Exhibit No.:	
Issues:	Residential Usage/Customer Fixture Specifications Future Declining Use Declining Use Impact on
Witness:	Gregory P. Roach
Exhibit Type:	Direct
Sponsoring Party:	Missouri-American Water Company
Case No.:	WR-2017-0285 SR-2017-0286
Date:	June 30, 2017

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO. WR-2017-0285
CASE NO. SR-2017-0286

DIRECT TESTIMONY

OF

GREGORY P. ROACH

ON BEHALF OF

MISSOURI-AMERICAN WATER COMPANY

Exhibit 30
WR-2017-0285
Direct Testimony of Gregory P. Roach

DIRECT TESTIMONY
GREGORY P. ROACH
MISSOURI-AMERICAN WATER COMPANY
CASE NO. WR-2017-0285
CASE NO. SR-2017-0286

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BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

IN THE MATTER OF MISSOURI-AMERICAN WATER COMPANY FOR AUTHORITY TO FILE TARIFFS REFLECTING INCREASED RATES FOR WATER AND SEWER SERVICE	)))))	CASE NO. WR-2017-0285 CASE NO. SR-2017-0286

AFFIDAVIT OF GREGORY P. ROACH

Gregory P. Roach, being first duly sworn, deposes and says that he is the witness who sponsors the accompanying testimony entitled "Direct Testimony of Gregory P. Roach"; that said testimony and schedules were prepared by him and/or under his direction and supervision; that if inquiries were made as to the facts in said testimony and schedules, he would respond as therein set forth; and that the aforesaid testimony and schedules are true and correct to the best of his knowledge.

Greg P. Roach

Gregory P. Roach

State of Indiana
County of Johnson
SUBSCRIBED and sworn to
Before me this 20th **day of** June **2017.**

Dakota M Rose

Notary Public

My commission expires: May 19, 2022

DAKOTA M. ROSE
Notary Public, State of Indiana
Johnson County
Commission # 653738
My Commission Expires
May 19, 2022

STATE OF NOTARY SEAL INDIANA

DIRECT TESTIMONY

GREGORY P. ROACH

I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Gregory P. Roach. My business address is 555 East County Line Road, Suite 201, Greenwood, Indiana 46143.

Q. By whom are you employed and in what capacity?

A. I am employed by American Water Works Service Company (the "Service Company") as Manager of Revenue Analytics. My responsibilities include leading the Revenue Analytics group, whose main area of focus is the analysis and forecasting of system delivery, customer usage and revenue for the Service Company affiliates, including Missouri-American Water Company ("MAWC" or "Company").

Q. Please summarize your educational background and professional experience.

A. I graduated from Indiana University in 1980 with a Bachelor of Arts degree in Economics and Political Science. I graduated from Butler University in 1982 with a Master's Degree in Economics.

I have over 25 years of experience working in the electric, gas and water utility sectors as both a consultant and utility employee. I began my career with Public Service Indiana (PSI, now Duke Energy) in January of 1980, where my responsibilities included transforming PSI's load forecasting processes from time series to econometric-based models. In May 1982, I accepted the position of Senior Economist with the management consulting firm R.W. Beck and Associates (now part of Science Applications International Corporation), where I was ultimately promoted to Principal Economist. During my career at Beck, I was responsible for the management of all rates and regulatory matters, load forecasting, and financing feasibility client engagements managed by the firm's Indianapolis office. In May 1991, I took the position of Principal Economist with the regulatory management consulting firm SVBK Consulting Group. There, I was responsible for all consulting engagements executed from the Indianapolis regional office on behalf of SVBK's national utility clients. From July 1993 to November 1998, I was owner and president of a retail operations holding company with three franchise store outlets, and was responsible for all management, operation, sales and financial functions of the firm. In November 1998, I started the Roach Consulting Group, Ltd. As Principal Consultant, I advised industrial and utility clients related to business intelligence systems, enterprise and manufacturing resource planning systems, customer information systems, and general accounting systems. In July 2011, I joined the Service Company as Manager of Rates and Regulation. In August 2014, I accepted my current position of Manager of Revenue Analytics.

Q. What are your duties as Manager of Revenue Analytics?

A. I manage and direct a team of financial and regulatory analysts whose responsibilies are to analyze and project customer water usage, system delivery, customer counts and water and sewer sales revenues for each of the American Water affiliate companies. As such, our group supports both the regulatory and financial functions of the Service Company organization and the affiliated American Water companies.

Q. Have you previously submitted testimony before the Missouri Public Service Commission?

A. Yes I presented direct, supplement direct, rebuttal and surbuttal testimony in the most recent MAWC general rate case (Case No. WR-2015-0301) before the Missouri Public Service Commission ('the Commission"). Further, I have provided testimony in numerous regulatory proceedings before the Indiana Utility Regulatory Commission, the Pennsylvania Public Utility Commission, the Public Utilities Commission of Ohio, the Iowa Utilities Board, the Public Service Commission of West Virginia, the Public Service Commission of Louisiana, the Council of the City of New Orleans, the Virginia State Corporation Commission, the Public Utility Commission of Texas, the Arkansas Public Service Commission, the Common Pleas Court of Ohio, the Illinois Commerce Commission and the Federal Energy Regulatory Commission.

Q. What is the purpose of your testimony in this proceeding?

A. My direct testimony supports the direct testimony of Brian LeGrand, James Jenkins and John Watkins regarding MAWC's Test Year revenue, expense normalizations and the need for a revenue stabilization mechanism ("RSM"). MAWC has experienced residential declining usage per customer since approximately the year 2000 and my analysis indicates it will continue to experience residential declining usage per customer for the foreseeable future. My testimony discusses the analyses we have performed that identify and define this declining usage historically and demonstrates that the trend of declining usage will continue beyond the Test Year. These analyses show there is a continuing annual decline in residential water use across all MAWC districts averaging a combined approximate -1,356 gallons per customer per year ("gpcy"), or approximately -3.715 gallons per customer per day ("gpcd"). Furthermore, the ongoing and significant nature of the residential declining usage trend offers justification for the creation and application of a RSM that will allow MAWC the opportunity to attain its authorized revenue in this proceeding.

Q. Have you prepared, or caused to be prepared, exhibits in support of the Company's application to increase rates?

A. Yes, I am sponsoring the following exhibits:

- Schedule GPR-1: MAWC Residential Usage Trend 2006-2015;
- Schedule GPR-2: AWC Residential Usage Trend 2006-2015;
- Schedule GPR-3: US Water Fixture Specifications;
- Schedule GPR-4: State of Missouri & St. Louis County - Housing Stock Vintage;
- Schedule GPR-5: Effect of Tornado Rebuild on Water Usage;
- Schedule GPR-6: Authorized and Actual Revenue & Water Sales; and
- Schedule GPR-7: Household of 4 Theoretical Water Reduction.

II. <u>OVERVIEW</u>

Q. Please summarize your testimony.

A. The purpose of my testimony is to quantify and estimate the potential term and impact of the declining usage trend of MAWC's residential customers. My analysis concludes the following:

1. There is a continuing annual decline of residential water use across all MAWC districts averaging 1,356 gallons per customer.
2. That revised mandated efficiency standards for water fixtures will continue the existing trend of declining usage into the foreseeable future.
3. Similar water use trends are being experienced on affiliated American Water systems similar to MAWC.
4. Empirical analysis indicates that the MAWC use trend:
    a. May continue for up to the next 30 years.
    b. Is confirmed by the Joplin case study that illustrates that a significant reduction in usage per household (-8%) can rapidly occur due to water fixture replacement. This reduction is an amount equal to approximately an entire month's level of water sales.

III. MAWC RESIDENTIAL CUSTOMER USAGE TREND ANLYSIS

Q. Please describe the water use trend among MAWC's residential customers?

A. Since the year 2000, residential usage has declined on a per-customer basis in the MAWC service territory. The slope, or change rate, of residential decline has, however, accelerated since the passage of more stringent water fixture and appliance usage regulations in the 2000s. This decline can be attributed to several key factors, including but not limited to: increasing prevalence of low flow (water efficient) plumbing fixtures and appliances in residential households, customers' conservation efforts, conservation programs implemented by the federal government, state government, MAWC and other entities, and price elasticity.

Q. How did you arrive at your conclusions regarding the current downward trend in usage for MAWC's customers?

A. Our conclusions were derived through a rigorous analysis of monthly customer consumption by MAWC residential customers over the past ten years. For purposes of this analysis, we have divided total residential customer monthly usage into its base, non-weather sensitive usage and non-base, weather sensitive usage components. We analyzed base usage by applying regression analysis using time as a proxy variable for the ever-increasing penetration of government mandated usage reductions occurring by reason of water fixture and water appliances installed by the MAWC residential customer base over time. We derived the annual non-base usage by calculating the mean annual non-base usage over the period of 2008 through 2017 and profiling each month using the mean monthly contribution to the mean annual total over that same period. Discrete monthly non-base usage was estimated using the 10-year average allocation of non-base usage for each month to the 10-year average annual total.

In summary, the per customer trend of base usage was developed as illustrated by the three-step process outlined below. To further illustrate this process, I have attached graphs of the calculations described below as Schedule GPR-1, pages 1-3.

1) Monthly residential water sales data over the period of January 2008 to December 2017 were summed, and then divided by the number of customers to yield the average usage per month, per customer. For analysis purposes, we plotted average per-customer monthly usage over the period of January 2007 to December 2016. In this instance, the time variable (months) was plotted on the x-axis, and the consumption per customer variable was plotted on the y-axis. (Note that water sales data lag behind actual consumption by approximately one

month for customers on a monthly meter reading cycle and as much as two months for customes on a quarterly billing cycle). See Schedule GPR-1, page 1.

2) Average annual residential base consumption, expressed in gallons per customer, was calculated for each year from 2008 through 2017 based on the average of the months December through April. A single point representing the annual average monthly non-discretionary base (total usage less seasonal discretionary outdoor usage) usage was estimated and is plotted for illustrative purposes on Schedule GPR-1, page 2.

3) We then applied a linear regression analysis to the resulting annual base usage data to derive a trend line employing the 10-year annual average non-discretionary usage per residential customer as a function of time that stands as a proxy for the ever-increasing saturation of more water efficient fixtures and appliances. The resulting regression model has a good statistical fit with an R-Square of .912 (meaning the resulting regression model explains approximately 91 % of the variance in annual customer usage over the period estimated) and the time variable is very significant in explaining usage per customer with a t-statistic of -8.474. See Schedule GPR-1, Page 3.

Q. What are the results of your analysis for residential customers?

A. The results of our analysis indicate that MAWC has experienced a substantial and continuing decline in residential water consumption over the period covered by the historical data set, January 2008 to December 2017. The regression analysis projects a continuing annual system-wide decline of -1,356 gallons per customer year; this is equal to an annual decrease of -1.89% per year, or approximately -3.715 gallons per customer day.

Q. Have you performed a similar analysis of residential base usage for each of the exisitng MAWC rate districts?

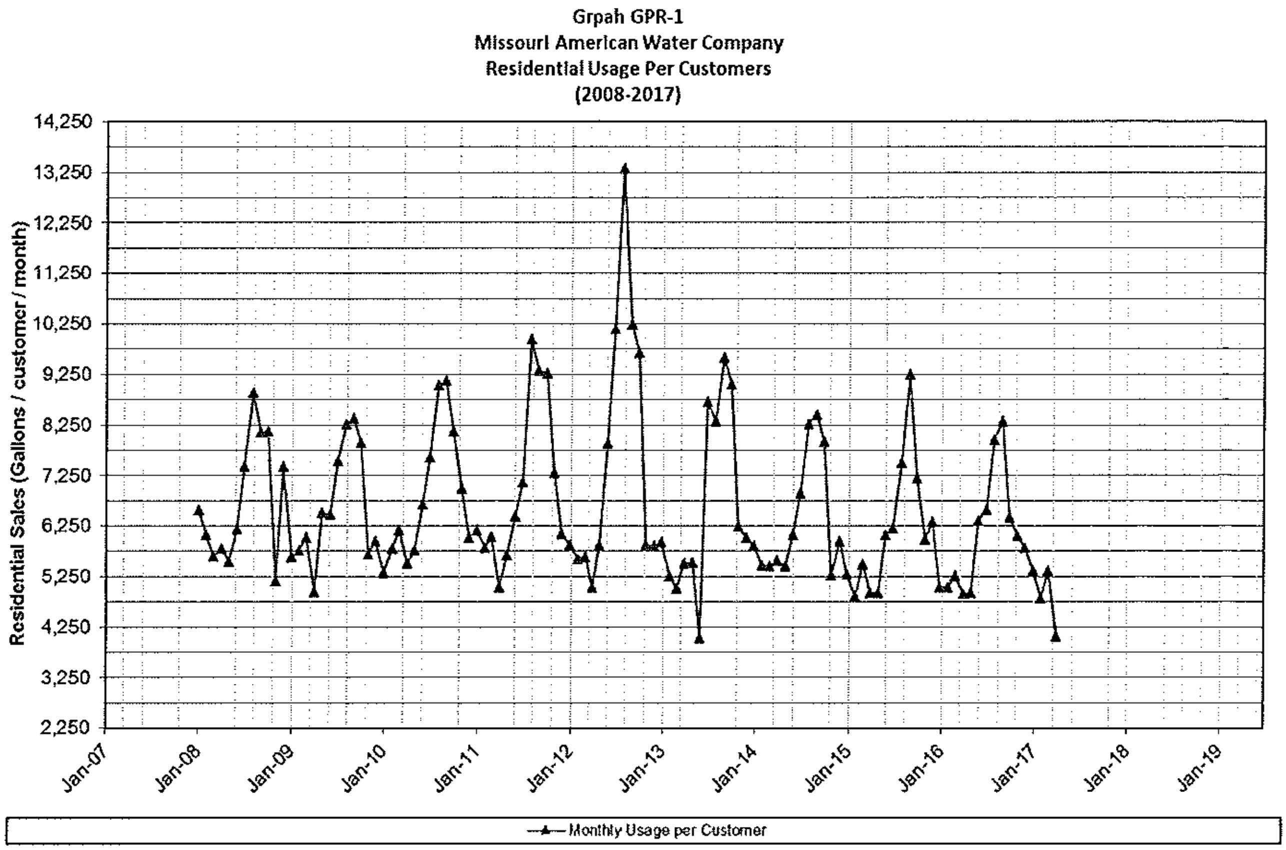
A. Yes I have. Using the same base usage analysis described above to analyze MAWC system wide residential customer base usage, I have performed an analysis of the trend of base usage for each of the existing three rate districts. The results of that analysis is presented in Table GPR-1. Table GPR-1 illustrates that the results of the district level modeling which has very similar results as compared to the state level modeling.

Table GPR-1
Missouri American Water Company
Residential Base Usage Trends
(2008-2017)

District	R2	Time	%	g/cust/yr	g/cust/day	Customers
MAWC	0.912	-8.47	-1.89%	-1,356	-3.72	426k
East District (D-1)	0.919	-8.87	-1.75%	-1,332	-3.65	358k
Northwest District (D-2)	0.896	-7.74	-1.74%	-912	-2.50	34 k
Southwest District (D-3)	0.928	-8.47	-2.68%	-1,344	-3.68	34 k

Q. Is residential usage affected by seasonal factors?

A. Yes. Outdoor usage by most customers is seasonal. For instance, for the residential customer class, outdoor usage during the summer season includes discretionary usage such as lawn and landscape irrigation, car washing, filling swimming pools, and similar such activities. Short-term summer weather patterns will influence outdoor water use; for instance, lawn irrigation decreases during a rainy period and increases during a dry period. These weather-related fluctuations in usage can mask underlying trends that occur on a monthly basis to non-weather sensitive base usage. The annual pattern of seasonal usage by MAWC residential over the period of 2008-2017 is clearly illustrated by the Graph GPR-1 below.



Q. How does your analysis of base usage account for weather-related changes to residential usage affected by seasonal factors?

A. I conducted a regression analysis that trends "base usage" over time without attempting to normalize for weather. As explained above, base (or non-discretionary) usage is defined as the residential average usage per customer measured over the period of December through April of each year, a period in which there is no appreciable outdoor usage of water. In other words, our methodology studies the trending decline of base usage over time having removed the effects of weather by excluding non-base (or discretionary) usage from the data set and hence the analysis.

Base usage is not weather sensitive and, therefore, is a more appropriate metric for studying the trend of residential usage as opposed to some methodology for creating "weather-normalized total usage." This is because there has never been a consistent definition of "weather" for weather normalization purposes, or a generally accepted weather normalization adjustment methodology in the water industry. To date, weather has never been satisfactorily addressed through existing ratemaking models for water companies using a regulatory "standard" for weather "normalization". [1] Therefore, base water usage is a more reliable metric for analyzing the long-term declining usage trend I have described.

Q. Given that you have separated water usage into base usage and seasonal non-base usage, how did you address variations in seasonal usage to arrive at non-base usage billing determinants?

A. In prior cases, without a standard regulatory model to follow for weather normalization, MAWC has used a ten year average of the non-base usage on a rate district basis. Prior to filing the MAWC 2017 rate case, MAWC met with the staff of both the Commission and the OPC to discuss improvements and outstanding issues between the parties that we could address in this case. As part of those discussions, MAWC agreed to undertake non-base usage modeling that would incorporate the effects of climatic parameters such as maximum temperature, average temperature, precipitation and cooling degree-days

[1] By contrast, degree-days have been determined to be a reasonable measure of 'weather' for the gas and electric industry. In the water industry, the interplay between precipitation and temperature can be as important as degree-days in the measurement of water usage.

on non-base usage. In preparation for this case, I undertook regression modeling for each rate district with the intent of developing statistical models that make non-base usage a function of certain climatic conditions. As we had not performed this analysis on prior occasions, we performed a broad exploratory analysis that measured the relationship of several climatic causal variables to non-base usage including: precipitation, average monthly high temperature, average temperature and cooling degree-days. Further we explored both unit change models (algebraic) and percentage change models (logarithmic). In addition, we explored the use of a binary variable to mitigate the dramatic impact of the summer of 2012 with its historic high temperature and drought. Finally, we used climatic data from NOAA weather reporting stations that reflected the load center for each rate district: East District (Rate District 1) – St. Louis, Northwest District (Rate District 2) – St. Joseph and Southwest District (Rate District 3)– Joplin. In the end, we attempted to develop similar models for each Rate District and the results of our modeling of non-base load is reported in Table GPR-2 below. Table GPR-2 identifies the structure of each rate district model that we relied on to forecast non-base usage for the Rate Year and that models' associated statistical parameters, the term used to average the climatic variable applied in the forecast and the NOAA weather station data used in the modeling. Lastly, as noted in Table GPR-2 below, we resorted to our prior approach of averaging ten years of non-base usage for the Southwest District due to a low R2 indicating that the model was able to explain approximately 27% of the variance of non-base usage over the ten years analyzed. As such, a ten year average of Southwest non-base usage has a greater probability (50%) of being within a standard deviation of actual value then what the model would have produced. In summary, we used climatic based regression models to forecast non-base usage for East and Northwest Districts based on 10 year averages for the climatic terms. Due to the poor explanatory cabapability of all climatic regression models designed for the Southwest District, we relied on the 10 year arithmetic mean to forecast non-base usage for that district.

Table GPR-2
Missouri American Water Company
Residential Non-Base Usage Trends
(2008-2017)

District	R2	Precip	CDD	Forecast	NOAA	Customers
MAWC	0.707	-4.051	1.629	10 Year	STL	426k
East District (D-1)*	0.756	-4.984	N/A	10 Year	STL	358k
Northwest District (D-2)	0.709	-3.439	2.814	10 Year	St. Joe	34 k
Southwest District (D-3)**	0.266	-0.745	0.773	10 Year	Joplin	34 k

* CDD were insignificant and excluded from final model.
** Due to low R2 this model was not used and a 10 year average of non-base usage was the basis of estimating non-base usage for the Rate Year.

Q. Table GPR-2 indicates that you relied on a ten year averge of the climatic variable (precipitation or cooling degree days) in your forecast of non-base usage. Please explain why you chose a ten year averaging technique to develop your forecast of the climatic variable in your forecast model?

A. As this is the first time we have used non-base climatic based regression modeling in a MAWC case, we chose to use the ten year average for purposes of consistency with the term of our base usage modeling which is also based on a ten year term. The use of a ten-year term to forecast the climatic variable, when a binary variable is NOT used to mitigate the effects of summer of 2012 in the model, is to produce results equal to a ten-year average of the non-base usage itself.

Q. What would have been the impact to your non-base usage forecast if you had used a three or five year average value to forecast the climatic variable?

A. If we had used either a five-year or three-year average to estimate the forecast value for the climatic variables we would have excluded the summer of 2012 from the forecast data set. As a result, our forecast of non-base load would have been lower then what has been included in this case.

Q. What is a binary variable and why is it used in statistical modeling?

A. In simple terms, a binary variable is used to describe and mitigate the impact or effect of a one-time event. The binary variable has two possible values, one and zero. The value of one is applied to the single event occurrence you are attempting to adjust the model for, such as the abnormally hot and dry climate of 2012. All other values in the time series are zero and have NO impact on the model.

Q. What would have been the impact to your non-base usage forecast if you had used a binary variable in your models to mitigate the impact of the summer of 2012 on the model coeeficients?

A. Developing a non-base usage model that includes a binary variable to mitigate the impact of the summer of 2012, results in coefficients that are reduced proportionately to the impact of the binary variable. When using the same ten year average for the climatic variable we applied in the models delineated in Table GPR-2, the forecast results for non-base usage would be lower than a forecast generated without the binary variable. That is the impact of adjusting the model coefficients for the extreme conditions of the summer of 2012.

Q. Why did you choose not to employ a binary variable in your non-base usage modeling?

A. In developing this case, we were attempting to explore new methods of forecasting non-base usage consistent and in conjunction with our base model approach. As we develop further expertise with non-base usage and climatic variable forecasting, we may consider more advanced models.

Q. You mentioned that the declining usage per customer experience of MAWC is not unique among the companies in the American Water system?

A. Yes, I have.

Q. Are the results of your analysis of MAWC customers' usage consistent with the results of your analyses in other states?

A. Yes, they are consistent. We have studied the residential consumption patterns for other American Water state operating systems many of which are located in climates and geographies similar to Missouri. The trend experienced by MAWC is very similar to the trends experienced in other states. The results of my analysis are shown on Schedule GPR-2, which illustrates that states in the American Water footprint have experienced a decline in residential consumption per customer averaging -2.0% per year over the last 10 years. The estimated MAWC system-wide reduction in residential customer usage per year of -1.89% falls close to the mean, appears reasonable, and is well within the bounds of the comparable rates of decline experienced by similar states in the American Water footprint.

Q. Is this trend being observed across the industry, beyond MAWC and other American Water companies?

A. Yes. According to the 2010 Water Research Foundation ("WRF") report, "many water utilities across the United States and elsewhere are experiencing declining water sales among households."[2] The report further states: "A pervasive decline in household consumption has been determined at the national and regional levels."[3]

IV. MAWC RESIDENTIAL USAGE FORECAST VS FIVE YEAR AVERAGE

Q. The Commission and PSC Staff have relied on a historic five year average of residential sales and revenue to set current or future test year ("Test Year") billing determinants in prior MAWC cases. Have you compared the results of using the MAWC base and non-base forecast method versus a five year average of 2012-2016 to set Test Year billing determinants?

A. Yes, we have presented in Table GPR-3 below a comparison of the five-year average of MAWC Residential sales volumes and revenues for the period 2012-2016 vs. the forecast of Test Year sales volumes and revenues developed using the MAWC method detailed above. That comparison illustrates that the five-year averaging method results in Test Year sales volumes and revenues that were 2,311 million gallons greater than the forecast employed by MAWC. The five-year average method results in a 7% overstatement of sales volumes for the Test Year.

[2] Coomes, Paul et al., North America Residential Water Usage Trends Since 1992 – Project #4031, page 1 (Water Research Foundation, 2010).
[3] WRF Report, page xxviii.

Table GPR-3
Missouri American Water Company
2012-2016 Residential Water Sales & Billed Water Revenues

Res Water Sales (TG)

	2012	2013	2014	2015	2016	5 Year Avg
Actuals	38,080,966	33,393,428	32,455,304	31,362,239	30,933,541	33,245,096
Test Year 2016						30,933,541
Variance						(2,311,554)
% Var						-7%

Res Billed Water Revenues ($000s)

	2012	2013	2014	2015	2016	5 Year Avg
Actuals	$177,880	$168,485	$166,325	$158,943	$168,135	$167,953
Test Year 2016						$168,135
Variance						$181
% Var						0%

Q. What is the catalyst for the overstatement of residential Test Year sales volumes using the five year method vs the base/non-base method used by MAWC?

A. The simple answer is atypically warmer and dryer weather during the period of 2012-2016 lead to greater than average water sales volumes and hence revenues. As discussed above, the MAWC approach incorporates modeling of residential non-base weather sensitive sales that estimates the responsiveness of weather sensitive sales to changes in climatic conditions. As such, when forecasting future levels of residential non-base sales, we are able to incorporate that responsiveness into the resulting forecast. In the case of the five-year average method, the simple average embeds the climatic conditions occurring during the five year averaging period into the average used for the forecast of Test Year sales volumes. To the extent the five year period experienced warmer and dryer then normal climatic conditions, then the five year averaging technique will overstate Test Year sales volumes. Conversely, to the extent that any given five-year period experienced cooler and or wetter than normal climatic conditions, then that five-year averaging technique will understate Test Year sales volumes.

Q. Have you analyzed the climatic conditions occuring during the five year 2012-2016 period and have you compared those conditions to the ten and forty year climatic averages?

A. Yes, I have. Table GPR-4 illustrates that the 2012-2016 five year averaging period, using cooling degree-days as the measure, was 12% warmer than the 40-year average and 3.2% warmer than the 10-year average. So too, using monthly precipitation as the measure, this same time period was 24.7% dryer than the 40 year average and 9.1% dryer than the 10 year average.

Table GPR-4
Missouri American Water Company
Comparison of 10 and 40 Year Weather to 2012-2016
Summer Season (May - Sept)

Time Period Measured	Cooling Degree Days	Precipatation	Maximum Monthly Temperature	Mean Maximum Daily Temperature	Mean Minimum Daily Temperature	Mean Average Daily Temperature
Mean % Change 5 to 40 Years	12.0%	-24.7%	1.9%	1.7%	2.3%	1.9%
S. Dev % Change 5 to 40 Years	-8.9%	-15.6%	-1.8%	-9.1%	-10.5%	-10.3%
Mean % Change 5 to 10 Years	3.2%	-9.1%	0.8%	0.6%	0.5%	0.6%
S. Dev % Change 5 to 10 Years	-9.2%	-7.4%	-5.4%	10.2%	7.6%	9.8%

Q. Reviewing Table GPR-3 on page 16, the 5 year averageing technique results in an overstatment of sales by 7% as compared to the MAWC trending approach. Using the same 5 year averaging technique with revenue results in an average that is relative close to year ending December 31, 2016 ("Year Ending 2016"). What

is causing the disassociation between sales and revenue using the five year average technique?

A. As illustrated in detail by Schedule GPR-6, it is the addition of $62.2 million dollars in revenue associated with approved ISRS rate increases (ISRS 12 through 15) and the base rate increase from the 2015 rate case over the period of 2012 through 2016 that cause the majority of the disassociation between the 5 year water sales and revenue averages. Further as Schedule GPR-6 illustrates, even with these rate increases and the very warm/dry summer of 2012, due to declining sales volumes, MAWC over the period of 2012-2016 was $9.7 below its authorized revenue for that period.

Q. What is your conclusion related to the relatively hotter and dryer climatic conditions during the five year average period and the same five year period average sales and revnues being greater than the MAWC forecast of Test Year sales volumes?

A. The warmer and dryer climatic conditions occurring during the 2012-2016 five year period employed by the averaging technique results in estimates for sales volumes and revenues driven primarily by that warmer and dryer than normal climatic conditions. This is illustrated by Graph GPR-1 on page 9 which clearly illustrate that over the nine summer periods of 2008-2016, the five year averaging technique for sales volumes and revenues would be based on summer sales volumes influenced by warmer and dryer conditions which drove summer residential usage per customer that ranks as the first, third and fourth greatest usage levels in the data set.

Q. Why is the MAWC forecast of Test Year sales volumes lower than the results of the five year averaging techique?

A. As demonstrated earlier in my testimony, the MAWC forecast is based on models estimated over the ten-year period 2008-2016 for two residential usage components we have defined as base and non-base usage. The base non-discretionary non-weather sensitive usage has been modeled to estimate the impact of reductions in usage per customer for increasingly greater penetration rates of increasingly efficient water fixtures and appliances. The non-base, discretionary, weather sensitive usage was modeled as a function of climatic conditions over the same time period. The result is that the MAWC approach is able to produce a Test Year sale volume and revenue forecast that incorporates the trend of residential usage reductions while allowing the forecast to reflect non-base sales volumes based on ten-year average climatic conditions. Comparatively, the five-year averaging approach is unable to capture the nearly two decade long trend of declining base residential usage and is biased by the climatic effects during the 2012-2016 average period resulting in three of the four highest summer per customer usage periods during the 2008-2016 period MAWC analyzed. Generally, the MAWC approach is based on ten years of climatic data that mitigates the influence of the relatively warmer and dryer 2012, 2014 and 2015 summer non-base usage periods, which have a far greater impact on the five-year average technique.

V. CATALYST FOR MAWC RESIDENTIAL CUSTOMER DECLINING WATER USE

Q. What is causing the decline in residential customers' usage?

A. A number of factors drive the decline in residential customers' usage, including the prevalence of low-flow fixtures and appliances resulting from existing and new regulations that will lead to further reductions in fixture flow-rates, conservation programs and public initiatives that have led to greater consumer water conservation awareness, consumers' response to price increases for water service or competing products, and consumers' responses to changes in income or employment.

Q. Please explain what you mean by the prevalence of low flow fixtures and appliances.

A. Plumbing fixtures such as toilets, showerheads, and faucets available to consumers today are more water-efficient than those manufactured in the past. Similarly, appliances such as dishwashers and washing machines are also more water-efficient. When a customer replaces an older toilet, washing machine, or dishwasher with a new unit, the new unit will almost certainly use less water than the one it replaced. When new homes or business establishments are built, they include water efficient fixtures, and every time a customer remodels or installs new appliances in his or her kitchen, bathroom or laundry room, he or she will consume less water in the future.

Q. How much water do the new fixtures and appliances save?

A. The Energy Policy and Conservation Acts of 1992 and 2005 ("EPAct92" and "EPAct05," respectively) mandated the manufacture of water-efficient toilets, showerheads and faucet fixtures. For example, a toilet manufactured after 1994 must use no more than 1.6 gallons per flush, compared to a pre-1994 toilet, which typically used from 3.5 to 7 gallons per flush. In fact, toilets using only 1.28 gallons per flush or less are becoming more prevalent in the marketplace. Replacing an old toilet with a new one, therefore, can save from 2 to nearly 6 gallons per flush. The United States Environmental Protection Agency ("USEPA") estimates that there are more than 220 million toilets in the United States, and that approximately 10 million new toilets are sold each year for installation in new homes and businesses or replacement of aging fixtures in existing homes and businesses

The Energy Independence & Security Act of 2007 ("EISA"), which established stringent efficiency standards for dishwashers and washing machines has further reduced indoor water consumption. Dishwashers manufactured after 2009 and washing machines manufactured after 2010 must use 54% and 30% less water, respectively. All other factors being equal, a typical residential household in a new home constructed in 2015, with water efficient toilets, washing machines, dishwashers and other fixtures, uses approximately 35% less water for indoor purposes than a non-retrofitted home built prior to 1994. Schedule GPR-3, pages 1-3 provides additional detail about the expected impact of water efficiency measures on residential water consumption.

Q. Haven't new federal regulations related to efficiency standards for water-using fixtures and appliances already had their full impact on MAWC residential customer usage?

A. No, not at all. Due to the age of the Missouri residential housing stock, these water efficiency standards have only just begun to have an impact on residential usage. The potential impact of replacing these fixtures is significant as, according to the 2015 American Housing Survey, 84% of the homes in the State of Missouri were built prior to the year 2000 (70 % of homes prior to 1990)[4]. Further, making the same housing stock comparison for St. Louis County where approximately two-thirds of the MAWC residential customers reside, we find that 94% of homes were built prior to the year 2000 and 84% prior to the year 1990. These data are detailed in Schedule GPR-4 and summarized in Table GPR-5 above. Both the state-wide level and St. Louis County data illustrate that approximately 84% or more of the housing stock was constructed with toilets, washing machines, and dishwashers that are much more water-intensive than newer fixtures and appliances now on the market which will eventually replace this existing fixture and appliance stock.

Table GPR-5
Missouri American Water Company
Housing Stock Vintage
State of Missouri

	State of Missouri		St. Louis County	
Year Structure Built	Units	% Total	Units	% Total
Built 2014 or later	2,050	0.08%	227	0.05%
Built 2010 to 2013	36,827	1.35%	2,432	0.56%
Built 2000 to 2009	388,234	14.22%	25,397	5.80%
Built 1990 to 1999	397,789	14.57%	42,187	9.63%
Built 1980 to 1989	333,064	12.20%	52,263	11.93%
Built 1970 to 1979	432,511	15.84%	74,145	16.93%
Built 1960 to 1969	317,903	11.65%	79,606	18.17%
Built 1950 to 1959	294,186	10.78%	86,735	19.80%
Built 1940 to 1949	141,326	5.18%	31,386	7.16%
Built 1939 or earlier	385,974	14.14%	43,698	9.97%
Total housing units	2,729,864	100.00%	438,076	100.00%
Percentage Prior to 00		84.35%		93.60%

[4] U.S. Census Bureau, Selected Housing Characteristics. 2014 American Community Survey 10-Year Estimates (1990-1999), available at http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

Q. Please elaborate on other factors contributing to the continued decline in residential water consumption patterns.

A. Programs to raise customer awareness and interest in the benefits of conserving water and energy continue to increase. For example, WaterSense is a USEPA voluntary partnership program that seeks to protect the future of our water supply by offering people a simple way to use less water with water-efficient products, new homes, and services. These programs' specifications, as well as others, are detailed in Schedule GPR-3, pages 4-12. This listing is a reproduction of the Alliance for Water Efficiency Water Products Standard Matrix, which was updated in March 2010. In addition, as MAWC witness Cheryl Norton describes, MAWC offers programs that encourage customers to use water efficiently. As awareness of water efficiency increases, customers may decide to replace a fixture or appliance even before it has broken. Additionally, customers may further reduce consumption by changing their household water use habits in various ways. MAWC's residential customers have reduced their base usage by approximately 2.5 gpcd on average, since 2008. A 2.5 gallon per day decrease can be achieved by subtle changes in customer behavior. For instance, here are some ways a customer can reduce his or her usage by 2.5 gallons per day:

- Taking a shower that is 1 minute shorter per day;
- Two flushes per day with a newer replacement low-flow toilet fixture vs. an older toilet;
- Running the dishwasher 5 times per week instead of 7; or
- Turning off the water for approximately 1 minute while brushing your teeth.

In addition, negative price elasticity can contribute to a reduction in usage. As the price of water has increased over time with successive rate increases, as with typical consumer price responsive behavior, water consumers reduce their usage in response to those successive price increases.

Q. The historic period in this case is Year Ending 2016. Given that the declining use trend has been progressing for over two decades, weren't the majority of non-efficient fixtures and appliances already replaced by the end of the Test Year?

A. No, as illustrated above, it will take many years to achieve complete implementation and saturation of fixtures and appliances consistent with current efficiency standards because the full implementation of the new standards only occurs as older fixtures are replaced. This occurs over a very long period of time as housing stocks are remodeled and appliances and fixtures wear out, break or become obsolete. As explained later in my testimony, the decline in usage for the theoretical family of four indicates a 40-year term to reach total implementation of the current fixture standards and realize the total impact in reduced water usage. As mentioned earlier in my testimony, to date, we have observed a trend of declining residential usage on the MAWC system for approximately 17 years, leaving another 23 years for further reductions.

Q. You've explained the laws and programs that drive the water conservation trend. Can you point to a "real world" example of how these laws and programs actually affect usage per customer?

A. Yes, as a matter of fact, there was a situation in the MAWC footprint that demonstrates this phenomenon in a rather dramatic fashion.

Q. Please describe it.

A. This phenomenon is illustrated by analyzing usage per customer in the MAWC Joplin district, before and after the devastating EF5 tornado of May 22, 2011 ("Joplin Tornado").

Q. How does the Joplin tornado provide evidence of future declining water use for MAWC?

A. The impact of the Joplin Tornado was an immediate reduction of customer connections in the Joplin district by approximately 3,060 (14.4% of the May 2011 Joplin residential total). Given that the devastation caused by an EF5 tornado to residential housing is nearly absolute, it follows that the 14.4% of the Joplin district residential housing stock would have to be completely rebuilt before being inhabited again. Such rebuilding would, in turn, be required to conform to the water use standards discussed earlier in my testimony and detailed in Schedule GPR-3. Hence, this event has implications for the potential future usage decline due to fixture replacement for the entire American Water affiliate system, including but not limited to MAWC.

Q. Please describe your analysis of the pre- and post-2011 Joplin tornado residential customer usage.

A. I developed and compared the results of two regression models: the first estimates the trend in base residential usage per Joplin customer for the 10 years leading up to and including 2011; the second model estimates the trend in base residential usage per Joplin customer for the period 2012-2015. By comparing the results of those two regression models, we can see the impact on average residential customer usage due to the rebuilding of housing stock in Joplin to the enhanced water use standards.

Q. Please describe the statistical results of your analysis of the pre- and post-2011 Joplin tornado residential customer usage.

A. The results of the analysis are provided in the table below:

Table GPR-6
Joplin Declining Use Analysis
Usage Trend Pre / Post-2011 Tornado

Measure	Prior to 2011	Post 2011
R-Square	0.820	0.974
Usage Trend	-1.74%	-2.77%

Table GPR-6 illustrates the results of the regression analysis of average base usage per customer both before and after the Joplin Tornado. It is clear from the statistical results of that regression analysis that the Joplin district's declining usage per customer trend has accelerated because a substantial number of residential customers have rebuilt using water use fixtures that meet or exceed the contemporary water efficiency standards and have replaced older less efficient fixtures as part of the rebuilding process. The results show that the decline in the base residential usage per customer has increased from an annual rate of approximately -1.7% to approximately -2.8% due to the reconstruction of approximately 2,500 (13.8% of that system) residential dwellings since May 2011 in the Joplin district. This is an approximate 59% acceleration of the rate of decline in Joplin post May 2011. This acceleration of the trend is illustrated graphically in Schedule GPR-5.

Q. Has the rate of resdiential usage reductions in Joplin continued to be greater in 2016 as compared to the pre-2011 Joplin tornado levels?

A. Yes, even though a majority of the post tornado recover rebuild was accomplished prior to 2016, the remaining residential structures added in 2016 contributed to a 26% sharper decline in usage for Joplin as compared to the pre-2011 levels. This emphasizes that due to the age of housing stock comprising the MAWC water system, that there exists a great inventory of water using fixtures and appliances currently in use, that when replaced with newer fixtures and appliances meeting more stringent water use regulations, will result in continued reductions in residential usage across the MAWC system.

Q. What do the results of the pre- and post-2011 Joplin tornado usage reveal about residential customers' usage and what do the data imply about future water usage declines?

A. The statistical results of the Joplin Tornado analysis, when combined with the results of the theoretical "household of four" user analysis outlined in Schedule GPR-5, offer compelling empirical evidence as to the potential scope and duration of continued reductions in customer water use patterns. First, as discussed, the rebuilding of homes in the Joplin district resulted in a 59% acceleration of the annual usage per customer reduction from approximately -1.7% to approximately -2.8%. Second, those 2,500 rebuilt customer dwellings experienced an annual usage reduction of approximately 3,200 gallons, or roughly an 8.4% reduction in usage, from their 2011 pre-Joplin tornado levels. That 3,200-gallon average residential usage reduction by the rebuilt customers is nearly equal to the loss of an entire month's worth of water sales to a typical Joplin residential customer (based on average usage in Joplin post-2011).

Q. What is your conclusion related to the continuation of reductions in residential water usage on the MAWC system?

A. Typically, households replace appliances on a sporadic basis, as they break or become obsolete. The replacement appliances are more efficient, but because they are installed over time, the reductions in usage due to increased efficiency are spread out over time and it is difficult to isolate the impact of any increase in the efficiency of a single appliance on overall water usage. In contrast, a significant number of households affected by the Joplin Tornado replaced all of their appliances at a single point in time. Therefore, by analyzing the decline in usage in Joplin after the tornado, we can assess the total impact that installation of the most recent, efficient, available technology will have on usage over time. In other words, as MAWC customers replace their appliances, usage on the MAWC system is likely to decline at a similar rate as usage in Joplin declined after the tornado. On this basis, and in conjunction with the results of the theoretical family of four analysis, I conclude that residential water use reductions will continue to be significant well into the near future for the MAWC system.

Q. Have you analyzed the impact of reduced water usage on MAWC's actual water sales and revenues, as compared to levels authorized for the Company since 2008?

A. Yes, I have. MAWC Schedule GPR-6, and summarized in Table GPR-7 below, illustrates that MAWC has collected revenue that is less than the revenue levels used to set revenue requirements in rate cases since 2008 for each post-case year of those proceedings from 2008 to 2016 except for 2012 when sales were driven by the historic drought. More specifically, for the period of 2008 through 2016, MAWC was under its authorized revenue for the period by approximately $69.4 million. Similarly, for that same period, MAWC was under its authorized total water sales by approximately 88.9 billion gallons. The inability of MAWC to collect its authorized revenue over the period of 2008-2016 is linked directly to water usage reductions attributed to the 88.9 billion-gallon short fall in total sales levels set in the MAWC cases over the period of 2008 through 2016[5].

Table GPR-7
Missouri American Water Company
Actual Revenue/Water Sales Compared to Authorized
(2007-2016)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total 2008-2016
MAWC Total Billed Annual Revenue*	177,389,283	180,166,727	203,017,639	222,749,546	240,218,004	274,501,000	261,186,872	266,484,898	264,979,705	283,508,099	2,374,201,772
Total Authorized Revenue**	168,290,426	197,386,326	224,188,475	236,684,056	247,231,384	258,154,279	265,880,783	273,892,338	283,861,950	287,994,720	2,443,564,736
Revenue Recovery to Authorized (Under)/Over	$9,098,857	($17,219,599)	(21,170,837)	(13,934,510)	(7,013,380)	16,346,721	(4,693,911)	(7,407,439)	($18,882,245)	($4,486,621)	($69,362,964)
	5.41%	-8.72%	-9.44%	-5.89%	-2.84%	6.33%	-1.77%	-2.70%	-6.65%	-1.56%	
MAWC Total Annual Water Sales (000 Gallons)	68,751,967	60,992,457	58,144,902	60,275,866	60,561,458	64,866,418	58,124,580	56,927,366	55,658,515	55,768,403	600,071,932
Total Authorized Water Sales*	84,846,470	86,852,062	83,324,702	71,286,441	61,618,498	60,559,014	60,272,780	60,272,780	60,272,780	59,647,313	688,952,841
Water Sales to Authorized (Under)/Over	(16,094,503)	(25,859,605)	(25,179,800)	(11,010,575)	(1,057,040)	4,307,404	(2,148,200)	(3,345,414)	(4,614,265)	(3,878,910)	(88,880,909)
	-18.97%	-29.77%	-30.22%	-15.45%	-1.72%	7.11%	-3.56%	-5.55%	-7.66%	-6.50%	

* Inclusive of Waste Water Revenue and Exclusive of Other Water Revenue
**Per Commission Orders Exclusive of Other Water Revenue

Q. Has MAWC factored the observed trend in residential customer usage into its Test Year revenues in this case?

[5] Prior to deployment of our new information technology systems (Business Transformation) in May of 2013, MAWC made all customer accounts "current" for dunning purposes. Following deployment, MAWC suspended the late-payment notice and disconnection process until the end of June 2103. MAWC took this action to ensure that the system had reached a certain level of stability and customers had some time to become accustomed to the bill redesign before reintroducing the dunning process. As a result, a significant amount of unbilled revenue from 2013 was billed in 2014 resulting in an unusual revenue swing between periods.

A. Yes. The development of MAWC's revenue requirement and Test Year revenues at present rates, including the adjustment to Test Year data to reflect the observed trend in residential customer, is addressed by Company witness Brian LeGrand.

VI. MAWC RESIDENTIAL CUSTOMER PROSPECTIVE USAGE TREND

Q. Do you expect the MAWC customer declining usage trend to continue in the future?

A. Yes. Water efficient fixtures and other drivers such as conservation education and federal government-mandated standards will continue to drive further water efficiency and hence an ongoing decline in usage per residential customer. The rate of the continued trend depends on the pace of fixture replacement within the MAWC service footprint and is influenced by the broadening acceptance of a conservation ethic through raised customer and business awareness programs, government conservation policy, and similar behavior modification related programs.

According to a American Water Works Association ("AWWA") Journal article dated February 2012, technology is now available for newer, more water-efficient products that further improve Energy Policy Act levels, and there is a growing movement to codify these more stringent specifications[6]. The recent introduction of progressive code modifications—such as the International Code Council's ("ICC's") International Green Construction Code ("IGCC") and the International Association of Plumbing and Mechanical Officials ("IAPMO") Green Plumbing and Mechanical Code Supplement

[6] Hoecker, Jay and Bracciano, David. Tampa Bay Water. "Passive Conservation: Codifying the use of Water-Efficiency Technologies" February 2012, Journal AWWA. 104:2.

(2011) support uniform implementation of increased water efficiency standards[7]. AWWA research also indicates that this decline in water consumption will continue. An article in the June 2012 issue of the AWWA Journal entitled "Insights Into Declining Single-family Residential Water Demands" states: "[r]educed residential demand is a cornerstone of future urban water resource management. Great progress has been made in the last 15 years and the industry appears poised to realize further demand reductions in the future."[8] The regulations mandating water efficient washing machines and dishwashers are relatively new. Based solely on the life expectancy of appliances, the replacement of existing appliances, and the corresponding reduction in water used, the trend in declining usage will likely continue to occur for at least the next fifteen years or more.[9]

Q. Is the decline residential water consumption showing any signs of reaching equilibrium?

A. No. New water efficiency technology and regulations are expected to continue to drive water use downward in the future. As explained by the American Council for Energy Efficiency:

> Home appliance manufacturers and energy efficiency advocates have recently agreed to improved efficiency standards and tax policies for

[7] Hoecker, Jay and Bracciano, David. Tampa Bay Water. "Passive Conservation: Codifying the use of Water-Efficiency Technologies" February 2012, Journal AWWA. 104:2.
[8] DeOreo, William and Mayer, Peter. American Water Works Association Journal. Vol. 104. Issue 6. http://apps.awwa.org/WaterLibrary/showabstract.aspx?an=JAW_0076117. June 2012.
[9] As I mentioned earlier, EISA will further reduce indoor water consumption. The average life expectancy of a new dishwasher, clothes washer and gas water heater is 11 years. An electric water heater has an average life one year longer. http://www.statista.com/statistics/220020/average-life-expectancy-of-major-household-appliances/ Consequently, it should be obvious that the trend of declining use due to appliance replacement will continue for years to come.

> refrigerators, freezers, clothes washers, clothes dryers, dishwashers, and room air conditioners. This agreement could save enough energy to meet the total energy needs of 40 percent of American homes for one year and the amount of water necessary to meet the current water needs of every customer in the City of Los Angeles for 25 years.[10]

These higher efficiency dishwasher and washing machine standards include tax incentives for consumer purchases that became effective in January 2013 and January 2015, respectively. Therefore, consumers will achieve an even higher level of water efficiency (i.e., lower usage) than the federal regulations mandated in the EPAct92es.

Q. Have you performed an analysis of the likely future of the declining use trend for MAWC?

A. Yes, I have developed estimates of the impact of the Water Sense/Energy Star usage specifications for a family of four occupants' water usage. The analysis results are depicted on Schedule GPR-7, Page 1 of 1. Generally, the model multiplies the typical usage per capita by the estimated reduction for specific appliance usage from the pre-regulatory standard in place until 1994 to the Water Sense/Energy Star usage specifications in effect since 2010/2011 respectively, by the number of users in the household (4 in this example), annualized. I then summed the various usage reductions for the sample family of four across all fixtures that could be replaced to get an average total usage reduction. My analysis indicates that a household of four would see a

[10] American Council for Energy Efficiency, Major Home Appliance Efficiency Gains to Deliver Huge National Energy and Water Savings and Help to Jump Start the Smart Grid, available at http://aceee.org/press/2010/08/major-home-appliance-efficiency-gains-deliver-huge-natio. Date Accessed: 8/7/2012.

reduction of approximately 54,315 annual gallons over the course of a year, due to fixture replacement at the Water Sense/Energy Star specification levels.

Q. Do the validity and applicability of the household of four analysis require that all four of the theoretical users reside in the same household?

A. Not at all. The household of four analysis is what economists and statisticians refer to as a stochastic analysis. A stochastic analysis implies that the data sample is randomly selected and distributed across the population of the data being analyzed. In this particularly instance, stochastic selection means that the household of four can be spread throughout multiple households across the MAWC service territory. In practical terms it means that the necessary number of toilets, water fixture, water heater, clothes washer, etc. replacements occur throughout the MAWC service territory to equal the number of replacements implied by the analysis and the annual amount of residential declining use. As an example, the analysis implies that on average 10,660 toilets are replaced annually amongst the 425,504 (2.50%) residential customers across the MAWC system.

Q. What does the estimated 54,315-gallon annual reduction in usage for a household of four imply related to the potential term of the declining use trend you have estimated for MAWC?

A. The estimated reduction in usage of the sample household of four analysis allows for the estimation of the time period over which all appliances in the MAWC service territory will be converted to meet the Water Sense/Energy Star specifications. Dividing the total estimated annual usage decline for MAWC of 577 million gallons by the estimated annual usage decline for the sample household of four of 54,315 gallons, reveals that 10,623 residential customers, or 2.5%, of the Year Ending 2016 average of 425,504 residential customers, would need to make these fixture changes to account for the estimated total annual residential declining usage. Further, taking the reciprocal of the 2.5% of residential customers needed to account for the annual usage decline reveals a theoretical term of 40 years to fully convert the installed fixture base to the Water Sense/Energy Star usage specifications, all other factors remaining equal.

Q. Conceptually, how many additional years could the estimated declining use trend for MAWC continue?

A. Based on the historical data available for MAWC; the current declining use trend has been evident since 2002. To date, that trend has progressed for approximately 17 consecutive years. Given that the implied theoretical term of the trend is 40 years, all factors staying the same, the trend could continue for an additional 23 years.

Q. Mr. Roach earlier in your testimoy you stated that there was a minimum 15 years remaining in the trend of residential usage reductions. The analysis you summariezed immediately above leads to the estimation that there are potentially 23 remaining years in the residential usage reduction trend. Would you please reconcil these two trend numbers?

A. Yes the minimum 15 year remaing term for residential usage reductions mentioned earlier in my testimony is based solely on the average service life of water using appliances (dish washers, clothes washers, hot water heaters). The four user analysis reported above, takes not only the impact of water using applicance retirements but also estimates the impact of water fixture changes such as shower heads, faucets and toilets in conjunction with those water using applicance service retirements. As a result. 15 years would be a minimum extension of the residential usage reduction trend and 23 years would be closer to the more probable term of the residential usage reduction trend.

Q. Have the Company's residential customers received any benefits from their reduced water usage?

A. Yes. Residential customers share in various environmental and operational benefits from lower water usage by residential customers. For example, reduced usage helps maintain source water supplies, as diversions from supply sources are lessened, leaving more water for passing flows or drought reserve. Reductions in power consumption, chemical usage, and waste disposal not only reduce water utility operating costs, but also provide environmental benefits such as reduced carbon footprint from lower power usage for treatment and pumping and reduced waste streams. Reduced water usage by residential customers also reduces energy consumption within the customer's home, for instance, through lower hot water heating needs. In addition, on a case-specific basis, reduced water usage has the potential to enable the utility to delay or downsize a capacity addition. In systems where demand is approaching the capacity of water supplies or treatment facilities, the water saved through efficient usage by customers can be a preferred alternative to a supply-side expansion, with a resulting lower cost to customers. Over the long term, reduced usage per residential customer has helped lower operating costs, and has helped avoid some capacity-related needs. These savings and avoided costs have benefitted customers through the ratemaking process.

Q. Please describe how declining usage and water conservation activities can result in avoided capital costs.

A. As discussed previously, the decline in residential water consumption has been steadily progressing since the early 2000's. Base water usage for the average MAWC per residential customer is approximately 32% lower today than it was in the early 2000's. As a result of these ongoing reductions in water usage, the water utility industry has avoided the need to build supply, treatment, and transmission facilities to meet those now avoided additional usage demands. The impact of reduced usage per customer on supply and large transmission investment notwithstanding, the ongoing decline of usage per customer does not delay nor mitigate the on-going need for MAWC to continue replacing its aging distribution infrastructure in order to continue providing its customers with reliable and safe drinking water.

VII. <u>RSM</u>

Q. Are you aware of the RSM that is described by witnesses Jenkins and Watkins?

A. Yes, I am.

Q, Based on the testimony you've provided above, is it your belief tht the RSM will best capture the revenue discrepancies that you've described?

A. Yes, I do. First, unless the trend in declining use per customer is captured explicitly in the forecast of revenue to be expected in the first year of rates, those rates will almost certainly fail to capture the actual revenue set in the rate order. Moreover, an event such as the Joplin tornado can occur that may exacerbate the declining use. Furthermore, the one thing we do know about weather is that it is unlikely to be "normal" for any given period. Therefore, even if we could accurately predict the exact usage that would accompany normal weather, revenue will exceed the expected amount in a hot, dry summer or, conversely, fall short of the expected levels in a cool wet summer. The RSM will resolve those anomalies so that customers will pay no more, or less revenue than the Commission found appropriate in its rate order.

VIII. <u>CONCLUSIONS</u>

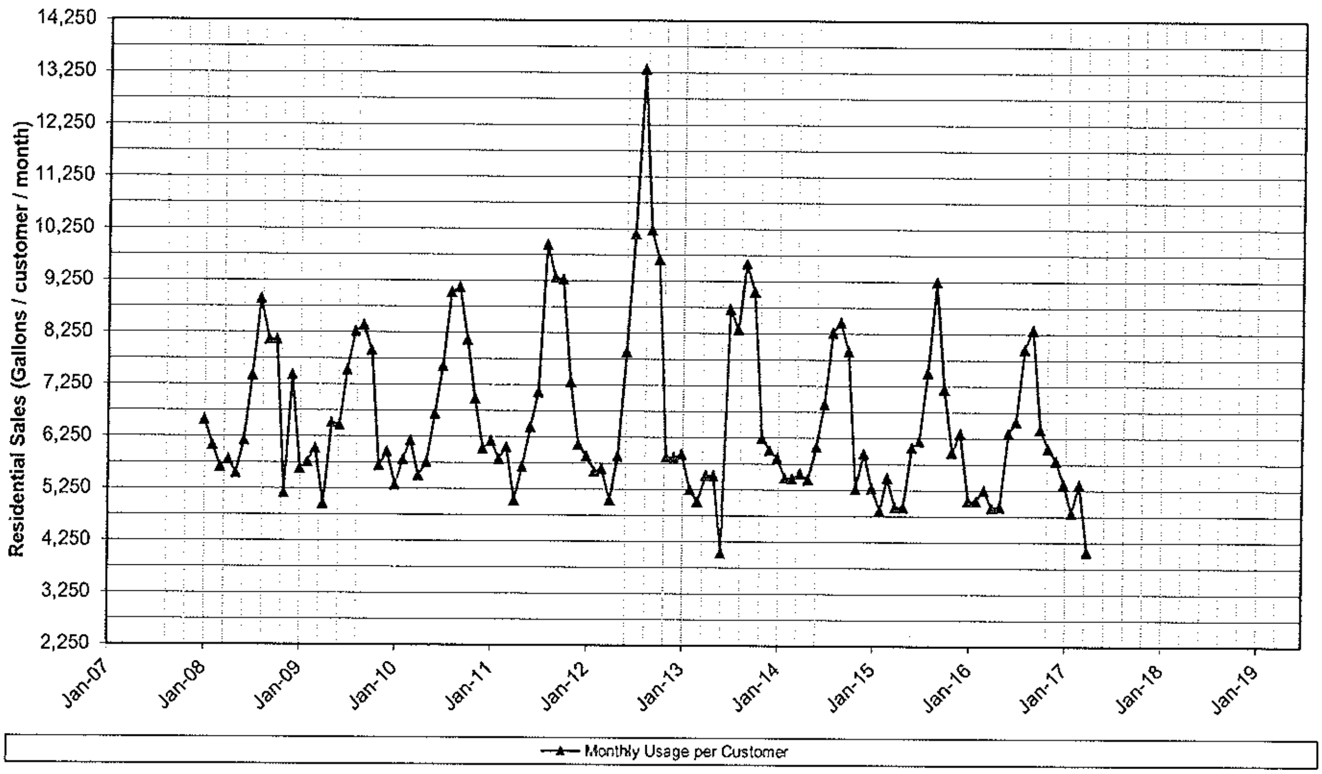
Q. What conclusions were you able to draw concerning the water usage trends of MAWC customers historically and the degree and length of potential future water usage reductions into the future?

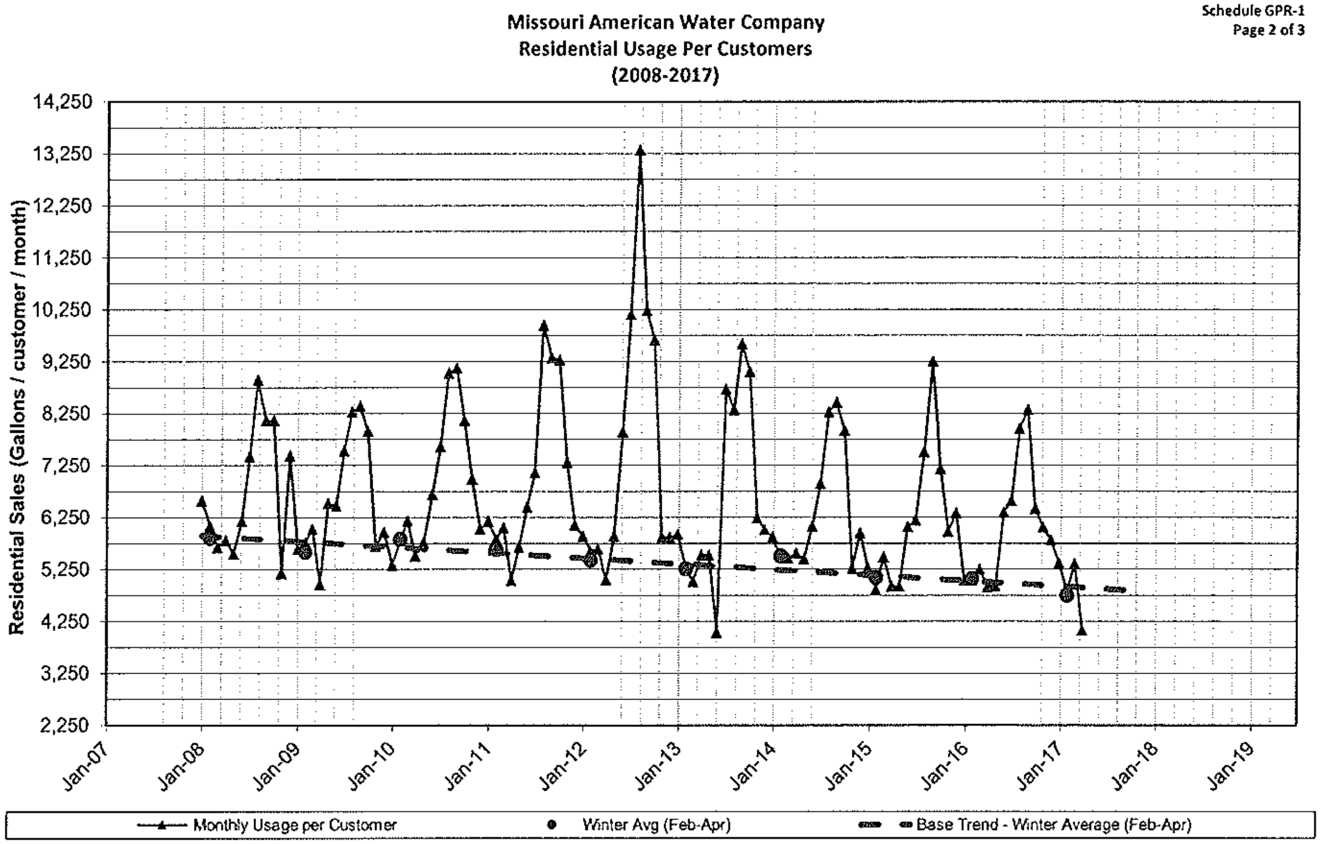
A. First, over the period of January 2008 to April 2017, MAWC residential customers' base usage fell -1,356 gpcy or approximately -1.89% per year. Second, there is potential for this trend to continue for up to 23 more years on the MAWC system. Third, housing stock data indicates that over 84% of the residential structures in Missouri were built prior to the passage of contemporary water use standards (over 90% in St. Louis County) which implies that a vast inventory of water fixtures and appliances currently exists that when replaced will result in large reductions in household water usage. Lastly, MAWC has not achieved Commission-authorized revenue levels in some time, with an accumulated under-recovery of $69.4 million over the period 2008-2016. The leading cause of this failure to achieve the revenue anticipated in Commission orders is the continued reduction in water usage by MAWC customers, which can render inaccurate and misleading the use of historic Test Year data as a proxy for rate year revenue. The inability of MAWC to meet its authorized revenue over the period of 2008-2016 is impacted substantially by water usage reductions which have attributed to the 88.9 billion-gallon short fall in total sales levels set in the MAWC cases over the period of 2008 through 2016. As a result, it is necessary to incorporate the continuing trend of reduced usage per customer for residential customers into the future.

Q. Does this conclude your direct testimony at this time?

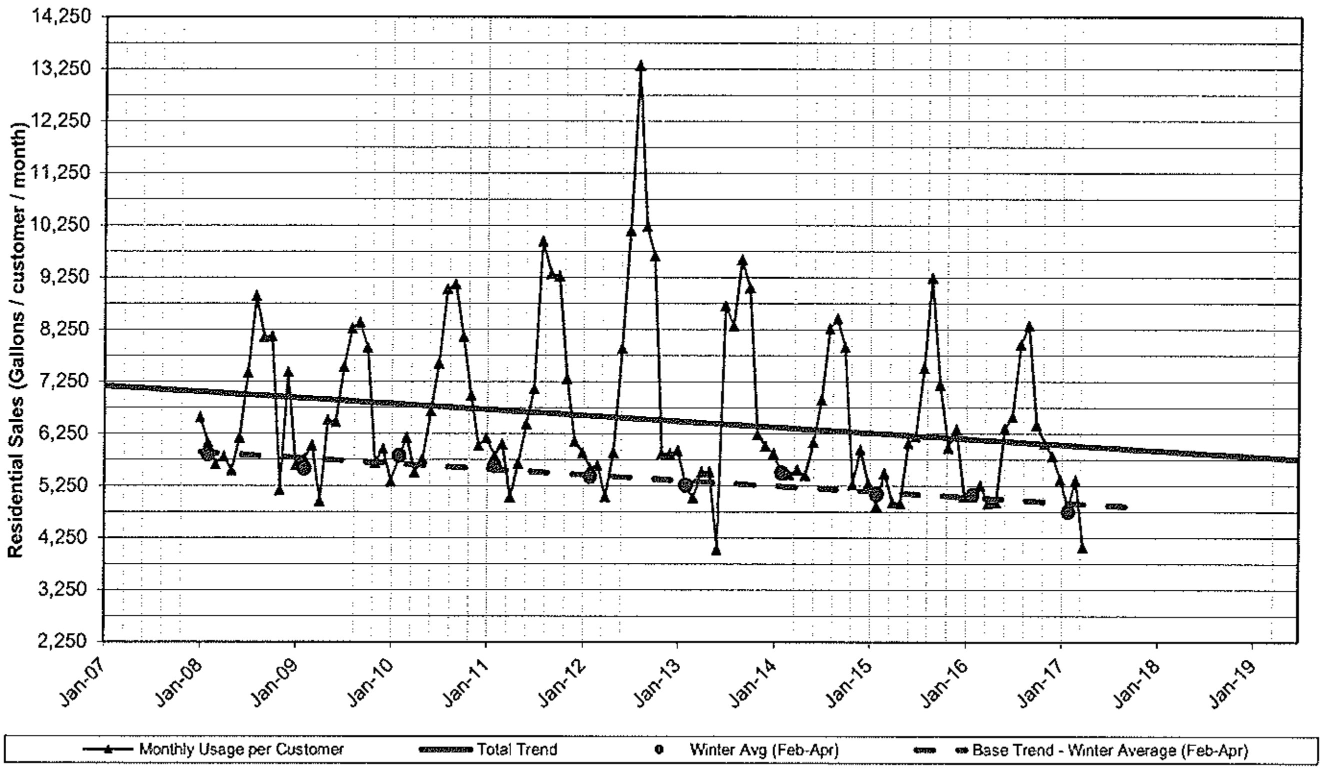
A. Yes it does.

Missouri American Water Company
Residential Usage Per Customers
(2008-2017)




Missouri American Water Company
Residential Usage Per Customers
(2008-2017)
Residential Sales (Gallons / customer / month)
14,250
13,250
12,250
11,250
10,250
9,250
8,250
7,250
6,250
5,250
4,250
3,250
2,250
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Monthly Usage per Customer
Winter Avg (Feb-Apr)
Base Trend - Winter Average (Feb-Apr)

Missouri American Water Company
Residential Usage Per Customers
(2008-2017)



American Water Works Company
Residential Water Usage Forecasts Based on 10 year history
Based on Winter Usage Trends except where noted below

State	Annual Decline (GPCY) 10-year (2007-2016)	Rate of Decline (%) 10-year (2007-2016)
California*	-4,773	-4.3%
Illinois	-996	-1.9%
Indiana	-984	-2.0%
Iowa	-1,164	-2.6%
Kentucky	-864	-1.7%
Maryland**	-444	-0.9%
Missouri	-1,320	-1.8%
New Jersey (SA1)	-1,176	-1.7%
New York	-1,824	-1.9%
Pennsylvania	-920	-2.1%
Tennessee	-612	-1.3%
Virginia	-1,032	-2.0%
West Virginia	-540	-1.4%
Michigan++	-1,017	-2.4%
Weighted Average (w/o CA)	-1,063	-1.9%
Weighted Average (w/ CA)	-1,263	-2.0%

Notes:

*California used the Annual Average Method for trending using a 10 yr (2006-2016) history

**MD used the Annual Average Method for trending using a 10 yr (2007-2016) history

++ MI Analyses presented were performed using an annual average method for a 10 year duration only

The following regulations are listed in the "*Energy Independence & Security Act of 2007,*" Public Law 110–140 – Dec. 19, 2007:

1. A top-loading or front-loading standard-size residential clothes washers manufactured on or after January 1, 2011 shall have a water factor of not more than 9.5. (water factor is equal to gallons/cycle/cubic feet)

2. Dishwashers manufactured on or after January 1, 2010, shall—
   a. for standard size dishwashers (≥ 8 place settings + six serving pieces) not exceed **6.5 gallon per cycle**; and
   b. for compact size dishwashers (< 8 place settings + six serving pieces) not exceed **4.5 gallons per cycle.**

TABLE 1
Flow rates from typical fixtures and appliances before and after Federal Standards

Type of Use	Pre-Regulatory Flow*	New Standard (maximum)	Federal Standard	Year Effective	WaterSense / ENERGY STAR Current Specification+ (maximum)
Toilets	3.5 gpf	1.6 gpf	**U.S. Energy Policy Act**	1994	**1.28 gpf**
Clothes washers**	41 gpl (14.6 WF)	Estimated 26.6 gpl (9.5 WF)	**Energy Independence & Security Act of 2007**	2011	**Estimated 16.8 gpl (6.0 WF)**
Showers	2.75 gpm	2.5 gpm	**U.S. Energy Policy Act**	1994	**2.0 gpm**
Faucets***	2.75 gpm	2.5 gpm (1.5 gpm)	**U.S. Energy Policy Act**	1994	**1.5 gpm at 60 psi**
Dishwashers	14.0 gpc	6.5 gpc for standard; 4.5 gpc for compact	**Energy Independence & Security Act of 2007**	2010	**4.25 gpc for standard; 3.5 gpc for compact**
Commercial Pre Rinse Spray Valves	1.8 to 6 gpm	1.6 gpm	**U.S. Energy Policy Act of 2005**	2006	**1.28 gpm**

* Source: *Handbook of Water Use and Conservation*, Amy Vickers, May 2001
** Average estimated gallons per load and water factor (see calculations)
*** Regulation maximum of 2.5 gpm at 80 psi, but lavatory faucets available at 1.5 gpm maximum (see calculations)
+Source: http://www.epa.gov/watersense/ and http://www.energystar.gov websites

ABBREVIATIONS USED	
gpcd	gallons per capita per day
gpf	gallons per flush
gpl	gallons per load
gpm	gallons per minute
gpc	gallons per cycle
WF	water factor, or gallons per cycle per cubic feet capacity of the washer (the smaller the water factor, the more water efficient the clothes washer)

TABLE 2
Daily indoor per capita water use from various fixtures and appliances in a typical single family home before and after Federal Regulations

Type of Use	Pre-Regulatory Standards Amount** (gpcd)	Post-Regulatory Standards Amount** (gpcd)	Savings from Pre-Reg	Water Sense/ Energy Star Amount** (gpcd)	Additional Savings from Post-Reg
Toilets	17.9	8.2	54%	6.5	21%
Clothes washers*	15	9.8	35%	6.2	37%
Showers	9.7	8.8	9%	7.1	19%
Faucets	14.9	10.8	28%	8.1	25%
Dishwashers*	1.4	0.65	54%	0.43	34%
Total Indoor Water Use	**58.9**	**38.3**	**35%**	**28.3**	**26%**

Note: List only includes common household fixtures and appliances and excludes leaks and "other domestic uses" in order to be conservative.

*Regulatory Standards effective in 2010 and 2011. For calculations of amount in gpcd, refer to the calculation below.
**Source: *Handbook of Water Use and Conservation*, Amy Vickers, May 2001

CALCULATIONS

Clothes washer (pre-regulatory):

Number of times clothes washer used everyday *	= 0.37 loads per day
Clothes washer water use rate range *	= 39 gpl to 43 gpl
Average water use rate	**= 41 gpl**
Water usage per capita	= 41 gpl * 0.37 loads/day
	= 15 gpcd
Water factor (WF) as gallons/cycle/cu. ft	= 41 gpl / 2.8 cu. ft (assuming capacity of an average washer to be 2.8 cu. ft, most washers range between 2.7 – 2.9 cu. ft)
	= **14.6**

Clothes washer (new standard):

Number of times clothes washer used everyday *	= 0.37 loads per day
New regulatory standard	**= 9.5 WF**
	= 9.5 gallons/per cycle/cubic feet

	= **26.6 gpl** (Assuming capacity of an average washer to be 2.8 cu. ft, most washers range between 2.7 – 2.9 cu. ft)
Therefore, new usage per capita	= 26.6 gpl * 0.37 loads/day
	= **9.8 gpcd**

Clothes washer (WaterSense/Energy Star):

Number of times clothes washer used everyday *	= 0.37 loads per day
New regulatory standard	= **6 WF**
	= 6 gallons/per cycle/cubic feet
	= **26.6 gpl** (Assuming capacity of an average washer to be 2.8 cu. ft, most washers range between 2.7 – 2.9 cu. ft)
Therefore, new usage per capita	= 16.8 gpl * 0.37 loads/day
	= **6.2 gpcd**

Dishwasher:

Number of times dishwasher used everyday*	= 0.10 times
New regulatory standard	= **6.5 gallons/per cycle** (for standard dishwashers only)
Therefore, new usage per capita	= 6.5 gallons/per cycle * 0.1
	= **0.65 gpcd**

Dishwasher (WaterSense/Energy Star):

Number of times dishwasher used everyday*	= 0.10 times
New regulatory standard	= **4.25 gallons/per cycle** (for standard dishwashers only)
Therefore, new usage per capita	= 4.25 gallons/per cycle * 0.1
	= **0.43 gpcd**

Faucet:

Actual faucet flow during use*	= 67% rated flow
Rated flow*	= **1.5 gpm** to **2.5 gpm**
Frequency of faucet use*	= 8.1 min/day
Range of usage per capita	= 8.1 gpcd to 13.5 gpcd
Assume average of range for estimated gpcd	= **10.8 gpcd**

Faucet (WaterSense/Energy Star):

Actual faucet flow during use*	= 67% rated flow
Rated flow*	= **1.5 gpm**
Frequency of faucet use*	= 8.1 min/day
Usage per capita	= 8.1 gpcd
Assume average of range for estimated gpcd	= **8.1 gpcd**

*Source: *Handbook of Water Use and Conservation,* Amy Vickers, May, 2001

Adapted from information provided by the U.S. EPA Office of Water, the Alliance for Water Efficiency, and other sources)

Fixtures and Appliances	EPAct 1992, EPAct 2005, "Energy Independence and Security Act of 2007" *(or backlog NAECA updates)*		WaterSense® or Energy Star®		Consortium for Energy Efficiency	
	Current Standard	Proposed/Future Standard	Current Specification	Proposed/Future Specification	Current Specification	Proposed/Future Specification
Residential Toilets	1.6 gpf[1]	1.28 gpf/ 4.8 Lpf proposed by efficiency advocates for tank-type only	Tank-type toilets: WaterSense = 1.28 gpf (4.8L) with at least 350 gram waste removal + LA Spec.		No specification	
Residential Lavatory (Bathroom) Faucets	2.2 gpm at 60 psi[2]	1.5 gpm/ 5.7 Lpm proposed by efficiency advocates	WaterSense = 1.5 gpm maximum & 0.8 gpm minimum at 20 psi		No specification	
Residential Kitchen Faucets				None proposed at this time	No specification	
Residential Showerheads	2.5 gpm at 80 psi		WaterSense = 2.0 gpm		No specification	
Residential Clothes Washers	MEF ≥ 1.26 ft^3/kWh/cycle *No specified water use factor Note: MEF measures energy consumption of the total laundry cycle (wash + dry). The higher the number, the greater the energy efficiency	Energy Independence and Security Act of 2007 specified effective in 2011: MEF ≥ 1.26 ft^3/kWh/cycle WF ≤ 9.5 gal/cycle/ft^3 Also specified: DOE shall publish final rule by Dec 31, 2011, determining if standards will change effective 1/1/2015.	Energy Star (DOE) effective July 1, 2009: MEF ≥ 1.8 ft^3/kWh/cycle WF ≤ 7.5 gal/cycle/ ft^3	Energy Star (DOE) To be effective Jan 1, 2011: MEF ≥ 2.0 WF ≤ 6.0 gal/cycle/ft^3	Tier 1: MEF ≥ 1.80 ft^3/kWh/cycle; WF ≤ 7.5 gal/cycle/ft^3 Tier 2: MEF ≥ 2.00 ft^3/kWh/cycle; WF ≤ 6.0 gal/cycle/ft^3 Tier 3: MEF ≥ 2.20 ft^3/kWh/cycle; WF ≤ 4.5 gal/cycle/ft^3	

[1] EPAct 1992 standard for toilets applies to both commercial and residential models.
[2] EPAct 1992 standard for faucets applies to both commercial and residential models.

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EPAct 2005: Energy Policy Act of 2005
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gpf: gallons per flush
kWh: kilowatt hour
MEF: modified energy factor
MaP: maximum performance
NAECA: National Appliance Energy Conservation Act
psi: pounds per square inch
WF: water factor
Lpf: Litres per flush

Updated March 2010
Koeller/Dietemann

National Efficiency Standards and Specifications for Residential and Commercial Water-Using Fixtures and Appliances

Adapted from information provided by the U.S. EPA Office of Water, the Alliance for Water Efficiency, and other sources)

Fixtures and Appliances	EPAct 1992, EPAct 2005, "Energy Independence and Security Act of 2007" *(or backlog NAECA updates)*		WaterSense® or Energy Star®		Consortium for Energy Efficiency	
	Current Standard	Proposed/Future Standard	Current Specification	Proposed/Future Specification	Current Specification	Proposed/Future Specification
Standard Size and Compact Residential Dishwashers[3]	*Standard models*: Energy Independence and Security Act of 2007 specified: effective 1/1/2010: Standard Size: 355 KWh/year (.62 EF + 1 watt standby) WF ≤ 6.5 gallons/cycle Compact Size: 260 kWh WF ≤ 4.5 gallons/cycle EF is the number of cycles the machine can run for each kWh of electricity	Also specified by the Act: DOE shall publish final rule by 1/1/2015 determining if dishwasher standards will change effective 1/1/2018.	Energy Star (DOE) Effective since July 1, 2009 Standard Size: 324 kWh/year WF ≤ 5.8 gallons/cycle Compact Size: 234 kWh/year WF ≤ 4.0 gallons/cycle kWH/yr is replacing EF since it includes the cycles the machine can run for each kWh, but also includes up to 8 kWh/yr of standby power (when the machine isn't cycling)	Energy Star effective July 1, 2011: Standard Size: 307 kWh/yr 5.0 gallons per cycle Compact Size: 222 kWh/yr 3.5 gallons per cycle	*Effective Aug. 11, 2009:* *Standard models*: EF; maximum kWh/year Tier 1: EF ≥ 0.72 cycles/kWh; and 307 max kWh/year; 5.0 gallons per cycle Tier 2: EF ≥ 0.75 cycles/kWh; 295 max kWh/year; 4.25 gallons per cycle *Compact models*: Tier 1: EF ≥ 1.0 cycles/kWh; 222 max kWh/year; 3.5 gallons per cycle	Could adjust Tiers after July 1, 2011 when new Energy Star becomes effective

[3] ***Standard models***: capacity is greater than or equal to eight place settings and six serving pieces; ***Compact models***: capacity is less than eight place settings and six serving pieces

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Fixtures and Appliances	EPAct 1992, EPAct 2005 *(or backlog NAECA updates)*		WaterSense[*] or Energy Star[*]		Consortium for Energy Efficiency	
	Current Standard	Proposed/ Future Standard	Current Specification	Proposed/Future Specification	Current Specification	Proposed /Future Specification
Commercial Toilets	1.6 gpf[4]/6.0 Lpf Except blow-out fixtures: 3.5-gpf/13 Lpf Note: Some states prohibit blow-out at 3.5 gpf	1.28 gpf/ 4.8 Lpf proposed by efficiency advocates for tank-type only	Tank-type only: WaterSense at 1.28 gpf (4.8L) with at least 350 gram waste removal + LA Spec.	Flushometer valve/ bowl combinations: WaterSense specification in development. No release date promised.	No specification	
Commercial Urinals	1.0 gpf	0.5 gpf/ 1.9 Lpf proposed by efficiency advocates	WaterSense = 0.5 gpf/1.9Lpf (flushing urinals only)		No specification	
Commercial Faucets	Private faucets: 2.2 gpm at 60 psi[5] Public Restroom faucets: 0.5 gpm at 60 psi[5] Metering (auto shut of) faucets: 0.25 gallons per cycle[6]			WaterSense draft specification now under consideration	No specification	

[4] EPAct 1992 standard for toilets applies to both commercial and residential models.
[5] In addition to EPAct requirements, the American Society of Mechanical Engineers standard for public lavatory faucets is 0.5 gpm at 60 psi (ASME A112.18.1-2005). This maximum has been incorporated into the national Uniform Plumbing Code and the International Plumbing Code for all except private applications, private being defined as residential, hotel guest rooms, and health care patient rooms. All other applications subject to the 0.5 gpm/1.9 Lpm flow rate maximum.
[6] Metering faucets not subject to flow rate maximum

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Fixtures and Appliances	EPAct 1992, EPAct 2005 *(or backlog NAECA updates)*		WaterSense* or Energy Star*		Consortium for Energy Efficiency	
	Current Standard	Proposed/ Future Standard	Current Specification	Proposed/Future Specification	Current Specification	Proposed /Future Specification
Commercial Clothes Washers (Family-sized)	MEF ≥ 1.26 ft^3/kWh; WF ≤ 9.5 gal/cycle/ft^3	New standards under development: DOE scheduled final action: January 2010; Rulemaking process postponed by DOE in 2008; began again in Dec. 2009.	Energy Star (DOE) MEF ≥ 1.72 ft^3/kWh/cycle; WF ≤ 8.0 gal/cycle/ft^3		Adopted Jan 1, 2007 (Note: this spec covers only normal capacity family washers, NOT large capacity commercial washers) Tier 1: 1.80 MEF 7.5 gal/cycle/ft^3 Tier 2: 2.00 MEF 6.0 gal/cycle/ft^3 Tier 3: 2.20 MEF 4.5 gal/cycle/ft^3	

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Fixtures and Appliances	EPAct 1992, EPAct 2005 *(or backlog NAECA updates)*		WaterSense[*] or Energy Star[*]		Consortium for Energy Efficiency	
	Current Standard	Proposed/ Future Standard	Current Specification	Proposed/Future Specification	Current Specification	Proposed /Future Specification
Commercial Dishwashers	No standard		Energy Star (EPA) using NSF/ANSI standards for water use and ASTM standards for energy use Effective **10/11/2007** *Under counter*: Hi Temp: 1.0 gal/rack; <= 0.90 kW; Lo Temp 1.70 gal/rack <= 0.5 kW *Stationary Single Tank Door*: Hi Temp: 0.95 gal/rack; <= 1.0 kW Lo Temp: 1.18 gal/rack; <= 0.6 kW *Single Tank Conveyor*: Hi Temp: 0.70 gal/rack; <= 2.0 kW; Lo Temp: 0.79 gal/rack; <= 1.6 kW *Multiple Tank Conveyor*: Hi Temp: 0.54 gal/rack; <= 2.6 kW Lo Temp: 0.54 gal/rack; <= 2.0 kW		No specification	

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Fixtures and Appliances	EPAct 1992, EPAct 2005 *(or backlog NAECA updates)*		WaterSense® or Energy Star®		Consortium for Energy Efficiency	
	Current Standard	Proposed/ Future Standard	Current Specification	Proposed/Future Specification	Current Specification	Proposed /Future Specification
Automatic Commercial Ice Makers[7]	Effective 1/1/2010: Energy and condenser water efficiency standards vary by equipment type on a sliding scale depending upon harvest rate and type of cooling (see link to additional information at end of this table)		Energy Star (EPA) Energy and water efficiency standards vary by equipment type on a sliding scale depending upon harvest rate and type of cooling (see link to additional information at end of this table). Water cooled machines excluded from Energy Star		Energy and water (potable and condenser) standards are tiered and vary by equipment type on a sliding scale depending upon harvest rate and type of cooling (see link to additional information at end of this table)	
Commercial Pre-rinse Spray Valves (for food service appli-cations)	Flow rate ≤ 1.6 gpm (no pressure specified; no performance requirement)		No specification	Proposed Energy Star specification abandoned after standard established in EPAct 2005; WaterSense specification in development in conjunction with Energy Star	No specification (program guidance recommends 1.6 gpm at 60 psi and a cleanability requirement)	

[7] Optional standards for other types of automatic ice makers are also authorized under EPAct 2005.

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Fixtures and Appliances	EPAct 1992, EPAct 2005 *(or backlog NAECA updates)*		WaterSense• or Energy Star•		Consortium for Energy Efficiency	
	Current Standard	Proposed/ Future Standard	Current Specification	Proposed/Future Specification	Current Specification	Proposed /Future Specification
Commercial Steam Cookers[8]	No standard		Energy Star (EPA) *Electric*: 50% cooking energy efficiency; idle rate 400–800 Watts *Gas*: 38% cooking energy efficiency; idle rate 6,250–12,500 British thermal units/hour *No specified water use factor		*Electric*: 50% cooking energy efficiency; idle rate 400–800 Watts *Gas*: 38% cooking energy efficiency; idle rate 6,250–12,500 British thermal units/hour Water Use Factor (for both electric and gas models): Tier 1A: ≤ 15 gal/hr Tier 1B: ≤ 4 gal/hr	

[8] Idle rate standards vary for 3-, 4-, 5-, and 6-pan commercial steam cooker models.

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National Efficiency Standards and Specifications for Residential and Commercial Water-Using Fixtures and Appliances

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Information/materials on EPAct 2005/NAECA standards:

Schedule for development of appliance and commercial equipment efficiency standards:
http://www.eere.energy.gov/buildings/appliance_standards/2006_schedule_setting.html

Commercial Clothes Washers and Dishwashers (agenda/presentations at 4/27/06 DOE public meeting on rulemaking):
http://www.eere.energy.gov/buildings/appliance_standards/residential/home_appl_mtg.html

Automatic Commercial Ice Maker Standards:
http://www.eere.energy.gov/buildings/appliance_standards/pdfs/epact2005_appliance_stds.pdf (Page 18)

Pre-rinse Spray Valves
http://www.eere.energy.gov/buildings/appliance_standards/pdfs/epact2005_appliance_stds.pdf (Page 10)

Information/materials on WaterSense specifications:

Toilets
http://www.epa.gov/watersense/products/toilets.html

Urinals
http://www.epa.gov/watersense/products/urinals.html

Bathroom Lavatory Faucets
http://www.epa.gov/watersense/products/bathroom_sink_faucets.html

Information/materials on Energy Star specifications:

Residential Clothes Washers
http://www.energystar.gov/index.cfm?c=clotheswash.pr_crit_clothes_washers

Commercial Clothes Washers
http://www.energystar.gov/index.cfm?fuseaction=clotheswash.display_commercial_cw

Residential Dishwashers
http://www.energystar.gov/index.cfm?c=dishwash.pr_dishwashers

Commercial Dishwashers
http://www.energystar.gov/index.cfm?c=new_specs.comm_dishwashers

Automatic Commercial Ice Makers
http://www.energystar.gov/index.cfm?c=new_specs.ice_machines

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Commercial Steam Cookers
http://www.energystar.gov/index.cfm?c=steamcookers.pr_steamcookers

Information/materials on CEE specifications:

Residential Clothes Washers
http://www.cee1.org/resid/seha/rwsh/rwsh-main.php3

Residential Dishwashers
http://www.cee1.org/resid/seha/dishw/dishw-main.php3

Commercial, Family-Sized Clothes Washers
http://www.cee1.org/com/cwsh/cwsh-main.php3

Commercial Ice-Makers
http://www.cee1.org/com/com-ref/ice-main.php3; Spec Table: http://www.cee1.org/com/com-kit/ice-specs.pdf

Pre-rinse Spray Valves
http://www.cee1.org/com/com-kit/prv-guides.pdf

Commercial Steam Cookers
http://www.cee1.org/com/com-kit/sc-hc-specs.pdf

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DP04 | SELECTED HOUSING CHARACTERISTICS

2011-2015 American Community Survey 5-Year Estimates

Supporting documentation on code lists, subject definitions, data accuracy, and statistical testing can be found on the American Community Survey website in the Data and Documentation section.

Sample size and data quality measures (including coverage rates, allocation rates, and response rates) can be found on the American Community Survey website in the Methodology section.

Tell us what you think. Provide feedback to help make American Community Survey data more useful for you.

Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

A processing error was found in the Year Structure Built estimates since data year 2008. For more information, please see the errata note #110.

Subject	Missouri			
	Estimate	Margin of Error	Percent	Percent Margin of Error
HOUSING OCCUPANCY				
Total housing units	2,729,862	+/-495	2,729,862	(X)
Occupied housing units	2,364,688	+/-6,201	86.6%	+/-0.2
Vacant housing units	365,174	+/-6,356	13.4%	+/-0.2
Homeowner vacancy rate	2.1	+/-0.1	(X)	(X)
Rental vacancy rate	6.9	+/-0.2	(X)	(X)
UNITS IN STRUCTURE				
Total housing units	2,729,862	+/-495	2,729,862	(X)
1-unit, detached	1,919,184	+/-4,353	70.3%	+/-0.2
1-unit, attached	91,786	+/-1,777	3.4%	+/-0.1
2 units	93,112	+/-2,261	3.4%	+/-0.1
3 or 4 units	127,965	+/-2,245	4.7%	+/-0.1
5 to 9 units	105,471	+/-2,404	3.9%	+/-0.1
10 to 19 units	93,400	+/-2,209	3.4%	+/-0.1
20 or more units	124,079	+/-2,219	4.5%	+/-0.1
Mobile home	173,130	+/-2,484	6.3%	+/-0.1
Boat, RV, van, etc.	1,735	+/-317	0.1%	+/-0.1
YEAR STRUCTURE BUILT				
Total housing units	2,729,862	+/-495	2,729,862	(X)
Built 2014 or later	2,050	+/-307	0.1%	+/-0.1
Built 2010 to 2013	36,827	+/-1,081	1.3%	+/-0.1
Built 2000 to 2009	388,234	+/-3,519	14.2%	+/-0.1
Built 1990 to 1999	397,789	+/-3,588	14.6%	+/-0.1
Built 1980 to 1989	333,064	+/-3,294	12.2%	+/-0.1
Built 1970 to 1979	432,511	+/-3,731	15.8%	+/-0.1
Built 1960 to 1969	317,903	+/-3,224	11.6%	+/-0.1

Subject	Missouri			
	Estimate	Margin of Error	Percent	Percent Margin of Error
Built 1950 to 1959	294,184	+/-3,029	10.8%	+/-0.1
Built 1940 to 1949	141,326	+/-2,487	5.2%	+/-0.1
Built 1939 or earlier	385,974	+/-3,275	14.1%	+/-0.1
ROOMS				
Total housing units	2,729,862	+/-495	2,729,862	(X)
1 room	38,963	+/-1,436	1.4%	+/-0.1
2 rooms	48,157	+/-1,351	1.8%	+/-0.1
3 rooms	198,939	+/-2,637	7.3%	+/-0.1
4 rooms	432,411	+/-4,659	15.8%	+/-0.2
5 rooms	605,534	+/-5,192	22.2%	+/-0.2
6 rooms	504,996	+/-4,291	18.5%	+/-0.2
7 rooms	345,714	+/-3,581	12.7%	+/-0.1
8 rooms	242,947	+/-2,803	8.9%	+/-0.1
9 rooms or more	312,201	+/-3,159	11.4%	+/-0.1
Median rooms	5.6	+/-0.1	(X)	(X)
BEDROOMS				
Total housing units	2,729,862	+/-495	2,729,862	(X)
No bedroom	42,772	+/-1,442	1.6%	+/-0.1
1 bedroom	259,929	+/-3,011	9.5%	+/-0.1
2 bedrooms	754,185	+/-5,317	27.6%	+/-0.2
3 bedrooms	1,147,930	+/-5,799	42.1%	+/-0.2
4 bedrooms	417,347	+/-3,847	15.3%	+/-0.1
5 or more bedrooms	107,699	+/-1,855	3.9%	+/-0.1
HOUSING TENURE				
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)
Owner-occupied	1,590,020	+/-7,835	67.2%	+/-0.2
Renter-occupied	774,668	+/-4,517	32.8%	+/-0.2
Average household size of owner-occupied unit	2.57	+/-0.01	(X)	(X)
Average household size of renter-occupied unit	2.31	+/-0.02	(X)	(X)
YEAR HOUSEHOLDER MOVED INTO UNIT				
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)
Moved in 2015 or later	36,000	+/-1,350	1.5%	+/-0.1
Moved in 2010 to 2014	722,159	+/-4,271	30.5%	+/-0.2
Moved in 2000 to 2009	852,228	+/-5,593	36.0%	+/-0.2
Moved in 1990 to 1999	377,113	+/-3,477	15.9%	+/-0.1
Moved in 1980 to 1989	174,836	+/-2,345	7.4%	+/-0.1
Moved in 1979 and earlier	202,352	+/-2,375	8.6%	+/-0.1
VEHICLES AVAILABLE				
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)
No vehicles available	174,302	+/-2,464	7.4%	+/-0.1
1 vehicle available	787,610	+/-5,305	33.3%	+/-0.2
2 vehicles available	907,514	+/-4,895	38.4%	+/-0.2
3 or more vehicles available	495,262	+/-3,998	20.9%	+/-0.2
HOUSE HEATING FUEL				
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)
Utility gas	1,220,485	+/-5,631	51.6%	+/-0.2
Bottled, tank, or LP gas	216,853	+/-2,466	9.2%	+/-0.1
Electricity	812,569	+/-4,041	34.4%	+/-0.2
Fuel oil, kerosene, etc.	5,293	+/-492	0.2%	+/-0.1
Coal or coke	321	+/-130	0.0%	+/-0.1
Wood	94,910	+/-1,638	4.0%	+/-0.1
Solar energy	543	+/-160	0.0%	+/-0.1

Subject	Missouri			
	Estimate	Margin of Error	Percent	Percent Margin of Error
Other fuel	7,669	+/-557	0.3%	+/-0.1
No fuel used	6,045	+/-545	0.3%	+/-0.1
SELECTED CHARACTERISTICS				
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)
Lacking complete plumbing facilities	10,554	+/-692	0.4%	+/-0.1
Lacking complete kitchen facilities	18,729	+/-966	0.8%	+/-0.1
No telephone service available	65,216	+/-1,397	2.8%	+/-0.1
OCCUPANTS PER ROOM				
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)
1.00 or less	2,326,540	+/-6,497	98.4%	+/-0.1
1.01 to 1.50	28,638	+/-1,270	1.2%	+/-0.1
1.51 or more	9,510	+/-669	0.4%	+/-0.1
VALUE				
Owner-occupied units	1,590,020	+/-7,835	1,590,020	(X)
Less than $50,000	187,394	+/-2,252	11.8%	+/-0.1
$50,000 to $99,999	340,783	+/-3,743	21.4%	+/-0.2
$100,000 to $149,999	339,921	+/-3,609	21.4%	+/-0.2
$150,000 to $199,999	279,158	+/-2,721	17.6%	+/-0.2
$200,000 to $299,999	256,056	+/-3,326	16.1%	+/-0.2
$300,000 to $499,999	132,426	+/-1,928	8.3%	+/-0.1
$500,000 to $999,999	43,782	+/-1,101	2.8%	+/-0.1
$1,000,000 or more	10,500	+/-592	0.7%	+/-0.1
Median (dollars)	138,400	+/-484	(X)	(X)
MORTGAGE STATUS				
Owner-occupied units	1,590,020	+/-7,835	1,590,020	(X)
Housing units with a mortgage	1,011,490	+/-5,727	63.6%	+/-0.2
Housing units without a mortgage	578,530	+/-4,047	36.4%	+/-0.2
SELECTED MONTHLY OWNER COSTS (SMOC)				
Housing units with a mortgage	1,011,490	+/-5,727	1,011,490	(X)
Less than $500	27,576	+/-964	2.7%	+/-0.1
$500 to $999	308,831	+/-3,357	30.5%	+/-0.3
$1,000 to $1,499	359,011	+/-3,080	35.5%	+/-0.3
$1,500 to $1,999	178,580	+/-2,508	17.7%	+/-0.2
$2,000 to $2,499	72,577	+/-1,755	7.2%	+/-0.2
$2,500 to $2,999	31,804	+/-1,075	3.1%	+/-0.1
$3,000 or more	33,111	+/-1,001	3.3%	+/-0.1
Median (dollars)	1,210	+/-4	(X)	(X)
Housing units without a mortgage	578,530	+/-4,047	578,530	(X)
Less than $250	91,164	+/-1,715	15.8%	+/-0.3
$250 to $399	195,925	+/-2,645	33.9%	+/-0.4
$400 to $599	192,805	+/-2,694	33.3%	+/-0.4
$600 to $799	64,911	+/-1,215	11.2%	+/-0.2
$800 to $999	19,070	+/-781	3.3%	+/-0.1
$1,000 or more	14,655	+/-774	2.5%	+/-0.1
Median (dollars)	402	+/-2	(X)	(X)
SELECTED MONTHLY OWNER COSTS AS A PERCENTAGE OF HOUSEHOLD INCOME (SMOCAPI)				
Housing units with a mortgage (excluding units where SMOCAPI cannot be computed)	1,006,985	+/-5,704	1,006,985	(X)
Less than 20.0 percent	468,951	+/-4,724	46.6%	+/-0.3
20.0 to 24.9 percent	165,766	+/-2,732	16.5%	+/-0.2
25.0 to 29.9 percent	105,640	+/-2,184	10.5%	+/-0.2
30.0 to 34.9 percent	70,469	+/-1,674	7.0%	+/-0.2

Subject	Missouri			
	Estimate	Margin of Error	Percent	Percent Margin of Error
35.0 percent or more	196,159	+/-2,862	19.5%	+/-0.3
Not computed	4,505	+/-482	(X)	(X)
Housing unit without a mortgage (excluding units where SMOCAPI cannot be computed)	571,797	+/-4,076	571,797	(X)
Less than 10.0 percent	245,209	+/-3,032	42.9%	+/-0.4
10.0 to 14.9 percent	119,807	+/-1,604	21.0%	+/-0.3
15.0 to 19.9 percent	67,825	+/-1,497	11.9%	+/-0.3
20.0 to 24.9 percent	41,481	+/-1,319	7.3%	+/-0.2
25.0 to 29.9 percent	26,397	+/-934	4.6%	+/-0.2
30.0 to 34.9 percent	17,640	+/-731	3.1%	+/-0.1
35.0 percent or more	53,438	+/-1,446	9.3%	+/-0.2
Not computed	6,733	+/-467	(X)	(X)
GROSS RENT				
Occupied units paying rent	724,705	+/-4,525	724,705	(X)
Less than $500	127,692	+/-2,054	17.6%	+/-0.3
$500 to $999	435,780	+/-3,790	60.1%	+/-0.4
$1,000 to $1,499	127,732	+/-2,644	17.6%	+/-0.3
$1,500 to $1,999	22,238	+/-1,195	3.1%	+/-0.2
$2,000 to $2,499	6,485	+/-559	0.9%	+/-0.1
$2,500 to $2,999	2,360	+/-377	0.3%	+/-0.1
$3,000 or more	2,418	+/-314	0.3%	+/-0.1
Median (dollars)	746	+/-3	(X)	(X)
No rent paid	49,963	+/-1,106	(X)	(X)
GROSS RENT AS A PERCENTAGE OF HOUSEHOLD INCOME (GRAPI)				
Occupied units paying rent (excluding units where GRAPI cannot be computed)	706,982	+/-4,712	706,982	(X)
Less than 15.0 percent	94,042	+/-2,225	13.3%	+/-0.3
15.0 to 19.9 percent	93,984	+/-2,091	13.3%	+/-0.3
20.0 to 24.9 percent	90,922	+/-1,737	12.9%	+/-0.3
25.0 to 29.9 percent	84,282	+/-2,280	11.9%	+/-0.3
30.0 to 34.9 percent	62,181	+/-1,910	8.8%	+/-0.3
35.0 percent or more	281,571	+/-3,401	39.8%	+/-0.4
Not computed	67,686	+/-1,647	(X)	(X)

Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see Accuracy of the Data). The effect of nonsampling error is not represented in these tables.

Households not paying cash rent are excluded from the calculation of median gross rent.

Telephone service data are not available for certain geographic areas due to problems with data collection. See Errata Note #93 for details.

While the 2011-2015 American Community Survey (ACS) data generally reflect the February 2013 Office of Management and Budget (OMB) definitions of metropolitan and micropolitan statistical areas; in certain instances the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB definitions due to differences in the effective dates of the geographic entities.

Estimates of urban and rural population, housing units, and characteristics reflect boundaries of urban areas defined based on Census 2010 data. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.

Source: U.S. Census Bureau, 2011-2015 American Community Survey 5-Year Estimates

Explanation of Symbols:

1. An '**' entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
2. An '-' entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
3. An '-' following a median estimate means the median falls in the lowest interval of an open-ended distribution.
4. An '+' following a median estimate means the median falls in the upper interval of an open-ended distribution.
5. An '***' entry in the margin of error column indicates that the median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.
6. An '*****' entry in the margin of error column indicates that the estimate is controlled. A statistical test for sampling variability is not appropriate.
7. An 'N' entry in the estimate and margin of error columns indicates that data for this geographic area cannot be displayed because the number of sample cases is too small.
8. An '(X)' means that the estimate is not applicable or not available.

DP04 | SELECTED HOUSING CHARACTERISTICS

2011-2015 American Community Survey 5-Year Estimates

Supporting documentation on code lists, subject definitions, data accuracy, and statistical testing can be found on the American Community Survey website in the Data and Documentation section.

Sample size and data quality measures (including coverage rates, allocation rates, and response rates) can be found on the American Community Survey website in the Methodology section.

Tell us what you think. Provide feedback to help make American Community Survey data more useful for you.

Although the American Community Survey (ACS) produces population, demographic and housing unit estimates, it is the Census Bureau's Population Estimates Program that produces and disseminates the official estimates of the population for the nation, states, counties, cities and towns and estimates of housing units for states and counties.

A processing error was found in the Year Structure Built estimates since data year 2008. For more information, please see the errata note #110.

Subject	Missouri				St. Louis County, Missouri
	Estimate	Margin of Error	Percent	Percent Margin of Error	Estimate
HOUSING OCCUPANCY					
Total housing units	2,729,862	+/-495	2,729,862	(X)	438,076
Occupied housing units	2,364,688	+/-6,201	86.6%	+/-0.2	401,839
Vacant housing units	365,174	+/-6,356	13.4%	+/-0.2	36,237
Homeowner vacancy rate	2.1	+/-0.1	(X)	(X)	1.6
Rental vacancy rate	6.9	+/-0.2	(X)	(X)	7.6
UNITS IN STRUCTURE					
Total housing units	2,729,862	+/-495	2,729,862	(X)	438,076
1-unit, detached	1,919,184	+/-4,353	70.3%	+/-0.2	318,494
1-unit, attached	91,786	+/-1,777	3.4%	+/-0.1	20,377
2 units	93,112	+/-2,261	3.4%	+/-0.1	7,119
3 or 4 units	127,965	+/-2,245	4.7%	+/-0.1	20,663
5 to 9 units	105,471	+/-2,404	3.9%	+/-0.1	24,283
10 to 19 units	93,400	+/-2,209	3.4%	+/-0.1	22,628
20 or more units	124,079	+/-2,219	4.5%	+/-0.1	23,563
Mobile home	173,130	+/-2,484	6.3%	+/-0.1	938
Boat, RV, van, etc.	1,735	+/-317	0.1%	+/-0.1	11
YEAR STRUCTURE BUILT					
Total housing units	2,729,862	+/-495	2,729,862	(X)	438,076
Built 2014 or later	2,050	+/-307	0.1%	+/-0.1	227
Built 2010 to 2013	36,827	+/-1,081	1.3%	+/-0.1	2,432
Built 2000 to 2009	388,234	+/-3,519	14.2%	+/-0.1	25,397
Built 1990 to 1999	397,789	+/-3,588	14.6%	+/-0.1	42,187
Built 1980 to 1989	333,064	+/-3,294	12.2%	+/-0.1	52,263
Built 1970 to 1979	432,511	+/-3,731	15.8%	+/-0.1	74,145

Subject	Missouri				St. Louis County, Missouri
	Estimate	Margin of Error	Percent	Percent Margin of Error	Estimate
Built 1960 to 1969	317,903	+/-3,224	11.6%	+/-0.1	79,606
Built 1950 to 1959	294,184	+/-3,029	10.8%	+/-0.1	86,735
Built 1940 to 1949	141,326	+/-2,487	5.2%	+/-0.1	31,386
Built 1939 or earlier	385,974	+/-3,275	14.1%	+/-0.1	43,698
ROOMS					
Total housing units	2,729,862	+/-495	2,729,862	(X)	438,076
1 room	38,963	+/-1,436	1.4%	+/-0.1	4,428
2 rooms	48,157	+/-1,351	1.8%	+/-0.1	5,511
3 rooms	198,939	+/-2,637	7.3%	+/-0.1	29,134
4 rooms	432,411	+/-4,659	15.8%	+/-0.2	62,426
5 rooms	605,534	+/-5,192	22.2%	+/-0.2	89,492
6 rooms	504,996	+/-4,291	18.5%	+/-0.2	77,420
7 rooms	345,714	+/-3,581	12.7%	+/-0.1	57,087
8 rooms	242,947	+/-2,803	8.9%	+/-0.1	48,333
9 rooms or more	312,201	+/-3,159	11.4%	+/-0.1	64,245
Median rooms	5.6	+/-0.1	(X)	(X)	5.9
BEDROOMS					
Total housing units	2,729,862	+/-495	2,729,862	(X)	438,076
No bedroom	42,772	+/-1,442	1.6%	+/-0.1	4,779
1 bedroom	259,929	+/-3,011	9.5%	+/-0.1	41,078
2 bedrooms	754,185	+/-5,317	27.6%	+/-0.2	120,712
3 bedrooms	1,147,930	+/-5,799	42.1%	+/-0.2	167,042
4 bedrooms	417,347	+/-3,847	15.3%	+/-0.1	85,483
5 or more bedrooms	107,699	+/-1,855	3.9%	+/-0.1	18,982
HOUSING TENURE					
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)	401,839
Owner-occupied	1,590,020	+/-7,835	67.2%	+/-0.2	282,099
Renter-occupied	774,668	+/-4,517	32.8%	+/-0.2	119,740
Average household size of owner-occupied unit	2.57	+/-0.01	(X)	(X)	2.54
Average household size of renter-occupied unit	2.31	+/-0.02	(X)	(X)	2.23
YEAR HOUSEHOLDER MOVED INTO UNIT					
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)	401,839
Moved in 2015 or later	36,000	+/-1,350	1.5%	+/-0.1	5,489
Moved in 2010 to 2014	722,159	+/-4,271	30.5%	+/-0.2	111,267
Moved in 2000 to 2009	852,228	+/-5,593	36.0%	+/-0.2	133,136
Moved in 1990 to 1999	377,113	+/-3,477	15.9%	+/-0.1	69,755
Moved in 1980 to 1989	174,836	+/-2,345	7.4%	+/-0.1	35,867
Moved in 1979 and earlier	202,352	+/-2,375	8.6%	+/-0.1	46,325
VEHICLES AVAILABLE					
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)	401,839
No vehicles available	174,302	+/-2,464	7.4%	+/-0.1	29,359
1 vehicle available	787,610	+/-5,305	33.3%	+/-0.2	140,837
2 vehicles available	907,514	+/-4,895	38.4%	+/-0.2	158,768
3 or more vehicles available	495,262	+/-3,998	20.9%	+/-0.2	72,875
HOUSE HEATING FUEL					
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)	401,839
Utility gas	1,220,485	+/-5,631	51.6%	+/-0.2	317,913
Bottled, tank, or LP gas	216,853	+/-2,466	9.2%	+/-0.1	4,459
Electricity	812,569	+/-4,041	34.4%	+/-0.2	77,119
Fuel oil, kerosene, etc.	5,293	+/-492	0.2%	+/-0.1	427
Coal or coke	321	+/-130	0.0%	+/-0.1	8

Subject	Missouri				St. Louis County, Missouri
	Estimate	Margin of Error	Percent	Percent Margin of Error	Estimate
Wood	94,910	+/-1,638	4.0%	+/-0.1	789
Solar energy	543	+/-160	0.0%	+/-0.1	24
Other fuel	7,669	+/-557	0.3%	+/-0.1	315
No fuel used	6,045	+/-545	0.3%	+/-0.1	785
SELECTED CHARACTERISTICS					
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)	401,839
Lacking complete plumbing facilities	10,554	+/-692	0.4%	+/-0.1	945
Lacking complete kitchen facilities	18,729	+/-966	0.8%	+/-0.1	2,368
No telephone service available	65,216	+/-1,397	2.8%	+/-0.1	6,183
OCCUPANTS PER ROOM					
Occupied housing units	2,364,688	+/-6,201	2,364,688	(X)	401,839
1.00 or less	2,326,540	+/-6,497	98.4%	+/-0.1	397,456
1.01 to 1.50	28,638	+/-1,270	1.2%	+/-0.1	3,254
1.51 or more	9,510	+/-669	0.4%	+/-0.1	1,129
VALUE					
Owner-occupied units	1,590,020	+/-7,835	1,590,020	(X)	282,099
Less than $50,000	187,394	+/-2,252	11.8%	+/-0.1	14,614
$50,000 to $99,999	340,783	+/-3,743	21.4%	+/-0.2	50,735
$100,000 to $149,999	339,921	+/-3,609	21.4%	+/-0.2	49,318
$150,000 to $199,999	279,158	+/-2,721	17.6%	+/-0.2	48,341
$200,000 to $299,999	256,056	+/-3,326	16.1%	+/-0.2	55,539
$300,000 to $499,999	132,426	+/-1,928	8.3%	+/-0.1	40,198
$500,000 to $999,999	43,782	+/-1,101	2.8%	+/-0.1	19,037
$1,000,000 or more	10,500	+/-592	0.7%	+/-0.1	4,317
Median (dollars)	138,400	+/-484	(X)	(X)	173,400
MORTGAGE STATUS					
Owner-occupied units	1,590,020	+/-7,835	1,590,020	(X)	282,099
Housing units with a mortgage	1,011,490	+/-5,727	63.6%	+/-0.2	194,507
Housing units without a mortgage	578,530	+/-4,047	36.4%	+/-0.2	87,592
SELECTED MONTHLY OWNER COSTS (SMOC)					
Housing units with a mortgage	1,011,490	+/-5,727	1,011,490	(X)	194,507
Less than $500	27,576	+/-964	2.7%	+/-0.1	2,023
$500 to $999	308,831	+/-3,357	30.5%	+/-0.3	37,215
$1,000 to $1,499	359,011	+/-3,080	35.5%	+/-0.3	65,866
$1,500 to $1,999	178,580	+/-2,508	17.7%	+/-0.2	41,582
$2,000 to $2,499	72,577	+/-1,755	7.2%	+/-0.2	20,588
$2,500 to $2,999	31,804	+/-1,075	3.1%	+/-0.1	11,121
$3,000 or more	33,111	+/-1,001	3.3%	+/-0.1	16,112
Median (dollars)	1,210	+/-4	(X)	(X)	1,435
Housing units without a mortgage	578,530	+/-4,047	578,530	(X)	87,592
Less than $250	91,164	+/-1,715	15.8%	+/-0.3	3,254
$250 to $399	195,925	+/-2,645	33.9%	+/-0.4	18,430
$400 to $599	192,805	+/-2,694	33.3%	+/-0.4	35,738
$600 to $799	64,911	+/-1,215	11.2%	+/-0.2	16,558
$800 to $999	19,070	+/-781	3.3%	+/-0.1	6,501
$1,000 or more	14,655	+/-774	2.5%	+/-0.1	7,111
Median (dollars)	402	+/-2	(X)	(X)	516
SELECTED MONTHLY OWNER COSTS AS A PERCENTAGE OF HOUSEHOLD INCOME (SMOCAPI)					
Housing units with a mortgage (excluding units where SMOCAPI cannot be computed)	1,006,985	+/-5,704	1,006,985	(X)	193,707
Less than 20.0 percent	468,951	+/-4,724	46.6%	+/-0.3	89,942

Subject	Missouri				St. Louis County, Missouri
	Estimate	Margin of Error	Percent	Percent Margin of Error	Estimate
20.0 to 24.9 percent	165,766	+/-2,732	16.5%	+/-0.2	30,713
25.0 to 29.9 percent	105,640	+/-2,184	10.5%	+/-0.2	20,089
30.0 to 34.9 percent	70,469	+/-1,674	7.0%	+/-0.2	13,016
35.0 percent or more	196,159	+/-2,862	19.5%	+/-0.3	39,947
Not computed	4,505	+/-482	(X)	(X)	800
Housing unit without a mortgage (excluding units where SMOCAPI cannot be computed)	571,797	+/-4,076	571,797	(X)	86,711
Less than 10.0 percent	245,209	+/-3,032	42.9%	+/-0.4	35,516
10.0 to 14.9 percent	119,807	+/-1,604	21.0%	+/-0.3	18,281
15.0 to 19.9 percent	67,825	+/-1,497	11.9%	+/-0.3	9,785
20.0 to 24.9 percent	41,481	+/-1,319	7.3%	+/-0.2	6,537
25.0 to 29.9 percent	26,397	+/-934	4.6%	+/-0.2	4,174
30.0 to 34.9 percent	17,640	+/-731	3.1%	+/-0.1	3,078
35.0 percent or more	53,438	+/-1,446	9.3%	+/-0.2	9,340
Not computed	6,733	+/-467	(X)	(X)	881
GROSS RENT					
Occupied units paying rent	724,705	+/-4,525	724,705	(X)	114,733
Less than $500	127,692	+/-2,054	17.6%	+/-0.3	8,660
$500 to $999	435,780	+/-3,790	60.1%	+/-0.4	64,367
$1,000 to $1,499	127,732	+/-2,644	17.6%	+/-0.3	31,643
$1,500 to $1,999	22,238	+/-1,195	3.1%	+/-0.2	6,260
$2,000 to $2,499	6,485	+/-559	0.9%	+/-0.1	1,843
$2,500 to $2,999	2,360	+/-377	0.3%	+/-0.1	877
$3,000 or more	2,418	+/-314	0.3%	+/-0.1	1,083
Median (dollars)	746	+/-3	(X)	(X)	882
No rent paid	49,963	+/-1,106	(X)	(X)	5,007
GROSS RENT AS A PERCENTAGE OF HOUSEHOLD INCOME (GRAPI)					
Occupied units paying rent (excluding units where GRAPI cannot be computed)	706,982	+/-4,712	706,982	(X)	111,835
Less than 15.0 percent	94,042	+/-2,225	13.3%	+/-0.3	14,021
15.0 to 19.9 percent	93,984	+/-2,091	13.3%	+/-0.3	14,960
20.0 to 24.9 percent	90,922	+/-1,737	12.9%	+/-0.3	13,939
25.0 to 29.9 percent	84,282	+/-2,280	11.9%	+/-0.3	13,939
30.0 to 34.9 percent	62,181	+/-1,910	8.8%	+/-0.3	9,953
35.0 percent or more	281,571	+/-3,401	39.8%	+/-0.4	45,023
Not computed	67,686	+/-1,647	(X)	(X)	7,905

Subject	St. Louis County, Missouri		
	Margin of Error	Percent	Percent Margin of Error
HOUSING OCCUPANCY			
Total housing units	+/-402	438,076	(X)
Occupied housing units	+/-1,523	91.7%	+/-0.3
Vacant housing units	+/-1,521	8.3%	+/-0.3
Homeowner vacancy rate	+/-0.2	(X)	(X)
Rental vacancy rate	+/-0.7	(X)	(X)
UNITS IN STRUCTURE			
Total housing units	+/-402	438,076	(X)
1-unit, detached	+/-1,329	72.7%	+/-0.3
1-unit, attached	+/-777	4.7%	+/-0.2
2 units	+/-676	1.6%	+/-0.2
3 or 4 units	+/-1,036	4.7%	+/-0.2
5 to 9 units	+/-1,069	5.5%	+/-0.2
10 to 19 units	+/-913	5.2%	+/-0.2
20 or more units	+/-937	5.4%	+/-0.2
Mobile home	+/-218	0.2%	+/-0.1
Boat, RV, van, etc.	+/-14	0.0%	+/-0.1
YEAR STRUCTURE BUILT			
Total housing units	+/-402	438,076	(X)
Built 2014 or later	+/-96	0.1%	+/-0.1
Built 2010 to 2013	+/-320	0.6%	+/-0.1
Built 2000 to 2009	+/-859	5.8%	+/-0.2
Built 1990 to 1999	+/-1,147	9.6%	+/-0.3
Built 1980 to 1989	+/-1,450	11.9%	+/-0.3
Built 1970 to 1979	+/-1,765	16.9%	+/-0.4
Built 1960 to 1969	+/-1,847	18.2%	+/-0.4
Built 1950 to 1959	+/-1,626	19.8%	+/-0.4
Built 1940 to 1949	+/-1,251	7.2%	+/-0.3
Built 1939 or earlier	+/-1,213	10.0%	+/-0.3
ROOMS			
Total housing units	+/-402	438,076	(X)
1 room	+/-546	1.0%	+/-0.1
2 rooms	+/-526	1.3%	+/-0.1
3 rooms	+/-1,162	6.7%	+/-0.3
4 rooms	+/-1,392	14.3%	+/-0.3
5 rooms	+/-1,830	20.4%	+/-0.4
6 rooms	+/-1,608	17.7%	+/-0.4
7 rooms	+/-1,534	13.0%	+/-0.4
8 rooms	+/-1,296	11.0%	+/-0.3
9 rooms or more	+/-1,187	14.7%	+/-0.3
Median rooms	+/-0.1	(X)	(X)
BEDROOMS			
Total housing units	+/-402	438,076	(X)
No bedroom	+/-559	1.1%	+/-0.1
1 bedroom	+/-1,369	9.4%	+/-0.3
2 bedrooms	+/-2,010	27.6%	+/-0.5
3 bedrooms	+/-2,044	38.1%	+/-0.5
4 bedrooms	+/-1,437	19.5%	+/-0.3
5 or more bedrooms	+/-714	4.3%	+/-0.2
HOUSING TENURE			
Occupied housing units	+/-1,523	401,839	(X)
Owner-occupied	+/-2,003	70.2%	+/-0.4
Renter-occupied	+/-1,655	29.8%	+/-0.4

Subject	St. Louis County, Missouri		
	Margin of Error	Percent	Percent Margin of Error
Average household size of owner-occupied unit	+/-0.01	(X)	(X)
Average household size of renter-occupied unit	+/-0.03	(X)	(X)
YEAR HOUSEHOLDER MOVED INTO UNIT			
Occupied housing units	+/-1,523	401,839	(X)
Moved in 2015 or later	+/-610	1.4%	+/-0.2
Moved in 2010 to 2014	+/-1,837	27.7%	+/-0.5
Moved in 2000 to 2009	+/-1,991	33.1%	+/-0.5
Moved in 1990 to 1999	+/-1,630	17.4%	+/-0.4
Moved in 1980 to 1989	+/-1,121	8.9%	+/-0.3
Moved in 1979 and earlier	+/-1,012	11.5%	+/-0.3
VEHICLES AVAILABLE			
Occupied housing units	+/-1,523	401,839	(X)
No vehicles available	+/-1,045	7.3%	+/-0.3
1 vehicle available	+/-2,334	35.0%	+/-0.5
2 vehicles available	+/-2,156	39.5%	+/-0.5
3 or more vehicles available	+/-1,665	18.1%	+/-0.4
HOUSE HEATING FUEL			
Occupied housing units	+/-1,523	401,839	(X)
Utility gas	+/-2,166	79.1%	+/-0.5
Bottled, tank, or LP gas	+/-393	1.1%	+/-0.1
Electricity	+/-1,796	19.2%	+/-0.4
Fuel oil, kerosene, etc.	+/-132	0.1%	+/-0.1
Coal or coke	+/-12	0.0%	+/-0.1
Wood	+/-176	0.2%	+/-0.1
Solar energy	+/-27	0.0%	+/-0.1
Other fuel	+/-126	0.1%	+/-0.1
No fuel used	+/-176	0.2%	+/-0.1
SELECTED CHARACTERISTICS			
Occupied housing units	+/-1,523	401,839	(X)
Lacking complete plumbing facilities	+/-210	0.2%	+/-0.1
Lacking complete kitchen facilities	+/-346	0.6%	+/-0.1
No telephone service available	+/-550	1.5%	+/-0.1
OCCUPANTS PER ROOM			
Occupied housing units	+/-1,523	401,839	(X)
1.00 or less	+/-1,585	98.9%	+/-0.1
1.01 to 1.50	+/-423	0.8%	+/-0.1
1.51 or more	+/-217	0.3%	+/-0.1
VALUE			
Owner-occupied units	+/-2,003	282,099	(X)
Less than $50,000	+/-709	5.2%	+/-0.2
$50,000 to $99,999	+/-1,385	18.0%	+/-0.4
$100,000 to $149,999	+/-1,177	17.5%	+/-0.4
$150,000 to $199,999	+/-1,172	17.1%	+/-0.4
$200,000 to $299,999	+/-1,249	19.7%	+/-0.4
$300,000 to $499,999	+/-1,027	14.2%	+/-0.4
$500,000 to $999,999	+/-718	6.7%	+/-0.2
$1,000,000 or more	+/-327	1.5%	+/-0.1
Median (dollars)	+/-1,176	(X)	(X)
MORTGAGE STATUS			
Owner-occupied units	+/-2,003	282,099	(X)
Housing units with a mortgage	+/-1,913	68.9%	+/-0.5

Subject	St. Louis County, Missouri		
	Margin of Error	Percent	Percent Margin of Error
Housing units without a mortgage	+/-1,587	31.1%	+/-0.5
SELECTED MONTHLY OWNER COSTS (SMOC)			
Housing units with a mortgage	+/-1,913	194,507	(X)
Less than $500	+/-262	1.0%	+/-0.1
$500 to $999	+/-1,100	19.1%	+/-0.5
$1,000 to $1,499	+/-1,384	33.9%	+/-0.6
$1,500 to $1,999	+/-1,246	21.4%	+/-0.6
$2,000 to $2,499	+/-933	10.6%	+/-0.5
$2,500 to $2,999	+/-620	5.7%	+/-0.3
$3,000 or more	+/-636	8.3%	+/-0.3
Median (dollars)	+/-9	(X)	(X)
Housing units without a mortgage	+/-1,587	87,592	(X)
Less than $250	+/-353	3.7%	+/-0.4
$250 to $399	+/-782	21.0%	+/-0.8
$400 to $599	+/-1,140	40.8%	+/-1.0
$600 to $799	+/-713	18.9%	+/-0.8
$800 to $999	+/-532	7.4%	+/-0.6
$1,000 or more	+/-482	8.1%	+/-0.5
Median (dollars)	+/-5	(X)	(X)
SELECTED MONTHLY OWNER COSTS AS A PERCENTAGE OF HOUSEHOLD INCOME (SMOCAPI)			
Housing units with a mortgage (excluding units where SMOCAPI cannot be computed)	+/-1,946	193,707	(X)
Less than 20.0 percent	+/-1,782	46.4%	+/-0.8
20.0 to 24.9 percent	+/-1,190	15.9%	+/-0.6
25.0 to 29.9 percent	+/-928	10.4%	+/-0.5
30.0 to 34.9 percent	+/-734	6.7%	+/-0.4
35.0 percent or more	+/-1,362	20.6%	+/-0.6
Not computed	+/-194	(X)	(X)
Housing unit without a mortgage (excluding units where SMOCAPI cannot be computed)	+/-1,595	86,711	(X)
Less than 10.0 percent	+/-1,112	41.0%	+/-1.1
10.0 to 14.9 percent	+/-636	21.1%	+/-0.7
15.0 to 19.9 percent	+/-652	11.3%	+/-0.7
20.0 to 24.9 percent	+/-457	7.5%	+/-0.5
25.0 to 29.9 percent	+/-391	4.8%	+/-0.4
30.0 to 34.9 percent	+/-387	3.5%	+/-0.4
35.0 percent or more	+/-525	10.8%	+/-0.5
Not computed	+/-229	(X)	(X)
GROSS RENT			
Occupied units paying rent	+/-1,707	114,733	(X)
Less than $500	+/-676	7.5%	+/-0.6
$500 to $999	+/-1,817	56.1%	+/-1.3
$1,000 to $1,499	+/-1,455	27.6%	+/-1.2
$1,500 to $1,999	+/-655	5.5%	+/-0.6
$2,000 to $2,499	+/-301	1.6%	+/-0.3
$2,500 to $2,999	+/-226	0.8%	+/-0.2
$3,000 or more	+/-236	0.9%	+/-0.2
Median (dollars)	+/-10	(X)	(X)
No rent paid	+/-501	(X)	(X)
GROSS RENT AS A PERCENTAGE OF HOUSEHOLD INCOME (GRAPI)			

Subject	St. Louis County, Missouri		
	Margin of Error	Percent	Percent Margin of Error
Occupied units paying rent (excluding units where GRAPI cannot be computed)	+/-1,788	111,835	(X)
Less than 15.0 percent	+/-973	12.5%	+/-0.8
15.0 to 19.9 percent	+/-1,081	13.4%	+/-0.9
20.0 to 24.9 percent	+/-920	12.5%	+/-0.8
25.0 to 29.9 percent	+/-938	12.5%	+/-0.8
30.0 to 34.9 percent	+/-828	8.9%	+/-0.7
35.0 percent or more	+/-1,381	40.3%	+/-1.2
Not computed	+/-645	(X)	(X)

Data are based on a sample and are subject to sampling variability. The degree of uncertainty for an estimate arising from sampling variability is represented through the use of a margin of error. The value shown here is the 90 percent margin of error. The margin of error can be interpreted roughly as providing a 90 percent probability that the interval defined by the estimate minus the margin of error and the estimate plus the margin of error (the lower and upper confidence bounds) contains the true value. In addition to sampling variability, the ACS estimates are subject to nonsampling error (for a discussion of nonsampling variability, see Accuracy of the Data). The effect of nonsampling error is not represented in these tables.

Households not paying cash rent are excluded from the calculation of median gross rent.

Telephone service data are not available for certain geographic areas due to problems with data collection. See Errata Note #93 for details.

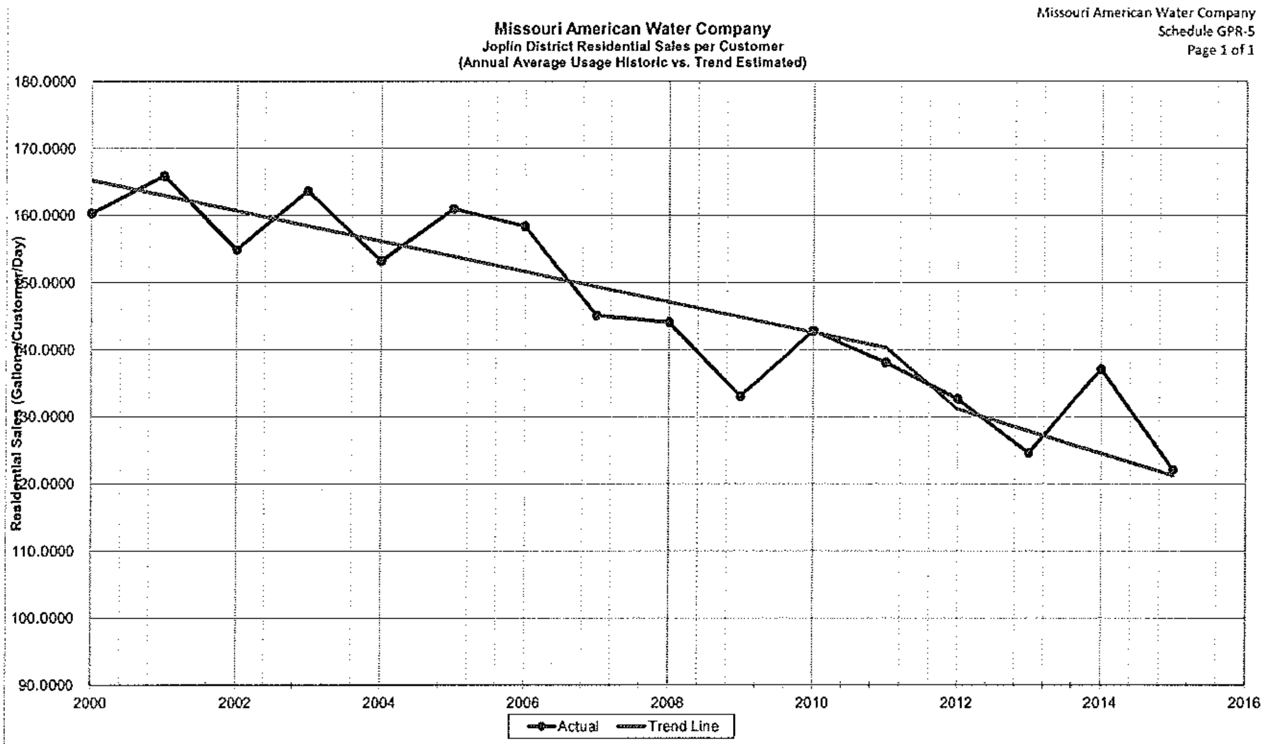
While the 2011-2015 American Community Survey (ACS) data generally reflect the February 2013 Office of Management and Budget (OMB) definitions of metropolitan and micropolitan statistical areas; in certain instances the names, codes, and boundaries of the principal cities shown in ACS tables may differ from the OMB definitions due to differences in the effective dates of the geographic entities.

Estimates of urban and rural population, housing units, and characteristics reflect boundaries of urban areas defined based on Census 2010 data. As a result, data for urban and rural areas from the ACS do not necessarily reflect the results of ongoing urbanization.

Source: U.S. Census Bureau, 2011-2015 American Community Survey 5-Year Estimates

Explanation of Symbols:

1. An '**' entry in the margin of error column indicates that either no sample observations or too few sample observations were available to compute a standard error and thus the margin of error. A statistical test is not appropriate.
2. An '-' entry in the estimate column indicates that either no sample observations or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest interval or upper interval of an open-ended distribution.
3. An '-' following a median estimate means the median falls in the lowest interval of an open-ended distribution.
4. An '+' following a median estimate means the median falls in the upper interval of an open-ended distribution.
5. An '***' entry in the margin of error column indicates that the median falls in the lowest interval or upper interval of an open-ended distribution. A statistical test is not appropriate.
6. An '*****' entry in the margin of error column indicates that the estimate is controlled. A statistical test for sampling variability is not appropriate.
7. An 'N' entry in the estimate and margin of error columns indicates that data for this geographic area cannot be displayed because the number of sample cases is too small.
8. An '(X)' means that the estimate is not applicable or not available.


Missouri American Water Company
Joplin District Residential Sales per Customer
(Annual Average Usage Historic vs. Trend Estimated)
180.0000
170.0000
160.0000
150.0000
140.0000
130.0000
120.0000
110.0000
100.0000
90.0000
Residential Sales (Gallons/Customer/Day)
2000
2002
2004
2006
2008
2010
2012
2014
2016
Actual
Trend Line

Missouri American Water Company
Authorized Sales and Revenue Compared to Annual Actual
(2007 - 2016)

Measure	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2007-2016
MAWC Total Revenue - Actual (Water & Wastewater)	$177,389,283	$180,166,727	$203,017,639	$222,749,546	$240,218,004	$274,501,000	$261,186,872	$266,484,898	$264,979,705	$283,508,099	$2,374,201,772
Total Authorized Water & Wastewater Revenue*	165,367,604	195,813,138	222,974,772	234,564,303	243,871,871	255,703,794	258,900,352	258,900,352	258,900,352	273,736,021	2,368,732,559
ISRS 3 Eff 10/23/2006	1,579,606										1,579,606
ISRS 4 Eff 4/15/2007	1,343,216										1,343,216
ISRS 5 Eff 4/27/2008		1,573,188									1,573,188
ISRS 6 Eff 7/18/2009			1,213,703	1,315,451							2,529,154
ISRS 7 Eff 3/30/2010				804,302							804,302
ISRS 8 Eff 3/21/2011					2,839,722	903,548					3,743,270
ISRS 9 Eff 10/6/2011					519,790	543,689					1,063,479
ISRS 10 Eff 9/25/12						1,003,248	3,736,587	3,736,587	3,736,587	2,057,682	14,270,691
ISRS 11 Eff 6/21/13							3,097,184	5,827,176	5,827,176	3,208,938	17,960,474
ISRS 12 Eff 12/14/13							146,660	2,973,943	2,973,943	1,637,706	7,732,252
ISRS 13 Eff 5/30/14								2,434,221	4,113,382	2,265,177	8,812,780
ISRS 14 Eff 12/31/14								20,059	7,321,583	4,031,885	11,373,528
ISRS 15 Eff 6/27/15									988,927	1,057,310	2,046,237
Total Authorized Revenue By Year	$168,290,426	$197,386,326	$224,188,475	$236,684,056	$247,231,384	$258,154,279	$265,880,783	$273,892,338	$283,861,950	$287,994,720	$2,443,564,736
Revenue Recovery Compared to Authorized (Under)/Over	$9,098,857	($17,219,599)	($21,170,837)	($13,934,510)	($7,013,380)	$16,346,721	($4,693,911)	($7,407,439)	($18,882,245)	($4,486,621)	($69,362,964)
MAWC Total Annual Water Sales (000s Gallons)	68,751,967	60,992,457	58,144,902	60,275,866	60,561,458	64,866,418	58,124,580	56,927,366	55,658,515	55,768,403	600,071,932
Authorized Water Sales (000s Gallons)*	84,846,470	86,852,062	83,324,702	71,286,441	61,618,498	60,559,014	60,272,780	60,272,780	60,272,780	59,647,313	688,952,841
Water Sales Compared to Authorized (Under)/Over (000s Gallons)	(16,094,503)	(25,859,605)	(25,179,800)	(11,010,575)	(1,057,040)	4,307,404	(2,148,200)	(3,345,414)	(4,614,265)	(3,878,910)	(88,880,909)

* Per State of Missouri Public Service Commission Order, Adjusted for Subsequent ISRS Filings, actual billing determinants and effective date allocation.
** Summer 2012 historically warm and dry; 4th driest summer since 1895, warmest summer since 1895 NOAA/NCDC

Missouri American Water Co.
Reasonableness of Consumption Decline Calculation
1,356 Gallons Per Customer Per Year

Illustrating: Replacement of Clothes Washing, Toilet, Fixtures and Dishwashers Based on Family of Four

Washer:

Old: Usage per load - gallons	41	Average Use Per Capita Per Day	0.37
New: Usage per load - gallons	17	Average Loads per week - 4 People	10
Usage decline	24	Savings per week	251
		Savings per year - Gallons	**13,037**

Toilet:

Old: Usage per flush - gallons	3.5	Flush per person per day	5
New: Usage per flush - gallons	1.3	Household number	4
Usage decline	2.2		
		Flush per day per household	20
		Flush per year per household	7,300
		Savings per year - Gallons	**16,206**

Fixtures (Showers):

Old: Gallons/min flow	2.75	Flow Minutes Per Person Day	8
New: Gallons/min flow	2.00	Household Number	4
Usage Decline	0.75		
		Total Flow Minutes Per Day	32
		Total Flow Savings Per Day	24
		Savings per year - Gallons	**8,870**

Fixtures (Faucets):

Old: Gallons/min flow	2.75	Flow Minutes Per Person Day	8
New: Gallons/min flow	1.50	Household Number	4
Usage Decline	1.25		
		Total Flow Minutes Per Day	32
		Total Flow Savings Per Day	41
		Savings per year - Gallons	**14,783**

Dish Washer:

Old: Gallons/cycle	14	Average Use Per Capita Per Day	0.10
New: Gallons/cycle	4	Average Loads per week - 4 People	3
Usage decline	10	Savings per week	27
		Savings per year - Gallons	**1,420**

Total Impact of All Appliances:

Total Calculated Annual MAWC Decrease in Usage (Gallons)	576,983,424
Divided by: Total Estimate Water Usage Savings For Family of Four (Gallons)	**54,315**
Implied Number of Toilet, Clothes Washer, Fixture and Dish Washer Changes Accounting For Annual Usage Reduction MAWC (Number of Customers)	**10,623**
MAWC - Average Number of Residential Customers (2016)	425,504
Maximum number of Customers in a single year contributing to decline	**2.50%**
Implied Years For Complete Impact of Appliance Replacement	**40**

*1 Source: Handbook of Water Use and Conservation, Amy Vickers, May, 2001
*2 Source: www.home-water-works.org, A project of the Alliance for Water Efficency, 2011