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
- Statewide Integrated Model (SWIM)
- Travel Demand Models
- Regional Strategic Planning Model (RSPM)
- Land Use Scenario Tools

> *In a future update, RSPM will be updated and replaced by VisionEval which Is the current tool for strategic planning assessments.*

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 tools for strategic planning analysis typically are SWIM and RSPM.

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 and 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.

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
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 Statewide Integrated Model (SWIM2)

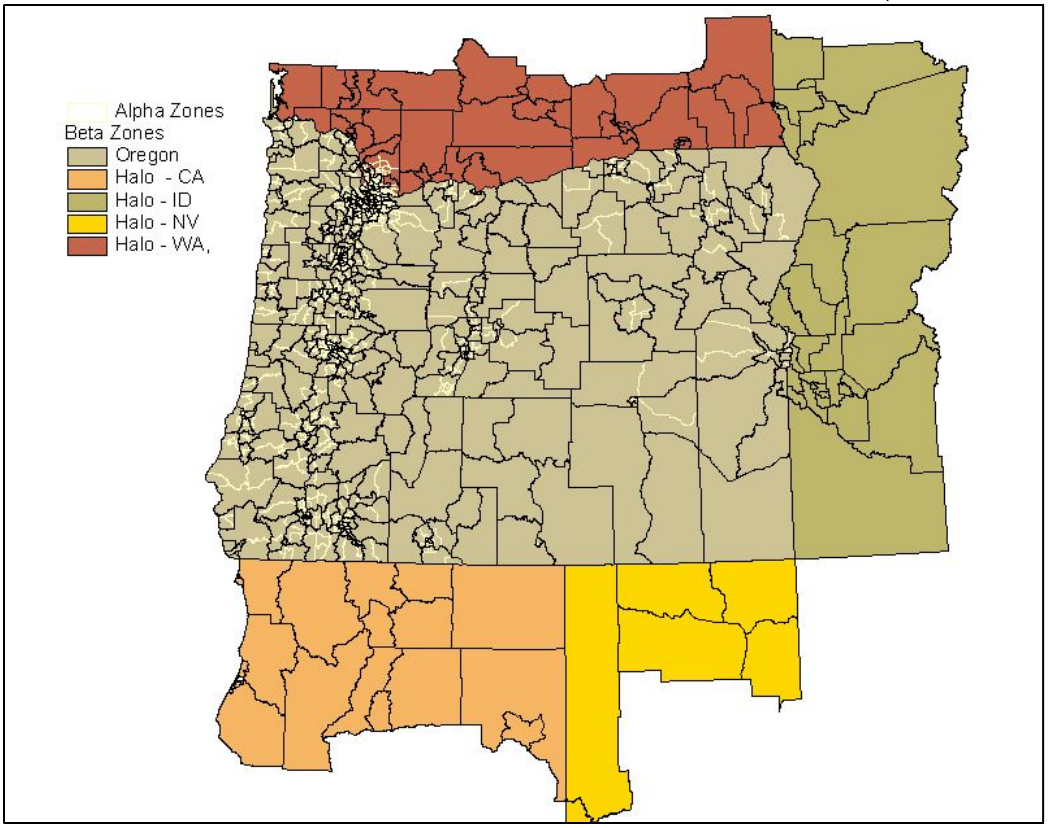
7.3.1 Introduction/Purpose

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.

7.3.2 Geography, Zone Size and Network Level of Detail

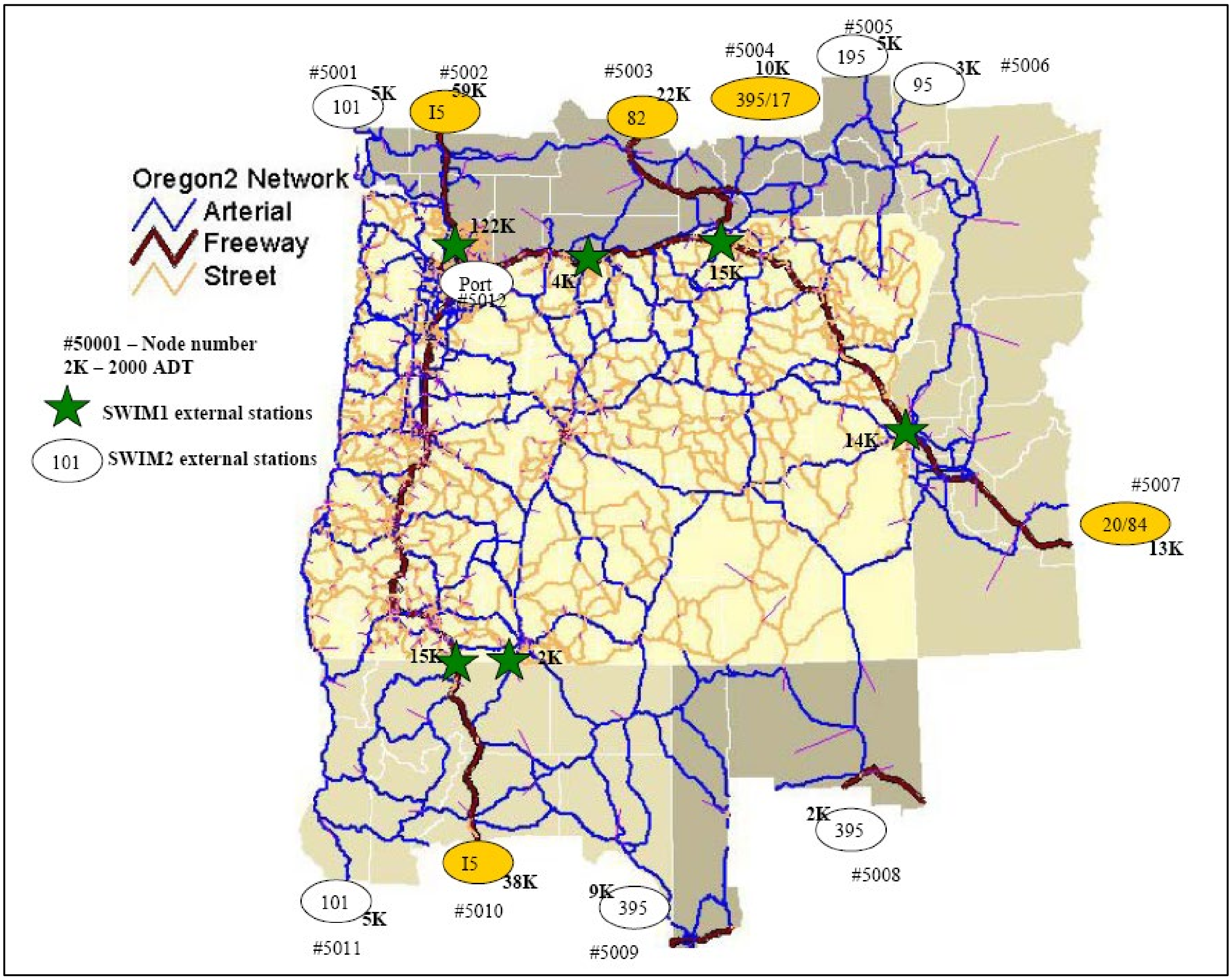
SWIM2 operates at two geographic levels within the model area (Exhibit 7-18). Both levels encompass all 36 Oregon and 39 (Halo) adjacent state counties. The halo encompasses a roughly 50-mile buffer around Oregon. A system of alpha zones used for trip assignment (light and dark lines in Exhibit 7-18) 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 7-2: Current SWIM2 Model Extent and Zone Structure (October 2010)



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

Exhibit 7-3: Map of SWIM2 External Stations



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

7.3.3 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[1] 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[2]. 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.

[1]Area Commissions on Transportation (ACTs), used in Oregon transportation planning, provide a convenient way to divide the State into 12 areas.

[2]For a complete list of Industries and commodities please refer to the Model Build Documentation - 2nd Generation StateWide Integrated Model (SWIM) Model Description

7.3.4 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 for 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.

7.3.5 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.

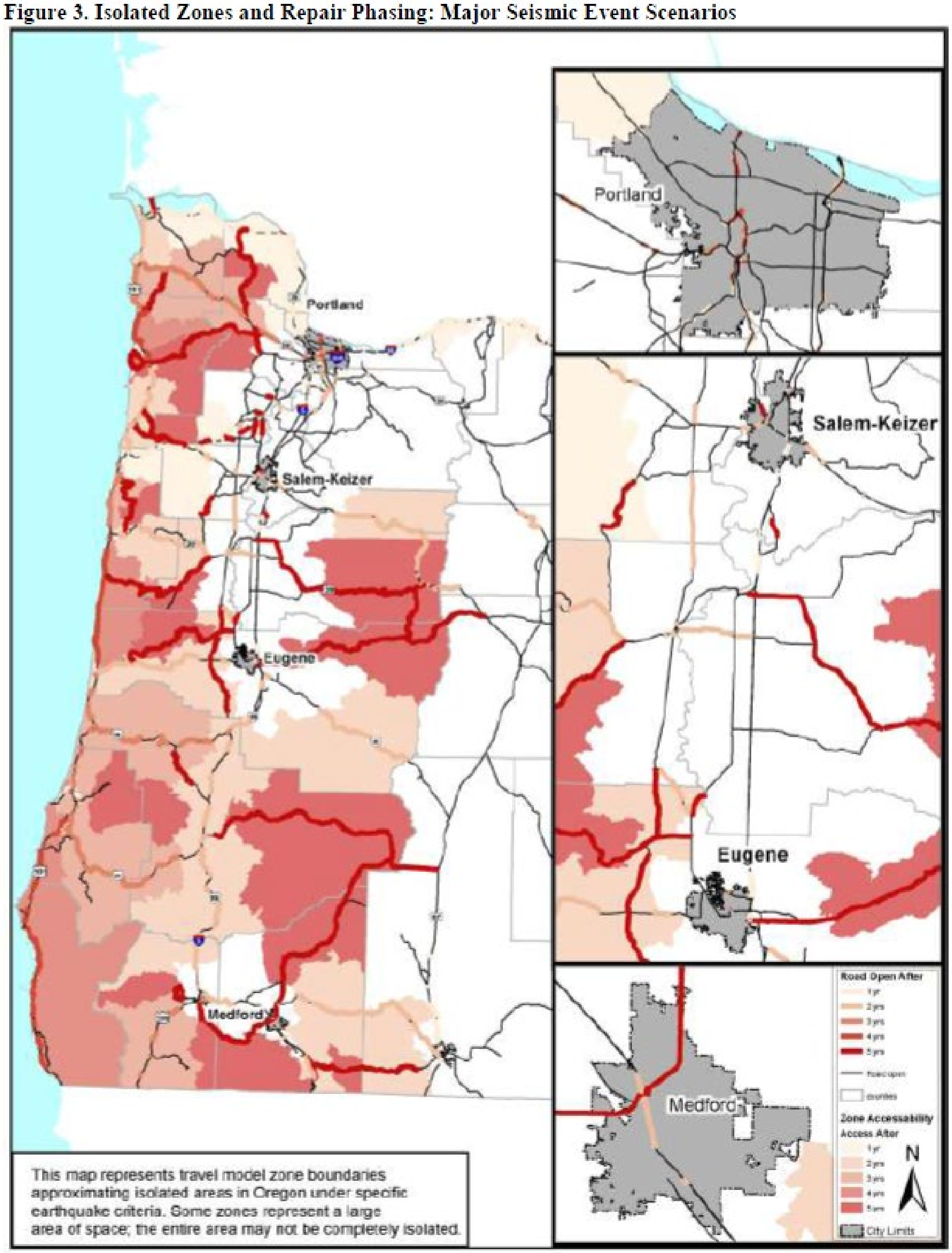
Results of this analysis indicate strengthening corridors before a major seismic event will enable the state to avoid a significant amount of economic loss. Significant economic losses in production activity can be avoided by preparing for a major earthquake ahead of time. With no preparation ahead of 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 of transportation on economic activity separately, therefore building loss, damage to utilities, other damage or loss of life resulting from an earthquake was 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 7-4

Figure 3. Isolated Zones and Repair Phasing: Major Seismic Event Scenarios



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 to determine whether the objectives of the freeway would be accomplished. The objectives and measures are summarized in Exhibit 7-21.

Exhibit 7-5: 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

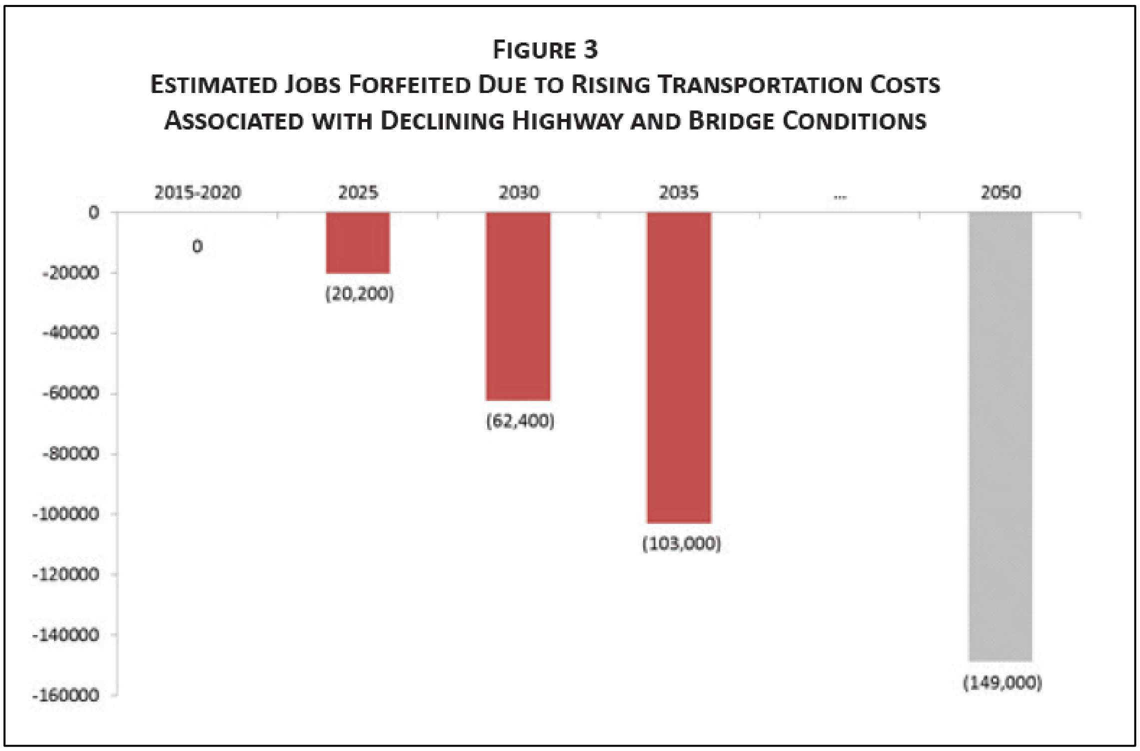
The results of the study found that building a new freeway connecting I-82 with California or Nevada to the south would significantly reduce travel time from border to border but would have little effect on the growth of Central or Eastern Oregon or the Willamette Valley. It would also have little effect 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 7-6: Jobs Forfeited



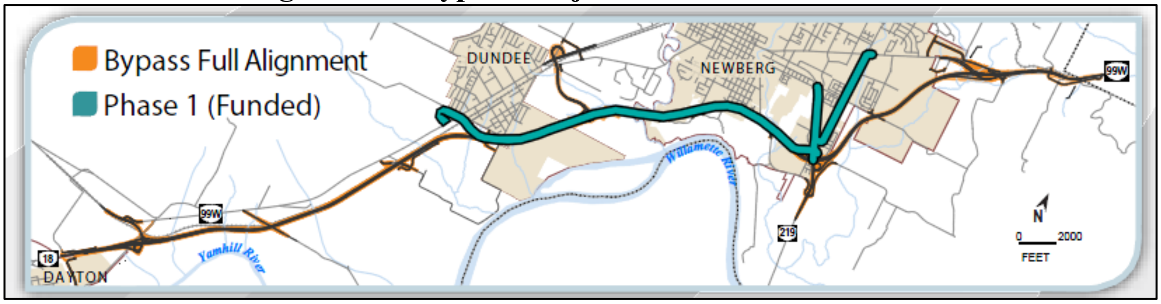
Rough Roads Ahead: The Cost of Poor Highway Conditions to Oregon's Economy, ODOT, 2014

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 7-7: 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 because of the Bypass.

Freight Plan

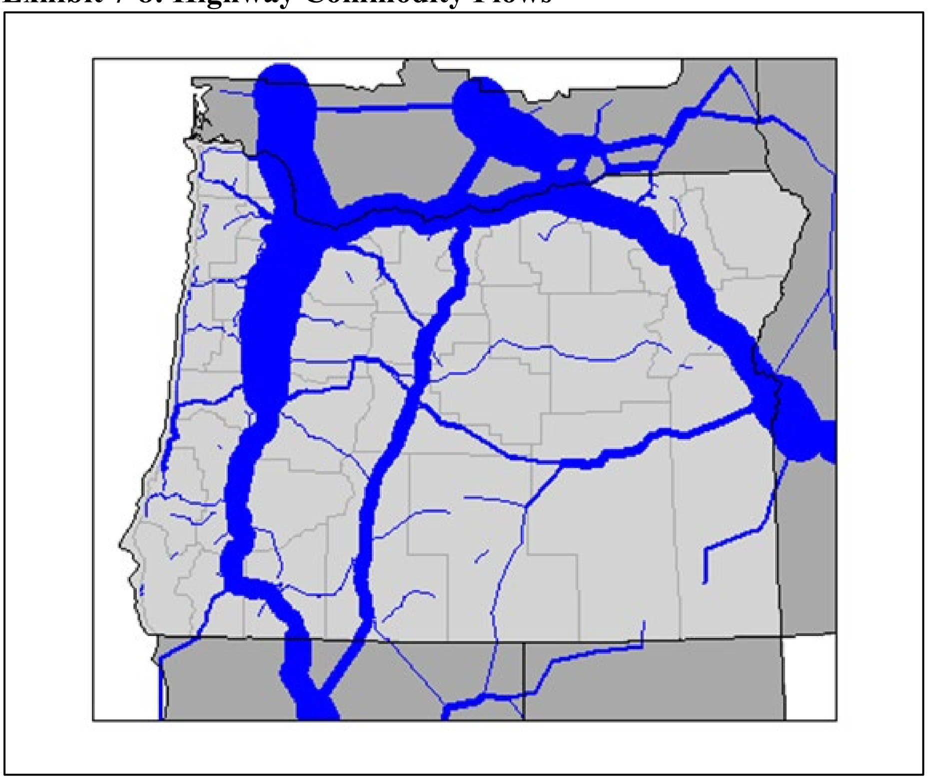
The purpose of the Oregon Freight Plan analysis was to gain an understanding of the spatial land use and transportation implications of different economic conditions. This analysis illustrated the variation in statewide and regional activity and commodity flow to help evaluate the risk associated with 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 7-8: Highway Commodity Flows



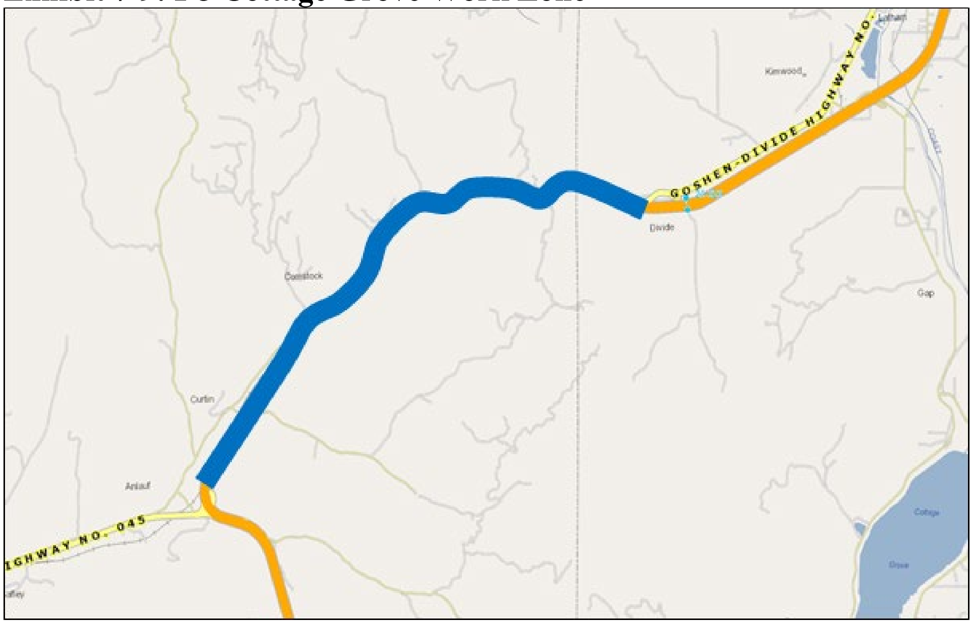
Oregon Freight Plan Modeling Analysis Technical Memorandum, ODOT/TPAU, August 2010

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 7-9: 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.

7.4 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 socioeconomics, 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 can 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, and 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.

7.4.1 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 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 details 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.

7.4.2 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 trips 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.

7.4.3 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 can 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 occur. This provides much more context for trips that do not begin or end at home (e.g., the mode for a lunch trip depends on the 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.

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

7.5.1 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.

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 complement 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),[3] 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 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.

[3] 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.

General categories of RSPM inputs are shown in Exhibit 7-26.

Exhibit 7-10: General RSPM inputs

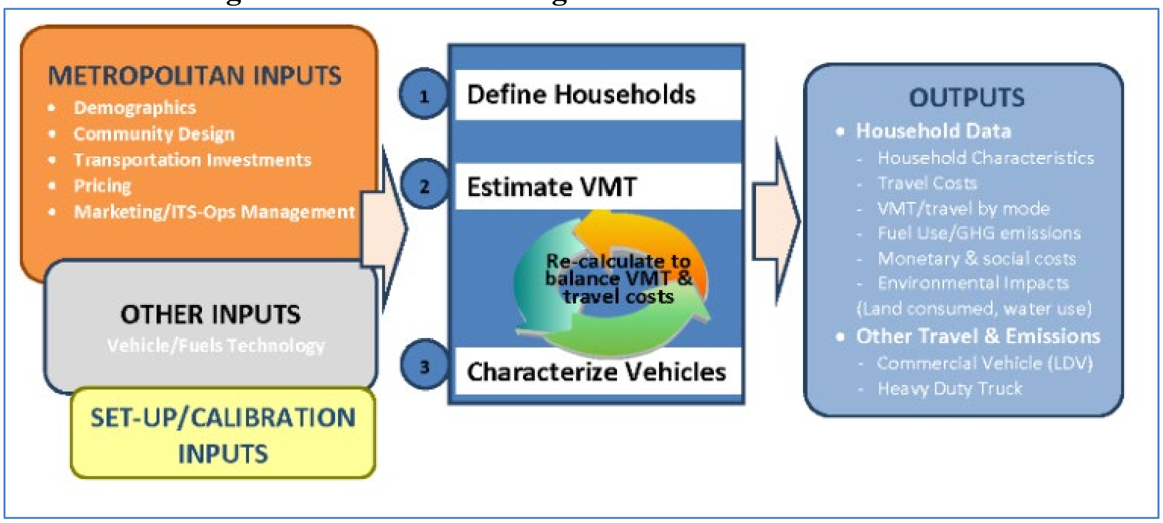
Regional Context	Local Actions		Collaborative Actions	
	Community Design	Marketing & Incentives	Fleet & Technology	Pricing
• Demographics • Income Growth • Fuel Price	• Future Housing (Single- & multi-family) • Parking Fees • Transit service • Biking • Roads	• TDM (home & work-based) • Car sharing • 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 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 7-11: Regional Scenario Planning Model Process



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 in 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 to inquire about use of RSPM for an application.

7.5.2 Outputs

The primary outputs of the RSPM are household travel, fuel, 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.

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.

7.5.3 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 staff 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.

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.

7.5.4 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.

MPO Target Rule

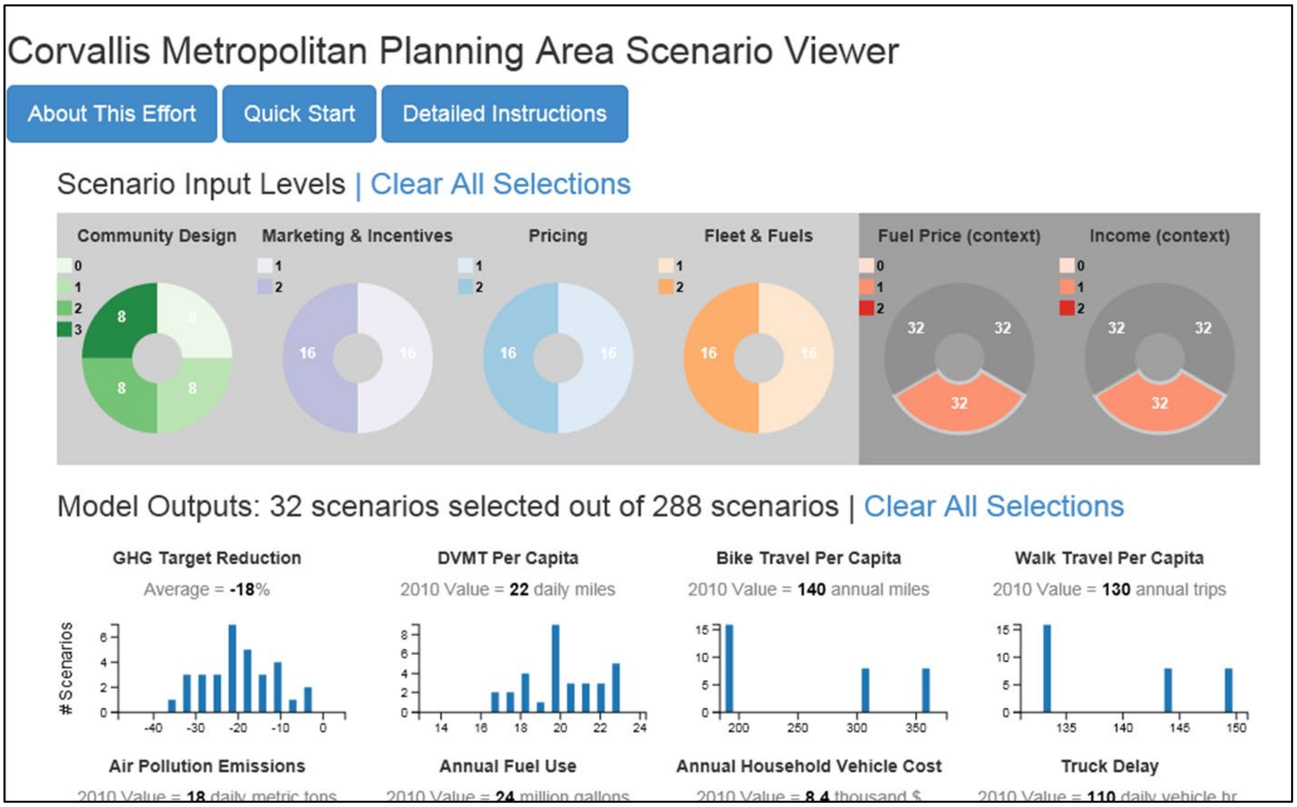
One action following from ODOT's STS is the establishment of GHG reduction targets for each MPO by 2035 by the Land Conservation and Development Commission (LCDC). Although the overall reduction target is set by the legislature, RSPM was used to evaluate the share of this target that could be achieved 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

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 was 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 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 7-12: CAMPO Scenario Viewer



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

7.6.1 Introduction/Purpose

Objective: Develop sets 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 the use of 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.

7.6.2 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).

7.6.3 LUSDR Variations

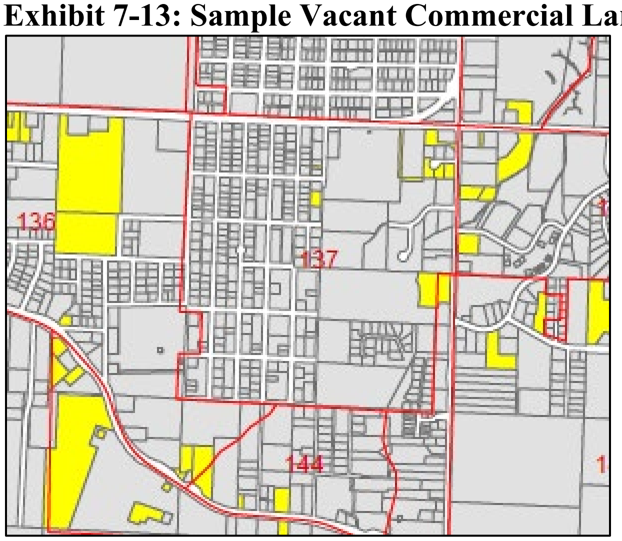
LUSDR-inspired land use scenario methods are now the norm for creating future land use inputs in a new or updated travel demand model scenario. Typically this involves using simplified LUSDR components and inputs. These methods provide an objective method that can simplify the land use development process 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 potential 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 scenarios 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 7-13: Sample Vacant Commercial Lands 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 7-14: 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).

7.6.4 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 centers)
- 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 7-15: Logic for Developing Oregon Place Type

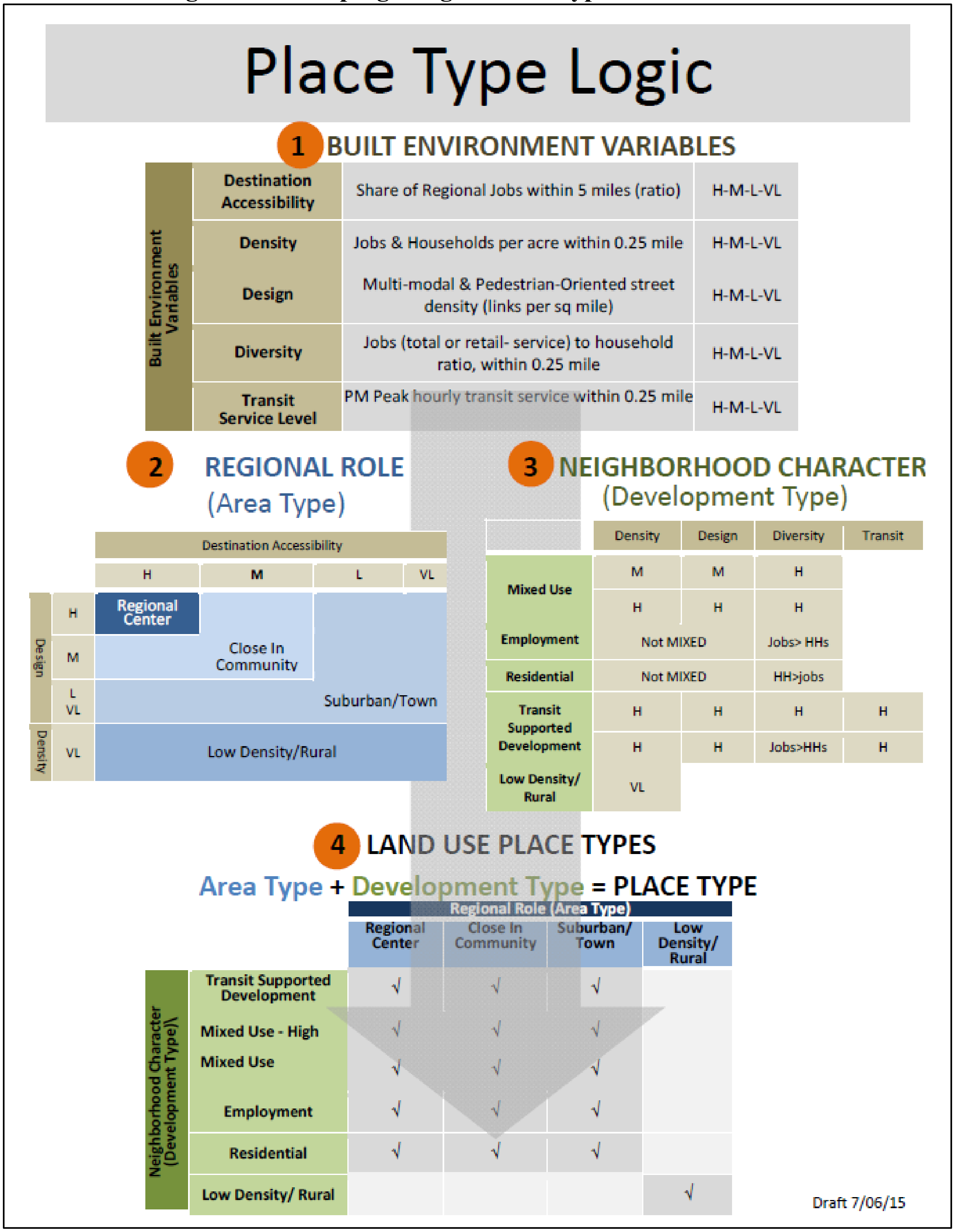


Exhibit 7-16: Example Place Type Maps for 2010 RVMPO