7 SYSTEM PLANNING ANALYSIS

7.1 Purpose

The purpose of this chapter is to illustrate the different types of system planning analysis and related tools, applications, limitations, and data needs. These methods are recommended for use in larger scale planning studies.

- System Planning Analysis
- Highway Economic Requirements System (HERS-ST)
- Statewide Integrated Model (SWIM)
- Travel Demand Models
- Regional Strategic Planning Model (RSPM)
- Land Use Scenario Tools

7.2 System Planning Analysis

The following is a list of the different kinds of system planning from a low to a high level of detail.

7.2.1 Strategic Planning

Strategic Planning is a way to understand the first order effects of a broad array of policies with less required input detail (e.g., doubling transit service miles), to understand the tradeoffs of different futures (e.g., operational strategies vs. transit investment). Because these models may be less detailed, they run quickly and thus are able to make lots of runs to test plan resilience under a variety of future uncertainties (e.g. changing fuel price and income forecast). Strategic planning level of detail is limited to a state or regional scope. The key ODOT tools are the RSPM (Regional Strategic Planning Model), and the HERS-ST tool for roadway investment/policies.

7.2.2 Statewide Systems

Statewide system planning generally is policy or economic-based, such as relating to the Oregon Transportation Plan and/or state modal plans such as the Oregon Highway Plan. Statewide system planning is conducted to explore alternative futures related to greenhouse gas (GHG) emissions, land use development, population demographics and economic forecasts as they relate to use of the transportation system. Statewide system planning is used to develop investment strategies associated with different budget options, policy goals and legislative concepts evaluating the best options to meet statewide objectives. Tools used for statewide system analysis include SWIM, HERS-ST model, and the RSPM.

7.2.3 Regional Systems

Regional system planning generally focuses on specific areas like Metropolitan Planning Organizations (MPO), individual cities, or unincorporated or rural areas. These will involve creation or analysis of Regional Transportation Plans (RTP) or Transportation System Plans (TSP). Typical tools used could be regional or urban travel demand models.

7.2.4 Corridor Systems

Corridor system planning can involve an individual route which can be made up of one or many different highways. This also can be just a small segment in a regional or urban area. A commonly used tool would be HERS-ST (Highway Economic Requirements System).

Exhibit 7-1 shows the typical tool applications for each type of system planning analysis.

Exhibit 7-1: System Planning Analysis Tool Applications

	Strategic	Statewide	Regional	Corridor
HERS-ST	X	X	X	X
SWIM		X	X	X
Travel Demand Models			X	X
RSPM	X	X	X	
Land Use Scenario Tools			X	

System planning analysis may be a tool for considering the impacts of emerging trends and technologies, including connected and automated vehicles (CAVs). Although no CAVs are currently available commercially, it is expected that CAVs will start to become available within the 20- to 50-year planning horizons of transportation system plans and other long-range transportation studies. There are many potential impacts of CAVs on safety, operational efficiency, travel behavior, transportation accessibility, transportation equity, environmental impacts, and more. Appendix 6B provides more information on CAVs and their potential effects, focused on the methods in the HCM 7th Edition (HCM7) for adjusting roadway capacity for the presence of CAVs in the traffic stream on freeways and at signalized intersections and roundabouts.

Oregon has begun to assess the potential range of impacts of CAVs using travel demand models, with more information available in the Final Report for the project *Scenario Guidance for Travel Demand Modeling*, available at https://www.oregon.gov/odot/planning/pages/apm.aspx under “Supplemental Materials." While the Task 11 Final Report provides the most concrete guidance on capacity changes to make in a TDM for CAVs, it also provides guidance on other potential changes to make and use of TDMs to understand impacts beyond capacity, e.g. land use and urban form.

7.3 Highway Economic Requirements System (HERS-ST)

HERS was first developed by the FHWA to examine the relationship between national investment levels and the condition and performance of the Nation's highway system. FHWA uses the model to estimate future investment required to either maintain or improve the nation's highway system. FHWA provides this information to the U.S. Congress on a biennial basis. The HERS-ST model is a direct extension of the national level model. HERS-ST has been used to conduct analysis for the 1999 Oregon Highway Plan, Congestion Management System, and other analyses as shown on the ODOT HERS-ST website. The model focuses on motor vehicle modes. The state system dataset is updated annually. Non-state roadways can be added to the dataset to analyze a road network. This section is based on the current HERS 4.5 version but this still compatible with other versions.

HERS-ST offers a high-level identification of needs (deficiencies) on roadway segments over a specified number of periods. HERS-ST can report out numerous performance measures like speed, delay, and travel time. The biggest advantage of HERS-ST is that it forecasts future conditions and quantifies these impacts on an alternative into costs and can calculate relative benefit-cost ratios in comparisons between alternatives. HERS-ST can forecast needs or performance, depending on the study.

The state version of the Highway Economic Requirements System (HERS-ST) uses an input dataset formatted in the standard Highway Performance Monitoring System (HPMS), where each data record represents a unique roadway segment. For each funding period, the HERS-ST model evaluates each data record one at a time, independent of all other records, to determine whether a road segment has a deficiency as defined by the user. For each deficiency, the HERS-ST model uses a benefit-cost analysis process to evaluate several potential improvements to determine the best economical solution to correct the problem. The most economical improvement is then implemented in the dataset and simulated during future funding period analysis.

The analyst defines the timeframe for the HERS-ST analysis period. The general analysis consists of four five-year funding periods for a total 20-year analysis period.

The HERS-ST model consists of several individual complex sub-models: Fleet Composite, Widen Feasibility, Capacity, Pavement Deterioration, Speed, and Travel Forecast. The Fleet Composite, Capacity, and Speed sub-models are the most useful for a typical HERS-ST analysis.

7.3.1 Fleet Composition

HERS-ST categorizes the AADT into three vehicle categories which include a total of seven vehicle types. These data on fleet composition are used by HERS when estimating speed, operating costs, travel-time costs, gallons of fuel used, section capacity, and pavement deterioration (used as interim measure only as noted in Section 7.3.4). The progression from the entire fleet to the seven vehicle types is shown (proceeding from left to right) in Exhibit 7-2. It should be noted that HERS-ST fleet composition does not currently reflect the anticipated shift to a lower emission vehicle mix in future years.

Exhibit 7-2: Fleet Composition

Fleet		Weighing Factor	Vehicle Category	Weighting Factor	Vehicle Type
All Vehicles		Section data item: Percent Combination Trucks	Combination Trucks	Prorated from HPMS Vehicle Classification Study	Five or More Axle Combination Trucks
					Three/Four Axle Combination Trucks
		Section data item: Percent Single Unit Trucks	Single Unit Trucks	Prorated from HPMS Vehicle Classification Study	Three or More Axle Single Unit Trucks
					Six-Tire Trucks
		100% less percent of Single Unit and Combination Trucks	Four Tire Vehicles	Prorated from HPMS Vehicle Classification Study	Pickups & Vans
					Medium/Large Automobiles
					Small Automobiles

Source: Table 2-3. Fleet Composition, HERS-ST Highway Economic Requirements System - State Version: Technical Report, August 2005

The fleet is divided into vehicle categories based upon section-specific percentages of single unit and combination truck classifications. The four-wheel category consists of the percentage of total traffic which is not part of either truck category.

7.3.2 Capacity

HERS capacity routines are based upon Appendix N, "Procedures for Estimating Highway Capacity," of the HPMS Field Manual. Appendix N was revised in February 2002 and incorporates algorithms from the Highway Capacity Manual 2000.

For each section, HERS develops separate estimates of capacity for the peak and off-peak periods; and the peak-period estimates are developed separately for the peak direction and the opposite, or "counter peak," direction. These three capacities are referred to as peak, counter peak, and off-peak capacity. Differences in the three capacities result primarily from differences in the number of available travel lanes.

For urban and rural multi-lane facilities, the capacity is defined as the total capacity per direction. The capacity for rural two or three-lane facilities with two-way operation is defined for both directions.

7.3.3 Speed

The speed procedure within HERS-ST is based on the Aggregate Probabilistic Limiting Velocity Model (APLVM) and covers two distinct processes: free-flow speed (FFS) and average effective speed (AES). The FFS estimation is developed to reflect the average unconstrained speed that exists on the highway system in the absence of any other traffic or geometric influences. Then, the FFS estimates are adjusted to account for the effects of congestion delay and traffic control devices to produce the AES for each roadway segment.

Several key data elements affect speed, including vehicle type, curves, grades, pavement surface quality, speed limits, congestion, and traffic control devices. There are three controlling factors in the APLVM that potentially limit the free speed on a roadway section: curves, pavement roughness and posted speed limit. All these factors have the potential of lowering the sectional speed estimate.

A vehicle traveling through a curved roadway section is subject to a centrifugal force that acts against the vehicle, forcing it to leave the curve path of the roadway. The higher the vehicular speed entering the curve, the heavier the vehicle, and the sharper the curvature of the road, the greater the external force acting upon the vehicle. This results in a reduced FFS for the roadway section.

When the pavement is smooth, and the curvature is low (below two degrees) the average speed is governed by the posted speed limits. This model does not explicitly consider enforcement.

7.3.4 HERS Scenario Development

HERS-ST is intended to be used for high-level studies such as corridor plans or as a screening tool in more detailed plans or project development. HERS-ST can be used to determine numerous outcomes or to answer different questions depending on the analysis purpose. It can be used to screen alternatives in a TSP or a RTP, identify needs in a policy or corridor plan, compare performance between alternatives in a plan or project, or to perform before/after analysis on a roadway segment.

If a no-build scenario is to be part of the analysis, there are two ways to utilize the HERS-ST analysis. The first process is to create a scenario dataset with the no-build existing conditions and future volume (i.e., historical, model, or post-processed), then turn off the improvement and run the typical four five-year funding increments; HERS-ST creates performance metrics for each funding period analysis. The second process is to create a future no-build scenario dataset by using the project/future year as a base year and run the typical analysis. The future year performance metrics can be found in the base year data analysis.

The typical HERS-ST analysis will evaluate pavement and capacities deficiencies and identify segment-based improvement on a roadway facility, such as adding/widening lanes and shoulders. These improvements can form the basis for future alternative solutions. In order to compare alternatives, separate scenario datasets should be created; this includes evaluating other geometric features such as medians, signals, turn lanes, and interchanges. HERS-ST can also generate pavement needs. Although ODOT does not use this feature because it has a robust Pavement Management System (PMS) that quantifies pavement needs, other jurisdictions that lack their own PMS will find this feature quite useful. Alternative analysis years will be dependent on the study requirements.

Analysis can be done either on a sectional or system analysis. A sectional analysis is based on each funding period which is typically four to five years. For example, a 20-year project can be divided into four five-year periods with output data reported for each period separately. The system analysis aggregates the impacts and costs of each period up into the total for the whole project.

7.3.5 HERS Data Requirements

ODOT has complete state highway HERS-ST datasets available. These are typically updated every five years. Contact the Transportation Planning Analysis Unit (TPAU) to obtain these or for questions on this methodology. HPMS sample data (covering any jurisdiction) can be run through HERS-ST. HERS datasets can be created from HPMS sample datasets by adding in the necessary specific section data for non-sample sections. HERS-ST can also be tied to a travel demand model for supplying volumes.

By following the data needs and formats in the HERS-ST User's Guide, a roadway dataset can be created from scratch for any area. Datasets are typically done in Excel and exported into HERS-ST in .csv format. Depending on the type of analysis, defaults can be used as necessary. For example, if pavement is not a concern, a "perfect" pavement default can be added. However, the following data elements are generally easy to obtain and should not have default values.

- Functional Class
- Type of Facility (One-way or Two-way)
- Number of Lanes
- Lane Width
- Median Type
- Median Width
- Shoulder Type
- Shoulder Width (both Right and Left)
- Terrain Type
- Speed Limit
- Directional Factor
- Peak Number of Lanes
- AADT
- FADT
- K-Factor
- % Truck (both Single Unit and Combined)
- Number of At Grade Signals, Stop Signs & Other
- Turn Lanes (both Right and Left)

Data can be obtained from online databases such as TransInfo, GIS, road inventories, aerial photography, online maps, video logs, and local knowledge. Field inventory may still be necessary to fill in missing data or to verify data (especially if obtained from on-line mapping or aerial photos).

Datasets need to be broken into homogenous segments. Any changes in the key elements (i.e. speed, functional class, etc.) need to be separate segments. Segments can be broken further as desired. For example a section with two signalized intersections may need to be broken if different g/c ratios need to be entered for each. Short segments of less than a quarter mile are not uncommon in urban areas. Rural segments can range from many miles to less than a mile.

7.3.6 HERS Analysis Types

Running HERS with unlimited funding creates a financially unconstrained scenario. HERS will identify improvements solely based on geometric/capacity needs and pavement deterioration. HERS will implement needs based on user criteria such as minimum benefit-cost ratio. This will create a list of needs without regard for the future ability to fund those needs.

Adding in funding constraints will limit identification of improvements to the best improvements available up to the funding threshold. Once beyond the threshold, HERS will not identify any improvements (Constrained Fund).

HERS also has a minimum benefit-cost threshold analysis (Minimum BCR). For this analysis, HERS will solve for both the required funding level and the resultant performance levels when improvements are constrained to return a minimum benefit/cost ratio. This type of analysis does not have any funding constraints. This analysis types includes two special cases. The first is an "engineering needs" run (sometimes referred to as "full needs"), which is a minimum BCR run with the minimum BCR set to a very low negative number so that all sections with deficiencies are selected for improvement. The second is a "maintain current conditions" run in which the model first determines the level of system performance at the beginning of the run based on user-specified parameters (for example, current highway-user costs), and selects the least costly mix of improvements to maintain that level of performance.

The last major type of HERS analysis is Performance Constrained. The user can specify what values are to be maintained. Maintaining pavement condition will have a different set of needs and costs than trying to maintain overall delay. In this analysis, HERS will solve for the funding levels required to bring the system to a specified level of performance.

For more information on HERS analysis types, refer to the HERS-ST Technical Report.

7.3.7 HERS Analysis Results

HERS creates several results such as delay, speed, volumes, v/c ratios and other performance measures at a roadway segment level. Most of these can be displayed in different kinds of outputs as described in the following sections.

Average Delay

There are three kinds of delays estimated in HERS-ST:

- Zero-Volume Delay is the delay associated with traffic control devices. This is the expected delay that a single vehicle would encounter even if it were the only vehicle on the road. Zero-volume delay only exists for sections controlled with stop signs or traffic signals and is not calculated for uncontrolled sections.
- Incident Delay is the delay associated with crashes. HERS-ST estimates delay due to crashes through a secondary (or inferred) process where the HERS-ST model estimates the delay cost of crashes and then back-calculates the delay estimates due to crash incidents from the cost calculations.
- Other Congestion (or Recurring) Delay is the average delay due to non-incident congestion.

Total daily traffic is broken into three phases, or demand periods, for all capacity, delay and speed analysis:

- Peak period analysis in the peak direction.
- Peak period analysis in the counter peak direction.
- Off peak analysis in both directions.

Speed

HERS computes vehicle speed for three purposes: calculation of travel time costs; calculation of external costs due to vehicular emissions; and calculation of vehicle operating costs. For each section, HERS models speed for each of the seven vehicle types (except for autos and pickup trucks) in each direction of travel. Overall average speed per section is aggregated from the speeds of the individual vehicle types. HERS considers the effects of vehicle type, curves, pavement condition, and posted speed limit in calculating free-flow speeds (FFS). Average Effective Speed (AES) is calculated to account for grades, stop signs or traffic signals, and congestion.

V/C Ratio

The HERS capacity model has two functions. The first is the calculation of section capacity; the second is the calculation of the number of lanes needed to accommodate the projected traffic volume in the design year (that is, how many additional lanes are needed). HERS capacity routines are based upon Appendix N, "Procedures for Estimating Highway Capacity," of the HPMS Field Manual. Appendix N was revised in February 2002 and incorporates algorithms from the Highway Capacity Manual 2000. For each section, HERS develops separate estimates of capacity for the peak and off-peak periods; and the peak-period estimates are developed separately for the peak direction and the opposite, or "counter peak," direction. These three capacities are referred to as peak, counter peak, and off-peak capacity. Differences in the three capacities result primarily from differences in the number of available travel lanes.

Volume/capacity (v/c) ratio is HERS' estimate of the ratio of design-hour volume to peak-period hourly capacity.

The traffic growth information is used to forecast traffic and volume-to-capacity (v/c) ratios. HERS-ST uses this information to estimate the point at which a capacity improvement will be required, and the extent of improvement indicated.

Benefit-Cost Ratio

HERS-ST defines the benefit-cost Ratio (BCR) of a highway improvement as the discounted sum of the present value benefits for the user, agency, and environment divided by the implementation costs of the improvement. For BCR analysis, HERS-ST recognizes four broad classes of costs:

- **User costs** are the costs incurred by the highway user and include Travel Time Costs, Operating Costs (including fuel consumption), and Safety Costs.
- **Agency Costs** are roadway maintenance costs borne by the administrative agency responsible for the highway section.
- **External Costs** (emissions costs) are the social costs passed to the non-users of the highway system.
- **Capital Improvement Costs** are the estimated construction costs of the improvement.

The analyst can change many variables and factors[1] within the HERS-ST model that influence User, Agency, and External Costs. The HERS-ST procedure estimates the incremental costs and benefits of each potential improvement for each period of the benefit-cost analysis period, as well as the residual value of the improvement at the end of the analysis period. For BCR, the benefits of an improvement are defined as a reduction in user, agency, and external costs as the result of implementing an improvement and are measured as the difference in costs between the no-improved case and the improved case. The cost variable is the estimated capital improvement cost.

The little-known part of the BCR equation is in the residual value (RV) of an improvement. The residual value is the capital value of the improvement that remains at the end of the final analysis period and is credited back as the unused portion of the investment. The RV for an improvement is discounted back to the initial year of the analysis period and treated as a benefit.

In theory, any project with BCR greater than one is considered a worthy project. However, the HERS-ST BCR is used to reveal the value of a set of alternative projects related to each other even though the BCR may be less than one.

[1] User parameters affect deficiency levels, design standards, improvement costs, auto and truck growth factors, funding and performance constrains, and weights for highway performance goals.

User Costs

For Travel Time Costs, HERS-ST incorporates national U.S. Department of Transportation values of time per person for personal and business travel. The Operating Costs evaluate vehicle operating costs as a function of cost for fuel and oil consumption, tire wear, vehicle maintenance and repair, and mileage-related depreciation due to pavement conditions. The Safety Costs use national crash rates to estimate the number of crashes and severity for improved and unimproved roadway segments.

The benefits for each variable are defined as a reduction in costs because of the implementation of an improvement. Some improvements might show a savings in one variable, such as travel time, while showing an increased cost (disbenefit) in another variable, such as increased fuel consumption. A reduction in the summation of all three costs is defined as the total benefit for the selected improvement.

Agency Costs

Agency Costs include the cost of routine maintenance. A selected improvement may or may not be associated with a reduction in roadway maintenance costs. HERS-ST evaluates this measure for the current funding period and evaluates the potential reduction of improvement costs in future years resulting from the improvement.

External Costs

The HERS-ST model uses national values to estimate the cost of damages from vehicular emissions (air pollutants) resulting from the implementation of a selected improvement. The air pollution costs are measured as the difference between total pollution costs generated by the forecast volumes of travel on the section under unimproved and improved conditions. Because the cost of air pollutant emissions per vehicle-mile varies by both travel speed and vehicle class, this effect can be negative or positive depending on how a proposed improvement influences forecast travel volumes, the mix of vehicle types and travel speeds. It should be noted that HERS-ST does not currently reflect the anticipated shift to a lower emission vehicle mix in future years.

Capital Improvement Costs

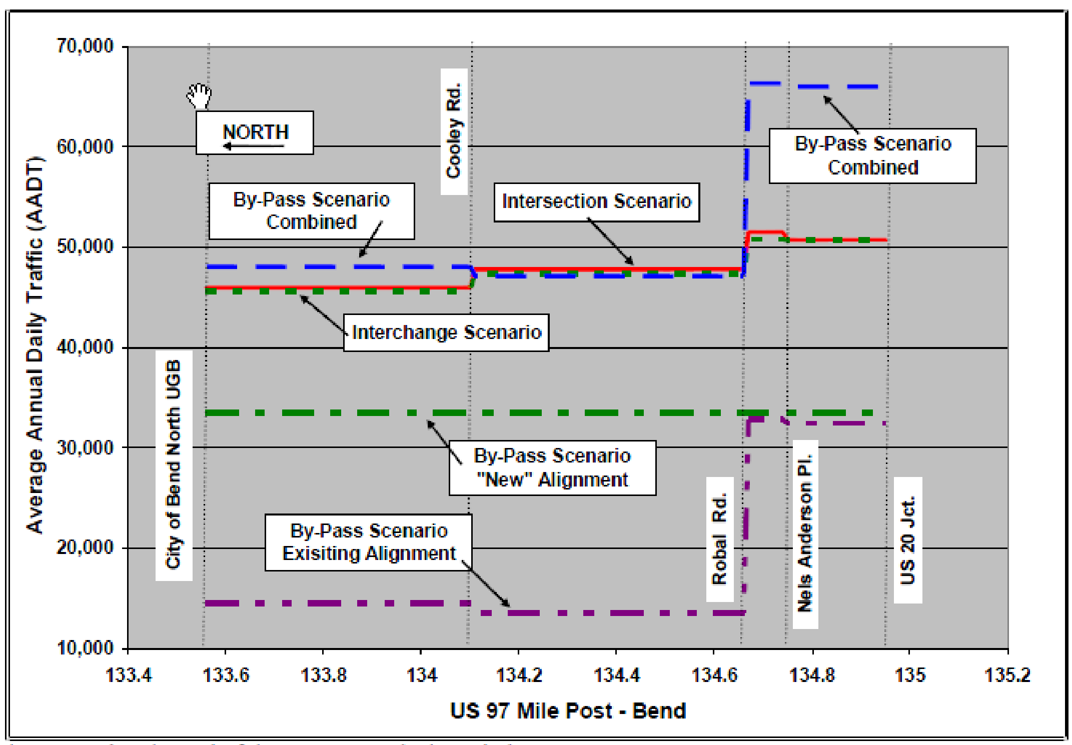
HERS-ST identifies segment deficiencies, evaluates a series of improvements that will correct the condition, and estimates the cost of the highway improvement. The Capital Improvement Costs are simply the construction costs for the selected improvements. When analyzing the economic attractiveness of a potential improvement, the improvement cost is used as the denominator in the benefit-cost equation.

7.3.8 HERS Output

HERS provides a variety of output options. Which output to use depends on the analysis purpose. Benefit/cost analysis leads itself to more tabular output while speed and delay should be plotted via an Excel export. Sectional output also can be exported to GIS for mapping. The [ODOT HERS-ST website] has example HERS applications, reports and outputs used for presentations. Total User Costs is a major selling point of national HERS use, but for Oregon, this has not been t well received to date and probably should be minimized in report documentation. HERS is very valuable for showing corridor metrics such as v/c ratio, delay, and speed.

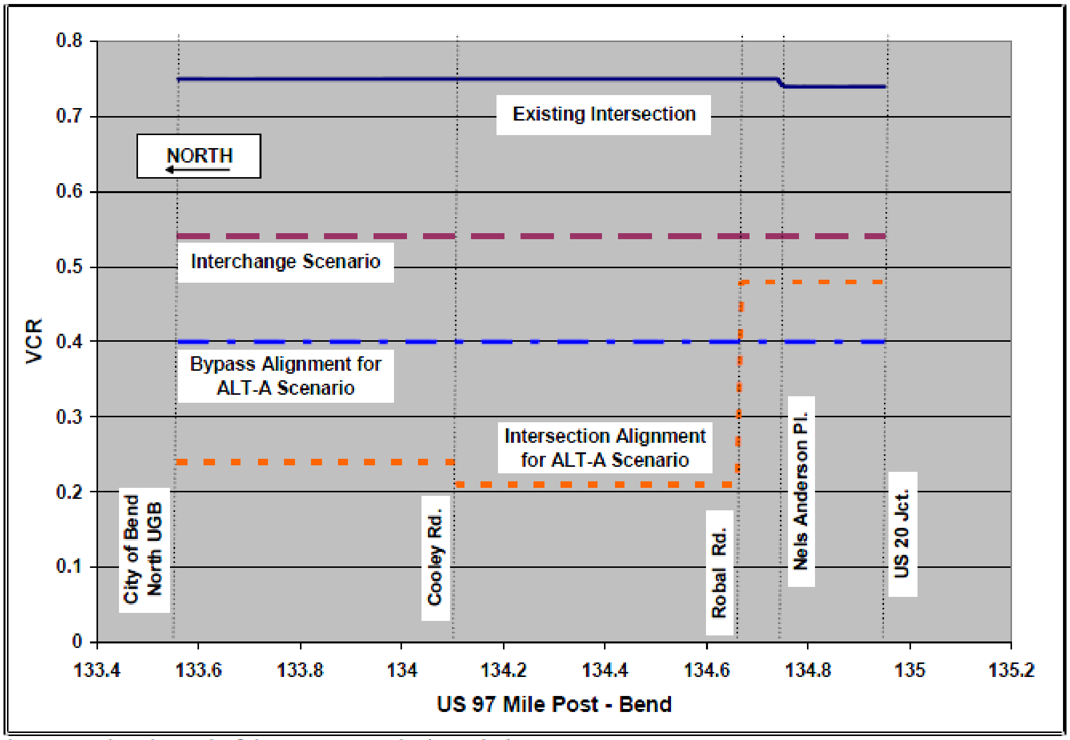
Daily traffic, speed, delay and v/c ratio results can be plotted using color-patterned lines on a profile type graph which will clearly show the differences between alternatives and/or the no-build (as long as care is taken on how many different scenarios are compared at once). Examples of these plots are shown in Exhibits 7-3 through 7-9.

Exhibit 7-3: HERS-ST Scenario Comparison - AADT



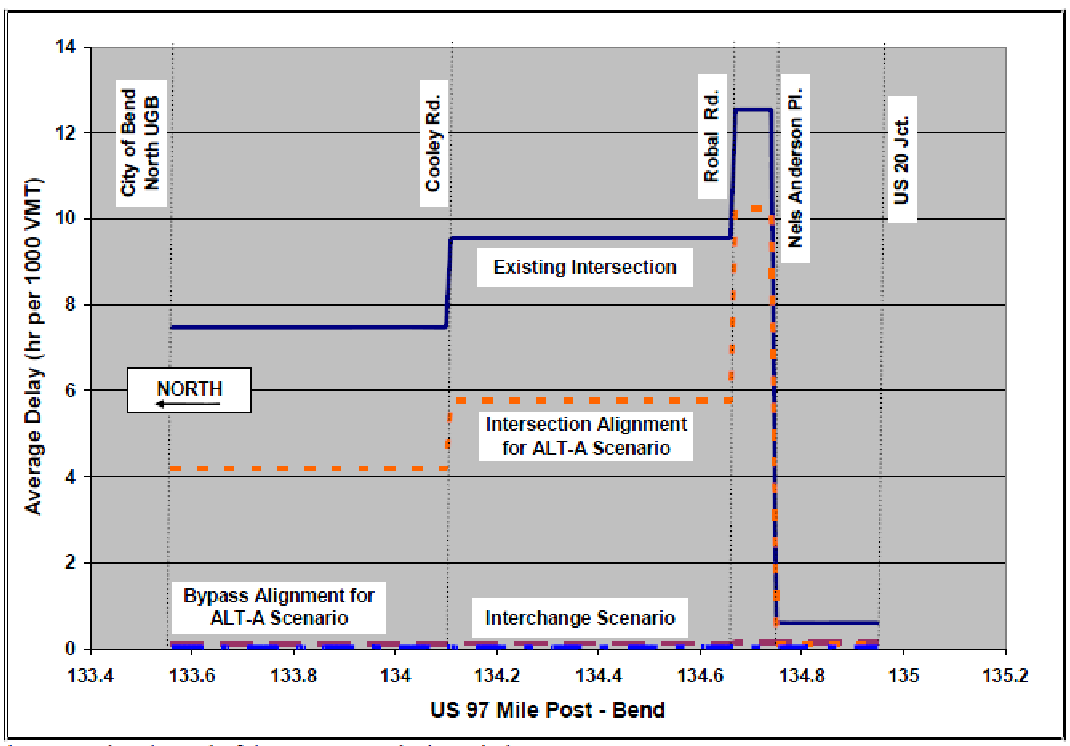
*Measured at the end of the 20-year analysis period.

Exhibit 7-4: HERS-ST Scenario Comparison – V/C Ratio



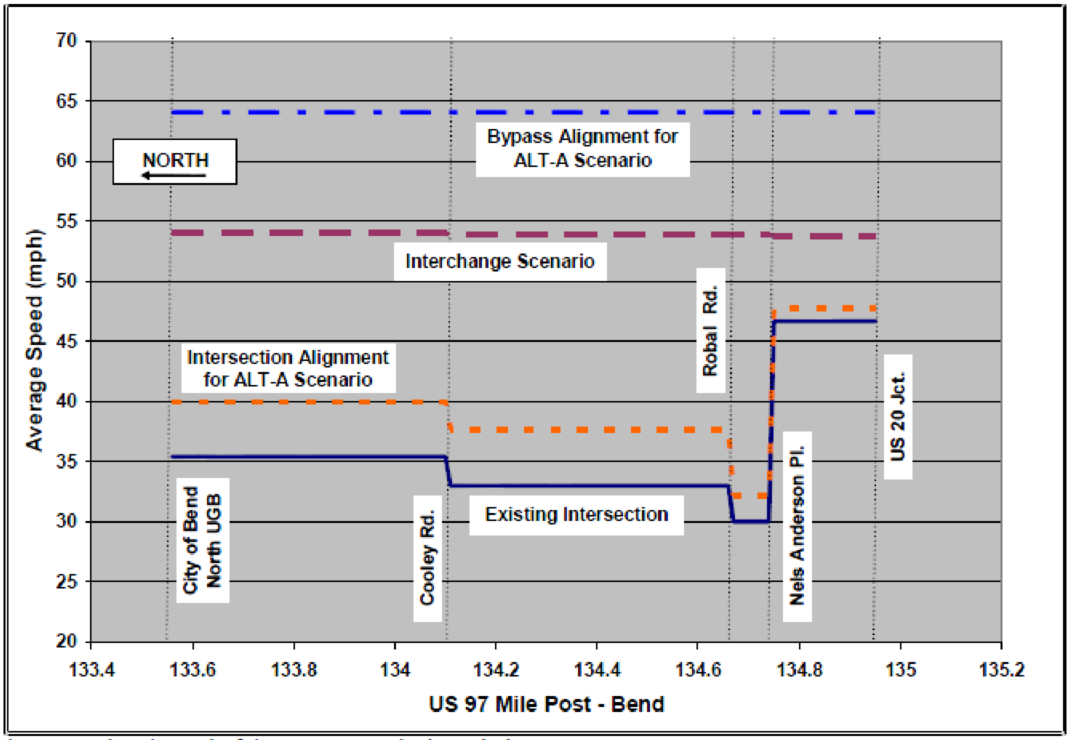
*Measured at the end of the 20-year analysis period.

Exhibit 7-5: HERS-ST Scenario Comparison - Average Delay



*Measured at the end of the 20-year analysis period.

Exhibit 7-6: HERS-ST Scenario Comparison - Average Speed



*Measured at the end of the 20-year analysis period.

Other results are best compared in tables such as VMT or benefit-cost ratio, as shown in Exhibits 7-7 through 7-8.

Exhibit 7-7: HERS-ST Benefit/Cost Ratio Summary

Scenarios		Description
Interchange	Bypass	
$149,578,657	$133,893,192	Total Benefit
$18,750,000	$18,750,000	RV for $50m
$50,000,000	$50,000,000	Capital Improvement Costs
3.37	3.05	BCR for $50M

RV: residual value

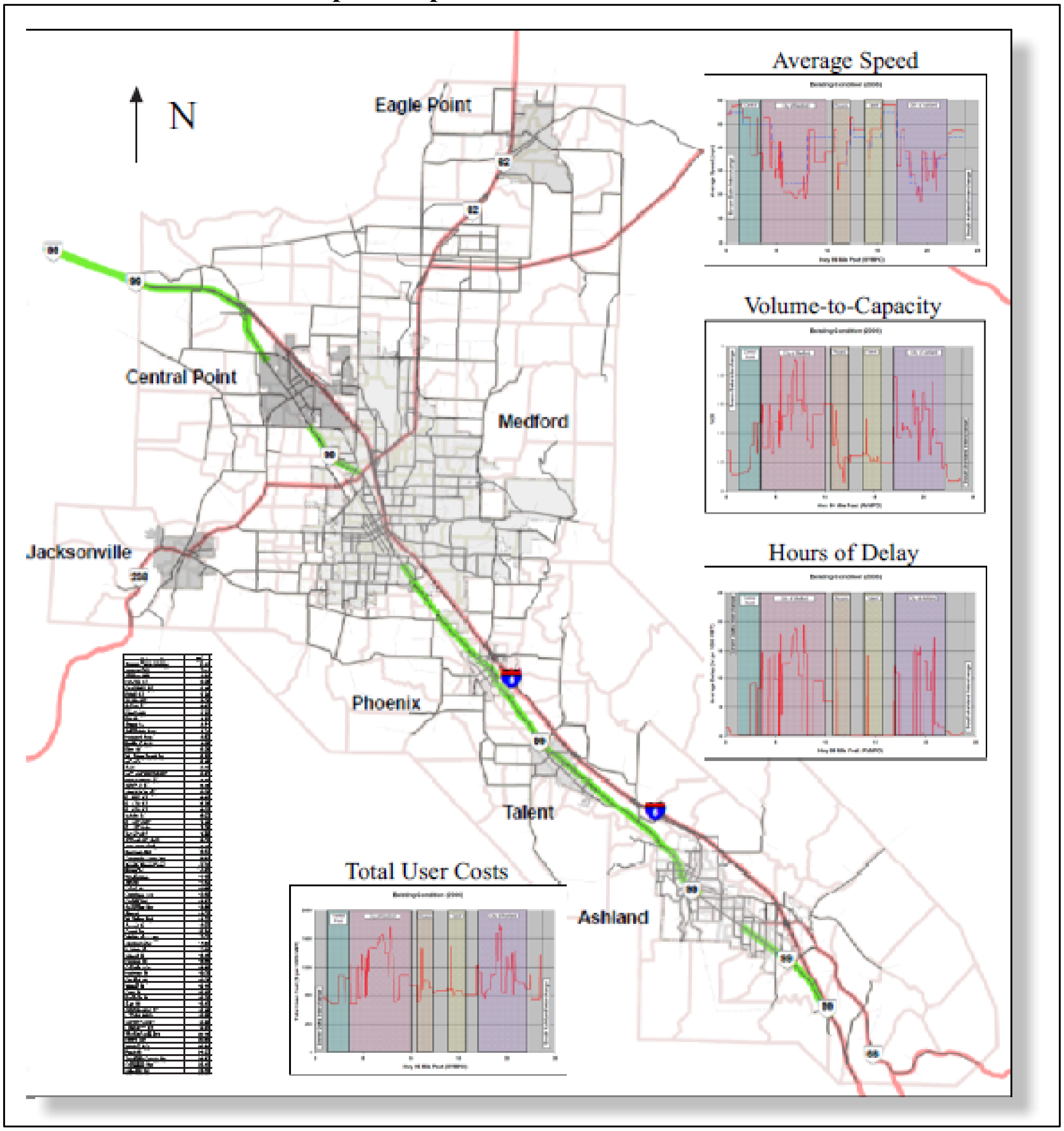
Exhibit 7-8: HERS-ST Scenario Performance Summary

Scenarios	VCR	VMT (million)	Avg. Speed (mph)	Delay (hr/1000 VMT)
No Build: Intersection	*0.75*	*24.4*	*36.0*	*35.1*
Build: Interchange	0.54	24.2	54.0	0.5
Build: Bypass	0.36	26.3	53.1	7.2

*Measured at the end of the 20-year analysis period.

Performance measures are best shown on a map for easy spatial reference since HERS is segment based.

Exhibit 7-9: HERS-ST Map Example



7.3.9 Documentation Requirements

The documentation of the HERS analysis needs to give an adequate discussion of the context and study area that HERS was used for. There should be documentation in the report (or appendix) showing all of the assumptions used in the dataset creation and what inputs were defaulted. Also, the analysis assumptions need to be defined such as funding periods, analysis types, etc.

The documentation of HERS results should include discussions on alternatives and between alternatives including any issues or considerations. Since there typically is a large amount of data in a HERS analysis, summaries are critical to reader understanding. It is easy to create too much data and information for the reader to sift through.

Additional general information on documentation is in the APM Documentation Chapter 19.

7.3.10 HERS Application Examples

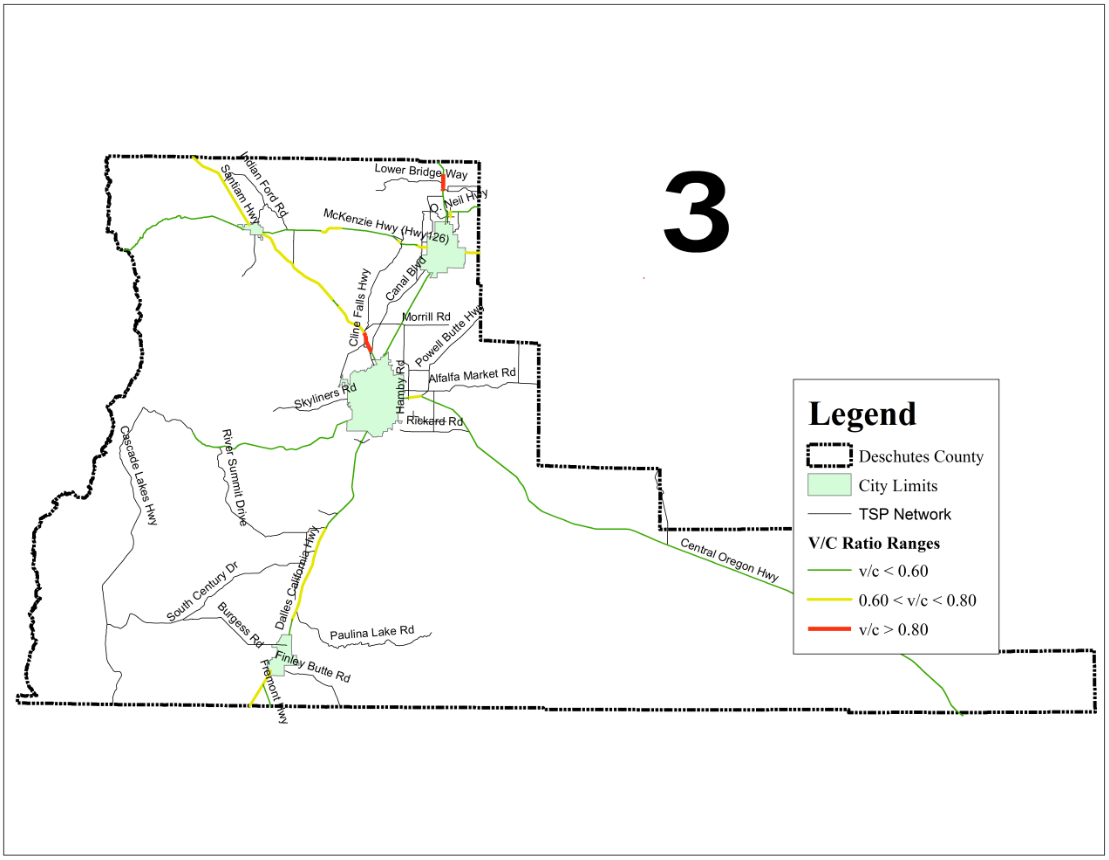
Plans TSP/RTP: Deschutes County TSP Update

Transportation System Plans (TSPs) are to identify needs/risks of transportation systems. Instead of detailed project level analysis outlined in Transportation Planning Analysis Unit's Analysis Procedure Manual (TPAU's APM), a system-level analysis was used for the Deschutes County TSP update. The analysis is based on the Deschutes County travel demand model along with other data to estimate deficiencies with a high, medium, and low ranking. A high rank indicates a near-term project will be needed with a combination of the available funding. Medium and low ranks show need of a refinement plan for mid-term and long-term projects to be amended back into the TSP.

Capacity analysis of the TSP's roadways was performed using the Highway Economic Requirements System – State Version (HERS-ST).

- State highways used existing 2006 HPMS data from ODOT's Integrated Transportation Information System (ITIS). Exhibit 7-10 shows the HERS-ST calculated v/c ratios for state highways in the TSP.
- County roadways use HPMS data developed from the base Deschutes County travel demand model (e.g. Annual Average Daily Traffic (AADT) volumes, speeds, number of lanes), data provided by Deschutes County (e.g. truck percentages), an assumed average K-factor of 15 percent and some national default values in the HERS-ST analytical program for unattainable data.

Exhibit 7-10: Scenarios 1 and 2 V/C Ratio[1] Ranges on State Highways



[1] V/C ratios were calculated by HERS-ST

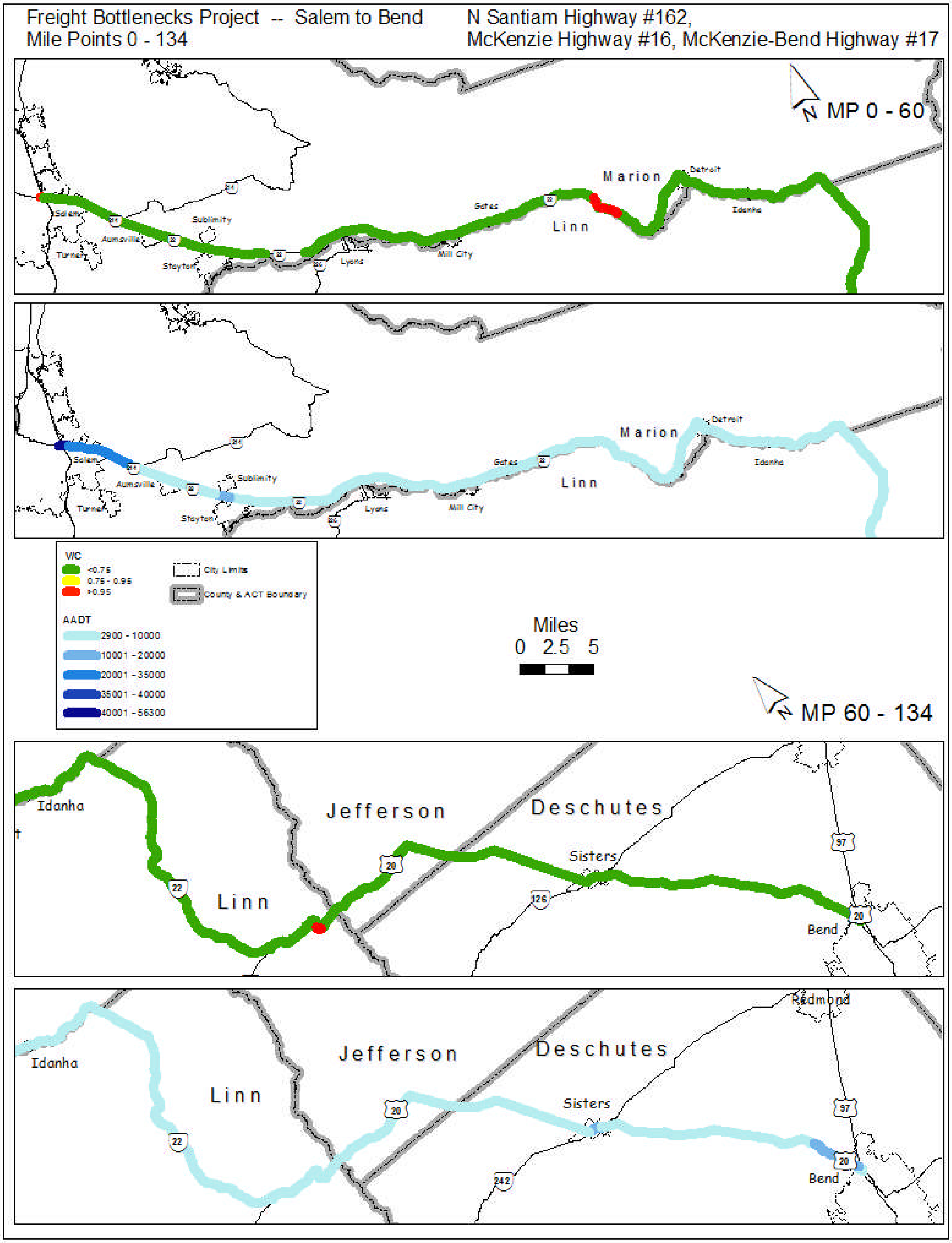
System/Policy: Freight Bottlenecks Project

The Oregon State Highway Performance Data and Metrics Related to Freight study described highway corridor performance and economic use in order to support informed decisions by identifying and prioritizing transportation investments. The study was intended to reveal locations with performance issues related to freight, and support strategic prioritization of additional refined traffic analysis necessary to develop bottleneck solutions. The report was prepared in support of an effort to identify freight bottleneck locations. Nineteen corridors were evaluated.

HERS-ST and the Oregon Statewide Integrated Model (SWIM) were used in the study. HERS-ST was used for this study to provide metrics including average annual daily traffic, daily vehicle miles traveled (VMT), truck share of traffic, annual hours of delay, volume to capacity ratios, highway user costs, vehicle operating costs, and vehicle travel time costs.

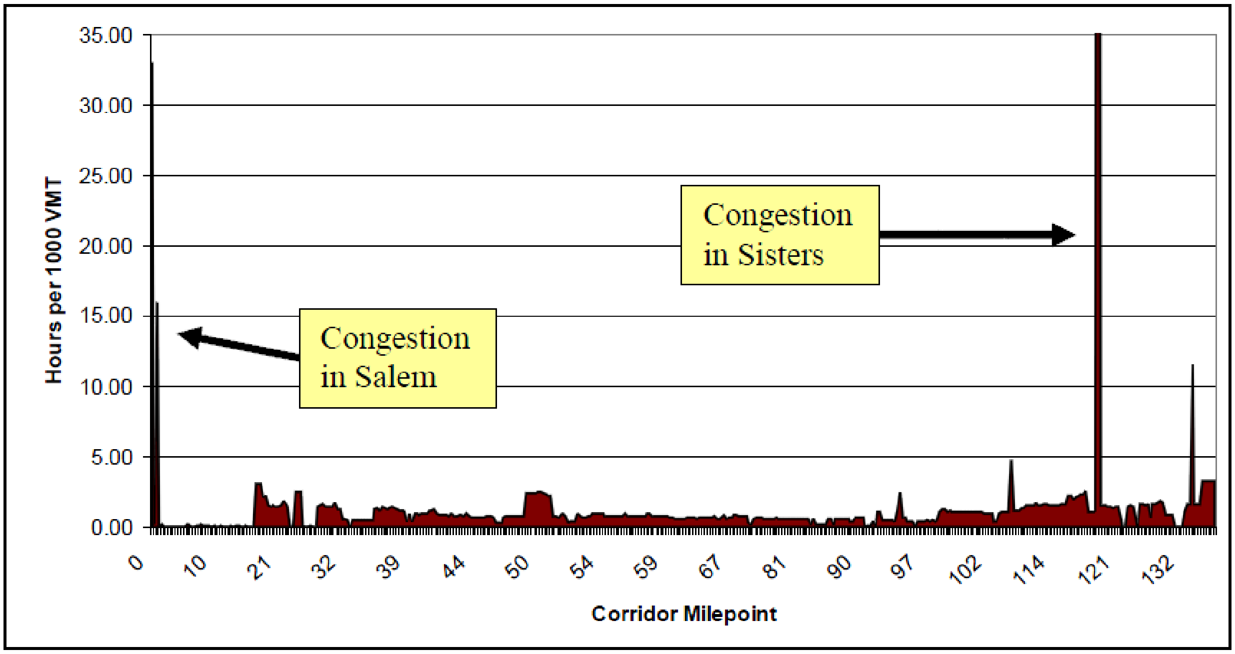
Example HERS-ST outputs from this study are shown below for the OR 22/US 20 Salem to Bend corridor in Exhibits 7-11 and 7-12.

Exhibit 7-11: Freight Bottlenecks Project – Salem to Bend



Source: Freight Corridor Study, Figure 46.

Exhibit 7-12: Annual Average Delay: Hours per 1000 VMT (OR 22/US 20 Salem to Bend)

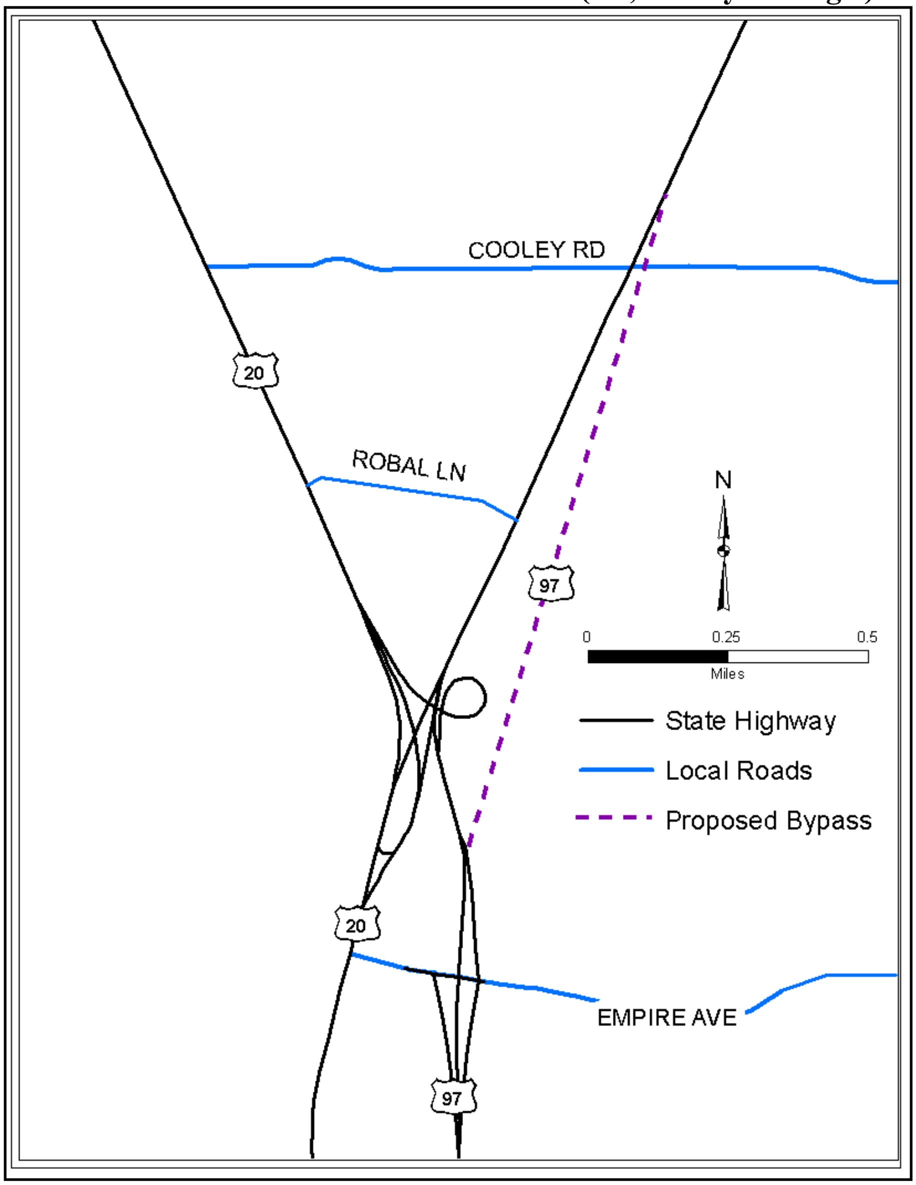


Source: Freight Corridor Study, Figure 47.

Project: Bend North Corridor Bypass Alternative

Over the past decade, the northern area of the City of Bend has undergone considerable business growth and change. The area known locally as the "Cooley Triangle" has been the location of choice for many retail organizations moving into this Central Oregon community (Exhibit 7-13).

Exhibit 7-13: US 97 Bend North Corridor (i.e., Cooley Triangle) Study Area



The original costs for the larger-scale alternative solutions recommended to address the transportation needs were estimated at $350-$400 million, which far exceeded the region's available funding stream for the next 20 years, so the likelihood of full funding seemed unlikely. The project team sought to investigate smaller-scale solutions that would begin to address the system needs at a more reasonable cost. The HERS-ST analysis was undertaken to help inform decision-makers on the range of funding levels that could produce the highest value to the state.

This project analysis evaluated changes in long-range system performance measures and looked at economic benefits for improving the roadway system based on a generic benefit-cost ratio (BCR) concept. Several system performance measures were evaluated using the state version of the Highway Economic Requirements System (HERS-ST). Based on the BCR concept, the analysis looked at economic benefits for a no-build and build scenario.

The No-Build Scenario was the existing roadway system, with no signal or widening improvements. The No-Build scenario is the base case that reflects the existing system layout, assuming that no improvements are made other than routine maintenance. Separate HERS-ST input datasets were built for each of the five roadway alignments. The dataset development process began with importing key traffic data elements provided by the Transportation Planning Analysis Unit (TPAU), such as base and horizon year average annual daily traffic (AADT), truck percentages for single units and combinations, peak hour traffic factors, direction factors, signal control locations and lane configurations. The input data were checked using the Oregon Department of Transportation's (ODOT) video log and on-line mapping images to ensure that the data correctly reflected the existing condition.

The pavement condition was defined as "perfect" at the beginning of the analysis period in order to minimize improvement analysis within HERS-ST and to avoid introducing an additional complication factor in the BCR analysis. It was generally assumed that the pavement condition would continue to deteriorate over the 20-year analysis period and that resurfacing would be required at or near the end of the analysis period. The local costs for resurfacing, when warranted, use national improvement costs.

The Build Scenario added a new bypass alignment, as well as some moderate widening and intersection signalization improvements, on several roadway systems within the immediate area. The Build scenario is based on the "Alternative East DS2 Modified" traffic analysis data provided by TPAU. Various data element changes were applied to the Build scenario dataset to reflect the proposed project improvements for the roadway systems. The easterly bypass alignment was coded as an urbanized expressway with full access control, and the number of lanes and speed values were coded as two lanes per direction and 45 miles per hour (mph), respectively.

The HERS-ST model evaluated each scenario as if it were operational at the beginning of the analysis period. The analysis addressed the question, "What is the long-range system user costs and performance for this condition?"

The regional significance of the US 97 bypass project and five roadway alignments were identified as key transportation facilities for analysis within the immediate area of the proposed project. Both Build and No-Build scenario datasets were developed for the five alignments (10 datasets total) and the HERS-ST model was used to evaluate and compare the system condition and performance for each alignment, as well as the total user costs. The average segment peak speed, peak delay, and volume-to-capacity ratio (VCR) analyses showed reasonable improvement for the Build scenario, as compared with the No-Build scenario.

The performance improvements are due to the added bypass alignment and the other improvements to the local infrastructure that enhance the flow in and through the project area. The bypass alignment pulls many trips off the existing US 97 alignment that are considered "pass-through" trips because they do not stop within the project area. Pulling the pass-through trips out of the general flow has advantages both to the general performance of the regional system and to safety and travel cost savings as well. As a result of the improved flow, the travel time, operational costs, and crash costs are reduced for the general users of the facilities, which can be directly measured with the BCR analysis.

The capital improvement cost was evaluated using two different contingency costs: 25% and 40%. The analysis showed a BCR range of 1.48 and 1.40 for a 25% and 40% contingency, respectively. Exhibit 7-14 shows the 25% contingency table as an example. These numbers are rough estimates for high level planning purposes. A detailed analysis should be conducted to develop a precise BCR.

Exhibit 7-14: Summary of BCR – 25% Contingency Costs

Roadway	No-Build ($)	Build ($)	Diff ($)
US 97	1,514,900,000	1,456,800,000	58,100,000
US 20	825,100,000	771,500,000	53,600,000
Cooley Rd.	203,000,000	188,700,000	14,300,000
Empire Ave.	244,000,000	230,700,000	13,300,000
Robal Rd.	54,500,000	49,800,000	4,700,000
Total	**2,841,500,000**	**2,697,500,000**	**144,000,000**
Total Net Benefit			$ 144,000,000
Residual Value			$ 111,400,000
Total Capital Improvement Cost (25% Contingency)			$ 172,600,000
Benefit-to-Cost-Ratio (BCR)			1.48

Arterial: Seaside (US 101)

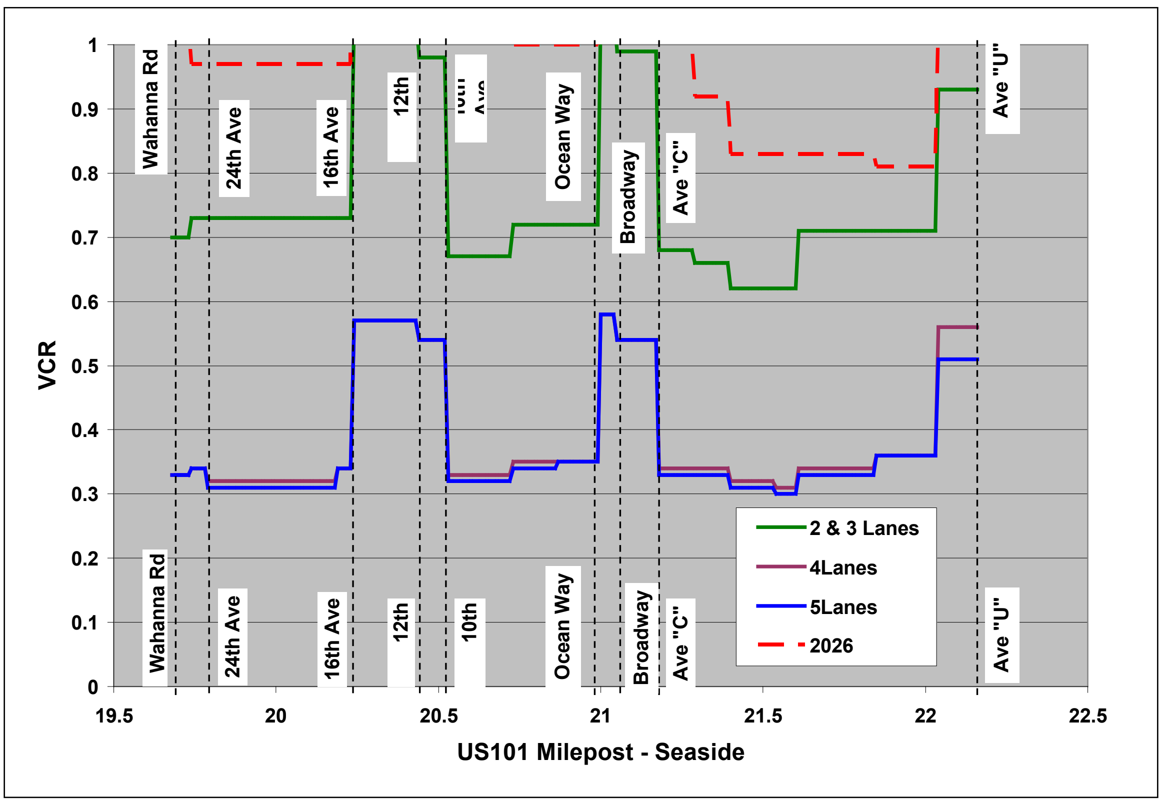
HERS-ST was used to evaluate US 101 performance through Seaside, Oregon. The termini for this project were from Wahanna Rd (M.P. 19.68) at the north to Avenue "U" (M.P. 22.17) at the south. The total length of the highway segment was 2.4 miles.

The HERS-ST dataset was double checked using aerial imagery, such as Google Earth. The checking process verified the intersection locations, the shoulder and median types, and the location and number of through and turning lanes. Three signalized intersections were found on this segment of US 101 through Seaside: at 12th Ave (M.P. 20.44), at Broadway St (M.P. 21.05), and at Avenue "U" (M.P. 22.17).

Four scenarios were developed and run for this project: 2Lane (Existing Condition), 3Lane, 4Lane and 5Lane. For this analysis, average speed, average delay, volume-to-capacity (VCR) and total user costs were evaluated. All four of these measures are outputted individually for each of the 18 segments. The sectional outputs were compiled and graphed in **E**xhibit 7-15 through 7-17, below. By plotting along a profile of US 101, the analyst can see how each performance measure varies along the entire US 101 alignment.

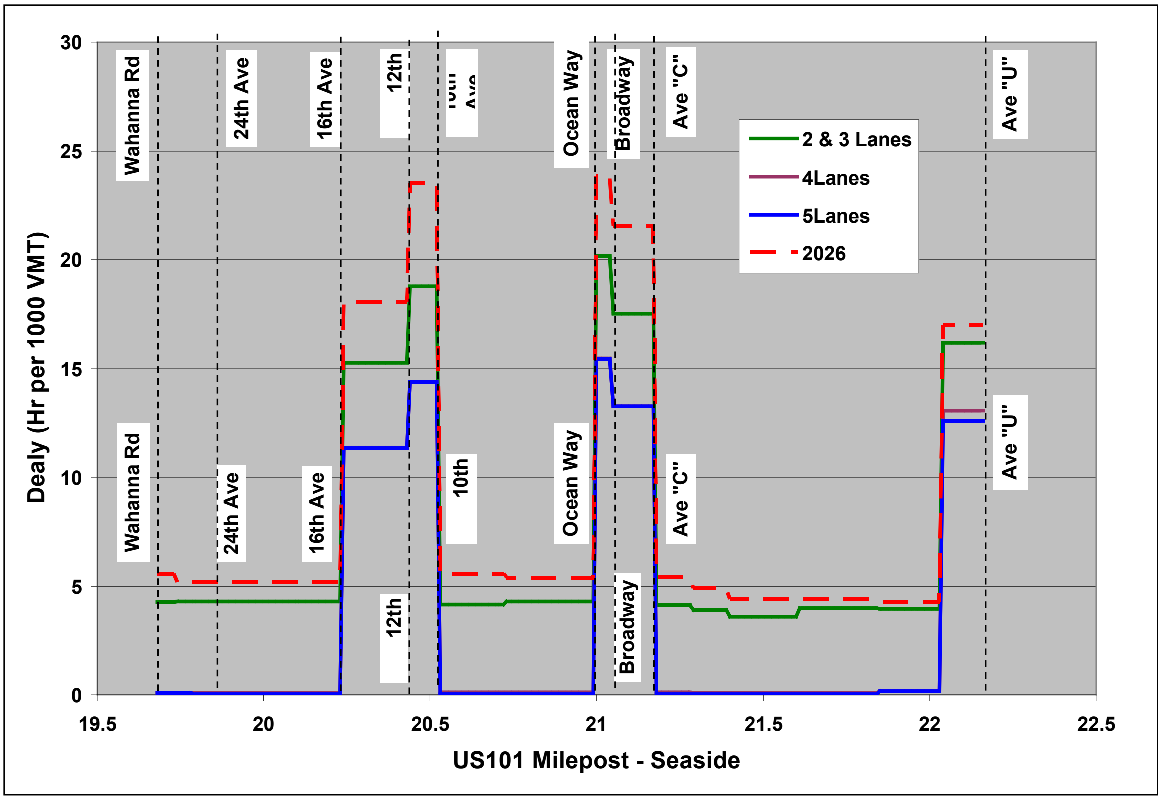
The VCR analysis of all four scenarios is shown in Exhibit 7-15. The volume-to-capacity ratio (VCR) is often used to identify congestion and define performance on the roadway system. The HERS-ST model uses refined HCM formulas to calculate peak VCR for each segment. It should be noted that HERS-ST does not produce intersection VCR.

Exhibit 7-15: US 101 – Volume-to-Capacity



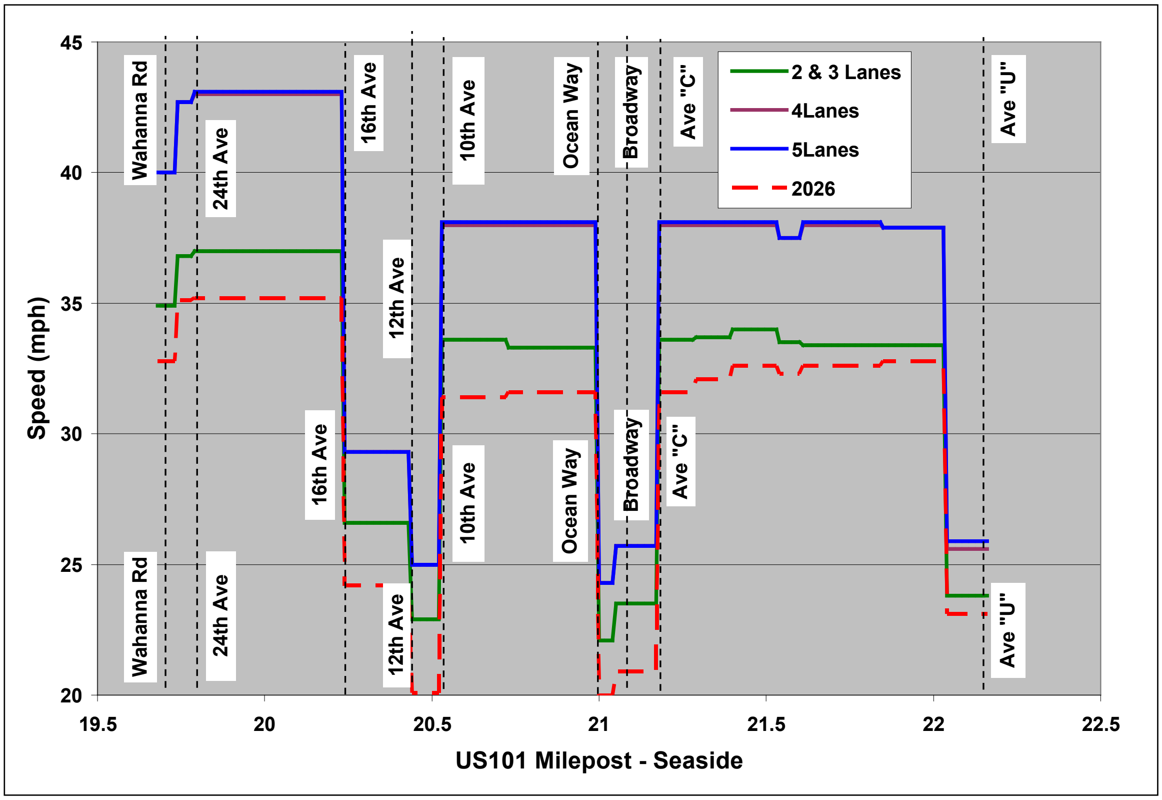
Average Peak Delay is plotted for each scenario in Exhibit 7-16. As expected, the highest level of delay is associated with signalized intersections.

Exhibit 7-16: US 101 – Hours of Delay



The average speed along US 101 for the four scenarios is shown in Exhibit 7-17. As expected, the average speeds decrease around the signalized intersections, suggesting a level of congestion due to restrictions on traffic movement due to the control. As with the VCR and Delay analysis, the Speed analysis shows no difference in the average speed for the Existing and 3Lane scenarios.

Exhibit 7-17: US 101 – Average Speed



7.4 Statewide Integrated Model (SWIM2)

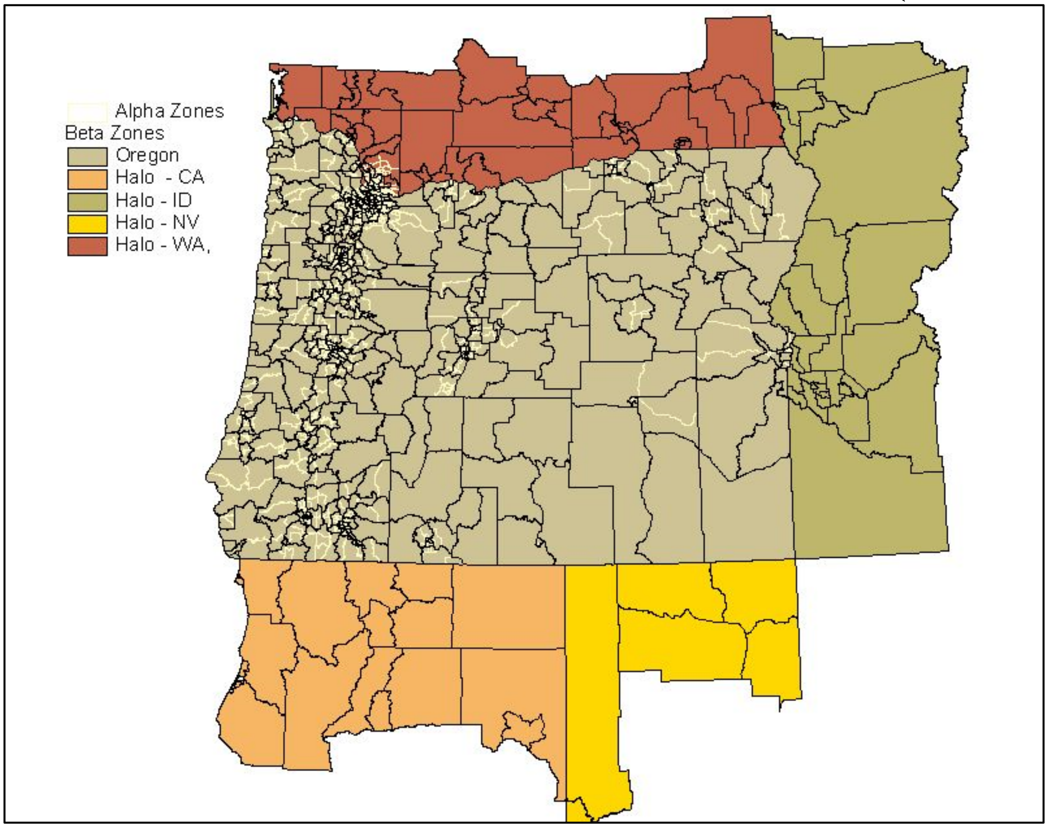
7.4.1 Introduction/Purpose

Transportation, land use and economics are all interwoven. Oregon's SWIM2 model allows regional and statewide policies to be tested to inform decision-makers on the complex interactions between land use, the transportation network, and the economy. SWIM2 has been used to examine a variety of transportation and land use policy actions, investments, and their interactions through time. It is designed to answer questions at a larger scale than the typical regional or small urban travel demand model. Unlike typical travel demand models where land use is the major input, the SWIM2 model uses the economy in terms of gross domestic product (GDP) and models land use and its impact on transportation.

7.4.2 Geography, Zone Size and Network Level of Detail

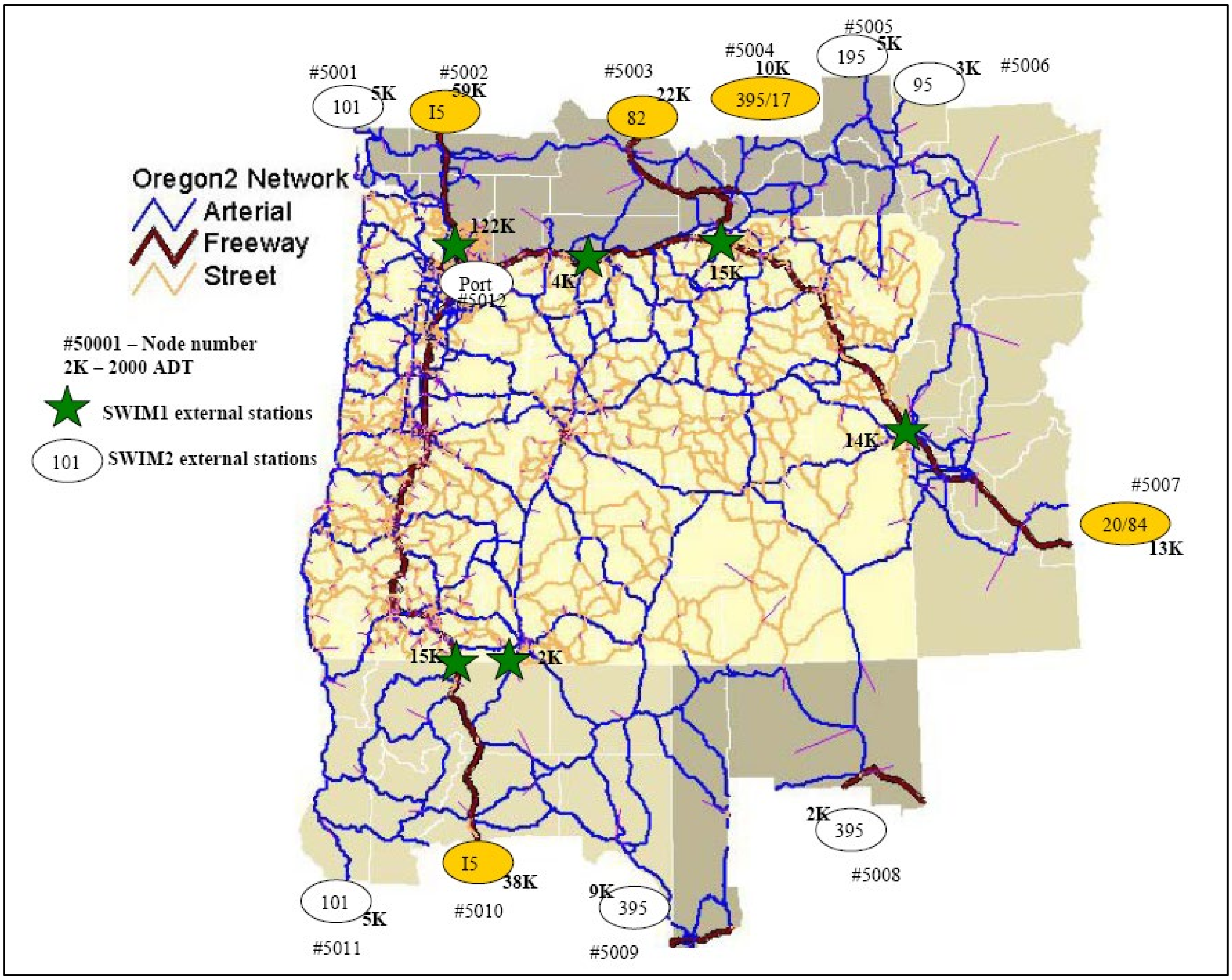
SWIM2 operates at two geographic levels within the model area (Exhibit 7-18). Both levels encompass all 36 Oregon and 39 (Halo) adjacent state counties. The halo encompasses a roughly 50-mile buffer around Oregon. A system of alpha zones used for trip assignment (light and dark lines in Exhibit 7-18) has the finest level of detail. A system of larger beta zones is used for land use allocations. The External Stations (Exhibit 7-19) serve as model area entry/exit points or gateways to World Market zones.

Exhibit 7-18: Current SWIM2 Model Extent and Zone Structure (October 2010)



Source: [2nd Generation StateWide Integrated Model (SWIM) Model Description]() - Model Build Documentation November 2010

Exhibit 7-19: Map of SWIM2 External Stations



Source: [2nd Generation StateWide Integrated Model (SWIM) Model Description]() - Model Build Documentation November 2010

7.4.3 SWIM2 Structure

The SWIM2 model is comprised of the following individually calibrated modules that represent the behavior of the land use, economy, and transport system in the sState of Oregon. Because the structure is modular, it allows for updates and improvements to be made with minimal disruption to the full model.

- **ED** – The Economics and Demographics module determines model- wide production activity levels, employment, and imports/exports.
- **SPG** – The Synthetic Population Generator module samples household and person demographic attributes (SPG1) and assigns a household to an alpha zone (used for trip assignment) (SPG2).

- **ALD** – The Aggregate Land Development module allocates model-wide land development decisions among study area alpha zones considering floor space prices and vacancy rates.
- **PI** – The Production allocations and Interactions module determines commodity (goods, services, floor space, labor) quantity and price in all exchange zones to clear markets, including the location of business and households by beta zone (used for land use).
- **PT** – The Person Travel module generates activity-based person trips for each study area person in the synthetic population, during a typical weekday.
- **CT** – The Commercial Transport module generates mode split for goods movement flows and generates truck trips, combining shipments and possible trans-shipment locations, for a typical weekday.
- **ET** – The External Transport module generates truck trips from input origin-destination trip matrices representing import, export (within 75 miles) and through movements based on PI and external station growth rates.
- **TS** – The Transport Supply module assigns vehicle, truck, and transit trips (separately) to paths on the congested transport network for a 24-hour period, generating time and distance skims for AM and off-peak periods.

The PI module operates on the less-detailed beta zone system (dark lines in Exhibit 7-18) where the external stations are replaced by world markets. The beta zones consolidate (aggregate) the alpha zones, with a focus on the small urban zones. In other urban areas, zones were consolidated based on a sliding population scale (approximately 25,000 persons per zone), respecting similar employment clusters and transportation commute-sheds. In rural areas, homogenous public lands (e.g., BLM, National Forests) were consolidated, while retaining most county and all ACT[2] boundaries.

The world markets assume that goods transport by truck and rail is limited to the US (except Hawaii), Canada and Mexico. Imports and exports to other regions in the world are shipped by barge, either from the Port of Portland or other US east or southeast marine ports.

The ED module estimates production activity, imports/exports, and employment exclusively at the model-wide level. Due to data limitations, ED uses an aggregated set of general industry sectors such as Wholesale Trade, Lumber and Wood Products, and Education[3]. ED outputs are disaggregated using fixed relationships into the industry categories used in the SPG and PI modules. These fixed relationships rely on employment and economic data.

[2] Area Commissions on Transportation (ACTs), used in Oregon transportation planning, provide a convenient way to divide the sState into 12 areas.
[3] For a complete list of Industries and commodities please refer to the Model Build Documentation - 2nd Generation StateWide Integrated Model (SWIM) Model Description

7.4.4 Scenario Development

SWIM is intended to respond to large (regional or statewide) projects and policy questions, and is not suitable for fine-grained questions, such as specific land use changes (i.e., a new shopping center) or small network projects (i.e., widening of a 1-mile section of urban road). These kinds of smaller requests need to use the appropriate MPO or small urban model. However, SWIM can be used on smaller projects to help inform on trends such as trip distributions or verification of future growth rates where other rural information is unavailable or spotty.

Typical inputs would be to make any network modifications like adding a new highway corridor or significant bridge crossing that would affect the regional economy. The inputs are all integrated and provide feedback to each other (i.e. the transport system can affect land use which, in turn, affects the economy). The SWIM2 model network is primarily state highways. City networks are not as detailed as a MPO regional model. Land use inputs involve defining the allowable zoning and capability for each zone type. Economic inputs are based on the GDP by sector at a state level.

Because of its complexity and statewide application, ODOT staff and resources use SWIM2 to develop scenarios. SWIM2 is not to be requested using the standard model request form. Any potential SWIM application requests need to be routed to the TPAU unit manager. Although it is useful for developing and analyzing a wide range of policy alternatives and options, it can require several weeks to run the model to respond to the input changes. SWIM2 outputs are on an annual basis rather than a typical 20-year planning horizon for most travel demand models. Outputs are not intended for post-processing as the model is not to the typical link level of detail. There also is no "official" future no-build to compare to as there is no consistent statewide vision of a future network and zoning. Every SWIM module has generated outputs such as dollars traded by sectors from the PI module or population by zone from the SPG module. These outputs require analysis to be able to "tell the story" of the impacts of a particular scenario.

7.4.5 SWIM Applications

Estimated Economic Impact Analysis Due to Failure of the Transportation Infrastructure in the Event of a 9.0 Cascadia Subduction Zone Earthquake

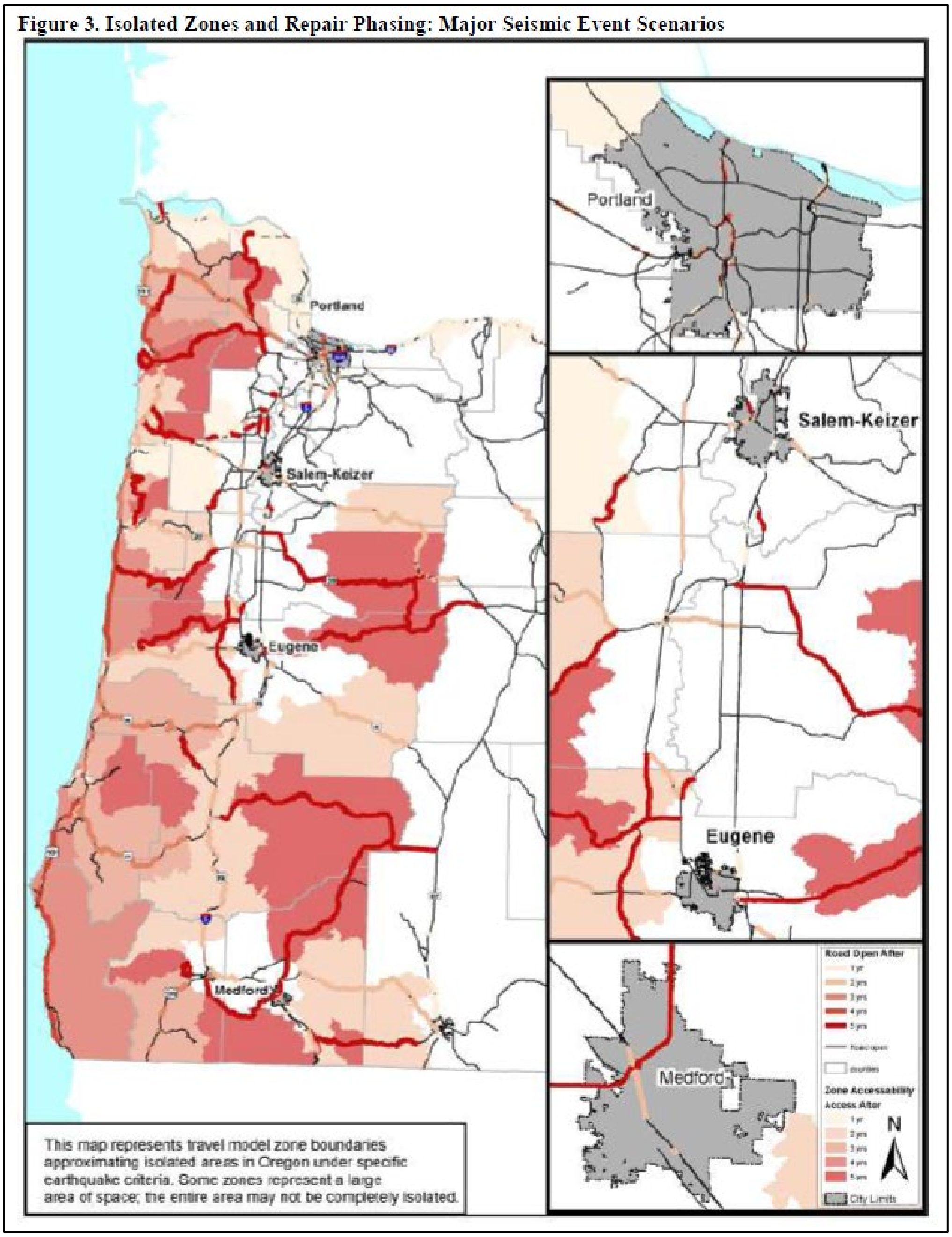
The purpose of this analysis was to provide high- level estimates of avoidable economic impacts caused by damage to the transportation system from a major seismic event (a 9.0 Cascadia Subduction Zone Earthquake, where the fault breaks along the entire subduction zone – a worst case earthquake scenario). Four alternative scenarios were used to evaluate the impacts of pre-emptive mitigation. This analysis was prepared for the ODOT Bridge Engineering Section, which is evaluating risks and identifying strategies to mitigate seismic vulnerabilities of the state highway system. The scenario approach was designed to provide a general sense of the magnitude and direction of avoidable economic impacts to Oregon from damage occurring on the highway/street transportation system alone (non-transportation losses were not accounted for). This analysis focused on the western portion of the state, defined as the area to the west of the Oregon Cascade Range.

Results of this analysis indicate strengthening corridors before a major seismic event will enable the state to avoid a significant amount of economic loss. Significant economic losses in production activity can be avoided by preparing for a major earthquake ahead of time. With no preparation ahead of time, Oregon could lose up to $355 billion in gross state product in the 8 to 10 year period after the event. Proactive investment in bridge strengthening and landslide mitigation reduces this loss between 10% and 24% over the course of the eight years simulated for this analysis.

The analysis was conducted using the Oregon Statewide Integrated Model (SWIM). Only the roadway network was altered for the modeled scenarios. Corridors expected to experience damage from a major seismic event were represented as "failing." The points of failure were identified by the ODOT Bridge Engineering Section for high-use state-owned facilities. For lower use corridors and non-state owned facilities in the SWIM network, adjacent parallel routes within these corridors were altered to maintain consistency in network coding. Nearby facilities with similar proximity and characteristics of those identified to fail were represented to fail in the same manner. The purpose of this analysis was to evaluate the effects of impacts to transportation on economic activity separately, therefore building loss, damage to utilities, other damage or loss of life resulting from an earthquake werewas outside the scope.

Exhibit 7-20 shows the sections of highways affected by failures and areas of isolation. The roadway network is color- coded to illustrate when corridors would be repaired and returned to pre-earthquake conditions. Areas coded with the lightest color regain access to the highway system within one year, where the darkest red areas remain isolated for the full five- year repair period. Isolation means severely limited [(day(s) of travel]) access to markets for the local economy, causing delay in economic recovery.

Exhibit 7-20



Estimated Economic Impact Analysis Due to Failure of the Transportation Infrastructure in the Event of a 9.0 Cascadia Subduction Zone Earthquake Technical Memorandum, ODOT/TPAU, January, 2013.

Eastern Oregon Freeway Alternatives

The 1999 Legislature asked ODOT to look at the results of designating a north-south freeway in Central or Eastern Oregon, from the Washington to California borders. The objectives of House Bill 3090 were to:

- Define a better north-south connection to I-82 in Eastern Oregon
- Increase growth of Central/Eastern Oregon
- Decrease growth in the Willamette Valley
- Decrease travel and congestion on I-5 in the Willamette Valley

The basic approach of this study was to use SWIM to evaluate several alternative freeway scenarios. The alternative scenarios were modeled over a long time horizon because of the amount of time required to build such a freeway and the time would take for land use effects to occur afterward. For the purposes of this study, completion of the freeway was set at 2020 and 2025. Since significant land use effects of major transportation changes take decades to occur, the modeling time horizon was established as 2050. Data for several evaluation measures were extracted from the model outputs in order to determine whether the objectives of the freeway would be accomplished. The objectives and measures are summarized in Exhibit 7-21.

Exhibit 7-21: House Bill 3090 Study Objectives and Evaluation Measures

Objective	Evaluation Measures
• Decrease travel time in Central & Eastern	• Average travel for Central and Eastern Oregon (minutes per passenger mile and minutes per ton mile)
• Increase the amount of travel occurring in Central & Eastern Oregon • Decrease travel and congestion on I-5 in the Willamette Valley	• VMT by region of the state • Average travel time for the Willamette Valley • Traffic growth on I-5 and other selected highways
• Increase growth of Central/Eastern Oregon and decrease in Willamette Valley	• Percent of households by region • Percent of jobs by region

Study of Eastern Oregon Freeway Alternatives Pursuant to House Bill 3090, ODOT/TPAU, April, 2001

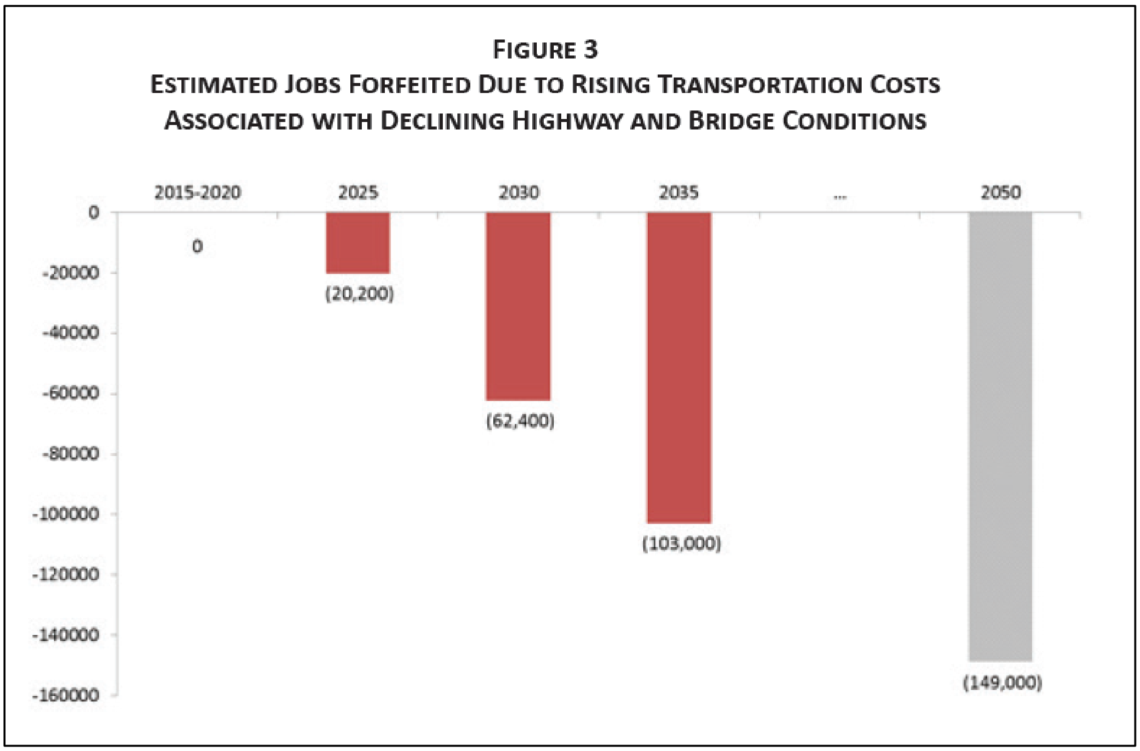
The results of the study found that building a new freeway connecting I-82 with California or Nevada to the south would significantly reduce travel time from border to border, but would have little effect on the growth of Central or Eastern Oregon or the Willamette Valley. It would also have little effect on diverting traffic away from the Willamette Valley.

Rough Roads Ahead

The purpose of this analysis is to prepare a high- level strategic comparison between the current forecast budget and an alternative budget designed to preserve current conditions of state highways, roads and bridges. Two funding scenarios were developed for this high- level comparative analysis. The *Current Revenue/Deterioration Scenario* represents the current 20-year ODOT budget forecast for state highway spending. The *Maintain Current Conditions Scenario* represents a 20-year forecast for highway spending designed to preserve current highway conditions. The second generation Oregon Statewide Integrated Model (SWIM2) is used for the scenario analysis.

One of the results were the estimated number of jobs forfeited due to higher transportation costs imposed in Oregon by declining highway and bridge conditions shown in Exhibit 7-22. Impacts to transportation costs start out small but increase rapidly; within 20 years there is significant impact on the growth of Oregon jobs. The number of estimated jobs lost increases over time. Between year 2025 and 2030 the number triples. By 2035 the number rises another 65 percent.

Exhibit 7-22: Jobs Forfeited



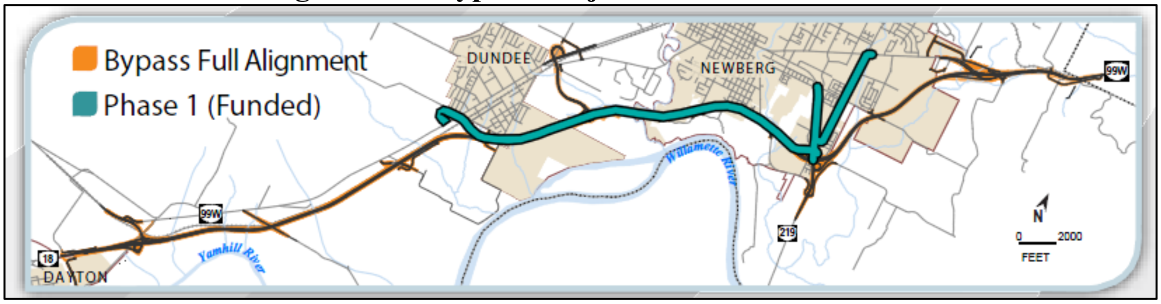
Rough Roads Ahead: The Cost of Poor Highway Conditions to Oregon's Economy, ODOT, 2014

The results of the study showed that deteriorating state highway conditions can be avoided. ODOT estimates that keeping the state highway system in its current good condition would cost an additional $405 million per year (constant dollars) compared to current budget levels. Given the expected economic losses and additional costs caused by a deteriorating system, the typical household will likely come out ahead with increased public investment in roads.

Newberg-Dundee Bypass

The Newberg-Dundee Bypass project was considered for funding under the Oregon Transportation Investment Act. The project, as shown in Exhibit 7-23, was modeled to assess potential land use, transportation and economic impacts of constructing or not constructing the project.

Exhibit 7-23: Newberg-Dundee Bypass Project



SWIM was used to model two scenarios: a Newberg-Dundee Bypass scenario, and a reference case or No-Action scenario. The distributions of households and jobs for the two scenarios were compared across external zones on the OR 99W/OR 18 corridor representing nearby communities in Yamhill County. Some of the conclusions from this modeling analysis effort were:

- The Newberg-Dundee Bypass will provide better access to McMinnville, which will help to stimulate the economic growth in the community.
- With the Bypass, there will be greater travel for all purposes between McMinnville and the Portland area consistent with the growth of population and jobs in McMinnville.
- Minimal effects will be seen in Newberg and other smaller communities in Yamhill County as a result of the Bypass.

Freight Plan

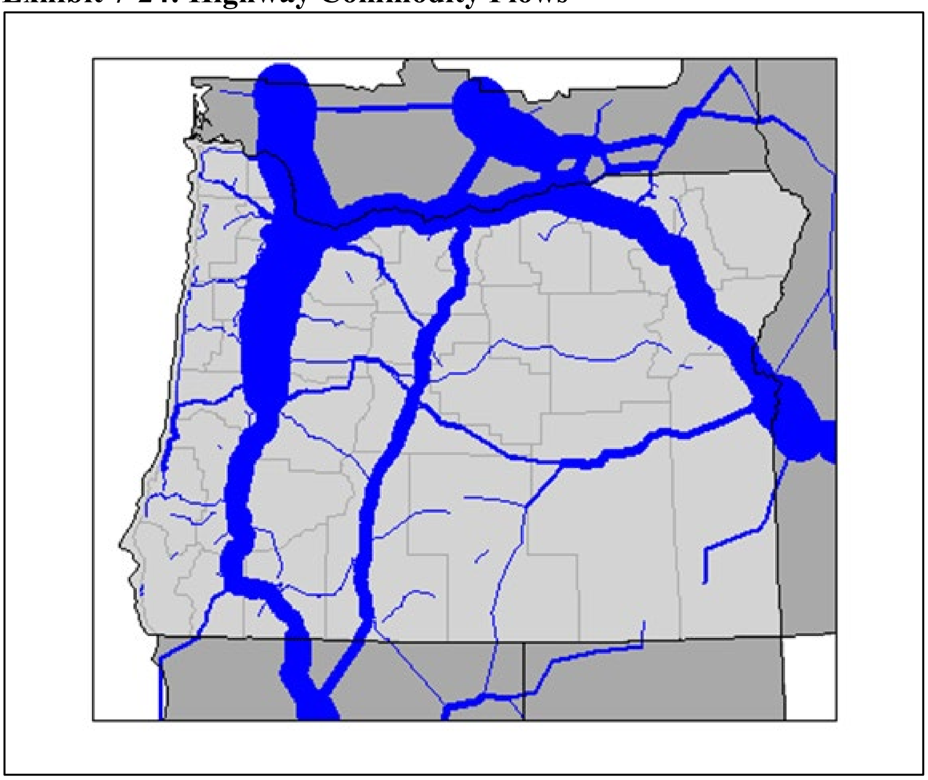
The purpose of the Oregon Freight Plan analysis was to gain an understanding of the spatial land use and transportation implications of different economic conditions. This analysis illustrated the variation in statewide and regional activity and commodity flow in order to help evaluate the risk associated with economic volatility on alternative Freight Plan strategies. As a result of the analysis, decision makers were better able to assess the robustness of freight strategies and avoid the creation of barriers that may prohibit the freight industry from reacting nimbly to economic change.

SWIM was used for this analysis. Four model scenarios were produced: business-as-usual Reference; Optimistic Economic Forecast; Pessimistic Economic Forecast; and High Transportation Cost. Highlights of the analysis findings include:

- Future demands on the freight system will be large, even if economic growth is muted. Economic inertia causes the dominant commodity mix and geographic flow patterns in Oregon to remain intact, with relatively small changes over time under various scenarios.

- Higher per-mile highway transportation costs result in less congestion, providing the impetus for shippers to increase the length of individual truck tours to increase operating efficiency. Higher transport costs result in reduced miles of travel and hours of travel statewide.
- Households relocate to reduce transport costs, causing urban density to rise and statewide auto miles of travel to fall.
- Commodities have unique and diverse patterns and logistics. Transportation services used to move these commodities are just as varied. Maintaining access to markets is key to economic competitiveness.
- The net results of thousands of shippers and buyers of goods and services are complex and, at times, counter intuitive. Modeling the dynamic nature of these forces provides valuable insight into the collective Oregon freight system needs.
- Assessing system performance and economic impacts is multifaceted. Attention must be given to regional issues, commodity characteristics, industry logistics, and employment patterns when evaluating alternative strategies.
- The largest commodity flows are on the I-5 and I-84 corridors, with significant flows on US-97 and US-20. Exhibit 7-24 shows the total commodity flows in the study area.

Exhibit 7-24: Highway Commodity Flows



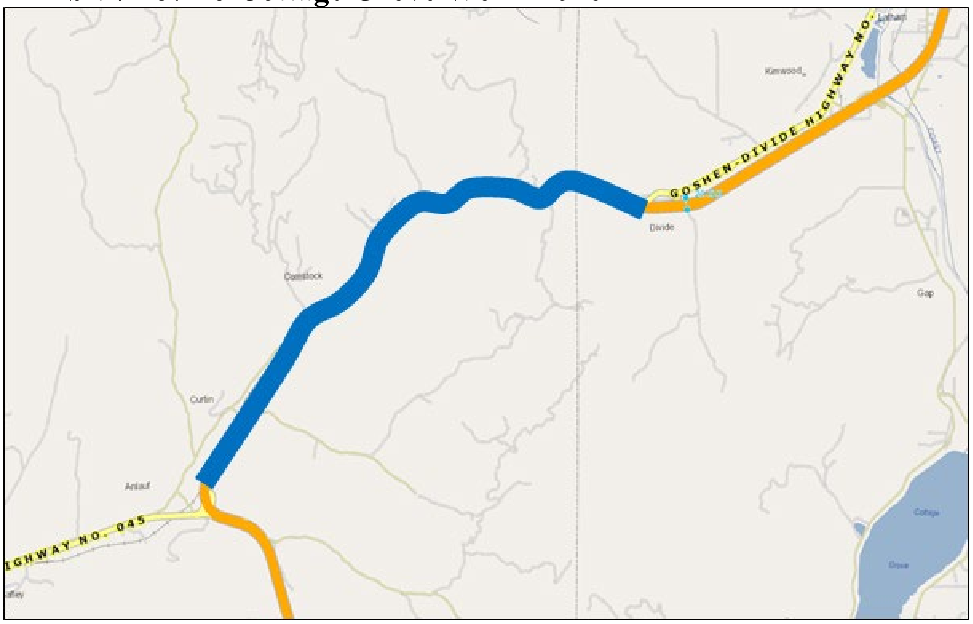
Oregon Freight Plan Modeling Analysis Technical Memorandum, ODOT/TPAU, August, 2010

I-5 Cottage Grove Work Zone

The SWIM network was utilized to answer a question from Region 3 regarding an upcoming pavement replacement project. If VMS signs were in place in the Willamette

Valley and in California, what would be the diversion potential away from this section of I-5? Delay was added to the blue portion of I-5 in Exhibit 7-25 below and the model run to determine the potential traffic shifts.

Exhibit 7-25: I-5 Cottage Grove Work Zone



Signage in Eugene and Reedsport has the potential to encourage typical users of OR 38 (, Umpqua Hwy), to use OR 126 (Florence- Eugene Hwy). Signs in Eugene and in California have the potential to encourage trucks and some autos to use OR 58 rather than I-5 when traveling North of Eugene or South into California. Using the statewide model, and engineering judgment it would be reasonable to estimate that with the additional signage there is a possibility to remove between 8%-10% of trucks and 5%-10% of autos from this section of I-5.

7.5 Travel Demand Models (Trip-based)

The intent of the travel demand model is to represent travel decisions that are consistent with the actual travel trends and patterns. The decisions are influenced by the available transportation system, the allocation of households and employment, household socio-economics, and travel costs. Known Oregon travel behavior and relationships from household surveys are used to replicate the impacts on the actual transportation system.

Travel demand models can be used to predict future travel patterns and demands based on changes in the transportation system (i.e., new roads, wider roads with more capacity, closed roads, introduction of CAVs, etc.), changes in the land use (i.e., more residential development, a new industrial site, etc.), and changing demographics (i.e., more or less people in a specific area, access to a vehicle, aging population, etc.).

Travel demand forecasting has the ability to test the impacts of critical "what if" questions about proposed plans and policies. Model results can provide users with a variety of information on travel behavior and travel demand for a specified future time

frame, such as forecasted highway volumes for roadways, transit forecasts, the effects of a proposed development or zoning change on the system. They allow planners to analyze the effects of latent demand and other unanticipated impacts to the system.
It is an important tool in planning future network enhancements and analyzing proposed projects and policies. Information from travel demand models is used by decision-makers to identify and evaluate different approaches to addressing transportation issues and to select policies and programs that most closely achieve a desired future vision. See Chapter 17 for more details on model structures, processes, and application elements.

7.5.1 RTP

Models can be used to quickly assess the entire MPO planning area which may contain multiple cities and the interactions between them. Use of demand- to- capacity ratios can indicate bottleneck areas or areas that potentially need improvements. Conceptual project scenarios can be added to test impacts of them on the overall network. These can be bundled into groups of projects for specific objectives (capital projects, multi-modal, mobility, etc.). Impacts of land use changes can also be tested, such as in a UGB expansion scenario, nodal development, neighborhood urban centers, etc. Transit and other multimodal benefits can be evaluated depending on the detail of the individual networks (i.e. walk, bike and transit) and zone structure. If the model has enough detail, such as economic sensitivities, items like congestion pricing, parking pricing, and tolling can be evaluated. Models can also be used to create and evaluate accessibility, connectivity, and equity measures. Some operational strategies can be modeled such as TDM or ramp metering. Projects that come out of modeling are generally high level such as “Widen to four4 lanes”, or “Add overcrossing”, etc. which are consistent with the general level of detail available.

7.5.2 TSP-IAMP-Refinement Plans

TSPs, IAMPs and refinement plans typically deal with smaller areas or individual facilities or corridors. Like with the larger regional (MPO) areas, models can evaluate across a single city to determine capacity constraints to eventually determine project concepts. Modeling will be generally more specific such as adding or modifying roadway connections such as a new interchange. Individual facilities can be tested with different speeds or number of lanes or one-way/two-way directions to determine the impact on the city. Land use scenarios with differing levels of growth can be evaluated and compared with a baseline scenario from a localized zone to the whole city.

Some areas have air quality issues that require them to go through an air quality conformity basis which requires improvements on the system not to add more emissions than the specific target values. These can be for CO or particulate matter (PM). Trapped PM from woodstoves has been the focus of most Oregon AQ issues such as in Grants Pass and Klamath Falls. The overall roadway network including any improvements is based on VMT and run through the MOVES emission tool. Models streamline the process by allowing testing of multiple strategies with different mixes of projects. Certain projects could lessen VMT and emissions if trip are shortened or mode shifted or allow travel at faster speeds. Conversely, some projects like a new interchange could encourage travel and increase VMT and emissions. It is this balance that needs to be obtained in the conformity process.

7.5.3 ABM

The Activity-Based Model (ABM) is a computer-based model used to estimate travel behavior and travel demand for a specific future time frame, based on several assumptions. It includes elements such as roadway and transit networks, a synthesized population and employment data, socio-economic characteristics, and travel costs. It deals with individual persons with a rich set of attributes that influence travel and linked trips or tours (i.e. home to shop to work) instead of groups of households and separate trips (i.e. home to shop and shop to work). This type of model has the ability to answer questions in finer detail. For example, demographics of individual users (i.e., low-income users) can be forecasted versus just a single number of trips by purpose from a zone. The ABM micro-simulates tours which are groups of linked trips (i.e. trip chaining) as that is how trips actually occur. This provides much more context for trips that do not begin or end at home (e.g., mode for lunch trip depends on if work commute mode) and allows household interactions for shared vehicle use. Microsimulation of households and persons over an entire day of travel enables the evaluation of pricing strategies in the context of a household budget. An ABM does everything the trip-based travel demand model does, but with considerably more behavioral content.

The ABM introduces two levels of zones with the typical transportation analysis zone (TAZ) created at the census block level and the micro-analysis zone (MAZ) at the parcel level. The non-auto modes are captured better because of the smaller MAZ structure which will make shorter trips more evident.

The ABM application is best used for providing the required detail for long range regional transportation plans (RTP) required by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) for metropolitan areas. Currently, ABM is under development for some MPO areas in Oregon.

7.6 Regional Strategic Planning Model (RSPM) (aka GreenSTEP)

7.6.1 Introduction/Purpose

RSPM allows for strategic planning and testing of policy scenarios. Strategic Assessment is the first step in strategic planning. It assesses financially constrained adopted plans and does sensitivity tests of more ambitious plans and resilience to other future trends (e.g., fuel price). Scenario planning results in a preferred scenario. Metro & Lane Council of Governments (LCOG) were required to develop a preferred scenario by legislation. Metro also had to implement the preferred scenario in plans. CAMPO is to run several scenarios with RSPM that precede and inform local plans. These local plans will use more detailed traditional tools to implement the plans. For more information on scenario planning/strategic assessments see https://www.oregon.gov/ODOT/Planning/Pages/Strategic-Assessment-Tools.aspx

The strategic nature allows a broad view of policies associated with the development of land use, transportation, energy production, and economic development. These policies can be tested for resilience under uncertainties such as changing demographics, new untested technology solutions, and limited funding. The limited detail allows many high-level policy scenarios to be evaluated. RSPM captures policy interactions by micro-simulating reactions of individual households, primarily using relationships found in the National Household Transportation Survey. RSPM uses simplified inputs and relationships in order to facilitate quick run times for the policy tool. It sets the strategic components (e.g., doubling transit service miles), which complements more detailed traditional models (travel demand models, ABMs) that can be used to develop implementation details (e.g., new transit corridors and/or increased stop frequency).

RSPM produces high-level community outcomes (outputs) such as household travel (average daily VMT to all locations, congestion), health (active mode travel, air quality indicator),[4] environment (GHG emissions), economy (travel costs such as fuel, fees/taxes, and parking), etc. RSPM can comprehensively evaluate sets of local strategies, providing measures to help planners and decision-makers assemble programs to achieve the desired community vision/outcomes acceptable to policymakers. RSPM is sensitive to factors and new policies (i.e. car-sharing) that traditional travel demand models do not include. A key component of RSPM is that it models changes using a budget-based process that enables analysis of policies based on constraints where existing data are limited or does not exist. It also enables analysis of the travel response to pricing (e.g. pay-as-you-drive insurance). RSPM does not include an explicit roadway or transit network, but instead uses supply and demand relationships by functional class to approximate congestion and Intelligent Transportation Systems (ITS) policy impacts.

The RSPM model estimates vehicle ownership, vehicle travel, fuel consumption, and GHG emissions at the individual household level. This structure accounts for the synergistic and antagonistic effects of multiple policies and factors (e.g. gas prices) on vehicle travel and emissions. For example, the battery range of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) is less of an issue for households residing in compact mixed-use neighborhoods because those households tend to drive fewer miles each day. Modeling at the household level makes it possible to evaluate the relationships between travel, emissions and the characteristics of households, land use, transportation

[4] RSPM has been connected to the ITHIM (Integrated Transport and Health Impact Modeling) Tool in Portland and Eugene studies, allowing burden of disease (air quality and active mode travel) and safety outcomes.

systems, vehicles, and other factors. In addition, household level analysis makes it possible to evaluate the equitability of the costs and benefits of different strategies.

General categories of RSPM inputs are shown in Exhibit 7-26. For more information on the inputs, see the RSPM User Guide Appendix 1 and 2.

Exhibit 7-26: General RSPM inputs

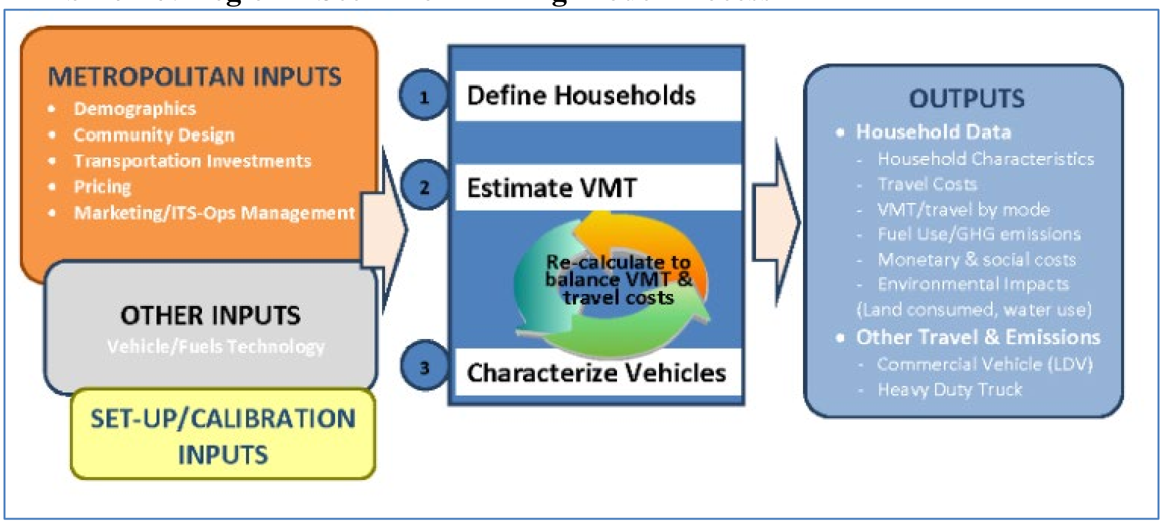
Regional Context	Local Actions		Collaborative Actions	
	Community Design	Marketing & Incentives	Fleet & Technology	Pricing
• Demographics • Income Growth • Fuel Price	• Future Housing (Single- & multi-family) • Parking Fees • Transit service • Biking • Roads	• TDM (home & work-based) • Car sharing • Education on Driving Efficiency • Intelligent Transportation Systems	• Vehicle Fuel economy (mpg) • Fuels • Commercial Fleets	• Pay as you drive insurance • Gas taxes • Road user fee

RSPM simulates how the following characteristics could impact the community outcomes:

- Demographics Trends – Household income, age mix, household size, university group quarters
- Community design
  - Urban characteristics, such as land use (density, mixed use), alternative modes (public transit, non-motorized transportation), and parking management.
  - Road characteristics, such as the supply of freeways and other arterials and the management of incident delay.
- Marketing & Incentives
  - Marketing characteristics, such as the deployment of employer-side and household-side travel demand management programs.
  - Efficiency education programs such as eco-driving, low-rolling resistance tires, and pay-as-you-drive insurance.
- Vehicles & Fuels – for personal and commercial service vehicles
  - Vehicle and fuels technology characteristics, such as fuel economy, proportions of electric vehicles, and fuel carbon intensity.
  - Vehicle fleet characteristics, such as the proportions of autos and light trucks and the age distribution of vehicles.
- Pricing
  - Prices, including fuel price, fuel taxes, mileage taxes (e.g., to cover road costs), congestion charges, and recovery of externalities or social costs, e.g, carbon taxes.

RSPM operates at the individual household level. The treatment of assumptions that determine travel characteristics is simplified, enabling the model to have a high degree of policy sensitivity and interactivity and yet be easy to set up and run quickly. RSPM links a series of sub-models that forecast outputs, such as vehicle ownership and household daily VMT. The demand side of the model is disaggregated; it includes a synthetic population generator and an auto ownership model. The supply side is handled in an aggregate way without a detailed transportation infrastructure network. RSPM can be run at a state or MPO level. The MPO level uses census tract level districts to represent different neighborhoods, while the state tools use county zones to be responsive to regional differences. Exhibit 7-27 illustrates the RSPM process. The model distinguishes between households living in metropolitan, other urban and rural areas to reflect their different characteristics in terms of density, urban form, transportation system characteristics, and demand management programs. The environmental outputs of the model include fuel consumption by fuel type, electric power consumption by electric vehicles, and CO_2 equivalents for fuel and electric power consumed.

Exhibit 7-27: Regional Scenario Planning Model Process



Data requirements are available here in a checklist: https://www.oregon.gov/ODOT/Planning/Documents/Appendix-Metropolitan-Data-Decision.pdf. For more information on RSPM and its application, please see the User's Guide: https://www.oregon.gov/ODOT/Planning/Documents/Oregon-Strategic-Assessment-RSPM-Users-Guide.pdf

RSPM is intended to be used in an environment where there are many unknown policy implementation details (e.g. doubling transit service-miles) combined with uncertainty about factors that may or may not be controllable. RSPM is intended to be run at the statewide (at county resolution) or MPO (Census tract resolution) level. It could be run on smaller areas if data are available. RSPM requires construction of a base-year scenario using local data which are then calibrated with Census data (i.e. household size and income). RSPM is predicting household travel, so a conversion factor is necessary from a travel demand model or HPMS to create roadway-based travel within the MPO. Contact TPAU for inquiring about use of RSPM for an application.

7.6.2 Outputs

The primary outputs of the RSPM are household travel, fuel, and power consumption, and GHG emissions calculations, but other information is produced for households and commercial vehicles as well. The amount of commercial (light-duty) and freight (heavy-duty) travel is calculated as well as associated fuel, power consumption and GHG emissions for those vehicles. In addition, heavy vehicle travel, fuel and power consumption, and emissions are calculated. The RSPM User Guide Appendix 4 gives the full list of MPO-based outputs and their definitions. Examples of statewide assessment outputs are available in the RSPM User Guide Outputs section (Page 14).
Typically, RSPM scenario development includes many unknowns and potential combinations to explore the future uncertainties. This can result in hundreds if not thousands of individual runs. Interactive web-based visualization tools have been developed to effectively access many previously run scenarios allowing users to explore the tradeoffs and outcomes of various policy investment mixes.

7.6.3 Applications

The typical MPO application for RSPM is the strategic assessment. A strategic assessment uses the Regional Strategic Planning Model (RSPM) to estimate future GHG emissions and other outcomes based on state and local conditions. ODOT and DLCD staff work with MPO and local government staff to gather the data needed to develop the model inputs, and ODOT staff runs the model. ODOT and DLCD staffs then work with the MPO staff to develop a report of the model outputs. The report also includes possible next steps for the region**.**

A strategic assessment evaluates the region's adopted plans and policies, assesses how far those plans help the region reach its goals over the next 20 years, and identifies alternative paths to achieving those goals. It also identifies the value of state-led actions such as newer clean vehicles and fuels. Largely a technical exercise, the assessment provides information that can help inform decisions about the future, helping communities to understand where the current path leads and what options exist for the region. This can inform plan updates and general decision-making. Additional work may be desired to help answer specific policy questions or to evaluate scenarios to formulate a vision for the region. If additional work is desired, support for scenario planning or additional analysis may be provided. A short video can be viewed about strategic assessments at https://www.oregon.gov/ODOT/Planning/Pages/Strategic-Assessment-Tools.aspx.

The purpose of the strategic assessment is to estimate travel and emissions likely to result if adopted plans are implemented and current trends continue. The assessment can provide information about:

- Household travel costs
- Transportation and energy costs
- Air quality
- Mixed-use development
- Health impacts
- VMT

- Travel delay
- Fuel consumed
- Walk trips and bike miles
- GHG emissions

The results of a strategic assessment can help the region determine whether current plans and trends are achieving the outcomes the region wants to see and identify potential actions to better meet the region's goals. The results of the assessment can also help local governments better understand issues and quantify the effect of adopted policies as they review and update the area's transportation plans and make investment decisions. It can also bolster collaboration on policies such as transit, parking, and state-led actions such as implementation of pay-as-you-drive insurance, by quantifying the value of such policies. The effort can inform the public of new policies and the tradeoffs of alternative paths to meet regional goals. In addition, the information provided in the assessment is intended to help local officials decide whether to pursue a more comprehensive analysis of land use and transportation options through formal scenario planning.

7.6.4 Examples

Statewide Applications

Statewide Transportation Strategy (STS): A 2050 Vision for Greenhouse Gas Emissions Reduction (OTC accepted in 2011)

RSPM (previously named GreenSTEP) was built for addressing legislative GHG reduction requirements for ground transportation. The STS process evaluated what it would take to achieve a 75 percent reduction from 1990 GHG emission levels by 2050 statewide. Many policy combinations were evaluated in cooperation with a stakeholder committee in three phases. The STS, through hundreds of runs of the RSPM tool, identified the most effective GHG emissions reduction strategies in transportation systems, vehicle and fuel technologies, and urban land use patterns to accommodate future growth and it showed how collaborative efforts in all areas were required to meet these goals. Beyond reducing GHG emissions, these strategies are expected to reap other benefits, including improved health, cleaner air, and a more efficient transportation system, as noted in the various RSPM outputs. The strategies resulting from the RSPM-based analysis and accepted by the OTC serve as guidance to help meet the state's GHG reduction goals while supporting other societal goals such as livable communities, economic vitality and public health. The STS points to promising approaches that should be further considered by policymakers at the state, regional, and local levels. https://www.oregon.gov/ODOT/Planning/Pages/STS.aspx

MPO Target Rule

One action following from ODOT's STS is the establishment of GHG reduction targets for each MPO by 2035 by the Land Conservation and Development Commission (LCDC). Although the overall reduction target is set by the legislature, RSPM was used to evaluate the share of this target that could be achieved by state-led actions on vehicles and fuel programs, with the remainder the responsibility for GHG reduction attributed to the local MPOs. RSPM was critical in being able to assess the fleet turnover, multi-modal response to the cost of travel, and land use dependencies (e.g., EV range limitations) important in assessing the impact of new vehicle and fuel technologies across the state.

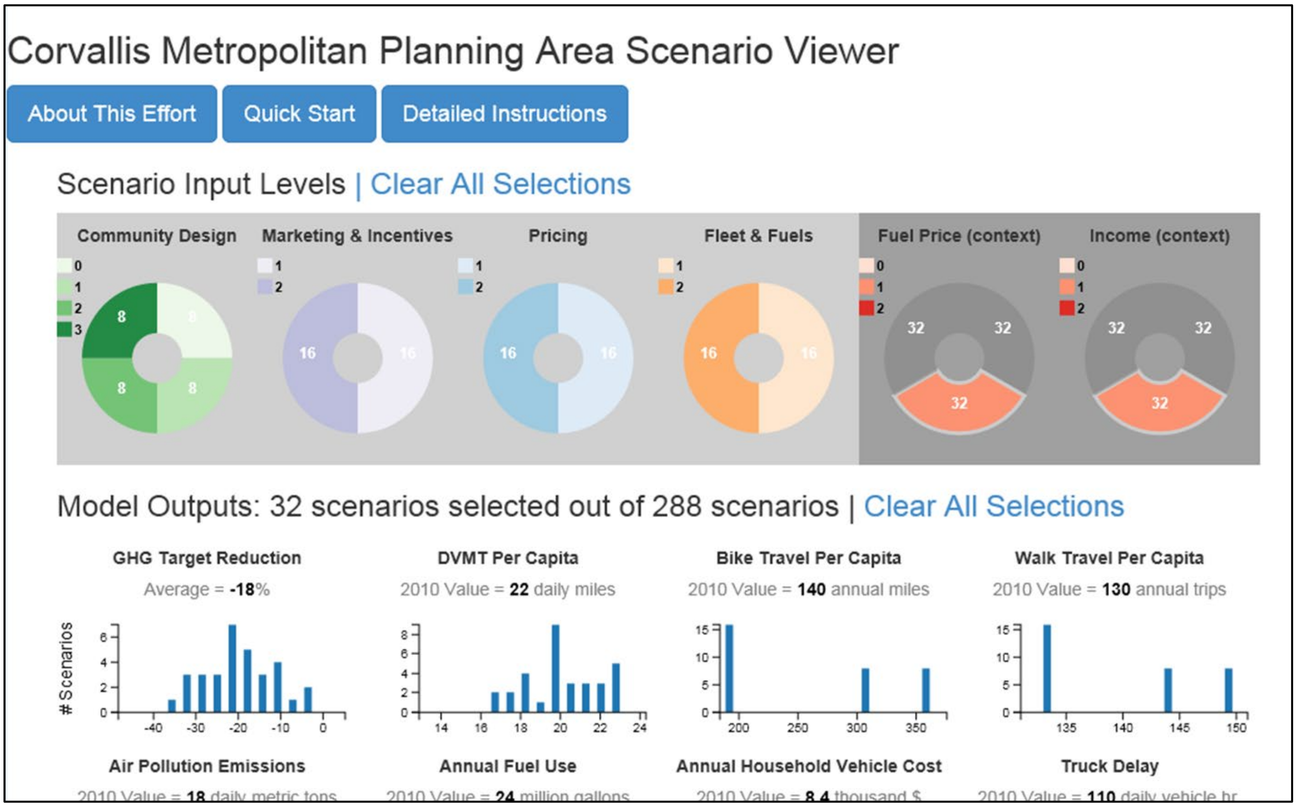
MPO Applications

CAMPO Strategic Assessment and Interactive Viewer

AA Strategic Assessment, as supported by ODOT for mid-sized MPOs, is the first step in Scenario Planning as undertaken by Portland and Eugene-Springfield. Corvallis was the first to volunteer to use the RSPM model in a Strategic Assessment. It assessed their financially constrained adopted plans and performed sensitivity tests of more ambitious plans (e.g., more transit, alternative land use patterns) and resilience to future uncertainties (e.g., fuel price). The RSPM scenarios in this effort precede and inform local plans. The local plans (e.g., RTPs, TSPs) will use more detailed traditional tools to implement the strategic understanding resulting from the assessment.

As part of the Strategic Assessment, an interactive viewer has been created to help simplify exploring the completed runs. Exhibit 7-28 shows a screenshot of the viewer created for the CAMPO Strategic Assessment project. The viewer for CAMPO is available at: https://www.oregon.gov/ODOT/Planning/Pages/PTV-SV.aspx?sv=CAMPO. The viewer shows how community outcomes (e.g., household travel costs, health, walk and biking travel, vehicle delays) change under adopted and more ambitious policies and investments (user input adjustments). Additionally, the user can identify the desired outcomes (e.g., meet GHG reduction targets, high bike trips), and be shown the policy combinations that reach those goals. The viewer can be customized for a particular area. The scenario data that forms the basis for the viewer can also be mined using data analysis software.

Exhibit 7-28: CAMPO Scenario Viewer



7.7 <u>Land Use Scenario Tools</u>

7.7.1 Introduction/Purpose

Objective: Develop sets t of plausible future LU patterns and demographic consistent with various constraints, for local review. Travel impacts can be ascertained by combining the resulting land use inputs in a travel model, ABM, SWIM or RSPM.

Land Use Scenario Tools should:

- Allow us more thoughtful land use inputs. It is important to tie together the inter-relationships between land use inputs (e.g., dwelling unit type varies with density, income and household size will change with the development of a TOD, population and employment locations are driven by different criteria).
- Be a starting place for framing a land use conversation with local planners using their frame of reference and their resources (e.g. comprehensive plan, jobs-housing ratios).
- Serve as a check on the reasonability of local input variables. – the models are only as good as these key inputs.

Land use models are designed to predict the future pattern of population and employment, typically in an iterative fashion with a travel model. By connecting land use and transport models, land use can respond to market forces such as accessibility and congestion (e.g., locations with good accessibility are more likely to develop than remote locations). Travel can respond to market-driven development patterns (e.g., distributions of residents and employment locations determine activities and create demand for travel on the transportation system). The resulting land use forecast (population and employment by model zone) is a critical input to travel models, including JEMnR, OSUM, SWIM, and RSPM, which assess demand for travel against available infrastructure capacities.

The complexity of most land use models precludes widespread use by planning agencies. However, they are useful tools for forecasting land use inputs to transportation models and for analyzing the land use effects of transportation projects, such as fully considering how a development pattern will impact transportation, induced demand, and the cost of the resulting congestion.

Many tools have attempted various versions of these land use objectives in Oregon. No tool solves the issue fully for all purposes. This section will outline the various applications to date involving alternative versions of several tools and note future opportunities.

Metroscope:

In Portland, Metroscope serves the role of developing alternative land use inputs for their travel model. Metroscope is a complex land use model that has been developed over decades making use of the extensive Portland- area GIS data and the region's economic/demographic forecasts for the multi-county, and multi-state region. It runs in a connected manner with the Metro travel demand model and has supported a variety of planning studies. The website below provides more information.

Metroscope website: https://www.oregonmetro.gov/forecasting-models-and-model-documentation

7.7.2 LUSDR (Land Use Scenario Developer in R)

LUSDR differs from most land use models in that it is designed to run quickly in order to create a large number (rather than just one) plausible future land use scenarios that meet zoning constraints and respond to market forces (when used iteratively with a travel demand model). This is important because the likely future development pattern can take many forms, the result of many factors that are not easy to forecast. By running many scenarios, one can understand the range of possible development patterns and the likelihood of development for a particular zone. The large number of plausible futures can be used to help evaluate how different possible development patterns will affect the transportation demand and resulting network performance. Using this information, local agencies can have a better sense for how future land use will improve or hinder traffic operation, which can be used to improve land use forecasts that help meet transportation objectives in modeling studies. LUSDR (or variations thereof) can be used to speed up development of land use inputs for travel models by creating a few "bookend scenarios" for local staff to pick from rather than trying to figure out where market forces will combine with available land capacities leading to likely locations for growth 20+ years in the future from now. By making it easier to develop alternative land use futures, LUSDR gives users the ability to test transportation networks under various future land use patterns. This enables testing transportation investment resilience to different futures, which is a risk assessment approach. It allows users to see how transportation infrastructure will perform under a range of possible future land use patterns, and it provides municipalities with a tool to assist with planning future growth.

LUSDR operates on a zonal (sub-regional) scale within an urban area but not at a parcel or urban block level. It requires substantial data and analytic resources to set up for a specific locality. LUSDR requires local zoning/comprehensive plan parameters (such as compatible development types and densities under the zoning designation) which are used to create a large series of plausible future land use development patterns. These development patterns can then be analyzed in a travel demand model, which provides an evaluation of travel resulting from each land use scenario. LUSDR and the travel demand model can be run iteratively through time, passing this information back and forth to simulate the effects of land use and transportation interactions (i.e., accessibility from the travel model is used to determine land development, while development from the land use model is used to determine travel demand). This process allows the testing of many future possible outcomes, to give local and regional agencies insight into how different land use patterns affect the transportation network. LUSDR can also help in other types of analyses, (e.g., GHG analysis in the RSPM model).

7.7.3 LUSDR Variations

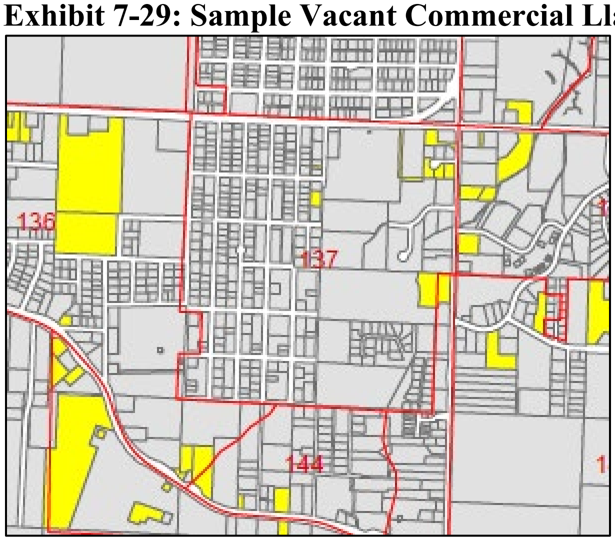
LUSDR-inspired land use scenario methods are now the norm for creating future land use inputs in a new or updated travel demand model scenario. Typically this involves using simplified LUSDR components and inputs. These methods provide an objective method that can simplify the land use development process at the local level by creating plausible scenarios that can be considered and modified rather than a review of TAZ by TAZ to assess the explicit future number of households and employees.

The earliest LUSDR variation was an application in Klamath Falls when a travel model update required new land use inputs. Local staff was challenged by the sheer number of possible future growth scenarios as the available vacant lands within the UGB was so large. Several household and employment growth scenarios were created and shown to local staff which later picked a couple to average together to create the final future scenario.

Another LUSDR variation was completed in both the Coos Bay/North Bend model update and a new model for The Dalles. The method resulted in a significantly shortened future scenario development process and increased understanding of the planned future on all sides. In this method, the local staff is asked to provide growth potentials for households and employment which is later translated into TAZ values. This allows local staff to be more comfortable with planning- level terms instead of having to deal with TAZ-level detail. Small jurisdictions usually have little or no exposure to travel demand models, so limiting the technical details will make the process much smoother, especially if some introductory outreach is performed initially. The process ends with creating a single or small set of scenario(s) that the local staff can choose or modify as needed. The general process is as follows:

- Regional Land Use Control Totals - Use the base year land use total and other sources to determine total population and employment within the model area. Population sources include Oregon Office of Economic Analysis (OEA) and Portland State University Population Forecasts by County/Cities. Employment is typically scaled to achieve historic Census (or adjusted) jobs-household ratios.
- TAZ Land Acres by type - Based on the most current GIS parcel-level database available for the jurisdiction, extract the parcel-acres of the existing and vacant parcels by residential, commercial, industrial, and other property classes. Exhibit 7-29 shows part of the overall GIS plot for vacant developable commercial lands for the City of North Bend staff to which apply TAZ growth potentials to.

Exhibit 7-29: Sample Vacant Commercial Llands in the City of North Bend



- User-defined TAZ Growth Potential - Identify the growth potential by ranking the TAZs with 0, 1, 2, and 3 for no growth (0%), low (50%), medium (80%) and high (100%) with respective to land uses. Exhibit 7-30 shows part of the TAZ growth potential review that City of North Bend staff did as their part of the Coos Bay-North Bend model update.

Exhibit 7-30: Example Growth Potential Allocation from City of North Bend

COMMERCIAL			
	TAZ	DEVELOP. RATING	NOTES
	101	3	
	107		W. of Hamilton = 0; others = 2
	109		S. of Virginia = 2; others = 0
	110	2	
	111	2	
	112		E. of Hamilton = 1; others = 0
	113		S. of 15th & N. of 11th = 2; others = 0
	118	1	
	121	0	

- Available Residential Capacity - Calculate the current population density of residential land with each TAZ and residential land available for development based on the buildable land inventory and potential growth ranking;
- Allocate New Households - Allocate the future year population total in terms of household total into each TAZ according to the relative potential capacity for residential development;
- TAZ Accessibility - Use the existing base year model to figure out the accessibilities to each TAZ as one of the variables to determine the employment capacity;
- Available Employment Capacity - Calculate the employment capacity by retail, service, industrial and other sectors by TAZ according to the available vacant land (by commercial, industrial, and other category) and growth potential rankings; and
- Allocate New Employment - Apply the future total land use forecasts by sector by using the "Long's Model" methodology (a simplified technique that allocates employment growth to zones based on accessibility to potential customers) to allocate the potential employment growth to TAZs based on the buildable land capacity and potential growth rankings.
- Review/Sensitivity Tests - Adjustments can be done by having the local staff review the resulting TAZ plots to see if too much or too little growth by land use sector occurred. By changing the growth potential ranking up or down will re-allocate growth amongst the TAZ's by making certain ones attractive.

The Coos Bay-North Bend model update process ended up with a single land use scenario that was reviewed and slightly adjusted allowing the entire model update to complete on time. Since this process uses more planner-based terms it is important to keep the definitions consistent (i.e. the term vacant means no parcel development, not partially developed).

7.7.4 Place Types

Place Types can be helpful in visualizing and providing a common language for the land use conversation using any of the tools noted above. Adopted for Oregon from SHRP2 C16 RPAT (Rapid Policy Assessment Tool, formerly SmartGAP, a RSPM-derived modeling tool), Place Types provide a criteria-driven topology of land use patterns and allows for ways to visualize and map the different functions and roles of a community. Oregon Place Types are built on TAZ data, consistent with the travel demand model zones, and can be aggregated for use in other models. They use data on the 5Ds (development density, destination accessibility, design, diversity, and distance to transit) built environment of the area, building on TAZ household and employment data (e.g., density, mixed uses), as well as attributes representing urban design/walkability (i.e.., link density) and transit accessibility. From these land use coverages, logic and threshold criteria are applied resulting in the following two Place Type dimensions:

- Regional Role (i.e., accessibility to regional job center)
- Neighborhood Character (i.e., how well the pattern of development supports a multi-modal transportation system)

The full Place Type logic is summarized in Exhibit 7-31 with example outcomes for RVMPO noted in Exhibit 7-32. A visualizer has been developed to enable interactive viewing of the 5Ds and resulting Place Types. Place Types have been shown to be useful in quickly encapsulating the role of different community neighborhoods (e.g., job center, multi-modal main street), identifying locations to best support alternative mode investment (e.g., mixed use areas), and as a check on land use inputs (e.g., expected higher density highlights miscoding of employment data). The use of common Place Type criteria across the state enables useful comparisons for envisioning possible future development patterns (e.g., parts of Rogue Valley are planned to reach the density and multi-modal potential of Corvallis's near-campus districts, with opportunities to support car-sharing and other modes).

In addition to facilitating the conversation and visualization of current and forecast land use patterns and opportunities for growth, Place Types will soon be utilized in RSPM to better model the effectiveness of TDM programs. Efforts to translate the method to census block-group coverage is underway and will allow stratifying out-of-state data by place type for use in Oregon tools that use Place Type land use classification.

Exhibit 7-31: Logic for Ddeveloping Oregon Place Type

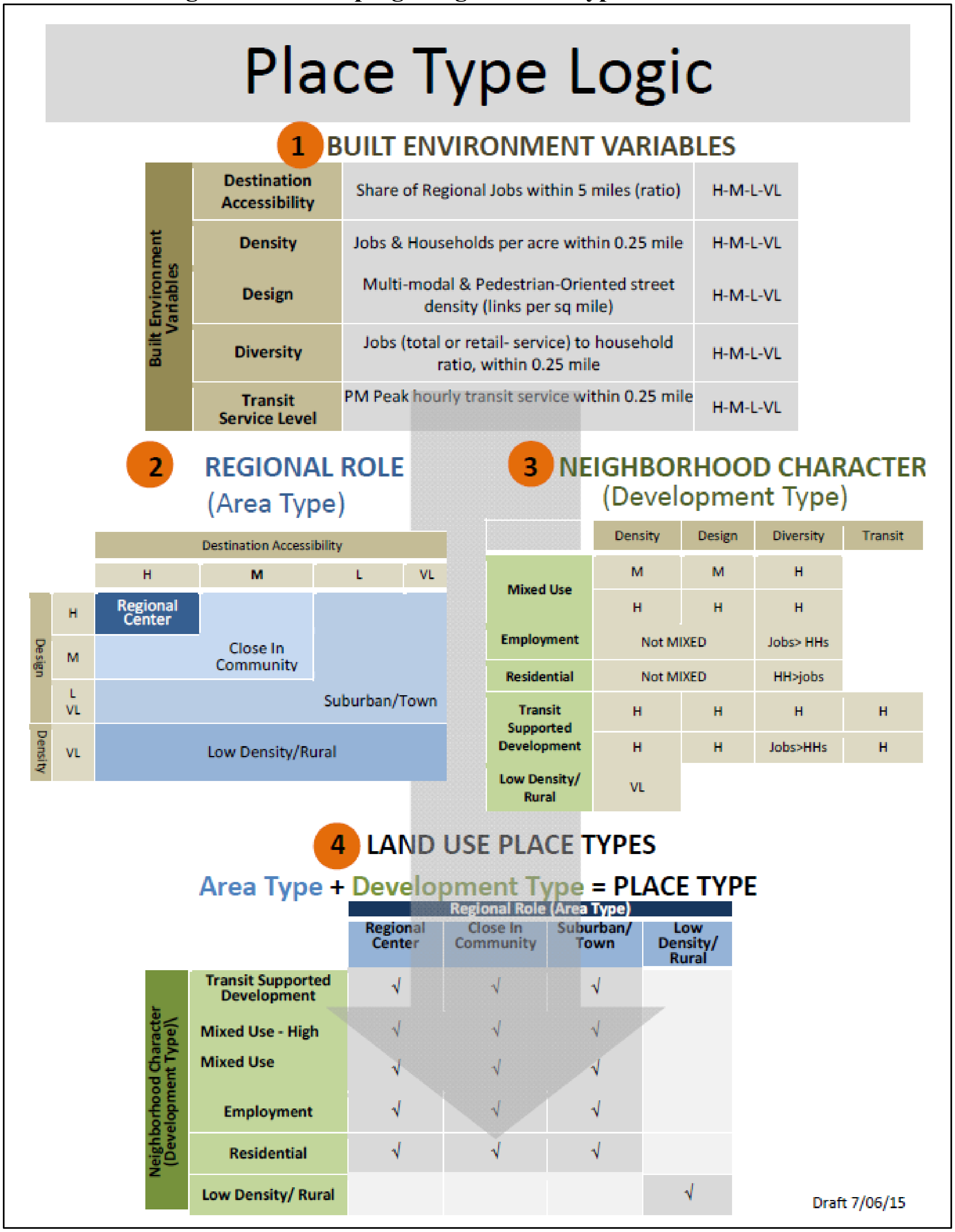


Exhibit 7-32: Example Place Type Maps for 2010 RVMPO