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## Factors Influencing Rural Water Purchase

Charles R. Rosenstiel  
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Research Report No. 38

FACTORS INFLUENCING RURAL WATER PURCHASE

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One of a series of technical reports on  
Project A-022-KY, Dr. Henry F. Dobyms,  
Principal Investigator

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1970

## ABSTRACT

The following report is an analysis of factors which influence domestic water purchase among residents of a rural Kentucky county who must purchase hauled water. The results of the analysis are compared with previous studies of factors which influence domestic water use by urban dwellers participating in a piped water distribution system.

The results of the analysis of rural water purchase corroborates the findings from the studies of urban water use, showing that the amount of water purchased by a household is influenced by the socio-economic status of that household and by the price paid for water. As socio-economic status rises, domestic water purchase increases, and as the price of water increases, the amount of water purchased decreases.

FCST Category - VI-F

KEY WORDS: Social change, social values, social impact, social attitudes

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## CHAPTER I

### INTRODUCTION

The two major objectives of this thesis are: 1) the description of certain characteristics of domestic water use among members of a rural population and 2) the delineation of factors related to high water purchase. Data were acquired between May and September of 1969. Research was funded by the Water Resources Research Institute, an agency of the United States Department of Interior, and the Department of Anthropology, University of Kentucky.

#### Justification of the Study

Many municipal water systems are hard pressed to supply water to their constituents. In 1965 a survey of 268 large cities and towns in the United States showed that 66 have experienced "severe" water shortages, and "... a vast majority of them anticipate such a crisis in the foreseeable future" (Wright 1966: 40). The water crisis is compounded variously by inadequate planning for future needs, pollution of water sources, general population increase, increased industrial demands for water and a consistent increase in average household water demands. Domestic water purchase from municipalities has increased nationally from 50 gallons per person per day (ppd) in 1950 (Ackerman and Lof 1959: 49), to 60 gallons ppd in 1964 (Landsberg 1964: 126), and continues to increase. Knowledge and understanding of the factors that have influenced this

increase, and high domestic water use in general could be helpful in averting a major water crisis by providing data from which future community water needs could be projected and by suggesting means by which domestic water demands could be curbed.

### Pertinent Literature

Factors related to domestic water consumption have been studied in and among communities having a piped or "closed-ended" water distribution system. It has been found that the amount of water consumed by a household is related to socio-economic status. Domestic demand for water increases as status rises. Irving A. Spaulding, in a study of the city of Warwick, Rhode Island, found that "among the indicators of status, house value and household income are more closely related to water use than are the education and occupation of the household head" (1967: 24). A similar study of a piped water system in Kankakee, Illinois, showed that an increase in assessed property valuation was accompanied by an increase in the amount of household water used (Dunn and Larson 1963: 449). A comparison of water consumption in six northern Utah counties indicated that an increase in lot size was the variable most closely correlated with an increased demand for water (Gardner and Schick 1964: 18).

Non status factors related to domestic water use in piped water systems are the price of water and the number of persons residing in a household. In the study that considered price as an influencing variable it was found that "average consumers in communities with high prices purchase less water than

those in communities with low prices" (Ibid: 14). In the Warwick study household size, not considered to be a status indicator, was more closely related to increased water use than other non status variables (Spaulding 1967: 24). No comparable studies were found on rural domestic use.

#### Relevance of this Study

The water using population in this study differs from that of previous research. The people studied live in a rural area, and many of them derive at least a portion of their income from farming. They also obtain their water differently. The source of water for the urban population is a municipal water works, where water is conveyed from a centralized source through pipes to the houses. People participating in a piped water distribution system have only one water source, so that it can be called "closed-ended". All of the people contacted in this study used stone, concrete or metal lined holes (cisterns) for water storage, and "caught" from their roofs a portion of their domestic water supply. They supplement their supply when necessary by purchasing from a water vendor who delivers water to the house by truck. He in turn purchases water from the county seat's municipal water company. Since customers have alternative sources of potable water the system is referred to as "open-ended". A portion of this population's domestic water supply is free, while in a piped or "closed-ended" system all water is usually purchased.

The present research was initiated on the premise that a study of a different type of water system, and a comparison of two sub-cultural systems

could disclose additional factors that influence high water use, and/or add an element of universality to past findings.

#### The Study Area

All households represented by the study sample are located in Mahogany County. (All place names have been changed.) Mahogany is a rural northern Kentucky county with a population of approximately 10,000 people. Only one town, Disasterville, the county seat, with a population of 2,500 is classed as urban. All other towns with the exception of Barrow, population 450, have fewer than 50 inhabitants. The county is served by one U. S. highway, eight state routes and numerous other hard surfaced roads. Railroad freight service is provided twice daily to the two larger towns. Average annual precipitation is 42.08 inches, which is sufficient rainfall for growing area crops without irrigation. Average annual temperature is 53.6 degrees Fahrenheit.

A 1965 survey showed that of the 2,676 working people in Mahogany County, 2,000 were employed in agriculture, but the county's residents are not to be confused with the poverty-stricken, Appalachian stereotype. There are certain urban influences which may affect household water consumption. In 80 percent of the farm households in the study sample, one or more of the family members were employed full-time at some other job. For the most part their jobs were in the large metropolitan area 25 miles away. Three and one half months of participant observation disclosed that the majority of the county's inhabitants frequently travel to one of the large surrounding cities to

visit friends and relatives, to shop in the larger urban stores, or to use urban recreational facilities. Radios, televisions and metropolitan newspapers are almost universally enjoyed. While the county inhabitants are mainly employed in agricultural pursuits, they form a generally affluent community which is increasingly coming under urbanizing influences. (See Table VIII).

#### Research Procedures

Previous to field work, literature pertinent to household water use was reviewed, and a questionnaire providing data comparable to that obtained by the urban household water studies was constructed.

Upon entering the field the business records of the Mahogany County water vendor with the greatest volume of business were obtained. This man, who ran two trucks and hired a helper during periods of heavy purchase, hauled three times as much water as any one of the county's other five water vendors. Because of his large business, this water vendor kept records, noting under each sale the name of the purchaser, date of purchase, price charged and whether the water was for domestic or farm consumption. His 260 customers represent the universe in this study. From this universe a fifteen percent sample was selected. The name of each customer and the number of loads purchased per year was transferred onto cards. At this point, the addresses of every other customer were obtained. The sample population was selected with the idea in mind of covering as many county roads as possible to insure a more equal representation within the county.

Thirty-nine interviews were completed, and from one to three hours was spent at each house. Interviewing was done in the evening so that the corroboration of both the male and female heads of household was usually obtained in answering questions. Only single family dwellings were considered in this study, and for a person to be considered a member of a household he must have resided in the home for more than six months out of the year. To insure the accuracy of the base figure of water purchased, no interviews were made unless the householder had purchased water from only one vendor and had been living in his present home during the year covered by the water vendor's records.

Kentucky has had 100 percent property valuation for tax purposes since 1968. This means that property is assessed at 100 percent of its value. The present market value of real-estate is determined by its sale price if it has changed hands within the last two years. If a particular piece of real-estate has not changed hands in that time the value of comparable land near it which has sold is used in figuring its value. The 100 percent valuation of automobiles is based on their present blue book value. Accurate records pertaining to real-estate valuation, and automobile value were obtained from the county court house tax records.

#### Representativeness of the Sample Population

It is proposed that the patterns of water purchase characterizing the sample population are more representative of the county population than they

are of the universe (water vendor's customers). Approximately every third person approached for an interview did not purchase exclusively from the water vendor whose records were used, and therefore could not be interviewed. Most of those who did not purchase exclusively from him contacted him in extremely dry months when their regular water vendor could not handle their business promptly. (The sample population usually purchased water only when their personal supply was extremely low.) Two people owned trucks and hauled their own water, contacting the water vendor only when they were too busy to haul water themselves. The result is that many of the water vendor's 260 customers had other sources of purchased water, and the mean purchase of 9,846 gallons of water per year per household for the sample is much higher than the mean yearly water purchase of the universe. On the other hand, it was found that the need to purchase hauled water by people doing business primarily with other vendors closely approximated that of the sample.

## CHAPTER II

### SELECTED CHARACTERISTICS RELATED TO HOUSEHOLD WATER USE

#### Alternative Sources of Potable Water

Each of Mahogany County's two largest towns has its own water works which supplies potable water to town residents and water vendors. The Mahogany County water system which purchases water from one of the town water works serves only a small portion of the county's rural residents. Many of the interviewees expressed the desire to be on the piped water distribution system, but money has not been made available for its extension. The absence of a county wide piped water distribution system has retarded the expansion into the county by real-estate developers. It has also made the development of alternative sources of potable water a necessity for a majority of the county's residents.

Through the years four sources of potable water, other than piped water, have been used and developed. In the past springs and later hand-dug wells were used. Today drilled wells and cisterns, especially the latter, provide potable water for the county's inhabitants.

#### Springs

When the first settlers migrated into Mahogany County in the 1770's there was an abundance of potable ground water. A dependable source of household

water used for drinking, cooking, cleaning and cooling perishable foods was a prerequisite to homestead development. The usual procedure was to build the cabin near a surface stream and within easy carrying distance of a surface spring. A small square of earth immediately surrounding the spring was excavated to a depth of one to several feet. This was walled with stones, usually without any binding mortar. Within the immediate area of the homestead other springs were usually improved and used for watering livestock.

No one in Mahogany County uses surface springs as a source of household water today, as some people do in the more mountainous regions of Kentucky. Modern agricultural practices and a lowering of the water table have caused springs to dry up, also eliminating them as a major source of water for livestock. This has led to the construction of ponds throughout the county.

#### Hand-Dug Wells

As roads were improved and became important as lines of communication and transportation, the settlement pattern in Mahogany County shifted away from streams. Frame houses were constructed near roads, not necessarily close to a surface spring. This shift in settlement pattern necessitated the development of a new source of water, and this was provided by hand-digging wells. Hand-dug wells were usually situated within 20 to 60 feet of the house. Their usual depth was 20 to 30 feet with some being as deep as 40 feet. After excavation they were walled with stones. The few wells still used are rarely more than one-third filled with water. At one time hand-dug wells were the main source of household water and cooling in the county, but within the last

twenty to thirty years nearly all have been replaced as a major source of household water.

No one is constructing hand-dug wells in Mahogany County today. Of the households interviewed, only five of the thirty-nine or 7.8 percent had hand-dug wells on their lot, and none of these had been dug within the last 40 years. None of these wells are used as a source of household water. Two major reasons were given for the decline in their use. First, they do not provide a dependable source of water for modern needs. In three of the five cases the water vein had shifted, leaving the well all but dry, while in the other two cases the vein did not provide enough water to run modern, water using apparatus. Secondly, underground water in Mahogany County is "hard" water; it contains a heavy concentration of minerals. These impart to the water a "salty" flavor that is only appreciated by a few older citizens who learned to drink the water as children. The high mineral concentration also leaves deposits in cooking utensils, toilets, pipes, etc. and makes it difficult to work up suds when washing clothes or dishes. For these reasons well water is disliked by the local housewives.

As hand-dug wells declined in importance as sources of household water, two economic specialties related to their use and maintenance disappeared. The "water-witch", who located the underground spring, and the traveling well cleaner are no longer employed in Mahogany County.

### Drilled Wells

Drilled wells are infrequently used as a source of domestic water. Where adequate underground water is available, the price of drilling a well, which runs from \$700 to \$1200 depending on its depth, is usually considered prohibitive. Water from deep wells in the area is often so mineral laden that it turns silverware black and has a sulphurous odor. For this reason a water softener is felt to be a necessary part of a drilled well water system. Water softeners cost from \$250 to \$500 and are highly undependable. Two people told me that they would drill wells if a dependable water softener were marketed, but that the necessity of constant maintenance coupled with the initial drilling costs would make the system highly uneconomical for them. It should be noted that drilled wells are frequently used by residents in a nearby county where the water has a low mineral content.

### Cisterns and Hauled Water

Rainwater is the most frequently used source of household water in Mahogany County. It is collected from the house roof by a system of rain troughs, and transported by drain pipes, usually through a charcoal-sand filter, and into a storage tank (cistern). Cisterns were initially holes 20 to 30 feet deep, that were lined with limestone rocks and sealed with cement. Today they are usually constructed from concrete blocks or are large metal tanks sunk into the ground.

If the house is situated on a farm, the barn nearest the house usually has a similar system of water retrieval and a separate cistern. Water from this

supply is used for watering livestock and cleaning the barn and milking apparatus if the farm has a dairy operation. Only one man met during the summer tapped his barn cistern for household use. On the contrary, if the farm is also a dairy the farmer usually must buy water during the year for his barn cistern as well as his home.

During the period before the use of bathtubs, toilets and electric clothes washing machines the cistern with its rainwater supply could provide enough water for household needs. But, today most homes have these water using conveniences, and rainwater is not sufficient. Hauled water must be purchased, if not regularly, at least once or twice yearly. A few rural residents, usually farmers who have large trucks for farm purposes, have purchased a water tank and haul their own water. Most householders, however, rely on the rural water vendor to supplement their personal supply. Households represented by the sample pay an average of more than \$55 a year for water. As the role of water witch and well cleaner declined in importance, the water vendor became a necessary part of the rural water supply system.

#### Variation and Regularity of Water Purchase

Water purchase for the sample ranged from 1,000 to 26,000 gallons of water per household per year. In Table I the sample population is divided according to its frequency of water purchase. Self-sufficiency in water supply is approached by 23 percent of the sample, who purchase from one to three loads of water per year. Water was purchased by 51 percent of the sample seven or more times a year and these households are considered to be regular

water purchasers. Thirty percent of the sample purchased water an average of more than once a month and are heavily dependent on hauled water to augment their rainwater supply.

When asked whether they had to purchase water regularly or only in dry seasons, 41 percent said that they purchased only in dry seasons, and 59 percent thought that they purchased water regularly. The water vendor's sales records generally substantiate the customer's replies if six loads of water per year is considered to be regular water purchasing. Power pumps with piped water into the house were features found in 80 percent of the homes. Sixty-one percent of the households with power pumps and 50 percent of those without them considered themselves to be regular water customers. The high percentage of regular water purchasers among those without power pumps and piped water into the house was unexpected, but can be partially explained by the use of washing machines in three out of the four households. In addition, two of the householders were living in rented houses whose water retrieval systems were in ill repair.

To summarize, there is a wide variation in the need to purchase water among Mahogany County's rural residents, and a heavy dependency on hauled water is a characteristic of over half of the sample. This variation in water purchase cannot be attributed to the occurrence of plumbing in the household because a part of those with plumbing and a part of those without it must purchase water on a regular basis, while a percentage of each group does not.

TABLE I

FREQUENCY OF YEARLY WATER PURCHASE BY SAMPLE,  
 MAHOGANY COUNTY, KENTUCKY, MARCH 1968-FEBRUARY 1969.

Number of Loads Purchased per Year	Number of Purchasers	Percentage of Sample
1-3	9	23.1
4-6	10	25.6
7-9	5	12.8
10-12	3	7.7
13-15	3	7.7
16-18	2	5.1
19-21	1	2.6
22-24	1	2.6
25-26	5	12.8

Source: Water vendor's records.

Plumbing and water using apparatus has caused an increase in the amount of household water used, but there is a wide variation in water purchase among those with plumbing that can only be explained by other factors.

#### Effects of Precipitation on Water Purchase

A comparison of monthly precipitation with water purchase indicates that the amount of rainfall influences but does not strictly determine water purchase. In Table II precipitation and water purchase are compared on a monthly basis. Mean water purchase for the three months with the lightest precipitation was 30.1 percent above the monthly mean for the year. Inversely, the mean water purchase for the three months with the heaviest precipitation decreased 27.7 percent. It was also found that an extreme rate of precipitation in one month influences water purchase in the following month. An average increase of 20 percent occurred during those months immediately succeeding the three months of least precipitation and decreased by an average of 12 percent during those months immediately succeeding the three months of highest precipitation. Precipitation extremes do influence the volume of water purchased, but it seems significant that deviation from the monthly mean for the year does not exceed 30 percent for those three months with the highest and lowest precipitation or for those months succeeding them. It suggests that even in months of heavy precipitation there is a heavy dependence on hauled water for a certain segment of the population.

Table III, which shows the number and percent of households in the sample that purchased water each month, further illustrates the point. The number of

TABLE II

MONTHLY PRECIPITATION AND PERCENTAGE OF MONTHLY  
WATER PURCHASE OF THE SAMPLE, MAHOGANY COUNTY, KENTUCKY,  
MARCH 1968-FEBRUARY 1969.

Month	Amount of Precipitation	% for Year	% of Purchase by Sample
Feb. <u>68</u>	.41		
March	5.38	11.2	11.2
April	5.68	11.9	4.1
May	8.63	18.0	4.8
June	1.65	3.4	10.9
July	6.10	12.7	9.2
Aug.	5.40	11.3	6.1
Sept.	2.70	5.6	5.9
Oct.	1.38	2.9	10.2
Nov.	3.28	6.8	9.7
Dec.	3.05	6.4	5.6
Jan. <u>69</u>	3.72	7.8	11.2
Feb.	.92	1.9	11.2

Source for data on precipitation: Climatological Data, U. S. Department of Commerce.

TABLE III

MONTHLY PRECIPITATION AND NUMBER OF WATER PURCHASES AND  
PURCHASERS PER MONTH AMONG SAMPLE, MAHOGANY COUNTY,  
KENTUCKY, MARCH 1968-FEBRUARY 1969

Month	Precipitation	Number of Purchases	Number of Purchasers
March <u>68</u>	5.38	44	17
April	5.68	16	13
May	8.63	19	16
June	1.65	43	24
July	6.10	36	22
Aug.	5.40	24	18
Sept.	2.70	23	17
Oct.	1.38	40	24
Nov.	3.28	38	25
Dec.	3.05	22	13
Jan. <u>69</u>	3.72	44	26
Feb.	.92	44	19

water purchasers per month fluctuates from 33 percent to 66 percent of the sample. The mean number of purchasers per month is 19.5 or one half of the sample. Of those surveyed, 40 percent purchased water in May, the month of highest precipitation (8.63 inches). An appreciable number of rural dwellers are dependent on an outside source of water regardless of the monthly amount of precipitation.

#### Effects of the Water Retrieval System on Water Purchase

Three variables related to the water retrieval system: roof size, cistern capacity and problems with the retrieval system were anticipated as explanatory factors of high water purchase. Unfortunately none of the informants knew the area of the roofs used in catching water. It is presumed, however, that roof-size roughly corresponds to the size of the house, and this, in turn, is at least partially reflected in real estate valuation and household size.

Cistern capacity was known by less than half of the informants. Average capacity for those who did know it is 5,420 gallons, with no cistern having less than a 1,000 gallon capacity. Only five respondents had a cistern capacity of less than 2,000 gallons. The mean yearly water purchase for these five householders is 9,600 gallons a year, or slightly below the 9,846 gallon mean of the sample. Only two people mentioned instances when they were unable to collect water because of a full cistern, which further suggests that cistern capacity is not a major determinant of high water purchase.

Three cases of problems related to the water retrieval system were reported as cause for higher than usual water purchase. The mean yearly purchase for

these three cases was 5,333 gallons, well below the sample mean. This variable is considered to be insignificant as a determinant of high water purchase.

The high cost of hauled water is considered in planning the water retrieval system. Cisterns are usually constructed of a capacity that will take full advantage of rainwater run-off. Problems with the retrieval system are quickly remedied because the cost of maintenance is usually less than the cost of replacement of lost water. For these reasons the water retrieval system has little effect on the need to purchase water.

#### Attitudes Pertaining to Household Water Conservation

The attitude that there is a need to conserve household water was expressed by 90 percent of the sample and is held generally by those Mahogany County residents who have an "open-ended" water system. Concern over domestic water conservation is directly attributable to the high cost of hauled water. Prices for 1,000 gallons (one load) of hauled water range from five to nine dollars depending on the distance that the water is to be hauled from the source. The mean price paid by the sample is \$5.83 per load, as compared with a maximum of \$1.25 paid by county seat residents for the same quantity. It should also be noted that hauled water customers achieve no decrease in price for increased consumption, while the price per thousand gallons decreases after the first two thousand gallon minimum charge, for "closed-ended" system customers. The general attitude of the sample population is that if they were living in town where water is cheap, they would not be concerned with saving water.

It was found that a move into the rural area from a "closed-ended" (low cost) water system usually entailed a change in water using habits, toward a more economical use of water. This is especially true of members of lower income households. A middle-aged female informant who had lived at the county seat up to the time of her marriage to a county farmer said, "When I was growing up in town we never considered water as something important or as something to be saved, but since moving to the farm I don't waste a drop. In town I was always leaving the water running or flushing things down the toilet, but not out here." The attitudes that water is something to be saved is especially prevalent among farmers who have had the least urban contact.

#### Effects of Attitudes on Water Use and Purchase

The generally conservative use of domestic water is reflected in the outdoor use of household water represented in Table IV. Only four persons irrigated their lawns, while lawn irrigation is considered to be a major determinant of high summer water use in suburban communities. Cars are washed and flowers are watered by several in the sample, but usually infrequently and without the aid of a hose so that neither influences domestic water consumption significantly. Recreational use usually means filling a small children's swimming pool several times during the summer months resulting in little water consumption. Total outside uses only exceeded the number in the sample by two.

TABLE IV

OUTDOOR USE OF DOMESTIC WATER BY SAMPLE, MAHOGANY COUNTY,  
KENTUCKY, MARCH 1968-FEBRUARY 1969

Uses	Number of Sample	Percentage of Sample
Irrigation of Yard	4	10.3
Irrigation of Flowers	15	38.5
Washing Automobile	10	25.6
Recreation	8	20.5
Watering Livestock	3	7.7
Other Uses	1	2.6

TABLE V

FREQUENCY OF OCCURRENCE OF WATER USING APPARATUS AMONG  
THE SAMPLE, MAHOGANY COUNTY, KENTUCKY,  
MARCH 1968-FEBRUARY 1969

Water Using Apparatus	Frequency of Occurrence	Percentage of Sample
Bathtub	27	69.2
Shower	9	23.1
Toilet	27	69.2
Washing Machine	32	82.1
(automatics)	9	23.1
Heating	0	0.0
Cooling	2	5.1
Dishwasher	1	2.6
Other	0	0.0

The desire to conserve water is also reflected in the purchasing patterns of the sample. A bathtub, toilet and especially a washing machine are considered to be necessities by most county residents who own their own homes. Showers, which are generally thought to require more water than a bathtub, are used by only 23 percent of the sample. Automatic washing machines and electric dishwashers are regarded as "using too much water", and are therefore infrequently purchased. Many women desire automatic clothes washers, and say that they could easily afford them if it was not for the high cost of the water needed to run them. While many Mahogany Countians could well afford additional water using apparatus, few feel able to purchase the water to run them.

## CHAPTER III

### FACTORS RELATED TO VARIATION IN WATER PURCHASE

A high degree of variation in the amount of water purchased is characteristic of the sample. Water purchase for those with plumbing and a washing machine ranges from 1,000 to 26,000 gallons per household per year, and several households without plumbing must purchase water regularly. It was also shown that a small cistern capacity and problems with the water retrieval system did not raise water purchase, for those of which it was characteristic, above the sample mean. The variables clearly do not determine the wide variation in water purchase found among those households represented in the sample.

#### Regression Analysis of Variables Affecting Water Purchase

A step-by-step multiple linear regression analysis was used to determine the relationship between selected variables and the amount of water purchased, by an equation of the form:

$$Y = b(0) + b(1)X(1) + b(2)X(2) + \dots + b(n)X(n).$$

Y represents the dependent or influenced variable, the amount of water purchased.

X(1), X(2), . . . , X(n) are the independent or influencing variables.

b(0), b(1), . . . , b(n) are the coefficients to be determined (Zerof 1968: 167).

Independent variables considered in this analysis are:

- X 1 = real estate valuation
- X 2 = automobile valuation
- X 3 = number of full-time jobs held by the family
- X 4 = education of household head
- X 5 = tobacco acreage from which profit was derived
- X 6 = estimated value of the house
- X 7 = estimated value of the farm
- X 8 = reported family income
- X 9 = number of water using apparatus
- X10 = number of outside uses of household water
- X11 = price of water
- X12 = age of household head
- X13 = number in family

Actual amounts were used for all variables except X6, X7 and X8. Equal interval groupings of \$10,000 were used for X6 and X7 and equal interval groupings of \$3,000 for X8. The intervals used for X6 and X8 follow those used by Spaulding (1967: 29). The mean and range for each variable can be found in appendix B.

Variables one through nine are considered to be potentially indicative of socio-economic status.

Real estate and automobile valuation were obtained for each householder from Kentucky tax records. (Estimated value of house and farm were included because some of the informants were renters.) The volume of water

purchased and the price paid for water was obtained from the water vendor's sales records. All other information was taken from the interviews.

### Results of the Regression Analysis

The results of the regression analysis are shown in Table VI. The total F, or variance ratio was 4.9718 showing significance at the 0.05 level. The thirteen variables explained 72.11 percent of the variation in Y, the amount of water purchased per household. (This compares favorably with the two urban studies that used a multiple regression analysis. In one study the  $r^2$  did not exceed 24 percent (Spaulding, 1967: 16-24), and in the other the explained variation in Y using the same analysis was 55 percent (Gardner and Schick, 1964: 13). Only four variables: tobacco base and price of water, with a negative regression coefficient and value of farm and household income, with a positive regression coefficient, had a t value showing significance at the 0.05 level.

The significant relationships between the three variables indicative of status and water purchase seem to provide conflicting evidence. Tobacco is Kentucky's most important cash crop, and its production is controlled by a federal acreage allotment system. The negative relationship between tobacco allotment and water purchase would seem to contradict the positive relationships found between farm valuation, income and water purchase. Yet, the negative relationship between tobacco allotment and water purchase was not wholly unexpected after a summer of participant observation. It is to be remembered that in 80 percent of the farmer households some member of the family was

TABLE VI

REGRESSION OF SELECTED VARIABLES ON QUANTITY OF WATER  
PURCHASED BY HOUSEHOLDS, FINAL ANALYSIS, 39 HOUSEHOLDS,  
MAHOGANY COUNTY, KENTUCKY, MARCH 1968-FEBRUARY 1969.

Variables	t Value	Explained Variation in Y (r <sup>2</sup> )
X1 - Real estate value	0.23773 (13)	.0007 (13)
X2 - Value of Car	1.75405 ( 5)	.0370 ( 4)
X3 - Number of jobs	-0.35930 (12)	.0187 ( 7)
X4 - Ed. Household Head	0.56811 (11)	.0079 (12)
X5 - Tobacco Base	-2.44971 ( 4)*	.0296 ( 5)
X6 - Value of House	-1.03149 ( 9)	.0096 (10)
X7 - Value of Farm	2.57326 ( 1)**	.0192 ( 6)
X8 - Family income	2.46089 ( 3)*	.3183 ( 1)
X9 - Apparatus	-1.43758 ( 7)	.0154 ( 8)
X10 - Outside Uses	1.12557 ( 8)	.0089 (11)
X11 - Price of water	-2.53477 ( 2)**	.1834 ( 2)
X12 - Age Household Head	-0.74332 (10)	.0133 ( 9)
X13 - Number in Household	1.67300 ( 6)	.0592 ( 3)

\*.05, \*\*.02 levels of significance at 35 degrees of freedom. Total explained variation in Y (r<sup>2</sup>): 72.11%. F ratio: 4.9718, 0.05 level of significance at 25 degrees of freedom.

employed elsewhere on a full-time basis. Farmers with larger than average tobacco allotments are those least likely to hold urban jobs for two reasons. First, the raising of tobacco takes intensive care, and those with large allotments must spend much of their time caring for the crop. Second, those with larger than average allotments are able to derive sufficient income for household maintenance from their agricultural endeavors. Those with small tobacco allotments must seek outside employment. Also included in the category of tobacco allotments are individuals employed in urban jobs who raise tobacco on "shares" to supplement their income. Their acreage was computed as one half of the tobacco they raised, which is their percentage of the profit. Both groups are likely to achieve a higher net income than people who rely strictly on farming alone for a living.

It was also found during the course of interviewing that people with a strictly rural orientation were most likely to be conservative in their use of water. Traditionally rural people, unlike their urbanized counterparts, have matured with the idea, and are more likely to retain it, that water is a free good. This idea, probably influenced also by their lower income, makes traditional farmers reluctant to spend money for water. They try to conserve their water supply in several ways, i. e., many do not flush their toilets after urination, and they are less likely to purchase automatic washing machines because of their high water use.

While a larger than average tobacco allotment may mean a below average income, a high farm valuation which ranked first in t value, is usually indicative

of high income. A higher than average farm valuation usually means that the farm contained a dairy operation. Since the institution of bulk milk tanks a dairyman must have a large enterprise to survive. Dairying proved to be a most lucrative means of making a living, with dairy farmers ranking high among the sample respondents in net income.

Household income, with a positive regression coefficient, and the price of water, with a negative regression coefficient, ranking three and two in  $t$  values, explained 31.83 percent and 18.34 percent, respectively, of the variation in water purchase. The price of an item and income are not highly separable entities, they are more like the top and bottom of the same well. To find the depth, or the ability to purchase, one must consider the distance between the ends. The two variables taken together seem to show conclusively that the ability to purchase water is the most important factor influencing the amount of water purchased by a household. It would be desirable, however, to have higher levels of significance for these two variables.

In Table VII the results of the regression analysis using only household income and price of water as the independent variables is shown. Eliminating the other variables has the desired effect of raising the total  $F$  to 18.1236, showing significance at the 0.001 level. The  $t$  values for income and price are raised, showing significance at the 0.001 level reducing the possibility of chance occurrence for the regression coefficients to one in one thousand. Explained variation of the dependent variable ( $r^2$ ) is 50.17 percent.

TABLE VII

REGRESSION OF HOUSEHOLD INCOME AND PRICE ON QUANTITY OF  
 WATER PURCHASED BY HOUSEHOLDS, 39 HOUSEHOLDS,  
 MAHOGANY COUNTY, KENTUCKY, MARCH 1968-FEBRUARY 1969.

Variables	t Value	Explained Variation in ( $r^2$ )
X8 - Family Income	4.066 (1)*	.3183 (1)
X11 - Price of water	3.634 (2)*	.1834 (2)

\*0.001 level of significance at 35 degrees of freedom. Total explained variation in Y ( $r^2$ ): 0.5017. F ratio: 18.1236, 0.001 level of significance.

The effects of income on water purchase are shown in Table VIII. The highest income group purchases more than eight and one half times as much water per household as does the lowest income group. In one urban study where similar statistics are presented, the highest income group uses only 79 percent more water per person per household and only slightly more than twice as much water per household as does the lowest income group, using five intervals of income (Dunn and Larson 1963: 446). The figures for this rural study represent only the amount of water purchased. We do not know how much water is obtained from rainfall, but it is likely that there is not such a wide variation in the amount of water used by the various status groups.

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The wide variation in water purchased by the households could be explained this way. In an "open-ended" system like the one we are dealing with, a household, through the conservation of water, can be self-sufficient in water supply. Enough water for basic needs (cooking, drinking, cleaning, etc.) is provided by rainfall. The mean price paid per thousand gallons of water, \$5.83, would be infinitely more important to a household making below \$3,000 a year than it would be for those households in the \$15,000 income category. Lower income households can, by practicing economy in water use, avoid what is often seen as an unnecessary expense, or pay the high price for water infrequently.

#### Summary

The regression analysis shows that socio-economic status and price of water or, more precisely, the ability to purchase water is significantly related to variation in water purchase. As income rises, water purchase increases, and as price rises, water purchase decreases.

TABLE VIII

FAMILY INCOME AND WATER PURCHASE, 39 HOUSEHOLDS,  
 MAHOGANY COUNTY, KENTUCKY, MARCH 1968-FEBRUARY 1969.

Unit Income	Sample Size	% of Renters	House Hold Size	Average		Real Estate Value
				Per Person	Per House-Hold	
\$ 0,000- 2,999	3	0	2.33	857	2,000	\$ 13,000
\$ 3,000- 5,999	9	4	4.78	789	4,111	\$ 4,889
\$ 6,000- 8,999	6	3	6.50	1,692	11,000	\$ 10,167
\$ 9,000-11,999	14	1	3.50	3,510	12,292	\$ 18,729
\$ 12,000-14,999	4	1	3.50	3,643	12,750	\$ 12,875
\$ 15,000+	3	0	4.67	3,714	17,333	\$ 14,333

The high real estate value for the first group is the result of all household heads in the group being retired farmers who own their own land.

## CHAPTER IV

### COMPARISON OF "OPEN-ENDED" AND "CLOSED-ENDED" WATER SYSTEMS

The findings of this study generally uphold the hypotheses concerning factors that influence variation in water use in and among urban communities. This study substantiates the hypothesis that "quantities of water used in household are related to the social status of those households" (Spaulding 1967: 1). Water purchase increases as status rises. It has also been shown that price, as in urban communities, is an important factor affecting variation in household water use (Gardner and Schick 1964: 18-19). As the price paid for water increases the amount of water purchased by households decreases.

#### Status Factors Affecting Variation in Water Purchase

##### Lot Size

In a study done of water use among 43 water systems in six northern Utah counties it was found that an increase in lot size correlated with an increase in water use (Ibid: 18-19). Lot size was not considered as an independent variable in this analysis, but outside uses of water had an insignificant t value and explained less than one percent of the variation in the amount of water purchased. The difference in results between the two studies can probably be attributed to the extremely high price paid for hauled water as compared to the relatively low price paid for water in urban communities. In the Utah study, it was hypothesized

that "outside water use is affected by lawn irrigation, and normally the amount of water required is related to the size of lot. . ." (Ibid: 6). Hauled water in Mahogany County is generally considered to be too costly to use in irrigating the lawn, and only ten percent of the households in the sample used water for this purpose.

### House Value

House value has been shown to correlate significantly with the amount of water used by households within an urban community; increased valuation being related to increased water use (Dunn and Larson 1963: 448-449). In the Mahogany County study neither property valuation nor estimated value of house was significantly related to variations in water purchase. The t values for the regression coefficients were not significant, and taken together the two variables explained only one percent of the variation in water purchase. Farm value, however, did show a significant relationship to variation in water purchase. The conflicting results provided by the sub-cultural comparison can probably be ascribed to certain characteristics of rural dwellers in the area. In Mahogany County and the surrounding area in general, the house is usually the last item to be improved. Ready capital goes into farm improvement, because it is the farm and not the house from which income and status are usually derived. House value except in the extremes rarely reflects an accurate picture of the occupant's affluence. (See Table VIII and compare real estate value with income.)

### Occupation of Household Head

In one of the two studies of factors influencing water use within a community, the occupation of the male head of household was shown to be best correlated with variations in water use (Dunn and Larson 1963: 443). In the Mahogany County study the occupation of the male head of household was not used as an influencing variable because many of the respondents worked two full-time jobs, and any assignment of principle occupation would have been purely arbitrary. Also, in some instances, the female in the household made more money and had a higher status occupation than the male, e. g. , the wife of a farmer being a secondary school teacher.

Number of jobs was used as an independent variable in the regression analysis, but did not have a significant t value and explained less than two percent of the variation in water purchase. This may have been caused by the limited range in the number of jobs, it being none to four. The mean number of jobs per household was 1.8.

### Household Income

Household income was found to be significantly related to variation in water use in both of the studies done within urban communities (Spaulding 1967: 24, Dunn and Larson 1963: 445). It was not found to be significant in the water study that compared water use among urban communities, and the authors give two possible reasons for this unexpected result. "One is that these results may be valid only for the area covered in the study." The authors state that "if the

geographic study area had included communities where median incomes were more diverse, the income factor might have been more important" (Gardner and Schick 1964: 18-19). This variable proved to have the most significant influence on the variation in the amount of water purchased by rural dwellers.

### Non Status Factors

#### Household Size

Household size was considered as an independent variable influencing water use in one study and was found to be significantly related to variation in water use within an urban community (Spaulding 1967: 24). In this study of rural dwellers, household size had an insignificant t value but it ranked third in  $r^2$ , explaining 5.92 percent of the variation in water purchasing.

#### Price

In the only study that considered price to be an influencing variable, it was found to have a highly significant relationship to water use (Gardner and Schick 1964: 14). This is substantiated by the study of rural dwellers, where price had a highly significant t value and explained 18.43 percent of the variation in Y, the amount of water purchased by household.

### Summary

The comparison of two distinct water distribution systems shows that socio-economic status positively correlates with variation in water purchase. Family income would seem to be the most significant variable causing fluctuation in water purchase.

Price is the variable among those not considered to be related to status that most significantly influences water purchase in both water systems.

Household size, although showing significance as a variable influencing variation in water use, is of less importance as a determining factor of water purchase.

## CHAPTER V

### APPLICATION OF THIS STUDY

#### Mahogany County and Rural Areas

The mean price paid for water by the sample was over \$55 a year, which is well above what buyers participating in a "closed-ended" distribution system pay for water even though rural dwellers "catch" a goodly part of their supply. More than one half of the people approached for interviews volunteered that they desired to be a part of a "closed-ended" water distribution system. If a county wide water system was instituted in Mahogany County, many rural customers could be anticipated because a large percentage do not approach self-sufficiency in their personal water supply.

It is the belief of the writer that this would apply to any affluent rural population with strong cultural influences from urban centers.

#### Planning Water Needs For an Urban Community

In planning the future water needs of an urban community the level of affluence, indicated by the socio-economic status of the water-using population, must be taken into consideration. The higher the mean status of the water customers, the higher will be the demand for water. Possible changes in the status of members of a community must also be taken into consideration in any

projection of future needs. Thus, if a change in a community were to bring increased affluence to the members of that community, it could be projected that their demand for water would increase.

Secondarily, mean family size should also be considered in any projection of future water needs. As family size increases water demands increase, although not in arithmetic proportions.

If the urban water works supplies water to rural water vendors, changing socio-economic status of rural dwellers should also be considered.

Of course, changes such as general population increase, industrial use, commercial use, etc., would change the demand for water, but common sense dictates that these variables would be considered in projections of future community water needs.

#### Controlling Domestic Water Use

Water purchase is affected by the price of water. Water in other words is not price "inelastic". If a community anticipates a water crisis, or is in one, there is reason to believe that water demand could be curbed by a well publicized rise in water price. Water purchase decreases as the price for water increases. If this means of reduction in water demand were used, however, the level at which the customers would consider water expensive and something to be saved would have to be determined. Purchase is a function of need, price, and an ability to pay, so that what is considered to be expensive would probably vary directly with the affluence of the community as well. By

making a good expensive that was hitherto considered not to be so, one creates an increased consciousness of that good. If the good is expensive enough, people can be expected to conserve it, especially if they had considered it as a free good or relatively free good previously.

APPENDIX A

UNIVERSITY OF KENTUCKY

Department of Anthropology

Water Resource Research

Random Sample Anonymous Questionnaire on Water Use in Mahogany County

Interviewer \_\_\_\_\_

N \_\_\_\_\_

1. Have you lived at the present residence since March of 1968?  
Yes \_\_\_\_\_ No \_\_\_\_\_
2. How much water did you have to buy from March 1968 through April 1969?
  - a. Number of loads \_\_\_\_\_
  - b. Size of loads \_\_\_\_\_
  - c. Price payed per load \_\_\_\_\_
3. Are piped water facilities available? \_\_\_\_\_
4. Do you get your household water from a cistern \_\_\_\_\_, or from a well \_\_\_\_\_?
5.
  - a. (If it is a well) How large is it? \_\_\_\_\_
  - b. Does the well go dry periodically? \_\_\_\_\_
  - c. (If yes) At what season? \_\_\_\_\_
6. (If a cistern is used) How large is it? \_\_\_\_\_
7. Do you have to purchase water regularly \_\_\_\_\_, or only in dry seasons \_\_\_\_\_?
8. How is the water conveyed from its source to the house? Power pump \_\_\_\_\_  
Artesian well \_\_\_\_\_, other \_\_\_\_\_.
9. Is the same water source utilized inside the home also used outside?
  1. Irrigation of the yard \_\_\_\_\_
  2. Washing the car \_\_\_\_\_
  3. Recreation \_\_\_\_\_
  4. Feeding stock \_\_\_\_\_
  5. Other \_\_\_\_\_

10. What water using appliances are used by the household?
1. Indoor bath \_\_\_\_\_ Shower \_\_\_\_\_
  2. Indoor toilet \_\_\_\_\_
  3. Washing Machine \_\_\_\_\_
  4. Heating \_\_\_\_\_
  5. Cooling \_\_\_\_\_
  6. Dish washer \_\_\_\_\_
  7. Other \_\_\_\_\_
11. Do you feel there is a need to conserve household water? Yes \_\_\_\_\_  
No \_\_\_\_\_
12. What is the most important reason why you do business with a particular water hauler?
1. He is close \_\_\_\_\_
  2. He gives good service \_\_\_\_\_
  3. He has a pleasing personality \_\_\_\_\_
  4. He is a relative \_\_\_\_\_
  5. He is a friend \_\_\_\_\_
13. What is the occupation of the male head of the household? \_\_\_\_\_  
What is the occupation of his wife? \_\_\_\_\_
14. How much formal school training does the head of the household have?
1. Grade school 1 2 3 4 5 6 7 8
  2. High School 1 2 3 4
  3. College 1 2 3 4
  4. Graduate study 1 2 3 4
15. How large is your tobacco allotment? \_\_\_\_\_
- a. Do you raise tobacco on shares? \_\_\_\_\_
  - b. If so, how much? \_\_\_\_\_
16. What is the age of the head of the household? Age at last birthday: \_\_\_\_\_  
years.
1. In your household, which of the following is the way the most water is used?  
Check one:
- \_\_\_\_\_ a. For cooking and beverages.
  - \_\_\_\_\_ b. For fountains and other water-using decorations.
  - \_\_\_\_\_ c. For maintenance of the house and the yard.
  - \_\_\_\_\_ d. For personal cleanliness of household members.
  - \_\_\_\_\_ e. For recreation at home.
  - \_\_\_\_\_ f. For sanitation in the house and the yard.
  - \_\_\_\_\_ g. Other (specify) \_\_\_\_\_

2. How much would the house in which you are living sell for at the present time? Check one:
- a. Under \$10,000 \_\_\_\_\_; b. \$10,000-19,000 \_\_\_\_\_;  
 c. \$20,000 or more \_\_\_\_\_.
3. How much would the farm on which you are living sell for at the present time?
- a. Under \$10,000 \_\_\_\_\_; b. \$10,000-19,000 \_\_\_\_\_;  
 c. \$20,000 to 29,000 \_\_\_\_\_; d. \$30,000-39,000 \_\_\_\_\_;  
 e. \$40,000 or more \_\_\_\_\_.
4. How many people resided in your household at least 6 months during 1968?  
 Check one: 1 2 3 4 5 6 7 8 9 10 or more.
5. Check the income range which indicates the total income for all your household members during 1968.
- |                       |                          |
|-----------------------|--------------------------|
| a. \$ 0.0-2,999 _____ | d. \$ 9,000-11,999 _____ |
| b. 3,000-5,999 _____  | e. 12,000-14,999 _____   |
| c. 6,000-8,999 _____  | f. 15,000 or more _____  |

APPENDIX B

MEANS AND RANGE OF INDEPENDENT VARIABLES

Variables	Mean	Range
X 1	.1288 D 05	\$0-32,000
X 2	715.4	\$0-2,350
X 3	1.795	0-4
X 4	10.31	8-17
X 5	1.529	0-6.00
X 6	.1108 D 05	\$5,000-25,000
X 7	.1794 D 05	\$0-45,000
X 8	8,731	\$1,500-16,500
X 9	2.564	0-5
X10	1.051	0-4
X11	5.833	\$5.00-7.00 (\$ .50 inter.)
X12	44.83	21-72
X13	4.256	2-11

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