Exhibit No.:	
Issues:	Residential and Commercial Customer Usage
Witness:	Gregory P. Roach
Exhibit Type:	Surrebuttal
Sponsoring Party:	Missouri-American Water Company
Case No.:	WR-2020-0344
Date:	February 9, 2021

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO. WR-2020-0344

SURREBUTTAL 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 Manager 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

February 9, 2021
Dated

SURREBUTTAL TESTIMONY
GREGORY P. ROACH
MISSOURI-AMERICAN WATER COMPANY
CASE NO. WR-2020-0344

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SURREBUTTAL 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, IN 46143.

Q. Are you the same Gregory P. Roach who previously submitted direct testimony and rebuttal testimony in this proceeding on behalf of Missouri-American Water Company ("Missouri-American", the "Company", or "MAWC")?

A. Yes.

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

A. The purpose of my Surrebuttal Testimony is to address issues raised in the rebuttal testimony of Missouri Public Service Commission Staff ("Staff") witness Jarrod J. Robertson and Office of Public Counsel ("OPC") witness Lena M. Mantle regarding:

- Historic Test Year Adjustments versus Forecasts
- Measuring Predictive Accuracy
- Weather Influence on Historic Usage vs. "Trend"
- Weather Normalization via Regression Analysis
- Regression Data, Observations and Residuals

II. SUMMARY OF CONCLUSIONS

Q. Please outline your positions and recommendations for the issues you are addressing in your Surrebuttal Testimony:

A. My positions and recommendations are summarized as follows:

1. The proposed MAWC regression-based weather normalized test year usage adjustment is based on a historical trend and is not a "forecast".
2. The predictive accuracy of the MAWC regression-based weather normalized usage adjustment is significantly superior to any of the averaging techniques proposed in this case based on error of estimation of the various techniques.
3. Each of the various averaging techniques proposed in this case are unable to capture any kind of trend due to overwhelming influence of weather perturbations on the historic data.
4. The MAWC regression analysis is the only technique proposed in this case capable of accounting for the influence of weather on usage and identify the underlying structural usage decline.

III. HISTORIC TEST YEAR ADJUSTMENTS VERSUS FORECASTS

Q. Staff witness Robertson does a detailed analysis of what he claims are MAWC usage forecasts. How do you respond?

A. Staff witness Robertson makes a twofold error where he: 1) presents the MAWC proposed historic test year adjustment for structural residential and commercial usage decline as a "forecast"; and 2) he fails to properly account for the impact of the weather variable in the years where his comparative analysis of Staff's averaging methods is compared to the results of MAWC's regression models. Mr. Robertson's analysis misses the point that the MAWC proposed test year adjustment is not a forecast of test year usage.

Q. Please detail how Mr. Robertson has obfuscated the nature of the MAWC proposed test year residential and commercial usage adjustment as a "forecast"?

A. The MAWC proposed test year usage adjustment for residential and commercial structural decline is not and was not meant to be used as a "forecast". Rather, the MAWC proposed usage adjustments relies on certain statistical techniques to estimate the relationship of weather on residential and commercial usage over the period 2010-2019 in order to remove the influence of weather over that time frame to reveal the weather normalized trend of usage. Removing the influence of weather reveals the relationship of residential and commercial usage to time, that is, the trend of weather normalized usage. The MAWC proposed residential and commercial test year usage adjustments are simply the regression estimated year to year historic trend of weather normalized usage removing the influence year to year weather fluctuations. It is not a "forecast" of some future usage level for either residential or commercial customers. Rather, it is historic actual test year usage adjusted for the implicit structural usage decline of residential and commercial customers over the period of 2010-2019.

Q. In summary, MAWC is proposing an adjustment to test year usage for historic actual residential and commercial structural usage trends that are net of weather impacts over the period 2010-2019. Isn't that correct?

A. Yes, the Company has identified a structural usage trend based on actual historic usage data, net of weather impacts, over the period of 2010-2019 for the residential and commercial customer groups and applied an adjustment to test year usage for the continuation of this long-term historic trend. As such, the MAWC adjustment is not a forecast of test year usage but rather an extension of an existing, fixed, known and measurable historic trend for the residential and commercial customer groups.

IV. MEASURING PREDICTIVE ACCURACY

Q. Mr. Roach, Staff Witness Robertson is his rebuttal testimony claims that the MAWC regression-based analysis is not an accurate method of weather normalization or estimating a test year usage adjustment for structural usage reductions. Is MAWC's regression-based approach more or less reliable than Staff's averaging method employed in this case?

A. As I will demonstrate and support below, the MAWC regression-based approach is more reliable than Staff's averaging method for estimating test year revenue, usage and billing determinants.

Q. Mr. Robertson beginning at page 13, line 21 through page 15 line 16 of his rebuttal testimony undertakes an analysis and comparison of what he has defined as "MAWC Est. Normalized Usage" indicating that such time series represents the results of MAWC analysis and that it results in large forecast errors limiting its analytical value. How do you respond?

A. Mr. Robertson has misrepresented both the MAWC weather normalization process and has chosen to apply a diagnostic time series the Company employs to estimate total weather-related usage over the period 2010-2019. In so doing, Mr. Robertson has failed to accurately report the result of the Company's weather normalization process of annual historic residential and commercial customer usage over the period 2010-2019. I will detail this misrepresentation and illustrate the Company's weather normalization process in greater detail below.

Q. How would you analytically measure the predictive error of the MAWC regression analysis used to estimate both weather normalized UPC and structural usage reductions over the period of 2010-2019?

A. The predictive error of the regression analysis developed by MAWC to simulate the response of UPC to weather and isolate the structural conservation decline is the difference on an annual basis of the actual observed usage per customer ("UPC") versus the predicted value of the regression using the historic values of the independent variables for each time period, i.e., time, cooling degree days and precipitation. That analysis is summarized in Table GPR-1SR for St. Louis residential customers and Table GPR-2SR for non-St Louis residential customers (pages 18 and 19, respectively herein). Focusing specifically on Table GPR-1SR, Column I presents the results of that analysis and indicates that the sum of the errors of the ten time periods included in the simulation was 0. Further, in any particular year, the error of the regression model in absolute percentage terms was between 0.3% and 3.8%. Graphically, this is illustrated in Figure GPR-1SR (and Figure GPR-2SR) as the difference between the green actual UPC series as compared to blue predicted UPC. Generally, the two-time series, actual UPC and the predicted UPC, move in the same direction and are tightly bound. In summary, when you compare the predicted value of the regression model to the actual value of UPC in each time period, the absolute error of the regression over the 10-year period is 0 gallons per customer ("gpc").

Q. How do you explain your analytical results of the predictive error of the MAWC regression model versus the substantially greater "forecast error" that Mr. Robertson reported to have identified on page 14 at line 3 of his rebuttal testimony?

A. Mr. Robertson's analysis, which claims to measure the predictive error of the MAWC regression "forecast", is a comparison of apples to oranges. Instead of measuring the predictive error of the MAWC regression over the period 2013-2020, he measures instead the estimated indexed weather influenced usage for each of the periods analyzed to the average weather over the period of 2010-2019. In essence, as opposed to measuring "forecast error", Mr. Robertson's analysis illustrates the weather influenced usage (indexed to the 2010-2019 average) that I report in column G of Table GPR-1SR. Specifically, Mr. Robertson's analysis fails to measure the error of the regression (or a forecast) as he has chosen to employ the average decade-long value for each weather variable in each period analyzed as opposed to using each discrete annual value of the weather variables as illustrated in column I of Table GPR-1SR or Table GPR-2SR, which should be employed to accurately measure the predictive error of the regression. Hence Mr. Robertson's analysis does not measure either a forecast or regression error, but rather is an estimate of the weather influenced usage indexed to the 2010-2019 average (column G of Table GPR-1SR). Such estimate of weather influenced usage was employed in the MAWC analysis to isolate weather effects over the 2010-2019 time period, allowing MAWC to identify and estimate the annual average reduction in customer usage associated with structural conservation effects serving as the basis of the test year usage adjustment. Such weather normalization technique is not and was never meant to be a "forecast" of either prior or future usage as Mr. Robertson implies with his analysis. It is simply a tool used to isolated weather influenced usage based on a decadal average weather value.

Q. So, in summary Mr. Robertson is not measuring "forecast error" of the MAWC regression model over the period 20201-2019?

A. No, Mr. Robertson is measuring neither "forecast error" nor error of the regression with the analysis presented on Page 13, Line 21 through Page 15, Line 16 of his rebuttal testimony. His analysis fails to employ the appropriate values of the weather variables in each time period he analyzed for the MAWC regression analysis results and hence his comparison to Staff's average technique is flawed and biased.

Q. Mr. Roach how should Mr. Robertson's table and chart at Line 3 of Page 14 of his rebuttal testimony be corrected?

A. Mr. Robertson's table and figure at Line 3 of Page 14 should be corrected to include the regression estimated usage for each time period based on actual weather, which is reported in Column H of Table GPR-1SR (and Table GPR-2SR) and compared to actual usage graphically in Figure GPR-1SR (and Figure GPR-2SR). With this modification, the MAWC regression's estimates of usage produces significantly less error than the Staff's averaging approach.

Q. Mr. Roach, how does the MAWC error of the regression compare to the Staff averaging method predictive results as reported by Mr. Robertson in his rebuttal testimony?

A. Mr. Robertson's rebuttal analysis provides the data necessary for a comparison of the Staff's usage averaging technique error to the MAWC error of the regression. Presented in Table GPR-3SR (page 20 herein) is replication of the percentage error by period of the Staff's averaging method as reported by Mr. Robertson from Page 11, Line 11 through Page 12, Line 12. In summary of that data, Staff's averaging method for tariff district 1 usage for the period July 2012 through June 2020 had a cumulative percentage error of -25.9%, an average error of -3.2% with a largest absolute variance of 9.6%. Reviewing Table GPR-2SR for the tariff district 2 customer usage results in a cumulative error of -3.7%, an average error of -0.5% with a largest absolute variance of -6.6%. For comparison, as reported in Table GPR-2SR, the MAWC regression analysis results is 0% cumulative error, 0% average error and absolute variance of 2.5%.

Q. Mr. Roach what does your review of the relative predictive error of the Staff's averaging method versus the error of the MAWC proposed regression indicate?

A. Based on Staff's analysis of its averaging technique over prior periods versus the error of the MAWC proposed regression analysis over prior periods, the MAWC model is significantly more accurate with 0% cumulative and average error in conjunction with an absolute variance for any particular estimate that is approximately 1/3 the magnitude of the

Staff's averaging approach. As it applies to predictive capability, the Staff's approach results in far more error of the estimate as compared to the MAWC regression-based analysis. Thus, the Staff averaging method is significantly less reliable for estimating test year revenue, usage or billing determinants as compared to the MAWC regression-based approach.

V. WEATHER INFLUENCES ON HISTORIC USAGE VERSUS "TRENDS"

Q. Mr. Roach, prior to the COVID-19 pandemic, what is the single largest factor in determining residential and commercial customer water usage in any specific period of time?

A. Generally, beginning sometime in the month of May an extending through the month of October, the single largest determinant of residential and commercial water usage is weather. In periods that are either warm or dry, customers will consume relatively more water. In periods that are cooler and wet, these same consumers will consume relatively less water.

Q. Mr. Roach, what did Staff Witness Robertson observe about water consumption variability?

A. Mr. Robertson at Page 13, Line 4 of his testimony observes "While a trend, no matter the level, may exist, it does not mean the trend will be without fluctuations".

Q. Mr. Roach what is the most likely cause of the variability that Staff Witness Robertson observed about water consumption variability?

A. The various fluctuations of water usage from one period to the next are most likely due to variability of weather conditions influencing the levels of residential and commercial customer water usage over time.

Q. OPC Witness Lena Mantle at Page 12, Line 3 through Page 13, Line 2, infers "Nothing in the data over the five most recent years indicates a precipitous decline in usage for MAWC customers." How do you respond?

A. As I reported in my Rebuttal Testimony in Table GPR-2R (page 5) and Table GPR-3R (page 7), the period chosen by the OPC and Staff for purposes of estimating test year residential and commercial customer usage, sales, revenues and billing determinants is considerably influenced by the impact of lower precipitation and higher temperatures over the period leading to higher water usage per customer (Roach RT. page 5, Table GPR-2R). Specifically, the data that Ms. Mantle reports in her figures on Page 12, Line 1 of her rebuttal testimony offer no clear indication of the trend of water usage by MAWC residential and commercial customers due to a singular factor – weather influence. Without normalization of actual usage data for varying weather conditions, no clear trend can be established for either the MAWC residential or commercial customers.

Q. Mr. Roach, did either Staff, OPC or MIEC use any type of weather normalization technique when estimating test year revenues, sales, usage or billing determinants?

A. No, as delineated throughout my Rebuttal Testimony, each of these parties rely on various term length water usage averages influenced by the specific weather conditions during those historic periods. By ignoring the influence of weather on the historic data they rely on, or performing weather normalizing to identify a non-weather influenced trend of water usage, each party presumes that the weather conditions influencing average usage will be repeated during the test year. The probability of that presumption being accurate for any particular period of time is extremely limited, which when using a period of time where usage is demonstrably influenced by either warmer or dryer weather conditions will result in billing determinants that overstate usage and promote under recovery of MAWC's authorized revenue requirement.

Q. Mr. Roach, if Staff, OPC or MIEC failed to use any type of weather normalization technique when quantifying test year revenues, sales, usage or billing determinants relying instead on averages, could any of their averaging techniques reveal or capture the existence of a trend?

A. No, each of these averaging techniques is overwhelmed by the impact of weather on residential and commercial customer usage over the period analyzed. As such, each of these techniques is simply averaging the impact of weather on residential or commercial customer usage over the period analyzed. In the case of employing a 3- or 5-year average, the basic premise underlying these techniques' is that the weather experienced during the 3 or 5 years averaged, and the customers response to those weather conditions, will be exactly the same in the test year. That underlying premise of averaging is illogical, improbable and renders the application of an averaging technique (when demonstrably influenced by highly variable weather conditions) highly speculative and error prone as demonstrated by the significant errors Mr. Robertson calculated and I reported in Table GPR-3SR. As such, an averaging technique should be avoided for setting test year sales, usage, revenue and billing determinants when superior weather normalization techniques are available and result in significantly less error as illustrated in Table GPR-1SR and Table GPR-2SR.

VI. WEATHER NORMALIZATION VIA REGRESSION ANALYSIS

Q. Mr. Roach, OPC Witness Mantle and Staff Witness Robertson both reject a regression-based weather normalization technique for a simpler weather influenced averaging technique that results in greater estimation error than the MAWC regression-based technique. Will you please describe the MAWC weather normalization process?

A. The MAWC regression-based weather normalization technique employs the ability of regression analysis to estimate the relationship of residential or commercial usage per customer over the period 2010-2019 with weather and the passage of time. Based on the mathematical relationships for weather and time derived from the regression analysis, I was able to assess the impact of the passage of time by indexing the weather values to their decadal average, which estimates the weather influenced usage and produces a time series that better reveals the impact of usage by the passage of time (which stands as proxy for structural usage reductions due to government authority mandated conservation via efficiency standards for water using appliances and fixtures). Having estimated a time series normalized for the fluctuation of various weather conditions from period to period, I was able to take the average annual decadal reduction over the period 2010-2019 and apply that to historic test year usage values in order to adjust the test year historic values for what will be additional structural usage decline by the time new rates are set in this proceeding. Given the annual indexed value of the actual data based structural decline usage adjustment, the amount of the adjustment can be scaled up or down for the number of periods between the end of the period defining the regression and the effective date of new rates.

Q. Mr. Roach, is your regression-based weather normalized structural decline usage adjustment for residential and commercial customers a "forecast"?

A. No, it is based on actual historic date, weather normalized and indexed to the decadal average weather values. As such, it estimates the historic decadal usage decline due to conservation induced through water using appliance and fixture regulations. As such, the technique is an application of a historic trend into the test year and presumes the trend occurring over the period 2010-2019, weather normalized, will continue into the near-term future over the life of the rates authorized in this case.

Q. Mr. Roach, why is the MAWC regression-based weather normalization technique superior to the various usage averaging techniques employed by the Staff, OPC and MIEC?

A. In simple terms, the regression-based analysis allows for identification of underlying trends free from the influence of various weather conditions that occur from one time period to the next. As illustrated in Table GPR-1SR, Table GPR-2SR and Table GPR-3SR, the various averaging techniques proposed in this case result in significantly greater error of estimation as compared to the regression analysis and presume that the weather conditions (and usage response to those weather conditions) will be the same in the test year as occurred over the period of time being averaged. As a result of these two issues with averaging, that technique should be avoided when setting test year sales, revenue, usage and billing determinants for weather influenced customer groups such as residential and commercial customers.

VII. REGRESSION DATA, OBSERVATIONS AND RESIDUALS

Q. OPC witness Mantle beginning at Page 8 Line 5 through Page 11, Line 14 lists a few isolated usage data related changes over the period of 2010 through 2019. Without supporting analysis, Ms. Mantle infers these data related changes could have an outsized impact on your regression analysis. How do you respond?

A. Referring to Table GPR-2 on page 17 of my Direct Testimony in this case, I note that even with a change in the methodology employed to normalize for weather and with a 3 year difference in the term of analysis for the 2017 case (2007-2016) and the current case (2010-2019), the result of our analysis for the residential class has been highly stable. In the Company's 2017 base rate case, I estimated a structural usage decline of -1.9% for all MAWC residential customers and a weighted -2.2% for all MAWC residential customers (STL and non-STL rates of decline weighted by customer count) in this case. That is a change of only 0.3% in the estimated rate of structural usage decline with different data sets and differing weather normalization techniques being employed from one case to the other. If there were significant changes to the underlying residential usage data set, we would anticipate equally significant changes in the results of the MAWC regression-based weather normalization analysis. That the result of the analysis has been highly stable over the last three years indicates that the minor adjustments to the data over time has not had an impact on the results of the analysis allying all of Ms. Mantle's observations related to data revisions somehow having a major impact of the results of the MAWC regression-based weather normalization analysis. The stable results render her unsupported observations moot.

Q. OPC Witness Mantle beginning at Page 5 Line 12 through Page 7, Line 9 makes several assertions that the annual frequency of the MAWC regression analysis somehow makes it unreliable. How do you respond?

A. The MAWC weather normalization analysis is performed at an annual frequency as that fits the goal of the analysis; that is to weather normalize annual usage per customer for the MAWC residential and commercial classes in order to identify the underlying annual structural reduction in residential and commercial customer usage. As reported in my Direct Testimony on page 14 in Table GPR-1 and Table GPR-1A, the annual models have statistically significant results explaining over 92% of the variance of residential usage. Further, each of the independent variables pass all standards of statistical significance and the totality of the regression model has a very strong F-value indicating the regression model estimates with great accuracy the overall relationship between the various independent variables and customer usage per customer. None of the statistics indicate ANY issue with the number of observations included in the model.

Q. OPC Witness Mantle beginning at Page 5 Line 12 through Page 7, Line 9 asserts that a monthly frequency model would somehow make for a more reliable simulation. How do you respond?

A. Again, Ms. Mantle's assertion fails to understand the goal of the analysis, that is the annual normalization of MAWC residential and commercial customer usage as compared to the properties that come with a monthly frequency model. If the MAWC weather normalization regression analysis was to be specified at a monthly frequency, you gain no more insight into weather sensitivity than you do with the annual frequency model. This is so because with a monthly frequency model, we would have 10 observations for each monthly observation and that month's specific relationship with weather. The same number of observations that we have for annual usage except specific to each month. Next, in order to do an annual adjustment, we would estimate each of the twelve months weather normalized usage and sum into an annual value. Given the associative property of mathematics, we would expect the summation of the twelve individual monthly estimated adjustments (within the bounds of the regression error terms) to be similar to the annual estimated adjustment. Having said that, by adding so many additional observations for each of the independent variables and then summing the adjustment, the probability for greater error of the regression estimate is a significant probability given the basic principles of regression analysis, which is, minimizing the sum of squares of the error terms over all observations. That is, more observations increase the probability of greater simulation error. In summary, the result of Ms. Mantle's suggestion that more data is better in regression analysis is not always correct, is specific to the application of the regression analysis and is likely to result in greater regression estimation error.

Q. OPC Witness Mantle at Page 10 Line 3 through Line 5 claims "However, using data across a shorter time-period lessens the opportunity for problems in the data and, if there are problems, the problems are more likely to be consistent across all of the data." How do you respond?

A. Ms. Mantle's assertion is incorrect. Referring to Table GPR-4SR (page 20, herein) I have created an example of how the fewer observations employed in an averaging technique can have large consequences when fewer observations are averaged. In the first example of a 10-year series average, the revision of the 2017 observation from 8 to 9 results in 1.8% change to the series average. In the second example of a 3-year series average, the revision of 2017 from 8 to 9 results in 3.6% change in the series average. This example illustrates that the opposite of Ms. Mantle's assertion is at work. With fewer observations to average, the impact of a revision to the data in the average has significantly greater impact on the calculated average. So in the case of an averaging technique, more observations serve to better protect the average of the data series from revisions in the data set.

Q. OPC Witness Mantle at Page 4 Line 1 through Page 5 Line 7 claims that the MAWC error of regression, that is the residual values from where the regression estimated usage value is not completely equal to the actual values in the historic data set, are "extreme". How do you respond?

A. This is a similar claim made by Mr. Robertson which I address with Table GPR-1SR and Table GPR-2SR. Ms. Mantle is attempting to associate the estimated weather influenced usage series reported in column G of that table as regression "residuals". As with Mr. Robertson, Ms. Mantle is comparing apples and oranges. The true error of the regression estimate is derived by using the actual value for each independent variable within the regression equation and calculating the resulting difference from the actual observed value. That comparison is reported in column I of Table GPR-1SR (and Table GPR-2SR) and graphically represented in Figure GPR-1SR (and Figure GPR-2SR). Both column I of Table GPR-1SR (and Table GPR-2SR) and the associated figure illustrate the MAWC regression model has a cumulative and average error of 0% and a single largest estimation variance of 3.8%. Comparatively, as I report in Table GPR-3SR, the Staff's 5-year averaging method has a cumulative error of -21%, an average error of -4.2% and largest estimation variance of -8.3% for tariff district 1 residential usage. Using that same analysis, similar to the OPC 3-year averaging method, the 3-year average there has a cumulative error of -5.2%, an average error of -1.7% and a largest estimation variance of -7.09% for tariff district 1 residential usage.

Thus, the greater usage estimation error occurs with the Staff, OPC and MIEC averaging techniques when using the appropriate apples to apples comparison to measure predictive error. Hence, Ms. Mantle's observation related to the estimation error of the MAWC proposed regression analysis is unfounded and false when confronted with analysis of the regression estimated error.

Q. Does this conclude your Surrebuttal Testimony?

A. Yes.

VIII. TABLES AND FIGURES

Table GPR - 1SR
MAWC STL Residential Regression Model Results
(2010 - 2019)

Year	Day	Annual CDD	Precip Jul-Nov	Residential Annual UPC	Ten Year Weather Norm UPC	Weather Influenced UPC	Predicted UPC	Predicted Error UPC	%
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
2009				7,039					
2010	40359	2,040	20.5	7,307	7,522	-215	7,461	-154	-2.1%
2011	40724	1,974	13.5	7,488	7,440	48	7,628	-140	-1.8%
2012	41090	2,172	11.7	8,133	7,314	819	7,866	267	3.4%
2013	41455	1,689	10.7	7,096	7,184	-88	7,229	-133	-1.8%
2014	41820	1,699	18.4	6,902	7,054	-152	6,652	250	3.8%
2015	42185	1,833	21.4	6,650	6,924	-274	6,540	110	1.7%
2016	42551	2,123	26.0	6,503	6,794	-291	6,541	-38	-0.6%
2017	42916	1,917	10.2	6,874	6,664	210	6,935	-61	-0.9%
2018	43281	2,138	14.6	6,888	6,534	354	6,909	-20	-0.3%
2019	43646	1,859	21.1	6,025	6,404	-379	6,106	-80	-1.3%
Average		1,944	16.8				Sum	0	0%
							Average	0	0%
							Largest Variance		3.8%

Predicted Res_Ann._Avg_Use = 18,560 + 1.282*Annual_CDD - 0.328*Day - 50.153*Jul_Nov_Precip + 0.078*LagUse1

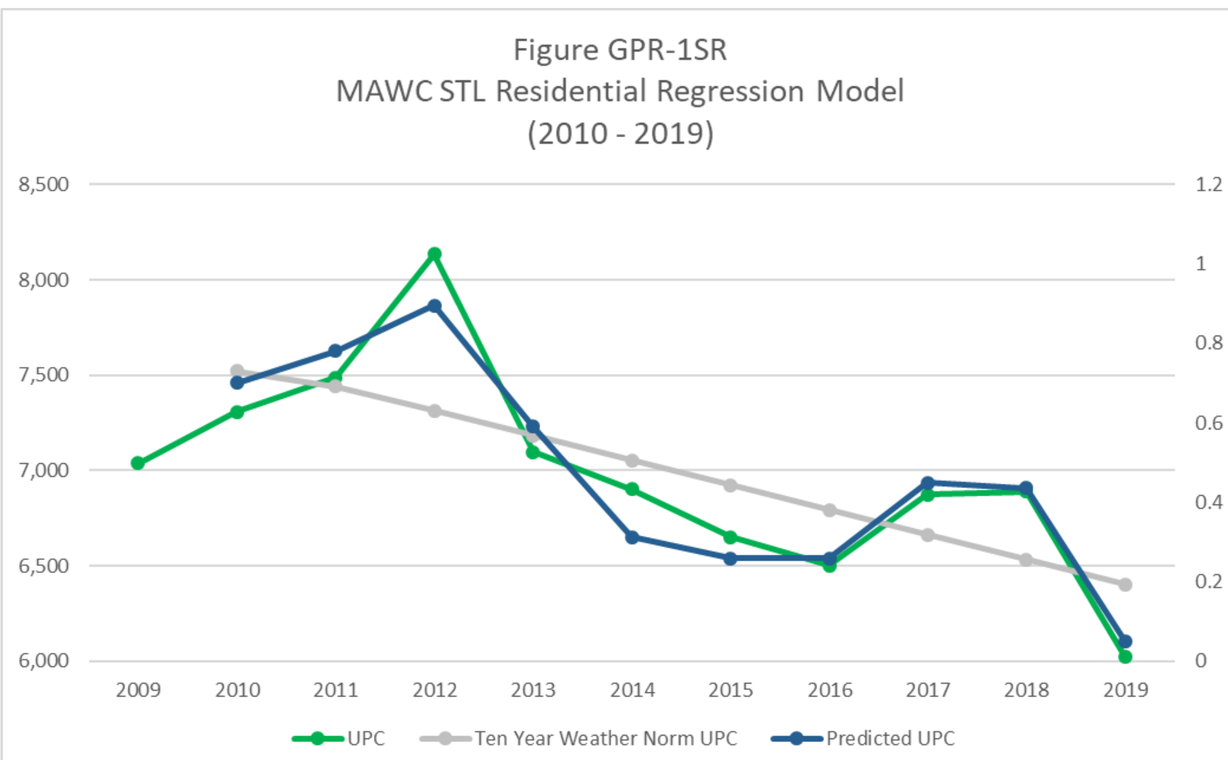

Table GPR - 2SR
MAWC Non-STL Residential Regression Model Results
(2010 - 2019)

Year	Day	Annual CDD	Precip Jul-Nov	Residential Annual UPC	Ten Year Weather Norm UPC	Weather Influenced UPC	Predicted UPC	Predicted Error UPC	%
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
2009				5,235					
2010	40359	2,040	20.5	5,443	5,540	-97	5,551	-108	-1.9%
2011	40724	1,974	13.5	5,607	5,498	109	5,602	4	0.1%
2012	41090	2,172	11.7	5,953	5,392	562	5,807	146	2.5%
2013	41455	1,689	10.7	5,148	5,273	-125	5,252	-104	-2.0%
2014	41820	1,699	18.4	4,923	5,152	-230	4,807	115	2.4%
2015	42185	1,833	21.4	4,787	5,031	-244	4,739	48	1.0%
2016	42551	2,123	26.0	4,786	4,909	-124	4,822	-36	-0.8%
2017	42916	1,917	10.2	4,869	4,788	81	4,909	-39	-0.8%
2018	43281	2,138	14.6	4,913	4,666	247	4,960	-47	-0.9%
2019	43646	1,859	21.1	4,399	4,545	-146	4,379	20	0.5%
Average		1,944	16.8				Sum	0	0%
							Average	0	0%
							Largest Variance		2.5%

Predicted Res_Ann._Avg_Use = 13,711 + 1.136*Annual_CDD - 0.27*Day - 26.659*Jul_Nov_Precip + 0.187*LagUse1

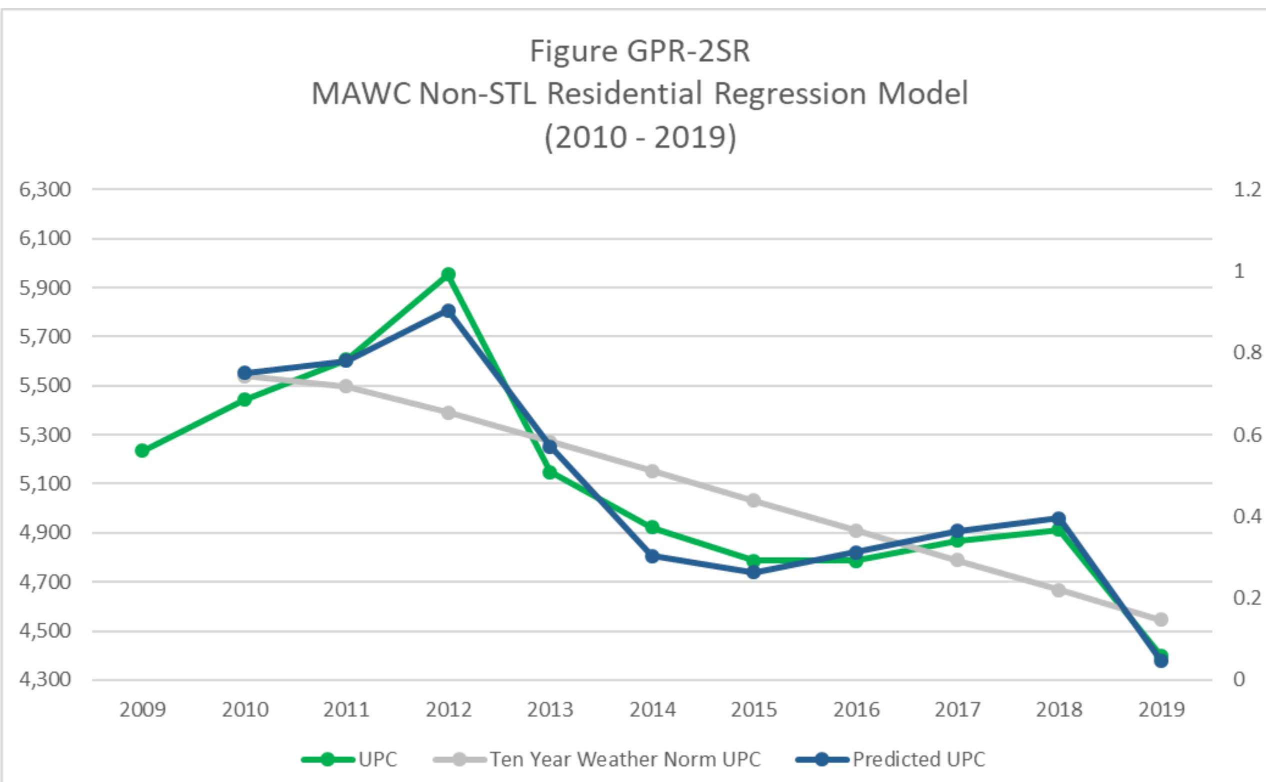

Table GPR-3SR
Staff Averaging Techique Predictive Error Per Period
(July 2012 to June 2020)

	8 Years		5 Years		3 Years	
	Tariff Dist 1	Tariff Dist 2	Tariff Dist 1	Tariff Dist 2	Tariff Dist 1	Tariff Dist 2
July 12 - June 13	4.6%	4.8%				
July 13 - June 14	0.1%	-1.3%				
July 14 - June 15	-9.6%	-6.6%				
July 15 - June 16	-8.3%	-4.5%	-8.3%	-4.5%		
July 16 - June 17	-7.5%	-1.4%	-7.5%	-1.4%		
July 17 - June 18	1.8%	5.4%	1.8%	5.4%	1.8%	5.4%
July 18 - June 19	0.9%	1.6%	0.9%	1.6%	0.9%	1.6%
July 19 - June 20	-7.9%	-1.7%	-7.9%	-1.7%	-7.9%	-1.7%
Sum	-25.9%	-3.7%	-21.0%	-0.6%	-5.2%	5.4%
Average	-3.2%	-0.5%	-4.2%	-0.1%	-1.7%	1.8%
Largest Variance	-9.6%	-6.6%	-8.3%	5.4%	-7.9%	5.4%

Table GPR-4SR
Illustrative Impact of Data Revision on Averages

	10 Year Series		3 Year Series	
	Orginal	Revised	Orginal	Revised
2010	1	1		
2011	2	2		
2012	3	3		
2013	4	4		
2014	5	5		
2015	6	6		
2016	7	7		
2017	8	9	8	9
2018	9	9	9	9
2019	10	10	10	10
Average	5.5	5.6	9	9.3
Change		1.8%		3.6%