Exhibit No.:	
Issues:	Residential Usage/Customer Fixture Specifications Future Declining Use Declining Use Impact on Residential & Commercial Customer Usage
Witness:	Gregory P. Roach
Exhibit Type:	Direct
Sponsoring Party:	Missouri-American Water Company
Case No.:	WR-2020-0344 SR-2020-0345
Date:	June 30, 2020

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO. WR-2020-0344
CASE NO. SR-2020-0345

DIRECT TESTIMONY

OF

GREGORY P. ROACH

ON BEHALF OF

MISSOURI-AMERICAN WATER COMPANY

AFFIDAVIT

I, Gregory P, Roach, under penalty of perjury, and pursuant to Section 509.030, RSMo, state that I am Senior Mange of Revenue Analytics for American Water Works Service Company, that the accompanying testimony has been prepared by me or under my direction and supervision; that if inquiries were made as to the facts in said testimony, I would respond as therein set forth; and that the aforesaid testimony is true and correct to the best of my knowledge and belief.

Gregory P. Roach

Gregory P. Roach

Dated: 6-30-2020

DIRECT TESTIMONY
GREGORY P. ROACH
MISSOURI-AMERICAN WATER COMPANY
CASE NO. WR-2020-0344
CASE NO. SR-2020-0345

TABLE OF CONTENTS

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 153 N. Emerson Ave, 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 Senior 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 associations.

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 am a past member of the National Association of Business Economist and the American Economic Association.

Q. Please summarize your educational background and professional associations.

A. 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 (now a part of Duke Energy) in January of 1980, continuing as an economist for a large consulting firm and a regulatory consultant through my own firm, and then joining the Service Company in 2011. The details of my professional experience are provided in Appendix A to this testimony.

Q. What are your duties as Senior 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, supplemental direct, rebuttal and surbuttal testimony in the two most recent MAWC general rate case (Case No. WR-2015-0301 and Case No. WR-2017-0285-GRC) before the Missouri Public Service Commission (‘the Commission”). Additionally, I have provided testimony before the following regulatory bodies: the Indiana Utility Regulatory Commission, the Pennsylvania Public Service Commission, the Illinois Commerce Commission, the Public Service Commission of New York, 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 Direct Testimony in this proceeding?

A. My Direct Testimony supports the testimony of Company's witnesses Brian LaGrand and John Watkins regarding MAWC's Test Year revenue, expense normalizations and the Company's request 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 and Commercial customer usage per customer reductions for the foreseeable future. In my Direct Testimony I will further discuss the analyses we have performed that identify and define this declining usage, historically, and demonstrate 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 the St. Louis MAWC district of approximate 1,563 gallons per customer per year ("gpcy"), and an approximate 1,460 gallons per customer per day ("gpcd") decline in the non-St. Louis districts and a continuing annual decline in Commercial water use in the St. Louis MAWC district of approximately 1,780 gpcy. Furthermore, the ongoing and significant nature of the Residential and Commercial declining usage trend justifies 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, Schedules in support of the Company's application to increase rates?

A. Yes, I am sponsoring the following Schedules:

- Schedule GPR-1: Authorized and Actual Revenue & Water Sales
- Schedule GPR-2: AWC Residential Usage Trend 2010-2019;
- Schedule GPR-3: US Water Fixture Specifications;
- Schedule GPR-4: Reasonableness Test of MAWC Residential Consumption Decline;
- Schedule GPR-5: State of Missouri & City of St. Louis - Housing Stock Vintage; and
- Schedule GPR-6: Effect of Tornado Rebuild on Water Usage.

Q. Were each of Schedules GPR-1 through GPR-6 prepared by you or under your direction and supervision?

A. Yes.

Q. What were the sources of the data used to prepare Schedules GPR-1 through GPR-6?

A. The data used to prepare these Schedules was obtained from the Company's SAP system, the US Bureau of Economic Analysis, the US Bureau of Labor Statistics, the US Bureau of the Census and the National Oceanic and Atmospheric Administration.

Q. Do Schedules GPR-1 through GPR-6, inclusive, accurately summarize such

data and the results of analyses using such data?

A. Yes they do.

Q. Have you prepared a glossary of the technical and statistical terms used in your Direct Testimony?

A. Yes, a Glossary of Technical and Statistical Terms is provided as Appendix B to my Direct Testimony.

II. OVERVIEW

Q. Please summarize your Direct Testimony.

A. My Direct Testimony presents the normalized usage for Residential and Commercial customers, which is subsumed in the econometric models developed for those customer classes. The Industrial, Sale for Resale and Other Public Authority classes' water usage, however, is significantly more heterogeneous as compared to MAWC Residential and Commercial customer usage; hence, it is difficult to apply statistical techniques to these classes as usage varies greatly from customer to customer. Consequently, due to the heterogeneous customer mixtures of these groups, we have chosen to use a 12-month average to forecast their future usage as described by Company witness Brian LaGrand. My Direct Testimony, therefore, focuses only on the forecasted usage in the Residential and Commercial Classes. Mr. LaGrand also translates that declining usage into a revenue forecast for the Residential and Commercial classes based on forecasted numbers of customers in each class.

With respect to the models developed for the Residential and Commercial classes, in addition to determining weather-normal levels of usage, the models also quantify and estimate the potential term and impact of the declining usage trend of MAWC's Residential and Commercial customers. My analysis concludes the following:

1. There is a continuing annual decline of Residential water use across the St. Louis MAWC district averaging -1,563 gallons per customer. Additionally there is a continuing annul decline of Residential water use across the non-St. Louis MAWC districts averaging -1,460 gallons per customer.
2. There is a continuing annual decline of Commercial water use across the St. Louis MAWC district averaging -1,780 gallons per customer.
3. The revised federally mandated efficiency standards for water fixtures will support the existing trend of declining usage into the foreseeable future.
4. Similar water use trends as are seen with MAWC are occurring within affiliated American Water systems.
5. Empirical analysis indicates that the MAWC declining use trend:
    a. Is projected to continue for up to the next 16 years.
    b. Is confirmed by the Joplin case study that illustrates that a significant reduction in usage per household (-8.4%) can rapidly occur due to water fixture replacement. This reduction amounts to approximately one month's level of water sales.
    c. Is also confirmed by the permanent California Residential water use reductions that have endured following removal of mandatory state water use restrictions during the drought of 2016-2017.

III. MAWC NORMALIZED USAGE AND FORECAST

Q. Please describe the water use trend among MAWC's Residential and Commercial customers?

A. As I noted above, the water use trend for the Residential and Commercial classes indicates a distinctly downward trend in usage from year to year. I will explain this further in my Direct Testimony.

Q. In addition to a continuing downward trend in usage, is there also a seasonality component to water usage for these classes? If so, please describe the water use trend among MAWC's Residential and Commercial customers?

A. Yes generally there is a seasonality component to water useage among the Residential and Commercial classes. Outdoor usage by most Residential customers and many Commercial customers is seasonal. Generally, in the Residential customer class, outdoor usage during the summer season includes discretionary usage including turf and landscape irrigation, car washing, swimming pool fills, and similar activities. Many Commercial customers also exhibit seasonal usage patterns similar to Residential customers primarily attributable to turf irrigation, although the class as a whole is somewhat less influenced as compared to the Residential class. Short-term summer weather patterns will influence outdoor water use; for instance, turf 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 and annual basis that require a weather normalization approach to Residential or Commercial customer usage modeling and forecasting to identify and capture long-term customer usage trends.

Q. Did you make a discrete weather normalization in this case to account for such seasonal weather adjustments?

A. As I explain in the succeeding sections concerning the regression analysis, due to the addition of climatic variable(s) to the regression models, we capture the effects of weather and need not make a separate adjustment to normalize revenue for weather, such as was made in the 2017 case.

Q. What are the results of your forecasting analysis?

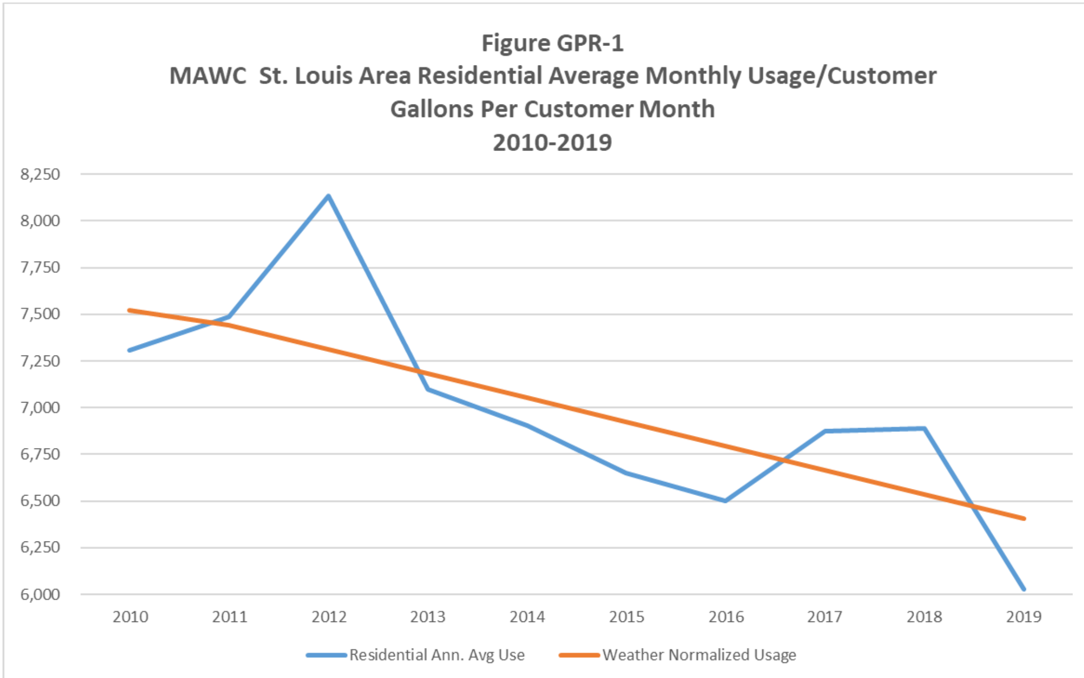
A. I examined historical and forecasted sales by analyzing regression analyses for the Residential and Commercial classes successfully creating statistical models for purposes of forecasting both classes usage using the results of these regression analysis. The Industrial, Sale for Resale and Other Public Authority classes' water usage, however, is significantly more heterogeneous as compared to MAWC Residential customer usage. Hence, it is difficult to apply statistical techniques to these classes as usage varies greatly from customer to customer in response to climatic conditions as well as efficiency improvements in water fixtures and appliances. In many cases, the use of water as part of a specific production process, such as with Industrial customers, tends to obscure the impact of either climate or water use efficiency standards on specific customers' usage patterns. Due to the heterogeneous customer mixtures of these groups, we have chosen to use a 12-month average to forecast their future usage as described in the Direct Testimony of Company witness Brian LaGrand. The discussion that follows, therefore, focuses on the forecasted usage in the Residential and Commercial classes. Mr. LaGrand also translates that declining usage into a revenue forecast for ther Residential and

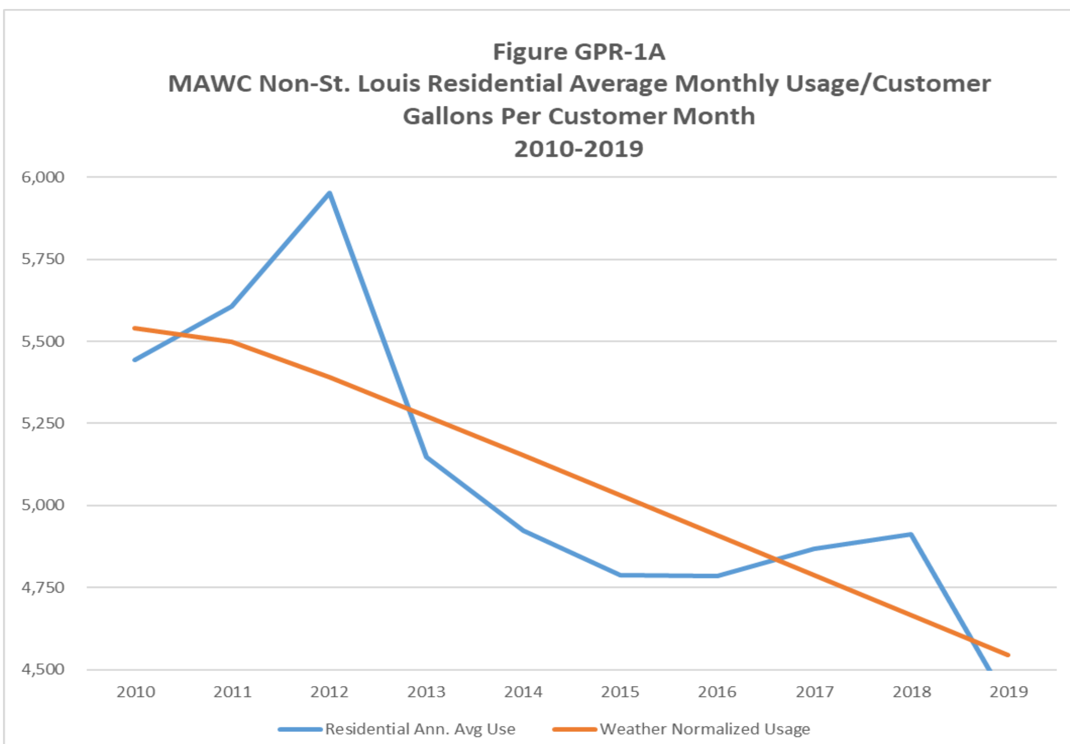
Commercial classes based on, among other things, forecasted numbers of customers in those classes.

IV. RESIDENTIAL USAGE REGRESSION ANALYSIS

Q. Please describe the analytical methodology you employed related to MAWC Residential usage trends?

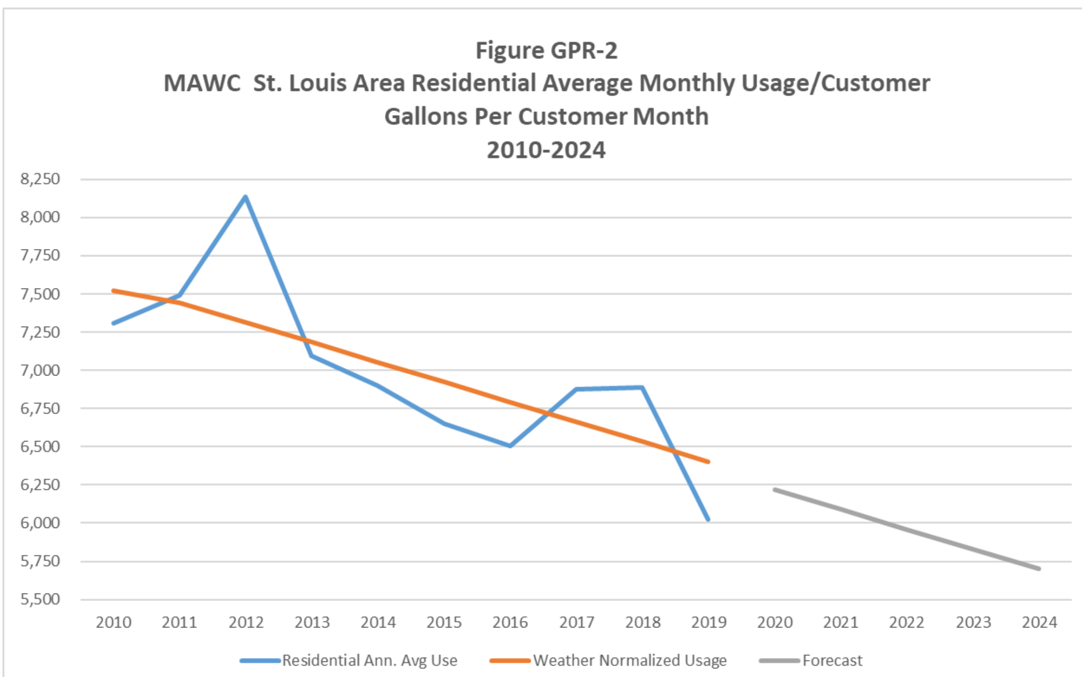
A. Our analysis examined the annual average of monthly per customer consumption by MAWC's Residential customers over the past ten years separated into two groups; one group comprising St. Louis area customers and a second group comprised of all other MAWC Residential customers. Presented in Figure GPR-1 and GPR-1A is the Residential usage per customer data that formed the basis of the analysis for each customer grouping. To this data, we applied standardized statistically linear regression analysis a) to estimate the Residential customer usage trend over time and b) to normalize the Residential customer usage data for the potential impact of weather. We analyzed the impact of time and numerous weather related variables including: cooling degree-days (CDD), days with 90 degree maximums, average temperature, maximum temperature and precipitation (precip) as independent explanatory variables for the trend of Residential usage per customer over the time series analyzed. Figure GPR 1 and Figure GPR-1A illustrate the Residential average usage per customer trend over that same time frame.

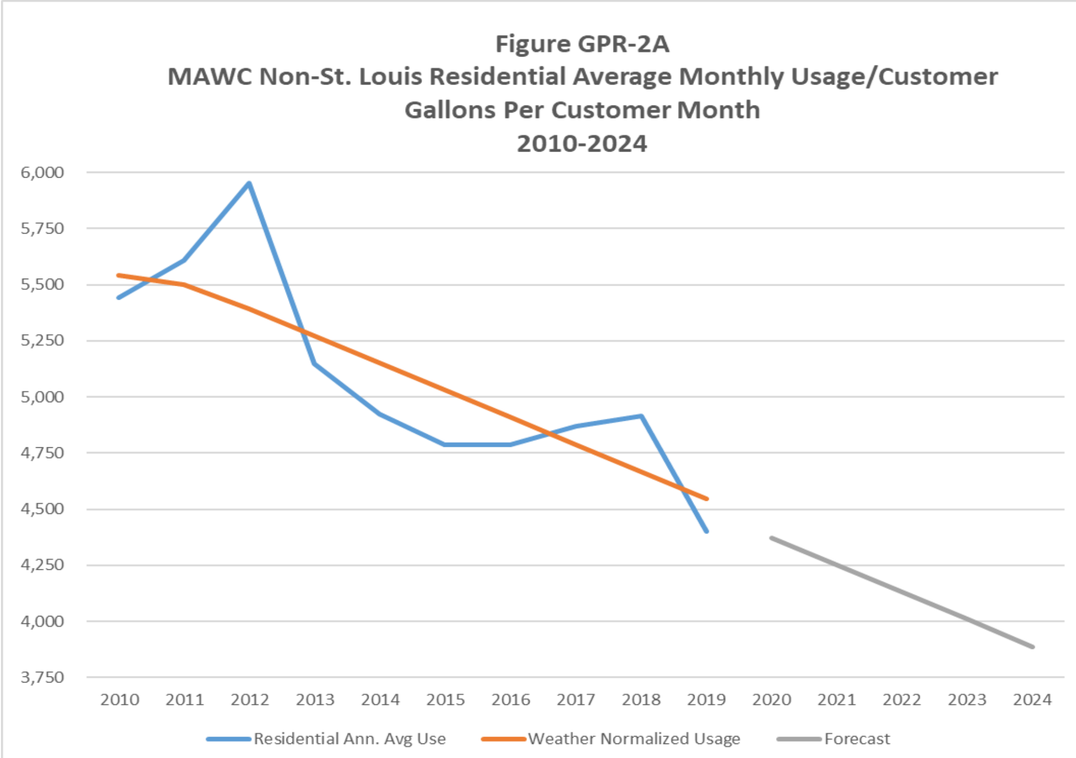




Q. What are the results of your analysis?

A. The results of our linear regression analysis based on the explanatory variables time, precipitation (July-November) and annual cooling degree days indicate that Residential usage per customer is declining at a rate of approximately -2.04% or 1,563 gallons per customer per year (equivalent to -130 gpcm) for the St. Louis based Residential customer group and approximately -2.68% or 1,460 gallons per customer per year (equivalent to -122 gpcm) for the non-St. Louis based Residential customer group. Figure GPR-2 and Figure GPR-2A graphically illustrates that Residential average usage trend for the the St. Louis and Non-St. Louis Residential customer groups.





Our analysis employed the use of numerous regression models exploring combinations of potential explanatory variables including time and various weather variables. Table GPR-1 & GPR-1A below summarizes the types of models that we evaluated and their relative statistical merits. As delineated in those tables, generally models that incorporated precipitation and cooling degree days result in a reasonable R-Square as compared to those relying solely on temperature as a weather factor; meaning that each of the models explains in excess of ~90% of the variance in MAWC Residential usage per customer over the period of 2010-2019. Generally, models incorporating cooling degree days, and various percipitation series were often statistically significant and resulted in logically relevant explanatory variables for MAWC Residential average usage as delineated by the t-statistic results (and sign of coefficient). As a final model specification I choose to rely on a model incorporating both cooling degree days and precipitation as that combination of variables maximized the R-Squre of the model, minimized the standard error and result in significant T-statistics for each of the variables included in the final model. For each of the other weather variables, the regression coefficients where statistically less significant, could not be estimated with anything less than a +/- 10% error or resulted in an illogical relationship with Residential average usage (such as increases in precipitation illogically producing additional Residential average usage when common knowledge would predict that water usage increases during periods of relatively lower precipitation). As a result, inclusion of these weather variables in the final model was statistically unsupportable.

In summary, I have chosen to rely on MAWC Residential average use models defined by the statistically significant explanatory variables time and the weather explanatory variable annual cooling degree days and precipitation during the period July through November (STL) or July through September (Non-STL) due to these models' highest R-Square and F-Statistic values with acceptable Durbin-Watson score, while minimizing the error of the estimate as compared to all the other Residential models evaluated.

Table GPR-1
Missouri American Water
St. Louis District Residential Usage Per Customer Model Summaries

Model	Period Ending	R-2	F-Statistic	Durbin-Watson	T-Statistic										
					Day	CDD	Precip	JLSCDD	JNRain	JLSRain	DX90	TMAX	TAVG	Lag	Custs
2017 Case - Base Usage															
MAWC	Dec	0.912			-8.47										426k
East (D-1)	Dec	0.919			-8.87										358k
Northwest (D-2)	Dec	0.896			-7.74										34k
Southwest (D-3)	Dec	0.928			-8.47										34k
2017 Case - NonBase Usage															
MAWC	Dec	0.707				1.629	-4.051								
East (D-1)	Dec	0.756				N/A	-4.984								
Northwest (D-2)	Dec	0.709				2.814	-3.439								
Southwest (D-3)**	Dec	0.266				0.773	-0.745								
2020 Case - Total Usage															
Day, CDD, JLNRain, Lag	Dec	0.927	15.795	2.372	-4.155	2.916			-3.382					0.355	317k
Day, CDD, JLNRain	Dec	0.925	24.601	2.200	-5.797	3.295			-4.307						317k
Day, CDD, JLSRain	Dec	0.915	21.599	1.871	-5.728	3.298				-3.972					317k
Day, JLNRain	Dec	0.789	13.067	3.015	-3.850				-2.578						317k
Day, CDD	Dec	0.692	7.877	1.659	-3.605	1.539									317k
Day, DX90	Dec	0.736	9.761	1.641	-3.487						1.980				317k
Day, TMAX	Dec	0.711	8.607	1.717	-3.606							1.723			317k
Day, TAVG	Dec	0.673	7.213	1.752	-3.454								1.350		317k
Day	Dec	0.537	11.428	1.912	-3.381										317k

** 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.

Table GPR-1 A
Missouri American Water
Non St. Louis District Residential Usage Per Customer Model Summaries

Model	Period Ending	R-2	F-Statistic	Durbin-Watson	T-Statistic										
					Day	CDD	Precip	JLSCDD	JNRain	JLSRain	DX90	TMAX	TAVG	Lag	Custs
2017 Case - Base Usage															
MAWC	Dec	0.912			-8.47										426k
East (D-1)	Dec	0.919			-8.87										358k
Northwest (D-2)	Dec	0.896			-7.74										34k
Southwest (D-3)	Dec	0.928			-8.47										34k
2017 Case - NonBase Usage															
MAWC	Dec	0.707				1.629	-4.051								
East (D-1)	Dec	0.756				N/A	-4.984								
Northwest (D-2)	Dec	0.709				2.814	-3.439								
Southwest (D-3)**	Dec	0.266				0.773	-0.745								
2020 Case - Total Usage															
Day, CDD, JLSRain, Lag	Dec	0.971	41.574	2.408	-5.492	5.684				-3.384				1.812	115k
Day, CDD, JLSRain	Dec	0.952	39.367	1.573	-8.468	4.586				-4.006					115k
Day, CDD, JNRain	Dec	0.928	25.942	1.905	-7.380	2.673			-2.982						115k
Day, JLSRain	Dec	0.782	12.570	2.442	-4.443					-1.698					115k
Day, CDD	Dec	0.822	16.200	1.438	-5.145	2.262									115k
Day, DX90	Dec	0.862	21.827	1.462	-5.237						2.928				115k
Day, TMAX	Dec	0.805	14.481	1.506	-4.791							2.014			115k
Day, TAVG	Dec	0.781	12.512	1.522	-4.589								1.687		115k
Day	Dec	0.693	18.018	1.735	-4.245										115k

** 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. Does your model imply that the mere passage of time is a major driver of declining use per customer?

A. No. Time simply captures the range of conservation effects, such as the installation of more water efficient fixtures and appliances that occur over time. Of course the passage of time, independent of an ongoing sequential tend, is of no consequence. However, time is a powerful variable in usage modeling as it is the medium for capturing the ongoing forced conservation effect. Further, as the models indicate, time is a very powerful statistical explanatory variable, as indicated by the high R-squared values. With the addition of the cooling degree day and precipitation variables in the final model, I am able to normalize Residential average usage per customer for climatic variations that occur from year to year. Later in my Direct Testimony, I will describe some of the reasons for the declining usage per customer, explain how they affect consumption and show that this trend will not diminish any time soon. Noteably, since approximately 2005, Residential usage has declined on a per-customer basis in the MAWC service territory and the slope, or change rate, of Residential decline has accelerated since the passage of more stringent water fixture and appliance usage regulations in the 2000s. The decline is attributable to several key factors, including but not limited to the following: 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. Accordingly, this trend of declining use per Residential customer should be employed to forecast Residential usage though the end of MAWC's forecasted Test Year adjustment period.

Q. How does the Residential usage modeling you are sponsoring in this case compare to the analysis you sponsored in MAWC'S prior 2017 base rate case?

A. The analyses in the two cases are similar in terms of methodology. The principle difference is that in the Company's 2017 base rate case, we separately normalized for weather based on a discrete 10-year average on non-base weather influenced usage. In this case, by the addition of the weather-related variables to the regression analyses, (i.e., cooling degree days) we no longer have to normalize for weather separately. The 2020 analysis continues to demonstrate that time is the main statistically significant explanatory variable, but is also influenced by weather indices. I found one modification to the 2017 analysis was warranted due to billing and timing differences, complicated by billing data or events that may bleed into or outside of the "base period." Further, my previous analysis of "base usage" was complicated by the impact of the Polar Vortex influence during the winter of 2014. So in order to continuously improve our modeling methods, I determined it was appropriate to no longer bifurcate the Residential usage data into base (non-discretionary non-weather sensitive usage) and non-base (discretionary weather sensitive usage) water usage components in order to eliminate the possible impact of timing in billing, better simulate the impact of climatic conditions on usage, and rely on modeling total Residential annual average usage for the analysis used in this case.

Q. How did the decision not to use a bifurcated analytical approach compare to MAWC's 2017 base rate case analysis?

A. Table GPR-2 illustrates the difference in results from the Residential trend analytics, which I am sponsoring in this proceeding as compared to the approach used in the previous 2017 MAWC base rate case. To summarize that table, the change in analytical approach results in an annual -.15% or 207 gpcy difference in usage per Residential customer for the STL customer group and an annual -.79% or 104 gpcy difference in usage per Residential customer for the non-STL customer group compared to the approach and period analyzed for the 2017 MAWC base rate case. The differences in the results of this analysis from those filed in the 2017 base rate case are due mainly to incorporating and modeling the influence of weather factors simultaneously with the conservation trend, particularly the impact of the Summer 2012 data point, to our previously modeling results.

Table GPR-2
Missouri American Water
Residential Usage Per Customer Model Summaries

Model	Period Analyzed	Period Ending	Gal/Cust/Yr	% Annum	Custs
2017 Case - Base Usage					
MAWC System	2007-2016	Dec	-1,356	-1.89%	426k
2020 Case - STL Usage					
Day, CDD, JLNRain	2010-2019	Dec	-1,563	-2.04%	317k
2020 Case - Non-STL Usage					
Day, CDD, JLSRain	2010-2019	Dec	-1,460	-2.68%	115k

Q. Setting aside the weather normalization analysis you have performed for Residential usage in this case and focusing on the actual MAWC average Residential usage per customer per month since 2015, what has been the trend of that usage?

A. Tables GPR-3 and GPR-3A show that even with the influence of weather fluctuations impacting the actual data, Residential average usage per month for the STL Residential customer group has been declining by -156 gpcm (-1,875 gpcy) or -2.2% per annum and . non-STL Residential customer group has been declining by -97 gpcm (-1,164 gpcy) or -2.0% per annum over that time period.

Table GPR-3 MAWC Residential Customers STL Average Usage Per Month 2016-2019			
	Res Usage	Difference	
Year	gpcm	Gallons	%
2015	6,650		
2016	6,503	-147	-2.2%
2017	6,874	371	5.7%
2018	6,888	14	0.2%
2019	6,025	-863	-12.5%
Average		-156	-2.2%

Table GPR-3A MAWC Residential Customers Non-STL Average Usage Per Month 2016-2019			
	Res Usage	Difference	
Year	gpcm	Gallons	%
2015	4,787		
2016	4,786	-1	0.0%
2017	4,869	83	1.7%
2018	4,913	44	0.9%
2019	4,399	-514	-10.5%
Average		-97	-2.0%

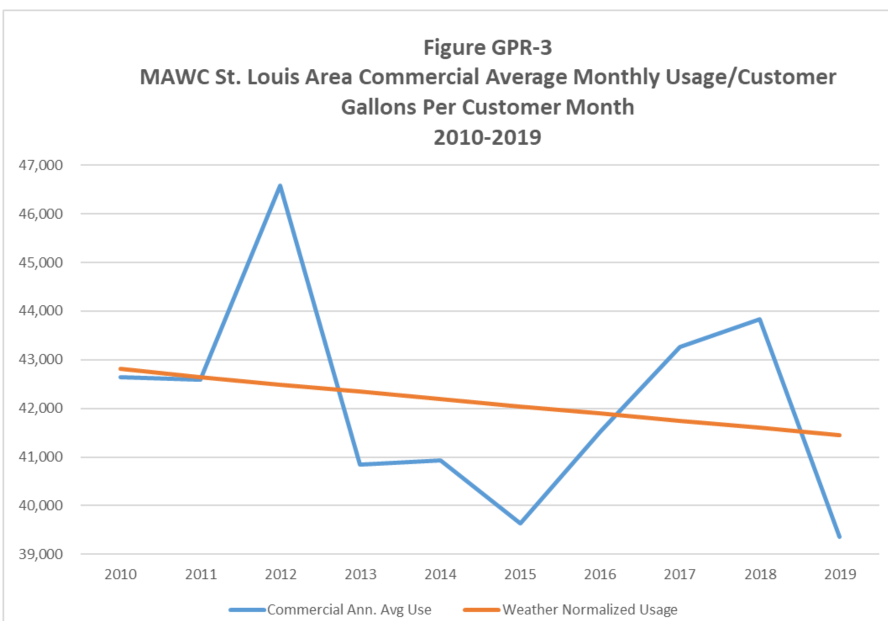
V. COMMERCIAL USAGE REGRESSION ANALYSIS

Q. Have you performed a similar analysis of Commercial usage for MAWC?

A. Yes, we have. Using the same regression type analysis described above to forecast MAWC Residential customer usage per customer, we have performed an analysis of the trend for Commercial usage per customer for the STL MAWC Commercial customers.

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

A. Similar to the Residential class, since the early 2000s, Commercial usage has declined on a per-customer basis in the MAWC service territory. The slope, or change rate, of Commercial decline has accelerated since the passage of more stringent water fixture and appliance usage regulations in the 2000s. As with the Residential class, the decline is attributable to several key factors, including but not limited to the following: increasing prevalence of low flow (water efficient) plumbing fixtures and appliances in Commercial establishments; customers' conservation efforts; conservation programs implemented by the federal government, state government, MAWC and other entities; and price elasticity. The trend of this decline in MAWC STL Commercial usage per customer is illustrated in Figure GPR-3 below.

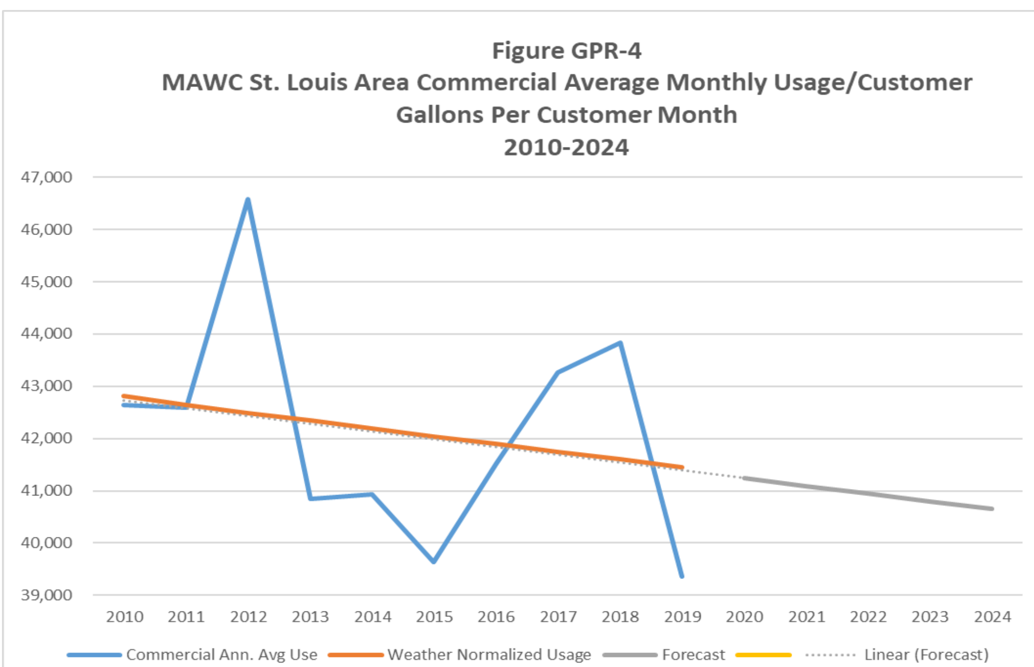


Q. Do seasonal factors affect Commercial usage of MAWC customers?

A. The weather seasonality of AMW affiliated company Commercial sales is heavily dependant on the specific nature and composition of the specific affiliated companies Commercial customer base. In the case of MAWC Commercial customer class usage seasonal weather factors appear to have a statistically significant influence on MAWC Commercial usage. To that end, based on the weather variables used to explain MAWC Commercial customer class weather sensitivity illustrates a remarkably similar trend to what we estimated for the MAWC Residential class.

Q. What are the statistical and forecast results of your Commercial usage analysis?

A. As graphically illustrated in Figure GPR-4 below, the results of our linear regression analysis indicate that STL Commercial usage per customer is declining at a rate of approximately -0.36% or -1,780 gallons per customer per year, which is equivalent to -4.875 gallons gpcd. Figure GPR-4 graphically illustrates that Residential average usage trend.



As with the Residential analysis, I employed the use of numerous regression models exploring varying combinations of potential explanatory variables including time and various weather variables. Table GPR-4, below, summarizes the types of models that we evaluated and their relative statistical merits. As delineated in Table GPR-4, generally models that incorporated precipitation and cooling degree days result in a reasonable R-Square as compared to those relying solely on temperature as a weather factor; meaning that each of the models explains in excess of ~90% of the variance in MAWC Commercial usage per customer over the period of 2010-2019. Generally, models incorporating cooling degree days, and various percipitation series were often statistically significant and resulted in logically relevant explanatory variables for MAWC Commercial average usage as delineated by the t-statistic results (and sign of coefficient). As a final model specification I choose to rely on a model incorporating both cooling degree days and precipitation as that combination of variables which maximized the R-Squre of the model, minimized the standard error and result in significant T-statistics for each of the variables included in the final model. For each of the other weather variables, the regression coefficients where statistically less significant, could not be estimated with anything less than a +/- 10% error or resulted in an illogical relationship with Residential average usage (such as increases in precipitation illogically producing additional Residential average usage when common knowledge would predict that water usage increases during periods of relatively lower precipitation). As a result, inclusion of these weather variables in the final model was statistically unsupportable.

In summary, I chose to rely on the MAWC Commercial average use model defined by the single statistically significant explanatory variable time due to this model's highest R-Square and F-Statistic with minimizing the error of the estimate as compared to all the other Commercial models evaluated.

Table GPR-4
Missouri American Water
St. Louis District Commercial Usage Per Customer Model Summaries

					T-Statistic								
Model	Period Ending	R-2	F-Statistic	Durbin-Watson	Day	CDD	MSRain	JLSRain	DX90	TMAX	TAVG	Lag	Custs
2020 Case - Total Usage													
Day, CDD, MSRain, Lag	Dec	0.974	47.462	2.601	-2.938	5.590	-8.273					-0.246	16.8k
Day, CDD, MSRain	Dec	0.974	75.009	2.537	-3.210	6.846	-9.525						16.8k
Day, CDD, JLSRain	Dec	0.886	15.584	2.693	-1.501	5.614		-4.011					16.8k
Day, MSRain	Dec	0.771	11.796	2.373	-1.148		-4.541						16.8k
Day, CDD	Dec	0.581	4.859	1.851	-1.179	2.845							16.8k
Day, DX90	Dec	0.631	5.996	2.225	-0.710				3.185				16.8k
Day, TMAX	Dec	0.466	3.053	2.029	-0.928					2.198			16.8k
Day, TAVG	Dec	0.389	2.232	2.031	-0.933						1.830		16.8k
Day	Dec	0.097	0.861	2.023	-0.928								16.8k

** 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

Q. Setting aside the normalization analysis you have performed for Commercial usage in this case and focusing on the actual MAWC average Commercial usage per customer per month since 2015, what has been the trend of that usage?

A. Table GPR-5 shows that even without normalizing the time series for 10 years of variance, Commercial average usage per month has been declining by -70 gpcm (-834 gpcy) or -0.02 %per annum over that time period.

Table GPR-5 MAWC Commercial Customers Average Usage Per Month 2016-2019			
	Res Usage	Difference	
Year	gpcm	Gallons	%
2015	39,630		
2016	41,250	1,620	4.1%
2017	43,260	2,010	4.9%
2018	43,842	582	1.3%
2019	39,352	-4,490	-10.2%
Average		-70	0.0%

VI. MAWC RESIDENTIAL USAGE FORECAST VS FIVE YEAR AVERAGE

Q. The Commission and its 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 forecast method versus a five year average of 2015-2019 to set Test Year billing determinants?

A. Yes, we have presented in Table GPR-6 below a comparison of the five-year average of MAWC Residential sales volumes and revenues for the period 2015-2019 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 2.372 million gallons greater than the forecast employed by MAWC. The five-year average method results in a 8% overstatement of sales volumes for the Test Year.

Table GPR-6
Missouri American Water Company
2015-2019 Residential Water Sales & Billed Water Revenues

Res Water Sales (TG)

	2015	2016	2017	2018	2019	5 Year Avg
Actuals	31,362,239	30,933,541	32,947,131	33,195,818	29,143,580	**31,516,462**
Test Year 2019						**29,143,580**
Variance						**(2,372,882)**
% Var						**-8%**

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 that weather variances during the period of 2015-2019 lead to greater than average water sales volumes and hence revenues. As discussed above, the MAWC approach incorporates modeling of Residential usage including weather sensitive sales estimating the responsiveness of weather sensitive sales to changes in climatic conditions. As such, when forecasting future levels of Residential sales, I was 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 weather conditions warmer and dryer from those conditions during the the Test Year, 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 2015-

2019 period and have you compared those conditions to the ten and forty year climatic averages?

A. Yes, I have. Table GPR-7 illustrates that the 2015-2019 five year averaging period, using cooling degree-days as the measure, was 14% warmer than the 40-year average and 1.2% warmer than the 10-year average. So too, using monthly precipitation as the measure, this same time period experienced 5.0% greater than the 40 year average and 2.7% dryer than the 10 year average.

Table GPR-7
Missouri American Water Company
Comparison of 10 and 40 Year Weather to 2015-2019
Summer Season (May - Sept)

Time Period Measured	Cooling Degree Days	Precipitation	Maximum Monthly Temperature	Mean Maximum Daily Temperature	Mean Minimum Daily Temperature	Mean Average Daily Temperature
Mean % Change 5 to 40 Years	14.0%	5.0%	0.7%	2.0%	3.1%	2.5%
S. Dev % Change 5 to 40 Years	-19.4%	-12.0%	-21.5%	-21.2%	-18.3%	-19.6%
Mean % Change 5 to 10 Years	1.2%	2.7%	-1.0%	0.2%	0.8%	0.4%
S. Dev % Change 5 to 10 Years	-14.8%	3.0%	-13.5%	18.7%	14.7%	16.6%

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

A. The weather conditions occurring during the 2015-2019 five year period employed by the averaging technique results in estimates for sales volumes influenced by that warmer and dryer than normal climatic conditions. This is illustrated by Figure GPR-1 which clearly illustrates that over the period of 2015-2019, the five year averaging technique for sales volumes would be heavily influenced by warmer and dryer conditions in the summers of 2017 & 2018 which drove summer Residential usage per customer well above the trend for both the 10 year period analyzed by MAWC or above the 3 other annual totals included in the 2015-2019 averaging.

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 Direct Testimony, the MAWC forecast is based on models estimated over the ten-year period 2010-2019, incorporating the impact of reductions in usage influenced by certain conservation effects and normalized for weather conditions over that 10 year period. Based on this technique, the MAWC approach produces a Test Year sales volume and revenue forecast that incorporates the trend of Residential usage conservation reductions while normalizing to ten-year average weather conditions over the forecast period. Comparatively, the five-year averaging approach is unable to capture the nearly two decade long trend of declining Residential usage and is biased by the climatic effects during the 2015-2019 average period resulting in 8% higher usage than experienced in the 2019 Test Year. Generally, the MAWC approach is based on ten years of climatic data that mitigates the influence of departures of average weather, which have an impact on the five-year average technique.

VII. DECLINING CUSTOMER WATER USE

Q. You mentioned that the declining usage per customer experience of MAWC is not unique among the companies of the American Water system. Have you studied water consumption trends for other American Water subsidiaries?

A. Yes, I have.

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

A. Yes, they are consistent. I have studied the Residential consumption patterns for MAWC's affiliate water systems located in climates and geographies similar to Missouri. The trend experienced by MAWC is very similar to the trends experienced by MAWC affiliates in other states including New Jersey, Indiana, Illinois and Pennsylvania. 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 approximately -2.0% per year over the last 10 years. The estimated MAWC reduction in STL Residential customer usage per year of -2.04% falls close to the mean, is 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."[1] The report further states: "A pervasive decline in household consumption has been determined at the national and regional levels.[2]

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

---

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

A. Several factors drive the decline in Residential customers' usage. These factors include the incremental introduction of low-flow fixtures and appliances, new regulations that 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. Similarly, construction of new homes or business establishments result in the installation of water efficient fixtures meeting new, more efficient, regulatory standards. Further, 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 efficientRtoilets, 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. 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. Schedule GPR-3, pages 4-12 detail these program's specifications as well as others. This listing is a reproduction of the Alliance for Water Efficiency Water Products Standard Matrix, which was last updated in March 2010.

As awareness of water and energy 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 other various ways. Our analysis of Residential declining usage per customer indicates that the Company's Residential customers will continue to reduce their usage by approximately 2.2 gallons per customer per day on average. A 2.2 gallon per day decrease can be achieved by subtle changes in customer behavior. For instance, here are some ways a customer can reduce 2.2 gallons per day:

1. Taking a shower that is 1 minute shorter;
2. Flushing a low-flow toilet fixture instead of an older toilet just once per day;
3. Running the dishwasher 5 times per week instead of 7; or
4. Turning off the water for approximately 1 minute while brushing their teeth.

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 government-mandated standards will continue to drive further efficiency into Residential and Commercial usage per customer. In fact, the trend is well established and continues to affect water usage on the MAWC system as well as most water utilities across the United States. The rate of the continued trend is dependent on the pace of fixture replacement within the MAWC service footprint as well as the broadening acceptance of a conservation ethic through raised customer and business awareness programs, government conservation policy, and similar behavior modification related programs.

As I will explain further below, many of the homes in Missouri are older housing stock, built prior to 2000. These homes were constructed with toilets, washing machines, and dishwashers that are more water-intensive than newer fixtures and appliances now on the market. As turnover of household fixtures and appliances continues to occur over time, Residential usage will continue to decline accordingly. The regulations mandating water efficient washing machines and dishwashers also are relatively new. Given the life expectancy of appliances, it is likely that the replacement of existing appliances, and the corresponding reduction in water used, will continue to occur over time for the indefinite future.

According to an American Water Works Association ("AWWA") Journal article dated February 2012, technology is now available for newer, more water efficient products that further improve on Energy Policy Act levels, and there is now a growing movement to codify these more stringent specifications. The 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 (2011) support uniform implementation of increased water efficiency standards.[3] 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."[4]

As I stated, the regulations mandating water efficient washing machines and dishwashers also are relatively new. Based solely on the life expectancy of appliances, it is likely that the replacement of existing appliances, and the corresponding reduction in water used, will continue to occur for at least the next 11 years or more (from compliance date for appliance manufactures to meet the new flow rates) if all appliances were replaced in their average life cycles.[5]

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

---

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

[4] 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

[5] 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.

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 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.[6]

These higher-efficiency dishwasher and washing machine standards include tax incentives for consumer purchases that became effective in January 2013 and January 2015, respectively.

Q. Have you researched and identified recent water conservation studies with similar conclusions to those cited in your testimony?

A. Yes, I have. The following studies reach similar conclusions as those cited above: Residential End Uses of Water, Version 2 by the Water Research Foundation dated April 2016; Study: Efficient Fixtures Cut US Indoor Water Use by Circle of Blue dated April 25, 2016; and Why Overall Water Use Is Declining in US Despite Population Growth, Environmental Leader dated January 2, 2019. The results of these contemporary studies affirm and support the original findings I have cited in detail. That is, there is a water industry-wide recognized trend of Residential water

---

[6] 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.

usage reductions due to conservation effects from fixture/appliance regulation, consumer conservation behavior and the age of housing stock which influences the installation of water conserving devices throughout the United States. Further, these studies affirm that these trends are expected to continue into the foreseeable future. These contemporary studies provide further evidence illustrating a trend of Residential customer water usage reductions going forward.

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 usage impact of the WaterSense/Energy Star usage specifications for a family of four. The results of that analysis are depicted on Schedule GPR-4. 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 WaterSense/Energy Star usage specifications in effect since 2010/2011, respectively, by the number of users in a proto-typical household (4 in this example), annualized. I then summed the various usage reductions for the sample four users across all fixtures that could be replaced to get an average total usage reduction. My analysis indicates that a set of four random users would see a reduction of approximately 48,178 annual gallons over the course of a year, due to fixture and appliance replacement at the Water Sense/Energy Star specification levels.

The estimated reduction in usage analysis of the sample household of four allows for the estimation of the length of time 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 Residential usage decline for MAWC of 662 million gallons by the estimated annual usage decline for the sample household of four of 48,178 gallons, reveals that 13,752 Residential customers, or 3.19% of the 2019 year-ending average of 431,440 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 3.19% of Residential customers needed to account for the annual usage decline reveals a theoretical term of 31 years to fully convert the installed fixture base to the Water Sense/Energy Star usage specifications, all other factors remaining equal. As noted earlier in my testimony, reductions in Residential usage per customer have steadily occurred on an annual basis beginning approximately 2005 indicating based on the analysis above that an approximate additional 16 years where water efficiency technology and regulations are expected to continue to drive water use downward.

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 2018 American Housing Survey, 82.5% of the homes in the State of Missouri were built prior to the year 2000 (68% of homes prior to 1990)[7]. Further, making the same housing stock comparison for the St. Louis SMSA where approximately two-thirds of the MAWC Residential customers reside, we find that 84.3% of homes were built prior to the year 2000 and 71.8% prior to the year 1990. These data are detailed in Schedule GPR-5 and summarized in Table GPR-8 below. Both the state-wide level and St. Louis County data illustrate that approximately 70% 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-8
Missouri American Water Company
Housing Stock Vintage
State of Missouri

Year Structure Built	State of Missouri Units	State of Missouri % Total	St. Louis SMSA Units	St. Louis SMSA % Total
Built 2014 or later	78,674	2.80%	30,614	2.43%
Built 2010 to 2013	67,815	2.42%	26,324	2.09%
Built 2000 to 2009	344,984	12.29%	141,305	11.19%
Built 1990 to 1999	403,269	14.37%	157,260	12.46%
Built 1980 to 1989	337,491	12.03%	140,466	11.13%
Built 1970 to 1979	439,416	15.66%	166,066	13.16%
Built 1960 to 1969	328,081	11.69%	162,781	12.90%
Built 1950 to 1959	276,687	9.86%	159,911	12.67%
Built 1940 to 1949	137,342	4.89%	70,306	5.57%
Built 1939 or earlier	392,537	13.99%	207,303	16.42%
Total housing units	2,806,296	100.00%	1,262,336	100.00%
Percentage Prior to 00		82.49%		84.30%

[7] 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. The historic period in this case is Year Ending 2019. 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, the steady replacement of older fixtures due to remodel or failure as well as new construction will result in many years to achieve complete implementation and saturation of fixtures and appliances consistent with the current efficiency standards. This occurs over a very long period of time as housing stocks are remodeled and appliances and fixtures wear out, break or become obsolete. Further, as explained above in my testimony, the decline in usage for the theoretical four user analysis indicates an approximate 31-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 an ongoing trend of declining Residential usage on the MAWC system for approximately 15 years, leaving another 16 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-6. 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 Table GPR-9 below:

Table GPR-9 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.

Table GPR-9
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%

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 futur e water usage declines?

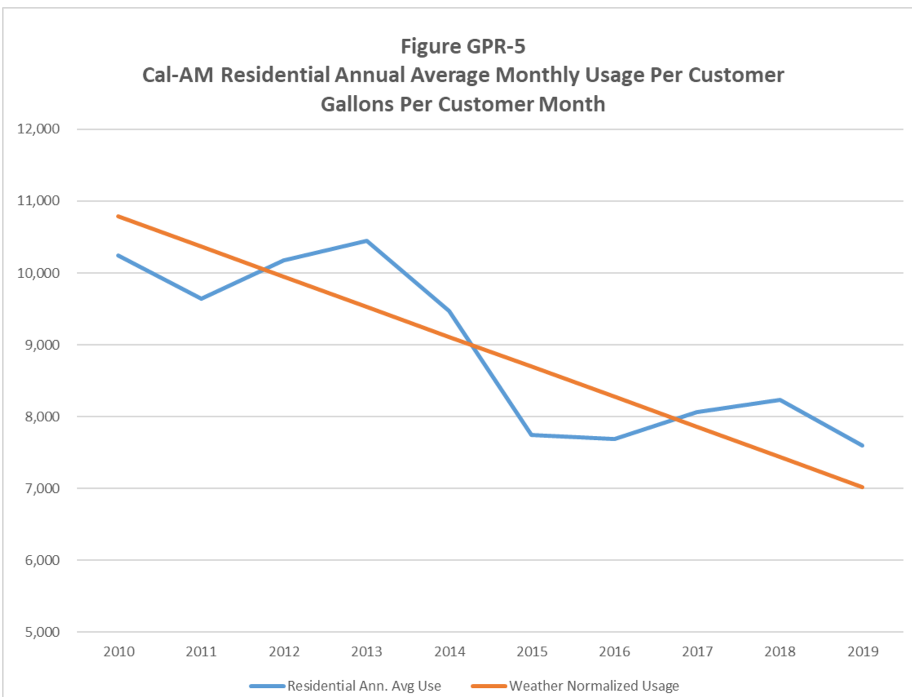
A. The statistical results of the Joplin Tornado analysis, when combined with the results of the theoretical "household of four" user analysis outlined in Schedule GPR-6, offer compelling empirical evidence as to the potential scope and duration of continued reductions in customer water use patterns. 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. Mr. Roach, are there other American Water affiliated companies that have experienced extraordinary reductions in Residential water usage resulting in lasting modifications to customer water consumption behavior?

A. Yes. The trend of California-American Water ("Cal-AM") Residential customer usage since 2013 both during and post removal of drought related state mandated usage restrictions is one instance in particular that must be noted. In summary, in response to state mandatory 25% water reductions established in June 2015, Cal-AM Residential usage per customer fell 26% from 2013 annual average levels to 2015 annual average levels. Following removal of the state mandated 25% water usage reductions on April 1, 2017, Cal-AM Residential usage per customer remains 27% lower than the annual average 2013 levels. Hence, 32 months following removal of state mandated water usage reductions, Cal-AM's Residential customers have incorporated water conservation behavior such that their water usage remains 27% lower than it was in 2013 at the end of 2019. This reflects a real and significant and apparently permanent incorporation of water conservation behavior by Cal-AM customers since 2013. This trend is detailed below in Figure GPR-5 and Table GPR-10, below.

Table GPR-10
California American Water
Residential Annual Average Usage Per Customer
Gallons Per Customer Month

Year	Annual Avg. Usage	% of 2013	Reduction From 2013
2013	10,443		
2014	9,468	90.7%	-9.3%
2015	7,751	74.2%	-25.8%
2016	7,685	73.6%	-26.4%
2017	8,070	77.3%	-22.7%
2018	8,237	78.9%	-21.1%
2019	7,596	72.7%	-27.3%



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

A. Typically, households replace appliances and fixtures on a sporadic basis, as they break or become obsolete. As they are installed over time, the replacement appliances and fixtures being more efficient then the originals, result in reductions in usage due to increased efficiency that are spread out over time making it difficult to isolate the impact of any increase in the efficiency of a single appliance or fixture on overall water usage. In contrast, households affected by the Joplin Tornado replaced all of their appliances and fixtures 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 and fixtures, usage on the MAWC system is likely to decline at the rate I have estimated and potentially up to the rate of usage decline in Joplin following the tornado rebuild. On this basis, and in conjunction with the results of the energy star four user analysis (see Schedule GPR-4), I conclude that Residential water use reductions will continue to be significant well into the near future for the MAWC system. Lastly, the steady year-to-year water use decline attributed to federally mandated water using appliance and fixture usage reductions detailed herein notwithstanding, the permanent effect of state mandated water usage restrictions on Cal-AM Residential customers water usage illustrate the potential for significant and dramatic water use reductions in response to state regulated water use restrictions on any of the American Water affiliated systems going forward.

<u>VIII. AUTHORIZED REVENUE AND DECLINING CONSUMPTION</u>

Q. Are there reasons why a water company's actual revenue could deviate

significantly from the level of revenue upon which its rates are based ("Authorized Revenue")?

A. Yes. Water utility revenue forecasts are properly based on normal weather. Weather, however, is seldom normal. Therefore, there is an equal chance that the utility will exceed the forecast due to abnormally warm and dry weather or fall short of the revenue forecast due to cooler and wetter summer weather. Usage per customer results that capture several years of abnormally hot and dry weather will represent usage per customer that simply cannot be achieved in a year of normal weather. In addition, the failure of a forecast to capture the full effect of a trend of reduced usage per customer will result in the adoption of a faulty forecast that improperly captures a usage trend.

This variability in customer usage patterns and weather can have a substantial effect on a water company's actual revenues. Changes in customer usage patterns can reflect seasonal variation in usage as well long term water use trends (for example as a result of sustained water efficiency and conservation efforts). This is true for MAWC as well as other water utilities across the country. Although the effect of weather can be random and work either in favor of or against the Company from a financial standpoint, the declining use per customer is another factor, altogether, because customers are using less water every year.

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. Referenced earlier in this testimony, MAWC Schedule GPR-1, page 1 of 1 and summarized in Table GPR-11 below, illustrates that MAWC has collected revenue that is less than the revenue levels used to set revenue requirements in rate cases since 2010 for each post-case year of those proceedings from 2010 to 2019 except for 2012 when sales were driven by the historic drought. More specifically, for the period of 2010 through 2019, MAWC was under its authorized revenue for the period by approximately $52.453 million. Similarly, for that same period, MAWC was under its authorized total water sales by approximately 22.766 billion gallons.

Table GPR-11
Missouri American Water Company
Actual Revenue/Water Sales Compared to Authorized
(2010-2019)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total 2010-2019
MAWC Total Billed Annual Revenue*	222,749,546	240,218,004	274,501,000	261,186,872	266,484,898	264,979,705	283,508,099	285,259,835	314,031,807	318,252,981	2,731,172,747
Total Authorized Revenue**	235,368,605	247,231,384	258,154,279	265,880,783	273,892,338	283,861,950	287,994,720	290,964,127	310,586,678	329,691,126	2,783,625,989
Revenue Recovery to Authorized (Under)/Over	($12,619,059)	($7,013,380)	16,346,721	(4,693,911)	(7,407,439)	(18,882,245)	(4,486,621)	(5,704,292)	$3,445,129	($11,438,145)	($52,453,242)
	-5.36%	-2.84%	6.33%	-1.77%	-2.70%	-6.65%	-1.56%	-1.96%	1.11%	-3.47%	-1.88%
MAWC Total Annual Water Sales (000 Gallons)	60,275,866	60,561,458	64,866,418	58,124,580	56,927,366	55,658,515	55,768,403	58,857,091	58,583,100	52,303,229	581,926,027
Total Authorized Water Sales*	71,286,441	61,618,498	60,559,014	60,272,780	60,272,780	60,272,780	59,647,313	58,968,552	56,671,611	55,122,757	604,692,527
Water Sales to Authorized (Under)/Over	(11,010,575)	(1,057,040)	4,307,404	(2,148,200)	(3,345,414)	(4,614,265)	(3,878,910)	(111,461)	1,911,489	(2,819,528)	(22,766,500)
	-15.45%	-1.72%	7.11%	-3.56%	-5.55%	-7.66%	-6.50%	-0.19%	3.37%	-5.11%	-3.76%

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

The inability of MAWC to collect its authorized revenue over the period of 2010-2019 is linked directly to water usage reductions attributed to the 22.766 billion-gallon short fall in total sales levels set in the MAWC cases over the period of 2010 through 2019[8].

[8] 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.

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

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 LaGrand.

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

A. Yes. Our customers share in various environmental and operational benefits from lower water usage. For example, reduced usage helps maintain source water supplies, lessening diversions from supply sources, 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 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 and Commercial 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. Can declining usage and water conservation activities result in certain avoided capital costs?

A. Yes. Reductions in water usage can avoid 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.

Q. Please summarize why accounting for usage reductions and weather fluctuations into the future Test Year is important for MAWC and its customers.

A. As the data analyzed herein indicate, the Company's revenue is affected by two distinct matters. First, the variability of weather and, second, the trend of declining use per customer. By normalizing for the unpredictability of weather from one period to the next in conjunction with capturing and forecasting the trend of declining use per Residential customer when estimating future Test Years billing determinants, MAWC will be provided a higher probability opportunity to collect its authorized revenue in those future Test Years and is more likely to not be forced to file for base rate relief solely to recover the revenue shortfall due to the residential declining use trend. For all those reasons, accounting for weather variability and declining Residential and Commercial usage in future Test Year data is in the best interest of all stakeholders, the Company, its customers and the State of Missouri.

IX. RSM

Q. Are you aware of the RSM that is supported by Company witnesses John 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.

X. CONCLUSIONS

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 2010 to December 2019, MAWC Residential customers' usage in St. Louis fell -1,563 gpcy or approximately -2.04% per year. Non-St. Louis Residential usage fell -1460 gpcy or approximately -2.68% while Commercial customers' usage fell -1,780 gpcy or approximately -0.36% per year. Second, there is potential for this trend to continue for up to 16 more years on the MAWC system. Third, housing stock data indicates that over 82% 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 consistently achieved Commission-authorized revenue levels in some time, with an accumulated under-recovery of $52 million over the period 2010-2019. 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 2010-2019 is impacted substantially by water usage reductions which have attributed to the 22.766 billion-gallon short fall in total sales levels set in the MAWC cases over the period of 2010 through 2019. 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

Appendix A

Professional Experience of Gregory P. Roach

I have over 25 years of experience working in the electric, gas and water utility sectors as both a consultant and utility employee, beginning with Public Service Indiana (now Duke Energy) in January 1980, where my responsibilities were focused on 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 of R. W. Beck and Associates ("Beck") (now part of Science Applications International Corporation, "SAIC"). I received numerous promotions through my career with Beck to the eventual position of Principal Economist. During my career at Beck, I was responsible for the management of all rates/regulatory, load forecasting and financing feasibility client engagements managed by the Indianapolis office. As such, I delivered testimony on behalf of agency, municipal and co-op clients throughout the United States related to cost of service, rate design, load forecasting, system planning, electric and gas production plant economic feasibility, revenue requirement pro-forma adjustments, production cost optimization and cost of capital to state regulatory commissions and the Federal Energy Regulatory Commission.

In May 1991, I took the position of Principal Economist with the regulatory management consulting firm of SVBK Consulting Group ("SVBK") (now part of Alliant Energy Integrated Services, "Alliant"). In that position, I was responsible for all consulting engagements executed from the Indianapolis regional office on behalf of SVBK's national utility clients. In addition to the regulatory matters that I testified to while at SVBK, I offered testimony related to merger & acquisition cost reductions/synergies, large power pool generation and transmission dispatch strategies, power pool generation/transmission pricing schemes, price elasticity sales adjustments and retail rate impact of specific power/transmission pooling cost minimization arrangements and payments.

In July 1993, I became owner and president of a retail operations holding company with three franchise store outlets. In that position, I was responsible for all management, operation, sales and financial functions of the firm.

In November 1998, I sold the retail holding company to begin operations of the Roach Consulting Group, Ltd as Principal Consultant. In that position I advised industrial and utility clients related to business intelligence systems, enterprise/manufacturing resource planning systems, customer information systems as well as general accounting systems. I also appeared as an expert witness providing testimony related to economic and punitive damages in personal injury and wrongful death legal proceedings. In July 2011, I joined the Service Company as Manager of Rates and Regulation, supporting Indiana-American and Michigan-American Water Company. In August 2014, I accepted the position of Manager of Revenue Analytics with the Service Company. In November 2017, I was promoted to the position of Senior Manager of Revenue Analytics with the Service Company.

MISSOURI-AMERICAN WATER COMPANY

Appendix B
Glossary of Technical and Statistical Terms

Autocorrelation - Autocorrelation is a characteristic of data in which the correlation between the values of the same variables is based on related objects. Informally, it is the similarity between observations as a function of the time lag between them. In regression modeling, the estimate errors follow a pattern, showing that something is wrong with the regression model. ... If this assumption is violated and the error term observations are correlated, autocorrelation is present.

Cooling Degree Day – ("CDD") A cooling degree day (CDD) is a measurement designed to quantify the demand for energy needed to cool a building. It is the number of degrees that a day's average temperature is above 65° Fahrenheit (18° Celsius), which is the temperature above which buildings need to be cooled. Annual CDD would be the sum of all CDD occurring in a calendar year.

Durbin-Watson Statistic - The Durbin Watson statistic is a number that tests for autocorrelation in the residuals from a statistical regression analysis. The Durbin-Watson statistic is always between 0 and 4. A value of 2 means that there is no autocorrelation in the sample.

F-Statistic - The F value is the ratio of the mean regression sum of squares divided by the mean error sum of squares. Its value will range from zero to an arbitrarily large number. The value of Probability (F) is the probability that the null hypothesis for the full model is true (i.e., that all of the regression coefficients are zero). The higher the F value, the greatest confidence that the null hypothesis can be rejected.

Heating Degree Day – ("HDD") A heating degree day (HDD) is a measurement designed to quantify the demand for energy needed to heat a building. It is the number of degrees that a day's average temperature is below 65 ° Fahrenheit (18 ° Celsius), which is the temperature below which buildings need to be heated. Annual HDD would be the sum of all HDD occurring in a calendar year.

R-Squared - In statistics, the coefficient of determination, denoted R2 or r2 and pronounced "R squared", is the proportion of the variance in the dependent variable that is predictable from the independent variable(s).

T- Statistic - The t statistic is the coefficient divided by its standard error. The standard error is an estimate of the standard deviation of the coefficient, the amount it varies across cases. It can be thought of as a measure of the precision with which the regression coefficient is measured. The higher the t statistic, the greater probability is that the regression coefficient has been estimated precisely

Missouri American Water Company
Actual Revenue/Water Sales Compared to Authorized
(2010-2019)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total 2010-2019
MAWC Total Billed Annual Revenue*	222,749,546	240,218,004	274,501,000	261,186,872	266,484,898	264,979,705	283,508,099	285,259,835	314,031,807	318,252,981	2,731,172,747
Total Authorized Revenue**	235,368,605	247,231,384	258,154,279	265,880,783	273,892,338	283,861,950	287,994,720	290,964,127	310,586,678	329,691,126	2,783,625,989
Revenue Recovery to Authorized (Under)/Over	($12,619,059)	($7,013,380)	16,346,721	(4,693,911)	(7,407,439)	(18,882,245)	(4,486,621)	(5,704,292)	$3,445,129	($11,438,145)	($52,453,242)
	-5.36%	-2.84%	6.33%	-1.77%	-2.70%	-6.65%	-1.56%	-1.96%	1.11%	-3.47%	-1.88%
MAWC Total Annual Water Sales (000 Gallons)	60,275,866	60,561,458	64,866,418	58,124,580	56,927,366	55,658,515	55,768,403	58,857,091	58,583,100	52,303,229	581,926,027
Total Authorized Water Sales*	71,286,441	61,618,498	60,559,014	60,272,780	60,272,780	60,272,780	59,647,313	58,968,552	56,671,611	55,122,757	604,692,527
Water Sales to Authorized (Under)/Over	(11,010,575)	(1,057,040)	4,307,404	(2,148,200)	(3,345,414)	(4,614,265)	(3,878,910)	(111,461)	1,911,489	(2,819,528)	(22,766,500)
	-15.45%	-1.72%	7.11%	-3.56%	-5.55%	-7.66%	-6.50%	-0.19%	3.37%	-5.11%	-3.76%

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

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

State	Annual Decline (GPCY) 10-year (2010-2019)	Rate of Decline (%) 10-year (2010-2019)
Illinois	-1,311	-2.7%
Indiana	-884	-1.8%
Iowa	-894	-2.0%
Kentucky	-761	-1.6%
Maryland	-797	-1.9%
Missouri	-1,580	-2.2%
New Jersey*	-1,203	-1.8%
Pennsylvania	-893	-2.2%
Tennessee	-613	-1.3%
Virginia	-656	-1.2%
West Virginia	-585	-1.6%
Weighted Average	-1,079	-2.0%

Notes:

California & Michigan used three year average per customer

New York is aligned to Revenue Stabilization Mechanism

New Jersey based on 10 years ending June, 2019

Weighted average based on 2019 average residential customer connections

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.

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005
EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute
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

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005
EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute
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

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 *(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

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005
EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute
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

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 *(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	

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005

EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute

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 *(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	

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005
EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute
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

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 *(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.

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005
EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute
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 *(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.

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005
EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute
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

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)

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

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005

EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute

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)

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

DOE: Department of Energy
EPA: Environmental Protection Agency
EPAct 1992: Energy Policy Act of 1992
EPAct 2005: Energy Policy Act of 2005
EF: energy factor
ft^3: cubic feet
gal: gallons
gpm: gallons per minute
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

Missouri American Water Co.
Reasonableness of Residential Consumption Decline Calculation
1,536 Gallons Per Customer Per Year

Illustrating: Replacement of Clothes Washing, Toilet, Fixtures and Dishwashers Based Typical Customer

Washer:			
Old: Usage per load - gallons	41	Average Use Reduction Per Load (g/load)	24.20
New: Usage per load - gallons	17	Average Loads per week	5
Usage decline	24	Savings per week	121
		Savings per year - Gallons	**6,292**
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 Reduction Per Load (g/load)	9.75
New: Gallons/cycle	4	Average Loads per week	4
Usage decline	10	Savings per week	39
		Savings per year - Gallons	**2,028**

Total Impact of All Appliances:	
Average Number of Residential Customers (2019)	**431,440**
Forecasted Decline in Usage Per Residential Customer (gpcy)	**1,536**
Total Estimated Annual Residential Decrease in Usage	**662,539,598**
Divided by: Total Estimate Water Usage Savings For Typical Customer (Gallons)	**48,178**
Equals: Implied Number of Toilet, Clothes Washer, Fixture and Dish Washer Changes	
Necessary For Residential Annual Usage Reduction (Total # of Custs)	**13,752**
Maximum number of Resdiential customers per annum contributing to decline	**3.19%**
Implied Years For Complete Impact of Appliance Replacement @ 2007 Standards	**31**

*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.

United States Census Bureau

Note: This is a modified view of the original table produced by the U.S. Census Bureau.

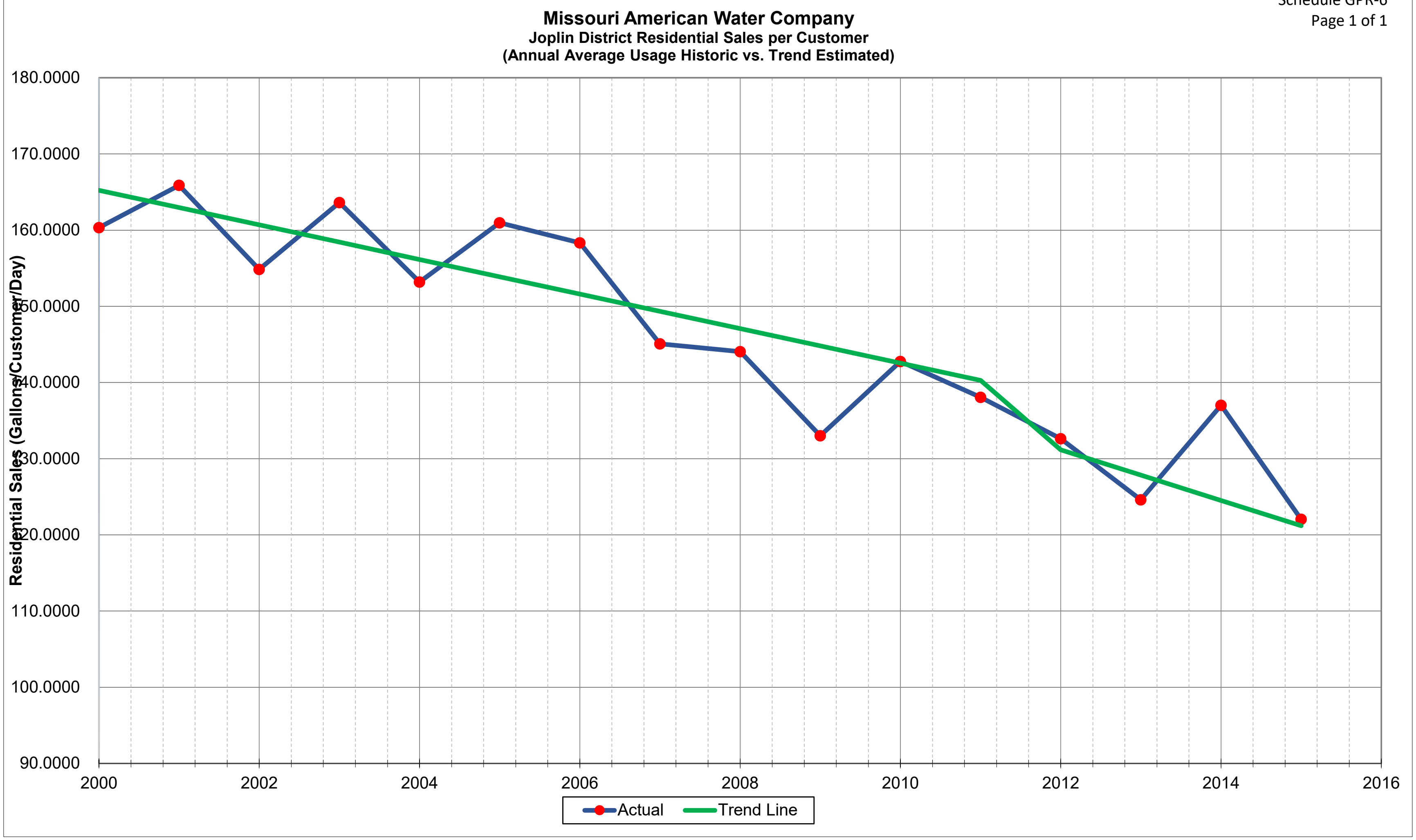
Note: This download or printed version may have missing information from the original table.

SELECTED HOUSING CHARACTERISTICS

Survey/Program:
American Community Survey
Year:
2018
Estimates:
1-Year
Table ID:
DP04

	Missouri				St. Louis, MO-IL Metro Area			
	Estimate	Margin of Error	Percent	Percent Margin of Error	Estimate	Margin of Error	Percent	Percent Margin of Error
HOUSING OCCUPANCY								
Total housing units	2,806,296	+/-623	2,806,296	(X)	1,262,336	+/-1,908	1,262,336	(X)
Occupied housing units	2,434,806	+/-10,407	86.8%	+/-0.4	1,137,478	+/-6,265	90.1%	+/-0.5
Vacant housing units	371,490	+/-10,483	13.2%	+/-0.4	124,858	+/-6,451	9.9%	+/-0.5
Homeowner vacancy rate	1.7	+/-0.2	(X)	(X)	2.0	+/-0.3	(X)	(X)
Rental vacancy rate	6.6	+/-0.5	(X)	(X)	6.7	+/-0.8	(X)	(X)
UNITS IN STRUCTURE								
Total housing units	2,806,296	+/-623	2,806,296	(X)	1,262,336	+/-1,908	1,262,336	(X)
1-unit, detached	1,958,515	+/-10,999	69.8%	+/-0.4	880,425	+/-7,600	69.7%	+/-0.6
1-unit, attached	101,246	+/-4,789	3.6%	+/-0.2	49,176	+/-3,543	3.9%	+/-0.3
2 units	91,418	+/-4,950	3.3%	+/-0.2	51,927	+/-3,803	4.1%	+/-0.3
3 or 4 units	129,205	+/-6,241	4.6%	+/-0.2	65,441	+/-4,498	5.2%	+/-0.4
5 to 9 units	113,178	+/-6,380	4.0%	+/-0.2	57,673	+/-4,695	4.6%	+/-0.4
10 to 19 units	100,929	+/-5,801	3.6%	+/-0.2	46,187	+/-4,217	3.7%	+/-0.3
20 or more units	132,538	+/-5,685	4.7%	+/-0.2	68,710	+/-4,003	5.4%	+/-0.3
Mobile home	176,697	+/-5,633	6.3%	+/-0.2	42,446	+/-2,699	3.4%	+/-0.2
Boat, RV, van, etc.	2,570	+/-759	0.1%	+/-0.1	351	+/-282	0.0%	+/-0.1
YEAR STRUCTURE BUILT								
Total housing units	2,806,296	+/-623	2,806,296	(X)	1,262,336	+/-1,908	1,262,336	(X)
Built 2014 or later	78,674	+/-4,821	2.8%	+/-0.2	30,614	+/-3,128	2.4%	+/-0.2
Built 2010 to 2013	67,815	+/-4,572	2.4%	+/-0.2	26,324	+/-2,515	2.1%	+/-0.2
Built 2000 to 2009	344,984	+/-9,288	12.3%	+/-0.3	141,305	+/-4,824	11.2%	+/-0.4
Built 1990 to 1999	403,269	+/-8,969	14.4%	+/-0.3	157,260	+/-5,533	12.5%	+/-0.4
Built 1980 to 1989	337,491	+/-7,290	12.0%	+/-0.3	140,466	+/-5,563	11.1%	+/-0.4
Built 1970 to 1979	439,416	+/-9,656	15.7%	+/-0.3	166,066	+/-6,177	13.2%	+/-0.5
Built 1960 to 1969	328,081	+/-9,092	11.7%	+/-0.3	162,781	+/-6,476	12.9%	+/-0.5
Built 1950 to 1959	276,687	+/-8,002	9.9%	+/-0.3	159,911	+/-5,479	12.7%	+/-0.4
Built 1940 to 1949	137,342	+/-5,427	4.9%	+/-0.2	70,306	+/-3,720	5.6%	+/-0.3
Built 1939 or earlier	392,537	+/-8,522	14.0%	+/-0.3	207,303	+/-5,799	16.4%	+/-0.5
ROOMS								
Total housing units	2,806,296	+/-623	2,806,296	(X)	1,262,336	+/-1,908	1,262,336	(X)
1 room	51,997	+/-4,421	1.9%	+/-0.2	18,170	+/-2,855	1.4%	+/-0.2
2 rooms	58,999	+/-3,972	2.1%	+/-0.1	20,067	+/-2,363	1.6%	+/-0.2
3 rooms	201,824	+/-7,765	7.2%	+/-0.3	87,916	+/-4,977	7.0%	+/-0.4
4 rooms	427,123	+/-10,495	15.2%	+/-0.4	199,781	+/-6,555	15.8%	+/-0.5
5 rooms	604,324	+/-11,966	21.5%	+/-0.4	260,550	+/-7,652	20.6%	+/-0.6
6 rooms	521,299	+/-10,330	18.6%	+/-0.4	228,275	+/-6,704	18.1%	+/-0.5
7 rooms	343,424	+/-7,117	12.2%	+/-0.3	156,488	+/-5,555	12.4%	+/-0.4
8 rooms	256,037	+/-7,262	9.1%	+/-0.3	123,393	+/-5,070	9.8%	+/-0.4
9 rooms or more	341,269	+/-7,483	12.2%	+/-0.3	167,696	+/-5,406	13.3%	+/-0.4
Median rooms	5.6	+/-0.1	(X)	(X)	5.7	+/-0.1	(X)	(X)
BEDROOMS								
Total housing units	2,806,296	+/-623	2,806,296	(X)	1,262,336	+/-1,908	1,262,336	(X)
No bedroom	55,785	+/-4,441	2.0%	+/-0.2	20,079	+/-2,872	1.6%	+/-0.2
1 bedroom	260,688	+/-7,641	9.3%	+/-0.3	129,321	+/-5,581	10.2%	+/-0.4
2 bedrooms	759,214	+/-13,758	27.1%	+/-0.5	342,635	+/-8,869	27.1%	+/-0.7
3 bedrooms	1,178,406	+/-12,960	42.0%	+/-0.5	500,060	+/-8,286	39.6%	+/-0.7
4 bedrooms	435,781	+/-10,337	15.5%	+/-0.4	220,699	+/-6,202	17.5%	+/-0.5
5 or more bedrooms	116,422	+/-5,493	4.1%	+/-0.2	49,542	+/-3,185	3.9%	+/-0.3
HOUSING TENURE								
Occupied housing units	2,434,806	+/-10,407	2,434,806	(X)	1,137,478	+/-6,265	1,137,478	(X)

Owner-occupied	1,625,854	+/-12,819	66.8%	+/-0.4	777,590	+/-8,581	68.4%	+/-0.7
Renter-occupied	808,952	+/-10,736	33.2%	+/-0.4	359,888	+/-8,773	31.6%	+/-0.7
Average household size of	2.56	+/-0.01	(X)	(X)	2.54	+/-0.02	(X)	(X)
Average household size of	2.22	+/-0.03	(X)	(X)	2.14	+/-0.04	(X)	(X)
YEAR HOUSEHOLDER MOVED								
Occupied housing units	2,434,806	+/-10,407	2,434,806	(X)	1,137,478	+/-6,265	1,137,478	(X)
Moved in 2017 or later	458,434	+/-9,200	18.8%	+/-0.4	206,358	+/-7,081	18.1%	+/-0.6
Moved in 2015 to 2016	405,328	+/-7,718	16.6%	+/-0.3	175,295	+/-6,648	15.4%	+/-0.6
Moved in 2010 to 2014	442,530	+/-9,309	18.2%	+/-0.4	202,269	+/-7,138	17.8%	+/-0.6
Moved in 2000 to 2009	544,475	+/-9,517	22.4%	+/-0.4	254,868	+/-7,014	22.4%	+/-0.6
Moved in 1990 to 1999	292,547	+/-5,967	12.0%	+/-0.2	146,387	+/-4,784	12.9%	+/-0.4
Moved in 1989 and earlier	291,492	+/-6,071	12.0%	+/-0.2	152,301	+/-5,096	13.4%	+/-0.4
VEHICLES AVAILABLE								
Occupied housing units	2,434,806	+/-10,407	2,434,806	(X)	1,137,478	+/-6,265	1,137,478	(X)
No vehicles available	167,815	+/-6,577	6.9%	+/-0.3	83,571	+/-4,766	7.3%	+/-0.4
1 vehicle available	787,674	+/-13,017	32.4%	+/-0.5	378,641	+/-8,988	33.3%	+/-0.8
2 vehicles available	918,830	+/-13,640	37.7%	+/-0.5	436,372	+/-10,015	38.4%	+/-0.9
3 or more vehicles availabl	560,487	+/-9,731	23.0%	+/-0.4	238,894	+/-6,391	21.0%	+/-0.5
HOUSE HEATING FUEL								


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