Implementing Land Use & Transportation Scenario Planning Tools in Oregon

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FHWA SHRP2 Solutions;
Advanced Travel Analysis Tools- C16 RPAT Tool

Final Project Report

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The project team would like to thank the agencies and local jurisdictions that contributed over the course of this project.

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Background

Long range planning for Oregon communities has been enhanced through the development of the Regional Strategic Planning Model (RSPM). The RSPM tool is an enhancement and rebranding of the GreenSTEP tool, originally built to assess changes in greenhouse gas (GHG) emission from state and local policy actions in a manner that includes a broader set of metrics, as well as implementation at a metropolitan area level. The GreenSTEP tool provided the starting software for both the SHRP2 C16 Rapid Policy Assessment Tool (RPAT; formerly SHRP2 C16 SmartGAP) and FHWA Energy and Emissions Reduction Policy Analysis Tool (EERPAT). An ongoing partnership between FHWA and ODOT is establishing a VisionEval Open Source Project, which will merge these tools into a common code framework and provide a forum for sharing how the tools are used and updated.

This report summarizes the activity performed under the SHRP2 C16 Implementation Assistance Program User Incentive award, implementing and evaluating the RPAT tool as implemented in the Corvallis Area Metropolitan Planning Organization (CAMPO). Due to limited staff at CAMPO, the Oregon Department of Transportation (ODOT) assists in the implementation of travel model tools, including traditional travel demand models and RSPM/RPAT. ODOT place type work and comparative tool analysis was assisted by Brian Gregor of Oregon Systems Analytics, an ODOT contractor and author of RSPM/GreenSTEP framework. The Oregon Department of Land Conservation and Development (DLCD) provided assistance throughout the project.

Dual Approach

In this SHRP2 C16 award, the ODOT implemented RPAT to enhance ODOT's capabilities for integrating transportation and land use analysis into planning processes, starting with the ongoing RSPM work with the CAMPO local planning community. Additionally, to inform the partnership between FHWA and ODOT that is merging the GreenSTEP family of models into the VisionEval open source project on a common code base,[1] a secondary goal is to compare the functionality of the two tools. Such an effort can point to additional capabilities of RPAT that might improve ongoing CAMPO strategic planning and decision-making, with applications for other Oregon communities and statewide planning efforts, as well as the larger VisionEval user community across the nation.

A key value of the effort is contrasting the RSPM and RPAT tool implementation in the same location. This comparison will include both technical differences in inputs and outcomes, as well as more subjective differences about how the tool is used and level of user engagement of the different processes, particularly in the application with the CAMPO local jurisdictions.

ODOT, in partnership with CAMPO, has completed the following efforts under this User Incentive award:

(1) Policy Scenario Analysis with CAMPO (RPAT and RSPM)
(2) RPAT – RSPM Comparison (including scenario viewer)

[1] https://github.com/gregorbj/VisionEval

It should be noted that a related FHWA-funded Lead Adopter award task implemented an RPAT scenario viewer, enabling hundreds of additional scenarios to be run and evaluated in the latter task under this User Incentive award.

Throughout the User Incentive award period, the recipient partners communicated with various agencies locally, throughout the state, and nationally about how Oregon has found value in using strategic planning supported by RSPM and RPAT tools. Appendix C provides a list of these more formal outreach efforts with academic and practitioner communities.

I. Policy Scenario Analysis with CAMPO

For the policy test, RPAT was implemented alongside RSPM in CAMPO and both tools were used to analyze policy scenarios of regional interest. The purpose is to model a number of policy options identified by the metropolitan planning organization (MPO) related to land use and transportation and to evaluate these options for achieving regional values in preparation for the MPO's upcoming Regional Transportation Plan (RTP) update and related planning efforts in the region. The policy scenarios were evaluated using both models, the primary assessment was performed using RSPM results supplemented with RPAT outcomes, while one scenario that incorporated inputs not included in RSPM was assessed using RPAT.

Background on using RPSM in Oregon Planning

In an era of constrained and limited funding, investing in the right solutions to solve transportation and land use issues that address the needs of Oregonians is more important than ever. We need to better understand the outcomes of policy choices to know if the policies themselves truly get us where we want to go and to test the resiliency of those policies in the face of unknown variables (e.g. population and demographics). Performance based planning and scenario planning offer ways to evaluate policy alternatives. ODOT has successfully researched and put into practice a new type of strategic planning model, GreenSTEP and the RSPM, to assist the agency and metropolitan areas with long range performance-based planning. This model served as the primary tool in the development of a Statewide Transportation Strategy (STS) to address GHG emissions, and is currently being used by Portland Metro and the Central Lane Metropolitan Planning Organization in their state-mandated scenario planning. Seeing the merits of the process and tools, other Oregon MPOs are following with similar work.

The following specific efforts highlight how RSPM has supported strategic planning in Oregon to date:

- **ODOT Statewide Transportation Strategy** (STS). Challenged by the state legislature to find a way of reducing GHG emissions substantially, ODOT embarked on a 2-year effort to determine the best strategies for reducing transportation-related emissions. The resulting Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Emissions Reduction was accepted by Oregon's Transportation Commission in early 2013. The report charts a potential path forward to help meet Oregon's 2050 goal of a 75% reduction in GHG emissions compared with 1990. GreenSTEP was created to quickly evaluate various ground transportation GHG policies at a strategic level (separate elements covered long-haul freight and air travel). The effort played out as a "what would it take"

exercise with a broad group of stakeholders (Figure I-1), where initial advocacy based scenario bundles were evaluated in the tool, but none alone met the target. When run together they still were shy of the required 75% reduction by 2050. Further evaluation of 144 scenarios was shared in a primitive interactive tool to help stakeholders understand the impacts of various policies. The committees worked through several additional rounds of enhanced combinations and looking at co-benefits from the model before reaching the target, resulting in 100s of runs within a short time frame, impossible with more detailed models with longer run times. Figure I-1 illustrates that process. The resulting vision was documented in the STS report with associated Strategies and Actions, and soon followed with a 5-year implementation plan with plans for periodic performance tracking. The STS was not intended or designed to be a regulatory document that directs the actions of others. Instead, it makes the case for how public sector agencies and the private sector need to move forward to address the serious and challenging issue of climate change. Implementation of the STS will be managed in an iterative way to address the challenges of mitigating GHG emissions from the transportation sector and balancing other goals and objectives. The key value of this "conversation with the model" led to stakeholder learning, enabling them to "think better" about the impact and interaction of the various policies.[2] The advisory committees had the benefit of working through this process and had the time to become comfortable with the aggressive assumptions. The model and stakeholder process provided transparent and defensible identification of strategies effective in reducing GHG emissions.

Figure I-1. STS Scenario Conversation using GreenSTEP

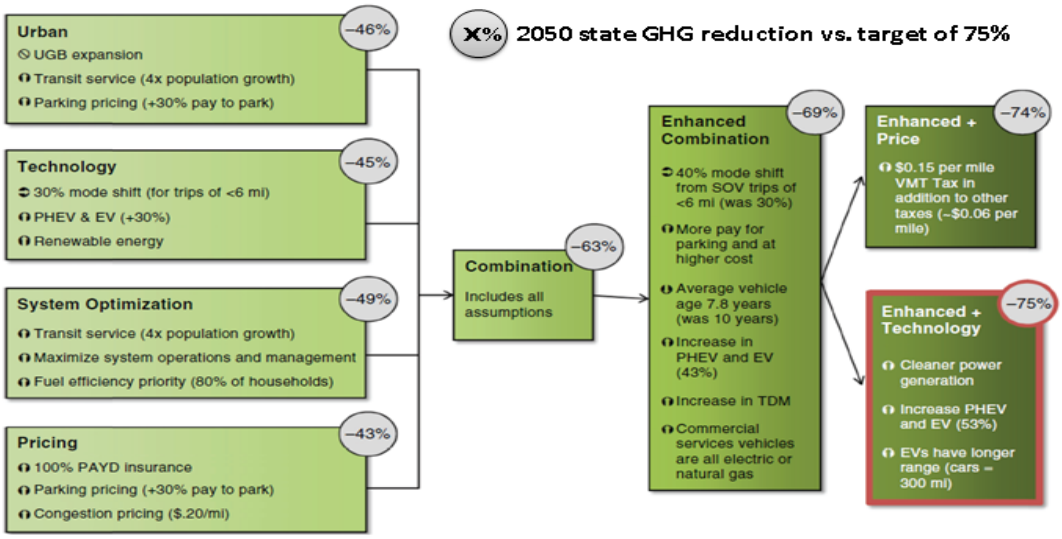


FIGURE 1 Evolution of STS scenarios for on-ground passengers (SOV = single-occupant vehicle, TDM = transportation demand management, UGB = urban growth boundary).

[2] NCRHP Report 750 The effects of Socio-Demographics on Future Travel Demand Volume 6,Impacts2050 notes: "models should be viewed as tools for exploring scenarios, rather than providers of hard predictions, and should be designed to be flexible enough to explore scenarios, while avoiding (as much as possible) traps such as assumption drag. Models may have a poor track record at making precise numerical forecasts of the evolution of complex systems, such as the transportation network, but they are still invaluable for thinking about the future and comparing different possible outcomes (Orrell and Fernandez 2010)"

- **Setting MPO GHG Reduction Targets**. In addition to the implementation of the STS, the legislature mandated that MPO GHG reduction targets be set for the state's six MPOs (SB1059). A Core Technical Committee of three state agencies responsible for travel, vehicles, and fuels, ODOT, the Department of Environmental Quality (DEQ), and the Oregon Department of Energy (ODOE), initially developed an Agency Technical Report that provide technical background and estimates of the GHG reductions needed for each of the six MPO regions to reach state goals. GreenSTEP was used to assess the MPO targets including evaluating different metrics (arrived at GHG emissions per capita), technology options (vehicles and fuel assumptions), and adjusting the legislatively mandated baseline to ease reporting (1990 to 2005). The Land Conservation and Development Commission's (LCDC) relied on this technical work to set MPO GHG reduction targets and associated rules.
- **Statewide Planning.** Building off the statewide GreenSTEP model established in the GHG work, GreenSTEP model runs have been used to quantify the impacts of statewide plans and guidance documents, such as the tradeoff discussion for the ODOT Transportation Options Plan shown in the box to the right.[3]
- **MPO Scenario Planning & Strategic Assessments**. The Oregon Legislature also sought to have MPOs assess their adopted plans, and evaluate more ambitious strategies using a scenario planning process. The largest MPO, Portland Metro was required to adopt and implement a scenario in their RTP. Funding was allotted to enable smaller MPOs to volunteer for a Strategic Assessment to simply assess their adopted plans relative to the GHG targets, among other outcomes. These efforts have all involved using a metropolitan version of the GreenSTEP model, rebranded as the RSPM to distinguish it and reflect its broader outcomes. Thus, a continuously improving RSPM tool has been used in regional conversations of the effects of their adopted plans, as well as more ambitious policy mix to reach

ODOT's GreenSTEP model demonstrates the benefits of transportation options investments

GreenSTEP was developed by the Oregon Department of Transportation (ODOT) to estimate and forecast the effects of various policies and other influences on the amount of vehicle travel, the types of vehicles and fuels used, energy consumption, and resulting GHG emissions. The model estimates vehicle ownership, vehicle travel, fuel consumption, and GHG emissions at the individual household level. One factor or input into the model is the participation of households in transportation demand management/TO programs. Other factors include land use and transportation system characteristics, vehicle ownership, household daily vehicle miles traveled, etc.[12]

The GreenSTEP model was run to evaluate the general outcomes/ benefits of increasing transportation options programs and associated community design variables across the state. The analysis hinges off the GreenSTEP setup and inputs assumed in the ODOT Statewide Transportation Strategy (STS) report;[13] pivoting off the STS-Reference scenario, and assuming levels in the OTC accepted STS-Recommended or Vision scenario.

Results

The effect of ambitious implementation of transportation options programs across all Oregon metropolitan areas in year 2035 was evaluated. This included home and work based TDM programs, car-sharing, and parking cash-out programs. Other related policies were increased marginally to reflect TO program effects (transit service, bicycle promotion, parking coverage, and parking fees). Benefits of transportation options include benefits to individual households and the overall transportation system. This general assessment shows:

- → 7 percent reduction in daily vehicle miles traveled per capita
- → 7 percent reduction in GHG emissions
- → 3 percent reduction in number of vehicles per household
- → 2 percent reduction in annual household travel costs
- → 10 percent reduction in annual vehicle travel delay per capita
- → 3 percent reduction in daily heavy truck delay

Note: Additional information is being pursued to monetize some of the TO benefits from the GreenSTEP model, including cost savings from reduced truck delay.
Source: GreenSTEP model results based on setup for the Oregon Statewide Transportation Strategy (2011)

regional goals, including the GHG target. The discussion of more ambitious policies and "what would it take?" to reach regional GHG targets and other desired community outcomes, has been facilitated by an interactive web-based "Scenario Viewer" tool that enables stakeholders and the public to view hundreds of RSPM scenarios, to help them understand policy tradeoffs and correct inconsistent thinking (e.g., want to build roads but don't support funding; want GHG reduction but don't want policies that accomplish that). These efforts are evolving into a performance-based planning process for state and local planning processes, similar to that advocated by MAP-21.

Moving forward, the challenge for Oregon is to integrate strategic planning (using RSPM) into standard practice. Our current thinking is that the planning process, such as an MPO's RTP should start by setting a vision and overall performance targets for a long-term horizon (longer than 25-year RTP, e.g., 2050). This could be done using strategic tools (e.g., RSPM was used to set our GHG targets, which are reasonable to handle at this level unlike criteria pollutants). Given that direction, more traditional detailed travel demand modeling tools (e.g., ABM, 4-step) can be used to identify the best way to implement the vision (e.g., given vision to double transit, what routes/service plans make the best use of those funds). These more detailed plans would need to demonstrate progress towards meeting the vision's sub-goals, but not necessarily need to re-evaluate the higher level vision outcomes that would continue to be evaluated in the strategic tool. We envision that when the detailed modeling is complete it will feed back information to the strategic tool (e.g., finalized level of ambition on actions, improved performance of actions) which will re-assess the higher level vision goals, maintaining as much consistency as possible while keeping both tools current. We recognize that the tools will have different but hopefully not unexplainably diverging results (e.g., different definition of Vehicle Miles Travelled (VMT), different horizon years, different approach to pricing, etc.). Thus, the process will need to respect the technical value of this diversity of future forecasts, while navigating the political challenges; avoiding direct comparison when not technically accurate or useful (e.g., 2010-2050 change in strategic model vs. absolute values from detailed models).

It is helpful to highlight how these new strategic tools complement traditional travel demand models. Figure I-2 contrasts strategic with standard travel demand models in role and methods. It should be noted that travel demand models vary in sophistication, but the contrasting functionality noted in Figure I-2 provides a better understanding of how the tools compare. Strategic tools provide a long term perspective that includes broader mix of policies and outcomes, the travel demand models are best at project level details, where variables like fuel price and land use have been set. To effectively serve these roles, strategic tools must simplify to keep runtimes short, focusing on "qualitative accuracy" as noted in the IMPACTS2050 report[2], stressing analytical reasoning over computation precision. While travel demand models can add more details to improve precision. And as noted above, the tools are best used together, where strategic tools set a vision, while the travel demand model provides the detail needed to evaluate and implement the chosen mix of policies from the vision.

ODOT looks forward to collaborating with agencies around the state to further integrate strategic planning into our existing planning practices. The VisionEval open source project and forum can provide insight in how strategic planning is being implemented elsewhere in the US.

Figure I-2. Contrasting the functionality of Strategic and Travel Demand Models

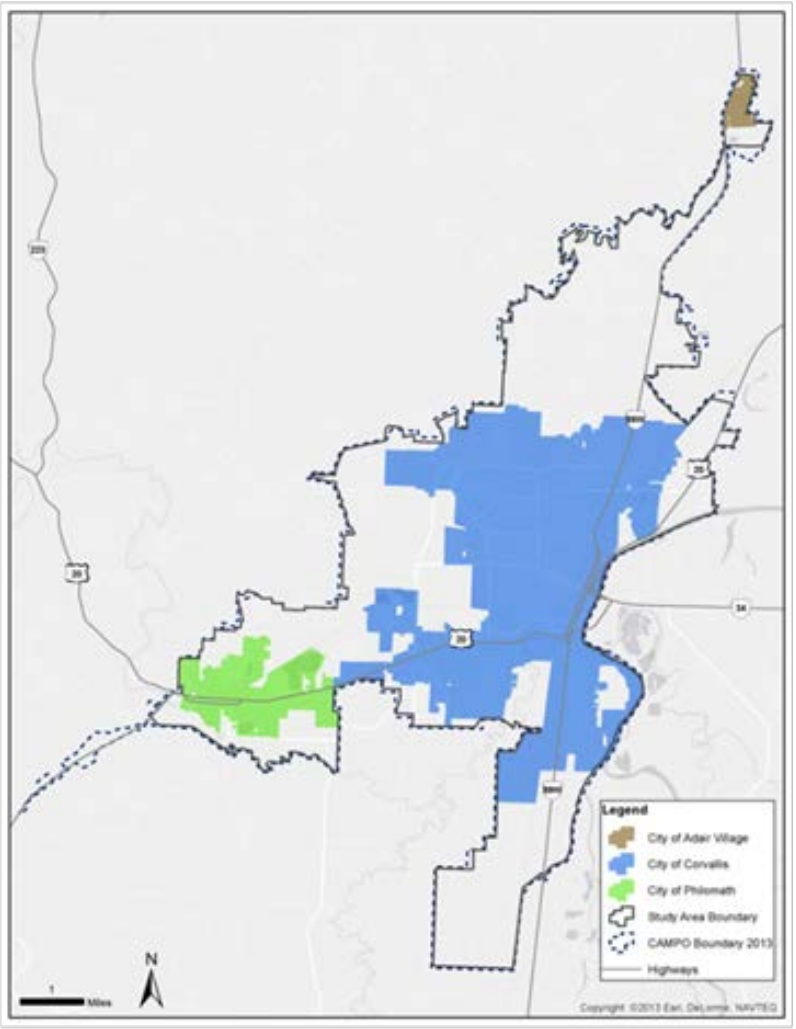
Strategic Model	Travel Demand Model
Role:	
• Strategic; less detailed but considers a wider range of potential policies and outcomes.	• Specific transportation projects, network links. • Air quality conformity, detail projects
Methods:	
• Household-based VMT & GHG emissions; (synthetic population but no network) • All days (weekend and weekday) VMT • "Indicator" results regarding the use of other modes (secondary)	• Model area road VMT (no GHG); trip based network assignment • Average weekday & congested peak period • Multi-modal, trip purposes, etc.
Price Signals:	
• Includes broad travel costs and associated policies (gas prices, gas taxes, parking charges, carbon tax, congestion fee, etc.). • HH travel is reduced so that their travel cost budget is not exceeded. • Interactions between vehicle fuel economy and travel costs are also modeled. (rebound effect)	• Utilities accounts for short-run elasticity to selected trip costs • No overall HH budget considerations
Use Tools Together:	
• Supports discussion of a region's future, identifies mix of policies in a region's vision.	• Evaluates /implements specific elements of a region's vision

Policy Scenario Assessment in CAMPO

The Corvallis Area MPO, in partnership with the ODOT and the state lands agency DLCD, engaged in a voluntary planning effort, known as a Strategic Assessment in 2014. A Strategic Assessment estimates how close the region's existing land use and transportation plans come to reaching greenhouse gas emissions reduction targets and other regional planning goals, including reductions to vehicle miles traveled and air pollutants. The Strategic Assessment results demonstrate the likely outcomes of implementing existing plans in CAMPO combined with other demographic and technology changes expected over the next 20 years. The assessment illustrate that by implementing adopted plans the region is on the right track to reduce emissions and that there is a variety of policies and actions that the region could consider further to meet the MPO target.

Scenario Analysis is the second phase of the Strategic Assessment process, it allows for high level analysis of combinations of the policies and actions identified in the Strategic Assessment that the MPO could consider incorporating into its future planning processes. CAMPO engaged in Scenario Analysis to inform the MPOs upcoming RTP. The CAMPO Policy Board will use the results of the analysis to guide policy decisions during the RTP development process.

Figure I-3; Corvallis Area MPO Strategic Assessment Study Area



Policies regarding Land Use changes and Parking Fee changes were investigated relative to a baseline of current adopted regional plans to determine the extent that these policy scenarios help meet the region's GHG reduction target and achieve CAMPO's regional planning goals. These policies were tested under alternative State and regional context variables to better understand their resilience to various possible future conditions. Additional factors of alternative transportation modes and Transportation Options[3] strategies were analyzed for each policy scenario to determine the effect of other potential regional investments and policy actions. The CAMPO Policy Board identified the following policy options to be investigated during the Scenario Analysis project:

[3] Transportation Options (TO) programs, as defined in Oregon's statewide TO Plan (2015, http://www.oregon.gov/odot/td/tp/pages/toplan.aspx), include an expanded set of transportation demand management programs and supporting modal options. In RSPM, this includes employer-based transportation demand management (TDM) programs (RPAT's vanpooling, ridesharing, telework, and transit subsidy), as well as home-based Individualized Marketing (IM) programs, and car sharing.

Land Use Changes

- Decrease development in central area and direct development to outer areas
- Increase development in central area
- Most new development is concentrated in multi-modal areas
- New developments in form of mixed use

Parking Fee Changes

- Expand parking fee coverage areas
- Increase parking fees
- Cash-out parking programs

Multi- Modal Investments

- Expand transit service
- Expand bicycle & pedestrian facilities

Transportation Options

- Work based marketing programs
- Home based marketing programs
- Expand Car-sharing
- Telecommuting
- Transit Subsidies

Policy Inputs

The inputs needed to run RPAT involved collecting data from various sources in the region. These include assumptions on conditions for the base 2010 to 2040 scenario, as well as assumptions reflecting the alternative policy scenarios of interest.

Base scenario Inputs and Assumptions

Figure I-4, summarizes the RPAT inputs as developed for the CAMPO 2010-2040 Adopted Plans base scenario (augmented version of comments.csv RPAT file, kept with model run files). Most of the inputs were previously developed for the RPSM 2010-2035 CAMPO scenarios, with some edits as noted in the table, including an extension from 2035 to2040. The key sources include;

- Census data,
- CAMPO's travel demand model (CAMPO production travel demand model, and its 2016 CALM replacement),
- State and local population and employment forecasts,
- Adopted local plans, including:
    - Comprehensive plans and zoning from Adair Village, Corvallis, Philomath, and Benton County,
    - Transit agency plans,
    - Enterprise car sharing plans,
    - Public works ITS program plans, and
    - Oregon State University Campus Master Plan.

Assumptions about future state and federal policies and conditions are drawn from state-level sources, including:

- Oregon's Greenhouse Gas Target Rule
- Oregon's Statewide Transportation Strategy

Figure I-4 input summary also indicates a level of effort for each input, indicating the ease in developing each input from readily available sources and/or discussions with local MPO, city, or transit agency staff. This considered the development for both RSPM and RPAT. One minor issue was the lack of freeways in CAMPO, an issue that may impact other smaller MPOs. The issue was resolved by putting a very small non-zero value as the input. (Note: an easy fix that was applied to RSPM for this issue when used initially in Corvallis).

Needing to develop place type land use inputs for RPAT, and seeing complimentary value in a data-driven criteria-based approach to discuss complex land use issues with local communities, ODOT and DLCD in a multi-agency collaboration developed an Oregon place type method. The successful development, Oregon MPO review, value to the planning and analysis processes, and future opportunities of this new Oregon land use framework are further documented in Appendix B. The method relies on the communities already developed TAZ data for Households and Employment by type, and adds two variables from the US block-group coverage of the EPA Smart Location Database (SLD). Using this data for each TAZ, "built form" 5D variables[4] are calculated, converted to levels (Low-Med-High), which are further used in a lookup method (Figure I-5) to determine the area and development place type for each TAZ in the MPO. This was done for the base year 2010 as well as the future year 2038. Alternative future years were also built to reflect MPO-defined modifications of adopted plans to evaluate. The SLD data for two of the 5D built form attributes (design and transit service level) were held constant overtime due to the use of the 2010 EPA SLD data source. The resulting 2010 place type mix of population and employment was used directly for the place_type_existing.csv RPAT input file. The increase in households and employment between the two years was tabulated and its place type mix recorded in the place_type_growth.csv RPAT input file. **Some RPAT parameters were also updated to better match RSPM assumptions, as noted in the table.**

[4] Ewing & Cervero, Travel and the Built Environment, Journal of the American Planning Association, 76:3, 265-294.(2010) Note: 5th 'D' is typically 'Distance to Transit', not 'Transit Service Level', as used here

Figure I-4. CAMPO Adopted Plans Scenario Input Sources

name	Level of Effort	comment
Scenario	NA	Adopted Plans 2040
Population (Existing and Growth) [pop_by_age.csv]	L	CALM Travel Model TAZ data (Census-based in 2010), age from OR Office of Economic Analysis (OEA) Benton County forecast age distributions (modified S.A so had TAZ data for place types & used latest CALM TAZ data, extended 5 years)
Employment (Existing) [employment.csv]	L	OR Office of Economic Development (OED) 2010 QCEW Average monthly point data (GIS) stratified by firm size and NAICS code (not in RSPM)
Employment (Growth) [employment_growth.csv]	L	Ratio of Employment from 2010 Census-based CALM Travel Model TAZ data and 2040 CALM Travel Model TAZ data (match S.A., extended 5 years)
Regional Income [regional_income.csv]	L	Combines RSPM inputs, CAMPO-to-state Per Capita Income ratio (BEA based) with Statewide income growth (historic trend) used in Statewide Transportation Strategy (STS) (Match S.A, extended 5 years)
Road Lane Miles and Transit Revenue Miles [transportation_supply.csv]	M	Roads - 2010 HPMS by functional class; Transit - 2010 National Transit Database (NTD); (match S.A., except transit fixed to reflect corrected HH+GQ 2010 population)
% Increase in Road Lane Miles, Transit [transportation_supply.csv]	L	CAMPO RTP (match S.A)
Auto and Transit Trips per Capita [trips_per_cap.csv]	M	2 sources used for vehicle trip rate (2010 OHAS HH survey, 2010 CALM travel model) and validated against national standards; 2014 on-board transit survey for transit trip rate. (not in RSPM)
Base Daily Vehicle Miles Traveled [base_vmt.csv]	M	2010 HPMS (RSPM file mpo_base_dvmt_parm.csv) FwyArtProp and LtVehDvmt
Truck and Bus Vehicle Miles Traveled [truck_bus_vmt.csv]	L	2010 HPMS (match S.A. RSPM parameters file)
% Increase in Auto Operating Cost [auto_op_cost_growth.csv]	H	Tabulation of future divided by base per mile costs including: VehMtnce+Tire (0.04) + Gas Tax (increase from 0.424 to 0.484/gal) + STS Fuel Cost; latter 2 are converted to $/mile using RSPM assumed MPG by year. CPI applied to convert from 2005$RSPM to 2000$RPAT (see Auto_op_costCalc.xlsx) (Match S.A, extended 5 years, adjusted from 2005$ to 2000$ using Portland CPI)
Auto VMT Surcharge [vmt_charge.csv]	M	None, beyond those in auto_op_cost_growth.csv input file. (match S.A)
% Road Miles with ITS Treatment [its.csv]	H	Discussions with ODOT ITS lead and Corvallis Public Works Dept. (match S.A.)
Bicycling/Light Vehicle Targets [light_vehicles.csv]**	H	Comparable range given Oregon peer cities from 2010 Oregon Household Activity Survey (in absence of full funding of Survey in Corvallis); 2040 - Discussions with MPO and City of Corvallis (match S.A.)
Increase in Parking Cost and Supply [parking_growth.csv]**	H	RTP 2010 and 2035 Parking Assumptions (match S.A. except adjusted for % avoiding fee by parking in neighborhoods near campus/downtown)
% of Employees Offered Commute Options [commute_options.csv]**	M-H	"Drive Less Save More" program participants in TDM, rideshare/vanpool programs, and conversations with MPO (not in RSPM, but consistent with RSPM TDM assumptions where possible); Telework combined OHAS HH survey and Census data; Transit subsidy assumed weighted average of free in Corvallis $1 in Philomath)
Population and Jobs by Place Type [place_type_existing.csv] [place_type_growth.csv]**	M-H	CALM Travel Model TAZ data (Census-based in 2010), using Oregon Place Type logic/thresholds, rolled up to regional place type shares (not in RSPM, but non-"Low Density/Rural" consistent with RSPM urbanized "Metropolitan" land supply and DUs)
PARAMETERS		
Accidents [accident_rates.csv]	L-M	ODOT (2009-2013) 5-year Comprehensive Crash Report for the CAMPO area annual crash rates by severity types; divided by DVMT (all purposes) from CAMPO's 2010 Travel Model expanded to annual.
Fuel mix [fuel.csv]	H	Combine RSPM file for each mode (auto, light truck, bus, HD Truck)
Fuel carbon intensity [fuel_co2.csv]*	L-M	Used RSPM 2040 values
Vehicle MPG [vehicle_mpg.csv]	L-M	Since RSPM has MPG by EV, HEV, PHEV vehicle types, RPAT values were used instead.
Key Values [keyvalues.csv]*	M	Base cost (vehicle maintenance& tires), fuel cost, and gas tax match RSPM.
Transportation Infrastructure Costs [transportation_costs.csv]	M	Although RSPM has some measures of roadway infrastructure costs (modernization and Operations/Maintenance), they were not compatible, and so RPAT values were used.

* Only one year value used in RPAT, does not allow changes over time or policy scenarios that lead to change.

** Developed more ambitious inputs for these variables to reflect desired CAMPO policy tests.

Figure I-5. Oregon Place Types Method

Place Type Logic

1 BUILT ENVIRONMENT VARIABLES

Built Environment Variables		
Destination Accessibility	Regional Jobs within 5 miles relative to highly accessible location (ratio)	H-M-L-VL
Density	Jobs & Households per acre within 0.25 mile	H-M-L-VL
Design	Multi-modal & Pedestrian-Oriented street density (street lane-miles per sq mile)	H-M-L-VL
Diversity	Jobs (total or retail- service) to household ratio, within 0.25 mile (ratio)	H-M-L-VL
Transit Service Level	PM Peak hourly transit service within 0.25 mile (combined frequency)	H-M-L-VL

2 REGIONAL ROLE (Area Type)

Density \ Design	Destination Accessibility: H	M	L	VL
H	Regional Center		Secondary Center	
M		Close In Community		
L, VL			Suburban/Town	
VL		Low Density/Rural		

3 NEIGHBORHOOD CHARACTER (Development Type)

	Density	Design	Diversity	Transit
Mixed Use	M	M	H	
	H	H	H	
Employment	Not MIXED		Jobs> HHs	
Residential	Not MIXED		HH>jobs	
Transit Supported Development	H	H	H	H
	H	H	Jobs>HHs	H
Low Density/ Rural	VL			

4 LAND USE PLACE TYPES

Area Type + Development Type = PLACE TYPE

Neighborhood Character (Development Type)	Regional Role (Area Type): Regional Center	Close In Community	Secondary Center	Suburban/ Town	Low Density/ Rural
Transit Supported Development	√	√	√	√	
Mixed Use – High	√	√	√	√	
Mixed Use	√	√	√	√	
Employment	√	√	√	√	
Residential	√	√	√	√	
Low Density/ Rural					√

Draft 12/11/15

Alternative Scenario Inputs and Assumptions

MPO, ODOT, and DLCD staff engaged regional stakeholder and the CAMPO Technical Advisory Committee in order to develop RSPM inputs that would test the different policy options identified by the CAMPO Policy Board. The regional stakeholders included the City of Corvallis, City of Philomath, Benton County, Oregon State University, and the regional Transportation Options provider Oregon Cascades West Council of Governments. The process was guided by the CAMPO Technical Advisory Committee. The project team worked closely with staff from local jurisdictions to provide reasonable and accurate inputs to best represent the policy options identified for investigation.

The RPAT/RSPM input files adjusted to represent the alternative policy scenarios discussed in the next section include the following:

Land use (place_type_growth.csv) – All the scenarios kept overall MPO control totals for population and employment, but moved population growth from one location to another. Key issues included pressures from residents in the core area, leading to interest in growth in adjacent cities central areas. The local jurisdiction TAC members identified focused changes from adopted plan land use forecasts to evaluate, including sharing growth among the 3 cities within the MPO and location of growth in central multi-modal areas or outlying areas. This had minor impacts on the place type inputs of RPAT, and more significant changes to the RPSM dwelling unit by district inputs.

Parking (parking_growth.csv) – A key parking issue in Corvallis is people avoiding paying for parking in downtown or campus by parking in nearby adjacent neighborhoods. The amount of "avoiders" was estimated for current conditions from parking inventory surveys and the future scenarios reduced that to 0, reflecting policies to limit that from happening (e.g., residential parking permits, a recent ballot measure that was not approved by voters.). A range of current conditions were modeled because of the political sensitivity of the issue and lack of clarity on the extent of the problem today. Other parking policies were more straight-forward in the model inputs: increasing fees, and implementing cash-out programs.

Multi-Modal Investments (transportation_supply_growth.csv, light_vehicles.csv) – These scenarios are a mix of increasing transit service or investing/promoting bike diversion from single occupancy vehicles (SOV). It should be noted that one challenge to modeling transit in RPAT/RSPM is that the transit is not spatially located. In the case of CAMPO, the bulk of the transit occurs in just a few areas of Corvallis, and some policy scenarios called for increasing transit to other areas (Adair Village to the north) but the input was MPO-wide, which was compounded by the lack of TOD place types in the region to indicate level of service.

Transportation Options (commute_options.csv) RPAT provides a more detailed input on employer-based TDM programs than RSPM, although RSPM also includes home-based individualized marketing (IM) programs, which have been shown to have a larger impact when targeting multi-modal neighborhoods (5% vs. 7% VMT reduction per participant in RSPM). Corvallis also considered expansion of its growing car share program currently focused around the Oregon State University campus. Car

sharing is only available in RSPM, not RPAT. One challenge for both tools is that transit is free in Corvallis, but not in Philomath, so a weighted average was used in the transit subsidy.

Model Development and Validation

Both RSPM[6] and RPAT[5] tools were applied in CAMPO for this scenario work. RSPM was previously developed for the area as part of the prior Strategic Assessment project. However, in the new phase, there was a desire to update to the latest land use inputs (2040 instead of 2035) and improvements were made to the RSPM model (version 3.5 replacing version 3.0). Validation of these tools included the following efforts:

- Validation of CAMPO 2010-2035 RSPMv3.0 (part of prior study)
    - CAMPO base year inputs were set-up and run;
    - RSPM Housing module allocates population to household and district to match census targets of household size and income. Consistencies between base year dwelling units, population, and household size often require attention.
    - Calibration factor was set (HhDvmtToRoadDvmt) to match 2010 HPMS Daily VMT data
    - Results were checked for reasonableness in terms of 2010-2035 growth relative to prior RSPM runs for 2 other MPOs.[6]
- Validation of CAMPO 2040 RSPM v3.5
    - When the updated RSPM version set up and run for 2040 (an additional 5 years) produced significant differences, a 2035 scenario was developed in both model versions to isolate the difference due to the change in versions. Some inconsistent inputs were resolved (change in input metrics), and minor corrections to the v3.5 code were resolved. The key remaining difference was a change in commercial vehicle travel due to new methods.
    - The adjustments to get the 2035 version comparisons in line were translated to the 2040 v3.5 scenario inputs, and the calibration of the housing module and calibration factors was improved. Results and trends were now reasonably compatible with the prior CAMPO work.
- Comparison of CAMPO 2040 RPAT
    - RPAT inputs were developed largely from RSPM inputs, with adjustments and supplemental data, as needed. This included transfer of the calibration factor (HhDvmtToRoadDvmt).
    - Initial RPAT outputs and key inputs were processed to produce a set of comparable outputs, with challenges do to RSPM operating in a single year, and RPAT only producing a future year or change over time; and struggles with output units.
    - Some inconsistencies in key inputs were corrected. RPAT-to-RSPM comparison was reasonable for daily vehicle miles travelled (DVMT), but less so for others measures, such as delays. Given the differences in the two models' methods and knowing that RPAT was serving as a supplement to RSPM in the CAMPO work, the results were deemed sufficient.

[5] RPAT website and documentation: https://planningtools.transportation.org/551/rapid-policy-analysis-tool.html
[6] More information on validation can be found in the RSPM technical documentation: https://github.com/gregorbj/RSPM/blob/master/GreenSTEP-RSPM_Documentation_20151220.docx.

Policy Option Testing

Part 1. Policy in Isolation

The first part of the analysis tested each policy option against the adopted plans reference case to understand how implementing each policy choice in isolation would impact the region relative to implementing the adopted plans. Figure I-6a identifies these scenarios, while Figure I-6b demonstrates how the policy options will be tested and reported with the MPO TAC and policy board in early 2016.

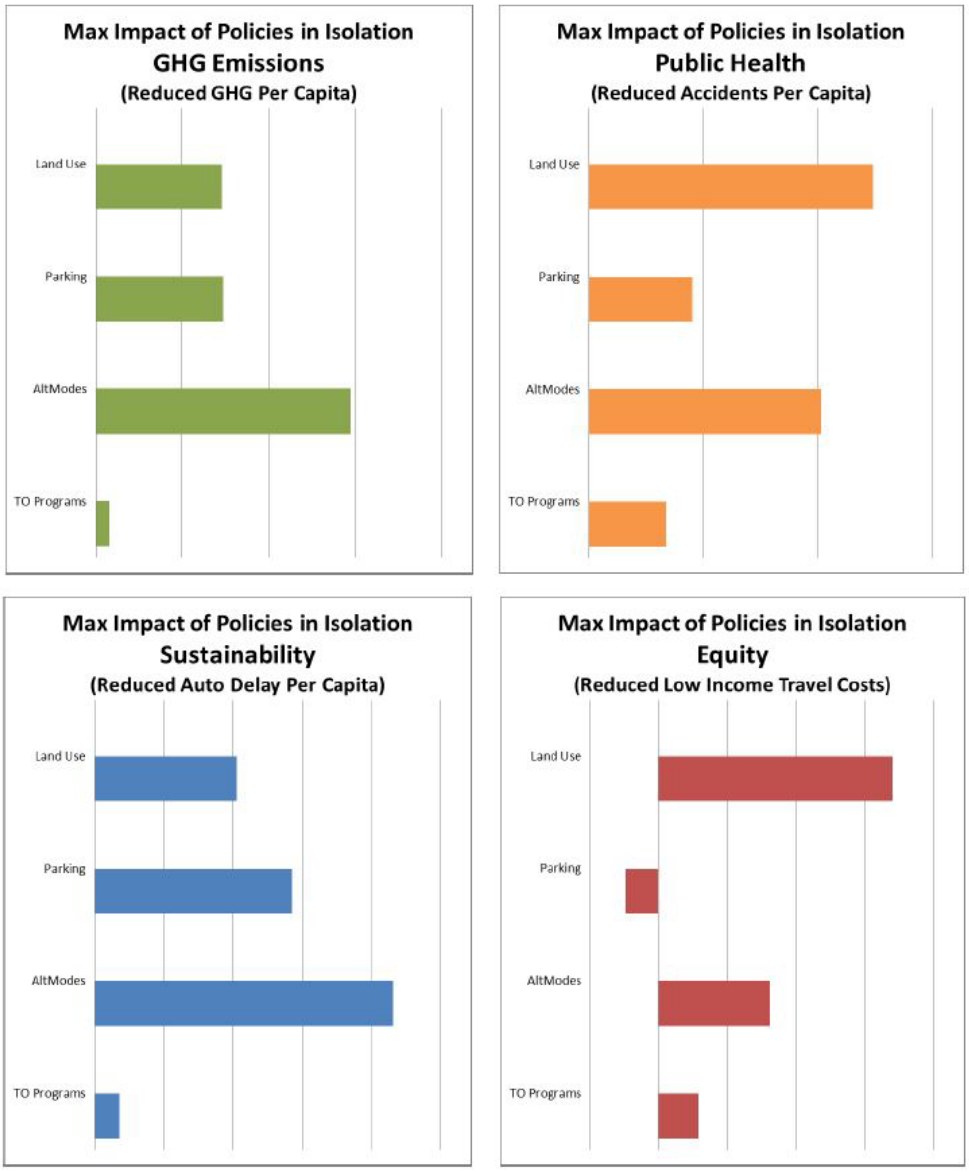
Figure I-6a. Scenario Analysis; Policy in Isolation Scenarios

Policy	Land Use	Parking	Alt Mode	Trans Options
0	Adopted Plans	Adopted Plans	Adopted Plans	Adopted Plans
1	**Decrease developments in central area and direct new developments to outer areas**	Adopted Plans	Adopted Plans	Adopted Plans
2	**Increase developments in central areas**	Adopted Plans	Adopted Plans	Adopted Plans
3	**Most new development is concentrated near alternative mode facilities**	Adopted Plans	Adopted Plans	Adopted Plans
4	**Climate Refugees- Increased population growth**	Adopted Plans	Adopted Plans	Adopted Plans
5	Adopted Plans	**Expanded parking districts**	Adopted Plans	Adopted Plans
6	Adopted Plans	**Increase parking fees downtown**	Adopted Plans	Adopted Plans
7	Adopted Plans	**Increased fees in downtown and expanded districts**	Adopted Plans	Adopted Plans
8	Adopted Plans	**Cash-out parking programs**	Adopted Plans	Adopted Plans
9	Adopted Plans	Adopted Plans	**Increase transit frequency**	Adopted Plans
10	Adopted Plans	Adopted Plans	**Expand transit to Philomath and Adair Village**	Adopted Plans
11	Adopted Plans	Adopted Plans	**Expand bicycle facilities**	Adopted Plans
12	Adopted Plans	Adopted Plans	Adopted Plans	**Home/Work-based marketing programs**
13	Adopted Plans	Adopted Plans	Adopted Plans	**Expanded car sharing**

The reporting of Land use Policies in Figure I-6b, provides a definition of the scenarios tested at the top, followed by bar charts of both RSPM (GHG, VMT, Household costs)) and RPAT (accidents, transit trips) outcomes of each policy relative to that outcome in the adopted plans reference scenario. For example, daily transit trips are shown to improve for all land use scenarios by roughly 3.5%. In contrast, for other measures shown Scenario LU1, which channels growth in other MPO city central areas to a function

mixed use threshold, rather than intensify the already dense Corvallis central area, results in more benefits according to the model. Scenario LU3 which directs growth to outlying concentrated new developments further from the regional center does not fare as well, all else being equal.

Figure I-6b. Example- Scenario Analysis; Policy in Isolation Output Reporting



Part 2. Policy in Combination

The second part of the analysis will combine policy options into bundles to represent policy scenarios to test relative to the adopted plans reference case. The CAMPO Technical Advisory Committee (TAC)_identified which policy bundles to test in order to assess the impacts of different combinations of policy scenarios that could potentially be implemented in the future. Here, a logical mix of the policies previously tested in isolation in Part 1, are combined into more complete scenarios that include a mix of complementary land use, parking, and supportive multi-modal and TO policies and investments. These combination scenarios will be evaluated through the lens of their impact on indicators of regional importance. Unlike the original Strategic Assessment report that was largely a state-led exercise, in this follow-up stage of RSPM analysis the MPO TAC was very engaged in defining the evaluation criteria and specific metrics for assessing the scenarios. The evaluation criteria identified by the CAMPO Policy Board include Public Health, GHG Emissions Reductions, Livability & Sustainability, and Equity measures. Figure I-7a demonstrates how the MPO TAC bundled policies into scenarios for analysis, while Figure I-7b provides an example of how the model results will be packed for reporting to the TAC.

Figure I-7a. Scenario Analysis; Policy in Combination Scenarios

Part 2- Policies in Combination

		Land Use	Parking	Alt Mode	Transportation Options
Policy Bundles	A	Adopted Plans	Expanded parking districts	Expand bicycle facilities	Home/Work-based Marketing
			Increased fees downtown	Expand bicycle and pedestrian facilities	Car Sharing
			Cashout Parking		
	B	Decrease developments in central area and direct new developments to outer areas	Expanded parking districts	Expand transit to Philomath and Adair Village	Home/Work-based Marketing
			Adopted Plans		Transit Subsidies
	C	Increase developments in central areas	Expanded parking districts	Increased transit frequency	Home/Work-based Marketing
			Increased fees downtown	Expand bicycle facilities	Car Sharing
	D	Most new development is concentrated near alternative mode facilities	Expanded parking districts	Increased transit frequency	Home/Work-based Marketing
			Increased fees downtown	Expand bicycle facilities	Car Sharing
			Cashout Parking		
	E	Adopted Plans	Cashout Parking	Increased transit frequency	Home/Work-based Marketing
				Expand bicycle facilities	Car Sharing
Climate Refugee	F	Climate Refugees	Expanded Disticts	Increased transit frequency	Home/Work-based Marketing
			Increased fees downtown	Expand bicycle facilities	Car Sharing
			Cashout Parking		

For example, the reporting of Bundle C as shown in Figure I-7b includes a definition of mix of policy actions on the left, and model findings, by evaluation criteria and specific sub-metrics to the right. The example results for Bundle C show generally positive (green arrows) for the scenario's concentrated growth in the existing dense Corvallis central area, which builds on existing multi-modal investments there where residents have half the VMT per capita of outlying areas. The scenario provides further enhancements including implementing supportive policies such as multi-model incentives (investments in bike facilities and doubling transit service levels) and pricing disincentives (increased parking fees, and implementation of neighborhood parking permit system to avoid current diversion of parking fees in adjacent residential neighborhoods). The model's percent change from adopted plans (percentages) are small but positive for all but the equity-impact from increased travel costs (net of increased parking costs and reduced costs with increase used of non-auto or reduced VMT).

Figure I-7b. Example- Scenario Analysis; Policy in Combination Output Reporting

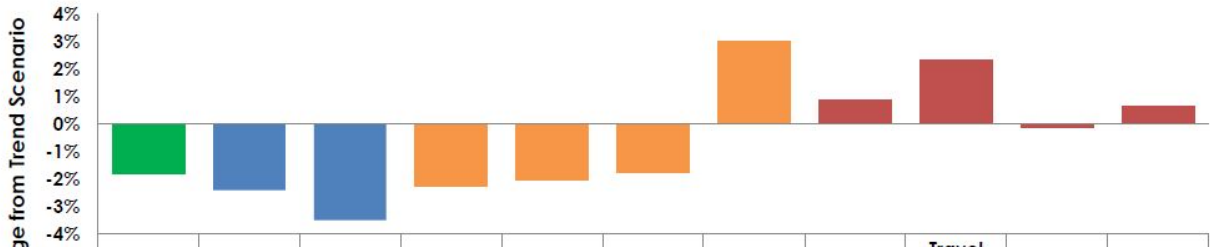
Policy Bundle- Scenario A

This policy bundle uses the land use pattern from the adopted plans reference case, and combines the highest levels of parking with bicycle and Transportation Options policies. This scenario serves to give an understanding of the likely effects of implementing a more comprehensive set of transportation policies in the region with adopted land use plans.

Land Use	Parking	Alternative Modes	Transportation Options
Trend Scenario	• Expanded parking districts • Increased fees downtown • Cash-out parking	• Expand bicycle facilities	• Home/Work-based marketing • Car Sharing

Findings

Most of the evaluation criteria are trending in the right direction, however it under performs on most indicators in comparison to other scenarios. Inclusion of transit in Scenario B, leads to larger impacts on reducing driving than the parking policies in this bundle. Parking policies are much more aggressive than the parking policies tested in Scenario B and would require much more work to realize. Given the small differences between the outcomes, parking policies had a relatively small impact. Equity measures show that travel costs, mostly due to parking cost increase, have a disproportionate burden on poorer households. Walk and transit trips remain unchanged, primarily as a result of the unchanged population living in mixed use development.



	Annual GHG Emissions	Daily VMT	Annual Auto Delay	Daily Air Quality Pollutants	Daily Accidents	Annual Social Costs	Light Vehicle/ Bike Diversion	Travel Costs % of Household Income	Travel Costs % of Low Income Households	Auto Owned Per Household	% Zero Vehicle Households
A	-1.8%	-2.4%	-3.5%	-2.3%	-2.0%	-1.8%	3.0%	0.9%	2.3%	-0.1%	0.7%

Policy Planning Tool Implementation Evaluation

Statewide Policy Planning in Oregon

ODOT has found the GreenSTEP, RSPM, and RPAT scenario planning tools to provide significant value to the statewide and regional land use and transportation policy planning process. Quantification of impacts enables a clearer picture of relative impacts and their magnitude. At the statewide planning level, the tools have provided a method for ODOT and its partner state agencies to collaborate in envisioning a shared path to meet legislative GHG emissions reduction requirements. The process to develop model inputs and create a baseline for assessment allowed the state agencies, including ODOT, DLCD, ODOE, and ODEQ to learn and discuss key tradeoffs of various policy actions, and thereby collaboratively address the requirements in a more coordinated manner, allowing the results of the assessment to represent more likely outcomes. The GreenSTEP tool has also provided ODOT with a method to test the possible outcomes of a variety of statewide transportation policy changes, providing a greater amount of insight for planning and investment discussions. The scenario planning tools provide a suite of information to enable high-level discussion about what bundle of policies may best meet the state's long term vision.

At the local level RSPM and RPAT have allowed ODOT to provide regions (4 to date: Portland, Eugene-Springfield, Corvallis, and Rogue Valley) with powerful analytical tools to estimate how well communities will do in meeting important local and statewide needs given different assumptions over a long-term planning horizon, typically the 25 year metropolitan RTP horizon. The tools also provide a method to evaluate how well communities are prepared to deal with changing circumstances, such as changing demographics and energy costs. The tools are helpful for enabling communities within a metropolitan area to collaboratively identify shared planning goals and discuss policy options, and to gain broader understanding about issues and their intended and unintended consequences on local communities. The scenario planning tools help local decision makers and the general public better understand the regional impacts of different policy choices at a strategic level, and open a dialogue to better coordinate planning decisions over a long term horizon. The tools allow regions and communities to assess the path of their adopted plans in achieving regional and state goals, better understand how their adopted plans are affected by emerging trends, and consider policy changes to better cope with these trends. The scenario planning tools have shown to be beneficial to the federally mandated metropolitan RTP planning process and as a stand-alone assessment process to provide information to the MPO. Current efforts focus on integrating the "strategic" conversation supported by these tools into standard planning practice.

Insights for Decision Making

The greatest benefit provided by the scenario planning tools is enabling local policy makers and State agencies to frame planning discussions leading to more informed performance-based transportation investment and policy plans. Over time, it is envisioned that this will be used to influence decisions and feedback to the plans in a more complete planning-monitoring approach. The ability to implement a tool to quickly test hundreds of high level policy scenarios in order to develop regional and statewide planning goals is of great importance as ODOT seeks innovative methods to help Oregon communities adaptively plan while recognizing future uncertainties and need for judicious use of limited dollars.

Regional Policy Planning; Corvallis Area MPO

The Strategic Assessment process and scenario planning tools (RSPM/RPAT) have provided the Corvallis Area MPO with a method to quantify adopted plans on GHG emissions reductions relative to the state set target, as well as investigate other outcomes important to the region. The Strategic Assessment created a platform for MPO staff to frame conservations with MPO planning committees and local jurisdictions about the tradeoffs associated with different policy options in achieving regional planning goals and State GHG reduction targets as well as unexpected secondary impacts. The RPAT and RSPM policy analysis tools (including land use place types) provided the region with an effective method to engage local jurisdictions and regional stakeholders in a collaborative planning process to support ongoing implementation of adopted regional plans and to provide policy analysis to inform the development of future regional plans. The scenario evaluation process allowed the MPO a collaborative tool to effectively engage their MPO planning committees, local jurisdictions, and regional stakeholders to develop policy objectives that represent regional values and quantitatively represent alternative implementation of these objectives for discussion. The results of the policy investigation will be used to inform policy discussions and guide decisions during future local and regional plan updates, including the MPO RTP, a regional Transit Plan, and City-University campus planning. The intention is to continue to update RSPM to monitor plan progress in a performance-based planning manner, during and after the RTP and provide guidance to downstream investment and policy decision.

As a supplement to the RSPM analysis, the RPAT tool specifically allowed the region to quantify additional policies and an expanded set of outcomes of regional importance of alternatives to their adopted plans. Specifically the RPAT tool allowed more detailed TDM programs, integration of employment and place types, as well as outcomes on accidents, transit trips and accessibility, many stratified by income group were valuable expansion to RSPM to better capture local conditions and regional values in the analysis. The CAMPO region, particularly near campus, has a strong history of multi- modal investment. The RPAT tool allowed the stakeholders to quantify benefits of past investment and to better understand the tradeoffs associated with changes to their multi-modal investment policies in the future. The increased detail in the RPAT work-based TDM program inputs, including inputs for components such as vanpools and telework beyond the single on/off option in RSPM, allowed the city and region to better quantify the effects of these programs. The RSPM-only policy input for the newer Individualized Marking IM programs (RSPM only), allowed the City and Council of Governments to make a quantified business case for expanding the existing IM pilot program as well as discussions of good candidate areas for future efforts. The area's free transit, the need to analyze IM programs and car sharing along with expanded vehicle and fuels policies in Oregon, make RPAT less suitable than RSPM for this work.

Improved Modeling Toolkit

The GreenSTEP, RSPM and RPAT scenario planning tools have provided ODOT with additional transportation and land use analysis capabilities to complement traditional transportation demand models at a strategic level, evaluate and screen scenarios across a broad set of options and test resiliency to uncertainty before engaging more detailed tools. The RSPM/GreenSTEP model (more than RPAT as discussed in Section II) provides a way to evaluate the impacts of future vehicles at a strategic

level. The EPA MOVES model is still the tool to use for more detailed project air quality emissions conformity, but often the fleet and fuel assumptions of MOVES analyses are not fully accurate, as agencies don't take the trouble to update these assumptions if they pass conformity thresholds without doing so. Additionally, RSPM/RPAT can serve many communities not subject to conformity requirements that don't have any emission tools. ODOT has also found GreenSTEP useful in multi-agency collaboration to evaluate the impact of existing and proposed state regulations on vehicles & fuels relative to GHG emission targets, separate from conformity requirements. The tool enabled common understanding and learning, leading to a GHG vision for the state across the diverse domains of four state agencies covering policies ranging from vehicles, fuels, land use, and transportation options. Compared to most travel demand models, RSPM/RPAT introduces the constraint of household travel monetary budgets, which is important in more accurately addressing the complex effects of prices on household vehicle travel including highly effective pricing strategies of growing interest to policy makers short on funds. Today's advanced models, e.g., activity based models and RSPM/RPAT capitalize on the value of simulating travel at the individual household level (with a rich set of synthetic households with realistic range of attributes) This approach enhances policy sensitivity and the range of the input policies that can be modeled (e.g., TDM and pay-as-you-drive insurance) and the reporting outputs (e.g., equity, such as by income group) for analysis, reflecting the rich set of household attributes available under this approach.

Strategic tools such as RSPM/RPAT simplify inputs and methods to keep runtimes short, stressing analytical reasoning over computation precision. As such, these tools can be useful screening of scenarios before engaging the longer runtimes and input requirements of more detailed models that provide the increased accuracy for implementation. The short runtimes also provide the ability to assess hundreds of model runs in a reasonable time frame, enabling testing the resilience of regional plans to a broad range of future uncertainties, such as fluctuations in income and fuel prices, not available or difficult in more detailed models. The creation of a web-based interactive Scenario Viewer integrated with the tool, allows stakeholders to explore the outcomes of hundreds of alternative futures, correct inconsistent thinking, and better understand complex tradeoffs of different policy choices. The strategic nature of the tool has enabled ODOT to quickly assess the impact of changes to transportation funding packages discussed in the State Legislature, and allowed statewide planning advisory committees to analyze the various impacts of state policy implementation scenarios (such as the earlier text box excerpt from the ODOT TO Plan) . The tools help to identify policy choices that have a significant impact on travel behavior, inform planners about how the future will differ from today, and identify policy effectiveness customized for their region. The framework enables the simplified testing of emerging policies, informing priorities for expensive research and upgrades of more detailed tools.

ODOT and DLCD also anticipate the place type approach, developed under this contract, to be a constructive way to engage mid-size MPOs with limited staff and technical capabilities to participate in meaningful land use planning at minimal cost.

Place Types Evaluation

ODOT is pleased with the piloting of the place types as demonstrated in the SmartGAP and RPAT land use inputs. Place Types fill a void that has existed in land use planning for small and mid-size

communities that seek guidance on how the many dimensions of land use can affect their community. Maintaining accurate and up to date future land use assumptions is the foundation for long term regional planning and travel forecasting, the scenario planning tools provide a foundation for creating and maintaining this data. ODOT's data-driven methods will bring consistency across the state and provide a set of comparable places for growing communities to model themselves after. As noted in Appendix B, ODOT has a number of further improvements to pursue with the Place Type method, including better integration with disaggregate transit and road networks to replace the use of the EPA Smart Location Database. The Place Type method has allowed significant progress towards inter-agency coordination to date on a criteria-driven method to discuss land use, and is reaping rewards in planning conversations across the state. The success of these efforts will provide the motivation to continue to improve the tool for use in Oregon.

Some of the notable outcomes of the work on place types in Oregon include:

- **Increased interagency coordination**; Oregon's sister land agency, DLCD, was a key partner with ODOT in the development of the Oregon Place Types methodology and has expressed interest in using Place Types to help metropolitan areas reach their Greenhouse Gas reduction targets and to support other statewide planning goals.
- **MPO Pilot testing**. Successful pilot evaluation by 5 MPOs (Portland, Salem, Eugene, Bend, and RVMPO) of Oregon Place Type maps have led to adjustments to the method, terminology, and value of this new land use "language".
- **RVMPO Strategic Assessment (RSPM).** Oregon Place Types were used to review land use inputs in separate projects in Rogue Valley. A website with interactive viewer of the tool was distributed. Several jurisdictions/agencies found value in thinking about land use in this way, including the Rogue Valley Transit District which felt it was a good way to think about areas to focus mixed use investment and travel demand marketing programs,
- **Future RVMPO Regional Transportation Plan**. After initial use of Oregon Place Types in the Rogue Valley MPO Strategic Assessment (seven jurisdictions), the MPO has decided to use the framework in their review/development of land use forecasts in their RTP. A Place Type training occurred on December 15, 2015. Rogue Valley Training on Oregon Place types, including the 5Ds of built form and more formal definitions for vague concepts like TODs
- **Bend MPO staff use**. Bend MPO staff used Oregon Place Type maps to provide a check on the TAZ-level HH and employment land use inputs used in their regional travel demand model.
- **Census Place Types**. A census Block Group-based place type method was built and applied in several US cities, and presented to participants in the Oct 2015 RPAT Training in Las Vegas. ODOT's interest was to stratify survey data available from another state by place types, without having to use their TAZ data. Broader usage in the RPAT toolkit may follow from interest from participants in October 2015 presentations at the RPAT Peer Exchange and Training. With that in mind, details of the method were shared with FHWA in a 12/17/15 conference call/presentation.

RPAT Tool Evaluation

Input Development

The RPAT tool has provided ODOT with a method to expand and improve on RSPM to better serve Oregon communities. The input for the two tools was able to be woven into one seamless input development process for working with local planners, appropriate local authorities and stakeholders. The Transportation Options, including TDM programs (both RSPM and RPAT, but more detailed sub-programs in RPAT) and car share (RSPM), which are variants of the base scenario with enhanced funding levels, were assembled through discussions with the local jurisdictions and authorities responsible for implementing Transportation Options programs. The inputs aligned with data available from a statewide rideshare program (Drive Less Save More), making the base year inputs at least relatively easy to compile. The more specific RPAT TDM component inputs were more tangible than RSPM's single participation input. The household-based IM program, missing in RPAT, was of keen interest to the MPO, as they look to capitalize on their current pilot program to obtain the success demonstrated in other Oregon regions. Land use inputs variations to the future year TAZ data were also developed through discussions with local jurisdictions, where local staff identified potential changes. The bicycling input (in both models) were more challenging to adopt, as it is difficult to translate investments such as bike lanes or promotion programs into diversion potential; this process was aided by investigating peer Oregon city values from the 2010 Oregon Household Activity Survey. Parking policies were the hardest to evaluate as some policies that influence parking choices and availability were unable to be evaluate in the model, including; non-fee parking management options (hourly parking limits, residential permits), and transit availability, bike diversion, and car sharing by specific location (as some locations are more amenable to these modes and programs). There is interest in using the results to make a stronger case for the residential parking permit system, which was not approved in a recent ballot measure. The free transit was a challenge in both models, as well as the RPAT-only transit subsidy scenario.

Reporting Results

The outcomes were also able to be woven into a combined report of scenario findings, although the RPAT results tend to show fewer differences across scenarios than the RSPM-reported measures. The additional outcomes from RPAT (accidents, accessibility, transit trips) are of interest to the region, but secondary to the top metrics covered in both models (VMT, GHG, household costs). However, the ability to break metrics down by income could have been more fully exploited to address the MPO's "Equity" evaluation criteria. The transit subsidy scenario (only in RPAT) may not be reported in the final work, due to the challenge of getting reasonable inputs and outputs to represent the free transit fare structure in the bulk of the community. The less ambitious policies of this round of modeling, relative to the more extreme sensitivity tests of the Strategic Assessment project tested the limits of the precision of these strategic-level tools; teasing the "signal from the noise" when considering the randomness of the RSPM and RPAT methods (e.g., 10% TDM input is randomly assigned to likely households, and could fall on a large or small household in different runs). At first blush the CAMPO results are showing that the outcome measures and ordering of scenarios seem reasonable despite the lower impact (most measures showed less than 5% difference from adopted plans). Further validation of this level of analysis with the tools will be confirmed as the results are shared with local MPO committees in early

2016. Finally, this work, as with the Strategic Assessment before it, exemplifies successful inter-agency efforts, a model collaboration led by ODOT and DLCD at the state level, in partnership with MPO leadership and involvement by local jurisdictions, transit agencies, and campus planners in reaching common goals and understandings that should lead to more informed and consensus-based actions.

Utilizing the Graphic User Interface

During the course of the User Incentive award, ODOT, DLCD and CAMPO staff acquired a good understanding of RPAT inputs and outputs and its supplemental value to the CAMPO project and beyond. ODOT Analysis and Planning Staff, along with consultant Brian Gregor actually used the software and/or interacted with model files. Initial use was with the SmartGAP tool, with Analysis staff and consultant eventually completed the reported model runs using RPATv1.8. ODOT staff identified the following issues with the SmartGAP/RPAT Graphical User Interface (GUI) software:

- Initial issues with SmartGAP include saving inputs, where sometimes the files appeared to have been saved, but actually were not. This was largely corrected with RPATv1.8.
- The RPAT v1.8 improved GUI made it more difficult to use already prepared files, which needed be to manually copied into the new GUI. This was cumbersome for users, particularly with the NAICS employment file which has a large number of rows and did not allow users to delete rows.
- Both SmartGAP and RPATv1.8 had to be approved for installation by ODOT computer software office. After this approval, installation of the initial SmartGAP model required some script changes to run. The RPAT software was easier to run if installed on the C:\ drive, but would not run properly if installed in the C:\ProgramFiles\ folder.
- Some issues remain with the RPAT install on some computers due to unknown issues. This includes inability to save input files through the GUI and/or complete a model run successfully.
- Detailed SmartGAP Users Guide documentation was lacking. This improved with the release of RPATv1.8. However, some outstanding methodological questions were never truly resolved (e.g.,. 5D place type _relative_values.csv to match 5D-based Oregon place type input ranges for CAMPO), and more information should be provided in the User's guide on some issues (e.g., is "change in walking" trips or miles, and assumed densities for various place types per the place type _relative_values.csv).

These GUI issues are important but did not pose an obstacle to the successful implementation of the tool in Policy analysis (Section I) or comparison of the RSPM-RPAT tools (Section II).

II. RPAT–RSPM Comparison

For the model comparison test, the project team compared RSPM and RPAT functionality to gain an understanding of how the RPAT capabilities can be merged with ODOT's RSPM capabilities. Supplemental FHWA RPAT funding allowed the project team to run nearly 650 scenarios and visualize the RPAT results in a scenario viewer as we have done in CAMPO[7]

Below we document the RPAT-RSPM comparisons, both the choice of scenario inputs tested, as well as a comparison and discussion of the outputs. Key differences between the models that provided challenges in creating comparable inputs as well as comparing model and sub-model or module methods and results are also discussed. Findings from the comparison moving forward into the future common VisionEval functionalities are noted in closing.

SOW for supplemental FHWA Task to build RPAT Scenario Viewer

Task 1: Implement RPAT Sensitivity Testing & Scenario Viewer

- Identify inputs and develop policy bundles for RPAT sensitivity tests
- Modify scripts developed for the RSPM to build a set of RPAT scenarios for comparison to the RSPM scenarios previously modeled;
- Develop scripts to run the many RPAT scenarios and to produce output measures comparable to the measures produced from the RSPM model runs;
- Modify RSPM visualization methods for use with RPAT results;
- Document script changes, and User instructions for building/using the scenario tool

Comparison Test Inputs

The CAMPO 2010 to 2040 "Adopted Plans" scenario from Policy Scenario section previously noted in the first half of this report was used as the reference future scenario for these comparison sensitivity test scenarios. The tests were performed with the RPAT v1.8 and RSPM v3.5 models. Several more ambitious scenarios were considered and tested, with more simplified assumptions than performed for the policy tests. These comparison tests are for illustration purposes only and were created without consultation with CAMPO staff and the MPO TAC.

Figure II-1 notes the policy scenarios tested in both tools. These policies represent more or less ambitious policies than the Adopted Plans base 2010-2040 scenario, which is always represented as Level 1. Each policy noted was run in isolation, such that it was the only change to the base scenario. Additionally, all combinations of these policy levels were also evaluated, resulting in 648 RSPM and RPAT scenarios. Figure II-1 also indicates the input files changed in each module.

[7] CAMPO Scenario Viewer: http://www.oregon.gov/ODOT/TD/TP/Pages/scenarioviewer.html
NOTE: The RSPM-RPAT model comparison involves an updated RSPM version 3.5 and 2040 horizon year for CAMPO, rather than the 2035 RSPMv3.0 scenarios on this viewer.

Figure II-1. RPAT-RSPM Comparison Scenarios Defined (level 1 = reference "Adopted Plans" scenario)

P - Parking (RSPM & RPAT: parking.csv) 1- Base, existing costs ($3.33/day) and proportions (13.9%work/11.9%nonwork) paid 2- Increase parking fee coverage to 20% of work and 20% of non-work 3- Same as level 2 but double parking cost
T - Transit (RSPM & RPAT: transit_growth.csv) 1- Base, supply stays at present level 2- Double transit supply 3- Triple transit supply
B - Bikes/Light vehicles (RSPM by district & RPAT, light_vehicles.csv) 1- Base bike diversion (12% in 2040) 2- Double bike diversion (24%)
D - Demand Management (RSPM: TDM.csv; RPAT: commute_options.csv) 1- Base (3% TDM in RSPM; 5% rideshare/0.9% Telework/1.3%Vanpool/100% subsidy at level $0.75 in RPAT) 2- Double all TDM & Telework participation rates, (no RSPM IMP, no RPAT transit subsidy change)
L - Land Use Growth (RSPM: du_2040.csv, RPAT: place_type_growth.csv) 1- Reference, Adopted Plans growth proportions 2- 25% Sub/Rural pop growth (-1.1%Rur, -5.4%Sub) (no employment change), distribute to CIC (+2.3%) and UC (+4.2%) (S.A. Lvl2)
C - Costs/Pricing Policies (RSPM: costs.csv in 2005$, RPAT: vmt_charge.csv in 2000$; adjust for CPI) 1- Base, no charge 2- 4 cents per mile in 2005$ (less in RPAT 2000$) 3- 8 cents per mile in 2005$
I - Income growth (RSPM: regional_income.csv, RPAT: per_cap_inc.csv) 0- Keep 2010 income constant (in real terms, same purchasing power as 2010) 1- Reference/historic income growth (0.7% CAGR) 2- 1.5x Reference income growth rate (1.1% CAGR)

This input alignment included the following considerations:

- **Dropped Policies not in both models**: (ITS, IM programs, car share, etc.)
- **TDM Alignment**: Assumed RPAT policies of rideshare, vanpool, & telework were equivalent to RSPM work-based TDM policy option.
- **Some RPAT Inputs do not vary by year**. Some inputs, such as the light truck share (Keyvalues.csv) and fuel carbon intensity (fuel_co2.csv) are not allowed to vary over time in RPAT as they do in RSPM, as further discussed in points below.
- **Operating Cost Alignment**: The two models account for costs in different ways. The RSPM accounts for many types of operating costs, including fuel costs, gas taxes, vehicle maintenance and tire wear as well as pricing policies such as VMT fees, PAYD insurance, and social cost recovery (through a carbon tax). RSPM requires the user to specify these costs explicitly for each forecast year. The inputs reflect intuitive values for each component; a mix of $/gallon and

$/mile. With the RPAT, the operating costs are simplified as users specify base year costs in key values (BaseCostPerMile, fuel price, and gas taxes) and an operating cost increase factor for the future year. The base year operating cost is multiplied by the operating cost increase factor to obtain the future year operating cost (in units of $/gallon, not as an annual growth factor). As with the RSPM, the RPAT also allows users to specify a mileage cost and parking costs. These differences made it challenging to set up the base case, and an average MPG from the RSPM runs for each year were required to convert all inputs to $/gallon, and a CPI was applied to move from 2005$ in RSPM to 2000$ in RPAT. The calculations for the CAMPO RSPM and RPAT scenarios are included in Appendix E. To simplify, the comparison scenarios put all new mileage-based fees in the RPAT VMT_fee.csv input file. However, differences noted with the pricing scenario results indicate that the costs may not be correctly aligned. The higher sensitivity to prices by RSPM may indicate that RSPM operating costs are higher or income is lower, producing a tighter budget constraint in RSPM.

- **Different Cost Basis**: RPAT inputs/outputs are specified in 2000$, RSPM in 2005$. An Oregon CPI factor of 0.9 was applied to RSPM 2005$ values.
- **Fuel Carbon Intensity**: RSPM allows for a low carbon fuel policy, being implemented in California and other aligned states including Oregon, which reduces the carbon intensity of the fleet state-wide, without specifying the specific fuel mix, required in RPAT inputs. The inputs to RPAT were adjusted to try to account for this, but it is not an ideal solution. Additionally, carbon intensity should be allowed to vary by year to represent differences in fuel sources (e.g., greater mix of Alberta Tar Sands).
- **Vehicles**: Inputs differ,
    - RPAT uses Federal CAFE standards MPG by sales year combined with an assumed vehicle age/ turnover rate, with no considerations for electric vehicles, while RSPM calculates MPG from power train mix (ICE, EV, etc.) along with sales year and user-specified year-specific vehicle age/turnover rate.
    - Additionally, percent light truck varies by year in RSPM, but RPAT only allows 1 value for both years in KeyValues.csv. Light truck share has a large impact on GHG emissions and ODOT's vision for meeting GHG goals assumes a large decline in light truck shares.
- **Place Type parameters**: Further comparison of the TAZ-level data place type attributes could be performed to determine if changes to the place_type_relative_value.csv parameter file that better reflect the implied 5D values would improve consistency.

It is important that some of these definitional issues (e.g., well-to-wheels carbon intensity rather than tank-to-wheels) are included in the RPAT Users Guide.

The number of scenarios resulting from all combination of the policies noted in Figure II-1 is quite large, and can be calculated as the product of the options for each policy (e.g., 2 land use x 3 transit x 2 bike, etc.). The resulting 648 comparable policies were run in both the RSPM and RPAT models. To do so efficiently, a process used in RSPM was adapted for RPAT and used by both models. The process specifies a folder format for housing the policies of interest. Scripts then run a process of building all the scenarios in their correct file structure, and then running these many scenarios in an automated fashion

(e.g., overnight), concluding with running a summary script to compile the outcome of all the runs into a single CSV file. This effort is necessary to provide the hundreds of model runs used in the web-based interactive Scenario Viewer, which has been valuable in letting individuals explore the many model results and tradeoffs among policies. The RPAT version of this code was developed with supplemental FHWA funding outside the C16 User Incentive award**.**

Comparison Test Outputs

A set of 12 common outcomes, shown in Figure II-2, were compared across the two models in the 648 scenarios tested. That meant aligning the output units of each model to make them as consistent as possible. This output alignment included the following considerations:

- **Totals vs. Deltas**: RSPM results are for a specific year, and any trends over time need to be computed by the users. RPAT outputs are a mix of single year outcomes and base-to-future year changes or "deltas". This is more properly documented in the RPATv1.8 user's guide, but can be confusing. Part of why that occurs in RPAT is due to the need to apply post-model elasticities to adjust the outcomes for land use place types.
- **Different populations**: Many measures were evaluated on a per capita basis, to avoid differences in the population evaluated (e.g., RSPM has separate inputs for University Group Quarters and light duty commercial vehicles). Likewise, most measures compared only household activity and vehicles.
- **Limited to household vehicles**: For GHG emissions & fuel consumption RPAT includes household vehicles only, for comparison RSPM was restricted to household vehicles as well, not reporting on commercial light duty vehicles (LDV) and heavy duty vehicles (buses and heavy freight trucks) in the comparison results. Commercial vehicles are pulled out separately in RSPM to address the unique opportunities for fleet vehicle GHG reduction strategies.
- **Not in both models**: Couldn't compare measures that are only included in one model (e.g., RPAT's Transit Trips, Accidents, and Accessibility measures)
- **HH travel costs not comparable**: RPAT user cost output combines auto operating costs and the less solid travel time cost, assuming a monetary value of time (not clear of value used). Since RSPM does not currently output travel time costs, we were unable to compare this outcome that has proven valuable to community use of the tool. By not reporting household costs, we could avoid the need to use CPI to align RPAT 2005$ and RSPM 2000$.
- **Different GHG definitions:** RPAT uses EPA tank-to-wheels GHG vs. RSPM well-to-wheels, although it was easy to copy RSPM's well-to-wheels carbon intensities into the RPAT input file, as done in these tests.
- **Stochastic model noise:** Both models include stochastic elements, such as randomly choosing the percentage of households enrolled in the TDM program. RSPM has been modified to enable the user to set a random seed. By re-using the same seed, the same households will be chosen. This reduced the impact of choosing a large household in one run, and a small household in another run.

Given the many differences and compatibility challenges in aligning the inputs, methods, and outputs of the two models, we accepted that all issues would not be resolved in this effort. Thus, our goal was to document how the models differed and go beyond checking absolute numbers, to identifying whether the results would affect decisions. This is particularly important as we attempt to merge the unique functionality of the various tools into the VisionEval common framework project.

The scenario outputs from the two models are compared in three different ways as noted below:

1. **Reference Case Outcomes** (table): Figure II-2 identifies the base scenario comparable outcomes of both models. This serves as a check for differences in the absolute values of the models results. As a strategic model and given the issues in aligning inputs, outputs, and methods, this is less important than the relative magnitude and ranking of the scenarios explored in the other measures. However, since GHG in particular may be reported for inventory purposes, the models should be compatible, and their differences understood.
2. **Relative Impact by Outcome** (Bar Charts): Figure II-3a through Figure II-3d identify the relative impact of the various policies on a certain outcome, where policies are represented by bars, their impact by the size of the bar, in any "outcome" chart. We have grouped them into topic areas to facilitate the discussion of results below. In each chart, a pair of bars is shown, one for each model. The bar represents the percentage difference between the reference scenario and the most ambitious policy level. When looking at these charts, similar ranking or ordering of the policies' effectiveness in a particular outcome indicates similar responsiveness in the model, and would lead to the same policy decisions being made, even if absolute values outcomes of the models differ. We have found these type of bars helpful in policy discussions, as stakeholders may differ in their desired outcomes, and thus gravitate towards different policies (e.g., pricing is most effective for GHG reduction, but transit service is most effect in reducing household costs). The user should take note of the x-axes in these plots as they are not held constant.
3. **Range of Outcomes from Combination Policies** (Box & Whiskers plots): Appendix A, Figures A-1 through A-12 identify the range of outcomes after running all the policy combinations from Figure II-1. These 648 scenarios in each model were combined into the box and whisker plots of Appendix A. Each sheet represents a certain outcome, and the set of sub-charts, indicates the impact of the seven policies on that particular outcome. For instance, Bike policies can be run in isolation or in combination with other policies. All the scenarios that included the "level 2" bike policies are encapsulated in the "level 2" box and whisker plot of the bike sub-plot. The y-axis shows the normalized values of the measure where 0 represents the mean value for all scenarios and each unit represents one standard deviation from the mean. Normalized values are shown to make it easier to compare the policy sensitivity of the models. As exemplified in the chart legend, each box and whisker plot shows the distribution of normalized values for a measure for all scenarios matching the specified policy condition (e.g. "level 2" bike policy). The box shows the range of values in the middle two quartiles. The heavy line dividing the box shows the median value. The whiskers show the extent of the range of values. The user should take note of the x- and y-axes in these plots as they are not held constant.

Figure II-2. 2010-2040 CAMPO Adopted Plans Reference Scenario, RPAT-RPSM Outcomes compared

Measure	RSPM	RPAT	PctDiff
Share of Population in Urban Mixed Use	16%	22%	39%
Walking 2010-2040 Percent Change	1.8%	1.1%	-39%
Daily VMT Per Capita	25.1	20.8	-17%
Annual Emissions Per Capita	1.36	1.77	30%
Emissions Per Mile	149	233	57%
Annual Fuel Gallons Per Capita	151	159	5%
Average Miles Per Gallon (DVMT/daily gallons)	60.6	47.9	-21%
Daily Vehicle Hours of Delay- LDV	5,719	1,888	-67%
Daily Vehicle Hours of Delay- HD Truck	193	13	-93%
Annual Vehicle Hours of Delay Per Capita - LDV	24.6	8.9	-64%
Average Speed - LDV	23.7	24.3	2%
Average Speed - HD Truck	23.6	24.9	5%

Note: Values reflect Household activity only unless otherwise noted (excludes university GQ and commercial service light duty vehicles in RSPM, and heavy duty vehicles in both models)

The results have been grouped in the discussion below to combine related outcomes. It should be noted that this comparison is based on a quick review of the two models, including a cursory look at their methods as scripted. A more detailed review is recommended to confirm these comparisons/findings before making any changes to the models.

Share of Population in Urban Mixed-Use Neighborhoods

Mixed use, Transportation Options, and multi-modal investments and policies build off land use as characterized in the two models. The scenario inputs for both models were aggregated versions of the same travel analysis zone (TAZ) level land use scenarios. The results differ because of how the models represent land use and how they account for the effects of land use policies on travel behavior. Both models use common NHTS-estimated auto ownership and DVMT modules where population density and mixed use are dependent variables and/or interaction variables.

The RSPM calculates population density at the district level, based on the population that results from applying a housing allocation module that meets user specified population, dwelling units by type, developable acres by district, along with a base year district calibration factor that tries to locate households within districts with historically similar income patterns.[8] Given the population and acres by district, RSPM calculates population density and uses the NHTS Claritas definition of urban mixed-use neighborhoods to estimate the mixed use proportion from the district's population density (no employment in RSPM).[9]

[8] The housing allocation model assigns households to districts based on the characteristics of the user specified dwelling unit types in the district (e.g. single-family detached, multifamily) and a calibration factor set to match base year user-specified (census) income and household size by district. This calibrated income weighting factor allocates households to districts that more closely reflect their income characteristics..

[9] The RSPM also enables an "overwrite" function where users can directly specify the proportion of households in each district who live in an urban mixed use neighborhood. The default is for RSPM to calculate the proportion

RPAT treats land use differently; user land use inputs characterize the share of population in various place types (a combination of area types and development type), where the latter includes the designation of mixed use developments. Not a lot of guidance is given for the definition of these types in the RPAT Users Guide, despite adjustments for density along with the other "5D" built form variables by place type in the "place_type_relative_value.csv" parameter file. ODOT's use of a more data-driven approach to building place type inputs for RPAT, which also used 5Ds criteria as noted in Section I, might be a useful way to impose more consistency between user place type inputs and RPAT's 5D assumptions. Simulated households within RPAT are assigned to area types using a module that is sensitive to various household characteristics, but are randomly assigned to development types.

Regarding the mixed use values in the model, Figure II-2 shows that the RSPM housing model-based allocation calculation assigned 16% of the population to urban mixed-use neighborhoods while per RPAT's user-specified place type inputs (base year and growth increment specified separately) assumed 22% of households were allocated to mixed-use development types (in either regional center or close-in-community area types), a difference of 6 percentage points, which seems large given they were built off the same data. The lower mixed use percentage in RSPM is probably due to the following model differences:

- The RSPM in its default mode, estimates the percentage of households in each district living in a mixed use neighborhood using a sub-model in which district population density is the predictor variable; and,
- RPAT relies on user inputs of the proportions of population by place type to determine what households are located in mixed use neighborhoods.

Overall, use of data-driven place types, as created for Oregon under this User Incentive award, provide the opportunity to include more variables in the mixed use designation than just the population density used in RSPM, such as factors related to employment and other 5D effects.

When looking at the sensitivity to policy inputs (Figures II-3a and A-1), it can be seen that only land use and income "policies" have an effect on the estimated mixed use percentages. Given that urban mixed use population is determined fairly directly by inputs in either model, it makes sense that land use inputs have the largest effect. The greater responsiveness of the RSPM is a consequence of how the allocation of population affects district population density and how that in turn affects the calculation of the mixed use proportion. The different income responses of the two models are small but interesting. The results for the RPAT test (Figure II-3a) show a small decline in the mixed use proportion with increased income, while the results for the RSPM test show a slight increase. These results may be a consequence of the different sub-models the two tools use to assign households to place types (RPAT)

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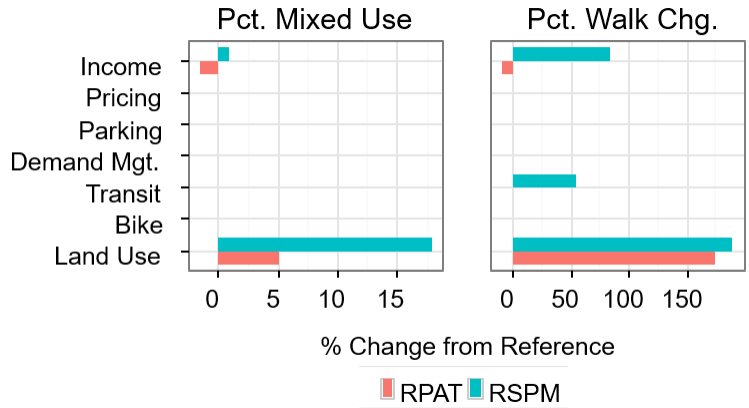
based on population density, as done in these comparison tests. If the RSPM "overwrite" function had been used to "fix" the mixed-use proportions consistent with the RPAT input place type proportions, then it is expected that the mixed use response to land use inputs would have been much more consistent.

or districts/housing types (RSPM housing allocation module). However, the stochasticity of the models also plays a significant role as can be seen by examining Figure A-1. The variation within each grouping (height of two quartile box) is much greater than the variation between groupings (mean "line" of each model).

Figure II-3a Model Comparisons – Mixed Use & Walking



Walking

The sensitivity of the walking outcome to land use and income policies (Figure II-3a) may also reflect the different RSPM and RPAT land use approaches. The land use policy impact on walking, with RSPM being slightly higher, is fully consistent with the mixed use findings noted above. However, walking shows notable differences between the two models in their responses to transit and income. The differences in response can be explained by the different ways that these models calculate the number of walk trips. RPAT uses a table of base level trip rates and then adjusts the values as a final step using place type elasticities. The RSPM uses a two-part (Hurdle) method estimated from the 2001 NHTS datasets to predict the number of walk trips;[10] both have income as a dependent variable along with urban mixed use land use designation.

The sensitivity to policy inputs differs between the two models as shown in Figure II-3a, and A-2:

- **Income**. The RSPM results indicate that walking increases with income, counter to the negligible decline observed in RPAT. This may seem counterintuitive, but surveys consistently show that lower income households make fewer walk trips. This has been attributed to a number of factors including lower income neighborhoods having lower access to destinations, lower income households having less discretionary time, lower income households having less discretionary income (reducing the demand for travel), and potentially cultural/social preferences. Unfortunately, it appears that people in low income households who could benefit health-wise from walking, have historically been less likely to engage in it.[11] If this NHTS-based relationship estimated in RSPM holds, the approach of tying walking impacts to the combined land use and income attributes would better reflect walking behaviors expected from expensive new urban mixed-use developments that reflect a different income mix than traditional multi-family housing in similar mixed use neighborhood densities. This will be of keen interest to the ongoing ODOT research on mode shifting in RSPM.
- **Transit**. The RSPM effect of transit service on walking, not observed with RPAT, is indirect. Although the level of transit service is not a variable in the RSPM walk sub-models, it is a

[10] The first part of the RSPM walk model uses a binomial logit model to predict whether any walk trips would be taken by the household on any particular day. The second part uses a linear model to predict the number of walk trips if any that were taken. Income has a positive sign in the logit model and a negative sign in the linear model.
[11] http://www.bms.com/documents/together_on_diabetes/2012-Summit-Atlanta/Physical-Activity-for-Low-Income-Populations-The-Health-Trust.pdf

variable in the auto ownership module with the resulting ratio of household vehicles to drivers included as a variable in the walk sub-models. Since the signs of the parameters for these variables in the auto ownership and walk modules are negative, an increase in transit service leads to an increased amount of walking. The RSPM response that the level of transit service positively affects the amount of walking seems logical.

Overall, the consequence of the greater responsiveness of the RSPM walk module to income and transit as well as the land use response found in both models, likely explains the larger 2010-2040 change in walk trips predicted by RSPM relative to RPAT (1.8% to 1.1% per Figure II-2).

DVMT

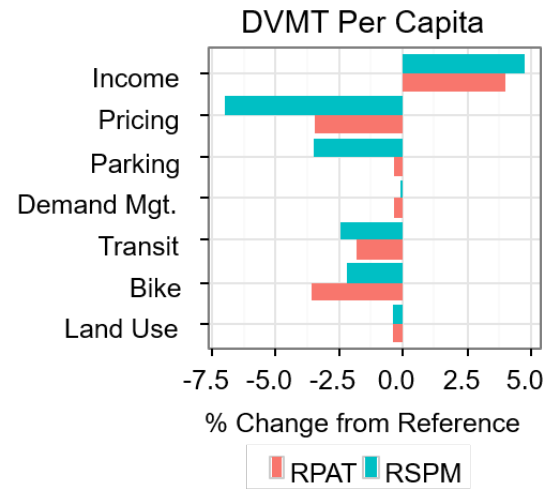
Daily VMT Per Capita is within 20%, or 5 miles per person higher in RSPM than RPAT in the base scenario comparison of Figure II-2. It should be noted that this comparison only includes household DVMT, which is the only light-duty DVMT that the RPAT models. RSPM also models commercial service DVMT and the DVMT of group-quarters populations (e.g. university students), but those DVMT numbers were excluded from the comparison to make the results more comparable. The difference in household DVMT predicted by the two models is larger than expected but not unreasonable given several key differences in how DVMT is modeled and how costs are accounted for.

There are key methodological differences in how the two models account for the effects of land use on travel. In both models, population density and urban mixed-use characteristics are variables in the household vehicle ownership and DVMT predictions. However, all RPAT households are assumed to be mixed use and assigned the same population density (a low value of 500 persons per square mile) for the application of the auto ownership and DVMT modules. This fixed land use assumption for all households is thus used in several sub-models including the auto ownership, DVMT, light truck vehicle type module, and the budget module. After all the modules are complete, the last step in RPAT is to adjust the baseline DVMT and other outcomes using elasticity factors which vary by place type. This "average" land use assumption combined with waiting until the end of the module chain to apply elasticity adjustments has a significant impact on a number of outcomes.

Similarly, although both models apply the same budget module that adjusts household DVMT to reflect costs, RPAT does so before place type elasticity adjustments are made to the DVMT. Thus, RSPM is budget sensitive to the specific household's density and urban mixed use characteristics. In the case of the RPAT, the budget adjustment is made after the household's base DVMT has been modeled using uniform density and mixed use assumptions (as described above) but before the DVMT has been adjusted using the place type elasticities. The different ordering for applying the budget module could have contributed to the RPAT's lower DVMT predictions.

The budget module may also be impacted by differences in how the two models treat costs and income forecasts. The two models also account for costs in different ways, as noted with scenario inputs above. The different accounting methods made it challenging to develop equivalent cost-related inputs for the two models. The higher sensitivity seen in RSPM to pricing/parking fee policies, as shown in Figure II-3b, could be due to higher costs assumed in the RSPM scenarios, or lower RSPM incomes relative to RPAT, both making household budgets tighter. Working against this effect, the travel costs faced by household in the budget module reflect the vehicle characteristics, notably the assumed vehicle MPG. As noted in more detail in the Speed-Delay outputs below, the RSPM scenarios assume higher MPG than the RPAT scenarios in later years. This would tend to loosen the budgets in RSPM, as more miles could be driven for the same cost with a higher MPG vehicle.

Figure II-3b Model Comparisons – DVMT/Cap



Given the differences in how the models treat costs, it is not surprising that the responses of the models to cost-related scenario inputs are significantly different. The RSPM model is more sensitive to mileage-based pricing and much more sensitive to parking pricing scenarios. This seems to reflect more constrained budgets in the RSPM scenario -- higher costs relative to income. This can also be seen in the higher sensitivity to income in the case of the RSPM model.

The two models are more similar in how other policies affect DVMT (Figure II-3b and A-3):

- **Land Use**. The land use responses of the two models are almost identical despite differences in how the models treat the effects of land use.
- **TDM**. Both models show very low response to employer-based demand management strategies. The differences in the responses of the two models are probably a result of the different ways in which these demand management programs are characterized by the models, which makes it difficult to align the scenarios. The RPAT characterizes employer-based demand management programs in much more detail and the effects are sensitive to place type, where RSPM applies a simple 5% reduction to all participating households DVMT. RPAT does not address household-based individualized marketing programs (assumed to have a 7% reduction in participating household VMT) so that policy was not included in the comparison tests.
- **Transit**. The RSPM response of DVMT to transit service is slightly higher than RPAT. This is probably due to the RPAT's use of uniform (low) densities in various modules with adjustment for place type not occurring until the last step. The zero-vehicle auto ownership module common in both tools intersects population density with transit service. By using low population densities, RPAT dilutes the responsiveness of zero-vehicle households and the subsequent DVMT module to transit service.

- **Bicycles/Light Vehicles**. RSPM's lower DVMT sensitivity to bicycle policies is also affected by RPAT "average" land use assumptions, but the effect is the opposite of the transit policies noted above.[12] Both tools use a common bike SOV diversion module to calculate bike miles to be removed from the household base DVMT. RPAT, by assuming mixed use and a fixed low population density for all households without adjusting for place type until later, dilutes the effect of the NHTS-estimated module. To further complicate things, the functional form of the SOV diversion module calculates the net impact of a density term and an interactive density-mixed use term, and the effect varies with tour length. Thus, it is unclear if the same relative responsiveness between the two models would be repeated given different inputs.

Delay and Speeds

The average light-vehicle and heavy truck speeds calculated by the two models are fairly close, but the calculated delays are more substantial as shown in Figure II-2 comparison of the base scenarios. RPAT estimates average speeds of light and heavy duty vehicle that are about 2 and 5 percent higher respectively. This most likely reflects differences in estimated demand rather than the differences in the congestion modules. RSPM assumes light duty DVMT from university Group Quarters and commercial service vehicles, in addition to the household DVMT and metropolitan area heavy-duty vehicle DVMT generated in both tools. This results in more demand for the same road miles input, and was calibrated to match HPMS demand on metropolitan roadways. A modification of the "HhDvmtToRoadDvmt" factor in the keyvalues.csv file might provide a way to account for this additional demand, but this was not done in the comparison runs.

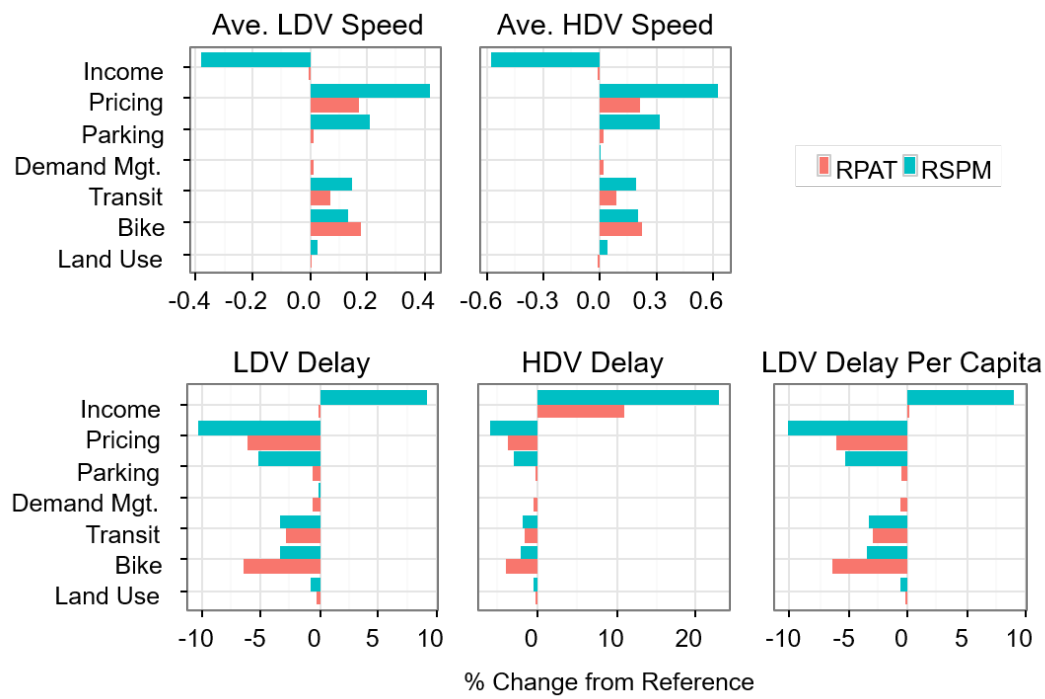
More pronounced than the 2-5 percent speed difference is the estimated total hours of delay which are higher in RSPM by 67 percent and 93 percent, for light and heavy duty vehicles respectively. This discrepancy in the relative differences in speed and delay is due to the way in which delay is defined and calculated. Delay is the difference in travel time between traveling at the congested speed and traveling at a reference speed; usually the free-flow speed. This makes the "percent" delay response to a change in speed very non-linear; large percentage changes in delay occur near the reference speed, and smaller percentage changes at speeds far from the reference speed. This greatly amplifies the seemingly small percentage differences in speed. The non-linearity of the response of delay to speed (in both models) makes proportional differences in delay a questionable measure to be using for comparing models or scenarios when the amounts of delay are small as is shown in Figure II-2 for annual light-duty vehicle per capita delay. The RSPM annual value of 24.6 hours is equivalent to about 61 seconds per household trip (about the time spent waiting at one traffic signal) while the RPAT annual value of 8.9 hours is

[12] The bicycle model calculates the amount of bicycle travel as a substitution for single-occupant vehicle (SOV) travel that occurs within a specified tour length threshold. The user specified input sets the level of diverting single-occupant vehicle travel to bicycle travel within a specified tour length threshold. Both models include the same sub-model for predicting the amount of qualifying single-occupant vehicle travel for each household. The calculated mileage to be diverted is then subtracted from the household's DVMT. An unfortunate consequence of this model approach is that the greater the SOV travel predicted for a household, the greater the reduction in household DVMT.

equivalent to about 22 seconds per household trip.[13] The Texas Transportation Institute Urban Mobility Report is a good reference for gauging current delays for a community and if the %delay from the RPAT/RSPM models is applied to these values a future value can be created and compared to other cities in the TTI report for context.

The responses of estimated speed and delay to policies of bike, transit and pricing/parking fees of Figure II-3c and A-4 through A-7, largely reflect the tool differences in the DVMT outcome noted earlier. The one exception is the sensitivity to income policies, where the RSPM response is much larger than observed with DVMT output and RPAT's speed and delay impact from changes in income is minimal. This asymmetrical response is most likely a result of the higher level of congestion estimated by the RSPM and the highly nonlinear asymmetrical response of congestion to changes in traffic volume (e.g. in traditional volume-delay curves). Congestion and the consequent delay increases at an increasing rate as traffic volume increases. Therefore it is not surprising that the relative income response, which increases traffic volume, is much greater than the relative cost response, which reduces traffic volume.

Figure II-3c Model Comparisons – Speeds & Delays



Vehicle Emissions & Gallons

GHG Emissions is an important output of both models. Although there are several similarities in how both models address emissions, owing to their GreenSTEP roots, there are also several notable differences. Both models address aspects of household vehicles and fuels that prevailing travel demand

[13] Assuming 365 days per year, 2.5 persons per household, and 10 trips per household per day.

models don't address but are important to the calculation of GHG emissions. These include the modeling of:

- light-duty vehicle types (autos vs. light-trucks)
- vehicle ages
- vehicle miles per gallon (MPG) or fuel economy variations by vehicle type and age
- types of vehicle fuels that are used
- carbon intensities of various fuels

These are important considerations because the characteristics of vehicles and fuels have some of the largest effects on GHG emissions, can be substantially affected by public policies, and can affect households differently. The two models differ most notably in how they address different types of vehicles (powertrains in RSPM) and fuel carbon intensities.

Regarding vehicles RSPM recognizes four types of vehicle powertrains: internal combustion engine powered vehicles (ICE), hybrid electric vehicle (HEV), plug-in hybrid electric vehicles (PHEV), and electric vehicles (EV). The user defines key characteristics of these vehicle types by sales year, such as MPG (or MPk, miles per kilowatt-hour for electric vehicles) of each powertrain type, as well as the distance an EV can travel on a fully charged battery. The key market input by the user is to specify the proportions of each powertrain type and vehicle type (auto vs. light trucks) purchased by sales year. Vehicle turnover assumptions control the rate of vehicle purchases by households. In contrast, RPAT has a similar user input to specify the proportions of each vehicle type (auto vs. light trucks) purchased by sales year. However it only considers ICE vehicles and the default data that is packaged with the RPAT includes MPG data consistent with the latest EPA/NHTSA MPG standards (CAFE), but don't specify any MPG improvements after 2025, in contrast to the continued drop in MPG over time assumed in the RSPM scenarios to achieve state GHG reduction goals. Additionally light truck share, which has a significant effect on MPG is specified differently in the two models. Although both models establish different MPG by vehicle type (auto vs. light truck) and vehicle model year, RPAT doesn't allow users to assume a change in the light truck proportion over time. If other powertrain vehicles are to be considered in a scenario, the user needs to preprocess the MPG inputs to account for the relative MPG of different vehicle powertrain types.

Another key difference between the models is the fuel and emission usage during congestion. The older RPAT congestion module assumes a relationship between speed and fuel economy based on historic data for ICE vehicles. The newer module in the RSPM is based on modeling the fuel usage of the specific vehicle types using the Environmental Protection Agency's PERE model, including HEV, PHEV, and EVs, which have very different responses to congestion. For example, stop-start capability in electric or hybrid vehicles can almost eliminate idling emissions.

Regarding fuels, both models have users specify several important aspects about fuels including the proportions of different fuel types used (e.g. gasoline, diesel, ethanol, biodiesel) and the carbon intensities of fuels, which vary depending on fuel type, the source, and how it is produced. However, RSPM takes a "well to wheels" approach, which means that the calculated carbon intensity of a fuel

includes the emissions produced by extracting, refining, and distributing the fuel as well as the emissions produced by burning the fuel to power the vehicle. RPAT adopts the EPA definition of "tank-to-wheels" carbon intensities (which don't include emissions from fuel production, refining, and distribution), as the default unless modified by the user (as done in the comparison scenarios). Additionally, to simplify policy inputs in RSPM users are allowed to specify a single "composite" fuel type and its associated carbon intensity. This approach is useful for estimating the effects of low carbon fuels regulations that specify the average carbon intensity of fuels sold by distributors and don't specify the types of fuels to be sold. Without this function in RPAT, the user needs to carefully preprocess the carbon intensity inputs to account for the relative carbon intensities (which as a case in point was done incorrectly in the comparison runs, with the primary impact on HDV which are not being compared). Finally, for vehicles that consume electricity for some or all of their travel (PHEV and EV) the RSPM counts the emissions from producing and distributing the electricity that is consumed. Since RPAT assumes only ICE vehicles, no electricity usage or associated GHG emissions are calculated. This would not affect the comparison of fuel gallons between the two tools, but would have some effect on GHG emissions.

These differences account for the energy use and emissions variations of the two models as shown in Figure II-2. The estimates of annual fuel consumed per capita are quite close, within 5 percent, the effect higher DVMT of the RSPM model is offset by lower MPG assumed in the RPAT model inputs of the horizon year. This can be confirmed by multiplying the ratio of MPG by the ratio of DVMT in the two scenarios.

Although the per capita fuel consumption estimates of the two models are fairly close, the per capita GHG emissions estimates are more divergent. This reflects different assumptions about fuel carbon intensities used in the respective model runs as noted above, and is reflected in the larger proportional difference in emissions per mile than in miles per gallon (57% vs. 37%, respectively from Figure II-2). The net overall difference in carbon intensity (emissions per gallon) between the two models is about 24%. The carbon intensity input differences are countered by the different inventory approaches (well-to-wheels vs. tank-to-wheels). On the one hand, the use of the well-to-wheel accounting method by the RSPM increases carbon intensity estimates over what would be the case if the tank-to-wheels approach of the RPAT was used. On the other hand, the RSPM scenarios assume that carbon intensity will decline over time in line with Oregon's low carbon fuels regulations. The RPAT can't easily account for that since its carbon intensity is a base year only parameter that varies by fuel type but not by year.

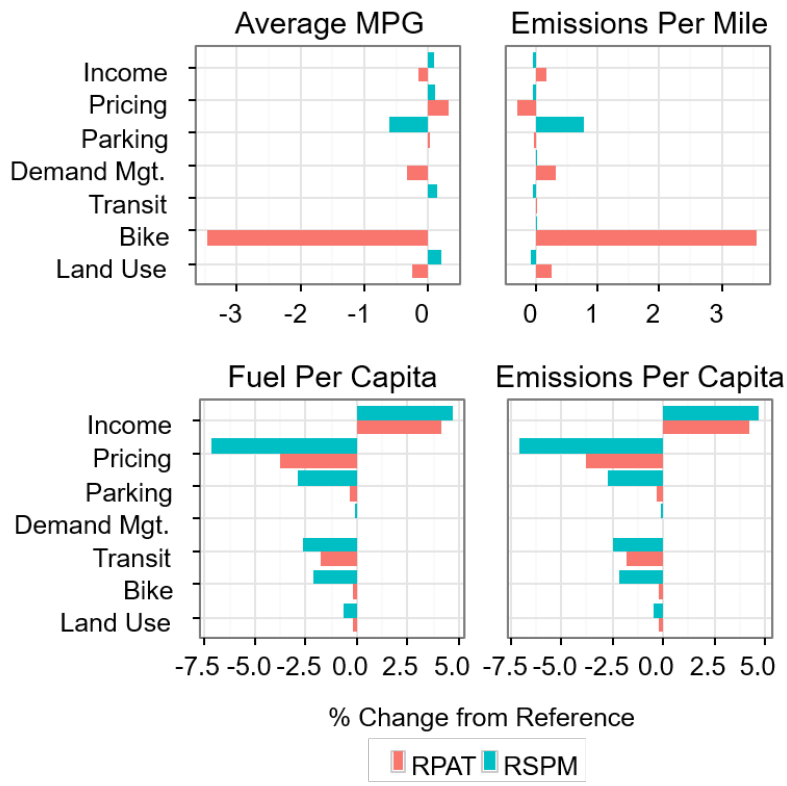
Other differences in how the models address vehicle types make it difficult to compare the results.

- RSPM enables users to specify different light-truck proportions for the future year whereas the RPAT does not.
- RSPM scenarios assume that about 6 percent of vehicles sold in 2040 will be either EVs or PHEVs. The emissions of these vehicles are counted based on the estimated electricity consumed. This cannot be accounted for in the RPAT.

To do comparable runs for the RPAT and RSPM, the RSPM would have to be set up with the inputs used in the RPAT. This could be done, but the results would not reflect the policy assumptions in Oregon and the Corvallis area.

Figures II-1d and A-9 through A-12 highlight differences in how the models predicted energy and emissions outcome, and intermediate outcomes of MPG and emission rates respond to various policies. These reflect differences in the vehicle and fuel inputs noted above, as well as related modules (e.g., DVMT and budget modules). In most cases the direction of the policy responses is the same. In many cases, the ordering of policy effects is also the same. However, the magnitudes of effects are often different. The most notable differences in policy responses include the following:

Figure II-3d Model Comparisons – Vehicle Emissions & Gallons



- **Bicycles/Light Vehicles**. The difference that most stands out is the effect of bike policies in the RPAT runs on MPG and emissions per mile, with almost no effect observed in the RSPM runs. Figures A-9 and A-10 show that this is clearly a model effect by the tight distributions of RPAT model run results in the "Bike" boxplots. The reason is unclear and warrants further investigation. Perhaps the reduction in DVMT from the RPAT SOV diversion module (noted above) in conjunction with the place type adjustments differentially affect the amount of DVMT by vehicle age, with greater reductions in DVMT by newer vehicles. This would reduce the average fuel economy of the fleet. It is unlikely that the effect is due to a congestion response because, as Figure II-3b shows, the RPAT pricing policy has almost the same effect on DVMT, but almost no effect on fuel economy. The resulting negative effect of bike policies on fuel economy in the RPAT model results attenuates the positive effect of bike policies on total fuel consumption and reduction in household emissions. The RPAT shows an almost 2.5 percent reduction in fuel consumption and emissions, whereas the RSPM results show almost no reduction. The small RSPM response seems more sensible. More testing and examination of the simulated household results should be done to gain a better understanding of how the bicycle module affects fuel economy in the RPAT.
- **Pricing/Parking.** There are significant differences in the total emissions and fuel consumption responses of the two models to pricing and parking policies. This mostly reflects the differences

in how the models estimate the effects of these policies on household DVMT, and the challenge in creating equivalent household cost assumptions in the two models (noted above). However, parking policies in the RSPM noticeably reduce fuel economy and increase emission rates, which is surprising. This can be seen in Figure II-3d, and the tightness of the distributions in Appendix Figures A-9 and A-10 confirms that this is a model effect, not a stochastic effect. This result may be due to the differential effect of cash out policies (employees are charged for parking but get a rebate in their pay checks) on different income groups. In theory, the model should reduce DVMT with cash out policies, as incomes rise with the reimbursement and budgets shrink by an equal amount only if parking is continued.[14] More testing of RSPM is needed to determine conclusively why parking policies cause the fuel economy and emission results to behave in this way.

- **Income.** Although the models both show very small effects for income on fuel economy and vehicle emission rates, the effects are opposite in direction (Figure II-3d). The RSPM shows increasing income leads to increased MPG while the RPAT shows the reverse. The differences between the models may be a result of differences in the interactions between the vehicle turnover rate module, the assumed MPG (by powertrain mix in RSPM) by vehicle model year, and the congestion module and its effects on MPG. In the case of both tools, as household incomes increase and turnover rates increase, households purchase newer vehicles. If vehicle MPG is assumed to decrease with vehicle age, then rising household income will result in improved fuel economy. However, as noted previously, the RPAT fuel economy assumptions do not increase after 2025, consistent with the current EPA regulations. However, ODOT's RSPM model scenarios assume continued improvements in fuel economy after 2025, consistent with state policy. Therefore, the RPAT will show less of a positive income response on fuel economy.

  The different RPAT and RSPM congestion modules may also contribute to the different income responses. In both tools, high incomes result in more congestion (see above), but the energy and emission impact of congestion is very different between the tools. The older RPAT congestion module assumes a relationship between speed and fuel economy based on historic data for ICE vehicles that result in much higher fuel consumption at lower speeds (in part due to idling losses). The newer RSPM congestion module recognizes that the future relationship between fuel economy and speed will not be like the past relationship, particularly for electric vehicles and hybrid-electric vehicles (which can almost eliminate idling losses). With the old module, increasing congestion has a negative effect on fuel usage and resulting model-wide average MPG.
- **Land Use/Transit**. The models also differ, although to a lesser extent, in their energy and emissions responses to land use and transit. The MPG responses of the two models to more aggressive land use policies are opposite (but small). The transit-MPG response difference of the

[14] One explanation for the RSPM decrease in MPG with parking is if the income rise is greater than the budget response for the lowest income households, then perhaps the parking policies would result in more DVMT by households that drive older, less fuel-efficient vehicles.

two models is minimal and the resulting variation in total emissions and total fuel consumption is largely the result of differences in the effect of transit policies on DVMT.

Comparison Evaluation and Recommendations

The comparison of the two models has shown that they perform similarly despite a number of differences in inputs, methods, and outputs, highlighted throughout Section II of the document. The comparison looked at the absolute magnitude difference in the model outputs, as well as the more important measure of whether a different decision/action would have been recommended (e.g., ordering of the scenarios). There are a number of areas where merging the functionality of the two models can improve their usefulness for policy applications. There are also other areas which should be looked into further to understand inconsistent results. Following is a summary of key findings from the model comparison. These findings and recommendations are offered as ways to build on the success to date of both tools.

☐ **Model Policy Responses Requiring Further Investigation:**

- RPAT "average" land use (low population density and mixed use designation) was used for all households, in several key modules (auto ownership, DVMT, budget), before elasticities are applied, which seems to distort the modules as estimated and limits sensitivity to the land use.
- RPAT increase in bike policies resulted in a consistent reduction in average fuel economy.
- RPAT did not show an increase in walk trips with transit policies, as RSPM did.
- RSPM bigger pricing/parking impact on DVMT (perhaps resolvable with further work on reconciling costs and incomes between the models).
- RSPM parking policies resulted in a consistent reduction in average fuel economy.

☐ **Opportunities for Better Alignment Between Models:**

- More work needs to be done to figure out how to make costs and incomes consistent between the two models.
- Methods are needed for developing RPAT vehicle and fuels inputs so that they can better reflect advanced vehicle technologies and low carbon fuels policies. One way to increase consistency across tools is to generate an RSPM weighted average MPG by year from ICE, EV, etc. for use in RPAT.
- The Land use allocation process, that assigns mixed use land use location to specific households could user further research. Both models are highly sensitive to the mixed use designation, affecting a large number of the evaluated policies (compact land use, multi-modal investments). It is recommended that further evaluation of the existing methods be reviewed and an improved method be developed that fits the strategic objective of the model and makes use of the richness of the synthetic population and recognizes the complexity of land use issues (dwelling unit type impacts household characteristics like household size and income).

☐ **Features of RSPM that could Improve RPAT**

- RPAT would benefit greatly by adding sensitivity to emerging policies on vehicles and fuels. Electric vehicles are consistently being spoken of as the most likely vehicle technology for moving to a carbon-free future. All the major vehicle manufacturers are developing electric and hybrid-electric vehicles. Since electric and hybrid-electric vehicles have very different fuel economy responses to congestion than internal-combustion engine vehicles, it is very important to the calculation of GHG emissions that they be included. This could be best achieved by adopting the RSPM's approach to vehicles/fuels, combined with the more recent RSPM congestion module (to capture emission differences during idling). Alternatively, a pre-processor could be provided to help RPAT users convert assumptions about future electric vehicle and hybrid electric vehicle sales to fuel economy assumptions (although this would not account for different congestion effects). Additionally, light truck shares should be allowed to vary by year.
- Another important policy sensitivity is that of low carbon fuels. "Cap & Trade" programs and low carbon fuel standards are adopting reductions in the carbon intensity of fuels, without prescribing a specific mix of fuels, which is needed as input to RPAT. In the comparison tests, manual adjustments to the inputs, was a back-door way to implement a low carbon fuel policy. RSPM has simplified this by enabling a "composite" fuel carbon intensity option, which enables easy approach to modeling fuel carbon intensity reductions.
- Incorporating the newer RSPM congestion module into RPAT should be a priority. Ideally, this would need to be done in tandem with implementation of different vehicle power trains (as discussed above). Although the comparison showed that the scenarios are ranked similarly between the two models, the test metropolitan area is small and will not have substantial amounts of congestion. Additionally, the new congestion module allows for additional ITS policies as well as testing congestion fees.
- RPAT might consider adding university group quarters and Commercial service LDV to the current households analyzed in the model, since their travel response to policies and associated emissions differ significantly from typical households. This may improve the congestion module (fuller picture of demand) and enables testing of commercial vehicle/fuel policies that could be implemented locally.
- RPAT might consider adding some of these RSPM policies not currently in RPAT: expanded ITS policies (with RPSM congestion module and vehicle types), car share, EcoDrive and household based Individualized Marketing (IM) programs.
- The following items developed under this User Incentive award, might be useful additions to a broader RPAT Toolkit (or VisionEval), given their interest by others, including those at the October 2015 RPAT Peer Exchange/Training:
    - **Census-based place types.** Consistent criteria-based place types consistent with the place_type_relative_value.csv file would improve tool accuracy. This option is bolstered by the current update of the EPA Smart Location Database to 2015 data.

- **RPAT Scenario Viewer**. The web-based interactive viewer fulfills what IMPACTS 2050 calls for in defining strategic modeling, "many scenario possibilities need to be studied so that a policy or investment strategy that minimizes risk, or moves toward some desired goal(s), can be followed". ODOT has demonstrated in several Oregon communities the value of the viewer in allowing stakeholders and the public to explore hundreds of RSPM results. More work is needed to implement the proof-of-concept viewer (https://github.com/gregorbj/RPAT) developed in association with this User Incentive award, using RPAT model data.

☐ **Features of RPAT that Could Improve RSPM**

- Beyond use of place types as a "language" for land use planning, ODOT is interested in adding place types to the RSPM with the switch to VisionEval. It will replace the current 3-placetype land use inputs. The inputs will continue to be at a district level, and initially inform just the Transportation Options programs. The exact functionality has yet to be worked out, and may involve adding employment information to the synthetic household, including work location place type. Any additional borrowing of RPAT place type policy impacts need to reconcile Oregon place type 5D values with the 5D adjustments in RPAT.

  The ability to join the NHTS and EPA Smart Location Database (SLD) and re-estimate VisionEval modules with place types as variables rather than post-processed elasticities is likely to be a better approach. It could be put to use immediately in ODOT's currently funded RSPM mode shift research effort being carried out by Portland State University. This depends on acquiring the joined NHTS and SLD data.

- The RPAT employment module may be useful for some of the future planned enhancements to the RSPM. These include making TDM policies a function of work place location and making commercial service vehicle travel a function of employment. The keen interest by communities in adding intercity travel and associated policies might begin to be addressed with an assigned job location. The RPAT job-accessibility measure is also of interest.

- The RSPM model assigns a fixed proportion of DVMT to local roads (i.e. not freeways or arterials). The RPAT adjusts the local road proportion to reflect the "connectedness" of the local road system. That approach is more consistent with research on the relationships between the design and use of the local road system.

- The RPAT includes some additional measures that would be good to include in the RSPM including the estimation of accidents, job accessibility, transit trips, and transit capital and service provision costs. Additionally, although RSPM has some measures of roadway infrastructure costs (modernization and Operations/Maintenance), they were not compatible, and so RPAT values were used. ODOT would like to harmonize and borrow the RPAT values to improve this outcome measure in RSPM.

Overall, both models yield similar results regarding the relative effectiveness of policies for reducing GHG emissions. To tackle GHG reduction in the transportation industry requires significant changes to our vehicle fleet as well as pricing the externalities of vehicle travel. The former has the added

significant benefits to air quality and safety. The latter can provide some much needed revenue to maintain the 1950s roadway network we've established and more effectively implement many of the proposed multi-modal investment strategies that can lead to lower travel costs when auto ownership declines and increases health with more active mode use.

Some other policies don't have nearly as much effect. In particular, land use policies and travel demand policies produce relatively little effect. The relatively small effect of these policies is the result of two things: 1) the amount of change to the travel of affected households is small, and 2) the number of affected persons is relatively small. While compact land use has a demonstrable effect on VMT, very large changes in population density and land use mixing are necessary to achieve substantial reductions in VMT (as has been documented in TRB Special Report 298).[15] At the high end, when increased density is matched with mixed use development, pedestrian-oriented design, and good accessibility to destinations, a doubling of density might produce as much as a 25 percent decline in VMT, and consequently about a 25 percent decline in fuel consumption. In contrast, a doubling of fuel economy will cut fuel consumption almost in half. Moreover, unless an urban area is rapidly growing and the populace is willing to have substantial portions torn down and rebuilt to create a higher density mixed use development pattern, the degree of effect and number of people affected will not be that great. Similarly, strong employer TDM programs are estimated to reduce VMT by about 5 percent. This would be a substantial reduction to VMT if all employers and employees participated in these programs. However, since only a small percentage of employers have programs, the relative effect is quite small.

Transit policies show up as fairly effective at reducing GHG emissions in both of the model results. The degree of reduction is very similar although there are significant differences in how the models compute the transit effects. The RSPM calculates a similar level of reduction in emissions for bicycling. However the RPAT shows a much lower reduction; more like that of land use. The lower value calculated by the RPAT, however, is mostly due to the questionable result that increasing the diversion of single-occupant vehicle travel to bicycling lowers average fuel economy.

Both the RSPM and RPAT can provide a quantitative way for communities to realize the value of such policies, as politically infeasible as they may seem today. Oregon's work has shown that using these models helps engage planners, the public, and decision-makers in serious discussions about what can and should be done to meet the challenge of reducing the impact of transportation on the environment.

[15] "The literature suggests that doubling residential density across a metropolitan area might lower household VMT by about 5 to 12 percent, and perhaps by as much as 25 percent, if coupled with higher employment concentrations, significant public transit improvements, mixed uses, and other supportive demand management measures." (TRB Special Report 298, p. 4) Sensitivity testing of the GreenSTEP model showed similar results.

Appendix A: RPAT-RPSM Comparison Runs, Range of outcomes from Combination Policies

Figure A-0. How to read the Box and Whisker plots

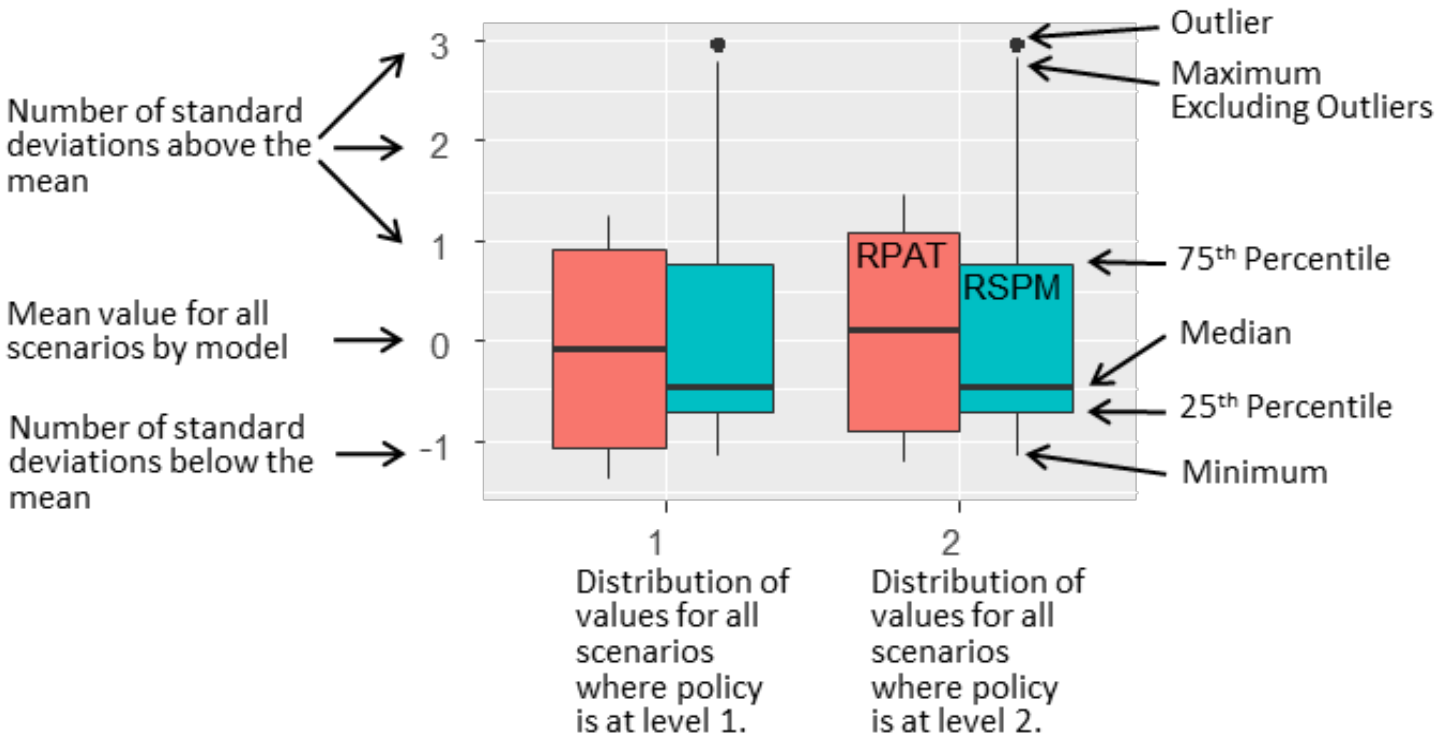


Figure A-1. Percentage of Households In Mixed Use Neight

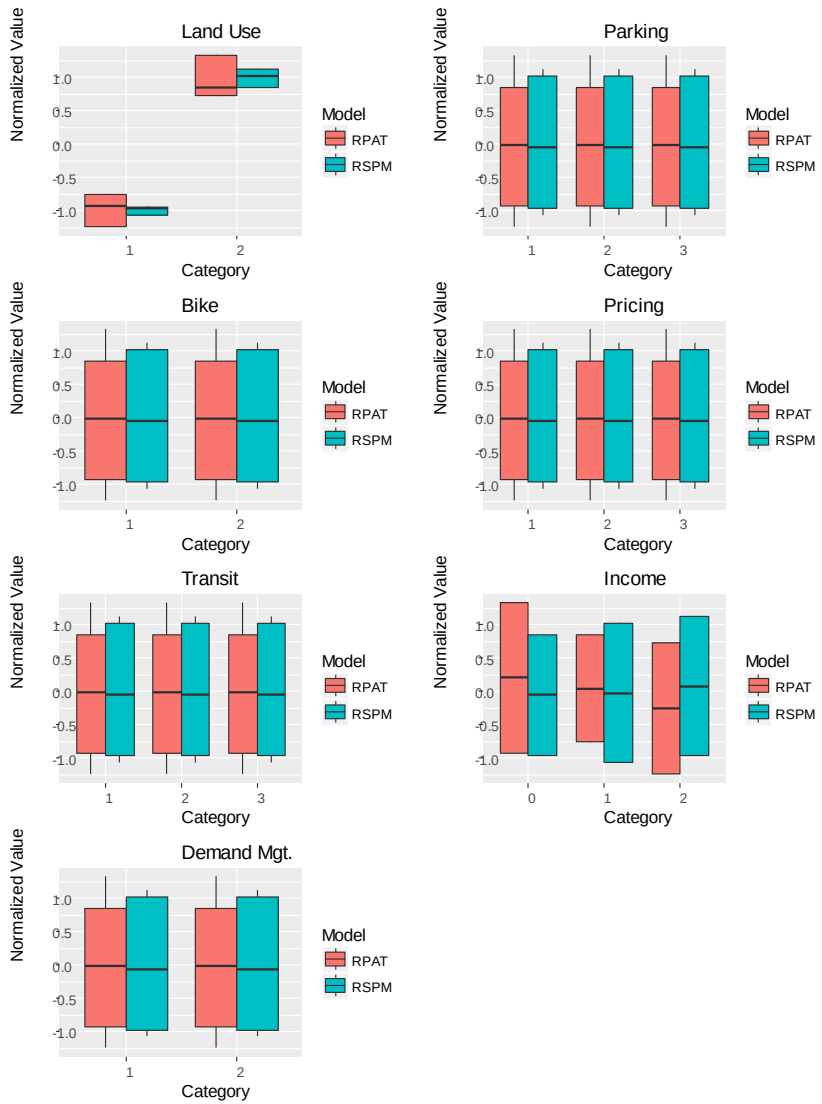


Figure A-2. Percent Change From 2010 In Household Walk

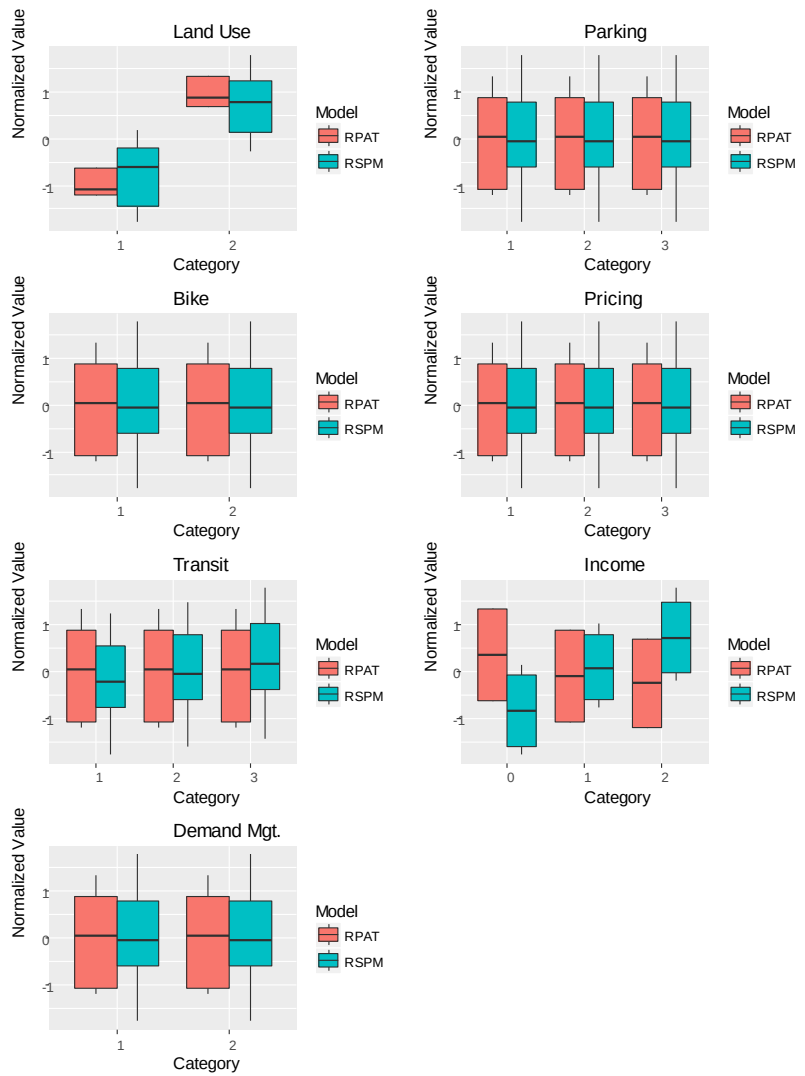


Figure A-3. Household Per Capita Daily Vehicle Miles Trave

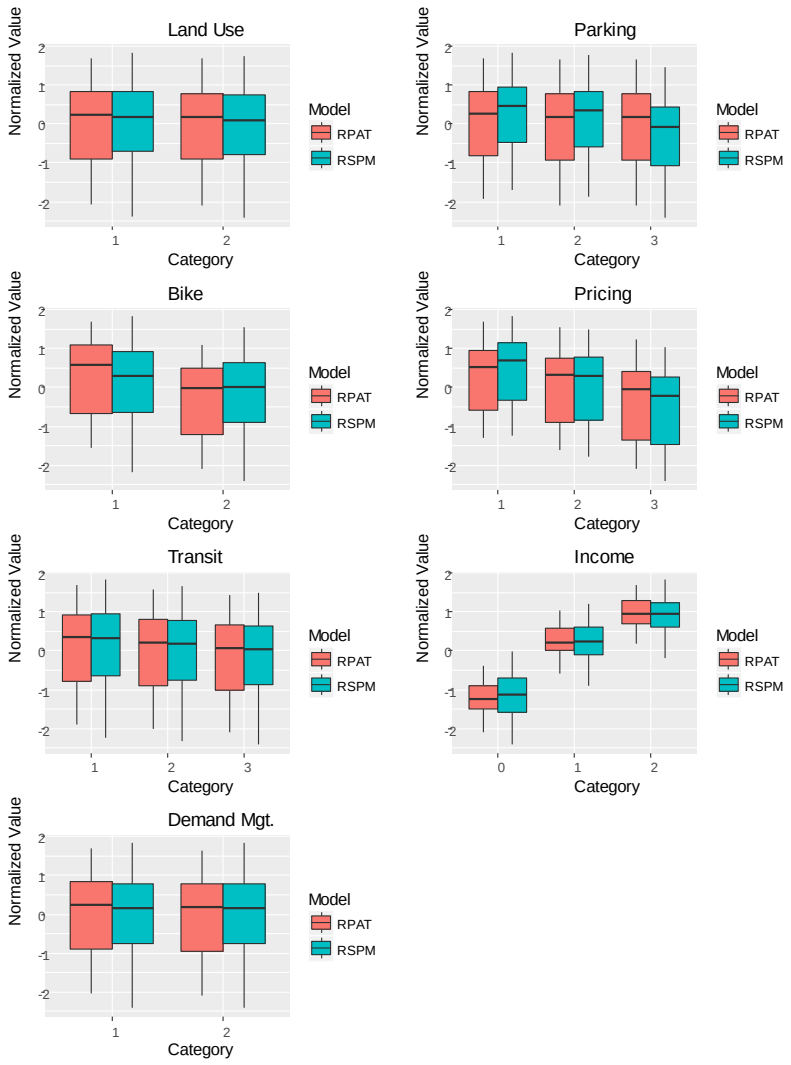


Figure A-4. Household Vehicle Average Speed (miles per h

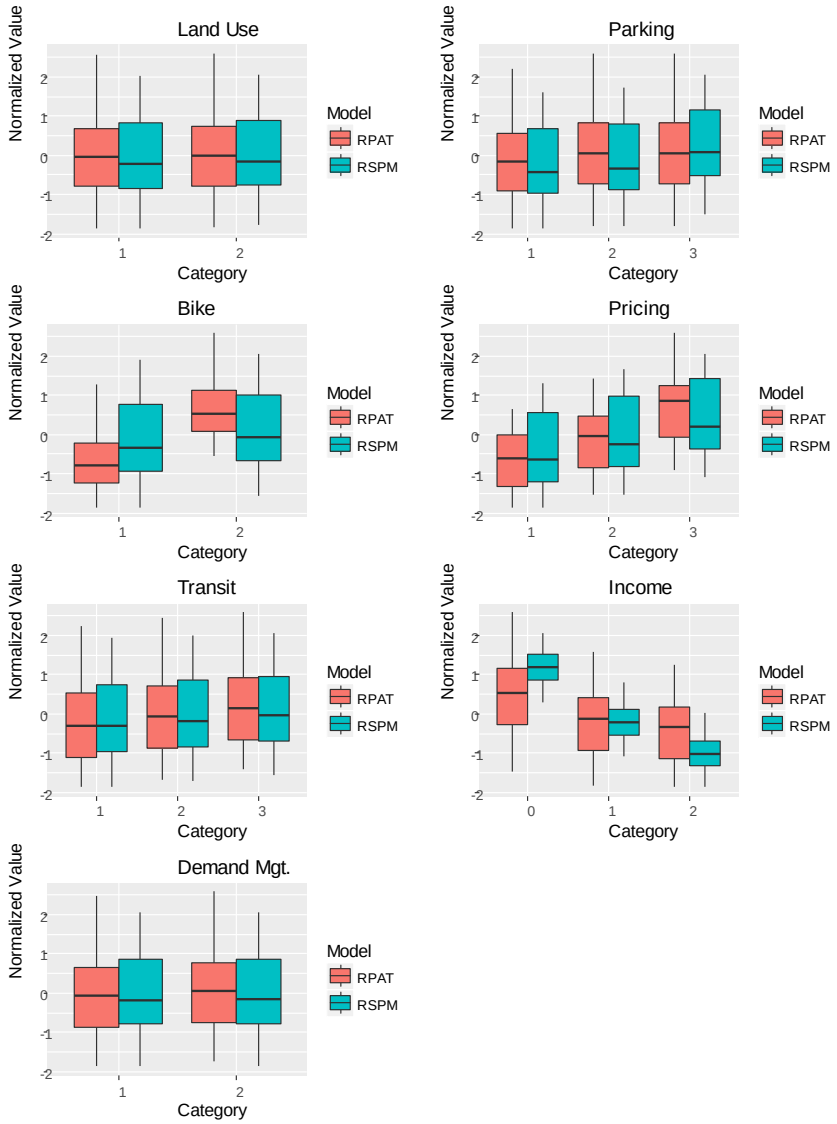


Figure A-5. Heavy Truck Average Speed (miles per hour)

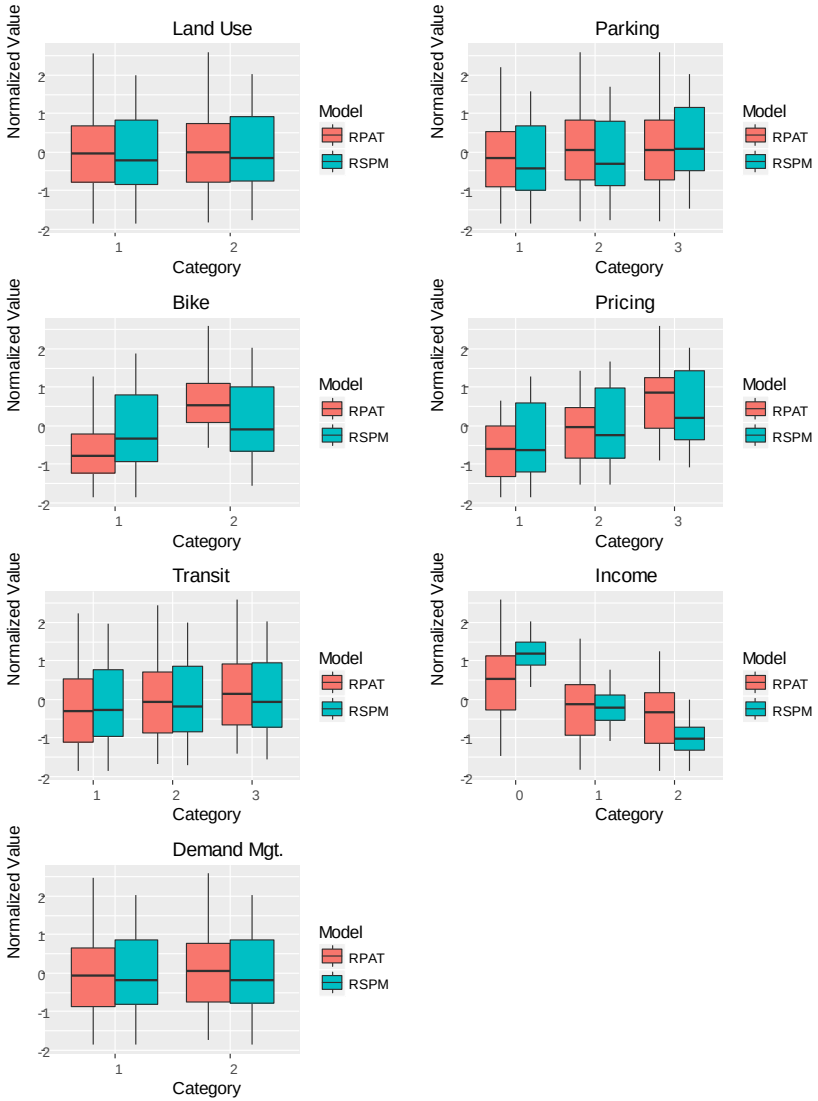


Figure A-6. Household Vehicle Daily Vehicle Hours of Delay

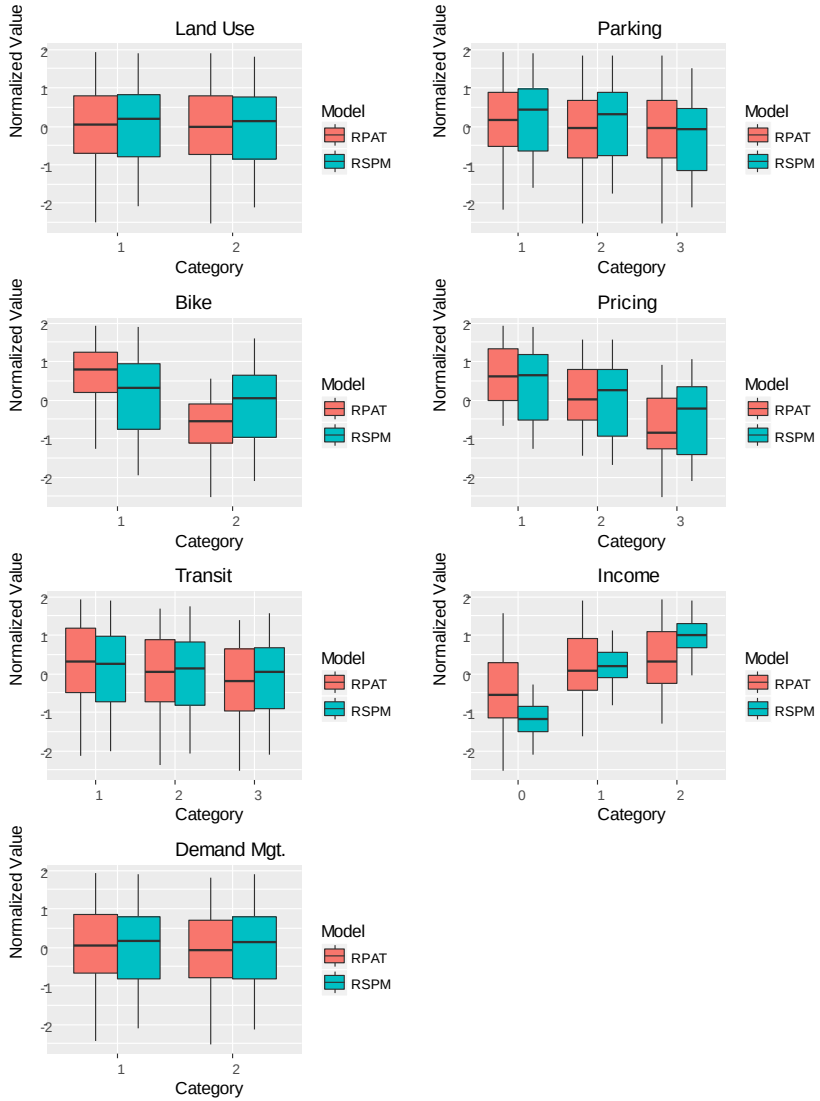


Figure A-7. Heavy Truck Daily Vehicle Hours of Delay

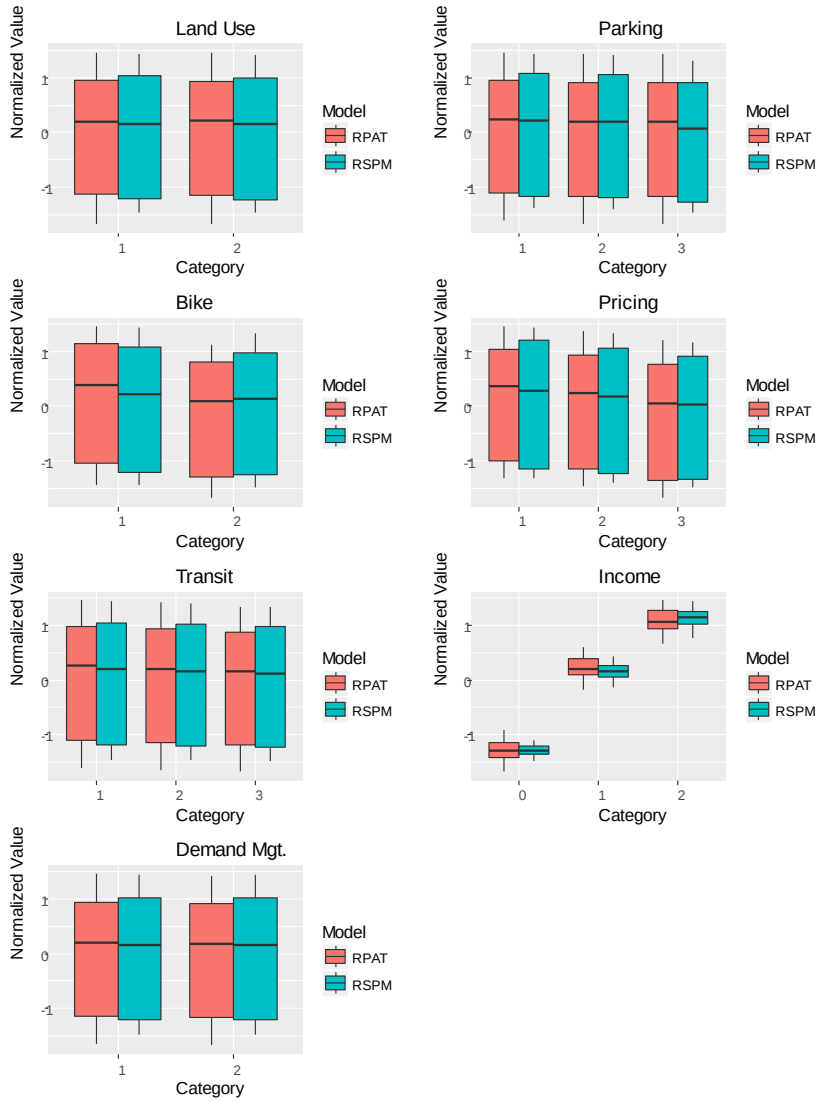


Figure A-8. Household Vehicle Per Capita Daily Vehicle Ho

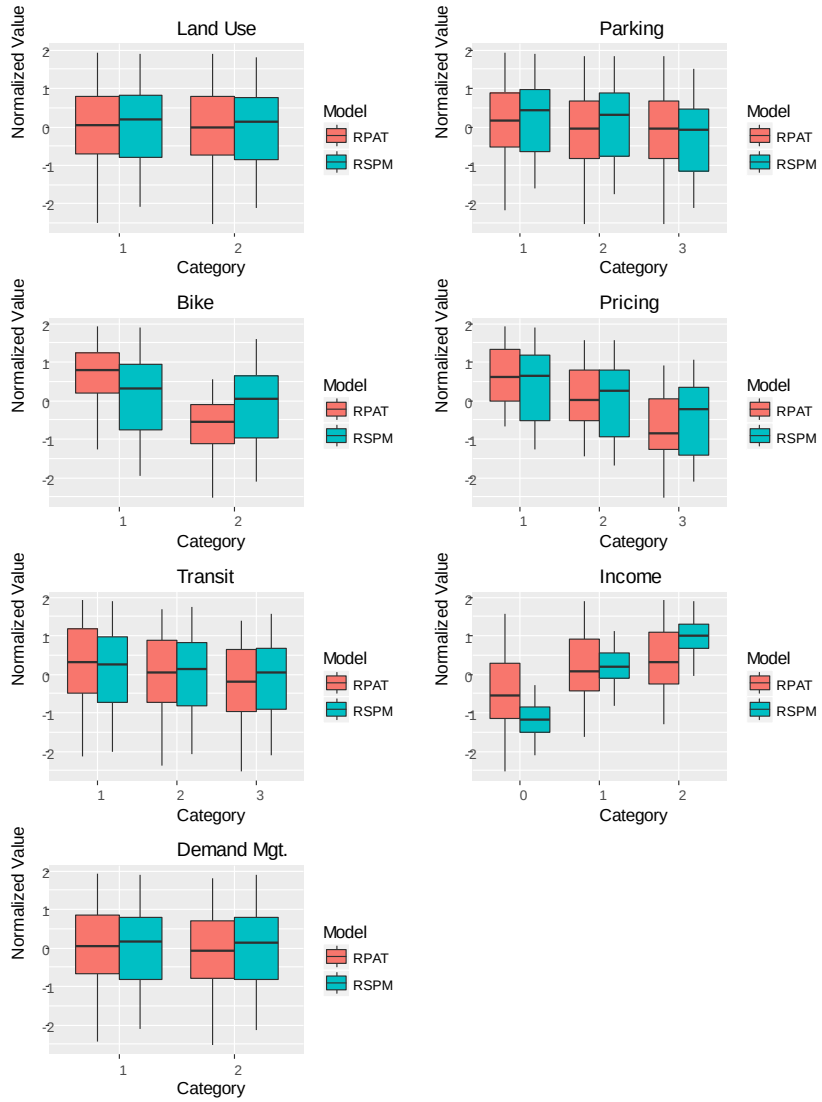


Figure A-9. Household Vehicle Average Miles Per Gallon

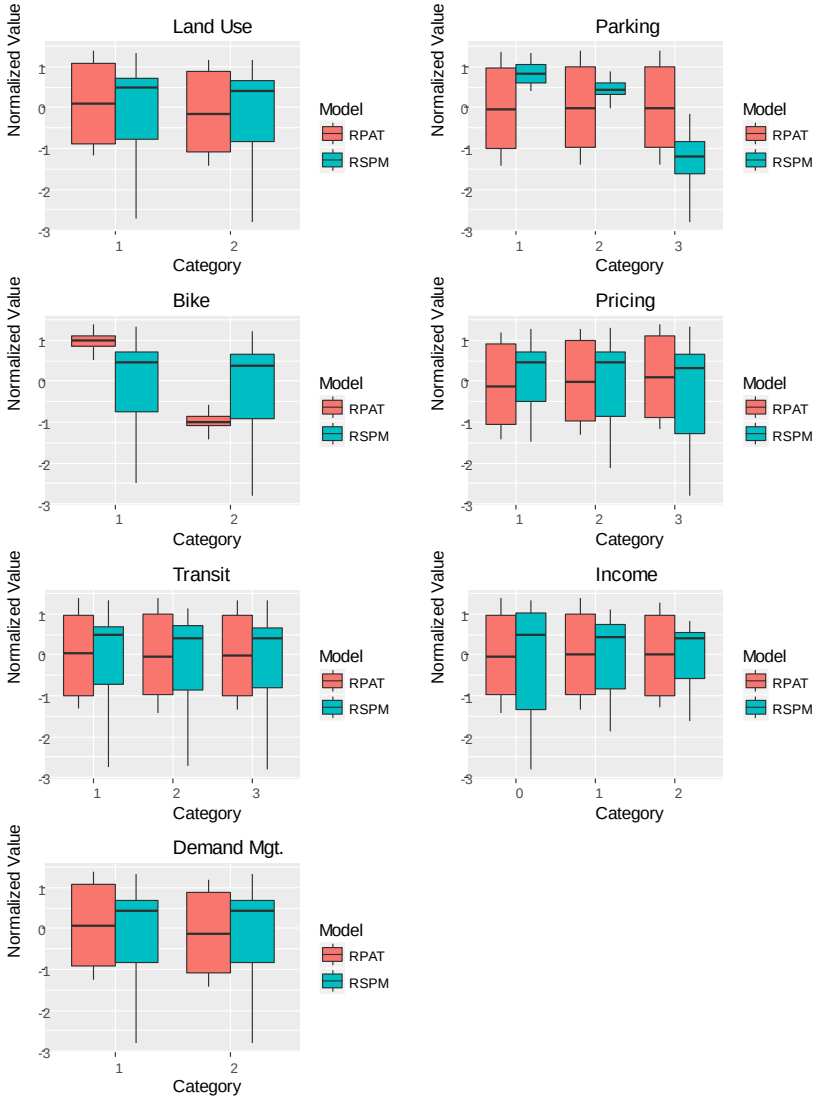


Figure A-10. Household Vehicle Emissions Per Mile (grams

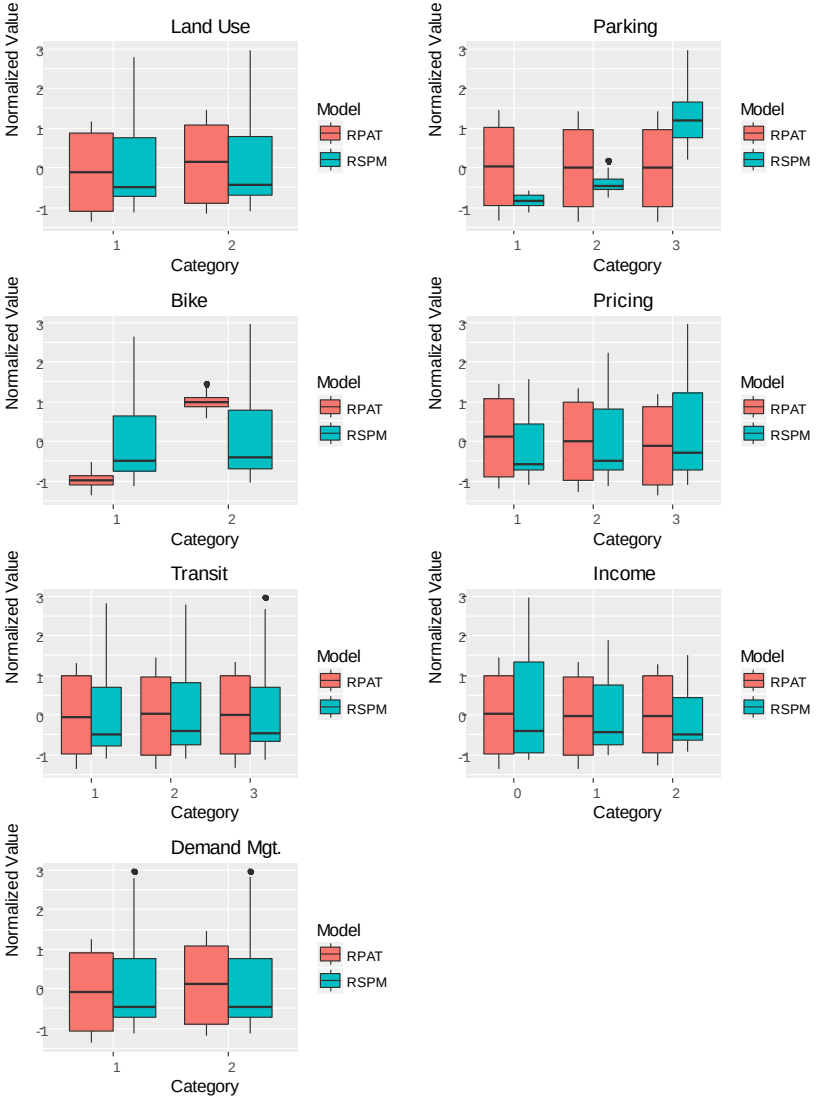


Figure A-11. Household Per Capita Annual Gallons Fuel Co

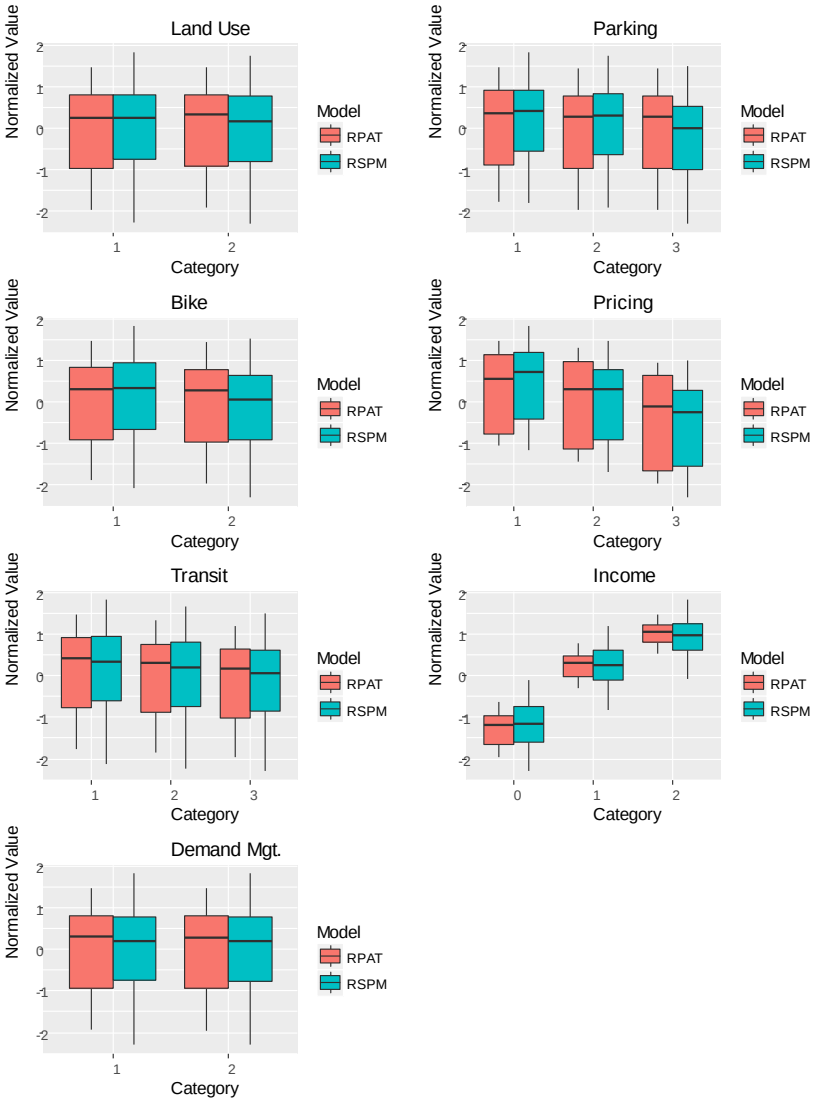
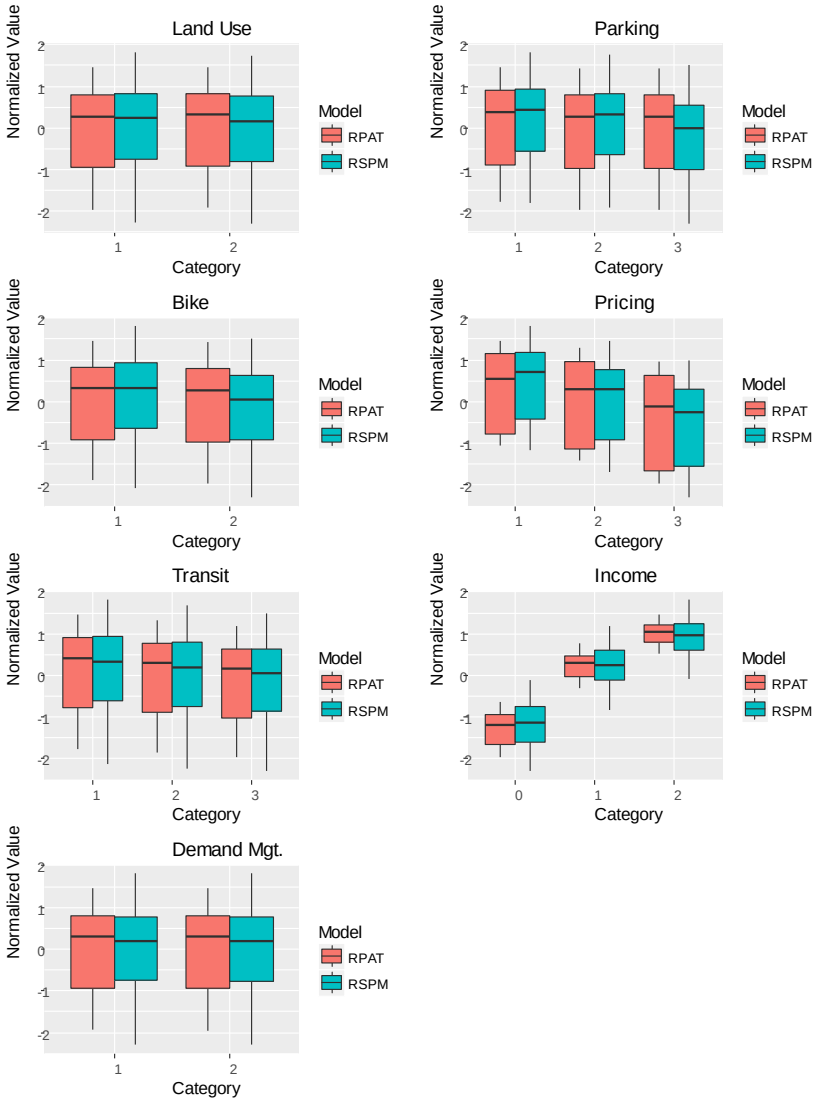


Figure A-12. Household Per Capita Annual Emissions (met



Appendix B: Oregon Place Type Review

As part of the SHRP2 C16 User Incentive award, ODOT invested significant energy in creating a simple data-driven system for defining land use Oregon Place Types, based on the RPAT place types. This appendix provides a summary of the findings from this work, including review by five Oregon MPOs, and additional next steps.

Oregon Place Type Methodology

Place Type Goal: The primary goal is to develop a new way to configure land use inputs for RSPM and ODOT's travel demand models to better support mid-size communities in Oregon that do not have land use forecasting capabilities. A secondary goal is to provide a criteria-driven definition of land use types (e.g., Transit-Oriented Development) that is consistent across the state, and to verify enhanced local linkages between the built environment and travel behavior as identified in national studies. A third goal was to develop the approach collaboratively with our sister state Land Use Agency, DLCD.

Place Type Approach: The method, builds on the land use inputs required for the SHRP2 C16 RPAT tool, where land use is based on the share of activity that occurs in thirteen different place types. RPAT provides limited guidance in how to identify these place types from local data. Oregon developed a data-driven method to identify place types from local Transportation Analysis Zone (TAZ) data (i.e., Households, Group Quarters, employment by type, and unprotected acres) and the block group level EPA Smart Location Database (for design and transit attributes). Oregon Place Types utilizes TAZ-level measures of the 5D Built Environment variables[16] (Density, Design, Diversity, Destination Accessibility, Distance to Transit) and translate them into two place type dimensions; Regional Role and Neighborhood Character. The attributes of these two dimensions are combined into sixteen distinct place types which are assigned to locations within the region.

Oregon Place Type Dimensions

1. **Regional Role** (Area type):
   Regional-level view of how parts of the region interact focused on job accessibility.
   Types: Regional Center, Close in Community, Suburban, and Low density/rural

2. **Neighborhood Character** (Development type):
   Neighborhood-level view of the multi-modal and mixed use character of an area.
   Types: Residential, Commercial, Mixed Use-High, Mixed Use, Transit supported development, and Low density/rural.

[16] Ewing & Cervero, Travel and the Built Environment, Journal of the American Planning Association, 76:3, 265-294.(2010) Note: 5th 'D' is typically 'Distance to Transit', not 'Transit Service Level', as used here

Figure B-1. RPAT Place Types, modified for use in Oregon

Area Type + Development Type = PLACE TYPE

Neighborhood Character (Development Type)\	Regional Role (Area Type): Regional Center	Close In Community	Suburban/ Town	Low Density/ Rural
Transit Supported Development	√	√	√	
Mixed Use - High	√	√	√	
Mixed Use	√	√	√	
Employment	√	√	√	
Residential	√	√	√	
Low Density/ Rural				√

The Oregon Place types assumed the following thresholds for the 5D variables from the travel demand model TAZ data and EPA Smart Location database, combined with the place Type Logic of Figure I-5 in the body of the report.

Figure B-2. Oregon Place Types 5D built Form Levels

REGIONAL ROLE *(Area Type)*

NEIGHBORHOOD CHARACTER *(Development Type)*

Built Environment Variables:

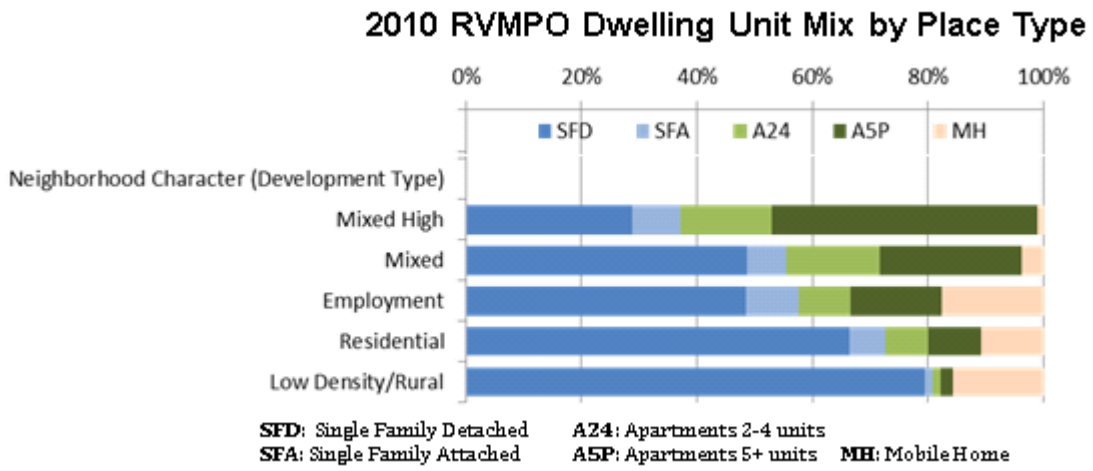
	Destination Accessibility	Density	Design		Diversity		Transit Service Level
	Share* of regional jobs within 5 miles (ratio)	**Jobs + households** per acre,** within 0.25 mile	**Multi-modal or pedestrian-oriented street density** (links per square mile) Maximum of two measures		**Jobs (total or retail-service) to household** ratio,** within 0.25 mile Maximum of two measures		**PM Peak hourly transit service on routes,** within 0.25 mile
Levels:			Multi Modal	Ped-oriented	Total	Retail/Service	
H	0.95 or more	15 or more	3.3 or more	20 or more	Between ½ - 2	Between ¼ - 10	150 or more
M	0.85 to 0.95	5 to 15	2.5 to 3.0	15.6 to 20	Between ¼ - ½ or 2-4	Between ¼ - 1/8 or 10-20	20 to 150
L	0.15 to 0.85	1 to 5	1.3 to 3.0	12.2 to 15.6	Between ¼ - 1/8 or 4-8	Between 1/16-1/8 or 20-40	1 to 20
VL	Less than 0.15	Less than 1	Less than 1.3	Less than 12.2	Otherwise	otherwise	Less than 1
Source:							
	All Years: Travel Model Jobs		**Base**: EPA Smart Location DB (NAVSTREETS) **Future**: User Input		**All Years**: Travel Model Households, Group Quarters, Jobs, plus unprotected lands		**Base**: EPA Smart Location DB (GTFS) **Future**: User Input

* Destination Accessibility shares are calculated relative to the 85th percentile value for the region.
**University Group Quarters converted to households, assuming 2 per household.
Note: Density & Diversity attributes assumed an average of TAZs' within 0.25 miles, measured as centroid-to-centroid distance. Thresholds set to approximate one standard deviation from the mean value

A flyer produced to help introduce the Place Type concept and language can be found here: http://www.oregon.gov/ODOT/TD/TP/ORPlaceTypes/PlaceType_Flyer.pdf

The resulting place type coverage for the Rogue Valley MPO was compared with Census block level data on dwelling unit type. As shown below the place types help to explain housing mix. More validation measures to observed data, including the 2010 statewide Oregon Household Activity Survey, are planned.

Figure B-3. Place Types and Census Dwelling Unit types



Terminology

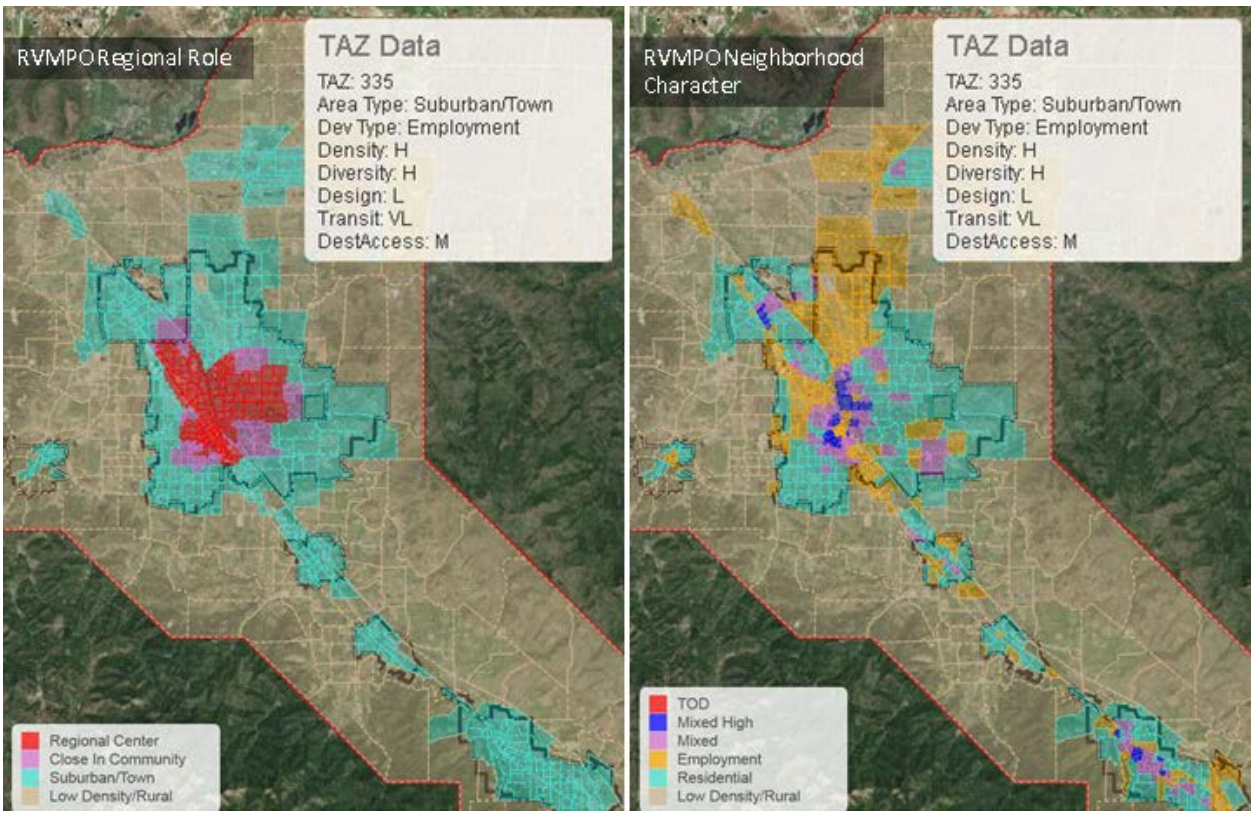
Some changes from the RPAT terminology were made to better reflect planning terminology commonly understood in Oregon: Urban Core to "Regional Center", Rural/Greenfield to "Low Density/Rural", and Unprotected Acres to "Developable Acres." A limited number of category changes were made to better reflect smaller sized MPO communities that are common in Oregon:

- A "Mixed use-High" designation was added to fill the gap in smaller communities where transit service is insufficient to contain TOD place types. The "Mixed use-High" type gives credit for 'everything but transit,' indicating a location with higher density and mixed use, where land use patterns have high potential for future transit options.
- Further distinctions considered but not ultimately chosen include the "Secondary Core" concept giving credit to poly-centric community in the regional role area type, and distinguishing "with" and "without" transit in the neighborhood character type.

Visualizer

The Place Type Visualizer developed by OSA has provided a valuable interface for planners to review data used in the Place Type calculations. The visualizer can be published on a website, and allows the user to interact with the data by zooming and panning a set of paired place type maps. When the curser is hovered over a TAZ, the TAZ will highlight and a list of associated values (5D levels and resulting place type) is presented. In addition to the Scenario Planning tools, the visualizer has been helpful in identifying TAZ data errors in other MPO travel demand model data.

Figure B-3. Screen Shot of Oregon Place Type Visualizer



Oregon MPO Development and Review

The place type approach was developed through a series of meetings between ODOT, our sister land use agency, DLCD, and our consultant on the SHRP2 C16 User Incentive award. Several rounds of criteria and various EPA SLD/TAZ data attributes were considered and compared on maps relative to our understanding of the various Oregon communities. When the place type method solidified, Place Type maps were developed for all the MPOs and some smaller communities within the state. Five MPOs (Portland, Eugene, Salem, Corvallis, and Rogue Valley) were asked to share their base year (roughly 2010) travel demand model TAZ land use and associated data. ODOT developed place type maps and interactive TAZ viewers for their areas, which were shared with the MPOs in order to test the place type method. The MPOs provided overall and TAZ-specific comments on how well the maps matched what currently exists according to their local expertise and mappings of the area (e.g., mixed use or CBD boundaries, Portland's Metro 2040 Plan and recent TOD plan, Eugene's 20-minute neighborhoods map. General comments on terminology and the value of the approach to planning discussions were also included.

The findings from the five MPO "ground-truth" reviews along with ODOT and DLCD's use of place types in discussions with the RVMPO and CAMPO RSPM-RPAT modeling exercises led to corrections to the existing method and for future adjustments to the method.

Summary of Findings from pilot use of Oregon Place Types

- A criterion driven approach is needed, rather than aspirational definitions for vague terms such as TOD, to better inform what it takes to achieve this form of built environment.
- The tool is scalable and the framework is useful for land use discussions with small communities and MPOS, but can also be scaled and used as a framework for larger community activities (e.g., Envision work in Bend). However, it was found that small communities have few block groups, which makes it a challenge to distinguish the "design" variable as currently specified using EPA Smart Location Database block group data. The tools would be greatly improved if this aspect could be developed from the local all streets network, rather than the national values.
- Identifying future land use opportunities, such as opportunities for an area to change from employment to mixed use.
- The method provides comparable places for communities to evaluate themselves against and set aspirational goals for future development and infrastructure investment. The mix of examples from different locations across the state is helpful to communities envisioning their future.
- The Place Type method, coupled with the interactive visualizer, is good to visually demonstrate the multi-dimensions of land use to policy makers and stakeholders
- The method has proven useful for identification and correction of land use input errors in travel demand models.
- The method provides good mid-level neighborhood scale information, however it can be difficult to compare to more detailed parcel level land use data commonly used for MPO and local jurisdiction planning.

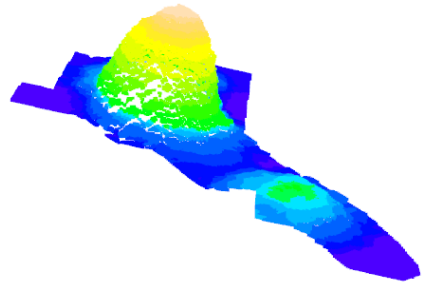
Place Type Logic and Data Thresholds

Several aspects of the place type logic in Figure I-5 were refined in response to the review process. These included; the need to average 5D values of adjacent zones to avoid boundary effects (and where TAZs were drawn with homogenous land uses), use of multiple SLD design variables (limitations with one-way streets), smaller distance criteria for destination accessibility to reflect mid-size communities (where typical 45 minute criteria covers the whole city), and improved density measures by removing parks and adding group quarters.

A couple issues surfaced during the pilot testing and review of place types that will also help with ongoing land use discussions include:

- **Adjustment for Transit Service**: It was important that TODs reflect a minimum service level not just access to transit as used in the original definition of the 5Ds. The minimum service level meant 3 of the 5 reviewed Oregon MPO test regions had no TODs as defined by the place type criteria, despite references to TODs within their community. As the goal is to better align with the literature definition of TOD and associated impacts, and give communities a set definition for the vague concept that had been previously used, these were constructive conversations.
- **Discomfort with the job-accessibility dominated "regional role" measure:** Many of the MPOs are polycentric and felt there should be more than one regional center place type, and felt slighted at being called a "suburban/town". This led to constructive discussions about the inter-dependent roles within the region economically, and acceptance after better understanding of the data, such as Figure B-4. Interest remains in designating a 'Secondary Core' place type, provided the area represented a minimum share of the region's jobs and meets a density threshold and multi-modal component. This can potentially represent a regional attractors and major job centers outside of the core.

Figure B-4 3D view of Accessibility Measure (jobs within 5 miles) in RVMPO



The pilot testing of the Oregon Place Types has been a success and continued use has been elected by communities, and allowed significant progress towards inter-agency coordination for land use planning across the state. The following next steps have been identified to improve the method, as well as opportunities for its continued use.

Next Steps

- **Obtain data by block group:** ODOT hopes to build all variables from local data in the future, replacing two variables – Design (link density) and Transit (GTFS service) which are taken from the EPA Smart Location Database (SLD). Since the SLD is at a block group level, this limits the disaggregation of these variables and reduces reporting capabilities, especially in smaller communities. Of particular concern are small communities where a single block group can span much of the community, leading to little attribute variation across the region. Use of local data could also assist in generating future year values for these two variables.
- **Resolve Gridding/TAZ size issues:** Use of TAZ data is better than block group but still imperfect as there are clearly issues along boundaries of adjacent areas (somewhat offset by our 0.25 mile averaging of nearby TAZs for some measures), non-uniform TAZ size, and adjacent TAZ boundaries built with homogenous land uses. We are considering ways to grid the data more uniformly.
- **Create Consistent data sources:** There are opportunities to leverage existing plans to make inputs more consistent. MPOs have different definitions and levels of inclusion for these areas:
    - Developable acres: Could be pulled from local zoning coverage and/or buildable lands with information on parks and water, and other usage restrictions.
    - University Group Quarters: K12 enrollment might also be added in an equivalent fashion.
    - Institutional Uses: There is interest in separating out special uses, such as an institution place type that might address issues that arose frequently about classification of schools, hospitals, public/parks, as well as highlight opportunities for mixed use areas nearby.
- **Improve Compatibility with other land use classification systems:** Oregon Place Type method was superficially compared to other land use classifications used elsewhere within the state (e.g., Envision), and would likely benefit from further discussions with these groups to see if a more unified system could continue to serve the various functions.
- **Enhancing the Place Types Visualizer tool:** Lots of ideas were generated to make the viewer more user friendly and immediately intuitive, such as revealing more of the underlying 5D values, mouse overs replacing documentation, and "suggested" changes necessary for a TAZ to reach different place types
- **Include more documentation:** More background documentation could be created to provide prototype pictures (aerial maps) and descriptions of different levels of the 5D attributes (e.g., design attributes). This would aid in explaining existing conditions to local jurisdictions and what is needed to reach the next level of land use intensity. Additionally, observed data (e.g., household travel survey) can be used to characterize the place types, as done with the census dwelling unit type mix in Figure B-2. Other validation measures to observed data are planned, such as per capita VMT, auto ownership, walk-bike-transit usage, as well as other demographics such as income and household size, etc. This is expected to help communities understand the unique attributes of these areas important to planning. Such information might also be used to improve demographic inputs needed for the travel demand model, which often lacks the ability to characterize the critical future demographics changes occurring in growing areas that have a big impact on travel.

Opportunities

- **Improved Land Use Forecasts:** There is interest in using the place type language to help communities develop their future land use forecasts. The tool can complement mathematical forecasting methods by allowing stakeholders to visualize what a community will look like in the future and provide comparable places across the state. The place types can also be goals for communities to channel growth in order to produce certain outcomes, such as adding housing to job-rich areas, or targeting multi-modal facility investment in mixed use areas. It is expected for small communities that this process will cut down on the time required to develop a forecast, and increase accuracy and ownership of the process, which in turn will improve land use inputs critical to travel demand models.
- **TAZ & Network viewer:** One future opportunity is to develop this visualizer into a more generalized form to share a larger set of TAZ data with local planners as they develop base and future year land use scenarios for evaluation in travel demand models. Another opportunity would be to develop a network version of the visualizer to share network attributes, such as lanes, capacities, and functional class on shaped links imported from a GIS file. Links could be color coded for a user-identified network attribute and transit routes could also be identified by links, and potentially turn restrictions could be displayed in a visual format for intersections.

Land use inputs are one of the most challenging and most important inputs to travel demand models used in regional planning studies, such as the RTP. Despite the recognition of the value of land use inputs, the complexity of the inputs and inability to visualize the complexities of the land use inputs for a future year makes it difficult and time-consuming for local communities, particularly smaller communities with limited technical staff, to arrive at land use scenarios. The Oregon Place Types method developed under the SHRP2 C16 User Incentive award provides a criteria-driven method to translate the numbers into a visual vocabulary that is more intuitive to planners, policy makers, and the general public.

Appendix C: RPAT-RSPM-VisionEval Outreach

The SHRP2 C16 User Incentive award funding was focused on implementing the models and developing technical outputs. However, partnership on this and related efforts, as well as ongoing activities allowed opportunities for outreach and communication of the RPAT and RSPM tools and their capabilities in supporting long range planning in Oregon. Completed and planned outreach efforts are noted below.

- **RPAT-specific** – Coordination with CAMPO staff and committees/boards to identify policy scenarios to apply in RPAT/RSPM. Sharing of these results as constructive to that effort. Other RPAT efforts relate to the development and use of Oregon Land Use Place Types.
    - Review of project and project kickoff with Ali Bonakdar CAMPO (January & May 2015) - Discussed the functionality of RPAT and broad differences relative to RSPM already implemented in their region. ODOT Analysis, ODOT Planning, and DLCD staff presentations.
    - Several CAMPO Policy Scenario Meetings with MPO TAC, and less formal meetings with local jurisdictions and stakeholders (June 2015-February 2016) to collect/review inputs and evaluation criteria. Future efforts will share RSPM/RPAT outputs. ODOT Analysis, ODOT Planning, and DLCD staff presentations
    - ODOT-DLCD collaboration on place types (Decembers 2014-March 2015) – several meetings digesting the TAZ land use data combined with the EPA Smart Location Database, to arrive at thresholds and logic for Oregon Place Types, and terminology to use.
    - Conversations with modeling staff and local DLCD land use reps in 5 Oregon MPOs (April 2015). Place Type maps were developed and shared for comment with these MPOs. Comments helped inform the method, identify its value, correct errors and language, and inform next steps.
    - RPAT Peer Exchange/Training (October 2015, Las Vegas) – Participated and led various conversations with RPAT/RSPM users (Peer Exchange) and potential users (RPAT training) in October 2015 meeting. Several formal ODOT/Tara Weidner presentations supported by partners and fellow attendees Ali Bonakdar/CAMPO and Brian Gregor/Oregon Systems Analytics.
    - ODOT Transit Staff discussions (November 2015) – CAMPO Strategic Assessment (RSPM) findings and use for transit planning in the Corvallis region and other regions with RSPM planning. ODOT Analysis and ODOT Planning staff presentations.
    - RVMPO Place Types Training (December 2015) –Trained to use place types in review/development of RTP land use inputs. ODOT Analysis, ODOT Planning, and DLCD staff presentations.
- **Related Oregon efforts** - ODOT shared the findings of the project with several planning and modeling forums that include a mix of state and MPO staff. In addition, CAMPO partnership on this effort provides the opportunity for the MPO to share the findings with other MPOs through their involvement in Oregon Metropolitan Planning Organization Consortium (OMPOC) and an informal working group of mid-size MPOs. ODOT expects other communities to implement a Strategic Assessment effort over the next year or two, and they may be interested in the RPAT capabilities, beyond that of RSPM.
    - **RVMPO Strategic Assessment** (February 2015-January 2016) - Using RSPM (not part of the User Incentive award), informed the MPO TAC of key findings about the future, and ability to meet GHG reduction goals, and other desired regional outcomes. The inputs, outputs, and draft findings were shared with the TAC (one

member said, “My head hurts, I learned a lot in the last hour!”) Final report and scenario viewer to be published in early 2016. ODOT Analysis, ODOT Planning, and DLCD staff presentations.

- **Oregon Modelers User Group** (OMUG) (Decembers 2015, Portland) - Shared Value of Strategic Planning and the VisionEval common framework approach with local agency planners and consultants.
- **AASHTO SCOP Workshop** (planned for spring 2016) - Performance-Based Planning using VisionEval, to include Visioning discussions on VisionEval tool. ODOT Analysis, and ODOT Planning staff planning/moderating/presentations.

- **Outside of Oregon**.
  - **American Planning Association National Conference** (April 2015, Seattle) –ODOT-moderated session with speakers and panel Q&A, “How Small Places Can Think Big,” part of Smart Cities and Sustainability Track, included presentation by recipient partner Ali Bonakdar/CAMPO.
  - **SESYNC “Model Integrated Workshop”** University of Maryland National Center for Smart Growth ((January and August 2015, Annapolis, MD) – Workshops included presentations and discussions with international modelers in economic, land use, and the environment. http://www.sesync.org/project/data-intensive-analysis-modeling-for-socio-environmental-synthesis/integrated-regional-model (presentations of RSPM, RPAT, and VisionEval open source project by Brian Gregor/OSA, and Tara Weidner/ODOT)
  - **TRB Planning Applications Conference** (May 2015, Atlantic City, NJ) - 5-minute “Speed-Data-ing” session covering GHG planning in 3 Oregon Communities, "Climate Change Modeling: How Reducing Greenhouse Gas Emissions is Shaping Great Communities in Oregon" ; Ali Bonakdar/CAMPO and Tara Weidner/ODOT co-authors. http://trbappcon.org/2015conf/Program.aspx
  - **AMPO conference** (October 2015, Las Vegas) – Scenario Planning 1 session including presentations including “RPAT/RSPM use in discussions with policy makers and stakeholders” & CAMPO’s GHG Reduction Work; http://www.ampo.org/2015-ampo-annual-conference-agenda/ (presentations by Brian Gregor/OSA, Ali Bonakdar/CAMPO, and Tara Weidner/ODOT)
  - **Regional Science Association International** (RSAI) conference (November 2015, Portland) -- Brian Gregor/Oregon System Analytics presented ongoing FHWA-ODOT VisionEval Common Framework project at the last day of the conference. It included the technical approach for modularizing the tools on common code base, providing exposure for the RPAT and RSPM family of tools. http://www.narsc.org/newsite/conference/conference-program/
  - **ITM Strategic Planning Conference** (forthcoming May 2016, Denver)
    - Collaborating with FHWA on development of a workshop on Strategic Planning at the ITM Conference - Why do it, what are the attributes of tools to support it, and discussion of the FHWA-ODOT open source project of RPAT/RSPM toolset.
    - An ITM conference presentation on the VisionEval framework (co-authored by Brian Gregor, Jeremy Raw, and Tara Weidner) has also been accepted at the conference.

Appendix D: CAMPO 2010-2040 base scenario Cost Assumptions

RPAT auto operating cost Calculation						
$/mile	2010	2035	2040			
Gas Tax ($/gal x MPG)	0.017482	0.008983	0.008983			
VehMaint ($/mile)	0.041	0.041	0.041			
VehTire ($/mile)	0.007	0.007	0.007			
Fuel Cost ($/gal x MPG)	0.087412	0.102637	0.097231			
Auto_Op in 2005$ (RSPM)	0.152894	0.15962	0.154214			
in 2000$ (RPAT)	0.138853	0.144961	0.140051			
growth		1.043987	1.00863			= RPAT inputs
						keyvalue.csv (baseyear)
MPG	24.253	53.87941	60.37186			auto_op_cost_growth.csv (future)
(per CAMPO2035/2040 model results as of 12/7/15)						
CPI 2005$ to 2000$	0.908163					
	RPAT	RSPM				
	2000$	2005$				
Keyvalues.csv						
BaseCostPerMile	0.043592	0.048				
FuelCost	1.925306	2.12				
GasTax	0.385061	0.424				

Source: Auto_op_costCalc.xlsx