RESIDENTIAL WATER CONSERVATION COMPUTER PROGRAM

by

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CONVERSION TABLE

This thesis has been written in U.S. Customary units. Below are some basic SI unit conversion factors.

To convert from	to	Multiply by
BTU	Joules	1054.8
BTU per Pound mass-°F	Joule per Kilogram-°K	4187
Cubic-feet	Cubic-meters	0.0283
°F	°K	(°F + 460)/1.8*
Feet	Meters	0.305
Foot-pound	Joules	1.365
Foot-pound per year	Kilowatt	42,757
Gallons	Liters	3.785
Gallons per day	Liters per day	3.785
Inches	Centimeters	2.54
Kilowatt-hour	Joules	3.6 E+6
Pound mass	Kilogram	0.454
Pound per cubic foot	Kilogram per cubic meter	16.018
Pound per square foot	Kilopascal	0.0479
Pound per square inch	Kilopascal	6.895

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* Use the formula as is. Do not multiply by °F.

CHAPTER ONE

INTRODUCTION

Residential water conservation is becoming increasingly important as water demands and costs increase, and existing supplies become less adequate. The Kansas State Water Plan studies [1] predict severe water supply shortages in southeast, south-central and east-central Kansas in the coming decades. Large interbasin water transfers have been proposed to satisfy these future demands. Water transfer legislation passed in 1983 requires the transferee to have a water conservation program in place before a transfer can be approved. Public input to the Kansas State Water Plan listed water conservation as a top priority for solving water problems. Public comments at the Extension Water Policy Seminars indicate widespread interest in household water conservation. The Kansas Water Resources Research Institute identified a major educational program in domestic water conservation as a priority need in its Five-Year Research and Development Plan (1980). No such program currently exists at the state level.

Conservation should be viewed as an alternative to developing new water supplies, since water conserved from existing supplies can be made available to new users. If an effective residential conservation program could produce savings of 10 to 20 gallons per person per day, then a statewide program could save 20 to 40 million gallons per day (mgd). For comparison, the city of Wichita averaged 39 mgd in 1984.

To succeed in a water conservation program, the public must first be made aware of their water habits. The Kansas Department of Health and Environment wants to establish a municipal water conservation education program [1]. The purpose of the program would be to encourage and assist

local governments in educating the public about their water habits and to assist them with the implementing of simple water saving techniques (i.e., low flow shower heads, aerated water faucets, and water displacement devices in toilet tanks).

Methods used in the past to educate the public include mailing information packets to the customer [2], or distributing the educational material door-to-door [3]. The microcomputer has now become an educational tool used in water conservation. In 1983, the Virginia Water Resources Research Center (VWRRC) developed an educational module on the Apple II Plus microcomputer that was used in water exhibit shows to promote residential water conservation [4]. The module covered a broad spectrum of water topics: the hydrologic cycle, water and human health, water pollution and treatment, and water conservation. Media included audio-visual displays, hands-on demonstrations, a computer game, and printed materials. The exhibits were presented in a cartoon format directed at the seventh-grade educational level. During the study period, the module was viewed by about 50,000 persons at museums, fairs, and shopping malls. Surveys showed the module to be an effective device for transmitting basic knowledge. A major limitation was that the module failed to show any direct financial incentives for residential water conservation.

The objective of the work presented herein is to develop a computer program which is to be the main feature of a demonstration module on cost-effective residential water conservation methods applicable to Kansas. The module is intended to promote household water conservation inside the home by increasing individual awareness of the direct personal financial benefits of various conservation measures. The microcomputer program is to provide the user with personalized recommendations and savings estimates of

water and dollars. It is available on 5-1/4 inch floppy diskette for both the Zenith Z-100 and Z-150 (IBM-PC compatible) computers. The module is intended to become part of an ongoing water conservation program of the Cooperative Extension at Kansas State University and part of the education program proposed by the Kansas Department of Health and Environment. Additional perspective users are municipal water offices, rural water districts, other water related organizations, and civic organizations.

CHAPTER TWO

METHODOLOGY

The in-home residential water conservation computer program (a complete listing is available in Appendix A) consists of two main sections--the utility rates and water habits sections. The utility rates section determines the orgin and cost of the user's water along with the type and cost of energy used to heat their water. The water habits section analyzes how an individual utilizes his/her water. The description of how each section was developed follows.

Utility Rates

Water and energy are the two utilities of concern in this program. There are three sources of water available to the public: municipal water plants, rural water districts, and private wells. The three common energy sources used to heat water are electricity, natural gas, and liquid propane. The following paragraphs will discuss the three water utilities individually. The energy utilities are discussed in a separate section.

Municipal Water Plant Rates: The municipal water rates for cities and towns in Kansas were obtained from the state's 1984 annual report [5]. The report included the monthly cost of water per 1000 gallons for 384 communities. The majority of the communities charge their customers based on a declining block rate, i.e., the more water used, the cheaper the rate charged. Therefore, a marginal rate cost between 5000 and 10,000 gallons per month was calculated and used in the program since a typical household of four averages about 8000 gallons of water per month [6]. Rates between 5000 and 10,000 gallons per month were used because it is water from this

portion of the rate schedule that will be saved. The marginal cost is less than the total average cost of all the water units. Most rates have a fixed monthly cost for hookup or debt retirement, regardless of the quanity of water used. The report lists the monthly cost of water at 5000 and 10,000 gallons, and the marginal rate was obtained by dividing the difference between the two costs values by five to obtain a marginal cost per 1000 gallons.

These rates were entered into the Z-100 microcomputer via a program called Multiplan--a Microsoft spreadsheet program. The advantage of this program is the ability to manipulate files: sorting, arithmetic operations, and printing. The information entered into Multiplan included the community's name, and the cost of water at 5000 and 10,000 gallons per month. The formula used to calculate the marginal rate was also entered. The community's name and marginal water rate were printed to a diskette as data files which are used in the conservation module as sequential files. These files aid the user who does not know his marginal water rate. The operation of the program to make use of these files is explained in the following paragraphs.

Community water rates are grouped in six different files. Five contain communities grouped by population and the sixth contains the communities that charge their customers a flat fee for water. The division of the communities by population is as follows: over 100,000, 10,000 to 99,999, 5000 to 9999, 1000 to 4999, and 999 or less. Files are divided into these groups to match a question which asks the user for the population of his community. The program user enters a number appropriate to his community's population.

Next, the computer asks the user from what source his water is sup-

plied: municipal water plant, rural water district, or a private well. With reference to muncipal water plants, the computer then asks the user if his water is metered. If so, the units in which the metering device operates must be known, since some communities meter in gallons of water while others meter in cubic feet. If the user does not know how his water is metered, then he is encouraged to enter the response that corresoonds to gallons since this is how the majority of the water in Kansas is metered. If the user's water is not metered, then the program assumes that he are charged a flat fee for his water.

If the user's water is metered, the program asks the user to input his monthly marginal water cost for either units (dollars per thousand gallons or hundred cubic feet). If the user does not know (very few will know), then the computer will access the sequential files based on the user's response to the population question and display the names of the communities on the screen. If the file contains less than 24 communities, then the entire list of those communities along with a line number beside each will be displayed. The user then enters the line number that corresponds to his community. For files with more than 24 communities, the user is asked to enter the first letter of his community's name. The program will search the files for names beginning with the letter entered, and will print the list on the screen. Then, the user is asked to enter the line number that corresponds to his community's name if listed. If it is not listed, then a default value will be used which is the average marginal water rate for the cities in the population range chosen previously. Table 2.1 shows the default values for each population range. A list of the files showing the names and marginal water costs for Kansas cities and towns is shown in Appendix C, Tables C.1 through C.5.

Table 2.1 Average marginal water rates for municipal water plants in Kansas for five population ranges--used as default values for the marginal water cost.

Population Range	Average Marginal Water Rate $/1000-gallons	$/100-cubic feet
Greater than 100,000	1.22	0.91
10,000 to 99,999	1.31	0.98
5,000 to 9,999	1.42	1.06
1,000 to 4,999	1.26	0.94
less than 999	1.70	1.27

Source: [5]

This annual water cost is computed as 1.3 times the cost of the total annual water use, computed at the marginal rate. The 1.3 factor accounts for service charges.

The program assumes that unmetered homes are charged a flat monthly fee for water, and asks the user to enter this fee. If the person does not know this fee, then a list of Kansas towns that charge a flat fee will appear on the screen. The user can then enter his community if listed, or a default value of $7.86 per month will be used. This default value is the average of the flat fees charged by the towns in this list. A listing of the file containing the towns that charge a flat fee is shown in Appendix C, Table C.6.

Communities that charge flat fees offer no financial incentives for their customers to conserve water. The program never uses the flat fee cost. The user is asked anyway, so they may at least know what they are paying for water. The program does inform the user via the printer that conserving water will not save them money on their water bill, but does point out potential savings in energy costs made possible by conservation.

Rural Water District Rates: Rural water districts (RWD's) usually serve households in rural areas, but sometimes serve small towns adjacent to bigger cities. Kansas has 275 RWDs scattered throughout the state. An attempt to locate a complete list of the districts' rate schedule was unsuccessful. The author therefore sent a letter to each district requesting a copy of its current rate schedule. The Kansas Rural Water Association provided a list of the districts' addresses along with stick-on mailing labels. Of the 275 districts contacted, 174 (63 percent) supplied the requested information.

The majority of the RWDs operate on a declining block rate system. Thus, a marginal rate was calculated in the same manner as the municipal water rates. The RWD names, numbers, and marginal rates were entered in Multiplan, and an alphabetical list was printed to a diskette as a data file to be used in the conservation program as a sequential file. A list of the file is shown in Appendix D, Table D.2.

The RWD sequential file is used as an aid for the program users who do not know their RWD's marginal water rate. The user who indicates that his water is supplied by a RWD will be asked to enter his marginal rate. If he does not know, then he is asked to enter the first letter of his RWD's name. The program then searches the file for those districts that begin with that letter, and displays them on the screen. The user is then asked to enter the line number corresponding to his district, if listed. If it is not listed, a default value of $2.41 per 1000 gallons per month will be used for computing the annual water cost. The $2.41 was obtained by averaging the marginal rates for the districts replying to the survey letter. The marginal water rates ranged from $0.50 to $6.50.

The total annual water cost is computed as 1.5 times the cost of the

total annual water use computed at the marginal rate. The 1.5 factor accounts for debt retirement bonds and service charges.

Private Wells: Many people in rural Kansas operate their own wells. The cost of operating a well depends on the cost of the electricity, pump, and drilling. Since the last two are extremely variable, the program only includes a question about electricity costs required to pump the water.

The cost analysis for a private well user is based on the cost required to pump the water from the well to the pressure reservoir (see Fig. 2.1). To start the cost analysis, the depth of the well must be known. The program asks the user to enter the depth of his well in feet. If he has absolutely no idea of his well depth, then he will be encouraged to enter a default value of 50 feet.

The cost analysis is based on simple fluid mechanics principles and Bernoulli's equation, Eq. 2-1. The hydraulic system under consideration

$$P_1/\gamma + Z_1 + V_1^2/2g = P_2/\gamma + Z_2 + V_2^2/2g + \Sigma h_f + \Sigma h_m - h_p \qquad (2\text{-}1)$$

where
- P = pressure (psf),
- γ = unit weight of water (62.4 lb/ft^3),
- Z = height from some arbitrary datum (ft),
- V = water velocity (ft/s),
- g = gravitational constant (32.2 ft/s^2),
- h_f = friction loss (ft),
- h_m = minor losses (ft),
- h_p = pumping head (ft),
- and points 1 and 2 are defined in Fig. 2.1.

extends from the water table (point 1) to the pressure reservoir at the home (point 2). The head loss due to friction and minor losses was assumed to be 10 percent of the total well depth. The pressure in the reservoir tank (P_2) was assumed to be 40 psig. Since $P_1 = 0$, $Z_1 = 0$, and $V_1 = V_2 = 0$), Eq. 2-1 becomes:

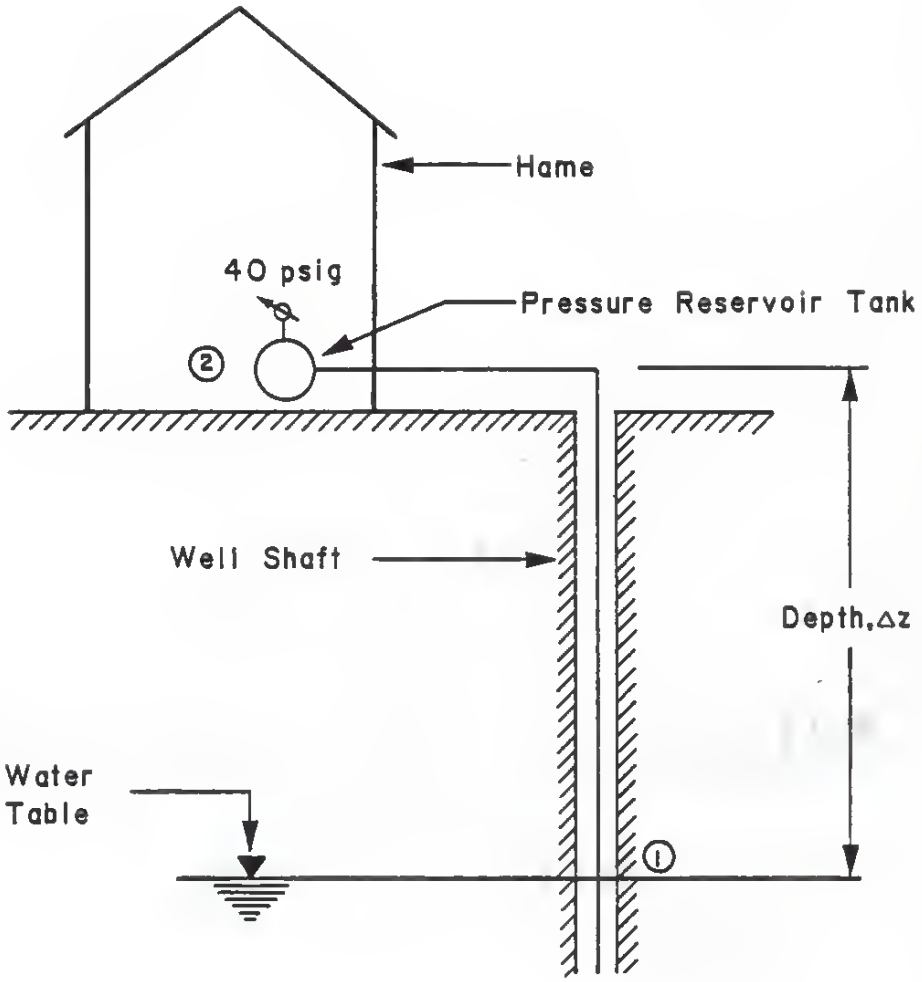


Figure 2.1 Schematic of home-well setup. The circled members one and two are the beginning and end of the hydraulic system, respectively.

$$hp = P_2/\gamma + \Delta Z + \Sigma(h_f + h_m) = 92.3 + 1.1\Delta Z \qquad (2\text{-}2)$$

where ΔZ is the depth of the well. To calculate the power required to pump the water for one year, the following equation was used:

$$P = [(365/7.48) * \gamma * Q * hp] / \eta p \qquad (2\text{-}3)$$

where P = power (ft-lb/yr),
Q = flow rate per day (gpd),
ηp = pump efficiency.

The coefficients 365 and 7.48 are the number of days per year and gallons of water per cubic feet, respectively. To estimate the cost of operating the pump for one year, the cost of electricity per kilowatt-hour (kwh) must be supplied by the user. If the user does not know this cost, a default value of eight cents per kwh is used. The variable name used in the program for the cost of electricity is KWAT. Therefore, the annual pumping cost (APC) is calculated as:

$$APC = k * P * KWAT \qquad (2\text{-}4)$$

where APC = annual pumping cost ($/yr),
k = unit conversion factor = 3.766×10^{-7} kwh/ft-lb,
P = power (ft-lb/yr),
KWAT = electricity cost ($/kwh).

The actual equations used in the program are shown in Eqs. 2-5 and 2-6. The coefficient 62.4 is the unit weight of water in pounds per cubic foot and 144 is a unit conversion from square inches to square feet (see Eq. 2-5). In Eq. 2-6, the coefficient 365 converts from days to years.

```
P = (62.4 * SUM / 7.48 * (1.1 * DEPTH + 144 * 40 / 62.4)) / .25    (2-5)
```

where P = power (ft-lb/day),
SUM = Q (gpd),
1.1 * DEPTH = well depth plus friction loss, h_f (ft),
40 = P_2 (psi),
.25 = ηp.

$$APC = P * 3.766E-07 * KWAT * 365 \quad (2\text{-}6)$$

Energy Rates: The energy required to heat water in a home is a major expense. As a rule of thumb, the energy cost for heating water is about two to four times the cost of water. The water conservation program approximates this cost for the three common energy sources most commonly used to heat water: electricity, natural gas, or liquid propane (LP).

The general thermodynamic equation used to calculate the energy cost is given by Eq. 2-7a. The mass is equal to the total volume of hot water

$$Q = m * c * \Delta T \quad (2\text{-}7a)$$

where Q = thermal heat (BTU),
m = mass (lbm),
c = heat capacity (BTU/lbm-°F),
ΔT = temperature change (°F).

used yearly (gal/yr) times the conversion of 8.34 lbm/gal which yields pounds mass per year. The increase in temperature is assumed to be 60°F. The heat capacity constant is equal to 1 BTU/lbm-°F. In the program, the variable name HOTSUM represents the total daily hot water consumed in gallons per day. To obtain the total annual amount of hot water, HOTSUM is multiplied by 365 days per year. After substituting these into Eq. 2-7a, the equation takes the form of Eq. 2-7b, with Q having the units of BTU per year.

$$Q = 182{,}646\ HOTSUM \quad (2\text{-}7b)$$

Table 2.2 shows the available number of BTUs per unit of energy for electricity, natural gas, and LP gas. The program stores the values shown in Table 2.2 under the variable name BTU. Each of these three energy sources

have a certain efficiency at which they produce heat. Table 2.3 shows the efficiency ratings generally used for the three heat sources.

Table 2.2 Available BTUs* per unit of energy.

Energy Type	Available BTUs
Electricity	3414 BTU/kwh!
Natural Gas	1,000,000 BTU/MCF#
Liquid Propane	95,000 BTU/gal@

* BTU = British Thermal Unit,
! kwh = Kilowatt-hour,
MCF = Thousand Cubic Feet,
@ gal = gallon.

Source: [7]

Table 2.3 Efficiency ratings for the three energy sources commonly used to heat water.

Energy Type	Efficiency
Electricity	0.90
Natural Gas	0.70
Liquid Propane	0.70

The final unknown is the cost of the energy, which has the variable name ENERGYCOST. The program uses default values for ENERGYCOST if the user does not know his energy cost (see Table 2.4). If the user wishes to enter his energy cost, it must lie within the ranges shown in Table 2.4. These ranges were established by the author to eliminate the possibility of entering an outlandish value for ENERGYCOST.

With this information, the annual energy cost (AEC) to heat the water can be calculated by Eq. 2-8. The actual equation used in the

Table 2.4 Energy cost default values and ranges.

Energy Type	Default Cost	Cost Range
Electricity	$0.08/kwh*	$0.05 to $0.11/kwh
Natural Gas	$5.50/MCF#	$2.00 to $9.00/MCF
Liquid Propane	$0.70/gal!	$0.50 to $1.25/gal

* kwh = Kilowatt-hour,
\# MCF = Thousand Cubic Feet,
! gal = gallon.

$$AEC = (182,646 * HOTSUM * ENERGYCOST) / (BTU * EFF) \quad (2\text{-}8)$$

program does not combine the terms that make up the coefficient, 182,646. The formula used in the program is shown in Eq. 2-9, with the terms defined above.

$$AEC = ENERGYCOST * 8.34 * 60 / BTU / EFF * HOTSUM * 365 \quad (2\text{-}9)$$

Water Habits

Once the computer is informed about the user's utility rates, it asks questions to determine the user's water use habits. The information requested from the user deals strictly with water uses within the home (e.g., bathing, clothes washing, etc.), which are called water functions. It does not include lawn, garden, or house-plant watering or any outside use. The water functions covered in the program are water softening (limited to private well users), bathing/showering, shaving (limited to males), flushing toilet, brushing teeth, washing hands, dishwasher/dish-washing by hand, drinking water, and washing clothes.

The program asks the user questions about the water functions and uses

his responses to analyze his habits. This analysis is based on an average water user, i.e., one who uses approximately 64 gallons of water per day. Table 2.5 shows the baseline of in-home water use for a typical family of four.

Table 2.5 Baseline water use for a typical family of four.

Water Function	gal/day	gal/day/person	Percent of Total
Toilet	100	25	40
Bathing/Showering	80	20	30
Laundry	35	9	15
Dishwasher	15	4	5
Kitchen sink	12	3	5
Lavatory & Utiltiy sink	13	3	5
Totals	255	64	100

Source: [8]

The answer to each of the water function questions (excluding water softening and toilet flushing) is either acceptable or unacceptable. An acceptable response is one that does not exceed with the baseline values in Table 2.5, and an unacceptable response is one that exceeds the baseline values. For example, for a user who bathes by showering, the program will ask how long (in minutes) he spends in the shower. For a conventional shower head that releases four gallons of water per minute, the acceptable answer would be five minutes or less. If a user showers longer than five minutes, then the computer informs him later via the printer that the length of time he spends in the shower is wasteful. The other questions, except water softening and toilet flushing, are handled in the same manner. These two water functions are excluded because of the diffuculty in determining

why someone flushes his toilet more than average, and because of the large variation between water softeners.

Each water function contributes to the total amount of water a person uses. Once a person answers a question, the program will sum the cold and/or hot water used by that function to the variables SUM and HOTSUM, respectively. The variable SUM includes all the water used by a water function, including water that is heated. HOTSUM is only that portion of water heated for a water function.

As mentioned earlier, each question has an acceptable and unacceptable answer. The amount of water added to SUM for an acceptable answer is based on the baseline values in Table 2.5. The amount added for an unacceptable answer was the judgment of the author. Table 2.6 shows the possible responses to the water function questions and the amount of water summed for each response.

The amount of water added to HOTSUM is a fraction of the full amount of the water used in a function. For example, if a conventional bathtub was filled one-quarter full, there would be approximately 20-gallons of water used, and 67 percent (13.4-gallons) would be hot water. Table 2.7 shows the percent of water heated for each water function based on the author's judgment.

Table 2.6 Possible responses to water habit questions.

Water Function	Response	A/U*	SUM (gpd)!	HOTSUM (gpd)
Water Softening	User inputs days between regeneration cycles.	NA@	30-gal. per regeneration	0
Bathing#				
Shower	User inputs minutes spent in shower.	A--5 min. or less	4 gal. per min.	67% of SUM
Bath	1. Fill tub 1/4 full.	A	20	13.4
	2. Fill tub 1/2 full.	U	35	23.5
	3. Fill tub over 1/2 full.	U	50	33.5
Toilet	User inputs number of flushes per day.	NA	5 gal. per flush	0
Shaving	1. Run water.	U	3	3
	2. Don't run water.	A	1	1
	3. Don't shave w/ water.	---	---	---
Brushing Teeth	1. Run water.	U	2	0
	2. Don't run water.	A	0.5	0
Washing Hands	1. Run water.	U	4	1.32
	2. Dont' run water.	A	2	0.66
Dishwashing#				
By Hand	1. Always run water.	U	7	5.6
	2. Sometimes run water.	U	5	4
	3. Never run water.	A	4	3.2
Dishwasher	User will enter number of load washed per day.		15 gal. per load	100% of SUM
	1. Always wash full load.	A		
	2. Sometimes wash full load.	U		
	3. Never wash full load.	U		
Drinking	1. Always run water.	U	1	0
	2. Sometimes run water.	U	1	0
	3. Never run water.	A	0.5	0
Clothes Washer	User enter number of loads washed per week.		50 gal. per load	50% of SUM
	1. Always wash full load.	A		
	2. Sometimes wash full load.	U		
	3. Never wash full load.	U		

* A/U = acceptable/unacceptable; ! gpd = gallons per day; @ NA = not applicable
# either of the two options.

Table 2.7 Percent of water heated in each water function.

Water Function	Percent
Water Softener	0
Shower/Bath	67
Toilet	0
Shaving	100
Brushing Teeth	0
Washing Hands	33
Dishwasher	100
Washing Dishes by Hand	80
Drinking	0
Clothes Washer	50

CHAPTER THREE

DESCRIPTIVE EXAMPLE

This chapter contains an example to illustrate how the program operates. This example does not cover all the possible options; therefore, a detailed flowchart is provided at the end of this chapter to illustrate the different paths in the program. A complete listing of the program is shown in Appendix A. A glossary of the variables used in the progras is shown in Appendix B.

Introduction Instructions

The program begins with the title "IN-HOME WATER CONSERVATION ANALYSIS", printed on the screen, along with the following introduction:

"This program asks you questions to determine how you use water at home. It will estimate how much money you spend annually on water and energy used to heat your water.

At the end of the session, a summary table will be printed on the printer showing how each function (i.e., showering, dishwashing, etc.) contributes to your annual consumption of water. Along with the summary table, some other information will be printed explaining ways to save you money by conserving water.

Press any key to continue."

Once the user has pressed a key to continue, the next display will appear and introduce them to the types of questions that will be asked of them. This display reads as follows:

"There are two types of questions asked in this program. They are:

1. Multiple choice questions.
2. Fill-in-the-blank questions.

To answer the multiple choice questions, you need only enter the number that corresponds to the answer. To do this, you have to type the number by using the numbers across the top of the key board. You then must press the key marked RETURN to complete the entry.

Try the multiple choice example below.

What time is it?
[1] Before 12 o'clock noon
[2] Exactly 12 o'clock noon
[3] After 12 o'clock noon Answer = "

The user then enters the answer at the flashing cursor located to the right of the equal sign. The program does not check the answer against the computers clock since it cannot be assumed that the microcomputer's clock is running; therefore, someone could enter the wrong answer and the computer would not acknowledge the error. This is not a problem though, since the purpose of the multiple choice example is to give the inexperenced computer user a sample problem.

If the user makes a wrong entry, then the computer will display a message asking that he enter either a one, two, or three, and will then repeat the question. This will continue until the question is answered correctly. If the user answers the question correctly by entering either a one, two, or three, then the computer will print the message "Good Job!" on the screen, and then will instruct him to press any key to continue.

The next screen display discribes the fill-in-the-blank question, and gives an example question. This display reads as follows:

"The fill-in-the-blank question allows you to enter either letters, numbers, or symbols. You must supply the answer to the question that is asked.

Answer the fill-in-the-blank example below.

Enter your first name. Answer = "

The user types in his name to the right of the equal sign. For example purposes, suppose the user entered John. After completing the entry by pressing the RETURN key, the computer will display:

```
"You entered your name as John.
Is this spelled correctly?
     [1] Yes
     [2] No                                Answer =  "
```

If the user typed his name incorrectly, he should answer by entering number two, at which time he will be able to re-enter his name. If his name is spelled correctly, he should enter a one, and the computer will display:

"Press any key and we'll get started with the program."

After the user presses any key, the computer will start the second part of the program--the utility rate section.

Utility Rate Information

This section of the program asks the user questions dealing with his utility rates for water and energy. The following example is based on a male individual living in Manhattan, Kansas, who heats his water with natural gas. As mentioned earlier, the program branches into many different categories (e.g., water supplied from municipal water plants, rural water districts, or a private well); thus, the flow diagram at the back of this chapter illustrates the different branches of the program. The example of the utility section will not include much discussion, but will follow the sequence of questions asked by the computer program. The numbers shown to the right of the ANSWER are supplied answers to the questions.

"Are you male or female?
[1] Male
[2] Female Answer = 1

Do you live in Kansas?
[1] Yes
[2] No Answer = 1

What is the population of your community?
[1] Grester then 100,000 people
[2] Between 10,000 and 99,999
[3] Between 5,000 and 9,999
[4] Between 1,000 snd 4,999
[5] 999 people or less
[6] You live in a rural area Answer = 2

Where does your water come from?
[1] Municipsl water plsnt
[2] Rural water district
[3] Privste well Answer = 1

Is your home on a water meter?
[1] Yes
[2] No Answer = 1

How does your water bill read? Most bills read in dollars per one-thousnd gsllons.
[1] Dollsrs per one-thousand gsllons
[2] Dollsrs per one-hundred cubic feet Answer = 2"

The response to this question is number two since Manhattan's water is metered in cubic feet.

"What is the marginal cost per one-hundred cubic feet of wster per month where you live?
Enter the smount as s dollsr decimal.
If you don't know, then press the RETURN key. Answer = RETURN"

At this point, the computer displays a list of community's names having a population that ranges between 10,000 and 99,999 people. The screen looks as follows:

"You entered that your community has between 10,000 and 99,999 people, thus the reason for the list below. In the srea marded ANSWER, enter the line number that corresponds to your community.

If your community is not listed, and your population size is correct, then press the key marked RETURN. If you think you answered the question dealing with your population incorrectly, then type the key marked 'H' and press RETURN.

Line No.	Community	Line No.	Community
1.	Arkansas City	13.	Lawrence
2.	Atchison	14.	Leavenworth
3.	Chanute	15.	Liberal
4.	Coffeyville	16.	Manhattan
5.	Dodge City	17.	McPherson
6.	El Dorado	18.	Olathe
7.	Emporia	19.	Ottawa
8.	Garden City	20.	Parsons
9.	Hays	21.	Pittsburg
10.	Hutchinson	22.	Salina
11.	Independence	23.	Winfield
12.	Junction City		

Answer = 16"

After entering the number 16 to tell the computer that the user's community is Manhattan, the program then displays the marginal water rate as follows:

"The monthly marginal water rate for Manhattan is $0.60 per one-hundred cubic feet."

The program continues as follows:

"How is your hot water heated?
[1] Electricity
[2] Natural gas
[3] LP gas Answer = 2

What is your natural gas cost per 1000 cubic feet (MCF)?
Enter the amount as a dollar decimal (e.g., $5.50).
If you don't know, then press the RETURN key. Answer = RETURN

Then I'll use an estimate cost of $5.50 per MCF.

Press the RETURN key to continue."

This concludes the questions about the utility rates. The third part of the program will question the user about his water use habits.

Water Habit Information

The program continues once the user presses the RETURN key. The explanation of this section is similar to that of the utility rate section, i.e., there will not be much discussion about the questions or supplied answers. Instead, the following example will proceed in the same sequence as the program would operate. The program continues on as follows:

```
"Do you usually take a bath or shower?
     [1] Bath
     [2] Shower                          Answer = 2

How many minutes do you spend in the shower?
Enter your answer here.                  Answer = 10

Estimate how many times a day you flush your home toilet.
Enter your answer here.                  Answer = 4

Do you let the water run while you shave?
     [1] Yes
     [2] No
     [3] Don't shave with water          Answer = 2

Do you let the water run while you brush your teeth?
     [1] Yes
     [2] No                              Answer = 2

Do you let the water run while you wash your hands?
     [1] Yes
     [2] No                              Answer = 1


Does your home have a dishwasher?
     [1] Yes
     [2] No                              Answer = 2

Do you let the water run while you wash and rinse the dishes?
     [1] Yes
     [2] Sometimes
     [3] No                              Answer = 3

Do you let the water run to get cold when getting a drink?
     [1] Yes
     [2] Sometimes
     [3] No                              Answer = 2
```

```
Do you have a clothes washer?
     [1] Yes
     [2] No                                Answer = 1

How many loads do you wash per week?       Answer = 2

Do you wash a full load of clothes?
     [1] Almost always
     [2] Sometimes
     [3] Not usually                       Answer = 1"
```

This concludes the water habits portion of the program. After the user answers the last question, the screen clears and the following message appears.

"Thank you for running the program. Your results should be coming out on the printer. If they aren't, then turn the printer on. Thanks again...."

Printout of Results and Recommendations

When the program concludes with the user interaction portion, it begins printing the results of the run on the printer. An example of the printout is shown in Fig. 3.1.

The table of results shows an annual breakdown of the water functions, illustrating the amount of water used for each function, and the amount of money spent on energy for heating water. The sentence directly under the table informs the user of his annual water and energy costs.

The values in the table are calculated in a manner similar to those described in Chapter Two. The total and hot water amounts are determined by the user's responses to the water habit questions, and are based on Table 2.6.

Below the table of results are some conservation instructions. These instructions will point out potential economic savings to the user. These instructions are printed only for unacceptable responses. Their purpose

Figure 3.1 Printout of the results.

Water Conservation Analysis Results

Below is a table showing your water habits, John.

Water Function	Water Used (Gal/yr) Total	Hot	Hot Water Energy Cost ($/yr)
Shower	14600	9782	38.50
Toilet	7300	----	-----
Shaving	365	365	1.40
Brushing Teeth	183	----	-----
Washing Hands	1460	482	1.90
Dish washing	1460	1168	4.60
Drinking	365	----	-----
Clothes Washer	5214	2607	10.30
Total =	30947	Total = 14404	

Your annual gas cost to heat your water is $ 56.60 and your annual water cost is $ 32 per year.

BELOW ARE SOME INSTRUCTIONS THAT MAY HELP YOU CONSERVE ON WATER.

You spend 10 minutes in the shower. This means you use approximately 40 gallons of water per shower - 13 gallons cold and 27 gallons hot water. If you would reduce your time down to 5 minutes, you would use about 20 gallons of water per shower - 7 gallons cold and 13 gallons hot. On an annual basis, this could save you approximately $ 6 per year in water cost and $ 20 per year in the energy required to heat your water (assuming you take one shower each day).

Don't run the water while you wash your hands. Put a stopper in your sink and fill it one-quarter full. This could save about 2 gallons of water per washing. Annually you could save $1 per year on water cost, and $ 1 per year on the energy required to heat the water (assuming you wash your hands twice a day.)

Instead of letting the water run to get cold while getting a drink, place a water bottle in the refrigerator to keep the water cold.

==========

If you would follow the instructions above you could save approximately $ 7 per year on your water bill, and $ 21 per year on energy used to heat your water.

==========

is to try to persuade the user to reduce his water consumption down to the baseline value of 64 gallons per day by showing him the economic benefits.

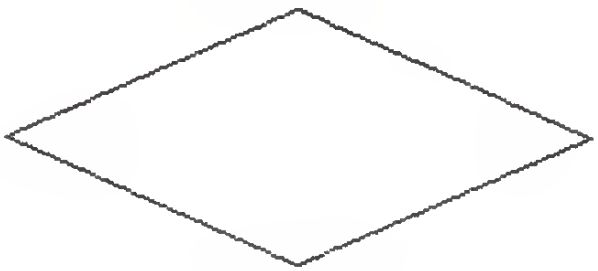
The last sentence on the printout shows the user's estimated annual cost savings if he follows the conservation instructions.

Flow Chart of the Program

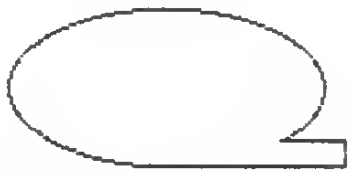
The following flow chart (Fig. 3.3) shows the many different paths a user may follow depending on his situation. Figure 3.2 is a pictorial description of the different figures in the flow chart. The flow chart was drawn using the graphics program DOODLER [9].

Processing Operation

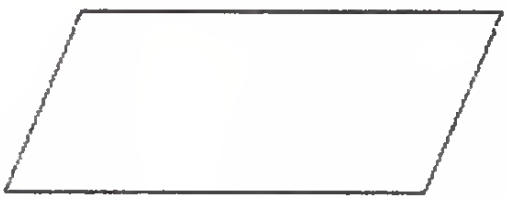
Output: Screen or Printer



Decision



File Operation



Manual or Clerical Operation

Start/Stop

Goto/Gosub

Figure 3.2 Description of the figures used in the residential water conservation flow chart.

Figure 3.3 Flowchart of the Residential Water Conservation Program.

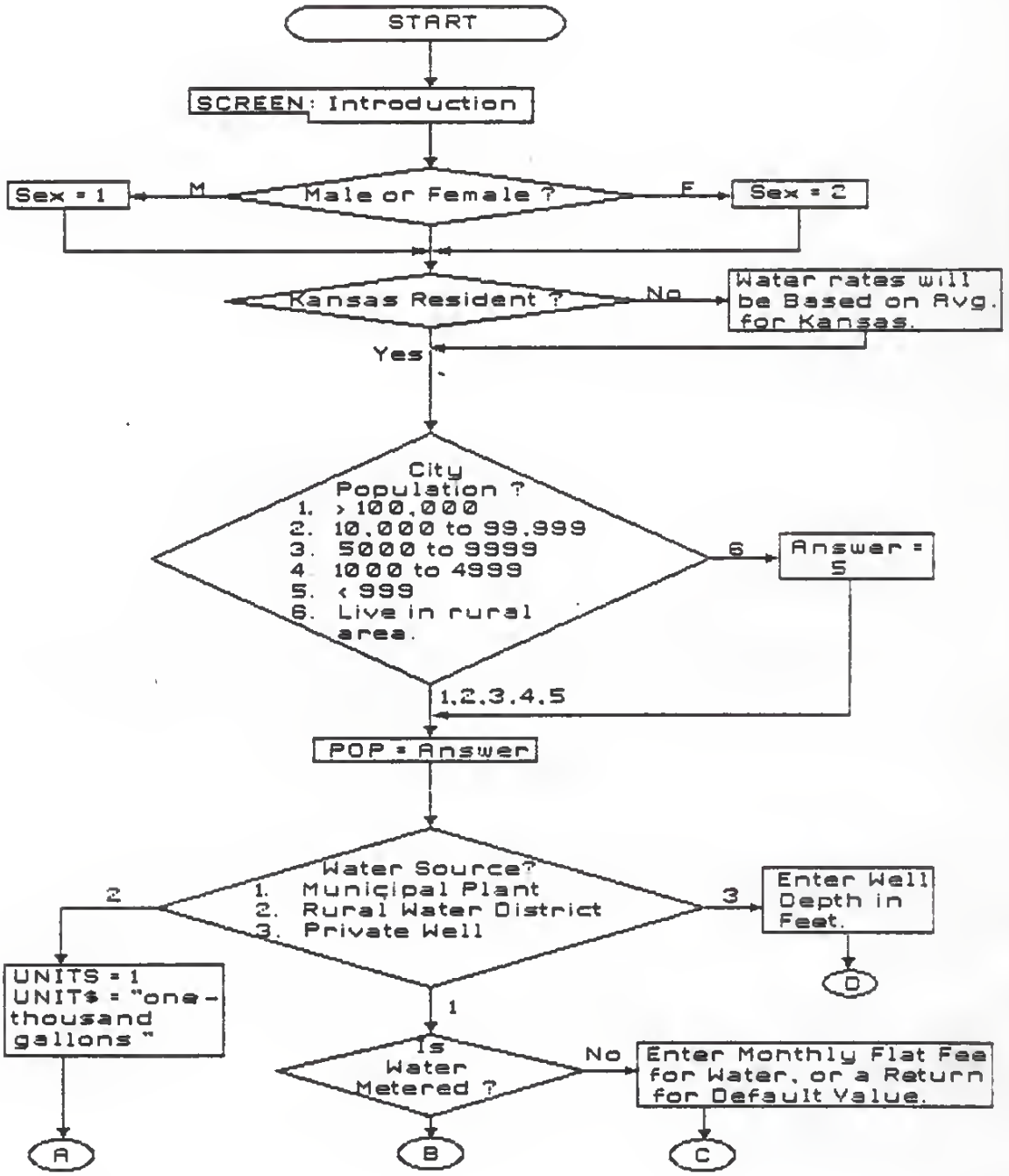


Figure 3.3 (continued)

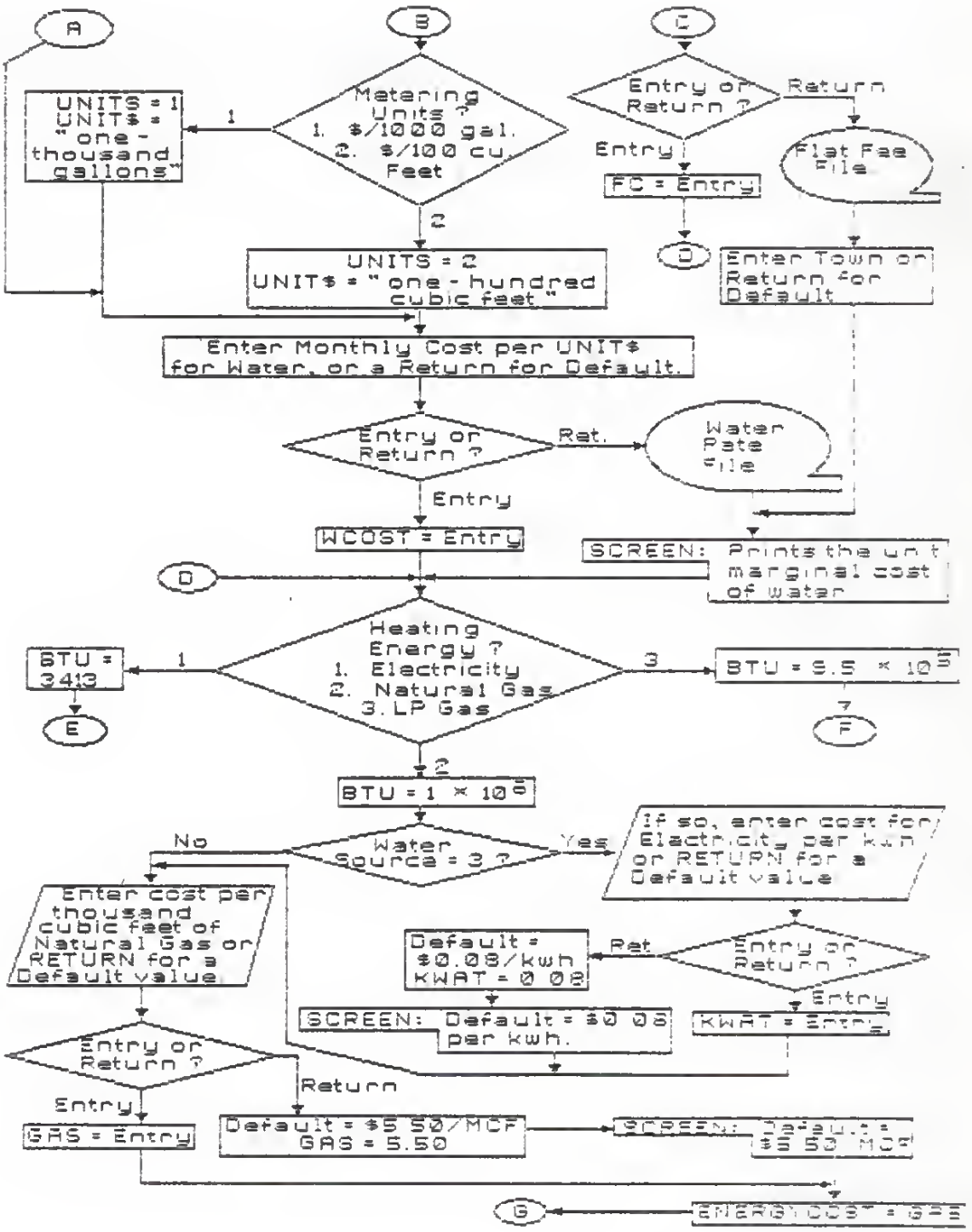


Figure 3.3 (continued)

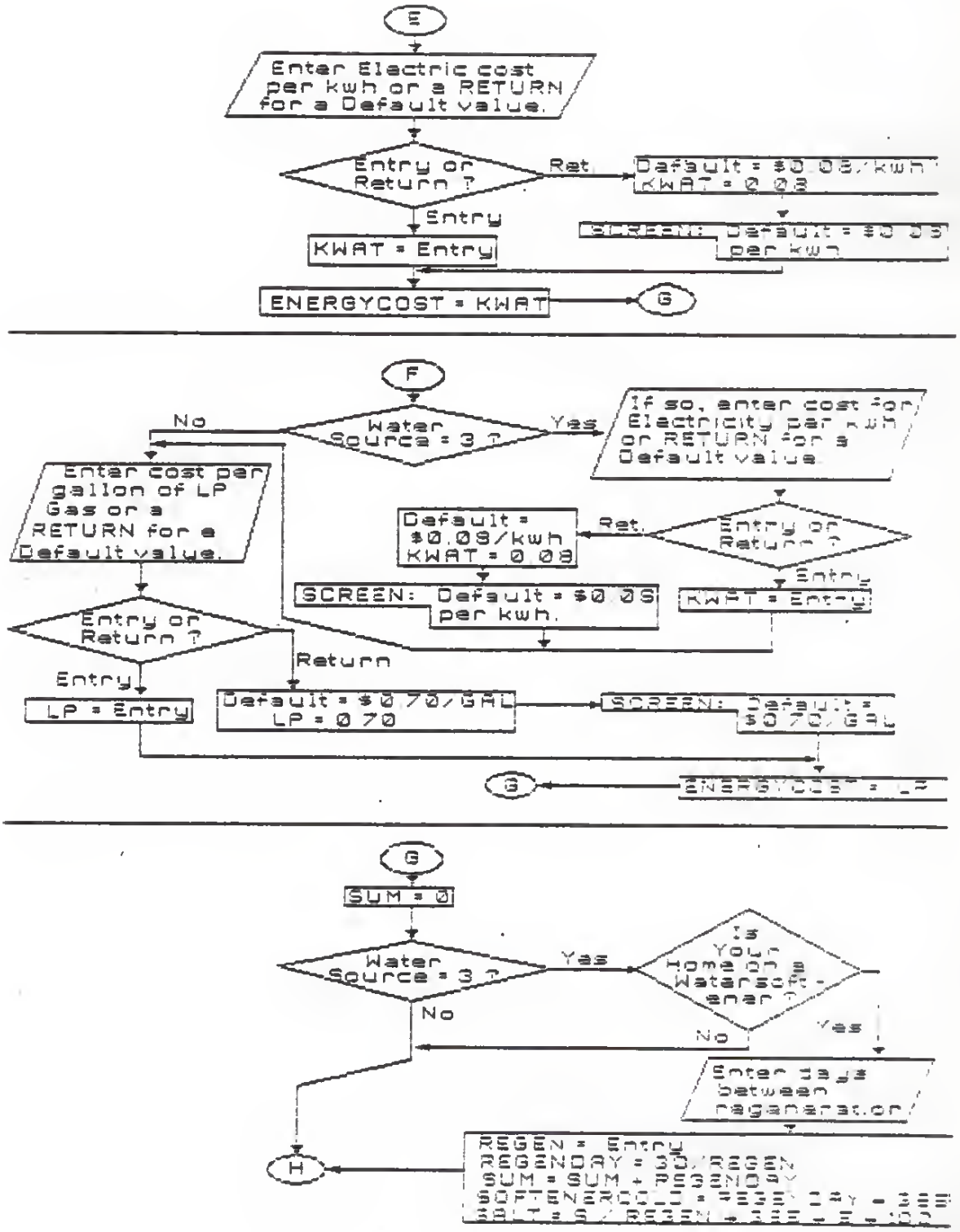


Figure 3.3 (continued)

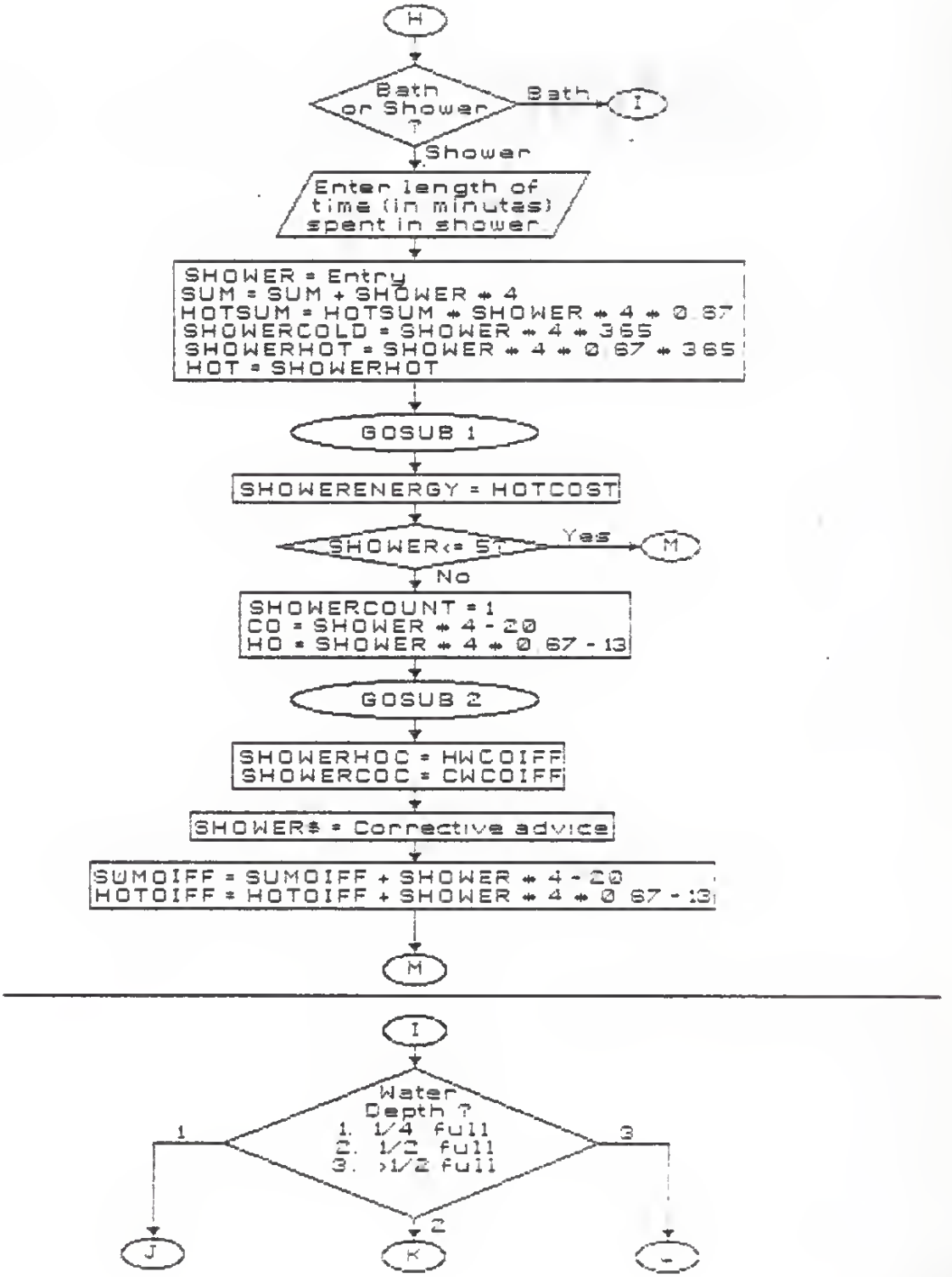


Figure 3.3 (continued)

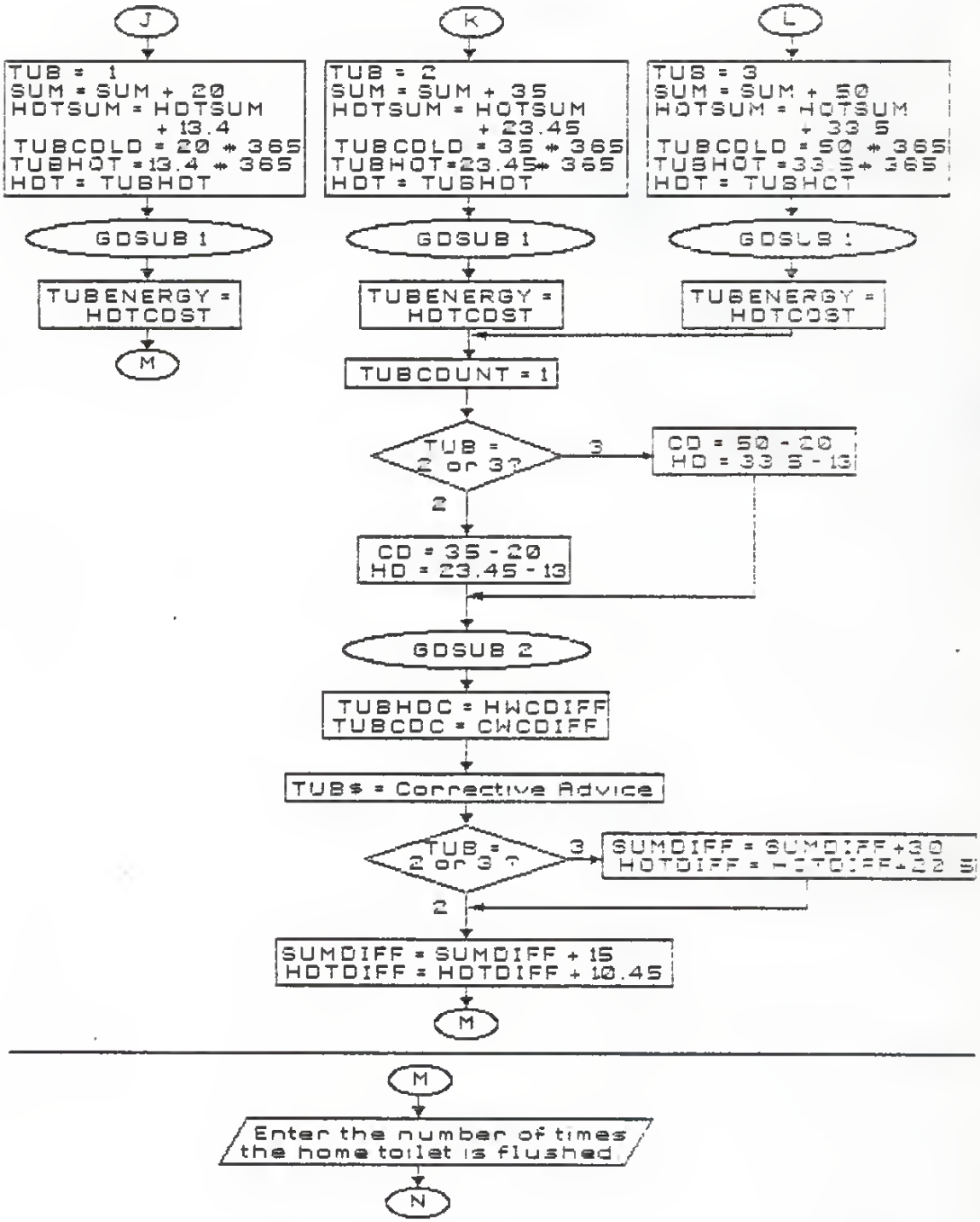


Figure 3.3 (continued)

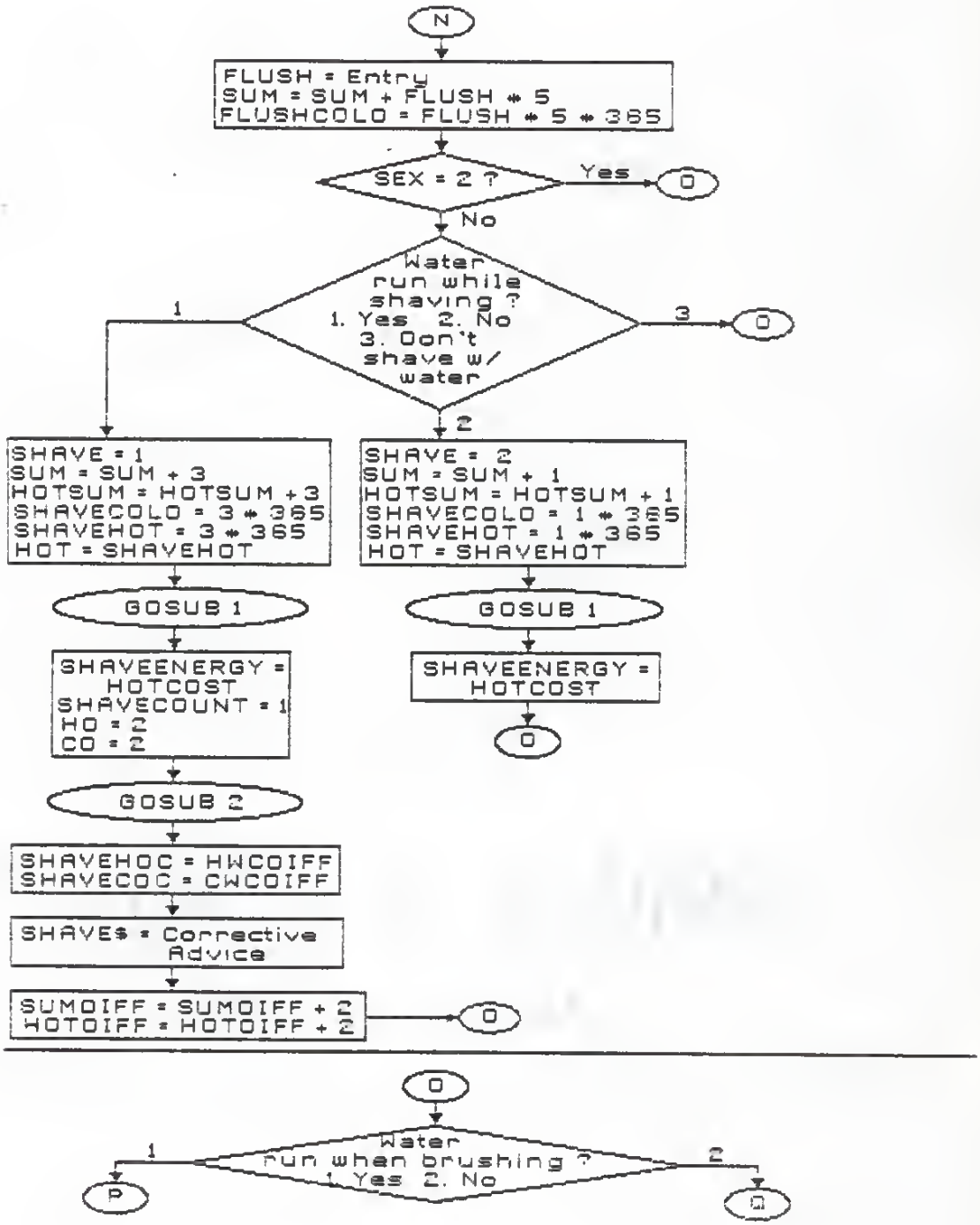


Figure 3.3 (continued)

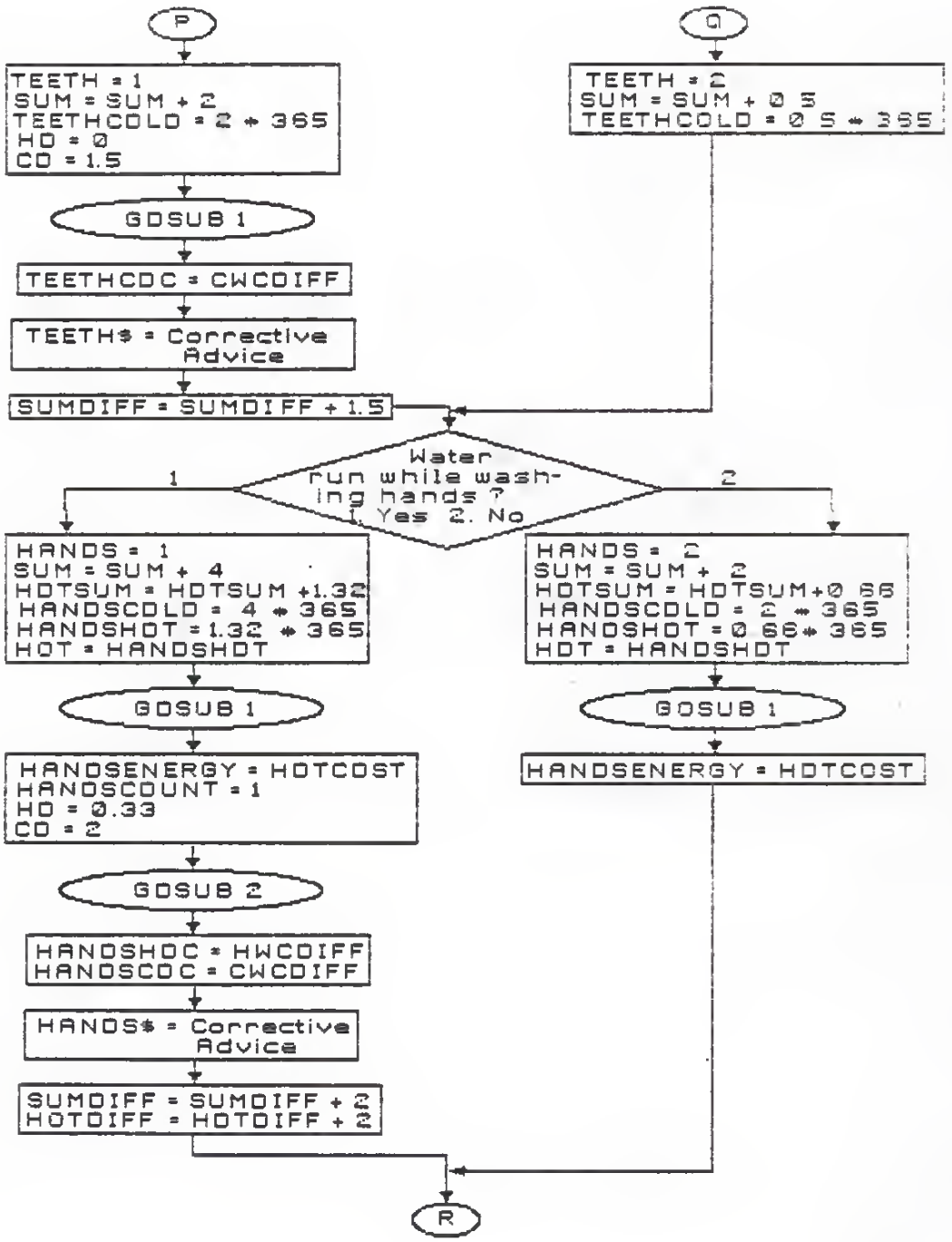


Figure 3.3 (continued)

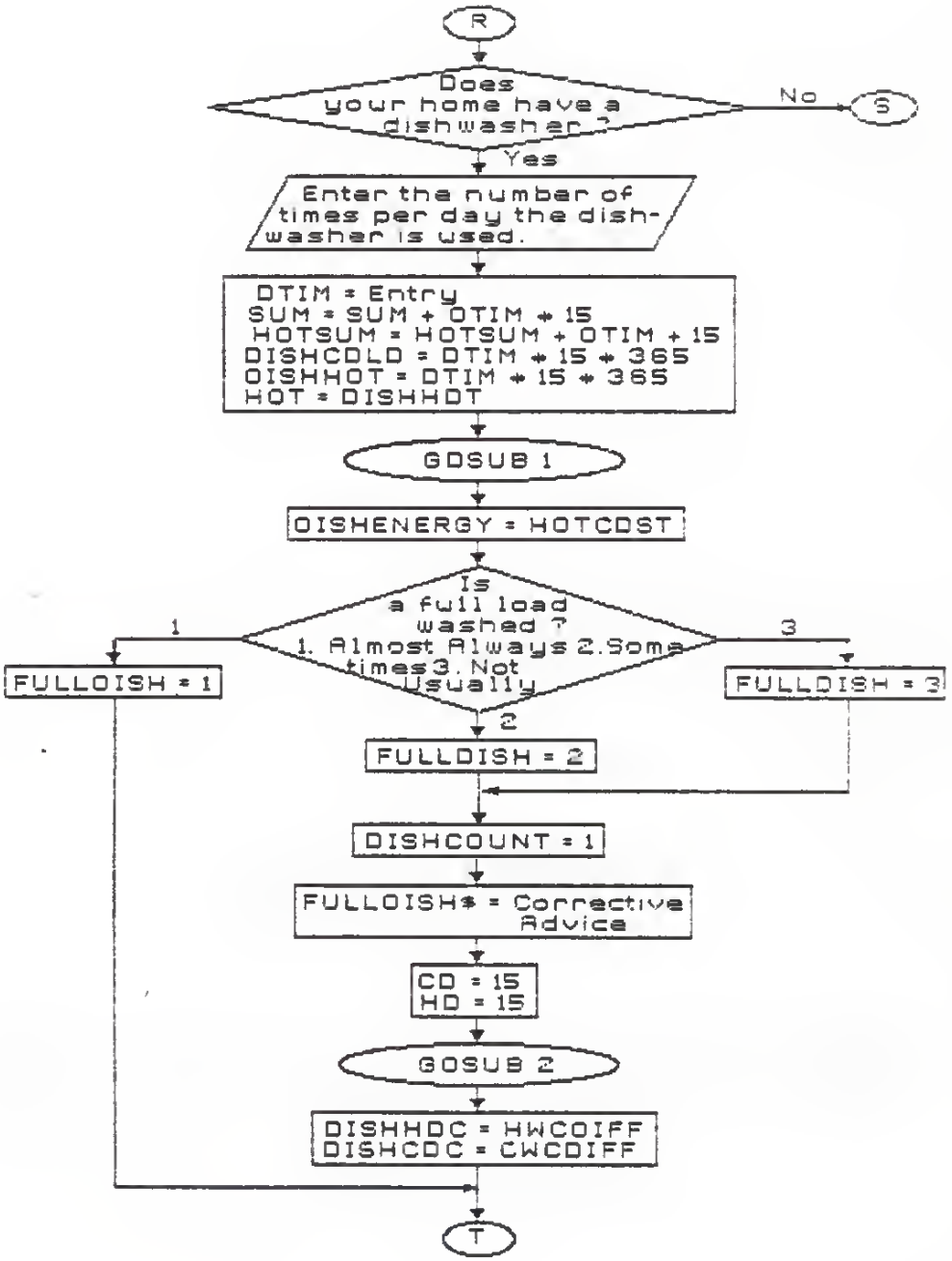


Figure 3.3 (continued)

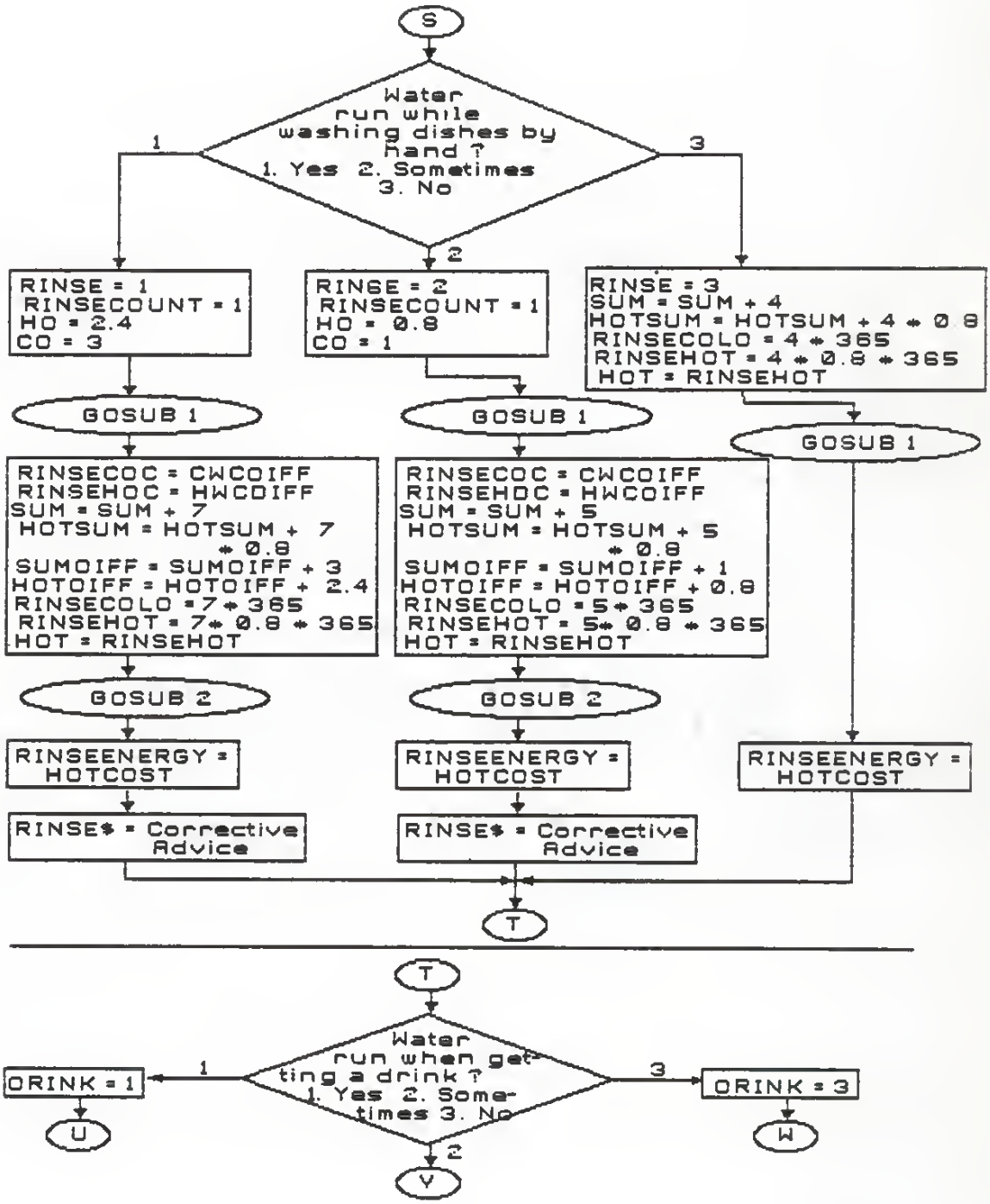


Figure 3.3 (continued)

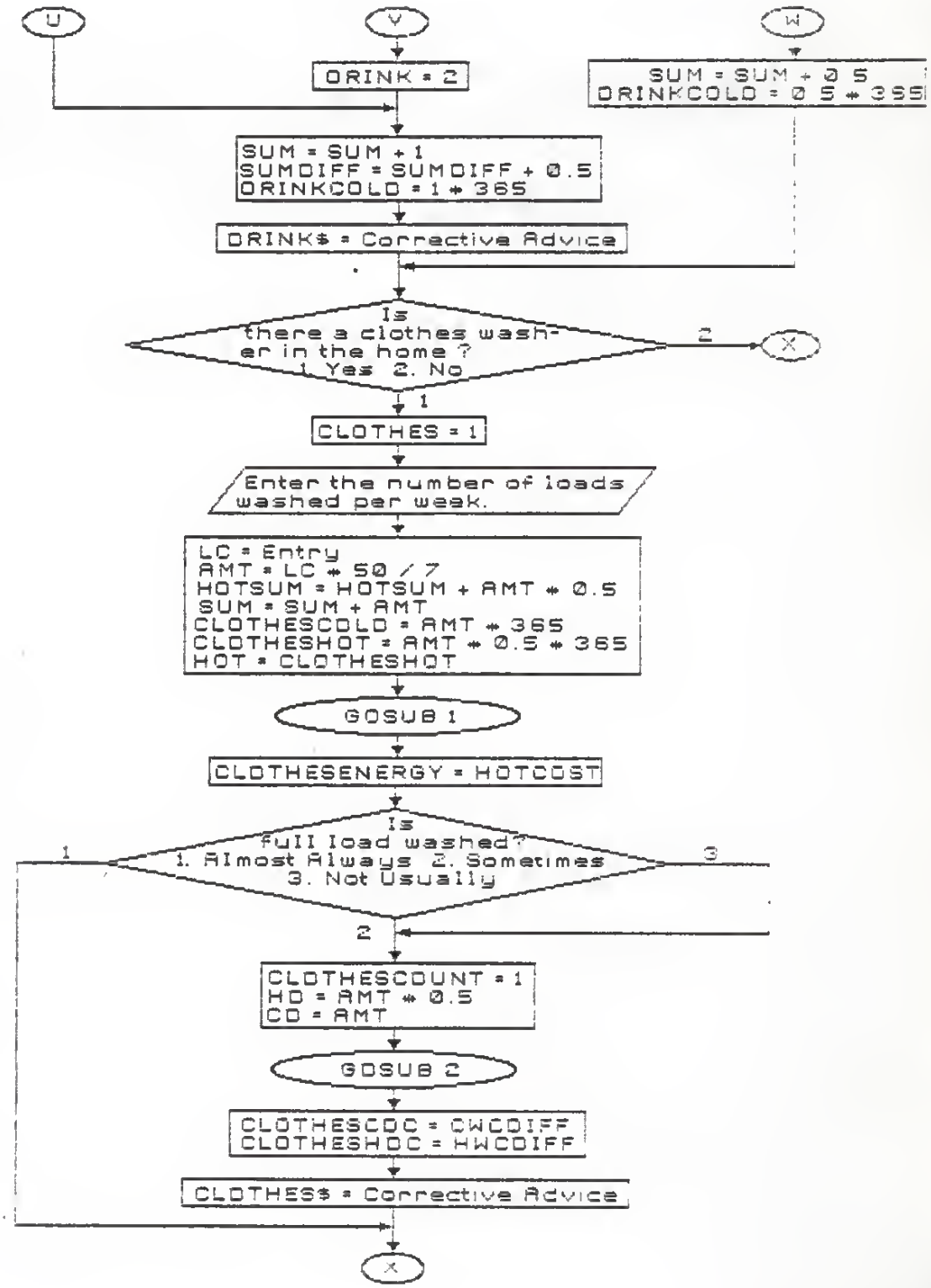


Figure 3.3 (continued)

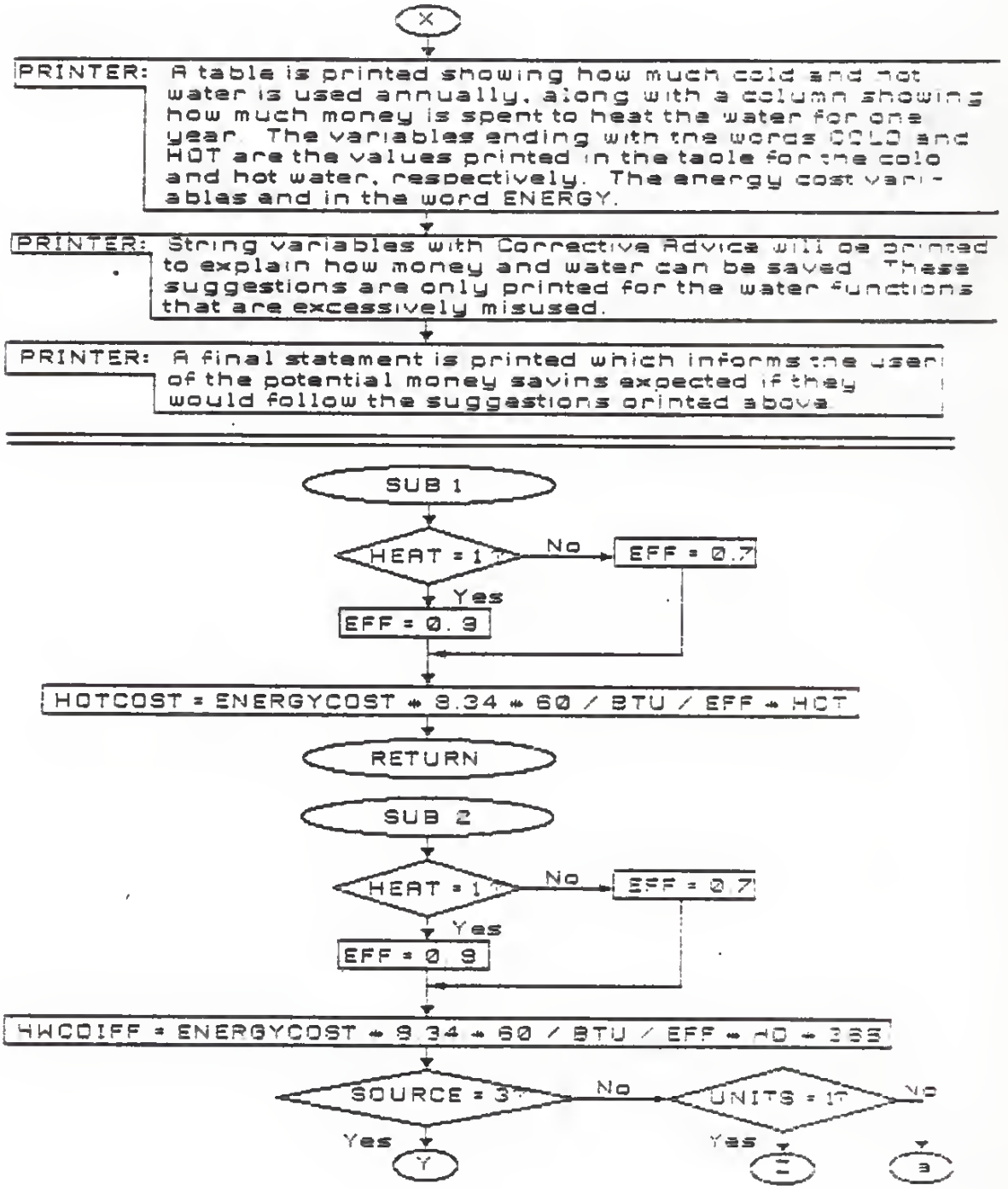
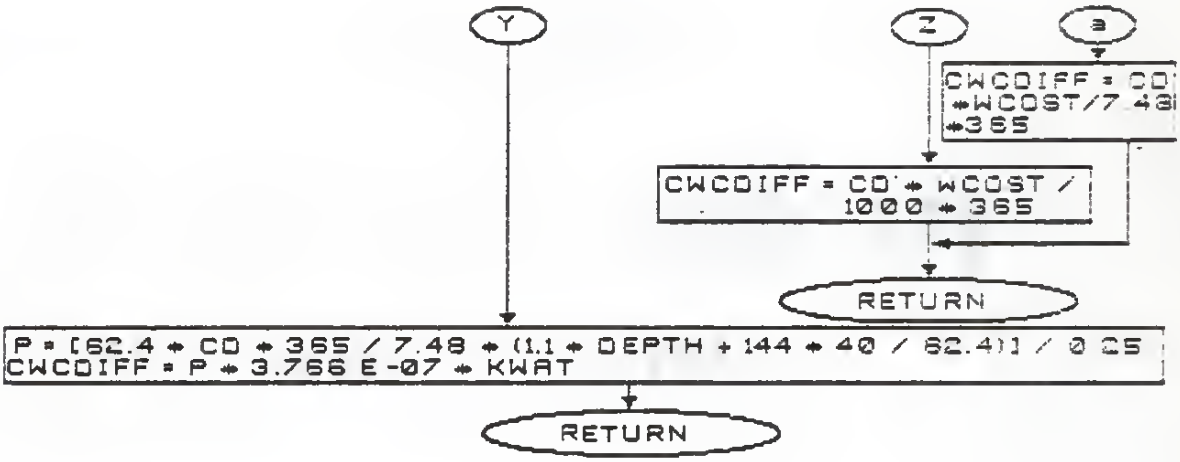


Figure 3.3 (continued)



CHAPTER FOUR

PROGRAM ANALYSIS

Data Collection

Twenty-five people assisted in the analysis of the residential water conservation program by running it. This sample included nine faculity members and 16 students from Kansas State University. The purpose for asking their assistance was twofold. First, they provided a check of the program's integrity. Second, the 25 runs provided a data set that was extropolated to predict the amount of water that could be saved if the program's conservation instructions were followed. All 25 users were given values to enter for the utility rate questions because the users all lived in Manhattan, Kansas. This enabled most combinations of the program to be used, thus checking the programs clarity and flexibility. Each user was asked to critique the program and report any difficulties he had while running it. All functional problems reported were corrected.

Data Analysis

Each person submitted his printout to the author for statistical analysis. The analysis was done on an annual basis; that is, attention was paid to the total annual amount of water used by each individual. Analyzing the potential economic savings was not done due to the large variability in the marginal water rates.

The annual amount of total and hot water used by each individual was calculated by the program and presented in the table of results on the computer printout. The potental annual savings of total and hot water for each user were obtained by analyzing the conservation suggestions from each user's printout. Table 4.1 shows the results from the 25 users. The

column labled "Total" under the heading "Water Uaed" is the total amount of cold

Table 4.1 Reaults of the 25 individuals who ran the Residential Water Conservation Program (sorted by column 2).

Observation Number	Water Used (gal/yr)		Potential Savings (gal/yr)	
	Total	Hot	Total	Hot
1	23,725	8,862	4,380	2,431
2	23,725	12,819	9,855	6,008
3	26,098	16,104	8,213	4,986
4	26,567	12,097	4,745	2,942
5	26,645	12,089	9,125	5,278
6	29,383	10,848	913	241
7	29,930	15,739	8,760	4,986
8	31,599	16,427	913	241
9	32,042	15,426	9,308	6,008
10	33,033	9,373	4,928	3,307
11	33,554	15,635	8,578	5,278
12	34,466	13,897	2,190	971
13	37,308	17,731	913	241
14	39,837	19,597	17,885	11,702
15	41,688	23,352	9,490	5,957
16	41,975	15,118	13,505	8,453
17	43,461	20,953	8,213	4,986
18	43,644	23,274	16,608	7,176
19	45,625	18,294	17,155	11,118
20	46,981	17,731	1,460	241
21	47,540	21,244	4,380	2,431
22	49,730	11,363	1,460	241
23	50,474	19,806	17,155	10,972
24	51,648	21,871	23,178	15,498
25	58,125	25,055	24,455	8,782
Sum:	948,803	414,705	227,765	130,475
Mean:	37,952	16,588	9,111	5,219
Max:	58,125	25,055	24,455	15,498
Min:	23,725	8,862	913	241
Range:	34,400	16,193	23,542	15,257

water used annually by each individual. The hot water is a fraction of the cold water used by the water functions (e.g., 67 percent of the total

water used in showering was estimated to be hot water).

The results of the 25 computer runs estimated average potential savings of 24 percent for the total water and 32 percent for the hot water, if all suggestions given on the printout were followed. Total cost savings cannot be estimated accurately due to the high variability in the marginal water rates. Using the average unit cost of $0.08 for electricity, $5.50 for natural gas, and $0.70 for liquid propane, $70, $21, and $27 per year could be saved for the three energy sources, respectively, based on the mean of the potential hot water savings shown in Table 4.1.

Statistical models were investigated for use in determining the exceedance probability for any given water usage. Seven different distributions were tested; one by hand calculations and the other six with the aid of a Fortran program called International Mathematical and Statistical Library (IMSL) [10]. The Continuous Uniform Distribution (CUD) was the distribution tested by hand calculations. The six distributions tested by using IMSL were the normal, log-normal, half-normal, exponential, Weibull, and extreme value distributions. Of the seven, the CUD was the only one which seemed to fit the data collected from the 25 computer runs.

The goodness-of-fit test for the six distributions using IMSL was simple. A few lines of computer code were written to read the data file (see computer listing in Appendix E); then a subroutine named USPRP was called from the IMSL program which analyzed the data and plotted the points on the appropriate distribution paper (see Appendix E, Figs. E.1-E.6). If the data plotted approximately in a straight line, then that distribution was acceptable; otherwise, the data did not fit the distribution. The data did not fit any of the six distributions.

To test the fit of the data for the CUD, the first step was to plot

the cummulative distribution function (c.d.f.) for both the theoretical and observed CUD on arithmetic paper (see Appendix E, Fig. E.7). The Kolmogorov-Smirnov one-sample test for goodness of fit test [11] was carried out on the two graphs. The critical diatance, D_C, for a Type I error with alpha equal to 0.01 is 0.32. The maximum distance, D_{max}, between the two c.d.f. plots is 0.165, which is less than D_C. Therefore, the null hypotheais (i.e., the asaumption that the data fitted the CUD) waa not rejected. Finally, the exceedance probability graph, Fig. 4.1, was constructed, and was judged to be acceptable baaed on the 25 data pointa obtained. The exceedance probability graph ia the complement of the c.d.f. It was chosen because most civil engineers are accuatomed to working with this type of probability graph.

Table 2.5 shows that an average individual nationwide uses approximately 64 gallons of water per day. From Table 4.1, it is seen that the 25 individuals use an average of 37,952 gallons per year, or 104 gallons per day--a difference of 40 gallons per day when compared to the national average. The CUD model shows a slightly higher average of 112 gallons per day (40,925 gallons per year). Based on the CUD model, the difference in the baseline value of the average daily use and the model is 48 gallons per day. Assuming that the sample of 25 is a reasonably good sample of how people in Kansas use their water, it is concluded that there is a potential for aaving 48 gallons of water per day per person, or 17,520 gallons per year per person. Once again, it is not posaible to assign a dollar value to the figure of 48 gallons per day since the water rates throughout Kanaaa are highly variable.

The computer program should be used in other parts of the atate to

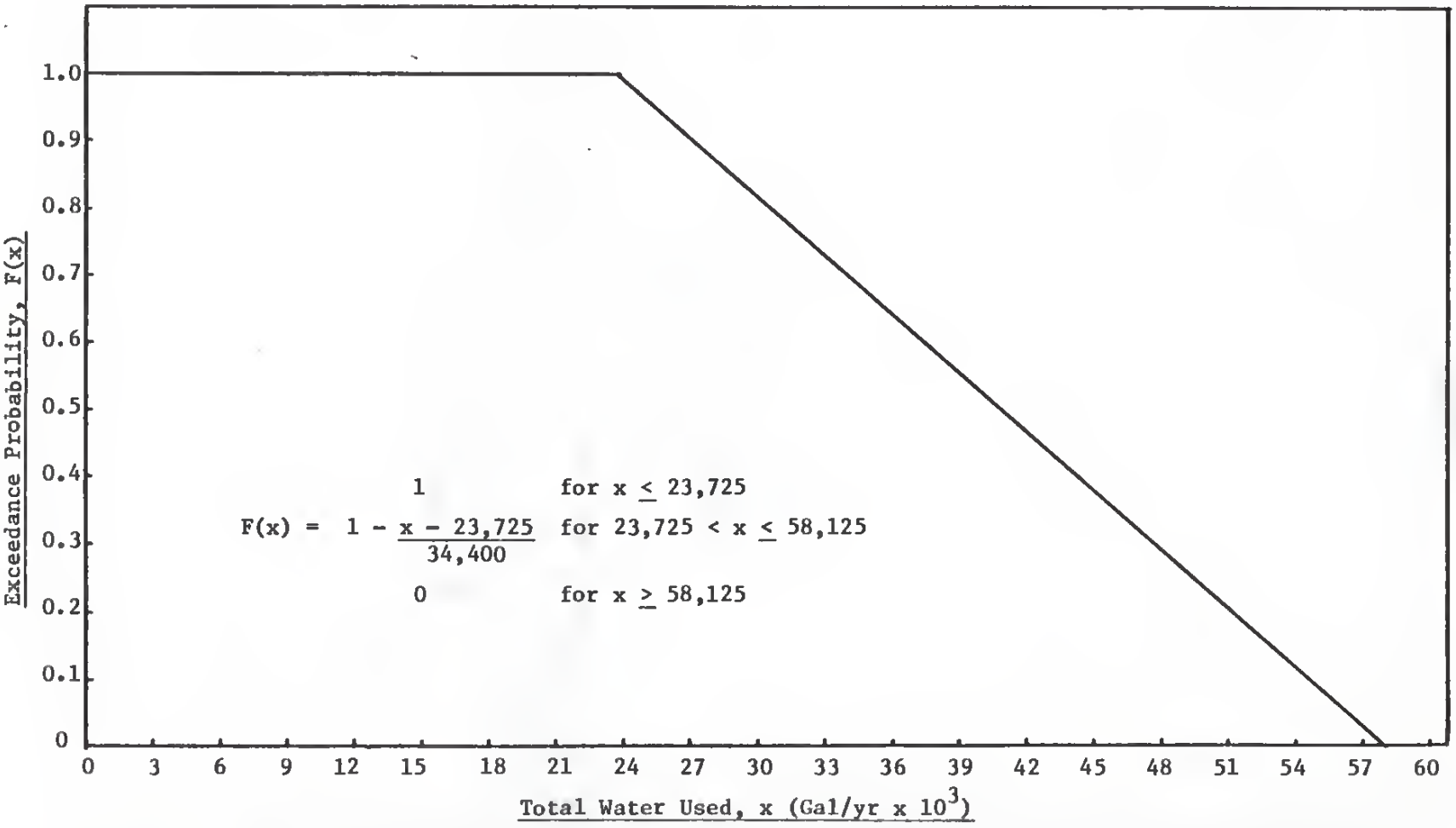


Figure 4.1 Exceedance probability graph for water used annually by an individual. The graph is based on the results from the 25 users of the Residential Water Conservation Program.

obtain a larger and more widespread cross-sectional sample. Such a sample would provide a more reliable check on the appropriateness of the CUD. This sample would also provide a better estimate of average water use within the state.

CHAPTER FIVE

CONCLUDING REMARKS

The objective of this work was to develop a microcomputer program that could be used to educate the general public on ways to conserve water in their homes. The goal of the program is to provide an economic incentive for the user to conserve water.

After educating the public on how they use their water at home, the next step is to educate them on what steps they would follow to begin saving water. The two major water use functions in the home are the toilet and shower. Toilet flushing and showering use approximately 40 percent and 30 percent, respectively, of the total water used at home. The flush volume of most conventional toilets (5 gallons) can be reduced by at least 15 percent without hindering performance. This can be achieved by placing weighted plastic containers or other displacement devices in the tank. Plastic "dams" are available for about $5.00 which save as much as 2.5 gallons per flush. Specially designed low-flush toilets can reduce flush volumes by 70 to 90 percent, but are rather expensive, and have a long payback period compared to the displacement devices.

The cost of heating water averages two to four times the cost of the water. Therefore, large cost savings can be achieved by reducing hot water use. The greatest potential here lies in reducing shower flows. Two types of shower devices are common: specially designed low-flow shower heads, and flow restricting orifice disks which are placed just upstream of the existing shower head. These devices can reduce shower flows by 40 percent. Although shower heads are more expensive than the flow restrictors, their performance is generally more satisfactory. The additional cost is quickly

recovered in water and energy aavinge, in moet caeea in a few monthe. Additional water and energy conaervation can be achieved through the uae of faucet aerators and water saving diehwaahere and clothes waahere. Faucet aeratore can reduce water uee in einka and lavatories by 30 percent. These are especially advantageous where dishea are waahed by hand.

The author hoated a water conaervation exhibit at the 1985 Kansaa State Univeraity Open House. The exhibit demonstrated the uae of dieplacement devicea in a toilet tank, and diaplayed both conventional and low-flow ahower heada. Many of the people remarked about the old "brick in the toilet tank" method of dieplacing water. Thie ia the concept that the exhibit waa trying to get acrose to the public, but this particular method waa discouraged since the brick will start to break down and fall apart once it gete aatruated, thus, plugging up the toilet plumbing. One man remarked that he found a dime with a amall hole drilled in it placed in hia shower head that was being used as a flow restricting orifice.

Overall, the exhibit proved to be eucceaeful in educating the public about ways to save water, but the people seemed to need an incentive to eave. Thia ie where the water conservation program developed herein can be ueed. Since it gives an economic incentive to aave water, and aince aaving money ie the goal of many people today, then the uee of thia program ia a first step in a aucceaaful education program.

Appendix A

Residential Water Conservation Program Listing

Listing of Residential Water Conservation Program.

```
1000 CLS
1010 '*****************************************************************************
1020 '*                                                                           *
1030 '* RESIDENTIAL WATER CONSERVATION ANALYSIS DEALING WITH IN-HOME WATER USE    *
1040 '*                                                                           *
1050 '*                Written By:  John R. Hollenbeck                            *
1060 '*                             Graduate Student, Civil Engineering           *
1070 '*                             Kansas State University                       *
1080 '*             Supervised By:  Dr. James Koelliker                           *
1090 '*                             Professor, Civil Engineering                  *
1100 '*                             Kansas State University                       *
1110 '*                                                                           *
1120 '*              Date Started: 4 January 1985                                 *
1130 '*            Date Completed: 3 November 1985                                *
1140 '*                                                                           *
1150 '*****************************************************************************
1160 '
1170 '*****************************************************************************
1180 '*                                                                           *
1190 '*       To use this program, refer to the user's manual entitled "User'     *
1200 '*  Manual for Residential Water Conservation Program" written by John       *
1210 '*  Hollenbeck, Nov. 1985.                                                   *
1220 '*                                                                           *
1230 '*       The user's manual documents all of the variables used in this       *
1240 '*  program.  Some of the variables are documented in the program listing    *
1250 '*  but for a complete listing, please go to the user's manual.              *
1260 '*                                                                           *
1270 '*****************************************************************************
1280 '
1290 ON ERROR GOTO 12640
1300 DIM A$(69), CITY$(69), MCU1(18), MCU2(18), COUNTY$(25), RWDNO$(25)
1310 DIM RWDMWC(25), FC(11), ALPH$(26)
1320 '
1330 '*****************************************************************************
1340 '                          * * *  INTRODUCTION  * * *
1350 '*****************************************************************************
1360 '
1370 CLS : COLOR 2,0
1380 PRINT TAB(22) "IN-HOME WATER CONSERVATION ANALYSIS" : COLOR 7,0
1390 LOCATE 5,1
1400 PRINT "     This program will ask you questions to determine how you use wa
ter at home.It will estimate how much money you spend annually on water and
energy used to  heat your water in a year."
1410 PRINT
1420 PRINT "     At the end of the session, a summary table will be printed on
the printer showing how each water function (i.e., showering, dishwashing, etc.)
contrib-    uites to your annual consumption of water.  Along with the summary
table, some"
```

Listing of Residential Water Conservation Program (continued).

```
1430 PRINT "other information will be printed explaining ways to save you money
by          conserving water."
1440 PRINT : PRINT
1450 LOCATE ,,0
1460 PRINT TAB(28) "Press any key to continue."
1470 A$ = INPUT$(1)
1480 CLS
1490 PRINT "     There are two types of questions asked in this program.  They
are:
1500 PRINT
1510 PRINT TAB(15) "1.  Multiple choice questions."
1520 PRINT TAB(15) "2.  Fill-in-the-blank questions."
1530 PRINT
1540 PRINT "     To answer the multiple choice questions, you need only enter
the number  that corresponds to the answer.  To do this, you have to type the
number by "
1550 PRINT "using the numbers across the top of the keyboard.  You then must
press the   key  marked RETURN to complete the entry."
1560 PRINT
1570 PRINT "Try the multiple choice example below."
1580 PRINT
1590 LOCATE ,,1
1600 PRINT "What time is it?"
1610 PRINT "     [1]  Before 12 o'clock noon."
1620 PRINT "     [2]  Exactly 12 o'clock noon."
1630 INPUT "     [3]  After 12 o'clock noon.              ANSWER = ",ANS$
1640 '
1650 '  Any answer will be accepted as long as the user enters 1, 2, or 3.  The
1660 '  reason any answer will be accepted is because some machines do not have
1670 '  a continous clock in them, so I could not check their answer with the
1680 '  correct time.
1690 '
1700 IF VAL(ANS$) = 1 OR VAL(ANS$) = 2 OR VAL(ANS$) = 3 THEN T = VAL(ANS$) :
GOTO 1720
1710 PRINT : COLOR 7,1 : PRINT " You must enter either 1, 2, or 3....  Try
again. "; : COLOR 7,0 : PRINT : GOTO 1600
1720 PRINT : COLOR 0,7 : PRINT "     GOOD JOB!     "; : COLOR 7,0
1730 PRINT : PRINT
1740 PRINT TAB(28) "Press any key to continue."
1750 LOCATE ,,0 : A$ = INPUT$(1)
1760 CLS : LOCATE 5,1
1770 PRINT "The fill-in-the-blank questions allow you to enter either letters,
numbers, or symbols.  You must supply the answer to the question that is asked."
1780 PRINT
1790 PRINT "Answer the fill-in-the-blank example below."
1800 PRINT : PRINT
1810 LOCATE ,,1
1820 LINE INPUT "     Enter your first name.       ANSWER = ", NNAME$
1830 IF NNAME$ = "" OR VAL(NNAME$) <> 0 THEN 1840 ELSE 1850
1840 PRINT : COLOR 7,1 : PRINT " Try again "; : COLOR 7,0 : PRINT : GOTO 1820
```

Listing of Residential Water Conaervation Program (continued).

```
1850 PRINT : PRINT USING "You entered your name as &.  Is this spelled
correctly?"; NNAME$
1860 PRINT "     [1]  Yea"
1870 INPUT "     [2]  No                Answer = ", ANS$
1880 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN 1940
1890 IF VAL(ANS$) = 2 OR ANS$ = "n" OR ANS$ = "N" THEN 1900 ELSE 1910
1900 PRINT : PRINT "     Ok... Try again." : PRINT : GOTO 1820
1910 COLOR 7,1
1920 PRINT " You must enter either 1 or 2.....  Try again. ";
1930 COLOR 7,0 : PRINT : GOTO 1850
1940 PRINT:PRINT TAB(20) "Press any key and we'll get started with the program."
1950 LOCATE ,,0 : A$ = INPUT$(1) : LOCATE ,,1
1960 CLS : LOCATE 5,1
1970 SEX = 0
1980 PRINT "Are you male or female?"
1990 PRINT "     [1]  Male"
2000 INPUT "     [2]  Female                    Answer = ", ANS$
2010 PRINT
2020 IF VAL(ANS$) = 1 OR VAL(ANS$) = 2 THEN SEX = VAL(ANS$) : GOTO 2240
2030 COLOR 7,1
2040 PRINT " You must enter either 1 or 2....  Try again. ";
2050 COLOR 7,0 : PRINT
2060 GOTO 1980
2070 '
2080 '*************************************************************************
2090 '                    * * *  UTILITY RATE SECTION  * * *
2100 '*************************************************************************
2110 '
2120 PRINT
2130 IF COUNTER = 1 THEN CLS ELSE 2240
2140 LOCATE 5,1 : COLOR 7,0
2150 '
2160 '               = = =  SETTING PARAMETERS TO ZERO  = = =
2170 '
2180 SUM = 0 : HOTSUM = 0 : SUMDIFF = 0 : HOTDIFF = 0 : KANCOUNT = 0
2190 BS = 0 : DISH = 0 : CLOTHES = 0 : SOFTENER = 0 : CLOTHESCOUNT = 0
2200 DRINK = 0 : SHAVECOUNT = 0 : NOTWISE = 0 : FRC = 0 : TUBCOUNT = 0
2210 SHOWERCOUNT = 0 : TEETHCOUNT = 0 : HANDSCOUNT = 0 : DISHCOUNT = 0
2220 RINSECOUNT = 0 : WC = 0 : WCOST = 0 : HWC = 0 : WATER = 0
2230 '
2240 PRINT "Do you live in Kanaas?"
2250 PRINT "     [1]  Yea"
2260 INPUT "     [2]  No                     Answer = ", KAN$
2270 PRINT
2280 IF VAL(KAN$) = 1 OR KAN$ = "y" OR KAN$ = "Y" THEN 2370
2290 IF VAL(KAN$) = 2 OR KAN$ = "n" OR KAN$ = "N" THEN 2300 ELSE 2330
2300 PRINT "     I do not have any information about water rates for any place
outside     Kansas, but I will use averages based on Kansas water rates."
2310 PRINT
2320 KANCOUNT = 1 : GOTO 2370
```

Listing of Reaidential Water Conservation Program (continued).

```
2330 COLOR 7,1
2340 PRINT " You must enter either 1 or 2.... Try again. ";
2350 COLOR 7,0 : PRINT : PRINT : GOTO 2240
2360 '
2370 PRINT "What is the population of your community?"
2380 PRINT "      [1]  Greater than 100,000 people"
2390 PRINT "      [2]  Between 10,000 and 99,999"
2400 PRINT "      [3]  Between 5,000 and 9,999"
2410 PRINT "      [4]  Between 1,000 and 4,999"
2420 PRINT "      [5]  999 people or less."
2430 INPUT "      [6]  You live in a rural area.          Answer = ", ANS$
2440 PRINT
2450 IF VAL(ANS$) = 6 THEN ANS$ = "5"
2460 IF VAL(ANS$) >=1 AND VAL(ANS$) <=5 THEN POP = VAL(ANS$) : GOTO 2500
2470 COLOR 7,1
2480 PRINT " You must enter either 1, 2, 3, 4, 5, or 6....  Try again. ";
2490 COLOR 7,0 : GOTO 2310
2500 IF COUNTER = 1 THEN COUNTER = 0 ELSE 2520
2510 GOTO 3640
2520 PRINT
2530 '              ++++++++++++++++++++++++++++++++++++++++
2540 '              = = =  WATER UTILITY RATE SECTION  = = =
2550 '              ++++++++++++++++++++++++++++++++++++++++
2560 '
2570 PRINT "Where does your water come from?"
2580 PRINT "      [1]  Municipal water plant"
2590 PRINT "      [2]  Rural Water District"
2600 INPUT "      [3]  Private well                    Answer = ", ANS$
2610 PRINT
2620 IF VAL(ANS$) =1 OR VAL(ANS$) =2 OR VAL(ANS$) =3 THEN SOURCE = VAL(ANS$) :
GOTO 2670
2630 COLOR 7,1
2640 PRINT " You must enter either 1, 2, or 3....  Try again. ";
2650 COLOR 7,0 : PRINT
2660 GOTO 2570
2670 IF SOURCE <> 3 THEN 2750
2680 '
2690 PRINT "How deep (in feet) is your well?  If you don't know, then make a
rough eatimate.
2700 INPUT "      Answer = ",DEPTH$
2710 PRINT
2720 IF VAL(DEPTH$) <= 0 OR DEPTH$ = "" THEN COLOR 7,1 ELSE DEPTH = VAL(DEPTH$)
: GOTO 6420
2730 PRINT " You must give me an eatimate.  If you don't know, then guesa 50
feet. ";
2740 COLOR 7,0 : PRINT : GOTO 2690
2750 IF SOURCE = 2 THEN UNITS = 1 : UNIT$ = "1000 gallona" : GOTO 3500
2760 PRINT "Ia your home on a water meter?"
2770 PRINT "      [1]  Yea"
2780 INPUT "      [2]  No                              Anawer = ", ANS$
```

Listing of Residential Water Conservation Program (continued).

```
2790 PRINT
2800 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN METER = 1 : GOTO 2880
2810 IF VAL(ANS$) = 2 OR ANS$ = "n" OR ANS$ = "N" THEN METER = 2 : GOTO 2860
2820 COLOR 7,1
2830 PRINT " You must enter either 1 or 2....  Try again. ";
2840 COLOR 7,0 : PRINT
2850 GOTO 2750
2860 IF METER = 2 THEN 2990
2870 '
2880 PRINT "How does your water bill read?  Most bills read in dollars per ";
2890 PRINT "one-thousand" : PRINT "gallons."
2900 PRINT "      [1]  Dollars per one-thousand gallons"
2910 INPUT "      [2]  Dollars per one-hundred cubic feet        Answer = ", ANS$
2920 PRINT
2930 IF VAL(ANS$) =1 OR VAL(ANS$) =2 THEN UNITS = VAL(ANS$) : GOTO 3470
2940 COLOR 7,1
2950 PRINT " You must enter either 1 or 2....  Try again. ";
2960 COLOR 7,0 : PRINT
2970 GOTO 2880
2980 '
2990 PRINT "What is your flat rate water fee in dollars per month?"
3000 PRINT "   Enter the amount as a dollar decimal."
3010 INPUT "   If you don't know, then hit the RETURN key.     Answer = $",FLAT$
3020 PRINT
3030 IF KANCOUNT = 1 AND FLAT$ = "" THEN 3420 : IF VAL(FLAT$) > 0 AND VAL(FLAT$)
<= 20 THEN FLATFEE = VAL(FLAT$) ELSE 3060 : GOTO 3420
3040 IF FLAT$ = "" THEN FRC = 1 : GOTO 3130
3050 IF VAL(FLAT$) > 0 AND VAL(FLAT$) <= 20 THEN 3090
3060 COLOR 7,1
3070 PRINT " Please enter a cost between $1 and $20 per month. ";
3080 COLOR 7,0 : PRINT : PRINT : GOTO 2990
3090 FC = VAL(FLAT$) : FRC = 1 : GOTO 6420
3100 '
3110 '          = = =  OPENING THE SEQUENTIAL FILE "FLATFEE.DAT"  = = =
3120 '
3130 CLS
3140 OPEN "I", #1, "FLATFEE.DAT"
3150 FOR I = 1 TO 11
3160     INPUT #1, CITY$(I), FC(I)
3170 NEXT I
3180 CLOSE
3190 PRINT "Below is a list of Kansas communities that charge a flat fee for
their water.If your community is listed, enter the line number that corresponds
to it and"
3200 PRINT "hit the RETURN key.  If your community is not listed, then hit
RETURN key only."
3210 PRINT
3220 PRINT "                    Line No.          Community"
3230 PRINT "                    ---- ---          ---------"
3240 FOR I = 1 TO 11
```

Listing of Residential Water Conservation Program (continued).

```
3250     LOCATE (6 + I), 21
3260     PRINT USING "##.              &"; I, CITY$(I)
3270 PRINT
3280 NEXT I
3290 LOCATE 20,35
3300 INPUT "ANSWER = ", ANS$
3310 IF ANS$ = "" THEN FC = 7.86 : PRINT : GOTO 3420
3320 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= 11 THEN 3330 ELSE 3370
3330 FC = FC(VAL(ANS$)) : FRC = 1 : PRINT
3340 COLOR 7,4
3350 PRINT USING " The flat rate water fee for & is $##.##. "; CITY$(VAL(ANS$)),
FC(VAL(ANS$));
3360 COLOR 7,0 : PRINT : PRINT : LOCATE 24,1 : GOTO 6420
3370 CLS
3380 LOCATE 12,1 : COLOR 7,1
3390 INPUT " You must have hit the wrong key....  Press the RETURN key and try
again. ", RET$
3400 IF RET$ = "" THEN COLOR 7,0 : CLS : GOTO 3190
3410 COLOR 7,0 : GOTO 3370
3420 FRC = 1 : COLOR 7,4
3430 PRINT " Then I'll use a rough estimate for the flat rate equal to $7.86 ";
3440 PRINT "per month. ";
3450 COLOR 7,0 : PRINT : PRINT : GOTO 6420
3460 PRINT : GOTO 6310
3470 IF UNITS = 1 THEN UNIT$ = "one-thousand gallons" : GOTO 3500
3480 IF UNITS = 2 THEN UNIT$ = "one-hundred cubic feet"
3490 '
3500 PRINT "What is the marginal cost per ";UNIT$;" of water per month where ";
3510 PRINT "you live?"
3520 PRINT "   Enter the amount as a dollar decimal."
3530 INPUT "   If you don't know, then press the RETURN key.    Answer = $",
WCOST$
3540 PRINT
3550 IF WCOST$ = "" AND KANCOUNT = 1 AND SOURCE = 2 THEN 6260
3560 IF WCOST$ = "" AND KANCOUNT = 1 THEN 5960
3570 IF WCOST$ = "" THEN 3630
3580 IF VAL(WCOST$) > 0  AND VAL(WCOST$) <= 8 THEN 3620
3590 COLOR 7,1
3600 PRINT " Please enter a cost between $0.50 and $8. ";
3610 COLOR 7,0 : PRINT : PRINT : GOTO 3500
3620 WCOST = VAL(WCOST$) : LOCATE 24,1 : PRINT : GOTO 6420
3630 PRINT
3640 CLS
3650 IF SOURCE = 2 THEN 4710
3660 ON POP GOTO 3670, 3680, 3690, 3700, 3710
3670 FFN$ = "CITY1" : POP$ = "over 100,000" : GOTO 3760
3680 FFN$ = "CITY2" : POP$ = "between 10,000 & 99,999" : GOTO 3760
3690 FFN$ = "CITY3" : POP$ = "between 5000 & 9999" : GOTO 3760
3700 FFN$ = "CITY4" : POP$ = "between 1000 & 4999" : GOTO 3760
3710 FFN$ = "city5" : POP$ = "less than 1000" : GOTO 3760
```

Listing of Residential Water Conservation Program (continued).

```
3720 '
3730 '    = = =  OPENING THE SEQUENTIAL FILE FOR THE MUNICIPAL WATER  = = =
3740 '    = = =  PLANTS BASED ON COMMUNITY POPULATION                 = = =
3750 '
3760 OPEN "I", #1, FFN$ + ".DAT"
3770 IF POP = 4 OR POP = 5 THEN 4200
3780 LOCATE 1,1
3790 PRINT USING "     You entered that your community had & people, thus";POP$
3800 PRINT "the reason for the list below.  In the area marked ANSWER, enter the
line number that corresponds to your community."
3810 PRINT "     If your community is not listed, and your population size is
correct,    then press the key marked RETURN.  If you think you answered the
question    dealing with your population incorrectly, then press the key marked
'H' and hit RETURN."
3820 IF POP = 2 THEN 3990
3830 LOCATE 8,5
3840 PRINT "Line No.          Community"
3850 LOCATE 9,5
3860 PRINT "---- ---          ---------"
3870 IF POP = 1 THEN N = 9 ELSE N = 36
3880 FOR I = 1 TO N
3890     INPUT #1, A$(I)
3900 NEXT I
3910 J = 0
3920 FOR I = 1 TO (N - 2) STEP 3
3930     J = J + 1 : LOCATE (9 + J),8
3940     CITY$(I) = A$(I)
3950     PRINT USING "##.             &";J,CITY$(I)
3960 NEXT I
3970 LOCATE 15,45 : INPUT "ANSWER = ", ANS$
3980 CLOSE : GOTO 5660
3990 LOCATE 8,1
4000 PRINT "Line No.          Community             Line No.          Community"
4010 PRINT "---- ---          ---------             ---- ---          ---------"
4020 FOR I = 1 TO 69
4030     INPUT #1, A$(I)
4040 NEXT I
4050 J = 0
4060 FOR I = 1 TO 36 STEP 3
4070     J = J + 1
4080     CITY$(I) = A$(I)
4090     PRINT USING "    ##.          &"; J, CITY$(I)
4100 NEXT I
4110 FOR I = 37 TO 67 STEP 3
4120     J = J + 1
4130     LOCATE (J - 3),40
4140     CITY$(I) = A$(I)
4150     PRINT USING "    ##.           &"; J, CITY$(I)
4160 NEXT I
4170 LOCATE 23,35 : INPUT "ANSWER = ", ANS$
```

Liating of Reaidential Water Conservation Program (continued).

```
4180 CLOSE
4190 GOTO 5660
4200 CLS
4210 PRINT "     In the area by the word ANSWER, enter the firat letter";
4220 COLOR 4,0 : PRINT " (IN CAPS ONLY) "; : COLOR 7,0
4230 PRINT "of your community's name.  ";
4240 COLOR 4,0 : PRINT "DO NOT PUT ANY SPACES IN FRONT OF THIS LETTER!"; : COLOR
7,0
4250 PRINT
4260 INPUT "           ANSWER = ", FL$
4270 PRINT
4280 PRINT USING "I am attempting to look for the towna that begin with the
letter &.                                          Please Wait...."; FL$
4290 J = 0
4300 IF POP = 4 THEN N = 120 ELSE N = 209
4310 FOR I = 1 TO N
4320     INPUT #1, A$, B, C
4330     IF LEFT$(A$,1) < FL$ THEN 4360
4340     IF LEFT$(A$,1) > FL$ THEN 4370 ELSE J = J + 1
4350     CITY$(J) = A$ : MCU1(J) = B : MCU2(J) = C
4360 NEXT I
4370 CLOSE
4380 IF J = 0 THEN 5930
4390 COLOR 7,0 : CLS : LOCATE 1,1
4400 PRINT USING "     You entered that your community had & people, thua";POP$
4410 PRINT "the reason for the list below.  In the area marked ANSWER, enter the
line number that corresponds to your community."
4420 PRINT "     If your community is not listed, and your population size is
correct,    then press the key marked RETURN.  If you think you answered the
question    dealing    with your population incorrectly, then press the key
marked 'H'  and hit RETURN."
4430 IF POP = 5 AND (FL$ = "B" OR FL$ = "C" OR FL$ = "L" OR FL$ = "M" OR FL$ =
"W") THEN 4540
4440 LOCATE 8,5
4450 PRINT "Line No.          Community"
4460 LOCATE 9,5
4470 PRINT "---- ---          ---------"
4480 FOR I = 1 TO J
4490     LOCATE (9 + I), 8
4500     PRINT USING "##.             &";I,CITY$(I)
4510 NEXT I
4520 LOCATE 15,45 : INPUT "ANSWER = ", ANS$
4530 CLOSE : GOTO 5660
4540 LOCATE 8,1
4550 PRINT "Line No.         Community            Line No.          Community"
4560 PRINT "---- ---         ---------            ---- ---          ---------"
4570 K% = J / 2
4580 FOR I = 1 TO K%
4590     PRINT USING "  ##.            &";I, CITY$(I)
4600 NEXT I
```

Listing of Residential Water Conservation Program (continued).

```
4610 L = 0
4620 FOR I = (K% + 1) TO J
4630     L = L + 1
4640     LOCATE (9 + L),40
4650     PRINT USING "    ##.            &";I,CITY$(I)
4660 NEXT I
4670 CLOSE
4680 LOCATE 23,35 : INPUT "ANSWER = ", ANS$
4690 GOTO 5660
4700 LOCATE 1,1
4710 PRINT "You answered that your water is supplied by a Rural Water District
(RWD).  Somedistricts are named after the city they serve.  Below is a list of
the dis-"
4720 PRINT "tricts that fit this category.  If your district is one of these,
then enter  the line number that corresponds to it and hit the RETURN key.  If
this is not your case then enter the first letter";
4730 COLOR 4,0 : PRINT " (IN CAPS ONLY) "; : COLOR 7,0
4740 PRINT "of your district's name and"
4750 PRINT "press the RETURN key.  ";
4760 COLOR 4,0 : PRINT "DO NOT PUT ANY SPACES BEFORE THE LETTER!" : COLOR 7,0
4770 '
4780 '          = = =  OPENING THE RWD SEQUENTIAL FILE  = = =
4790 '
4800 OPEN "I", #1, "RWD.DAT"
4810 FOR I = 1 TO 5
4820     INPUT #1, CITY$(I), RWDMWC(I)
4830 NEXT I
4840 LOCATE 8,1
4850 PRINT "        Line No.            Community"
4860 PRINT "        ---- ---            ---------
4870 FOR I = 1 TO 5
4880     PRINT USING"          #.                &"; I, CITY$(I)
4890 NEXT I
4900 LOCATE 17,10
4910 INPUT "ANSWER = ", ANS$
4920 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= 5 THEN WCOST = RWDMWC(VAL(ANS$)) ELSE
     4970
4930 CLOSE
4940 LOCATE 23,1 : COLOR 7,4
4950 PRINT USING " The marginal water rate for the & is $##.##.           ";
CITY$(VAL(ANS$)), WCOST; : PRINT
4960 COLOR 7,0 : PRINT : GOTO 6420
4970 IF ANS$ = "" THEN 4900
4980 FOR I = 1 TO 26
4990     READ ALPH$(I)
5000     IF ANS$ = ALPH$(I) THEN 5070
5010 NEXT I
5020 DATA A,B,C,D,E,F,G,H,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W,X,Y,Z
5030 IF VAL(ANS$) < 1 OR VAL(ANS$) > 5 THEN LOCATE 23,1 ELSE 5070
5040 COLOR 7,1
```

Listing of Residential Water Conservation Program (continued).

```
5050 PRINT " You cannot enter a number less than 1 or larger than 5.... Try
again. ";
5060 COLOR 7,0 : GOTO 4900
5070 CLS : FL$ = ANS$
5080 PRINT
5090 PRINT USING "I am attempting to look for the RWDs that begin with the
letter &.                                  Please Wait......"; FL$
5100 FOR I = 1 TO 169
5110     INPUT #1, A$, B$, C
5120     IF LEFT$(A$,1) < FL$ THEN 5150
5130     IF LEFT$(A$,1) > FL$ THEN 5170 ELSE J = J + 1
5140     COUNTY$(J) = A$ : RWDNO$(J) = B$ : RWDMWC(J) = C
5150 NEXT I
5160 CLOSE
5170 IF J = 0 THEN 6220
5180 CLS
5190 PRINT USING "Below is a list of RWD's that begin with the letter &.  If
your district is  listed, then enter the number that corresponds to it and
press the RETURN  key."; FL$
5200 PRINT "If your district is not listed, then press the RETURN key only."
5210 PRINT
5220 IF FL$ = "C" OR FL$ = "L" OR FL$ = "M" THEN 5400
5230 PRINT "       Line No.      County            RWD No. "
5240 PRINT "       ---- ---     ------            --- ---"
5250 FOR I = 1 TO J
5260     LOCATE (6 + I), 8
5270     PRINT USING "  ##.         &"; I, COUNTY$(I)
5280     LOCATE (6 + I), 43 : PRINT USING "&"; RWDNO$(I)
5290 NEXT I
5300 LOCATE 23,35
5310 INPUT "ANSWER = ", ANS$
5320 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= J THEN WCOST = RWDMWC(VAL(ANS$)) ELSE
     5360
5330 LOCATE 24,1 : COLOR 7,4
5340 PRINT USING " The marginal water rate for & county RWD No. & is $##.## ";
COUNTY$(VAL(ANS$)), RWDNO$(VAL(ANS$)), WCOST : PRINT " per 1000 gallons. ";
5350 COLOR 7,0 : PRINT : PRINT : GOTO 6420
5360 IF ANS$ = "" THEN 6170
5370 CLS : LOCATE 12,5 : COLOR 7,1
5380 INPUT " You must have hit the wrong key.... Press the RETURN key and try
again. ", RET$;
5390 IF RET$ = "" THEN 5190 ELSE COLOR 7,0 : GOTO 5370
5400 PRINT
5410 PRINT "Line No.  County           RWD No.    |   Line No.  County
RWD No."
5420 PRINT "---- ---  ------           -------    |   ---- ---  ------
-------"
5430 K% = J / 2
5440 FOR I = 1 TO K%
5450     PRINT USING "   ##.    &"; I, COUNTY$(I)
```

Liating of Reaidential Water Conaervation Program (continued).

```
5460      LOCATE (7 + I), 30
5470      PRINT USING "&"; RWDNO$(I)
5480 NEXT I
5490 L = 0
5500 FOR I = (K% + 1) TO J
5510      L = L + 1
5520      LOCATE (7 + L), 38
5530      PRINT USING "|      ##.    &"; I, COUNTY$(I)
5540      LOCATE (7 + L), 73
5550      PRINT USING "&"; RWDNO$(I)
5560 NEXT I
5570 LOCATE 25,35 : INPUT "ANSWER = ", ANS$
5580 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= J THEN WCOST = RWDMWC(VAL(ANS$)) : CLS :
ELSE 5620
5590 LOCATE 3,1 : COLOR 7,4
5600 PRINT USING " The marginal water rate for & county RWD No. & is $##.## ";
COUNTY$(VAL(ANS$)), RWDNO$(VAL(ANS$)), WCOST : PRINT " per 1000 gallons. ";
5610 COLOR 7,0 : PRINT : PRINT : GOTO 6420
5620 IF ANS$ = "" THEN 6170
5630 CLS : LOCATE 12,5 : COLOR 7,1
5640 INPUT " You must have hit the wrong key.... Press the RETURN key and try
again. ", RET$
5650 IF RET$ = "" THEN 5190 ELSE COLOR 7,0 : GOTO 5630
5660 ON POP GOTO 5670, 5680, 5690, 5700, 5700
5670 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= 3 THEN 5710 ELSE 5770
5680 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= 23 THEN 5710 ELSE 5770
5690 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= 12 THEN 5710 ELSE 5770
5700 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= J THEN 5750 ELSE 5770
5710 NUM = VAL(ANS$) * 3
5720 IF UNITS = 1 THEN WCOST = VAL(A$(NUM - 1)) : GOTO 6310
5730 IF UNITS = 2 THEN WCOST = VAL(A$(NUM)) : GOTO 6310
5740 GOTO 5770
5750 IF UNITS = 1 THEN WCOST = MCU1(VAL(ANS$)) : GOTO 6310
5760 IF UNITS = 2 THEN WCOST = MCU2(VAL(ANS$)) : GOTO 6310
5770 IF ANS$ = "" THEN 5960
5780 IF ANS$ = "H" OR ANS$ = "h" THEN 5860
5790 CLS
5800 COLOR 7,1
5810 LOCATE 12,5
5820 INPUT " You must have hit the wrong key -- Press the RETURN key and try
again. ",RET$
5830 IF RET$ = "" AND POP = 4  OR POP = 5 THEN 4390 ELSE 5850
5840 GOTO 5820
5850 COLOR 7,0 : GOTO 3640
5860 COUNTER = 1 : CLS
5870 COLOR 2,0 : LOCATE 5,1
5880 PRINT "     Since you might have answered the population question
incorrectly,I will  return you to that question and let you try again."
5890 PRINT
5900 INPUT "     Press the RETURN key when you are ready to go back.  ", RET$
```

Listing of Residential Water Conservation Program (continued).

```
5910 IF RET$ = "" THEN 5920 ELSE 5900
5920 COLOR 7,0 : CLS : GOTO 2370
5930 COLOR 7,4 : LOCATE 24,1 : PRINT
5940 PRINT USING "     I have no community listed that begins with the letter &,
therefore I'll    use a  very rough estimate according to the size of your
community."; FL$
5950 GOTO 6040
5960 LOCATE 24,1 : PRINT
5970 COLOR 7,4
5980 PRINT "Then I'll use a very rough estimate according to the size of your";
5990 PRINT " community.    ";
6000 PRINT
6010 '
6020 '= = =  MARGINAL WATER RATE DEFAULT VALUES FOR MUNICIPAL WATER PLANTS = = =
6030 '
6040 IF POP = 1 AND UNITS = 1 THEN WCOST = 1.22 : GOTO 6140
6050 IF POP = 2 AND UNITS = 1 THEN WCOST = 1.31 : GOTO 6140
6060 IF POP = 3 AND UNITS = 1 THEN WCOST = 1.42 : GOTO 6140
6070 IF POP = 4 AND UNITS = 1 THEN WCOST = 1.26 : GOTO 6140
6080 IF POP = 5 AND UNITS = 1 THEN WCOST = 1.7  : GOTO 6140
6090 IF POP = 1 AND UNITS = 2 THEN WCOST = .91  : GOTO 6140
6100 IF POP = 2 AND UNITS = 2 THEN WCOST = .98  : GOTO 6140
6110 IF POP = 3 AND UNITS = 2 THEN WCOST = 1.06 : GOTO 6140
6120 IF POP = 4 AND UNITS = 2 THEN WCOST = .94  : GOTO 6140
6130 IF POP = 5 AND UNITS = 2 THEN WCOST = 1.27 : GOTO 6140
6140 PRINT USING"The estimate I will use for your marginal water cost is $#.##
";WCOST
6150 PRINT USING "per & per month.";UNIT$;
6160 COLOR 7,0 : PRINT : PRINT : GOTO 6420
6170 CLS : LOCATE 3,1 : COLOR 7,4
6180 PRINT "Then I'll use a very rough estimate for your marginal water rate
based on    the average of the RWOs in the state of Kansas.  This cost is $2.41
per 1000    gallons.";
6190 WCOST = 2.41
6200 COLOR 7,0 : PRINT
6210 PRINT : GOTO 6420
6220 CLS : LOCATE 3,1 : COLOR 7,4
6230 PRINT USING "I have no RWO listed that begin with the letter &.  Therefore
I will use a very rough estimate of your marginal water cost based on the
average for the   districts in Kansas.  This cost is $2.41 per 1000 gallons. ";
FL$
6240 WCOST = 2.41
6250 COLOR 7,0 : PRINT : GOTO 6420
6260 COLOR 7,4
6270 PRINT " Since you do not live in Kansas, I will use an average for your
monthly      marginal water cost based on Kansas RWOs.  This cost is $2.41 per
1000 gallons.";
6280 WCOST = 2.41
6290 COLOR 7,0 : PRINT : PRINT : GOTO 6420
6300 PRINT
```

Listing of Residential Water Conservation Program (continued).

```
6310 LOCATE 24,1
6320 COLOR 7,4 : IF POP = 4 OR POP = 5 THEN 6350
6330 PRINT USING " The monthly marginal water rate for & is $##.## per ";
CITY$(NUM-2), WCOST; : PRINT : PRINT USING " &. "; UNIT$;
6340 COLOR 7,0 : PRINT : PRINT : GOTO 6420
6350 PRINT USING " The monthly marginal water rate for & is $##.## per ";
CITY$(VAL(ANS$)), WCOST; : PRINT : PRINT USING " &. "; UNIT$;
6360 COLOR 7,0 : PRINT : PRINT
6370 '
6380 '              ++++++++++++++++++++++++++++++++++++++++
6390 '              = = =  ENERGY UTILITY RATE SECTION  = = =
6400 '              ++++++++++++++++++++++++++++++++++++++++
6410 '
6420 PRINT "How is your hot water heated?"
6430 PRINT "      [1]  Electricity"
6440 PRINT "      [2]  Natural gas"
6450 INPUT "      [3]  LP gas                          Answer = ", ANS$
6460 PRINT
6470 IF VAL(ANS$) = 1 OR VAL(ANS$) = 2 OR VAL(ANS$) = 3 THEN HEAT = VAL(ANS$) :
GOTO 6520
6480 COLOR 7,1
6490 PRINT " You must enter either 1,2 or 3....  Try again. ";
6500 COLOR 7,0 : PRINT
6510 GOTO 6420
6520 IF HEAT = 1 THEN BTU = 3413 : GOTO 6580
6530 IF HEAT = 2 THEN BTU = 1000000! ELSE 6550
6540 IF SOURCE = 3 THEN 6570 ELSE 6750
6550 IF HEAT = 3 THEN BTU = 95000!
6560 IF SOURCE = 3 THEN 6570 ELSE 6900
6570 PRINT "For the purpose of pumping your water, what is your electric cost
per kilowatt- hour, (kwh)?" : GOTO 6590
6580 PRINT "What is your electric cost per kilowatt-hour, (kwh)?"
6590 PRINT "   Enter the amount as a dollar decimal (e.g., $0.08)."
6600 INPUT "   If you don't know, then press the RETURN key.     Answer =
$",KWAT$
6610 PRINT
6620 IF KWAT$ = "" THEN KWAT = .08 ELSE 6660
6630 COLOR 7,4
6640 PRINT " Then I'll use an estimated cost of $0.08 per kwh. ";
6650 COLOR 7,0 : PRINT : GOTO 6710
6660 IF VAL(KWAT$) < .049 OR VAL(KWAT$) > .115 THEN 6670 ELSE 6700
6670 COLOR 7,1
6680 IF VAL(KWAT$) < .049 THEN PRINT " Your electricity cost is too low.  The
price for electricity ranges between   $0.05 and $0.11 per kwh.  Try again...
and enter a cost that is in this range. ";: COLOR 7,0 : PRINT:PRINT : GOTO 6580
6690 IF VAL(KWAT$) > .115 THEN PRINT " Your electricity cost is too high.  The
price for electricity ranges between   $0.05 and $0.11 per kwh.  Try again...
and enter a cost that is in this range.";: COLOR 7,0 : PRINT : PRINT : GOTO 6580
6700 KWAT = VAL(KWAT$)
6710 ENERGYCOST = KWAT : PRINT
```

Listing of Residentisl Wster Conservstion Progrsm (continued).

```
6720 IF SOURCE = 3 AND HEAT = 2 THEN 6750
6730 IF SOURCE = 3 AND HEAT = 3 THEN 6900 ELSE 7040
6740 '
6750 PRINT "What is your natural gas cost per 1000 cubic feet (MCF)?"
6760 PRINT "   Enter the amount as a dollar decimal (e.g., $5.50)."
6770 INPUT "   If you don't know, then press the RETURN key.      Answer =
$",GAS$
6780 PRINT
6790 IF GAS$ = "" THEN GAS = 5.5 ELSE 6830
6800 COLOR 7,4
6810 PRINT " Then I'll use an estimated cost of $5.50 per MCF. ";
6820 COLOR 7,0 : PRINT : GOTO 6880
6830 IF VAL(GAS$) < 1.99 OR VAL(GAS$) > 9.01 THEN 6840 ELSE 6870
6840 COLOR 7,1
6850 IF VAL(GAS$) < 1.99 THEN PRINT " Your gas cost is too low.  The cost of gas
ranges between $2.00 and $9.00.      Try again... and enter a cost in this
range.";: COLOR 7,0 : PRINT : PRINT : GOTO 6750
6860 IF VAL(GAS$) > 9.01 THEN PRINT " Your gas cost is too high.  The cost of
gas ranges between $2.00 and $9.00.  Try again... and enter a cost in this
range." ;: COLOR 7,0 : PRINT : PRINT : GOTO 6750
6870 GAS = VAL(GAS$)
6880 ENERGYCOST = GAS : GOTO 7040
6890 '
6900 PRINT "What is your cost per gallon for LP gas?"
6910 PRINT "   Enter the amount as a dollar decimal (e.g., $0.70)."
6920 INPUT "   If you don't know, then press the RETURN key.     Answer = $",LP$
6930 PRINT
6940 IF LP$ = "" THEN LP = .7 ELSE 6980
6950 COLOR 7,4
6960 PRINT " Then I'll use an estimated cost of $0.70 per gallon. ";
6970 COLOR 7,0 : PRINT : GOTO 7030
6980 IF VAL(LP$) < .49 OR VAL(LP$) > 1.26 THEN 6990 ELSE 7020
6990 COLOR 7,1
7000 IF VAL(LP$) < .49 THEN PRINT " Your LP gas cost is too low.  The cost range
for LP gas is between $0.50 and    $1.25.  Try again... and enter a cost in this
range. ";: COLOR 7,0 : PRINT : PRINT : GOTO 6900
7010 IF VAL(LP$) > 1.26 THEN PRINT " Your LP gas cost is too high.  The cost
range for LP gas is between $0.50   and $1.25.  Try again... and enter a cost in
this range. ";: COLOR 7,0 : PRINT : PRINT : GOTO 6900
7020 LP = VAL(LP$)
7030 ENERGYCOST = LP
7040 PRINT
7050 INPUT "     Press the RETURN key to continue.", RET$
7060 IF RET$ = "" THEN 7070 ELSE 7050
7070 CLS : LOCATE 5,1
7080 SUM = 0
7090 IF SOURCE <> 3 THEN 7380
7100 '
7110 '*************************************************************************
7120 '                        * * *  WATER HABITS SECTION  * * *
```

Listing of Reaidentia1 Water Conservation Program (continued).

```
7130 '*************************************************************************
7140 '
7150 PRINT "Do you have a water softener?"
7160 PRINT "     [1]  Yes"
7170 INPUT "     [2]  No          Anawer = ",ANS$
7180 PRINT
7190 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN SOFTENER = 1 : GOTO 7240
7200 IF VAL(ANS$) = 2 OR ANS$ = "n" OR ANS$ = "N" THEN SOFTENER = 2 : GOTO 7240
7210 COLOR 7,1
7220 PRINT " You must enter either 1 or 2....  Try again. ";
7230 COLOR 7,0 : PRINT  : GOTO 7150
7240 IF SOFTENER = 2 THEN 7380
7250 '
7260 PRINT "How many days between regeneration is your water softener aet for?"
7270 INPUT "   Enter your answer here.       Anawer = ", ANS$
7280 PRINT
7290 IF VAL(ANS$) <= 0 OR VAL(ANS$) > 10 THEN 7300 ELSE REGEN = VAL(ANS$) : GOTO
     7330
7300 COLOR 7,1
7310 PRINT " P1eaae enter an number between 1 and 10 days. ";
7320 COLOR 7,0 : PRINT : GOTO 7260
7330 REGENDAY = 30 / REGEN
7340 SUM = SUM + REGENDAY
7350 SOFTENERCOLD = REGENDAY * 365
7360 SALT = 6 / REGEN * 365 * 5 / 100
7370 '
7380 PRINT "Do you uaua11y take a bath or ahower?"
7390 PRINT "     [1]  Bath"
7400 INPUT "     [2]  Shower                  Answer = ", ANS$
7410 PRINT
7420 IF VAL(ANS$) = 1 OR VAL(ANS$) = 2 THEN BS = VAL(ANS$) : GOTO 7470
7430 COLOR 7,1
7440 PRINT " You must enter either 1 or 2....  Try again. ";
7450 COLOR 7,0 : PRINT
7460 GOTO 7380
7470 IF BS = 2 THEN 7930
7480 '
7490 PRINT "How fu11 do you fi11 the bath tub?"
7500 PRINT "     [1]  One-quarter full"
7510 PRINT "     [2]  One-ha1f fu11"
7520 INPUT "     [3]  Over one-ha1f full      Answer = ", ANS$
7530 PRINT
7540 IF VAL(ANS$) = 1 OR VAL(ANS$) = 2 OR VAL(ANS$) = 3 THEN TUB = VAL(ANS$) :
GOTO 7590
7550 COLOR 7,1
7560 PRINT " You must enter either 1, 2, or 3.... Try again. ";
7570 COLOR 7,0 : PRINT
7580 GOTO 7490
7590 IF TUB = 1 THEN SUM = SUM + 20 : HOTSUM = HOTSUM + 20 * .67 : GOTO 7610
7600 GOTO 7630
```

Listing of Residential Water Conservation Program (continued).

```
7610 TUBCOLD = 20 * 365 : TUBHOT = 20 * .67 * 365 : HOT = TUBHOT : GOSUB 12600
7620 TUBENERGY = HOTCOST : GOTO 8240
7630 IF TUB = 2 THEN SUM = SUM + 35 : HOTSUM = HOTSUM + 35 * .67 : GOTO 7650
7640 GOTO 7670
7650 TUBCOLD = 35 * 365 : TUBHOT = 35 * .67 * 365 : HOT = TUBHOT : GOSUB 12600
7660 TUBENERGY = HOTCOST : GOTO 7700
7670 SUM = SUM + 50 : HOTSUM = HOTSUM + 50 * .67 : ' TUB = 3
7680 TUBCOLD = 50 * 365 : TUBHOT = 50 * .67 * 365 : HOT = TUBHOT : GOSUB 12600
7690 TUBENERGY = HOTCOST : GOTO 7700
7700 TUBCOUNT = 1
7710 IF TUB = 2 THEN HD = (35 * .67) - 13 ELSE 7730
7720 CD = 35 - 20 : GOTO 7740
7730 HD = (50 * .67) - 13 : CD = 50 - 20
7740 GOSUB 12500
7750 TUBHDC = HWCDIFF
7760 TUBCDC = CWCDIFF
7770 IF TUB = 2 THEN 7780 ELSE 7790
7780 TUB1$ = "You fill your bath tub one-half full.  If you have a conventional
tub, you may  be using 35 gallons of water per bath - 11 gallons cold and 24
gallons hot." : GOTO 7800
7790 TUB1$ = "You fill your bath tub over half full.  If you have a conventional
tub, you may  be using 50 gallons of water per bath - 17 gallons cold and 33
gallons hot."
7800 IF SOURCE = 3 THEN 7840
7810 IF FRC = 1 THEN 7860
7820 TUB2$="If you would fill your tub one-quarter full you would only use 20
gallons of  water per bath. This could save you $### per year on your water
cost and    $### per year on the energy required to heat your water (assuming
one bath a  day)."
7830 GOTO 7870
7840 TUB2$ = "If you would fill your tub to one-quarter full you would only use
20 gallons of water.  This could save you $### per year on the pumping cost of
water and $###per year on the energy required to heat your water (assuming one
bath a day)."
7850 GOTO 7870
7860 TUB2$ = "If you would fill your tub to one-quarter full you would only use
20 gallons of water.  This could save you $### per year on your water heating
requirments."
7870 IF TUB = 2 THEN SUMDIFF = SUMDIFF + 15 ELSE 7890
7880 HOTDIFF = HOTDIFF + (35 * .67) - 13 : GOTO 8240
7890 IF TUB = 3 THEN SUMDIFF = SUMDIFF + 30 ELSE 8240
7900 HOTDIFF = HOTDIFF + (50 * .67) - 13
7910 GOTO 8240
7920 '
7930 PRINT "How many minutes do you spend in the shower?"
7940 INPUT "   Enter your answer here.        Answer = ", ANS$
7950 PRINT
7960 IF VAL(ANS$) > 0 AND VAL(ANS$) <= 45 THEN SHOWER = VAL(ANS$) : GOTO 8000
7970 COLOR 7,1
7980 PRINT " Please enter a time between 1 and 45 minutes. ";
```

Listing of Residential Water Conservation Program (continued).

```
7990 COLOR 7,0 : PRINT : PRINT : GOTO 7930
8000 SUM = SUM + SHOWER * 4
8010 HOTSUM = HOTSUM + SHOWER * 4 * .67
8020 SHOWERCOLD = SHOWER * 4 * 365 : SHOWERHOT = SHOWER * 4 * .67 * 365
8030 HOT = SHOWERHOT : GOSUB 12600
8040 SHOWERENERGY = HOTCOST
8050 IF SHOWER <= 5 THEN 8240
8060 SHOWERCOUNT = 1
8070 CD = SHOWER * 4 - 20
8080 HD = SHOWER * 4 * .67 - 13
8090 GOSUB 12500
8100 SHOWERHDC = HWCDIFF
8110 SHOWERCDC = CWCDIFF
8120 SHOWER1$ = "You spend ## minutes in the shower. This means you use
approximately ###gallonsof water per shower - ### gallons cold and ### gallons
hot water.  If   you would"
8130 SHOWER2$ = "reduce your time down to 5 minutes, you would use about 20
gallons of water per shower - 7 gallons cold and 13 gallons hot.  On an annual
basis, this could"
8140 IF SOURCE = 3 THEN 8180
8150 IF FRC = 1 THEN 8200
8160 SHOWER3$ = "save you approximately $### per year in water cost and $### per
year in the      energy required to heat your water (assuming you take one
shower each day)."
8170 GOTO 8210
8180 SHOWER3$ = "save you approximately $# per year in pumping cost of your
water and $###   per   year on energy required to heat your water (assuming one
shower each day)."
8190 GOTO 8210
8200 SHOWER3$ = "save you $### per year on your water heating requirments."
8210 SUMDIFF = SUMDIFF + SHOWER * 4 - 20
8220 HOTDIFF = HOTDIFF + SHOWER * 4 * .67 - 13
8230 '
8240 PRINT "Estimate how many times a day you flush your home toilet."
8250 INPUT "   Enter your answer here.        Answer = ", ANS$
8260 PRINT
8270 IF VAL(ANS$) > 0 AND VAL(ANS$) <= 10 THEN FLUSH = VAL(ANS$) : GOTO 8310
8280 COLOR 7,1
8290 PRINT " Please enter a number between 1 and 10. ";
8300 COLOR 7,0 : PRINT : PRINT : GOTO 8240
8310 SUM = SUM + FLUSH * 5
8320 FLUSHCOLD = FLUSH * 5 * 365
8330 IF SEX = 2 THEN 8680
8340 '
8350 PRINT "Do you let the water run while you shave?"
8360 PRINT "      [1]  Yes"
8370 PRINT "      [2]  No"
8380 INPUT "      [3]  Don't shave with water          Answer = ",ANS$
8390 PRINT
8400 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN SHAVE = 1 : GOTO 8470
```

Listing of Residential Water Conservation Program (continued).

```
8410 IF VAL(ANS$) = 2 OR ANS$ = "n" OR ANS$ = "N" THEN SHAVE = 2 : GOTO 8470
8420 IF VAL(ANS$) = 3 THEN SHAVE = 3 : GOTO 8470
8430 COLOR 7,1
8440 PRINT " You must enter either 1 or 2....  Try again. ";
8450 COLOR 7,0 : PRINT
8460 GOTO 8350
8470 IF SHAVE = 3 THEN 8680
8480 IF SHAVE = 1 THEN SUM = SUM + 3 : HOTSUM = HOTSUM + 3 : GOTO 8500
8490 GOTO 8520
8500 SHAVECOLD = 3 * 365 : SHAVEHOT = 3 * 365 : HOT = SHAVEHOT : GOSUB 12600
8510 SHAVEENERGY = HOTCOST : GOTO 8570
8520 IF SHAVE = 2 THEN SUM = SUM + 1 : HOTSUM = HOTSUM + 1 : GOTO 8540
8530 GOTO 8680
8540 SHAVECOLD = 1 * 365 : SHAVEHOT = 1 * 365 : HOT = SHAVEHOT : GOSUB 12600
8550 SHAVEENERGY = HOTCOST
8560 IF SHAVE = 2 THEN 8680
8570 SHAVECOUNT = 1
8580 HD = 2 : CD = 2 : GOSUB 12500
8590 SHAVEHDC = HWCDIFF
8600 SHAVECDC = CWCDIFF
8610 SHAVE1$ = "Don't run the water while you shave. Put a stopper in your sink
basin and fill  the basin one-quarter full.  This could save you 2 gallons of
hot water per   day."
8620 IF FRC = 1 OR SOURCE = 3 THEN 8650
8630 SHAVE2$ = "On an annual basis, you could save $# per year in water cost and
$## per year    for the energy required to heat the water."
8640 GOTO 8660
8650 SHAVE2$ = "On an annual basis, you could save $## on the energy required to
heat the water."
8660 SUMDIFF = SUMDIFF + 2 : HOTDIFF = HOTDIFF + 2
8670 '
8680 PRINT "Do you let the water run while you brush your teeth?"
8690 PRINT "     [1]  Yes"
8700 INPUT "     [2]  No                          Answer = ",ANS$
8710 PRINT
8720 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN TEETH = 1 : GOTO 8780
8730 IF VAL(ANS$) = 2 OR ANS$ = "n" OR ANS$ = "N" THEN TEETH = 2 : GOTO 8780
8740 COLOR 7,1
8750 PRINT " You must enter either 1 or 2....  Try again. ";
8760 COLOR 7,0 : PRINT
8770 GOTO 8680
8780 IF TEETH = 1 THEN SUM = SUM + 2 : GOTO 8800
8790 GOTO 8810
8800 TEETHCOLD = 2 * 365 : GOTO 8830
8810 IF TEETH = 2 THEN SUM = SUM + .5
8820 TEETHCOLD = .5 * 365 : GOTO 8920
8830 TEETHCOUNT = 1
8840 HD = 0
8850 CD = 1.5 : GOSUB 12500
8860 TEETHCDC = CWCDIFF
```

Listing of Residential Water Conservation Program (continued).

```
8870 TEETH1$ = "Don't let the water run while you brush your teeth.  By using a
cup to rinse    your mouth, you could save 1.5 to 2 gallons of water per brush."
8880 IF SOURCE = 3 OR FRC = 1 THEN 8900
8890 TEETH2$ = "This could save you $# per year on water coat assuming all the
water is cold."
8900 SUMDIFF = SUMDIFF + 1.5
8910 '
8920 PRINT "Do you let the water run while you wash your hands?"
8930 PRINT "     [1]  Yes"
8940 INPUT "     [2]  No                          Answer = ",ANS$
8950 PRINT
8960 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN HANDS = 1 : GOTO 9020
8970 IF VAL(ANS$) = 2 OR ANS$ = "n" OR ANS$ = "N" THEN HANDS = 2 : GOTO 9020
8980 COLOR 7,1
8990 PRINT " You must enter either 1 or 2....  Try again. ";
9000 COLOR 7,0 : PRINT
9010 GOTO 8920
9020 IF HANDS = 1 THEN SUM = SUM + (2 * 2) ELSE 9070
9030 HOTSUM = HOTSUM + (2 * 2 * .33)
9040 HANDSCOLD = (2 * 2) * 365 : HANDSHOT = (2 * 2 * .33) * 365
9050 HOT = HANDSHOT : GOSUB 12600
9060 HANDSENERGY = HOTCOST : GOTO 9110
9070 SUM = SUM + (1 * 2) : HOTSUM = HOTSUM + (1 * 2 * .33)
9080 HANDSCOLD = (1 * 2) * 365 : HANDSHOT = (1 * 2 * .33) * 365
9090 HOT = HANDSHOT : GOSUB 12600
9100 HANDSENERGY = HOTCOST : GOTO 9230
9110 HANDSCOUNT = 1
9120 HD = (2 * 2 * .33) - (1 * 2 * .33)
9130 CD = (2 * 2) - (1 * 2) : GOSUB 12500
9140 HANDSHDC = HWCDIFF
9150 HANDSCDC = CWCDIFF
9160 HANDS1$ = "Don't run the water while you wash your hands.  Put a stopper in
your sink and   fill it one-quarter full.  This could save about 2 gallons of
water per      washing."
9170 IF FRC = 1 OR SOURCE = 3 THEN 9200
9180 HANDS2$ = "Annually you could save $# per year on water coat, and $## per
year on the     energy required to heat the water (assuming you wash your hands
twice a day.)"
9190 GOTO 9210
9200 HANDS2$ = "Annually you could save $## per year on the energy required to
heat your water."
9210 SUMDIFF = SUMDIFF + 2 : HOTDIFF = HOTDIFF + .66
9220 '
9230 PRINT "Does your home have a dishwasher?"
9240 PRINT "     [1]  Yes"
9250 INPUT "     [2]  No                          Answer = ", ANS$
9260 PRINT
9270 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN DISH = 1 : GOTO 9330
9280 IF VAL(ANS$) = 2 OR ANS$ = "n" OR ANS$ = "N" THEN DISH = 2 : GOTO 9330
9290 COLOR 7,1
```

Listing of Residential Water Conservation Program (continued).

```
9300 PRINT " You must enter either 1 or 2.... Try again. ";
9310 COLOR 7,0 : PRINT
9320 GOTO 9230
9330 IF DISH = 2 THEN 9710
9340 '
9350 PRINT "How many times a day do you use the dishwasher?"
9360 INPUT "   Enter your answer here.           Answer = ", ANS$
9370 PRINT
9380 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= 3 THEN DTIM = VAL(ANS$) : GOTO 9420
9390 COLOR 7,1
9400 PRINT " Please enter a number between 1 and 3. ";
9410 COLOR 7,0 : PRINT : PRINT : GOTO 9350
9420 SUM = SUM + DTIM * 15
9430 HOTSUM = HOTSUM + DTIM * 15
9440 DISHCOLD = DTIM * 15 * 365 : DISHHOT = DTIM * 15 * 365
9450 HOT = DISHHOT : GOSUB 12600
9460 DISHENERGY = HOTCOST
9470 '
9480 PRINT "Do you wash a full load of dishes?"
9490 PRINT "      [1]  Almost always"
9500 PRINT "      [2]  Sometimes"
9510 INPUT "      [3]  Not usually              Answer = ", ANS$
9520 PRINT
9530 IF VAL(ANS$) = 1 OR VAL(ANS$) = 2 OR VAL(ANS$) = 3 THEN FULLDISH =
VAL(ANS$) ELSE 9660
9540 IF FULLDISH = 1 THEN 10160 ELSE DISHCOUNT = 1
9550 FULLDISH1$ = "When using your dishwasher, always wash a full load of dishes.
A conventional     dishwasher uses 15 gallons of water (approximately all hot)
per load.  If you"
9560 HD = 15 : CD = 15 : GOSUB 12500
9570 DISHHDC = HWCDIFF : DISHCDC = CWCDIFF
9580 IF SOURCE = 3 THEN 9620
9590 IF FRC = 1 THEN 9640
9600 FULLDISH2$ = "wash a load of dishes every day for a year, the water alone
would cost $## per year and the energy required to heat the water would cost
$## per year."
9610 GOTO 10160
9620 FULLDISH2$ = "wash a load of dishes every day for a year, the cost to pump
the water would be $# per year, and the energy required to heat the water would
cost $## per year."
9630 GOTO 10160
9640 FULLDISH2$ = "wash a load of dishes every day for a year, the cost of the
energy required to heat the water would be about $##.
9650 GOTO 10160
9660 COLOR 7,1
9670 PRINT " You must enter either 1,2, or 3.... Try again. ";
9680 COLOR 7,0 : PRINT
9690 GOTO 9480
9700 '
9710 PRINT "Do you let the water run while you wash and rinse the dishes?"
```

Listing of Residential Water Conservation Program (continued).

```
9720 PRINT "      [1]  Yes"
9730 PRINT "      [2]  Sometimes"
9740 INPUT "      [3]  No                    Answer = ", ANS$
9750 PRINT
9760 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN RINSE = 1 : GOTO 9830
9770 IF VAL(ANS$) = 2 THEN RINSE = 2 : GOTO 9830
9780 IF VAL(ANS$) = 3 OR ANS$ = "n" OR ANS$ = "N" THEN RINSE = 3 : GOTO 9830
9790 COLOR 7,1
9800 PRINT " You must enter either 1, 2, or 3....  Try again. ";
9810 COLOR 7,0 : PRINT
9820 GOTO 9710
9830 IF RINSE = 3 THEN 10110
9840 RINSECOUNT = 1
9850 IF RINSE = 1 THEN HD = 2.4 ELSE 9870
9860 CD = 3 : GOTO 9880
9870 HD = .8 : CD = 1
9880 GOSUB 12500
9890 RINSECDC = CWCDIFF
9900 RINSEHDC = HWCDIFF
9910 IF RINSE = 1 THEN 9920 ELSE 9940
9920 RINSE1$ = "When washing dishes by hand, use the other sink (or a dishpan if
you only have   one sink) to hold your rinse water.  This could save you 3
gallons of waterper"
9930 GOTO 9950
9940 RINSE1$ = "When washing dishes by hand, use the other sink (or a dishpan if
you only have   one sink) to hold your rinse water.  This could save you 1
gallons of waterper"
9950 IF FRC = 1 OR SOURCE = 3 THEN 9980
9960 RINSE2$ = "wash.  On an annual basis, you could save $## per year on water
cost and $## peryear for the energy used to heat your water."
9970 GOTO 9990
9980 RINSE2$ = "wash.  On an annual basis, you could save $## per year on the
energy required to heat your water."
9990 IF RINSE = 1 THEN SUM = SUM + 7 ELSE 10050
10000 HOTSUM = HOTSUM + 7 * .8 : SUMDIFF = SUMDIFF + 3 : HOTDIFF = HOTDIFF + 2.4
10010 RINSECOLD = 7 * 365 : RINSEHOT = 7 * .8 * 365
10020 HOT = RINSEHOT : GOSUB 12600
10030 RINSEENERGY = HOTCOST
10040 GOTO 10160
10050 IF RINSE = 2 THEN SUM = SUM + 5 ELSE 10110
10060 HOTSUM = HOTSUM + 5 * .8 : SUMDIFF = SUMDIFF + 1 : HOTDIFF = HOTDIFF + .8
10070 RINSECOLD = 5 * 365 : RINSEHOT = 5 * .8 * 365
10080 HOT = RINSEHOT : GOSUB 12600
10090 RINSEENERGY = HOTCOST
10100 GOTO 10160
10110 SUM = SUM + 4 : HOTSUM = HOTSUM + 4 * .8 : ' RINSE = No
10120 RINSECOLD = 4 * 365 : RINSEHOT = 4 * .8 * 365
10130 HOT = RINSEHOT : GOSUB 12600
10140 RINSEENERGY = HOTCOST
10150 '
```

```
10160 PRINT "Do you let the water run to get cold when getting s drink?"
10170 PRINT "     [1]  Yes"
```

Residentis1 Wster Conservstion Progrsm Listing (continued)

```
10180 PRINT "     [2]  Sometimes"
10190 INPUT "     [3]  No                          Answer = ", ANS$
10200 PRINT
10210 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN DRINK = 1 : GOTO 10280
10220 IF VAL(ANS$) = 2 THEN DRINK = 2 : GOTO 10280
10230 IF VAL(ANS$) = 3 OR ANS$ = "n" OR ANS$ = "N" THEN DRINK = 3 : GOTO 10280
10240 COLOR 7,1
10250 PRINT " You must enter either 1, 2, or 3.... Try sgsin. ";
10260 COLOR 7,0 : PRINT
10270 GOTO 10160
10280 IF DRINK = 3 THEN 10330
10290 DRINK$ = "Instead of letting the wster run to get cold while getting a
drink, plsce a  wster bottle in the refrigerator to keep the water cold."
10300 SUMDIFF = SUMDIFF + .5
10310 IF DRINK = 1 OR DRINK = 2 THEN SUM = SUM + 1
10320 DRINKCOLD = 1 * 365 : GOTO 10360
10330 IF DRINK = 3 THEN SUM = SUM + .5
10340 DRINKCOLD = .5 * 365
10350 '
10360 PRINT "Do you hsve s clothes wssher?"
10370 PRINT "     [1]  Yes"
10380 INPUT "     [2]  No                          Answer = ", ANS$
10390 PRINT
10400 IF VAL(ANS$) = 1 OR ANS$ = "y" OR ANS$ = "Y" THEN CLOTHES = 1 : GOTO 10460
10410 IF VAL(ANS$) = 2 OR ANS$ = "n" OR ANS$ = "N" THEN CLOTHES = 2 : GOTO 10460
10420 COLOR 7,1
10430 PRINT " You must enter either 1 or 2.... Try sgsin. ";
10440 COLOR 7,0 : PRINT
10450 GOTO 10360
10460 IF CLOTHES = 2 THEN 10870
10470 PRINT
10480 '
10490 INPUT "How many loads do you wssh s week?          Answer = ", ANS$
10500 PRINT
10510 IF VAL(ANS$) >= 1 AND VAL(ANS$) <= 10 THEN LC = VAL(ANS$) : GOTO 10550
10520 COLOR 7,1
10530 PRINT " Please enter s number between 1 and 10. ";
10540 COLOR 7,0 : PRINT : PRINT : GOTO 10490
10550 AMT = LC * 50 / 7
10560 HOTSUM = HOTSUM + AMT * .5
10570 SUM = SUM + AMT
10580 CLOTHESCOLD = AMT * 365 : CLOTHESHOT = AMT * .5 * 365
10590 HOT = CLOTHESHOT : GOSUB 12600
10600 CLOTHESENERGY = HOTCOST
10610 PRINT
10620 '
10630 PRINT "Do you wssh s full load of clothes?"
10640 PRINT "     [1] Almost slways"
```

Listing of Residential Water Conservation Program (continued).

```
10650 PRINT "      [2] Sometimes"
10660 INPUT "      [3] Not usually                Answer = ", ANS$
10670 PRINT
10680 IF VAL(ANS$) = 1 OR VAL(ANS$) = 2 OR VAL(ANS$) = 3 THEN FULLCLOTHES =
VAL(ANS$) : GOTO 10730
10690 COLOR 7,1
10700 PRINT " You must enter either 1, 2, or 3.... Try again. ";
10710 COLOR 7,0 : PRINT
10720 GOTO 10630
10730 IF FULLCLOTHES = 1 THEN 10870
10740 CLOTHESCOUNT = 1
10750 HD = AMT * .5
10760 CD = AMT : GOSUB 12500
10770 CLOTHESCDC = CWCDIFF
10780 CLOTHESHDC = HWCDIFF
10790 CLOTHES1$ = "You should always wash a full load of clothes.  A clothes
washer will use    about 50 gallons of water per wash.  Wash a full load to use the
water more effici-"
10800 IF SOURCE = 3 THEN 10840
10810 IF FRC = 1 THEN 10860
10820 CLOTHES2$ = "ently.  On an annual basis, you spend about $## on the water
cost, and $### on  the energy required to heat the water."
10830 GOTO 10870
10840 CLOTHES2$ = "ently.  On an annual basis, you spend about $# to pump your
water and $### on  the energy required to heat the water."
10850 GOTO 10870
10860 CLOTHES2$ = "ently.  On an annual basis, you spend about $### per year on
the energy requiredto heat your water."
10870 CLS : LOCATE 7,1
10880 '
10890 '*************************************************************************
10900 '                          * * *  RESULTS  * * *
10910 '*************************************************************************
10920 '
10930 COLOR 2,0
10940 PRINT "     Thank you for running this program.  Your results should be
coming out onthe printer.  If they aren't, then turn the printer on.  Thanks
again...." : COLOR 7,0
10950 LPRINT CHR$(27);CHR$(37);CHR$(67);"174";
10960 LPRINT CHR$(28)
10970 LPRINT CHR$(31); "  Water Conservation Analysis Results";
10980 LPRINT CHR$(27);CHR$(37);CHR$(67);"174";
10990 LPRINT CHR$(28)
11000 '
11010 '                    = = =  TABULAR RESULTS  = = =
11020 '
11030 LPRINT: LPRINT USING "Below is a table showing your water habits, &.";
NNAME$
11040 LPRINT "                                                              Hot Water
11050 LPRINT "                                Water Used (Gal/yr)       Energy Cost"
```

Listing of Residential Water Conservation Program (continued).

```
11060 LPRINT "     Water Function        Total              Hot       ($/yr)"
11070 LPRINT "     ----- --------       ------             ------   -----------"
11080 IF SOFTENER = 2 OR SOFTENER = 0 THEN 11100
11090 LPRINT "     Water Softener";: LPRINT TAB(27) USING "#####
----        -----"; SOFTENERCOLD
11100 IF BS = 1 THEN 11110 ELSE 11130
11110 LPRINT "     Bath";: LPRINT TAB(27) USING "#####                #####
###.#0"; TUBCOLD, TUBHOT, TUBENERGY
11120 GOTO 11140
11130 LPRINT "     Shower";: LPRINT TAB(27) USING "#####               #####
###.#0"; SHOWERCOLD, SHOWERHOT, SHOWERENERGY
11140 LPRINT "     Toilet";: LPRINT TAB(27) USING "#####                ----
-----"; FLUSHCOLD
11150 IF SEX = 2  OR SHAVE = 3 THEN 11170
11160 LPRINT "     Shaving";: LPRINT TAB(28) USING "####                ####
##.#0"; SHAVECOLD, SHAVEHOT, SHAVEENERGY
11170 LPRINT "     Brushing Teeth";: LPRINT TAB(28) USING "####
----        -----"; TEETHCOLD
11180 LPRINT "     Washing Hands";: LPRINT TAB(28) USING"####
####       ##.#0"; HANDSCOLD, HANDSHOT, HANDSENERGY
11190 IF DISH = 2 THEN 11220
11200 LPRINT "     Dishwasher";: LPRINT TAB(27) USING "#####                #####
###.#0"; DISHCOLD, DISHHOT, DISHENERGY
11210 GOTO 11230
11220 LPRINT "     Dish washing";: LPRINT TAB(27) USING "#####
#####      ###.#0"; RINSECOLD, RINSEHOT, RINSEENERGY
11230 LPRINT "     Drinking";: LPRINT TAB(28) USING "####                ----
-----"; DRINKCOLD
11240 IF CLOTHES = 2 THEN 11260
11250 LPRINT "     Clothes Washer";: LPRINT TAB(27) USING "#####
#####      ###.#0"; CLOTHESCOLD, CLOTHESHOT, CLOTHESENERGY
11260 LPRINT TAB(18) USING "Total = ######       Total = #####"; SUM * 365,
HOTSUM * 365
11270 IF SOURCE <> 3 THEN 11300
11280 P = (62.4 * SUM / 7.48 * (1.1 * DEPTH + 144 * 40 / 62.4)) / .25
11290 APC = P * 3.766E-07 * KWAT * 365 : ' APC = Annual Pumping Cost, P = Power
11300 ON HEAT GOTO 11320, 11350, 11380
11310 ' AEC = Annual Energy Cost
11320 AEC = KWAT * 8.34 * 60 / BTU / .9 * HOTSUM * 365
11330 LPRINT USING"Your annual electric cost to heat your water is $####.#0
";AEC;
11340 GOTO 11400
11350 AEC = GAS * 8.34 * 60 / BTU / .7 * HOTSUM * 365
11360 LPRINT USING "Your annual gas cost to heat your water is $###.#0 ";AEC;
11370 GOTO 11400
11380 AEC = LP * 8.34 * 60 / BTU / .7 * HOTSUM * 365
11390 LPRINT USING " Your annual LP cost to heat your water is $###.#0 ";AEC;
11400 IF SOURCE = 3 THEN 11410 ELSE 11430
11410 LPRINT "and the annual cost"
11420 LPRINT USING "to pump your water is $##."; APC : GOTO 11520
```

Listing of Residential Water Conservation Program (continued).

```
11430 IF METER = 2 THEN LPRINT "." : GOTO 11520
11440 IF UNITS = 1 THEN TOTWATER = SUM / 1000 ELSE TOTWATER = SUM / 748
11450 IF SOURCE = 1 THEN FF = 1.3 : GOTO 11500
11460 IF SOURCE = 2 THEN FF = 1.5 : GOTO 11500
11470 '
11480 ' FF = Fudge Factor, used to increase WCOST to cover service charges.
11490 '
11500 LPRINT "and your annual water"
11510 LPRINT USING "cost is $### per year."; TOTWATER * 365 * WCOST * FF
11520 LPRINT
11530 '
11540 '            = = =  PRINTED SUGGESTIONS SECTION  = = =
11550 '
11560 LPRINT "BELOW ARE SOME INSTRUCTIONS THAT MAY HELP YOU CONSERVE ON WATER."
11570 LPRINT
11580 LPRINT CHR$(27);CHR$(37);CHR$(67);"160";
11590 LPRINT CHR$(28);
11600 IF TUBCOUNT = 1 THEN LPRINT TUB1$ ELSE 11650
11610 IF FRC = 1 THEN 11640
11620 LPRINT USING TUB2$; TUBCDC, TUBHDC : LPRINT : NOTWISE = 1
11630 GOTO 11650
11640 LPRINT USING TUB2$; TUBHDC : LPRINT : NOTWISE = 1
11650 IF SHOWERCOUNT = 1 THEN LPRINT USING SHOWER1$; SHOWER, SHOWER*4, SHOWER*4-
SHOWER*4*.67, SHOWER*4*.67 ELSE 11710
11660 LPRINT SHOWER2$
11670 IF FRC = 1 THEN 11700
11680 LPRINT USING SHOWER3$; SHOWERCDC, SHOWERHDC : LPRINT : NOTWISE = 1
11690 GOTO 11710
11700 LPRINT USING SHOWER3$; SHOWERHDC : LPRINT : NOTWISE = 1
11710 IF SHAVECOUNT = 1 THEN LPRINT SHAVE1$ ELSE 11760
11720 IF FRC = 1 OR SOURCE = 3 THEN 11750
11730 LPRINT USING SHAVE2$; SHAVECDC, SHAVEHDC : LPRINT : NOTWISE = 1
11740 GOTO 11760
11750 LPRINT USING SHAVE2$; SHAVEHDC : LPRINT : NOTWISE = 1
11760 IF TEETHCOUNT = 1 THEN LPRINT TEETH1$ ELSE 11790
11770 IF FRC = 1 OR SOURCE = 3 THEN LPRINT : NOTWISE = 1 : GOTO 11790
11780 LPRINT USING TEETH2$; TEETHCDC : LPRINT : NOTWISE = 1
11790 IF HANDSCOUNT = 1 THEN LPRINT HANDS1$ ELSE 11840
11800 IF FRC = 1 OR SOURCE = 3 THEN 11830
11810 LPRINT USING HANDS2$; HANDSCDC, HANDSHDC : LPRINT : NOTWISE = 1
11820 GOTO 11840
11830 LPRINT USING HANDS2$; HANDSHDC : LPRINT : NOTWISE = 1
11840 IF DISHCOUNT = 1 THEN LPRINT FULLDISH1$ ELSE 11890
11850 IF FRC = 1 THEN 11880
11860 LPRINT USING FULLDISH2$; DISHCDC, DISHHDC : LPRINT : NOTWISE = 1
11870 GOTO 11890
11880 LPRINT USING FULLDISH2$; DISHHDC : LPRINT : NOTWISE = 1
11890 IF RINSECOUNT = 1 THEN LPRINT RINSE1$ ELSE 11940
11900 IF FRC = 1 OR SOURCE = 3 THEN 11930
11910 LPRINT USING RINSE2$; RINSECDC, RINSEHDC : LPRINT : NOTWISE = 1
```

Listing of Residential Water Conservation Program (continued).

```
11920 GOTO 11940
11930 LPRINT USING RINSE2$; RINSEHDC : LPRINT : NOTWISE = 1
11940 IF DRINK = 1 OR DRINK = 2 THEN LPRINT DRINK$ : LPRINT : NOTWISE = 1
11950 IF CLOTHESCOUNT = 1 THEN LPRINT CLOTHES1$ ELSE 12000
11960 IF FRC = 1 THEN 11990
11970 LPRINT USING CLOTHES2$; CLOTHESCDC, CLOTHESHDC : LPRINT : NOTWISE = 1
11980 GOTO 12000
11990 LPRINT USING CLOTHES2$; CLOTHESHDC : LPRINT : NOTWISE = 1
12000 IF NOTWISE = 0 THEN 12300
12010 IF FRC = 1 THEN 12070
12020 IF UNITS = 2 THEN 12050
12030 WATER = SUMDIFF * 365 / 1000
12040 GOTO 12060
12050 WATER = SUMDIFF * 365 / 748
12060 WC = WATER * WCOST
12070 HWC = AEC / HOTSUM * HOTDIFF
12080 IF FRC = 1 THEN 12140
12090 IF SOURCE = 3 THEN 12190
12100 FOR I = 1 TO 80 : LPRINT "="; : NEXT I
12110 LPRINT USING "If you would follow the instructions above you could save
approximately $###  per year on your water bill, and $### per year on energy
used to heat your   water."; WC; HWC
12120 FOR I = 1 TO 80 : LPRINT "="; : NEXT I
12130 GOTO 12330
12140 FOR I = 1 TO 80 : LPRINT "="; : NEXT I
12150 LPRINT USING "Since you are charged a flat rate for your water, there is
no incentive to savewater in your  community.  But if you would follow the
instructions given  above,you could save approximately $### per year on energy
uaed to ";HWC;
12160 LPRINT "heat your water."
12170 FOR I = 1 TO 80 : LPRINT "="; : NEXT I
12180 GOTO 12330
12190 DAPC = APC / SUM * SUMDIFF
12200 FOR I = 1 TO 80 : LPRINT "="; : NEXT I
12210 LPRINT USING "If you would follow the instructions above, you could save
about $# per year onyour pumping cost, and $### per year on the energy used to
heat your hot water."; DAPC; HWC
12220 IF SOFTENER = 2 THEN 12280
12230 CD = REGENDAY : GOSUB 12570
12240 REGENCOST = CWCDIFF
12250 LPRINT USING "Since you have a water softener, it is estimated that you
spend $### per year on salt for regeneration of your softener.  This is based on
salt costing $5.00  per 100 pounds.  It is also estimated that you spend $#
";SALT, REGENCOST;
12260 LPRINT "for water used during"
12270 LPRINT "regeneration.  If these costs seem high, you should analyze your
water habits  to try to reduce this cost."
12280 FOR I = 1 TO 80 : LPRINT "="; : NEXT I
12290 GOTO 12330
12300 FOR I = 1 TO 80 : LPRINT "="; : NEXT I
```

Listing of Residential Water Conservation Program (continued).

```
12310 LPRINT USING "You are a wise water user &, and I would like to
congratulate you."; NNAME$
12320 FOR I = 1 TO 80 : LPRINT "="; : NEXT I
12330 LPRINT CHR$(12);
12340 LPRINT CHR$(27); CHR$(37); CHR$(67); "001"; CHR$(30);
12350 PRINT : PRINT
12360 '
12370 PRINT "Do you want to run the program again?"
12380 PRINT "     [1]  Yes"
12390 INPUT "     [2]  No                    Answer = "; ANS$
12400 IF VAL(ANS$) = 1 OR ANS$ = "Y" OR ANS$ = "y" THEN CLS : GOTO 2140
12410 IF VAL(ANS$) = 2 OR ANS$ = "N" OR ANS$ = "n" THEN RUN
12420 PRINT : COLOR 7,1
12430 PRINT " Enter either a 1 or 2....  Try again. ";
12440 COLOR 7,0 : PRINT : PRINT : GOTO 12370
12450 '
12460 '*************************************************************************
12470 '                        * * *  SUBROUTINES  * * *
12480 '*************************************************************************
12490 '
12500 IF HEAT = 1 THEN EFF = .9 ELSE EFF = .7
12510 HWCDIFF = ENERGYCOST * 8.34 * 60 / BTU / EFF * HD * 365
12520 IF SOURCE = 3 THEN 12570
12530 IF UNITS = 1 THEN 12540 ELSE 12550
12540 CWCDIFF = CD * WCOST / 1000 * 365 : GOTO 12560
12550 CWCDIFF = CD * WCOST / 748 * 365
12560 RETURN
12570 P = (62.4 * CD * 365 / 7.48 * (1.1 * DEPTH + 144 * 40 / 62.4)) / .25
12580 CWCDIFF = P * 3.766E-07 * KWAT
12590 RETURN
12600 IF HEAT = 1 THEN EFF = .9 ELSE EFF = .7
12610 HOTCOST = ENERGYCOST * 8.34 * 60 / BTU / EFF * HOT
12620 RETURN
12630 '
12640 '*************************************************************************
12650 '                      * * *  ERROR STATEMENT  * * *
12660 '*************************************************************************
12670 '
12680 CLS : LOCATE 12,1 : COLOR 4,0
12690 PRINT USING "I'm sorry, but an error has been detected in this program.
It is error number ###.  Please note the error number.  If you want to try
again, then type   the word RUN and press the RETURN key."; ERR
12700 COLOR 7,0 : END
```

Appendix B

Glossary for the variables used in the Residential Water Conservation Program.

Table B.1 Glossary of the variables used in the Residential Water Conservation Program.

Variable Name	Definition
A$.....	Temporary storage for data file information.
AEC.....	Annual energy cost to heat the water.
AMT.....	Average amount of water used per day when washing clothes.
ANS$.....	Temporary storage for a response to a question.
APC.....	Annual pumping cost.
BS.....	Response to user taking either a bath or shower.
BTU.....	British Thermal Units for different types of HEAT.
CD.....	Subroutine dummy variable equal to cold water difference.
CITY$.....	Storage for citys name.
CLOTHES.....	Y/N response if user has a clothes washer.
CLOTHES1$.....	String variable.
CLOTHES2$.....	String variable.
CLOTHESCDC.....	Cold water cost difference for clothes washing.
CLOTHESCOLD....	Annual amount of water used in clothes washer.
CLOTHESCOUNT...	Conditional variable.
CLOTHESENERGY..	Annual cost to heat clothes washer water.
CLOTHESHDC.....	Hot water cost difference for clothes washing.
CLOTHESHOT.....	Annual amount of hot water used in clothes washer.
COUNTER.....	Counter variable.
COUNTY$.....	Stroage of county's name.
CWCDIFF.....	Potential cold water cost difference.
DAPC.....	Potential difference in annual pumping cost.
DEPTH$.....	User's private well depth.
DISH.....	Y/N response if user has a dishwasher.
DISHCDC.....	Dishwasher cold water cost difference.
DISHCOLD.....	Annual water amount used in dishwasher.
DISHCOUNT.....	Conditional variable.
DISHENERGY.....	Annual cost to heat dishwasher water.
DISHHDC.....	Dishwasher hot water cost difference.
DISHHOT.....	Annual water amount used in dishwasher.
DRINK$.....	String variable.
DRINK.....	Response to water habits employed while getting a drink.
DRINKCOLD.....	Annual amount of drinking water.
DTIM.....	Response about how often dishwasher is used daily.
EFF.....	Heating energy efficiency.

Table B.1 Continued.

Variable Name	Definition
ENERGYCOST.....	Storage for energy cost.
FC.....	Flat rate water cost.
FFN$.....	String storage for sequential data file name.
FL$.....	First letter for a community or county name.
FLAT$.....	Temporary storage for user's flat rate water fee.
FLUSH.....	Response to number time per day the user flushes the home toilet.
FLUSHCOLD.....	Annual water amount used to flush toilet.
FRC.....	Counter used if user is charged a flat fee for water.
FULLCLOTHES....	Response to water habits while washing clothes.
FULLDISH.....	Response to water habits employed when using dishwasher.
FULLDISH1$.....	String variable.
FULLDISH2$.....	String variable.
GAS$.....	Natural gas cost per 1000 cubic feet.
GAS.....	Natural gas cost per 1000 cubic feet.
HANDS.....	Response to water habits employed while washing the hands.
HANDS1$.....	String variable.
HANDS2$.....	String variable.
HANDSCDC.....	Cold water cost difference while washing the hands.
HANDSCOLD.....	Annual water amount used to wash hands.
HANDSCOUNT.....	Conditional variable.
HANDSENERGY....	Annual cost for heating the water used in washing hands.
HANDSHDC.....	Hot water cost difference while washing the hands.
HANDSHOT.....	Annual hot water amount used to wash hands.
HD.....	Subroutine dummy variable equal to hot water difference.
HEAT.....	Defines the type of energy used to heat water.
HOT.....	Subroutine dummy variable.
HOTCOST.....	Annual hot water energy cost used in subroutine.
HOTDIFF.....	Total summation of potential hot water savings.
HOTSUM.....	Total summation of hot water.
HWC.....	Potential annual hot water energy cost savings.
HWCDIFF.....	Potential hot water cost difference.
I.....	For-Next loop counter.
J.....	For-Next loop counter.
K%.....	Integer counter.
KWAT$.....	Electricity cost per kilowatt hour.

Table B.1 Continued.

Variable Name	Definition
KWAT.....	Electricity cost per kilowatt hour.
L.....	Counter variable.
LC.....	Response to the number of loads of clothes washed per week.
LP$.....	Liquid propane cost per gallon.
LP.....	Liquid propane cost per gallon.
MCU1.....	Marginal cost of water for UNITS = 1.
MCU2.....	Marginal cost of water for UNITS = 2.
METER.....	Y/N response if user's water is metered.
NNAME$.....	Program users name.
NUM.....	Array storage number.
P.....	Power required to lift one days supply of water from well to house.
POP$.....	String storage for population size.
POP.....	User's community population size.
REGEN.....	Number of days between regeneration of water softener.
REGENCOST.....	Annual cost of water used to regenerate water softener.
REGENDAY.....	Average amount of water used per day for regeneration of water softener.
RET$.....	Temporary storage for RETURN answer.
RINSE.....	Response to water habits employed when rinsing dishes by hand.
RINSE1$.....	String variable.
RINSE2$.....	String variable.
RINSECDC.....	Cold water difference for rinsing dishes.
RINSECOLD.....	Annual water amount used to rinse dishes by hand.
RINSECOUNT.....	Conditional variable.
RINSEENERGY....	Annual cost of heating dish rinsing water.
RINSEHDC.....	Hot water difference for rinsing dishes.
RINSEHOT.....	Annual hot water amount used to rinse dishes by hand.
RWDMWC.....	Rural water district marginal water cost.
RWDNO$.....	Storage for rural water districts number.
SALT.....	Annual salt cost for regeneration of water softener.
SEX.....	Used to ask shaving question is user is male.
SHAVE.....	Response to the type of water habits employed while shaving.
SHAVE1$.....	String variable.
SHAVE2$.....	String varialbe.
SHAVECDC.....	Shaving cold water cost difference.
SHAVECOLD.....	Annual water amount used to shave.
SHAVECOUNT.....	Conditional variable.

Table B.1 Continued.

Variable Name	Definition
SHAVEENERGY....	Annual cost for heating shaving water.
SHAVEHDC.....	Shaving hot water cost difference.
SHAVEHOT.....	Annual hot water amount used to shave.
SHOWER.....	Response to length of time spent in the shower.
SHOWER1$.....	String variable.
SHOWER2$.....	String variable.
SHOWER3$.....	String variable.
SHOWERCDC.....	Shower cold water cost difference.
SHOWERCOLD.....	Annual water amount used in shower.
SHOWERCOUNT....	Conditional variable.
SHOWERENERGY...	Annual cost for heating shower water.
SHOWERHDC.....	Shower hot water cost difference.
SHOWERHOT.....	Annual hot water amount used in shower.
SOFTENER.....	Y/N response if user has a water softener.
SOFTENERCOLD...	Annual water amount used in regenerating water softener.
SOURCE.....	User's water source.
SUM.....	Total summation of water.
SUMDIFF.....	Total summation of potential water savings.
TEETH.....	Response to water habits employed while brushing the teeth.
TEETH1$.....	String variable.
TEETH2$.....	String variable.
TEETHCDC.....	Cold water cost difference while brushing teeth.
TEETHCOLD.....	Annual water amount used to brush teeth.
TEETHCOUNT.....	Conditional varialble.
TUB.....	Response to water level in bath tub.
TUB1$.....	String variable.
TUB2$.....	String variable.
TUBCDC.....	Bath tub cold water cost difference.
TUBCOLD.....	Annual water amount used in bath tub.
TUBCOUNT.....	Conditional variable.
TUBENERGY.....	Annual cost for heating bath water.
TUBHDC.....	Bath tub hot water cost difference.
TUBHOT.....	Annual hot water amount used in bath tub.
UNIT$.....	String storage for water meter units.
UNITS.....	User's water billing units.
WATER.....	Potential annual water savings.
WC.....	Potential annual cold water cost savings.
WCOST$.....	Temporary storage for marginal water cost.
WCOST.....	Marginal water cost.

Appendix C

Municipal marginal water rates for Kansas cities and towns.

List of the municipal marginal water rates in 1983 for Kansas cities and towns [5].

Table C.1 Population over 100,000 people.

CITY	$/1000 gallons	$/100 ft^3
Kansas City	1.85	1.38
Topeka	1.07	0.80
Wichita	0.75	0.56

Table C.2 Population between 10,000 and 99,999 people.

CITY	$/1000 gallons	$/100 ft^3
Arkansas City	1.81	1.35
Atchison	1.10	0.82
Chanute	1.39	1.04
Coffeyville	2.30	1.72
Dodge City	1.50	1.12
El Dorado	0.86	0.65
Emporia	1.00	0.75
Garden City	0.70	0.52
Hays	0.90	0.67
Hutchinson	0.67	0.50
Independence	1.41	1.05
Junction City	0.91	0.68
Lawrence	1.81	1.35
Leavenworth	1.76	1.31
Liberal	0.70	0.52
Manhattan	0.80	0.60
McPherson	0.73	0.54
Olathe	2.81	2.10
Ottawa	1.18	0.88
Parsons	1.47	1.10
Pittsburg	2.27	1.70
Salina	1.30	0.97
Winfield	0.85	0.64

Table C.3 Population between 5,000 and 9,999 people.

CITY	$/1000 gallons	$/100 ft^3
Abilene	0.86	0.64
Augusta	1.20	0.90
Bonner Springs	2.20	1.65
Colby	0.58	0.43
Concordia	1.49	1.11
Fort Scott	1.74	1.30
Goodland	0.68	0.51
Haysville	1.25	0.94
Iola	1.44	1.08
Pratt	0.81	0.61
Russell	2.80	2.09
Wellington	2.00	1.50

Table C.4 Population between 1,000 and 4,999 people.

CITY	$/1000 gallons	$/100 ft^3
Anthony	0.95	0.71
Arma	2.10	1.57
Ashland	0.60	0.45
Atwood	0.50	0.37
Baldwin City	2.47	1.85
Baxter Springs	1.57	1.17
Bel Aire	1.00	0.75
Belle Plaine	1.00	0.75
Belleville	0.79	0.59
Beloit	0.95	0.71
Blue Rapids	0.59	0.44
Buhler	0.60	0.45
Burlingame	2.00	1.50
Burlington	1.05	0.79
Carbondale	1.50	1.12

Table C.4 Continued.

CITY	$/1000 gallons	$/100 ft^3
Chapman	2.00	1.50
Cheney	0.94	0.70
Cherryvale	1.00	0.75
Chetopa	1.56	1.17
Cimmarron	0.42	0.31
Clay Center	0.73	0.55
Clearwater	2.50	1.87
Conway Springs	0.99	0.74
Council Grove	1.32	0.99
De Soto	1.14	0.85
Dighton	0.72	0.54
Downs	0.42	0.31
Edgerton	3.30	2.47
Elkhart	0.65	0.49
Ellinwood	0.82	0.61
Ellis	1.00	0.75
Erie	0.80	0.60
Eudora	2.73	2.04
Eureka	2.50	1.87
Frankfort	1.00	0.75
Fredonia	2.71	2.03
Galena	1.00	0.75
Garnett	3.85	2.88
Girard	1.50	1.12
Goddard	0.70	0.52
Hesston	1.05	0.79
Hiawatha	1.20	0.90
Hill City	0.60	0.45
Hillsboro	2.85	2.13
Hoisington	1.10	0.82
Holton	1.63	1.22
Horton	2.40	1.80
Hoxie	0.50	0.37
Hugoton	0.44	0.33
Humboldt	1.60	1.20

Table C.4 Continued.

CITY	$/1000 gallons	$/100 ft^3
Johnson City	0.65	0.49
Kingman	1.00	0.75
Kinsley	0.55	0.41
Kiowa	2.00	1.50
LaCrosse	1.70	1.27
Grandview Plaza	0.69	0.51
Greensburg	0.55	0.41
Harper	0.80	0.60
Haven	0.34	0.25
Herington	1.36	1.02
LaCygne	1.05	0.79
Lakin	0.30	0.22
Larned	0.65	0.49
Leoti	0.30	0.22
Lincoln Center	0.67	0.50
Lindsborg	0.96	0.72
Louisburg	3.00	2.24
Lyndon	1.40	1.05
Lyons	0.52	0.39
Madison	1.25	0.94
Mankato	1.45	1.08
Marysville	1.27	0.95
Meade	1.40	1.05
Medicine Lodge	0.70	0.52
Minneapolis	1.00	0.75
Moundridge	0.80	0.60
Mulvane	1.25	0.94
Ness City	1.30	0.97
Nickerson	0.60	0.45
North Newton	1.00	0.75
Norton	0.48	0.36
Oakley	0.59	0.44
Oberlin	0.29	0.22

Table C.4 Continued.

CITY	$/1000 gallons	$/100 ft^3
Ogden	4.55	3.40
Osage City	1.23	0.92
Osawatomie	1.67	1.25
Osborne	0.40	0.30
Oskaloosa	2.00	1.50
Oswego	2.90	2.17
Paola	1.35	1.01
Park City	1.00	0.75
Peabody	1.34	1.00
Phillipsburg	1.50	1.12
Plains	0.70	0.52
Plainville	0.75	0.56
Pleasanton	1.80	1.35
Rose Hill	1.80	1.35
Rossville	0.90	0.67
Sabetha	1.80	1.35
Sedan	2.15	1.61
Sedgwick	0.80	0.60
Seneca	0.80	0.60
Silver Lake	1.55	1.16
Smith Center	1.26	0.94
Solomon	1.05	0.79
South Hutchinson	0.54	0.40
St. Marys	0.70	0.52
Stafford	1.00	0.75
Stockton	0.85	0.64
Syracuse	0.50	0.37
Tonganoxie	1.50	1.12
Towanda	2.20	1.65
Ulysses	0.70	0.52
Valley Falls	1.50	1.12
Victoria	0.95	0.71
WaKeeney	1.00	0.75
Wamego	0.80	0.60
Washington	0.50	0.37
Wathena	1.80	1.35
Wellsville	3.39	2.54
Yates Center	1.75	1.31

Table C.5 Population of 999 or less people.

CITY	$/1000 gallons	$/100 ft^3
Admire	3.50	2.62
Agenda	0.75	0.56
Agra	0.65	0.49
Allen	2.00	1.50
Alma	0.85	0.64
Alton	0.60	0.45
Altoona	1.75	1.31
Arcadia	2.90	2.17
Argonia	0.70	0.52
Arlington	0.40	0.30
Atlanta	1.85	1.38
Attica	1.00	0.75
Axtell	1.00	0.75
Bazine	1.10	0.82
Belpre	0.50	0.37
Belvue	1.00	0.75
Beverly	0.80	0.60
Bird City	0.55	0.41
Bison	0.70	0.52
Blue Mound	2.00	1.50
Bluff City	0.60	0.45
Bogue	0.50	0.37
Brewster	0.60	0.45
Brookville	1.00	0.75
Brownell	0.36	0.27
Buffalo	2.50	1.87
Burden	0.85	0.64
Burdett	0.44	0.33
Burns	1.25	0.94
Burrton	1.00	0.75
Bushton	0.44	0.33
Cassoday	2.00	1.50
Cawker City	0.66	0.49
Cedar Vale	2.00	1.50
Centralia	1.30	0.97

Table C.5 Continued.

CITY	$/1000 gallons	$/100 ft^3
Chase	0.48	0.36
Chautauqua	1.75	1.31
Circleville	1.00	0.75
Clayton	0.25	0.19
Clifton	0.35	0.26
Clyde	1.00	0.75
Collyer	0.52	0.39
Colony	2.00	1.50
Coolidge	0.50	0.37
Copeland	1.00	0.75
Corning	0.75	0.56
Cottonwood Falls	2.50	1.87
Courtland	1.00	0.75
Cunningham	0.50	0.37
Deerfield	0.60	0.45
Delphos	0.70	0.52
Denison	2.50	1.87
Dexter	1.25	0.94
Durham	1.00	0.75
Dwight	0.50	0.37
Easton	1.20	0.90
Elbing	1.40	1.05
Elgin	0.50	0.37
Elk City	1.80	1.35
Elmdale	1.00	0.75
Emmett	1.50	1.12
Esbon	2.00	1.50
Eskridge	1.25	0.94
Everest	1.50	1.12
Fall River	3.00	2.24
Florence	1.00	0.75
Fontana	2.00	1.50
Fowler	0.50	0.37
Galesburg	2.00	1.50
Galva	1.00	0.75

Table C.5 Continued.

CITY	$/1000 gallons	$/100 ft^3
Gas	1.74	1.30
Gaylord	0.91	0.68
Geneseo	1.00	0.75
Glade	0.75	0.56
Glen Elder	0.96	0.72
Goessel	0.43	0.32
Gorham	3.20	2.39
Gove	0.40	0.30
Grainfield	0.64	0.48
Grinnell	0.50	0.37
Gypsum	1.60	1.20
Haddam	1.50	1.12
Hanston	0.40	0.30
Hartford	2.00	1.50
Harveyville	2.00	1.50
Haviland	0.60	0.45
Herndon	0.36	0.27
Highland	1.50	1.12
Holcomb	0.69	0.52
Hollenberg	8.00	5.98
Hope	0.80	0.60
Horace	1.50	1.12
Howard	1.77	1.32
Hoyt	2.80	2.09
Hunter	2.00	1.50
Ingalls	1.00	0.75
Inman	0.75	0.56
Jamestown	2.00	1.50
Jennings	0.20	0.15
Kanopolis	0.85	0.64
Kanorado	0.32	0.24
Kechi	2.10	1.57
Kensington	1.70	1.27
Kirwin	0.50	0.37
Kismet	0.75	0.56

Table C.5 Continued.

CITY	$/1000 gallons	$/100 ft^3
Lancaster	1.50	1.12
LeRoy	2.00	1.50
Lebanon	2.00	1.50
Lebo	2.40	1.80
Lecompton	1.25	0.94
Lehigh	0.50	0.37
Lewis	0.50	0.37
Liebenthal	1.00	0.75
Linn	0.80	0.60
Little River	2.00	1.50
Long Island	0.75	0.56
Longford	0.44	0.33
Longton	1.20	0.90
Lorraine	1.00	0.75
Lucas	0.75	0.56
Luray	1.00	0.75
Manchester	1.50	1.12
Manter	1.00	0.75
Maple Hill	1.30	0.97
Matfield Green	2.50	1.87
Mayfield	2.24	1.68
McCune	3.00	2.24
McFarland	1.50	1.12
McLouth	2.80	2.09
Melvern	1.50	1.12
Milford	1.40	1.05
Miltonvale	1.00	0.75
Mineral	1.32	0.99
Moline	1.50	1.12
Montezuma	0.60	0.45
Morrowville	1.00	0.75
Mound City	3.30	2.47
Mount Hope	0.22	0.16
Munden	0.80	0.60
Narka	1.00	0.75

Table C.5 Continued.

CITY	$/1000 gallons	$/100 ft^3
Natoma	1.00	0.75
Netawaka	1.20	0.90
New Strawn	7.00	5.24
Norcatur	1.50	1.12
Nortonville	1.00	0.75
Norwich	0.75	0.56
Oketo	1.00	0.75
Olpe	1.75	1.31
Onaga	2.00	1.50
Oneida	0.80	0.60
Otis	0.50	0.37
Ozawkie	0.75	0.56
Palmer	0.90	0.67
Paradise	1.00	0.75
Park	0.35	0.26
Parker	1.00	0.75
Paxico	1.00	0.75
Peru	4.00	2.99
Pomona	1.25	0.94
Potwin	2.46	1.84
Powhattan	2.00	1.50
Prairie View	0.50	0.37
Pretty Prairie	1.14	0.85
Princeton	2.50	1.87
Protection	0.60	0.45
Quenemo	1.75	1.31
Quinter	0.50	0.37
Randolph	0.75	0.56
Ransom	0.90	0.67
Rantoul	2.00	1.50
Raymond	0.21	0.16
Riley	0.80	0.60
Sawyer	0.50	0.37
Scandia	0.28	0.21
Selden	0.75	0.56

Table C.5 Continued.

CITY	$/1000 gallons	$/100 ft^3
Severy	2.00	1.50
Sharon Springs	0.50	0.37
Soldier	1.30	0.97
South Haven	1.00	0.75
Spearville	0.40	0.30
St. George	0.55	0.41
Summerfield	0.75	0.56
Susank	1.50	1.12
Tescott	0.50	0.37
Thayer	3.50	2.62
Timken	0.80	0.60
Toronto	3.75	2.81
Tribune	1.43	1.07
Turon	0.50	0.37
Udall	1.80	1.35
Uniontown	4.35	3.25
Viola	2.70	2.02
Virgil	2.00	1.50
Wakefield	1.25	0.94
Wallace	0.90	0.67
Walnut	2.25	1.68
Walton	1.76	1.32
Waterville	0.30	0.22
Waverly	2.42	1.81
Westmoreland	2.00	1.50
Wetmore	14.40	10.77
White City	1.00	0.75
Whitewater	3.35	2.51
Whiting	0.75	0.56
Williamsburg	2.30	1.72
Windom	0.50	0.37
Winona	0.50	0.37
Woodston	0.80	0.60
Zenda	0.75	0.56

Table C.6 Kansas towns that charge their customers a flat rate for water.

City	Cost, $	Amount, gallons
Assaria	9.00	Unlimited
Barnes	6.00	Unlimited
Cullison	7.00	Unlimited
Dorrance	9.50	Unlimited
Effingham	10.00	Unlimited
Ford	7.00	Unlimited
Greenleaf	7.00	Unlimited
Ogden	4.50	Unlimited
Republic	7.50	Unlimited
Rolla	11.70	Unlimited
Scammon	7.25	Unlimited

Appendix D

Marginal water rates for Kansas Rural Water Districts.

Table D.1 Marginal water rates for Kansas Rural Water Districts that are named after the town they serve.

Town	$/1000 gallons
City of Beattie	1.25
City of Edgerton	3.30
City of Richmond	1.95
City of Scranton	5.00
City of Spring Hill	6.50

Table D.2 Marginal water rates for Kansas Rural Water Districts that are named after the county they serve.

County	RWD No.	$/1000 gallons
Allen	7	2.50
Allen	8	3.00
Allen	10	3.02
Anderson	2	1.50
Anderson	3	2.50
Anderson	4	2.52
Anderson	4A	3.50
Anderson	5	4.75
Atchison	2	1.32
Atchison	3	1.10
Atchison	4	2.50
Atchison	5	1.25
Atchison	6	1.30
Barber	1	1.14
Barber	2	2.00
Bourbon	C-2	2.20
Bourbon	4	2.75
Butler	1	1.70
Butler	3	3.00
Butler	5	2.25

Table D.2 Continued.

County	RWD No.	$/1000 gallons
Butler	6	2.50
Butler	7	2.00
Butler	8	1.50
Chase	1	2.00
Chautauqua	1	1.37
Cherokee	1	1.20
Cherokee	2	0.61
Cherokee	4	1.00
Cherokee	5	1.55
Cherokee	6	2.75
Clay	2	2.51
Cloud	1	2.20
Coffey	2	3.00
Coffey	3	3.00
Comanche	1	1.25
Comanche	2	3.00
Cowley	1	1.50
Cowley	2	1.25
Cowley	3	1.00
Cowley	4	1.70
Cowley	5	2.20
Crawford	4	0.90
Crawford	5	1.00
Crawford	6	2.02
Crawford	7	1.45
Crawford	8	1.80
Crawford-Chicopee		3.00
Dickenson	2	3.03
Douglas	1	2.55
Douglas	3	2.60
Douglas	4	1.60
Douglas	5	2.00
Douglas	6	2.25
Elk	1	3.80
Ellis	2	1.00

Table D.2 Continued.

County	RWD No.	$/1000 gallons
Ellis	3	0.50
Ellis	6	1.00
Ellis	7	3.00
Ellsworth	1	4.20
Franklin	1	3.79
Franklin	3	3.50
Franklin	4	1.75
Franklin	5	0.76
Greenwood	1	4.00
Greenwood	2	3.40
Harvey	1	1.80
Jackson	1	1.54
Jackson	2	2.25
Jefferson	1	1.76
Jefferson	2	0.72
Jefferson	3	1.50
Jefferson	6	1.50
Jefferson	9	3.03
Jefferson	11	2.00
Jefferson	12	2.02
Jewell	1	1.25
Johnson	1	2.75
Johnson	3	2.20
Johnson	5	4.12
Johnson	6	3.50
Johnson	7	3.37
Kingman	1	3.00
Labette	1	4.75
Labette	2	4.04
Labette	3	4.55
Labette	4	3.30
Labette	6	1.78
Lane	1	1.03
Leavenworth	2	2.00
Leavenworth	5	2.00

Table D.2 Continued.

County	RWD No.	$/1000 gallons
Leavenworth	7	2.94
Leavenworth	8	2.85
Leavenworth	10	2.50
Linn	1	3.00
Lyon	1	2.50
Lyon	2	1.50
Lyon	3	2.50
Lyon	4	2.50
Lyon	5	1.60
Marion	1	1.25
Marion	4	2.00
Marshall	3	1.70
McPherson	1	1.15
McPherson	4	2.02
Miami	1	2.22
Miami	2	4.04
Mitchell	2	2.27
Mitchell	3	2.50
Montgomery	3	3.00
Montgomery	4	2.70
Montgomery	5	4.00
Montgomery	6	4.50
Montgomery	7	2.75
Montgomery	8	2.57
Montgomery	9	3.50
Montgomery	10	2.30
Montgomery	11	2.00
Montgomery	12	3.20
Nemaha	1	1.26
Nemaha	2	0.98
Nemaha	3	1.70
Neosho	5	4.50
Neosho	6	4.92
Neosho	7	1.71
Neosho	8	1.50

Table D.2 Continued.

County	RWD No.	$/1000 gallons
Neosho	9	2.07
Neosho	10	3.12
Neosho	12	2.26
Neosho-Allen	2	2.21
Neosho-Labette	4	2.76
Osage	2	2.33
Osage	3	2.00
Osage	5	2.75
Osage	6	3.05
Osage	8	3.50
Ottawa	2	2.30
Pottawatomie	1	1.00
Pottawatomie	3	1.70
Public Wholesale	6	3.25
Reno	1	1.25
Republic	1	1.12
Republic	2	1.08
Riley	1	2.00
Russell	3	1.90
Saline	1	2.00
Saline	2	1.20
Saline	4	1.26
Saline	5	2.00
Saline	6	1.70
Sedgwick	1	2.30
Sedgwick	2	2.50
Sedgwick	3	2.30
Shawnee	1	1.89
Shawnee	4	1.75
Shawnee	6	2.25
Shawnee	7	3.00
Shawnee	11	2.00
Sumner	2	2.81
Sumner-Cowely	4	3.20
Wabaunsee	1	5.00

Table D.2 Continued.

County	RWD No.	$/1000 gallons
Washington	1	1.60
Wilson	1	4.00
Wilson	9	5.00
Wilson	10	4.28
Wilson	11	3.50
Wilson	12	2.90
Wilson	13	4.20
Woodson	1	3.40
Wyandotte/Leavenworth	1	2.19

Appendix E

Statistical analysis program and graphs.

Fortran program listing which uses the USPRP subroutine in the IMSL program.

```
//*** PRINT  VM___
//*** VMMSG LOG PRINT IQL
//*** SERVICE *
//     EXEC      FORTVCLG
      INTEGER N, N1, N2, IDIST, IOPT, IER, I, L
      REAL X(25), WK(50)
C *** X = VECTOR OF LENGTH N2 - N1 + 1 CONTAINING THE DATA.
C ***
C *** N = NUMBER OF OBSERVATIONS.
C ***
      N = 25
C ***
C *** N1 = THE RANKED NUMBER OF THE SMALLEST OBSERVATION.
C ***
      N1 = 1
C ***
C *** N2 = THE RANKED NUMBER OF THE LARGEST OBSERVATION.
C ***
      N2 = N
C ***
C *** IDIST = PARAMETER TO INDICATE THE DIFFERENT DISTRIBUTIONS.
C ***     IDIST = 1, NORMAL DIST.
C ***       "   = 2, LOGNORMAL DIST.
C ***       "   = 3, HALF-NORMAL DIST.
C ***       "   = 4, EXPONENTIAL DIST.
C ***       "   = 5, WEIBULL DIST.
C ***       "   = 6, EXTREME VALUE DIST.
C ***
C *** IOPT = OPTION INDICATING THE NUMBER OF PRINTER COLUMNS.
C ***      IOPT = 0,  80 COLUMNS.
C ***       "   = 1, 129 COLUMNS.
C ***
      IOPT = 0
C ***
C *** WK = WORK VECTOR OF LENGTH 2N
C ***
C *** IER = ERROR PARAMETER (OUTPUT)
C ***       IER =  67, SOME DATA POINTS WERE DELETED BECAUSE THEY DIDN'T
C ***                  SATISFY THE DISTRIBUTION.
C ***        "  = 131, INDICATES THAT N1 OR N2 ARE SPECIFIED INCORRECTLY.
C ***        "  = 132, INDICATES THAT THE SAMPLE SIZE IS LESS THAN 2.
C ***        "  = 133, INDICATES THAT IDIST IS SPECIFIED INCORRECTLY.
C ***
      DO 200 I = 1, N
           READ(5,100) X(I)
100        FORMAT(F5.0)
200 CONTINUE
C ***
      DO 300 IDIST = 1, 6
           CALL USPRP (X, N, N1, N2, IDIST, IOPT, WK, IER)
```

Fortran program listing (continued)

```
300 CONTINUE
C ***
      STOP
      END
//LKED.SYSLIB   DD
//              DD
//              DD
//              DD DSN=SYS1.IMSL.SPFLIB,DISP=SHR
//GO.SYSIN      DD  *
23725
23725
26098
26567
26645
29383
29930
31599
32042
33033
33554
34466
37308
39837
41688
41975
43461
43644
45625
46981
47540
49730
50474
51648
58125
```

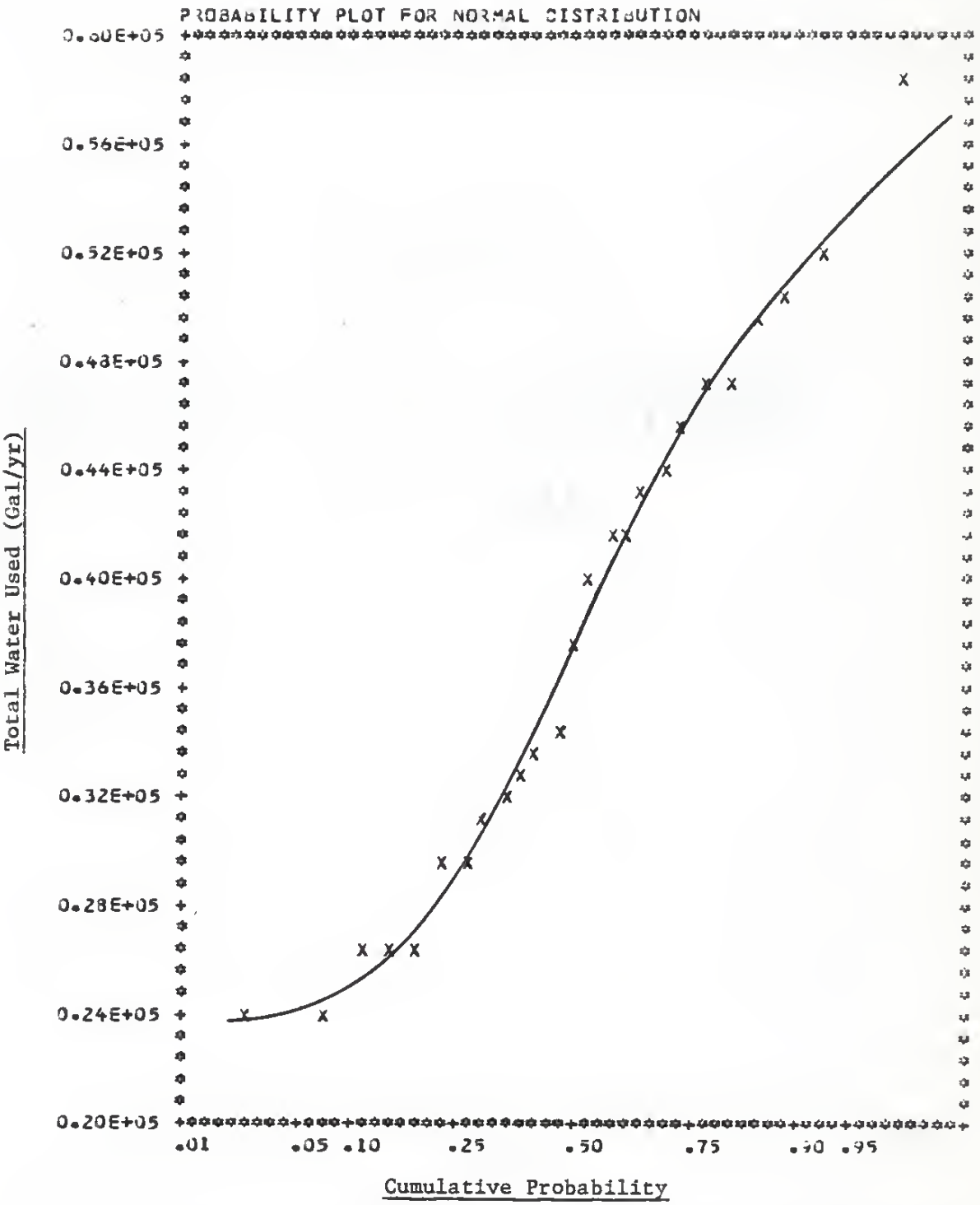


Figure E.1 Annual water usage sample tested against the normal distribution model using the USPRP subroutine in the IMSL fortran program. The sample was obtained from the 25 people who ran the Residential Water Conservation Program.

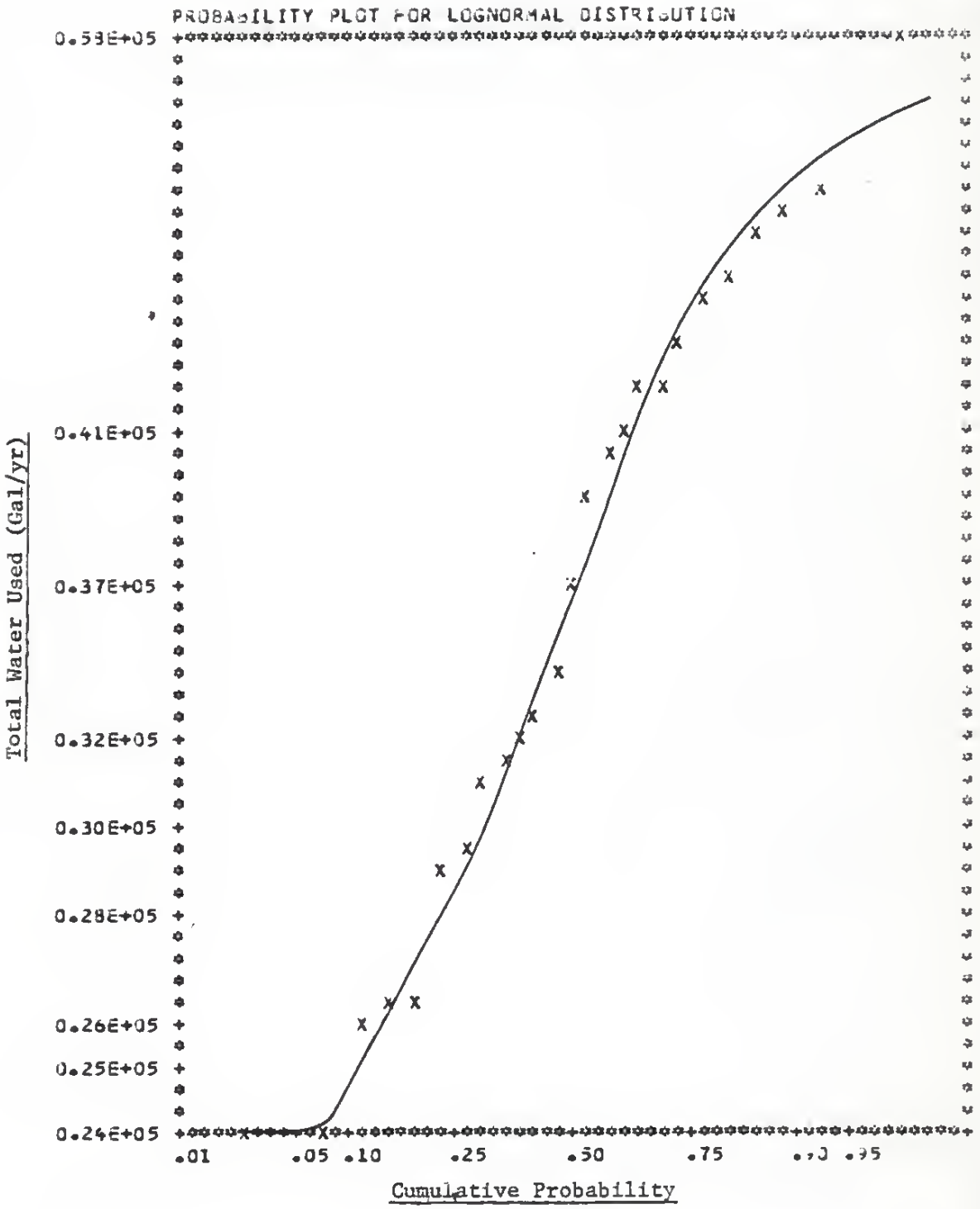


Figure E.2 Annual water usage sample tested against the lognormal distribution model using the USPRP subroutine in the IMSL fortran program. The sample was obtained from the 25 people who ran the Residential Water Conservation Program.

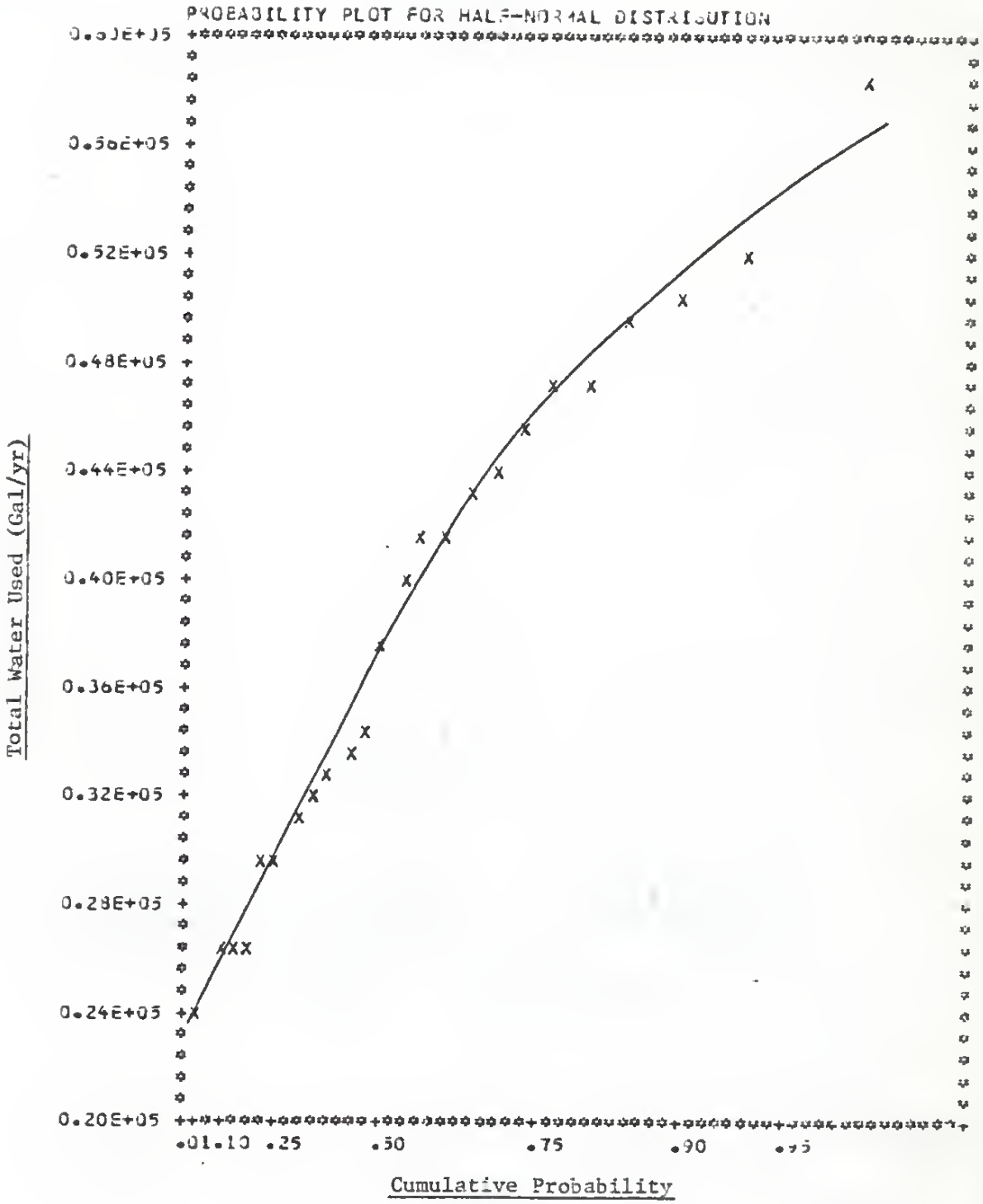


Figure E.3 Annual water usage sample tested against the half-normal distribution model using the USPRP subroutine in the IMSL fortran program. The sample was obtained from the 25 people who ran the Residential Water Conservation Program.

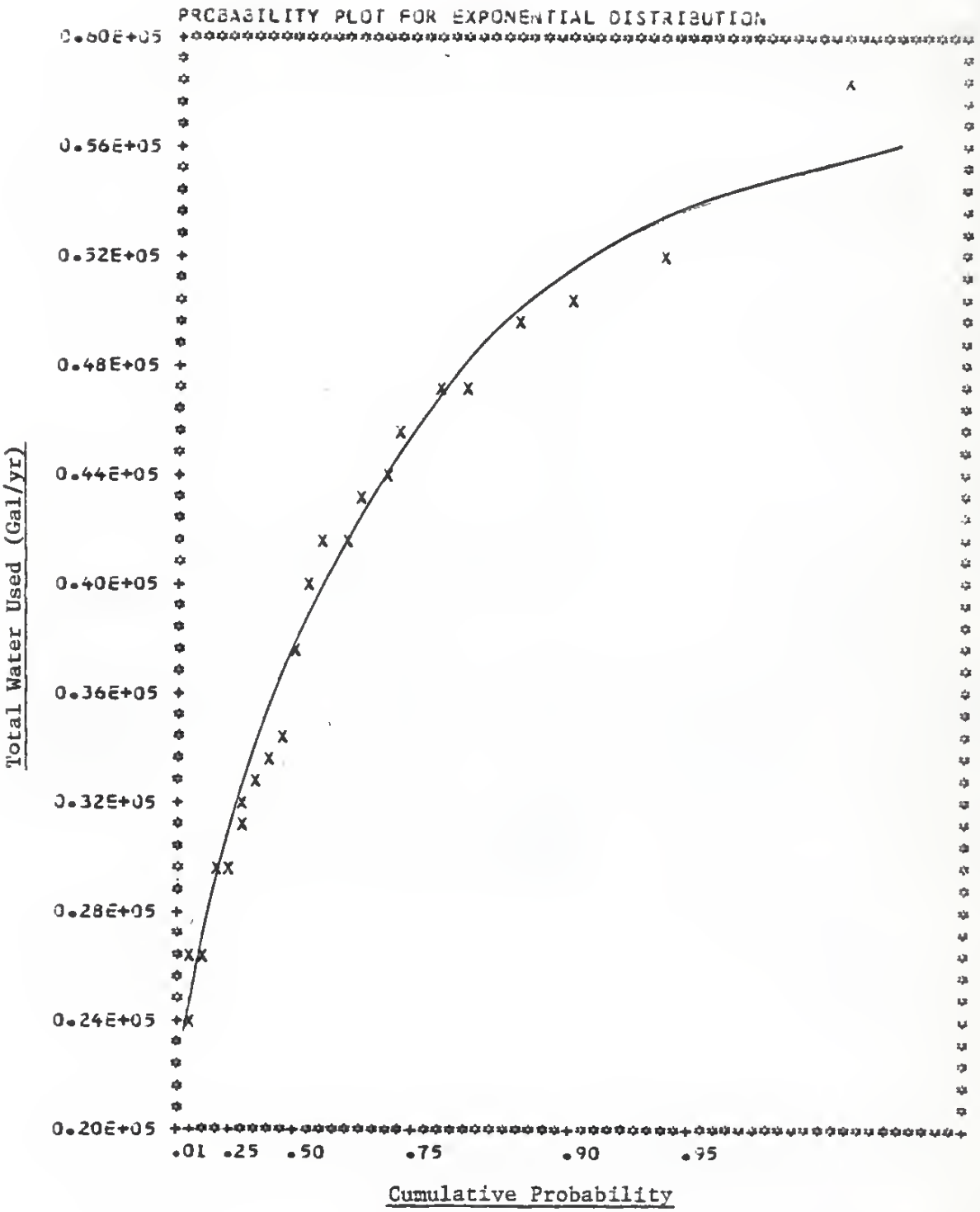


Figure E.4 Annual water usage sample tested against the exponential distribution model using the USPRP subroutine in the IMSL fortran program. The sample was obtained from the 25 people who ran the Residential Water Conservation Program.

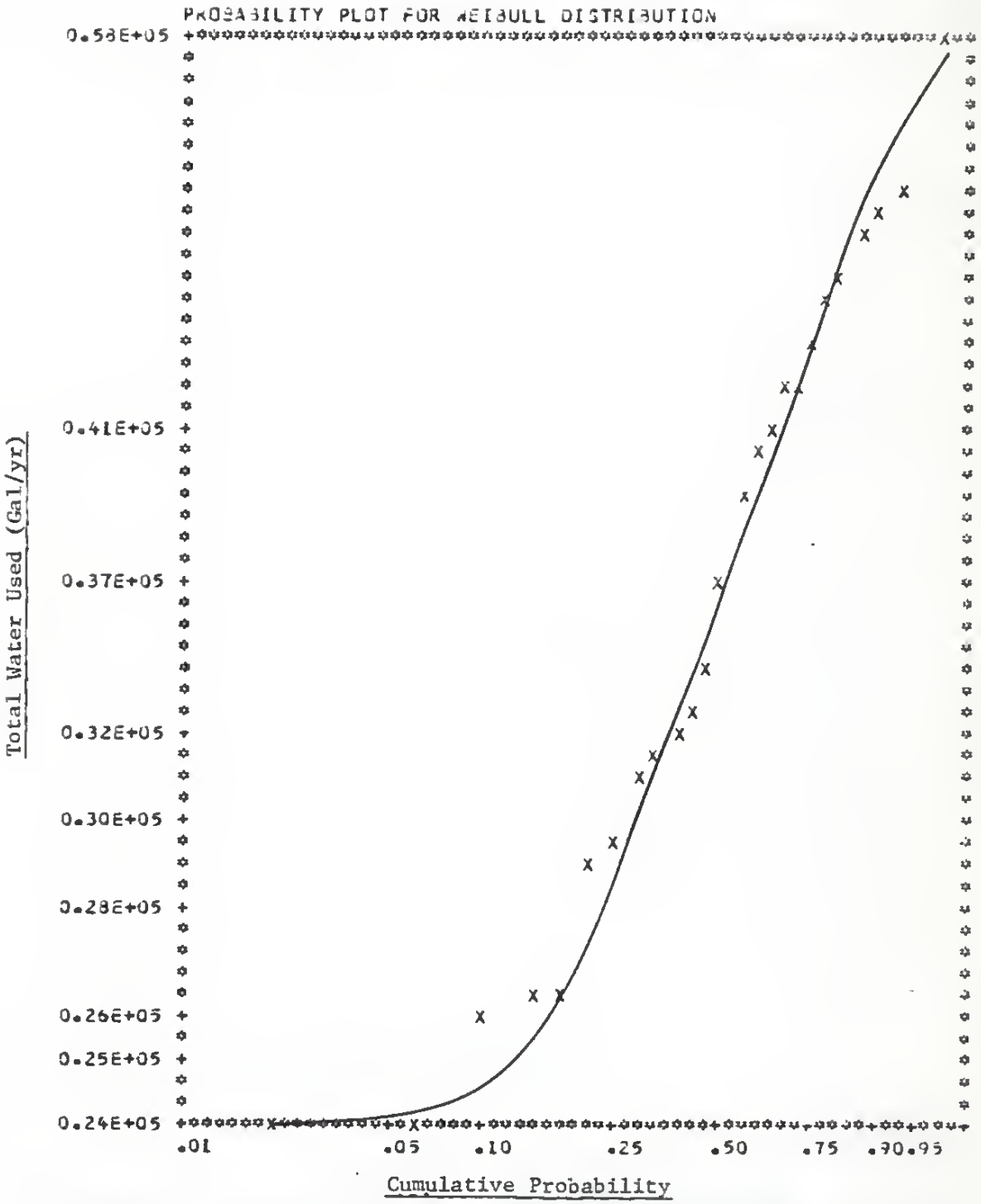


Figure E.5 Annual water usage sample tested against the Weibull distribution model using the USPRP subroutine in the IMSL fortran program. The sample was obtained from the 25 people who ran the Residential Water Conservation Program.

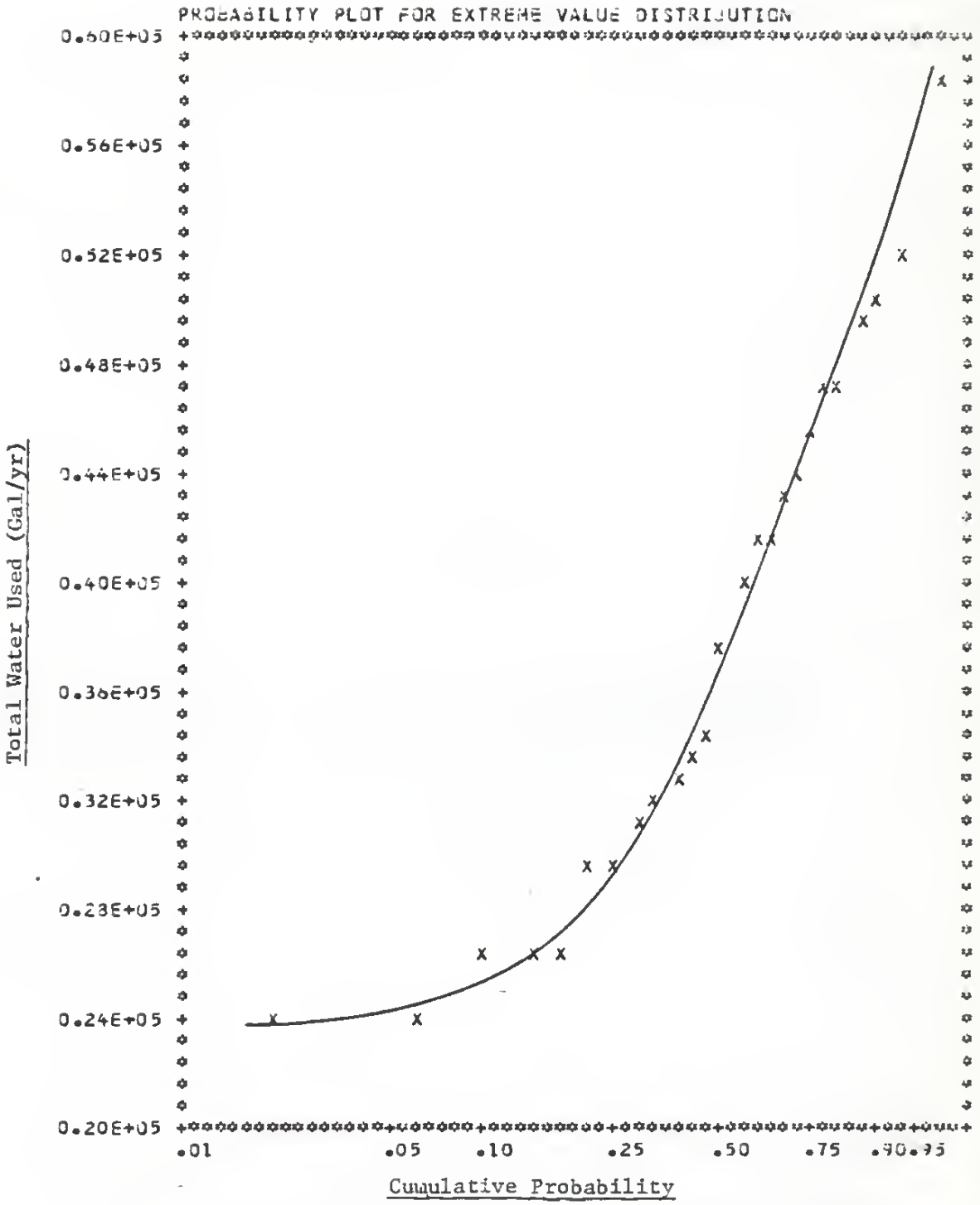


Figure E.6 Annual water usage sample tested against the extreme value distribution model using the USPRP suboroutine in the IMSL fortran program. The sample was obtained from the 25 people who ran the Residential Water Conservation Program.

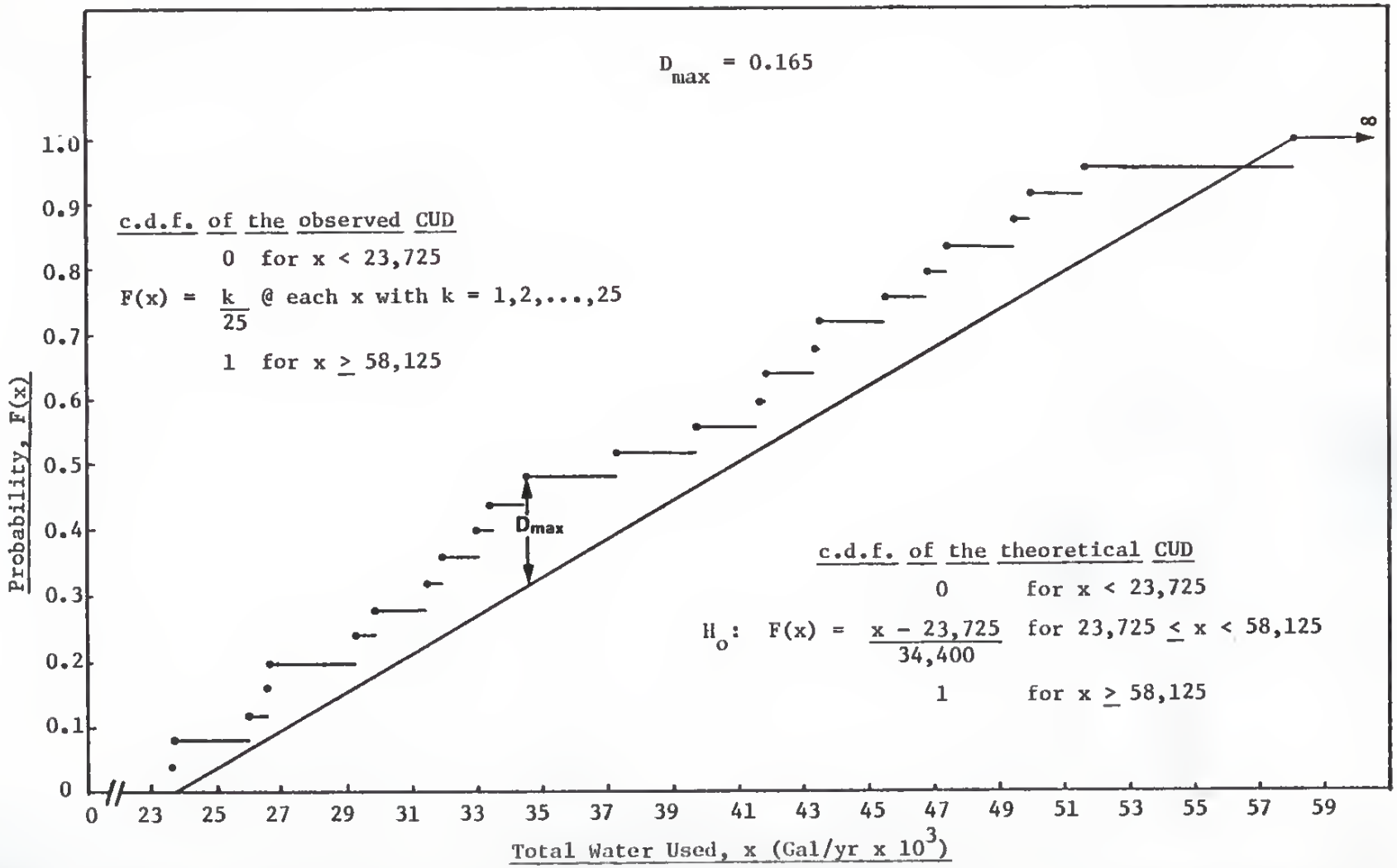


Figure E.7 Comparison of the cummulative distribution function (c.d.f.) between the observed and theoretical continuous uniform distribution (CUD). The plot was used in the Kolmogorv-Smirnov one-sample test for goodness of fit.

References Cited

1. Kansas Water Office, Kansas Water Plan (Final Draft), January 1985.

2. Bringham, A. P., "A Public Education Campaign to Conserve Water," Journal of the American Water Works Association, Vol. 68, No. 12, pp. 665-668, December 1976.

3. Morgan, W. D. and Pelosi, P., "The Effects of Water Conservation Kits on Water Use," Journal of the American Water Works Association, Vol. 72, No. 3, pp. 131-133, March 1980.

4. Sevebeck, K. P. and Walker, W. R., "Evaluating the Effectiveness of Promoting Residential Water Conservation through Exhibits," Virginia Water Resources Center, Blacksburg, VA, August 1983. National Technical Information Service PB84-114056 5.

5. League of Kansas Municipalities, Municipal Utilities: Annual Report, June 1984.

6. Flack, J. E., "Residential Water Conservation," Journal of the Water Resources Planning and Management Division, American Society of Civil Engineers, Vol. 107, No. WR1, pp. 85-95, March 1981.

7. Hodgman, C. D., Handbook of Chemistry and Physics, 44th Ed. Cleveland: Chemical Rubber Publishing Co.: pp. 1938 & 3305, 1962.

8. Hopp, W. J. and Darby, W. P., "In-Home Conservation and Wastewater Management," Journal of the Water Resources Planning and Management Divison, American Society of Civil Engineers, Vol. 107, No. WR2, pp. 401-418, October 1981.

9. Herman, P. F., Doodler: Z-DOS Software, Safety Harbor, FL, 1983.

10. International Mathematical and Statistical Library, Mainframe Computer System, Kansas State University, 1985.

11. Siegel, S., Nonparametric Statistics, McGraw-Hill Book Co.: pp.47-51, 1956.

RESIDENTIAL WATER CONSERVATION COMPUTER PROGRAM

by

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AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

Residential water conaervation is becoming increaaingly important aa water demands and costs increaae, and existing supplies become lesa adequate. Conservation should be viewed aa an alternative to developing new water aupplies since water conaerved from existing suppliea can be made available to new users. The first step for a succeasful conservation program is educetion. Thus a microcomputer progrem was written that analyzes a person's water habits and gives him an economic incentive to aave water, using a printed copy of specific recommendations.

The user of the program entera his source of water, either municipal water plant, rural water district, or private well. If hia water source was one of the first two, then he is aaked to enter the unit price for his water, and if not known, then the computer aids him in determining his water cost, based on Kansas water rates. In the caae of the private well user, the program aaka him for the depth of his well, and the unit price for electricity--both are needed to calculate the coat to pump the water from the well to the home.

The user also enters into the program the type of energy uaed to heat the water, either electricity, natural gaa, or liquid propane. The unit oost of energy must also be supplied to calculate the cost to heat the water. If the uaer does not know the unit coat of energy, then the program uses default values.

The program then asks the user aome queationa about how he uses water at home, and finally supplies printed output on the printer. This output explains ways the user might be able to aave both water and money by conaerving water. The auggestions printed on the output are baaed upon

baseline values which reflect the use of water by the average American. A descriptive example is shown which reflects the water uses of the author.

Twenty five people (students and faculity members at Kansas State Univeraity) ran the program to determine the program's integerity and to obtain a set of data that could be used to determine the potential water savings suggested by the program. The program estimated that 24 percent (227,700 gallons) of the total water used annually by the 25 individuals could be saved. A total of 32 percent of the hot water (130,500 gallons) was the estimated annual savings of the 25 individuals provided the program output suggestions were to be followed.

To follow up after educating the public about their own water habits, an educational program should be developed to instruct people of the phyaical ways to go about saving water. For example, instructions and detailed information about installation of displacement devices in toilet tanks, installing low flow shower heads, and faucet aerators should be made available.

A complete listing of the program, along with a glossary of the variables used in the program is provided in the appendices.