

Exhibit No.:
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)	CASE NO. WR-2010-0131
RATES FOR WATER AND SEWER)	CASE NO. SR-2010-0135
SERVICE)	

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.

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

Notary Public

My commission expires:

REBUTTAL TESTIMONY
EDWARD L. SPITZNAGEL, JR.

WITNESS INTRODUCTION

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

2 A. My name is Edward L. Spitznagel, Jr., and my business address is Campus Box
3 1146, One Brookings Drive, St Louis, Missouri 63130. I am employed by
4 Washington University.

5
6 **Q. WHAT IS YOUR PRESENT POSITION?**

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

10
11 **Q. ARE YOU THE SAME EDWARD L. SPITZNAGEL, JR WHO FILED DIRECT**
12 **TESTIMONY IN THIS CASE?**

13 A. Yes, I am.

14
15 **PURPOSE AND SCOPE**

16 **Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?**

17 A. I will respond to both the Staff Report and to the testimony of Brian C. Collins, who
18 propose to use a six-year average consumption to estimate future water sales by
19 Missouri-American Water Company ("Missouri-American" or "Company"). I will

1 demonstrate that there is statistically significant evidence that water usage does
2 depend upon an important weather variable, that is the Palmer Drought Severity
3 Index (PDSI). I will also demonstrate that there is a statistically significant
4 downward trend in per-customer per-day water consumption. A simple average of
5 historical usage amounts will not adequately capture and predict for these variables.
6 I will demonstrate the significance of both of these variables for the St. Louis County
7 residential customers, who are the largest-consuming class of MAWC customers, in
8 number and total volume. Generally, my arguments for the St. Louis County
9 residential customers will hold true for the other customer classes for which I
10 propose a weather normalization or trend adjustment.

11
12 **Q. PLEASE DESCRIBE YOUR EVIDENCE FOR WATER CONSUMPTION BEING**
13 **DEPENDENT UPON THE PALMER DROUGHT SEVERITY INDEX.**

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

1 2002-2007 and thus omitting the extremely wet year 2008, Mr. Collins has
2 increased the magnitude of his over-estimate.

3
4 **Q. DO YOU SEE THE SAME DEPENDENCE OF CONSUMPTION ON YEAR AND**
5 **MOISTURE OVER THE ENTIRE RANGE OF AVAILABLE DATA?**

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

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

21 A. No. There are two issues with using annual rainfall. The first is in the St. Louis
22 region during the months of January through April, water consumption is almost
23 entirely indoors and thus is not driven by weather conditions. In fact, outside water

1 taps are usually turned off to prevent freezing. The second is that soil moisture is
2 only partly determined by rainfall, the other parts being runoff, evaporation (from the
3 soil) and evapotranspiration (through vegetation). It is better not to change
4 predictors, particularly because of the two caveats regarding annual rainfall that I
5 mentioned above, that it does not account for seasonality of water use, and it is only
6 one determinant of soil moisture. (Two different years can have identical rainfall,
7 but if in one year the rain takes the form of several downpours, there will be
8 massive runoff and thus relatively low soil moisture compared with a year in which
9 the rainfall is more evenly distributed over time.)

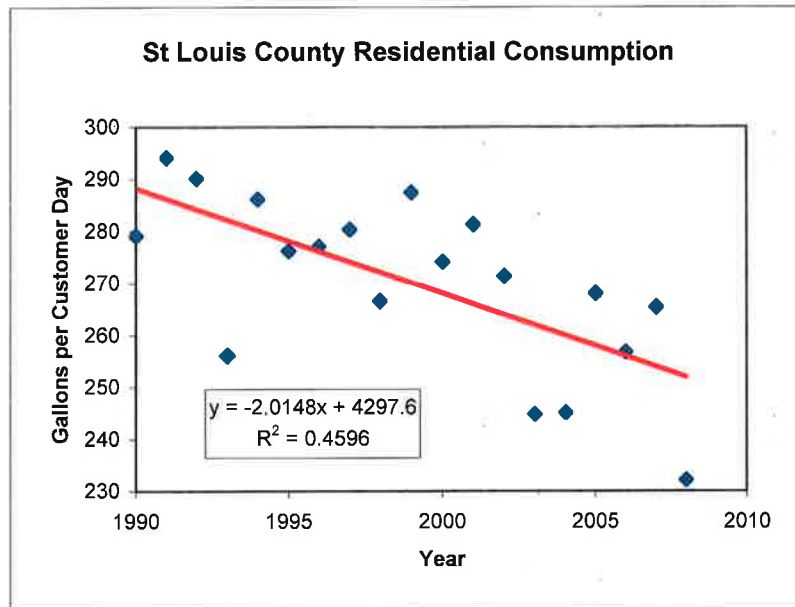
10
11 **Q. IN SUMMARY, IS EITHER THE STAFF OR MIEC ESTIMATE OF FUTURE**
12 **WATER CONSUMPTION BIASED, AND IF SO, IN WHICH DIRECTION?**

13 A. Because neither takes into account the downward trend in consumption over time,
14 both estimates are biased upward. For example, Mr. Collins' six-year average over
15 the years 2002 through 2007 is centered halfway between the years 2004 and
16 2005. Referring back to the slope coefficient -2.875 on Pages 1 and 2 of
17 Schedule_ELS-2 from my Direct Testimony, it overestimates 2010 weather-
18 normalized consumption by $2.875 \times (2010 - 2004.5) = 15.81$ GCD.

19
20 **Q. ON A DIFFERENT MATTER, ON PAGE 66-67 OF THE STAFF REPORT, STAFF**
21 **RECOMMENDS DISALLOWING THE PORTION OF THE INCENTIVE PAY**
22 **RELATING TO THE CUSTOMER AND SERVICE QUALITY SURVEYS BECAUSE**
23 **THE SAMPLE OF CUSTOMERS IS, IN ITS OPINION, TOO SMALL. PLEASE**

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

<i>Regression Statistics</i>	
Multiple R	0.677944131
R Square	0.459608245
Adj R Square	0.427820495
Std Error	12.65025588
Observations	19

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	2313.80438	2313.80438	14.45865912	0.001423242
Residual	17	2720.492553	160.0289737		
Total	18	5034.296933			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
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	PDSI_12	GCD	ID Code	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1990	1.8950	279.040	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
1991	0.0075	293.898	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
1992	-0.6363	289.892	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
1993	5.3400	255.977	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
1994	2.2613	286.074	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
1995	1.1838	276.154	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
1996	1.2113	277.010	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
1997	-0.8050	280.274	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
1998	2.2775	266.493	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
1999	-1.6038	287.354	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
2000	1.3038	273.989	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
2001	1.7375	281.165	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
2002	-0.3500	271.307	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
2003	0.9688	244.906	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
2004	2.4788	245.209	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
2005	-1.9750	267.914	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
2006	-1.5375	256.723	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
2007	-1.2200	265.361	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
2008	5.0338	232.105	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
PDSI_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

<i>Regression Statistics</i>	
Multiple R	0.915764758
R Square	0.838625092
Adj R Square	0.818453228
Std Error	7.125698241
Observations	19

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	4221.887726	2110.943863	41.57400179	0.000000460
Residual	16	812.4092067	50.77557542		
Total	18	5034.296933			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
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