

EXECUTIVE SUMMARY

In the previous four studies conducted in 1992 through 1997 by the Center for Energy and Environmental Policy (CEEP) of the University of Delaware, demand-side management (DSM) programs undertaken by Artesian Water Company, Inc. were shown to influence water conservation during the summer months. The DSM measures included in these studies were conservation oriented rates, information campaigns and the delivery of conservation kits.

In these studies, the DSM programs were evaluated based on the empirical results founded on consumers' behavioral responses to program options. The findings, useful as water conservation policy guidelines, indicate that the most influential water conservation option was a pricing policy. The next most influential policy option was conservation device rebate programs, followed by information campaigns.

Objectives and Tasks

It is the purpose of the 1998 study to evaluate the persistence of Artesian's DSM measures on residential water conservation during the summer. For this purpose, we adopted a panel study approach by adding the 1997 data to the existing 1992-96 data set and consulted the results of a simplified interview which was conducted in 1994 to identify any changes in household and housing characteristics since the last interview in early 1993. In addition, the current study includes information on the lot size and the assessed property value for the sample households. These data were gathered in 1995 from the New Castle County's Recorder of Deeds Office.

As a means of accomplishing the objectives of the current study, the following tasks were conducted: a review of the general characteristics of Artesian's residential demand-side management (DSM) programs; an analysis of the representativeness of the current sample; a trend analysis of water consumption between 'the conservation group' and 'the non-conservation group'; a regression analysis along with a correlation and t-test to measure the persistence of conservation performances; and the development of policy recommendations based on the above findings.

Artesian's Residential DSM Programs

As part of long-range strategic planning, Artesian set a goal to become a leader in encouraging water conservation. According to direct testimony (1992) before the Delaware Public Service Commission (DPSC) by Dian C. Taylor, President of Artesian Water Company, Inc., Artesian has a three-part conservation plan:

- ? To enhance public awareness through education;
- ? To promote direct conservation measures such as the use of water-saving devices to give customers the knowledge and means to incorporate conservation and sensible water use in their routines; and
- ? To employ a conservation-oriented rate structure to allow pricing to encourage conservation.

A Customer Profile of Sample Households

Major findings on Artesian's residential customer survey conducted in 1993 by CEEP are listed with the focus being on the DSM measures implemented by Artesian.

- Almost 70 percent of the sample households of Artesian customers are aware that their water prices increased on September 1, 1992. However, the respondents seem to be unsure of the exact nature of the price increases. The proportion of those who responded that prices during periods of high use are "higher", "about the same", or "not sure" compared to periods of low use is about the same (approximately 30% each).
- A little over half of Artesian's customers (56%) are aware of the free water conservation devices offered by Artesian. Only 13%, however, actually obtained the devices.
- Three-quarters of the sample households are aware of Artesian's summertime sprinkling regulations, but less than 2% indicate that they have observed these regulations.
- Artesian is buying water from Wilmington Suburban Corporation and Chester Water Authority in Pennsylvania, as well as the City of Wilmington and the City of New Castle, but almost half of the surveyed customers (45%) indicated that they believe there are currently no problems with water supply.
- Whereas about 60% of the sample households installed water conservation fixtures, only 13% obtained the devices from Artesian prior to the Consumer Conservation Program (CCP) jointly sponsored by the State and Artesian. The remaining 47% of customers purchased the devices themselves.
- The most popular water conservation devices installed by customers were low-flow showerheads (36%), faucet restrictors (23%) and ultra low-consumption toilets (21%).
- Around 60% of sample households were very supportive or somewhat supportive of conservation devices supplied by water companies for a fee.

- Three-quarters of the sample households regularly check their water bills to see if they are increasing or decreasing. When their bills increase, households report active efforts to curtail water consumption indoors and outdoors, identify leaks or changed usage behavior of family members, and contact the company to register their complaints. Only 21% indicate that they take no action in the face of increased bills.
- Although 76% of the respondents do not support a policy option to have water prices increased to encourage greater water conservation per se, 63% are supportive of a policy designed to increase higher summer prices for large water users. Only 19% responded that they would not support such a policy. More than 72% of the small consumption group are supportive, while 62% of the large consumption group are in agreement with a policy of higher summer prices.
- Large water users in summer tend to have characteristics which are more conducive to a seasonal pricing than small users: they are more price sensitive; are younger with larger family size; belong to a higher income category; have more water-consuming appliances with higher frequency and longer duration of usages; and water their lawn and/or garden(s) and wash their cars more frequently and longer.

Current Sample and Its Representativeness

The sample size of the current 1992-97 panel study conducted in 1998 is 510 households, 70% of the 1992 sample size of 662 which is considered to be representative. As a means of examining the representativeness of the 510 sample, t-test was conducted to compare the two samples (the 510 sample and the 662 sample) for such variables as the level of water consumption, the average prices they paid, the level of family income, the size of household and the assessed value of property. There were no statistically significant differences in these variables between the two samples. In fact, t-statistics for all five variables range from 0.04 to 0.85, far less than the critical t-value of 1.965.

The comparison was also done for the three customer groups. Within each consumption group, there were no significant differences in these variables between the two samples. The 1992 sample (662 households) and the 1992-97 panel sample (510 households) are basically the same, implying that the 510 sample is also considered to represent the population.

A Trend Analysis of Water Consumption

The trend analysis focused on the evaluation of differences in water consumption trends during the study period between those customers who were affected by Artesian's DSM programs (the conservation group) and those customers who were not affected, or less affected by the programs (the non-conservation group). Both of these groups were divided three ways in terms of their overall consumption: small, medium or large consumption.

In this trend analysis, a panel study approach was adopted so that the same households were included in the study in 1992 through 1997. The focus of the analysis was on the three policy variables which were also statistically significant: conservation-oriented pricing (PRICE), conservation kit delivery (DEVICES) and information campaigns (INFORM). One noticeable finding is that regardless of the group, the 1997 consumption is higher than the 1996 consumption, reversing the decreasing trends of water consumption during the study period.

- ? Artesian's information campaigns as part of its DSM program (INFORM) had a moderate effect on water conservation. Compared to the less informed group (the non-conservation group), the more informed group (the conservation group) steadily reduced its consumption after 1992, widening the gap throughout the study period. The consumption difference became statistically significant in 1994, 1995 and in 1996.
- ? Those customers who received conservation devices from Artesian (DEVICES) as part of the Customer Conservation Program (the conservation group) showed significantly lower water consumption than those without conservation devices (the non-conservation group). The group with devices started with almost same level of water consumption as the group without devices in 1992, but continued decreasing its consumption afterward. Consequently, the water consumption gap between the two groups became significant since 1993.
- ? Those customers who experienced a higher percentage increase in average prices (the conservation group) tended to consume less water during the study period compared to those with lower percentage increases in average water prices (the non-conservation group).

Persistence of Conservation Performances

As a means of evaluating the persistence of Artesian's DSM performances, we estimated water demand models using a regression approach. Preliminary tests (a correlation analysis and t-test) were utilized to examine bivariate relationships between day- and weather-adjusted actual water consumption of the sample households and factors that are expected to influence their water-using activities. The variables which were statistically significant in the preliminary tests were considered in our full range water demand analyses.

Cross-sectional regression models were first estimated with both linear and log forms. Price elasticities estimated from these models are elastic, greater than 1. It should be noted, however, that the coefficient of PRICE is likely to be biased upward because the average price paid by customers facing block or flat rates with customer charges depends upon the quantity consumed. More importantly, there exists a conceptual problem to estimate the price elasticity of water demand using cross-sectional data.

A regression model with proportional changes (between two years) was adopted instead of a

cross-sectional model for a single year because the latter cannot supply information on changes in price and consumption which are essential for the estimation of price elasticity. For consistency with the previous model constructed for the period of 1992-93, the same variable specification was adopted in the subsequent equations (1994 through 1997). The dependent variable (WATER) and an independent variable (PRICE) were entered in the equation in proportional change forms between the two years, while INFORM and DEVICES were inserted as base-year variables.

For the equations from the period of 1994, it was possible to elaborate the model by including additional information which was gathered from the survey conducted during November 1994. Change in the size of household (HHSIZE) between the two years was added into these equations from the 1994 analyses. These revised equations explained more than 22 % of the variance in water consumption growth, basically a little higher than the previous equations. The magnitudes of the coefficients of the three policy variables (PRICE, DEVICES and INFORM) in these revised equations were not significantly different from those of the original equations, implying that the results of our model are stable.

The most statistically significant variable in the equation was PRICE, followed by DEVICES and then INFORM (based on t-values). An estimated price elasticity of -0.45 in the 1992-97 equation is slightly lower than those of the 1992-94, 1992-95 and 1992-96 equations (-0.66, -0.59, and -0.53, respectively). This means that the price responsiveness by consumers has been persistent since the 1992 price reform, but their magnitudes have softened as time goes.

The 1992-97 equation indicates that those who received the conservation devices from Artesian reduced their consumption by 16% compared to those who did not. Also, those who were more informed about water conservation reduced their demand by 5% compared to those who were less informed. It should be noted, however, that only 12% of the sample households have received the conservation devices from Artesian, whereas 50% of the households have access to the Company's conservation information campaigns.

Since our panel study has a 6-year duration from 1992 to 1997, we reestimated the equations using inflation-adjusted water prices. The results show that, in overall, the price elasticities become larger, and the coefficients of the constant term become smaller compared to the original equations estimated with nominal water prices. As expected, there are no changes in the coefficients of INFORM and DEVICES and such statistics as R^2 s and F-values as shown in Table 80. Even though the magnitude of the price elasticities was higher in every equation (also larger in the later years of the study period) compared to the original equations, but their historical trends of the elasticities were almost identical between the two.

Policy Implications

Policy implications are derived from our trend and demand analyses. Our discussion focuses on three policy options which have been adopted by Artesian Water Company, Inc.: a conservation rate, education, and the delivery of conservation kits. To successfully promote water conservation programs, we recommend that the programs be designed which take into account empirical results founded on water users' behaviors in response to program options. The findings below can be useful as policy guidelines.

The estimated impacts of Artesian's DSM measures were based on five years of experience (1992-97), and the results have been persistent. There is a need, however, to examine whether the level of information perceived by the sample customers has been changed since 1992, and whether the customers received conservation devices from Artesian have installed and still used them. Also whether they added new water-conserving devices from Artesian since the recent survey of 1994.¹

Enhancement of Information Quality

Our demand and statistical tests indicate that Artesian's information campaigns through the Company's bill inserts and pamphlets (INFORM) have had some water conservation impact. But INFORM was not statistically significant except for the 1992-95 equation. Its influence becomes stronger in 1995, but is decreased after 1995. Based on the 1992-95 equation, those customers who received and remembered water conservation-related information supplied by Artesian tended to reduce their consumption by around 9% more than those who did not.

Water utilities in collaboration with state and local governments could play an active role in the dissemination of quality information on the water supply situation and conservation needs. From a policy standpoint, the amount of information the residents have is not that important. The most critical matter is to get them to take the message seriously enough to change their behavior. The information should be clear and understandable to residents and motivate them to take actual conservation measures. The information campaign should also be persistent to be most effective. Billings and Day indicate that "the effect of publicity exists only as long as the publicity continues" (1989: 63).

Delivery of Conservation Devices

Our analyses and engineering estimates (Postel, 1986; and Vickers, 1989, 1991 and 1993) generally indicate that efficient water fixtures can significantly reduce water consumption. Those customers who received conservation kits either prior to Consumer Conservation Program (CCP) or as part of CCP had a significant reduction in water consumption (16% in the 1992-97 equation). However, because the

¹ For this purpose, a simple survey can be conducted by Artesian on the basis of a questionnaire developed by the Center for Energy and Environmental Policy.

percentage of customers using Artesian's conservation devices is small,² Artesian might consider adopting combined strategies of information and pricing (including utility rebate programs) to promote installation of conservation devices by customers.

A high-penetration program could be adopted to increase participation in the delivery of water conservation devices whether for free or for a fee. One example from an electric utility program is introduced here. The Santa Monica Energy Fitness Program used new techniques designed to increase participation in the Residential Conservation Service (RCS) Program by utility customers. The technique was to complete a direct-service-home-energy audit, which included the actual on-site installation of energy saving devices in the participant's home (Egel, 1986). This type of energy program could clearly be applied to water conservation as well, especially since several of the Santa Monica measures were for hot water savings.³ This approach resulted in participation among the highest ever achieved by an RCS Program. Since program costs and energy savings per household were comparable to those associated with most traditional RCS Programs, far more total conservation was achieved at similar cost per unit saved.

Adoption of Conservation-Oriented Pricing

Pricing policy is essential for ensuring that water utilities and customers alike weigh efficiency alternatives properly in their water supply and demand decisions. Our survey indicates that residential customers of Artesian are sensitive to water prices (price elasticity of -0.45 in the 1992-97 equation). The most serious water supply problem faced by water utilities (including Artesian) is peak summer demand when capacity is limited. In this case, utilities satisfy demand through such options as purchasing expensive water from other utilities, reactivating old wells currently not in use, or expanding storage capacities. These supply-side actions impose high costs on the utilities (higher marginal costs). Consumers who are the principal source of peak demand should shoulder higher costs. Seasonal pricing, which is generally supported by Delaware residents, reflects these higher costs.

Since pricing is a significant policy variable influencing water conservation, Artesian should continue considering pricing as a water DSM alternative to conventional supply options. To be most effective, pricing structure should be designed in such a way that discretionary water users in the summer months are given signals to reduce consumption.

² The policy of free distribution of conservation kits by Artesian in collaboration with the State as part of CCP had limited reach.

³ Santa Monica is a liberal, environmentally-oriented community, quite different from New Castle County. However, the penetration technique undertaken by its Energy Fitness Program did not rely on these characteristics and is considered to be generally applicable to communities regardless of political or social beliefs.

