Exhibit No.:	122
Issues:	Weather Normalization, Water Utilization Trend Estimates, and Customer Service Sureys
Witness:	Edward L. Spitznagel, Jr.
Exhibit Type:	Rebuttal
Sponsoring Party:	Missouri-American Water Company
Case No.:	WR-2010-0131 SR-2010-0135
Date:	April 15, 2010

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO. WR-2010-0131
CASE NO. SR-2010-0135

REBUTTAL TESTIMONY

OF

EDWARD L. SPITZNAGEL, JR.

ON BEHALF OF

MISSOURI-AMERICAN WATER COMPANY

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

IN THE MATTER OF MISSOURI-AMERICAN WATER COMPANY FOR AUTHORITY TO FILE TARIFFS REFLECTING INCREASED RATES FOR WATER AND SEWER SERVICE	)))))	**CASE NO. WR-2010-0131** **CASE NO. SR-2010-0135**

AFFIDAVIT OF EDWARD L. SPITZNAGEL, JR.

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

Edward L. Spitznagel, Jr.

Edward L. Spitznagel, Jr.

State of Missouri
County of St. Louis
SUBSCRIBED and sworn to
Before me this 16 **day of** April **2010.**

Cindy M Ferguson
Notary Public

My commission expires: 8/12/2012

CINDY M FERGUSON
Notary Public, Notary Seal
State of Missouri
Commission # 08617964

REBUTTAL TESTIMONY

EDWARD L. SPITZNAGEL, JR.

WITNESS INTRODUCTION

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND EMPLOYER.

A. My name is Edward L. Spitznagel, Jr., and my business address is Campus Box 1146, One Brookings Drive, St Louis, Missouri 63130. I am employed by Washington University.

Q. WHAT IS YOUR PRESENT POSITION?

A. I am Professor of Mathematics in the College of Arts and Sciences at Washington University. I also hold a joint appointment in the Division of Biostatistics of the Washington University School of Medicine.

Q. ARE YOU THE SAME EDWARD L. SPITZNAGEL, JR WHO FILED DIRECT TESTIMONY IN THIS CASE?

A. Yes, I am.

PURPOSE AND SCOPE

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

A. I will respond to both the Staff Report and to the testimony of Brian C. Collins, who propose to use a six-year average consumption to estimate future water sales by Missouri-American Water Company ("Missouri-American" or "Company"). I will demonstrate that there is statistically significant evidence that water usage does depend upon an important weather variable, that is the Palmer Drought Severity Index (PDSI). I will also demonstrate that there is a statistically significant downward trend in per-customer per-day water consumption. A simple average of historical usage amounts will not adequately capture and predict for these variables. I will demonstrate the significance of both of these variables for the St. Louis County residential customers, who are the largest-consuming class of MAWC customers, in number and total volume. Generally, my arguments for the St. Louis County residential customers will hold true for the other customer classes for which I propose a weather normalization or trend adjustment.

Q. PLEASE DESCRIBE YOUR EVIDENCE FOR WATER CONSUMPTION BEING DEPENDENT UPON THE PALMER DROUGHT SEVERITY INDEX.

A. This evidence is contained on pages 1 and 2 of Schedule_ELS-2 from my Direct Testimony, in which both year (since 1990) and PDSI (averaged over the weather-sensitive months of May through December) are statistically significant predictors in a multiple regression model. The overall model is statistically significant with a P-value of 0.0031. Said another way, there is a probability of only about 1 in 323 that the correlation of these factors in the model to actual results could occur by chance alone. The <u>year</u> term is statistically significant with a P-value of 0.0051, and the <u>PDSI</u> term is statistically significant with a P-value of 0.0159. Because the year term is negative, the use of a six-year average produces an over-estimate of consumption. Furthermore, by calculating the six-year average over the years

2002-2007 and thus omitting the extremely wet year 2008, Mr. Collins has increased the magnitude of his over-estimate.

Q. DO YOU SEE THE SAME DEPENDENCE OF CONSUMPTION ON YEAR AND MOISTURE OVER THE ENTIRE RANGE OF AVAILABLE DATA?

A. Yes, a total of 19 years of consumption, from 1990 through 2008 is available. On page 1 of Schedule ELS-1 attached to this rebuttal testimony, I have produced a scatterplot of consumption in gallons per customer day (GCD) against year. There is a clear downward trend over time, which is characterized by the regression line superimposed on the scatterplot. A simple six year average will not adequately or accurately reflect this downward trend. The downward slope of the regression line is −2.01 GCD per year, and this is statistically significant with a P-value of 0.0014. When PDSI5_12 is added to the regression model, on Page 2, the downward slope of the regression line becomes −2.27 GCD/year, with a P-value of 0.0000080. The P-value for PDSI5_12 is 0.00018. The P-value of the model itself is 0.0000055, and the fraction of variability explained by the model is R-square = 0.78. That is, 78% of the variability in consumption (GCD) is explained by just two variables, time (year), and soil moisture (PDSI5_12).

Q. CAN ANNUAL RAINFALL BE USED AS A MEASURE OF SOIL MOISTURE TO REPLACE PDSI5_12?

A. No. There are two issues with using annual rainfall. The first is in the St. Louis region during the months of January through April, water consumption is almost entirely indoors and thus is not driven by weather conditions. In fact, outside water taps are usually turned off to prevent freezing. The second is that soil moisture is only partly determined by rainfall, the other parts being runoff, evaporation (from the soil) and evapotranspiration (through vegetation). It is better not to change predictors, particularly because of the two caveats regarding annual rainfall that I mentioned above, that it does not account for seasonality of water use, and it is only one determinant of soil moisture. (Two different years can have identical rainfall, but if in one year the rain takes the form of several downpours, there will be massive runoff and thus relatively low soil moisture compared with a year in which the rainfall is more evenly distributed over time.)

Q. IN SUMMARY, IS EITHER THE STAFF OR MIEC ESTIMATE OF FUTURE WATER CONSUMPTION BIASED, AND IF SO, IN WHICH DIRECTION?

A. Because neither takes into account the downward trend in consumption over time, both estimates are biased upward. For example, Mr. Collins' six-year average over the years 2002 through 2007 is centered halfway between the years 2004 and 2005. Referring back to the slope coefficient −2.875 on Pages 1 and 2 of Schedule_ELS-2 from my Direct Testimony, it overestimates 2010 weather-normalized consumption by $2.875 \times (2010 - 2004.5) = 15.81$ GCD.

Q. ON A DIFFERENT MATTER, ON PAGE 66-67 OF THE STAFF REPORT, STAFF RECOMMENDS DISALLOWING THE PORTION OF THE INCENTIVE PAY RELATING TO THE CUSTOMER AND SERVICE QUALITY SURVEYS BECAUSE THE SAMPLE OF CUSTOMERS IS, IN ITS OPINION, TOO SMALL. PLEASE

COMMENT ON THE RELIABILITY OF SAMPLING A SMALL FRACTION OF THE POPULATION?

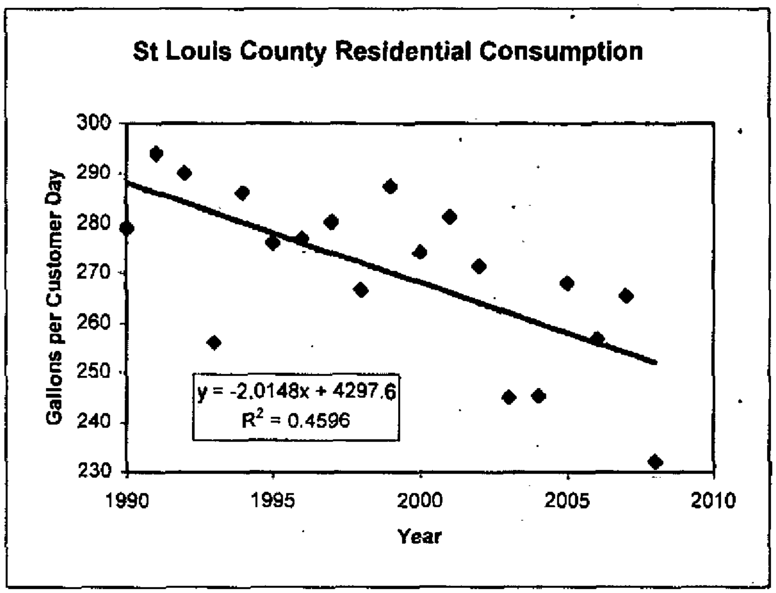
A. The accuracy of an estimate depends primarily on the sample size and the estimated proportion. It depends on the population size only if the sample is an appreciable fraction of the population, which it is definitely not in this case. I have reviewed the results of the customer and service quality surveys and agree with the opinion research firms that the surveys were statistically valid. The best way to look at the issue is to calculate from the empirical proportion a single-sided exact binomial confidence interval for the population proportion. For example, based on the customers who said they were "satisfied" or "very satisfied" out of those sampled, the lower limit of a single-sided 95% confidence interval is more than 90% satisfied.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

Simple Linear Regression Model Predicting Consumption from Year

Year	GCD
1990	279.040
1991	293.898
1992	289.892
1993	255.977
1994	286.074
1995	276.154
1996	277.010
1997	280.274
1998	266.493
1999	287.354
2000	273.989
2001	281.165
2002	271.307
2003	244.906
2004	245.209
2005	267.914
2006	256.723
2007	265.361
2008	232.105



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.677944131
R Square	0.459608245
Adj R Square	0.427820495
Std Error	12.65025588
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2313.80438	2313.80438	14.45865912	0.001423242
Residual	17	2720.492553	160.0289737		
Total	18	5034.296933			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4297.573561	1059.195938	4.057392412	0.000818834	2062.862351	6532.284772
Year	-2.01477193	0.529860911	-3.80245435	0.001423242	-3.1326823	-0.89686156

Multiple Regression Model Predicting Consumption from Year and PDSI

Year	PDSI5_12	GCD
1990	1.8950	279.040
1991	0.0075	293.898
1992	-0.6363	289.892
1993	5.3400	255.977
1994	2.2613	286.074
1995	1.1838	276.154
1996	1.2113	277.010
1997	-0.8050	280.274
1998	2.2775	266.493
1999	-1.6038	287.354
2000	1.3038	273.989
2001	1.7375	281.165
2002	-0.3500	271.307
2003	0.9688	244.906
2004	2.4788	245.209
2005	-1.9750	267.914
2006	-1.5375	256.723
2007	-1.2200	265.361
2008	5.0338	232.105

ID Code	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2302051990	-3.23	0.64	1.00	0.70	2.37	2.40	2.47	2.23	1.31	1.30	1.09	1.99
2302051991	-0.01	-0.59	-0.80	-0.78	-0.40	-1.32	0.52	-0.51	-0.51	0.41	0.89	0.98
2302051992	-0.31	-0.19	-0.27	-0.38	-1.17	-1.95	-1.32	-1.33	-1.16	-1.68	1.59	1.93
2302051993	2.46	2.46	2.24	2.84	2.47	3.10	4.51	5.17	7.54	6.80	6.95	6.18
2302051994	5.44	5.08	3.84	5.58	4.54	3.70	2.67	2.14	1.37	0.99	1.50	1.18
2302051995	2.17	1.86	1.14	1.49	3.54	3.04	2.79	3.13	-0.34	-0.56	-0.89	-1.24
2302051996	-0.78	-1.10	0.09	0.65	1.55	1.31	1.40	1.24	1.18	0.79	1.35	0.87
2302051997	1.12	2.26	-0.30	0.11	0.35	-0.30	-1.01	-0.76	-1.16	-1.20	-1.17	-1.19
2302051998	0.31	1.05	1.99	2.15	1.43	2.49	2.90	2.19	2.01	2.45	2.56	2.19
2302051999	2.83	2.91	2.53	2.68	-0.28	-0.28	-0.76	-1.40	-1.69	-2.11	-3.19	-3.12
2302052000	-3.47	-3.25	-3.32	-3.69	0.18	1.22	1.35	1.99	1.63	1.51	1.45	1.10
2302052001	1.40	2.41	1.74	1.29	1.44	1.69	1.57	1.77	1.65	2.14	1.88	1.76
2302052002	2.16	1.69	1.41	1.72	3.30	-0.29	-0.71	-0.52	-1.15	-0.67	-1.26	-1.50
2302052003	-1.81	-1.68	-1.56	0.15	0.28	0.94	0.58	0.07	1.22	1.08	1.53	2.05
2302052004	2.21	1.63	1.98	1.28	1.78	1.19	1.61	3.03	2.33	2.82	3.73	3.34
2302052005	5.01	4.63	-0.61	-0.88	-1.58	-1.73	-2.33	-1.85	-1.78	-2.02	-2.05	-2.46
2302052006	-2.36	-2.81	-2.32	-2.69	-3.00	-2.61	-2.56	-2.18	-2.33	0.06	0.08	0.24
2302052007	0.83	1.14	-0.28	0.26	-0.49	-0.53	-0.99	-1.31	-1.92	-2.00	-2.57	0.05
2302052008	0.18	1.45	2.17	2.62	3.11	3.32	5.53	4.93	6.67	5.95	5.21	5.55

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.883250517
R Square	0.780131477
Adj R Square	0.752647911
Std Error	8.31746443
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	3927.4135	1963.70675	28.38538104	0.000005461
Residual	16	1106.883433	69.18021455		
Total	18	5034.296933			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	4821.295634	704.8069816	6.840590062	0.000003969	3327.171916
Year	-2.27463023	0.352510783	-6.45265433	0.000007984	-3.02191954
PDSI5_12	-4.61215107	0.954982264	-4.82956725	0.000184850	-6.63662257

Multiple Regression Model Predicting Consumption from Year and Rainfall

Year	Rainfall	GCD
1990	45.09	279.040
1991	33.48	293.898
1992	33.49	289.892
1993	54.76	255.977
1994	34.70	286.074
1995	41.68	276.154
1996	43.67	277.010
1997	31.23	280.274
1998	43.62	266.493
1999	34.06	287.354
2000	37.37	273.989
2001	35.29	281.165
2002	40.95	271.307
2003	46.06	244.906
2004	42.27	245.209
2005	37.85	267.914
2006	29.93	256.723
2007	30.57	265.361
2008	57.96	232.105

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.915764758
R Square	0.838625092
Adj R Square	0.818453228
Std Error	7.125698241
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	4221.887726	2110.943863	41.57400179	0.000000460
Residual	16	812.4092067	50.77557542		
Total	18	5034.296933			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	4279.281846	596.63655	7.172342771	0.000002219	3014.469148	5544.094545
Year	-1.97929965	0.298518744	-6.63040325	0.000005781	-2.61213098	-1.34646833
Rainfall	-1.32584901	0.216283219	-6.13015201	0.000014500	-1.78434884	-0.86734917