire to emulate the change in travel speeds along a corridor as vehicles slow for controlled intersections, which is a different delay impact than general link congestion. Links approaching an intersection are coded with a capacity to approximate intersection throughput, while departure links are coded with a capacity closer to general highway traffic flow characteristics (lanes * free flow speed = capacity). While these two capacities and the resulting delays generated during trip assignment are combined within the model, the delays generated by links approaching intersections appear to dominate the total trip delays in the congested network conditions.

As Metro is transitioning their regional travel demand model to a VISUM platform, they realized that the approach vs. departure link methodology could not be directly applied. Instead, the approach link capacity and delay (impedance) calculations needed to be coded at the node rather than the link level. To code this into the model structure, the approach link capacities that had been used in the past needed to be allocated to left, through, and right turn movements. To maintain consistency with the level of effort and detail utilized to develop the regional model, a general macro was developed to allocate the left/through/right capacities according to the number of lanes on the approach link and the intersection type (4-leg or T). While the values used to generate this macro seemed reasonable and were based on general traffic capacity concepts, review from other agencies led to numerous questions and the desire for additional research.

To expedite the research process and allow implementation of the VISUM model for the I-5 to 99W Corridor Study, DKS Associates compiled a database of intersection capacity analysis based on *Highway Capacity Manual Methodology (HCM)*. The database included approximately 100 signalized study intersections in or near the project study area that had been analyzed under existing conditions scenarios for other area-wide plans. Each approach of the study intersections was coded into the database with a corresponding model link lane value to allow tabulation for different sized facilities. The specific movement (left/through/right) capacities identified in the HCM analyses were averaged by facility size to determine the approximate capacity value that should be utilized. This information was reviewed, refined, and rounded to 5% increments as listed in Table 1.

Table 1: Allocation of Link Approach Capacity to Turn Movements

	Recommended Capacity Allocation Values			Resulting Typical Capacities			
Link Lanes	LT%	THRU %	RT %	Sample 1-Hour Approach Capacity	LT Capacity	THRU Capacity	RT Capacity
1.0	25%	50%	25%	700	175	350	175
1.5	25%	55%	20%	900	225	495	180
2.0	10%	70%	20%	1400	140	980	280
2.5	15%	70%	15%	2100	315	1470	315
3.0	5%	80%	15%	2400	120	1920	360
3.5	10%	75%	15%	2800	280	2100	420

Note: The values in Table 1 only apply to 4-leg intersections. Link lanes with a 0.5 represent roadways that generally have continuous center turn lanes.

While applying the values in Table 1 at a macro level to the regional model does not reflect individual intersection deviations in the number of turn lanes or control type (e.g. permitted or protected left turns), it does reflect a significant change from the previous link delay based assignments in past models. For the I-5 to 99W Corridor Study, this change was important for accurately forecasting volumes at each signalized intersection along study corridors and identifying which crossing routes would be impacted by regional facility congestion.

Farm-to-Market Roads

Historically, rural roadways were not a major component of the Metro model network. Recent model area expansions have incorporated large rural areas to the south and west of the Portland/Metropolitan Region (e.g. Newberg, Canby, and McMinnville). The rural lands between these areas continue to rely on farm-to-market roads as key connections providing alternates to major regional facilities (e.g. state highways and rural arterials). In addition, several farm-to-market roads have become attractive "short-cuts" for drivers avoiding congestion between urban area fringe cities in the I-5 to 99W Corridor Study area (e.g. between Sherwood and Wilsonville). While these roadways are high-speed, un-congested routes, they typically have fronting uses, geometric deficiencies, and driver expectations that reduce their through capacity as two-lane roadways and make them less attractive to average drivers. In the I-5 to 99W Corridor Study area, the differences between a farm-to-market roadway and a rural arterial can be summarized by the following characteristics:

Farm-to-Market Roads

- 22-foot paved width
- 1 to 3 foot gravel shoulders
- Horizontal and vertical curve deficiencies
- Active agricultural fronting uses
- 45 to 55 mph speed limits

Rural Arterials

- 22 to 24 foot paved width
- Paved shoulders or wider (4-6 foot) gravel shoulders
- Turn lanes at major intersections
- Adequate horizontal and vertical curves

While both types of roadways include 2-lanes of travel in each direction, there is a different driver expectation of congestion (or a lesser route choice attractiveness) on these roadways that requires consideration of different roadway coding parameters in the travel demand model. Initially, reducing the model link capacity on the farm-to-market roads was explored as a way to incorporate the facility differences. The Metro model typically uses 700 vehicle per hour (vph) per direction to code 2-lane roadways. To estimate a more rural capacity based on different driver expectancies, an HCM based approach was used to determine level of service (LOS) B conditions at a T-intersection with low side-street volume. This analysis determined that a traffic flow (or link capacity) of 300 vph per direction would be appropriate for farm-to-market roads. This capacity value was also checked against hand calculation of what a farm vehicle (heavy truck or tractor) turning left onto a roadway would require for adequate traffic flow gaps. Assuming a 55 mph roadway, an entering farm vehicle would need approximately 810 feet of clearance in both directions to safely enter the roadway (equivalent to a 10 second critical gap). Assuming uniform traffic flow, a spacing of 810 feet per vehicle corresponds to a density of 6.5 vehicles per mile and a traffic flow of 350 vph per direction. Although Metro staff did not necessarily agree with modifying typical link capacities in the model to reflect route attractiveness, a link capacity value of 300 vph was tested in the refined I-5 to 99W Corridor model to determine if the reduced capacity reasonably emulated the difference in attractiveness between the types of rural routes. This test was found to reduce assigned volume to the congested farm-to-market roads, but the reduced capacity was not adequate to calibrate traffic assignments on the lower volume roadways.

As a second test, reduced link speeds were coded for farm-to-market roads in the refined I-5 to 99W Corridor model. This test found that reducing farm-to-market road free-flow speeds by 10 to 20 miles per hour helped achieve model calibration. Therefore, modifying farm-to-market road speeds within the travel demand model was chosen as the method to reflect their relative lack of route choice attraction compared to higher grade roadways.

DATA ANALYSIS

The refined travel demand model created using the detailed methods described in the previous sections provides a valuable tool to evaluate travel conditions in the I-5 to 99W Corridor Study area. The level of network detail and refined model calibration significantly reduce the level of effort required to post-process the travel forecasts for use in operations analysis at the 90 study intersections, which allows rapid evaluation of multiple scenarios. However, reporting volume to capacity (v/c) ratios and level of service (LOS) results at 90 study intersections and listing projected volumes on study area roadways was found lacking in terms of providing the project decision makers with information they could easily comprehend about study area travel conditions. To meet this need, the detailed travel demand model and operations analysis were utilized to prepare measures of study area travel conditions and patterns, including corridor travel times, queuing conditions on corridors, and travel patterns throughout the study area. These measures are described in the following sections.

Operations Analysis for Corridor Travel Times and Queuing

Isolated intersection analysis over a large study area does not provide a clear picture of roadway conditions for decision makers in a corridor study planning effort. In addition, isolated intersection analysis does not provide a means of measuring the magnitude of the queuing and delay impact on the system performance of the corridor. Commonly, traffic on congested corridors spills back through upstream traffic signals. Users of the facility recognize this as queuing and reduced travel time. To measure the arterial performance as a system (rather than a series of intersections), the detailed travel forecasting was exported into a calibrated Synchro/SimTraffic operations model. The results of this system level analysis were then summarized into corridor specific measures, such as those listed in Table 2 for Tualatin-Sherwood Road (a key arterial roadway for the I-5 to 99W Corridor Study). This form of travel conditions information allows project stakeholders to easily draw conclusions such as "travel times through the study area would be doubled" or "stop-and-go traffic will cover the majority of the corridor".

Table 2: Tualatin-Sherwood Road PM Peak Hour Arterial Performance

		2005 Conditions		2030 Conditions**	
Direction	**Segment**	**Average Travel Speed**	**Percent Queued***	**Average Travel Speed**	**Percent Queued***
Westbound	I-5 to Avery	18 mph	20% to 25%	13 mph	40% to 45%
	Avery to OR 99W	7 mph	60% to 70%	7 mph	60% to 70%
Eastbound	OR 99W to Avery	25 mph	5% to 10%	14 mph	40% to 45%
	Avery to I-5	17 mph	20% to 25%	9 mph	40% to 45%

*Percent of the roadway from I-5 to OR 99W with average travel speeds below 15 mph

**Based on traffic operations simulation conducted with Synchro/Simtraffic

Market Analysis

Perhaps the most common transportation question from the key stakeholders and decision makers in the I-5 to 99W Corridor Study is "who is using the study area roadways". This question relates to both assessing which travel patterns (local, regional, or through) are causing congestion on existing roadways and what user groups (or market areas) would be served by the construction of a new corridor facility. The VISUM software used for the travel demand model includes flow-bundle (select link) and trip table aggregation tools allowing rapid completion of the tasks without re-assigning the model (which was a significant time/labor cost with previous EMME/2 models) such as:

- Determine the split of local, regional, and through trips in aggregate for the study area. This task includes querying the model for all trips that use any roadway facility in the study area (freeway only trips were excluded).
- Determine the split of local, regional, and through trips on specific roadways in the study area.
- Determine the origin and destination (O-D) of trips in aggregate for the study area related to specific geographic market areas. This included a definition of market areas using the TAZ boundaries, as shown in Figure 3.

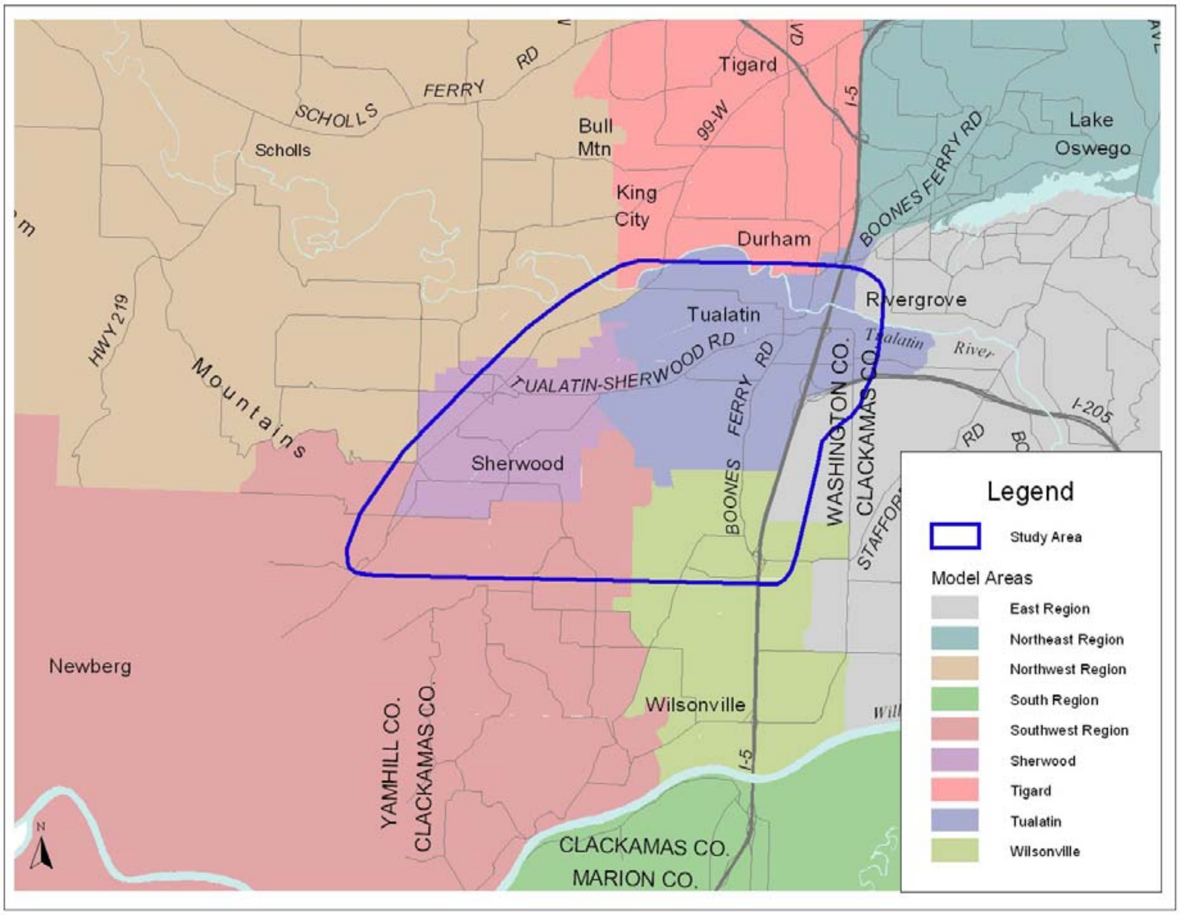

Figure 3: I-5 to 99W Study Market Area Definitions

CONCLUSIONS

Metro has long been a national leader in travel demand modeling practice. Their recent transition to a new modeling platform (VISUM) is a significant change in the local planning market that enhances a cost-effective approach to refining regional models to a level of detail that can accurately estimate urban corridor traffic volumes, as well as reasonably monitor and asses the surrounding rural farm-to-market roads that are at risk of significant traffic diversion impacts. The refined corridor study models, combined with detailed operations analysis, can be rapidly queried to provide useful travel pattern and condition information that aids in educating a diverse project decision making body.

The model refinement and analysis methods described in this paper represent a step forward in utilizing technical tools to improve public education and committee decision making. However, there is more that can be done to further improve these efforts, including:

- Distinguish between control types at intersections in the travel demand model, so that unsignalized intersections (including roundabouts) can be accurately modeled.
- Provide tools within travel demand software to easily summarize general transportation conditions, such as average travel time delay per vehicle over a study area.

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