Development of a Water Demand Forecasting Model for Tyler Water Utilities

PROJECT COMPLETION REPORT

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Acknowledgements

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This project would not have been possible without the assistance of Greg Morgan from Tyler Water Utilities in providing the university with the utility's water production. I am also very grateful to Dr. Ben Dziegielewski at Southern Illinois University Carbondale for his assistance in developing the model.

Lastly, thanks be to God by whose mercy, grace, and protection I have come this far in my life.

Executive Summary

Water utilities are facing unprecedented challenges resulting from aging infrastructure, tighter water quality and environmental standards, urbanization, and declining budgets. In responding to these challenges, utilities must learn to “work smarter” by embracing performance measurement initiatives. One such approach involves leveraging the use of information technology combined with improving existing asset management and long-term planning practices (Rogers, 2006).

One of the most challenging aspects in the operation and management of a water system is the development of effective long-range infrastructure and capital financing plans. Assessing infrastructure needs and developing capital improvement plans requires a thorough understanding of future water demands. The multitude of factors influencing water use such as population, housing, employment, income, and weather make it difficult even for water utilities with large planning staffs and detailed water use records. However, smaller utilities rarely have specialized staff or detailed water use records needed to conduct demand studies to assess future infrastructure needs. Ironically, the development of infrastructure and capital plans are specially important for smaller utilities where over-investment in infrastructure waste scarce capital resources and under-investment can result in antiquated systems with insufficient coverage and high maintenance costs (Dziegielewski, 2007).

The purpose of this research was to develop a water demand forecasting model for Tyler Water Utilities (TWU). TWU currently provides water for the communities of Tyler (est. population 100,000) and Whitehouse (est. population 8,000). Since Whitehouse is transitioning into the development and management of its own water resources, the model was developed exclusively for the Tyler system. The model uses a multivariate approach to incorporate the climatic, socioeconomic, demographic, and water cost variables that influences water use. The model’s dependent variable, average daily production, was determined from supply data provided by the utility. Conversely, data for the model’s independent variables (water price, median household income, temperature, and precipitation) came from a variety of sources including the U.S. Census Bureau, Bureau of Economic Analysis, and the National Climatic Data Center (NCDC).

The accuracy of the model was tested by comparing the known monthly water supply production to the predicted supply production from 1998 to 2008. The coefficient of determination (R^2) between the known and forecasted production was 0.80 respectively. A similar test was conducted for the first six months of year 2009 based on an assumed annual median household income data for this year. The R^2 between the predicted and actual production for this period was 0.94.

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1. Methodology

The following sections provide some general information about the water resources available to TWU, the rationale for developing an aggregated withdrawal based model, and the specifics regarding the multivariate model.

1.1 Background

Water supply planning and management focuses on two fundamental issues: forecasting the amount of water required in the future and the availability of existing and potential sources of supply to meet this demand.

The city of Tyler is endowed with abundant water resources which include Lake Tyler (43,500 acre feet of storage), Lake Palestine (67,200 acre feet of storage), and the Carizzo-Wilcox aquifer. While these resources are more than adequate for the city's immediate needs, TWU is concerned about the system's ability to accommodate the community's future water demands and the negative impact that an inadequate system might have on growth.

1.2 Withdrawals vs. Consumptive Use

The research focused on forecasting water need as measured by water withdrawals and did not include an analysis of consumptive and non-consumptive uses. Whereas the term "water use" is inclusive of off-stream and in-stream uses such as water withdrawal, delivery, consumptive use, wastewater release, reclaimed wastewater, and return flow, the term "water withdrawal" is more specific and designates the amount of water taken out of a natural water source such as lakes, rivers, or aquifers (Dziegielewski, 2008).

"Consumptive use" represents the difference between the amount of water withdrawn and the amount returned to the source. This is the part of water that is "evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate environment' (Hutson et al., 2004). The amount of "consumed" water represents the measure of water that is not available for repeated use.

This study addresses water demand in terms of water withdrawals from surface and groundwater sources. It does not quantity water volumes of consumptive use, discharges of treated wastewater into surface or groundwater bodies, or quantities recirculated or reused within industrial facilities. This project did not include the partitioning the water withdrawal data into consumptive and nonconsumptive uses since this depth of analysis would have required a significant time and financial commitment required to review utility billing records and return flow data. An inventory of actual return flows should be developed in the future in order to estimate consumptive and nonconsumptive use of water withdrawals for each major sector.

1.3 Multivariable Regression Model

Water-use relationships can be expressed using mathematical functions which quantify the relationship between water use (dependent) and independent (explanatory) variables. Tyler Water currently uses a per-capita bivariate model which forecasts water use as the product of one explanatory variable (future population) times a constant average rate usage:

$$Q_t = N_t * q_t \qquad (1)$$

where: Q_t = average daily water use in time t
N_t = number of users such as population, employment, etc. at time t
q_t = average rate of water usage in gallons per capita-day, gallons per employee-day etc.

This type of model assumes that future water demand will be proportional to the future number of users (N_t) and that the average water use rate (q_t) remains constant. Hence, once an average water use rate has been established, future water use forecasts can be generated through population forecasts. While this approach simplifies the forecasting procedure, it does not consider how the water use rates change depending on climatic, socioeconomic, demographic, and water cost factors. Another limitation is that the per-capita approach only addresses residential water use, neglecting other water use sectors including commercial, institutional, industrial, and public uses of water (Baumann et al, 1998).

A multivariate linear model overcomes the aforementioned limitations by expressing the water use rate as a function of independent (explanatory) variables shown to have a strong impact with water use. Examples of explanatory variables include: temperature, precipitation, median family income, percent population employed, multi-family housing, and water price. For public supply withdrawals, a general expression for a multivariate model is given as (Dziegielewski, 2008):

$$PS_t = a + \sum_j b_j X_{jt} + \varepsilon_t \qquad (2)$$

where: PS_t = public supply withdrawal at time t
X_{jt} = explanatory variable j at time t
a, b_j= coefficients estimated by fitting the multivariate linear model to historical water use data

The actual model used in this study was a double-log form of the multivariate linear model in which all variables are expressed using natural log transforms:

$$\ln PS_t = \alpha + \sum_j \beta_j \ln X_{jt} + \varepsilon_t \qquad (3)$$

Expressing equation (3) for the four explanatory variables used is this study yields:

$$\ln PS_t = \alpha + \beta_1 \ln(C_t) + \beta_2 \ln(I_t) + \beta_3 \ln(P_t) + \beta_4 \ln(T_t) + \varepsilon_t \quad (4)$$

where: PS_t = average daily public supply withdrawal at month t
C_t = marginal water price at month t
I_t = median household income at month t
P_t = total precipitation at month t
T_t = average daily maximum temperature at month t
ε_t = random error

2. Model Application

2.1 Data Sources and Data Quality

Data on water withdrawals for this study was provided by Tyler Water Utilities in the form of daily pumpage reports from January 1998 through June 2009. The information was provided in an Excel format, clearly distinguishing pumping activity from Lake Tyler, Lake Palestine, and the well installations. This daily pumpage information was then used to determine the average daily supply withdrawal.

Population, economic, and weather information reflect the data quality of the governmental agencies involved in data collection and reporting. Table 1 shows the data sources for the explanatory variables used in the model.

Table 1. Data Sources used for the Explanatory Variables

Explanatory Variable	Data Source
Marginal Water Price	Tyler Water Utilities
Population	U.S. Census Bureau
Median Household Income	U.S. Census Bureau
Total Monthly Precipitation	National Oceanic and Atmospheric Administration (NOAA)
Average Daily Maximum Temperature	National Oceanic and Atmospheric Administration (NOAA)

Standard procedures were used to identify, correct, and discard data with apparent errors caused by mistakes in data collection and/or input. These procedures included:

- Arranging data in spreadsheets and inspecting for anomalies
- Graphing time-series data in order to identify outliers
- Comparing data values against other available sources

Through this investigation, the researcher discovered that temperature and precipitation data for February 1998 was not available since the weather station at Tyler Pounds Regional Airport had been malfunctioning throughout the month. Despite having data for the economic terms for this time period, this data point was removed from the dataset since climatic data comprises half of the variables in equation (4).

2.2 Water Demand Relationships

The majority of the research involved data collection and processing in order to identify the statistically relevant explanatory variables and prepare these variables for development of water-demand relationships. The dependent variable for the public supply (withdrawal) sector was the average daily production which includes deliveries to residential, commercial, industrial, institutional, and governmental users.

Four independent (explanatory) variables were identified as relevant and analyzed from 1998 to 2008:

- Marginal price of water
- Median household income
- Gross monthly precipitation
- Average daily maximum temperature

2.2.1 Marginal Price of Water

Data for this variable was provided by Tyler Water Utilities and summarized in Table 2. Rather than attempting to model a "normal" residential, commercial, industrial, etc. monthly usage, the marginal price of water was calculated as the incremental price per 1,000 gallons at the level between 2,000 and 25,000 gallons (as per the utility's rate structure).

Table 2. Marginal Water Price per 1,000 Gallons for Consumption between 2,000 and 25,000 Gallons

Year	Marginal Water Price
1998	$1.95
1999	$2.05
2000	$2.15
2001	$2.15
2002	$2.15
2003	$2.26
2004	$2.26
2005	$2.26
2006	$2.42
2007	$2.42
2008	$2.57

During this 11 year period, there were a total of five price changes with all price changes taking place on October 1 of the corresponding year. Prior to analyzing this data for statistical relevance, all prices were converted into constant 2008 dollars through the Consumer Price Index (CPI) values found online at the Bureau of Labor Statistics website. A summary of the monthly water prices expressed in 2008 dollars can be found in Appendix A.

The negative elasticity for the water price shown in Table 3 illustrates that this variable is inversely related to water usage. The elasticity of -3.9483 indicates that, on average, a 1% increase in the marginal price of water decreases the average daily water usage by 3.9483%. The t ratio illustrates that this variable is statistically significant.

Table 3. Explanatory Variable Elasticity and t Ratio Values for Average Daily Water Production

Variables	Elasticity	t Ratio	Probability > |t|
Marginal price of water (ln)	-3.9483	-5.0281	< 0.0001
Median household income (ln)	-1.4860	-2.2946	0.0234
Monthly precipitation (ln)	-0.1186	-5.9641	< 0.0001
Ave. maximum daily temperature (ln)	1.3909	19.3242	< 0.0001

2.2.2 Median Household Income

Data for this variable came from the U.S. Census Bureau and was converted into constant 2008 dollars through the CPI. Unexpectedly, the elasticity of this variable was negative implying that a 1% increase in the median household income decreases the daily water production by 1.4860%. The exceedance probability associated with the t ratio indicates a 98% level of significance. The monthly income values used over the 11 year period are listed in Appendix A.

2.2.3 Temperature and Precipitation

All weather data for Tyler from 1998 ~ 2008 (Appendix A) was extracted from the NOAA's National Weather Service Forecast Office website for Shreveport Louisiana. As expected, the negative elasticity for precipitation confirms an inverse relationship between precipitation and water use whereas the positive elasticity for temperature verifies a direct relationship between increases in temperature and increased water usage. The larger magnitude of the temperature variable indicates a stronger correlation.

3. Results

The results of this research are presented by comparing the results from the model's average daily production estimates to the actual production. This analysis was conducted for two datasets: the 11 year data set used in developing the model and the 6 month data set for the year 2009.

<u>1998 ~ 2008 Record</u>

Having established the elasticity and statistical relevance of the explanatory variables as each relates to the average daily water production (Table 3), the α and β terms needed for the cumulative multivariate model were determined by performing a simultaneous regression analysis of all four explanatory variables for the 131 monthly records (recall information for February 1998 was excluded from this analysis due to a lack of weather data).Rather than establishing how each explanatory variable independently affects water production, this form of analysis provides a measure of the elasticity relative to the variables themselves. Table 4 shows the coefficients (α,β) used in the final model.

Table 4. Variables and t Ratio Values used in the Final Double-Log Model of Average Daily Water Production

Variables	Coefficient	t Ratio	Probability $> \lvert t \rvert$
Model			
Intercept	21.6157	6.4241	< 0.0001
Marginal price of water (ln)	-0.4685	-1.0739	0.2849
Median household income (ln)	-0.9060	-2.9088	0.0043
Monthly precipitation (ln)	-0.0532	-4.8553	< 0.0001
Ave. maximum daily temperature (ln)	1.2297	16.2488	< 0.0001

In equation form, the final model for the public supply at time t is expressed as:

$$\ln PS_t = 21.6157 - 0.4685\ln(C_t) - 0.9060\ln(I_t) - 0.0532\ln(P_t) + 1.2297\ln(T_t) \qquad (5)$$

Figure 1 shows the variance between the predicted and actual average daily production. For the 11 years of data from 1998 to 2008, the R^2 between the forecasted and actual production was an acceptable 0.80. Aside from the large spike from June 2006 to August 2006 in which the model underestimates the production by 22%, the majority of the forecasts are within 10% the actual values. This deviation corresponds to a period in which the monthly precipitation was at a minimum for the entire 11 year record while the temperature was 2 degrees above normal.

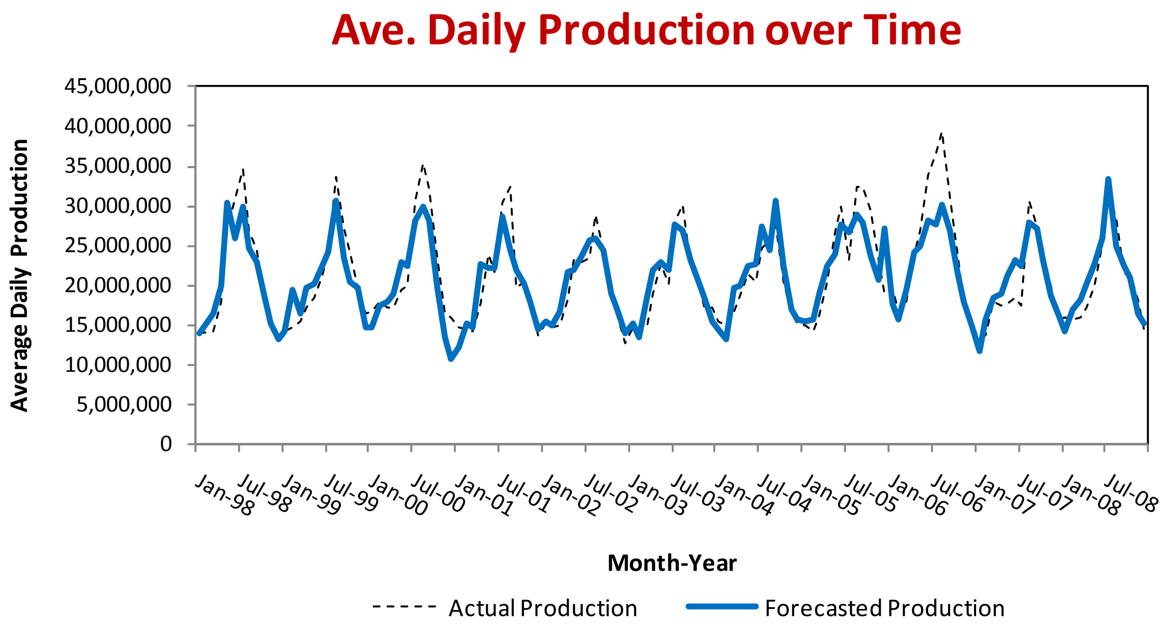

Figure 1. Variance between the Predicted and Actual Average Daily Production in the Tyler Water System from 1998 to 2008

<u>January 2009 ~ June 2009 Record</u>

In order to assess the performance of the model in predicting future daily production, the final model shown in equation (5) was tested over the first 6 months of year 2009. In doing so, the researcher made the following assumptions:

- The median household income was estimated at $41,978, which represents a 2% increase from 2008.
- Marginal water price was assumed to remain at $2.57 per 1,000 gallons.
- Year 2009 water price and household income values were normalized using the six month CPI average.

Figure 2 shows the deviation between the predicted and actual average daily production for the first 6 months of 2009. The R^2 between the model-predicted production and the actual production was 0.94.

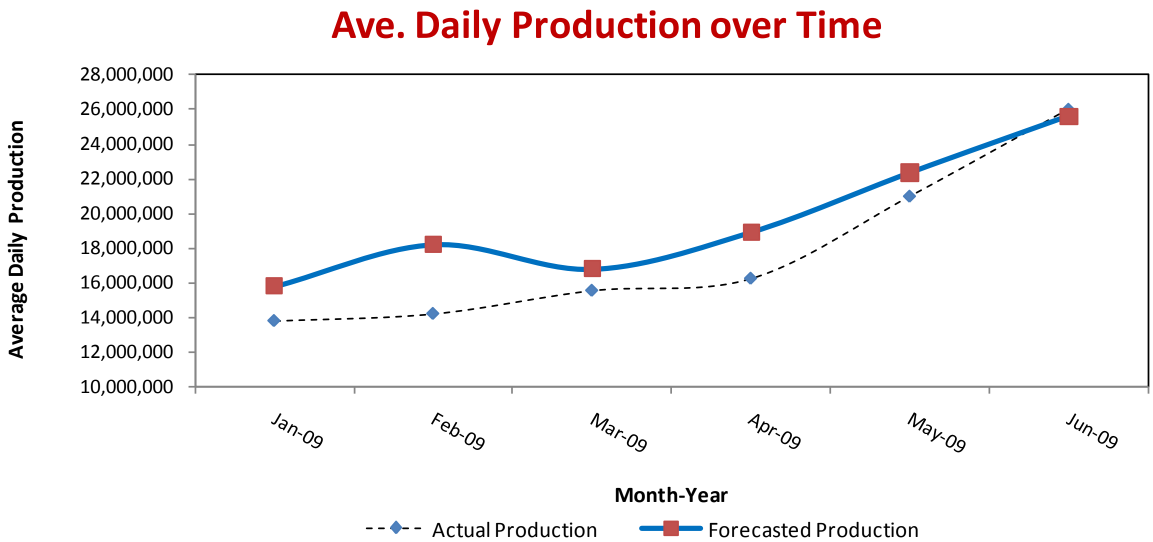

Figure 2. Variance between the Predicted and Actual Average Daily Production in the Tyler Water System from the first six months of 2009

4. Conclusions

The purpose of this project was to assist Tyler Water Utilities with their infrastructure and capital improvement planning by developing a model to forecast water production. The model is an improvement over the utility's existing forecasting approach in that it incorporates several factors known to have a strong impact with water use including temperature, precipitation, water price, and household income. Based on the R^2 values for the 11 year record from 1998 to 2008 (R^2 =0.80) and the records from the first 6 month 2009 (R^2 =0.94), it appears that the model can be an effective tool for the utility.

In addition to providing TWU with a water production forecasting model, this project also provided an undergraduate student researcher, Donald Hodges, with the opportunity to apply the content of several of his engineering courses to a meaningful project that impacts his community's future. The project also was useful in fostering a much-needed relationship between the local utility and the College of Engineering and Computer Science.

5. References

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Appendix A – Explanatory Variable Data for Years 1998 ~ 2008

Month-Year	Actual Ave. Daily	Explanatory Variables			
	Production (gal)	Water Price	Median Income	Precip (in)	Temp (°F)
Jan-98	14,042,677.42	$2.46	$46,009.03	7.50	62.87
Mar-98	14,151,709.68	$2.46	$45,838.83	3.77	69.29
Apr-98	17,899,366.67	$2.45	$45,754.21	1.17	77.27
May-98	27,120,033.33	$2.45	$45,669.89	0.02	91.19
Jun-98	31,003,100.00	$2.44	$45,613.86	1.86	96.83
Jul-98	34,663,612.90	$2.44	$45,557.96	0.37	101.61
Aug-98	27,005,709.68	$2.44	$45,502.19	4.71	96.74
Sep-98	24,389,733.33	$2.43	$45,446.57	5.73	91.57
Oct-98	17,998,000.00	$2.56	$45,335.72	9.21	79.68
Nov-98	15,512,566.67	$2.56	$45,335.72	6.92	67.13
Dec-98	13,713,612.90	$2.56	$45,363.38	5.59	59.26
Jan-99	14,214,677.42	$2.56	$44,768.09	8.17	63.65
Feb-99	14,676,321.43	$2.55	$44,713.66	0.29	70.82
Mar-99	15,308,580.65	$2.54	$44,578.16	3.32	68.65
Apr-99	17,074,700.00	$2.53	$44,256.30	5.29	80.73
May-99	18,404,166.67	$2.53	$44,256.30	6.98	83.32
Jun-99	21,237,233.33	$2.53	$44,256.30	5.54	89.87
Jul-99	24,226,774.19	$2.52	$44,123.55	2.96	92.26
Aug-99	33,704,354.84	$2.51	$44,017.93	0.15	98.16
Sep-99	27,213,966.67	$2.50	$43,808.20	2.66	88.93
Oct-99	24,230,290.32	$2.62	$43,730.06	1.90	79.39
Nov-99	19,542,100.00	$2.62	$43,704.08	0.76	73.90
Dec-99	16,293,806.45	$2.62	$43,704.08	3.59	62.23
Jan-00	16,767,612.90	$2.61	$43,574.62	2.59	61.23
Feb-00	17,884,464.29	$2.60	$43,318.00	3.10	70.76
Mar-00	17,044,645.16	$2.58	$42,963.76	4.92	73.45
Apr-00	17,136,466.67	$2.58	$42,938.68	4.25	75.63
May-00	19,518,433.33	$2.57	$42,888.61	1.62	85.39
Jun-00	19,784,266.67	$2.56	$42,664.71	5.60	87.43
Jul-00	30,678,096.77	$2.55	$42,565.95	0.48	94.74
Aug-00	35,282,419.35	$2.55	$42,565.95	0.38	98.16
Sep-00	32,013,600.00	$2.54	$42,345.40	0.17	90.07
Oct-00	23,606,096.77	$2.66	$42,272.39	3.60	78.65
Nov-00	16,493,083.33	$2.66	$42,248.11	13.32	60.20
Dec-00	16,002,096.77	$2.66	$42,272.39	6.98	49.10
Jan-01	14,762,838.71	$2.64	$42,072.00	6.27	53.45
Feb-01	14,310,828.57	$2.63	$41,904.48	7.45	64.21
Mar-01	14,069,967.74	$2.63	$41,809.35	9.92	63.35
Apr-01	17,691,100.00	$2.62	$41,643.91	0.63	79.70
May-01	23,839,666.67	$2.60	$41,456.43	4.72	84.77
Jun-01	21,583,733.33	$2.60	$41,386.56	8.11	87.03
Jul-01	30,449,612.90	$2.61	$41,503.14	0.35	93.32
Aug-01	32,438,612.90	$2.61	$41,503.14	4.19	91.87
Sep-01	19,706,946.67	$2.60	$41,316.92	4.70	83.67
Oct-01	20,284,000.00	$2.60	$41,456.43	2.42	76.58
Nov-01	18,754,500.00	$2.61	$41,526.54	3.77	70.50
Dec-01	13,605,290.32	$2.62	$41,691.04	6.35	60.77
Jan-02	15,077,483.87	$2.61	$42,005.36	1.57	61.16
Feb-02	14,772,071.43	$2.60	$41,839.98	2.91	60.64
Mar-02	14,811,838.71	$2.59	$41,605.98	5.37	68.10
Apr-02	18,187,500.00	$2.57	$41,374.58	2.36	80.63
May-02	23,100,933.33	$2.57	$41,374.58	5.87	84.58
Jun-02	23,014,600.00	$2.57	$41,351.58	4.84	89.20
Jul-02	23,390,903.23	$2.57	$41,305.66	3.51	93.35
Aug-02	28,791,838.71	$2.56	$41,168.51	2.83	93.58
Sep-02	24,314,666.67	$2.56	$41,100.27	2.84	88.57
Oct-02	18,912,419.35	$2.55	$41,032.26	5.39	73.97
Nov-02	16,160,766.67	$2.55	$41,032.26	2.38	65.53
Dec-02	12,553,161.29	$2.56	$41,122.99	6.92	58.58
Jan-03	14,582,774.19	$2.55	$41,600.76	0.66	56.68
Feb-03	14,170,035.71	$2.53	$41,282.67	6.57	56.21
Mar-03	14,647,000.00	$2.51	$41,036.14	2.61	70.00
Apr-03	18,933,800.00	$2.52	$41,125.45	1.91	79.17
May-03	22,705,633.33	$2.52	$41,192.69	3.63	85.10
Jun-03	20,247,533.33	$2.52	$41,147.84	14.08	86.67
Jul-03	27,906,387.10	$2.52	$41,103.09	0.81	92.61

Month-Year	Actual Ave. Daily Production (gal)	Explanatory Variables			
		Water Price	Median Income	Precip (in)	Temp (°F)
Aug-03	30,180,612.90	$2.51	$40,947.22	1.91	93.71
Sep-03	22,764,733.33	$2.50	$40,814.57	3.54	84.43
Oct-03	21,591,064.52	$2.63	$40,858.69	2.68	79.65
Nov-03	17,170,203.33	$2.64	$40,969.42	1.63	69.43
Dec-03	17,049,774.19	$2.64	$41,013.88	3.55	62.03
Jan-04	15,407,193.55	$2.63	$41,717.86	2.95	58.74
Feb-04	14,816,392.86	$2.61	$41,493.81	5.22	55.79
Mar-04	16,579,935.48	$2.60	$41,228.11	2.37	74.55
Apr-04	18,761,366.67	$2.59	$41,096.53	5.00	77.10
May-04	21,522,733.33	$2.57	$40,857.47	4.12	83.97
Jun-04	20,518,386.67	$2.57	$40,728.25	7.93	87.03
Jul-04	24,718,677.42	$2.57	$40,792.76	0.69	91.52
Aug-04	25,741,838.71	$2.57	$40,771.23	4.62	90.19
Sep-04	27,562,700.00	$2.56	$40,685.35	0.04	88.07
Oct-04	20,285,161.29	$2.55	$40,472.23	4.38	82.90
Nov-04	16,429,766.67	$2.55	$40,451.04	6.93	67.13
Dec-04	15,146,741.94	$2.56	$40,599.83	2.77	61.00
Jan-05	14,865,096.77	$2.55	$41,640.30	2.85	61.70
Feb-05	14,266,071.43	$2.54	$41,401.49	4.78	63.80
Mar-05	16,095,387.10	$2.52	$41,080.21	1.95	70.30
Apr-05	20,377,400.00	$2.50	$40,805.78	0.97	77.70
May-05	26,770,866.67	$2.50	$40,847.76	1.87	84.90
Jun-05	29,823,390.00	$2.50	$40,826.76	1.47	94.30
Jul-05	23,091,322.58	$2.49	$40,638.72	3.18	93.90
Aug-05	32,326,300.00	$2.48	$40,431.80	1.82	97.10
Sep-05	32,503,426.67	$2.45	$39,943.69	2.29	94.60
Oct-05	29,287,590.32	$2.44	$39,863.48	1.15	80.00
Nov-05	23,136,533.33	$2.46	$40,186.26	1.28	72.40
Dec-05	18,790,709.68	$2.47	$40,349.62	0.73	89.00
Jan-06	19,615,774.19	$2.45	$41,237.64	4.71	68.80
Feb-06	16,708,428.57	$2.45	$41,154.62	4.22	61.70
Mar-06	17,843,774.19	$2.44	$40,928.04	4.71	73.50
Apr-06	23,949,280.00	$2.41	$40,582.75	1.69	83.40
May-06	26,862,263.33	$2.40	$40,382.34	2.21	85.90
Jun-06	33,872,666.67	$2.40	$40,302.73	1.32	92.60
Jul-06	36,544,290.32	$2.39	$40,183.90	2.90	94.50
Aug-06	39,413,193.55	$2.39	$40,105.07	1.55	98.10
Sep-06	31,107,033.33	$2.40	$40,302.73	0.94	88.30
Oct-06	23,770,419.35	$2.58	$40,522.41	3.90	80.50
Nov-06	17,942,766.67	$2.59	$40,582.75	4.83	70.30
Dec-06	14,747,483.87	$2.58	$40,522.41	5.44	60.40
Jan-07	13,493,709.68	$2.57	$42,222.22	8.79	52.60
Feb-07	13,784,328.57	$2.56	$41,997.52	1.41	60.80
Mar-07	17,814,193.55	$2.54	$41,618.55	2.19	70.45
Apr-07	17,419,133.33	$2.52	$41,349.93	5.56	73.90
May-07	17,562,700.00	$2.51	$41,098.79	8.33	82.30
Jun-07	18,423,100.00	$2.50	$41,019.30	8.57	88.40
Jul-07	17,499,838.71	$2.50	$41,029.73	13.75	87.80
Aug-07	30,717,267.74	$2.51	$41,105.12	1.03	94.00
Sep-07	27,321,550.00	$2.50	$40,992.15	0.54	88.90
Oct-07	24,172,419.35	$2.49	$40,904.64	1.19	80.60
Nov-07	19,948,833.33	$2.48	$40,663.12	2.37	69.00
Dec-07	15,584,774.19	$2.48	$40,690.42	3.48	62.50
Jan-08	15,857,838.71	$2.47	$41,978.37	2.12	56.00
Feb-08	15,671,035.71	$2.46	$41,856.82	3.92	66.80
Mar-08	15,971,677.42	$2.44	$41,497.11	6.67	71.60
Apr-08	17,251,200.00	$2.43	$41,246.96	4.31	76.30
May-08	19,810,266.67	$2.41	$40,902.52	5.98	84.10
Jun-08	25,209,433.33	$2.38	$40,494.46	5.17	92.10
Jul-08	31,960,838.71	$2.37	$40,282.93	0.14	95.90
Aug-08	28,481,483.87	$2.38	$40,444.37	10.07	91.50
Sep-08	21,452,966.67	$2.38	$40,500.38	6.80	82.80
Oct-08	21,344,806.45	$2.55	$40,913.66	4.50	79.70
Nov-08	18,169,600.00	$2.60	$41,712.58	6.72	67.50
Dec-08	14,347,074.19	$2.63	$42,148.50	1.38	60.10