APPENDIX G

INDICATOR METHODOLOGY & SCENARIO OUTCOMES

Pikes Peak Area Council of Governments

Communities Working Together

Memorandum

Date: November 6, 2014

Re: Indicator Methodology and Scenario Outcomes of the PPACG 2014 CommunityViz Analysis

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This memorandum describes the development of the indicators and basic assumptions used in the scenarios developed for the 2040 Moving Forward Plan. Please contact us if you have any questions or thoughts about the indicators or their methodology.

Scenario Creation

To support the transportation planning process, two "what-if" scenarios were created representing alternate urban development patterns. The scenarios were intended to represent different urban growth patterns. The Infill Scenario was developed with a strong emphasis on the clustering of new development near the existing urban edge and infill development (developing undeveloped areas within the existing urban area or redevelopment of existing built areas). The Accelerated Trend Scenario assumes that much of the new growth takes the form of very low density development in rural areas that are distant from any urban core.

Both the Infill and Accelerated Trend Scenarios have their origins in scenarios that were created for the Moving Forward 2035 Regional Transportation Plan Update. The Infill Scenario is based on that plan's Infill and Cluster Scenario while the Accelerated Trend Scenario is based on the Conservation Scenario. A number of updates were made to the 2035 Scenarios to create the Infill and Accelerated Trend Scenarios:

- **New Transportation Analysis Zones (TAZs)**. The household and employment information from the 2035 scenarios were moved to a new, updated set of TAZs via a spatial join function called OverlapSum. This function allocated values from the old TAZs to the new TAZs based on the proportional amount of overlap between the two sets of polygons.
- **Demographic Adjustments**. PPACG transportation planners rely on population and household projections developed by the Colorado State Demography Office (SDO). The SDO forecast control totals for jobs changed since the last forecast (from 563,563 to 499,222). The projected number of households changed only slightly; SFO forecast 378,821 households in 2035 and 378,956 households in 2040. The number of net new jobs was decreased in both the Infill and Accelerated Trend Scenarios to match the SDO's forecasts by subtracting an equal number of jobs from all TAZs that gained more than 500 jobs in 2040 (as compared to the current 2010 scenario).

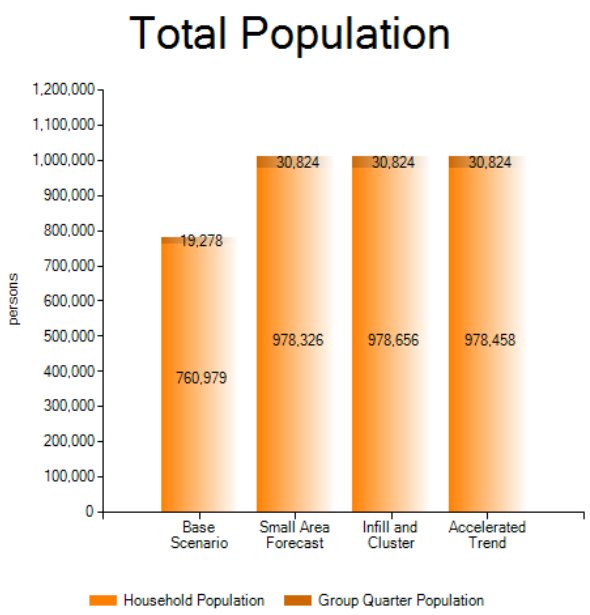
- **Scenario Planning Workshop**. On Tuesday, May 6th, 2014 PPACG and Placeways hosted a workshop for representatives of local cities, county governments, business groups, military installations and the PPACG Community Advisory Committee. Participants broke into two different groups, with each group focusing on a different scenario. Limited only by the general theme of each scenario and the amount of net new growth, participants used their knowledge of the region, its opportunities and limitations to reassign the new growth to TAZs in the region. A set of indicators (as described below) were used to track the changes they were making and the Small Area Forecast was used as a reference as necessary. Due to time limitations, this process continued after the conclusion of the meeting. Placeways staff and participants worked over email to continue reassigning households and jobs to the TAZs in each scenario.
- **Final Modifications**. The draft final scenarios were reviewed by PPACG and Placeways staff. Both scenarios had a small number of TAZs with negative net growth (i.e., the TAZs have fewer households or jobs in 2040 than they do currently). This appeared to be the unintended result of transferring the 2035 Moving Forward Plan Update scenarios to the new TAZs. PPACG made the decision to change negative net growth TAZs to zero growth. This created a modest surplus of households and jobs which were then allocated equally to all TAZs that experienced positive growth in the region. After this final change, the scenarios were considered complete.

Overview of Indicator Methodology and Outcomes

Population

Two distinct populations are tracked for this indicator, the household population and the group quarters population. For this analysis, the group quarters population was maintained constant for all scenarios. The Small Area Forecast had established the number of households and household population at the TAZ scale. Using the 2040 Small Area Forecast, household population was divided by households to identify the number of persons per household (pp/hh) in each TAZ. This established a pp/hh value by TAZ that could then be multiplied by the number of households in different scenarios to find the household population for each TAZ in each scenario. Because the SAF pp/hh values varied considerably across TAZs some adjustments to the pp/hh value had to be made in order get the regional scenario population levels to match. These adjustments included the following calculation, designed in part to limit some of the more extreme persons per household values observed in the Small Area Forecast:

- If the Small Area Forecast persons per household value exceeded the mean Small Area Forecast persons per household value plus one standard deviation, the TAZ was assigned the Small Area Forecast persons per household value plus one standard deviation.
- If the Small Area Forecast persons per household value was less the mean Small Area Forecast persons per household value minus one standard deviation, the TAZ was assigned the Small Area Forecast persons per household value minus one standard deviation.



Scenario Outcomes

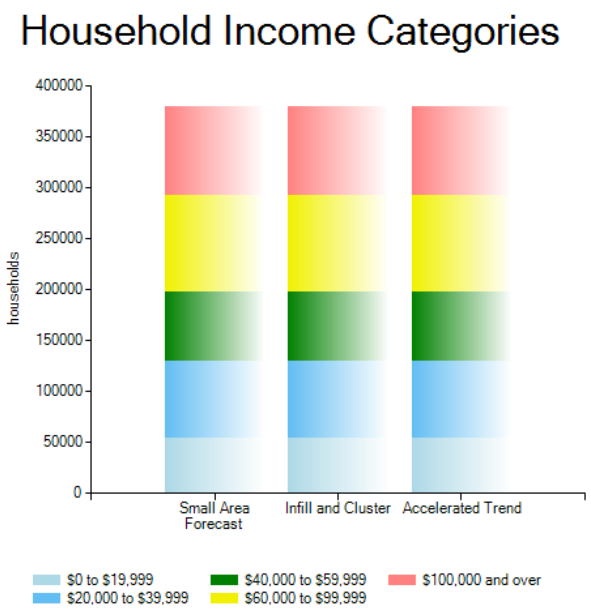
As total regional population is held constant across the scenarios, the differences between the scenarios are best seen in spatial form. The SAF was adopted by the PPACG Board of Directors prior to this scenario planning effort and it forecasts moderate growth throughout the region but especially in areas between Falcon and Colorado Springs and north into Black Forest. Areas of significant population loss are seen along and south of Briargate Parkway. The Accelerated Trend scenario forecasts much of the population growth to occur in eastern El Paso County, leapfrogging undeveloped areas that are closer to Colorado Springs. The Infill Scenario envisions a greater share of growth occupying undeveloped or redeveloping areas within existing urban areas.

Households by Income

PPACG used five income categories that are required inputs to the travel demand model. Similar to household population, the Small Area Forecast had established the proportion of households by income. The income categories were maintained and applied to the new scenarios on a TAZ by TAZ basis. Because the number of new households added (allocated) to each TAZ changed depending on the scenario, anadjustment had to be made in order to maintain the total number of households regionally in each income category. The adjustment included the following calculation:

Income Categories:
Income1 - $0 to $19,999
Income2 - $20,000 to $39,999
Income3 - $40,000 to $59,999
Income4 - $60,000 to $99,999
Income5 - $100,000 and over

- For each income class, if a given scenario added more households than the Small Area Forecast, then the difference between the Small Area Forecast and the given scenario was multiplied by the percentage of households in the given income class. This value was then added to the number of households in the Small Area Forecast yielding the number of households in that income class for that TAZ.
- For each income class, if a given scenario added less households than the Small Area Forecast, then the difference between the Small Area Forecast and the given scenario was multiplied by the percentage of households in the given income class. This value was then subtracted from the number of households in the Small Area Forecast yielding the number of households in that income class for that TAZ.



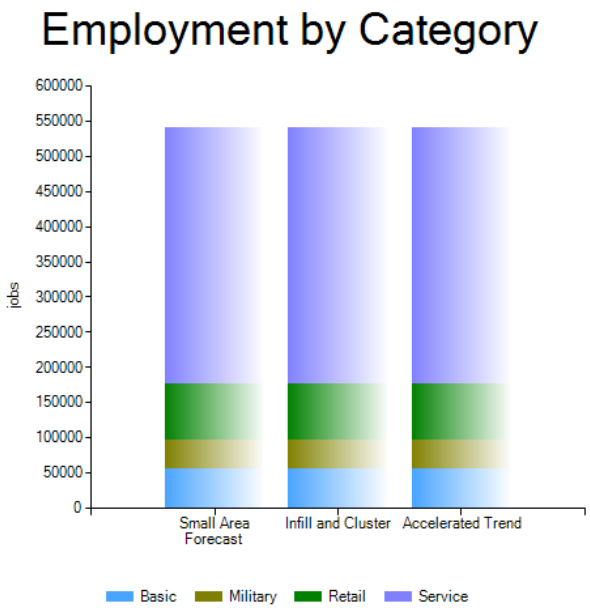
Scenario Outcomes

The SAF suggests that lower income households will be concentrated in older neighborhoods and subdivisions in Colorado Springs. In rural areas, lower income households are more common in south Teller County and in southeast El Paso County. Wealthier households are found around the edges of Colorado Springs, especially north of the city, and northern Teller County. This is consistent with patterns seen in much of the USA for the last half of the 20th century. Recent trends have reversed this somewhat with some amenity-rich central districts growing modestly in population and this trend is expressed to some degree by the Infill Scenario. The Accelerated Trend and Infill Scenarios maintain the existing household income levels identified in the Small Area Forecast. It does not suggest a departure in the patterns reflected in the Small Area Forecast or the dominant urban migration patterns of recent decades.

Employment by Sector

PPACG used four employment classifications that are required inputs to the travel demand model: basic, retail, service, and military. Similar to households by income, the Small Area Forecast had identified the proportion of jobs by class regionally. The class ratios were maintained and applied to the new scenarios on a TAZ by TAZ basis. Because the number of jobs added to each TAZ changed depending on the scenario in question, an adjustment had to be made in order to maintain equal the total number of jobs in each employment class. The adjustment included the following calculation:

- For each employment class in each TAZ, if a given scenario added more jobs than the Small Area Forecast, then the difference between the Small Area Forecast and the given scenario was multiplied by the percentage of jobs in the given employment class. This value was then added to the number of jobs in the Small Area Forecast yielding the number of jobs in that employment class for that TAZ.
- For each employment class in each TAZ, if a given scenario added less jobs than the Small Area Forecast, then the difference between the Small Area Forecast and the given scenario was multiplied by the percentage of jobs in the given employment class. This value was then subtracted from the number of jobs in the Small Area Forecast yielding the number of jobs in that employment class for that TAZ.



Scenario Outcomes

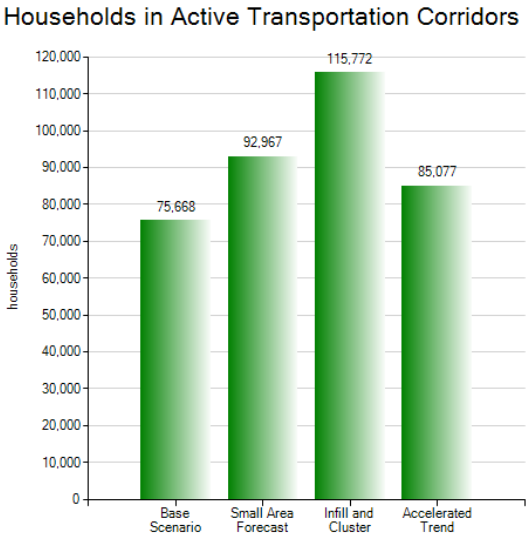
The proportion of jobs in each category was identified in the Small Area Forecast. Basic and military jobs are both clustered around existing facilities, albeit in different sectors of the study area. The largest categories of employment, retail and service jobs, are more widely dispersed throughout the area while maintaining greater proximity to the more urban core of the region than households. This is also consistent with trends seen nationwide.

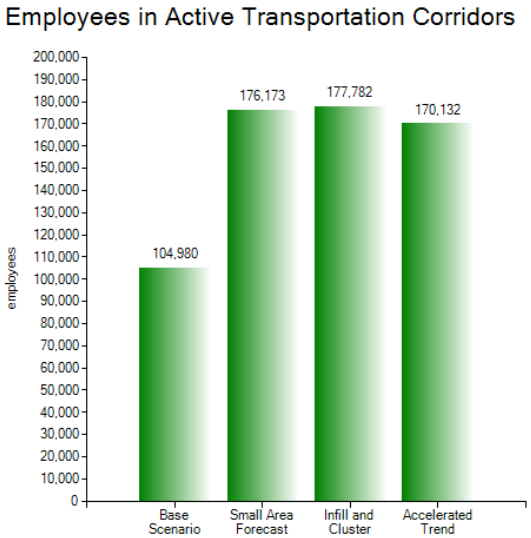
Residential Population/Employees in Active Transportation Accessible Zones

These two indicators measure the residential population and number of employees near off-street trails and greenways. This does not include sidewalks or bike lines. The indicator reflects the current and future access that households and jobs have to corridors that currently serve as recreation, physical fitness, and commuting amenities. Nearness is defined as being less than one quarter mile as the crow flies from a trail or greenway. No new trails or greenways are included or forecast for this indicator.

Scenario Outcomes

Proximity to trails, open space and greenways are important amenities, especially for residential populations. Well designed and integrated paths and trails can connect people to their schools, workplaces or neighborhood commercial areas. With some exceptions, the network of active corridors is



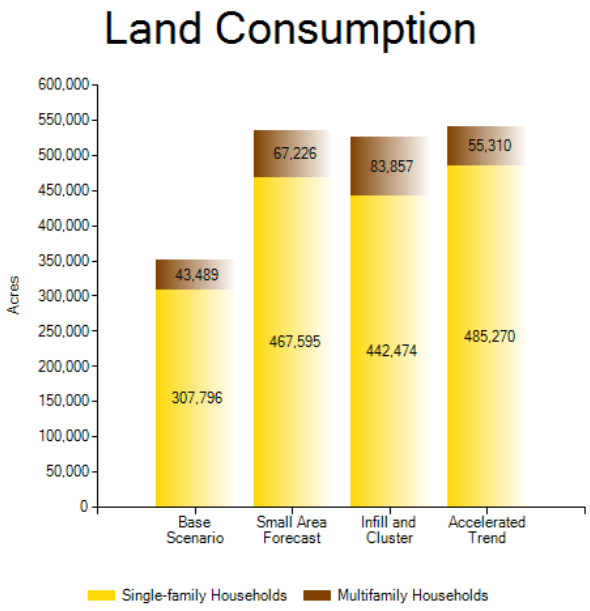


tilted towards the west and north central areas of Colorado Springs and Manitou Springs. The Infill and Small Area Forecast tended to forecast more new households and jobs in these corridors than the Accelerated Trend Scenario. It's important to note, however, that this indicator doesn't factor in any changes to the network of active corridors. As urban areas grow, new trails and paths can be built and added to the existing network, improving new resident's access to these and potentially new corridors.

Land Consumed

The Land Consumed indicator helps gauge the change in the residential urban footprint among different scenarios. A footprint in this context consists of more than just the area of the dwelling unit and includes yard, parking, and outbuildings. The proportion of single family and multi-family households is a critical factor in this indicator as the total number of households in the region is constant across all scenarios. Single family residences have a higher per household footprint than multi-family residences (where the footprint is shared by one or more families).

In urban environments, the proportion of multi-family residences increases as the overall household density increases. The proportion of multi-family households to single family households varies on a TAZ-by-TAZ basis and for the base (current) scenario is taken from the nearest 2010 census tract. Using this information, a model was calibrated to allow the proportion of multifamily housing to increase as household density increased. In TAZs where housing density decreased (i.e., in TAZs where population declined) the 2010 value was kept constant. Following this calculation, the number of single and multi-family households was multiplied by assumptions reflecting the average size of a single family dwelling (1.5 ac) and multi-family (0.6 ac) footprints, respectively. These footprints encompass yards, driveways, outbuildings, roads and other support infrastructure that represent the full human impact associated a dwelling unit. They were developed during the development of the previous regional transportation plan and reused here.



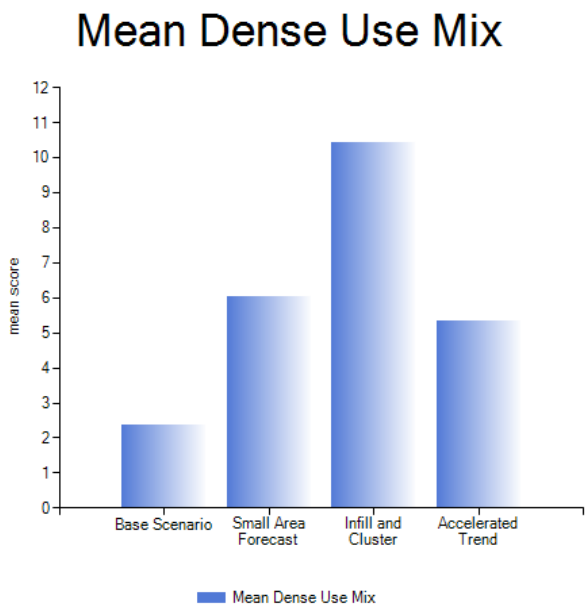
Scenario Outcomes

The Land Consumed indicator reflects, to a large extent, where new residential growth occurs in the scenarios. The Infill Scenario concentrates new growth inside the existing urban area. The Small Area Forecast sees growth occurring east and north of Colorado Springs while the largest impact is seen further out in areas of northern and eastern El Paso County in the Accelerated Trend Scenario. The indicator factors in different urban footprint sizes based on whether the household is forecast to be a single family home or multi-family home, with multi-family homes occupying a smaller footprint. Because the Infill Scenario concentrates new residential growth in areas already urbanized, a higher percentage of that growth takes shape as multi-family dwelling units and so it consumes the

least amount of land among the three scenarios. This indicator does not factor any redevelopment; the idea that areas that are currently built up may be redeveloped to allow for denser residential and/or commercial units. By not factoring in redevelopment this indicator likely overestimates how much land is consumed in the Infill Scenario and to a lesser extent, the Small Area Forecast.

Dense Use Mix

Understanding and quantifying the mix of land uses in an urban environment is an important component to understanding the character of the urban environment. Not all possible land uses are included in this indicator and typically urban planners focus on a mix of housing, service, and retail jobs at a neighborhood scale (e.g., industrial, military, agriculture, etc. are not included in the use mix). Dense Use Mix is the measure of the mix of residential and commercial uses weighted by the density of those uses. Factoring in density equalizes the results across TAZs of different sizes. To calculate this indicator, the TAZ attributes reflecting two types of residential use with two types of commercial use are combined. These uses are: multi-family households, single family households, retail jobs, and service jobs. The method for estimating single and multi-family houses is described in the "Land Consumed" indicator and jobs are described in the "Employment by Sector" indicator. The four uses are combined using an entropy formula to scale them between 0 and 1 and then weighed by (i.e., multiplied by) the combined household and employment density of the TAZ. This set of attributes is then rescaled so that they range between 0 and 100. The lowest value represents TAZs with the lowest mix of uses (i.e. very homogenous areas) and where housing and employment is the least dense. The highest values represent the opposite: the highest mix of uses (i.e. greatest mix of residential and commercial use) and where housing and employment is the densest. The mean score for the area within the adjusted urban boundary is used for charting purposes.



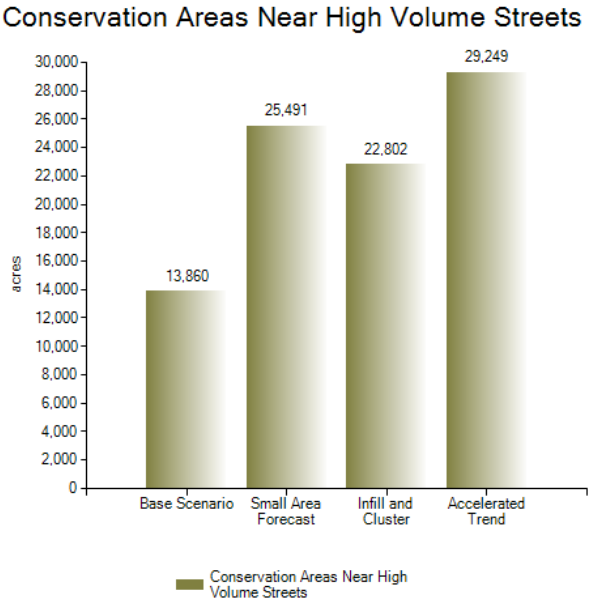
Scenario Outcomes

In base year (2010), older neighborhoods on the edge of downtown areas and some suburban corridors with a mix of residential and commercial use tend to do better in this indicator. By design, the Infill Scenario concentrates residential and commercial development in and around downtown, and along major corridors in Colorado Springs. The Small Area Forecast poses modest gains in this indicator throughout the urban area while the Accelerated Trend Scenario shows the least amount of change.

Conservation Areas Near High Volume Streets

This indicator measures the number of acres of sensitive environmental areas near high volume streets. While all roads present some risk to sensitive species and ecological communities, high volume roads

are especially damaging. Sensitive environmental areas were represented using a vectorized "Conservation Value Summary," a NatureServe Vista analysis product from the previous transportation plan update. The Conservation Value Summary ranks all mapped ecological occurrences and ecological communities according to their conservation status rank, or G-Rank. The higher the G-rank, the greater the likelihood that a species will become extinct or the ecological community will be eliminated. High volume streets are defined on a per scenario basis using the PPACG travel demand model. No changes to the G-Rank or extent of sensitive environmental areas are modeled into the future.



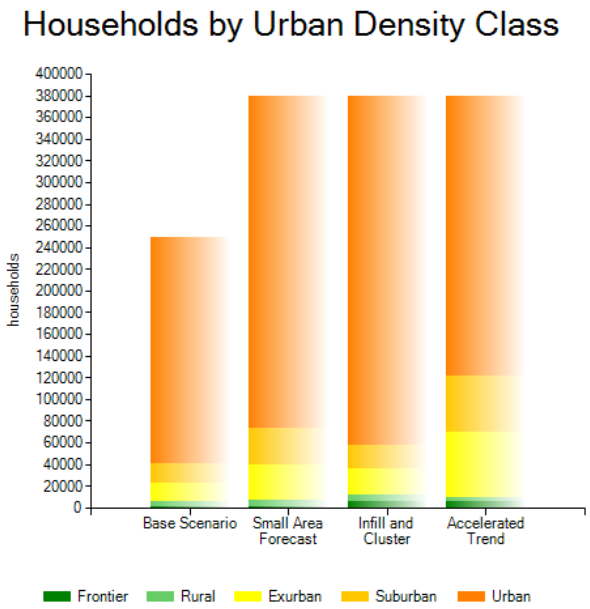
Scenario Outcomes

While conservation areas are distributed around the analysis area, most impacts to the conservation areas from high volume streets occur around Banning-Lewis Ranch. Differing traffic volumes in this area drive much of differences between the three scenarios. The number of high volume roads increases significantly as residential growth extends from Colorado Springs east into El Paso County. The Accelerated Trend Scenario maximizes this trend and therefore has higher volume on its road networks. The physical location of much of this development on the east side of Banning-Lewis means that much of this conservation area is now in closer proximity to high volume roads. This trend is apparent although much less pronounced with the Small Area Forecast and Infill Scenario.

New Households by Density

This indicator shows the total number of households by density level using PPACG categories at the TAZ scale. It does not include population housed in group quarters. These categories include urban, suburban, exurban, rural, and frontier and correspond to the persons per square mile ranges illustrated at right.

Density Definitions: in people per mi^2	
Urban	1,000+
Suburban	325 to 999
Exurban	40 to 324
Rural	7 to 39
Frontier	Less than 7



Scenario Outcomes

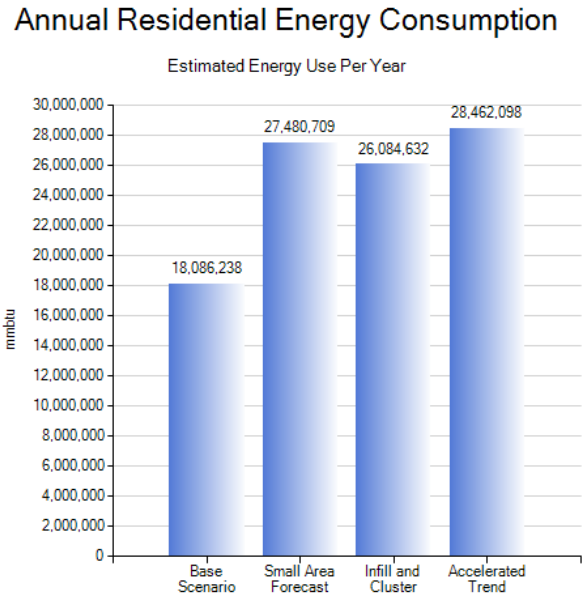
The vast majority of households in the region are in the urban density class for all scenarios. However the proportion of households in each class changes depending on the scenario. The Infill Scenario maintains a large proportion of households in the urban class as does the Small Area Forecast to a lesser degree. In the Accelerated Trend Scenario, the proportion of houses in the suburban and exurban classes increases markedly as development is spread widely across larger areas.

Residential Building Energy Use

Residential building energy use estimates the annual residential energy use for the region. It is the total number of single family and multi-family households multiplied by assumptions about residential energy consumption (see the "Land Consumed" indicator for the method for estimating single and multi-family households by TAZ). For a single family household in the western USA, this is 87.3 mmBtu (million British Thermal Units) annually while the value for multi-family households is 37.3 mmBtu. Multi-family households consume considerably less energy. This is due to a combination of factors: multi-family dwelling units are generally more energy efficient than single family dwelling units and multi-family households tend to have fewer family members. These figures come from the Residential Energy Consumption Survey (Energy Information Administration, 2009) published by the Energy Information Administration, Department of Energy. No future change to building energy use is factored into this indicator.

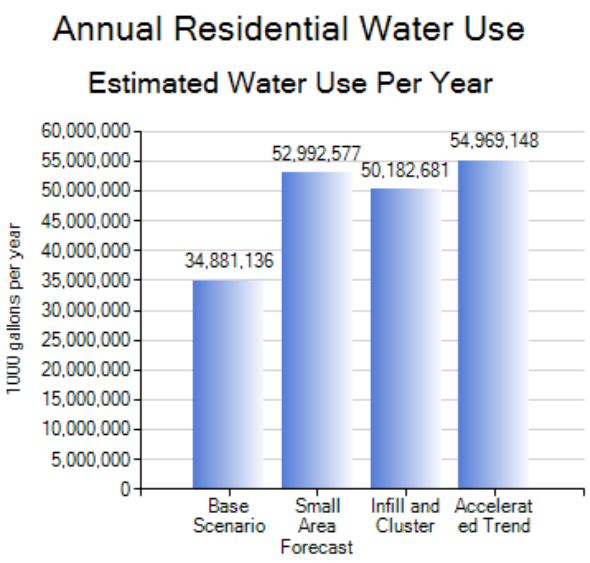
Scenario Outcomes

This indicator relies on assumptions about current energy use based on averages for the western region of the USA. While energy use in the region will likely increase, the long term trends for energy use per household have slowly but steadily declined as more energy efficient technologies are adopted. It was beyond the current scope to model future energy use so the most current value was used. However, if current trends hold, energy consumption may be overestimated in this indicator. Both the SAF and Infill Scenario consumed less energy than the Accelerated Trend Scenario.



Residential Water Use

Residential water use is an estimate of the amount of water consumed by households in the region. Residential water use is broken down by single family and multi-family households and is multiplied by assumptions about residential water consumption (See the "Land Consumed" indicator for the method for estimating single and multi-family households by TAZ). Since no estimates exist for the Pikes Peak region, for purposes of estimating water budgets, the City of Boulder uses 84,000 gallons per year (gpy) for single family dwellings and 48,000 gpy for multi-family dwellings (City of Boulder, 2014). However, neither of the Boulder figures accounts for outdoor use which may account for as much as 70% of the residential water used annually. In a study focusing primarily on single family housing, Mayer et al (1999) found that Denver households used an average of 169,600 gpy (64% for outdoor use, 35% for indoor use). Water use by multifamily units is not well studied and most studies fail to account for outdoor resources (landscaping, pools, etc) which can be significant but that are often shared by all the tenants of the unit or complex. Wentz et al (2010) took a more comprehensive look at water consumption in multifamily housing in Tempe, AZ and found that multifamily households consume 68,939 gpy on average when all in-common water usage was divided and added to indoor usage. Mayer et al's and Wentz et al's values were used as assumptions for this indicator and no future change to residential water use is factored into this indicator.



Scenario Outcomes

Residential water use is driven by current assumptions about water usage drawn from two different sources. Local patterns of water use may be different and local data could not be obtained to use for this indicator. As with energy, nationally per household water use is declining as more water efficient appliances are installed but overall water use increases as population grows. Multi-family units tend to use much less water than single family units even when shared water resources are accounted for and therefore, the Infill Scenario shows the lowest water consumption patterns. The Accelerated Trend Scenario forecasts the most water use while the SAF and Infill Scenario forecast more modest uses of water.

References

Energy Information Administration. 2009. Residential Energy Consumption Survey. US Department of Energy. http://www.eia.gov/consumption/residential/

City of Boulder. 2014. Water Budget Basics. https://bouldercolorado.gov/pages/the-basics-of-your-water-budget

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Wentz, E.A., Willis, A.J., Kim W.K., Myint, S.W. 2010. Factors Influencing Water Consumption in Multifamily Housing in the US Southwest. Arizona State University GeoDa Center for Geospatial Analysis and Computation Working Paper, Number 09. https://geodacenter.asu.edu/drupal_files/2010-09.pdf

GIS Data Sources

Name	Layer Name (if different)	Source
2010_2040_Approved SAF.xlsx	NA	PPACG
SAF TAZ shapefile	Final_2040_SAF	PPACG
2035 Scenarios	TAZ_Scenarios	PPACG/Placeways
Trails	TRAILS	PPACG
Conservation Areas	g-rank_p.grd (raster), grankp100x.shp (vector)	NatureServe