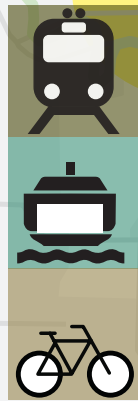


Transportation 2040

UPDATE

toward a sustainable transportation system

Appendix H: Analysis Tool Documentation



MAY 29, 2014

Puget Sound Regional Council

Transportation 2040 Update

Appendix H – Updated Documentation of Analysis Results and Tools

This update to Appendix H was prepared to provide updated information about PSRC’s analysis results and tools. To make use of the best available information, PSRC staff, working with other technical staff from member agencies, has developed several enhancements to PSRC’s suite of models and analysis tools. Some of these improvements were prepared specifically for the 2014 update of Transportation 2040. The discussion below provides a summary of the analysis results and the changes to the tools. The remainder of Appendix H remains unchanged from adoption of T-2040 in 2010.

Introduction

This update to Appendix H of the Transportation 2040 plan documents the modeling results as well as the tools and key assumptions used to support technical analysis of the Transportation 2040 Update package and regional project scenarios. This update highlights where changes were made to the original suite of tools and assumptions described in Appendix H: Analysis Tools Documentation, available at: www.psrc.org/transportation/t2040/t2040-pubs/final-draft-transportation-2040.

Analysis Results

There are minor changes to this plan update including limited revisions to the project list with a net reduction of almost 60 lane-miles. Based largely on Prioritization, approximately 80 projects are moving out of the financially constrained plan.

To make use of the best available information, the suite of modeling tools has been updated. Changes to the models have resulted in changes from the original published analysis, but the base year and adopted plan have been re-calibrated using the new modeling framework, to ensure a consistent comparison. Regional network measures such as vehicle miles of travel, vehicle hours of travel, delay and average speed are provided in Table 1 below. For comparison, this information is provided for several scenarios:

Transportation 2040 Update – 2006: This is the base year conditions used for the plan adopted in 2010, run through the new suite of analysis tools and models.

Transportation 2040 Update – 2010: This is the new base year conditions for the T2040 Update run through the new suite of analysis tools and models.

Transportation 2040 Adopted Plan 2040: This is the current adopted full plan (2012) run through the new suite of analysis tools and models.

Transportation 2040 Update – Constrained Plan 2040: This is the proposed Constrained portion of the Draft Transportation 2040 Plan Update run through the new suite of analysis tools and models.

Transportation 2040 Full Plan 2040: This is the proposed Constrained plus Unprogrammed Draft Transportation 2040 Plan Update run through the new suite of analysis tools and models.

Regional Network Measures

	Base Year (2006)	Updated Base Year (2010)	2012 Adopted – Constrained Plan 2040	2012 Adopted – Full Plan 2040	2014 Update – Constrained Plan 2040	2014 Update – Full Plan 2040
Daily Vehicle Mile Traveled	79,535,979	80,317,885	96,108,116	94,325,653	94,851,846	93,477,203
Daily Vehicle Hours Traveled	2,956,071	2,987,202	3,638,353	3,470,958	3,581,634	3,415,796
Delay (hours)	954,206	954,289	1,179,804	1,064,173	1,152,734	1,033,002
Average Speed (miles per hour)	26.9	26.9	26.4	27.2	26.5	27.4

Travel mode share results summarized in the table below show a reduction in drive alone trips and an increase in transit and non-motorized trips between the 2006 base year and the proposed Transportation 2040 Update – Full Plan.

Travel Mode Shares

	Base Year (2006) (%)	Update – Base Year (2010) (%) *	2012 Adopted – Constrained Plan 2040 (%) *	2012 Adopted – Full Plan 2040 (%)	2014 Update – Constrained Plan 2040 (%)	2014 Update – Full Plan 2040 (%)
Drive Alone	44.7	44.0	41.2	40.5	41.2	40.5
Shared Ride	42.4	42.8	42.6	42.7	42.5	42.7
Transit	3.1	3.1	4.3	4.5	4.3	4.5
Non-Motorized	9.8	10.2	12.0	12.3	12.0	12.3
Total	100	100	100	100	100	100

Air Quality Analysis Results

The results of the air quality analysis as illustrated in the table below are consistent with the changes in EPA's motor vehicle emissions software, as well as the lower regional vehicle miles traveled resulting from the changes described for the other modeling tools elsewhere in this document. These results also reflect the continued improvements in vehicle and fuel technology and the turnover of the fleet over the next 30 years. A more complete description of the changes in the EPA emissions software since 2010 is included in the Air Quality section below.

	Base Year (2006)	2012 Adopted – Constrained Plan	2012 Adopted – Full Plan	2014 Update – Constrained Plan	2014 Update – Full Plan
Carbon Dioxide equivalent (CO _{2e})*	17,739,298	18,110,977	17,779,561	17,983,298	17,637,698
Carbon monoxide (CO)	800,947	374,948	372,370	373,162	371,199
Ozone					
Summer Nitrogen Oxides (NOx)	81,117	14,789	14,548	14,649	14,443
Summer Volatile Organic Compounds	29,291	5,623	5,560	5,603	5,538
Fine Particulates					
Winter PM _{2.5}	3,814	1,090	1,064	1,075	1,049
Winter NOx	89,920	16,904	16,658	16,751	16,545

While the new emissions software produces different results than published in the 2010 adopted plan, the region continues to meet all required federal and state transportation conformity requirements, as illustrated in the table below. A demonstration of conformity ensures that the projects and programs in Transportation 2040 will not impede the region from meeting and maintaining air quality standards.

Transportation Conformity Emissions Analysis Results

	CO (tons per day)	PM _{2.5} (pounds per day)	NO _x (pounds per day)
Emissions Budget	2,512.00 ^a	3,002 ^b	71,598 ^b
2016	1,301	n/a	n/a
2020	1,139	1,823	37,729
2030	944	1,200	19,015
2040	959	1,082	14,174

^a CO motor vehicle emissions budget as identified in The updated CO maintenance plan, effective September 7, 2004

^b PM_{2.5} and NO_x motor vehicle emissions budgets as identified in the revision to the Washington State Implementation Plan, effective October 21, 2013

The results of the Four-Part Greenhouse Gas Strategy – specifically the application of the two vehicle and fuel technology scenarios developed as part of the adopted plan in 2010 – are included in Appendix L.

Modeling tools and key Assumptions

Regional Macroeconomic Forecast

Purpose

The Regional Macroeconomic Forecast provides long-range regional growth assumptions for key demographic and economic variables (e.g. population, households, and employment) out to the year 2040. The regional forecast values serve as control totals for developing small area (sub-county) long-range land use assumptions, which in turn serve as key inputs to the regional travel demand model and analysis (described below). It also provides (for revenue projections) future estimates of transportation related tax bases upon which transportation taxes get levied.

Model/Tool

The current 2012 Regional Macroeconomic Forecast was developed using a new model system – the Puget Sound Regional Macroeconomic Forecasting (PSRMF) model – a series of linked forecasting modules. The model system was developed by the firm ECONorthwest (principals Dr. Andrew Dyke and Dr. Randall Pozdena), and replaces the former Puget Sound Economic Forecast (PSEF) model utilized during development of the Transportation 2040 plan.

The PSRMF model system links a highly regarded national macroeconomic model (developed by Professor Ray Fair of Yale University) to a regional model and series of regional sub models. The Ray Fair U.S. forecast is an open source model of the U.S. economy, which has been extended out to 2040 as an exogenous input to forecasting the region's economy. The regional sub models provide geographic dimensionality and, in turn, are linked to regional transportation tax base modules. The model system reflects the latest thinking on the regional and national economies and their projected long-range trajectories subsequent to the Great Recession of 2009.

Detailed documentation of the 2012 Regional Macroeconomic Forecast is available at:

<http://www.psrc.org/assets/7879/MacroecoForecastTechMemo.pdf>.

Key Assumptions

Key assumptions from the latest 2012 Regional Macroeconomic Forecast (in comparison to the preceding 2006 Puget Sound Economic Forecast) are as follows:

- The 2012 regional macroeconomic forecast for wage and salary employment in 2040 – 2.7 million jobs – is lower than the 2006 forecast by 3 percent, reflecting the impact of the Great Recession of 2009 on the region's long-range economic trajectory
- The long-range forecast for population in 2040 remains stable at just under 5.0 million persons
- The 2012 regional forecast predicts a more moderate decline in average household size, which results in a lower long-range households forecast for 2040 of 2.1 million, a 6% decline from the 2006 forecast
- The long-range forecast for personal income increases by nearly 7%, which can be expected to have a noticeable impact upon household travel choices and behaviors

Land Use Forecast – Transportation 2040 Update Land Use (TULU) Dataset

Purpose

The land use forecast provides the long-range land use and growth assumptions that are utilized as key inputs to the regional travel demand model and analysis. The land use forecast starts with the long-range forecast of population, household, and job growth through the year 2040 from the regional macroeconomic forecast, and distributes the projected growth across the region into approximately 3,700 traffic analysis zones (or TAZs).

Model/Tool

For the Transportation 2040 Update technical analysis, PSRC utilized a spreadsheet allocation model to develop a tailored land use forecast product called the Transportation 2040 Update Land Use (or TULU) dataset. The TULU dataset was purposefully crafted to meet the technical specifications and policy requirements outlined below in the Key Assumptions section.

The TULU spreadsheet allocation model was used as an alternative to the UrbanSim land use forecasting model, the tool used to generate the future land use assumptions used for the Transportation 2040 environmental analysis of alternatives. While the UrbanSim forecasting model offers a number of powerful analytic features, PSRC opted to use the TULU model for the Transportation 2040 Update in order to be able to set specific growth allocation values for geographic subareas relevant to the analysis, e.g. regional geographies, including municipalities, unincorporated urban growth areas, and rural areas.

Key Assumptions

The technical and policy assumptions underlying the TULU dataset were established to ensure they met federal air quality conformity analysis requirements regarding use of “latest available planning assumptions.” The key assumptions are as follows:

- The TULU dataset is consistent with the region’s most current long-range regional forecast of households, population and employment from the 2012 Regional Macroeconomic Forecast (see above)
- The TULU dataset reflects the regional long-range strategic growth assumptions as detailed by VISION 2040 regional growth strategy
- The TULU dataset is reflective of locally adopted growth targets developed to begin implementing the VISION 2040 regional growth strategy

Travel Demand Analysis / Geodatabase

Purpose

PSRC has developed a customized set of computer programs and mathematical procedures to simulate current and future travel patterns and conditions within the four counties (King, Kitsap, Pierce, and Snohomish) of the central Puget Sound region. These programs and procedures are collectively referred to as the “regional travel demand forecasting model” or simply as the “travel model.” The travel model produces detailed spatial and network data that are used to analyze how the region’s transportation infrastructure and environment are likely to be impacted by future population growth and development. The travel model provides the analytical foundation from which PSRC develops many of its plans, most recently the regional transportation plan, Transportation 2040.

Model/Tool

Periodically, as new data becomes available, as new methods advance from theory to practice, and as computer resources become more productive, the travel model is subject to upgrades and improvements to better represent travel conditions. Following the adoption of Transportation 2040 in 2010, PSRC staff initiated a series of improvements to be implemented prior to the Transportation 2040 update. The most significant upgrades are summarized below:

- Increased the number of transportation analysis zones from 938 to 3700 (see network images below comparing sections of the old and new model network)
- Increased the number of links in the transportation network from 20,500 to 67,500
- Implemented and automated transportation network development through the geodatabase input/output tool
- Refactored, reorganized, and debugged existing software code base
- Used PSRC's *2006 Household Travel Survey* dataset to re-estimate coefficients and parameters for most models
- Validated model output and results against 2010 observed conditions where possible

Old Network – 2.3 Miles



New Network – 2.00 Miles



As shown by the graphics above, the new, more accurate representation of the regional transportation network produces slightly different distance estimates for similar trips. On average, trip distances are shorter across the region within the new network and this has contributed to lower future regional VMT Estimates than those published in the Transportation 2040 documentation.

Key Assumptions

Land use and population allocations (representing demand conditions) along with transportation projects, policies, and network attributes (representing supply conditions) represent the key input assumptions for any travel demand analysis framework. For the travel demand analysis used to support the Transportation 2040 Update, the previously mentioned TULU dataset, allocated throughout the region across 3,700 transportation analysis zones comprises the key land use assumption, while the set of transportation projects and policies enumerated within Transportation 2040 (as amended in 2012) form the basis for the key transportation network assumptions and any subsequent scenarios developed for analysis.

Air Quality / Climate Change Analysis

Purpose

The air quality analysis estimates future regional motor vehicle emissions of criteria pollutants and greenhouse gases. The analysis combines mobile source emissions factors from the latest EPA model and output from the travel demand analysis, including link-specific VMT and vehicle speed. EPA's emissions software has been updated and MPOs are required to use this updated tool. The results of the 2040 Update are consistent with changes to emissions that EPA advised would occur using the new software, and the region continues to meet all federal and state air quality requirements.

Model/Tool

PSRC utilized the EPA's Motor Vehicle Emission Simulator version 2010b (MOVES2010b) model to develop emissions factors used to conduct the air quality analysis of the Transportation 2040 Update. The MOVES2010b model represents EPA's most up-to-date assessment of on-road mobile source emissions and replaces the MOBILE6.2 model. Key changes between MOVES2010b and MOBILE6.2 include the following:

- Volatile organic compound (VOC) emissions are lower, most noticeably for Tier 1 and newer vehicles
- Nitrogen oxide (NOx) emissions from both light- and heavy-duty trucks are higher than previously estimated
- Emissions of fine particulates (PM2.5) are significantly higher for both light- and heavy-duty vehicles, based on extensive research conducted over the last several years
- MOVES2010b incorporates new fuel economy and greenhouse gas standards adopted through September 2010, which were not included in either Mobile6.2 or MOVES Demo, which was the tool used to estimate greenhouse gas emissions for the adopted plan in 2010

Key Assumptions

The key assumptions underlying the air quality analysis are as follows:

- The fleet mix and age distribution from the base year are utilized
- The model accounts for the phase-in of current emissions standards, inspection/maintenance programs, fuel standards, and engine technology, and contains assumptions regarding the rate of vehicle changeout and fleet turnover for each forecast year
- The model does not predict future regulations or technological advances, and PSRC does not make any additional assumptions about the future vehicle fleet as it is input to the model; the only place where alternate vehicle fleet assumptions are utilized is in the technology scenarios contained within the Four-Part Greenhouse Gas Strategy

Benefit Cost Analysis

Purpose

PSRC has developed a set of procedures and methods for project and program evaluation that fall generally into the category of transportation benefit-cost analysis. The purpose of these methods is to be able to produce information about project or program performance, relative to a baseline set of conditions where the project or program has not been implemented. Benefit-cost methods produce information about the relative magnitude of benefits and costs that accrue (over time) to society as a result of any given action.

Model/Tool

The benefit calculator tool used at PSRC is a custom-built computer application which at its core uses the economic concept of “user benefits”. Essentially what this does is accrue the measurable benefits and costs of an alternative with an established “baseline” alternative, summed over a variety of different users and benefit/cost categories. So, travel time and price benefits accrued to auto drivers, transit passengers, freight (truck) trips, costs of accidents, emissions, and reliability measures, are all captured by the tool.

Key Assumptions

- The project alternative and the base case must be explicitly defined as a set of implementable projects.
- Values of time, vehicle operating costs, accident rates and costs, emission rates, and income categories are all established, and based on existing data sources or extrapolated to year 2040 levels.
- Present values of benefits and costs are determined using established inflation rates for all project years.
- Only measurable benefits and measurable costs are included in the analysis. Every effort has been made to capture a wide range of measures to best reflect an overall measure of user benefit.