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Climate Smart Communities: Scenarios Project

Phase 1
Metropolitan GreenSTEP Scenarios Technical Documentation

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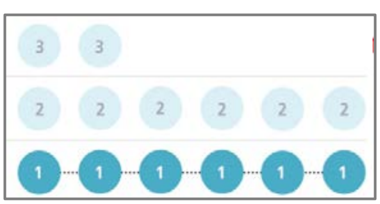
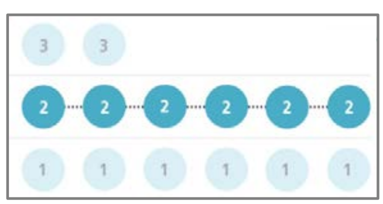
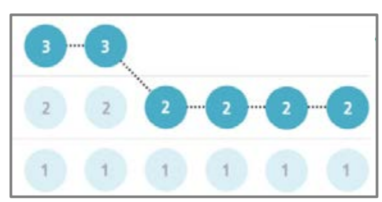
January 2012







About Metro

Clean air and clean water do not stop at city limits or county lines. Neither does the need for jobs, a thriving economy, and sustainable transportation and living choices for people and businesses in the region. Voters have asked Metro to help with the challenges and opportunities that affect the 25 cities and three counties in the Portland metropolitan area.

A regional approach simply makes sense when it comes to providing services, operating venues and making decisions about how the region grows. Metro works with communities to support a resilient economy, keep nature close by and respond to a changing climate. Together we're making a great place, now and for generations to come.

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PURPOSE AND LEGISLATIVE BACKGROUND

This document provides a detailed description of the rationale behind all Phase 1 Metropolitan GreenSTEP policy inputs. The inputs were developed by Metro staff in consultation with a work group of members of the Metro Technical Advisory Committee (MTAC) and the Transportation Policy Alternatives Committee (TPAC). The assumptions used Phase 1 are ambitious and were based on the need to create a starting point to test scenarios. The input assumptions are for research purposes only and do not necessarily reflect current or future policy decisions of the Metro Council, MPAC or JPACT.

The purpose of the analysis is to test the Greenhouse Gas (GHG) emissions reduction potential of current plans and policies, including different combinations of land use and transportation strategies. Metropolitan GreenSTEP, a transportation GHG emissions model developed by the Oregon Department of Transportation (ODOT), provides a new and innovative opportunity to conduct this type of transportation emissions analysis. Using Metropolitan GreenSTEP – the same model used to set the region's GHG emissions reduction target – ensures compatibility with the state's planning efforts and provides a common GHG emissions reporting tool across the state.

The inputs for each of the strategies outlined in this report are used to create 144 scenarios. The foundation of this work is the development of a Base Case – the existing conditions for 2010 – and a Reference Case – a forecast of how the region will perform in 2035 based on projected population and demographic trends. The Reference Case assumes the realization of existing plans and policies, and represents the Level 1 assumptions for each policy area. The remaining 143 scenarios test plausible combinations of land use and transportation strategies that could affect GHG emissions from light-duty vehicles (Figure 1). Each of these policy areas includes individual strategies that have been shown to affect GHG emissions and each level of effort tests different implementation levels for each of the policy areas. While some strategies are new, many of the strategies tested are already being implemented to realize the 2040 Growth Concept and the aspirations of communities across the region.

Technical inputs were localized using regional data, where possible. Policy inputs for all Fleet and Technology inputs were defined in the State Agencies' Technical Report (March 1, 2011) and assumed for purposes of this analysis, to be consistent with the Metropolitan Greenhouse Gas Emissions Reduction Targets Rule (OAR 660-044) in May 2011.[1]

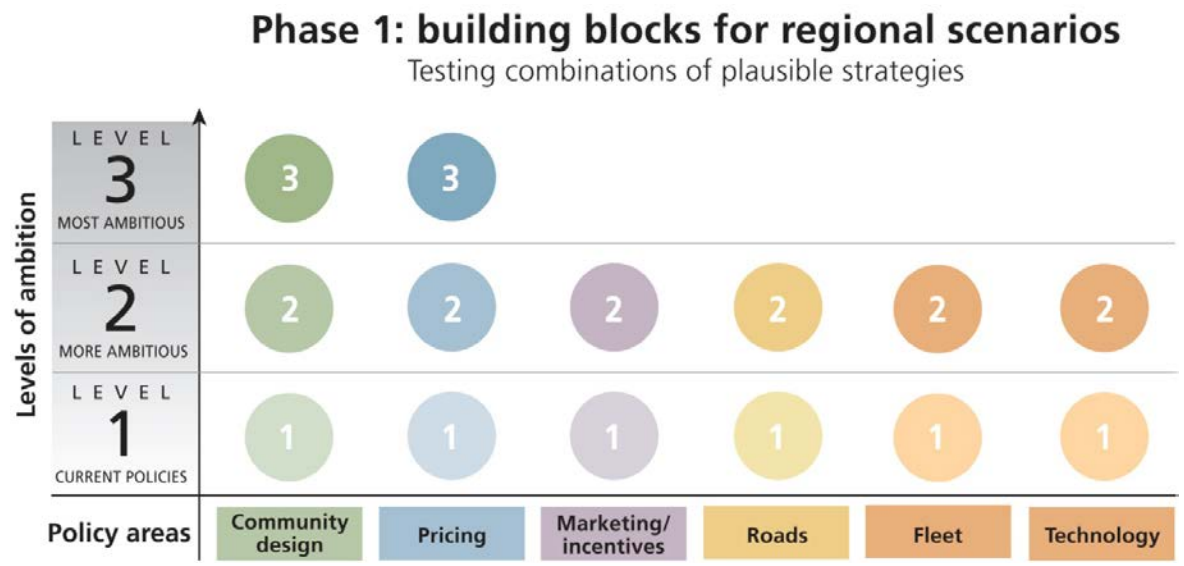
The results of the analysis will be used to frame policy choices and tradeoffs presented by the most effective strategies and to begin identifying implementation opportunities and challenges associated with different approaches to meeting the GHG emissions reduction target. The findings from this regional-level scenarios analysis and the Strategy Toolbox report (September 2011) will be used to recommend policy options and packages of strategies for further evaluation in 2012. The findings and

[1] http://www.oregon.gov/LCD/docs/rulemaking/trac/660_044.pdf

recommendations also will be included in a progress report that ODOT and DLCD staff will provide to the Oregon State Legislature in January 2012.[2]

In Phase 2, the level of implementation of these strategies as well as their timing and sequencing will be explored and further refined to develop alternative scenarios.

Figure 1: Metropolitan GreenSTEP policy areas, by level of ambition



Strategies tested

- **Community design:** Complete neighborhoods and mixed-use areas, urban growth boundary, transit service, bike travel, parking
- **Pricing:** Pay-as-you-drive insurance, gas tax, road use fee, carbon fee
- **Marketing and incentives:** Eco-driving, individualized marketing programs, employer commute programs, car-sharing
- **Roads:** Freeway and arterial capacity, traffic management
- **Fleet:** Fleet mix and age
- **Technology:** Fuel economy, carbon intensity of fuels, electric and plug-in hybrid electric vehicle market share

The input data for each of the six GreenSTEP model policy levers in this documentation report include: (1) a brief description of the policy input tested; (2) input values assumed for each policy lever; (3) supplemental research where applicable; and (4) other background assumptions used in the analysis. This documentation report is not intended to be a Metropolitan GreenSTEP model user guide but rather to provide background information on the rationale behind each Phase 1 policy area assumption.

[2] The Phase 1 findings report (January 2012), and the Strategy Toolbox report (September 2011) can be found through the project website at http://www.oregonmetro.gov/index.cfm/go/by.web/id=36945.

GEOGRAPHIC SCOPE OF ANALYSIS

Regional districts

Metropolitan GreenSTEP runs using 20 districts (see Figure 2) and provides a comparable structure to the State GreenSTEP model, which runs using the 36 Oregon counties. Because GreenSTEP calculates greenhouse gas (GHG) emissions from household VMT estimates, Metro adapted the region's 18-district transportation analysis zone (TAZ) map in an effort to define sub-regional geographies with similar travel behavior and land use characteristics. The original 18-district map used TAZs as the base geographic unit. However, in order to have the regional districts nest within county geographies, these boundaries were adjusted to Census tract geographies. A number of the original 18 districts were adjusted in an effort to keep Regional Centers within a single district when possible (most Regional Centers are intact with only a few being intersected by neighboring districts). In addition, two districts were added in order to better account for local land use and travel characteristics.

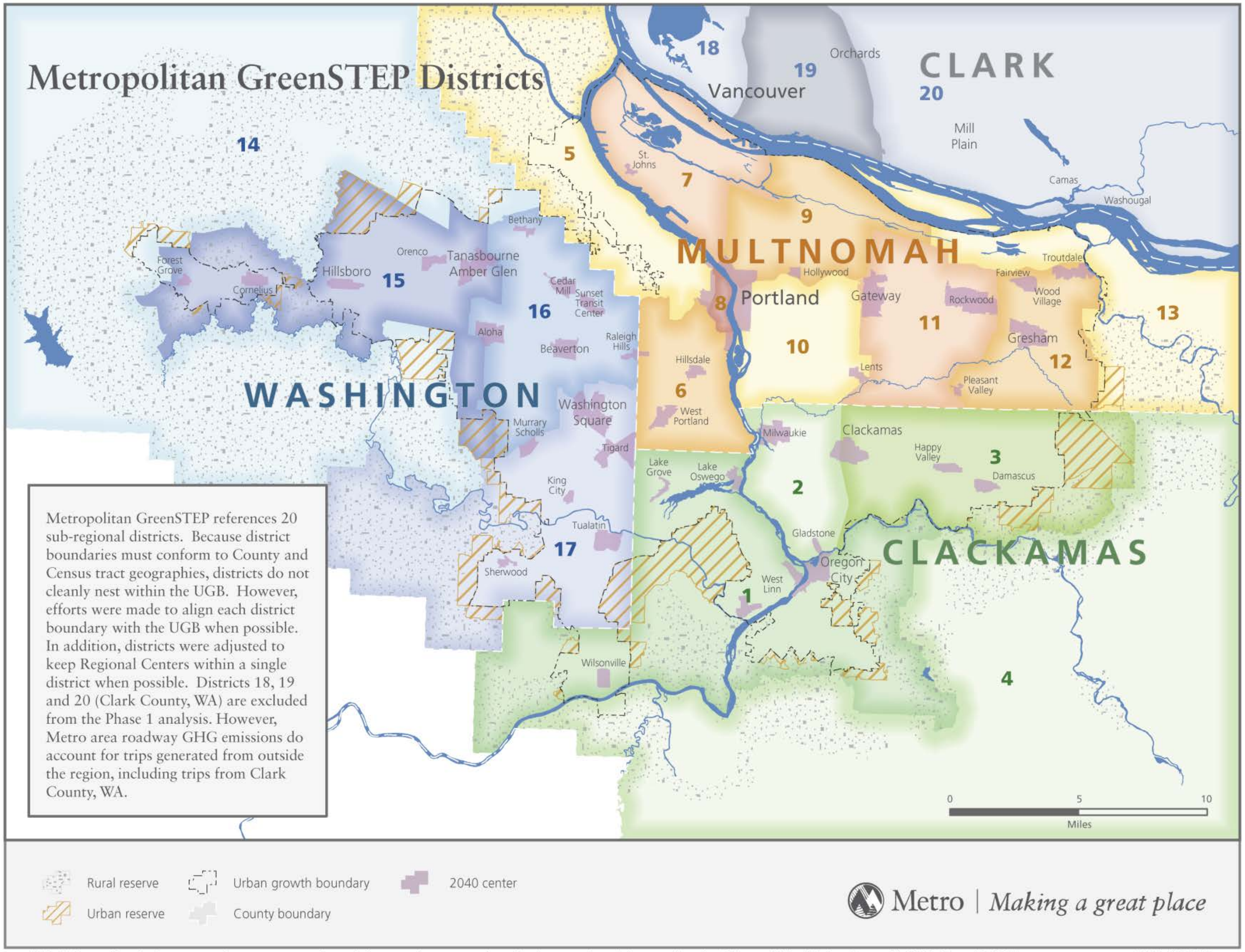
1. In Washington County, District 2 was subdivided and District 19 was created to isolate Hillsboro, Forest Grove and Cornelius from the rest of rural Washington County.
2. In Multnomah County, District 13 was subdivided and District 20 was created to isolate Gresham and Troutdale from the rest of Multnomah County.

The land use characteristics of the 20 districts influence a number of factors used to estimate household vehicle ownership and vehicle travel. These include the land use characteristics of the area where a household resides, population density and urban form characteristics. Land use characteristics are assigned to households using the following method (from ODOT's GreenSTEP documentation report)[3]:

1. Each household in each county is assigned to one of three land use types - metropolitan, other urban, or rural.
2. The geographic extent of urban growth in metropolitan and other urban areas in each county is calculated.
3. Overall metropolitan, other urban and rural densities are calculated.
4. Households are assigned a Census tract population density based on the overall metropolitan, urban or rural area where it is located.
5. Households in metropolitan areas are designated as being in an urban mixed-use community/neighborhood or not, based on Census tract density and metropolitan goals for urban mixed-use development.

[3] Gregor, Brian, ODOT Transportation Planning Analysis Unit, Greenhouse Gas Statewide Transportation Emissions Planning Model (GreenSTEP Model) Documentation, September 2010.

Figure 2: Metropolitan GreenSTEP 20 districts map



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Because the district geographies will be used to calculate the above mentioned background conditions – which in combination with the UGB expansion rates affects the proportion of households in mixed use areas – it is important to net out the land areas that are not designated as developable by 2035 (the planning time horizon of the scenarios project).
Therefore, after establishing the new district boundaries the following steps were taken to create a net acreage for each district:

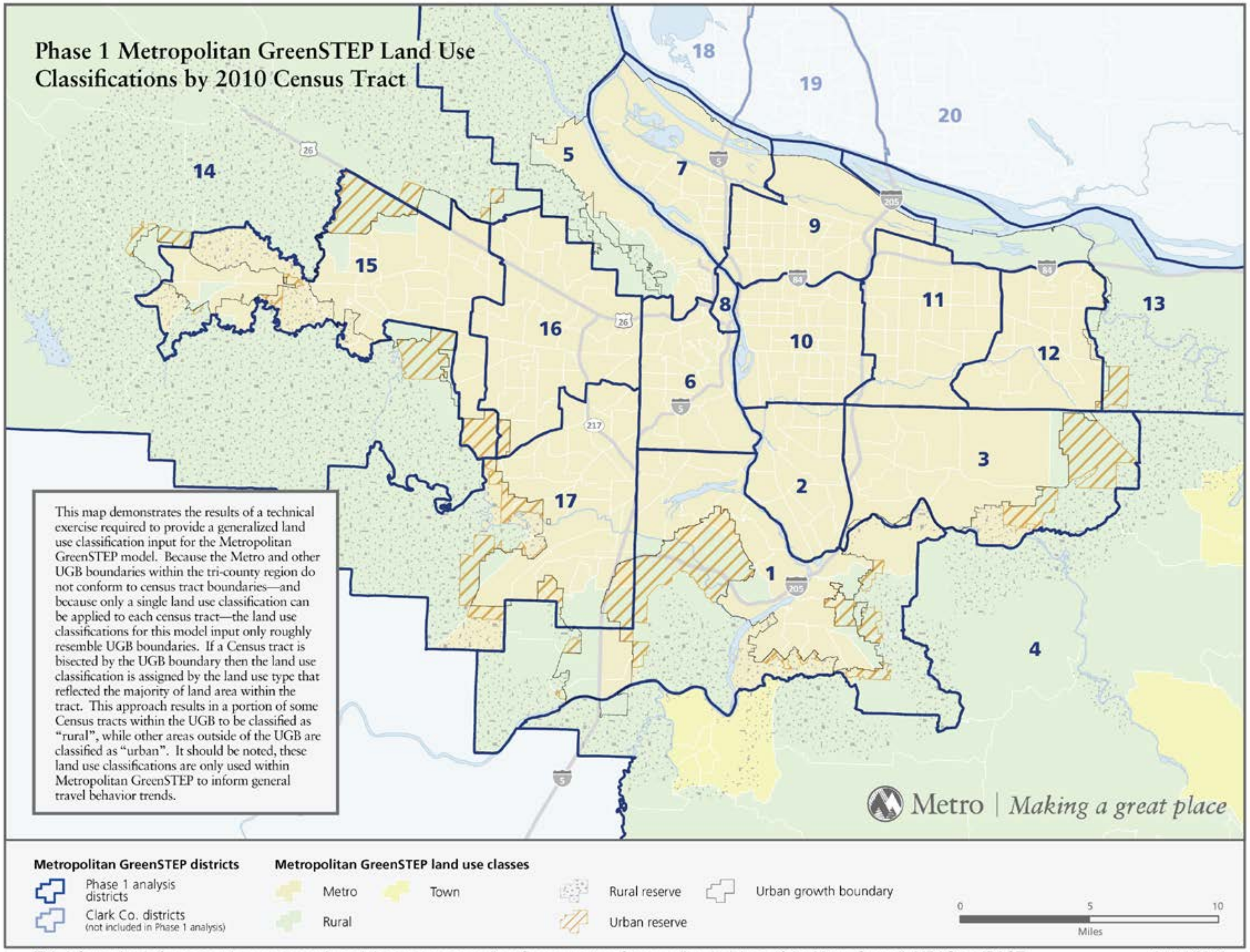
1. Total acreage is calculated for each district.
2. Within the UGB, the area designated as parks and rivers is subtracted from the total UGB land area.
3. Outside of the UGB the land area designated as Urban Reserves is added to the net land area in step 2.
4. Outside of the UGB the land area designated as Rural Reserves is subtracted.
5. Similarly, outside of the UGB the Undesignated land area is also subtracted.
6. The land area outside of the Metro MPO boundary, but within a UGB is designated as a "other urban."
7. The remaining land area is identified as Rural.

These seven steps result in the following land area designations by district:

- **"Metropolitan"** includes the land area within the Metro UGB (minus parks and rivers) plus Urban Reserves. This land is the developable land area to be used for the "metropolitan" population density calculation.
- **"Other urban"** includes the land areas within a UGB that are outside of the MPO boundary (conforming to the GreenSTEP model land use definition for "other urban").
- **"Rural"** designations include all land area outside of the UGB that is a Rural Reserve, Undesignated and/or all remaining county land area that is not included as "metropolitan" or "other urban."

Figure 3 includes the land use designations used for the Phase 1 Metropolitan GreenSTEP scenario runs. It should be noted that assigning a single land use characteristic to each Census tract results in a generalized land use map that does NOT reflect adopted land use policy. Figure 3 only reflects a technical exercise required to provide a generalized land use classification input into the Metropolitan GreenSTEP model. Because the Metro and other UGB boundaries within the tri-county region do not conform to census tract boundaries—and because only a single land use classification can be applied to each census tract—the land use classifications for this model input only roughly resemble UGB boundaries. When a Census tract was bisected by a UGB boundary the classification was designated with the land use type that reflected the majority of the land area within the tract. For example, a tract with two thirds of its land area inside the UGB and one third outside would be designated as "Metropolitan", while if the opposite ratio were to be true, the tract was designated as "Rural".

Figure 3: Phase 1 Metropolitan GreenSTEP land use



Background demographic characteristics

The 2035 regional household growth forecast assumed in the Phase 1 analysis comes from the Beta 2050 growth forecast prepared by Metro's Data Resource Center in August 2011. The Beta forecast is an interim forecast that will continue to be reviewed and refined in coordination with local governments in the region prior to being considered for adoption by the Metro Council in 2012.

The Beta forecast reflects updated assumptions for redevelopment and infill opportunities and designated urban reserves, and provides the background demographic characteristics that serve as the foundation of the Phase 1 scenarios. The updated assumptions reflect the 2010 Council actions and the urban and rural reserves designated in 2010 and 2011. The Climate Scenarios project will continue to coordinate its technical assumptions with development of the final regional forecast and update the forecast information as data are made available.

While the Phase 1 scenarios used the Beta forecast, Phase 2 future scenarios will use the updated Gamma forecast. While each phase will use updated forecast data, alternative population growth assumptions will not be tested as part of the scenarios project. The final adopted regional forecast will be used in Phase 3 of the Scenarios Project in 2013. The Metropolitan GreenSTEP results presented in this documentation report use the following forecasted population growth: between the years 2010 and 2035, the population within the Metro urban growth boundary is forecast to increase by 400,000, growing from 1.4 to 1.8 million residents. This assumption represents the lower middle-third of the Beta population growth forecast range. This range value is consistent with Metro Council's recent adoption of an ordinance (in October 2011), which focused its growth management decision on the lower end of the middle-third of the population growth forecast range.

These growth rates do *not* reflect the entire region's projected population growth but rather the growth anticipated within the region's urban growth boundary. The growth forecast does not include anticipated growth within the areas of Clackamas, Multnomah, and Washington Counties that are outside of the Metro UGB; or Clark County, WA. It is important to note that Metropolitan GreenSTEP travel behavior estimates are made irrespective of housing choice or supply. Therefore, there is no assumption about the type of housing assumed to be built in the future and the following housing supply growth characteristics are presented for context purposes only.

Recently, approximately 40 percent of new housing units constructed in the region are multi-family (MF) and 60 percent is single-family (SF). The draft Beta forecast reflected a marginal growth split of 78 percent MF and 22 percent SF by 2035, which would result in a total housing stock split of 34 percent MF and 66 percent SF by 2035. However, Metro, in coordination and consultation with local government partners, refined these assumptions resulting in a draft Gamma forecast. The Gamma forecast demonstrates that over the next 25 years approximately 59 percent of new housing units in the region will be MF, and 41 percent will be SF. This growth split results in a total housing stock split of 35 percent MF and 65 percent SF. These updated Gamma assumptions will be reflected in the Phase 2 and Phase 3 scenarios.

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The input assumptions for Levels 2 and 3 are for research purposes only and do not reflect current or future policy decisions of the Metro Council, MPAC or JPACT

This table summarizes the inputs for the 2010 Base Year and 144 alternative scenarios that reflect different levels of implementation for each category of policies. The inputs were developed by Metro staff in consultation with a technical work group of MTAC and TPAC members. This information is for research purposes only.

Table 1: 2010 Base Year and alternative scenarios inputs

	Strategy	2010	Reference case: 2035	2035	2035
		Base Year Reflects existing conditions	**Level 1** Reflects current plans and policies	**Level 2** Reflects more ambitious policy changes	**Level 3** Reflects even more ambitious policy changes
Community design	Households living in mixed-use areas and complete neighborhoods (percent)	GreenSTEP calculates			
Community design	Urban growth boundary expansion (acres)	2010 UGB	7,680 acres	7,680 acres	No expansion
Community design	Bicycle mode share[1] (percent)	2%	2%	12.5%	30%
Community design	Transit service level	2010 service level	2035 RTP service level	2.5 times RTP service level	4 times RTP service level
Community design	Workers/non-work trips paying for parking (percent)	13% / 8%	13% / 8%	30% / 30%	30% / 30%
Community design	Average daily parking fee ($2005)	$5.00	$5.00	$5.00	$7.25
Pricing	Pay-as-you-drive insurance (percent of households participating and cost)	0%	0%	100% at $0.06/mile	No change from Level 2
Pricing	Gas tax (cost per gallon $2005)	$0.42	$0.48	$0.18	
Pricing	Road use fee (cost per mile $2005)	$0	$0	$0.03	
Pricing	Carbon emissions fee (cost per ton)	$0	$0	$0	$50

[1] Percent of all tours less than 6 miles roundtrip.

Strategy		2010 Base Year Reflects existing conditions	2035 Level 1 (Reference case) Reflects current plans and policies	2035 Level 2 Reflects more ambitious policy changes	2035 Level 3 Reflects even more ambitious policy changes
Marketing and incentives	Households participating in eco-driving	0%	0%	40%	No Level 3
Marketing and incentives	Households participating in individualized marketing programs (percent)	9%	9%	65%	
Marketing and incentives	Workers participating in employer-based commuter programs (percent)	20%	20%	40%	
Marketing and incentives	Car-sharing in high density areas (target participation rate)	Participation rate of 1 member/100 people	Participation rate of 1 member/100 people	Double participation to 2 members/100 people	
Marketing and incentives	Car-sharing in medium density areas (target participation rate)	Participation rate of 1 member/200 people	Participation rate of 1 member/200 people	Double participation to 2 members/200 people	
Roads	Freeway and arterial expansion	2010 system	2035 financially constrained system	No expansion	
Roads	Delay reduced by traffic management strategies (percent)	10%	10%	35%	
Fleet	Fleet mix (proportion of autos to light trucks and SUVs)	auto: 57% light truck/SUV: 43%	auto: 56% light truck/SUV: 44%	auto: 71% light truck/SUV: 29%	
Fleet	Fleet turnover rate (age)	10 years	10 years	8 years	
Technology	Fuel economy (miles per gallon)	auto: 29.2 mpg light truck/SUV: 20.9 mpg	auto: 59.7 mpg light truck/SUV: 41 mpg	auto: 68.5 mpg light truck/SUV: 47.7 mpg	
Technology	Carbon intensity of fuels	90 g CO_2e/megajoule	81 g CO_2e/megajoule	72 g CO_2e/megajoule	
Technology	Light-duty vehicles that are electric or plug-in electric vehicles (percent)	auto: 0% light truck/SUV: 0%	auto: 4% light truck/SUV: 1%	auto: 8% light truck/SUV: 2%	

COMMUNITY DESIGN

Households in mixed use areas or complete neighborhoods

While population density is not the only predictor for mixed-use areas, land use policies aimed at changing the amount and types of mixed-use development are also important factors to consider. However, population density was found to be highly significant and, as an indicator, is in keeping with the large scale nature of the GreenSTEP model. It is also more likely to provide a more consistent indicator of transportation effects. Because there is not one regionally endorsed approach for estimating the percent of population living in complete communities, the proportion of households living in mixed use areas was estimated using the Metropolitan GreenSTEP's internal land use characteristics model.

In GreenSTEP, the land use characteristics of the area where a household resides affects vehicle ownership and travel. Land use characteristics are defined by three broad land use categories (metropolitan, other urban, rural), population density (persons per square mile) and the urban form characteristics. The last two characteristics (density and urban form) are defined at the census tract level. The GreenSTEP model estimates the proportion of households in mixed-use areas or complete neighborhoods using the following approach[4]:

1. Population densities are calculated from the metropolitan population and the metropolitan area for each Census tract.
2. Density is used as a proxy to identify the urban mixed-use characteristics that affect vehicle travel. Mixed-use household estimates are calculated using a probability model to estimate the percent of households in mixed-use areas based on population density. (A number of urban design and form variables – the "5-Ds" – were tested using National Household Travel Survey data and census tract population density was found to be highly significant and is representative of several urban land use characteristics. These characteristics include neighborhood-level mixing of different land uses, well-connected street system, greater pedestrian accessibility orientation of land uses, and greater transit accessibility.)
3. The proportion of households in mixed-use areas by census tract are then summed by county and divided by total county households to estimate the percent households in mixed-use areas by county.

Complete neighborhoods are characterized by a mix of land uses, interconnected streets to minimize travel distances (particularly walking and bicycling), and sidewalks.

Phase 1 (2011) For all policy levels, an estimated proportion of households in mixed-use areas was calculated using the following: Metropolitan GreenSTEP internal mixed use households probability model and Metro's interim beta forecast.

[4] Gregor, Brian, ODOT Transportation Planning Analysis Unit, Greenhouse Gas Statewide Transportation Emissions Planning Model (GreenSTEP Model) Documentation, September 2010.

Phase 2 (2012) For all policy levels, an estimated proportion of households in mixed-use areas will be calculated using the following: Envision Tomorrow inputs will override the internal mixed use model in Metropolitan GreenSTEP.

Because the UGB expansion rates for all levels reflect a decline from current or historic expansion rates population densities will increase (e.g., UGB expansion will not grow at the same rate as population growth). As a result, the proportion of households in mixed-use areas increases (resulting from GreenSTEP's internal mixed-use probability model using density as an indicator variable for neighborhood mixed-use characteristics).

The following values reflect the Metropolitan GreenSTEP calculated mixed-use inputs:

2010 Base Year 24% (GreenSTEP calculation)
2035 Level 1 33% (GreenSTEP calculation)
2035 Level 2 33% (GreenSTEP calculation)
2035 Level 3 34% (GreenSTEP calculation)

Urban growth boundary expansion

The geographic extent of metropolitan and other urban areas is calculated from base year measurements of urban growth boundary areas and policy inputs which describe how rapidly urban growth boundaries grow relative to population growth.

The following reflect Metropolitan GreenSTEP inputs:

2010 Base Year captures the 2010 UGB land area and the adopted urban reserves UGB expansion rate.
2035 Level 1 reflects the change in historic UGB expansion relative to population growth (1990 – 2010: .375:1) to the adopted urban reserves UGB expansion rate relative to population growth (.15:1). This ratio represents the equivalent of 7,680 acres being added to the current UGB.
2035 Level 2 assumes the same level of expansion as Level 1.
2035 Level 3 tests no expansion of the urban growth boundary from 2010.

Bicycle travel

GreenSTEP models bicycle travel as a component of a class of light-weight vehicles (including bicycles, electric bicycles, Segways and similar) that are small, light-weight and can travel at bicycle speeds or slightly higher than bicycle speeds. This class of vehicles, though currently a minor mode of urban transportation has the potential for having a large impact on transportation emissions in the future. Standard bicycles are the dominant form of light-weight vehicle in use in the United States. This could potentially change as electric bicycles and other light-weight electric vehicles grow in market share. The GreenSTEP light-weight electric vehicles model assumes that light-weight vehicles have the potential for substantially increasing light-weight vehicle travel because they increase the ease and convenience of this mode of travel.

Currently, the only data available for this light-weight vehicle model is bicycle mode share. No distinctions are made between bicycles and electric bicycles and there are no data available on neighborhood electric vehicle or Segway use. Therefore, the input values only represent bicycle mode share.

In addition to identifying regional input data, Metro staff conducted background research on bicycle mode share rates and targets in other U.S. and international cities (see Table 2).

Table 2: U.S. and international bike mode share and targets

City or region	Current bike mode share	Adopted or defined bike mode share target
Portland, OR	6% (2009 ACS) 7% (2010 Auditor report work trips)	30% of work trips (Draft Portland Plan)
Corvallis, OR	9.4% (2000 Census)	*None*
Davis, CA	14% (2000 census)	25% of all trips by 2012 (adopted in 2009 bike plan)
Boulder, CO	12.3% (2009 ACS) 7% (2000 census) 15.9% (2009 travel diary survey - includes all trips, not just commute)	Increasing bicycle mode share (all trips) at least 4% between 1994 (11.3%) and 2020 (1996 bicycle system plan). (Goal has been met according to travel diary survey results.) Other related targets are: 75% non-SOV mode share by 2020 (2008 Transportation plan) zero growth in VMT from 1994 levels.
Eugene, OR	10.8% (2009 ACS)	Approximately 22% (Draft bike/ped plan has defined a target of doubling bike mode share by 2020)
Seattle, WA region	0.90% (2009 ACS) Seattle-Tacoma-Bellevue MSA	*None*
San Francisco, CA region	1.5% (2009 ACS) SF-Oakland-Fremont MSA	None, but they have a goal to increase active transportation activity per day from 8 to 15 minutes by 2040
Nashville, TN region	0.10% (2009 ACS) Nashville-Davidson-Murfreesboro-Franklin MSA	None
Sacramento, CA region	1.6% (2009 ACS) Sacramento-Arden-Arcade-Roseville, MSA	Double the percentage of all trips made by bicycling and walking in the Sacramento Region from 6.6%in 2000 to 13.2% of all trips by 2020. (Modeled data)
Copenhagen, Denmark	37%	50% by 2015

Table 3 provides a summary of U.S. cities (population of 65,000 or more) with the highest bicycle mode share. Table 4 provides comparable data for a sample of international cities.

Table 3: Top U.S. cities commuting bicycle mode share (Only cities with 65,000 + population[5])

City	Population	Bicycle Mode Share
Boulder ,CO	100,160	12%
Eugene, OR	153,275	11%
Fort Collins, CO	138,722	10%
Berkeley CA	102,802	9%
Cambridge, MA	108,776	9%
Missoula, MT	68,875	7%
Gainesville, FL	116,615	6%
Portland, OR	566,606	6%
Somerville, MA	76,489	5%
Madison, WI	235,410	5%
Minneapolis, MN	385,384	4%
Boise, ID	205,698	4%

Table 4: Sample of International Cities bicycle mode share

City	Population	Bicycle Mode Share
Groningen	188,000	57%
Delft	96,000	43%
Houten	46,000	42%
Amsterdam	750,000	40%
Copenhagen	520,000	37%
Utrecht	300,000	33%
Bogota	7,500,000	5%
Sydney	4,500,000	2%
Brisbane	2,000,000	2%

2010 Base Year is the current estimated regional bike mode share of 2% for all tours less than or equally to 6 miles roundtrip, as reflected in the 2035 RTP.

2035 Level 1 reflects 2035 RTP regional bicycle mode share of 2% for all tour lengths of 6 miles or less. This tour length reflects the assumptions for bicycle travel for the Portland Plan and better reflects regionally specific bicycle mode share studies (most reflect a roughly 3 mile trip length; 3 mile trips * 2 = 6 mile tour length).

2035 Level 2 is based on the Level 3 STS Round 1 scenarios, reflecting a mode share increase to 12.5%, with a tour length of 6 miles.

2035 Level 3 reflects the Portland Bike Master Plan target for 2030: mode share will increase to 30% for all tours less than or equal to 6 miles roundtrip. Level 3 reflects a significantly more aggressive bike mode share than the STS Scenarios in an effort to evaluate whether bike mode share, at a regional scale, might have a larger impact on reducing GHG emissions than it would at a state level.

[5] Source: American Community Survey; American Community Survey only includes cities with populations greater than 65,000

Transit service

GreenSTEP uses revenue miles, rather than revenue hours to quantify GHG emissions. TriMet defines revenue hours as the amount of time a TriMet vehicle and operator are available to serve passengers. Revenue hours describe how much service is available to customers (Transit Investment Plan Glossary). Revenue miles refer to the distance traveled by a TriMet vehicle when the vehicle is available to serve passengers. Revenue miles are used to calculate the emissions associated with the provision of service.

In an effort to reconcile these two transit service variables, revenue miles are converted to vehicle miles, and grouped by age, range of fleet, and assumptions of miles per gallon. These are adjusted by estimated congestion levels, the result of which is transit GHG emissions/mile.

TriMet uses revenue hours because it better reflects costs, which makes conversion of revenue hours to revenue miles difficult given revenue hours shift over time due to congestion. However, based on TriMet annual revenue mile and revenue hour data TriMet staff calculated a regional conversion rate of 14 revenue miles per revenue hour.

This conversion rate is based on TriMet annual data on revenue miles and revenue hours for bus-only for the system as a whole from FY 1971 to FY 2010. In FY 2010, the factor was 14.68 revenue miles per revenue hour. When assessed on a year-to-year change in revenue miles per revenue hour, there is a very small downward trend. Taking out two years of extreme outliers, the trend during this 40 year period, if continued into the future, would result in 14.06 revenue miles per revenue hour in FY 2035. (See Table 5; NOTE: Table 5 does *not* represent a Metropolitan GreenSTEP input level but rather provides an example of how revenue hours are converted to revenue miles.)

Table 5: Ratio of transportation service expansion to population growth (w/revenue mile conversion rate)

Demonstration example: conversion of revenue hours to revenue miles				
TriMet service district	**2005**	**2035**	**Percent increase**	**Ratio (revenue mile growth: population growth)**
Population estimate	1,543,910	2,333,604	**51%**	**.86:1**
Revenue Hours	*3,073,579*	*4,433,847*	*44%*	
Conversion rate (revenue hours to revenue miles) 14 RM/RH				
Revenue Miles	43,030,106	62,073,858	**44%**	

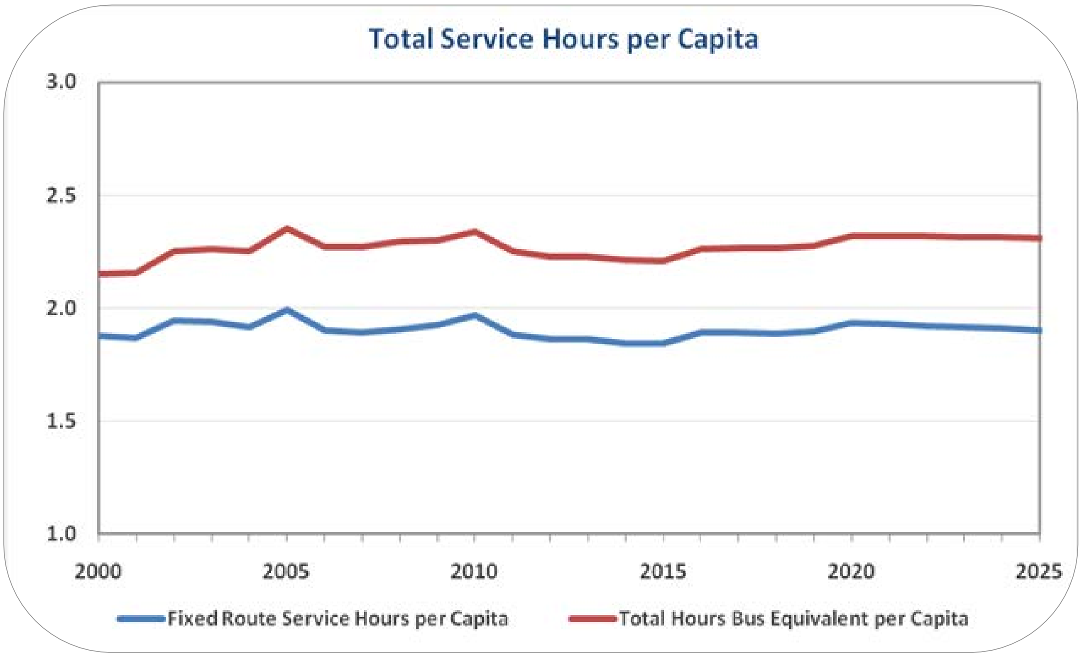
2010 Base Year reflects current TriMet service levels for light-rail streetcar and bus service growth. This ratio represents the equivalent of 9 revenue miles per capita.

2035 Level 1 represents TriMet's current service trend, roughly a 1:1 ratio of fixed and bus route transit service growth compared to population growth (see Figure 4). This ratio represents the equivalent of 29 revenue miles per capita. The percent of transit service growth that is electrified reflects the current revenue mile mode split of 80/20, which represents 80% B-5 biodiesel and 20% electric.

2035 Level 2 reflects the input value in the RTP transit investment scenario (Scenario B), with a ratio of 2.4:1 service mile growth compared to population growth. This ratio represents the equivalent of 69 revenue miles per capita.

2035 Level 3 is a 4:1 ratio of transit service mile growth compared to population growth, which is more aggressive than the transit scenario analysis conducted for the 2035 RTP. This ratio represents the equivalent of 115 revenue miles per capita.

Figure 4: TriMet total service hours per capita (fixed and bus routes), projected 2000–2025



The results of the 2035 RTP transit scenario analysis yield a 2.4:1 ratio of service mile growth compared to population growth. This ratio was calculated by first using TriMet's service hour bus capacity equivalents to calculate the total service hour growth from 2005 to 2035 by mode (light rail, bus, streetcar, commuter rail) in bus service hour equivalents (common unit). These equivalents were summed to calculate a subsequent growth rate, after converting revenue hours to revenue miles. The total revenue hours for 2005 and 2035 are shown in Table 6 for reference. The resulting growth rate of 2.4:1 is less than the proposed 3:1 ratio, which represents a tripling of service levels.

Table 6: 2035 RTP transit investment scenario (Scenario B)

RTP Scenario B: Conversion of revenue hours to revenue miles				
TriMet service district	**2005**	**2035**	**Percent increase**	**Ratio (revenue mile growth : population growth)**
UGB Population estimate (from RTP)	1,408,207	2,039,195	45%	**2.4 : 1**
Revenue Hours	*8,092*	*16,865*	*108%*	
Conversion rate (revenue hours to revenue miles) 14 RM/RH				
Revenue Miles	113,288	236,110	**108%**	

To help put the transit service level growth projections for Level 2 and Level 3 into context, TriMet staff sought to identify other regions whose current capacity-weighted per capita service levels represent roughly the same level of service projected using this growth rate. In other words, Level 2, for example, seeks to answer the question, "If transit service levels were to grow at a 2.4:1 ratio until 2035, what other regions' levels of service would this be similar to?"

For this analysis, TriMet staff assessed the per capita capacity-weighted service provision of other regions using data from the 2009 National Transit Database, using a capacity adjustment factor of 4.87 to account for higher-capacity modes such as heavy rail, light rail, and commuter rail.

This capacity adjustment factor is based on TriMet's current MAX-bus capacity ratio (MAX light rail vehicles have 4.87 times the capacity of a bus), as a means of simulating the levels of service likely to be provided in the Portland region. That is, while other regions provide heavy rail service with 8 to 10-car trains with substantially more capacity than MAX, it is assumed for this exercise that constraining the additional vehicle capacity to current MAX levels is more realistic and appropriate for purposes of this analysis.

Using this approach, TriMet staff assessed comparable regions on the basis of both Vehicle Revenue Hours and Vehicle Revenue Miles on a per capita basis to adjust for population growth. This analysis provided a range of results due to differences in the nature of the regions' services (e.g., long-haul commuter rail services vs. downtown core services) as well as in the ratio of regions' vehicle miles to vehicle hours. The results of the analysis are summarized in Table 7.

Table 7: Regional capacity-weighted transit service provisions, National Transit Database 2009

UZA Name	2009 capacity-weighted vehicle revenue miles (VRM) (thousands)	2009 capacity-weighted VRM/capita	Growth ratio (x:1)	2009 capacity-weighted vehicle revenue hours (VRH) (thousands)	2009 capacity-weighted VRH/capita	Growth ratio (x:1)
New York-Newark, NY-NJ-CT	2,990,712	168.0	**4.2**	154,295	8.7	3.0
Chicago, IL-IN	650,339	78.3	**2.0**	34,060	4.1	1.4
Washington, DC-VA-MD	430,460	109.4	**2.7**	20,139	5.1	1.8
San Francisco-Oakland, CA	448,781	139.0	**3.5**	19,055	5.9	2.0
Portland, OR-WA	63,377	40.0	**1.0**	4,580	2.9	1.0

The ranges of service mile and service hour growth ratios need to equalize for the Chicago region, the San Francisco Bay Area and the Washington, D.C. region support the use of the 2.4:1 ratio in Level 2, while the range for New York City region supports the use of 4:1 for Level 3.

Parking fees

GreenSTEP considers parking pricing as a trip-based cost that also serves as a proxy for managing the supply of parking in the region. It is assumed that parking costs are commonly paid for at one or both ends of a trip, and sometimes paid for on a monthly basis. GreenSTEP includes parking pricing as a component of the trip costs for auto travel, but in a more general way than traditional urban travel demand models. There are two types of parking costs addressed in GreenSTEP; (1) parking costs at places of employment and (2) non-work parking costs. Daily parking costs are calculated for each household by estimating the proportion of work and non-work trips with parking factors for each household. These annual parking costs are then added in with other variable transportation costs.

Table 8 provides a summary of the calculated average regional daily parking cost in 2005 dollars and the proportion of work trips where parking factors exist for the 2010 base year and 2035 reference case. All population and employment data are from the 2035 RTP forecast and do not represent 2010 Census figures (these values will change slightly based on regional population and employment differences between the 2035 RTP forecast and the forthcoming draft interim forecast).

The following description outlines the approach for calculating these regional averages.

1. Sum of total employment for the 4-County area
2. Calculate total employment in the TAZs where a parking factor exists
3. Calculate percent of employees who have to pay for parking (total employment in TAZ with Parking factor divided by total employment)
4. Calculated a weighted average long-term parking “cost” for employment in TAZs with parking factors. This is calculated by multiplying the total employment in each TAZ by the parking factor for each TAZ, and then dividing that total by #2 above.
5. Same as #4, only using short-term parking “cost” (typically 50% of long-term).
6. This is the straight average of #4 and #5.

The following table was prepared using data from Metro’s Research Center at the Transportation Analysis Zone (TAZ) level.

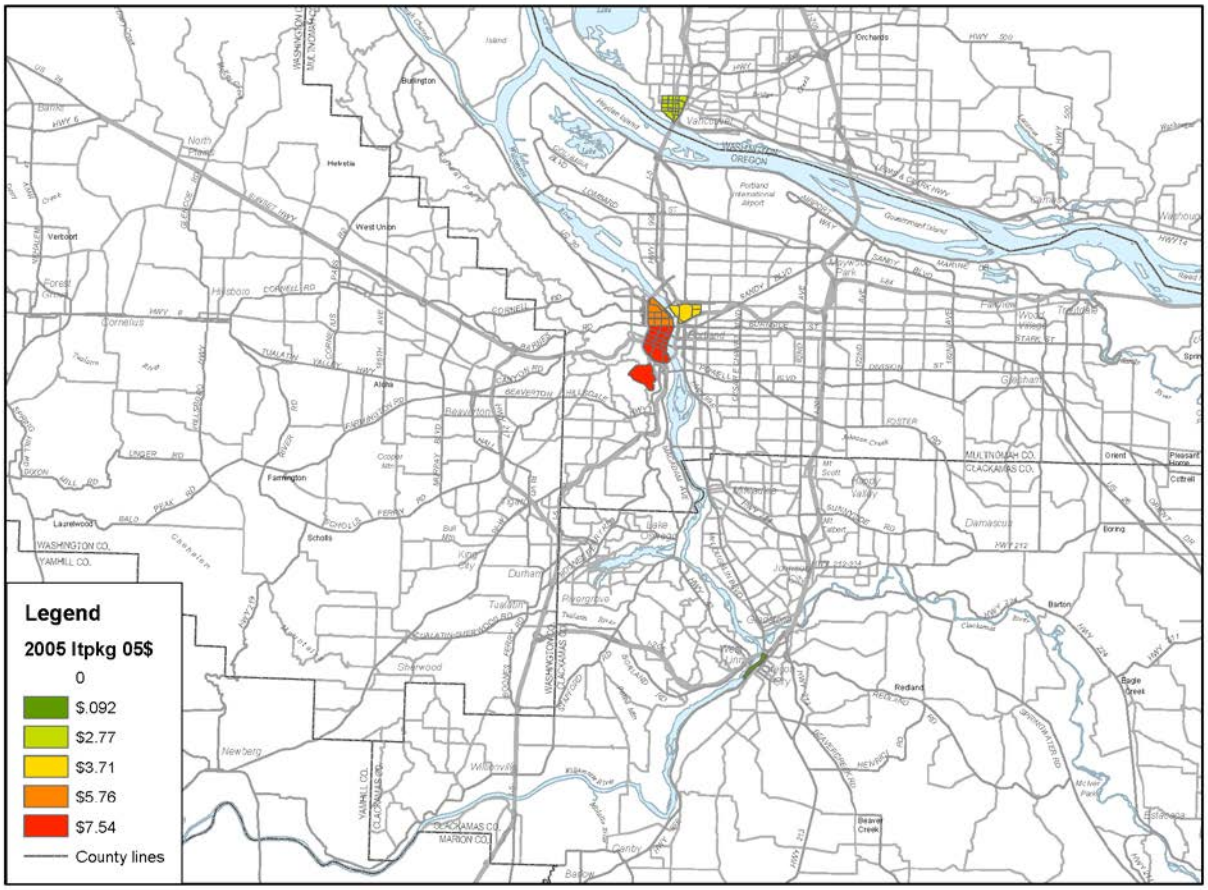
Table 8: Regional parking cost, weighted average for work and non-work trips in 2005 dollars

Parking factor approach	2005	2010	2035
1. Total Regional Employment	1,032,246	917,296	1,799,152
2. Employment in TAZs w/ parking factors	142,712	122,770	559,145
3. Regional % of Employment in TAZ w/parking factors	13.8%	13.4%	31.1%
4. Long-term cost, 2005 $ (weighted average for employees in TAZ w/parking factors)	$6.50	$6.52	$5.13
5. Short-term cost, 2005 $ (weighted average for employees in TAZ w/parking factors)	$3.25	$3.25	$2.91
6. Average cost assuming even split, 2005 $ (long-term/short-term)	$4.87	$4.89	$4.02

Note: the 2035 average parking cost is lower because smaller parking factors are scattered throughout the region instead of having fewer, higher valued factors focused in the Central City. Overall, the “cost” is less, but more employment is located in TAZs with parking factors (31% vs. 13.8%).

Level 1 includes the modeled estimate for the percent of workers paying a parking fee in 2010 from the 2035 RTP (13%) (see Figure 5 and Table 8). The percent of non-work trips paying parking fees reflects current (2010) modeled estimates from the 2035 RTP (8%). The average daily cost ($5) also reflects current modeled estimates from the 2035 RTP (in 2005$) and captures work and non-work parking factors.

Figure 5: 2005 Long Term Parking Factors (2005 $), 2035 RTP



Level 2 tests the affect of increasing the parking fee coverage area (based on the 2035 RTP), without adjusting parking costs (see Figure 6 and Table 9). The percent of workers paying a parking fee reflects future modeled estimates from the 2035 RTP (30%). The percent of non-work trips paying parking fees reflects future modeled estimates from the 2035 RTP (30%). The average daily cost ($5) deviates from the future 2035 modeled estimate in the RTP ($4) to maintain directional consistency with all other Metropolitan GreenSTEP input variables (all input variables increase by level. It is not anticipated that this adjustment will result in a large deviation from adopted policy, nor will it result in significantly altered scenario results).

Figure 6: 2035 Long Term Parking Factors (2005 $), 2035 RTP

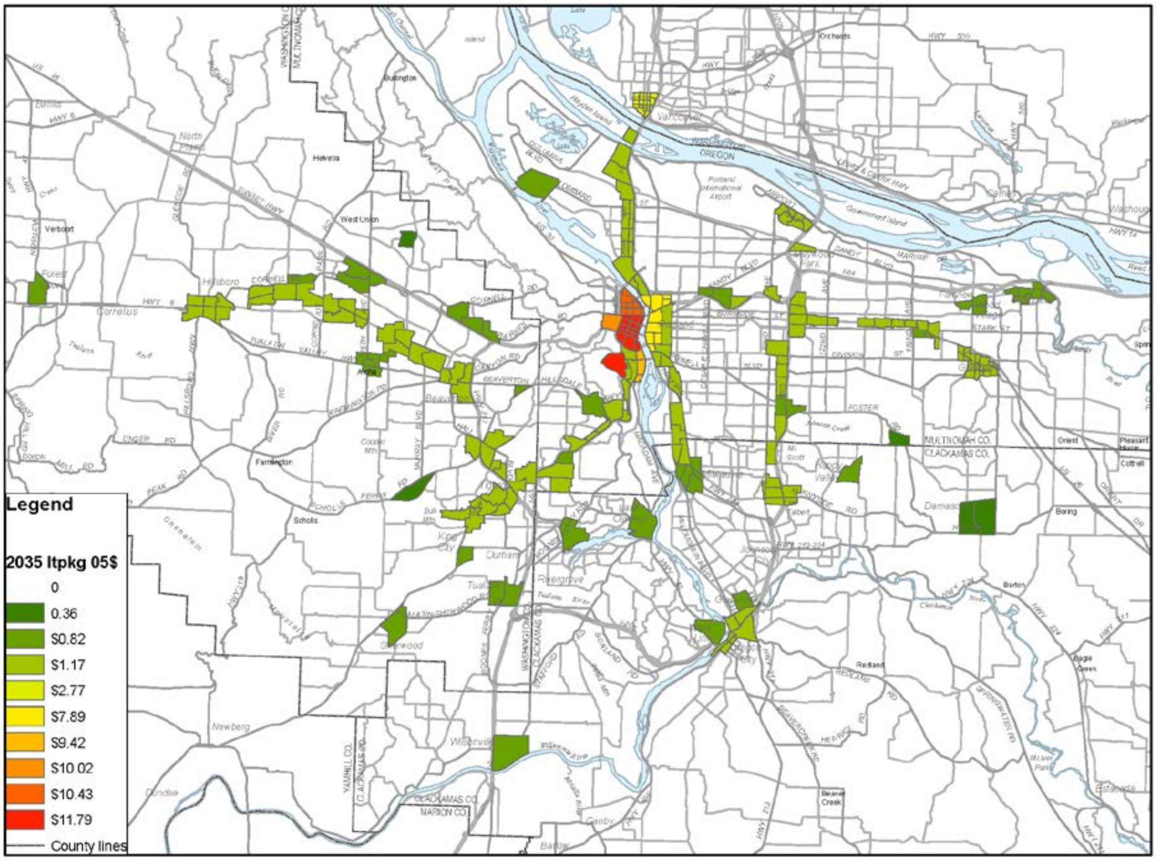


Table 9: Level 2 2035 proportion of regional trips with parking factor, work and non-work

Share of trips with parking factors		
	Work trips	Non-Work trips
Level 1	13%	8%
Level 2	30%	30%
Percent change	138%	263%

Level 3 tests the affect of increasing parking costs, without adjusting the parking coverage area. The percent of workers paying a parking fee reflects the Level 2 input value from the 2035 RTP (30%). The percent of non-work trips paying parking fees reflects the Level 2 input value from the 2035 RTP (30%). Based on the 2035 RTP, the City of Portland parking price increases roughly 1.5% per year over inflation (since 1994). The average parking price in 2035 for Level 3 assumes this growth rate from 2005 (see Table 10).

Table 10: Level 3 Parking pricing

2005 parking cost	1.5% annual increase over 25 years
$5	$7.25

PRICING

Pay-as-you-drive insurance

This pricing strategy converts a portion of liability and collision insurance from dollars-per-year to cents-per-mile (or cents-per-minute/hour if advanced tracking technology is utilized) to charge insurance premiums based on the total amount of miles driven per vehicle on an annual basis and other important rating factors, such as the driver's safety record. If a vehicle is driven more, the crash risk consequently increases.

Description of pay-as-you-drive (PAYD) insurance from the GreenSTEP documentation report.[6] "PAYD insurance is automobile insurance that is paid strictly on a mileage traveled basis, rather than on a lump-sum periodic basis. On average, PAYD insurance does not change the amount that households pay for insurance. However, since the cost of PAYD to the motorist varies with the number of miles driven, there is an incentive to reduce travel to save money on the cost of insurance. It has been estimated that a PAYD insurance rate of 4 to 6 cents per mile, could reduce VMT from light vehicles by about 3.8%.[7] The estimates of the effect of PAYD insurance is on based on assumptions about the price elasticity of vehicle travel. The right value to use is uncertain.[8] Since GreenSTEP treats variable costs as a budget effect, price elasticity depends on the sum of all variable costs, therefore the estimated effect of PAYD insurance will depend on what other costs are being paid as well."

2035 Level 1 reflects current policy - no participation in pay-as-you-drive insurance options. There is no cost associated with pay-a-you-drive insurance.
2035 Level 2 reflects the Level 2 input value in the STS Round 1 Scenarios analysis (100% of households participate in pay-as-you-drive insurance programs). The intent of this level is to test the impact of a relatively new and untested policy strategy. The cost also reflects the Level 2 input value in the STS Round 1 Scenario analysis ($.06/mile).
2035 Level 3 assumes no change from Level 2.

Gas tax, mileage-based road use fee & carbon emissions fee

The model inputs for the gas tax, and road use and carbon emissions fees were developed with the goal of better understanding the relationship between these three pricing mechanisms. First, it is assumed that the current gas tax mechanisms do not provide stable revenue streams when considering the effects of increased fuel efficiency and inflation. While the pricing mechanisms tested in the Phase 1 scenarios do not provide guidance on how transitioning to alternative pricing mechanisms can address this issue, they do provide insight into how improvements in fuel efficiency may affect revenue generation. (Table 11 provides an overview of all pricing mechanisms tested during Phase 1.)

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[6] Gregor, Brian, ODOT Transportation Planning Analysis Unit, Greenhouse Gas Statewide Transportation Emissions Planning Model (GreenSTEP Model) Documentation, September 2010.
[7] U.S. Department of Transportation, Report to Congress, Transportation's Role in Reducing U.S. Greenhouse Gas Emissions, Volume 2: Technical Report, April 2010, pp. 5-22
[8] U.S. Department of Transportation, Report to Congress, Transportation's Role in Reducing U.S. Greenhouse Gas Emissions, Volume 1: Synthesis Report, April 2010, pp. 3-15.

Table 11: Background calculations for gas tax, carbon emissions & vehicle travel fee inputs (Levels 1–3)

Pricing mechanism	Level 1 Cost (2005 Dollars)	Level 2 Cost (2005 Dollars)	Level 3 Cost (2005 Dollars)
2010 Federal gas tax ($/gallon)	$ 0.18	$ 0.18	$ 0.18
2011 State gas tax ($/gallon)	$ 0.30		
Road use fee ($/mile)		$ 0.03	$ 0.03
Carbon emissions fee ($/ton)[9]			$ 50.0

Because all pricing inputs are in 2005 dollars it is assumed (within Metropolitan GreenSTEP) that the pricing mechanisms discussed below are adjusted to account for inflation between 2005 and 2035. It is also important to note that the costs per mile presented in tables 12-14 should not be used to estimate revenue generation for each scenario without also considering changes in DVMT. Further analysis will be completed during Phase 2 to better understand the role of these pricing mechanisms in supporting reinvestment of revenues generated to address implementation costs and anticipated funding shortfalls for achievement of existing plans and policies.

Gas tax

2010 Base Year reflects state and federal gas taxes, which were $.42/gallon ($.24/gallon state gas tax and $.18/gallon federal gas tax).

2035 Level 1 represents existing pricing mechanisms, which demonstrate a declining revenue stream based on anticipated fuel efficiency and technology gains (including Level 1 technology levels). In 2011, the State gas tax was increased to $.30/gallon, as directed by Oregon House Bill 2001, while the Federal gas tax did not change. The input value for Level 1 reflects this state gas tax increase, resulting in a combined gas tax of $.48/gallon.

2035 Level 2 represents an attempt to model the pricing mechanisms needed to maintain a steady state revenue source based on current policies (current state gas tax and average fuel efficiency). Because these pricing mechanisms have not previously been tested using Metropolitan GreenSTEP, the following assumption represents an attempt to model the transition from the state gas tax to a mileage-based road use fee. The current federal gas tax ($.18/gallon) is applied as a cost/gallon (declining revenue), however the state gas tax is applied as a cost per mile equivalent. Therefore, only the federal gas tax is charged in Level 2.

2035 Level 3 assumes no change from Level 2.

[9] Cambridge Systematics, Inc. *White Paper: Costs of Motor Vehicle Travel*. Prepared for ODOT for the purpose of modeling Statewide Transportation Scenarios. Accessed at http://www.oregon.gov/ODOT/TD/OSTI/docs/TAC/Sept22/WP.pdf

Road use fee

2010 Base Year does not test a road use fee (no current policy).
2035 Level 1 does not test a road use fee (no current policy).
2035 Level 2 includes a road use fee that is the equivalent of the current $.30/gallon tax[10] combined with an annual increase of $.01 per year ($.55/gallon in 2035). The assumed gas tax increase reflects the financial assumptions used in the 2035 RTP.[11] However, these gas tax assumptions are modeled as a cost per mile equivalent road use fee. In addition, the road use fee was rounded to $.03/mile to better test the affects of different pricing mechanisms (by rounding up to $.03/mile, there is a greater distinction between Levels 1 and 2).
2035 Level 3 assumes no change from Level 2. The road use fee reflects the Level 2 input value of $.03/mile (2011 State gas tax plus a $.01 per year gas tax increase, in cost per mile equivalents).

Carbon emissions fee

2010 Base Year does not test a carbon emissions fee (no current policy).
2035 Level 1 does not test a carbon emissions fee (no current policy).
2035 Level 2 does not test a carbon emissions fee.
2035 Level 3 reflects a pricing strategy that converts the State gas tax to a road use fee (consistent with Level 2), and begins to account for the estimated external climate costs of greenhouse gas emissions. The carbon emissions fee represents an estimated value of the external costs of transportation GHG emissions ($50/Ton CO_2e).[12]

Tables 12-14 demonstrate the implications of fuel efficiency changes relative to the pricing mechanisms tested in Phase 1[13]

[10] As provided for in the Oregon Jobs for Transportation Act (House Bill 2001).
[11] ODOT Financial Services Policy and Economic Analysis Unit, Financial Assumptions for the development of Metropolitan Transportation Plans 2005 - 2030, 2004.
[12] ODOT, Statewide Transportation Strategy (STS) Technical Advisory Committee meeting, 5/31/11 (value from forthcoming Cambridge Systematics report on external costs to households related to their vehicle travel, Date TBD)
[13] State GreenSTEP input assumption for the Portland Metro area (the average fuel efficiency for all light vehicles is not weighted by proportional share of light trucks to automobiles)

Cost per mile equivalents

Table 12: 2010 Base Year fuel efficiencies, cost per mile equivalent[14]

Pricing mechanism	Level 1 Cost (2005 Dollars)	Level 2 Cost (2005 Dollars)	Level 3 Cost (2005 Dollars)
2010 Federal gas tax ($/mile)	$ 0.007	$ 0.007	$ 0.007
2011 State gas tax ($/mile)	$ 0.012		
Road use fee ($/mile)		$ 0.03	$ 0.03
Carbon emissions fee ($/mile)[15]			$ 0.018
Total (rounded)	**$ 0.02**	**$ 0.04**	**$ 0.06**

Table 13: 2035 Level 1 estimated fuel efficiencies, cost per mile equivalent[16]

Pricing mechanism	Level 1 Cost (2005 Dollars)	Level 2 Cost (2005 Dollars)	Level 3 Cost (2005 Dollars)
2010 Federal gas tax ($/mile)	$ 0.004	$ 0.004	$ 0.004
2011 State gas tax ($/mile)	$ 0.006		
Road use fee ($/mile)		$ 0.03	$ 0.03
Carbon emissions fee ($/mile)			$ 0.01
Total (rounded)	**$ 0.01**	**$ 0.03**	**$ 0.04**

Table 14:2035 Level 2 estimated fuel efficiencies, cost per mile equivalent[17]

Pricing mechanism	Level 1 Cost (2005 Dollars)	Level 2 Cost (2005 Dollars)	Level 3 Cost (2005 Dollars)
2010 Federal gas tax ($/mile)	$ 0.003	$ 0.003	$ 0.003
2011 State gas tax ($/mile)	$ 0.005		
Road use fee ($/mile)		$ 0.03	$ 0.03
Carbon emissions fee ($/mile)			$ 0.01
Total (rounded)	**$ 0.01**	**$ 0.03**	**$ 0.04**

[14] Assuming average fuel efficiency of 25 mpg, which reflects the State GreenSTEP input assumption for the Portland Metro area (the average fuel efficiency for all light vehicles is not weighted by proportional share of light trucks to automobiles)

[15] All carbon emissions fee cost per mile estimates assume 19.4 lbs CO2/gallon. Accessed at: www.epa.gov/otaq/climate/420f05001.htm

[16] Assuming average fuel efficiency of 50 mpg, which reflects the State GreenSTEP Reference Case input assumption for the Portland Metro area (the average fuel efficiency for all light vehicles is not weighted by proportional share of light trucks to automobiles)

[17] Assuming average fuel efficiency of 58 mpg, which reflects the State GreenSTEP input assumption used to determine the Metro region's GHG emissions reduction target (the average fuel efficiency for all light vehicles is not weighted by proportional share of light trucks to automobiles).

MARKETING AND INCENTIVES

Eco-driving

Eco-driving involves educating motorists on how to drive in order to reduce fuel consumption and cut emissions. Examples of eco-driving practices include avoiding rapid starts and stops, matching driving speeds to synchronized traffic signals, and avoiding idling. Practicing eco-driving also involves keeping vehicles maintained in a way that reduces fuel consumption such as keeping tires properly inflated and reducing aerodynamic drag. For the purposes of GreenSTEP, fuel economy benefits of improved vehicle maintenance are included in the eco-driving benefit. The effect of eco-driving programs is modeled by identifying participating households based on a policy assumption about the proportion of participating households. A default 19% improvement in vehicle fuel economy is assumed within the GreenSTEP model based on information in the "Moving Cooler" study.[18]

2010 Base Year reflects the current status of no existing eco-driving marketing programs.
2035 Level 1 reflects the current status of no existing eco-driving marketing programs. Because eco-driving is a relatively new phenomenon and there is currently no existing regional eco-driving marketing program, there is no supporting data to indicate the proportion of households that follow eco-driving practices; 0% households follow eco-driving practices.
2035 Level 2 reflects an adoption of and participation in eco-driving marketing programs at a rate of 40%. Given current data limitations for this GHG emissions reduction strategy, Level 2 reflects the input assumption for the first round of STS scenarios.

Individualized marketing programs

Individualized marketing (IM) programs are travel demand management programs focused on individual households. IM programs involve individualized outreach to households that identify household travel needs and ways to meet those needs with less vehicle travel.

2010 Base Year is an estimate of current participation rates, based on the current results of the City of Portland and Regional Travel Options (RTO) Individualized Marketing Program; 9% of households in the region participate in an Individualized Marketing Program.
2035 Level 1 reflects the current results of the City of Portland and Regional Travel Options (RTO) Individualized Marketing Program (given current funding); 9% of households in the region participate in an Individualized Marketing Program. Because the region is expected to experience population growth over the next 25 years, maintaining a steady participation rate will result in the total number of households participating in IM programs to increase.
2035 Level 2 assumes that IM participation rates increase to 65% of all households. This assumption is based on the Financially Constrained 2035 RTP estimate of "covered households." Covered households capture the percent of households with proximity to high capacity transit and frequent bus service, as reflected in the 2035 RTP.

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[18] Cambridge Systematics, "Moving Cooler", Urban Land Institute, Washington, D.C., 2009, Technical Appendix, Table 7.1, page B-63.

Employee commute options programs

Employee commute options (ECO) programs are work-based travel demand management programs. They may include transportation coordinators, employer-subsidized transit pass, bicycle parking, showers for bicycle commuters, education and promotion, carpool and vanpool programs, etc.

Research conducted using the Washington State Commute Trip Reduction (CTR) database provide detailed information on TDM strategies implemented by employer worksite characteristics as well as employees' travel behavior and their job related characteristics. Similar to Oregon, employers in the state of Washington that have 100 or more full-time employees are required to implement a Commute Trip Reduction program. The state CTR database tracked more than 1,000 worksites and approximately 300,000 individual employees from 1993 to 2005. The analysis of the longitudinal CTR data indicates that for the employees affected by a CTR program, the participation rates of compressed work week increased steadily from 14.5 percent in 1993 to 20 percent in 2005. This evaluation focused on one TDM strategy, and may underestimate the participation rate when taking into account the range of employer-based TDM programs available – parking cash out, telecommuting, transit passes, preferential parking for carpools and vanpools, etc.[19]

2010 Base Year reflects the best available data for current regional participation in ECO programs; 20% of working age persons participating in an ECO program.

2035 Level 1 assumes a steady participation rate from current levels while accounting for population growth. While Metro's current Regional Travel Options program estimates roughly 20% of the region's workforce has access to a transportation options program, this value does not reflect all worksites that meet the State ECO Rule threshold in the region (sites with 100+ employees). Given this limitation, and based on the research discussed above, it is assumed that the RTO access rate underestimates regional access and potential participation rates.

2035 Level 2 demonstrates an increase in ECO participation rate to 40% (doubling of Level 1), which could reasonably be accomplished with increased programmatic resources/funding and would most likely not require a legislative change to the State ECO Rule.

Car-sharing

Because car-sharing is a relatively new phenomenon, GreenSTEP models the approximate effects of car-sharing on vehicle travel (there is currently no National Household Travel Survey (NHTS) data on car-sharing). However, based on *Moving Cooler*, it is assumed that on average there are 20 participating households per car-share vehicle.[20] By using this participation rate per car-share vehicle, the target number of "car-share" vehicles per member is calculated in GreenSTEP using a rate of 2,000 inhabitants of medium-density Census tracts and 1,000 inhabitants for high-density census tracts. Medium density

[19] Zhou, Liren, University of South Florida. *Modeling the impacts of an employer based travel demand management program on commute travel behavior*. Thesis and Dissertations, Paper 581. University of South Florida, June, 2011, p. 46.

[20] Cambridge Systematics, "Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions", Urban Land Institute, Washington, D.C., October 2009.

census tracts are defined as having 4,000-10,000 persons per square mile and high-density Census tracts are defined as having at least 10,000 persons per square mile.

No low-density target is set for GreenSTEP because of the synergistic relationship between density and car-share participation rates. In other words, if the participation rate for an average car-share vehicle is 20 households, the lower the density the greater the catchment area needs to be to meet the participation rate. This would result in the walk distance for a participating household to increase beyond a reasonably expected distance. However, because of the synergistic relationship within GreenSTEP between density and car-share participation, the VMT (and GHG) benefits of car-share programs can be tested through the community design policy lever (as low-density areas meet the medium-density population threshold the number of households participating in car-share programs is assumed to increase). The car-share input variable is the estimated population needed per vehicle to support a viable car-share market.

2010 Base Year is an estimate of current participation rates, which is the equivalent of 5,000 people per car-share vehicle. Metro staff contacted multiple car-sharing companies and confirmed that car-share vehicles require about 55 members (households) per vehicle, therefore the assumption
2035 Level 1 input value of 10,000 people per car-share vehicle in medium density areas reflects the State's input assumptions for the first round of STS scenarios (the best available data). The input value of 5,000 people per car-share vehicle in high density areas reflects the State's input assumption for the first round of STS scenarios (the best available data).
Level 2 The input value of 5,000 people per car-share vehicle in medium density areas reflects the State's input assumptions for the first round of STS scenarios (the best available data). The input value of 2,500 people per car-share vehicle in high density areas deviates from the State's input assumption for the first round of STS scenarios. The rationale for using a value other than the State's input assumption is to test a comparable order of magnitude difference between the levels 1 and 2 for both medium and high density areas.

ROADS

Road capacity

The road capacity input in GreenSTEP only models the affect of roadway expansion relative to population growth. GreenSTEP does not reflect the impact of street connectivity projects. Metropolitan area freeway supply (lane-miles per capita) is a significant predictor of metropolitan household vehicle ownership and travel, however arterial supply (lane-miles per capita) is not. Both freeway and arterial lane-mile supply are important inputs for estimating traffic congestions levels. GreenSTEP calculates future year growth rates of freeway and arterial lane miles relative to metropolitan area population growth rates, from a defined inventory of lane-miles.

2010 Base Year reflects current freeway and arterial systems.
2035 Level 1 reflects the 2035 financially constrained RTP (see Table 15).
2035 Level 2 tests the effects of no roadway expansion relative to population growth.

Table 15: Ratio of road expansion to population growth

Regional Transportation Plan		2005	2035	Percent increase	Ratio (lane mile growth : population growth)
2035 RTP Financially Constrained	Population estimate	1,961,153	3,096,746	58%	
	Freeway lane miles	1,206	1,318	9%	**.16:1**
	Arterial lane miles	8,416	8,921	6%	**.10:1**
2035 State RTP network	Population estimate	1,961,153	3,096,746	58%	
	Freeway lane miles	1,206	1,318	9%	**.16:1**
	Arterial lane miles	8,416	8,996	7%	**.11:1**

System management

GreenSTEP models mean travel speeds with and without incidents to compute an overall average speed by road type and congestion level. The approach provides a simple level of sensitivity testing of the potential effects of system management programs on GHG emissions. Overall average speeds by congestion level are calculated based on input assumptions about the degree of system management, which includes traffic signal timing and incident management. The input is defined as the percent of delay addressed through system management.

2010 Base Year assumes 10 percent of delay is reduced through system management, as assumed in the state's first round of STS Scenarios.

2035 Level 1 there is no existing regional data or modeling assumptions available for future delay reduction through system management strategies. Level 1 reflects the input assumption for the first round of STS scenarios (no change from the 2010 Base year – 10 percent).

2035 Level 2 reflects the input assumption for the first round of STS scenarios, which tests the effect of a 35 percent delay reduction through system management strategies.

FLEET

All fleet assumptions reflect the values defined in the State Agencies' Technical report (3/1/11). Level 2 reflects the assumptions recommended in the Metropolitan GHG Reduction Target Rule adopted by LCDC in May 2011 (http://www.oregon.gov/ LCD/docs/rulemaking/trac/ 660_044.pdf)

Auto/light truck proportions

The vehicle type model in GreeenSTEP calculates the likelihood that a vehicle is a light truck, by county; based on National Household Travel Survey data, western states tend to have higher light truck (pickups, vans, sport utility vehicles) ownership than the U.S. national average.

2010 Base Year is an estimate of existing conditions and reflects a current fleet mix of 57 percent auto and 43 percent light truck and SUVs.

2035 Level 1 reflects the Level 1 values used in the first round of STS scenarios, by county. (Clackamas County: 49 percent auto and 51 percent light truck/SUV; Multnomah County: 58 percent auto and 42 percent light truck/SUV, Washington County 54 percent auto and 46 light truck/SUV)
2035 Level 2 reflects the Level 3 values used in the first round of STS scenarios, by county (assumed in the Metropolitan GHG Reduction Targets Rule). (Clackamas County: 66 percent auto and 34 percent light truck/SUV; Multnomah County: 72 percent auto and 28 percent light truck/SUV; Washington County 69 percent auto and 31 percent light truck/SUV)

Fleet turnover rate

Fleet turnover reflects the rate at which new vehicles will replace exiting vehicles. Since newer vehicles are typically more fuel efficient than older vehicles, newer fleets will yield greater GHG reductions. The mean age for vehicles owned by western region households is about a year older than the mean values for households located in other parts of the country and is even older in Oregon. In addition to capturing this regional difference Metropolitan GreenSTEP is responsive to the relationship between household income and vehicle age. Wealthier households typically own newer vehicles, which is important to capture because vehicle age affects not only fuel economy but also fuel expenditures.

2010 Base Year is an estimate of current fleet turnover rates. The average state replacement rate of light duty vehicles is 10 years.
2035 Level 1 reflects the Level 1 value used in the first round of STS scenarios, which captures the current replacement rate observed statewide (10 years), as reported in the Agencies' Technical Report.
2035 Level 2 reflects the Level 3 value used in the first round of STS scenarios, which captures the current replacement rate observed in other parts of the country (8 years), as reported in the Agencies' Technical Report (assumed in the Metropolitan GHG Reduction Targets Rule).

TECHNOLOGY

All technology assumptions reflect the values defined in the State Agencies' Technical report (3/1/11). Level 2 reflects the assumptions recommended in the Metropolitan GHG Reduction Target Rule adopted by LCDC in May 2011 (http://www.oregon.gov/LCD/docs/rulemaking/trac/660_044.pdf)

Fuel economy

The fuel economy values, used in the Agencies' Technical Report assume the current Federal Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy (CAFE) Standards for Model Years 2017-2025. The fuel economy values reflect anticipated improvements in light vehicle fuel efficiency for 2035 model year vehicles.

2010 Base Year is an estimate of the region's existing fleet fuel efficiency and reflects the base year assumptions used in the first round of STS scenarios; the average regional light duty auto fuel efficiency is 29.2 mpg and the average light truck fuel efficiency is 20.9 mpg.
2035 Level 1 reflects the Level 1 value used in the first round of STS scenarios. The 2035 light-duty vehicle fuel economy is estimated to be 59.7 mpg and light truck is 41 mpg.

2035 Level 2 reflects the Level 3 value used in the first round of STS scenarios. The 2035 light-duty vehicle fuel economy is estimated to be 68.5 mpg and light truck is 47.7 mpg; regional fleet average is 58 mpg (assumed in the Metropolitan GHG Reduction Targets Rule).

Carbon intensity of fuels

The values for carbon intensity of fuels, used in the Agencies' Technical report, assume the proposed low carbon fuel standard is adopted. These assumptions are modeled in the first round of STS Scenarios and used for the Metropolitan GHG Reduction Targets Rule. GreenSTEP allocates fuel consumption between gasoline, Compressed Natural Gas (CNG) and diesel types; current proportions are specified for automobiles and light trucks/SUVs separately. After defining the carbon intensity for each fuel type a composite value is then calculated. The composite value includes the carbon values of all fuel types used by light vehicles (autos and trucks/SUVs).

2010 Base Year is an estimate of the current composite carbon intensities for fuels used throughout the region, which for 2010 is assumed to be 90.38 g CO_2e/megajoule.
2035 Level 1 reflects the Level 1 value used in the first round of STS scenarios, which assumes the carbon intensity of vehicle fuels will be 10% below the current (2010) average by 2035 (81.34 g CO_2e/megajoule).
2035 Level 2 assumes the carbon intensity of vehicle fuels will decline 20% below the current (2010) average by 2035 (72.3 g CO_2e/megajoule). This assumption reflects the Level 3 value used in the first round of STS scenarios, and that was assumed in the Metropolitan GHG Reduction Targets Rule.

Plug-in hybrids market share

The values for this input represent the proportion of plug-in hybrids as a share of total fleet that are driven within the average range of EVs, by model year as documented in the Agencies' Technical Report and assumed in the first round of STS Scenarios.

2010 Base Year is an estimate of the current proportion of PHEVs as a share of the region's total fleet (0 percent).
2035 Level 1 reflects the midpoint between the Base year and Level 1 from the first round of STS scenarios and assumes 4 percent of model year autos – driven within the average range of plug-in hybrids for that model year (175 miles) – are plug-in hybrids. It is assumed that 1 percent of model year light trucks – driven within the average range of plug-in hybrids for that model year (175 miles) – are plug-in hybrids.
2035 Level 2 reflects the Level 3 value used in the first round of STS scenarios and assumed in the Metropolitan GHG Reduction Targets Rule. It is assumed that by 2035, 8 percent model year autos – that are driven within the average range of plug-in hybrids for that model year (175 miles) – are plug-in hybrids. It is assumed that by 2035, 2 percent of model year light trucks, that are driven within the average range of plug-in hybrids for that model year (175 miles), are plug-in hybrids.

Electric vehicles market share

The values for this technology input represent the proportion of electric vehicles (EV) as a share of PHEVs – driven within the average range of EVs – by model year, as documented in the Agencies' Technical Report and assumed in the first round of STS Scenarios.

2010 Base Year is an estimate of the current proportion of EVs as a share of the region's PHEV market (less than 1 percent).

2035 Level 1 reflects the Level 1 value used in the first round of STS scenarios and assumes 26 percent of 2035 model year PHEVs (autos and light trucks) – driven within the average range of EVs for that model year (175 miles) – are EVs. Assumes 26% of 2035 model year light trucks that are EVs – driven within the average range of EVs for that model year (175 miles) – are EVs.

2035 Level 2 reflects the Level 3 value used in the first round of STS scenarios and assumes 26% of the 2035 model year PHEVs (autos and light trucks) that are driven within the average range of EVs for that model year (175 miles), are EVs (assumed in the Metropolitan GHG Reduction Targets Rule).